4 Herring (*Clupea harengus*) in divisions 6.a (combined) and 7.b–c

This is the fifth time since 1982 that the working group presents a joint assessment of herring in Division 6.aN and 6.aS/7.b and 7.c. This follows from the benchmark workshop, ICES, WKWEST (2015). This benchmark was unable to differentiate the two stocks and although HAWG still considers them to be discrete, they will be assessed together as a meta-population until the combined survey indices can be successfully split.

The WG noted 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 this section. 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, there is a difference of one year between "age" and "rings", which is not the case for the spring spawners. Further elaboration on the rationale behind this, specific to the 6.a, 7.b and 7.c autumn, winter and spring spawners, can be found in the Stock Annex. It is the responsibility of any user of age-based data for any of these herring stocks to consult the stock annex and if in doubt, consult a relevant member of the Working Group.

4.1 The Fishery

4.1.1 Advice applicable to 2016–2018

ICES gave separate advice for the constituent stocks up to 2015 and advice for the combined stocks since 2016.

After the benchmarking process in early 2015 (WKWEST, 2015), the stocks were assessed together. The management plans in place for either stock were no longer applicable for the combined stocks. Considering the low SSB and low recruitment estimated for the combined stocks in recent years, ICES advised in 2016 that it was not possible to identify any non-zero catch that would be compatible with the MSY and precautionary approach. There were no catch options consistent with the combined stocks recovering to above B_{lim}, and consequently, ICES advised that the TAC be set at 0 t. In February 2016, the European Commission asked ICES to provide advice on a TAC of sufficiently small size to enable ongoing collection of fisheries-dependent data and continue the long-term catch-at-age dataset. ICES advised on a scientific monitoring TAC of 4840 t (with a TAC split of 3480 t to be taken in 6.aN and 1360 t in 6.aS and 7.b–c (ICES, 2016a)). Furthermore, the data should be collected in a way that (i) satisfied standard length, age, and reproductive monitoring purposes by EU Member States for ICES, and (ii) ensured that sufficient spawning-specific samples were available for morphometric and genetic analyses as agreed by the Pelagic Advisory Council monitoring scheme 2016 (Pelagic Advisory Council, 2016).

The EC set a monitoring TAC slightly higher than this advice, at 5800 t (TAC split of 4170 t in 6.aN and 1630 t in 6.aS and 7.b–c; EU 2016/0203, and the same for 2017 (EU, 2017/127) and 2018 (EU2018/120).

4.1.2 Changes in the fishery

There have been no significant changes in the fishing technology of the fleets in this area in recent years. In 6.aN, the fishery has become restricted to the northern part of the area since 2006. Prior to 2006 there was a much more even distribution of effort, both temporally and spatially. In 6.aS, only two main areas have been fished in recent years, particularly in Lough Swilly and in inshore areas of Donegal Bay. There has been little effort in 7.b in recent years.

In 6.aN there were three fisheries prior to 2016, (i) a Scottish domestic pair trawl fleet and the Northern Irish fleet; (ii) the Scottish single boat trawl and purse-seine fleets and (iii) an international freezer-trawler fishery. In 6.aS a wide size range of pair and single trawlers predominate, and there are also small scale artisanal fisheries using drift and ringnets in coastal waters.

Since 2016 the fishery has been restricted to a monitoring fishery with a combined TAC of 5800 t, a significant reduction on the 2015 TAC of 22 690 t for 6.aN; in 6.aS and 7.b–c the TAC was already zero in 2015. For a detailed description of the monitoring fisheries in 6.aN and 6.aS/7.b–c see Section 5, this report.

4.1.3 Regulations and their affects

The 4^{o} meridian divides 6.aN from the North Sea stock. It is not clear if this boundary is appropriate, as it bisects some of the spawning grounds. Area misreporting is known to have occurred across the boundary. The north–south boundary between 6.aN and 6.aS (56th parallel) is not appropriate as a boundary, because it traverses the spawning and feeding grounds of 6.aS herring. Transboundary catches have occurred along this line in the past, although this has been less of an issue recently.

4.1.4 Catches in 2018

The Working Group's best estimate of removals from the stock is shown in Table 5.1.2 for the 6.aS and 7.b–c constituent stock and in Table 5.2.1 for the 6.aN constituent stock.

4.2 Biological Composition of the Catch

Catch and sample data for the 6.aS, 7.b–c and 6.aN constituent stocks were combined to construct the input data for the Herring in Division 6.a (Combined) and 7.b–c assessment. Catch number- and weight-at-age information is given in the stock assessment report Section 4.6 (cf tables 4.6.1a, b and 4.6.2a, b respectively).

The 2013 year class (age 4-wr) dominates both in the catches and the acoustic survey in 2018. This year class was already strongly represented at-age 3 wr in the 2017 catches. Previous stronger cohorts are less influential in the stock with small amounts of older fish present.

4.3 Fishery-independent Information

4.3.1 Acoustic surveys

An acoustic survey has been carried out in Division 6.aN by Marine Scotland Science in June–July since 1991. It originally covered an area bounded by the 200 m depth contour in the north and west, to the 4°W in the east and extended south to 56°N; it had provided an age-disaggregated index of abundance as the sole tuning index for the analytical assessment of 6.aN herring

since 2002. In 2008, it was decided that this survey should be expanded into a larger coordinated summer survey on recommendation from WESTHER, HAWG and SGHERWAY (Hatfield *et al.*, 2007; HAWG ICES, 2007; HAWG ICES, 2010a). The Scottish 6.aN survey was augmented with the participation of the Irish Marine Institute and the area was expanded to cover all of ICES divisions 6.a and 7.b. The Malin Shelf Herring Acoustic Survey (MSHAS), as it is now known, has covered this increased geographical area in the period 2008 to 2018 as well as maintaining coverage of the original survey area in 6.aN.

The Malin Shelf herring estimate of SSB for 2018 is 159 000 tonnes and 925 million individuals (Table 4.3.1.2), a slight increase compared to the 145 000 tonnes and 798 million herring estimate in 2017. The estimate is still however very low in the time-series (Table 4.3.1.3). In 2018, 83% of the biomass was observed north of 56°N (the geographic area included in the West of Scotland (6.aN index) in line with observations through the time-series. The West of Scotland (6.aN) estimate of SSB is 152 000 tonnes and 875 million individuals (Table 5.2.4), an increase compared to the 139 000 tonnes and 765 million herring estimate in 2017. Long-term indices of abundance per age class for West of Scotland herring are provided in Table 5.2.5. In 2018, the biomass of herring located in 6.aS and 7.b–c during the MSHAS was 7000 tonnes.

Although there was a slight increase in the 2018 estimates for the Malin Shelf and West of Scotland compared to 2017, the estimates are still among the lowest in the time-series. The distribution of herring schools was similar to 2017 with some herring distributed south of 56°N line of latitude (WGIPS ICES, 2019). There were some strong herring marks found to the west and northwest of the Outer Hebrides and around St. Kilda in 2018 again. This year larger aggregations of herring were observed around the Northern end of the Hebrides, around the Butt of Lewis and the North Minch and on Stanton banks. These were predominantly juvenile herring. Herring has in the past been found in high densities to the east of the 4°W line in association with a specific bathymetric feature and the occurrence of these herring west of the line in some years has the ability to strongly influence the annual estimate of abundance of the Malin Shelf/West of Scotland estimates. There no evidence in 2018 that herring distributions in this area influenced the Malin Shelf/West of Scotland estimates. It appears that the increase in the 2017 and 2018 estimates compared to 2016 were a result of a greater spread in the distribution of herring rather than distributions occurring around the 4°W line.

In 2017, 3 to 6 winter ringed fish dominated the index representing 89% of both biomass and total abundance. This year (2018), the 2012- and 2013-year classes (age 4 and 5 winter rings in 2018) are still strong in the stock and comprised 20% of total abundance and 35% of the biomass. In contrast to recent years, a large proportion of the stock was made up of 1 and 2 winter ring fish this year (69% of the total abundance and 44% of total biomass). As 1 winter ring fish are only sporadically picked up in the survey due to their distribution typically being in the more inshore areas it cannot be confirmed yet whether 2016 is a strong year class, but it looks like the 2015-year class (2 winter ringers in 2018) is above average. Age disaggregated survey abundance indices for the West of Scotland and Malin Shelf (WoS_MSHAS) herring since 2008 are given in Table 4.3.1.3 and Figure 4.3.1.3.

The stock is highly contagious in its spatial distribution, which explains some of the high variability in the time-series. The survey covers the area at the time of year when aggregations of herring from both the 6.aN and 6.aS, 7.b–c stocks are offshore feeding (i.e. not at spawning time). These distributions of offshore herring aggregations are considered to be more available to the survey compared to surveying spawning aggregations, which aggregate close to the seabed and are generally found inshore in areas unsuitable for the large vessels carrying out the summer acoustic surveys.

4.3.1.1 Industry–Science Acoustic survey

In 2016–2018 industry acoustic surveys of herring during the spawning and pre-spawning period were undertaken as part of the monitoring fishery on this stock. The surveys covers known active spawning grounds in both 6.aN and 6.aS,7b at spawning time and aims to provide estimates of minimum spawning stock size in each of the areas. Full results from the surveys can be found in (WGIPS ICES, 2019) and a summary for each of the components is in Section 05 of this report. Consistent with observations from other surveys, the industry acoustic/trawl survey recorded an abundance of juvenile herring, which has not previously been seen during these surveys (Figure 4.3.1.1.1)

4.3.2 Scottish Bottom-trawl surveys

Marine Scotland Science carries out two annual bottom-trawl surveys in western waters covering the herring stocks in ICES Division 6.a. The Scottish West Coast Ground fish survey in quarter 1 has been carried out in a consistent manner since 1987 and in quarter 4 since 1996. For quarter 1 in the years 1990–1993 age-data were not available on haul resolution and therefore the survey index for quarter 1 starts in 1994. For quarter 4 there were no survey in 2010, and in 2013 only part of the area were covered and the data were not included in the survey calculations. The two indices were recalculated in 2019 following an Interbenchmark procedure (IBPher6a7bc, ICES 2019).

The internal consistencies in the trawl surveys indicate ability to follow cohorts particularly in the Q1 and Q4 indices (figures 4.3.2.1 and 4.3.2.2). Historic retrospectives for the index calculations for Q1 and Q4 are given in Figures 4.3.2.5 and 4.3.2.6, no new data were added to the index calculations between the interbenchmark and the calculations for the assessment and the lines therefore overlap completely. For Q4 data from 2018 were added to the calculations after the interbenchmark and the two calculated Q4 indices show good agreement.

The abundance of 2 winter ring fish were at higher levels earlier in the time-series particularly in quarter 1, but since 2003 older fish have been numerically more abundant in the index in both quarters (figures 4.3.2.3 and 4.3.2.4). Recent years show an increase in 3 wr for quarter 4 and an increase in 4 wr for the most recent year in quarter 1. Full details for the survey can be found in the Stock Annex.

4.4 Mean Weights-at-age, Maturity-at-age and natural mortality

4.4.1 Mean weight-at-age

Weights-at-age in the stock are obtained from the acoustic surveys and are given in Table 4.3.1.2 (for the current year) and Table 4.6.3 (for the time-series). The weights-at-age in the stock have been declining since 2010 particularly for younger ages. Weights-at-age in the catches for 6.aN and 6.aS, 7.bc are presented separately in Table 4.6.2a and 4.6.2b and are used separately in the multi fleet assessment. Both areas show fluctuations in catch weights over time. In several years no 1 winter ring fish have been taken in the 6.aN fishery. In 2018 the catch weights have decreased slightly for most age classes.

4.4.2 Maturity ogive

The maturity ogive is obtained from the acoustic survey (Table 4.3.1.2, Figure 4.4.2.1). The Malin Shelf Acoustic Survey (MSHAS) provides estimated values for the period 2008 to 2018 (cf. Table 4.6.5). For earlier years, the maturity ogive is as per the 6.aN stock, and from 1991 is taken from the geographically split west of Scotland acoustic survey. The proportion mature of ages 2, 3- and 4-wr in 2018 were lower than in 2016 and 2017 (Figure 4.4.2.1). A greater proportion of immature fish were encountered in the survey in 2018 than in previous years.

4.4.3 Natural mortality

The natural mortality used in previous assessments of several herring stocks to the West of Scotland, including 6.aN, were based on the results of a multispecies VPA for North Sea herring calculated by the ICES multispecies working group in 1987 (ICES, 1987). From 2012 onwards the assessment of North Sea herring has used variable estimates of M-at-age derived from a new multispecies stock assessment model, the SMS model, used in WGSAM (Lewy and Vinther, 2004; ICES, 2011).

The most recent benchmark of herring in Division 6.a and 7.b–c (WKWEST 2015) agreed to use the natural mortalities for North Sea herring from the current North Sea multispecies model, as it is deemed the best available proxy for natural mortality of herring in 6.a and 7.b–c. The input data to the assessment of herring in divisions 6.a and 7.b–c are averaged annual M values from the 2011 SMS key run (period 1974–2010) for each age (Table 4.6.4). This approach is similar to the pre-benchmarked assessment in that it is time invariant and age variant. This time-series reflects the most recent period of stability in terms of M from the North Sea SMS as it excludes the gadoid outburst of the 1960 which is of little relevance to present day conditions.

Detailed explanation regarding the natural mortality estimates can be found in the Stock Annex.

4.5 Recruitment

There are no specific recruitment indices for this stock. Although both the catch and the surveys generally have some catches at 1-wr, both the fishery and survey encounter this age group only incidentally. The first reliable appearance of a cohort appears at 2-wr in both the catch and the stock.

4.6 Assessment of 6.a and 7.b–c herring

The assessment presented here follows the procedure agreed by the recent interbenchmark (IBPher6a7bc, ICES 2019). The tool for the assessment of herring in 6.a and 7.b–c is a multi-fleet implementation of the State–space Assessment Model (www.stockassessment.org), embedded inside the FLR library (Kell *et al.*, 2007).

Data Exploration

A comparison of the age structure in each of the data sources is presented in Figure 4.3.1.1 there is generally good agreement between the catch data and the tuning indices. In some years the acoustic survey picks up a higher proportion of 1 winter ring fish but this is variable between years.

The internal consistency from the combined acoustic survey is presented in Figure 4.3.1.2. The best agreement is seen for older ages and is poor for the younger ages. The survey estimates were slightly higher in 2018 than 2017. The internal consistency for the IBTS survey Q1 (Figure 4.3.2.1)

and Q4 (Figure 4.3.2.2) is similar across all ages. The poorest consistency can be seen for 9 wr in the IBTS Q4.

The two trawl surveys and the West of Scotland acoustic surveys were updated and the methods used are the same as the interbenchmark (IBPher6a7bc, ICES 2019). Both of the trawl surveys have obvious year effects (1998 and 2004 in IBTS-Q1 and 2000–2002 in IBTS-Q4), and are generally noisy with low internal consistencies (Figures 4.3.2.1 and 4.3.2.2). Similarly for the West of Scotland acoustic survey which has a marked year effect in 2005.

Assessment

The catch residuals are presented for 6.aN in Figure 4.6.1. The biggest residuals can be seen in the earliest part of the time series. The residuals from 6.aS, 7.b, c are presented in Figure 4.6.2 and show the biggest residuals at older ages in the most recent years. This is unsurprising because there are very few older ages present in this tuning series. There are no age or year effects in the residuals.

The residuals from each of the tuning series are also presented. The combined acoustic survey (Figure 4.6.3) shows the smallest residuals overall. The IBTS Q1 (Figure 4.6.4) and IBTS Q4 (Figure 4.6.5) both show the largest residuals for younger and older age classes. In the previous assessment strong year effects were seen in both of these surveys. Adding correlation to the survey observations in the updated assessment has fixed this problem.

The estimated observation variance parameters for each data set fitted by the model are presented in Figure 4.6.6. The model is influenced largely by information from the catch in both North and South followed by the acoustic survey (combined WOS MSHERAS) ages 3–6. The youngest age (1 wr) in both the catch data from the North and South have a higher variance compared to older ages and contribute less to the model fit.

The observation variance by data source as estimated by the assessment model plotted against the CV estimate of the observation variance parameter and presented in Figure 4.6.7. The uncertainty associated with the parameters estimated is low for most data (Figure 4.6.7). The IBTS Q4 age 2 wr have a low observation variance and a high CV value. The CVs do not indicate a lack of convergence of the assessment model.

The estimated catchability for each of the tuning indices is presented in Figure 4.6.8. The catchability in the acoustic survey remains a problem in this update assessment Catchability is free for all ages and is only bound for the two oldest ages. The assessment shows catchability to be increasing towards the oldest ages reaching values of almost 6. It is not clear what is causing this catchability pattern or why the catchability is so high. The IBTS surveys show a similar catchability pattern but the magnitude of the estimates is lower.

Figure 4.6.9 shows the correlation plot of the parameters estimated in the model. The horizontal and vertical axes show the parameters fitted by the model (labelled with names stored and fitted by FLSAM). The colouring of each pixel indicates the Pearson correlation between the two parameters. The diagonal represents the correlation with the data source itself.

Uncertainty estimates from this assessment of recruitment, SSB and Mean F are shown in Figure 4.6.10. The highest uncertainty can be seen for recruitment in the terminal year. This is unsurprising given that there is no independent index of recruitment in this assessment.

Figure 4.6.11 shows the trajectories for SSB, recruitment and mean F over the complete time-series from 1957–2018. SSB peaked in the early 1970s and has been declining steadily since 2004. Recruitment also peaked in the early period of the time-series with no comparatively strong year classes evident in recent years. Since 2010, recruitment has dropped to an even lower level. Fishing mortality was at its highest in the early 1970s. The zero catch advice in 2016, 2017 and 2018 and the resulting monitoring fishery has decreased F.

The analytical retrospective for this stock is shown in Figure 4.6.12. The 2018 assessment had a strong retrospective bias in SSB, pulling down the series as far back as the mid-1980s (ICES, 2018). The changes applied to the assessment following the interbenchmark have improved the retrospective but bias is still present. The Mohn's Rho on 5 year peels is -23.

The diagnostics of the assessment model fit to each of the individual data sources, catch N, catch S, WOS_MSHAS, IBTSQ1 and IBTS Q4 by age are presented in figures 4.6.13–4.6.57. These plots show a good fit to the catch data. Some divergence can be seen between observed and predicted values at some ages in the tuning data particularly the IBTS Q4 in more recent years.

The final assessment in 2018 and 2019 are compared in Figure 4.6.58. The new assessment shows a very different perception of stock status. The SSB has been significantly revised downwards and F has been revised upwards. Recruitment has also been revised downwards. SSB and recruitment are at very low levels with decreases in F evident in recent years.

4.6.1 Final Assessment for 6.a and 7.b–c herring

In accordance with the settings described in the Stock Annex, the final assessment of 6.a and 7.b–c herring was carried out by fitting a State–space model (multi fleet SAM, in the FLR environment). This follows on from the interbenchmark in early 2019 (IBPher6a7bc, ICES 2019).

4.6.2 State of the combined stocks

Fishing mortality has been reduced since the introduction of zero catch advice and in line with the monitoring TAC in 2016. However, there is no information on the F on each of the constituent stocks. Unless the two stocks are of equal size, F on the smaller stock will be higher than indicated in the overall F. SSB has decreased steadily since 2003. SSB in 2018 is estimated to be at a very low level. Recruitment has been low with no big cohorts evident in recent years. Recent catches have been amongst the lowest in the time-series.

4.7 Short-term Projections

4.7.1 Short-term projections

No short term projections were carried out in 2019.

4.7.2 Yield per Recruit

No yield per recruit analysis was conducted at HAWG 2019.

4.8 Precautionary and Yield Based Reference Points

The change in perception of SSB and recruitment had a profound effect on the breakpoints estimated by the segmented regression analysis. IBPher6a7bc concluded that after a considerable amount of work being carried out within the interbenchmark and given all the uncertainties and the inability to estimate several reference points, the IBP decided not to present any reference points for 6.a, 7.bc herring. It is anticipated that a full benchmark will be carried out within a few years which hopefully will allow the two separate stocks to again be assessed independently. That would also be the time to revisit the estimation of reference points (IBPher6a7bc, ICES 2019).

4.9 Quality of the Assessment

This assessment combines two separate stocks, as estimation of independent stock sizes was not possible. These stocks are 6.aN herring and 6.aS/7.b–c herring. The stock went through an interbenchmark in 2019. Improvements were made to the input data. The IBTS data series was recalculated using the delta GAM method and the acoustic surveys were combined into a single tuning index. The model was changed to a multi fleet SAM assessment with data from 6.aN and 6.aS 7.bc treated separately. The updated assessment provides the best statistical fit to the input data, but the assessment still has a strong retrospective bias. There is also a pattern of increasing catchability with age for the acoustic survey data which cannot be explained, given what would reasonably be expected for an acoustic survey.

The assessment does not provide any information on the state of either constituent stock. The fishing mortality information from this assessment is not informative of the mortality being experienced by either stock. The overall F may mask important differences in F between the stocks. Unless the two stocks are of equal size, which is not likely, the smaller stock may be experiencing a much higher F than the overall F estimates imply.

SSB is at a very low level. Recruitment is estimated to be the lowest in the series. This reflects very low numbers of 1-wr fish in the catches in recent years. Since 2012, there have been very few 1-wr herring observed in the 6.a (combined) and 7.b–c fishery.

The updated assessment shows a very different perception of the stock with SSB and recruitment revised downwards and at very low levels. The fishing mortality has been revised upward with a decrease evident since the introduction of the monitoring TAC in 2016.

The interbenchmark points to continued concerns with the quality of the combined assessment and how well it is able to represent the dynamics of the separate stocks and fisheries in 6.aN and 6.aS/7.bc. The new model remains sensitive to assumptions on age-dependent catchabilities, lack of information on recruitment and the abundance of fish of younger ages. Given unresolved issues with the assessment it was used as indicative of trends only.

4.10 Management Considerations

There is anecdotal evidence that the stocks are not the same size and managers are advised to ensure that any exploitation pattern imposed in this area ensures that the smaller, more vulnerable, stock is not over-exploited. There is a clear need to determine the relative stock sizes and to ensure that the smaller / weaker stock is adequately assessed and protected from over-exploitation.

The working group suggests that it returns to assessing each discrete, constituent stock in this area separately when methods allow doing so. Until that is possible, a joint assessment is necessary.

A research project is currently underway to assess the identity of herring stocks in this area through genetic analysis. The project also aims to develop genetic profiles of these stocks, which can be used in the future to discriminate the stocks even during times of mixing. The final results of this project are expected at the end of 2020. It is anticipated that when these results are available it will be possible to carry out a full benchmark on these stocks.

In its autumn 2015 plenary report, STECF noted that from a stock assessment perspective, it would be beneficial to allow small catches to maintain an uninterrupted time-series of fishery-dependent catch data from the stocks in both management areas (6.aN and 6.aS/7.b–c). The monitoring TAC taken in 2016–2018 and agreed for 2019 (5800 t) is associated with decreased F.

4.11 Ecosystem Considerations

Herring constitute some of the highest biomass of forage fish to the west of Scotland and Ireland, and are thus an integral part of the ecosystem. As a dominant planktivore, herring link zooplankton production with higher trophic level predators that eat them, including fish, sea mammals and birds. Ecosystem models of the West of Scotland (Bailey *et al*., 2011; Alexander *et al*., 2015) show herring to be an important mid-trophic level species along with sprat, sandeel, and horse mackerel. They can also act as predators on other fish species by their predation on fish eggs at certain times of year (ICES, WGSAM 2012). Recent work, using length-based ecosystem modelling, suggests a link between herring biomass and North Sea cod (Speirs *et al*., 2010), via the predation of cod eggs by herring.

There is no ecosystem model that covers the whole of the 6.a and 7.b–c area, so it is difficult to predict the impact of increasing or reducing the herring biomass on the ecosystem functioning as a whole. However, as herring constitute an important part of the overall biomass of plankton feeding and forage fish in the west of Scotland and Ireland ecosystem, impacts from changes in productivity from environmental drivers are likely to be widely felt.

Observers monitor some of the fleets. Herring fisheries tend to be clean with little bycatch of other fish. Scottish pelagic discard observer programs since 1999 and more recently Dutch observers indicate that discarding of herring in these directed fisheries is at a low level. The Scottish pelagic discard observer programme has recorded occasional catches of seals and zero catches of cetaceans in the past. Unfortunately, the Scottish pelagic discard observer programme is no longer active.

4.12 Changes in the Environment

Grainger (1978; 1980) found significant negative correlations between sea surface temperature and catches from the west of Ireland component of this stock at a time lag of 3–4 years later. This indicates that recruitment responds favourably to cooler temperatures. The influence of the environment on herring productivity means that the biomass will always fluctuate (Dickey-Collas *et al.*, 2010). Temperature trends are similar for the sea area to the west of Scotland and the North Sea. The broad trend in oceanic temperatures over the period 1900–2006 is for warming. Oceanic temperatures around the Scottish coast for the period (1970–2006) have increased by ~0.5°C (Baxter *et al.*, 2008). Salinity and surface temperature of coastal waters around the Scottish coast also shows a slight increasing trend over the same time period.

The environmental conditions in the North Sea and west of Scotland are similarly impacted by climate change, with trends in oceanic temperature, sea surface temperature and salinity all increasing over recent decades around the coast of Scotland. Climate models predict a future increase in air and water temperature and a change in wind, cloud cover and precipitation in Europe (Drinkwater, 2010).

Table 4.3.1.2. Herring in Divisions 6.a (combined) and 7.b–c. Total numbers (millions) and biomass (thousands of tonnes) of Malin Shelf herring (6.a.N-S, 7.b and 7.c) June–July 2018. Mean weights, mean lengths and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	Weight (g)	Length (cm)
0	294	0.7	0.00	2.5	6.6
1	1289	64.2	0.00	49.8	17.7
2	447	47.9	0.40	107.0	22.7
3	106	16.2	0.85	152.1	25.4
4	343	60.2	0.98	175.8	26.8
5	153	29.1	0.98	190.0	27.5
6	52	10.8	1.00	208.8	28.6
7	72	15.1	1.00	209.4	28.8
8	27	5.8	1.00	218.0	29.1
9+	13	3.0	1.00	224.4	29.4
Immature	**1872**	**95**		**50.5**	**16.7**
Mature	**925**	**159**		**171.4**	**26.5**
Total	**2797**	**253**	**0.33**	**90.5**	**19.9**

Table 4.3.1.3. Herring in Divisions 6.a (combined) and 7.b–c. Numbers-at-age (millions) and SSB (thousands of tonnes) of Malin Shelf herring acoustic survey combined with West of Scotland acoustic survey (WoS_MSHAS) (6.a.N-S, 7.b and 7.c) time-series. Age (rings) from acoustic surveys 1991 to 2018.

Year\Age (Rings)	1	2	3	4	5	6	7	8	9	SSB
1991	338	294	328	368	488	176	99	90	58	410
1992	74	503	211	258	415	240	106	57	63	351
1993	2	579	690	689	565	900	296	158	161	845
1994	494	542	608	286	307	268	407	174	132	534
1995	441	1103	473	450	153	187	169	237	202	452
1996	41	576	803	329	95	61	77	78	115	370
1997	792	642	286	167	66	50	16	29	24	175
1998	1222	795	667	471	179	79	28	14	37	376
1999	534	322	1388	432	308	139	87	28	35	460
2000	448	316	337	900	393	248	200	95	65	445
2001	313	1062	218	173	438	133	103	52	35	359
2002	425	436	1437	200	162	424	152	68	60	549
2003	439	1039	933	1472	181	129	347	114	75	739
2004	564	275	760	442	577	56	62	82	76	396
2005	50	243	230	423	245	153	13	39	27	223
2006	112	835	388	285	582	415	227	22	59	472
2007	0	126	294	203	145	347	243	164	32	299
2008	50	267	996	720	363	331	744	386	274	841
2009	773	265	274	444	380	225	193	500	456	593
2010	133	375	374	242	173	146	102	100	297	366
2011	63	257	900	485	213	228	205	113	264	494
2012	796	548	832	517	249	115	111	57	105	427
2013	0	209	434	672	195	71	61	29	37	282
2014	1012	278	242	502	534	148	33	19	13	285
2015	0	212	397	747	423	476	90	24	2	430
2016	0	30	108	88	112	79	62	6	1	88
2017	0	25	339	155	106	110	47	13	5	145
2018	1289	447	106	343	153	52	72	27	13	159

Table 4.6.1a. Herring in 6.a (combined) and 7.b–c. CATCH-IN-NUMBER for 6.aN

age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1	6496	15616	53092	3561	13081	55048	11796	26546	299483	211675	207947
2	74622	30980	67972	102124	45195	92805	78247	82611	19767	500853	27416
3	58086	145394	35263	60290	61619	22278	53455	70076	62642	33456	218689
4	25762	39070	116390	22781	33125	67454	11859	26680	59375	60502	37069
5	33979	24908	24946	48881	22501	44357	40517	7283	22265	40908	39246
6	19890	27630	17332	11631	12412	19759	26170	24227	5120	19344	29793
7	8885	17405	16999	10347	5345	24139	8687	18637	22891	5563	11770
8	1427	9857	7372	6346	4814	6147	13662	8797	18925	17811	5533
9	4423	7159	8595	4617	2582	7082	6088	15103	19531	27083	25799

age	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	220255	37706	238226	207711	534963	51170	309016	172879	69053	34836	22525
2	94438	92561	99014	335083	621496	235627	124944	202087	319604	47739	46284
3	20998	71907	253719	412816	175137	808267	151025	89066	101548	95834	20587
4	159122	23314	111897	302208	54205	131484	519178	63701	35502	22117	40692
5	13988	211243	27741	101957	66714	63071	82466	188202	25195	10083	6879
6	23582	21011	142399	25557	25716	54642	49683	30601	76289	12211	3833
7	15677	42762	21609	154424	10342	18242	34629	12297	10918	20992	2100
8	6377	26031	27073	16818	55763	6506	22470	13121	3914	2758	6278
9	10814	26207	24082	31999	16631	32223	21042	13698	12014	1486	1544

age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	247	2692	36740	13304	81923	2207	40794	33768	19463	1708	6216
2	142	279	77961	250010	77810	188778	68845	154963	65954	119376	36763
3	77	95	105600	72179	92743	49828	148399	86072	45463	41735	109501
4	19	51	61341	93544	29262	35001	17214	118860	32025	28421	18923
5	13	13	21473	58452	42535	14948	15211	18836	50119	19761	18109
6	8	9	12623	23580	27318	11366	6631	18000	8429	28555	7589
7	4	8	11583	11516	14709	9300	6907	2578	7307	3252	15012
8	1	1	1309	13814	8437	4427	3323	1427	3508	2222	1622
9	0	0	1326	4027	8484	1959	2189	1971	5983	2360	3505

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	14294	26396	5253	17719	1728	266	1952	1193	9092	7635	4511.46
2	40867	23013	24469	95288	36554	82176	37854	55810	74167	35252	22960.61
3	40779	25229	24922	18710	40193	30398	30899	34966	34571	93910	21825.16
4	74279	28212	23733	10978	6007	21272	9219	31657	31905	25078	51420.22
5	26520	37517	21817	13269	7433	5376	7508	23118	22872	13364	15504.75
6	13305	13533	33869	14801	8101	4205	2501	17500	14372	7529	9002.21
7	9878	7581	6351	19186	10515	8805	4700	10331	8641	3251	3897.69
8	21456	6892	4317	4711	12158	7971	8458	5213	2825	1257	1835.56
9	5522	4456	5511	3740	10206	9787	31108	9883	3327	1089	576.39

year

age	2001	2002	2003	2004	2005	2006	2007	2008
1	147.07	992.20	56.11	0.00	182.50	132.46	130.75	0.00
2	83318.40	38481.61	33331.96	7235.79	9632.71	6691.49	34326.00	7898.43
3	15368.56	93975.05	46865.58	23483.32	23236.71	9186.07	17754.83	13039.08
4	9569.99	9014.40	53766.66	29421.79	20602.39	13644.88	6555.14	5427.59
5	25175.08	18113.71	7462.98	48394.28	10237.93	41067.79	14264.99	3219.52
6	9544.89	28016.08	4344.55	4151.94	9783.17	27781.86	30566.16	5688.56
7	6813.78	9040.10	12818.38	8100.36	1014.99	20972.98	21517.07	14832.27

8	4741.98	1547.87	9187.62	9023.67	1194.95	3041.71	13585.45	8142.31
9	1028.78	1422.68	1407.96	4265.93	1430.76	5088.99	4242.60	8968.60

age	2009	2010	2011	2012	2013	2014	2015	2016
1	1923.62	10074.12	1667.19	979.53	0.00	0.00	231.18	12
2	11508.54	20339.85	40587.92	14952.63	13681.14	8705.73	10854.96	8148
3	10475.63	16331.31	15782.93	46647.39	18181.74	15144.82	13937.56	3341
4	16586.96	9957.96	10333.90	9704.45	53116.88	21063.66	15716.60	3197
5	8332.17	14608.15	7190.29	8097.30	11681.99	42229.47	19386.70	2791
6	5688.68	6322.33	5071.43	6311.66	7093.01	7130.95	21621.33	2821
7	7514.70	4322.24	3164.16	3873.67	5098.64	2944.09	6397.35	3148
8	11793.98	5388.91	2611.38	1129.80	4324.63	2854.21	1932.73	739
9	9443.85	13199.28	7225.68	4013.80	5031.77	3511.43	1250.55	431

age	2017	2018
1	0.00	0.00
2	1122.16	1508.98
3	11929.71	3215.53
4	4082.50	6873.26
5	2075.35	5253.61
6	1443.79	3068.25
7	1416.35	844.50
8	767.37	852.31
9	273.34	680.89

Table 4.6.1b Herring in 6.a (combined) and 7.b–c. CATCH-IN-NUMBER for 6.aS/7.bc.

year												
age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
1	0	100	1060	516	1768	259	132	88	234	0	0	574	1495
2	7709	3349	7251	18221	7129	7170	6446	7030	3847	16809	1232	10192	15038
3	9965	9410	3585	7373	14342	5535	5929	5903	10135	11894	55013	4702	13013
4	1394	6130	8642	3551	6598	10427	2032	4048	9008	10319	12681	78638	4410
5	6235	4065	3222	2284	2481	5235	3192	2195	2426	7392	9071	5316	54809
6	2062	5584	1757	770	2392	3322	3541	3972	2019	3356	6348	4534	4918
7	943	3279	2002	1020	566	4111	2079	3779	6349	7112	3455	1889	3234
8	287	1192	858	578	706	1653	1293	1830	2737	2987	4862	839	1954
9	490	2195	839	326	387	1525	2517	3559	4276	6109	8165	3340	3136

year												
age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	135	883	1001	6423	3374	7360	16613	4485	10170	5919	2856	1620
2	35114	6177	28786	40390	29406	41308	29011	44512	40320	50071	40058	22265
3	26007	7038	20534	47389	41116	25117	37512	13396	27079	19161	64946	41794
4	13243	10856	6191	16863	44579	29192	26544	17176	13308	19969	25140	31460
5	3895	8826	11145	7432	17857	23718	25317	12209	10685	9349	22126	12812
6	40181	3938	10057	12383	8882	10703	15000	9924	5356	8422	7748	12746
7	2982	40553	4243	9191	10901	5909	5208	5534	4270	5443	6946	3461
8	1667	2286	47182	1969	10272	9378	3596	1360	3638	4423	4344	2735
9	1911	2160	4305	50980	30549	32029	15703	4150	3324	4090	5334	5220

year												
age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	748	1517	2794	9606	918	12149	0	2241	878	675	2592	191
2	18136	43688	81481	15143	27110	44160	29135	6919	24977	34437	15519	20562
3	17004	49534	28660	67355	27818	80213	46300	78842	19500	27810	42532	22666
4	28220	25316	17854	12756	66383	41504	41008	26149	151978	12420	26839	41967

```
  5 18280 31782  7190 11241 14644 99222 23381 21481  24362 100444 12565 23379
  6  8121 18320 12836  7638  7988 15226 45692 15008  20164  17921 73307 13547
  7  4089  6695  5974  9185  5696 12639  6946 24917  16314  14865  8535 67265
  8  3249  3329  2008  7587  5422  6082  2482  4213   8184  11311  8203  7671
  9  2875  4251  4020  2168  2127 10187  1964  3036   1130   7660  6286  6013
   year
age  1994  1995  1996  1997  1998  1999  2000  2001  2002  2003  2004  2005
  1 11709   284  4776  7458  7437  2392  4101  2316  4058  1731  1401   209
  2 56156 34471 24424 56329 72777 51254 34564 21717 32640 32819 15122 28123
  3 31225 35414 69307 25946 80612 61329 38925 21780 37749 28714 32992 30896
  4 16877 18617 31128 38742 38326 34901 30706 17533 18882 24189 19720 26887
  5 21772 19133  9842 14583 30165 10092 13345 18450 11623  9432  9006 10774
  6 13644 16081 15314  5977  9138  5887  2735  9953 10215  5176  4924  5452
  7  8597  5749  8158  8351  5282  1880  1464  1741  2747  2525  1547  1348
  8 31729  8585 12463  3418  3434  1086   690  1027  1605   923   975   858
  9 10093 14215  6472  4264  2942   949  1602   508   644   303   323   243
   year
age  2006  2007  2008  2009  2010  2011  2012  2013  2014 2015 2016 2017 2018
  1   598    76   483   202  1271   121  5142    61    34   22   69   30    6
  2 22036 24577 12265 12574 13507 14207 12844  3118   465 1320 1983 1051 1567
  3 36700 43958 19661 12077 20127  9315 16387  4532  8825  994 4252 5241 1838
  4 30581 23399 28483 12096  6541  9114  4042 12238  6735 2291 1369 4078 3280
  5 21956 13738 11110 12574  7588  3386  1776  1665 12146 1886 3025 1025 2288
  6  9080  5474  5989  5239  6780  3780   553  1792  2406  663 2085 2250  613
  7  2418  1825  2738  2040  2563  2871   541   425  1045  107  824 1061  700
  8   832   231   745   853   661   980   103   382   437   23   43  480  260
  9   369   131   267    17   189    95    21   202   204   10    9   76   29
```

Table 4.6.2a. Herring in 6.a (combined) and 7.b–c. WEIGHTS-AT-AGE IN THE CATCH for 6.aN

```
Units  :  kg
, , area = 6.aN

   year
age  1957  1958  1959  1960  1961  1962  1963  1964  1965  1966  1967  1968
  1 0.079 0.079 0.079 0.079 0.079 0.079 0.079 0.079 0.079 0.079 0.079 0.079
  2 0.104 0.104 0.104 0.104 0.104 0.104 0.104 0.104 0.104 0.104 0.104 0.104
  3 0.130 0.130 0.130 0.130 0.130 0.130 0.130 0.130 0.130 0.130 0.130 0.130
  4 0.158 0.158 0.158 0.158 0.158 0.158 0.158 0.158 0.158 0.158 0.158 0.158
  5 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164
  6 0.170 0.170 0.170 0.170 0.170 0.170 0.170 0.170 0.170 0.170 0.170 0.170
  7 0.180 0.180 0.180 0.180 0.180 0.180 0.180 0.180 0.180 0.180 0.180 0.180
  8 0.183 0.183 0.183 0.183 0.183 0.183 0.183 0.183 0.183 0.183 0.183 0.183
  9 0.185 0.185 0.185 0.185 0.185 0.185 0.185 0.185 0.185 0.185 0.185 0.185
   year
age  1969  1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980
  1 0.079 0.079 0.079 0.079 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090
  2 0.104 0.104 0.104 0.104 0.121 0.121 0.121 0.121 0.121 0.121 0.121 0.121
  3 0.130 0.130 0.130 0.130 0.158 0.158 0.158 0.158 0.158 0.158 0.158 0.158
  4 0.158 0.158 0.158 0.158 0.175 0.175 0.175 0.175 0.175 0.175 0.175 0.175
  5 0.164 0.164 0.164 0.164 0.186 0.186 0.186 0.186 0.186 0.186 0.186 0.186
  6 0.170 0.170 0.170 0.170 0.206 0.206 0.206 0.206 0.206 0.206 0.206 0.206
  7 0.180 0.180 0.180 0.180 0.218 0.218 0.218 0.218 0.218 0.218 0.218 0.218
```

```
  8 0.183 0.183 0.183 0.183 0.224 0.224 0.224 0.224 0.224 0.224 0.224 0.224
  9 0.185 0.185 0.185 0.185 0.224 0.224 0.224 0.224 0.224 0.224 0.224 0.224
   year
age  1981  1982  1983  1984  1985  1986  1987  1988  1989  1990  1991  1992
  1 0.090 0.080 0.080 0.080 0.069 0.113 0.073 0.080 0.082 0.079 0.084 0.091
  2 0.121 0.140 0.140 0.140 0.103 0.145 0.143 0.112 0.142 0.129 0.118 0.119
  3 0.158 0.175 0.175 0.175 0.134 0.173 0.183 0.157 0.145 0.173 0.160 0.183
  4 0.175 0.205 0.205 0.205 0.161 0.196 0.211 0.177 0.191 0.182 0.203 0.196
  5 0.186 0.231 0.231 0.231 0.182 0.215 0.220 0.203 0.190 0.209 0.211 0.227
  6 0.206 0.253 0.253 0.253 0.199 0.230 0.238 0.194 0.213 0.224 0.229 0.219
  7 0.218 0.270 0.270 0.270 0.213 0.242 0.241 0.240 0.216 0.228 0.236 0.244
  8 0.224 0.284 0.284 0.284 0.223 0.251 0.253 0.213 0.204 0.237 0.261 0.256
  9 0.224 0.295 0.295 0.295 0.231 0.258 0.256 0.228 0.243 0.247 0.271 0.256
   year
age  1993  1994  1995  1996  1997  1998  1999   2000   2001   2002   2003
  1 0.089 0.083 0.106 0.081 0.089 0.097 0.076 0.0834 0.0490 0.1066 0.0609
  2 0.128 0.142 0.142 0.134 0.136 0.138 0.130 0.1373 0.1398 0.1464 0.1448
  3 0.158 0.167 0.181 0.178 0.177 0.159 0.158 0.1637 0.1628 0.1625 0.1593
  4 0.197 0.190 0.191 0.210 0.205 0.182 0.175 0.1829 0.1828 0.1728 0.1690
  5 0.206 0.195 0.198 0.230 0.222 0.199 0.191 0.2014 0.1922 0.1595 0.1852
  6 0.228 0.201 0.214 0.233 0.223 0.218 0.210 0.2147 0.1959 0.1780 0.1997
  7 0.223 0.244 0.208 0.262 0.219 0.227 0.225 0.2394 0.2047 0.1863 0.1942
  8 0.262 0.234 0.227 0.247 0.238 0.212 0.223 0.2812 0.2245 0.2449 0.1854
  9 0.263 0.266 0.277 0.291 0.263 0.199 0.226 0.2526 0.2716 0.2802 0.2938
   year
age   2004   2005   2006   2007   2008   2009   2010   2011   2012   2013
  1 0.0000 0.1084 0.0908 0.1152 0.0000 0.1121 0.0818 0.0613 0.0725 0.0000
  2 0.1541 0.1327 0.1580 0.1667 0.1705 0.1726 0.1549 0.1550 0.1469 0.1441
  3 0.1732 0.1632 0.1676 0.1881 0.2060 0.2141 0.1883 0.1894 0.1894 0.1746
  4 0.1948 0.1845 0.1929 0.1968 0.2310 0.2379 0.2129 0.2178 0.2076 0.1965
  5 0.2160 0.2108 0.2076 0.2105 0.2309 0.2457 0.2337 0.2340 0.2161 0.2020
  6 0.2197 0.2258 0.2251 0.2214 0.2489 0.2535 0.2394 0.2388 0.2261 0.2124
  7 0.1986 0.2341 0.2443 0.2161 0.2529 0.2599 0.2369 0.2470 0.2408 0.2304
  8 0.1885 0.2556 0.2615 0.2618 0.2840 0.2549 0.2400 0.2463 0.2817 0.2343
  9 0.3030 0.2496 0.2750 0.3030 0.2877 0.2730 0.2549 0.2522 0.2467 0.2476
   year
age   2014   2015  2016  2017  2018
  1 0.0000 0.0769 0.100 0.000 0.000
  2 0.1451 0.1425 0.144 0.137 0.126
  3 0.1877 0.1795 0.178 0.167 0.151
  4 0.2030 0.2059 0.204 0.187 0.174
  5 0.2279 0.2136 0.219 0.204 0.190
  6 0.2449 0.2307 0.229 0.213 0.208
  7 0.2608 0.2386 0.237 0.221 0.218
  8 0.2614 0.2454 0.251 0.233 0.238
  9 0.2835 0.2685 0.257 0.249 0.246
```

Table 4.6.2b. Herring in 6.a (combined) and 7.b–c. WEIGHTS-AT-AGE IN THE CATCH for 6.aS/7.bc.

year												
age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
2	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129
3	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
4	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191
5	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209
6	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222
7	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231
8	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237
9	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241

year												
age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
2	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129
3	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
4	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191
5	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209	0.209
6	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222
7	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231	0.231
8	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237
9	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241	0.241

year												
age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.110	0.110	0.090	0.106	0.077	0.095	0.085	0.082	0.080	0.094	0.089	0.095
2	0.129	0.129	0.129	0.141	0.122	0.138	0.102	0.098	0.130	0.138	0.134	0.141
3	0.165	0.165	0.165	0.181	0.161	0.164	0.150	0.133	0.141	0.148	0.145	0.147
4	0.191	0.191	0.191	0.210	0.184	0.194	0.169	0.153	0.164	0.160	0.157	0.157
5	0.209	0.209	0.209	0.226	0.196	0.212	0.177	0.166	0.174	0.176	0.167	0.165
6	0.222	0.222	0.222	0.237	0.206	0.225	0.193	0.171	0.183	0.189	0.185	0.171
7	0.231	0.231	0.231	0.243	0.212	0.239	0.205	0.183	0.192	0.194	0.199	0.180
8	0.237	0.237	0.237	0.247	0.225	0.208	0.215	0.191	0.193	0.208	0.207	0.194
9	0.241	0.241	0.241	0.248	0.230	0.288	0.220	0.201	0.203	0.216	0.230	0.219

year												
age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.112	0.081	0.080	0.085	0.093	0.095	0.106	0.102	0.086	0.097	0.102	0.085
2	0.138	0.141	0.140	0.135	0.135	0.136	0.144	0.129	0.122	0.127	0.134	0.140
3	0.153	0.164	0.161	0.172	0.155	0.145	0.145	0.154	0.139	0.140	0.150	0.150
4	0.170	0.177	0.173	0.182	0.181	0.173	0.163	0.172	0.167	0.155	0.167	0.167
5	0.181	0.189	0.182	0.199	0.201	0.191	0.186	0.180	0.183	0.175	0.183	0.182
6	0.184	0.187	0.198	0.209	0.217	0.196	0.195	0.184	0.188	0.196	0.196	0.193
7	0.196	0.191	0.194	0.220	0.217	0.202	0.200	0.204	0.222	0.204	0.216	0.222
8	0.229	0.204	0.206	0.233	0.231	0.222	0.216	0.203	0.222	0.218	0.210	0.221
9	0.236	0.220	0.217	0.237	0.239	0.217	0.222	0.204	0.213	0.226	0.228	0.285

year												
age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.105	0.106	0.118	0.111	0.077	0.104	0.094	0.090	0.083	0.105	0.090	0.090
2	0.135	0.137	0.144	0.148	0.146	0.131	0.122	0.134	0.121	0.139	0.113	0.125
3	0.150	0.141	0.145	0.150	0.171	0.168	0.141	0.179	0.141	0.136	0.145	0.149
4	0.162	0.158	0.168	0.166	0.194	0.189	0.174	0.196	0.170	0.155	0.152	0.163
5	0.174	0.169	0.179	0.175	0.200	0.201	0.193	0.214	0.181	0.168	0.161	0.182
6	0.188	0.178	0.189	0.185	0.207	0.212	0.202	0.237	0.196	0.175	0.168	0.188

```
  7 0.200 0.199 0.197 0.194 0.211 0.218 0.217 0.228 0.202 0.184 0.176 0.190
  8 0.237 0.221 0.233 0.199 0.218 0.226 0.218 0.243 0.226 0.183 0.185 0.210
  9 0.296 0.243 0.237 0.241 0.275 0.229 0.246 0.236 0.226 0.187 0.188 0.201
   year
age  2017  2018
  1 0.072 0.085
  2 0.106 0.101
  3 0.132 0.127
  4 0.145 0.144
  5 0.159 0.155
  6 0.168 0.166
  7 0.172 0.172
  8 0.179 0.170
  9 0.183 0.174
```

Table 4.6.3. Herring in 6.a (combined) and 7.b–c. WEIGHTS-AT-AGE IN THE STOCK.

```
Units  :  kg
   year
age  1957  1958  1959  1960  1961  1962  1963  1964  1965  1966  1967  1968
  1 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090
  2 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164
  3 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208
  4 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233
  5 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246
  6 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252
  7 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258
  8 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269
  9 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292
   year
age  1969  1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980
  1 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090
  2 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164
  3 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208
  4 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233
  5 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246
  6 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252
  7 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258
  8 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269
  9 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292
   year
age  1981  1982  1983  1984  1985  1986  1987  1988  1989  1990  1991  1992
  1 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.068
  2 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.164 0.152
  3 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.208 0.186
  4 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.233 0.206
  5 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.246 0.233
  6 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.252 0.253
  7 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.258 0.273
  8 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.269 0.299
  9 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.292 0.302
   year
age  1993  1994  1995  1996  1997  1998  1999  2000  2001  2002  2003  2004
```

```
  1 0.073 0.052 0.042 0.045 0.054 0.066 0.054 0.062 0.062 0.062 0.064 0.059
  2 0.164 0.150 0.144 0.140 0.142 0.138 0.137 0.141 0.132 0.153 0.138 0.138
  3 0.196 0.192 0.191 0.180 0.180 0.176 0.166 0.173 0.170 0.177 0.176 0.159
  4 0.206 0.220 0.202 0.209 0.199 0.194 0.188 0.183 0.190 0.198 0.190 0.180
  5 0.225 0.221 0.225 0.219 0.213 0.214 0.203 0.194 0.198 0.212 0.204 0.189
  6 0.234 0.233 0.227 0.222 0.222 0.226 0.219 0.204 0.212 0.215 0.213 0.202
  7 0.253 0.241 0.247 0.229 0.231 0.234 0.225 0.211 0.220 0.225 0.217 0.213
  8 0.259 0.270 0.260 0.242 0.242 0.225 0.235 0.222 0.236 0.243 0.223 0.214
  9 0.276 0.296 0.293 0.263 0.263 0.249 0.245 0.230 0.254 0.259 0.228 0.206
   year
age   2005  2006  2007  2008  2009  2010  2011  2012       2013  2014
  1 0.0751 0.075 0.075 0.055 0.059 0.068 0.057 0.066 0.06366667 0.064
  2 0.1296 0.135 0.168 0.172 0.151 0.162 0.132 0.150 0.15500000 0.108
  3 0.1538 0.166 0.183 0.191 0.206 0.194 0.160 0.183 0.16500000 0.158
  4 0.1665 0.185 0.191 0.208 0.223 0.227 0.208 0.189 0.20200000 0.180
  5 0.1802 0.192 0.195 0.214 0.233 0.239 0.236 0.206 0.21000000 0.206
  6 0.1911 0.204 0.195 0.214 0.231 0.248 0.245 0.217 0.23600000 0.214
  7 0.2125 0.211 0.202 0.221 0.232 0.258 0.238 0.214 0.24300000 0.231
  8 0.2030 0.224 0.203 0.224 0.232 0.226 0.222 0.218 0.24500000 0.244
  9 0.2284 0.231 0.214 0.238 0.238 0.212 0.253 0.215 0.25400000 0.264
   year
age       2015   2016   2017   2018
  1 0.06373333 0.0638 0.0638 0.0478
  2 0.15500000 0.1370 0.1350 0.1100
  3 0.18300000 0.1400 0.1700 0.1550
  4 0.19500000 0.1750 0.1810 0.1761
  5 0.20400000 0.2020 0.1980 0.1901
  6 0.21100000 0.2080 0.1990 0.2097
  7 0.21700000 0.2090 0.2140 0.2094
  8 0.21500000 0.2100 0.2230 0.2180
  9 0.22000000 0.2420 0.2360 0.2222
```

Table 4.6.4. Herring in 6.a (combined) and 7.b–c. NATURAL MORTALITY.

```
Units  :  NA
   year
age     1957     1958     1959     1960     1961     1962     1963     1964
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
  4 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791
  5 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385
  6 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574
  7 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  8 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  9 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
   year
age     1965     1966     1967     1968     1969     1970     1971     1972
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
  4 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791
  5 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385
```

```
  6 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574
  7 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  8 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  9 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
   year
age     1973     1974     1975     1976     1977     1978     1979     1980
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
  4 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791
  5 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385
  6 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574
  7 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  8 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  9 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
   year
age     1981     1982     1983     1984     1985     1986     1987     1988
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
  4 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791
  5 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385
  6 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574
  7 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  8 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  9 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
   year
age     1989     1990     1991     1992     1993     1994     1995     1996
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
  4 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791
  5 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385
  6 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574
  7 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  8 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  9 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
   year
age     1997     1998     1999     2000     2001     2002     2003     2004
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
  4 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791 0.338791
  5 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385 0.319385
  6 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574 0.313574
  7 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  8 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
  9 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805 0.306805
   year
age     2005     2006     2007     2008     2009     2010     2011     2012
  1 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005 0.767005
  2 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728 0.384728
  3 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633 0.355633
```

age	2013	2014	2015	2016	2017	2018
4	0.338791	0.338791	0.338791	0.338791	0.338791	0.338791
5	0.319385	0.319385	0.319385	0.319385	0.319385	0.319385
6	0.313574	0.313574	0.313574	0.313574	0.313574	0.313574
7	0.306805	0.306805	0.306805	0.306805	0.306805	0.306805
8	0.306805	0.306805	0.306805	0.306805	0.306805	0.306805
9	0.306805	0.306805	0.306805	0.306805	0.306805	0.306805

Table 4.6.5. Herring in 6.a (combined) and 7.b–c. PROPORTION MATURE.

Units : NA

age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
3	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
3	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.57	0.57	0.57	0.57	0.57	0.47	0.93	0.59	0.21	0.76	0.55	0.85	0.57	0.45	0.93
3	0.96	0.96	0.96	0.96	0.96	1.00	0.96	0.93	0.98	0.94	0.95	0.97	0.98	0.92	0.99
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

```
  9 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
   year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  1 0.00 0.00 0.00 0.00 0.00    0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
  2 0.92 0.76 0.83 0.84 0.81    1 0.91 0.67 0.88 0.50 0.62 0.35 0.18 0.48 0.97
  3 1.00 1.00 0.97 1.00 0.97    1 0.99 0.99 0.99 0.93 0.99 0.72 0.73 0.85 0.99
  4 1.00 1.00 1.00 1.00 1.00    1 1.00 1.00 1.00 1.00 1.00 0.98 0.99 0.99 1.00
  5 1.00 1.00 1.00 1.00 1.00    1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
  6 1.00 1.00 1.00 1.00 1.00    1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
  7 1.00 1.00 1.00 1.00 1.00    1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
  8 1.00 1.00 1.00 1.00 1.00    1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
  9 1.00 1.00 1.00 1.00 1.00    1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
   year
age 2017 2018
  1 0.00 0.00
  2 0.95 0.40
  3 1.00 0.85
  4 1.00 0.98
  5 1.00 0.98
  6 1.00 1.00
  7 1.00 1.00
  8 1.00 1.00
  9 1.00 1.00
```

Table 4.6.6. Herring in 6.a (combined) and 7.b–c. FRACTION OF HARVEST BEFORE SPAWNING.

```
Units  :  NA
   year
age 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
```

```
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 2017 2018
  1 0.67 0.67
  2 0.67 0.67
  3 0.67 0.67
  4 0.67 0.67
  5 0.67 0.67
  6 0.67 0.67
  7 0.67 0.67
  8 0.67 0.67
  9 0.67 0.67
```

Table 4.6.7. Herring in 6.a (combined) and 7.b–c. FRACTION OF NATURAL MORTALITY BEFORE SPAWNING.

```
Units  :  NA
   year
age 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
```

```
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   year
age 2017 2018
  1 0.67 0.67
  2 0.67 0.67
  3 0.67 0.67
  4 0.67 0.67
  5 0.67 0.67
  6 0.67 0.67
  7 0.67 0.67
  8 0.67 0.67
  9 0.67 0.67
```

Table 4.6.8. Herring in 6.a (combined) and 7.b–c. SURVEY INDICES.

```
MS_HERAS - Configuration

Malin Shelf assessment  . Imported from VPA file.

      min       max plusgroup   minyear   maxyear    startf      endf

     1.00      9.00      9.00   1991.00   2018.00      0.52      0.57

Index type : number

MS_HERAS - Index Values

Units  :  NA

   year

age   1991   1992   1993   1994    1995   1996   1997    1998    1999   2000

  1 338312  74310   2357 494150  441200  41220 792320 1221700  534200 447600
```

```
  2 294484 503430 579320 542080 1103400 576460 641860  794630  322400 316200
  3 327902 210980 689510 607720  473300 802530 286170  666780 1388000 337100
  4 367830 258090 688740 285610  450300 329110 167040  471070  432000 899500
  5 488288 414750 564850 306760  153000  95360  66100  179050  308000 393400
  6 176348 240110 900410 268130  187200  60600  49520   79270  138700 247600
  7  98741 105670 295610 406840  169200  77380  16280   28050   86500 199500
  8  89830  56710 157870 173740  236700  78190  28990   13850   27600  95000
  9  58043  63440 161450 131880  201700 114810  24440   36770   35400  65000
   year
age    2001    2002    2003   2004   2005   2006   2007   2008   2009   2010
  1  313100  424700  438800 564000  50200 112300     -1  50389 772520 132551
  2 1062000  436000 1039400 274500 243400 835200 126000 267367 265151 375304
  3  217700 1436900  932500 760200 230300 387900 294400 995596 273910 373804
  4  172800  199800 1471800 442300 423100 284500 202500 719782 443603 242388
  5  437500  161700  181300 577200 245100 582200 145300 363484 380436 173333
  6  132600  424300  129200  55700 152800 414700 346900 331462 225046 145891
  7  102800  152300  346700  61800  12600 227000 242900 743706 192866 101960
  8   52400   67500  114300  82200  39000  21700 163500 386202 500074 100421
  9   34700   59500   75200  76300  26800  59300  32100 273892 456113 297021
   year
age   2011   2012   2013    2014   2015   2016   2017    2018
  1  62834 796012     -1 1012160     -1     -1     -1 1287728
  2 257258 548481 209403  277504 212467  29593  25426  447304
  3 899637 832257 434425  241674 396545 108126 338563  106491
  4 484732 517267 671507  502471 747121  87773 155357  342609
  5 212913 249024 194706  534431 423139 111676 105728  153194
  6 227515 114507  70507  148259 476249  79130 110226   51928
  7 205093 111385  61392   32565  90102  62045  47158   72276
  8 113298  56526  28597   18677  23931   5530  13069   26636
  9 263837 104571  37398   13003   2086    957   4721   12887
```

IBTS_Q1 - Configuration

```
Malin Shelf assessment  . Imported from VPA file.
      min       max plusgroup   minyear   maxyear    startf      endf
     2.00      9.00      9.00   1994.00   2018.00      0.00      0.25
Index type : number
IBTS_Q1 - Index Values
```

Units : NA

year											
age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	48858	359063	102681	105593	8228	79866	83246	87821	39782	111770	103820
3	85955	130445	166694	182703	50010	333860	133023	78560	151663	124660	341797
4	27794	99865	51454	86852	34866	208576	174698	57335	39246	128306	200643
5	26540	12344	56103	29176	17070	90024	70164	104040	15131	21032	197167
6	37467	28326	29507	20283	5848	39781	61480	54985	42189	16407	53480
7	24419	12360	12935	11476	6776	26574	33102	40676	13304	30259	48221
8	9183	20940	19509	26942	2517	18665	9304	17583	13566	12989	54582
9	4219	12450	44164	26153	7179	30853	17792	18941	15126	17252	47875

year											
age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2	125745	268325	26180	27389	42487	14782	91792	8778	53919	9274	5269
3	140658	327416	80640	33459	85317	41870	103871	125519	55635	36331	9431
4	274189	141568	51265	34702	82570	21274	82452	48715	115480	26226	23111
5	215004	386173	45189	27111	80809	20394	39608	26421	47149	42635	10477
6	204336	372941	79092	23681	58959	21170	47603	13956	38007	8153	12225
7	28338	214968	58735	28915	54262	22578	34354	13225	26073	5237	3574
8	58870	35946	31858	33013	94629	18305	25936	10641	22175	4801	2960
9	52942	104800	28751	20189	114061	38890	69963	28906	32456	4565	863

year			
age	2016	2017	2018
2	12389	6201	6875
3	19720	60854	30327
4	6688	24001	201648
5	14430	11204	45882
6	17865	11704	34825
7	5893	10430	17341
8	1303	5470	13837
9	541	2965	5129

IBTS_Q4 - Configuration

Malin Shelf assessment . Imported from VPA file.

min	max	plusgroup	minyear	maxyear	startf	endf
2.00	9.00	9.00	1996.00	2018.00	0.75	1.00

Index type : number

IBTS_Q4 - Index Values

Units : NA

age	year 1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	17315	13923	12755	6865	5626	33686	10282	15064	16457	5361	7120	7145	3142
3	15935	8976	10203	15684	4192	6757	7886	10166	18695	3768	2449	4221	3784
4	6763	7137	8434	11078	10446	7423	1199	16343	13894	7389	3240	2855	3742
5	5334	4245	11118	9835	4424	14837	1734	2331	9265	8881	6430	4974	2100
6	2228	3038	6295	9164	5664	10428	3401	3326	2185	6120	7978	3734	2902
7	2020	788	1948	4425	3305	6520	2307	3470	2842	910	4498	4438	5691
8	4236	1821	896	1494	2357	3269	1853	2193	1535	2257	1110	1327	3736
9	5828	1797	3866	3433	1746	1701	861	2354	1200	2545	1972	500	4075

age	year 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2	7394	-1	10574	2212	-1	3510	6530	13701	5834	4029
3	3741	-1	4559	5937	-1	8345	6330	11385	33661	4814
4	3648	-1	3880	3599	-1	6947	10553	12037	18397	14217
5	4576	-1	2263	3819	-1	11708	11892	14342	24040	6490
6	1723	-1	2194	2709	-1	2998	5400	14991	12292	3827
7	1966	-1	814	2526	-1	935	644	6399	8832	2450
8	2342	-1	564	865	-1	981	618	1465	3417	1768
9	3371	-1	2436	5679	-1	255	484	613	666	234

Table 4.6.9. Herring in 6.a (combined) and 7.b–c. STOCK OBJECT CONFIGURATION.

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
1	9	9	1957	2018	3	6

Table 4.6.10. Herring in 6.a (combined) and 7.b–c. SAM CONFIGURATION SETTINGS.

```
name           : Herring in 6.aN and 6aS,7bc multifleet
desc           : Imported from a VPA file. ( ./data/index.txt ).  Wed Mar 13 14:39:39 2019
range          :       min       max plusgroup   minyear   maxyear   minfbar   maxfbar
range          :         1         9         9      1957      2018         3         6
fleets         :  catch N  catch S MS_HERAS  IBTS_Q1  IBTS_Q4
fleets         :        0        0        2        2        2
plus.group     : TRUE
states         :           age
states         : fleet       1  2  3  4  5  6  7  8  9
states         :   catch N   0  1  2  3  4  5  6  7  7
states         :   catch S   8  9 10 11 12 13 14 15 15
states         :   MS_HERAS -1 -1 -1 -1 -1 -1 -1 -1 -1
states         :   IBTS_Q1  -1 -1 -1 -1 -1 -1 -1 -1 -1
states         :   IBTS_Q4  -1 -1 -1 -1 -1 -1 -1 -1 -1
logN.vars      : 0 1 1 1 1 1 1 1 1
logP.vars      :
catchabilities :           age
catchabilities : fleet       1  2  3  4  5  6  7  8  9
catchabilities :   catch N  -1 -1 -1 -1 -1 -1 -1 -1 -1
catchabilities :   catch S  -1 -1 -1 -1 -1 -1 -1 -1 -1
catchabilities :   MS_HERAS  0  1  2  3  4  5  6  7  7
catchabilities :   IBTS_Q1  -1  8  9 10 11 12 13 14 14
catchabilities :   IBTS_Q4  -1 15 16 17 18 19 20 21 21
power.law.exps :           age
power.law.exps : fleet       1  2  3  4  5  6  7  8  9
power.law.exps :   catch N  -1 -1 -1 -1 -1 -1 -1 -1 -1
power.law.exps :   catch S  -1 -1 -1 -1 -1 -1 -1 -1 -1
power.law.exps :   MS_HERAS -1 -1 -1 -1 -1 -1 -1 -1 -1
power.law.exps :   IBTS_Q1  -1 -1 -1 -1 -1 -1 -1 -1 -1
power.law.exps :   IBTS_Q4  -1 -1 -1 -1 -1 -1 -1 -1 -1
f.vars         :           age
f.vars         : fleet       1  2  3  4  5  6  7  8  9
f.vars         :   catch N   4  5  5  5  5  5  5  5  5
f.vars         :   catch S   0  1  2  2  2  2  2  3  3
f.vars         :   MS_HERAS -1 -1 -1 -1 -1 -1 -1 -1 -1
f.vars         :   IBTS_Q1  -1 -1 -1 -1 -1 -1 -1 -1 -1
```

```
f.vars         :   IBTS_Q4  -1 -1 -1 -1 -1 -1 -1 -1 -1

obs.vars       :           age

obs.vars       : fleet       1  2  3  4  5  6  7  8  9

obs.vars       :   catch N   4  5  6  6  6  6  6  7  7

obs.vars       :   catch S   0  1  2  2  2  2  3  3  3

obs.vars       :   MS_HERAS  8  9 10 10 10 10 11 11 11

obs.vars       :   IBTS_Q1  -1 12 13 13 13 14 14 15 15

obs.vars       :   IBTS_Q4  -1 16 17 17 17 17 18 18 18

srr            : 0

scaleNoYears   : 0

scaleYears     : NA

scalePars      :

cor.F          : 2

cor.obs        : NA NA 0 -1 -1 NA NA 0 2 3 NA NA 1 2 4 NA NA 1 2 5 NA NA 1 2 6 NA NA 1 2 6 NA NA 1 2
6 NA NA 1 2 6

cor.obs.Flag   : ID ID AR AR AR

biomassTreat   : -1 -1 -1 -1 -1

timeout        : 3600

likFlag        : LN LN LN LN LN

fixVarToWeight : FALSE

simulate       : FALSE

residuals      : TRUE

sumFleets      :
```

Table 4.6.11. Herring in 6.a (combined) and 7.b–c. FLR, R SOFTWARE VERSIONS.

```
FLSAM.version                          2.1.0

FLCore.version                        2.6.12

R.version      R version 3.5.2 (2018-12-20)

platform                  x86_64-w64-mingw32

run.date                 2019-03-13 14:46:47
```

Table 4.6.12. Herring in 6.a (combined) and 7.b–c. STOCK SUMMARY.

Year	Recruitment Age 1	TSB	SSB	Fbar (Ages 3-6) f	Landings tonnes	Landings SOP
1957	1610616	758332	352173	0.1515	48508	0.7531
1958	2805288	818733	357815	0.1968	66494	0.7733
1959	3974532	957292	358279	0.1812	70447	0.7446
1960	1697903	889258	437457	0.1277	69160	0.6012
1961	2725457	915450	457029	0.0908	52535	0.6332
1962	3594943	1007184	433310	0.1319	65594	0.7990
1963	3587445	1066244	461062	0.1011	54089	0.7245
1964	2484701	1044910	516068	0.0958	70403	0.6145
1965	9759776	1660952	519841	0.0997	76685	0.8730
1966	1850328	1584135	765094	0.1243	112834	1.0130
1967	3777159	1608164	872184	0.1237	109281	0.8399
1968	5042446	1690873	830094	0.0964	105345	0.8364
1969	3793197	1627792	803348	0.1506	126777	0.7945
1970	4109764	1553572	727088	0.2165	186236	0.7750
1971	8163797	1790285	554595	0.4220	222211	1.0255
1972	3332761	1506324	622156	0.2588	188230	1.0349
1973	2037610	1257246	586239	0.3893	246989	1.0331
1974	2160900	935558	375177	0.5590	214749	1.1069
1975	2285652	705479	245986	0.5217	152765	0.9806
1976	1505048	549530	193415	0.5219	126409	0.9888
1977	1805695	475716	170107	0.3401	61908	0.9200
1978	2540325	546474	177813	0.2315	41871	0.9961
1979	2839959	655878	233321	0.1182	22668	0.9380
1980	1846187	687498	312349	0.1214	30430	1.0375
1981	2384169	736083	310758	0.2517	76342	0.9699
1982	1939624	680362	266446	0.3770	111569	1.0235
1983	4732220	855677	230178	0.3824	96511	1.0182
1984	2535309	859497	316292	0.2652	83462	0.9756
1985	2939428	906494	383682	0.2254	62485	1.0078
1986	2616127	905012	390144	0.2558	99549	1.0389
1987	4460708	1027659	363752	0.2806	92960	1.0148
1988	1977987	932269	418660	0.2187	64691	1.0126
1989	1648685	839529	437738	0.1928	63236	1.0086
1990	1292288	719283	374123	0.2399	88662	0.9933
1991	1039444	577189	301988	0.2258	66229	1.0315
1992	1538777	473741	224000	0.2459	60841	1.0024
1993	1280468	440827	228212	0.2539	68541	0.9932
1994	2094558	411522	172470	0.2752	58338	0.9999
1995	1620770	393747	138517	0.2889	57367	0.9748
1996	1777372	385739	183956	0.2966	58639	1.0233
1997	2009732	414326	156499	0.4271	62458	1.0033
1998	1047501	382878	183125	0.4704	72248	0.9994
1999	932291	307731	148887	0.3447	55845	0.9998
2000	2602809	374851	118796	0.3025	43008	0.9990
2001	1790112	410548	198737	0.2846	40007	1.0028
2002	1935693	471047	230691	0.3271	50740	0.9998
2003	1097488	411641	214875	0.2736	44583	1.0021
2004	952224	337501	184948	0.2551	40186	1.0119
2005	946705	305815	161836	0.1786	30360	1.0021

2006	843148	294471	147296	0.2768	46539	0.9990
2007	549669	254200	143269	0.2927	47407	0.9990
2008	667165	210217	117085	0.2351	29394	1.0008
2009	746488	203230	96390	0.2748	28976	1.0312
2010	1175669	233411	97335	0.3298	30118	0.9960
2011	536483	189613	81330	0.2785	24678	0.9992
2012	559713	186930	93817	0.2592	25087	1.0017
2013	279995	155402	66594	0.3730	26947	0.9978
2014	358520	114563	45040	0.4198	27123	1.0091
2015	564442	117552	39992	0.4837	19885	0.9982
2016	226356	93324	57094	0.1616	6937	1.0011
2017	240130	94444	58095	0.1341	6424	0.9986
2018	230732	82724	42979	0.1305	5558	0.9978

Table 4.6.13. Herring in 6.a (combined) and 7.b–c. ESTIMATED FISHING MORTALITY for 6.aN and 6.aS/7.bc.

Units : f

, , area = 6.aN

age \ year	1957	1958	1959	1960	1961	1962
1	0.01278177	0.01610326	0.01594731	0.01316791	0.01094825	0.01626646
2	0.05878204	0.07581411	0.07415057	0.05913794	0.04704914	0.07171389
3	0.10114092	0.12812699	0.11756336	0.08621278	0.06316329	0.09415807
4	0.12324686	0.15969552	0.15032408	0.10468969	0.07244291	0.10809145
5	0.15048065	0.19858106	0.18800697	0.13219529	0.08727377	0.12945948
6	0.16490265	0.22083195	0.20294891	0.13658316	0.08487313	0.13161823
7	0.20112399	0.28288919	0.26062664	0.17196113	0.10313954	0.15956093
8	0.20775537	0.30388987	0.28391669	0.18585710	0.11145080	0.17574467
9	0.20775537	0.30388987	0.28391669	0.18585710	0.11145080	0.17574467

age \ year	1963	1964	1965	1966	1967	1968
1	0.01330236	0.01278744	0.01252865	0.01619423	0.01517169	0.01190372
2	0.05592224	0.05189256	0.04931358	0.06451226	0.05989109	0.04609725
3	0.07399567	0.06891798	0.06688024	0.08309303	0.07908722	0.06165659
4	0.08268292	0.07812463	0.08074841	0.10014797	0.09547726	0.07158418
5	0.09604492	0.08730126	0.09036615	0.11096398	0.10594473	0.07781175
6	0.09952039	0.09338508	0.09705964	0.12142231	0.12029169	0.08961747
7	0.12084483	0.11869889	0.12625118	0.15200437	0.15303354	0.11659806
8	0.13896056	0.14387040	0.15881044	0.19096547	0.18987284	0.14252748
9	0.13896056	0.14387040	0.15881044	0.19096547	0.18987284	0.14252748

age \ year	1969	1970	1971	1972	1973	1974
1	0.01713674	0.02701114	0.05705368	0.03427909	0.04728765	0.05746725
2	0.07113783	0.12146322	0.29098771	0.16796766	0.25098660	0.32509170
3	0.10213809	0.17912936	0.42447714	0.23431424	0.34461280	0.43796930
4	0.11917066	0.19168413	0.41480664	0.22623811	0.34078920	0.46455641
5	0.13244474	0.19153373	0.37884952	0.21210538	0.32268129	0.46926458
6	0.15382260	0.20071352	0.36358973	0.20808172	0.31886692	0.50834745
7	0.20766037	0.24907304	0.40108500	0.21960390	0.30670125	0.48718406
8	0.25453618	0.29172864	0.43852469	0.22882034	0.29832466	0.45335881
9	0.25453618	0.29172864	0.43852469	0.22882034	0.29832466	0.45335881

year

age	1975	1976	1977	1978	1979	1980
1	0.04962553	0.04690412	0.02664148	0.01478806	0.00004878419	0.00005343669
2	0.28952022	0.28693908	0.16101544	0.08809487	0.00015006388	0.00017753511
3	0.37006153	0.35407320	0.20157460	0.10695419	0.00016789105	0.00019090145
4	0.38203852	0.35037806	0.20097699	0.10967954	0.00015723113	0.00017723446
5	0.39697678	0.35224012	0.19553514	0.10023319	0.00013922643	0.00015494038
6	0.46178404	0.44382544	0.25343025	0.12568909	0.00016992195	0.00018068337
7	0.46027968	0.46828495	0.27863420	0.14267795	0.00019914793	0.00021545996
8	0.42046880	0.42677958	0.24697224	0.12761064	0.00017130325	0.00018031362
9	0.42046880	0.42677958	0.24697224	0.12761064	0.00017130325	0.00018031362

year

age	1981	1982	1983	1984	1985	1986
1	0.01755653	0.0257593	0.01921557	0.01146841	0.008928836	0.01036853
2	0.13279036	0.2247249	0.17649501	0.10788163	0.087509220	0.11201649
3	0.15207306	0.2665520	0.22091020	0.13749947	0.110248755	0.13870318
4	0.14802983	0.2689499	0.22956689	0.14074597	0.109810758	0.13679712
5	0.13966180	0.2772086	0.25956520	0.15952817	0.125382670	0.15380591
6	0.16075887	0.3223159	0.31163899	0.18252316	0.141830290	0.16475123
7	0.18694822	0.3855203	0.38696947	0.21507346	0.156958108	0.16615139
8	0.15492649	0.3555088	0.38919552	0.21995284	0.161875035	0.17149119
9	0.15492649	0.3555088	0.38919552	0.21995284	0.161875035	0.17149119

year

age	1987	1988	1989	1990	1991	1992
1	0.007245468	0.005396861	0.004530871	0.005790776	0.004481547	0.004880897
2	0.081319139	0.063338390	0.055834812	0.079108445	0.064202567	0.077778193
3	0.102649760	0.080478060	0.071035283	0.100161219	0.080047804	0.094432000
4	0.107209684	0.082658106	0.070858562	0.102730749	0.080621681	0.089661374
5	0.131603313	0.101924276	0.087344565	0.128848467	0.099273017	0.105998643
6	0.152307750	0.115084617	0.097550110	0.148042204	0.115132554	0.122420468
7	0.173456267	0.133972543	0.120920719	0.190248479	0.146406012	0.155719279
8	0.201699015	0.163100383	0.156568688	0.259869988	0.192707544	0.199097523
9	0.201699015	0.163100383	0.156568688	0.259869988	0.192707544	0.199097523

year

age	1993	1994	1995	1996	1997	1998
1	0.004903048	0.004005363	0.003850505	0.002574314	0.004231113	0.003964946
2	0.086018626	0.076176163	0.080281967	0.055041598	0.103512396	0.102156677
3	0.100635070	0.093292705	0.102645362	0.074271439	0.149610317	0.152688765
4	0.088028762	0.081383242	0.095711847	0.077657181	0.178584392	0.183960032
5	0.102082228	0.094188536	0.111429093	0.103057623	0.265840952	0.272377322
6	0.116444854	0.108180068	0.124628943	0.124050560	0.339289278	0.339735738
7	0.162480996	0.163604011	0.198631505	0.208305346	0.540351200	0.507937177
8	0.205062539	0.216265136	0.254722578	0.263018448	0.566707708	0.481151810
9	0.205062539	0.216265136	0.254722578	0.263018448	0.566707708	0.481151810

year

age	1999	2000	2001	2002	2003	2004
1	0.003149817	0.002535134	0.001945686	0.002031844	0.001477374	0.001181301
2	0.084447384	0.071560431	0.057462177	0.063904760	0.046916904	0.037479888
3	0.130047255	0.117684562	0.102005490	0.124216328	0.097958979	0.081922898
4	0.143099767	0.132247471	0.118059574	0.149979478	0.124812312	0.112786551
5	0.191493075	0.179764622	0.174764967	0.230974303	0.194522024	0.190654142
6	0.214269162	0.194877542	0.197193930	0.254196306	0.214351432	0.225276836
7	0.286196757	0.250103850	0.264070765	0.332081821	0.303179720	0.322616984
8	0.259592111	0.223553408	0.244448168	0.306464285	0.309306733	0.361438034

```
  9 0.259592111 0.223553408 0.244448168 0.306464285 0.309306733 0.361438034
   year
age         2005        2006        2007         2008        2009        2010
  1 0.0007333903 0.001080441 0.001437691 0.0009702172 0.001564754 0.002018582
  2 0.0225186830 0.035533432 0.049412290 0.0316488618 0.054061709 0.072285284
  3 0.0473412964 0.073555028 0.092339048 0.0572734325 0.097569908 0.128257385
  4 0.0580753805 0.096804119 0.110683735 0.0660452761 0.117799893 0.156135705
  5 0.0887044790 0.167390525 0.185429500 0.1026524138 0.171746496 0.227730579
  6 0.1040185940 0.224184567 0.260768370 0.1451893537 0.221793394 0.273312025
  7 0.1396443335 0.326201506 0.385431459 0.2207289831 0.313172938 0.354746272
  8 0.1564480167 0.393049589 0.494120339 0.3015101596 0.432626876 0.498871480
  9 0.1564480167 0.393049589 0.494120339 0.3015101596 0.432626876 0.498871480
   year
age        2011        2012        2013        2014        2015         2016
  1 0.001793122 0.001783682 0.002141142 0.002049314 0.002312379 0.0006698209
  2 0.064360977 0.065542822 0.082686375 0.080841367 0.095132695 0.0239647897
  3 0.114395612 0.121514032 0.163911832 0.167952043 0.209982068 0.0544504591
  4 0.139624155 0.151739383 0.228850320 0.245648137 0.305295386 0.0768266804
  5 0.203606155 0.225115704 0.355038431 0.400968415 0.500381454 0.1197889519
  6 0.242708054 0.277198711 0.465345759 0.547094835 0.749126106 0.1754474321
  7 0.303798188 0.335648764 0.582426172 0.704778821 0.997481615 0.2368863480
  8 0.442203100 0.512121956 0.989231889 1.250386797 1.646342940 0.4088762822
  9 0.442203100 0.512121956 0.989231889 1.250386797 1.646342940 0.4088762822
   year
age         2017         2018
  1 0.0005330201 0.0005830342
  2 0.0185296877 0.0204985278
  3 0.0445931532 0.0505987136
  4 0.0591564231 0.0670626578
  5 0.0854696625 0.0998463358
  6 0.1109208818 0.1248782228
  7 0.1302726325 0.1274293945
  8 0.2236598358 0.2147850956
  9 0.2236598358 0.2147850956

, , area = 6aS7bc
   year

age         1957         1958         1959         1960         1961
  1 0.0001589773 0.0002042697 0.0001828107 0.0001484279 0.0001667669
  2 0.0065364441 0.0078171070 0.0070886591 0.0060569519 0.0066217797
  3 0.0125584731 0.0148187859 0.0130706318 0.0109673455 0.0120617523
  4 0.0144572900 0.0175988390 0.0150490615 0.0120804380 0.0133104753
  5 0.0178033591 0.0214425967 0.0172542021 0.0128835828 0.0139366203
  6 0.0214289913 0.0261401890 0.0205906859 0.0150497172 0.0163097676
  7 0.0306303584 0.0376988069 0.0296914693 0.0216963942 0.0234151110
  8 0.0315731831 0.0448287516 0.0300213017 0.0177281391 0.0199461634
  9 0.0315731831 0.0448287516 0.0300213017 0.0177281391 0.0199461634
   year
age         1962         1963         1964         1965        1966
  1 0.0001665472 0.0001017708 9.420517e-05 0.0001044282 0.000144639
  2 0.0068117956 0.0049036203 4.706336e-03 0.0050949340 0.006370028
  3 0.0130200127 0.0099443437 9.926018e-03 0.0110717530 0.013948578
  4 0.0150791394 0.0119818664 1.254819e-02 0.0144100393 0.018557938
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  5 0.0162574449 0.0132474413 1.430961e-02 0.0165386602 0.021372168
  6 0.0199211789 0.0168699651 1.857932e-02 0.0217310636 0.027705518
  7 0.0292845584 0.0255118665 2.826636e-02 0.0327151622 0.040781395
  8 0.0293030011 0.0236239911 2.746558e-02 0.0332697906 0.045007870
  9 0.0293030011 0.0236239911 2.746558e-02 0.0332697906 0.045007870
   year
age         1967         1968         1969         1970         1971
  1 0.0001757384 0.0001705775 0.0002134766 0.0002454161 0.0002493541
  2 0.0072535495 0.0070364169 0.0081788664 0.0090668206 0.0090018534
  3 0.0158174372 0.0147758405 0.0164262938 0.0176301576 0.0173038117
  4 0.0215720128 0.0197914574 0.0216983678 0.0230279648 0.0228191323
  5 0.0249238250 0.0225636450 0.0253286386 0.0274125260 0.0283994994
  6 0.0317827439 0.0277828158 0.0313715356 0.0347430524 0.0377365634
  7 0.0452690212 0.0373469428 0.0406283964 0.0443283074 0.0493512017
  8 0.0513763890 0.0341119472 0.0361487547 0.0391181965 0.0464664152
  9 0.0513763890 0.0341119472 0.0361487547 0.0391181965 0.0464664152
   year
age         1972       1973        1974        1975        1976
  1 0.0004753816 0.00100625 0.002032569 0.003201889 0.004271171
  2 0.0139196510 0.02316667 0.038064614 0.052459926 0.064540910
  3 0.0253040382 0.03917356 0.061987021 0.083678335 0.102374806
  4 0.0328164566 0.04985552 0.078447341 0.107222807 0.133907107
  5 0.0410332544 0.06089953 0.094417854 0.126781046 0.159281889
  6 0.0553201500 0.08038675 0.120961970 0.158237126 0.191633253
  7 0.0729189824 0.10440900 0.152786381 0.194799887 0.228053471
  8 0.0879772526 0.15382251 0.273567726 0.386060549 0.468661448
  9 0.0879772526 0.15382251 0.273567726 0.386060549 0.468661448
   year
age        1977        1978        1979        1980        1981
  1 0.003249554 0.002832315 0.002371403 0.002172779 0.001492657
  2 0.054157623 0.050146604 0.045554575 0.044268395 0.035039648
  3 0.086764206 0.082474057 0.078242530 0.079786892 0.066446901
  4 0.114630548 0.107904694 0.104317654 0.106969533 0.089372679
  5 0.138991509 0.131469950 0.128378003 0.132321121 0.110480667
  6 0.168320600 0.161489881 0.161218843 0.165773966 0.139965772
  7 0.195109902 0.188397618 0.191467908 0.196634784 0.163560958
  8 0.339736387 0.310061888 0.319315197 0.330681889 0.237638413
  9 0.339736387 0.310061888 0.319315197 0.330681889 0.237638413
   year
age        1982       1983        1984        1985        1986
  1 0.001191179 0.00175845 0.001356946 0.001121586 0.001079304
  2 0.030689992 0.04127501 0.034310802 0.030019594 0.029847338
  3 0.060828389 0.08239441 0.070470891 0.063841300 0.065248990
  4 0.082249193 0.11208178 0.095519251 0.088156973 0.091539929
  5 0.101517617 0.13859894 0.119439303 0.112699479 0.117754628
  6 0.128371213 0.17499850 0.154976185 0.149491584 0.154697315
  7 0.148026889 0.19733156 0.176946035 0.172960257 0.177302805
  8 0.190212225 0.28534197 0.232427264 0.217592273 0.215274178
  9 0.190212225 0.28534197 0.232427264 0.217592273 0.215274178
   year
age        1987        1988         1989        1990        1991
  1 0.001785717 0.001165317 0.0009520352 0.001091435 0.001288945
  2 0.043246854 0.032597186 0.0288444308 0.032821806 0.038090023
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  3 0.094526599 0.074100689 0.0662339394 0.073328117 0.083294793
  4 0.134312016 0.106130662 0.0952300091 0.104543227 0.114833921
  5 0.173189336 0.136059875 0.1220428082 0.131351702 0.143801586
  6 0.226539496 0.178373695 0.1608699461 0.170472474 0.186370481
  7 0.253231211 0.198091670 0.1798019766 0.186330810 0.204158943
  8 0.365574587 0.235852863 0.2024422795 0.209601944 0.248363985
  9 0.365574587 0.235852863 0.2024422795 0.209601944 0.248363985
   year
age        1992        1993        1994        1995        1996
  1 0.001510267 0.001636317 0.002245863 0.002122482 0.002697911
  2 0.043766962 0.047857446 0.060277565 0.059173212 0.069738074
  3 0.095400556 0.104866721 0.127803470 0.127378009 0.146479859
  4 0.128846573 0.142872184 0.173239581 0.173648696 0.197794930
  5 0.152354335 0.163595203 0.195545539 0.196322566 0.218302961
  6 0.194462871 0.197063188 0.227014279 0.223943184 0.244733628
  7 0.209338263 0.209703252 0.231947003 0.221189081 0.237988282
  8 0.258352952 0.257024269 0.304176004 0.272896082 0.299015053
  9 0.258352952 0.257024269 0.304176004 0.272896082 0.299015053
   year
age        1997        1998        1999        2000        2001
  1 0.002843992 0.004068604 0.002883136 0.002213862 0.001761528
  2 0.072258408 0.093883635 0.074816153 0.063358660 0.055043020
  3 0.146750085 0.185103797 0.147072019 0.127371244 0.115586992
  4 0.194478802 0.238410479 0.182336885 0.154048886 0.143810977
  5 0.208575812 0.249641807 0.183983130 0.152988925 0.144289950
  6 0.225206739 0.259852527 0.186625018 0.151072892 0.142742851
  7 0.219344966 0.248890655 0.176215379 0.139513293 0.126241495
  8 0.254490300 0.309493389 0.177950920 0.120793342 0.097364445
  9 0.254490300 0.309493389 0.177950920 0.120793342 0.097364445
   year
age        2002        2003        2004        2005        2006
  1 0.001662131 0.001262449 0.001045556 0.001072574 0.001530505
  2 0.054044729 0.045814261 0.041638442 0.044508485 0.059228305
  3 0.114109246 0.098230126 0.090931919 0.098726105 0.133306413
  4 0.144816778 0.121455313 0.108887571 0.114461656 0.155183069
  5 0.146606763 0.123324543 0.106800492 0.106163063 0.138962784
  6 0.143438600 0.119858120 0.103299999 0.096718109 0.117933567
  7 0.122154517 0.098182531 0.082130288 0.074448996 0.084762708
  8 0.087220864 0.056445716 0.039543047 0.031023314 0.034363561
  9 0.087220864 0.056445716 0.039543047 0.031023314 0.034363561
   year
age        2007        2008        2009        2010         2011
  1 0.001353242 0.001401947 0.001051942 0.001126647 0.0007363583
  2 0.055698233 0.057151538 0.046393462 0.047901536 0.0349135597
  3 0.128273459 0.132594829 0.109477876 0.112760772 0.0836460763
  4 0.151354689 0.162310281 0.135685290 0.141716088 0.1064507314
  5 0.134122094 0.150824780 0.132101886 0.145345509 0.1129309505
  6 0.107833327 0.123595701 0.112828614 0.133818757 0.1104700665
  7 0.071881989 0.079629383 0.072518827 0.091156091 0.0816286505
  8 0.022494948 0.024034621 0.019138233 0.029217979 0.0268711485
  9 0.022494948 0.024034621 0.019138233 0.029217979 0.0268711485
   year
age         2012         2013         2014         2015         2016
```

```
  1 0.0004018293 0.0003197844 0.0002969859 0.0001177891 0.0001658619
  2 0.0221264628 0.0192405070 0.0186747194 0.0097720916 0.0125053416
  3 0.0534987588 0.0500219509 0.0516185641 0.0279236885 0.0353760600
  4 0.0663321058 0.0666729176 0.0724792559 0.0384894842 0.0487520727
  5 0.0705822141 0.0773105695 0.0901709256 0.0481121137 0.0623865732
  6 0.0708167593 0.0848520590 0.1031662529 0.0553136896 0.0735708607
  7 0.0557654459 0.0725928308 0.0928753848 0.0513095794 0.0689572323
  8 0.0159486652 0.0287221535 0.0466716716 0.0181330149 0.0296255954
  9 0.0159486652 0.0287221535 0.0466716716 0.0181330149 0.0296255954
   year
age         2017         2018
  1 0.0001744684 0.0001197688
  2 0.0131663799 0.0102258848
  3 0.0370794782 0.0290036334
  4 0.0515349763 0.0393430248
  5 0.0665782298 0.0504790904
  6 0.0812296454 0.0606409796
  7 0.0789686261 0.0593940431
  8 0.0392509947 0.0245791324
  9 0.0392509947 0.0245791324
```

Table 4.6.14. Herring in 6.a (combined) and 7.b–c. ESTIMATED POPULATION ABUNDANCE.

```
Units  :  NA

   year
age       1957       1958       1959       1960       1961       1962      1963
  1 1610615.96 2805288.50 3974532.03 1697902.88 2725456.77 3594942.66 3587444.8
  2 1771371.62  722740.65 1326798.30 1906067.39  726257.04 1239482.00 1671885.6
  3  616188.84 1155157.62  466763.25  877000.97 1215145.79  401900.57  748487.1
  4  261592.85  354935.42  708713.16  319478.81  591316.39  776974.16  225806.7
  5  293587.64  175340.91  196004.52  400845.29  230643.24  413692.11  476194.4
  6  133240.36  174076.71  108527.57  108424.14  242663.10  161820.24  276533.1
  7   59006.40   79050.04   92787.47   66969.00   67386.05  170271.06  102449.5
  8   10613.32   35189.44   40273.14   48472.35   41808.96   45093.27  107156.9
  9   33821.54   27028.70   32307.77   36811.86   47960.91   58653.93   64381.7
   year
age       1964       1965       1966       1967       1968      1969      1970
  1 2484700.95 9759776.38 1850327.58 3777158.64 5042445.61 3793197.4 4109763.6
  2 1702988.73 1051739.56 5232226.11  736931.90 1741150.90 2350523.0 1680008.1
  3 1087399.14 1112578.63  682251.19 3726170.60  449311.47 1087210.2 1563024.8
  4  445913.94  721128.39  725580.31  447112.79 2675235.63  287624.0  691286.9
  5  138961.96  275114.68  451980.23  460413.07  273213.90 1835845.3  183812.1
  6  310588.53   89871.73  174000.42  278870.01  294870.66  180520.4 1133044.7
  7  186236.79  205537.29   60235.69  104484.20  167645.21  196015.7  110093.0
  8   67666.48  121706.69  127067.78   38078.46   61157.98  104986.0  109968.5
  9  113750.43  118335.31  149982.39  162345.14  114710.30  109040.3  113912.5
   year
age       1971       1972       1973       1974       1975       1976
  1 8163796.88 3332761.21 2037609.86 2160900.12 2285652.33 1505048.02
  2 1825662.91 3911449.42 1444316.58  861051.38  934359.16 1018962.28
  3  966551.35  951038.08 2417613.85  711924.47  403218.07  440027.53
  4  898749.51  405493.27  518138.20 1213988.39  299770.51  181543.30
```

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  5  394448.69  410487.58  229922.19  251305.70  509766.85  131723.22
  6  110321.40  189034.02  232828.17  116582.30  102057.86  220521.22
  7  661911.85   55327.30  106207.19  114942.86   44056.30   39337.36
  8   60504.93  320342.96   29936.85   54362.21   45416.53   16500.99
  9  115750.86   80613.61  214776.86  114540.62   62035.68   36224.95
   year
age       1977       1978       1979       1980       1981       1982
  1 1805695.42 2540324.65 2839958.62 1846186.52 2384168.94 1939623.80
  2  631149.16  805980.14 1162590.25 1337463.68  802459.16 1115883.92
  3  483770.90  336023.85  475751.99  751952.97  859742.35  434726.34
  4  188596.02  257226.21  196991.57  309351.00  491423.03  473682.37
  5   80343.28   98743.67  136208.56  133340.08  193812.40  274372.78
  6   57221.70   41667.83   58212.00   86821.76   90330.25  109001.52
  7   87442.71   25351.81   22792.71   36460.41   59900.00   48820.01
  8   14385.93   40249.46   12966.44   13245.44   20796.92   32947.88
  9   15456.81   12595.65   24712.57   20073.73   17421.50   19099.32
   year
age       1983       1984       1985       1986       1987       1988
  1 4732220.37 2535308.76 2939427.96 2616126.96 4460708.36 1977987.20
  2  845013.29 2358553.22 1136078.90 1334427.73 1169279.43 2175024.33
  3  595955.66  450833.73 1512597.66  702197.44  760259.62  688902.18
  4  216285.49  305048.11  243234.37  948887.24  406517.98  431866.76
  5  231534.43  108864.07  170904.37  144101.27  550805.20  232097.80
  6  134912.07  106717.65   59569.64  101869.51   77737.75  296713.93
  7   51874.23   59935.28   55004.50   31635.74   53921.92   37317.48
  8   21659.51   21274.12   29718.59   27990.63   17343.14   25016.86
  9   22865.09   16464.18   17448.23   23135.35   27106.83   18505.83
   year
age       1989       1990       1991       1992       1993       1994
  1 1648685.45 1292288.47 1039444.11 1538777.45 1280468.25 2094557.85
  2  894761.60  755342.32  591351.09  457199.23  734335.69  599023.79
  3 1462535.57  586682.46  456825.08  361384.62  256931.67  421180.97
  4  403071.87  908843.77  392139.46  281277.77  212489.25  131128.04
  5  246725.27  249666.94  494090.51  281318.20  166690.51  122815.35
  6  133518.92  139554.21  141229.10  255644.47  183816.49   98870.52
  7  156494.24   80987.21   72440.20   76570.94  125686.87  104783.08
  8   19265.48   80969.83   44479.44   37072.82   40411.82   61615.60
  9   21863.62   20714.69   42735.70   40515.67   36254.16   37054.40
   year
age       1995       1996       1997       1998       1999        2000
  1 1620769.77 1777371.67 2009731.93 1047500.80 932291.141 2602808.770
  2  995716.77  773871.62  830721.41  963208.64 454647.401  397915.062
  3  336259.90  555563.07  462346.46  476350.95 650038.389  257116.200
  4  226813.54  182525.43  266773.03  246850.18 237843.603  377285.292
  5   69179.55  103740.51  101599.91  126249.10 115184.498  118810.907
  6   71259.01   40538.49   55532.54   48142.53  49633.954   57901.116
  7   53164.42   37326.53   21011.45   22472.22  19679.432   25115.885
  8   55279.24   28838.55   21490.99    7337.87   7050.697    8718.176
  9   44383.03   45707.57   28533.56   17214.76   8744.604    7609.857
   year
age        2001       2002       2003      2004      2005       2006      2007
  1 1790111.970 1935692.87 1097488.47 952223.78 946705.14 843147.819 549668.68
  2 1291491.952  828547.32  922600.74 504337.80 430109.22 455340.594 406813.97
```

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  3  213419.943  832334.84  497125.11 581053.82 311410.81 243852.397 275439.04
  4  136625.322  108615.57  463557.21 305271.22 374338.12 175305.981 126201.75
  5  208101.504   77347.05   56430.73 236873.14 200291.76 244199.460 100272.47
  6   63875.802  115281.13   41259.86  28087.54 119678.12 138606.604 128930.67
  7   31857.617   34750.35   53267.75  27404.15  13106.02  72548.314  76646.41
  8   12527.812   15057.47   16861.23  23060.11  15618.15   8179.643  35014.53
  9    8395.482   10718.30   12691.02  15389.00  16786.71  19699.141  13249.04
   year
age      2008      2009       2010       2011       2012      2013       2014
  1 667164.58 746488.47 1175669.40 536482.565 559713.280 279995.27 358520.358
  2 256221.16 314104.80  338568.10 571431.694 239529.315 254031.43 123804.230
  3 232692.70 156847.57  191384.55 199294.092 375506.331 160196.25 153123.954
  4 148332.25 125646.97   85805.60 102219.938 110960.181 226355.05 103682.821
  5  67300.42  83148.67   67740.91  44018.491  52258.476  58559.57 120651.491
  6  52706.78  39071.72   39866.51  33555.394  23892.213  25215.61  26377.016
  7  68160.73  29980.52   20933.13  17239.873  16789.613  13828.48  10213.488
  8  35366.47  37214.42   15223.87   9596.348   7358.307   8012.51   5673.299
  9  23058.20  31255.76   33454.63  22186.352  14992.954   9734.98   4347.939
   year
age       2015        2016       2017       2018
  1 564442.027 226356.3443 240130.092 230731.697
  2 164147.988 285939.2209 100490.150 111951.569
  3  77170.660  99657.0864 217108.465  69031.229
  4  88747.433  47046.5979  69375.816 147482.236
  5  56734.745  42543.8359  32208.033  48040.283
  6  46898.085  26097.0808  24500.318  20182.669
  7   9192.354  13512.6529  14833.385  14224.709
  8   4027.079   2370.7618   5834.938   8540.271
  9   1716.545    804.2196   1608.691   3724.353
```

Table 4.6.15. Herring in 6.a (combined) and 7.b–c. PREDICTED CATCH NUMBERS-AT-AGE.

Units : NA

<0 x 0 matrix>

Table 4.6.16. Herring in 6a (combined) and 7.b-c. CATCH-AT-AGE RESIDUALS.

Units : NA

<0 x 0 matrix>

Table 4.6.18. Herring in 6.a (combined) and 7.b-c. PREDICTED INDEX-AT-AGE catch unique 6.aN and 6.aS/7.bc.

Units : NA

Area: 6.aN

year							
age	1957	1958	1959	1960	1961	1962	1963
1	14294.621	31321.613	43950.093	15522.018	20735.706	40542.831	33129.560
2	83846.886	43751.386	78642.598	90774.079	27664.141	71141.943	75444.345
3	49739.929	116548.265	43455.777	60806.303	62357.341	30293.336	44815.624
4	25646.785	44277.651	83677.959	26864.027	34904.692	67257.258	15150.377
5	34963.706	26911.778	28673.722	42386.976	16431.974	42827.516	37195.703
6	17291.119	29427.447	17041.272	11841.697	16858.505	17031.715	22368.341
7	9175.975	16610.450	18208.642	9060.516	5640.082	21422.725	9955.077
8	1699.011	7843.893	8518.520	7055.813	3772.831	6202.647	11884.055
9	5414.247	6024.826	6833.697	5358.469	4327.982	8067.937	7140.145

year							
age	1964	1965	1966	1967	1968	1969	1970
1	22062.682	84916.440	20775.705	39749.662	41694.365	45049.43	76602.72
2	71450.086	41976.039	271109.062	35510.381	64997.219	133779.26	159464.10
3	60783.629	60377.250	45594.618	237248.228	22494.589	88428.46	215124.47
4	28321.391	47240.875	58312.861	34283.580	155637.016	27226.57	101761.28
5	9901.497	20241.157	40355.029	39275.162	17361.287	193361.22	27224.11
6	23622.741	7081.944	16913.816	26818.825	21468.180	21864.16	175002.48
7	17770.385	20744.537	7206.632	12553.405	15662.700	31236.97	20618.30
8	7738.328	15217.959	18726.024	5566.157	6911.848	20117.71	23720.07
9	13008.482	14796.409	22102.958	23730.965	12964.132	20894.61	24570.79

year							
age	1971	1972	1973	1974	1975	1976	1977
1	317253.52	78578.575	65885.719	84503.28	77408.04	48210.593	33158.159
2	384646.45	501555.066	265501.023	197109.97	192267.00	206940.844	76423.255
3	282728.16	166427.390	588849.595	209534.45	102294.18	106684.287	71898.084
4	259263.74	69052.192	125349.438	374760.74	77879.70	43348.981	27816.327
5	106214.40	66289.553	53286.007	78322.22	136722.25	31513.324	11531.601
6	28657.75	29887.708	53089.986	38372.38	30634.93	63206.271	10268.005
7	186179.08	9139.398	23241.434	36198.16	13024.90	11629.065	16913.496
8	18328.83	54539.429	6258.418	15361.54	11518.42	4097.289	2349.167
9	35064.54	13724.729	44899.955	32366.62	15733.32	8994.859	2524.038

year							
age	1978	1979	1980	1981	1982	1983	1984
1	26031.838	96.643587	68.823034	28987.456	34482.109	62920.022	20190.414
2	55290.615	141.769580	193.063533	81867.969	185205.999	112024.805	197781.847
3	27705.895	64.797850	116.368808	99470.389	83963.904	96421.101	47387.676
4	21637.779	25.019690	44.234192	55293.884	92025.947	36018.630	32651.268
5	7609.135	15.285850	16.622387	20636.765	54744.220	42886.992	13069.256
6	3936.931	7.874077	12.461535	10849.811	24562.675	28937.764	14315.918
7	2674.175	3.574513	6.171651	8207.382	12731.208	13286.250	9275.193
8	3622.173	1.650682	1.765877	2317.787	7881.835	5370.435	3278.734
9	1133.521	3.146016	2.676222	1941.602	4568.964	5669.358	2537.434

year							
age	1985	1986	1987	1988	1989	1990	1991
1	18247.112	18847.246	22480.177	7432.959	5203.805	5209.939	3244.712
2	78154.484	116207.828	74507.988	109377.783	39871.434	47094.825	30055.658
3	129459.863	74590.744	59950.775	43425.456	82023.010	45630.971	28527.791
4	20668.798	99070.856	33065.675	27739.450	22425.622	71944.188	24492.596

```
  5  16426.585  16734.766 53920.468  18135.294 16736.932 24414.436 37515.515
  6   6339.333  12434.861  8543.545  25596.907  9919.004 15313.628 12144.636
  7   6386.029   3864.602  6627.838   3694.539 14181.906 11162.485  7772.921
  8   3480.769   3461.926  2332.201   2926.918  2202.405 14634.006  6035.777
  9   2043.612   2861.416  3645.165   2165.142  2499.421  3743.851  5799.154
   year
age      1992      1993      1994      1995      1996      1997      1998
  1  5230.038  4371.559  5842.385  4346.580  3187.728  5919.604  2890.081
  2 27903.314 49286.690 35562.659 62214.219 33374.074 65827.458 74638.229
  3 26303.483 19787.961 29859.572 26123.405 31361.014 50817.793 52459.621
  4 19334.394 14259.740  8048.704 16264.786 10590.826 34083.135 31791.179
  5 22649.947 12882.283  8663.143  5726.498  7893.986 18641.742 23250.210
  6 23214.390 15901.138  7869.111  6495.020  3644.914 12540.373 10724.208
  7  8682.626 14823.904 12315.744  7505.800  5462.604  6981.280  7027.053
  8  5160.407  5781.996  9064.766  9549.128  5068.377  7302.275  2143.500
  9  5639.639  5187.132  5451.371  7666.879  8033.107  9695.221  5028.684
   year
age      1999      2000      2001      2002      2003       2004       2005
  1  2045.193  4598.157  2428.236  2742.000  1130.868   784.7265   484.4493
  2 29612.596 22207.458 58474.397 41615.813 34417.680 15124.5765  7793.1151
  3 62641.306 22746.830 16569.676 77958.867 37426.537 36974.6763 11592.4753
  4 24868.512 37099.576 12125.780 12066.525 43801.939 26357.7983 17019.3741
  5 15898.720 15689.863 26880.981 12865.244  8117.731 33703.9306 13890.4108
  6  7599.621  8261.855  9247.466 20970.327  6509.635  4669.0160  9732.4155
  7  3929.151  4524.639  6057.803  8079.358 11572.449  6325.8017  1426.5321
  8  1290.834  1432.375  2253.216  3317.917  3796.552  5973.5022  1927.8844
  9  1600.953  1250.281  1509.987  2361.781  2857.568  3986.3749  2072.1298
   year
age       2006       2007       2008       2009      2010       2011       2012
  1   635.4049   551.1607   451.5366   814.7304  1654.916   671.0064   696.4811
  2 12853.0466 15892.6752  6459.4824 13454.2527 19215.805 29155.3286 12512.2312
  3 13718.4710 19331.8326 10271.9603 11703.7038 18486.343 17506.8522 35407.8023
  4 12814.5145 10500.1049  7477.0115 11169.0212  9910.200 10806.0391 12910.4464
  5 30385.0917 13739.7744  5259.1288 10627.1274 11131.376  6631.7879  8786.6550
  6 22790.8276 24370.6542  5800.4718  6377.2538  7764.736  5943.9905  4844.8131
  7 16886.3077 20655.1061 11277.1730  6774.7457  5218.048  3779.5472  4055.9779
  8  2277.5071 11789.0334  7903.0103 11284.0909  5149.437  2951.8000  2555.0585
  9  5484.9497  4460.8151  5152.5973  9477.3171 11315.949  6824.4375  5206.0719
   year
age       2013       2014       2015      2016       2017       2018
  1   418.1869   512.5287   910.4549  105.8361   89.35047   93.90935
  2 16631.1718  7933.2636 12347.3162 5592.3058 1522.99920 1877.83463
  3 20018.7674 19556.6843 12220.9616 4378.8926 7842.24245 2832.02691
  4 38358.2442 18670.3896 19636.0893 2891.3377 3305.64300 7982.29708
  5 14615.5249 33148.4499 18977.4643 4007.5930 2194.92736 3827.59908
  6  7857.7414  9261.3931 21150.6675 3501.7569 2132.97914 1984.20611
  7  5173.3391  4357.6272  5020.2579 2393.4070 1509.53679 1430.61697
  8  4392.4267  3533.4205  2894.8405  683.3515  994.87751 1413.38753
  9  5336.6781  2707.9654  1233.9280  231.8093  274.28749  616.36842
```

Units : NA

Area: 6aS7bc

year							
age	1957	1958	1959	1960	1961	1962	1963
1	177.7938	397.3142	503.8182	174.9632	315.8523	415.1054	253.4605
2	9323.6042	4511.1561	7518.0884	9297.1493	3893.5009	6757.4686	6615.4438
3	6176.1113	13479.6248	4831.3901	7735.3234	11907.8462	4188.9093	6022.8112
4	3008.4581	4879.5060	8377.0658	3099.9159	6413.2987	9382.6250	2195.4933
5	4136.5546	2905.9085	2631.5099	4130.9800	2623.9979	5378.2543	5130.3902
6	2246.9696	3483.3683	1728.9646	1304.8035	3239.6390	2577.8484	3791.7167
7	1397.4633	2213.5669	2074.3902	1143.1683	1280.4317	3931.7586	2101.6422
8	258.2036	1157.1031	900.7468	673.0248	675.2173	1034.2059	2020.3487
9	822.8188	888.7609	722.5939	511.1222	774.5717	1345.2173	1213.8603

year							
age	1964	1965	1966	1967	1968	1969	1970
1	162.536	707.7915	185.5585	460.4326	597.4704	561.1917	695.9922
2	6480.083	4336.8407	26769.6799	4300.7450	9921.3629	15380.8839	11903.4588
3	8754.455	9995.2096	7653.8323	47449.6236	5390.7693	14221.4505	21172.8458
4	4548.912	8430.4183	10805.6750	7745.9895	43030.2273	4957.3629	12225.0876
5	1622.961	3704.5022	7772.5621	9239.6035	5034.3801	36978.2641	3896.3451
6	4699.836	1585.6043	3859.3075	7085.9078	6655.4712	4459.1121	30292.5306
7	4231.751	5375.4817	1933.4740	3713.4367	5016.8413	6111.4603	3669.5028
8	1477.286	3188.0667	4413.4599	1506.1083	1654.2537	2857.0795	3180.6490
9	2483.385	3099.7547	5209.3557	6421.1988	3102.7827	2967.4131	3294.7228

year							
age	1971	1972	1973	1974	1975	1976	1977
1	1386.562	1089.726	1402.005	2988.811	4994.444	4390.140	4044.415
2	11899.234	41564.379	24506.383	23079.381	34838.024	46546.989	25704.999
3	11525.414	17972.809	66936.972	29655.997	23130.767	30846.116	30947.254
4	14262.485	10016.209	18337.911	63283.990	21857.692	16567.067	15865.502
5	7962.095	12824.173	10056.650	15758.734	43664.491	14250.227	8196.964
6	2974.355	7945.881	13384.053	9130.760	10497.512	27290.963	6819.694
7	22908.265	3034.717	7911.983	11352.149	5512.408	5663.323	11843.451
8	1942.137	20969.417	3226.973	9269.529	10575.829	4499.375	3231.527
9	3715.466	5276.908	23151.368	19530.803	14445.813	9877.566	3472.081

year							
age	1978	1979	1980	1981	1982	1983	1984
1	4985.804	4697.852	2798.400	2464.515	1594.545	5757.920	2388.938
2	31473.305	43036.691	48140.409	21602.658	25293.018	26198.052	62902.777
3	21364.450	30197.844	48636.117	43462.656	19160.946	35962.849	24287.016
4	21287.634	16599.737	26697.465	33383.559	28143.012	17585.428	22159.247
5	9980.453	14094.787	14195.737	16324.890	20048.092	22900.187	9784.998
6	5058.311	7470.781	11433.250	9446.459	9782.764	16249.781	12155.314
7	3531.087	3436.664	5632.422	7180.636	4888.357	6775.202	7630.921
8	8800.972	3076.929	3238.488	3555.204	4217.115	3937.380	3464.685
9	2754.173	5864.282	4907.994	2978.181	2444.589	4156.538	2681.342

year							
age	1985	1986	1987	1988	1989	1990	1991
1	2292.092	1961.890	5540.460	1604.962	1093.433	981.9601	933.2171
2	26810.499	30964.142	39624.572	56291.419	20597.702	19539.4716	17831.3853
3	74965.798	35089.108	55206.586	39984.266	76478.995	33406.4747	29684.9672
4	16593.080	66294.810	41424.592	35616.666	30138.802	73213.4982	34886.1600
5	14764.940	12812.227	70959.080	24209.010	23385.796	24888.7536	54342.9689
6	6681.767	11676.026	12707.498	39673.546	16357.435	17633.8369	19659.0938
7	7037.096	4123.978	9676.072	5462.741	21087.657	10932.6228	10839.1128

```
  8  4678.846  4345.781  4227.059  4232.497  2847.695 11803.2721  7778.9877
  9  2747.021  3591.957  6606.773  3130.924  3231.734  3019.6577  7474.0251
   year
age      1992      1993      1994      1995      1996      1997      1998
  1  1618.300  1458.941  3275.906  2395.929  3340.776  3978.931  2965.638
  2 15701.615 27421.213 28140.437 45856.066 42285.176 45951.862 68593.737
  3 26573.269 20620.034 40905.202 32417.902 61850.920 49846.265 63596.525
  4 27784.209 23143.802 17133.185 29508.979 26975.120 37116.610 41201.071
  5 32555.300 20644.922 17985.617 10089.294 16721.525 14626.100 21309.500
  6 36875.671 26909.983 16513.215 11670.768  7190.882  8323.801  8202.589
  7 11672.323 19132.212 17460.452  8358.196  6241.010  2833.913  3443.276
  8  6696.248  7247.123 12749.556 10230.422  5762.033  3279.218  1378.773
  9  7318.110  6501.522  7667.331  8213.882  9132.515  4353.814  3234.622
   year
age       1999       2000       2001       2002       2003       2004
  1  1872.0349  4015.4427  2198.4054  2243.0673   966.3513   694.5524
  2 26235.2770 19662.1901 56012.6258 35194.8018 33608.7953 16802.7130
  3 70841.8126 24619.1343 18775.8419 71615.6053 37530.1319 41040.7630
  4 31687.3125 43215.5588 14770.6808 11651.1625 42623.8258 25446.6212
  5 15275.2067 13352.8789 22193.5517  8165.9808  5146.5405 18880.2421
  6  6619.1487  6404.7521  6693.9669 11833.1945  3639.9694  2140.9629
  7  2419.2334  2523.9408  2895.9893  2971.9485  3747.6527  1610.3923
  8   884.8695   773.9598   897.4629   944.2913   692.8368   653.5297
  9  1097.4564   675.5683   601.4325   672.1715   521.4805   436.1285
   year
age       2005       2006       2007       2008       2009       2010
  1   708.5009   900.0867   518.7858   652.4627   547.7215   923.6713
  2 15403.1987 21423.8848 17914.4483 11664.5379 11545.8682 12733.8033
  3 24175.0865 24862.4765 26854.9558 23780.8134 13132.0882 16252.7427
  4 33543.7450 20542.4698 14358.3889 18375.2104 12864.7984  8994.9625
  5 16624.2851 25224.8265  9938.0483  7727.1144  8174.0449  7104.4282
  6  9049.3515 11989.2445 10077.7895  4937.7820  3244.1755  3801.7623
  7   760.5313  4387.8681  3852.1249  4068.3118  1568.7710  1340.8369
  8   382.2955   199.1180   536.6986   629.9816   499.1774   301.5930
  9   410.8990   479.5385   203.0797   410.7348   419.2507   662.7542
   year
age       2011        2012        2013       2014       2015       2016
  1   275.5536   156.90386    62.45715   74.27551   46.37720   26.20727
  2 15815.7373  4223.97768  3869.95047 1832.61958 1268.32425 2918.18516
  3 12801.0111 15588.92783  6109.24659 6010.57267 1625.15937 2844.93409
  4  8238.6230  5643.73653 11175.23478 5508.75722 2475.57934 1834.76240
  5  3678.3471  2754.94579  3182.56970 7454.51835 1824.69976 2087.17071
  6  2705.4439  1237.71846  1432.79600 1746.43071 1561.71498 1468.40148
  7  1015.5404   673.86936   644.79818  574.24583  258.23766  696.71690
  8   179.3706    79.57045   127.53325  131.88770   31.88411   49.51301
  9   414.6974   162.12915   154.94940  101.07694   13.59063   16.79601
   year
age       2017       2018
  1   29.24625   19.29117
  2 1082.17615  936.77559
  3 6520.87231 1623.34306
  4 2879.75886 4682.89988
  5 1709.78068 1935.11077
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  6 1562.02454  963.53231
  7  915.05057  666.80161
  8  174.59519  161.74232
  9   48.13585   70.53469
```

Table 4.6.19. Herring in 6.a (combined) and 7.b–c. INDEX-AT-AGE RESIDUALS catch 6.aN and 6.aS/7.bc.

Units : NA

Area 6.aN

age	1957	1958	1959	1960	1961
1	4.3917972158	5.022033576696010	1.70247523	-1.77488509	-0.03983159
2	0.0007331323	1.556387285203030	0.28173625	1.18023271	-0.86506926
3	0.0007765353	1.432487194204824	-0.09186191	-0.01015073	-0.09283212
4	0.4522077984	0.000000026169952	1.42626448	0.06541195	0.10625283
5	1.0739205341	5.889297200829849	-0.76677184	-0.05674340	2.38542371
6	1.8038697426	-0.000000009133377	0.20707534	-1.16350511	-0.82079381
7	2.5811242810	-4.775733081218419	-0.84623080	0.41770971	0.01150809
8	-0.0156308090	-0.610909562467760	-0.45900596	-0.43563998	1.05131617
9	0.2094578318	-0.015843162368102	-0.11765810	-1.48054103	-1.67397781

age	1962	1963	1964	1965	1966	1967
1	1.269258418	-0.44968310	0.796223563	2.3878086	2.04026200	0.67156742
2	0.006445572	0.31751772	0.040389662	-1.2988343	0.97492027	-1.89325120
3	-2.661977958	-0.07217268	-0.007199186	1.1241703	-2.11175109	2.50401816
4	0.133812306	-1.81319449	-1.547110693	1.0888458	-0.77381574	0.77429340
5	1.401858195	0.02582365	-1.196911480	-0.2990116	-0.26040681	-0.02259793
6	2.097960573	1.13472979	0.198874974	-1.0705915	-0.07685659	0.17042617
7	0.625360692	-0.26082616	0.648640421	0.4197033	-1.10908559	-0.47604216
8	0.556184228	0.82575143	0.814302805	0.6795441	-0.25337062	0.09933413
9	0.482647198	0.45854583	0.897037057	0.8988713	0.51124979	0.19912689

age	1968	1969	1970	1971	1972	1973
1	1.3785544	-0.28188070	0.75449313	0.8704819	1.07754106	-1.153220797
2	-0.1060101	0.08349402	-0.54059647	0.2795461	0.50008389	-0.003190731
3	-1.2980853	0.34482081	1.98406248	0.5955658	-0.57635434	2.080997531
4	0.4681987	0.25102076	-0.07464869	-0.1402377	-1.68001974	-0.010204198
5	-1.1803030	1.26393032	-0.42545055	-1.0033699	0.02943696	0.407580545
6	0.2652489	0.17142699	-1.46703936	-0.2422761	-0.29109911	-0.019581108
7	-0.2669021	1.21181720	-0.27784866	-0.9628498	0.21199259	-1.684307647
8	-0.5126255	0.31171576	-0.29538062	-0.2903139	-0.10365019	-0.209019474
9	-0.2738214	0.32718757	-0.47294208	-0.9123296	1.10486894	-0.893016451

age	1974	1975	1976	1977	1978	1979
1	0.1422292	0.05168102	-0.43330660	-0.8311299	-0.42909607	-2.4541592
2	-1.2092655	-0.18202540	0.52613569	-0.7663225	-0.11594789	-3.2375007
3	-0.2183268	-1.07110065	-1.21958117	0.9082179	-1.15028155	-2.2825087
4	2.4417072	-0.66393707	-0.67170603	-0.7034812	1.71193774	-2.3694639
5	0.6140869	0.99552769	-0.69381595	-0.2066251	-1.11112898	-1.6691966
6	1.4282400	0.04495045	0.98942171	0.7003477	-0.64000735	-0.2648352
7	-0.0689113	-0.22175532	-0.04007801	0.8611206	-1.11608855	0.2032683
8	0.6780525	0.08013269	-0.43833676	-0.2090611	0.95378344	-1.7070140
9	-1.0276136	-0.18819528	0.36626645	-1.9070495	-0.01367888	0.0000000

year						
age	1980	1981	1982	1983	1984	1985
1	1.3323675	2.287328	-0.74457174	0.07998807	-1.6169597	0.01548741
2	-0.3342339	3.284511	1.77438826	-0.51474458	1.8968439	-0.19393072
3	-1.1390351	2.741852	-1.13712917	0.20046123	-0.8328606	0.83921794
4	0.2877466	1.788054	0.04451531	-1.06192351	-0.7794058	-1.53450505
5	-0.3470003	1.199861	0.69322347	0.15117435	-0.2261800	-0.23665098
6	-1.0065887	1.310477	-0.13908931	-0.20603872	-1.6972269	-0.02068447
7	1.0267917	1.592876	-0.22524711	0.34586410	-0.7902994	-0.57862836
8	-1.3665184	-1.224726	2.21345755	1.35050486	0.3872153	-0.23719959
9	0.0000000	-1.456588	-0.41502612	0.50479145	-1.4021758	-0.63324617

year						
age	1986	1987	1988	1989	1990	1991
1	-0.1356420	-0.61446545	-1.5022477	-0.53215975	0.05523805	0.28583697
2	0.5698682	-0.05972924	1.4178990	0.08589540	0.01593894	-0.77088581
3	0.1736999	-0.64250851	-0.5402370	1.30006566	0.44485120	-0.07990382
4	0.4199626	0.64797743	-0.3240279	-1.38773148	0.37609913	1.30121983
5	-0.2258954	0.57137162	0.2151300	-0.23853892	0.31847134	-0.77188178
6	0.2805172	0.15375861	-0.1693651	-0.88313437	-0.59169815	0.31548680
7	-2.6179585	0.87890807	-0.8139342	0.32013748	0.46346283	-0.36097224
8	-2.0700684	1.78631546	-0.3642854	-0.09006003	0.92657029	0.58975651
9	-1.1563733	0.99312886	-0.3083588	0.42167418	-0.03430650	-1.76396662

year						
age	1992	1993	1994	1995	1996	1997
1	-0.38347586	0.43108764	-0.7401649	-1.9027985	-0.6006532	-0.7882884
2	0.07415504	1.50011763	1.1242039	1.9596362	0.5950655	1.1454886
3	0.25499161	-1.81465404	-0.1606038	-0.3238788	-0.9732834	-0.2510514
4	0.76876892	-0.36397563	-1.8268762	0.4652382	-0.1492441	0.4904937
5	0.67026937	0.44486612	-0.1091893	-0.6310172	-0.0535481	1.8705754
6	0.26303737	0.60848026	0.5458070	-1.0329587	0.3379536	1.7033877
7	-0.93973863	1.12264217	0.6388384	1.2692288	0.7585103	1.2242269
8	-0.34078474	0.01302651	1.0420958	0.1440212	1.9392218	-0.7229502
9	0.01694900	-0.07842021	1.6637021	1.1107856	3.1974302	-0.4967928

year						
age	1998	1999	2000	2001	2002	2003
1	-0.05541706	-0.1723384	-0.17595453	-1.7947362	-0.7018864	-2.1864311
2	0.10997431	-0.5262732	-0.37017852	2.1062474	0.5706162	1.2877754
3	-0.74881122	2.1782942	0.38144779	-1.2526717	0.9027011	0.6578451
4	0.59628642	-1.2568593	1.34567783	-0.6410266	-1.2858047	0.4597038
5	0.04385107	-1.2866145	-0.29636476	0.6766599	1.3656502	-0.5597169
6	1.07549085	-1.1495778	-0.01414491	0.6428161	0.5355600	-0.9180326
7	0.11631606	-1.0987785	-0.55522214	0.9319922	-0.1081675	0.5116131
8	0.14615194	-0.4258939	0.29026377	1.6500542	-1.9320623	2.4898505
9	-0.51520904	-0.1621007	-1.45563062	-0.9627594	-0.9043214	-1.3646884

year						
age	2004	2005	2006	2007	2008	2009
1	0.00000000	-0.9659948	-0.58622648	-0.5932267	0.0000000	0.931966123
2	-0.77137155	0.2765088	0.59225515	1.9450531	0.1257339	-0.001491468
3	0.40350331	0.8773285	-0.82056636	-1.6234822	-0.6249303	-0.371324364
4	1.71776993	-0.8345316	1.15490996	-2.1052749	-1.3568968	1.155190713
5	1.23025881	-1.6789009	2.16191048	0.2906616	-1.6171798	-1.096754204
6	-0.05130849	-0.6285523	2.01006883	0.8782066	0.2708454	-0.638199198
7	1.94359562	-2.0034600	1.16768317	0.4152053	1.1552937	-0.247997100

```
  8  0.74205014 -0.1369614  1.21735119  0.6153892  0.3773517  0.001648594
  9  0.24028030 -0.8055671  0.06385637  0.1464580  1.7387483 -0.034654312
   year
age        2010       2011       2012       2013       2014       2015
  1  1.26348195 -0.0129332 -0.1552613  0.0000000  0.0000000 -0.4430714
  2 -0.56498314  0.3847270 -0.1786066 -0.4392724 -0.3203017  0.4845850
  3 -0.41329309 -0.8211570  1.1994448  1.3508415  0.2029241  0.6181630
  4  0.07272197 -0.1288458 -1.1037785  1.6305154  1.6055511 -0.6210978
  5  0.75034313  0.1807860 -0.2676154 -0.8800551  0.8333459  0.3390211
  6 -1.53750872 -0.4250448  1.2623347 -0.3407591 -0.9826136 -0.1590258
  7 -0.96830317 -1.2649829 -0.5729064  0.7435359 -1.1645701  0.2476817
  8  0.22042849 -0.2175667 -2.1289042  0.2550639  0.1330717 -0.7014103
  9  0.46041282  0.3830976 -0.2052476 -0.2556361 -0.3624311 -1.4333914
   year
age        2016        2017        2018
  1 -1.91656870  0.00000000  0.00000000
  2  1.17848168 -0.75234568  0.03388321
  3 -1.65251515  2.37082235  0.57947239
  4  0.29306482 -0.20982771 -0.39270017
  5 -1.60833567 -0.76141442  1.37794418
  6 -0.06505294 -2.09648883  0.79524817
  7 -0.06002684 -1.35620752 -2.85900054
  8 -0.05484937 -1.84190880 -1.34388727
  9  0.78231276 -0.06251396 -0.26424844

Units  :  NA
Area 6aS7bc
   year
age         1957           1958         1959        1960       1961       1962
  1  0.000000000 -0.00001154036  1.299234398  0.12012274  0.3963300 -0.8488289
  2  2.438927976  2.28623830802  1.771175211  1.98403294 -0.3060049 -0.4391285
  3  0.346625541 -2.65423307329 -0.002432615 -0.02072613  0.5640517  0.2152831
  4  0.246431619  0.00581784888  0.266145195  0.82009179  0.7749017  0.5531736
  5  0.004254281  1.71736645378 -1.718123763 -2.97119194  0.3413027  0.5412235
  6  1.841818048  0.13021008621 -0.025617407 -0.21647183  0.1850896  1.4810754
  7  0.131966240  1.71777849047 -0.145918042  0.60278966 -0.4712157  0.8535776
  8  0.005179995  0.00554113526 -0.631754037 -0.11005742  0.4886074  1.2238293
  9 -0.173476870  0.54549813623 -0.557871432 -1.33353006 -0.4428591  0.6274153
   year
age       1963        1964        1965       1966       1967        1968
  1 -1.0967866 -0.96966547  0.07061733  0.0000000  0.0000000  0.24198619
  2 -0.5469598  0.22661170  0.26985868  0.0784538 -2.1205248  0.08898079
  3 -0.8447105 -0.46286632  0.59541030  2.0540424  1.6220396 -0.64254308
  4 -0.4458808  0.15350023  0.45075294  0.3413917  1.5725720  1.51002244
  5 -1.0364109  1.17660080 -0.89778545  0.1128351  0.1763672 -0.17984802
  6  0.5519582  0.06229596  1.12049436 -0.3222501 -0.3934966 -1.23706377
  7  0.6369200  0.34505346  0.45128476  2.0754478 -0.4042260 -1.88779443
  8 -0.2159319  0.50534880 -0.29792968 -0.8604611  1.3999317 -1.61934910
  9  1.5548010  0.68746454  0.51166015  0.1675243 -0.1688788 -0.10066140
   year
age       1969        1970        1971        1972        1973       1974
  1  1.0918879 -1.01011563  0.16945425  0.02237775  1.69452054  0.7491029
  2  0.5054955  1.86815813 -2.30890476  1.20601406  0.62374254  0.4146509
```

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  3 -0.4480297 -0.26840385 -1.48445341  0.50964846 -0.51939310  0.6584690
  4 -0.4164952 -0.39623912 -0.86155129 -0.64739641  0.04941272 -0.8010545
  5  1.1513201  0.03113083  0.64066564  0.02087480 -0.49963187  0.3347122
  6  0.4421371  0.94021730  1.93834286  0.91610769 -0.12646632 -0.4257344
  7 -1.0317815 -0.22709369  0.49845331  0.70908663  0.39392425 -0.2129399
  8 -0.8578392 -1.03791907  0.60692172  1.65590553 -0.28579773  0.3991478
  9 -0.0139810 -0.58012711 -0.09940247 -0.08974515  1.60578038  0.9584914
   year
age       1975        1976        1977         1978        1979       1980
  1  0.7113929  0.88027983  0.02247884  0.806305165 -0.01913319 -0.8666914
  2 -0.2736174 -1.59426676 -0.10998054 -0.107197274 -0.27697615 -0.7280055
  3 -0.2532532 -0.08581135 -3.13248918 -0.006162482 -1.23625339  1.0947544
  4  0.5266560  0.95014974 -0.25848374 -2.097658799  0.75036519 -0.1563418
  5 -1.7213247  1.07890744  0.59233194 -0.044109970 -1.14804358  1.2649499
  6 -0.3495905 -2.20714581  0.09985050 -0.093428599  0.43958789 -0.8253788
  7 -0.3631677 -0.76389797 -1.79219173 -0.106746391  0.46512189 -0.0139479
  8 -0.1781788 -0.66079376 -1.66269671 -1.379246302  0.69871359  0.5905850
  9  1.2278417  0.29659311  0.06001715  0.215846830 -0.85977000 -0.3425383
   year
age       1981        1982       1983       1984       1985       1986
  1 -0.4473852 -0.67949399  0.1986670  0.2395528  0.9733340 -0.4001281
  2 -0.8618326 -0.46929019  1.6031865  0.6152487 -1.3409010 -0.2619943
  3 -0.4978979 -0.21746337  0.9462775 -0.4836287  0.1212864  0.0489608
  4 -0.3913488 -0.08156550  0.6502812 -1.2621132 -0.5577660  0.6034837
  5 -0.9447739 -0.45765783  0.1262363 -1.2946209 -0.4222053  0.4700672
  6  0.6130807 -0.49829371 -0.2114874 -0.2261643  0.2951142 -1.0402960
  7 -1.1949068 -0.25178566 -0.3728685 -0.5610803  0.3340699  0.4790133
  8 -0.2843664 -0.46420756 -0.4396621 -0.9042712  0.4989841  0.1914753
  9  0.4197364 -0.03723604 -0.3265791  0.3349331 -0.8717841 -1.3498737
   year
age       1987         1988        1989         1990        1991        1992
  1 1.50475958  0.000000000  0.23804112 -0.123545522 -0.37155997  0.55827431
  2 0.64651347 -1.036750581 -1.68014426  0.972311512  1.33745737  0.01331471
  3 1.40216726  0.085745028  0.44473566 -0.409287624 -0.09469925  1.23631816
  4 0.38407916 -0.005903153 -0.14050511  1.808013680 -1.78029053  0.15861160
  5 0.99002955 -0.483001271 -0.35139861 -0.197903560  1.31919703 -1.31999461
  6 0.27483847 -0.126462677  0.02383359 -0.003335206 -0.28975329  1.33751230
  7 0.08151306 -0.199222608 -0.08822319  0.354109765  0.20814234 -0.35502945
  8 0.35473982 -1.268413171  0.50867747 -0.954282477  1.01126372  0.28813170
  9 0.01895785 -1.370982699 -0.74864356 -1.908585894 -0.38510924 -0.27990155
   year
age         1993       1994        1995        1996         1997        1998
  1 -1.926344182  1.9541426 -1.35656978  1.03246091  1.189267823  0.58588892
  2 -0.006357313  1.4406576  0.28600531  0.03141098  0.904684985  0.69451007
  3  0.527445894 -1.1441074  0.24186828  0.52223267 -1.264146708  1.07020582
  4  2.133922598 -0.1175905 -1.01011219  0.46879671 -0.346292507 -0.15926605
  5  0.625849610  0.7121196  1.53196615 -1.71202340 -0.302968951  0.58683871
  6 -0.874052540 -0.1569499  1.08308062  2.02303328 -1.291402895 -0.09140187
  7  1.739959540 -0.8998471 -0.70460753  0.33469641  1.483616737  0.45065942
  8  0.152876100  1.3040314 -0.07404816  1.22349656  0.644990877  1.26482238
  9  0.052380376  0.2532077  0.90118286 -0.60923534  0.002832676  0.21476562
   year
age        1999       2000        2001       2002       2003         2004
```

```
  1 -0.51837177  0.3736147 -0.01294346  0.6369771  0.1957462  0.295545884
  2  0.31406774  0.4054136 -0.93901859  0.2965149  0.3527435  0.424534499
  3 -0.31351493  0.5928672  0.18192596 -1.2203810 -0.7354446 -0.004279228
  4 -0.27673552 -1.1437593  0.57644500  1.0976674 -1.4429527 -0.593566737
  5 -1.34699218 -0.3710227 -0.20429310  0.6430705  1.4097366 -2.121904538
  6 -0.82165418 -2.0877564  1.09523365 -0.3980346  1.0128479  1.815331838
  7 -0.37673295 -0.6869495 -0.90928797 -0.2439391 -1.0522905  0.108250080
  8  0.03114187 -0.3535679 -0.41210949  0.1648984 -0.6187893 -0.463164457
  9  0.09677066  1.3342508 -0.53074976 -0.6268842 -1.3578118 -0.987227093
   year
age        2005        2006       2007       2008       2009         2010
  1 -1.15984856  0.17162452 -1.9858085 -0.1675898 -0.8809157  0.412299984
  2  0.90900068  1.25759576  0.1790318 -0.1901420  0.1764853 -0.344743953
  3  0.46165828  1.27114417  1.0554124 -0.9095596 -0.5407717  0.285586726
  4 -0.04242593  1.05780661  1.0064921  1.1090280 -0.8709138 -1.078603244
  5 -0.32376097  0.01865539  0.6953537  1.2384328  0.9924570  0.004331795
  6 -1.37851862 -0.36610251 -1.7319523  0.7608910  1.3240547  1.425677518
  7  0.75749602 -0.95916560 -1.0982359 -0.4075279  0.4859469  1.432526161
  8  0.83348653  1.24958723 -1.9704124 -0.1526282  0.1184041  1.540895817
  9 -1.63675520 -1.28267769 -0.8922525 -0.7281057 -4.6283770 -1.435634768
   year
age       2011        2012        2013       2014        2015       2016
  1 -1.4968219  2.10305940 -1.03202106 -0.7826962 -0.74239886  0.7505958
  2 -0.5487751 -0.04118249 -0.61763779 -2.0638298 -0.24473311  0.1418034
  3 -1.0764889 -1.19701777 -0.07982554  1.7713074 -1.94997107  1.3718954
  4 -0.1288369 -1.90475346  0.38617936  1.1193788 -0.64247339 -0.3611380
  5 -0.5674248 -1.95215759 -0.97973439  1.3786205 -0.31158143  1.1575249
  6  0.6335438 -2.30536837  0.97849146  0.5978095 -2.82666554  1.2289272
  7  1.3996383 -0.30174470  0.10663319  0.7680451 -1.50245275 -0.1091049
  8  2.3616819  0.50963250  2.57311035  1.6914877 -0.09134806 -0.2181315
  9 -2.2133260 -2.49298732  0.62984123 -0.2409165 -0.95943349 -0.9825197
   year
age        2017        2018
  1  0.02490121 -1.04635313
  2  0.20751043  1.12041830
  3 -0.12532476 -0.09719226
  4  1.01282077 -1.04019078
  5 -0.87946454  0.12660661
  6  1.06379383 -1.64020169
  7  0.39378756  0.08492086
  8  1.20110611  0.30435272
  9  0.61330771 -1.87391211
```

Table 4.6.20. Herring in 6.a (combined) and 7.b–c. PREDICTED INDEX-AT-AGE IBTS_Q1.

Units : NA

year / age	1994	1995	1996	1997	1998	1999	2000
2	59898.05	99527.14	77494.58	82658.90	95599.197	45332.021	39796.266
3	136531.37	108881.52	180100.86	148472.28	152179.330	209248.037	83098.360
4	53795.28	92879.00	74686.36	107835.26	99168.922	96715.449	154169.710
5	58192.88	32705.20	48960.82	47041.88	58107.937	53995.374	55993.563
6	70717.01	50882.76	28873.62	38597.27	33314.465	35210.267	41358.054
7	88042.09	44535.13	31164.64	16868.90	18048.146	16397.668	21118.828
8	76185.06	68289.12	35472.74	25592.25	8771.637	8808.692	11019.562
9	45816.19	54828.51	56222.39	33978.79	20578.393	10924.952	9618.674

year / age	2001	2002	2003	2004	2005	2006	2007
2	129527.04	83040.60	92758.99	50792.87	43382.68	45768.67	40838.15
3	69213.20	269231.86	161652.17	189495.52	101899.13	79188.75	89292.60
4	55999.79	44336.34	190373.09	125754.40	155156.10	71942.98	51726.30
5	98242.79	36248.67	26644.45	112127.95	96035.16	115467.48	47334.76
6	45660.01	81813.61	29514.69	20106.20	87050.47	99052.43	91833.20
7	26785.32	28984.95	44724.77	22999.39	11264.73	60840.08	63905.48
8	15839.87	18915.25	21255.24	28941.80	20131.90	10232.07	43314.68
9	10615.05	13464.38	15998.28	19314.11	21638.18	24642.04	16389.70

year / age	2008	2009	2010	2011	2012	2013	2014	2015
2	25773.33	31549.86	33923.27	57405.21	24097.70	25511.174	12436.820	16478.470
3	75725.43	50933.57	61885.52	64790.25	122428.54	51976.242	49646.616	24963.380
4	61053.45	51554.01	35012.05	41980.57	45729.88	92388.619	42199.566	36005.107
5	32033.42	39328.40	31764.63	20787.26	24742.88	27256.678	55746.323	26026.698
6	38012.70	27947.99	28259.22	23946.56	17061.51	17557.176	18137.556	31632.851
7	57956.36	25221.66	17478.33	14503.84	14114.47	11248.325	8161.019	7118.092
8	44807.55	46410.75	18805.68	11941.91	9089.56	9309.778	6365.826	4315.819
9	29213.58	38979.60	41325.70	27609.18	18520.48	11311.125	4878.682	1839.621

year / age	2016	2017	2018
2	28951.439	10180.734	11343.277
3	32839.618	71615.878	22776.687
4	19614.726	28978.128	61636.019
5	20431.151	15525.870	23162.786
6	18868.059	17839.973	14708.252
7	11481.794	12757.149	12267.999
8	2961.524	7450.679	10937.286
9	1004.620	2054.150	4769.674

Table 4.6.21. Herring in 6.a (combined) and 7.b–c. INDEX-AT-AGE RESIDUALS IBTS_Q1.

Units : NA

age	1994	1995	1996	1997	1998	1999
2	-0.2339927	1.2860131	0.4885735	0.3413032	-2.3637995	0.2841476
3	-1.1140432	-1.8017036	-1.1998994	0.3390645	0.4195610	1.1733973
4	-0.7636904	-0.3586611	-1.0341681	-1.5046954	-0.4588010	1.3947811
5	-0.3426614	-2.8087745	1.5235293	-0.6981846	-0.8480083	-0.3543068
6	0.5449681	1.1865791	-0.1169654	-0.5672650	-1.5059419	-0.8743364
7	-1.7647226	-1.8256106	-2.2188445	0.5512949	1.4161137	1.1646110
8	-2.3607343	0.1541607	0.4745758	1.5736480	-0.5190211	0.8452474
9	-1.3730777	-1.0610698	0.7138803	-0.6026017	0.6913411	1.5285790

age	2000	2001	2002	2003	2004	2005
2	0.6406441	0.20363406	-0.3829759	0.3968827	1.0779306	0.77641129
3	0.5398035	0.14142785	-0.7390121	-1.0667062	0.4728370	-0.50273549
4	-0.5394337	0.07900812	0.6649731	-0.6521560	-0.0275774	1.44662592
5	0.1984424	-0.10394651	-2.1156629	0.1665567	-0.2459491	1.47038571
6	0.7155699	0.42514604	0.1830605	-0.4575347	1.3498683	-0.02819150
7	0.2922121	0.60519856	-0.3776694	-0.3722311	0.3302790	0.63548498
8	-1.6030607	-0.82644434	0.9351219	-0.2223319	-0.8636014	0.60396127
9	2.0322323	1.30032595	0.8308443	1.4263599	0.9242059	-0.09474366

age	2006	2007	2008	2009	2010	2011
2	1.8088348	-0.6236535	-0.15999528	0.3167245	-1.10109660	0.407434469
3	0.5553793	0.2330136	-2.76185091	0.6787739	0.01145636	-0.114060766
4	-1.1498293	0.2284261	0.45657331	-0.5432999	-0.68697840	0.678115835
5	1.8443135	0.3283264	0.95934510	0.9554874	-0.22065631	0.007057524
6	0.8234830	-0.4160753	-0.75288445	0.2703002	0.04200966	-0.057927739
7	0.2395817	0.4733694	-0.73788956	0.5646233	1.48501801	0.044524352
8	0.3783614	-0.7322199	0.90130740	-0.2038543	-0.64083290	-0.047662392
9	0.9069454	2.2391381	-0.09600786	1.3732293	-0.12649541	0.795511868

age	2012	2013	2014	2015	2016	2017
2	-1.60231915	0.876711765	-0.1400813	-0.7426291	-0.08312669	-0.04602807
3	2.16883008	-0.829538605	-0.2249072	-0.9724493	-0.61653006	0.36431957
4	-0.11745498	-0.006796075	-1.3641691	0.9548023	-1.68048054	-0.14322741
5	-0.17528936	0.625580520	-0.1140443	-1.3576940	1.14991879	-0.43652639
6	-0.62783236	0.439901387	-1.8355889	-0.8952510	0.74453237	-0.87547622
7	-0.18032953	0.290792791	0.5428624	0.2280499	-2.38490344	0.42080719
8	0.01459855	-0.355321700	-0.1988339	1.0248299	-0.01397404	-0.71048919
9	0.86831632	0.256269758	-0.6263003	-0.7941213	0.52436200	1.69797471

age	2018
2	-0.5777772
3	1.8427633
4	2.8109458
5	-1.1663627
6	0.7107380
7	-1.2194089
8	-0.1775555
9	-0.7724783

Table 4.6.22. Herring in 6.a (combined) and 7.b–c. PREDICTED INDEX-AT-AGE WoS_MSHAS.

Units : NA

year / age	1991	1992	1993	1994	1995	1996	1997	1998
1	208934.3	309198.5	257273.7	420907.9	325748.1	357359.0	403680.57	210294.16
2	469128.0	358917.4	572618.1	466449.3	774079.9	606446.4	633154.63	726067.76
3	715260.4	557717.2	393145.4	639018.3	507699.4	843062.1	673283.17	678188.87
4	864220.7	612157.6	459337.1	279817.8	480131.9	385099.6	533688.73	480738.60
5	1237136.4	698542.2	412260.8	299791.9	167217.0	248902.9	224257.98	271528.75
6	413182.3	741674.9	534269.7	283994.5	203196.7	114330.0	140772.28	119727.11
7	253650.1	266004.6	434938.9	358013.0	179260.4	124055.2	58867.27	63058.38
8	174607.7	144239.1	156833.3	231637.4	207005.2	105985.6	68578.52	23808.57
9	167762.5	157634.2	140698.0	139302.2	166201.9	167981.6	91051.62	55855.27

year / age	1999	2000	2001	2002	2003	2004	2005
1	187369.09	523470.90	360227.66	389525.99	220966.18	191772.47	190704.79
2	349652.15	310108.72	1018873.94	651714.61	735737.47	405184.31	347833.75
3	956584.67	385037.45	324420.91	1251020.95	764549.33	905063.77	492194.58
4	488326.56	791321.34	290399.30	226758.32	993712.52	663230.26	835358.32
5	268328.56	283296.51	499922.24	179977.59	135652.85	575778.76	514854.24
6	137553.45	165342.39	183002.50	320053.27	118577.95	80969.82	369898.64
7	64832.80	86091.57	109159.34	114994.37	181424.74	93163.83	49434.24
8	27731.36	36076.43	51912.62	60655.73	68963.72	92524.00	70397.71
9	34393.73	31490.12	34789.11	43176.35	51907.23	61745.24	75664.90

year / age	2006	2007	2008	2009	2010	2011	2012
1	169769.65	110666.13	134352.53	150306.6	236654.68	108026.73	112725.62
2	362714.43	322236.60	204764.40	249433.9	265984.68	454071.92	191542.81
3	372855.71	418007.93	359102.69	239799.1	287234.15	306193.34	584210.43
4	374628.14	268219.29	321094.32	268287.9	178839.56	219148.58	241545.16
5	590715.40	240819.36	167558.57	201410.4	158012.70	105890.83	127148.83
6	396632.48	363657.18	156974.12	112264.2	110109.48	95444.06	68149.85
7	245802.79	253210.01	245286.16	102986.5	69586.36	59229.49	57494.65
8	32349.77	131908.22	147856.31	145239.3	56994.47	37100.69	27548.00
9	77908.37	49912.33	96399.22	121984.0	125246.04	85775.24	56130.56

year / age	2013	2014	2015	2016	2017	2018
1	56382.27	72199.27	113662.831	45621.462	48400.90	46506.67
2	201567.26	98364.56	130035.898	235125.243	82847.42	92345.49
3	244001.31	232513.82	116016.055	162413.831	355403.36	113130.68
4	472377.58	213725.19	180398.041	107708.891	160123.52	341193.80
5	132254.19	263893.80	120273.626	110118.919	84746.24	126522.99
6	64420.38	63810.99	104311.529	78565.544	76080.26	62899.68
7	41017.42	28029.01	21999.796	48482.070	56097.78	54457.14
8	22968.36	13968.05	8115.699	9319.662	25241.15	37421.22
9	27905.93	10704.92	3459.323	3161.454	6958.98	16319.13

Table 4.6.23. Herring in 6.a (combined) and 7.b–c. INDEX-AT-AGE RESIDUALS WoS_MSHAS.

Units : NA

age	1991	1992	1993	1994	1995	1996
1	-0.38207072	-0.564739830	-2.4210469	0.2732751	0.64986277	-1.0266629
2	-1.36391260	0.657571116	1.1841847	-0.0444795	0.55288602	0.7352207
3	-1.07506185	-1.666190809	0.9439812	-0.5015496	-0.68126148	-0.3988337
4	0.08856845	0.417543822	0.5545097	0.2145568	-0.03944884	-0.4530634
5	-1.78634960	2.011172293	0.4279894	0.4437706	-0.13561660	-2.8799848
6	-0.08291713	-3.090411498	1.8893935	0.2243779	0.89450376	0.9259957
7	-0.33393220	1.079085987	-3.2020075	0.5791505	0.04718490	0.5694067
8	0.49253951	-0.016033976	1.4941230	-1.4377953	1.06367653	0.6874866
9	-1.63245663	0.004155934	0.5709592	0.5621467	0.20431146	-0.2233089

age	1997	1998	1999	2000	2001	2002
1	0.55098142	0.56475369	0.4308374	0.48585808	0.37864182	0.3217654
2	-0.04000537	-0.18451249	-0.6370719	-0.13729122	0.95295845	-0.1936536
3	-1.36496873	-0.13615854	1.3896713	-0.02939282	-1.02527314	0.5685102
4	-2.40209020	-0.19490959	-1.2609518	1.28249000	-0.34369481	-1.4332010
5	-0.59175404	-1.40066738	1.0203610	0.66161178	0.96098149	-0.1852729
6	0.09698535	0.02329595	-0.3312759	0.85808494	-0.70882853	1.3166431
7	-0.21214886	-0.67908231	1.2336112	1.12724977	0.81095924	0.1991398
8	2.20405691	1.20876972	-0.4033402	0.44272027	-0.06992316	-0.4052562
9	-1.73647754	1.23649729	1.1193953	0.23750955	0.30369477	0.5494637

age	2003	2004	2005	2006	2007	2008
1	0.55547744	0.7434190	-0.6917824	0.08839452	0.0000000	-0.51315260
2	0.80401189	-0.1871501	-0.7425716	1.67617282	-1.7916256	0.28890551
3	0.16637549	0.1022588	-1.3977810	-0.74798600	-0.3944309	1.26095086
4	0.74052027	-0.9908571	0.9796532	-0.96372418	0.1243905	0.08979021
5	-0.29781483	0.5065524	0.3790768	1.15121060	-0.4862652	0.41305381
6	-0.02355934	-1.2234318	-1.2773217	0.72243740	1.2513018	0.17996321
7	0.78649673	0.7688306	-1.2742327	-0.50681712	0.5835885	1.04576220
8	-0.09125582	-0.4114687	2.0836023	-0.80288318	0.5504169	0.21003841
9	0.23028413	1.1788691	-1.7182554	0.31667494	-1.3747168	0.84470113

age	2009	2010	2011	2012	2013	2014
1	1.05631700	-0.475833712	-0.65627301	0.52525120	0.0000000	1.9736078608
2	-0.17375634	0.151362835	-0.58906541	0.40146833	0.4711578	1.1903091503
3	0.08165747	0.050899950	2.01115333	0.28316366	1.2850485	-0.5394502300
4	0.50535977	-0.004959979	-0.59910502	1.30433095	-1.2895081	2.1922429006
5	0.93905995	-0.959571267	-0.33103047	-0.25818788	-0.2051069	-0.9395957878
6	0.63977175	0.174746675	0.42795502	-0.32456094	-1.6767752	-0.0002221021
7	0.04368103	0.825204937	0.40255861	-0.05254043	0.9527257	-2.1447839837
8	1.79278739	0.446252562	-0.08613774	-0.43249398	-1.6837454	-0.8626557903
9	1.27882002	1.139953251	0.78712428	0.22359647	-0.3613021	-1.8184675779

age	2015	2016	2017	2018
1	0.00000000	0.000000000	0.000000000	2.1456671
2	1.57059852	-2.059763451	-1.054005661	1.5938764
3	2.23625874	0.242098887	0.887235963	-0.7396830
4	1.37696716	0.640542277	-0.082347933	0.4583092
5	0.16644276	0.210314666	0.990675631	0.2158091

```
  6  0.55059409  0.000790029  0.009104051 -1.2730669
  7 -0.82462491 -0.396057770 -1.500914762  1.2390189
  8  0.02384646 -1.550467808 -2.245276343 -1.6852266
  9 -4.64968914 -1.977259611  0.989580125 -0.4590744
```

Table 4.6.24. Herring in 6.a (combined) and 7.b–c. PREDICTED INDEX-AT-AGE IBTS_Q4.

```
Units  :  NA
   year
age      1996      1997       1998      1999      2000      2001      2002
  2 15487.631 15899.902 18111.6011  8828.494  7893.205 26125.954 16681.262
  3 14881.962 11592.105 11518.0052 16574.695  6742.491  5732.739 21955.661
  4  7631.287 10240.551  9075.6495  9518.562 15625.120  5780.517  4464.939
  5  7181.488  6151.724  7332.3386  7604.938  8143.159 14435.021  5097.363
  6  3829.911  4420.756  3716.5724  4559.297  5580.653  6188.988 10619.786
  7  3849.195  1647.073  1766.0086  2000.966  2721.687  3450.157  3558.715
  8  4056.261  2409.486   844.9836  1105.839  1483.545  2136.551  2454.020
  9  6428.958  3199.072  1982.3445  1371.513  1294.946  1431.805  1746.836
   year
age      2003      2004      2005      2006      2007     2008     2009
  2 18989.282 10504.835  9054.015  9355.338  8282.975 5291.800 6421.465
  3 13605.871 16230.960  8905.144  6611.989  7379.128 6403.912 4252.184
  4 19882.366 13378.157 17125.646  7481.488  5338.719 6462.596 5355.179
  5  3918.475 16744.272 15488.074 17128.274  6952.407 4944.018 5844.887
  6  4017.791  2748.615 13097.703 13404.119 12182.786 5434.855 3803.342
  7  5713.350  2930.600  1656.003  7716.227  7828.101 7986.251 3260.022
  8  2815.983  3734.349  3048.728  1294.326  5124.601 6118.032 5764.565
  9  2119.519  2492.092  3276.835  3117.142  1939.081 3988.829 4841.561
   year
age     2010      2011      2012      2013      2014       2015      2016
  2 6803.109 11694.254  4951.958 5186.6596 2533.0975 3342.75262 6182.2718
  3 5036.538  5445.667 10469.479 4316.8789 4105.9969 2036.38646 2993.5562
  4 3517.855  4385.040  4878.054 9299.0246 4176.0362 3495.12904 2242.6197
  5 4481.927  3060.089  3699.770 3678.6410 7199.1543 3219.60690 3326.5500
  6 3642.145  3213.763  2298.633 2032.6000 1947.9748 3026.38153 2737.9463
  7 2159.410  1875.064  1816.551 1187.9806  774.4735  559.53245 1575.6688
  8 2205.853  1464.144  1066.195  756.2541  419.4431  215.87681  371.5210
  9 4847.388  3385.038  2172.430  918.8280  321.4555   92.01766  126.0289
   year
age      2017      2018
  2 2181.7855 2432.6967
  3 6568.3234 2092.2332
  4 3350.3704 7149.1274
  5 2585.6536 3862.4800
  6 2701.5618 2238.4209
  7 1882.2365 1840.7562
  8 1066.2465 1593.0923
  9  293.9639  694.7364
```

Table 4.6.25. Herring in 6.a (combined) and 7.b–c. INDEX-AT-AGE RESIDUALS IBTS_Q4.

Units : NA

age \ year	1996	1997	1998	1999	2000	2001
2	0.46862791	-0.03232711	-0.3235851135	-0.8224970	-0.6713630	1.4755578
3	-0.56838984	-0.38401522	0.0605013374	1.2038542	0.0393891	-1.6127204
4	-0.70528091	-0.80394739	-0.0008564055	1.1466022	0.6995904	0.7559927
5	-0.50881535	0.10055782	1.6649824386	0.4633583	-0.8819154	-0.8300496
6	-0.48318493	-0.04963468	0.7071205602	1.3036304	1.2376992	1.0972528
7	-0.09015188	-0.57987088	-0.5464856898	0.6095354	0.3640479	0.2933856
8	1.35944111	1.48818828	0.6269522282	-0.5369220	0.7002697	-0.2019155
9	-0.24456337	-0.42356845	1.8307332318	1.7305320	-0.1816295	-0.4007196

age \ year	2002	2003	2004	2005	2006	2007
2	-0.20662553	-0.1237115	1.37603180	-1.46496784	-0.4405871	-0.5256339
3	-1.57478645	-0.1635478	-1.32140321	0.06223746	-2.2308260	-0.8413243
4	-2.23015322	0.1807755	-0.31315645	0.65504778	1.3961733	-0.3804967
5	0.62096755	-1.1526467	-2.53894534	1.09080143	-0.6606085	1.1653362
6	-0.72215370	0.9032819	0.48436660	-0.77575253	0.7559328	-1.9763669
7	1.28291947	-1.1773233	0.83153390	0.15150157	-0.2713922	1.1416289
8	0.05397029	0.3972349	-2.33852887	0.40784387	0.6632950	-1.8201409
9	-1.17644615	0.6939203	-0.09179512	-0.02254330	-0.7687594	-0.5025864

age \ year	2008	2009	2010	2011	2012	2013	2014
2	-1.5088248	0.2990901	0	-0.29524291	-2.09504704	0	0.7613667
3	0.6323104	-1.0381890	0	-0.61940058	1.26326610	0	0.7147430
4	-0.0410025	-1.8385720	0	-0.01808687	0.63201868	0	-1.6227066
5	-1.1786990	0.1585631	0	-0.78776681	0.71058532	0	-0.7401405
6	0.2017415	-1.2975423	0	-0.70566441	0.27232547	0	-0.4110866
7	0.5546091	0.4795667	0	-1.70539940	-0.01807494	0	-0.6815008
8	-0.4109151	-1.1673002	0	-0.80000929	-1.69478566	0	0.2720043
9	1.0325733	0.8194454	0	0.86557823	2.20276017	0	-2.8801446

age \ year	2015	2016	2017	2018
2	1.7861924	2.6182642	2.4514104	1.0034151
3	0.6459794	-0.1600548	0.7069717	0.6067063
4	-0.4508718	2.1615905	0.5173736	-0.7892003
5	1.2418292	-0.7949132	2.0227884	-0.4346098
6	-1.5522245	0.9915353	-0.9603940	0.2467588
7	-0.6724769	-0.4040112	0.5179574	-0.3912039
8	2.3719561	0.8766801	-0.4942643	-0.2781320
9	1.7694622	1.1168667	-0.3364251	-2.7394018

Table 4.6.29. Herring in 6.a (combined) and 7.b–c. FIT PARAMETERS.

	name	value	std.dev
1	logFpar	-1.18325907	0.35572229
2	logFpar	0.03389203	0.14693520
3	logFpar	0.73118787	0.12037409
4	logFpar	1.08137510	0.11956687
5	logFpar	1.22437637	0.12007105
6	logFpar	1.40872258	0.12272301
7	logFpar	1.61146102	0.15320678
8	logFpar	1.77510729	0.16291600
9	logFpar	-2.23750959	0.21286677
10	logFpar	-1.05441706	0.14128409
11	logFpar	-0.81681172	0.14008604
12	logFpar	-0.67077915	0.13976691
13	logFpar	-0.25402893	0.15265421
14	logFpar	-0.08628277	0.15596950
15	logFpar	0.31565603	0.17390541
16	logFpar	-3.46554510	0.12910011
17	logFpar	-3.11549603	0.17697416
18	logFpar	-2.63717032	0.17643915
19	logFpar	-2.10973380	0.17728299
20	logFpar	-1.76234707	0.17987915
21	logFpar	-1.61287915	0.18919391
22	logFpar	-1.20121774	0.20005080
23	logSdLogFsta	-0.80567349	0.22225021
24	logSdLogFsta	-1.20400092	0.17394231
25	logSdLogFsta	-1.30630888	0.14571970
26	logSdLogFsta	-0.79004804	0.18944099
27	logSdLogFsta	0.12892261	0.16613121
28	logSdLogFsta	0.24219326	0.09105500
29	logSdLogN	-0.55502696	0.13086170
30	logSdLogN	-2.05362040	0.12335368
31	logSdLogObs	0.09739185	0.10834383
32	logSdLogObs	-0.59032844	0.11403731
33	logSdLogObs	-0.90556297	0.06139394
34	logSdLogObs	-0.40569153	0.06827268
35	logSdLogObs	0.35904759	0.11621414
36	logSdLogObs	-0.93086747	0.14112957
37	logSdLogObs	-1.29670323	0.07427764
38	logSdLogObs	-0.84707122	0.09608205
39	logSdLogObs	0.51307896	0.15020026
40	logSdLogObs	-0.33423204	0.13854424
41	logSdLogObs	-0.55456444	0.11011930
42	logSdLogObs	-0.32057175	0.11523160
43	logSdLogObs	0.02322622	0.14139983
44	logSdLogObs	-0.42095775	0.12410951
45	logSdLogObs	-0.32899340	0.12186900
46	logSdLogObs	-0.25054065	0.12065350
47	logSdLogObs	-0.69139849	0.18153292
48	logSdLogObs	-0.27537314	0.14362712
49	logSdLogObs	-0.25286437	0.14030869
50	transfIRARdist	0.44709326	0.39935582
51	transfIRARdist	-1.52285373	0.25453568

```
52 transfIRARdist -1.48905680 0.25297835
53 transfIRARdist -1.79995564 0.57247491
54 transfIRARdist -3.03487692 0.52824149
55 transfIRARdist -2.07064797 0.46442481
56 transfIRARdist -1.18347971 0.33668081
57     itrans_rho  2.96513107 0.21662760
58     itrans_rho  1.74454624 0.20887268
```

Table 4.6.30. Herring in 6.a (combined) and 7.b–c. NEGATIVE LOG-LIKELIHOOD.

1538.0642221481

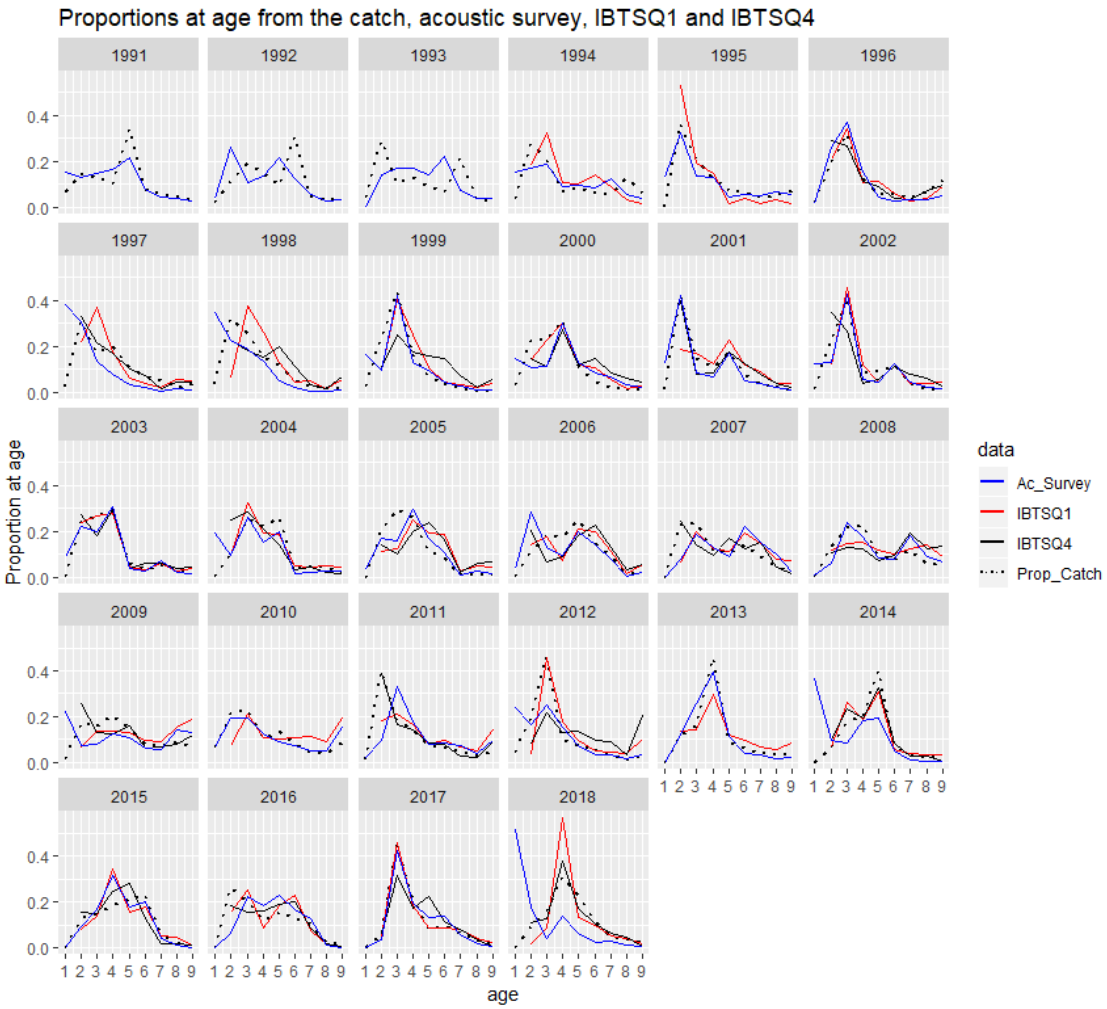

Figure 4.3.1.1. Herring in 6.a (combined) and 7.b–c. Comparison of the proportions-at-age, by age (-wr), of the catch, acoustic survey (WOS MSHAS), IBTS Q1 and IBTSQ4.

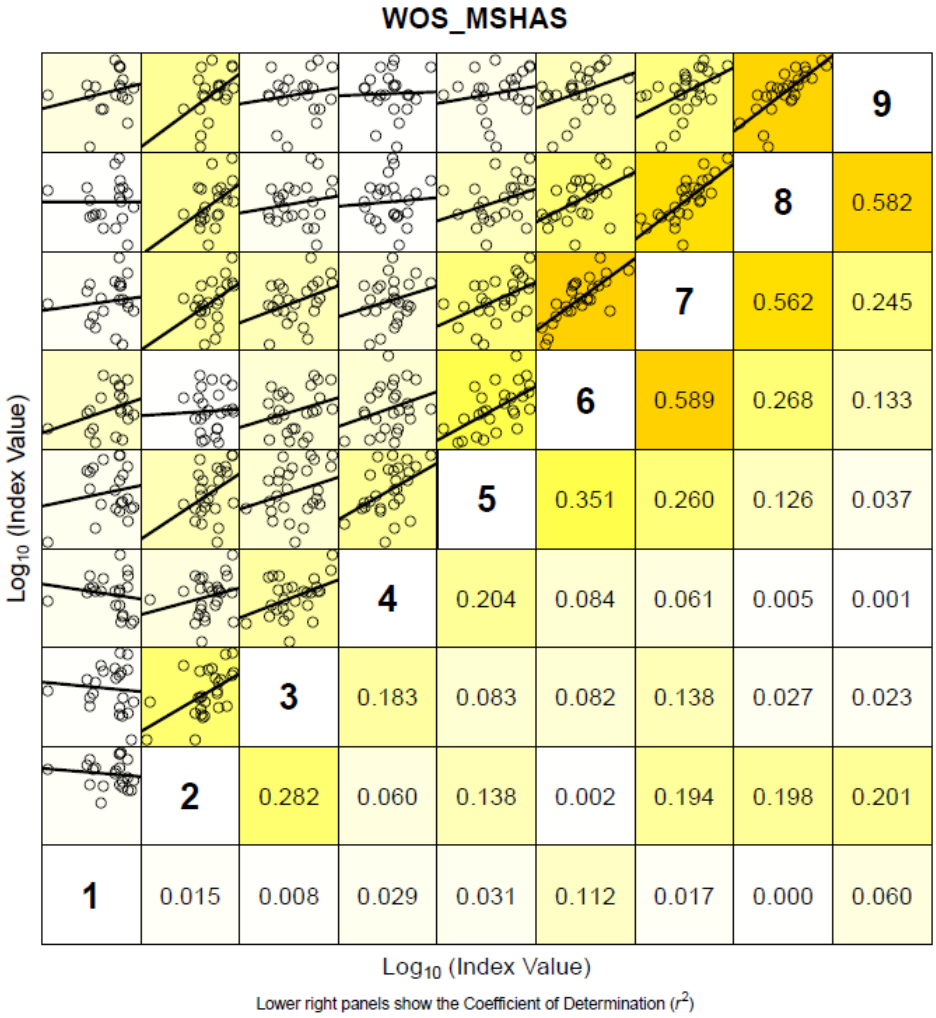

Figure 4.3.1.2. Herring in 6.a (combined) and 7.b–c. Internal consistency between ages (rings) in the WoS_MSHAS herring acoustic survey time-series (1991–2018).

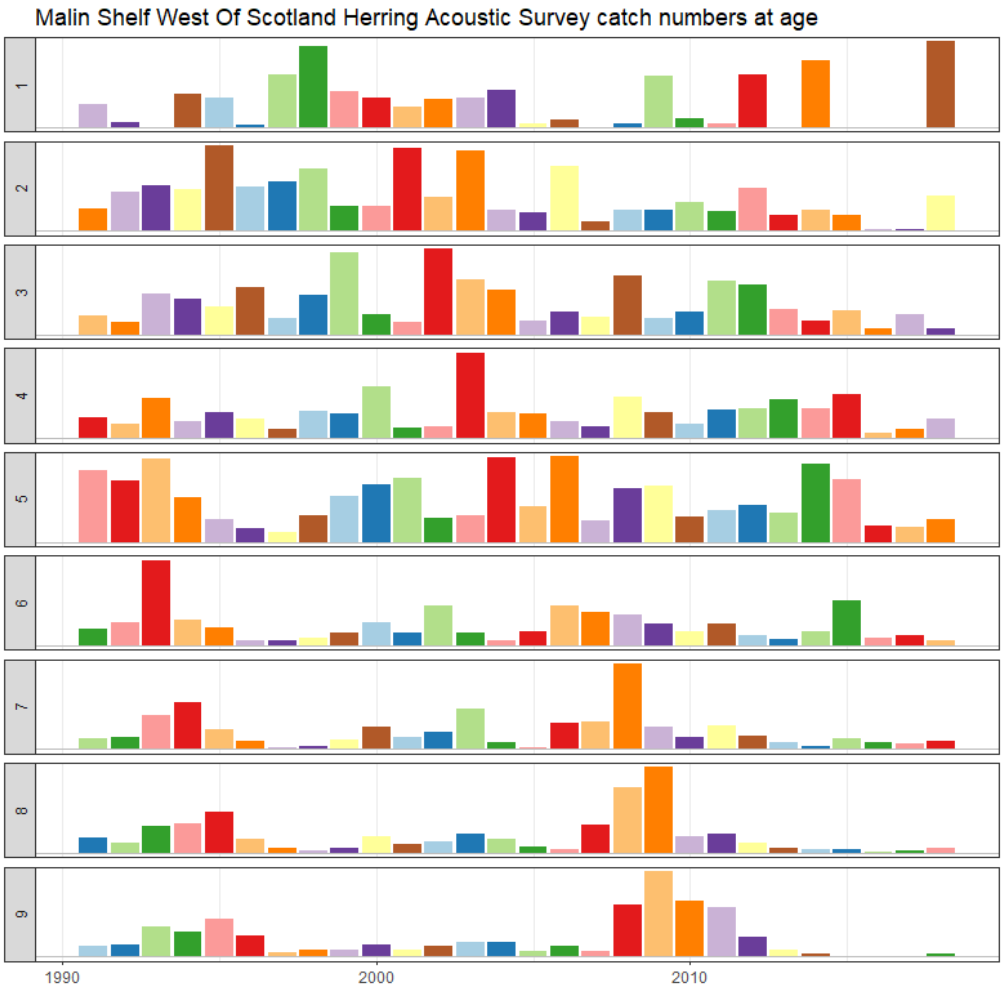

Figure 4.3.1.3 Herring in Divisions 6.a (combined) and 7.b–c. Catch numbers-at-age from Malin Shelf herring acoustic survey combined with West of Scotland acoustic survey (WoS_MSHAS) (6.a.N-S, 7.b and 7.c) time-series. Age (rings) from acoustic surveys 1991 to 2018.

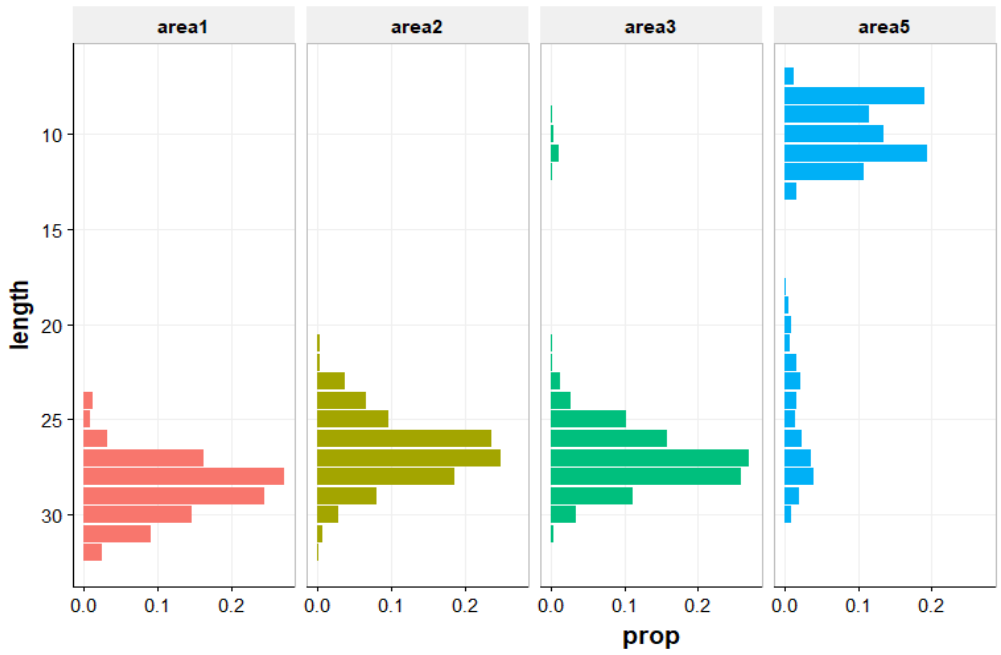

Figure 4.3.1.1.1 Length-frequency distributions recorded from industry survey samples.

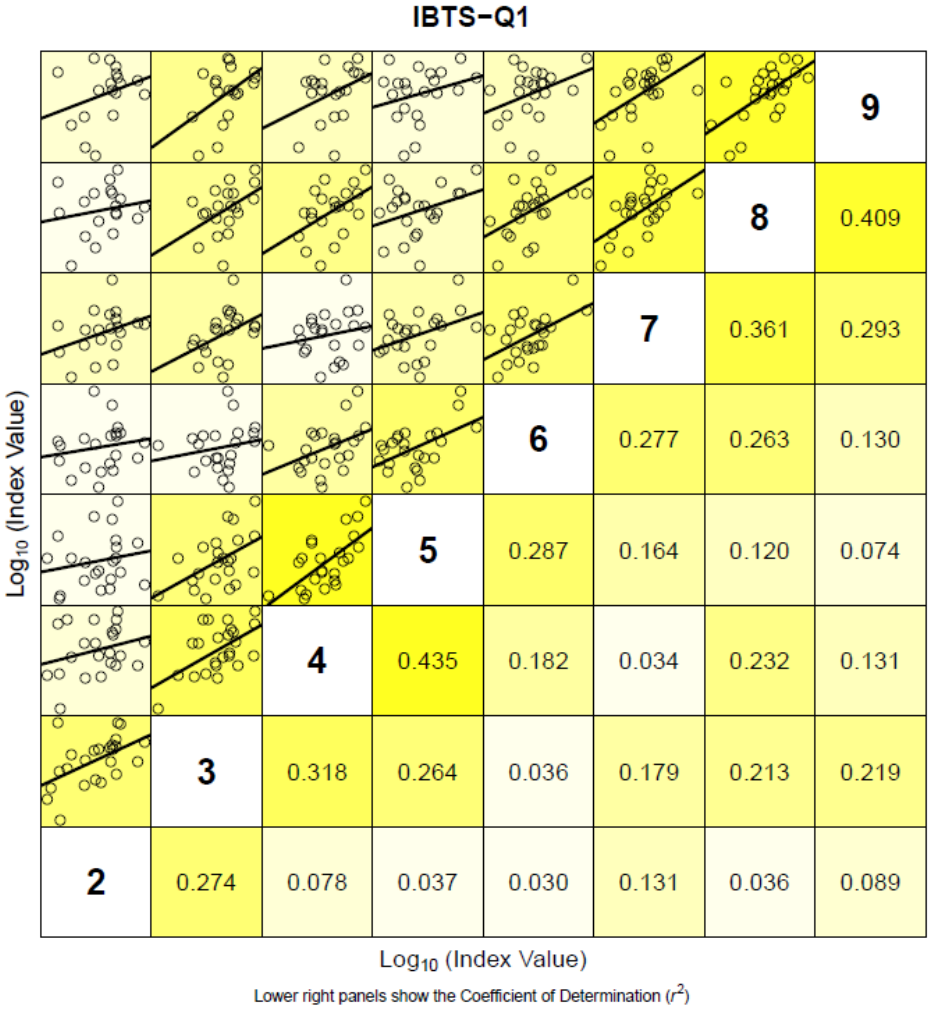

Figure 4.3.2.1. Herring in divisions 6.a (combined) and 7.b–c. Internal consistency plot of the quarter 1 Scottish bottom-trawl survey (1994–2018). Above the numbered diagonal the linear regression is shown including the observations (in points) while under the numbered diagonal the r^2 value that is associated with the linear regression is given.

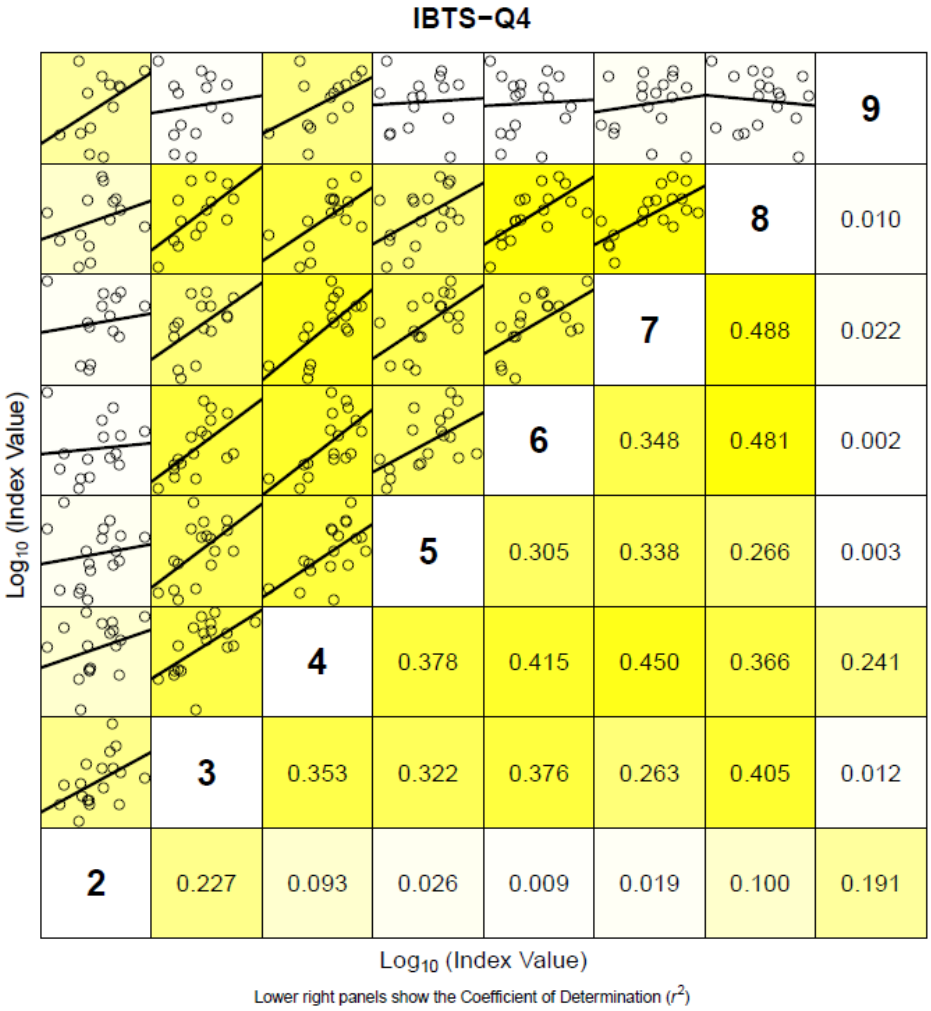

Figure 4.3.2.2. Herring in divisions 6.a (combined) and 7.b–c. Internal consistency plot of the quarter 4 Scottish bottom-trawl survey in (1996–2018). Above the numbered diagonal the linear regression is shown including the observations (in points) while under the numbered diagonal the r^2 value that is associated with the linear regression is given.

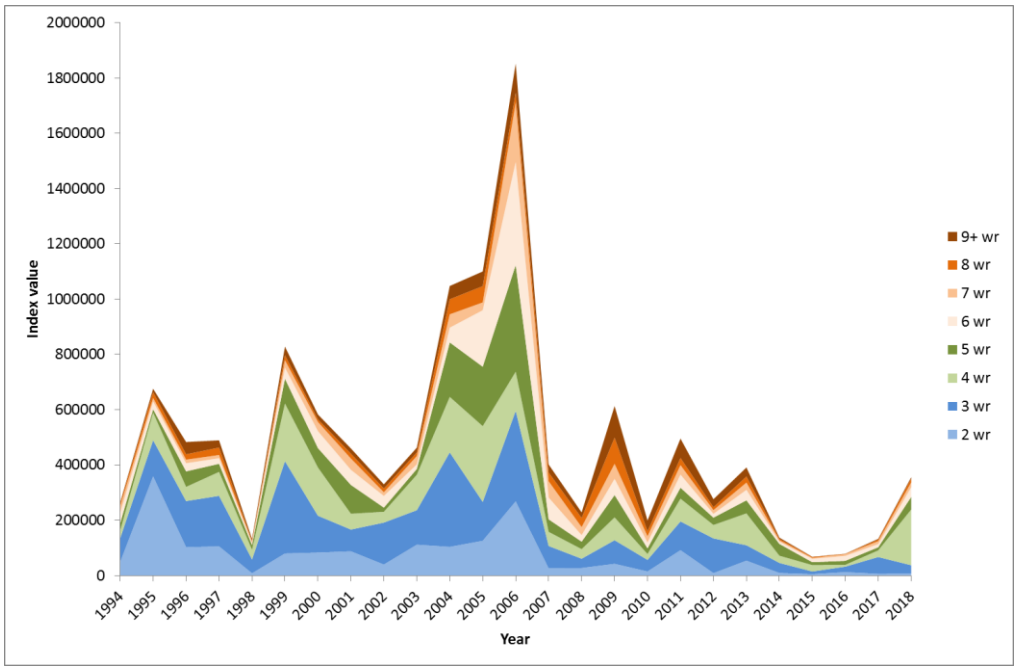

Figure 4.3.2.3. Herring in 6.a (combined) and 7.b-c. Trends in stock composition from abundance-at-age index from Scottish ground fish survey in Quarter 1.

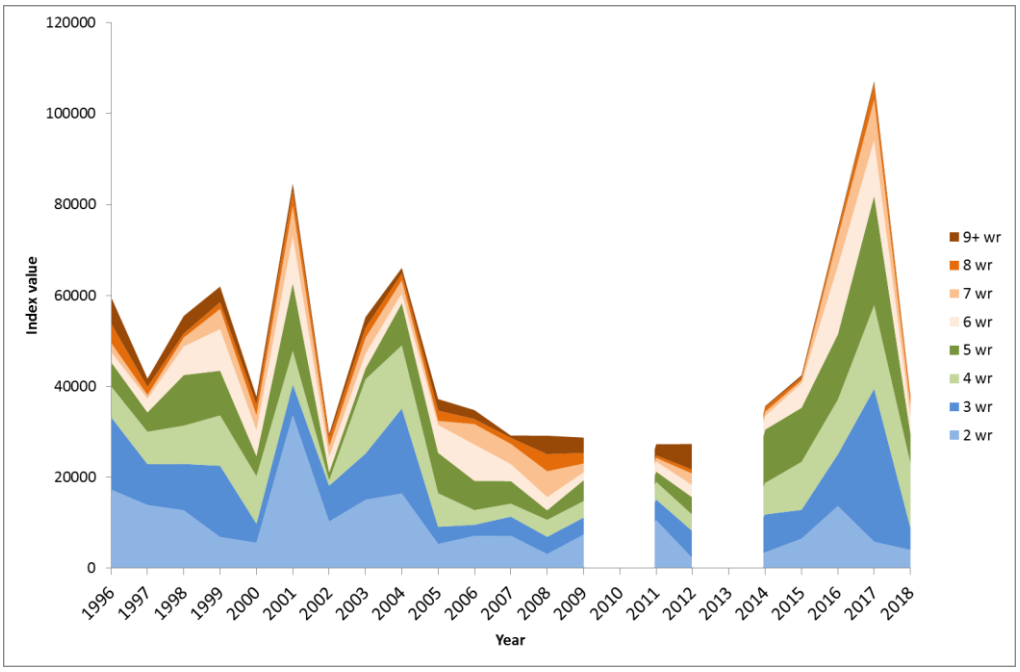

Figure 4.3.2.4. Herring in 6.a (combined) and 7.b-c. Trends in stock composition from abundance-at-age index from Scottish ground fish survey in Quarter 4. There was no survey in 2010 and in 2013 only half of the survey was completed and the data were not used for the index.

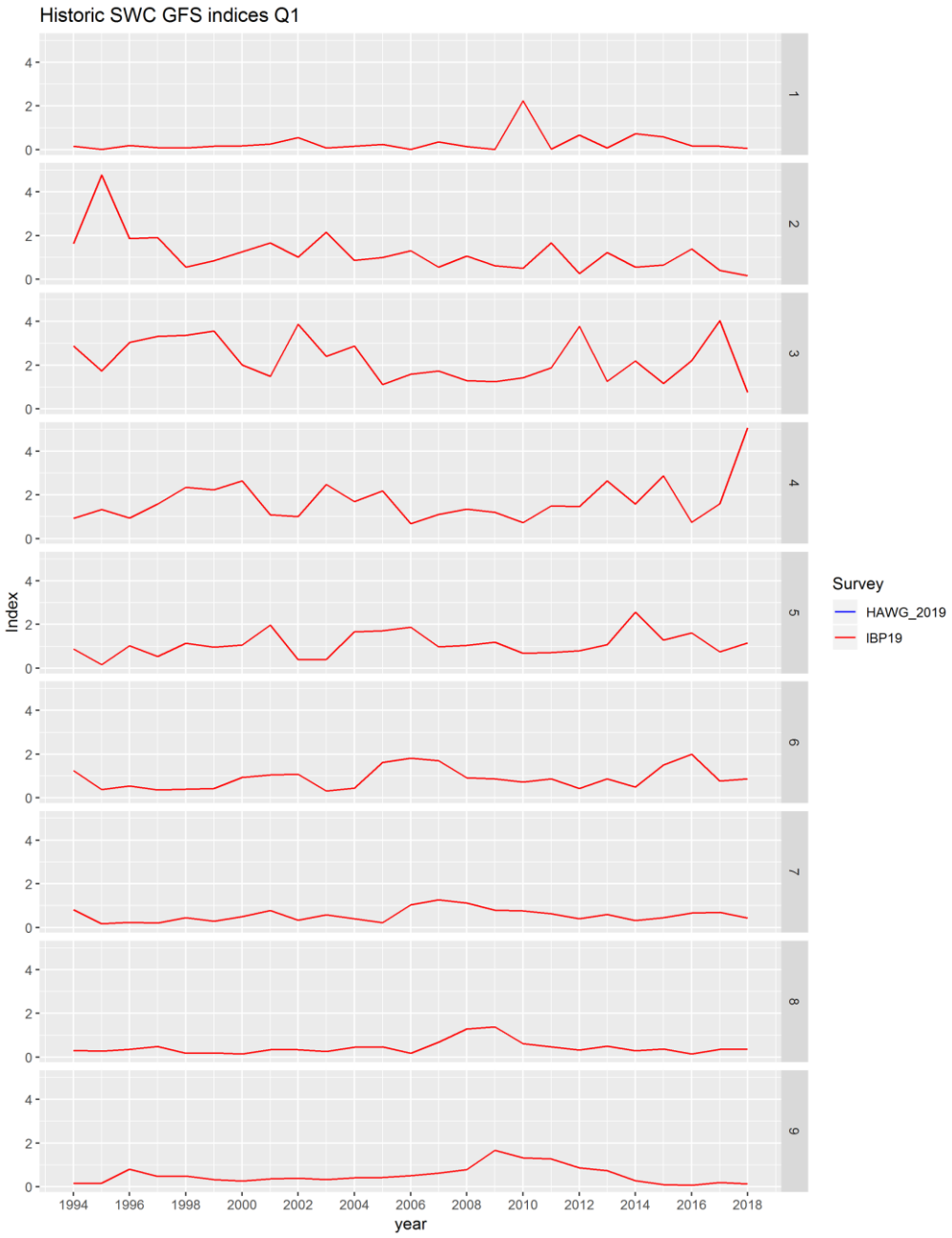

Figure 4.3.2.5 Herring in 6.a (combined) and 7.b–c. Abundance-at-age index from Scottish ground fish survey in Quarter 1 for age from the IBPher6a7bc in 2019 and from HAWG 2019. There were no additional data included between the IBPher6a7bc and HAWG 2019, the line therefor completely overlap. Each index was mean standardized by year.

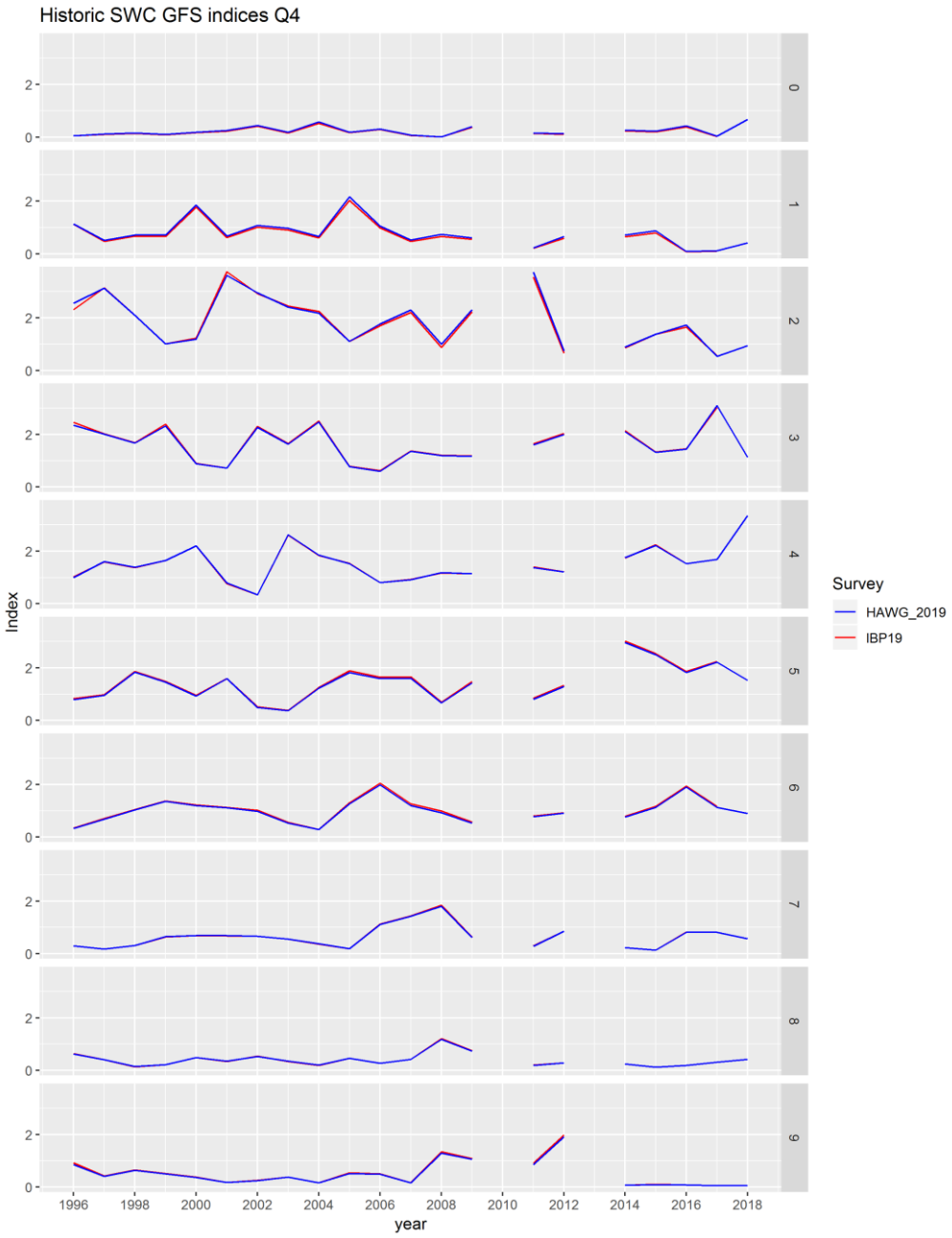

Figure 4.3.2.6 Herring in 6.a (combined) and 7.b–c. Abundance-at-age index from Scottish ground fish survey in Quarter 4 for age from the IBPher6a7bc in 2019 and from HAWG 2019. Each index was mean standardized by years.

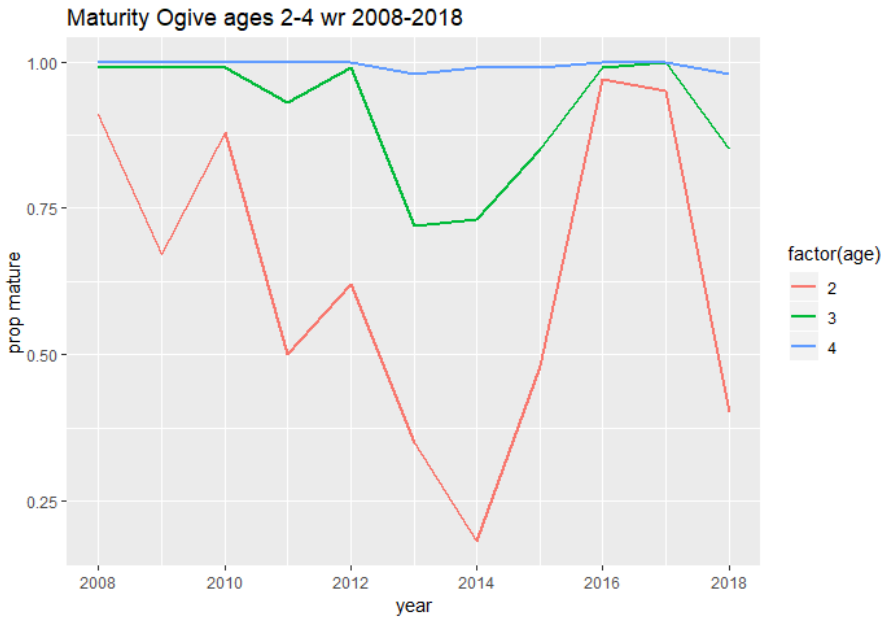

Figure 4.4.2.1. Herring in 6.a (combined) and 7.b–c. Maturity-at-ages 2–4 wr for the years 2008 to 2018.

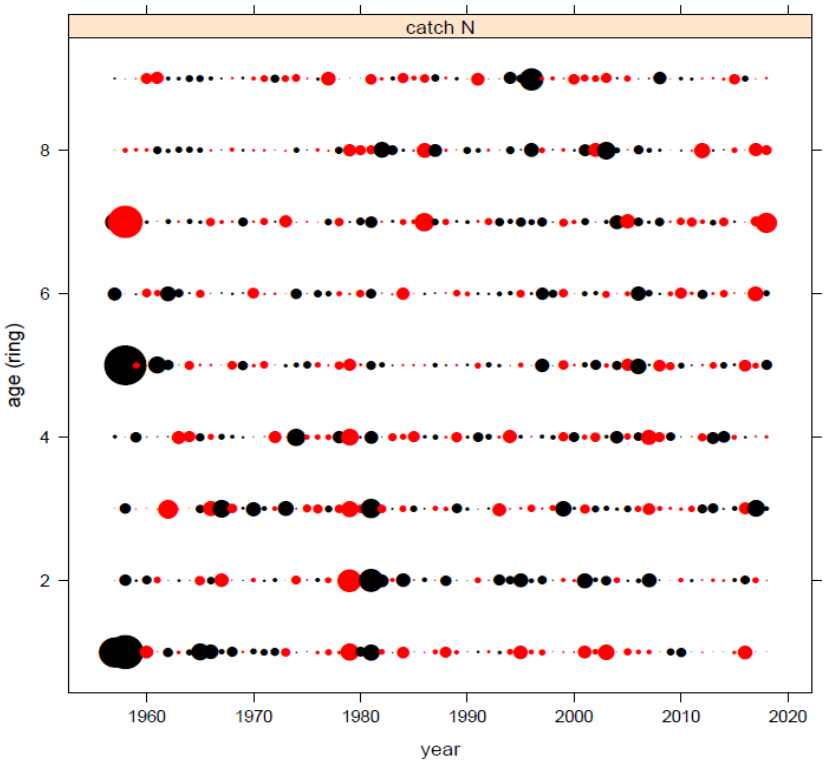

Figure 4.6.1. Herring in 6.a (combined) and 7.b–c. Bubble plot of catch N residuals (1957–2018).

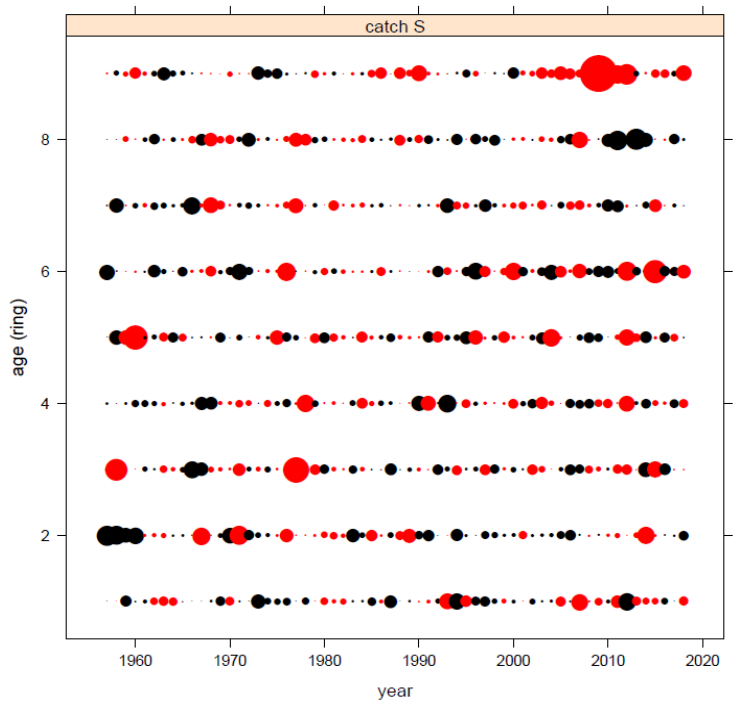

Figure 4.6.2. Herring in 6.a (combined) and 7.b–c. Bubble plot of catch S residuals (1957–2018).

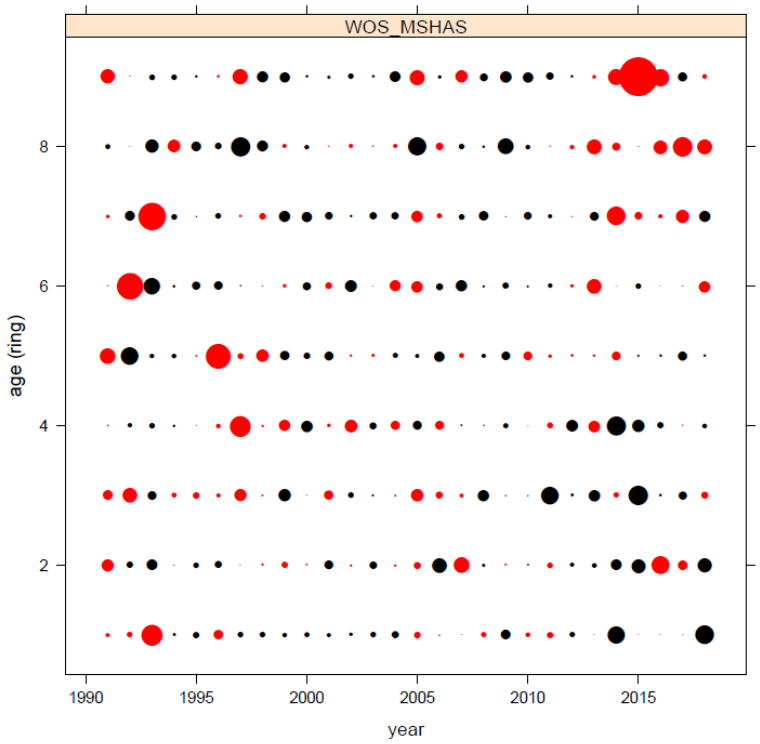

Figure 4.6.3. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardised survey residuals from the WoS_MSHAS acoustic survey (1991–2018).

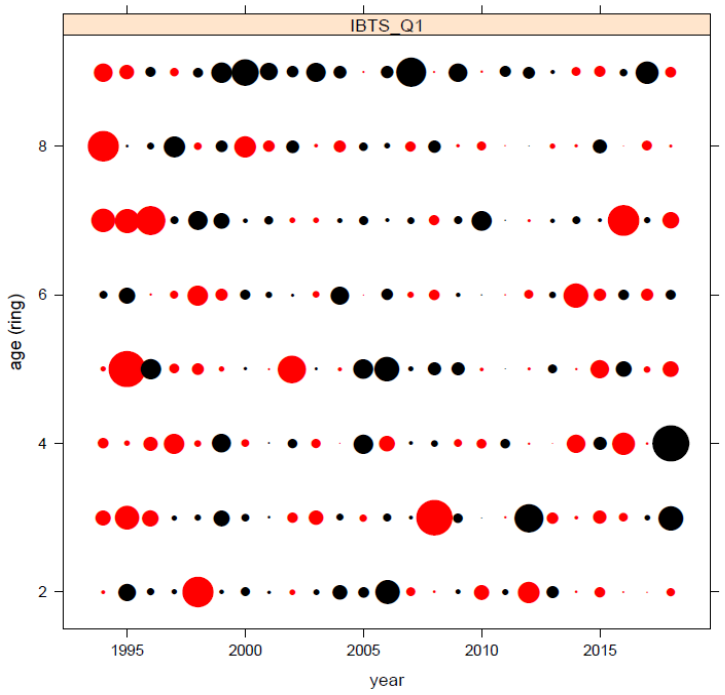

Figure 4.6.4. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardised survey residuals from the Scottish bottom-trawl survey in quarter 1 (1994–2018).

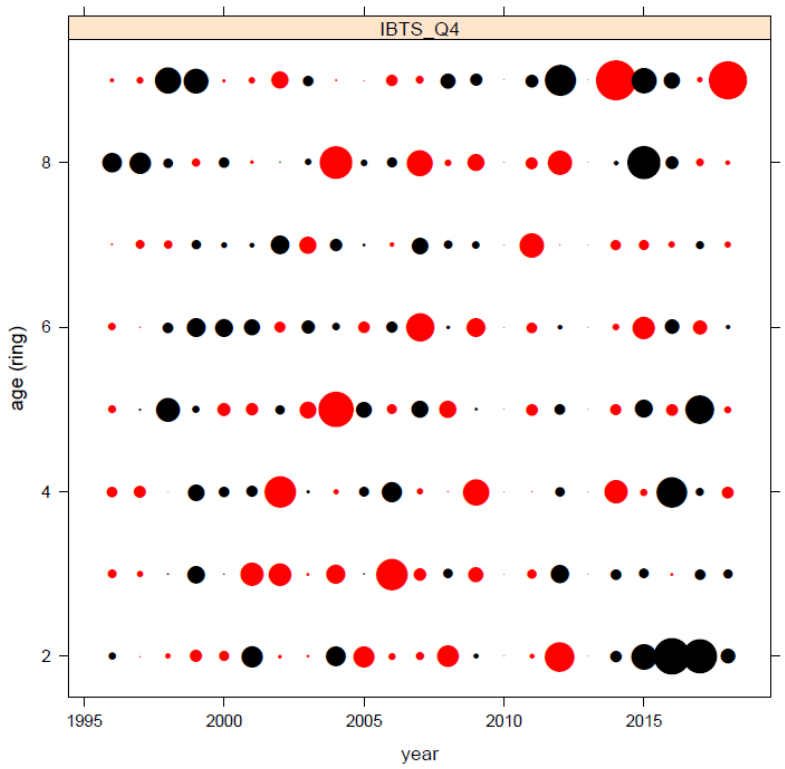

Figure 4.6.5. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardised survey residuals from the Scottish bottom-trawl survey in quarter 4 (1996–2018).

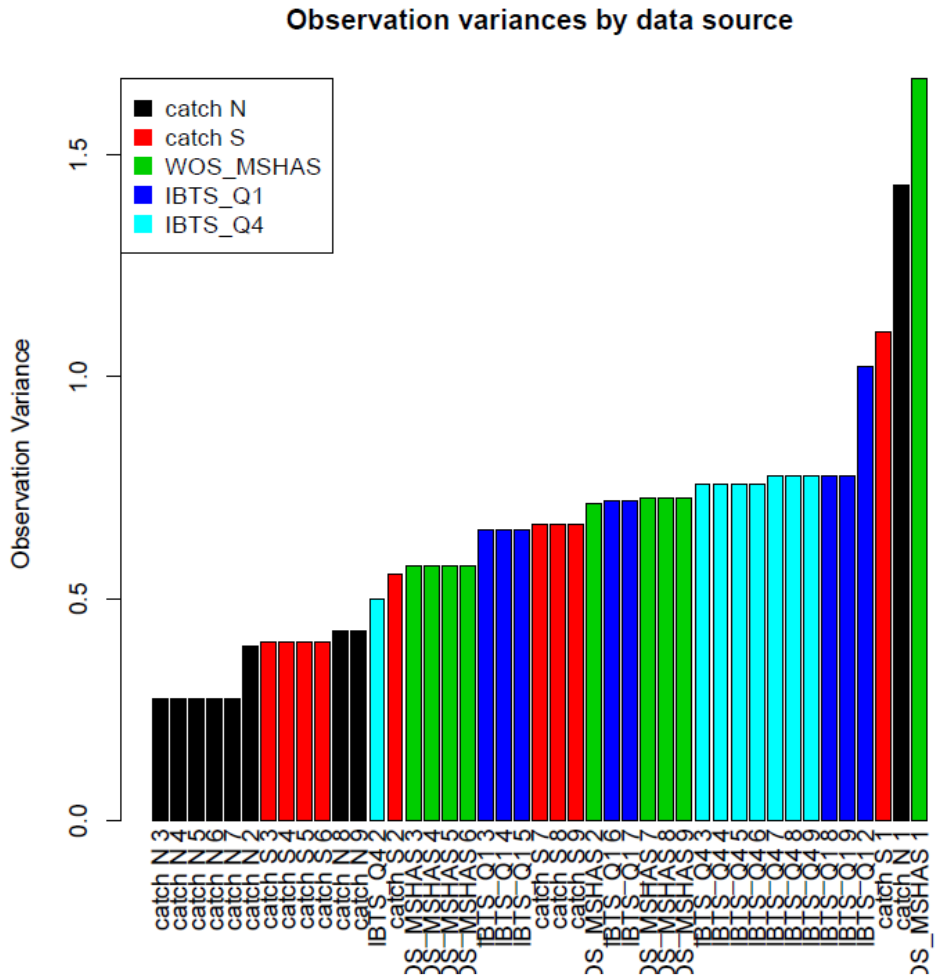

Figure 4.6.6. Herring in 6.a (combined) and 7.b–c. Observation variance by data source, ordered from least (left) to most (right). Colours indicate the different data sources. In cases where parameters are bound, observation variances have equal values.

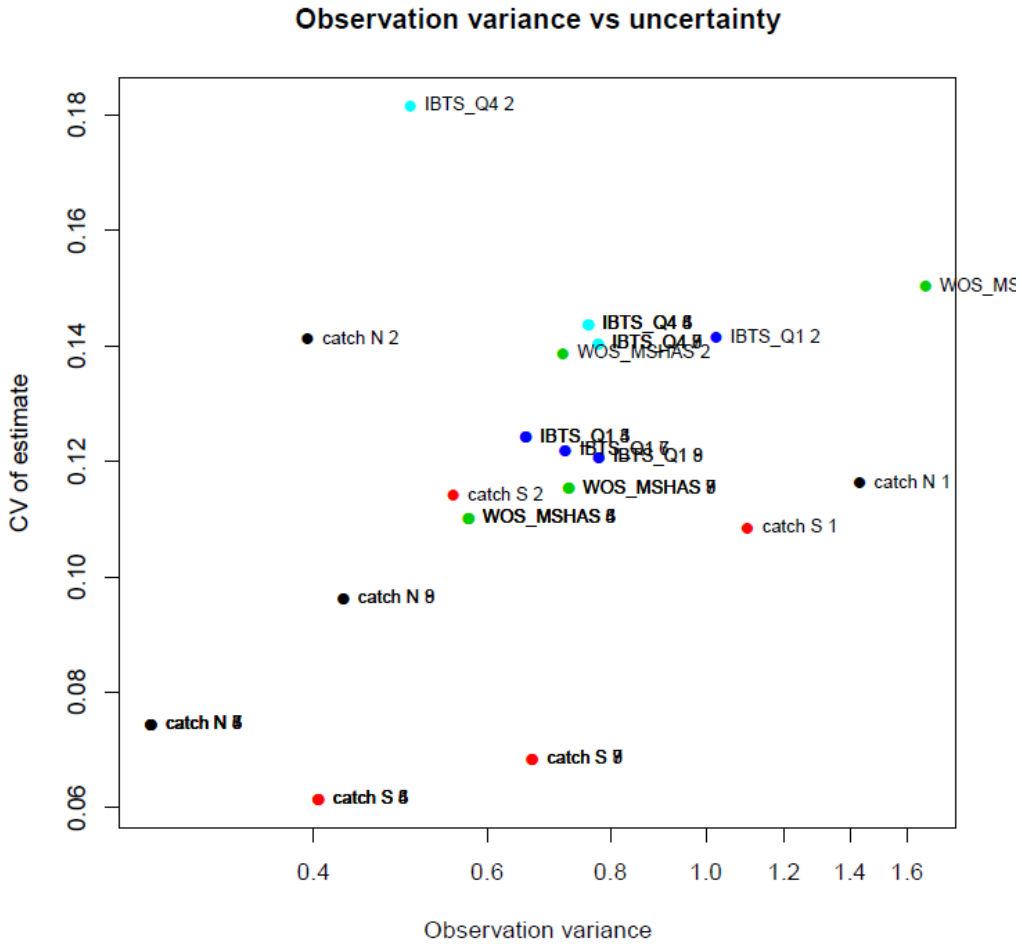

Figure 4.6.7. Herring in 6.a (combined) and 7.b–c. Observation variance by data source as estimated by the assessment model plotted against the CV estimate of the observation variance parameter.

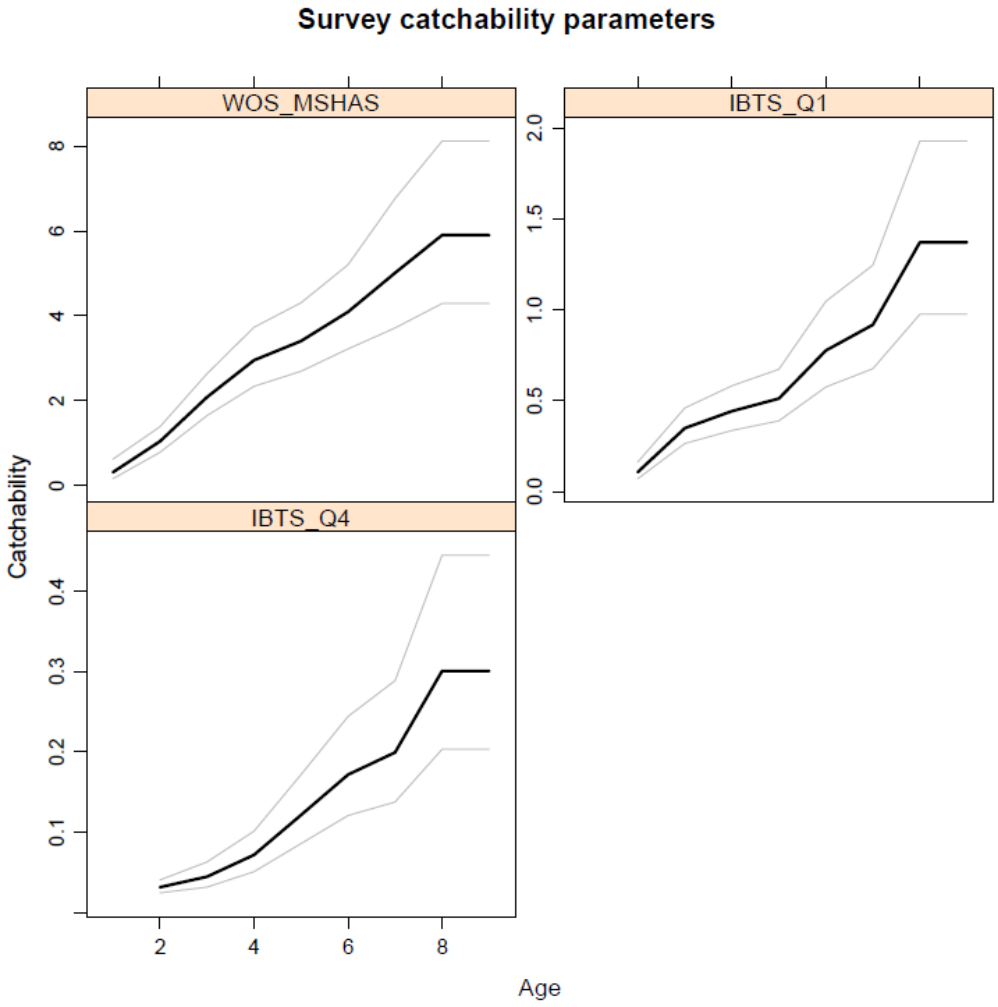

Figure 4.6.8. Herring in 6.a (combined) and 7.b–c. Survey catchability parameters from the WOS_MSHAS acoustic survey (topleft), Scottish groundfish survey index quarter 1 (IBTS_Q1, topright) and Scottish groundfish survey index quarter 4 (IBTS_Q4, bottomleft).

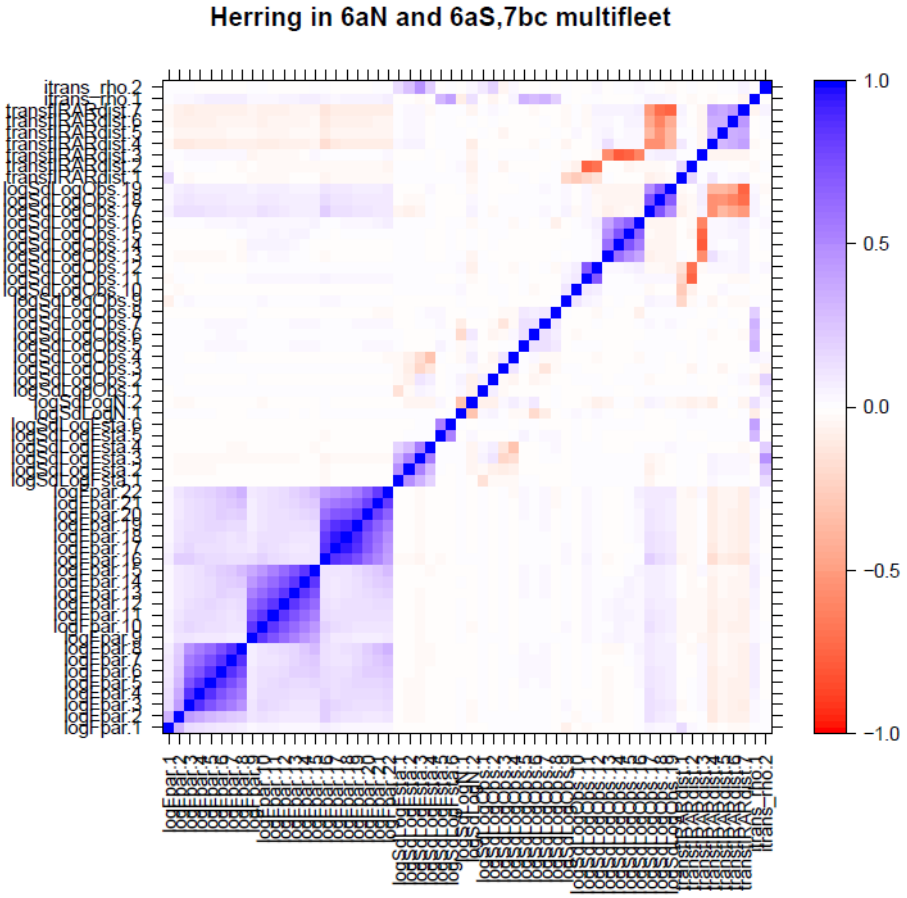

Figure 4.6.9. Herring in 6.a (combined) and 7.b–c. Correlation plot of the parameters estimated in the model. The horizontal and vertical axes show the parameters fitted by the model (labelled with names stored and fitted by FLSAM). The colouring of each pixel indicates the Pearson correlation between the two parameters. The diagonal represents the correlation with the data source itself.

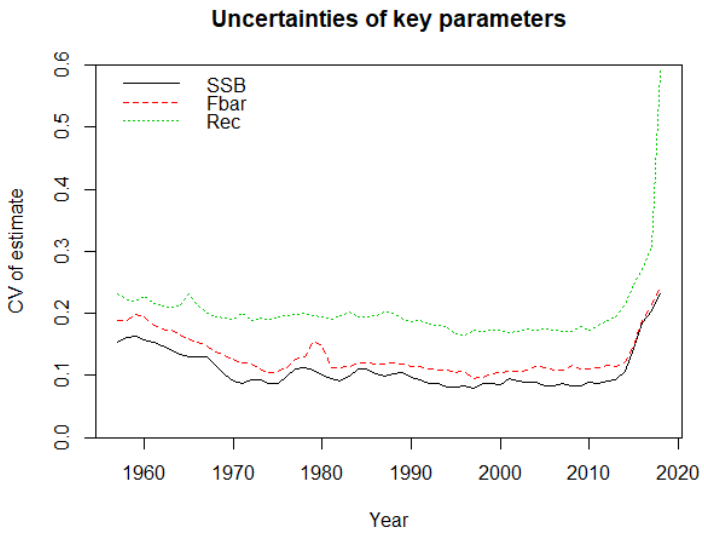

Figure 4.6.10. Herring in 6.a (combined) and 7.b–c. Uncertainty estimates in SSB, F_{bar} and recruitment parameters (1957–2018).

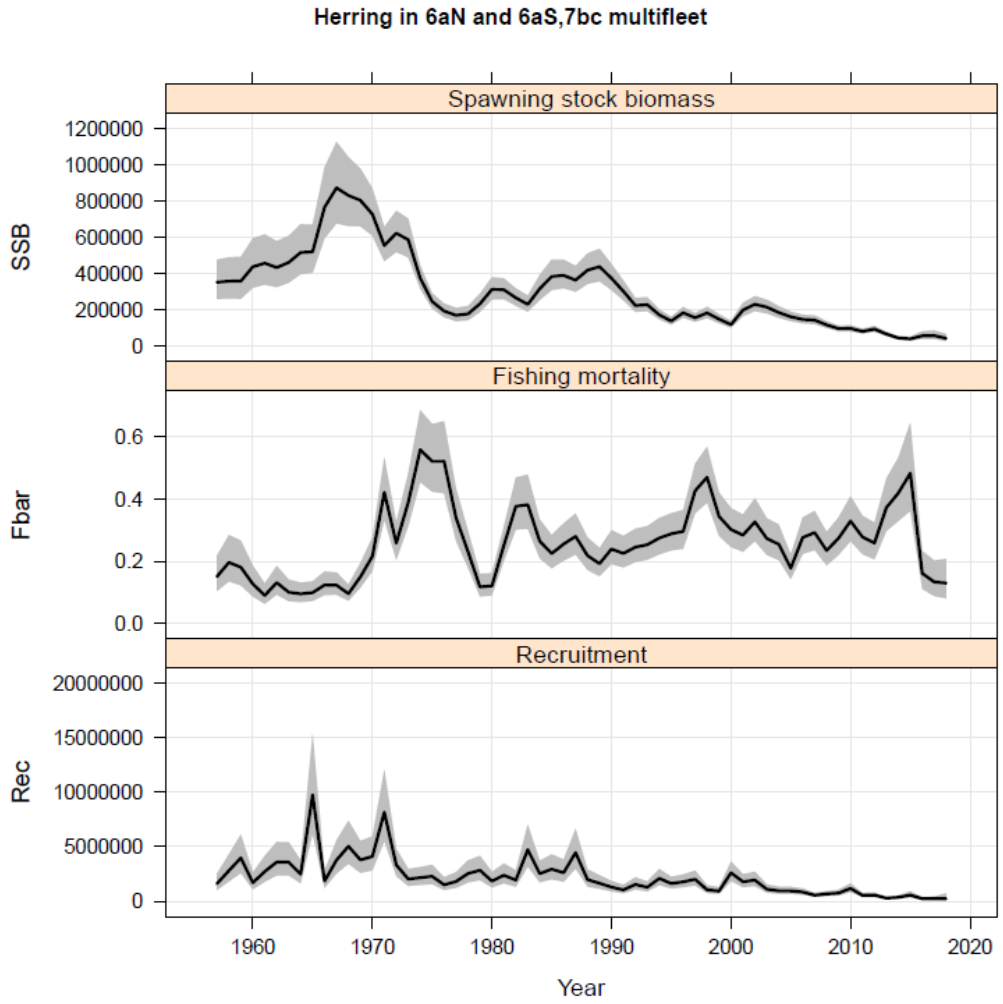

Figure 4.6.11. Herring in 6.a (combined) and 7.b–c. Stock summary plot with associated uncertainty for SSB (top panel), F ages 3–6 (middle panel) and recruitment (bottom panel).

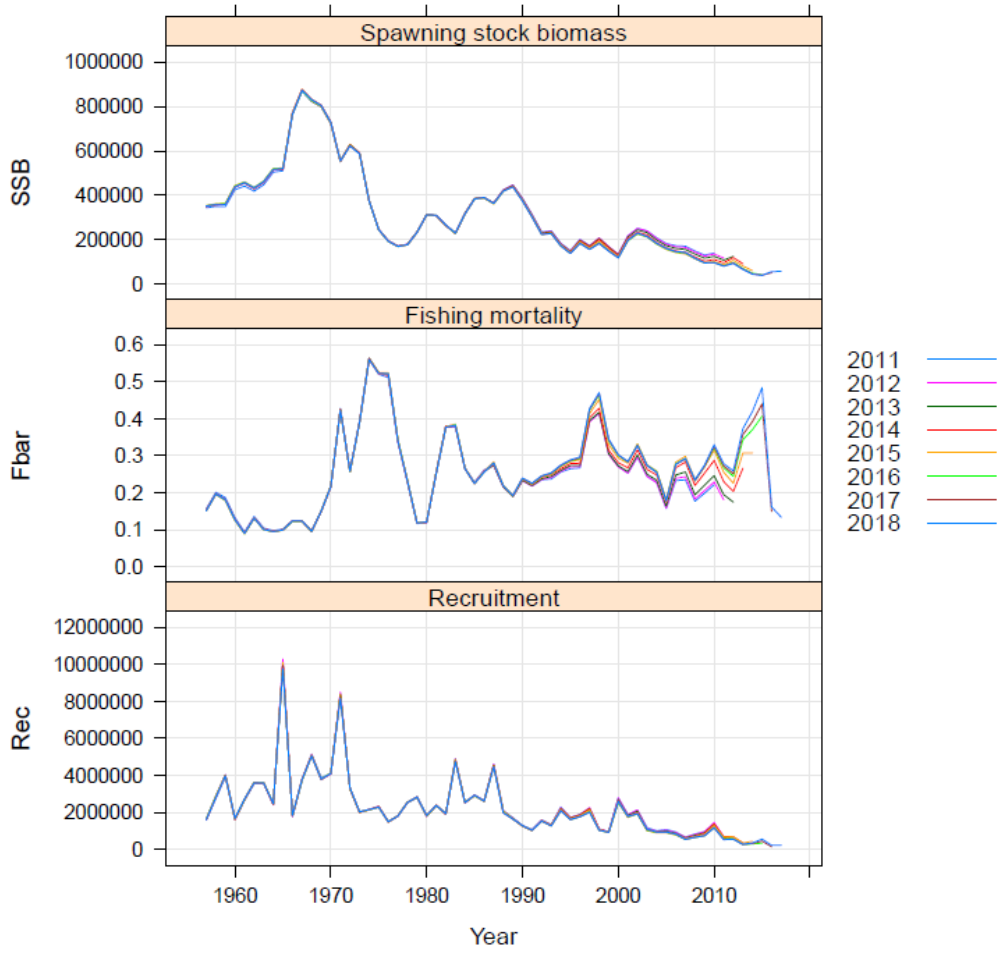

Figure 4.6.12. Herring in 6.a (combined) and 7.b–c. Analytical retrospective of the estimated spawning–stock biomass (top panel), fishing mortality (middle panel) and recruitment (bottom panel) as estimated over the years 2011–2018.

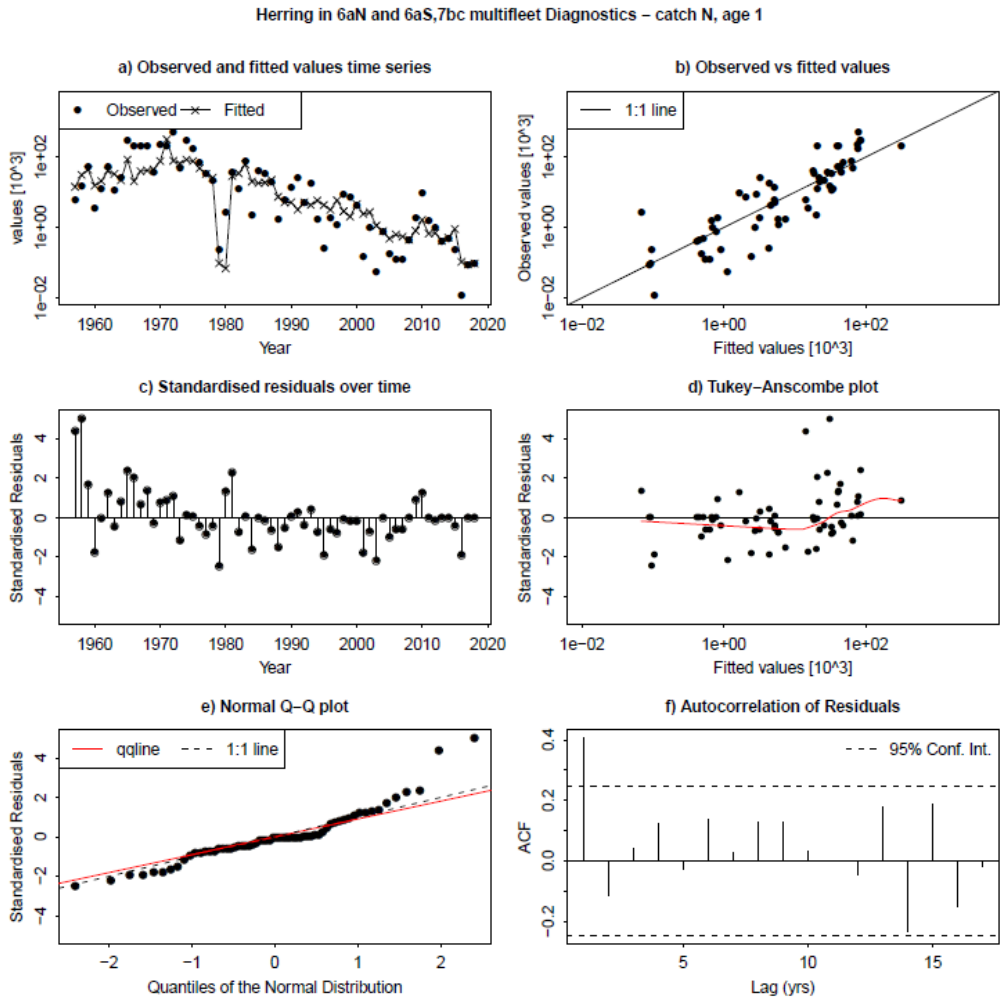

Figure 4.6.13. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from catch abundance at 1-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 1-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 1-winter ring. Middle right: catch observation versus standardized residuals at 1-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

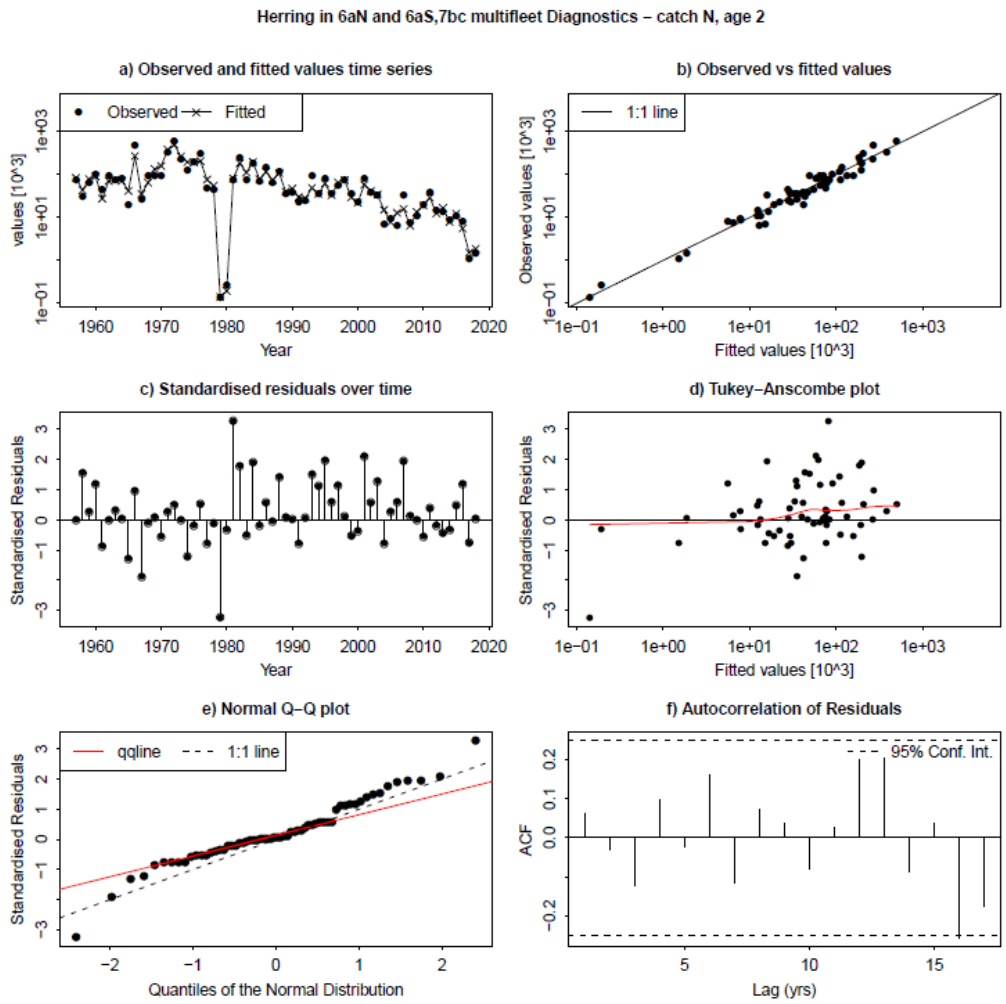

Figure 4.6.16. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from catch abundance at 2-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 2-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 2-winter ring. Middle right: catch observation versus standardized residuals at 2-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

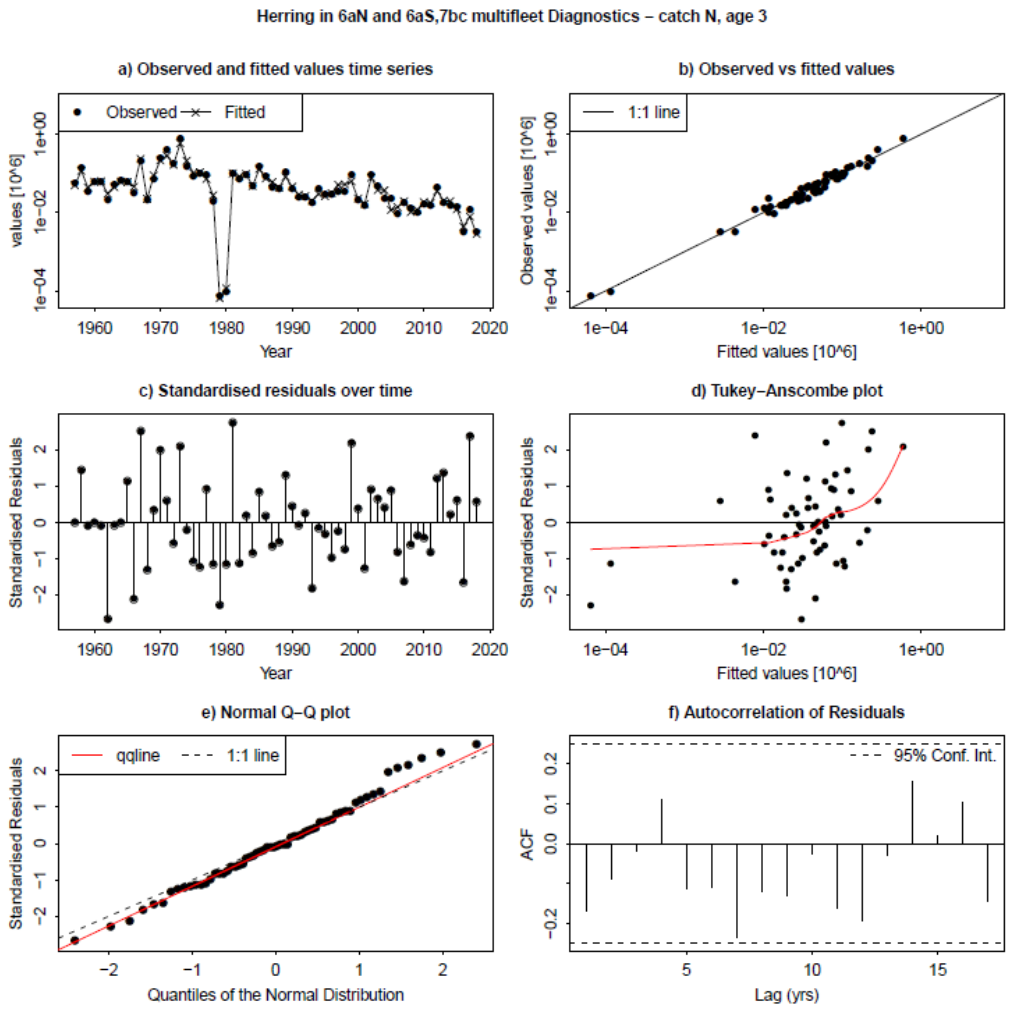

Figure 4.6.17. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from catch abundance at 3-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 3-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 3-winter ring. Middle right: catch observation versus standardized residuals at 3-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

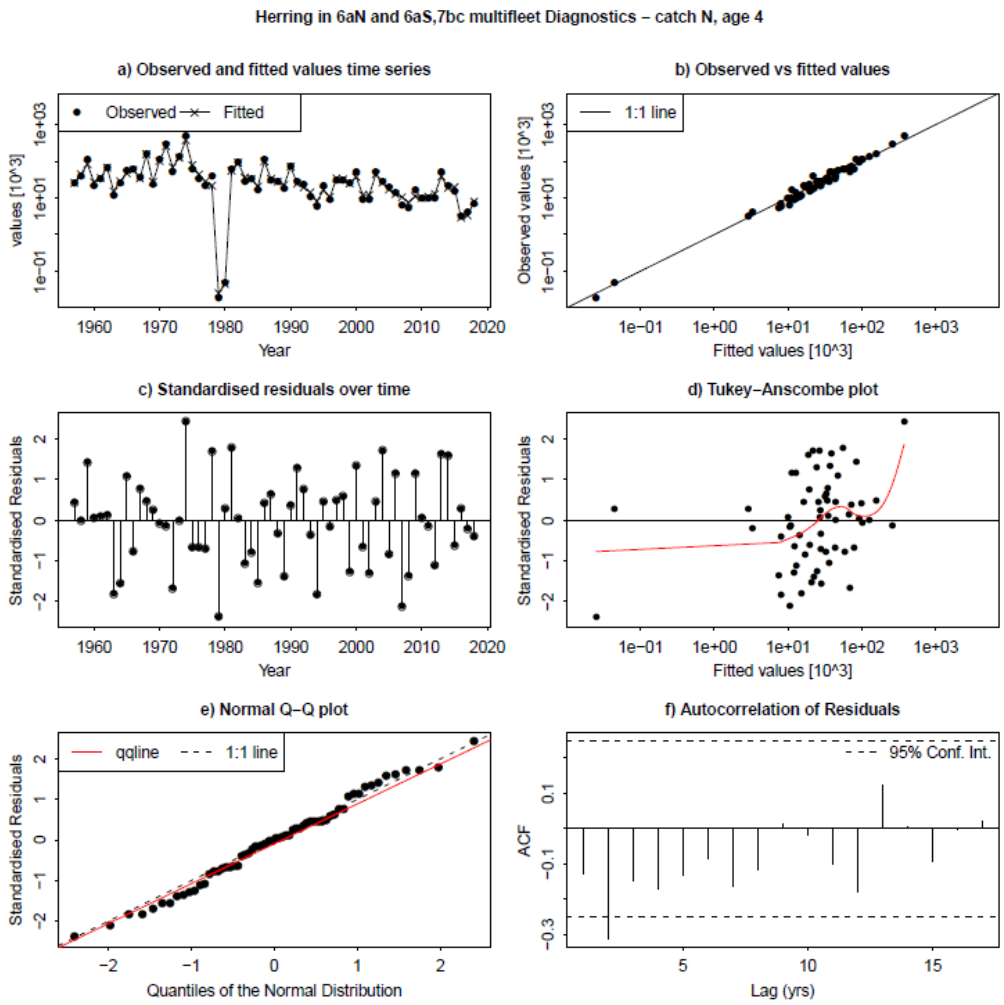

Figure 4.6.18. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from catch abundance at 4-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 4-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 4-winter ring. Middle right: catch observation versus standardized residuals at 4-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

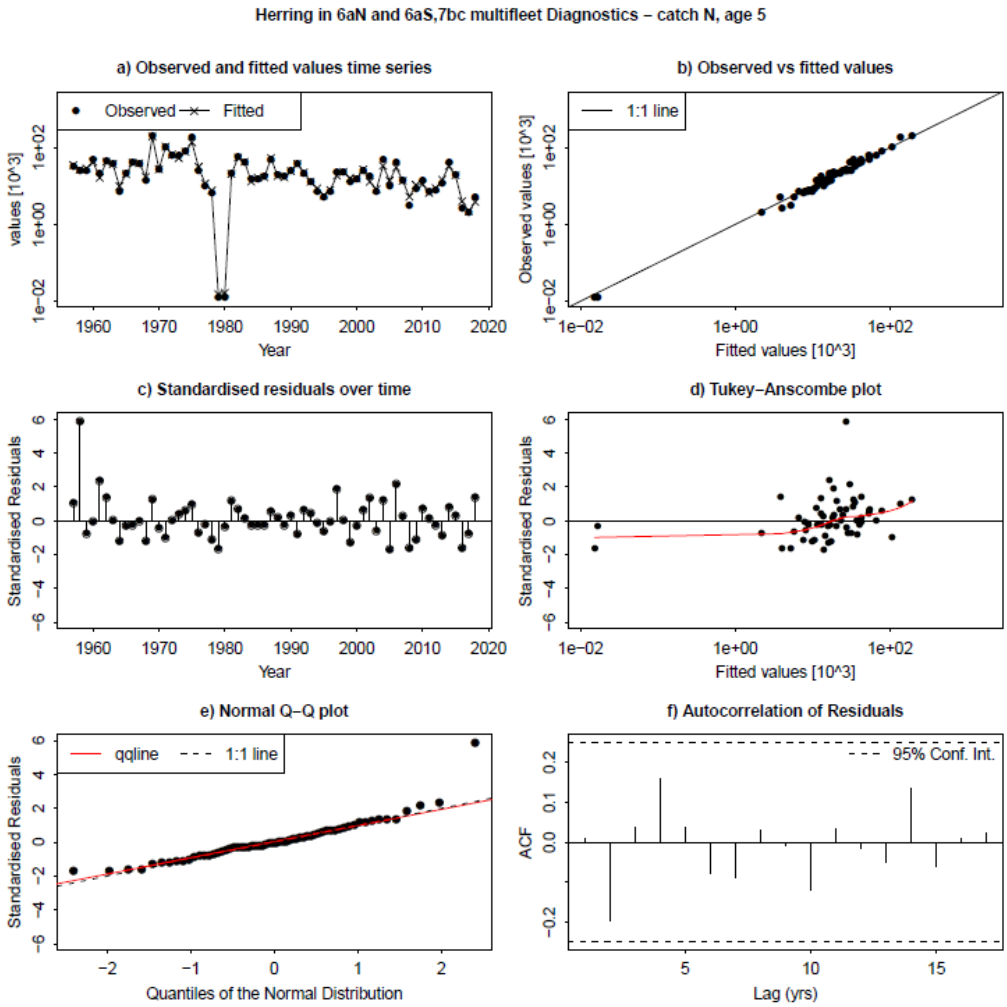

Figure 4.6.19. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from catch abundance at 5-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 5-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 5-winter ring. Middle right: catch observation versus standardized residuals at 5-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

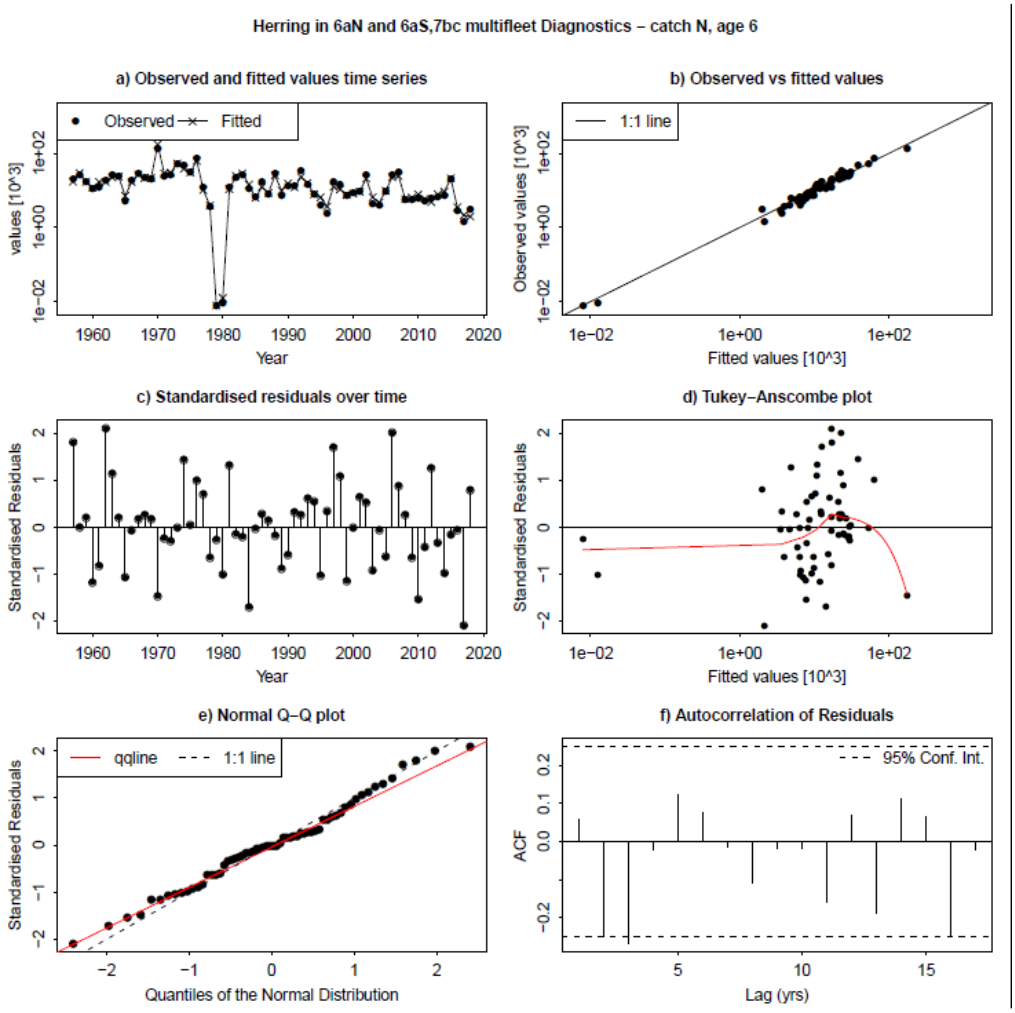

Figure 4.6.20. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from catch abundance at 6-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 6-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 6-winter ring. Middle right: catch observation versus standardized residuals at 6-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

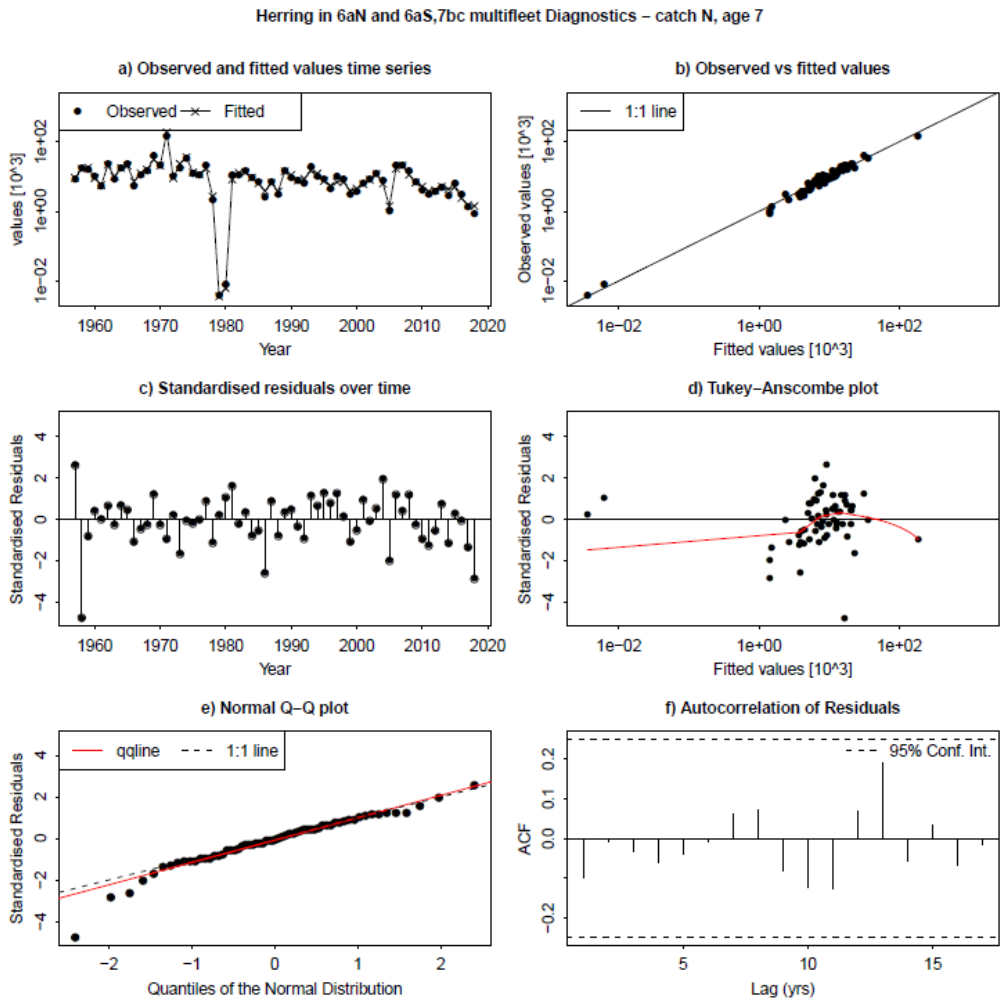

Figure 4.6.21. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from catch abundance at 7-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 7-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 7-winter ring. Middle right: catch observation versus standardized residuals at 7-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

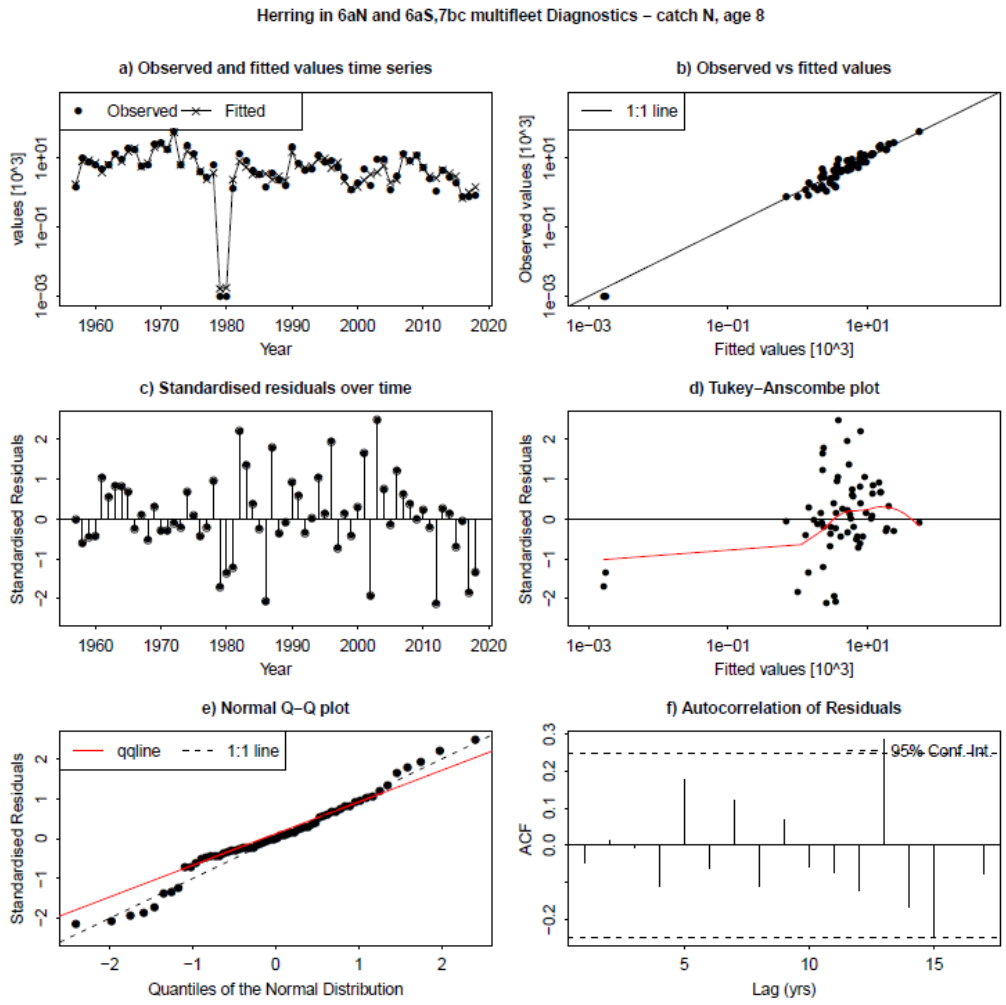

Figure 4.6.22. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from catch abundance at 8-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 8-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 8-winter ring. Middle right: catch observation versus standardized residuals at 8-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

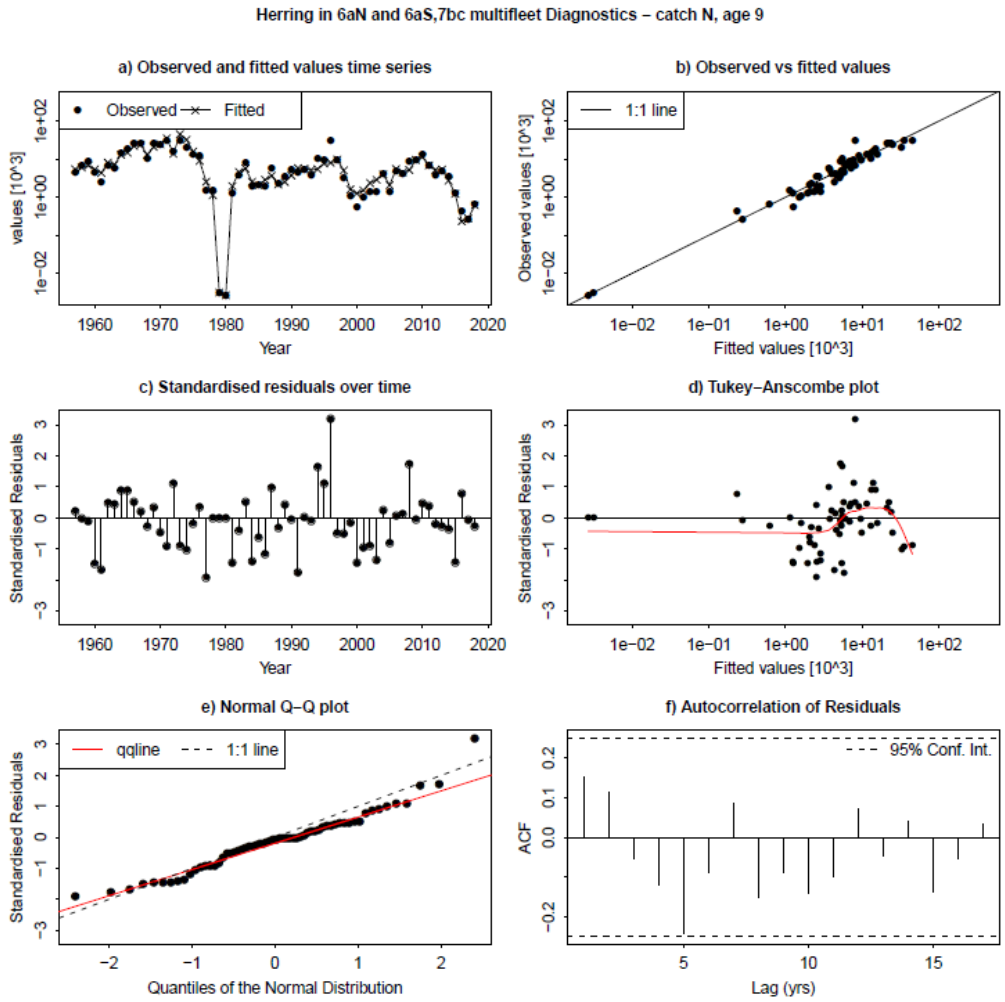

Figure 4.6.23. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from catch abundance at 9-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 9-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 9-winter ring. Middle right: catch observation versus standardized residuals at 9-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

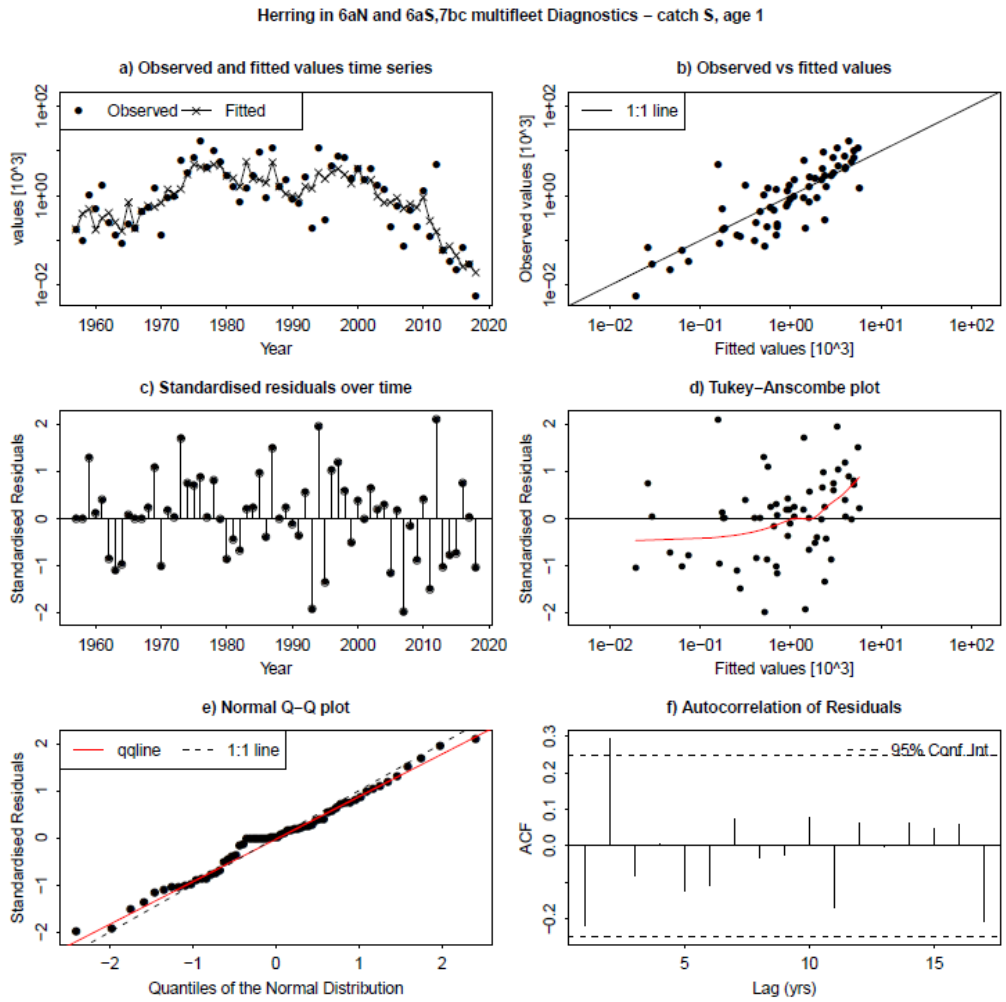

Figure 4.6.24. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from catch abundance at 1-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 1-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 1-winter ring. Middle right: catch observation versus standardized residuals at 1-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

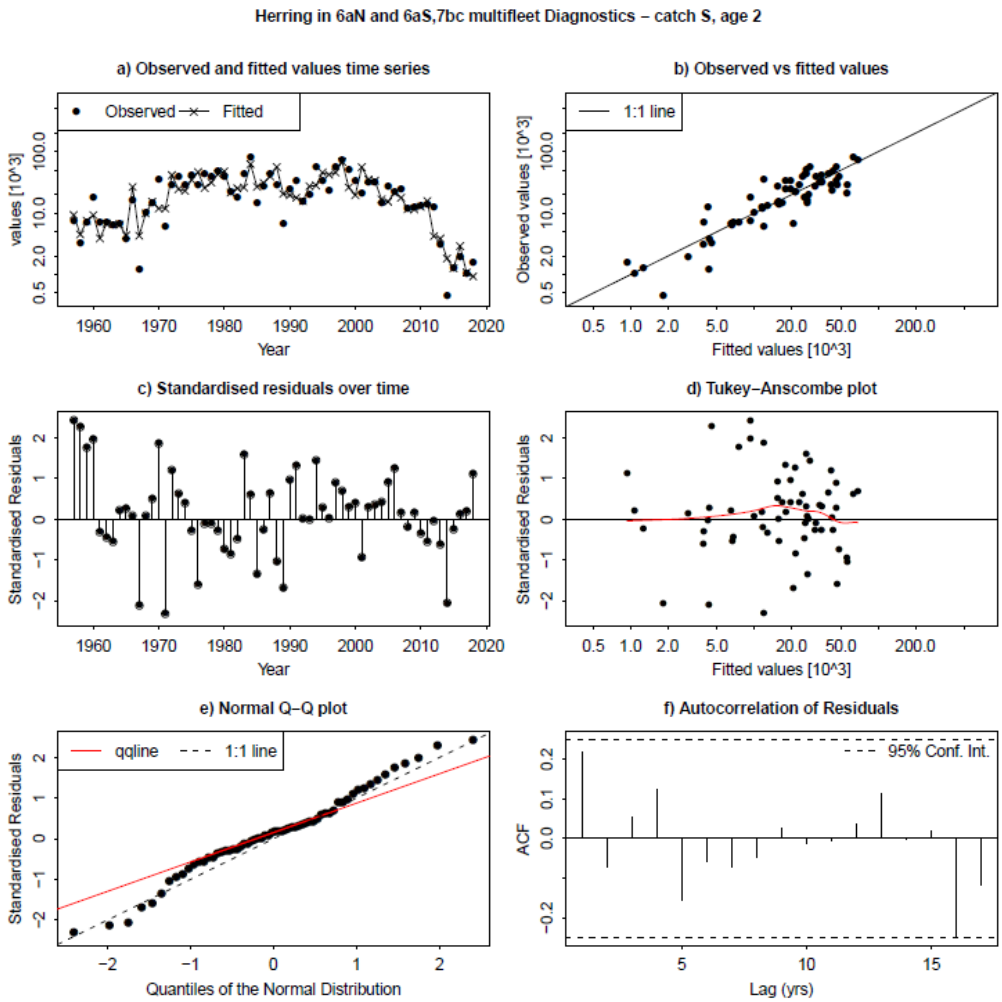

Figure 4.6.25. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from catch abundance at 2-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 2-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 2-winter ring. Middle right: catch observation versus standardized residuals at 2-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

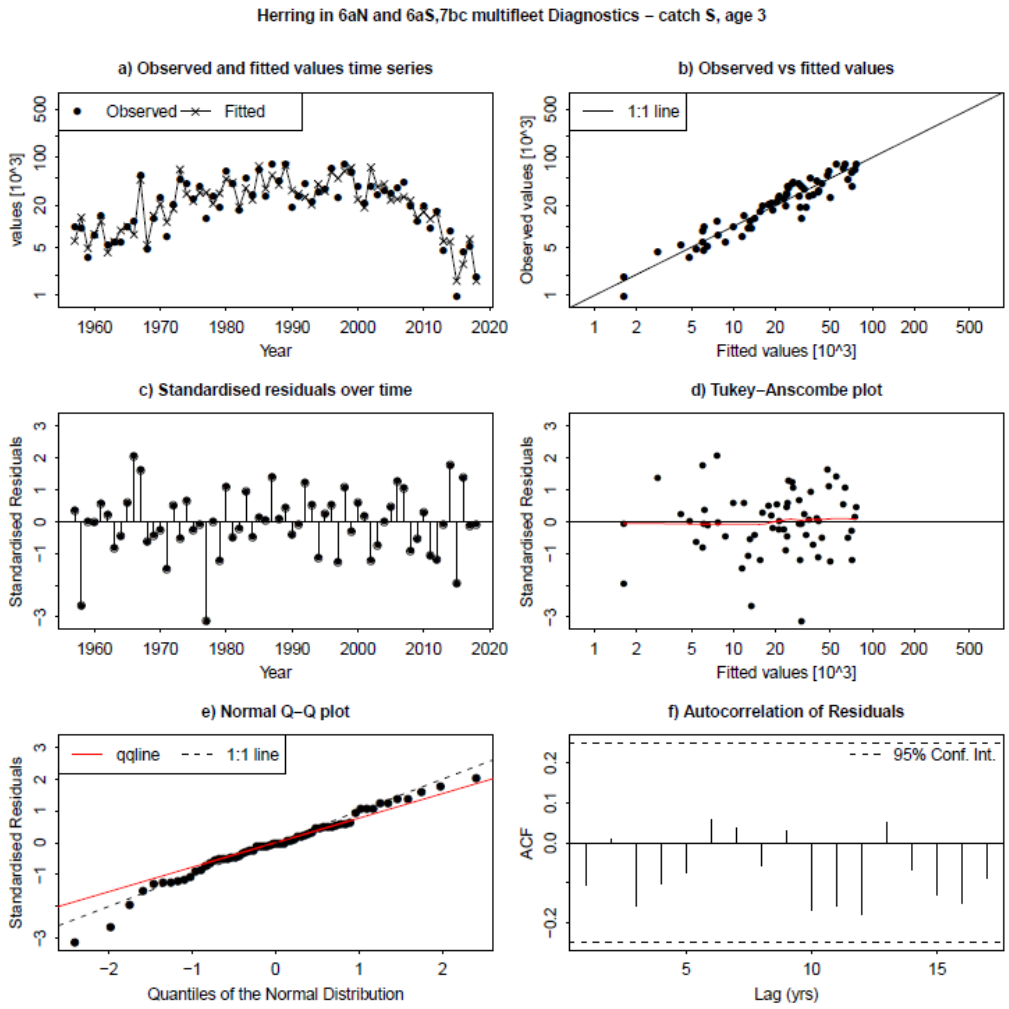

Figure 4.6.26. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from catch abundance at 3-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 3-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 3-winter ring. Middle right: catch observation versus standardized residuals at 3-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

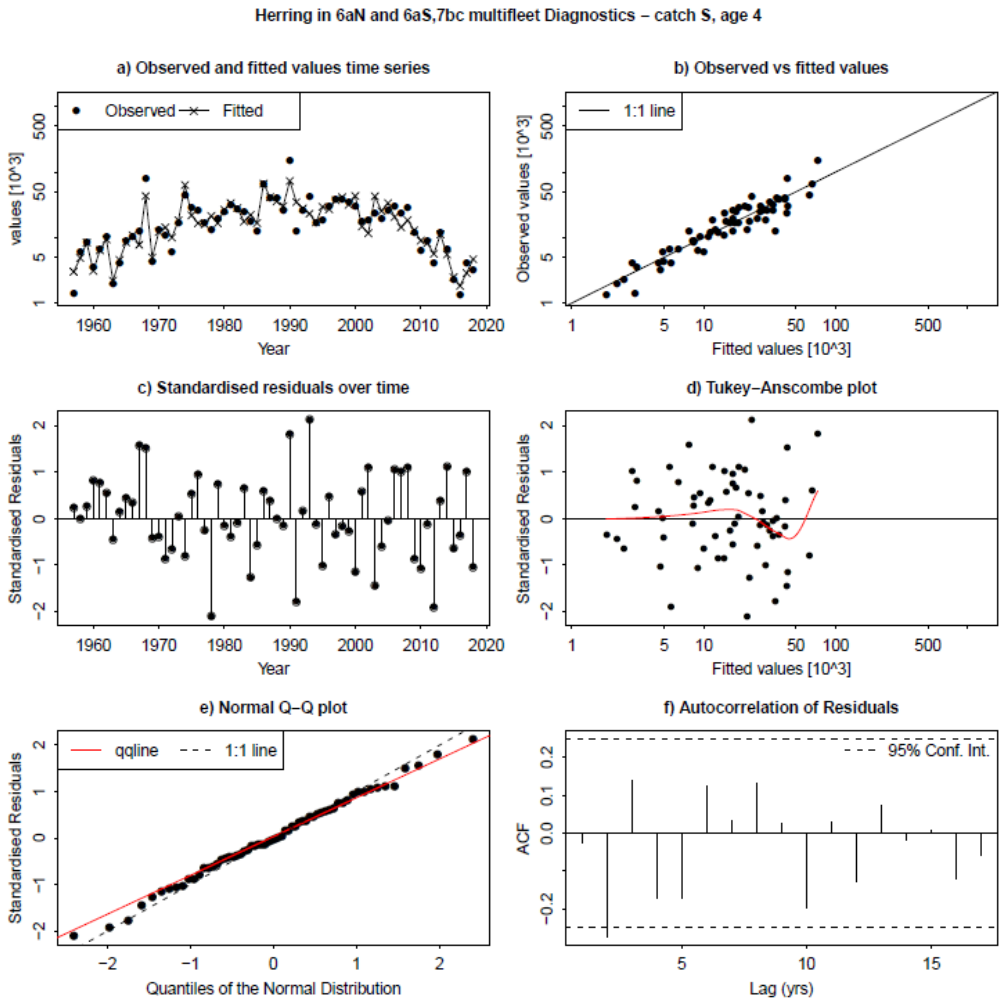

Figure 4.6.27. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from catch abundance at 4-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 4-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 4-winter ring. Middle right: catch observation versus standardized residuals at 4-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

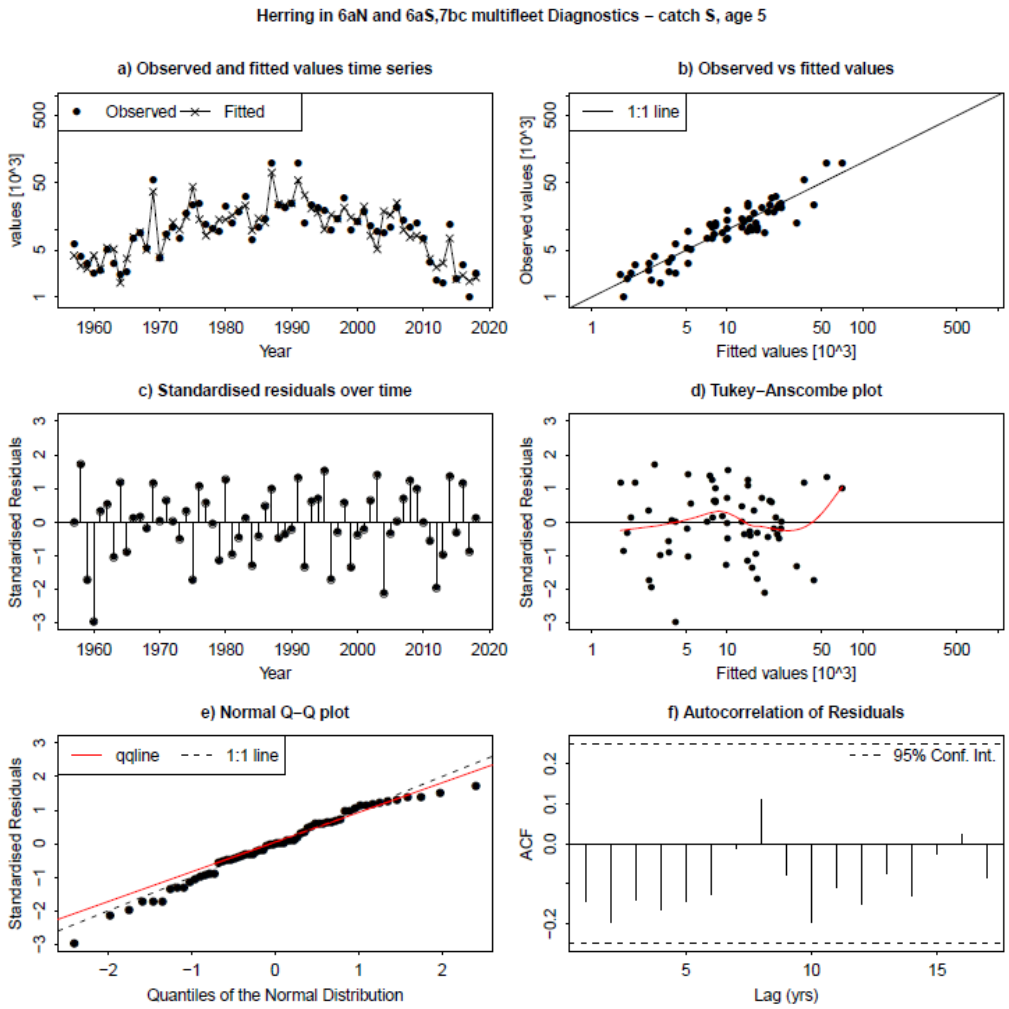

Figure 4.6.28. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from catch abundance at 5-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 5-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 5-winter ring. Middle right: catch observation versus standardized residuals at 5-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

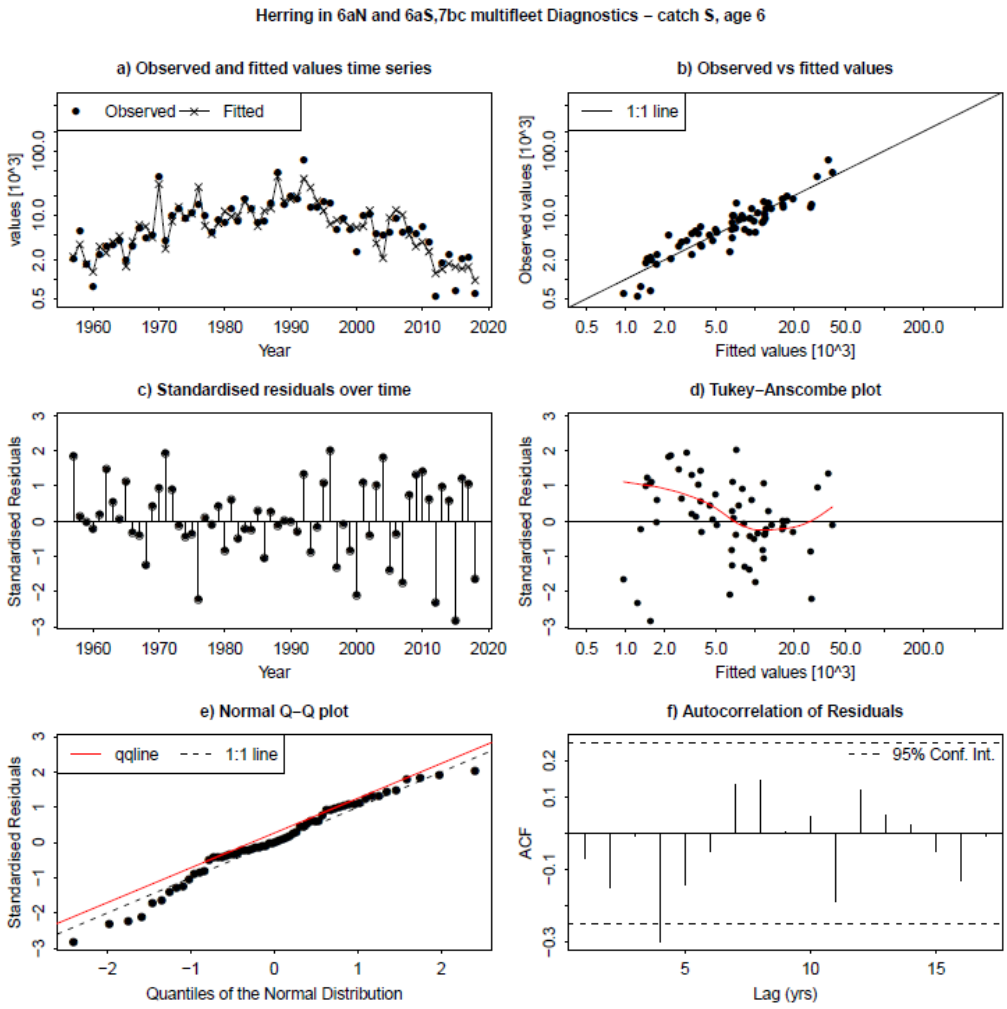

Figure 4.6.29. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from catch abundance at 6-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 6-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 6-winter ring. Middle right: catch observation versus standardized residuals at 6-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

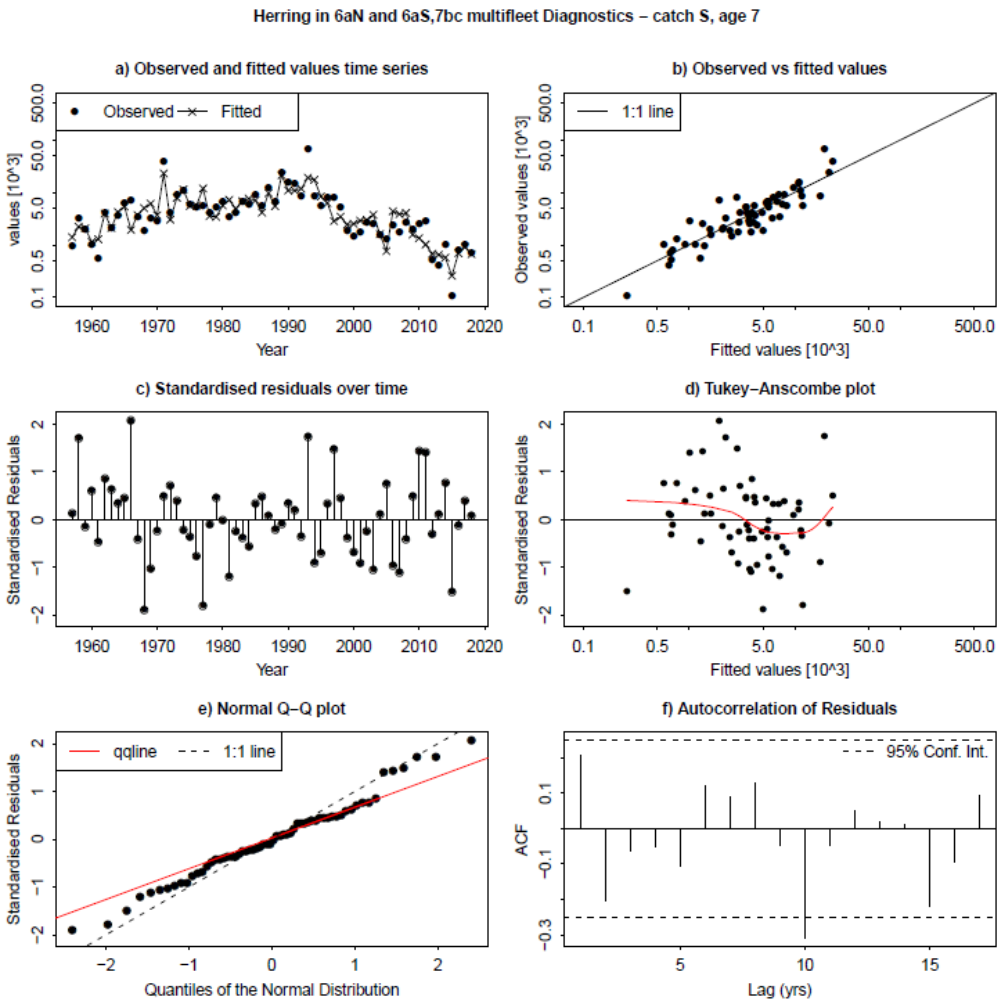

Figure 4.6.30. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from catch abundance at 7-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 7-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 7-winter ring. Middle right: catch observation versus standardized residuals at 7-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

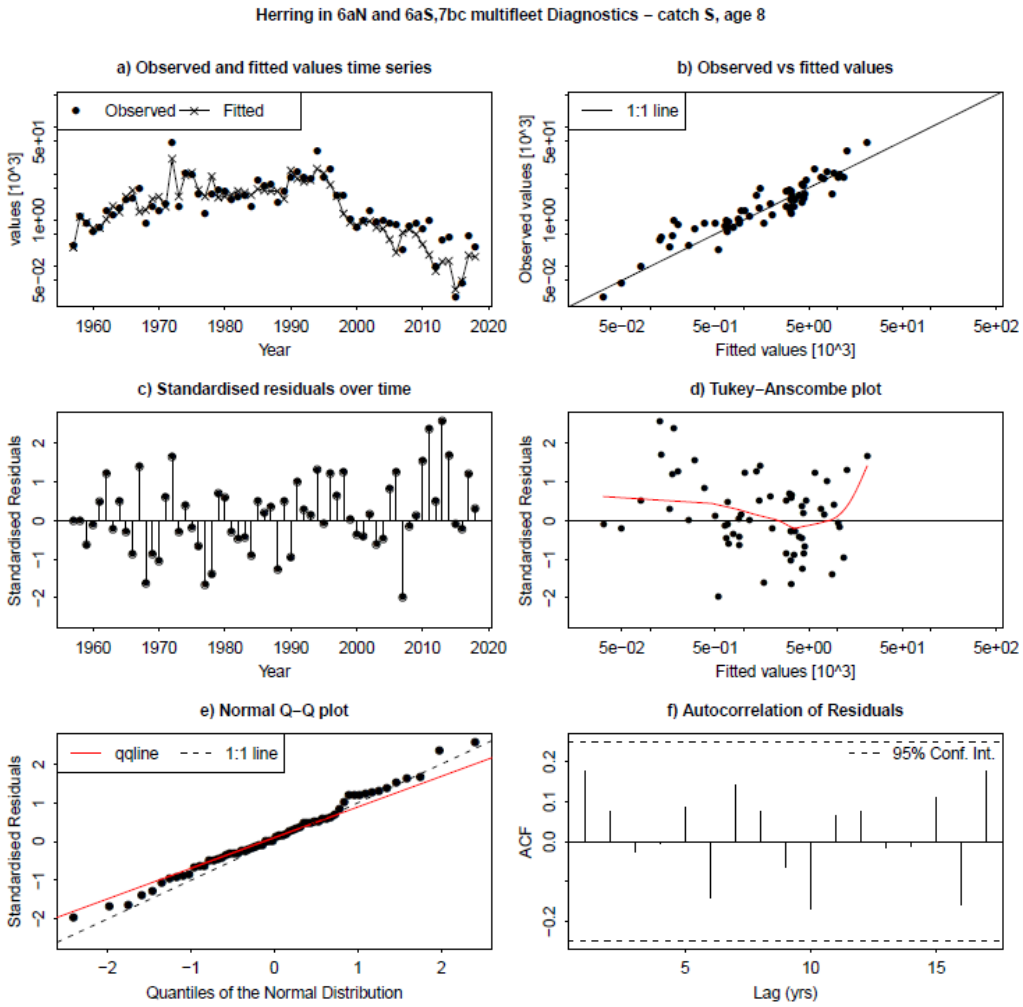

Figure 4.6.31. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from catch abundance at 8-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 8-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 8-winter ring. Middle right: catch observation versus standardized residuals at 8-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

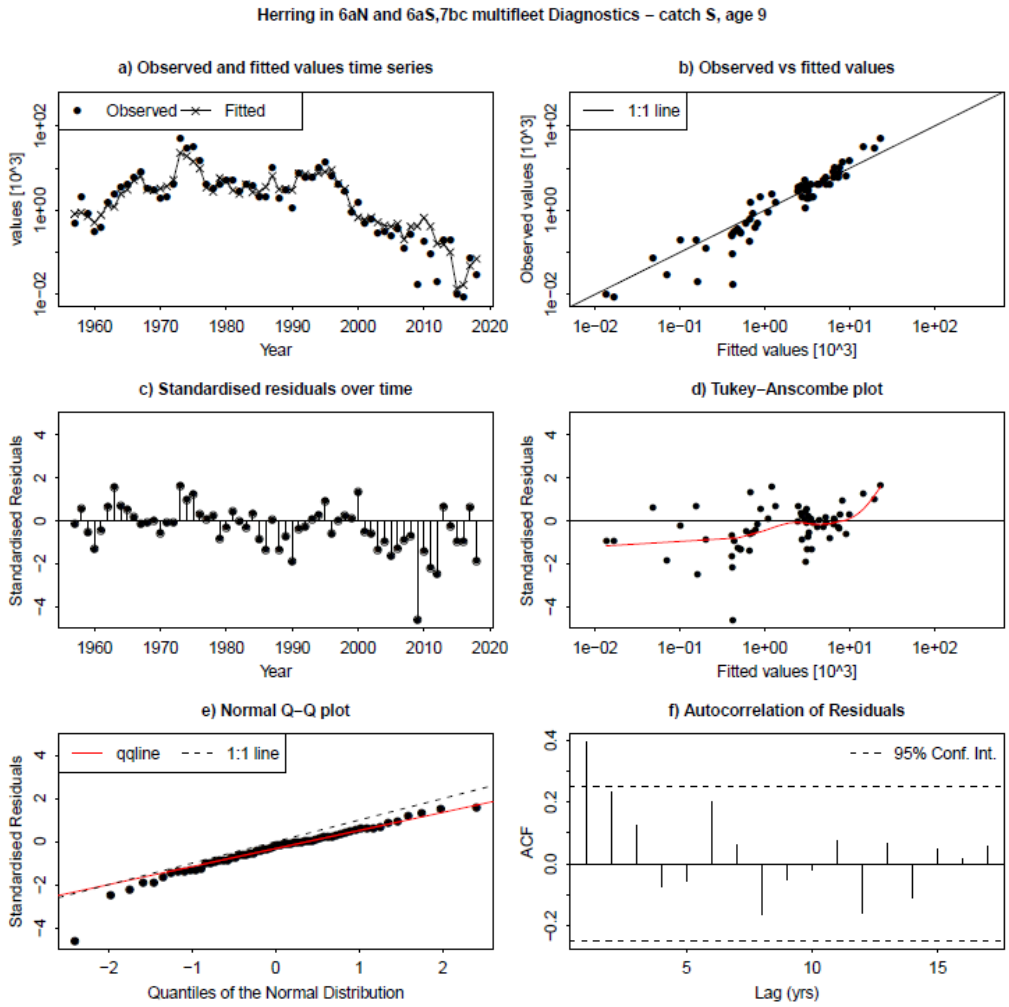

Figure 4.6.32. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from catch abundance at 9-winter ring. Top right: scatterplot of catch observations versus assessment model estimates of numbers at 9-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the catch at 9-winter ring. Middle right: catch observation versus standardized residuals at 9-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

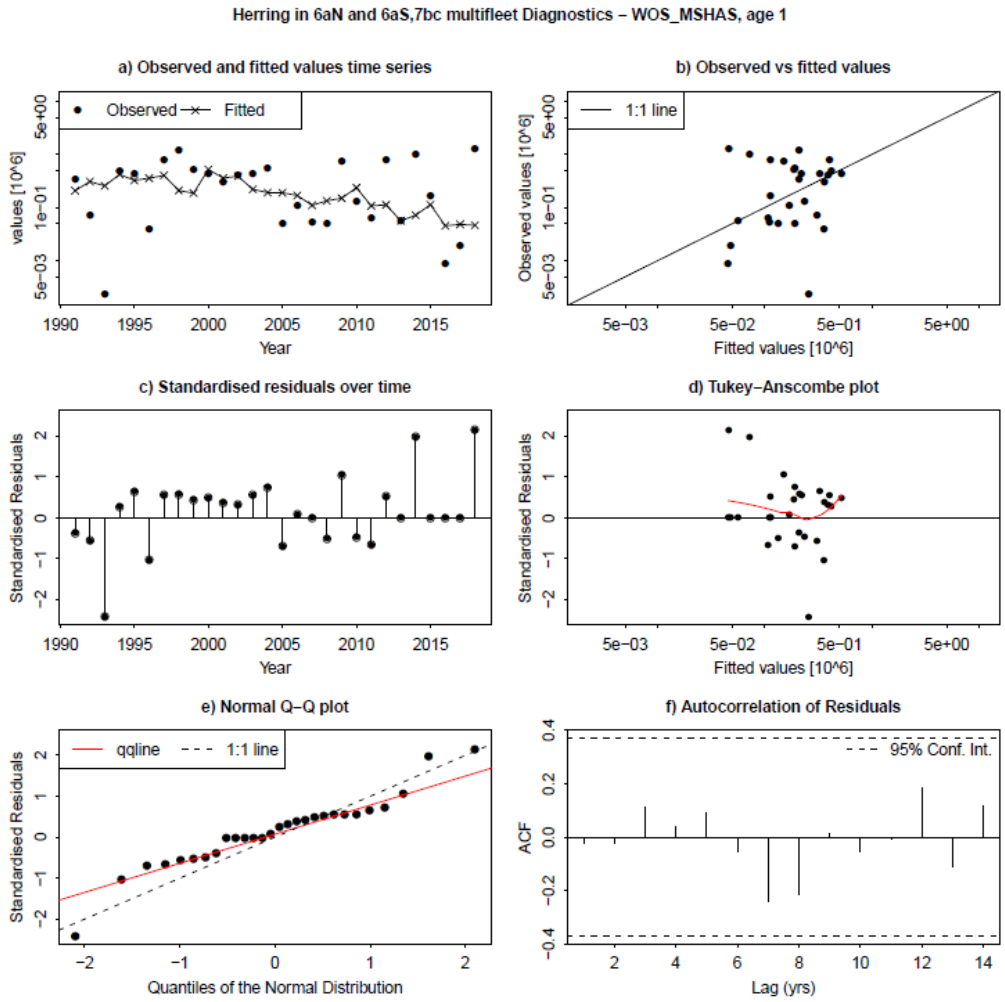

Figure 4.6.33. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from index abundance at 1-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 1-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 1-winter ring. Middle right: index observation versus standardized residuals at 1-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot. There were no observations of 1 winter ring fish in this survey in 2015 and 2016, therefore the figure stops at 2014.

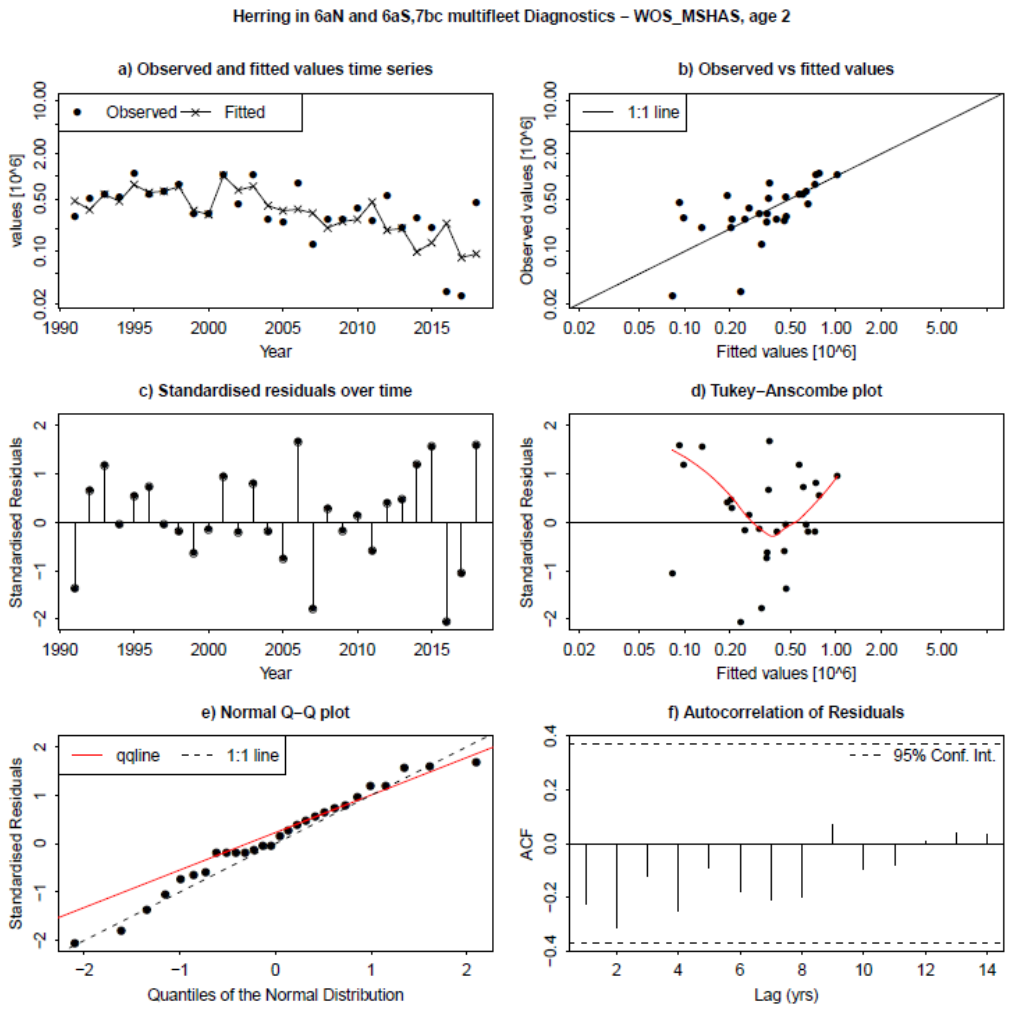

Figure 4.6.34. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 2-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 2-winter ring. Middle right: index observation versus standardized residuals at 2-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

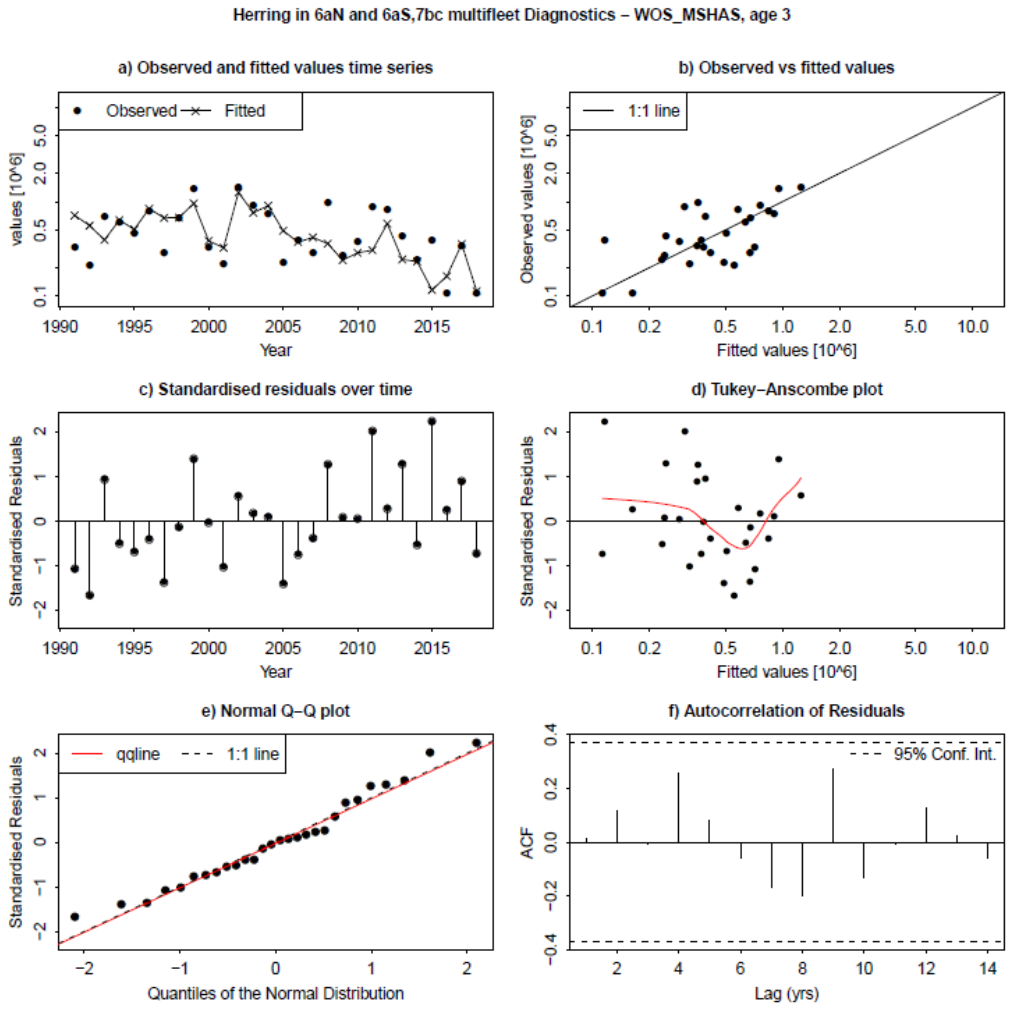

Figure 4.6.35. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 3-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 3-winter ring. Middle right: index observation versus standardized residuals at 3-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

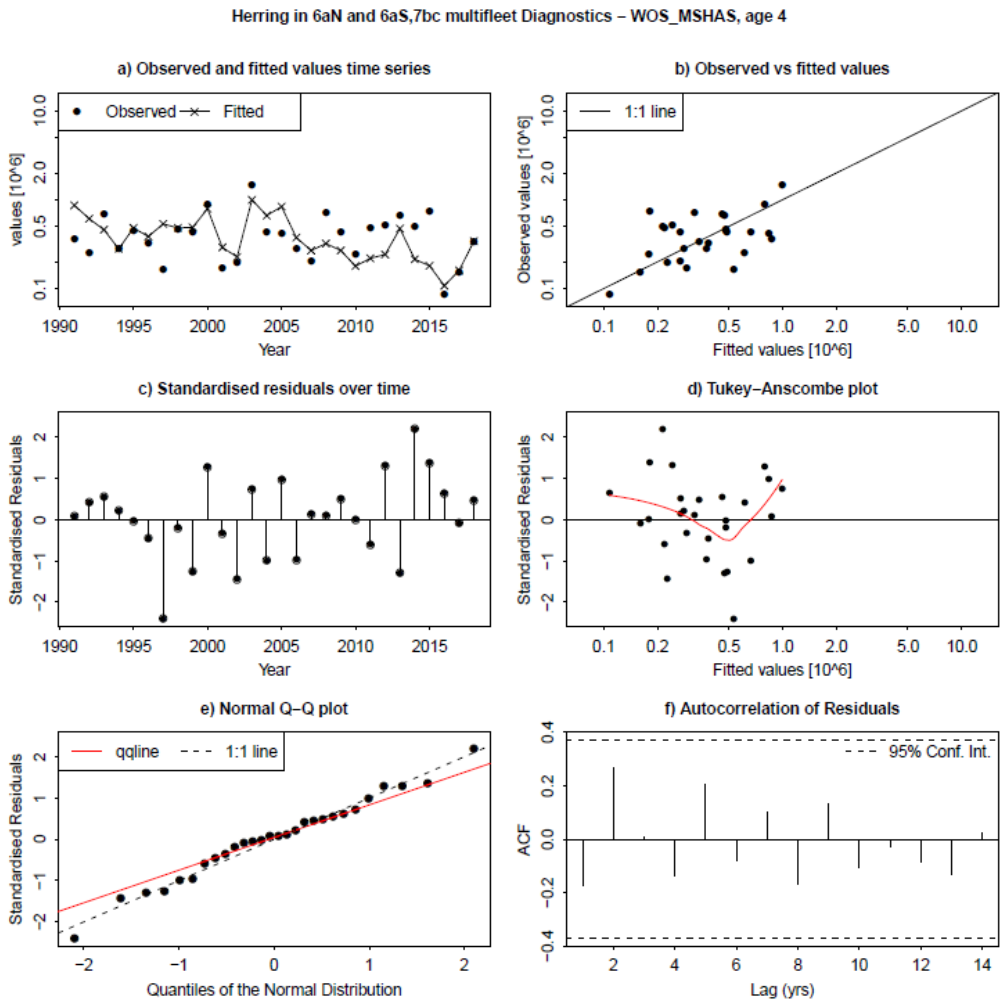

Figure 4.6.36. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 4-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 4-winter ring. Middle right: index observation versus standardized residuals at 4-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

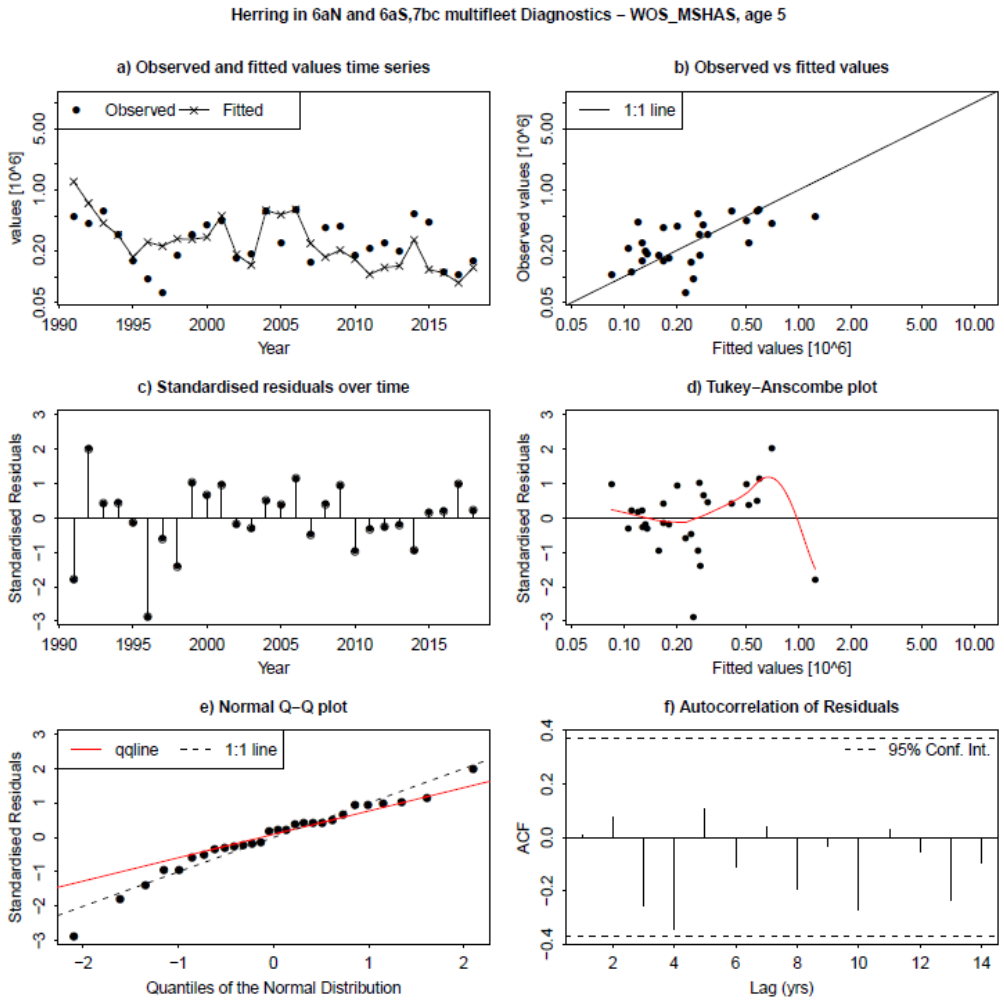

Figure 4.6.37. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 5-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 5-winter ring. Middle right: index observation versus standardized residuals at 5-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

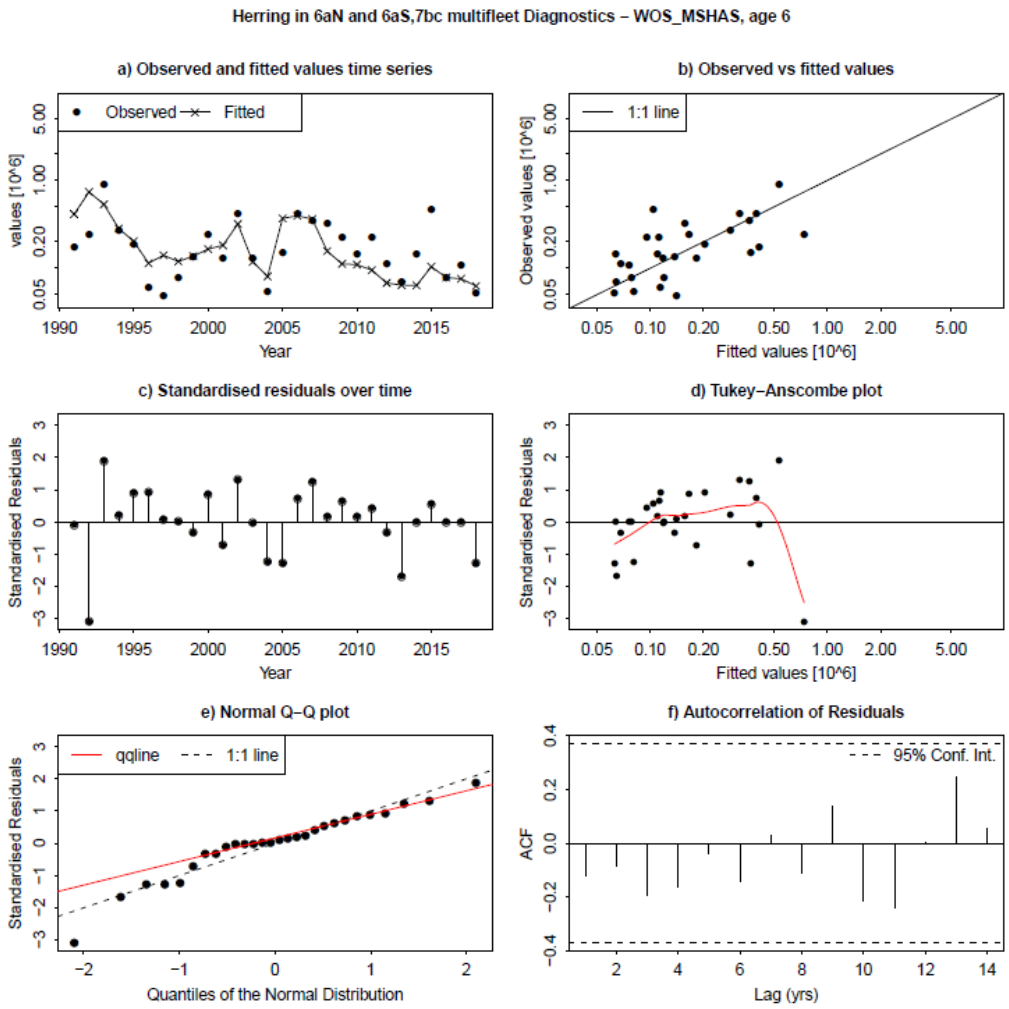

Figure 4.6.38. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 6-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 6-winter ring. Middle right: index observation versus standardized residuals at 6-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

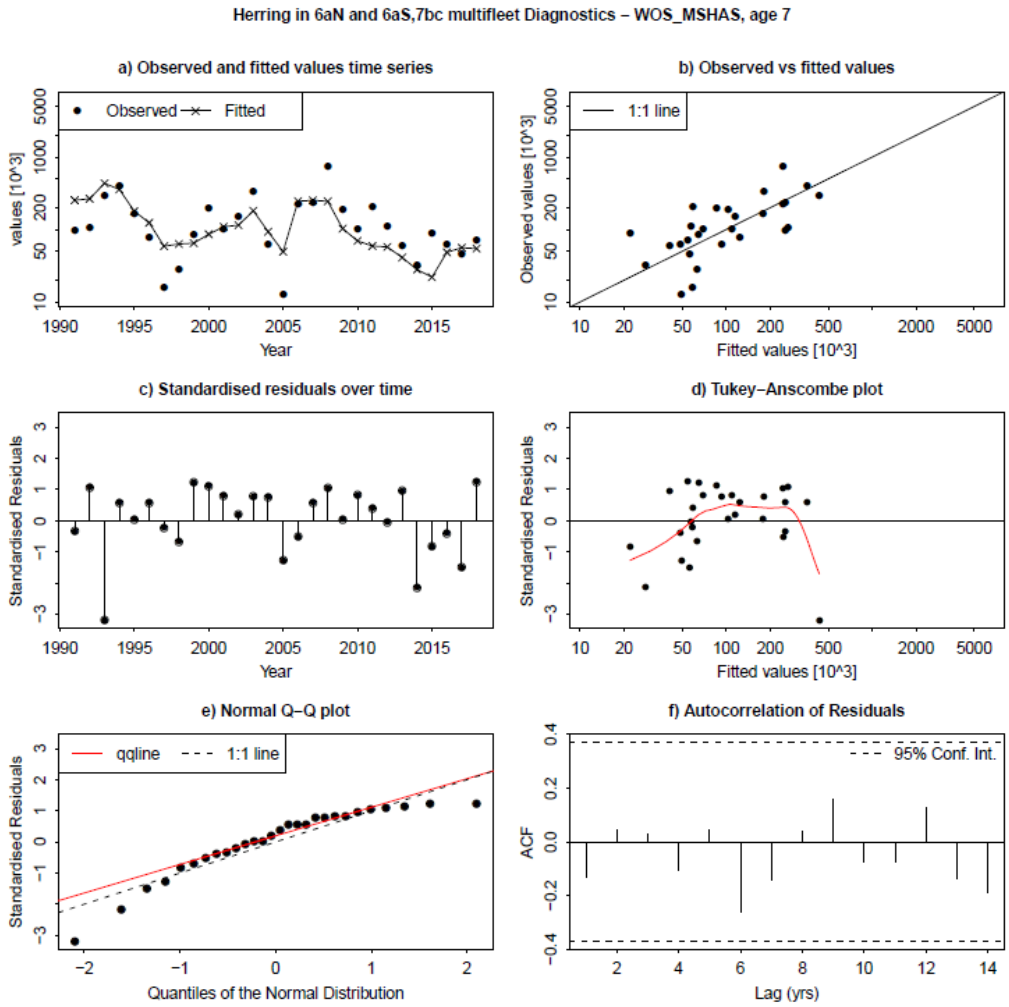

Figure 4.6.39. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 7-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 7-winter ring. Middle right: index observation versus standardized residuals at 7-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

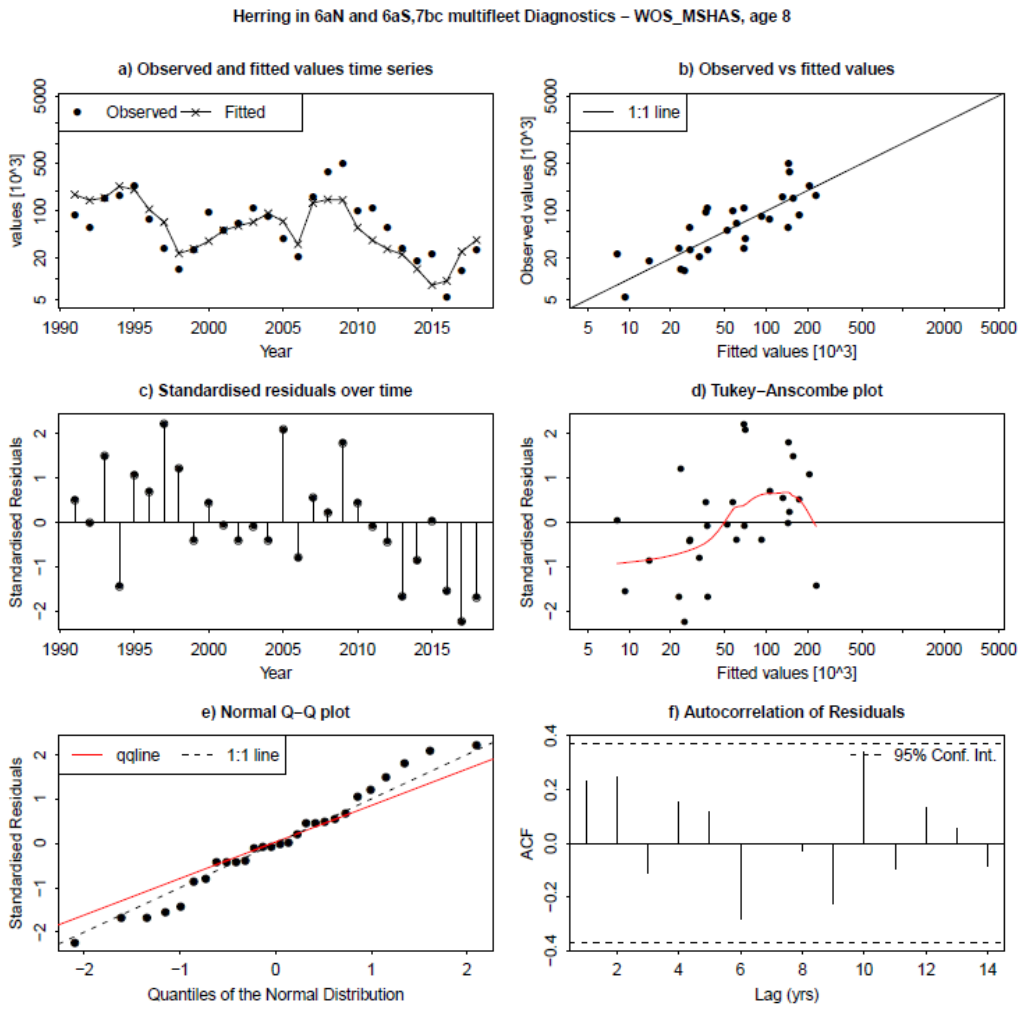

Figure 4.6.40. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 8-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 8-winter ring. Middle right: index observation versus standardized residuals at 8-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

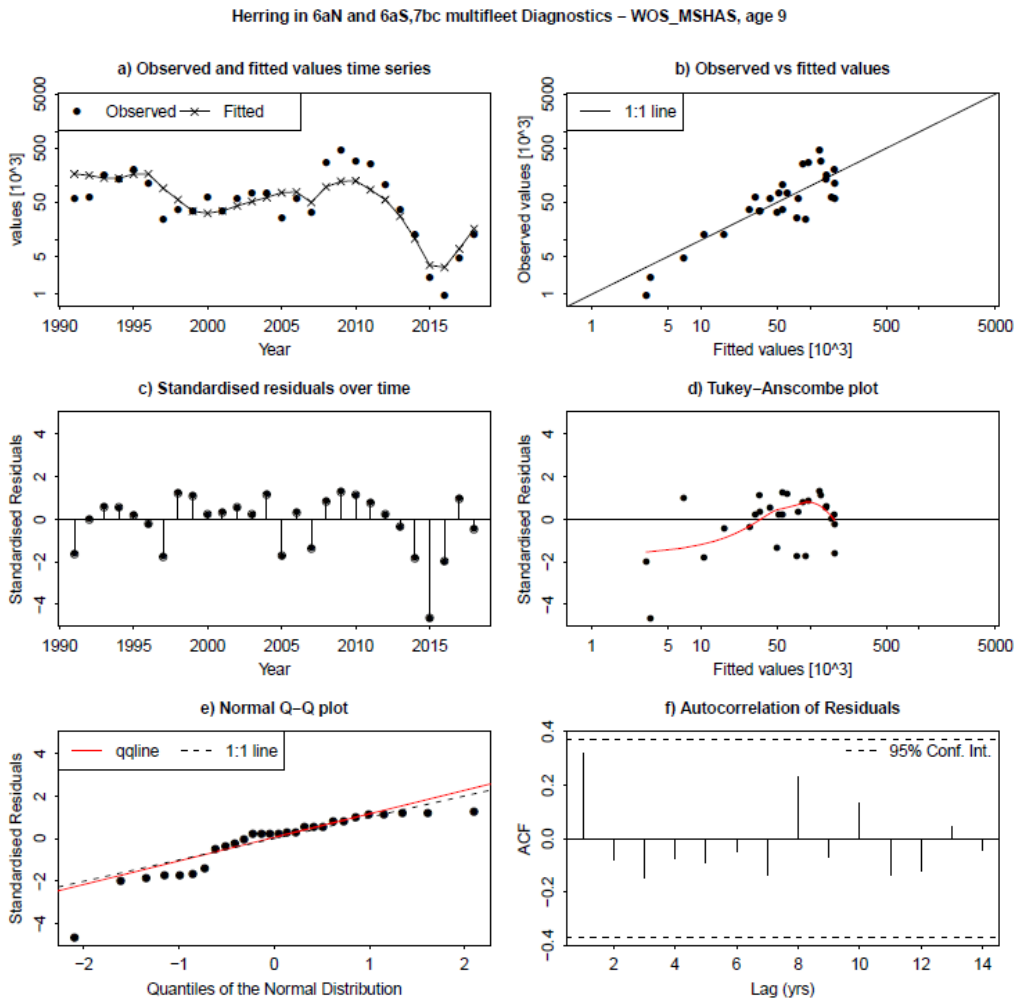

Figure 4.6.41. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 9-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 9-winter ring. Middle right: index observation versus standardized residuals at 9-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

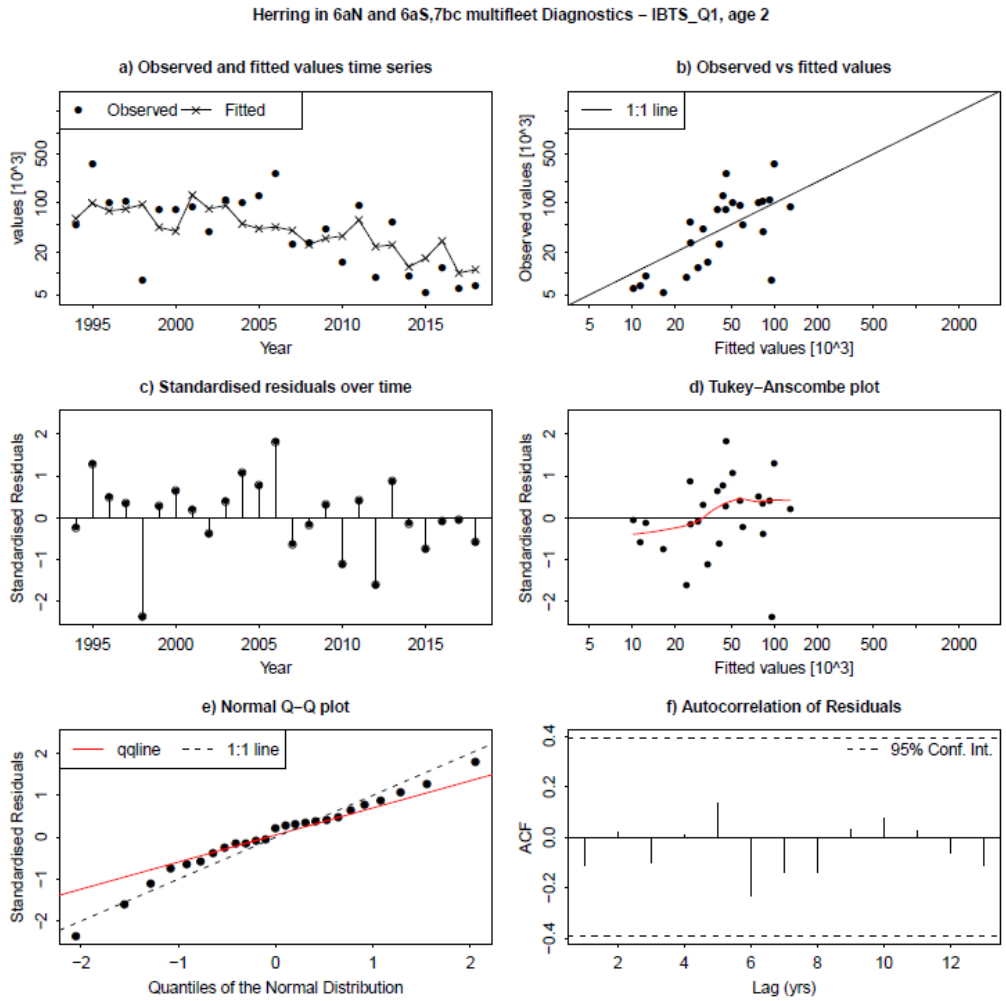

Figure 4.6.42. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 2-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 2-winter ring. Middle right: index observation versus standardized residuals at 2-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

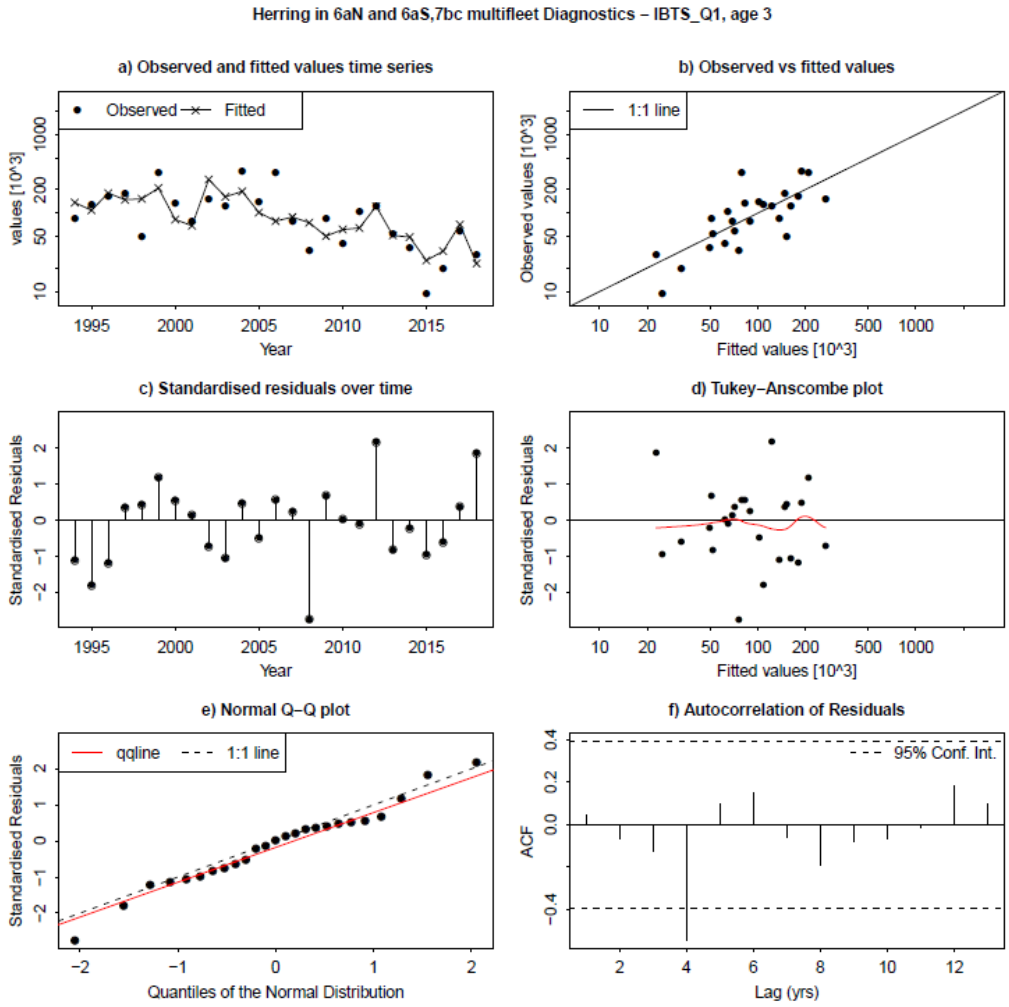

Figure 4.6.43. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 3-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 3-winter ring. Middle right: index observation versus standardized residuals at 3-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

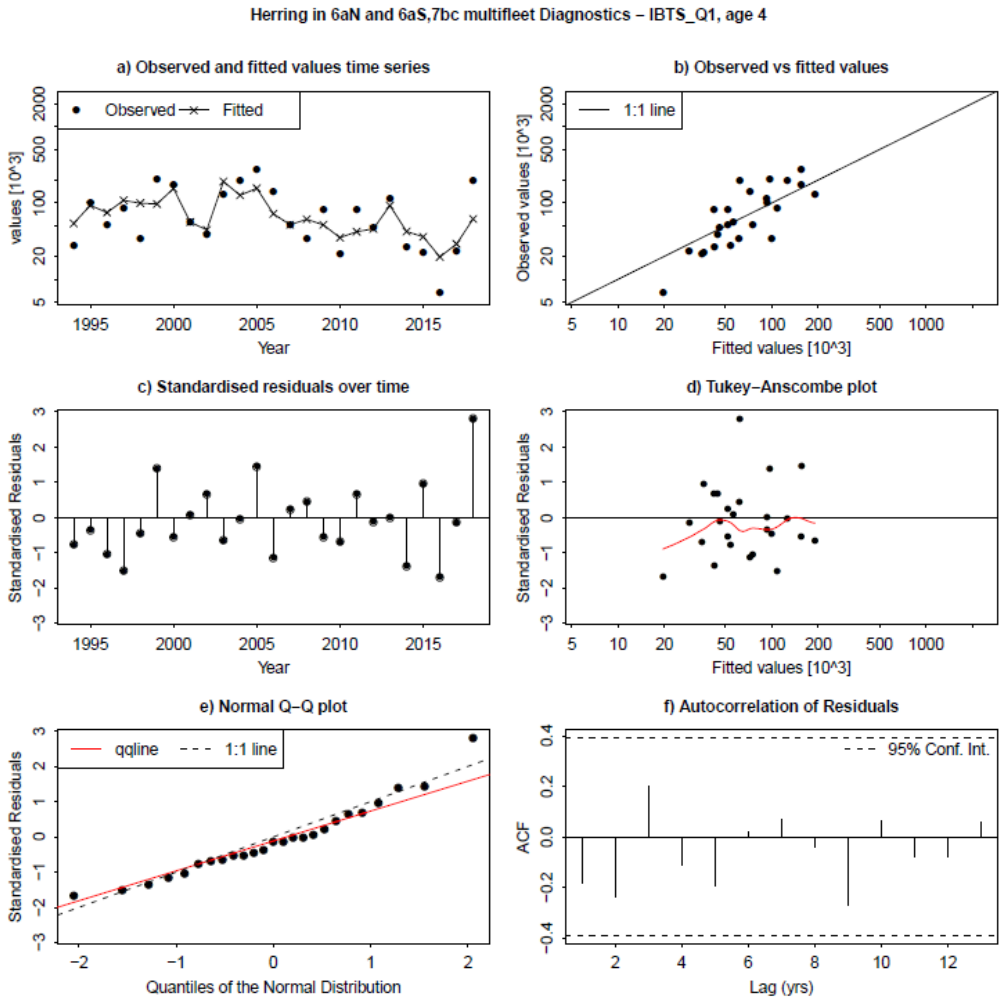

Figure 4.6.44. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 4-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 4-winter ring. Middle right: index observation versus standardized residuals at 4-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

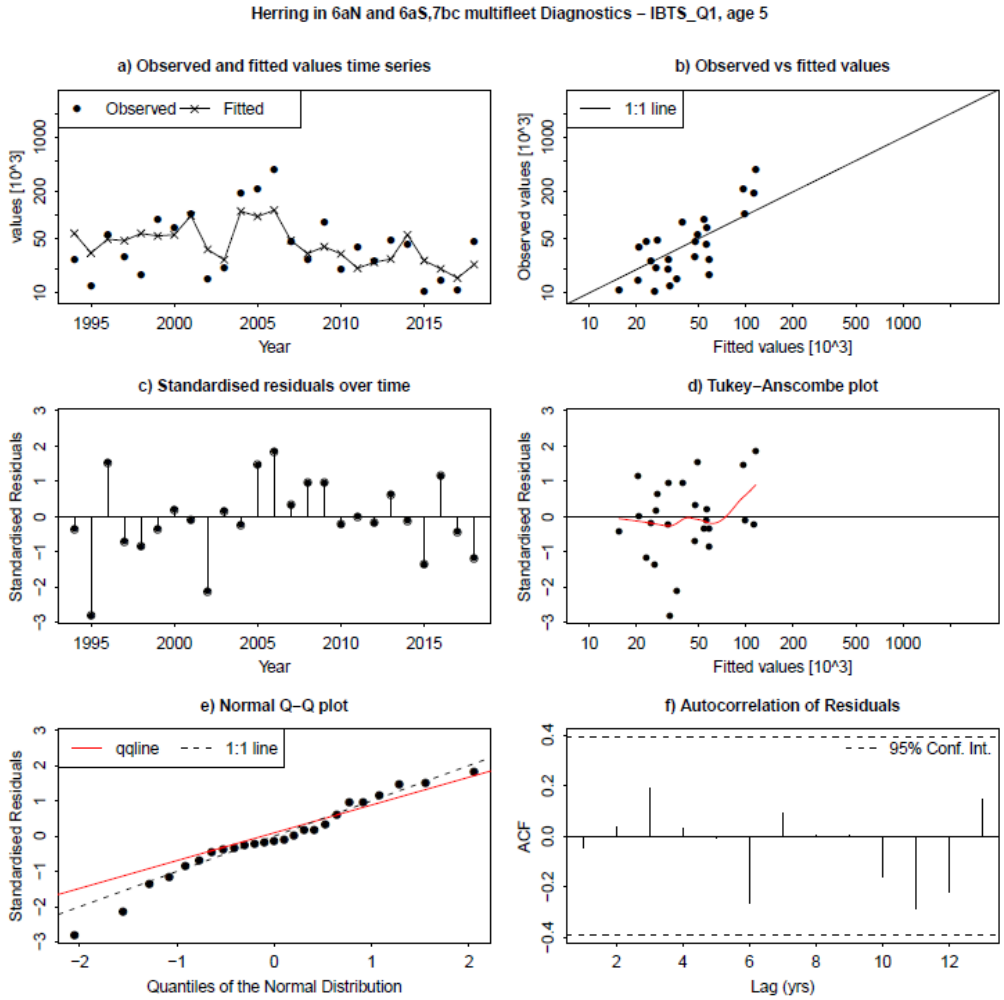

Figure 4.6.45. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 5-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 5-winter ring. Middle right: index observation versus standardized residuals at 5-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

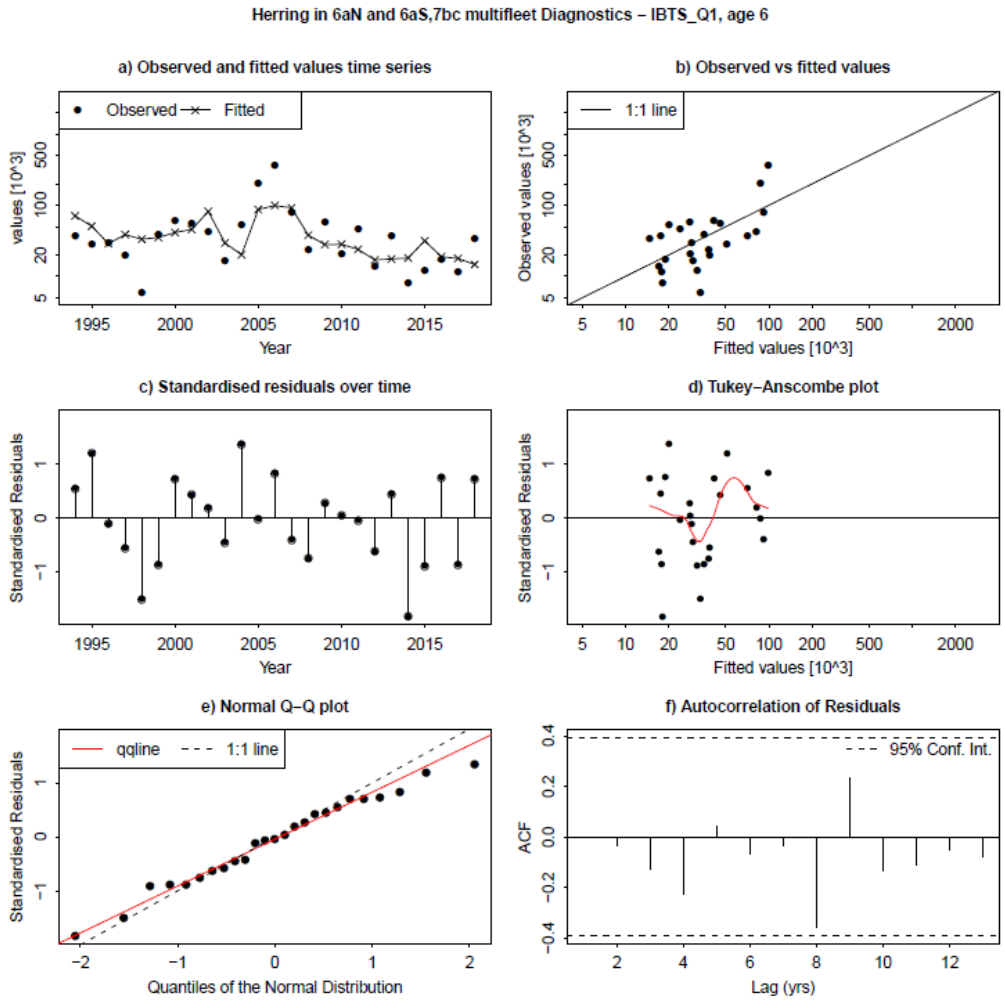

Figure 4.6.46. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 6-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 6-winter ring. Middle right: index observation versus standardized residuals at 6-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

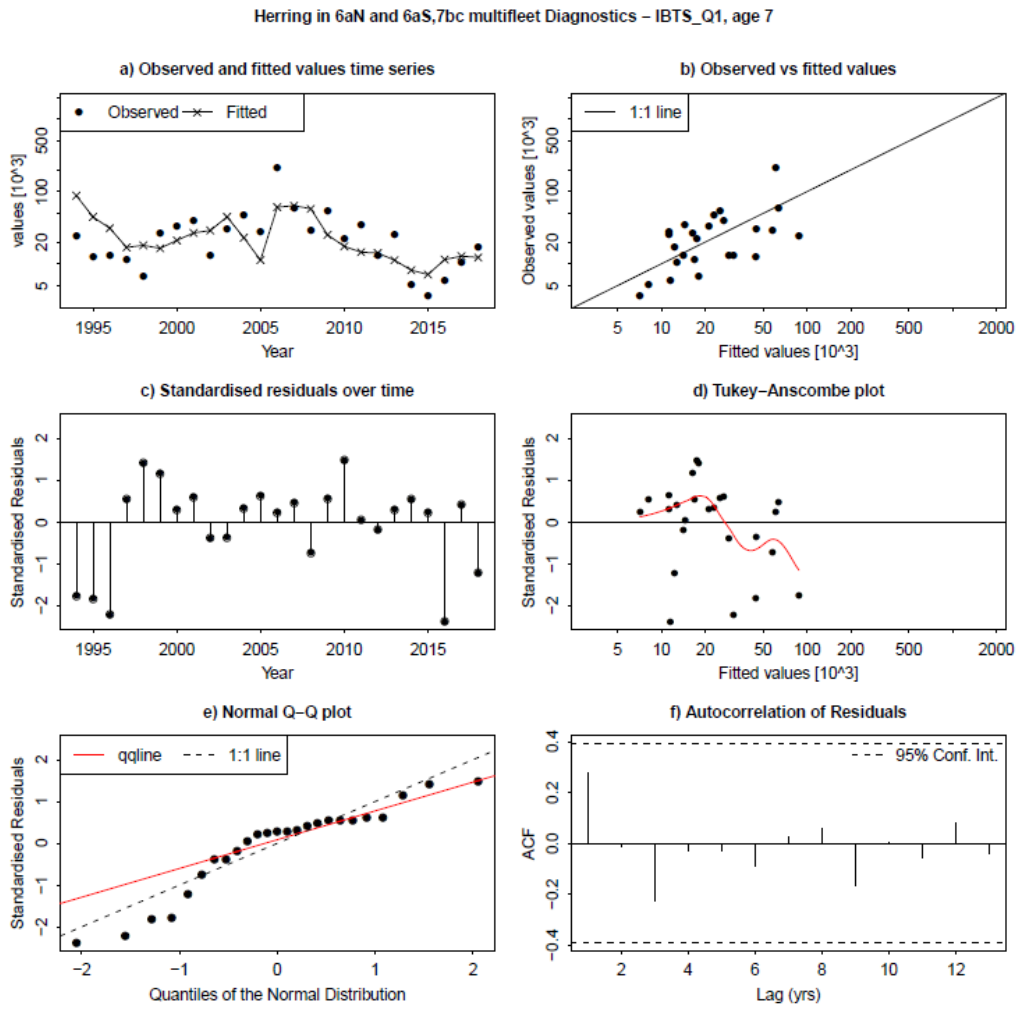

Figure 4.6.47. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 7-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 7-winter ring. Middle right: index observation versus standardized residuals at 7-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

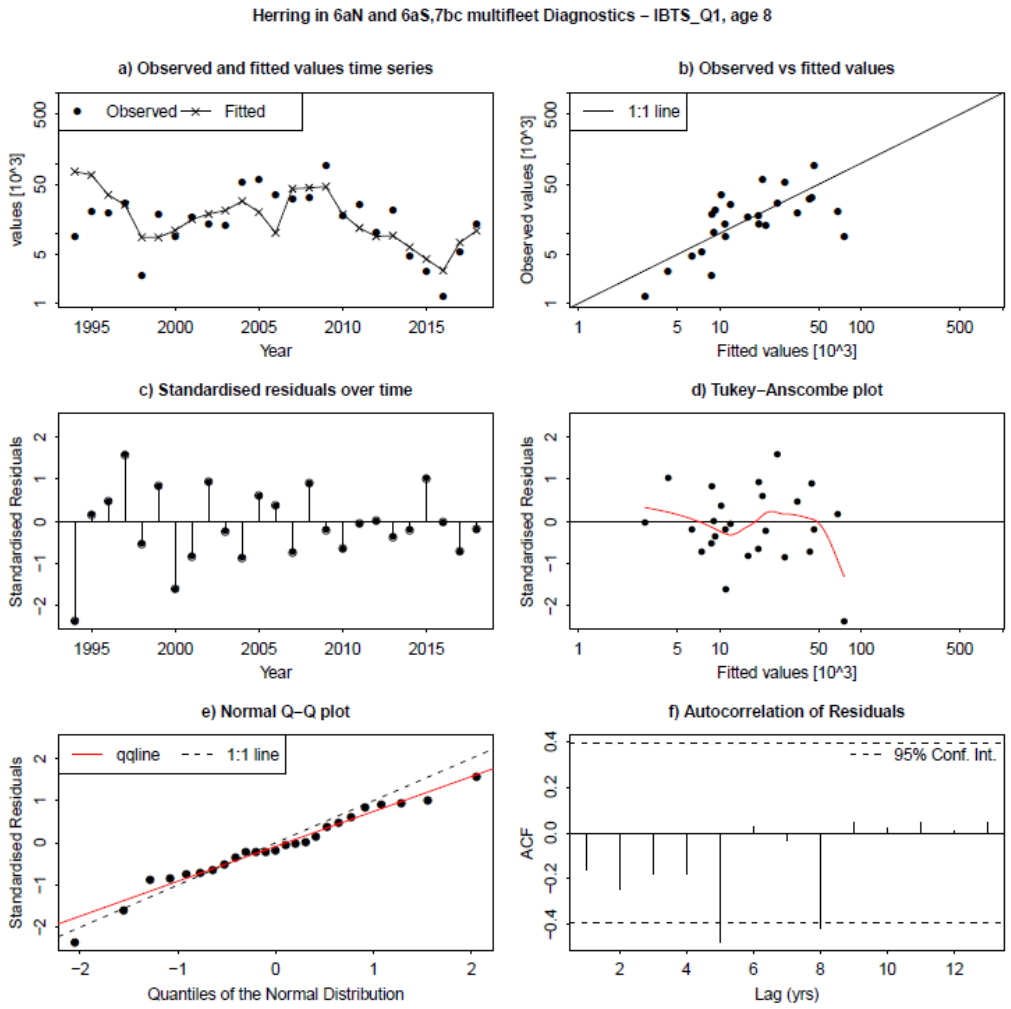

Figure 4.6.48. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 8-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 8-winter ring. Middle right: index observation versus standardized residuals at 8-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

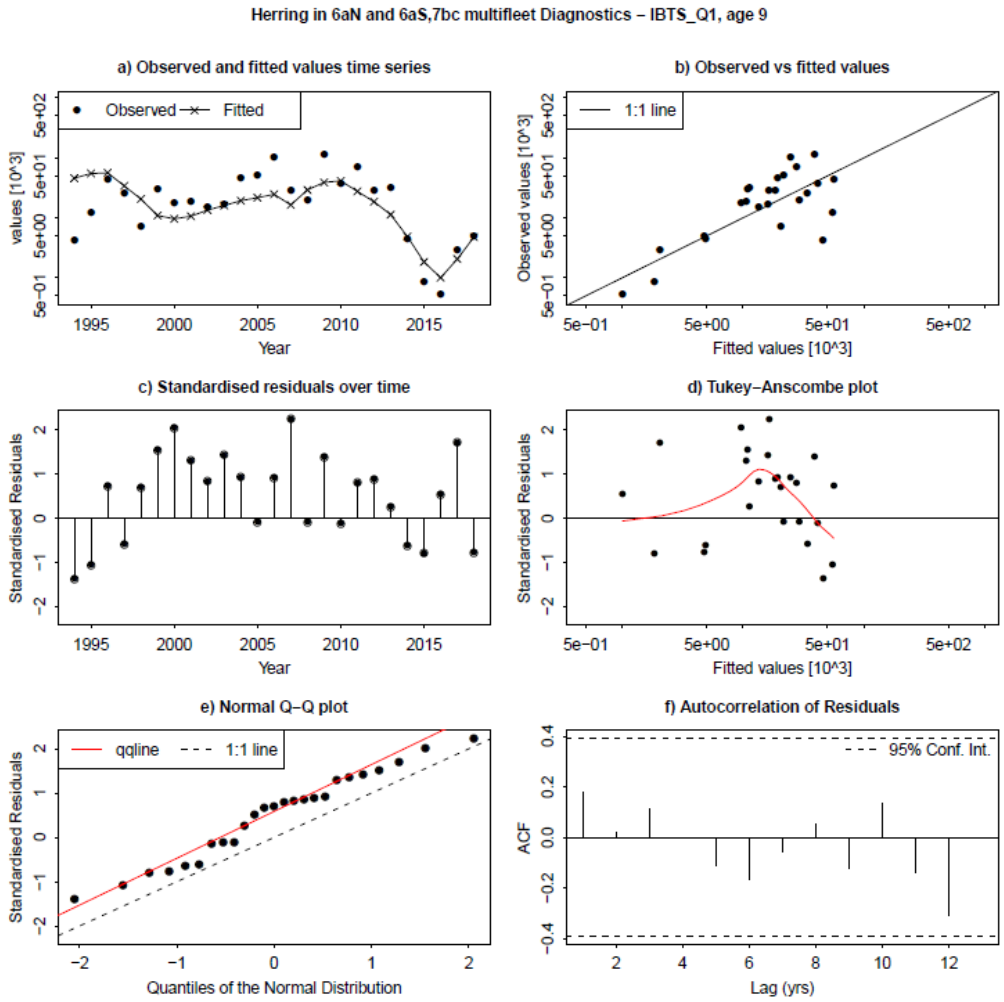

Figure 4.6.49. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 9-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 9-winter ring. Middle right: index observation versus standardized residuals at 9-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

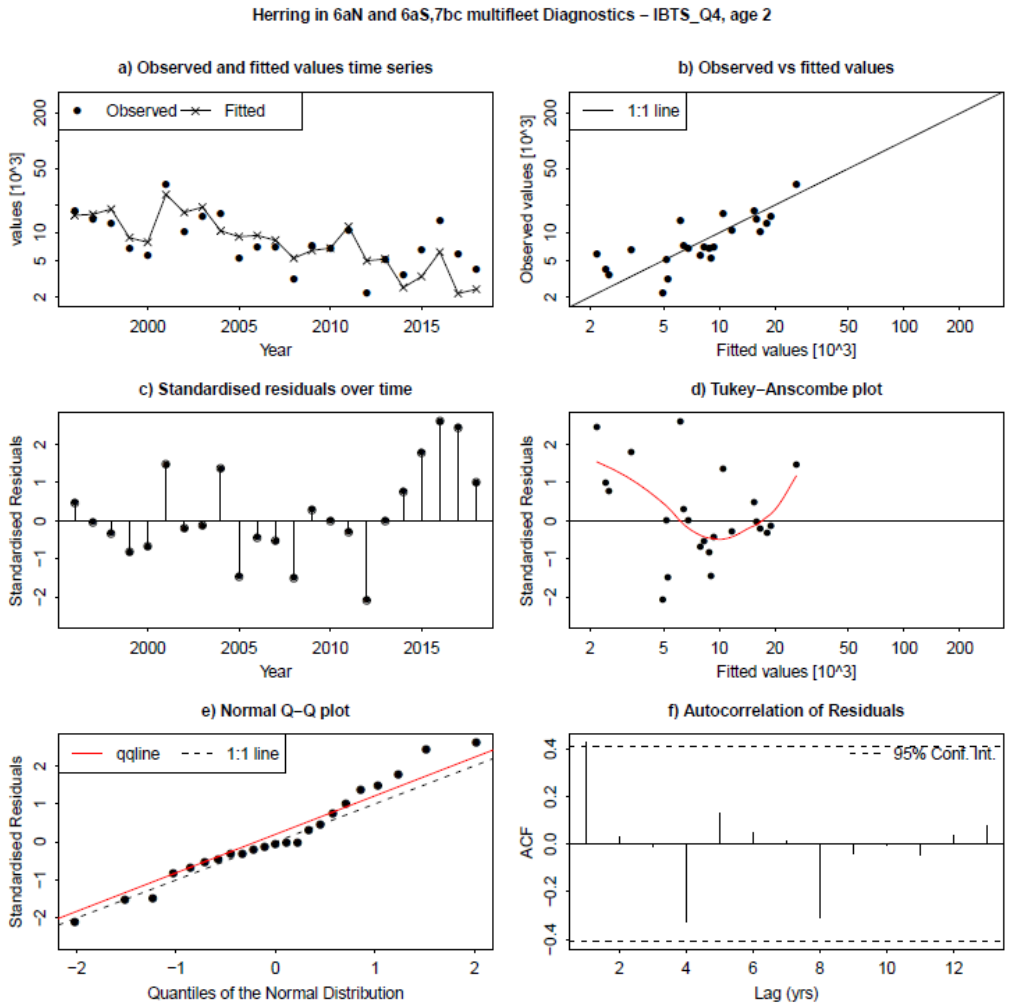

Figure 4.6.50. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 2-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 2-winter ring. Middle right: index observation versus standardized residuals at 2-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

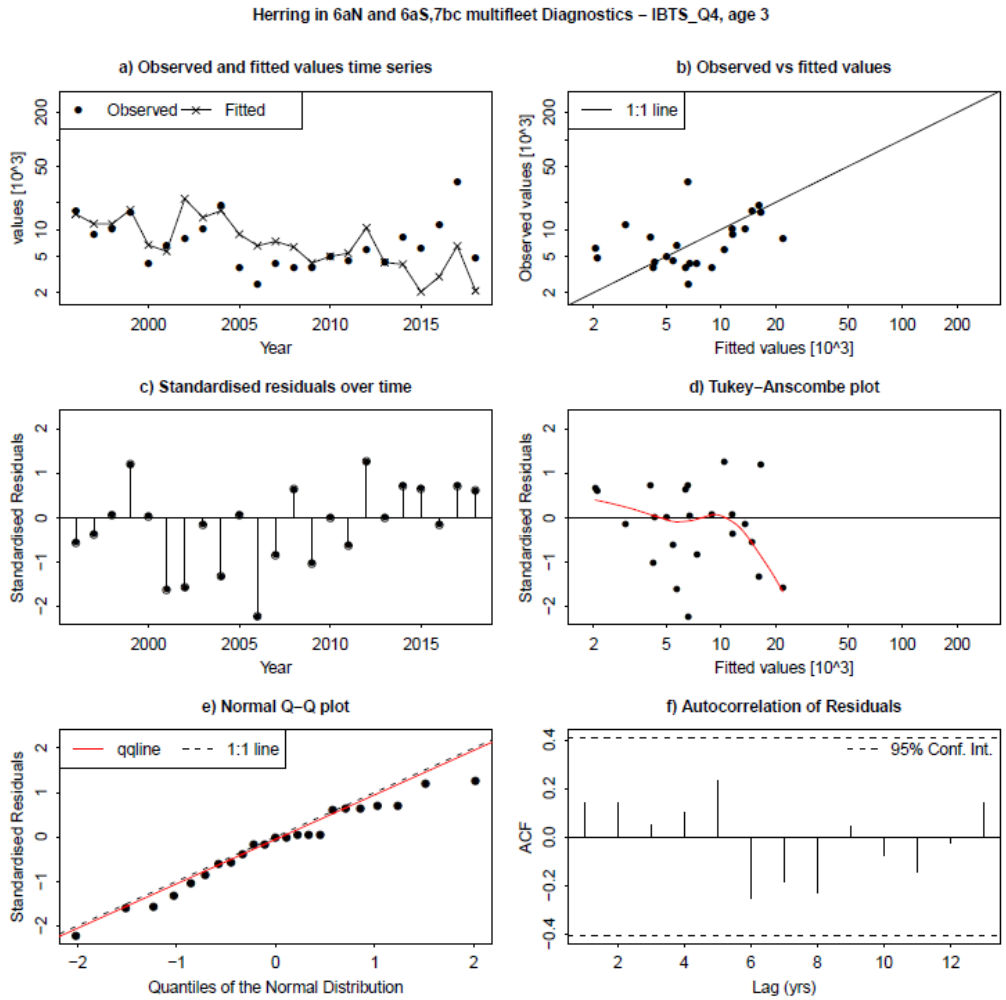

Figure 4.6.51. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 3-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 3-winter ring. Middle right: index observation versus standardized residuals at 3-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

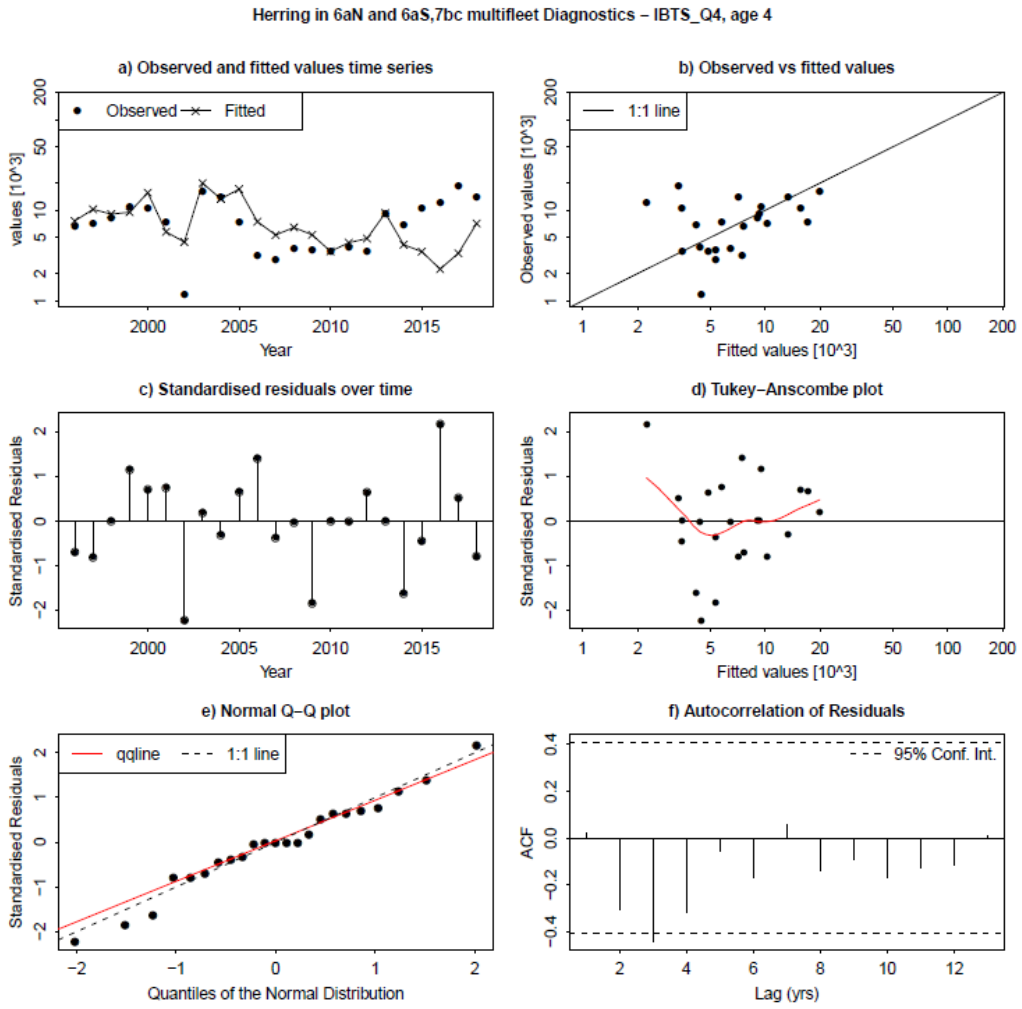

Figure 4.6.52. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 4-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 4-winter ring. Middle right: index observation versus standardized residuals at 4-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

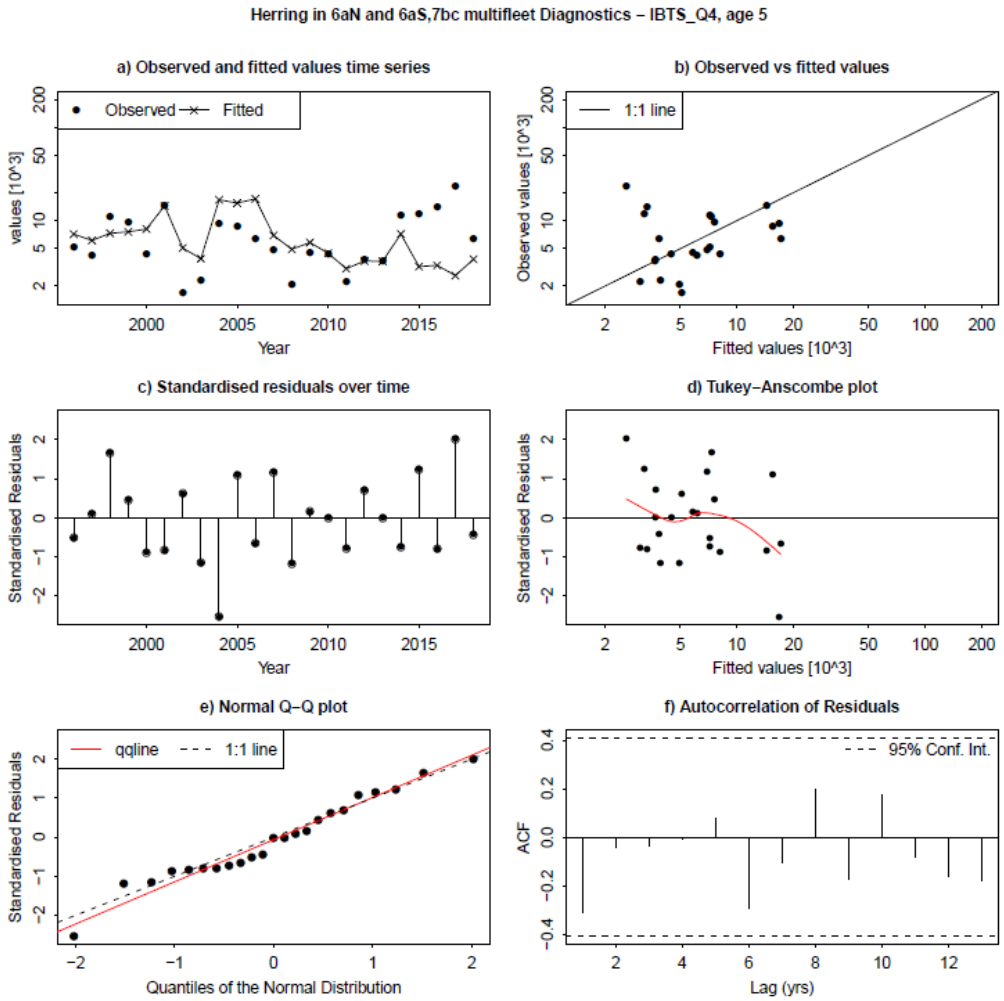

Figure 4.6.53. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 5-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 5-winter ring. Middle right: index observation versus standardized residuals at 5-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

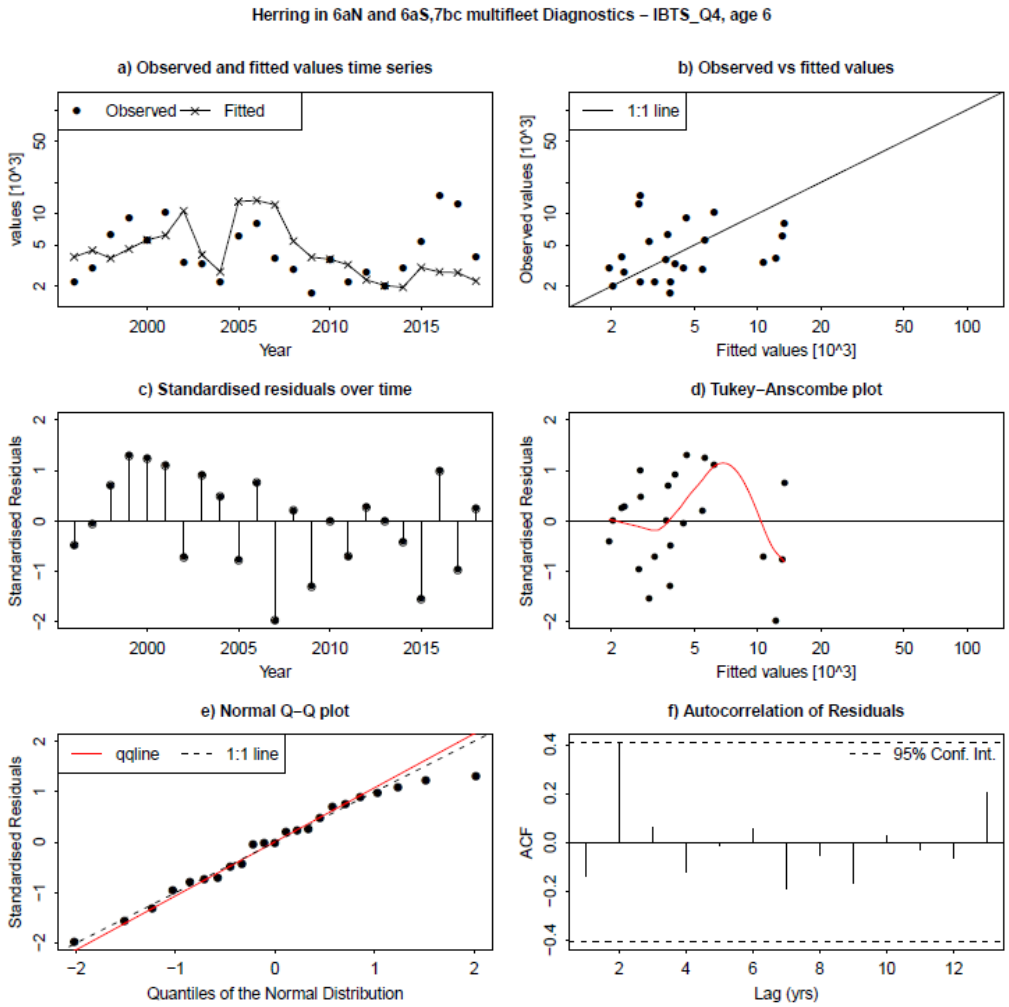

Figure 4.6.54. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 6-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 6-winter ring. Middle right: index observation versus standardized residuals at 6-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

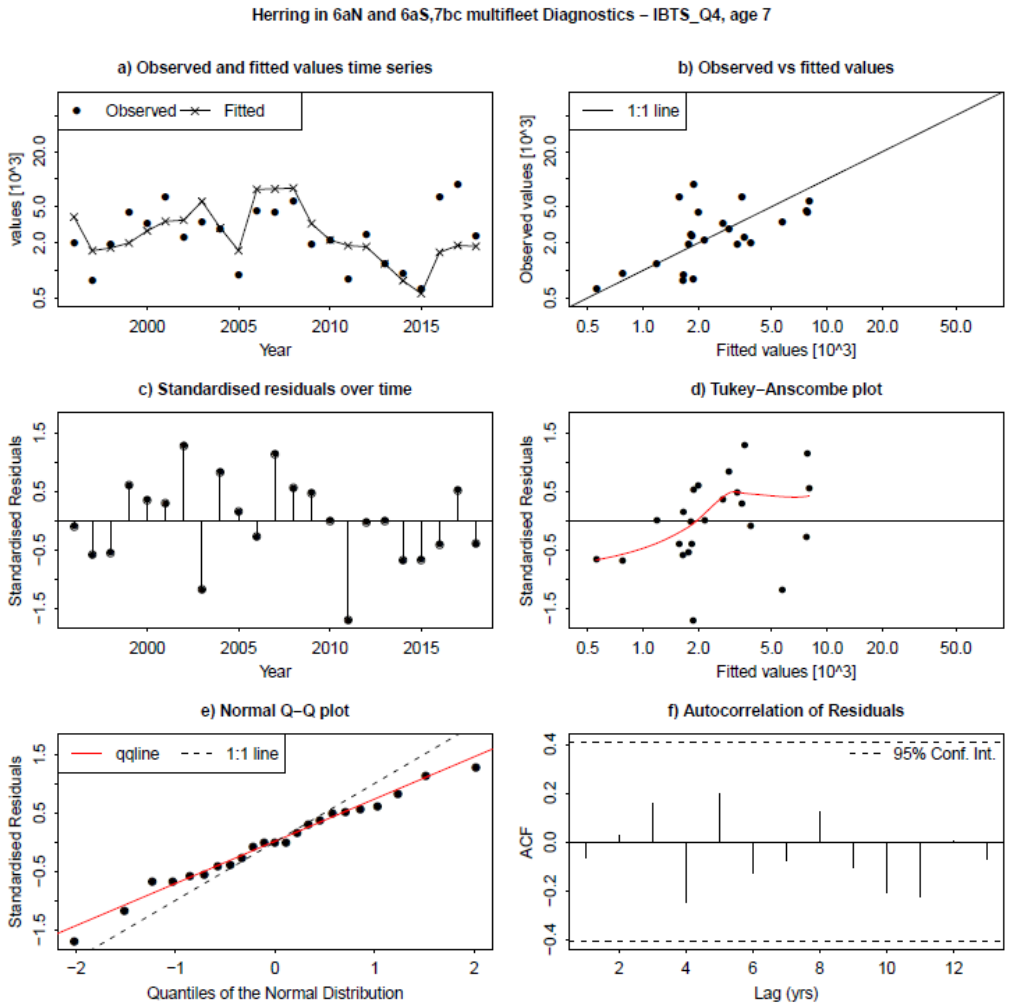

Figure 4.6.55. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 7-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 7-winter ring. Middle right: index observation versus standardized residuals at 7-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

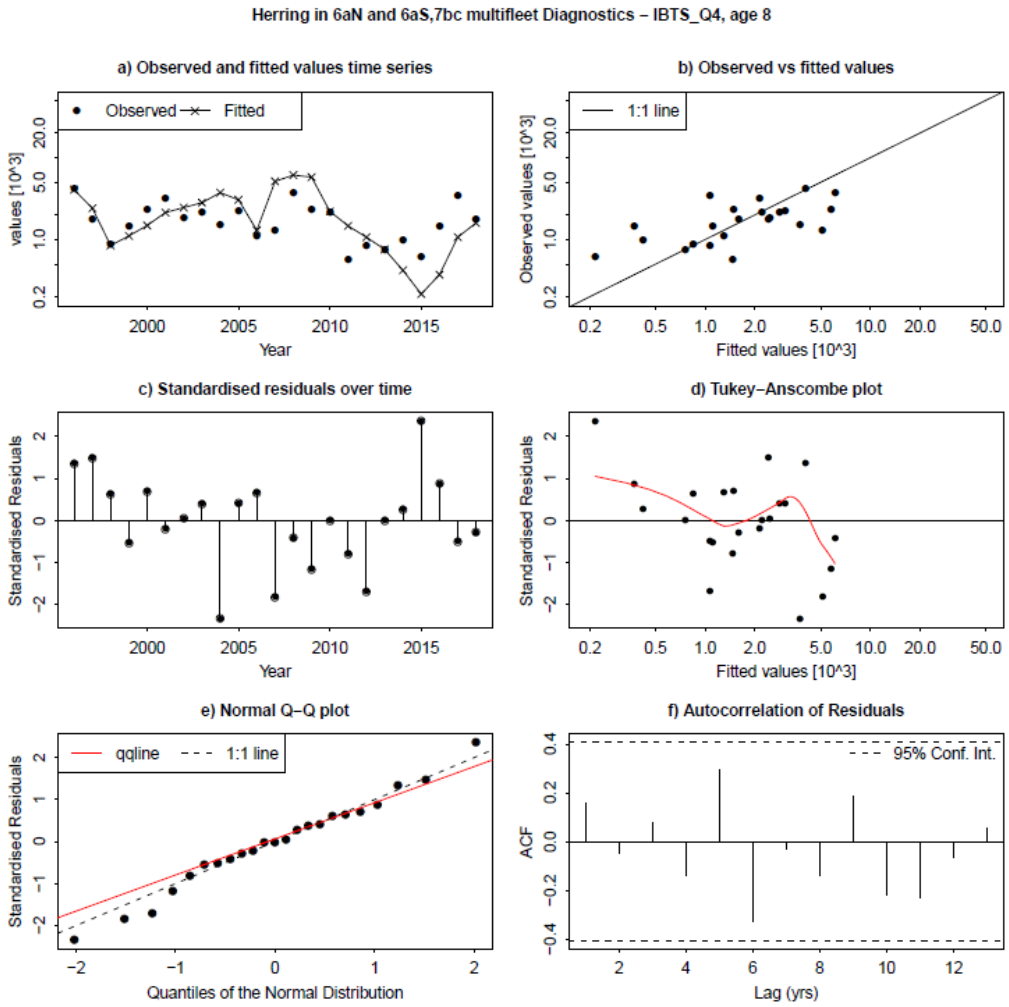

Figure 4.6.56. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 8-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 8-winter ring. Middle right: index observation versus standardized residuals at 8-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

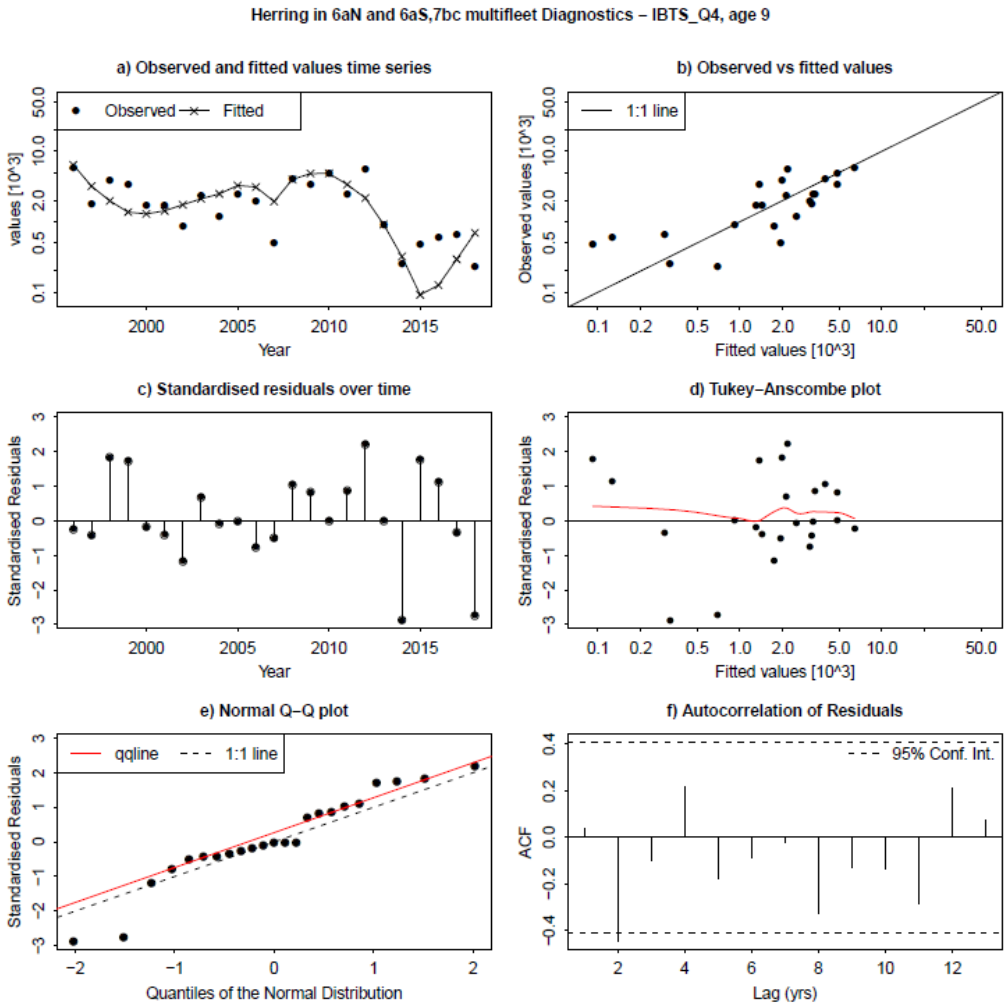

Figure 4.6.57. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: scatterplot of index observations versus assessment model estimates of numbers at 9-winter ring with the best-fit catchability model (linear function). Middle left: Time-series of standardized residuals of the index at 9-winter ring. Middle right: index observation versus standardized residuals at 9-winter ring. Bottom left: normal Q-Q plot of standardized residuals. Bottom right: Autocorrelation of residuals plot.

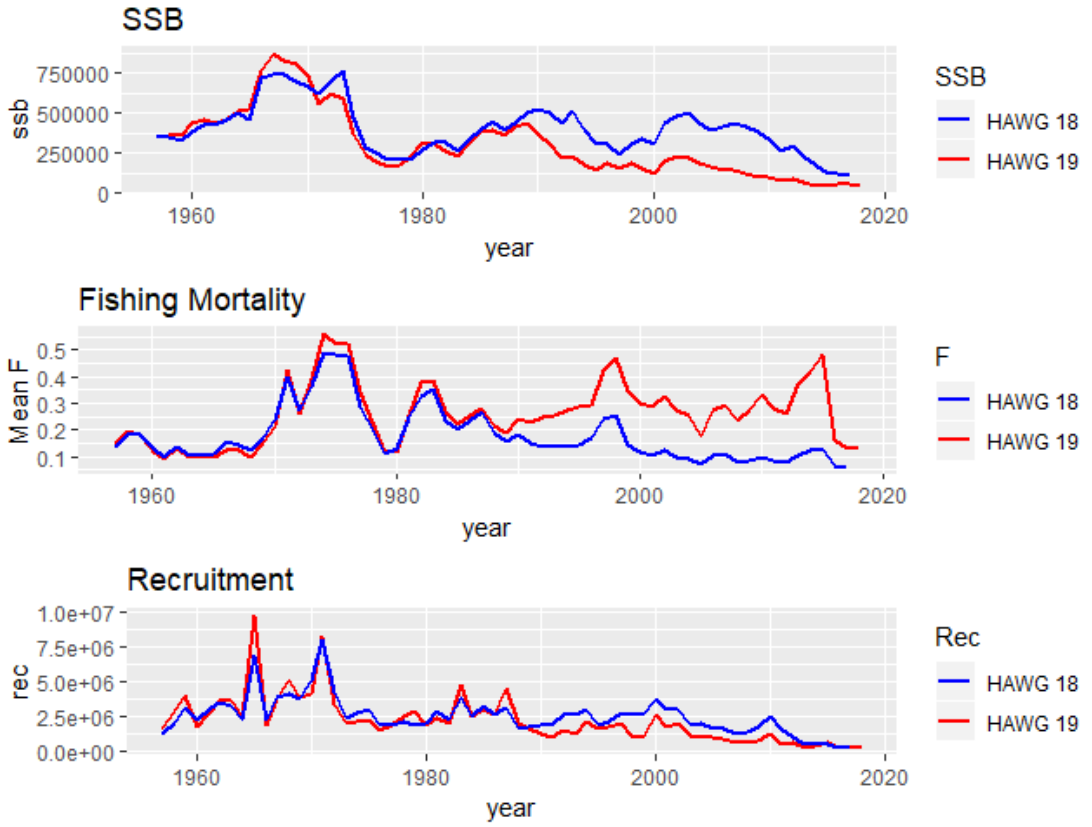

Figure 4.6.58. Herring in 6.a (combined) and 7.b–c. Perception of stock estimates in the 2018 and 2019 HAWG assessments.