8 Blue Whiting – Subareas I–IX, XII and XIV

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

8.1 ICES advice in 2013

ICES notes that SSB has almost doubled from 2010 (2.9 million tonnes) to 2013 (5.5 million tonnes) and is well above Bpa (2.25 million tonnes). This increase is due to the lowest Fs in the time-series in 2011 and 2012, in combination with increased recruitment since 2010.

ICES advises on the basis of the management plan agreed by Norway, the EU, the Faroe Islands, and Iceland (target F=0.18) that landings in 2014 should be no more than 948 950 tonnes.

8.2 The fishery in 2013

The total catch was 626036 tonnes while the agreed TAC was 643000 tonnes. The main fisheries on blue whiting were targeting spawning and post-spawning fish in the EU region, International waters west of Porcupine Bank/Rockall Bank areas, west of Scotland and the Faroese region (Figure 8.3.1.2-8.3.1.3). Most of the catches (91%) were taken in the first two quarters of the year. The multi-national fleet currently targeting blue whiting consists of several types of vessels but the bulk of the catch is caught with large pelagic trawlers. Thirteen countries reported blue whiting landings in 2013. Specific details from some of these fisheries are provided below. Even though the majority of the blue whiting quotas for most national fleets are landed in the first half of the year, detailed information on the timing and location of catches in the current year are not always available by the time of the WGWIDE meeting.

8.2.1 Denmark

Danish landings of blue whiting in 2013 were just 2167 tonnes as the main part of the Danish quota was swapped with other species.

8.2.2 Germany

The vessels targeting blue whiting belong to the pelagic freezer trawler fleet and are owned by a Dutch company and operating under German flag. Depending on season and the economic situation these vessels are targeting other pelagic species in European and international waters. This fleet consists of four large pelagic freezer-trawlers with power ratings between 4200 and 12000 hp and crews of about 35 to 40 men. The vessels are purpose built for pelagic fisheries. The catch is pumped into large storage tanks filled with cool water to keep the catch fresh until it is processed. Total landings increased from 278 tonnes in 2011 to 6 238 tonnes in 2012 to 11418 tonnes in 2013. The majority of catches was taken in areas VIa,b and VIIc.

8.2.3 Faroe Islands

The reported landings of blue whiting from Faroese vessels were 85768 tonnes in 2013. Approximately 98 % of the blue whiting was caught within the Faroese EEZ and 2 % in international waters. The majority (96 %) of the blue whiting fishery occurred near the southern boundary of the Faroese EEZ in winter and early spring, January to May, and began again in December. In March, however, the catches were taken in international waters west of the British Isles. Later in the year scattered catches (4 %) were taken as bycatch in the herring and mackerel fisheries in the northern part of the Faroese EEZ. The fishing fleet consists of seven large trawlers/purse-seiners and one factory freezer utilizing pelagic trawls.

8.2.4 Iceland

The Icelandic landings in 2013 amounted around 105 000 t. Around 92% of the catches were taken in the Faroes EEZ during April and May, and 3% there in December. The remaining catches were taken in the Icelandic EEZ during July-December. A negligible amount was taken in international waters. The catches in the Icelandic EEZ were mainly from a mixed fishery with mackerel and Norwegian spring-spawning herring.

8.2.5 Ireland

The Irish Fishery in 2013 took place mainly in the first quarter, with a catch of 12428 t landed. In quarter two 777 t was landed. The fishery was concentrated on spawning aggregations to the west and northwest of Ireland. The majority of the catch was from VIIc (6813 t), VIa (2731 t) and VIb (2583 t), followed by small catches in VIIk (930 t) and VIIb (148t). Fifteen vessels participated in the fishery.

8.2.6 Netherlands

The Dutch catches of blue whiting in 2013 were mostly taken in the period February-May, with some catches in November-December, mainly in area VIa and VIIc by freezer trawlers. The total catch was 51600 tonnes. The majority of the catch (>95%) was recorded from 18 fishing trips. The remaining catches (<5%) are by-catch in the fisheries directed to other pelagic species. Estimated discards of blue whiting in 2013 are 1% in weight originating from non-directed fisheries.

8.2.7 Norway

After the coastal states agreement in 2012 and quota transfers in other international agreements, the Norwegian TAC for 2013 was set to 189132 t (up to 144408 t could be taken in the EU zone). The majority of the Norwegian catches (186000 t) were taken in a directed pelagic trawl fishery west of the British Isles and south of the Faroe Islands during the first half of the year. The remaining catches were mainly taken by the industrial trawl fleet (which uses both pelagic and demersal trawls) in the Norwegian deeps and Tampen area (east of 4ºW).

8.2.8 Russia

Two Russian trawlers operated in the Faroese area since the beginning of the year until February 11, and then on March 20—21. Five other vessels started to work here on April 3. The number of trawlers increased gradually to 18 but decreased to 2 in May.

The fishery was finished in that area on June 22 and resumed on December 22. In the first half of July, 11 trawlers were operating in the central part of Norwegian Sea when later in October one vessel carried out the directed BW fishery until the total catch in the international waters closed to the allowed value 48879 t. Majority of this amount refers to the spring fishery in the spawning area west of British islands. That fishery was from February 7 to April 4. The total Russian landings of blue whiting in 2013 were 120674 tonnes.

8.2.9 Spain

The Spanish blue whiting fishery is carried out mainly by bottom pair trawlers in a directed fishery (approx. one third of the fleet) and by single bottom otter trawlers in a by-catch fishery (approx. two thirds of the fleet). The fleet operates throughout the year. Small quantities are also caught by longliners. These coastal fisheries have trip durations of 1 or 2 days and catches are for human consumption. Thus, coastal landings are driven mainly by market forces, and are rather stable. The Spanish fleet has decreased from 279 vessels in the early 1990s to 135 vessels in 2008. After a period of decreasing trend, Spanish landings increased in 2013 to a total landing of 15273 tonnes, and 99% of it was obtained in Spanish waters.

8.2.10 Portugal

Blue whiting is commonly caught as by-catch by the Portuguese bottom-trawl fleets targeting finfish and crustaceans, which comprises around 100 vessels under 30 meters long. Some vessels of the artisanal fishing fleet also catch blue whiting as by-catch, although this is mostly discarded it is rarely used for human consumption in Portugal and there is no market demand for industrial transformation. Total landings in 2013 were about 2056 tonnes.

8.2.11 UK

The whole catch, 13498 tonnes was obtained in the first half of 2013. The vessels from Northern Ireland caught 1232 tonnes in the area VIIk. The Scottish trawlers operated in VIa-b and VIIc landing 8166 tonnes. The rest of the catch was taken by English trawlers in the same areas in the 2nd quarter.

8.2.12 France

The total French catch in 2013 was 8981 tonnes, and 80% of it was obtained in the first half of year west of the British Isles.

8.3 Input to the assessment

8.3.1 Catch data

Total landings in 2013 were about 626 036 tonnes. Total catches in 2013 were provided by members of the WG. The data provided as catch by rectangle represented more than 96% of the total WG catch in 2013. Total catch by country for the period 1988 to 2013 is presented in Table 8.3.1.1.

After a minimum of 104000 tonnes in 2011, catches increased to around 384000 tonnes in 2012 and around 626000 tonnes in 2013. The spatial and temporal distribution in 2013 (Figure 8.3.1.1, 8.3.1.2 and 8.3.1.3 and Table 8.3.1.2), is quite similar to the distribution in previous years. The majority of catches is coming from the spawning area, but compared to previous years, the 2013 catches have a much larger contribution from

Division Vb (Figure 8.3.1.4 and 8.3.1.5). The temporal allocation of catches has been relatively stable in recent years (Figure 8.3.1.6) however with an increase of the proportion of catches from the second quarter that was also observed in 2013. In the first two quarters catches are taken over a broad area while later in the year catches are mainly taken further north in sub-area II and in the North Sea (Division IVa) and Division V. The proportion of landings originating from the Norwegian Sea has been decreasing steadily over the recent period to less than 10% of the total catch in 2013.

8.3.1.1 Discards

Discards of blue whiting are thought to be small. Most of these discards are by-catch in fisheries not directed to blue whiting. Most of the blue whiting is caught in directed fisheries for reduction purposes.

Discards information for blue whiting in 2013, are presented in Table 8.3.1.1.1. Only a few countries have supplied quantitative discards information for 2013.

The main fishing nations, Faroe Islands, Iceland, Norway and Russia have already a discard ban in place and discards are assumed zero or negligible.

Germany and Netherlands presented a discard percentage of 1 and 2% (respectively) in the total amount of catches. Discards estimates from Germany are based on a single trip operation in ICES Division VIIj in a fishery directed on horse mackerel.

The 99.8% of blue whiting French landings are mainly from one industrial boat targeting the species to producing surimi. Although no information is available by observer programmes on this fishery, the industry confirms that there are no discards. Discards could however occur at a very low level, in case of the total catch is too low to process the fish or if other species are mixed with blue whiting.

Blue whiting discards in Portugal are relatively high and mostly due to by-catch and a reduced market-demand. In 2013, the discards were around 700 ton, corresponding to 25% of the total Portuguese catches.

The discard scenery observed in Spain is similar, with a 26% of the blue whiting total catches being discarded. By-catch, undersized fish, and market-demand dynamics are the driving forces to discard this species in Spain.

The Portuguese and Spanish landings contribute by less than 2.8 % of the total international landings. At a stock level, discards are considered negligible as most of the blue whiting landings are from directed fisheries for reduction purposes by nations where a discards ban already is in force.

8.3.1.2 Sampling intensity

Sampling intensity for blue whiting from the commercial catches by fishery and quarter is shown in Table 8.3.1.2.1, while detailed information on the number of samples, number of fish measured, and number of fish aged by country and quarter is given in Table 8.3.1.2.2 and are presented and described by year, country and area in section 1.3 (Quality and Adequacy of fishery and sampling data). In total 915 samples were collected from the fisheries in 2013. 111079 fish were measured and 14633 were aged. Sampled fish were not evenly distributed throughout the fisheries (Table 8.3.1.2.2). Considering the proportion of samples per catch, the most intensive sampling took place in the mixed fishery with one sample for every 62 tonnes, followed by the southern fishery of Spain and Portugal. Here one sample was taken for every 69 tonnes, and lastly the directed fishery where there was one sample for every 1028 tonnes caught. In this context it should be noted that implementation of the EU Collection of Fisheries

Data, Fisheries Regulation 1639/2001, requires EU Member States to take a minimum of one sample for every 1000 t landed in their country. As can be seen, no sampling data were submitted by France and UK (England, Wales and Northern Ireland), all with relatively small landings. Sampling intensity for age and weight of herring and blue whiting are made in proportion to landings according to CR 1639/2001 and apply to EU member states. For other countries there are no guidelines. Current precision levels of the sampling intensity are unknown and the group recommends reviewing the sampling frequency and intensity on a scientific basis and provide guidelines for sampling intensity.

8.3.1.3 Length and age compositions

Data on the combined length composition of the 2013 commercial catch by quarter of the year from the directed fisheries in the Norwegian Sea and from the stock's main spawning area were provided by the Faroes, France, Germany, Iceland, Ireland, the Netherlands, Norway, Russia and Scotland (Table 8.3.1.3.1). Length composition of blue whiting varied from 10 to 46 cm, with 95% of fish ranging from 21—36 cm in length, a size range similar to that observed last year. The mean length in the fishery was 28.6, which is 0.5 cm smaller than last year, confirming the decreasing trend in the mean length observed last year, after a period of increasing trend in the mean length observed in recent years.

Length compositions of the blue whiting catch and by-catch from "mixed fisheries" in the Norwegian Sea and the North Sea and Skagerrak were presented by Norway (Table 8.3.1.3.2). The catches of blue whiting from the mixed industrial fisheries consisted of fish with lengths of 18—38 cm with 95% of fish ranging from 19—34 cm. The mean length was 23.6 cm, 5 cm shorter than last year.

The Spanish and Portuguese length distribution of catches showed a length range of 13—40 cm with 95% of fish ranging from 16 to 28cm (Table 8.3.1.3.3). This distribution is similar as last year. The mean length was 22.1, 0.8 cm shorter than the previous year.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the by-catch of blue whiting in "other fisheries" and for landings in the Southern area, were assumed to represent the overall age composition of the total landings for the blue whiting stock. The InterCatch program was used to calculate the total international catch-at-age, and to document how it was done. The catch numbers-at-age used in the stock assessment are given in Table 8.3.1.3.4. The calculation of mean age assigns an age of 10 to all fish in the plus group. Therefore in years of high plus group abundance the mean age could be significantly underestimated. The mean age of the catch (and stock) has been increasing in the period 2001-2010, followed by a drop in 2011, due to the relatively high catches of one and two groups this year. There was also a high increase to a mean age of 5 years in 2013.

Catch proportions at age plotted in Figure 8.3.1.3.1. Strong year classes can be clearly seen in the early 1980s, 1990 and the late 1990s. Poor recruitment over the recent period is clearly seen in the decreasing proportion of younger fish. This pattern was different in 2011 onwards, where stronger year classes can also be observed.

Catch curves made on the basis of the international catch-at-age (Figure 8.3.1.3.2) indicate a consistent decline in catch number by cohort and thereby reasonably good quality catch-at-age data, especially for year classes since 1995.

8.3.1.4 Weight at age

Table 8.3.1.4.1 and Figure 8.3.1.4.1 show the mean weight-at-age for the total catch during 1983—2013 used in the stock assessment. Compared to the 2007 mean weights, the values from the succeeding years are higher for most ages, which show that the decreasing trend in mean weight for the period 1995—2005 (2007) has ended.

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

8.3.2 Information from the fishing industry

No comprehensive information has been received from the fishing industry this year.

8.3.3 Maturity and natural mortality

Blue whiting natural mortality and proportion of maturation-at-age is shown in Table 8.3.3.1. See the Stock Annex for further details. A new working document shows a higher proportion mature for age 1 (from 11% to 22%) and slightly higher for ages 2—6 (Heino, 2014, WD to WGWIDE 2014). These values have not fully been evaluated by the WG and as the assessment is an update assessment they have not been used in this year’s assessment.

8.3.4 Fisheries independent data

8.3.4.1 International Blue Whiting spawning stock survey

Background and status

The International Blue Whiting Spawning Stock Survey (IBWSS) is carried out on the spawning grounds west of the British Isles in March-April. The survey started in 2004 and is carried out by Norway, Russia, the Faroe Islands and the EU. This international survey, allowed for broad spatial coverage of the stock as well as a relatively dense amount of trawl and hydrographical stations. The survey is coordinated by WGIPS (ICES CM 2014/ SSGESS:01).

Use of this survey in stock assessment

Indices of age 3—8 from the IBWSS survey have been used in the assessment since 2007.

Quality of the survey

WGIPS decided that in 2014, the survey design should follow the principle of the one used during the two previous surveys. The focus was still on a good coverage of the shelf slope in areas II and III. However, given the increasing stock biomass observed over recent years, it was expected that the distribution was more extended over the whole survey area as well. In previous years when larger stock sizes were observed (2004—2011), blue whiting aggregations were distributed more evenly over the whole survey area, including the Rockall Bank and Rockall Trough. Therefore, the survey design in 2014 was to allocate more effort in these areas as well. The design was the same as in the previous two years and the design is based on variable transect spacing, ranging from 30 nmi in areas containing less dense aggregation (e.g. subarea I, south Porcupine), to 7.5 nmi in the core survey area (subarea III, Hebrides). To ensure transect coverage was not replicated, transects were allocated systematically with a random start location.

Due to acceptable - good weather conditions throughout the survey period, the survey resulted in high quality coverage of the stock. Transects of all vessels were consistent in spatial coverage and timing, delivering full coverage of the respective distribution areas within 14 days

A post-cruise meeting held in Torshavn 22—24 April 2014 compiled a joint survey report. This will be reviewed in the next WGIPS meeting. The post-cruise meeting concluded that the estimate is a valid extension of the survey time series.

Uncertainties in spawning stock estimates based on bootstrapping of available data have been assessed again in 2014 (Figure 8.3.4.1.1 A). At present, only one source of uncertainty is considered namely the spatio-temporal variability in acoustic re-cordings. The overall trend indicates a continued decrease year-on-year in biomass from 2007—2011 for this stock. The uncertainty around the decline in biomass from 2008 to 2011 is more than could be accounted for from spatial heterogeneity alone and is regarded as statistically significant. The biomass estimate from 2010 was omitted in the assessment process due to coverage problems in the survey and a resulting possibility of biomass underestimation. The 2014 estimate shows a slightly decreasing trend in biomass again when compared to the previous two years.

The International spawning stock survey shows good internal consistency for the main age groups in the fishery (Figure 8.3.4.1.1 B).

Results

The distribution of acoustic backscattering densities for blue whiting for the last 4 years is shown in Figure 8.3.4.1.2. The highest concentrations of blue whiting were recorded in the Hebrides area but the observed biomass there was 37% less than in the previous year. Due to the perceived later northward migration of the stock as compared to 2013 the centre of gravity was located further south within the northern Porcupine Bank area. This area saw an increase in biomass of 310% as compared to 2013. Compared to the last year, more high density aggregations were found on the Rockall Bank. The blue whiting spawning stock estimates based on the international survey are given in Table 8.3.4.1.1

The estimated total abundance of blue whiting for the 2014 international survey on the spawning grounds was 3.25 million tonnes, representing an abundance of 31.1x109 individuals. The spawning stock was estimated at 3 million tonnes and 26.4x109 individuals. In comparison to the results in 2013, there is a decrease (-3%) in the observed stock biomass and a related increase in stock numbers (+15%).

The stock biomass within the survey area is dominated by age classes 3, 4, and 5 and 1 years of the 2010, 2009, 2008 and 2013 year classes respectively. The main contribution (76%) to the spawning stock biomass was the age groups 4, 3, 5 and 6.

Mean length (27 cm) and weight (104.6 g) are lower than in 2013 and in previous years. This can be attributed to the increasing contribution of young fish to the total stock biomass (Figure 8.3.4.1.3). A positive signal of 3 and 4-year old fish (strong 2010 & 2011 year classes) continues to be observed across all areas and the 2009 and 2010 year classes are now considered fully recruited to the spawning stock. Signs of a potentially strong 2013 year class could be seen in the survey. However, it is too early to predict the magnitude of that year class yet with any degree of accuracy until it can be confirmed in upcoming surveys.

8.3.4.2 International ecosystem survey in the Nordic Seas

Background and status

The international ecosystem survey in the Nordic Seas (IESNS) 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. Estimates in 2000—2014 are available both for the total survey area and for a "standardized" survey area (Figure 8.3.4.2.1). The latter is more meaningful as the survey coverage has been rather variable in the non-standard areas. However, the historical time series has not been recalculated using the new TS-value for blue whiting, thus the estimates are not directly comparable. The new TS-value gives estimates of roughly 1/3 of the old cal-culations (i.e. around 3.1 times the current values corresponds to the old value).

The survey is carried out in May since 1995 by the Faroes, Iceland, Norway, and Russia, and since 1997 (except 2002 and 2003) the EU. The high effort in this survey with such a broad international participation allowed for broad spatial coverage as well as a relatively dense net of trawl and hydrographic stations.

Since 2005 this survey has extended into the Barents Sea where the main focus of investigations has been young herring. Low numbers of blue whiting found in the Norwegian bottom trawl survey in this area suggest that this gap would not signifi-cantly change the estimate for blue whiting. The survey is coordinated by WGIPS (ICES CM 2014/ SSGESS:01).

Use of this survey in stock assessment

After the benchmark in February 2012 (ICES 2012b) it was decided to not use this survey in the assessment, but it is used as basis for a qualitative estimate of recruitment

Results for blue whiting

The total biomass of blue whiting registered during the May 2014 survey was 0.63 million tons, which is somewhat less than the biomass estimate in 2013. The stock estimate in number for 2014 is 8.9 billion, which is approximately the same number as in 2012 estimate. The decrease in biomass without a decrease in abundance is caused by more young fish in the stock. Age one is dominating the estimate whereas in 2013 the 1-group was more or less absent. The estimate of 1-group in 2014 is 3.7 billion compared to only 0.6 billion in 2013. The number of 2 year olds was lower than in 2013, 2.5 billion compared to 6.3 billion. These results confirm the weak 2012 year class and suggest that the 2013 year class is stronger. This year class constituted to 41% of the total number and 26% of the total biomass.

An estimate was also made from a subset of the data or a "standard survey area" between 8°W–20°E and north of 63°N, which has been used as an indicator of the abundance of blue whiting in the Norwegian Sea because the spatial coverage in this area provides a coherent time-series with adequate spatial coverage. This standard survey area estimate is used as an abundance index in WGWIDE. The age-disaggregated total stock estimate in the "standard area" is presented in Table 8.3.4.2.1, showing that the blue whiting in this index area was dominated by fish at age 2 in terms of numbers and age 3 in terms of biomass, i.e. the youngest fish (age 1) is mostly found outside the "standard survey area".

The distribution of blue whiting in 2014 was similar to 2013, but the strong concentration found in the north eastern corner of the Norwegian Sea in 2013 was absent in 2014. The main concentrations were observed both in connection with the continental slopes of Norway and south and southwest Iceland and in the open sea in the southern part of the Norwegian Sea (Figure 8.3.4.2.1). It should be noted that the spatial survey design was not intended to cover the whole blue whiting stock during this period.

Age and length distributions from the last five years are shown in Figure 8.3.4.2.2.

8.3.4.3 Norwegian bottom trawl survey in the Barents Sea (BS-NoRu-Q1(Btr))

Background and status

Norway has conducted bottom trawl surveys targeting cod and other demersal fish in the Barents Sea since late 1970s. From 1981 onwards there have been systematically designed surveys carried out during the winter months (usually late January-early March) by at least two Norwegian vessels. In some years the survey has been conducted in co-operation with Russia. Blue whiting are regularly caught as a by-catch species in these surveys, and have in some years been among the numerically dominant species (Heino et al., 2003). This survey has in earlier years given the first reliable indication of year class strength of blue whiting.

Most of the blue whiting catches (or samples thereof) have been measured for body length, but very few age readings are available (from 2004 onwards otoliths are systematically collected). The existing age readings suggest that virtually all blue whiting less than 19 cm in length belong to 1–group and that while some 1–group blue whiting are larger, the resulting underestimation is not significant. An abundance index of all blue whiting and putative 1–group blue whiting from 1981 onwards is given in Table 8.3.4.3.1 and follows methods described in Heino *et al.* (2003).

In 2014 1-group blue whiting were again found in this survey, but not at the same level as in 2012. The catch rate was ranked as the seventh highest in the time series.

Use of this survey in blue whiting assessment

The survey is not used in the assessment, but as basis for a qualitative estimate of recruitment.

8.3.4.4 Other surveys

The stock Annex provides information and time series from surveys covering just a small fraction of the stock area. The International Survey in Nordic Seas and adjacent waters in July-August (IESSNS) is an expansion of the Norwegian Sea summer survey (Stock Annex), however the coverage and main focus has changed. Blue whiting is not main target, but the survey gives useful information of the stock in this period. This survey started in 2009.

8.4 Stock assessment

Blue whiting was benchmarked February 2012 (ICES 2012b) and the SAM model (Nielsen and Berg, 2014) was chosen as the default assessment model for the stock. ICES has classified the assessment this year as an update assessment, and no new methods were applied at this year's WG. The results from the SAM model were however compared with the results from methods previously applied for the stock (SMS and XSA). The two models gave similar results. This report will just present the results from the SAM method.

The configuration of the SAM model (see the Stock annex for details) is the same as agreed during the Benchmark WK (ICES 2012b). Residuals from the catch at age observation and survey indices are shown in figure 8.4.1. The catch residuals for 2012—2013 show a tendency for a higher observed catch of older fish than estimated by the model.

The SAM model allows a gradually change in exploitation pattern, however it might not fully adapt to the changes in the individual years. Residuals from the IBWSS survey showed a "year effect" with higher indices for ages 3—7 than estimated by the model using all data sources. This however, is often seen time series from acoustic surveys. The IBWSS residuals for 2014 show a tendency to overestimate the age 3—4 and underestimate age 5—8.

The diagnostic output from the SAM model is limited. There is only 13 parameter estimated within the model of which the uncertainties of catch and survey observations are shown in Table 8.4.2. The CV of the catch and survey observations of the main age groups in the fishery are low for both catch observations (0.15) and suvey (0.22-0.29). The fit for other age groups is also quite good. Compared to noise estimated last year the observation noise for catches is practically the same, while the noise for the survey is shlightly lower.

Figure 8.4.2 presents estimated F at age and exploitation pattern for the whole time series. There are no abrupt changes in the exploitation pattern from 2010 to 2013, even though the landings in 2011 were just 19% of the landings in 2010, which might have given a different fishing practice. The estimated rather stable exploitation pattern might be due to the use of correlated random walks for F at age with a high estimated correlation coefficient (0.98).

The retrospective analysis shows a stable estimate of F and SSB (Figures 8.4.3). The use of the SAM option for correlated random walks for F at age (and a high estimated correlation coefficient at 0.98) limits the changes in exploitation pattern when a new year's data are added to the time series, which probably stabilize the estimate of F and SSB. Recruitment in the terminal year is determined from catch data and an assumption on random walk in recruitment as there is no survey indices for age 1 and 2. This gives variable recruitment estimate in the terminal year, but the available short time series indicates that recruitment estimates have been in the range of the final (more converged) model estimate.

Stock summary results with added 95% confidence limits (Figure 8.4.4 and Table 8.4.5) show a decreasing trend in fishing mortality since 2004, with a historical low F in 2011 at 0.04, and an increase in F to 0.161 in 2013. Recruitment decreased substantially in the period 2000—2009 with a resulting strong decreasing SSB up to 2010. SSB has almost doubled from 2010 (2.9 million tonnes) to 2014 (5.5 million tonnes) and is estimated to be above Bpa. The year classes 2005—2008 are at historic low levels, but information from catches and survey show an increase in recruitment since 2009. However, the uncertainty around the recruitment in the most recent year is high. The rather high estimates are however confirmed by qualitative analysis of recruitment indices from surveys not used in the SAM assessment.

8.5 Final assessment

Input data are catch numbers at age (Table 8.3.1.4.1), mean weight-at-age in the stock and in the catch (Table 8.3.3.1) and natural mortality and proportion mature in Table 8.3.3.2. Applied survey data are presented in Table 8.3.4.1.1.

This is the third year that the SAM model has been applied for this stock. The model settings can be found in the Stock annex.

The model was run until 2013. The SSB January 1st in 2014 is estimated from survivors and estimated recruits (with an assumption of random walks for recruitment, which in this case give recruitment in 2014 as estimated for 2013). 11% of age-group 1 is assumed mature thus the recruitment influences the size of SSB. The key results are presented in Tables 8.4.3–8.4.4 and summarized in Table 8.4.5 and Figure 8.4.4. Residuals of the model fit are shown in Figures 8.4.1.

8.6 State of the Stock

SSB has almost doubled from 2010 (2.9 million tonnes) to 2014 (5.5 million tonnes) and is clearly above Bpa (2.25 million tonnes). This increase is due to historical low F since 2011 in combination with a higher recruitment (age 1) since 2010. The uncertainty around the recruitment in the most recent year is high.

The year classes 2005—2008 are in the very low end of the historical recruitments, but recruitment since 2009 and 2010 year class are estimated higher. Information on the 2012 and 2013 year classes is uncertain, but the level is confirmed from qualitative analysis of survey indices.

8.7 Biological reference points

As a response to a special request from NEAFC, ICES re-evaluated in May 2013 (ICES advice, 2013) the reference points for the stock. ICES concluded that Blim and Bpa should remain unchanged. Fpa and Flim were undefined. Equilibrium stochastic simulations have been used to give a new value for Flim = 0.48. On the basis of this and the uncertainty in the assessment, a corresponding value for Fpa = 0.32 was derived. Currently MSY advice is based on a management strategy evaluation which used F0.1 as a proxy for FMSY and an MSY Btrigger = Bpa. The new simulations provide estimates of FMSY = 0.30. There are no scientific reasons to reduce MSY Btrigger below Bpa, and no estimates of MSY Btrigger are above Bpa. Under these circumstances it is proposed that Bpa be retained as MSY Btrigger for the MSY framework.

In a new request from NEAFC, June 2013, ICES was requested to confirm the suggested reference points, more specifically to confirm:

a) That the value of F0.1 is considered to be 0.22 rather than 0.18, as stated in the advice of September 2012

b) That the value of Fmsy is considered to be 0.30 rather than 0.18, as stated in the advice of September 2012

ICES confirmed (ICES advice October 2013) that the value of F0.1 is currently estimated to be 0.22. ICES advises that the value of FMSY is considered to be 0.30 and this replaces the F0.1 proxy for FMSY of 0.18 from the advice of September 2012.

The present reference points and their technical basis are:

Reference point	Blim	Bpa	Flim	Fpa
Value	1.5 mill t	2.25 mill. t	0.48	0.32
Basis	Bloss	Blim* exp(1.645* σ), with σ= 0.25.	Equilibrium stochastic simulations, (ICES advice, 2013)	Based on Flim and assessment uncertainties (ICES advice, 2013)

Reference point	FMAX	F0.1	FMSY	MSY Btrigger
Value	NA	0.22	0.30	2.25 mill. t
Basis	FMAX is poorly defined	Yield per recruit (ICES advice, 2013 and WGWIDE, 2013)	Equilibrium stochastic simulations, (ICES advice, 2013)	Bpa

8.8 Short term forecast

8.8.1 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 rec-ommendation 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 8.8.1.1.

The International Ecosystem Survey in the Nordic Seas (IESNS) only partially covers the known distribution of recruitment from this stock. Both the 1-group (2013 year class) and 2-group (2012 year class) indices from the survey in 2013 were near the middle of the historical range.

The International Blue Whiting Spawning Stock Survey (IBWSS) is not designed to give a representative estimate of immature blue whiting. However, the 1-group indices appear to be fairly consistent with corresponding indices from older ages. The 1-group (2013 year class) index from the survey in 2014 were the highest in the time series.

The Norwegian bottom trawl survey in the Barents Sea (BS-NoRu-Q1(Btr)) in February-March 2014, showed that 1-group blue whiting was present and the index was close to the mean value in the time series (Table 8.3.4.3.1). 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 (Heino *et al.* 2008), as all known strong year classes have been strong also in the Barents Sea.

The Icelandic bottom trawl survey (March) has a time series from 1996 to present. This survey is aimed at demersal species, but blue whiting juveniles are caught as bycatch. Some signals in recruitment are evident in the time series. The recruitment index of age 1 fish was obtained by a cut-off length at 22 cm. The 1-group estimate in 2014 (2013 year class) was the highest observed in the time series.

The Faroese Plateau spring (March) bottom trawl survey has a time series from 1994 to present. While this survey is not specifically aimed at blue whiting, nor has it been used in any assessments, there are some signals in recruitment evident in the time series. An index (number per trawl hour) was created based on a length split at 22 cm as an estimate of the abundance of age 1 blue whiting. The 1-group estimate in 2014 (2013 year class) was the highest observed in the time series.

In conclusion, the indices from available survey time series indicate that the 2012 year class is around or lower than average. Moreover, the new information regarding the 2011 year class suggests that this is above average. The WG therefore decided to use the estimate from the assessment for the 2011 year class (approximately at the 70th percentile), and the geometric mean of the whole period (1981—2011) for the 2012 year-class. The 2013 year classes is assumed to be strong from the survey series and the WG deceided to use the 75th percentile as input (26.94 billion at age 1 in 2014). No information is available for the 2014 and 2015 yearclasses and the geometric mean of the whole period (1981—2011) was used for these yearclasses (13.77 billion at age 1 in 2015 and 2016) (Table 8.8.1.1).

8.8.2 Short term forecast

The SAM model provides uncertainty of fishing mortality and stock numbers in the final year estimates which only can be fully applied in a stochastic short-term forecast. The default stochastic projections applied for SAM assessments are carried out by projecting the final year's SAM estimates of stock numbers (log(N)) and fishing mortality (log(F)). Using the variance-covariance matrix of those estimates, a high number (1000) of replicates of the initial stock numbers and fishing mortalities are randomly drawn, such that the variance and co-variance between stock N and F are maintained. Due to additional information affecting recruitment (qualitative use of recruitment indices from surveys not used by SAM), the initial stock estimate for age 1 and age 2 can optionally be changed by an input factor. The 1000 replicates are then simulated forward according to the management options. The presented forecast result in the option table is finally derived from the median of the 1000 replicates.

Compared to a deterministic forecast the stochastic forecast gives slightly higher estimates of TAC and SSB. For this year's advice the TAC for 2015 is estimated 4-5% higher and SSB in 2016 8-9% higher. The difference is due to the assumed log-normal distributed stock number. The median of the projected stock N is unbiased compared to the stock N from a deterministic forecast, but the median of quantities like yield and SSB, which is the sum of several age groups N weighted by e.g. F, mean weight and proportion mature, will be higher. The difference increases by increasing uncertainty of the initial stock numbers used for the forecast.

The default stochastic forecast has been applied for the last two years. For this year however, a deterministic version was applied for advice. The MSE evaluation (ICES advice 2014) used a deterministic forecast in the evaluation. The conclusion, that a HCR with target F=0.30 is precautionary is sensitive to the choice of forecast model. With a TAC estimated 4-5% lower in the MSE than actually applied in the MSE will give a too high target F for precautionary management. Due to time constraint it is not possible to correct the MSE and re-estimate a precautionary target F. Therefore the WGWIDE concluded to use the other alternative, to use a deterministic forecast this year.

8.8.2.1 Input

Table 8.8.2.1.1 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 (2011—2013). Selection (exploitation pattern) is based on average F in the most recent three years. The proportion mature for this stock is assumed constant over the years and values are copied from the assessment input.

Recruitment (age 1) in 2012 is assumed as estimated by the SAM model. Recruitment in 2013 is assumed to be somewhat lower than the SAM estimate and is thus assumed at the long term average (GM 1981—2011). The recruitment in 2014 is believed to be stronger and is thus assumed to be at the 75^{th} percentile of SAM the estimated recruitment 1981—2011. The recruitment in 2015 and 2016 are assumed at the long term average (GM 1981—2011).

The "Agreed Records of conclusion of fisheries consultations between the European Union, the Faroe Islands, , Iceland and Norway on the management of blue-whiting in the North East Atlantic in 2014" a limitation of 1200000 tonnes of blue whiting in 2014 was set in accordance to the management plan. Information from the WG members indicates a full quota uptake in 2014. F in 2014 is calculated on the basis of this TAC.

8.8.2.2 Output

A range of predicted catch and SSB options from the deterministic short term forecast used for advice are presented in Table 8.8.2.2.1. For comparison the stochastic forecast is presented in Table 8.8.2.2.2.

The existing management plan has a target F of 0.18 which applies once SSB is above B_{pa} (2.250 million tonnes) on the 1st January of the year in which the TAC is to be set. SSB in 2015 is estimated to be 5.7 million tonnes (above B_{pa}) such that F in 2015 should be 0.18. This will lead to a TAC in 2015 of 840000 tonnes (an decrease of 30%). This is expected to lead to an SSB of 5.904 million tonnes in 2015, which is high above B_{pa}.

The option table provides TAC calculation for F in the range 0.18 to 0.32 (Fpa). All of them will produce a SSB in 2016 higher than Bpa.

Following the ICES MSY framework implies fishing mortality to be at FMSY = 0.30 which will give a TAC in 2015 at 1.326 million tonnes (11% increase).

8.9 Comparison with previous assessment and forecast

Comparison of the final assessment results from the last 6 years (Figure 8.9.1) show stable and consistent output, except for the 2010 assessment. In 2010 the survey results from the IBWSS 2010 survey were applied, which gave a too low stock estimate and a corresponding too high F. An evaluation of the survey coverage led to a later exclusion of the 2010 observations.

This year's assessment gave a decrease in SSB for 2013. This is mainly due to the applied mean weight at age, where the last year's estimate of SSB for 2013 was calculated using the 2012 set of mean weight. Appling the observed mean weight available this year, the calculated SSB 2013 decreases.

8.10 Quality considerations

The assessment shows a low to moderate uncertainty of the absolute estimate of F and SSB, and a higher uncertainty on the recruiting year-classes. The assessment presented this year should be considered to be at the same quality as the assessment presented last year with respect to the absolute estimates of stock metrics, and certain in the conclusion on the steep decline in F in the most recent two years and an increase in SSB. Recruitment (age 1) is estimated significantly higher in 2011—2014 than in the years (2007—2009) with the historically low recruitments.

The quality of age readings of blue whiting was evaluated at a workshop (WKARBLUE) on age reading of blue whiting which took place in Bergen, Norway, from 10—14 June 2013 chaired by Jane Amtoft Godiksen and Manuel Meixide. Blue whiting otoliths have proven to be quite difficult to age, and though guidelines has been constructed, the experience of the reader determines the interpretation of the otolith structure. This strongly indicates that biased readings might have been present in many cases for the historical data used in the assessment, even for experienced age-readers. **It is therefore recommended** to have regular exchanges and workshops in order to improve the agreement between readers. WKARBLUE recommends a new workshop in 2017, and the survey group recommended that the age readers look closer into a discrepancy problem for ages 1—3 in the 2014 blue whiting age reading material. **It is therefore recommended** that an age reading workshop will be held as soon as possible.

The population structure of blue whiting in the NE Atlantic appears to be more complex than the current single-stock structure used for management purposes. The ICES SIMWG (Stock Identification Methods Working Group) has concluded "Blue whiting in the NE Atlantic should be considered as two stock units: Northern and Southern". WGWIDE **therefore recommends** that during the next "Age Reading Workshop for Blue Whiting", otoliths from the whole distribution area of this stock should be collected to perform shape analysis, aiming to clarify the blue whiting stock structure composition.

Assessment results for blue whiting are highly dependent on the quality of the only survey that covers the spawning stock (IBWSS). A post-cruise meeting compiled a joint survey report (Anon 2014) where it was concluded that the quality of the survey was high this year. The post-cruise meeting noted that the favourable weather conditions allowed the five survey vessels to successfully cover the entire planned area within the time available and achieved good containment of the stock. Estimated uncertainty around the mean acoustic density is low and comparable to the previous two years.

The assessment model SAM was applied for the third time for blue whiting. The two assessment models (SMS and XSA) previously applied for the stock gave a similar result as SAM and a consistent picture of the state of the stock.

8.11 Management considerations

The assessment shows a low to moderate uncertainty of the absolute estimate of F and SSB, and a higher uncertainty on the recruiting year-classes. SSB and F are estimated from a fairly good quality catch data and from only one survey giving information on the spawning stock (IBWSS). It is essential that this survey be maintained and it is important to maintain good geographical survey coverage within the agreed time window to avoid increases in assessment uncertainty. A continuous lack of one or more vessels (Norway did not take part of the 2013 survey) will put the survey quality at risk. Due to good planning and favourable weather conditions the implementation of the survey in 2014 resulted in good quality data.

Recruitment (age 1) is estimated significantly higher in 2011—2014 than in the years (2007—2009) with the historically low recruitments. Information from surveys and the fishery suggest a good recruitment in 2014 as well.

8.12 Ecosystem considerations

An extensive overview of ecosystem considerations relevant for blue whiting can be found in the stock annex. A more general overview of the pelagic complex in the NE Atlantic can be found in Chapter 1 of this report.

8.13 Regulations and their effects

Existing TAC are based on annual agreement between the "Coastal States" EU, Norway, Iceland and the Faroe Island. No minimum landing size is associated with blue whiting.

8.13.1 Management plans and evaluations

A meeting was held in 2008 (Anon, 2008) at which a number of potential management strategies for blue whiting were examined through simulations. Following this meeting a new management plan was proposed by the Coastal States. The full text of this plan is also presented in the stock annex. ICES was requested by the coastal states to evaluate this proposed management plan and this evaluation was carried out by WGWIDE in 2008. ICES considers that this plan is precautionary if fishing mortality in the first year is immediately reduced to the fishing mortality that is implied by the harvest control rule. The reduction to F=0.18 was followed by managers for setting the 2010 TAC. Likewise an F=0.05 according to the management plan was applied for 2011. The full text of the management plan is presented in the stock annex.

In May 2013 ICES answered (ICES advice May 2013) a request from NEAFC to review a potential new HCR function:

ICES considered that the current management plan is precautionary. A number of alternative F targets in the range of 0.1—0.35 were evaluated for the current harvest control rule (HCR) form and found to be precautionary up to an F target of 0.32 (corresponding to Fpa), with only a minimal increase in mean TAC for F targets above 0.3.

Inclusion of catch stabilization mechanisms have been tested in the current HCR and are considered precautionary as they do not increase the probability of SSB< Blim above 0.05. Over the entire time period examined there are no significant differences in catch either with or without the stabilizers.

Initial evaluations indicate that a number of options for the newly proposed HCR form (with increasing F at high biomass) have been found to be precautionary. However, these preliminary evaluations are not considered sufficiently robust. Based on the results presented, ICES suggests that a small subset of such rules should be selected and tested further with greater rigour before they are judged suitable for precautionary management. This suggestion led to a new request from NEAFC to evaluate a specified HCR. The conclusion of this new evaluation was not finalised during the WGWIDE meeting

Testing of banking and borrowing scenarios showed very little impact of either extreme banking or borrowing. Allowing a maximum of 10% to be banked or borrowed any year is considered precautionary when used with the existing HCR.

In October 2013 ICES answered (ICES advice October 2013) a request from NEAFC to elaborate the advice from May. ICES confirmed the advice from May. The request proposes also a new multistage HCR with two optional values for a slope parameter that determine the target F as function of SSB. The results of the evaluations showed that the HCRs gave similar performance with both values and no differences could be seen in the plots of SSB and F. The increase in F at high biomass leads to greater catch variability and 4% higher yields over the 40-year period simulated (particularly during periods of high recruitment). The multistage HCR leads to higher interannual variability (IAV) in TAC during the period of declining stock as recruitment changes from the high to the low regime. IAV for the multistage HCR is 33% compared to 25% for the F target of 0.22.

No international agreement has been obtained with respect a specific HCR to be used for a new management plan for blue whiting. The TAC for 2014 was set to 1.2 million tons equivalent to an F of around 0.23.

8.14 References

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

ICES advice 2013. NEAFC request to ICES to evaluate the extra harvest control rule options for the long-term management plan for blue whiting, Advice October 2013. Section 9.3.3.7 of ICES advice Book 9.

Nielsen, A., and Berg, C.W. 2014. Estimation of time-varying selectivity in stock assessments using state-space models. Fisheries Research, 158: 96-101.

Table 8.3.1.1. Blue whiting landings (tonnes) by country for the period 1988–2013, as estimated by the Working Group.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Denmark	18 941	26 630	27 052	15 538	34 356	41 053	20 456	12 439	52 101	26 270	61 523	64 653	57 686	53 333	51 279	82 935
Estonia					6 156	1 033	4 342	7 754	10 982	5 678	6 320					
Faroes	79 831	75 083	48 686	10 563	13 436	16 506	24 342	26 009	24 671	28 546	71 218	105 006	147 991	259 761	205 421	329 895
France		2 191				1 195		720	6 442	12 446	7 984	6 662	13 481	13 480	14 688	14 149
Germany	5 546	5 417	1 699	349	1 332	100	2	6 313	6 876	4 724	17 969	3 170	12 655	19 060	17 050	22 803
Iceland		4 977						369	302	10 464	68 681	160 430	260 857	365 101	287 336	501 493
Ireland	4 646	2 014			781		3	222	1 709	25 785	45 635	35 240	25 200	29 854	17 825	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	35 843	46 128	73 595	37 529	45 832
Norway	233 314	301 342	310 938	137 610	181 622	211 489	229 643	339 837	394 950	347 311	560 568	528 797	533 280	573 311	571 479	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	2 625	2 032	1 746	1 659	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	23 777	22 622	23 218	17 506	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	12 993	3 319	2 086	18 549	65 532
UK (England)****																
UK (Scotland)	5 183	8 056	6 019	3 876	6 867	2 284	4 470	10 583	14 326	33 398	92 383	98 853	42 478	50 147	26 403	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	178 179	245 198	315 478	290 068	355 319
TOTAL	557 847	627 447	561 610	369 524	475 026	480 679	459 414	578 905	645 982	672 437	1 128 969	1 256 228	1 412 927	1 780 170	1 556 792	2 318 935

Table 8.3.1.1 (continued). Blue whiting landings (tonnes) by country for the period 1988–2013, as estimated by the Working Group.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Denmark	89 500	41 450	56 979	48 659	18 134	248	140	165	340	2 167
Estonia	**									
Faroes	322 322	266 799	321 013	317 859	225 003	58 354	49979	16405	43290	85 768
France		8 046	18 009	16 638	11 723	8 831	7839	4337	9799	8 978
Germany	15 293	22 823	36 437	34 404	25 259	5 044	9108	278	6239	11 418
Iceland	379 643	265 516	309 508	236 538	159 307	120 202	87942	5887	63056	104 918
Ireland	75 393	73 488	54 910	31 132	22 852	8 776	8324	1195	7557	13 205
Japan										
Latvia										
Lithuania			4 635	9 812	5 338					
Netherlands	95 311	147 783	102 711	79 875	78 684	35 686	33762	4595	26526	51 635
Norway	957 684	738 490	642 451	539 587	418 289	225 995	194317	20539	118832	196 246
Poland										
Portugal	3 937	5 190	5 323	3 897	4 220	2 043	1482	603	1955	2 056
Spain	15 612	17 643	15 173	13 557	14 342	20 637	12891	2416	6726	15 274
Sweden ***	19 083	2 960	101	467	4	3	50	1	4	199
UK (England + Wales)	2 593	7 356	10 035	12 926	14 147	6 176	2475	27	2866	4 100
UK (Northern Ireland)										1 232
UK (Scotland)	57 028	104 539	72 106	43 540	38 150	173	5496	1331	6305	8 166
USSR / Russia *	346 762	332 226	329 100	236 369	225 163	149 650	112553	45841	88303	120 674
Greenland***										2 133
Unallocated									3 499	

TOTAL	2377568	2026953	1968456	1612330	1246465	635639	523832	103592	385297	626036

*** From 1992 only Russia**

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

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

****** From 2012**

Table 8.3.1.2. Blue whiting total landings by country and area for 2013 in tonnes, as estimated by the Working Group.

Area	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Netherlands	Norway	Portugal	Russia	Spain	UK (England + Wales)	UK (Scotland)	UK (Northern Ireland)	Grand Total
IIa	14	3904		38	1096		18	1589		20669					27 328
IIb				40			13			870					922
IIIa	89														89
IVa	144	10	12					8265		158					8 590
IVb	30							40							70
IVc															0
IXa									2056		2997				5 053
Va					3322			2							3 324
Vb		78396	3		89715					58798					226 911
VIa	1033	2456	2222	3624	10775	2731	21406	29521		12163		705	1370		88 008
VIb	811	804	684			2584	5204	19086		12832		1540	3147		46 690
VIIb			988	5120		148	83				148				6 485
VIIc	46	19	948	2341		6813	24193	67931		5213		1856	3649		113 009
VIIg															0
VIIh															0
VIIIa			1110								25				1 136
VIIIb							619				50				669
VIIIc											12051				12 051
VIIId			683								2				685
VIIj			10	256			30								296
VIIk		180	2319			930	69	69810		9544				1232	84 084
XII										253					253
XIVa										174					174
XIVb					10										10
Grand Total	**2 167**	**85 768**	**8 978**	**11 418**	**104 918**	**13 205**	**51 635**	**196 246**	**2 056**	**120 674**	**15 274**	**4 100**	**8 166**	**1 232**	**625 837**

*** Note: the value for area IXa is summed across CN, CS and S subdivisions of this area.**

Table 8.3.1.3. Blue whiting total landings of by quarter and area for 2013 in tonnes, as estimated by the Working Group.

Area	1	2	3	4	Total
IIa	844	9699	11439	5346	27328
IIb			239	683	922
IIIa			74	15	89
IVa	165	3304	4750	371	8590
IVb		16	25	29	70
IVc					0
IXa	580	1740	1984	749	5053
Va	29	1119	1822	354	3324
Vb	39025	168874	487	18525	226911
VIa	3249	84672	86	1	88008
VIb	36185	10505			46690
VIIb	5286	1199			6485
VIIc	109801	3207			113009
VIIg					0
VIIh					0
VIIIa	4	7	44	1081	1136
VIIIb	14	13	13	629	669
VIIIc	1785	2061	3534	4672	12051
VIIId	1	0	327	356	685
VIIj	4	252	10	30	296
VIIk	84084				84084
XII	253				253
XIVa			174		174
XIVb	8			2	10
Total	281318	286669	25009	32842	625837

Table 8.3.1.1.1. Blue whiting total catches (tonnes), total landings (tonnes) and discards (tonnes) for 2013.

Country	Catches	Landings	Discards	% Discards	Comments
Denmark	2167	2167	-	no sampling, discard assumed zero	
Faroe Islands	85768	85768	-	no sampling, discard assumed zero	Discard ban in place
France*	8978	8978	-	no discards	
Germany**	11655	11418	237	2%	Discards due to by-catch
Iceland	104918	104918	-	no sampling, discard assumed zero	Discard ban in place
Ireland	13205	13205	-	0	
Netherlands	51750	51635	115	1%	
Norway	196246	196246	-	no sampling, discard assumed zero	Discard ban in place
Portugal***	2756	2056	700	25%	Discards mainly reason: by-catch/market-forces/offer-demand dynamics
Russia	120674	120674	-	no sampling, discard assumed zero	Discard ban in place
Spain****	20680	15274	5406	26%	Discards mainly reason: by-catch/market-forces/offer-demand dynamics/undersized fish
UK (England + Wales)		4100	non available		
UK (Scotland)		8166	non available		
UK (Northern Ireland)		1232	non available		

*** Working Document (Tetard, 2014)**

**** Working Document (Ulleweit, 2014)**

***** Working Document (Prista *et al.* 2014)**

****** Working Document (Pérez *et al.* 2014)**

Table 8.3.1.2.1. Sampling intensity for blue whiting from the commercial catches by fishery in 2013.

Quarter	Fisheries	Directed	Mixed*	Southern	Total
1	No. of samples	217	39	48	304
	WG Catch	278509	277	2532	281318
2	No. Of samples	229	12	82	323
	WG Catch	279489	3358	3821	286669
3	No. of samples	48	87	58	193
	WG Catch	14764	4699	5546	25009
4	No. of samples	33	0	62	95
	WG Catch	27199	212	5431	32842
Total No. of samples		527	138	250	915
Total WG Catch		599961	8546	17329	625837
tonnes per sample		1138	62	69	684

* Norwegian mixed fishery only.

Table 8.3.1.2.2 Blue whiting. Total landings, No. of samples, No. of fish measured and No. of fish aged by country and quarter for 2013.

Country	Quarter	Landings (t)	No. Samples	No. Fish Measured	No. Fish Aged
Denmark	1	84	2	59	59
	2	1760	1	53	53
	3	273			
	4	50			
	Total	2167	3	112	112
Faroe Islands	1	36170	3	235	200
	2	30177	3	410	299
	3	2690	1	50	20
	4	16730	2	150	125
	Total	85768	9	845	644
France	1	5073			
	2	2103			
	3	366			
	4	1436			
	Total	8978	0	0	0
Germany	1	6403			
	2	4938	29	2033	155
	3	14			
	4	64			
	Total	11418	29	2033	155
Iceland	1	35	1	97	50
	2	98506	34	1752	2593
	3	2694			
	4	3683	2	200	100
	Total	104918	37	2049	2743
Ireland	1	12428	11	3751	900
	2	777			
	3	0			
	4	0			
	Total	13205	11	3751	900
Netherlands	1	23191	70	11263	1749
	2	27764	5	827	125
	3	0			
	4	680			
	Total	51635	75	12090	1874
Norway	1	156320	99	3140	544
	2	34705	28	2254	596
	3	4699	87	2467	200
	4	521			
	Total	196246	214	7861	1340
Portugal	1	143	9	705	269
	2	580	8	852	279
	3	987	3	351	93
	4	346	3	197	84
	Total	2056	23	2105	725
Russia	1	30488	64	12212	692
	2	77212	140	27958	2161
	3	8728	47	11016	801
	4	4246	29	5765	484
	Total	120674	280	56951	4138
Spain	1	2389	39	3765	471
	2	3242	74	7741	274
	3	4558	55	5930	529
	4	5085	59	4887	492
	Total	15274	227	22323	1766
UK (England + Wales)	1				
	2	4100			
	3				
	4				
	Total	4100	0	0	0
UK (Scotland)	1	7362	6	827	178
	2	804	1	132	58
	3				
	4				
	Total	8166	7	959	236
UK (Northern Ireland)	1	1232			
	2				
	3				
	4				
	Total	1232	0	0	0
	Grand Total	625837	915	111079	14633

Table 8.3.1.3.1. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the directed fishery in 2013

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5					
6					
7					
8					
9					
10			13		13
11			63		63
12			254		254
13			390		380
14			456		444
15			5 665	1	5 652
16	314		12 453	82	12 835
17	2 535	281	11 323	97	14 224
18	5 876	3 314	5 292	51	14 461
19	8 858	9 922	1 098	97	19 900
20	11 666	28 609	282	509	40 705
21	18 894	30 875	847	2 209	50 868
22	60 107	41 471	2 108	4 299	101 850
23	79 347	66 012	3 691	6 580	148 195
24	62 396	108 991	5 558	7 622	175 360
25	71 377	108 331	5 252	7 797	181 412
26	123 554	111 253	3 515	6 138	223 079
27	210 961	125 266	1 831	4 985	311 743
28	191 392	119 038	1 136	3 078	281 605
29	137 182	109 059	853	2 044	227 473
30	135 909	150 096	1 029	1 821	266 625
31	112 469	167 888	1 089	1 458	260 429
32	117 856	178 831	1 268	2 104	278 192
33	92 798	142 778	951	1 432	218 036
34	86 647	117 239	761	1 591	188 386
35	58 070	69 166	571	1 051	116 644
36	29 130	26 169	317	606	51 722
37	19 617	13 680	190	323	30 893
38	11 045	4 769	63	202	14 386
39	2 629	2 305	25	40	4 923
40	2 695	673	13		3 122
41	599	328	13		940
42	140	688			828
43	8	322		20	350
44	78	322			400
45	5				5
46		322			322
47					
48					
49					
50					
51					
52					
53					
54					
55					
TOTAL numbers	1654 153	1737 997	68 369	56 238	3246 720

Table 8.3.1.3.2. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the mixed fishery in 2013.

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18	29				29
19	117	1			118
20	427	2	1		430
21	494	16	6		516
22	310	52	23		385
23	139	110	47		296
24	64	114	47		225
25	20	99	34		153
26	10	58	21		89
27	18	18	8		44
28	18	7	8		33
29	8	10	9		27
30	20	10	15		45
31	12	17	11		40
32	23	15	18		56
33	23	18	13		54
34	33	13	11		57
35	39	21	9		69
36	20	5	5		30
37	2	3	4		9
38			1		1
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
TOTAL numbers	1 826	589	291		2 706

Table 8.3.1.3.3. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the southern fishery in 2013.

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14	2				2
15	1 327	3	979		2 309
16	5 670	223	840		6 734
17	7 358	974	2 278	38	10 648
18	6 353	2 946	2 435	140	11 874
19	2 741	5 726	3 663	1 668	13 798
20	1 384	6 204	7 121	4 947	19 656
21	1 136	7 111	10 903	9 550	28 699
22	1 590	7 250	14 991	11 160	34 990
23	1 662	5 936	10 853	11 564	30 016
24	2 417	5 565	8 124	9 525	25 631
25	1 779	4 155	4 546	5 972	16 453
26	1 565	2 940	2 983	3 589	11 077
27	1 042	1 692	1 523	1 632	5 888
28	920	1 164	1 304	1 571	4 959
29	737	661	675	680	2 753
30	472	347	614	367	1 800
31	298	162	279	172	911
32	233	50	117	214	615
33	196	35	26	57	314
34	114	20	30	27	191
35	16	13	7	17	52
36	43	2	3	16	63
37		1			1
38	36		1	5	42
39		3		2	6
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
TOTAL numbers	39 092	53 183	74 297	62 911	229 483

Table 8.3.1.4.1. Blue whiting. Catch at age numbers (millions)

Year/Age	1	2	3	4	5	6	7	8	9	10+
1981	258	348	681	334	548	559	466	634	578	1460
1982	148	274	326	548	264	276	266	272	284	673
1983	2283	567	270	286	299	304	287	286	225	334
1984	2291	2331	455	260	285	445	262	193	154	255
1985	1305	2044	1933	303	188	321	257	174	93	259
1986	650	816	1862	1717	393	187	201	198	174	398
1987	838	578	728	1897	726	137	105	123	103	195
1988	425	721	614	683	1303	618	84	53	33	50
1989	865	718	1340	791	837	708	139	50	25	38
1990	1611	703	672	753	520	577	299	78	27	95
1991	267	1024	514	302	363	258	159	49	5	10
1992	408	654	1642	569	217	154	110	80	32	12
1993	263	305	621	1571	411	191	107	65	38	17
1994	307	108	368	389	1222	281	174	90	79	31
1995	296	354	422	465	616	800	254	160	60	42
1996	1893	534	632	537	323	497	663	232	98	83
1997	2131	1519	904	578	296	252	282	407	104	169
1998	1657	4181	3541	1045	384	323	303	264	212	86
1999	788	1549	5821	3461	413	207	151	153	69	140
2000	1815	1193	3466	5015	1550	514	213	151	58	140
2001	4364	4486	2962	3807	2593	586	170	97	77	66
2002	1821	3232	3292	2243	1824	1647	344	169	103	143
2003	3743	4074	8379	4825	2035	1117	400	121	20	27
2004	2156	4426	6724	6698	3045	1276	650	249	75	37
2005	1427	1519	5084	5871	4450	1419	518	249	100	55
2006	413	940	4206	6151	3834	1719	506	181	68	37
2007	167	307	1795	4211	3867	2353	936	321	130	89
2008	409	179	545	2917	3263	1919	736	316	113	127
2009	61	156	232	595	1596	1157	592	252	89	49
2010	350	223	160	208	646	992	703	257	70	44
2011	163	102	64	54	70	116	120	55	26	13
2012	240	352	663	142	107	203	364	357	212	158
2013	228	508	849	897	463	224	321	398	344	384

Table 8.3.1.4. Blue whiting landings (tonnes) from the main fisheries, 1988–2013, as estimated by the Working Group.

Area	Norwegian Sea fishery (SAs 1+2; Divs. Va, XIVa-b)	Fishery in the spawning area (SA XII; Divs. Vb, VIa-b, VIIa-c)	Directed- and mixed fisheries in the North Sea (SA IV; Div. IIIa)	**Total northern areas**	Total southern areas (SAs VIII+IX; Divs. VIId-k)	**Grand total**
1988	55 829	426 037	45 143	**527 009**	30 838	**557 847**
1989	42 615	475 179	75 958	**593 752**	33 695	**627 447**
1990	2 106	463 495	63 192	**528 793**	32 817	**561 610**
1991	78 703	218 946	39 872	**337 521**	32 003	**369 524**
1992	62 312	318 081	65 974	**446 367**	28 722	**475 089**
1993	43 240	347 101	58 082	**448 423**	32 256	**480 679**
1994	22 674	378 704	28 563	**429 941**	29 473	**459 414**
1995	23 733	423 504	104 004	**551 241**	27 664	**578 905**
1996	23 447	478 077	119 359	**620 883**	25 099	**645 982**
1997	62 570	514 654	65 091	**642 315**	30 122	**672 437**
1998	177 494	827 194	94 881	**1 099 569**	29 400	**1 128 969**
1999	179 639	943 578	106 609	**1 229 826**	26 402	**1 256 228**
2000	284 666	989 131	114 477	**1 388 274**	24 654	**1 412 928**
2001	591 583	1 045 100	118 523	**1 755 206**	24 964	**1 780 170**
2002	541 467	846 602	145 652	**1 533 721**	23 071	**1 556 792**
2003	931 508	1 211 621	158 180	**2 301 309**	20 097	**2 321 406**
2004	921 349	1 232 534	138 593	**2 292 476**	85 093	**2 377 569**
2005	405 577	1 465 735	128 033	**1 999 345**	27 608	**2 026 953**
2006	404 362	1 428 208	105 239	**1 937 809**	28 331	**1 966 140**
2007	172 709	1 360 882	61 105	**1 594 695**	17 634	**1 612 330**
2008	68 352	1 111 292	36 061	**1 215 704**	30 761	**1 246 465**
2009	46 629	533 996	22 387	**603 012**	32 627	**635 639**
2011	20 599	72 279	7 524	**100 401**	3 191	**103 592**
2012	24 391	324 545	5678.346	**354 614**	29401.78	**384 016**
2013	31 759	481 356	8 749	**521 864**	103 973	**625 837**

Table 8.3.3.1. Blue whiting: Individual mean weight (Kg) at age in the catch

Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1981	0.052	0.065	0.103	0.125	0.141	0.155	0.170	0.178	0.187	0.213
1982	0.045	0.072	0.111	0.143	0.156	0.177	0.195	0.200	0.204	0.231
1983	0.046	0.074	0.118	0.140	0.153	0.176	0.195	0.200	0.204	0.228
1984	0.035	0.078	0.089	0.132	0.153	0.161	0.175	0.189	0.186	0.206
1985	0.038	0.074	0.097	0.114	0.157	0.177	0.199	0.208	0.218	0.237
1986	0.040	0.073	0.108	0.130	0.165	0.199	0.209	0.243	0.246	0.257
1987	0.048	0.086	0.106	0.124	0.147	0.177	0.208	0.221	0.222	0.254
1988	0.053	0.076	0.097	0.128	0.142	0.157	0.179	0.199	0.222	0.260
1989	0.059	0.079	0.103	0.126	0.148	0.158	0.171	0.203	0.224	0.253
1990	0.045	0.070	0.106	0.123	0.147	0.168	0.175	0.214	0.217	0.256
1991	0.055	0.091	0.107	0.136	0.174	0.190	0.206	0.230	0.232	0.266
1992	0.057	0.083	0.119	0.140	0.167	0.193	0.226	0.235	0.284	0.294
1993	0.066	0.082	0.109	0.137	0.163	0.177	0.200	0.217	0.225	0.281
1994	0.061	0.087	0.108	0.137	0.164	0.189	0.207	0.217	0.247	0.254
1995	0.064	0.091	0.118	0.143	0.154	0.167	0.203	0.206	0.236	0.256
1996	0.041	0.080	0.102	0.116	0.147	0.170	0.214	0.230	0.238	0.279
1997	0.047	0.072	0.102	0.121	0.140	0.166	0.177	0.183	0.203	0.232
1998	0.048	0.072	0.094	0.125	0.149	0.178	0.183	0.188	0.221	0.248
1999	0.063	0.078	0.088	0.109	0.142	0.170	0.199	0.193	0.192	0.245
2000	0.057	0.075	0.086	0.104	0.133	0.156	0.179	0.187	0.232	0.241
2001	0.050	0.078	0.094	0.108	0.129	0.163	0.186	0.193	0.231	0.243
2002	0.054	0.074	0.093	0.115	0.132	0.155	0.173	0.233	0.224	0.262
2003	0.049	0.075	0.098	0.108	0.131	0.148	0.168	0.193	0.232	0.258
2004	0.042	0.066	0.089	0.102	0.123	0.146	0.160	0.173	0.209	0.347
2005	0.039	0.068	0.084	0.099	0.113	0.137	0.156	0.166	0.195	0.217
2006	0.049	0.072	0.089	0.105	0.122	0.138	0.163	0.190	0.212	0.328
2007	0.050	0.064	0.091	0.103	0.115	0.130	0.146	0.169	0.182	0.249
2008	0.055	0.075	0.100	0.106	0.120	0.133	0.146	0.160	0.193	0.209
2009	0.056	0.085	0.105	0.119	0.124	0.138	0.149	0.179	0.214	0.251
2010	0.052	0.064	0.110	0.154	0.154	0.163	0.175	0.187	0.200	0.272
2011	0.055	0.079	0.107	0.136	0.169	0.169	0.179	0.189	0.214	0.270
2012	0.041	0.072	0.098	0.140	0.158	0.172	0.180	0.185	0.189	0.203
2013	0.051	0.077	0.094	0.117	0.139	0.162	0.185	0.188	0.198	0.197
arith. mean	0.050	0.076	0.101	0.123	0.145	0.164	0.183	0.198	0.216	0.251

Table 8.3.3.2. Blue whiting natural mortality and proportion of maturation-at-age

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

Table 8.3.4.1.1 Blue whiting age composition (millions) from the IBWSS for 2004–2014.

Year\Age	1	2	3	4	5	6	7	8	9	10+	Total
2004	1559	5 650	11086	14353	5426	1785	1007	635	367	40	41908
2005	1159	1427	6034	8178	8526	2657	646	233	105	1	28967
2006	1010	1 775	10332	12504	5338	2570	798	261	95	0	34685
2007	552	855	5 270	10606	8001	4501	2348	810	308	135	33461
2008	301	566	1440	5668	6516	3845	2122	1050	248	299	20943
2009	245	620	373	2057	5066	4181	2037	516	125	15	15238
2010*	580	648	212	452	982	2264	2456	1242	352	47	9311
2011	202	2617	942	912	1647	2301	1767	1221	430	31	12075
2012	1178	1832	6678	1013	544	1343	2077	1444	1078	1025	18393
2013	502	1682	7056	7776	3122	1287	1327	1515	867	1892	27026
2014	2886	1502	8396	7771	5927	1468	532	536	599	1468	31085

*** The quality of the survey was regarded as not satisfactory**

Total stock biomass (kt)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TSB (1000t)	3612	2557	3357	3583	2458	1981	1266	1578	2219	3347	3251

2008	1440	5668	6516	3845	2122	1050

Table 8.3.4.2.1. Estimated blue whiting stock numbers from the International Norwegian Sea ecosystem survey, 2000–2014. The estimates are for the standard area, north of 63°N and between 8°W–20°E.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	Total
2000*	48927	3133	3580	1668	201	5						57514
2001*	85772	25110	7533	3020	2066							123501
2002*	15251	46656	14672	4357	513	445		15		6		81915
2003*	35688	21487	35372	4354	639	201	43	3				97787
2004*	49254	22086	13292	8290	1495	533	83	39				95072
2005*	54660	19904	13828	4714	1886	326	103	43	8	3	11	95486
2006*	570	18300	15324	6550	1566	384	246	80	47	2	8	43077
2007*	21	552	5846	3639	1674	531	178	49	19			12509
2008*	29	75	534	2151	715	287	116	44				3951
2009*	0	14	56	617	963	621	296	84	13			2664
2010*	0	0	0	10	107	165	68	96				446
2011*	1447	3138	1	43	204	226	431	120	84			5694
2012	9425	3142	427	153	87	169	98	31				13532
2013	241	5723	457	81	22	42	62	125	102	26	42	6938
2014	1402	1966	1024	438	97	33	28	50	37	22	11	5112

*** Using the old TS-value. To compare the results with 2012 all values should be divided by approximately 3.1**

Table 8.3.4.3.1 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	<19cm
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	5.8	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
2008	17.03	0.04
2009	4.5	0.01
2010	3.3	0.08
2011	1.48	0.01
2012	127.89	126.83
2013	39.54	2.33
2014	31.95	25.2

Table 8.4.1. Blue Whiting: Survey indices used in the assessment.

IBWSS

	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8
2004	11086	14353	5426	1785	1007	635
2005	6034	8178	8526	2657	646	233
2006	10332	12504	5338	2570	798	261
2007	5270	10606	8001	4501	2348	810
2008	1440	5668	6516	3845	2122	1050
2009	373	2057	5066	4181	2037	516
2010	-1	-1	-1	-1	-1	-1
2011	942	912	1647	2301	1767	1221
2012	6678	1013	544	1343	2077	1444
2013	7056	7776	3122	1287	1327	1515
2014	8396	7771	5927	1468	532	536

Table 8.4.2. Blue Whiting: Estimated observation noise.

Index	Age	log(observation noise) ~ CV
Catch	1	0.42
Catch	2	0.28
Catch	3-8	0.15
Catch	9-10	0.43
IBWSS	3	0.39
IBWSS	4-6	0.22
IBWSS	7-8	0.29

Table 8.4.3. Blue whiting. Estimated fishing mortalities.

Year\Age	1	2	3	4	5	6	7	8	9+	F37
1981	0.070	0.118	0.174	0.218	0.262	0.346	0.375	0.477	0.488	0.275
1982	0.057	0.095	0.140	0.178	0.208	0.278	0.303	0.383	0.389	0.222
1983	0.067	0.112	0.164	0.209	0.243	0.334	0.362	0.451	0.452	0.262
1984	0.082	0.133	0.198	0.255	0.301	0.414	0.440	0.543	0.540	0.322
1985	0.085	0.136	0.207	0.271	0.330	0.444	0.465	0.572	0.567	0.343
1986	0.110	0.172	0.266	0.364	0.453	0.587	0.614	0.756	0.749	0.457
1987	0.098	0.152	0.242	0.337	0.421	0.550	0.572	0.699	0.684	0.424
1988	0.097	0.149	0.248	0.339	0.437	0.581	0.583	0.704	0.678	0.438
1989	0.110	0.169	0.296	0.399	0.508	0.669	0.682	0.816	0.779	0.511
1990	0.112	0.170	0.309	0.419	0.529	0.685	0.726	0.851	0.815	0.534
1991	0.054	0.083	0.156	0.215	0.269	0.338	0.363	0.418	0.402	0.268
1992	0.047	0.071	0.140	0.193	0.234	0.284	0.314	0.366	0.353	0.233
1993	0.041	0.061	0.127	0.176	0.212	0.249	0.278	0.328	0.315	0.209
1994	0.037	0.054	0.119	0.166	0.199	0.230	0.259	0.311	0.294	0.195
1995	0.046	0.068	0.153	0.221	0.252	0.291	0.328	0.401	0.371	0.249
1996	0.055	0.082	0.189	0.282	0.302	0.358	0.401	0.497	0.455	0.307
1997	0.053	0.078	0.185	0.284	0.294	0.349	0.389	0.486	0.443	0.300
1998	0.070	0.105	0.253	0.399	0.406	0.487	0.533	0.669	0.600	0.415
1999	0.058	0.088	0.214	0.348	0.354	0.424	0.451	0.570	0.510	0.358
2000	0.074	0.111	0.269	0.444	0.478	0.573	0.588	0.729	0.660	0.470
2001	0.069	0.105	0.252	0.421	0.472	0.564	0.562	0.691	0.633	0.454
2002	0.073	0.109	0.259	0.437	0.518	0.629	0.617	0.742	0.681	0.492
2003	0.067	0.099	0.238	0.403	0.499	0.590	0.578	0.666	0.617	0.462
2004	0.075	0.109	0.263	0.451	0.585	0.686	0.682	0.750	0.700	0.533
2005	0.070	0.099	0.237	0.419	0.563	0.650	0.652	0.700	0.652	0.504
2006	0.056	0.080	0.191	0.341	0.472	0.544	0.544	0.572	0.532	0.418
2007	0.055	0.079	0.184	0.332	0.476	0.555	0.559	0.572	0.533	0.421
2008	0.050	0.072	0.164	0.294	0.432	0.502	0.514	0.513	0.480	0.381
2009	0.030	0.045	0.103	0.176	0.268	0.311	0.328	0.321	0.294	0.237
2010	0.023	0.035	0.078	0.130	0.203	0.239	0.257	0.243	0.221	0.181
2011	0.005	0.008	0.017	0.028	0.044	0.053	0.057	0.054	0.049	0.040
2012	0.013	0.020	0.045	0.070	0.115	0.138	0.153	0.144	0.130	0.104
2013	0.020	0.030	0.068	0.106	0.178	0.213	0.240	0.224	0.201	0.161

Table 8.4.4. Blue Whiting. Estimated stock numbers at age (million).

Year\Age	1	2	3	4	5	6	7	8	9	10+
1981	4013	3563	4718	2037	2461	2087	1651	1807	1463	3227
1982	5417	2946	2639	3269	1540	1403	1200	945	899	2187
1983	21232	4278	1993	1790	1852	1171	955	810	545	1520
1984	20625	16453	2744	1289	1274	1356	781	521	425	1029
1985	10089	15173	10724	1572	779	909	759	444	252	737
1986	7018	6517	9811	5891	1011	481	497	407	227	516
1987	8589	4887	4123	6696	2566	419	247	244	163	296
1988	6224	6524	3389	2879	3715	1253	207	117	95	176
1989	8495	4538	5015	2511	2150	1630	374	98	50	116
1990	17505	5885	2917	2671	1478	1213	594	140	38	73
1991	9295	14798	4172	1769	1488	850	534	185	41	38
1992	7181	7741	13125	3338	1238	782	463	290	101	43
1993	5283	5278	5471	10069	2318	968	504	274	160	80
1994	7393	3649	3693	3392	6756	1527	767	350	181	140
1995	9781	5593	3138	2531	2769	3783	1012	521	214	190
1996	29006	7527	3997	2294	1521	1776	2211	623	297	238
1997	45947	22499	5604	2498	1370	1010	993	1168	303	300
1998	28488	39153	17176	3482	1357	908	724	568	575	294
1999	21338	21596	29326	10756	1746	738	488	365	229	391
2000	37393	16240	16535	16079	4543	1147	477	304	162	307
2001	57887	30554	13270	11029	7580	1731	503	224	132	199
2002	49131	44902	19211	8049	5390	3510	777	285	104	158
2003	52746	40956	37920	14218	5163	2761	1189	305	96	100
2004	34518	40792	30892	22522	7557	2671	1336	568	137	87
2005	20379	26776	28205	18256	11117	3375	1106	510	218	95
2006	7641	15823	24643	21147	9989	4538	1394	462	212	130
2007	4235	5593	13111	17039	11206	5521	2327	777	240	179
2008	5257	3172	4466	11106	9742	5299	2202	968	338	216
2009	5833	3671	2461	3985	7167	5030	2424	942	428	257
2010	18403	5091	2500	2029	3570	4676	2967	1340	503	368
2011	25393	16240	3745	1823	1839	2733	2701	1475	838	520
2012	23347	20075	15203	2629	1180	1736	2637	2481	1278	1136
2013	15433	20075	15697	11195	2905	1203	1475	2041	1810	1823
2014	15433*	12385	17505	12865	8032	1967	767	868	1336	2431

***Replaced by the 75% percentile of recruitment 1981-2011 in forecast**

Table 8.4.5. Blue whiting. Estimated recruitment in millions, total stock biomass (TBS) in 1000 tonnes, spawning stock biomass (SSB) in 1000 tonnes, and average fishing mortality for ages 3 to 7 (F37).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F37	Low	High
1981	4013	2509	6419	3413	2782	4186	2917	2338	3638	0.275	0.217	0.349
1982	5417	3378	8687	2816	2325	3412	2318	1884	2851	0.222	0.176	0.279
1983	21232	13378	33695	3076	2518	3757	1899	1588	2272	0.262	0.212	0.325
1984	20625	13201	32224	3358	2711	4161	1849	1557	2194	0.322	0.263	0.394
1985	10089	6482	15705	3482	2867	4227	2233	1870	2667	0.343	0.283	0.417
1986	7018	4581	10751	3236	2753	3805	2381	2025	2800	0.457	0.379	0.550
1987	8589	5613	13144	2769	2359	3251	1916	1637	2243	0.424	0.351	0.513
1988	6224	4050	9566	2374	2029	2777	1614	1392	1870	0.438	0.362	0.529
1989	8495	5516	13084	2393	2027	2825	1550	1338	1797	0.511	0.423	0.617
1990	17505	11143	27500	2419	1959	2988	1338	1141	1570	0.534	0.432	0.660
1991	9295	5878	14699	3138	2474	3979	1727	1399	2132	0.268	0.211	0.342
1992	7181	4587	11243	3653	2928	4557	2528	2023	3160	0.233	0.183	0.297
1993	5283	3353	8325	3527	2865	4342	2610	2110	3229	0.209	0.165	0.265
1994	7393	4754	11495	3345	2762	4051	2498	2054	3039	0.195	0.155	0.245
1995	9781	6299	15189	3338	2788	3997	2281	1922	2706	0.249	0.201	0.309
1996	29006	18773	44816	3745	3074	4563	2176	1855	2553	0.307	0.249	0.377
1997	45947	29778	70896	5532	4382	6983	2466	2077	2927	0.300	0.246	0.367
1998	28488	18605	43622	7039	5694	8702	3753	3113	4525	0.415	0.343	0.503
1999	21338	13815	32959	7460	6159	9034	4597	3789	5578	0.358	0.295	0.434
2000	37393	24162	57869	7482	6225	8993	4299	3675	5030	0.470	0.390	0.567
2001	57887	37532	89281	9193	7535	11217	4690	4011	5485	0.454	0.377	0.547
2002	49131	31716	76108	10211	8348	12490	5304	4508	6241	0.492	0.408	0.593
2003	52746	34151	81466	12299	10199	14831	7189	6057	8531	0.462	0.384	0.555
2004	34518	21894	54422	10875	9137	12945	7053	6021	8262	0.533	0.442	0.643
2005	20379	12882	32239	8833	7368	10589	6212	5256	7343	0.504	0.413	0.616
2006	7641	4817	12119	8170	6848	9748	6306	5308	7492	0.418	0.340	0.515
2007	4235	2651	6767	6083	5104	7249	5061	4252	6023	0.421	0.335	0.529
2008	5257	3260	8475	4607	3802	5581	3817	3153	4620	0.381	0.296	0.491
2009	5833	3490	9747	3645	2915	4559	2931	2343	3667	0.237	0.180	0.312
2010	18403	11147	30382	4143	3206	5354	2914	2268	3744	0.181	0.136	0.242
2011	25393	15361	41977	5194	3919	6884	3009	2330	3885	0.040	0.030	0.053
2012	23347	13294	41002	6156	4716	8036	4078	3195	5204	0.104	0.081	0.135
2013	15433	6655	35789	7082	5306	9451	4960	3847	6396	0.161	0.122	0.213

2014	5471	4024	7438

Table 8.8.1.1. Blue Whiting. Upper part: Recruitment candidates (R_1, number at age 1, millions) to be used in the forecast section. Lower part: Geometric means of age 1 blue whiting from the final assessment run.

Year	Number at age 1
2013	13770
2014	26940
2015	13770
2016	13770
Year range	Geometric mean
1981-1995, 2006-2009	7974
1981-2011	13770
1996-2005	35520

Table 8.8.2.1.1. Blue Whiting. Input to short term projection (median values for exploitation pattern and stock numbers).

Table X1. Blue Whiting. Input to short term projection.

Age	Mean weight in the stock (kg)	Mean weight in the catch (kg)	Proportion mature	Natural mortality	Exploitation pattern	Stock numbers (millions)
1	0.049	0.049	0.11	0.20	0.125	26939*
2	0.076	0.076	0.40	0.20	0.188	11050**
3	0.099	0.099	0.82	0.20	0.429	17505
4	0.131	0.131	0.86	0.20	0.670	12865
5	0.156	0.156	0.91	0.20	1.105	8032
6	0.168	0.168	0.94	0.20	1.321	1967
7	0.181	0.181	1.00	0.20	1.474	767
8	0.188	0.188	1.00	0.20	1.380	868
9	0.201	0.201	1.00	0.20	1.244	1336
10	0.223	0.223	1.00	0.20	1.244	2431

***Changed to 75% percentile of recruitment 1981-2011 .**

****Changed to match GM(1981-2011)**

Table 8.8.2.2.1. Blue whiting. Deterministic forecast, used for the ICES advice

Basis: F(2014) = 0.273 (catch constraint = 1200 = TAC). SSB(2015) = 5738. R(2013), R(2015) and R(2016) = GM(1981-2011) = 13770 million at age 1, R(2014)=75% percentile of recruitment 1981-2011 .

Rationale	Catch 2015	Basis	F 2015	SSB 2016	% SSB change1	% TAC change2
Management plan F=0.18	839.886	Management Plan	0.18	5904.242	3	-30
F=0.19	882.497		0.19	5864.151	2	-26
F=0.20	924.713		0.20	5824.446	2	-23
F=0.21	966.538		0.21	5785.123	1	-19
F=0.22	1007.975		0.22	5746.177	0	-16
F=0.23	1049.030		0.23	5707.604	-1	-13
F=0.24	1089.705		0.24	5669.400	-1	-9
F=0.25	1130.007		0.25	5631.561	-2	-6
F=0.26	1169.938		0.26	5594.083	-3	-2
F=0.27	1209.502		0.27	5556.961	-3	1
F=0.22	1248.704		0.28	5520.193	-4	4
F=0.29	1287.547		0.29	5483.774	-4	7
F=0.30	1326.035		0.30	5447.701	-5	11
F=0.31	1364.173		0.31	5411.968	-6	14
Fpa 0.32	1401.963	Fpa	0.32	5376.574	-6	17
Flim 0.48	1962.330	Flim	0.48	4853.303	-15	64
MSY framework 0.30	1326.035	Fmsy=0.30	0.30	5447.701	-5	11
Zero catch	0	F=0	0.00	6696.989	17	-100
0.50*F(2014)	650.489		0.14	6082.598	6	-46
1.00*F(2014)	1222.488		0.27	5544.780	-3	2
1.50*F(2014)	1726.900		0.41	5072.776	-12	44
2.00*F(2014)	2173.016		0.55	4657.393	-19	81

Weights in thousand tonnes.

1) SSB 2016 relative to SSB 2015.

2) Catch 2015 relative to TAC 2014 (1200.000).

Table 8.8.2.2.2. Blue whiting. Stochastic forecast (NOT used for advice).

Basis: F(2014) = 0.266 (catch constraint = 1200 = TAC). SSB(2015) = 6066. R(2013), R(2015) and R(2016) = GM(1981-2011) = 13770 million at age 1, R(2014)=75% percentile of recruitment 1981-2011 .

Rationale	Catch 2015	Basis	F 2015	SSB 2016	% SSB change1	% TAC change2
Management plan F=0.18	884.578	Management Plan	0.18	6464.584	7	-26
F=0.19	929.173		0.19	6421.030	6	-23
F=0.20	973.024		0.20	6379.514	5	-19
F=0.21	1017.094		0.21	6335.471	4	-15
F=0.22	1059.853		0.22	6292.610	4	-12
F=0.23	1102.983		0.23	6248.048	3	-8
F=0.24	1145.596		0.24	6203.954	2	-5
F=0.25	1187.505		0.25	6159.985	2	-1
F=0.26	1229.191		0.26	6116.272	1	2
F=0.27	1270.822		0.27	6076.063	0	6
F=0.22	1312.301		0.28	6036.214	-0	9
F=0.29	1353.018		0.29	5996.563	-1	13
F=0.30	1393.140		0.30	5957.596	-2	16
F=0.31	1433.369		0.31	5919.978	-2	20
Fpa 0.32	1472.969	Fpa	0.32	5882.726	-3	23
Flim 0.48	2067.402	Flim	0.48	5314.122	-12	72
MSY framework	1393.140	Fmsy=0.30	0.30	5957.596	-2	16
Zero catch	0	F=0	0.00	7302.251	20	-100
0.50*F(2014)	667.786		0.13	6670.156	10	-44
1.00*F(2014)	1254.183		0.27	6092.236	0	5
1.50*F(2014)	1775.884		0.40	5588.546	-8	48
2.00*F(2014)	2240.720		0.53	5147.044	-15	87

Weights in thousand tonnes.

1) SSB 2016 relative to SSB 2015.

2) Catch 2015 relative to TAC 2014 (1200.000).

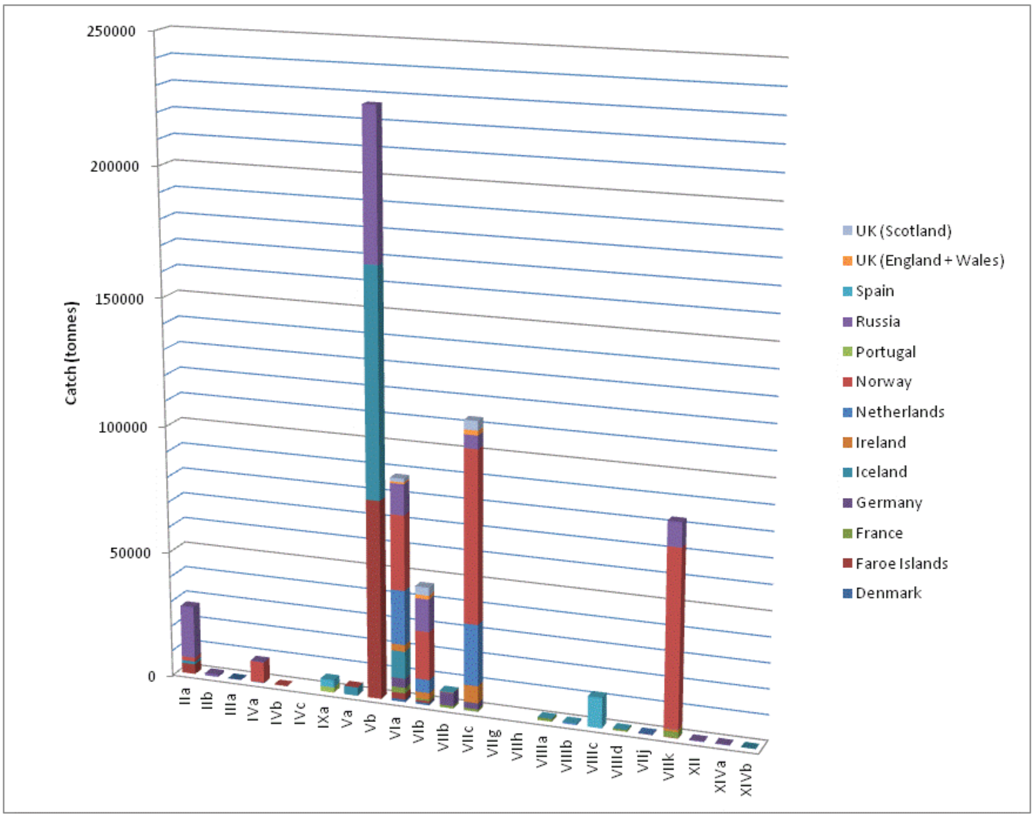


Figure 8.3.1.1 Blue whiting landings (tonnes) in 2013 presented by ICES area and country.

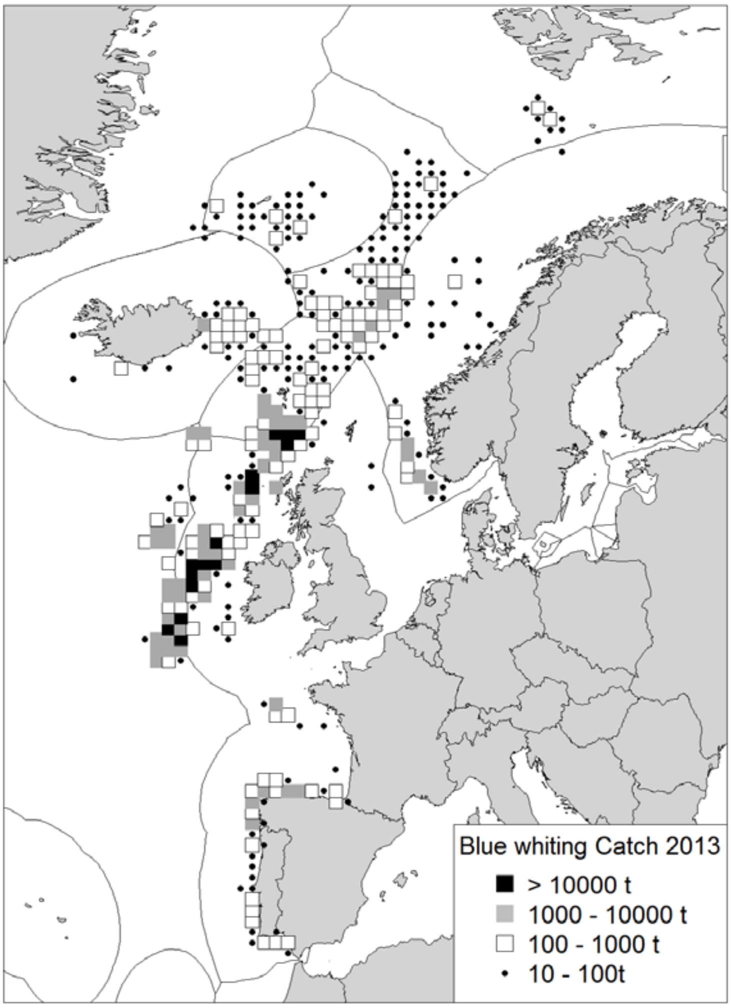


Figure 8.3.1.2. Total blue whiting catches (t) in 2013 by ICES rectangle. Catches below 10 t are not shown on the map. The catches on the map constitute close to 100 % of the total catches.

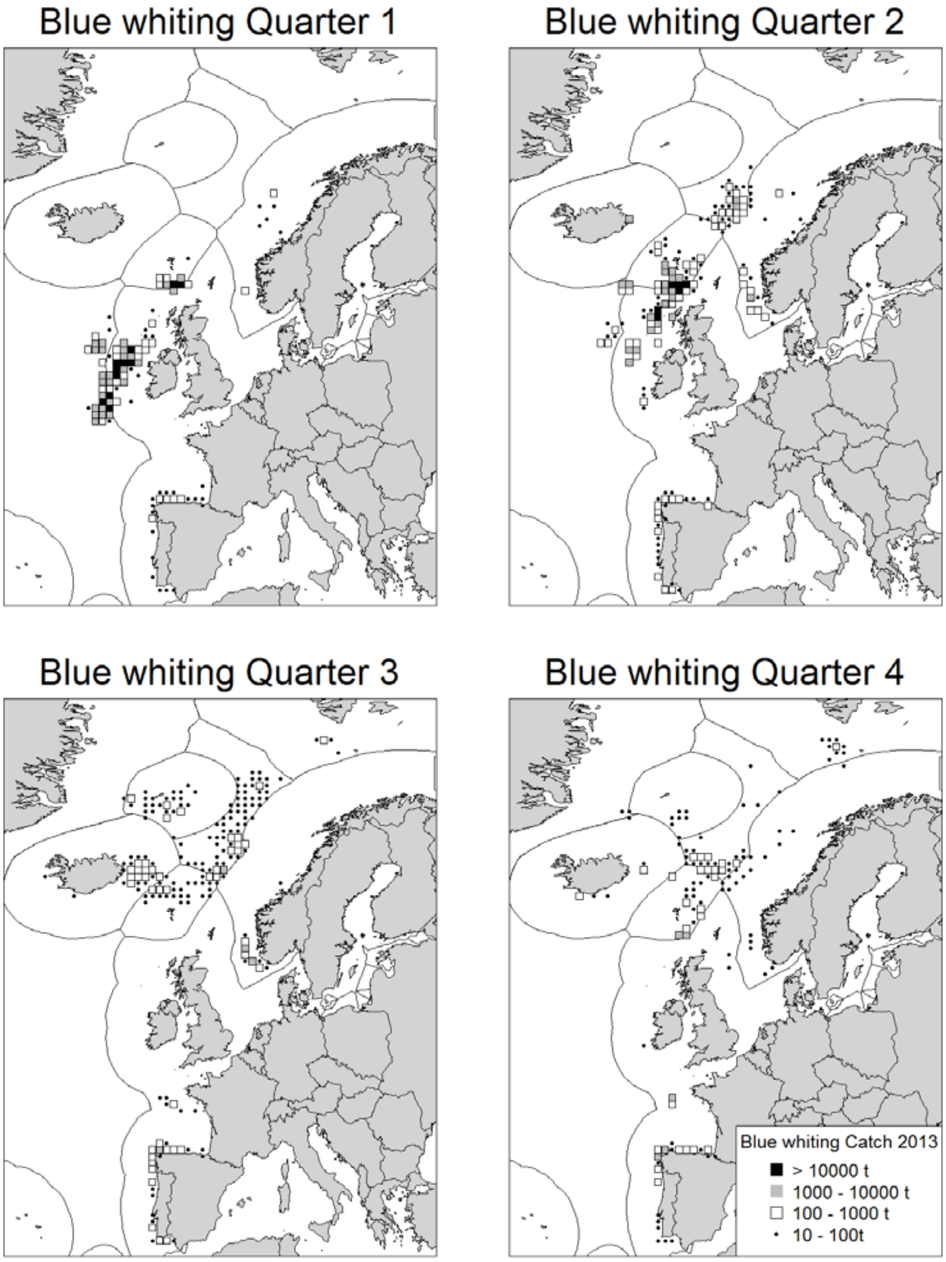
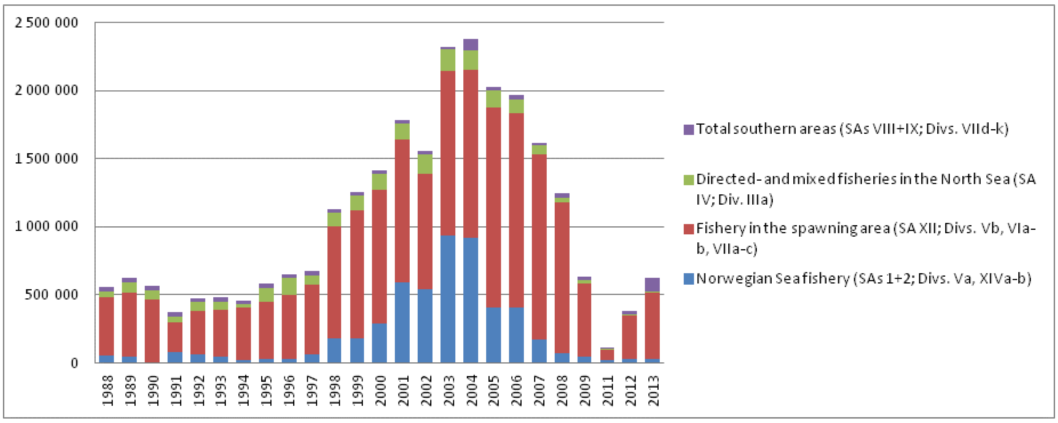


Figure 8.3.1.3. Blue whiting total catches (t) in 2013 by quarter and ICES rectangle. The catches on the maps constitute close to 100 % of the total catches.

A



B

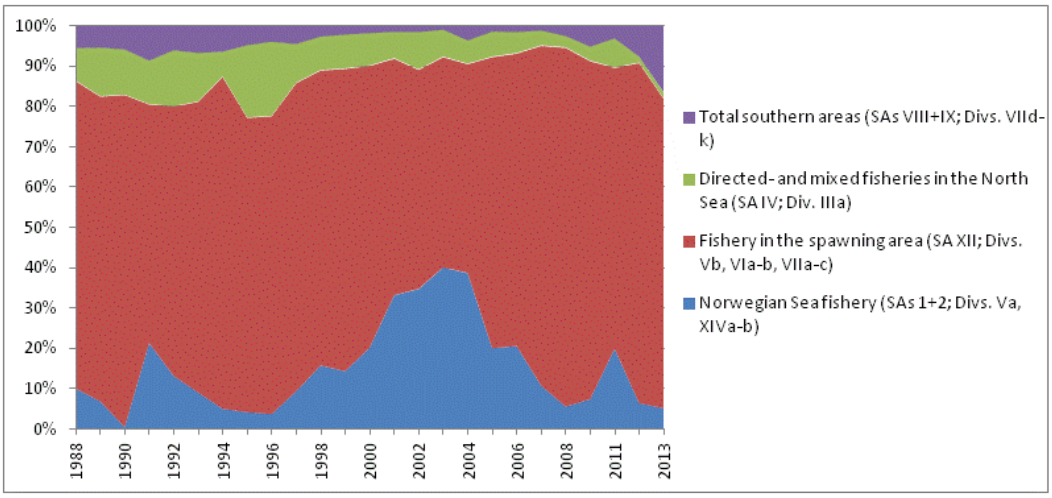


Figure 8.3.1.4. (A) Annual catch (tonnes) of blue whiting by fishery sub-areas from 1988-2013 and (B) the percentage contribution to the overall catch by fishery sub-area over the same period.

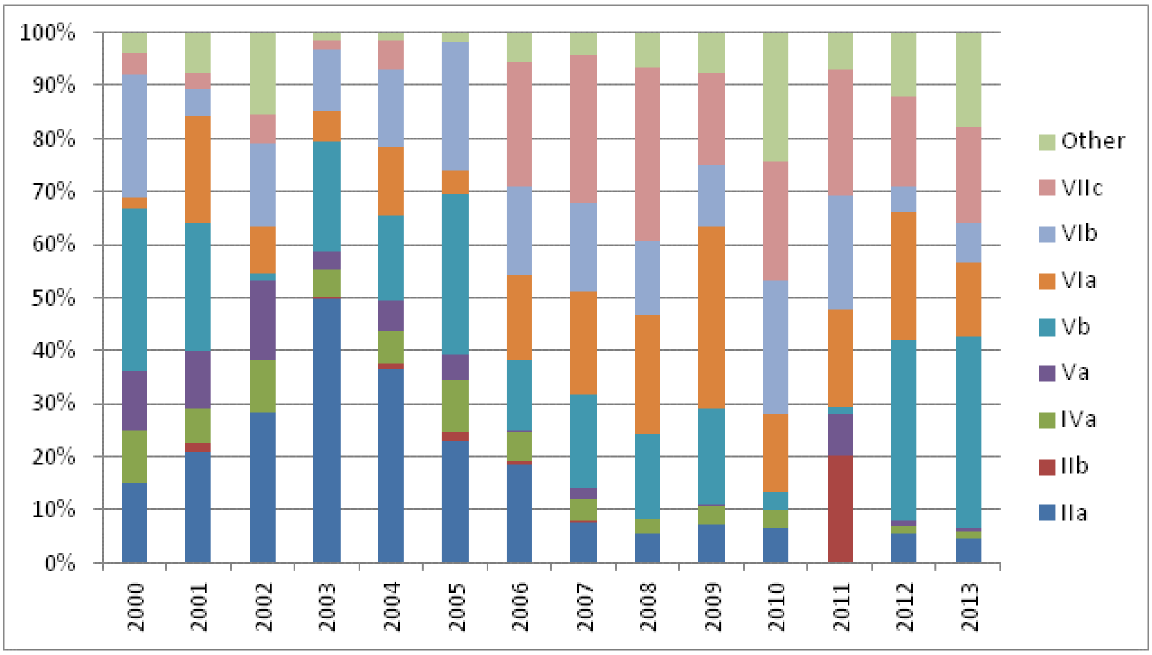


Figure 8.3.1.5. Distribution of total landings of blue whiting by ICES sub-area.

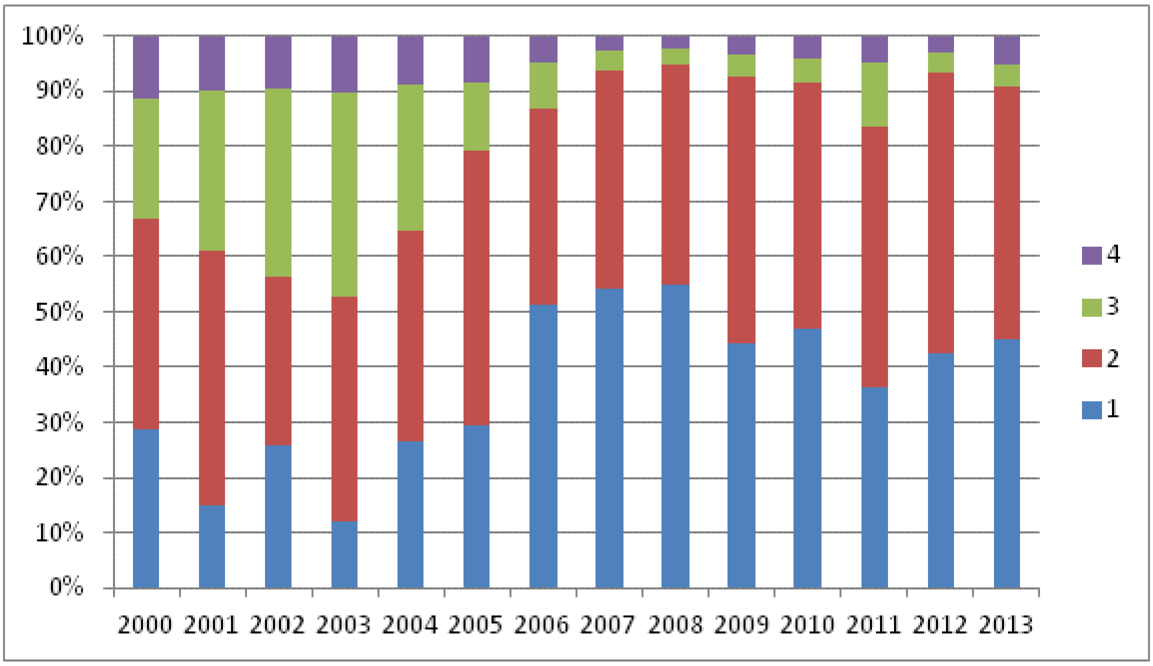


Figure 8.3.1.6. Distribution of total landings of blue whiting by quarter.

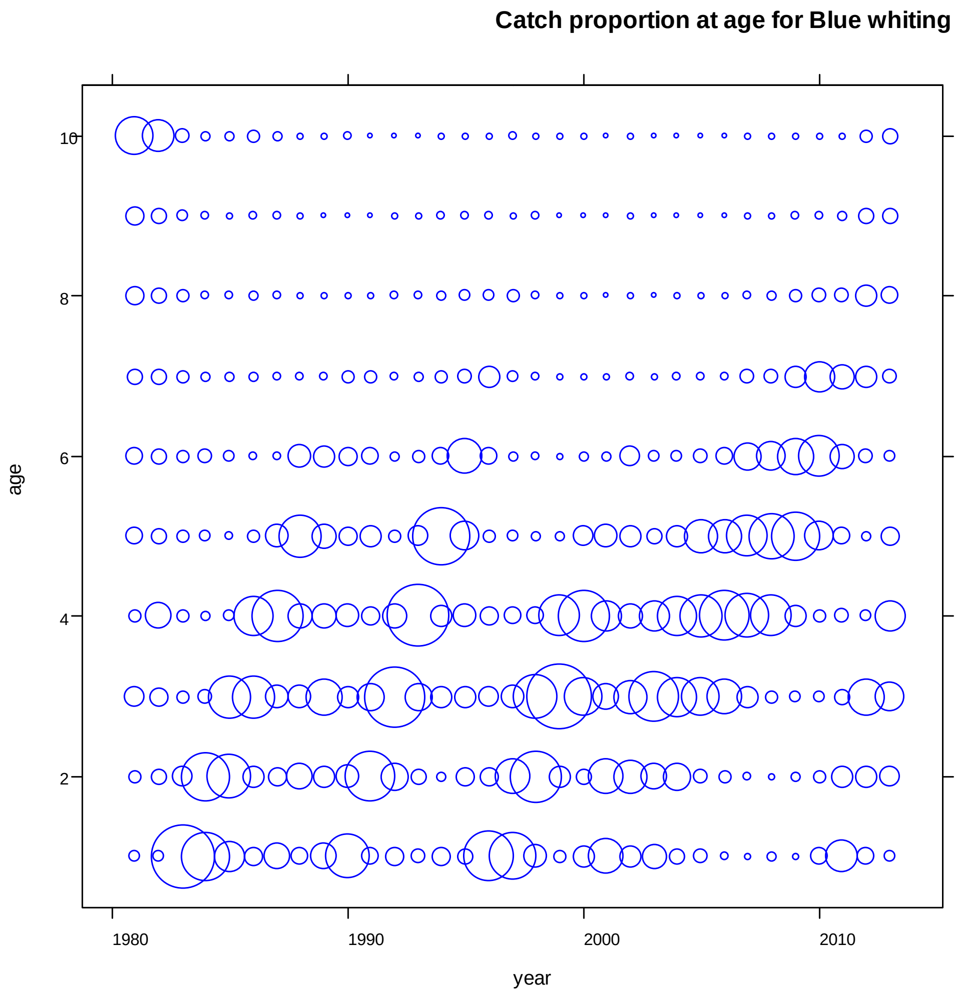


Figure 8.3.1.3.1 Catch proportion at age of blue whiting in the International catch from 1981-2013.

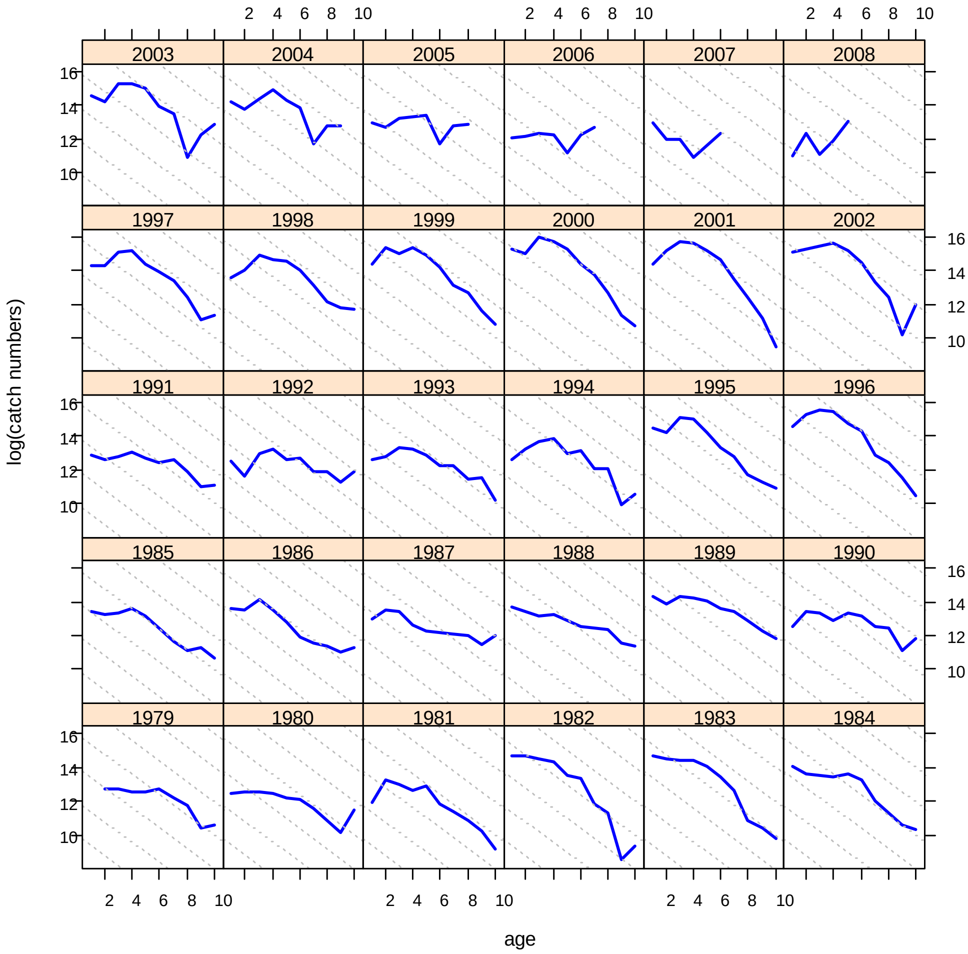


Figure 8.3.1.3.2. Blue whiting. Age disaggregated blue whiting catch (numbers) plotted on log scale. The labels behind each panel indicate year classes. The grey dotted lines correspond to *Z*=0.6.

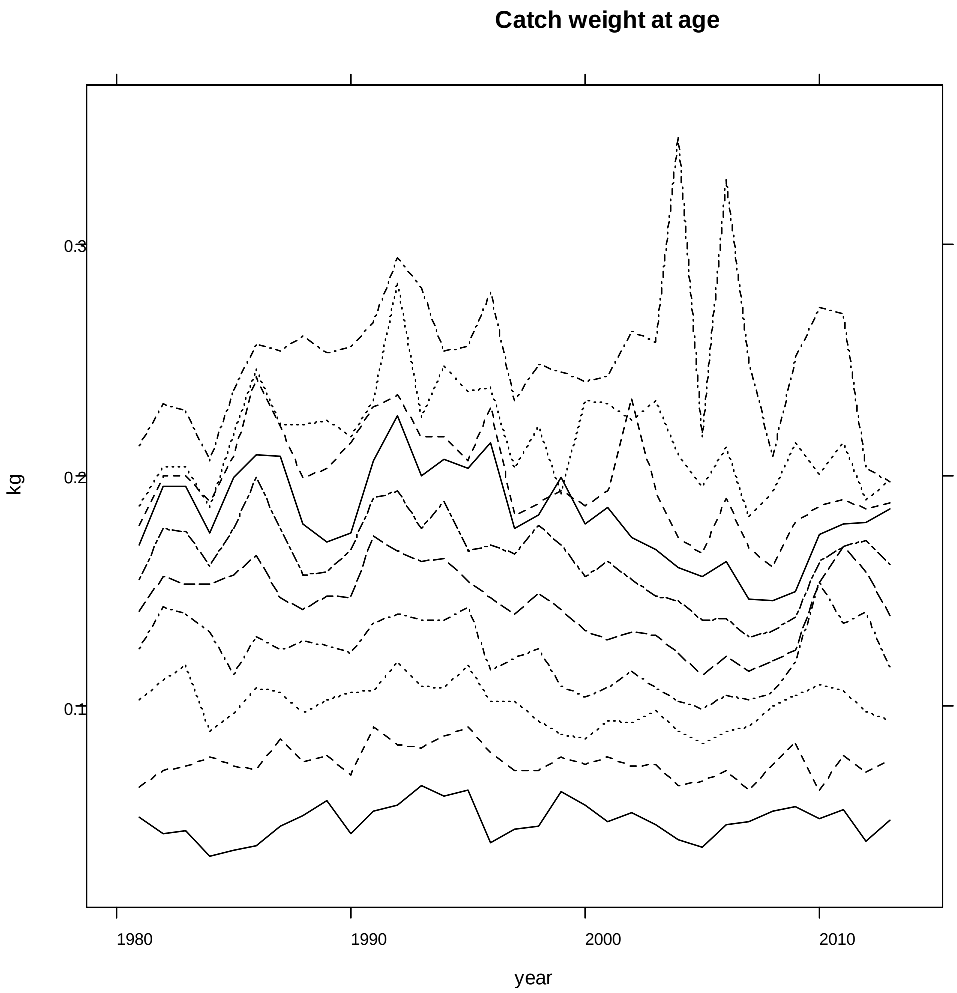
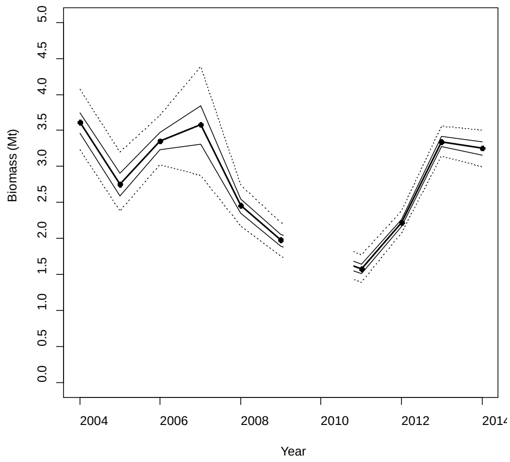


Figure 8.3.1.4.1. Mean catch weight (kg) at age of blue whiting by year.

A



B

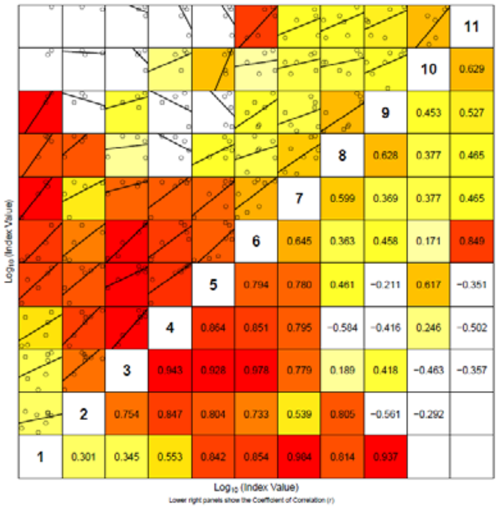


Figure 8.3.4.1.1 (A) Approximate 50% and 95% confidence limits for blue whiting biomass estimates. The confidence limits are based on the assumption that confidence limits for annual estimates of mean acoustic density can be translated to confidence limits of biomass estimates by expressing them as relative deviations from the mean values. These confidence limits only account for spatio-temporal variability in acoustic observations. (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.

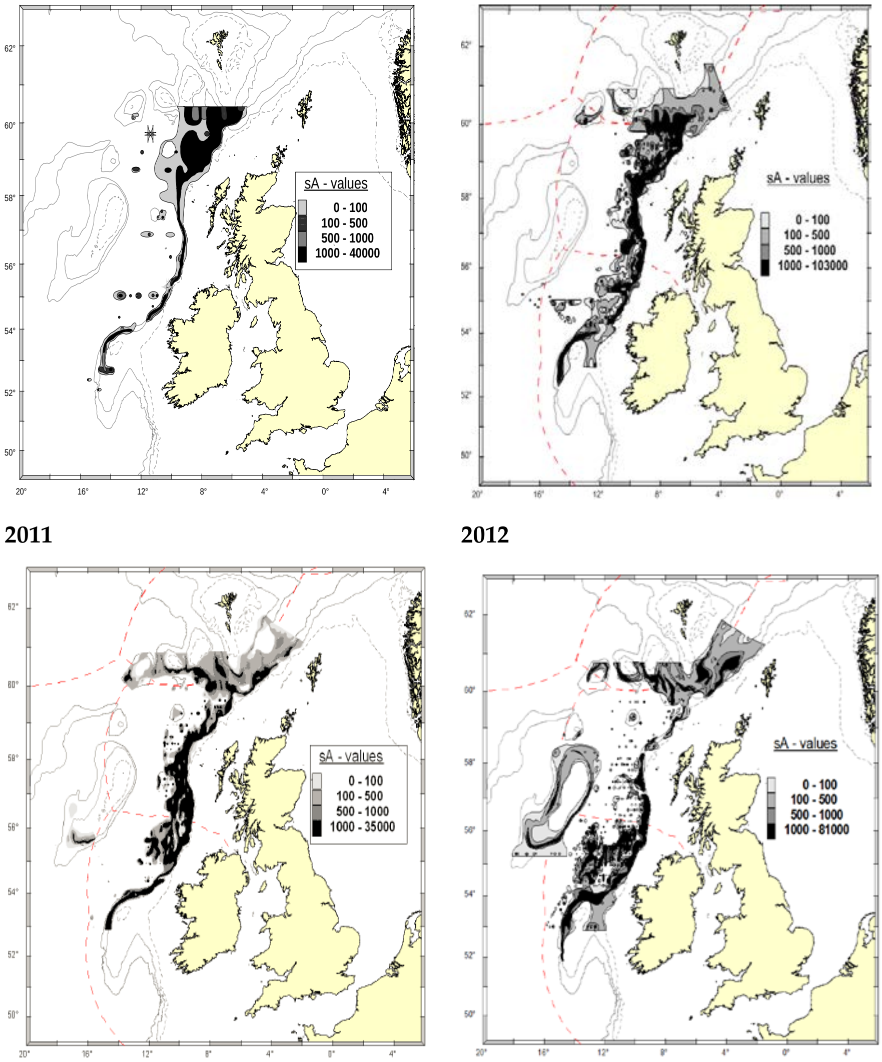
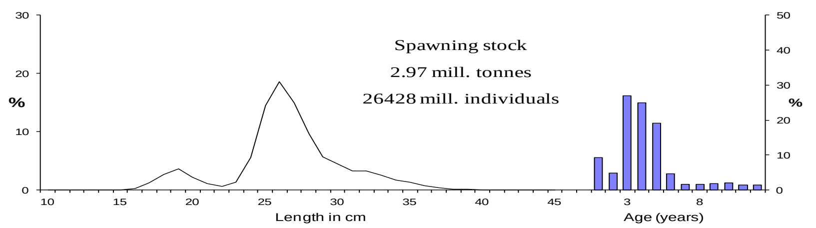
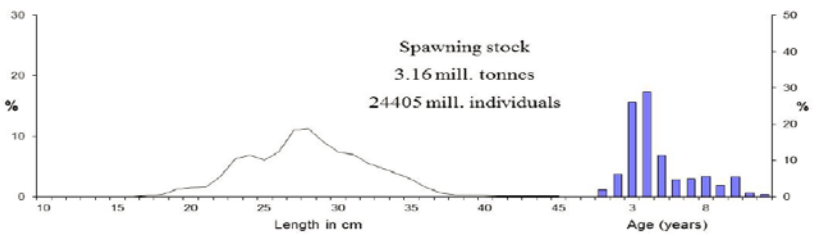


Figure 8.3.4.1.2. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the spawning survey in spring 2011-2014.

2014	
2013	

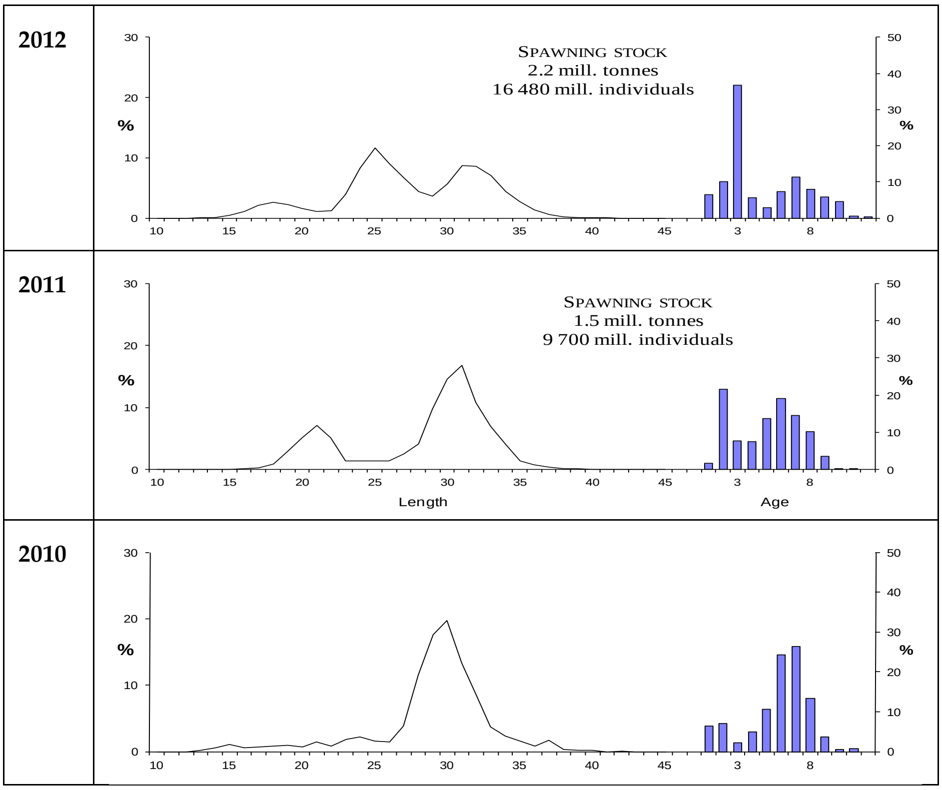


Figure 8.3.4.1.3 Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2010 (lower panel) to 2014 (upper panel). Spawning stock biomass and numbers are given.

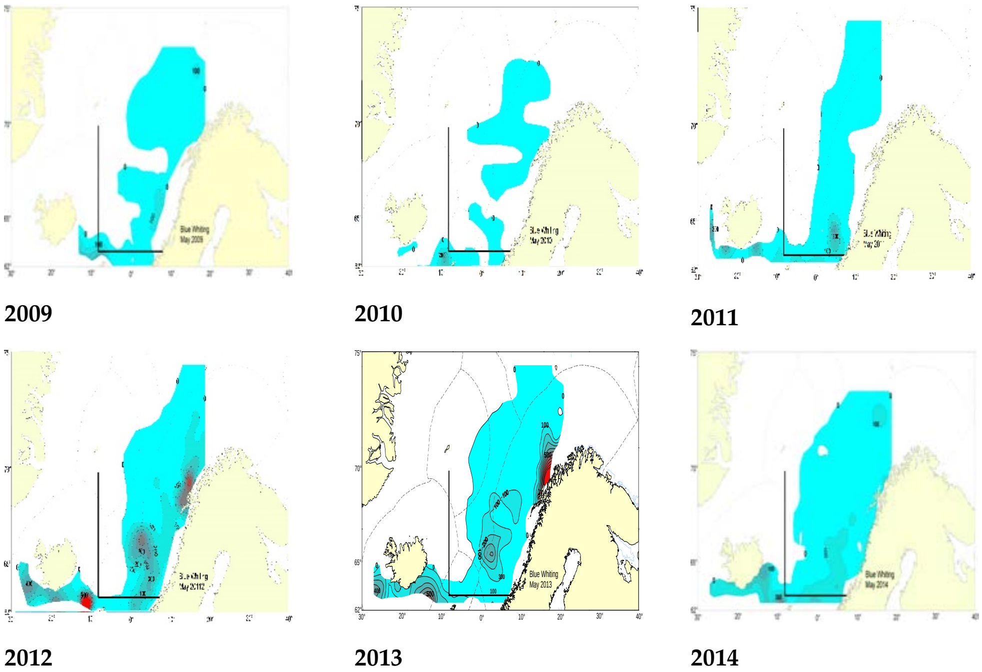
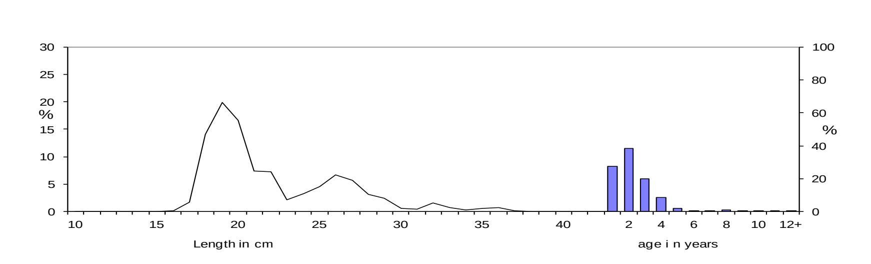
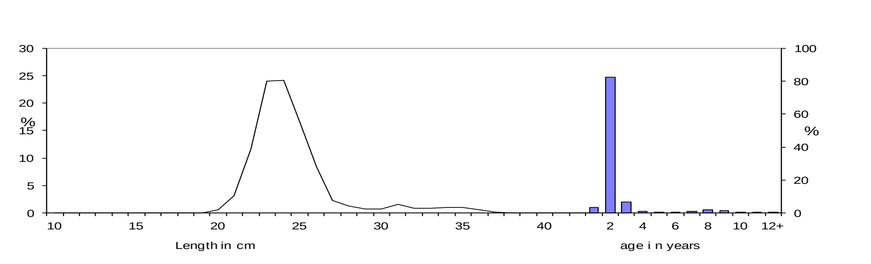


Figure 8.3.4.2.1. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the International Ecosystem survey in the Nordic Seas in spring 2009–2014.

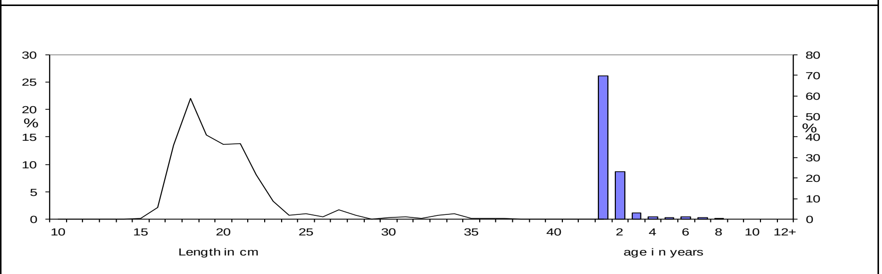
2014



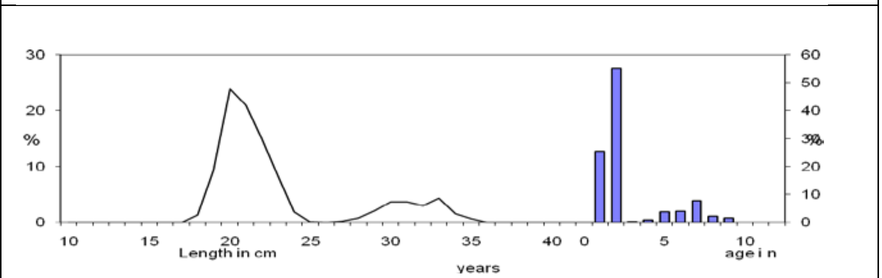
2013



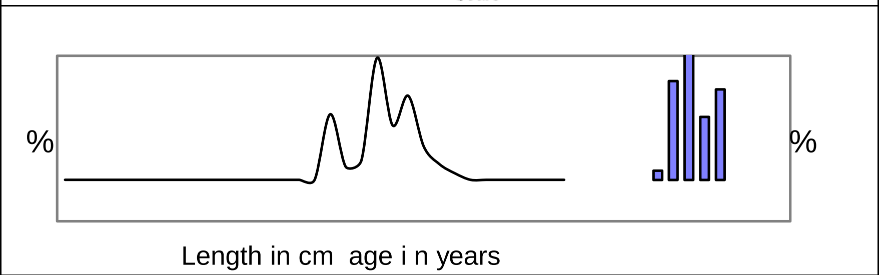
2012



2011



2010



2009

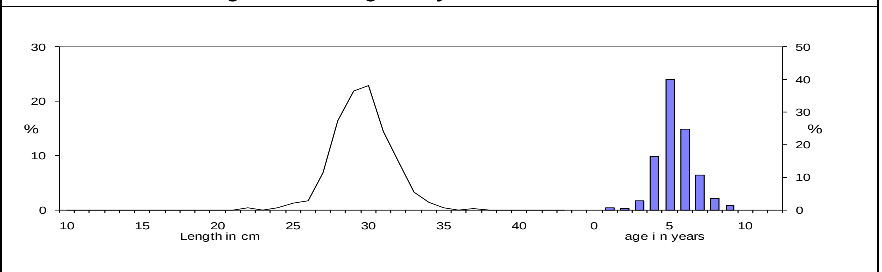


Figure 8.3.4.2.2 Estimated length (line) and age (bar) distributions of blue whiting in the International Ecosystem Survey in the Nordic Seas in May–June for 2009-2014 based on the "standard survey area" between 8°W-20°E and north of 63°N.

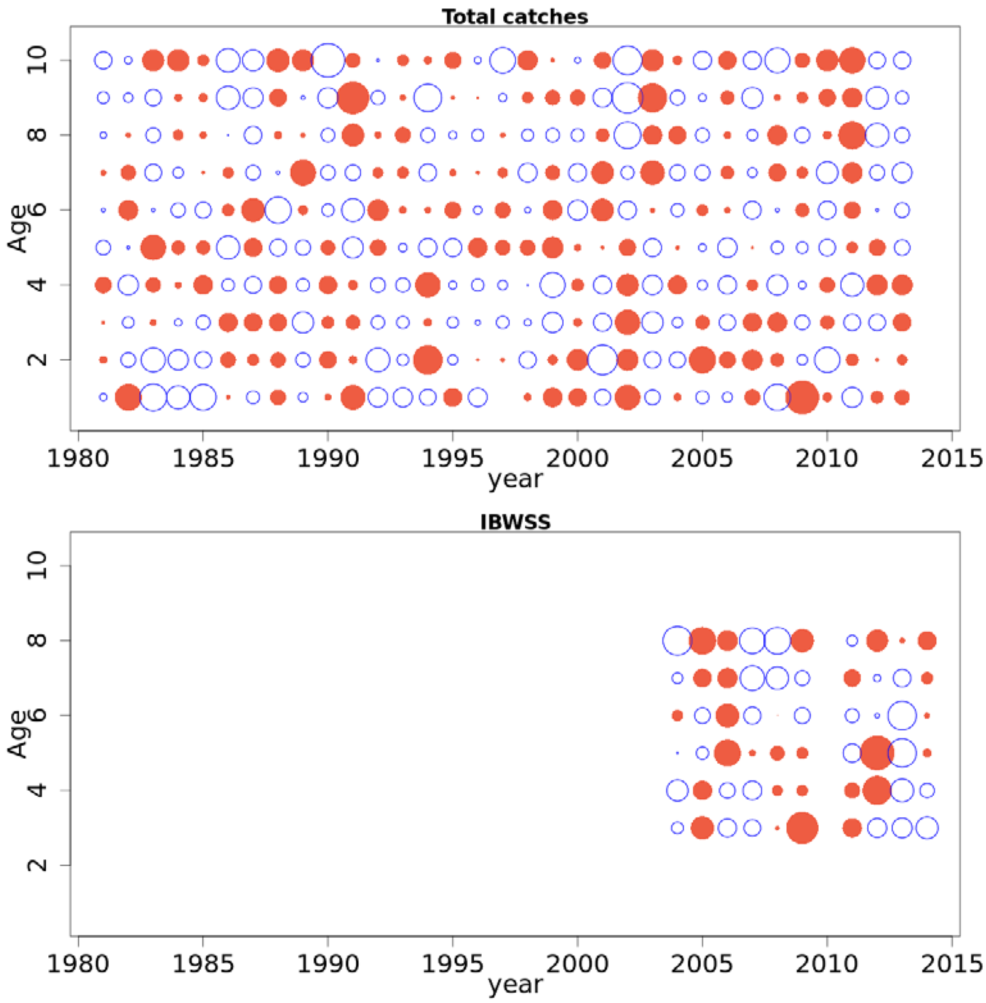


Figure 8.4.1 Blue Whiting. Standardized residuals from catch at age and the IBWSS survey. red (dark) bubbles show that the observed value is less than the expected value

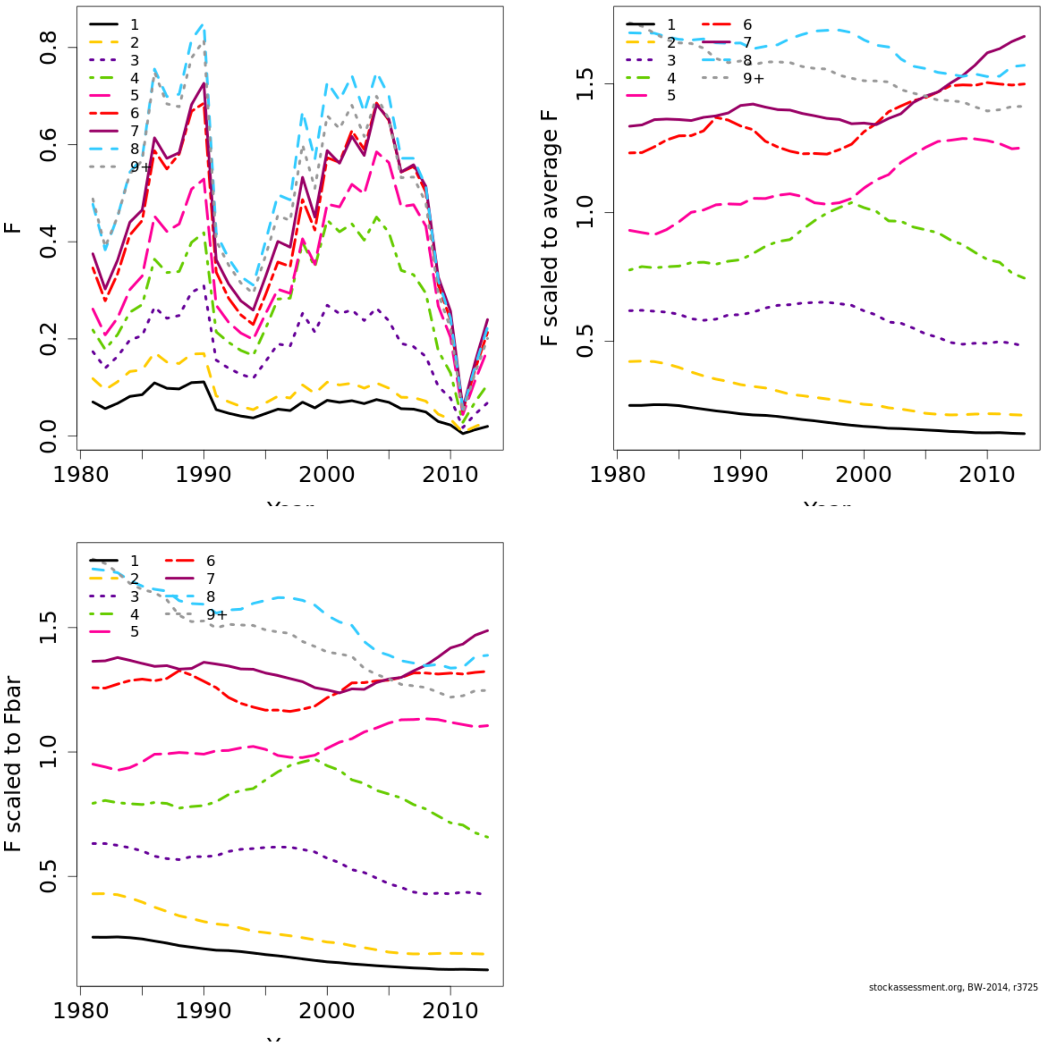


Figure 8.4.2. Blue Whiting. F at age and exploitation pattern (F scaled to mean F all ages, and F scaled to mean F ages 3-7).

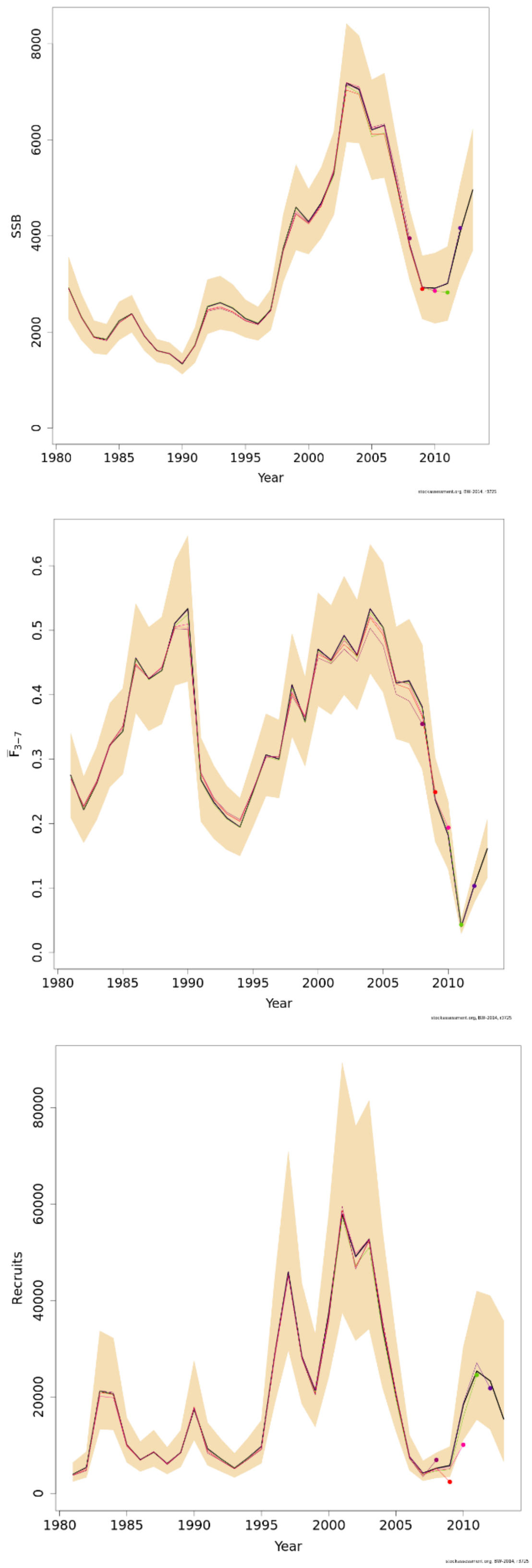


Figure 8.4.3 Blue Whiting. Retrospective analysis of SSB, F and recruitment (age 1) using the SAM model. The 95% confidence interval is shown for the most recent assessment.

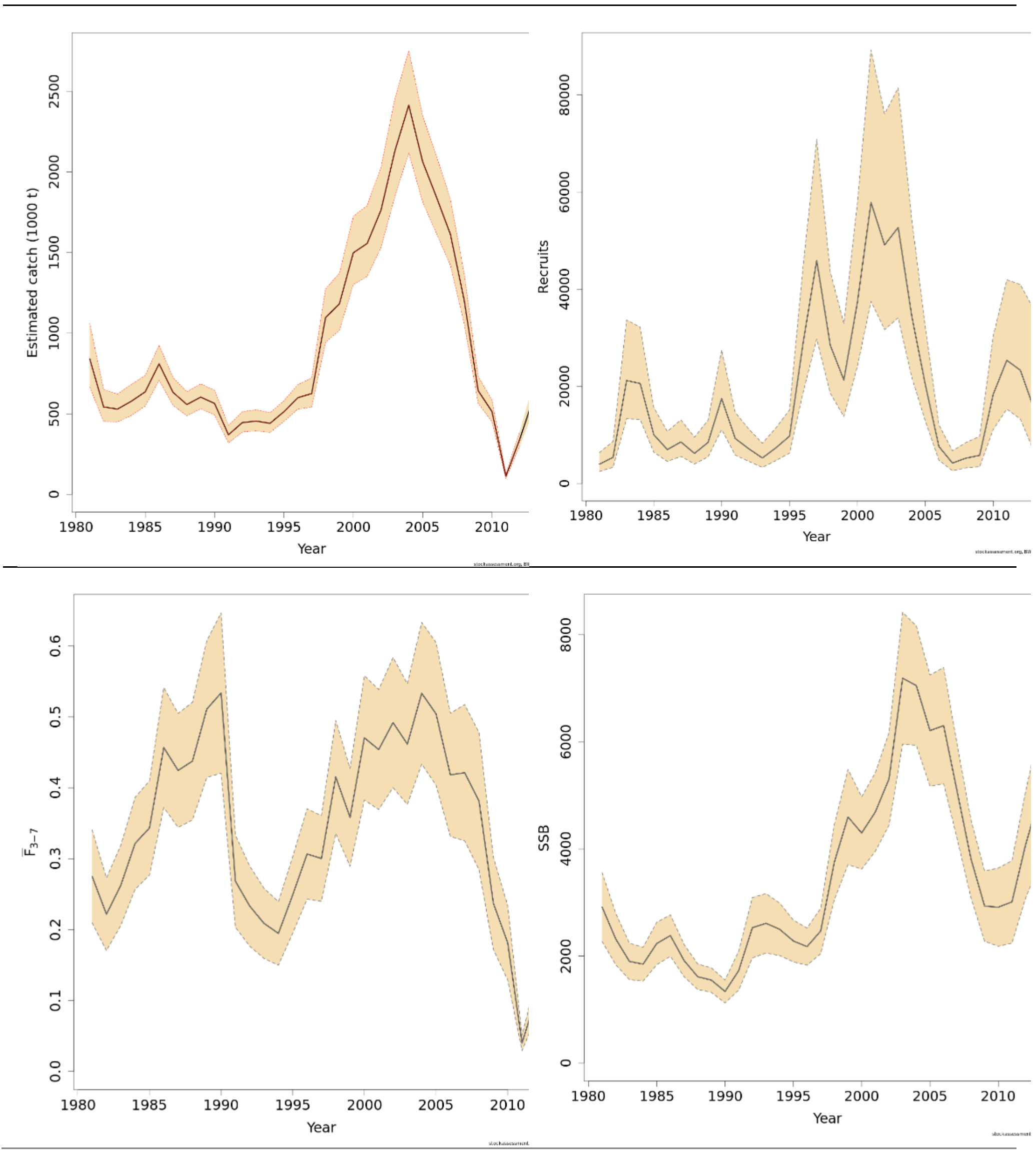


Figure 8.4.4 Blue whiting. SAM final run: Stock summary landings, recruitment (age 1), F and SSB. The graphs show the median value and the 95% confidence interval.

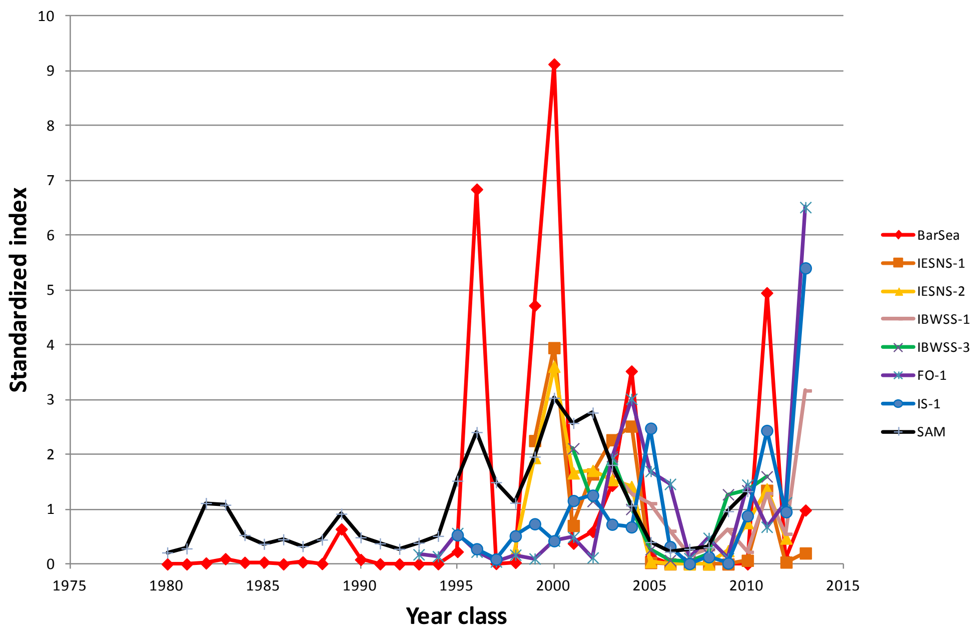


Figure 8.8.1.1. Blue whiting young fish indices from five different surveys and recruitment index from the assessment, standardized by dividing each series by their mean. BarSea - Norwegian bottom trawl survey in the Barents Sea, IESNS: International Ecosystem Survey in the Nordic Seas in May (1 and 2 is the age groups), IBWSS: Internationl Blue Whiting Spawning Stock survey (1 and 3 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.

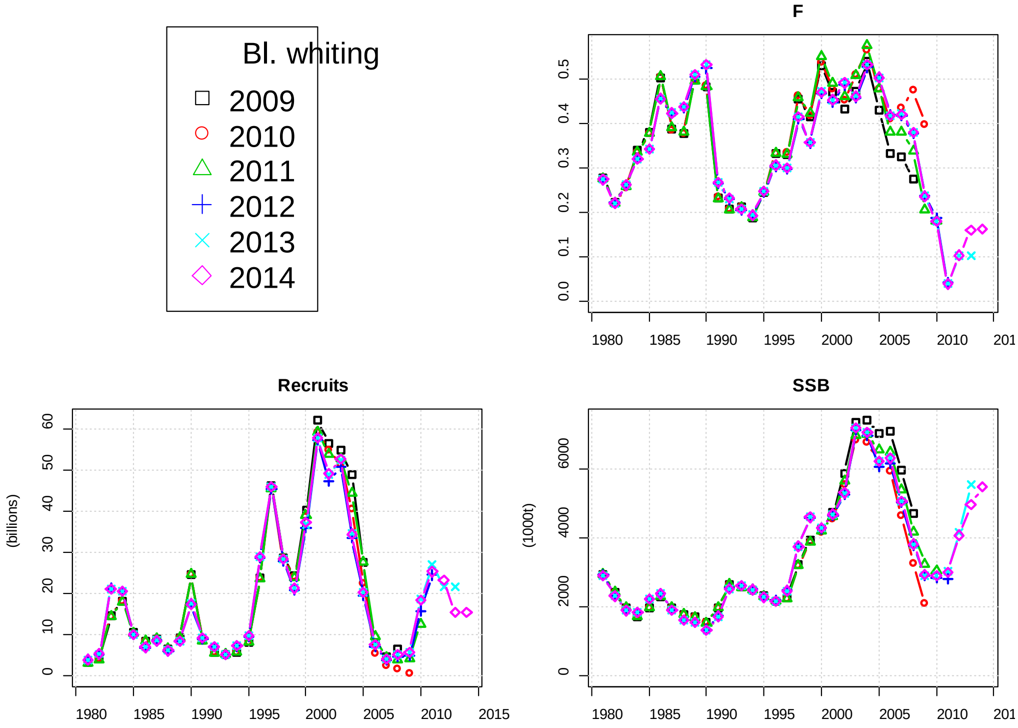


Figure 8.9.1. Blue whiting. Comparison of the 2009 - 2014 assessments.