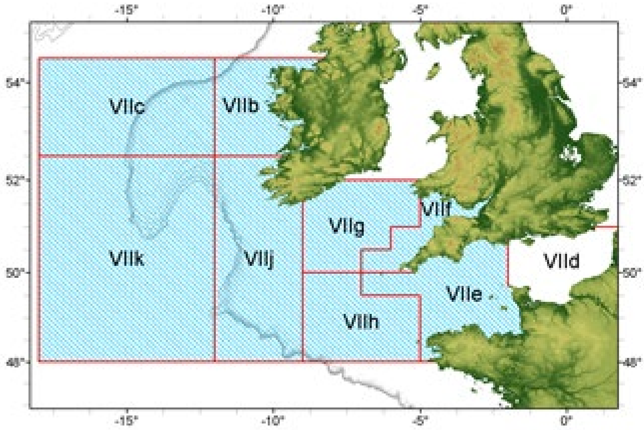
Stock Annex: Whiting (*Merlangius merlangus*) in divisions 27.7b–ce–k (southern Celtic Seas and eastern English Channel)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Whiting
Working Group	Working Group for the Celtic Seas Ecoregion (WGCSE)
Last updated	19 September 2020
Last updated by	David Stokes at WKCELTIC 2020

A. General

A.1. Stock definition



Celtic Sea whiting continues to be managed by TAC covering 7b-k while the assessment area excludes 27.7d which is as part of the North Sea stock. Having reviewed the available information, the WKCELT Benchmark proposed no changes at this time.

The degree of separation of whiting stocks between the Irish Sea, North Sea and ICES Divisions 7.b–c from the Celtic Sea, is currently not conclusive. Genetic studies suggest NE Atlantic whiting, including northern North Sea is quite genetically homogeneous. In contrast potentially low levels of structuring has been suggested between this NE stock and that in the southern Bay of Biscay as well as within the Irish Sea and particularly the North Sea (Charrier, Coombs, McQuinn, and Laroche, 2007).

Since 2012 Irish landings of cod, haddock and whiting, reported from ICES rectangles immediately north of the Irish Sea–Celtic Sea boundary (ICES rectangles 33E2 and 33E3) have been reallocated into the Celtic Sea. These represent a combination of inaccurate area reporting and catches considered by ICES to be part of the Celtic Sea stocks (ICES, 2009). WKROUND 2012 reviewed this practice and concluded it should continue in the future. No changes were suggested by WKCELTIC 2020.

A.2. Fishery

Whiting in Divisions 7b-ce-k are taken as a component of catches in mixed demersal otter-board trawl (OTB) and seine fisheries. VMS and logbook data 2014-2018[1] show fishing activity in the main stock area (Irish EEZ) by country and gear type (Fig Figure A.2.1.).

[1] https://doi.org/10.20393/e55a4ab7-cddd-465b-ba9b-a63c6dbcd050

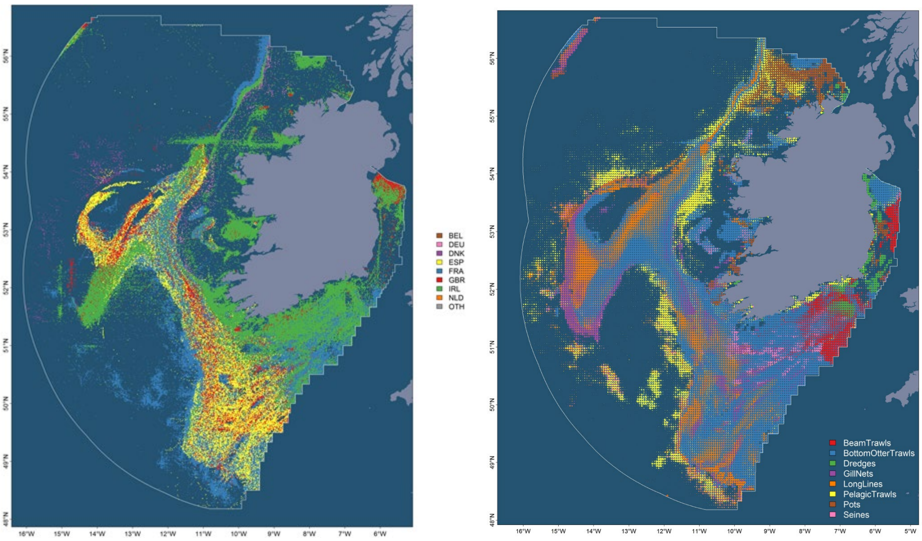


Figure A.2.1. Spatial distribution of intertnational demersal otter trawl effort (left panel) by country and gear type (right panel).

International OTB landings of gadoids into Ireland show a high occurance in the Celtic Sea, southeast Porcupine and along the shelf edge. Much of the western distribution will be hake and some haddock with the distribution of whiting indicated by Irish OTB landings (Fig A.2.2) and concentrated around the north eastern Celtic Sea and particularly the commercial 'Smalls' area.

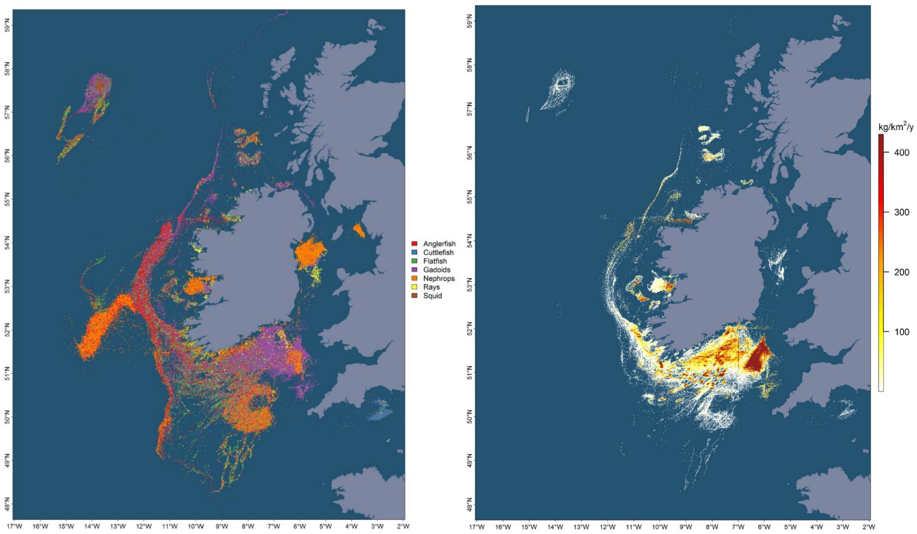


Figure A.2.2 shows international landings by species group from demersal trawlers ≥12m landing into Ireland (left panel) and Irish landings for whiting from vessels ≥12m using all gears (right panel).

Landings over time have fluctuated considerably. The underlying trend has been an increase in landings from less than 5000 t in the 1950s to a peak of c. 20 000 t in the late 1980s and 1990s. Since then landings shown a declining trend.

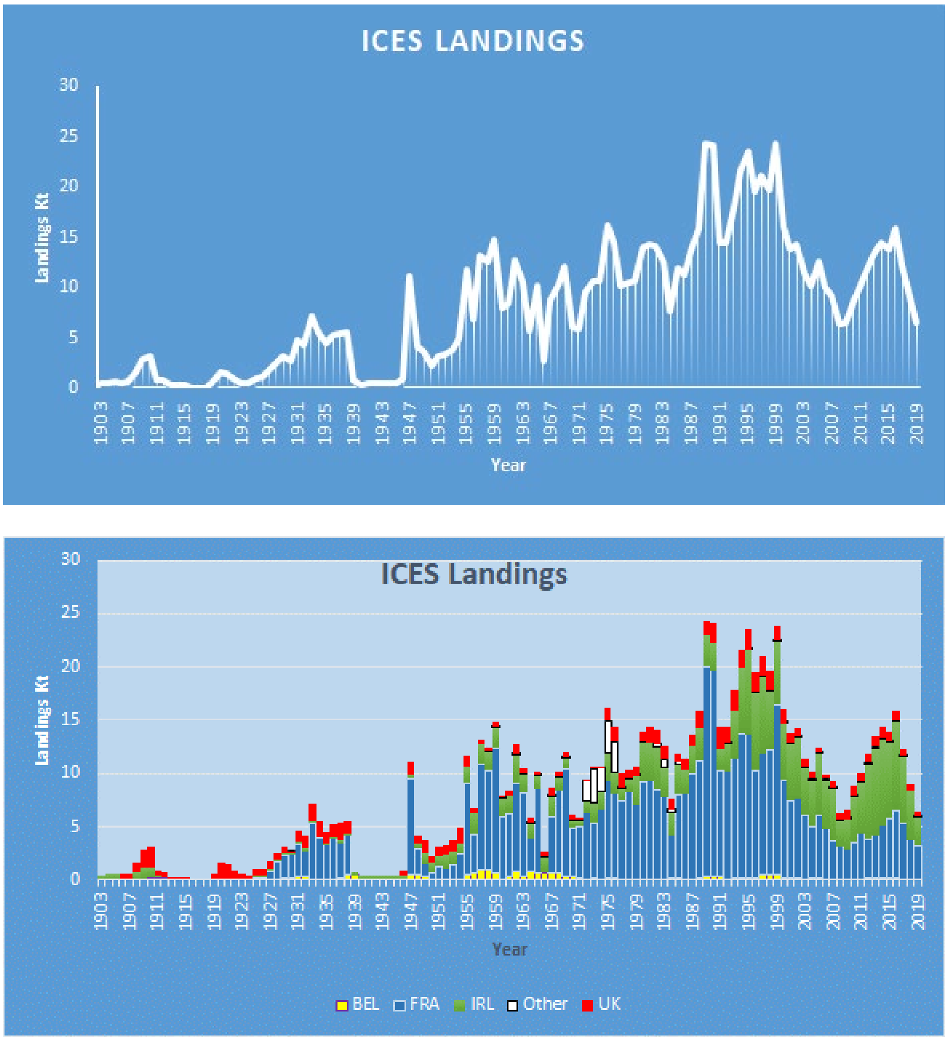


Figure A.2.2. ICES official international landings (top panel), by country (lower panel) in tonnes ('000).

Further details can be found in the WKCELT 2014 Report.

A.3. Ecosystem aspects

There is some evidence of a relationship between whiting mean weight-at-age in the Celtic Sea and herring abundance. This was discussed briefly at WKCELT2014 and summarised in the WKCELT2014 report[2].

B. Data

B.1. Commercial catch

During the WKCELTIC2020 preparatory data workshop, WKCELTIC I, it was agreed that a data call would be issued to provide updated catch-at-age data from member states targeting this stock. The years 2003 – 2019 were considered a reasonable time

[2] http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2014/WKCELT/WKCELT%20Final%20Report.pdf

series as not too extendive, but also acknowledged the increased smapling coordination from that point intigated by the EU Data Collection Regulation and it's successors.

A general data handling approach was agreed and data submitted to Intercatch (IC) by France, Ireland, Belgium, UK, Spain and the Netherlands in advance of this Benchmark meeting (Fig B.1.1).

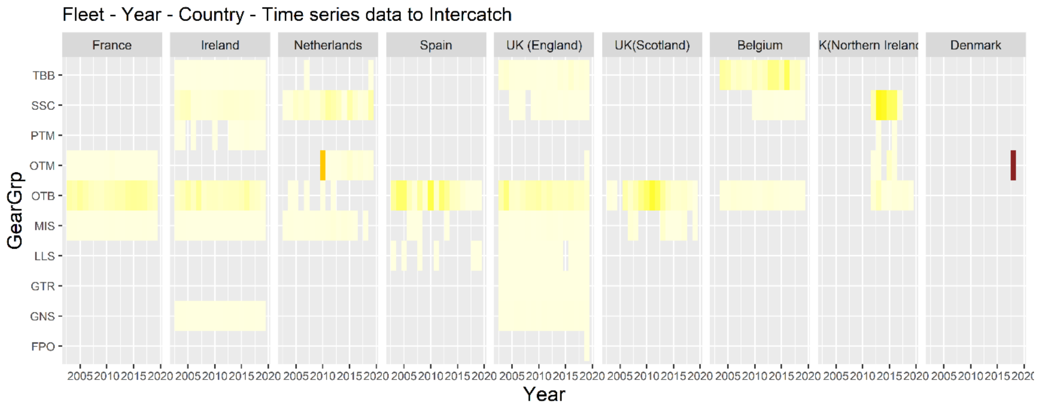


Figure B.1.1 Overview of submission to Intercatch of international catch data by country in 2003-2019.

At the second data workshop, WKCELTIC II, a transparent and standardized approach to international catch data exploration and QC was taken across the three stocks in the form of a shared R markdown document[3] to be adapted for use across the three stocks. In so far as was possible, the allocation of sampling to un-sampled métiers was likewise standardized across stocks using the same R markdown template and editing only where necessary.

Raising of un-sampled catches to CNAA was implemented using a simple hierarchy for available samples where priority was given to the same:

i. Country & Season & Year

ii. Season & Year

iii. Year

With gears set to: GNS_DEF, OTB_CRU, OTB_DEF, TBB_DEF and MIS_MIS.

Discard raising was likewise implemented where samples were missing by estimating ratios at three levels:

i. Year, country and gear

ii. Year and gear

iii. Year

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[3] https://community.ices.dk/ExpertGroups/benchmarks/2019/wkceltic/2014%20Meeting%20docs/02.%20Background%20documents/WHG/aggregate_IC_data_whg.27.7b-ce-k_Oct_2020.html

Overall the degree of sample allocation required was relatively small (Fig B.) in comparison to historic input data. As well as revising data sets, this was in part made possible by sharing age length keys (ALKs) and length-weight (LW) parameters to allow improved sample estimation at the national level prior to submission to IC.

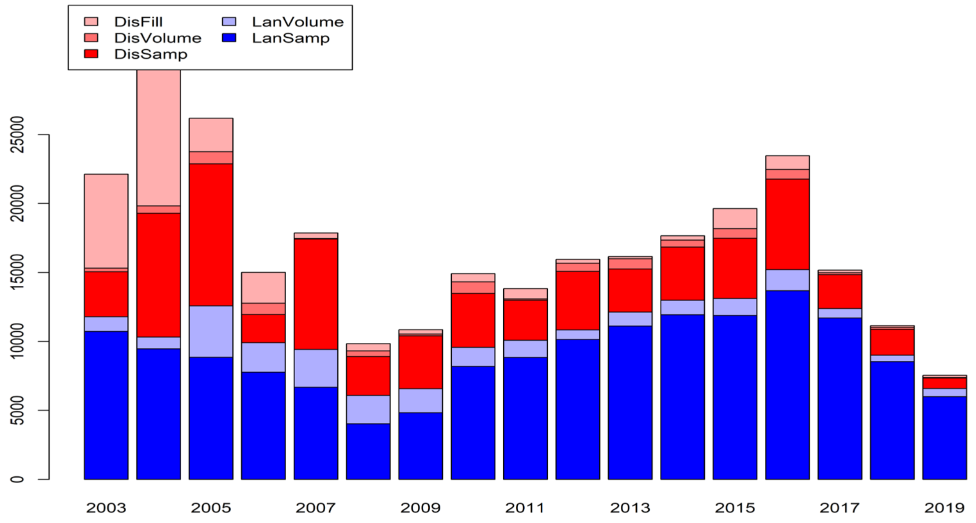

Figure B.1.2. Overview of annual raising of landings and discards data (tonnes) in Intercatch by year in 2004-2018.

Data on international landings-at-age and mean weight-at-age between 1999-2002 were compiled for Irish, French and UK fleets at WKCELT2014 and has been maintained in the current benchmark. However, discard data constructed at WKCELT 2014 was only available for ages 0-4 until 2012. Therefore, given the current data revision, SAM estimates discard numbers at age for ages 5-7+ at the start of the time series (1999 – 2002).

B.2. Biological

Found in the shelf seas of Iceland and Northern Norway to north coast of Portugal in the south and western Baltic, Mediteranean, Agean, Adriatic and Black Seas in the east (Hureau, 1984). Voracious feeders appearing in large shoals; feeding largely on crustaceans and increasingly small fish with age (Hureau, 1984). Generally found from 30–100 m over sandy/muddy ground, juveniles found close inshore. Considered "shy" by Day ((Day, 1880) whiting tend to remain 0.5–3 miles off the coast and are also reported susceptible to the influence of cold by the same author, moving to deeper water with temperature changes of a few degrees.

http://www.fishbase.org/summary/Merlangius-merlangus.html

Age group 0 is included in the assessment data to allow inclusion of 0-group indices in the XSA, although in most years, no landings are recorded. Mean weights-at-age in the catch were derived by combining landings and discards weight-at-age data, divided by the combined landings and discard numbers-at-age.

The NOAA NFT Calculator Utility (v2.1) is used to apply a Rivard correction to annual weights-at-age data to produce the January 1st whiting stock weights for the catch. Stock weights are quite variable and need to be monitored on an ongoing basis (Table B.2.1).

Table B.2.1. Revised maturity ogives for whiting available to WKCELTIC2020 as well as knife edged maturity ogive used in current WGCSE whg7bc-ek assessment.

WHG-7B-K	AGE:	0	1	2	3	4	5	6	7+
Sex:	F	0	0.29	0.96	0.98	0.99	1	1	1
	M	0	0.49	0.82	0.95	0.85	0.8	1	1
	All	0	0.61	0.94	0.97	0.97	0.95	1	1
	WGCSE	0	0	1	1	1	1	1	1

Natural mortality was updated with additional survey data (Table B.2.2) and evaluated against Gislason (see WD Pawlowski 2019, Natural mortality in the Celtic sea gadoids, WKCELTIC2020). The weight based Lorenzen model provided the most consistent values and lower Mohn's rho compared to the length based Gislason approach when tested in XSA and SAM assessment runs. Lorenzen was again adopted at the current benchmark.

Table B.2.2. Mortality estimates for ages 0 (M0) to age 7+ (M7+) from both Lorenzen and Gislason models.

	METHOD	M0	M1	M2	M3	M4	M5	M6	M7+
WKCELT2014	Reference Lorenzen	1.22	0.86	0.65	0.5	0.43	0.40	0.38	0.36
WKCELT2019 using mean W	Lorenzen	1.136	0.805	0.644	0.545	0.499	0.473	0.473	0.460
WKCELT2019 using mean L	Gislason	0.972	0.530	0.365	0.280	0.245	0.223	0.222	0.213

A number of options for applying updated maturity were reviewed using updated data from 2004-2018[4]. Options included maintaining the 2012 estimates, and introducing year specific estimates by age. It was decided to adopt a revised fixed set of maturity at age proportions (Table B.2.2) as this was more likely to be reflective of the general maturity at age, and not depend upon year specific estimates which may lack accuracy owing to sample sizes and origins. This also negates the annual dependence of recalculating maturity for every annual assessment.

B.3. Surveys

A data preparation workshop, Workshop on Evaluating Survey Information Celtic Sea Gadoids (WKESIG), was instigated to help identify and evaluate robust methods to

[4] https://community.ices.dk/ExpertGroups/benchmarks/2019/wkceltic/2014%20Meeting%20docs/02.%20Background%20documents/2019%20DC%20WKCELTIC%20Cod.27.7.e-k%2C%20Had.27.7e-k%2C%20Whg.27.7b-k%20IE%202004-2019%20Maturity%20Ogives_updated.docx

estimate survey indices specifically for the WKCELTIC2020 benchmark. Work has largely focused on the Spatio-Temporal approach and R library VAST[5].

As well as evaluating model performance for quality assuring the survey index as far as possible where data may unavoidably be unavailable, the VAST model outputs were checked in terms of internal consistency. When compared against the standard grid index method, considerable gains were seen particularly in younger ages with the modelled index (Fig B.3.1). The VAST model approach was supported by the benchmark and implemented in exploratory and final runs.

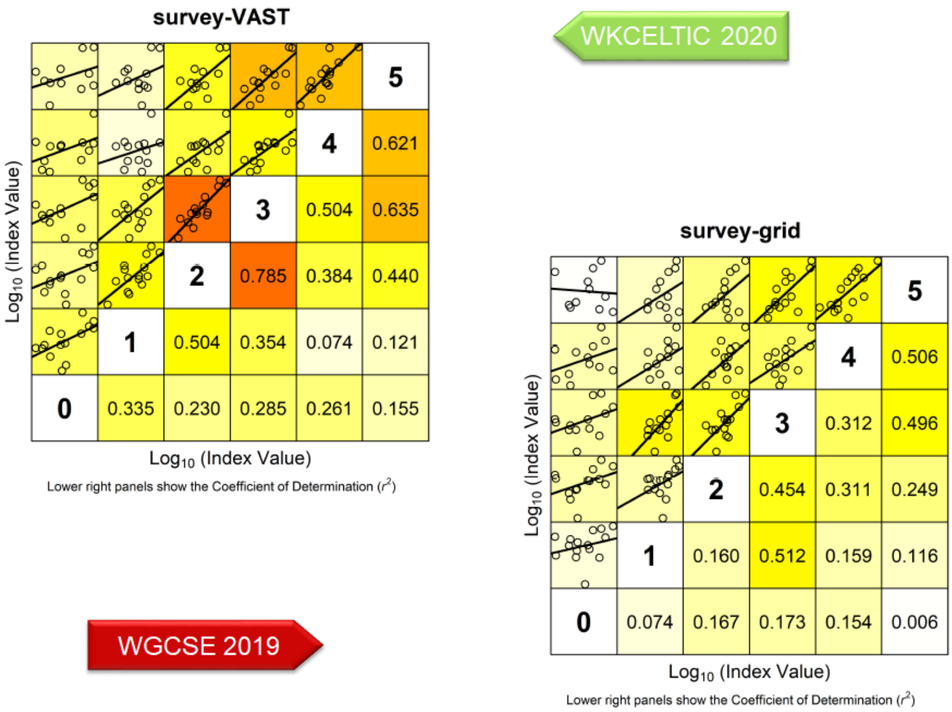

Figure B.3.1. Summary of correlation between paired ages between proposed VAST modelled index (upper panel) and standard Grid Index approach (lower panel). Age groups are given on the diagonal so the correlation between log abundance of age 1 fish and age 2 fish the following year is 0.160 for the historic Grid approach. This increases substantially to 0.504 for example for the VAST index.

B.4. Commercial cpue

An updated French commercial tuning fleet for whiting was made available. The Working Document Laviale et al 2019[6] details the issues raised by the old commercial tuning fleet and the work done to provide the updated French commercial tuning index. In summary, the list of species and the threshold used to select trips has been

[5] https://github.com/James-Thorson-NOAA/VAST

[6] https://community.ices.dk/ExpertGroups/benchmarks/2019/wkceltic/2014%20Meeting%20docs/04.%20Working%20documents/WD_03_WKCELTIC%20-%20French%20commercial%20tuning%20fleets_Final_2020.pdf

modified to better account for the fact that cod is no longer a target of these fisheries, but more a bytcatch of whiting and haddock directed fisheries. Moreover, the commercial tuning now accounts for both landings and discards.

Comparison of runs were performed using SAM with or without the candidate French commercial tuning series. The final decision at WKCELTIC was to use the French commercial index as a biomass index, rather than numbers-at-age to avoid 'double dipping' i.e. using some of the same age composition data in the catch and the index.

C. Historical stock development

Model used: State-Space Assessemnt Model (SAM)

Software used: https://www.stockassessment.org

Model Options:

- Full time-series of catch data(1999 to 2019, ages 0 to 7+)
- Model-filled discards for ages 5 – 7+ in 1999-2002
- VAST Model index for ages 0-2 from IGFS:EVHOE 2003 - 2019
- French Commercial biomass index in Kg/Hr for 2000 - 2019
- Fishing mortality states were bound for ages 6+
- Catchability for ages 1+ were bound for the survey index
- Default settings for remaining configuration
- Observation error on the first age in the survey was estimated separately from the older ages (i.e. ages 1 -2 were bound).

[See Annex 1 for details]

Input data types and characteristics:

File	Details	Year range	Age range	Variable yearly
Cn.dat	Total catch numbers	1999–current	0–7+	Yes
Cw.data	Catch mean weights	1999–current	0–7+	Yes
Lw.dat	Landings mean weights	1999–current	0–7+	Yes
Dw.dat	Discard mean weights	1999–current	0–7+	Yes
Lf.dat	Landings fraction	1999–current	0–7+	No
Survey.dat	Survey index (IGFS VAST No/Km2)	≥2003	0–2	Yes
	Commercial biomass index (FRA_OTB_lpue_WHG_kg_h)	>2000	NA	Yes
Nm.dat	Natural mortality (Lorenzen)	1999–current	0–7+	No
Mo.dat	Maturity ogive	1999–current	0–7+	No
Sw.dat	Stock mean weights (Rivard corrcted – Jan 1st)	1999–current	0–7+	Yes

Pf.dat	F before spawnig	1999–current	0–7+	No
Pm.dat	M before spawnig	1999–current	0–7+	No

D. Forecast

Model used: State-Space Assessemnt Model (SAM)

Software used: https://www.stockassessment.org

Initial stock size: initial stock numbers derived from SAM object.

Natural mortality: That used in the assessment

Maturity: Maturity ogive used in the assessment

F and M before spawning: Those used in the assessment method

Weight-at-age in the stock: Rivard corrected mean catch weights

Weight-at-age in the catch: Raw mean catch weights-at-age

Exploitation pattern: last 3 years for fishing selectivity and for average weight, maturity, M

Intermediate year assumptions: *Status quo* F (Catch constraint)

Stock–recruitment model used: Plain Random Walk

FBAR: That used in the assessment (yrs 2-5).

E. Biological reference points

Fmsy is estimated as 0.534 F(5%), Blim as 35,353t and Bpa as 49,126t. The full range of reference point values and their rationale are summarized in Table E.1.

Framework	Reference Point	Value	Bio 5y Value	Rationale
MSY Approach	MSY Btrigger	49126t	49126t	Tonnes, Bpa
	Fmsy	0.534	0.557	ICES Advice Rule Fp.05 < Fmsy
	Blim	35353t	35353t	Bpa minus error
Precautionary Approach	Bpa	49126t	49126t	Btrigger
	Flim	NA	NA	F with 50% probability of SSB less than Blim - cannot be estimated by interpolation
	Fpa**	0.534	0.557	Fp.05
Management Plan*	FmsyLower	0.422	0.434	ICES Advice Rule
	FmsyUpper	0.534	0.557	ICES Advice Rule (capped ≤Fmsy)

Table E.1. Summary reference points for Celtic Sea whiting.

* Proposed EU multiannual plan (MAP) for the Western Waters (EU, 2018[7]).

** Amended ICES position Fpa -> Fp.0.5 (Rui pers. Com.!)

H. Annex

Annex 1.

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#

Where a matrix is specified rows corresponds to fleets and columns to ages.

Same number indicates same parameter used

Numbers (integers) starts from zero and must be consecutive

#

$minAge

The minimium age class in the assessment

0

$maxAge

The maximum age class in the assessment

7

$maxAgePlusGroup

Is last age group considered a plus group for each fleet (1 yes, or 0 no).

1 0 0

$keyLogFsta

Coupling of the fishing mortality states (nomally only first row is used).

0 1 2 3 4 5 6 6

-1 -1 -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, 2 AR(1), 3 separable AR(1).

2

[7] REGULATION (EU) 2019/472 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

$keyLogFpar

Coupling of the survey catchability parameters (nomally first row is not used, as that is covered by fishing mortality).

-1 -1 -1 -1 -1 -1 -1 -1

0 1 1 -1 -1 -1 -1 -1

2 -1 -1 -1 -1 -1 -1 -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 -1 -1 -1

$keyVarF

Coupling of process variance parameters for log(F)-process (nomally only first row is used)

0 0 0 0 0 0 0 0

-1 -1 -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 1 1

$keyVarObs

Coupling of the variance parameters for the observations.

0 0 1 1 1 1 1 0

2 3 3 -1 -1 -1 -1 -1

4 -1 -1 -1 -1 -1 -1 -1

$obsCorStruct

Covariance structure for each fleet ("ID" independent, "AR" AR(1), or "US" for un-structured). | Possible values are: "ID" "AR" "US"

"ID" "ID" "ID"

$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

NA NA NA NA NA NA NA

NA NA -1 -1 -1 -1 -1

-1 -1 -1 -1 -1 -1 -1

$stockRecruitmentModelCode

Stock recruitment code (0 for plain random walk, 1 for Ricker, 2 for Beverton-Holt, and 3 piece-wise constant).

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, 2 FSB index, 3 total catch, 4 total landings and 5 TSB index).

-1 -1 0

$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

$fracMixF

The fraction of t(3) distribution used in logF increment distribution

0

$fracMixN

The fraction of t(3) distribution used in logN increment distribution

0

$fracMixObs

A vector with same length as number of fleets, where each element is the fraction of t(3) distribution used in the distribution of that fleet

0 0 0

$constRecBreaks

Vector of break years between which recruitment is at constant level. The break year is included in the left interval. (This option is only used in combination with stock-recruitment code 3)