Stock Annex 6.8: Sole VIIa

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Irish Sea Sole (Division VIIa)
Working Group	WGCSE
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Revised by	WKFLAT 2011/Sofie Nimmegeers, Willy Vanhee, Kelle Moreau

A. General

A.1. Stock definition

Sole occur throughout the Irish Sea, but are found more abundant in depth less than 60 m. Recent information on stock identity, distribution and migration issues is included in the report of WKFLAT 2011. Cuveliers *et al.* (2011) combined the results obtained from ten microsatellite markers (long-term estimate of population structure) with results from otolith microchemistry analyses (short-term estimate of connectivity) on adult sole populations in the Northeast Atlantic area. Major large-scale differentiation was detected between three distinct regions (Baltic transition area, North Sea, Irish/Celtic Seas) with both types of markers. The assignment success of individuals to their collection location was much higher based on otolith edge microchemistry compared to the genetic assignments at all sampling locations, except for the Irish Sea. Only 28.6% of individuals (n=30) caught in the Irish Sea could be assigned to their catch location based on otolith edge microchemistry, whereas this region showed high genetic self-assignment scores (ca. 60% of 91 individuals) suggesting a spawning population that is genetically distinct. 32% of the misclassifications based on otolith microchemistry were allocated to the neighbouring Celtic Sea. These results are consistent with tagging studies of sole in the Irish Sea and Bristol Channel, showing mainly local recruitment and limited movement of sole outside the management areas (Horwood *et al.*, 1993). Therefore, the management unit is considered to correspond to the stock unit for Irish Sea sole.

A.2. Fishery

There are three main countries fishing for sole in the Irish Sea; Belgium, taking the bulk of the landings (60–80% in recent years). UK and Ireland taking about 20% and 10% respectively of the sole landings. The Netherlands and France take the remainder. Approximately 25 Belgian beam trawlers are operating in the Irish Sea, targeting sole. The UK trawl fleet and the Belgian beam trawls operate predominantly in the eastern part of the Irish Sea (Liverpool Bay and Morecambe Bay). Sole catches from Ireland are mainly coming from bycatches in the *Nephrops* fishery (operation in the northwest of the Irish Sea).

When fishing in VIIa it is prohibited to use any beam trawl of mesh size range 70–90 mm unless the entire upper half of the anterior part of such a net consists of a panel of netting material attached directly to the headline of the net, extending towards the posterior of the net for at least 30 meshes and constructed of diamond-meshed netting material of

which no individual mesh is of mesh size less than 180 mm. The Irish otter trawl fleet employs either a 70 mm mesh with square mesh panels or more commonly an 80 mm mesh. Similarly the Belgian and UK(E&W) beam trawls use 80 mm mesh gear. Otter trawlers targeting roundfish have, since 2000, used 100 mm mesh gear.

It was concluded at the 2000 working group and confirmed in 2001 that the cod recovery measures first enacted (EU Regulations 304/2000 and 2549/2000 + revisions in 2001–2003) in 2000 would have had little impact on the sole fishery. The closed area in 2001 covered a reduced area confined to the west of the Irish Sea and therefore is also expected to have had little effect on the level of fishing effort for sole The spawning closure for cod in 2002 is also unlikely to have had an impact on the sole fishery. The effort regulations and maximum daily uptake, implemented in 2003 will delay the uptake of the quota but is also unlikely to be restrictive for the total uptake. It is unlikely that any measures concerning the cod management plan in the Irish Sea had restrictions on the sole fishery after 2003.

Discard are estimated to be minor. Preliminary data indicate ranges from 0 to 2% by weight discarded.

Although no data are available on the extent of misreporting of landings from this stock, it is not considered to be a problem for this stock.

A.3. Ecosystem aspects

No information.

B. Data

B.1. Commercial catch

Quarterly age compositions are available from UK(E&W), Belgium and Ireland, as well as quarterly landings from France and Northern Ireland. The total international age composition is obtained using a combined ALK from UK(E&W), Belgium and Ireland raw data, responsible for 99% of the total international sole landings. The combined ALK is applied to the length distributions of the separate countries to obtain an aggregated age composition.

Catch weights were obtained from the combined AWK (UK(E&W), Belgium and Ireland raw data).

Stock weights were obtained using the Rivard weight calculator (http://nft.nefsc.noaa.gov./) that conducts a cohort interpolation of the catch weights.

B.2. Biological

Currently there are no direct (from tagging) or independent (from survey information) estimates of natural mortality. Therefore, annual natural mortality (M) is assumed to be constant over ages and years, at 0.1 yr^{-1}.

The maturity ogive used in this and previous assessments is based on survey information for this stock:

AGE	1	2	3	4	5	6 AND OLDER
Mat.	0.00	0.38	0.71	0.97	0.98	1.00

Proportions of M and F before spawning were set to zero, as in previous years.

Males and females of this stock are strongly dimorphic, with males showing much reduced rates of growth after reaching maturity, whereas females continue to grow. Given the minimum landing size of 24 cm the majority of landings represent mature females.

B.3. Surveys

One survey is used in the assessment of VIIa sole: the UK beam trawl survey (UK (BTS-3Q)).

Area covered

Irish Sea; 52°N to 55°N; 3°W to 6°30'W.

Target species

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

Time period

1988–2009:   September (continuing)

Gear used

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

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

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

Survey design

Survey design is stratified by depth band and sector (Depth bands are 0–20, 20–40, 40+). Station positions are fixed. Number of stations = 35 in the eastern Irish Sea, 15 in the western Irish Sea, and 16 in St George's Channel (primary stations). Sampling intensity highest in the eastern Irish Sea, in the main flatfish nursery and fishery areas.

Method of analysis

Raised, standardized length frequencies for each station combined to give total length distribution for a stratum (depth band/sector). Sector age–length keys applied to stratum length distributions 1988–1994; stratum age–length keys applied 1995 onwards. Mean stratum cpue (kg per 100 km and numbers-at-age per 100 km) are calculated. Overall

mean cpue values are simple totals divided by distance in metres (or hours fished). Population number estimates derived using stratum areas as weighting factors.

The September beam trawl survey has proven to estimate year-class strength well, and providing 50% to over 90% of the weighting to the total estimates of the incoming years classes.

B.4. Commercial cpue

Cpue and effort series were available from the Belgium beam trawlers, UK(E&W) beam and otter trawlers, the Irish otter trawlers and from two UK beam trawl surveys (September and March).

Cpue for both UK and Belgian beam trawlers has declined since the beginning of the time-series, but has remained relatively constant over the last decade, with a renewed increase over the last few years (2008–2009 for Belgium and 2007–2009 for UK).

Effort from both commercial beam trawl fleets increased from the early seventies until the late eighties. Since then Belgian beam trawl effort has declined over the nineties, increased again in the period 2000–2005 and subsequently dropped to much lower values in 2008–2009 (the lowest values since 1984). In the nineties, the UK beam trawl effort fluctuated around a lower level than the late eighties, and dropped during the 21st century to the lowest value of the time-series in 2009.

Indices of abundance derived from the UK September survey (UK (BTS-3Q)) (data from 1988 onwards) are shown in WGNSDS 2002 (Table 12.2.2). High abundance indices for the UK September survey (UK (BTS-3Q)) can be seen for year classes 1989, 1995 and 1996. The dataseries from the UK March beam trawl survey (UK (BTS-1Q)) is rather short (from 1993 to 1999), and therefore difficult to interpret.

B.5. Other relevant data

No information.

C. Assessment: data and method

Model used: XSA

Software used: IFAP/Lowestoft VPA suite

Model Options chosen since 2004:

ASSESSMENT YEAR	2004	2005	2006	2007–2010	WKFLAT 2011
Assessment Model	XSA	SURBA	XSA	XSA	XSA
Fleets					
BEL-CBT	1975–2003 4–9		omitted	omitted	omitted
UK-CBT	1991–2003 2–9		omitted	omitted	omitted
UK (BTS-3Q)	1988–2003 2–9	1988–2004 1–9	1988–rec yr 2–7	1988–rec yr 2–7	1988–rec yr 2–7

ASSESSMENT YEAR	2004	2005	2006	2007–2010	WKFLAT 2011
UK (BTS-1Q)	1993–1999 2–9		1993–1999 2–7	1993–1999 2–7	omitted
Time-ser. Wts	tricubic 20yrs		linear 20 yrs	linear 20 yrs	uniform
Power Model	none		none	none	none
Q plateau	5		5	7	4
Shk se	0.8		1.5	1.5	1.5
Shk Age-yr	5 yrs 5 ages		5 yrs 3 ages	5 yrs 3 ages	5 yrs 3 ages
Pop Shk se	0.3		0.3	0.3	0.3
Prior Wting	none		none	none	None
Plusgroup	10		8	8	8
F_{bar}	4–7		4–7	4–7	4–7

Input data types and characteristics:

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR YES/NO
Caton	Catch in tonnes	1970–last data year	2–8+	Yes
Canum	Catch-at-age in numbers	1970–last data year	2–8+	Yes
Weca	Weight-at-age in the commercial catch	1970–last data year	2–8+	Yes
West	Weight-at-age of the spawning–stock at spawning time	1970–last data year	2–8+	Yes-but based on back calculated catch weights
Mprop	Proportion of natural mortality before spawning	1970–last data year	2–8+	No-set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1970–last data year	2–8+	No-set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1970–last data year	2–8+	No-the same ogive for all years
Natmor	Natural mortality	1970–last data year	2–8+	No-set to 0.1 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	UK (BTS-3Q)	1988–last data year	2–7

Note : several other commercial tuning fleets – BEL-CBT (Belgian beam trawl fleet), UK-CBT (UK beam trawl fleet), UK-COT (UK otter trawl fleet), IRL-COT (Irish otter trawl fleet) – and two other surveys (UK (BTS-1Q) and Irish Juvenile Plaice Survey) have been used or made available in the past. A thorough investigation of the utility of these tuning indices was conducted at the 2002 working group. The results are summarized in the Stock Annexes of the reports of WGNSDS 2002–2008 and WGCSE 2009.

D. Short–term projection

Model used: Age structured deterministic projection

Software used: MFDP

Initial stock size: Taken from the XSA for ages 3 and older. The recruitment-at-age 2 in the last data year is estimated using RCT3. The long-term geometric mean recruitment (1970–penultimate estimate) is used for age 2 in all projection years.

Maturity: the same ogive as in the assessment is used for all years (see table above)

F and M before spawning: set to 0 for all ages in all years

Weight-at-age in the stock: average weight of the last three years

Weight-at-age in the catch: average weight of the three last years

Exploitation pattern: average of the three last years, scaled to the last year's Fbar (4–7) if a trend in F was detected (not scaled to the last year's Fbar (4–7) if no trend in F was detected)

Intermediate year assumptions: *status quo* F

Stock–recruitment model used: none

Procedures used for splitting projected catches: not relevant

E. Medium–term projections

Medium-term projections were not conducted at WKFLAT 2011. The last medium-term projections were carried out in 2008. The settings used are described below.

Model used: Age structured

Software used: IFAP single option prediction

Initial stock size: Same as in the short-term projections.

Natural mortality: Set to 0.2 for all ages in all years

Maturity: The same ogive as in the assessment is used for all years

F and M before spawning: Set to 0 for all ages in all years

Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch

Weight-at-age in the catch: Average weight of the three last years

Exploitation pattern: Average of the three last years, scaled by the Fbar (3–6) to the level of the last year

Intermediate year assumptions: F-factor from the management option table corresponding to the TAC

Stock recruitment model used: None, the long-term geometric mean recruitment-at-age 2 is used

Uncertainty models used: @RISK for excel, Latin Hypercubed, 500 iterations, fixed random number generator

- Initial stock size: Lognormal distribution, LOGNORM(mean, standard deviation), with mean as in the short-term projections and standard deviation calculated by multiplying the mean by the external standard error from the XSA diagnostics (except for age 2, see recruitment below)
- Natural mortality: Set to 0.2 for all ages in all years
- Maturity: The same ogive as in the assessment is used for all years
- F and M before spawning: Set to 0.2 for all ages in all years
- Weight-at-age in the stock: Assumed to be the same as weight-at-age in the catch
- Weight-at-age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years, scaled by the Fbar (3–6) to the level of the last year
- Intermediate year assumptions: F-factor from the management option table corresponding to the TAC
- Stock–recruitment model used: Truncated lognormal distribution, TLOG-NORM(mean, standard deviation, minimum, maximum), is used for recruitment age 2, also in the initial year. The long-term geometric mean, standard deviation, minimum, maximum are taken from the XSA for the period 1960; 4th last year.

F. Long-term projections

Model used: age structured deterministic projection

Software used: MFYPR

Inputs as for short-term projection.

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	3100 t	Default to value of B_{pa}.
Approach	F_{MSY}	0.16	Provisional proxy based on stochastic simulations assuming a Ricker S/R relationship (range 0.1–0.25).
	B_{lim}	2200 t	$B_{lim} = B_{loss}$. The lowest observed spawning stock (ACFM 1999), followed by an increase in SSB.
Precautionary	B_{pa}	3100 t	B_{pa}. B_{lim} * 1.4. The minimum SSB required ensuring a high probability of maintaining SSB above its lowest observed value, taking into account the uncertainty of assessments.
Approach	F_{lim}	0.4	$F_{lim} = F_{loss}$. Although poorly defined, there is evidence that fishing mortality in excess of 0.4 has led to a general stock decline and is only sustainable during periods of above-average recruitment.
	F_{pa}	0.3	This F is considered to have a high probability of avoiding F_{lim}.

Precautionary approach reference points have not been changed during 1999–2006. In this period, F_{pa} was set at 0.45 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above B_{pa}. In 2007, F_{pa} was changed to 0.3 due to the rescaling of SSB estimates. In 2010, MSY reference points were added by WGCSE.

H. Other issues

A management plan for Irish Sea sole could be developed, also taking into account the dynamics of the plaice stock in that area.

I. References

ICES. 2002. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS). ICES CM 2002/ACFM:02. 448 pp.

ICES. 2010. Report of the Working Group on the Celtic Seas Ecoregion (WGCSE), 13–19 May 2009, Copenhagen, Denmark. ICES CM 2009/ACOM:09. 1430 pp.

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