

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 metres, 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.

Russian catches for 2021 and preliminary data for 2022 were not reported to ICES for use by WGWIDE 2022, which changed the default data compilation of international catch data, and have probably increased the uncertainty of the assessment.

2.1 ICES advice in 2021

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 2019 is estimated to be low, followed by a slight increase. ICES advises that when the long-term management strategy, agreed by the European Union, the Faroe Islands, Iceland, and Norway, is applied, catches in 2022 should be no more than 752 736 tonnes.

2.2 The fishery in 2021

Total catch of blue whiting by Russia in 2021 was not reported to ICES for consideration by WGWIDE 2022. Preliminary catch data for quarters 1 and 2 of 2021 (submitted by Russia to WGWIDE 2021) has therefore been used in compiling the total catch in 2021 (1.143 million tonnes, Table 2.3.1.1 and Section 2.3). The description of the 2021 fishery below does not include the Russian fishery.

As in previous years, 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 (87.3%) 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 and around the Faroes. Smaller quantities were taken in the southern part of the Norwegian Sea, in the Norwegian Trench, in the Rockall Trough 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 2021 consisted of several types of vessels from 17 countries. The bulk of the catch is caught by 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, 85-90% of the total 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 2021 data as reported to ICES and a brief description of the 2022 preliminary catch data. A section describing the procedure adopted to estimate the catch-at-age and the catch-at-weight corresponding to the missing data from Russia was also included (2.3.1.3)

2.3.1 Officially reported catch data

Official catches in 2021 were estimated as 1 143 450 tonnes based on data provided by WGWIDE members (Table 2.3.1.1). Data provided as catch by rectangle represented 86% of the total WG catch in 2021.

In 2021, the majority of catches were caught on the spawning grounds with largest contribution from ICES divisions 27.7.c, 27.7.k and 27.5.b, 27.6.a (Figure 2.3.1.1; Tables 2.3.1.2, 2.3.1.3), 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 in 27.6.a, 27.5.b, 27.7.c and 27.7.k, while later in the year catches are mainly taken further north in division 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 2021 are similar to previous years (Figures 2.3.1.2, 2.3.1.3, 2.3.1.4; Table 2.3.1.4 and Figure 1.10.7 in Section 1). The majority of the blue whiting catch was caught by four 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.

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) discards ranged between 43% and 38% (in weight). In 2021, discards were 44% of the total catches for blue whiting along the Portuguese coast (Table 2.3.1.5). The total catch from Portugal is less than of one percent 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 8% (in weight) in 2021 (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. Discards data contributed to final catches of the following countries: Denmark, Ireland, Portugal, Spain, UK (England and Wales) and UK (Scotland). The total discards constituted 0.34% of the total catches, 3 936 tonnes. The largest fishing nations, Norway, Faroe Islands, Russia and Iceland do not have discards on blue whiting.

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 2021.

2.3.1.1 Sampling intensity

In 2021, 81% of catches were covered by the sampling program. In 2021, 1 676 length samples and 1 588 age samples were collected from the fisheries with 129 317 fish measured and 15 215 aged. Sampling intensity for blue whiting with detailed information on catch, proportion of catch covered by the sampling program, the number of samples, number of fish measured, and number of fish aged per year from 2000 to 2021 is given in Table 2.3.1.1.1. Sampling intensity per country, quarter and ICES division for 2021 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 and Sweden, which together represent 6% 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 2021, data from ICES area 27.6.a is presented by quarter and country (Figure 2.3.1.2.1). The mean length (mm) by age reveals that age classifications do present some differences between countries. A difference in mean length-at-age was observed in age 1. Although, the differences in mean length-at-age increase in older ages, higher than age 7.

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

2.3.1.3 Missing data

ICES estimated missing data from Russia using the 2021 ICES preliminary catch statistics reported by the Russian governmental statistical office and the 2021 preliminary available catch-at-age and catch-at-weight data for quarters 1 and 2 submitted to WGWIDE in 2021. A comparison between the ICES preliminary catch statistics reported by the Russian governmental statistical office with the final data submitted to WGWIDE for the most recent years (2018 to 2020) revealed no differences between the two data sources. Also, the comparison between the submitted data to WGWIDE, i.e. between the preliminary available catch-at-age and catch-at-weight data for quarters 1 and 2 and the final data, was performed. From the comparison between the preliminary data with the finalized data, no differences were found for quarter 1, but for quarter 2 a difference in average of around 8% in total catch was found. For the period between 2018 and 2020, 89% of the Russian total catches were from quarters 1 and 2. The allocation of the total catch by ICES area and quarter was based on the spatial and temporal pattern distribution observed

in the period 2018 until 2020. For ICES areas 27.6.b and 27.7, Russian catches were taken during quarter 1 and were included in the data submitted to WGWIDE in 2021. For the other ICES areas (27.2.a, 27.4.a, 27.5.b and 27.6.a), the approach for the ICES estimates by quarter was based on the average catch distribution from the period 2018 to 2020. Russian data on age composition of the catch in 2021 for quarters 3 and 4 were not available, however, samples available from other fishing nations operating in the same areas were used to estimate catch and weight at age.

For the 2022 preliminary catch data, the approach to complete the preliminary ICES estimated catches was based on the assumption that the missing Russian data correspond to 13% of the 2022 ICES estimated total preliminary catch in weight for this stock. This assumed percentage was based on data analysis for the most recent 3 years (2019-2021).

2.3.2 Preliminary 2022 catch data (Quarters 1 and 2)

The preliminary catches for 2022 as reported by the WGWIDE members are presented in Table 2.3.2.1.

The spatial distribution of these 2022 preliminary catches is similar to the distribution in 2021 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 2022 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 2021, preliminary and final catch estimates are similar with maximum deviation in 2021 when the final catch was 8.3% lower 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 with the exception of an increase in age 1 in the final data from 2021 compared to the preliminary 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

The catch in numbers-at-age from 1981 to 2022 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, the late 1990s and early 2000's. More recently, the propagation of the large 2014 year class is also evident. In 2021 there is also an indication of a stronger year class in the catch data.

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 2010-2015 show a consistent decline in the stock numbers with an estimated total mortality ($Z=F+M$) around 0.6-0.7 for the ages fully recruited to the fisheries. 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 1981-2022 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. In 2021 and 2022, a decrease in mean weight in almost all ages was observed.

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 2.3.7.1.1 A.

The survey time-series (2004-2022) show variable internal consistency ranging from 0.26 to 0.84 (Figure 2.3.7.1.1 B) The overall internal consistency 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 0.68 and 0.84, but poor ($0.2 < r < 0.3$) between ages 5 to 7. This may indicate age readings problems for this group of ages.

The distribution of acoustic backscattering densities for blue whiting for the period 2019-2022 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 2018 to 2022 are given in Figure 2.3.7.1.3.

Survey indices, (ages 1-8 years 2004-2022) 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 have been considered as a main target species in this survey since 2016 and as such methods were changed to ensure there was sampling for 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 in 2021 and 2022.

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.

At WGWIDE in 2021 the time period for estimating recruitment for the short term forecast was changed from the full time series (minus terminal year) to the more recent period since 1996 (minus terminal year). This approach was again followed by WGWIDE 2022.

2.4.1 2022 stock assessment

For a model such 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 may be an indication of a "year effect" (too low index values) for the IBWSS 2015 observations which has also been seen in previous assessment.

The estimated parameters from the SAM model from this year's assessment and those from assessments conducted since 2018 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 therefore 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 reasonably well randomly distributed. Process noise within 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 the 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 change in exploitation pattern. 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 stable exploitation pattern might be influenced by the use of correlated random walks for F at age with a high estimated correlation coefficient ($\text{Rho} = 0.93$, Table 2.4.1.1).

The retrospective analysis (Figure 2.4.1.6) shows a reasonably stable assessment for the last 5 years, with the previous years within the 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). The annual values are rather high (and negative) for recruitment such that the average Mohn's rho for recruitment becomes -0.257. Last year this value was -0.051 due to a large positive value in the first year (which not is used anymore) but also lower absolute values for the negative values in the remaining 4 years. The average Mohn's rho for F and SSB indicates 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 decreased to around 0.35 (above F_{MSY} at 0.32). Recruitment (age 1) was high in 2015, followed by a lower recruitment in 2016 and much lower recruitments in 2017-2020. The recruitment in 2021 is estimated to be a historical high. SSB has increased since 2021 with a huge increase from 2022 to 2023 when 40% of the large 2021 recruitment is assumed to be mature.

A comparison of the assessments in 2021 and 2022 (Figure 2.4.1.8) shows a substantial revision of the historical values of F , SSB and recruitment for the most recent years of the assessment. The 2021 recruitment is now estimated to be at a historical high (71.6 billion) while last year's estimate for the same year class was 22.8 billion. F for 2021 is now estimated at 0.36 while the same value in last year's assessment was 0.51. Likewise SSB for 2022 is now estimated to 4.96 million tonnes while last year's value was 3.40 million tonnes.

The reasons for this revision is linked to 1) an historical high survey index for the age 2 in 2022 (the 2020 year class) corroborated by high commercial catch at age of the same year class in 2021 and 2022, and 2) the use of (uncertain) preliminary catch data for 2021 in the 2021 assessment.

With respect to point 1, while the IBWSS index for age 2 in 2022 is a historical high, the index for age 1 in 2021 was not especially high such that last year's estimate of year class strength was not especially high. Preliminary catch corroborate the high age 2 index with high age 2 catch numbers in 2022 (6th highest in the time series back to 1981) and high age 1 catches in 2021 (8th highest in the time series). Data for other surveys confirm the large 2020 year class (see section 2.3.7 for further discussion).

With respect to point 2, the final numbers at age in the catch are higher than the preliminary catch for age 1, while the final catch data are lower than the preliminary data for age 2-10+ (Figure 2.3.2.2). The final total catch weight is 8.3% lower than the preliminary values for 2021 (Table 2.3.2.4). Figure 2.4.1.9 shows the results from the default assessment configuration, a configuration without preliminary catches for 2022, and a configuration with preliminary catches for 2021 (last year's data not updated) and preliminary data for 2022. When the preliminary catch data for 2021 are maintained (without updating to "final" data), F becomes higher and SSB lower in the final year compared to the default run, as the total catch weigh for the 2021 preliminary catch is higher than the final. Recruitment in 2021 is however estimated lower when the 2021

preliminary data are applied as the catch at age number for age 1 is lower in the preliminary data set. The exclusion of the preliminary catch data provides a similar result for F and SSB as the default configuration. Recruitment in 2021 is also similar but recruitment for 2022 is estimated higher in the run without 2022 catches, as the historically high age 1 index from the IBWSS 2022 data is not corroborated by high catch numbers in the preliminary catch data. If the preliminary catch data for 2021 (applied in last year's assessment) had been a more accurate estimate of the final data, the revision of the historical F and SSB between the 2021 and 2022 assessments would have been smaller. This is seen for the retrospective analysis (Figure 2.4.1.6). F in 2021 was estimated to 0.43 when 2021 was the terminal year (with final 2021 catch at age) whereas the F in 2021 in previous year's assessment was 0.51, as it used the preliminary 2021 catch data.

If the preliminary 2022 catch are not used, estimates of $SSB(2022)$ and $F(2021)$ becomes very similar to the results from the default run compared with the default assessment (Figure 2.4.1.9). Recruitment in 2022 is however estimated considerably higher, as the survey index is at a record high for age 1 in 2022 IBWSSS and there are no additional catch data.

2.4.2 Alternative model runs

The working document WD08 “Blue whiting, an updated alternative assessment including more surveys” (Hølleland *et al.*, 2022) describes an alternative assessment presented to the WGWIDE in 2021. The assessment is a SAM assessment, and makes use of two (IESNS and IESSNS) additional survey indices for blue whiting. The time series for IESSNS is still relatively short (7 years), while the IESNS has been running for 15 years. The alternative assessment gave similar results with a slightly lower SSB and higher F point estimate compared to the presently used SAM (Figure 2.4.2.1). The estimated recruitment in 2021 and 2022 was however larger in the alternative assessment, due to high abundance of age 1 in 2021 and 2022 in both additional surveys.

The WGWIDE assessment for 2021 estimated an F of 0.508, while in the 2022 assessment there was a large correction for this year to 0.356. This could be related to lack of information from the cancelled IBWSS in 2020 or an overestimate of the catches for 2021. The estimated F from the alternative assessment was quite consistent between the 2021 and 2022 assessments (see Figure 2.4.2.2).

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 1981–2022, with catch data up to 2021 and preliminary catch data for the first half-year (Q1 and Q2) of 2022 raised to expected annual catches, and survey data from March–April, 2004–2022. SSB 1st January in 2022 is estimated from survivors and estimated recruits (for 2022 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 (2022) on the stock is above F_{MSY} and between F_{pa} and F_{lim} ; spawning-stock size (2023) is above MSY $B_{trigger}$, B_{pa} and B_{lim} .

F increased from a historic low at 0.052 in 2011 to around 0.50 in 2015 followed by a decrease in F to 0.37 in 2022. F has been above F_{MSY} and F_{pa} 0.32 since 2015. SSB has increased from 2020 (4.48 million tonnes) to an almost historical high in 2023 (6.66 million tonnes). SSB has been above MSY $B_{trigger}$ since 1998.

Recruitment (age 1) in 2021 is estimated to be at a historical high. Survey data indicates that the 2022 recruitment is also above average, but this estimate has a high uncertainty.

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 $F_{p0.05}$ (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	$B_{lim} \exp(1.645 \times \sigma)$, with $\sigma = 0.246$	ICES (2013a, 2013b, 2016b)
	F_{lim}	0.88	Equilibrium scenarios with stochastic recruitment: F value corresponding to 50% probability of ($SSB < B_{lim}$)	ICES (2016b)
	F_{pa}	0.32	F_{p05} ; the F that leads to $SSB \geq B_{lim}$ 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 (2021 year class) and the 2-group (2020 year class) indices from the survey in 2022 were both well above the median of the historical range.

The 1-group (2021 year class) and the 2-group (2020 year class) indices from The International Blue Whiting Spawning Stock Survey (IBWSS) were both the highest 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 2022, showed that 1-group blue whiting was above the median 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 2022 (2021 year class) from the Icelandic bottom-trawl survey showed an increase compared to 2021 and was the highest in the time-series.

The 1-group estimate in 2022 (2021 year class) from the Faroese Plateau spring bottom-trawl survey showed a decrease compared to 2021 and was below the median in the time-series. This is the only survey which doesn't pick up a strong signal from the 2020 and 2021 year classes.

In conclusion, the indices from available survey time-series indicate that the 2020 year class is among the strongest in the time series, which corresponds to the SAM assessment results. The 2021 year class estimated from surveys are also above the median, also seen in the SAM assessment. It was therefore decided not to change the SAM estimates of the 2020 and 2021 year classes for the purposes of the short term forecast.

No information is available for the 2022 and 2023 year classes and the geometric mean of the time-series from 1996-2021) was used for these year classes (22.5 billion at age 1 in 2023) (Table 2.8.1.1).

As described in the Stock Annex, WGWIDE decided in 2021 to change from using the geometric mean of the full time-series (since 1981) to use a shorter time-series (since 1996) for the calculations recruitment.

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 (2020–2022) 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 as used by the assessment.

Recruitment (age 1) in 2021 and 2022 are assumed as estimated by the SAM model, as additional survey information was not conflicting this result. Recruitment in 2023 and 2024 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, 1996-2021).

As the assessment uses preliminary catches for 2022 an estimate of stock size is available for the 1st of January 2023. The normal use of an “intermediate year” calculation is not relevant in this case and F in the “intermediate year” (2022) is as calculated by the assessment model. Catches in 2022 are based on the preliminary catches based on declared national quotas and expected national uptake for 2022. 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 for the target F from the LTMS implies fishing mortality to be at $F_{MSY} = 0.32$ which will give a TAC in 2022 at 1 359 629 tonnes. This corresponds to a 80.6% increase compared to the ICES advice last year, and a 22.8% increase compared to the preliminary estimate of catches in 2022.

The LTMS specifies a default TAC constraint at +25/-20%. However, it states that the TAC constraint shall not be applied when the TAC advice deviates more than 40% from the TAC of the preceding year (paragraph 6b in the LTMS). With an increase of 80.6% in catches in relation to the ICES advice last year (LTMS advice), the TAC constraint is not applied.

SSB in 2024 is predicted to increase by 17.5% to 7 781 444 tonnes, if the advised catches are taken. The high recruitment estimated for 2021 and 2022 contributes to this increase in SSB.

2.9 Comparison with previous assessment and forecast

Comparison of the assessment made in 2021 and 2022 (Figure 2.4.1.8) shows a substantial revision of the historical values of F , SSB and recruitments. The 2021 recruitment is now estimated to be historical high (71.6 billion) while last year's estimate was 22.8 billion. F for 2021 is now estimated to 0.36 while the same value in last year's assessment was 0.51. Likewise SSB for 2022 is now estimated to 4.96 million tonnes while last year's value was 3.40 million tonnes. See section 2.4.1 for further discussion.

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) shows a tendency to underestimate recruitment, but unbiased estimates of F and SSB. An alternative run (Figure 2.4.2.1) with the SAM model using two additional surveys (IESNS and IESSNS) not covering the full distribution area shows results consistent with the default configuration of the assessment.

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

calibration exercise. The use of additional survey data may be beneficial, especially in years without IBWSSS data, however the length of the time series is still short (7 years) for the survey (IESSNS) with a low observation variance for age 1 and 2.

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 potentially biased survey data in the final year are supplemented by additional catch data. The preliminary catch weight was however 9% higher than the final data for 2021, although the differences are smaller for the year 2016-2020.

2.11 Management considerations

The assessment this year estimates a lower $F(2021)$, a higher $SSB(2022)$ and a much larger 2020 year class size than estimated last year. The 2020 year class will be fully recruited to the fishery in 2023 and contribute considerably to the SSB (82% mature at age 3). SSB in 2023 is estimated to be well above $MSY B_{trigger}$, but F in 2021 and 2022 remains above F_{MSY} .

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 tonnes during the period from 1981 to 2020 (ICES, 2020). The stock is widely distributed and highly migratory. Its 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 are 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). Blue whiting is an important species in the NE Atlantic and its 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 causal 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).

(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).

(c) It is still disputed whether 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.

(d) Trophic interactions in the Norwegian Sea: there 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 competition between blue whiting and mackerel can be explained by limited vertical spatial 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).

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 2022 to be 1 107 529 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 752 736 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. The sum of unilateral quotas for 2022 exceeds the agreed TAC.

2.13.1 Management plans and evaluations

A response to a 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 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 B_{lim} (1.5 million t), B_{pa} (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 B_{pa} . However, the 20% TAC change limits can lead to the TAC being lowered significantly if the stock is estimated to be below B_{pa} , while also limiting how quickly the TAC can increase once the stock is estimated to have recovered above B_{pa} .
- 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.

The Agreed Records by the Coastal States (25-26 October 2021) states a TAC for blue whiting at 752 736 tonnes for 2022, as advised by ICES (on the basis of the LTMS from 2016). Annex 1 of the Agreed Records “Arrangement for the long-term management of the blue-whiting stock” is similar to the managing plan evaluated by ICES in 2016, but the present version of the LTMS includes a paragraph 6: *The TAC constraint described in Paragraph 5 shall not apply if:*” and a paragraph 6b: *“The rules in paragraph 4 [TAC from $F=F_{MSY}$, when SSB is above $B_{trigger}$] would lead to a TAC that deviates by more than 40% from the TAC of the preceding year.”*. The management plan evaluated by ICES in 2015-2016, described in the WKBWMSE (ICES 2016b) report, did not include the deviation from the default -20%/25% TAC constraint as described in paragraph 6 of the presently used LTMS. Therefore, ICES has not evaluated the presently used plan.

2.14 Recommendations

No recommendations.

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 and 2022. The stock assessment this year followed the approach outlined in the Stock Annex.

2.16 References

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2.17 Tables

Table 2.3.1.1. Blue whiting. ICES estimated catches (tonnes) by country for the period 1988–2021.

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 1988–2021.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Denmark	89500	41450	54663	48659	18134	248	140	165	340	2167	35256	45178	39395	60868	87348	68716	58997	40321
Estonia	*															0		
Faroe Islands	322322	266799	321013	317859	225003	58354												
							49979	16405	43290	85768	224700	282502	282416	356501	349838	336569	343372	202415
France		8046	18009	16638	11723	8831	7839	4337	9799	8978	10410	9659	10345	13369	16784	16095	13769	14612
Germany	15293	22823	36437	34404	25259	5044	9108	278	6239	11418	24487	24107	20025	45555	47708	38244	42362	35327
Iceland	379643	265516	309508	236538	159307	120202	87942	5887	63056	104918	182879	214870	186914	228934	292944	268356	243725	190146
Ireland	75393	73488	54910	31132	22852	8776	8324	1195	7557	13205	21466	24785	27657	43238	49903	38836	40135	39514
Lithuania			4635	9812	5338						4717		1129	5300			9543	21183
Netherlands	95311	147783	102711	79875	78684	35686	33762	4595	26526	51635	38524	56397	58148	81156	121864	75020	62309	62017
Norway	957684	738490	642451	539587	418289	225995	194317	20539	118832	196246	399520	489439	310412	399363	438426	351429	354033	233968
Poland														15889	12152	27185	47616	26077
Portugal	3937	5190	5323	3897	4220	2043	1482	603	1955	2056	2150	2547	2586	2046	2497	3481	2819	2522
Spain	15612	17643	15173	13557	14342	20637	12891	2416	6726	15274	32065	29206	31952	28920	24718	22782	23676	25509
Sweden	19083	2960	101	464	4	3	50	1	4	199	2	32	42	90	16**	54	25	40
UK (England + Wales)	2593	7356	10035	12926	14147	6176	2475	27	1590	4100	11	131	1374+	3447	1864	4062	7458	8783
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	65085
Russia	346762	332226	329100	236369	225163	149650	112553	45841	88303	120674	152256	185763	173655	188449	170892	188006	181496	133605^
Greenland										2133				20212	23333	19753	19611	20190
Unallocated									3499									22137
TOTAL	2380161	2034309	1976176	1625255	1260615	641818	526357	103620	384021	628169	1155279	1396244	1181850	1558061	1711461	1515527	1495248	1143450

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

** only landings (2018).

+ data updated in 2018.

^ Russia 2021 preliminary data (Q1+Q2) submitted to WGWIDE 2021.

Table 2.3.1.2. Blue whiting. ICES estimated catches (tonnes) by country and ICES division for 2021.

ICES Division	Denmark	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Lithuania	Netherlands	Norway	Poland	Portugal	Russia ^	Spain	Sweden	UK (England)	UK(Scotland)	Unallocated	Total
27.4																	100		100
27.2.a	20	27550	296	21	2933	26450			7.62	7918	121		7214		6			19071	91606
27.3.a	98														8				106
27.4.a	63	903	467	2095	344	6861		170	457.01	26578	243		34		25		22	1029	39290
27.4.b	4									8					1				13
27.5.a		1192				19284													20476
27.5.b	98	127617	53	636	12750	101488		127	132.25	973	4053		48792					1920	298640
27.6.a	14476	19565	7296	23309	4163	32826	18577.45	15865	30921.13	52402	14975		24239	3		6251	41400	117	306385
27.6.b		4805				206				1176			2568	20			29		8804
27.7.b	8		455	483			2102.687		5693.73	1092				32		58	2807		12732
27.7.c	16450	2940	3748	8770		1533	14904.99	5021	10909.26	64982			22809	137		2276	20728		175208
27.7.e			62						0.05								1		64
27.7.f				1													19		20
27.7.g				0			554.4149							14			1		569
27.7.h	2		31						260.37					40			4		336
27.7.j	2		2	13			109.572		557.52					368			174		1225
27.7.k	9098	17843	27			1498	3264.397		9731.67	78841	6686		27949	0					154937
27.8.a	3		889						2669.33					9					3570
27.8.b			3											160					164
27.8.c			0									197		16563					16760
27.8.d			1282						676.94										1959
27.9.a												2325		8162					10487
Total	40321	202415	14612	35327	20190	190146	39513.51	21183	62016.88	233968	26077	2522	133605	25509	40	8783	65085	22137	1143450

^ Russia 2021 preliminary data (Q1+Q2) submitted to WGWIDE 2021.

Table 2.3.1.3. Blue whiting. ICES estimated catches (tonnes) by quarter and ICES division for 2021.

ICES Division	Quarter 1	Quarter 2	Quarter 3	Quarter 4	2021*	Total
27.4					100	100
27.2.a	1094	56453	14557	19502		91606
27.3.a	0	11	93	2		106
27.4.a	1084	15793	8037	14376		39290
27.4.b	0	7	1	4		13
27.5.a	1	262	5	20208		20476
27.5.b	52819	227524	16	18281		298640
27.6.a	86866	188481	2	31003	33	306385
27.6.b	8756	19	0	0	29	8804
27.7.b	6443	6263	21	4		12732
27.7.c	162839	12325	16	28		175208
27.7.e	0	1		62		64
27.7.f	20					20
27.7.g	0	13	554	1		569
27.7.h	6	35	4	291		336
27.7.j	151	316	547	212		1225
27.7.k	154911	27	0			154937
27.8.a	0	10	0	3560		3570
27.8.b	80	67	7	10		164
27.8.c	4188	4179	5627	2766		16760
27.8.d	0			1959		1959
27.9.a	1806	4041	2318	2323		10487
Total	481063	515826	31806	114591	162	1143450

*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 1988–2021 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
2021	112082	801768	39509	953359	190091	1143450

* 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 2021.

Country	Catches	Landings	Discards	% discards
Denmark	40321	40269	52	0.13
Faroe Islands	202415	202415	0	0.00
France	14612	14612	0	0.00
Germany	35327	35327	0	0.00
Greenland	20190	20190	0	0.00
Iceland	190146	190146	0	0.00
Ireland	39514	38959	554	1.40
Lithuania	21183	21183	0	0.00
Netherlands	62017	62017	0	0.00
Norway	233968	233968	0	0.00
Poland	26077	26077	0	0.00
Portugal	2522	1417	1105	43.81
Russia ^	133605	133605	0	0.00
Spain	25509	23471	2038	7.99
Sweden	40	40	0	0.00
UK (England)	8783	8758	24	0.28
UK(Scotland)	65085	64923	162	0.25
Unallocated	22137	22137	0	0.00
Total	1143450	1139514	3936	0.34

^ Russia 2021 preliminary data (Q1+Q2) submitted to WGwide 2021.

Table 2.3.1.6. Blue whiting. ICES estimated catches (tonnes) inside and outside NEAFC regulatory area for 2021 by country.

Country	Catches inside NEAFC RA	Catches outside NEAFC RA	Total catches
Denmark	1965	38356	40321
Faroe Islands	27809	174606	202415
France*	0	14612	14612
Germany	57	35270	35327
Greenland	11211	8979	20190
Iceland	4737	185409	190146
Ireland	1202	38312	39514
Lithuania	127	21055	21183
Netherlands	5	62012	62017
Norway*	100017	133952	233968
Poland	7531	18546	26077
Portugal	0	2522	2522
Spain	0	25509	25509
Sweden	0	40	40
UK (England)	0	8783	8783
UK(Scotland)	0	65085	65085
Total in 2021**	154661	833047	987708

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

** without the Russian preliminary catch data and the unallocated catch data.

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 2000-2021.

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
2021	1143450	81	1424	129317	15379

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 2021.

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	40321	94	19	19	817	815	20	20
Faroe Islands	202415	93	17	17	1796	1651	8	9
France	14612	15	21	0	3613	0	0	247
Germany	35327	27	4	4	2492	691	20	71
Greenland	20190	0	0	0	0	0	0	0
Iceland	190146	97	64	64	5639	1725	9	30
Ireland	39514	98	53	29	10548	1800	46	267
Lithuania	21183	0	0	0	0	0	0	0
Netherlands	62017	82	55	55	11483	1350	22	185
Norway	233968	90	68	68	2020	2020	9	9
Poland	26077	0	0	0	0	0	0	0
Portugal	2522	83	34	34	3129	1003	398	1241
Russia ^	133605	88	133	133	40413	1382	10	302
Spain	25509	98	984	984	41289	2259	89	1619
Sweden	40	0	0	0	0	0	0	0
UK (England)	8783	0	13	0	95	0	0	11
UK(Scotland)	65085	95	47	17	5983	683	10	92
Unallocated	22137	0	0	0	0	0	0	0
Total GERAL	1143450	81	1512	1424	129317	15379	13	113

^ Russia 2021 preliminary data (Q1+Q2) submitted to WGWIDE 2021.

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 2021.

Country	Catches (ton)	No. of Length Samples	No. of Length Measured	No. Age Readings
Denmark				
Quarter 1	27685	12	541	539
Quarter 2	10331	7	276	276
Quarter 3	102	0	0	0
Quarter 4	2204	0	0	0
Total	40321	19	817	815
Faroe Islands				
Quarter 1	64013	9	1025	894
Quarter 2	124078	7	702	688
Quarter 3	2541	0	0	0
Quarter 4	11783	1	69	69
Total	202415	17	1796	1651
France				
Quarter 1	237	0	0	0
Quarter 2	12110	5	302	0
Quarter 3	1	0	0	0
Quarter 4	2263	16	3311	0
Total	14612	21	3613	0
Germany				
Quarter 1	21899	1	327	162
Quarter 2	11979	0	0	0
Quarter 3	14	0	0	0
Quarter 4	1434	3	2165	529
Total	35327	4	2492	691
Greenland				
Quarter 2	17737	0	0	0
Quarter 3	79	0	0	0
Quarter 4	2374	0	0	0
Total	20190	0	0	0
Iceland				
Quarter 1	23123	10	739	244
Quarter 2	129192	37	3650	1116
Quarter 3	1861	0	0	0
Quarter 4	35970	17	1250	365
Total	190146	64	5639	1725
Ireland				
Quarter 1	22817	20	5266	1300
Quarter 2	16131	9	2368	500
Quarter 3	554	24	2914	0
Quarter 4	11	0	0	0
Total	39514	53	10548	1800

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 2021.

Lithuania				
Quarter 1	9117	0	0	0
Quarter 4	12066	0	0	0
Total	21183	0	0	0
Netherlands				
Quarter 1	22908	30	5544	737
Quarter 2	32039	22	5219	538
Quarter 3	375	0	0	0
Quarter 4	6694	3	720	75
Total	62017	55	11483	1350
Norway				
Quarter 1	174903	59	1753	1753
Quarter 2	41332	8	237	237
Quarter 3	8130	0	0	0
Quarter 4	9604	1	30	30
Total	233968	68	2020	2020
Poland				
Quarter 1	12445	0	0	0
Quarter 4	13633	0	0	0
Total	26077	0	0	0
Portugal				
Quarter 1	646	6	434	100
Quarter 2	529	12	1092	269
Quarter 3	631	10	825	333
Quarter 4	716	6	778	301
Total	2522	34	3129	1003
Russia ^				
Quarter 1	61551	84	25439	1092
Quarter 2	72054	49	14974	290
Total	133605	133	40413	1382
Spain				
Quarter 1	5502	191	8051	200
Quarter 2	8254	268	9292	709
Quarter 3	7340	313	12849	593
Quarter 4	4414	212	11097	757
Total	25509	984	41289	2259
Sweden				
Quarter 1	0	0	0	0
Quarter 2	0	0	0	0
Quarter 3	9	0	0	0
Quarter 4	31	0	0	0
Total	40	0	0	0

^ Russia 2021 preliminary data (Q1+Q2) submitted to WGWIDE 2021.

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 2021.

UK (England)				
Quarter 1	20	0	0	0
Quarter 2	7136	13	95	0
Quarter 3	180	0	0	0
Quarter 4	1447	0	0	0
Total	8783	13	95	0
UK(Scotland)				
Quarter 1	34198	10	2248	456
Quarter 2	30703	7	872	227
Quarter 4	22	0	0	0
2021*	162	30	2863	0
Total	65085	47	5983	683
Unallocated				
Quarter 2	2223	0	0	0
Quarter 3	9988	0	0	0
Quarter 4	9925	0	0	0
Total	22137	0	0	0
Total Geral	1143450	1512	129317	15379

* discards data not raised by quarter 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 2021.

ICES Division	Catch (tonnes)	No. Length samples	No. Age samples	No. Measured	No. Aged	No Aged/ 1000 tonnes	No Measured/ 1000 tonnes
27.4	100	18	0	1508	0	0	15050
27.2.a	91606	19	14	1936	540	6	21
27.3.a	106	0	0	0	0	0	0
27.4.a	39290	2	2	149	58	1	4
27.4.b	13	0	0	0	0	0	0
27.5.a	20476	13	13	932	287	14	46
27.5.b	298640	54	54	11644	2179	7	39
27.6.a	306385	133	124	21812	3501	11	71
27.6.b	8804	7	4	1670	226	26	190
27.7.b	12732	6	6	1210	174	14	95
27.7.c	175208	179	179	26304	3270	19	150
27.7.e	64	0	0	0	0	0	0
27.7.f	20	0	0	0	0	0	0
27.7.g	569	32	0	2950	0	0	5182
27.7.h	336	30	25	376	0	0	1118
27.7.j	1225	109	109	525	24	20	428
27.7.k	154937	74	74	12187	1835	12	79
27.8.a	3570	7	1	744	23	6	208
27.8.b	164	111	111	1465	0	0	8959
27.8.c	16760	383	383	25706	1066	64	1534
27.8.d	1959	10	0	2890	0	0	1475
27.9.a	10487	325	325	15309	2196	209	1460
TOTAL	1143450	1512	1424	129317	15379	13	113

Table 2.3.2.1. Blue whiting. ICES estimated preliminary landings (tonnes) in 2022 by quarter and ICES division. Data submitted to InterCatch.

	Landings			
ICES div.	Quarter 1	Quarter 2	Quarter 3	Total
27.2.a	1487	14702	65	16253
27.3.a		4	6	11
27.4.a	6026	22379		28405
27.4.b		0.09		0.09
27.5.a		15		15
27.5.b	54091	242073	1	296165
27.6.a	31769	113921		145691
27.6.b	5860	680		6540
27.7	4	28		32
27.7.b	1639			1639
27.7.c	116209	855		117065
27.7.f	0.38			0.38
27.7.g	1			1
27.7.j	2165			2165
27.7.k	69116			69116
27.8.a	5	18		23
27.8.c	4574	7183		11757
27.8.d	2700			2700
27.9.a	362	524		886
Total	296008	402383	72	698463

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 2022 preliminary data (quarters 1 and 2). Data submitted to InterCatch.

ICES Division	Catch (tonnes)	No. samples	No. Measured	No. Aged
27.2.a	16253	1	116	100
27.3.a	11	0	0	0
27.4.a	28405	1	100	100
27.4.b	0	0	0	0
27.5.a	15	0	0	0
27.5.b	296165	6	494	459
27.6.a	145691	31	4645	1458
27.6.b	6540	1	30	30
27.7	32	0	0	0
27.7.b	1639	0	0	0
27.7.c	117065	27	3964	1349
27.7.f	0	0	0	0
27.7.g	1	0	0	0
27.7.j	2165	0	0	0
27.7.k	69116	11	888	516
27.8.a	23	0	0	0
27.8.c	11757	0	0	0
27.8.d	2700	0	0	0
27.9.a	886	18	1526	369
Total	698463	96	11763	4381

Table 2.3.2.3. Blue whiting. ICES estimates of catches (tonnes) in 2022, based on (initial) declared quotas and expected uptake estimated by WGWISE.

Country	Q1	Q2	Q3	Preliminary Catch	Expected Catch remained catch or Total year catch	Total Catch
Denmark	25639	19782	6	45427	10	45437
Faroe Islands	65427	139620	66	205113	66218	271331
France					9128	9128
Germany	15594	601		16195	13988	30183
Greenland					22878	22878
Iceland	0	157563		157563	12707	174557
Ireland	17232	11221		28453	0	28453
Lithuania					6467	6467
Netherlands	4799			4799	74948	79747
Norway	111166			164650	25350	190000
Poland	18024	2924		20948	5865	26814
Portugal	224	412		636	1364	2000
Spain	4716	7323		12039	10961	23000
UK(Scotland)	35264	16945	1277	53486	0	53486
Sweden				0	70	70
Total reporting countries						963550
Russia (assumed 13 % of total)						143979
Total						1107529

Table 2.3.2.4. Blue whiting. Comparison of preliminary and final catches (in tonnes) calculated from sum of product of catch number and mean weight at age used in the assessment).

	Final	Preliminary	Change in % *
2016	1180786	1147000	2.9
2017	1555069	1559437	-0.3
2018	1709856	1712874	-0.2
2019	1512026	1444301	4.7
2020	1460507	1478358	-1.2
2021	1139531	1242727	-8.3

* (final-preliminary)/preliminary*100

Table 2.3.3.1. Blue whiting. Catch-at-age numbers (thousands) by year. Discards included since 2014. Values for 2022 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

Year Age	1	2	3	4	5	6	7	8	9	10+
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
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

Year Age	1	2	3	4	5	6	7	8	9	10+
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	2069387	830692	1266077	1214790	1438769	1404443	1360104	304891	100993	59441
2022	906699	3344062	1873517	1778289	1092800	814544	753595	795714	130995	95271

Table 2.3.4.1. Blue whiting. Individual mean weight (kg) at age in the catch. Preliminary values for 2022.

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

[illegible]

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

[illegible]

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 2004-2022) are used as input to the assessment

Year	Age										TSB
	1	2	3	4	5	6	7	8	9	10+	
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**											
2021	1948	2095	2545	2275	3914	3197	3379	463	189	114	2357
2022	4461	9313	4830	5460	2587	1880	898	1764	71	178	2707

*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), 2003–2022.

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	3937	2030
2015	8563	2796
2016	4223	8089
2017	1236	2087
2018	441	1491
2019	3157	215
2020	2822	481
2021	10264	1500
2022	17169	10575

*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	12.66	6.00
2020	26.42	19.33
2021	182.86	161.04
2022	79.19	41.55

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
2022	91.2

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
2022	1781

Table 2.4.1.1. Blue whiting. Parameter estimates, from final assessment (2022) and retrospective analysis (2018-2021).

Parameter Year	2018	2019	2020	2021	2022
Random walk variance					
-F Age 1-10	0.38	0.37	0.37	0.36	0.36
Process error					
-log(N) Age 1	0.62	0.61	0.60	0.61	0.62
--- Age 2-10	0.18	0.18	0.18	0.18	0.18
Observation variance					
-Catch Age 1	0.44	0.43	0.44	0.44	0.43
--- Age 2	0.28	0.28	0.28	0.28	0.27
--- Age 3-8	0.19	0.19	0.19	0.19	0.18
--- Age 9-10	0.40	0.39	0.38	0.38	0.37
-IBWSS Age 1	0.74	0.75	0.74	0.72	0.74
--- Age 2	0.31	0.33	0.33	0.33	0.33
--- Age 3	0.42	0.41	0.41	0.39	0.39
--- Age 4-6	0.39	0.37	0.37	0.36	0.35
--- Age 7-8	0.50	0.54	0.54	0.53	0.53
Survey catchability					
-IBWSS Age 1	0.07	0.07	0.06	0.06	0.06
--- Age 2	0.12	0.11	0.11	0.12	0.11
--- Age 3	0.37	0.37	0.37	0.37	0.36
--- Age 4	0.69	0.68	0.68	0.68	0.67
--- Age 5-8	0.87	0.87	0.88	0.89	0.88
Rho					
--	0.93	0.93	0.93	0.94	0.93

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

Last data year	R(age 1)	SSB	Fbar(3-7)
2017	-0.109	-0.107	0.142
2018	-0.218	-0.102	0.074
2019	-0.335	-0.001	-0.024
2020	-0.216	-0.076	0.077
2021	-0.406	-0.172	0.180
Rho mean	-0.257	-0.091	0.090

Table 2.4.1.3. Blue whiting. Estimated fishing mortalities. Catch data for 2022 are preliminary.

Year Age	1	2	3	4	5	6	7	8	9	10+
1981	0.078	0.119	0.172	0.212	0.245	0.318	0.347	0.444	0.486	0.486
1982	0.067	0.102	0.149	0.183	0.209	0.271	0.294	0.372	0.405	0.405
1983	0.078	0.118	0.171	0.211	0.240	0.314	0.338	0.420	0.446	0.446
1984	0.095	0.143	0.212	0.265	0.305	0.397	0.418	0.509	0.530	0.530
1985	0.101	0.150	0.229	0.294	0.346	0.447	0.465	0.560	0.575	0.575
1986	0.113	0.168	0.268	0.357	0.431	0.552	0.573	0.692	0.705	0.705
1987	0.100	0.150	0.247	0.337	0.414	0.537	0.560	0.674	0.676	0.676
1988	0.098	0.148	0.253	0.349	0.439	0.575	0.589	0.694	0.678	0.678
1989	0.113	0.171	0.304	0.420	0.526	0.686	0.712	0.842	0.806	0.806
1990	0.105	0.159	0.292	0.408	0.511	0.665	0.713	0.850	0.817	0.817
1991	0.059	0.089	0.168	0.235	0.290	0.368	0.396	0.466	0.451	0.451
1992	0.048	0.073	0.140	0.196	0.233	0.286	0.311	0.370	0.363	0.363
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	0.150	0.216	0.244	0.285	0.314	0.383	0.369	0.369
1996	0.055	0.085	0.185	0.271	0.297	0.348	0.383	0.473	0.451	0.451
1997	0.054	0.084	0.188	0.279	0.300	0.349	0.382	0.474	0.453	0.453
1998	0.070	0.110	0.251	0.382	0.408	0.473	0.510	0.630	0.593	0.593
1999	0.064	0.101	0.237	0.369	0.397	0.458	0.482	0.592	0.558	0.558

Year Age	1	2	3	4	5	6	7	8	9	10+
2000	0.073	0.117	0.279	0.446	0.498	0.576	0.589	0.705	0.665	0.665
2001	0.069	0.111	0.265	0.430	0.494	0.572	0.574	0.679	0.644	0.644
2002	0.065	0.104	0.250	0.418	0.504	0.595	0.597	0.702	0.667	0.667
2003	0.067	0.107	0.261	0.440	0.545	0.634	0.629	0.710	0.670	0.670
2004	0.068	0.109	0.269	0.461	0.592	0.690	0.688	0.753	0.711	0.711
2005	0.059	0.095	0.238	0.419	0.557	0.650	0.656	0.704	0.667	0.667
2006	0.051	0.082	0.208	0.372	0.509	0.596	0.606	0.640	0.606	0.606
2007	0.048	0.077	0.197	0.357	0.506	0.604	0.629	0.661	0.629	0.629
2008	0.041	0.068	0.170	0.309	0.444	0.529	0.563	0.590	0.569	0.569
2009	0.027	0.045	0.112	0.198	0.288	0.342	0.371	0.386	0.375	0.375
2010	0.019	0.032	0.080	0.138	0.201	0.236	0.259	0.264	0.257	0.257
2011	0.006	0.010	0.024	0.040	0.057	0.066	0.073	0.075	0.074	0.074
2012	0.012	0.020	0.051	0.085	0.121	0.141	0.159	0.166	0.165	0.165
2013	0.019	0.034	0.090	0.150	0.214	0.244	0.278	0.292	0.292	0.292
2014	0.036	0.066	0.175	0.295	0.416	0.472	0.538	0.569	0.566	0.566
2015	0.046	0.085	0.230	0.389	0.546	0.624	0.698	0.734	0.727	0.727
2016	0.039	0.073	0.197	0.339	0.478	0.554	0.616	0.644	0.637	0.637
2017	0.037	0.069	0.188	0.326	0.457	0.527	0.577	0.595	0.590	0.590
2018	0.036	0.068	0.187	0.328	0.463	0.534	0.584	0.597	0.594	0.594
2019	0.032	0.060	0.168	0.298	0.421	0.482	0.527	0.531	0.528	0.528
2020	0.035	0.066	0.182	0.326	0.463	0.527	0.577	0.578	0.572	0.572
2021	0.030	0.056	0.156	0.281	0.399	0.453	0.494	0.497	0.491	0.491
2022	0.031	0.058	0.161	0.292	0.417	0.470	0.516	0.518	0.511	0.511

Table 2.4.1.4. Blue whiting. Estimated stock numbers-at-age (thousands). Preliminary catch data for 2022 have been used

Year Age	1	2	3	4	5	6	7	8	9	10+
1981	3948198	3483134	4853128	2063381	2615682	2138821	1642831	1743162	1227396	2980519
1982	4696698	2963754	2517522	3288737	1583208	1494152	1291796	1012284	889662	1940890
1983	18293953	3809208	1877680	1818746	1897666	1218555	1014568	854628	627992	1252407
1984	18077398	14562962	2450003	1233914	1261344	1397475	815593	549720	481649	922153
1985	9550303	13545071	9807290	1453542	749637	914081	747079	458534	265294	722100
1986	7206799	6372536	9406612	5561299	948825	452061	469404	376188	231523	499543
1987	9113538	5032490	4072187	6882719	2568177	394492	253898	238137	156693	293640
1988	6409993	6861313	3511774	2870746	3727659	1275834	199445	125573	99146	170141
1989	8492388	4620755	4994215	2424184	2130302	1684904	350755	103076	60787	115044
1990	18840757	5973402	3093924	2728803	1480249	1186791	560115	120836	33119	85695
1991	9049081	15643199	4259229	1785365	1491130	874989	562933	188115	32126	45442
1992	6698667	7458376	12503692	3310414	1257597	788315	485873	287464	101477	39068
1993	4942776	5123283	5296885	9738212	2263702	976646	516955	281742	156944	74164
1994	8113390	3379619	4070890	3390595	6950171	1439175	766071	328519	207427	115713
1995	9322644	5867025	3129586	2563312	2856905	3741838	1041446	545237	221227	184619
1996	28090039	7109483	4071822	2392659	1544304	1861760	2238167	645981	306922	249290
1997	45080996	21344009	5501906	2566564	1414602	1064387	1059818	1211979	288024	336938

Year Age	1	2	3	4	5	6	7	8	9	10+
1998	26696161	37985412	16454475	3496892	1370190	925363	782485	604708	616206	291964
1999	20303064	20503747	27713908	10599808	1703960	770894	518846	410948	236101	427358
2000	39448363	15270043	16580561	15810425	4338169	1111059	472766	323676	153198	313508
2001	55947436	31755217	12078805	10736413	7446097	1691153	488651	227410	163649	177810
2002	49106855	45338753	20408977	8304748	5441968	3392286	687547	255845	103097	154656
2003	52947963	39192643	35075975	13575701	5077023	2966716	1200986	344891	88649	106704
2004	28714768	42109802	30137706	20847617	7248626	2464658	1312509	500226	151135	80113
2005	22271163	21718324	28499051	18145779	10750885	3223618	1108963	512665	191117	98337
2006	9009113	15413359	22321756	19293696	9481605	4454118	1354232	481870	217274	119414
2007	4913368	5967442	13108559	15933357	10301052	4703381	1836143	608879	228295	162451
2008	5883847	3465837	4331922	11056361	9160778	4912569	1855148	753418	234404	199862
2009	5813482	4042546	2418910	3703135	6937430	4708636	2192796	855782	323765	188156
2010	15534228	5108247	2365111	1853628	3372665	4350095	2847425	1199051	411438	264795
2011	19713440	13522085	3355946	1661963	1613842	2613131	2697703	1346774	811348	389208
2012	19509226	15674187	12781899	2296933	1185528	1619913	2344919	2125776	1077665	896461
2013	16196200	16181915	11820392	7461025	2245751	1097606	1384976	1645697	1349228	1380746
2014	37769539	12759745	14030071	8116097	4403727	1351921	942553	1011060	1026225	1492297
2015	64728113	33248750	10910324	8533489	4211336	1736364	738558	523308	487940	1058255

Year Age	1	2	3	4	5	6	7	8	9	10+
2016	35567778	57871493	21657974	7737276	4336329	1809839	707922	354459	223199	594127
2017	12172965	28851639	46306625	15275299	4577931	2166987	738670	285246	162222	375993
2018	13119298	9414030	22960923	30015459	8861786	2498004	952440	316812	143809	266442
2019	15254049	9759745	9037146	15384432	16762022	4668475	1155173	412610	140328	199051
2020	26772174	12754712	7294693	7026232	8955708	8254837	2249921	583463	201500	163929
2021	71562826	19445326	9940991	5134725	4644904	4294899	4043115	878041	288811	172055
2022	43220294	65372551	13900332	7564442	3356125	2474668	2082227	2211891	397414	249106
2023	22537250*	34317672	50514113	9683829	4624746	1811531	1265829	1018083	1078587	317446

*assuming GM(1996-2021) recruitment in 2023.

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 (TSB) in tonnes. Preliminary catch data for 2022 are included. Low and High refer to the 95% confidence limits

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
1981	3948198	2549746	6113656	2846036	2245456	3607250	0.259	0.189	0.354	3343771	2686598	4161696
1982	4696698	3001694	7348843	2299742	1835126	2881988	0.221	0.164	0.297	2770115	2248453	3412808
1983	18293953	11937083	28036056	1854216	1512075	2273776	0.255	0.192	0.337	2886828	2353546	3540944
1984	18077398	11900836	27459608	1756125	1454927	2119676	0.319	0.244	0.417	3093702	2500953	3826939
1985	9550303	6312234	14449447	2095632	1732609	2534718	0.356	0.275	0.461	3234759	2645700	3954969
1986	7206799	4792760	10836753	2274475	1884455	2745217	0.436	0.339	0.562	3113722	2585083	3750467

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
1987	9113538	6047121	13734894	1933155	1603976	2329890	0.419	0.324	0.541	2817509	2341994	3389573
1988	6409993	4251396	9664593	1638205	1370653	1957983	0.441	0.342	0.569	2425857	2024649	2906570
1989	8492388	5609692	12856438	1546404	1297863	1842541	0.529	0.412	0.680	2391067	1985764	2879096
1990	18840757	12270809	28928337	1356528	1128145	1631147	0.518	0.396	0.676	2499552	2000264	3123468
1991	9049081	5826489	14054068	1777830	1429325	2211309	0.291	0.216	0.393	3224253	2529151	4110395
1992	6698667	4365051	10279865	2460102	1951887	3100643	0.233	0.173	0.315	3532097	2804852	4447902
1993	4942776	3184796	7671146	2543671	2027313	3191545	0.204	0.151	0.275	3420359	2744348	4262893
1994	8113390	5277115	12474069	2535468	2042807	3146943	0.184	0.136	0.248	3415435	2776614	4201231
1995	9322644	6125353	14188844	2308211	1901995	2801183	0.242	0.183	0.320	3354448	2764391	4070452
1996	28090039	18496998	42658289	2207682	1836837	2653398	0.297	0.226	0.390	3726979	3035570	4575870
1997	45080996	29748090	68316864	2467358	2048273	2972189	0.300	0.229	0.392	5448075	4288051	6921914
1998	26696161	17717886	40224044	3685247	3017327	4501018	0.405	0.313	0.524	6834539	5472054	8536268
1999	20303064	13419599	30717343	4449851	3630259	5454480	0.389	0.300	0.504	7178200	5844370	8816443
2000	39448363	26002313	59847495	4233012	3521792	5087862	0.477	0.372	0.613	7470574	6096978	9153629
2001	55947436	37187292	84171646	4575712	3821738	5478433	0.467	0.363	0.600	9021213	7286025	11169642
2002	49106855	32631938	73899478	5401566	4504809	6476838	0.473	0.367	0.609	10346234	8388365	12761075
2003	52947963	35655989	78625974	6875173	5716742	8268346	0.502	0.395	0.638	11858110	9739057	14438233
2004	28714768	19302031	42717673	6778079	5701925	8057341	0.540	0.428	0.682	10401328	8701897	12432648

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
2005	22271163	14998683	33069881	6031586	5083744	7156150	0.504	0.396	0.641	8508967	7156398	10117173
2006	9009113	6005043	13515995	5891687	4948048	7015288	0.458	0.358	0.587	7732632	6496994	9203272
2007	4913368	3264414	7395256	4673775	3915203	5579322	0.459	0.355	0.593	5709625	4792945	6801625
2008	5883847	3862867	8962167	3593824	2971047	4347144	0.403	0.303	0.535	4414990	3665381	5317902
2009	5813482	3702391	9128311	2754203	2222003	3413874	0.262	0.192	0.357	3474921	2822816	4277670
2010	15534228	10141289	23795027	2690487	2129607	3399087	0.183	0.131	0.255	3776135	3014174	4730713
2011	19713440	12986631	29924598	2717639	2166277	3409333	0.052	0.036	0.075	4477901	3566528	5622163
2012	19509226	13074672	29110475	3476370	2840438	4254677	0.112	0.084	0.149	5176194	4222226	6345701
2013	16196200	10896851	24072726	3803134	3168694	4564602	0.195	0.149	0.255	5642058	4679857	6802092
2014	37769539	25189811	56631551	4045006	3409524	4798933	0.379	0.292	0.492	6710627	5543292	8123787
2015	64728113	43428474	96474232	4218197	3548784	5013883	0.497	0.389	0.635	8265505	6686427	10217500
2016	35567778	23913789	52901145	4974200	4114630	6013339	0.437	0.339	0.562	9254134	7480583	11448171
2017	12172965	8062125	18379902	6199504	5085700	7557239	0.415	0.322	0.536	8988316	7357708	10980297
2018	13119298	8655930	19884169	6090429	5006887	7408460	0.419	0.322	0.546	8082094	6653535	9817373
2019	15254049	9638265	24141898	5284355	4319920	6464102	0.379	0.285	0.505	7305759	5945587	8977098
2020	26772174	16299607	43973408	4480563	3571612	5620836	0.415	0.302	0.571	7042419	5456145	9089872
2021	71562826	40213851	127350103	4440379	3320100	5938666	0.356	0.243	0.523	9511299	6526756	13860608
2022	43220294	19011128	98257917	4955777	3341999	7348815	0.371	0.228	0.605	9506755	6004619	15051478

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
2023	22537250*			6621207^								

*assuming GM(1996-2021) recruitment in 2023.

^ SSB calculated from the survivors age 2-10 and GM(1996-2021) recruitment in 2023

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 (TSB) in tonnes. Preliminary catch data for 2022 are included. Low and High refer to the 95% confidence limits

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
1981	3948198	2549746	6113656	2846036	2245456	3607250	0.259	0.189	0.354	3343771	2686598	4161696
1982	4696698	3001694	7348843	2299742	1835126	2881988	0.221	0.164	0.297	2770115	2248453	3412808
1983	18293953	11937083	28036056	1854216	1512075	2273776	0.255	0.192	0.337	2886828	2353546	3540944
1984	18077398	11900836	27459608	1756125	1454927	2119676	0.319	0.244	0.417	3093702	2500953	3826939
1985	9550303	6312234	14449447	2095632	1732609	2534718	0.356	0.275	0.461	3234759	2645700	3954969
1986	7206799	4792760	10836753	2274475	1884455	2745217	0.436	0.339	0.562	3113722	2585083	3750467
1987	9113538	6047121	13734894	1933155	1603976	2329890	0.419	0.324	0.541	2817509	2341994	3389573
1988	6409993	4251396	9664593	1638205	1370653	1957983	0.441	0.342	0.569	2425857	2024649	2906570
1989	8492388	5609692	12856438	1546404	1297863	1842541	0.529	0.412	0.680	2391067	1985764	2879096
1990	18840757	12270809	28928337	1356528	1128145	1631147	0.518	0.396	0.676	2499552	2000264	3123468
1991	9049081	5826489	14054068	1777830	1429325	2211309	0.291	0.216	0.393	3224253	2529151	4110395
1992	6698667	4365051	10279865	2460102	1951887	3100643	0.233	0.173	0.315	3532097	2804852	4447902

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
1993	4942776	3184796	7671146	2543671	2027313	3191545	0.204	0.151	0.275	3420359	2744348	4262893
1994	8113390	5277115	12474069	2535468	2042807	3146943	0.184	0.136	0.248	3415435	2776614	4201231
1995	9322644	6125353	14188844	2308211	1901995	2801183	0.242	0.183	0.320	3354448	2764391	4070452
1996	28090039	18496998	42658289	2207682	1836837	2653398	0.297	0.226	0.390	3726979	3035570	4575870
1997	45080996	29748090	68316864	2467358	2048273	2972189	0.300	0.229	0.392	5448075	4288051	6921914
1998	26696161	17717886	40224044	3685247	3017327	4501018	0.405	0.313	0.524	6834539	5472054	8536268
1999	20303064	13419599	30717343	4449851	3630259	5454480	0.389	0.300	0.504	7178200	5844370	8816443
2000	39448363	26002313	59847495	4233012	3521792	5087862	0.477	0.372	0.613	7470574	6096978	9153629
2001	55947436	37187292	84171646	4575712	3821738	5478433	0.467	0.363	0.600	9021213	7286025	11169642
2002	49106855	32631938	73899478	5401566	4504809	6476838	0.473	0.367	0.609	10346234	8388365	12761075
2003	52947963	35655989	78625974	6875173	5716742	8268346	0.502	0.395	0.638	11858110	9739057	14438233
2004	28714768	19302031	42717673	6778079	5701925	8057341	0.540	0.428	0.682	10401328	8701897	12432648
2005	22271163	14998683	33069881	6031586	5083744	7156150	0.504	0.396	0.641	8508967	7156398	10117173
2006	9009113	6005043	13515995	5891687	4948048	7015288	0.458	0.358	0.587	7732632	6496994	9203272
2007	4913368	3264414	7395256	4673775	3915203	5579322	0.459	0.355	0.593	5709625	4792945	6801625
2008	5883847	3862867	8962167	3593824	2971047	4347144	0.403	0.303	0.535	4414990	3665381	5317902
2009	5813482	3702391	9128311	2754203	2222003	3413874	0.262	0.192	0.357	3474921	2822816	4277670
2010	15534228	10141289	23795027	2690487	2129607	3399087	0.183	0.131	0.255	3776135	3014174	4730713

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
2011	19713440	12986631	29924598	2717639	2166277	3409333	0.052	0.036	0.075	4477901	3566528	5622163
2012	19509226	13074672	29110475	3476370	2840438	4254677	0.112	0.084	0.149	5176194	4222226	6345701
2013	16196200	10896851	24072726	3803134	3168694	4564602	0.195	0.149	0.255	5642058	4679857	6802092
2014	37769539	25189811	56631551	4045006	3409524	4798933	0.379	0.292	0.492	6710627	5543292	8123787
2015	64728113	43428474	96474232	4218197	3548784	5013883	0.497	0.389	0.635	8265505	6686427	10217500
2016	35567778	23913789	52901145	4974200	4114630	6013339	0.437	0.339	0.562	9254134	7480583	11448171
2017	12172965	8062125	18379902	6199504	5085700	7557239	0.415	0.322	0.536	8988316	7357708	10980297
2018	13119298	8655930	19884169	6090429	5006887	7408460	0.419	0.322	0.546	8082094	6653535	9817373
2019	15254049	9638265	24141898	5284355	4319920	6464102	0.379	0.285	0.505	7305759	5945587	8977098
2020	26772174	16299607	43973408	4480563	3571612	5620836	0.415	0.302	0.571	7042419	5456145	9089872
2021	71562826	40213851	127350103	4440379	3320100	5938666	0.356	0.243	0.523	9511299	6526756	13860608
2022	43220294	19011128	98257917	4955777	3341999	7348815	0.371	0.228	0.605	9506755	6004619	15051478
2023	22537250*			6621207^								

*assuming GM(1996-2021) recruitment in 2023.

^ SSB calculated from the survivors age 2-10 and GM(1996-2021) recruitment in 2023

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 2022 are included.

Year	Estimate	Low	High	SOP catch
1981	788899	568869	1094034	922980
1982	544462	415928	712717	550643
1983	511429	397097	658681	553344
1984	562849	436560	725671	615569
1985	638357	503485	809358	678214
1986	760657	600423	963653	847145
1987	638031	503867	807920	654718
1988	569671	450572	720253	552264
1989	618818	492656	777287	630316
1990	553618	437776	700115	558128
1991	407963	318674	522271	364008
1992	438562	347202	553963	474592
1993	440392	346971	558966	475198
1994	424782	332919	541992	457696
1995	508660	405109	638679	505176
1996	597489	475874	750185	621104
1997	640338	505643	810912	639681
1998	1080858	848979	1376068	1131955
1999	1248067	975731	1596416	1261033
2000	1503388	1184000	1908931	1412449
2001	1560119	1228373	1981459	1771805
2002	1711364	1347754	2173071	1556955
2003	2202490	1742780	2783462	2365319
2004	2319262	1842881	2918785	2400795
2005	1998969	1590932	2511659	2018344
2006	1854141	1475771	2329521	1956239
2007	1558186	1238596	1960237	1612269

Year	Estimate	Low	High	SOP catch
2008	1167284	920948	1479510	1251851
2009	656865	517289	834101	634978
2010	478520	370983	617227	539539
2011	135746	100837	182742	103771
2012	326794	260010	410731	375692
2013	591003	469650	743713	613863
2014	1113687	879716	1409885	1147650
2015	1348361	1074286	1692359	1390656
2016	1243182	987399	1565224	1180786
2017	1481707	1175774	1867243	1555069
2018	1706765	1348261	2160595	1709856
2019	1535424	1211096	1946607	1512026
2020	1428866	1132542	1802721	1460507
2021	1147426	915250	1438500	1139531
2022	1121336	884135	1422175	1107529

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 2022	Mean weight in the stock and catch (kg) in 2023+	Proportion mature	Natural mortality	Exploitation pattern	Stock number (2023) (thousands)
1	0.042	0.055	0.11	0.20	0.083	22537250
2	0.065	0.079	0.40	0.20	0.156	34317672
3	0.084	0.094	0.82	0.20	0.435	50514113
4	0.104	0.113	0.86	0.20	0.787	9683829
5	0.119	0.127	0.91	0.20	1.122	4624746
6	0.136	0.138	0.94	0.20	1.267	1811531
7	0.139	0.145	1.00	0.20	1.389	1265829
8	0.158	0.162	1.00	0.20	1.396	1018083
9	0.154	0.170	1.00	0.20	1.377	1078587
10+	0.199	0.205	1.00	0.20	1.377	317446

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

Variable	Value	Notes
$F_{\text{ages } 3-7}$ (2022)	0.37	From the assessment (based on assumed 2022 catches)
SSB (2023)	6 621 207	From the forecast; in tonnes
$R_{\text{age } 1}$ (2022)	43 220 294	From the assessment; in thousands
$R_{\text{age } 1}$ (2023–2024)	22 537 250	GM (1996–2021); in thousands
Total catch (2022)	1 107 529	As estimated by ICES, based on declared national quotas and expected up-take; in tonnes

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

Basis	Catch(2023)	F(2023)	SSB(2024)	% SSB change*	% Catch change**	% Advice change***
Long-term management strategy (F=FMSY)	1359629	0.320	7781444	17.5	22.8	80.6
MSY approach: FMSY	1359629	0.320	7781444	17.5	22.8	80.6
F = 0	5	0.000	9039585	36.5	-100.0	-100.0
Fpa	1359629	0.320	7781444	17.5	22.8	80.6
Flim	3146002	0.880	6157129	-7.0	184.1	317.9
SSB (2024) = Blim	8696303	6.503	1499996	-77.3	685.2	1055.3
SSB (2024) = Bpa	7715688	4.401	2249993	-66.0	596.7	925.0
SSB (2024) = MSY Btrigger	7715688	4.401	2249993	-66.0	596.7	925.0
F = F (2022)	1550784	0.371	7605942	14.9	40.0	106.0
SSB (2024) = SSB (2023)	2631402	0.698	6621196	-0.0	137.6	249.6
Catch (2023) = Catch (2022)	1107553	0.255	8013430	21.0	0.0	47.1
Catch (2023) = Catch (2022) -20 %	886105	0.200	8217731	24.1	-20.0	17.7
Catch (2023) = Catch (2022) +25%	1384385	0.327	7758694	17.2	25.0	83.9
Catch (2023) = Advice (2022) -20 %	602183	0.133	8480325	28.1	-45.6	-20.0
Catch (2023) = Advice (2022) +25%	940871	0.214	8167163	23.3	-15.0	25.0
F = 0.05	233147	0.050	8822699	33.2	-78.9	-69.0
F = 0.10	458089	0.100	8613869	30.1	-58.6	-39.1
F = 0.15	675211	0.150	8412714	27.1	-39.0	-10.3
F = 0.16	717729	0.160	8373372	26.5	-35.2	-4.7
F = 0.17	759951	0.170	8334319	25.9	-31.4	1.0

Basis	Catch(2023)	F(2023)	SSB(2024)	% SSB change*	% Catch change**	% Advice change***
F = 0.18	801880	0.180	8295552	25.3	-27.6	6.5
F = 0.19	843520	0.190	8257070	24.7	-23.8	12.1
F = 0.20	884872	0.200	8218869	24.1	-20.1	17.6
F = 0.21	925939	0.210	8180947	23.6	-16.4	23.0
F = 0.22	966725	0.220	8143300	23.0	-12.7	28.4
F = 0.23	1007231	0.230	8105927	22.4	-9.1	33.8
F = 0.24	1047460	0.240	8068825	21.9	-5.4	39.2
F = 0.25	1087415	0.250	8031990	21.3	-1.8	44.5
F = 0.26	1127098	0.260	7995421	20.8	1.8	49.7
F = 0.27	1166512	0.270	7959115	20.2	5.3	55.0
F = 0.28	1205659	0.280	7923070	19.7	8.9	60.2
F = 0.29	1244542	0.290	7887282	19.1	12.4	65.3
F = 0.30	1283163	0.300	7851750	18.6	15.9	70.5
F = 0.31	1321525	0.310	7816471	18.1	19.3	75.6
F = 0.32	1359629	0.320	7781444	17.5	22.8	80.6
F = 0.33	1397479	0.330	7746664	17.0	26.2	85.7
F = 0.34	1435076	0.340	7712131	16.5	29.6	90.6
F = 0.35	1472423	0.350	7677841	16.0	32.9	95.6
F = 0.45	1832624	0.450	7347865	11.0	65.5	143.5
F = 0.50	2004100	0.500	7191261	8.6	81.0	166.2

* SSB 2024 relative to SSB 2023.

** Catch 2023 relative to expected catch in 2022 (1 107 529 tonnes).

*** Catch 2023 relative to advice for 2022 (752 736 tonnes).

2.18 Figures

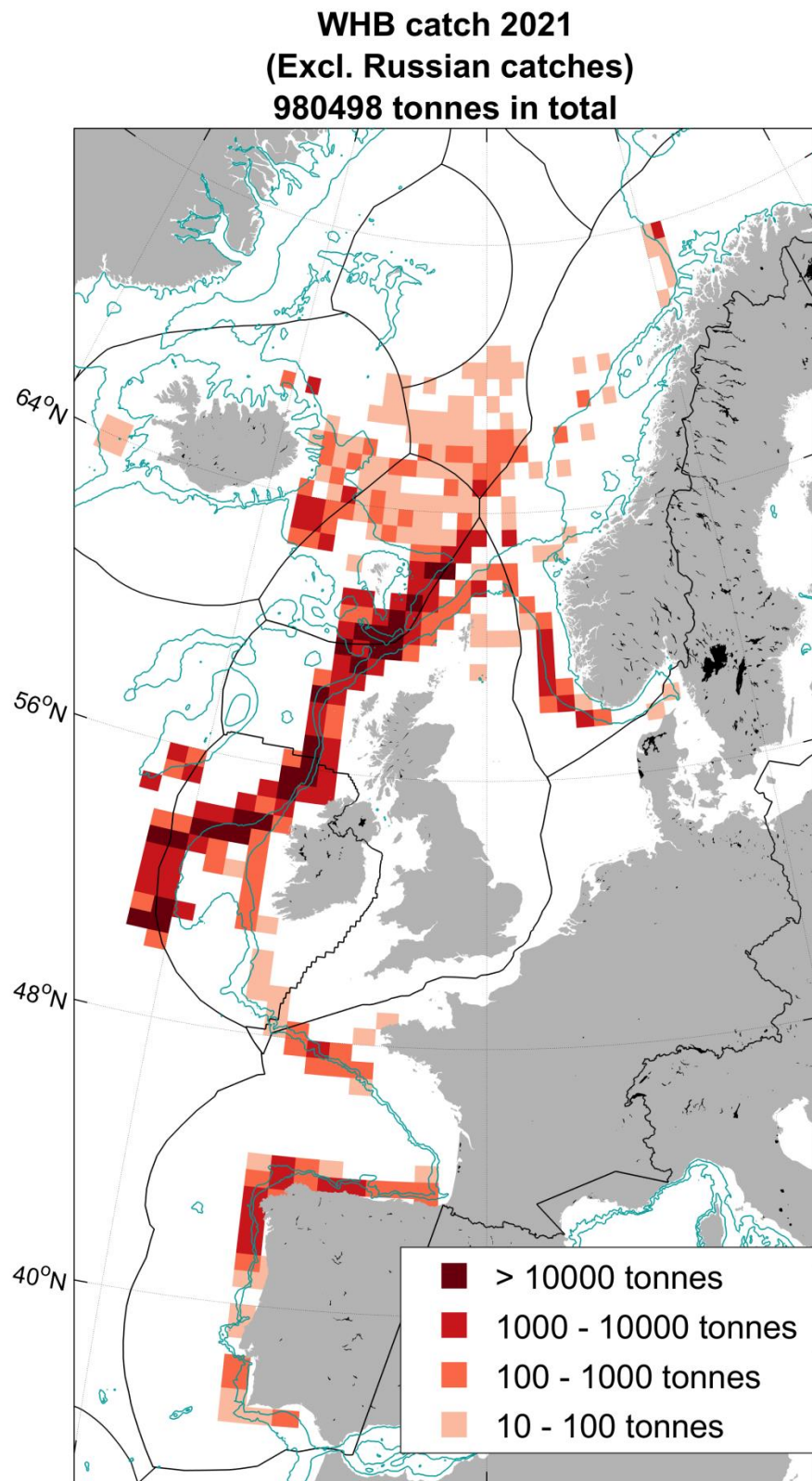


Figure 2.2.1. Blue whiting catches in 2021. Catch data from Russia are not available and the catches on the map constitute 86 % of the ICES estimated catches. The 200 m and 1000 m depth contours are indicated in blue.

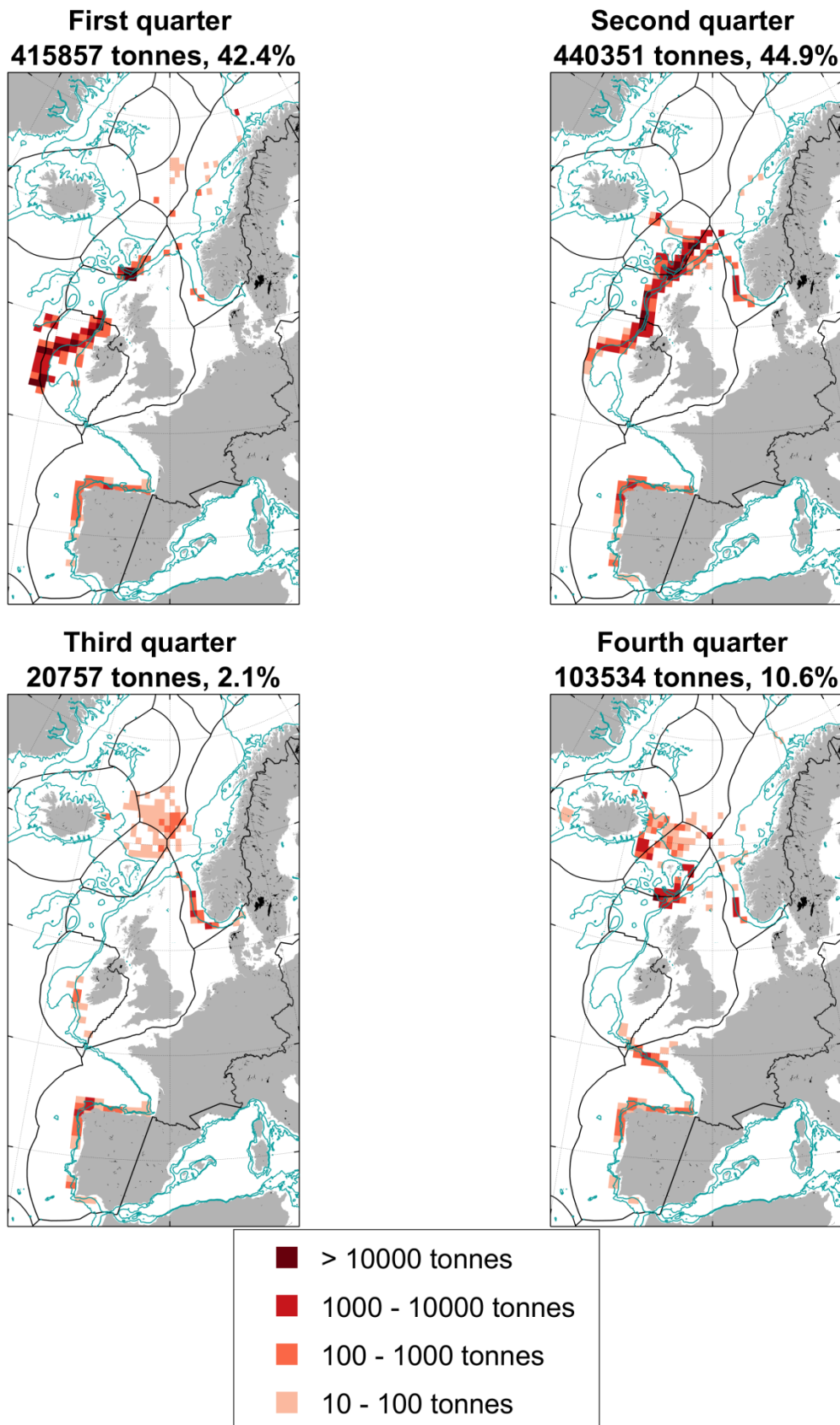


Figure 2.2.2. Blue whiting catches per quarter 2021. Catch data from Russia are not available and the catches on the maps constitute 86 % of the ICES estimated catches and thus, the total catches and percentages shown on each panel might deviate slightly from the ICES estimated catches pr. quarter. The 200 m and 1000 m depth contours are indicated in blue.

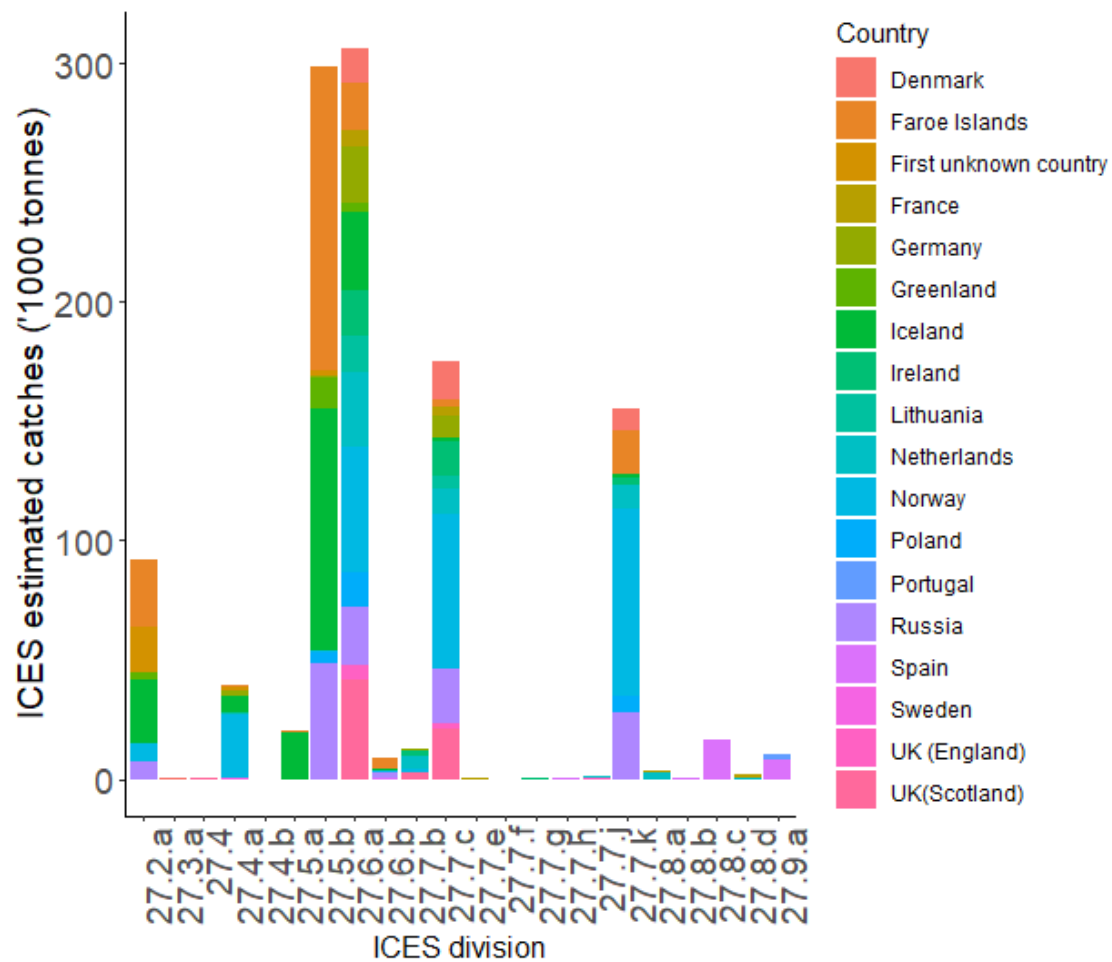


Figure 2.3.1.1. Blue whiting. ICES estimated catches ('1000 tonnes) in 2021 by ICES division and country. Note: Russia 2021 catch data is preliminary and only for quarters 1 and 2, submitted to WGWISE 2021.

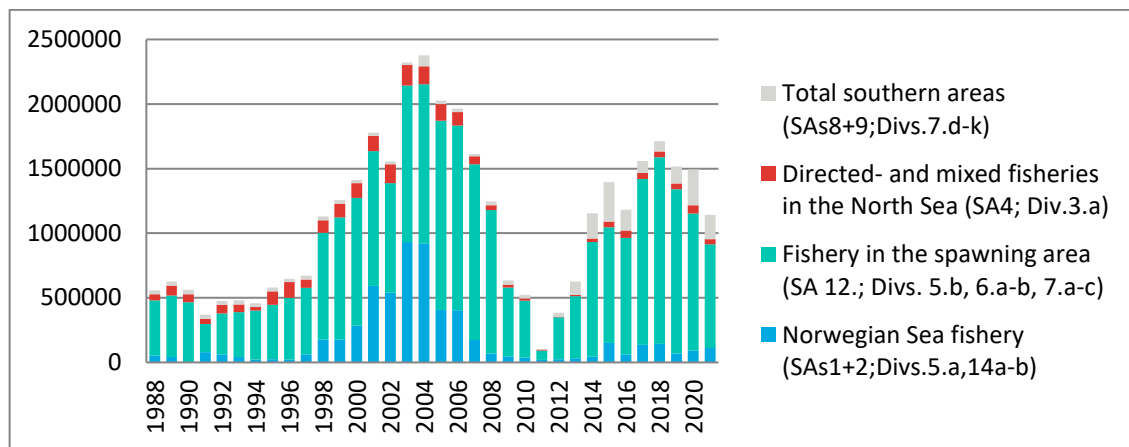
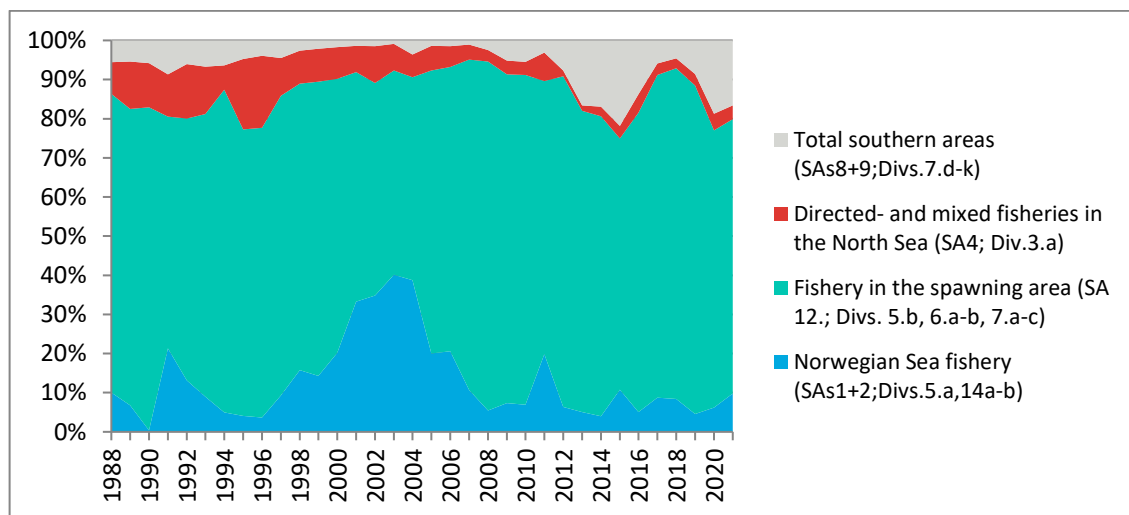
A**B**

Figure 2.3.1.2. Blue whiting. (A) ICES estimated catches (tonnes) of blue whiting by fishery subareas from 1988-2021 and (B) the percentage contribution to the overall catch by fishery subarea over the same period.

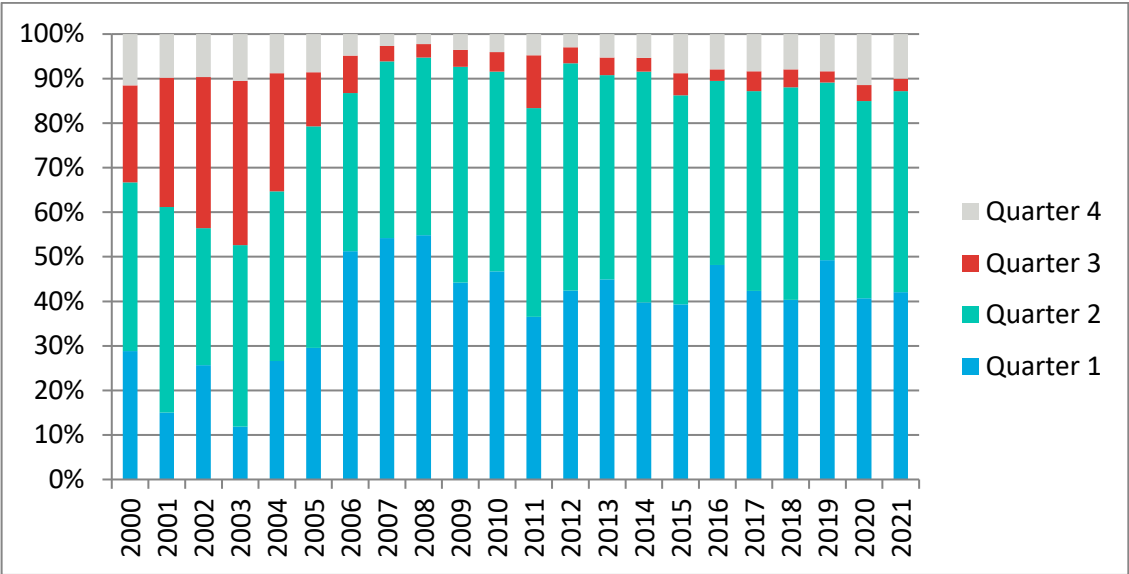


Figure 2.3.1.3. Blue whiting. Distribution of 2021 ICES estimated catches (in percentage) by quarter.

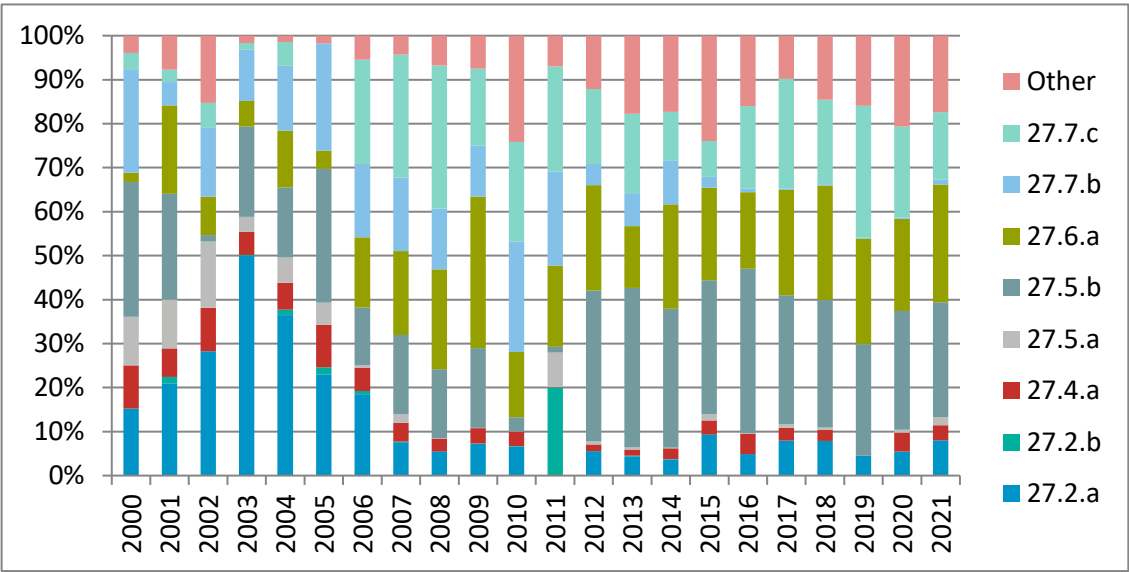


Figure 2.3.1.4. Blue whiting. Distribution of 2021 ICES estimated catches (in percentage) by ICES division area.

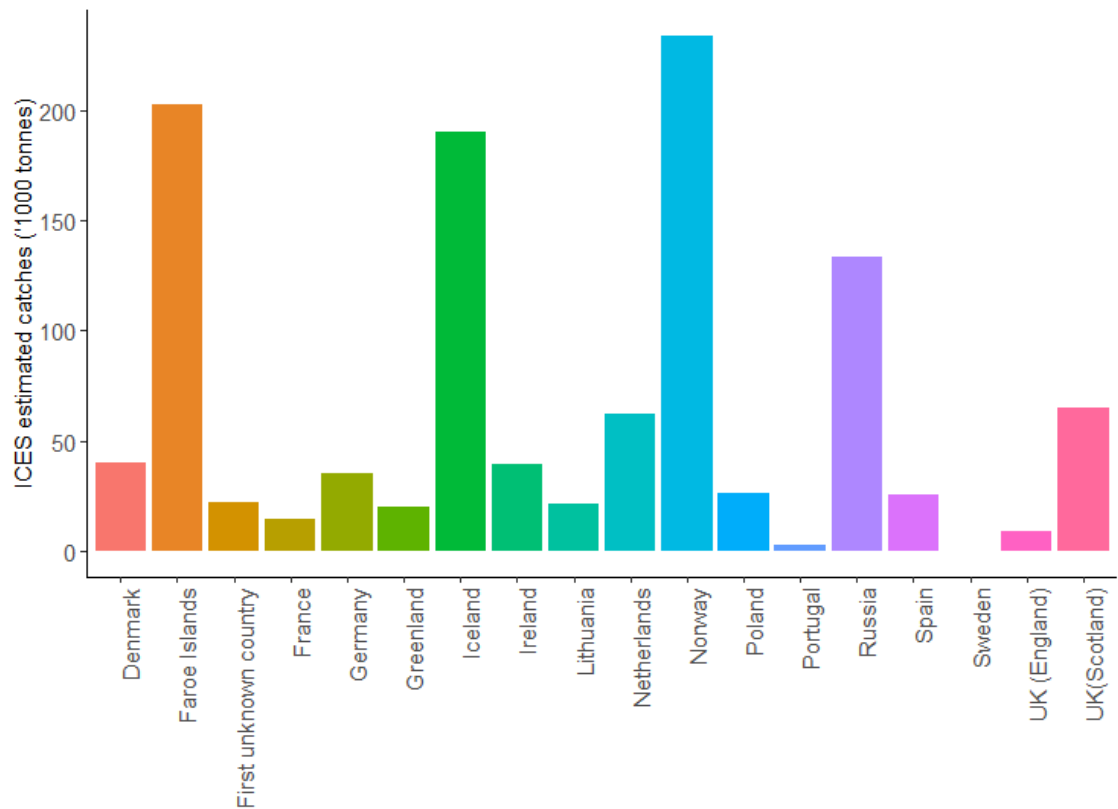


Figure 2.3.1.5. Blue whiting. ICES estimated catches ('1000 tonnes) in 2021 by country. Note: Russia 2021 catch data is preliminary and only for quarters 1 and 2, submitted to WGWiDE 2021.

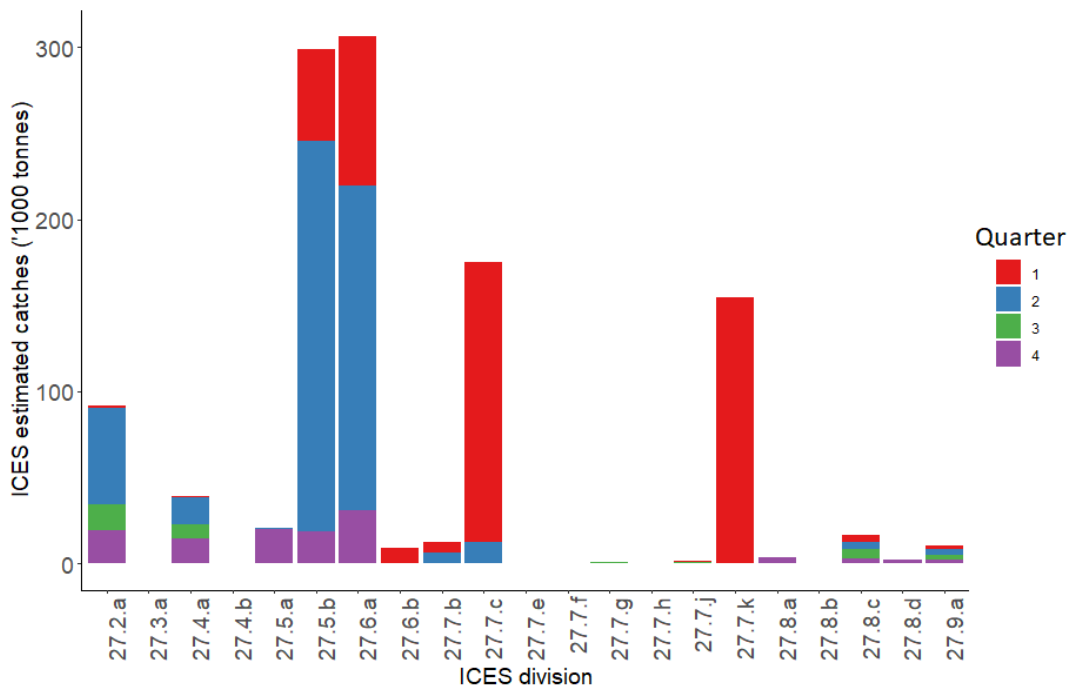


Figure 2.3.1.6. Blue whiting. Distribution of 2021 ICES estimated catches ('1000 tonnes) by ICES division and by quarter.

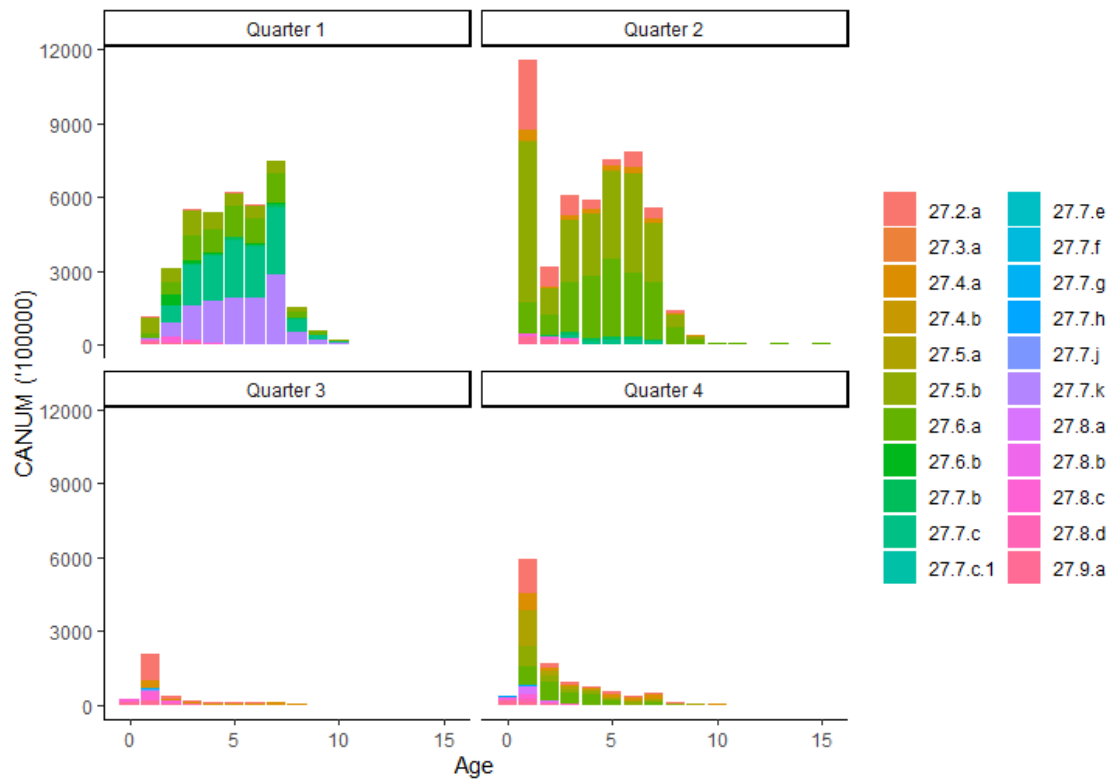


Figure 2.3.1.7. Blue whiting. Catch-at-age numbers (CANUM) distribution by quarter and ICES division for 2021.

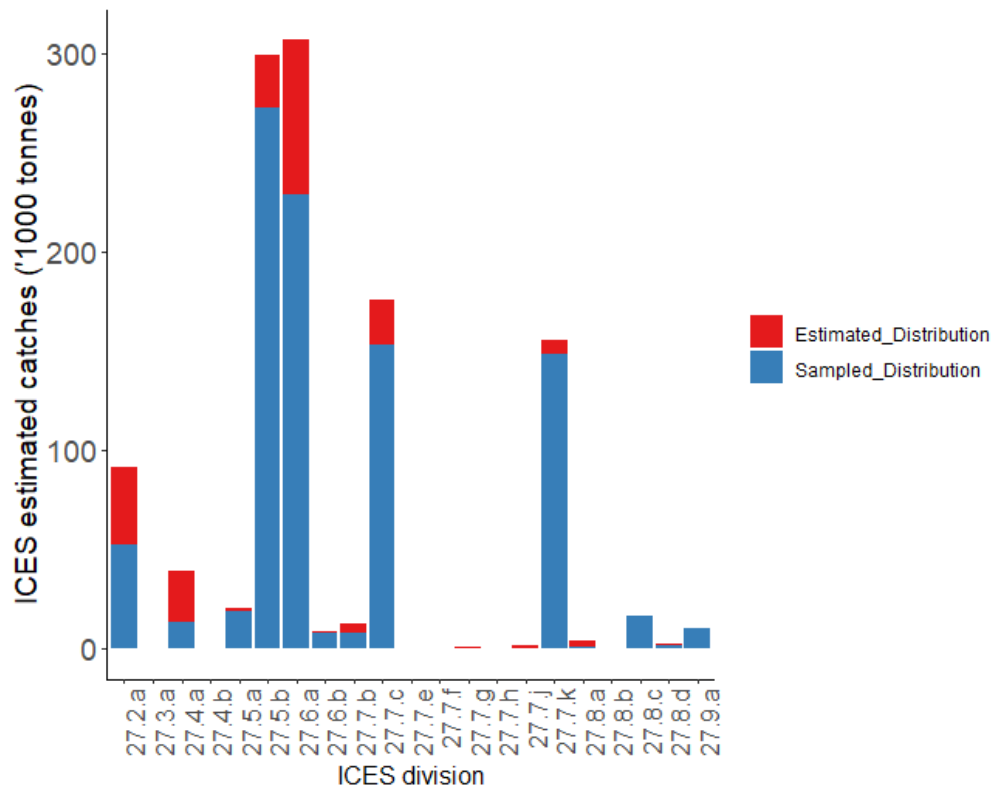


Figure 2.3.1.1.1. Blue whiting. 2021 ICES catches ('1000 tonnes) based on sampled or estimated distribution by ICES division.

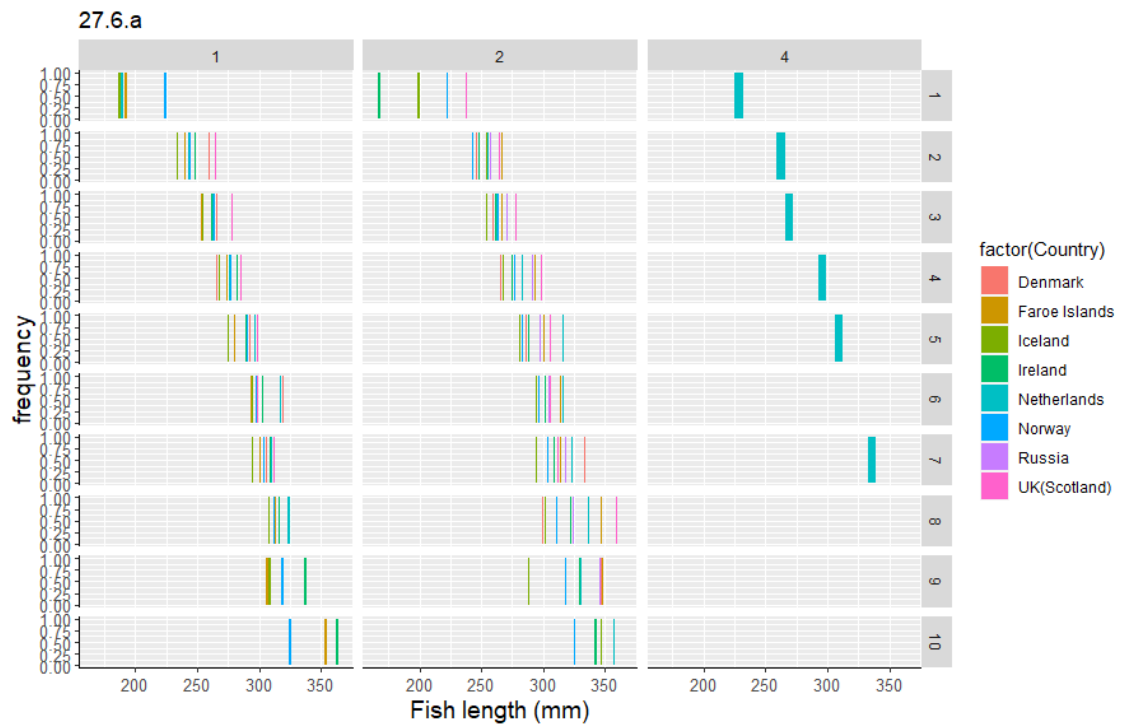


Figure 2.3.1.2.1. Blue whiting. Mean length (mm) by age (0-10 year), by quarter (1,2,4), by country for ICES division area 27.6.a. These data only comprises the 2021 ICES catch-at-age sampled estimates for ICES division 27.6.a.

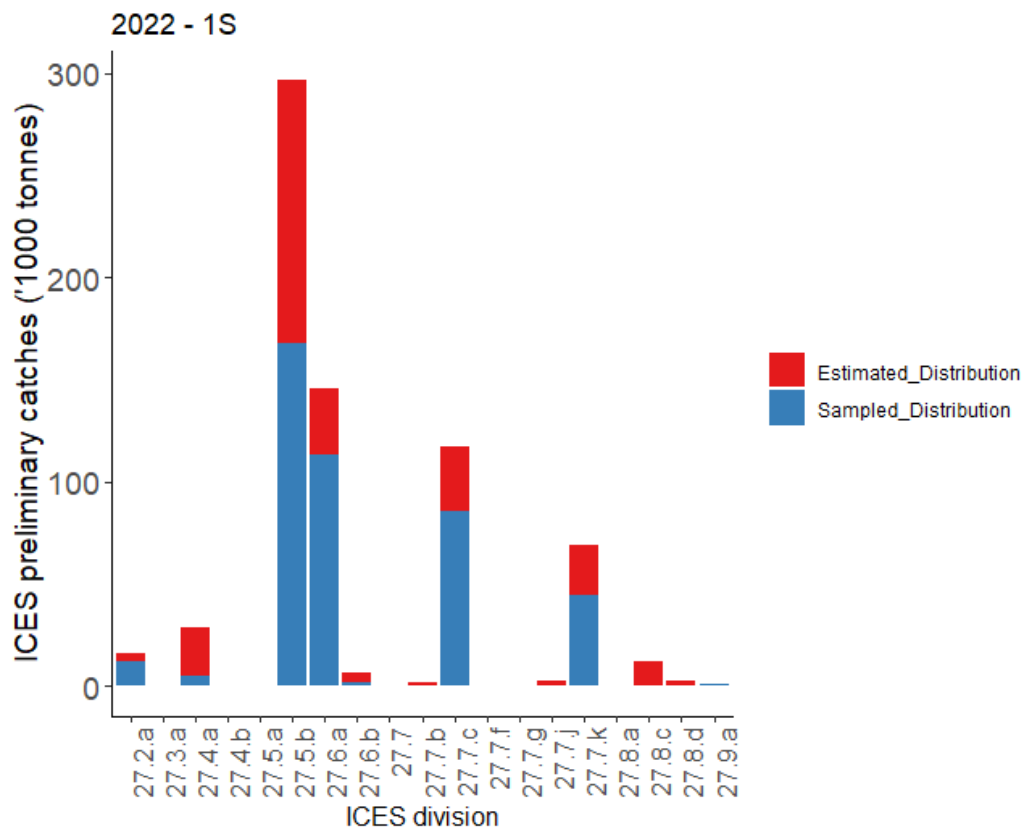


Figure 2.3.2.1. Blue whiting. 2022 ICES preliminary catches ('1000 tonnes) (Quarter 1 + Quarter 2) based on sampled or estimated distribution by ICES division.

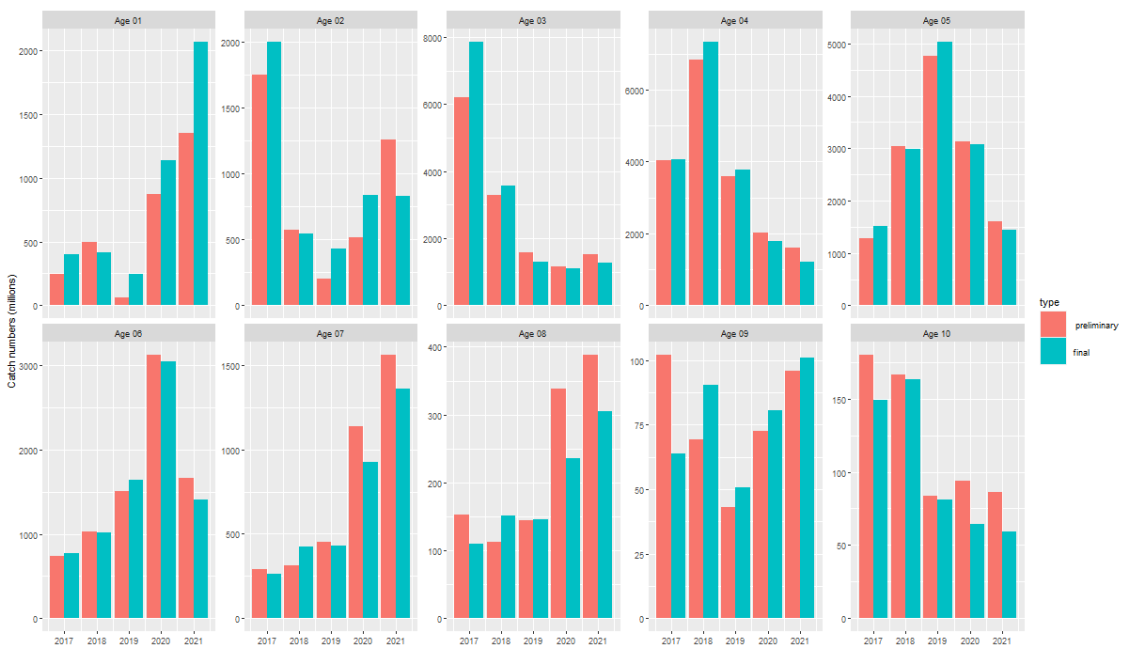


Figure 2.3.2.2 Preliminary and final estimates of catch at age number by age and year.

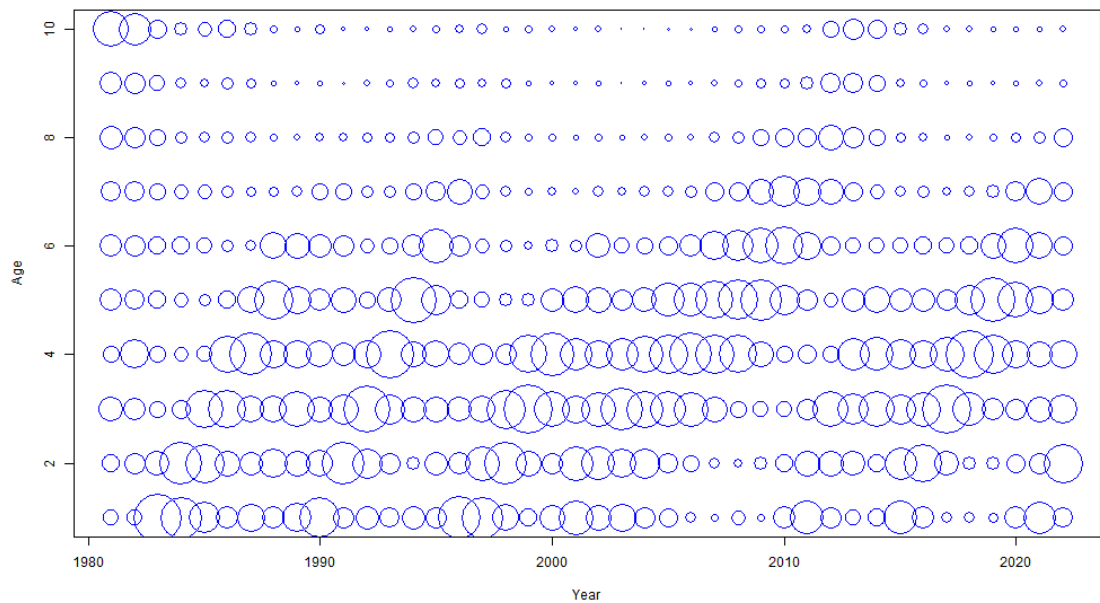


Figure 2.3.3.1. Blue whiting. Catch proportion at age, 1981-2021. Preliminary values for 2022 have been used.

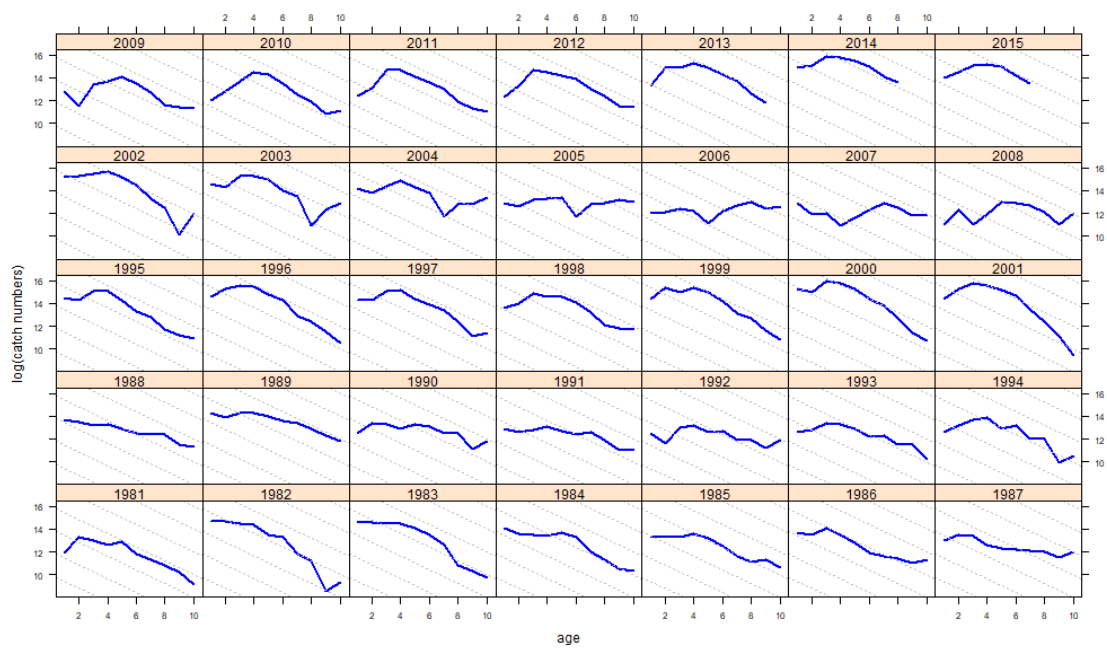


Figure 2.3.3.2. Blue whiting. Age disaggregated catch (numbers) plotted on log scale. The labels for each panel indicate year classes. The grey dotted lines correspond to $Z=0.6$. Preliminary catch-at-age data for 2022 have been used.

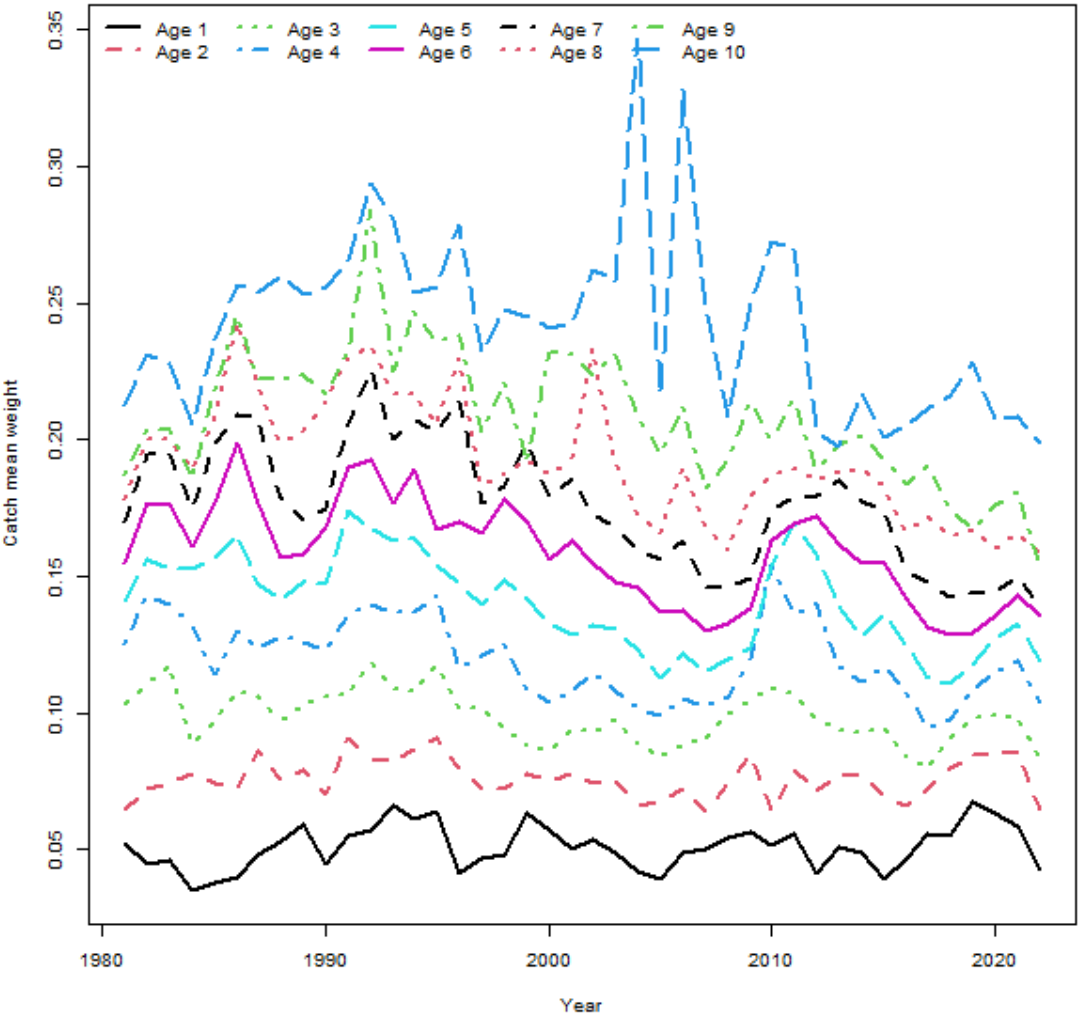


Figure 2.3.4.1. Blue whiting. Mean catch (and stock) weight (kg) at age by year. Preliminary values for 2022 have been used

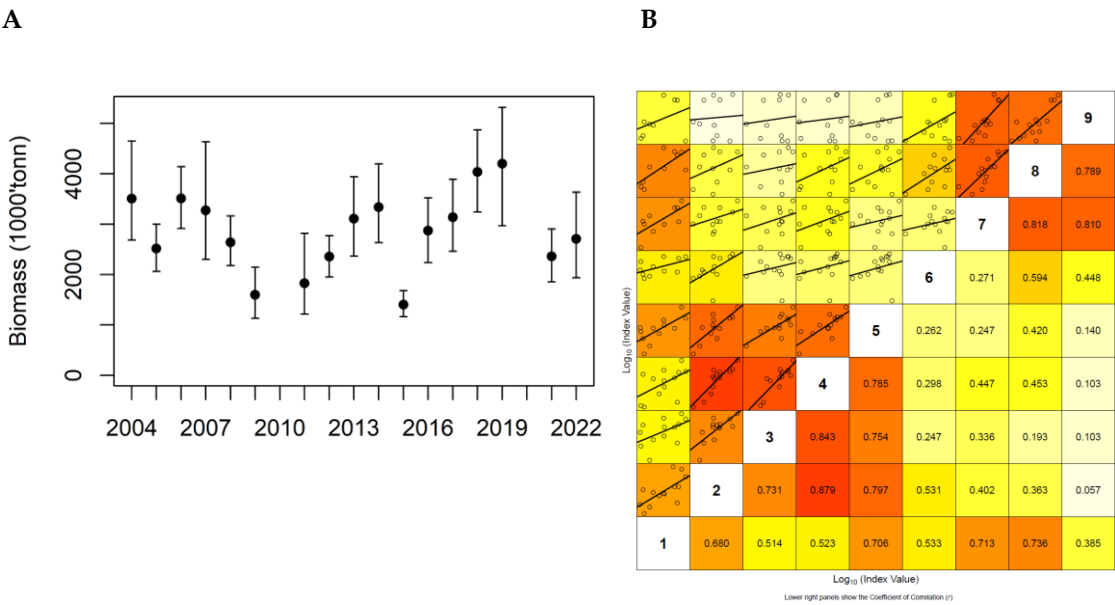


Figure 2.3.7.1.1. Blue whiting. (A) Estimate of total biomass from the International blue whiting spawning stock survey. The black dots and error bands are StoX estimates with 90 % confidence intervals. (B) Internal consistency within the International blue whiting spawning stock survey. The upper left 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 $r<0$.

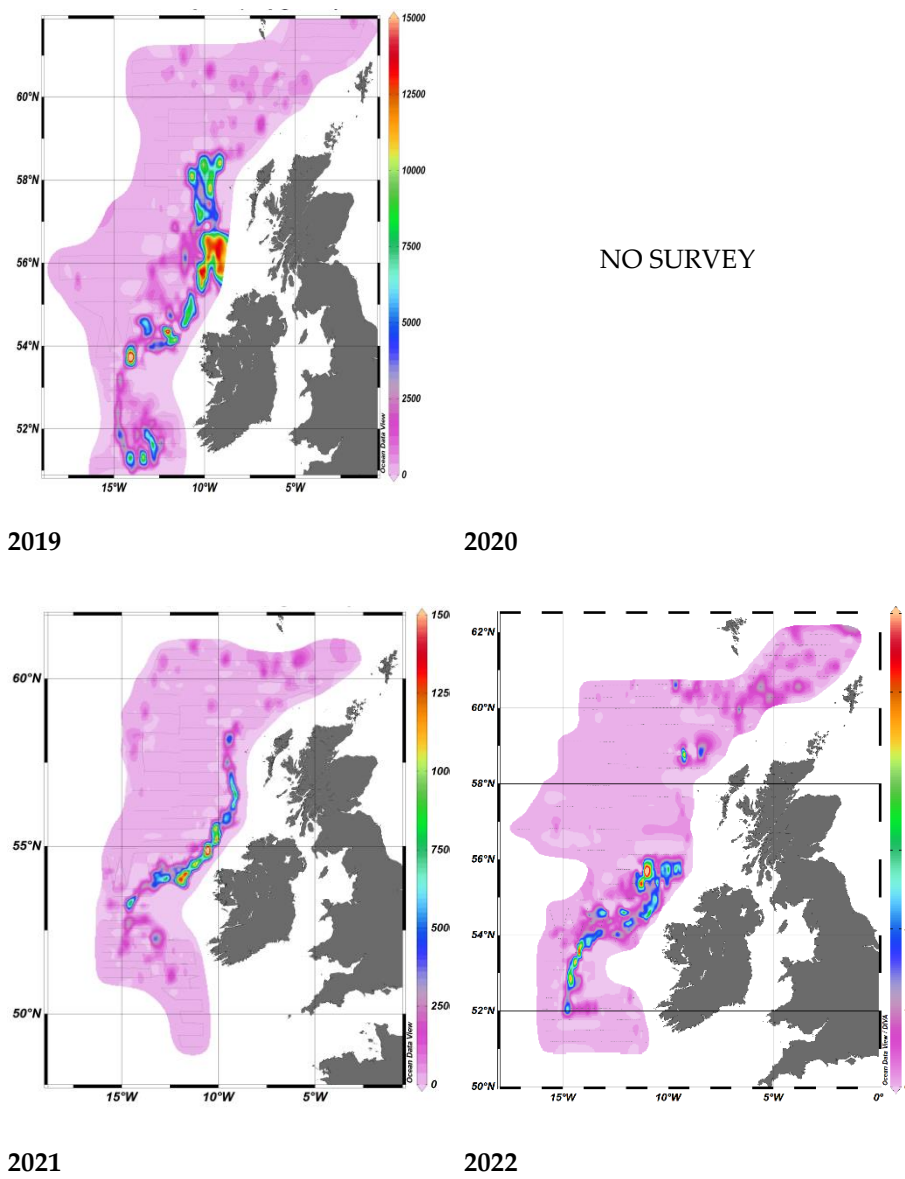


Figure 2.3.7.1.2. Blue whiting. Distribution of the blue whiting stock in the area to the west of the British Isles, spring 2019 (upper panel) to 2022 (lower panel).

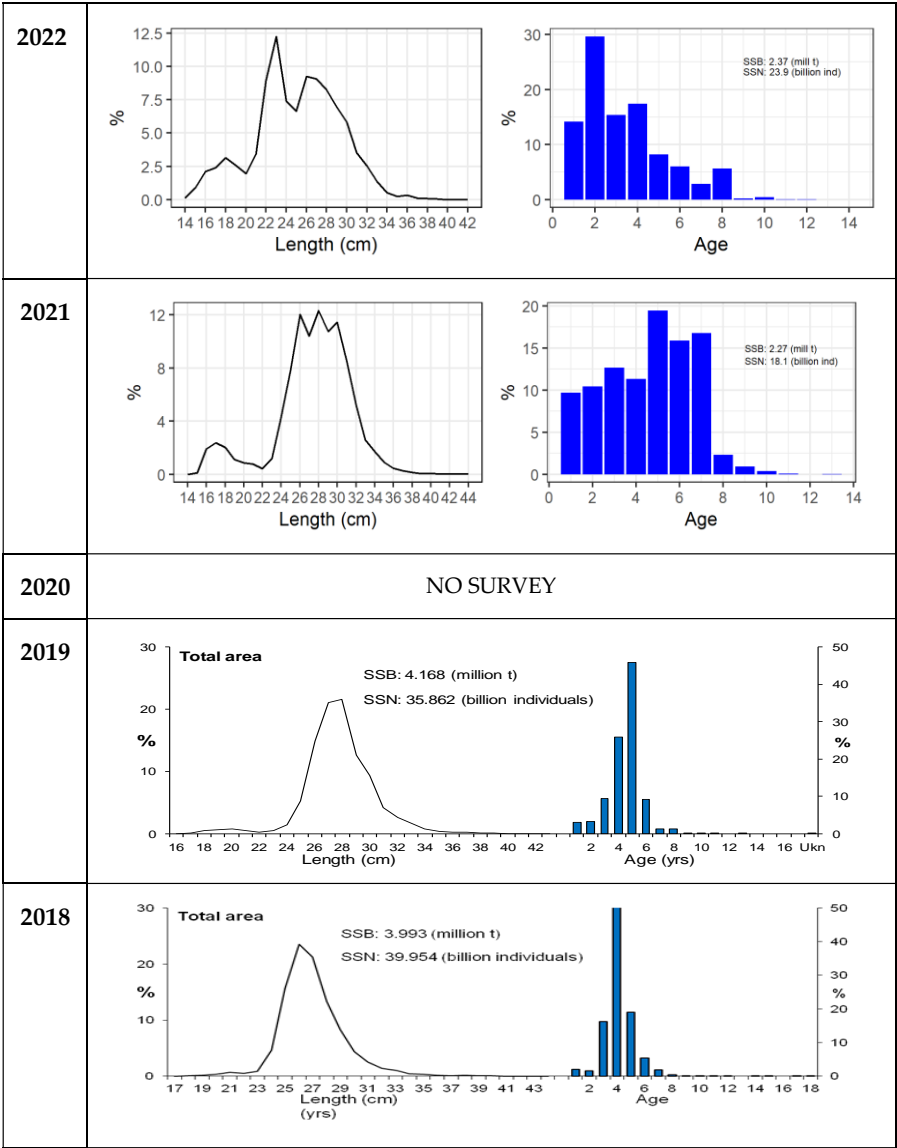


Figure 2.3.7.1.3. Blue whiting. Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2018 (lower panel) to 2022 (upper panel). Spawning-stock biomass and numbers are given.

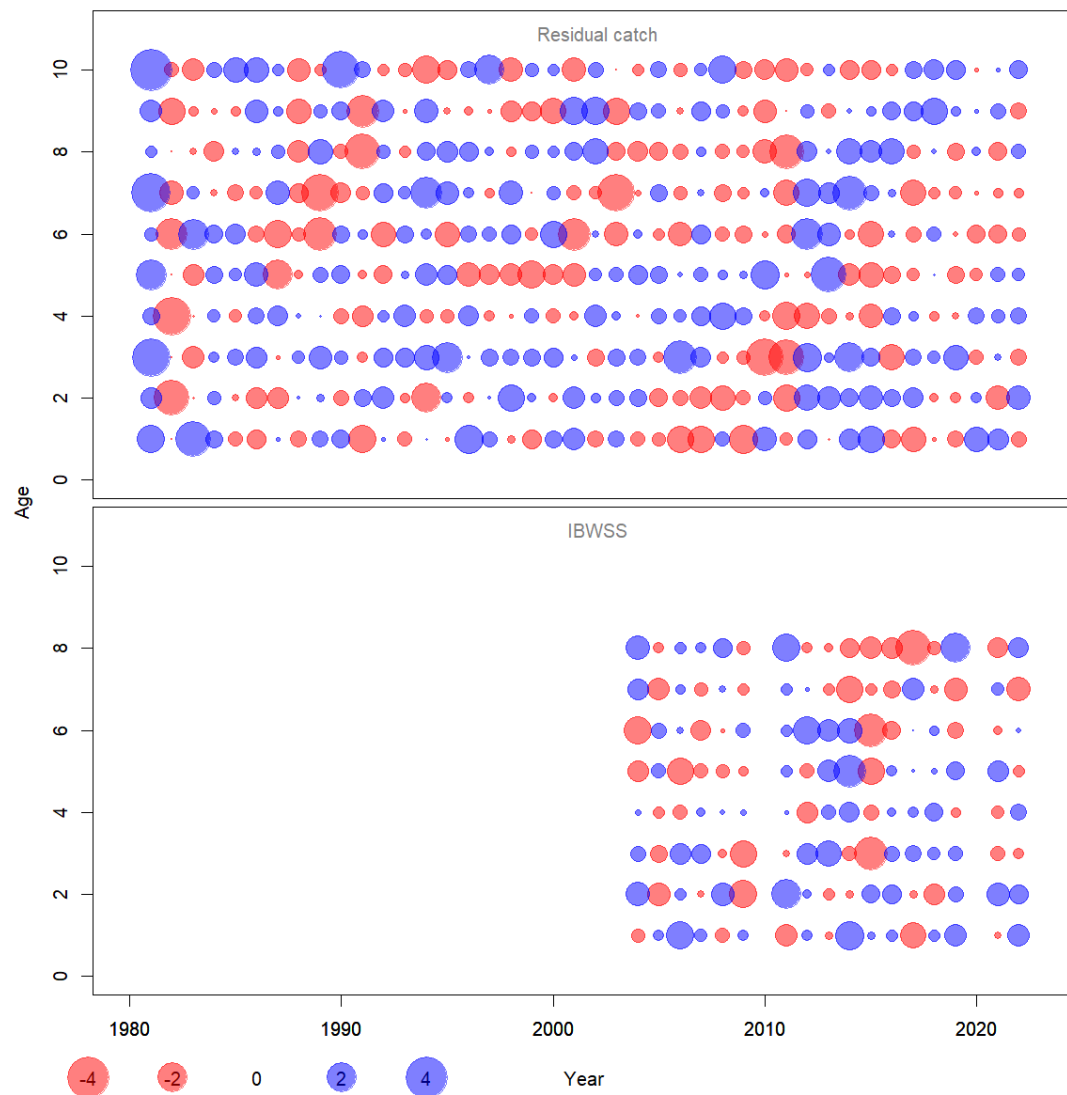


Figure 2.4.1.1. Blue Whiting. OSA (One Step Ahead) residuals (see Berg and Nielsen, 2016) from catch-at-age and the IBWSS survey 2004-2022 (no survey in 2020). Red (lighter) bubbles show that the observed value is less than the expected value. Preliminary catch data for 2022 have been used.

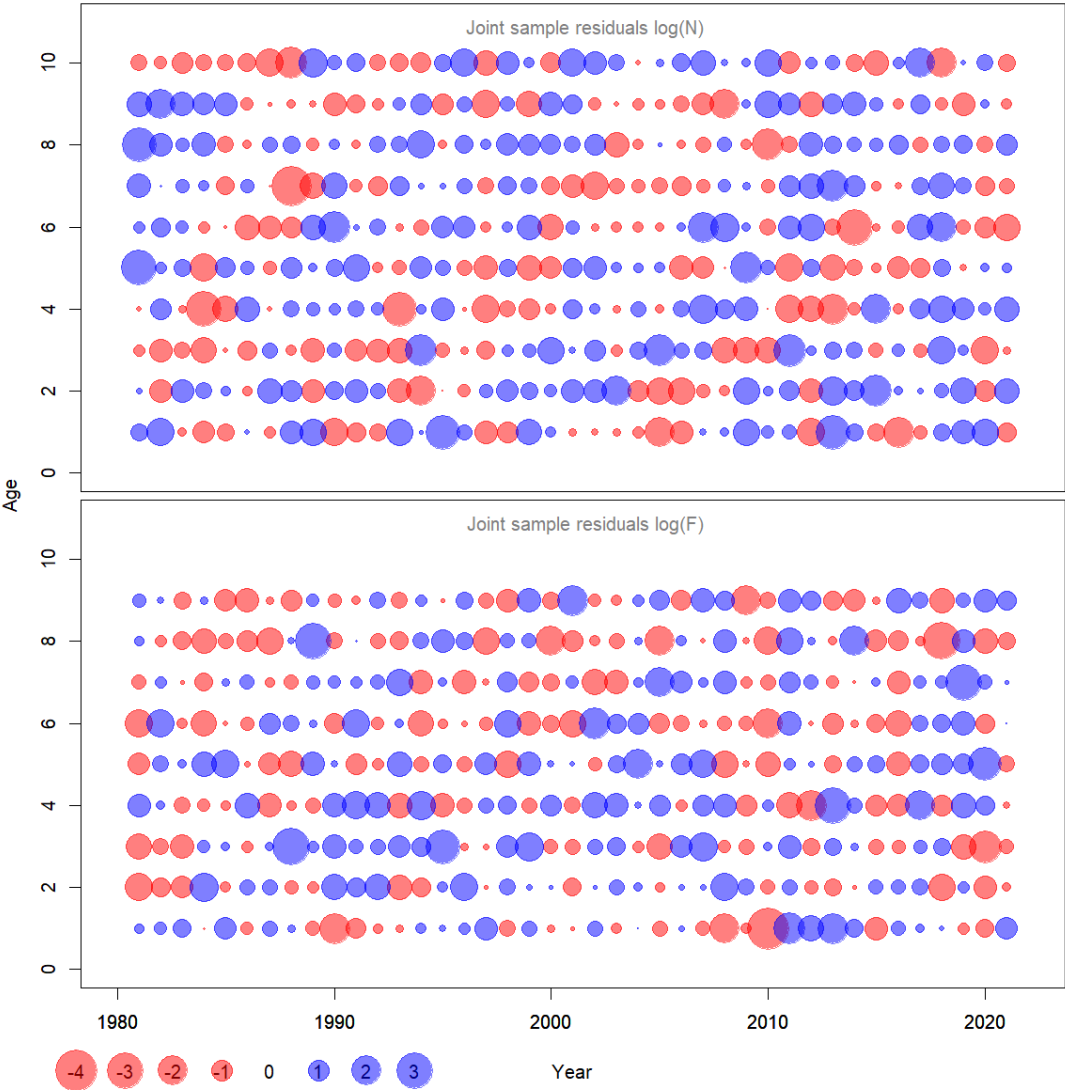


Figure 2.4.1.2 Blue whiting. Joint sample residuals (Process errors) for stock number and F at age. Red (lighter) bubbles show that the observed value is less than the expected value. Preliminary catch data for 2022 have been used.

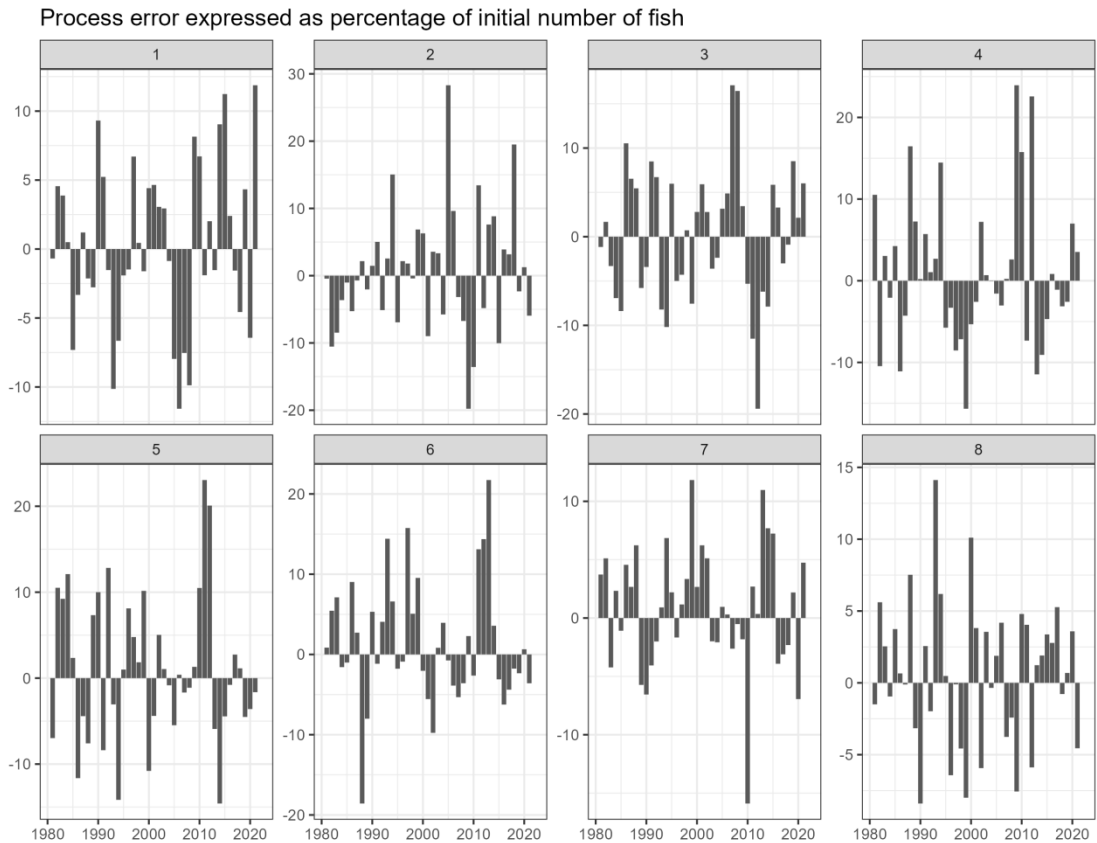


Figure 2.4.1.3. Blue whiting. Process errors expressed as deviation in instantaneous mortality at age by age and year.

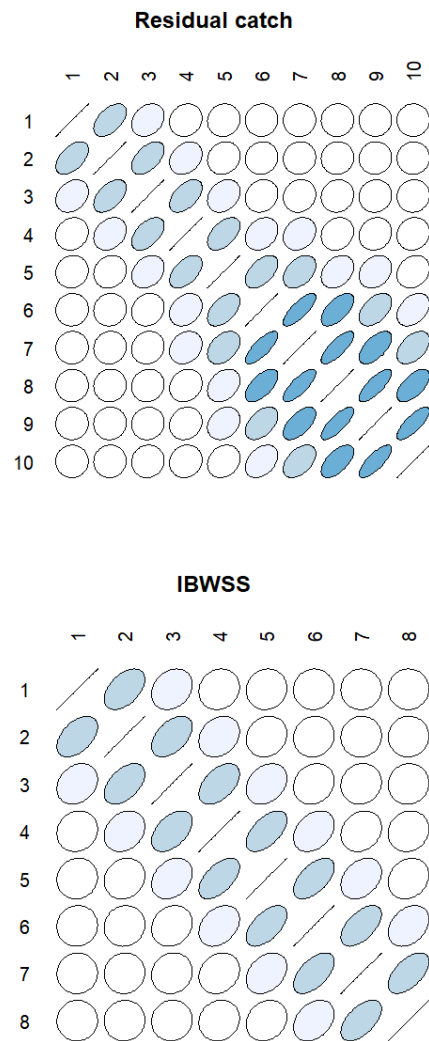


Figure 2.4.1.4. Blue whiting. The correlation matrix between ages for the catches and survey indices. Each ellipse represents the level curve of a bivariate normal distribution with the corresponding correlation. Hence, the sign of a correlation corresponds to the sign of the slope of the major ellipse 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 2022 have been used.

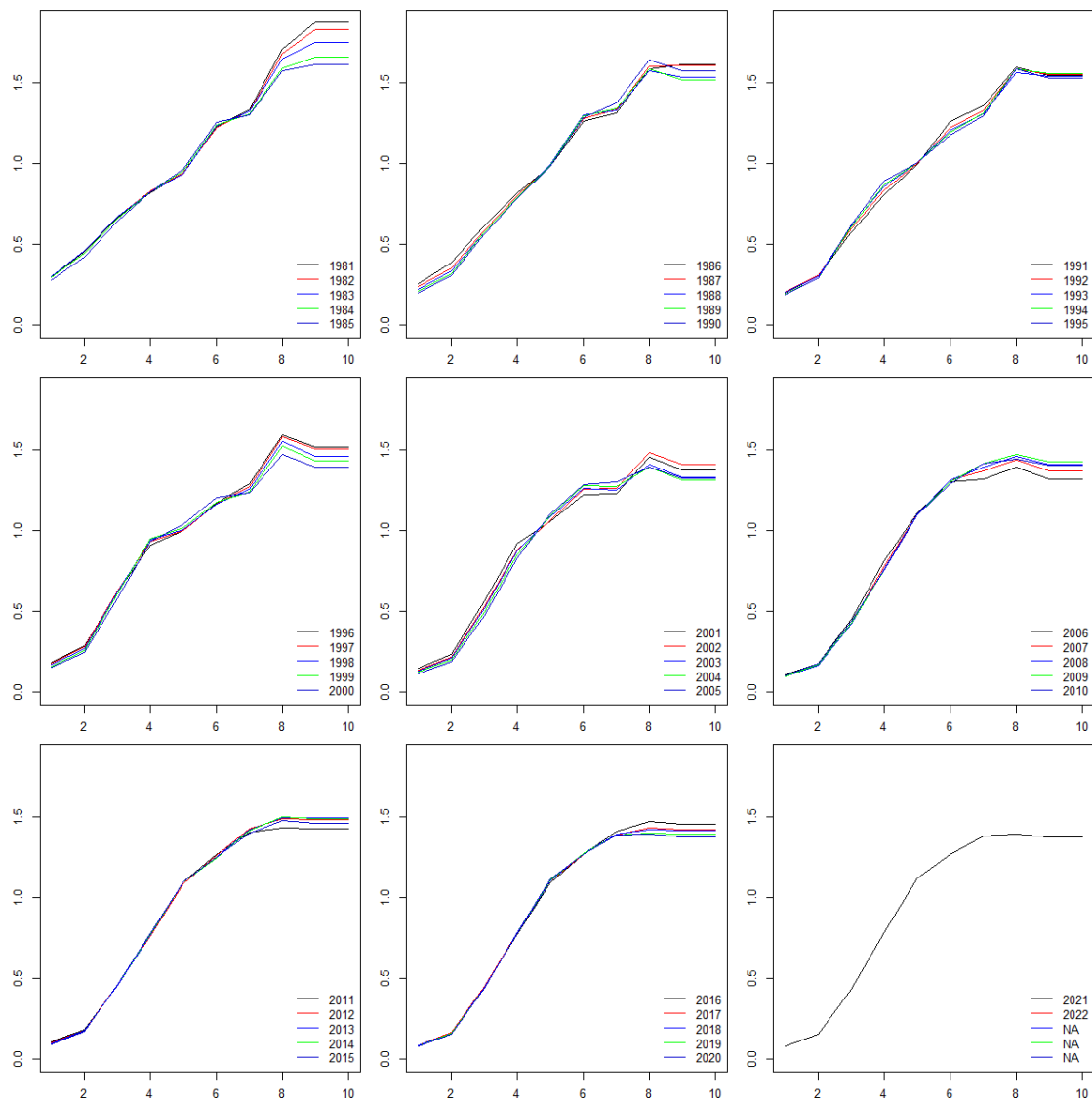


Figure 2.4.1.5. Blue whiting. Exploitation pattern by 5-years' time blocks. Preliminary catch data for 2022 have been used.

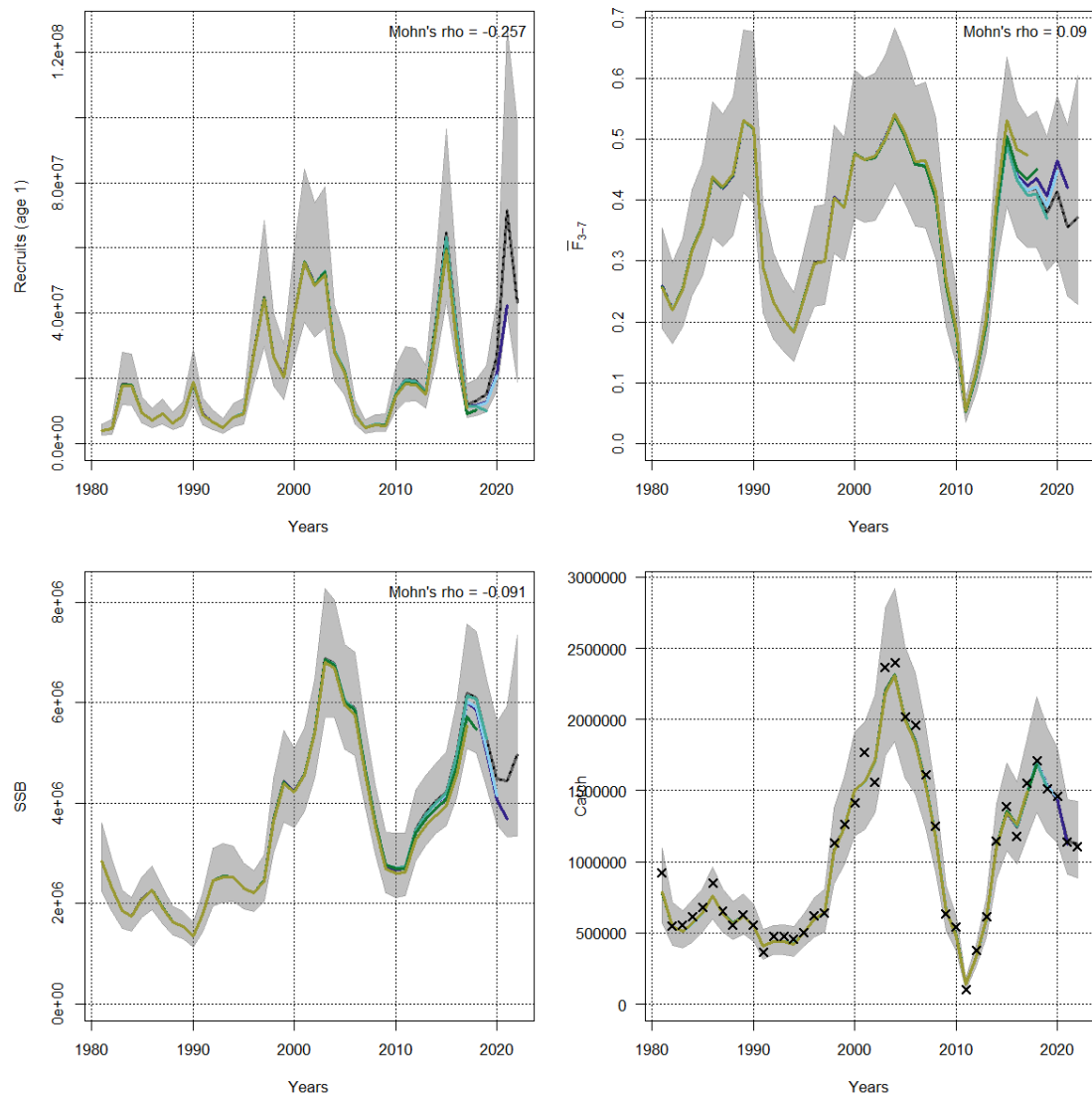


Figure 2.4.1.6. Blue whiting. Retrospective analysis of recruitment (age 1), SSB (tonnes), F and total catch using the SAM model. The 95% confidence interval is shown for the most recent assessment.

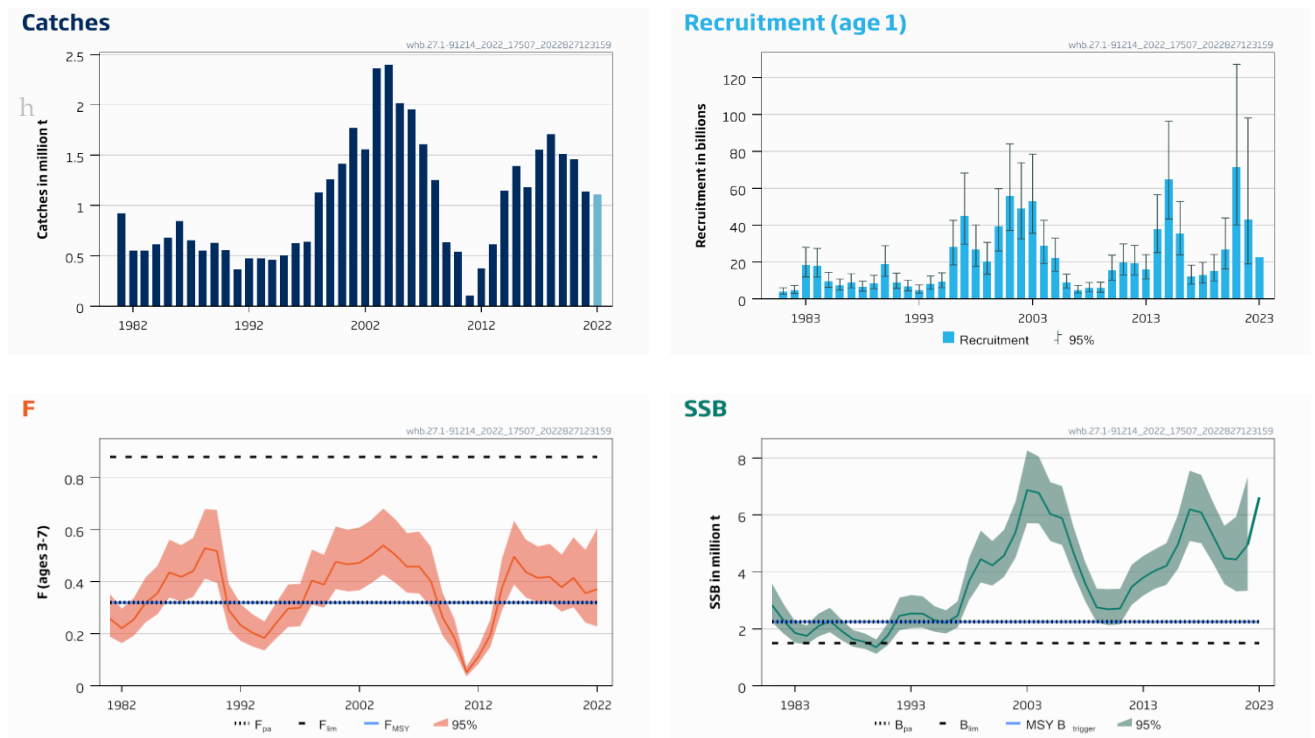


Figure 2.4.1.7. Blue whiting. SAM final run: Stock summary, total catches, recruitment (age 1), F and SSB. The graphs show the median value and the 95% confidence interval. Catches for 2022 are preliminary.

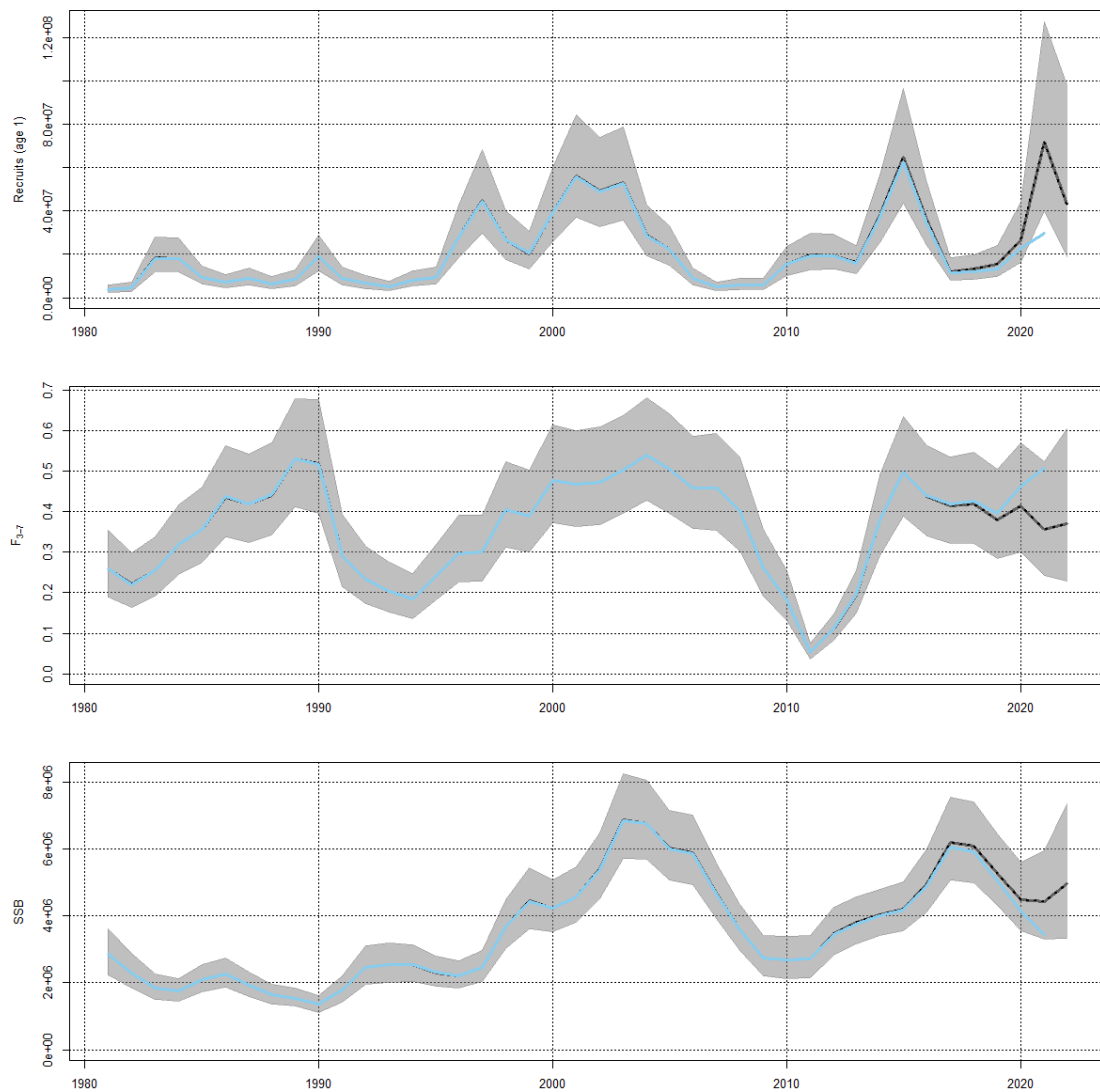


Figure 2.4.1.8. Blue whiting. SAM final run: Comparison of the 2021 and 2022 stock assessments, shown with 95% confidence intervals. Catches for 2022 are preliminary.

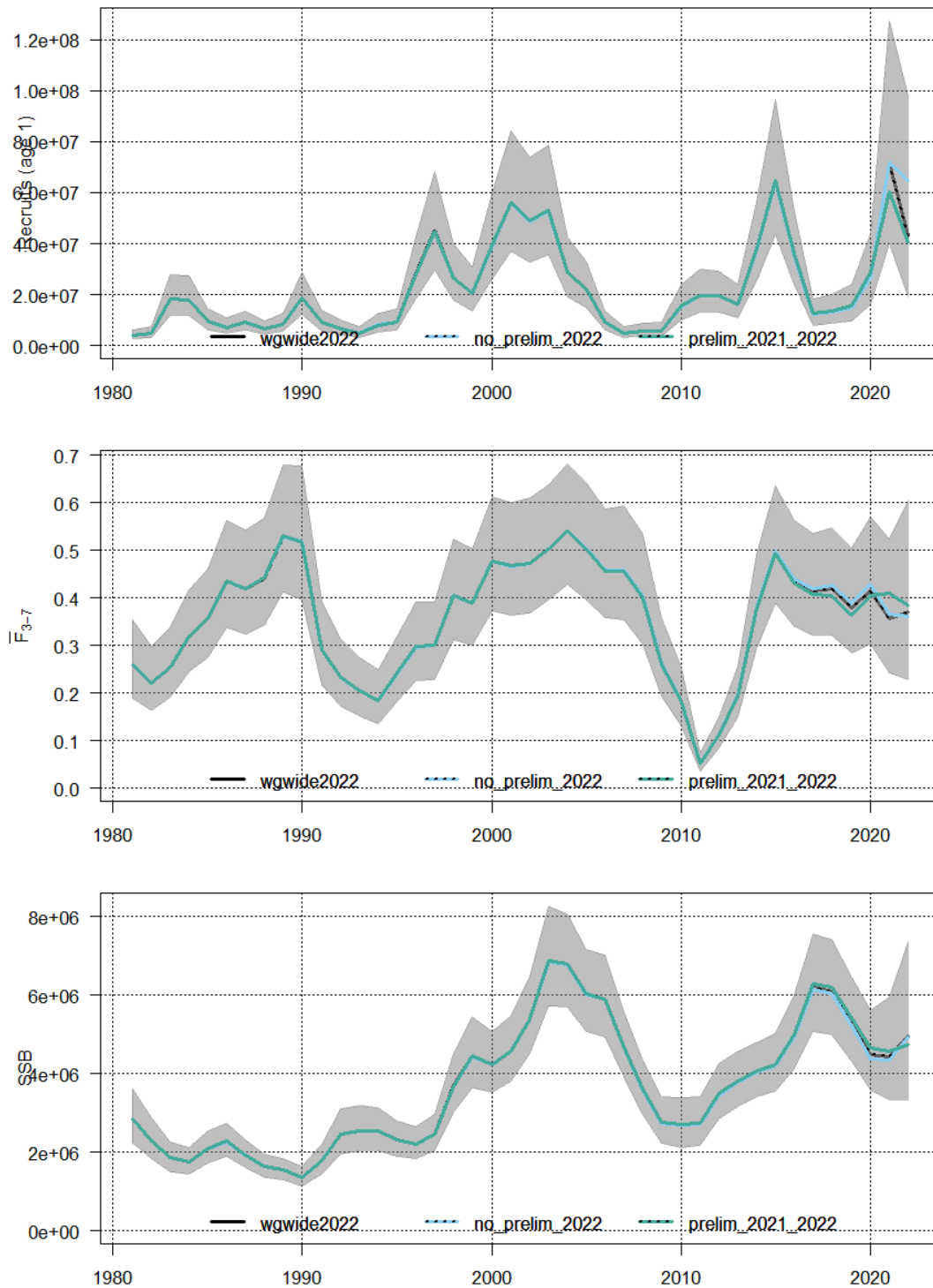


Figure 2.4.1.9. Blue whiting. Comparison of assessment runs with the default configuration (wgwide2020: final 2021 data and preliminary 2022 catch data), a run with no catch information for 2022 ("no_prelim_2022") and a run with preliminary catch data for both 2021 and 2022 ("prelim_2020_2022").

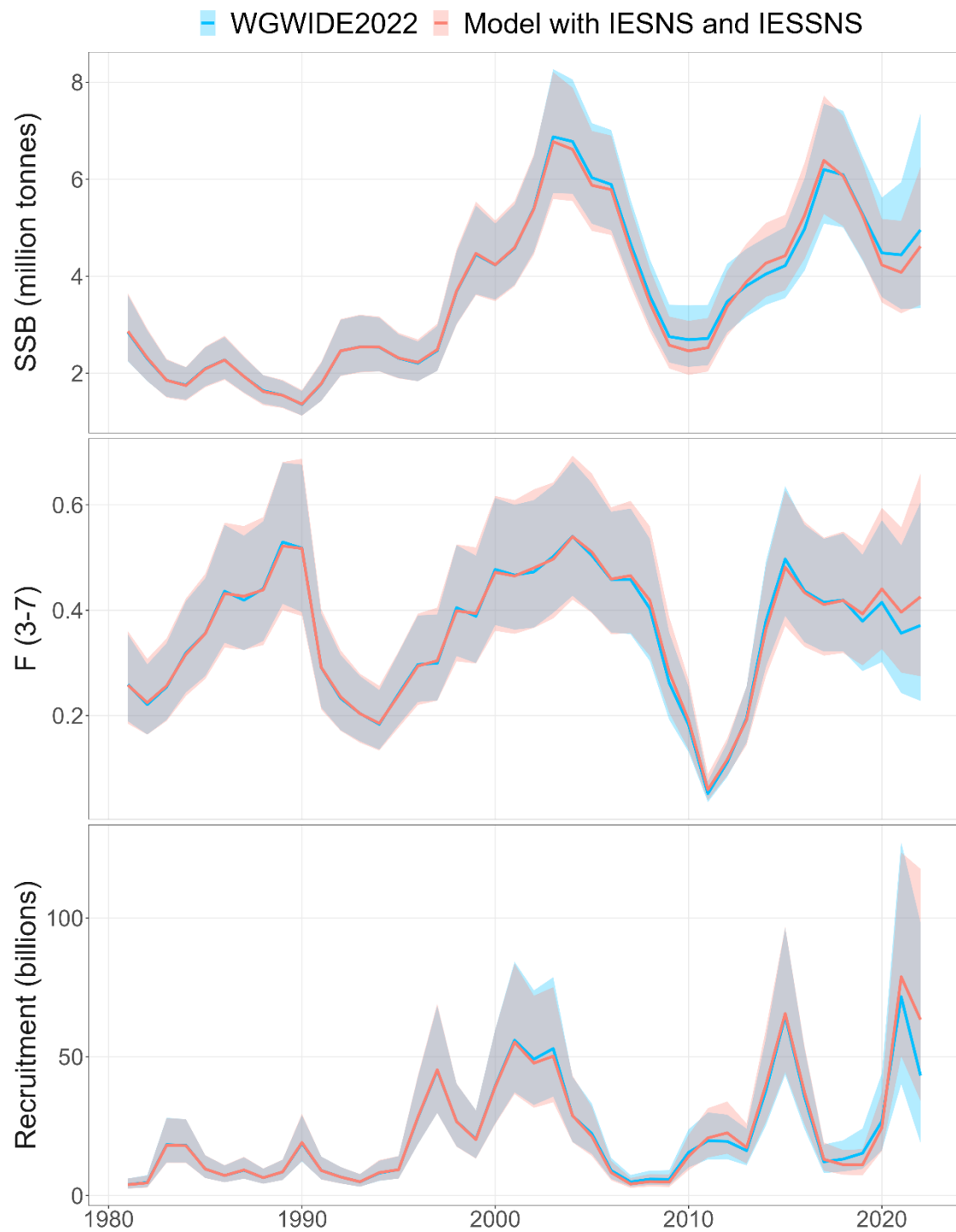


Figure 2.4.2.1. Blue whiting. Comparison of SSB, F and recruitment estimated by the final WGWISE 2022 SAM model and an alternative version including the two surveys IESNS and IESSNS. Catch values for 2022 are preliminary.

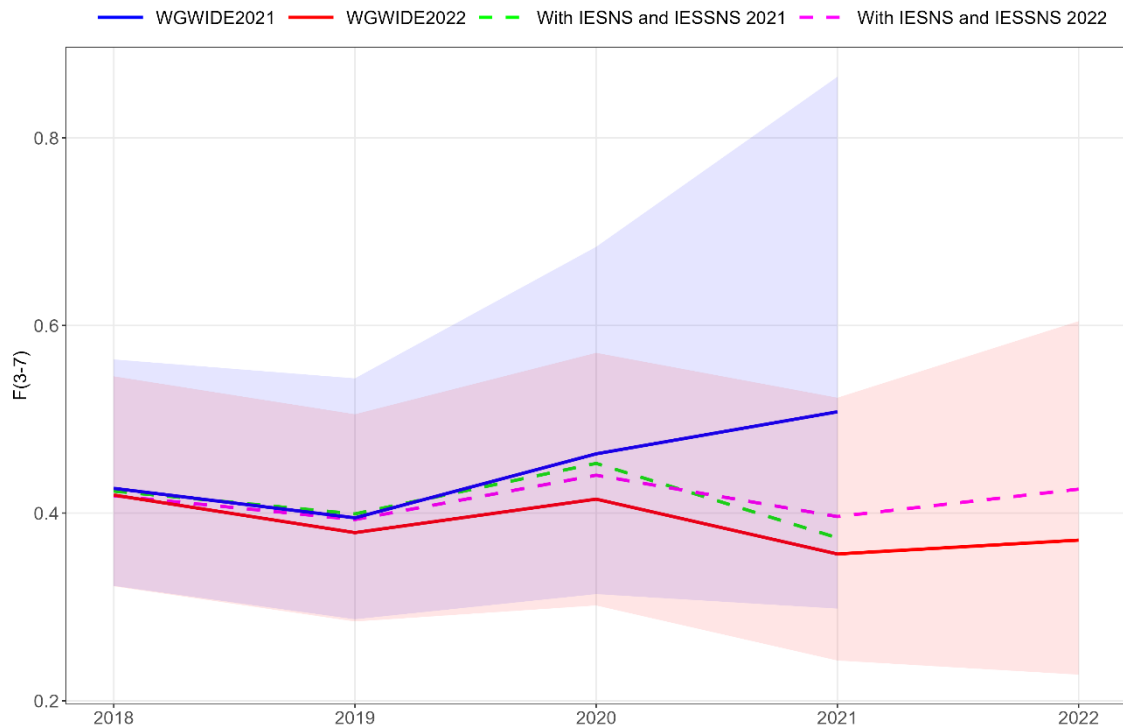


Figure 2.4.2.2. Blue whiting. Historical retrospective F estimated by the final WGwide SAM model and the alternative version including the two surveys IESNS and IESSNS for 2021 and 2022 showing only the last 5 years. Catch values for both years and assessments are preliminary. The confidence intervals are from the respective final WGwide assessments.

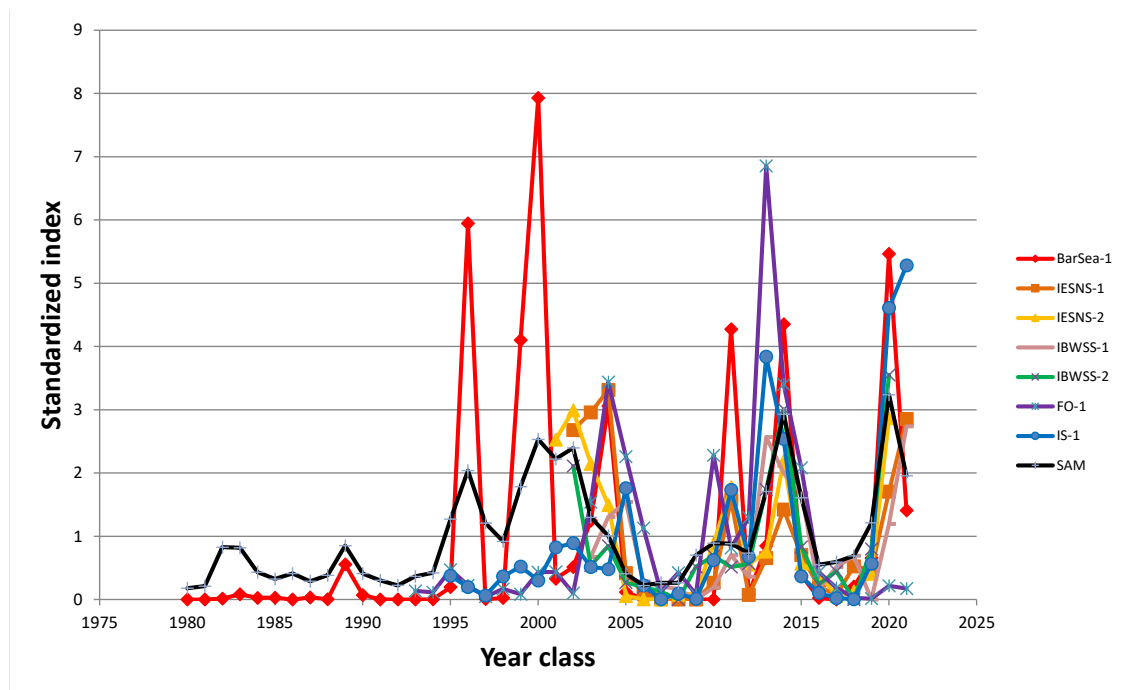


Figure 2.8.1.1. Blue whiting young fish indices from five different surveys and recruitment index from the assessment, standardized by dividing each series by their mean. BarSea - Norwegian bottom-trawl survey in the Barents Sea, IESNS: International Ecosystem Survey in the Nordic Seas in May (1 and 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.

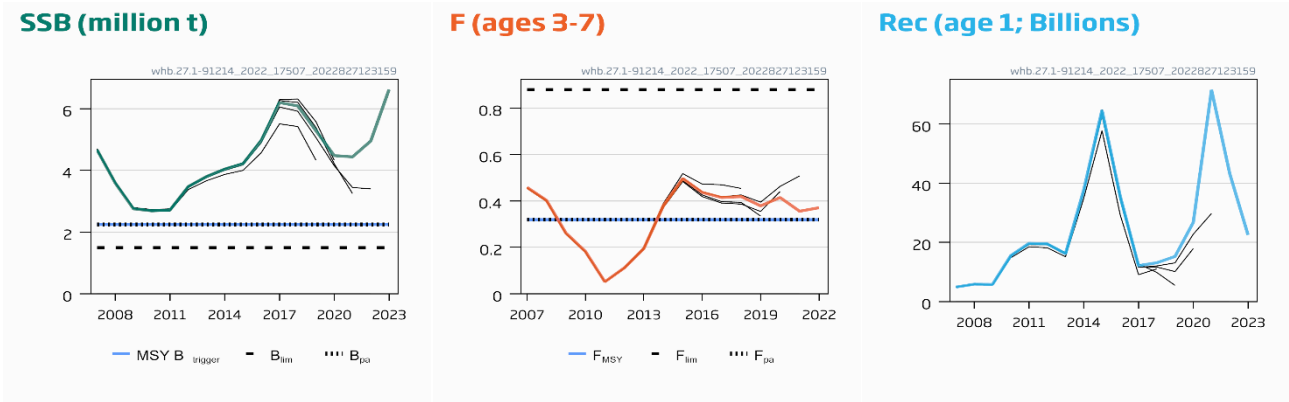


Figure 2.9.1. Blue whiting. Comparison of the 2018 - 2022 assessments (historical retrospective).