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, and 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 between the feeding and 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 2020

ICES notes fishing mortality (F) is estimated to be above F_{MSY} since 2014. Spawning-stock biomass (SSB) has been decreasing since 2018; however, it is estimated to remain above MSY $B_{trigger}$. Recruitment (R) from 2017 to 2020 is estimated to be low, following a three-year period of high recruitment. ICES advises that when the long-term management strategy agreed by the European Union, the Faroe Islands, Iceland, and Norway is applied, catches in 2021 should be no more than 929 292 tonnes.

2.2 The fishery in 2020

The total catch in 2020 was 1.495 million tonnes. 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 (85.5%) were taken in the first two quarters of the year and the largest part of this was taken along the slopes of the Western European shelf, in the Rockall Trough and in the deep trenches around the Faroes. Smaller quantities were taken in the southern part of the Norwegian Sea, in the Norwegian Trench and along the coast of Spain and Portugal. The fishery in the second half of the year was mainly east of the Faroes and in the central Norwegian Sea, with smaller amounts in the Norwegian Trench and along the coast of Portugal and Spain.

The multinational fleet targeting blue whiting in 2020 consisted of several types of vessels from 17 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 (ICES, 2016a), it was decided to use preliminary within year, quarter 1 and quarter 2, catch-at-age data in the assessment to get additional information to the within year IBWSS survey estimates. In recent years, between 85-90% of the annual catches of the age 3+ fish have been taken in the first half of the year, which makes it reasonable to estimate the total annual catch-at-age from reported first semester (Q1 & Q2) data and expected total catches for the remainder of the year. The catch data sections in this report contain a comprehensive description of the 2020 data as reported to ICES and a brief description of the 2021 preliminary catch data.

2.3.1 Officially reported catch data

Official catches in 2020 were estimated as 1 495 248 tonnes based on data provided by WGWIDE members (Table 2.3.1.1). Data provided as catch by rectangle represented 99% of the total WG catch in 2020.

In 2020, the majority of catches were caught on the spawning grounds with largest contribution from ICES area 27.7.c, 27.7.k, and 27.5.b, 27.6.a respectively (Figure 2.3.1.1; Tables 2.3.1.2, 2.3.1.3), and caught respectively in quarter 1 and quarter 2 (Figure 2.3.1.6). In the first two quarters, catches are taken over a broad area, with the highest catches respectively in 27.5.b, 27.6.a, 27.7.c and 27.7.k while later in the year catches are mainly taken further north in area 27.2.a and in the North Sea (27.4.a) (Figures 2.3.1.6 and 2.3.1.7 and Table 2.3.1.3).The spatial and temporal distribution of catches in 2020 are similar to previous years (Figures 2.3.1.2, 2.3.1.3, 2.3.1.4; Table 2.3.1.4). The majority of the blue whiting catch was caught by five nations - Norway, Faroe Islands, Iceland, and Russia, respectively (Figure 2.3.1.5).

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 targeting 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 provided by Portuguese vessels operating with bottom otter trawl within the Portuguese portions of ICES Division 27.9.a are 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 where it was significant (2004, 2006, 2010) ranged between 43% and 38% (in weight). In 2020, discards were 28% of the total catches for blue whiting along 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 the catch of the last day 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 4% (in weight) in 2020 (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 Denmark, Ireland, Portugal, Spain, Sweden, UK (England and Wales) and UK (Scotland) to the working group. The discards constituted 0.19% of the total catches, 2 828 tonnes. BMS landings were reported by UK (England and Wales), although no minimum conservation reference size is defined on blue whiting, those landings are related to fish that have not been sold at market but was landed, for example damaged fish, and it correspond to 8 tonnes in 2020. The largest fishing nations, Norway, Faroe Islands, Russia and Iceland do not provide discards information.

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 16% of the total catches of blue whiting in 2020.

2.3.1.1 Sampling intensity

In 2020, 81% of catches were covered by the sampling program. In 2020, 672 length samples, 580 age samples, were collected from the fisheries , and 89 110 fish were measured and 16 641 were aged. Sampling intensity for blue whiting with detailed information on catch, proportion of catch covered by sampling program, the number of samples, number of fish measured, and number of fish aged per year from 2000 to 2020 is given in Table 2.3.1.1.1. Sampling intensity per country, quarter and ICES division for 2020 is listed in Tables 2.3.1.1.2, 2.3.1.1.3 and 2.3.1.1.4. The most intensive sampling, considering the age samples and the number of aged fish, took place in areas 27.2.a, 27.5.b, 27.6.b, 27.7.b, 27.7.c, 27.7.k, 27.8.c and 27.9.a. No sampling was carried out by Greenland, Lithuania, Poland, Sweden and the UK (Northern Ireland) which combined represent 5% 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

As an example of an age-length key from sampled catches in 2020, data from ICES area 27.6.a 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 difference in mean length-at-age increases in older ages, higher than age 6.

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

2.3.2 Preliminary 2021 catch data (Quarters 1 and 2)

The preliminary catches for 2021 as reported by the WGWIDE members are presented in Table 2.3.2.1.

The spatial distribution of these 2021 preliminary catches is similar to the distribution in 2020 with majority of catches taken in division 27.6.a, 27.5.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 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.

WGWIDE estimated the expected total catch for 2021 from the sum of declared national quotas, corrected for expected national uptake and transfer of these quotas (Table 2.3.2.3).

For the period 2016 to 2020, preliminary and final catch estimates are similar with maximum deviation in 2020 when the final catch was 21 % higher than the preliminary catch (Table 2.3.2.4). Age compositions (Figure 2.3.2.2) are also similar between preliminary and final catch data. There is no clear pattern in the deviations; it is both the catch at age for young and older fish that change between preliminary and final data.

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

2.3.3 Catch-at-age

Catch-at-age numbers from 1981 to 2021 are presented in Table 2.3.3.1 and catch proportions at age shown 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. More recently, the propagation of the large 2014 year class is also evident.

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 2010-2014 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 ages to the fisheries. With an assumed natural mortality (M=0.2), the assessment F around 0.4-0.5 fits well to the Z values estimated from the catch curves.

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 1981-2021 used in the stock assessment. Mean weight at ages 3-9 has generally decreased in the period 2010-2018, followed by an increase in the most recent years, for the most abundant ages in the catches.

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 the only survey used as input to the assessment model.

The full time series of IBWSS was recalculated in summer 2020, using the same software (StoX; Johnsen *et al*., 2019) and method as previously applied. The values are presented in Table 2.3.7.1.1 and Figure 2.3.7.1.1A

The survey time-series (2004-2021) show variable internal consistency ranging from 0.26 to 0.86 (Figure 2.3.7.1.1B) The overall internal consistency plot for age-disaggregated year classes was slightly reduced compared to last year. There is a high internal consistency for the younger ages (1-5 years) and older ages (7-9 years) with correlation between 0.70 and 0.86, but poor ($0.02 < r < 0.03$) between ages 5 to 8. This may indicate age readings problems for this group of ages.

The distribution of acoustic backscattering densities for blue whiting for the period 2018-2021 is shown in Figure 2.3.7.1.2. The abundance estimate of blue whiting for IBWSS are presented in Table 2.3.7.1.1.

Length and age distributions for the period 2017 to 2021 are given in Figure 2.3.7.1.3.

Survey indices, (ages 1-8 years 2004-2021) 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. The 1-group in this survey is defined 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 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. The 1-group in this survey is defined as equal or 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 WGWIDE 2015 to try to have one more time-series for blue whiting. Data for the survey are not used yet, due to the short time series.

2.4 Stock assessment

The IBWSS survey is the only survey used by the SAM assessment. The survey was cancelled in 2020 due to the COVID-19 pandemic, but conducted as planned in 2021.

The presented assessment in this report follows the recommendations from the Inter-Benchmark Protocol of Blue (ICES, 2016a) to use the SAM model. The configuration of the SAM model was kept unchanged in this year's assessment.

The time period for estimating recruitment for forecast, was changed from the full time series (minus terminal year) to the period since 1996 (minus terminal year).

2.4.1 2021 stock assessment

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 2.4.1.1) show a quite random distribution of residuals. There might be an indication of "years effect" (too low index) for the IBWSS 2015 observations which has also be seen in previous assessment.

The estimated parameters from the SAM model from this year's assessment and from previous years (retrospective analysis) are shown in Table 2.4.1.1. There are no abrupt changes in the estimated parameters over the time-series presented. The lowest observation noises, and thereby

the largest weight in the assessment model, have in all years been from catches at ages 3-8, which constitute the largest proportion of the catch.

The process error residuals ("Joint sample residuals") (Figure 2.4.1.2) are reasonable randomly distributed. Process noise SAM is implemented as a "process mortality, Z"; these deviations in mortalities are shown in Figure 2.4.1.3. The deviations in mortality (plus or minus mortality) seems fairly randomly distributed without very pronounced clusters as also seen in Figure 2.4.1.2).

The correlation matrix between ages for the catches and survey indices (Figure 2.4.1.4) shows 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 2.4.1.5 presents exploitation pattern for the whole time-series. There are no abrupt changes in the exploitation pattern from 2010 to 2021, even though the landings in 2011 were just 19% of the landings in 2010, which might have given a different fishing practice. The plateau in selection at age 6 and older seen since mid-2000s seems more realistic than the more linear selection estimated for the beginning of the time series. 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 2.4.1.1).

The retrospective analysis (Figure 2.4.1.6) shows a stable assessment for the last 5 years, previous years within 95% CI for the current assessment. Mohn's rho by year and as the average value over the last five years are presented in (Table 2.4.1.2). Even though the annual values might be high for recruitment (reflecting large changes from one year to the next) the average Mohn's rho is low for both recruitment, F and SSB, indicating no bias.

Stock summary results with added 95% confidence limits (Figure 2.4.1.7 and Table 2.4.1.5) show a decrease in fishing mortality in the period 2004—2011, followed by a steep increase in F up to 2015 after which F has fluctuated around 0.45. Recruitment was historically high in 2015, followed by a lower recruitment in 2016 and much lower recruitments in 2017-2019. The recruitment in most recent years is estimated higher. SSB has increased in the period 2010-2018, followed by a large reduction.

Comparison of the assessment made in 2020 and 2021 (Figure 2.4.1.8) shows that the uncertainties on F and SSB in the terminal year are higher in the assessment from last year, where the IBWSS survey was cancelled due to Covid-19. The uncertainties on the recruitment estimates in the terminal seem however slightly higher this year. Last year, there were only one (the catch) observation for age 1 in the terminal year, while both catch and survey observations are present in 2021. For age 1, the lowest observation variance (Table 2.4.1.1) is estimated for catch observation, so the 2020 situation with only one age 1 observation, seems (statistically) to produce a more certain recruitment estimate in the terminal year.

2.4.2 Alternative model runs

The assessment XSA and TISVPA models were run for a better screening of potential errors in input and for comparison with the SAM results. The three models gave a similar result (Figure 2.4.2.1), however with some differences in F in the terminal years. even though the absolute values differ between models. XSA estimates the highest F, TISVPA the lowest F and SAM estimates a value in between.

The working document WD11 "Blue whiting, an alternative assessment including more surveys" (Hølleland *et al*., 2021) was presented to the WGWIDE. The assessment is a SAM assessment, and made use of two (IESNS and IESSNS) additional survey data for blue whiting. The time

series for IESSNS is still short (6 years). The alternative assessment gave similar results for SSB and F as estimated by the presently used SAM (Figure 2.4.3.2). The estimated recruitment in 2021 was however larger in the alternative assessment, due to high abundance of age 1 in 2021 in both additional surveys.

2.5 Final assessment

Following the recommendations from Inter-Benchmark Protocol on Blue Whiting (ICES, 2016a) the SAM model is used for the final assessment. The model settings can be found in the Stock Annex.

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—2021, with catch data up to 2020 and preliminary catch data for the first semester (Q1 and Q2) of 2021 raised to expected annual catches, and survey data from March-April, 2004–2021. SSB 1st January in 2022 is estimated from survivors and estimated recruits (for 2021 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 2.4.1.3–2.4.1.4 and summarized in Table 2.4.1.5 and Figure 2.4.1.7. Residuals of the model fit are shown in Figures 2.4.1.1 and 2.4.1.2.

2.6 State of the Stock

Fishing pressure (2021) on the stock is above F_{MSY} and between F_{pa} and F_{lim}; spawning-stock size (2022) is above MSY $B_{trigger}$, B_{pa} and B_{lim}.

F has increased from a historic low at 0.052 in 2011 to around 0.45 since 2014. F has been above F_{MSY} and Fpa 0.32) since 2015. SSB increased from 2010 (2.69 million tonnes) to 2017 (6.06 million tonnes), followed by a decline to 3.40 million tonnes in 2022.

Recruitment (age 1 fish) was high in 2014-2016 followed by recruitments in the low end of the historical recruitments in the years 2017-2019. This is followed by a moderate increase in recruitment in 2020 and 2021. 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) (ICES, 2016a) 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 WGWIDE meeting 2017, WKBWMSE concluded to keep B_{lim} and B_{pa} unchanged but revised F_{lim}, F_{pa}, and F_{MSY}.

ICES made in 2021 the decision to use F_{p05} as the value for F_{pa}. F_{p05} was estimated by WKBWMSE (ICES 2016b), where it was concluded that the EQSIM simulations showed that $Fp_{0.05}$ (0.32) is less than the F_{MSY} in the constant F simulations, so F_{MSY} was set to this lower value.

The table below summarises 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 × σ), with σ = 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}	0.32	Fp05; the F that leads to SSB ≥ Blim with 95% probability	ICES (2016b) and WGWIDE 2021

2.8 Short-term forecast

2.8.1 Recruitment estimates

The benchmark WKPELA in February 2012 concluded that the available survey indices should be used in a qualitative way to estimate recruitment, rather than using them in a strict quantitative model framework. The WGWIDE has followed this recommendation and investigated several survey time-series indices with the potential to give quantitative or semi-quantitative information of blue whiting recruitment. The investigated survey series were standardized by dividing with their mean and are shown in Figure 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 (2020 year class) and the 2–group (2019 year class) indices from the survey in 2021 were above the median and below the median of the historical range, respectively.

The 1-group (2020 year class) and the 2–group (2019 year class) indices from The International Blue Whiting Spawning Stock Survey (IBWSS) was above the median in the time series (Table 2.3.7.1.1).

The Norwegian bottom-trawl survey in the Barents Sea (BS-NoRu-Q1(Btr)) in February-March 2021, showed that 1-group blue whiting was the third highest in the time series (Table 2.3.7.2.2). 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 2021 (2020 year class) from the Icelandic bottom-trawl survey showed an increase compared to 2020 and was the highest in the time-series.

The 1-group estimate in 2021 (2020 year class) from the Faroese Plateau spring bottom-trawl survey showed an increase compared to 2020 and was below the median in the time-series.

In conclusion, the indices from available survey time-series indicate that the 2019 year class is above the median it corresponds to the SAM assessment results. The 2020 year classes estimated from surveys are also above the median, which also is the result of the SAM assessment. It was therefore decided not to change the SAM estimate of the 2019 and 2020 year classes.

No information is available for the 2022 and 2023 year classes and the geometric mean of the time-series from 1996-2020) was used for these year classes (20.98 billion at age 1 in 2022) (Table 2.8.1.1). WGWIDE decided to change from using the geometric mean of the full time-series (1981–2020) to use a shorter time-series for the calculations. The motivation for this change was to use a more recent period, which is assumed to better reflect the environmental changes and more variable recruitment in general since 1996. The reasons to shorten the time-series were two-fold. Firstly, prior to 1995 only one time-series, the Barents Sea demersal trawl index, was available as a proxy for blue whiting recruitment. After 1995 several indices became available, beginning with the Faroese and Icelandic spring demersal surveys and later other proxies were included (Figure 2.8.1.1). Secondly, hydrographic time series in the northeast North Atlantic and Nordic Seas show that the freshening trend of the 1960s–1990s completely reversed in the upper ocean in the mid-1990s (Holliday *et al.*, 2008). Since the weakening of the subpolar gyre in the mid-1990s temperature and salinity have rapidly increased in the Atlantic inflow to the Rockall/Hatton Plateau region, apparently leading to changes in the recruitment levels of blue whiting in the following decades (Hátún *et al.*, 2009b, Payne *et al.*, 2012). Recent hydrographic observations indicate again a freshening occurred in the area after 2015 (González-Pola *et al.*, 2020).

2.8.2 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.

2.8.2.1 Input

Table 2.8.2.1.1 lists the input data for the short-term predictions. Mean weight at age in the stock and mean weight in the catch are the same, and are calculated as three year averages (2019—2021) 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 2020 and 2021 are assumed as estimated by the SAM model, as additional survey information was not conflicting this result. Recruitment in 2022 and 2023 are assumed as the long-term average from the period with both high and low recruitments (geometric mean of the time-series since 1996, minus the terminal year, 1996-2020).

As the assessment uses preliminary catches for 2021 an estimate of stock size exist for the 1st of January 2022. The normal use of an "intermediate year" calculation is not relevant in this case. F in the "intermediate year" (2021) is as calculated by the assessment model. Catches in 2021 is the (model input) preliminary catches. Intermediate year assumptions are summarised in Table 2.8.2.1.2.

2.8.2.2 Output

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

Following the ICES MSY framework or the target F from the LTMS implies fishing mortality to be at F_{MSY} = 0.32 which will give a TAC in 2022 at 752 736 tonnes. This corresponds to a 19.0 % reduction compared to the ICES advice last year, and 39.4% reduction compared to the preliminary estimate of catches in 2021.

The LTMS specifies a TAC constraint at +25 / -20 %. With at maximum decrease at 19% in catches in relation to the ICES advice last year (LTMS advice), the TAC constraint is not applied.

SSB in 2023 is predicted to increase by 19.1 % to 4052163 tonnes, if the advised catches are taken. The higher recruitment estimated for 2020 and 2021 contributes to this increase in SSB.

2.9 Comparison with previous assessment and forecast

Comparison of the final assessment results from the last 5 years shows a consistent assessment (Figure 2.9.1). Historic fishing mortalities and recruitments are estimated higher this year, but the differences between this year's and last year's assessment results are small.

2.10 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 2.4.1.7). The retrospective analysis (Figure 2.4.1.6), the comparison of SSB and F estimated by three different assessment programs TISVPA, XSA and SAM (Figure 2.4.3.1) and the comparison of the 2017-2021 assessments (Figure 2.9.1) suggest a consistent assessment.

There are several sources of uncertainty: age reading, stock identity, and survey indices. As there is only one survey (IBWSS) that covers the spawning stock, the quality of the survey influences the assessment result considerably. The 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, a biased survey indices will still give a biased stock estimate with the new SAM configuration. The estimated correlation for catch at age observations might correspond to the age reading discrepancy as also estimated from inter-calibration exercise.

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.

Exploratory assessments (XSA, TISVPA) using the same data as the default assessment gave similar results as the default run. Another SAM assessments with data from two additional surveys (IESNS and IESSNS) included, showed a higher recruitment in the terminal year, and estimates similar F and SSB.

The assessment uses data from one survey only, the International Blue Whiting Spawning Stock Survey, which was cancelled in 2020 due to the COVID-19 disruption, but continued in 2021. The lack of 2020 survey data seems not to increase the uncertainties of the assessment results this year, and the assessment results are consistent with the results from previous years.

2.11 Management considerations

The assessment estimates low 2016-2018 year classes and slightly higher 2019 and 2020 year classes. The large year 2014 and 2015 year classes have been reduced considerably through fishing and natural mortality and the will not contribute much to the catches in the coming years. The forecast predicts a 10-20% increase in SSB (compared to SSB in 2022) depending on the F in 2022. This increase is dependent on the year class strength of the 2019 and 2020 year classes, whereas the size of the 2021 and 2022 have a limited effect for SSB in 2023.

2.12 Ecosystem considerations

Blue whiting is one of the most abundant pelagic and mesopelagic fish stocks in the Northeast Atlantic, SSB estimated from 1.4 - 6.9 million ton during the period from 1981 to 2020 (ICES, 2020). The stock is widely distributed and highly migratory. It´s distribution range is approximately from latitude 30 °N to 80 °N and from the coast of Europe to Greenland, into Barents Sea and the Mediterranean Sea (Trenkel *et al*., 2014). Spawning is in the spring and mostly occurs on the shelf and banks west of Ireland and Scotland and major summer feeding area is in the Norwegian Sea. Blue whiting is most frequently observed at 100-600 m depth (Heino and Godo, 2002). Their most important prey is respectively euphausiids, amphipods and copepods (Pinnegar *et al*., 2015, Bachiller *et al*., 2016) and they are prey for piscivorous fish (Dolgov *et al*., 2010) and cetaceans (Hátún *et al*., 2009a). Large stock size suggests blue whiting is an important species in the pelagic and mesopelagic ecosystem of the NE Atlantic and it´s best documented ecosystem interactions are listed below:

(a) Stock productivity - recruitment: blue whiting population dynamic is driven by large annual variability in recruitment (at age 1 in the assessment model) which is not linked to spawning stock size (ICES, 2020). Changes in recruitment have been correlated to changes in the North Atlantic subpolar gyre between strong and weak states (Hátún *et al*., 2009a,b). Two hypotheses have been suggested to explain a mechanical relationship between low gyre index and high recruitment (Payne *et al*., 2012). One suggests changes in marine climate where weak gyre results in increased flow of warm subtropical waters and increased abundance of important prey for juvenile blue whiting on their nursing grounds west of Ireland and Scotland. The other suggests increasing predation of mackerel on blue whiting larvae during years of weak index, but neither has been proven right (Payne *et al*., 2012). Future benchmarks should explore options to include the subpolar gyre index in the assessment model forecast for recruitment.

(b) Changes in distribution: blue whiting spawning distribution varies between years. It has been linked to the North Atlantic subpolar gyre as a strong gyre, cold and fresh water masses on the Rockall Plateau, shrinks the spawning area compared to a weak gyre, increasing saline and warm waters at Rockall, which expands the spawning area northward and westward into Rockall Plateau (Hátún *et al.,* 2009a,b; Miesner and Payne, 2018). Salinity appears specifically to impact spawning location of blue whiting (Miesner and Payne, 2018). Future benchmarks should explore options to include information on spawning ground salinity in the assessment model forecast for recruitment.

(c) It is disputed if there are one or two blue whiting populations in the Northeast Atlantic (Keating *et al*., 2014; Pointin and Payne, 2014; ICES, 2016c; Mahé *et al*., 2016). Currently blue whiting is considered a single population for management purpose. Future benchmarks should explore the impact of single population assessment versus an assessment for two populations.

(d) Trophic interactions in the Norwegian Sea: it appears to be limited prey competition between blue whiting and the two other abundant pelagic species, Norwegian spring-spawning herring and Atlantic mackerel, as studies show limited dietary overlap between blue whiting and the two other species (Bachiller *et al*., 2016; Pinnegar *et al*., 2015). Limited prey competitions between blue whiting and mackerel can be explained by limited geographical overlap, mackerel mostly feed in the surface layer and blue whiting deeper in the water column (Utne *et al*., 2012). Where distribution of blue whiting and herring overlap (Utne *et al*., 2012) they appear to feed on different species, herring mainly feed on copepods and blue whiting mainly on euphausiids and amphipods, although juvenile blue whiting feed on copepods (Bachiller *et al*., 2016; Pinnegar et al., 2015). Given the current knowledge, future benchmarks do not need to consider prey competition between blue whiting and herring/mackerel, and therefore do not need to consider adding mackerel and NSS herring stock size to the blue whiting stock assessment model.

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

2.13 Regulations and their effects

There is a long-term management strategy agreed by the European Union, the Faroe Islands, Iceland and Norway. However there is no agreement between the Coastal States, i.e. EU, Norway, Iceland and the Faroe Island on the share of the blue whiting TAC. The catch advice does not take into account consistent deviations from the long-term management strategy as evident from the sum of unilateral quotas since 2018. During the evaluation of the management strategy (ICES, 2016b), the implementation error in the form of a consistent overshoot of the TAC was not included. Therefore, the current implementation of the long-term management strategy may no longer be precautionary. See section 1.8 for a comparison of historic advice, TAC and catch.

WGWIDE estimates the total expected catch for 2021 to be 1 242 727 tonnes, whereas ICES advised that when the long-term management strategy agreed by the European Union, the Faroe Islands, Iceland, and Norway is applied, catches in 2021 should be no more than 929 292 tonnes. This advice was followed by the Coastal States by setting a TAC at the ICES advice, however there was no agreement on the split of TAC between nations.

2.13.1 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 F_{MSY} (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.

The management strategy evaluation did not take into account consistent deviations from the long-term management strategy as evident from the sum of unilateral quotas in recent years. During the evaluation of the management strategy (ICES, 2016b), the implementation error in the form of a consistent overshoot of the TAC was not included. Therefore, the current implementation of the long-term management strategy may no longer be precautionary.

2.14 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 different areas. Although, is expected that on the next year data, those differences should be almost neglected, because an age reading workshop just took place in 2021 (WKARBLUE3) and an increase on age classification precision was achieved. The results from the age reading inter-calibration exercise, conducted previously to the WKARBLUE3, revealed

an increase on the age classifications precision between participants, with an overall of 70% of agreement on advanced readers. Although, there are still issues on ageing this species, and the main assumptions to overcome those felt in the expertise of the readers. The main issues are: otoliths from some areas revealed to be more difficult to read (*e.g.* 27.2.a, 27.5.b); the first ring identification; edge type interpretation and false or double rings identification. During the WKARBLUE3 objective and more clear guidelines had been constructed. Thus, the main goal during the WKARBLUE3 has been to increase the ageing precision and that was achieved. Nonetheless, in order to increase the accuracy on age classifications, age validation studies to clarify growth rings pattern interpretation must be conducted.

The age-error matrixes, by quarter and area, resulting from the inter-calibration exercise are now available and can be used to correct the catch-at-age and survey data used for assessment. Furthermore, the impact of these uncertainties on age reading on the stock assessment results will be investigated.

2.15 Deviations from stock annex caused by missing information from Covid-19 disruption.

The one and only survey used for the SAM assessment, the International Blue Whiting Spawning Stock Survey (IBWSS) was not conducted in 2020, but resumed in 2021. The stock assessment this year followed the approach outlined in the Stock Annex.

The uncertainties on F and SSB in the terminal year are estimated lower in this year's assessment compared to last year's assessment with no survey in the terminal year.

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2.17 Tables

Table 2.3.1.1. Blue whiting. ICES estimated catches (tonnes) by country for the period 1988–2020.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2003
Denmark	18 941	26 630	27 052	15 538	34 356	41 053	20 456	12 439	52 101	26 270	61 523	82 935
Estonia					6 156	1 033	4 342	7 754	10 982	5 678	6 320	
Faroe Islands	79 831	75 083	48 686	10 563	13 436	16 506	24 342	26 009	24 671	28 546	71 218	329 895
France		2 191				1 195		720	6 442	12 446	7 984	14 149
Germany	5 546	5 417	1 699	349	1 332	100	2	6 313	6 876	4 724	17 969	22 803
Iceland		4 977						369	302	10 464	68 681	501 493
Ireland	4 646	2 014			781		3	222	1 709	25 785	45 635	22 580
Japan					918	1 742	2 574					
Latvia					10 742	10 626	2 582					
Lithuania						2 046						
Netherlands	800	2 078	7 750	17 369	11 036	18 482	21 076	26 775	17 669	24 469	27 957	48 303
Norway	233 314	301 342	310 938	137 610	181 622	211 489	229 643	339 837	394 950	347 311	560 568	834 540
Poland	10											
Portugal	5 979	3 557	2 864	2 813	4 928	1 236	1 350	2 285	3 561	2 439	1 900	2 651
Spain	24 847	30 108	29 490	29 180	23 794	31 020	28 118	25 379	21 538	27 683	27 490	13 825
Sweden **	1 229	3 062	1 503	1 000	2 058	2 867	3 675	13 000	4 000	4 568	9 299	65 532
UK (England + Wales)***												
UK (Northern Ireland)												
UK (Scotland)	5 183	8 056	6 019	3 876	6 867	2 284	4 470	10 583	14 326	33 398	92 383	27 382
USSR / Russia *	177 521	162 932	125 609	151 226	177 000	139 000	116 781	107 220	86 855	118 656	130 042	355 319
Greenland**												
Unallocated												
TOTAL	557 847	627 447	561 610	369 524	475 026	480 679	459 414	578 905	645 982	672 437	1 128 969	2 321 406

* From 1992 only Russia.

** 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 1988–2020.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Denmark	89500	41450	54663	48659	18134	248	140	165	340	2167	35256	45178	39395	60868	87348	68716	58997
Estonia	*															0	
Faroe Islands	322322	266799	321013	317859	225003	58354	49979	16405	43290	85768	224700	282502	282416	356501	349838	336569	343372
France		8046	18009	16638	11723	8831	7839	4337	9799	8978	10410	9659	10345	13369	16784	16095	13769
Germany	15293	22823	36437	34404	25259	5044	9108	278	6239	11418	24487	24107	20025	45555	47708	38244	42362
Iceland	379643	265516	309508	236538	159307	120202	87942	5887	63056	104918	182879	214870	186914	228934	292944	268356	243725
Ireland	75393	73488	54910	31132	22852	8776	8324	1195	7557	13205	21466	24785	27657	43238	49903	38836	40135
Lithuania			4635	9812	5338						4717		1129	5300			9543
Netherlands	95311	147783	102711	79875	78684	35686	33762	4595	26526	51635	38524	56397	58148	81156	121864	75020	62309
Norway	957684	738490	642451	539587	418289	225995	194317	20539	118832	196246	399520	489439	310412	399363	438426	351429	354033
Poland														15889	12152	27185	47616
Portugal	3937	5190	5323	3897	4220	2043	1482	603	1955	2056	2150	2547	2586	2046	2497	3481	2819
Spain	15612	17643	15173	13557	14342	20637	12891	2416	6726	15274	32065	29206	31952	28920	24718	22782	23676
Sweden	19083	2960	101	464	4	3	50	1	4	199	2	32	42	90	16**	54	25
UK (England + Wales)	2593	7356	10035	12926	14147	6176	2475	27	1590	4100	11	131	1374+	3447	1864	4062	7458
UK (Northern Ireland)										1232	2205	1119			4508	2899	2958
UK (Scotland)	57028	104539	72106	43540	38150	173	5496	1331	6305	8166	24630	30508	37173	64724	66682	54040	41344
Russia	346762	332226	329100	236369	225163	149650	112553	45841	88303	120674	152256	185763	173655	188449	170892	188006	181496
Greenland										2133				20212	23333	19753	19611
Unallocated									3499								
TOTAL	2380161	2034309	1976176	1625255	1260615	641818	526357	103620	384021	628169	1155279	1396244	1181850	1558061	1711461	1515527	1495248

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

**** only landings (2018).**

+ data updated in 2018.

Table 2.3.1.2. Blue whiting. ICES estimated catches (tonnes) by country and ICES division for 2020.

ICES Division	Denmark	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Netherlands	Norway	Poland	Portugal	Russia	Spain	Sweden	UK (England + Wales)	UK (Northern Ireland)	UK (Scotland)	Total
27.2.a	52	32692	14	5085	375	13463	4	441	109	988	41		28458		1	216		2	**81941**
27.3.a	107									6					16				**130**
27.4																		47	**47**
27.4.a	160	19338	267	1731	1241	9687		1539	1211	26467	1357		1126		8			0	**64132**
27.4.b	10									8						0			**18**
27.5.a		1692				8451													**10143**
27.5.b	731	169885	965		13450	135617		2487	533	469	5787		73645						**403570**
27.6.a	25611	51894	9236	19913	2695	31548	10089	5076	32414	56541	26767		21744	147		7241	30	11787	**312732**
27.6.b	422	495	0		690	5723	1192		1284	9252			9572	9				563	**29201**
27.7.b	148		733	1			544		141					28				2779	**4373**
27.7.c	18716	26191	1446	15162		177	22195		18034	174868	10951		1066	440				20074	**309320**
27.7.e	0		0						0							2			**2**
27.7.g									0					2					**2**
27.7.h	0		27						38					9					**74**
27.7.j			0	16			955		99		22			160		0			**1252**
27.7.k	13041	41185	60		1160	39059	5156		8444	85434	2691		45885	74			2929	6092	**251208**
27.8.a			476				0		1					0					**477**
27.8.b			5	20										89		0			**114**
27.8.c												229		13963					**14192**
27.8.d			540	434															**974**
27.9.a												2590		8756					**11346**
Total	**58997**	**343372**	**13769**	**42362**	**19611**	**243725**	**40135**	**9543**	**62309**	**354033**	**47616**	**2819**	**181496**	**23676**	**25**	**7458**	**2958**	**41344**	**1495248**

.

Table 2.3.1.3. Blue whiting. ICES estimated catches (tonnes) by quarter and ICES division for 2020

ICES Division	Quarter 1	Quarter 2	Quarter 3	Quarter 4	2020*	Total
27.2.a	526	37015	24430	19971		81941
27.3.a		1	128	1		130
27.4					47	47
27.4.a	529	33299	19688	10616		64132
27.4.b	0	9	9	0		18
27.5.a	5		1391	8747		10143
27.5.b	27120	271893	254	104303		403570
27.6.a	36486	255516	7	20679	44	312732
27.6.b	21940	7163	13	7	79	29201
27.7.b	3093	1203	63	16		4373
27.7.c	262985	46265	34	37		309320
27.7.e	2	0		0		2
27.7.g			2	0		2
27.7.h			7	67		74
27.7.j	1	997	144	110		1252
27.7.k	251139			70		251208
27.8.a	4	1	1	471		477
27.8.b	6	39	18	51		114
27.8.c	2901	4737	4087	2467		14192
27.8.d	365	69		540		974
27.9.a	1355	3623	3136	3231		11346
Total	**608455**	**661830**	**53411**	**171382**	**170**	**1495248**

***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 1988–2020 by area.

Year	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
2019	68593	1271883	44856	1385333	130194	1515527
2020	**92084**	**1059197**	**64327**	**1215608**	**279640**	**1495248**

*** Official catches by area from Sweden are not included (2012); ~**

**** Official catches by area from Sweden and Greenland are not included (2013);**

***** Grand total includes only 1336 tonnes from UK(England + Wales) (2016 total catch from UK(England + Wales) = 1374 ton).**

Table 2.3.1.5. Blue whiting. ICES estimates (tonnes) of catches, landings and discards by country for 2020.

Country	Catches	Landings	Discards	% discards
Denmark	58997	58983	14	0.02
Faroe Islands	343372	343372		0.00
France	13769	13769		0.00
Germany	42362	42362		0.00
Greenland	19611	19611		0.00
Iceland	243725	243725		0.00
Ireland	40135	39180	955	2.38
Lithuania	9543	9543		0.00
Netherlands	62309	62309	0	0.00
Norway	354033	354033		0.00
Poland	47616	47615	1	0.00
Portugal	2819	2026	793	28.13
Russia	181496	181496		0.00
Spain	23676	22789	887	3.75
Sweden	25	25		0.00
UK (England+Wales)	7458	7450	8	0.11
UK(Northern Ireland)	2958	2958		0.00
UK(Scotland)	41344	41174	170	0.41
Total	**1495248**	**1492420**	**2828**	**0.19**

Table 2.3.1.6. Blue whiting. ICES estimated catches (tonnes) inside and outside NEAFC regulatory area for 2020 by country.

Country	Catches inside NEAFC RA	Catches outside NEAFC RA	Total catches
Denmark	5103	53895	58997
Faroe Islands	39850	303522	343372
France*	512	13257	13769
Germany	508	41854	42362
Greenland*	15326	4285	19611
Iceland	45792	197933	243725
Ireland	559	39576	40135
Lithuania*	2753	6790	9543
Netherlands	69	62240	62309
Norway*	58583	295450	354033
Poland	10	47605	47616
Portugal	0	2819	2819
Russia	77348	104148	181496
Spain	0	23676	23676
Sweden	0	25	25
UK (England+Wales)	0	7458	7458
UK(Northern Ireland)	0	2958	2958
UK(Scotland)	0	41343	41344
Total in 2020	**246412**	**1248836**	**1495248**

*** the values of catches inside/outside NEAFC RA have been estimated based on the ICES Preliminary Catch Statistics.**

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 2000-2020.

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
2019	1515527	84	1253	136604	17869
2020	**1495248**	**81**	**672**	**89110**	**16641**

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 2020.

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	58997	90	18	18	655	590	10	11
Faroe Islands	343372	96	25	25	2447	1908	6	7
France	13769	0	24	0	1619	0	0	118
Germany	42362	7	8	8	1704	755	18	40
Greenland	19611	0	0	0	0	0	0	0
Iceland	243725	95	99	99	7663	2438	10	31
Ireland	40135	91	38	18	6425	1807	45	160
Lithuania	9543	0	0	0	0	0	0	0
Netherlands	62309	90	47	47	10826	1108	18	174
Norway	354033	92	86	86	2484	2484	7	7
Poland	47616	0	0	0	0	0	0	0
Portugal	2819	92	19	19	1493	756	268	530
Russia	181496	79	120	120	38166	1598	9	210
Spain	23676	61	133	133	9913	2848	120	419
Sweden	25	0	0	0	0	0	0	0
UK (England+Wales)	7458	0	3	0	30	0	0	4
UK(Northern Ireland)	2958	0	0	0	0	0	0	0
UK(Scotland)	41344	49	52	7	5685	349	8	138
Total	**1495248**	**81**	**672**	**580**	**89110**	**16641**	**11**	**60**

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 2020.

Country	Catches (ton)	No. of Length Samples	No. of Length Measured	No. Age Readings
Denmark				
Quarter 1	33047	14	512	448
Quarter 2	25674	4	143	142
Quarter 3	199	0	0	0
Quarter 4	77	0	0	0
Total	**58997**	**18**	**655**	**590**
Faroe Islands				
Quarter 1	97687	10	904	749
Quarter 2	174380	10	1001	899
Quarter 3	9685	0	0	0
Quarter 4	61620	5	542	260
Total	**343372**	**25**	**2447**	**1908**
France				
Quarter 1	2314	8	599	0
Quarter 2	9734	0	0	0
Quarter 3	1	0	0	0
Quarter 4	1721	16	1020	0
Total	**13769**	**24**	**1619**	**0**
Germany				
Quarter 1	9987	0	0	0
Quarter 2	28510	2	473	272
Quarter 3	2948	6	1231	483
Quarter 4	917	0	0	0
Total	**42362**	**8**	**1704**	**755**
Greenland				
Quarter 1	2400	0	0	0
Quarter 2	12064	0	0	0
Quarter 3	25	0	0	0
Quarter 4	5122	0	0	0
Total	**19611**	**0**	**0**	**0**
Iceland				
Quarter 1	51297	22	1918	546
Quarter 2	134167	51	3867	1246
Quarter 3	1956	1	45	25
Quarter 4	56305	25	1833	621
Total	**243725**	**99**	**7663**	**2438**

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 2020.

Ireland	Catches (ton)	No. of Length Samples	No. of Length Measured	No. Age Readings
Quarter 1	28117	13	2972	1307
Quarter 2	12007	25	3453	500
Quarter 4	11	0	0	0
Total	**40135**	**38**	**6425**	**1807**
Lithuania				
Quarter 4	9543	0	0	0
Netherlands				
Quarter 1	13038	22	5122	525
Quarter 2	44286	25	5704	583
Quarter 3	116	0	0	0
Quarter 4	4869	0	0	0
Total	**62309**	**47**	**10826**	**1108**
Norway				
Quarter 1	252430	71	2040	2040
Quarter 2	77987	15	444	444
Quarter 3	19509	0	0	0
Quarter 4	4108	0	0	0
Total	**354033**	**86**	**2484**	**2484**
Poland				
Quarter 1	10456	0	0	0
Quarter 2	25052	0	0	0
Quarter 3	22	0	0	0
Quarter 4	12087	0	0	0
Total	**47616**	**0**	**0**	**0**
Portugal				
Quarter 1	678	8	548	204
Quarter 2	585	4	255	194
Quarter 3	831	3	384	236
Quarter 4	725	4	306	122
Total	**2819**	**19**	**1493**	**756**
Russia				
Quarter 1	65293	68	17888	928
Quarter 2	95733	37	11227	227
Quarter 3	11345	10	4618	295
Quarter 4	9125	5	4433	148
Total	**181496**	**120**	**38166**	**1598**

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 2020.

Spain	Catches (ton)	No. of Length Samples	No. of Length Measured	No. Age Readings
Quarter 1	3986	14	1165	100
Quarter 2	8006	30	1693	100
Quarter 3	6535	28	2380	1408
Quarter 4	5150	61	4675	1240
Total	**23676**	**133**	**9913**	**2848**
Sweden				
Quarter 3	24	0	0	0
Quarter 4	1	0	0	0
Total	**25**	**0**	**0**	**0**
UK (England)				
Quarter 1	202	3	30	0
Quarter 2	7040	0	0	0
Quarter 3	216	0	0	0
Quarter 4	0	0	0	0
Total	**7458**	**3**	**30**	**0**
UK(Northern Ireland)				
Quarter 1	2958	0	0	0
UK(Scotland)				
Quarter 1	34565	7	1488	349
Quarter 2	6606	0	0	0
Quarter 3	0	0	0	0
Quarter 4	2	0	0	0
2020*	170	45	4197	0
Total	**41344**	**52**	**5685**	**349**
Total Geral	**1495248**	**672**	**89110**	**16641**

*** 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 2020.

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	81941	32	32	11107	1309	16	136
27.3.a	130	0	0	0	0	0	0
27.4	47	30	0	845	0	0	18155
27.4.a	64132	5	5	431	192	3	7
27.4.b	18	0	0	0	0	0	0
27.5.a	10143	8	8	397	200	20	39
27.5.b	403570	113	108	19625	2397	6	49
27.6.a	312732	78	61	10562	2342	7	34
27.6.b	29201	31	26	7011	441	15	240
27.7.b	4373	0	0	0	0	0	0
27.7.c	309320	91	88	10376	3279	11	34
27.7.e	2	3	0	30	0	0	16379
27.7.g	2	0	0	0	0	0	0
27.7.h	74	0	0	0	0	0	0
27.7.j	1252	20	0	2228	0	0	1780
27.7.k	251208	98	98	14079	2605	10	56
27.8.a	477	5	0	300	0	0	629
27.8.b	114	0	0	0	0	0	0
27.8.c	14192	110	110	7818	1474	104	551
27.8.d	974	6	2	713	272	279	732
27.9.a	11346	42	42	3588	2130	188	316
TOTAL	**1495248**	**672**	**580**	**89110**	**16641**	**11**	**60**

Table 2.3.2.1. Blue whiting. ICES estimated preliminary landings (tonnes) in 2021 by quarter and ICES division. Data submitted to InterCatch.

	Landings		
ICES div.	**Quarter 1**	**Quarter 2**	**Total**
27.2.a	1096	52924	54020
27.3.a		1	1
27.4.a	1104	13715	14819
27.4.b		5	5
27.5.a	1		1
27.5.b	52948	216436	269384
27.6.a	74121	152749	226870
27.6.b	8755		8755
27.7	9		9
27.7.b	6427	65	6492
27.7.c	154051		154051
27.7.f	1		1
27.7.g	0		0
27.7.j	109		109
27.7.k	144221		144221
27.8.b		27	27
27.8.c	5078	7423	12502
27.9.a	303	350	653
Total	**448223**	**443695**	**891918**

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 2021 preliminary data (quarters 1 and 2). Data submitted to InterCatch.

ICES Division	Catch (ton)	No. samples	No. Measured	No. Aged
27.2.a	54020	1	95	95
27.3.a	1	0	0	0
27.4.a	14819	0	0	0
27.4.b	5	0	0	0
27.5.a	1	0	0	0
27.5.b	269384	49	8961	709
27.6.a	226870	89	14754	2443
27.6.b	8755	4	832	226
27.7	9	0	0	0
27.7.b	6492	2	508	102
27.7.c	154051	97	22447	2679
27.7.f	1	0	0	0
27.7.g	0	0	0	0
27.7.j	109	1	281	102
27.7.k	144221	52	9292	1045
27.8.b	27	0	0	0
27.8.c	12502	0	0	0
27.9.a	653	8	834	398
Total	**891918**	**303**	**58004**	**7799**

Table 2.3.2.3. Blue whiting. ICES estimates of catches (tonnes) in 2021, based on (initial) declared quotas and expected uptake estimated by WGWIDE.

Country	Quarter 1	Quarter 2	Prelim Q1-Q2 catch	Expected remaining catch	Total catch
Denmark	27702	10317	38019	13	38032
Faroe Islands	64194	124641	188835	141323	330158
France	237	12109	12346	0	12346
Germany	21899	11979	33878	2800	36678
Greenland					20207
Iceland	23124	128931	152055	31634	183689
Ireland	22817	16091	38908	0	38908
Lithuania	8682	0	8682	0	8682
Netherlands	33684	20912	54596	10600	65196
Norway	174903	41179	216082	24000	240000
Poland	12445		12445	16000	28445
Portugal	291	313	604	1396	2000
Russia	61551	72054	133605	20017	153622
Spain	5099	7487	12586		12586
UK(Scotland)	34198	30703	64901	0	72107
Sweden	0.112	0.004	0.116	70	70
Total	490826	476716	967542	247853	
Best estimate of catch for 2021					1242727

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	1515527	4.7
2020	1179029	1495248	21

*** (final-preliminary)/final*100**

Table 2.3.3.1. Blue whiting. Catch-at-age numbers (thousands) by year. Discards included since 2014. Values for 2021 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
2002	1821053	3232244	3291844	2242722	1824047	1647122	344403	168848	102576	142743

Year/Age	1	2	3	4	5	6	7	8	9	10+
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	249923	433573	1288871	3778379	5037323	1645999	431925	145916	50622	81357
2020	1135859	834162	1106838	1797157	3072708	3041983	923392	235330	80440	64535
2021	1349673	1259314	1517653	1602500	1600311	1668786	1562070	388584	96018	86107

Table 2.3.4.1. Blue whiting. Individual mean weight (kg) at age in the catch. Preliminary values for 2021.

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

Year /Age	1	2	3	4	5	6	7	8	9	10+
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
2010	0.052	0.064	0.110	0.154	0.154	0.163	0.175	0.187	0.200	0.272
2011	0.055	0.079	0.107	0.136	0.169	0.169	0.179	0.189	0.214	0.270
2012	0.041	0.072	0.098	0.141	0.158	0.172	0.180	0.185	0.189	0.203
2013	0.051	0.077	0.094	0.117	0.139	0.162	0.185	0.188	0.198	0.197
2014	0.049	0.078	0.093	0.112	0.128	0.155	0.178	0.190	0.202	0.217
2015	0.039	0.070	0.094	0.117	0.137	0.155	0.174	0.183	0.193	0.201
2016	0.047	0.066	0.084	0.107	0.125	0.142	0.152	0.167	0.184	0.206
2017	0.056	0.072	0.080	0.094	0.113	0.131	0.148	0.172	0.190	0.212

Year /Age	1	2	3	4	5	6	7	8	9	10+
2018	0.055	0.080	0.091	0.098	0.111	0.129	0.142	0.165	0.175	0.216
2019	0.068	0.085	0.099	0.109	0.118	0.130	0.144	0.167	0.167	0.228
2020	0.063	0.084	0.099	0.115	0.127	0.135	0.144	0.161	0.176	0.207
2021	0.048	0.069	0.095	0.113	0.131	0.139	0.147	0.158	0.181	0.176

Table 2.3.5.1. Blue whiting. Natural mortality and proportion mature.

AGE	0	1	2	3	4	5	6	7–10+
Proportion mature	0.00	0.11	0.40	0.82	0.86	0.91	0.94	1.00
Natural mortality	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 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 2004-2021) are used as input to the assessment

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	TSB
2004	1097	5538	13062	15134	5119	1086	994	593	164	0	3505
2005	2129	1413	5601	7780	8500	2925	632	280	129	23	2513
2006	2512	2224	10881	11695	4717	2719	923	352	198	39	3517
2007	468	706	5241	11244	8437	3155	1110	456	123	65	3274
2008	337	524	1455	6661	6747	3882	1719	1029	269	296	2647
2009	275	329	360	1292	3739	3458	1636	587	250	194	1599
2010*											
2011	312	1361	1135	930	1043	1713	2171	2423	1298	272	1827
2012	1140	1816	6454	1021	595	1415	2220	1777	1249	1085	2347
2013	582	1337	6175	7211	2938	1282	1308	1398	929	1807	3110
2014	4183	1491	5239	8420	10202	2754	772	577	899	2251	3761
2015	3255	4570	1891	3641	1797	466	174	108	206	365	1405
2016	2745	7893	10164	6274	4687	1539	413	133	235	361	2873
2017	262	2248	15682	10176	3762	1793	921	76	84	173	3135
2018	836	628	6615	21490	7692	2187	755	188	72	138	4035
2019	1129	1169	3468	9590	16979	3434	484	513	99	43	4198
2020**											

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	TSB
2021	1948	2095	2545	2275	3914	3197	3379	463	189	114	2357

*Survey discarded. **No survey

Table 2.3.7.2.1. Blue whiting. Estimated abundance of 1 and 2 year old blue whiting from the International Ecosystem Survey in Nordic Seas (IESNS), 2003–2021.

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
2020	2822	481
2021	10264	1500

***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
2020	20.96	16.20
2021	182.86	161.04

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
2020	9.8
2021	79.6

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	1401
1995	1162
1996	4821
1997	2307
1998	463
1999	1717
2000	863
2001	4424
2002	4480
2003	1038
2004	15749
2005	35159
2006	23105
2007	11568
2008	1268
2009	4362
2010	855
2011	23323
2012	8366
2013	13254
2014	70139
2015	34806
2016	21316
2017	4446
2018	1890
2019	286
2020	141
2021	2224

Table 2.4.1.1. Blue whiting. Parameter estimates, from final assessment (2021) and retrospective analysis (2017-2020).

Parameter Year	2017	2018	2019	2020	2021
Random walk variance					
-F Age 1-10	0.38	0.38	0.37	0.37	0.36
Process error					
-log(N) Age 1	0.63	0.61	0.61	0.60	0.60
--- Age 2-10	0.18	0.18	0.18	0.18	0.18
Observation variance					
-Catch Age 1	0.44	0.43	0.43	0.44	0.43
--- Age 2	0.29	0.28	0.28	0.28	0.28
--- Age 3-8	0.20	0.19	0.19	0.19	0.19
--- Age 9-10	0.40	0.40	0.39	0.38	0.38
-IBWSS Age 1	0.73	0.73	0.75	0.72	0.71
--- Age 2	0.30	0.31	0.33	0.33	0.32
--- Age 3	0.42	0.43	0.41	0.40	0.39
--- Age 4-6	0.39	0.38	0.37	0.37	0.37
--- Age 7-8	0.47	0.51	0.54	0.53	0.53
Survey catchability					
-IBWSS Age 1	0.07	0.06	0.07	0.06	0.06
--- Age 2	0.12	0.11	0.11	0.11	0.11
--- Age 3	0.38	0.38	0.37	0.37	0.37
--- Age 4	0.70	0.68	0.68	0.68	0.67
--- Age 5-8	0.90	0.87	0.87	0.89	0.89
Rho					
--	0.93	0.93	0.93	0.93	0.93

Table 2.4.1.2. Blue whiting. Mohn's rho by year and average over the last five years (n=5).

Year	R(age 1)	SSB	Fbar(3-7)
2016	0.257	0.056	-0.100
2017	-0.062	-0.086	0.134
2018	-0.149	-0.075	0.056
2019	-0.224	0.044	-0.063
2020	-0.079	-0.002	-0.035
rho.mean	-0.051	-0.013	-0.002

Table 2.4.1.3. Blue whiting. Estimated fishing mortalities. Catch data for 2020 are preliminary.

Year/ Age	1	2	3	4	5	6	7	8	9	10+
1981	0.078	0.118	0.172	0.212	0.244	0.318	0.346	0.443	0.484	0.484
1982	0.067	0.102	0.148	0.183	0.208	0.270	0.293	0.371	0.403	0.403
1983	0.078	0.117	0.171	0.211	0.240	0.314	0.337	0.419	0.445	0.445
1984	0.095	0.143	0.212	0.265	0.305	0.397	0.418	0.509	0.529	0.529
1985	0.101	0.150	0.230	0.295	0.346	0.448	0.465	0.561	0.576	0.576
1986	0.113	0.169	0.268	0.358	0.431	0.552	0.573	0.691	0.703	0.703
1987	0.100	0.150	0.248	0.338	0.415	0.538	0.560	0.673	0.675	0.675
1988	0.098	0.148	0.253	0.349	0.439	0.575	0.588	0.694	0.677	0.677
1989	0.113	0.171	0.304	0.420	0.526	0.686	0.712	0.841	0.805	0.805
1990	0.105	0.159	0.292	0.408	0.510	0.664	0.712	0.848	0.815	0.815
1991	0.059	0.089	0.167	0.235	0.290	0.367	0.395	0.465	0.450	0.450
1992	0.048	0.073	0.140	0.195	0.233	0.286	0.311	0.370	0.362	0.362
1993	0.042	0.063	0.125	0.176	0.206	0.246	0.268	0.319	0.314	0.314
1994	0.036	0.054	0.113	0.160	0.186	0.219	0.241	0.292	0.286	0.286
1995	0.046	0.070	0.149	0.215	0.243	0.284	0.313	0.382	0.368	0.368
1996	0.055	0.085	0.185	0.271	0.297	0.347	0.382	0.472	0.450	0.450
1997	0.054	0.084	0.188	0.279	0.300	0.349	0.382	0.474	0.452	0.452
1998	0.070	0.110	0.251	0.381	0.408	0.473	0.509	0.629	0.592	0.592
1999	0.064	0.101	0.237	0.370	0.398	0.459	0.483	0.593	0.558	0.558
2000	0.074	0.117	0.279	0.446	0.498	0.576	0.589	0.705	0.665	0.665

Year/ Age	1	2	3	4	5	6	7	8	9	10+
2001	0.070	0.111	0.265	0.430	0.494	0.572	0.574	0.679	0.643	0.643
2002	0.065	0.104	0.251	0.418	0.504	0.595	0.597	0.701	0.665	0.665
2003	0.067	0.107	0.262	0.440	0.545	0.635	0.629	0.710	0.669	0.669
2004	0.068	0.109	0.269	0.462	0.592	0.691	0.689	0.754	0.710	0.710
2005	0.060	0.095	0.239	0.420	0.557	0.651	0.657	0.705	0.667	0.667
2006	0.051	0.082	0.209	0.373	0.509	0.597	0.607	0.641	0.606	0.606
2007	0.048	0.078	0.197	0.357	0.505	0.604	0.629	0.661	0.628	0.628
2008	0.042	0.068	0.171	0.308	0.443	0.529	0.563	0.590	0.568	0.568
2009	0.027	0.045	0.112	0.197	0.286	0.340	0.369	0.385	0.372	0.372
2010	0.019	0.032	0.080	0.137	0.199	0.235	0.258	0.263	0.256	0.256
2011	0.006	0.010	0.024	0.040	0.057	0.067	0.074	0.075	0.075	0.075
2012	0.012	0.021	0.052	0.086	0.121	0.141	0.160	0.167	0.165	0.165
2013	0.020	0.035	0.091	0.151	0.214	0.245	0.279	0.294	0.292	0.292
2014	0.037	0.067	0.177	0.297	0.414	0.473	0.538	0.570	0.564	0.564
2015	0.048	0.087	0.233	0.392	0.543	0.625	0.697	0.736	0.724	0.724
2016	0.042	0.075	0.201	0.344	0.476	0.556	0.617	0.648	0.636	0.636
2017	0.040	0.072	0.194	0.332	0.456	0.531	0.579	0.601	0.591	0.591
2018	0.040	0.072	0.196	0.339	0.464	0.542	0.591	0.608	0.599	0.599
2019	0.037	0.067	0.181	0.316	0.431	0.501	0.546	0.556	0.547	0.547
2020	0.043	0.078	0.212	0.372	0.505	0.586	0.641	0.653	0.638	0.638
2021	0.047	0.086	0.233	0.411	0.555	0.642	0.699	0.713	0.698	0.698

Table 2.4.1.4. Blue whiting. Estimated stock numbers-at-age (thousands). Preliminary catch data for 2021 have been used.

Year /Age	1	2	3	4	5	6	7	8	9	10+
1981	3946080	3488881	4858076	2075467	2616594	2143488	1646105	1741446	1221690	2961401
1982	4696923	2959384	2521927	3288270	1587238	1501436	1296370	1014308	889757	1937887
1983	18021467	3782040	1880233	1824547	1909739	1218909	1013368	854387	627623	1261812
1984	17927420	14381350	2440981	1235055	1264728	1394828	814494	550144	481759	928367
1985	9575365	13474205	9725627	1452648	750741	911346	746052	458313	265779	723204
1986	7251591	6399491	9402588	5526602	941898	452591	469648	375703	230561	497593
1987	9110901	5062609	4095247	6842718	2562332	395447	253537	237551	156389	293029
1988	6440989	6871604	3530169	2883688	3710117	1264149	199052	125606	99146	170848
1989	8544270	4636631	4990194	2429990	2128243	1682736	351574	102766	60487	115489
1990	18706545	6006263	3104831	2736494	1482317	1186471	560884	120929	33178	85010
1991	9030557	15592087	4278056	1796965	1491288	872112	562067	189376	32515	45368
1992	6712684	7420121	12475541	3308264	1264549	793022	487040	288012	101778	39265
1993	4997346	5135998	5290113	9703194	2260163	978270	517956	283011	157397	74552
1994	8107500	3423023	4074643	3409003	6915122	1439820	764662	328260	206786	116756
1995	9366200	5876598	3140124	2574833	2855583	3748486	1039795	543767	220424	185407
1996	27896658	7121356	4080055	2396819	1557094	1864865	2239686	644778	306620	248928
1997	44565707	21247721	5491471	2570938	1422353	1070470	1063302	1214840	289054	335056

Year /Age	1	2	3	4	5	6	7	8	9	10+
1998	26745578	37619991	16365576	3495404	1378636	927874	781552	604311	617341	293256
1999	20454274	20561707	27519932	10505249	1712468	775156	520777	410520	236969	427921
2000	39231005	15357190	16581016	15783843	4333439	1107303	471714	323498	153941	313533
2001	55702658	31542480	12087266	10727537	7448094	1696260	489467	227019	162370	178502
2002	48895878	45190583	20424747	8313086	5459108	3392787	689885	254824	102602	154135
2003	52676531	38992385	34898597	13541168	5062130	2966580	1206065	345959	88994	106649
2004	28616022	42041076	29939138	20814843	7229138	2458915	1311090	501127	151230	80317
2005	22242605	21717708	28462681	18093591	10702844	3216550	1105461	512185	191274	98226
2006	9091134	15514301	22144581	19234358	9447264	4441803	1351317	481054	216722	119469
2007	4952577	6036750	13145859	15891635	10270967	4678374	1828853	606023	227072	161760
2008	5842915	3500008	4369894	11056804	9144335	4900979	1853861	752867	234131	198052
2009	5763280	4034046	2433903	3727750	6943856	4709063	2193544	854440	323777	188236
2010	15334306	5043345	2375179	1866784	3375653	4341237	2838047	1201574	413724	266316
2011	19236335	13403215	3336216	1666726	1619700	2610523	2699455	1354322	813827	392473
2012	19175444	15434634	12543207	2305415	1193211	1614801	2331692	2112107	1077976	899109
2013	16039501	16001936	11658859	7392216	2225768	1091745	1376169	1633502	1344090	1377427
2014	37131235	12692933	13840809	8026599	4371632	1344042	932427	998166	1015186	1489049
2015	62818315	32746083	10794145	8486052	4202017	1734666	735296	517757	481589	1055653

Year /Age	1	2	3	4	5	6	7	8	9	10+
2016	34221938	56546333	21364733	7660431	4323342	1802708	704454	350670	220580	592519
2017	11565966	27889368	45064410	15023031	4538325	2150495	737486	282998	160395	373641
2018	12061390	8949817	22089472	29231257	8721742	2459198	943081	313308	142157	263927
2019	13079208	8976003	8450272	14735133	16294262	4545275	1122193	404091	138783	196561
2020	22788112	10675689	6577758	6442614	8554151	7877493	2164844	537652	196205	161396
2021	29805438	17686107	7861257	4594971	4050703	3999555	3592288	863904	217528	167554
2022		23273308	13288721	5098852	2493135	1903468	1724028	1462329	346655	156875

Table 2.4.1.5. Blue whiting. Estimated recruitment (R) in thousands, spawning-stock biomass (SSB) in tonnes, average fishing mortality for ages 3 to 7 (Fbar 3-7) and total-stock biomass (TBS) in tonnes. Preliminary catch data for 2021 are included.

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High	TSB	Low	High
1981	3946080	2551853	6102055	2843799	2239591	3611014	0.258	0.188	0.355	3342019	2681169	4165754
1982	4696923	3008509	7332898	2302366	1834150	2890108	0.221	0.163	0.298	2772773	2247559	3420720
1983	18021467	11775650	27580072	1856506	1510944	2281099	0.255	0.191	0.339	2877093	2345564	3529071
1984	17927420	11823410	27182717	1750611	1448333	2115976	0.319	0.243	0.419	3074915	2485224	3804526
1985	9575365	6344090	14452447	2086876	1723059	2527512	0.357	0.275	0.463	3222250	2633423	3942737
1986	7251591	4832635	10881347	2269479	1877212	2743714	0.436	0.337	0.564	3110695	2579468	3751324
1987	9110901	6058765	13700566	1930865	1599576	2330768	0.420	0.324	0.544	2816340	2338790	3391399
1988	6440989	4280013	9693041	1637715	1367908	1960738	0.441	0.340	0.571	2427518	2023738	2911861

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High	TSB	Low	High
1989	8544270	5656169	12907066	1547055	1296180	1846487	0.529	0.411	0.682	2395175	1987409	2886604
1990	18706545	12204475	28672664	1358764	1128574	1635905	0.517	0.394	0.678	2498157	2000107	3120228
1991	9030557	5832076	13983178	1778560	1429332	2213114	0.291	0.214	0.394	3221839	2527447	4107008
1992	6712684	4385689	10274357	2458361	1949402	3100202	0.233	0.172	0.316	3528675	2801747	4444208
1993	4997346	3228601	7735075	2540185	2023037	3189531	0.204	0.151	0.276	3419865	2742863	4263967
1994	8107500	5285973	12435091	2534082	2039662	3148352	0.184	0.135	0.249	3415911	2775418	4204212
1995	9366200	6166052	14227206	2311535	1902342	2808745	0.241	0.181	0.320	3361278	2768183	4081447
1996	27896658	18407554	42277400	2210376	1836492	2660377	0.296	0.225	0.391	3723606	3033596	4570564
1997	44565707	29460840	67414990	2464353	2044176	2970896	0.300	0.228	0.394	5419396	4268697	6880286
1998	26745578	17791745	40205497	3669862	3001545	4486986	0.404	0.311	0.525	6804090	5445360	8501850
1999	20454274	13544156	30889878	4432233	3610899	5440387	0.389	0.299	0.506	7167410	5831204	8809803
2000	39231005	25926555	59362755	4230752	3514368	5093167	0.477	0.371	0.615	7460737	6088676	9141986
2001	55702658	37101728	83629152	4568522	3811227	5476291	0.467	0.362	0.602	8993257	7264374	11133604
2002	48895878	32563927	73418876	5400006	4498373	6482357	0.473	0.366	0.611	10328562	8372831	12741113
2003	52676531	35556956	78038651	6849571	5686857	8250010	0.502	0.394	0.640	11807831	9692142	14385353
2004	28616022	19265060	42505797	6755492	5672809	8044810	0.540	0.426	0.685	10368413	8665497	12405980
2005	22242605	15018310	32942020	6018029	5061918	7154734	0.505	0.395	0.645	8492573	7131484	10113436
2006	9091134	6072432	13610481	5870609	4920034	7004839	0.459	0.357	0.590	7715302	6471565	9198066

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High	TSB	Low	High
2007	4952577	3298315	7436530	4666706	3899972	5584181	0.458	0.353	0.595	5706469	4780348	6812012
2008	5842915	3846303	8875965	3593810	2963508	4358168	0.403	0.302	0.538	4414939	3657374	5329421
2009	5763280	3675852	9036107	2758087	2218803	3428445	0.261	0.190	0.358	3476623	2816989	4290718
2010	15334306	10024968	23455530	2689104	2122772	3406527	0.182	0.130	0.255	3763510	2998591	4723555
2011	19236335	12696647	29144431	2713450	2156951	3413526	0.052	0.036	0.076	4444320	3535979	5586000
2012	19175444	12878334	28551649	3445804	2808274	4228064	0.112	0.084	0.150	5118998	4169337	6284965
2013	16039501	10807867	23803549	3768379	3131928	4534165	0.196	0.149	0.258	5587760	4626764	6748358
2014	37131235	24799212	55595662	4004460	3366398	4763460	0.380	0.292	0.495	6634143	5473331	8041146
2015	62818315	42154778	93610758	4177415	3506095	4977273	0.498	0.388	0.639	8134033	6575161	10062489
2016	34221938	22968425	50989175	4900689	4039993	5944752	0.439	0.339	0.568	9066287	7305713	11251136
2017	11565966	7599119	17603565	6058300	4940280	7429336	0.418	0.322	0.544	8753473	7119023	10763176
2018	12061390	7806099	18636342	5916510	4806789	7282428	0.426	0.323	0.564	7807196	6341420	9611776
2019	13079208	7890921	21678799	5061219	4030938	6354834	0.395	0.287	0.544	6885890	5441112	8714299
2020	22788112	12759097	40700221	4151143	3134696	5497181	0.463	0.314	0.684	6354193	4650674	8681701
2021	29805438	13152311	67544339	3444751	2332874	5086562	0.508	0.298	0.865	5747899	3681372	8974465
2022	20982149*			3403663*			0.508			6050174		

***assuming long term GM(1996-2020) recruitment (20982149) in 2022.**

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 2021 are included.

Year	Estimate	Low	High	Observed catch
1981	786026	563271	1096875	922980
1982	544001	413221	716170	550643
1983	511286	394907	661961	553344
1984	560913	432749	727035	615569
1985	637584	500137	812804	678214
1986	759594	596217	967739	847145
1987	638131	501148	812557	654718
1988	569422	447815	724051	552264
1989	619197	490191	782154	630316
1990	553363	435299	703448	558128
1991	407488	316557	524539	364008
1992	438354	345107	556796	474592
1993	439560	344372	561059	475198
1994	424293	330597	544543	457696
1995	507974	402262	641466	505176
1996	597227	473104	753915	621104
1997	640039	503037	814355	639681
1998	1076678	841112	1378217	1131955
1999	1245781	968337	1602717	1261033
2000	1502768	1176771	1919076	1412449
2001	1559029	1221058	1990546	1771805
2002	1713207	1342017	2187065	1556955
2003	2198166	1729901	2793186	2365319
2004	2315573	1829682	2930497	2400795
2005	1998062	1581349	2524587	2018344
2006	1850619	1464595	2338389	1956239
2007	1553869	1227788	1966552	1612269
2008	1165559	914098	1486193	1251851

Year	Estimate	Low	High	Observed catch
2009	654934	512561	836854	634978
2010	476283	367095	617948	539539
2011	136701	100757	185467	103771
2012	326445	258292	412581	375692
2013	590207	466426	746836	613863
2014	1108591	870497	1411808	1147650
2015	1348148	1068156	1701533	1390656
2016	1247107	984705	1579434	1180786
2017	1481534	1168794	1877956	1555069
2018	1703786	1337677	2170095	1709856
2019	1534129	1202155	1957778	1512026
2020	1470581	1159558	1865027	1460507
2021	1239847	977113	1573228	1242727

Table 2.8.2.1.1. Blue whiting. Input to short-term projection (median values for exploitation pattern and stock numbers).

Age	Mean weight in the stock and catch (kg) in 2021	Mean weight in the stock and catch (kg) in 2022+	Proportion mature	Natural mortality	Exploitation pattern	Stock number(2022) (thousands)
Age 1	0.048	0.060	0.11	0.20	0.093	20982149
Age 2	0.069	0.079	0.40	0.20	0.169	23273308
Age 3	0.095	0.097	0.82	0.20	0.459	13288721
Age 4	0.113	0.112	0.86	0.20	0.810	5098852
Age 5	0.131	0.125	0.91	0.20	1.093	2493135
Age 6	0.139	0.135	0.94	0.20	1.263	1903468
Age 7	0.147	0.145	1.00	0.20	1.376	1724028
Age 8	0.158	0.162	1.00	0.20	1.404	1462329
Age 9	0.181	0.175	1.00	0.20	1.374	346655
Age 10	0.176	0.204	1.00	0.20	1.374	156875

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

Variable	Value	Notes
F ages 3–7 (2021)	0.508	From the assessment (based on assumed 2021 catches)
SSB (2022)	3 403 663	From the forecast; in tonnes
$R_{age\ 1}$ (2021)	29 805 438	From the assessment; in thousands
$R_{age\ 1}$ (2022–2023)	20 982 149	GM (1996–2020); in thousands
Total catch (2021)	1 242 727	As estimated by ICES, based on declared national quotas and expected uptake; in tonnes

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

Basis	Total catch (2022)	F (2022)	SSB (2023)	% SSB change *	% catch change **	% advice change ***
ICES advice basis						
Long-term management strategy F = FMSY	752736	0.32	4052163	19.1	-39.4	-19.0
Other scenarios						
MSY approach: FMSY	752736	0.32	4052163	19.1	-39.4	-19.0
F = 0	0	0	4738902	39.2	-100	-100
Fpa	752736	0.32	4052163	19.1	-39.4	-19.0
Flim	1695700	0.88	3214818	-5.5	36.4	82.5
SSB2023 = Blim	3797974	3.929	1500000	-55.9	205.6	308.7
SSB2023 = Bpa	2838799	2.034	2250000	-33.9	128.4	205.5
SSB2023 = MSY Btrigger	2838799	2.034	2250000	-33.9	128.4	205.5
F = F2021	1113313	0.508	3728501	9.5	-10.4	19.8
SSB2023 = SSB2022	1479984	0.731	3403629	0	19.1	59.3
Catch2022 = Catch2021	1242727	0.583	3613292	6.2	0	33.7
Catch2022 = Catch2021 −20%	994181	0.443	3834987	12.7	-20	7.0
Catch2022 = Catch2021 +25%	1553409	0.780	3339158	-1.9	25	67.2
Catch2022 = Advice2021 −20%	743434	0.315	4060575	19.3	-40.2	-20

*** SSB 2023 relative to SSB 2022.**

**** Catch 2022 relative to expected catch in 2021 (1 242 727tonnes).**

***** Catch 2022 relative to advice for 2021 (929 292 tonnes).**

2.18 Figures

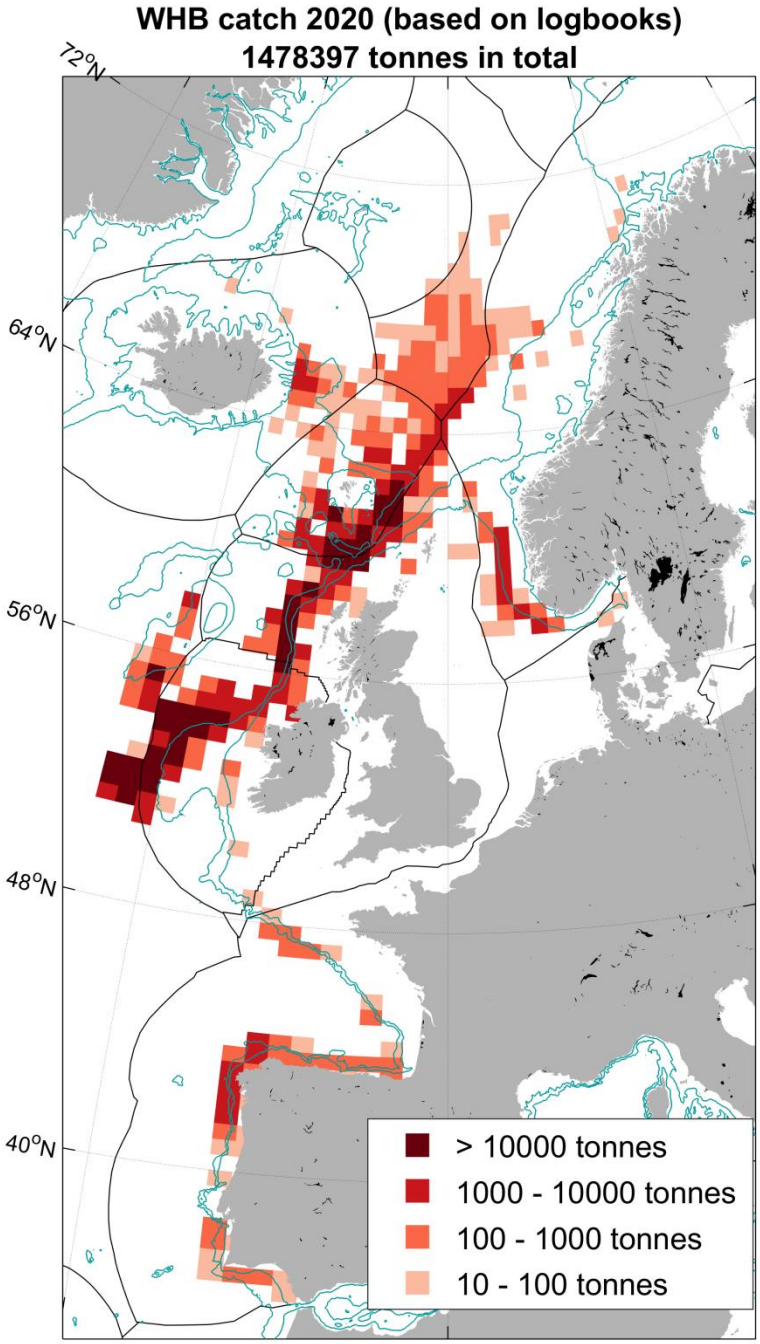


Figure 2.2.1. Blue whiting landings in 2020, based on logbook data. The catches on the map constitute 98.9 % of the ICES estimated catches. The 200 m and 1000 m depth contours are indicated in blue.

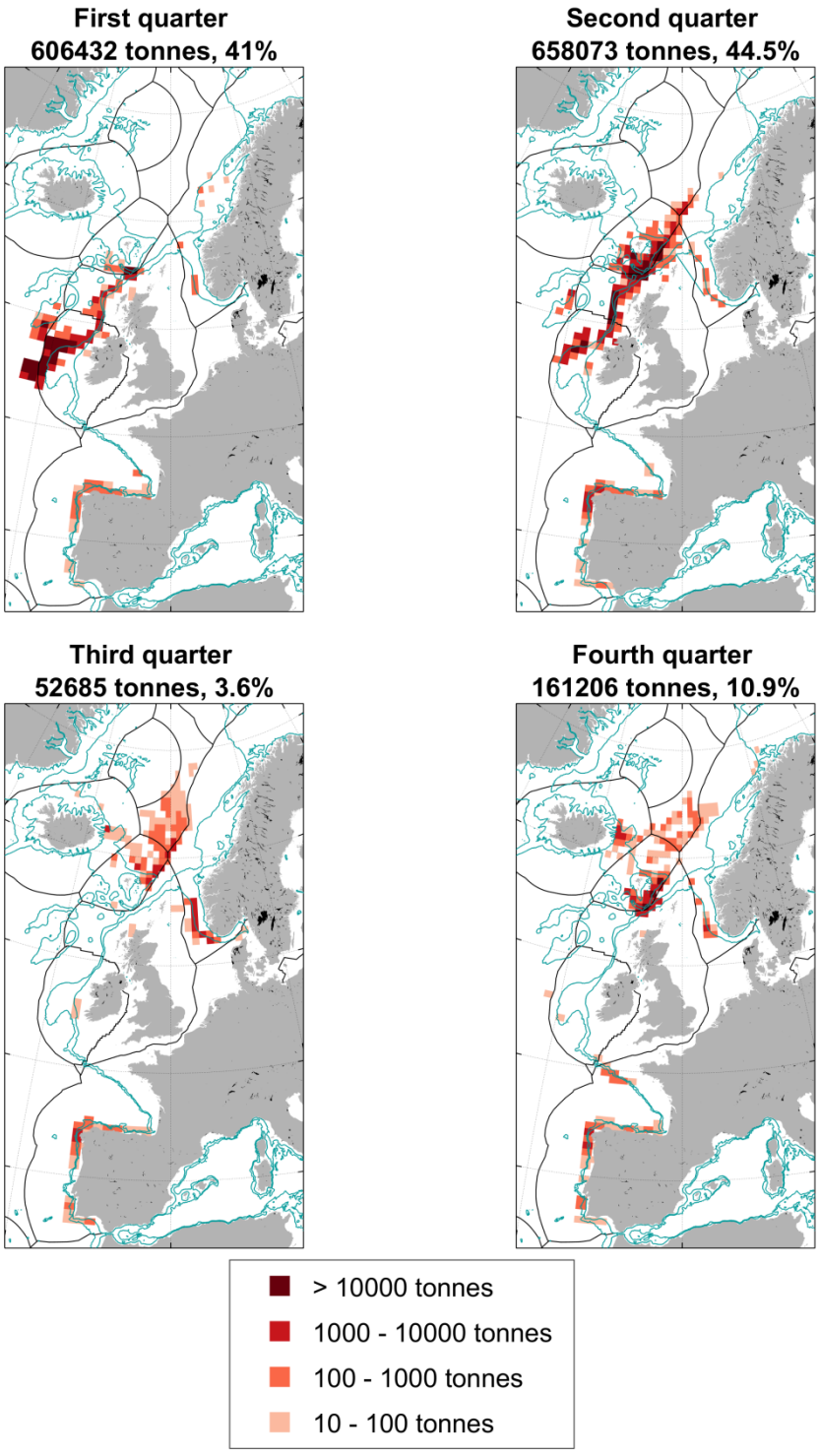


Figure 2.2.2. Blue whiting catches per quarter 2020. The catches on the map are based on logbook data and constitute 98.9 % of the ICES estimated catches. The total catches and percentages shown on each panel are also based on logbook data, and therefore deviate slightly from the ICES estimated catches pr. quarter. The 200 m and 1000 m depth contours are indicated in blue.

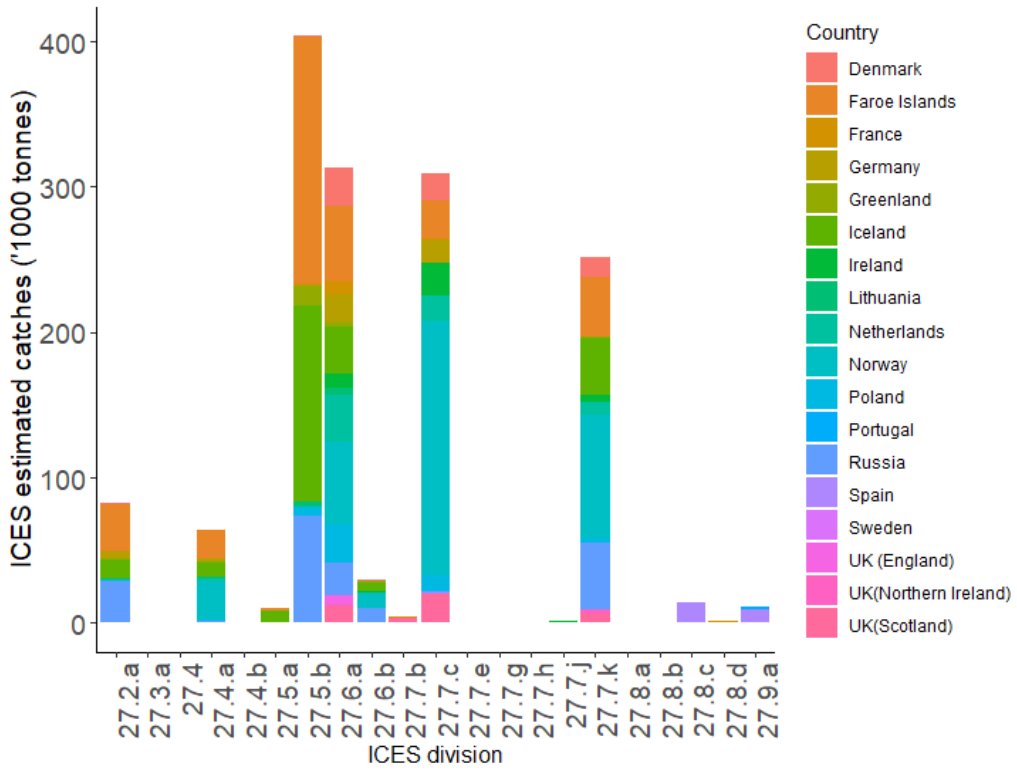
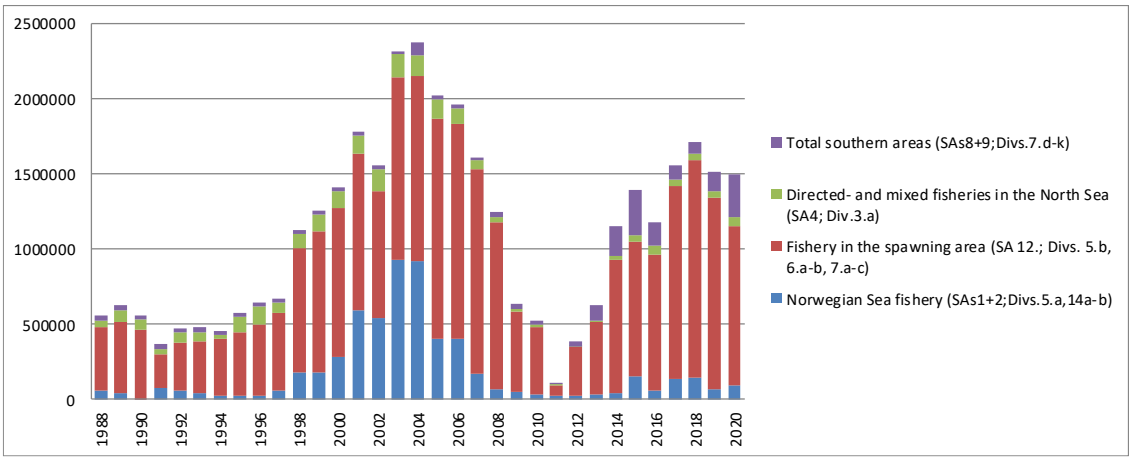


Figure 2.3.1.1. Blue whiting. ICES estimated catches ('1000 tonnes) in 2020 by ICES division and country.

A



B

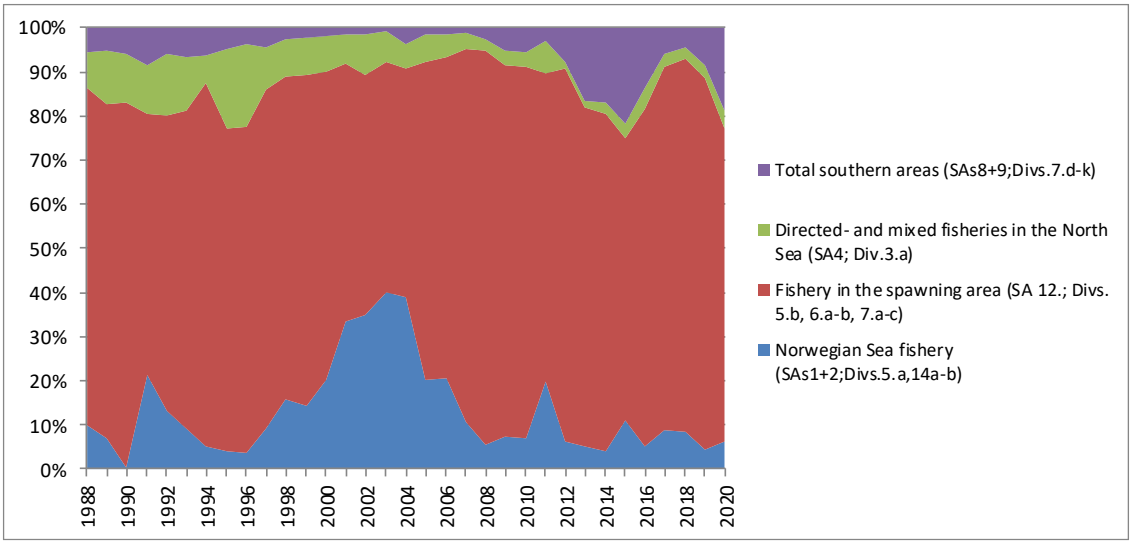


Figure 2.3.1.2. Blue whiting.(A) ICES estimated catches (tonnes) of blue whiting by fishery subareas from 1988-2020 and (B) the percentage contribution to the overall catch by fishery subarea over the same period.

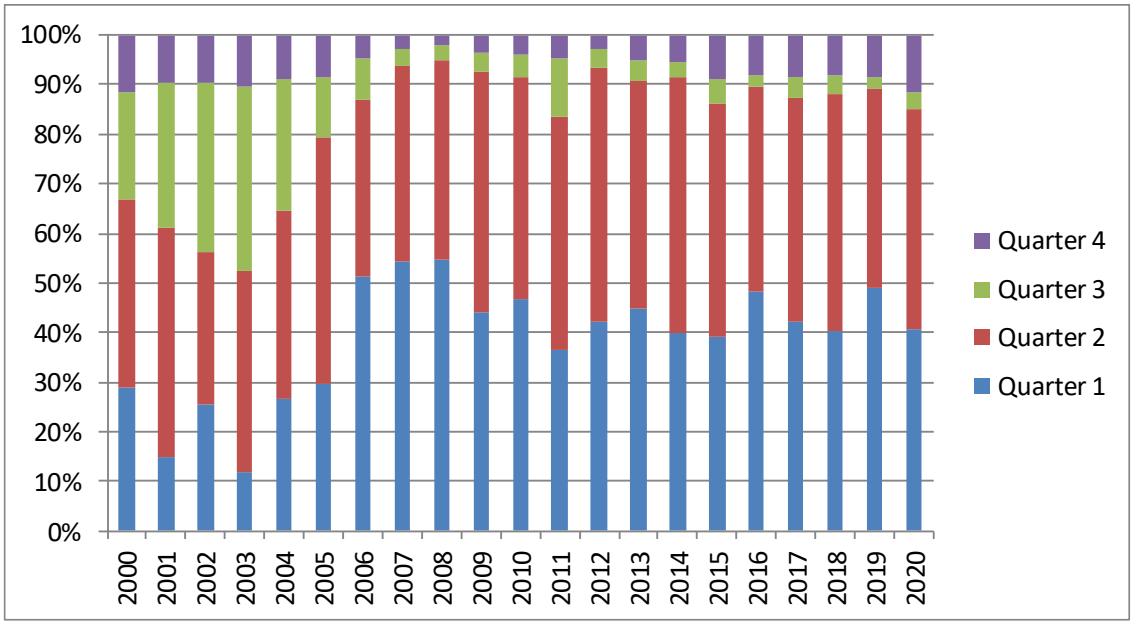


Figure 2.3.1.3. Blue whiting. Distribution of 2020 ICES estimated catches (in percentage) by quarter.

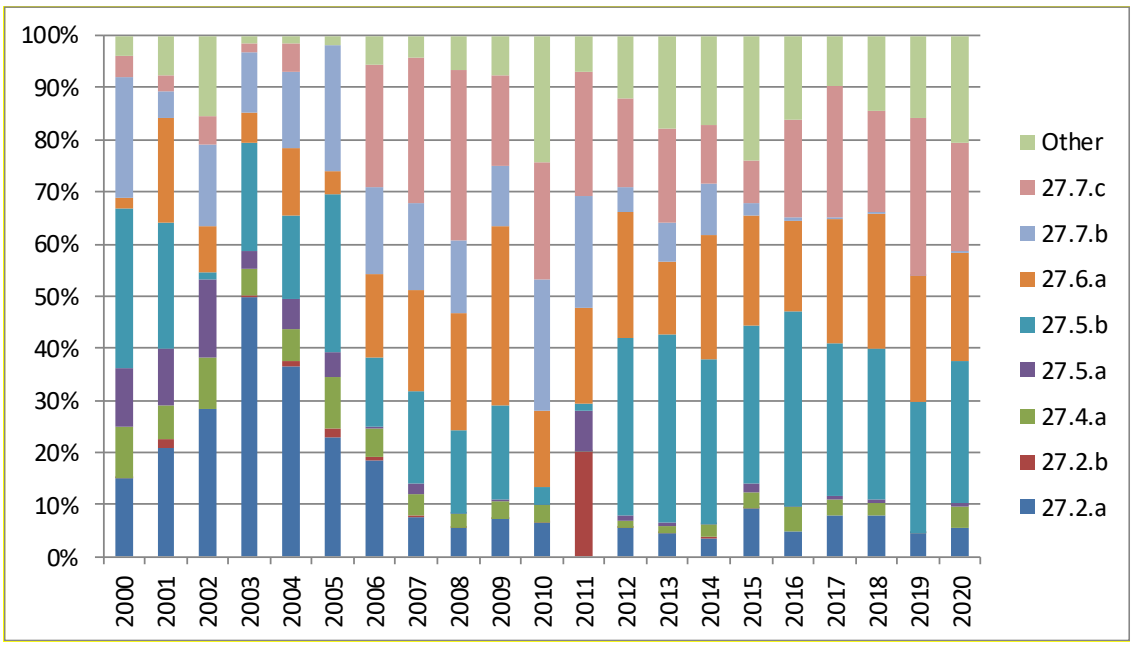


Figure 2.3.1.4. Blue whiting. Distribution of 2020 ICES estimated catches (in percentage) by ICES division area.

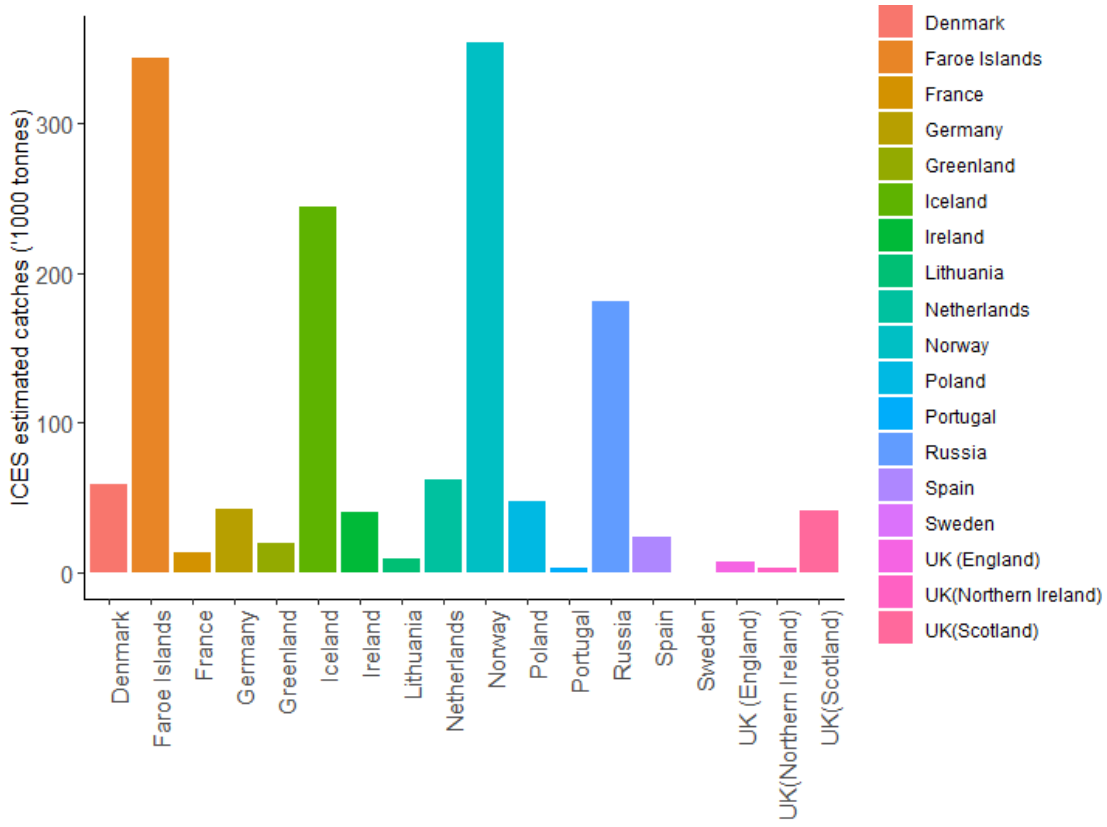


Figure 2.3.1.5. Blue whiting. ICES estimated catches ('1000 tonnes) in 2020 by country.

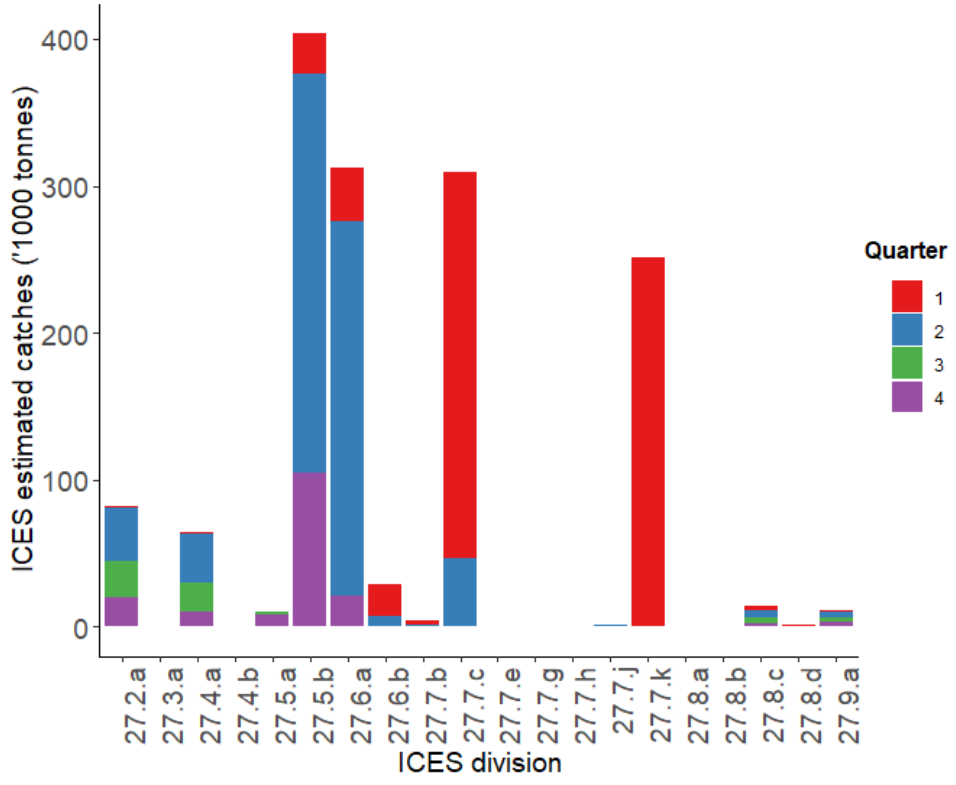


Figure 2.3.1.6. Blue whiting. Distribution of 2020 ICES estimated catches ('1000 tonnes) by ICES division and by quarter.

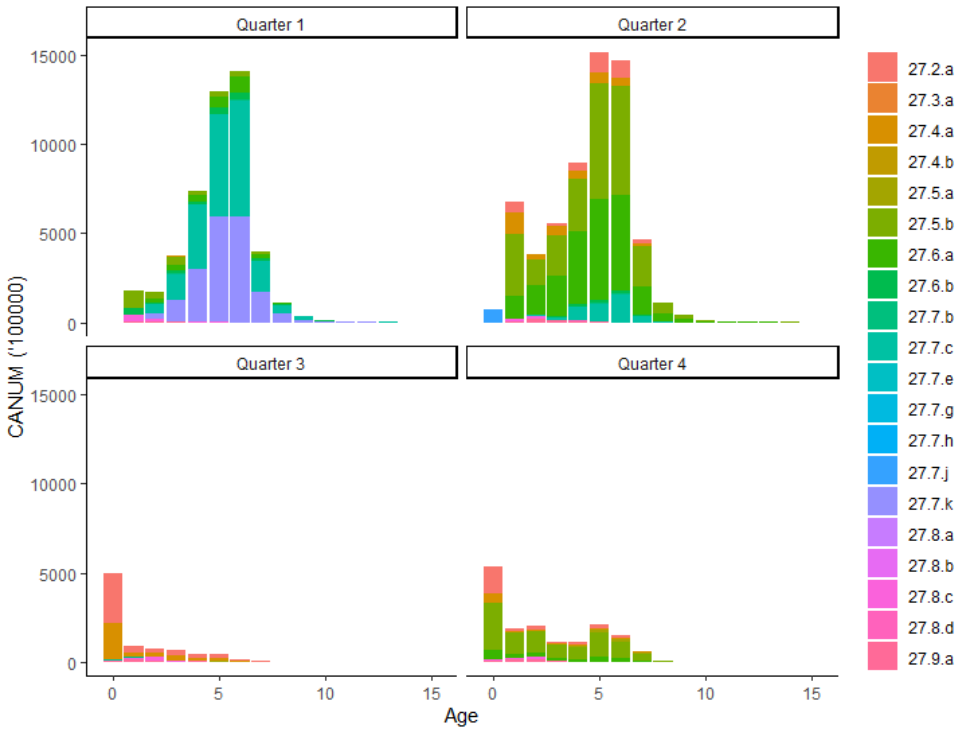


Figure 2.3.1.7. Blue whiting. Catch-at-age numbers (CANUM) distribution by quarter and ICES division for 2020.

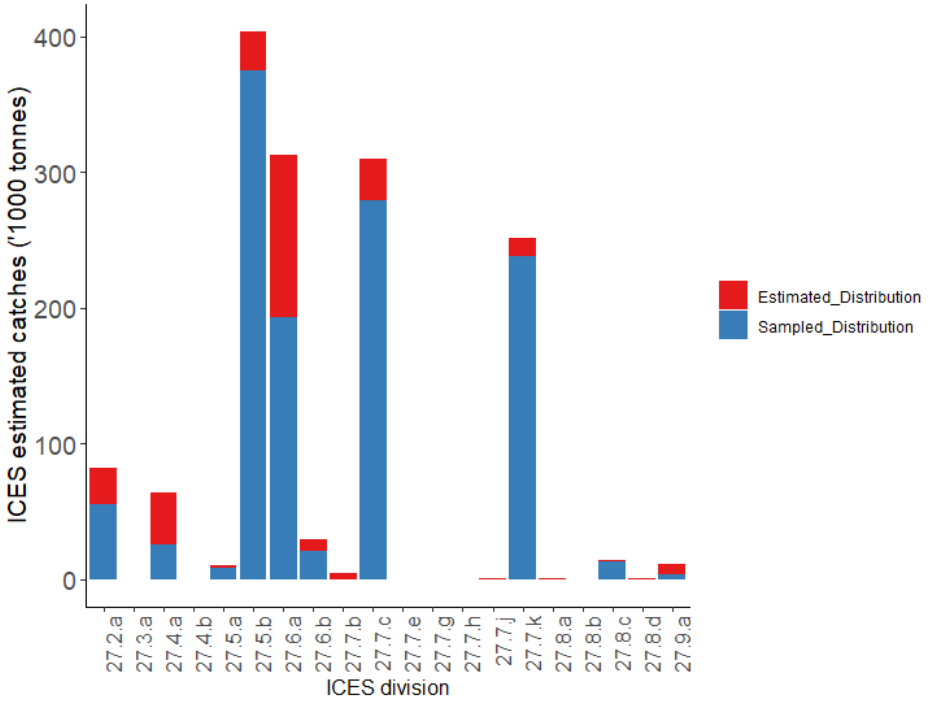


Figure 2.3.1.1.1. Blue whiting. 2020 ICES catches ('1000 tonnes) based on sampled or estimated distribution by ICES division.

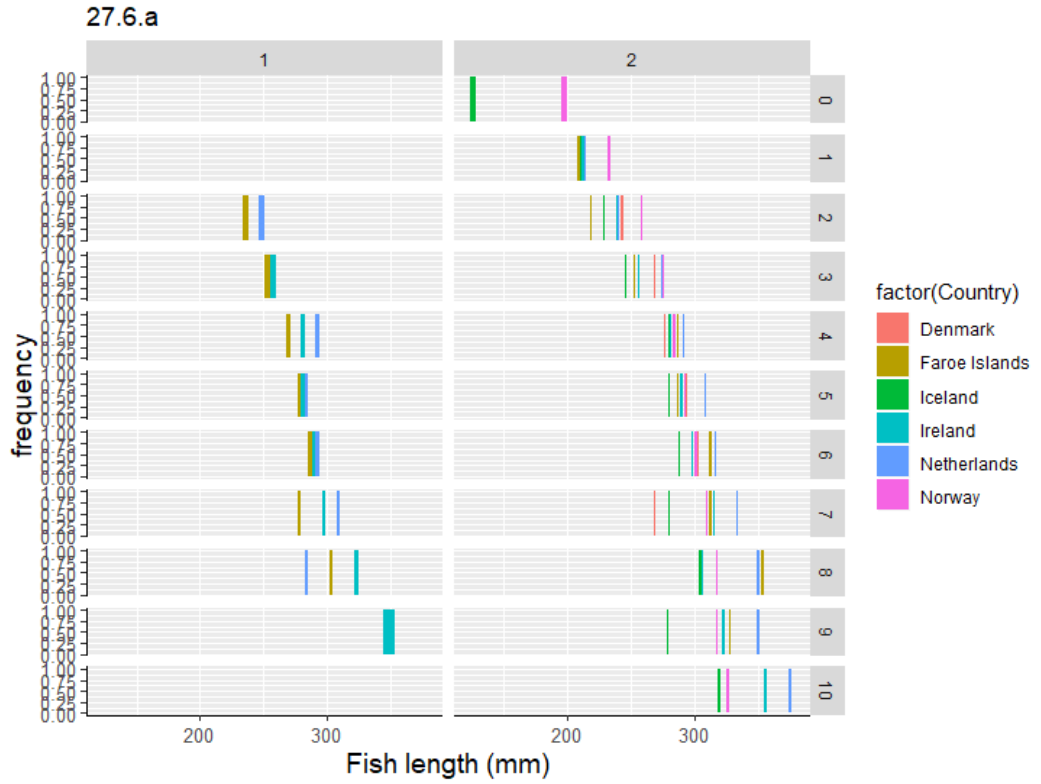


Figure 2.3.1.2.1. Blue whiting. Mean length (mm) by age (0-10 year), by quarter (1,2), by country for ICES division area 27.6.a. These data only comprises the 2020 ICES catch-at-age sampled estimates for ICES division 27.6.a.

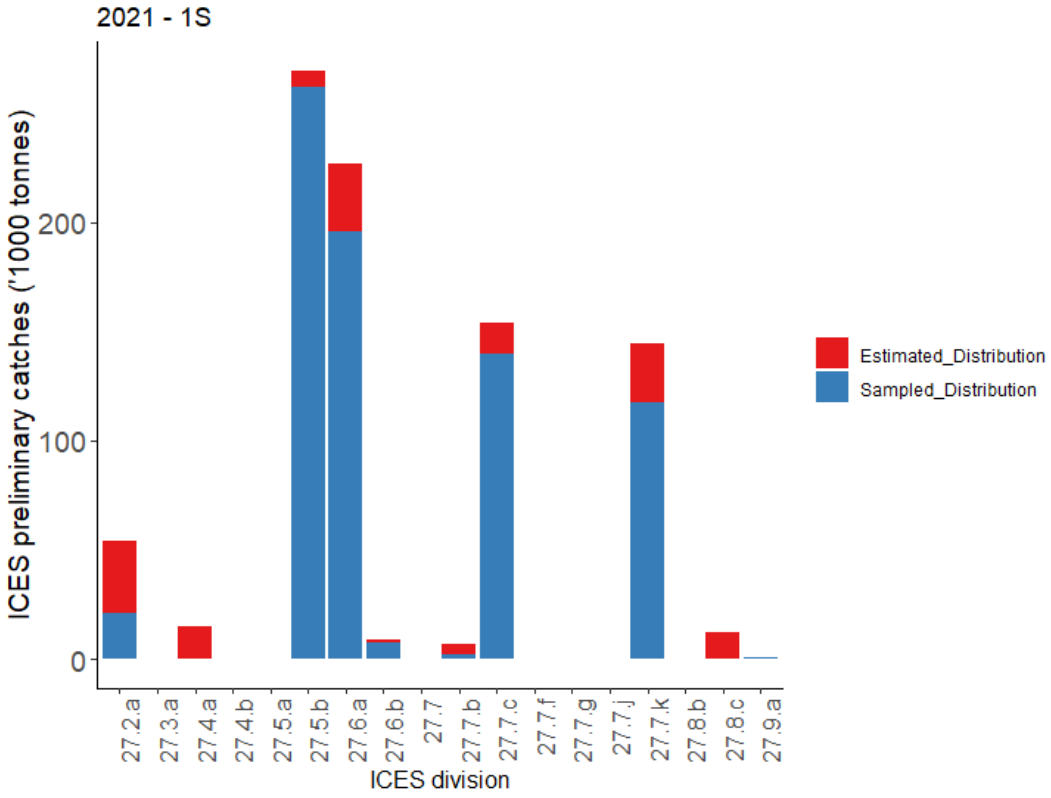


Figure 2.3.2.1. Blue whiting. 2021 ICES preliminary catches ('1000 tonnes) (Quarter 1 + Quarter 2) based on sampled or estimated distribution by ICES division.

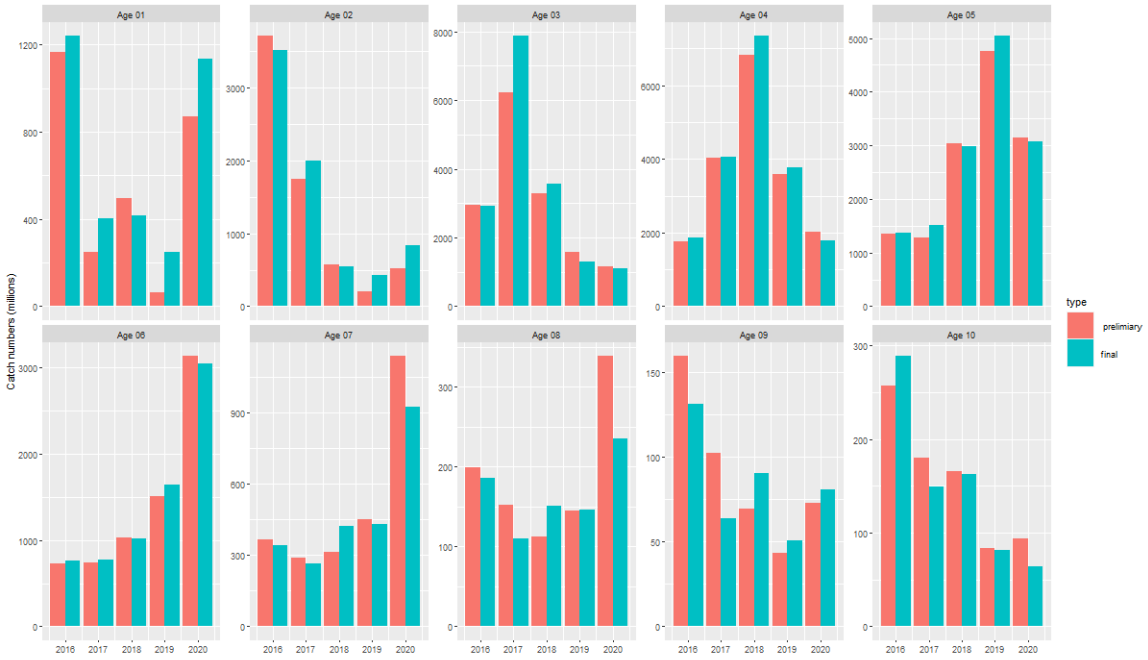


Figure 2.3.2.2 Preliminary and final estimates of catch at age number by age and year.

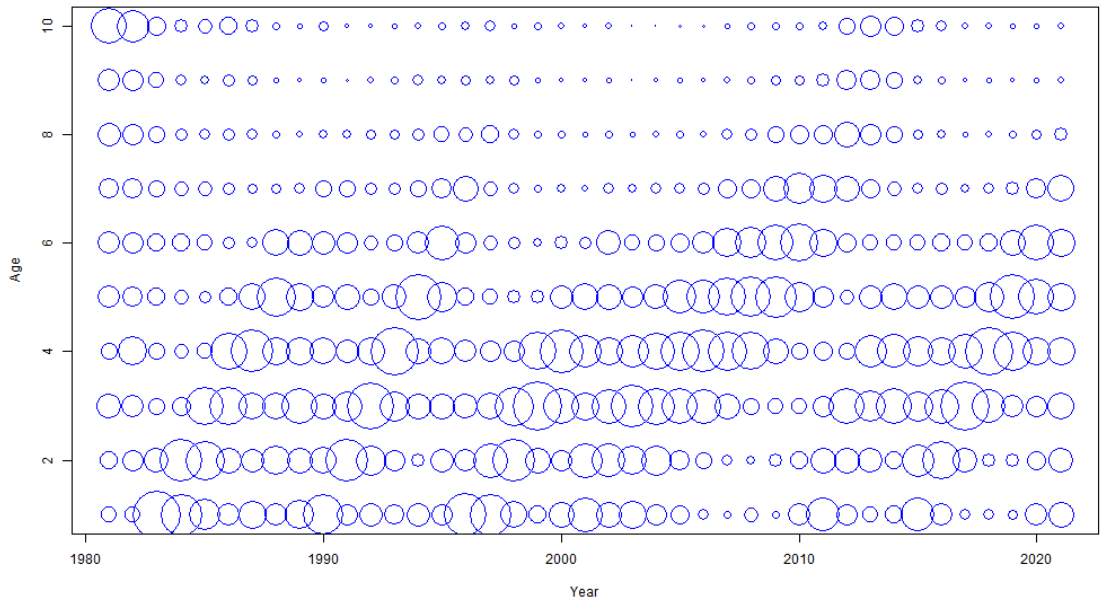


Figure 2.3.3.1. Blue whiting. Catch proportion at age, 1981-2021. Preliminary values for 2021 have been used.

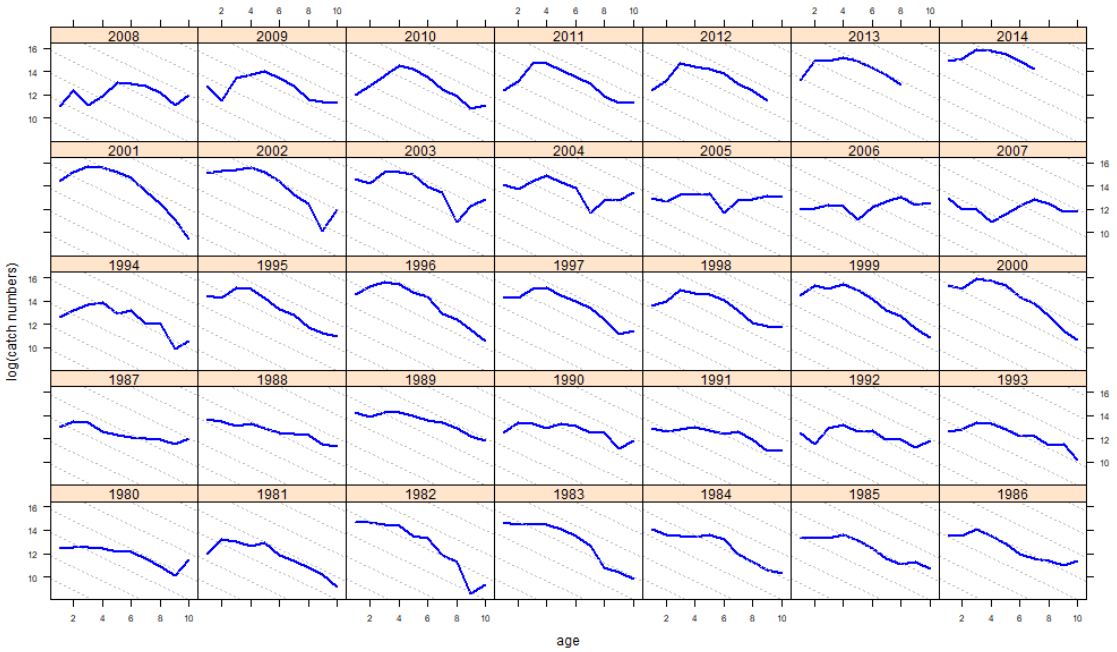


Figure 2.3.3.2. Blue whiting. Age disaggregated catch (numbers) plotted on log scale. The labels for each panel indicate year classes. The grey dotted lines correspond to *Z*=0.6. Preliminary catch-at-age data for 2021 have been used.

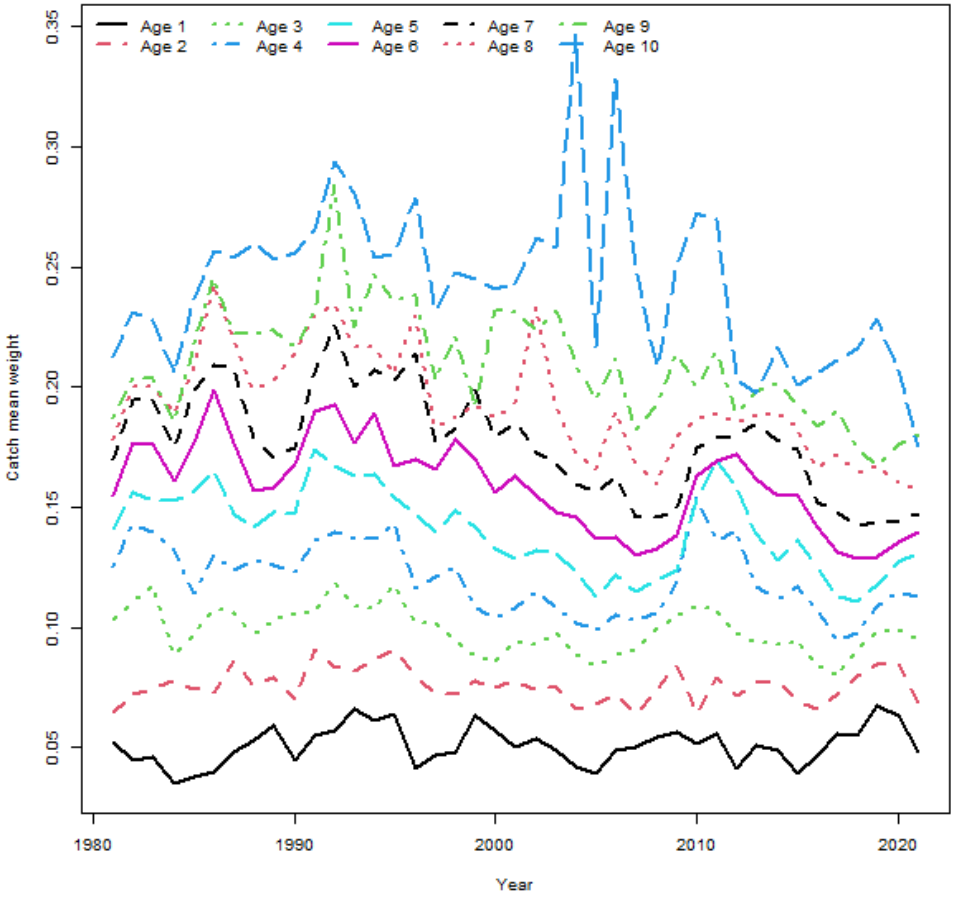


Figure 2.3.4.1. Blue whiting. Mean catch (and stock) weight (kg) at age by year. Preliminary values for 2021 have been used

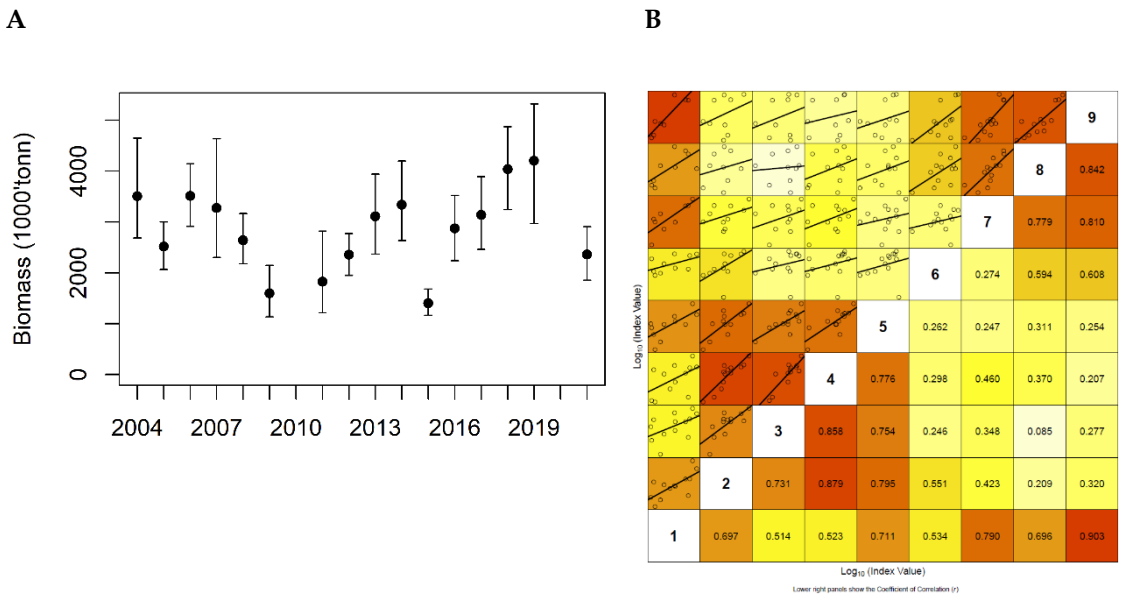
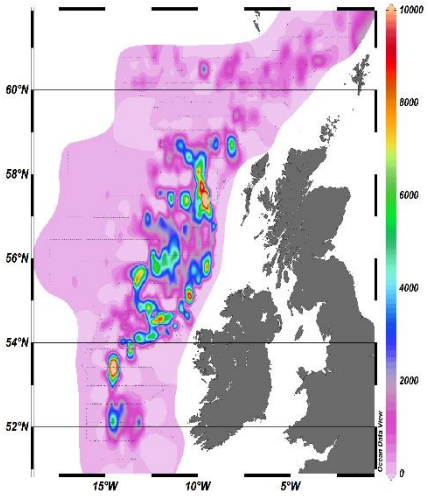
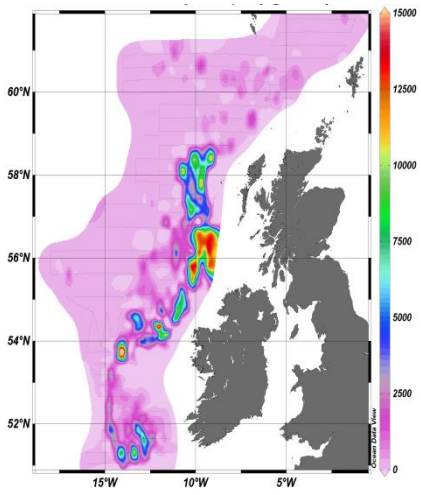


Figure 2.3.7.1.1. Blue whiting. (A) Estimate of total biomass from the International blue whiting spawning stock survey. The black dots and error bands are StoX estimates with 90 % confidence intervals. (B) Internal consistency within the International blue whiting spawning stock survey. The upper left 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.



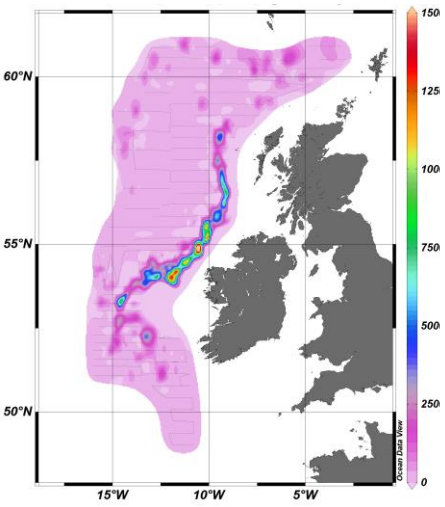
2018



2019

NO SURVEY

2020



2021

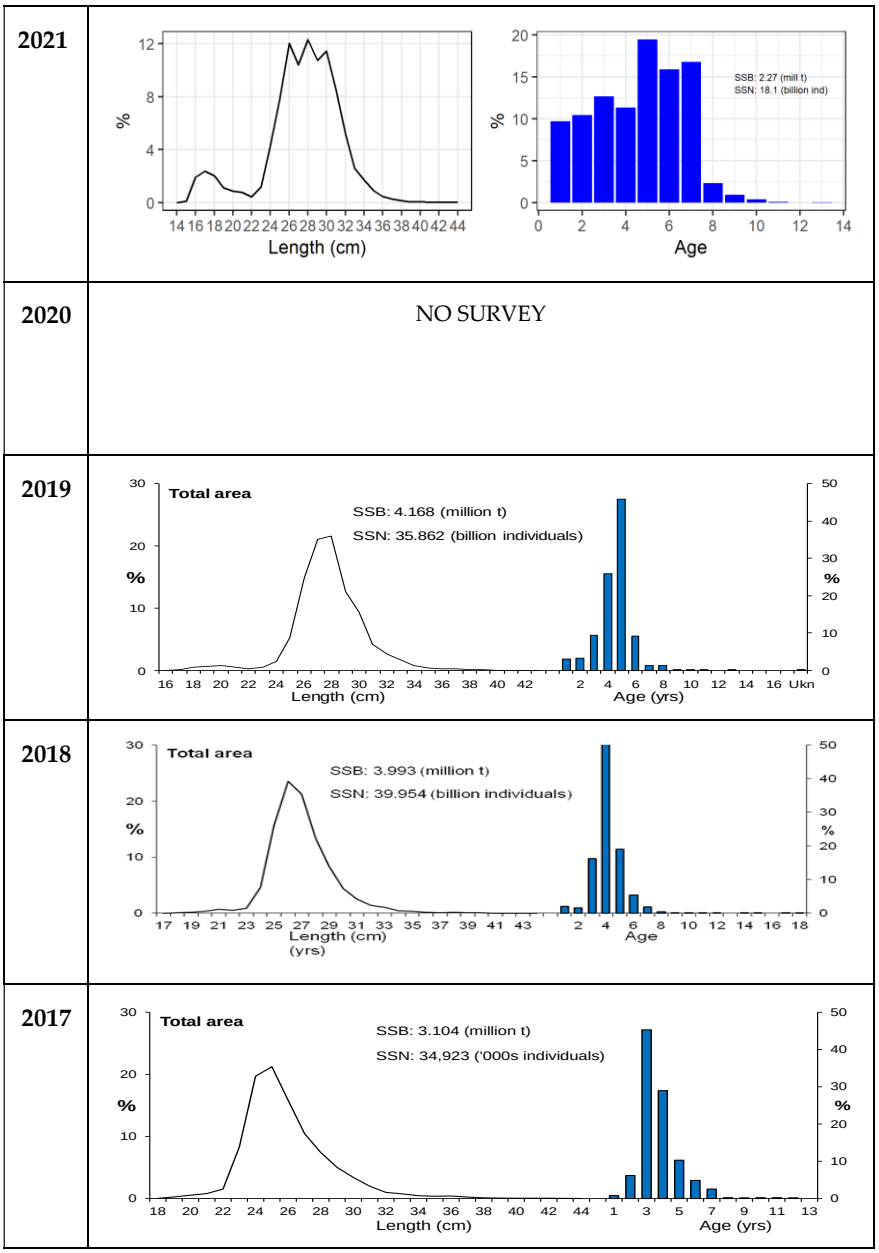


Figure 2.3.7.1.3. Blue whiting. Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2017 (lower panel) to 2021 (upper panel). Spawning-stock biomass and numbers are given.

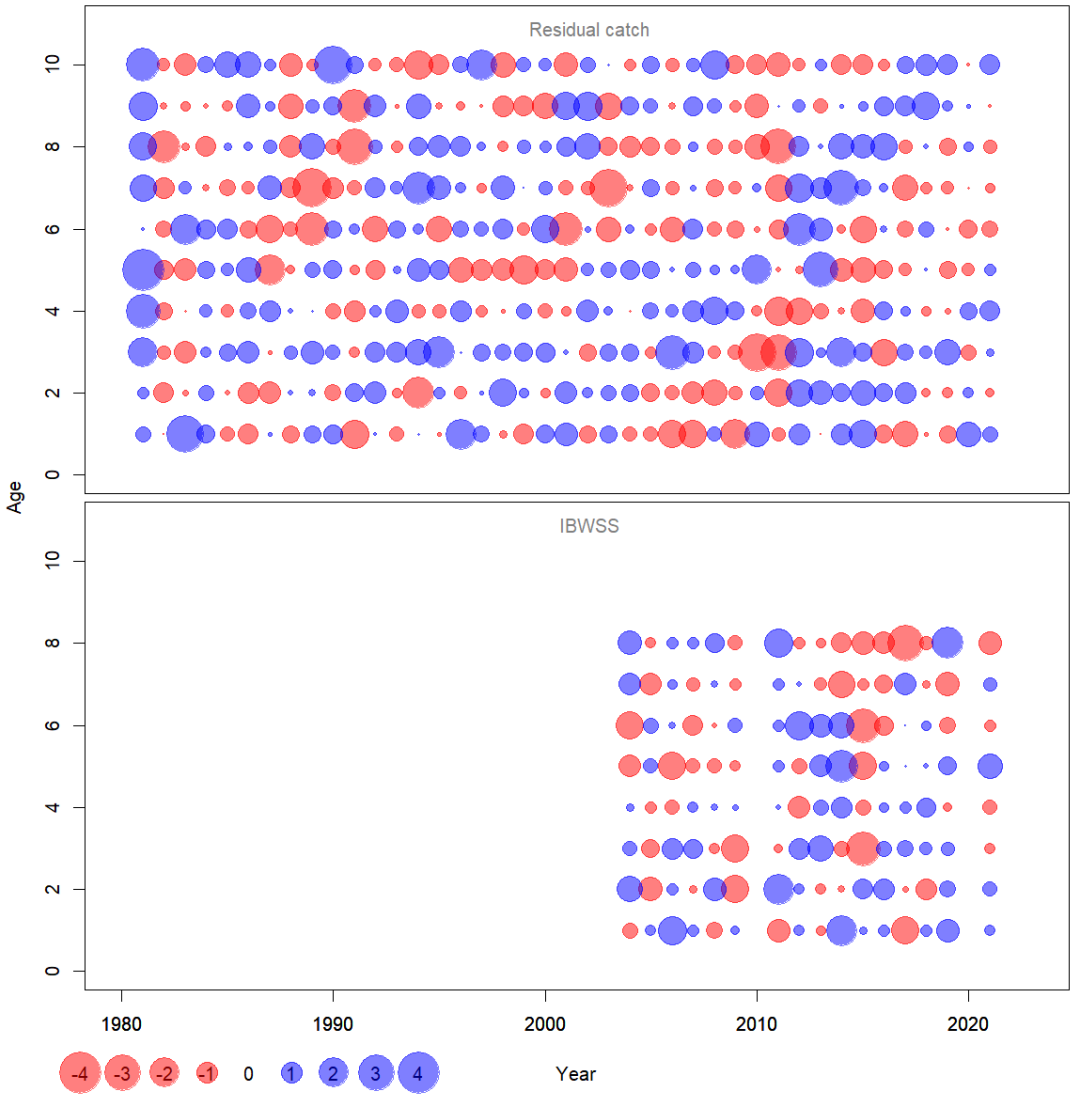


Figure 2.4.1.1. Blue Whiting. OSA (One Step Ahead) residuals (see Berg and Nielsen, 2016) from catch-at-age and the IBWSS survey 2004-2021 (no survey in 2020). Red (lighter) bubbles show that the observed value is less than the expected value. Preliminary catch data for 2021 have been used.

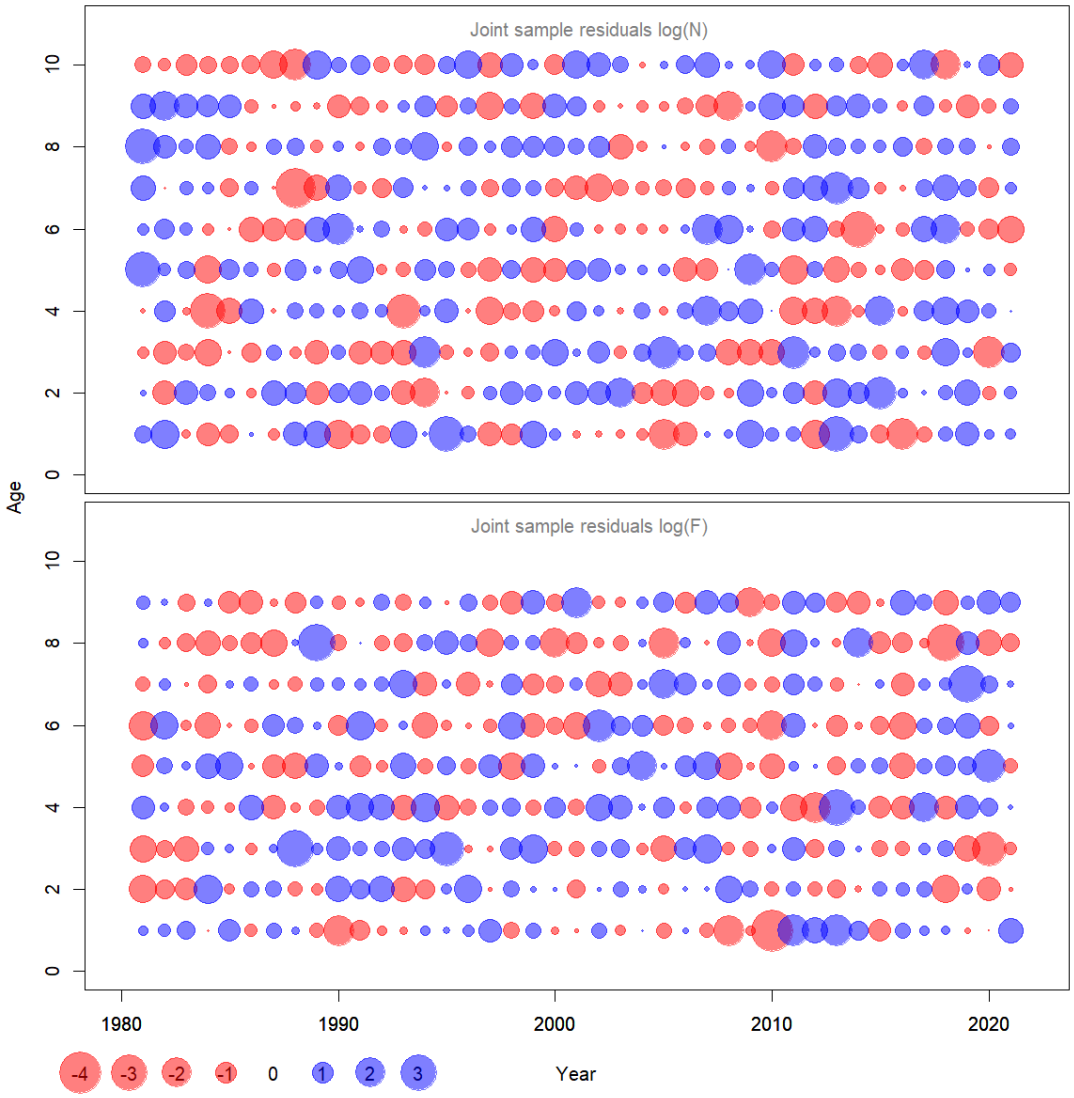


Figure 2.4.1.2 Blue whiting. Joint sample residuals (Process errors) for stock number and F at age. Red (lighter) bubbles show that the observed value is less than the expected value. Preliminary catch data for 2021 have been used.

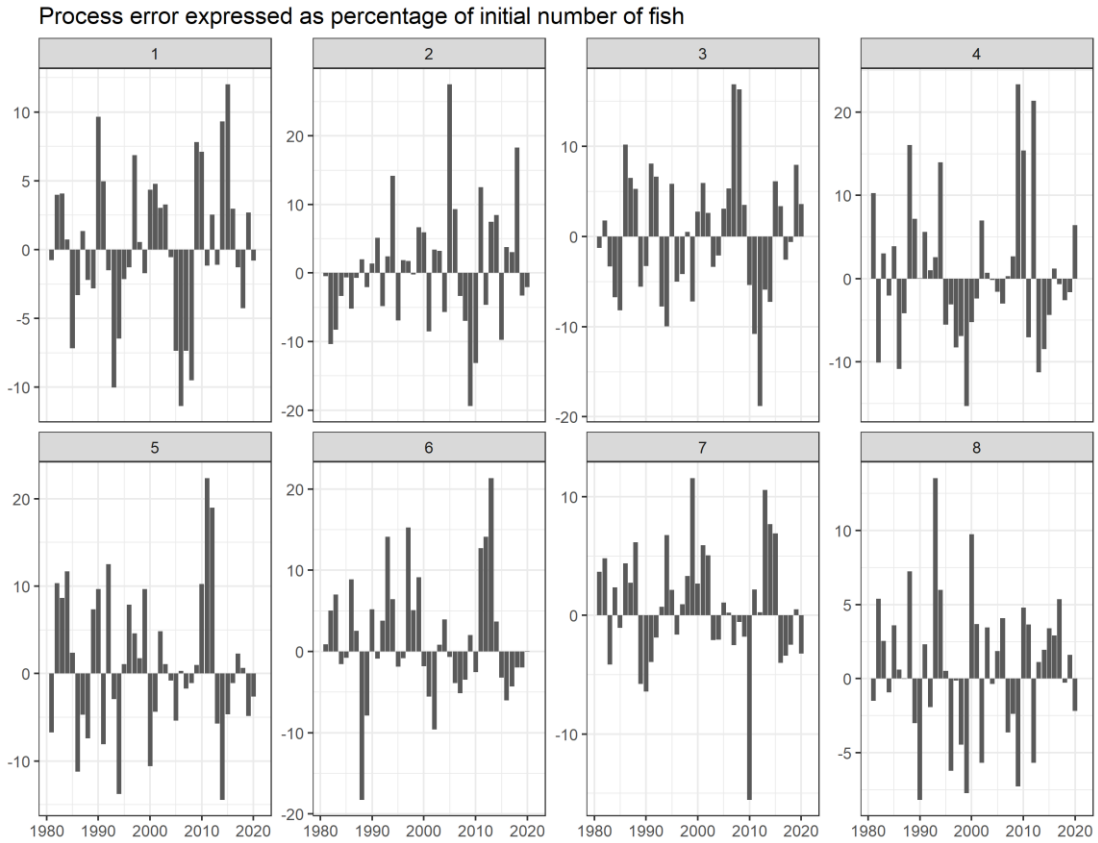


Figure 2.4.1.3. Blue whiting. Process errors expressed as deviation in instantaneous mortality at age by age and year.

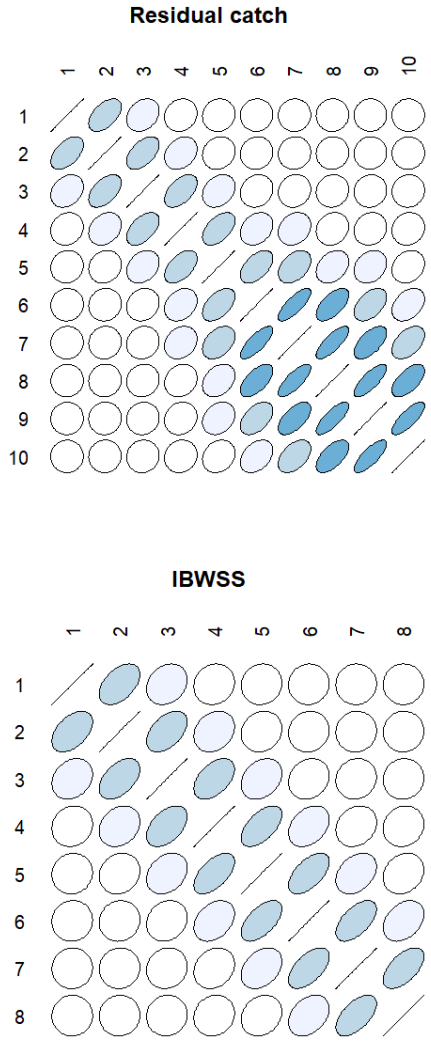


Figure 2.4.1.4. Blue whiting. The correlation matrix between ages for the catches and survey indices. Each ellipse represents the level curve of a bivariate normal distribution with the corresponding correlation. Hence, the sign of a correlation corresponds to the sign of the slope of the major ellipse axis. Increasingly darker shading is used for increasingly larger absolute correlations, while uncorrelated pairs of ages are depicted as circles with no shading. Preliminary catch data for 2021 have been used.

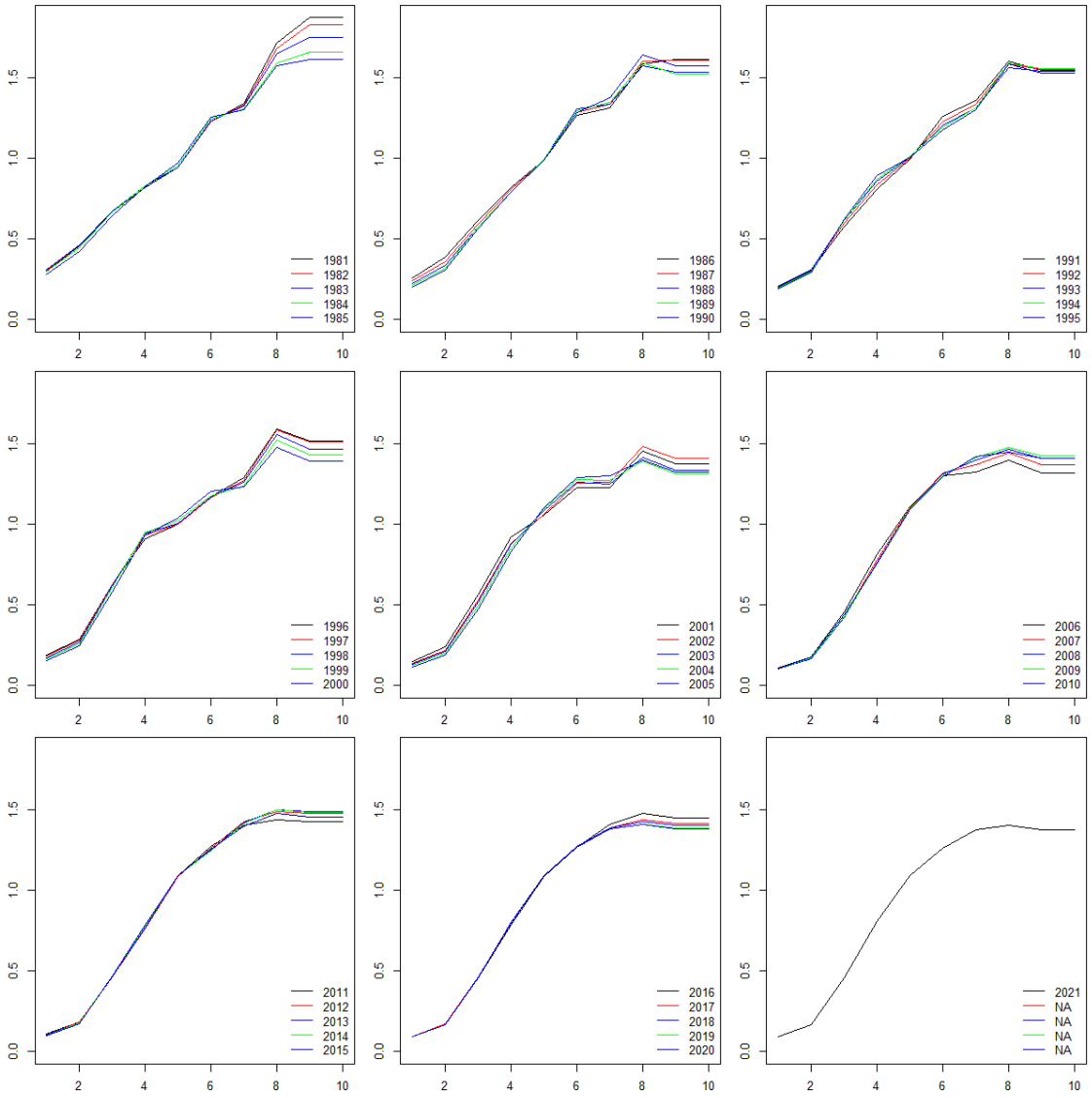


Figure 2.4.1.5. Blue whiting. Exploitation pattern by 5-years' time blocks. Preliminary catch data for 2021 have been used.

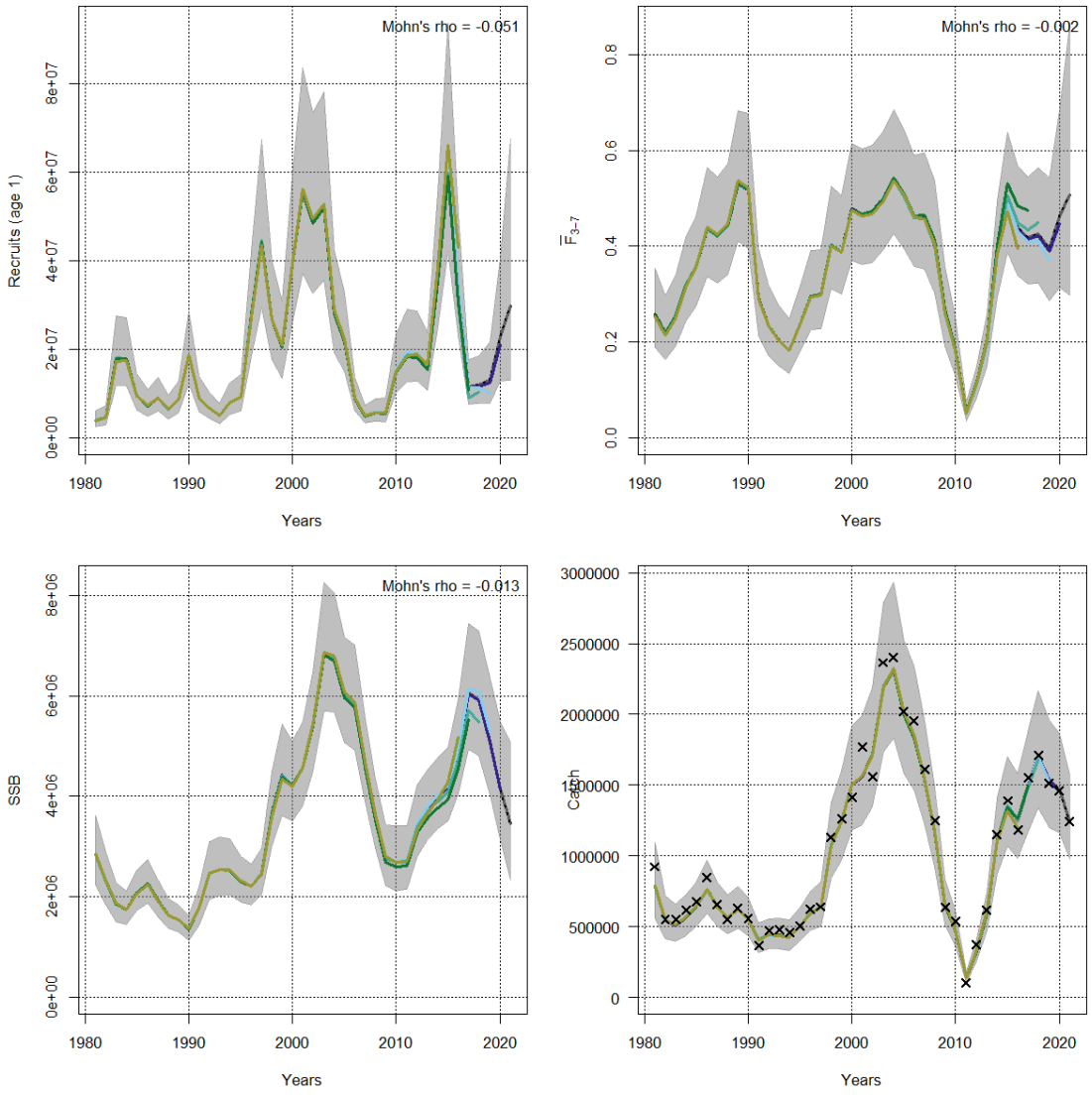


Figure 2.4.1.6. Blue whiting. Retrospective analysis of recruitment (age 1), SSB (tonnes), F and total catch using the SAM model. The 95% confidence interval is shown for the most recent assessment.

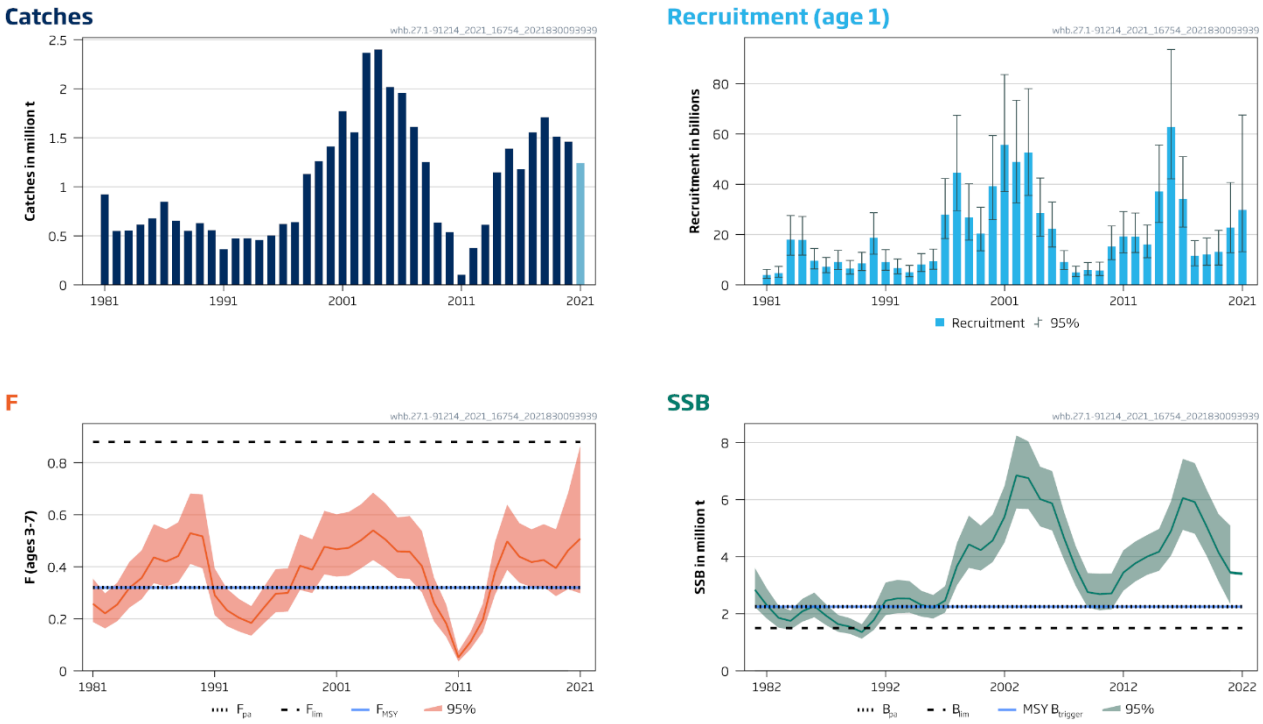


Figure 2.4.1.7. Blue whiting. SAM final run: Stock summary, total catches, recruitment (age 1), F and SSB. The graphs show the median value and the 95% confidence interval. Catches for 2021 are preliminary.

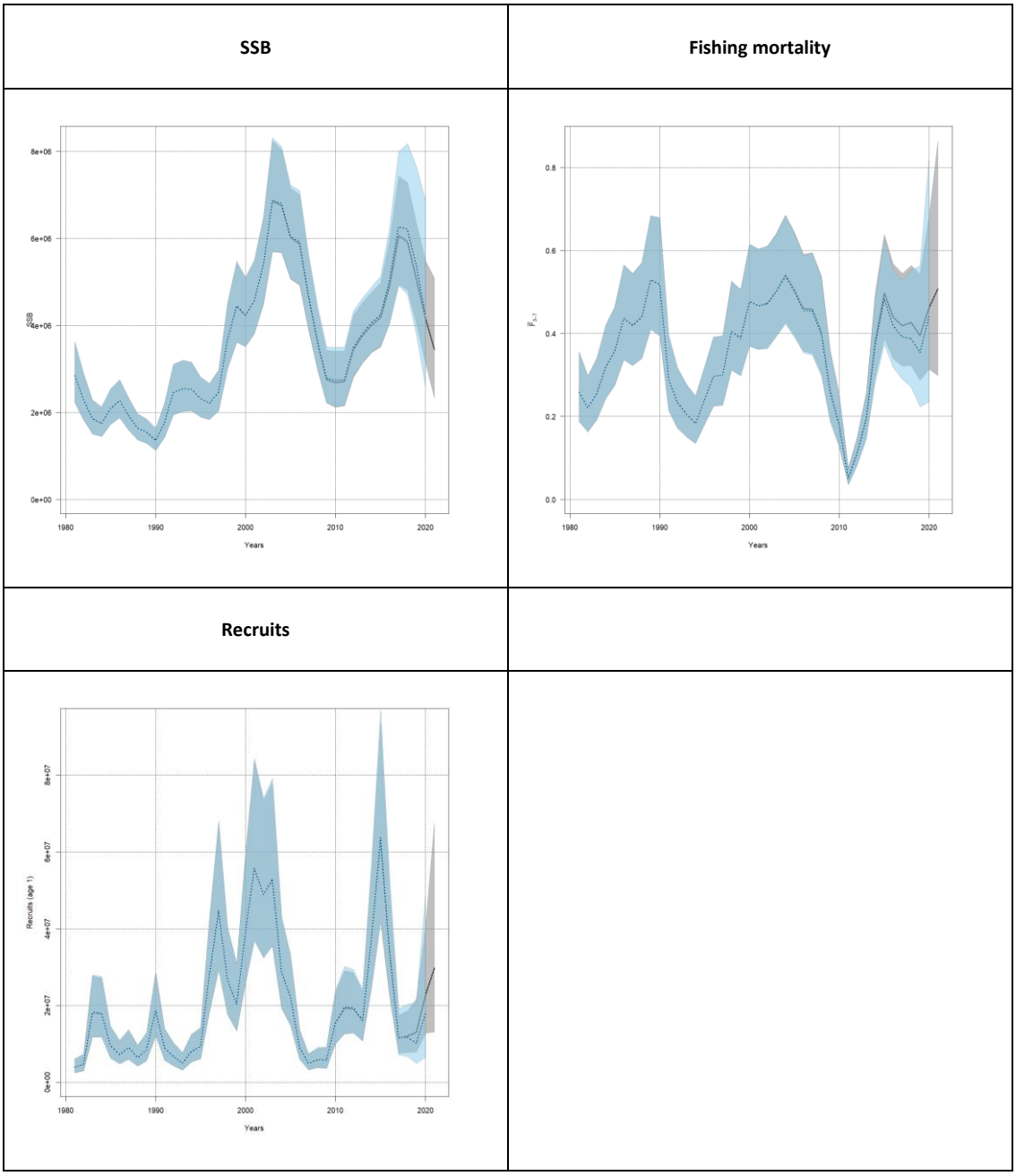


Figure 2.4.1.8. Blue whiting. SAM final run: Comparison of the 2020 and 2021 stock assessments, shown with 95% confidence intervals. Catches for 2021 are preliminary.

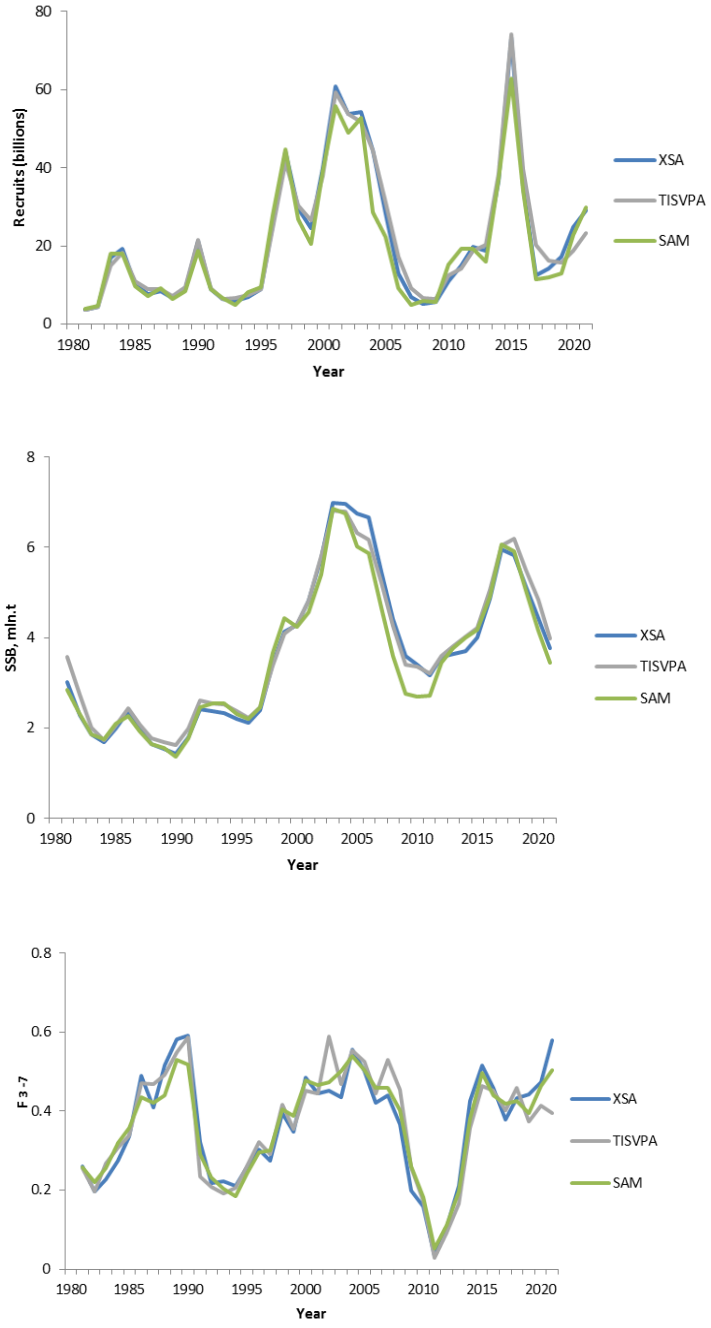


Figure 2.4.3.1. Blue whiting. Comparison of SSB, F and recruitment estimated by the assessment programs XSA, TISVPA and SAM. Catch values for 2021 are preliminary.

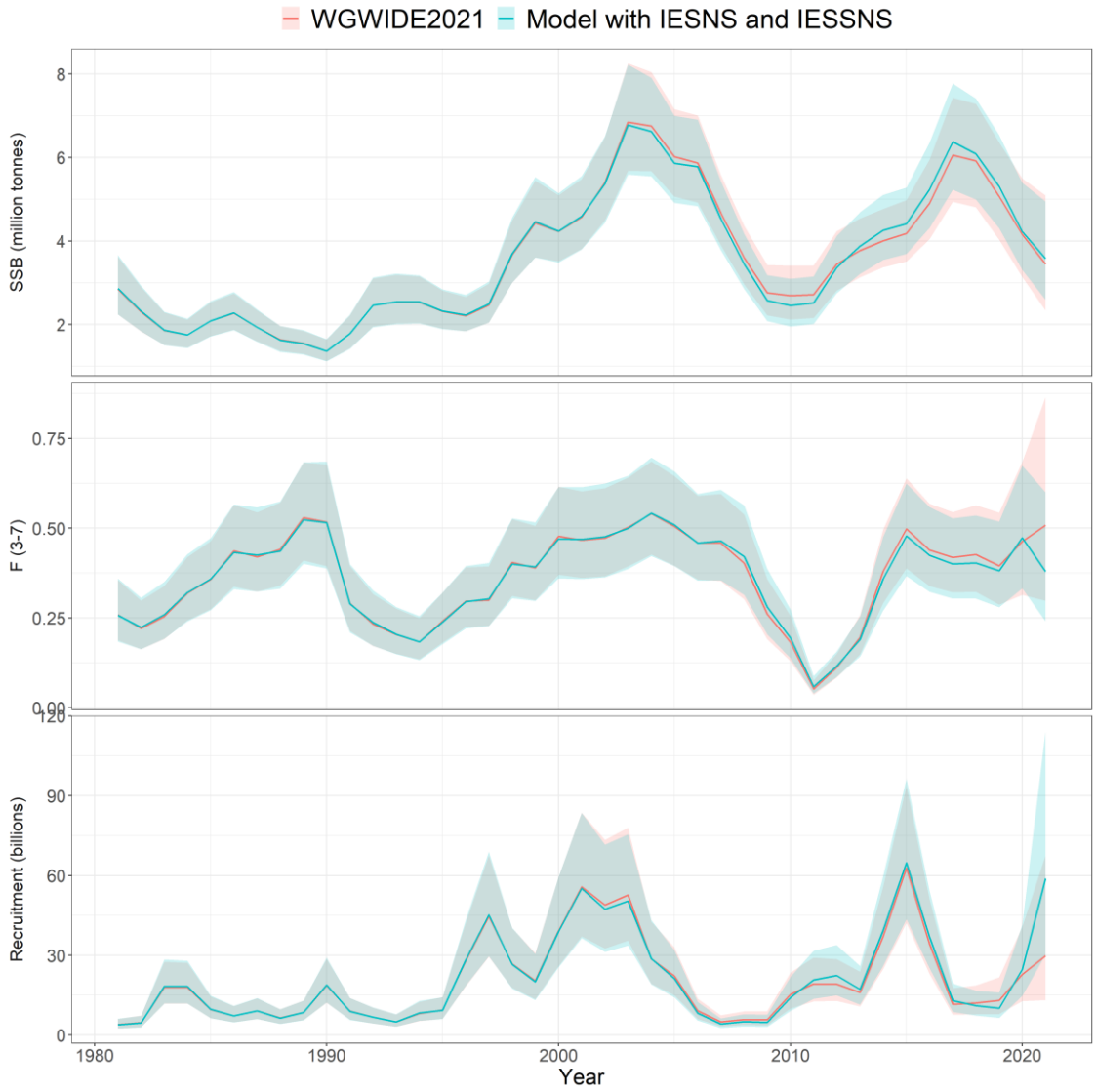


Figure 2.4.3.2. Blue whiting. Comparison of SSB, F and recruitment estimated by the official WGWIDE 2021 SAM model and an alternative version including the two surveys IESNS and IESSNS. Catch values for 2021 are preliminary.

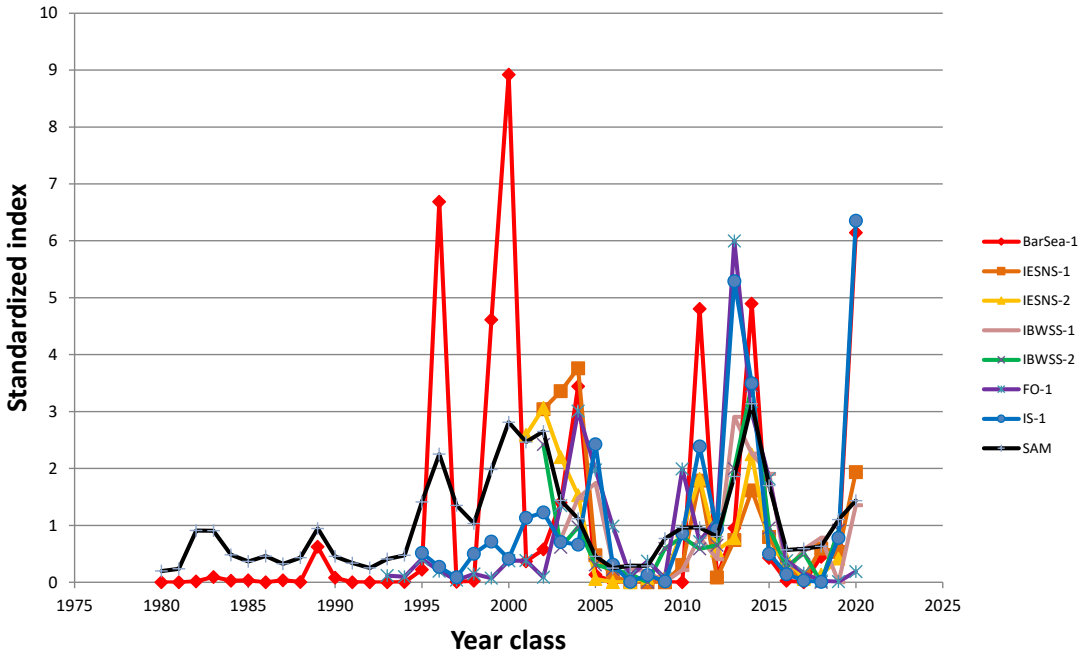


Figure 2.8.1.1. Blue whiting young fish indices from five different surveys and recruitment index from the assessment, standardized by dividing each series by their mean. BarSea - Norwegian bottom-trawl survey in the Barents Sea, IESNS: International Ecosystem Survey in the Nordic Seas in May (1 and 2 is the age groups), IBWSS (Not updated in 2020): 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.

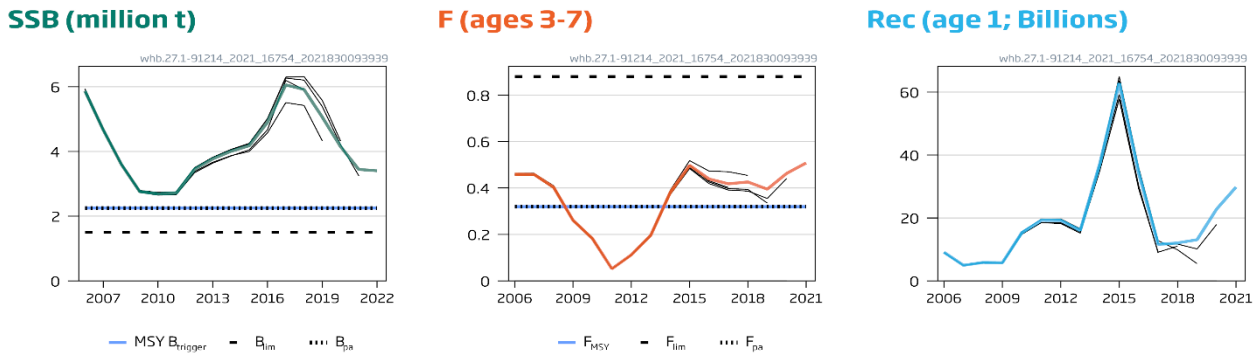


Figure 2.9.1. Blue whiting. Comparison of the 2017 - 2021 assessments.