Stock Annex: Celtic Sea Sole

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Sole (division 7.f and 7.g)
Working Group	Working Group for the Celtic Seas Ecoregion
Date	7th February 2014
Last updated	23 May 2019 by Lies Vansteenbrugge and Bart Vanelslander

A. General

A.1 Stock definition

A description of the sole stock in the Celtic Sea was given in the leaflet "Fisheries information – cod, sole, plaice and whiting in the south west of the British Isles" published by Cefas under a EU funded project (SAMFISH: EU Study Contract 99-009, Improving sampling of western and southern European Atlantic Fisheries) and is taken over here.

In the coastal waters of western England and Wales, sole are found in greatest abundance in the eastern Celtic Sea. The main spawning areas for sole in the Celtic Sea are in deep waters (40–75 m) off Trevose Head, where spawning usually takes place between March and May. Sole nursery grounds are generally located in shallow waters such as estuaries, tidal inlets and sandy bays. Juvenile sole (0 and 1 year old fish) are found mainly in depths up to 40 m, and adult sole (fish aged 3 plus) are generally found in deeper water. Spawning and nursery grounds are well defined.

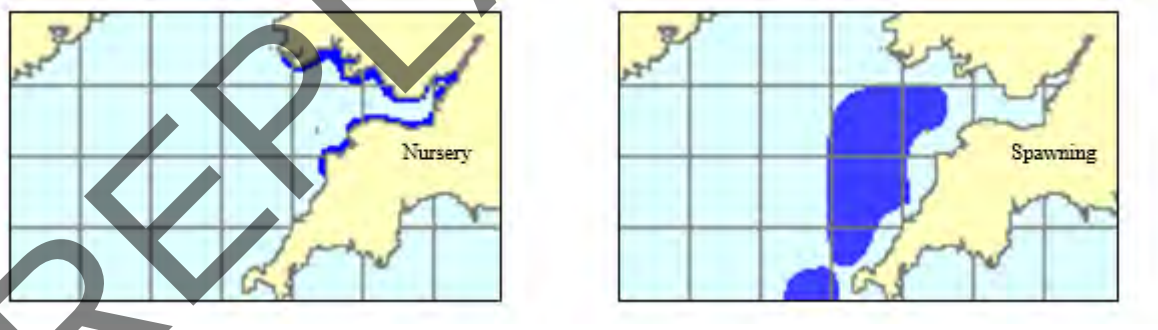


Figure A.1 Nursery and spawning areas of sole in the Celtic Sea (After Coull, K.A., Johnstone, R., and S.I. Rogers. 1998. Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.).

Over 6000 sole were tagged on the nursery grounds of the Bristol Channel and the Irish Sea between 1977 and 1988. The majority of fish tagged in Swansea Bay and Carmarthen Bay were between 15 and 24 cm in length. Most of the recaptures of these tagged fish occurred two or more years after release, which meant that many fish tagged as juveniles were recaptured as adults. The majority of returned fish were reported off the north coasts of Devon and Cornwall, and over a wide area in the eastern Celtic Sea and St George's Channel. These results suggest that once an adult sole has recruited to an area, it tends to remain there, and that there is only limited movement of sole between the Celtic Sea and adjacent areas.

A.2 Fishery

Fisheries for sole in 7.f and 7.g involve vessels from Belgium, taking approximately 70%, the UK taking approximately 20%, and France and Ireland taking minimal amounts of the total landings. Nominal landings are available from 1971 onwards. Sole are mainly targeted by beam trawlers and the fishery is concentrated on the north Cornish coast off Trevose Head and around Lands End (See also Figures A.2 and A.3). There is an average landing of 1109 tonnes throughout its history.

Discard information is being collated since 2004 and it seems to be minor. Discarding of sole in the UK(E&W) fleet was estimated to fluctuate between 1% and 9% in numbers. Discard rates of sole in the Belgian beam trawl fleet (responsible for the main uptake of this stock) account for about 1%–5% in weight.

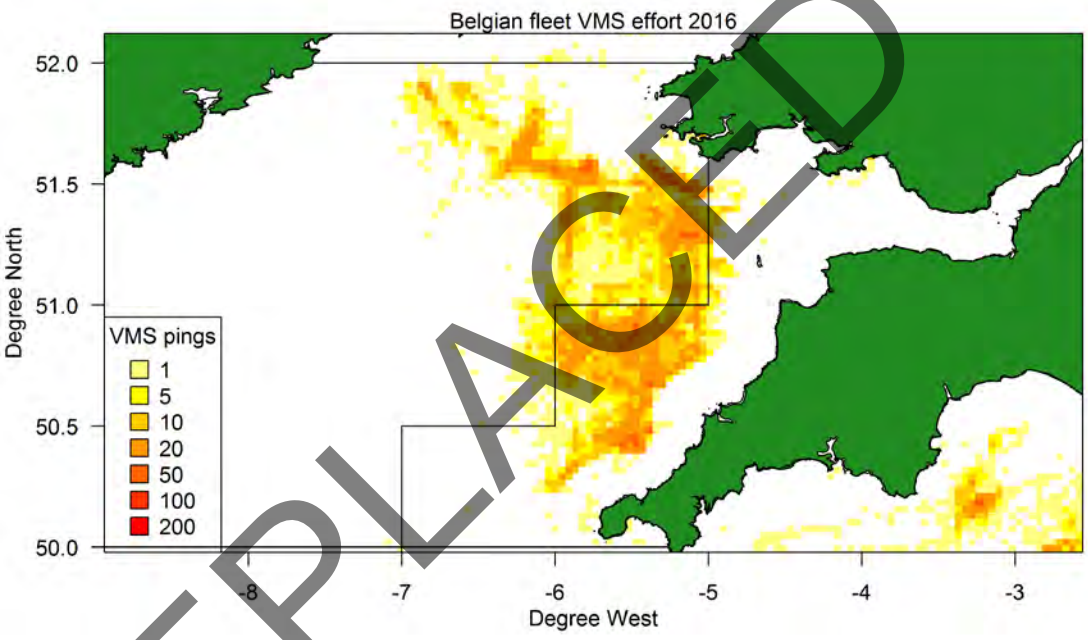


Figure A.2. Effort distribution of the Belgian beam trawl fleet operating in the Celtic Sea (VMS data 2016).

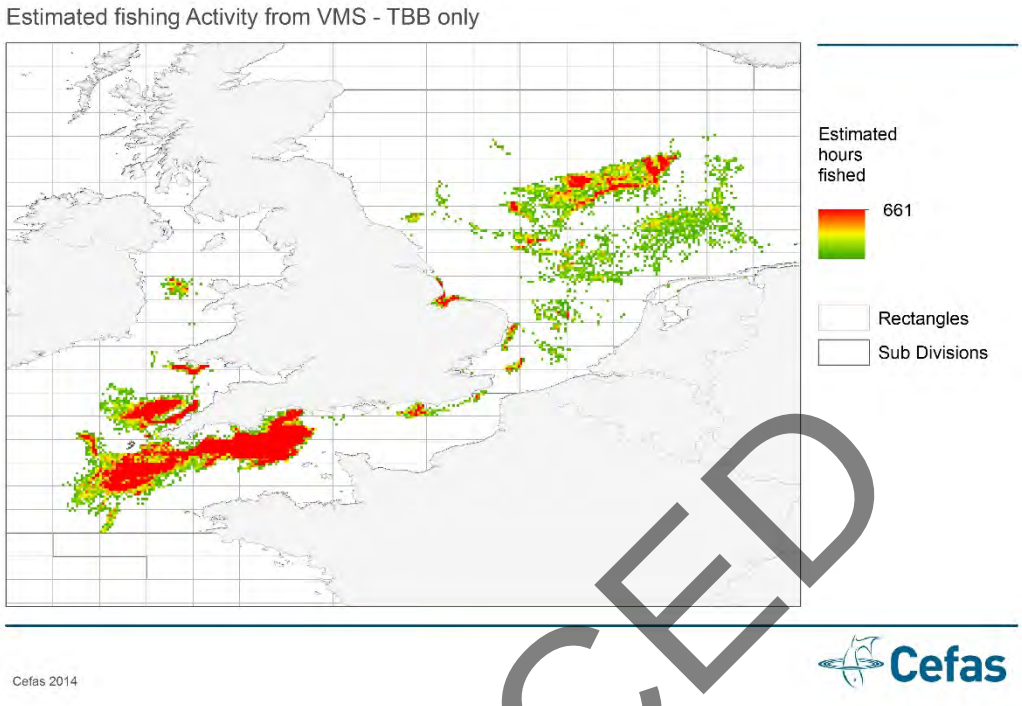


Figure A.2 Effort distribution of the UK(E&W) beam trawl fleet operating in the Celtic Sea (VMS data 2012).

A.3 Management

Celtic Sea sole has been managed by TAC since 1983. Other management measures are technical measures including minimum landing size (24 cm and 25 cm for Belgian vessels from March 11th 2017 onwards; except vessels <221 kW and/or <70 GT) and minimum mesh sizes (80 mm for beam trawlers).

Furthermore national authorities can impose additional management measures, such as temporal closures, trip catch controls and monthly catch controls.

The area referred to in this report as the Trevose Box, consists of the ICES rectangles 30E4, 31E4 and 32E3.

Council Regulation (EC) No 27/2005, Annex III, part A 12 (b) prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during January–March 2005. This prohibition did not apply to beam trawlers during March.

Council Regulation (EC) No 51/2006, Annex III, part A 4.2; (EC) No 41/2007, Annex III, part A 7.2; (EC) No 40/2008, Annex III, part A 6.2; (EC) No 43/2009, Annex III, part A 6.2 prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March 2006-2009 with derogations for vessels using pots, creels or nets with less than 55 mm mesh size. The prohibition does not apply within 6 nautical miles from the baseline.

Council Regulation (EC) No 1288/2009, Article 1 stipulates that the prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March referred to in Council Regulation (EC) No 43/2009, Annex III, part A 6.2 shall be applicable until 30 June 2011.

Council Regulation (EC) No 579/2011, Article 2 stipulates that the prohibited fishing in ICES rectangles 30E4, 31E4 and 32E3 during February and March stipulated in Council

Regulation (EC) No 43/2009, Annex III, part A 6.2, and prolonged in Council Regulation (EC) No 1288/2009, Article 1, shall be applicable until 31 December 2012.

Council Regulation (EC) No 227/2013, Article 29c of the European Parliament and of the Council of 13 March 2013 amending Council Regulation (EC) No 850/98 for the conservation of fishery resources through technical measures for the protection of juveniles of marine organisms and Council Regulation (EC) No 1434/98 specifying conditions under which herring may be landed for industrial purposes other than direct human consumption.

A.4 Ecosystem aspects

The following description of the ecosystem in the Celtic Sea is taken from the MEFEPO atlas (Connolly, P.L., *et al*., 2009).

Physics

Bathymetry: Shelf Sea south of Ireland, limited to the west by the slope of the Porcupine Seabight and the Goban Spur.

Circulation: Along the shelf edge, there is a poleward flowing „slope current"; on the Shelf a weaker current flows north from Brittany across the mouth of the English Channel. Thermal stratification and tidal mixing generates the Irish coastal current which runs westwards in the Celtic Sea and northwards along the west coast of Ireland. Several rivers discharge freshwater into the ecoregion and influence the circulation patterns. These are notably the River Loire, the Severn and the Irish rivers Lee and Blackwater.

Fronts: The Irish Shelf Front is located to the south and west of Ireland (at ca. 11°W), and consists of a tidal mixing front existing all year-round. On the shelf, there are the Ushant Front in the English Channel and the Celtic Sea front at the southern entrance to the Irish Sea.

Temperature: Sea surface temperatures measured in coastal stations northwest of Ireland since the 1960s show a trend of sustained positive temperature anomalies from 1990. An offshore weather buoy maintained off the southwest coast of Ireland (51.22°N 10.55°W) since mid-2002, indicated that 2003 and 2005 had the warmest summer temperatures of the record while 2007 saw the warmest winter temperatures. Temperatures in 2008 started above the time-series mean (2003–2008) until April and from July onwards, temperatures remained well below the time-series mean (WGOH, 2009).

Biology

Phytoplankton: Productivity is reasonably high on the shelf with a rapid decrease west of the shelf break. Continuous Plankton Recorder (CPR) data suggest a steady increase in phytoplankton over at least the last 20 years. Toxic algal blooms occur around Irish coasts especially along the southwest of Ireland.

Zooplankton: CPR data suggest an overall decline in the abundance of zooplankton in recent years. Calanus abundance is now below the long-term mean.

Benthos, larger invertebrate, biogenic habitats: The major commercial invertebrate species is Norway lobster (*Nephrops norvegicus*). Two epibenthic assemblages predominate in the Celtic Sea: one along the shelf edge and the slope, dominated by the anemone *Actinauge richardi* and a more widely distributed assemblage on the

continental shelf, dominated by *Pagurus prideaux* and other mobile invertebrates (shrimp and echinoderms).

Fish Community: The area is a spawning area for key migratory fish species, notably mackerel *Scomber scombrus* and horse mackerel *Trachurus trachurus*. On the continental shelf the main pelagic species are herring *Clupea harengus*, sardine *Sardina pilchardus* and sprat *Sprattus sprattus*. The groundfish community consists of over a hundred species with the most abundant 25 making up 99% of the total biomass. Surveys revealed a downward trend in the biomass and abundance of cod, whiting and hake.

Birds, Mammals & Elasmobranchs: Basking shark (*Cetorhinus maximus*) is seen throughout the area but the stock seems to be severely depleted. Blue sharks (*Prionace glauca*) are found during the summer. The Harbour porpoise *Phocoena phocoena* is the most numerous cetacean in the region. Bottlenosed dolphins (*Tursiops truncates*) occur in large numbers while the common dolphin (*Delphinus delphis*) is also widely distributed in the area. White-beaked dolphin and White-sided dolphin (*Lagenorhynchus albirostris* and *L. acutus*) occur over much of the shelf area. Grey seals (*Halichoerus grypus*) are common in many parts of the area. Petrels (fulmar and storm-petrel) dominate the seabird populations in the west of Ireland and Celtic Sea region but there are also large breeding colonies of kittiwake, guillemot and gannet.

Environmental signals & implications: Increasing temperature and changes in zooplankton communities are likely to have an impact on the life histories of many species. Cod in the Celtic Sea are at the southern limit of the range of the species in the Northeast Atlantic. It is known that at the southern limits of their range, recruitment tends to decrease in warmer waters (above 8.5°C), and that cod are not found in waters warmer than 12°C. Celtic Sea cod has higher growth rates and mature earlier than other cod stocks. Although it is uncertain, Drinkwater (2005) has predicted that a sustained 1°C rise in sea bottom temperature, over the course of this century, could result in the disappearance of cod stocks from the Celtic Sea and the English Channel. Already there has been a northward shift in the distribution of some fish with an increase of seabass *Dicentrarchus labrax* and red mullet *Mullus surmuletus* populations around British coasts. The region also recently experienced an unprecedented increase in the numbers of snake pipefish, *Entelurus aequoreus*. Abundance of herring *Clupea harengus* and pilchard *Sardina pilchardus* occurring off the southwest coast of England, has been shown to correspond closely with fluctuations in water temperature. Sardines were generally more abundant and their distribution extended further to the east when the climate was warmer, whilst herring were generally more abundant in cooler times. The migration timing of squid (*Loligo forbesi*) and flounder (*Platichthys flesus*) off the southwest of England has also been linked to temperature (Sims *et al*., 2001; 2004). Zooplankton abundance has declined in the region in recent years and the overall substantial decline in Calanus abundance, which is currently below the long-term mean, may have longer term consequences given the fish community shift towards smaller pelagic species feeding on zooplankton.

Fishery effects on benthos and fish communities: Temporal analyses of the effects of fishing and climate variation suggest that fishing has had a stronger effect on size-structure than changes in temperature. A marked decline in the mean trophic level of the fish community over time has been documented and this has resulted from a reduction in the abundance of large piscivorous fishes such as cod and hake, and an increase in *Nephrops* and smaller pelagic species such as boarfish (*Capros aper*) which feed at a lower trophic level. In the Celtic Seas, discarding levels differ between the different fleets but can be as high as two thirds of the total catch with increasing trends

in recent years. Discarding of undersized fish is a problem in several fisheries (e.g. cod, haddock, *Nephrops* and megrim). Improving the selection pattern should benefit the stocks and result in a higher long-term yield. Sole and plaice are predominantly caught by beam trawl fisheries. Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method. Benthic drop-out panels have been shown to release around 75% of benthic invertebrates from the catches. Information from the UK industry (Trebilcock and Rozarieux, 2009) suggests that uptake in 2008 was minimal. The high mud content and soft nature of *Nephrops* grounds means that trawling readily marks the seabed, trawl marks remaining visible for some time. Despite the high intensity of fishing (some areas are impacted >7 times/year) burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling. Cetacean bycatch has been noted in some fisheries, including the pelagic trawl fishery for mackerel and horse mackerel in the SW of Ireland, although the numbers caught were low.

B. Data

B.1 Commercial Catch

Before 2013

7.f and 7.g	**BEL**	**IRL***	**UK(E&W)**	**Derivation of international landings in 7.f and 7.g**
Length composition	7.f and 7.g	7.f and 7.g	7.f and 7.g	The quarterly national catch numbers-at-age and catch weights-at-age were raised to the total international landings (including France, Northern Ireland and Scotland).
ALK	7.f and 7.g	7.f and 7.g	7.f and 7.g	
Age Composition	7.f and 7.g	7.f and 7.g	7.f and 7.g	

*** From 2005 to 2009 no Irish Length compositions or ALK's therefore from 2005 to 2009, BEL + UK age composition raised to total international landing.**

Numbers-at-age 1 in the catch are low in most years, therefore these were not considered to add useful information and are replaced by zeros.

From 2013 onwards, quarterly data (landing numbers and weight-at-age) from Belgium, Ireland and UK are provided under the ICES InterCatch format on a métier basis. These comprise about 89% of the international landings. Additionally, quarterly total landings from France, Northern Ireland and Scotland can be accessible. Allocation for the unsampled strata is based on a match between gear and mesh size. The remaining unsampled métiers are raised by all original age compositions. All raising is proportional to the catch numbers-at-age. Quarterly stratification has not been taken into account.

WKCELT 2014

For the period 2003–2005, the catch numbers-at-age and the total international landings were corrected for a substantial misreporting of Belgian landings into 7.j–k.

B.2 Biological

Weights-at-Age

Before 2013

The total international catch weights-at-age are calculated as the weighted mean of the annual weight-at-age data supplied by Belgium, UK(E&W) and Ireland, which account for about 95% of the total international landings (weighted by landed numbers).

From 2013 onwards,

The total international catch weights-at-age are calculated by applying the weighting algorithm for 'Mean weight weighted by numbers-at-age or length' in InterCatch. This means that the mean weights-at-age of the sampled catches (supplied by Belgium, UK(E&W) and Ireland) and the allocated mean weights-at-age are weighted by their numbers-at-age. Note that the catch weights-at-age for the years before 2013 were not updated according to the InterCatch protocol.

In the recent assessments (upon 2013), the catch weights-at-age were smoothed using a quadratic fit where catch weights-at-age are mid-year values (age = 1.5, 2.5, etc.). Stock weights-at-age were the first quarter catch weights smoothed by fitting a quadratic fit. Catch weights-at-age and stock weights-at-age have been scaled to give a SOP of 100%.

For the period 2002–2004 the stock weights-at-age are the catch weights of the Belgian beam trawl fleet (BEL-BEAM) in the first quarter, smoothed by fitting a Gompertz function. For the period 2005–2007, the stock weights were calculated as the weighted mean of the 1st quarter weights-at-age data supplied by Belgium and UK(E&W) (weighted by landed numbers) and smoothed using a quadratic fit through these points. The values for 2001 showed a strange convergence and were replaced by the mean of the 2000 and the 2002 weights.

WKCELT 2014

For the period 2008–2012, the original total international catch weights-at-age were used. The stock weights were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./) that conducts a cohort interpolation of the catch weights. This protocol is maintained in future assessments.

Natural Mortality and Maturity Ogives

Natural mortality was assumed to be 0.1 for all ages and years. This is consistent with the natural mortality estimates used for other sole stocks (4, 7.d, 7.a, 8.a and 8.b) and consistent with estimates of M reported in Horwood (1993).

The maturity ogive applied to all years is, a combined sex maturity ogive taken from area 7.f and 7.g attributed to Pawson and Harley, WD presented to WGSSDS in 1997.

Age	1	2	3	4	5	6 and older
	0.00	0.14	0.45	0.88	0.98	1.00

The proportion of M and F before spawning was set to zero.

B.3 Surveys

Target species

Flatfish species, particularly juvenile plaice and sole. Length data recorded for all finfish species caught; samples for age analysis taken from selected species.

Time Period

1988–2018: September (continuing)

Gear used

Commercially-rigged 4 m steel beam trawl; chain matrix; 40 mm codend liner.

Mean towing speed: 4 knots over the ground. Tow duration: 30 minutes. Tow duration for trips in 1988–1991 was 15 minutes; in 1992 comparative tows of 15 and 30 minutes length were carried out, and subsequent cruises used a standard 30 minute tow. The data from earlier years were converted to 30 minutes tow equivalent using relationships for each species derived from the comparative work in 1992.

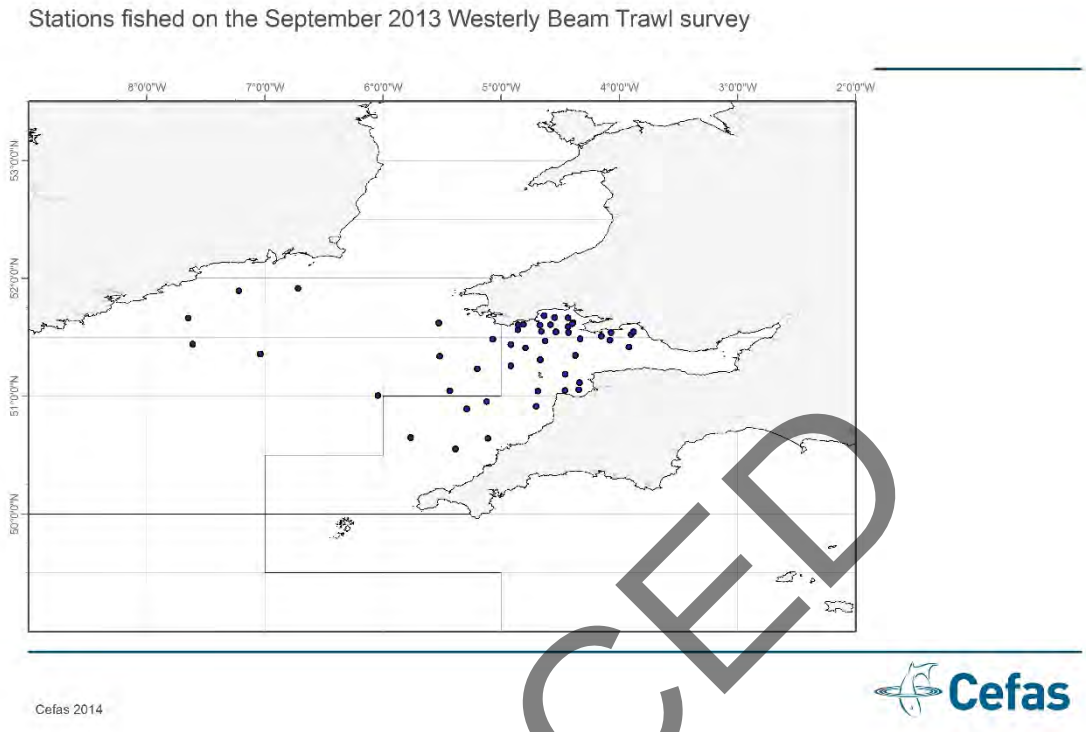
Vessel used: R.V. *Endeavour* (Cefas).

Survey design

Survey design is stratified by depth band and sector (Depth bands are 0–20, 20–40, 40+). Station positions are fixed. There are 101 core fishing and hydrographic stations distributed around the Irish Sea, Bristol Channel and Celtic Sea between 50 to 55 degrees N and between the English, Welsh and Irish coasts.

Method of analysis

Raised, standardized length frequencies for each station combined to give total length distribution for a stratum (depth band/sector). Sector age–length keys applied to stratum length distributions 1988–1994; stratum age–length keys applied 1995 onwards. Mean stratum cpue (kg per 100 km and numbers-at-age per 100 km) are calculated. Overall mean cpue values are simple totals divided by distance in metres (or hours fished). Population number estimates derived using stratum areas as weighting factors.



The Irish Groundfish survey, held in the 4th quarter is available since 2003. The possible inclusion of the Irish Groundfish survey was examined at WKCELT 2014, but not retained because the consistency between ages is very poor.

The 2019 Inter-benchmark Protocol (IBP) planned to investigate the suitability of the UK-Q1SWBeam survey to include in the assessment (ToR a ii.). However, this ToR was postponed and will be reconsidered in the upcoming 2020 WKFLAT CSNS as the UK-Q1SWBeam tuning series was not long enough to be included in the assessment at the time of the IBP. The survey started covering the Celtic Sea area (27.7.f and 7.g) from 2013 onwards. However, during the first two years (2013 and 2014), there was limited coverage due to bad weather conditions and operational difficulties. The addition of a new fisheries independent tuning series would benefit the estimates for recruitment. Currently, only the UK-BTS-Q3 survey provides age 1 information.

B.4 Commercial cpue

Commercial cpue data are available from the Belgian, the UK(E&W) and the Irish beam trawl fleets, as well as the UK(E&W) and Irish Otter trawl fleets. There is also information on the cpue of the hardly significant Scottish seine fleet for the sole fisheries. Only the Belgian and the UK(E&W) beam trawl tuning fleet is used for the assessment. The other available tuning data (e.g. UK otter trawl fleet) were not considered representative for this stock and therefore not included in the assessment.

During the 2019 IBP, the Belgian commercial beam trawl tuning fleet (BE-CBT) was substantially revised. Prior to the IBP, the BE-CBT tuning series consisted of two parts, which were included separately in the assessment: one with the original data from 1971 up to 1996 and one series with data from 1997 up to 2017. For the latter, the effort was corrected for engine power, based on a study carried out by IMARES and Cefas in the mid-1990s (applicable to sole and plaice effort in the beam trawls fisheries). Currently, this method is outdated and during the IBP, a more realistic conversion factor for engine power was investigated to convert nominal fishing effort to effective effort.

The new Belgian index focussed on the period 2006–2017 for which information on ICES statistical rectangle, year, month, fleet segment and engine power (kW) was available. A series of data exploration steps revealed that spatial and temporal distribution parameters were needed in the model to account for the seasonal fisheries in the Trevose Box. ICES statistical rectangles 30E4, 31E4 and 32E3 are closed for fishing from February 1st until March 31st. This management measure is in place since 2006 and aims to protect spawning fish, cod and other demersal stocks such as sole in particular (ICES special request, 2007; Sys *et al*., 2017). This measure has a significant effect on the behaviour of the fleet. The largest effort of the Belgian commercial beam trawl fleet is situated in this Trevose Box or on its edges during closure.

Further data exploration revealed two important drawbacks, which resulted in retaining only a subset of all Belgian commercial beam trawl data for sole in 27.7.f and 7.g for constructing the new index:

- The small fleet segment vessels (engine power ≤221 kW), which have quite limited effort and landings in divisions 27.7.fg compared to the large fleet segment (engine power >221 kW), are likely to misreport effective engine power. Only the large fleet segment was considered for the new index.
- The Belgian beam trawl fleet has fishing opportunities spread over different ICES divisions. This flexibility creates an opportunity for noncompliance. It is generally known that fishers occasionally 'transfer' landings from one stock to another as a consequence of quota limitations (e.g. day limits). Only the 'pure' trips (i.e. with landings only in divisions 27.7fg) were considered for the new index.

The new commercial tuning fleet for Belgian beam trawlers was calculated using the following model:

$\text{Log(lpue)} \sim \beta_0 + \beta_1$ *as.factor(Year) + β_2 *log(kW) + β_3 *as.factor(IcesStatisticalRectangle) + β_4 *as.factor(Month) +(1|VesselName)

+ Dispersion formula : ~as.factor(IcesStatisticalRectangle) + as.factor(Month)

The exponent of the estimated coefficients of the year effect is used as the landing rate for the tuning series, which was standardised by the total weight landed by the pure trips of the large fleet segment per year. More information is provided in the IBP report and dedicated working document (ICES, 2019b).

The 2019 IBP also had a ToR on the revision of the UK commercial beam trawl tuning fleet. More specifically, a suitable time-series of effort data for the tuning fleet had to be provided to account for the recent change in e-logbook effort recording. However, this ToR was postponed to the upcoming 2020 WKFLAT CSNS.

B.5 Other relevant data

No information.

C. Historical stock development

This paragraph was updated after the WGCSE 2019 and considers the changes made to the reference points after the IBP and WGCSE 2019.

During the eighties fishing mortality increased for this stock. In the following decades, fishing mortality fluctuated between this higher level and F_{pa}. Since 2006, fishing mortality decreased and fluctuated between F_{pa} (0.420) and F_{MSY} (0.297). In the period 2012–2014, fishing mortality increased again but remained just below F_{pa}. In 2015 and

2016, fishing mortality was just above F_{MSY} (=0.297), but decreased to below F_{MSY} from 2017 onwards (F in 2018=0.23).

Recruitment has fluctuated around 5 million recruits with occasional strong year classes. The 1998 year class is estimated to be the strongest in the time-series (14 451 thousand fish at age 1). The 2007 year class is also considered as quite strong (9941 thousand fish at age 1). The 2009 year class is by far the lowest in the time-series (2023 thousand fish at age 1). The 2014 and 2016 year class are estimated to be well above the average, with the latter being the second highest of the time-series.

SSB has declined almost continuously from the highest value of 7385 t in 1971 to the lowest observed in the time-series in 1998 (1592 t). The exceptional year class of 1998 has increased SSB from B_{lim} to above MSY $B_{trigger}$. From 2001 onwards, SSB remained above MSY $B_{trigger}$. From 2017 onwards, SSB further increases as a result of the decreasing fishing mortality and continuous good recruitment.

Tuning Data

The tuning data that are used in the assessment are:

Until 2013

- UK Corystes September beam-trawl survey (UK(E&W)-BTS-Q3 survey) from1988 onwards
- Belgium commercial beam trawl fleet (BEL-CBT) from 1971–2003
- UK beam trawl fleet (UK-CBT), Division 7.f, from 1991 onwards.

WKCELT2014

- UK Corystes September beam-trawl survey (UK(E&W)-BTS-Q3 survey) from1988 onwards
- Belgium commercial beam trawl fleet (BEL-CBT) from 1971–1996
- Belgium commercial beam trawl fleet (BEL-CBT) from 1997 onwards
- UK beam trawl fleet (UK-CBT), Division 7.f, from 1991 onwards.

The Belgian beam trawl tuning fleet was temporally discontinued in 2003. This is due to a change in the calculation of the effort statistics from the official logbooks and sale slip notes. At the 2014 benchmark assessment, a new derivation of the Belgium beam trawl data was available from 1997 onwards. The Belgian tuning series was split into two separate fleets (WKCELT 2014 report): one with the original data from 1971 up to 1996 and the new series from 1997 up to 2012. The effort series used to calculate cpue for the index is HP corrected. For the period 2003–2005, a correction for a substantial misreporting of Belgian landings into 7.j–k, was introduced. For the UK(E&W)-BTS-Q3 tuning series, only ages 1 to 5 were retained.

WGCSE 2015–2018

- UK Corystes September beam-trawl survey (UK(E&W)-BTS-Q3 survey) from 1988 onwards
- Belgium commercial beam trawl fleet (BEL-CBT) from 1971–1996
- Belgium commercial beam trawl fleet (BEL-CBT) from 1997 onwards
- UK beam trawl fleet (UK-CBT), Division 7.f, from 1991–2012.

Due to effort reporting issues, the 2013–2018 UK-CBT indices were not available and could not be used in the assessment.

WGCSE 2019: first WG post-IBP

- UK Corystes September beam-trawl survey (UK(E&W)-BTS-Q3 survey) from 1988 onwards
- Belgium commercial beam trawl fleet (BEL-CBT) from 1971–1996
- New Belgium commercial beam trawl fleet (BEL-CBT3) from 2006 onwards
- UK beam trawl fleet (UK-CBT), Division 7.f, from 1991–2012.

During the IBP 2019 inter-benchmark, it was decided to include the new Belgian tuning series (BE_CBT3) from 2006 up until the last data year with ages 2–9. The old Belgian CBT from 1971–1996 was trimmed to ages 3–9. The BE_CBT2 series running from 1997 up until the last data year was excluded. Finally, the UK(E&W)-CBT from 1991–2012 was also trimmed to ages 3–8. Due to effort reporting issues, the 2013–2018 UK-CBT indices were not available and could not be used in the assessment. Settings for the UK BTS Q3 survey remained unchanged. More information is provided in the 2019 IBP report (ICES, 2019b).

Assessment Methods and Settings

Celtic Sea sole has been assessed with XSA. An overview of the changes in parameter settings of the XSA are given below:

	assessment 1998-1999			2000 assessment			assessment 2001-2002		
Fleets	Years	Ages	α-β	Years	Ages	α-β	Years	Ages	α-β
BEL-CBT commercial	71-asses-year-1	2-9	0-1	86-asses-year-1	2-9	0-1	86-asses-year-1	2-9	0-1
UK-CBT commercial	91-asses-year-1	2-9	0-1	87-asses-year-1	3-9	0-1	91-asses-year-1	2-9	0-1
UK(E&W)-BTS-Q3 survey	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-4	0.75-0.85
-First data year	1989			1986			1986		
-Last data year	assessment year-1			assessment year-1			assessment year-1		
-First age	1			1			1		
-Last age	10+			10+			10+		
Time series weights	None			None			None		
-Model	Mean q model all ages			Power model (ages 1 & 2)			Power model (ages 1 & 2)		
-Q plateau set at age	7			7			7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages			5 years / 5 ages			5 years / 5 ages		
-s.e. of the means	0.5			1.5			1.5		
-Min s.e. for pop. Estimates	0.3			0.3			0.3		
-Prior weighting	None			None			None		
Fbar (4-8)									

	2003 assessment			assessment 2004-2005			assessment 2006-2012		
Fleets	Years	Ages	α-β	Years	Ages	α-β	Years	Ages	α-β
BEL-CBT commercial	87-asses-year-1	2-9	0-1	71-asses-year-1	2-9	0-1	71-asses-year-1	2-9	0-1
UK-CBT commercial	91-asses-year-1	2-9	0-1	91-asses-year-1	2-9	0-1	91-asses-year-1	2-9	0-1
UK(E&W)-BTS-Q3 survey	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-4	0.75-0.85	88-asses-year-1	1-9	0.75-0.85
-First data year	1987			1971			1971		
-Last data year	assessment year-1			assessment year-1			assessment year-1		
-First age	1			1			1		
-Last age	10+			10+			10+		
Time series weights	None			None			None		
-Model	Power model (ages 1 & 2)			Power model (ages 1 & 2)			Mean q model all ages		
-Q plateau set at age	7			7			7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages			5 years / 5 ages			5 years / 5 ages		
-s.e. of the means	1.5			1.5			1.5		
-Min s.e. for pop. Estimates	0.3			0.3			0.3		
-Prior weighting	None			None			None		
Fbar (4-8)									

	WKCELT2014		
Fleets	Years	Ages	α-β
BEL-CBT commercial 1	71-96	2-9	0-1
BEL-CBT commercial 2	97-asses-year-1	2-9	0-1
UK-CBT commercial	91-asses-year-1	2-9	0-1
UK(E&W)-BTS-Q3 survey	88-asses-year-1	1-5	0.75-0.85
-First data year	1971		
-Last data year	2012		
-First age	1		
-Last age	10+		
Time series weights	None		
-Model	Mean q model all ages		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	1.5		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		
Fbar (4-8)			

	2014-2018 assessment		
Fleets:	Years	Ages	α–β
BEL-CBT commercial	1971–1996	2–9	0–1
BEL-CBT2 commercial	1997–2017	2–9	0–1
UK-CBT commercial	1991–2012	2–9	0–1
UK(E&W)-BTS-Q3 survey	1988– 2017	1–5	0.75–0.85

-First data year	1971		
-Last data year	assessment year-1		
-First age	1		
-Last age	10+		
Time-series weights	None		
-Model	Mean q model all ages		
-Q plateau set at age	7		
-Survivors estimates shrunk towards mean F	5 years / 5 ages		
-s.e. of the means	1.5		
-Min s.e. for pop. Estimates	0.3		
-Prior weighting	None		
Fbar (4–8)			

	2019 assessment		
Fleets	Years	Ages	α-β
BE_CBT	71–96	3–9	0–1
BE_CBT3	06–18	2–9	0–1
UK(E&W)-CBT	91–12	3–8	0–1
UK(E&W)-BTS-Q3	88–18	1–5	0.75–0.85

-First data year	1971
-Last data year	2018
-First age	1
-Last age	10+
-Time series weights	None
-Model	Mean q model all ages
-Q plateau set at age	7
-Survivors estimates shrunk towards mean F	5 years / 5 ages
-s.e. of the means	1.5
-Min s.e. for pop. Estimates	0.3
-Prior weighting	None
-Fbar	Ages 4–8

Short-term projection

Population numbers for ages 2 and older are taken from the XSA output (estimates of the year = the assessment year minus 1). If age 2, solely assumed by the UK(E&W)-BTS-Q3 survey is exceptionally high, the estimate is reduced by 23% (calculated as the average reduction from the first year estimate to the converged estimate, four years later).

The long-term geometric mean (starting year up to assessment year minus 2) is assumed for age 1 in the forecast.

Standard procedure for setting the fishing mortality in the forecast is to take the mean over the last three years, not rescaled. If a trend occurs in fishing mortality (three consecutive higher or lower estimates), the Working Group may use a scaled F to the last year.

Weights-at-age in the catch and in the stock are averaged over the last three years.

WKCELT 2014, decided as an interim solution to change the standard procedure for setting the fishing mortality. In case such as in 2012 the estimate of fishing mortality is considered to be uncertain, the fishing mortality should not be rescaled to the last year, but taken as the mean of the last three years.

In 2018, the working group decided to use a TAC constraint for the intermediate year (2018) as recent landings have been close to the TAC or only slightly overshot. Moreover, *status quo* fishing mortality gives higher landings in the intermediate year than the agreed TAC.

The *status quo* fishing mortality assumed for 2019 was set as the mean over the last three years not scaled to 2017.

In 2019, the working group decided again to use TAC constraint settings for the intermediate year (2019)) as recent landings have been close to the TAC or only slightly overshot.

E. Medium-term projections

No medium-term projections were done since 2007.

F. Yield and biomass per recruit / long-term projections

No long-term projections were done in 2018.

G. Biological reference points

ICES carried out an evaluation of MSY and PA reference points for this stock in 2015 at WKMSYREF4 (ICES, 2016a). During the 2019 IBP, reference points have been re-estimated (ICES, 2019b). However, these values were rejected by the 2019 WGCSE and re-estimated at the working group (ICES, 2019a).

Previous biological reference point values are given in the text table below:

Reference points	ACFM 98 onwards	2016 onwards
F_{MSY}	0.31 (PLOTMSY, WG2010)	0.274 (Eqsim, WKMSYREF 4)
F_{lim}	0.52 (based on F_{loss}, WG1998)	0.488 (based on segmented regression with B_{lim} as breakpoint)
F_{PA}	0.37 (F_{lim} x 0.72)	0.34857 (F_{lim}/1.4)
B_{lim}	Not defined	1700 t (B_{loss} estimated in 2015)
B_{PA}	2200 t (based on B_{loss} (1991), WG1998)	2380 t (B_{lim} *1.4)
$B_{trigger}$	B_{PA}	2380t

The current biological reference points are listed below.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	2228 tonnes	B_{pa}	ICES (2019a)
	F_{MSY}	0.297	EQsim analysis based on the recruitment period 1971–2017	ICES (2019a)
Precautionary approach	B_{lim}	1592 tonnes	B_{loss} estimated in 2018, corresponding to SSB in 1998	ICES (2019a)
	B_{pa}	2228 tonnes	$B_{lim} \times 1.4$	ICES (2019a)
	F_{lim}	0.587	EQsim analysis, based on the recruitment period 1971–2017	ICES (2019a)
	F_{pa}	0.420	$F_{lim} \times \exp(-1.645 \times 0.2) \approx F_{lim} / 1.4$	ICES (2019a)
Management plan*	MAP MSY $B_{trigger}$	2228 tonnes	MSY $B_{trigger}$	
	MAP B_{pa}	2228 tonnes	B_{pa}	
	MAP B_{lim}	1592 tonnes	B_{lim}	
	MAP F_{MSY}	0.297	F_{MSY}	
	MAP range F_{lower}	0.165–0.297	Consistent with ranges provided by ICES (2019a), resulting in no more than 5% reduction in long-term yield compared with MSY	ICES (2019a)
	MAP range F_{upper}	0.379–0.499	Consistent with ranges provided by ICES (2019a), resulting in no more than 5% reduction in long-term yield compared with MSY	ICES (2019a)

***EU multiannual plan (MAP) for the Western Waters (EU, 2019).**

H. Other Issues

An evaluation of the Trevose box closure (ICES rectangles 30E4, 31E4 and 32E3) was based on Belgian data that account for about 70% of the total international landings. Furthermore, the Belgian fleet is predominantly active in the Trevose Box (see map in Section A.2). This study showed that the cpue substantially increased in the month after the opening of the Trevose Box. The quota uptake also increased substantially in that month, however as the Belgian fleet is subjected to a limited quota uptake by month, the overall uptake levels off at the end of the year. The annual quota has not or only limited been exceeded since the introduction of the closure.

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