

Stock Annex: Whiting (*Merlangius merlangus*) in Division 7.a (Irish Sea)

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Whiting

Working Group: Working Group for the Celtic Seas Ecoregion (WGCSE)

Created:

Authors:

Last updated: 2016

Last updated by: WGCSE

A. General

A.1. Stock definition

Whiting in Division 7.a are considered a single stock for management purposes. In 2004 an informal meeting was established to review current knowledge of the distribution, movements and stock structure of whiting in the Irish Sea, and linkages between whiting in the Irish Sea and surrounding management areas. Information on egg and larval, tagging, survey studies was presented as a working document (WD10) in WGN SDS, 2005. The results of this are synopsized below:

UK egg and larva surveys have shown that whiting spawn in spring throughout the eastern Irish Sea and in the coastal waters of the western Irish Sea. This is supported by the distribution of actively spawning fish caught during trawl surveys in March.

Transport of whiting eggs, larvae or pelagic pre-recruits from Celtic Sea spawning grounds into the Irish Sea is likely to be impeded by the Celtic Sea thermal front that becomes increasingly established from spring onwards.

Whiting recruitment grounds are in the same general area as the spawning grounds, and young whiting are widespread in the coastal bights of the Irish Sea. The gyre system that becomes established from late spring onwards in the western Irish Sea appears important in retaining larvae and pelagic pre-recruits of whiting, as shown by the results of frame-trawl surveys of pelagic pre-recruits in the western Irish Sea.

As the whiting become demersal from late summer onwards, they are found throughout the western Irish Sea although densities appear highest around the periphery of the mud patch in coastal waters and along the southern boundary between Ireland and the Isle of Man. This pattern is also noted by fishermen operating in this area. Densities of young whiting in the eastern Irish Sea appear highest off Cumbria and the Solway Firth in autumn, but are more widespread in spring.

Tagging studies in the late 1950s show some seasonal dispersal of whiting from the Irish Coast to as far as the Clyde, Liverpool Bay and the Celtic Sea, with evidence of return migrations. Whiting tagged in these studies ranged from about 20–40 cm, averaging

around 30 cm. Whiting recaptured well away from the tagging sites off County Down in the western Irish Sea tended to be several cm larger, on average, than the tagged whiting.

Both the western Irish Sea and the Clyde have historically been characterised bycatches of immature and first-maturing whiting, whilst the eastern Irish Sea has a broader age range of whiting. This pattern persists to the present day.

The evidence for interchange of whiting between the western Irish Sea and other areas within the Irish Sea precludes treating different areas within the Irish Sea as containing functionally separate stocks. Spatial modelling of the populations would require information on rates of dispersal between areas.

Trawl surveys continue to show that juvenile whiting are very abundant in the coastal waters of the Irish Sea, and that whiting are one of the most abundant fish species taken in the surveys. Hence, there have been no indications of depressed recruitment associated with the apparent steep decline in abundance of large whiting. Length at 50% maturity in female whiting is only 20–21 cm in the Irish Sea and neighbouring management areas, and spawning appears predominantly by young whiting of 1–3 years old.

A.2. The fishery

Most landings by the Irish and UK(NI) fleet, which take the bulk of the Division 7.a whiting catch, are from the western Irish Sea (ICES CM 2003/ACFM:04) and are made predominately by single- and twin-rig trawlers. A small number of UK pairtrawlers also fish for whiting. The UK(E&W) fleet has declined substantially over time, and the bulk of its landings are from inshore otter trawlers targeting mixed flatfish and roundfish in the eastern Irish Sea. Discarding in this stock is thought to be high in all fleets, particularly in the *Nephrops* fishery. The *Nephrops* directed fishery operates on the main whiting nursery areas in the western Irish Sea, and is particularly intensive in the summer months. The mesh size mainly in use in the fishery is 70 mm in single trawls and 80 mm in twin trawls targeting *Nephrops*. The western Irish Sea fishery for whiting has declined substantially in recent years, and the increase in abundance of haddock has resulted in few vessels targeting whiting.

Vessels operating with 70 mm and 80 mm mesh are required to use square mesh panels. Square mesh panels were introduced as a technical measure to reduce fishing mortality on whiting. Square mesh panels have been mandatory for all UK trawlers (excluding beam trawlers) in the Irish Sea since 1993 and for Irish trawlers since 1994. While the effects of this technical measure have not been formally evaluated, the *Nephrops* fishery still generates substantial quantities of whiting discards. Effort by Irish *Nephrops* trawlers in the main areas of whiting bycatch has shown some reduction during the period of the Irish Sea cod recovery plan closures. However, the summer peak in activity of the *Nephrops* fishery was not affected by the recovery plans. As the activities of the *Nephrops* fleet were not restricted by the cod recovery plan, it is unlikely that the recovery plan was effective in reducing levels of discarding in this stock.

There has been some recent decommissioning of vessels in the Irish Sea. Ireland introduced a further decommissioning scheme in 2008 with the aim of removing 11 140 GT from the fleet register. This is targeted at vessels over ten years of age and >18 m in length. The reported landings of whiting in 1999–2001 by UK vessels decommissioned in 2002 amounted to about 7% of the total international landings of whiting in those years.

Whilst few new Irish vessels have joined the fishery, some vessels from County Donegal have reported catches of whiting in 7.a. These vessels have been attracted into the Celtic Sea fishery in recent years in response to poor catches in other areas. Irish landings of whiting in the southwestern part of 7.a now contribute the bulk of the total Irish landings in the division (ICES CM 2003/ACFM:04). The difference in grounds in the southern part of 7.a means that whiting in the area are more likely to function as part of the Celtic Sea stock rather than the Irish Sea stock.

Irish otter board trawlers fishing ICES Area 7.a generally use twin-rig gear to fish for *Nephrops*. However there are also localized mixed fisheries both in the north and south ends of 7.a. The Irish Sea *Nephrops* fleet is highly opportunistic and of this fleet, there are only a handful of boats that fish the Irish Sea Prawn Grounds 100% of the time. The rest of the fleet divides its time between the Irish Sea, Smalls, Aran and Porcupine Grounds dependant on tides, weather and market forces. In late 2009 and 2010, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan. It is expected that this will reduce the whiting catches of these vessels by ~60% in weight. Furthermore, a small number of vessels began utilizing an inclined separator panel expected to reduce whiting catch by ~75% in weight (STECF, 2010). Preliminary Irish discard data show a reduction in 45% by number of whiting on boats using these gear technology mitigation measures.

In recent times, *Nephrops* landings from the Smalls grounds (7.g) have surpassed those from the Irish Sea grounds. This reflects the increasing amount of effort by East Coast vessels in 7.g where in general, better prices are obtained for their catch. The main species targeted by the otter trawl fleet are *Nephrops*, cod, ray, haddock, anglerfish and whiting. The Irish beam-trawl fleet predominantly targets black sole and other high-quality flat-fish and divides its effort between 7.a and 7.g depending on weather, tides and market forces.

For the UK NI fleet decommissioning at the end of 2003 removed 19 out of 237 UK vessels that operated in the Irish Sea, representing a loss of 8% of the fleet by number and 9.3% by tonnage. Of these vessels, 13 were vessels that used demersal trawls with mesh size ≥ 100 mm. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and four UK(E&W) vessels registered in Irish Sea ports at the end of 2001. Of these, 13 were vessels that used demersal trawls with mesh size ≥ 100 mm.

Since late 2009, a number of Irish vessels operating within the Irish Sea *Nephrops* fishery incorporated a Swedish grid into otter trawls, as part of the cod long-term management plan although the number using grids has declined in favour of alternative species selective gears. The use of species selective gears to mitigate effort restrictions to avoid effort limits has increased steadily since 2009. A conditional national licence has been introduced by Ireland since March 2012, making the use of grids or separator panels or SELTRA trawls mandatory for all TR2 boats fishing in the Irish Sea. Since October 2012, all TR2 vessels in the UK(NI) fleet are required to use a highly selective fishing gear. In the Irish Sea these currently include Seltra 300 mm box trawl, 270 mm diamond mesh panel Seltra box trawl and 300 mm square mesh panel. All these gears are being developed with the aim of achieving exemption from the cod recovery plan under Article 11 (less than 1.5% cod catch). While the species selective gears have been introduced to re-

duce cod catches, it would be expected that they would also contribute to a reduction in whiting bycatch this doesn't appear to be the case."

In recent years, Irish East Coast *Nephrops* vessels have moved away from their traditional Irish Sea grounds to the Smalls grounds (FU22; 7.g), which is not controlled by effort limitation and generally better prices are obtained for their catch.

A.3. Ecosystem aspects

Recruitment in Irish Sea whiting appears less variable than in cod and haddock, although there is some similarity in the timing of strong and weak year classes that may indicate a similar response to changes in environmental conditions affecting spawning or early-stage survival. The diet of Irish Sea whiting has been examined in some detail since the 1970s using samples collected from research vessels. Cannibalism occurs in adult whiting; however the effect of this on the assessment of the stock has not yet been investigated. Young whiting are common in the diets of larger predators such as cod and anglerfish.

B. Data

B.1. Commercial catch

B.1.1. Landings

The following table gives the source of landings data for Irish Sea whiting:

Country	Kind of data				
	Caton (catch-in-weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature-by-age)	Length composition-in-catch
UK(NI)	X	X	X	X	X
UK(E&W)	X	X	X		X
UK(Scotland)	X		X		
UK (IOM)	X				
Ireland	X	X	X		X
France	X				
Belgium	X				
Netherlands	X				

Quarterly landings and length–age composition data are supplied from databases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated misreporting by area or species. Data are supplied on paper or Excel files to a stock coordinator nominated by the ICES Northern Shelf Demersal Working Group, who compiles the international landings and catch-at-age data, and maintains a time-series of such data with any amendments. To avoid double counting of landings data, each UK region supplies data for UK landings into its regional ports, and landings by its fleet into non-UK ports.

The UK(E&W) currently supplies raised quarterly length frequencies of landings but only sporadic age data. The catch and mean weight-at-age are estimated using combined UK(NI) and Irish quarterly length–weight relationships and age–length keys. Quarterly landings are provided by the UK(Scotland), Belgium and France and annual landings are provided by UK(IOM). The quarterly estimates of landings-at-age into UK(E&W), UK(NI) and Ireland are raised to include landings by France, Belgium, UK(Scotland), UK(IOM) (distributed proportionately over quarters), and then summed over quarters to produce the annual landings-at-age.

The Excel spreadsheet files used for age distribution, adjustments and aggregations can be found with the stock coordinator and for the current and previous year in the ICES computer system under **w:\acfm\wgnsds\year\personal\name** (of stock coordinator).

The result files (FAD data) can be found at ICES and with the stock coordinator, as ASCII files on the Lowestoft format, under **w:\acfm\wgnsds\year\data\whg_7.a**.

B.1.2.Discards

The Irish Sea *Nephrops* fishery takes place on the whiting nursery grounds of the north-western Irish Sea and has traditionally produced high whiting discarding. The quantity of whiting discarded from the UK (NI) *Nephrops* fishery in 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length–weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of whiting in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e. those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of whiting discarded using the whiting: *Nephrops* ratio in the discard samples. The length–frequency of whiting in the discard samples is then raised to the fleet estimate, and numbers and mean weight-at-age of discarded whiting is computed from the age–length key and length–weight parameters for whiting. The UK(NI) estimates are available since 1980 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually.

There are several limitations to these data: only a small subset of single-rig trawlers is sampled; the method of raising to the fleet discards will be affected by any inaccuracies in the reported landings of *Nephrops*; and there are no estimates of landings of whiting from these vessels with which to calculate proportions discarded-at-age. However, the WG has used these data in past assessments because removal of discards data would remove a large fraction of catch from the assessment.

A re-analysis of the Irish discard data raised to the *Nephrops* landings produced estimates of discards from the Irish *Nephrops* fleet that were more consistent with those of the UK(NI) *Nephrops* fleet. However, this method of raising could not be used to recalculate an entire time-series of discard estimates from the Irish *Nephrops* fleet. The quarterly UK(NI) discard ratios were therefore used by the Working Group to estimate the tonnage discarded from the Irish *Nephrops* fishery. Length frequencies and age–length keys from the whiting discarded by the Irish *Nephrops* fleet are used to estimate the numbers discarded-at-age from the Irish *Nephrops* fleet.

At the WGCSE 2011 Irish discard estimates (1996–2011) raised according to the methods described in Borges *et al.*, 2005 were available to the Working Group, see Table 1.0. These are available in the ICES files. Discard rates in this series were variable compared with previous estimates based on the UK NI self-sampling scheme. Given the differences in raising procedure applied to the NI Discard estimates and the Irish discard estimates further examination of the discard data is needed before international estimates of discard numbers-at-age can be made. The Working Group did therefore has not estimate international discard volumes and numbers-at-age since 2003.

- Discard numbers-at-age from 1980–2002 estimated from the NI *Nephrops* fishery and raised to the International Fleet (from the NI self-sampling scheme).
- Discard numbers-at-age from the Irish Otter Trawl Fleet from 1996–2015, including length–frequency data. Note the data in 2010 are not thought to be fully representative of discarding in the Irish Sea for the Irish OTB fleet as there were only four trips sampled. Data in 2015 are raised by effort (days at sea). Prior to this discard data were raised using “trip” as the auxiliary variable. In recent years discard raising stratification and auxiliary variables for Irish discard sampling have been explored for a number of stocks; 7.a Plaice (ICES, 2011), 7.b–k Haddock (ICES, 2012a), 7 megrim (ICES, 2012b). The general experience with these analysis is that effort based raising auxiliaries (fishing days or hours) tended to be more precise and generated fleet landings estimates closer to the reported landings than trips. Fishing trip durations are quite variable in the Irish Sea in recent years and the number of sampling trips is also relatively low. As a consequence trip based raising may introduce additional variability into the discard estimates.
- Discard–Length Frequencies for the UK (E and W) fleet, 2004–2015, raised to trip.
- Discard numbers-at-age for the NI fleet for 1997–2001, and 2006, 2007, 2009–2015, raised to trip, including length–frequency data from the NI observer scheme.

Methods for estimating quantities and composition of discards from UK(NI) and Irish *Nephrops* trawlers are described in the stock annex Section B.1.2. Irish otter trawl fleet discard estimates (1998–2015) raised according to the methods described in Borges *et al.* (2005) were available to the Working Group (Table 6.6.11).

B.2. Biological

Natural mortality was assumed to be constant ($M=0.2$, applied annually) for the whole range of ages and years.

A combined sex maturity is assumed, knife-edged at age 2. The use of a knife edged maturity ogive has been a source of criticism in previous assessments. However, recent research on gadoid maturity conducted by the UK (NI) gives no evidence for substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity at age 1, particularly in males, since 1998.

As in previous years, SSB is computed at the start of each year, and the proportions of M and F before spawning were set to zero.

Stock weights are calculated using a procedure first described in the 1998 Working Group report. To derive representative stock weights for the start of the year for year i and age j the following formula is adopted:

$$(CW_{i,j} + CW_{i+1,j+1})/2 = \text{SW at start of year.}$$

These values are then smoothed using a 3-year moving average.

Recent investigations into the biological parameters (maturity, sex and growth parameters) of whiting in 7.a (funded under the Data Directive Regulation (1639/2001)) took place during a Biological Sampling survey (BBS) in March 2004. Parameter estimates of maturity-at-length indicate the L_{50} for whiting in 7.a for males and females is 13.65 cm and 19.76 cm, respectively. Maturity-at-age for both sexes are similar for most stock area (7.a, b, j and g) with the notable exception of age 1 males in the Celtic Sea where the estimates are outside the 95% CI bounds for 7.a and considerably lower than 6.a. In most areas whiting were mature by age three and most were mature at age 2. The sex ratio for whiting tended to increase with length for nearly all the age classes in all areas indicating that females tend to have larger length at age than males (Gerritsen, 2005).

Gerritsen *et al.*, 2002 describes the relationships between maturity, length and age of whiting sampled on a length-stratified basis from NI groundfish surveys of the Irish Sea during spawning in spring 1992–2001. Findings show that most one year old females were immature whilst most two year old females were mature, almost all three year olds of both sexes were mature. Length at 50 maturity average around 19 cm in males and 22 cm in females.

B.3. Surveys

Seven research vessel survey series for whiting in 7.a were available to the Working Group in 2011. In all surveys listed the highest age represents a true age not a plus group.

- UK(England and Wales) Beam-Trawl Survey (**UK (E&W)-BTS-Q3**): ages 0 and 1, years 1988–2011: The survey covers the entire Irish Sea and is conducted in September on the R.V. *Corystes*. The survey uses a 4 m beam trawl targeted at flatfish. The survey is stratified by area and depth band, although the survey indices are calculated from the total survey catch without accounting for stratification. Numbers of whiting at-age per km towed are provided for prime stations only (i.e. those fished in most surveys).
- UK(Northern Ireland) October Groundfish Survey (**NIGFS-WIBTS-Q4-EAST & WEST**): ages 0–5, years 1992–2011: The survey series commenced in its present form in 1992. It comprises 45 three mile tows at fixed station positions in the northern Irish Sea, with an additional twelve 1 mile tows at fixed station positions in the St George's Channel from October 2001 (the latter are not included in the tuning data). The surveys are carried out using a rock-hopper otter trawl deployed from the R.V. *Lough Foyle*. The survey designs are stratified by depth and sea bed type. The mean numbers-at-length per 3 mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The strata are grouped into western Irish Sea and eastern Irish Sea, and a separate age-length key is derived for each area to calculate abundance indices by age class. The survey

design and time-series of results including distribution patterns of whiting are described in detail in Armstrong *et al.*, 2003.

- UK(Northern Ireland) March Groundfish Survey (**NIGFS-WIBTS-Q1-EAST & WEST**): ages 1–5, years 1992–2012: Description as for **NIGFS-WIBTS-Q4-EAST & WEST** above.
- UK(Northern Ireland) Methot-Isaacs Kidd Survey (**NIMIK**): age 0, years 1994–2011: The survey uses a Methot-Isaacs Kidd frame trawl to target pelagic juvenile gadoids in the western Irish Sea at 40–45 stations. The survey is stratified and takes place in June during the period prior to settlement of gadoid juveniles. Indices are calculated as the arithmetic mean of the numbers-per-unit sea area.
- Ireland's Irish Sea Celtic Sea Groundfish Survey (IR-ISCSGFS): ages 0–5, years 1997–2002: This survey commenced in 1997 and is conducted in October–November on the R.V. *Celtic Voyager*. The α and β of the series are set to account for the variable timing of this survey within the fourth quarter. The survey uses a GOV otter trawl with standard groundgear and a 20 mm codend liner. The survey operates mainly in the western Irish Sea but has included some stations in the eastern Irish Sea. The survey design has evolved over time and has different spatial coverage in different years. Indices are calculated as arithmetic means of all stations, without stratification by area.
- UK(Scotland) groundfish survey in spring (ScoGFS-spring): ages 1–8, years 1996–2006: This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (nine stations). The survey extends from the Northern limit of the Irish Sea to around 53°30'.
- UK(Scotland) groundfish survey in autumn (ScoGFS – autumn): ages 0–5, years 1997–2005: The survey covers a similar area to the ScoGFS in spring, but has only 11–12 stations.
- IRGFS(Ireland) (IR-Q4 IBTS): This survey commenced in 2003 aboard the R.V. *Celtic Explorer*. It is a depth stratified survey using a GOV trawl with a 20 mm mesh liner on the codend. The survey currently covers 7.b,j,g and 6.a. Protocols for the survey are governed by the International Bottom Trawl Survey Working Group (IBTS).

To allow the inclusion of the IR-Q4 IBTS and ScoGFS spring surveys for the year after the last year with commercial catch data in an XSA, the surveys may be treated as if they took place at the end of the previous year, and the age range and year range of the surveys may be shifted back accordingly in the data files.

The following research surveys were available to the 2011 Working group:

- UK(NI) groundfish survey: March 1992–2012.
- UK(NI) groundfish survey: October 1992–2011.
- UK(Scotland) groundfish survey: March 1996–2006.
- UK(Scotland) groundfish survey: autumn 1997–2005.

- Irish groundfish survey: autumn 2003 and 2004.
- UK(NI) MIK net surveys of pelagic-stage 0-group cod, western Irish Sea 1994–2011.
- UK(E&W) beam-trawl survey: 0-1 gp cod, 1988–2011.

FSP surveys of Irish Sea round fish: 2004–2010.

Further details of the tuning data are given in Appendix 1 and 2 of the 1999 WG Report.

B.4. Commercial cpue

No cpue data have been provided for the French (Lorient) trawl fleet since 1992. Four commercial catch–effort dataserries were available to the WG:

- Irish otter trawl (IR-OTB): ages 1–6, years 1995–2002: Effort and cpue data provided for the Irish fleet comprise total annual effort (hours fished, not corrected for fishing power) and total numbers-at-age in landings from otter trawlers. The data were revised to take account of updated logbook information. This fleet operates mainly in the western Irish Sea, targeting *Nephrops* and/or whitefish. The distribution of fishing is concentrated in the western part of the range of the whiting stock in the Irish Sea. Hence the catch rates will represent changes in abundance of whiting in the western part of 7.a. The use of this fleet as a tuning index therefore relies on the assumption that trends in abundance in the west of 7.a reflect those of the entire stock. The catch-at-age data comprise a large proportion of the total international catch. Hence, some correlation of errors can be expected between the tuning data set and the catch-at-age data. The effect of such correlations has not been evaluated. The otter trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded.
- UK(Northern Ireland) pelagic trawl: ages 2–6, years 1993–2002: The pelagic trawl catch-at-age data contained data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet currently targets haddock and cod in the deeper waters of the western Irish Sea and the North Channel. Bycatches of whiting are currently very small and are heavily discarded due to their low value. The fleet is considered unsuitable for indexing whiting abundance.
- UK(Northern Ireland) single-rig otter trawl: ages 0–6, years 1993–2002: This fleet operates mainly in the western Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea). Whiting discards from single-rig trawlers (estimated from fisher self-sampling scheme) are included.
- UK(England and Wales) otter trawl: ages 2–6, years 1981–2000: Estimates up to and including 2000 of commercial lpue from UK(E&W) otter trawlers contain data for landings only. Hence the reliability of the tuning fleet will be limited for age groups which are heavily discarded. This fleet operates mainly in the eastern Irish Sea. The distribution of fishing does not encompass the entire range of the whiting stock (which surveys suggest is distributed across the Irish Sea) or the main whiting nursery grounds (in the western Irish Sea). Age compositions in most years have been estimated from length frequencies using

ALKs that were obtained from sampling of fleets operating mainly in the western Irish Sea. This has introduced additional uncertainties into the data.

B.5. Other relevant data

C. Historical stock development

No assessment was carried out for this stock in 2011. The last assessment for this stock was a survey based assessment in 2007.

- Model used:
 - XSA (up to 2002)
 - SURBA 2.0–2003
 - SURBA 3.0–2004
 - SURBA 2.2 – 2005–2011
- Software used
 - Lowestoft VPA suite
 - SURBA 2.2
- XSA Model Options chosen:

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for ages ≥ 4

Survivor estimates shrunk towards the mean F of the final five years or the two oldest ages

S.E. of the mean to which the estimate are shrunk = 0.500

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics for XSA:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1980–last data year	0–6+	Yes
Canum	Catch-at-age in numbers	1980–last data year	0–6+	Yes
Weca	Weight-at-age in the commercial catch	1980–last data year	0–6+	Yes

West	Weight-at-age of the stock at spawning time.	1980–last data year	0–6+	Yes: uses smoothed catch weights adjusted to start of year
Mprop	Proportion of natural mortality before spawning	1980–last data year	0–6+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1980–last data year	0–6+	No – set to 0 for all ages in all years
Matprop	Proportion mature-at-age	1980–last data year	0–6+	No – the same ogive for all years
Natmor	Natural mortality	1980–last data year	0–6+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct	1992–last data year	0–5
Tuning fleet 2	NIGFS-Mar (adjusted)	1991–(last data year-1)	0–4
Tuning fleet 3	ScoGFS-Spring	1996–last data year	1–5
Tuning fleet 4	UK(E&W) BTS	1988–last data year	0–1

Input data types and characteristics for SURBA 2.2

Default settings used

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	NIGFS-Oct NIGFS-WIBTS-Q4-EAST & WEST	1992–2011	ALL
Tuning fleet 2	NIGFS-Oct NIGFS-WIBTS-Q1-EAST & WEST	1992–2012	ALL

D. Short-term projection

Currently, there is no analytical assessment for this stock.

- Model used:

Age structured

- Software used: MFDP prediction with management option table and yield per recruit routines. MLA suite (WGFRANSW) used for sensitivity analysis and probability profiles.
- Initial stock size. Taken from the XSA for age 1 and older. The recruitment-at-age 0 in the last data year is estimated as a short-term GM

(1992 onwards) because of a reduction in mean recruitment since then.

- 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:

average stock weights for last three years.
- Weight-at-age in the catch:

Average weight of the three last years.
- Exploitation pattern:

Average of the three last years. Discard F's, which are generated by the *Nephrops* fleet as there are no discard estimates for other fleets, are held constant while landings F's are varied in the management option table.
- Intermediate year assumptions:

status quo F
- Stock–recruitment model used:

None, the short-term geometric mean recruitment-at-age 0 is used.
- Procedures used for splitting projected catches:

F vectors in each of the last three years of the assessment are multiplied by the proportion landed or discarded at age to give partial Fs for landings and discards. The vectors of partial Fs are then averaged over the last three years to give the forecast values.

E. Medium-term projections

No medium-term projections are done for this stock due to problems with estimating current F.

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

- Model used: yield and biomass per recruit over a range of F values that may reflect fixed or variable discard F's.
- Software used: MFY or MLA
- Selectivity pattern:

mean F array from last three years of assessment (to reflect recent selection patterns).
- Stock and catch weights-at-age:

mean of last three years (weights-at-age have declined as the stock has declined since the 1980s; it is not known if this is an environmental effect on growth that is independent of stock size).

- Proportion discarded:

Partial F vectors are the recent average.

- Maturity: Fixed maturity ogive as used in assessment.

G. Biological reference points

Precautionary approach reference points have remained unchanged since 1999. B_{pa} is set at 7000 t and is defined as $B_{lim} * 1.4$. B_{lim} is defined as the lowest observed SSB (ACFM, 1999), considered to be 5000 t. There is not considered to be clear evidence of reduced recruitment at the lowest observed SSBs. F_{pa} is set at 0.65 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above B_{pa} in the long term. F_{lim} is defined as 0.95, the fishing mortality estimated to lead to a potential stock collapse.

H. Other issues

I. References

- Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area 7.aN): 1992–2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessment of Northern Shelf Demersal Stocks. 33pp.
- Borges, L.; Rogan, E. and Officer, R. 2005. "Discarding by the demersal fishery in the waters around Ireland", Fish. Res. In press.
- Gerritsen, H. 2005. Biological parameters for Irish Demersal Stocks in 2004. WD5 (WGNSDS, 2005)

Table 1.0. Discard estimates raised according to the method outlined in Borges *et al.*, 2005.

Age	1996		1997		1998		1999		2000		2001		2002		2003	
	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	5631.20	0.015	4110.63	0.027	5073.57	0.027	187.26	0.036	7850.12	0.033	20981.54	0.016	29017.16	0.021	1921.76	0.016
1	5925.33	0.035	8361.19	0.044	5939.53	0.064	276.50	0.102	3098.24	0.047	8883.11	0.054	12097.93	0.033	2419.56	0.036
2	1802.90	0.111	3243.45	0.120	3826.20	0.107	150.99	0.174	137.80	0.153	1413.48	0.126	576.17	0.112	1287.21	0.178
3	144.34	0.217	696.18	0.200	440.05	0.185	43.70	0.235	30.31	0.229	479.38	0.133	152.95	0.105	603.20	0.246
4	6.02	0.206	68.71	0.241	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	108.64	0.268
5	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	22.95	0.136	17.66	0.123	0.00	0.000
6	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
7	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
8	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
9	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
10+	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
Total weight (t)	520.8		1024.1		1010.3		71.6		434.3		1054.5		1100.9		523.6	
Sampling Information	1996		1997		1998		1999		2000		2001		2002		2003	
Number of Trips	8		8		7		4		10		2		1		9	
Number of Hauls	48		44		58		40		111		34		7		60	
Age	2004		2005		2006		2007		2008		2009		2010		2011	
	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)	Numbers ('000)	Weight (kg)
0	17091.56	0.018	442.07	0.010	1534.97	0.016	5138.89	0.043	4585.77	0.025	13319.29	0.028	1406.81	0.016	6293.64	0.018
1	7347.29	0.034	2531.84	0.035	1483.43	0.060	23000.16	0.038	7879.78	0.040	12913.10	0.036	4513.61	0.038	4912.12	0.026
2	731.35	0.101	783.68	0.091	621.58	0.133	3282.67	0.095	1485.70	0.093	712.51	0.081	1383.11	0.084	307.09	0.080
3	142.50	0.165	129.28	0.159	99.02	0.218	916.09	0.145	161.03	0.119	2.60	0.175	129.68	0.133	30.38	0.164
4	96.30	0.218	40.12	0.154	16.82	0.312	10.96	0.276	13.46	0.130	0.89	0.257	5.41	0.163	2.73	0.198
5	0.00	0.000	24.48	0.371	0.00	0.000	1.92	0.304	0.00	0.000	0.00	0.000	0.47	0.167	0.18	0.199
6	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
7	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
8	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
9	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
10+	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000
Total weight (t)	680.3		201.3		223.2		1544.7		585.3		892.3		329.8		268.8	
Sampling Information	2004		2005		2006		2007		2008		2009		2010		2011	
Number of Trips	11		8		5		15		18		12		4		6	
Number of Hauls	122		96		56		90		91		55		29		74	