Stock Annex: Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Plaice
Working Group	Working Group for the Celtic Seas Ecoregion (WGCSE)
Created:	WKFLAT 2010
Authors:	
Last updated:	November 2015, (extended in May 2016)
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A. General

A.1. Stock definition

The management area for this stock is strictly that for ICES Division 7.e, the Western English Channel, but the TAC area also includes the larger component of 7.d (the Eastern English Channel).

More than 5500 plaice were tagged and released around Start Point between 1965 and 1976. Previous analysis of the recaptures from plaice tagged while spawning in the Channel (Eastern and Western areas) during January and February showed that 20% spent summer in the Western Channel, 24% in the Eastern Channel, and approximately 56% migrated to the North Sea after spawning (Pawson, 1995). Few of the plaice tagged in the Western Channel during April and May were recaptured outside the Channel suggesting that there is a resident stock that does not migrate into the North Sea after spawning in the Channel.

The main spawning areas are south of Start Point and south of Portland Bill. Spawning takes place between December and March with a peak in January and February. Figure A shows the spawning areas for 7.e plaice.

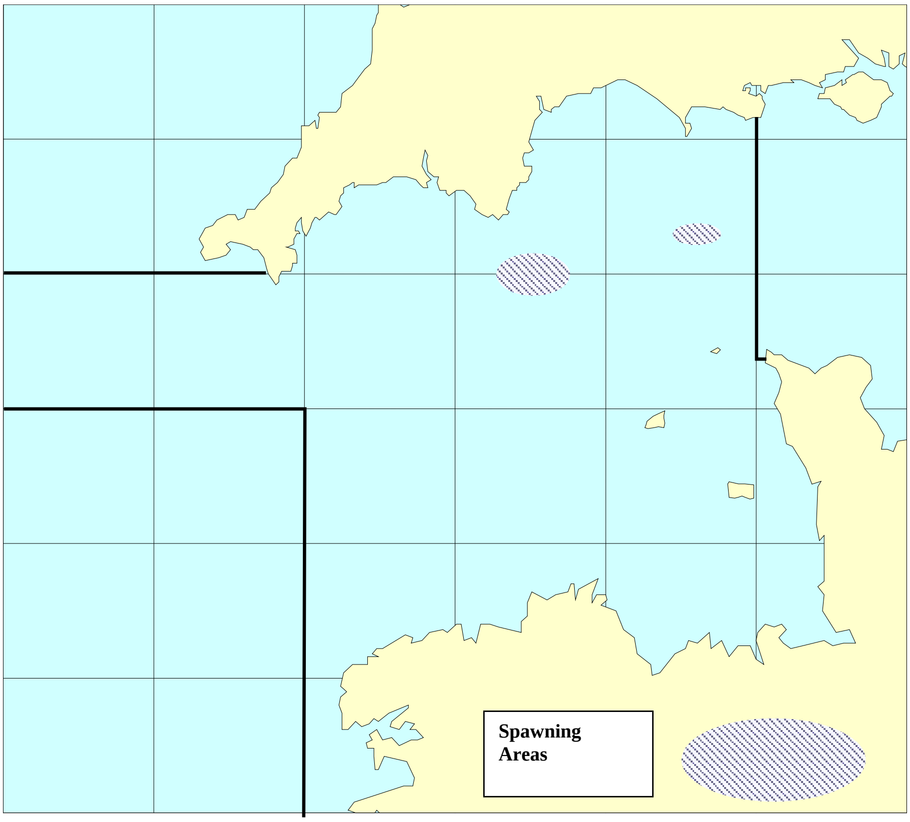

Figure A. Map of spawning areas for 7.e plaice.

The spawning habitat in 7.e is much smaller than that in 7.d and tagging studies have estimated that 87% of the recruits to the Western Channel (7.e) originate outside the area (34% from the Eastern Channel (7.d) and 53% from the North Sea, Pawson, 1995). Similarly, 38% of recruits to the Eastern Channel are estimated to originate from the North Sea. The historic tagging data on which these studies were based also show that there is substantial mixing of adult plaice between the Western and Eastern Channel and between the English Channel and the North Sea, but very limited exchange between the Channel and the Celtic and Irish Seas (Burt *et al.*, 2006).

The stocks of plaice in the Channel and North Sea are known to mix greatly during the spawning season (January–February). At this time, many Western Channel and North Sea plaice can be found in the Eastern Channel (Pawson, 1995). The comparable lack of spawning habitat in the Western Channel alone suggests that this migration from 7.e to 7.d during the first quarter may be of considerable importance. North Sea (Division 4) plaice have been shown to spawn in 7.d during January–February and subsequently return to the North Sea (Hunter *et al.*, 2004). This migration is tracked by the international fleets fishing in the area given that landings peak in January over the spawning grounds, when migrant fish are present, and track the movement towards the North Sea in February and March. A similar migration of plaice from the smaller 7.e stock into 7.d during quarter 1 is believed to take place. Once fish have moved into 7.d to spawn, they are then subject to fishing, largely by the Belgian and French trawlers that take the majority of their annual catch in January and February.

Conventional tags inform the recapture position and date of a tagged fish (with known release point) and such data have been investigated to estimate the likely movement rates of fish from Division 7.d in quarter 1 into 7.e and 4. The movement rates can then be used to determine the proportion of the catch in 7.d during quarter 1 that is due to immigrant spawning fish. The resulting estimates of the catch of fish from Division 7.e and 4 that are caught in 7.d can then be reallocated to the appropriate catch-at-age matrix.

WKFLAT (ICES, 2010) re-analysed data from historical tagging experiments on plaice, which were archived in the Cefas 'Tagfish' database (Burt *et al.*, 2006). The tags were captured through the fisheries and most are returned to Cefas within a few months of release; however these fish have had little chance to migrate. Therefore data from tagged fish with <six months at liberty were excluded from further analysis. In order to focus on movement rates of fish that are available to the fishery, only fish greater than the minimum landing size were considered for further analysis. Since tags are returned via the fishery, the probability that a tag will be caught depends on the catch of plaice in an area: the greater the catch taken the more likely the tag to be caught. However, the more fish that are present within an area the less likely a tag is to be caught. Therefore, the probability that a tag is caught in an area (Number recaptured / Number released) in a particular period must be weighted by the ratio of biomass/catch in that area and year so that probabilities can be comparable between areas and years. The resulting weighted proportions of tags returned from each area provide estimates of the movement probabilities between areas (Table below).

					WEIGHTED BY INTN CATCH AND SSB			
Release Information		**period**			**pr(recap) after 6 or more months at liberty**			
DIV	**Sex**	**Release**	**Recapture**	**N**	**7A**	**7E**	**7D**	**4**
VIIe	B	ALL		**564**	0.001	**0.90**	0.06	0.04
	M	Jan-Mar		**2**	0	**0.74**	0.26	0
	F			**3**	0	**0.60**	0.40	0
	M	Apr_Dec		**180**	0	**0.91**	0.05	0.03
	F			**224**	0.001	**0.93**	0.03	0.04
	M	Jan-Mar	Apr_Dec	**17**	0	**0.66**	0.11	0.23
	F			**8**	0	**0.67**	0.24	0.09
	M	Apr_Dec	Jan-Mar	**68**	0	**0.83**	0.12	0.05
	F			**62**	0	**0.88**	0.07	0.06
VIId	B	ALL		**990**	0.00	0.10	**0.54**	0.36
	M	Jan-Mar		**31**	0	0.04	**0.73**	0.22
	F			**86**	0	0.08	**0.58**	0.34
	M	Apr_Dec		**144**	0	0.10	**0.76**	0.14
	F			**180**	0	0.09	**0.79**	0.12
	M	Jan-Mar	Apr_Dec	**144**	0	0.14	**0.35**	0.52
	F			**305**	0	0.09	**0.33**	0.58
	M	Apr_Dec	Jan-Mar	**31**	0	0.20	**0.57**	0.23
	F			**63**	0	0.11	**0.72**	0.17
IVc	B	ALL		**812**	0	0.01	0.06	**0.93**
	M	Jan-Mar		**54**	0	0	0.03	**0.97**
	F			**17**	0	0	0.28	**0.72**
	M	Apr_Dec		**172**	0	0.01	0.06	**0.92**
	F			**235**	0	0.01	0.04	**0.95**
	M	Jan-Mar	Apr_Dec	**102**	0	0	0	**1**
	F			**38**	0	0	0	**1**
	M	Apr_Dec	Jan-Mar	**54**	0	0.02	0.05	**0.93**
	F			**71**	0	0.01	0.18	**0.80**

Summary of estimated movement probabilities for plaice (≥270 mm) recaptured after 6 or more months at liberty, for data collected between 1960 and 2006.

The best estimates of the proportion of fish in quarter 1 in 7.d that would return, if not caught by the fishery, to 7.e and 4 are circled in red in the table above. So 14% of males and 9% of females would migrate to 7.e, while 52% of males and 58% of females would migrate to 4. To the nearest 5%, this suggests that 10 to 15% of the catch in Q1 in 7.d should be allocated to 7.e, while between 50 and 60% of the catch in Q1 in 7.d should be allocated to 4. These estimates are in agreement with previous analyses (based on the same data) reported by Pawson (1995), which suggest that 20% of the plaice spawning in 7.e and 7.d spend summer in 7.e, while 56% migrate to the North Sea. Given the assumptions involved in these calculations and the relatively small numbers of adult tags returned, the estimates of movement rates are subject to great variability. The limitations of the data do not permit an estimate of annual movement probabilities. Recent studies based on data storage tags suggest that the retention rate of spawning plaice tagged in the Eastern Channel is 28%, while 62% of spawning fish tagged were recaptured in the North Sea (Kell *et al.*, 2004).

WKFLAT (ICES, 2010) adopted a 15% movement of catches from 7.d into 7.e in Q1 and similarly an additional 50% movement in Q1 from 7.d to 4.

WKPLE (ICES, 2015a) agreed that a migration correction should be applied to plaice 7.e and a reciprocal removal should be taken from plaice 7.d. Revising the plaice migration rate between 7.d and 7.e was considered appropriate given that the traditional removal was applied to total catch (landing matrix) rather than just the mature spawning component of the population. The revised migration correction included reallocating 15% of quarter 1 landings for the mature proportion of the catch from Division 7.d to 7.e and applying the associated age composition to plaice 7.e. International catch numbers and weights-at-age were reconstructed in accordance with the revised migration rates at IBPWCFlat2 to retain a consistent degree of population exchange between 7.d and 7.e (ICES, 2015c).

A.2. Fishery

A.2.1. General description

In the Western Channel, plaice are taken largely as bycatch in beam trawls targeting sole and anglerfish. The main plaice fishery is concentrated to the south and west of Start Point. Although plaice are taken throughout the year, landings are usually heaviest during February/March and October/November. The fisheries taking plaice in the Western Channel mainly involve vessels from the bordering countries: the UK, France and Belgium.

Main métiers

There are ten main métiers that exploit important fish and shellfish stocks in the Channel. Otter trawling accounts for a wide range of target species in season - cuttlefish, anglerfish, gurnard, rays, cod, whiting, plaice, sole, squid and lemon sole - and involves boats from France (600), England (470), Belgium (15) and the Channel Islands (11). Beam trawling is also important for boats from the three former nations (26, 83 and 65 respectively), targeting sole, anglerfish and plaice, with up to 25 of the Belgian boats extending this fishery into the Bay of Biscay. Many boats from France (626) and England (80) join two Channel Islands vessels dredging for scallops and taking a valuable bycatch of sole and anglerfish. The other main towed gear is midwater trawls, used either for the small pelagic species - mackerel, sprat, pilchard and herring - or for bass and black bream with a bycatch of gadoids by French (40) and English (25) boats. Purse-seines are used by eight UK vessels to take mainly mackerel and pilchard in the Western Channel.

The fixed netting métier in the Channel is really composed of several métiers using specific net gears and mesh sizes depending on target species, the most important being with gillnets and trammelnets (580 French and 380 English boats) for sole, cod, ling, pollack, hake, plaice, bass and spider crab. Rays, anglerfish, turbot, crabs, lobster and crawfish are also taken in tanglenets (305 Fr., 300 Eng. and 7 CI).

Similarly, potting (960 Fr., 275 Eng and 560 CI) uses several distinct gears to catch brown (edible) crabs, spider crabs, cuttlefish, lobsters and whelk, both inshore and offshore, and there are zones in the Western Channel partitioning potting and towed gears for alternating periods. Longlining has been replaced by fixed net in many cases, but conger eel, sharks, rays and bass are still taken (260 Fr., 60 Eng and 13 CI). Handlines are used for mackerel, bass, pollack and ling by small boats working along both the English (390) and French (120 Fr and 90 CI) coasts of the Channel. This information is accurate as at WG07.

A.2.2. Fishery management regulations

Technical measures currently in force in the Western Channel are a minimum mesh size of 80 mm for otter and beam trawlers and 70 mm for *Nephrops* trawlers. Panels of 75 mm square mesh are compulsory in all *Nephrops* fisheries in ICES Subarea 7.

There is also a minimum landing size (MLS) on 27 cm in force.

A.3. Ecosystem aspects

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 7.e plaice. Environment influences were considered by WKFLAT (ICES, 2010) by incorporating sea surface temperature into the XSA model as a tuning fleet for age 1 catch numbers i.e. as an index of recruitment (ICES Working Document 4.3). Although the large recruitment signal in the late 1980s was partly tracked by the temperature time-series little information was gained, other than a mean recruitment level, for the recent period.

There is some anecdotal evidence of changes in the range of some species such as langoustine, triggerfish, and black sea bream from warmer parts of the Atlantic.

B. Data

B.1. Commercial catch

B.1.1. Landings data

The fisheries that take plaice in the Western Channel mainly involve vessels from the bordering countries: UK vessels report about 70%, France 20% and Belgium 10% of the total plaice landings from ICES Division 7.e. Although plaice are taken throughout the year, landings have historically been heaviest during February/March and October/November. However, the bulk of landings have been taken between May and November in more recent years. Landings reached a peak of around 2985 tonnes in 1990 after a series of good recruitments in the late 1980s. Landings then declined rapidly once recruitment returned to average levels. Between 1994 and 2006, landings were stable at around 1200 tonnes; however, in 2007–2009 landings fell to near the lowest levels on record due to a series of poor recruitments in the mid-2000s. Above average recruitments in the early 2010s led to increased landings above 1400 tonnes between 2011 and 2015.

Most of the landings are made by beam trawlers, with around 70% of the UK landings being reported by these vessels and another 25% being landed by otter trawlers. The unallocated landings reported in the WG landings table in past years are generally additional French landings derived from sales note information.

B.1.1.1. Data coverage and quality

Quarterly age compositions were available only from UK (England and Wales) landings for the years 1995–2015 (and 1989), which accounted for approximately 70% of total international landings. Until 2011, the total international age composition was obtained by raising the combined gears quarterly UK (England and Wales) age compositions to include the landings of the Channel Isles, France and Belgium, and summing to give an annual total. In 2012, data were provided disaggregated by métier for each contributing nation and this was uploaded into the ICES InterCatch software and all aggregation was carried out using the tools provided within the software. Unsampled quarterly UK métiers were derived using the sampled quarterly data for the same métier weighted by tonnage (where such data existed). Where no sampled quarterly data were available for a métier, all sampled métiers for the quarter were used (weighted by tonnage). This method was applied to all remaining unsampled UK and non UK métiers. This method was adopted as it is a more consistent approach than previously used.

For the earlier years of 1990–1994, French age compositions were also available. For these years, the UK (England and Wales) age compositions were raised to UK (Total) by including landings from the Channel Islands. Finally, UK (Total) and French age compositions were combined and raised to include Belgian landings. For the years 1981–1988. Prior to this, the stock data were aggregated for Division 7.d and 7.e. For these years, Belgium also provided age compositions data and these were combined with UK (Total) and French age compositions. French age compositions were based on age data provided by the UK.

WKFLAT (ICES, 2010) recommended a 'migration' model which reassigns 15% of the first quarter Belgian, French and UK catch in 7.d to the 7.e catch-at-age matrix and similarly raises the landings by including 15% of the first quarter landings in 7.d for each country. During the meeting, quarterly data for Belgium and France were available back to 1998 and UK data to 1997. In order to extend the time-series back to 1980, the first quarter landings and catch-at-age matrix for each country were inferred from the total annual international landings and catch-at-age data (which begin in 1980 for 7.d). Total annual international catch-at-age at age data (1980–1997 for France and Belgium and 1980–1996 for UK) were down-raised using the average proportion of catch at each age in the first quarter by each country over the period in which quarterly data were available. Similarly, SOP corrected Q1 landings for each country were calculated back to 1980 using the mean (calculated over the period in which quarterly data were available) proportion of the annual landings that were landed in Q1.

Age data representing French landings were available for 2002 and 2003, but were not used in the assessment.

WKPLE (ICES, 2015a) revised the plaice migration rate between 7.d and 7.e given that the removal was traditionally applied to total catch rather than just the mature spawning component of the population. The migration correction included reallocating 15% of quarter 1 landings for the mature proportion of the catch from Division 7.d to 7.e and applying the associated age composition to plaice 7.e. International catch numbers and weights-at-age were reconstructed in accordance with the revised migration rates at IBPWCFlat2 (ICES, 2015c).

Table A shows a time-series of CV's of numbers-at-age for sampling; UK (E+W) all fleets combined.

Table B shows the national data availability for 7.e plaice stock for the period 1981–2015.

Table A. CV of numbers-at-age for commercial sampling.

		CV BY AGE								
YEAR	COUNTRY	1	2	3	4	5	6	7	8	9
2005	UK(E+W)	18%	3%	3%	3%	6%	7%	11%	10%	9%
2006	UK(E+W)	21%	4%	3%	5%	5%	8%	10%	15%	14%
2007	UK(E+W)	42%	5%	3%	4%	6%	6%	9%	13%	20%
2008	UK(E+W)	42%	4%	4%	5%	6%	8%	8%	10%	14%
2009	UK(E+W)	39%	5%	3%	6%	7%	9%	11%	11%	16%
2010	UK(E+W)	17%	4%	3%	3%	7%	9%	14%	26%	23%
2011	UK(E+W)	23%	4%	3%	4%	6%	9%	10%	14%	18%
2012	UK(E+W)	N/A	8%	3%	4%	6%	6%	8%	12%	15%

Table B. Catch derivation between 1981 and 2015. *Stock assessed as 7d & 7.e plaice.

			SOURCE			
Year of WG	Data	UK	Belgium	France	Derivation of international landings	% sampled
1981*	length composition	quarterly	quarterly	quarterly	UK ALK used with French LDs	100
	ALK	quarterly	quarterly	-	UK+Belgium+France combined to total international	
	Age composition	quarterly	quarterly	-	No analytical assessment carried out	
1982*		As for 1981	As for 1981	As for 1981	As for 1981	100
1983*		As for 1981	As for 1981	As for 1981	As for 1981	100
1984*		As for 1981	As for 1981	As for 1981	As for 1981	100
1985*		As for 1981	As for 1981	As for 1981	As for 1981	100
1986*		As for 1981	As for 1981	As for 1981	As for 1981	100
1987*		As for 1981	As for 1981	As for 1981	As for 1981	100
1988*		As for 1981	As for 1981	As for 1981	As for 1981	100
1989*	length composition	quarterly	-	-	UK raised to total international	70
	ALK	quarterly	-	-		
	Age composition	quarterly	-	-		
1990	length composition	quarterly	-	quarterly	UK+France raised to total international	96
	ALK	quarterly	-	quarterly		

		SOURCE				
Year of WG	Data	UK	Belgium	France	Derivation of international landings	% sampled
	Age composition	quarterly	-	quarterly		
1991		As for 1990	-	As for 1990	As for 1990	97
1992		As for 1990	-	As for 1990	As for 1990	97
1993		As for 1990	-	As for 1990	As for 1990	98
1994	length composition	quarterly	-	quarterly	UK ALKs applied to French LDs	96
	ALK	quarterly	-	-	UK+France raised to total international	
	Age composition	quarterly	-	-		
1995		As for 1989	-	-	As for 1989	83
1996		As for 1989	-	-	As for 1989	82
1997		As for 1989	-	-	As for 1989	78
1998		As for 1989	-	-	As for 1989	79
1999		As for 1989	-	-	As for 1989	75
2000		As for 1989	-	-	As for 1989	72
2001		As for 1989	-	-	As for 1989	72
2002		As for 1989	-	-	As for 1989	78
2003		As for 1989	-	-	As for 1989	81
2004		As for 1989	-	-	As for 1989	79
2005		As for 1989	-	-	As for 1989	74
2006		As for 1989	-	-	As for 1989	74
2007		As for 1989	-	-	As for 1989	68
2008		As for 1989	-	-	As for 1989	70
2009		As for 1989	-	-	Migration correction added equal to 15% of Q1 7.d	78
					Landings from UK, Belgium and France. In addition, 15%	
					Of Q1 Age comps added to the 7.e international AC.	

		SOURCE				
Year of WG	Data	UK	Belgium	France	Derivation of international landings	% sampled
					Also –back calculated for years 1985-2008.	
2010		As for 1989	-	-	As 2009 – with Netherlands 7.d Q1 component added	79
2011		As for 1989	-	-	As for 1989	78
2012		As for 1989	-	-	As for 1989	70
2013		As for 1989	-	-	As for 1989	73
2014		As for 1989	-	-	As for 1989	76
2015		As for 1989	-	-	As for 1989	73

Weights-at-age

Total international catch and stock weights-at-age were calculated as the weighted mean of the annual weight-at-age data supplied (weighted by landed numbers), and smoothed using a quadratic fit:

[e.g: $W_t = (0.0963*Age) + (0.0005*(Age^2)) - 0.0192$; $R^2 = 0.93$]

where catch weights-at-age are mid-year values (age=1.5, 2.5 etc.), and stock weights-at-age are 1st of January values (age=1.0, 2.0 etc.). Catch weights-at-age have been scaled to give a SOP of 100%, and the same scaling has been applied to stock weights-at-age.

This technique has been used for many years (at least since stock has been assessed by the Southern Shelf Demersal WG). In early years in the time-series, weights-at-age were averaged over a period of years, and derived from separate-sex mean weights-at-age.

WKFLAT (ICES, 2010) recommended a 'migration' model that alters the catch-at-age data. However, this model does not alter the weights-at-age since it is not possible to distinguish which weight measurements in 7.d are from 7.e migratory spawners. WKPLE (ICES, 2015a) corrected the migration rate included in the model, so that 15% of quarter 1 landings for the mature proportion of the catch from 7.d were reallocated to 7.e and the associated age composition including catch weights-at-age was applied to plaice 7.e.

B.1.2. Discards estimates

Discards are known to occur but have not been included the assessment so far. In 2016 discards were raised within InterCatch for the first time. Discard tonnage data are only available for the years 2012–2015. The UK provided discard data for 2012–2015, Belgium only in 2012 and 2013, and in 2015 France provided discard data for the first time. Discarding age structure from samples is only available from the UK. The discard information is scarce and uncertain but available information suggest a substantial increase in discards in recent years. The discard rates for 2012–2015 were 22, 17, 45 and 52% respectively (mean value of the discard reporting fleets, weighted by the impact of the particular fleet). The discard rate is now higher than in the North Sea and the Eastern English Channel but not as high as in the Bristol Channel, Celtic Sea and Irish

Sea. A trial assessment run in 2016 included the available discard information and resulted in lower SSB and higher F estimates in recent years. The landings only assessment is probably overly optimistic and the stock did not increase as much as estimated.

B.1.3. Recreational catches

B.2. Biological sampling

B.2.1. Maturity

The main spawning areas for plaice in the western Channel are south of Start Point and Portland Bill. Spawning takes place from December to March, with a peak in January and February.

Initial estimates of maturity were based on values estimated for Irish Sea plaice (Siddeek, 1981). A new maturity ogive based on UK(E&W) 7.fg 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+
Old Maturity	0	0.15	0.53	0.96	1.00
New Maturity	0	0.26	0.52	0.86	1.00

On average, about a quarter of plaice in the Western Channel are mature at age 2, half are mature at age 3 and all are mature at age 5. The majority of plaice landed in the western Channel in 2001, for example, were at ages 2–5, and therefore 73% of those landed were mature.

B.2.2. Natural mortality

Initial estimates of natural mortality (0.12 for all years and ages) were based on values estimated for Irish Sea plaice (Siddeek, 1981). 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 prior to the 1994 Southern Shelf Demersal Working Group as it was considered that these settings were more robust to seasonal changes in fishing patterns, especially with respect to the medium-term projections.

B.3. Surveys

An annual 4 m beam-trawl survey (UK-WEC-BTS) has taken place in the Lyme Bay area of the Western Channel since 1984, initially aboard chartered fishing vessels (MV BOGEY 1 and latterly MV CARHELMAR) and more recently aboard the Cefas research vessel CORYSTES, coming back to MV CARHELMAR in 2005. However, the UK-WEC-BTS survey undertaken by the MV CARHELMAR was terminated in 2013 due to a lack of UK science funding and removed from the assessment input data in 2015.

Appendix 1 provides a history of the survey included in the plaice 7.e assessment between 1984 and 2015 and details the survey methodology and objectives.

The UK-WEC-BTS survey data were used to calculate assessment tuning data for both 7.e plaice and sole. Indices of abundance-at-age for years 1986 to 2013, and for ages 1–5 have been used. This age range was extended to include data for ages 1–8 between 2007 and 2013.

Appendix 1 describes how these indices of abundance-at-age were derived.

Since 2003, a UK Fisheries Science Partnership (UK-FSP: Cefas-UK industry cooperative project) has been conducting a survey using commercial vessels with scientific observers and following a standard grid of stations extending from the Scilly Isles to Lyme Bay. The survey covers a substantially larger area than the UK-WEC-BTS survey and is thought to be more representative of the stock in UK waters. This dataset was first included in the 2007 assessment, and the exploratory analysis can be seen in that report (ICES, 2007; Section 3.2.5). However, recently the vessel(s) used for the survey have changed from the FV Nellie and the FV Lady T, to the FV Carhelmar. In 2008, in addition to the vessel changes there have been other sample protocol changes, notably the change to using 4 m 'survey' beam trawls from the commercial 12 m beam trawls previously used by the other vessels. The working group, WGCSE 2009, decided to leave out the 2008 data from the FSP survey since it had an undue influence on estimates of SSB and F.

Indices of abundance-at-age from the UK Q1 South West Beam Trawl (Q1SWBeam) survey were included in the assessment for the first time at IBPWCFlat (ICES, 2015b). Including the Q1SWBeam survey in the assessment was considered appropriate given the ability to track the progression of year-classes among ages with few clear year effects and the loss of abundance estimates from the UK-WEC-BTS survey after 2013.

Appendix 1 provides a description of the survey.

The survey-series provides indices of abundance-at-age starting in 2006 and is based on a stratified random survey approach that covers the entire region of the management area and some adjacent waters. The survey shows strong gradients in species composition within the Western Channel justifying the stratification approach.

Given sampling effort, fundamentally this survey is more variable than fixed stations survey designs of equal effort, but also inherently is less biased when there are potential changes in the distribution of the species within the area. Although estimates of survey variance of the limited dataseries are available, these are unlikely to reflect the full range of the variance that would be encountered in a longer time-series as variance estimates are unlikely to have reached their asymptote, particularly since the range of SSBs observed by the survey is very restricted.

Age information provides estimates of abundance for all ages in the assessment, despite the fact that the survey only catches between 250 and 300 plaice in a given year. Theoretically, this removes the necessity of retaining the commercial lpue-at-age information. Internal consistency estimation is very difficult given the short time-series, and relatively small contrast in cohort strength observed (based on other series). Despite this, some cohort tracking is apparent and the signal matches the cohort signal from other survey series, particularly the UK-FSP survey.

B.4. Commercial lpue

The UK(E+W) commercial lpue data are calculated for two gear groups (beam trawl, and otter trawlers both over 12 m) and for three sectors within 7.e (7.e north, 7.e south and 7.e west) made up of 'collections' of ICES rectangles. The lpue values are corrected for fishing power using a given relationship between fishing power and gross tonnage and are calculated using the total effort for a month/sector not species-directed effort. This relationship is FP=0.0072*GRT+0.6017 and this is standardised fit to pass through the mean GRT of Irish Sea trawlers in 1979 (Brander, unpublished).

Beam-trawl lpue in the North of 7.e reached a peak in 1990, fell sharply to 1994 and now fluctuates at low levels. The south and west sectors both peaked in the early 1990s but have steadily declined since. Otter trawl lpue in north of 7.e peaked in 1988 before falling sharply until 1995. Since then, it has remained at these much lower levels. Lpue in the south is generally lower, but fluctuates to high peaks throughout the time-series, whereas in the west it has remained stable at a lower level for the duration of the time-series.

UK beam-trawl effort has increased rapidly over the time-series, reaching record high levels in 2003 and has remained at this high level since. UK trawl effort has slowly decreased over the time-series, reaching a record low level in 2008. Effort is calculated as fishing power corrected using GRT.

Figures B and C show plots of UK effort for 1998–2008 by ICES rectangle for otter trawl and beam-trawl gears, respectively.

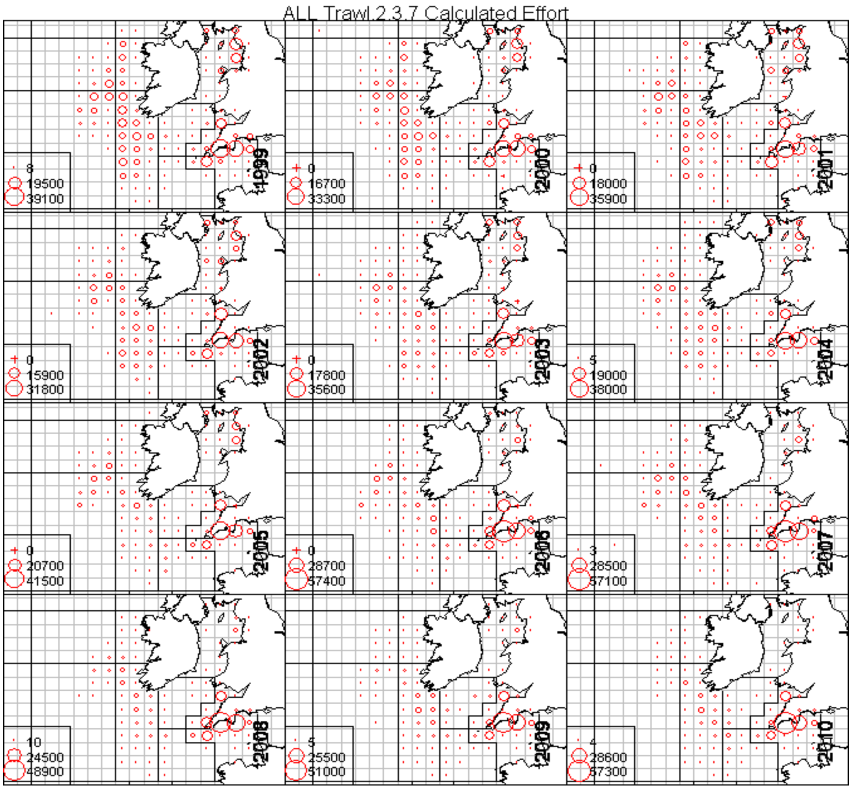

Figure B. UK (E+W) Trawl fleet effort (hours fished) based on demersal landings.

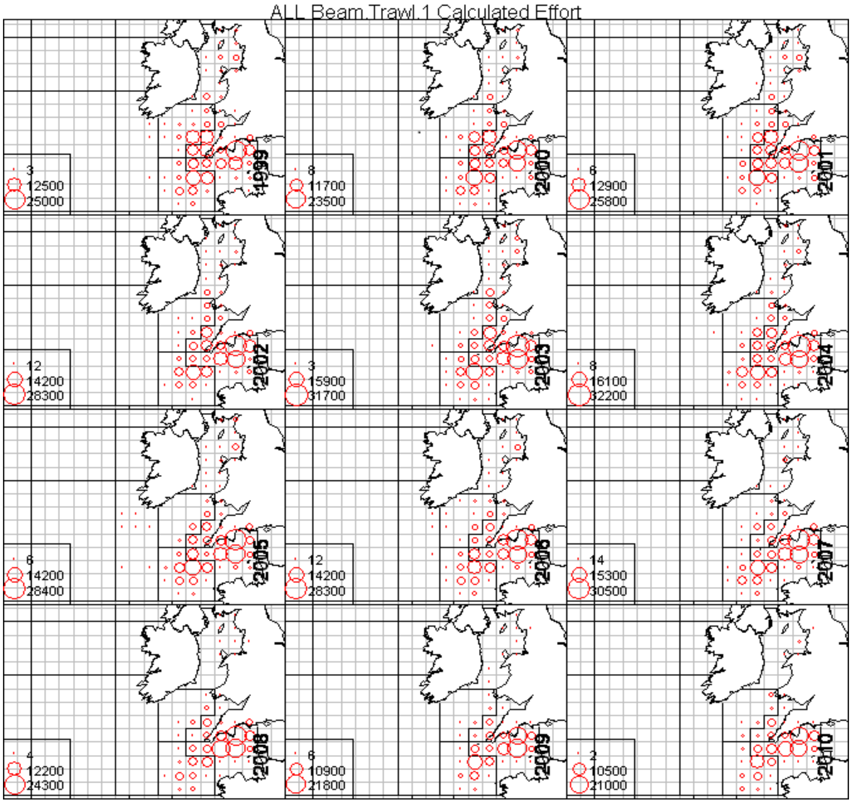

Figure C. UK (E+W) Beam trawl fleet effort (hours fished) based on demersal landings.

At IBPWCFlat2 (ICES, 2015c), the entire effort time-series for the UK beam and otter trawl fleets were converted from hours into days fished to account for modifications in the UK e-logbook effort recording system. Consequently, lpue estimates for the commercial fleets were converted from kg per hour into kg per day. The revised lpue estimates exhibited similar temporal trends to those presented previously but with more stability after 2012.

Commercial tuning data

Commercial tuning information for this stock comprises of the UK(E+W) otter trawl fleet and the UK(E+W) beam-trawl fleet. These fleets have been used by Working Groups for a number of years, and initially contained data for years back to 1976 (otter) and 1978 (beam). However, more recent assessments have used otter trawl fleet data from 1988 onwards for ages 3–9 and beam-trawl fleet data from 1989 onwards for ages 3–9. Since 2004, an historic otter trawl fleet (1976–1987) has been reintroduced using ages 2–9 only and this is calculated differently from the later data.

WKFLAT (ICES, 2010) proposed a ‘migration’ model for Western Channel plaice. If this is not acceptable and the ‘truncated’ model is taken forward, then the commercial beam-trawl and commercial otter trawl fleets should be truncated so that the first year of the time-series is 1998 and the last year is the most recent year. The ‘truncated’ model does not use the historic commercial otter trawl fleet, but has F-shrinkage increased from 2.5 to 1.0 to compensate for the increased variability of estimates of F.

Lpue estimates for the beam and otter trawl fleets were converted into kg per day for the entire time-series at IBPWCFlat2 to account for changes in the UK e-logbook effort recording system (ICES, 2015c). Furthermore, lpue estimates for the UK WECOT historic, UK WECOT and UK WECBT fleets were excluded from the assessment in 2015 due to inappropriate residual patterns. Log catchability residuals for the UK WECOT historic and UK WECOT fleets showed a relatively minor domed-shaped trend and a weak decreasing trend over time, respectively. In contrast, residuals for the UK WECBT fleet were highly variable and have increased over the last decade with a distinct period of mainly positive residuals for ages 3 to 8 since 2009. Long-term creep in the residuals for the UK WECBT fleet may have resulted from technological changes over time and potential changes in selectivity due to the fleet operating further offshore than in the past.

Since 2015 the assessment does not include any commercial tuning data.

B.5. Other relevant data

Discarding

Discard length summary data from the UK (E+W) and French discard sampling programmes have been made available to ICES working groups for the period 2002–2010. In addition, Belgian quarterly discard length compositions were also available in 2010. All data indicate that discarding is at its highest in quarters 1 and 2 in this fishery, but is still low compared to other plaice stocks. No attempt has previously been made to raise these estimates to total landings.

For the 2010 benchmark meeting (WKFLAT), an analysis was carried out to determine the true level of discarding including trends in sampling effort, discarding patterns and an attempt to raise the sampling to an estimate of total discards. This work was presented to the meeting as ICES, WKFLAT 2010, Working Document 4.4 'Western Channel (7.e) plaice discard data availability, trends and raising estimates to total landings, and comparisons with the trends of adjacent plaice stocks. The summary points made were as follows:

- Previous assumptions made by the Working Group that discarding is small compared to other plaice stocks, and that most discarding takes place in Quarter 1 and 2 appear robust. 7.e discard rates range from 9% in 2003 to 24% in 2008 with an average of 16%. Discarding is at its heaviest in quarters 1 and 2 with 26% and 19% discarded in these quarters and around 5% discarded in the remainder of the year.
- The discard rate appears to be increasing over time but are still at relatively low levels. Discard rates for 7.e plaice stock (16%) are much less than those for adjacent plaice stocks in 7.d (57%) and 7.fg (73%).
- Sampling effort on discards is very good for the 7.e plaice stock and discard sampling effort is increasing. Most of the sampling effort has been carried out on beam and otter trawlers.
- Most discard sampling was carried out on vessels of length 10<20 m and with engine power between 100<300 Kw.
- Around 10% by weight, are discarded and this measure is increasing. The proportion discarded by weight has increased steadily from 5% in 2002 to around 13% in 2008. This compares favourably with the adjacent stocks that have rates of around 40% in 7.d and around 60% in 7.fg (in 2008).
- There is no evidence of seasonal differences in the proportions discarded at length. The proportions of fish discarded at length for this stock shows good levels of consistency over the period and in addition the L50 values for each year are very close. This is not the case for the 7.d and 7.fg stocks but for these stocks, the inconsistencies may be a feature of lower sample numbers.

- Around 60–70% of fish discarded are regarded as immature.
- Raising the discard sample data is possible by using either landings or effort but neither method is perfect. The main problem encountered was the limited availability of age data at the smaller/larger lengths.
- Most discards are at age 2 and age 3, where an estimated 28% and 5% respectively would be added to the landings age composition. For 2008, the resulting age compositions from both raising methods were almost identical although this may not be the case for other years.
- The total weight of the discarded catch in 2008 was estimated to be approximately 55 t amounting to around 6% of the commercial landings.

On reflection, the workshop considered the possible effects of the lack of discards included in this assessment and recommended that further investigations are conducted to include discard information in future assessments, but not to include the preliminary information available as it may reduce the management of the exploited portion of the stock. The data suggest discarding is minor in the years it has been raised to the fleet level. It was therefore concluded that the effect of including these data in the assessment would at best change the level of F and SSB over the whole time-series and at worst obscure the trends now seen because of the short and variable time-series of discard data available.

Potential discard raising methods

Two methods were used historically to raise the discard sample data to total discards.

1. Using landings. Sample data for the 2 main gear groups of beam trawl (gear 1) and otter trawl (gears 2, 3, 7) and the remaining gears (other) were extracted by quarter. For each gear group and quarter, the weight of the total catch from the sampled trips was calculated by quarter using the formula (W=aL^b * N) where ‘a’ and ‘b were quarterly condition factors for the stock in use within Cefas stock processing. The discarded Length Distributions (LD’s) were then raised to total catches using the ratio of total reported catch/weight of discard trip catches.

An Age–Length Key (ALK) was applied to each raised quarterly LD to produce quarterly Age Compositions (AC) for each gear group/quarter. The ALK data used were taken from the age samples from the discard programme. Due to the small quantity of discard age data available, the ALK used was at the annual level. However even the ALK at this level only had small numbers of fish and did not cover the full length range of the discard LDs. In these instances, the discard ALK was supplemented by supplements by annual ALK data from the relevant commercial landings samples. At the smallest lengths without age data, an assumption about the age structure was made, but these were generally considered to be age 1.

These discarded ACs were then combined across gears and then across quarters to give an annual estimate of discarded catches.

2. Using effort data. Given the recognised difficulties is assessing the ‘true’ effort levels of gears such as gillnetters and longlines, discard sample data only for the two main gear groups of beam trawl (gear 1) and otter trawl (gears 2,3,7) were extracted by quarter. The discarded LDs were raised to total catches using the ratio total reported effort (hours fished) catch/hours fished on sampled trips.

The same ALK as constructed above was applied to the quarterly raised LDs to give quarterly age compositions by gear/quarter. At the quarterly level, the two age compositions were combined and then raised to include the catches form the ‘other’ gears.

These ACs were then combined across gears and then across quarters to give an annual estimate of discarded catches.

Historical stock development

This stock was assessed by the ICES Southern Shelf Demersal WG from 1992 to 2008. For years 2009–present, this stock was assessed at the ICES Working Group for the Celtic Seas Ecoregion (WGCSE). The stock has been managed by a TAC since 1984. The TAC is applicable to 7.d (Eastern Channel) and 7.e combined, although in 1997 there was a separate limit for landings from 7.e. This was unpopular with the industry due to the national split being based on 7.d & 7.e combined reported landings for the reference period, and has not been repeated since.

Benchmark 2010

This stock was 'benchmarked' at the WKFLAT 2010 meeting where the main issue under review was to overcome the problematic retrospective pattern that meant that forecasts had not been possible for some years. Solutions explored included making an 'allowance' for migration patterns between the two channel plaice stocks, termed the 'migration model'; this clearly had a knock-on effect on the Eastern channel stock and the North Sea where there was also migration issues. Another option considered (the 'truncate model') involves truncating the commercial otter and commercial beam fleets back to 1998 but this was thought to only temporarily hide the underlying problem. Additionally, the 'truncate' model excludes the commercial historic otter trawl time-series and increases F-shrinkage from 2.5 to 1.0. WKFLAT (ICES, 2010) recommends that the F_{bar} range is altered to 3–6 since very few age 7 fish are caught by the fishery (<4% of the catch numbers). The age range of the FSP survey was reduced to 2–8 since very few age 9 are caught by the survey and that age created positive residuals in catchability for every year.

Outcome: The workshop considered making an allowance for migration between the two channel plaice stocks. Having further examined tagging evidence available it was agreed that an 'allowance' of 15% of quarter 1 catches (both landings and the catch numbers-at-age) from 7.d needed to be added into quarter 1 of the 7.e. This was required from all contributing nations.

The combination of the two channel plaice stocks was examined. It was agreed that this would require further investigation as the inclusion of the north-sea stock would also need to be considered. Any combining of stocks would a have a wide ranging impact on the assessment and any subsequent management.

The issue of including discard estimates was also considered, but based on the short time-series of data available and the 'limited' impact on the assessment outcome, this inclusion was deferred until a longer time-series of data were available.

Inter-benchmark 2015

Reductions in UK science funding resulted in the termination of the UK Western Channel beam-trawl (UK-WEC-BTS) survey in 2013. Concern had been expressed about the impact of terminating the UK-WEC-BTS survey on the perception of stock status and the ICES management forecast for 7.e plaice (ICES, 2013). Consequently, the Inter-Benchmark Protocol of West of Channel Flatfish (IBPCWCFlat) meeting convened in 2015 to: (1) examine the impacts of truncating and excluding the UK-WEC-BTS time-series on recruitment, spawning–stock biomass and fishing mortality estimates; and (2) revise the XSA settings to increase the robustness of the assessment to changes in tuning information resulting from the termination of the UK-WEC-BTS survey (ICES, 2015b).

IBPWCFlat recommended revising the parameterisation and tuning index configuration of the XSA assessment. Given the termination of the UK-WEC-BTS survey and the potential bias that it has introduced into the assessment, IBPWCFlat advised that the time-series should be excluded from the assessment data and replaced by the Q1SWBeam survey. The revised XSA assessment had frequently smaller fleet log-catchability residuals with lower standard errors, a more balanced weighting of survivor estimates and less pronounced retrospective patterns in stock status estimates compared to the assessment conducted at ICES, WGCSE 2013. Accordingly, the revised XSA assessment settings increased the robustness of the assessment to changes in tuning information resulting from the termination of the UK-WEC-BTS survey and improved the fit of the XSA model to 7.e plaice data.

At ICES, WGCSE 2015, the assessment was rejected due to retrospective bias in stock status and fishing mortality estimates. Concern was expressed over the magnitude and direction of the retrospective patterns arising from the most recent assessment input data. Another Inter-Benchmark Protocol of West of Channel Flatfish (IBPWCFlat2) meeting was subsequently opened later in 2015 to review the assessment input data and evaluate the parameterisation of XSA model (ICES, 2015c).

Revisions to plaice migration rates between 7.d and 7.e agreed at WKPLE (ICES, 2015a) resulted in problems with the derivation of international catch numbers and weights-at-age at WGCSE 2015. WKFLAT (ICES, 2010) agreed that a migration correction should be applied to plaice 7.e and a reciprocal removal should be taken from plaice 7.d. The migration correction reallocated 15% of quarter 1 landings from Division 7.d to 7.e and the associated age composition was applied to plaice 7.e. This procedure continued until 2015, when WKPLE (ICES, 2015a) revised the established migration correction. The revised migration correction included reallocating 15% of quarter 1 landings for the mature proportion of the catch from Division 7.d to 7.e and applying the associated age composition to plaice 7.e.

IBPWCFlat2 updated the XSA assessment settings to incorporate revised input data due to alterations in migration rates agreed at WKPLE (ICES, 2015a) and fluctuations in lpue estimates after 2012 resulting from modifications in the UK e-logbook effort recording system. The updated assessment settings outlined in the Table C optimised the fit of the XSA model to the revised input data by generating the smallest log catchability residuals with lowest standard errors, the most evenly weighted survivor estimates and the greatest stability in the retrospective patterns in stock status and fishing mortality estimates.

Table C. History of 7.e plaice assessments – assessment parameters used 1991–2015.

assessment years	assessement age range	Fbar age ramge	assessment method	UK trawl		UK trawl (historic)		UK beam		UK beam–trawl survey		UK FSP surveys		QUSWBeam surveys		Time taper	Power model ages	P shrinkage	Q plateau age	F shrinkage S.E.	Num Years	Num agens	Fleet S.E.
				years	ages	years	ages	years	ages	years	ages	years	ages	years	ages								
1991*	1–10+	3–8	LS/Trad VPA	76–90	1–9			78–90	1–9														
1992*	1–10+	3–7	XSA	76–91	1–9			78–91	1–9	86–91	1–5					20yr tri	1	TRUE	8	0.3	5	5	0.3
1993*	1–10+	3–7	XSA	76–92	1–9			78–92	1–9	86–92	1–5					20yr tri	1	TRUE	7	0.3	5	5	0.3
1994	1–10+	3–7	XSA	84–93	2–9			84–93	2–9	86–93	1–5					20yr tri	1	TRUE	7	0.3	5	5	0.3
1995	1–10+	3–7	XSA	84–94	2–9			84–94	2–9	86–94	1–5					20yr tri	1–3	TRUE	7	0.8	5	4	0.3
1996	1–10+	3–7	XSA	86–95	2–9			86–95	3–9	86–95	1–5					None	1–3	TRUE	7	1.5	5	4	0.3
1997	1–10+	3–7	XSA	87–96	2–9			87–96	3–9	87–96	1–5					None	1–3	TRUE	7	1.5	5	4	0.3
1998	1–10+	3–7	XSA	88–97	2–9			89–97	3–9	88–97	1–5					None	0	FALSE	7	1.5	5	4	0.3
1999	1–10+	3–7	XSA	88–98	2–9			89–98	3–9	86–98	1–5					None	1	TRUE	7	2.5	5	4	0.3
2000	1–10+	3–7	XSA	88–99	3–9			89–99	3–9	86–99	1–5					None	1–5	TRUE	7	2.5	5	4	0.3
2001	1–10+	3–7	XSA	88–00	3–9			89–00	3–9	86–00	1–5					None	1–5	TRUE	7	2.5	5	4	0.3

assessment years	assessement age range	Fbar age ramge	assessment method	UK trawl		UK trawl (historic)		UK beam		UK beam–trawl survey		UK FSP surveys		QUSWBeam surveys		Time taper	Power model ages	P shrinkage	Q plateau age	F shrinkage S.E.	Num Years	Num agens	Fleet S.E.
				years	ages	years	ages	years	ages	years	ages	years	ages	years	ages								
2002	1–10+	3–7	XSA	88–01	3–9			89–01	3–9	86–01	1–5					None	1-5	TRUE	7	2.5	5	4	0.3
2003	1–10+	3–7	XSA	88–02	3–9			89–02	3–9	86–02	1–5					None	1-5	TRUE	7	2.5	5	4	0.3
2004	1–10+	3–7	XSA	88–03	3–9	76–87	2–9	89–03	3–9	86–03	1–5					None	0	FALSE	7	2.5	5	4	0.3
2005	1–10+	3–7	XSA	88–04	3–9	76–87	2–9	89–04	3–9	86–04	1–5					None	0	FALSE	7	2.5	5	4	0.3
2006	1–10+	3–7	XSA	88–05	3–9	76–87	2–9	89–05	3–9	86–05	1–5					None	0	FALSE	7	2.5	5	4	0.3
2007	1–10+	3–7	XSA	88–06	3–9	76–87	2–9	89–06	3–9	86–06	1–8	03-06	2-8			None	0	FALSE	7	2.5	5	4	0.3
2008	1–10+	3–7	XSA	88–07	3–9	76–87	2–9	89–07	3–9	86–07	1–8	03–07	2–8			None	0	FALSE	7	2.5	5	4	0.3
2009	1–10+	3–7	XSA	88–08	3–9	76–87	2–9	89–08	3–9	86–08	1–8	03–07	2–8			None	0	FALSE	7	2.5	5	4	0.3
2010	1–10+	3–6	XSA	88–09	3–9	80–87	2–9	89–09	3–9	86–09	1–8	03–09	2–8			None	0	FALSE	7	2.5	5	4	0.5
2010	1–10+	3–6	XSA	88–09	3–9	80–87	2–9	89–09	3–9	86–09	1–8	03–09	2–8			None	0	FALSE	7	2.5	5	4	0.5
2011	1–10+	3–6	XSA	88–10	3–9	80–87	2–9	89–10	3–9	86–10	1–8	03–10	2–8			None	0	FALSE	7	2.5	5	4	0.5
2012	1–10+	3–6	XSA	88–11	3–9	80–87	2–9	89–11	3–9	86–11	1–8	03–11	2–8			None	0	FALSE	7	2.5	5	4	0.5
2013	1–10+	3–6	XSA	88–12	3–9	80–87	2–9	89–12	3–9	86–12	1–8	03–12	2–8			None	0	FALSE	7	2.5	5	4	0.5

assessment years	assessement age range	Fbar age ramge	assessment method	UK trawl		UK trawl (historic)		UK beam		UK beam–trawl survey		UK FSP surveys		QUSWBeam surveys		Time taper	Power model ages	P shrinkage	Q plateau age	F shrinkage S.E.	Num Years	Num agens	Fleet S.E.
				years	ages	years	ages	years	ages	years	ages	years	ages	years	ages								
2014	1–10+	3–6	XSA	88–13	3–9	80–87	2–9	89–13	3–9	86–13	1–8	03–13	2–8			None	0	FALSE	7	2.5	5	4	0.5
2015	2–10+	3–6	XSA	–	–	–	–	–	–	–	–	03–14	2–8	06–14	2-9	None	0	FALSE	6	1.0	3	3	0.3
2016	2–10+	3–6	XSA	–	–	–	–	–	–	–	–	03–15	2–8	06–15	2-9	None	0	FALSE	6	1.0	3	3	0.3

(* Early version of XSA/VPA and tuning fleet age/year ranges used not specified. Assumed all years used but age range used uncertain).

(# Revised XSA assessment settings agreed at the Inter-Benchmark Protocol of West of Channel Flatfish (IBPCWCFlat2) meeting in 2015. Note that the age-based analytical assessment was rejected at IBPWCFlat2 and considered indicative of trends only).

C. Assessment methods and settings

C.1. Choice of stock assess model

Model used: XSA

Software used: Lowestoft VPA suite

C.2. Assessment model configuration

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980–2015	-	Yes
Canum	Catch-at-age in numbers	1980–2015	2–10	Yes
Weca	Weight-at-age in the commercial catch	1980–2015	2–10	Yes
West	Weight-at-age of the spawning–stock at spawning time.	1980–2015	2–10	Yes
Mprop	Proportion of natural mortality before spawning	1980–2015	2–10	No
Fprop	Proportion of fishing mortality before spawning	1980–2015	2–10	No
Matprop	Proportion mature at age	1980–2015	Age2– 26%; Age3–52%; Age4– 86%; Age 5+ 100%	No
Natmor	Natural mortality	1980–2015	2–10 (0.12)	No

Tuning data: 'migration model.'

Type	Name	Year range	Age range
Old survey fleet (Excluded in 2015)	UK Western Channel Beam Trawl Survey (UK-WEC-BTS)	1986–2013	1–8
Commercial fleet 1	UK Western Channel Otter Trawl (UK-WECOT)	1988–2014	3–9
Commercial fleet 2	UK Western Channel Beam Trawl (UK-WECBT)	1989–2014	3–9
Commercial fleet 3	UK Western Channel Otter Trawl - Historic (UK-WECOT historic)	1980–1987	2–9
Survey fleet 1	UK FSP Survey (UK(E+W) FSP)	2003–2014	2–8
Survey fleet 2	UK Quarter 1 South West Beam Trawl Survey (Q1SWBeam)	2006–2014	2–9

Tuning data: 'truncated model.'

Type	Name	Year range	Age range
Old survey fleet (Excluded in 2015)	UK Western Channel Beam Trawl Survey (UK-WEC-BTS)	1986–2013	1–8
Commercial fleet 1	UK Western Channel Otter Trawl (UK-WECOT)	1998–2014	3–9
Commercial fleet 2	UK Western Channel Beam Trawl (UK-WECBT)	1998–2014	3–9
Commercial fleet 3	UK Western Channel Otter Trawl - Historic (UK-WECOT historic)	excluded	
Survey fleet 1	UK FSP Survey (UK(E+W) FSP)	2003–2014	2–8
Survey fleet 2	UK Quarter 1 South West Beam Trawl Survey (Q1SWBeam)	2006–2014	2–9

History of Assessment Methods and Settings investigations

The standard settings for a catch data screening run using a separable VPA are reference age of 4; F set to 0.7 and S set to 0.8.

In 1991, the stock was assessed using a Laurec–Shepherd tuned VPA. Concerns about deteriorating data quality prompted the use in 1992 of XSA.

Trial runs have, over the years, explored most of the options with regards XSA settings:

- The effect of the power model on the younger ages was explored in 1994, 1995, 1996, 1998, 2004, 2010 and 2015.
- The use of P shrinkage was investigated in 2001, 2004 and 2015.
- Different levels of F shrinkage were explored in 1994, 1995, 2000, 2002, 2004, 2010 and 2015.
- The level of the plus group was examined in 1995, 2004, 2010 and 2015.
- The effect of different time tapers was investigated in 1996 and 2015.
- The S.E. threshold on fleets was examined in 1996, 2001, 2007 and 2015
- The level of the catchability plateau was investigated in 1994, 1995, 2002, 2004, 2010 and 2015.
- An Inter-Benchmark Protocol of West of Channel Flatfish (IBPCWCFlat) meeting convened in 2015 to evaluate the parameterisation and tuning index configuration of the XSA assessment due to the termination of the UK-WEC-BTS survey.
- A second Inter-Benchmark Protocol of West of Channel Flatfish (IBPCWCFlat2) meeting convened later in 2015 to update the XSA assessment settings to incorporate revised input data due to alterations in plaice migration rates agreed at WKPLE (ICES, 2015a) and fluctuations in lpue estimates after 2012 resulting from modifications in the UK e-logbook effort recording system.

Table C shows the history of 7.e plaice assessments and details the parameters used.

D. Short-term prediction

Model used: XSA

Software used: MFDP

No short-term forecast has been provided since 2006 as the review group deemed it unhelpful in the management of the stock given the strong retrospective bias in F.

However, WKFLAT (ICES, 2010) was able to carry out a forecast following the removal of the strong retrospective bias in F.

The diagnostics suggest that estimation of the recruiting year class at age 1 is poorly estimated in the assessment, both because catchability is very low in the commercial fisheries and because the surveys are very noisy at this age. Consequently, estimation of survivors from the recruiting age are poorly estimated and should not be used in the forecast. It was deemed more appropriate to estimate survivors at age 2 on the basis of the geometric mean abundance of historic recruitment. The period chosen should be consistent with that chosen for estimating future recruitment. Currently this could be formulated as.

The short-term forecast uses:

1) the survivors at age 3 and greater from the XSA assessment.
2) N-at-age 2 = mean(ln(recruitment (1980–current year-1)).
3) Stock and catch weights = average stock and catch weights over the preceding three years, unless there is an indication that there are strong trends in these, in which case they will be need to be dealt with appropriately by WGCSE.
4) The F vector used will be the average F-at-age in the last three years, unless there is strong indication of a significant trend in F. In the latter case, the average selectivity pattern will be rescaled to the final F in the series.

This procedure is in line with the convention used at WGCSE and the historic treatment of the short-term forecast for this stock.

A short-term forecast of the status of the 7.e plaice stock was not conducted at WGCSE 2015 given the lack of a full analytical assessment. Instead, IBPWCFlat2 concluded that the ICES DLS framework for category 3 stocks should be applied to provide catch advice for the first time, where temporal trends in SSB from the assessment were used as an index of stock development. This is because of the presence of large retrospective patterns (SSB tends to be underestimated and fishing mortality tends to be overestimated) and discards were not accounted for in the assessment (ICES, 2015c).

E. Medium-term prediction

F. Long-term prediction

Standard ICES software is used for the long-term projections; MFYPR.

As with most plaice stocks, there is no clear stock–recruitment relationship evident.

Not carried for this stock between 2006 and 2009. YPR projections run for 2010–2014.

G. Biological reference points

WGCSE 2010, F_{MSY} evaluation

To derive an F_{MSY} estimate, the SRMSYMC package was employed and F_{MSY} was calculated based on the three common stock–recruit relationships; Ricker, Beverton–Holt and smooth Hockey-stick. Models were fitted using 1000 MCMC resamples. For all three stock–recruit relationships (SRR), all resamples allowed F_{MSY} and F_{crash} values to be determined. All three models show that there is little evidence of a stock–recruitment relationship with only limited information as to the trends at extreme levels of SSB.

The smooth hockey-stick model showed a 'break-off' point in the SRR that was inconsistent with the data and as such was rejected. The yield-per-recruit estimates were highly uncertain with high CVs. Therefore these estimates were also rejected. The two SRR models have very different levels of estimated F_{MSY}. Full diagnostics for all model fits can be found in the WGCSE 2010 report.

Stock–recruit relationship Model	FMSY	FCrash
Ricker	0.312	0.750
Beverton–Holt	0.143	0.781

Therefore, the suggested level of F_{MSY} for this stock is Fs within the range of 0.14 and 0.31.

F_{MSY} (and PA) reference points in use after WGCSE 2010 until 2014:

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	2500 t	B_{pa}
Approach	F_{MSY}	0.19	Provisional proxy by analogy with plaice in the Celtic Sea. Fishing mortalities in the range 0.14–0.31are consistent with F_{MSY}
	B_{lim}	1300 t	B_{lim}=B_{loss} The lowest observed spawning–stock biomass.
Precautionary	B_{pa}	2500 t	MBAL, biomass above this affords a high probability of maintaining SSB above B_{lim}, taking into account the uncertainty in assessments.
Approach	F_{lim}	Not defined.	
	F_{pa}	0.45	This F affords low probability that (SSBMT< B_{pa}).

However, the Working Groups since 2004 had considered the precautionary reference points for this stock as unreliable for the following reasons:

- The stock–recruitment relation shows no evidence of reduced recruitment at low stock levels;
- The basis for B_{pa} is weak, and heavily dependent on two consecutive points (1985 and 1986);
- F_{pa} is based on B_{pa}, and then this reference point is also rejected.

In 2010, WKFLAT (ICES 2010) examined the stock dynamics provided by the new preferred XSA model based on migration at length to determine appropriate biological reference points for this stock on the basis of the new assessment. It concluded that the historic reference points for this stock were no longer appropriate as the new assessment indicated significant changes to the historical perspective of the stock caused by the inclusion of catches from 7.d in the 7.e plaice stock.

In the event that alternate assessment models will be used, these reference point discussions will need to be repeated on the basis of the alternative model, as our understanding of stock dynamics are likely to be different for such a model.

Examination of the biomass reference points indicated with some certainty that recruitment to the stock was not negatively affected by SSB levels greater than 2200 t (B_{loss} (1996) following which a significant recovery in SSB of the stock had been observed, MBAL.), but there was little or no evidence of stock collapse at lower SSB levels Consequently, the group had difficulty in deciding whether this should be considered a limit reference point or a precautionary reference point. Dependent on this choice B_{pa} would either be 2200 t (with a commensurate B_{lim} set at 1600 t), or 3100 t (B_{lim} = 2200 t) on the basis that there should be a 40% buffer between the two reference points (procedure consistent with the development of reference points in WGCSE).

F reference points consistent with these biomass reference points based on a short-term recruitment series were calculated on the basis of the yield-per-recruit calculations and shown in the table below as option 1 and 2. Bold numbers indicate the basis of the reference points for each option.

	Option 1	Option 2	Option 3
B_{lim}	1600	2200	2100
B_{pa}	2200	3100	3000
F_{lim}	0.55	0.7	0.60
F_{pa}	0.40	0.55	0.42

Option 1 indicates that B_{lim} is lower than the observed spawning–stock biomass for this stock, whereas option 2 suggests that F_{lim} is higher than levels of F observed in the stock, therefore both sets of reference points would move to areas of stock dynamics not previously observed which the group considered risky. The new assessment indicates that the trend in F has been relatively flat since the late 1980s at levels around 0.6. Over this period SSB has increased and declined in response to recruitment, but without causing a collapse in the stock. It might therefore be considered as a limit reference point (F_{lim}), option (3).

The problem with this stock is that we have an insufficient understanding of the stock dynamics outside the relatively small range of Fs and little or no response in recruitment to the range of SSBs observed. Consequently, each of the choices made in considering the calculation of the other reference points is also precautionary so that the final set of reference points invariably is ultra-precautionary. The group could not come to a consensus with regards to suitable precautionary reference points but clearly stated that F_{sq} is currently too high and should be reduced, while biomass dynamics below the reasonably well estimated SSB levels of 2200 t are poorly understood.

The group felt more confident in using the 2200 t as a $B_{trigger}$ in the new advisory framework based on MSY based management targets, provided that the management intervention at this level of SSB was sufficient to move the stock away from this level of SSB with considerable certainty. It is deemed unlikely that low levels of SSB near $B_{trigger}$ would be reached if long-term management aimed to attain F levels near an appropriate proxy of F_{MSY}.

No appropriate proxy was developed for F_{MSY} given the current uncertainty over the basis for such advice, however WKFLAT (ICES, 2010) commented that because plaice are taken largely in conjunction with sole in area 7.e it is important that the target levels between the stocks are consistent especially because a management plan has been agreed for sole 7.e.

Previous biological reference points proposed for this stock by the 1998 working group have been in use until 2009 (as below).

F_{lim}	Not defined	F_{pa}	0.45	(low probability that $SSB_{MT}<B_{pa}$)
B_{lim}	1300 t (equal to B_{loss})	B_{pa}	2500 t	(equal to MBAL)

The recent Working Groups view of these reference points had been that they were considered unreliable.

WKMSYREF4

During WKMSYREF (ICES, 2016) in 2015 MSY the reference points were calculated but not used since plaice in 7.e was categorised as category 3 stock in 2015.

Instead during WKProxy (ICES, 2016b) the following proxies were estimated:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$ proxy	1910 t	F_{MSY} (estimated by SPiCT from model parameters using data from 1980–2014)	WKPROXY 2015 (ICES, 2016b)
	F_{MSY} proxy	0.56	0.5 x B_{MSY} (estimated by SPiCT from model parameters using data from 1980–2014)	WKPROXY 2015 (ICES, 2016b)

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Appendix A Beam-trawl surveys in the Western Channel (7.e)

1. History of the survey

Complaints from the fishing industry in the southwest about the lack of scientific investigation and knowledge of the local sole stock provided the catalyst for the survey in 7.e. Following enquiries of the local fishery officers and normal tendering procedures, a skipper-owned 300-hp beam trawler, the Bogey 1, was selected. The first year (1984) the survey consisted of a collection of tows on the main sole grounds. In 1989, the Bogey 1 was replaced with the Carhelmar and the survey continued unchanged until 2002 when R.V. Corystes took over the survey as an extension to its 'near-west groundfish survey'.

Due to the changes occurring through the time-series, the surveys completed on R.V. Corystes (2002 onwards) will be described separately to the 'previous' surveys (pre-2002).

The Western Channel Beam-Trawl Survey (UK-WEC-BTS) was terminated in 2013 due to a lack of UK science funding and was removed from the assessment input data in 2015 (ICES, 2015b).

2. Development of survey objectives over time

2.a. Survey objectives (1984 to 2001, and 2005 onwards)

To provide independent (of commercial) indices of abundance of all age groups of sole and plaice on the west channel grounds, and an index of recruitment of young (1–3 year old) sole prior to full recruitment to the fishery.

2.b. Survey objectives (2002 to 2004)

The primary objectives of the Irish Sea beam-trawl survey are to (a) carry out a 4 m beam-trawl survey of groundfish to: i) obtain fisheries-independent data on the distribution and abundance of commercial flatfish species, and ii) derive age compositions of sole and plaice for use in the assessment of stock size; and (b) to collect biological data, including maturity and weight-at-age, for sole, plaice, lemon sole and other commercially important species. The epibenthic bycatch from these catches has been quantified, and these surveys are also used to collect biological samples in support of other Cefas projects and training courses.

3. Development of survey methods over time

3.a. Survey methods (1984 to 2001, and 2005 onwards)

For the years 1984–1988, the vessel was unchanged and was equipped with two 6 m chain-mat beam trawls with 75 mm codends. For the survey hauls, one of the codends was fitted with a 60 mm liner. In 1989, the Bogey 1 was replaced by the latest design 24 m 300 hp(220 kw) beam trawler Carhelmar. In 1988, two commercial chain-mat 4 m beam trawls (measured inside the shoe plates) were purchased by MAFF as dedicated survey gear. Both beams were fitted with the standard flip-up ropes and 75 mm codend. For years 1989 and 1990, only one codend was fished with a 40 mm liner but from 1991 with the introduction of 80 mm codends both were fitted with 40 mm liners. The vessel and gear has remained unchanged since 1991.

Between 1989 and 2001, the survey remained relatively unchanged apart from small adjustments to the position of individual hauls to provide an improved spacing. In

1995, two inshore tows in shallow water (8–15 m) were introduced. The survey now consists of 58 tows of 30 minutes duration, with a towing speed of 4 knots in an area within 35 miles radius of Start Point. The survey design is stratified by 'distance from the coast' bands, in contrast to the 7.a,f+g survey that is stratified by depth bands. The reason for this is that the coastal shelf with a depth of water less than 40 m is relatively narrow and in addition is often fished with fixed gear. The survey bands (in miles) are 0–3, 3–6, 6–12, 12+ inshore, and 12+offshore.

3.b. Survey methods (2002 to 2004)

The standard gear used is a single 4 m beam trawl with chain mat, flip up rope, and a 40 mm codend liner to retain small fish. The gear is towed at 4 knots (over the ground) for 30 minutes, averaging 2 nautical miles per tow. Fishing is only carried out in daylight, shooting after sunrise and hauling no later than sunset, as the distribution of some species is known to vary diurnally.

Once on board, the catch is sorted to species level, with the exception of small gobies and sandeels, which are identified to genus. Plaice, sole, dab, and elasmobranchs are sorted by sex, all fish categories weighed, and total lengths are measured to the full centimetre below, or half centimetre if the species is pelagic. Area stratified samples of selected species are sampled for weight, length, sex, maturity, and otoliths or scales removed for ageing.

The standard grid of 58 stations was fished in 2002 and 2003 (see map), and although other stations have been fished in this period, they were for exploratory purposes and were not included in the assessment.

4. Abundance index calculation

Plaice and sole abundance indices are calculated by allocating the appropriate ages to the fish that are caught. This gives the age composition (AC) of the catch, and this is used in the appropriate working group analysis.

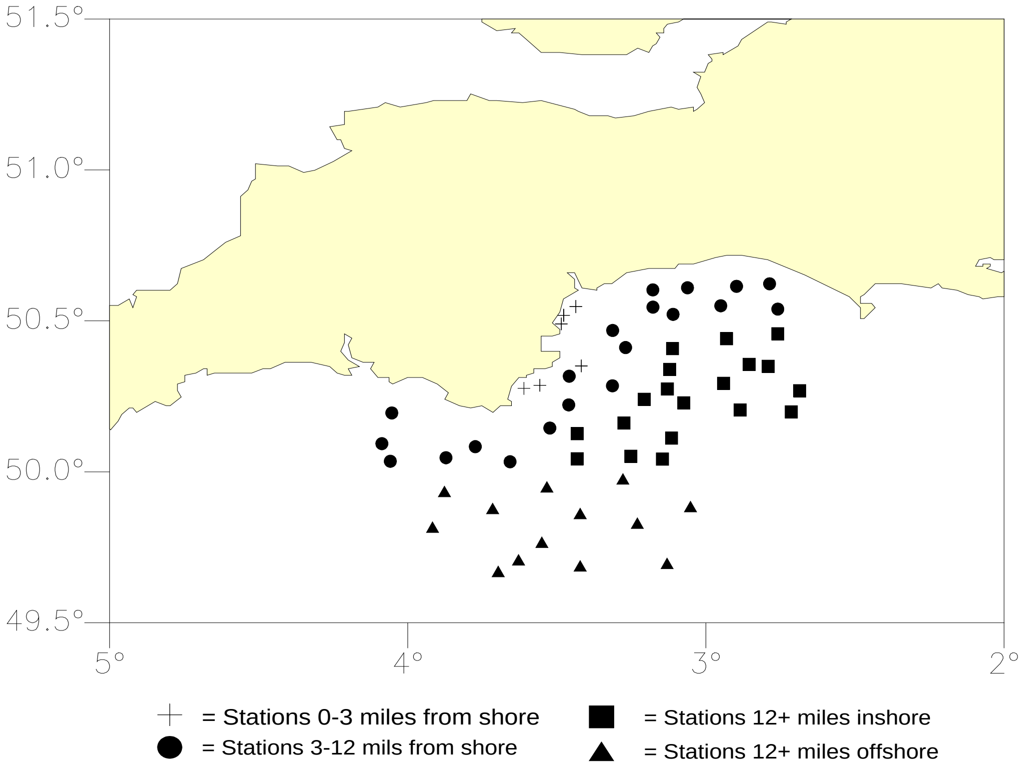
The ACs are calculated by proportioning a length distribution (LD) to an appropriate age–length key (ALK). To account for possible population differences within ICES Division 7.Ie, biological samples are taken from sectors stratified by distance from shore (see map). The survey bands (in miles) are 0–3, 3–12, 12+ inshore, and 12+ offshore. Where appropriate the ALK's are separated by sex, and this allows a particular 'sector, depth-band and sex' ALK to be raised to the corresponding LD to give an accurate AC for that particular habitat. The AC's can then be combined as required to give results in the form of 'numbers-at-age, per distance or time'.

Between 1984 and 1990, a total survey age–length key was applied to the 'grid' length distribution, but from 1990 onwards stratum stratified age–length keys were used.

The table below show the stratifications currently used to calculate the 'near-west groundfish survey' abundance indices.

5. Map of survey grid

Additional stations have been fished throughout the period, but as these stations are not consistently fished, they are excluded from this map.



6. Summary

AREA COVERED	–	ICES DIVISION 7.E
Target species	-	Flatfish, particularly prerecruit plaice and sole
Time period	-	September-October 1988 to 2013.
Gear used	-	1984–1988 – 2 * 6 m beam trawls
	-	1989–2001 – 2 * 4 m beam trawls
	-	– 1* 4 m beam trawl
	-	2005-2013 – 2 * 4 m beam trawls
Mean towing speed	-	4 knots over the ground
Tow duration	-	30 minutes
Vessel used	-	1984–1988 - F.V. Bogey 1
	-	1989–2001 - F.V. Carhelmar
	-	2002–2004 - R.V. Corystes
	-	2005-2013 - F.V. Carhelmar
	-	2013 onwards – Suvey terminated

7. UK Quarter 1 South West Beam Trawl (Q1SWBeam) survey

Indices of abundance-at-age from the Q1SWBeam survey were included in the assessment for the first time at IBPWCFlat (ICES, 2015b). Including the Q1SWBeam survey in the assessment was considered appropriate given the ability to track the progression of year-classes among ages with few clear year effects and the loss of abundance estimates from the UK-WEC-BTS survey after 2013.

The survey-series provides indices of abundance-at-age from 2006. Important considerations were that the survey is based on a stratified random survey approach and covers the entire region of the management area and some adjacent waters. The survey shows strong gradients in species composition within the Western Channel justifying the stratification approach.

Given sampling effort, fundamentally this survey is more variable than fixed stations survey designs of equal effort, but also inherently is less biased when there are potential changes in the distribution of the species within the area. Although estimates of survey variance of the limited data-series are available, these are unlikely to reflect the full range of the variance that would be encountered in a longer time-series as variance estimates are unlikely to have reached their asymptote, particularly since the range of SSBs observed by the survey is very restricted.

Age information provides estimates of abundance for all ages in the assessment. Theoretically, this removes the necessity of retaining the commercial lpue-at-age estimates. Internal consistency estimation is very difficult given the short time-series, and relatively small contrast in cohort strength observed (based on other series). Despite this, some cohort tracking is apparent and the signal matches the cohort signal from other survey series, particularly the UK-FSP survey.