7 Herring (*Clupea harengus*) in Division 7.a North of 52°30'N (Irish Sea)

The stock was benchmarked in 2017 and a state-space assessment model, SAM, was proposed as the assessment model for the stock (WKIRISH, 2017).

The WG notes that the use of "age", "winter rings", "rings" and "ringers" still causes confusion outside the group (and sometimes even among WG members). The WG tries to avoid this by consequently using "rings", "ringers", "winter ringers" or "wr" instead of "age" throughout the report. However, if the word "age" is used it is qualified in brackets with one of the ring designations. It should be observed that, for autumn and winter spawning stocks such as this one, there is a difference of one year between "age" and "rings". Further elaboration on the rationale behind this, specific to each stock, can be found in the individual Stock Annexes. It is the responsibility of any user of age based data for any of these herring stocks to consult the relevant annex and if in doubt consult a relevant member of the Working Group.

7.1 The Fishery

7.1.1 Current advice

ICES advised that when the MSY approach is applied, catches in 2021 should be no more than 7341 tonnes. ICES advised that when the MSY approach is applied, catches in 2022 should be no more than 8455 tonnes.

7.1.2 The fishery in 2021

The catches reported from each country for the period 1987 to 2021 are given in Table 7.1.1, and total catches from 1987 to 2021 in Figure 7.1.1. Reported international landings in 2021 for the Irish Sea amounted to 7208 t with UK vessels acquiring the majority of the quota through swaps with the Republic of Ireland. The majority of catches in 2021 were taken during the 3rd quarter, with landings also made in quarter 4, this is typical of the annual fishery pattern.

As in previous years, the 2021 7.a (N) herring fishery began in late August, with catches taken to the north-west of the Isle of Man, before moving to the Douglas Bank. The majority of catches were taken by Northern Irish and Irish midwater pelagic fishing vessels. In previous years an extensive 'Mourne' gillnet fishery was active, this is limited to boats under 40 ft usually in October and November, this fishery landed 55 t in 2021.

7.1.3 Regulations and their effects

Closed areas for herring fishing in the Irish Sea along the east coast of Ireland and within 12 nautical miles of the west coast of Britain were maintained throughout the year. The traditional gillnet fishery on the Mourne herring has a derogation to fish within the Irish closed box. The area to the east of the Isle of Man, encompassing the Douglas Bank spawning ground (described in ICES 2001, ACFM:10), was closed from 21 September to 15 November. Boats from the Republic of Ireland are not permitted to fish east of the Isle of Man.

The arrangement of closed areas in Division 7.a(N) prior to 1999 is discussed in detail in ICES (1996/ACFM:10) with a change to the closed area to the east of the Isle of Man being altered in

1999 (ICES 2001/ACFM:10). The closed areas consist of: all year juvenile closures along part of the east coast of Ireland, and the west coast of Scotland, England and Wales; spawning closures along the east coast of the Isle of Man from 21 September to 15 November, and along the east coast of Ireland all year-round. In 2020 theses restrictions were no longer in place due to the changes within the EU Technical Regulations (EU) 2019/1241, however, national licensing measures still restrict vessels from fishing in some areas and seasons.

7.1.4 Changes in fishing technology and fishing patterns

UK Northern Irish and Irish pelagic pair and single trawlers take the majority of catches during the 3rd and 4th quarters. A small local fishery continues to record landings on the traditional Mourne herring grounds during the 3rd or 4th quarter. This fishery resumed in 2006 and has seen increasing catches of herring since, peaking at ~171 t in 2009, there was less than 10 t landings attributed to this fishery in 2018, no catches in 2019, 33 t in 2020 and 55 t in 2021. Recently there has been a marked increase in the landings made by Irish vessels comprising 19% of the landings in 2018, 21% in 2019 and 27% in 2020. This decreased in 2021 to be 10% but remains above the previous low levels of on average of 2% during 2015 - 2017.

7.2 Biological Composition of the Catch

7.2.1 Catch in numbers

Routine sampling of the main catch component was conducted in 2021. Sampling was carried out on landings at fish processing factories for both Irish, Northern Irish vessels and UK English vessels. There was no biological sampling of the main catch component (pair trawlers) in 2009 due to a failure to acquire samples from the landings. Catches in numbers-at-age are given in Table 7.6.3.1 for the years 1972 to 2021 and a graphical representation is given in Figure 7.2.1. The catch in numbers at length is given in Table 7.2.2 for 1995 to 2021, excluding 2009.

7.2.2 Quality of catch and biological data

The number of samples acquired from the main catch component was 34 in 2021, which are similar sampling levels than has been achieved in the past. The number of measurements also remained similar to past sampling levels. At sea observer data have been collected since 2010 (~15% of fishing trips sampled annually) with no discards observed. In 2020 at-sea observations were not carried out due to the Covid-19 'social distancing' requirements, observations were reinstated in 2021 and discarding is not thought to be a feature of this fishery. Details of sampling are given in Table 7.2.3.

As a result of quality issues identified with the ageing of herring in the Irish Sea, a larger scale otolith exchange was completed in 2015. The results indicated relatively good agreement between ages and a consistent issue with inexperience readers that can be solved through further training.

The 2017 benchmark concluded to conduct future assessments only to include data back to 1980. Data extends back to 1961 and the entire data series was included in the assessment up to 2016, but there are well documented concerns over the quality of historic landings information, especially in the 1970s (see Stock Annex). Recent landings data, particularly since the introduction of buyers and sellers regulation in 2006, are considered to be of good quality.

7.3 Fishery Independent Information

7.3.1 Acoustic surveys AC(7.aN)

The information on the time-series of acoustic surveys in the Irish Sea is given in Table 7.3.1. The SSB estimates from the survey are calculated using the (annually varying) maturity ogives from the commercial catch data.

The acoustic survey in 2021 was carried out over the period 29th August– 12th September. The survey conditions were good. A survey design of stratified, systematic transects was employed, as in previous years (Figure 7.3.1). There was an area reduction in the survey due to logistical issues with vessel access to the survey area. Sprat and 0-group herring were distributed around the periphery of the Irish Sea (Figure 7.3.1). Highest abundance of 1+ herring targets in 2021 were observed on the western sides of the Isle of Man (Figure 7.3.1). Local areas of high abundance of herring were also observed on the known spawning banks toward the county Down coast. The survey followed the methods described in the ICES WGIPS International Pelagic Survey Manual. Sampling intensity was high during the 2021 survey with 31 successful trawls completed. The length frequencies generated from these trawls highlight the spatial heterogeneous nature of herring age groups in the Irish Sea (Figure 7.3.2).

The age-disaggregated acoustic estimates of the herring abundance, excluding 0-ring fish, are given in Table 7.3.2. Results of a microstructure analysis of 1-ringer+ fish (Figure 7.3.6–7) have not been updated since 2011. Winter hatched fish, of which the majority are thought to be of Celtic Sea origin, are present in the prespawning aggregations sampled in the Irish Sea during the acoustic survey. The presence of these winter hatched fish has implications for the estimates of 1-ringer+ biomass and SSB, as well as confounding traditional cohort type assessment methods. However, removal of winter hatched fish, leaving only fish of autumn spawning origin, does not change the perception of a significant increase in biomass estimates (Figures 7.3.6–7). The benchmark working group (ICES WKPELA 2012) investigated the mixing issue and its impact on the assessment. The benchmark group concluded that the data should be treated as for a mixed stock. Both the fishery and survey operate on this mixture and by using the data without adjustment for winter hatched fish, the assessment is conducted on the mixed stock. The recruitment data (1 winter rings) have the largest proportion of "alien" stock. The benchmark suggested that this is considered in the assessment model configuration and dealt with objectively within the model.

7.3.2 Spawning-stock biomass survey (7.aNSpawn)

A series of additional acoustic surveys has been conducted since 2007 by Northern Ireland, following the annual pelagic acoustic survey (conducted during the beginning of September). This enhanced survey programme was initiated to investigate the temporal and spatial variability of the population estimates from the routine acoustic survey. The purpose was to track the spawning migration entering into the Irish Sea via the North Channel on route to the main spawning grounds of the Douglas Bank. This informed design of the current survey to concentrate on the spawning grounds surrounding the Isle of Man and the Scottish coastal waters (Figure 7.3.3). Herring found in this area represents >75% of the SSB index generated from the routine survey. In 2021 the survey was conducted from the 3rd to 6th of October. The spawning stock biomass was estimated to be 57.1kt, this is a increase from 2020 (47.9kt) but remains within the previously observed range (28.4 – 114.0kt).

The historic density distributions from the surveys highlight the temporal and spatial complexity of the herring distributions. Problems with timing of the survey are further exacerbated by the

significant interannual variation in the migration patterns, evident from the changes in density distributions. The results confirm the high estimate of abundance observed during the routine annual acoustic survey estimates. The survey results support the high abundance of herring in the Irish Sea. Since 2012 this extended survey series has been reduced to one repeat survey in late September/early October to coincide with the main spawning time. The primary aim to generate an SSB index constituted from her- ring on or around the Irish Sea spawning ground to eliminate some of the ageing and mixing issues.

The 2012 benchmark (ICES WKPELA 2012) also suggested that the survey series could be used to fine tune the main survey used as the tuning fleet in the assessment. The survey uses a stratified design similar to the AC(7.a.N.). Survey methodology, data processing and subsequent analysis is exactly the same as for AC(7.a.N) and follows standard protocols for surveys coordinated by WGIPS. The survey was presented to WGIPS in 2017 prior to inclusion into the benchmark. The results of the survey are reported in the WGIPS 2018 report (ICES, 2018) and updated annually. The survey is included in the assessment as an SSB index. A comparison with the SSB estimates from this survey and the acoustic survey that is conducted earlier confirms the high abundance of herring in the Irish Sea, but with some clear year effect (Figure 7.3.5). This index is generated from a survey where the timing mostly coinciding with the spawners being present on the Douglas Bank. The survey has been conducted on a chartered commercial vessel since 2007, timing of the survey is directed by input from the commercial fishery reporting movements of fish onto the spawning grounds.

7.4 Mean weight, maturity and natural mortality-at-age

Biological sampling in 2021 was used to calculate mean weights-at-age in the catch (Table 7.6.3.2). The mean weights-at-age in the 3rd quarter catches (for the time-series 1980 to present) are used as estimates of stock weights at spawning time (Table 7.6.3.3). Mean weights-at-age have shown a general downward trend (Figure 7.4.1). This has also been observed in other stocks. It is recommended that potential drivers for this decline is investigated to explore potential large- scale ecosystem changes. No biological sampling information was available for 2009 and the weights at age for 2009 were replaced by averaging the weight at age observed in 2008 and 2010. The final agreed model from the 2012 benchmark used the natural mortality estimates from the North Sea (Table 7.6.3.4). These were again reviewed at the 2017 benchmark and although not considered ideal it is still the best available in the absence of specific Irish Sea derived natural mortality estimates. A variable maturity ogive is used based on the corresponding annual quarter 3 biological sampling from the catch (Table 7.6.3.5).

7.5 Recruitment

An estimate of total abundance of 0-ringers and 1-ringers is provided by the AC(7.aN) acoustic survey, with trends also provided by the groundfish surveys. There is evidence that a proportion of these are of Celtic Sea origin (e.g. Brophy and Danilowicz, 2002). Further, the SAM assessment provides estimates of the recruitment of herring in which information from the catch and from all fishery independent indices is incorporated. The recruitment trends from the assessment are dealt with in Section 7.6.

7.6 Assessment

7.6.1 Data exploration and preliminary modelling

The stock was benchmarked in 2017. The assessment model did not change and was applied without change in 2022. At the benchmark the following changes were made to the input data and model setting:

- The input data series was shortened to include data only from 1980 onwards, to remove poor quality historic data. Mohn's rho on SSB was reduced from 13.3 to 9% under shortened time-series, which will improve the basis for advice (9% in the current assessment);
- Minor changes have been made to the variance and parameter bindings, to improve the model fit (see Table 7.6.3.10);
- The random walk assumption on recruitment was removed. Recruitment patterns are now estimated from cohort back-tracking from older ages;
- Includes a new SSB survey index (derived from acoustic methods; see Section 7.3.2). The primary aim is to generate an SSB index constituting mainly herring on or around spawning ground to eliminate some of the age and mixing issues. The larval survey (also an indicator of SSB) was removed as it contributes little to the assessment model. In addition, the modelling framework did not allow from a technical perspective to include two SSB surveys;
- The SSB survey index was included in the assessment without estimating catchability, which effectively implies an assumed catchability of 1, with variance fixed at 0.4 (this corresponded to the observation variance value when catchability was freely estimated in a trial run).

The benchmark accepted the assessment and model settings, but requested further exploration of the sensitivity to catchability assumption for the SSB survey. This was completed post benchmark, however, the reviewers could not reach consensus and proposed that HAWG is best place to propose a final assessment model.

HAWG in 2017 had discussions on the final assessment model that could form the basis for the advice. This process is described in detail in Section 1.9 in the HAWG 2017 report. Despite ongoing concerns over the catchability assumption and the mixing issues from some members, the decision was made to use the SAM assessment settings agreed at the benchmark, together with the catchability assumptions discussed at HAWG, as the final model.

The primary issue with the current perception of stock status of Irish Sea herring is trying to reconcile the SAM model estimates of stock size (primarily driven by catch data) and the much higher estimate of stock size estimates from surveys that specifically focused on the spawning population within the Irish Sea. By design, acoustic surveys are aimed to produce an absolute estimate of stock biomass (with some uncertainty). This would result in a catchability of ~1. The previous assessment estimates catchability to be around ~ 2.5 for the acoustic survey. The benchmark also revealed very significant issues with the catch data, on which the previous assessment and advice is based on.

The concerns from the benchmark were satisfactorily addressed and did not highlight any major issues that could not be explained. In general, the assessment model fit improved in the proposed model where the SSB survey is included at the catchability set to 1. Given that the primary aim is to provide credible scientific advice, the best proposal on this trade-off scenario (neither of which are ideal), is to base the assessment and advice on a more balanced assessment model.

HAWG did recognize that this is not an ideal scenario and further work needs to be done in the short term to improve the assessment (see Section 1.9, HAWG 2017)

Acoustic (AC(7.a.N)) 1–8+ winter rings) and the SSB indices are available for the assessment of Irish Sea herring. 2021catch-at-age data are derived from the international landings. The SAM model fits the catch well, with the model being weighted towards the catch information. The residuals are relatively small (figures 7.6.1–17). The residuals in the numbers-at-age in the catch and acoustic survey generally appear to be independent of time, but there are still some patterns in later years. These patterns are somewhat expected and could be explained by annual changes in migration patterns, magnitude and extent of the mixed component and converging trends in the surveys in recent years. The year effect in the 2011 survey is also evident from these plots with consistent negative residuals at older (3+) ages (winter rings).

The acoustic survey fits reasonably well at all ages except for 1 winter rings, with a model overestimate of fish 5 years +. The model fit is poor for SSB survey index (Figure 7.6.17). This is expected considering the catchability assumption, but it also highlights the fact that the model can deviate from the q=1 fit and the realized catchability for the survey deviated from one.

Model fit is poor for 1 ringers in the catch and survey, which is the age with the highest occurrence of fish mixing from different hatching seasons. The modelled acoustic survey catchability parameter and the selectivity of the fishery by pentad are illustrated in figures 7.6.18–19. The variability of fishery selection is thought to reflect variable migration patterns and the effect of the spawning closure.

A feature of the assessment model is the estimation of an observation variance parameter for each dataset (Figure 7.6.20). Overall, the catch data (2+ winter ring) are associated with low observation variances, where 1 ringers (from catch and survey) are perceived to be the noisiest data series. Figure 7.6.21 shows observation variance vs. uncertainty of the data sources used in the model. Although the majority of the data sources are associated with relatively high observation variances, none of the uncertainty estimates are particularly high. The CVs do not indicate a lack of convergence of the assessment model.

7.6.2 Final assessment

The final assessment was carried out by fitting the state-space model (SAM, in the FLR environment) using the settings and data inputs in accordance to the stock annex (as decided at the 2017 benchmark and HAWG 2017). The input data and model settings are shown in Tables 7.6.3.1–11, the SAM output is presented in Tables 7.6.3.13–21, the stock summary in Table 7.6.3.12 and Figure 7.6.22, model fit and parameter estimates in Table 7.6.3.22, and negative log-likelihood for the model fit in Table 7.6.3.23.

Diagnostics and selectivity parameters for this run are presented in Figure 7.6.1–19. The stock parameters are estimated well by the model, as indicated by the relatively low uncertainty associated with the stock parameter (Figure 7.6.23), except for the most recent estimates.

The retrospective pattern shows a very similar perception in SSB, F and recruitment for the years 2016–21 (Figure 7.6.24). The retrospective bias from the model is low.

Comparison with previous assessments

A comparison of the estimates of this year's assessment with last year's is given in Figure 7.6.25. The stock was benchmarked in 2017, with updates made to the model configurations and input data sources (including a new SSB survey). The new perception of the stock provides biomass estimates more in between the acoustic survey and catch estimates. Recruitment assumptions in the assessment were changed, which resulted in higher interannual variability. While the trend in

fishing mortality is estimated to be stable, a historical comparison of the current assessment with previous assessments shows annual upward revision of fishing mortality and wide confidence intervals. The assessed historic SSB appears to be sensitive to addition of a new year of data resulting in revision during the recent time period.

7.6.3 State of the stock

Trends from the final assessment indicate an increase in SSB and recruitment since the mid-2000s, with a stabilizing trend in the most recent years (although uncertain). The associated F has decreased significantly over the last 10 years to below F_{MSY}. Based on the most recent estimates the stock is being harvested sustainably at, or below, F_{MSY}.

7.7 Short-term projections

7.7.1 Deterministic short-term projections

A deterministic short-term forecast was conducted for Irish Sea herring with code in R (FLR). Population abundances, F at age and input data were taken from the final SAM assessment, 1980–2021 (Table 7.7.1). Geometric mean recruitment of 1-ringers (2010–2019) replaced recruitment for 1-ringers in 2021 and is used as the intermediate year assumption. The forecast was based on catches (2021 advice = 8455 t) assuming full uptake of the ICES fishing opportunity advice. Fishing mortality, maturity-at-age, catch weights at age and stock weights were averaged over the most recent three years. Fishing mortality was not scaled to the last year, as the terminal estimate of F was not considered more informative.

The short-term catch option table is given in Table 7.7.2. SSB is expected to be well above MSY $B_{trigger}$ in 2022–2024, but is predicted to decrease if fishing at F_{MSY}. SSB with zero catch is forecast to increase (+14%). This is largely in response to maturation of the 2022 and 2023 year classes, which will contribute more than 53% of the SSB in 2024.

7.7.2 Yield per recruit

Not available, previous explorations are detailed in the stock annex.

7.8 Medium term projections

No medium term stock projections of stock size were conducted by the Working Group.

7.9 Reference points

MSY evaluations

New reference points were derived using the stock-recruit pairs generated by the 2017 assessment (WKIRISH3 and HAWG 2017). B_{lim} was set to the lowest SSB that generate above average recruitment, 8500 t. B_{pa}, 11 800 t calculated from B_{lim} with assessment error (σ = 0.201, based on the average CV from the terminal assessment year) MSY $B_{trigger}$ is set to B_{pa} as the stock has not been fished at or below F_{MSY} for more than five years. F_{MSY} median point estimates is 0.27 (0.266). The upper bound of the F_{MSY} range giving at least 95% of the maximum yield was estimated to 0.35(0.345) and the lower bound at 0.20(0.198). F_{lim} is estimated to be 0.40 (0.397) as F with 50%

probability of SSB $<B_{lim}$ with F_{pa} was modified to Fp_{05} as 0.309 calculated as the F that leads to SSB $\geq B_{lim}$ with 95% probability.

7.10 Quality of the assessment

The data used within the assessment, the assessment methods and settings were scrutinized during the 2017 benchmark (WKIRISH3 2017). The benchmark group performed sensitivity tests to test model configurations and optimized the model fit to the data with the least amount of parameters estimated. The Working Group checked for convergence and judged that a good model fit was found. FLSAM will not run if convergence criteria are not achieved.

The stock is very well sampled and catch information is representative of the fishery (with the exception of 2009 when no samples were provided). The current assessment, being a time-series model, can estimate the missing catch numbers in 2009.

The main issues with the stock are stock mixing (at younger ages from fish of different spawning season origin) and the different trends in mortality observed in the survey and the commercial catches. The majority of this variation may arise from the inter-annual variation in herring migration patterns and their effect on the selectivity of both the fishery and acoustic survey, but is also affected by the effect the annual closure of the Douglas Bank spawning grounds has on the fishery patterns. There are some inconsistencies between observed and modelled landings. The magnitude of these differs between years, but is on average +/-12% over the assessment period and mostly falls within the confidence limits of the estimate. The reason behind these needs further investigation, but might be due to conflicting mortality signals from the surveys and catches and the use of a constant M throughout the time-series.

The data are treated as for a mixed stock. Both the fishery and survey operate on this mixture and by using the data without adjustment for winter hatched fish, the assessment is conducted on the mixed stock. The mixing issue was considered in detail during the 2012 benchmark, but no further analysis was performed at the 2017 benchmark given that there was no new information presented. The noise in the data due to juvenile stock mixing resulted in increased estimates of F, catchability estimates >1 across the younger ages in the survey, or most likely a combination of these. Most of the mixing occurs at younger ages, and this is objectively, but only partially, corrected for in the model through a high catchability estimated for the acoustic survey. Currently, the model doesn't have the structure to specifically deal with the contribution of small herring from other stocks.

The F_{bar} range 4–6 is considered representative of the mortality (Figure 7.6.26) on the autumn spawning stock in the Irish Sea, excluding most the ages with significant mixed components and represent the age range with highest fish mortality.

The survey data quality is good, but the survey index is linked to the migration and biological characteristics of the stock and the need to assess similar stock components which the fishery exploits to ensure the sustainable exploitation of the Irish Sea spawning stock.

No major violations of the assumptions underpinning the assessment model were found. The final assessment model is dominated by information from the catch, but with the noise being added to the survey information as age and year effects. The model does fit the catch data significantly better despite the significant quality issues with the catch data reported at the 2017 benchmark. This is not desirable. The new survey information adds more weight to the previously observed increase abundance trend observed from the main age-disaggregated acoustic survey. The 2017 assessment model attempted to provide a more balanced model, giving more weight to the SSB survey.

SAM down weights the 1 ring data and survey information in general. The uncertainty estimates of the model parameters, suggest the model is both appropriate for the available data and that the model describes these data reasonably well. Whilst, the trend in fishing mortality is estimated to be stable the historic comparison of the current assessment with previous assessments shows an annual upward revision of fishing mortality. The confidence range of Fishing mortality estimates are large and inter-annual signal difficult to observe. This should be further explored.

7.11 Management considerations

Given the historical landings from this stock and the knowledge that fishing pressure is light and mostly confined to one pair of UK vessels it can be assumed that fishing pressure and activity has not varied considerably in recent years. The catches have been close to TAC levels and the main fishing activity has not varied considerably as shown from landing data (Figure 7.1.1).

The current assessment indicates SSB in 2021 to be the highest in the time-series and fishing mortalities below F_{MSY}. The forecast predicts a reduction in SSB in 2022. The Working Group supports the development of a long-term management plan for this stock. Such a plan should be further developed with stakeholders and for- warded to ICES for evaluation.

Characteristically of most herring stocks, the Irish Sea herring represents a mixture and management of this stock should be considered as part of a metapopulation. The consequence of this needs to be further evaluated for management and advice.

7.12 Ecosystem Considerations

The Sixth Workshop on an Ecosystem Based Approach to Fishery Management for the Irish Sea (WKIRISH6), set out to operationalise the WKIrish regional benchmark process. WKIrish aimed to incorporate ecosystem information into the ICES single-species stock assessment process for the Irish Sea. Three independent ecosystems models have been in development for the Irish Sea. Of these, an Ecopath with Ecosim (EwE) model has been reviewed by the ICES Working Group on Multispecies Assessment Methods (WGSAM). WKIrish propose to use relevant ecosystem indicators to inform the FMSY within the established F ranges ($F_{MSYLower}$ to $F_{MSYUpper}$). F_{ECO} uses indicaors of current ecosystem suitability for individual stocks to refine the F target values within these precautionary ranges. FIND is based on finding ecosystem indicators which are positively related to the stock development over the model tuning range, and where the likely underlying mechanisms for this link are likely to continue acting in the short to medium term. The EwE model was used to provide ecosystem indicator(s) for individual stocks (cod, whiting, haddock, sole, plaice, herring, and Nephrops) in the Irish Sea. The selection of the indicator aimed to cover a range of possible ecosystem processes on each stock. For herring, the large zooplankton index was observed to be strongly positively correlated with stock biomass and therefore selected as an appropriate indicator of favourable environmental condition for the stock.

Table 7.1.1 Herring (Clupea harengus) in Division 7.a North of 52°30'N (Irish Sea)Herring in Division 7.a North (Irish Sea).Working Group catch estimates in tonnes by country, 1987–2021. The total catch does not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995
Ireland	1 200	2 579	1 430	1 699	80	406	0	0	0
UK	3 290	7 593	3 532	4 613	4 318	4 864	4 408	4 828	5 076
Unallocated	1 333								
Total	5 823	10 172	4 962	6 312	4 398	5 270	4 408	4 828	5 076

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004
Ireland	100	0	0	0	0	862	286	0	749
UK	5 180	6 651	4 905	4 127	2 002	4 599	2 107	2 399	1 782
Unallocated	22								
Total	5 302	6 651	4 905	4 127	2 002	5 461	2 393	2 399	2 531

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013
Ireland	1 153	581	0	0	0	0	0	18	0
UK	3 234	3821	4 629	4895	4594	4894	5202	5675	4828
Unallocated						-			
Total	4 387	4 402	4 629	4895	4594	4894	5202	5693	4828

Country	2014	2015	2016	2017	2018	2019	2020	2021	
Ireland	119	0	82	200	1299	1317	1957	753	
UK	5089	4868	4245	3696	5504	5061	5969	6455	
Unallocated		22							
Total	5208	4891	4327	3896	6804	6378	7927	7208	

Table 7.2.2 Herring (Clupea harengus) in Division 7.a North of 52°30'N (Irish Sea)Herring in Division 7.a North (Irish Sea).Catch at length data 1995–2021. Numbers of fish in thousands. Table amended with 1990–1994 year-classes removed (see Annex 8).

Length (cm)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
14															-					-				16			
14.5															-					-				0	11		
15															-					15				31	50	11	
15.5					10								16		-	93				14				54	74		
16	21	21	17		19	12	9					2			-	107	30		8	0		109		47	233		
16.5	55	51	94		53	49	27			13	1	44	33	1	-	487	165		84	14		174		176	401	106	
17	139	127	281	26	97	67	53			25	39	140	69	3	-	764	356	89	202	213	16	261	86	431	883	428	37
17.5	148	200	525	30	82	97	105			84	117	211	286	11	-	1155	851	143	470	808	32	413	62	749	1170	1250	54
18	300	173	1022	123	145	115	229			102	291	586	852	34	-	1574	1406	301	533	1644	72	326	148	594	1532	1934	124
18.5	280	415	1066	206	135	134	240	36		114	521	726	2088	64	-	1405	841	533	555	3246	64	457	148	1097	1346	2913	144
19	310	554	1720	317	234	164	385	18		203	758	895	2979	85	-	866	1029	479	588	5357	136	522	234	841	1051	2832	337
19.5	305	652	1263	277	82	97	439	0	29	269	933	1246	3527	108	-	673	1026	493	680	5371	199	718	382	928	1331	1996	368
20	326	749	1366	427	218	109	523	0	73	368	943	984	3516	100	-	787	1062	298	1041	4025	271	826	1121	1608	1585	2438	825
20.5	404	867	1029	297	242	85	608	18	215	444	923	1443	2852	133	-	888	1502	511	1419	2905	279	1087	1343	1881	2263	2857	970
21	468	886	1510	522	449	115	1086	307	272	862	1256	1521	3451	192	-	1470	1874	643	2364	2608	439	1783	3154	3352	2716	3624	2 048

Length (cm)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
21.5	782	1258	1192	549	362	138	1201	433	290	1007	1380	1621	2929	217	-	1758	1396	1104	2963	2381	854	1762	3007	3838	3340	5419	2 879
22	1509	1530	2607	1354	1261	289	1748	1750	463	1495	1361	2748	3821	271	-	2363	2372	1586	3052	2906	1896	2588	4374	5232	4676	6 594	5 058
22.5	2541	2190	2482	1099	2305	418	1763	1949	600	2140	1448	3629	3503	229	-	3362	2778	2404	3599	2766	2028	2675	2711	6046	4289	7 828	6 343
23	4198	2362	3508	2493	4784	607	2670	2490	1158	2089	1035	4358	4196	322	-	4530	4100	3920	3432	2596	2470	2893	3475	7485	4476	7 872	7 176
23.5	4547	2917	3902	2041	4183	951	2254	1552	1380	2214	1256	2920	3697	264	-	5232	3394	6024	3039	1775	1977	3110	2625	6404	3745	7 378	6 435
24	4416	3649	4714	3695	4165	1436	3489	1029	1273	2054	1276	3679	3178	259	-	4559	4759	8849	3882	2161	2124	2849	2649	6912	4841	6 065	5 589
24.5	3391	4077	4138	2769	3397	1783	4098	758	1249	2269	1083	2431	2136	204	-	3616	3729	7777	3985	1879	1911	2523	2144	4992	5033	5 004	3 986
25	3100	4015	5031	2625	2620	2144	5566	776	1163	1749	1086	3438	1503	148	-	3083	3430	7020	3364	2282	2367	2414	2378	4462	3713	3 362	2 586
25.5	2358	3668	3971	2797	1817	1791	4785	1335	1211	1206	584	2198	952	114	-	2582	2662	5759	2693	2264	2319	2458	1824	2632	2079	3 102	1 190
26	2334	2480	3871	3115	1694	1349	3814	1570	1140	823	438	1714	643	78	-	1777	2343	4835	1934	1612	1962	1936	1331	1455	1401	1 945	772
26.5	1807	2177	2455	2641	1547	840	2243	1552	1573	587	203	605	330	42	-	950	1595	2664	1026	900	1016	1631	739	798	421	900	290
27	1622	1949	1711	2992	1475	616	1489	776	1607	510	165	445	147	23	-	460	1083	1716	412	498	827	826	370	458	210	342	181
27.5	990	1267	1131	1747	867	479	644	433	1189	383	60	155	72	10	-	216	472	629	179	326	252	283	123	198	41	119	76
28	834	906	638	1235	276	212	496	162	726	198	45	104	33	12	-	9	248	231	85	256	141	65	37	104	52	29	18
28.5	123	564	440	170	169	58	179	108	569	51	18	9	26	1	-		53	159	28	156	48	65	12	0	11	80	2
29	248	210	280	111	61	42	10	36	163		12	46			-	9		108		57	16	22	25	16			
29.5	56	79	59	92		12	0	36	129				7		-			54		14	8		12	0			

Length (cm)	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
30	40	32	8	84		6	9		43						-			17		0	8						
30.5																											
31																											1

Table 7.2.3 Herring (Clupea harengus) in Division 7.a North of 52°30'N (Irish Sea)Herring in Division 7.a North (Irish Sea).Sampling intensity of commercial landings in 2021.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged
1	Ireland	0	-	-	-
	UK (N. Ireland)	784	-	-	-
	UK (Isle of Man)	*	-	-	-
	UK (Scotland)	0	-	-	-
	UK (England & Wales)	0	-	-	-
2	Ireland	0	-	-	-
	UK (N. Ireland)	0	-	-	-
	UK (Isle of Man)	*	-	-	-
	UK (Scotland)	0	-	-	-
	UK (England & Wales)	0	-	-	-
3	Ireland	403	7	1840	350
	UK (N. Ireland)	5576	24	2715	1180
	UK (Isle of Man)	*	-	-	-
	UK (Scotland)	0	-	-	-
	UK (England & Wales)	0	0	0	0
4	Ireland	350	3	789	150
	UK (N. Ireland)	95	0	0	0
	UK (Isle of Man)	*	-	-	-
	UK (Scotland)	0	-	-	-
	UK (England & Wales)	0	-	-	-

* no information, but catch is likely to be negligible

Table 7.3.1. Herring (Clupea harengus) in Division 7.a North of 52°30'N (Irish Sea)Herring in Division 7.a North (Irish Sea).Summary of acoustic survey AC(7.aN) information for the period 1989–2021. Small clupeoids include sprat and 0-ring herring unless otherwise stated. CVs are approximate. Biomass in t. All surveys carried out at 38 kHz except December 1996, which was at 120 kHz.

Year	Area	Dates	herring biomass (1+rings)	CV	herring biomass (SSB)	CV	small clupeoids (biomass)	CV
1989	Douglas Bank	25/09–26/09			18 000	-	-	-

Year	Area	Dates	herring bio-mass (1+rings)	CV	herring biomass (SSB)	CV	small clupeoids (biomass)	CV
1990	Douglas Bank	26/09–27/09			26 600	-	-	-
1991	W. Irish Sea	26/07–8/08	12 760	0.23			66 0001	0.20
1992	W. Irish Sea + IOM E. coast	20/07–31/07	17 490	0.19			43 200	0.25
1994	Area 7.a(N)	28/08–8/09	31 400	0.36	25 133	-	68 600	0.10
	Douglas Bank	22/09–26/09			28 200	-	-	-
1995	Area 7.a(N)	11/09–22/09	38 400	0.29	20 167	-	348 600	0.13
	Douglas Bank	10/10–11/10		-	9 840	-	-	-
	Douglas Bank	23/10–24/10			1 750	0.51	-	-
1996	Area 7.a(N)	2/09–12/09	24 500	0.25	21 426	0.25	-2	-
1997	Area 7.a(N)-reduced	8/09–12/09	20 100	0.28	10 702	0.35	46 600	0.20
1998	Area 7.a(N)	8/09–14/09	14 500	0.20	9 157	0.18	228 000	0.11
1999	Area 7.a(N)	6/09–17/09	31 600	0.59	21 040	0.75	272 200	0.10
2000	Area 7.a(N)	11/09–21/09	40 200	0.26	33 144	0.32	234 700	0.11
2001	Area 7.a(N)	10/09–18/09	35 400	0.40	13 647	0.42	299 700	0.08
2002	Area 7.a(N)	9/09–20/09	41 400	0.56	25 102	0.83	413 900	0.09
2003	Area 7.a(N)	7/09–20/09	49 500	0.22	24 390	0.24	265 900	0.10
2004	Area 7.a(N)	6/09–10/09 15/09–16/09 28/09–29/09	34 437	0.41	21 593	0.41	281 000	0.07
2005	Area 7.a(N)	29/08–14/09	36 866	0.37	31 445	0.42	141 900	0.10

Year	Area	Dates	herring biomass (1+rings)	CV	herring biomass (SSB)	CV	small clupeoids (biomass)	CV
2006	Area 7.a(N)	30/08–9/09	33 136	0.24	16 332	0.22	143 200	0.09
2007	Area 7.a(N)	29/08–13/09	120 878	0.53	51 819	0.42	204 700	0.09
2008	Area 7.a(N)	27/08–14/09	106 921	0.22	77 172	0.23	252 300	0.12
2009	Area 7.a(N)	1/09–13/09	95 989	0.39	71 180	0.47	175 000	0.08
2010	Area 7.a(N)	28/08–11/09	131 849	0.22	99 877	0.22	107 400	0.10
2011	Area 7.a(N)	27/08–10/09 11–12/10	131 527	0.36	49 128	0.22	280 000	0.11
2012	Area 7.a(N)	29/08–12/09	79 051	0.18	56 759	0.22	171 190	0.11
2013	Area 7.a(N)	29/08–12/09	65 649	0.24	55 350	0.25	255 268	0.09
2014	Area 7.a(N)	27/08–14/09	79 826	0.30	56 629	0.33	393 024	0.10
2015	Area 7.a(N)	29/08–17/09	55 773	0.24	29 056	0.23	237 063	0.09
2016	Area 7.a(N)	31/08–15/09	102840	0.25	91332	0.28	240 926	0.10
2017	Area 7.a(N)	28/08–09/09	40974	0.21	36499	0.23	219 186	0.09
2018	Area 7.a(N)	29/08–13/09	54661	0.29	39997	0.31	196 600	0.13
2019	Area 7.a(N)	28/08–13/09	68078	0.09	39318	0.08	146 140	0.08
2020	Area 7.a(N)	26/08–09/09	59645	0.09	40076	0.09	110401	0.10
2021	Area 7.a(N)	29/08–12/09	69432	0.09	56486	0.09	84398	0.17

[1] **sprat only**

[2]**Data can be made available for the IoM waters only**

Table 7.3.2. Herring (Clupea harengus) in Division 7.a North of 52°30'N (Irish Sea)Herring in Division 7.a North (Irish Sea).Age-disaggregated acoustic estimates (thousands) of herring abundance from the Northern Ireland surveys in September AC(7.aN). Ages in winter rings.

AGE (RINGS)	1	2	3	4	5	6	7	8+
1994	66.8	68.3	73.5	11.9	9.3	7.6	3.9	10.1
1995	319.1	82.3	11.9	29.2	4.6	3.5	4.9	6.9
1996	11.3	42.4	67.5	9	26.5	4.2	5.9	5.8
1997	134.1	50	14.8	11	7.8	4.6	0.6	1.9
1998	110.4	27.3	8.1	9.3	6.5	1.8	2.3	0.8
1999	157.8	77.7	34	5.1	10.3	13.5	1.6	6.3
2000	78.5	103.4	105.3	27.5	8.1	5.4	4.9	2.4
2001	387.6	93.4	10.1	17.5	7.7	1.4	0.6	2.2
2002	391	71.9	31.7	24.8	31.3	14.8	2.8	4.5
2003	349.2	220	32	4.7	3.9	4.1	1	0.9
2004	241	115.5	29.6	15.4	2.1	2.3	0.2	0.2
2005	94.3	109.9	97.1	17	8	0.8	0.6	5.8
2006	374.7	96.6	15.6	10.0	0.5	0.4	0.5	0.5
2007	1316.7	251.3	46.6	21.1	20.8	1.2	0.7	0.6

AGE (RINGS)	1	2	3	4	5	6	7	8+
2008	475.7	452.4	114.2	39.1	26.4	17.1	4.3	0.6
2009	371.2	182.6	177.8	92.7	32.5	15.1	13.9	6.9
2010	580.6	561.2	117.7	120.8	34.3	16.8	4.3	6.5
2011	1927.0	330.2	43.9	15.0	21.9	6.3	2.7	2.0
2012	369.1	191.9	161.0	51.4	21.6	19.3	12.1	3.1
2013	100.0	285.2	81.6	54.3	41.2	13.4	11.1	6.8
2014	299.7	193.3	127.3	29.7	43.1	17.3	7.8	12.5
2015	491.9	141.9	25.2	17.0	10.3	9.0	1.9	4.3
2016	131.5	449.3	257.2	110.2	32.2	18.3	8.2	7.0
2017	42.2	89.7	104.1	56.5	9.0	20.3	4.4	11.8
2018	237.9	120.7	63.3	110.9	29.6	7.6	7.9	5.1
2019	148.9	247.5	44.7	21.2	14.6	9.0	1.8	0.9

AGE (RINGS)	1	2	3	4	5	6	7	8+
2020	247.4	96.7	115.6	16.2	7.8	11.7	2.7	0.9
2021	101.8	423.9	177.6	24.4	2.0	2.5	0.3	0.1

Table 7.6.3.1. Irish Sea Herring. Catch in number. Units: thousands

age/year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	5840	5050	5100	1305	1168	2429	4491	2225	2607	1156	2313	1999	12145
2	25760	15790	16030	12162	8424	10050	15266	12981	21250	6385	12835	9754	6885
3	19510	3200	5670	5598	7237	17336	7462	6146	13343	12039	5726	6743	6744
4	8520	2790	2150	2820	3841	13287	8550	2998	7159	4708	9697	2833	6690
5	1980	2300	330	445	2221	7206	4528	4180	4610	1876	3598	5068	3256
6	910	330	1110	484	380	2651	3198	2777	5084	1255	1661	1493	5122
7	360	290	140	255	229	667	1464	2328	3232	1559	1042	719	1036
8+	230	240	380	59	479	724	877	1671	4213	1956	1615	815	392

age/year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	646	1970	3204	5335	9551	3069	1810	1221	2713	179	694	3225	8692
2	14636	7002	21330	17529	21387	11879	16929	3743	11473	9021	4694	8833	13980
3	3008	12165	3391	9761	7562	3875	5936	5873	7151	1894	3345	5405	10555
4	3017	1826	5269	1160	7341	4450	1566	2065	13050	1866	2559	2161	3287
5	2903	2566	1199	3603	1641	6674	1477	558	3386	2395	882	623	1422
6	1606	2104	1154	780	2281	1030	1989	347	936	953	2945	213	415
7	2181	1278	926	961	840	2049	444	251	650	474	872	673	292
8+	848	1991	1452	1364	1432	451	622	147	803	337	605	127	368

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	5669	20290	8939	NA	9588	7454	2491	3889	27377	1654	2216	2112
2	15253	18291	18974	NA	17627	17598	9664	18916	9567	15414	19064	12844
3	8198	4980	7487	NA	6679	8984	12247	6836	7917	4840	5992	12419
4	6318	1655	2696	NA	6201	3982	7944	6631	1997	7376	4677	4407
5	1325	1062	2082	NA	3200	3671	3061	2901	1759	1613	2050	609
6	605	325	1761	NA	925	1751	3158	1472	964	4276	1421	1065
7	262	122	328	NA	370	690	1591	625	409	1678	896	487
8+	246	111	216	NA	185	425	652	352	830	1112	759	623

age	2018	2019	2020	2021
1	7991	12176	15260	5708
2	22903	23112	29059	35337
3	15657	11083	20869	13744
4	12364	6776	4099	3033
5	3240	6661	3355	1163
6	538	1360	3200	976
7	391	182	777	140
8+	50	194	209	26

Table 7.6.3.2. Irish Sea Herring. Weights-at-age in the catch. Units: kg

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.074	0.074	0.074	0.074	0.076	0.087	0.068	0.058	0.070	0.081	0.096	0.073
2	0.155	0.155	0.155	0.155	0.142	0.125	0.143	0.130	0.124	0.128	0.140	0.123
3	0.195	0.195	0.195	0.195	0.187	0.157	0.167	0.160	0.160	0.155	0.166	0.155
4	0.219	0.219	0.219	0.219	0.213	0.186	0.188	0.175	0.170	0.174	0.175	0.171
5	0.232	0.232	0.232	0.232	0.221	0.202	0.215	0.194	0.180	0.184	0.187	0.181
6	0.251	0.251	0.251	0.251	0.243	0.209	0.228	0.210	0.198	0.195	0.195	0.190
7	0.258	0.258	0.258	0.258	0.240	0.222	0.239	0.218	0.212	0.205	0.207	0.198
8+	0.278	0.278	0.278	0.278	0.273	0.258	0.254	0.229	0.232	0.218	0.218	0.217

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.062	0.089	0.070	0.075	0.067	0.064	0.080	0.069	0.064	0.067	0.085	0.081
2	0.114	0.127	0.123	0.121	0.116	0.118	0.123	0.120	0.120	0.106	0.113	0.116
3	0.140	0.157	0.153	0.146	0.148	0.146	0.148	0.145	0.148	0.139	0.144	0.136
4	0.155	0.171	0.170	0.164	0.162	0.165	0.163	0.167	0.168	0.156	0.167	0.160
5	0.165	0.182	0.180	0.176	0.177	0.176	0.181	0.176	0.188	0.168	0.180	0.167
6	0.174	0.191	0.189	0.181	0.199	0.188	0.177	0.188	0.204	0.185	0.184	0.172
7	0.181	0.198	0.202	0.193	0.200	0.204	0.188	0.190	0.200	0.198	0.191	0.186
8+	0.197	0.212	0.212	0.207	0.214	0.216	0.222	0.210	0.213	0.205	0.217	0.199

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.073	0.067	0.064	0.067	0.071	0.0620	0.053	0.058	0.070	0.059	0.066	0.070
2	0.107	0.103	0.105	0.112	0.110	0.1080	0.106	0.106	0.120	0.100	0.110	0.106
3	0.130	0.136	0.131	0.135	0.135	0.1330	0.131	0.134	0.138	0.130	0.146	0.136
4	0.157	0.156	0.149	0.158	0.153	0.1490	0.145	0.152	0.152	0.142	0.177	0.148
5	0.165	0.166	0.164	0.173	0.156	0.1545	0.153	0.159	0.164	0.157	0.174	0.155
6	0.187	0.180	0.177	0.183	0.182	0.1730	0.164	0.175	0.174	0.165	0.176	0.157
7	0.200	0.191	0.184	0.199	0.196	0.1855	0.175	0.187	0.179	0.170	0.196	0.167
8+	0.205	0.209	0.211	0.227	0.206	0.1890	0.172	0.196	0.191	0.180	0.198	0.171

age	2016	2017	2018	2019	2020	2021
1	0.054	0.072	0.060	0.057	0.057	0.069
2	0.102	0.093	0.096	0.096	0.095	0.101
3	0.126	0.121	0.120	0.119	0.119	0.119
4	0.143	0.140	0.132	0.137	0.138	0.133
5	0.159	0.147	0.147	0.143	0.143	0.148
6	0.161	0.154	0.159	0.156	0.152	0.148
7	0.167	0.154	0.164	0.159	0.160	0.160
8+	0.177	0.162	0.204	0.181	0.174	0.167

Table 7.6.3.3. Irish Sea Herring. Weights-at-age in the stock. Units: kg.

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.074	0.074	0.074	0.074	0.076	0.087	0.068	0.058	0.070	0.081	0.077	0.070
2	0.155	0.155	0.155	0.155	0.142	0.125	0.143	0.130	0.124	0.128	0.135	0.121
3	0.195	0.195	0.195	0.195	0.187	0.157	0.167	0.160	0.160	0.155	0.163	0.153
4	0.219	0.219	0.219	0.219	0.213	0.186	0.188	0.175	0.170	0.174	0.175	0.167
5	0.232	0.232	0.232	0.232	0.221	0.202	0.215	0.194	0.180	0.184	0.188	0.180
6	0.251	0.251	0.251	0.251	0.243	0.209	0.229	0.210	0.198	0.195	0.196	0.189
7	0.258	0.258	0.258	0.258	0.240	0.222	0.239	0.218	0.212	0.205	0.207	0.195
8+	0.278	0.278	0.278	0.278	0.273	0.258	0.254	0.229	0.232	0.218	0.217	0.214

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.061	0.088	0.073	0.072	0.067	0.063	0.073	0.068	0.063	0.066	0.085	0.081
2	0.111	0.126	0.126	0.120	0.115	0.119	0.121	0.121	0.120	0.105	0.113	0.116
3	0.136	0.157	0.154	0.147	0.148	0.148	0.150	0.145	0.149	0.139	0.144	0.136
4	0.151	0.171	0.174	0.168	0.162	0.167	0.166	0.168	0.171	0.156	0.167	0.160
5	0.159	0.183	0.181	0.180	0.177	0.178	0.179	0.178	0.188	0.167	0.180	0.167
6	0.171	0.191	0.190	0.185	0.195	0.189	0.190	0.189	0.204	0.183	0.184	0.172
7	0.179	0.198	0.203	0.197	0.199	0.206	0.200	0.199	0.205	0.199	0.191	0.186
8+	0.191	0.214	0.214	0.212	0.212	0.214	0.230	0.214	0.215	0.205	0.217	0.199

age	2004	2005	2006	2007	2008		2009	2010	2011	2012	2013	2014	2015
1	0.067	0.067	0.064	0.073	0.071	0.0660	0.060	0.057	0.059	0.057	0.069	0.070	
2	0.114	0.103	0.105	0.114	0.110	0.1140	0.118	0.109	0.109	0.100	0.112	0.106	
3	0.144	0.136	0.131	0.137	0.135	0.1350	0.134	0.136	0.131	0.131	0.150	0.136	
4	0.161	0.156	0.149	0.158	0.153	0.1500	0.147	0.155	0.149	0.142	0.178	0.148	
5	0.170	0.166	0.164	0.174	0.156	0.1550	0.153	0.162	0.153	0.157	0.174	0.155	
6	0.192	0.180	0.177	0.183	0.182	0.1740	0.165	0.177	0.162	0.167	0.176	0.157	
7	0.202	0.191	0.184	0.199	0.196	0.1860	0.176	0.188	0.168	0.175	0.196	0.167	
8+	0.214	0.209	0.211	0.227	0.206	0.1895	0.173	0.197	0.190	0.180	0.202	0.171	

age	2016	2017	2018	2019	2020	2021
1	0.054	0.072	0.060	0.057	0.057	0.069
2	0.102	0.093	0.096	0.096	0.095	0.101
3	0.126	0.121	0.120	0.119	0.119	0.119
4	0.143	0.140	0.132	0.137	0.138	0.133
5	0.159	0.147	0.147	0.143	0.143	0.148
6	0.161	0.154	0.159	0.156	0.152	0.148
7	0.167	0.154	0.164	0.159	0.160	0.160
8+	0.177	0.162	0.204	0.181	0.174	0.167

Table 7.6.3.4 Irish Sea Herring. Natural mortality. Units: NA

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787
2	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380
3	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353
4	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335
5	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
6	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311
7	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
8+	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787
2	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380
3	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353
4	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335
5	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
6	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311
7	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
8+	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787	0.787
2	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380
3	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.353
4	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335	0.335
5	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
6	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311	0.311
7	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
8+	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304

age	2016	2017	2018	2019	2020	2021
1	0.787	0.787	0.787	0.787	0.787	0.787
2	0.380	0.380	0.380	0.380	0.380	0.380
3	0.353	0.353	0.353	0.353	0.353	0.353
4	0.335	0.335	0.335	0.335	0.335	0.335
5	0.315	0.315	0.315	0.315	0.315	0.315
6	0.311	0.311	0.311	0.311	0.311	0.311
7	0.304	0.304	0.304	0.304	0.304	0.304
8+	0.304	0.304	0.304	0.304	0.304	0.304

Table 7.6.3.5. Irish Sea Herring. Proportion mature. Units: NA.

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.20	0.19	0.10	0.02	0.00	0.14	0.31	0.00	0.00	0.07	0.06	0.04	0.28	0.00	0.19
2	0.88	0.89	0.80	0.73	0.69	0.62	0.73	0.85	0.90	0.63	0.66	0.30	0.48	0.46	0.68
3	0.95	0.90	0.89	0.88	0.83	0.71	0.66	0.91	0.96	0.93	0.90	0.74	0.72	0.99	0.99
4	0.95	0.94	0.91	0.90	0.93	0.88	0.81	0.87	0.99	0.95	0.95	0.82	0.81	1.00	0.97
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.10	0.02	0.04	0.30	0.02	0.14	0.15	0.02	0.11	0.114	0.20	0.19	0.16	0.16	0.13
2	0.86	0.60	0.82	0.83	0.84	0.79	0.54	0.92	0.76	1.000	0.97	0.89	0.94	0.84	0.82
3	0.94	0.96	0.95	0.97	0.95	0.99	0.88	0.95	0.95	0.970	0.99	1.00	0.98	1.00	0.97
4	0.99	0.83	1.00	0.99	0.97	1.00	0.97	0.98	0.97	1.000	1.00	1.00	1.00	1.00	0.98
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00	1.00	1.00
8+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00	1.00	1.00

age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	0.11	0.08	0.10	0.06	0.16	0.11	0.07	0.10	0.08	0.16	0.04	0.12
2	0.92	0.90	0.84	0.82	0.94	0.87	0.81	0.85	0.67	0.90	0.80	0.95
3	1.00	1.00	1.00	0.99	1.00	1.00	0.99	1.00	0.97	1.00	0.97	1.00
4	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 7.6.3.6. Irish Sea Herring. Fraction of harvest before spawning. Units: NA

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
4	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8+	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
4	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8+	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
3	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
4	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8+	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Table 7.6.3.7. Irish Sea Herring. Fraction of natural mortality before spawning. Units: NA

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
3	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
4	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
5	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
6	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
7	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
8+	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
3	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
4	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
5	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
6	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
7	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
8+	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
3	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
4	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
5	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
6	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
7	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
8+	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

TABLE 7.6.3.9 Irish Sea Herring. STOCK OBJECT CONFIGURATION

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
1	8	8	1980	2020	4	6

TABLE 7.6.3.10 Irish Sea Herring. sam CONFIGURATION SETTINGS

```
name         :
desc         :
range        :     min     max plusgroup   minyear   maxyear   minfbar   maxfbar
range        :       1       8       8     1980      2021       4       6
fleets       :    catch  AC(VIIaN) VIIaNSpawn
fleets       :       0       2       3
plus.group   : TRUE
states       :          age
states       : fleet       1  2  3  4  5  6  7  8
states       :  catch      1  2  3  4  5  6  7  7
states       :  AC(VIIaN)  NA NA NA NA NA NA NA NA
states       :  VIIaNSpawn NA NA NA NA NA NA NA NA
logN.vars    : 1 1 1 1 1 1 1 1
catchabilities :          age
catchabilities : fleet       1  2  3  4  5  6  7  8
catchabilities :  catch     NA NA NA NA NA NA NA NA
catchabilities :  AC(VIIaN)  1  2  3  4  4  4  4  4
catchabilities :  VIIaNSpawn NA NA NA NA NA NA NA NA
power.law.exps :          age
power.law.exps : fleet       1  2  3  4  5  6  7  8
power.law.exps :  catch     NA NA NA NA NA NA NA NA
power.law.exps :  AC(VIIaN)  NA NA NA NA NA NA NA NA
power.law.exps :  VIIaNSpawn NA NA NA NA NA NA NA NA
f.vars       :          age
f.vars       : fleet       1  2  3  4  5  6  7  8
f.vars       :  catch      1  1  2  2  2  3  4  4
f.vars       :  AC(VIIaN)  NA NA NA NA NA NA NA NA
f.vars       :  VIIaNSpawn NA NA NA NA NA NA NA NA
obs.vars     :          age
obs.vars     : fleet       1  2  3  4  5  6  7  8
obs.vars     :  catch      1  2  2  2  3  3  3  3
```

obs.vars : AC(VIIaN) 4 5 5 5 5 6 6 6

obs.vars : VIIaNSpawn NA NA NA NA NA NA NA NA

srr : 0

cor.F : FALSE

nohess : FALSE

timeout : 3600

sam.binary :

TABLE 7.6.3.11 Irish Sea Herring. FLR, R SOFTWARE VERSIONS

FLSAM.version 1.02

FLCore.version 2.6.6

R.version R version 3.2.0 (2015-04-16)

platform i386-w64-mingw32

run.date 2021-03-18 19:44:30