# Stock annex: Plaice (*Pleuronectes platessa*) in divisions 7.f–d (Celtic Sea Plaice)

| | |
|---|---|
| Stock | Plaice (Division 7.f_g) |
| Working Group | Celtic Seas Ecoregion (WGCSE) |
| Date | May 2017 |
| Revised by | Vladimir Laptikhovsky |
| Last benchmarked | WKFLAT 2011 |

## A General

### A.1 Stock definition

The degree of separation between the stocks of plaice in the Celtic Sea and the Irish Sea is unclear. Juvenile fish does not move far away from local nursery grounds (Mariott *et al*., 2016), so there is likely no redistribution of recruitment and only adult begin to migrate.

Historic tagging studies indicate a southerly movement of mature fish (or fish maturing for the first time) from the southeast Irish Sea, off North Wales, into the Bristol Channel and Celtic Sea during the spawning season (Figure A.1.1). While some of these migrant spawning fish will remain in the Bristol Channel and Celtic Sea, the majority are expected to return to summer feeding grounds in the Irish Sea (Dunn and Pawson, 2002).

Very little mixing is considered to occur between the stocks (Pawson, 1995). Nevertheless, time-series of recruitment estimates for all stocks in waters around the UK (Irish Sea, Celtic Sea, western and eastern Channel, North Sea) show a significant level of synchrony (Fox *et al*., 2000). This could indicate that the stocks are subject to similar large-scale environmental forces and respond similarly to them and recruitment strength is “shaped” at the larval and early post-larval stages prior to settlement.

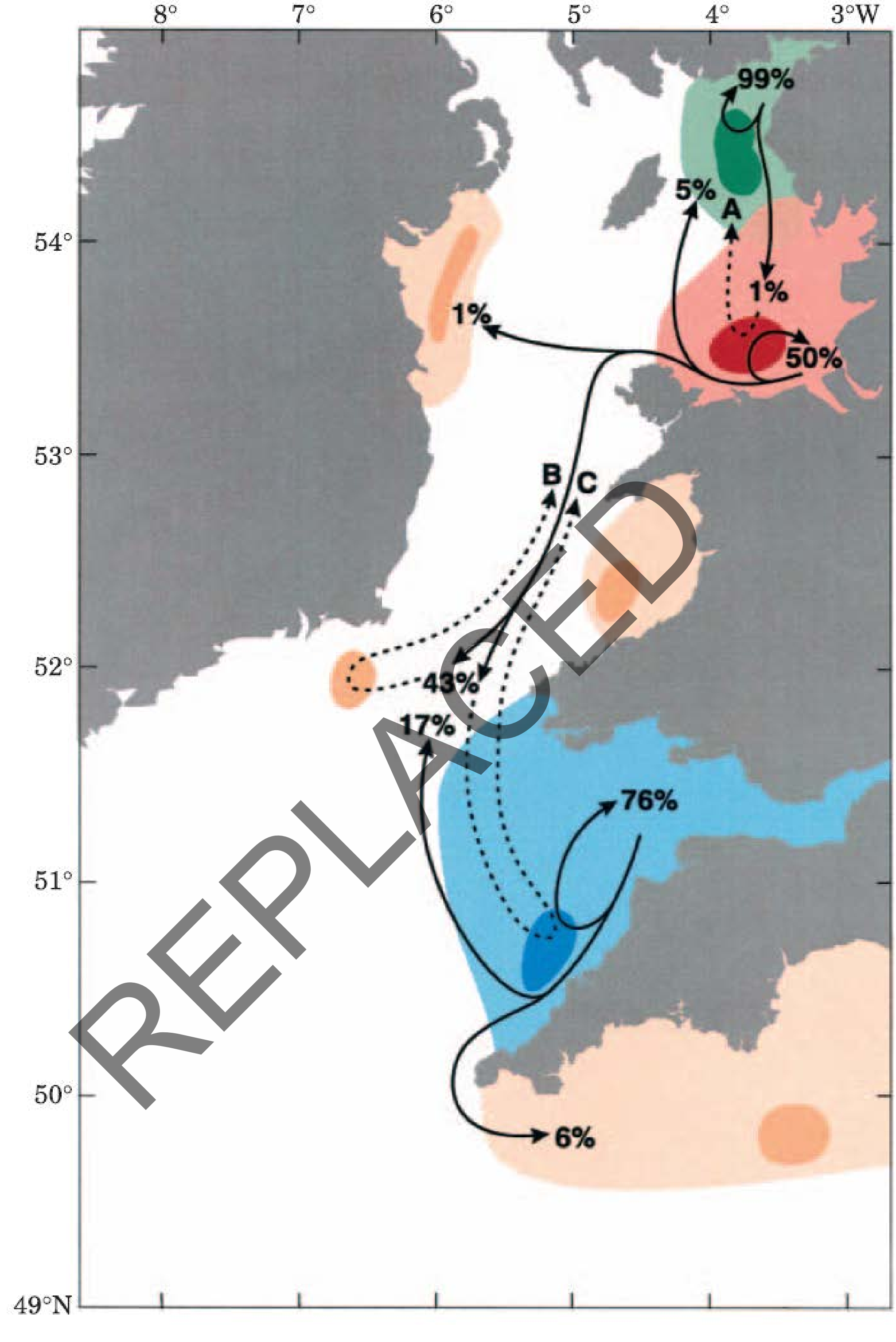



**Figure A.1.1. (right): Principal substock areas and movements of plaice on the west coast of England and Wales. Percentages are the recaptures rates of tagged plaice <25 cm total length when released, and >26 cm when recaptured in English and Welsh commercial fisheries. Tagging exercises in 1979–1980 and 1993–1996 were combined based on the assumption that the dispersal patterns of plaice were consistent over time. For each substock, the main feeding area (derived from tag recaptures during April–December; light shading), and the main spawning area (derived from tag recaptures during January–March, and ichthyoplankton surveys; dark shading) are indicated. The substocks tagged have been coloured green, red and blue. The substocks coloured orange are less well determined, with the feeding area around south-east Ireland unknown. Letters represent return migrations, where A ≈ 6%, and B+C ≈ 46%. Reproduced from Dunn and Pawson (2002).**

## A.2 Fishery

Plaice are caught in mixed fisheries with sole, which generates high discards of plaice due to the mismatch in the selectivity properties of the gear and the plaice minimum landings size (to catch sole of MLS of 24 cm a vessel needs no use smaller mesh size than if it would target solely adult plaice in which MLS is 27 cm). In addition, the relatively low market value of plaice may contribute to the high discard rates (Figure A.2.1).

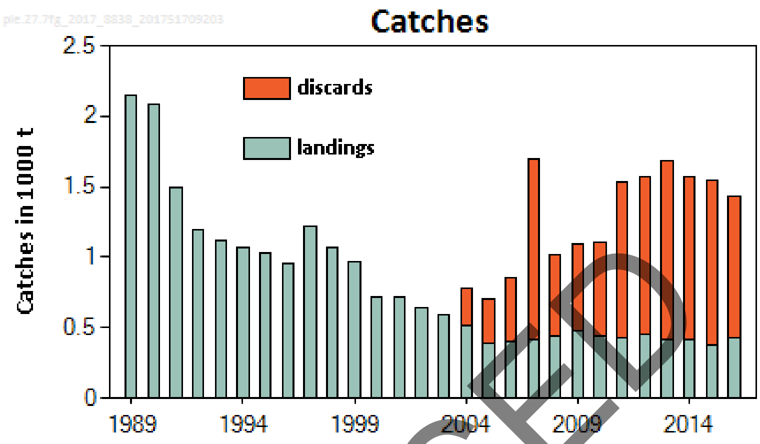


Figure A.2.1. Landings and discards of plaice in ICES subdivision 7.f–g.



The main fishery is concentrated on the Trevose Head ground off the north Cornish coast and around Land's End. Although plaice are taken throughout the year, the bulk of landings usually is taken in March, after the peak of spawning, with a second peak in September. The fisheries harvesting plaice in the Celtic Sea involve vessels from Belgium, France, Ireland and UK.

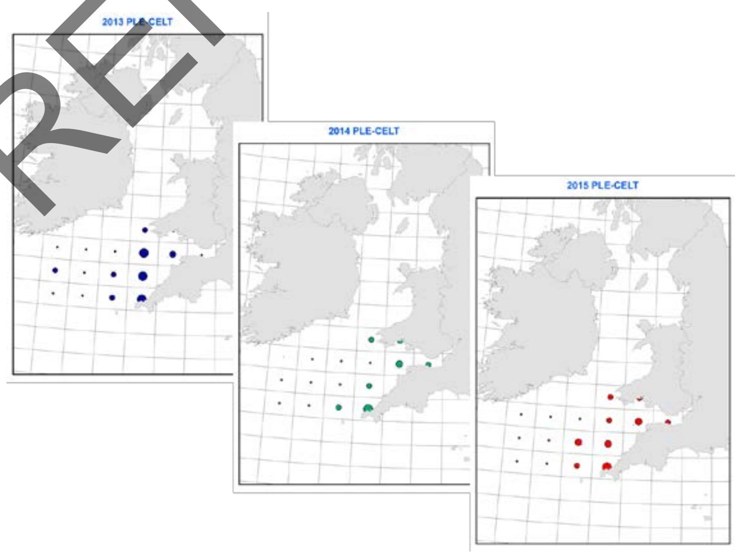


Figure A.2.2. Spatial distribution of landings by the U.K. fleet in 2013–2015.

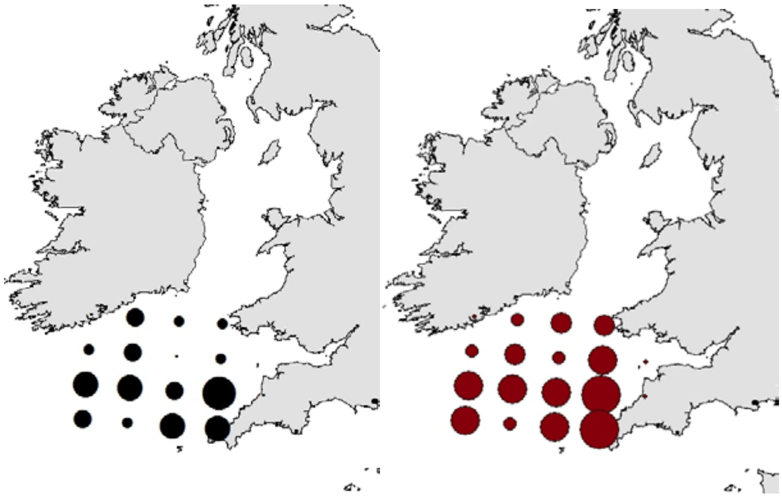

**Figure A.2.3. Spatial distribution of landings by the French fleet in 2015 and 2016.**

The main métiers in plaice fisheries in the Celtic Sea is the beam trawler that accounts for 43–57% of the total catch and otter trawlers accounting for 32–51% of landings. The rest of métiers (3–11%) is represented by seines, purse seines, gillnets, trammelnets and longlines with seines being the most important among them. Most of the fish are taken by Belgium and France with UK and Ireland fleets having lesser impact on the stock.

Technical measures currently in force in the ICES subdivision 7f–g are the MLS of 27 cm, a minimum mesh size of 80 mm for otter and beam trawlers and 70 mm for *Nephrops* trawlers, the latter accounting for some 5–10% of landings.

**Table A2.1. Plaice in divisions 7.f and 7.g. History of official landings by country, ICES estimated landings, and discards in 1977–2016. Catches are in tonnes.**

| Year | Belgium | UK | France | Ireland | The Netherlands | Total reported | Discards | Unallocated | ICES landings | ICES catch |
|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 214 | 150 | 365 | 28 | | 757 | N/A | 0 | 757 | N/A |
| 1978 | 196 | 152 | 527 | 0 | | 875 | N/A | 0 | 875 | N/A |
| 1979 | 171 | 176 | 467 | 49 | | 863 | N/A | 0 | 863 | N/A |
| 1980 | 372 | 234 | 706 | 61 | | 1373 | N/A | 0 | 1373 | N/A |
| 1981 | 365 | 251 | 697 | 64 | | 1377 | N/A | 0 | 1377 | N/A |
| 1982 | 341 | 196 | 568 | 198 | | 1303 | N/A | 0 | 1303 | N/A |
| 1983 | 314 | 279 | 532 | 48 | | 1173 | N/A | −27 | 1146 | N/A |
| 1984 | 283 | 366 | 558 | 72 | | 1279 | N/A | −69 | 1210 | N/A |
| 1985 | 357 | 466 | 493 | 91 | | 1407 | N/A | 345 | 1752 | N/A |
| 1986 | 665 | 539 | 878 | 302 | 9 | 2384 | N/A | −693 | 1691 | N/A |
| 1987 | 581 | 496 | 708 | 127 | | 1912 | N/A | −11 | 1901 | N/A |
| 1988 | 617 | 630 | 721 | 226 | | 2194 | N/A | −78 | 2116 | N/A |
| 1989 | 843 | 471 | 1089 | 180 | | 2583 | N/A | −432 | 2151 | N/A |
| 1990 | 794 | 498 | 767 | 160 | | 2219 | N/A | −137 | 2082 | N/A |
| 1991 | 836 | 392 | 444 | 155 | | 1827 | N/A | −326 | 1501 | N/A |
| 1992 | 371 | 307 | 504 | 180 | | 1362 | N/A | −174 | 1188 | N/A |
| 1993 | 542 | 299 | 373 | 89 | | 1303 | N/A | −189 | 1114 | N/A |
| 1994 | 350 | 252 | 298 | 82 | | 982 | N/A | 88 | 1070 | N/A |
| 1995 | 346 | 286 | 254 | 70 | | 956 | N/A | 72 | 1028 | N/A |
| 1996 | 410 | 239 | 246 | 83 | | 978 | N/A | −26 | 952 | N/A |
| 1997 | 594 | 258 | 329 | 78 | | 1259 | N/A | −42 | 1217 | N/A |
| 1998 | 540 | 176 | 298 | 135 | | 1149 | N/A | −82 | 1067 | N/A |
| 1999 | 371 | 170 | N/A | 115 | | N/A | N/A | 312 | 968 | N/A |
| 2000 | 224 | 134 | 287 | 76 | | 721 | N/A | −3 | 718 | N/A |
| 2001 | 241 | 136 | 262 | 45 | | 684 | N/A | 30 | 714 | N/A |
| 2002 | 248 | 105 | 186 | 79 | | 618 | N/A | 24 | 642 | N/A |
| 2003 | 221 | 127 | 165 | 51 | | 564 | N/A | 30 | 594 | N/A |
| 2004 | 212 | 87 | 145 | 45 | | 489 | 274 | 21 | 510 | 784 |
| 2005 | 168 | 55 | 132 | 44 | | 399 | 321 | −13 | 386 | 707 |
| 2006 | 172 | 88 | 106 | 48 | | 414 | 453 | −10 | 404 | 857 |
| 2007 | 194 | 61 | 104 | 58 | | 417 | 1288 | −7 | 410 | 1698 |
| 2008 | 187 | 63 | 62 | 63 | | 375 | 583 | 62 | 437 | 1020 |
| 2009 | 216 | 56 | N/A | 61 | | N/A | 608 | N/A | 481 | 1071 |
| 2010 | 188 | 54 | 136 | 63 | | 442 | 670 | 0 | 442 | 1103 |
| 2011 | 210 | 45 | 98 | 67 | | 420 | 1107 | -7 | 427 | 1528 |
| 2012 | 203 | 44 | 126 | 76 | | 450 | 854 | 0 | 450 | 1298 |
| 2013 | 186 | 40 | 106 | 80 | | 412 | 1274 | -2 | 414 | 1686 |
| 2014 | 181 | 24 | 155 | 50 | | 410 | 1158 | 0 | 410 | 1568 |
| 2015* | 185 | 25 | 111 | 59 | | 381 | 778 | 0 | 381 | 1159 |
| 2016* | 244 | 27 | 108 | 52 | | 431 | 571 | 0 | 431 | 1002 |

N/A = not available.

* Preliminary.

### A.3 Ecosystem aspects

Plaice are preyed upon and consume a variety of species through their life history, particularly during its juvenile part in very shallow waters where it is intensively preyed upon by a shrimp *Crangon crangon* being very important predator (Albaina *et al*., 2012). As a predator, plaice typically consume high proportions of polychaetes and molluscs. In spite its important part in ecosystems, plaice have not as yet been included in an interactive role in multispecies assessment methods (e.g. ICES, WGSAM 2008).

The spawning in Celtic Sea occurs in spring, with peak in March (Ellis, Nash, 1997). Eggs are pelagic so their survival highly depend on environmental variability. Other than statistical correlations between recruitment and temperature (Fox *et al*., 2000), little is known about the effects of the environment on the stock dynamics of plaice in the Irish and Celtic Seas. Negative correlations between year-class strength of plaice (in either the Irish Sea, Celtic Sea, Channel and North Sea) and sea surface temperature are generally strongest for the period February–June. However, eastern (North Sea and Channel) and western (Irish Sea and Celtic Sea) stocks have been found to respond to different time-scales of temperature variability, which might imply that different mechanisms are operating in these stocks and/or that the Irish Sea and Celtic Sea share common spawning (Fox *et al*., 2000). Stock is increasing from ~2008 after a period of low abundance in ~1995–2007 as some other plaice stocks around the UK, like in divisions 7.e and 7.h–k (ICES, 2017) and in the North Sea (Dutz *et al*., 2016) that possibly might be caused by some global processes.



## B. Data

### B.1 Commercial catch

#### B.1.1 Landings

International landings-at-age data based on quarterly market sampling and annual landings figures are available from 1977. Landings rose to a maximum in the late 1980s, declined during the early 1990s, and then fluctuated around 1000 t. The decline reached a low at 386 t in 2005 following which landings fluctuated between 381 and 463 t. Estimates of the level of discarding have been collected since 2004 and have shown a consistent increase, apart from 2007 when a substantial increase occurred by all fleets, followed by a return to the previously lower levels.

Landing age compositions is provided on quarterly basis for some fleets of the UK and Belgium, and on annual basis for Ireland and the rest of Belgium, and from 2015 some data were received from landings by French fleet.

#### B.1.2 Discards

Discard information was not routinely incorporated into the assessment prior to 2011. Working Group estimates of the combined, raised, level of discards are available from 2004, they have shown a consistent increase apart from 2007 when a substantial increase occurred in the discarding by all fleets followed by a return to the previously lower levels. Recent discard rates, although variable, are high and increasing. Total discard information is available for some fleets, and data are raised for others. In recent years the discards represent some 70–75% of catches. Data on age structure of discards are provided by the U.K. on quarterly basis, and by Ireland and Belgium on annual basis.

All discarded fish is assumed to be dead for assessment reasons. However, it might partially survive, and this survival could be considerable in larger fish of commercial size (Revill *et al*., 2013).

#### B.1.3 Recreational catches

Not estimated so included in the assessment. Likely not important.

### B.2 Biological sampling

#### B.2.1 Weights-at-age

***Landings***

Landings weight-at-age data were available for Belgium, the UK(E+W) and Ireland. In 2015 some information was provided also by France. Historically, landings weights-at-age were constructed by fitting a quadratic smoother through the aggregated catch weights for each year. WKFLAT (2011) decided not to continue this approach, following concerns raised by WGCSE that poor fits of the quadratic smoothing curve were resulting in the youngest ages being estimated to have heavier weights than adjacent older ages. WKFLAT (2011) rejected the use of the polynomial smoother for weights-at-age and suggested that raw landings weights are used in future. Raw data back to 1995 were obtained by WKFLAT (2011) and used to update the catch weights and stock weights files.

***Discards***

Discard weight-at-age data were available for Belgium, the UK(E+W) and Ireland. These values were used to derive a weight-at-age matrix in grammes for an individual fish. The national weight-at-age matrices were 'combined' to a total international matrix by weighting the individual weights-at-age for each year, by the total discard tonnages from the two countries for that year. Where only one estimate of weight was available for an age/year, then that estimate was used.

The above processes also produced estimates of discard numbers-at-age for these countries. The UK estimates were raised to incorporate equivalent levels of discards for the 'unsampled' countries of France, Scotland, and Northern Ireland (on the basis of similar gear types and seasons). A raising factor based on tonnages 'landed' for these countries was calculated and applied to the UK(E+W) estimates of discard numbers. Finally, these estimates were added to those calculated for Belgium and Ireland to give total international discard numbers-at-age estimates.

***Stock***

For the years 2004–2016 where discard estimates were available, a revised set of stock weights-at-age were calculated. The stock weights-at-age based on landings, with SOP correction but no 'fitting,' were combined with the international discard weights-at-age data. These were weighted by the relative landed or discarded international annual tonnages. The international annual discard tonnage was not readily available, as the 'unsampled' countries did not have estimates. These were derived using the ratio of UK(E+W) tonnages of landings and discards and this ratio was applied to these unsampled nations landings to produce an estimate of total discard biomass for each of these countries. For the years prior to 2004, a revised set of stock weights-at-age data based on the international landings only were produced. These new values were based on the 'observed' weight data, but were SOP corrected. For this series of data, the ‘smoothing’ of the data by fitting a curve through the observed data, was removed.

Stock weights-at-age demonstrate a steep decline between 2011 and 2012 with further stabilization but in the most important commercial ages 3.4. and 5 y.o. when a gradual decrease was going on.

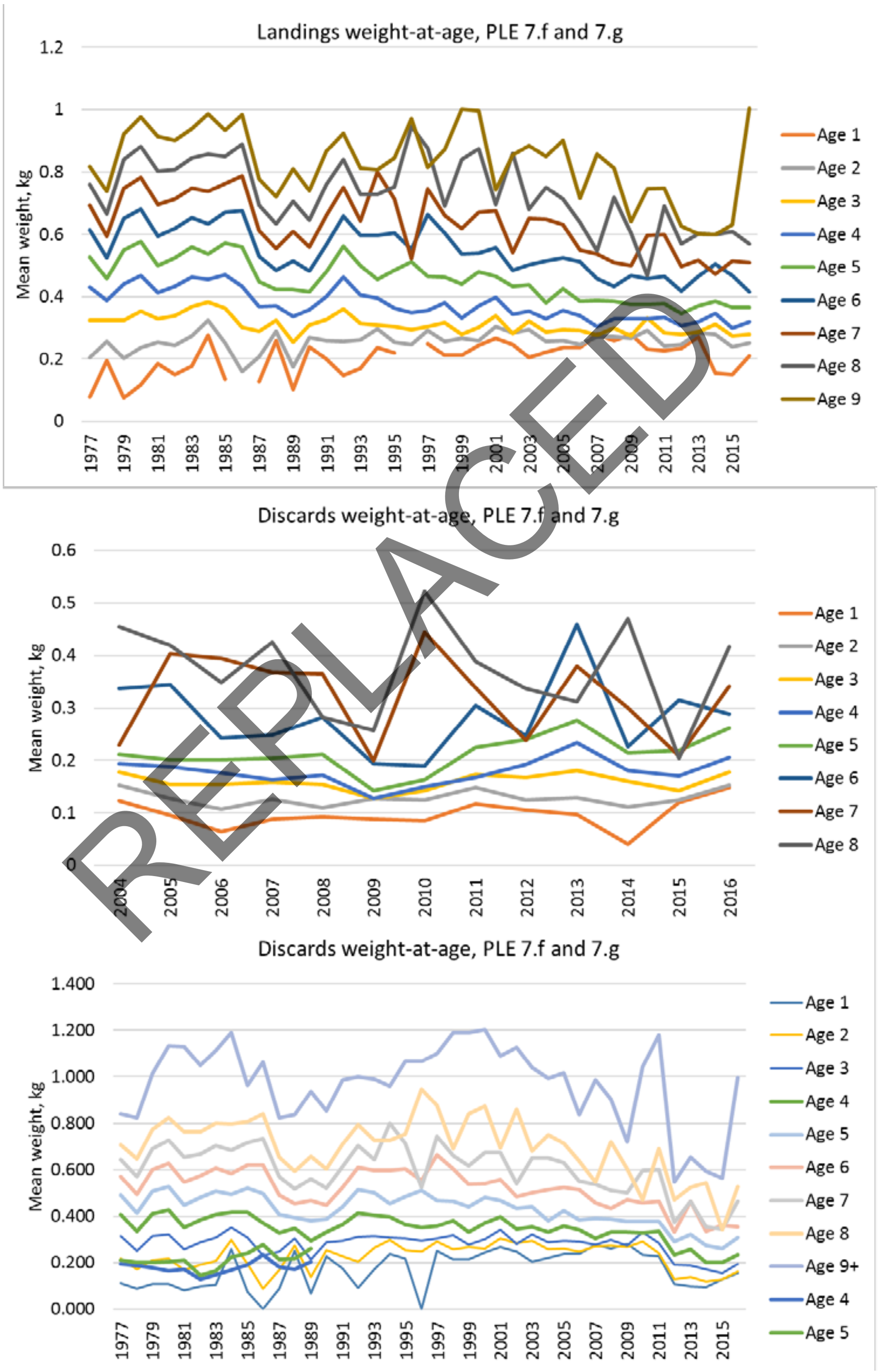




**Figure B.2.1. Trends in weights-at-age.**

### B.2.2 Natural mortality and maturity ogives

Initial estimates of natural mortality (0.12 for all years and ages from tagging studies) and maturity were based on values estimated for Irish Sea plaice. A new maturity ogive based on UK(E&W) 7.f–g survey data for March 1993 and March 1994 (Pawson and Harley, 1997) was produced in 1997 and is applied to all years in the assessment.

| Age | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|
| Historic maturity | 0 | 0.15 | 0.53 | 0.96 | 1.00 |
| Revised maturity | 0 | 0.26 | 0.52 | 0.86 | 1.00 |

The proportion of mortality before spawning was originally set at 0.2 since approximately 20% of the total catch was taken prior to late February–early March, considered to be the time of peak spawning activity. The proportion of F and M before spawning was changed to zero at the request of ACFM in 1996 given that it was considered that these settings were more robust to seasonal changes in fishing patterns, especially with respect to the medium term projections. No updated information was provided to WKFLAT and the estimates were retained.

Th recent size of 50% maturity was estimated from results of surveys by “Cefas Endeavour” in the area 7.fg in 2015 and 2016. Length-at-maturity was estimated as 202.4 mm, L95 as 288.1 mm.

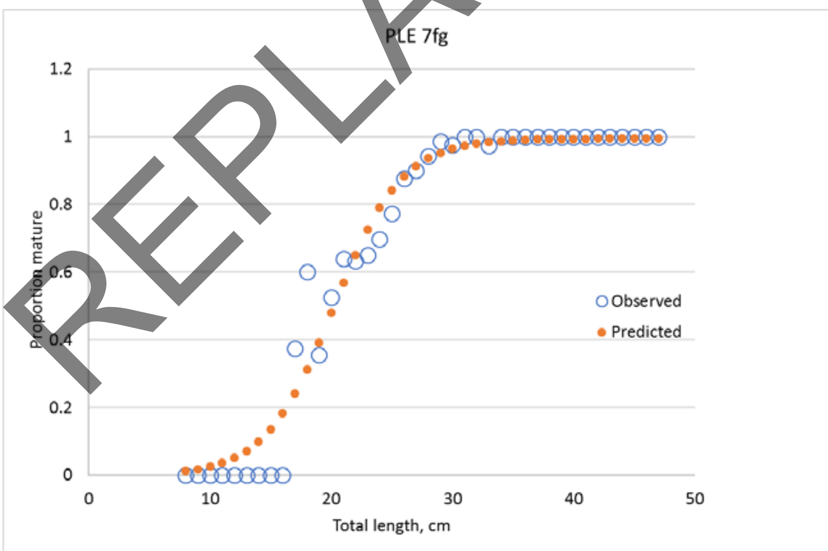


**Figure B.2.2.1. Plaice maturity ogive, all sexes combined.**



## B.3 Surveys

Indices of abundance are available from the UK(E&W)-BTS-Q3 beam trawl survey in 7.f and the Irish Celtic Explorer IBTS survey (IGFS-WIBTS-Q4) in 7.g.

The UK(E&W) beam-trawl survey series that began in 1988; since 1991, tow duration has been 30 minutes but prior to this it was 15 minutes. In 1997, values for 1988 to 1990 were raised to 30 minute tows. However, data for 1988 and 1989 were of poor quality and gave spurious results: thus, the series was truncated to 1990. A similar March beam trawl survey began in 1993 and was made available to the Working

Group in 1998. The March beam trawl survey ended in 1999 but continued to be used as a tuning index in the assessment until 2003.

The IGFS is a demersal trawl survey which started in 2003. It is coordinated through the ICES International Bottom Trawl (IBTS) Working Group, providing annual indices of abundance for commercially exploited groundfish stocks on the Irish continental shelf (ICES 6.a, 7.b,g&j) for Q3–4. Plaice are caught by the survey off the SE coast up to, and just over, the border of 7.g with 7.a (ICES rectangles (32E2, 32E3).

Year effects in the survey catch rates dominate the abundance indices. The year class and catch curve plots illustrate that the consistency of plaice year-class abundance estimates at each age is relatively poor. The survey was not fitted within the assessment Aarts&Poos model, but will be monitored as the time-series progresses.

In 2015–2016 both survey trends were used to fit SPiCT model.

### B.4 Commercial lpue

Commercial tuning indices of abundance from the UK(E&W) beam trawl and otter trawl data are used in the assessment to provide information on the oldest ages in the population. Historically, only ages 4–8 have been used to calibrate the assessment because of concerns about the level of discarding at the youngest ages. The data show good historical consistency of year-class estimates throughout the time-series, especially for the beam trawls, with more noise resulting from two major year effects in the otter trawl data. Since the year 2014, lpues of the UK(E&W) beam trawl are expressed in kg per fishing day rather than per hour due to changes in the reporting system.

In recent years, the trends of commercial lpues were different from those of surveys (Figure B.4.1). At least partially it was caused by increasing numbers of commercial-sized fish being discarded (Figure B.4.2).



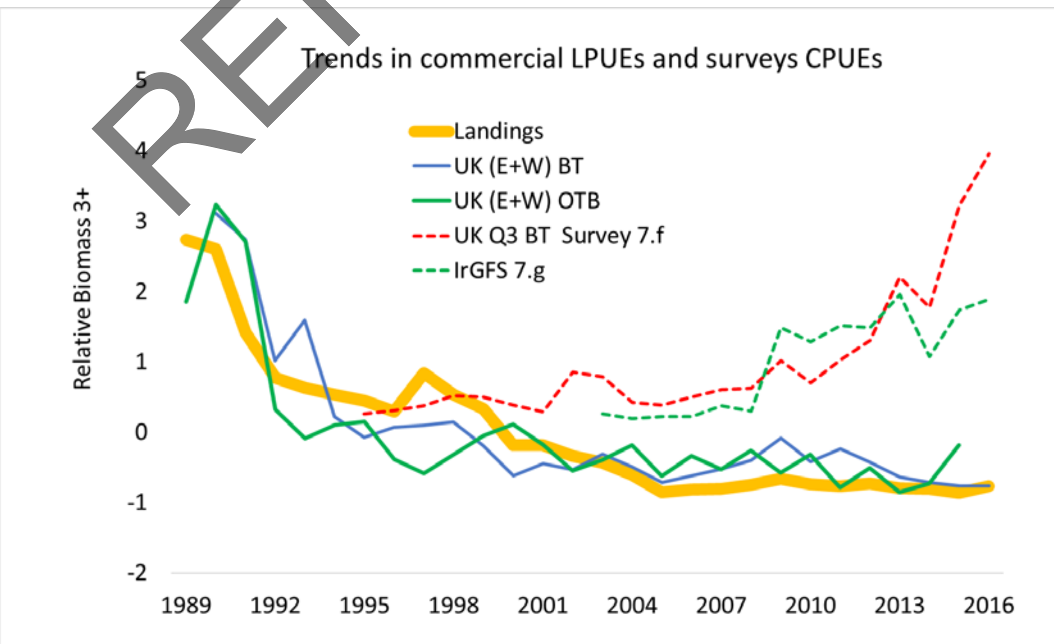


**Figure B.4.1. Trends in the UK(E&W)-BTS-Q3 and IGFS-WIBTS-Q4 survey biomass and commercial fleet lpues of plaice older and equal to three years old.**

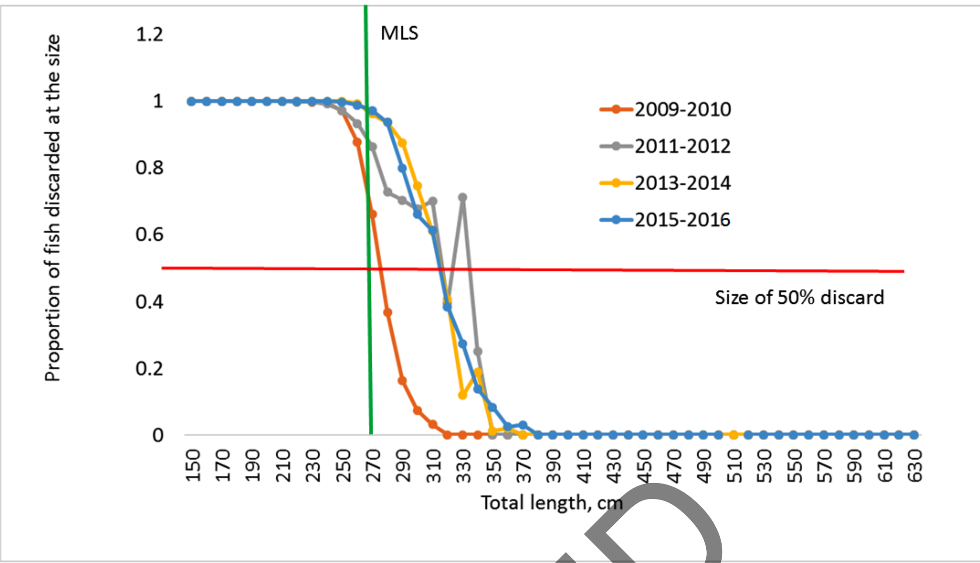


**Figure B.4.2. Discarding practices of the UK TBB_DEF_70_99 in respect to plaice in Division 7.f–g.**



## C Stock assessment

In 2013, no assessment was presented for this stock given that the "preferred" Aarts and Poos (2009) model failed to converge and other model variants could not provide realistic representations of observed landings and discards. Consequently, WGCSE 2013 decided to avoid the use of the "preferred" TV_PTVS AP model variant and instead focus on assessing the stock using trends derived from the fishery-independent UK(E&W) beam-trawl survey. Trends derived from the UK(E&W) beam-trawl survey were selected for the basis of advice given that this survey most appropriately covered the spatial extent of the stock and well represented the mean age (2–5) landed in the fishery. The UK(E&W) beam-trawl survey was used to infer trends in recruitment, stock size (spawning–stock biomass) and fishing mortality.

In 2014 corrected TV_PTVS Aarts and Poos (2009) model converged and produced realistic results and confirmed conclusions derived in 2013 from the fishery-independent UK(E&W) beam-trawl survey.

In both 2015 and 2016 all three model variants converged but only of the "preferred" TV_PTVS AP variant provided estimations consistent with the previous run, observed catches and landings. However, trends of both UK(E&W)-BTS-Q3 beam-trawl and IGFS-WIBTS-Q4 surveys on one hand and data on lpues of commercial fleet produced conflicting signal that resulted in asymmetrical distribution of residuals. Because of this the ICES stock advice was based on surveys' cpue trends.

Independently of WGCSE, the stock status was explored in 2015 by WKLife using a biomass dynamic model (SPiCT) (ICES, 2016 a). As discard data were not available prior 2004, the group approximated the total catch values from 1977 onwards. An adjustment was made to the data by applying the 2004 discard ratio back in time (landings prior to 2004 were multiplied by K=1.54). These total catch data were combined with cpue trends of both surveys expressed in two mean-standardized biomass index series of +3-year-old plaice, which were considered to reflect "exploitable biomass" for this stock.

Results of modelling were found to be sensitive to truncating the catch to ensure 100% overlap between the survey and catch time-series. In this case, truncation lead to a ~60% increase in $B_{MSY}$ and ~30% decrease in $F_{MSY}$, whereas CVs were hugely increased (by ~200% and ~75% respectively). Therefore, the time-series was not truncated. Estimation of the observation error corresponding to the catch ($\beta$) and survey ($\alpha$) was tried, but the model did not converge when trying to estimate both of these, so $\alpha$ was fixed at 1, while $\beta$ was estimated. Under all these assumptions the results indicated current stock status (2015) to be well above the biomass reference point 0.5 $B_{MSY}$, and F (2015) to be well be $F_{MSY}$ (ICES, 2016a).

In 2017 the AP model did not converge. The ICES framework for category 3.2 stocks was applied (ICES, 2012; 2016b–d). As the previous ICES advice used both catch/landings and biomass index series, the stock was investigated by applying SPiCT. The SPiCT results were chosen as the basis for advice using comparison of the two latest biomass index (B/ $B_{MSY}$) values (index A) with the three preceding values (index B), multiplied by the recent advised catch of 1500 tonnes.

The settings and data for the SPiCT model fits are set out in the table below:

| ASSESSMENT YEAR | | 2016 |
|---|---|---|
| Assessment model | | SPiCT |
| Catch data | | Including discards 1989–2016 (reported discards for 2004–2016, and estimated discards for 1989–2003) |
| Discard rate | | Average (proportion by number) 2004–2016. Calculated as discards/(landings + discards). |
| Tuning fleets | UK(E&W)-BTS-Q3 | 1995–2016 ages 3+ |
| | IGFS-WIBTS-Q4 | 2003–2016 ages 3+ |
| | UK commercial beam trawl | 1990–2010 ages 4–8 |
| | UK commercial otter trawl | 1989–2010 ages 4–8 |



On the relative scale the spawning biomass is estimated to have been increasing between 2005 and 2016, whereas F has been steadily declining from 2001 onwards (Figure 28.8, Table 28.13). The estimated biomass was above $B_{MSY}$ from 2012, and the lower limit of this estimation exceeded $B_{MSY}$ in 2016. Estimated F was below $F_{MSY}$ from 2009, and upper limit of this estimation, from 2012. The stock increase was likely based on strong generations born in 2010 and 2013. Stock is increasing from ~2008 after a period of low abundance in ~1995–2007 as some other plaice stocks around the UK, like in the North Sea (Dutz *et al*., 2016) that might be caused by some global processes.

## D Short-term projection

The short-term project of the model for the year 2017 (Table D1) forecasts B> $B_{MSY}$ and F< $F_{MSY}$ within 95% confidence intervals.

**Table D.1. Short-term projection of the SPiCT model, plaice 7.fg.**

| Reference Point | Estimate | CI 95% $_{LOW}$ | CI 95% $_{UPP}$ | CV, % |
|---|---|---|---|---|
| $B/B_{MSYS}$ | 1.767 | 1.072 | 2.914 | 25.5 |
| $F/F_{MSYS}$ | 0.231 | 0.114 | 0.472 | 36.3 |

## E Medium-term projections

Medium-term projections are not carried out for this stock either.

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

Yield-per-recruit calculations are not conducted.

## G Biological reference points

On the basis results of the AP model no MSY reference points were recommended for this stock. The SPiCT model run at ICES WKProxy (ICES, 2016a) resulted in estimation of $B_{trigger}$ as 3800 t (50% of $B_{MSY}$) and $F_{MSY}$ = 0.27. In 2016 application of the same model resulted in estimation of $B_{trigger}$ as 4550 t (50% of $B_{MSY}$) and $F_{MSY}$ = 0.29. A comparison of the two latest B/ $B_{MSY}$ index values with the three preceding values, multiplied by the recent advised catch demonstrated that estimated biomass have increased by more than 20%, so the uncertainty cap was applied.

**Table G1. Stochastic reference points updated by the SPiCT model in 2017.**

| Framework | Reference point | Value | Technical basis |
|---|---|---|---|
| MSY approach | $B_{trigger}$ | 4550 t | 0.5 x $B_{MSY}$ (estimated by SPiCT from model parameters) |
| | $F_{MSY}$ | 0.28 | $F_{MSY}$ (estimated by SPiCT from model parameters using data from 1989–2016) |



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