23 Whiting (*Merlangius merlangus*) in Subarea 4 (North Sea), Division 7.d (Eastern English Channel)

This Section contains the assessment and forecast relating to whiting in the North Sea (ICES Subarea 4) and eastern Channel (ICES Division 7.d). The current assessment is formally classified as an update assessment. The most recent benchmark for this stock was conducted in January 2018 (ICES, 2018a). The benchmark concluded with a SAM assessment with new input data and updated reference points. An interbenchmark was carried out in 2021 to assess the impact of new natural mortality estimates on the assessment, and the reference points were updated as a result (ICES, 2021a). The assessment in 2021 follows the stock annex and the decisions made during the benchmark in 2018 and the interbenchmark in 2021. However, since 2020, survey indices are recalculated using a new automated substitution procedure to fill ALK key in areas with low sample size. This new automated method is seen as an improvement to data quality and transparency of the procedure. For the 2021 assessment of whiting in 27.4 and 7.d, the historical time series of survey indices obtained with the new automated substitution procedure are used.

23.1 General

23.1.1 Stock definition

A summary of available information on stock definition can be found in the Stock Annex and in the WKNSEA 2018 benchmark report working documents (ICES, 2018a). A complex population structure for whiting in the North Sea has been proposed, based on studies about whiting movements, life-history traits, genetic data, identification of spawning aggregation, as well as on population temporal asynchrony observed in SSB, recruitment and egg abundance between areas. The benchmark concluded that literature and provided data did not suffice to revise management units for this stock. As before, the new assessment was run for the combined North Sea and Eastern Channel (27.4 and 27.7d). Exploratory SURBAR assessments were run for individual components (northern and southern component) and compared to the combined stock.

23.1.2 Ecosystem aspects

No new information was presented at the WG. A summary of available information on ecosystem aspects is presented in the Stock Annex prepared by ICES WKROUND (2013).

23.2 Fisheries

Information on the fishery (and its historical development) is contained in the Stock Annex prepared by ICES WKNSEA (2018a).

23.3 ICES advice

ICES advice for 2019

In November 2018, ICES concluded as follows:

ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 24 195 tonnes. If discard and industrial bycatch rates do not change from the average of the last 3 years (2015–2017), this implies landings of no more than 13 052 tonnes and human consumption catch of no more than 21 088 tonnes.

ICES advice for 2020

In May 2019, ICES concluded as follows:

ICES advises that when the MSY approach is applied, catches in 2020 should be no more than 22 082 tonnes. If discard and industrial bycatch rates do not change from the average of the last 3 years (2016–2018), this implies landings of no more than 12 737 tonnes and human consumption catch of no more than 19 354 tonnes.

ICES advice for 2021

In April 2020, ICES concluded as follows:

ICES advises that when the MSY approach is applied, catches in 2021 should be no more than 26 304 tonnes. If discard and industrial bycatch rates do not change from the average of the last 3 years (2017–2019), this implies landings of no more than 14 487 tonnes and human consumption catch of no more than 24 071 tonnes.

23.4 Management

Management of whiting is implemented by TAC and technical measures. The TACs for this stock are split between two areas: (i) Subarea 4 and Division 2.a (EU waters), and (ii) Divisions 7b–k. Since 1996 the North Sea and eastern Channel whiting assessments have been combined into one.

The TAC in Subarea 4 for 2016 was set as a Roll-over TAC at 13 678 tonnes and for 2017 the TAC was increased to 16 003 tonnes of landings for human consumption. Since 2018, with introduction of the landing obligation the TAC accounts for total human consumption catch in Subarea 4, including discards and landings below minimum landings size (BMS) but excluding industrial bycatch (IBC). The TAC in Subarea 4 for 2020 was set to 17 158 tonnes and for 2021 was 21 306 tonnes. There is no separate TAC for Division 7.d; landings from this Division are counted against the TAC for Divisions 7.b–k combined (22 778 tonnes in 2016, 27 500 tonnes in 2017, 22 213 tonnes in 2018, 19 184 tonnes in 2019, 10 863 in 2020, for 2021 no TAC value available). There are no means to control how much of the Division 7.b–k TAC is taken from Division 7.d. By comparison, a specific TAC for Division 7.d was established for cod in 2009, and the same procedure for whiting may be appropriate.

Since 2006, the landings data have been collated separately for each area. In previous years, the human consumption landings in Subarea 4 and Division 7.d were calculated as about 80% and 20% of the combined area totals, respectively. In 2020, 81% of the total landings originated from Subarea 4.

The minimum landing size for whiting in Subarea 4 and Division 7.d is 27 cm. The minimum mesh size for targeting whiting in Subarea 4 is 120 mm and in Division 7.d is 80 mm.

Whiting are a by-catch in some *Nephrops* fisheries that use a mesh size of 80 mm, although landings are restricted through bycatch regulations. They are also caught in flatfish fisheries that use a smaller mesh size. Industrial fishing with small-meshed gear is permitted, subject to by-catch limits of protected species. Regulations also apply to the area of the Norway pout box, preventing industrial fishing with small meshes in an area where the by-catch limits are likely to be exceeded. Industrial bycatch occurred mainly in Subarea 4 by Danish industrial fisheries. In 2016–2018, some very minor catches in the Norwegian fishery have been reported as BMS may be considered industrial bycatch but were not reported as such.

Conservation credit scheme

Since 2008, real time closures (RTCs) have been implemented under the Scottish Conservation Credits Scheme (CCS). The CCS has two central themes aimed at reducing the capture of cod

through (i) avoiding areas with elevated abundances of cod through the use of Real Time Closures (RTCs) and (ii) the use of more species selective gears. Within the scheme, efforts are also being made to reduce discards generally. In 2009, 144 RTCs were implemented, and the CCS was adopted by 439 Scottish and around 30 English and Welsh vessels. In 2010, there were 165 closures, and from July 2010, the area of each closure increased (from 50 square nautical miles to 225 square nautical miles). In more recent years, the following numbers of closures were implemented: 185 (2011), 173 (2012), 166 (2013), 94 (2014), 97 (2015) and 114 (2016). Although the scheme is intended to reduce mortality on cod, it undoubtedly has an effect on the mortality of associated species such as whiting. However, the scheme was suspended 20 November 2016 and there are no plans for its reintroduction.

In 2016, 14 Scottish demersal whitefish vessels participated in a trial Fully Documented Fishery (FDF) scheme, following similar schemes during 2010–2015. The uptake of the scheme declined due to concerns about monitoring of discards under the EU Landing Obligation. The cod-specific FDF scheme terminated at the end of 2016, due to the suspension of most aspects of the EU Cod Recovery plan which removed the opportunity for countries to provide additional quota for participants. However, a new Scottish FDF scheme has commenced, which is being run along similar lines and which is intended to monitor discarding of saithe and monkfish. Since 2017 there were no data submissions to InterCatch on discard rates from the FDF fleets for whiting.

23.5 Data available

23.5.1 Catch

Since 2009, international data on landings and discards have been collated through the InterCatch system. As additional categories logbook registered discards and BMS landings can be uploaded. In 2020 data, no logbook registered discards are submitted. Minor whiting landings have been reported as BMS landings into InterCatch since 2016. In 2020 data, these mostly originated from Scotland OTB_DEF métiers (36 t). Generally, BMS was treated as discards as in previous years.

2019 Swedish landing data in area 4 were missing from the submission to InterCatch in 2020 and the Swedish catches (6 tonnes) were added manually in the assessment. In 2021, Swedish catch data for 2019 was submitted to InterCatch. InterCatch data was therefore raised for both 2019 and 2020. In 2020 data, 47% of the landings (here total landings include industrial bycatch) had associated discard data imported to InterCatch. The landings of métiers for which discard data was provided in 2020 are illustrated in Figure 23.1. Discards were raised from discard ratios from Subarea 4 and Division 7.d combined. Normally, the data are stratified by gear type (TR1 and TR2) and quarter to raise discards for fleets without imported discards, while for other gear types discards are raised using discard rates from all available fleets. However, unlike previous years, no stratification by quarter was done in 2021 due to poorer sampling caused by COVID-19 during 2020, and raising was done annually instead. The raised discards amounted to 60% of total discards (Table 23.3b). Industrial bycatch landings were excluded from the discard raising, as no discards occur in that fleet. Throughout this report minor BMS landings were grouped together with discards for age allocations as well as estimation of mean weights-at-age.

Figure 23.2a shows métier specific landings in percent of the total landings in 2020 for whiting in Subarea 4 and Division 7.d, for fleets sampled for age compositions in landings and unsampled fleets. The Figure also shows the cumulative landings when sampled and unsampled fleets are ordered by landings yield. Sampled fleets comprise around 50% of the overall landings, and are available for 9 métiers (Table 23.3.c).

However, although the unsampled fleets provide considerable landings overall (50%), most métiers provide less than 5% of the overall landings each. A métier summarized as miscellaneous

landings of industrial bycatch (MIS_MIS_0_0_0_IBC) provides 9% of the total landings, all of which occurred in the Danish fishery and were not sampled.

For raising discard rates from sampled to unsampled fleets all samples were used with splitting of fleets on the basis of gear type. Discard rates for unsampled whiting fleet components were obtained from discards reported by France, UK (England, Scotland), Netherlands, Denmark, Belgium and Germany.

Of the total discards, 40% were imported into InterCatch. 17% of the discards were sampled for age distributions (Table 23.3c). The 12 métiers providing discard samples and unsampled métiers are listed in Figure 23.2b.

Official reported landings by country, WG estimates of total catch and catch component yields, as well as TACs covering the respective areas are given in Table 23.1 for the North Sea (Subarea 4) and in Table 23.2 for the Eastern Channel (Division 7.d).

ICES estimates of numbers and weights at age for the defined catch components (total catch, landings, discards and industrial bycatch) are given in tables 23.4–23.11. In 2020, discards represented 35% of the total catches (Table 23.12). Figure 23.3 plots the trends in the commercial catch for each component in Subarea 4 and Division 7.d combined. Recent years have seen these time series stabilize to a certain extent. There has been an increase in discards and bycatch in recent years. There continued to be high discard of whiting up to age 2 (Figure 23.4).

23.5.2 Age compositions

Age compositions in the landings and discards were based on samples provided by France, UK (England, Scotland) and Denmark. Normally, age compositions are applied to landings with splitting of fleets on the basis of quarter (1,2 vs 3,4) and gear type (TR1 and TR2), while discards age compositions are allocated using all discard samples with splitting of fleets on the basis of gear type (TR1) and quarter (1,2 vs 3,4). However, unlike previous years, no stratification by quarter was done in 2021 due to poorer sampling caused by COVID-19 during 2020, and raising was done annually instead. For the remaining gear types age compositions were allocated using all available samples.

Limited sampling of the industrial bycatch component resulted in the 2006 data appearing as an outlier and the 2007 to 2010 data were deemed unreliable. This applies to both the age compositions and the estimates of mean weights at age. Thus, the data for 2006 to 2010 were replaced with estimates derived from the years 1990 to 2005 (as described in the Stock Annex). For the industrial bycatch in 2011 and 2012, age compositions were inferred in InterCatch from corresponding age samples taken from small-mesh fisheries of France and the UK. In recent years, age compositions for industrial bycatch are estimated from all samples (landings and discards) without splitting of fleets. Minor BMS landings (below minimum landing size) were not sampled. BMS was treated the same as discards, and age compositions are inferred from discard samples only. BMS and discards were combined as discards.

Total international catch numbers at age (Subarea 4 and Division 7.d combined) as estimated by ICES are presented in Table 23.4. Numbers for human consumption landings, discards, and industrial bycatch are given in tables 23.5 to 23.7. Total catches, and catch components, as estimated by ICES are listed in Table 23.12.

23.5.3 Weight at age

Mean weights at age (Subarea 4 and Division 7.d combined) in the catch are presented in Table 23.8. Mean weights at age (both areas combined) in human consumption landings are presented in Table 23.9, and for the discards and industrial by-catch in the North Sea in tables 23.10 and 23.11, respectively. Weights-at-age are depicted graphically in Figure 23.5, which indicates an

increasing trend (with annual fluctuations) in mean weight-at-age in the landings, discards and total catch for ages > 2 since the early 2000s. In recent years, mean weights at age have stabilized on the higher level. Mean weights at age in landings have decreased for age 0 since the late 2000s.

Unrepresentative sampling of industrial bycatch in 2006 to 2010 resulted in poor estimates of the mean weights at age and these have been replaced by the mean weight at age for the period 1995 to 2005 (zero weights are taken as missing values). From 2009 onwards, the weights at ages of total catches were used for weights at ages of industrial bycatch.

Stock mean weights at age are estimated from commercial catch weights at age scaled to the level of weights at age estimated in IBTS Q1 (ICES WKNSEA 2018, Figure 23.6).

Unsmoothed values of weights at age are used in the assessment (Table 23.13).

23.5.4 Maturity and natural mortality

Values for proportion mature at age are estimated using IBTS Q1, in Table 23.14 and Figure 23.7. The estimation procedure is discussed in the Stock Annex. Values prior 1991 are assumed constant using values of 1991, due to data quality issues and high variability in results in the earlier time period. The same maturation proportion was assumed for individuals 6 years and older.

Estimates of natural mortality (M) are taken from the 2020 update key run from of the SMS multispecies model (ICES WGSAM, 2021b) (Table 23.15 and Figure 23.8). At the 2021 interbenchmark (ICES, 2021a), the most recent estimates of natural mortality values were smoothed. The new natural mortality values for 2020 are assumed to be the same as in 2019 (Figure 23.8). The same natural mortality was assumed for individuals 8 years and older.

23.5.5 Research vessel data

Up until 2019, the historical time series of survey indices has been calculated using a manual substitution procedure. The data obtained with this manual procedure is only available until Q3 2019. Since 2020, survey indices are recalculated using a new automated substitution procedure to fill ALK key in areas with low sample size. This new automated method is seen as an improvement to data quality and transparency of the procedure. A comparison of the historical survey indices obtained with the old manual method and the historical survey indices recalculated with the new automated method show that the new method revealed that assessment outputs obtained with the new methods result in lower Mohn's rho values for SSB, F and recruitment. The new data series therefore appear to lead to more consistent assessment results (see Annex 9). As a result, for the 2021 assessment on whiting in 27.4 and 7d it was decided to use the historical time series of survey indices obtained with the new automated substitution procedure.

Survey tuning indices are presented in Table 23.16a and b. The indices used in the assessment are ages 1–5 from the IBTS–Q1 and ages 0–5 from IBTS–Q3 surveys, from 1983–2021 and 1991–2020, respectively. The report of the 2001 meeting of WGNSSK (ICES WGNSSK, 2002), and the ICES advice for 2002 (ICES ACFM, 2001) provide arguments for the exclusion of commercial CPUE tuning series from calibration of the catch-at-age analysis. Such arguments remain valid and only survey data have been considered for tuning purposes. All available tuning series are presented in the Stock Annex.

In Figure 23.9, survey distribution maps based on the IBTS–Q1 survey in the North Sea, for ages 1–3+ of the first quarter (Q1) 2017–2021, are presented. Figure 23.10, the third quarter is represented (Q3) for ages 0–3+ for the years 2017–2020 For ages 2–3+ CPUE is higher along the UK east coast. Whiting at age 0 are found in the Northern North Sea and Scottish east coast as well as in the German Bight. CPUE at age 0 in Q3 is low in 2017 and 2018, but is higher in 2019 and 2020.

23.6 Benchmark

The ICES Benchmark Workshop on North Sea Stocks 2018 (WKNSEA) was held at ICES in Copenhagen in early 2018. Analyses focused on a number of key issues (maturity, natural mortality, stock-weights at age, stock identity, assessment model) details can be found in WKNSEA report (ICES, 2018a) and stock annex.

No changes were made to the use of survey indices. Catch data was updated in Intercatch following a data call for 2009–2016. A new stratification design to allocate discard ratios and age distributions was introduced, details of the allocation scheme can be found in the Stock Annex and in Section 23.5. The assessment model was updated from XSA to SAM and new reference points were estimated.

As before, Area 27.4 represents the management unit with TAC advice to be given. WGNSSK and WKNSEA recommended, that the stock identity issue should be reviewed in the future when firm evidences become available. Until then it is recommended to monitor area-specific stock development based on survey data when it is available (see Section 23.15). The feasibility of combining Division 3.a with Subarea 4 components was explored, but data showed there were biological reasons to leave the components as separate stocks.

In April 2021, an interbenchmark was carried out to assess the impact of new natural mortality estimates from WGSAM (ICES, 2021b) on the assessment, and the reference points previously defined during the 2018 benchmark were updated as a result (ICES, 2021a).

23.7 Data analyses

23.7.1 Exploratory survey-based analyses

In Figure 23.11, time-series of survey log CPUE at age (ages 1–5+) are presented, which suggest that while broad trends are captured in a consistent way by the two surveys, finer-scale details of year-class strength may not be.

Catch-curve analyses for the surveys are shown in Figure 23.12. These show consistent tracking of year classes (since catch curves are mostly smooth) and consistent selection with some exceptions in recent years. The catchability of the IBTS–Q1 seems to have changed since 2007, underestimating the size of the 2006-year class at age 1. The 2007 to 2010- and 2012-year classes also seem to have been underestimated at age 1. The IBTS–Q3 survey shows low mortality for the 2006-year class, and a potential under estimate of the 2007, 2012- and 2013-year class at age 1. However, numbers at age 2 in the 2007-year class may well be an overestimate.

The consistency within surveys is assessed using correlation plots in Figures 23.13 and 23.14. These indicate that the IBTS–Q1 and Q3 surveys both show good internal consistency across ages. The log CPUE plots by survey (Figure 23.15) support the conclusion of good internal consistency. Only in recent years, age 1 differs somewhat from overall pattern.

Figures 23.16–23.18 summarize the results of a SURBAR analysis using the available IBTS surveys. These show a well-specified analysis in which the data agree broadly with the separability assumptions in the model and uncertainty bounds are fairly tight. Mortality has been on a relatively lower level since the early 2000s. Recruitment (age 1) in 2020 is estimated to have been much higher than in recent years and on par with historical high values, while SSB and TSB, although at an intermediate level compared to the historical time series, are increasing. The log survey residuals (Figure 23.17) suggest in most recent years some negative residuals in Q1 and positive residuals in Q3 that should be investigated if trends continue in the coming year.

23.7.2 Exploratory catch-at-age-based analyses

Catch curves for the catch data are plotted in Figure 23.19 and show numbers-at-age on the log scale linked by cohort. This shows partial recruitment to the fishery up to age 2 for some cohorts. Also evident is the persistence of the 1999- to 2001-year classes in past catches and the recent low catches of the 2002–2011 year classes.

The negative gradients of log catches per cohort, averaged over ages 2–6 are given in Figure 23.20. The gradients appear to be have been decreasing since 1990 and are fluctuating around a mean level for more recent cohorts that is lower than the mean level prior to 1990, suggesting a fishing mortality likely to be lower than in the past for the cohorts 2000 to 2010. For the 2000 cohort the negative gradient of commercial catch data was lowest in the series (similar to 2010 cohort). Slopes for the catch curves were less steep for this cohort, indicating relatively higher CPUE at higher ages. However, for the last 3 cohorts (2011, 2012 and 2013), a strong and continuous increase in the gradient can be observed which suggests an increase in fishing mortality in recent years.

Within cohort correlations between ages are presented in Figure 23.21. In general, catch numbers correlate well between cohorts with the relationship breaking down as cohorts are compared across increasing age gaps. Correlation were negative comparing age groups up to age 4 to ages 8+. This is due to the increased catches of older fish over the years and decreasing trends for younger age groups (Figure 23.19).

23.7.3 Conclusions drawn from exploratory analyses

Catch curve analysis and correlation plots show that in general both surveys and catch data track cohorts well and are internally consistent (Figures 23.12–14, 23.19–21). However, beginning with the 2006-year class, the IBTS Q1 appears to be underestimating the abundance of age 1 whiting in some years (Figure 23.12). In previous assessments, this had implications for the estimation of recruitment and can result in a considerable retrospective bias in recruitment.

23.7.4 Final assessment

The final assessment used SAM (stockassessment.org) fitted to the combined landings, discards and industrial bycatch data for the period and two survey tuning indices. The used time range for input data for SAM was agreed at WKNSEA and is detailed in the stock annex (ICES, 2018a). The assessment model, including input data, results and diagnostics can be found on www.stockassessment.org as "NSwhiting_2021".

The settings as given by the configuration file decided during the benchmark are provided below (further details can be found in the Stock Annex).

```
Catch-at-age data                                   1978-2019      ages 0-8+
Survey: IBTS Q1                                     1983-2020      ages 1-5
Survey: IBTS Q3                                     1991-2019      ages 0-5

$minAge
 0
$maxAge
 8
$maxAgePlusGroup
 1
$keyLogFsta
   0   1   2   3   4   5   6   7   7
  -1  -1  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1  -1  -1
$corFlag
2
$keyLogFpar
  -1  -1  -1  -1  -1  -1  -1  -1  -1
  -1   0   1   2   3   3  -1  -1  -1
   4   5   6   7   8   8  -1  -1  -1
$keyQpow
```

```
  -1  -1  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1  -1  -1
$keyVarF
   0   0   0   0   0   0   0   0   0
  -1  -1  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1  -1  -1
$keyVarLogN
 0 1 1 1 1 1 1 1 1
$keyVarObs
   0   1   1   1   1   1   1   1   1
  -1   2   2   2   2   2  -1  -1  -1
   3   3   3   3   3   3  -1  -1  -1
$obsCorStruct
 "ID" "AR" "AR"
$keyCorObs
  NA  NA  NA  NA  NA  NA  NA  NA
  -1   0   1   1   1  -1  -1  -1
   2   2   3   3   3  -1  -1  -1
$stockRecruitmentModelCode
 0
$noScaledYears
 0
$keyScaledYears
$keyParScaledYA
$fbarRange
 2 6
$keyBiomassTreat
 -1 -1 -1
$obsLikelihoodFlag
 "LN" "LN" "LN"
$fixVarToWeight
 0
```

The results of the final assessment run are illustrated in Figure 23.22.

Fishing mortality estimates at age from final SAM run are presented in Table 23.17. Estimated stock numbers at age are given in Table 23.18. The assessment summaries are presented in Table 23.19 for recruitment, SSB, mean F, and TSB including upper and lower ranges. Catch biomass with lower and upper range as estimated in SAM are given in Table 23.20.

Estimated correlations are illustrated in Figure 23.23. The correlations reflect SAM settings of autocorrelations and parameter coupling, assuming independence in the catch fleet and correlation between ages in each survey fleet coupled for ages 2+.

The joint–sample residuals for the unobserved processes (stock size N and fishing mortality F) show no apparent cohort effects across ages, although in the final year the residuals (for log(N)) are quite large with some tendency for a year effect (Figure 23.24).

Standardized one-observation–ahead residuals are presented in Figure 23.25. These show that the IBTS–Q3 survey fits more closely to the model than the IBTS–Q1 survey, which demonstrate some year effects in the 2000s and towards the end of the time series. This indicates that the model is effectively paying less attention to the Q1 survey than to the Q3 survey, and this is visible in Figures 23.27 and 28 which show the comparison of predicted and observed points for each survey fleet. The single fleet SAM runs were conducted to compare trends in the catch data with using only survey data for quarter 1 or 3 separately. The leave-one-out runs show that both surveys used were in agreement. Summary plots of these runs together with the final run are presented in Figure 23.29. The population trends from each survey are consistent. The mean F estimates are consistent across the time series with only some difference in most recent year's estimates. Estimates of SSB is in some years lower and recruitment dynamics are less pronounced when using only IBTS Q1 data in the model. The run using only quarter 3 matches more closely the final SAM run with both surveys included, in particular for recruitment, because only IBTS Q3 survey delivers indices for age 0.

A retrospective analysis is shown in Figure 23.30. The retrospective patterns show that results were robust to removing up to 3 years of recent data, but when removing 4 years two of the peels ended outside the confidence intervals for SSB and recruitment. Despite some retrospective bias

in recruitment and SSB, there is very low retrospective bias in catches and fishing mortality. Mohn's rho measures the retrospective bias, values are given in Table 23.21 and confirm the relatively higher retrospective bias in recruitment and SSB, although Mohn's Rho values are below the acceptable threshold of 0.2 set by WKFORBIAS (ICES, 2020a). Retrospective peels are generally covered by the confidence interval, apart from two peels for both SSB and recruitment.

Final SAM run model parameters are given in Table 23.22.

The spawning stock recruitment relationship shows no apparent pattern, confirming that the assumed random walk in recruitment in the model is appropriate (Figure 23.31).

Finally, Figure 23.32 compares the SURBAR results with the final SAM assessment. Dynamics in SAM and SURBAR are similar with higher variability in the SSB estimates from SURBAR. The comparison of recruitment (at age 1) shows similar dynamics with more variability in SURBAR results. The mean Z (total mortality, ages 2–4) estimates from SURBAR show higher mortalities since 1990 than SAM and some increase in mortality in recent years, but the trends are similar. The relative constant mortality estimated by SAM in recent years follows the lower variability in SSB from SAM and relatively constant catches, data which are included only in the SAM assessment.

23.8 Historical stock trends

Historical trends for catch, mean F, SSB and recruitment are presented in Figure 23.22. These show that mean F has been declining since 1990 and reached the minimum of time-series in 2020 of 0.185. The SSB was at extremely high levels before 1983 (no survey information included prior 1983). The medium level of 1990 has not been reached since, although the recent increase in SSB indicate that SSB is trending towards this level, with the 2020 SSB estimate being on par with what was observed in the mid-1990s. Recruitment is fluctuating around a recent (post 2001) lower average but is showing an increase in recent years. The levels of high recruitment which occurred between 1998 and 2001 have not been reached since. Recruitment was relatively low in 2017 and 2018, but is estimated to be relatively higher in 2019 and slightly higher still in 2020. In the most recent year, landings, discards and industrial bycatch have also all remained at or around a recent average. The stock–recruitment plot in Figure 23.31 does not show a clear relationship between SSB and subsequent recruitment.

23.9 Biological reference points

The 2013 benchmark meeting (ICES WKROUND, 2013) attempted to calculate F_{MSY} for North Sea whiting, but concluded that this value was inestimable using standard equilibrium considerations and would need to be determined as part of a management strategy evaluation. After the considerable revisions in the 2012 assessment, caused by new estimates of natural mortality, the target F of 0.3 was no longer considered applicable. The management plan was re-evaluated in October 2013 (ICES, 2013) and ICES advised that updating the target F from 0.3 to 0.15 within the management plan. New revisions of natural mortalities were presented at WGSAM 2014. An interbenchmark was performed for whiting in the North Sea and Division 7.d in early 2016 (ICES, 2016). This included Eqsim runs and MSE. A target F of 0.15 together with a TAC constraint of 15% according to the EU–Norway Management Plan may not be sufficient to keep SSB above B_{lim}. It was concluded to use instead the MSY approach with target F of 0.15.

In the WKNSEA 2018 benchmark new data and assessment model were introduced, Eqsim was run to determine new reference points (ICES, 2018a). $F_{p.05}$ was calculated by running Eqsim to ensure that the long-term risk of SSB < B_{lim} of any F used does not exceed 5% when applying the advice rule. Accordingly, F_{MSY} had to be set to $F_{p.05}$ = 0.172.

At WGNSSK 2020, it was recommended to use new survey indices provided by DATRAS for the whiting assessment in 2020 and onwards (see Section 23.5.5). At the benchmark 2018, the reference points B_{lim} = 119 970 and F_{MSY} = 0.172 were set for North Sea whiting and are suggested to remain unchanged (ICES, 2018a). The new indices resulted in minor changes of assessment results, with the level of estimated SSB and F generally remaining the same over the time series. Retrospectives and Mohn's rho indicated that using the complete new survey indices leads to more consistent assessments with lower retro than using a survey series combining old (up to 2019) and new method (Q1 2020) (Annex 9, see ICES (2020b)).

The use of both new and old survey indices would lead to higher but similar F_{MSY} reference points if recalculated using EqSim this year. Even though new survey indices would have led to a slight increase in the reference points even when used with benchmark data, it was not recommended to change the reference points due to the issue of precautionarity. Previous management strategy evaluations indicated that the current F_{MSY} may not be precautionary (WKNSMSE 2018). A further increase in the reference point F_{MSY} by recalculating F_{MSY} with EqSim was therefore not recommended at the time (Annex 9 for more details, see ICES, 2020b).

In April 2021, an interbenchmark was carried out to include new natural mortality estimates from WGSAM (ICES, 2021b). Eqsim was run to determine new reference points, and the reference points previously defined during the 2018 benchmark were updated as a result (ICES, 2021a). The new F_{MSY} value is 0.371 and the new B_{lim} value is 103 560. Current reference points are listed in Table 23.23.

23.10 Short-term forecasts

A short-term forecast was carried out based on the final SAM assessment. SAM survivors from 2020 were used as input population numbers for ages 1 and older in 2021. Recruitment assumptions are detailed in Table 23.24. In the intermediate and following two years the geometric mean of recruitment from 2002–2020 is used.

The exploitation pattern is chosen as the mean exploitation pattern over the most recent three years 2018–2020. The mean exploitation pattern was scaled to the mean F_{2-6} in 2020 for forecasts (Figure 23.33). Partial F at age for each catch component was estimated by splitting the forecast F at age using the mean proportion in the catch of each catch component over the years 2018–2020. The F at age used in the forecast is compared with the F at age estimates for 2018–2020 in Figure 23.33.

Mean weights at age are generally consistent over the recent period but there is variability at several ages (Figure 23.5 and 6). To avoid introducing bias, therefore, the average of estimates of 2018–2020 are used for the purposes of forecasting. The strong trend as observed between 2000 and 2010 is not apparent in the recent three years.

The inputs to the short-term forecast are given in Table 23.25, and results are presented in Table 23.26. As in previous years, the MFDP program was used to carry out the forecasts, accounting for separate fleet for industrial bycatch.

No TAC constraint was applied in the intermediate year since it is not considered that fishing will stop when the TAC is reached.

Assuming mean F_{2021} equal to mean F_{2020} (using the average selectivity over the last 3 historical years) results in human consumption catches in the intermediate year 2021 of 34 753 tonnes from a total catch of 37 295 tonnes, giving an SSB in 2021 of 225 375 tonnes (Table 23.26).

Carrying the same fishing mortality forward into 2022 (the status quo F option, F_{sq}) would result in human consumption catches of 41 681 tonnes out of total catches of 44 890 tonnes, and would result in an SSB of 269 861 tonnes in 2023 (a 2.96% increase in SSB relative to 2022).

Since SSB in 2022 is predicted to be higher than MSY $B_{trigger}$, following the MSY approach allows for applying F_{MSY} leading to an F_{target} of 0.371.

Applying the F_{MSY} of 0.371 in 2022 would generate human consumption catches of 85 460 tonnes out of total catches of 88 426 tonnes, and result in an SSB of 238 600 tonnes in 2023 (a 9% decrease in SSB relative to 2022). In 2023, SSB would be above B_{lim} and MSY Bt_{rigger}. F of 0.371 would cause the TAC (relative to the TAC in 2021) to be changed by +224.9%.

23.11 MSY estimation and medium-term forecasts

No medium-term forecasts or MSY estimation were conducted during the WG meeting.

23.12 Quality of the assessment

Previous meetings of WGNSSK and the benchmark workshop (ICES WKROUND 2009; ICES WKROUND 2013) have concluded that the historical survey data and commercial catch data contain different signals concerning the stock. Analyses by Working Group members and by the ICES Study Group on Stock Identity and Management Units of Whiting (ICES SGSIMUW, 2005) indicate that data since the early to mid–1990s are sufficiently consistent to undertake a catch-at-age analysis calibrated against survey data from 1990. WKNSEA (ICES, 2018a) considered the question of time series length again and concluded that the divergence between survey-based and catch-based analysis are not sufficient to exclude pre-1990 data. Survey data was included since 1983 with standardization of survey design.

Given the spatial structure of the whiting stock and of the fleets exploiting it, it is important to have data that covers all fleets. Considering that age 1 and age 2 whiting make up a large proportion of the total stock biomass, good information of the discarding practices of the major fleets is important.

The survey information for Division 7.d were not available in a form that could be used by WGNSSK. Due to the recent changes in distribution of the stock, tuning information from this area would be extremely useful, and could improve the estimate of recruitment in the most recent year. However, previous analyses of the survey in Division 7.d showed it did not track cohorts well (ICES WKROUND, 2009).

Age distributions and mean weights at age have been estimated for the industrial bycatch from 2006 to 2010. This was due to low sampling levels of the Danish industrial bycatch fisheries. In recent years, no samples of industrial bycatch were available. Age distributions and weights at age were inferred from sampling of landings and discards from other fleets.

In 2017, French samples for quarter 1 and 2 particularly in Subdivision 7.d are sparse due a disruption in the onshore sampling scheme. Therefore, a percentage of data was simulated randomly from previous year's data. This affected about 8% of total catch weight (landings more than discards, in particular TR2 fleet in 7.d).

There have been issues with regard to the age readings of North Sea whiting as compared to other gadoids in the past (Norway as compared to Netherlands and UK (Scotland)). This applies in particular to the age readings used for the IBTS indices. An otholith workshop, WKARWHG2, took place in late 2016, to improve consistency in preparation techniques and readings (ICES, 2016b). This exercise showed an improvement in age reading compared to the same read in the 2015 exchange. A recommendation was made to investigate the quality of age readings further. The historical performance of the assessment is summarized in Figure 23.34. The difference in SSB is due to new benchmark model and input data. SSB is estimated using new, scaled stock weights at age and maturity estimates. As the assessment model operates on numbers at age rather than biomass the new stock weights at age and maturities did not directly affect estimates

of fishing mortality. Since 2018, recruitment is estimated at age 0 instead of age 1 such that previous assessment results are not plotted in Standard graphs. Catch data and natural mortalities were updated. Estimates of fishing mortality remained at a similar level as before. Retrospective bias compared to the 2020 assessment is high, owing to the update of the natural mortality estimates employed.

23.13 Status of the stock

For North Sea whiting, SSB has a generally downwards trend since the start of the assessment time-series. SSB is estimated to be above B_{lim} (Figures 23.22, 23.34). The stock, at the level of the entire North Sea and Eastern Channel, was at an historical low level in the late 2000s (relative to the period since 1978), and the recent increase in SSB is in large part due to relatively improved perception of recruitment in 2007–2010 and 2014–2016. All indications are that fishing mortality has been declining over most of the time-series, currently fluctuating around a low level. Since 2002, fishing mortality has been below $F_{MSY} = 0.371$. While landings have been relatively stable and even decreased slightly in recent years, discards and industrial bycatch increased in recent years slightly. The development of whiting biomass depends on the size of recruitment. Recruitment is varying around a recent mean, but that mean is lower relative to recruitment in the late 1990s. Recruitment in 2014–2016 was above the average of recent years, however recruitment in 2017 2018 was lower. Recruitment in 2019 and 2020 is estimated to be higher still and on par with early 2000s levels. Stock biomass estimated for 2021 increased and is now well above MSY $B_{trigger}$.

23.14 Management considerations

In 1996, 2006, 2012, 2017 and 2018, the whiting stock produced the lowest recruitments in the series (below 13 billion). In recent years and increased proportion of whiting mature already at age 1 and grow quickly at young ages; therefore, an increase in SSB is seen the year immediately after a good recruitment. Managers should consider the age structure of the population as well as the SSB since at low stock sizes short term forecasts are highly sensitive to recruitment assumptions.

Catches of whiting have been declining since 1980 (from 243 570 tonnes in 1979 to 35 123 tonnes in 2020, including discards and industrial bycatch).

Catch rates from localized fleets may not represent trends in the overall North Sea and English Channel. The localized distribution of the stock is known to be resulting in substantial differences in the quota uptake rate. This is likely to result in localized discarding problems that should be monitored carefully.

Whiting are caught in mixed demersal roundfish fisheries, fisheries targeting flatfish, the *Nephrops* fisheries, and the industrial fishery. The current minimum mesh-size in the targeted demersal roundfish fishery in the northern North Sea has resulted in reduced discards from that sector compared with the historical discard rates. Mortality may have increased on younger ages due to increased discarding in recent years as a result of recent changes in fleet dynamics of *Nephrops* fleets and small mesh fisheries in the southern North Sea. The industrial bycatch of whiting in the sprat, Norway pout and sandeel fisheries is dependent on activity in that fishery, which has recently declined after strong reductions in the fisheries. Industrial bycatches are considered low in the forecast.

Catches of whiting in the North Sea are also likely to be affected by the effort reduction seen in the targeted demersal roundfish and flatfish fisheries, although this will in part be offset by increases in the number of vessels switching to small mesh fisheries. It is important to consider both the species-specific assessments of these species for effective management, but also the broader mixed-fisheries context. This is not straight forward when stocks are managed via a

series of single-species management plans that do not incorporate such mixed stocks considerations. WGMIXFISH monitors the consistency of the various single species management plans and TAC advice under current effort schemes, in order to estimate the potential risks of quota over and under shooting for the different stocks, and it was demonstrated that the current basis for whiting advice was not consistent with other single-stock management objectives. It is recommended that the ongoing discussions about the whiting management plan takes into account such mixed-fisheries considerations before implementation.

The stock dynamics of North Sea whiting are largely driven by recruitment and natural mortality. To maximize the benefit for the fishery of this stock, the most significant measure would be to improve selectivity and reduce under-sized catches in those fisheries with high rates of discarding.

BMS landings reported to ICES in 2015–2019 were low. In 2020, whiting was fully under Landings Obligation with a *de minimis* exemption for whiting caught with bottom trawls in ICES Division 4.c. Nevertheless, reported BMS was very low and discarding was still observed in the sampled fleets and are assumed to take place also in unsampled fleets. The amount of reported BMS is expected to increase in the next years as the landing obligation continues to be implemented.

ICES has developed a generic approach to evaluate whether new survey information that becomes available in autumn forms a basis to update the advice. ICES will publish new advice in November 2021 if this is the case for this year.

23.15 SURBAR Northern Southern stock component

Exploratory SURBAR assessments were run for individual components (northern and southern component) using component area-specific DATRAS survey indices provided by ICES (Figure 23.35, Tables 23.27–28) and estimated area-specific maturity ogives (Tables 23.29–30, Figure 23.37). Stock weights at age were assumed to be the same in northern, southern components and combined areas. The stock dynamics for the combined stock were more similar to the northern component and more variable in the southern one. Nevertheless, stock dynamics in northern and southern were comparable (recruitment, SSB in Figure 23.36). The SURBAR analyses indicate that the southern stock component is at a historically high level of SSB and unlikely to be negatively affected by management decisions based on the combined analyses dominated by the northern component.

23.16 Issues for future benchmarks

The stock was benchmarked in 2018, implementing a new assessment model, natural mortality estimates, maturity ogive estimation and stock weights at age estimation. The stock identity issue was revisited and decided to continue with the assessment area previously used (North Sea and Eastern Channel). The discard raising and age allocations method in InterCatch was revised to account for fleet differences (TR1/TR2, seasonal) in discard rate and age distributions. An interbenchmark was performed in 2021 to include new mortality estimates from WGSAM (ICES, 2021b), and reference points were updated accordingly (ICES, 2021a).

23.16.1 Data and assessment

Stock weights at age are estimated each year by scaling the catch-at-weight time series by using the NS-IBTS quarter 1 weights at age (shorter time series). Even though the entire time series of stock weights at age is re-estimated each year, so far historical values did not change. If estimated stock weights at age in the historical time period differ significantly from one year to the next,

the estimation should be reconsidered, i.e. only add newly estimated most recent data point (not an issue this year).

Natural mortality: When new natural mortality estimates (WGSAM) become available these data need to be included and potentially reference points may need to be revised (not an issue this year).

Stock identity: In the last benchmark, stock identity was considered for North Sea whiting distinguishing a northern and a southern stock component. Analysis (see Section 23.1.1) suggest similar dynamics in the northern and southern component with dynamics being dominated by the northern component. At this point in time, a separate assessment is not considered necessary from reviewed literature and SURBAR analyses.

Survey indices: There has been a new French data upload for the historical time series. The use of a delta GAM method to calculate indices should be explored.

SAM assessment: the use of unsmoothed maturity and natural mortality estimates as input for the assessment model, in order to use the new SAM method to estimate missing historical values, should be explored.

23.16.2 Forecast

Forecast continues to be done in MFDP. A SAM forecast is being considered which allows fleet separation (human consumption and industrial bycatch fleet) and stochastic forecast.

23.17 References

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ICES. 2021b. Working Group on Multispecies Assessment Methods (WGSAM; outputs from 2020 meeting). ICES Scientific Reports. 3:10. 231 pp. https://doi.org/10.17895/ices.pub.7695

Table 23.1. Whiting in Subarea 4 and Division 7.d: Whiting in Subarea 4. Nominal landings (in tonnes) as officially reported to ICES, ICES estimates of catch components, and TACs. *Before 2015, the official landings from Denmark are likely to exclude Industrial bycatch.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
belgium.4	1040	913	1030	944	1042	880	843	391	268	529	536
denmark.4	1206	1528	1377	1418	549	368	189	103	46	58	105
faroe.4	26	0	16	7	2	21	0	6	1	1	0
france.4	4951	5188	5115	5502	4735	5963	4704	3526	1908	0	2527
germany.4	692	865	511	441	239	124	187	196	103	176	424
netherlands.4	3273	4028	5390	4799	3864	3640	3388	2539	1941	1795	1884
norway.4	55	103	232	130	79	115	66	75	65	68	33
sweden.4	16	48	22	18	10	1	1	1	0	9	4
uk.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
england.wales.4	2338	2676	2528	2774	2722	2477	2329	2638	2909	2268	1782
scotland.4	27486	31257	30821	31268	28974	27811	23409	22098	16696	17206	17158
total.landings.4	41083	46606	47042	47301	42216	41400	35116	31573	23937	22110	24453
unallocated.landings.4	-1097	396	1832	691	346	850	-434	633	247	-3590	173
ices.landings.4	42180	46210	45210	46610	41870	40550	35550	30940	23690	25700	24280
ices.discards.4	52270	30840	28470	41400	31840	28940	27130	16660	12480	22110	21931
ices.ibc.4	51337	39755	25045	20723	17473	27379	5116	6213	3494	5038	9160
ices.catch.4	145787	116805	98725	108733	91183	96869	67796	53813	39664	52848	55371
tac.4.2a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	30000

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
belgium.4	454	270	248	144	105	93	45	116	162	147	74
denmark.4	105	96	89	62	57	251	78	42	79	158	135
faroe.4	0	17	5	0	0	0	0	0	2	0	0
france.4	3455	3314	2675	1721	1261	2711	3336	3076	2305	2644	2794
germany.4	402	354	334	296	149	252	76	76	124	156	111
netherlands.4	2478	2425	1442	977	805	702	618	656	718	614	514
norway.4	44	47	38	23	16	17	11	92	73	118	28
sweden.4	6	7	10	2	0	2	1	2	4	8	6
uk.4	NA	NA	NA	NA	NA	11632	12110	10391	8853	7845	8892
england.wales.4	1301	1322	680	1209	2560	NA	NA	NA	NA	NA	NA
scotland.4	10589	7756	5734	5057	3441	NA	NA	NA	NA	NA	NA
total.landings.4	18834	15608	11255	9491	8394	15660	16275	14451	12320	11690	12554
unallocated.landings.4	-426	738	805	541	-2286	563	609	972	-124	-1111	-706
ices.landings.4	19260	14870	10450	8950	10680	15097	15666	13479	12444	12801	13260
ices.discards.4	16130	17144	26135	18142	10300	14018	5206	8356	6597	8451	7989
ices.ibc.4	940	7270	2730	1210	890	2190	1240	0	1344	1907	1035
ices.catch.4	36330	39284	39315	28302	21870	31305	22112	21835	20385	23159	22283
tac.4.2.a	29700	41000	16000	16000	28500	23800	23800	17850	15173	12897	14832

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
belgium.4	45	33	46	70	65	71	71	141	211
denmark.4	131	124	160	2375	4727	2804	2026	2357	3606
faroe.4	0	0	0	0	8	1	0	80	25
france.4	1925	942	1884	1131	1232	952	918	890	677
germany.4	25	44	31	73	111	82	99	81	277
netherlands.4	471	495	464	581	644	791	684	853	780
norway.4	94	560	918	1088	1150	993	1025	1102	1674
sweden.4	4	1	2	0	6	11	8	18	28
uk.4	9893	11162	10290	10015	9412	9263	10689	11897	12177
england.wales.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
scotland.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
total.landings.4	12588	13361	13795	15333	17355	14968	15520	17419	19475
unallocated.landings.4	-356	-456	-52	2101	5113	3140	2942	1885	3694
ices.landings.4	12944	13817	13847	13232	12242	11828	12578	15534	15781
ices.discards.4	9307	4608	7016	12265	10413	9799	8026	7581	10034
ices.ibc.4	1117	1654	1623	2097	4551	2635	1658	1864	3132
ices.catch.4	23368	20079	22486	27593	27206	24262	22263	24979	28947
tac.4.2.a	17056	18932	16092	13678	13678	16003	22057	17191	17158

Table 23.2. Whiting in Subarea 4 and Division 7.d: Whiting in Division 7.d. Nominal landings (in tonnes) as officially reported to ICES, ICES estimates of catch components, and TACs.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
belgium.7.d	83	83	66	74	61	68	84	98	53	48	65
france.7.d	0	0	5414	5032	6734	5202	4771	4532	4495	0	5875
netherlands.7.d	0	0	0	0	0	0	1	1	32	6	14
uk.7.d	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
england.wales.7.d	239	292	419	321	293	280	199	147	185	135	118
scotland.7.d	0	0	24	2	0	1	1	1	0	0	0
total.landings.7.d	322	375	5923	5429	7088	5551	5056	4779	4765	189	6072
unallocat.landings.7.d	-3158	-5345	183	219	468	161	106	159	165	-4241	1772
ices.landings.7.d	3480	5720	5740	5210	6620	5390	4950	4620	4600	4430	4300
ices.discards.7.d	3330	4220	4090	2970	3850	3240	3370	3000	3210	3570	4129
ices.catch.7.d	6810	9940	9830	8180	10470	8630	8320	7620	7810	8000	8429
tac.7b.k	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22000

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
belgium.7.d	75	58	67	46	45	73	75	68	71	88	78
france.7.d	6338	5172	6654	5006	4638	3487	3135	2875	6248	5512	4833
netherlands.7.d	67	19	175	132	128	117	118	162	112	275	282
uk.7.d	NA	NA	NA	NA	NA	72	63	87	138	258	271
england.wales.7.d	134	112	109	99	90	NA	NA	NA	NA	NA	NA
scotland..7.d	0	0	0	0	0	NA	NA	NA	NA	NA	NA
total.landings.7.d	6614	5361	7005	5283	4901	3749	3391	3192	6569	6133	5464
unalloc.landings.7.d	814	-439	1295	933	111	306	137	-1279	649	-967	315
ices.landings.7.d	5800	5800	5710	4350	4790	3443	3254	4471	5920	7100	5149
ices.discards.7.d	3109	1356	604	907	2219	2291	1763	1943	2086	4532	3183
ices.catch.7.d	8909	7156	6314	5257	7009	5734	5017	6414	8006	11632	8332
tac.7b.k	21000	31700	31700	27000	21600	19940	19940	19940	16949	14407	16568

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
belgium.7.d	66	95	90	121	146	128	138	144	45
france.7.d	3093	3076	2126	3102	2771	2378	2720	2095	1309
netherlands.7.d	437	650	663	565	556	593	484	603	330
uk.7.d	261	472	345	379	259	358	283	259	287
england.wales.7.d	NA	NA	NA	NA	NA	NA	NA	NA	NA
scotland.7.d	NA	NA	NA	NA	NA	NA	NA	NA	NA
total.landings.7.d	3857	4293	3224	4167	3732	3457	3625	3101	1971
unalloc.landings.7.d	-556	-15	99	190	32	103	143	126	114
ices.landings.7.d	4413	4308	3125	3977	3700	3354	3482	2975	1857
ices.discards.7.d	2389	2186	2709	4627	2313	1550	2562	2499	4195
ices.catch.7.d	6802	6494	5834	8604	6013	4904	6044	5474	6052
tac.7b.k	19053	24500	20668	17742	22778	27500	22213	19184	10863

Table 23.3.a. Whiting in Subarea 4 and Division 7.d: Description of InterCatch raising procedure. SOP.

Catch Category	SOP
BMS landing	1.065
Discards	1.318
Landings (incl. IBC)	1.024
Logbook Registered Discard	NA

Table 23.3.b. Whiting in Subarea 4 and Division 7.d: Description of InterCatch raising procedure using Table 2 of CatchAndSampleData.Tables.txt. Summary of imported and raised data (uploads in weight)

Catch Category	Raised or Imported	CATON tonnes	Percent
BMS landing	Imported_Data	35.92	100
Discards	Raised_Discards	6472	60
Discards	Imported_Data	4297	40
Landings	Imported_Data	21177	100
Logbook Registered Discard	Imported_Data	0	NA

Table 23.3.c. Whiting in Subarea 4 and Division 7.d: Description of InterCatch raising procedure using Table 2 of CatchAndSampleData.Tables.txt. Summary of the imported/raised/sampled or estimated data (uploads in weight).

Catch Category	Raised or Imported	Sampled or estimated distribution	CATON tonnes	Percent
Logbook Registered Discard	Imported_Data	Estimated_Distribution	0	NA
Landings	Imported_Data	Estimated_Distribution	10572	50
Landings	Imported_Data	Sampled_Distribution	10605	50
Discards	Raised_Discards	Estimated_Distribution	6472	60
Discards	Imported_Data	Estimated_Distribution	2481	23
Discards	Imported_Data	Sampled_Distribution	1817	17
BMS landing	Imported_Data	Sampled_Distribution	32.82	91
BMS landing	Imported_Data	Estimated_Distribution	3.101	9

Table 23.3d. Whiting in Subarea 4 and Division 7.d: Description of InterCatch raising procedure using Table 2 of CatchAndSampleData.Tables.txt. Summary of the imported/raised/sampled or estimated data by area (uploads in weight).

Catch Category	Raised or Imported	Sampled or Estimated distribution	Area	CATON tonnes	Percent
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.7.d	0	NA
Landings	Imported_Data	Estimated_Distribution	27.7.d	1143	59
Landings	Imported_Data	Sampled_Distribution	27.7.d	798	41
Discards	Raised_Discards	Estimated_Distribution	27.7.d	2689	87
Discards	Imported_Data	Sampled_Distribution	27.7.d	275.3	9
Discards	Imported_Data	Estimated_Distribution	27.7.d	125.6	4
BMS landing	Imported_Data	Estimated_Distribution	27.7.d	0.052	100
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4.c	0	NA
Landings	Imported_Data	Estimated_Distribution	27.4.c	731.7	100
Discards	Raised_Discards	Estimated_Distribution	27.4.c	1007	99
Discards	Imported_Data	Estimated_Distribution	27.4.c	14.88	1
BMS landing	Imported_Data	Estimated_Distribution	27.4.c	0	NA
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4.b	0	NA
Landings	Imported_Data	Estimated_Distribution	27.4.b	925.7	100
Discards	Raised_Discards	Estimated_Distribution	27.4.b	370.2	98
Discards	Imported_Data	Estimated_Distribution	27.4.b	7.441	2
BMS landing	Imported_Data	Estimated_Distribution	27.4.b	0	NA
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4.a	0	NA
Landings	Imported_Data	Estimated_Distribution	27.4.a	1007	100
Discards	Raised_Discards	Estimated_Distribution	27.4.a	175.9	100
BMS landing	Imported_Data	Estimated_Distribution	27.4.a	0	NA
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4	0	NA
Landings	Imported_Data	Sampled_Distribution	27.4	9807	59
Landings	Imported_Data	Estimated_Distribution	27.4	6765	41
Discards	Imported_Data	Estimated_Distribution	27.4	2333	38

Table 23.4. Whiting in Subarea 4 and Division 7.d: Total catch numbers at age (thousands). Age 8 is a plus-group. Estimated by ICES, input data for SAM. Ages 0–8+ are included in the final assessment. Model input.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	687238	418909	313391	242369	90047	7564	7564	1851	253	11	9	4	0	0	0	0	277
1979	476383	615525	467538	218283	100976	29267	3111	1657	264	35	1	4	0	0	0	0	304
1980	332209	265359	416009	286077	90719	52969	10752	1153	689	58	14	5	1	0	0	0	767
1981	516869	162899	346343	266518	102295	27776	12297	3540	244	45	37	1	0	0	0	0	327
1982	101057	192641	114443	245247	88137	26796	6909	2082	400	53	26	4	1	0	0	0	484
1983	668604	205647	184747	118411	131507	37231	8688	1780	793	101	35	0	0	0	0	0	929
1984	157819	323408	175965	124886	49504	59817	13860	2964	410	182	21	0	0	0	0	0	613
1985	186723	203321	141716	82037	37847	14420	17446	3329	805	89	9	1	0	0	0	0	904
1986	225202	576732	167078	169578	46516	13368	3487	3975	497	71	0	1	0	0	0	0	569
1987	84863	267051	368230	122748	85240	11391	4555	928	930	98	7	0	0	0	0	0	1035
1988	416924	430344	307429	179503	39635	17902	2174	544	59	72	37	0	0	0	0	0	168
1989	87325	331672	173676	191942	78464	14367	5051	517	291	37	6	1	0	0	0	0	335
1990	289174	258102	501373	127967	84147	31102	1933	719	93	16	0	0	0	0	0	0	109
1991	1057999	135797	194921	184960	36290	25554	5339	526	249	17	1	0	0	0	0	0	267
1992	259390	230302	167479	87820	91081	11654	6634	2546	104	7	1	0	0	0	0	0	112
1993	628301	223424	172049	125599	46181	45300	3898	1501	682	56	15	0	0	0	0	0	753
1994	218287	191544	158369	97559	51041	18683	17905	1258	441	73	0	0	0	0	0	0	514
1995	1597900	148169	144023	112416	35649	15061	5117	4472	314	101	54	0	0	0	0	0	469
1996	96515	86318	118910	99644	48304	14087	4638	1282	897	166	24	6	2	0	0	0	1095
1997	19001	60946	80471	84336	41975	18303	3333	1012	305	135	16	0	0	0	0	0	456
1998	72289	92556	50362	43424	36295	17628	6343	1417	306	66	34	0	0	0	0	0	406
1999	76975	189162	95415	45920	33921	18271	7443	2021	565	95	12	0	0	0	0	0	672
2000	1970	82546	129582	63706	23913	16199	8758	4309	969	244	47	3	0	0	0	0	1263
2001	18012	52567	83085	52076	20800	9256	4826	2233	896	246	124	2	0	0	0	0	1268

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2002	135848	51338	62462	84600	34659	8099	2048	1461	621	102	13	9	9	0	0	0	754
2003	60744	83680	111144	55866	41841	14217	2359	473	329	50	16	1	0	0	0	0	396
2004	34210	47966	23009	32557	30400	21755	8342	1352	198	93	12	1	4	0	0	0	308
2005	17622	47805	34626	12204	18146	14931	8979	3041	540	83	29	1	0	0	0	0	653
2006	15673	73908	42199	21651	8642	15077	11822	4618	1300	142	14	0	0	0	0	0	1456
2007	2490	39041	34001	24900	9906	4008	7657	5268	2560	476	82	0	0	0	0	0	3118
2008	5631	62163	28301	22741	13571	4305	1847	3954	2134	631	143	43	0	0	0	0	2951
2009	12139	57412	31004	15181	12782	7432	3380	2153	2601	1801	1967	20	1	0	0	0	6390
2010	3930	33756	33320	25516	9932	7776	6263	2136	4347	1491	1053	30	1	0	3	0	6925
2011	3563	31377	42201	28903	12537	3813	3178	2090	877	472	1293	31	1	0	0	0	2674
2012	3548	53445	32509	18882	14862	6952	2773	1558	1213	624	482	15	37	0	0	0	2371
2013	4341	20378	15548	25362	15593	10812	3343	1048	643	660	292	0	0	0	0	0	1595
2014	6225	29785	14623	17450	19683	11351	4710	2038	1018	641	431	0	0	0	0	0	2090
2015	7705	48349	53345	15714	10220	14163	5068	2086	1210	607	401	4	0	0	0	0	2222
2016	17208	27639	36165	36788	9129	7813	6046	2548	691	694	376	0	0	0	0	0	1761
2017	28724	27355	27315	24442	18432	4176	2421	2683	1349	1165	26	5	0	0	0	0	2545
2018	15656	17302	41274	26023	17040	6786	1437	1013	803	36	163	38	0	0	0	0	1040
2019	4515	29380	24143	39670	17364	7152	3087	1063	554	274	76	0	0	0	0	0	904
2020	27979	39439	30168	30241	20146	6623	2312	636	531	35	1	1	0	0	0	0	568

Table 23.5. Whiting in Subarea 4 and Division 7.d: Landings numbers at age (thousands), as estimated by ICES. Age 8 is a plus-group. Data used to calculate the landing fraction in the model estimates of catches.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	0	14793	99836	155424	76829	6693	7202	1837	253	11	9	4	0	0	0	0	277
1979	8	8488	108548	144343	89093	26584	3011	1617	250	35	1	4	0	0	0	0	290
1980	0	3656	62405	152570	68422	41430	9911	1135	689	58	14	5	1	0	0	0	767
1981	6	4240	69211	104348	78253	23698	12036	3530	244	45	37	1	0	0	0	0	327
1982	0	10890	46703	124656	59393	21376	5664	2058	400	53	26	4	1	0	0	0	484
1983	1	10568	68640	67312	101342	31266	8330	1730	784	101	35	0	0	0	0	0	920
1984	0	14388	62693	99204	41277	51745	12735	2813	410	182	21	0	0	0	0	0	613
1985	1	2288	51194	57049	32340	12974	16361	3238	805	89	9	1	0	0	0	0	904
1986	29	12879	44500	111527	37287	11285	3379	3912	485	71	0	1	0	0	0	0	557
1987	22	11074	72372	70504	73742	10808	4506	928	899	98	7	0	0	0	0	0	1004
1988	0	7462	61360	94163	29147	16556	2158	544	56	72	37	0	0	0	0	0	165
1989	52	8636	28406	77009	44307	9249	3888	420	208	35	6	1	0	0	0	0	250
1990	23	6910	52533	43850	48537	16845	1341	605	91	16	0	0	0	0	0	0	107
1991	410	11565	42525	88974	25738	21261	4581	396	249	17	1	0	0	0	0	0	267
1992	298	9565	44697	47843	59208	9784	6099	1453	99	7	1	0	0	0	0	0	107
1993	720	5957	28935	63383	32819	33741	2932	1339	682	56	15	0	0	0	0	0	753
1994	77	17124	31351	45492	36289	13920	14407	914	366	73	0	0	0	0	0	0	439
1995	277	8829	28027	58046	27775	13652	4911	4359	308	101	54	0	0	0	0	0	463
1996	1015	12517	26611	47125	35828	11861	4396	1103	897	166	24	6	2	0	0	0	1095
1997	608	6511	23436	47717	31503	15615	2931	1010	289	135	15	0	0	0	0	0	439
1998	1202	17071	19828	24860	24473	14579	5395	1204	219	64	16	0	0	0	0	0	299
1999	68	16661	26669	25504	23465	14483	6554	1854	514	61	12	0	0	0	0	0	587
2000	0	15384	31808	28283	14241	11775	6618	3758	862	244	47	3	0	0	0	0	1156
2001	150	12260	28476	27293	17491	8633	4503	2091	877	246	124	2	0	0	0	0	1249

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2002	0	2610	10346	30890	22353	6712	1710	1330	511	99	10	9	9	0	0	0	638
2003	20	403	11613	13990	18974	9513	1861	443	329	50	16	0	0	0	0	0	395
2004	0	3973	2812	9629	13302	11846	4409	747	174	84	12	1	4	0	0	0	275
2005	74	11009	10414	5669	10926	10283	5933	2343	321	78	29	1	0	0	0	0	429
2006	11	11055	11023	8494	5362	12259	10161	4118	1080	105	6	0	0	0	0	0	1191
2007	140	10378	14740	16491	7666	3310	6681	4227	2179	383	77	0	0	0	0	0	2639
2008	0	13234	12334	14120	9106	3564	1519	2505	1481	568	143	43	0	0	0	0	2235
2009	79	3056	17397	11259	10762	6411	3072	1994	2408	1679	1846	19	1	0	0	0	5953
2010	2	1368	8848	15426	6939	6296	3922	1922	1331	1378	979	24	1	0	0	0	3713
2011	32	4524	17621	14180	10021	2811	2303	1741	820	441	1215	30	1	0	0	0	2507
2012	0	2540	10148	11200	11692	6127	2020	1331	902	557	401	14	35	0	0	0	1909
2013	0	1724	7008	15154	11656	9344	2774	937	556	405	232	0	0	0	0	0	1193
2014	1	3211	7422	9439	12082	8031	3221	1673	806	566	329	0	0	0	0	0	1701
2015	136	3022	15736	7802	6584	9232	3800	1617	887	523	358	4	0	0	0	0	1772
2016	0	1405	9098	16279	5922	4187	4104	1747	550	573	312	0	0	0	0	0	1435
2017	0	731	6509	10287	12841	2666	1711	1640	1092	962	23	5	0	0	0	0	2082
2018	0	1264	12061	13819	11797	5389	1159	798	729	33	150	35	0	0	0	0	947
2019	0	2387	6217	21428	13320	6133	2529	963	500	227	69	0	0	0	0	0	796
2020	509	3918	9055	13072	13103	4989	1898	449	447	26	1	1	0	0	0	0	475

Table 23.6. Whiting in Subarea 4 and Division 7.d: Discards numbers at age (thousands), as estimated by ICES. Age 8 is a plus–group. Data used to calculate the discard fraction from the model estimate of catches.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	28587	52684	114965	37682	7154	255	110	0	0	0	0	0	0	0	0	0	0
1979	4577	473830	126724	31601	7322	1263	27	7	0	0	0	0	0	0	0	0	0
1980	3144	103203	250735	88399	14135	10795	786	0	0	0	0	0	0	0	0	0	0
1981	867	50407	96509	57403	7313	1285	149	10	0	0	0	0	0	0	0	0	0
1982	18639	53753	26922	52349	18230	2972	343	22	0	0	0	0	0	0	0	0	0
1983	71016	152488	85318	33325	23442	4309	295	25	9	0	0	0	0	0	0	0	9
1984	16724	200589	82563	16814	4437	4495	1034	151	0	0	0	0	0	0	0	0	0
1985	8497	154232	48791	15117	2985	761	801	65	0	0	0	0	0	0	0	0	0
1986	7966	404604	120492	43479	5242	627	108	63	12	0	0	0	0	0	0	0	12
1987	9978	158531	202154	34824	9776	582	49	0	31	0	0	0	0	0	0	0	31
1988	21321	65021	87197	51135	5877	846	16	0	3	0	0	0	0	0	0	0	3
1989	6898	150598	36712	61442	21267	3276	103	8	12	0	0	0	0	0	0	0	12
1990	147764	83152	241924	33084	23009	11665	246	85	0	0	0	0	0	0	0	0	0
1991	7208	81678	82053	75035	5176	1885	91	60	0	0	0	0	0	0	0	0	0
1992	7587	105838	63830	27659	23115	1231	355	1064	2	0	0	0	0	0	0	0	2
1993	48873	128248	104844	51054	9205	10727	521	131	0	0	0	0	0	0	0	0	0
1994	8352	96890	102020	37751	9867	2885	2338	7	0	0	0	0	0	0	0	0	0
1995	33363	53830	81783	50019	7136	1336	206	113	6	0	0	0	0	0	0	0	6
1996	4575	43126	86878	49817	11506	2205	240	179	0	0	0	0	0	0	0	0	0
1997	11525	26188	34948	32473	9398	2412	400	2	16	0	1	0	0	0	0	0	17
1998	6098	50703	24200	17053	11076	2987	936	213	87	2	18	0	0	0	0	0	107
1999	14762	96413	56365	15228	9016	3104	862	167	51	34	0	0	0	0	0	0	85
2000	1682	48162	81086	24082	3075	2311	1560	478	107	0	0	0	0	0	0	0	107
2001	17352	39826	52156	23055	2795	471	283	142	19	0	0	0	0	0	0	0	19

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2002	1158	10597	33371	45125	10136	1182	218	131	110	3	3	0	0	0	0	0	116
2003	3584	65829	94497	39301	21654	4314	449	30	0	0	0	1	0	0	0	0	1
2004	10478	31169	15698	21879	16951	9909	3922	605	24	9	0	0	0	0	0	0	33
2005	5499	25753	23486	6041	7192	4616	2992	688	211	5	0	0	0	0	0	0	216
2006	15662	51961	25906	10935	2474	2595	1598	493	219	37	8	0	0	0	0	0	264
2007	2350	22508	16283	7153	1784	572	940	1037	380	93	5	0	0	0	0	0	478
2008	5631	48929	15967	8621	4465	741	328	1449	653	63	0	0	0	0	0	0	716
2009	11540	51883	12179	3192	1382	653	139	52	64	32	24	0	0	0	0	0	120
2010	3701	30464	22610	8713	2444	1038	1988	99	2775	34	18	4	0	0	3	0	2834
2011	3430	25925	23211	13753	2053	862	760	272	24	13	29	0	0	0	0	0	66
2012	3471	49677	21362	6943	2497	493	633	154	259	37	59	0	0	0	0	0	355
2013	4149	17715	7711	8710	2899	693	343	40	44	217	43	0	0	0	0	0	304
2014	5943	25159	6425	7025	6438	2597	1193	239	155	38	79	0	0	0	0	0	272
2015	7249	43271	34943	6950	2940	3947	888	313	238	39	13	0	0	0	0	0	290
2016	14941	22682	22342	15500	1889	2536	1075	432	42	23	11	0	0	0	0	0	76
2017	26493	24515	18650	11973	3735	1111	476	804	129	100	0	0	0	0	0	0	229
2018	14985	15331	27274	10665	4071	914	172	145	13	1	0	0	0	0	0	0	14
2019	4130	25433	16810	15830	2913	453	342	18	21	34	0	0	0	0	0	0	55
2020	26180	33498	18836	14421	4744	805	107	110	11	5	0	0	0	0	0	0	16

Table 23.7. Whiting in Subarea 4 and Division 7.d: Industrial bycatch numbers at age (thousands), as estimated by ICES. Data used to calculate the IBC fraction in the model estimates of catches.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	658651	351432	98590	49263	6064	616	252	14	0	0	0	0	0	0	0	0	0
1979	471798	133207	232266	42339	4561	1420	73	33	14	0	0	0	0	0	0	0	14
1980	329065	158500	102869	45108	8162	744	55	18	0	0	0	0	0	0	0	0	0
1981	515996	108252	180623	104767	16729	2793	112	0	0	0	0	0	0	0	0	0	0
1982	82418	127998	40818	68242	10514	2448	902	2	0	0	0	0	0	0	0	0	0
1983	597587	42591	30789	17774	6723	1656	63	25	0	0	0	0	0	0	0	0	0
1984	141095	108431	30709	8868	3790	3577	91	0	0	0	0	0	0	0	0	0	0
1985	178225	46801	41731	9871	2522	685	284	26	0	0	0	0	0	0	0	0	0
1986	217207	159249	2086	14572	3987	1456	0	0	0	0	0	0	0	0	0	0	0
1987	74863	97446	93704	17420	1722	1	0	0	0	0	0	0	0	0	0	0	0
1988	395603	357861	158872	34205	4611	500	0	0	0	0	0	0	0	0	0	0	0
1989	80375	172438	108558	53491	12890	1842	1060	89	71	2	0	0	0	0	0	0	73
1990	141387	168040	206916	51033	12601	2592	346	29	2	0	0	0	0	0	0	0	2
1991	1050381	42554	70343	20951	5376	2408	667	70	0	0	0	0	0	0	0	0	0
1992	251505	114899	58952	12318	8758	639	180	29	3	0	0	0	0	0	0	0	3
1993	578708	89219	38270	11162	4157	832	445	31	0	0	0	0	0	0	0	0	0
1994	209858	77530	24998	14316	4885	1878	1160	337	75	0	0	0	0	0	0	0	75
1995	1564260	85510	34213	4351	738	73	0	0	0	0	0	0	0	0	0	0	0
1996	90925	30675	5421	2702	970	21	2	0	0	0	0	0	0	0	0	0	0
1997	6868	28247	22087	4146	1074	276	2	0	0	0	0	0	0	0	0	0	0
1998	64989	24782	6334	1511	746	62	12	0	0	0	0	0	0	0	0	0	0
1999	62145	76088	12381	5188	1440	684	27	0	0	0	0	0	0	0	0	0	0
2000	288	19000	16688	11341	6597	2113	580	73	0	0	0	0	0	0	0	0	0
2001	510	481	2453	1728	514	152	40	0	0	0	0	0	0	0	0	0	0
2002	134690	38131	18745	8585	2170	205	120	0	0	0	0	0	0	0	0	0	0

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2003	57140	17448	5034	2575	1213	390	49	0	0	0	0	0	0	0	0	0	0
2004	23732	12824	4499	1049	147	0	11	0	0	0	0	0	0	0	0	0	0
2005	12049	11043	726	494	28	32	54	10	8	0	0	0	0	0	0	0	8
2006	0	10892	5270	2222	806	223	63	7	1	0	0	0	0	0	0	0	1
2007	0	6155	2978	1256	456	126	36	4	1	0	0	0	0	0	0	0	1
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	520	2473	1428	730	638	368	169	107	129	90	97	1	0	0	0	0	317
2010	227	1924	1862	1377	549	442	353	115	241	79	56	2	0	0	0	0	378
2011	101	928	1369	970	463	140	115	77	33	18	49	1	0	0	0	0	101
2012	77	1228	999	739	673	332	120	73	52	30	22	1	2	0	0	0	107
2013	192	939	829	1498	1038	775	226	71	43	38	17	0	0	0	0	0	98
2014	281	1415	776	986	1163	723	296	126	57	37	23	0	0	0	0	0	117
2015	320	2056	2666	962	696	984	380	156	85	45	30	0	0	0	0	0	160
2016	2267	3552	4725	5009	1318	1090	867	369	99	98	53	0	0	0	0	0	250
2017	2231	2109	2156	2182	1856	399	234	239	128	103	3	0	0	0	0	0	234
2018	671	707	1939	1539	1172	483	106	70	61	2	13	3	0	0	0	0	79
2019	385	1560	1116	2411	1131	565	216	82	34	12	7	0	0	0	0	0	53
2020	1290	2023	2277	2748	2299	830	306	77	72	4	0	0	0	0	0	0	76

Table 23.8. Whiting in Subarea 4 and Division 7.d: Total catch mean weights at age (kg), as estimated by ICES. Age 8 is a plus-group. Ages 0–8+ and years 1978–2020 are included in the final assessment. Model input.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	0.010	0.074	0.182	0.234	0.321	0.428	0.428	0.466	0.615	0.702	1.539	0.589	0.000	0.000	0.000	0.000	0.648
1979	0.009	0.098	0.167	0.259	0.301	0.411	0.455	0.492	0.578	0.617	0.737	0.515	0.000	0.000	0.000	0.000	0.582
1980	0.013	0.075	0.176	0.252	0.328	0.337	0.457	0.459	0.568	0.539	0.790	0.688	1.711	0.000	0.000	0.000	0.572
1981	0.011	0.083	0.168	0.242	0.322	0.379	0.411	0.444	0.651	0.833	1.041	0.695	0.000	0.000	0.000	0.000	0.720
1982	0.029	0.061	0.184	0.253	0.314	0.376	0.478	0.504	0.702	0.772	1.141	0.853	1.081	0.000	0.000	0.000	0.735
1983	0.015	0.107	0.191	0.273	0.325	0.384	0.426	0.452	0.520	0.677	0.516	0.000	0.000	0.000	0.000	0.000	0.537
1984	0.020	0.089	0.189	0.271	0.337	0.381	0.390	0.462	0.575	0.514	0.871	0.000	0.000	0.000	0.000	0.000	0.567
1985	0.014	0.094	0.192	0.284	0.332	0.401	0.435	0.494	0.426	0.507	0.852	0.976	0.000	0.000	0.000	0.000	0.439
1986	0.015	0.105	0.183	0.255	0.318	0.378	0.475	0.468	0.540	1.226	0.990	0.535	0.000	0.000	0.000	0.000	0.626
1987	0.013	0.077	0.148	0.247	0.297	0.375	0.380	0.542	0.555	0.857	0.603	1.193	0.000	0.000	0.000	0.000	0.584
1988	0.013	0.054	0.146	0.223	0.301	0.346	0.424	0.506	0.856	0.585	0.648	0.000	0.000	0.000	0.000	0.000	0.694
1989	0.023	0.070	0.157	0.225	0.267	0.318	0.391	0.431	0.370	0.515	0.857	0.609	0.000	0.000	0.000	0.000	0.395
1990	0.016	0.084	0.137	0.210	0.252	0.279	0.411	0.498	0.636	0.351	0.918	0.000	0.000	0.000	0.000	0.000	0.594
1991	0.018	0.104	0.168	0.217	0.289	0.306	0.339	0.365	0.385	0.589	0.996	2.756	0.000	0.000	0.000	0.000	0.400
1992	0.013	0.085	0.185	0.257	0.277	0.331	0.346	0.313	0.481	0.763	1.728	0.000	0.000	0.000	0.000	0.000	0.510
1993	0.012	0.073	0.174	0.250	0.316	0.328	0.346	0.400	0.376	0.417	0.359	0.000	0.000	0.000	0.000	0.000	0.379
1994	0.013	0.084	0.167	0.255	0.328	0.382	0.376	0.419	0.438	0.392	0.499	0.000	0.000	0.000	0.000	0.000	0.431
1995	0.010	0.089	0.180	0.257	0.340	0.384	0.429	0.434	0.445	0.346	0.406	0.000	0.000	0.000	0.000	0.000	0.419
1996	0.018	0.094	0.167	0.235	0.302	0.388	0.407	0.431	0.439	0.404	0.376	0.398	0.287	0.000	0.000	0.000	0.432
1997	0.028	0.096	0.178	0.242	0.295	0.334	0.384	0.386	0.394	0.479	0.458	0.000	0.000	0.000	0.000	0.000	0.421
1998	0.018	0.090	0.179	0.236	0.281	0.314	0.340	0.333	0.335	0.494	0.434	0.600	0.000	0.000	0.000	0.000	0.369
1999	0.023	0.078	0.174	0.232	0.256	0.289	0.305	0.311	0.286	0.315	0.344	0.000	0.000	0.000	0.000	0.000	0.292
2000	0.034	0.117	0.182	0.238	0.287	0.286	0.276	0.275	0.268	0.264	0.280	0.321	0.000	0.000	0.000	0.000	0.268
2001	0.024	0.101	0.192	0.244	0.282	0.267	0.298	0.284	0.286	0.301	0.315	0.505	0.000	0.000	0.000	0.000	0.292

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2002	0.010	0.069	0.155	0.218	0.273	0.303	0.350	0.343	0.327	0.411	0.289	0.231	0.304	0.643	0.000	0.000	0.336
2003	0.012	0.057	0.118	0.193	0.259	0.299	0.354	0.385	0.342	0.462	0.620	0.000	0.000	0.000	0.000	0.000	0.368
2004	0.031	0.111	0.150	0.213	0.253	0.286	0.285	0.286	0.346	0.351	0.352	1.463	0.337	0.000	0.000	0.000	0.351
2005	0.032	0.124	0.199	0.239	0.250	0.282	0.305	0.298	0.271	0.376	0.316	0.337	0.670	0.000	0.000	0.000	0.286
2006	0.093	0.131	0.180	0.231	0.274	0.288	0.360	0.345	0.318	0.299	0.289	0.000	0.000	0.000	0.000	0.000	0.316
2007	0.059	0.098	0.206	0.257	0.325	0.345	0.309	0.309	0.325	0.288	0.328	0.000	0.000	0.000	0.000	0.000	0.320
2008	0.027	0.104	0.218	0.282	0.315	0.402	0.407	0.317	0.359	0.337	0.334	0.433	0.000	0.000	0.000	0.000	0.354
2009	0.042	0.091	0.213	0.286	0.370	0.374	0.373	0.344	0.351	0.335	0.330	0.350	0.419	0.000	0.000	0.000	0.340
2010	0.049	0.111	0.234	0.373	0.406	0.456	0.355	0.459	0.272	0.475	0.471	0.399	0.259	0.000	0.368	0.000	0.346
2011	0.048	0.114	0.214	0.298	0.374	0.415	0.424	0.364	0.341	0.372	0.320	0.550	0.894	0.000	0.000	0.000	0.339
2012	0.038	0.105	0.195	0.311	0.445	0.411	0.430	0.428	0.366	0.418	0.406	0.552	0.733	0.000	0.000	0.000	0.395
2013	0.028	0.110	0.222	0.273	0.390	0.468	0.496	0.465	0.424	0.340	0.406	0.000	0.000	0.000	0.000	0.000	0.386
2014	0.055	0.137	0.227	0.294	0.331	0.442	0.465	0.469	0.403	0.403	0.359	1.754	0.000	0.000	0.000	0.000	0.394
2015	0.044	0.125	0.218	0.307	0.368	0.386	0.469	0.464	0.374	0.372	0.400	0.778	0.000	0.000	0.000	0.000	0.379
2016	0.030	0.120	0.210	0.291	0.399	0.389	0.415	0.488	0.452	0.460	0.472	1.293	0.000	0.000	0.000	0.000	0.459
2017	0.026	0.078	0.212	0.320	0.409	0.436	0.487	0.444	0.457	0.419	0.528	0.489	0.000	0.000	0.000	0.000	0.440
2018	0.029	0.108	0.197	0.275	0.373	0.407	0.514	0.458	0.485	0.598	0.448	0.583	0.000	0.000	0.000	0.000	0.487
2019	0.021	0.106	0.204	0.279	0.354	0.42	0.436	0.44	0.368	0.355	0.577	0.736	0	0	0	0	0.382
2020	0.101	0.105	0.242	0.289	0.377	0.429	0.484	0.553	0.411	0.495	0.665	0.564	0	0	0	0	0.417

Table 23.9. Whiting in Subarea 4 and Division 7.d: Landings mean weights at age (kg), as estimated by ICES. Age 8 is a plus-group.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	0.000	0.185	0.233	0.250	0.334	0.426	0.434	0.466	0.615	0.702	1.539	0.589	0.000	0.000	0.000	0.000	0.648
1979	0.113	0.206	0.231	0.277	0.304	0.416	0.456	0.491	0.583	0.617	0.737	0.515	0.000	0.000	0.000	0.000	0.587
1980	0.000	0.204	0.239	0.273	0.335	0.358	0.473	0.457	0.568	0.539	0.790	0.688	1.711	0.000	0.000	0.000	0.572
1981	0.144	0.194	0.242	0.292	0.331	0.378	0.411	0.445	0.651	0.833	1.041	0.695	0.000	0.000	0.000	0.000	0.720
1982	0.000	0.186	0.230	0.282	0.340	0.396	0.461	0.507	0.702	0.772	1.141	0.853	1.081	0.000	0.000	0.000	0.735
1983	0.132	0.199	0.240	0.282	0.332	0.383	0.429	0.452	0.522	0.677	0.516	0.000	0.000	0.000	0.000	0.000	0.539
1984	0.000	0.194	0.231	0.279	0.346	0.391	0.403	0.472	0.575	0.514	0.871	0.000	0.000	0.000	0.000	0.000	0.567
1985	0.137	0.187	0.248	0.307	0.337	0.408	0.443	0.498	0.426	0.507	0.852	0.976	0.000	0.000	0.000	0.000	0.439
1986	0.131	0.189	0.230	0.279	0.327	0.376	0.484	0.472	0.546	1.226	0.990	0.535	0.000	0.000	0.000	0.000	0.633
1987	0.135	0.188	0.226	0.286	0.310	0.381	0.381	0.542	0.564	0.857	0.603	1.193	0.000	0.000	0.000	0.000	0.593
1988	0.117	0.194	0.226	0.256	0.328	0.351	0.425	0.506	0.887	0.585	0.648	0.000	0.000	0.000	0.000	0.000	0.702
1989	0.171	0.178	0.226	0.253	0.288	0.345	0.370	0.440	0.373	0.522	0.857	0.609	0.000	0.000	0.000	0.000	0.406
1990	0.167	0.206	0.222	0.263	0.296	0.337	0.455	0.533	0.640	0.351	0.918	0.000	0.000	0.000	0.000	0.000	0.597
1991	0.139	0.202	0.249	0.252	0.308	0.317	0.349	0.387	0.385	0.589	0.996	2.756	0.000	0.000	0.000	0.000	0.400
1992	0.145	0.194	0.246	0.289	0.306	0.340	0.356	0.383	0.473	0.763	1.728	0.000	0.000	0.000	0.000	0.000	0.504
1993	0.153	0.194	0.248	0.284	0.345	0.358	0.385	0.418	0.376	0.417	0.359	0.000	0.000	0.000	0.000	0.000	0.379
1994	0.132	0.182	0.248	0.297	0.346	0.392	0.382	0.412	0.414	0.392	0.499	0.000	0.000	0.000	0.000	0.000	0.410
1995	0.140	0.171	0.256	0.299	0.367	0.397	0.437	0.437	0.448	0.346	0.406	0.000	0.000	0.000	0.000	0.000	0.421
1996	0.143	0.169	0.222	0.274	0.329	0.408	0.415	0.452	0.439	0.404	0.376	0.398	0.287	0.000	0.000	0.000	0.432
1997	0.149	0.171	0.206	0.260	0.315	0.349	0.401	0.386	0.398	0.479	0.437	0.000	0.000	0.000	0.000	0.000	0.424
1998	0.138	0.164	0.208	0.259	0.304	0.331	0.361	0.348	0.392	0.504	0.603	0.600	0.000	0.000	0.000	0.000	0.427
1999	0.135	0.184	0.237	0.271	0.281	0.303	0.316	0.320	0.292	0.368	0.344	0.000	0.000	0.000	0.000	0.000	0.301
2000	0.000	0.166	0.227	0.272	0.299	0.292	0.313	0.276	0.269	0.264	0.280	0.321	0.000	0.000	0.000	0.000	0.269
2001	0.138	0.160	0.216	0.268	0.285	0.267	0.301	0.288	0.287	0.301	0.315	0.505	0.000	0.000	0.000	0.000	0.293
2002	0.000	0.183	0.214	0.260	0.293	0.313	0.364	0.350	0.325	0.390	0.311	0.231	0.304	0.643	0.000	0.000	0.333

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2003	0.128	0.208	0.228	0.258	0.308	0.311	0.374	0.391	0.342	0.462	0.620	0.000	0.000	0.000	0.000	0.000	0.368
2004	0.000	0.210	0.216	0.242	0.290	0.326	0.330	0.334	0.366	0.351	0.352	1.463	0.337	0.000	0.000	0.000	0.364
2005	0.164	0.205	0.253	0.277	0.270	0.308	0.339	0.313	0.296	0.381	0.316	0.337	0.670	0.000	0.000	0.000	0.313
2006	0.133	0.217	0.254	0.285	0.295	0.298	0.377	0.353	0.334	0.306	0.290	0.000	0.000	0.000	0.000	0.000	0.331
2007	0.202	0.199	0.264	0.280	0.351	0.361	0.319	0.332	0.342	0.318	0.334	0.000	0.000	0.000	0.000	0.000	0.338
2008	0.000	0.223	0.265	0.324	0.356	0.431	0.424	0.359	0.389	0.339	0.334	0.433	0.000	0.000	0.000	0.000	0.374
2009	0.114	0.184	0.239	0.299	0.375	0.376	0.373	0.346	0.349	0.336	0.327	0.350	0.419	0.000	0.000	0.000	0.339
2010	0.069	0.312	0.303	0.424	0.433	0.468	0.413	0.468	0.459	0.478	0.470	0.409	0.259	0.000	0.368	0.000	0.469
2011	0.046	0.194	0.263	0.363	0.397	0.455	0.459	0.367	0.342	0.374	0.322	0.550	0.894	0.000	0.000	0.000	0.341
2012	0.046	0.203	0.236	0.362	0.478	0.420	0.483	0.431	0.376	0.387	0.356	0.552	0.733	0.000	0.000	0.000	0.383
2013	0.038	0.203	0.247	0.295	0.417	0.477	0.515	0.460	0.419	0.413	0.391	0.000	0.000	0.000	0.000	0.000	0.412
2014	0.064	0.194	0.259	0.330	0.363	0.490	0.508	0.457	0.375	0.393	0.358	1.754	0.000	0.000	0.000	0.000	0.378
2015	0.103	0.197	0.253	0.355	0.401	0.428	0.495	0.466	0.406	0.380	0.400	0.778	0.000	0.000	0.000	0.000	0.398
2016	0.050	0.169	0.265	0.339	0.434	0.463	0.448	0.537	0.463	0.466	0.477	1.293	0.000	0.000	0.000	0.000	0.467
2017	0.035	0.146	0.249	0.394	0.434	0.493	0.552	0.498	0.465	0.432	0.528	0.489	0.000	0.000	0.000	0.000	0.451
2018	0.035	0.171	0.239	0.318	0.416	0.427	0.529	0.480	0.488	0.607	0.448	0.583	0.000	0.000	0.000	0.000	0.489
2019	0.033	0.194	0.269	0.324	0.375	0.429	0.458	0.438	0.373	0.351	0.577	0.736	0	0	0	0	0.384
2020	0.141	0.214	0.332	0.36	0.419	0.447	0.495	0.609	0.415	0.539	0.665	0.564	0	0	0	0	0.423

Table 23.10. Whiting in Subarea 4 and Division 7.d: Discards mean weights at age (kg), as estimated by ICES. Age 8 is a plus-group.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	0.036	0.145	0.158	0.185	0.209	0.222	0.239	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.080	0.104	0.158	0.191	0.189	0.234	0.265	0.295	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.030	0.107	0.166	0.202	0.244	0.253	0.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.071	0.131	0.164	0.197	0.230	0.289	0.252	0.268	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.047	0.091	0.182	0.211	0.225	0.241	0.244	0.261	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.036	0.114	0.167	0.235	0.264	0.290	0.317	0.277	0.365	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.365
1984	0.038	0.101	0.162	0.216	0.246	0.265	0.248	0.278	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.022	0.105	0.169	0.213	0.238	0.242	0.253	0.255	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.028	0.123	0.166	0.190	0.208	0.227	0.194	0.217	0.311	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.311
1987	0.016	0.090	0.149	0.206	0.205	0.263	0.257	0.000	0.292	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292
1988	0.030	0.063	0.146	0.181	0.210	0.219	0.235	0.000	0.284	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.284
1989	0.033	0.083	0.164	0.191	0.213	0.227	0.241	0.351	0.221	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.221
1990	0.024	0.095	0.130	0.183	0.186	0.196	0.249	0.302	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.041	0.089	0.154	0.177	0.213	0.230	0.253	0.268	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.037	0.093	0.173	0.210	0.215	0.241	0.245	0.220	1.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.183
1993	0.023	0.087	0.160	0.205	0.237	0.235	0.225	0.213	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.040	0.090	0.151	0.203	0.230	0.244	0.254	0.332	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1995	0.032	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.290	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.290
1996	0.031	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.031	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.320	0.601	0.773	0.000	0.000	0.000	0.000	0.000	0.347
1998	0.026	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.191	0.180	0.284	0.000	0.000	0.000	0.000	0.000	0.206
1999	0.062	0.100	0.166	0.197	0.201	0.225	0.231	0.212	0.231	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.227
2000	0.033	0.127	0.167	0.195	0.226	0.209	0.219	0.222	0.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.264
2001	0.023	0.084	0.183	0.217	0.259	0.248	0.240	0.225	0.243	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.243
2002	0.039	0.130	0.167	0.196	0.224	0.224	0.225	0.272	0.334	1.120	0.217	0.000	0.000	0.000	0.000	0.000	0.351

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2003	0.048	0.062	0.105	0.170	0.214	0.262	0.257	0.293	0.237	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.079	0.131	0.158	0.203	0.223	0.239	0.235	0.227	0.204	0.351	0.000	0.000	0.000	0.000	0.000	0.000	0.244
2005	0.070	0.124	0.177	0.207	0.221	0.223	0.235	0.245	0.222	0.293	0.000	0.000	0.000	0.000	0.000	0.000	0.224
2006	0.093	0.131	0.161	0.193	0.229	0.233	0.247	0.273	0.239	0.279	0.289	0.000	0.000	0.000	0.000	0.000	0.246
2007	0.050	0.065	0.170	0.214	0.225	0.247	0.237	0.215	0.229	0.166	0.241	0.350	0.000	0.000	0.000	0.000	0.217
2008	0.027	0.072	0.181	0.213	0.230	0.265	0.328	0.244	0.291	0.317	0.057	0.000	0.000	0.000	0.000	0.000	0.293
2009	0.042	0.086	0.177	0.240	0.333	0.360	0.375	0.265	0.426	0.273	0.594	0.000	0.000	0.000	0.000	0.000	0.419
2010	0.049	0.102	0.207	0.283	0.331	0.381	0.242	0.277	0.182	0.362	0.521	0.337	0.000	0.000	0.368	0.000	0.187
2011	0.048	0.100	0.176	0.231	0.264	0.285	0.316	0.346	0.291	0.305	0.251	0.000	0.000	0.000	0.000	0.000	0.276
2012	0.038	0.100	0.175	0.229	0.290	0.296	0.261	0.405	0.333	0.877	0.746	0.000	0.000	0.000	0.000	0.000	0.458
2013	0.028	0.101	0.199	0.236	0.283	0.353	0.346	0.578	0.484	0.205	0.484	0.000	0.000	0.000	0.000	0.000	0.285
2014	0.055	0.130	0.189	0.245	0.270	0.294	0.348	0.556	0.547	0.550	0.361	0.000	0.000	0.000	0.000	0.000	0.493
2015	0.043	0.120	0.202	0.254	0.293	0.289	0.358	0.454	0.253	0.271	0.393	0.000	0.000	0.000	0.000	0.000	0.262
2016	0.030	0.117	0.188	0.241	0.291	0.267	0.287	0.290	0.309	0.305	0.315	0.000	0.000	0.000	0.000	0.000	0.309
2017	0.026	0.076	0.199	0.257	0.322	0.298	0.255	0.335	0.392	0.291	0.362	0.459	0.000	0.000	0.000	0.000	0.348
2018	0.029	0.103	0.178	0.219	0.247	0.292	0.411	0.340	0.316	0.296	0.311	0.369	0.000	0.000	0.000	0.000	0.315
2019	0.021	0.098	0.18	0.219	0.259	0.297	0.27	0.544	0.251	0.384	0	0	0	0	0	0	0.333
2020	0.1	0.092	0.198	0.224	0.259	0.319	0.295	0.325	0.235	0.266	0	0	0	0	0	0	0.245

Table 23.11. Whiting in Subarea 4 and Division 7.d: Industrial bycatch mean weights at age (kg), as estimated by ICES. Age 8 is a plus-group.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	0.009	0.059	0.158	0.220	0.295	0.529	0.351	0.449	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.008	0.069	0.141	0.249	0.428	0.477	0.467	0.605	0.482	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.482
1980	0.013	0.051	0.164	0.281	0.412	0.380	0.389	0.561	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.011	0.056	0.141	0.218	0.318	0.433	0.596	0.600	0.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.025	0.038	0.133	0.232	0.320	0.366	0.674	0.284	0.800	1.000	1.200	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.012	0.058	0.148	0.311	0.431	0.651	0.565	0.602	0.800	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.018	0.053	0.173	0.289	0.343	0.390	0.228	0.600	0.800	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.014	0.054	0.150	0.263	0.382	0.454	0.504	0.584	0.800	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.014	0.054	0.150	0.262	0.381	0.455	0.500	0.600	0.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.012	0.043	0.085	0.173	0.262	0.400	0.500	0.600	0.800	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.012	0.050	0.115	0.197	0.245	0.380	0.500	0.600	0.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.022	0.053	0.137	0.224	0.285	0.344	0.482	0.396	0.385	0.401	0.000	0.000	0.000	0.000	0.000	0.000	0.385
1990	0.007	0.073	0.123	0.181	0.201	0.280	0.355	0.335	0.472	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.472
1991	0.018	0.105	0.136	0.215	0.272	0.265	0.279	0.322	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.012	0.068	0.151	0.235	0.244	0.364	0.219	0.256	0.282	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.282
1993	0.011	0.045	0.156	0.260	0.264	0.307	0.235	0.392	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.012	0.055	0.131	0.259	0.388	0.521	0.555	0.440	0.555	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.555
1995	0.009	0.072	0.160	0.312	0.373	0.511	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1996	0.016	0.064	0.151	0.239	0.233	0.347	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	0.012	0.051	0.145	0.252	0.321	0.348	0.588	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	0.015	0.049	0.115	0.220	0.304	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.013	0.027	0.077	0.144	0.194	0.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.038	0.051	0.166	0.242	0.289	0.339	0.000	0.588	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	0.012	0.055	0.118	0.225	0.320	0.351	0.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	0.010	0.044	0.101	0.185	0.294	0.415	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2003	0.010	0.035	0.102	0.189	0.302	0.418	0.462	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	0.010	0.032	0.083	0.143	0.264	0.000	0.380	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2005	0.014	0.043	0.133	0.196	0.205	0.366	0.438	0.541	0.530	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.530
2006	0.000	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.530
2007	0.000	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.530
2008	0.000	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2009	0.042	0.092	0.213	0.286	0.370	0.374	0.373	0.343	0.351	0.335	0.331	0.350	0.419	0.000	0.000	0.000	0.340
2010	0.049	0.111	0.234	0.373	0.407	0.455	0.355	0.458	0.272	0.475	0.471	0.398	0.259	0.000	0.368	0.000	0.345
2011	0.048	0.114	0.214	0.298	0.374	0.415	0.424	0.364	0.340	0.372	0.320	0.550	0.894	0.000	0.000	0.000	0.338
2012	0.038	0.105	0.194	0.311	0.445	0.411	0.430	0.428	0.366	0.418	0.407	0.552	0.733	0.000	0.000	0.000	0.398
2013	0.028	0.110	0.222	0.273	0.391	0.468	0.496	0.464	0.424	0.341	0.406	0.000	0.000	0.000	0.000	0.000	0.389
2014	0.055	0.137	0.227	0.294	0.331	0.442	0.465	0.469	0.403	0.402	0.359	1.754	0.000	0.000	0.000	0.000	0.394
2015	0.044	0.125	0.218	0.308	0.368	0.386	0.469	0.464	0.374	0.372	0.400	0.778	0.000	0.000	0.000	0.000	0.378
2016	0.030	0.120	0.210	0.291	0.399	0.389	0.415	0.488	0.452	0.460	0.472	1.293	0.000	0.000	0.000	0.000	0.459
2017	0.026	0.078	0.212	0.320	0.409	0.436	0.487	0.444	0.457	0.419	0.526	0.488	0.000	0.000	0.000	0.000	0.441
2018	0.029	0.108	0.196	0.275	0.373	0.407	0.514	0.458	0.485	0.594	0.448	0.583	0.000	0.000	0.000	0.000	0.485
2019	0.021	0.107	0.204	0.279	0.354	0.42	0.435	0.44	0.369	0.355	0.577	0.736	0	0	0	0	0.393
2020	0.101	0.105	0.242	0.289	0.377	0.429	0.484	0.553	0.41	0.494	0.665	0.564	0	0	0	0	0.414

Table 23.12. Whiting in Subarea 4 and Division 7.d: Catch component as estimated by ICES in tonnes, model input. Discards include BMS.

Year	Catch	Landings	Discards	IBC
1978	188222	97553	35382	55287
1979	243570	107231	77391	58948
1980	223361	100775	77003	45584
1981	192119	89583	35894	66641
1982	140250	80576	26620	33055
1983	161316	88002	49562	23753
1984	145636	86275	40483	18878
1985	100330	56059	28961	15310
1986	161494	64019	79523	17953
1987	138737	68317	53901	16519
1988	133215	56100	28146	48969
1989	123533	45103	35787	42643
1990	152602	45662	55603	51337
1991	126742	51929	35058	39755
1992	108555	50946	32564	25045
1993	116911	51818	44370	20723
1994	101650	48486	35692	17473
1995	105494	45938	32176	27379
1996	76123	40503	30505	5116
1997	61435	35563	19660	6213
1998	47475	28288	15693	3494
1999	60845	30130	25677	5038
2000	63806	28583	26063	9160
2001	45242	25061	19237	944
2002	46450	20675	18501	7275
2003	45640	16161	26745	2734
2004	33557	13295	19048	1214
2005	28883	15471	12525	888
2006	36769	18535	16310	1924
2007	26974	18915	6971	1088
2008	28247	17951	10296	0
2009	28430	18403	8684	1344
2010	34436	19846	12683	1907
2011	30668	18461	11173	1035
2012	30221	17407	11697	1117
2013	26573	18211	6795	1654
2014	28375	17027	9725	1623
2015	36287	17299	16891	2097

Year	Catch	Landings	Discards	IBC
2016	33396	16118	12726	4551
2017	29344	15361	11348	2635
2018	28407	16160	10588	1658
2019	30523	18579	10080	1864
2020	35123	17762	14229	3132

Table 23.13. Whiting in Subarea 4 and Division 7.d: Stock weights at age (kg), as estimated from scaled (using IBTS Q1) commercial catch weights at age. Age 8 is a plus-group. Model input.

AGE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
1978	0.003	0.025	0.092	0.161	0.254	0.389	0.410	0.481	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761
1979	0.003	0.033	0.085	0.178	0.238	0.374	0.435	0.508	0.684	0.684	0.684	0.684	0.684	0.684	0.684	0.684	0.684
1980	0.004	0.025	0.089	0.174	0.259	0.306	0.437	0.474	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672	0.672
1981	0.004	0.028	0.085	0.167	0.254	0.345	0.393	0.459	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.846
1982	0.010	0.020	0.093	0.174	0.248	0.342	0.457	0.521	0.864	0.864	0.864	0.864	0.864	0.864	0.864	0.864	0.864
1983	0.005	0.036	0.097	0.188	0.257	0.349	0.408	0.467	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.631
1984	0.007	0.030	0.096	0.187	0.266	0.346	0.373	0.477	0.666	0.666	0.666	0.666	0.666	0.666	0.666	0.666	0.666
1985	0.005	0.031	0.098	0.196	0.262	0.365	0.416	0.510	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516
1986	0.005	0.035	0.093	0.176	0.251	0.344	0.455	0.483	0.736	0.736	0.736	0.736	0.736	0.736	0.736	0.736	0.736
1987	0.004	0.026	0.075	0.170	0.235	0.341	0.364	0.560	0.686	0.686	0.686	0.686	0.686	0.686	0.686	0.686	0.686
1988	0.004	0.018	0.074	0.154	0.238	0.315	0.406	0.523	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.815
1989	0.008	0.023	0.080	0.155	0.211	0.289	0.374	0.445	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464
1990	0.005	0.028	0.070	0.145	0.199	0.254	0.393	0.514	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698
1991	0.006	0.035	0.085	0.150	0.228	0.278	0.324	0.377	0.470	0.470	0.470	0.470	0.470	0.470	0.470	0.470	0.470
1992	0.004	0.028	0.094	0.177	0.219	0.301	0.331	0.323	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599	0.599
1993	0.004	0.024	0.088	0.172	0.250	0.298	0.331	0.413	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445
1994	0.004	0.028	0.085	0.176	0.259	0.347	0.360	0.433	0.506	0.506	0.506	0.506	0.506	0.506	0.506	0.506	0.506
1995	0.003	0.030	0.091	0.177	0.269	0.349	0.411	0.448	0.492	0.492	0.492	0.492	0.492	0.492	0.492	0.492	0.492
1996	0.006	0.031	0.085	0.162	0.239	0.353	0.389	0.445	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508	0.508
1997	0.009	0.032	0.090	0.167	0.233	0.304	0.367	0.399	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.495	0.495
1998	0.006	0.030	0.091	0.163	0.222	0.285	0.325	0.344	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434
1999	0.008	0.026	0.088	0.160	0.202	0.263	0.292	0.321	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343
2000	0.011	0.039	0.092	0.164	0.227	0.260	0.264	0.284	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
2001	0.008	0.034	0.098	0.168	0.223	0.243	0.285	0.293	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343	0.343

AGE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	8+
2002	0.003	0.023	0.079	0.150	0.216	0.275	0.335	0.354	0.395	0.395	0.395	0.395	0.395	0.395	0.395	0.395	0.395
2003	0.004	0.019	0.060	0.133	0.205	0.272	0.339	0.398	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432
2004	0.010	0.037	0.076	0.147	0.200	0.260	0.273	0.295	0.412	0.412	0.412	0.412	0.412	0.412	0.412	0.412	0.412
2005	0.011	0.042	0.101	0.165	0.198	0.256	0.292	0.308	0.336	0.336	0.336	0.336	0.336	0.336	0.336	0.336	0.336
2006	0.031	0.044	0.091	0.159	0.216	0.262	0.345	0.356	0.371	0.371	0.371	0.371	0.371	0.371	0.371	0.371	0.371
2007	0.020	0.033	0.105	0.177	0.257	0.314	0.296	0.319	0.376	0.376	0.376	0.376	0.376	0.376	0.376	0.376	0.376
2008	0.009	0.035	0.111	0.194	0.249	0.365	0.389	0.327	0.416	0.416	0.416	0.416	0.416	0.416	0.416	0.416	0.416
2009	0.014	0.030	0.108	0.197	0.292	0.340	0.357	0.355	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
2010	0.016	0.037	0.119	0.257	0.321	0.415	0.340	0.474	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407
2011	0.016	0.038	0.109	0.205	0.295	0.377	0.406	0.376	0.398	0.398	0.398	0.398	0.398	0.398	0.398	0.398	0.398
2012	0.013	0.035	0.099	0.214	0.352	0.374	0.412	0.442	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464
2013	0.009	0.037	0.113	0.188	0.308	0.425	0.475	0.480	0.454	0.454	0.454	0.454	0.454	0.454	0.454	0.454	0.454
2014	0.018	0.046	0.115	0.203	0.261	0.402	0.445	0.484	0.463	0.463	0.463	0.463	0.463	0.463	0.463	0.463	0.463
2015	0.015	0.042	0.111	0.212	0.291	0.351	0.449	0.479	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445
2016	0.010	0.040	0.107	0.200	0.315	0.354	0.397	0.504	0.539	0.539	0.539	0.539	0.539	0.539	0.539	0.539	0.539
2017	0.009	0.026	0.108	0.220	0.323	0.396	0.466	0.459	0.517	0.517	0.517	0.517	0.517	0.517	0.517	0.517	0.517
2018	0.010	0.036	0.100	0.189	0.295	0.370	0.492	0.473	0.572	0.572	0.572	0.572	0.572	0.572	0.572	0.572	0.572
2019	0.007	0.036	0.104	0.192	0.280	0.382	0.417	0.455	0.449	0.449	0.449	0.449	0.449	0.449	0.449	0.449	0.449
2020	0.034	0.035	0.123	0.199	0.298	0.390	0.463	0.571	0.490	0.490	0.490	0.490	0.490	0.490	0.490	0.490	0.490

Table 23.14. Whiting in Subarea 4 and Division 7.d: Estimated proportion mature at age as used in the assessment. Model input.

Age	0	1	2	3	4	5	6	7	8+
1978	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1979	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1980	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1981	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1982	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1983	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1984	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1985	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1986	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1987	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1988	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1989	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1990	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1991	0.000	0.186	0.838	0.997	1.000	1.000	1.000	1.000	1.000
1992	0.000	0.187	0.829	0.992	1.000	1.000	1.000	1.000	1.000
1993	0.000	0.188	0.820	0.987	1.000	1.000	1.000	1.000	1.000
1994	0.000	0.190	0.810	0.982	0.998	1.000	1.000	1.000	1.000
1995	0.000	0.194	0.800	0.975	0.996	0.999	1.000	1.000	1.000
1996	0.000	0.199	0.788	0.968	0.994	0.998	1.000	1.000	1.000
1997	0.000	0.206	0.776	0.960	0.991	0.998	1.000	1.000	1.000
1998	0.000	0.216	0.764	0.951	0.988	0.997	1.000	1.000	1.000
1999	0.000	0.229	0.750	0.942	0.985	0.997	1.000	1.000	1.000
2000	0.000	0.245	0.738	0.935	0.983	0.996	1.000	1.000	1.000
2001	0.000	0.262	0.730	0.930	0.982	0.996	1.000	1.000	1.000
2002	0.000	0.279	0.728	0.929	0.983	0.996	1.000	1.000	1.000
2003	0.000	0.294	0.731	0.931	0.984	0.997	1.000	1.000	1.000
2004	0.000	0.309	0.739	0.935	0.986	0.998	1.000	1.000	1.000
2005	0.000	0.321	0.750	0.941	0.988	0.998	1.000	1.000	1.000
2006	0.000	0.332	0.763	0.947	0.990	0.999	1.000	1.000	1.000
2007	0.000	0.341	0.778	0.954	0.993	0.999	1.000	1.000	1.000
2008	0.000	0.349	0.792	0.960	0.995	1.000	1.000	1.000	1.000
2009	0.000	0.356	0.805	0.965	0.996	1.000	1.000	1.000	1.000
2010	0.000	0.362	0.816	0.969	0.997	1.000	1.000	1.000	1.000
2011	0.000	0.366	0.825	0.972	0.998	1.000	1.000	1.000	1.000
2012	0.000	0.369	0.831	0.974	0.998	1.000	1.000	1.000	1.000
2013	0.000	0.370	0.834	0.975	0.998	1.000	1.000	1.000	1.000
2014	0.000	0.370	0.836	0.975	0.998	1.000	1.000	1.000	1.000
2015	0.000	0.369	0.836	0.975	0.998	1.000	1.000	1.000	1.000

Age	0	1	2	3	4	5	6	7	8+
2016	0.000	0.366	0.835	0.975	0.997	1.000	1.000	1.000	1.000
2017	0.000	0.360	0.830	0.974	0.997	1.000	1.000	1.000	1.000
2018	0.000	0.352	0.822	0.972	0.997	1.000	1.000	1.000	1.000
2019	0.000	0.341	0.811	0.969	0.996	1.000	1.000	1.000	1.000
2020	0.000	0.328	0.798	0.966	0.995	1.000	1.000	1.000	1.000

Table 23.15. Whiting in Subarea 4 and Division 7.d: Natural mortality at age estimates based on ICES WGSAM (2021b). Model input.

Age	0	1	2	3	4	5	6	7	8+
1978	1.351	1.420	0.833	0.546	0.514	0.454	0.434	0.296	0.243
1979	1.378	1.406	0.814	0.537	0.507	0.450	0.428	0.295	0.244
1980	1.406	1.392	0.795	0.529	0.499	0.446	0.422	0.295	0.245
1981	1.429	1.377	0.776	0.520	0.491	0.442	0.417	0.294	0.246
1982	1.446	1.357	0.756	0.512	0.484	0.437	0.412	0.292	0.247
1983	1.455	1.334	0.736	0.504	0.476	0.433	0.408	0.290	0.248
1984	1.459	1.311	0.715	0.496	0.469	0.430	0.405	0.289	0.249
1985	1.460	1.291	0.695	0.489	0.462	0.427	0.403	0.288	0.251
1986	1.463	1.278	0.676	0.484	0.457	0.425	0.402	0.291	0.254
1987	1.469	1.271	0.660	0.480	0.454	0.424	0.402	0.296	0.257
1988	1.480	1.268	0.645	0.477	0.451	0.424	0.404	0.304	0.261
1989	1.499	1.266	0.633	0.474	0.449	0.425	0.406	0.316	0.265
1990	1.524	1.266	0.623	0.472	0.447	0.426	0.408	0.329	0.269
1991	1.556	1.267	0.615	0.469	0.445	0.426	0.410	0.343	0.274
1992	1.595	1.270	0.610	0.466	0.444	0.425	0.412	0.356	0.279
1993	1.642	1.276	0.607	0.464	0.442	0.425	0.413	0.368	0.285
1994	1.696	1.285	0.606	0.462	0.441	0.424	0.413	0.377	0.292
1995	1.758	1.296	0.606	0.462	0.441	0.424	0.414	0.385	0.302
1996	1.827	1.311	0.608	0.463	0.441	0.424	0.414	0.393	0.314
1997	1.900	1.328	0.609	0.465	0.442	0.424	0.415	0.399	0.329
1998	1.978	1.347	0.612	0.468	0.444	0.425	0.416	0.405	0.346
1999	2.057	1.366	0.616	0.472	0.446	0.427	0.418	0.410	0.362
2000	2.137	1.384	0.622	0.477	0.449	0.429	0.420	0.415	0.378
2001	2.217	1.400	0.630	0.483	0.454	0.432	0.424	0.420	0.392
2002	2.293	1.411	0.639	0.490	0.459	0.436	0.428	0.424	0.405
2003	2.360	1.411	0.648	0.497	0.464	0.440	0.432	0.427	0.416
2004	2.415	1.399	0.656	0.503	0.469	0.444	0.436	0.429	0.425
2005	2.457	1.378	0.661	0.508	0.472	0.446	0.439	0.429	0.432
2006	2.486	1.351	0.663	0.510	0.474	0.447	0.439	0.425	0.435
2007	2.505	1.321	0.662	0.511	0.474	0.447	0.438	0.418	0.436
2008	2.516	1.290	0.659	0.510	0.472	0.446	0.434	0.408	0.433

Age	0	1	2	3	4	5	6	7	8+
2009	2.522	1.258	0.654	0.508	0.470	0.445	0.429	0.394	0.427
2010	2.526	1.229	0.649	0.507	0.468	0.443	0.421	0.378	0.418
2011	2.523	1.204	0.645	0.505	0.466	0.442	0.412	0.362	0.405
2012	2.508	1.184	0.641	0.505	0.466	0.442	0.401	0.345	0.390
2013	2.478	1.169	0.638	0.505	0.466	0.442	0.391	0.328	0.372
2014	2.433	1.158	0.637	0.505	0.467	0.443	0.381	0.314	0.353
2015	2.370	1.152	0.638	0.506	0.467	0.444	0.371	0.302	0.332
2016	2.289	1.150	0.642	0.507	0.468	0.445	0.362	0.294	0.312
2017	2.192	1.151	0.647	0.508	0.468	0.446	0.353	0.288	0.292
2018	2.083	1.151	0.652	0.510	0.469	0.447	0.344	0.283	0.273
2019	1.967	1.151	0.658	0.511	0.469	0.448	0.336	0.278	0.255
2020	1.967	1.151	0.658	0.511	0.469	0.448	0.336	0.278	0.255

Table 23.16a. Whiting in Subarea 4 and Division 7.d: NS IBTS tuning series used in the assessment and forecast; model input.

IBTS–Q1					
Age	1	2	3	4	5
1983	1.265	1.211	1.078	0.765	0.337
1984	4.265	1.645	0.805	0.276	0.267
1985	3.243	3.449	0.617	0.171	0.079
1986	4.511	2.826	2.127	0.349	0.093
1987	6.680	5.395	0.864	0.428	0.060
1988	4.329	8.312	2.998	0.308	0.173
1989	14.246	5.205	3.946	1.033	0.172
1990	5.140	8.397	1.992	0.988	0.201
1991	9.341	7.593	3.660	0.735	0.336
1992	9.984	4.501	2.423	0.748	0.573
1993	10.613	5.507	1.928	0.880	0.392
1994	7.317	5.711	1.922	0.677	0.135
1995	6.563	4.709	2.040	0.643	0.135
1996	4.796	4.686	2.174	0.676	0.351
1997	3.165	2.610	1.598	0.820	0.235
1998	5.107	1.621	1.175	0.484	0.220
1999	6.108	2.638	1.461	0.672	0.274
2000	8.133	4.628	1.857	0.317	0.181
2001	6.462	5.632	2.507	0.723	0.289
2002	5.347	3.505	2.588	0.484	0.124
2003	1.370	2.729	2.468	1.264	0.444
2004	1.874	0.932	1.599	0.778	0.435
2005	1.284	0.753	0.511	0.425	0.287

IBTS–Q1					
Age	**1**	**2**	**3**	**4**	**5**
2006	1.931	1.052	0.476	0.223	0.160
2007	0.638	1.485	0.640	0.217	0.112
2008	2.571	1.993	0.556	0.183	0.095
2009	2.115	2.873	0.681	0.173	0.162
2010	3.379	1.961	1.721	0.515	0.735
2011	1.751	3.521	1.350	0.708	0.188
2012	2.204	5.620	1.001	0.396	0.293
2013	0.525	1.629	2.447	0.670	0.346
2014	2.585	1.873	0.978	0.607	0.337
2015	3.241	2.032	0.510	0.244	0.225
2016	3.510	2.933	0.849	0.241	0.140
2017	5.651	2.333	1.012	0.305	0.111
2018	1.215	2.304	0.736	0.328	0.121
2019	2.175	1.749	1.169	0.442	0.129
2020	5.190	2.023	0.785	0.526	0.164
2021	5.994	7.009	1.139	0.405	0.154

Table 23.16b. Whiting in Subarea 4 and Division 7.d: NS IBTS tuning series used in the assessment and forecast, model input.

IBTS-Q3						
Age	**0**	**1**	**2**	**3**	**4**	**5**
1991	5.065	6.776	1.478	0.858	0.297	0.169
1992	13.232	5.468	2.504	0.709	0.539	0.316
1993	8.781	6.247	1.803	0.426	0.246	0.169
1994	5.687	6.932	2.358	0.494	0.186	0.106
1995	7.035	6.252	2.730	0.712	0.209	0.090
1996	2.832	4.446	3.279	1.267	0.347	0.099
1997	19.735	2.902	1.655	1.192	0.265	0.202
1998	25.563	3.176	1.386	0.539	0.315	0.124
1999	23.860	11.486	1.775	0.521	0.226	0.102
2000	18.681	8.953	3.048	0.582	0.172	0.084
2001	34.265	6.447	2.677	0.845	0.220	0.081
2002	2.566	7.703	2.390	1.275	0.344	0.075
2003	3.481	2.502	2.735	1.193	0.676	0.189
2004	6.800	1.377	0.597	0.629	0.428	0.246
2005	1.639	1.451	0.810	0.314	0.429	0.315
2006	1.894	1.653	0.775	0.287	0.228	0.183
2007	7.773	0.853	0.611	0.336	0.155	0.082
2008	7.281	3.425	0.615	0.294	0.131	0.066

IBTS-Q3						
Age	**0**	**1**	**2**	**3**	**4**	**5**
2009	5.553	5.414	3.361	0.504	0.131	0.089
2010	4.725	2.160	1.336	0.433	0.125	0.123
2011	2.311	4.031	1.360	0.593	0.191	0.082
2012	2.828	2.494	2.097	0.630	0.215	0.146
2013	3.083	0.627	0.575	0.624	0.198	0.072
2014	19.385	2.073	0.908	0.580	0.329	0.097
2015	19.307	2.926	2.093	0.539	0.265	0.176
2016	9.005	2.752	2.226	0.663	0.200	0.089
2017	1.710	8.764	1.926	0.825	0.260	0.114
2018	1.687	2.363	2.842	0.807	0.317	0.210
2019	13.649	4.285	1.461	0.831	0.220	0.150
2020	12.224	14.487	2.086	0.594	0.424	0.346

Table 23.17. Whiting in Subarea 4 and Division 7.d: Final fishing mortality estimates from SAM, model output.

Age	0	1	2	3	4	5	6	7	8+
1978	0.020	0.086	0.278	0.537	0.656	0.756	1.002	1.325	1.325
1979	0.021	0.094	0.300	0.574	0.671	0.761	0.913	1.123	1.123
1980	0.020	0.088	0.291	0.617	0.790	0.956	1.124	1.389	1.389
1981	0.020	0.091	0.279	0.594	0.784	0.984	1.194	1.436	1.436
1982	0.020	0.094	0.254	0.502	0.633	0.786	0.957	1.110	1.110
1983	0.024	0.121	0.319	0.597	0.709	0.842	1.003	1.196	1.196
1984	0.025	0.137	0.358	0.682	0.840	0.971	1.148	1.329	1.329
1985	0.022	0.118	0.295	0.583	0.795	0.989	1.198	1.472	1.472
1986	0.024	0.141	0.355	0.660	0.901	1.051	1.217	1.417	1.417
1987	0.023	0.135	0.376	0.713	0.991	1.243	1.412	1.613	1.613
1988	0.023	0.142	0.369	0.629	0.836	1.066	1.132	1.164	1.164
1989	0.021	0.126	0.359	0.617	0.837	1.212	1.321	1.440	1.440
1990	0.022	0.136	0.409	0.642	0.780	1.022	1.078	1.194	1.194
1991	0.018	0.113	0.346	0.543	0.638	0.846	0.927	1.167	1.167
1992	0.018	0.117	0.340	0.525	0.609	0.758	0.893	1.045	1.045
1993	0.018	0.120	0.355	0.586	0.677	0.799	0.936	1.095	1.095
1994	0.015	0.110	0.329	0.581	0.721	0.858	0.980	1.090	1.090
1995	0.013	0.098	0.294	0.526	0.662	0.825	0.972	1.094	1.094
1996	0.010	0.085	0.263	0.472	0.610	0.766	0.904	1.030	1.030
1997	0.009	0.076	0.236	0.406	0.519	0.617	0.687	0.788	0.788
1998	0.007	0.071	0.218	0.363	0.474	0.564	0.627	0.704	0.704
1999	0.007	0.078	0.254	0.425	0.547	0.640	0.674	0.741	0.741
2000	0.005	0.061	0.225	0.420	0.598	0.776	0.867	0.961	0.961

Age	0	1	2	3	4	5	6	7	8+
2001	0.004	0.047	0.161	0.298	0.462	0.663	0.778	0.889	0.889
2002	0.004	0.052	0.155	0.255	0.363	0.492	0.594	0.687	0.687
2003	0.006	0.081	0.197	0.248	0.297	0.352	0.394	0.432	0.432
2004	0.005	0.073	0.162	0.198	0.238	0.293	0.346	0.372	0.372
2005	0.004	0.075	0.161	0.185	0.206	0.241	0.288	0.318	0.318
2006	0.005	0.090	0.192	0.232	0.239	0.258	0.293	0.309	0.309
2007	0.004	0.080	0.175	0.228	0.236	0.234	0.261	0.287	0.287
2008	0.004	0.075	0.164	0.226	0.237	0.221	0.233	0.256	0.256
2009	0.003	0.066	0.148	0.226	0.267	0.275	0.315	0.352	0.352
2010	0.003	0.058	0.141	0.234	0.297	0.334	0.403	0.448	0.448
2011	0.003	0.056	0.135	0.216	0.265	0.295	0.342	0.368	0.368
2012	0.003	0.061	0.130	0.204	0.267	0.316	0.348	0.355	0.355
2013	0.002	0.050	0.113	0.190	0.261	0.333	0.337	0.329	0.329
2014	0.002	0.047	0.122	0.216	0.294	0.390	0.399	0.395	0.395
2015	0.002	0.051	0.149	0.261	0.333	0.430	0.429	0.427	0.427
2016	0.002	0.040	0.131	0.264	0.345	0.427	0.426	0.424	0.424
2017	0.002	0.031	0.107	0.228	0.317	0.359	0.364	0.387	0.387
2018	0.002	0.028	0.101	0.215	0.284	0.284	0.259	0.249	0.249
2019	0.002	0.029	0.103	0.230	0.289	0.271	0.238	0.206	0.206
2020	0.001	0.025	0.093	0.211	0.249	0.209	0.165	0.127	0.127

Table 23.18. Whiting in Subarea 4 and Division 7.d: Final abundance estimates from SAM, model output.

Age	0	1	2	3	4	5	6	7	8+
1978	40685696	10135429	1856647	783155	224526	19201	13703	2559	407
1979	29725244	10682227	2302890	609966	270452	68797	5931	3218	569
1980	16872504	7534857	2329517	745127	198272	86485	20491	1585	968
1981	15512459	3811087	1923959	766746	230062	53410	20844	4495	479
1982	13682956	3623434	856387	740194	247728	62313	12589	4083	868
1983	17859789	3026042	824499	322827	292046	81696	18093	3084	1280
1984	15453599	4235214	699022	285993	104484	99183	22612	4524	983
1985	24019471	3276047	1017094	234145	86046	27327	26320	4659	1137
1986	21586680	5840793	771173	415862	81247	25292	6335	5522	959
1987	18674788	4910838	1452117	267694	141443	19904	6172	1236	1210
1988	23358277	4056000	1332388	513751	79126	33877	3688	1029	348
1989	16125958	5553425	898937	511036	173432	21738	7668	775	353
1990	14036807	3452284	1486206	331210	177085	51015	3888	1350	192
1991	15476111	2893236	836403	513206	109208	50746	12649	842	353
1992	17444205	3260795	733581	312960	191507	37827	13016	3732	249
1993	16984436	3474216	770903	286900	119489	79583	10064	3205	1042

Age	0	1	2	3	4	5	6	7	8+
1994	15190205	3245816	830585	279168	104589	37647	26640	2493	967
1995	12269889	2827643	792840	320776	99009	31962	10025	6949	812
1996	10244438	2023882	703555	322692	120759	33559	8949	2432	1803
1997	16164421	1560879	484094	298241	124351	45172	9720	2313	1025
1998	25976121	2300418	369646	205336	119939	49649	15664	3281	1016
1999	26831680	3611434	518342	164083	93064	47188	19341	5349	1459
2000	23379703	3366837	774320	208410	63725	34970	16467	6945	2231
2001	23526676	2689760	827301	300099	75939	21754	10494	4474	2368
2002	13420546	2570236	657601	414537	135023	28529	6267	3142	1816
2003	12824947	1306682	632134	328984	200012	61788	10831	2029	1538
2004	14273340	1197301	254060	266521	168761	95134	29246	4883	1432
2005	13621487	1266667	271501	111732	132107	88732	45234	13202	2848
2006	11103414	1254679	307963	118603	57957	69921	48426	21958	7392
2007	16492418	890528	297277	139760	56968	27150	38273	23924	14374
2008	16688831	1399920	236674	127704	69571	28216	13734	20644	18954
2009	15740978	1355192	365065	102053	60108	37216	14719	7615	23163
2010	14995406	1267280	346670	157967	46410	32180	19123	7035	16256
2011	11290558	1247605	366604	159487	72432	21590	14138	8351	10131
2012	8475192	941499	408602	156083	74548	35126	10439	6506	8879
2013	12894319	640183	243716	200150	79910	37252	15693	4855	7432
2014	16988265	1123213	192168	114793	97053	40230	16634	7517	6531
2015	15535141	1467288	364689	92171	53431	45927	17679	7343	6867
2016	16713651	1337227	417956	161007	43944	24302	19046	8108	6548
2017	10381577	1769328	385401	178764	72045	19939	9892	8397	7194
2018	12047844	1125534	542138	179182	82194	32992	8841	4799	6914
2019	20392302	1518853	355548	242050	88598	37977	15166	5096	6338
2020	21546571	2993774	454358	172116	109652	43641	18339	7850	6654

Table 23.19. Whiting in Subarea 4 and Division 7.d: Final SAM summary table. Model output. Units are individuals and tonnes.

Year	R (age 0)	Low	High	SSB	Low	High	F (2–6)	Low	High	TSB	Low	High
1978	40685696	29546563	56024311	386906	337466	443589	0.646	0.558	0.747	757040	659015	869645
1979	29725244	21873198	40396017	431278	378897	490901	0.644	0.563	0.735	839157	726223	969653
1980	16872504	12579090	22631317	425283	372830	485116	0.755	0.665	0.858	688678	604931	784020
1981	15512459	11635856	20680593	370703	325231	422532	0.767	0.675	0.872	542764	480289	613365
1982	13682956	10302114	18173290	299759	263855	340548	0.627	0.547	0.718	507434	448661	573907
1983	17859789	13470623	23679087	260308	232027	292036	0.694	0.61	0.789	452059	402227	508065
1984	15453599	11637221	20521541	206037	184448	230153	0.8	0.706	0.906	423747	373738	480448
1985	24019471	18056916	31950916	193794	171254	219301	0.772	0.681	0.875	407284	356904	464776
1986	21586680	16298756	28590204	206303	182755	232885	0.837	0.741	0.945	494035	430326	567177
1987	18674788	14120885	24697299	203570	179600	230739	0.947	0.841	1.066	406475	358192	461266
1988	23358277	17544018	31099439	205977	181104	234266	0.807	0.712	0.914	384644	339201	436175
1989	16125958	12252942	21223191	209005	185259	235795	0.869	0.77	0.982	451641	397323	513386
1990	14036807	10676400	18454904	202350	179305	228355	0.786	0.693	0.891	374291	331878	422125
1991	15476111	11892267	20139981	198712	176443	223792	0.66	0.579	0.752	385870	342372	434894
1992	17444205	13418199	22678177	188442	168199	211120	0.625	0.546	0.715	352134	313979	394926
1993	16984436	13061636	22085371	179289	160691	200039	0.671	0.589	0.764	329477	294392	368745
1994	15190205	11670293	19771769	173863	155895	193902	0.694	0.609	0.79	328331	292752	368235
1995	12269889	9387893	16036631	174951	156233	195911	0.656	0.574	0.749	300090	267874	336180
1996	10244438	7728233	13579884	156241	139564	174911	0.603	0.525	0.692	283572	252074	319005
1997	16164421	12225838	21371829	139483	124646	156087	0.493	0.427	0.57	343018	295437	398263
1998	25976121	19638008	34359844	119526	107341	133093	0.449	0.387	0.521	340457	290960	398373
1999	26831680	20252384	35548362	119493	106679	133847	0.508	0.44	0.586	412233	347604	488877
2000	23379703	17580250	31092306	147410	130009	167141	0.577	0.496	0.672	534589	446257	640405

Year	R (age 0)	Low	High	SSB	Low	High	F (2–6)	Low	High	TSB	Low	High
2001	23526676	17629583	31396346	156643	135673	180854	0.472	0.397	0.562	438621	368179	522540
2002	13420546	10151042	17743112	152446	132010	176047	0.372	0.306	0.453	259321	226168	297334
2003	12824947	9741900	16883695	137920	119795	158788	0.298	0.244	0.363	221007	193769	252073
2004	14273340	10803764	18857153	132546	115006	152760	0.247	0.202	0.304	319696	271405	376579
2005	13621487	10283663	18042688	121497	105549	139855	0.216	0.176	0.265	311546	262986	369072
2006	11103414	8394158	14687095	115618	101179	132117	0.243	0.201	0.294	506130	411974	621803
2007	16492418	12508263	21745613	105168	92191	119972	0.227	0.188	0.274	458566	372502	564514
2008	16688831	12648928	22019027	109132	96275	123705	0.216	0.18	0.26	298363	252130	353074
2009	15740978	11911612	20801416	113282	99884	128477	0.246	0.206	0.295	369836	306493	446269
2010	14995406	11228779	20025526	134649	117991	153659	0.282	0.233	0.341	419745	346237	508860
2011	11290558	8515571	14969835	124574	108504	143025	0.251	0.206	0.305	344256	287429	412319
2012	8475192	6305955	11390641	129010	111833	148826	0.253	0.207	0.31	265552	224780	313718
2013	12894319	9643492	17241003	121940	105006	141606	0.247	0.2	0.304	263292	220763	314013
2014	16988265	12491228	23104306	115837	99128	135362	0.284	0.228	0.354	465581	368674	587961
2015	15535141	11338423	21285200	121574	101941	144988	0.32	0.251	0.409	396475	315285	498572
2016	16713651	12139349	23011622	125946	103138	153798	0.318	0.24	0.423	336226	268631	420830
2017	10381577	7461287	14444847	132785	106337	165812	0.275	0.198	0.383	260938	210021	324199
2018	12047844	8485333	17106051	138838	109454	176110	0.229	0.161	0.324	292974	230842	371828
2019	20392302	13665200	30431022	144019	111847	185444	0.226	0.159	0.323	331535	252665	435025
2020	21546571	12816023	36224555	177993	134419	235693	0.185	0.128	0.269	990378	648221	1513139

Table 23.20. Whiting in Subarea 4 and Division 7.d: Final summary catch table estimated by SAM, model output. Units: tonnes.

Year	Catch	Low	High
1978	190120	159808	226182
1979	224969	192863	262421
1980	220121	188477	257078
1981	189178	161831	221147
1982	144336	123408	168813
1983	146549	126995	169113
1984	134462	116550	155126
1985	111363	96090	129063
1986	145047	124161	169446
1987	137144	117723	159770
1988	128239	109437	150272
1989	133785	115049	155572
1990	131293	111935	153999
1991	112526	96672	130979
1992	104486	90324	120869
1993	104973	90890	121238
1994	100727	87304	116213
1995	92732	80075	107390
1996	75974	65690	87867
1997	61328	53042	70909
1998	49915	43472	57314
1999	56389	48874	65060
2000	64385	55547	74630
2001	51781	44052	60866
2002	45677	39272	53127
2003	41130	35434	47741
2004	33578	29317	38459
2005	29561	25928	33703
2006	33554	29235	38511
2007	27621	24138	31607
2008	27011	23604	30911
2009	28661	25092	32739
2010	34818	30412	39862
2011	29720	25910	34091
2012	30253	26397	34673
2013	27066	23598	31043
2014	29081	25549	33101
2015	33241	29104	37965

Year	Catch	Low	High
2016	32047	27984	36699
2017	29887	25925	34456
2018	28160	24380	32527
2019	30658	26454	35529
2020	32819	28165	38242

Table 23.21. Whiting in Subarea 4 and Division 7.d: SAM model parameters.

	par	sd(par)	exp(par)	Low	High
logFpar_0	-13.125	0.082	0	0	0
logFpar_1	-12.008	0.079	0	0	0
logFpar_2	-11.919	0.078	0	0	0
logFpar_3	-12.089	0.077	0	0	0
logFpar_4	-13.295	0.1	0	0	0
logFpar_5	-12.228	0.098	0	0	0
logFpar_6	-11.963	0.096	0	0	0
logFpar_7	-12.122	0.095	0	0	0
logFpar_8	-12.157	0.095	0	0	0
logSdLogFsta_0	-1.579	0.128	0.206	0.159	0.266
logSdLogN_0	-1.149	0.16	0.317	0.23	0.437
logSdLogN_1	-2.216	0.179	0.109	0.076	0.156
logSdLogObs_0	0.173	0.125	1.189	0.925	1.528
logSdLogObs_1	-1.669	0.101	0.188	0.154	0.231
logSdLogObs_2	-0.793	0.081	0.452	0.384	0.532
logSdLogObs_3	-0.754	0.085	0.47	0.397	0.557
transfIRARdist_0	-0.346	0.351	0.707	0.35	1.427
transfIRARdist_1	-0.654	0.259	0.52	0.31	0.873
transfIRARdist_2	1.03	0.49	2.8	1.05	7.466
transfIRARdist_3	-0.824	0.31	0.439	0.236	0.816
itrans_rho_0	1.101	0.146	3.006	2.246	4.023

Table 23.22. Whiting in Subarea 4 and Division 7.d: Mohn's rho.

Mohn's rho	
R(age 0)	0.131
SSB	0.1616
Fbar(2-6)	-0.1387

Table 23.23. Whiting in Subarea 4 and Division 7.d: Reference points as determined in the interbenchmark 2021 (ICES, 2021a).

Reference point	value
B_{lim}	103 560 t (B_{loss})
F_{lim}	0.718
B_{pa}	143 905 t (MSY $B_{trigger}$)
F_{pa}	0.385
$F_{p.05}$ (with $B_{trigger}$)	0.385
F_{MSY}	0.371

Table 23.24. Whiting in Subarea 4 and Division 7.d: Recruitment estimates (in millions) as used in the short-term forecast.

Year	Geometric mean of recruitment Time series 2002–2020
2021	14140
2022	14140
2023	14140

Table 23.25. Whiting in Subarea 4 and Division 7.d: Short-term forecast inputs. Forecasted SSB in the intermediate year used average maturities and stock weights at age (2018–2020).

MFDP version 1a						
Run: Run 3						
Time and date: 14:34 27/04/2021						
Fbar age range (Total) : 2-6						
Fbar age range Fleet 1 : 2-6						
Fbar age range Fleet 2 : 2-6						
2021*						
Age	N	M	Mat	PF	PM	SWt
0	14140017	2.00552	0	0	0	0.016862
1	3004698	1.15114	0.3402	0	0	0.035622
2	961254	0.65589	0.8105	0	0	0.108881
3	207670	0.51064	0.9689	0	0	0.193609
4	86543	0.46921	0.9959	0	0	0.29072
5	50683	0.44769	1	0	0	0.380568
6	22633	0.3387	1	0	0	0.457446
7	11116	0.27989	1	0	0	0.499628
8	9778	0.26069	1	0	0	0.503683
Catch						
Age	Sel	CWt	DSel	DCWt		
0	0.00001	0.069667	0.00123	0.05		
1	0.00204	0.193	0.02087	0.097667		
2	0.02454	0.28	0.05722	0.185333		
3	0.09588	0.334	0.08199	0.220667		
4	0.16798	0.403333	0.05113	0.255		
5	0.17671	0.434333	0.02348	0.302667		
6	0.15481	0.494	0.0175	0.325333		
7	0.13259	0.509	0.01839	0.403		
8	0.14516	0.432	0.00574	0.297667		
IBC						
Age	Sel	CWt				
0	0.00008	0.050333				
1	0.00117	0.106333				
2	0.00487	0.214333				
3	0.01344	0.281				
4	0.01975	0.368				
5	0.02024	0.418667				
6	0.01746	0.478				
7	0.0148	0.483667				
8	0.01488	0.428667				
2022						

Age	N	M	Mat	PF	PM	SWt
0	14140017	2.00552	0	0	0	0.016862
1	.	1.15114	0.3402	0	0	0.035622
2	.	0.65589	0.8105	0	0	0.108881
3	.	0.51064	0.9689	0	0	0.193609
4	.	0.46921	0.9959	0	0	0.29072
5	.	0.44769	1	0	0	0.380568
6	.	0.3387	1	0	0	0.457446
7	.	0.27989	1	0	0	0.499628
8	.	0.26069	1	0	0	0.503683

Catch

Age	Sel	CWt	DSel	DCWt
0	0.00001	0.069667	0.00123	0.05
1	0.00204	0.193	0.02087	0.097667
2	0.02454	0.28	0.05722	0.185333
3	0.09588	0.334	0.08199	0.220667
4	0.16798	0.403333	0.05113	0.255
5	0.17671	0.434333	0.02348	0.302667
6	0.15481	0.494	0.0175	0.325333
7	0.13259	0.509	0.01839	0.403
8	0.14516	0.432	0.00574	0.297667

IBC

Age	Sel	CWt
0	0.00008	0.050333
1	0.00117	0.106333
2	0.00487	0.214333
3	0.01344	0.281
4	0.01975	0.368
5	0.02024	0.418667
6	0.01746	0.478
7	0.0148	0.483667
8	0.01488	0.428667

2023

Age	N	M	Mat	PF	PM	SWt
0	14140017	2.00552	0	0	0	0.016862
1	.	1.15114	0.3402	0	0	0.035622
2	.	0.65589	0.8105	0	0	0.108881
3	.	0.51064	0.9689	0	0	0.193609
4	.	0.46921	0.9959	0	0	0.29072
5	.	0.44769	1	0	0	0.380568
6	.	0.3387	1	0	0	0.457446

7	.	0.27989	1	0	0	0.499628
8	.	0.26069	1	0	0	0.503683

Catch

Age	Sel	CWt	DSel	DCWt
0	0.00001	0.069667	0.00123	0.05
1	0.00204	0.193	0.02087	0.097667
2	0.02454	0.28	0.05722	0.185333
3	0.09588	0.334	0.08199	0.220667
4	0.16798	0.403333	0.05113	0.255
5	0.17671	0.434333	0.02348	0.302667
6	0.15481	0.494	0.0175	0.325333
7	0.13259	0.509	0.01839	0.403
8	0.14516	0.432	0.00574	0.297667

IBC

Age	Sel	CWt
0	0.00008	0.050333
1	0.00117	0.106333
2	0.00487	0.214333
3	0.01344	0.281
4	0.01975	0.368
5	0.02024	0.418667
6	0.01746	0.478
7	0.0148	0.483667
8	0.01488	0.428667

Input units are thousands and kg - output in tonnes

Table 23.26. Whiting in Subarea 4 and Division 7.d: MFDP output table for short-term forecasts.

MFDP version 1a; Run: Run3. Time and date: 14:34 27/04/2021; Basis: F(2021) = average exploitation (2018–2020), scaled to F(2020) = 0.185; Fbar age range: 2–6; Recruitment (2021-2023) = 14 140 million (geometric mean 2002–2020); TAC 27.4 (2021) = 21 306.

Output units in tonnes

2021																
			Catch		Landings					Discards			IBC		0.75*Fbar	1.25*Fbar
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	27.4+27.7d HC catch	27.4 HC catch	27.7d HC catch	FBar	Yield	FMult	FBar	Yield	0.139	0.231875
555612	225375	1	0.1855	37295	0.124	19629	34753	28153	6600	0.0463	15124	1	0.0152	2542		

2022															**2023**		**2021 TAC 27.4**	**21306**	
			Catch		**Landings**					**Discards**		**IBC**							
Biomass	**SSB**	**FMult**	**FBar**	**Yield**	**FBar**	**Yield**	**27.4+27.7d HC catch**	**27.4 HC catch**	**27.7d HC catch**	**FBar**	**Yield**	**FMult**	**FBar**	**Yield**	**Biomass**	**SSB**	**27.4 TAC change**	**SSB change**	
567211	262094	0	0.015	3439	0.000	0	0	0	0	0.000	0	1	0.015	3439	598594	299843	-100.0%	14.4%	No HC fishery
.	262094	0.1	0.032	7952	0.012	2762	4538	3676	862	0.005	1776	1	0.015	3414	595222	296534	-82.7%	13.1%	
.	262094	0.2	0.049	12405	0.025	5483	9015	7303	1712	0.009	3532	1	0.015	3390	591902	293277	-65.7%	11.9%	
.	262094	0.3	0.066	16797	0.037	8161	13431	10880	2551	0.014	5270	1	0.015	3366	588633	290070	-48.9%	10.7%	
.	262094	0.4	0.083	21132	0.050	10800	17790	14412	3378	0.019	6990	1	0.015	3342	585414	286913	-32.4%	9.5%	
.	262094	0.5	0.100	25408	0.062	13398	22090	17895	4195	0.023	8692	1	0.015	3318	582245	283806	-16.0%	8.3%	
.	262094	0.6	0.117	29629	0.074	15957	26334	21333	5001	0.028	10377	1	0.015	3295	579124	280746	0.1%	7.1%	
.	262094	0.7	0.134	33792	0.087	18477	30520	24724	5796	0.032	12043	1	0.015	3272	576051	277734	16.0%	6.0%	
.	262094	0.8	0.151	37902	0.099	20960	34653	28072	6581	0.037	13693	1	0.015	3249	573024	274768	31.8%	4.8%	
.	262094	0.9	0.168	41956	0.112	23405	38730	31375	7355	0.042	15325	1	0.015	3226	570044	271848	47.3%	3.7%	
.	262094	1	0.186	45958	0.124	25813	42754	34635	8119	0.046	16941	1	0.015	3204	567109	268973	62.6%	2.6%	Fsq
.	262094	1.1	0.203	49908	0.136	28186	46726	37853	8873	0.051	18540	1	0.015	3182	564218	266142	77.7%	1.5%	

2022																	2023		2021 TAC 27.4	21306
			Catch		Landings					Discards			IBC							
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	27.4+27.7d HC catch	27.4 HC catch	27.7d HC catch	FBar	Yield	FMult	FBar	Yield	Biomass	SSB	27.4 TAC change	SSB change		
.	262094	1.2	0.220	53806	0.149	30523	50646	41028	9618	0.056	20123	1	0.015	3160	561371	263354	92.6%	0.5%		
.	262094	1.3	0.237	57653	0.161	32825	54515	44163	10352	0.060	21690	1	0.015	3138	558567	260609	107.3%	-0.6%		
.	262094	1.4	0.254	61451	0.174	35093	58334	47256	11078	0.065	23241	1	0.015	3117	555805	257906	121.8%	-1.6%		
.	262094	1.5	0.271	65201	0.186	37328	62105	50311	11794	0.069	24777	1	0.015	3096	553084	255243	136.1%	-2.6%		
.	262094	1.6	0.288	68901	0.198	39529	65826	53326	12500	0.074	26297	1	0.015	3075	550405	252622	150.3%	-3.6%		
.	262094	1.7	0.305	72554	0.211	41698	69500	56302	13198	0.079	27802	1	0.015	3054	547765	250040	164.3%	-4.6%		
.	262094	1.8	0.322	76161	0.223	43835	73127	59240	13887	0.083	29292	1	0.015	3034	545165	247497	178.0%	-5.6%		
.	262094	1.9	0.339	79720	0.236	45940	76707	62140	14567	0.088	30767	1	0.015	3013	542603	244993	191.7%	-6.5%		
.	262094	2	0.356	83236	0.248	48015	80243	65005	15238	0.093	32228	1	0.015	2993	540079	242526	205.1%	-7.5%		
.	262094	0.75	0.143	35036	0.093	19159	31772	25738	6033	0.035	12613	1	0.015	3264	575228	276937	20.8%	5.7%		0.75 * Fsq
.	262094	3.88	0.676	159745	0.481	94179	157178	127330	29848	0.179	62999	1	0.015	2567	483806	187388	497.6%	-28.5%		Fmsy SSB(2020)/MSYBtrigger
.	262094	1.25	0.228	54961	0.155	31145	51808	41970	9838	0.058	20663	1	0.015	3153	560622	262629	97.0%	0.2%		1.25 * Fsq
.	262094	0.52	0.103	25672	0.064	13524	22355	18110	4245	0.024	8832	1	0.015	3316	582096	283664	-15.0%	8.2%		15% TAC decrease (27.4)
.	262094	0.71	0.136	33518	0.088	18245	30246	24502	5744	0.033	12001	1	0.015	3273	576342	278028	15.0%	6.1%		15% TAC increase (27.4)
.	262094	0.61	0.120	29595	0.076	15884	26300	21306	4994	0.028	10416	1	0.015	3294	579219	280846	0.0%	7.2%		Rollover TAC
.	262094	1.00	0.185	44890	0.124	25087	41681	33766	7915	0.046	16594	1	0.015	3209	568004	269861	58.5%	3.0%		Fsq
.	262094	2.17	0.385	91703	0.269	53247	88755	71900	16855	0.100	35508	1	0.015	2947	533687	236247	237.5%	-9.9%		Fpa
.	262094	1.73	0.310	74148	0.215	42687	71102	57600	13502	0.080	28415	1	0.015	3046	546556	248852	170.3%	-5.1%		Fp05 without AR
.	262094	4.13	0.718	169645	0.512	100134	167133	135395	31739	0.191	66999	1	0.015	2512	476549	180279	535.5%	-31.2%		Flim
.	262094	5.39	0.933	219997	0.669	130424	217767	176413	41354	0.249	87343	1	0.015	2230	439637	143905	728.0%	-45.0%		Bpa, MSY Btrigger
.	262094	6.80	1.173	276086	0.843	164164	274169	222104	52065	0.314	110004	1	0.015	1917	398519	103560	942.4%	-60.4%		Blim
.	262094	1.63	0.293	70169	0.202	40293	67101	54359	12742	0.075	26808	1	0.015	3068	549473	251709	155.1%	-4.0%		Fmsylower

2022																2023		2021 TAC 27.4	21306
			Catch		Landings					Discards		IBC							
Biomass	SSB	FMult	FBar	Yield	FBar	Yield	27.4+27.7d HC catch	27.4 HC catch	27.7d HC catch	FBar	Yield	FMult	FBar	Yield	Biomass	SSB	27.4 TAC change	SSB change	
.	262094	2.09	0.371	88426	0.259	51276	85460	69231	16229	0.097	34184	1	0.015	2966	536089	238600	224.9%	-9.0%	Fmsy
.	262094	2.17	0.385	91703	0.269	53247	88755	71900	16855	0.100	35508	1	0.015	2947	533687	236247	237.5%	-9.9%	Fmsyupper
.	262094	0.48	0.097	24364	0.060	12737	21040	17045	3996	0.022	8303	1	0.015	3324	583054	284603	-20.0%	8.6%	20% TAC decrease (27.4)
.	262094	0.78	0.148	36134	0.096	19818	32876	26633	6243	0.036	13057	1	0.015	3258	574425	276150	25.0%	5.4%	25% TAC increase (27.4)
.	262094	3.05	0.534	126494	0.378	74176	123741	100242	23498	0.141	49565	1	0.015	2753	508182	211264	370.5%	-19.4%	Fmsylower SSB(2020)/MSYBtrigger
.	262094	1.63	0.293	70169	0.202	40293	67101	54359	12742	0.075	26808	1	0.015	3068	549473	251709	155.1%	-4.0%	Fmsylower

Table 23.27 Whiting in Subarea 4 and Division 7.d: NS IBTS tuning series for northern component used in the area-specific SURBAR analysis.

	Q1	North				Q3	North				
Age	1	2	3	4	5	0	1	2	3	4	5
1983	143.401	154.856	150.829	113.598	50.897						
1984	323.567	212.552	106.415	41.278	40.292						
1985	412.895	341.159	81.823	23.344	11.227						
1986	587.697	385.153	239.606	39.83	12.625						
1987	707.64	788.303	122.369	57.297	8.179						
1988	301.643	1115.424	435.943	44.031	23.551						
1989	2049.504	668.536	580.893	160.983	20.942						
1990	490.822	1251.354	261.582	138.013	29.097						
1991	754.334	999.549	477.884	76.369	31.452	190.132	285.241	124.822	88.607	26.92	13.102
1992	1384.302	545.011	317.356	90.528	78.729	1357.232	615.218	191.926	84.976	65.436	33.848
1993	1529.746	810.122	269.711	122.998	52.18	339.611	578.148	248.966	55.832	30.695	21.417
1994	1058.43	853.101	299.173	105.475	20.999	237.937	712.663	324.467	57.501	16.051	11.43
1995	894.427	651.711	308.658	95.983	19.891	330.847	810.471	360.665	101.783	28.238	12.829
1996	603.663	651.987	314.636	96.581	45.633	83.743	444.379	388.123	165.359	48.308	13.145
1997	445.667	378.412	240.241	117.637	32.536	2750.385	330.418	225.354	161.952	35.658	29.341
1998	744.221	222.632	173.569	73.104	32.244	2484.246	405.455	197.391	75.867	44.141	17.651
1999	858.032	335.233	193.737	96.323	41.596	1723.648	810.794	242.511	74.55	33.258	15.492
2000	1127.728	652.372	272.851	45.871	27.249	1456.711	767.782	342.896	73.195	20.076	11.358
2001	413.843	588.073	343.71	77.607	29.033	291.479	642.804	296.602	111.774	25.051	9.898
2002	513.057	428.163	386.74	72.702	17.767	105.617	603.626	300.637	173.636	46.367	10.344
2003	156.456	311.894	344.993	184.118	64.629	413.41	245.277	326.312	166.634	88.931	24.592
2004	270.146	130.282	237.838	116.137	65.129	211.061	190.845	76.868	90.696	63.2	36.431
2005	160.63	70.445	71.669	61.544	43.237	154.069	195.852	97.403	45.119	64.845	47.659
2006	261.558	86.555	64.824	30.563	22.823	44.878	190.902	104.718	40.801	34.285	27.364

	Q1	North				Q3	North				
Age	1	2	3	4	5	0	1	2	3	4	5
2007	62.938	202.914	93.486	31.871	16.757	346.981	74.776	78.557	48.2	22.754	12.043
2008	198.753	195.499	78.913	27.568	14.458	848.142	334.74	72.776	39.989	18.66	9.79
2009	156.742	239.482	72.965	20.13	20.976	560.618	257.218	134.847	32.409	13.392	10.651
2010	302.33	269.377	239.438	76.001	110.69	70.104	248.174	175.906	57.992	16.82	16.516
2011	185.922	504.592	198.931	105.466	28.249	94.343	411.617	163.839	65.764	23.956	11.099
2012	266.626	796.159	145.62	58.537	44.488	316.803	238.565	268.773	84.896	30.912	21.17
2013	59.098	212.457	350.904	98.115	52.337	141.998	58.759	57.269	79.205	26.334	9.801
2014	367.829	274.711	147.237	91.846	51.213	2017.069	202.053	73.682	48.725	42.318	13.446
2015	423.217	250.756	67.447	34.917	33.132	2113.574	244.567	195.931	55.372	37.056	25.098
2016	263.992	199.177	97.841	31.325	18.422	729.877	318.709	194.394	72.089	26.372	11.006
2017	455.449	241.933	136.348	43.761	15.935	148.347	633.78	210.029	107.555	34.8	16.409
2018	84.998	236.167	92.087	52.645	20.466	204.112	147.061	258.238	97.385	39.992	27.824
2019	268.933	201.402	156.042	63.584	19.824	749.566	375.037	145.446	99.861	28.428	20.008
2020	473.6	186.579	100.513	70.269	21.467	654.4	1011.846	188.023	69.895	43.277	30.275
2021	483.541	830.134	143.297	54.078	21.874						

Table 23.28 Whiting in Subarea 4 and Division 7.d: NS IBTS tuning series for southern component used in the area-specific SURBAR analysis.

	Q1	South				Q3	South				
Age	1	2	3	4	5	0	1	2	3	4	5
1983	85.45	99.851	52.686	19.987	5.019						
1984	593.881	84.243	43.152	4.049	2.825						
1985	114.689	330.4	30.889	11.822	3.018						
1986	155.459	93.19	215.536	54.7	7.664						
1987	542.592	86.81	27.029	26.761	3.098						
1988	487.545	262.104	50.705	6.855	6.541						
1989	291.589	229.438	71.118	4.646	11.552						
1990	470.323	118.887	87.744	32.48	4.558						
1991	1106.472	287.446	151.874	66.871	37.686	958.688	1334.419	170.203	64.644	31.132	22.847
1992	265.104	258.351	117.67	56.676	27.94	1200.775	406.283	311.477	40.846	30.723	26.147
1993	140.264	59.43	62.389	31.774	23.154	1626.475	671.101	63.728	21.692	15.256	9.817
1994	191.711	156.048	25.782	8.463	4.159	951.75	640.529	84.975	43.115	25.091	10.09
1995	222.579	239.969	49.752	19.783	6.47	1219.269	222.51	80.845	7.972	6.656	1.232
1996	231.472	233.724	70.389	33.571	37.795	499.52	417.706	205.879	47.99	11.737	6.928
1997	67.325	43.278	13.87	22.699	10.577	480.258	227.918	35.787	32.328	8.812	2.345
1998	95.505	56.861	23.986	6.323	8.272	2229.932	238.089	36.015	15.326	9.628	3.981
1999	153.527	147.624	127.128	30.833	6.278	2794.07	1724.311	49.323	13.413	4.241	0.809
2000	219.275	151.941	55.605	10.679	3.761	2456.096	1090.356	226.153	30.001	12.365	2.95
2001	942.456	448.546	84.966	70.175	31.13	8867.757	697.026	218.85	36.408	18.91	5.883
2002	457.447	120.386	34.448	13.216	7.754	385.891	989.146	113.49	32.153	12.349	3.461
2003	96.052	216.304	81.629	29.913	8.828	227.231	288.794	171.351	28.265	26.959	8.576
2004	38.818	53.641	34.87	14.43	10.014	1641.775	81.054	65.172	14.855	5.381	3.609
2005	89.895	67.155	22.92	11.112	9.571	208.437	54.154	4.017	2.917	2.161	1.504
2006	48.506	67.392	25.404	10.769	8.899	443.497	74.551	15.069	4.141	3.422	2.752
2007	77.838	58.664	12.349	5.486	3.344	2203.686	142.166	20.52	6.177	1.968	0.942
2008	427.504	247.607	26.007	4.196	2.12	546.391	596.203	54.246	16.16	4.215	0.806
2009	438.147	459.551	74.428	18.35	15.819	634.897	1044.568	664.476	76.08	11.132	6.005
2010	508.82	81.019	64.927	17.96	9.475	914.23	154.524	49.117	12.785	3.941	3.783
2011	465.753	207.833	44.203	12.609	5.268	511.566	444.079	87.814	51.98	10.342	2.203
2012	244.074	196.178	21.112	13.571	10.862	208.426	295.544	101.813	22.997	3.231	1.612
2013	137.181	93.381	52.843	10.687	10.847	772.182	100.621	55.296	26.365	5.548	1.584
2014	1129.913	147.201	35.603	17.16	13.996	1884.952	283.798	169.738	124.258	70.136	15.764
2015	340.564	393.71	134.634	21.941	19.974	1622.776	462.836	309.691	79.912	13.378	5.747
2016	633.544	643.699	111.985	27.244	15.101	1245.384	208.678	157.555	55.207	9.166	6.349
2017	989.077	266.91	52.213	10.761	6.419	229.522	1442.214	199.056	49.837	12.495	3.198
2018	185.133	192.633	47.576	21.585	11.409	111.591	391.478	376.988	65.935	19.927	9.468
2019	152.457	74.143	38.974	21.925	3.684	2247.084	335.335	87.211	68.268	12.984	5.108
2020	531.834	171.636	32.179	24.304	10.195	2381.991	1827.924	242.773	51.621	49.584	51.996
2021	816.285	443.336	66.142	15.374	5.066						

Table 23.29 Whiting in Subarea 4 and Division 7.d: Maturity estimates for northern component used in the area-specific SURBAR analysis. Before 1991 used values of 1991.

Age	0	1	2	3	4	5	6	7	8+
1991	0	0.172	0.82	0.986	1	1	1	1	1
1992	0	0.175	0.817	0.985	1	1	1	1	1
1993	0	0.178	0.813	0.984	1	1	1	1	1
1994	0	0.183	0.807	0.981	0.999	1	1	1	1
1995	0	0.188	0.801	0.978	0.998	0.999	1	1	1
1996	0	0.195	0.793	0.974	0.997	0.999	1	1	1
1997	0	0.204	0.785	0.968	0.995	0.998	1	1	1
1998	0	0.215	0.776	0.962	0.994	0.998	1	1	1
1999	0	0.228	0.766	0.956	0.992	0.998	1	1	1
2000	0	0.244	0.757	0.951	0.991	0.997	1	1	1
2001	0	0.26	0.751	0.947	0.99	0.997	1	1	1
2002	0	0.274	0.751	0.946	0.99	0.998	1	1	1
2003	0	0.287	0.755	0.948	0.991	0.998	1	1	1
2004	0	0.296	0.763	0.951	0.992	0.999	1	1	1
2005	0	0.302	0.774	0.956	0.993	0.999	1	1	1
2006	0	0.305	0.787	0.961	0.994	0.999	1	1	1
2007	0	0.306	0.801	0.967	0.996	1	1	1	1
2008	0	0.306	0.814	0.973	0.997	1	1	1	1
2009	0	0.307	0.825	0.977	0.998	1	1	1	1
2010	0	0.308	0.834	0.98	0.999	1	1	1	1
2011	0	0.309	0.84	0.982	1	1	1	1	1
2012	0	0.309	0.843	0.983	1	1	1	1	1
2013	0	0.308	0.843	0.983	1	1	1	1	1
2014	0	0.306	0.842	0.982	1	1	1	1	1
2015	0	0.303	0.839	0.981	1	1	1	1	1
2016	0	0.3	0.835	0.98	0.999	1	1	1	1
2017	0	0.297	0.828	0.977	0.998	1	1	1	1
2018	0	0.293	0.818	0.974	0.997	1	1	1	1
2019	0	0.288	0.805	0.97	0.996	1	1	1	1
2020	0	0.281	0.791	0.966	0.995	1	1	1	1
2021	0	0.274	0.775	0.961	0.994	1	1	1	1

Table 23.30 Whiting in Subarea 4 and Division 7.d: Maturity estimates for southern component used in the area-specific SURBAR analysis. Before 1991 used values of 1991.

Age	0	1	2	3	4	5	6	7	8+
1991	0	0.297	0.864	0.995	1	1	1	1	1
1992	0	0.297	0.824	0.981	1	1	1	1	1
1993	0	0.293	0.789	0.968	0.999	1	1	1	1
1994	0	0.285	0.762	0.954	0.995	1	1	1	1
1995	0	0.269	0.737	0.938	0.989	0.998	1	1	1
1996	0	0.247	0.709	0.917	0.979	0.992	0.997	0.998	0.999
1997	0	0.228	0.687	0.892	0.963	0.983	0.992	0.996	0.998
1998	0	0.222	0.673	0.865	0.943	0.971	0.985	0.992	0.996
1999	0	0.23	0.653	0.831	0.918	0.957	0.977	0.988	0.994
2000	0	0.25	0.621	0.795	0.893	0.943	0.969	0.985	0.992
2001	0	0.276	0.594	0.773	0.88	0.937	0.965	0.983	0.992
2002	0	0.305	0.584	0.769	0.881	0.939	0.967	0.985	0.993
2003	0	0.337	0.589	0.778	0.889	0.945	0.97	0.987	0.994
2004	0	0.366	0.604	0.793	0.9	0.952	0.975	0.99	0.996
2005	0	0.391	0.626	0.812	0.913	0.961	0.981	0.992	0.997
2006	0	0.415	0.656	0.835	0.927	0.969	0.987	0.995	0.998
2007	0	0.442	0.693	0.862	0.942	0.977	0.992	0.997	0.999
2008	0	0.467	0.731	0.888	0.956	0.984	0.996	0.998	1
2009	0	0.487	0.765	0.91	0.967	0.989	0.999	1	1
2010	0	0.501	0.792	0.927	0.975	0.993	1	1	1
2011	0	0.51	0.81	0.938	0.98	0.995	1	1	1
2012	0	0.514	0.818	0.943	0.982	0.996	1	1	1
2013	0	0.514	0.819	0.944	0.982	0.997	1	1	1
2014	0	0.513	0.823	0.947	0.983	0.997	1	1	1
2015	0	0.511	0.833	0.952	0.985	0.997	1	1	1
2016	0	0.503	0.842	0.958	0.988	0.998	1	1	1
2017	0	0.491	0.845	0.962	0.99	0.998	1	1	1
2018	0	0.479	0.84	0.962	0.991	0.998	1	1	1
2019	0	0.468	0.829	0.959	0.991	0.998	1	1	1
2020	0	0.458	0.816	0.955	0.99	0.998	1	1	1
2021	0	0.447	0.802	0.95	0.99	0.999	1	1	1

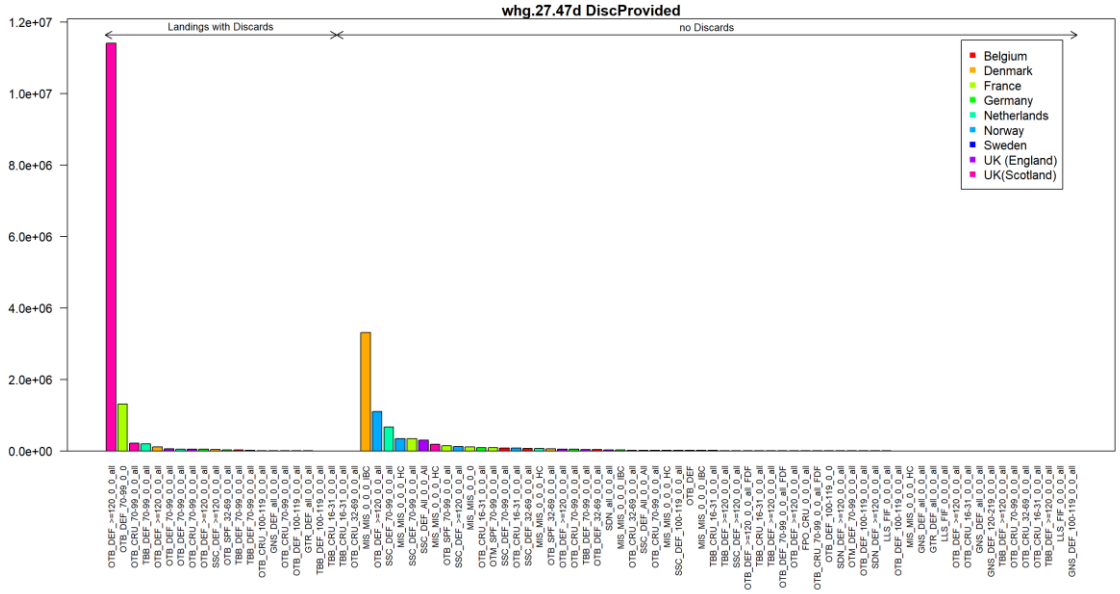


Figure 23.1. Whiting in Subarea 4 and Division 7.d: Landings with provided discards. Métier with industrial bycatch landings (MIS_MIS_0_0_IBC, Denmark, orange) generally does not have discards.

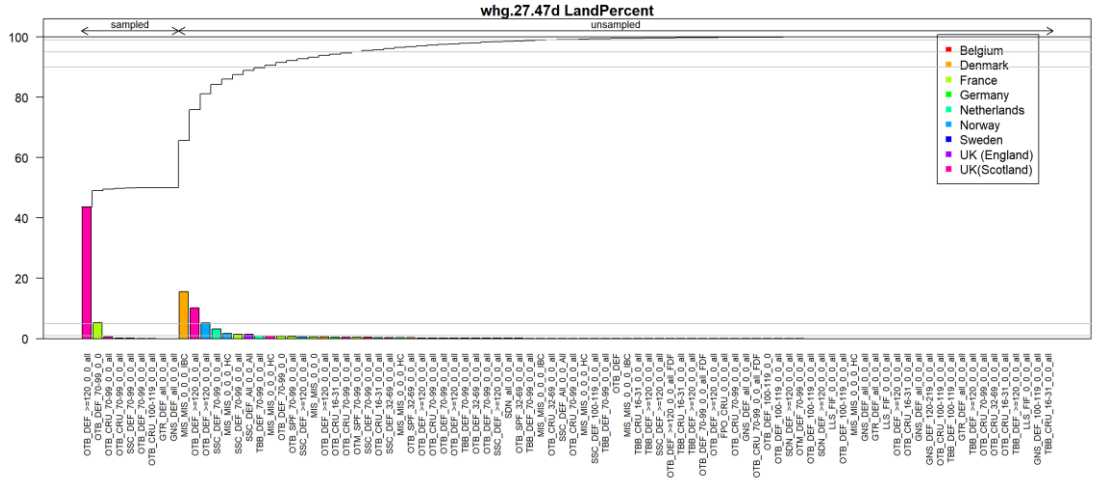


Figure 23.2a. Whiting in Subarea 4 and Division 7.d: Reported landings (in percent, colored bars) for each sampled and unsampled fleet, along with cumulative landings (in percent, black line) for fleets in descending order of yield.

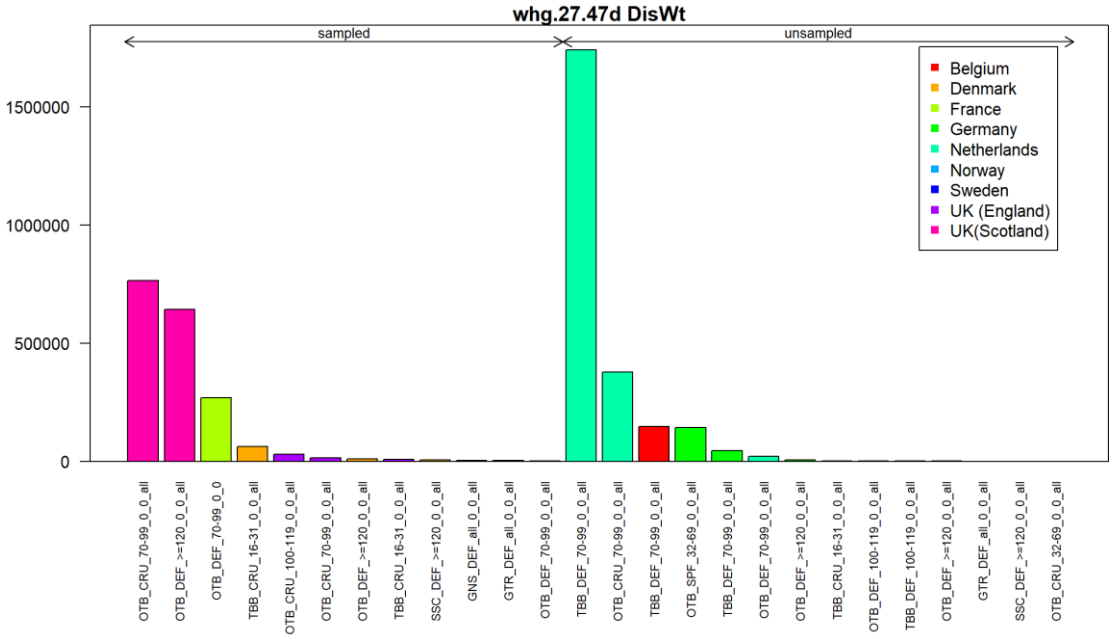


Figure 23.2b. Whiting in Subarea 4 and Division 7.d: Reported discards (in tonnes, colored bars) for each sampled and unsampled fleet, in descending order of yield.

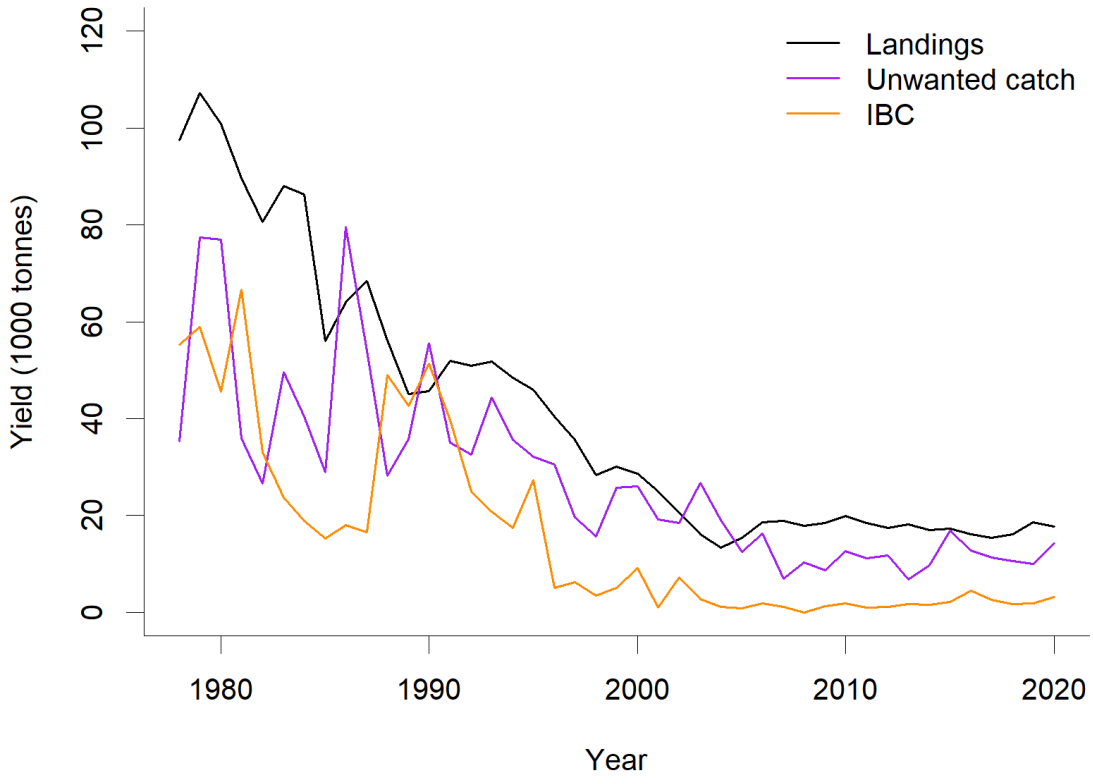


Figure 23.3. Whiting in Subarea 4 and Division 7.d: Yield by catch component. Unwanted catch or discards include BMS landings as estimated by ICES.

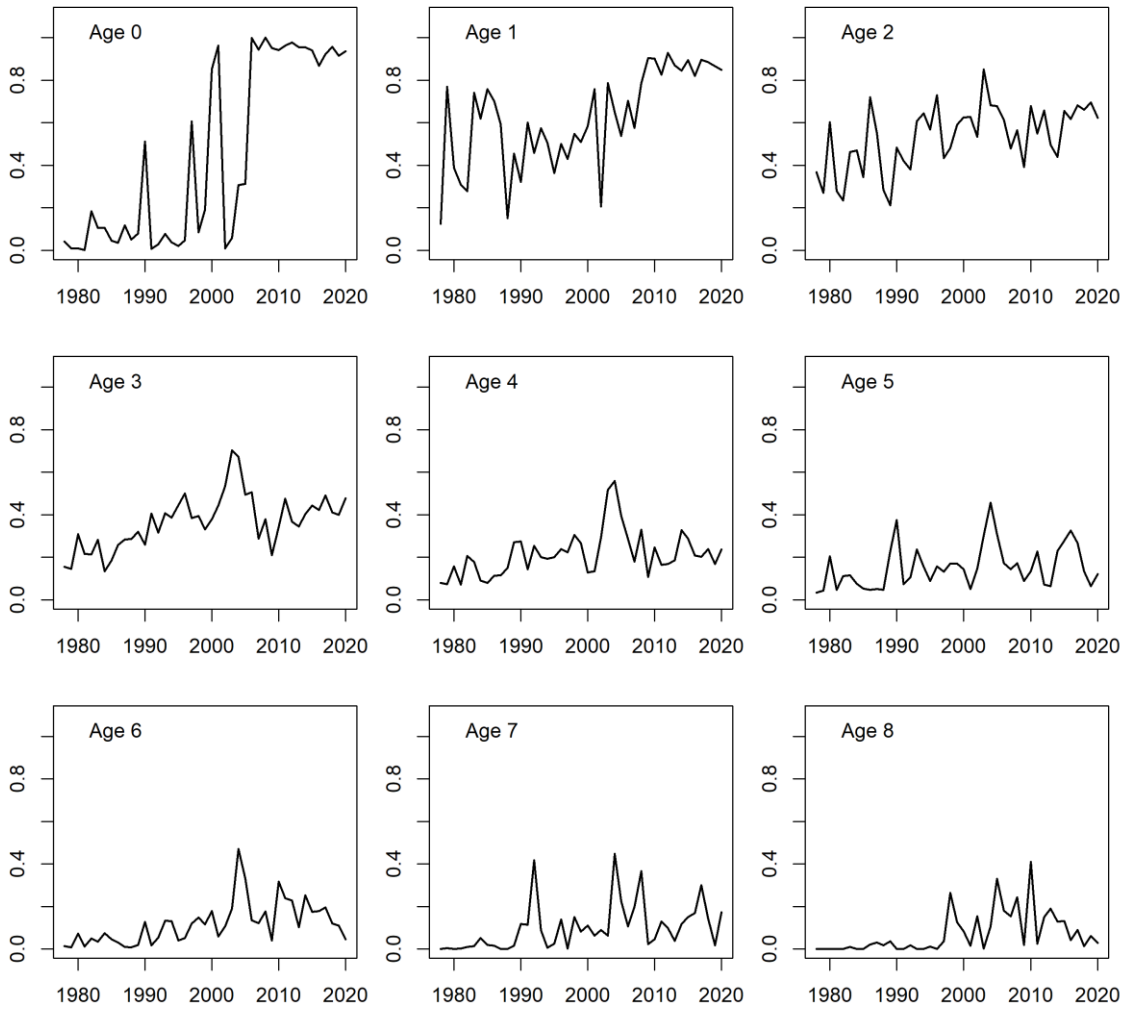


Figure 23.4. Whiting in Subarea 4 and Division 7.d: Proportion of discards in total catch, by age and year.

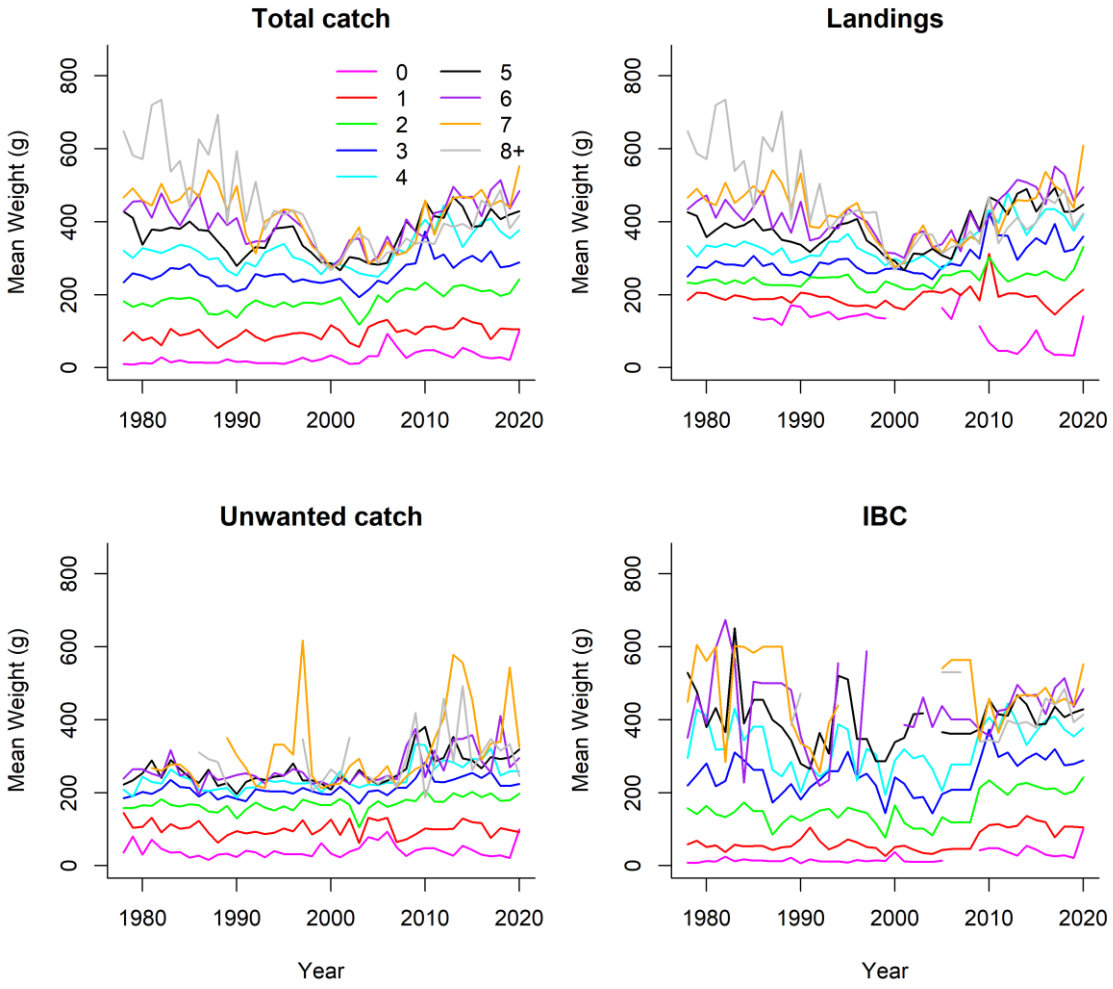


Figure 23.5. Whiting in Subarea 4 and Division 7.d: Mean weights-at-age (g) by catch component (black lines, age 0–8+).

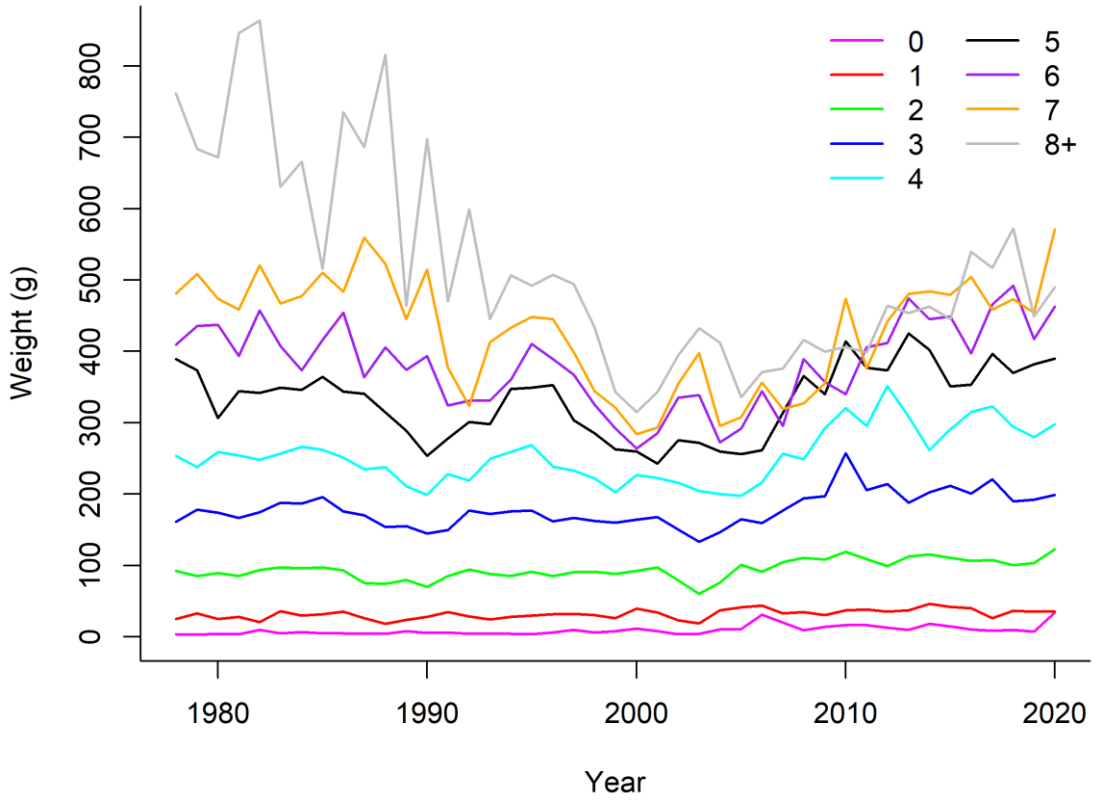


Figure 23.6. Whiting in Subarea 4 and Division 7.d: Stock mean weights-at-age (g) (age 0–8+).

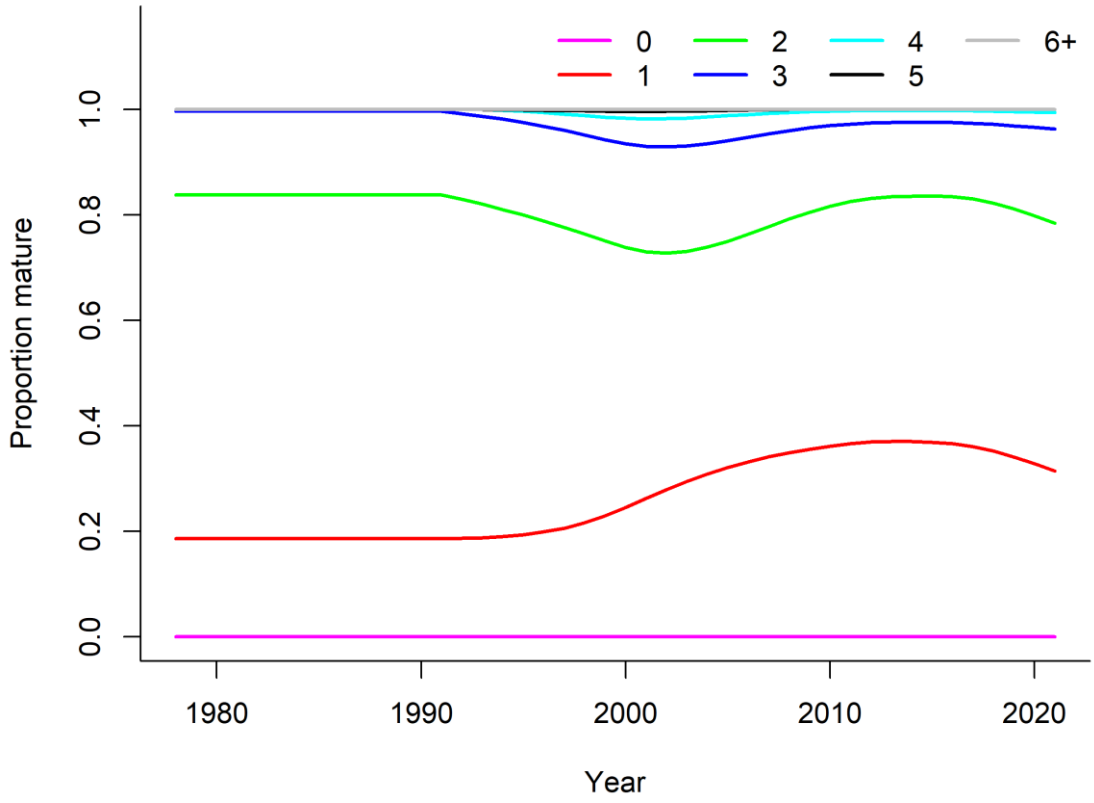


Figure 23.7. Whiting in Subarea 4 and Division 7.d: Maturity estimates from NS IBTS Q1 data. Ages 6–8+ have the same maturity values. Estimates prior 1991 are assumed constant using values of 1991.

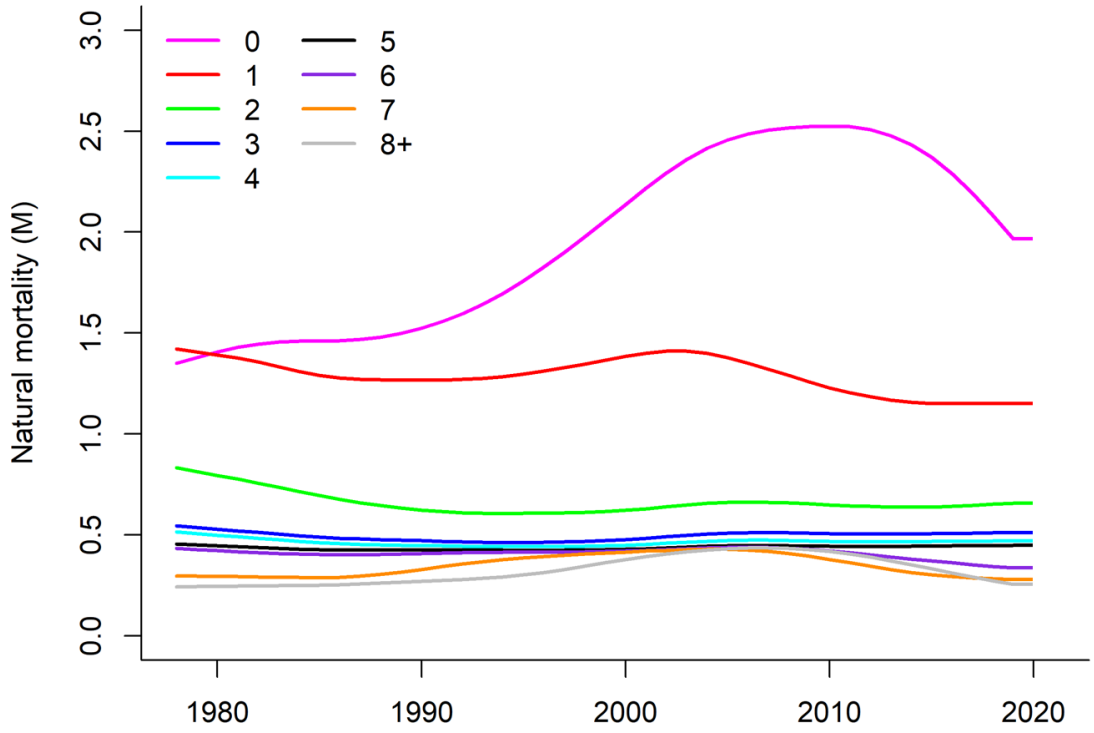


Figure 23.8. Whiting in Subarea 4 and Division 7.d: Natural mortality estimates from the 2020 update of SMS key run (WGSAM, 2021b) used in assessment.

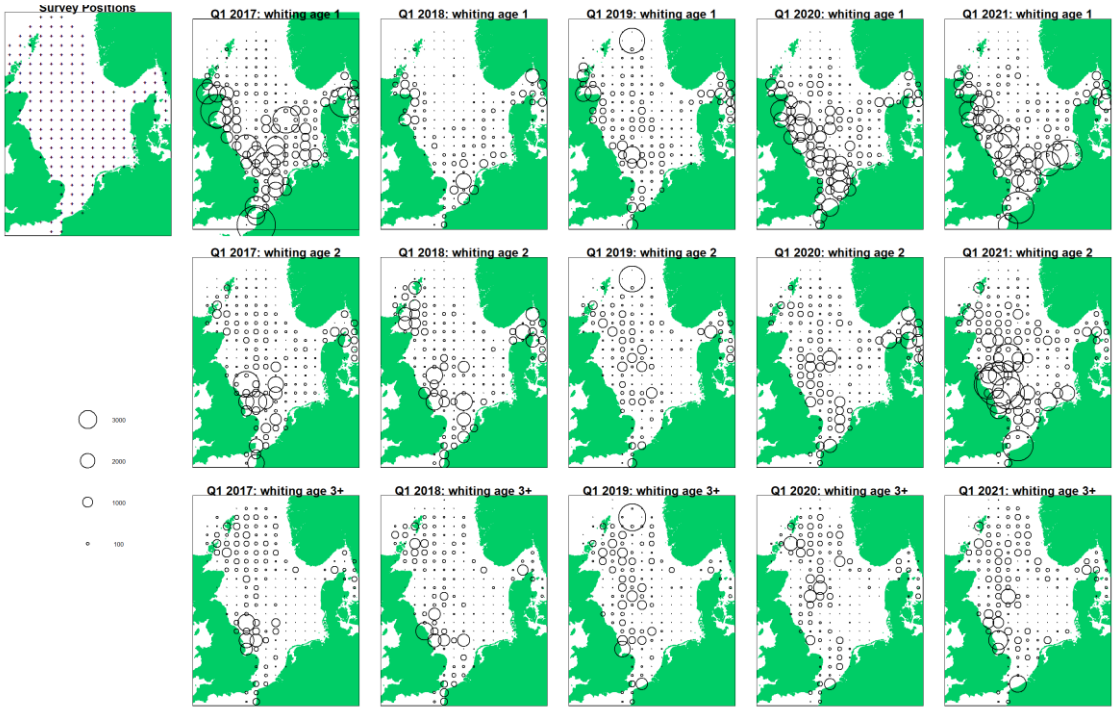


Figure 23.9. Whiting in Subarea 4 and Division 7.d: Survey distribution maps for Ages 1–3+ Q1 2017–2021. Size of the bubbles indicates numbers caught per 30 minutes for each age (on a log10 scale). The maps are based on the IBTS–Q1 survey in the North Sea.

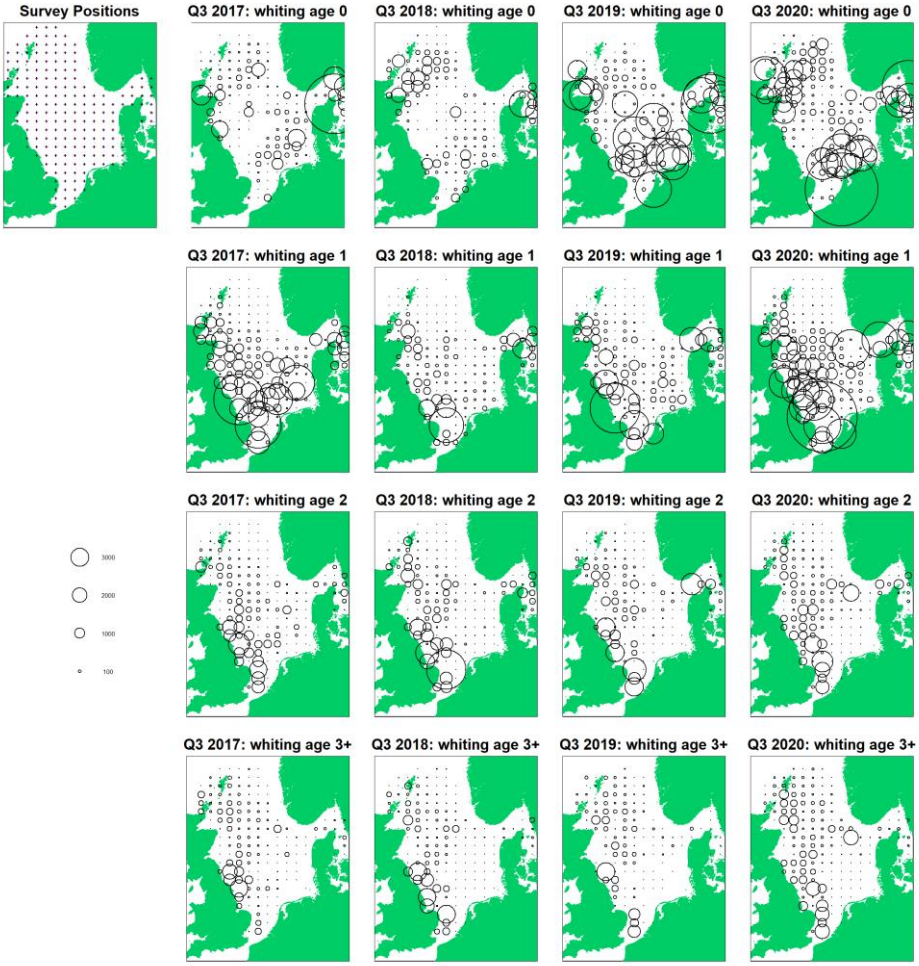


Figure 23.10. Whiting in Subarea 4 and Division 7.d: Survey distribution maps for ages 0–3+ Q3 2017–2020. Size of the bubbles indicates numbers caught per 30 minutes for each age (on a log10 scale). The maps are based on the IBTS–Q3 survey in the North Sea.

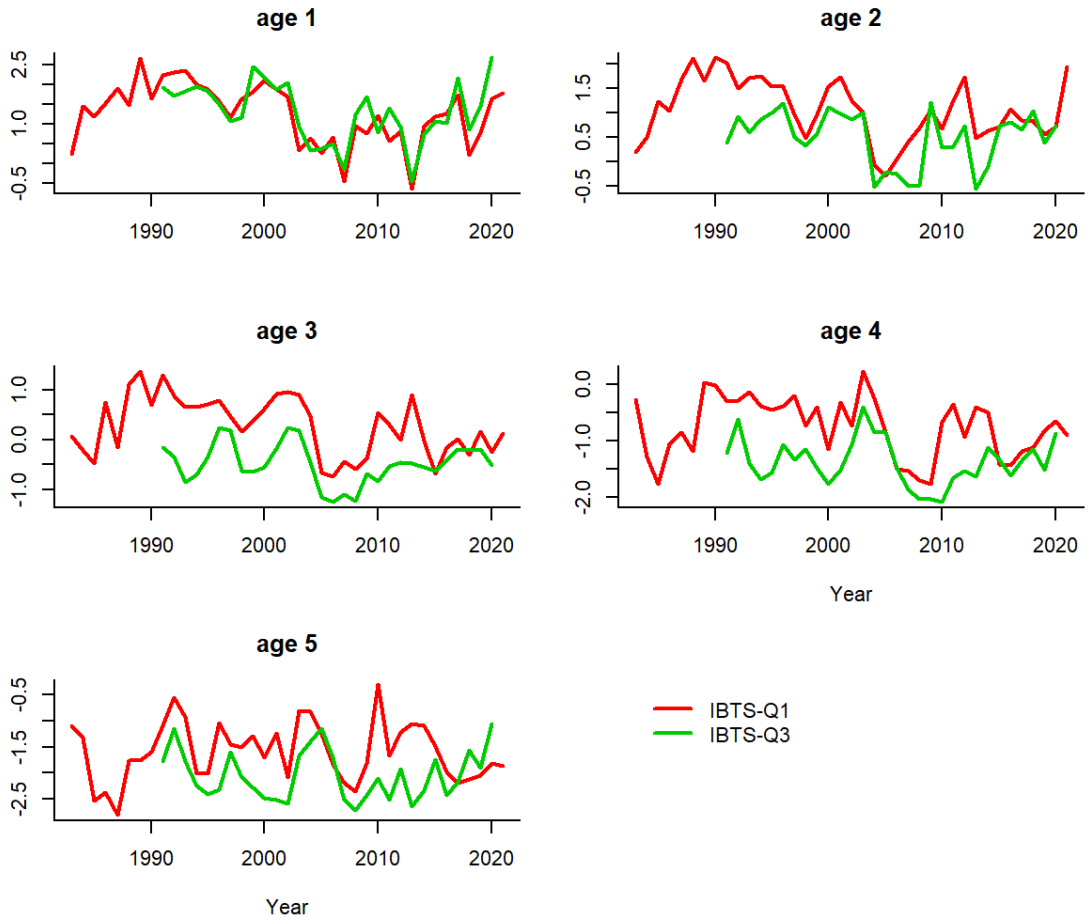


Figure 23.11. Whiting in Subarea 4 and Division 7.d: Survey log CPUE (catch per unit effort) at age.

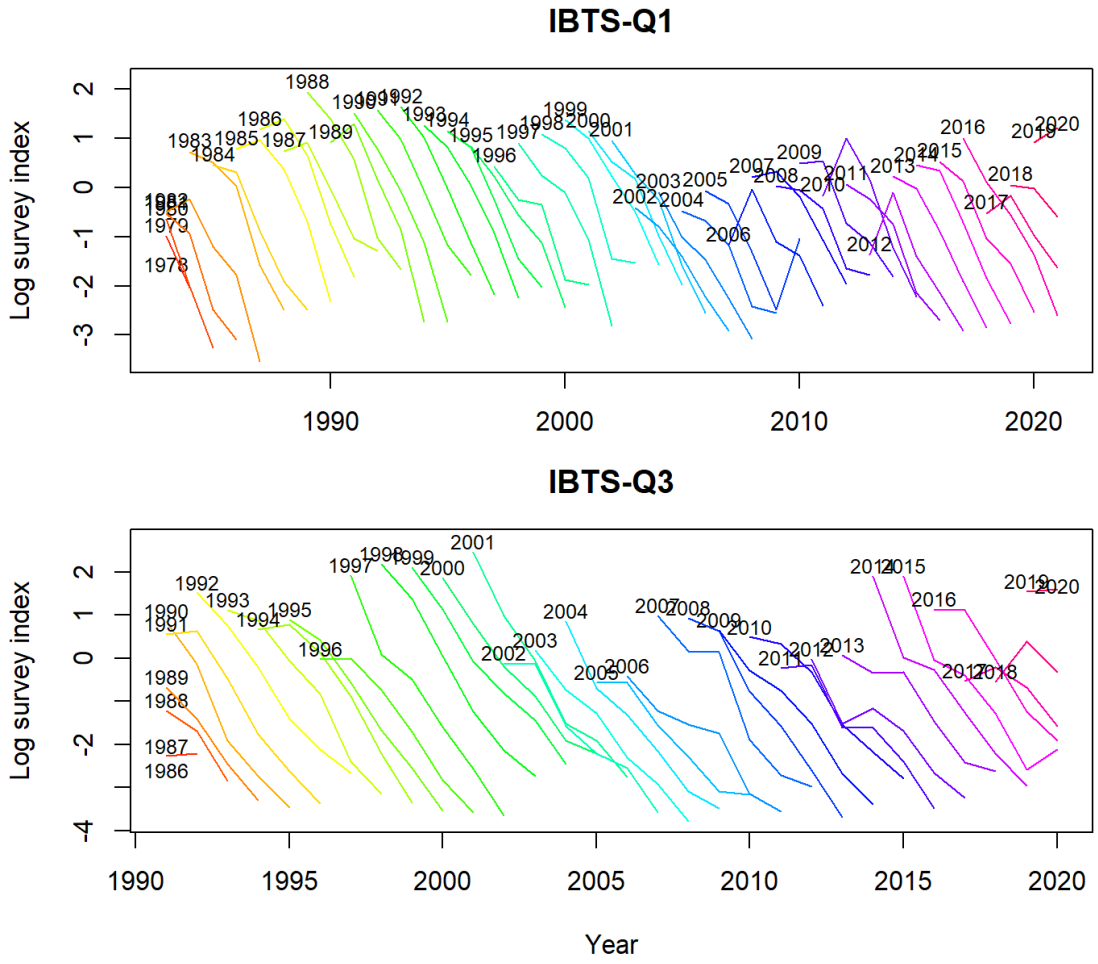


Figure 23.12. Whiting in Subarea 4 and Division 7.d: Log survey indices by cohort for each of the two surveys. The spawning year for each cohort is indicated at the start of each line.

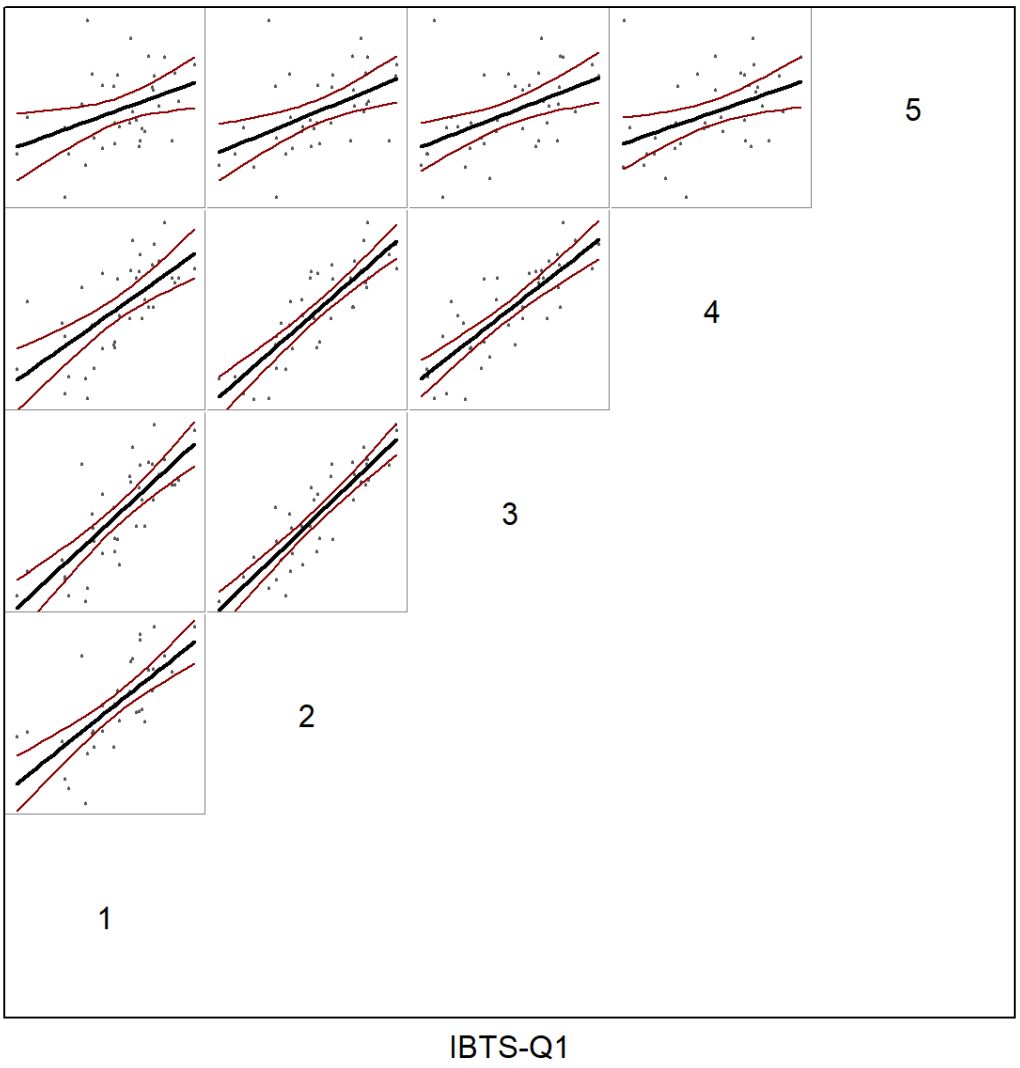


Figure 23.13. Within-survey correlations for the IBTS–Q1 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line (with black points) represents a significant ($p < 0.05$) regression, while a thin line (with blue points) is not significant. Approximate 95% confidence intervals for each fit are also shown.

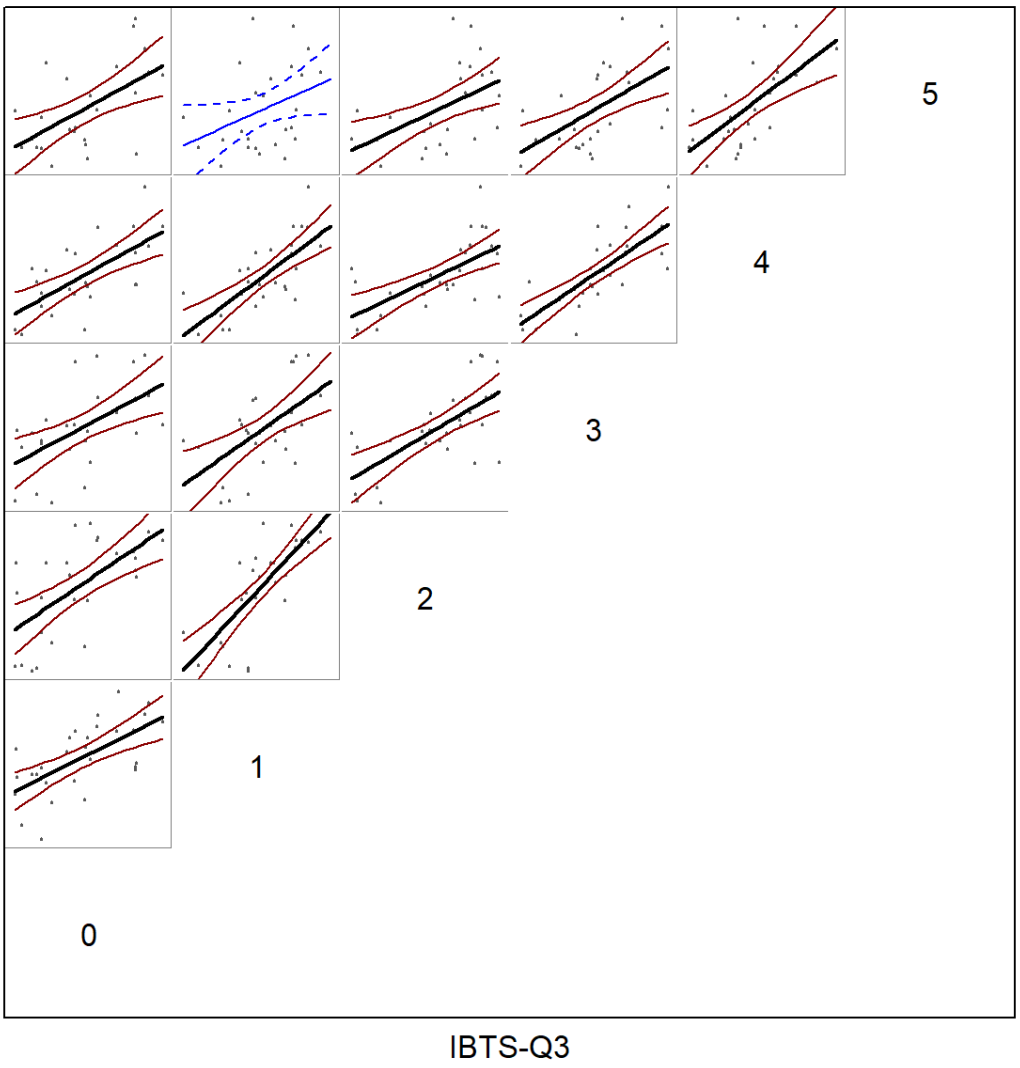


Figure 23.14. Within-survey correlations for the IBTS–Q3 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line (with black points) represents a significant ($p < 0.05$) regression, while a thin line (with blue points) is not significant. Approximate 95% confidence intervals for each fit are also shown.

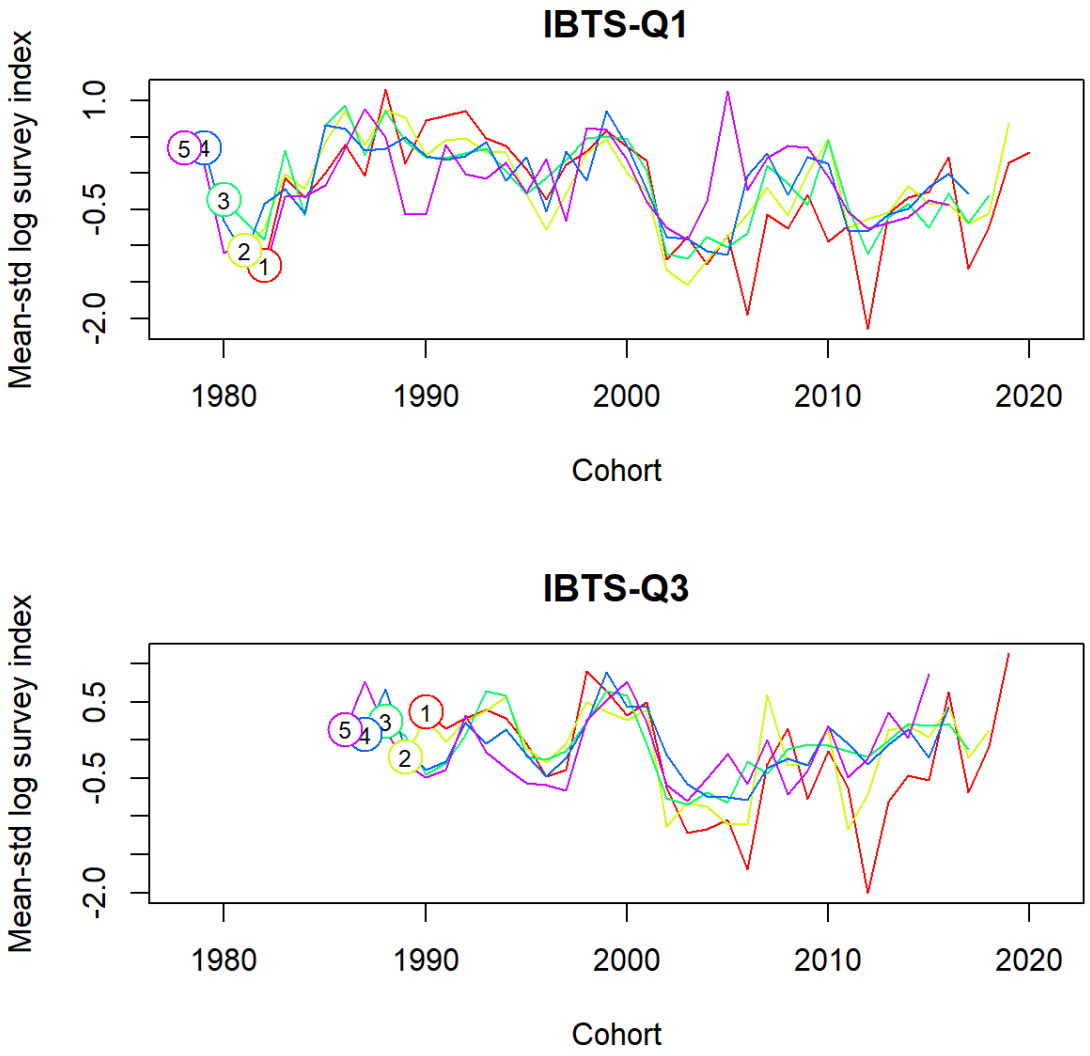


Figure 23.15. Whiting in Subarea 4 and Division 7.d: Survey log CPUE (catch per unit effort) for the IBTS–Q1 and Q3 surveys, by cohort. Each line shows the log CPUE for the age indicated at the start of the line.

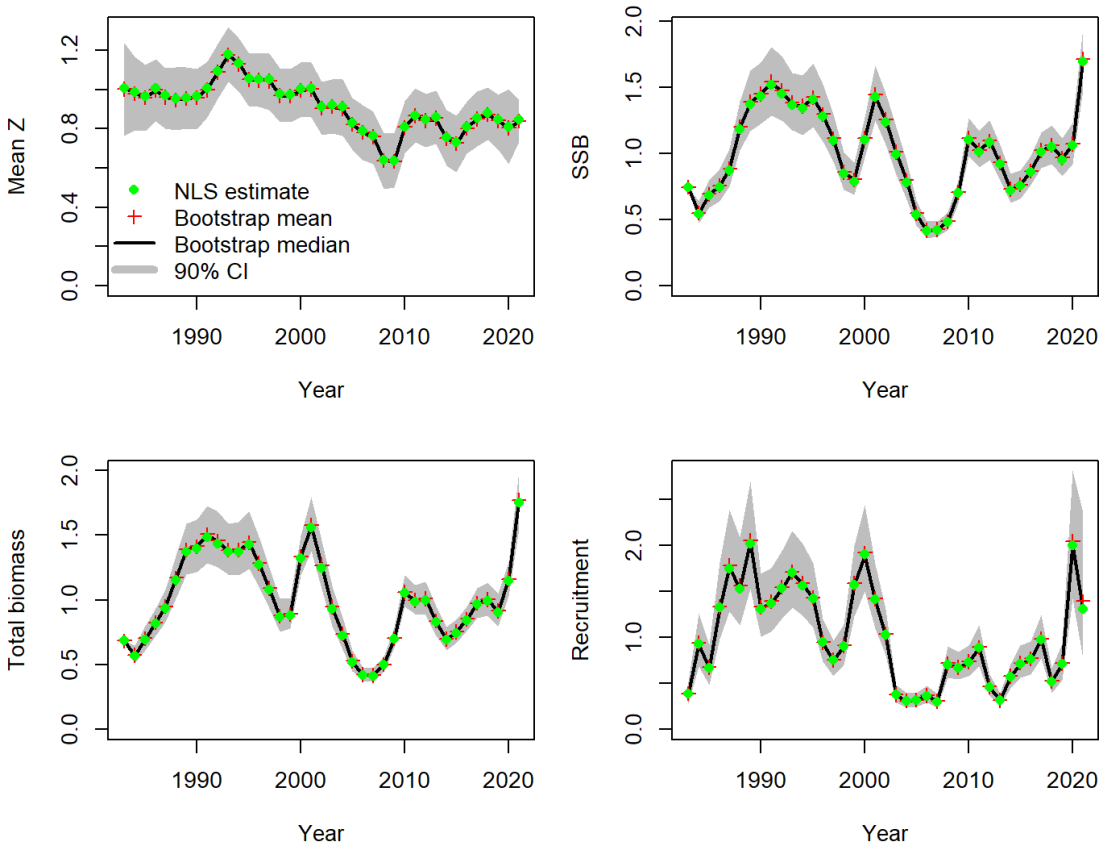


Figure 23.16. Whiting in Subarea 4 and Division 7.d: Summary plots from an exploratory SURBAR assessment, using both available surveys (IBTS–Q1 and Q3). Mean mortality Z (ages 2 to 4), relative spawning stock biomass (SSB), relative total biomass (TSB), and relative recruitment (age 1). Shaded grey areas correspond to the 90% CI. Green points give the model estimates, while red crosses and black lines give (respectively) the mean and median values from the uncertainty estimation bootstrap.

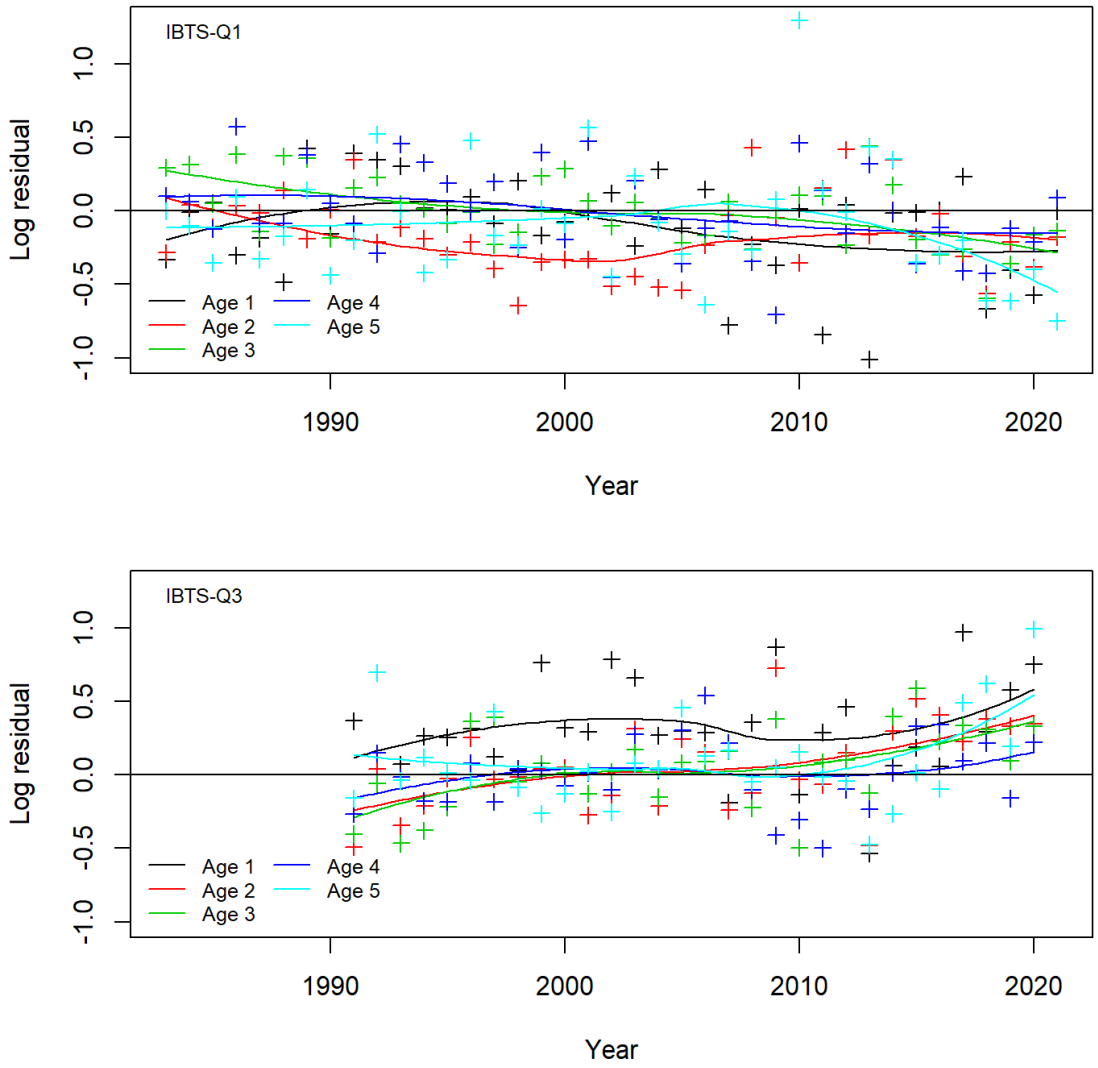


Figure 23.17. Whiting in Subarea 4 and Division 7.d: Log survey residuals from the SURBAR analysis. Ages are color-coded, and a LOESS smoother (span = 2) has been fitted through each age time-series.

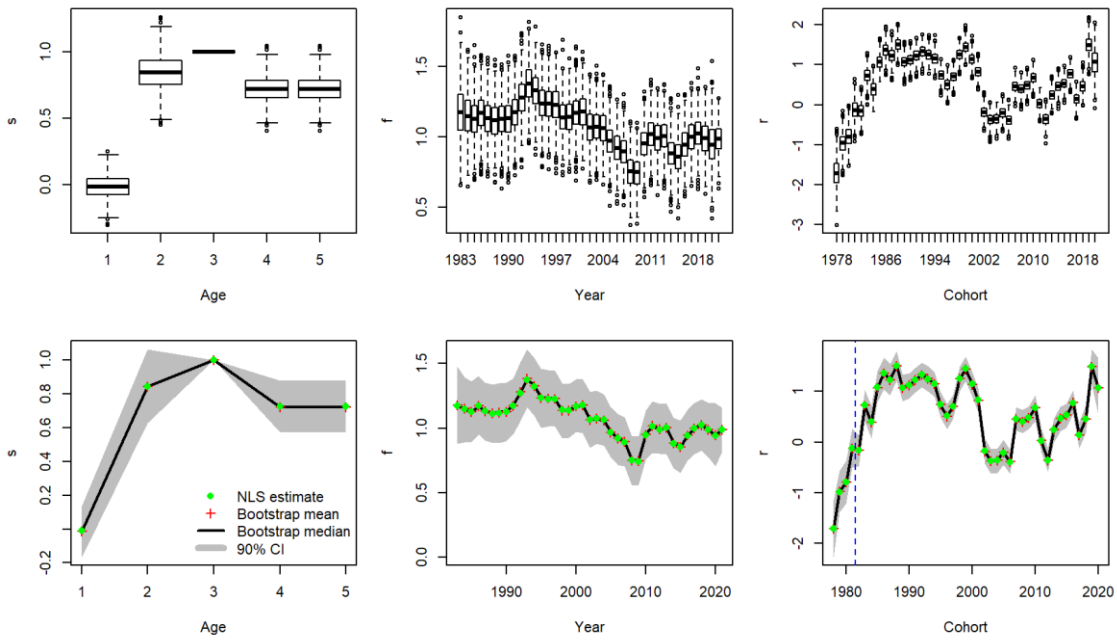


Figure 23.18. Whiting in Subarea 4 and Division 7.d: Parameter estimates from SURBAR analysis. Top row: age, year and cohort effect estimates as box-and-whisker plots. Bottom row: estimates as line plots with 90% confidence intervals.

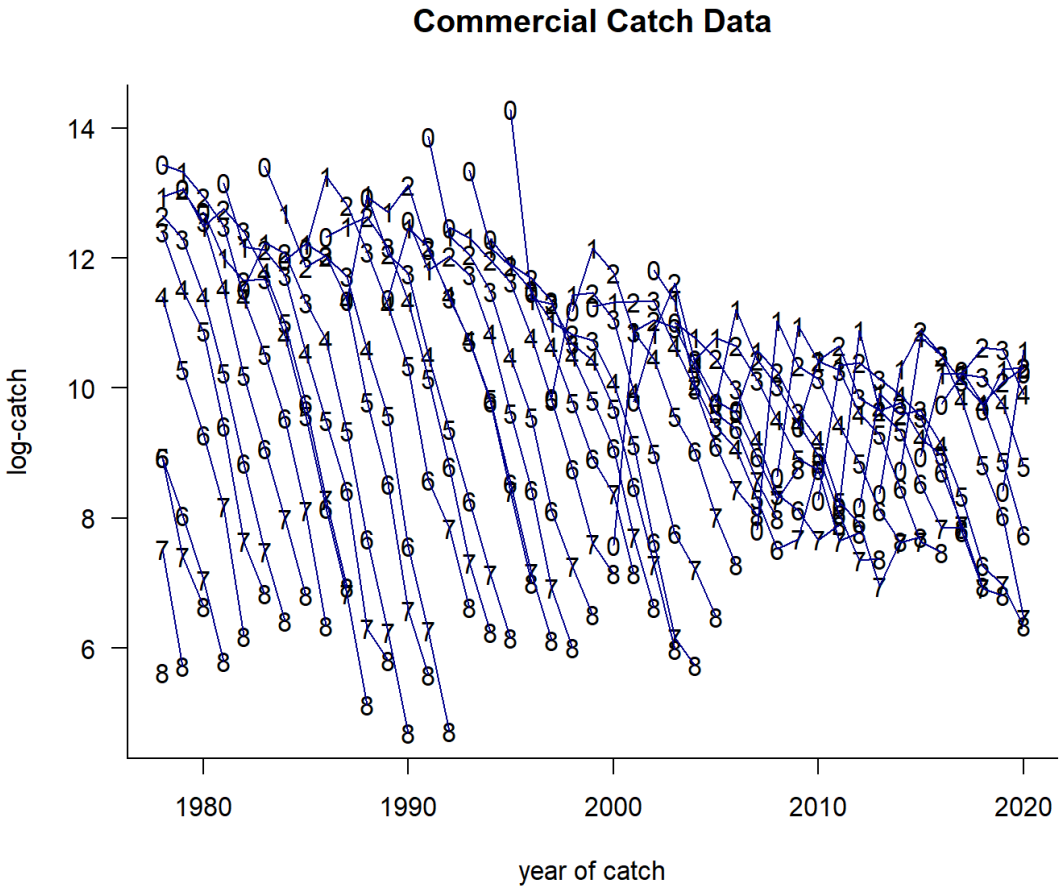


Figure 23.19. Whiting in Subarea 4 and Division 7.d: Log-catch curves by cohort for total catches (ages 0–8+).

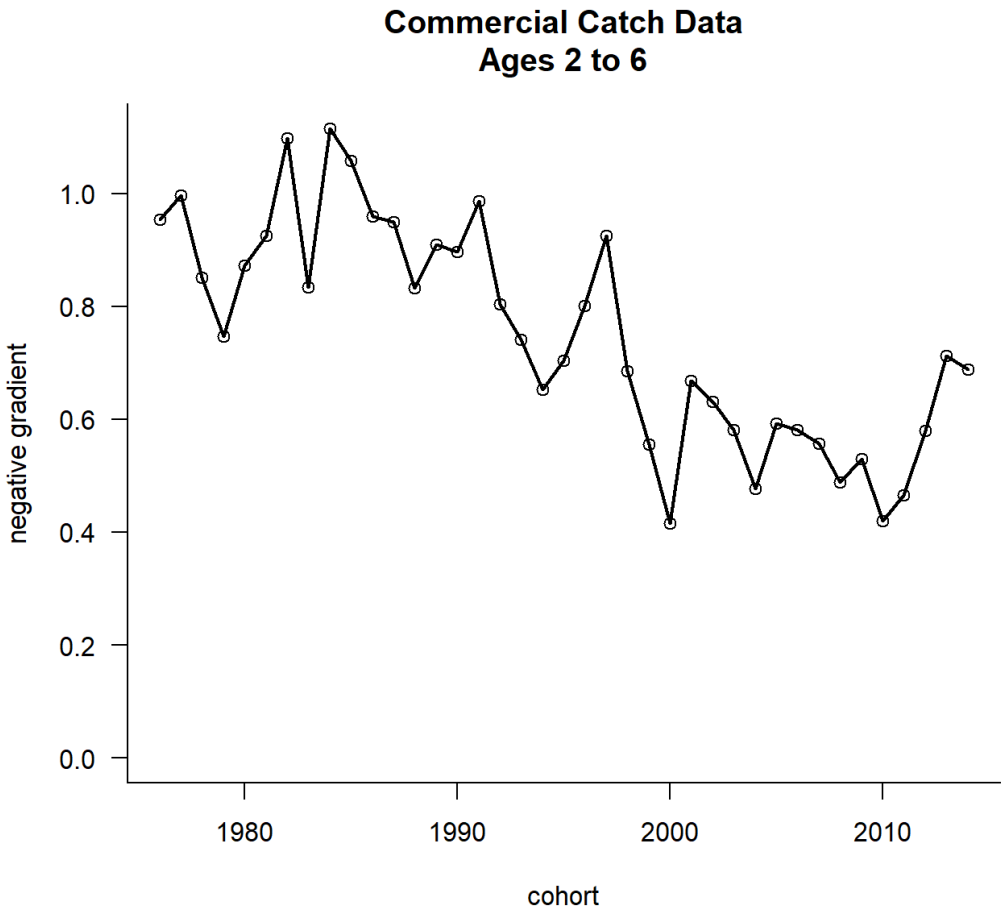


Figure 23.20. Whiting in Subarea 4 and Division 7.d: Negative gradients of log catches per cohort, averaged over ages 2–6. The x-axis represents the spawning year of each cohort.

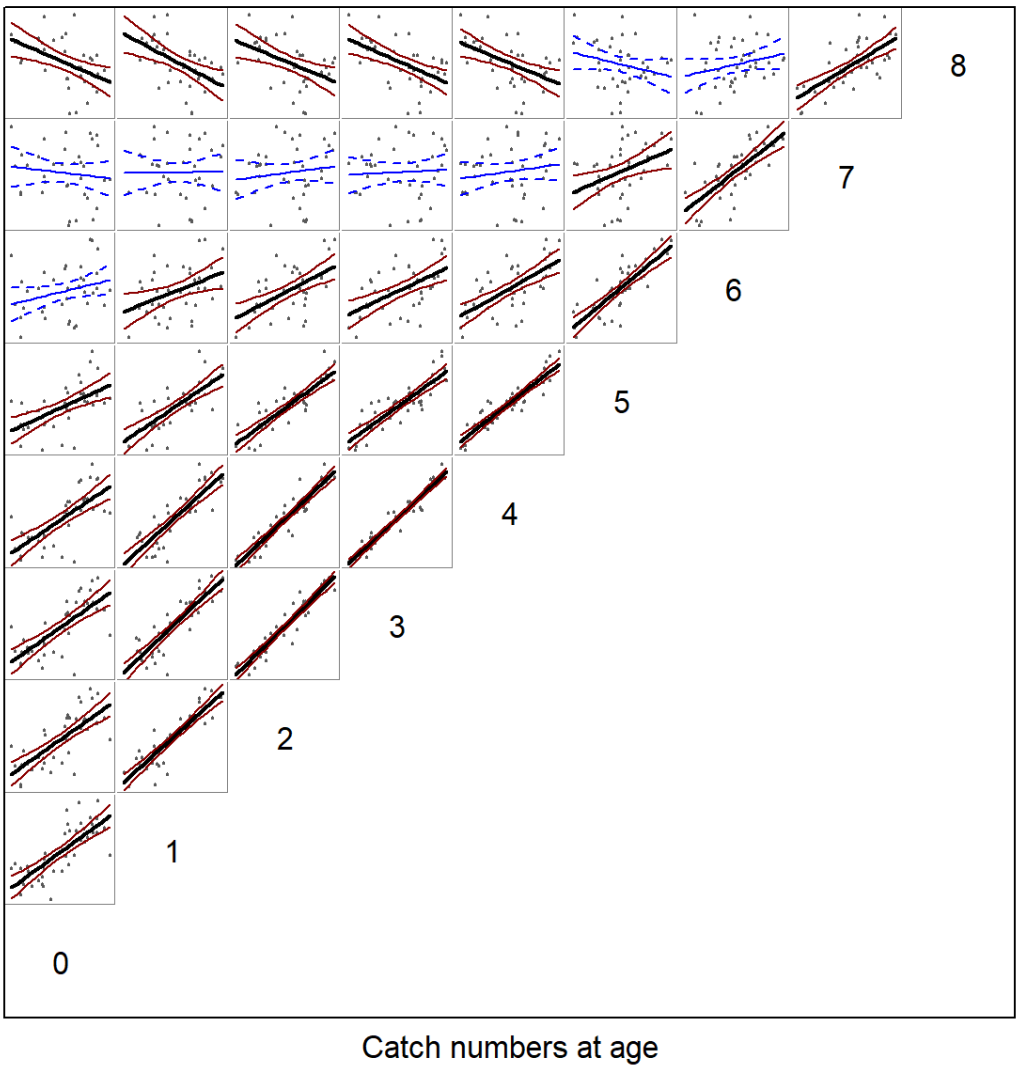
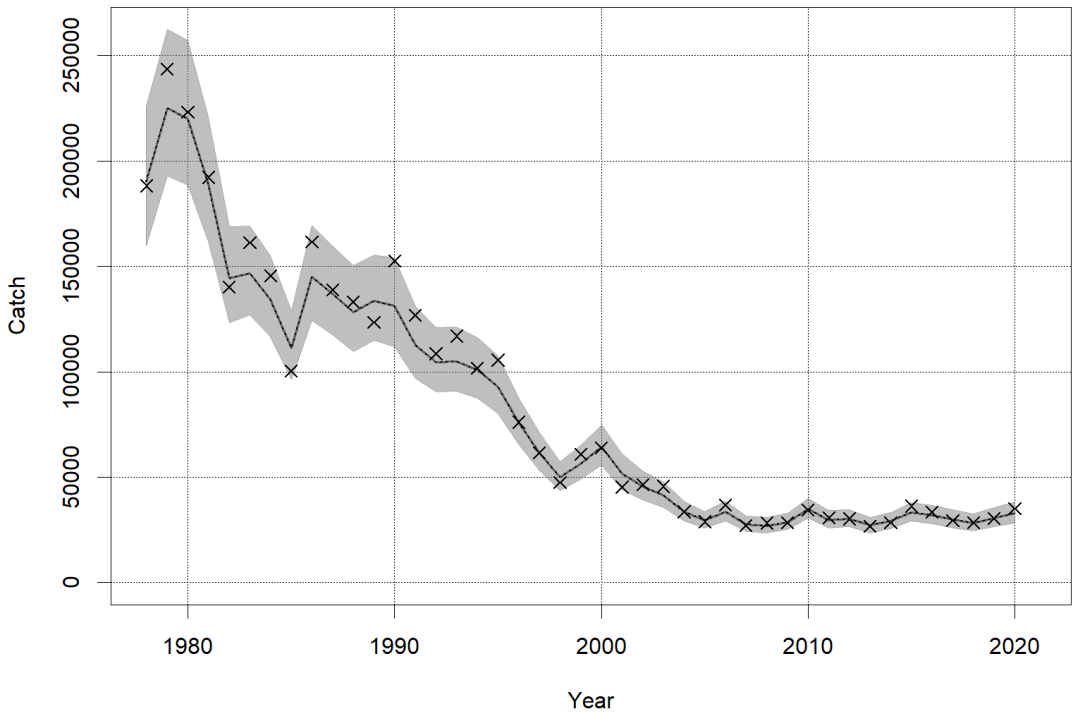
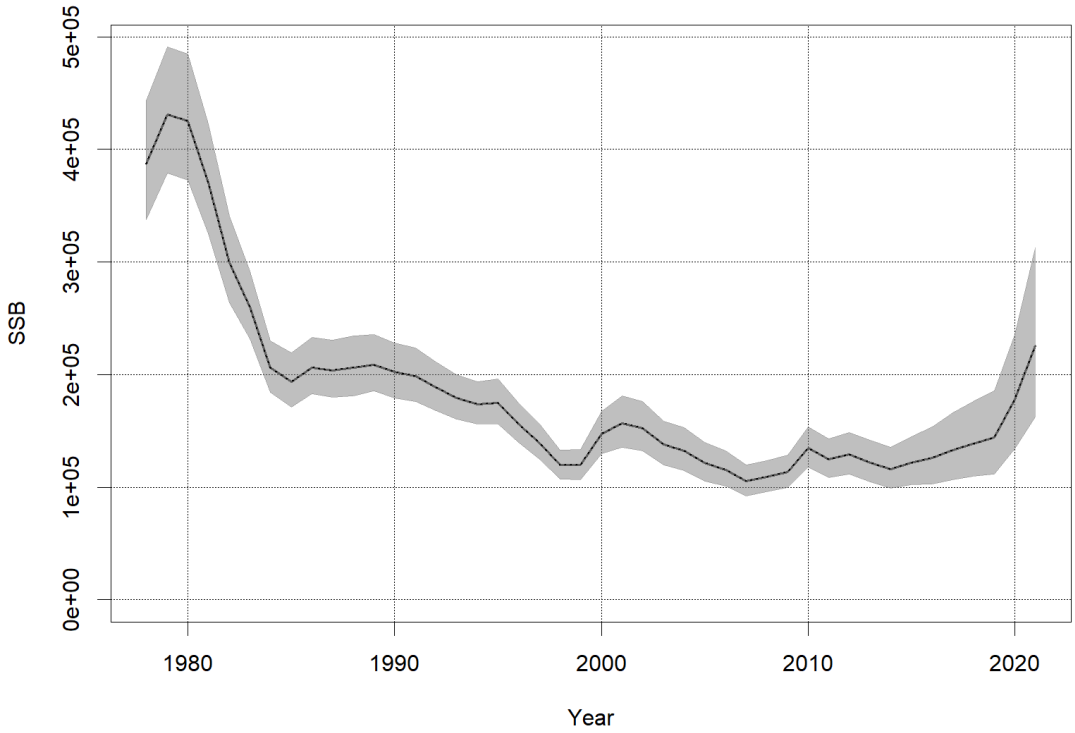


Figure 23.21. Whiting in Subarea 4 and Division 7.d: Correlations in the catch-at-age matrix (including the plus-group for ages 8 and older), comparing estimates at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line (and black points) represents a significant ($p < 0.05$) regression, while a thin line (and blue points) is not significant. Approximate 95% confidence intervals for each fit are also shown.


Catch
0
50000
100000
150000
200000
250000
1980
1990
2000
2010
2020
Year


SSB
0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
1980
1990
2000
2010
2020
Year

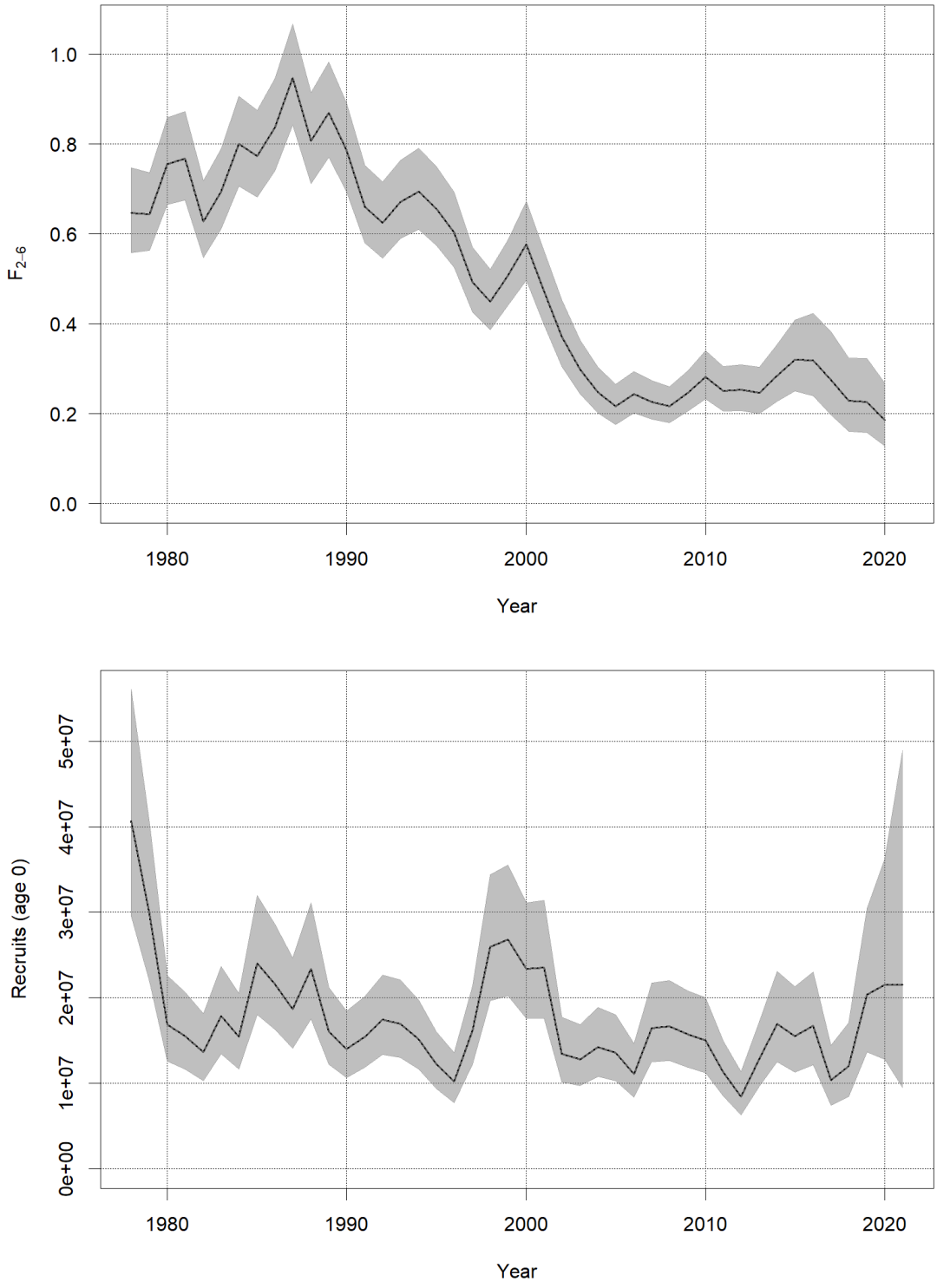


Figure 23.22. Whiting in Subarea 4 and Division 7.d: SAM assessment results using catch data series (1978–2019) with IBTS survey data starting in 1983 (Q1) and 1991 (Q3). Estimates with 95% Confidence intervals for total catch weight, SSB, mean fishing mortality and recruitment (at age 0).

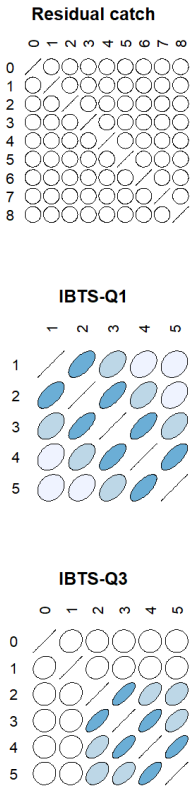


Figure 23.23. Whiting in Subarea 4 and Division 7.d: SAM estimated correlations between age groups for each fleet.

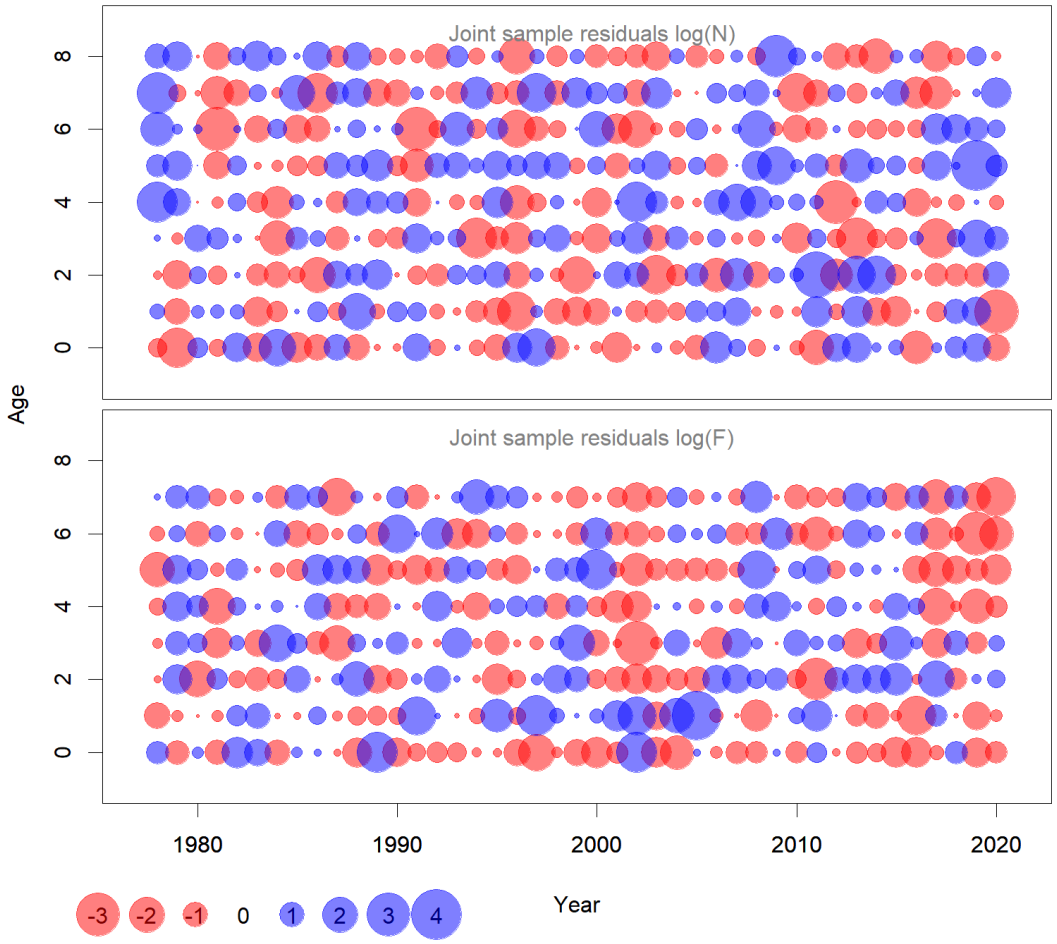


Figure 23.24. Whiting in Subarea 4 and Division 7.d: SAM standardised joint-sample residuals of process increments (for stock size N and fishing mortality F processes).

Figure 23.25. Whiting in Subarea 4 and Division 7.d: SAM standardized one-observation-ahead residuals.

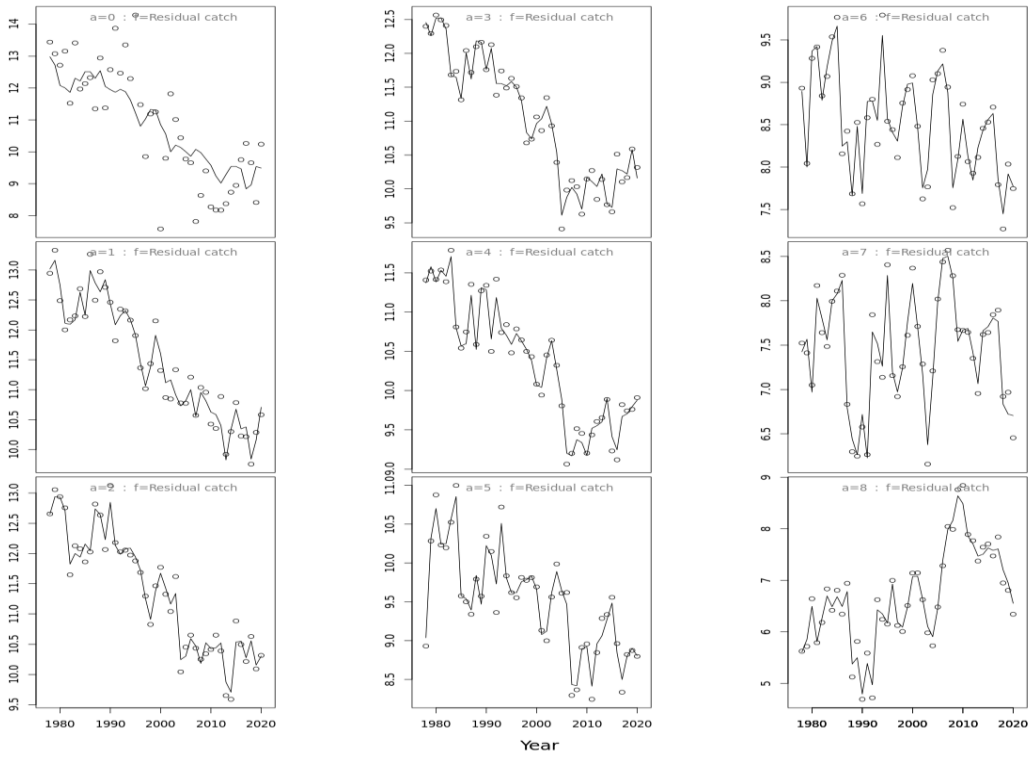


Figure 23.26. Whiting in Subarea 4 and Division 7.d: SAM predicted line and observed points (log scale) for the catch fleet.

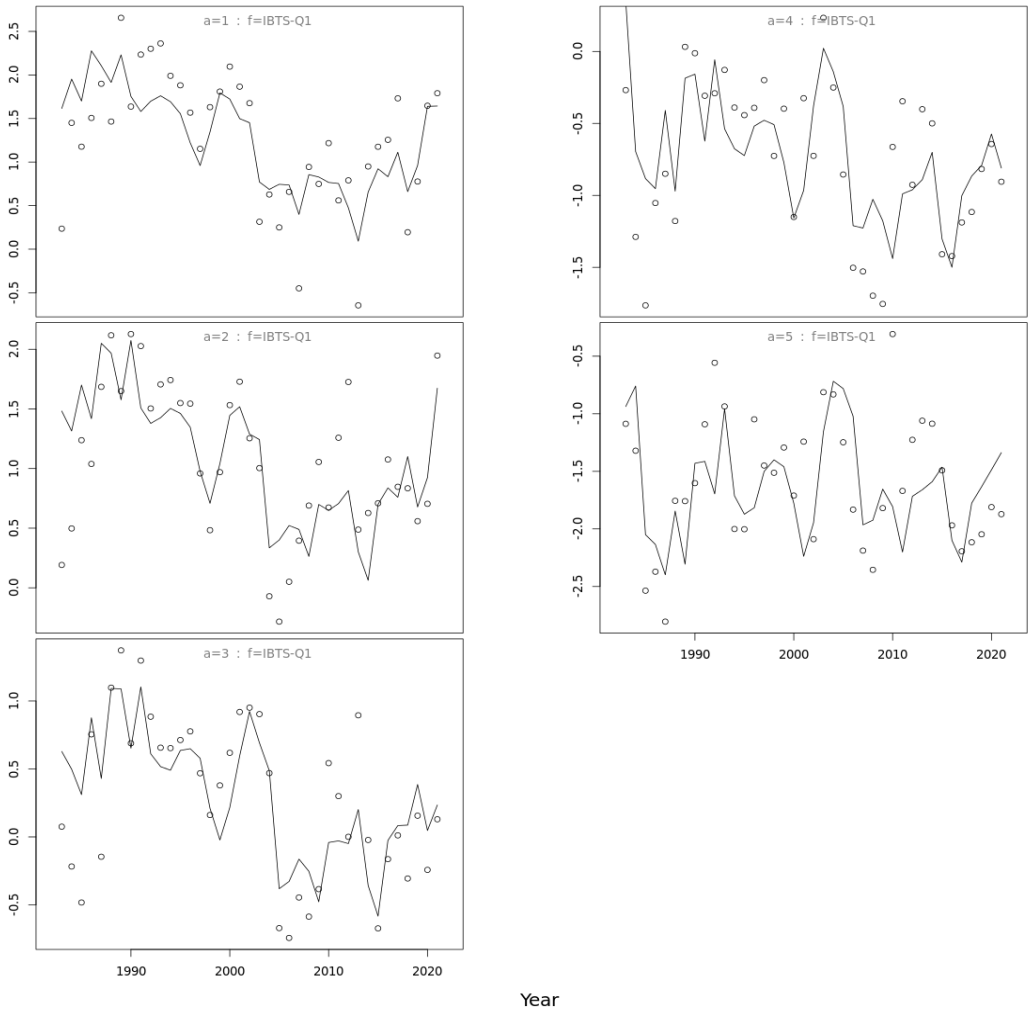


Figure 23.27. Whiting in Subarea 4 and Division 7.d: SAM predicted line and observed points (log scale), for survey fleet IBTS Q1.

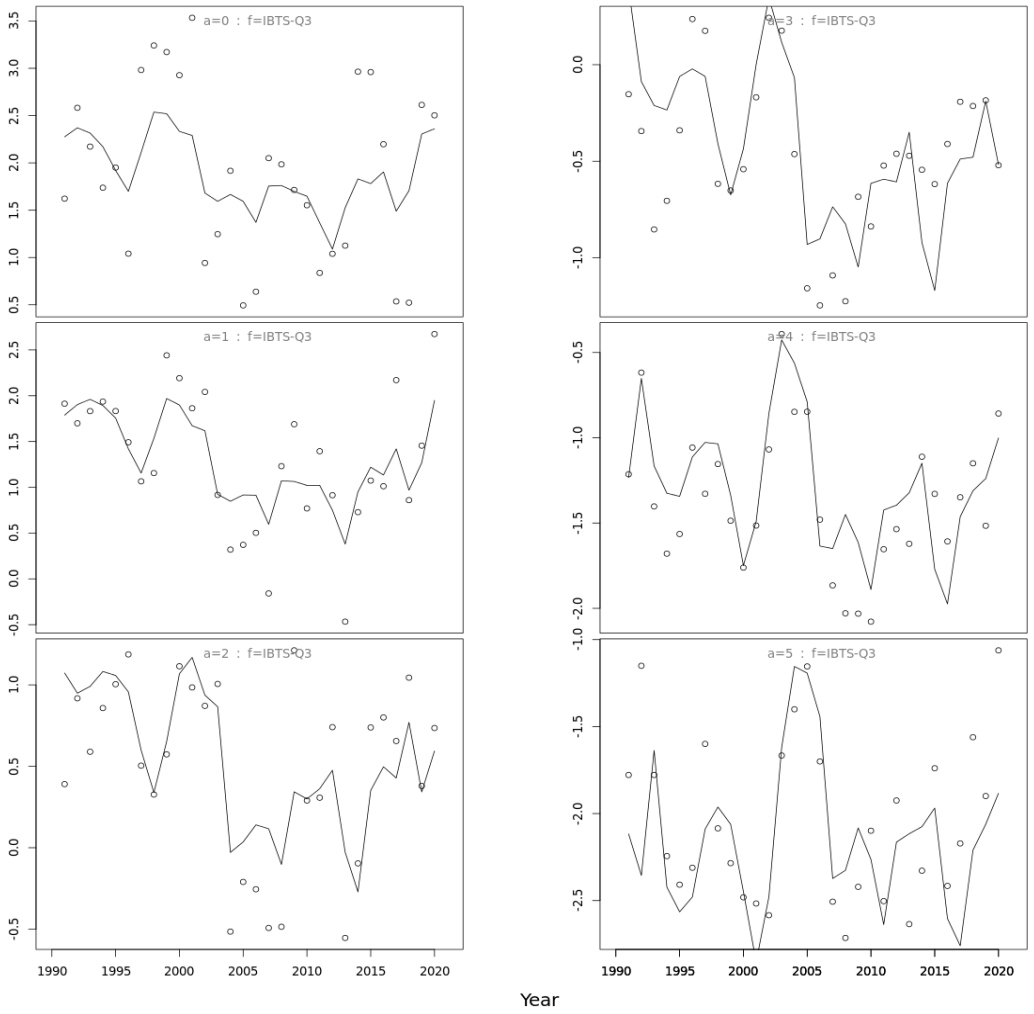
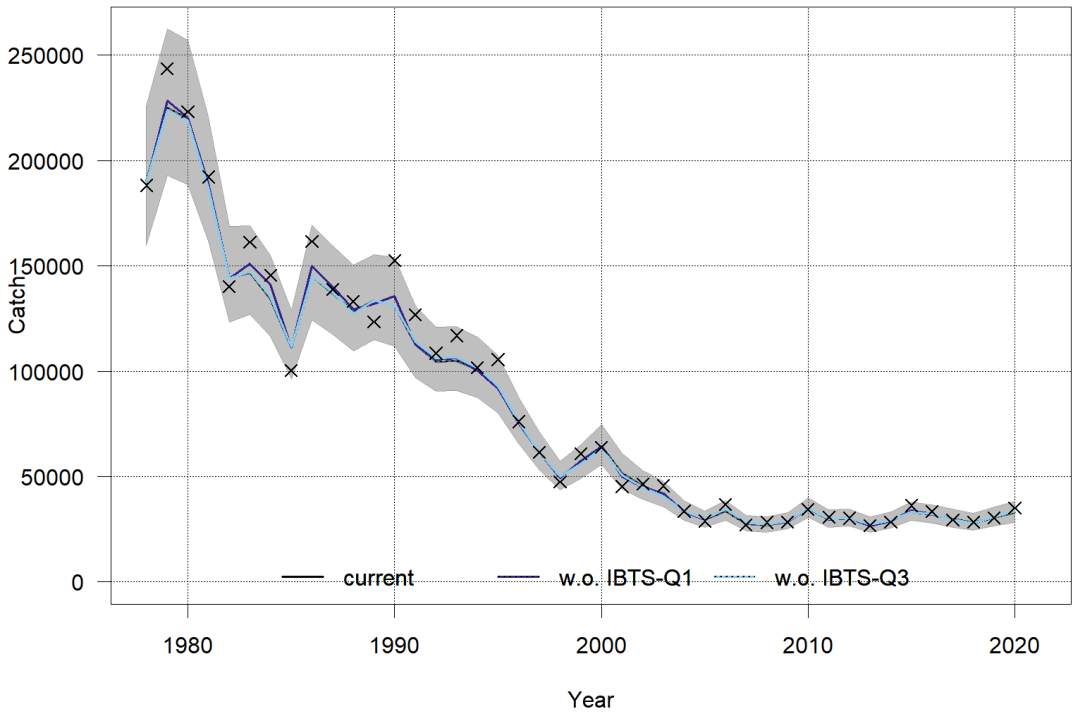
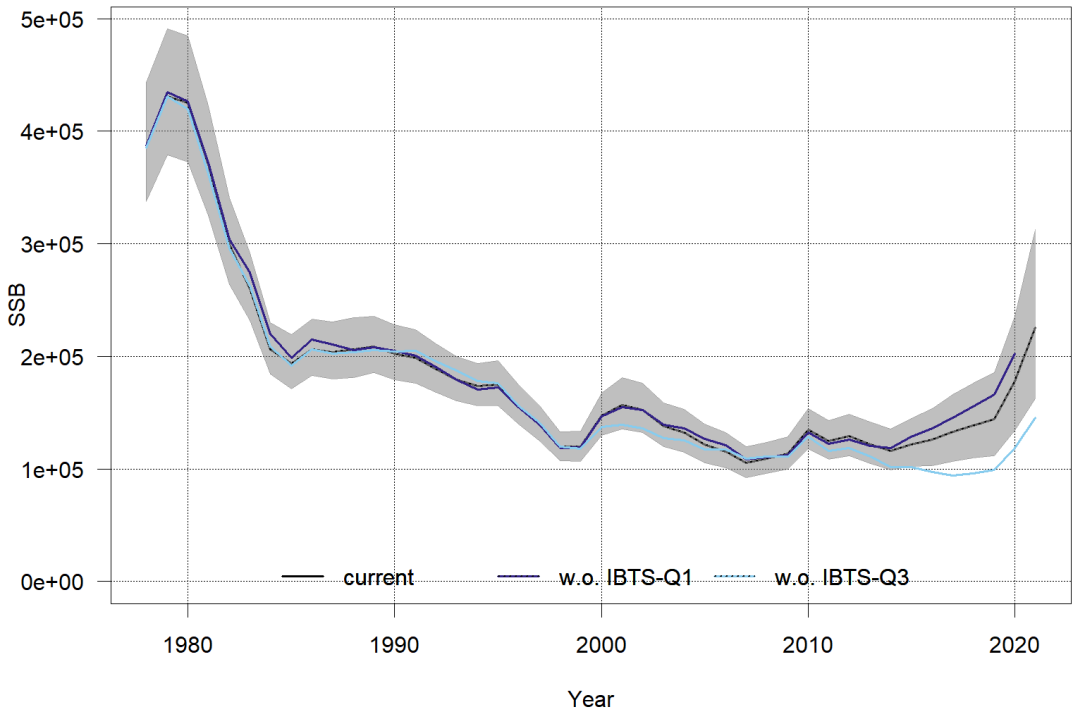


Figure 23.28. Whiting in Subarea 4 and Division 7.d: SAM predicted line and observed points (log scale), for survey fleet IBTS Q3.


250000
200000
150000
100000
50000
0
Catch
current
w.o. IBTS-Q1
w.o. IBTS-Q3
1980
1990
2000
2010
2020
Year


5e+05
4e+05
3e+05
2e+05
1e+05
0e+00
SSB
current
w.o. IBTS-Q1
w.o. IBTS-Q3
1980
1990
2000
2010
2020
Year

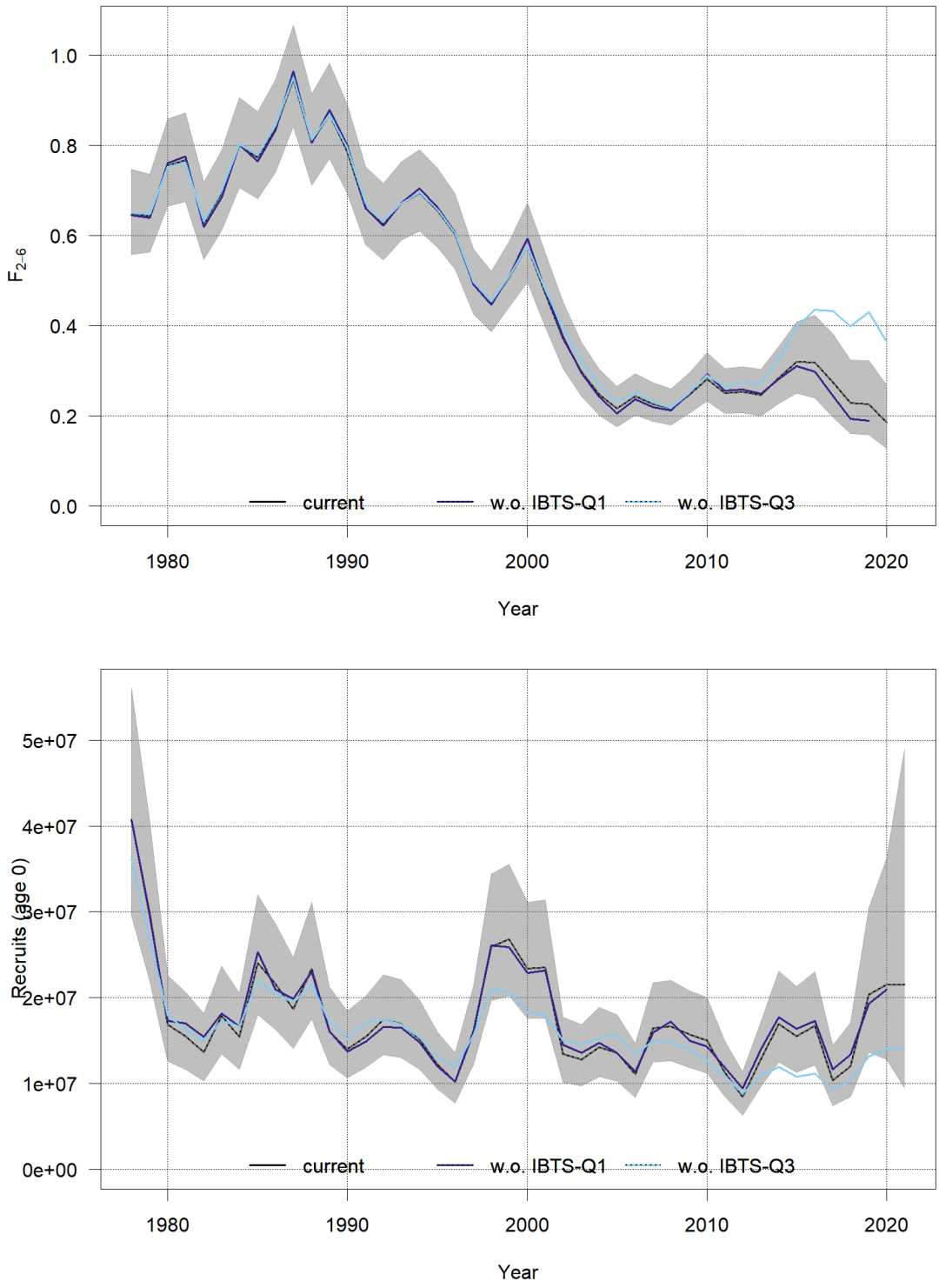
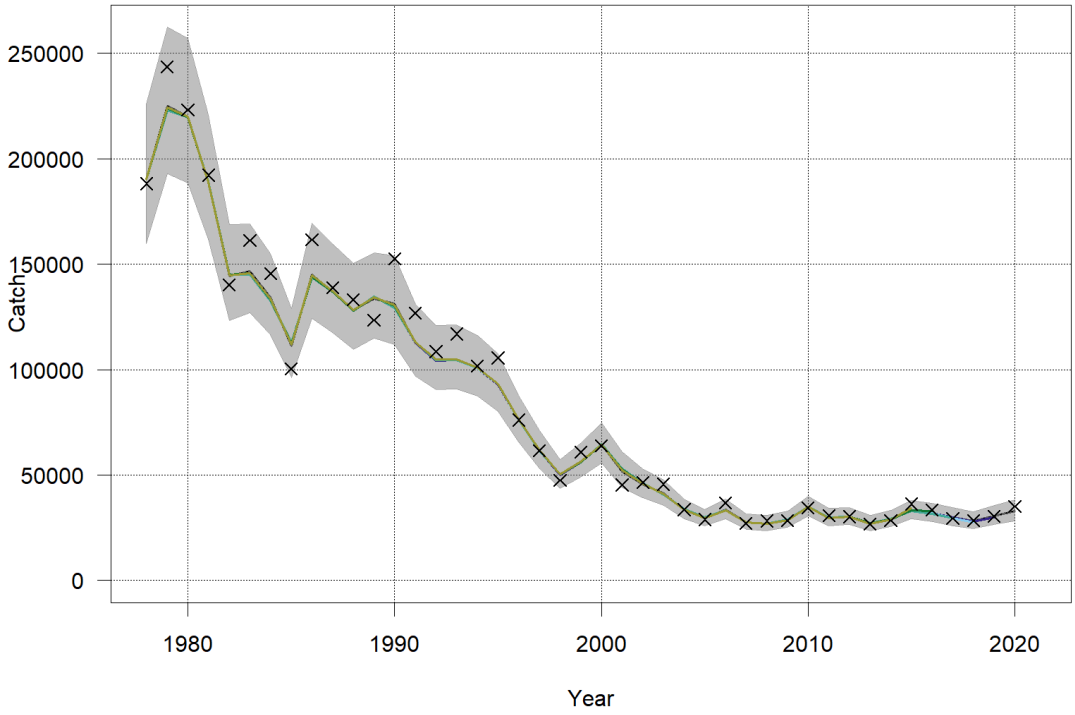
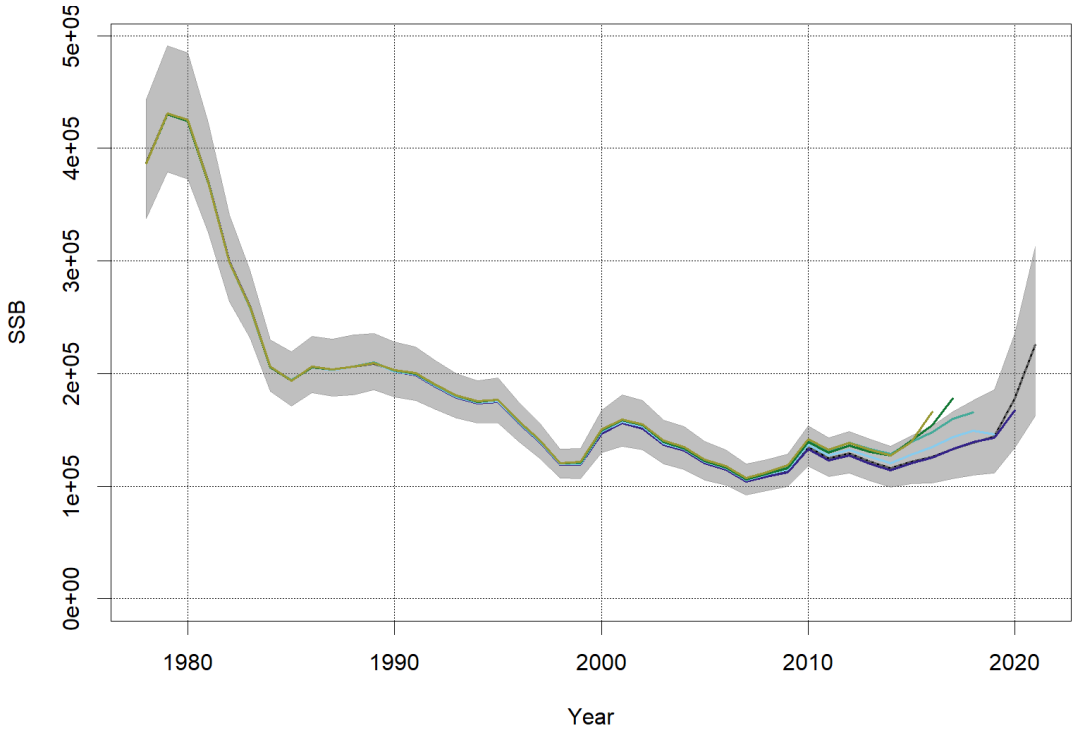


Figure 23.29. Whiting in Subarea 4 and Division 7.d: SAM leave-one-out diagnostics. Final run (black), run without IBTS Q1 (dark blue), run without IBTS Q3 (light blue).


250000
200000
150000
100000
50000
0
Catch
1980
1990
2000
2010
2020
Year


0e+00
1e+05
2e+05
3e+05
4e+05
5e+05
SSB
1980
1990
2000
2010
2020
Year

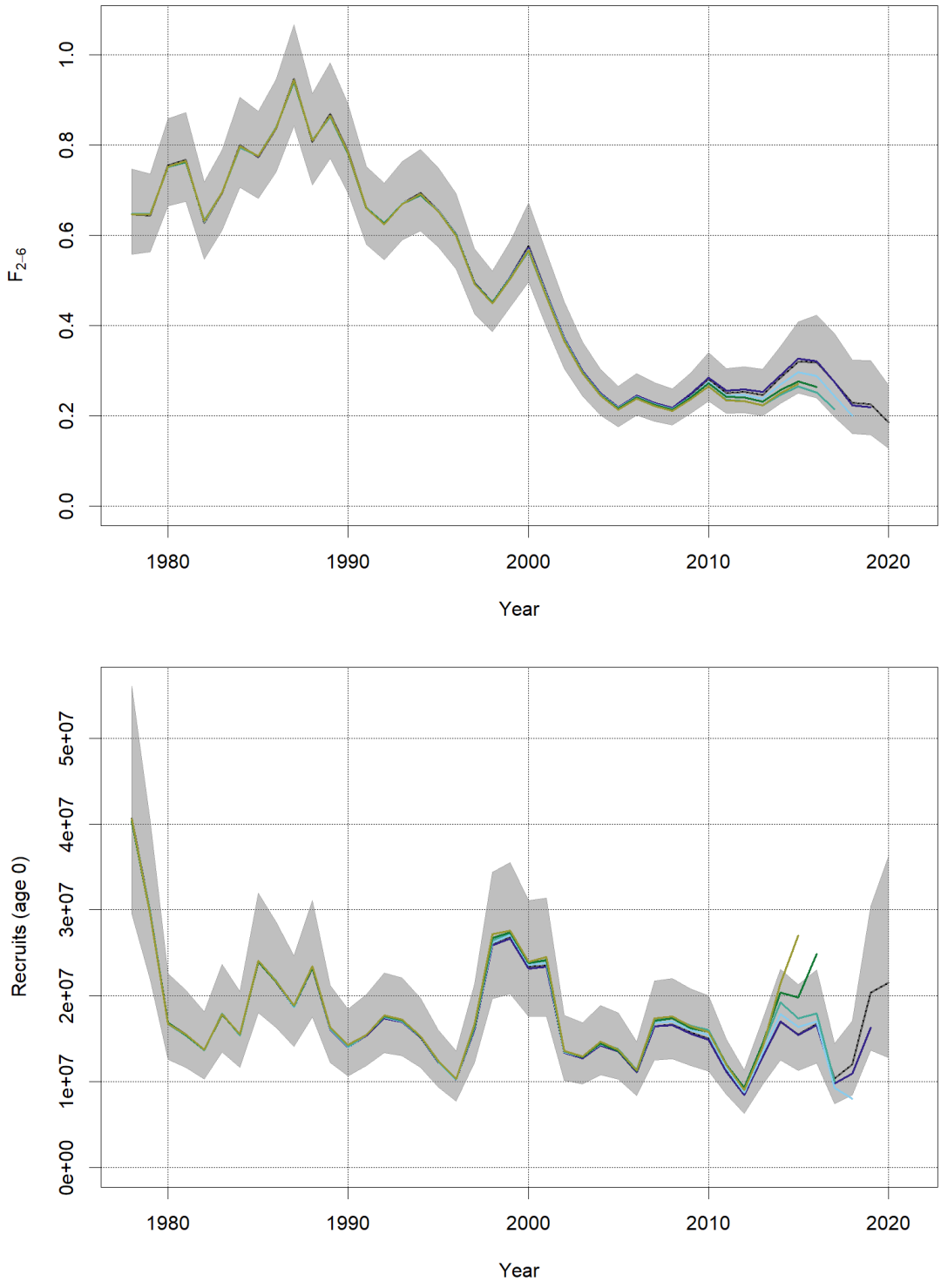


Figure 23.30. Whiting in Subarea 4 and Division 7.d: SAM Retrospective pattern in catch estimates, SSB, fishing mortality and recruitment.

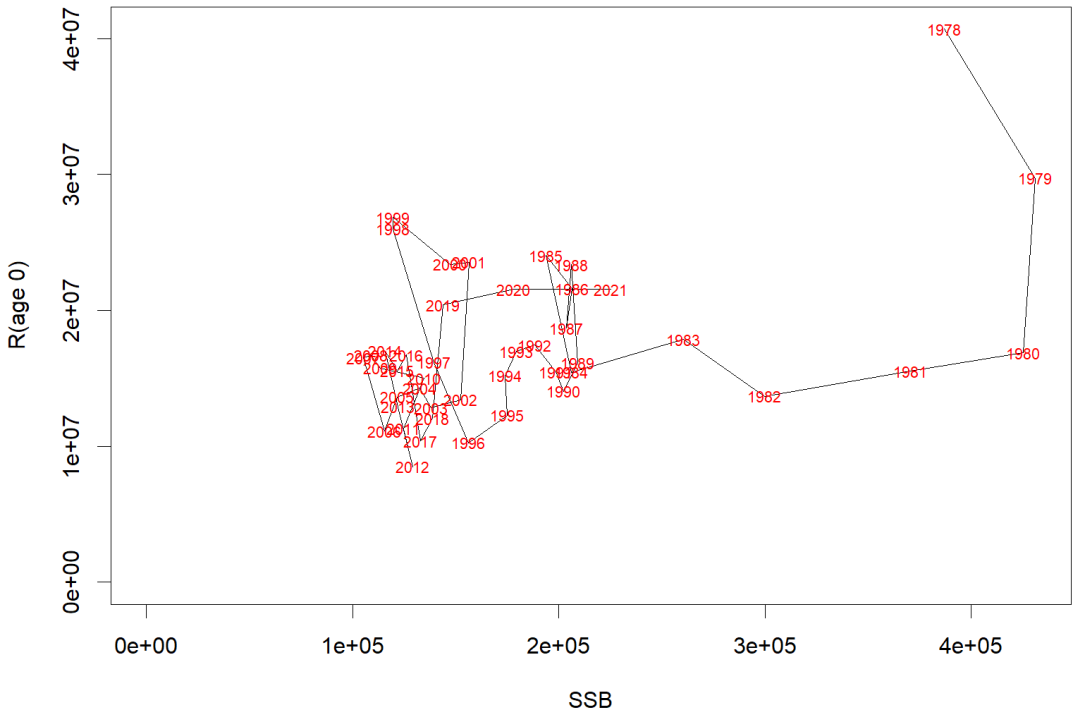


Figure 23.31. Whiting in Subarea 4 and Division 7.d: Stock-recruitment relationship.

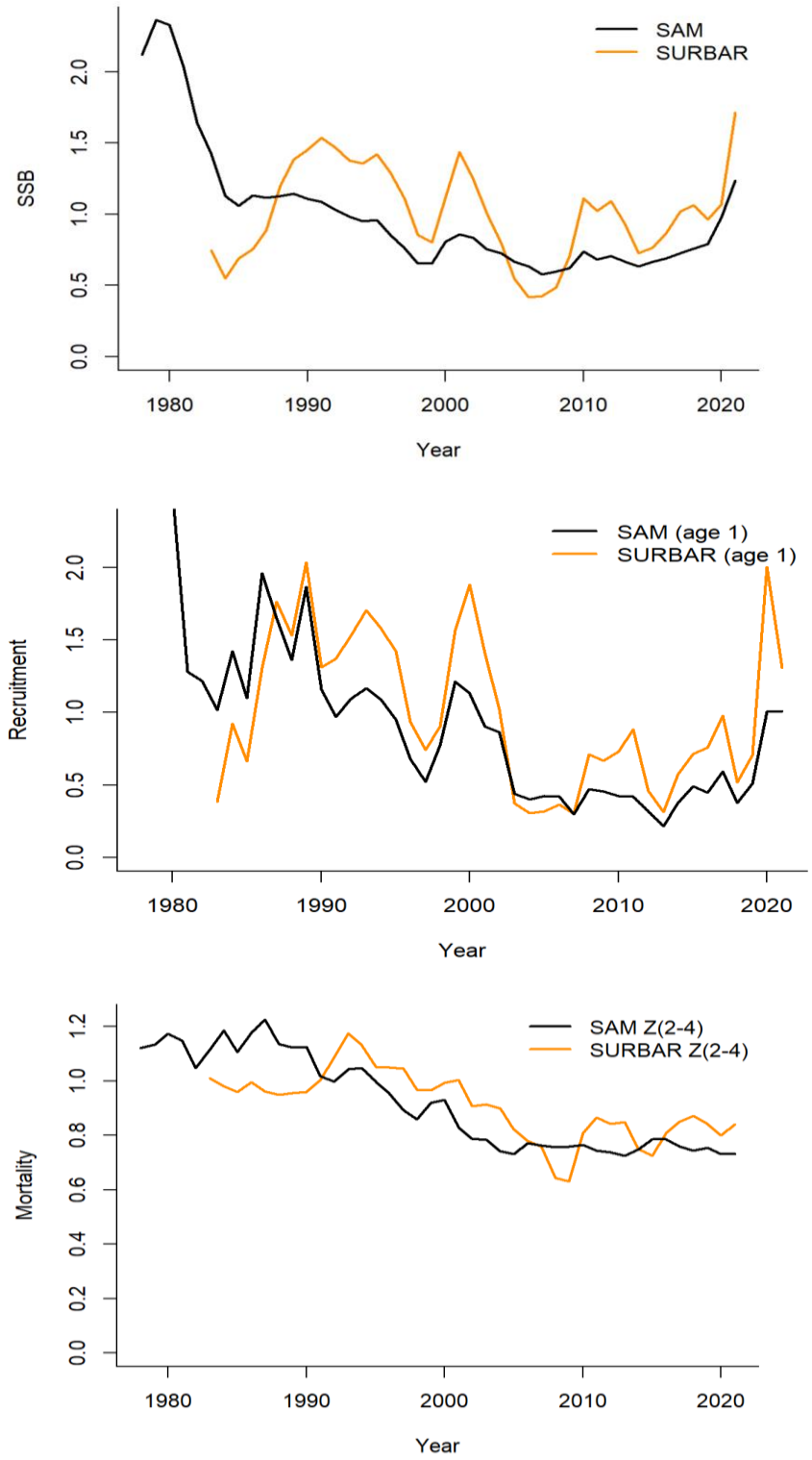


Figure 23.32. Whiting in Subarea 4 and Division 7.d: Comparisons of stock summary estimates from the final SAM (black) and SURBAR (orange) models. To facilitate comparison, recruitment and SSB values have been mean-standardised using the year range for which estimates are available from all three models. Mortality is presented as total mortality Z(2–4) for SAM and for SURBAR.

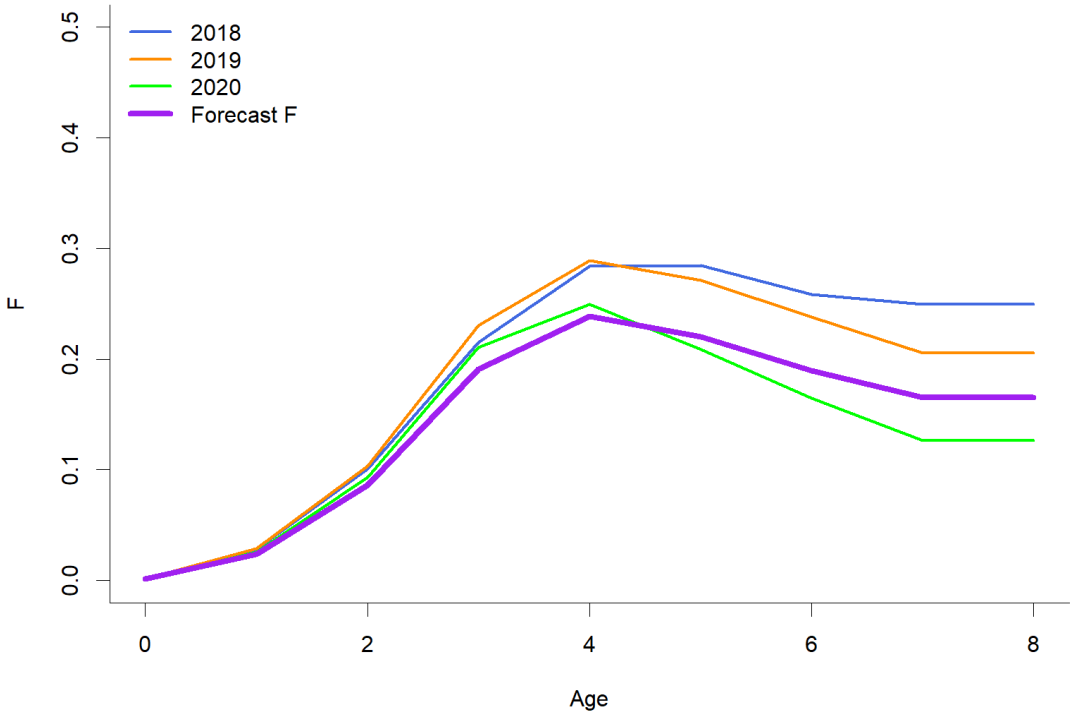


Figure 23.33. Whiting in Subarea 4 and Division 7.d: SAM F at age estimates for 2018–2020, along with scaled mean exploitation used for the forecast.

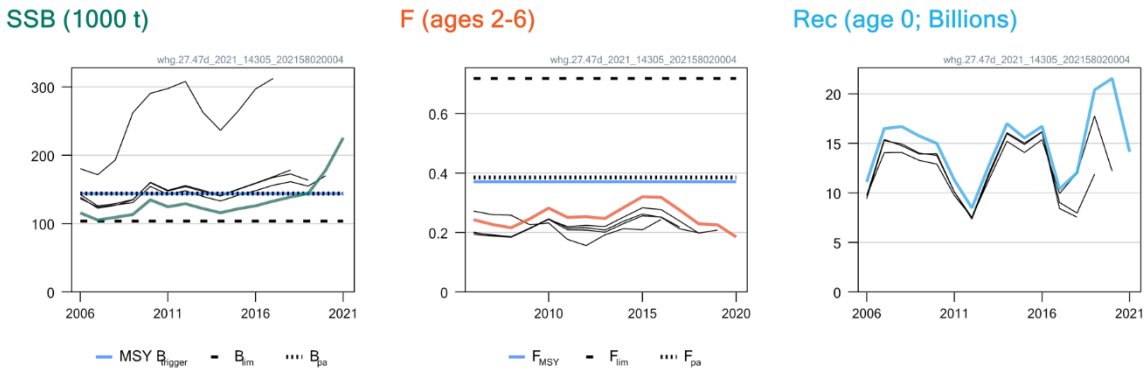


Figure 23.34. Whiting in Subarea 4 and Division 7.d: Historical assessments from Standard graphs.

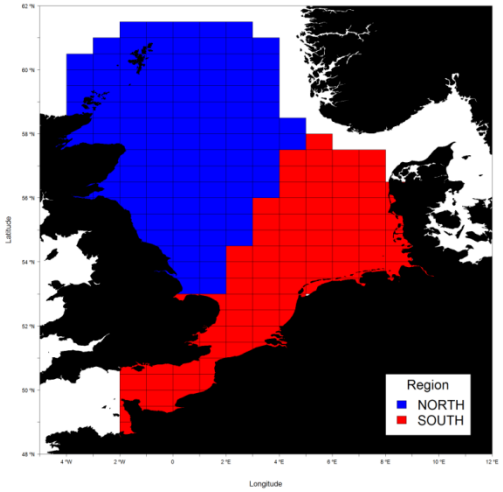


Figure 23.35. Whiting in Subarea 4 and Division 7.d: Components suggested by Holmes *et al*. (2014) to analyse spatial differences in maturation and SURBAR analysis.

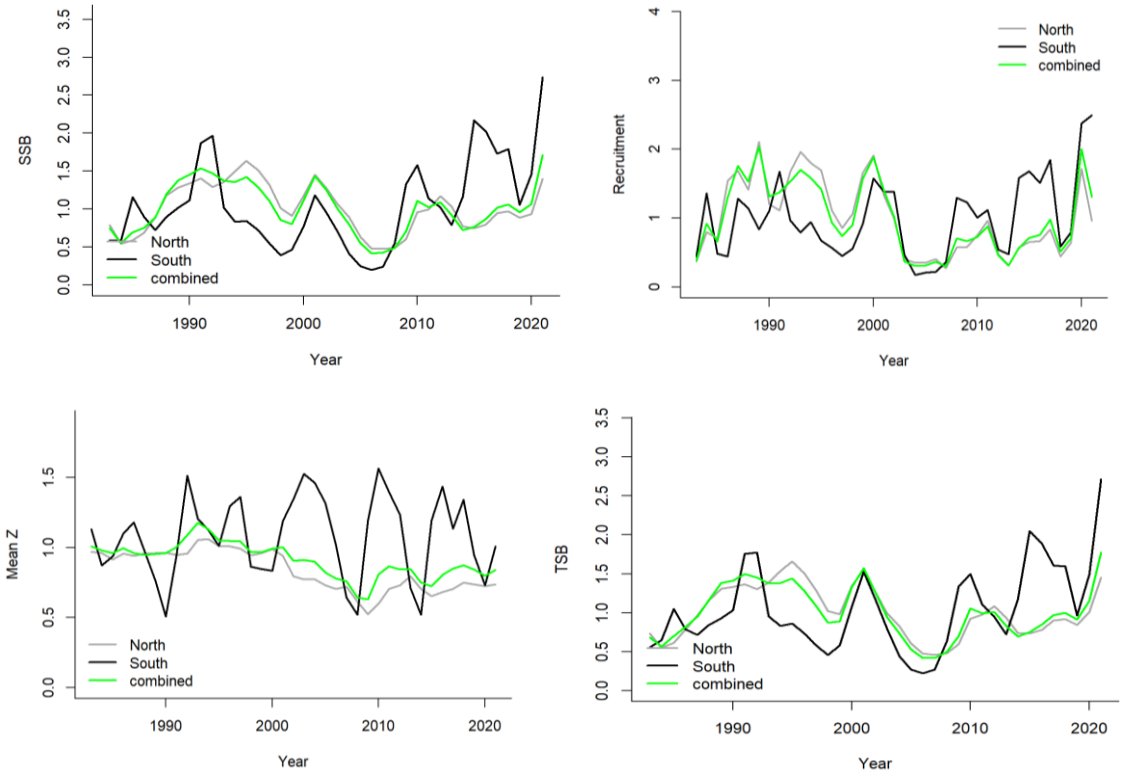


Figure 23.36. Whiting in Subarea 4 and Division 7.d: SURBAR results comparison combined (whg.27.4.47d) and northern and southern component as defined in WKNSEA 2018. Recruitment at age 1, total mortality is mean Z for ages 2–4.

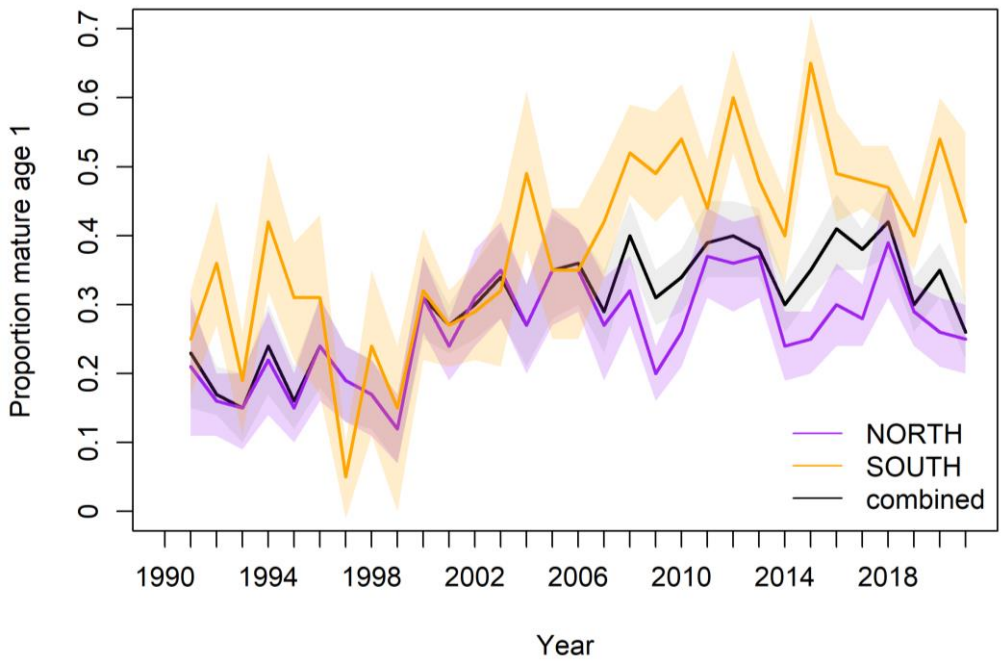


Figure 23.37. Whiting in Subarea 4 and Division 7.d: Trends in proportion mature individuals at age 1 for combined (whg.27.4.47d) and northern and southern component as defined in WKNSEA 2018.