7 Herring in Division 7.a North (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 Advice and management applicable to 2018 and 2019

In 2018 a TAC of 7016 t was adopted, partitioned as 5190 t to the UK and 1826 t to the Republic of Ireland. In 2018 ACOM advised on the basis of MSY approach that landings in 2019 should be equal or less than 6896 t. A TAC of 6896t was adopted for 2019 as advised by ICES.

7.1.2 The fishery in 2018

The catches reported from each country for the period 1987 to 2018 are given in Table 7.1.1, and total catches from 1961 to 2018 in Figure 7.1.1. Reported international landings in 2018 for the Irish Sea amounted to 6804 t with UK vessels acquiring the majority of the quota through swaps with the Republic of Ireland. The majority of catches in 2018 were taken during the 3rd quarter.

The 2018 7.a(N) herring fishery started off 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 a UK pair trawlers and by mid-water pelagic fishing vessels from Ireland. In previous years a 'Mourne' fishery, limited to boats under 40ft usually in October and November, this fishery landed 9.5 t in 2018

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. Any alterations to the present closures should be considered carefully.

7.1.4 Changes in fishing technology and fishing patterns

UK pair trawlers takes the majority of catches during the 3rd and 4th quarters, but from 2011 to 2015 a single pelagic trawler took some of the TAC. 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 10t landings attributed to this fishery in 2018. There was a marked increase in the landings made by Irish vessels in 2018 comprising 19% of the landings compared to an average of 2% in the preceding three years.

7.2 Biological Composition of the Catch

7.2.1 Catch in numbers

Routine sampling of the main catch component was conducted in 2018, with sampling coverage concentrated on the pelagic trawlers, with sampling carried out on landings at fish processing factories for both Irish and Northern Irish 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 2018 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 2018, excluding 2009.

7.2.2 Quality of catch and biological data

The number of samples acquired from the main catch component was 21 in 2018, 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 (~7% of fishing trips sampled annually) with no discards observed. 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 2018 was carried out over the period 29 August–13 September. The survey conditions were good. A survey design of stratified, systematic transects was employed, as in previous years (Figure 7.3.1). Sprat and 0-group herring were distributed around the periphery of the Irish Sea (Figure 7.3.1). The bulk of 1+ herring targets in 2018 were observed on both the east and western sides of the Isle of Man (Figure 7.3.1) and off the Northern Ireland County Down coast, where herring aggregations have now been observed consistently for a number of years. Abundance of herring was particularly high in this area. The continuing observation of herring aggregation in the western Irish Sea in distinct areas merits an investigation of possibly re-stratifying the survey area and index. The survey followed the methods described in the ICES WGIPS 2018 report. Sampling intensity was high during the 2017 survey with 32 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 estimate of herring SSB of 91 332 t for 2016 was near the series high 2010 estimate (Table 7.3.1, Figure 7.3.4). In 2018 the estimate was 39 997 t, similar to that observed in 2017. The biomass estimate of 54 661 t for 1+ ringers is a 25% increase on last year's biomass estimate. Unlike in previous years when a large proportion of the 1+biomass estimate is seen in north of the Isle of Man and in North Channel, in the current year the majority of biomass was observed in the south east of the Isle of Man area. The western and northern Irish Sea are areas of mixed size fish.

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 pre-spawning 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 the 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 highest 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). The enhanced survey programme was initiated to investigate the temporal and spatial variability in 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. The survey only concentrates on the spawning grounds surrounding the Isle of Man and the Scottish coastal waters (Figure 7.3.4). Herring found in this area represents >75% of the SSB index generated from the routine survey.

The surveys were roughly timed every fortnight, except for the last survey. The 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 to coincide with the main spawning time. The primary aim to generate an SSB index constituted from herring on or around the Irish Sea spawning ground to eliminate some of the age 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.aN. Survey methodology, data processing and subsequent analysis is exactly the same as for AC(7.aN) 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 is reported in the WGIPS 2018 report (ICES, 2018). The survey is included in the assessment as a SSB index. Comparison with the SSB estimates from this survey compared to 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.

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

Biological sampling in 2018 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 whole time-series 1961 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). 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 Northern Ireland 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 2019. 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 was reduced from 13.3 to 9% under shortened time series, which will improve the basis for advice

- 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 9 years of repeat surveys that specifically focussed 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 recognise 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.aN)) 1–8+ winter rings) and the SSB indices are available for the assessment of Irish Sea herring. 2018 catch-at-age data 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. 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 realised 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 in fishery selection reflects 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 data set (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 2016–18 (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.

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 stabilising 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 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 developed in R software. Population abundances, F at age and input data were taken from the final SAM assessment, 1980–2018 (Table 7.7.1). Geometric mean recruitment of 1-ringers (2007–2016) replaced recruitment for 1-ringers in 2018. The forecast was based on a TAC (2019 quota = 6896 t) assuming full uptake of the quota. 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 2018–2020, but is predicted to decrease if fishing at F_{MSY}. SSB with zero catch is forecast to increase (+19.3%). This is largely in response to maturation of the 2018 year class, which will contribute more than 26% of the SSB in 2020.

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} as 0.29 (0.286) calculated as F_{lim} combined with the assessment error; F_{lim} x exp(-1.645 x σ); σ = 0.231.

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 optimised 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 (3) estimated for the acoustic survey. Currently, the model doesn't have the structure to specifically deal with the emigration of small herring from other stocks.

The F_{bar} range 4–6 is considered representative of the mortality on the autumn spawning stock in the Irish Sea, excluding most the ages with significant mixed components.

The survey data quality is good, but the survey index is variable 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 validations of the assumption 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. Very little retrospective bias was also present.

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 and forecast indicate SSB to be the highest in the time series and fishing mortalities below F_{MSY}. 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 forwarded 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

No additional information presented (see Stock Annex).

Table 7.1.1 Herring in Division 7.a North (Irish Sea). Working Group catch estimates in tonnes by country, 1987–2018. 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
Ireland	119	0	82	200	1299
UK	5089	4868	4245	3696	5504
Unallocated	-	22	-		
Total	5208	4891	4327	3896	6804

Table 7.2.2 Herring in Division 7.a North (Irish Sea). Catch at length data 1995–2018. 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
14															-					-				16
14.5															-					-				0
15															-							15		31
15.5					10								16		-	93				14				54
16	21	21	17		19	12	9				2				-	107	30		8	0		109		47
16.5	55	51	94		53	49	27			13	1	44	33	1	-	487	165		84	14		174		176
17	139	127	281	26	97	67	53			25	39	140	69	3	-	764	356	89	202	213	16	261	86	431
17.5	148	200	525	30	82	97	105			84	117	211	286	11	-	1155	851	143	470	808	32	413	62	749
18	300	173	1022	123	145	115	229			102	291	586	852	34	-	1574	1406	301	533	1644	72	326	148	594
18.5	280	415	1066	206	135	134	240	36		114	521	726	2088	64	-	1405	841	533	555	3246	64	457	148	1097
19	310	554	1720	317	234	164	385	18		203	758	895	2979	85	-	866	1029	479	588	5357	136	522	234	841
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
20	326	749	1366	427	218	109	523	0	73	368	943	984	3516	100	-	787	1062	298	1041	4025	271	826	1121	1608
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
21	468	886	1510	522	449	115	1086	307	272	862	1256	1521	3451	192	-	1470	1874	643	2364	2608	439	1783	3154	3352

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
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
22	1509	1530	2607	1354	1261	289	1748	1750	463	1495	1361	2748	3821	271	-	2363	2372	1586	3052	2906	1896	2588	4374	5232
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
23	4198	2362	3508	2493	4784	607	2670	2490	1158	2089	1035	4358	4196	322	-	4530	4100	3920	3432	2596	2470	2893	3475	7485
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
24	4416	3649	4714	3695	4165	1436	3489	1029	1273	2054	1276	3679	3178	259	-	4559	4759	8849	3882	2161	2124	2849	2649	6912
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
25	3100	4015	5031	2625	2620	2144	5566	776	1163	1749	1086	3438	1503	148	-	3083	3430	7020	3364	2282	2367	2414	2378	4462
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
26	2334	2480	3871	3115	1694	1349	3814	1570	1140	823	438	1714	643	78	-	1777	2343	4835	1934	1612	1962	1936	1331	1455
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
27	1622	1949	1711	2992	1475	616	1489	776	1607	510	165	445	147	23	-	460	1083	1716	412	498	827	826	370	458
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
28	834	906	638	1235	276	212	496	162	726	198	45	104	33	12	-	9	248	231	85	256	141	65	37	104
28.5	123	564	440	170	169	58	179	108	569	51	18	9	26	1	-		53	159	28	156	48	65	12	0
29	248	210	280	111	61	42	10	36	163		12	46			-	9		108		57	16	22	25	16

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
29.5	56	79	59	92		12	0	36	129				7		-			54		14	8		12	0
30	40	32	8	84		6	9		43						-			17		0	8			
30.5	5	0	5	3					43						-			17		14				
31	1	2							43						-									
31.5															-									
32															-									
32.5															-									
33															-									
33.5															-									

Table 7.2.3 Herring in Division 7.a North (Irish Sea). Sampling intensity of commercial landings in 2018.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged
1	Ireland	0	-	-	-
	UK (N. Ireland)	0	-	-	-
	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	0	-	-	-
	UK (N. Ireland)	3671	11	1671	541
	UK (Isle of Man)	*	-	-	-
	UK (Scotland)	0	-	-	-
	UK (England & Wales)	275	0	0	0
4	Ireland	1299	5	899	333
	UK (N. Ireland)	1558	5	761	245
	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 in Division 7.a North (Irish Sea). Summary of acoustic survey AC(7.aN) information for the period 1989–2018. 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 bi-omass (1+rings)	CV	herring bi-omass (SSB)	CV	small clu-peoids (bi-omass)	CV
1989	Douglas Bank	25/09–26/09			18 000	-	-	-
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)-re-duced	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
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

Year	Area	Dates	herring bi-omass (1+rings)	CV	herring bi-omass (SSB)	CV	small clu-peoids (bi-omass)	CV
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

[1] sprat only

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

Table 7.3.2 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
2008	475.7	452.4	114.2	39.1	26.4	17.1	4.3	0.6

AGE (RINGS)	1	2	3	4	5	6	7	8+
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

Table 7.6.3.1 Irish Sea Herring. CATCH IN NUMBER (Thousands)

Year / Age	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
Year / Age	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

Year / Age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	5669	20290	8939	NA	9588	7454	2491	3889	27377	1654	2216	2112	7991
2	15253	18291	18974	NA	17627	17598	9664	18916	9567	15414	19064	12844	22903
3	8198	4980	7487	NA	6679	8984	12247	6836	7917	4840	5992	12419	15657
4	6318	1655	2696	NA	6201	3982	7944	6631	1997	7376	4677	4407	12364
5	1325	1062	2082	NA	3200	3671	3061	2901	1759	1613	2050	609	3240
6	605	325	1761	NA	925	1751	3158	1472	964	4276	1421	1065	538
7	262	122	328	NA	370	690	1591	625	409	1678	896	487	391
8	246	111	216	NA	185	425	652	352	830	1112	759	623	150

Table 7.6.3.2 Irish Sea Herring. WEIGHTS (Kgs) AT AGE IN THE CATCH

Year / 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	0.07	0.081	0.096	0.073
2	0.155	0.155	0.155	0.155	0.142	0.125	0.143	0.13	0.124	0.128	0.14	0.123
3	0.195	0.195	0.195	0.195	0.187	0.157	0.167	0.16	0.16	0.155	0.166	0.155
4	0.219	0.219	0.219	0.219	0.213	0.186	0.188	0.175	0.17	0.174	0.175	0.171
5	0.232	0.232	0.232	0.232	0.221	0.202	0.215	0.194	0.18	0.184	0.187	0.181
6	0.251	0.251	0.251	0.251	0.243	0.209	0.228	0.21	0.198	0.195	0.195	0.19
7	0.258	0.258	0.258	0.258	0.24	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

Year / Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.062	0.089	0.07	0.075	0.067	0.064	0.08	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	0.12	0.12	0.106	0.113	0.116
3	0.14	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	0.17	0.164	0.162	0.165	0.163	0.167	0.168	0.156	0.167	0.16
5	0.165	0.182	0.18	0.176	0.177	0.176	0.181	0.176	0.188	0.168	0.18	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	0.2	0.204	0.188	0.19	0.2	0.198	0.191	0.186

8	0.197	0.212	0.212	0.207	0.214	0.216	0.222	0.21	0.213	0.205	0.217	0.199
Year / Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.073	0.067	0.064	0.067	0.071	0.062	0.053	0.058	0.07	0.059	0.066	0.07
2	0.107	0.103	0.105	0.112	0.11	0.108	0.106	0.106	0.12	0.1	0.11	0.106
3	0.13	0.136	0.131	0.135	0.135	0.133	0.131	0.134	0.138	0.13	0.146	0.136
4	0.157	0.156	0.149	0.158	0.153	0.149	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	0.18	0.177	0.183	0.182	0.173	0.164	0.175	0.174	0.165	0.176	0.157
7	0.2	0.191	0.184	0.199	0.196	0.1855	0.175	0.187	0.179	0.17	0.196	0.167
8	0.205	0.209	0.211	0.227	0.206	0.189	0.172	0.196	0.191	0.18	0.198	0.171
Year / Age	2016	2017	2018									
1	0.054	0.072	0.060									
2	0.102	0.093	0.096									
3	0.126	0.121	0.120									
4	0.143	0.14	0.132									
5	0.159	0.147	0.147									
6	0.161	0.154	0.159									
7	0.167	0.154	0.164									
8	0.177	0.162	0.204									

Table 7.6.3.3 Irish Sea Herring. WEIGHTS (Kgs) AT AGE IN THE STOCK

Year / 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	0.07	0.081	0.077	0.07
2	0.155	0.155	0.155	0.155	0.142	0.125	0.143	0.13	0.124	0.128	0.135	0.121
3	0.195	0.195	0.195	0.195	0.187	0.157	0.167	0.16	0.16	0.155	0.163	0.153
4	0.219	0.219	0.219	0.219	0.213	0.186	0.188	0.175	0.17	0.174	0.175	0.167
5	0.232	0.232	0.232	0.232	0.221	0.202	0.215	0.194	0.18	0.184	0.188	0.18
6	0.251	0.251	0.251	0.251	0.243	0.209	0.229	0.21	0.198	0.195	0.196	0.189
7	0.258	0.258	0.258	0.258	0.24	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

Year / 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	0.12	0.115	0.119	0.121	0.121	0.12	0.105	0.113	0.116
3	0.136	0.157	0.154	0.147	0.148	0.148	0.15	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	0.16
5	0.159	0.183	0.181	0.18	0.177	0.178	0.179	0.178	0.188	0.167	0.18	0.167
6	0.171	0.191	0.19	0.185	0.195	0.189	0.19	0.189	0.204	0.183	0.184	0.172
7	0.179	0.198	0.203	0.197	0.199	0.206	0.2	0.199	0.205	0.199	0.191	0.186
8	0.191	0.214	0.214	0.212	0.212	0.214	0.23	0.214	0.215	0.205	0.217	0.199

Year / Age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.067	0.067	0.064	0.073	0.071	0.066	0.06	0.057	0.059	0.057	0.069	0.07
2	0.114	0.103	0.105	0.114	0.11	0.114	0.118	0.109	0.109	0.1	0.112	0.106
3	0.144	0.136	0.131	0.137	0.135	0.135	0.134	0.136	0.131	0.131	0.15	0.136
4	0.161	0.156	0.149	0.158	0.153	0.15	0.147	0.155	0.149	0.142	0.178	0.148
5	0.17	0.166	0.164	0.174	0.156	0.155	0.153	0.162	0.153	0.157	0.174	0.155
6	0.192	0.18	0.177	0.183	0.182	0.174	0.165	0.177	0.162	0.167	0.176	0.157
7	0.202	0.191	0.184	0.199	0.196	0.186	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	0.19	0.18	0.202	0.171

Year / Age	2016	2017	2018
1	0.054	0.072	0.060
2	0.102	0.093	0.096
3	0.126	0.121	0.120
4	0.143	0.14	0.132
5	0.159	0.147	0.147
6	0.161	0.154	0.159
7	0.167	0.154	0.164
8	0.177	0.162	0.204

Table 7.6.3.4 Irish Sea Herring. NATURAL MORTALITY

Year / 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	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
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

Year / 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	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
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

Year / 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	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
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

Year / Age	2016	2017	2018
1	0.787	0.787	0.787
2	0.38	0.38	0.38

3	0.353	0.353	0.353
4	0.335	0.335	0.335
5	0.315	0.315	0.315
6	0.311	0.311	0.311
7	0.304	0.304	0.304
8	0.304	0.304	0.304

Table 7.6.3.5 Irish Sea Herring. PROPORTION MATURE

Year / Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	0.2	0.19	0.1	0.02	0	0.14	0.31	0	0	0.07	0.06	0.04	0.28	0	0.19
2	0.88	0.89	0.8	0.73	0.69	0.62	0.73	0.85	0.9	0.63	0.66	0.3	0.48	0.46	0.68
3	0.95	0.9	0.89	0.88	0.83	0.71	0.66	0.91	0.96	0.93	0.9	0.74	0.72	0.99	0.99
4	0.95	0.94	0.91	0.9	0.93	0.88	0.81	0.87	0.99	0.95	0.95	0.82	0.81	1	0.97
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Year / Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.1	0.02	0.04	0.3	0.02	0.14	0.15	0.02	0.11	0.114	0.2	0.19	0.16	0.16	0.13
2	0.86	0.6	0.82	0.83	0.84	0.79	0.54	0.92	0.76	1	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	0.97	0.99	1	0.98	1	0.97
4	0.99	0.83	1	0.99	0.97	1	0.97	0.98	0.97	1	1	1	1	1	0.98
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Year / Age	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	0.11	0.08	0.1	0.06	0.16	0.11	0.07	0.1	0.08
2	0.92	0.9	0.84	0.82	0.94	0.87	0.81	0.85	0.67
3	1	1	1	0.99	1	1	0.99	1	0.97
4	0.98	1	1	1	1	1	1	1	1
5	0.97	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1

Table 7.6.3.6 Irish Sea Herring. FRACTION OF HARVEST BEFORE SPAWNING

Year / 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

Year / 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

Year / Age	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	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
3	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
5	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
7	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

Table 7.6.3.7 Irish Sea Herring. FRACTION OF NATURAL MORTALITY BEFORE SPAWNING

Year / 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

Year / 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

Year / Age	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	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
3	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
5	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
7	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

Table 7.6.3.8 Irish Sea Herring. SURVEY INDICES

AC(7.aN) - Configuration

Irish Sea herring (Division 7.a) (run name: ICAMDC20) . Imported from VPA file.

min	max	plusgroup	minyear	maxyear	startf	endf
1.0	8.0	8.0	1994.0	2018.0	0.7	0.8

Index type : number

AC(7.aN) - Index Values

Units : NA

Year / Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	66830	319116	11340	134146	110438	157756	78524	387559	390982	349216	241014
2	68290	82256	42372	49977	27312	77722	103439	93402	71935	220014	115529
3	73529	11935	67473	14812	8083	34017	105291	10194	31701	31984	29593
4	11860	29246	8954	10985	9266	5108	27543	17489	24804	4735	15398
5	9299	4574	26469	1751	6479	10260	8072	7704	31277	3921	2067
6	7550	3500	4171	4553	1778	13521	5432	1372	14830	4089	2299
7	3867	4887	5911	571	2254	1586	4899	626	2756	977	238
8	10118	6894	5815	1910	780	6289	2359	2263	4461	906	240

Year / Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	94330	374731	1316673	475675	371230	580602	1927032	369094	100023	299689
2	109938	96623	251276	452364	182643	561245	330180	191900	285238	193267
3	97111	15625	46570	114210	177813	117699	43855	160980	81601	127352
4	17023	9982	21101	39076	92741	120777	14978	51363	54347	29691
5	8029	530	20818	26370	32490	34325	21896	21643	41153	43057
6	810	369	1200	17063	15071	16759	6308	19285	13441	17342
7	607	478	718	4254	13940	4336	2715	12105	11132	7848
8	5804	469	556	599	6871	6453	1959	3128	6776	12481

Year / Age	2015	2016	2017	2018
1	491894	131512	42175	237857
2	141854	449316	89653	120683
3	25153	257152	104059	63334
4	17018	110196	56474	110874
5	10340	32232	9007	29555
6	8954	18312	20297	7645

7	1890	8157	4395	7926
8	4342	7042	11779	5053

7.aNSpawn - Configuration

FLT05: SSB acoustic (Catch: Unknown) (Effort: Unknown)

min	max plusgroup	minyear	maxyear	startf	endf
NA	NA NA	2007	2018	NA	NA

Index type : biomass

7.aNSpawn - Index Values

Units : NA

```
     year
age      2007      2008     2009     2010     2011     2012     2013     2014
  all 47582.61 41909.97 76786.97 91388.88 61907.54 52071.02 114044.2 28396.84
     year
age      2015     2016     2017     2018
  all 60328.27 74275.73 41683.6 38973.8
```

Table 7.6.3.9 Irish Sea Herring. STOCK OBJECT CONFIGURATION

min	max plusgroup	minyear	maxyear	minfbar	maxfbar
1	8 8	1980	2018	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      2018         4         6
fleets        :        catch  AC(7.aN) 7.aNSpawn
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(7.aN)  NA NA NA NA NA NA NA NA
states        :    7.aNSpawn 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(7.aN)   1  2  3  4  4  4  4  4
catchabilities :    7.aNSpawn 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(7.aN)  NA NA NA NA NA NA NA NA
power.law.exps :   7.aNSpawn 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(7.aN)  NA NA NA NA NA NA NA NA
f.vars         :   7.aNSpawn 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(7.aN)   4  5  5  5  5  6  6  6
obs.vars       :   7.aNSpawn NA NA NA NA NA NA NA NA
srr            : 0
cor.F          : FALSE
nohess         : FALSE
timeout        : 3600
sam.binary     : C:/Work/HAWG2019/SAM/sam.exe
```

Table 7.6.3.11 Irish Sea Herring. FLR, R SOFTWARE VERSIONS

```
FLSAM.version                      1.0
FLCore.version              2.5.20150309
R.version      R version 3.4.4 (2018-03-15)
platform              i386-w64-mingw32
run.date              2018-03-16 11:27:17
```

Table 7.6.3.12 Irish Sea Herring. STOCK SUMMARY

Year	Recruitment	Low	High	TSB	Low	High	SSB	Low	High	Fbar	Low	High	Landings	Landings
1980	174556	90497	336695	36243	25863	50788	13874	9473	20321	0.2893	0.1908	0.4385	10613	1.0308
1981	203414	104714	395145	37760	26550	53702	13924	9715	19958	0.2769	0.1869	0.4102	4377	1.0999
1982	222348	114428	432053	42959	29767	61998	14691	10021	21538	0.2637	0.1816	0.383	4855	1.0166
1983	183506	91366	368563	45071	31184	65143	16217	10991	23927	0.2577	0.1808	0.3671	3933	1.0165
1984	131006	67830	253026	43783	32039	59831	17257	12152	24509	0.2628	0.1903	0.3629	4066	1.0392
1985	171099	89174	328293	46028	34426	61539	16205	12237	21460	0.2809	0.2114	0.3733	9187	0.9802
1986	211928	110671	405827	47240	35593	62698	18574	14102	24464	0.2897	0.2215	0.3788	7440	1.0238
1987	273484	140482	532408	46630	34513	63002	16850	12472	22765	0.2981	0.2296	0.3869	5823	0.9632
1988	117360	60942	226008	43391	32880	57261	19732	14272	27281	0.3124	0.2406	0.4056	10172	0.9505
1989	151600	78515	292714	40175	29881	54016	15060	11060	20507	0.3096	0.2393	0.4004	4949	0.9966
1990	128927	67877	244886	37496	28583	49189	14357	10746	19181	0.3112	0.2417	0.4006	6312	0.9872
1991	78905	41609	149633	28796	22533	36801	9860	7453	13044	0.3092	0.2419	0.3953	4398	0.9994
1992	244019	128891	461979	32177	23152	44720	10267	7919	13311	0.3164	0.249	0.4019	5270	0.989
1993	63704	34667	117062	29912	22898	39073	10331	7897	13515	0.3182	0.2507	0.4039	4409	0.9869
1994	161458	89715	290572	30669	23220	40507	11485	8804	14982	0.3241	0.255	0.412	4828	0.9757
1995	132588	72479	242548	29466	22340	38865	11133	8436	14693	0.3287	0.2579	0.4189	5076	1.0007
1996	85991	46370	159468	24441	18768	31828	8962	6675	12034	0.3376	0.2633	0.433	5301	0.9999

Year	Recruitment	Low	High	TSB	Low	High	SSB	Low	High	Fbar	Low	High	Landings	Landings
1997	124991	68798	227084	23506	17571	31446	8309	6087	11342	0.3529	0.2711	0.4592	6651	0.9996
1998	166875	93347	298321	26742	19593	36500	9477	7136	12585	0.3612	0.2726	0.4787	4905	0.9951
1999	77111	42346	140416	22629	17197	29777	9085	6625	12458	0.3517	0.265	0.4666	4127	1.0001
2000	78669	42400	145960	19867	15054	26218	8718	6427	11825	0.3404	0.2562	0.4524	2002	0.9993
2001	109098	57533	206877	19932	14001	28377	6683	4665	9573	0.353	0.2586	0.4819	5461	1.0004
2002	82619	44879	152099	19206	13981	26384	6926	4852	9886	0.3472	0.25	0.4822	2393	0.9984
2003	146825	81138	265693	22629	15826	32356	6243	4520	8622	0.344	0.2425	0.4879	2399	1.001
2004	157000	85158	289449	24612	17465	34684	9118	6463	12864	0.3216	0.2275	0.4547	2531	0.9979
2005	176487	95645	325656	27889	19590	39706	10918	7664	15555	0.3065	0.2157	0.4353	4387	1.0062
2006	306202	167814	558711	36864	25410	53481	12150	8789	16798	0.281	0.1991	0.3966	4402	1.0005
2007	528607	273739	1020772	65251	42347	100543	19585	13970	27456	0.2452	0.1735	0.3467	4629	1.0012
2008	266999	133410	534358	59101	41480	84207	25084	17518	35919	0.2288	0.1602	0.327	4895	1.0008
2009	343176	176804	666107	61636	42963	88424	25034	17371	36077	0.2153	0.1486	0.3119	4594	NA
2010	394352	211814	734199	63831	45195	90152	26556	18647	37819	0.2026	0.1386	0.2961	4894	0.9989
2011	252206	127686	498156	56162	40509	77863	26849	19147	37651	0.1951	0.1331	0.2859	5202	1.0014
2012	291268	158535	535131	54122	39335	74468	24101	16999	34170	0.1898	0.1293	0.2785	5693	0.9999
2013	160011	86427	296247	44312	32632	60172	22018	15639	30998	0.1801	0.1213	0.2674	4828	0.9982
2014	340783	180798	642334	56331	39806	79717	23671	17130	32709	0.1707	0.1133	0.2573	5083	0.9405

Year	Recruitment	Low	High	TSB	Low	High	SSB	Low	High	Fbar	Low	High	Landings	Landings
2015	378890	205288	699299	59516	42493	83358	22093	15960	30583	0.1707	0.1139	0.2559	4891	1.0001
2016	208772	110175	395607	50970	37758	68807	24367	17429	34067	0.1648	0.1082	0.2509	4327	0.9999
2017	192529	89663	413406	48630	34761	68033	22948	16323	32263	0.1566	0.0999	0.2455	3896	0.9999
2018	333701	86352	1289560	54885	30958	97306	22020	14800	32763	0.1563	0.0982	0.2486	6804	1.0061

Table 7.6.3.13 Irish Sea Herring. ESTIMATED FISHING MORTALITY

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Units  :  f
```

Year / Age	1980	1981	1982	1983	1984	1985	1986
1	0.026292	0.025766	0.024972	0.023971	0.023645	0.023783	0.024026
2	0.330219	0.293376	0.259111	0.230017	0.213931	0.216406	0.219347
3	0.337969	0.298257	0.269146	0.249749	0.24522	0.25459	0.255227
4	0.333137	0.321261	0.300863	0.277843	0.271037	0.283087	0.28176
5	0.269335	0.248976	0.229788	0.23087	0.245539	0.266628	0.278121
6	0.265405	0.260566	0.260488	0.264266	0.271797	0.293054	0.30919
7	0.242731	0.190882	0.166161	0.086917	0.169297	0.318925	0.383794
8	0.242731	0.190882	0.166161	0.086917	0.169297	0.318925	0.383794
Year / Age	1987	1988	1989	1990	1991	1992	1993
1	0.024072	0.024682	0.025082	0.026168	0.027305	0.028207	0.028252
2	0.216233	0.21773	0.219874	0.231448	0.243704	0.259059	0.272477
3	0.252991	0.256892	0.251956	0.253118	0.25579	0.264689	0.271145
4	0.277898	0.28462	0.276374	0.272586	0.268931	0.275133	0.273269
5	0.290254	0.306021	0.304313	0.308449	0.30919	0.318574	0.324685
6	0.326084	0.346421	0.348018	0.352502	0.349553	0.355333	0.35665
7	0.470796	0.703097	0.570022	0.553779	0.423929	0.310895	0.336957
8	0.470796	0.703097	0.570022	0.553779	0.423929	0.310895	0.336957
Year / Age	1994	1995	1996	1997	1998	1999	2000
1	0.028898	0.030032	0.031039	0.03099	0.029674	0.028504	0.027215
2	0.299063	0.32514	0.350113	0.360523	0.330582	0.300953	0.275436
3	0.282352	0.292	0.298018	0.305563	0.301616	0.289877	0.277926
4	0.275739	0.280495	0.289558	0.312391	0.32566	0.322485	0.323777
5	0.334473	0.341332	0.351375	0.367218	0.373566	0.354836	0.335209
6	0.362149	0.364183	0.371915	0.378984	0.384428	0.37763	0.362366
7	0.408007	0.402951	0.518	0.844636	0.63575	0.410676	0.200008
8	0.408007	0.402951	0.518	0.844636	0.63575	0.410676	0.200008

Year / Age	2001	2002	2003	2004	2005	2006	2007
1	0.02614	0.024833	0.02522	0.026713	0.028184	0.028846	0.029585
2	0.27346	0.251981	0.226774	0.216189	0.214853	0.205255	0.188341
3	0.283569	0.266308	0.260826	0.259266	0.249574	0.234125	0.209779
4	0.347219	0.343764	0.342255	0.320267	0.301285	0.268904	0.229351
5	0.340786	0.328211	0.321937	0.308943	0.295821	0.27101	0.234453
6	0.37109	0.369686	0.367732	0.335679	0.322227	0.303037	0.271851
7	0.481562	0.490917	0.968074	0.5301	0.462962	0.409217	0.217121
8	0.481562	0.490917	0.968074	0.5301	0.462962	0.409217	0.217121

Year / Age	2008	2009	2010	2011	2012	2013	2014
1	0.029709	0.029349	0.028993	0.02845	0.027529	0.027332	0.026909
2	0.174366	0.169653	0.164212	0.160478	0.160301	0.163687	0.165018
3	0.193206	0.186188	0.178637	0.174122	0.171221	0.168217	0.163213
4	0.211506	0.20303	0.194991	0.19367	0.193728	0.188643	0.184464
5	0.219128	0.204763	0.191455	0.179892	0.170146	0.156343	0.142388
6	0.255892	0.238163	0.221308	0.211697	0.20542	0.19546	0.18537
7	0.225892	0.165002	0.12032	0.16967	0.184981	0.09715	0.116426
8	0.225892	0.165002	0.12032	0.16967	0.184981	0.09715	0.116426

Year / Age	2015	2016	2017	2018
1	0.025253	0.024783	0.024699	0.024967
2	0.1652	0.167579	0.176453	0.188266
3	0.160703	0.15812	0.164458	0.174697
4	0.191283	0.192396	0.186169	0.188266
5	0.136395	0.12986	0.125531	0.127314
6	0.18452	0.172131	0.158089	0.153217
7	0.197247	0.131941	0.087004	0.028607
8	0.197247	0.131941	0.087004	0.028607

Table 7.6.3.14 Irish Sea Herring. ESTIMATED POPULATION ABUNDANCE

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Units  :  NA
```

Year / Age	1980	1981	1982	1983	1984	1985	1986
1	174555.8	203414.3	222348.2	183505.5	131006.2	171099.4	211927.6
2	52891.61	73939.32	87991.9	96567.74	86681.87	60839.83	76879.92
3	32435.22	20702.3	36026.14	46027.76	56726.68	59694.79	34856.68
4	26984.02	12226.98	9595.984	19938.34	28623.98	37835.38	35525.29
5	4932.494	12732.33	4821.788	4507.509	12572.91	20211.36	21074.1
6	3821.889	2284.951	6764.881	2756.729	2721.667	8496.418	12523.97
7	1788.799	2052.472	1169.58	3757.466	1586.364	1761.463	4996.535
8	1172.156	1657.723	2150.38	1699.348	3688.223	3331.24	2894.304
Year / Age	1987	1988	1989	1990	1991	1992	1993
1	273484.4	117359.8	151599.9	128926.8	78905.01	244018.7	63703.83
2	92410.88	127899.5	51123.52	71467.64	57182.32	34166.47	100810.7
3	40215.19	52365.33	73791.59	30031.44	40660	31225.8	17349.17
4	19047.67	22359.35	26795.79	44267.23	17525.29	24270.09	16680.57
5	20060.34	11307.26	10784.88	14408.88	25925.96	10988.45	13210.93
6	11958.53	11602.78	5678.827	5593.162	7480.089	15602.71	6284.867
7	7259.745	6561.011	5487.346	2855.208	2669.643	4004.604	8442.215

8	4348.56	6087.544	4690.995	4154.303	2805.957	2408.357	3502.037
Year / Age	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1	161457.9	132587.8	85991.18	124991.4	166874.9	77110.91	78668.65
2	29554.76	78433	55436.86	39735.49	50412.78	76649.63	32565.22
3	54176.36	14531.88	42873.11	25796.65	16081.1	26186.52	42787.45
4	9379.671	28339.16	7546.959	23365.13	13011.65	7734.143	14071.41
5	9354.38	5106.656	15740.62	4372.106	12911.84	6138.895	4133.997
6	7148.087	4906.911	2752.046	7994.427	2468.831	6299.339	2731.483
7	3491.546	3613.023	2676.593	1369.773	4132.344	1267.498	2747.372
8	6674.837	5080.678	4221.307	2881.885	1267.118	2160.943	1493.384
Year / Age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1	109097.8	82619.42	146825.5	156999.8	176486.6	306201.9	528606.7
2	35596.41	44267.23	39300.79	68665.35	67846.29	76191.1	135537
3	17574.43	15269.31	20979.48	21741.97	43044.94	34030.08	39815.04
4	25745.11	8627.413	7264.829	10413.93	10848.69	22538.95	17831.11
5	7912.507	12439.1	3674.602	3101.683	4902.007	4531.009	11984.87
6	2401.383	3876.934	5886.401	1621.651	1541.791	2109.065	2450.629
7	1387.141	1287.04	1673.211	2343.732	817.3766	783.4443	1003.651
8	2428.429	1603.59	1182.398	633.3986	1332.351	890.2479	759.3782

Year / Age	2008	2009	2010	2011	2012	2013	2014
1	266998.9	343176.4	394352.3	252205.6	291268.3	160011.3	340782.6
2	209190.4	110414.9	150843.8	167879.2	96761.07	135401.5	71825.87
3	73570.54	114233.5	57930.54	75659.63	93807.49	50312.06	72765.7
4	22719.98	43870.61	58162.73	29732.62	43521.05	49711.92	24440.58
5	11432.32	13637.79	23599.95	29673.21	17520.03	22948.32	26081.98
6	7622.045	6687.531	7524.352	12842.3	17066.97	9884.271	11766.36
7	1612.756	4243.315	3588.896	4189.765	7786.136	9178.325	5356.146
8	1054.371	1685.808	3142.268	3724.918	4451.961	6408.625	9277.988

Year / Age	2015	2016	2017	2018			
1	378889.5	208772.4	192528.6	333700.8			
2	137447.9	182955.8	99111.43	96857.88			
3	39026.65	77419.97	111190.5	66237.36			
4	40134.84	23647.2	44134.63	73570.54			
5	14033.46	22925.38	10511.24	27173.57			
6	16079.49	9018.2	14298.36	6197.492			
7	6723.741	8580.093	5092.886	9824.161			
8	8058.639	7752.728	8568.946	6461.392			

Table 7.6.3.15 Irish Sea Herring. PREDICTED CATCH NUMBERS AT AGE

```
Units  :  NA
<0 x 0 matrix>
```

Table 7.6.3.16 Irish Sea Herring. CATCH AT AGE RESIDUALS

```
Units  :  NA
<0 x 0 matrix>
```

Table 7.6.3.18 Irish Sea Herring. PREDICTED INDEX AT AGE Fleet 1

Units : NA

Year / Age	1980	1981	1982	1983	1984	1985	1986
1	3139.253	3588.322	3801.42	3012.634	2122.437	2788.503	3487.254
2	12504.83	15783.18	16854.28	16634.76	13981.36	9916.249	12678.84
3	7913.932	4537.947	7218.915	8634.318	10464.25	11387.25	6665.365
4	6554.453	2880.531	2136.299	4141.528	5816.71	7987.715	7467.309
5	1006.103	2422.875	854.204	801.961	2363.077	4085.993	4420.862
6	770.9242	453.5067	1342.193	553.9808	560.5957	1869.04	2885.461
7	334.4542	309.012	155.0473	270.3264	213.973	418.1332	1386.558
8	219.1705	249.5876	285.0544	122.2612	497.4773	790.7248	803.1568
Year / Age	1987	1988	1989	1990	1991	1992	1993
1	4509.673	1984.595	2604.536	2309.07	1473.108	4706.736	1231.231
2	15055.67	20972.77	8451.676	12370.75	10364.79	6539.788	20165.93
3	7628.221	10073.26	13953.42	5702.557	7789.952	6165.719	3499.306
4	3957.39	4745.917	5540.389	9046.199	3537.693	5000.784	3415.195
5	4368.435	2577.435	2446.785	3306.912	5961.873	2593.102	3168.869
6	2883.73	2945.989	1447.452	1441.097	1913.616	4047.157	1635.379
7	2378.678	2907.416	2085.388	1061.523	803.9523	929.9306	2100.037

| 8 | 1424.833 | 2697.471 | 1782.781 | 1544.615 | 844.9944 | 559.3078 | 871.2161 |

Year / Age	1994	1995	1996	1997	1998	1999	2000
1	3189.534	2719.709	1822.237	2644.851	3384.969	1503.574	1465.073
2	6418.245	18299.52	13771.13	10115.66	11923.54	16737.55	6579.934
3	11319.48	3127.033	9386.99	5772.959	3558.983	5600.438	8819.32
4	1935.517	5934.868	1625.336	5375.194	3100.845	1827.803	3337.275
5	2301.002	1278.113	4037.173	1163.77	3486.906	1587.729	1018.871
6	1884.146	1299.39	741.6222	2188.453	683.933	1719.708	720.3376
7	1019.023	1043.818	945.3261	687.8495	1703.108	371.8795	431.6133
8	1948.373	1467.917	1491.041	1447.597	522.2467	634.1148	234.6347

Year / Age	2001	2002	2003	2004	2005	2006	2007
1	1951.669	1404.491	2535.13	2869.032	3400.372	6036.442	10691.67
2	7150.088	8265.372	6680.446	11187.36	10984.28	11836.82	19465.91
3	3686.6	3031.491	4088.854	4215.696	8067.589	6026.49	6389.428
4	6477.501	2153.005	1806.235	2446.638	2418.251	4549.534	3125.283
5	1977.76	3011.098	875.0053	712.8065	1085.016	929.3264	2162.348
6	645.9809	1039.838	1571.287	400.9032	368.021	477.4455	504.9402
7	462.6635	435.8334	916.6356	842.6739	264.2697	229.2172	169.8117
8	810.1343	543.1416	647.8764	227.764	430.7165	260.4576	128.4809

Year / Age	2008	2010	2011	2012	2013	2014	2015
1	5423.03	7816.952	4905.636	5485.92	2992.337	6273.126	6552.684
2	27998.33	19110.06	20820.64	11984.75	17094.46	9136.658	17495.69
3	10949.84	8024.142	10235.73	12499.7	6594.953	9276.875	4906.764
4	3703.635	8802.667	4472.309	6547.247	7296.791	3516.003	5970.524
5	1941.061	3543.995	4208.662	2361.849	2861.382	2979.349	1540.327
6	1489.313	1291.242	2117.031	2738.348	1515.848	1719.193	2339.354
7	282.8566	351.8623	566.2468	1139.232	734.5955	509.1537	1043.004
8	184.8103	308.1541	503.4629	651.3779	512.8995	881.9188	1250.251

Year / Age	2016	2017	2018
1	3543.11	3257.32	5703.641
2	23618.84	13407.51	13914.68
3	9580.068	14269.22	8991.905
4	3537.304	6402.732	10779.48
5	2403.569	1067.346	2796.265
6	1231.121	1804.358	759.7124
7	917.6261	366.7755	239.1043
8	829.033	617.0685	157.2458

Table 7.6.3.19 Irish Sea Herring. INDEX AT AGE RESIDUALS Fleet 1

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Units  :  NA

  year
```

Year / Age	1980	1981	1982	1983	1984	1985	1986
1	0.740459	0.407608	0.350534	-0.99795	-0.71246	-0.16465	0.301742
2	1.78992	0.001082	-0.12419	-0.77564	-1.25478	0.033173	0.459891
3	2.2347	-0.86517	-0.59816	-1.07322	-0.91328	1.04091	0.27961
4	0.649561	-0.07908	0.015832	-0.95186	-1.02782	1.26034	0.335337
5	1.5618	-0.12006	-2.19404	-1.35874	-0.14304	1.30883	0.055238
6	0.382602	-0.7334	-0.43818	-0.31153	-0.897	0.806283	0.237242
7	0.169801	-0.14649	-0.23552	-0.13464	0.156572	1.07731	0.125378
8	0.111272	-0.09037	0.663205	-1.68087	-0.08731	-0.20338	0.20291

Year / Age	1987	1988	1989	1990	1991	1992	1993
1	-0.84271	0.325391	-0.96894	0.002033	0.364145	1.13074	-0.76936
2	-0.36721	0.032535	-0.6945	0.091238	-0.15042	0.127393	-0.7938
3	-0.53508	0.696217	-0.36548	0.010161	-0.35745	0.222031	-0.3747
4	-0.68762	1.01813	-0.40321	0.172048	-0.55015	0.720764	-0.30703
5	-0.10173	1.3413	-0.6128	0.194629	-0.37474	0.525164	-0.20216
6	-0.08699	1.25877	-0.32914	0.327623	-0.5726	0.543348	-0.04181
7	-0.04968	0.244156	-0.67111	-0.04283	-0.25762	0.249164	0.087276
8	0.367648	1.02856	0.213904	0.102795	-0.08338	-0.81996	-0.0623

Year / Age	1994	1995	1996	1997	1998	1999	
1	-0.57477	0.195474	1.2814	1.53167	-0.11689	0.221256	
2	0.215608	0.37952	0.597581	1.85427	-0.00928	0.028159	
3	0.178419	0.200702	0.096774	0.668589	0.210686	0.144126	
4	-0.14426	-0.29474	-0.83536	0.771938	0.894646	-0.38286	
5	0.251458	-0.1474	-0.26248	0.792737	1.49766	-0.16676	
6	0.254599	-0.27374	0.116398	0.095553	0.944574	0.335608	
7	0.522406	-0.27628	0.037932	0.461	0.42654	0.408907	
8	0.049917	-0.02515	-0.20545	-0.02498	-0.33835	-0.04451	

Year / Age	2000	2001	2002	2003	2004	2005	2006
1	-0.21738	0.392896	-2.45733	-1.54538	0.13951	1.11952	-0.07492
2	-1.39717	1.17116	0.216672	-0.87401	-0.58522	0.597274	0.627996
3	-1.00695	1.6409	-1.16493	-0.49731	0.615471	0.665582	0.762126
4	-1.18887	1.73478	-0.35433	0.862808	-0.30747	0.760157	0.813293
5	-1.38897	1.24038	-0.52811	0.018368	-0.31066	0.623938	0.818279
6	-1.68495	0.855503	-0.20117	1.44923	-1.45895	0.277138	0.546229
7	-1.25053	0.784278	0.193662	-0.11516	-0.51867	0.2302	0.308365
8	-1.0787	-0.02042	-1.10105	-0.15795	-1.34751	-0.36304	-0.13173
Year / Age	2007	2008	2010	2011	2012	2013	2014
1	0.764219	0.596152	0.243598	0.499053	-0.94175	0.312647	1.75758
2	-0.15418	-0.96357	-0.20008	-0.41649	-0.53306	0.250777	0.11399
3	-0.61723	-0.94152	-0.45443	-0.32305	-0.05058	0.088908	-0.39257
4	-1.57448	-0.78646	-0.86768	-0.28759	0.478929	-0.23697	-1.401
5	-1.64031	0.161711	-0.23554	-0.31532	0.598163	0.031732	-1.21565
6	-1.01645	0.386553	-0.76951	-0.43791	0.328921	-0.06772	-1.33458
7	-0.76282	0.341595	0.115941	0.455996	0.770516	-0.37272	-0.5053
8	-0.33738	0.35975	-1.1771	-0.39084	0.0022	-0.86844	-0.13997
Year / Age	2015	2016	2017	2018			
1	-1.64218	-0.55981	-0.51682	0.402246			
2	-0.31374	-0.53057	-0.10635	1.23417			
3	-0.03394	-1.1622	-0.34395	1.37354			
4	0.523569	0.691716	-0.9251	0.339657			
5	0.106348	-0.36706	-1.29443	0.339783			
6	1.39139	0.330904	-1.21627	-0.79608			
7	1.09693	-0.05502	0.654036	1.13455			
8	-0.27035	-0.20361	0.022073	-2.64322			

Table 7.6.3.20 Irish Sea Herring. PREDICTED INDEX AT AGE Fleet 2

Units : NA

year

Year / Age	1994	1995	1996	1997	1998	1999	2000
1	185090.5	151812.3	98380.71	143028.6	191262.1	88468.34	90327.75
2	47164.65	122700.3	85093	60500.08	78503.62	122149.4	52881.03
3	62855.9	16742.24	49148.42	29413.23	18392.53	30224.25	49816.42
4	9903.366	29810.02	7886.281	24006.98	13232.48	7884.152	14331.71
5	9593.586	5210.338	15938.93	4375.342	12861.33	6200.902	4237.209
6	7202.763	4936.639	2752.432	7953.282	2446.295	6274.882	2751.799
7	3417.279	3549.919	2412.406	966.0156	3409.088	1238.108	3143.336
8	6533.839	4992.24	3805.033	2033.004	1045.364	2111.175	1708.772

Year / Age	2001	2002	2003	2004	2005	2006	2007
1	125316.8	94968.45	168771.3	180232	202359.3	350950.3	605918
2	57907.37	73123.13	66171.16	116611.1	115254.7	130378.9	234849.5
3	20375.53	17933.04	24738.1	25670.56	51184.91	40949.71	48800.7
4	25752.84	8655.411	7295.989	10632.71	11236.58	23918.32	19492.6
5	8076.792	12815.49	3804.006	3241.917	5173.89	4873.268	13250.49
6	2403.281	3884.735	5904.441	1666.449	1600.162	2220.128	2642.023
7	1284.699	1183.688	1075.617	2091.8	767.4244	765.5925	1132.723

Year / Age							
8	2249.538	1475.128	760.2368	565.3811	1250.789	869.9276	857.0275

Year / Age	2008	2009	2010	2011	2012	2013	2014
1	306048.8	393446.4	452118.7	289207.6	334302	183689.1	391171
2	366333.7	194172.1	266305.7	297241.4	171287.7	239043.3	126677.5
3	91253.81	142528.9	72634.84	95187.13	118302.5	63595.63	92327.75
4	25182.38	48917.97	65231.65	33382.93	48849.53	55999.61	27628.41
5	12783.75	15414.59	26932.8	34152.81	20322.42	26900.5	30878.02
6	8318.357	7394.561	8425.01	14480.53	19338.05	11283.09	13532.24
7	1809.471	4983.81	4357.44	4901.517	9004.502	11337.83	6521.502
8	1182.268	1979.639	3816.16	4358.094	5148.496	7916.227	11295.96

Year / Age	2015	2016	2017	2018			
1	435652.4	240073.4	221460.6	383540.3			
2	242292.3	322223.3	173268.9	167946.4			
3	49632.44	98567.81	140899.2	83333.01			
4	45152.46	26587.59	49826.39	82900.8			
5	16695.76	27413.75	12608.42	32552.19			
6	18503.03	10476.4	16785.15	7302.85			
7	7702.344	10324.14	6338.516	12774.55			
8	9232.914	9327.385	10664.01	8401.033			

Table 7.6.3.21 Irish Sea Herring. INDEX AT AGE RESIDUALS Fleet 2

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Units  :  NA
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  year
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Year / Age	1994	1995	1996	1997	1998	1999	2000
1	-1.07903	0.786881	-2.28842	-0.06786	-0.58167	0.612656	-0.1483
2	0.605701	-0.65436	-1.14096	-0.31272	-1.72765	-0.73987	1.09797
3	0.25665	-0.55385	0.518473	-1.12249	-1.3454	0.193509	1.22468
4	0.295038	-0.03126	0.207785	-1.2794	-0.58307	-0.71025	1.069
5	-0.05103	-0.21314	0.829988	-1.49859	-1.12199	0.824006	1.05464
6	0.063747	-0.4656	0.562736	-0.75515	-0.43198	1.03931	0.920656
7	0.16738	0.432753	1.21327	-0.71182	-0.56012	0.33525	0.600751
8	0.592043	0.436963	0.574169	-0.0845	-0.39643	1.47776	0.43655

Year / Age	2001	2002	2003	2004	2005	2006	2007
1	1.19582	1.4989	0.770237	0.307782	-0.80847	0.069496	0.822046
2	0.782232	-0.02686	1.96598	-0.01523	-0.07726	-0.49031	0.110687
3	-1.13324	0.93224	0.420328	0.232648	1.04795	-1.57653	-0.07662
4	-0.63324	1.72281	-0.70748	0.605946	0.679726	-1.42995	0.129735
5	-0.07733	1.46002	0.049577	-0.73648	0.71908	-3.63053	0.739287
6	-0.7589	1.81355	-0.49739	0.435626	-0.9217	-2.42944	-1.06845
7	-0.97329	1.14416	-0.13018	-2.9425	-0.31748	-0.63769	-0.61721
8	0.008075	1.49816	0.237464	-1.16002	2.07779	-0.83639	-0.58579

Year / Age	2008	2009	2010	2011	2012	2013	2014
1	0.467119	-0.0616	0.264905	2.00891	0.104834	-0.64378	-0.2822
2	0.345135	-0.10019	1.21992	0.171917	0.185942	0.289182	0.691317
3	0.367158	0.361933	0.78978	-1.26805	0.504002	0.407999	0.526212
4	0.718992	1.04671	1.00801	-1.31143	0.082036	-0.04902	0.117848
5	1.18482	1.22011	0.396914	-0.72747	0.103021	0.695718	0.544061
6	0.972642	0.963943	0.931055	-1.125	-0.00372	0.236922	0.335816
7	1.15726	1.39247	-0.00668	-0.79977	0.400579	-0.02481	0.250668
8	-0.92049	1.68467	0.711154	-1.0825	-0.67462	-0.21055	0.135055

Year / Age	2015	2016	2017	2018
1	0.128627	-0.63743	-1.75663	-0.50611
2	-0.87602	0.544119	-1.07818	-0.54077
3	-1.1122	1.56915	-0.4959	-0.44909
4	-1.59669	2.32655	0.204908	0.475725
5	-0.78404	0.264898	-0.55042	-0.15811
6	-0.98263	0.756009	0.257192	0.061986
7	-1.90202	-0.31897	-0.49574	-0.64618
8	-1.02136	-0.38051	0.134627	-0.68824

Table 7.6.3.22 Irish Sea Herring. PREDICTED INDEX AT AGE Fleet 3

Units : NA

Year / Age	2007	2008	2009	2010	2011	2012	2013
8	19584.62	25074.33	25039.25	26542.43	26857.49	24103.2	22015.46

Year / Age	2014	2015	2016	2017	2018		
8	23668.49	22086.02	24374.68	22941.44	22018.1		

Table 7.6.3.23 Irish Sea Herring. INDEX AT AGE RESIDUALS Fleet 3

Units : NA

   year

Year / Age	2007	2008	2009	2010	2011	2012	2013
8	1.40362	0.812138	1.77176	1.95493	1.32038	1.21793	2.60072

Year / Age	2014	2015	2016	2017	2018		
8	0.288037	1.58879	1.76184	0.944197	0.902875		

Table 7.6.3.25 Irish Sea Herring. FIT PARAMETERS

	name	value	std.dev
1	logFpar	0.74855	0.22053
2	logFpar	0.97627	0.16771
3	logFpar	0.62531	0.17124
4	logFpar	0.51233	0.16253
5	logSdLogFsta	-1.8965	0.57726
6	logSdLogFsta	-1.9814	0.32321
7	logSdLogFsta	-2.0027	0.46105
8	logSdLogFsta	-0.55843	0.20587
9	logSdLogN	-1.4842	0.25548
10	logSdLogObs	-0.17635	0.14484
11	logSdLogObs	-0.90691	0.12719
12	logSdLogObs	-0.83591	0.10832
13	logSdLogObs	-0.05752	0.1609
14	logSdLogObs	-0.49248	0.079939
15	logSdLogObs	-0.30198	0.0977

Table 7.6.3.26 Irish Sea Herring. NEGATIVE LOG-LIKELIHOOD

530.852

Table 7.7.1. Herring in Division 7.a North (Irish Sea). Input data for short-term forecast.

2019								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
1	300739.6	0.787	0.083333	0.9	0.75	0.062	0.024816	0.062
2	148157.8	0.38	0.776667	0.9	0.75	0.097	0.177433	0.097
3	54870.66	0.353	0.986667	0.9	0.75	0.122333	0.165759	0.122333
4	39077.52	0.335	1	0.9	0.75	0.138333	0.188944	0.138333
5	43596.59	0.315	1	0.9	0.75	0.151	0.127568	0.151
6	17460.32	0.311	1	0.9	0.75	0.158	0.161145	0.158
7	3895.912	0.304	1	0.9	0.75	0.161667	0.082517	0.161667
8	11677.59	0.304	1	0.9	0.75	0.181	0.082517	0.181

2020								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
1	300739.6	0.787	0.083333	0.9	0.75	0.062	0.024816	0.062
2	-	0.38	0.776667	0.9	0.75	0.097	0.177433	0.097
3	-	0.353	0.986667	0.9	0.75	0.122333	0.165759	0.122333
4	-	0.335	1	0.9	0.75	0.138333	0.188944	0.138333
5	-	0.315	1	0.9	0.75	0.151	0.127568	0.151
6	-	0.311	1	0.9	0.75	0.158	0.161145	0.158
7	-	0.304	1	0.9	0.75	0.161667	0.082517	0.161667
8	-	0.304	1	0.9	0.75	0.181	0.082517	0.181

2021								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
1	300739.6	0.787	0.083333	0.9	0.75	0.062	0.024816	0.062
2	-	0.38	0.776667	0.9	0.75	0.097	0.177433	0.097
3	-	0.353	0.986667	0.9	0.75	0.122333	0.165759	0.122333
4	-	0.335	1	0.9	0.75	0.138333	0.188944	0.138333
5	-	0.315	1	0.9	0.75	0.151	0.127568	0.151
6	-	0.311	1	0.9	0.75	0.158	0.161145	0.158
7	-	0.304	1	0.9	0.75	0.161667	0.082517	0.161667
8	-	0.304	1	0.9	0.75	0.181	0.082517	0.181

Table 7.7.2. Herring in Division 7.a North (Irish Sea). Management options table.

Rationale	Fbar (2019)	Catch (2019)	SSB (2019)	Fbar (2020)	Catch (2020)	SSB (2020)	SSB (2021)
1	0.218704	6896	23247.28	0	0	27725.76	28137.48
1	0.218704	6896	23247.28	0.1	3265.306	25408.68	26053.54
1	0.218704	6896	23247.28	0.2	6242.902	23296.36	24167.12
1	0.218704	6896	23247.28	0.3	8960.642	21370.23	22458.45
1	0.218704	6896	23247.28	0.4	11443.6	19613.45	20909.76
1	0.218704	6896	23247.28	0.5	13714.34	18010.74	19505.1
1	0.218704	6896	23247.28	0.6	15793.2	16548.19	18230.14
1	0.218704	6896	23247.28	0.7	17698.47	15213.17	17072
1	0.218704	6896	23247.28	0.8	19446.65	13994.23	16019.12
1	0.218704	6896	23247.28	0.9	21052.59	12880.95	15061.11
1	0.218704	6896	23247.28	1	22529.7	11863.86	14188.62
1	0.218704	6896	23247.28	1.1	23890.03	10934.36	13393.26
1	0.218704	6896	23247.28	1.2	25144.48	10084.62	12667.47
1	0.218704	6896	23247.28	1.3	26302.86	9307.549	12004.48
1	0.218704	6896	23247.28	1.4	27374.03	8596.675	11398.17
1	0.218704	6896	23247.28	1.5	28365.99	7946.126	10843.05
1	0.218704	6896	23247.28	1.6	29285.94	7350.56	10334.2
1	0.218704	6896	23247.28	1.7	30140.41	6805.119	9867.151
1	0.218704	6896	23247.28	1.8	30935.28	6305.384	9437.919
1	0.218704	6896	23247.28	1.9	31675.87	5847.335	9042.899
1	0.218704	6896	23247.28	2	32366.98	5427.314	8678.851
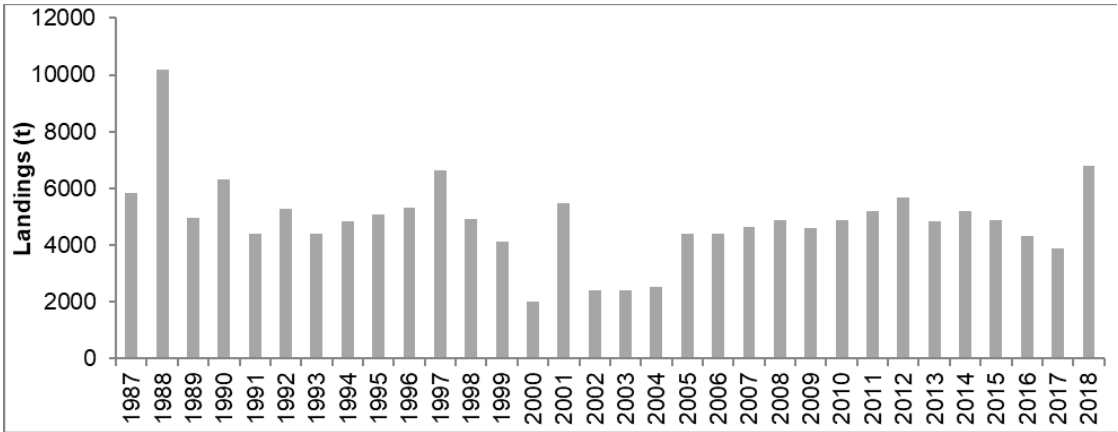
Figure 7.1.1 Herring in Division 7.a North (Irish Sea). Landings of herring from 7.a(N) from 1961 to 2018.
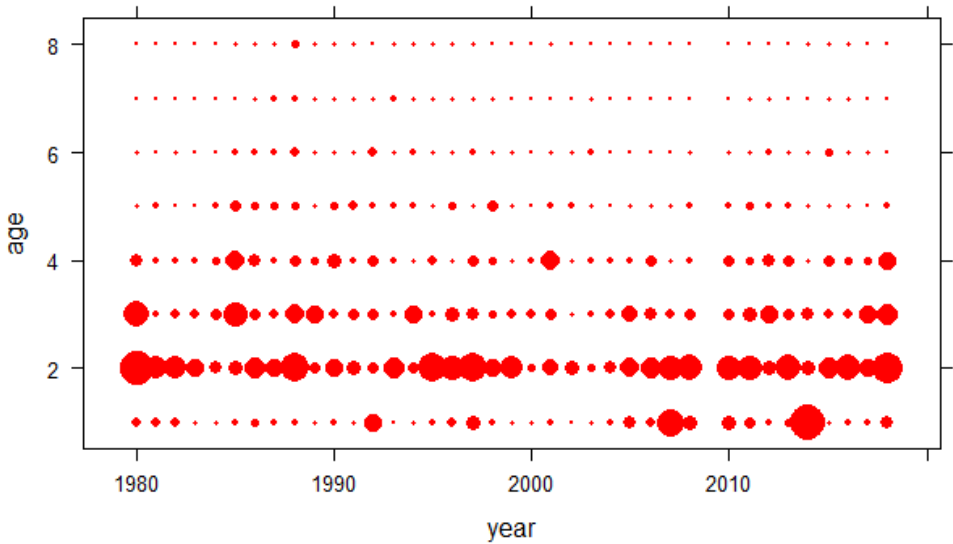
Figure 7.2.1 Herring in Division 7.a North (Irish Sea). Landings (catch-at-age) of herring from 7.a(N) from 1980 to 2018. No 2009 commercial samples.
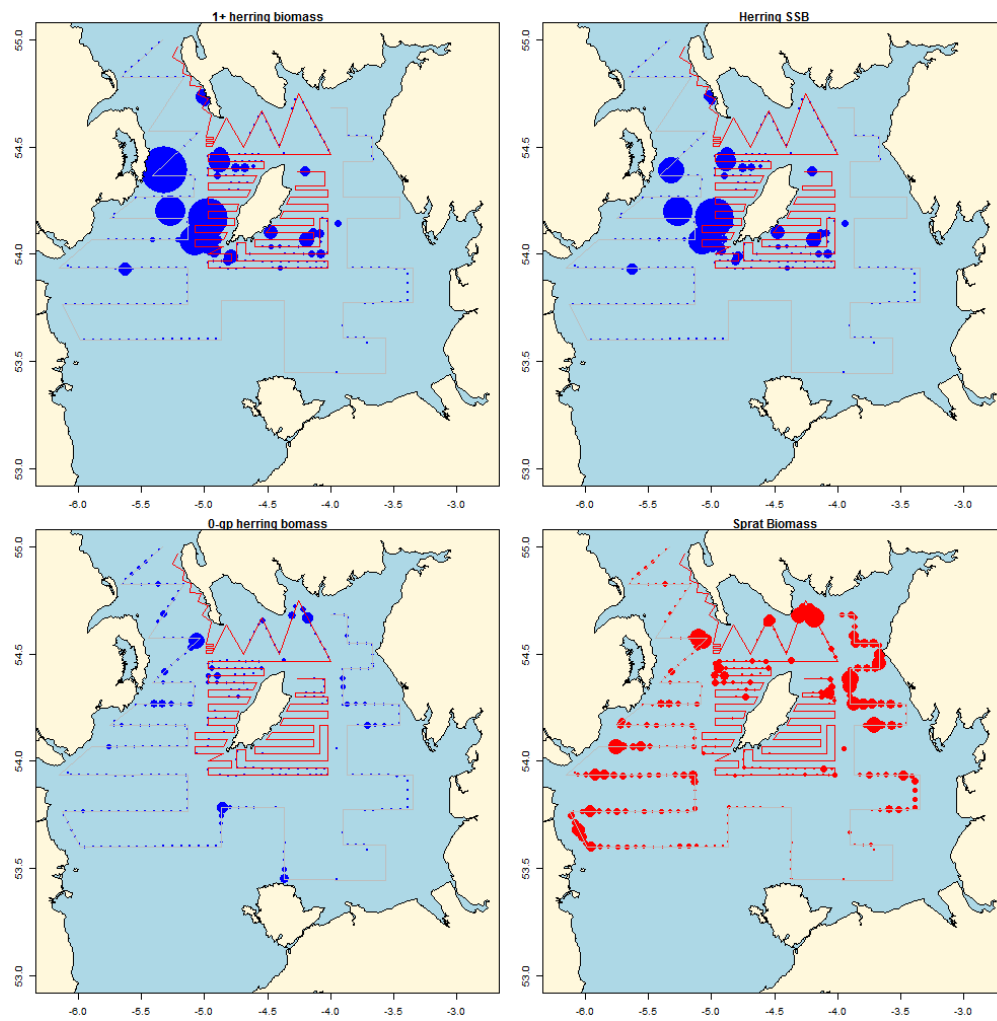
Figure 7.3.1 Herring in Division 7.a North (Irish Sea). Density distribution of 1-ring and older herring (top left panel) for the 2018 acoustic survey; SSB (top right panel); 0-ring herring (bottom left panel) and sprat biomass (bottom right panel). Note: size of ellipses is proportional to square root of the fish density (t n.mile^{-2}) per 15-minute interval and the same scaling is used for all figures.
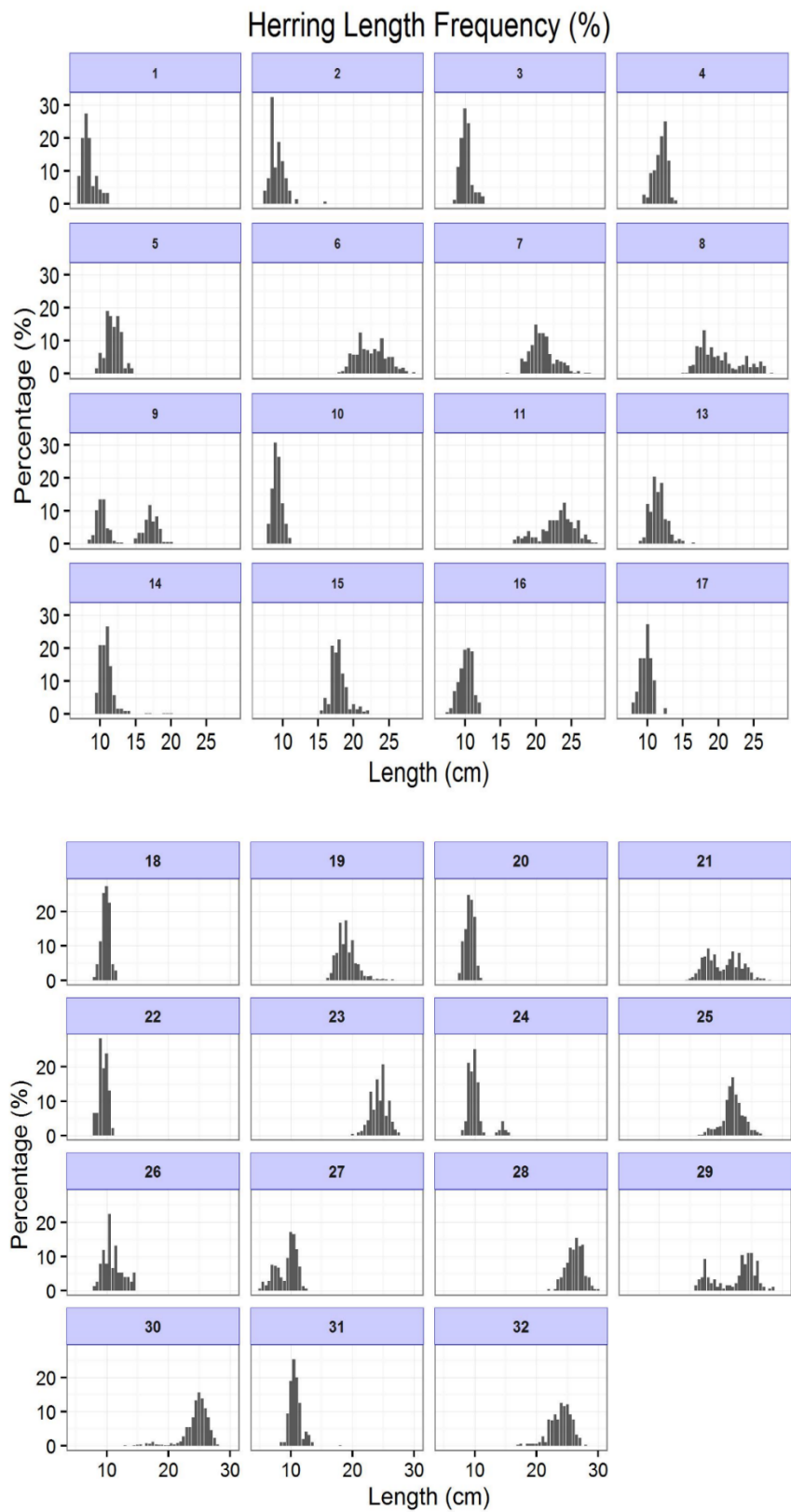
Figure 7.3.2 Herring in Division 7.a North (Irish Sea). Percentage length compositions of herring in each trawl sample in the September 2018 acoustic survey.
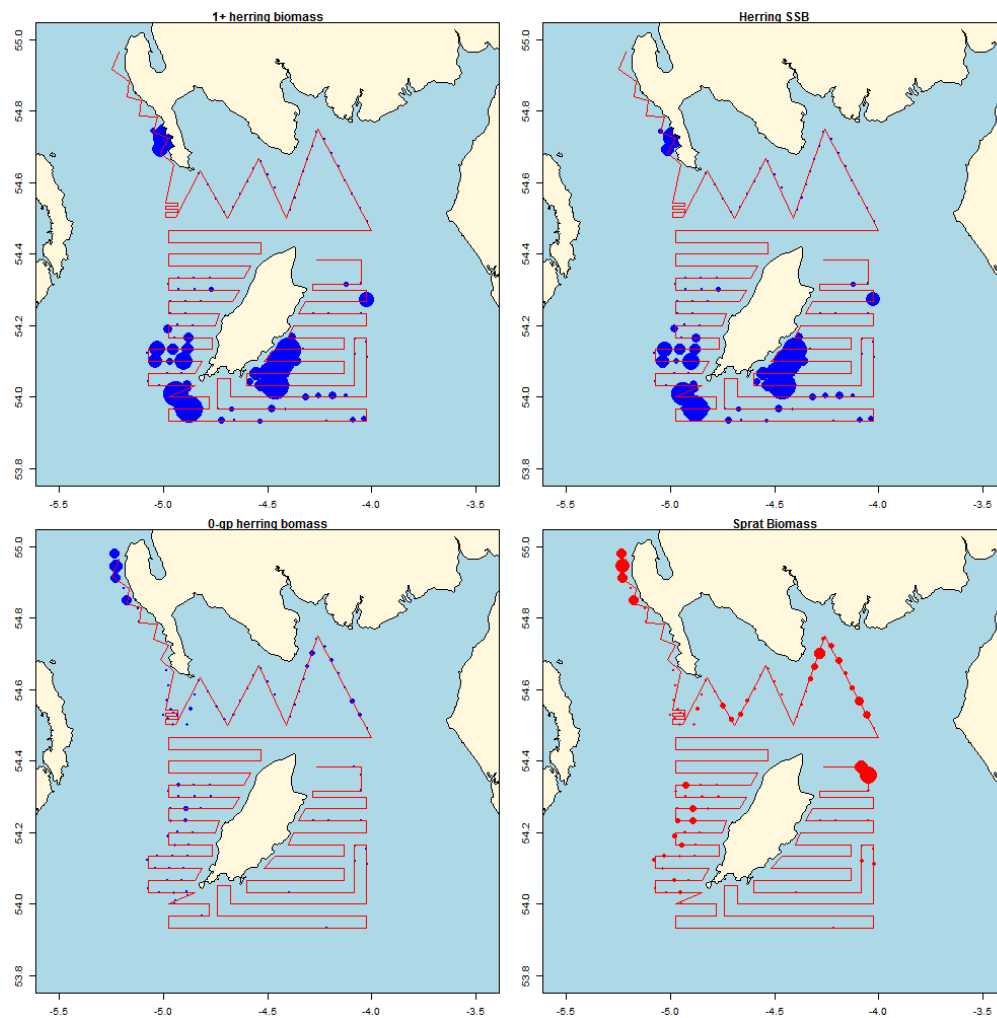
Figure 7.3.3 Herring in Division 7.a North (Irish Sea). Distribution plots for the 7.aNSpawn survey (2008–2018) (size of ellipses is proportional to square root of the fish density (t n.mile^{-2}) per 15-minute interval).
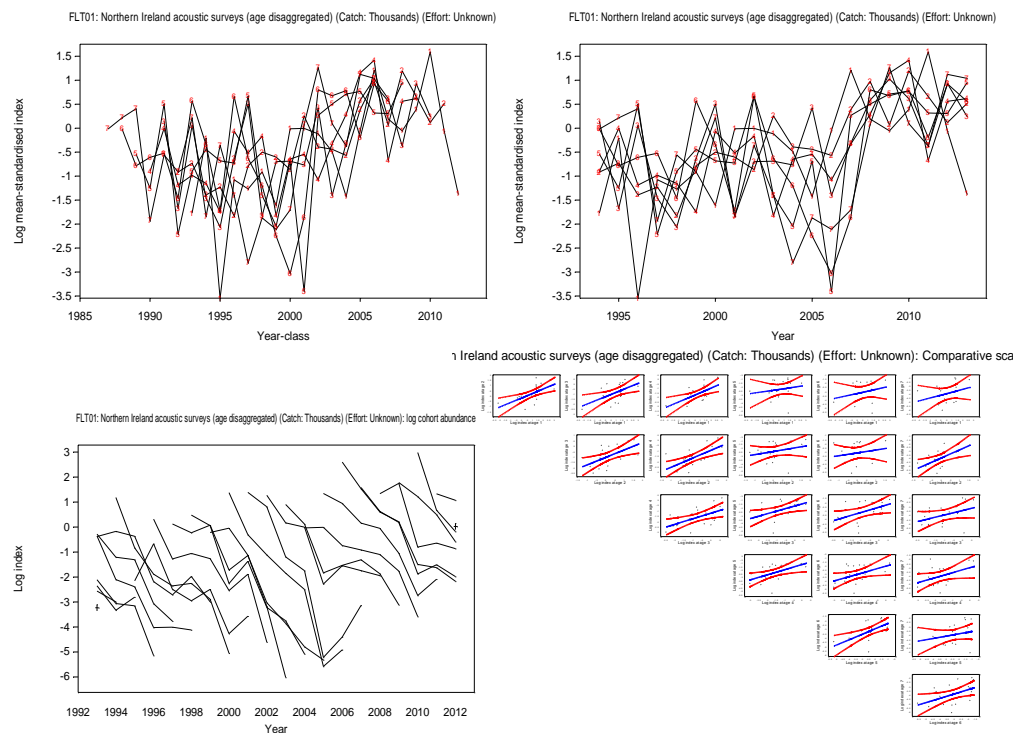
Figure 7.3.4 Herring in Division 7.a North (Irish Sea). Acoustic survey (AC(7.aN)) log mean-standardised indices by year and age class, scatter plots and catch curves.
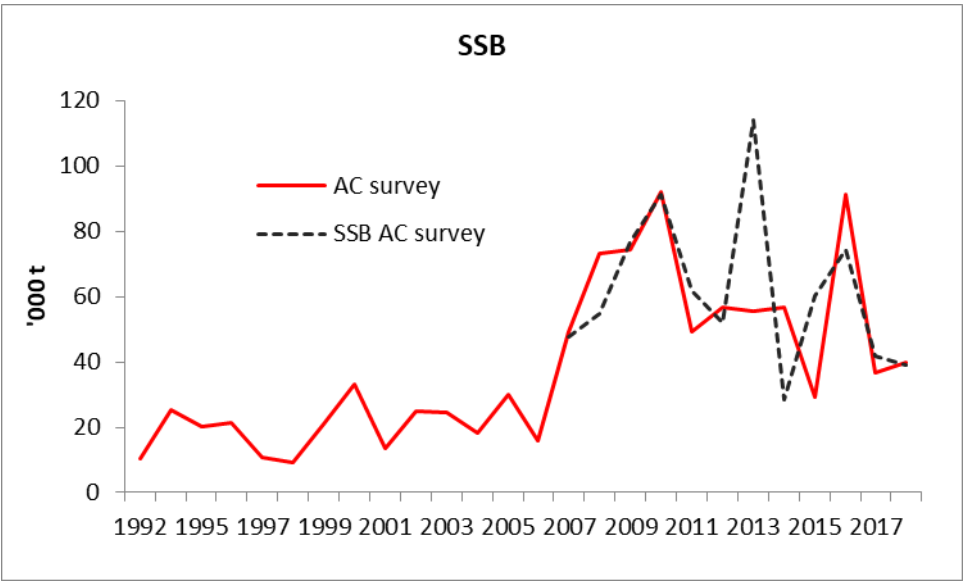
Figure 7.3.5 Herring in Division 7.a North (Irish Sea). Comparison of SSB indices from the acoustic survey estimates of SSB (red line) and the later survey 7.aNSpawn (dotted line).
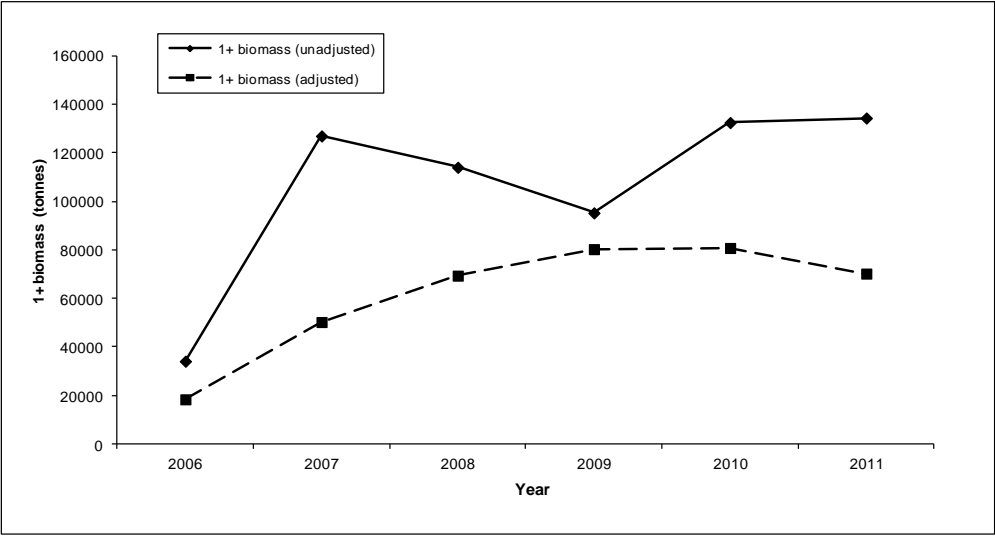
Figure 7.3.6 Herring in Division 7.a North (Irish Sea). Comparison of 1-ringer+ biomass estimates from acoustic survey with adjusted data ("winter spawners removed") and unadjusted data sets.
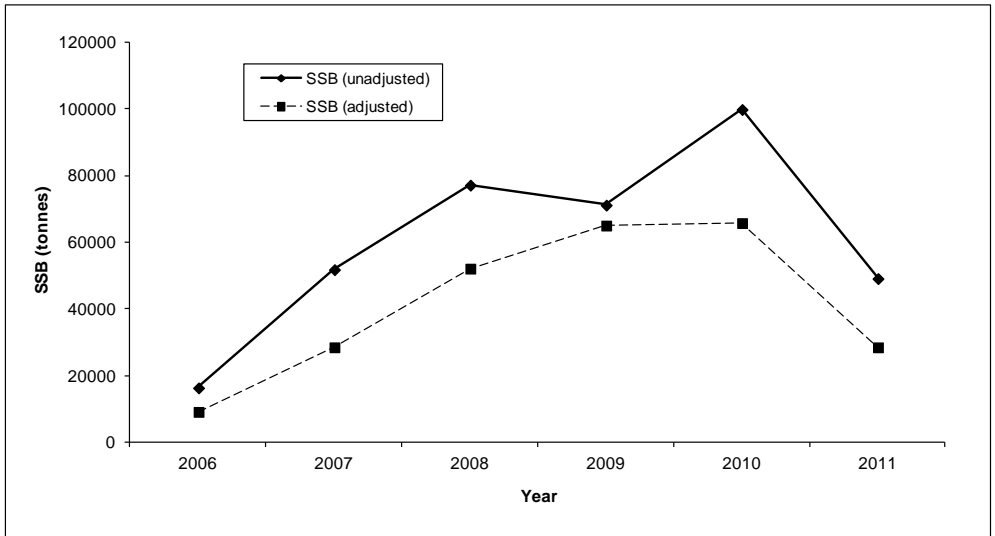
Figure 7.3.7 Herring in Division 7.a North (Irish Sea). Comparison of SSB biomass estimates from acoustic survey with adjusted data ("winter spawners removed") and unadjusted data sets.
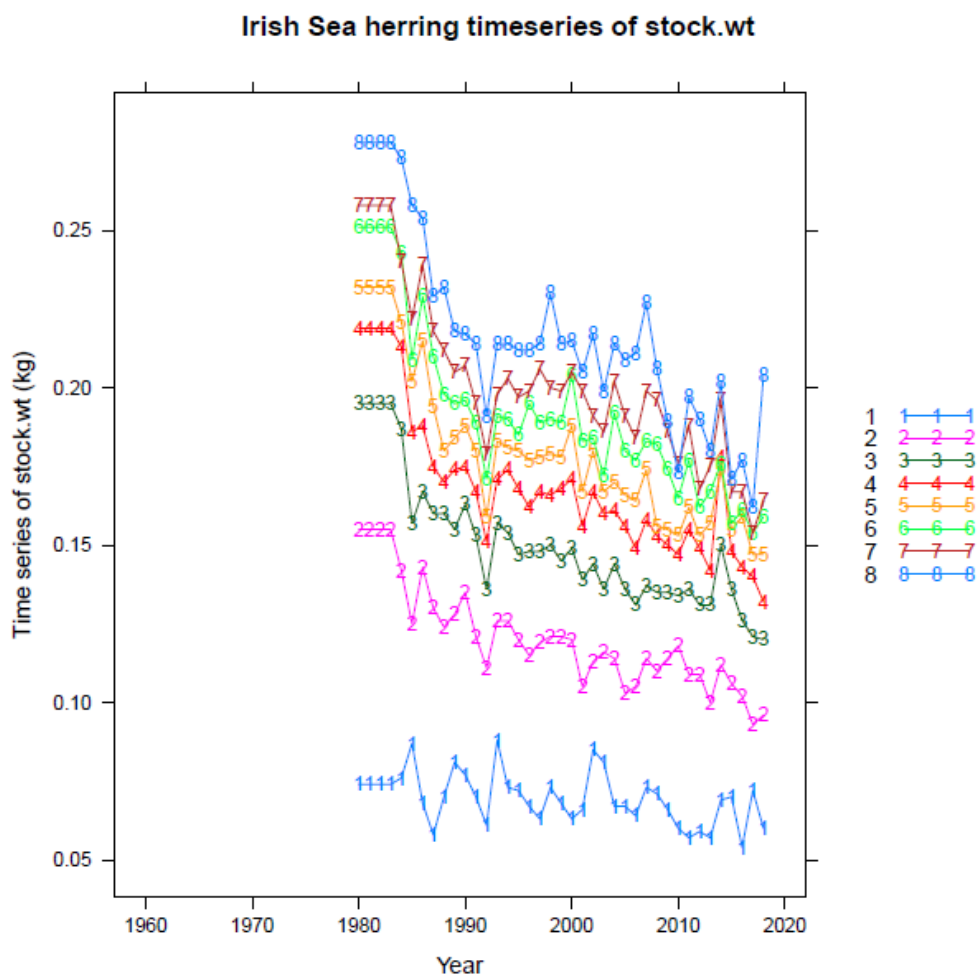
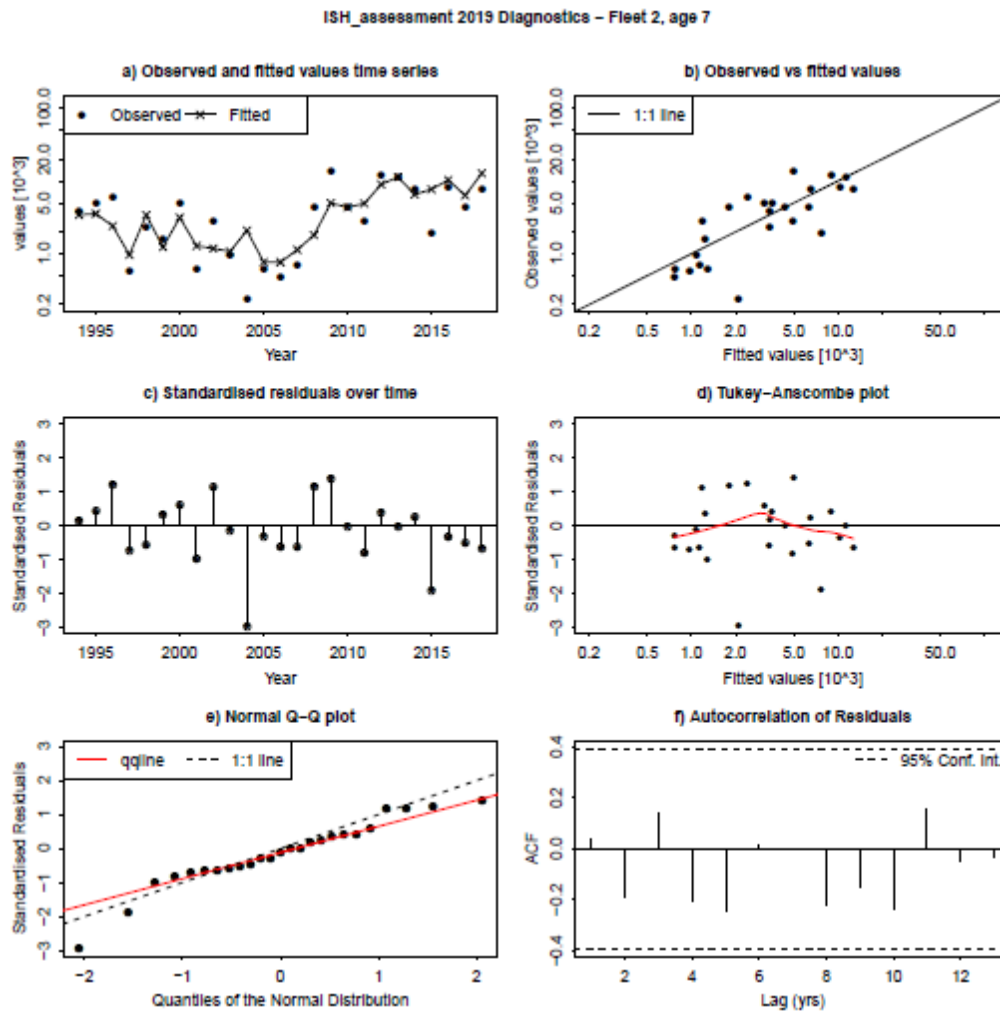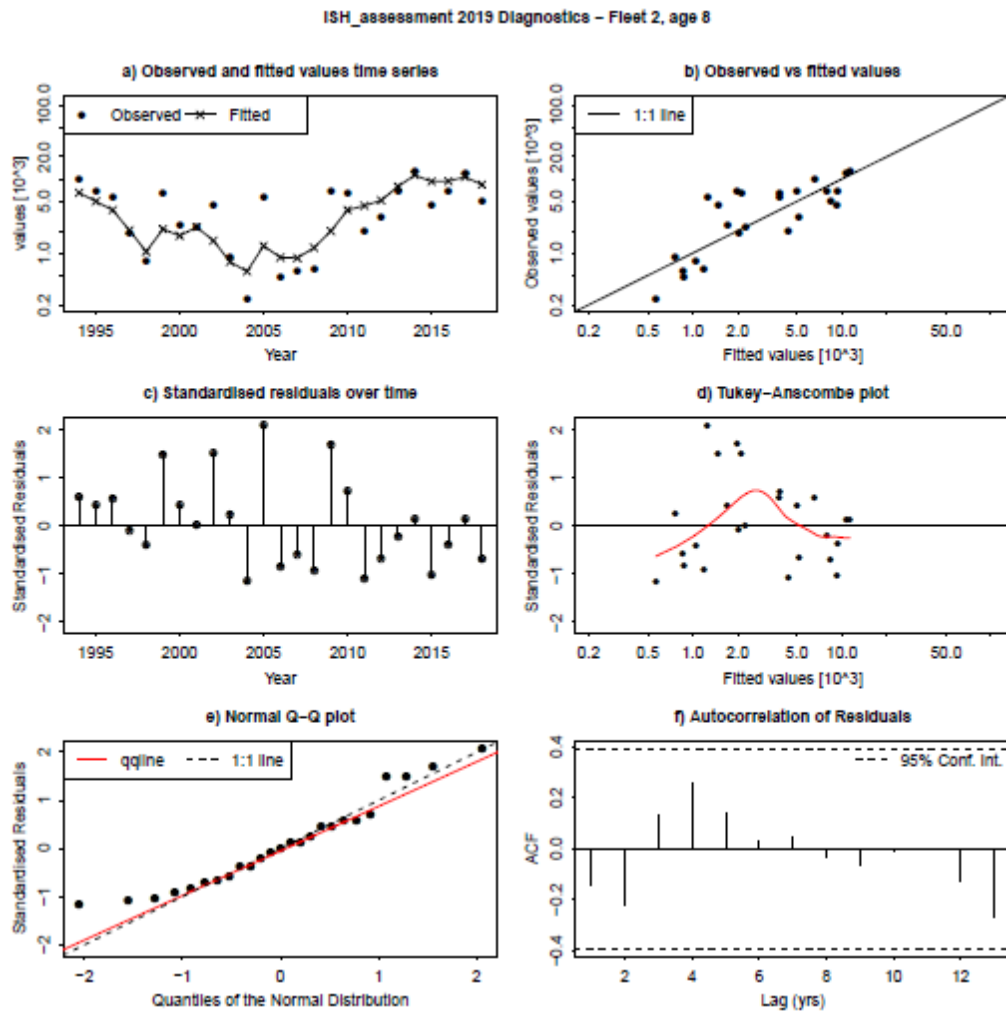**Figure 7.4.1 Herring in Division 7.a North (Irish Sea). Time series of catch weights at age.**
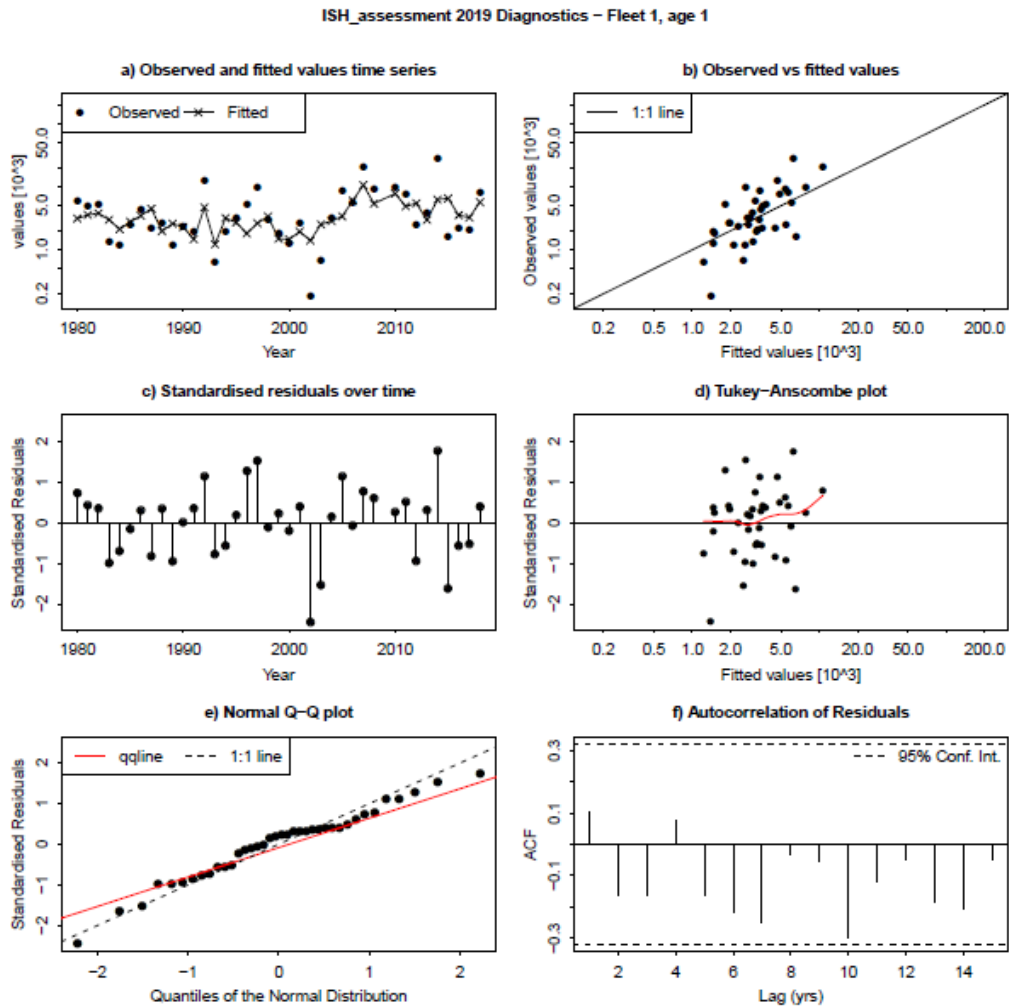
Figure 7.6.1 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age1.
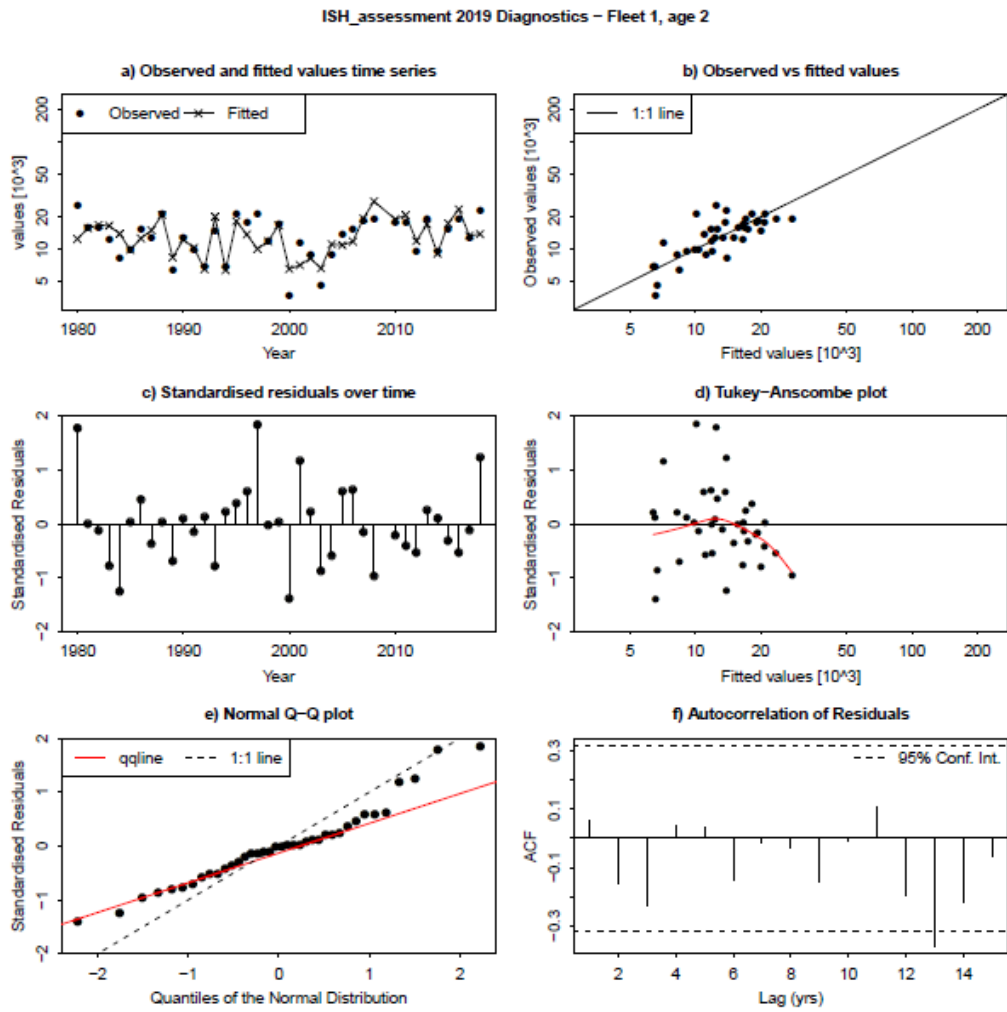
Figure 7.6.2 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age2.

ISH_assessment 2019 Diagnostics – Fleet 1, age 3
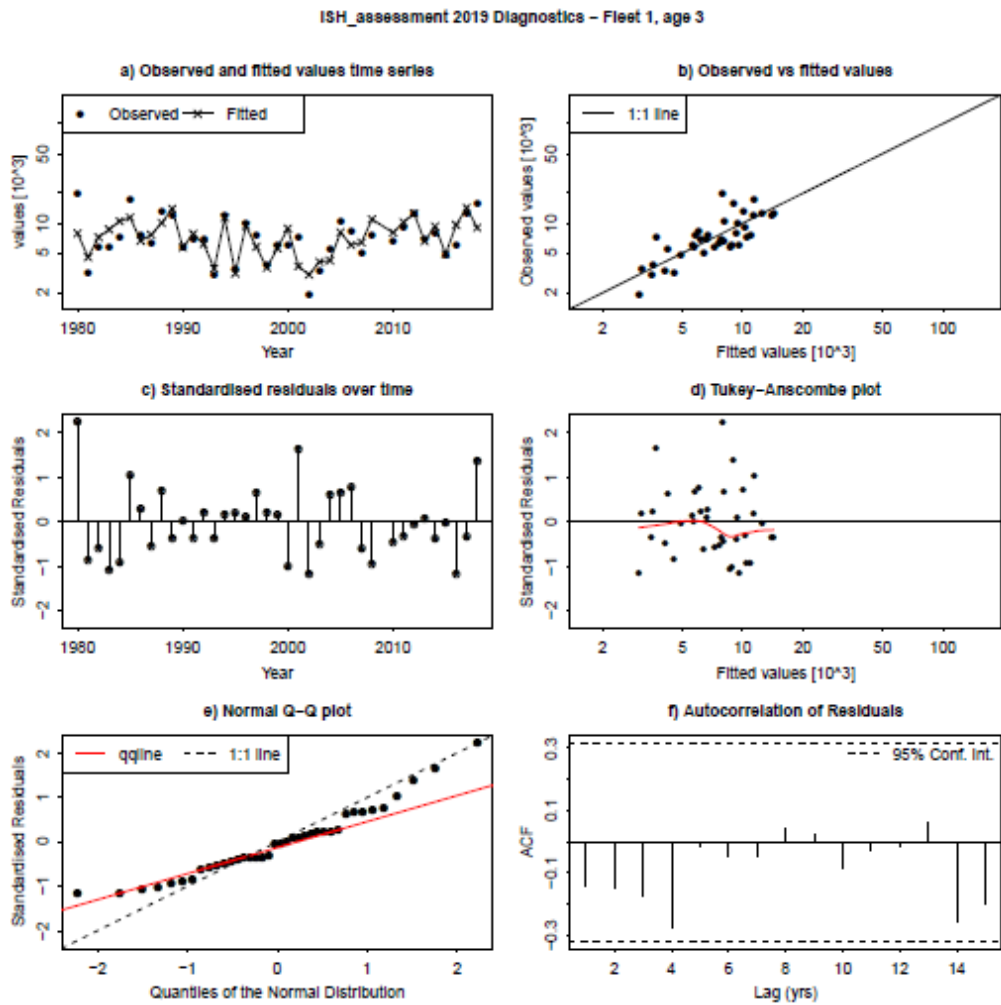
Figure 7.6.3 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age3.
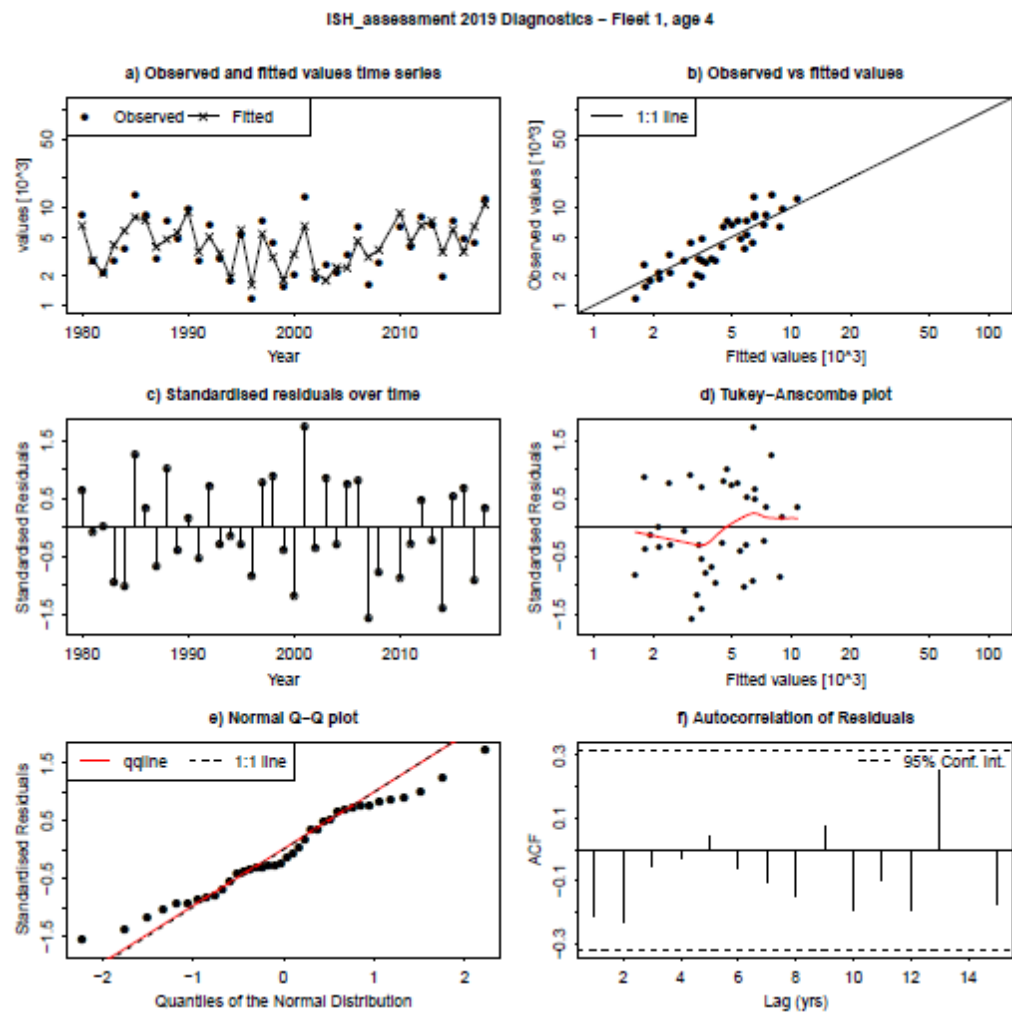
Figure 7.6.4 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age4.
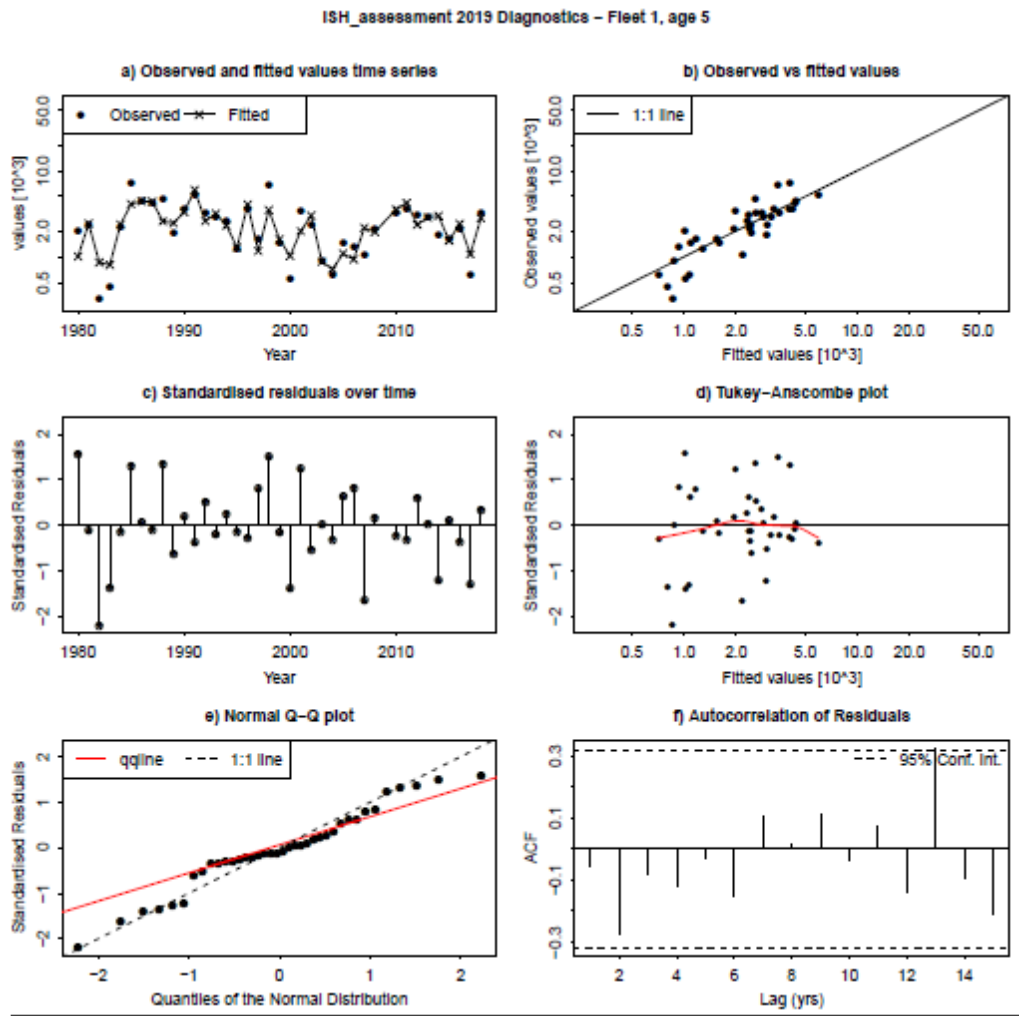
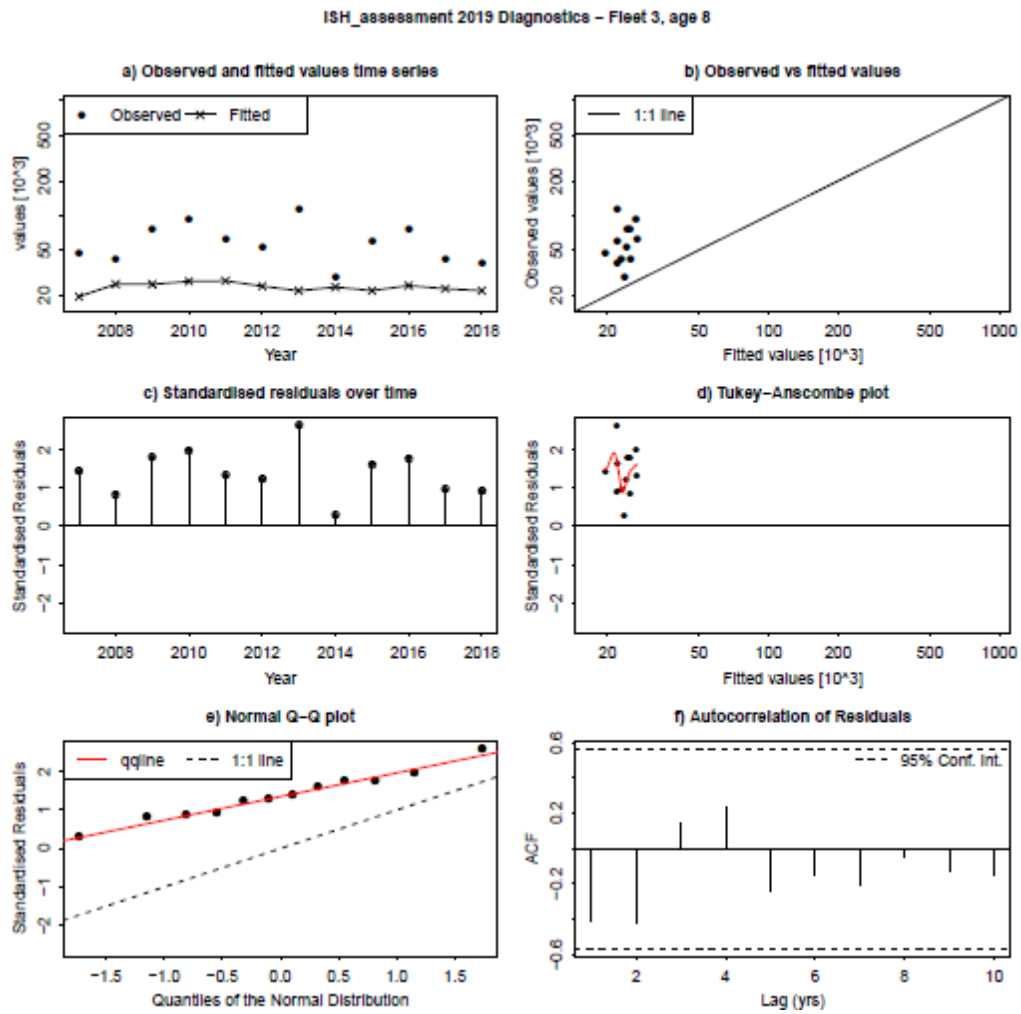**Figure 7.6.5 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age5.**
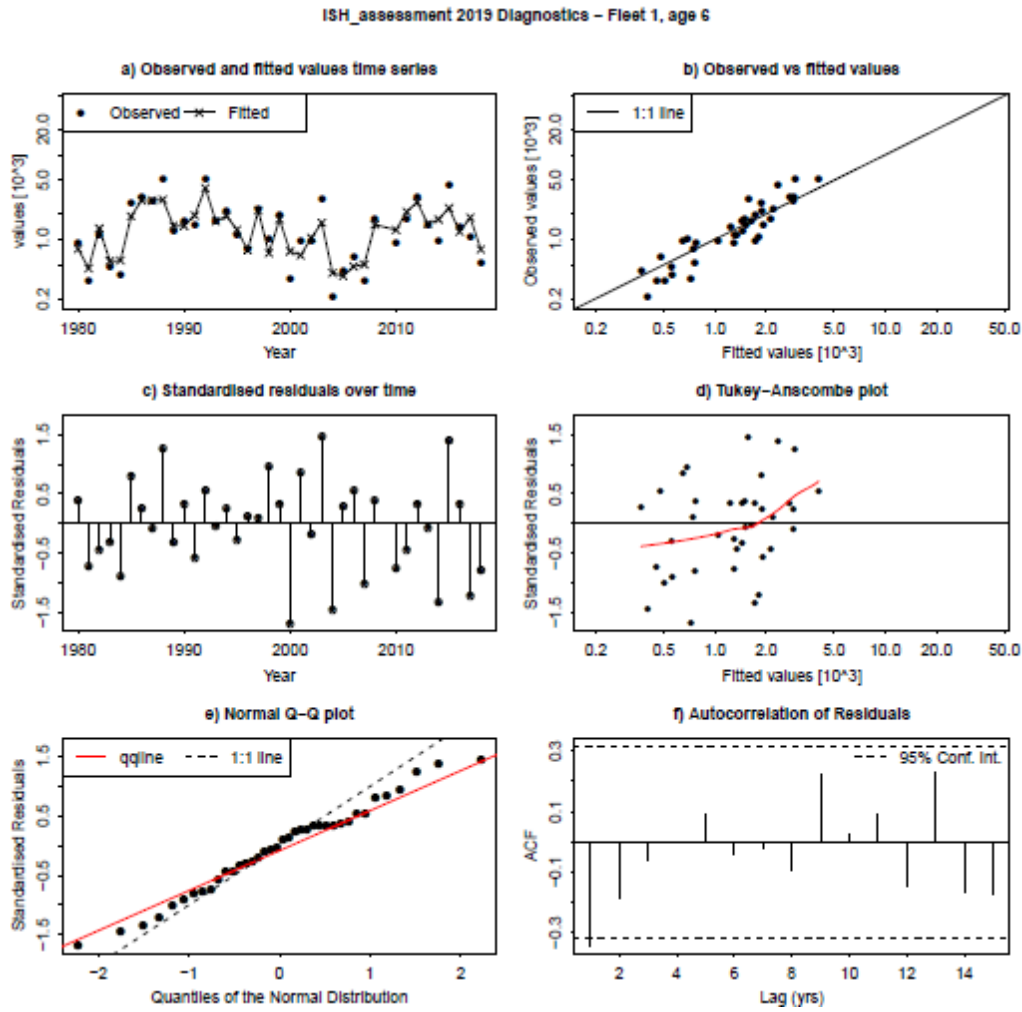
Figure 7.6.6 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age6.
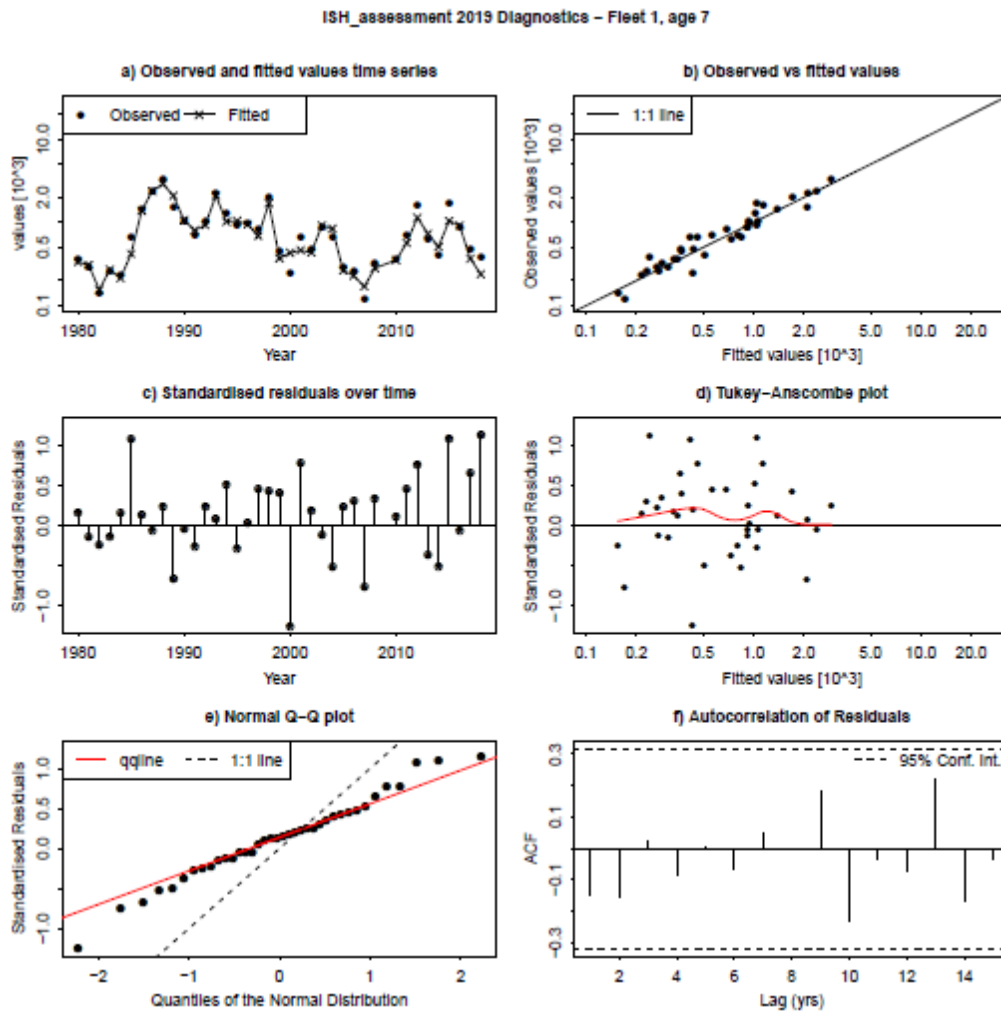
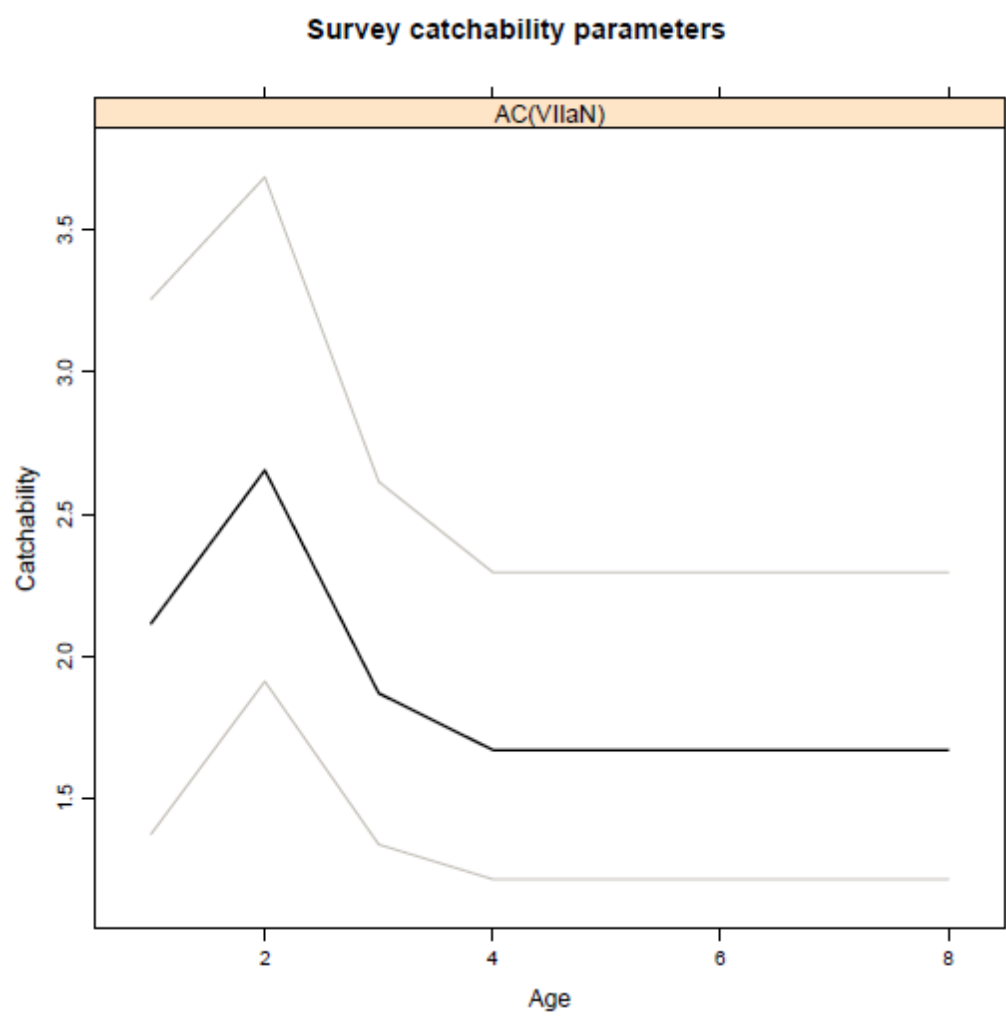**Figure 7.6.7 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age7.**
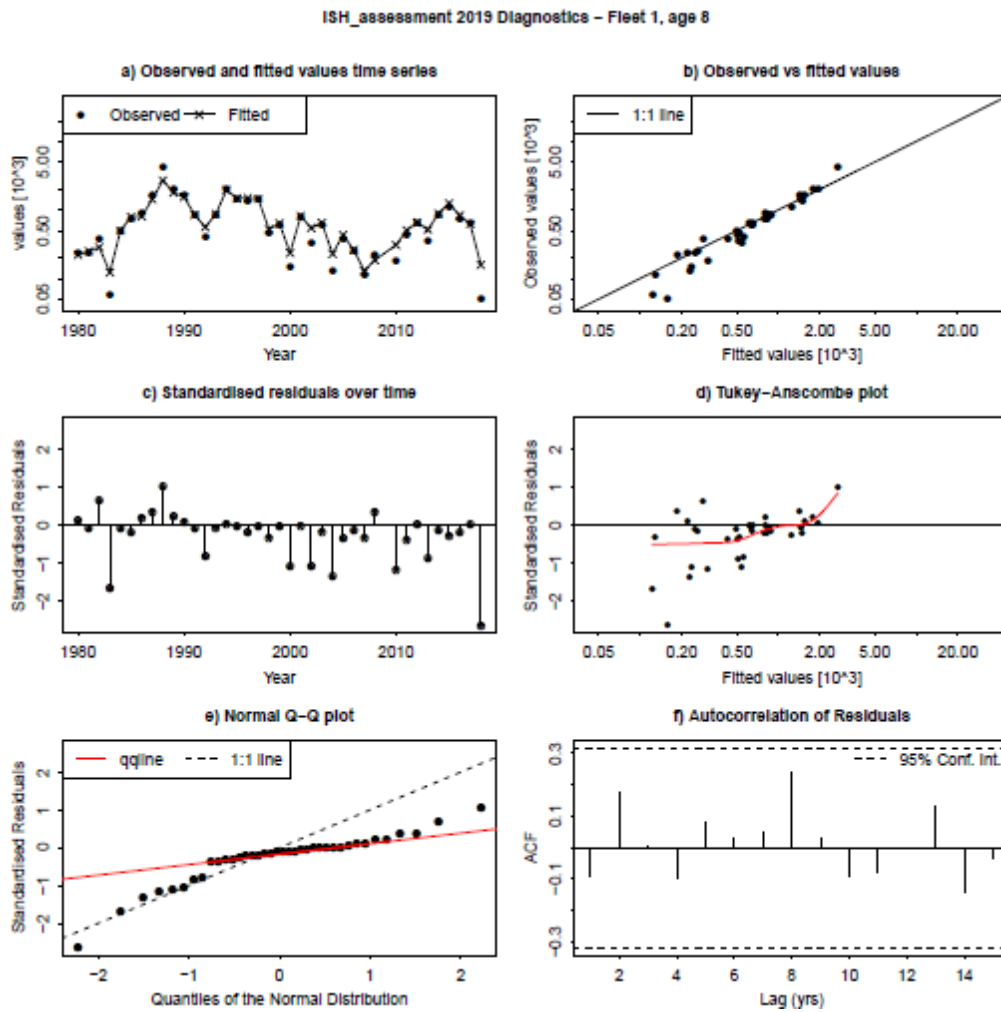
Figure 7.6.8 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the catch data at age8.
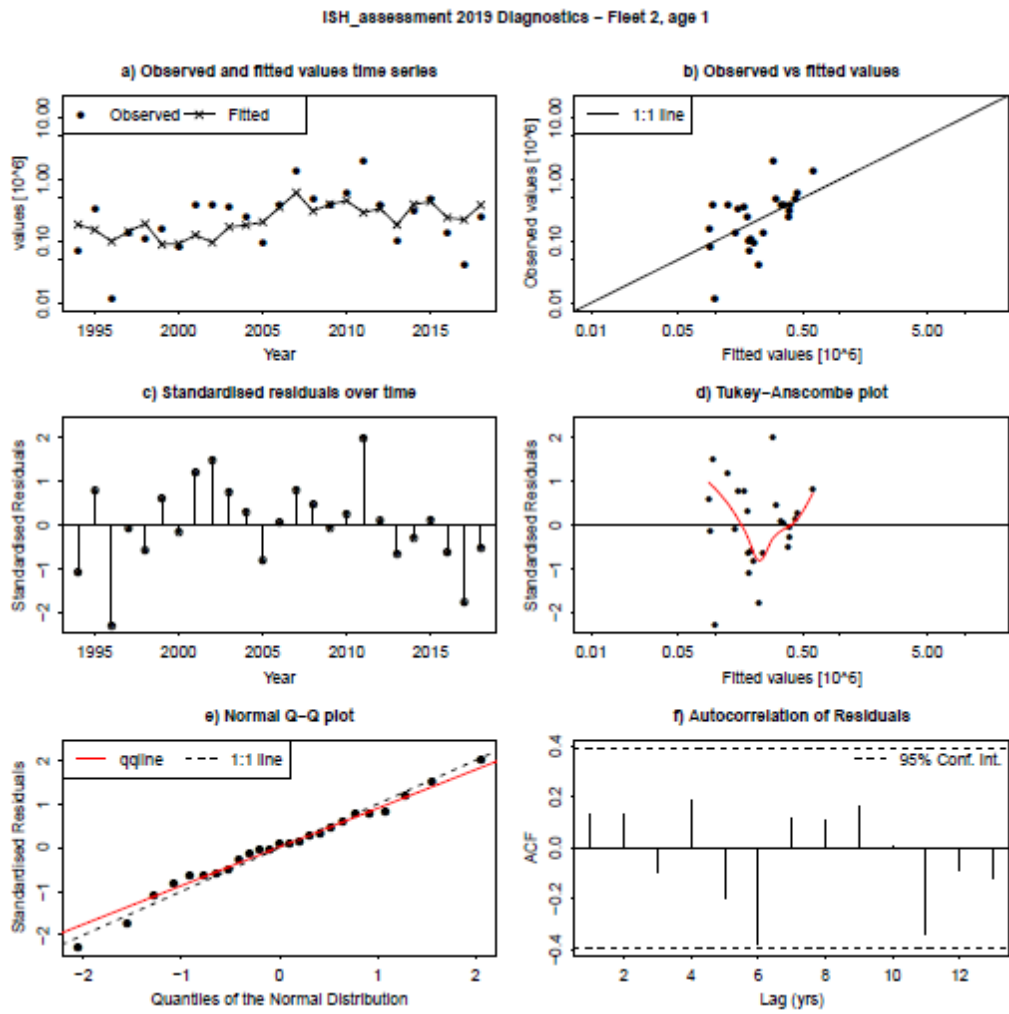
Figure 7.6.9 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age1.
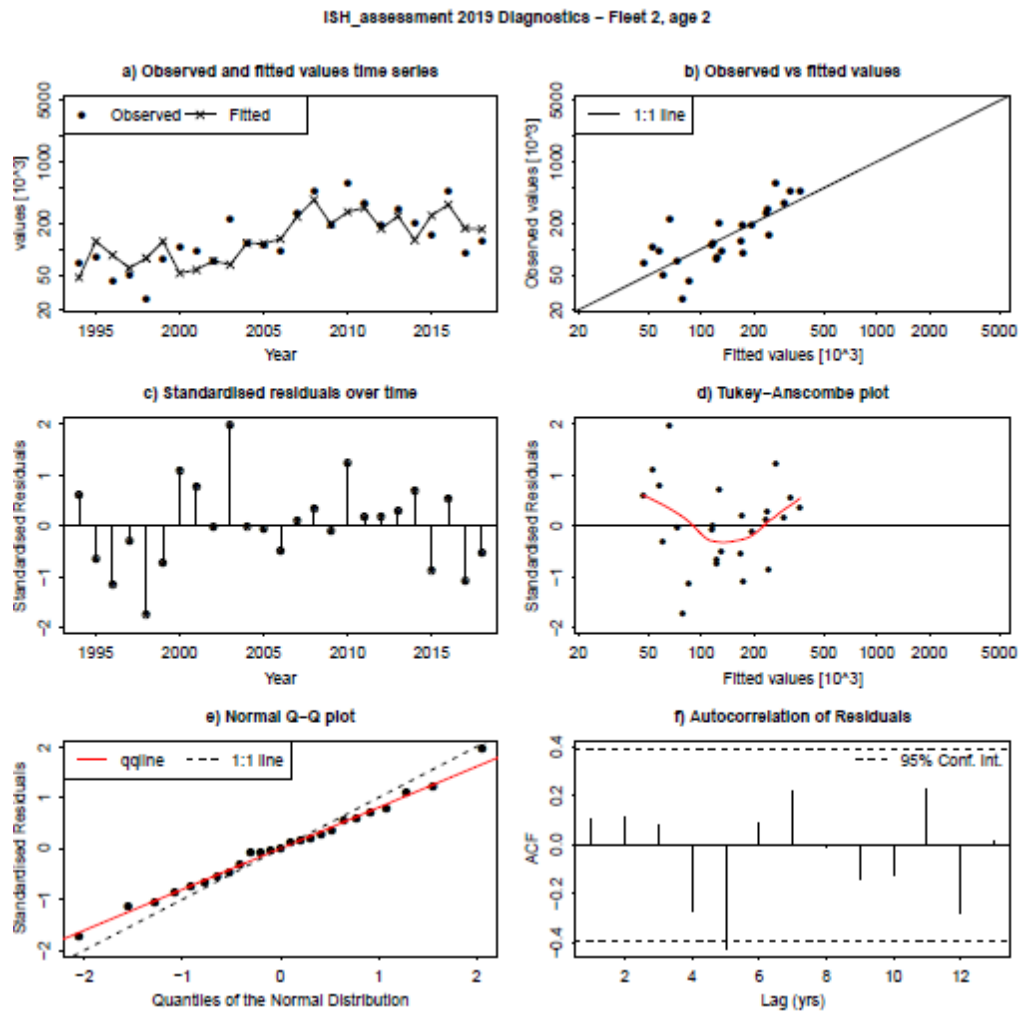
Figure 7.6.10 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age2.
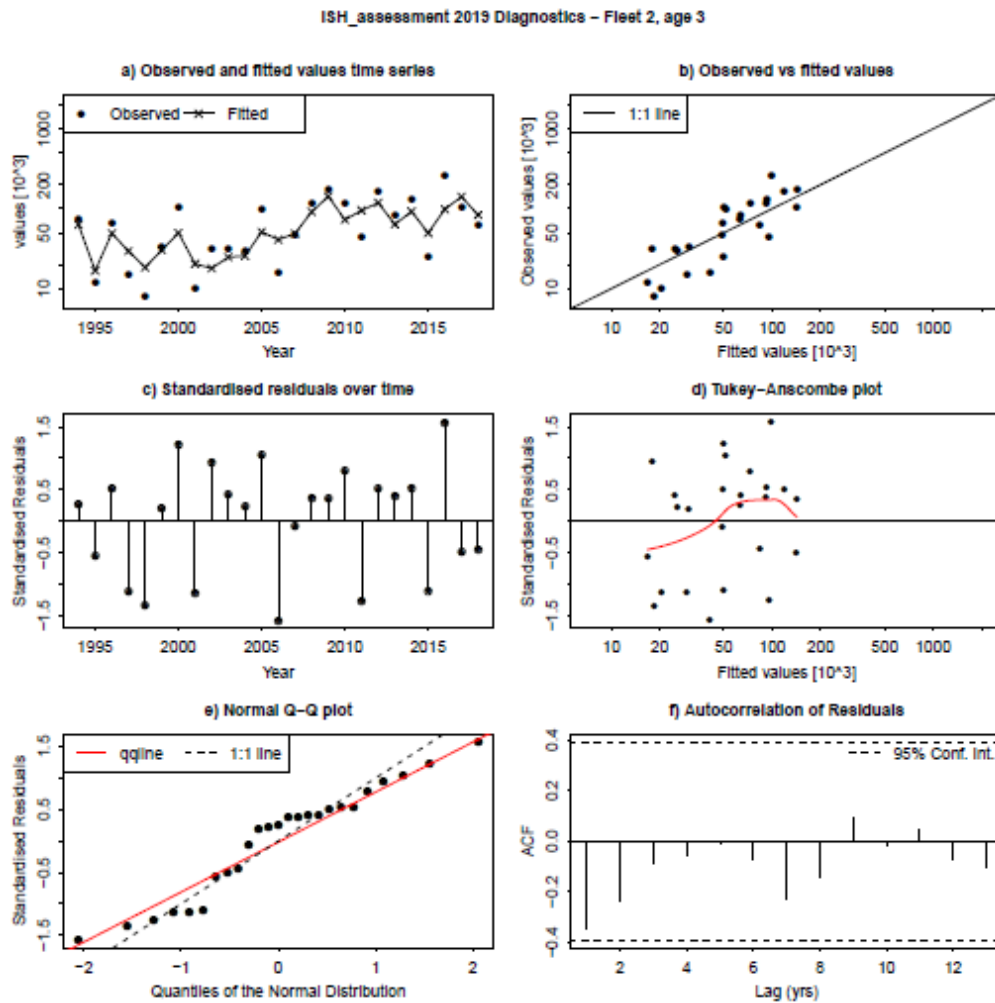
Figure 7.6.11 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age3.
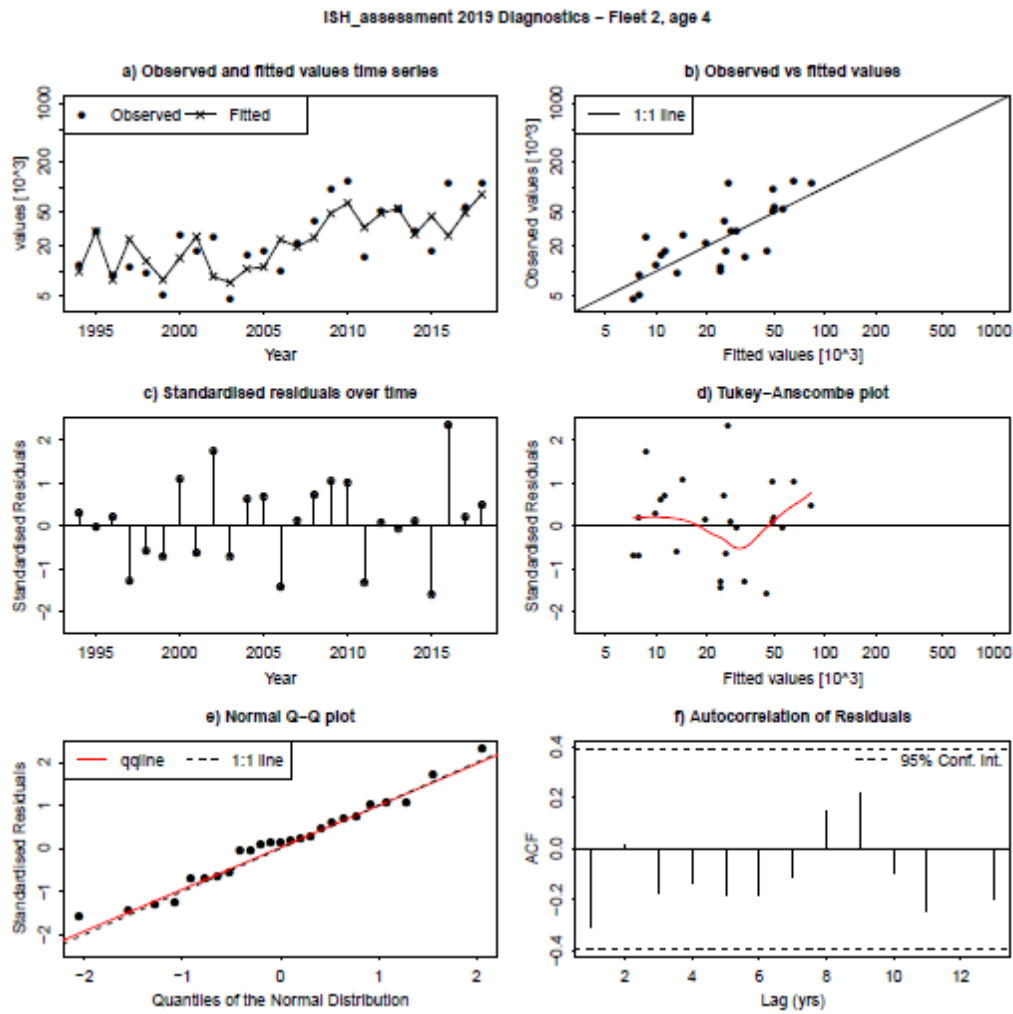
Figure 7.6.12 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age4.
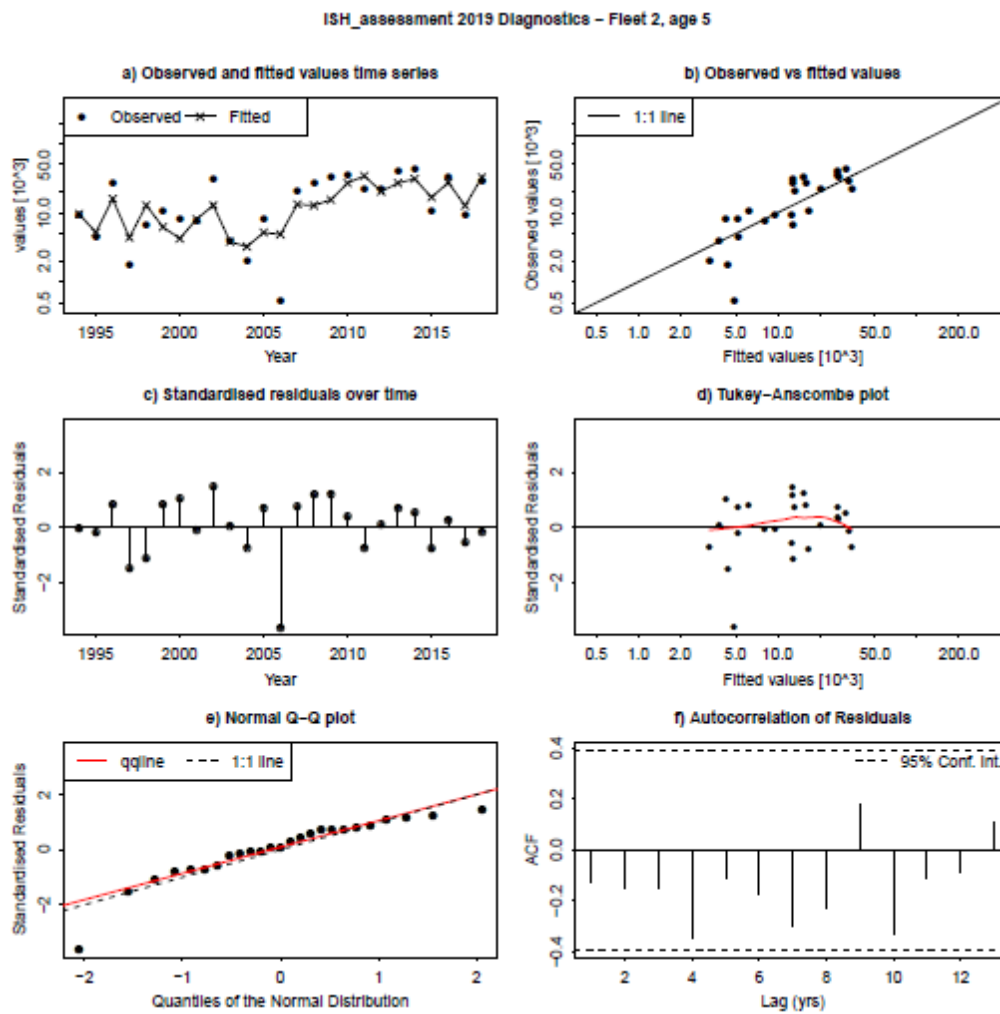
Figure 7.6.13 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age5.
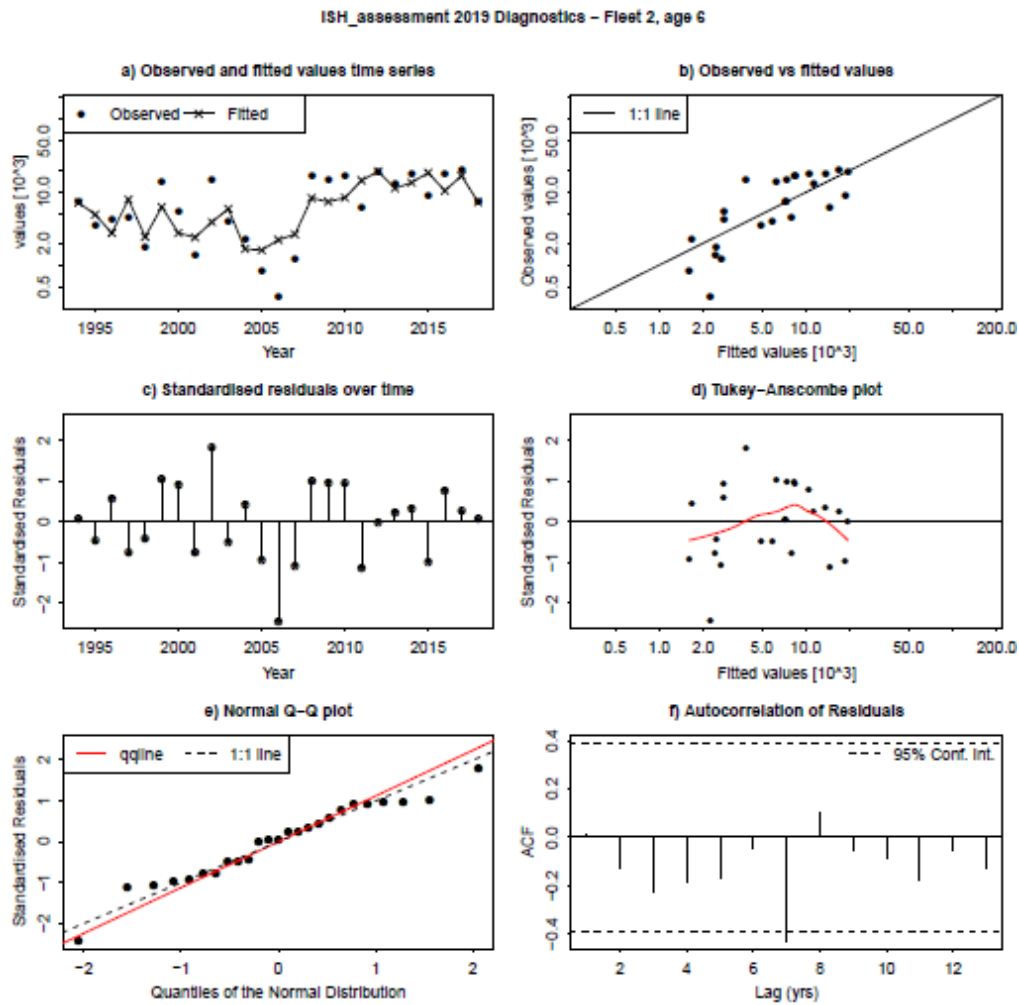
Figure 7.6.14 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age6.

Figure 7.6.15 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age7.

Figure 7.6.16 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to acoustic survey (AC(7.aN)) data at age8.

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a) Observed and fitted values time series
b) Observed vs fitted values
c) Standardised residuals over time
d) Tukey–Anscombe plot
e) Normal Q–Q plot
f) Autocorrelation of Residuals

Figure 7.6.17 Herring in Division 7.a North (Irish Sea). FLSAM run output. Diagnostics of model fit to the SSB acoustic survey (SSB 7.aN)).

Figure 7.6.18 Herring in Division 7.a North (Irish Sea). FLSAM run output. Survey catchability parameter from the acoustic survey AC(7.aN).

Selectivity of the Fishery by Pentad
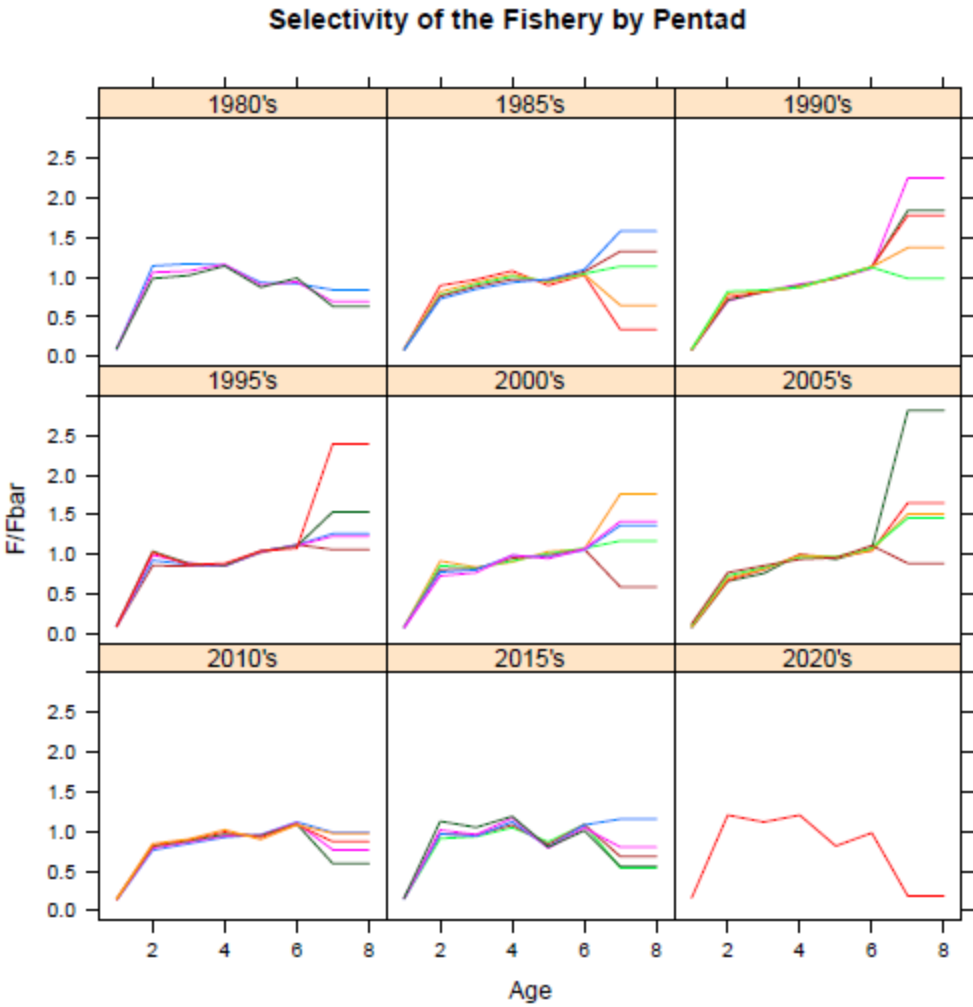
Figure 7.6.19 Herring in Division 7.a North (Irish Sea). FLSAM run output. Selectivity of the fishery by pentad.
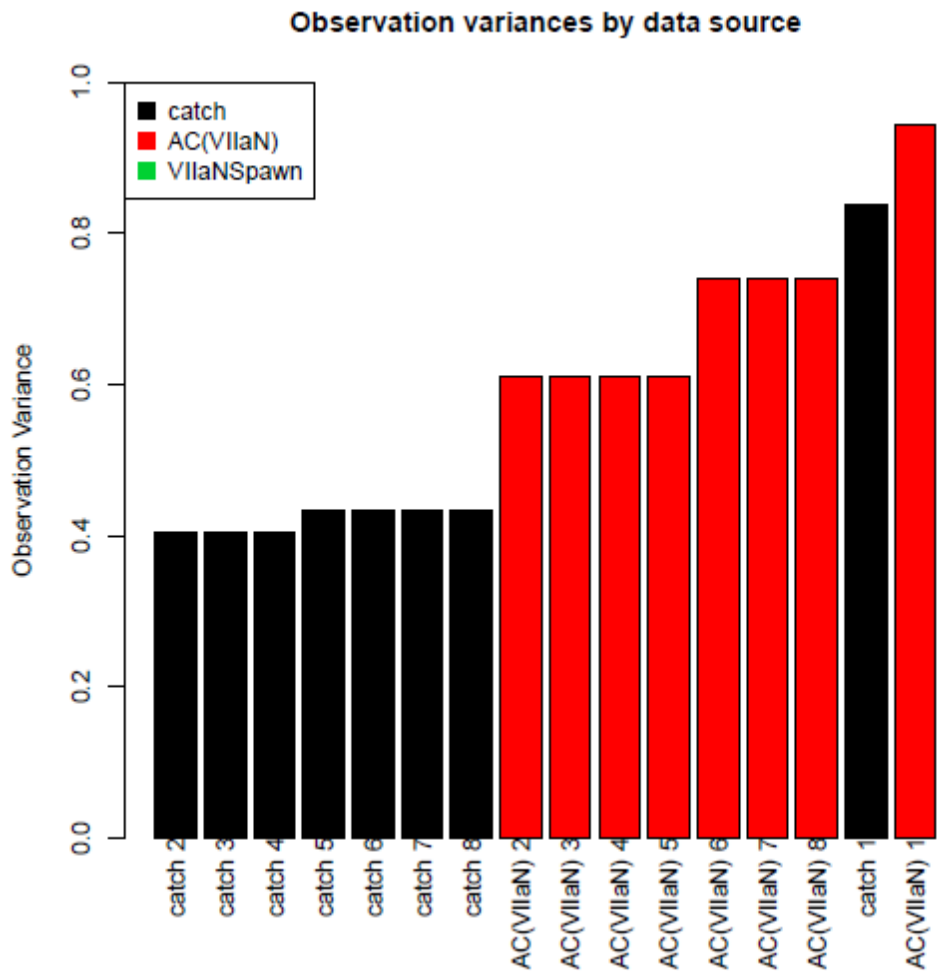
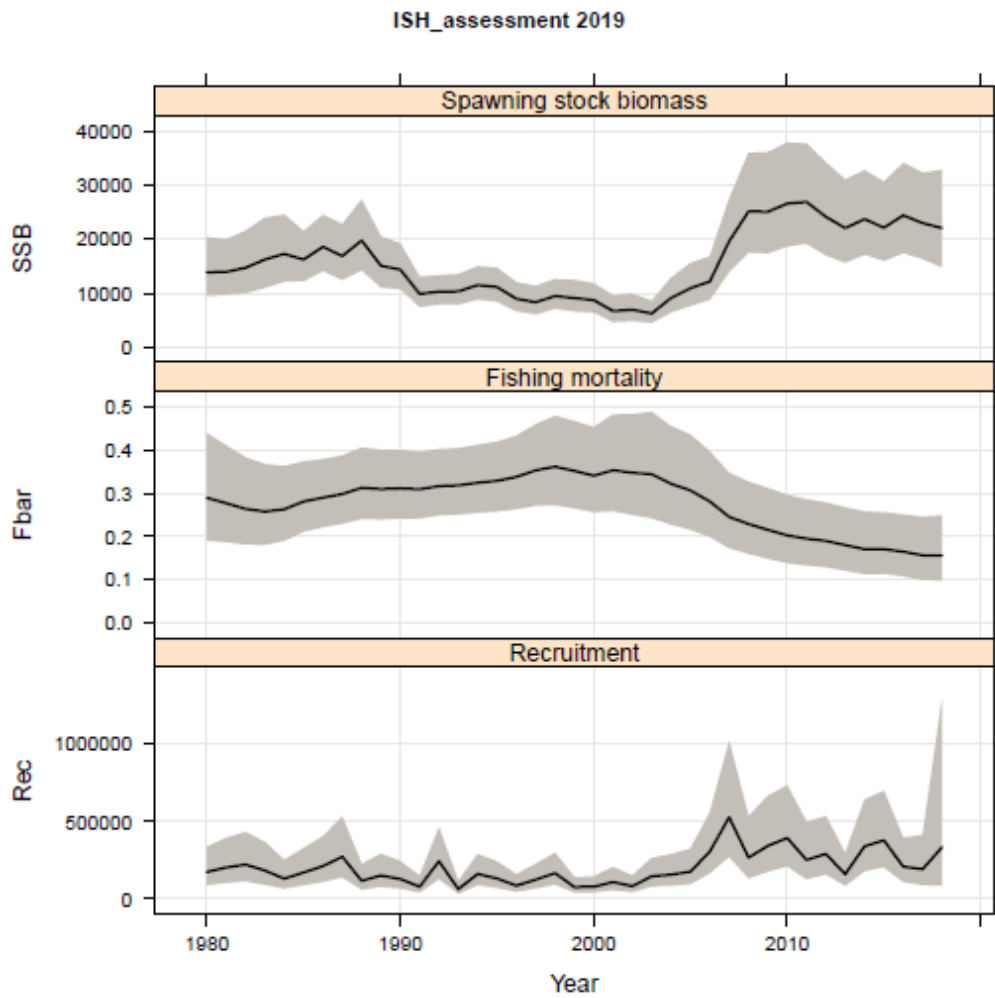**Figure 7.6.20 Herring in Division 7.a North (Irish Sea). Observation variances of all the data sources fitted in the FLSAM assessment model. The observation variance of 7.aNSpawn is fixed at 0.4**
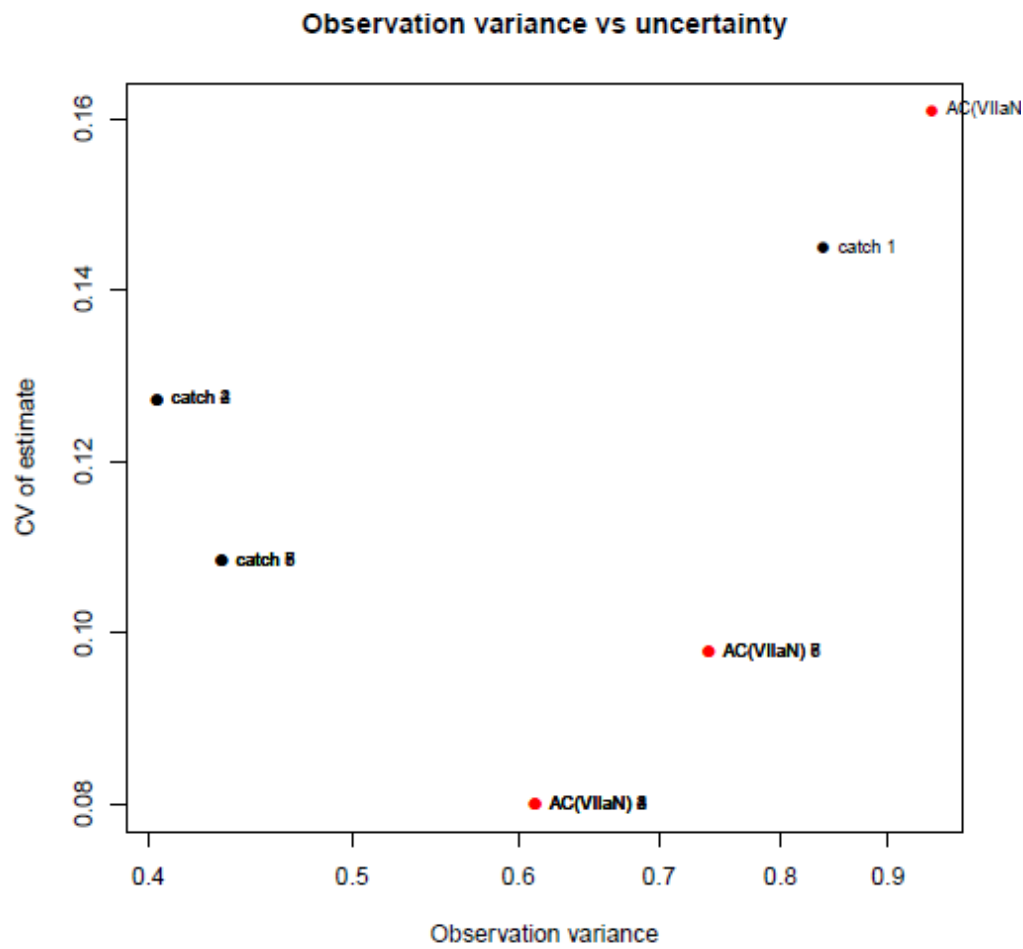
Figure 7.6.21 Herring in Division 7.a North (Irish Sea). Observation variances vs uncertainty of the data sources fitted in the FLSAM assessment model.

Figure 7.6.22 Herring in Division 7.a North (Irish Sea). Stock trends from the final FLSAM run, with 95% confidence intervals. Summary of estimates of spawning stock at spawning time, recruitment at 1-winter ring, mean F_{4-6}.
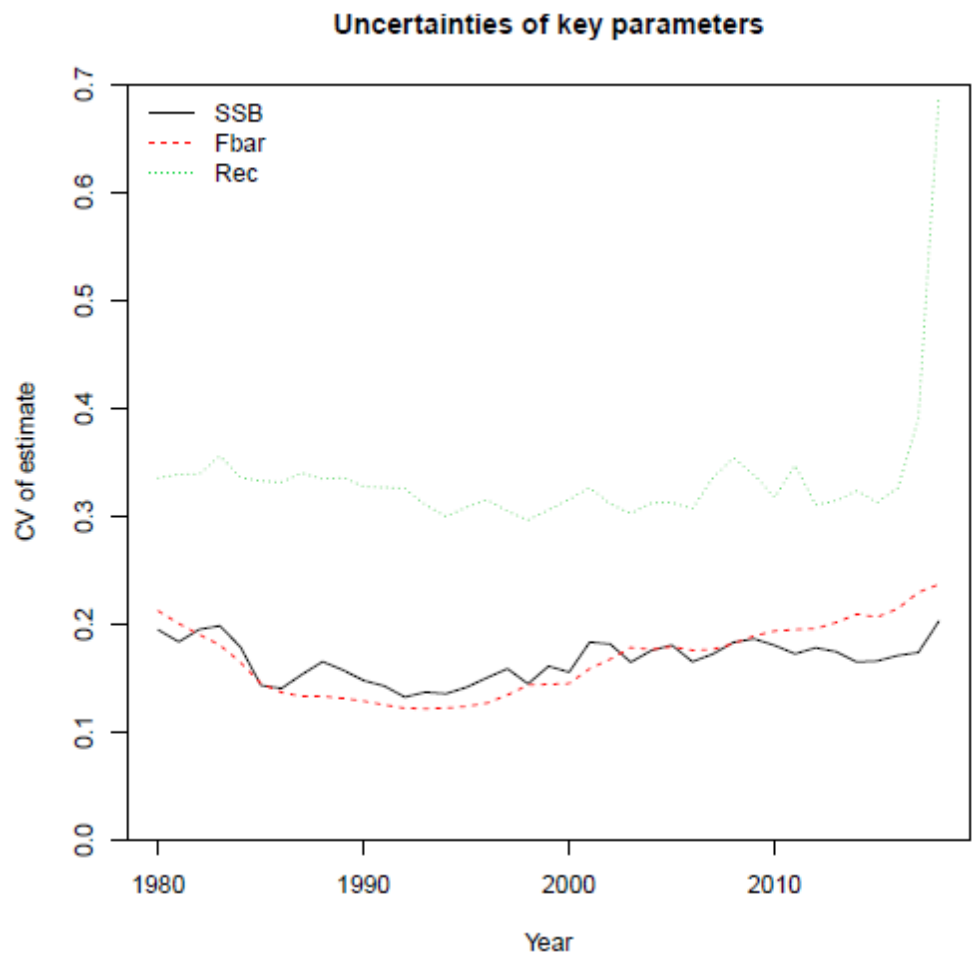
Figure 7.6.23 Herring in Division 7.a North (Irish Sea). Uncertainty of stock parameter estimates from the final FLSAM assessment. Rec = recruitment 1 winter ring.
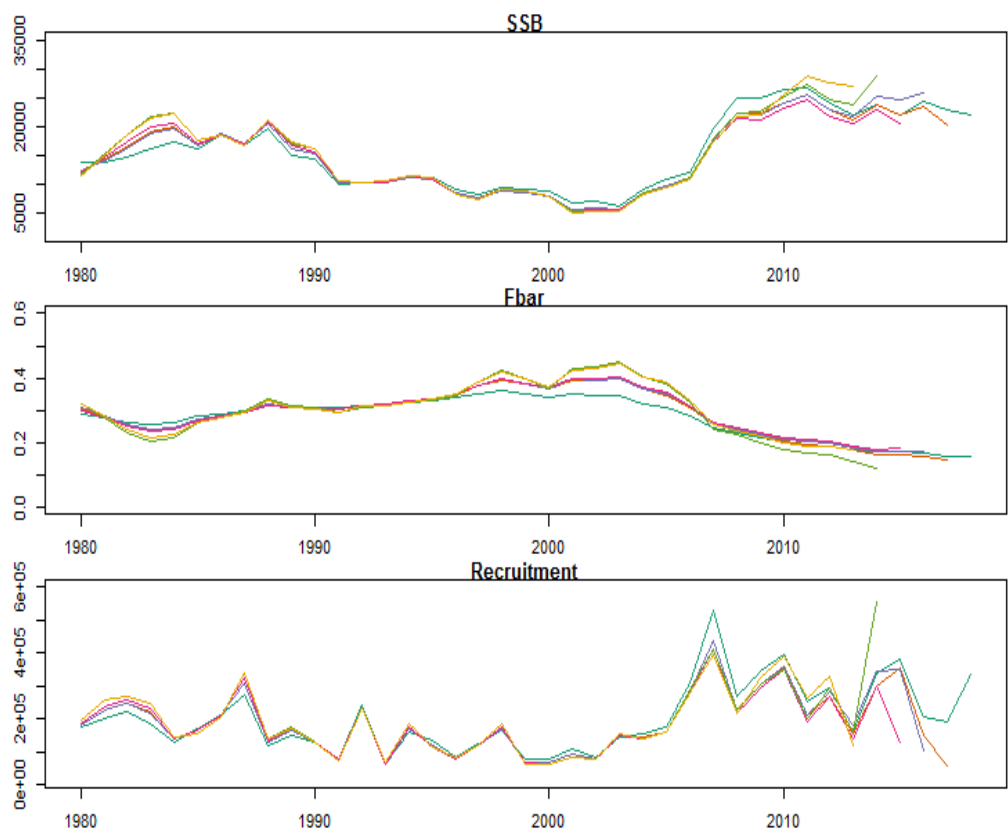
Figure 7.6.24 Herring in Division 7.a North (Irish Sea). Analytical retrospective patterns (2018 to 2013) of SSB, recruitment and mean F$_{4-6}$ from the final FLSAM assessment.
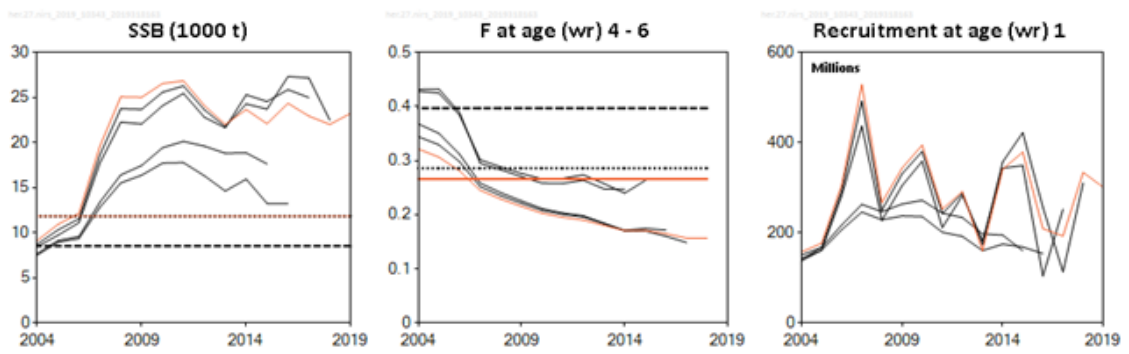

Figure 7.6.25 Herring in Division 7.a North (Irish Sea). Comparison of stock parameters between the 2018 (red line) and previous assessments.