23 Whiting in North Sea and eastern English Channel

whg.27.47d – *Merlangius merlangus* in Subarea 4 and Division 7.d

This section contains the assessment and forecast relating to whiting in the North Sea (ICES Subarea 4) and eastern English Channel (ICES Division 7.d). The current assessment is formally classified as an update assessment. At WGNSSK 2024, the most recent natural mortality estimates (WGSAM; ICES, 2024a) were included in the assessment model and the reference points were revised as a result.

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 (WKNSEA; ICES, 2018). 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 English Channel (27.4 and 27.7d). Exploratory SURBAR assessments were run for individual components (northern and southern component) and compared to the combined stock. Stock dynamics of the stock components show greater synchrony in recent years.

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 (ICES, 2013).

23.2 Fisheries

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

23.3 ICES advice

ICES advice for 2022

In April 2021, ICES concluded as follows:

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 88 426 tonnes. If discard and industrial bycatch rates do not change from the average of the last 3 years (2018–2020), this implies landings of no more than 51 276 tonnes and human consumption catch of no more than 85 460 tonnes.

ICES advice for 2023

In April 2022, ICES concluded as follows:

ICES advises that when the MSY approach is applied, catches in 2023 should be no more than 110 172 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock. Management should be implemented at the stock level.

ICES advice for 2024

In April 2023, ICES concluded as follows:

ICES advises that when the MSY approach is applied, catches in 2024 should be no more than 128 290 tonnes. ICES notes the existence of a precautionary management plan, developed and adopted by one of the relevant management authorities for this stock.

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 English Channel whiting assessments have been combined into one.

Since 2018, with introduction of the landing obligation the EU legislation specifies that 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). IBC of whiting, mainly occurring in the Danish fishery, is regulated separately relating to TAC of the respective target species in the industrial fishery (EU, 2024). In contrast, the TACs for whiting in Subarea 4 and Division 7.d were set by fisheries managers in recent years based on total catches of whiting which include IBC (EU–Norway–UK, 2023). This discrepancy between management and legislation may lead to excess catches of whiting in the North Sea.

The TAC in Subarea 4 has increased in recent years, for 2021 it was 21 306 tonnes, for 2022 it was 26 636 tonnes, for 2023 it was 34 294 tonnes and in 2024 it was 76 697 tonnes. Up to 2023, there was no separate TAC for Division 7.d; landings from this Division are counted against the TAC for Divisions 7.b–k combined (10 259 tonnes in 2021, 8 352 tonnes in 2022, and 8450 t in 2023. Since 2024, the TAC is given for Division 7.d separately (EU–Norway–UK, 2023). For 2024 the TAC for Division 7.d is 18 899 tonnes.

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 2022, 87% of the total landings originated from Subarea 4, in 2023 about 92% 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, these 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 submitted. In 2023 data, no logbook registered discards were submitted. Minor whiting landings have been reported as BMS landings into InterCatch since 2016. In 2023 data, these mostly originated from Scotland by otter bottom trawls (OTB_DEF_>=120, 21 t). Generally, BMS was treated as discards as in previous years.

In 2023 data, 63% 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 2023 are illustrated in Figure 23.1. Discards were raised from discard ratios from Subarea 4 and Division 7.d combined. Data were stratified by gear type (TR1 and TR2) and quarter to raise discards for fleets without imported discards as follows: discards for TR1 fleet were raised by quarter, discards for TR2 fleet were raised by half year (i.e., quarter 1 and 2 together, and quarter 3 and 4 together). For other gear types discards were raised using discard rates from all available fleets. The raised discards amounted to 31% 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 2023 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 64% of the overall landings, from 20 different métiers (Table 23.3.c).

However, although the unsampled fleets provide considerable landings overall (36%), 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 14% of the total landings, all of which occurred in the Danish fishery and were generally 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, 69% were imported into InterCatch. 56% of the imported discards were sampled for age distributions (Table 23.3c). The 9 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 English Channel (Division 7.d).

Figure 23.3 plots the trends in the commercial catch for each component in Subarea 4 and Division 7.d combined.

23.5.2 Age compositions

In 2023, age compositions for the landings and discards were based on samples provided by France, UK (England, Scotland) and Denmark. Age compositions are applied to landings with splitting of fleets on the basis of half year (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 half year (quarter 1 & 2 vs. 3 & 4). 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. In 2023, discards represented 33% of the total catches. In recent years have the catch level has stabilized to a certain extent. There continued to be a high proportion of discarding of whiting up to age 2 (Figure 23.4).

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 sampled weights-at-ages of total catches were used to estimate 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 (WKNSEA; ICES 2018, Figure 23.6). Unsmoothed values of weights-at-age are used in the assessment (Table 23.13). For the calculation of SSB in 2024, the recent 3-year average of maturity age was used in the assessment model.

23.5.4 Maturity

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

The number of individuals sampled at age has slightly decreased in 2024 but is still considered representative. This reduction is due to a combination of factors, low 2023 cohort, bad weather conditions during the survey, and lack of age sampling data from the Dutch IBTS Q1 survey (Table 23.24b). The sensitivity of maturity estimates to the lack of Dutch sampling data was tested and was found not have had an impact on maturity ogive estimation.

In 2022 and 2024, a high proportion mature at age 1 was estimated (A_{50} below 1). A new maturity scales was introduced in 2021, since then some countries submit more than 1 stage of immatures (A, Ba) allowing for higher resolution maturity data. Submission of mature stage B (combining immatures Ba and matures Bb) may impact maturity ogives by overestimation of the number of mature individuals. However, estimated proportions of matures at age were smoothed before inclusion in the assessment model, which limits the impact of these particular years. The sensitivity to the number of knots used in the GAM model was tested. Using constant 4 knots ensures smoothing including new years of data while keeping historical values stable. Increasing the number of knots increased variability of estimated values back in time. Therefore, 4 knots continues to be used in the GAM smoothing of maturity estimates.

For the calculation of SSB in 2024, the recent 3-year (2021-2023) average of maturity age was used in the assessment model.

23.5.5 Natural mortality

Estimates of natural mortality (M) are taken from the 2023 update key run from of the SMS multispecies model (WGSAM; ICES, 2024a). Natural mortality estimates were smoothed before inclusion in the assessment model (Table 23.15, Figure 23.8). The same natural mortality was assumed for individuals 6 years and older. Data is available up to 2022. For the assessment, natural mortality estimates for 2023 are assumed identical to 2022. For the year 2024, the recent 3-year (2021-2023) average of natural mortality was used.

The updated natural mortality values show a reduction in mortality on age 1. Details on the update of natural mortalities, impact on assessment and update of reference points are described in section 23.17.

23.5.6 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, ICES 2021a). 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. The time series is extended each year since 2021 with new indices calculated using 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 1983–2024 and 1991–2023, respectively. The report of the 2001 meeting of WGNSSK (ICES, 2002) and the ICES advice for 2002 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) 2019–2024, are presented. In recent years, high density of age 1 whiting appears mostly in the southern North Sea. Whiting aged 3+ can be found in high abundance throughout the Greater North Sea. Figure 23.10, the third quarter is represented (Q3) for ages 0–3+ for the years 2019–2023. Similarly, as in Q1, in recent years low recruitment at age 0 is seen in the northern North Sea, while significant survey catches occurred in the southern North Sea. High densities of fish aged 3+ can be observed throughout the North Sea in recent years.

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, 2018) 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 were updated as a result (IBPNSWhiting; ICES, 2021c). In April 2022, the SAM assessment model settings were updated to accommodate a plusgroup at age 6 (previously age 8) and F averaged across age 2 to 5 (previously 2 to 6). This was done in order to address retrospective patterns caused by a drop in the abundance of age 7 and 8 individuals which resulted in a much higher F, and lower SSB, compared to previous assessments. The reference points were updated during the WGNSSK 2022 meeting (Annex 8, ICES, 2022).

At WGNSSK 2024, the most recent natural mortality estimates provided by WGSAM (ICES, 2024a) were included in the assessment model and the reference points were revised as a result.

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 underestimate of the 2011, 2017- and 2018-year class at age 0. However, numbers at age 2 in the 2007- and 2013 year class may well be an overestimate.

In both quarters, indices at younger age have increased in recent years after low values in the late 2000s and early 2010s.

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 and 2021 is estimated to have been much higher than in recent years although values in 2024 are much lower, while SSB and TSB have increased to historically high values. The log survey residuals (Figure 23.17) suggest in most recent years some negative residuals in Q1 and positive residuals in Q3 that suggest a trade-off between surveys in the SURBAR model.

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, particularly in the more recent time period. Also evident is the persistence of the 1999- to 2001-year classes in past catches and the low catches of the year classes since 2002.

The negative gradients of log catches per cohort, averaged over ages 2–6 are given in Figure 23.20. The gradients appear to 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 since 2000. For the 2010-2012

cohort the negative gradient of commercial catch data was lowest in the series (similar to 2015 cohort). Slopes for the catch curves were less steep for this cohort, indicating relatively higher CPUE at higher ages.

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 6+. 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). For the 2006-2012 year classes, 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, 2018). During WGNSSK 2022, it was agreed to update the model with a plus group at age 6 and F averaged over ages 2 to 5 in order to address retrospective patterns (Annex 8, ICES, 2022). The 2024 assessment model, including input data, results and diagnostics can be found on www.stockassessment.org as “NSwhiting_2024”. For comparison also a SAM run of the 2024 assessment using old natural mortality estimates is available (“NSwhiting_2024_OldMs”).

The settings as given by the configuration file, updated during WGNSSK 2022, are provided below (further details can be found in the Stock Annex).

```
Catch-at-age data                                          1978-2019      ages 0-6+
Survey: IBTS Q1                                            1983-2020      ages 1-5
Survey: IBTS Q3                                            1991-2019      ages 0-5

$minAge
# The minimim age class in the assessment
 0

$maxAge
# The maximum age class in the assessment
 6

$maxAgePlusGroup
# Is last age group considered a plus group (1 yes, or 0 no).
 1

$keyLogFsta
# Coupling of the fishing mortality states (normally only first row is used).
   0   1   2   3   4   5   5
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$corFlag
# Correlation of fishing mortality across ages (0 independent, 1 compound symmetry, or 2 AR(1)
 2

$keyLogFpar
# Coupling of the survey catchability parameters (normally first row is not used, as that is covered
by fishing mortality).
  -1  -1  -1  -1  -1  -1  -1
  -1   0   1   2   3   3  -1
   4   5   6   7   8   8  -1

$keyQpow
```

```
# Density dependent catchability power parameters (if any).
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyVarF
# Coupling of process variance parameters for log(F)-process (normally only first row is used)
   0   0   0   0   0   0   0
  -1  -1  -1  -1  -1  -1  -1
  -1  -1  -1  -1  -1  -1  -1

$keyVarLogN
# Coupling of process variance parameters for log(N)-process
 0 1 1 1 1 1

$keyVarObs
# Coupling of the variance parameters for the observations.
   0   1   1   1  1   1   4
  -1   2   2   2   2   2  -1
   3   3   3   3   3   3  -1

$obsCorStruct
# Covariance structure for each fleet ("ID" independent, "AR" AR(1), or "US" for unstructured). |
Possible values are: "ID" "AR" "US"
 "ID" "AR" "AR"

$keyCorObs
# Coupling of correlation parameters can only be specified if the AR(1) structure is chosen above.
# NA's indicate where correlation parameters can be specified (-1 where they cannot).
#0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8
  NA  NA  NA  NA  NA  NA
  -1   0   0   0   0  -1
   1   1   2   2   2  -1

$stockRecruitmentModelCode
# Stock recruitment code (0 for plain random walk, 1 for Ricker, and 2 for Beverton-Holt).
 0

$noScaledYears
# Number of years where catch scaling is applied.
 0

$keyScaledYears
# A vector of the years where catch scaling is applied.


$keyParScaledYA
# A matrix specifying the couplings of scale parameters (nrow = no scaled years, ncols = no ages).

$fbarRange
# lowest and higest age included in Fbar
 2 5

$keyBiomassTreat
# To be defined only if a biomass survey is used (0 SSB index, 1 catch index, and 2 FSB index).
 -1 -1 -1

$obsLikelihoodFlag
# Option for observational likelihood | Possible values are: "LN" "ALN"
 "LN" "LN" "LN"

$fixVarToWeight
# If weight attribute is supplied for observations this option sets the treatment (0 relative weight,
1 fix variance to weight).

 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.

Final SAM run model parameters are given in Table 23.21.

Estimated correlations between ages 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 show no apparent cohort effects across ages. For the fishing mortality process, in recent years the negative residuals for log(F) are apparent with some tendency for a year effect (Figure 23.24). This might relate to relatively low fishing mortality estimated in the recent period.

Standardized one-observation–ahead residuals are presented for each fleet in Figure 23.25. These look reasonable with some negative residuals in the plusgroup in catch and IBTS Q1 in recent years. The IBTS–Q3 survey appear to fit slightly better to the model than the IBTS–Q1 survey, which demonstrate some year effects in the 2010s 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 23.28 which show the comparison of predicted and observed points for each survey fleet. The single fleet SAM runs were conducted to compare trends in estimated stock dynamics by using either survey data for quarter 1 or 3 separately. Summary plots of these runs together with the final run are presented in Figure 23.29. These leave-one-out runs show that leaving out IBTS Q3 has a stronger effect on the assessment results than leaving out IBTS Q1. With IBTS Q1 data alone, stock size is underestimated. This impact is comparable to the negative residuals observed for IBTS Q1 in the SURBAR results (Figure 23.17). The population trends from each survey are consistent. The mean F and SSB estimates are consistent across the time-series with only some differences in most recent year's estimates. Recruitment peaks are less pronounced when using only IBTS Q1 data in the model, since indices at age 0 are only available from IBTS Q3. The run using only quarter 3 matches more closely the final SAM run with both surveys included, in particular for recruitment.

A retrospective analysis is shown in Figure 23.30. The retrospective patterns show that results were robust to removing up to 5 years of recent data. Mohn's rho measures the retrospective bias, values are given in Table 23.21 and confirm the relatively low retrospective bias in recruitment, SSB and fishing mortality. The Mohn's Rho value for SSB is below the acceptable threshold of 0.2 set by WKFORBIAS (ICES, 2020a). Retrospective peels are generally covered by the confidence interval, apart from one peel for recruitment.

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). Standard deviation for log(Recruitment) is relatively low for most of the time series (just above 0.1). Only in recent years the values increases somewhat, with 2023 value just below 0.3, as expected since recruitment estimates become more uncertain at the end of the time series (Figure 23.32). The 2023 recruitment is value still considered reasonable for inclusion in the forecast calculations.

The total biomass at age for ages 2+ is illustrated in Figure 23.33. As the stock size increases, a large proportion of the stock biomass is found in age group 4+. The plusgroup (6+) currently contains around 10% of the total biomass (ages 2+), a slight increase in recent years.

Finally, Figure 23.34 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. 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 level and trends are similar.

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 2023 of 0.083. The SSB was at extremely high levels before 1983 (no survey information included prior 1983). SSB estimates since 2020 show a dramatic increase with recent values on par with the early 1980s estimates, although the values suggest that this increase may be starting to level off.

Recruitment has been fluctuating around a recent (post 2001) lower average but is showing an increase in recent years. Recruitment is estimated to be relatively high in 2019 and 2020, while values in 2021-2023 are back at the post-2001 average. In the most recent year, landings, discards and industrial bycatch have also all remained at or around a recent average.

23.9 Biological reference points

The 2013 benchmark meeting (WKROUND; ICES, 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, 2016a). This included EqSim runs and an MSE. It was found that 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, 2018). $F_{p.05}$ 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. Following a request by EU and Norway the management strategy was tested using a full MSE (ICES, 2019a, b). At the time results indicated that the MSY approach with F_{MSY}=0.172 was not precautionary in the long-term.

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). The reference points B_{lim} = 119 970 and F_{MSY} = 0.172, set for North Sea whiting at the benchmark 2018 (ICES, 2018), were suggested to remain unchanged. Retrospectives and Mohn's rho indicated that using the completely 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) (see Annex 9, 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, 2021c). The new F_{MSY} value is 0.371 and the new B_{lim} value is 103 560. In April 2022, following the update of the SAM assessment model new reference points were estimated using EqSim. In WGNSSK 2024, natural mortality estimates were updated following a new NS SMS key run by ICES WGSAM (see section 27.27). 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 2023 were used as input population numbers for ages 1 and older in 2024. Recruitment (age 0) assumptions are detailed in Table 23.24. In the intermediate and following two years the geometric mean of recruitment from 2003–2023 is used.

The exploitation pattern is chosen as the mean exploitation pattern over the most recent three years 2021–2023. The mean exploitation pattern was scaled to the mean F_{2-5} in 2023 for forecasts. 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 2021–2023. The F at age used in the forecast is compared with the F at age estimates for 2021–2023 in Figure 23.36.

Mean weights at age are generally consistent over the recent period but there is variability at several ages (Figure 23.5 and 23.6). To avoid introducing bias, therefore, the average of estimates of 2021–2023 are used for the purposes of forecasting. The strong trend as observed between 2000 and 2015 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_{2024} equal to mean F_{2023} (using the average selectivity over the last 3 historical years) results in human consumption catch in the intermediate year 2024 of 28 829 tonnes from a total catch of 30 988 tonnes (Table 23.26).

Carrying the same fishing mortality forward into 2025 (the status quo F option, F_{sq}) would result in human consumption catch of 27 549 tonnes out of total catches of 29 660 tonnes, and would result in an SSB of 363 356 tonnes in 2025 and 353 699 tonnes in 2026 (an SSB change of -2.7%).

Since SSB in 2025 is predicted to be higher than MSY $B_{trigger}$, following the MSY approach allows for applying F_{MSY} leading to an F_{target} of 0.68.

Applying the F_{MSY} of 0.68 in 2025 would generate human consumption catches of 235 580 tonnes out of total catches of 237 008 tonnes, and result in an SSB of 191 923 tonnes in 2026 (a 47% decrease in SSB relative to 2025 of 363 356 tonnes). In 2026, SSB would be above B_{lim} and MSY $B_{trigger}$.

Change in advice

The change in advice for 2025 (+85% when compared to 2024) is caused by an update of natural mortality estimates in the assessment and the revision of reference points.

The new natural mortality estimates led to reduction in recruitment and recruitment forecast numbers and biomass (Fig. 23.40, 23.41). Furthermore, recruitment in 2023 is estimated to be lower than previously assumed. Both the stock weights-at-age (Fig. 23.42) and the selectivity (Fig. 23.44) used in last year's and this year's forecasts are similar. The assumptions used in both last year's and this year's forecasts are summed up in Table 23.33 and Figure 23.45. Here, the difference in target fishing mortality in the forecasts are visible, caused by an update in reference points.

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, 2009; ICES, 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 (SGSIMUW; ICES, 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, 2018) 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, 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 both 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 otolith 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 23.35. The difference in stock numbers and fishing mortality is due to updates of the SAM assessment model and natural mortality estimates in 2021, 2022 and 2024.

23.13 Status of the stock

For North Sea whiting, SSB has an upwards trend in recent years trend. SSB is estimated to be above MSY $B_{trigger}$, B_{pa} and B_{lim} (Figures 23.22, 23.35). The stock, at the level of the entire North Sea and eastern English Channel, was at an historical low level in the late 2000s, and the recent increase in SSB is in large part due to relatively improved perception of recruitment in 2014–2016 and 2019-2020. All indications are that fishing mortality has been declining over most of the time-series, currently fluctuating around a low level. Since 1989, fishing mortality has been below $F_{MSY} = 0.68$. While landings have been relatively stable in recent years, discards decreased in recent years slightly. The development of whiting biomass depends on the size of recruitment. Recruitment in 2019 and 2020 is estimated to be high and on par with levels observed prior to 2002. Stock biomass estimated for 2024 increased and is well above MSY $B_{trigger}$.

23.14 Management considerations

In 1996, 2006, 2011, 2012, 2017 and 2023, the whiting stock produced the lowest recruitments in the series (below 8 billions). In recent years an increased proportion of whiting mature already at age 1 and grow quickly at young ages; therefore, an increase in SSB is seen soon 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. Due to the high stock size, there is currently little concern for this stock.

Catches of whiting have been declining since 1980 (from 243 570 tonnes in 1979 to 27 601 tonnes in 2023, including discards and industrial bycatch).

Catch rates from localized fleets may not represent trends in the overall North Sea and eastern 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 relatively 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. The most significant measure would be to improve selectivity and reduce under-sized catches in those fisheries with high rates of discarding. Currently, other choke species in the mixed fishery have helped to keep fishing mortality low on this whiting stock. Low fishing mortality together with high recruitment has led to stock biomass increase in recent years.

BMS landings reported to ICES in 2015–2023 were low. In 2023, 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. A reopening in autumn will not be necessary for this stock since stock biomass is well above $MSYB_{trigger}$.

23.15 SURBAR Northern Southern stock component

Exploratory SURBAR assessments were run for individual components (northern and southern component, Figure 23.37) using component area-specific DATRAS survey indices provided by

ICES (Tables 23.27–28) and estimated area-specific maturity ogives (Tables 23.29–30, Figure 23.39 a, b). 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 in recruitment, TSB and SSB; while mean total mortality showed stronger fluctuations for the southern component (Figure 23.38). The SURBAR analyses indicate that the southern stock component (as well as the combined stock) 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. The northern component has high SSB comparable to historic levels in the mid 1990ies.

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 English 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, 2021c). Following updates to the SAM assessment model during WGNSSK 2022, reference points were updated (see Annex 8, ICES, 2022). At WGNSSK 2024 new mortality estimates from WGSAM were included in the model (ICES, 2024a), and reference points were updated accordingly (see section 23.17).

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 (updated 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 with up-to- date data should be explored. This would allow incorporation of survey uncertainty into the assessment. The availability and impact of alternative indices (HERAS, DRS) can 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. Alternative plusgroup (previously 8+) and alternative settings in SAM should be explored.

23.16.2 Reference points and Forecast

An alternative management strategy can be explored, such the ICES approach to MSY-based management for short-lived species in the form of an escapement strategy based on a stochastic forecast.

Currently a deterministic forecast continues to be done in MFDP. A SAM forecast can be considered which allows fleet separation (human consumption and industrial bycatch fleet) and stochastic forecast.

23.17 Update of natural mortality and reference point recalculation

23.17.1 Update of natural mortality estimates

New estimates of natural mortality-at-age for North Sea whiting were obtained from the latest North Sea SMS key run reviewed during the last WGSAM meeting (ICES, 2024a). The new raw natural mortality-at-age estimates (Table 23.34, Figure 23.46) were smoothed to reduce the effect of interannual variability while capturing the trend in natural mortality over time, as was done during the benchmark in 2018. The gam function (R package gam) was used to fit a generalized additive model to smooth natural mortality for each age class separately. Smoothing spline was applied assuming Gaussian error and df=5 (where degrees of freedom df=1 implies a linear fit) as follows for each age:

gam(new_nm[,i] ~ s(c(1978:2022),5), family=gaussian)

Smoothed new natural mortality estimates are compared to old values in Figure 23.47. Compared to the smoothed natural mortality estimates from the previous key run from WGSAM (ICES, 2021b), the new mortalities show lower mortality estimates for age 0 and age 1. The differences between new and old mortalities are relatively small for age 1+. Predation on age 0 whiting is dominated by grey gurnard and to a smaller degree by cannibalism from older whiting. The difference between old and new natural mortality estimates of age 0 whiting is caused by a reduction in estimated predation mortality from horse mackerel.

For the assessment at WGNSS 2024, natural mortality estimates for 2023 are taken as the same as the smoothed values for 2022 (Table 23.15). For 2024, natural mortality were obtained by averaging the smoothed values at each age over the last 3 years (2021-2023).

Results from different SAM assessment models were compared in order to assess the impact of the new mortalities (Figure 23.48).

- The 2024 SAM assessment with the old mortalities
- The 2024 SAM assessment with the new mortalities (agreed WGNSSK 2024 assessment)
- The 2023 SAM assessment with the old mortalities

The assessments with old natural mortality estimates are similar for 2023 and 2024 assessment runs. The inclusion of new natural mortality estimates leads to lower recruitment, slight increase in SSB and decrease in F.

23.17.2 Update of reference points

The SAM was used to assess the North Sea whiting stock. The results were transformed into an FLR stock object and EqSim was run to determine the ICES reference points. The simulations

were run with a fisheries selectivity based on the last 3 years of selectivity data. The fisheries selectivities are relatively stable in the recent 3-10 years (Figure 23.50), using the most recent 3 years was found to be representative for recent fishing activity and was used throughout. Biological variables were used from the recent 10 years (Figures 23.51, 23.52). The assessment time series since 1983-2023 are included for estimation of stock-recruitment relationship, excluding the years prior to 1983 (years without survey data as input to assessment model).

B_{lim} is an important reference point from which other precautionary reference points are derived. The stock does not present a case of spasmodic recruitment (Figure 23.52). No clear relation between SSB and recruitment could be seen, with no identifiable SSB level at which recruitment was impaired (Figure 23.53). Following ICES technical guidelines, therefore this stock is classified as Type 5 stock, and B_{lim} should be equal to B_{loss} which is the lowest SSB observed historically. Based on the results, the lowest SSB was observed in 2007 with 119 585 tonnes, such that B_{lim} = 119 585 tonnes.

B_{pa} was estimated based on B_{lim} as follows:

$B_{pa}=B_{lim}*1.4$= 167 419 tonnes.

The spawning stock recruitment relationship was selected to be segmented regression with breakpoint at B_{lim} from the truncated time series 1983-2023 with an estimated autocorrelation in recruitment in the first lag of rho=0.42 for all EqSim runs (Figure 23.54).

To estimate F_{lim}, EqSim was run without assessment/advice error and without the advice rule. The resulting F_{lim} (F_{50}) obtained was 1.18.

EqSim run without advice/assessment error and without advice rule, to determine F_{lim}.

	catF	lanF	catch	landings	catB	lanB
F_{05}	0.563728	NA	72084.29	NA	182493.9	NA
F_{10}	0.680224	NA	76376.93	NA	169286.6	NA
F_{50}	1.183814	NA	78755.06	NA	119566	NA
medianMSY	NA	0.783784	NA	40523.55	NA	159147.9
meanMSY	0.942211	0.738693	81774.28	40482.8	144759.9	163501.6
Med_{lower}	NA	0.477477	NA	38513.8	NA	194247.5
$Mean_{lower}$	NA	0.467676	NA	39669.51	NA	NA
Med_{upper}	NA	1.084084	NA	38518.56	NA	130899.8
$Mean_{upper}$	NA	1.018946	NA	39654.1	NA	NA

F_{MSY} was initially calculated based on an EqSim with assessment/advice error and without advice rule (without MSY $B_{trigger}$), which should give maximum sustainable yield. Assessment and advice error is included using the values $(F_{cv}, F_{phi}) = (0.212, 0.423)$, the defaults suggested by WKMSYREF4 (ICES, 2015).

The resulting unconstrained F_{MSY} obtained (median MSY for lanF) was F_{MSY} = 0.74. The corresponding equilibrium plot is shown in Figure 23.55.

EqSim run with advice/assessment error and without advice rule, to determine unconstrained F_{MSY}.

	catF	lanF	catch	landings	catB	lanB
F_{05}	0.535176	NA	69960.28	NA	185248.2	NA
F_{10}	0.649524	NA	74356.53	NA	171536.1	NA
F_{50}	1.154819	NA	75697.8	NA	119582.6	NA
medianMSY	NA	0.743243	NA	39884.46	NA	161803.4
meanMSY	0.904523	0.723618	79424.12	39878.56	146062	163745.7
Med_{lower}	NA	0.463964	NA	37905.69	NA	195309.3
$Mean_{lower}$	NA	0.455725	NA	39421.27	NA	NA
Med_{upper}	NA	1.027027	NA	37912.7	NA	133925.5
$Mean_{upper}$	NA	0.987573	NA	39434.03	NA	NA

MSY $B_{trigger}$ is a lower bound of the SSB distribution when the stock is fished at F_{MSY}. Calculations for MSY $B_{trigger}$ were based on EqSim runs without assessment/advice error and without advice rule.

For most stocks that lack data on fishing at F_{MSY}, MSY $B_{trigger}$ is set at B_{pa}. However, as a stock starts to be fished consistently with F_{MSY}, a value for MSY $B_{trigger}$ could be set to reflect the 5th percentile definition of B_{Fmsy}. Here, the stock has been fished at or below the initial F_{MSY} (0.74) for the last 10 years. The 5th percentile of B_{Fmsy} was calculated running an EqSim without assessment/advice error and without advice rule and is estimated to be 100 255 tonnes which is below B_{pa} (167 419 tonnes, Figure 23.56). Therefore, MSY $B_{trigger}$ is set to B_{pa}.

Fbar (last 10 years) of the new assessment. All values are below the MSY reference point.

Year	Fbar
2014	0.212
2015	0.248
2016	0.248
2017	0.217
2018	0.201
2019	0.197
2020	0.170
2021	0.134
2022	0.094
2023	0.083

Using the advice rule, it should be checked that when fishing at F_{MSY} the probability of falling below B_{lim} remains smaller than 5%, $F_{p.05\ AR}$ (F_{pa}). This is to ensure consistency between the precautionary and the MSY frameworks. Therefore, if the initial F_{MSY} value is above $F_{p.05\ AR}$, F_{MSY} is reduced to $F_{p.05\ AR}$. The same test is performed for the F_{MSY} ranges.

$F_{p.05\ AR}$ was calculated by running EqSim with assessment/advice error and with advice rule to ensure that the long term risk of SSB<B_{lim} of any F used does not exceed 5% when applying the advice rule.

$F_{P.05\ AR}$ was estimated to be 0.68, which is lower than F_{MSY} and $F_{MSY\ upper}$ ranges, which were therefore capped.

$F_{MSY\ lower}$ was recalculated as the $F_{MSY\ lower}$ as the yield that is 95% of the yield at the new F_{MSY} (0.68), from the EqSim run with assessment/advice error and with advice rule. $F_{MSY\ lower}$ is 0.46.

Reference points are summarized in Table 23.23 and plotted together with recent assessment results in Figure 23.57.

EqSim run with assessment/advice error, with advice rule to test whether F_{MSY} was at or below $F_{p.05\ AR}$.

	catF	lanF	catch	landings	catB	lanB
F_{05}	0.681989	NA	75052.41	NA	170813.4	NA
F_{10}	0.850947	NA	79079.67	NA	158596.3	NA
F_{50}	NA	NA	NA	NA	NA	NA
medianMSY	NA	0.938438	NA	40521.02	NA	153513.5
meanMSY	1.5	0.964824	83210.29	40513.93	129288.9	152129.6
Med_{lower}	NA	0.51952	NA	38511.67	NA	187542.4
$Mean_{lower}$	NA	0.516977	NA	40137.62	NA	NA
Med_{upper}	NA	1.5	NA	38885.62	NA	129311.8
$Mean_{upper}$	NA	1.5	NA	40878.75	NA	NA

The reference points have changed substantially since the last reference point update in 2022 (Table 23.25). F_{MSY} is now 74% higher than previously estimated, while biomass reference points based on B_{loss} increased only by 12% only. The strong increase in fishing mortality reference points cannot solely be attributed to the update in natural mortality estimates. Retrospective reference points calculations were performed to evaluate the impact of additional years of data. From 2021 to 2024 the unconstrained F_{MSY} increased from 0.5 to 0.74, with the strongest increase when including data from 2022 and 2023. When plotting the equilibrium yield curves of the retrospectives for the EqSim runs for the estimation of the initial (unconstrained) F_{MSY}, with assessment/advice error and without advice rule, we find curves show an increase in maximum of mean landings moving to higher values of F and wider curves (Figure 23.58). When comparing the resulting harvest control rules the slope become steeper as F_{MSY} increases while B_{lim} and MSY $B_{trigger}$ stay the same being based on B_{loss} in 2007 (Figure 23.59).

In the two last years, SSB has reached historically high values of SSB. For the reference point calculation, only stock recruitment pairs from 1983 have been used such that recent SSB is substantially higher than previously used values. At the same time the proportion mature at age 1 has recently peaked, such that the around 50% of age 1 whiting assumed to contribute to

reproduction (Table 23.14a). When comparing selectivity and maturity (taking the absolute difference) indicates that in recent years for most age groups the proportion being mature is higher than the proportion selected by the fishery (Figure 23.60). This shift is particularly obvious for age 1 and 2. This ensure a sufficient proportion of the stock is mature ensuring reproduction and recruitment even at very high levels of fishing mortality.

Short-cut MSE robustness test show the reference points are precautionary in the long term (Figure 23.60, 23.61). Due to the stock having such high SSB, is difficult to push the stock below MSY $B_{trigger}$ in the short term.

In its current state North Sea whiting can not only sustain high levels of natural mortality (M>1 for age 0-1, M=0.5 for ages 2+, Figure 23.8) but also high levels of fishing mortality (F_{MSY} of 0.68).

23.18 References

EU–Norway–UK. 2023. Agreed record of fisheries consultations between the European Union, Norway and the United Kingdom for 2024. 8 December 2023, 26 pp. https://oceans-and-fisheries.ec.europa.eu/system/files/2023-12/2023-12-08-EU-NO-Bilateral-Agreed-Record-2024.pdf

EU. 2018. Regulation (EU) 2018/973 of the European Parliament and of the council of 4 July 2018 establishing a multiannual plan for demersal stocks in the North Sea and the fisheries exploiting those stocks, specifying details of the implementation of the landing obligation in the North Sea and repealing Council Regulations (EC) No 676/2007 and (EC) No 1342/2008. Official Journal of the European Union, L. 179. 13 pp. http://data.europa.eu/eli/reg/2018/973/oj

EU. 2024. Council Regulation (EU) 2024/257 of 10 January 2024 fixing for 2024, 2025 and 2026 the fishing opportunities for certain fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU) 2023/194. Official Journal of the European Union. 246 pp. http://data.europa.eu/eli/reg/2024/257/oj

ICES. 2002. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES CM 2002/ACFM:02.

ICES. 2005. Report of the Study Group on Stock Identity and Management Units of Whiting, (SGSIMUW), 15–17 March 2005, Aberdeen. ICES CM 2005/G:03.

ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Roundfish (WKROUND), January 16–23, 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:32: 259 pp.

ICES. 2013. Report of the Benchmark Workshop on Roundfish Stocks (WKROUND). 4-8 February 2013, Marine Laboratory, Aberdeen, UK. ICES CM 2013/ ACOM:47, 213 pp.

ICES. 2015. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.

ICES. 2016a. Report of the Inter-benchmark protocol for Whiting in the North Sea (IBP Whiting), By correspondence, March 2016. ICES IBP Whiting Report 2016. ICES CM 2016/ACOM: 48, 119 pp.

ICES. 2016b. Report of the Workshop on Age estimation of Whiting (Merlangius merlangus) (WKARWHG2), 22–25 November 2016, Lowestoft, UK. ICES CM 2016\SSGIEOM:15: 1–47.

ICES. 2018. Report of the Benchmark Workshop on North Sea Stocks (WKNSEA 2018), 5–9 February 2018, Copenhagen, Denmark. ICES CM 2018/ACOM:33. 636 pp.

ICES. 2019a. EU and Norway request concerning the long-term management strategy of cod, saithe, and whiting, and of North Sea autumn-spawning herring. In Report of the ICES Advisory Committee, 2019. ICES Advice 2019, sr.2019.06, https://doi.org/10.17895/ices.advice.4895

ICES. 2019b. Workshop on North Sea Stocks Management Strategy Evaluation (WKNSMSE). ICES Scientific Reports 1:12, 378 pp.

ICES. 2020a. Workshop on Catch Forecast from Biased Assessments (WKFORBIAS; outputs from 2019 meeting). ICES Scientific Reports. 2:28. 38 pp. http://doi.org/10.17895/ices.pub.5997.

ICES. 2020b. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. 2:61. 1140 pp. http://doi.org/10.17895/ices.pub.6092

ICES. 2021a. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. 3:66. 988 pp. http://doi.org/10.17895/ices.pub.8211

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

ICES. 2021c. Inter-benchmark Protocol of North Sea Whiting (IBPNSWhiting). ICES Scientific Reports. 3:34. 38 pp. https://doi.org/10.17895/ices.pub.7924.

ICES. 2022. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. 4:43. 1367pp.http://doi.org/10.17895/ices.pub.19786285

ICES. 2024a. Working Group on Multispecies Assessment Methods (WGSAM; outputs from 2023 meeting). ICES Scientific Reports. 6:13. 218 pp. https://doi.org/10.17895/ices.pub.25020968

ICES. 2024b. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports.

23.19 Tables and figures

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. n/a=not available

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Belgium.4	1040	913	1030	944	1042	880	843	391	268	529
Denmark.4	1206	1528	1377	1418	549	368	189	103	46	58
Faroe.4	26	0	16	7	2	21	0	6	1	1
France.4	4951	5188	5115	5502	4735	5963	4704	3526	1908	n/a
Germany.4	692	865	511	441	239	124	187	196	103	176
Lithuania.4	0	0	0	0	0	0	0	0	0	0
Nether-lands.4	3273	4028	5390	4799	3864	3640	3388	2539	1941	1795
Norway.4	55	103	232	130	79	115	66	75	65	68
Sweden.4	16	48	22	18	10	1	1	1	0	9
UK.4										
Eng-land.Wales.4	2338	2676	2528	2774	2722	2477	2329	2638	2909	2268
Scotland.4	27486	31257	30821	31268	28974	27811	23409	22098	16696	17206
Total.land-ings.4	41083	46606	47042	47301	42216	41400	35116	31573	23937	n/a

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Unallo-cated.land-ings.4	-1097	396	1832	691	346	850	-434	633	247	n/a
ICES.land-ings.4	42180	46210	45210	46610	41870	40550	35550	30940	23690	25700
ICES.dis-cards.4	52270	30840	28470	41400	31840	28940	27130	16660	12480	22110
ICES.ibc.4	51337	39755	25045	20723	17473	27379	5116	6213	3494	5038
ICES.catch.4	145787	116805	98725	108733	91183	96869	67796	53813	39664	52848
TAC.4.2a										

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium.4	536	454	270	248	144	105	93	45	116	162	147	74
Denmark.4	105	105	96	89	62	57	251	78	42	79	158	135
Faroe.4	0	0	17	5	0	0	0	0	0	2	0	0
France.4	2527	3455	3314	2675	1721	1261	2711	3336	3076	2305	2644	2794
Germany.4	424	402	354	334	296	149	252	76	76	124	156	111
Lithuania.4	0	0	0	0	0	0	0	0	0	0	0	0
Nether-lands.4	1884	2478	2425	1442	977	805	702	618	656	718	614	514
Norway.4	33	44	47	38	23	16	17	11	92	73	118	28
Sweden.4	4	6	7	10	2	0	2	1	2	4	8	6
UK.4							11632	12110	10391	8853	7845	8892
England. wales.4	1782	1301	1322	680	1209	2560						
Scotland.4	17158	10589	7756	5734	5057	3441						
Total. land-ings.4	24453	18834	15608	11255	9491	8394	15660	16275	14451	12320	11690	12554
Unallo-cated. land-ings.4	173	-426	738	805	541	-2286	563	609	972	-124	-1111	-706
ICES. landings.4	24280	19260	14870	10450	8950	10680	15097	15666	13479	12444	12801	13260
ICES. discards.4	21931	16130	17144	26135	18142	10300	14018	5206	8356	6597	8451	7989

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ICES.ibc.4	9160	940	7270	2730	1210	890	2190	1240	0	1344	1907	1035
ICES.catch.4	55371	36330	39284	39315	28302	21870	31305	22112	21835	20385	23159	22283
TAC.4.2.a	30000	29700	41000	16000	16000	28500	23800	23800	17850	15173	12897	14832

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Belgium.4	45	33	46	70	65	71	71	142	211	126	116	163
Denmark.4	131	124	160	2375	4727	2804	2026	2113	3520	2493	1311	2957
Faroe.4	0	0	0	0	8	1	0	80	25	0	0	0
France.4	1925	942	1884	1131	1232	952	918	890	677	478	457	253
Germany.4	25	44	31	73	111	82	99	81	277	201	103	228
Lithunania.4	0	0	0	0	0	0	0	0	20	0	0	0
Nether-lands.4	471	495	464	581	644	791	684	911	799	726	726	951
Norway.4	94	560	918	1088	1150	993	1025	1102	1674	1098	909	1014
Sweden.4	4	1	2	0	6	11	8	18	28	67	40	214
UK.4	9893	11162	10290	10015	9412	9263	10689	11846	12191	11591	10694	11474
Eng-land.wales.4												
Scotland.4												
Total.land-ings.4	12588	13361	13795	15333	17355	14968	15520	17183	19422	16775	14356	17254
Unallo-cated.land-ings.4	-356	-456	-52	2101	5113	3140	2942	1649	3444	2612	1218	2810
ICES.land-ings.4	12944	13817	13847	13232	12242	11828	12578	15534	15978	14163	13138	14444
ICES.dis-cards.4	9307	4608	7016	12265	10413	9799	8026	7581	9749	9930	9170	7881
ICES.ibc.4	1117	1654	1623	2097	4551	2635	1658	1864	3115	2048	827	2632
ICES.catch.4	23368	20079	22486	27593	27206	24262	22263	24979	28842	26141	23136	27601
TAC.4.2.a	17056	18932	16092	13678	13678	16003	22057	17191	17158	21306	26636	34294

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. n/a= not available

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	n/a	n/a	5414	5032	6734	5202	4771	4532	4495	n/a	5875
Nether-lands.7.d	0	0	0	0	0	0	1	1	32	6	14
Germany.7.d	0	0	0	0	0	0	0	0	0	0	0
Ireland.7.d	0	0	0	0	0	0	0	0	0	0	0
UK.7.d											
Eng-land.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.land-ings.7.d	n/a	n/a	5923	5429	7088	5551	5056	4779	4765	n/a	6072
Unallo-cat.land-ings.7.d	n/a	n/a	183	219	468	161	106	159	165	n/a	1772
ICES.land-ings.7.d	3480	5720	5740	5210	6620	5390	4950	4620	4600	4430	4300
ICES.dis-cards.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											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
Nether-lands.7.d	67	19	175	132	128	117	118	162	112	275	282
Germany.7.d	0	0	0	0	0	0	0	0	0	0	0
Ireland.7.d	0	0	0	0	0	0	0	0	0	0	0
UK.7.d						72	63	87	138	258	271
Eng-land.wales.7.d	134	112	109	99	90						
Scotland.7.d	0	0	0	0	0						
Total.land-ings.7.d	6614	5361	7005	5283	4901	3749	3391	3192	6569	6133	5464
Unalloc.land-ings.7.d	814	-439	1295	933	111	306	137	-1279	649	-967	315
ICES.land-ings.7.d	5800	5800	5710	4350	4790	3443	3254	4471	5920	7100	5149
ICES.dis-cards.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	2021	2022	2023
Belgium.7.d	66	95	90	121	146	128	138	144	45	56	50	29
France.7.d	3093	3076	2126	3102	2771	2378	2720	2106	1309	1724	1319	870
Nether-lands.7.d	437	650	663	565	556	593	484	611	330	229	259	243
Germany.7.d	0	0	0	0	0	0	0	0	1	3	7	3
Ireland.7.d	0	0	0	0	0	0	0	0	0	0	0	2
UK.7.d	261	472	345	379	259	358	283	259	302	417	323	134
Eng-land.wales.7.d												
Scotland.7.d												
Total.land-ings.7.d	3857	4293	3224	4167	3732	3457	3625	3120	1987	2429	1958	1281
Unalloc.land-ings.7.d	-556	-15	99	190	32	103	143	145	76	179	-42	-34
ICES.land-ings.7.d	4413	4308	3125	3977	3700	3354	3482	2975	1911	2250	2000	1315
ICES.dis-cards.7.d	2389	2186	2709	4627	2313	1550	2562	2499	4046	4708	2743	1288
ICES.catch.7.d	6802	6494	5834	8604	6013	4904	6044	5474	5957	6958	4742	2602
TAC.7b.k	19053	24500	20668	17742	22778	27500	22213	19184	10863	10259	8352	8450

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

Catch Category	SOP
BMS landing	0.9638
Discards	1.075
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	34.17	100
Discards	Imported_Data	5869	69

Catch Category	Raised or Imported	CATON tonnes	Percent
Discards	Raised_Discards	2631	31
Landings	Imported_Data	18371	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	Sampled_Distribution	11840	64
Landings	Imported_Data	Estimated_Distribution	6531	36
Discards	Imported_Data	Sampled_Distribution	3206	38
Discards	Raised_Discards	Estimated_Distribution	2631	31
Discards	Imported_Data	Estimated_Distribution	2663	31
BMS landing	Imported_Data	Estimated_Distribution	34.17	100

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).

CatchCategory	RaisedOrImported	SampledOrEstimated	Area	CATON	perc
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.7.d	0	NA
Landings	Imported_Data	Sampled_Distribution	27.7.d	655.9	51
Landings	Imported_Data	Estimated_Distribution	27.7.d	640.4	49
Discards	Raised_Discards	Estimated_Distribution	27.7.d	960.4	81
Discards	Imported_Data	Sampled_Distribution	27.7.d	189	16
Discards	Imported_Data	Estimated_Distribution	27.7.d	39.65	3
BMS landing	Imported_Data	Estimated_Distribution	27.7.d	0	NA
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4.c	0	NA
Landings	Imported_Data	Estimated_Distribution	27.4.c	861.3	100
Discards	Raised_Discards	Estimated_Distribution	27.4.c	490.7	100
BMS landing	Imported_Data	Estimated_Distribution	27.4.c	0	NA

CatchCategory	RaisedOrImported	SampledOrEstimated	Area	CATON	perc
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4.b	0	NA
Landings	Imported_Data	Estimated_Distribution	27.4.b	293.7	100
Discards	Raised_Discards	Estimated_Distribution	27.4.b	162.2	100
BMS landing	Imported_Data	Estimated_Distribution	27.4.b	0.001	100
Logbook Registered Discard	Imported_Data	Estimated_Distribution	27.4.a	0	NA
Landings	Imported_Data	Estimated_Distribution	27.4.a	1026	100
Discards	Raised_Discards	Estimated_Distribution	27.4.a	356.9	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	11184	75
Landings	Imported_Data	Estimated_Distribution	27.4	3710	25
Discards	Imported_Data	Sampled_Distribution	27.4	3017	48
Discards	Imported_Data	Estimated_Distribution	27.4	2624	42
Discards	Raised_Discards	Estimated_Distribution	27.4	660.7	10
BMS landing	Imported_Data	Estimated_Distribution	27.4	34.17	100

Table 23.4. Whiting in Subarea 4 and Division 7.d. Total catch numbers-at-age (thousands). Age 6 is a plus-group. Estimated by ICES, input data for SAM. Ages 0–6+ are included in the final assessment. Model input.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	687238	418909	313391	242369	90047	7564	7564	1851	253	11	9	4	0	0	0	0	9692
1979	476383	615525	467538	218283	100976	29267	3111	1657	264	35	1	4	0	0	0	0	5072
1980	332209	265359	416009	286077	90719	52969	10752	1153	689	58	14	5	1	0	0	0	12672
1981	516869	162899	346343	266518	102295	27776	12297	3540	244	45	37	1	0	0	0	0	16164
1982	101057	192641	114443	245247	88137	26796	6909	2082	400	53	26	4	1	0	0	0	9475
1983	668604	205647	184747	118411	131507	37231	8688	1780	793	101	35	0	0	0	0	0	11397
1984	157819	323408	175965	124886	49504	59817	13860	2964	410	182	21	0	0	0	0	0	17437
1985	186723	203321	141716	82037	37847	14420	17446	3329	805	89	9	1	0	0	0	0	21679
1986	225202	576732	167078	169578	46516	13368	3487	3975	497	71	0	1	0	0	0	0	8031
1987	84863	267051	368230	122748	85240	11391	4555	928	930	98	7	0	0	0	0	0	6518
1988	416924	430344	307429	179503	39635	17902	2174	544	59	72	37	0	0	0	0	0	2886
1989	87325	331672	173676	191942	78464	14367	5051	517	291	37	6	1	0	0	0	0	5903
1990	289174	258102	501373	127967	84147	31102	1933	719	93	16	0	0	0	0	0	0	2761
1991	1057999	135797	194921	184960	36290	25554	5339	526	249	17	1	0	0	0	0	0	6132
1992	259390	230302	167479	87820	91081	11654	6634	2546	104	7	1	0	0	0	0	0	9292
1993	628301	223424	172049	125599	46181	45300	3898	1501	682	56	15	0	0	0	0	0	6152

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1994	218287	191544	158369	97559	51041	18683	17905	1258	441	73	0	0	0	0	0	0	19677
1995	1597900	148169	144023	112416	35649	15061	5117	4472	314	101	54	0	0	0	0	0	10058
1996	96515	86318	118910	99644	48304	14087	4638	1282	897	166	24	6	2	0	0	0	7015
1997	19001	60946	80471	84336	41975	18303	3333	1012	305	135	16	0	0	0	0	0	4801
1998	72289	92556	50362	43424	36295	17628	6343	1417	306	66	34	0	0	0	0	0	8166
1999	76975	189162	95415	45920	33921	18271	7443	2021	565	95	12	0	0	0	0	0	10136
2000	1970	82546	129582	63706	23913	16199	8758	4309	969	244	47	3	0	0	0	0	14330
2001	18012	52567	83085	52076	20800	9256	4826	2233	896	246	124	2	0	0	0	0	8327
2002	135848	51338	62462	84600	34659	8099	2048	1461	621	102	13	9	9	0	0	0	4263
2003	60744	83680	111144	55866	41841	14217	2359	473	329	50	16	1	0	0	0	0	3228
2004	34210	47966	23009	32557	30400	21755	8342	1352	198	93	12	1	4	0	0	0	10002
2005	17622	47805	34626	12204	18146	14931	8979	3041	540	83	29	1	0	0	0	0	12673
2006	15673	73908	42199	21651	8642	15077	11822	4618	1300	142	14	0	0	0	0	0	17896
2007	2490	39041	34001	24900	9906	4008	7657	5268	2560	476	82	0	0	0	0	0	16043
2008	5631	62163	28301	22741	13571	4305	1847	3954	2134	631	143	43	0	0	0	0	8752
2009	12139	57412	31004	15181	12782	7432	3380	2153	2601	1801	1967	20	1	0	0	0	11923
2010	3930	33756	33320	25516	9932	7776	6263	2136	4347	1491	1053	30	1	0	3	0	15324
2011	3563	31377	42201	28903	12537	3813	3178	2090	877	472	1293	31	1	0	0	0	7942

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2012	3548	53445	32509	18882	14862	6952	2773	1558	1213	624	482	15	37	0	0	0	6702
2013	4341	20378	15548	25362	15593	10812	3343	1048	643	660	292	0	0	0	0	0	5986
2014	6225	29785	14623	17450	19683	11351	4710	2038	1018	641	431	0	0	0	0	0	8838
2015	7705	48349	53345	15714	10220	14163	5068	2086	1210	607	401	4	0	0	0	0	9376
2016	17208	27639	36165	36788	9129	7813	6046	2548	691	694	376	0	0	0	0	0	10355
2017	28724	27355	27315	24442	18432	4176	2421	2683	1349	1165	26	5	0	0	0	0	7649
2018	15656	17302	41274	26023	17040	6786	1437	1013	803	36	163	38	0	0	0	0	3490
2019	4515	29380	24143	39669	17364	7151	3087	1063	555	273	76	0	0	0	0	0	5054
2020	26813	41940	32019	29992	19892	6596	2286	640	166	35	1	1	0	0	0	0	3129
2021	35094	27281	57391	21520	12296	8836	3265	898	143	12	0	0	0	0	0	0	4318
2022	321	3998	27906	40950	13909	5750	2988	980	355	3	0	0	0	0	0	0	4326
2023	6120	15887	8945	27397	30546	6613	2881	1333	414	38	2	1	0	0	0	0	4669

Table 23.5. Whiting in Subarea 4 and Division 7.d. Landings numbers-at-age (thousands), as estimated by ICES. Age 6 is a plus-group. Data used to calculate the landing fraction in the model estimates of catches.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	0	14793	99836	155424	76829	6693	7202	1837	253	11	9	4	0	0	0	0	9316
1979	8	8488	108548	144343	89093	26584	3011	1617	250	35	1	4	0	0	0	0	4918
1980	0	3656	62405	152570	68422	41430	9911	1135	689	58	14	5	1	0	0	0	11813
1981	6	4240	69211	104348	78253	23698	12036	3530	244	45	37	1	0	0	0	0	15893

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1982	0	10890	46703	124656	59393	21376	5664	2058	400	53	26	4	1	0	0	0	8206
1983	1	10568	68640	67312	101342	31266	8330	1730	784	101	35	0	0	0	0	0	10980
1984	0	14388	62693	99204	41277	51745	12735	2813	410	182	21	0	0	0	0	0	16161
1985	1	2288	51194	57049	32340	12974	16361	3238	805	89	9	1	0	0	0	0	20503
1986	29	12879	44500	111527	37287	11285	3379	3912	485	71	0	1	0	0	0	0	7848
1987	22	11074	72372	70504	73742	10808	4506	928	899	98	7	0	0	0	0	0	6438
1988	0	7462	61360	94163	29147	16556	2158	544	56	72	37	0	0	0	0	0	2867
1989	52	8636	28406	77009	44307	9249	3888	420	208	35	6	1	0	0	0	0	4558
1990	23	6910	52533	43850	48537	16845	1341	605	91	16	0	0	0	0	0	0	2053
1991	410	11565	42525	88974	25738	21261	4581	396	249	17	1	0	0	0	0	0	5244
1992	298	9565	44697	47843	59208	9784	6099	1453	99	7	1	0	0	0	0	0	7659
1993	720	5957	28935	63383	32819	33741	2932	1339	682	56	15	0	0	0	0	0	5024
1994	77	17124	31351	45492	36289	13920	14407	914	366	73	0	0	0	0	0	0	15760
1995	277	8829	28027	58046	27775	13652	4911	4359	308	101	54	0	0	0	0	0	9733
1996	1015	12517	26611	47125	35828	11861	4396	1103	897	166	24	6	2	0	0	0	6594
1997	608	6511	23436	47717	31503	15615	2931	1010	289	135	15	0	0	0	0	0	4380
1998	1202	17071	19828	24860	24473	14579	5395	1204	219	64	16	0	0	0	0	0	6898
1999	68	16661	26669	25504	23465	14483	6554	1854	514	61	12	0	0	0	0	0	8995

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2000	0	15384	31808	28283	14241	11775	6618	3758	862	244	47	3	0	0	0	0	11532
2001	150	12260	28476	27293	17491	8633	4503	2091	877	246	124	2	0	0	0	0	7843
2002	0	2610	10346	30890	22353	6712	1710	1330	511	99	10	9	9	0	0	0	3678
2003	20	403	11613	13990	18974	9513	1861	443	329	50	16	0	0	0	0	0	2699
2004	0	3973	2812	9629	13302	11846	4409	747	174	84	12	1	4	0	0	0	5431
2005	74	11009	10414	5669	10926	10283	5933	2343	321	78	29	1	0	0	0	0	8705
2006	11	11055	11023	8494	5362	12259	10161	4118	1080	105	6	0	0	0	0	0	15470
2007	140	10378	14740	16491	7666	3310	6681	4227	2179	383	77	0	0	0	0	0	13547
2008	0	13234	12334	14120	9106	3564	1519	2505	1481	568	143	43	0	0	0	0	6259
2009	79	3056	17397	11259	10762	6411	3072	1994	2408	1679	1846	19	1	0	0	0	11019
2010	2	1368	8848	15426	6939	6296	3922	1922	1331	1378	979	24	1	0	0	0	9557
2011	32	4524	17621	14180	10021	2811	2303	1741	820	441	1215	30	1	0	0	0	6551
2012	0	2540	10148	11200	11692	6127	2020	1331	902	557	401	14	35	0	0	0	5260
2013	0	1724	7008	15154	11656	9344	2774	937	556	405	232	0	0	0	0	0	4904
2014	1	3211	7422	9439	12082	8031	3221	1673	806	566	329	0	0	0	0	0	6595
2015	136	3022	15736	7802	6584	9232	3800	1617	887	523	358	4	0	0	0	0	7189
2016	0	1405	9098	16279	5922	4187	4104	1747	550	573	312	0	0	0	0	0	7286
2017	0	731	6509	10287	12841	2666	1711	1640	1092	962	23	5	0	0	0	0	5433

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2018	0	1264	12061	13819	11797	5389	1159	798	729	33	150	35	0	0	0	0	2904
2019	0	2387	6217	21428	13320	6133	2529	963	500	227	69	0	0	0	0	0	4288
2020	1188	4844	9771	13246	13016	4932	1868	444	129	26	1	1	0	0	0	0	2469
2021	859	3751	11333	12400	8970	6456	1636	731	28	10	0	0	0	0	0	0	2405
2022	5	1250	8336	15847	7750	4676	2500	473	319	3	0	0	0	0	0	0	3295
2023	11	1206	3616	9277	18286	4892	2486	1064	357	23	2	1	0	0	0	0	3933

Table 23.6. Whiting in Subarea 4 and Division 7.d. Discards numbers-at-age (thousands), as estimated by ICES. Age 6 is a plus–group. Data used to calculate the discard fraction from the model estimate of catches.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	28587	52684	114965	37682	7154	255	110	0	0	0	0	0	0	0	0	0	110
1979	4577	473830	126724	31601	7322	1263	27	7	0	0	0	0	0	0	0	0	34
1980	3144	103203	250735	88399	14135	10795	786	0	0	0	0	0	0	0	0	0	786
1981	867	50407	96509	57403	7313	1285	149	10	0	0	0	0	0	0	0	0	159
1982	18639	53753	26922	52349	18230	2972	343	22	0	0	0	0	0	0	0	0	365
1983	71016	152488	85318	33325	23442	4309	295	25	9	0	0	0	0	0	0	0	329
1984	16724	200589	82563	16814	4437	4495	1034	151	0	0	0	0	0	0	0	0	1185
1985	8497	154232	48791	15117	2985	761	801	65	0	0	0	0	0	0	0	0	866
1986	7966	404604	120492	43479	5242	627	108	63	12	0	0	0	0	0	0	0	183
1987	9978	158531	202154	34824	9776	582	49	0	31	0	0	0	0	0	0	0	80

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1988	21321	65021	87197	51135	5877	846	16	0	3	0	0	0	0	0	0	0	19
1989	6898	150598	36712	61442	21267	3276	103	8	12	0	0	0	0	0	0	0	123
1990	147764	83152	241924	33084	23009	11665	246	85	0	0	0	0	0	0	0	0	331
1991	7208	81678	82053	75035	5176	1885	91	60	0	0	0	0	0	0	0	0	151
1992	7587	105838	63830	27659	23115	1231	355	1064	2	0	0	0	0	0	0	0	1421
1993	48873	128248	104844	51054	9205	10727	521	131	0	0	0	0	0	0	0	0	652
1994	8352	96890	102020	37751	9867	2885	2338	7	0	0	0	0	0	0	0	0	2345
1995	33363	53830	81783	50019	7136	1336	206	113	6	0	0	0	0	0	0	0	325
1996	4575	43126	86878	49817	11506	2205	240	179	0	0	0	0	0	0	0	0	419
1997	11525	26188	34948	32473	9398	2412	400	2	16	0	1	0	0	0	0	0	419
1998	6098	50703	24200	17053	11076	2987	936	213	87	2	18	0	0	0	0	0	1256
1999	14762	96413	56365	15228	9016	3104	862	167	51	34	0	0	0	0	0	0	1114
2000	1682	48162	81086	24082	3075	2311	1560	478	107	0	0	0	0	0	0	0	2145
2001	17352	39826	52156	23055	2795	471	283	142	19	0	0	0	0	0	0	0	444
2002	1158	10597	33371	45125	10136	1182	218	131	110	3	3	0	0	0	0	0	465
2003	3584	65829	94497	39301	21654	4314	449	30	0	0	0	1	0	0	0	0	480
2004	10478	31169	15698	21879	16951	9909	3922	605	24	9	0	0	0	0	0	0	4560
2005	5499	25753	23486	6041	7192	4616	2992	688	211	5	0	0	0	0	0	0	3896

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2006	15662	51961	25906	10935	2474	2595	1598	493	219	37	8	0	0	0	0	0	2355
2007	2350	22508	16283	7153	1784	572	940	1037	380	93	5	0	0	0	0	0	2455
2008	5631	48929	15967	8621	4465	741	328	1449	653	63	0	0	0	0	0	0	2493
2009	11540	51883	12179	3192	1382	653	139	52	64	32	24	0	0	0	0	0	311
2010	3701	30464	22610	8713	2444	1038	1988	99	2775	34	18	4	0	0	3	0	4921
2011	3430	25925	23211	13753	2053	862	760	272	24	13	29	0	0	0	0	0	1098
2012	3471	49677	21362	6943	2497	493	633	154	259	37	59	0	0	0	0	0	1142
2013	4149	17715	7711	8710	2899	693	343	40	44	217	43	0	0	0	0	0	687
2014	5943	25159	6425	7025	6438	2597	1193	239	155	38	79	0	0	0	0	0	1704
2015	7249	43271	34943	6950	2940	3947	888	313	238	39	13	0	0	0	0	0	1491
2016	14941	22682	22342	15500	1889	2536	1075	432	42	23	11	0	0	0	0	0	1583
2017	26493	24515	18650	11973	3735	1111	476	804	129	100	0	0	0	0	0	0	1509
2018	14985	15331	27274	10665	4071	914	172	145	13	1	0	0	0	0	0	0	331
2019	4130	25433	16810	15830	2913	453	342	18	21	34	0	0	0	0	0	0	415
2020	24349	34907	19827	13998	4592	838	115	119	19	5	0	0	0	0	0	0	258
2021	33070	22579	43621	7520	2258	1608	1400	82	109	1	0	0	0	0	0	0	1592
2022	310	2674	18938	23968	5695	839	365	477	21	0	0	0	0	0	0	0	863
2023	5719	13690	4687	15848	9096	971	41	117	7	12	0	0	0	0	0	0	177

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.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	658651	351432	98590	49263	6064	616	252	14	0	0	0	0	0	0	0	0	266
1979	471798	133207	232266	42339	4561	1420	73	33	14	0	0	0	0	0	0	0	120
1980	329065	158500	102869	45108	8162	744	55	18	0	0	0	0	0	0	0	0	73
1981	515996	108252	180623	104767	16729	2793	112	0	0	0	0	0	0	0	0	0	112
1982	82418	127998	40818	68242	10514	2448	902	2	0	0	0	0	0	0	0	0	904
1983	597587	42591	30789	17774	6723	1656	63	25	0	0	0	0	0	0	0	0	88
1984	141095	108431	30709	8868	3790	3577	91	0	0	0	0	0	0	0	0	0	91
1985	178225	46801	41731	9871	2522	685	284	26	0	0	0	0	0	0	0	0	310
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	1222
1990	141387	168040	206916	51033	12601	2592	346	29	2	0	0	0	0	0	0	0	377
1991	1050381	42554	70343	20951	5376	2408	667	70	0	0	0	0	0	0	0	0	737
1992	251505	114899	58952	12318	8758	639	180	29	3	0	0	0	0	0	0	0	212
1993	578708	89219	38270	11162	4157	832	445	31	0	0	0	0	0	0	0	0	476
1994	209858	77530	24998	14316	4885	1878	1160	337	75	0	0	0	0	0	0	0	1572
1995	1564260	85510	34213	4351	738	73	0	0	0	0	0	0	0	0	0	0	0

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1996	90925	30675	5421	2702	970	21	2	0	0	0	0	0	0	0	0	0	2
1997	6868	28247	22087	4146	1074	276	2	0	0	0	0	0	0	0	0	0	2
1998	64989	24782	6334	1511	746	62	12	0	0	0	0	0	0	0	0	0	12
1999	62145	76088	12381	5188	1440	684	27	0	0	0	0	0	0	0	0	0	27
2000	288	19000	16688	11341	6597	2113	580	73	0	0	0	0	0	0	0	0	653
2001	510	481	2453	1728	514	152	40	0	0	0	0	0	0	0	0	0	40
2002	134690	38131	18745	8585	2170	205	120	0	0	0	0	0	0	0	0	0	120
2003	57140	17448	5034	2575	1213	390	49	0	0	0	0	0	0	0	0	0	49
2004	23732	12824	4499	1049	147	0	11	0	0	0	0	0	0	0	0	0	11
2005	12049	11043	726	494	28	32	54	10	8	0	0	0	0	0	0	0	72
2006	0	10892	5270	2222	806	223	63	7	1	0	0	0	0	0	0	0	71
2007	0	6155	2978	1256	456	126	36	4	1	0	0	0	0	0	0	0	41
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	593
2010	227	1924	1862	1377	549	442	353	115	241	79	56	2	0	0	0	0	846
2011	101	928	1369	970	463	140	115	77	33	18	49	1	0	0	0	0	293
2012	77	1228	999	739	673	332	120	73	52	30	22	1	2	0	0	0	300
2013	192	939	829	1498	1038	775	226	71	43	38	17	0	0	0	0	0	395

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2014	281	1415	776	986	1163	723	296	126	57	37	23	0	0	0	0	0	539
2015	320	2056	2666	962	696	984	380	156	85	45	30	0	0	0	0	0	696
2016	2267	3552	4725	5009	1318	1090	867	369	99	98	53	0	0	0	0	0	1486
2017	2231	2109	2156	2182	1856	399	234	239	128	103	3	0	0	0	0	0	707
2018	671	707	1939	1539	1172	483	106	70	61	2	13	3	0	0	0	0	255
2019	385	1560	1116	2411	1131	565	216	82	34	12	7	0	0	0	0	0	351
2020	1276	2189	2421	2748	2284	826	303	77	18	4	0	0	0	0	0	0	402
2021	1165	951	2437	1600	1068	772	229	85	6	1	0	0	0	0	0	0	321
2022	6	74	632	1135	464	235	123	30	15	0	0	0	0	0	0	0	168
2023	390	991	642	2272	3164	750	354	152	50	3	0	0	0	0	0	0	559

Table 23.8. Whiting in Subarea 4 and Division 7.d. Total catch mean weights-at-age (kg), as estimated by ICES. Age 6 is a plus-group. Ages 0–6+ are included in the final assessment. Model input.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	0.01	0.074	0.182	0.234	0.321	0.428	0.428	0.466	0.615	0.702	1.539	0.589	0	0	0	0	0.442
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	0	0	0	0.475
1980	0.013	0.075	0.176	0.252	0.328	0.337	0.457	0.459	0.568	0.539	0.79	0.688	1.711	0	0	0	0.464
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	0	0	0	0.424
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	0	0	0.497
1983	0.015	0.107	0.191	0.273	0.325	0.384	0.426	0.452	0.52	0.677	0.516	0	0	0	0	0	0.439

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1984	0.02	0.089	0.189	0.271	0.337	0.381	0.39	0.462	0.575	0.514	0.871	0	0	0	0	0	0.409
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	0	0	0	0.444
1986	0.015	0.105	0.183	0.255	0.318	0.378	0.475	0.468	0.54	1.226	0.99	0.535	0	0	0	0	0.482
1987	0.013	0.077	0.148	0.247	0.297	0.375	0.38	0.542	0.555	0.857	0.603	1.193	0	0	0	0	0.435
1988	0.013	0.054	0.146	0.223	0.301	0.346	0.424	0.506	0.856	0.585	0.648	0	0	0	0	0	0.455
1989	0.023	0.07	0.157	0.225	0.267	0.318	0.391	0.431	0.37	0.515	0.857	0.609	0	0	0	0	0.395
1990	0.016	0.084	0.137	0.21	0.252	0.279	0.411	0.498	0.636	0.351	0.918	0	0	0	0	0	0.441
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	0	0	0	0.344
1992	0.013	0.085	0.185	0.257	0.277	0.331	0.346	0.313	0.481	0.763	1.728	0	0	0	0	0	0.339
1993	0.012	0.073	0.174	0.25	0.316	0.328	0.346	0.4	0.376	0.417	0.359	0	0	0	0	0	0.363
1994	0.013	0.084	0.167	0.255	0.328	0.382	0.376	0.419	0.438	0.392	0.499	0	0	0	0	0	0.381
1995	0.010	0.089	0.18	0.257	0.340	0.384	0.429	0.434	0.445	0.346	0.406	0	0	0	0	0	0.431
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	0	0	0.415
1997	0.028	0.096	0.178	0.242	0.295	0.334	0.384	0.386	0.394	0.479	0.458	0	0	0	0	0	0.388
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	0	0	0	0.340
1999	0.023	0.078	0.174	0.232	0.256	0.289	0.305	0.311	0.286	0.315	0.344	0	0	0	0	0	0.305
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	0	0	0	0.275
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	0	0	0	0.293

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2002	0.01	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	0	0.345
2003	0.012	0.057	0.118	0.193	0.259	0.299	0.354	0.385	0.342	0.462	0.620	0	0	0	0	0	0.360
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	0	0	0.288
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	0	0	0.302
2006	0.093	0.131	0.180	0.231	0.274	0.288	0.360	0.345	0.318	0.299	0.289	0	0	0	0	0	0.352
2007	0.059	0.098	0.206	0.257	0.325	0.345	0.309	0.309	0.325	0.288	0.328	0	0	0	0	0	0.311
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	0	0	0	0.348
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	0	0	0.350
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	0.368	0	0.366
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	0	0	0.379
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	0	0	0.417
2013	0.028	0.11	0.222	0.273	0.390	0.468	0.496	0.465	0.424	0.340	0.406	0	0	0	0	0	0.461
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	0	0	0	0.449
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	0	0	0	0.447
2016	0.03	0.120	0.210	0.291	0.399	0.389	0.415	0.488	0.452	0.460	0.472	1.293	0	0	0	0	0.440
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	0	0	0	0.457
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	0	0	0	0.490
2019	0.021	0.106	0.204	0.279	0.354	0.420	0.436	0.440	0.368	0.355	0.577	0.736	0	0	0	0	0.427

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2020	0.094	0.107	0.238	0.287	0.374	0.424	0.479	0.542	0.376	0.492	0.656	0.564	0	0	0	0	0.487
2021	0.038	0.125	0.189	0.319	0.391	0.461	0.403	0.538	0.336	0.681	1.065	0.779	0	0	0	0	0.430
2022	0.056	0.154	0.217	0.272	0.370	0.473	0.526	0.440	0.536	0.403	0.752	0.770	0	0	0	0	0.508
2023	0.024	0.108	0.224	0.278	0.345	0.451	0.541	0.572	0.574	0.456	0.691	0.651	0	0	0	0	0.552

Table 23.9. Whiting in Subarea 4 and Division 7.d. Landings mean weights-at-age (kg), as estimated by ICES. Age 6 is a plus-group.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	0	0.185	0.233	0.250	0.334	0.426	0.434	0.466	0.615	0.702	1.539	0.589	0	0	0	0	0.447
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	0	0	0	0.475
1980	0	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	0	0	0.478
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	0	0	0	0.425
1982	0	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	0	0	0.489
1983	0.132	0.199	0.240	0.282	0.332	0.383	0.429	0.452	0.522	0.677	0.516	0	0	0	0	0	0.442
1984	0	0.194	0.231	0.279	0.346	0.391	0.403	0.472	0.575	0.514	0.871	0	0	0	0	0	0.421
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	0	0	0	0.452
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	0	0	0	0.489
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	0	0	0	0.437
1988	0.117	0.194	0.226	0.256	0.328	0.351	0.425	0.506	0.887	0.585	0.648	0	0	0	0	0	0.456
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	0	0	0	0.378

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1990	0.167	0.206	0.222	0.263	0.296	0.337	0.455	0.533	0.640	0.351	0.918	0	0	0	0	0	0.485
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	0	0	0	0.354
1992	0.145	0.194	0.246	0.289	0.306	0.340	0.356	0.383	0.473	0.763	1.728	0	0	0	0	0	0.363
1993	0.153	0.194	0.248	0.284	0.345	0.358	0.385	0.418	0.376	0.417	0.359	0	0	0	0	0	0.393
1994	0.132	0.182	0.248	0.297	0.346	0.392	0.382	0.412	0.414	0.392	0.499	0	0	0	0	0	0.385
1995	0.140	0.171	0.256	0.299	0.367	0.397	0.437	0.437	0.448	0.346	0.406	0	0	0	0	0	0.436
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	0	0	0.424
1997	0.149	0.171	0.206	0.260	0.315	0.349	0.401	0.386	0.398	0.479	0.437	0	0	0	0	0	0.400
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	0	0	0	0.362
1999	0.135	0.184	0.237	0.271	0.281	0.303	0.316	0.320	0.292	0.368	0.344	0	0	0	0	0	0.316
2000	0	0.166	0.227	0.272	0.299	0.292	0.313	0.276	0.269	0.264	0.280	0.321	0	0	0	0	0.296
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	0	0	0	0.296
2002	0	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	0	0.354
2003	0.128	0.208	0.228	0.258	0.308	0.311	0.374	0.391	0.342	0.462	0.620	0	0	0	0	0	0.376
2004	0	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	0	0	0.332
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	0	0	0.331
2006	0.133	0.217	0.254	0.285	0.295	0.298	0.377	0.353	0.334	0.306	0.290	0	0	0	0	0	0.367
2007	0.202	0.199	0.264	0.28	0.351	0.361	0.319	0.332	0.342	0.318	0.334	0	0	0	0	0	0.327

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2008	0	0.223	0.265	0.324	0.356	0.431	0.424	0.359	0.389	0.339	0.334	0.433	0	0	0	0	0.380
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	0	0	0.349
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	0.368	0	0.446
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	0	0	0.389
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	0	0	0.433
2013	0.038	0.203	0.247	0.295	0.417	0.477	0.515	0.460	0.419	0.413	0.391	0	0	0	0	0	0.479
2014	0.064	0.194	0.259	0.330	0.363	0.49	0.508	0.457	0.375	0.393	0.358	1.754	0	0	0	0	0.461
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	0	0	0	0.465
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	0	0	0	0.473
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	0	0	0	0.497
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	0	0	0	0.503
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	0.440
2020	0.132	0.214	0.330	0.358	0.416	0.444	0.491	0.603	0.400	0.535	0.656	0.564	0	0	0	0	0.507
2021	0.064	0.173	0.235	0.367	0.440	0.514	0.534	0.574	0.854	0.724	1.065	0.779	0	0	0	0	0.551
2022	0.103	0.173	0.257	0.324	0.446	0.506	0.558	0.602	0.554	0.403	0.752	0.770	0	0	0	0	0.564
2023	0.039	0.187	0.257	0.330	0.383	0.483	0.544	0.597	0.577	0.558	0.691	0.651	0	0	0	0	0.562

Table 23.10. Whiting in Subarea 4 and Division 7.d. Discards mean weights-at-age (kg), as estimated by ICES. Age 6 is a plus-group.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	0.036	0.145	0.158	0.185	0.209	0.222	0.239	0	0	0	0	0	0	0	0	0	0.239
1979	0.080	0.104	0.158	0.191	0.189	0.234	0.265	0.295	0	0	0	0	0	0	0	0	0.271
1980	0.030	0.107	0.166	0.202	0.244	0.253	0.264	0	0	0	0	0	0	0	0	0	0.264
1981	0.071	0.131	0.164	0.197	0.230	0.289	0.252	0.268	0	0	0	0	0	0	0	0	0.253
1982	0.047	0.091	0.182	0.211	0.225	0.241	0.244	0.261	0	0	0	0	0	0	0	0	0.245
1983	0.036	0.114	0.167	0.235	0.264	0.29	0.317	0.277	0.365	0	0	0	0	0	0	0	0.315
1984	0.038	0.101	0.162	0.216	0.246	0.265	0.248	0.278	0	0	0	0	0	0	0	0	0.252
1985	0.022	0.105	0.169	0.213	0.238	0.242	0.253	0.255	0	0	0	0	0	0	0	0	0.253
1986	0.028	0.123	0.166	0.190	0.208	0.227	0.194	0.217	0.311	0	0	0	0	0	0	0	0.210
1987	0.016	0.09	0.149	0.206	0.205	0.263	0.257	0	0.292	0	0	0	0	0	0	0	0.271
1988	0.030	0.063	0.146	0.181	0.210	0.219	0.235	0	0.284	0	0	0	0	0	0	0	0.243
1989	0.033	0.083	0.164	0.191	0.213	0.227	0.241	0.351	0.221	0	0	0	0	0	0	0	0.246
1990	0.024	0.095	0.130	0.183	0.186	0.196	0.249	0.302	0	0	0	0	0	0	0	0	0.263
1991	0.041	0.089	0.154	0.177	0.213	0.230	0.253	0.268	0	0	0	0	0	0	0	0	0.259
1992	0.037	0.093	0.173	0.210	0.215	0.241	0.245	0.220	1.183	0	0	0	0	0	0	0	0.228
1993	0.023	0.087	0.160	0.205	0.237	0.235	0.225	0.213	0	0	0	0	0	0	0	0	0.223
1994	0.040	0.090	0.151	0.203	0.230	0.244	0.254	0.332	0	0	0	0	0	0	0	0	0.254
1995	0.032	0.102	0.163	0.204	0.233	0.247	0.247	0.332	0.290	0	0	0	0	0	0	0	0.277

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1996	0.031	0.094	0.151	0.198	0.225	0.281	0.265	0.304	0	0	0	0	0	0	0	0	0.282
1997	0.031	0.125	0.181	0.213	0.225	0.233	0.256	0.617	0.320	0.601	0.773	0	0	0	0	0	0.261
1998	0.026	0.086	0.173	0.204	0.228	0.234	0.224	0.247	0.191	0.180	0.284	0	0	0	0	0	0.226
1999	0.062	0.100	0.166	0.197	0.201	0.225	0.231	0.212	0.231	0.220	0	0	0	0	0	0	0.228
2000	0.033	0.127	0.167	0.195	0.226	0.209	0.219	0.222	0.264	0	0	0	0	0	0	0	0.222
2001	0.023	0.084	0.183	0.217	0.259	0.248	0.240	0.225	0.243	0	0	0	0	0	0	0	0.235
2002	0.039	0.130	0.167	0.196	0.224	0.224	0.225	0.272	0.334	1.120	0.217	0	0	0	0	0	0.270
2003	0.048	0.062	0.105	0.170	0.214	0.262	0.257	0.293	0.237	0	0	0	0	0	0	0	0.259
2004	0.079	0.131	0.158	0.203	0.223	0.239	0.235	0.227	0.204	0.351	0	0	0	0	0	0	0.234
2005	0.070	0.124	0.177	0.207	0.221	0.223	0.235	0.245	0.222	0.293	0	0	0	0	0	0	0.236
2006	0.093	0.131	0.161	0.193	0.229	0.233	0.247	0.273	0.239	0.279	0.289	0	0	0	0	0	0.252
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	0	0	0	0.224
2008	0.027	0.072	0.181	0.213	0.230	0.265	0.328	0.244	0.291	0.317	0.057	0	0	0	0	0	0.269
2009	0.042	0.086	0.177	0.240	0.333	0.360	0.375	0.265	0.426	0.273	0.594	0	0	0	0	0	0.374
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	0	0.368	0	0.211
2011	0.048	0.100	0.176	0.231	0.264	0.285	0.316	0.346	0.291	0.305	0.251	0	0	0	0	0	0.321
2012	0.038	0.100	0.175	0.229	0.290	0.296	0.261	0.405	0.333	0.877	0.746	0	0	0	0	0	0.342
2013	0.028	0.101	0.199	0.236	0.283	0.353	0.346	0.578	0.484	0.205	0.484	0	0	0	0	0	0.332

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2014	0.055	0.130	0.189	0.245	0.270	0.294	0.348	0.556	0.547	0.550	0.361	0	0	0	0	0	0.400
2015	0.043	0.120	0.202	0.254	0.293	0.289	0.358	0.454	0.253	0.271	0.393	0	0	0	0	0	0.359
2016	0.03	0.117	0.188	0.241	0.291	0.267	0.287	0.29	0.309	0.305	0.315	0	0	0	0	0	0.289
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	0	0	0	0.312
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	0	0	0	0.376
2019	0.021	0.098	0.180	0.219	0.259	0.297	0.270	0.544	0.251	0.384	0	0	0	0	0	0	0.290
2020	0.092	0.092	0.192	0.219	0.253	0.307	0.285	0.313	0.216	0.266	0	0	0	0	0	0	0.292
2021	0.037	0.117	0.177	0.240	0.199	0.250	0.251	0.216	0.203	0.251	1.065	1.395	0	0	0	0	0.246
2022	0.055	0.145	0.200	0.238	0.267	0.289	0.310	0.279	0.270	0.455	0.752	0.768	0	0	0	0	0.292
2023	0.024	0.101	0.198	0.248	0.268	0.291	0.356	0.341	0.409	0.261	0	0	0	0	0	0	0.342

Table 23.11. Whiting in Subarea 4 and Division 7.d. Industrial bycatch mean weights-at-age (kg), as estimated by ICES. Age 6 is a plus-group.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	0.009	0.059	0.158	0.220	0.295	0.529	0.351	0.449	0	0	0	0	0	0	0	0	0.356
1979	0.008	0.069	0.141	0.249	0.428	0.477	0.467	0.605	0.482	0	0	0	0	0	0	0	0.507
1980	0.013	0.051	0.164	0.281	0.412	0.380	0.389	0.561	0	1	0	0	0	0	0	0	0.431
1981	0.011	0.056	0.141	0.218	0.318	0.433	0.596	0.600	0.800	0	0	0	0	0	0	0	0.596
1982	0.025	0.038	0.133	0.232	0.320	0.366	0.674	0.284	0.800	1	1.200	0	0	0	0	0	0.673
1983	0.012	0.058	0.148	0.311	0.431	0.651	0.565	0.602	0.800	1	0	0	0	0	0	0	0.576

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1984	0.018	0.053	0.173	0.289	0.343	0.390	0.228	0.600	0.800	1	0	0	0	0	0	0	0.228
1985	0.014	0.054	0.150	0.263	0.382	0.454	0.504	0.584	0.800	1	0	0	0	0	0	0	0.511
1986	0.014	0.054	0.150	0.262	0.381	0.455	0.500	0.600	0.800	0	0	0	0	0	0	0	0
1987	0.012	0.043	0.085	0.173	0.262	0.400	0.500	0.600	0.800	1	0	0	0	0	0	0	0
1988	0.012	0.050	0.115	0.197	0.245	0.380	0.500	0.600	0.800	0	0	0	0	0	0	0	0
1989	0.022	0.053	0.137	0.224	0.285	0.344	0.482	0.396	0.385	0.401	0	0	0	0	0	0	0.470
1990	0.007	0.073	0.123	0.181	0.201	0.280	0.355	0.335	0.472	0	0	0	0	0	0	0	0.354
1991	0.018	0.105	0.136	0.215	0.272	0.265	0.279	0.322	0	0	0	0	0	0	0	0	0.283
1992	0.012	0.068	0.151	0.235	0.244	0.364	0.219	0.256	0.282	0	0	0	0	0	0	0	0.225
1993	0.011	0.045	0.156	0.260	0.264	0.307	0.235	0.392	0	0	0	0	0	0	0	0	0.245
1994	0.012	0.055	0.131	0.259	0.388	0.521	0.555	0.440	0.555	0	0	0	0	0	0	0	0.530
1995	0.009	0.072	0.160	0.312	0.373	0.511	0	0	0	0	0	0	0	0	0	0	0
1996	0.016	0.064	0.151	0.239	0.233	0.347	0.250	0	0	0	0	0	0	0	0	0	0.250
1997	0.012	0.051	0.145	0.252	0.321	0.348	0.588	0	0	0	0	0	0	0	0	0	0.588
1998	0.015	0.049	0.115	0.220	0.304	0.286	0	0	0	0	0	0	0	0	0	0	0
1999	0.013	0.027	0.077	0.144	0.194	0.286	0	0	0	0	0	0	0	0	0	0	0
2000	0.038	0.051	0.166	0.242	0.289	0.339	0	0.588	0	0	0	0	0	0	0	0	0.066
2001	0.012	0.055	0.118	0.225	0.320	0.351	0.386	0	0	0	0	0	0	0	0	0	0.386

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2002	0.010	0.044	0.101	0.185	0.294	0.415	0.380	0	0	0	0	0	0	0	0	0	0.380
2003	0.010	0.035	0.102	0.189	0.302	0.418	0.462	0	0	0	0	0	0	0	0	0	0.462
2004	0.010	0.032	0.083	0.143	0.264	0	0.380	0	0	0	0	0	0	0	0	0	0.380
2005	0.014	0.043	0.133	0.196	0.205	0.366	0.438	0.541	0.530	0	0	0	0	0	0	0	0.463
2006	0	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530	0	0	0	0	0	0	0	0.419
2007	0	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530	0	0	0	0	0	0	0	0.420
2008	0	0.046	0.119	0.208	0.277	0.362	0.401	0.564	0.530	0	0	0	0	0	0	0	0
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	0	0	0.350
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	0.368	0	0.364
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	0	0	0.379
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	0	0	0.418
2013	0.028	0.110	0.222	0.273	0.391	0.468	0.496	0.464	0.424	0.341	0.406	0	0	0	0	0	0.464
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	0	0	0	0.451
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	0	0	0	0.447
2016	0.03	0.120	0.210	0.291	0.399	0.389	0.415	0.488	0.452	0.460	0.472	1.293	0	0	0	0	0.441
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	0	0	0	0.457
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	0	0	0	0.490
2019	0.021	0.107	0.204	0.279	0.354	0.420	0.435	0.440	0.369	0.355	0.577	0.736	0	0	0	0	0.430

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2020	0.094	0.106	0.237	0.287	0.374	0.425	0.479	0.542	0.376	0.494	0.656	0.564	0	0	0	0	0.487
2021	0.037	0.125	0.189	0.319	0.391	0.461	0.403	0.538	0.335	0.685	1.065	0.779	0	0	0	0	0.438
2022	0.056	0.154	0.217	0.272	0.370	0.473	0.527	0.440	0.537	0.403	0.752	0.770	0	0	0	0	0.512
2023	0.024	0.108	0.224	0.279	0.345	0.451	0.541	0.572	0.573	0.455	0.691	0.651	0	0	0	0	0.552

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

Year	Catch	Landings	Discards	IBC
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	26660	18211	6795	1654
2014	28375	17027	9725	1623
2015	36287	17299	16891	2097
2016	33396	16118	12726	4551
2017	29344	15361	11348	2635
2018	28407	16160	10588	1658
2019	30523	18579	10080	1864
2020	34924	18014	13795	3115
2021	33186	16499	14638	2048
2022	27907	15167	11913	827
2023	27601	15800	9169	2632

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 6 is a plus-group. Model input.

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1978	0.003	0.025	0.094	0.164	0.258	0.388	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432
1979	0.003	0.033	0.086	0.182	0.242	0.373	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464	0.464
1980	0.004	0.025	0.091	0.177	0.264	0.306	0.453	0.453	0.453	0.453	0.453	0.453	0.453	0.453	0.453	0.453	0.453
1981	0.004	0.028	0.087	0.170	0.259	0.344	0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414
1982	0.010	0.020	0.095	0.177	0.253	0.341	0.486	0.486	0.486	0.486	0.486	0.486	0.486	0.486	0.486	0.486	0.486
1983	0.005	0.036	0.098	0.191	0.262	0.348	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429	0.429
1984	0.007	0.030	0.097	0.190	0.271	0.346	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400	0.400
1985	0.005	0.031	0.099	0.199	0.267	0.364	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434
1986	0.005	0.035	0.094	0.179	0.256	0.343	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471	0.471
1987	0.004	0.026	0.076	0.173	0.239	0.340	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.425	0.425
1988	0.004	0.018	0.075	0.156	0.242	0.314	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445
1989	0.008	0.023	0.081	0.158	0.215	0.288	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386
1990	0.005	0.028	0.071	0.147	0.203	0.253	0.431	0.431	0.431	0.431	0.431	0.431	0.431	0.431	0.431	0.431	0.431
1991	0.006	0.035	0.087	0.152	0.233	0.278	0.336	0.336	0.336	0.336	0.336	0.336	0.336	0.336	0.336	0.336	0.336
1992	0.004	0.028	0.095	0.180	0.223	0.300	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.331
1993	0.004	0.024	0.090	0.175	0.254	0.297	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355	0.355
1994	0.004	0.028	0.086	0.179	0.264	0.346	0.372	0.372	0.372	0.372	0.372	0.372	0.372	0.372	0.372	0.372	0.372

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
1995	0.003	0.030	0.093	0.180	0.274	0.348	0.421	0.421	0.421	0.421	0.421	0.421	0.421	0.421	0.421	0.421	0.421
1996	0.006	0.031	0.086	0.165	0.243	0.352	0.405	0.405	0.405	0.405	0.405	0.405	0.405	0.405	0.405	0.405	0.406
1997	0.009	0.032	0.092	0.170	0.237	0.303	0.379	0.379	0.379	0.379	0.379	0.379	0.379	0.379	0.379	0.379	0.379
1998	0.006	0.030	0.092	0.165	0.226	0.285	0.332	0.332	0.332	0.332	0.332	0.332	0.332	0.332	0.332	0.332	0.332
1999	0.008	0.026	0.090	0.163	0.206	0.262	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298
2000	0.011	0.039	0.094	0.167	0.231	0.259	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269
2001	0.008	0.034	0.099	0.171	0.227	0.242	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286
2002	0.003	0.023	0.080	0.153	0.220	0.275	0.337	0.337	0.337	0.337	0.337	0.337	0.337	0.337	0.337	0.337	0.337
2003	0.004	0.019	0.061	0.135	0.208	0.271	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352
2004	0.010	0.037	0.077	0.149	0.204	0.259	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.281
2005	0.011	0.041	0.102	0.168	0.201	0.256	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295	0.295
2006	0.031	0.043	0.093	0.162	0.221	0.261	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344	0.344
2007	0.020	0.033	0.106	0.180	0.262	0.313	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
2008	0.009	0.035	0.112	0.198	0.254	0.365	0.340	0.340	0.340	0.340	0.340	0.340	0.340	0.340	0.340	0.340	0.340
2009	0.014	0.030	0.110	0.200	0.298	0.339	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342
2010	0.016	0.037	0.121	0.261	0.327	0.414	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358	0.358
2011	0.016	0.038	0.110	0.209	0.301	0.376	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370	0.370
2012	0.013	0.035	0.100	0.218	0.358	0.373	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407	0.407

Year/Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	6+
2013	0.009	0.037	0.114	0.191	0.314	0.424	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
2014	0.018	0.045	0.117	0.206	0.266	0.401	0.439	0.439	0.439	0.439	0.439	0.439	0.439	0.439	0.439	0.439	0.439
2015	0.015	0.042	0.112	0.215	0.296	0.350	0.437	0.437	0.437	0.437	0.437	0.437	0.437	0.437	0.437	0.437	0.437
2016	0.010	0.040	0.108	0.204	0.321	0.353	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430	0.430
2017	0.009	0.026	0.109	0.224	0.329	0.395	0.446	0.446	0.446	0.446	0.446	0.446	0.446	0.446	0.446	0.446	0.447
2018	0.010	0.036	0.101	0.193	0.300	0.369	0.479	0.479	0.479	0.479	0.479	0.479	0.479	0.479	0.479	0.479	0.479
2019	0.007	0.035	0.105	0.196	0.285	0.381	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.417
2020	0.031	0.036	0.123	0.201	0.301	0.385	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476
2021	0.013	0.042	0.097	0.224	0.315	0.418	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420
2022	0.019	0.051	0.112	0.191	0.298	0.429	0.496	0.496	0.496	0.496	0.496	0.496	0.496	0.496	0.496	0.496	0.496
2023	0.008	0.036	0.115	0.195	0.278	0.409	0.539	0.539	0.539	0.539	0.539	0.539	0.539	0.539	0.539	0.539	0.539

Table 23.14a. Whiting in Subarea 4 and Division 7.d. Smoothed estimated proportion mature-at-age as used in the assessment. Model input.

Year/Age	0	1	2	3	4	5	6+
1978	0	0.126	0.880	1	1	1	1
1979	0	0.126	0.880	1	1	1	1
1980	0	0.126	0.880	1	1	1	1
1981	0	0.126	0.880	1	1	1	1
1982	0	0.126	0.880	1	1	1	1
1983	0	0.126	0.880	1	1	1	1
1984	0	0.126	0.880	1	1	1	1
1985	0	0.126	0.880	1	1	1	1
1986	0	0.126	0.880	1	1	1	1
1987	0	0.126	0.880	1	1	1	1
1988	0	0.126	0.880	1	1	1	1
1989	0	0.126	0.880	1	1	1	1
1990	0	0.126	0.880	1	1	1	1
1991	0	0.126	0.880	1	1	1	1
1992	0	0.130	0.870	0.998	1	1	1
1993	0	0.135	0.859	0.993	1	1	1
1994	0	0.140	0.847	0.988	0.998	1	1
1995	0	0.147	0.834	0.983	0.997	0.999	1
1996	0	0.155	0.821	0.977	0.995	0.999	1
1997	0	0.166	0.807	0.971	0.994	0.998	1
1998	0	0.178	0.793	0.964	0.992	0.998	1
1999	0	0.193	0.779	0.958	0.991	0.998	1
2000	0	0.209	0.767	0.952	0.990	0.998	1
2001	0	0.226	0.760	0.950	0.989	0.998	1
2002	0	0.242	0.759	0.950	0.990	0.998	1
2003	0	0.257	0.763	0.952	0.991	0.998	1
2004	0	0.271	0.772	0.956	0.992	0.999	1
2005	0	0.284	0.783	0.960	0.993	0.999	1

Year/Age	0	1	2	3	4	5	6+
2006	0	0.295	0.796	0.965	0.995	0.999	1
2007	0	0.304	0.810	0.970	0.996	1	1
2008	0	0.311	0.824	0.975	0.997	1	1
2009	0	0.3160	0.835	0.979	0.998	1	1
2010	0	0.320	0.845	0.983	0.999	1	1
2011	0	0.322	0.851	0.985	1	1	1
2012	0	0.325	0.855	0.987	1	1	1
2013	0	0.328	0.856	0.987	1	1	1
2014	0	0.333	0.856	0.987	1	1	1
2015	0	0.339	0.855	0.987	1	1	1
2016	0	0.348	0.854	0.986	1	1	1
2017	0	0.360	0.852	0.984	0.998	1	1
2018	0	0.374	0.849	0.980	0.996	0.999	1
2019	0	0.393	0.845	0.976	0.993	0.997	0.999
2020	0	0.416	0.841	0.970	0.990	0.995	0.998
2021	0	0.444	0.836	0.963	0.985	0.991	0.997
2022	0	0.476	0.831	0.954	0.979	0.987	0.995
2023	0	0.510	0.826	0.944	0.972	0.983	0.993

Table 23.14b. Whiting in Subarea 4 and Division 7.d. Samples-at-age with biological information in IBTS Q1 as used for maturity ogive estimation.

Year/Age	1	2	3	4	5	6+
1991	690	541	435	238	122	38
1992	1216	763	478	424	107	83
1993	815	650	508	269	278	59
1994	1011	925	537	450	144	124
1995	930	427	339	253	98	57
1996	634	419	311	209	95	52
1997	548	357	317	239	139	84
1998	654	338	307	253	147	83

1999	588	314	170	170	147	71
2000	792	815	491	305	164	186
2001	1120	1102	848	439	199	298
2002	893	920	701	394	142	94
2003	558	859	589	589	329	123
2004	591	382	381	366	310	163
2005	580	680	307	340	355	368
2006	952	669	355	194	250	359
2007	1016	1035	593	227	126	543
2008	1323	881	704	344	142	348
2009	1174	1172	475	324	207	244
2010	1169	948	711	325	229	190
2011	1191	1350	951	732	303	392
2012	1123	1256	850	603	461	258
2013	1080	949	979	612	322	344
2014	1219	1055	788	705	348	281
2015	1475	1429	589	498	535	331
2016	664	678	590	273	184	250
2017	1410	997	929	634	232	258
2018	708	1020	797	594	323	167
2019	1207	814	915	566	263	149
2020	1182	734	554	670	308	149
2021	1231	1183	677	634	439	237
2022	655	659	706	293	207	141
2023	684	591	962	754	221	181
2024	308	566	437	896	652	295

Table 23.15. Whiting in Subarea 4 and Division 7.d. Smoothed natural mortality-at-age estimates based on ICES WGSAM (2024) as used in the assessment. Model input.

Year/Age	0	1	2	3	4	5	6+
1978	1.126	1.281	0.729	0.577	0.521	0.474	0.268

Year/Age	0	1	2	3	4	5	6+
1979	1.143	1.275	0.729	0.570	0.516	0.475	0.270
1980	1.158	1.267	0.727	0.563	0.511	0.476	0.271
1981	1.168	1.257	0.722	0.555	0.506	0.475	0.273
1982	1.172	1.242	0.715	0.547	0.501	0.474	0.276
1983	1.170	1.224	0.704	0.538	0.496	0.472	0.279
1984	1.165	1.206	0.691	0.529	0.490	0.469	0.283
1985	1.159	1.191	0.678	0.521	0.485	0.465	0.290
1986	1.155	1.179	0.664	0.513	0.48	0.462	0.298
1987	1.154	1.172	0.652	0.507	0.475	0.459	0.308
1988	1.159	1.170	0.640	0.501	0.472	0.456	0.321
1989	1.171	1.171	0.631	0.496	0.468	0.454	0.335
1990	1.190	1.175	0.623	0.492	0.465	0.452	0.350
1991	1.218	1.183	0.618	0.489	0.462	0.450	0.364
1992	1.254	1.194	0.615	0.487	0.460	0.448	0.378
1993	1.298	1.208	0.615	0.485	0.459	0.447	0.391
1994	1.351	1.223	0.615	0.485	0.459	0.446	0.401
1995	1.412	1.239	0.617	0.486	0.459	0.447	0.411
1996	1.478	1.255	0.620	0.488	0.460	0.448	0.420
1997	1.549	1.269	0.622	0.49	0.463	0.450	0.428
1998	1.621	1.282	0.626	0.494	0.466	0.452	0.436
1999	1.692	1.292	0.630	0.498	0.47	0.456	0.444
2000	1.760	1.299	0.636	0.503	0.474	0.460	0.451
2001	1.822	1.303	0.643	0.509	0.48	0.466	0.459
2002	1.876	1.304	0.651	0.516	0.487	0.472	0.466
2003	1.923	1.297	0.66	0.524	0.494	0.479	0.473
2004	1.959	1.284	0.668	0.531	0.500	0.485	0.480
2005	1.987	1.267	0.676	0.537	0.507	0.491	0.484
2006	2.006	1.247	0.681	0.543	0.512	0.496	0.487
2007	2.019	1.227	0.685	0.547	0.516	0.499	0.487

Year/Age	0	1	2	3	4	5	6+
2008	2.027	1.208	0.687	0.549	0.519	0.501	0.484
2009	2.032	1.190	0.687	0.550	0.521	0.502	0.478
2010	2.037	1.174	0.687	0.549	0.522	0.502	0.469
2011	2.041	1.160	0.686	0.549	0.522	0.502	0.458
2012	2.039	1.148	0.685	0.547	0.522	0.501	0.444
2013	2.030	1.137	0.683	0.545	0.521	0.500	0.430
2014	2.012	1.127	0.681	0.542	0.519	0.498	0.415
2015	1.985	1.119	0.678	0.539	0.517	0.496	0.400
2016	1.948	1.112	0.676	0.535	0.513	0.493	0.387
2017	1.903	1.103	0.673	0.531	0.509	0.489	0.375
2018	1.851	1.091	0.671	0.526	0.504	0.483	0.365
2019	1.795	1.075	0.668	0.521	0.499	0.477	0.357
2020	1.737	1.057	0.666	0.515	0.493	0.469	0.349
2021	1.678	1.038	0.664	0.510	0.487	0.461	0.342
2022	1.618	1.018	0.662	0.504	0.481	0.452	0.335
2023	1.618	1.018	0.662	0.504	0.481	0.452	0.335

Table 23.16a. Whiting in Subarea 4 and Division 7.d. NS IBTS Quarter 1 tuning series used in the assessment and forecast; model input.

IBTS–Q1					
Year/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

IBTS–Q1					
Year/Age	**1**	**2**	**3**	**4**	**5**
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
2006	1.931	1.052	0.476	0.223	0.160
2007	0.638	1.485	0.64	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

IBTS–Q1					
Year/Age	**1**	**2**	**3**	**4**	**5**
2020	5.190	2.023	0.785	0.526	0.164
2021	5.994	7.009	1.139	0.405	0.154
2022	3.800	6.376	2.235	0.376	0.134
2023	3.161	5.506	2.728	1.575	0.309
2024	0.709	4.351	2.833	1.676	0.426

Table 23.16b. Whiting in Subarea 4 and Division 7.d. NS IBTS Quarter 3 tuning series used in the assessment and forecast, model input.

IBTS-Q3						
Year/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	23.86	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
2009	5.553	5.414	3.361	0.504	0.131	0.089

IBTS-Q3						
Year/Age	**0**	**1**	**2**	**3**	**4**	**5**
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
2021	6.020	11.442	4.037	0.633	0.204	0.102
2022	19.898	4.954	3.753	2.513	0.708	0.196
2023	7.863	10.117	3.065	3.220	2.207	0.290

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

Year/Age	0	1	2	3	4	5	6+
1978	0.025	0.096	0.283	0.523	0.661	0.847	0.847
1979	0.026	0.103	0.303	0.563	0.681	0.861	0.861
1980	0.024	0.094	0.286	0.586	0.754	0.961	0.961
1981	0.025	0.097	0.272	0.556	0.730	0.926	0.926
1982	0.025	0.101	0.253	0.484	0.615	0.777	0.777
1983	0.029	0.127	0.317	0.580	0.701	0.851	0.851
1984	0.031	0.141	0.352	0.667	0.841	1.019	1.019
1985	0.026	0.120	0.286	0.559	0.776	0.978	0.978
1986	0.029	0.140	0.342	0.636	0.897	1.099	1.099
1987	0.027	0.131	0.347	0.647	0.906	1.142	1.142
1988	0.027	0.138	0.343	0.586	0.786	1.006	1.006

Year/Age	0	1	2	3	4	5	6+
1989	0.024	0.121	0.321	0.535	0.713	0.942	0.942
1990	0.026	0.133	0.370	0.561	0.670	0.830	0.830
1991	0.022	0.111	0.312	0.468	0.516	0.608	0.608
1992	0.021	0.114	0.310	0.463	0.506	0.536	0.536
1993	0.021	0.117	0.330	0.532	0.595	0.626	0.626
1994	0.018	0.106	0.302	0.521	0.621	0.662	0.662
1995	0.015	0.092	0.264	0.460	0.550	0.595	0.595
1996	0.012	0.080	0.232	0.409	0.498	0.535	0.535
1997	0.010	0.071	0.208	0.357	0.447	0.473	0.473
1998	0.009	0.066	0.188	0.313	0.403	0.443	0.443
1999	0.009	0.071	0.215	0.354	0.447	0.489	0.489
2000	0.006	0.055	0.181	0.323	0.424	0.484	0.484
2001	0.005	0.042	0.128	0.223	0.306	0.355	0.355
2002	0.005	0.048	0.129	0.199	0.253	0.276	0.276
2003	0.007	0.076	0.173	0.216	0.244	0.251	0.251
2004	0.006	0.068	0.145	0.178	0.208	0.229	0.229
2005	0.006	0.067	0.140	0.167	0.189	0.213	0.213
2006	0.006	0.079	0.163	0.203	0.218	0.243	0.243
2007	0.005	0.069	0.145	0.192	0.207	0.222	0.222
2008	0.004	0.064	0.137	0.191	0.212	0.227	0.227
2009	0.004	0.056	0.122	0.185	0.222	0.256	0.256
2010	0.003	0.048	0.113	0.183	0.231	0.278	0.278
2011	0.003	0.046	0.108	0.171	0.210	0.251	0.251
2012	0.003	0.050	0.107	0.165	0.211	0.259	0.259
2013	0.003	0.043	0.097	0.161	0.217	0.281	0.281
2014	0.003	0.042	0.105	0.182	0.243	0.316	0.316
2015	0.003	0.046	0.132	0.225	0.282	0.351	0.351
2016	0.003	0.037	0.120	0.232	0.294	0.345	0.345
2017	0.002	0.029	0.099	0.203	0.273	0.291	0.291

Year/Age	0	1	2	3	4	5	6+
2018	0.002	0.026	0.094	0.197	0.260	0.254	0.254
2019	0.002	0.024	0.091	0.200	0.259	0.238	0.238
2020	0.002	0.019	0.076	0.174	0.228	0.201	0.201
2021	0.001	0.013	0.054	0.127	0.182	0.172	0.172
2022	0.001	0.007	0.032	0.083	0.131	0.131	0.131
2023	0.001	0.007	0.028	0.071	0.116	0.117	0.117

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

Year/Age	0	1	2	3	4	5	6+
1978	28766397	8508380	1747094	840875	220155	15995	18593
1979	23412983	9132331	2155798	634702	282098	67213	10358
1980	11209457	7357320	2276212	762604	203877	86565	21085
1981	10245260	3377928	1963161	816324	238789	57248	26780
1982	8986294	3102401	864282	754784	265997	68392	22044
1983	13386559	2683093	801533	330698	278157	87073	27102
1984	10196656	4091382	691757	287494	107597	86500	32006
1985	17832826	3023680	1076637	242510	86042	28420	28534
1986	16824076	5535607	802305	425685	82651	24384	14735
1987	12813476	5178578	1489683	289671	138722	20651	8808
1988	17989023	3882780	1456105	546653	90569	35085	6195
1989	11126616	5597082	1020491	558955	184120	25894	9764
1990	9948980	3342482	1563095	393389	202629	56496	8982
1991	10879669	2930731	895974	570722	138305	65440	18300
1992	12675335	3165304	803372	349401	218533	52951	29311
1993	12398328	3540166	837519	318516	135880	85265	30866
1994	11545336	3315642	929529	318646	116799	46896	40405
1995	8964030	2967602	870555	368705	116514	39392	29193
1996	7486904	2133594	785775	357772	143848	42664	24260
1997	11418670	1678001	555157	336959	142781	56176	24861

Year/Age	0	1	2	3	4	5	6+
1998	19025989	2367537	438642	242145	141930	57564	32239
1999	21632856	3718071	598621	197678	110039	58917	36774
2000	17843704	3952066	919658	252129	84652	44307	37500
2001	16726157	3039761	1042247	390465	105922	34932	31752
2002	8066932	2688047	801964	500229	183676	46558	28926
2003	8260261	1215086	699555	380522	246460	86696	35066
2004	9811859	1198861	293256	299276	187011	118319	58950
2005	9585826	1373241	308235	129436	145680	93415	87394
2006	7423456	1337187	366600	135819	64911	72482	91088
2007	11829047	986075	355523	162195	64778	30967	80064
2008	11741659	1579653	277361	155337	79120	31475	55367
2009	11511157	1542031	446069	121879	74589	39323	43578
2010	11978757	1506741	439677	196502	57737	37562	40393
2011	7856033	1584348	449591	198577	93358	27196	36631
2012	5776782	1027026	501233	198754	95376	45259	30922
2013	9449991	737385	299879	233986	98246	46318	36224
2014	11421837	1255416	229950	137169	115251	47331	38949
2015	10452857	1506620	400423	106749	65381	53989	39569
2016	12699306	1396099	457907	177409	50600	29461	41594
2017	8063813	1825627	432974	199798	81891	22788	32462
2018	10356309	1198169	582487	198866	93289	37691	26594
2019	21574670	1636096	397776	263810	96967	42822	31817
2020	18037249	3668913	541214	189013	124159	46119	37429
2021	9241311	3205653	1271811	254750	95696	59141	44384
2022	12605197	1679232	1116322	618567	135737	48925	57090
2023	6066015	2541916	612810	553208	345015	72702	62608

Table 23.19. Whiting in Subarea 4 and Division 7.d. Final SAM summary table. Model output. Recruitment is in thousands, all weights are in tonnes. Low and High refer to 95% confidence intervals.

Year	R_Low	R.age.0	R_High	SSB_Low	SSB	SSB_High	Fbar.2.6_Low	Fbar.2.6	Fbar.2.6_High	TSB_Low	TSB	TSB_High
1978	22595224	28766397	36623031	331610	379567	434459	0.466	0.578	0.719	604822	677353	758582
1979	17924023	23412983	30582853	365189	414123	469613	0.498	0.602	0.728	682082	765949	860128
1980	8904201	11209457	14111534	377898	429288	487666	0.536	0.647	0.779	591041	662458	742504
1981	8162887	10245260	12858851	345042	392419	446302	0.512	0.621	0.754	475463	531503	594147
1982	7209311	8986294	11201277	277742	315148	357592	0.439	0.532	0.644	420248	466377	517568
1983	10623955	13386559	16867538	230280	259433	292276	0.517	0.612	0.725	378448	418832	463526
1984	8135297	10196656	12780331	179066	200997	225613	0.612	0.720	0.846	344794	382416	424143
1985	14314735	17832826	22215548	176437	199605	225814	0.549	0.650	0.770	339497	377698	420196
1986	13322376	16824076	21246175	180859	203432	228823	0.630	0.743	0.877	415080	464918	520741
1987	10282392	12813476	15967605	186664	210733	237905	0.635	0.760	0.911	354260	395321	441141
1988	14460190	17989023	22379025	199453	226325	256818	0.563	0.680	0.822	339573	377899	420552
1989	8995317	11126616	13762894	201519	228004	257970	0.508	0.628	0.775	392341	436522	485679
1990	8063674	9948980	12275074	199631	226022	255901	0.496	0.608	0.746	335348	373531	416061
1991	8825747	10879669	13411577	197848	224303	254296	0.388	0.476	0.584	347477	387034	431094
1992	10307853	12675335	15586576	190012	215364	244099	0.372	0.454	0.553	321128	357854	398781
1993	10066158	12398328	15270827	178412	202317	229425	0.432	0.521	0.627	301929	336942	376016

Year	R_Low	R.age.0	R_High	SSB_Low	SSB	SSB_High	Fbar.2.6_Low	Fbar.2.6	Fbar.2.6_High	TSB_Low	TSB	TSB_High
1994	9364477	11545336	14234087	175258	199037	226042	0.431	0.527	0.644	305149	341328	381795
1995	7249042	8964030	11084751	178106	203294	232044	0.377	0.467	0.578	286663	322475	362761
1996	6023154	7486904	9306375	159608	183035	209900	0.336	0.419	0.522	263791	297667	335893
1997	8923168	11418670	14612077	143489	165505	190899	0.297	0.371	0.463	286844	328032	375133
1998	14922582	19025989	24257749	122687	142184	164780	0.269	0.337	0.423	280287	324145	374866
1999	17001630	21632856	27525624	120199	139952	162950	0.299	0.376	0.474	340782	396341	460958
2000	14037091	17843704	22682603	153172	179177	209597	0.272	0.353	0.458	446678	524324	615467
2001	13302509	16726157	21030945	173643	206095	244611	0.191	0.253	0.336	382407	446642	521666
2002	6378569	8066932	10202193	166490	198568	236826	0.163	0.214	0.281	249491	291731	341123
2003	6595482	8260261	10345251	145131	174078	208800	0.172	0.221	0.284	202194	237128	278097
2004	7742692	9811859	12433993	130861	157179	188789	0.148	0.190	0.244	254887	297871	348103
2005	7563416	9585826	12149015	117180	140389	168195	0.139	0.177	0.227	248088	290646	340504
2006	5901244	7423456	9338318	108952	129947	154987	0.163	0.207	0.262	345226	407917	481992
2007	9400882	11829047	14884384	101025	119585	141554	0.152	0.191	0.242	321838	381693	452681
2008	9323302	11741659	14787310	104629	122897	144356	0.153	0.192	0.241	233876	272005	316349
2009	9141899	11511157	14494444	110793	129968	152461	0.155	0.196	0.247	282224	330923	388025
2010	9211896	11978757	15576664	137668	161820	190210	0.157	0.201	0.258	340307	403612	478692
2011	6229881	7856033	9906652	130987	154257	181661	0.144	0.185	0.238	281055	328098	383014

Year	R_Low	R.age.0	R_High	SSB_Low	SSB	SSB_High	Fbar.2.6_Low	Fbar.2.6	Fbar.2.6_High	TSB_Low	TSB	TSB_High
2012	4569481	5776782	7303062	136195	161030	190394	0.144	0.185	0.238	228280	265985	309918
2013	7448944	9449991	11988588	125567	149199	177280	0.147	0.189	0.242	222457	260661	305425
2014	8760076	11421837	14892378	115073	136672	162325	0.165	0.212	0.272	321362	387586	467456
2015	8029120	10452857	13608243	115459	137883	164662	0.192	0.248	0.320	280490	338699	408989
2016	9832482	12699306	16402000	117478	141879	171348	0.189	0.248	0.326	259476	312346	375988
2017	6222190	8063813	10450512	124565	151812	185019	0.162	0.217	0.289	215816	259442	311887
2018	7927083	10356309	13529962	129104	158379	194292	0.150	0.201	0.270	242813	294761	357823
2019	16116214	21574670	28881868	133819	165249	204060	0.146	0.197	0.266	290187	358601	443143
2020	13224430	18037249	24601618	175973	219255	273184	0.125	0.170	0.231	674924	870529	1122825
2021	6494966	9241311	13148926	230036	290130	365924	0.098	0.134	0.183	397742	503877	638334
2022	8387337	12605197	18944152	269539	345525	442932	0.068	0.094	0.131	499033	652663	853588
2023	3482746	6066015	10565382	278383	362538	472132	0.059	0.083	0.116	365189	477302	623833

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

Year	Low	Catch	High
1978	157560	190827	231117
1979	192067	226324	266692
1980	184635	218258	258004
1981	159240	188799	223845
1982	122790	145295	171924
1983	123425	144188	168445
1984	113263	132441	154866
1985	93459	109975	129410
1986	122499	144477	170398
1987	114363	134659	158558
1988	109865	130002	153828
1989	112351	132109	155342
1990	111391	131870	156114
1991	95297	112283	132297
1992	89663	105047	123071
1993	91443	107103	125444
1994	88160	103209	120827
1995	79995	93855	110116
1996	64807	75930	88962
1997	53526	62700	73447
1998	43635	50842	59239
1999	48333	56538	66136
2000	54098	63595	74759
2001	43571	51863	61734
2002	38485	45326	53383
2003	35616	41949	49408
2004	28919	33651	39157
2005	25561	29715	34545

Year	Low	Catch	High
2006	28157	32991	38654
2007	22944	26811	31329
2008	23222	27050	31508
2009	23580	27481	32029
2010	28199	32965	38536
2011	25173	29382	34294
2012	25799	30089	35093
2013	23717	27693	32336
2014	24904	28942	33634
2015	28127	32791	38227
2016	27167	31735	37071
2017	25304	29711	34885
2018	24776	29039	34036
2019	25837	30355	35663
2020	28038	32781	38326
2021	26677	31234	36569
2022	23444	27787	32934
2023	24065	28911	34733

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

	par	sd(par)	exp(par)	Low	High
logFpar_0	-13.216	0.077	0	0	0
logFpar_1	-12.132	0.077	0	0	0
logFpar_2	-12.069	0.078	0	0	0
logFpar_3	-12.265	0.083	0	0	0
logFpar_4	-13.176	0.097	0	0	0
logFpar_5	-12.31	0.097	0	0	0
logFpar_6	-12.12	0.098	0	0	0
logFpar_7	-12.287	0.102	0	0	0

	par	sd(par)	exp(par)	Low	High
logFpar_8	-12.353	0.112	0	0	0
logSdLogFsta_0	-1.575	0.13	0.207	0.160	0.268
logSdLogN_0	-0.971	0.129	0.379	0.293	0.49
logSdLogN_1	-2.836	0.496	0.059	0.022	0.158
logSdLogObs_0	0.242	0.118	1.274	1.006	1.614
logSdLogObs_1	-1.57	0.091	0.208	0.174	0.249
logSdLogObs_2	-0.88	0.075	0.415	0.357	0.482
logSdLogObs_3	-0.75	0.08	0.472	0.403	0.554
logSdLogObs_4	-1.132	0.17	0.322	0.230	0.453
transfIRARdist_0	-0.23	0.229	0.794	0.503	1.255
transfIRARdist_1	0.879	0.425	2.409	1.029	5.639
transfIRARdist_2	-1.001	0.272	0.367	0.213	0.633
itrans_rho_0	1.139	0.19	3.123	2.135	4.568

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

Mohn's rho	
R(age 0)	-0.0971
SSB	-0.0222
Fbar(2-6)	-0.0398

Table 23.23. Whiting in Subarea 4 and Division 7.d. Reference points as determined in during WGNSSK 2024 (ICES, 2024b).

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	167 419	B_{pa}; in tonnes.	ICES (2024b)
	F_{MSY}	0.68	Stochastic simulation (EqSim) with segmented regression with a fixed breakpoint at B_{lim} based on recruitment period 1983–2023. Capped at F_{pa}.	ICES (2024b)
Precautionary approach	B_{lim}	119 585	B_{loss} (SSB in 2007, as estimated in the 2024 assessment); in tonnes.	ICES (2024b)
	B_{pa}	167 419	B_{lim} × 1.4; in tonnes.	ICES (2024b)

Framework	Reference point	Value	Technical basis	Source
	F_{lim}	1.18	The F that on average leads to B_{lim} from EqSim.	ICES (2024b)
	F_{pa}	0.68	The F that provides a 95% probability for SSB to be above B_{lim} ($F_{P.05}$ with advice rule [AR]).	ICES (2024b)
EU Management Plan (MAP)*	MAP MSY $B_{trigger}$	167 419	MSY $B_{trigger}$; in tonnes.	ICES (2024b)
	MAP B_{lim}	119 585	B_{lim}; in tonnes.	ICES (2024b)
	MAP F_{MSY}	0.68	F_{MSY}	ICES (2024b)
	MAP range F_{lower}	0.46–0.68	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2024b)
	MAP range F_{upper}	0.68–0.68	Consistent with ranges resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2024b)

*** EU multiannual plan (MAP) for the North Sea (EU, 2018).**

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 2003–2023
2024	10241
2025	10241
2026	10241

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 (2021–2023), age 6 is a plusgroup.

MFDP version 1a						
MFDP version 1a						
Run: run1						
Time and date: 17:15 15/04/2024						
Fbar age range (Total) : 2-5						
Fbar age range Fleet 1 : 2-5						
2024						
Age	N	M	Mat	PF	PM	SWt
0	10241134	1.638	0	0	0	0.013059

1	1177863	1.0247	0.4765	0	0	0.042828
2	905970	0.6627	0.8308	0	0	0.108150
3	307166	0.506	0.9537	0	0	0.203056
4	310671	0.483	0.9785	0	0	0.296777
5	189538	0.455	0.9872	0	0	0.418732
6	80781	0.3373	0.9950	0	0	0.485243
Catch						
Age	Sel	CWt	DSel	DCWt		
0	0.00001	0.06867	0.00079	0.03867		
1	0.00124	0.17767	0.00556	0.121		
2	0.00897	0.24967	0.01956	0.19167		
3	0.03224	0.34033	0.03748	0.242		
4	0.07213	0.423	0.03408	0.24467		
5	0.08604	0.501	0.01789	0.27667		
6	0.08142	0.559	0.02284	0.29333		
IBC						
Age	Sel	CWt				
0	0.00003	0.039				
1	0.00027	0.129				
2	0.00136	0.21				
3	0.00458	0.29				
4	0.00856	0.36867				
5	0.0091	0.46167				
6	0.00878	0.50067				
2025						
Age	N	M	Mat	PF	PM	SWt
0	10241134	1.638	0	0	0	0.013059
1	.	1.0247	0.4765	0	0	0.042828
2	.	0.6627	0.8308	0	0	0.10815
3	.	0.506	0.9537	0	0	0.203056

4	.	0.483	0.9785	0	0	0.296777
5	.	0.455	0.9872	0	0	0.418732
6	.	0.3373	0.995	0	0	0.485243
Catch						
Age	Sel	CWt	DSel	DCWt		
0	0.00001	0.06867	0.00079	0.03867		
1	0.00124	0.17767	0.00556	0.121		
2	0.00897	0.24967	0.01956	0.19167		
3	0.03224	0.34033	0.03748	0.242		
4	0.07213	0.423	0.03408	0.24467		
5	0.08604	0.501	0.01789	0.27667		
6	0.08142	0.559	0.02284	0.29333		
IBC						
Age	Sel	CWt				
0	0.00003	0.039				
1	0.00027	0.129				
2	0.00136	0.21				
3	0.00458	0.29				
4	0.00856	0.36867				
5	0.0091	0.46167				
6	0.00878	0.50067				
2026						
Age	N	M	Mat	PF	PM	SWt
0	10241134	1.638	0	0	0	0.013059
1	.	1.0247	0.4765	0	0	0.042828
2	.	0.6627	0.8308	0	0	0.10815
3	.	0.506	0.9537	0	0	0.203056
4	.	0.483	0.9785	0	0	0.296777
5	.	0.455	0.9872	0	0	0.418732
6	.	0.3373	0.995	0	0	0.485243

Catch				
Age	Sel	CWt	DSel	DCWt
0	0.00001	0.06867	0.00079	0.03867
1	0.00124	0.17767	0.00556	0.121
2	0.00897	0.24967	0.01956	0.19167
3	0.03224	0.34033	0.03748	0.242
4	0.07213	0.423	0.03408	0.24467
5	0.08604	0.501	0.01789	0.27667
6	0.08142	0.559	0.02284	0.29333
IBC				
Age	Sel	CWt		
0	0.00003	0.039		
1	0.00027	0.129		
2	0.00136	0.21		
3	0.00458	0.29		
4	0.00856	0.36867		
5	0.0091	0.46167		
6	0.00878	0.50067		
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: run1. Time and date: 17:15 15/04/2024; Basis: F(2024) = average exploitation (2021-2023),scaled to 2023 Fsq = 0.083; SSB (2024) = 372 494 t; Recruitment (2024-2026)=10 241 million; TAC 27.4 (2024) = 76 697 t; TAC 27.7d (2024)= 18899, Landings 4 (2023) = 15 800 t; Discards (2023) = 9 169 t; IBC (2023) = 2632 t.

Output units in tonnes

2024														
		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
555301	372494	1	0.083	30988	0.0498	20515	28829	23130	5699	0.0273	8314	1	0.0059	2159

2025														**2026**		**2024 TAC 27.4 + 7d**	**95596**	
		Catch			HC catch					Dis-cards		IBC	Land-ings					
Bio-mass	SSB	FMult	FBar	Yield	FBar	Yield	27.4+27.7d HC	27.4 HC	27.7d HC	FBar	Yield	FMult	FBar	Yield	Bio-mass	SSB	27.4 +7d TAC change	SSB change	
556028	363356	0	0.0059	2202	0.000	0	0	0	0	0.000	0	1	0.0059	2202	571481	375191	-97.7%	3.3%	No HC fishery
.	363356	0.1	0.014	5088	0.005	2092	2896	2323	573	0.003	804	1	0.0059	2192	569166	372918	-94.7%	2.6%	
.	363356	0.2	0.021	7952	0.010	4165	5769	4628	1141	0.006	1604	1	0.0059	2183	566871	370665	-91.7%	2.0%	

2025															2026		2024 TAC 27.4 + 7d	95596
.	363356	0.3	0.029	10793	0.015	6221	8619	6915	1704	0.008	2398	1	0.0059	2174	564597	368432	-88.7%	1.4%
.	363356	0.4	0.037	13612	0.020	8259	11447	9184	2263	0.011	3188	1	0.0059	2165	562343	366220	-85.8%	0.8%
.	363356	0.5	0.044	16408	0.025	10279	14252	11434	2818	0.014	3973	1	0.0059	2156	560110	364027	-82.8%	0.2%
.	363356	0.6	0.052	19179	0.030	12281	17033	13666	3367	0.016	4752	1	0.0059	2146	557896	361854	-79.9%	-0.4%
.	363356	0.7	0.060	21931	0.035	14266	19794	15881	3913	0.019	5528	1	0.0059	2137	555702	359700	-77.1%	-1.0%
.	363356	0.8	0.068	24661	0.040	16234	22532	18077	4455	0.022	6298	1	0.0059	2129	553527	357565	-74.2%	-1.6%
.	363356	0.9	0.075	27368	0.045	18185	25248	20256	4992	0.025	7063	1	0.0059	2120	551372	355450	-71.4%	-2.2%
.	363356	1	0.083	30054	0.050	20119	27943	22419	5524	0.027	7824	1	0.0059	2111	549235	353353	-68.6%	-2.8%
.	363356	1.1	0.091	32719	0.055	22036	30617	24564	6053	0.030	8581	1	0.0059	2102	547118	351276	-65.8%	-3.3%
.	363356	1.2	0.098	35362	0.060	23937	33269	26692	6577	0.033	9332	1	0.0059	2093	545019	349216	-63.0%	-3.9%
.	363356	1.3	0.106	37986	0.065	25821	35901	28803	7098	0.035	10080	1	0.0059	2085	542939	347176	-60.3%	-4.5%

2025															2026		2024 TAC 27.4 + 7d	95596	
.	363356	1.4	0.114	40588	0.070	27690	38512	30898	7614	0.038	10822	1	0.0059	2076	540878	345153	-57.5%	-5.0%	
.	363356	1.5	0.122	43169	0.075	29542	41102	32976	8126	0.041	11560	1	0.0059	2067	538834	343148	-54.8%	-5.6%	
.	363356	1.6	0.129	45731	0.080	31378	43672	35038	8634	0.044	12294	1	0.0059	2059	536809	341161	-52.2%	-6.1%	
.	363356	1.7	0.137	48271	0.085	33198	46221	37083	9138	0.046	13023	1	0.0059	2050	534801	339192	-49.5%	-6.7%	
.	363356	1.8	0.145	50793	0.090	35003	48751	39113	9638	0.049	13748	1	0.0059	2042	532811	337240	-46.9%	-7.2%	
.	363356	1.9	0.152	53294	0.095	36792	51260	41126	10134	0.052	14468	1	0.0059	2034	530839	335306	-44.3%	-7.7%	
.	363356	2	0.160	55776	0.100	38566	53751	43124	10627	0.055	15185	1	0.0059	2025	528884	333389	-41.7%	-8.2%	
.	363356	0.75	0.064	22970	0.037	14994	20836	16717	4119	0.020	5842	1	0.0059	2134	554904	358920	-76.0%	-1.2%	0.75 * F_{sq}
.	363356	1.25	0.102	36358	0.062	24631	34268	27493	6775	0.034	9637	1	0.0059	2090	544260	348474	-62.0%	-4.1%	1.25 * F_{sq}
.	363356	1.00	0.083	29660	0.050	19810	27549	22102	5446	0.027	7738	1	0.0059	2112	549585	353699	-69.0%	-2.7%	F_{sq}

2025															2026		2024 TAC 27.4 + 7d	95596	
.	363356	8.74	0.680	237008	0.436	169064	235580	189006	46574	0.238	66516	1	0.0059	1428	384734	191923	147.9%	-47.2%	F_{pa}
.	363356	6.93	0.540	188384	0.345	134063	186795	149866	36929	0.189	52732	1	0.0059	1589	423393	229861	97.1%	-36.7%	$F_{p.05}$ without AR
.	363356	15.23	1.180	410666	0.759	294067	409810	328791	81019	0.415	115743	1	0.0059	856	246668	564321	329.6%	-84.5%	F_{lim}
.	363356	9.91	0.770	268275	0.494	191571	266949	214174	52776	0.270	75379	1	0.0059	1325	359876	167419	180.6%	-53.9%	B_{pa}, MSY $B_{trigger}$
.	363356	12.20	0.946	329547	0.608	235676	328424	263495	64929	0.332	92748	1	0.0059	1123	311161	119585	244.7%	-67.1%	B_{lim}
.	363356	5.89	0.460	160599	0.294	114063	158918	127500	31418	0.161	44856	1	0.0059	1680	445483	251539	68.0%	-30.8%	$F_{MSY\ lower}$
.	363356	8.74	0.680	237008	0.436	169064	235580	189006	46574	0.238	66516	1	0.0059	1428	384734	191923	147.9%	-47.2%	F_{MSY}
.	363356	8.74	0.680	237008	0.436	169064	235580	189006	46574	0.238	66516	1	0.0059	1428	384734	191923	147.9%	-47.2%	$F_{MSY\ upper}$

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					
Year/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

Q1 North						Q3 North					
Year/Age	1	2	3	4	5	0	1	2	3	4	5
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
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

Q1 North						Q3 North					
Year/Age	**1**	**2**	**3**	**4**	**5**	**0**	**1**	**2**	**3**	**4**	**5**
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	473.535	186.89	100.121	70.15	21.446	654.4	1011.846	188.023	69.895	43.277	30.275
2021	483.497	830.364	143.204	53.927	21.881	48.177	538.947	416.742	73.307	28.946	17.553
2022	199.455	815.503	322.694	55.209	18.713	45.357	194.319	377.394	273.392	75.482	23.002
2023	85.576	129.587	270.776	156.587	38.762	59.164	674.879	318.557	468.036	271.126	35.897

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/ Year	1	2	3	4	5	0	1	2	3	4	5
1983	85.450	99.851	52.686	19.987	5.019						
1984	593.881	84.243	43.152	4.049	2.825						
1985	114.689	330.400	30.889	11.822	3.018						
1986	155.459	93.190	215.536	54.700	7.664						
1987	542.592	86.810	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	32.480	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	117.670	56.676	27.940	1200.775	406.283	311.477	40.846	30.723	26.147
1993	140.264	59.430	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	951.750	640.529	84.975	43.115	25.091	10.09
1995	222.579	239.969	49.752	19.783	6.470	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	13.870	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	34.870	14.430	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	20.520	6.177	1.968	0.942
2008	427.504	247.607	26.007	4.196	2.120	546.391	596.203	54.246	16.160	4.215	0.806

Q1 South						Q3 South					
Age/ Year	1	2	3	4	5	0	1	2	3	4	5
2009	438.147	459.551	74.428	18.350	15.819	634.897	1044.568	664.476	76.080	11.132	6.005
2010	508.82	81.019	64.927	17.960	9.475	914.230	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	17.160	13.996	1884.952	283.798	169.738	124.258	70.136	15.764
2015	340.564	393.710	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	266.910	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	531.832	171.634	32.164	24.288	10.189	2381.931	1825.626	248.69	51.606	47.583	50.993
2021	817.832	443.208	66.728	13.645	5.105	1643.416	2308.425	517.862	80.788	17.508	7.127
2022	1139.12	547.176	104.463	25.711	12.994	5821.460	933.007	300.835	160.140	55.881	11.422
2023	587.428	1177.124	255.787	150.679	17.017	2100.358	1405.675	259.491	57.295	128.207	18.437

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

Year/Age	0	1	2	3	4	5	6+
1991	0	0.122	0.861	0.996	1	1	1
1992	0	0.127	0.856	0.994	1	1	1
1993	0	0.132	0.850	0.991	1	1	1
1994	0	0.138	0.843	0.988	0.999	1	1
1995	0	0.145	0.835	0.985	0.998	0.999	1
1996	0	0.154	0.826	0.982	0.997	0.999	1
1997	0	0.164	0.816	0.978	0.997	0.999	1
1998	0	0.176	0.806	0.973	0.996	0.999	1
1999	0	0.190	0.796	0.969	0.995	0.999	1

Year/Age	0	1	2	3	4	5	6+
2000	0	0.204	0.787	0.966	0.995	0.999	1
2001	0	0.218	0.783	0.965	0.995	0.999	1
2002	0	0.231	0.783	0.965	0.995	0.999	1
2003	0	0.241	0.787	0.967	0.996	0.999	1
2004	0	0.249	0.795	0.970	0.996	0.999	1
2005	0	0.255	0.805	0.974	0.997	1	1
2006	0	0.257	0.817	0.977	0.998	1	1
2007	0	0.258	0.829	0.981	0.999	1	1
2008	0	0.257	0.840	0.985	1	1	1
2009	0	0.255	0.849	0.988	1	1	1
2010	0	0.253	0.857	0.991	1	1	1
2011	0	0.252	0.861	0.993	1	1	1
2012	0	0.253	0.863	0.994	1	1	1
2013	0	0.253	0.862	0.994	1	1	1
2014	0	0.256	0.860	0.993	1	1	1
2015	0	0.262	0.858	0.991	1	1	1
2016	0	0.272	0.855	0.989	1	1	1
2017	0	0.286	0.851	0.985	1	1	1
2018	0	0.305	0.846	0.980	0.997	0.999	0.999
2019	0	0.329	0.840	0.973	0.993	0.996	0.997
2020	0	0.358	0.833	0.965	0.987	0.991	0.995
2021	0	0.394	0.826	0.954	0.979	0.986	0.991
2022	0	0.434	0.819	0.942	0.969	0.979	0.987
2023	0	0.477	0.812	0.928	0.958	0.971	0.983

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

Year/Age	0	1	2	3	4	5	6+
1991	0	0.185	0.925	1	1	1	1
1992	0	0.185	0.885	1	1	1	1

Year/Age	0	1	2	3	4	5	6+
1993	0	0.184	0.846	0.992	1	1	1
1994	0	0.181	0.810	0.978	0.999	1	1
1995	0	0.174	0.774	0.961	0.992	0.998	0.999
1996	0	0.167	0.736	0.938	0.982	0.994	0.997
1997	0	0.164	0.703	0.91	0.968	0.987	0.994
1998	0	0.172	0.678	0.881	0.951	0.979	0.990
1999	0	0.190	0.651	0.848	0.931	0.969	0.985
2000	0	0.216	0.620	0.817	0.912	0.960	0.981
2001	0	0.246	0.598	0.798	0.902	0.956	0.979
2002	0	0.279	0.592	0.796	0.903	0.956	0.979
2003	0	0.314	0.602	0.805	0.910	0.959	0.980
2004	0	0.348	0.623	0.822	0.920	0.965	0.983
2005	0	0.379	0.653	0.844	0.934	0.972	0.987
2006	0	0.411	0.690	0.870	0.949	0.979	0.990
2007	0	0.444	0.732	0.897	0.962	0.986	0.994
2008	0	0.473	0.774	0.921	0.973	0.991	0.997
2009	0	0.494	0.808	0.940	0.982	0.995	0.999
2010	0	0.505	0.832	0.952	0.987	0.997	1
2011	0	0.510	0.845	0.959	0.989	0.998	1
2012	0	0.513	0.849	0.960	0.990	0.998	1
2013	0	0.514	0.846	0.959	0.989	0.998	1
2014	0	0.513	0.845	0.958	0.988	0.997	1
2015	0	0.511	0.847	0.96	0.988	0.997	1
2016	0	0.505	0.850	0.962	0.989	0.998	1
2017	0	0.498	0.852	0.965	0.990	0.998	1
2018	0	0.492	0.852	0.966	0.992	0.998	1
2019	0	0.491	0.851	0.968	0.993	0.998	1
2020	0	0.495	0.853	0.970	0.994	0.998	1
2021	0	0.501	0.858	0.973	0.996	0.999	1

Year/Age	0	1	2	3	4	5	6+
2022	0	0.508	0.863	0.976	0.998	0.999	1
2023	0	0.515	0.867	0.978	0.999	1	1

Table 23.31. Whiting in Subarea 4 and Division 7.d. Ratio of current (WGNSSK 2024) over previous (WGNSSK 2023) numbers-at-age from stock assessment and forecast results.

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023*	2024**	2025***
0	0.70	0.72	0.73	0.76	0.81	0.76	0.67	0.89	0.40	0.68	0.68
1	1.05	1.03	1.00	0.98	0.96	0.96	0.96	0.88	1.30	0.56	0.94
2	1.11	1.09	1.07	1.05	1.04	1.04	1.06	1.08	1.00	1.47	0.64
3	1.09	1.08	1.07	1.05	1.04	1.03	1.04	1.06	1.09	1.01	1.49
4	1.09	1.08	1.07	1.06	1.04	1.04	1.03	1.04	1.08	1.13	1.04
5	1.07	1.06	1.05	1.05	1.03	1.02	1.02	1.02	1.02	1.09	1.14
6+	1.03	1.03	1.02	0.99	0.98	0.98	0.97	0.98	0.98	1.00	1.06

*** 2023 was the intermediate year at WGNSSK 2023.**

**** 2024 was the advice year at WGNSSK 2023 and is the intermediate year at WGNSSK 2024.**

***** 2025 is the advice year at WGNSSK 2024.**

Table 23.32. Whiting in Subarea 4 and Division 7.d. Ratio of current (WGNSSK 2024) over previous (WGNSSK 2023) biomass-at-age from stock assessment and forecast results.

Age	2015	2016	2017	2018	2019	2020	2021	2022	2023*	2024**	2025***
0	0.71	0.73	0.74	0.77	0.82	0.77	0.68	0.90	0.16	0.43	0.43
1	1.06	1.04	1.02	0.99	0.97	0.98	0.97	0.89	1.10	0.57	0.96
2	1.11	1.09	1.08	1.06	1.04	1.04	1.06	1.09	1.04	1.45	0.62
3	1.10	1.09	1.07	1.06	1.04	1.03	1.04	1.07	1.04	1.00	1.48
4	1.10	1.08	1.08	1.06	1.05	1.04	1.04	1.04	0.99	1.10	1.02
5	1.06	1.06	1.05	1.04	1.03	1.01	1.01	1.01	1.01	1.10	1.15
6+	1.02	1.02	1.01	0.98	0.97	0.96	0.96	0.97	1.13	1.03	1.09

*** 2023 was the intermediate year at WGNSSK 2023.**

**** 2024 was the advice year at WGNSSK 2023 and is the intermediate year at WGNSSK 2024.**

***** 2025 is the advice year at WGNSSK 2024.**

Table 23.33. Whiting in Subarea 4 and Division 7.d. Summary of forecast assumptions from previous assessment (WGNSSK 2023) and current assessment (WGNSSK 2024). '2023' is the intermediate year in previous assessment, '2024' is the advice year in the previous assessment.

	Year	Previous assessment (2023)	Current assessment (2024)
Assumed recruitment	2023	15 061 millions	6 066 millions
	2024	15 061 millions	10 241 millions
Catch	2023	34 829 t	28 911 t
SSB	2023	348 144 t	362 538 t
	2024	347 863 t	372 494 t

	Year	Previous assessment (2023)	Current assessment (2024)
F	2023	0.101	0.083
Target F for TAC	2024/2025	0.393	0.68

Table 23.34. Whiting in Subarea 4 and Division 7.d. New raw natural mortality estimates (ICES, 2024a).

Year/Age	0	1	2	3	4	5	6+
1974	1.017	1.239	0.768	0.661	0.532	0.491	0.319
1975	0.940	1.108	0.658	0.602	0.542	0.462	0.270
1976	1.229	1.396	0.708	0.573	0.519	0.445	0.268
1977	0.930	1.341	0.690	0.581	0.544	0.475	0.258
1978	1.326	1.396	0.786	0.564	0.500	0.458	0.262
1979	0.770	0.985	0.745	0.574	0.514	0.500	0.297
1980	1.052	1.233	0.695	0.538	0.490	0.468	0.285
1981	1.915	1.636	0.871	0.640	0.526	0.507	0.289
1982	1.235	1.522	0.734	0.608	0.554	0.519	0.280
1983	0.948	1.130	0.766	0.515	0.489	0.474	0.283
1984	1.474	1.081	0.637	0.487	0.480	0.456	0.270
1985	0.933	1.125	0.711	0.488	0.472	0.456	0.273
1986	1.151	0.947	0.588	0.501	0.475	0.446	0.251
1987	1.193	1.121	0.638	0.497	0.446	0.431	0.256
1988	0.915	1.265	0.662	0.536	0.496	0.468	0.242
1989	1.205	1.218	0.578	0.487	0.472	0.452	0.434
1990	1.257	1.226	0.620	0.501	0.474	0.458	0.257
1991	1.080	1.017	0.583	0.501	0.471	0.471	0.450
1992	1.248	1.138	0.550	0.464	0.454	0.444	0.427
1993	1.201	1.265	0.644	0.479	0.444	0.438	0.427
1994	1.227	1.168	0.636	0.480	0.462	0.444	0.444
1995	1.501	1.272	0.627	0.469	0.439	0.435	0.377
1996	1.249	1.338	0.682	0.512	0.475	0.455	0.399
1997	1.547	1.191	0.598	0.494	0.468	0.454	0.436

Year/Age	0	1	2	3	4	5	6+
1998	1.628	1.386	0.696	0.500	0.455	0.437	0.422
1999	1.910	1.431	0.619	0.510	0.497	0.474	0.458
2000	1.717	0.901	0.535	0.465	0.433	0.433	0.43
2001	1.772	1.216	0.550	0.467	0.437	0.427	0.414
2002	2.028	1.605	0.663	0.506	0.484	0.455	0.437
2003	2.086	1.752	0.635	0.513	0.487	0.462	0.443
2004	2.006	1.248	0.785	0.555	0.53	0.526	0.503
2005	2.053	1.154	0.666	0.540	0.522	0.502	0.500
2006	2.116	1.059	0.741	0.588	0.531	0.531	0.516
2007	2.111	1.283	0.712	0.58	0.518	0.518	0.514
2008	1.966	1.210	0.689	0.574	0.554	0.516	0.516
2009	1.501	1.143	0.686	0.566	0.542	0.533	0.513
2010	1.725	1.026	0.638	0.495	0.489	0.461	0.461
2011	2.207	1.137	0.661	0.523	0.49	0.479	0.479
2012	2.316	1.263	0.729	0.558	0.511	0.500	0.500
2013	2.050	1.206	0.695	0.558	0.534	0.447	0.395
2014	2.026	0.928	0.671	0.533	0.533	0.508	0.403
2015	2.195	0.955	0.659	0.537	0.52	0.508	0.448
2016	1.925	1.149	0.673	0.544	0.526	0.516	0.272
2017	2.231	1.336	0.654	0.529	0.507	0.501	0.325
2018	1.747	1.220	0.707	0.554	0.522	0.513	0.258
2019	1.476	1.146	0.701	0.534	0.514	0.500	0.442
2020	1.671	0.982	0.579	0.480	0.457	0.449	0.355
2021	1.851	0.984	0.669	0.476	0.463	0.452	0.405
2022	1.472	0.964	0.692	0.528	0.493	0.423	0.323

Table 23.35. Whiting in Subarea 4 and Division 7.d. Reference points of the new 2024 assessment and retrospectives compared to reference points used until WGNSSK 2023

Reference point	WGNSSK 2022 Old reference points	% change	assessment retro (data 2020)	assessment retro (data 2021)	assessment retro (data 2022)	WGNSSK 2024 assessment (data 2023)
$F_{MSY\ lower}$	0.29	62%	0.34 (capped)	0.38 (capped)	0.41 (capped)	0.46 (capped)
F_{MSY}	0.39	74%	0.41 (capped)	0.49 (capped)	0.57 (capped)	0.68 (capped)
$F_{MSY\ upper}$	0.47	45%	0.41 (capped)	0.49 (capped)	0.57 (capped)	0.68 (capped)
$B_{trigger}$	148888	12%	167419	167419	167419	167419
B_{pa}	148888	12%	167419	167419	167419	167419
B_{lim}	107146	12%	119585	119585	119585	119585
$F_{pa} = F_{p.05\ (AR)}$	0.47	45%	0.41	0.49	0.57	0.68
F_{lim}	0.94	26%	0.67	0.79	0.96	1.18
$F_{MSY\_unconstr}$	0.39	90%	0.50	0.55	0.65	0.74

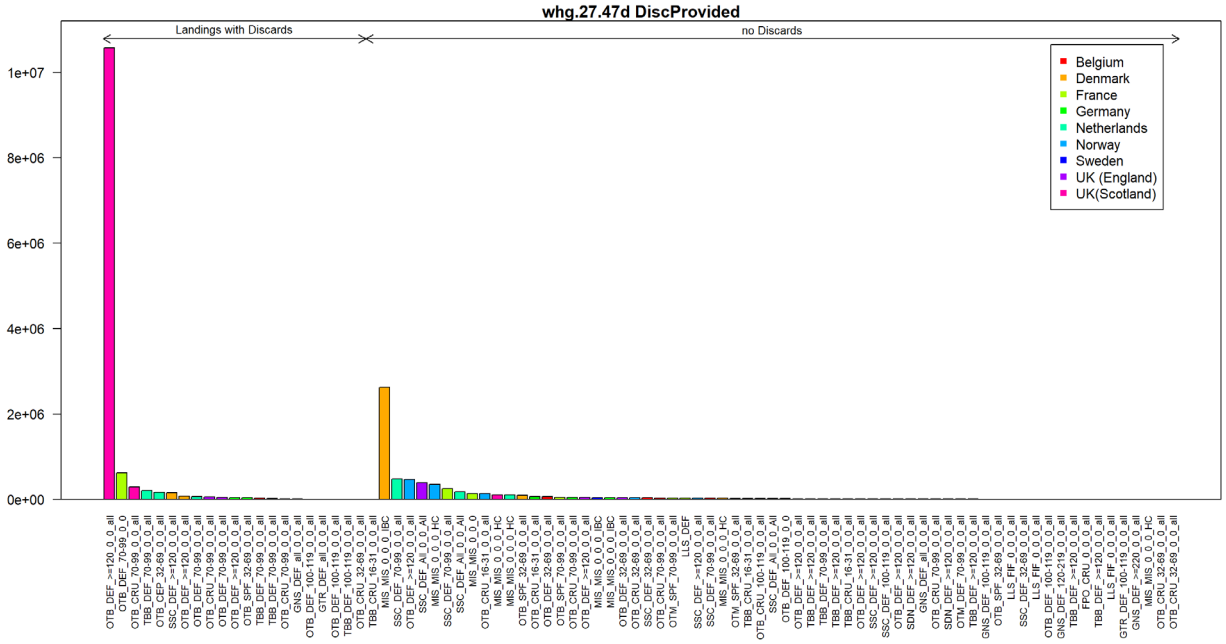

Figure 23.1. Whiting in Subarea 4 and Division 7.d. Landings with provided discards. Métier with industrial bycatch landings (MIS_MIS_0_0_0_IBC, Denmark, orange) generally does not have discards.

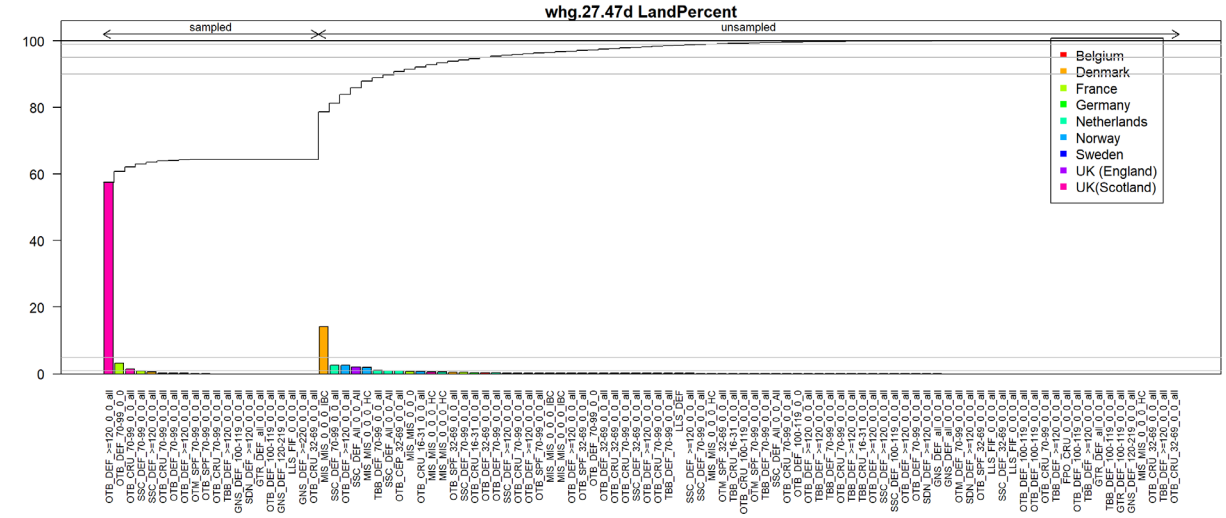

Figure 23.2a. Whiting in Subarea 4 and Division 7.d. Reported landings (in percent, colored bars) for each sampled and unsampled fleet, along with cumulative landings (in percent, black line) for fleets in descending order of yield.

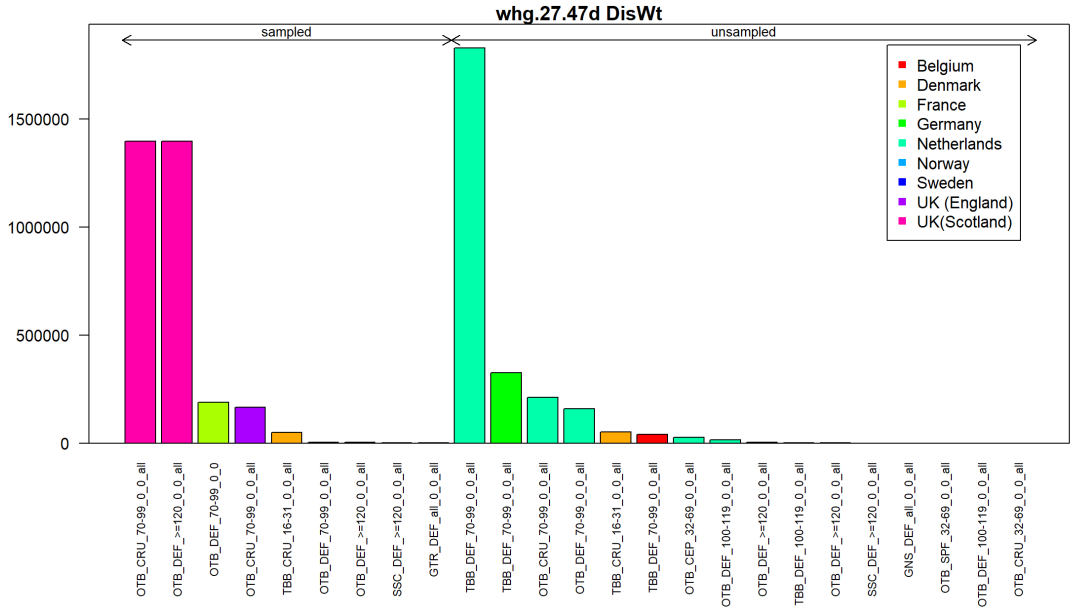

Figure 23.2b. Whiting in Subarea 4 and Division 7.d. Reported discards (in tonnes, colored bars) for each sampled and unsampled fleet, in descending order of yield.

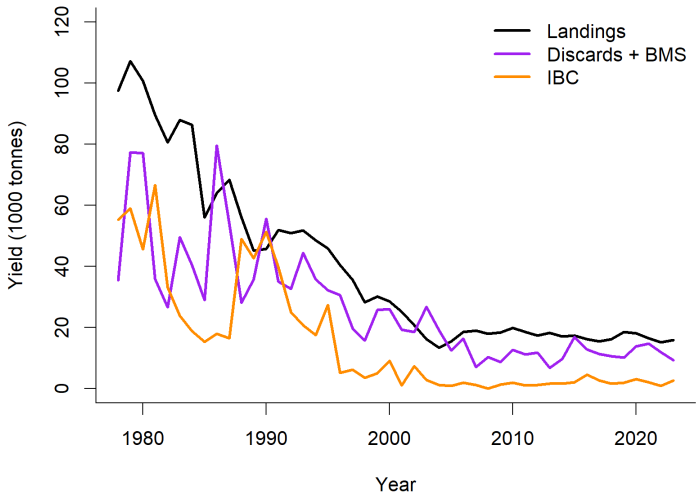

Figure 23.3. Whiting in Subarea 4 and Division 7.d. Yield by catch component as estimated by ICES.

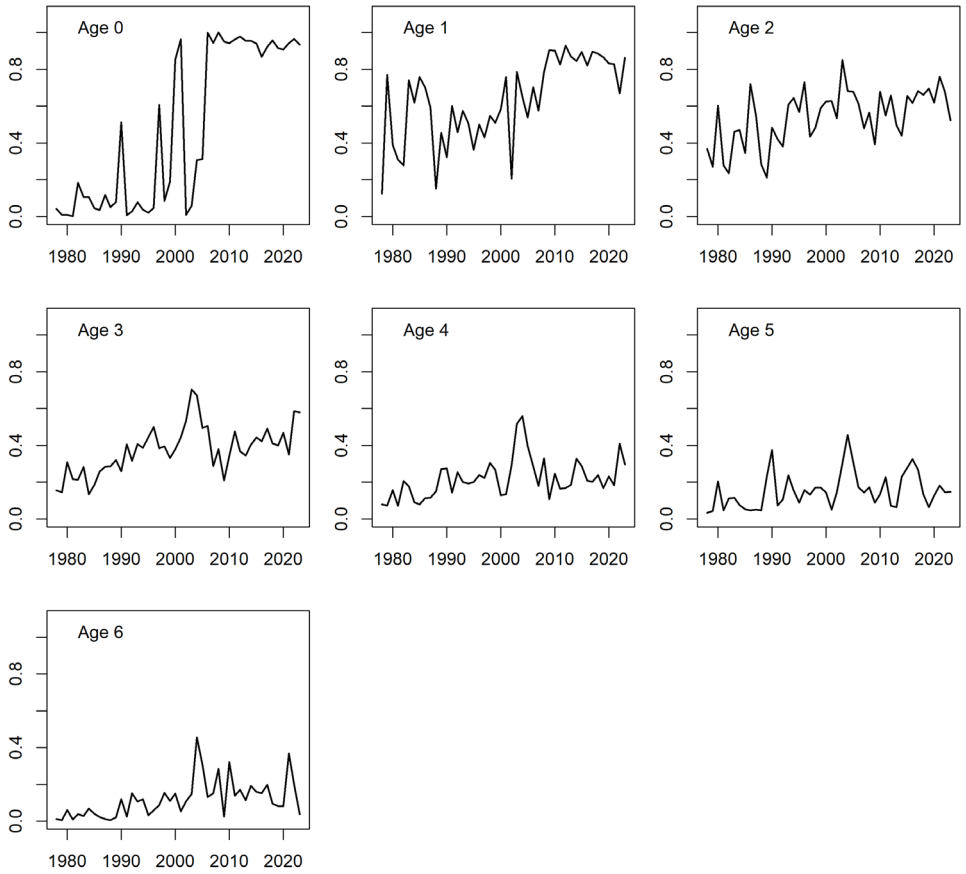

Figure 23.4. Whiting in Subarea 4 and Division 7.d. Proportion of discards in total catch, by age and year.

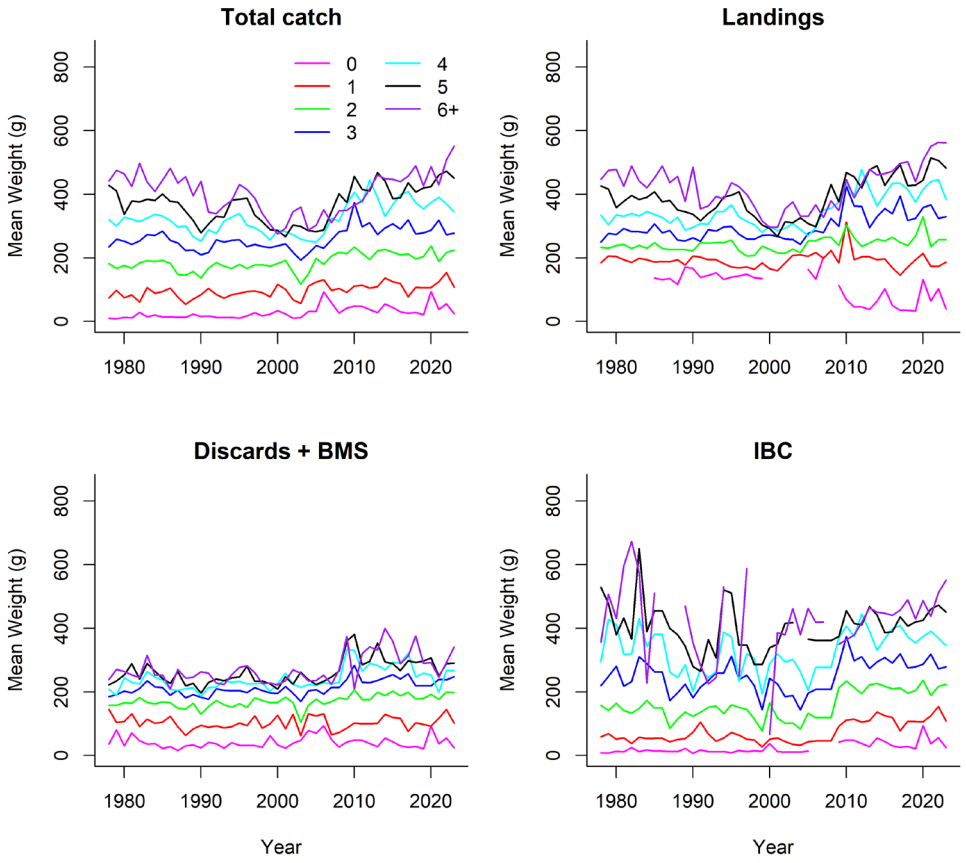

Figure 23.5. Whiting in Subarea 4 and Division 7.d. Mean weights-at-age (g) by catch component (age 0–6+).

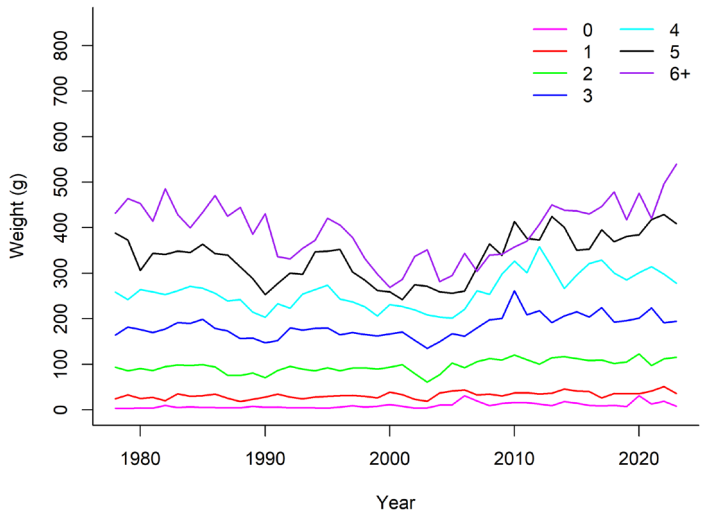

Figure 23.6. Whiting in Subarea 4 and Division 7.d. Stock mean weights-at-age (g) (age 0–6+).

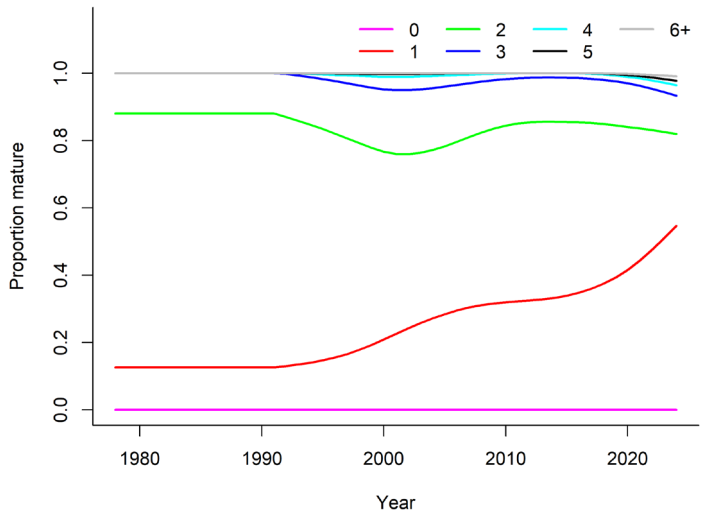

Figure 23.7. Whiting in Subarea 4 and Division 7.d. Maturity estimates from NS IBTS Q1 data. Ages 6 and older have the same maturity values. Estimates prior 1991 are assumed constant using values of 1991.

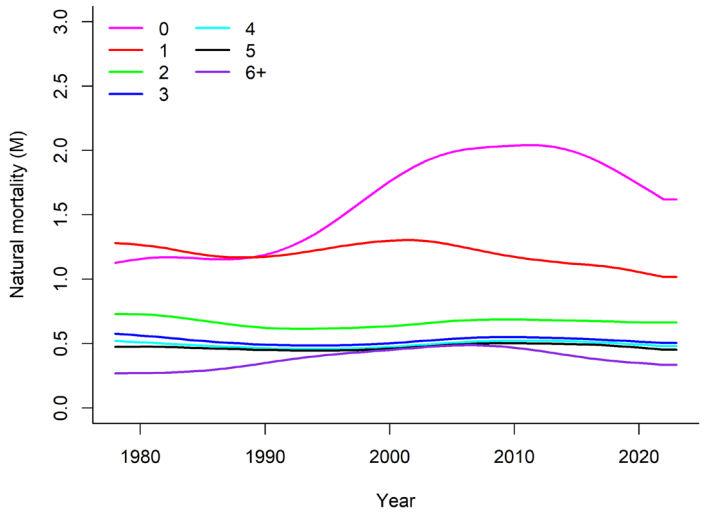

Figure 23.8. Whiting in Subarea 4 and Division 7.d. Natural mortality estimates from the 2023 update of the North Sea SMS key run (WGSAM, 2024a) used in the assessment.

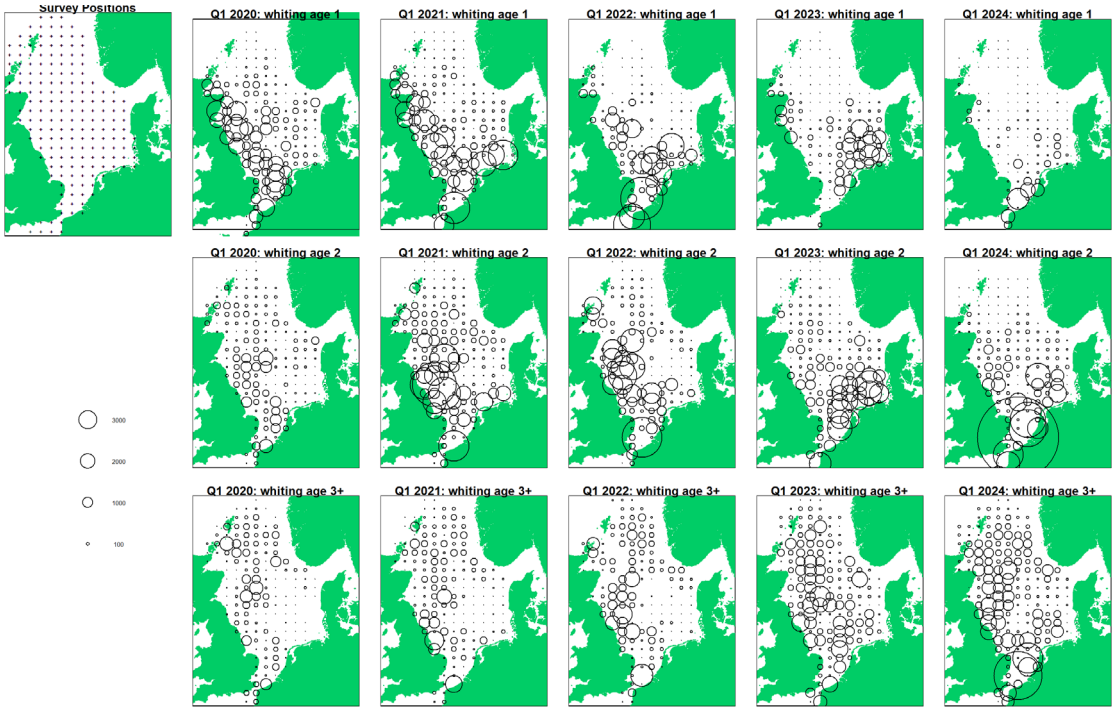

Figure 23.9. Whiting in Subarea 4 and Division 7.d. Survey distribution maps for Ages 1–3+ Q1 2020–2024. Size of the bubbles indicates numbers caught per 30 minutes for each age (on a log10 scale). The maps are based on the IBTS–Q1 survey in the North Sea.

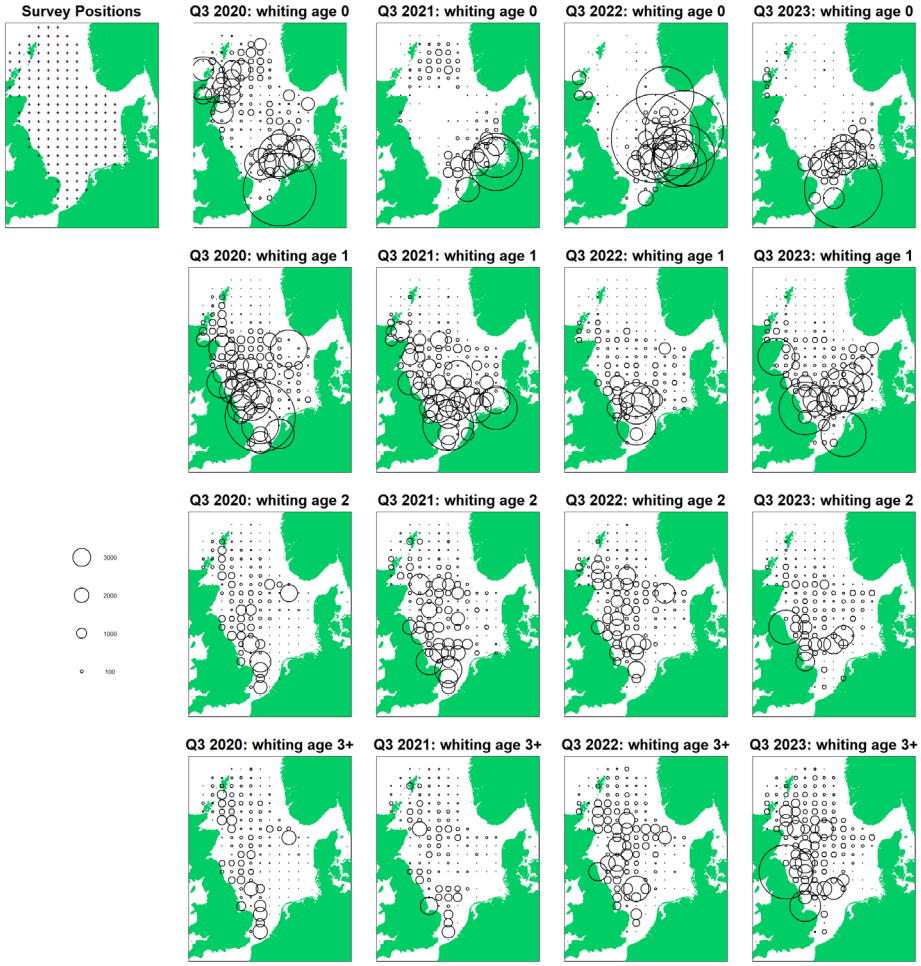

Figure 23.10. Whiting in Subarea 4 and Division 7.d. Survey distribution maps for ages 0–3+ Q3 2020–2023. Size of the bubbles indicates numbers caught per 30 minutes for each age (on a log10 scale). The maps are based on the IBTS–Q3 survey in the North Sea.

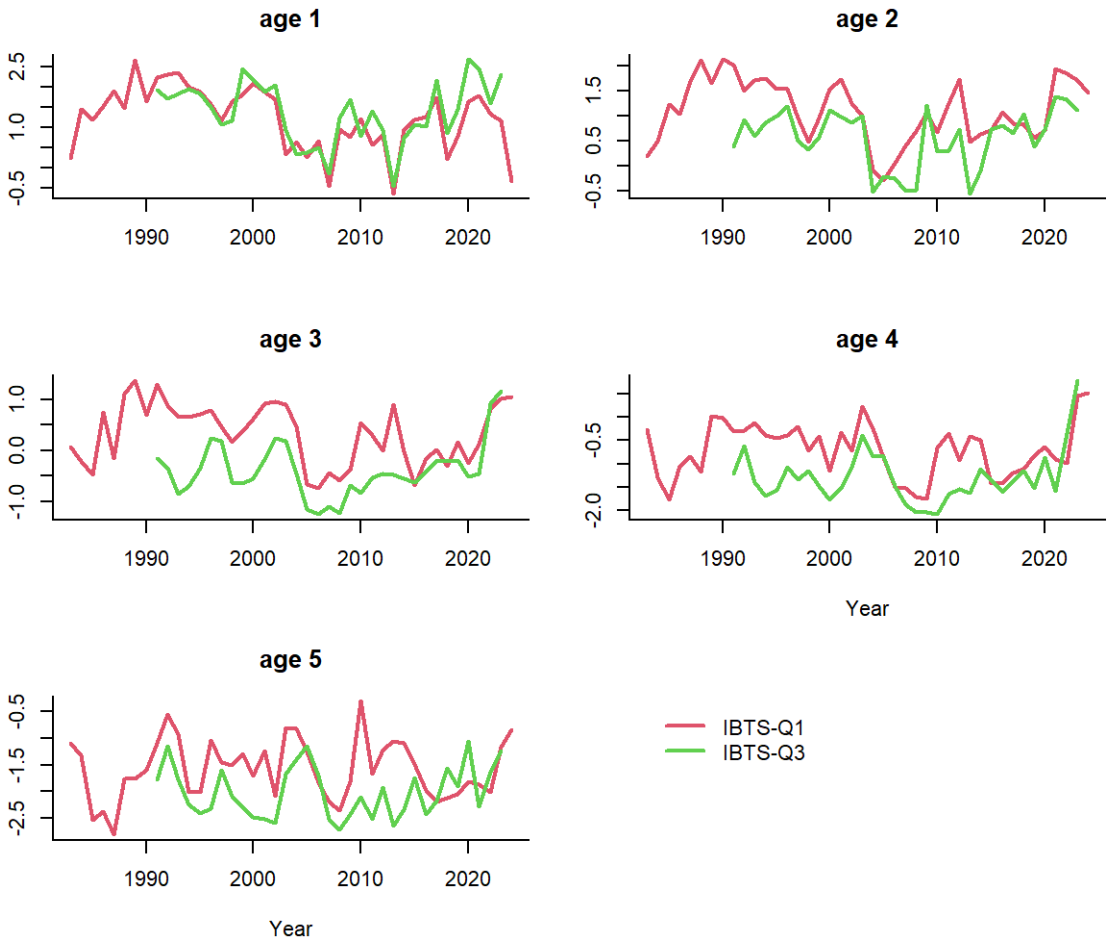

Figure 23.11. Whiting in Subarea 4 and Division 7.d. Survey log CPUE (catch per unit effort) at age.

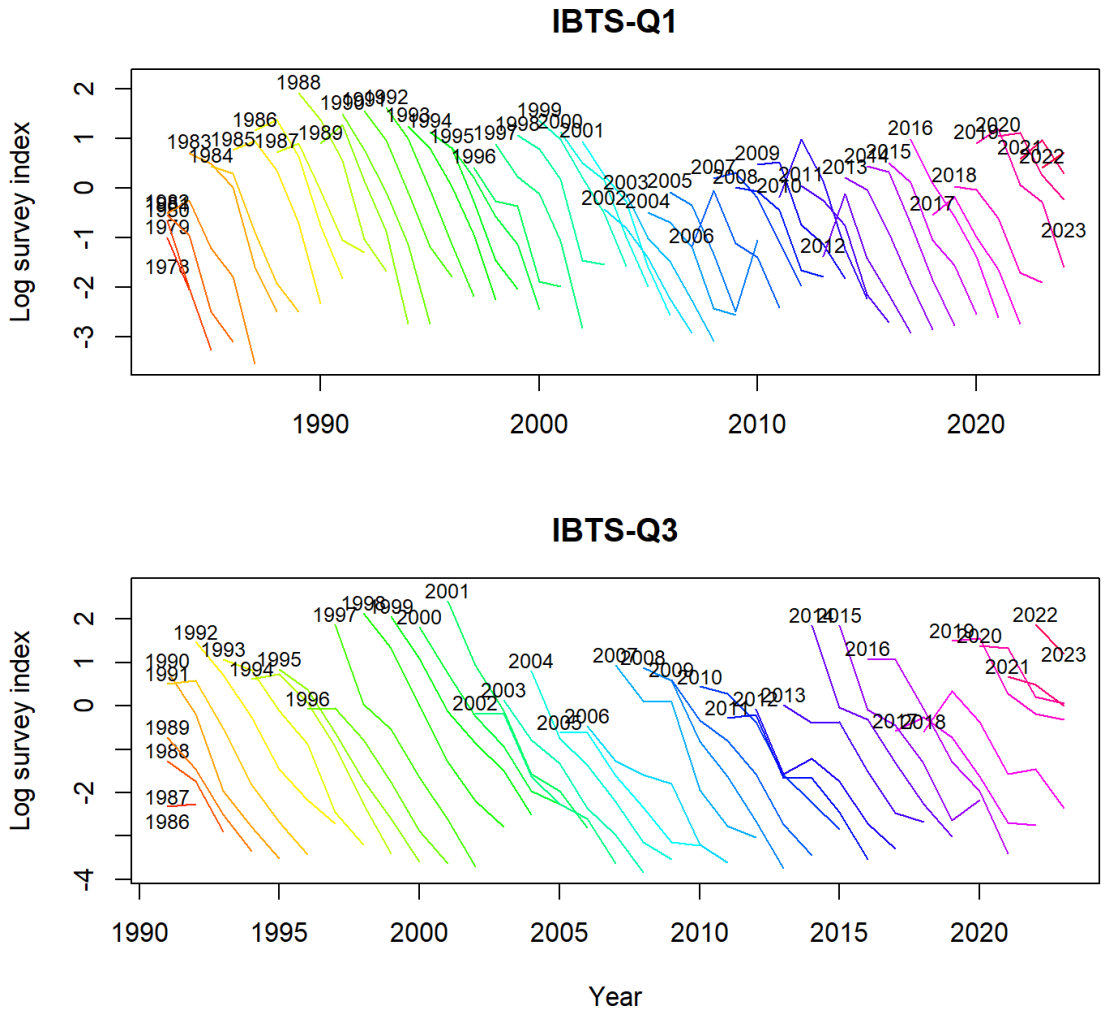

Figure 23.12. Whiting in Subarea 4 and Division 7.d. Log survey indices by cohort for each of the two surveys. The spawning year for each cohort is indicated at the start of each line.

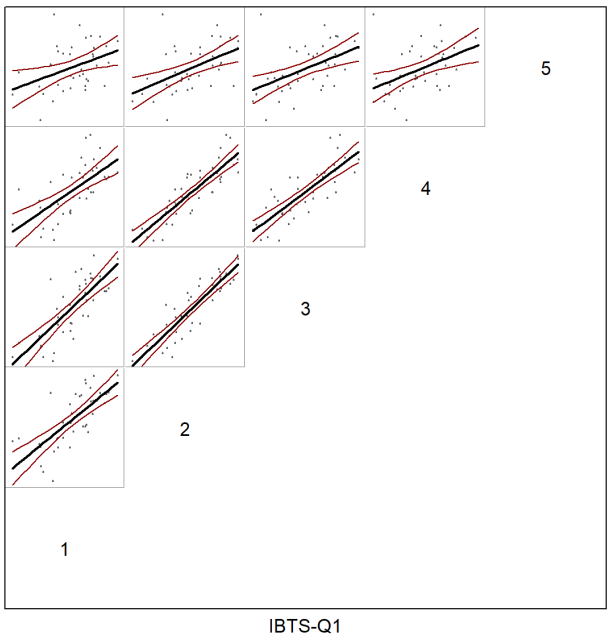

Figure 23.13. Whiting in Subarea 4 and Division 7.d. Within-survey correlations for the IBTS–Q1 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line (with black points) represents a significant ($p < 0.05$) regression, while a thin line (with blue points) is not significant. Approximate 95% confidence intervals for each fit are also shown.

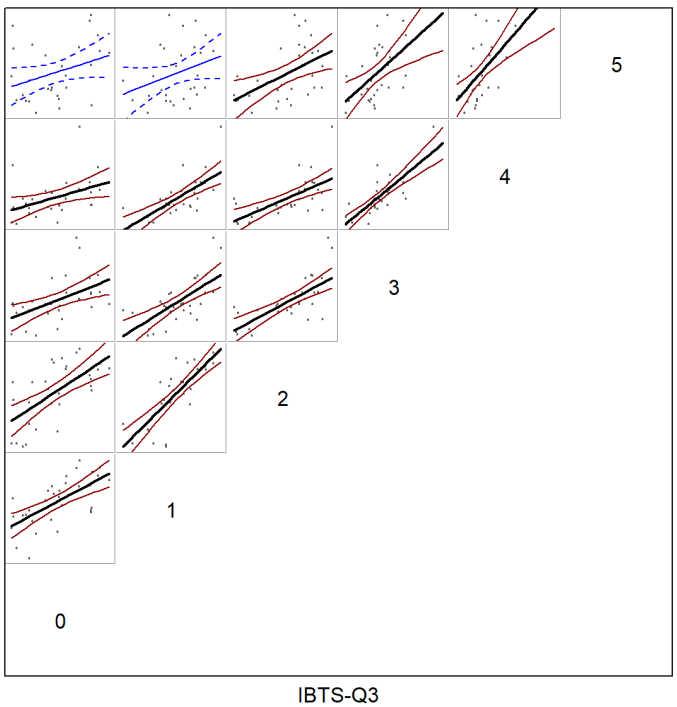

Figure 23.14. Whiting in Subarea 4 and Division 7.d. Within-survey correlations for the IBTS–Q3 survey series, comparing index values at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line (with black points) represents a significant ($p < 0.05$) regression, while a thin line (with blue points) is not significant. Approximate 95% confidence intervals for each fit are also shown.

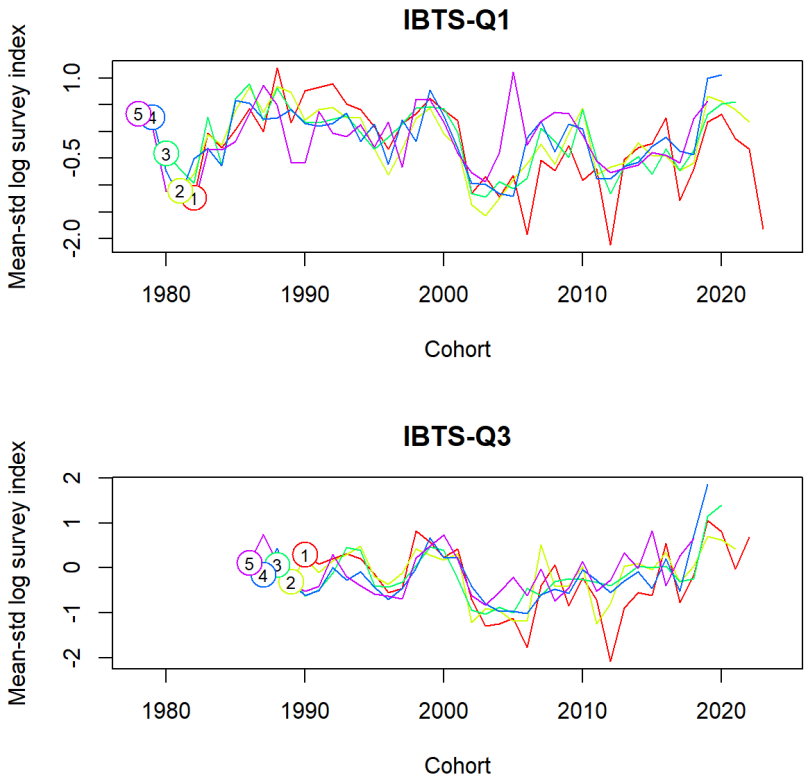

Figure 23.15. Whiting in Subarea 4 and Division 7.d. Survey log CPUE (catch per unit effort) for the IBTS–Q1 and Q3 surveys, by cohort. Each line shows the log CPUE for the age indicated at the start of the line.

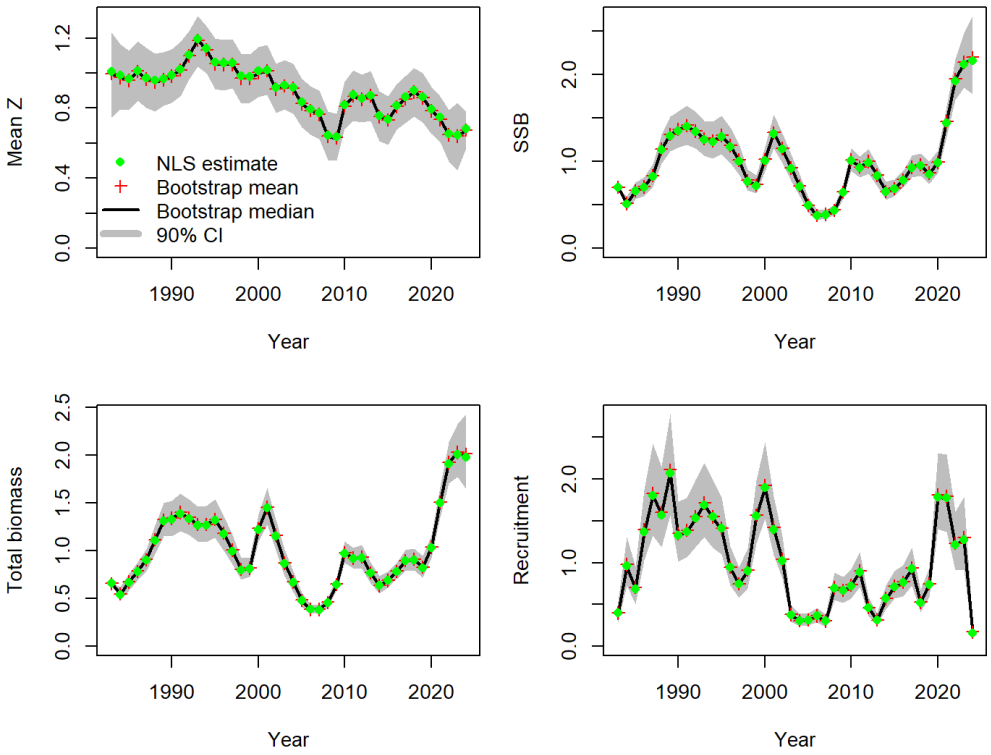

Figure 23.16. Whiting in Subarea 4 and Division 7.d. Summary plots from an exploratory SURBAR assessment, using both available surveys (IBTS–Q1 and Q3). Mean mortality Z (ages 2 to 4), relative spawning stock biomass (SSB), relative total biomass (TSB), and relative recruitment (age 1). Shaded grey areas 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.

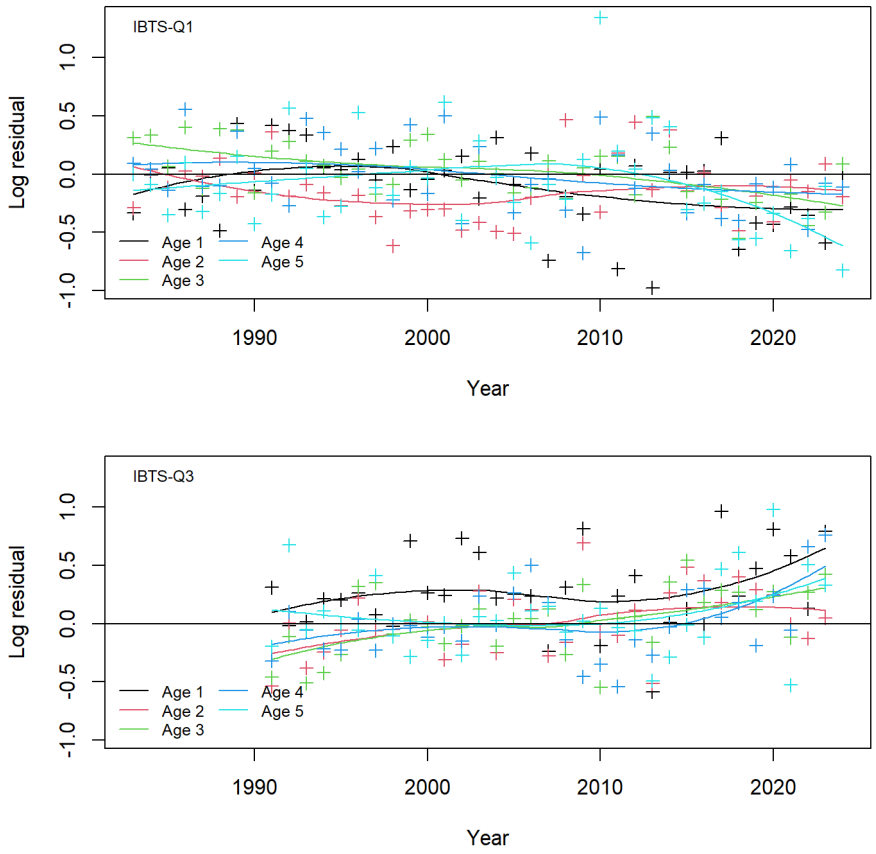

Figure 23.17. Whiting in Subarea 4 and Division 7.d. Log survey residuals from the SURBAR analysis. Ages are color-coded, and a LOESS smoother (span = 2) has been fitted through each age time-series.

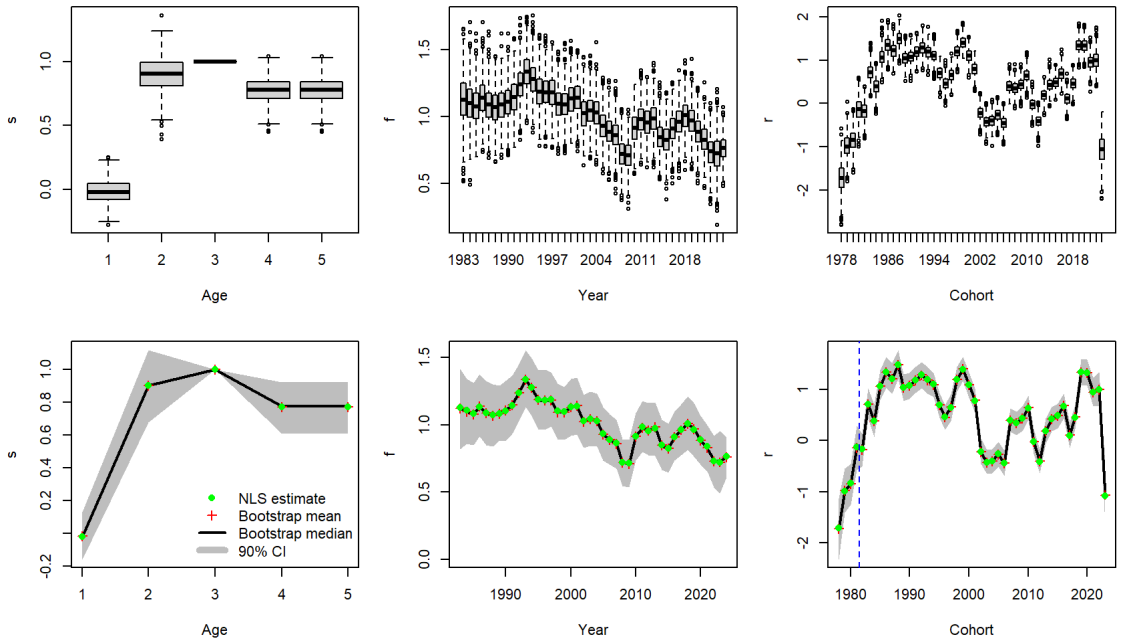

Figure 23.18. Whiting in Subarea 4 and Division 7.d. Parameter estimates from SURBAR analysis. Top row: age, year and cohort effect estimates as box-and-whisker plots. Bottom row: estimates as line plots with 90% confidence intervals.

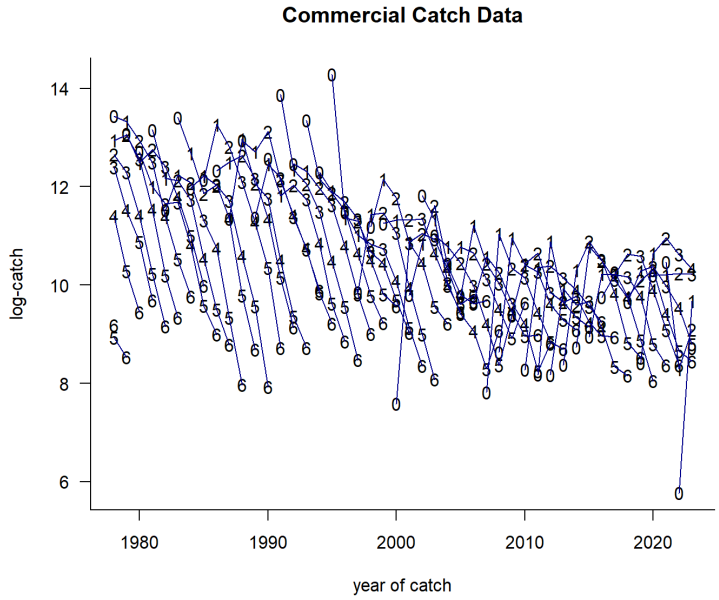

Figure 23.19. Whiting in Subarea 4 and Division 7.d. Log-catch curves by cohort for total catches (ages 0–6+).

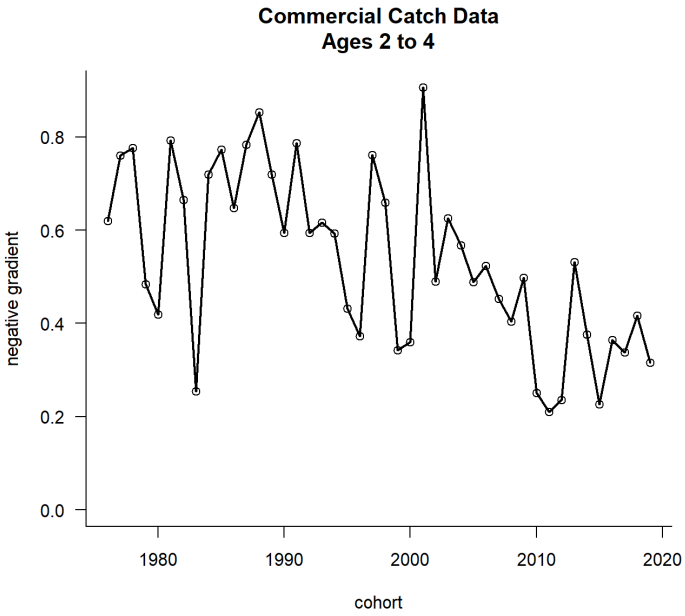

Figure 23.20. Whiting in Subarea 4 and Division 7.d. Negative gradients of log catches per cohort, averaged over ages 2–4. The x-axis represents the spawning year of each cohort.

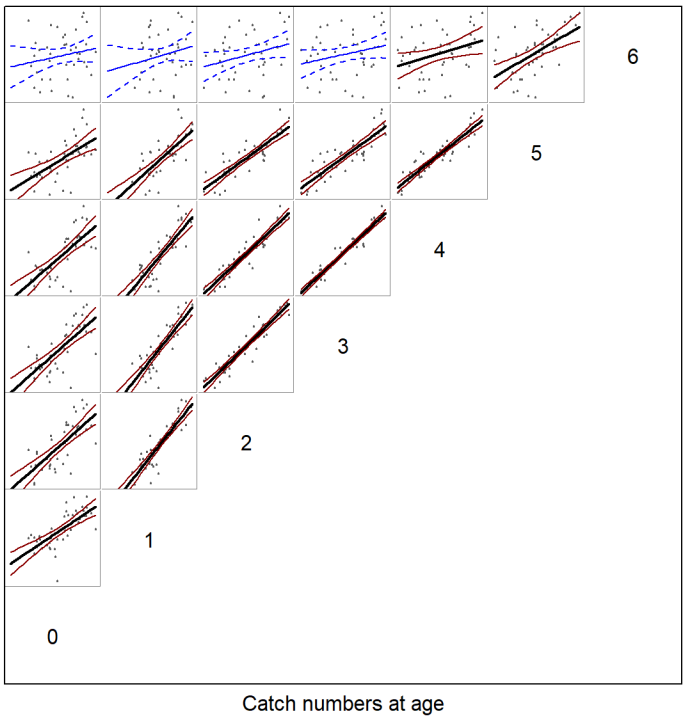

Figure 23.21. Whiting in Subarea 4 and Division 7.d. Correlations in the catch-at-age matrix (including the plus-group for ages 6 and older), comparing estimates at different ages for the same year-classes (cohorts). In each plot, the straight line is a normal linear model fit: a thick line (and black 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.

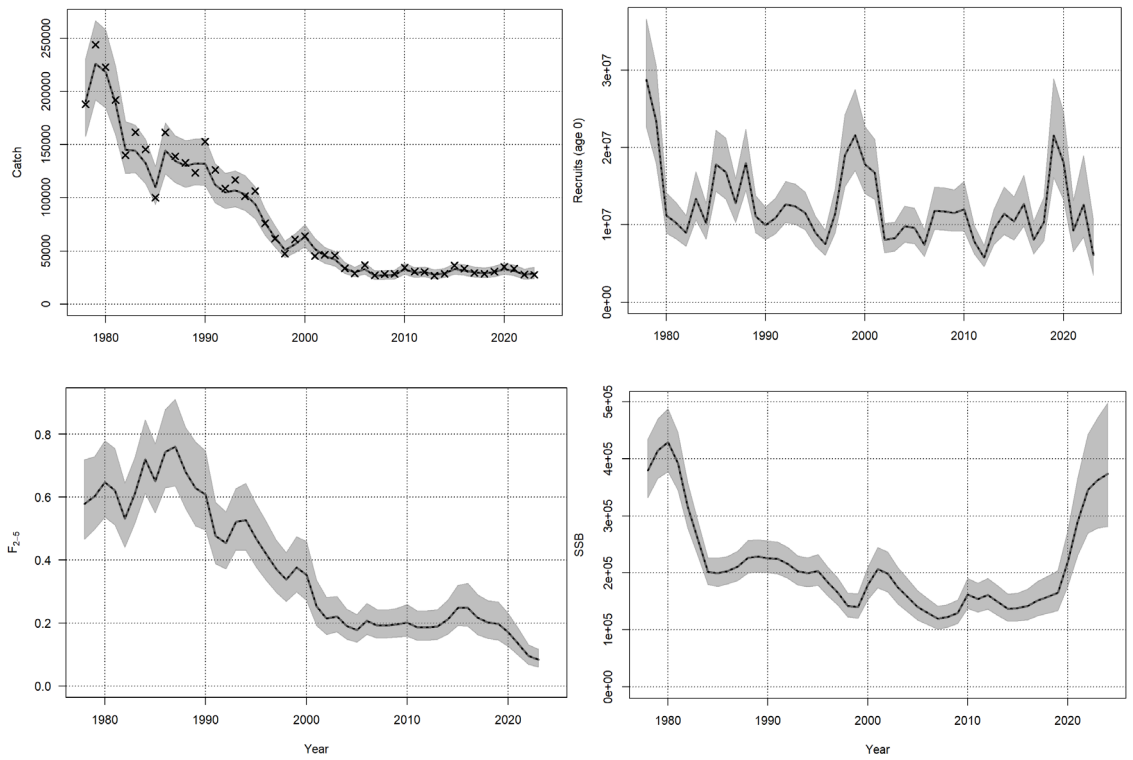

Figure 23.22. Whiting in Subarea 4 and Division 7.d. SAM assessment results using catch data series (1978–2023) with IBTS survey data starting in 1983 (Q1) and 1991 (Q3). Estimates with 95% Confidence intervals for total catch weight, SSB, mean fishing mortality and recruitment (at age 0).

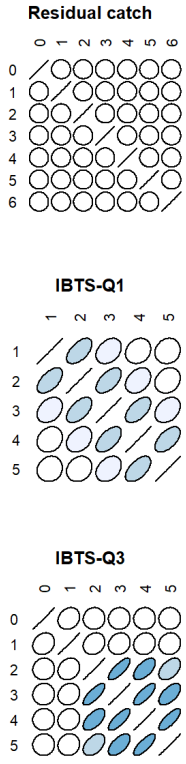

Figure 23.23. Whiting in Subarea 4 and Division 7.d. SAM estimated correlations between age groups for each fleet.

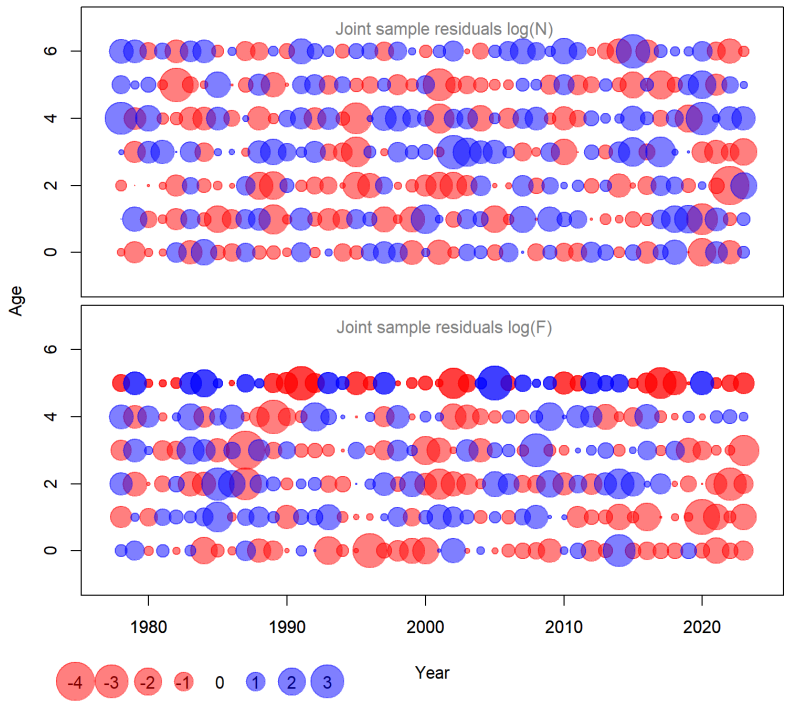

Figure 23.24. Whiting in Subarea 4 and Division 7.d. SAM standardised joint-sample residuals of process increments (for stock size N and fishing mortality F processes).

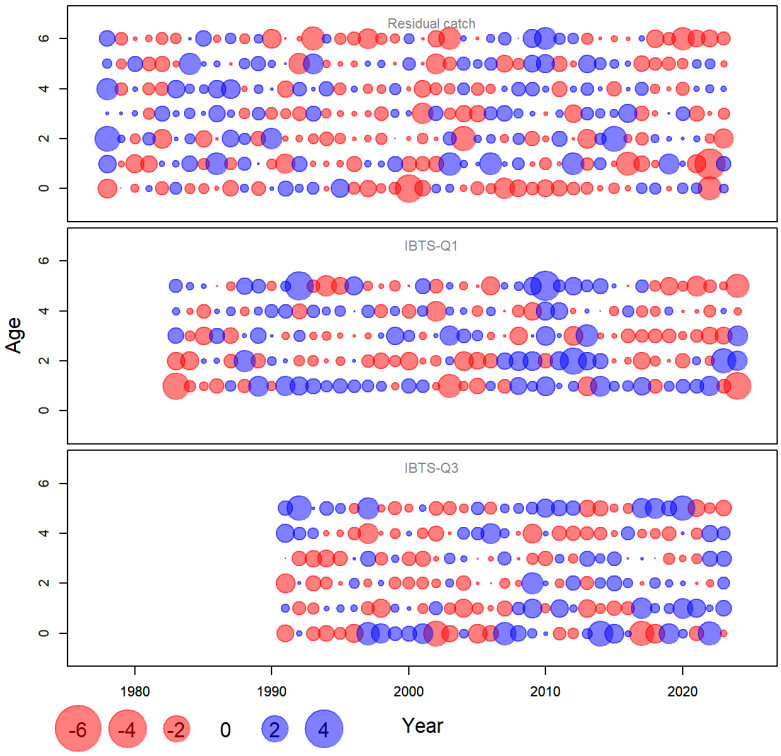

Figure 23.25. Whiting in Subarea 4 and Division 7.d. SAM standardized one-observation-ahead residuals.

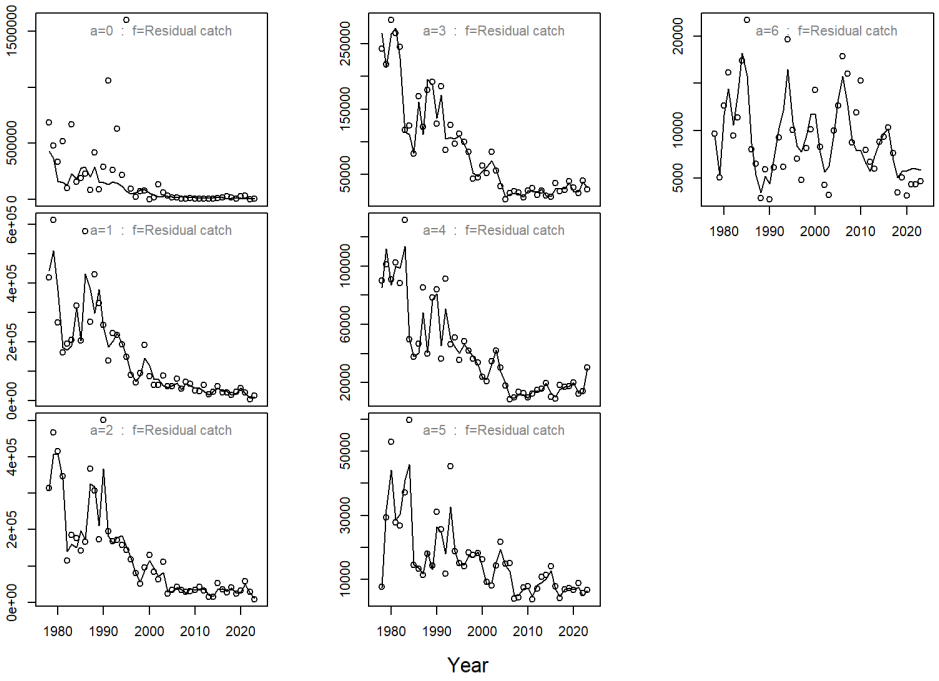

Figure 23.26. Whiting in Subarea 4 and Division 7.d. SAM predicted line and observed points (log scale) for the catch fleet.

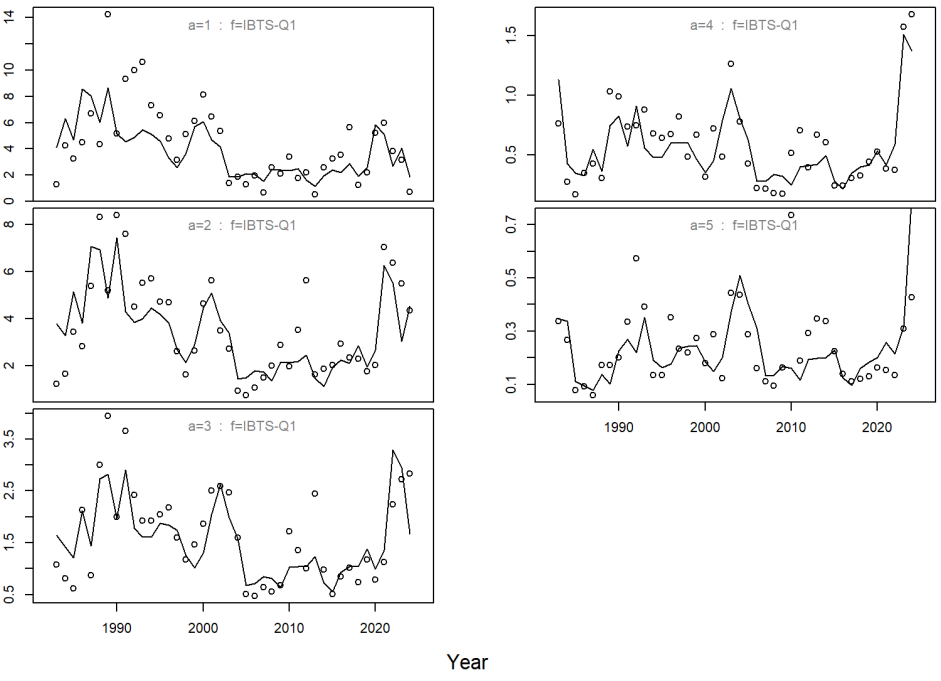

Figure 23.27. Whiting in Subarea 4 and Division 7.d. SAM predicted line and observed points (log scale), for survey fleet IBTS Q1.

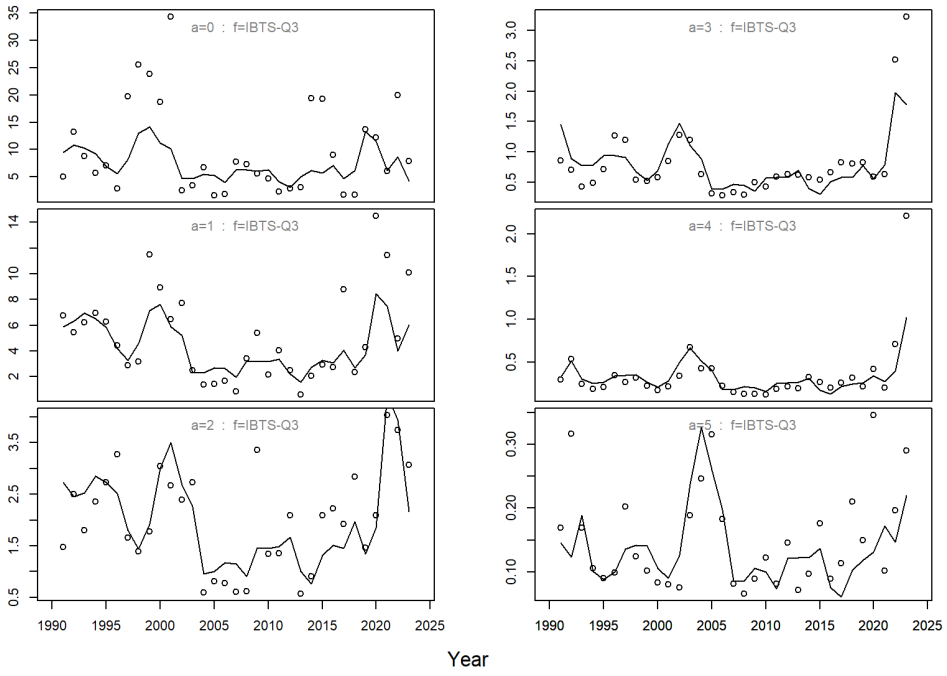

Figure 23.28. Whiting in Subarea 4 and Division 7.d. SAM predicted line and observed points (log scale), for survey fleet IBTS Q3.

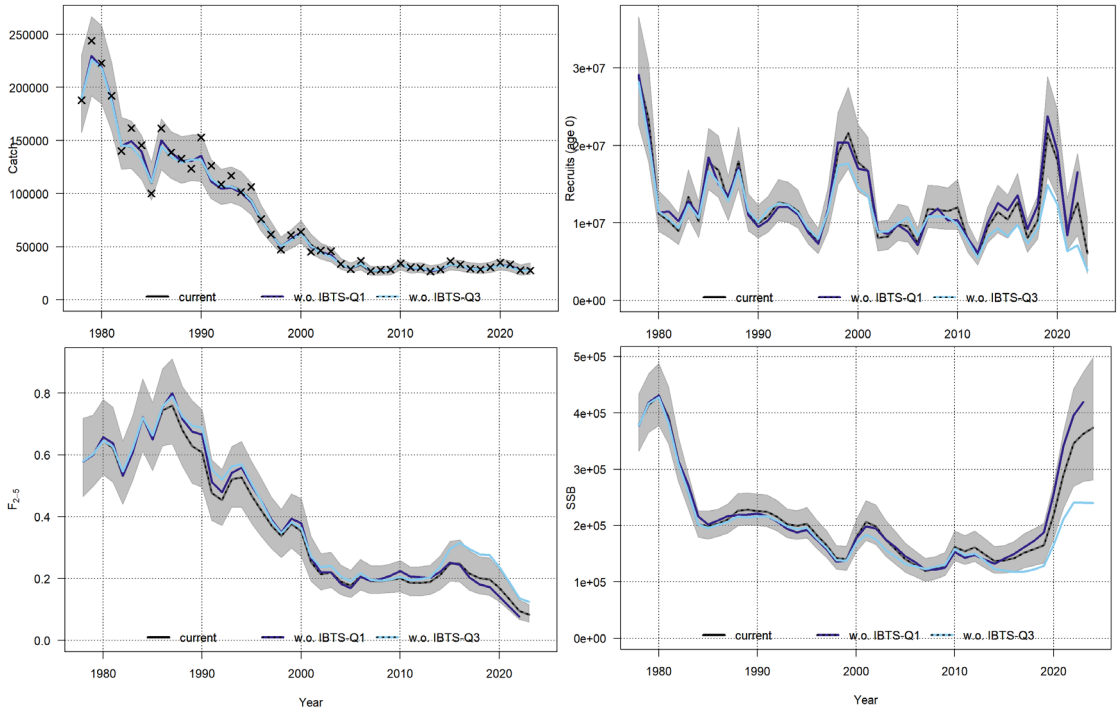

Figure 23.29. Whiting in Subarea 4 and Division 7.d. SAM leave-one-out diagnostics. Final run (black), run without IBTS Q1 (dark blue), run without IBTS Q3 (light blue).

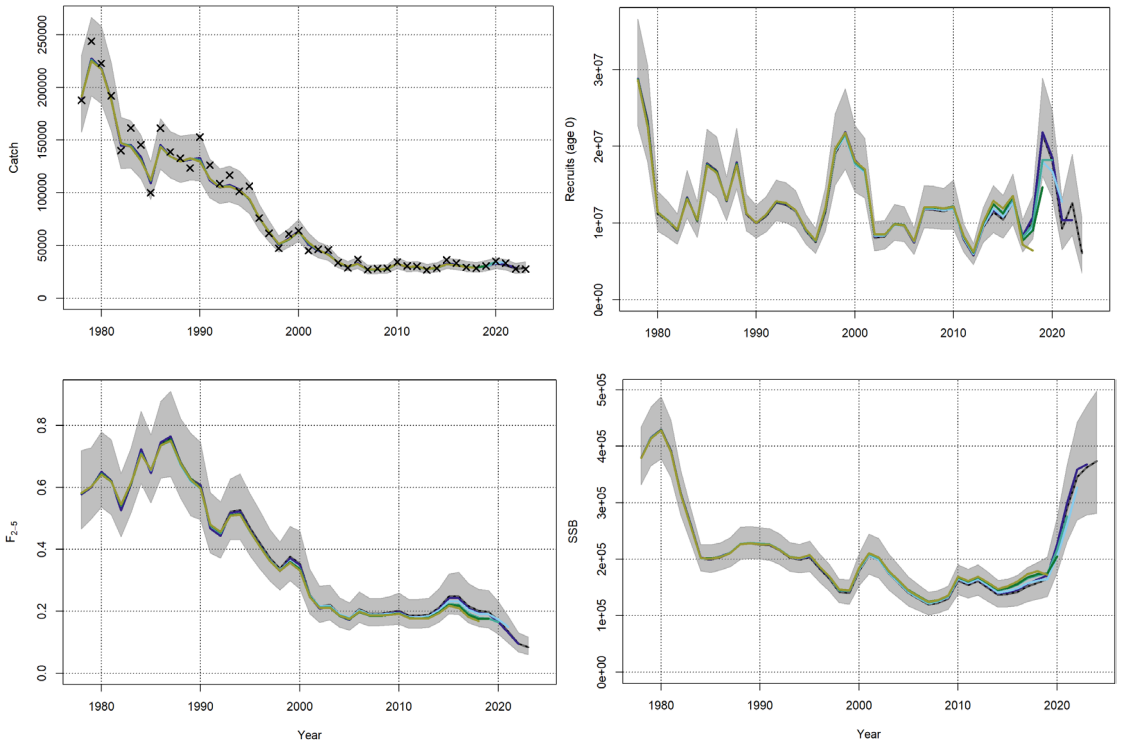

Figure 23.30. Whiting in Subarea 4 and Division 7.d. SAM Retrospective pattern in catch estimates, SSB, fishing mortality and recruitment.

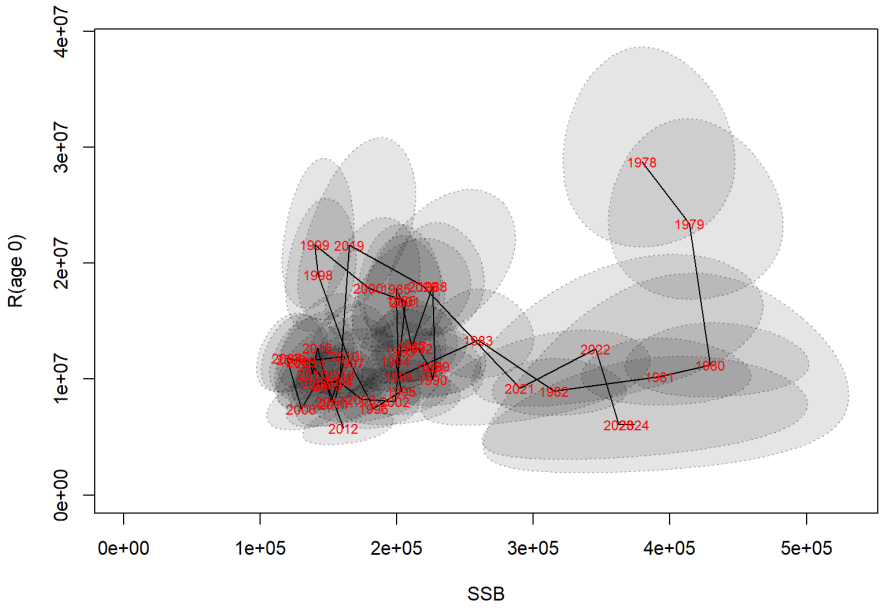

Figure 23.31. Whiting in Subarea 4 and Division 7.d. Stock-recruitment relationship.

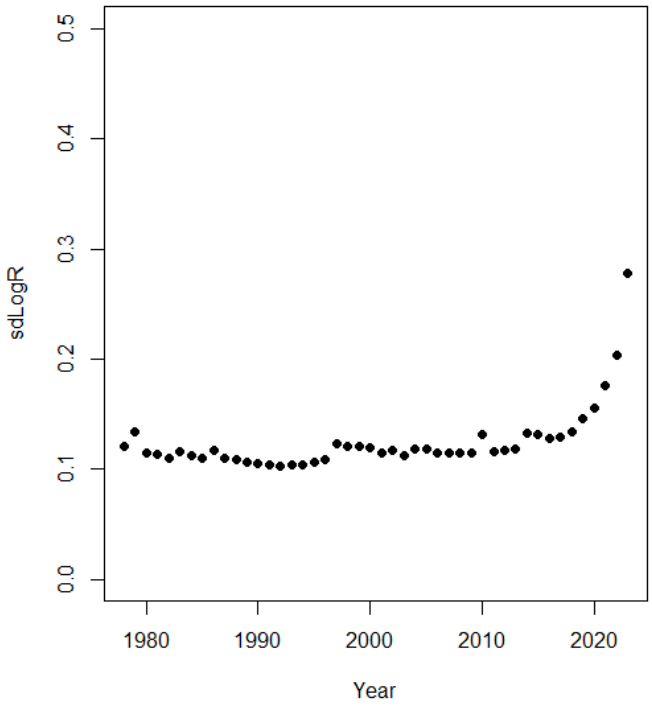

Figure 23.32. Whiting in Subarea 4 and Division 7.d. SAM estimated standard deviation in logarithmic recruitment (age 0).

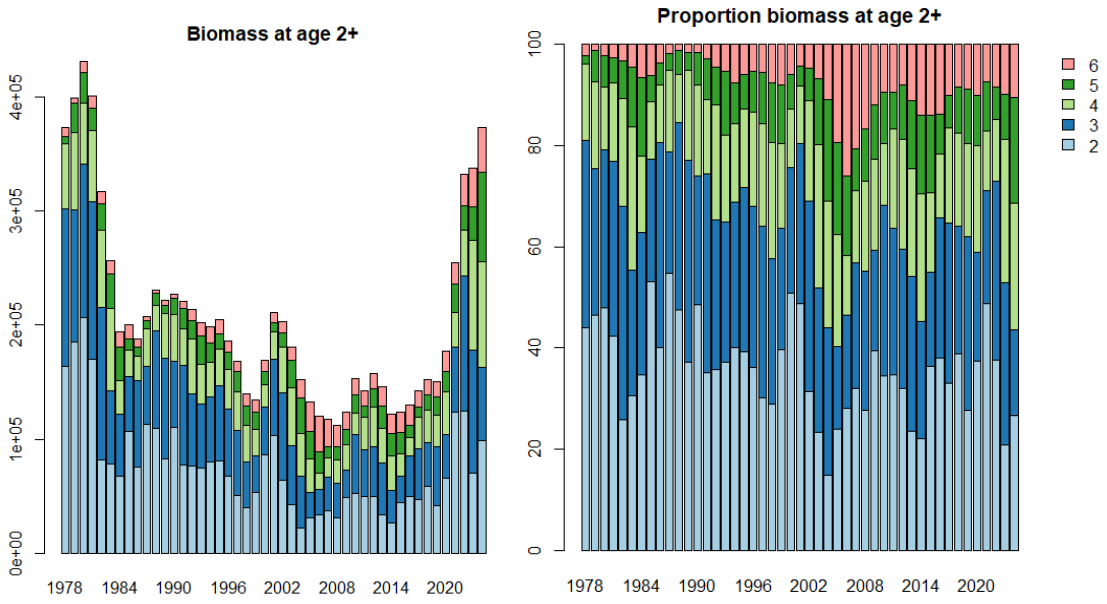

Figure 23.33. Whiting in Subarea 4 and Division 7.d. SAM estimated biomass at age, in absolute numbers (left) and as a percentage of total biomass (age2+).

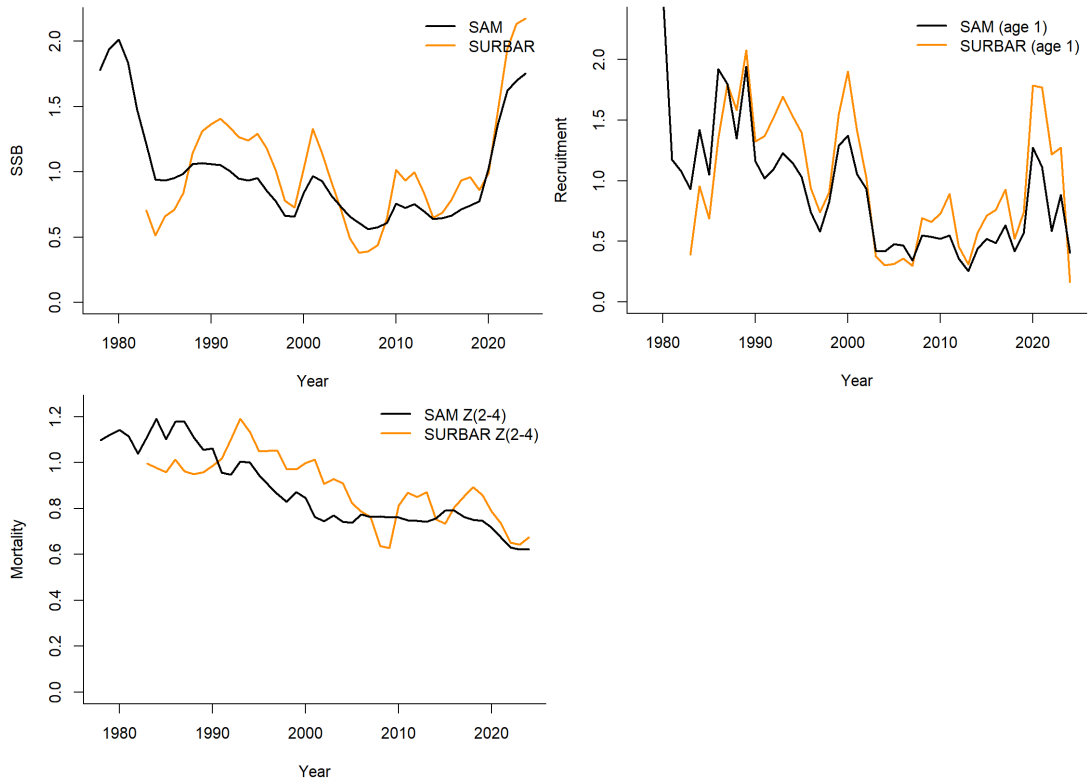

Figure 23.34. Whiting in Subarea 4 and Division 7.d. Comparisons of stock summary estimates from the final SAM (black) and SURBAR (orange) models. To facilitate comparison, recruitment and SSB values have been mean-standardised using the year range for which estimates are available from all three models. Mortality is presented as total mortality Z(2–4) for SAM and for SURBAR.

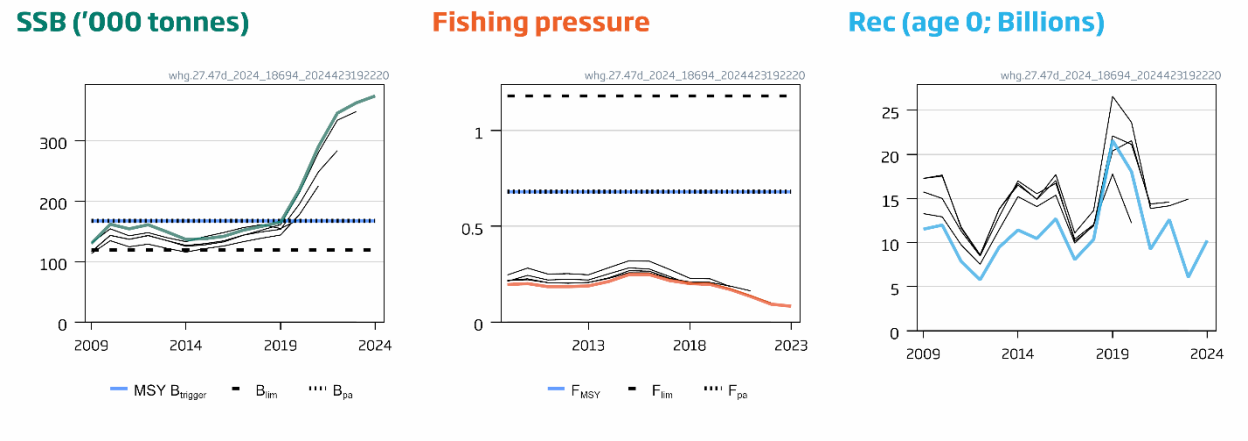

Figure 23.35. Whiting in Subarea 4 and Division 7.d. Historical assessments from Standard graphs.

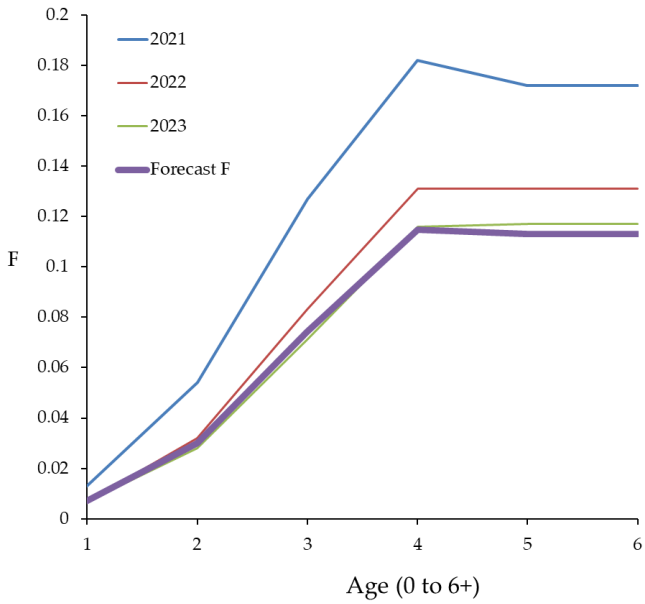

Figure 23.36. Whiting in Subarea 4 and Division 7.d. SAM F at age estimates for 2021–2023, along with scaled mean exploitation used for the forecast.

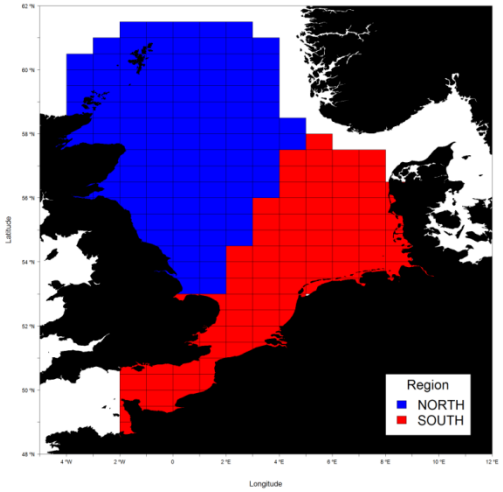

Figure 23.37. Whiting in Subarea 4 and Division 7.d. Components suggested by Holmes *et al.* (2014) to analyse spatial differences in maturation and SURBAR analysis.

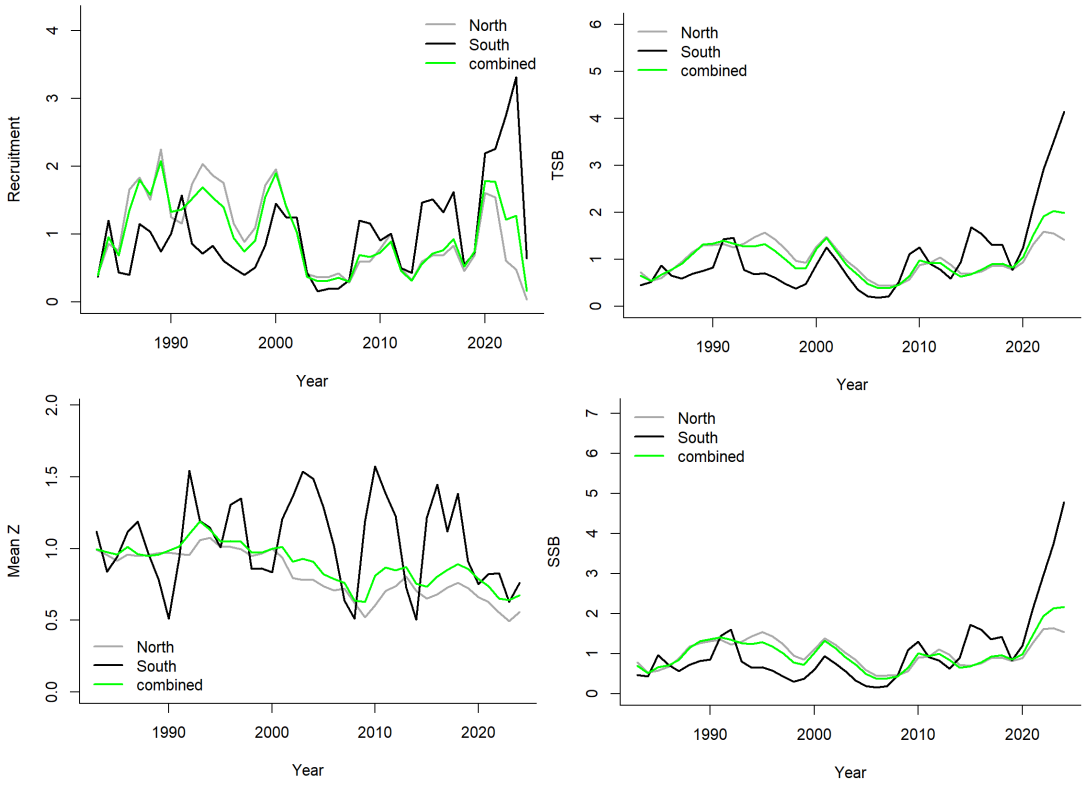

Figure 23.38. Whiting in Subarea 4 and Division 7.d. SURBAR results comparison combined (whg.27.4.47d) and northern and southern component as defined in WKNSEA 2018. Recruitment at age 1, total mortality is mean Z for ages 2–4, total stock biomass (TSB) and spawning stock biomass (SSB).

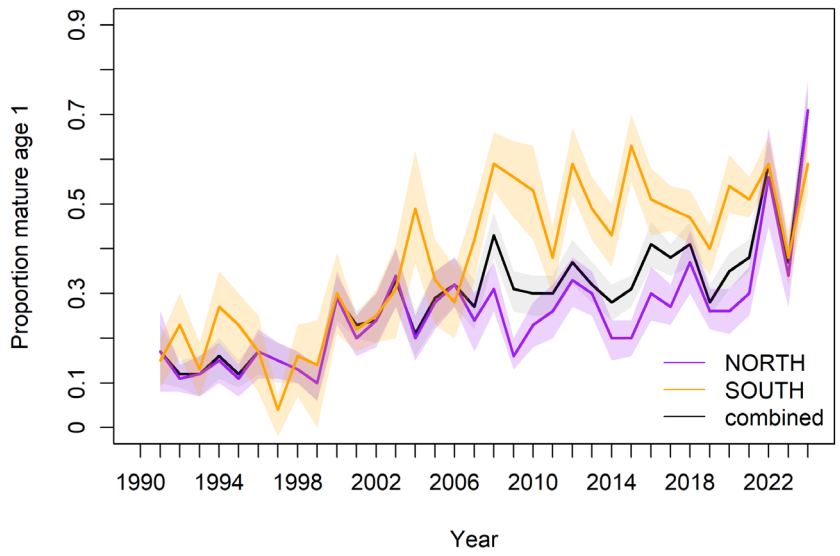

Figure 23.39a. Whiting in Subarea 4 and Division 7.d. Trends in proportion mature individuals at age 1 for combined (whg.27.4.47d) and northern and southern component as defined in WKNSEA 2018.

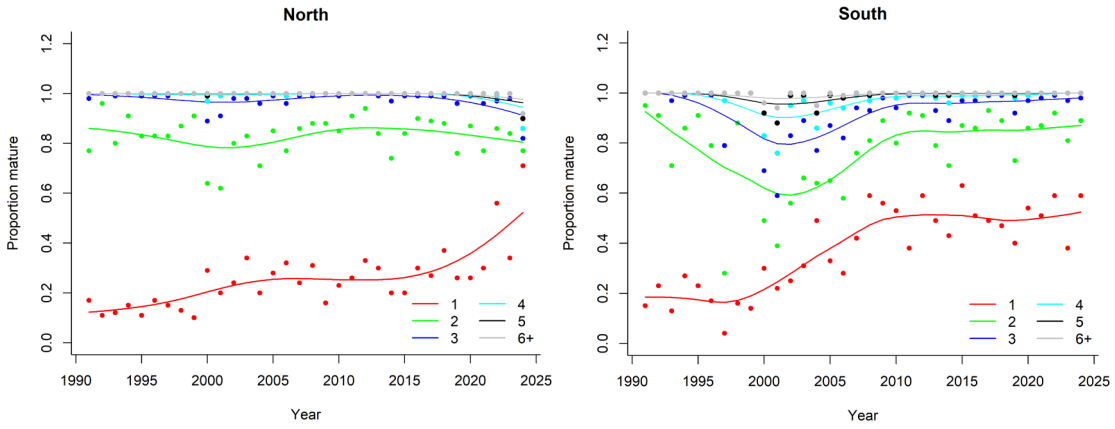

Figure 23.39b. Whiting in Subarea 4 and Division 7.d. Trends in proportion mature individuals at age for northern and southern component, as defined in WKNSEA 2018.

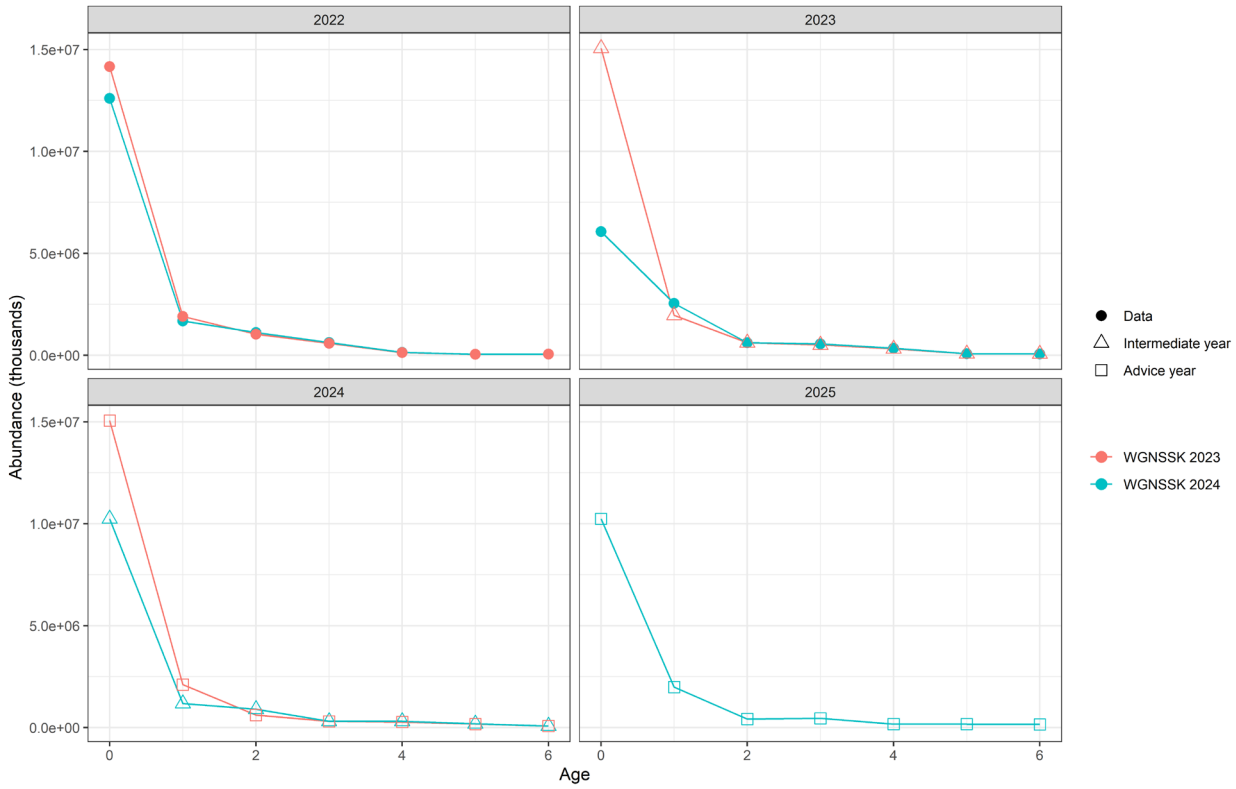

Figure 23.40. Whiting in Subarea 4 and Division 7.d. Comparison of numbers at age between previous (WGNSSK 2023) and current (WGNSSK 2024) assessments and forecasts.

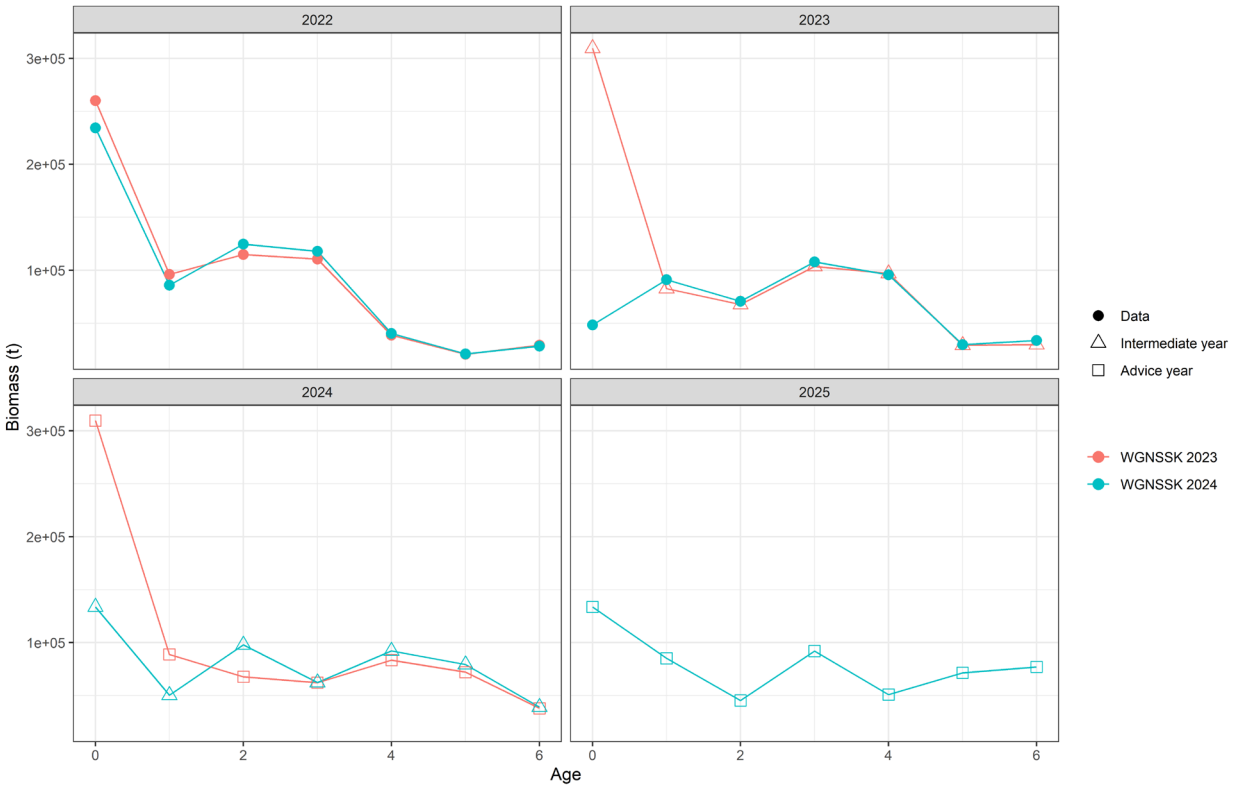

Figure 23.41. Whiting in Subarea 4 and Division 7.d. Comparison of biomass at age between previous (WGNSSK 2023) and current (WGNSSK 2024) assessments and forecasts.

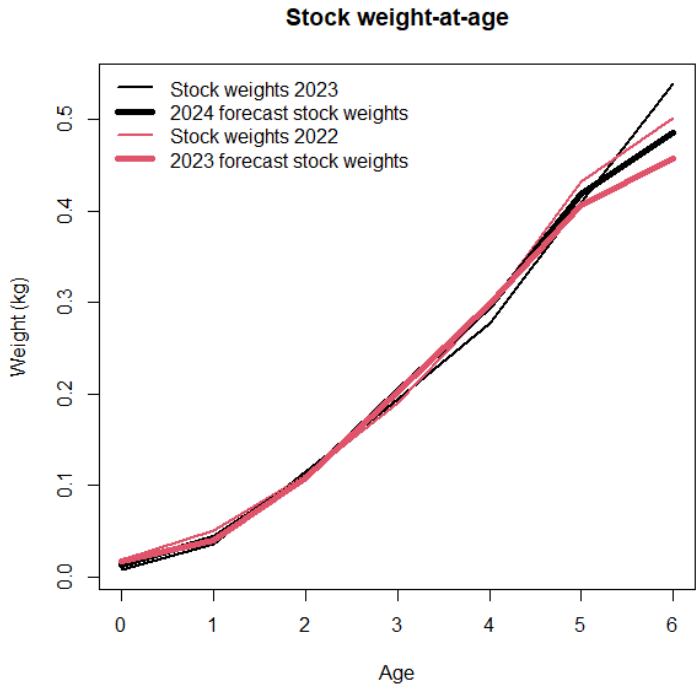

Figure 23.42. Whiting in Subarea 4 and Division 7.d. Comparison of stock weights at age used in the previous (WGNSSK 2022) and current (WGNSSK 2023) forecasts (thick line). Stock weights at age used in the last year of the previous (WGNSSK 2022) and current (WGNSSK 2023) assessments are shown as comparison (thin line).

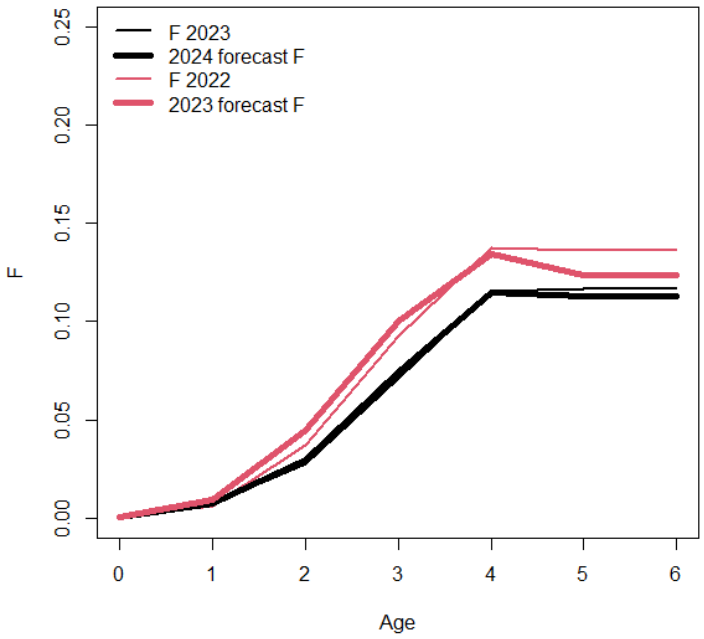

Figure 23.43. Whiting in Subarea 4 and Division 7.d. Comparison of F at age used in the previous (WGNSSK 2023) and current (WGNSSK 2024) forecasts (thick line). F at age from the last data year of the previous (WGNSSK 2023) and current (WGNSSK 2024) assessments are shown as comparison (thin line).

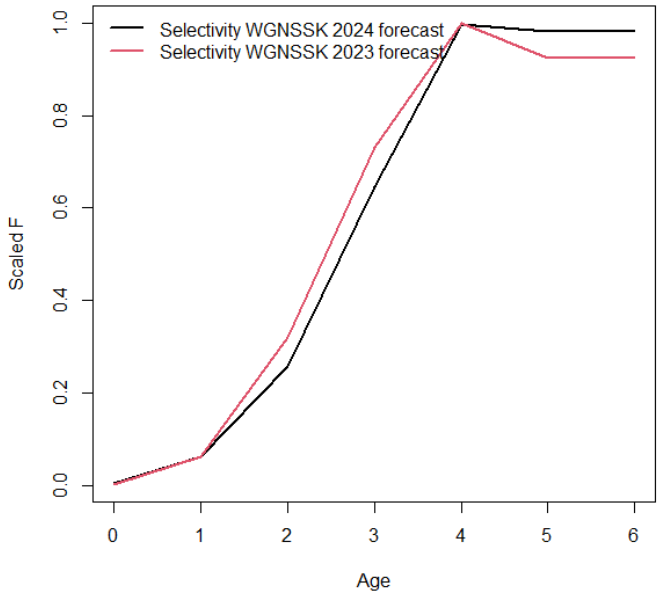

Figure 23.44. Whiting in Subarea 4 and Division 7.d. Comparison of selectivities (F scaled to 1) used in the previous (WGNSSK 2022) and current (WGNSSK 2023) forecasts.

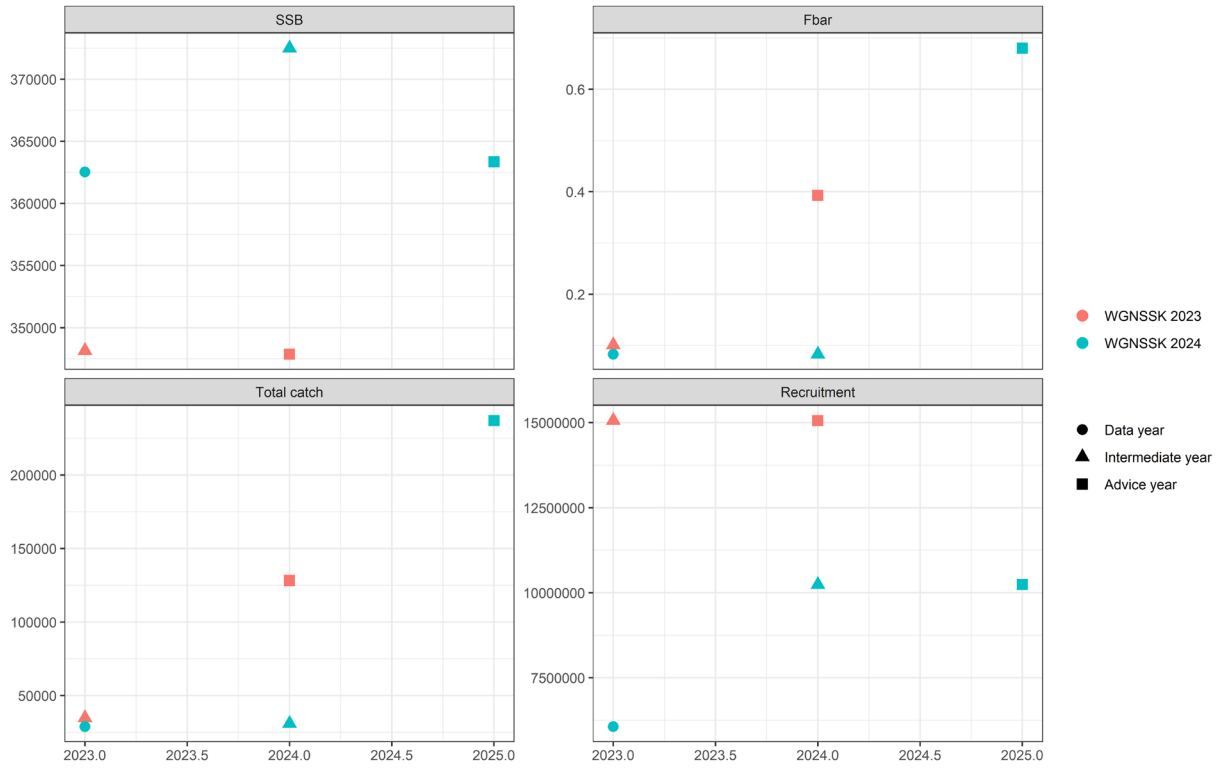

Figure 23.45. Whiting in Subarea 4 and Division 7.d. Comparison of assumptions used in the previous (WGNSSK 2023) and current (WGNSSK 2024) forecasts.

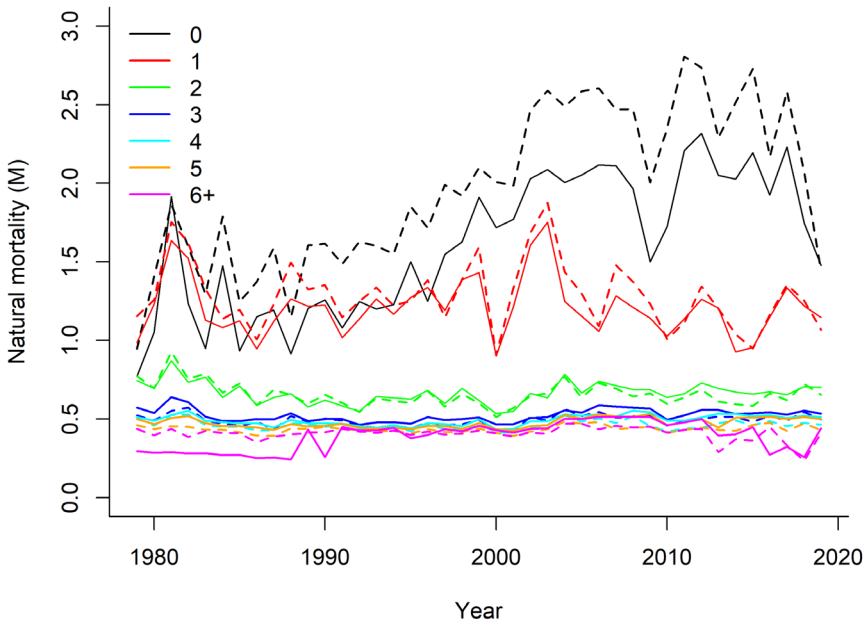

Figure 23.46. Whiting in Subarea 4 and Division 7.d. Comparison of raw natural mortality estimates for 1978-2019.

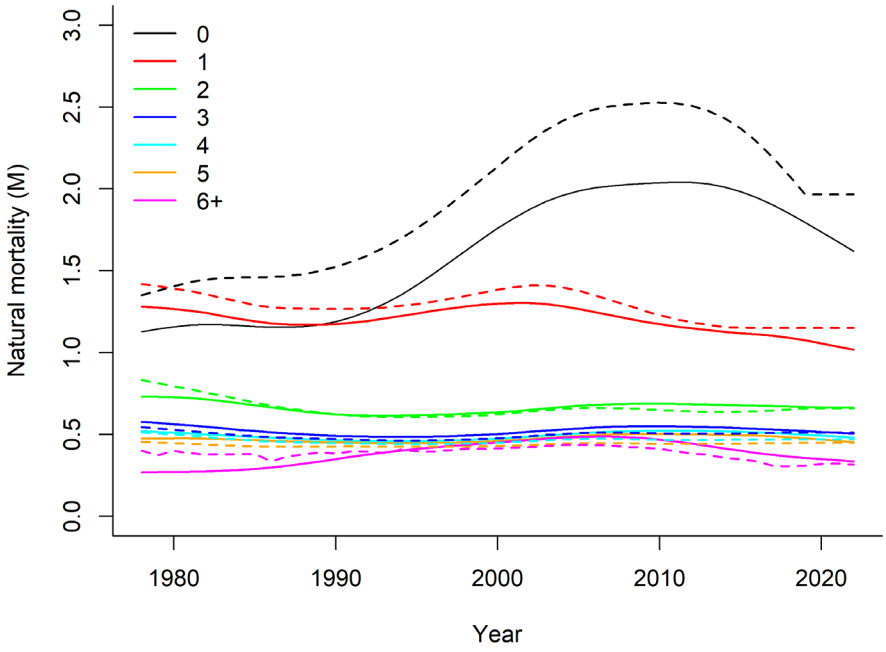

Figure 23.47. Whiting in Subarea 4 and Division 7.d. Comparison of smoothed natural mortality estimates for 1978-2022 for comparison.

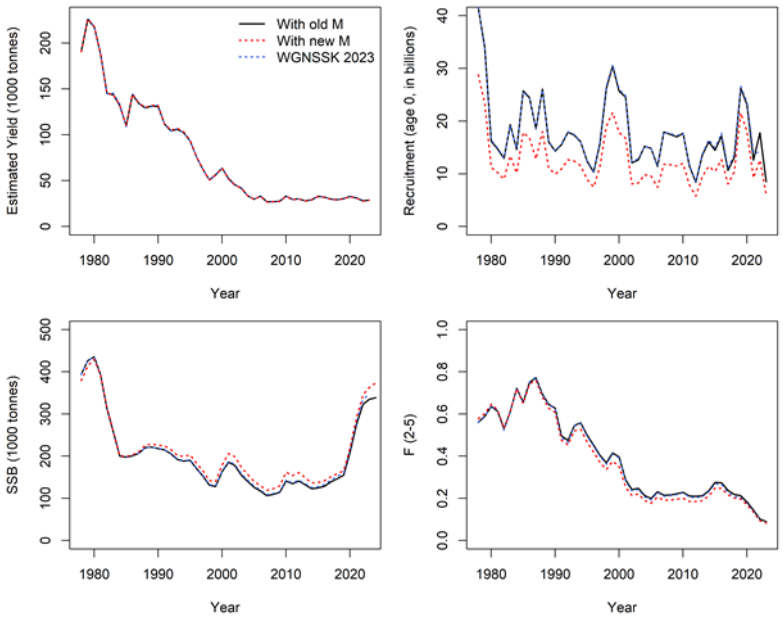

Figure 23.48. Whiting in Subarea 4 and Division 7.d. Comparison of assessments WGNSSK 2024 with new and old natural mortalities and WGNSSK 2023 (old natural mortalities).

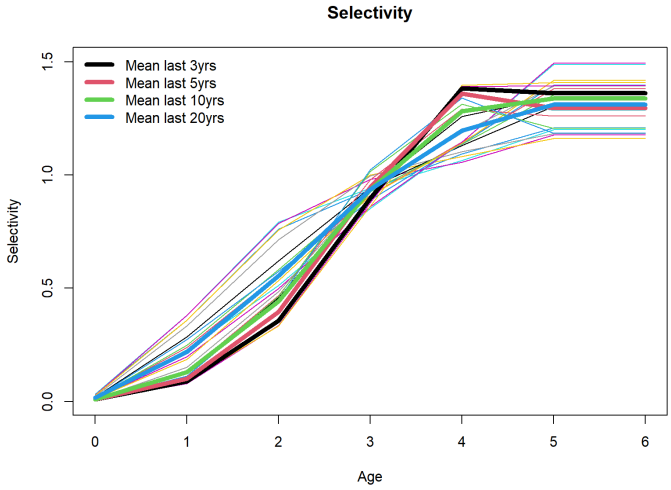

Figure 23.49. Whiting in Subarea 4 and Division 7.d. Fisheries selectivity at age by year and averages for recent 3, 5, 10, 20 years.

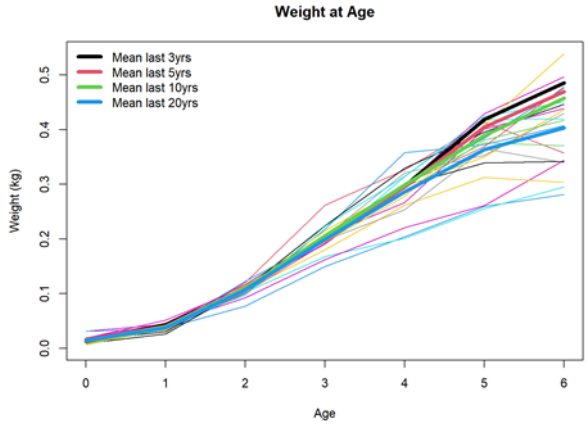

Figure 23.50. Whiting in Subarea 4 and Division 7.d. Stock weights at age by year and averages for recent 3, 5, 10, 20 years.

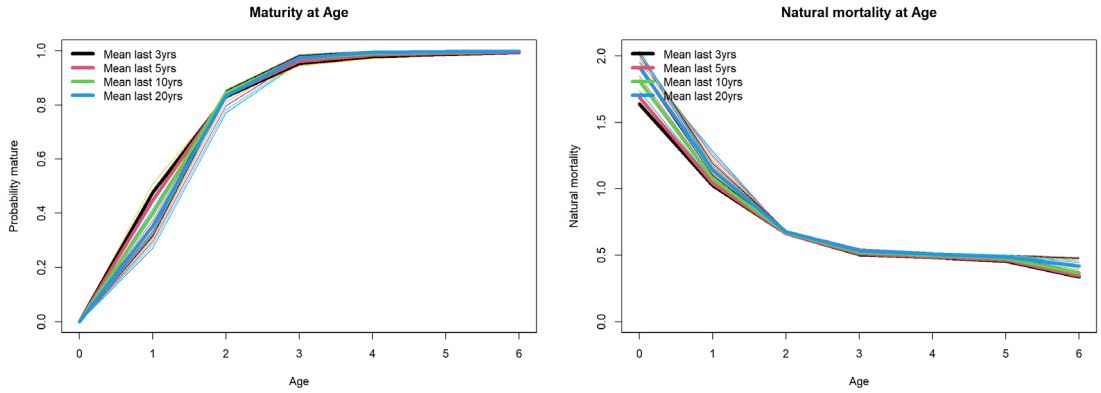

Figure 23.51. Whiting in Subarea 4 and Division 7.d. Maturity at age (left) and natural mortality at age (right) by year and averages for recent 3, 5, 10, 20 years.

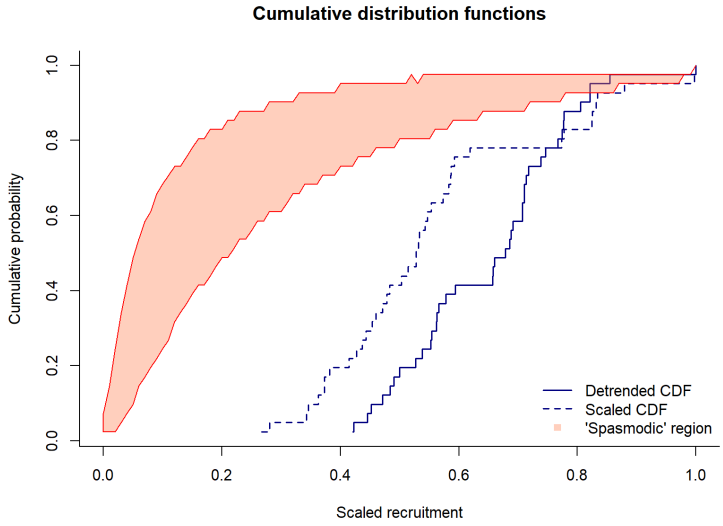

Figure 23.52. Whiting in Subarea 4 and Division 7.d. Negative test on spasmodic recruitment type.

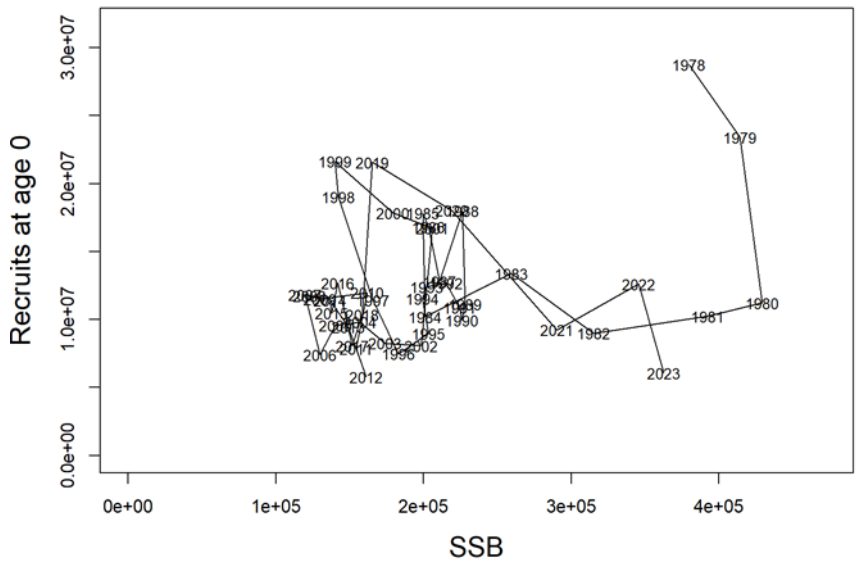

Figure 23.53. Whiting in Subarea 4 and Division 7.d. Plot of age 0 recruits against SSB for all years.

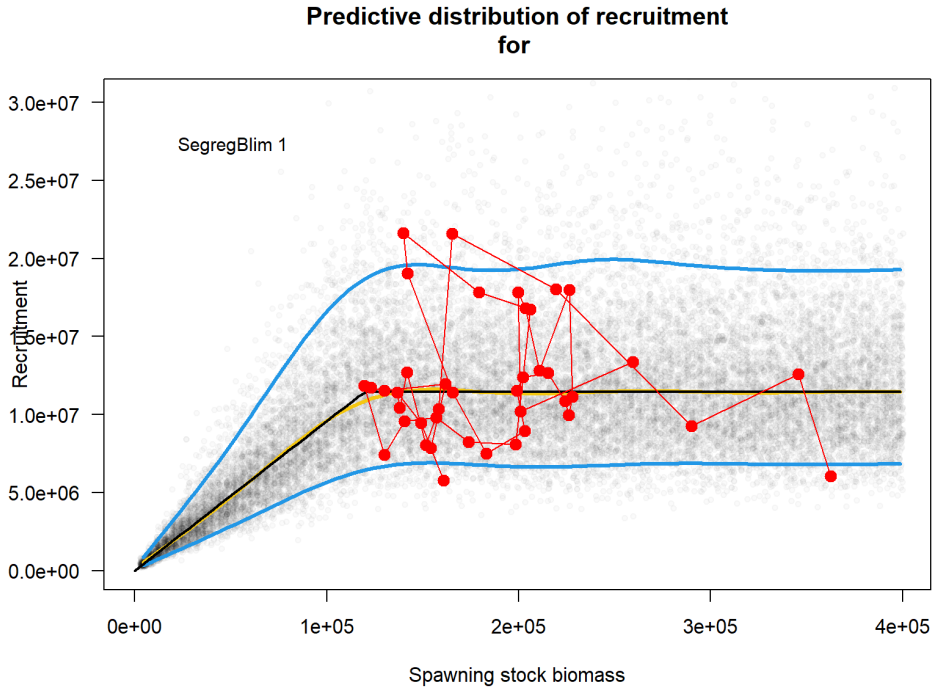

Figure 23.54. Whiting in Subarea 4 and Division 7.d. Stock recruitment relationship (segmented regression with fixed breakpoint at B_{lim}) on the truncated time series (1983-2023).

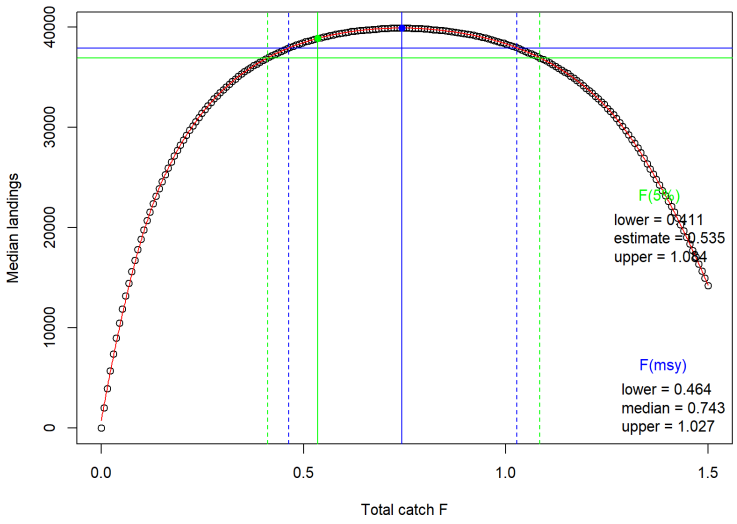

Figure 23.55. Whiting in Subarea 4 and Division 7.d. Estimation of the initial (unconstrained) F_{MSY}, EqSim run with assessment/advice error and without advice rule. $F_{p.05\ NAR}$ is listed in the plot.

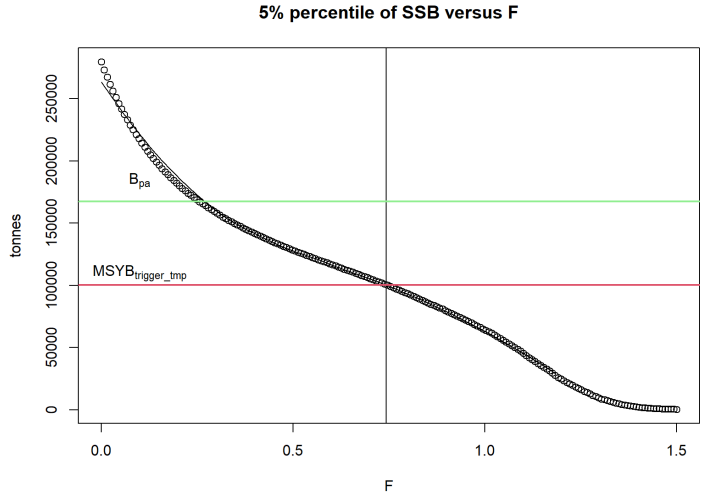

Figure 23.56. Whiting in Subarea 4 and Division 7.d. Biomass at F (without assessment/advice error and without advice rule), showing B_{pa} (green) and initial $MSYB_{trigger}$ (red).

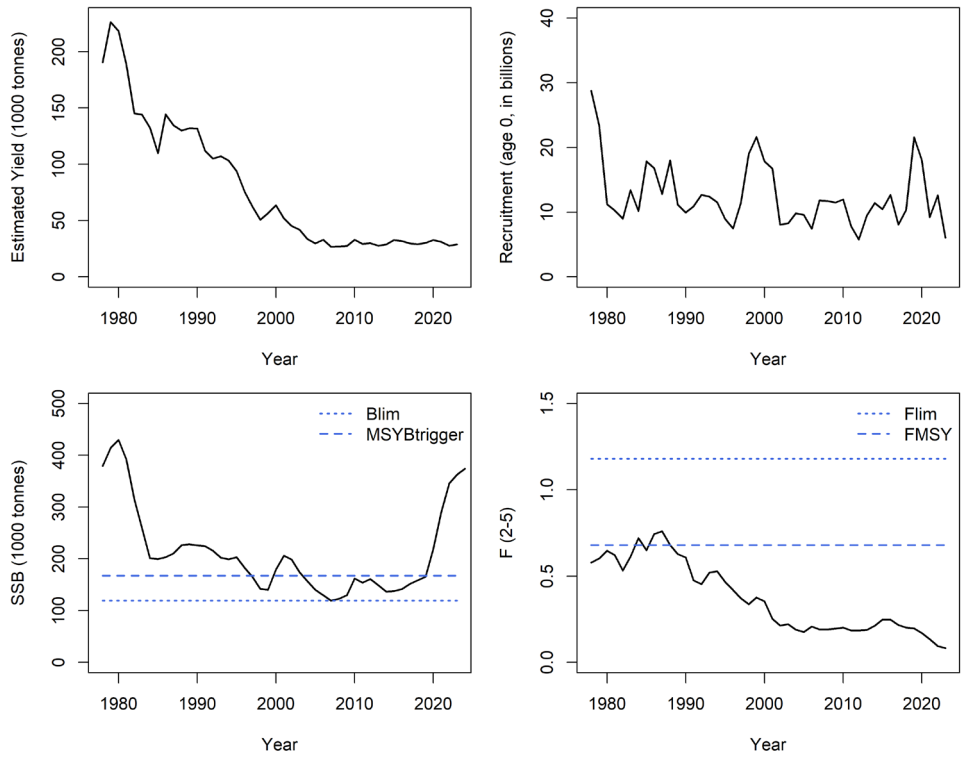

Figure 23.57. Whiting in Subarea 4 and Division 7.d. Stock summary with reference points (Catch and SSB in metric tonnes).

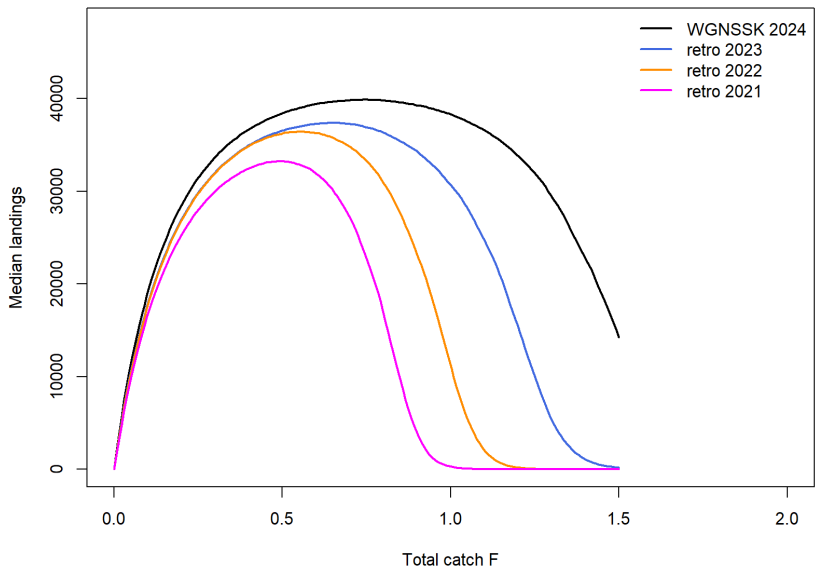

Figure 23.58. Whiting in Subarea 4 and Division 7.d. Comparison of retrospective reference point calculation. Estimation of the initial (unconstrained) F_{MSY}, EqSim run with assessment/advice error and without advice rule.

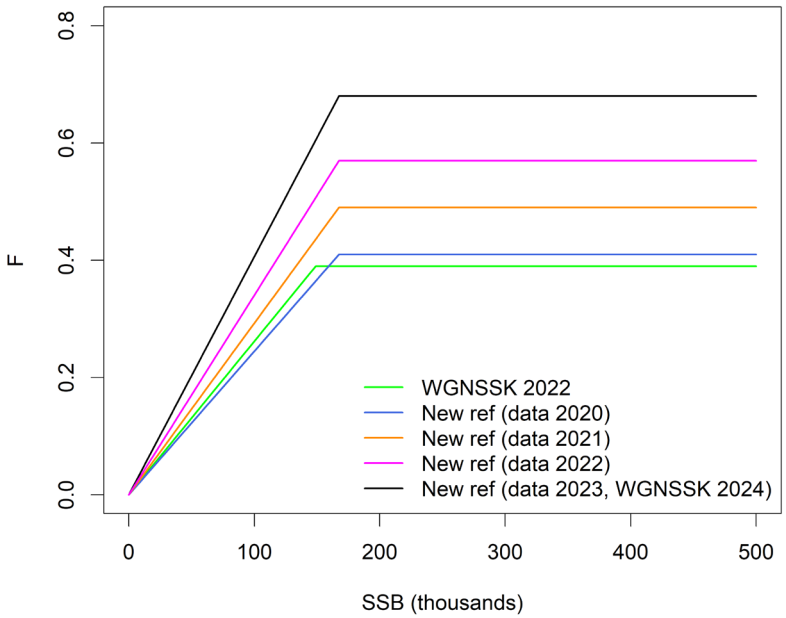

Figure 23.59. Whiting in Subarea 4 and Division 7.d. Comparison of harvest control rules for retrospective reference point runs and previous reference points. Note that if SSB falls below B_{lim} F would equal 0.

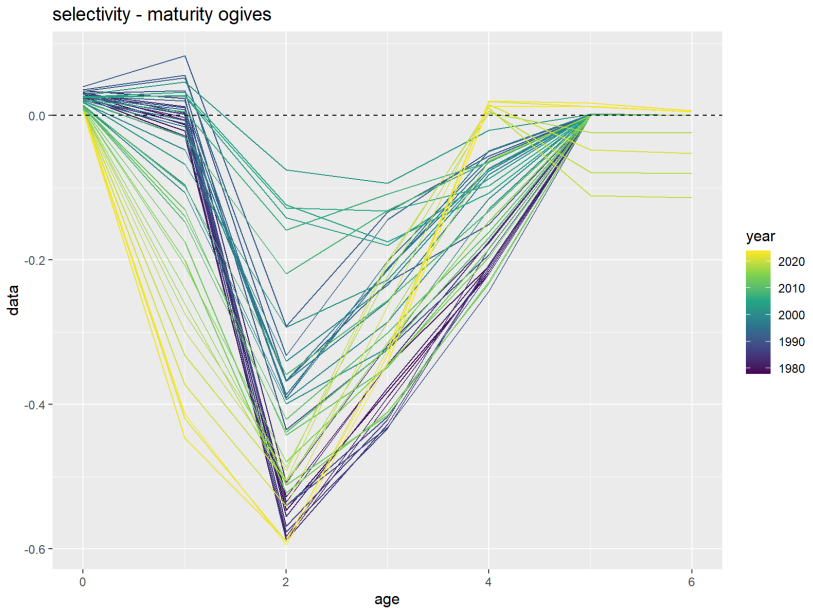

Figure 23.60. Whiting in Subarea 4 and Division 7.d. Difference of selectivity and maturity at age of time. Negative values indicate a high proportion is mature than selected by the fishery.

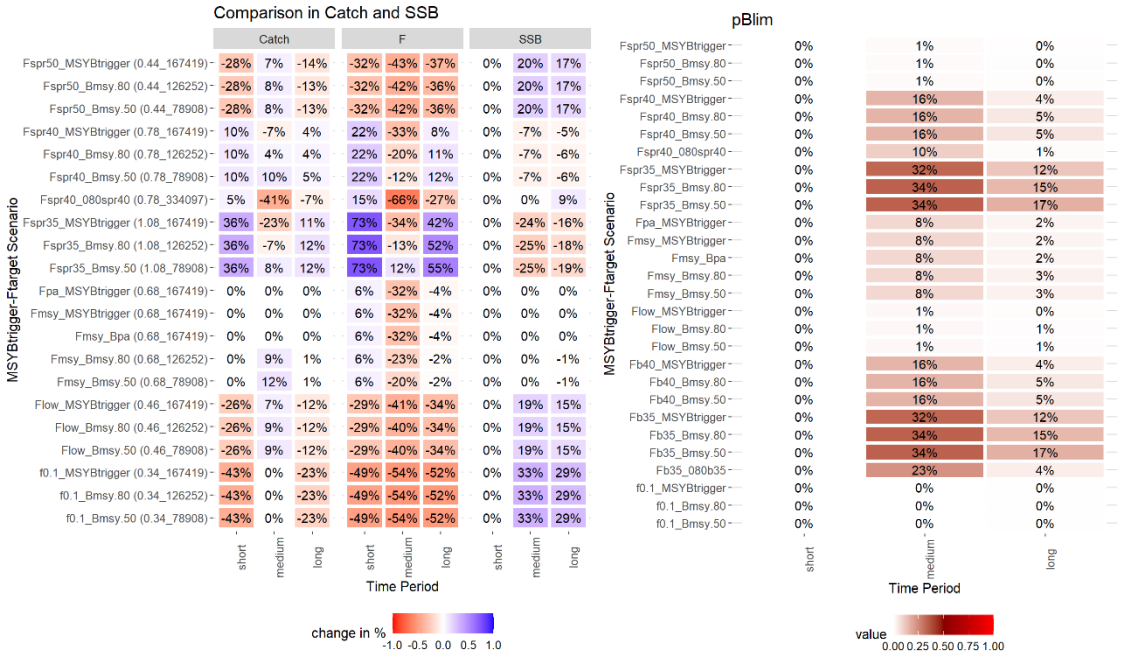

Figure 23.61. Whiting in Subarea 4 and Division 7.d. Short cut MSE, robustness test of reference points. Short term is the next 2 years, medium term is the next 5 years, long term is the years 2050-2059.

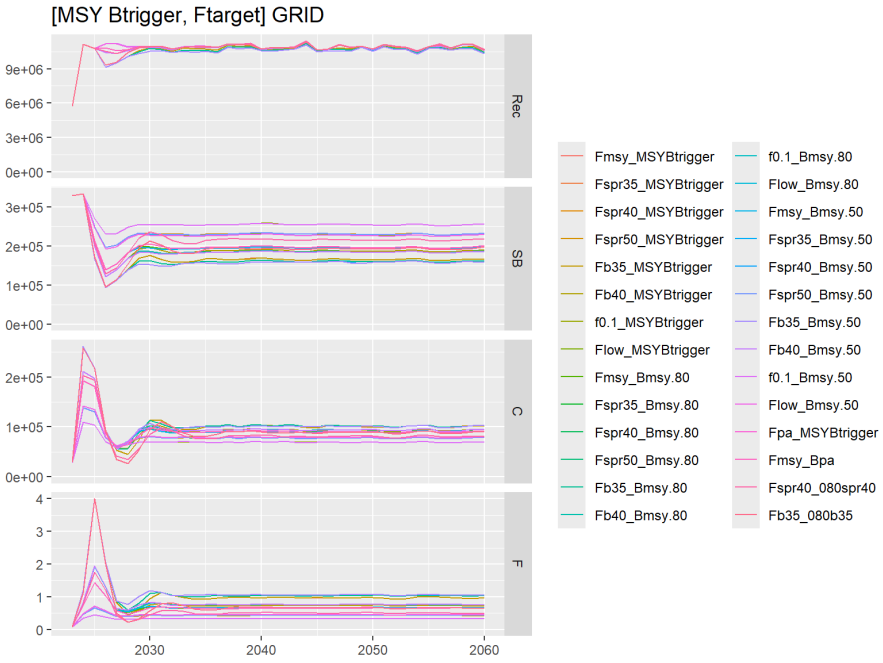

Figure 23.62. Whiting in Subarea 4 and Division 7.d. Short cut MSE, robustness test of reference points. Medians of simulations shown.

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