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

This is the seventh 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 2016–2020

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 The management plans in place for either stock were no longer applicable for the combined stocks.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), 2018 (EU2018/120), and 2019 (EU 2019/124). This was reduced to 4840 t, split of 3480 t in 6.aN and 1360 t in 6.aS and 7.b-c for 2020 (EU 2020/123).

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.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, 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.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 between 2016 – 2019, and 4840 t in 2020, 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° 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 (56° parallel) is also 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 2020

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 2018 and 2019 year class (age 1 and 2-wr) dominates both the catches and the survey indices in 2020. Previously strong cohorts (2013) are less influential in the stock with small amounts of older fish present.

4.3 Fishery-independent Information

4.3.1 Acoustic surveys (A9526 & A9481)

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 2020 as well as maintaining coverage of the original survey area in 6.aN.

The Malin Shelf herring estimate of SSB for 2020 is 226 000 tonnes and 1435 million individuals (Table 4.3.1.2), an increase compared to the 128 000 tonnes and 740 million herring estimate in 2019. The estimate is still very low in the time-series (Table 4.3.1.3). In 2019 and 2020, 55% and 60% of the biomass was observed north of 56°N (the geographic area included in the West of Scotland (6.aN index). This is not typical for the time-series; generally, the vast majority of herring are found north of 56°N. For instance, in 2018, 86% of the biomass was observed north of 56°N. The West of Scotland (6.aN) estimate of SSB is 158 000 tonnes and 943 million individuals (Table 5.2.4), a large increase compared to the 76 000 tonnes and 406 million herring estimate in 2019, and more in line with the 152 000 tonnes and 975 million herring estimated in 2018. Long-term indices of abundance per age class for West of Scotland herring are provided in Table 5.2.5. In 2019, the total biomass of herring located in 6.aS and 7.b–c during the MSHAS was 163 000 tonnes compared to 66 500 tonnes in 2019 and 34 900t in 2018.

Herring has in the past been found in high densities to the east of the 4°W line in association with a specific bathy- metric 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 is some evidence that this was the case in 2019 again. 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. The 2013-year class (age 6 winter rings in 2020) are still relatively strong in the stock and comprised 6% of total abundance and 18% of the spawning stock biomass. The stock is otherwise dominated by 1- and 2 winter ringers (2018 and 2019 year classes), making up 66% of the abundance and 52% of the biomass. 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 summer acoustic surveys.

4.3.1.1 Industry–Science Acoustic survey

In 2016–2020 industry acoustic surveys of herring during the spawning and prespawning period were undertaken as part of the monitoring fishery on this stock. The surveys cover 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, 2021) and a summary for each of the components is in Section 05 of this report. Consistent with observations from the HERAS survey on the Malin shelf, the industry acoustic/trawl survey in 6aN recorded an abundance of 1-2 WR herring in several hauls. The relative length frequency distributions from the survey samples are presented in Figure 4.3.1.1.1.

4.3.2 Scottish Bottom-trawl surveys (SCOWGFS G4748 and G4815 and SWC-IBTS G1179 and G4299)

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 Groundfish 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 parts 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 in both the Q1 and Q4 indices (figures 4.3.2.1 and 4.3.2.2)..

The abundance of 2 winter ring fish was 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). The stronger 2013 year-class which was age 6 wr in 2020 is still evident especially in Q1, but its effect on overall stock size is waning and overall abundance has decreased in both quarters. 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 2020 the catch weights have decreased markedly across age classes, due to the very low catch in 6a.N, leading to the slower growing 6.aS, 7.bc forming a larger than typical share of the catch.

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 2020 (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 and 4-wr in 2020 were similar to 2019. A lower proportion of mature 3 wr fish were found in 2020 (75%) than in 2019 (90%). In 2016 and 2017 (Figure 4.4.2.1) almost 100% of 3 wr fish were mature. A greater proportion of immature fish were encountered in the surveys in 2018-2020 than in 2016-2017.

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 multifleet 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 larger proportion of 1 winter ring fish but this is variable between years. In 2018, 2019 and 2020 the age profile of the catch data has diverged somewhat from that of the surveys, which may represent the effect of the switch to the monitoring fishery.

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 of both numbers-at-age and biomass were higher in 2020 compared to 2018 and 2019. 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 dataset 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 and from the acoustic survey 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. 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 concern in this 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 1957–2020. 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 2016–2021 and the resulting monitoring fishery has decreased F.

The analytical retrospective for this stock is shown in Figure 4.6.12. The changes applied to the assessment following the interbenchmark have improved the retrospective. A retrospective pattern is still present however the Mohn's Rho on 5 year peels in the 2021 assessment of SSB is -0.12, down from -0.17 in 2020 and -0.23 in 2019.

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.

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 2020 is estimated to have increased by 38% from 2019 levels, however it remains at a very low level relative to the long term mean. Recruitment has been low with no big cohorts evident in recent years. Recent catches have been among the lowest in the time-series.

4.7 Short-term Projections

4.7.1 Short-term projections

Given the current zero catch advice for herring, in divisions 6.a and 7.b–c and that a monitoring TAC has been agreed for 2021, exploratory forecasts were carried out with different catches assumed in the intermediate year (2021).

The two scenarios considered were

1. Full Uptake of the monitoring TAC (4840 t) in the intermediate year (2021).
2. Partial uptake of the monitoring TAC (1540 t) in the intermediate year (2021). This assumes full uptake in 6aS, 7b-c (1360 t) and uptake based on the 2020 catches in 6aN (180 t).

The results of these forecasts are presented in Tables 4.7.1.1-Table 4.7.1.4. All catch options show an increase in SSB in 2022 (17-21%) and a small decrease in SSB in 2023 (4-5%).

4.7.2 Yield-per-recruit

No yield-per-recruit analysis was conducted at HAWG 2021.

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. A full benchmark will be carried out in early 2022 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 inter-

benchmark 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 remains at a very low level. In this assessment, estimates of recruitment in 2019 and 2020, while still well below the long term average, are estimated to be stronger than any year since 2010 and 2002 respectively. There is, however, considerable uncertainty about these estimates. Since 2012, there have been very few 1-wr herring observed in the 6.a (combined) and 7.b–c fishery. An increase in the proportion of 1 winter ring fish in the catch data was seen in 2019, corresponding to an increase in the number of 2 winter ring fish in 2020 in 6.a (south) and 7.b-c. Catch data in 6.a (north) was insufficient to track cohorts.

The assessment shows a similar perception of the stock to the 2020 assessment, with an improving retrospective pattern.

Concerns remain as to 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 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 in 6.aN and 6.aS/7.bc are not of 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 overexploited. There is a clear need to determine the relative stock sizes and to ensure that exploitation is properly balanced to productivity to protect either component from overexploitation.

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 was carried out to assess the identity of herring stocks in this area through genetics, body morphometric and otolith shape analysis. The project aimed to develop methods, which can be used in future to discriminate the stocks even during times of mixing. The final results of this project were delivered at the end of 2020 and a final report available in April 2021 (Farrell, et al 2021). The genetic assignments developed during this project will be used as the basis for splitting survey indices into the different populations. This results of this will be presented at the benchmark data meeting in late 2021.

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 2016–2019 and agreed for 2020 (4 840 t) is associated with decreased F and a continuation of the catch sampling programme.

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.

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 2020. Mean weights, mean lengths and fraction mature by age ring.

Age (ring)	Numbers	Biomass	Maturity	Weight (g)	Length (cm)
0	0	0.0	0.00	0.0	0.0
1	1175	68.1	0.00	58.0	19.0
2	1226	142.0	0.32	115.8	23.4
3	609	85.6	0.68	140.5	24.9
4	235	38.3	1.00	163.0	26.2
5	110	19.6	1.00	178.4	27.0
6	209	41.1	1.00	196.9	27.8
7	42	8.9	1.00	211.5	28.5
8	18	3.8	1.00	214.2	28.4
9+	10	2.4	1.00	231.1	29.6

Immature	2199	184		83.6	21.0
Mature	1435	226		157.4	25.7
Total	3634	410	0.39	112.8	22.9

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 2020.

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

Year\Age (Rings)	1	2	3	4	5	6	7	8	9	SSB
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
2019	24	231	225	123	169	95	14	17	21	128
2020	1175	1226	609	235	110	209	42	18	10	226

TABLE 4.6.1 Herring in 6a and 7bc. CATCH IN NUMBER

Units : thousands

year

age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1	6496	15695	54063	3940	14473	55278	11890	26609	299701	211675	207947
2	80817	33616	74615	115501	50809	99167	82849	87652	23351	517616	28648
3	66094	152801	38547	65703	72914	27189	57688	74309	72085	45317	273723
4	26882	43895	124307	25388	38321	76706	13310	29583	67768	70793	49755
5	38989	28108	27898	50558	24455	49002	42796	8857	24525	38471	48320
6	21547	32025	18942	12196	14296	22707	28698	27075	7001	22691	36143
7	9643	19986	18833	11096	5791	27787	10171	21347	28806	12656	15226

```
  8  1658  10795   8158   6770  5370  7614 14585 10109  21475  20790  10397
  9  4817   8887   9364   4856  2887  8435  7885 17655  23515  33175  33967
   year
age   1968   1969   1970   1971   1972   1973   1974   1975   1976   1977  1978
  1 220870  39160 238361 208594 535964  57593 312390 180239  85666  39321 32695
  2 105348 107189 134128 341260 650282 276017 154350 243395 348615  92251 86604
  3  26031  84565 279726 419854 195671 855656 192141 114183 139060 109230 47666
  4 243304  27604 125140 313064  60396 148347 563757  92893  62046  39293 54000
  5  19679 264558  31636 110783  77859  70503 100323 211920  50512  22292 17564
  6  28436  25795 182580  29495  35773  67025  58565  41304  91289  22135  9189
  7  17699  45908  24591 194977  14585  27433  45530  18206  16126  26526  6370
  8   7275  27932  28740  19104 102945   8475  32742  22499   7510   4118  9916
  9  14389  29258  25993  34159  20936  83203  51591  45727  27717   5636  4868
   year
age  1979  1980   1981   1982   1983   1984   1985   1986   1987   1988   1989
  1  6166  5548  38360  14052  83440   5001  50400  34686  31612   1708   8457
  2 50213 40337 100226 268146 121498 270259  83988 182073 110114 148511  43682
  3 19238 65041 147394  89183 142277  78488 215754 113890 125676  88035 188343
  4 19988 25191  92801 121764  54578  52855  29970 185243  73529  69429  45072
  5  9362 22139  34285  76732  74317  22138  26452  33480 149341  43142  39590
  6  8430  7757  25369  31701  45638  24202  14269  25988  23655  74247  22597
  7  5447  6954  15044  15605  21404  15274  16092   8274  19946  10198  39929
  8  4424  4345   4044  17063  11766   6435  10910   6849   9590   4704   5835
  9  4090  5334   6546   6902  12735   5979   4357   4098  16170   4324   6541
   year
age   1990   1991   1992   1993  1994   1995   1996   1997   1998   1999  2000
  1  15172  27071   7845  17910 13437    550   6728   8651  16529  10027  8612
  2  65844  57450  39988 115850 92710 116647  62278 112139 146944  86506 57525
  3  60279  53039  67454  41376 71418  65812 100206  60912 115183 155239 60750
  4 226257  40632  50572  52945 22884  39889  40347  70399  70231  59979 82126
  5  50882 137961  34382  36648 29205  24509  17350  37701  53037  23456 28850
  6  33469  31454 107176  28348 21745  20286  17815  23477  23510  13416 11737
  7  26192  22446  14886  86451 19112  14554  12858  18682  13923   5131  5362
  8  29640  18203  12520  12382 43887  16556  20921   8631   6259   2343  2526
  9   6652  12116  11797   9753 20299  24002  37580  14147   6269   2038  2178
   year
age   2001   2002  2003  2004  2005  2006  2007  2008  2009  2010  2011  2012
```

1	2463	5050	1787	1401	392	730	207	483	2126	11345	1788	6122
2	105035	71122	66151	22358	37756	28727	58903	20163	24083	33847	54795	27797
3	37149	131724	75580	56475	54133	45886	61713	32700	22553	36458	25098	63034
4	27103	27896	77956	49142	47489	44226	29954	33911	28683	16499	19448	13746
5	43625	29737	16895	57400	21012	63024	28003	14330	20906	22196	10576	9873
6	19498	38231	9521	9076	15235	36862	36040	11678	10928	13102	8851	6865
7	8555	11787	15343	9647	2363	23391	23342	17570	9555	6885	6035	4415
8	5769	3153	10111	9999	2053	3874	13816	8887	12647	6050	3591	1233
9	1537	2067	1711	4589	1674	5458	4374	9236	9461	13388	7321	4035

age	2013	2014	2015	2016	2017	2018	2019	2020
1	61	34	258	81	30	6	3499	285
2	16799	9171	12697	10131	2173	3076	3960	5275
3	22714	23970	14536	7593	17171	5054	4294	2889
4	65355	27799	18270	4566	8160	10153	3517	1938
5	13347	54375	21086	5816	3101	7542	4995	753
6	8885	9537	22306	4906	3694	3681	2169	874
7	5524	3989	6493	3972	2478	1545	596	382
8	4707	3291	1942	782	1247	1112	543	110
9	5234	3715	1251	440	349	710	213	69

TABLE 4.6.2 Herring in 6a and 7bc. WEIGHTS AT AGE IN THE CATCH

Units : kg

age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	0.079	0.079	0.080	0.086	0.085	0.079	0.080	0.079	0.079	0.079	0.079	0.079
2	0.108	0.109	0.107	0.112	0.111	0.107	0.108	0.108	0.109	0.105	0.105	0.106
3	0.139	0.134	0.134	0.138	0.142	0.140	0.137	0.136	0.136	0.139	0.137	0.135
4	0.161	0.167	0.161	0.168	0.169	0.165	0.170	0.169	0.164	0.163	0.166	0.165
5	0.176	0.176	0.171	0.168	0.172	0.171	0.171	0.187	0.170	0.215	0.172	0.173
6	0.178	0.185	0.176	0.176	0.185	0.180	0.182	0.185	0.188	0.178	0.179	0.176
7	0.188	0.195	0.187	0.189	0.189	0.191	0.201	0.198	0.194	0.209	0.192	0.184
8	0.199	0.193	0.190	0.192	0.195	0.199	0.192	0.202	0.191	0.191	0.208	0.188
9	0.194	0.209	0.191	0.192	0.198	0.199	0.220	0.207	0.197	0.195	0.198	0.195

age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980

1	0.080	0.079	0.079	0.079	0.092	0.090	0.091	0.094	0.092	0.096	0.109	0.100
2	0.108	0.111	0.104	0.105	0.122	0.123	0.122	0.122	0.125	0.125	0.129	0.129
3	0.136	0.133	0.131	0.134	0.158	0.159	0.160	0.160	0.159	0.162	0.165	0.165
4	0.164	0.161	0.159	0.161	0.177	0.176	0.180	0.182	0.182	0.179	0.191	0.191
5	0.174	0.170	0.168	0.170	0.188	0.190	0.189	0.198	0.199	0.200	0.209	0.209
6	0.181	0.181	0.177	0.185	0.209	0.208	0.210	0.209	0.213	0.215	0.222	0.222
7	0.184	0.186	0.191	0.195	0.222	0.221	0.222	0.222	0.221	0.227	0.231	0.231
8	0.187	0.186	0.189	0.208	0.227	0.228	0.229	0.230	0.228	0.229	0.237	0.237
9	0.192	0.189	0.189	0.197	0.234	0.234	0.236	0.234	0.237	0.236	0.241	0.241

year

age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.091	0.082	0.080	0.095	0.071	0.113	0.078	0.080	0.081	0.080	0.084	0.092
2	0.123	0.139	0.136	0.140	0.106	0.144	0.127	0.109	0.140	0.132	0.128	0.128
3	0.160	0.173	0.172	0.177	0.142	0.171	0.162	0.144	0.143	0.165	0.152	0.160
4	0.180	0.202	0.199	0.207	0.171	0.195	0.187	0.163	0.175	0.167	0.189	0.175
5	0.195	0.226	0.222	0.229	0.188	0.214	0.191	0.183	0.181	0.193	0.179	0.204
6	0.214	0.245	0.241	0.245	0.203	0.228	0.209	0.180	0.193	0.203	0.204	0.186
7	0.221	0.260	0.258	0.259	0.212	0.240	0.218	0.201	0.201	0.207	0.211	0.207
8	0.233	0.275	0.271	0.272	0.224	0.217	0.229	0.201	0.196	0.229	0.227	0.215
9	0.238	0.273	0.277	0.263	0.231	0.274	0.233	0.216	0.224	0.242	0.245	0.236

year

age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.089	0.081	0.093	0.084	0.092	0.096	0.083	0.092	0.084	0.099	0.101	0.085
2	0.130	0.141	0.141	0.134	0.135	0.137	0.138	0.132	0.136	0.137	0.139	0.145
3	0.155	0.166	0.170	0.174	0.168	0.149	0.153	0.157	0.149	0.156	0.156	0.160
4	0.176	0.180	0.183	0.188	0.192	0.177	0.168	0.179	0.173	0.161	0.168	0.184
5	0.190	0.191	0.186	0.212	0.214	0.194	0.189	0.192	0.188	0.166	0.184	0.211
6	0.207	0.192	0.201	0.212	0.221	0.209	0.203	0.208	0.192	0.183	0.198	0.205
7	0.202	0.220	0.202	0.235	0.218	0.218	0.216	0.230	0.208	0.190	0.198	0.202
8	0.242	0.212	0.216	0.239	0.235	0.217	0.220	0.260	0.224	0.231	0.188	0.192
9	0.246	0.243	0.241	0.282	0.256	0.207	0.224	0.217	0.252	0.263	0.282	0.302

year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.107	0.103	0.116	0.111	0.109	0.084	0.064	0.087	0.083	0.105	0.078	0.091
2	0.134	0.142	0.157	0.157	0.159	0.145	0.146	0.141	0.140	0.145	0.138	0.140
3	0.156	0.146	0.157	0.172	0.191	0.177	0.171	0.187	0.168	0.169	0.178	0.162
4	0.172	0.169	0.174	0.176	0.219	0.203	0.197	0.204	0.192	0.191	0.198	0.192

5	0.192	0.194	0.195	0.188	0.218	0.223	0.221	0.216	0.199	0.215	0.209	0.200
6	0.212	0.213	0.216	0.216	0.231	0.225	0.223	0.227	0.209	0.227	0.229	0.212
7	0.215	0.240	0.215	0.244	0.249	0.230	0.233	0.239	0.228	0.241	0.238	0.227
8	0.248	0.253	0.261	0.277	0.252	0.238	0.239	0.278	0.234	0.251	0.245	0.249
9	0.256	0.273	0.301	0.286	0.273	0.255	0.252	0.247	0.247	0.278	0.269	0.256

age	2017	2018	2019	2020
1	0.072	0.085	0.074	0.066
2	0.122	0.113	0.109	0.092
3	0.156	0.142	0.132	0.109
4	0.166	0.164	0.167	0.124
5	0.189	0.179	0.184	0.143
6	0.186	0.201	0.185	0.155
7	0.200	0.197	0.194	0.169
8	0.212	0.222	0.186	0.156
9	0.234	0.243	0.187	0.183

TABLE 4.6.3 Herring in 6a and 7bc. WEIGHTS AT AGE IN THE STOCK

Units : kg

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

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 0.1300 0.135 0.168 0.172 0.151 0.162 0.132 0.150 0.15500000 0.108
  3 0.1540 0.166 0.183 0.191 0.206 0.194 0.160 0.183 0.16500000 0.158
  4 0.1670 0.185 0.191 0.208 0.223 0.227 0.208 0.189 0.20200000 0.180
  5 0.1800 0.192 0.195 0.214 0.233 0.239 0.236 0.206 0.21000000 0.206
  6 0.1910 0.204 0.195 0.214 0.231 0.248 0.245 0.217 0.23600000 0.214
  7 0.2130 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	0.2280	0.231	0.214	0.238	0.238	0.212	0.253	0.215	0.25400000	0.264

year						
age	2015	2016	2017	2018	2019	2020
1	0.06373333	0.06373333	0.06373333	0.06373333	0.06373333	0.06373333
2	0.15500000	0.13700000	0.13500000	0.11000000	0.11700000	0.12600000
3	0.18300000	0.14000000	0.17000000	0.15500000	0.15000000	0.15100000
4	0.19500000	0.17500000	0.18100000	0.17600000	0.17900000	0.17100000
5	0.20400000	0.20200000	0.19800000	0.19000000	0.19600000	0.18400000
6	0.21100000	0.20800000	0.19900000	0.21000000	0.20500000	0.20200000
7	0.21700000	0.20900000	0.21400000	0.20900000	0.21700000	0.21500000
8	0.21500000	0.21000000	0.22300000	0.21800000	0.22400000	0.21700000
9	0.22000000	0.24200000	0.23600000	0.22200000	0.21800000	0.23100000

TABLE 4.6.4 Herring in 6a and 7bc. 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
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	2013	2014	2015	2016	2017	2018	2019	2020
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

TABLE 4.6.5 Herring in 6a and 7bc. PROPORTION MATURE

Units : NA

year															
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

year															
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

year															
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	2019	2020
1	0.00	0.00	0.00	0.00
2	0.95	0.40	0.43	0.46
3	1.00	0.85	0.90	0.75
4	1.00	0.98	1.00	1.00
5	1.00	0.98	1.00	1.00
6	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00

TABLE 4.6.6 Herring in 6a and 7bc. 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	2019	2020
1	0.67	0.67	0.67	0.67
2	0.67	0.67	0.67	0.67

3	0.67	0.67	0.67	0.67
4	0.67	0.67	0.67	0.67
5	0.67	0.67	0.67	0.67
6	0.67	0.67	0.67	0.67
7	0.67	0.67	0.67	0.67
8	0.67	0.67	0.67	0.67
9	0.67	0.67	0.67	0.67

TABLE 4.6.7 Herring in 6a and 7bc. 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	2019	2020
1	0.67	0.67	0.67	0.67
2	0.67	0.67	0.67	0.67
3	0.67	0.67	0.67	0.67
4	0.67	0.67	0.67	0.67
5	0.67	0.67	0.67	0.67
6	0.67	0.67	0.67	0.67
7	0.67	0.67	0.67	0.67
8	0.67	0.67	0.67	0.67
9	0.67	0.67	0.67	0.67

TABLE 4.6.8 Herring in 6a and 7bc. SURVEY INDICES

```
WOS_MSHAS - Configuration

Malin Shelf assessment  . Imported from VPA file.
      min       max plusgroup   minyear   maxyear    startf      endf
     1.00      9.00      9.00   1991.00   2020.00      0.52      0.57
Index type : number

WOS_MSHAS - 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   2019    2020
  1  62834 796012     -1 1012160     -1     -1     -1 1287728  24011 1174546
```

2	257258	548481	209403	277504	212467	29593	25426	447304	231310	1226180
3	899637	832257	434425	241674	396545	108126	338563	106491	224691	609403
4	484732	517267	671507	502471	747121	87773	155357	342609	122704	235219
5	212913	249024	194706	534431	423139	111676	105728	153194	169202	109825
6	227515	114507	70507	148259	476249	79130	110226	51928	95226	208543
7	205093	111385	61392	32565	90102	62045	47158	72276	14485	42037
8	113298	56526	28597	18677	23931	5530	13069	26636	16839	17781
9	263837	104571	37398	13003	2086	957	4721	12887	21113	10495

IBTS_Q1 - Configuration

Malin Shelf assessment . Imported from VPA file.

min	max	plusgroup	minyear	maxyear	startf	endf
2.00	9.00	9.00	1997.00	2020.00	0.00	0.25

Index type : number

IBTS_Q1 - Index Values

Units : NA

year										
age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
2	102570	8604	78192	81810	80911	36889	107012	97048	119263	254674	25294
3	175949	48593	311999	128644	74495	145883	117986	323390	136461	321912	77348
4	84804	33925	197058	167097	55846	38200	122297	196806	279782	144542	50369
5	29128	16914	88257	69200	104206	15123	20574	196390	219800	390607	45323
6	20409	5879	38894	60327	55815	42052	15851	53047	211784	379889	80054
7	11742	6933	26446	32652	42177	13886	29896	48651	30304	226230	61328
8	27953	2668	18926	9590	18492	14425	13192	55728	63030	37997	33408
9	27223	7411	31068	17727	19703	15951	17391	49353	56681	111004	30862

year										
age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2	26413	39960	13671	85727	8348	49739	8635	4877	11977	5905	6445
3	32251	81500	39015	95261	117952	51240	34463	8627	18638	55938	28640
4	34616	79777	20855	80806	46095	111007	26037	22638	6798	22971	198984
5	27254	79270	20022	40123	25576	46691	43654	10460	14785	11185	46187
6	24567	59290	21239	47967	13617	37813	8287	12750	18521	11843	35126
7	30661	55935	23288	35036	13111	26229	5504	3740	6151	10785	17461

```
  8 35212  98504 18939 27134  10996  23004  5236  3135  1396  5825  14331
  9 21896 119197 40723 74931  29733  34201  5112   986   598  3167   5411
   year
age   2019  2020
  2   7889  7645
  3  18175 12111
  4  29504  7537
  5 112902  6205
  6  13339 28441
  7   9542  4448
  8   6376  4023
  9   5991  5506

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   2020.00      0.75      1.00
Index type : number

IBTS_Q4 - Index Values

Units  :  NA
   year
age  1996  1997  1998  1999  2000  2001 2002  2003  2004 2005 2006 2007 2008
  2 16909 13398 12430  6649  5468 32480 9940 14459 15894 5181 6811 6786 3018
  3 16090  8730 10050 15452  4130  6612 7696  9878 18196 3707 2383 4038 3669
  4  6688  6728  8166 10630 10052  7071 1134 15392 13176 7075 3053 2659 3515
  5  5224  4243 11176  9829  4409 14695 1715  2286  9045 8771 6315 4877 2107
  6  2237  3113  6433  9196  5744 10462 3403  3311  2177 6096 7959 3711 2970
  7  2059   780  1960  4431  3307  6458 2294  3434  2812  907 4440 4360 5672
  8  4133  1734   876  1441  2274  3162 1781  2111  1474 2177 1062 1252 3580
  9  5665  1707  3713  3281  1665  1649  827  2264  1143 2452 1875  466 3897
   year
age 2009 2010  2011 2012 2013  2014  2015  2016  2017  2018 2019 2020
  2 7138   NA 10250 2143   NA  3354  6161 13158  5480  3806 2409 6610
  3 3623   NA  4460 5790   NA  7920  5975 10953 31449  4475 1958  865
```

```
  4 3460   NA  3713 3450   NA  6477  9724 11277 16558 12982 2406 1288
  5 4625   NA  2211 3773   NA 11445 11463 14003 22941  6280 4456 1543
  6 1760   NA  2149 2668   NA  2983  5252 14743 11878  3701 2562 1911
  7 1980   NA   818 2549   NA   922   640  6358  8563  2400 1813  380
  8 2245   NA   538  840   NA   939   592  1406  3208  1682  722  421
  9 3236   NA  2311 5492   NA   244   460   589   617   222  726  468
```

TABLE 4.6.9 Herring in 6a and 7bc. STOCK OBJECT CONFIGURATION

```
      min       max plusgroup    minyear    maxyear    minfbar    maxfbar
        1         9         9       1957       2020          3          6
```

TABLE 4.6.10 Herring in 6a and 7bc. sam CONFIGURATION SETTINGS

```
name           : Herring in 6aN and 6aS,7bc multifleet
desc            : Imported from a VPA file. ( ./data/index.txt ).  Mon Mar 29
18:00:30 2021
range          :        min       max plusgroup    minyear    maxyear    minfbar
maxfbar
range          :          1         9         9       1957       2020          3
6
fleets         :   catch N   catch S WOS_MSHAS   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         :   WOS_MSHAS -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 :   WOS_MSHAS  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 :   WOS_MSHAS -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         :   WOS_MSHAS -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       :   WOS_MSHAS  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 6a and 7bc. FLR, R SOFTWARE VERSIONS

FLSAM.version	2.1.1
FLCore.version	2.6.15
R.version	R version 3.6.3 (2020-02-29)
platform	x86_64-w64-mingw32
run.date	2021-03-29 18:05:58

TABLE 4.6.12 Herring in 6a and 7bc. STOCK SUMMARY

Year	Recruitment Age 1	Low	High	TSB	Low	High	SSB	Low	High	Fbar (Ages 3-6)	Low	High	Landings f	Landings tonnes	Landings SOP
1957	1666802	1078079	2577016	767290	584400	1007416	354434	262672	478254	0.1510	0.1041	0.2191	48508	0.7531	
1958	2921925	1921963	4442148	836794	638339	1096947	362050	264905	494819	0.1953	0.1341	0.2842	66494	0.7733	
1959	4027555	2659241	6099937	975963	739520	1288002	366629	267713	502092	0.1776	0.1201	0.2626	70447	0.7446	
1960	1613618	1049378	2481245	893413	682355	1169753	446263	330117	603273	0.1246	0.0850	0.1826	69160	0.6012	
1961	2637163	1752234	3969008	910073	702003	1179813	460765	343377	618285	0.0893	0.0626	0.1272	52535	0.6332	
1962	3583533	2397924	5355347	1002361	779986	1288136	432542	325182	575347	0.1315	0.0934	0.1852	65594	0.7990	
1963	3616950	2431811	5379663	1065633	834068	1361489	459274	349961	602730	0.1010	0.0720	0.1417	54089	0.7245	
1964	2511576	1684231	3745339	1045370	829696	1317108	514580	397535	666086	0.0954	0.0689	0.1320	70403	0.6145	
1965	10422401	6786407	16006472	1722886	1310390	2265232	519935	405753	666250	0.0998	0.0729	0.1366	76685	0.8730	
1966	1814645	1219171	2700965	1614060	1271026	2049675	780345	611056	996533	0.1229	0.0908	0.1664	112834	1.0130	
1967	3794868	2605341	5527499	1630596	1322397	2010624	887509	692853	1136854	0.1231	0.0923	0.1642	109281	0.8399	
1968	5146091	3569379	7419289	1711798	1418289	2066048	839231	674076	1044849	0.0949	0.0725	0.1243	105345	0.8364	
1969	3774978	2625027	5428690	1642101	1393642	1934856	813645	673241	983330	0.1484	0.1145	0.1924	126777	0.7945	
1970	4140676	2889655	5933301	1566557	1346763	1822221	734710	618180	873207	0.2146	0.1675	0.2751	186236	0.7750	
1971	8352037	5751462	12128484	1818068	1514432	2182581	560413	476116	659636	0.4218	0.3330	0.5343	222211	1.0255	
1972	3330564	2324860	4771322	1518057	1281980	1797608	629119	528710	748597	0.2562	0.2029	0.3234	188230	1.0349	
1973	2034280	1413990	2926678	1259998	1087581	1459749	587340	493172	699488	0.3900	0.3140	0.4845	246989	1.0331	
1974	2151696	1500816	3084853	936031	813929	1076450	375023	318571	441479	0.5635	0.4588	0.6920	214749	1.1069	
1975	2258775	1562477	3265368	704017	601800	823595	246400	209004	290486	0.5229	0.4249	0.6435	152765	0.9806	
1976	1514032	1044263	2195130	549428	464781	649490	193549	160363	233603	0.5205	0.4176	0.6487	126409	0.9888	

1977	1813138	1246782	2636764	478858	395357	579994	171298	138970	211147	0.3386	0.2648	0.4329	61908	0.9200
1978	2551185	1753198	3712385	550627	444877	681514	180131	145651	222774	0.2277	0.1764	0.2941	41871	0.9961
1979	2794882	1934431	4038068	655621	532548	807136	236084	192428	289643	0.1161	0.0855	0.1578	22668	0.9380
1980	1796802	1248610	2585673	681913	570477	815117	312631	259131	377177	0.1211	0.0903	0.1623	30430	1.0375
1981	2390610	1667326	3427655	733819	623908	863093	309123	258897	369091	0.2520	0.2024	0.3139	76342	0.9699
1982	1942708	1344319	2807456	679861	578818	798544	266325	224107	316495	0.3752	0.3008	0.4680	111569	1.0235
1983	4982914	3416442	7267629	880106	708068	1093945	230938	191735	278157	0.3835	0.3060	0.4807	96511	1.0182
1984	2574537	1783076	3717307	878665	718339	1074775	323602	262042	399625	0.2624	0.2073	0.3322	83462	0.9756
1985	2974744	2059255	4297235	922556	765911	1111238	392423	317734	484671	0.2209	0.1744	0.2797	62485	1.0078
1986	2693134	1861799	3895677	922824	773681	1100716	397574	327410	482774	0.2519	0.1996	0.3180	99549	1.0389
1987	4745061	3244708	6939178	1069568	877302	1303972	373774	308942	452210	0.2772	0.2190	0.3510	92960	1.0148
1988	2059559	1412648	3002717	971498	805150	1172215	437112	359709	531170	0.2117	0.1666	0.2691	64691	1.0126
1989	1700327	1188999	2431553	875395	735975	1041226	459852	377121	560732	0.1836	0.1450	0.2326	63236	1.0086
1990	1339950	942929	1904137	752292	642083	881418	395605	328214	476833	0.2266	0.1804	0.2848	88662	0.9933
1991	1050381	737459	1496082	604056	520402	701158	321171	269219	383147	0.2127	0.1694	0.2669	66229	1.0315
1992	1490916	1053403	2110143	489934	424251	565787	238990	201765	283083	0.2316	0.1860	0.2882	60841	1.0024
1993	1275979	904892	1799246	449467	388414	520117	235896	200405	277672	0.2412	0.1948	0.2986	68541	0.9932
1994	1915841	1368682	2681737	409557	354138	473647	178035	152370	208023	0.2662	0.2150	0.3295	58338	0.9999
1995	1549957	1131809	2122591	382455	330345	442786	139837	119918	163064	0.2877	0.2338	0.3541	57367	0.9748
1996	1755450	1287804	2392913	376320	327056	433005	178525	152979	208338	0.2993	0.2424	0.3695	58639	1.0233
1997	2064130	1492806	2854111	411554	355883	475933	152840	131545	177582	0.4330	0.3598	0.5211	62458	1.0033
1998	1044229	760403	1433997	381458	329867	441117	181807	154156	214417	0.4793	0.3973	0.5783	72248	0.9994
1999	917625	664978	1266259	304306	264274	350403	146721	124805	172486	0.3486	0.2855	0.4255	55845	0.9998
2000	2620471	1898840	3616351	373516	314412	443729	116979	99933	136933	0.3050	0.2487	0.3739	43008	0.9990
2001	1778194	1294801	2442052	407346	345596	480129	197165	165080	235486	0.2852	0.2320	0.3506	40007	1.0028
2002	1949044	1415526	2683649	467346	398970	547439	227601	191572	270406	0.3297	0.2680	0.4057	50740	0.9998
2003	1094076	790201	1514809	409310	351154	477096	213464	180217	252843	0.2733	0.2208	0.3382	44583	1.0021
2004	935311	676476	1293181	335318	289534	388342	184279	155978	217715	0.2545	0.2040	0.3175	40186	1.0119
2005	942432	682457	1301443	302976	261658	350818	159956	136852	186962	0.1798	0.1443	0.2240	30360	1.0021
2006	822342	596539	1133616	289788	251882	333398	144696	124179	168603	0.2850	0.2314	0.3509	46539	0.9990
2007	532968	387165	733681	248577	216061	285986	139814	118991	164280	0.2996	0.2427	0.3699	47407	0.9990
2008	646806	469835	890436	205077	178577	235508	113799	97454	132884	0.2443	0.1953	0.3056	29394	1.0008
2009	713154	511348	994604	196710	170887	226437	93215	79984	108635	0.2846	0.2296	0.3527	28976	1.0312
2010	1163677	844419	1603639	227052	193303	266693	93240	79163	109821	0.3442	0.2781	0.4259	30118	0.9960
2011	516559	371385	718481	183641	157654	213912	78145	66540	91775	0.2908	0.2342	0.3610	24678	0.9992
2012	506443	359684	713083	178361	153490	207261	90161	76241	106623	0.2692	0.2152	0.3367	25087	1.0017
2013	247199	175337	348514	145151	125313	168130	62136	52700	73262	0.3968	0.3189	0.4936	26947	0.9978

2014	318736	221246	459186	103895	88397	122111	40081	33411	48083	0.4647	0.3722	0.5802	27123	1.0091
2015	519002	346276	777885	104571	83735	130590	33236	26535	41630	0.5837	0.4580	0.7440	19885	0.9982
2016	216836	142395	330193	81410	62038	106830	48261	36222	64301	0.2067	0.1517	0.2817	6937	1.0011
2017	258103	166595	399874	83473	62424	111619	48382	35486	65964	0.1771	0.1249	0.2510	6424	0.9986
2018	354564	222032	566202	81663	59213	112625	35329	24959	50010	0.1757	0.1185	0.2604	5557	0.9978
2019	1025677	598873	1756655	127996	86746	188861	38410	26632	55397	0.0844	0.0560	0.1270	3429	0.9978
2020	1320911	443066	3938022	191442	104087	352108	54817	37509	80112	0.0351	0.0221	0.0558	1397	0.9999

TABLE 4.6.13 Herring in 6a and 7bc. ESTIMATED FISHING MORTALITY

Units : f

, , area = N

year						
age	1957	1958	1959	1960	1961	1962
1	0.01291923	0.01573261	0.01548640	0.01321415	0.01149022	0.01645332
2	0.05811951	0.07410374	0.07168915	0.05791613	0.04739392	0.07268736
3	0.10189298	0.12736937	0.11455697	0.08414434	0.06284234	0.09439099
4	0.12269948	0.15793986	0.14739845	0.10200146	0.07136381	0.10755394
5	0.14942791	0.19608415	0.18473977	0.13002892	0.08630132	0.12929849
6	0.16447049	0.21910425	0.19912978	0.13329150	0.08243370	0.13037977
7	0.20003092	0.28214451	0.25710336	0.16846310	0.09990907	0.15735939
8	0.20291031	0.29969966	0.27753249	0.17988950	0.10658970	0.17113659
9	0.20291031	0.29969966	0.27753249	0.17988950	0.10658970	0.17113659

year						
age	1963	1964	1965	1966	1967	1968
1	0.01383333	0.01328812	0.01298415	0.01610277	0.01529155	0.01232650
2	0.05689716	0.05223114	0.04910679	0.06293942	0.05878848	0.04522708
3	0.07491268	0.06927264	0.06675582	0.08074535	0.07722351	0.06015445
4	0.08277692	0.07821052	0.08152240	0.09918699	0.09477750	0.07033978
5	0.09609888	0.08671492	0.09069883	0.11004862	0.10548991	0.07648427
6	0.09905168	0.09260255	0.09669171	0.12023855	0.12039153	0.08885289
7	0.11967045	0.11809756	0.12638566	0.14989420	0.15300737	0.11644923
8	0.13674420	0.14352344	0.16047687	0.19029458	0.19126951	0.14327788
9	0.13674420	0.14352344	0.16047687	0.19029458	0.19126951	0.14327788

year

age	1969	1970	1971	1972	1973	1974
1	0.01693637	0.02585181	0.05092843	0.03188604	0.04268641	0.05010418
2	0.06930743	0.12124477	0.29615084	0.16801550	0.25419509	0.32565058
3	0.09969470	0.17990758	0.43577470	0.23533123	0.34918212	0.43742950
4	0.11687884	0.19095954	0.41840448	0.22451101	0.34333442	0.46774092
5	0.13050576	0.18891026	0.37538467	0.20945297	0.32435251	0.47624746
6	0.15271916	0.19626280	0.35332823	0.20304748	0.31672821	0.51639503
7	0.21003355	0.24595077	0.38790508	0.21279526	0.29785426	0.48344557
8	0.25997120	0.29058039	0.42509312	0.22104569	0.28603637	0.44098822
9	0.25997120	0.29058039	0.42509312	0.22104569	0.28603637	0.44098822

year

age	1975	1976	1977	1978	1979	1980
1	0.04356979	0.04109164	0.02471393	0.01434337	0.0000893622	0.00009693455
2	0.28884212	0.28604786	0.16110198	0.08683371	0.0001493293	0.00017813862
3	0.36594741	0.34940648	0.20089853	0.10506522	0.0001654374	0.00018909283
4	0.37905948	0.34405065	0.19948637	0.10869854	0.0001543472	0.00017528381
5	0.39943230	0.34771769	0.19311323	0.09756888	0.0001342135	0.00015005358
6	0.46963208	0.44867859	0.25648663	0.12403284	0.0001656883	0.00017585980
7	0.46061274	0.47073031	0.28238430	0.14122339	0.0001959736	0.00021251487
8	0.41170869	0.42029487	0.24449631	0.12397768	0.0001642861	0.00017220381
9	0.41170869	0.42029487	0.24449631	0.12397768	0.0001642861	0.00017220381

year

age	1981	1982	1983	1984	1985	1986
1	0.01673753	0.02306787	0.01754562	0.01099009	0.008730894	0.01000122
2	0.13466442	0.22379371	0.17403940	0.10593056	0.085576266	0.11068888
3	0.15351737	0.26502964	0.21848332	0.13588316	0.108215329	0.13720426
4	0.14982422	0.26870013	0.22796481	0.13947627	0.107787219	0.13546359
5	0.13966842	0.27615917	0.25939816	0.15893390	0.124062636	0.15311762
6	0.16085547	0.32063310	0.31188933	0.18107230	0.140374156	0.16322841
7	0.18824429	0.38618384	0.39162986	0.21404094	0.154209724	0.16054018
8	0.15019646	0.34867889	0.39052296	0.21771019	0.158193147	0.16425362
9	0.15019646	0.34867889	0.39052296	0.21771019	0.158193147	0.16425362

year

age	1987	1988	1989	1990	1991	1992
1	0.007066574	0.005402601	0.004613033	0.005691674	0.004554726	0.004963241
2	0.078020562	0.060652182	0.053557883	0.075489839	0.061985354	0.076607584
3	0.098596175	0.077125900	0.067967693	0.094866924	0.076359811	0.091366341

```
  4 0.103855728 0.079579033 0.067520633 0.097177319 0.076574947 0.085629639
  5 0.129388163 0.099324014 0.083810814 0.122248928 0.093779231 0.100102217
  6 0.150622051 0.112094397 0.092959730 0.139163373 0.107265745 0.113161488
  7 0.170280400 0.129313874 0.114799600 0.177349633 0.133120555 0.138360210
  8 0.198966149 0.158571589 0.150265541 0.245369642 0.175281887 0.174637622
  9 0.198966149 0.158571589 0.150265541 0.245369642 0.175281887 0.174637622
   year
age        1993        1994        1995        1996        1997        1998
  1 0.005020354 0.004251855 0.004126713 0.002841044 0.004361192 0.004054092
  2 0.086157047 0.078275890 0.083669907 0.056512599 0.104944444 0.101752366
  3 0.098337908 0.094147597 0.105197773 0.075370616 0.151159796 0.152212098
  4 0.083487582 0.079000301 0.095762369 0.077920882 0.183323380 0.187987953
  5 0.095494582 0.089289697 0.107303668 0.101278642 0.272522114 0.278377420
  6 0.106847315 0.100899029 0.116836826 0.119675069 0.347222024 0.348552148
  7 0.143822171 0.150548145 0.186149768 0.202288186 0.557889640 0.523879201
  8 0.177280830 0.195591511 0.237327152 0.254918894 0.567128333 0.472243459
  9 0.177280830 0.195591511 0.237327152 0.254918894 0.567128333 0.472243459
   year
age        1999        2000        2001        2002        2003        2004
  1 0.003355364 0.002741395 0.002123772 0.002226596 0.001671471 0.001360294
  2 0.085981951 0.072261394 0.056711417 0.063739089 0.046469513 0.036555716
  3 0.132563416 0.119208427 0.101294692 0.125391207 0.098550456 0.081226944
  4 0.147920989 0.135971499 0.118392645 0.152235266 0.127098106 0.114137036
  5 0.195453073 0.183022361 0.175439162 0.233819624 0.195854376 0.192883553
  6 0.218336853 0.198126880 0.198990507 0.256752527 0.211819468 0.224113080
  7 0.291957871 0.255044293 0.269713761 0.337271062 0.304073786 0.321088642
  8 0.251386292 0.216751098 0.238706299 0.296290027 0.298970542 0.349851132
  9 0.251386292 0.216751098 0.238706299 0.296290027 0.298970542 0.349851132
   year
age         2005        2006        2007       2008        2009       2010
  1 0.0009223725 0.001291125 0.001688509 0.00122478 0.001909373 0.00242526
  2 0.0228193452 0.035333562 0.049469102 0.03238399 0.055902337 0.07488283
  3 0.0485754727 0.073847252 0.092371071 0.05848782 0.101087437 0.13333670
  4 0.0597304223 0.098768930 0.110916683 0.06720997 0.123304556 0.16535347
  5 0.0895157948 0.171164860 0.184962643 0.10228890 0.174055503 0.23347312
  6 0.1033837302 0.230691927 0.264994075 0.14761932 0.226000015 0.27927018
  7 0.1367997698 0.335708363 0.393175642 0.22783075 0.321357069 0.36161909
```

```
  8 0.1473905914 0.387548552 0.485917793 0.30159759 0.428717413 0.48755513
  9 0.1473905914 0.387548552 0.485917793 0.30159759 0.428717413 0.48755513
   year
age        2011        2012        2013        2014        2015         2016
  1 0.002204892 0.002220117 0.002640679 0.002586721 0.002974951 0.0009892286
  2 0.066556173 0.067758270 0.085357083 0.084086644 0.101520916 0.0250992765
  3 0.119225594 0.127180941 0.172394008 0.180544512 0.237827753 0.0622888457
  4 0.149513861 0.164633977 0.254060551 0.283558575 0.384804582 0.1036745762
  5 0.210231546 0.234312733 0.375732063 0.440280134 0.598743309 0.1572419222
  6 0.249748405 0.287954322 0.492576446 0.599753964 0.924642062 0.2411009000
  7 0.313463083 0.349607716 0.621327683 0.777588674 1.246162015 0.3464020391
  8 0.435623429 0.507841094 1.001398508 1.254265450 1.713100259 0.4630001288
  9 0.435623429 0.507841094 1.001398508 1.254265450 1.713100259 0.4630001288
   year
age         2017         2018         2019          2020
  1 0.0008070984 0.0008541556 0.0003455628 0.00006077613
  2 0.0189482853 0.0198913633 0.0061730900 0.00067677427
  3 0.0515903287 0.0574004150 0.0181473881 0.00216910462
  4 0.0855724973 0.1029279386 0.0338066480 0.00430195288
  5 0.1209514013 0.1498811282 0.0439046407 0.00570945771
  6 0.1631858998 0.1873543212 0.0462983715 0.00606806280
  7 0.2052779144 0.1980636311 0.0422495616 0.00608489211
  8 0.2515115378 0.2072364712 0.0347509592 0.00465894431
  9 0.2515115378 0.2072364712 0.0347509592 0.00465894431

, , area = S

   year
age         1957         1958         1959         1960         1961
  1 0.0001602408 0.0002040849 0.0001812764 0.0001503225 0.0001718929
  2 0.0064389725 0.0077369602 0.0069467805 0.0059750409 0.0066518037
  3 0.0123738875 0.0147728858 0.0127927060 0.0106730670 0.0119957800
  4 0.0141311370 0.0175671233 0.0147137219 0.0116410998 0.0130786624
  5 0.0177655071 0.0218037753 0.0169976453 0.0123150983 0.0134998824
  6 0.0211890829 0.0264452842 0.0201343538 0.0142199002 0.0155941342
   year
age         1962         1963         1964         1965         1966
```

```
  1 0.0001761371 0.0001093366 0.0001010802 0.0001107238 0.0001495062
  2 0.0069619633 0.0049476476 0.0047144753 0.0050657024 0.0062824775
  3 0.0132483640 0.0098889696 0.0098185974 0.0109476867 0.0138325099
  4 0.0152367327 0.0118898737 0.0124881277 0.0143950849 0.0186594876
  5 0.0162180773 0.0129991591 0.0141392293 0.0163927550 0.0213399221
  6 0.0197487306 0.0165426355 0.0183818047 0.0216017598 0.0276785729
   year
age         1967         1968         1969         1970         1971
  1 0.0001802079 0.0001762941 0.0002206153 0.0002593171 0.0002583204
  2 0.0071481879 0.0069411506 0.0081161673 0.0091576850 0.0089209111
  3 0.0157166390 0.0145141434 0.0161611758 0.0175186406 0.0167709019
  4 0.0218402735 0.0197388877 0.0215926655 0.0230111459 0.0222641301
  5 0.0250853663 0.0223282903 0.0251636974 0.0273852522 0.0279437460
  6 0.0319331397 0.0272751548 0.0309921167 0.0346203972 0.0373754318
   year
age         1972         1973        1974        1975        1976        1977
  1 0.0004755321 0.0009609356 0.001901085 0.002919789 0.003842138 0.002963473
  2 0.0137637367 0.0227693276 0.037800699 0.051903336 0.063761622 0.053161613
  3 0.0246918888 0.0383700453 0.062152857 0.084204551 0.103354522 0.085815648
  4 0.0320838180 0.0487607311 0.078357238 0.107695266 0.135422668 0.113676356
  5 0.0404787220 0.0598458011 0.094494774 0.127177406 0.161161521 0.138442949
  6 0.0550987576 0.0794984226 0.121188330 0.158338942 0.192025460 0.166380658
   year
age       1978        1979        1980        1981        1982        1983
  1 0.00262179 0.002232641 0.002109685 0.001496757 0.001213083 0.001772645
  2 0.04930748 0.044864023 0.044343764 0.035296242 0.030916367 0.041958247
  3 0.08129580 0.076994123 0.080014429 0.066516588 0.060761331 0.084269727
  4 0.10611706 0.102449287 0.106839485 0.089058232 0.081831282 0.114201008
  5 0.12971047 0.126329622 0.132184568 0.109998671 0.100864274 0.141055546
  6 0.15845913 0.158162727 0.164503378 0.138668380 0.126798052 0.176901946
   year
age       1984        1985       1986        1987        1988         1989
  1 0.00133625 0.001087931 0.00105386 0.001700073 0.001117057 0.0009162591
  2 0.03384900 0.029009265 0.02888744 0.041968521 0.031125079 0.0273182772
  3 0.06962480 0.061677460 0.06315343 0.093325944 0.071125183 0.0624482721
  4 0.09401013 0.085228194 0.08882157 0.133156799 0.102355904 0.0901873599
  5 0.11783283 0.109848911 0.11524909 0.173372700 0.132209084 0.1163860955
```

```
  6 0.15282223 0.146289499 0.15139753 0.226660669 0.173086879 0.1531573247
   year
age        1990        1991        1992        1993       1994        1995
  1 0.001058441 0.001255458 0.001482648 0.001648427 0.00223253 0.002192188
  2 0.031379205 0.036721153 0.042667540 0.047664538 0.06029820 0.060784197
  3 0.069388307 0.079255640 0.091914907 0.103198926 0.12719946 0.130211202
  4 0.098979204 0.108211754 0.122235166 0.138669390 0.17054028 0.177159539
  5 0.124478009 0.135475444 0.142670676 0.155909487 0.18953293 0.197921811
  6 0.160223162 0.173684969 0.179147174 0.182752796 0.21409225 0.220550044
   year
age        1996        1997       1998        1999        2000        2001
  1 0.002721118 0.002782702 0.00391027 0.002815089 0.002200145 0.001754557
  2 0.071292151 0.072503001 0.09457984 0.075163492 0.063816569 0.055024103
  3 0.150359284 0.147795670 0.18933407 0.148229103 0.128173798 0.115610188
  4 0.204142139 0.197831108 0.24632810 0.185253723 0.155902309 0.145846811
  5 0.222270098 0.209208073 0.25386785 0.182965095 0.151406798 0.143666933
  6 0.246038022 0.222981613 0.26070863 0.183527844 0.147990363 0.141681469
   year
age        2002        2003        2004        2005        2006       2007
  1 0.001646261 0.001263834 0.001067731 0.001132012 0.001621358 0.00146384
  2 0.053720152 0.045370075 0.041510209 0.045521759 0.061739926 0.05865808
  3 0.113567579 0.096804439 0.089950108 0.100551026 0.140841958 0.13705434
  4 0.147034676 0.121736729 0.108785712 0.116778267 0.164315110 0.16222912
  5 0.146583169 0.122035387 0.104647670 0.104785218 0.141160870 0.13723407
  6 0.143584219 0.119210854 0.102367354 0.095812867 0.119056428 0.10875864
   year
age        2008        2009        2010         2011         2012         2013
  1 0.001499992 0.001133621 0.001203845 0.0008057174 0.0004458143 0.0003754586
  2 0.059862510 0.048278767 0.049768866 0.0362520883 0.0226060098 0.0202562053
  3 0.141845563 0.115921615 0.120114550 0.0883648911 0.0547334867 0.0529911244
  4 0.175416146 0.145035611 0.152416209 0.1136586766 0.0680939252 0.0712443284
  5 0.156868472 0.136535626 0.151573400 0.1164831498 0.0693112585 0.0792469501
  6 0.127561489 0.116507061 0.141151870 0.1157851006 0.0704153565 0.0887858160
   year
age         2014        2015         2016        2017         2018         2019
  1 0.0003765394 0.000165528 0.0002497383 0.000281344 0.0002118981 0.0002507671
  2 0.0207091096 0.011192169 0.0152353554 0.016739467 0.0134590831 0.0148433653
```

```
  3 0.0581814217 0.031637756 0.0430744679 0.046663838 0.0363815785 0.0382884973
  4 0.0825995683 0.043829506 0.0593623466 0.063902797 0.0466422404 0.0457690167
  5 0.0986836889 0.052176307 0.0721981395 0.077308444 0.0541221123 0.0496766367
  6 0.1152058735 0.061192222 0.0879427797 0.099111112 0.0681137174 0.0615192181
   year
age         2020
  1 0.0001532206
  2 0.0102125671
  3 0.0260652194
  4 0.0297145261
  5 0.0303272015
  6 0.0359629308
```

TABLE 4.6.14 Herring in 6a and 7bc. ESTIMATED POPULATION ABUNDANCE

```
Units  :  NA
   year
age       1957       1958       1959       1960       1961       1962
  1 1666801.57 2921924.99 4027555.40 1613618.37 2637163.17 3583533.43
  2 1785795.34  751829.09 1373352.29 1914415.28  699386.58 1202412.31
  3  614169.90 1159119.19  484213.45  900737.77 1219258.01  398130.34
  4  266424.69  357783.23  711033.61  328008.90  602286.03  779240.32
  5  295521.50  177394.12  199851.17  407244.71  232975.53  417002.34
  6  133658.47  176205.80  109599.46  111774.94  248552.85  162273.15
  7   59064.04   79695.28   95087.11   67565.49   69699.61  172537.80
  8   10933.65   35124.59   41018.92   50392.63   42239.66   46528.79
  9   34327.22   27423.64   32591.24   38036.30   50678.36   60846.13
   year
age       1963      1964        1965       1966       1967       1968      1969
  1 3616949.65 2511576.2 10422400.98 1814645.38 3794867.65 5146090.87 3774978.3
  2 1660868.80 1704798.3  1080735.74 5421156.86  741846.14 1745324.07 2393142.9
  3  732388.37 1077530.2  1112305.88  698671.17 3816702.33  456289.39 1099018.4
  4  227768.81  441599.2   712279.31  725172.21  454259.32 2710478.01  292964.5
  5  478470.45  141425.0   274092.63  448712.64  460152.56  278624.05 1855197.3
  6  276339.97  311742.9    91736.59  173931.13  277775.22  294365.58  183688.8
  7  102818.75  185196.2   205747.80   61258.27  105162.28  167770.74  194793.8
```

```
  8  107945.94   67488.9   120346.12  127400.05   38507.04   61787.55  105120.9
  9   66481.08  114513.4   117493.51  147584.03  160930.32  114177.57  108968.2
   year
age      1970       1971       1972       1973      1974       1975       1976
  1 4140675.6 8352036.68 3330564.11 2034279.55 2151696.2 2258774.61 1514032.01
  2 1682803.2 1846477.40 3950973.70 1454984.91  872788.1  938146.17 1007551.56
  3 1573588.7  969154.22  952808.28 2407037.44  720057.5  408696.64  443906.45
  4  697163.6  902839.79  407122.08  518144.28 1196252.5  303345.73  184296.06
  5  186626.5  398746.18  411810.63  229935.69  250623.6  500608.15  133322.27
  6 1152899.2  111973.08  192130.48  233860.36  116077.1  101439.28  216308.35
  7  111994.2  676931.92   56472.38  108337.24  115523.1   43842.33   38962.04
  8  109596.7   61812.59  330502.10   30812.17   55364.3   45623.60   16504.30
  9  114226.0  116546.47   82554.47  223175.66  120341.1   64678.29   37171.83
   year
age       1977       1978       1979       1980       1981       1982
  1 1813138.36 2551185.07 2794882.17 1796802.10 2390610.00 1942708.24
  2  646133.24  811805.98 1167985.98 1314736.06  792533.40 1113598.01
  3  479861.45  345542.36  478567.91  756301.73  850631.71  434122.65
  4  191945.90  255419.43  202646.02  310265.64  491972.31  471415.24
  5   81775.77  100672.24  137777.28  136166.62  194376.91  274598.53
  6   57941.65   42523.79   59348.47   87906.90   90960.65  109245.79
  7   85189.03   26011.53   23398.79   37179.34   59405.32   49092.97
  8   14232.02   39240.36   13497.47   13796.71   21472.27   32315.42
  9   15923.80   12844.41   24851.33   20644.78   18104.34   19898.07
   year
age       1983       1984       1985       1986       1987       1988
  1 4982913.69 2574536.60 2974743.67 2693133.63 4745061.11 2059558.97
  2  853698.47 2442595.26 1159910.49 1353962.99 1210005.74 2290694.99
  3  595533.03  456302.57 1546475.85  716302.82  780461.73  717555.10
  4  217175.88  305912.80  247945.90  963776.13  416267.37  446451.21
  5  232036.60  109383.33  172080.95  146578.20  560168.21  238572.68
  6  135519.92  107981.39   60142.11  102246.39   79476.62  302438.70
  7   51831.39   60261.89   56061.78   32269.21   54468.03   38509.56
  8   21667.36   21114.35   30029.85   28927.84   17615.68   25436.61
  9   23053.31   16560.94   17587.69   23663.07   27824.84   18862.08
   year
age       1989       1990       1991       1992       1993       1994
```

```
  1 1700327.49 1339949.82 1050380.92 1490916.34 1275979.24 1915840.66
  2  936377.04  780429.11  614873.62  466388.75  703820.35  597400.62
  3 1528981.03  612829.41  473526.93  377678.61  266035.36  404868.75
  4  423583.99  957420.30  405562.72  292104.14  223745.74  140651.92
  5  257919.26  263086.52  532688.13  283629.82  173245.16  130428.13
  6  138614.58  148409.10  150694.79  284980.24  182750.26  101434.97
  7  161717.65   84230.71   78985.98   84185.91  147257.28  104910.12
  8   20126.85   85228.61   46465.97   41437.44   45934.17   75549.74
  9   22465.77   21857.76   47255.92   45301.65   42619.11   45620.91
   year
age       1995       1996       1997        1998       1999        2000
  1 1549956.98 1755449.56 2064130.04 1044229.436 917624.615 2620471.359
  2  899137.54  734319.46  818966.76  984040.891 458481.942  397499.282
  3  347015.46  522767.90  444074.07  468292.840 645958.552  259696.452
  4  211786.92  189068.05  260144.03  237238.837 230976.787  367411.344
  5   77394.43  100852.51  101690.76  123315.436 110932.177  115911.822
  6   73629.34   41407.69   54837.56   47087.518  48817.261   56646.825
  7   58205.69   41263.02   21247.20   22480.567  18878.036   24386.187
  8   54346.79   30937.29   22566.41    7209.928   7082.103    8340.331
  9   55241.88   48255.98   30009.07   17602.107   8847.407    7805.699
   year
age        2001       2002       2003      2004      2005      2006      2007
  1 1778193.593 1949044.28 1094076.32 935310.69 942432.24 822341.98 532968.50
  2 1281007.840  823006.96  923967.64 504602.96 424040.25 450606.00 393461.44
  3  216144.948  813565.35  501022.20 579044.02 311136.34 245567.96 273139.59
  4  137608.767  110571.21  448427.72 306426.71 366505.10 175117.31 125966.01
  5  201687.230   78539.86   56614.86 230331.40 196578.68 234739.78  99557.34
  6   63011.574  111623.96   42207.28  28548.87 117888.42 135250.79 124490.87
  7   30987.916   33997.45   52098.48  27524.70  13542.90  70201.34  74487.68
  8   12109.552   14862.89   16256.80  23077.57  15697.54   8454.46  33095.24
  9    8452.598   10733.05   12850.18  15408.77  17458.11  20571.05  14038.66
   year
age      2008      2009       2010       2011       2012       2013       2014
  1 646805.75 713154.32 1163676.50 516559.060 506443.021 247199.110 318736.346
  2 248126.59 303508.25  323952.95 561032.343 232765.838 230899.558 110318.548
  3 227705.01 151452.75  183640.06 189392.686 366098.510 151871.053 136990.749
  4 145804.63 123364.39   82973.30  97211.203 103400.216 216344.959  94965.022
```

5	66595.91	80499.34	66106.86	42383.036	49718.345	55005.259	111294.640
6	52388.68	38545.13	38863.30	32666.778	23011.877	24612.807	24731.249
7	65588.76	29548.11	20608.39	16758.340	16248.758	13026.753	9801.471
8	34474.60	35690.24	14846.63	9444.112	7239.809	7730.462	5137.261
9	22375.59	30670.27	32407.72	21846.764	14841.080	9621.701	4192.704

age \ year	2015	2016	2017	2018	2019	2020
1	519001.724	216836.3235	258102.666	354563.553	1025677.097	1320910.801
2	146043.579	258315.4882	97655.010	119690.182	161748.082	480505.476
3	66494.800	86172.5362	187714.593	67347.896	80614.251	105299.482
4	75849.683	37664.7343	56025.433	124022.753	48287.699	56329.201
5	49704.601	32859.2500	24514.100	36414.712	76155.999	30898.789
6	41821.623	20410.8330	17530.158	14649.042	21178.828	50824.275
7	8445.954	10214.1385	10559.518	8959.962	8036.753	12847.253
8	3466.617	1749.5584	4089.956	5522.842	4576.380	5365.815
9	1612.313	662.4485	1159.662	2526.755	4259.643	5632.593

TABLE 4.6.15 Herring in 6a and 7bc. PREDICTED CATCH NUMBERS AT AGE

Units : NA

<0 x 0 matrix>

TABLE 4.6.16 Herring in 6a and 7bc. CATCH AT AGE RESIDUALS

Units : NA

<0 x 0 matrix>

TABLE 4.6.18 Herring in 6a and 7bc. PREDICTED INDEX AT AGE catch N

Units : NA

age \ year	1957	1958	1959	1960	1961	1962	1963
1	14951.462	31878.111	43257.934	14802.985	21052.165	40874.915	34727.158
2	83606.286	44522.260	78794.421	89341.885	26831.170	69914.833	76217.836
3	49932.534	116299.297	43993.959	61020.354	62261.616	30076.985	44377.432
4	26014.955	44178.316	82441.165	26911.948	35043.982	67129.764	15299.385

```
  5 34965.320  26910.725 28774.642 42411.464 16423.952 43120.510 37397.861
  6 17305.254  29573.398 16918.656 11936.137 16796.032 16929.695 22255.671
  7  9142.211  16705.994 18443.301  8974.774  5662.435 21432.866  9900.975
  8  1713.709   7730.549  8507.935  7123.846  3655.842  6244.930 11792.903
  9  5380.351   6035.652  6759.910  5377.070  4386.211  8166.554  7262.941
   year
age      1964      1965       1966       1967      1968      1969      1970
  1 23169.381 93959.681  20260.747  40249.354  44054.43  44312.56  73903.13
  2 71981.122 42957.134 274260.539  35108.680  63951.75 132816.36 159451.44
  3 60534.993 60257.099  45424.474 237501.557  22305.64  87359.43 217453.47
  4 28077.846 47091.846  57743.756  34583.173 155039.47  27228.81 102272.86
  5 10012.836 20238.444  39750.209  39089.732  17415.68 192725.48  27295.28
  6 23522.567  7203.155  16751.613  26732.624  21261.12  22103.33 174482.92
  7 17587.237 20786.154   7233.504  12630.751  15661.86  31375.85  20747.18
  8  7698.768 15188.477  18703.658   5661.742   7021.03  20536.66  23575.46
  9 13063.070 14828.458  21666.877  23661.799  12974.20  21288.29  24571.27
   year
age      1971       1972       1973      1974      1975       1976      1977
  1 290490.27  73120.645  59497.196  73600.38  67347.29  42603.257 30915.612
  2 395043.84 506792.271 270542.298 200114.32 192698.79 204137.632 78311.731
  3 289678.77 167430.410 593066.330 211700.96 102690.94 106375.996 71129.478
  4 262354.49  68876.595 126206.593 371325.72  78278.70  43301.579 28131.085
  5 106573.36  65766.986  53550.518  79033.29 134930.60  31522.305 11607.194
  6  28398.72  29712.909  53038.472  38675.59  30862.78  62538.176 10517.427
  7 185275.57   9068.872  23127.050  36163.23  12973.30  11572.717 16703.251
  8  18271.01  54564.112   6214.613  15280.83  11357.85   4046.150  2315.775
  9  34449.65  13629.297  45013.064  33214.76  16101.45   9112.943  2591.054
   year
age      1978       1979       1980      1981       1982       1983       1984
  1 25364.226 174.227993 121.506994 27719.699  30964.301  60539.062  19651.971
  2 54945.692 141.775867 190.421211 81917.137 184118.746 111690.650 201346.594
  3 28026.608  64.266086 115.920795 99282.998  83427.220  95317.627  47451.659
  4 21320.400  25.287679  43.879374 55989.220  91527.508  35906.270  32489.256
  5  7566.739  14.919353  16.440443 20702.310  54622.981  42909.039  13095.653
  6  3973.241   7.838829  12.287662 10937.993  24524.065  29064.320  14393.439
  7  2723.343   3.617589   6.212120  8198.119  12831.907  13398.952   9292.198
  8  3457.084   1.655327   1.758945  2329.155   7621.819   5382.759   3231.048
```

```
  9  1131.595   3.047762   2.632007  1963.827   4693.100   5727.066   2534.257
   year
age       1985       1986      1987       1988      1989      1990      1991
  1  18058.789  18717.903 23325.463   7747.868  5464.015  5309.945  3332.334
  2  78136.762 116633.306 74130.768 110520.511 40094.549 46541.178 30221.734
  3 130167.210  75389.677 59254.791  43473.363 82305.152 45335.886 28308.236
  4  20727.631  99827.574 32866.373  27694.539 22543.134 72056.186 24176.900
  5  16396.557  16970.676 53963.173  18218.936 16859.019 24558.279 38448.321
  6   6347.840  12392.236  8643.964  25507.703  9867.842 15440.471 12185.328
  7   6408.172   3821.529  6573.322   3693.713 13988.917 10928.612  7790.883
  8   3450.504   3446.705  2334.852   2912.622  2226.950 14758.021  5835.780
  9   2020.869   2819.416  3688.014   2159.804  2485.741  3784.848  5934.991
   year
age      1992      1993      1994      1995      1996      1997      1998
  1  5152.734  4460.205  5672.175  4454.172  3474.184  6266.558  2945.920
  2 28064.925 47315.774 36408.619 58417.180 32469.710 65743.807 75940.697
  3 26676.429 20057.442 28962.856 27562.289 29879.168 49257.895 51325.871
  4 19268.645 14297.085  8399.731 15170.941 10975.091 33996.695 31059.898
  5 21718.417 12605.910  8764.554  6176.306  7534.384 19066.690 23108.307
  6 24186.344 14662.489  7598.179  6322.916  3596.644 12642.077 10717.297
  7  8602.817 15593.172 11463.381  7744.883  5868.008  7232.750  7192.552
  8  5177.934  5817.292 10214.948  8793.371  5253.281  7656.730  2066.208
  9  5660.798  5397.458  6168.324  8938.196  8194.067 10182.006  5044.381
   year
age      1999      2000      2001      2002      2003       2004       2005
  1  2144.253  5005.588  2632.646  3025.308  1275.354   887.5018   606.4679
  2 30378.994 22389.701 57262.144 41239.634 34154.003 14766.5642  7781.0058
  3 63348.321 23248.242 16669.492 76899.644 37962.069 36561.7380 11867.5571
  4 24878.430 37053.303 12234.465 12443.611 43098.366 26759.2078 17107.0097
  5 15608.092 15572.773 26152.338 13208.080  8199.843 33155.2195 13761.1611
  6  7613.213  8217.043  9202.443 20484.827  6589.801  4725.6124  9535.0770
  7  3837.283  4473.129  6004.518  8008.588 11350.427  6330.1716  1446.4627
  8  1260.217  1332.865  2131.871  3179.016  3555.369  5818.2748  1833.9005
  9  1574.342  1247.426  1488.069  2295.686  2810.340  3884.8302  2039.5837
   year
age      2006       2007       2008       2009      2010       2011      2012
  1   740.473   627.5497   552.5302   949.5946  1967.630   794.2868   784.227
```

```
  2 12634.411 15367.4119  6390.5608 13419.9856 19008.109 29553.0135 12554.324
  3 13820.768 19100.8746 10216.2256 11655.8638 18337.863 17264.5585 36017.153
  4 12995.394 10450.2104  7431.0797 11402.0225 10058.981 10919.9460 12966.770
  5 29786.837 13591.3581  5172.3414 10395.3828 11077.983  6563.2507  8670.196
  6 22806.918 23858.2099  5845.0565  6388.1206  7689.261  5921.8353  4825.082
  7 16745.118 20414.1892 11161.3042  6824.9816  5212.536  3768.2795  4063.223
  8  2327.388 11003.8178  7709.5632 10748.7164  4932.380  2869.3784  2498.271
  9  5662.907  4667.7054  5003.8575  9236.8706 10766.567  6637.6419  5121.273
   year
age       2013       2014      2015      2016      2017       2018      2019
  1   455.2306   574.9899  1076.698  149.7044  145.3963   211.3829  247.4374
  2 15578.6038  7335.0742 11681.229 5281.7160 1510.6575  1945.7938  820.7491
  3 19857.3981 18646.0100 11758.712 4300.4502 7784.4430  3113.8562 1198.9875
  4 40163.2535 19323.4388 20377.701 3070.3235 3793.1435 10099.3996 1333.9948
  5 14385.6202 32890.2000 19047.739 3976.3727 2314.5137  4249.2988 2739.1873
  6  8011.2318  9265.1599 21644.453 3630.4802 2174.7241  2092.9112  800.1513
  7  5104.4988  4454.9235  5227.438 2500.3951 1617.8790  1346.6921  277.3850
  8  4264.8728  3190.6590  2530.389  554.1544  764.2370   877.8962  132.1629
  9  5308.2638  2604.0120  1176.876  209.8237  216.6910   401.6463  123.0157
   year
age      2020
  1  56.05402
  2 268.57370
  3 189.67679
  4 202.28200
  5 148.47078
  6 259.53055
  7  65.82870
  8  21.30598
  9  22.36527
```

TABLE 4.6.19 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS catch N

Units : NA

age	1957	1958	1959	1960	1961	1962
1	2.738267365	0.00042246759	0.8345279	-1.17507614	-0.04072748	1.34938301
2	2.773025772	2.48099665085	0.4834641	0.07143911	-0.11032265	0.02571661
3	0.008832846	0.10362496575	-0.7131441	-0.09347119	-0.07767514	-1.41249884
4	2.747304618	-1.46162339968	1.0190350	0.16620324	1.24149822	0.79032501
5	0.007689976	-0.00003942468	-0.6291319	-0.03499483	1.19598642	0.81427240
6	4.012937536	-2.73998988496	0.2327993	-0.70797337	-1.04678085	1.45684664
7	0.000335778	-0.03433154155	-0.7153010	0.87693673	0.02905646	1.05229018
8	0.392774019	-2.00637088443	-0.5597752	-0.45967395	1.37076221	1.15201239
9	1.496855651	-0.00085028720	-0.3198755	-1.69431370	-0.21377992	0.12220547

age	1963	1964	1965	1966	1967	1968
1	-0.4006621910	0.24589996	1.0995369	2.00831328	0.58319259	1.2355700
2	0.1592545033	0.04097371	-1.9522247	0.73375008	-1.61378299	-0.2432530
3	-0.0406793461	0.20454570	1.4201624	-1.33237574	2.48944394	-0.8664334
4	-1.5120490519	-0.45670176	0.4845245	-0.29827859	0.63647209	0.5361185
5	-0.0007984914	-1.24302534	-0.4776931	-0.64101518	-0.02614713	-1.1688641
6	1.1063344172	0.33477828	-1.1394671	-0.06572614	0.16280933	0.2947427
7	-0.2542036324	0.66347216	0.4020401	-1.02193858	-0.48164997	-0.2271377
8	0.7961495488	0.79654568	0.6650987	-0.28812582	0.03441710	-0.5138562
9	0.4298029914	0.84861135	0.8702735	0.54244250	0.19990169	-0.2473821

age	1969	1970	1971	1972	1973	1974
1	-0.24180248	1.0126313	0.95043519	0.23273729	-0.34927982	0.3933181
2	0.08026832	-0.2715237	0.19753047	1.10166563	-0.08366549	-0.5025531
3	0.34913052	1.3170030	0.09762978	-0.42608801	1.32910186	-0.3521968
4	0.20840870	-0.2073455	-0.34968698	-1.03604058	-0.03059812	2.4371438
5	1.28496762	-0.4205221	-0.59484736	0.09896694	0.37611645	0.5785555
6	0.09031009	-1.1616071	-0.35466037	-0.26260015	-0.02408087	1.3951882
7	1.20224012	-0.4586583	-0.90652157	0.21275494	-1.24261101	-0.0644686
8	0.27726635	-0.2372672	-0.78234950	-0.72091468	-0.46115118	0.6867742
9	0.27171035	-0.4547379	-0.99316292	0.06704591	-0.87391355	-1.0087429

year

age	1975	1976	1977	1978	1979	1980
1	0.06197592	-0.325611111	-0.5045566	-0.37955988	-2.5799687	1.04473018
2	-0.38276058	1.111875169	-0.7962940	-0.08961234	-3.0121656	-0.02126671
3	-0.48912617	-0.630493792	0.8853495	-1.15729541	-2.2681602	-1.09524714
4	-0.68096404	-0.680560298	-0.7701975	1.77810396	-2.3856984	0.28323872
5	1.04761852	-0.733568233	-0.2838097	-1.15378178	-1.5223789	-0.36374496
6	0.02883519	1.034474432	0.5882325	-0.70818453	-0.2857750	-0.99488684
7	-0.15343698	-0.005968159	0.8938317	-1.09523157	0.2021739	1.01305468
8	0.10901803	-0.376690701	-0.1891111	1.05481676	-1.6320467	-1.28179730
9	-0.23039019	0.321541116	-1.9061637	-0.07214844	0.0000000	0.00000000

year

age	1981	1982	1983	1984	1985	1986
1	2.056503	-0.74088421	0.6459666	-1.5921182	0.04424960	-0.2474453
2	3.388304	1.94772714	-0.2249438	1.9945366	-0.27381390	0.2351617
3	2.728118	-0.49617558	0.1926591	-0.5925464	0.62991614	0.1929341
4	1.637689	0.08241607	-0.8422236	-0.7213418	-1.48518056	0.4211869
5	1.141386	0.65251284	0.2404323	-0.2238268	-0.20361194	-0.2791053
6	1.197581	-0.19093251	-0.2255353	-1.6423943	0.03764504	0.3052885
7	1.469925	-0.30134463	0.2856370	-0.7780691	-0.58150300	-2.4613655
8	-1.160819	2.23069741	1.3133440	0.4079912	-0.21375457	-1.9272497
9	-1.398658	-0.49554318	0.4367651	-1.3707701	-0.61274504	-0.7648786

year

age	1987	1988	1989	1990	1991	1992
1	-0.2581704	-1.5385576	-0.5328550	0.06102022	0.30694659	-0.36474831
2	-0.1322853	1.3588014	0.1085871	0.03169344	-0.68600432	0.03418524
3	-0.5989250	-0.5503570	1.2684669	0.43670756	-0.08381661	0.25896953
4	0.6504909	-0.3185622	-1.4426124	0.38218514	1.33256821	0.80851309
5	0.5331864	0.2035957	-0.2703157	0.24429630	-0.78336778	0.75429507
6	0.1156270	-0.1713580	-0.8559917	-0.58874327	0.32496844	0.22133541
7	0.9313464	-0.8091470	0.3634388	0.45350493	-0.38692974	-0.87035965
8	2.0538645	-0.3328094	-0.1130256	0.88463752	0.54500395	-0.35018121
9	0.5067161	-0.3099062	0.3973412	-0.06362524	-1.69365567	0.06608976

year

age	1993	1994	1995	1996	1997	1998
1	0.45631630	-0.6557356	-1.8530285	-0.5597062	-0.7638305	-0.05508909
2	1.12741967	0.9260616	1.8586750	0.6202514	1.0595145	0.11812368
3	-1.21722133	-0.1594763	-0.2733714	-0.6503292	-0.2160618	-0.38997166

```
  4 -0.84537852 -1.7865268  0.3190898 -0.5162119  0.3962233  0.68109319
  5  0.51011673 -0.1431833 -0.8008211 -0.1255034  1.5748066  0.04497291
  6  0.79108993  0.5219998 -1.1323010 -0.2504339  1.6981804  1.00780510
  7  1.07162221  0.8321637  1.4505018  0.8035744  0.9806860  0.12678184
  8  0.02523248  0.8759184  0.1307362  1.6714762 -1.0337248  0.09401553
  9 -0.06946946  1.6045001  0.5452096  2.6639308 -0.7780529 -0.61711458
   year
age        1999       2000       2001       2002       2003        2004
  1 -0.23582014 -0.1924166 -1.7921976 -0.7121110 -2.2199798  0.00000000
  2 -0.35985649 -0.3898411  2.1638018  0.5466615  1.2149594 -0.74793135
  3  2.25511577  0.3495823 -1.0181935  0.8450532  0.5877006  0.31390645
  4 -0.90760305  1.3831401 -0.6497070 -1.3493625  0.4413543  1.67592815
  5 -1.22234758 -0.1597484  0.8233401  1.3726291 -0.6615260  1.27770449
  6 -1.05576799  0.1532700  0.7643728  0.6321818 -0.9113702 -0.05664467
  7 -1.00398838 -0.5106459  0.9825024 -0.1043623  0.6291592  1.86762485
  8 -0.23674759  0.4265253  1.7254197 -1.7282246  2.5214549  0.83322559
  9 -0.01981255 -1.4134963 -0.9131195 -0.8000473 -1.3066670  0.27830313
   year
age        2005        2006        2007       2008        2009       2010
  1 -1.02790585 -0.64705366 -0.63558173  0.0000000  0.91822842  1.2651605
  2  0.28474024  0.58944415  2.15064595  0.1367804  0.01864254 -0.5403566
  3  0.79678815 -0.84006305 -1.30077581 -0.5703410 -0.31579845 -0.3388569
  4 -0.86158081  1.06870139 -2.16974368 -1.3670065  1.18898892  0.1360535
  5 -1.64314478  2.21772888  0.31929015 -1.6109821 -1.03197246  0.7889436
  6 -0.43930020  2.05908359  0.98818646  0.2339863 -0.64323706 -1.5021990
  7 -1.99506224  1.16666464  0.48577606  1.2491221 -0.26094810 -0.9220286
  8  0.01587533  1.11063022  0.64279173  0.4421223  0.10418591  0.2518617
  9 -0.68374650  0.03665972  0.06075916  1.7039217  0.03758788  0.5168589
   year
age        2011       2012       2013       2014       2015        2016
  1 -0.02168584 -0.1695708  0.0000000  0.0000000 -0.4432362 -1.93723124
  2  0.34508759 -0.1897759 -0.4314816 -0.3227769  0.4251327  1.08434999
  3 -0.78097231  1.1831121  1.2360296  0.1571322  0.5860693 -1.69657987
  4 -0.07563986 -1.0987506  1.5710817  1.5813347 -0.5953349  0.34171219
  5  0.25799659 -0.2227711 -0.7773433  0.8454477  0.4011084 -1.49710085
  6 -0.37090708  1.3010276 -0.2925139 -0.8822561 -0.0984991 -0.02016763
  7 -1.21294480 -0.5313384  0.8224835 -1.1051970  0.4243864  0.12248771
```

```
  8 -0.18036304 -2.0271912  0.3121499  0.2927277 -0.6190010  0.14805383
  9  0.47828440 -0.1544604 -0.2399892 -0.3165956 -1.2671535  0.89206908
   year
age       2017        2018       2019       2020
  1  0.0000000  0.00000000  1.3554135 -0.1313598
  2 -0.7166020  0.01842351 -1.1582775 -2.3585986
  3  2.1902192  0.45834448 -1.3787230  0.3339537
  4 -0.3428280 -0.37922089  1.3415001  0.6547358
  5 -0.6070494  1.46272687 -0.8627675 -0.1949470
  6 -2.0420803  0.84286600 -0.9172657 -0.9019673
  7 -1.2452375 -2.71307422 -2.0332888  1.8468275
  8 -1.5484642 -1.10580968 -2.9465379 -1.7401780
  9  0.1770651 -0.05863907 -3.1305644 -0.4669229
```

TABLE 4.6.20 Herring in 6a and 7bc. PREDICTED INDEX AT AGE catch S

```
Units  :  NA
   year
age      1957       1958      1959      1960       1961      1962      1963
  1  185.4472   413.5260  506.3566  168.3969   314.9390  437.5766  274.4782
  2 9262.6138  4648.4421 7635.2918 9217.1453  3765.7931 6696.4117 6627.7301
  3 6063.8091 13488.9276 4912.8549 7739.9660 11884.9277 4221.4922 5858.1150
  4 2996.1081  4913.8067 8229.5054 3071.3743  6422.4202 9510.0032 2197.5660
  5 4157.0324  2992.3653 2647.5141 4016.8091  2569.1545 5408.6616 5058.7558
  6 2229.4728  3569.4283 1710.6743 1273.3796  3177.3362 2564.3548 3716.9228
  7 1370.9337  2244.2812 2074.8654 1089.4799  1263.3787 3949.5963 2079.4291
  8  261.6064  1196.5093  900.8573  646.1119   640.2610 1075.9405 2033.6241
  9  821.3378   934.1786  715.7687  487.6845   768.1733 1407.0176 1252.4560
   year
age      1964      1965      1966       1967       1968       1969       1970
  1  176.2451  801.2518   188.111   474.3307   630.0684   577.2211   741.3155
  2 6497.1432 4431.3229 27376.097  4268.9218  9814.8873 15553.3076 12043.4560
  3 8580.1361 9881.9231  7781.680 48336.6581  5381.9344 14161.5458 21174.7007
  4 4483.2808 8315.3971 10863.006  7969.2541 43507.4793  5030.3588 12324.1584
  5 1632.6347 3657.8626  7708.106  9295.4882  5084.2131 37160.7013  3956.8428
  6 4669.2802 1609.2468  3856.174  7090.6702  6526.5212  4485.5480 30778.4657
```

```
  7 4195.1533 5388.4120  1978.553  3767.1093  4904.5561  5936.6663  3679.7253
  8 1501.5862 3225.5586  4551.716  1576.8019  1615.6073  2742.1717  3046.4783
  9 2547.8526 3149.1019  5272.844  6589.8399  2985.4900  2842.5332  3175.1594
   year
age      1971      1972      1973      1974      1975      1976      1977
  1  1473.432  1090.484  1339.372  2792.593  4513.216  3983.478  3707.123
  2 11899.851 41516.142 24233.616 23228.766 34626.909 45503.386 25841.880
  3 11148.362 17567.465 65169.380 30079.863 23629.199 31466.045 30383.609
  4 13960.401  9842.832 17923.999 62205.501 22239.901 17044.047 16030.364
  5  7933.352 12710.078  9880.527 15681.413 42961.282 14610.078  8321.202
  6  3004.046  8062.865 13312.596  9076.444 10405.549 26765.088  6822.564
  7 23205.190  3089.232  8005.386 11407.111  5465.483  5574.663 11287.369
  8  1926.126 21545.824  3300.455  9563.769 10725.679  4513.176  3096.827
  9  3631.675  5381.824 23905.525 20788.031 15205.257 10164.804  3464.951
   year
age      1978      1979      1980      1981      1982      1983      1984
  1  4636.265  4352.943  2644.480  2478.840  1628.337  6116.300  2389.421
  2 31200.256 42594.686 47401.251 21470.906 25435.401 26926.914 64338.192
  3 21686.010 29909.258 49051.761 43017.712 19126.724 36764.319 24313.626
  4 20814.062 16784.918 26745.481 33281.006 27874.246 17987.567 21898.485
  5 10059.408 14042.974 14482.646 16304.520 19950.478 23333.080  9709.054
  6  5076.045  7482.791 11494.166  9429.295  9698.324 16485.125 12147.840
  7  3541.452  3461.929  5698.724  7041.826  4851.508  6808.400  7607.916
  8  8263.269  3116.421  3347.892  3620.372  4041.209  3963.198  3376.406
  9  2704.788  5737.905  5009.636  3052.517  2488.356  4216.703  2648.268
   year
age      1985      1986      1987      1988      1989       1990       1991
  1  2250.252  1972.365  5611.629  1601.972  1085.284   987.4535   918.5198
  2 26487.367 30438.807 39876.138 56716.172 20451.033 19345.9833 17903.8569
  3 74188.961 34700.939 56087.463 40090.954 75621.436 33159.9279 29381.7831
  4 16389.499 65455.539 42139.043 35621.187 30110.881 73392.2689 34165.5443
  5 14518.021 12773.547 72307.549 24251.022 23411.721 25006.0733 55543.2502
  6  6615.337 11494.040 13007.701 39386.881 16257.925 17777.0987 19730.5148
  7  7107.706  4177.062  9885.502  5553.615 21190.508 10922.7660 11293.9341
  8  4636.823  4395.554  4344.395  4140.206  2813.188 11471.6571  7532.9380
  9  2715.665  3595.578  6862.185  3070.098  3140.106  2942.0258  7661.0025
   year
```

age	1992	1993	1994	1995	1996	1997	1998
1	1539.254	1464.503	2978.301	2366.141	3327.532	3998.440	2841.412
2	15631.106	26176.437	28046.621	42438.692	40961.406	45420.444	70587.634
3	26836.595	21048.917	39130.682	34115.920	59606.920	48161.639	63843.390
4	27505.734	23746.862	18132.746	28066.106	28753.249	36687.103	40699.020
5	30954.172	20581.073	18604.293	11392.207	16535.256	14636.997	21073.750
6	38289.663	25078.880	16122.170	11935.616	7394.281	8118.582	8016.281
7	12121.450	21303.353	16896.124	9187.204	7035.816	2858.995	3464.564
8	6820.510	7582.077	15030.261	10301.339	6479.941	3502.074	1397.871
9	7456.551	7034.878	9076.063	10471.001	10107.410	4657.097	3412.721

year

age	1999	2000	2001	2002	2003	2004
1	1798.9886	4017.3056	2174.9641	2236.7993	964.3221	696.6239
2	26556.6343	19773.1293	55558.4453	34757.3119	33345.9416	16767.9157
3	70834.5113	24996.6846	19025.3119	69648.4751	37289.4956	40488.1939
4	31157.3208	42484.6056	15071.5252	12018.5183	41280.3483	25504.6001
5	14610.8521	12882.7084	21416.1200	8280.2381	5109.2605	17988.1406
6	6399.4540	6137.6990	6552.1500	11455.7701	3708.7045	2158.5016
7	2300.9879	2420.7744	2800.6354	2907.7581	3641.8128	1602.3943
8	891.2791	740.4751	873.4939	947.9165	664.2358	643.5319
9	1113.4417	693.0091	609.7081	684.5257	525.0449	429.6827

year

age	2005	2006	2007	2008	2009	2010
1	744.3074	929.8654	544.0494	676.6859	563.7872	976.6873
2	15522.1399	22076.6765	18221.9368	11813.0921	11589.8617	12633.2301
3	24565.7936	26359.0593	28340.6660	24776.5458	13366.3154	16519.4134
4	33445.7196	21619.5475	15284.7017	19394.9098	13411.5020	9271.9665
5	16108.5120	24565.4152	10084.1844	7932.2122	8154.5258	7191.9524
6	8836.8166	11770.2871	9791.8663	5050.8571	3293.1907	3886.3928
7	778.7558	4233.9300	3693.5535	3938.0196	1552.6732	1366.8341
8	374.3931	202.3235	476.0076	585.3561	446.6838	293.5630
9	416.3835	492.2854	201.9175	379.9228	383.8561	640.7994

year

age	2011	2012	2013	2014	2015	2016
1	290.2504	157.47803	64.72588	83.69915	59.90812	37.79401
2	16097.0562	4188.46535	3696.97965	1806.50395	1287.79667	3206.02150
3	12795.7494	15500.31260	6103.84239	6008.77513	1564.23815	2973.88086

```
  4  8301.2143  5363.15927 11262.68524 5628.84654 2321.03416 1758.01645
  5  3636.5052  2564.70146  3034.12096 7371.95711 1659.87775 1825.76445
  6  2745.4041  1179.90896  1444.00682 1779.73119 1432.41606 1324.23612
  7  1027.5297   649.48668   635.86701  609.12951  245.99416  624.55283
  8   180.1334    74.96785   134.13312  149.19528   33.43771   53.18545
  9   416.6970   153.67863   166.94847  121.76366   15.55177   20.13801
   year
age       2017       2018      2019       2020
  1   50.68326   52.43965  179.5597  141.31591
  2 1334.55885 1316.58150 1973.5140 4052.79434
  3 7041.08696 1973.62688 2529.6989 2279.26638
  4 2832.59791 4576.58659 1806.0244 1397.20588
  5 1479.36652 1534.42285 3099.2991  788.63941
  6 1320.82077  760.88964 1063.2055 1538.13161
  7  823.96311  509.71730  459.4593  447.02414
  8  208.51179  178.42091  155.0594   78.79500
  9   59.12123   81.62935  144.3276   82.71254
```

TABLE 4.6.21 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS catch S

```
Units  :  NA
   year
age             1957        1958        1959        1960        1961       1962
  1  0.0000000000000 -0.07855290  1.78337599  0.68075410  0.99653160 -0.8117938
  2  2.6189949346334  1.85856923  0.06361703  0.09981635 -1.17778618 -0.4632582
  3  0.3953326365220 -0.16357473 -0.02290094 -0.10785263  0.08755328  0.1519307
  4  0.3705483792729  2.27844808  1.31457787  1.69633263  0.77300255  0.5104304
  5  5.0542671640955  0.56256682 -0.11951782 -2.42413421  0.40543740  0.5629290
  6  1.7000330637591  0.23898321 -0.14214188 -0.74250981  0.19881264  1.5253970
  7  0.0000001340854  0.78640883 -0.16172115  0.06527083 -0.48389485  0.8544587
  8  0.0642666012502 -0.02352481 -1.47392341 -0.36936587  1.45953334  1.1954926
  9 -2.9775537250838  0.86665278 -0.82126289 -2.02671354 -0.29095881  1.0688112
   year
age       1963        1964        1965        1966       1967        1968
  1 -1.0423619 -0.93699088  0.02432629  0.00000000  0.0000000  0.24444669
  2 -0.5606308  0.23183829  0.21857626  0.10798461 -2.1941799  0.12999125
```

```
  3 -0.8497768 -0.44898715  0.62807369  2.00313252  1.6819449 -0.68625254
  4 -0.4957890  0.16677745  0.47279686  0.30068769  1.5322699  1.52757272
  5 -1.0536553  1.14832760 -0.93511401  0.09298223  0.1468127 -0.24176652
  6  0.5934040  0.01992177  1.05921855 -0.37762337 -0.4347129 -1.24987087
  7  0.6480923  0.34045390  0.42822067  2.04551680 -0.4575512 -1.92530817
  8 -0.2647212  0.48758254 -0.32497121 -0.94039949  1.3608632 -1.62074879
  9  2.0557704  1.43681889  1.03913218  0.30334329 -0.2302539 -0.05135304
   year
age        1969        1970       1971         1972        1973       1974
  1  1.04935255 -0.95512835  0.2176951  0.842195592  1.62985639  0.7417059
  2  0.50745614  1.82468690 -2.2618810  0.110720255  0.65231450  0.3860149
  3 -0.47003715 -0.31703631 -0.3205637  1.307430146 -0.44103400  0.6326678
  4 -0.45706653 -0.42813753 -0.7719317 -0.333646939  0.09145423 -0.7568075
  5  1.22535496  0.01895863  0.5488526 -0.004246179 -0.51056644  0.3508157
  6  0.45118085  0.95837286  2.0306699  0.856451872 -0.16389095 -0.4391827
  7 -1.01151371 -0.23429738  0.2804521  0.792168336  0.35193496 -0.2477277
  8 -0.80561033 -0.99779793  1.3675057  1.535266147 -0.31490554  0.3787638
  9  0.06476194 -0.89845160 -0.7617035 -0.502465816  1.74793251  0.8957415
   year
age       1975       1976       1977        1978       1979        1980
  1  0.7141864  0.8973339  0.1046658  0.85523215  0.1327450 -0.69371066
  2 -0.2964170 -1.5705657 -0.1120212 -0.08301753 -0.2426144 -0.65929783
  3 -0.3119014 -0.1132790 -3.1324899 -0.01303075 -1.2339856  1.12822225
  4  0.5125712  0.9363374 -0.2668039 -2.07262305  0.7476951 -0.17831124
  5 -1.6936800  1.0651782  0.5864799 -0.08494481 -1.1786197  1.21231050
  6 -0.3321843 -2.1919141  0.1254967 -0.11362539  0.4268384 -0.91184983
  7 -0.3625384 -0.7563165 -1.7772707 -0.11594014  0.4592772 -0.03449135
  8 -0.1639293 -0.6311072 -1.5760550 -1.21666320  0.7845194  0.62390305
  9  1.3591763  0.4986624  0.1143097  0.27801198 -0.8323308 -0.37432744
   year
age       1981        1982       1983       1984       1985       1986
  1 -0.4818547 -0.64625522  0.1998651  0.2227332  0.9035720 -0.8106234
  2 -0.8560484 -0.43634045  1.4596400  0.6668407 -1.2869020 -0.1930286
  3 -0.4388287 -0.18621800  0.9750832 -0.4865624  0.2124670  0.3050720
  4 -0.3986487 -0.04862526  0.6313514 -1.2381437 -0.5239459  0.3074800
  5 -0.9802244 -0.45993935  0.1218833 -1.2468069 -0.3423946  0.4806793
  6  0.5913137 -0.51963144 -0.2387722 -0.1756035  0.3553617 -1.2743573
```

```
  7 -1.3339021 -0.25400309 -0.3834782 -0.5178024  0.3605528  0.3112589
  8 -0.1621269 -0.38983040 -0.4179564 -0.8465768  0.5318741  0.2393719
  9  0.3830480 -0.07015209 -0.3707683  0.3774307 -0.8885301 -1.3543816
   year
age        1987         1988        1989       1990        1991         1992
  1  1.41928328  0.000000000  0.22750219 -0.1186071 -0.38076934  0.526980845
  2  0.68190087 -0.951171097 -1.59863059  1.0357629  1.34549960 -0.004209043
  3  1.45033900  0.096674523  0.54504756 -0.3638062 -0.09427018  1.232385009
  4  0.40200603  0.008254849 -0.14258859  1.8591584 -1.76572070  0.195040466
  5  1.01033616 -0.465072309 -0.33243850 -0.2262688  1.36720902 -1.273099085
  6  0.25178059 -0.095783701  0.04911465 -0.0268440 -0.28335308  1.359753442
  7  0.08935928 -0.199696654 -0.04704360  0.3726518  0.22340993 -0.361242521
  8  0.33861731 -1.275544231  0.53951959 -0.9478763  1.06705689  0.293283910
  9 -0.02635400 -1.373743943 -0.73890058 -1.9132511 -0.39251806 -0.249658200
   year
age         1993       1994       1995       1996       1997        1998
  1 -1.824782572  1.8605283 -1.2314569  1.0201280  1.1652281  0.56102566
  2  0.004710759  1.4946338  0.3411954  0.1982629  0.9682183  0.71943109
  3  0.457377426 -1.1343684  0.2922726  0.8397428 -1.1887334  1.07766795
  4  2.118416109 -0.1303922 -1.1020523  0.3927335 -0.3457385 -0.09015064
  5  0.630183991  0.7422978  1.4394424 -1.8052787 -0.4613558  0.64196786
  6 -0.808904618 -0.1156032  1.0043783  1.7015832 -1.2423539 -0.03577696
  7  1.753962692 -0.8102203 -0.6642388  0.2994099  1.4154336  0.46316166
  8  0.150474495  1.3072393 -0.1322582  1.0162576  0.3866141  1.17654691
  9  0.043890177  0.2858937  0.5638861 -0.9565142 -0.2312327  0.05715848
   year
age       1999       2000         2001       2002       2003         2004
  1 -0.4780282  0.3483377 -0.009952588  0.5947092  0.2166374  0.262720845
  2  0.3024037  0.3755073 -0.936823576  0.2896322  0.3769318  0.386082855
  3 -0.2858459  0.5780323  0.116232886 -1.2420232 -0.7009093 -0.009762988
  4 -0.2068298 -1.0818065  0.570307246  1.0672588 -1.4361833 -0.580739637
  5 -1.1918385 -0.1988691 -0.064368568  0.7310831  1.4272312 -2.061152511
  6 -0.6216192 -1.8550920  1.339257941 -0.2178654  1.0792877  1.930192031
  7 -0.2920884 -0.6063770 -0.832510067 -0.1566659 -0.9738191  0.202330077
  8  0.1045226 -0.2597372 -0.337434291  0.2271488 -0.5280576 -0.337383120
  9  0.1564768  1.3479180 -0.532150376 -0.6135451 -1.3573179 -0.916570585
   year
```

age	2005	2006	2007	2008	2009	2010
1	-1.11707481	0.12747249	-1.9144960	-0.212399887	-0.8712117	0.33216093
2	0.86863926	1.19630803	0.1532992	-0.212498725	0.1647697	-0.34453823
3	0.44399744	1.20517571	0.9502346	-0.959090777	-0.5730133	0.32332018
4	-0.07803954	0.97305700	0.8154675	1.018160836	-0.9311826	-1.08482603
5	-0.33214839	0.07368337	0.6870527	1.216318693	1.0118162	0.02588731
6	-1.32258607	-0.28253518	-1.6518164	0.818251327	1.3658018	1.43620865
7	0.79295848	-0.93102356	-1.0227243	-0.291887475	0.5354773	1.47249179
8	0.93197380	1.27966561	-1.8890029	-0.005962772	0.2183961	1.62087037
9	-1.63312054	-1.31207145	-0.8521331	-0.632635265	-4.6239664	-1.41877014

year

age	2011	2012	2013	2014	2015	2016
1	-1.44847762	1.9724471	-1.00660747	-0.7805518	-0.73616192	0.68915470
2	-0.52659700	0.0035048	-0.62596568	-2.0443104	-0.22507349	0.22268399
3	-1.06550044	-1.0882715	-0.02091648	1.8372511	-1.92751530	1.38387112
4	-0.09335218	-1.8492495	0.46673486	1.1654162	-0.57753135	-0.35396213
5	-0.53249545	-1.8728774	-0.86163204	1.4366060	-0.21176455	1.20041246
6	0.62538472	-2.2323591	1.07758085	0.5988100	-2.80763335	1.29183611
7	1.40760499	-0.2598616	0.14754739	0.7261197	-1.43043419	-0.07035479
8	2.38226268	0.5899000	2.64071253	1.6462705	-0.05982866	-0.21847834
9	-2.24834565	-2.4727672	0.57072699	-0.3876158	-0.92971464	-0.98260675

year

age	2017	2018	2019	2020
1	-0.01919717	-1.0336414	2.53175948	0.11155885
2	0.19547385	1.0949500	0.12998757	0.92368506
3	-0.14481247	-0.1697891	0.62887186	-0.55609642
4	0.95436424	-1.0930450	-0.84230874	-0.38310827
5	-0.86389538	0.1796686	-1.85898034	-1.78300006
6	1.09415948	-1.5983594	-0.42258840	-2.51684872
7	0.41793710	0.1056432	-0.44981975	-1.36847088
8	1.21331505	0.2903369	1.46238298	0.09988218
9	0.63591616	-1.8877102	-0.06575532	-1.17512955

TABLE 4.6.22 Herring in 6a and 7bc. PREDICTED INDEX AT AGE WOS_MSHAS

Units : NA

age	1991	1992	1993	1994	1995	1996	1997	1998
1	204028.6	289499.0	247733.4	372000.9	300984.0	341029.0	400650.39	202595.71
2	528408.8	396336.3	593382.3	502358.3	753671.9	621129.2	674238.03	801844.72
3	808584.0	635264.6	443047.9	667016.7	567339.4	859199.4	701307.81	722586.70
4	951108.1	676467.9	514140.1	318413.1	473380.4	420499.6	548160.00	485619.85
5	1393430.5	736486.1	447745.1	332086.6	194240.8	250599.7	231811.64	273473.18
6	469107.2	881658.3	566219.3	309959.2	222262.9	123081.4	145810.42	122566.51
7	278301.3	295459.0	514846.2	360423.1	196241.0	136276.9	58506.98	61977.12
8	184315.8	164088.6	181532.0	286608.2	202610.9	111992.2	71006.84	23120.81
9	187449.3	179390.5	168430.8	173069.1	205947.9	174685.4	94425.70	56446.46

age	1999	2000	2001	2002	2003	2004	2005
1	178206.68	509247.86	345764.57	378987.12	212849.32	182012.25	183435.46
2	380827.00	334714.93	1093080.50	700082.33	797014.64	438550.31	370491.70
3	1030283.89	421819.04	356959.50	1327536.13	837204.39	980412.35	533171.70
4	499595.11	812789.22	309038.27	243622.18	1015558.01	703836.94	863398.35
5	267524.93	286316.41	502370.03	189202.60	141111.91	580503.76	524109.36
6	142274.84	170186.52	189871.05	325592.03	127852.10	86693.45	383703.24
7	61597.79	82843.30	105130.14	111373.68	176161.40	93032.61	50821.72
8	27672.49	34264.71	49767.64	59501.98	66148.37	92191.95	70354.47
9	34570.20	32068.27	34738.35	42968.59	52286.95	61556.06	78245.16

age	2006	2007	2008	2009	2010	2011	2012
1	159986.20	103675.18	125848.59	138733.9	226304.24	100490.92	98541.46
2	387585.65	336400.47	213986.58	260051.2	274489.14	481062.22	200945.35
3	406041.10	448017.55	379462.40	250107.3	297297.39	314370.43	616245.45
4	393521.73	281521.44	331324.20	276430.1	180981.60	218441.43	236236.01
5	586863.17	247563.77	171388.69	201443.4	158848.97	105132.38	124889.65
6	405536.50	368422.41	163597.65	116030.9	112124.88	97109.17	68675.46
7	234933.47	243408.22	233360.30	100302.7	67632.85	56748.65	54826.89
8	33178.04	123949.93	142613.99	138142.5	55313.09	36228.34	26877.39
9	80727.48	52578.28	92562.97	118712.3	120739.29	83805.87	55096.69

year

age	2013	2014	2015	2016	2017	2018	2019
1	48089.74	62008.27	100958.964	42223.89	50263.679	69049.60	199796.98
2	197684.46	94491.22	124552.212	229166.28	86854.969	106588.88	145014.64
3	249655.80	223563.17	106713.886	151231.95	330716.137	118943.28	145300.52
4	469958.31	201746.80	155743.268	89382.96	133941.440	296489.05	119925.31
5	127230.05	245912.91	103324.856	85946.08	65217.543	96575.27	214500.85
6	65047.48	60770.68	88661.592	61894.42	55128.335	46239.66	72452.73
7	37463.09	25481.65	17456.745	33953.25	37537.141	32496.15	31817.48
8	21736.90	12400.67	6645.710	6550.75	16959.551	23801.86	21682.77
9	27054.78	10120.64	3090.899	2480.36	4808.695	10889.59	20182.08

year

age	2020
1	257360.71
2	433179.64
3	192733.24
4	143413.93
5	89802.13
6	180216.73
7	52691.32
8	26177.18
9	27478.66

TABLE 4.6.23 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS WOS_MSHAS

Units : NA

year

age	1991	1992	1993	1994	1995	1996
1	-0.30668993	-0.521885521	-2.3587720	0.34063152	0.6869089	-0.9228596
2	-1.41973004	0.763922867	1.2120090	-0.08648409	0.4835738	0.7764924
3	-0.94736265	-1.504194017	0.8392884	-0.45979430	-0.7393770	-0.3136438
4	0.19162635	0.480008958	0.5711961	0.17569219	-0.1708378	-0.7907580
5	-1.67245291	1.973991291	0.5195261	0.44890387	-0.2371524	-2.6971821
6	-0.08485924	-3.017797403	1.8779826	0.19744398	0.6854758	0.2733911
7	-0.21933815	1.177024094	-2.9573226	0.77362366	0.2663684	0.8180318
8	0.53886418	-0.007449669	1.5194851	-1.44638349	0.8196700	0.3216749
9	-1.59250305	0.112769111	0.6130351	0.72978864	-0.2940664	-0.4782516

```
   year
age        1997        1998       1999        2000        2001        2002
  1  0.57326055  0.60092105  0.4801441  0.52912969  0.45988312  0.37375702
  2 -0.16544450 -0.24950564 -0.6777131 -0.20414464  0.95852070 -0.25735485
  3 -1.37753213 -0.17698594  1.4185767 -0.03905089 -1.08355018  0.53620143
  4 -2.33034413 -0.05378014 -1.0290266  1.41662982 -0.23152451 -1.31220895
  5 -0.73723443 -1.29218922  1.1705935  0.77352716  1.10790985  0.05495251
  6  0.07969709 -0.06796496 -0.3461205  0.84341878 -0.63518948  1.34708688
  7 -0.37613158 -0.50059408  1.2948672  1.09724720  0.89908585  0.29955657
  8  1.62792592  1.11768630 -0.2627522  0.52231961  0.02208773 -0.28717279
  9 -1.72402858  1.05285771  1.1275075  0.16962384  0.24905952  0.55433630
   year
age        2003        2004       2005       2006        2007       2008
  1  0.61825050  0.77175499 -0.6407741  0.1187135  0.00000000 -0.4467696
  2  0.74230097 -0.30252069 -0.8196870  1.5685445 -1.78308225  0.2702680
  3  0.12823982  0.04392717 -1.3831601 -0.8612019 -0.42360272  1.1904265
  4  0.78919502 -0.79319732  1.0005673 -0.8494764  0.07803731  0.0986367
  5 -0.27505980  0.63981309  0.4057233  1.2708496 -0.31708157  0.4512747
  6  0.02280014 -1.19682360 -1.1519121  0.6953555  1.25181907  0.2164398
  7  0.98322069  0.93521014 -1.1338229 -0.3906921  0.63938376  1.2169323
  8  0.02097525 -0.26258734  2.0736924 -0.7389290  0.53486011  0.2697028
  9  0.18365857  1.11894595 -1.6264295  0.3341892 -1.36620094  0.8519944
   year
age        2009         2010        2011        2012        2013        2014
  1  1.09186253 -0.426318270 -0.58119396  0.57640892  0.00000000  2.02999711
  2 -0.23467525  0.104197264 -0.57320455  0.29328957  0.46112406  1.16574757
  3  0.03195037  0.005259728  1.95948644  0.23564172  1.19490026 -0.63779838
  4  0.56499784  0.079294463 -0.45183539  1.29184266 -1.05331989  2.23810358
  5  0.92318467 -0.864391110 -0.18414955 -0.15579756 -0.01903541 -0.78484214
  6  0.59349093  0.116771345  0.39704448 -0.25380649 -1.54374247  0.09381305
  7  0.18158196  0.867289408  0.47093932  0.05197856  1.05000809 -1.91152818
  8  1.83599801  0.454974895  0.02186036 -0.40098912 -1.53606452 -0.61919641
  9  1.24027371  1.131432226  0.88357406  0.25751132 -0.33627225 -1.73454464
   year
age       2015        2016         2017       2018       2019        2020
  1  0.0000000  0.00000000  0.000000000  2.1442804 -1.2474624  1.14258264
  2  1.4890090 -2.05840543 -1.125744089  1.4442269  0.7504954  1.67619749
```

3	2.0892881	0.17914171	0.828121801	-0.8505018	0.7224551	1.15754246
4	1.4694972	0.73952406	0.001002937	0.5916152	-0.8535351	-1.04357154
5	0.3841348	0.25366194	1.144514071	0.3865503	-0.9428262	-0.75845233
6	0.6214652	0.04162194	0.030254969	-1.0673225	0.9007108	0.21331631
7	-0.5223897	-0.18819473	-1.231515519	1.2707618	-2.3088472	-1.70735840
8	0.1136514	-1.34109465	-1.926607590	-1.4666005	0.3445952	-0.09693202
9	-4.2453426	-1.79986783	1.056022554	-0.3009342	0.7478204	-1.73951647

TABLE 4.6.24 Herring in 6a and 7bc. PREDICTED INDEX AT AGE IBTS_Q4

Units : NA

year							
age	1996	1997	1998	1999	2000	2001	2002
2	13891.923	14834.708	17532.7288	8424.223	7465.687	24577.378	15711.303
3	13101.853	10438.857	10605.4783	15427.809	6386.483	5459.118	20155.296
4	7621.982	9616.302	8371.0168	8904.207	14685.006	5634.676	4390.895
5	7040.612	6181.517	7171.9110	7381.259	8015.245	14134.823	5216.856
6	3969.291	4395.437	3647.4364	4533.853	5524.005	6174.020	10380.830
7	4359.288	1676.460	1777.1770	1956.040	2695.687	3418.134	3545.206
8	4141.312	2412.096	794.4806	1071.739	1367.964	1987.324	2338.599
9	6459.617	3207.632	1939.6217	1338.884	1280.275	1387.173	1688.789

year							
age	2003	2004	2005	2006	2007	2008	2009
2	18038.529	9970.760	8450.474	8756.941	7572.811	4842.427	5861.719
3	12895.064	15221.796	8338.433	6214.284	6823.452	5835.086	3824.855
4	18610.977	13009.186	16204.708	7177.794	5117.899	6084.255	5033.318
5	3971.958	16449.918	15366.511	16549.133	6958.422	4918.588	5683.816
6	4170.604	2832.236	13073.162	13147.357	11849.890	5435.911	3770.682
7	5716.038	3017.969	1756.442	7575.525	7736.364	7809.084	3262.307
8	2625.524	3618.737	2960.773	1288.337	4678.891	5717.493	5319.623
9	2075.344	2416.211	3292.842	3134.730	1984.737	3710.913	4571.399

year							
age	2010	2011	2012	2013	2014	2015	2016
2	6145.503	10848.360	4550.135	4453.8271	2129.4599	2799.59200	5275.54207
3	4492.178	4822.588	9533.931	3807.4116	3394.5051	1603.95297	2399.56719
4	3242.047	3984.232	4352.301	8397.7761	3556.7769	2689.70956	1685.06045

```
  5 4373.213  2950.616 3531.929 3422.8150 6434.8524 2605.65478 2490.82603
  6 3551.254  3131.890 2220.110 1953.6408 1746.4716 2330.13988 2020.35322
  7 2155.199  1843.005 1776.747 1102.0715  705.1699  420.44398 1090.38839
  8 2081.343  1387.542 1009.184  689.7882  358.7827  167.23600  247.23850
  9 4543.225  3209.758 2068.753  858.5432  292.8155   77.78094   93.61378
   year
age      2017      2018      2019      2020
  2 2002.5207 2459.4003 3359.6717 10069.419
  3 5259.7319 1894.4758 2342.9804  3136.894
  4 2536.4092 5614.3491 2323.9833  2821.259
  5 1909.6353 2822.4666 6501.5551  2774.099
  6 1839.5714 1546.4472 2544.1114  6467.029
  7 1255.4631 1100.1395 1135.8653  1921.723
  8  680.8999  978.1908  943.7144  1159.672
  9  193.0617  447.5321  878.3987  1217.329
```

TABLE 4.6.25 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS IBTS_Q4

```
Units  :  NA
   year
age       1996        1997        1998       1999       2000        2001
  2  0.8178791  0.05793861 -0.14980481 -0.7173909 -0.5710625  1.61515130
  3 -0.7416322 -0.22280247  0.14908880  1.3237789  0.1896555 -1.54012863
  4 -1.3157047 -1.00731482 -0.02718096  0.7852305  0.6308550  0.53836483
  5 -0.4522882  0.05875687  1.62059132  0.5482873 -0.7927971 -0.63620275
  6 -0.6993594  0.05467170  0.76637629  1.2500209  1.3708797  1.17076148
  7 -0.2990185 -0.73814282 -0.60994558  0.5352676  0.3494037  0.29996281
  8  1.2950211  1.46438488  0.82307769 -0.6204466  0.7990178 -0.09399218
  9 -0.3660508 -0.46735193  1.84809710  1.6529744 -0.4020470 -0.46313555
   year
age        2002        2003        2004        2005       2006       2007
  2 -0.09669524 -0.03432222  1.40096716 -1.43834939 -0.4788390 -0.4158494
  3 -1.37542110 -0.03515361 -1.16389056  0.22757028 -1.8876544 -0.7661947
  4 -2.17078628  0.03781482 -0.38560474  0.43612819  0.9072488 -0.5472321
  5  0.80486193 -1.15639801 -2.37491895  1.12423744 -0.4523164  1.2832296
  6 -0.50562822  1.02983037  0.53730910 -0.78513166  0.8957283 -1.8462308
```

7	1.41148078	-1.05362827	0.98636368	0.13897357	-0.2493972	1.2753980
8	0.14323979	0.56838349	-2.22159009	0.58689971	0.6541238	-1.6706001
9	-1.16056002	0.62770539	-0.01738045	-0.05258613	-0.7604215	-0.6672993

age	year 2008	2009	2010	2011	2012	2013	2014
2	-1.3819574	0.3948515	0	-0.1200091	-1.98177295	0	0.9021843
3	0.6887225	-0.9326534	0	-0.5162412	1.36162805	0	0.5948622
4	-0.3113265	-1.6982519	0	-0.2259289	0.43768128	0	-1.2810092
5	-1.0610620	0.2946874	0	-0.7969036	0.69748950	0	-0.6601509
6	0.3292110	-1.2576152	0	-0.6718126	0.32215245	0	-0.2654621
7	0.6674713	0.5694632	0	-1.5410683	0.03233811	0	-0.7352208
8	-0.3182928	-0.9948897	0	-0.6530709	-1.62436921	0	0.5475298
9	1.0915820	0.8693629	0	0.9953384	2.25005737	0	-2.8724403

age	year 2015	2016	2017	2018	2019	2020
2	1.7674039	2.7018353	2.4582706	0.9720859	-0.97130548	-0.2432754
3	0.5932989	-0.3054724	0.6015737	0.5931333	0.90732814	-2.4707922
4	-0.4210318	1.8172530	0.3171823	-0.6590504	0.67046519	2.1400049
5	1.2908170	-0.7798330	2.1597324	-0.2472389	-1.56327458	0.5386020
6	-1.5926693	0.9880914	-1.0565245	0.2487108	0.59724370	-1.7181071
7	-0.6766159	-0.4765041	0.3621291	-0.3276997	1.03234225	-1.2400472
8	2.4745584	0.9820720	-0.4365795	-0.2155124	-1.64912229	0.8040222
9	1.6104059	0.9913599	-0.3591152	-2.6238727	0.04155989	-0.2413239

TABLE 4.6.26 Herring in 6a and 7bc. PREDICTED INDEX AT AGE IBTS_Q1

Units : NA

age	year 1997	1998	1999	2000	2001	2002	2003
2	67928.43	81427.90	38105.92	33141.14	107128.34	68777.34	77462.13
3	135149.42	141763.41	197037.74	79547.13	66459.66	249464.20	154468.48
4	110084.53	99726.88	98329.86	157221.43	59088.84	47271.54	192924.81
5	54345.29	65487.07	60054.62	63096.41	109998.60	42508.06	30881.99
6	42285.16	36132.28	38443.40	44921.10	50002.38	87920.23	33533.68
7	21214.34	22451.94	19596.96	25549.99	32456.86	35324.39	54526.40
8	34544.56	11085.02	11393.31	13572.69	19708.17	24044.13	26397.27

```
  9  45937.74  27062.65  14233.24  12702.65  13756.52  17363.16  20865.71
   year
age      2004      2005      2006     2007     2008     2009     2010     2011
  2  42377.00  35654.59  37752.48 32919.30 20800.98 25405.82 27047.89 46970.49
  3 179063.48  96481.32  75527.48 83852.88 70159.30 46567.67 56207.78 58301.79
  4 132260.13 159111.66  75205.77 54029.29 62777.50 52945.20 35390.91 41747.80
  5 125960.14 108898.13 128133.74 54276.80 36594.07 43950.45 35758.20 23093.39
  6  22694.97  95218.60 107205.60 98381.18 41914.39 30580.19 30533.79 25842.05
  7  28804.79  14516.85  73299.04 77350.62 69451.68 30952.86 21421.54 17545.24
  8  37315.01  26060.52  13614.59 52726.86 56191.40 57292.13 23624.96 15129.14
  9  24915.03  28983.37  33126.47 22366.19 36470.78 49233.79 51569.37 34997.77
   year
age      2012     2013      2014      2015      2016      2017      2018
  2  19517.85 19324.49  9233.744 12211.864 21796.118  8244.712 10108.027
  3 113060.40 46647.42 42006.807 20311.751 26868.111 58580.386 21029.115
  4  44575.01 92191.55 40261.523 31907.198 16379.032 24404.772 54023.879
  5  27168.51 29494.22 59053.768 26007.119 18123.166 13573.288 20148.104
  6  18220.56 18952.44 18728.265 30615.931 16220.431 14047.885 11749.112
  7  16997.80 13136.81  9658.107  7895.879 10648.413 11179.185  9529.489
  8  11511.11 11532.39  7400.212  4736.578  2787.198  6670.004  9086.830
  9  23596.94 14353.76  6039.580  2202.967  1055.338  1891.207  4157.316
   year
age      2019      2020
  2 13680.960 40693.546
  3 25289.264 33149.851
  4 21218.793 24893.790
  5 42722.424 17458.910
  6 17302.675 41865.265
  7  8721.141 14054.719
  8  7695.000  9083.095
  9  7162.419  9534.689
```

TABLE 4.6.27 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS IBTS_Q1

Units : NA

age	year 1997	1998	1999	2000	2001	2002
2	0.55277912	-2.1784745	0.5133014	0.86448328	0.38944014	-0.2390052
3	0.31858151	0.2139073	1.0653687	0.42973119	0.02866255	-0.7301654
4	-1.78965016	-0.6948971	1.1102948	-0.65820134	-0.09462279	0.3234922
5	-1.05714593	-1.1995909	-0.3838693	0.05126629	-0.14383731	-2.2033438
6	-0.48719841	-1.6630078	-0.7790111	0.87790444	0.56820285	0.2634784
7	0.05978633	1.0292827	0.9715627	-0.02179749	0.43709776	-0.6148019
8	1.43197472	-1.0462057	1.0418647	-1.66948877	-0.87448652	0.7395284
9	-0.87596519	0.5214387	1.7449214	2.04250154	1.34764643	0.8787474

age	year 2003	2004	2005	2006	2007	2008
2	0.6002231	1.2565051	0.9575004	2.00763312	-0.430667834	0.05220872
3	-1.1290079	0.4069359	-0.5643233	0.53928676	0.006628811	-2.79702856
4	-0.8435095	-0.1471560	1.3950892	-1.25847610	-0.030031146	0.17545766
5	-0.1523616	-0.3422976	1.2585945	1.68822114	0.123669268	0.64339638
6	-0.4403413	1.4622230	0.2894747	1.19537663	-0.205996505	-0.64423205
7	-0.5561608	0.1942236	0.3507599	0.02339286	0.234209659	-0.92811887
8	-0.4791816	-0.7635707	1.1776136	0.65338588	-0.948256390	0.63968819
9	1.4351125	1.0885380	-0.2134547	1.08986076	2.340987549	-0.11874453

age	year 2009	2010	2011	2012	2013	2014
2	0.50753982	-0.99140733	0.63915124	-1.5042915	1.0757734	0.04251665
3	0.57375643	-0.11972612	-0.26123794	1.9867976	-0.9241709	-0.37120452
4	-0.72338050	-0.81091185	0.54701685	-0.3227323	-0.1638314	-1.32485759
5	0.69458195	-0.58404435	-0.16569138	-0.4264081	0.4944612	-0.36741012
6	0.49388670	0.03712544	0.07157970	-0.5718599	0.5496877	-1.81861255
7	0.30399955	1.23101542	-0.25034342	-0.5169086	0.1281714	0.17712778
8	-0.01393181	-0.90869872	-0.05566304	-0.2683090	-0.3940330	-0.42637932
9	1.57504135	-0.12868611	1.03638882	0.9136143	0.2531835	-0.84136846

age	year 2015	2016	2017	2018	2019	2020
2	-0.6592520	0.1284854	0.1206639	-0.4862957	-0.88191454	-1.4280603
3	-1.1551230	-0.8779596	0.1452583	1.7041618	0.17269326	-1.1439270

```
  4  0.8465811 -1.6480306 -0.3168585  2.7063606  1.80290298 -0.5623538
  5 -1.5623403  0.8612535 -0.4551773 -1.2008603  1.89035546 -0.1180418
  6 -0.8255133  0.8760830 -0.7617581  0.9528242 -3.45790264  1.4178308
  7 -0.1107114 -2.6769726  0.1577571 -1.4229558  1.07173842 -2.6425885
  8  0.8193162 -0.3516141 -0.9591290 -0.2073744 -1.36995478  0.4539104
  9 -1.0098582  0.5111954  2.0485495 -0.8092327 -0.07941602  0.3642607
```

TABLE 4.6.29 Herring in 6a and 7bc. FIT PARAMETERS

	name	value	std.dev
1	logFpar	-1.21746378	0.34304280
2	logFpar	0.11192533	0.14114680
3	logFpar	0.81370624	0.11960868
4	logFpar	1.13770208	0.11941502
5	logFpar	1.26059648	0.12046397
6	logFpar	1.45959080	0.12365227
7	logFpar	1.60436557	0.15571360
8	logFpar	1.76397811	0.16548037
9	logFpar	-2.41931695	0.20889180
10	logFpar	-1.10778686	0.14153081
11	logFpar	-0.76999375	0.14086664
12	logFpar	-0.52643914	0.14127361
13	logFpar	-0.14946699	0.14800416
14	logFpar	0.13410452	0.15309241
15	logFpar	0.56745348	0.15740326
16	logFpar	-3.51917042	0.12226969
17	logFpar	-3.17769137	0.17831993
18	logFpar	-2.66782336	0.17846268
19	logFpar	-2.09939697	0.17982731
20	logFpar	-1.75050296	0.18318052
21	logFpar	-1.58997351	0.19854492
22	logFpar	-1.24430347	0.20877212
23	logSdLogFsta	-0.83930191	0.23514595
24	logSdLogFsta	-1.17981977	0.17314866
25	logSdLogFsta	-1.24067177	0.13856787
26	logSdLogFsta	-0.70980213	0.17747801

27	logSdLogFsta	0.03193858	0.16734356
28	logSdLogFsta	0.26241664	0.08932920
29	logSdLogN	-0.51949506	0.12008948
30	logSdLogN	-2.14823542	0.13334765
31	logSdLogObs	0.16260415	0.10370422
32	logSdLogObs	-0.60790311	0.11463162
33	logSdLogObs	-0.93182376	0.06232043
34	logSdLogObs	-0.43029717	0.06641453
35	logSdLogObs	0.35912746	0.11013427
36	logSdLogObs	-0.86034059	0.13578615
37	logSdLogObs	-1.28363892	0.07290240
38	logSdLogObs	-0.80858728	0.09722850
39	logSdLogObs	0.52149466	0.14315539
40	logSdLogObs	-0.33304563	0.13294138
41	logSdLogObs	-0.51647992	0.10392995
42	logSdLogObs	-0.27573909	0.10841419
43	logSdLogObs	-0.01939255	0.13559402
44	logSdLogObs	-0.44764913	0.11887042
45	logSdLogObs	-0.40920774	0.12080419
46	logSdLogObs	-0.47019348	0.12568328
47	logSdLogObs	-0.68900111	0.15391291
48	logSdLogObs	-0.21362356	0.12557651
49	logSdLogObs	-0.15892923	0.12644375
50	transfIRARdist	0.38826234	0.36623888
51	transfIRARdist	-1.39467410	0.23861868
52	transfIRARdist	-1.36693214	0.25064163
53	transfIRARdist	-1.72140222	0.51223926
54	transfIRARdist	-2.69057349	0.45856672
55	transfIRARdist	-2.17705709	0.42851273
56	transfIRARdist	-1.38934420	0.29683798
57	itrans_rho	2.86914201	0.19475923
58	itrans_rho	1.71249464	0.20274549

TABLE 4.6.30 Herring in 6a and 7bc. NEGATIVE LOG-LIKELIHOOD

1618.31607634768

Table 4.7.1.1: Herring in divisions 6.a and 7bc. Assumptions made for the intermediate year and in the forecast for scenario 1.

Variable	Notes
$F_{ages\ (wr)\ 3–6}$ (2021)	F corresponding to the assumed total catch for 2021
$R_{age\ (wr)\ 1}$ (2021-2023)	Geometric mean 2016–2020
SSB (2021)	Tonnes; Calculated in the short-term forecast based on the assumptions for the intermediate year
Total catch (2021)	Tonnes; Monitoring TAC 4840 t

Table 4.7.1.2: Herring in divisions 6.a and 7.bc. Catch Scenarios based on full uptake of the TAC.

Basis	Total catch (2022)	% SSB change 2022 relative to 2021	% SSB change 2023 relative to 2022	% TAC change 2022 relative to 2021
Precautionary approach: zero catch	0	+21%	-4%	-100%
Other scenarios				
TAC=Monitoring TAC	4840	+17%	-5%	0

Table 4.7.1.3: Herring in divisions 6.a and 7.bc. Assumptions made for the intermediate year and in the forecast for scenario 2.

Variable	Notes
$F_{ages\ (wr)\ 3–6}$ (2021)	F corresponding to the assumed total catch for 2021
$R_{age\ (wr)\ 1}$ (2021-2023)	Geometric mean 2016–2020
SSB (2021)	Tonnes; Calculated in the short-term forecast based on the assumptions for the intermediate year
Total catch (2021)	Tonnes; Monitoring TAC 1540 t

Table 4.7.1.4: Herring in divisions 6.a and 7.bc. Catch Scenarios based on partial uptake of the monitoring TAC.

Basis	Total catch (2022)	% SSB change 2022 relative to 2021	% SSB change 2023 relative to 2022	% TAC change 2022 relative to 2021
Precautionary approach: zero catch	0	+21%	-4%	-100%
Other scenarios				
TAC=Partial uptake of the Monitoring TAC	1540	+18%	-5%	-68%

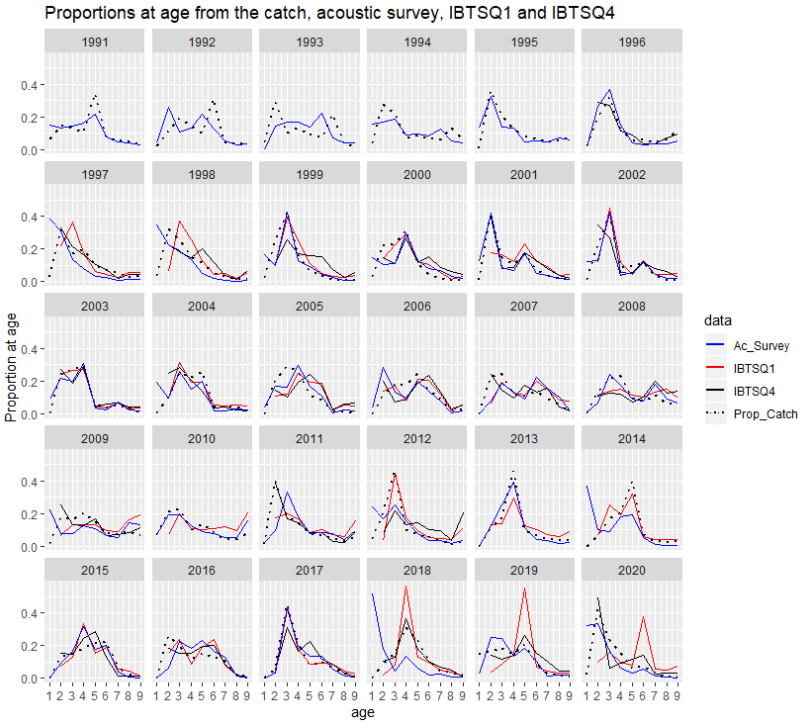

Figure 4.3.1.1. Herring in 6.a (combined) and 7.b–c. Comparison of the proportions-at-age, by age (-wr), of the catch, acoustic survey (WOS MSHAS), IBTS Q1 and IBTSQ4.

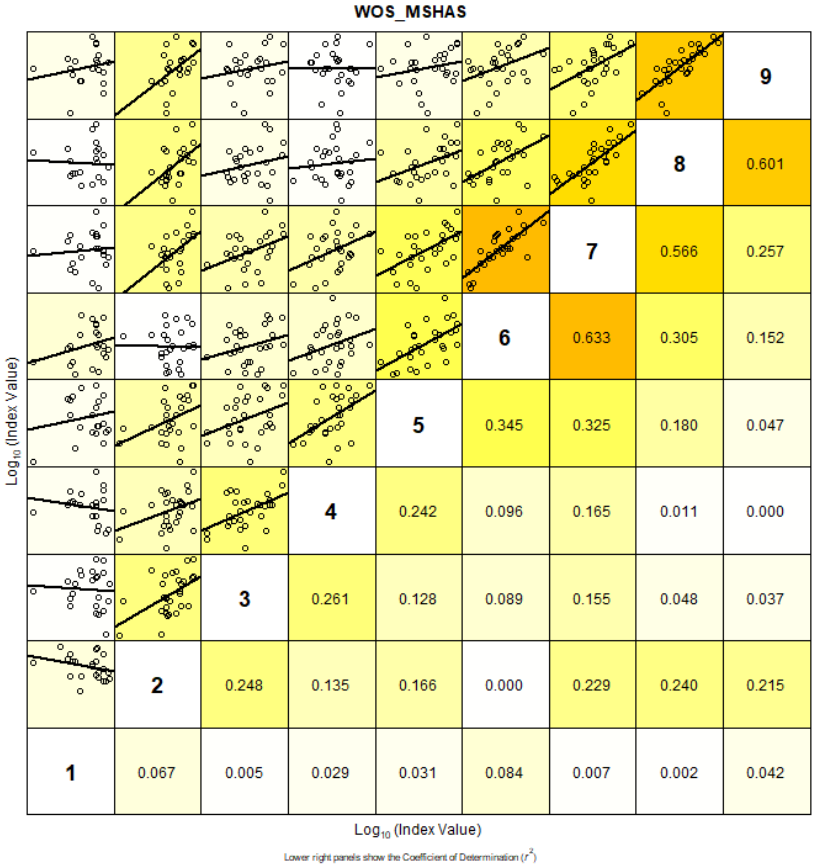

Figure 4.3.1.2. Herring in 6.a (combined) and 7.b–c. Internal consistency between ages (rings) in the WoS_MSHAS herring acoustic survey time-series (1991–2020).

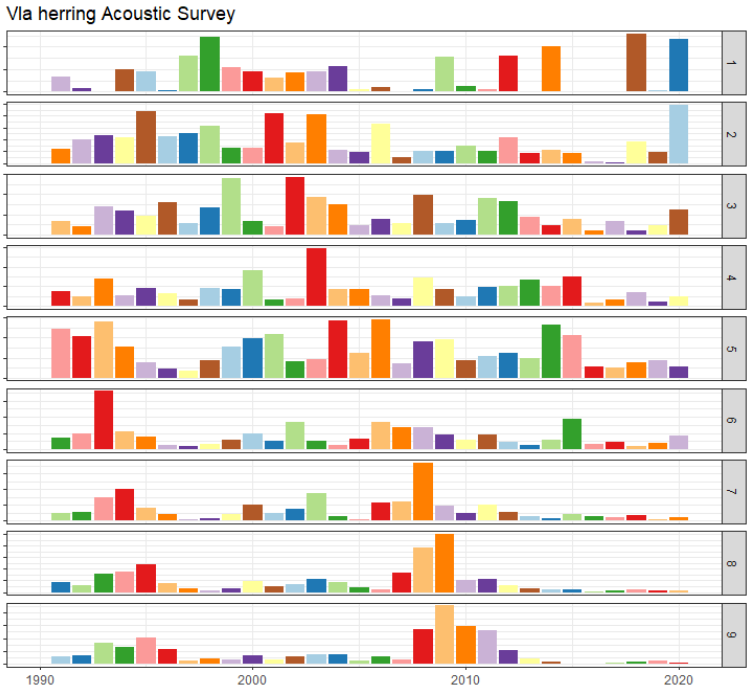

Figure 4.3.1.3 Herring in Divisions 6.a (combined) and 7.b–c. Catch numbers-at-age from Malin Shelf herring acoustic survey combined with West of Scotland acoustic survey (WoS_MSHAS) (6.a.N-S, 7.b and 7.c) time-series. Age (rings) from acoustic surveys 1991 to 2020.

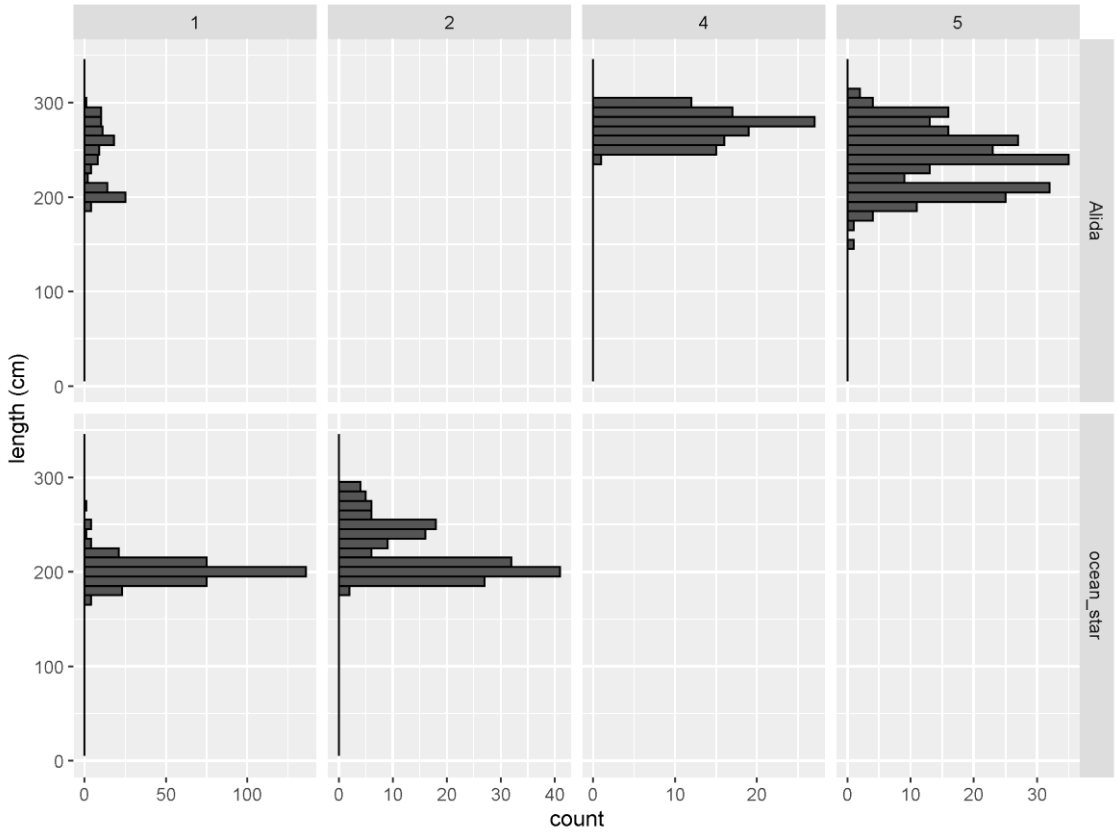

Figure 4.3.1.1.1 Relative Length-frequency distributions recorded from industry survey samples in 6aN.

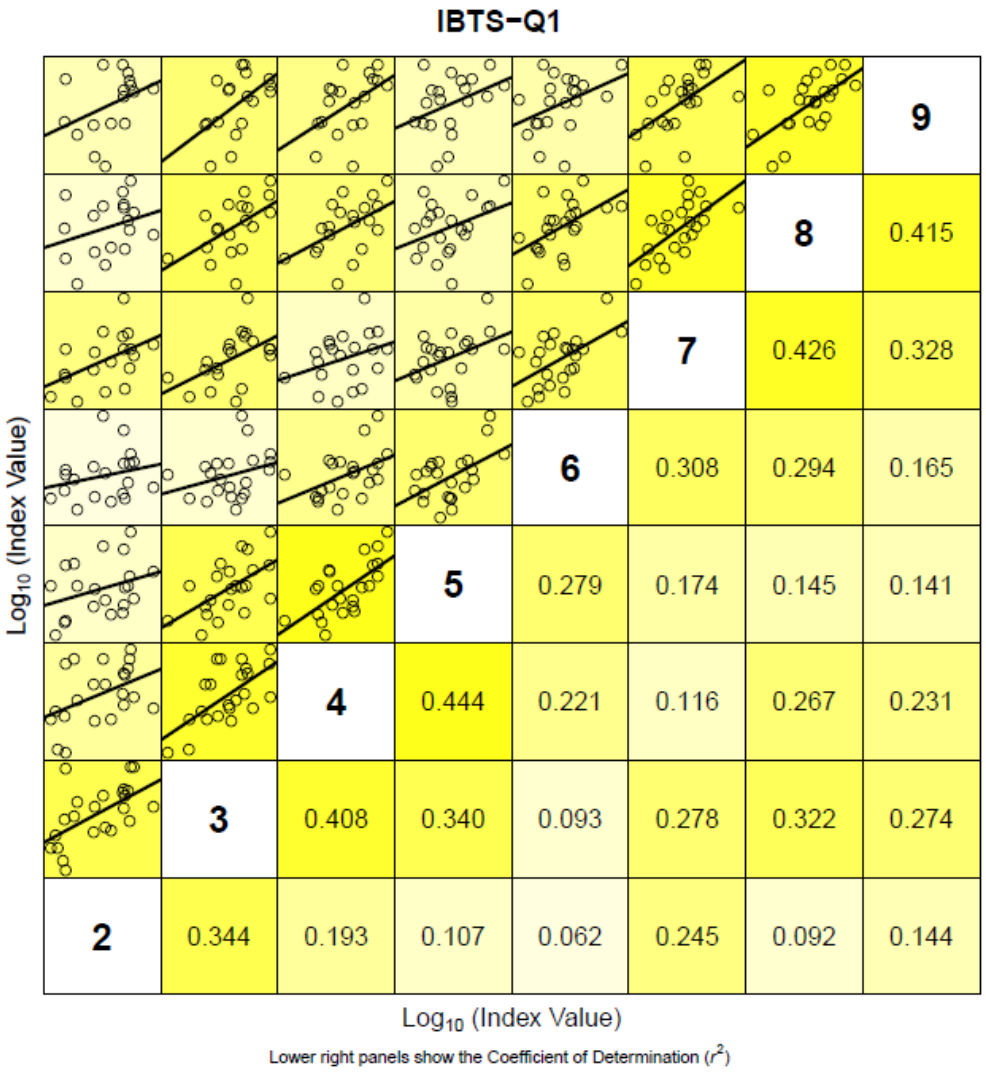

Figure 4.3.2.1. Herring in divisions 6.a (combined) and 7.b–c. Internal consistency plot of the quarter 1 Scottish bottomtrawl survey (1994–2020). Above the numbered diagonal the linear regression is shown including the observations (in points) while under the numbered diagonal the r^2 value that is associated with the linear regression is given.

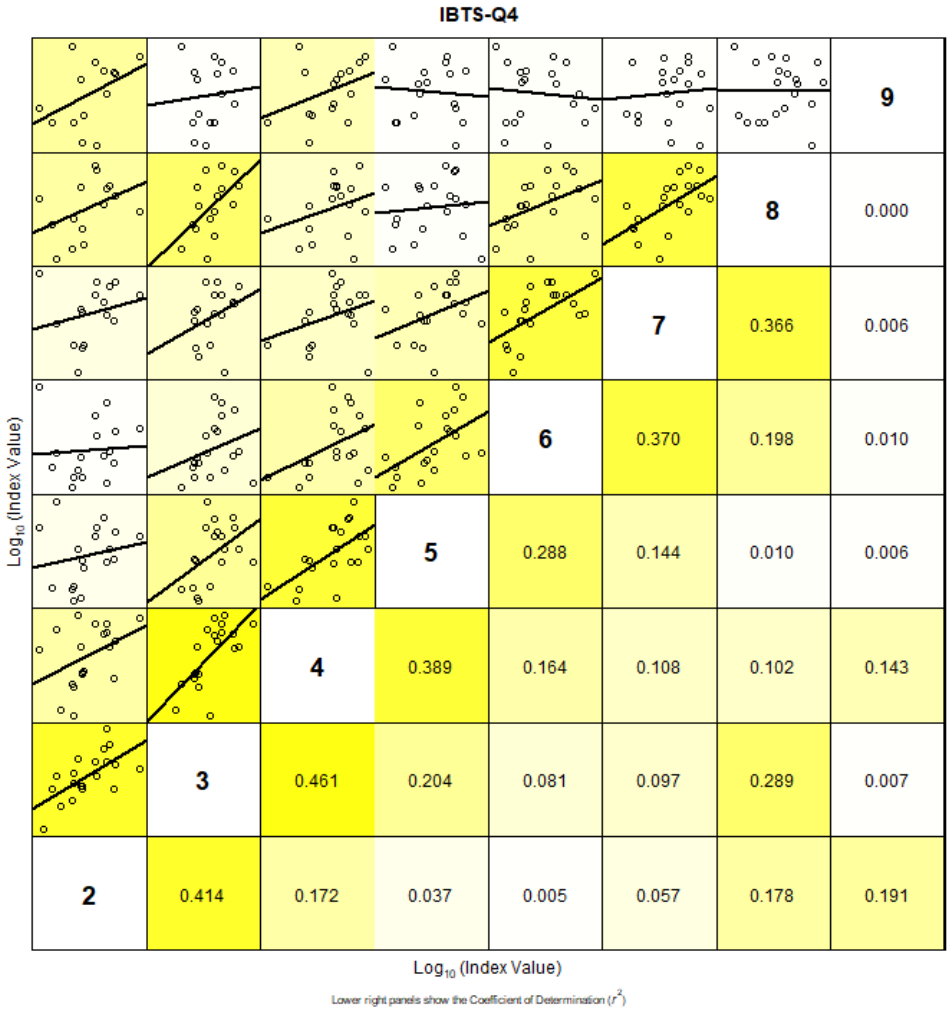

Figure 4.3.2.2. Herring in divisions 6.a (combined) and 7.b–c. Internal consistency plot of the quarter 4 Scottish bottomtrawl survey in (1996–2020). Above the numbered diagonal the linear regression is shown including the observations (in points) while under the numbered diagonal the r^2 value that is associated with the linear regression is given.

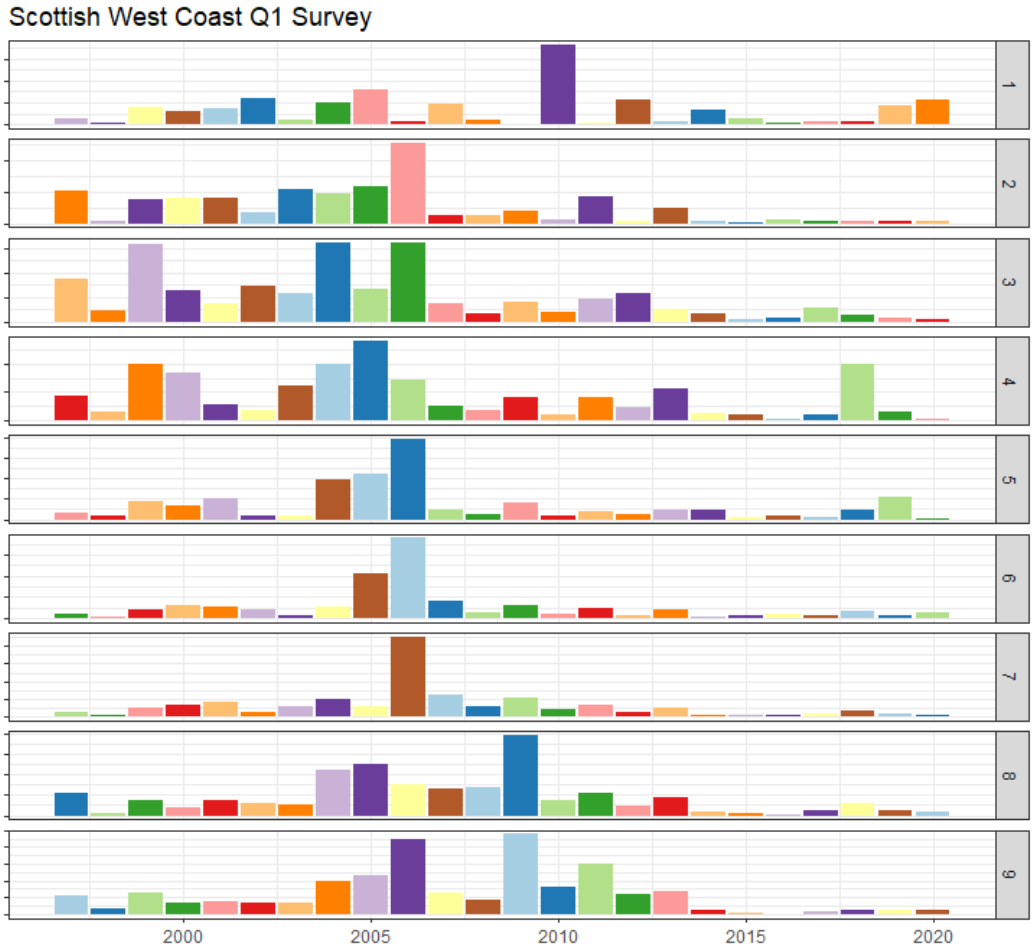

Figure 4.3.2.3. Herring in 6.a (combined) and 7.b-c. Trends in stock composition from abundance-at-age index from Scottish groundfish survey in Quarter 1.

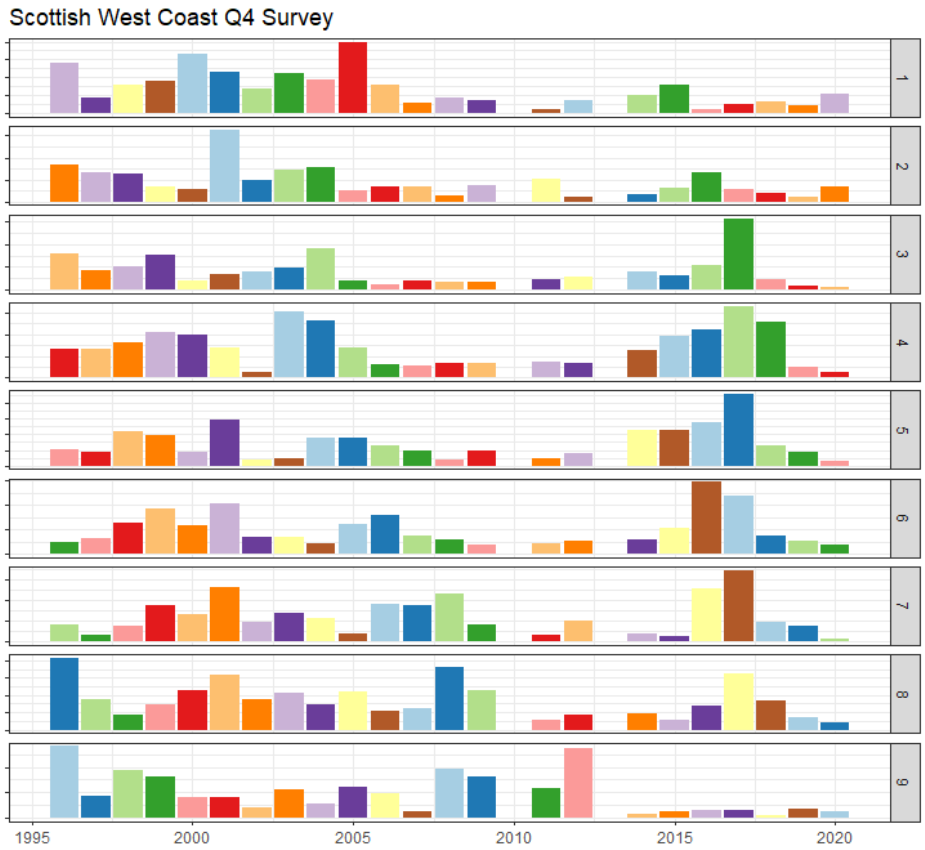

Figure 4.3.2.4. Herring in 6.a (combined) and 7.b-c. Trends in stock composition from abundance-at-age index from Scottish groundfish survey in Quarter 4. There was no survey in 2010 and in 2013 only half of the survey was completed and the data were not used for the index.

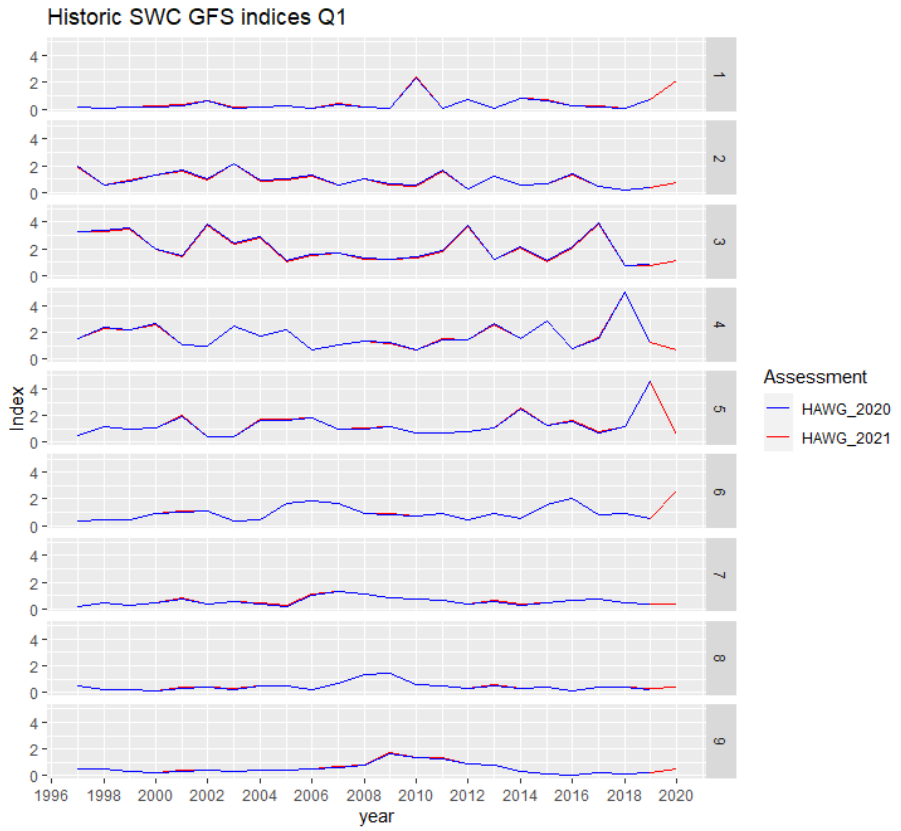

Figure 4.3.2.5 Herring in 6.a (combined) and 7.b–c. Abundance-at-age index from Scottish groundfish survey in Quarter 1 from HAWG 2020 and HAWG 2021. Each index was mean standardized by year.

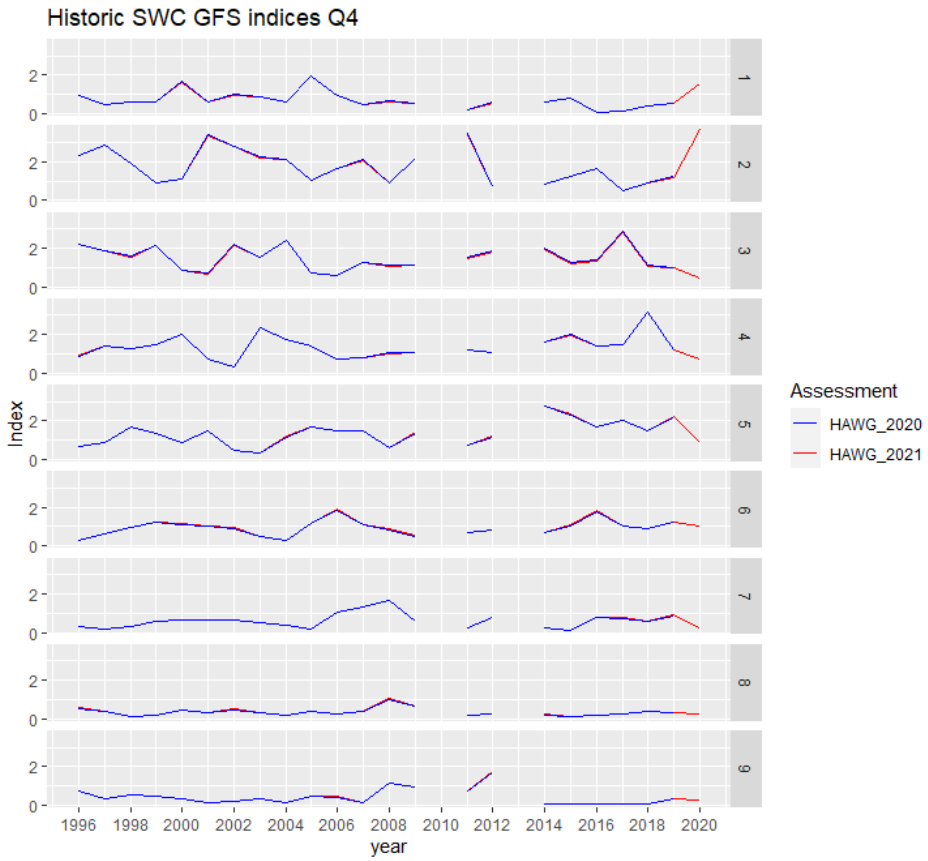

Figure 4.3.2.6 Herring in 6.a (combined) and 7.b–c. Abundance-at-age index from Scottish groundfish survey in Quarter 4 from HAWG 2020 and from HAWG 2021. Each index was mean standardized by years.

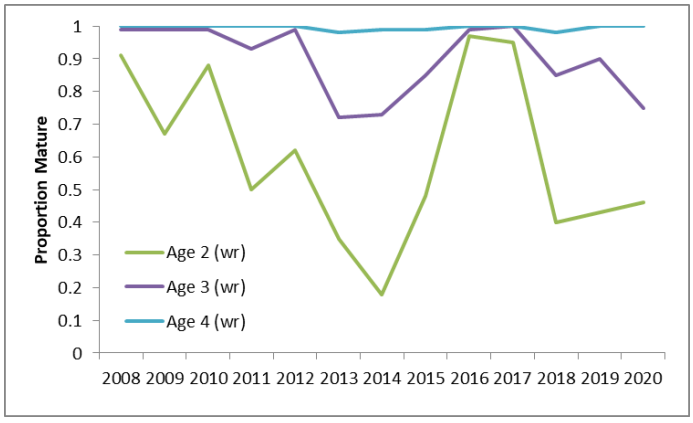

Figure 4.4.2.1. Herring in 6.a (combined) and 7.b–c. Maturity-at-ages 2–4 wr for the years 2008 to 2020.

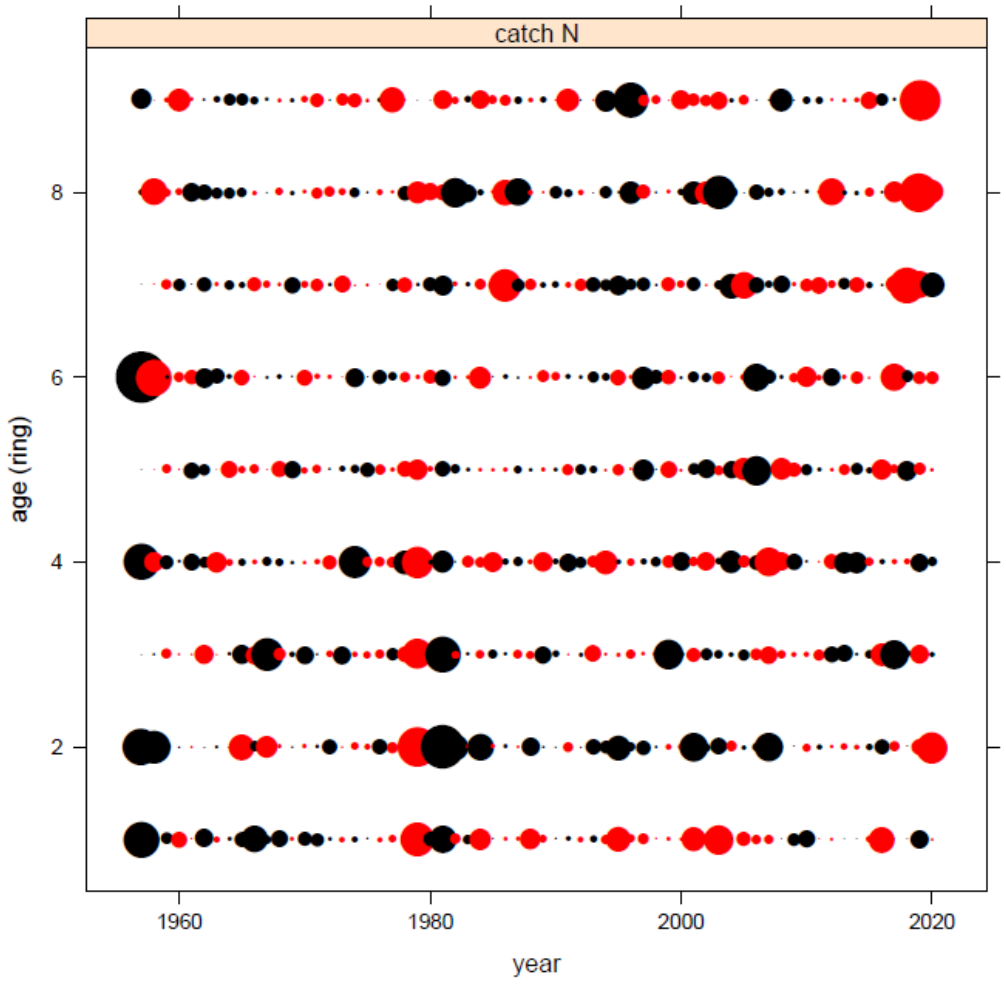

Figure 4.6.1. Herring in 6.a (combined) and 7.b–c. Bubble plot of catch N residuals (1957–2020).

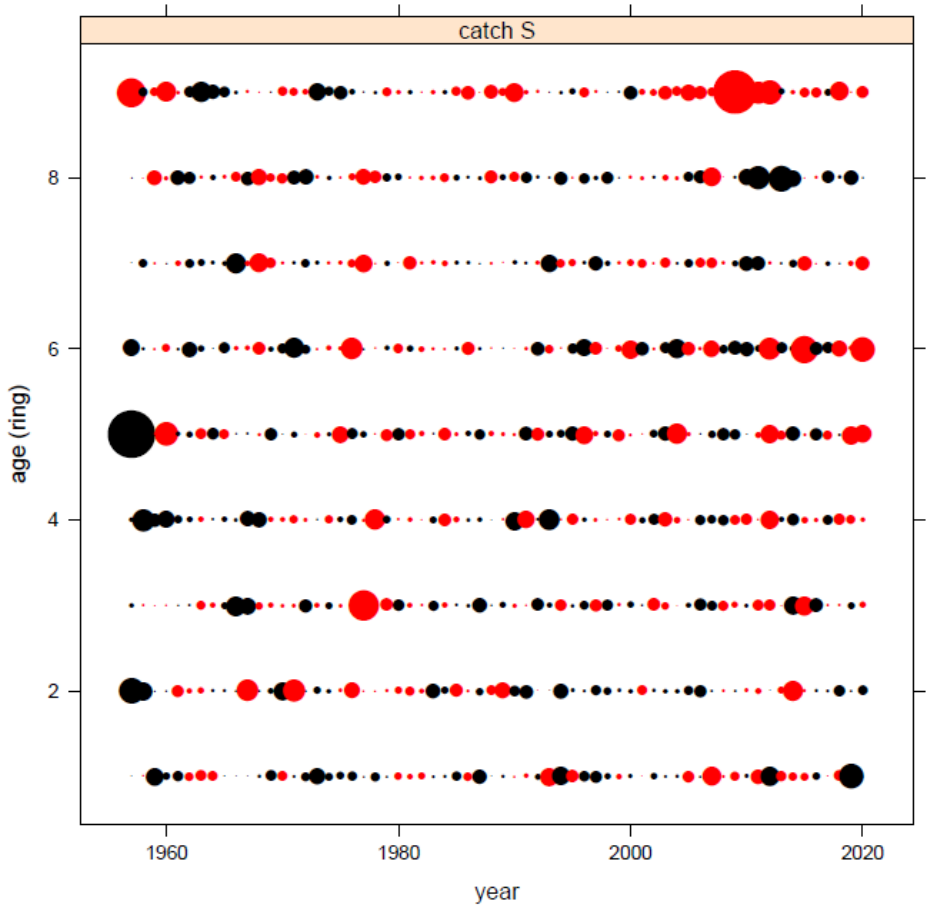

Figure 4.6.2. Herring in 6.a (combined) and 7.b–c. Bubble plot of catch S residuals (1957–2020).

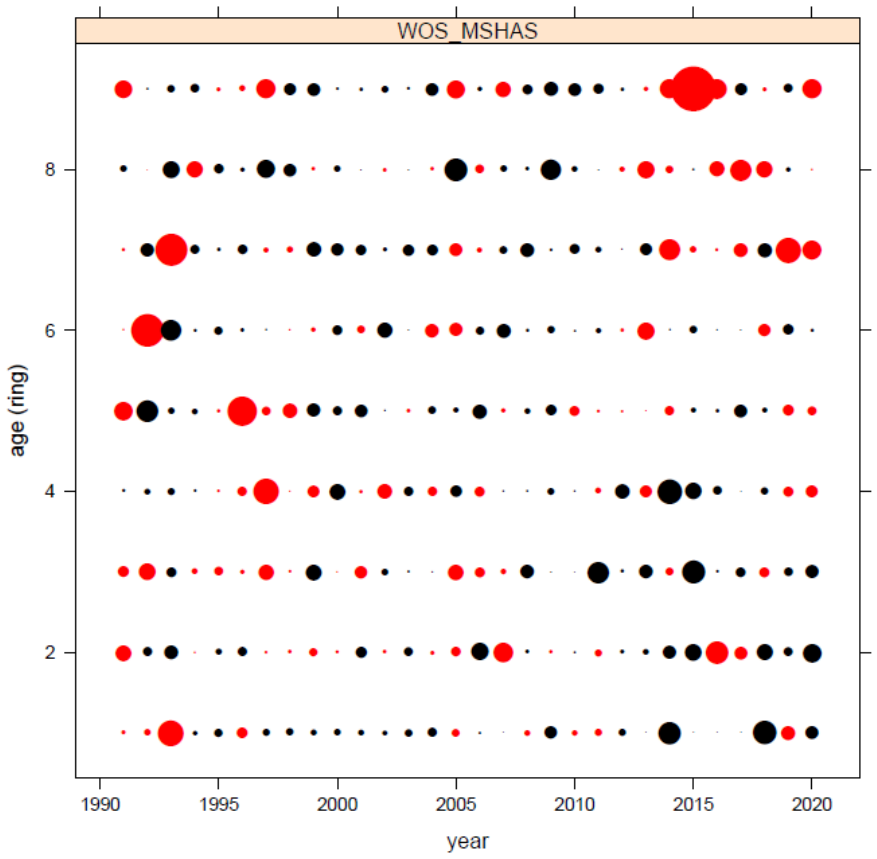

Figure 4.6.3. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardized survey residuals from the WoS_MSHAS acoustic survey (1991–2020).

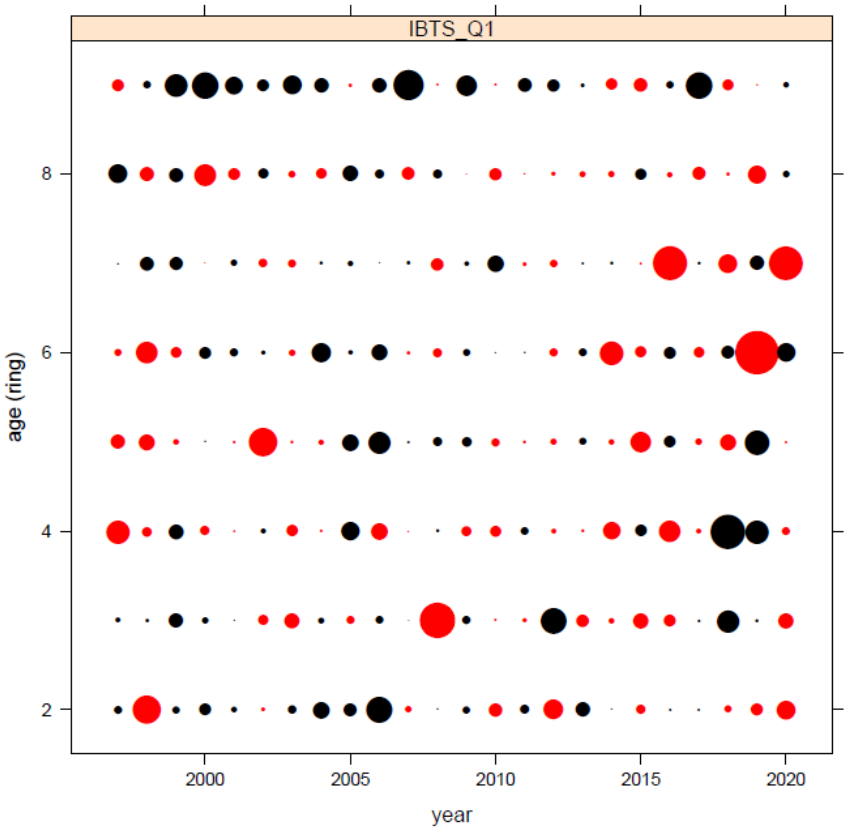

Figure 4.6.4. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardized survey residuals from the Scottish bottom-trawl survey in quarter 1 (1994–2020).

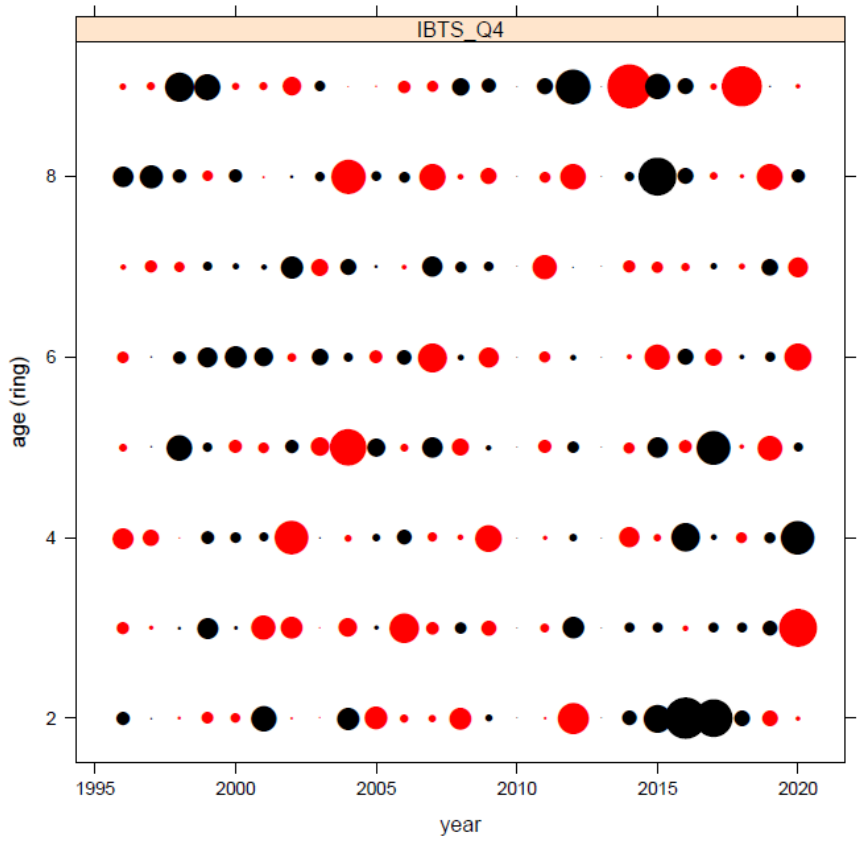

Figure 4.6.5. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardized survey residuals from the Scottish bottom-trawl survey in quarter 4 (1996–2020).

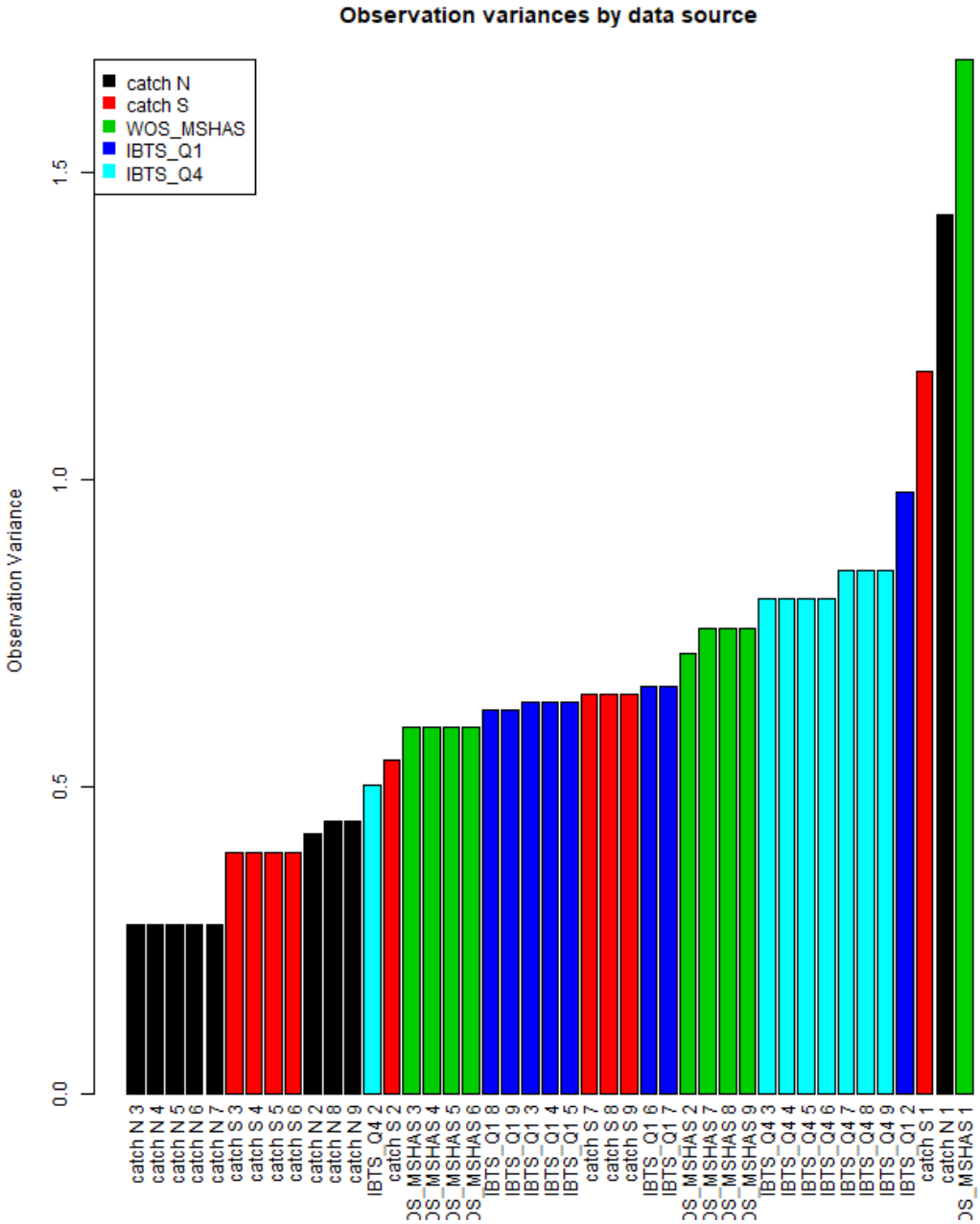

Figure 4.6.6. Herring in 6.a (combined) and 7.b–c. Observation variance by data source, ordered from least (left) to most (right). Colours indicate the different data sources. In cases where parameters are bound, observation variances have equal values.

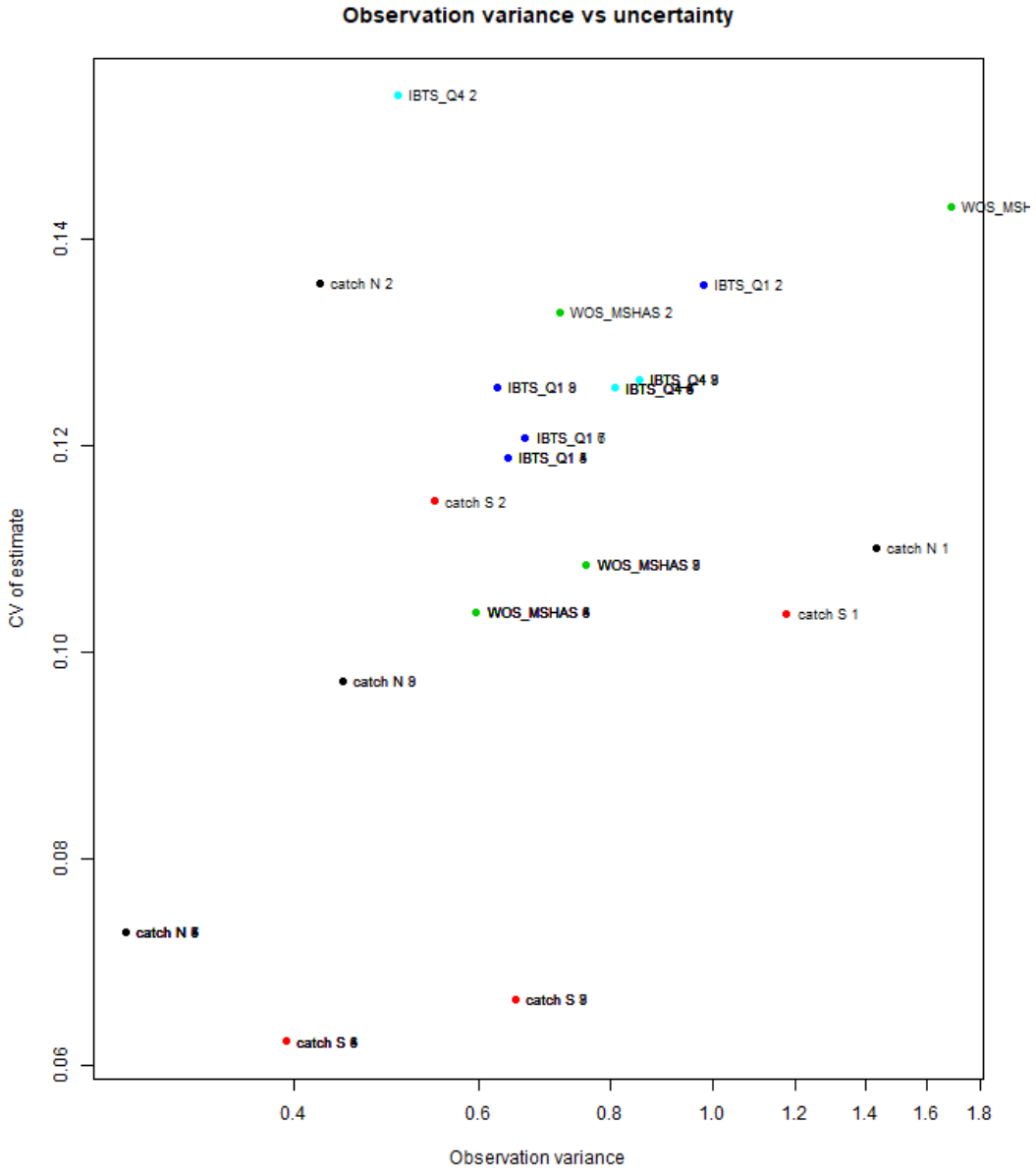

Figure 4.6.7. Herring in 6.a (combined) and 7.b–c. Observation variance by data source as estimated by the assessment model plotted against the CV estimate of the observation variance parameter.

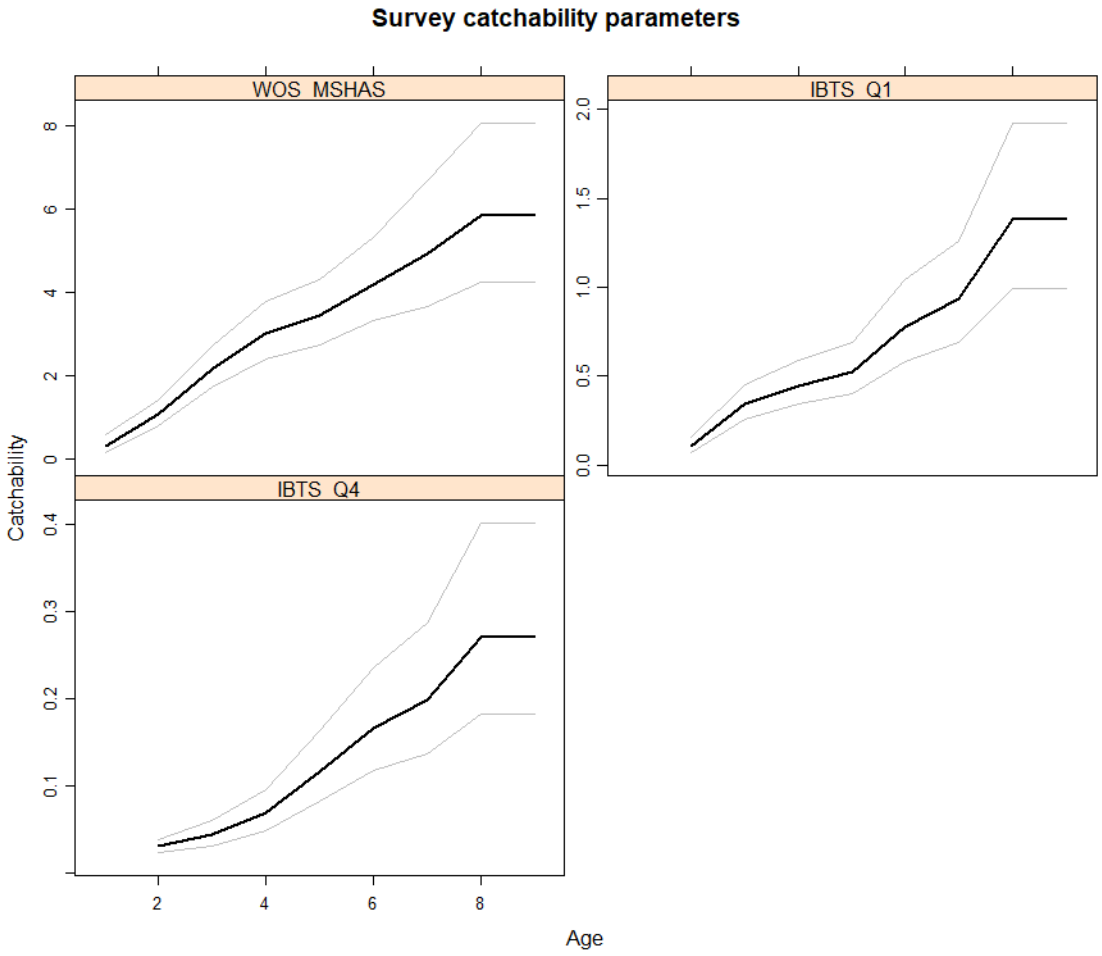

Figure 4.6.8. Herring in 6.a (combined) and 7.b–c. Survey catchability parameters from the WOS_MSHAS acoustic survey (top left), Scottish groundfish survey index quarter 1 (IBTS_Q1, top right) and Scottish groundfish survey index quarter 4 (IBTS_Q4, bottom left).

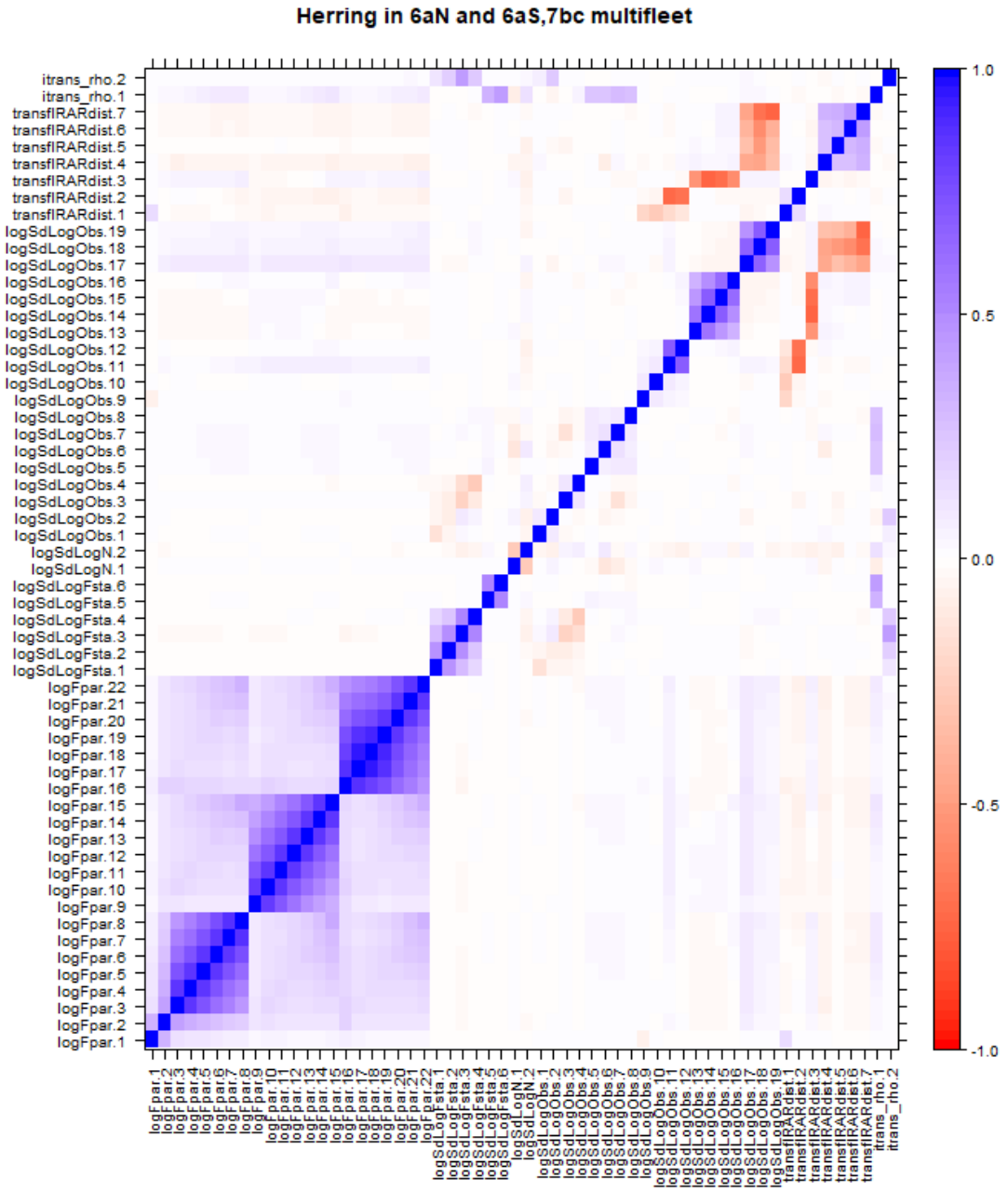

Figure 4.6.9. Herring in 6.a (combined) and 7.b–c. Correlation plot of the parameters estimated in the model. The horizontal and vertical axes show the parameters fitted by the model (labelled with names stored and fitted by FLSAM). The colouring of each pixel indicates the Pearson correlation between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

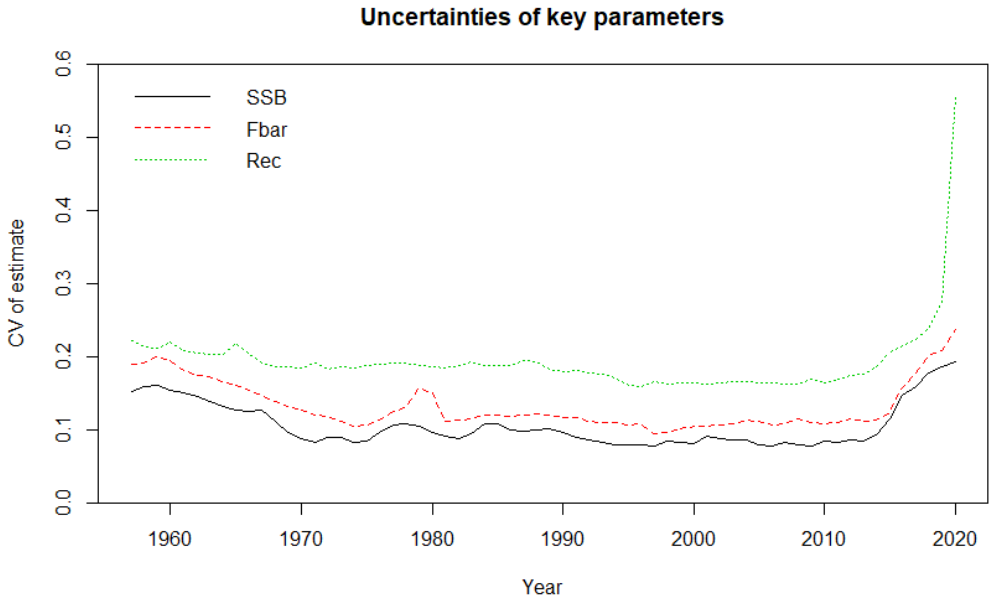

Figure 4.6.10. Herring in 6.a (combined) and 7.b–c. Uncertainty estimates in SSB, F_{bar} and recruitment parameters (1957–2020).

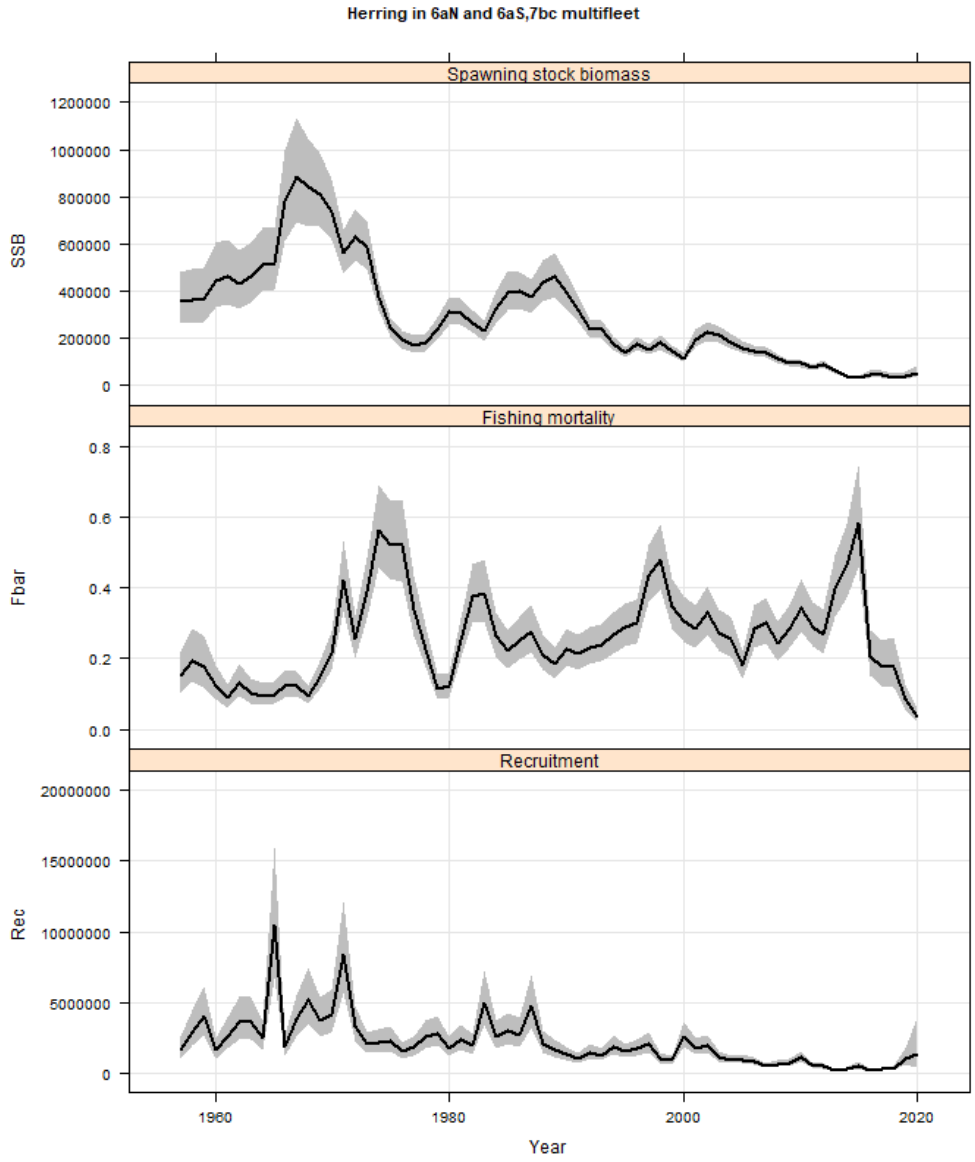

Figure 4.6.11. Herring in 6.a (combined) and 7.b–c. Stock summary plot with associated uncertainty for SSB (top panel), F ages 3–6 (middle panel) and recruitment (bottom panel).

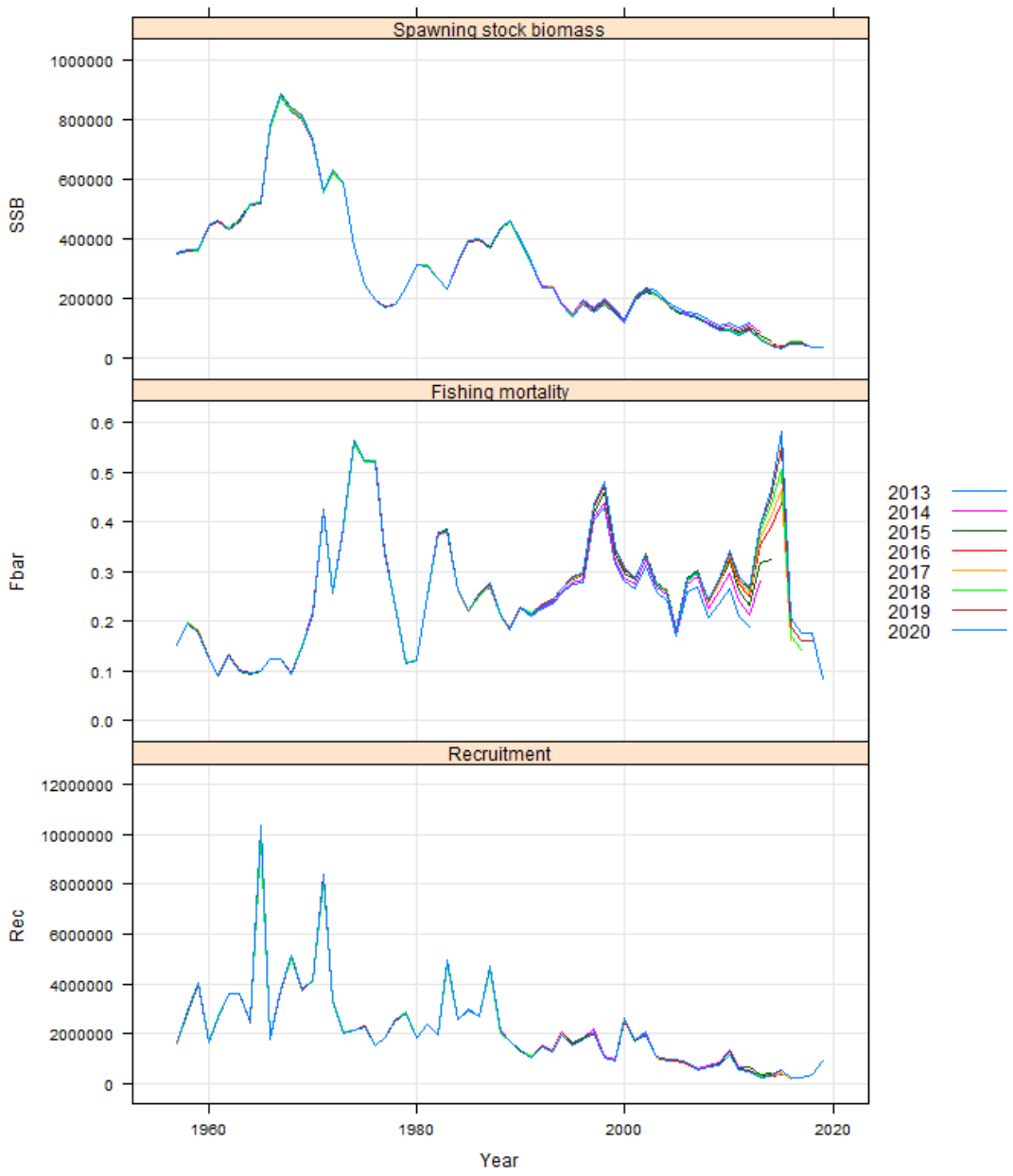

Figure 4.6.12. Herring in 6.a (combined) and 7.b–c. Analytical retrospective of the estimated spawning–stock biomass (top panel), fishing mortality (middle panel) and recruitment (bottom panel) as estimated over the years 2013–2020.

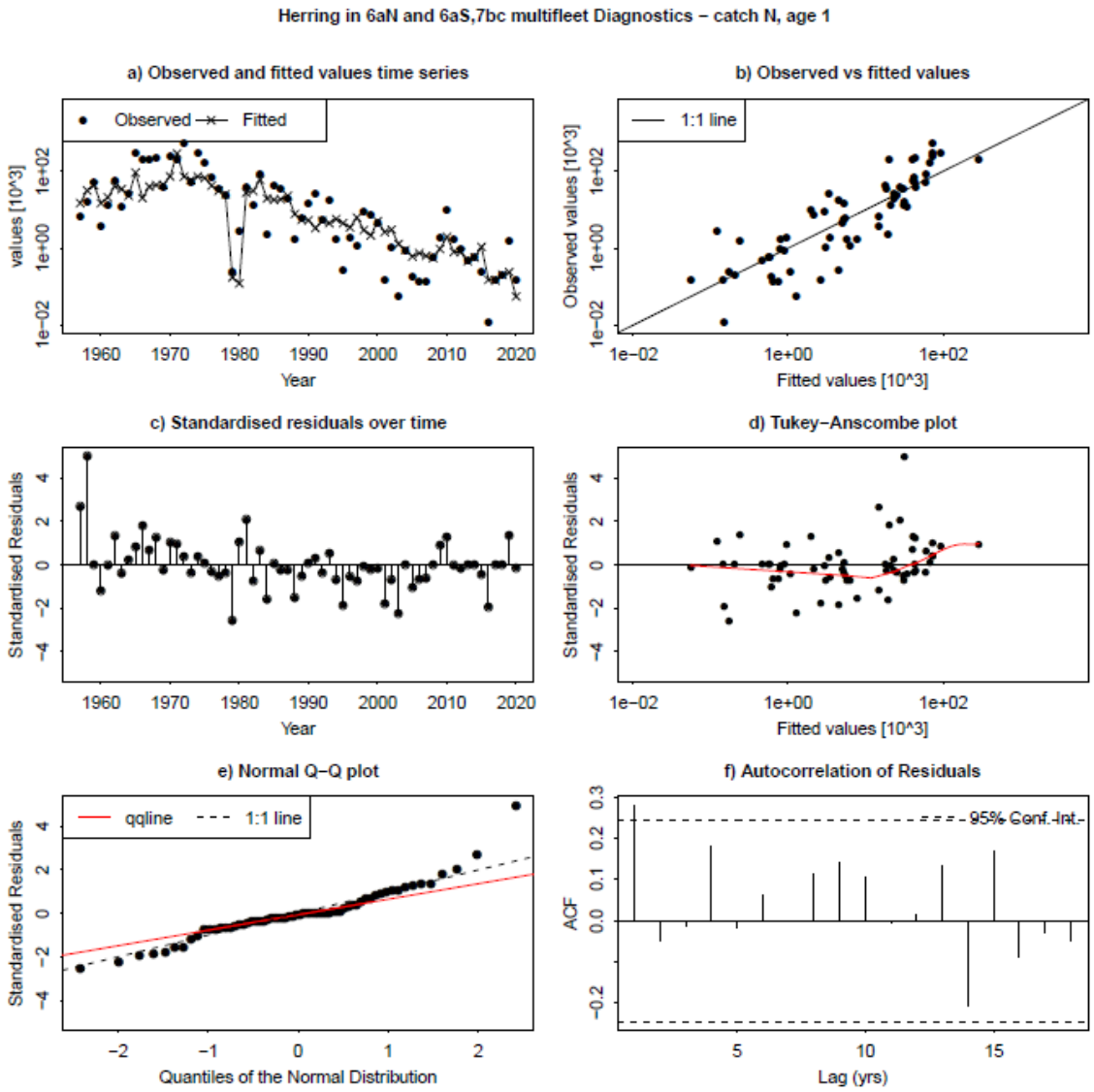

Figure 4.6.13. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from catch abundance at 1-winter ring. Top right: scatterplot of catch observations vs. assessment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

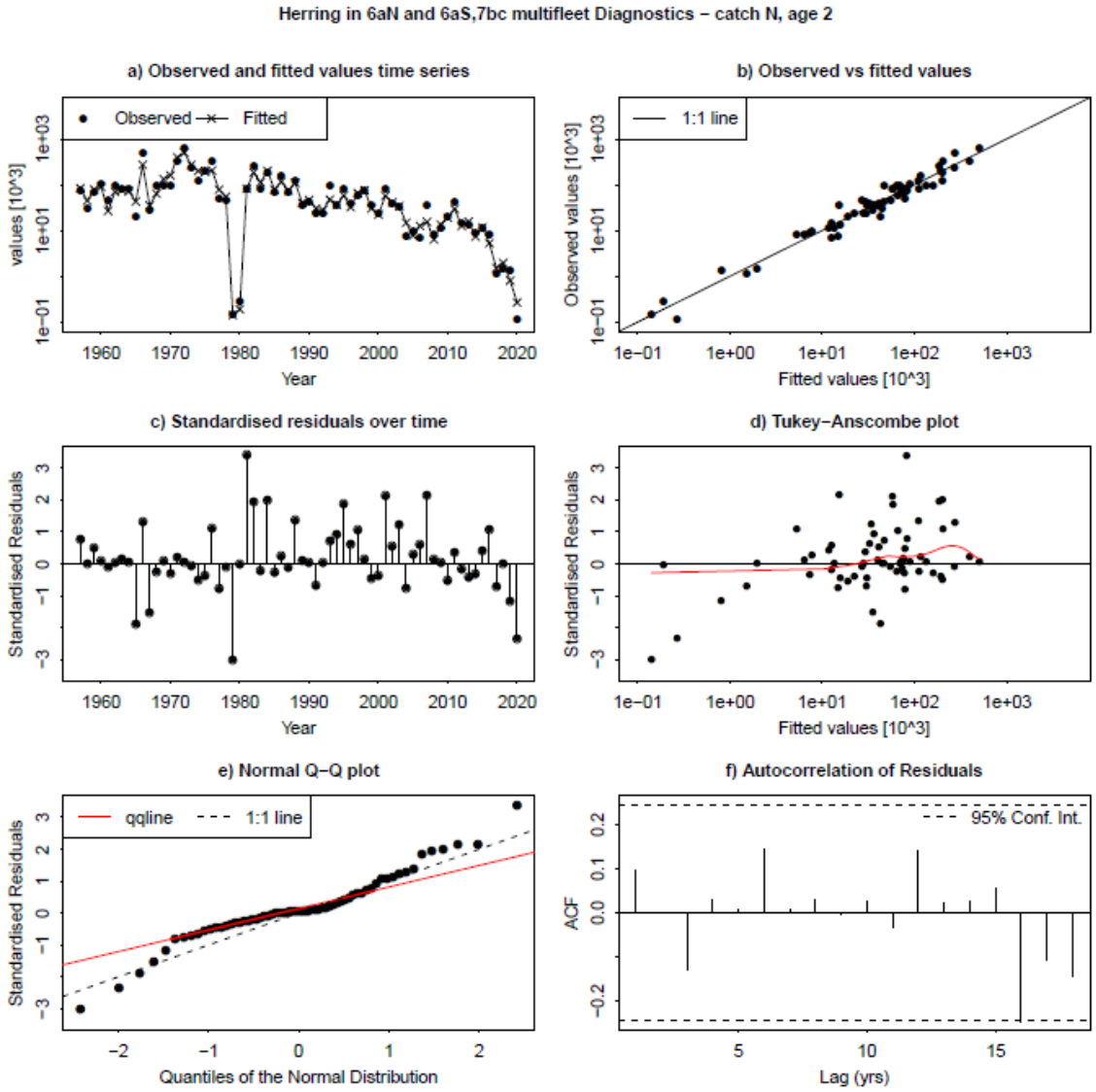

Figure 4.6.16. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from catch abundance at 2-winter ring. Top right: scatterplot of catch observations vs. assessment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

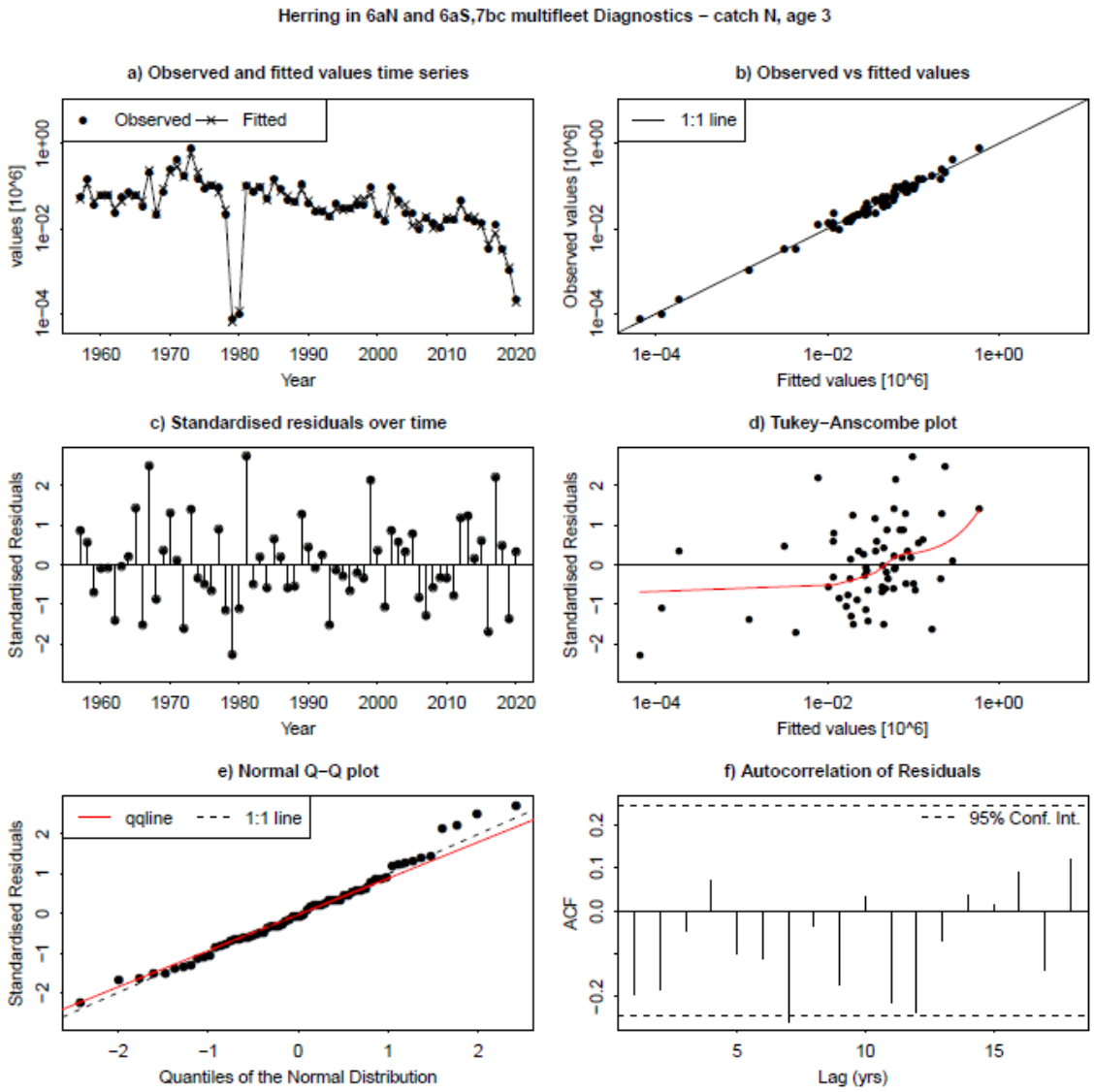

Figure 4.6.17. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from catch abundance at 3-winter ring. Top right: scatterplot of catch observations vs. assessment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

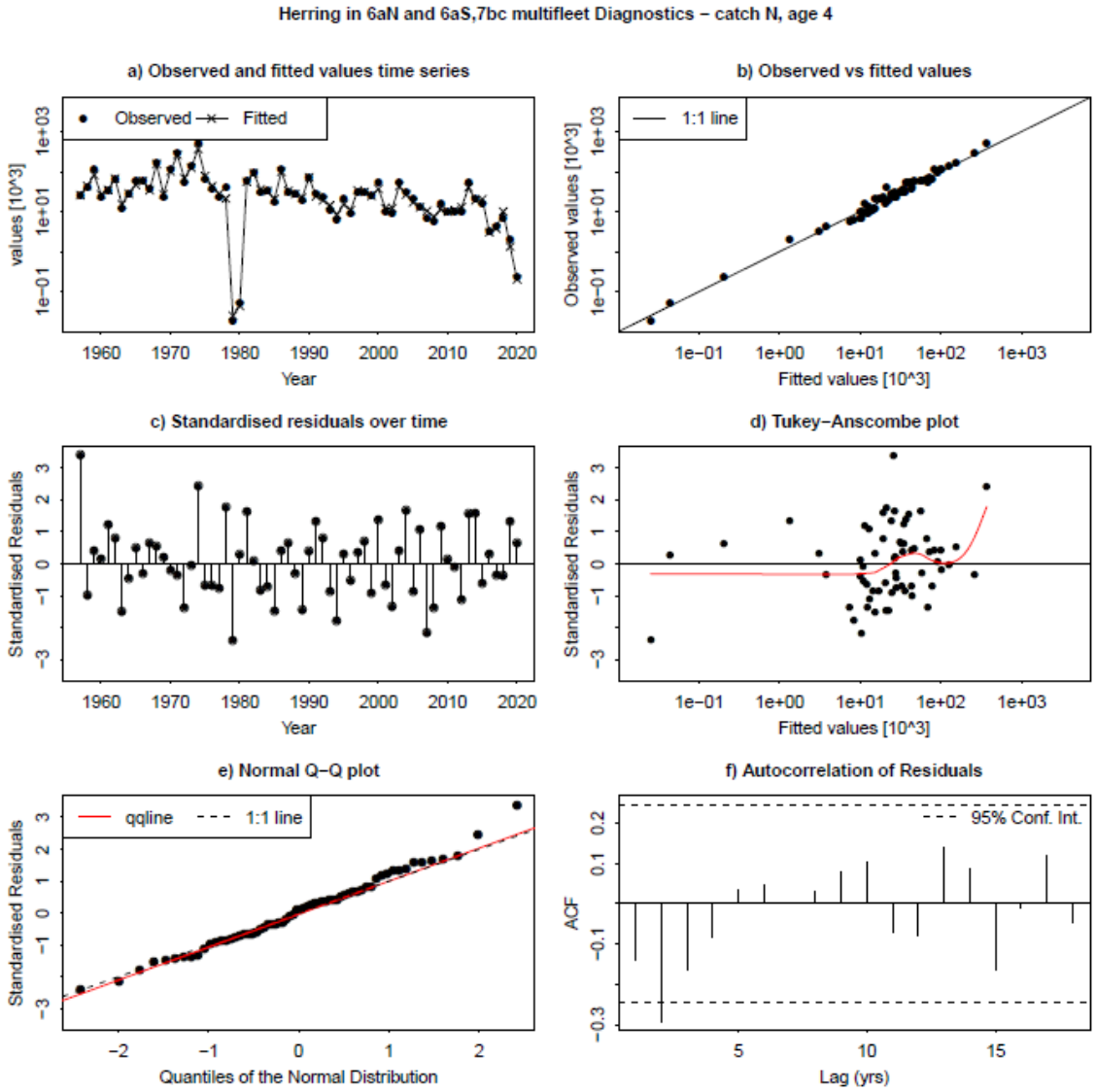

Figure 4.6.18. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from catch abundance at 4-winter ring. Top right: scatterplot of catch observations vs. assessment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

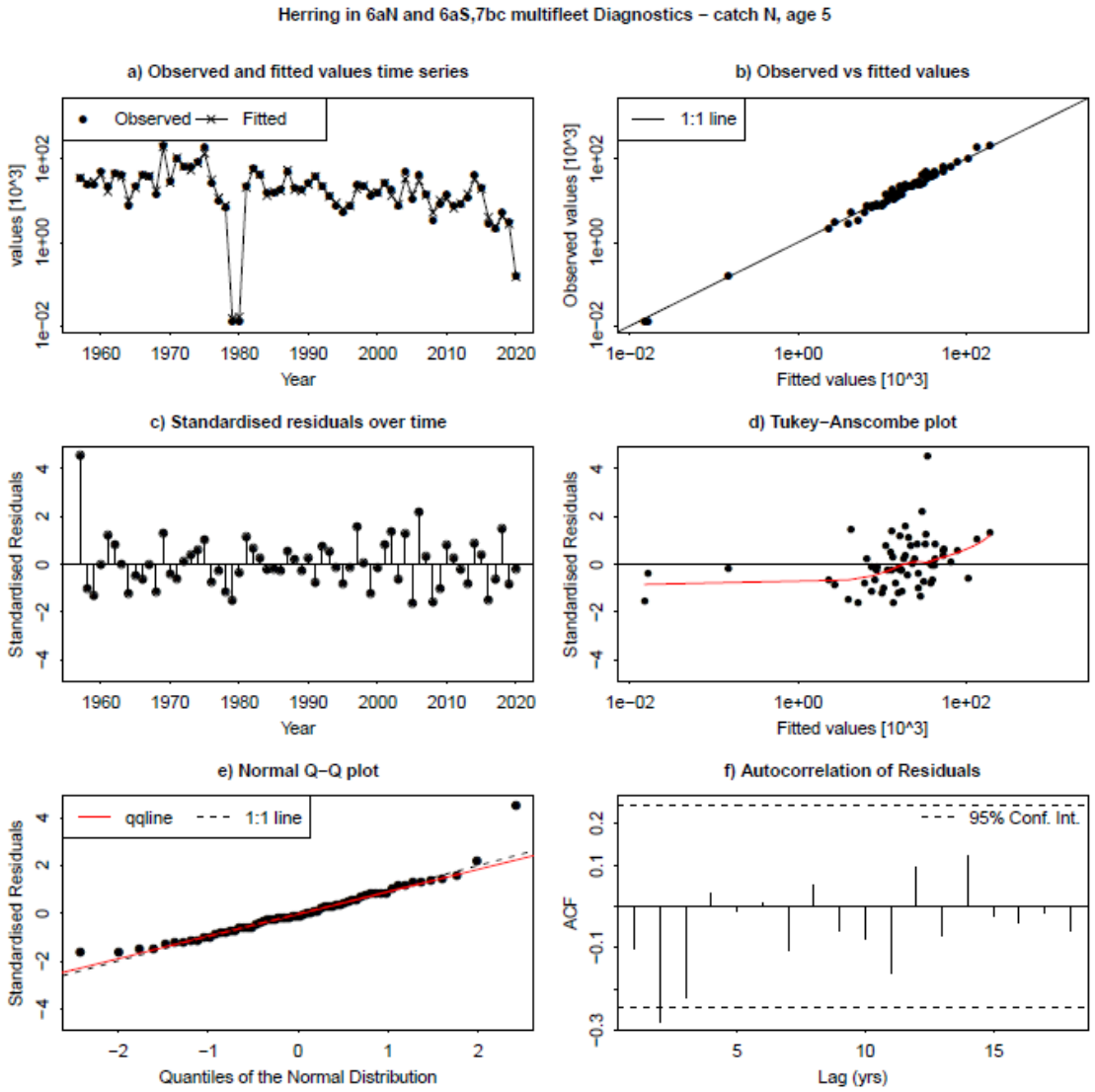

Figure 4.6.19. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from catch abundance at 5-winter ring. Top right: scatterplot of catch observations vs. assessment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

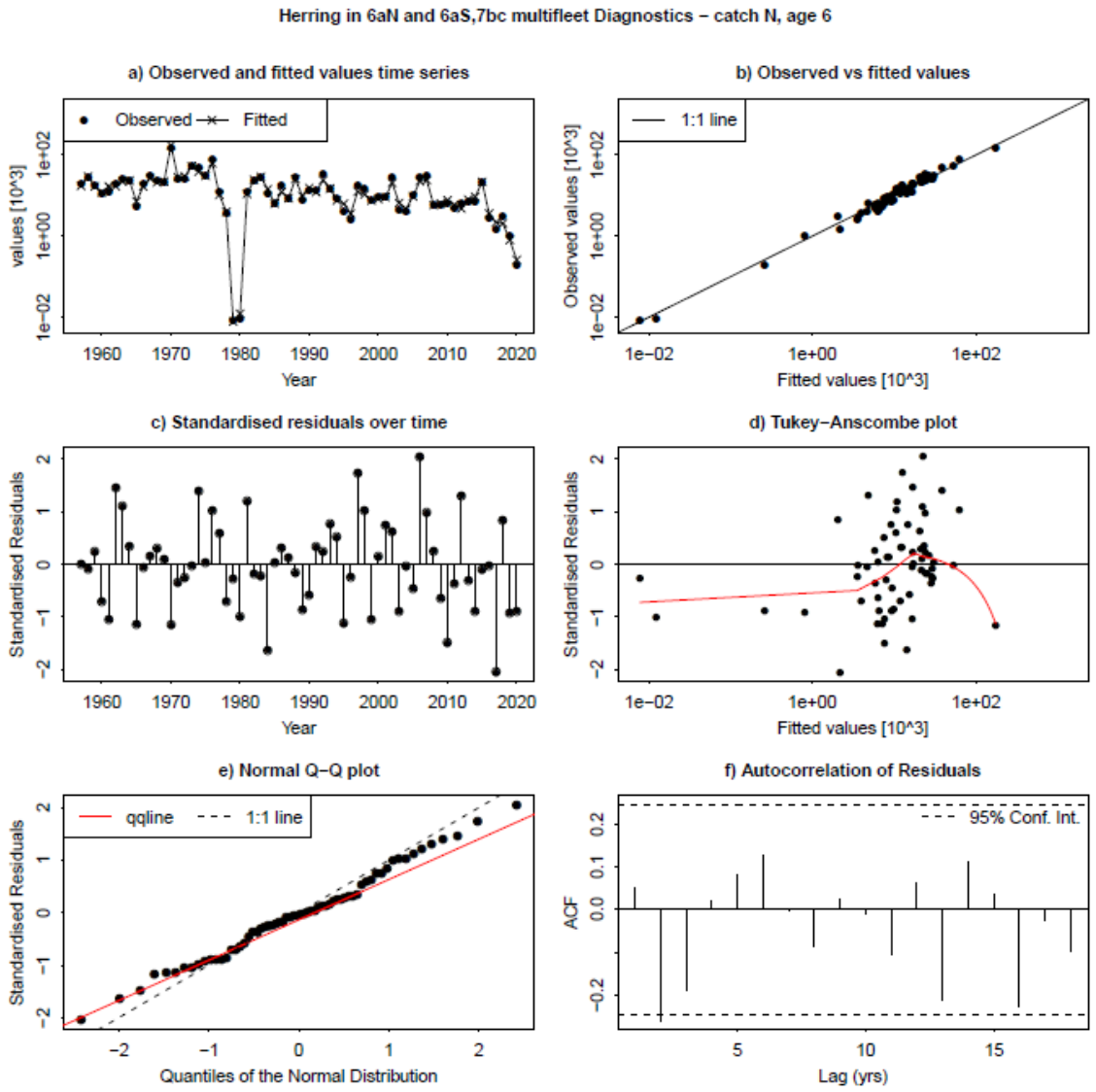

Figure 4.6.20. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from catch abundance at 6-winter ring. Top right: scatterplot of catch observations vs. assessment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

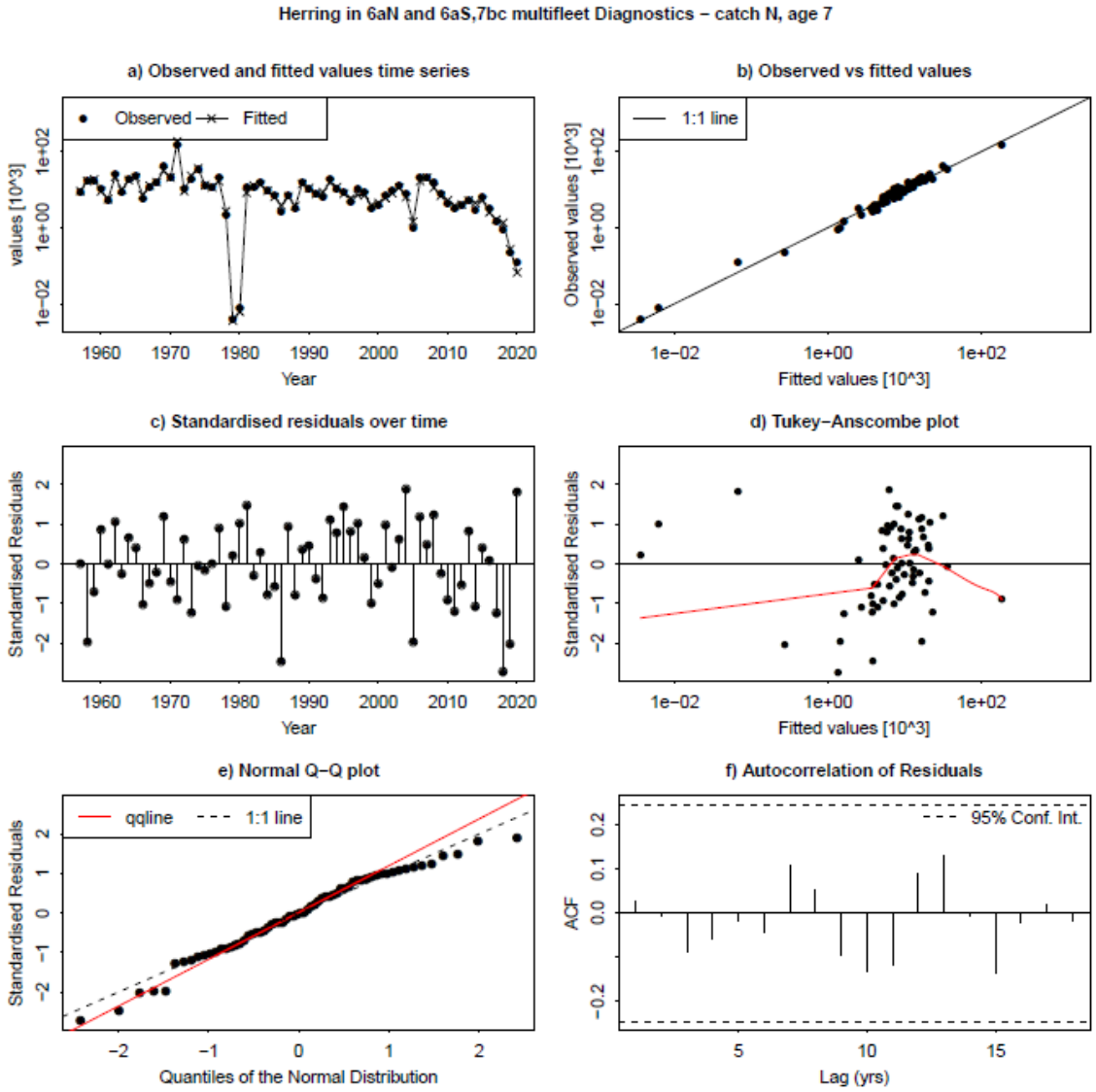

Figure 4.6.21. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from catch abundance at 7-winter ring. Top right: scatterplot of catch observations vs. assessment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

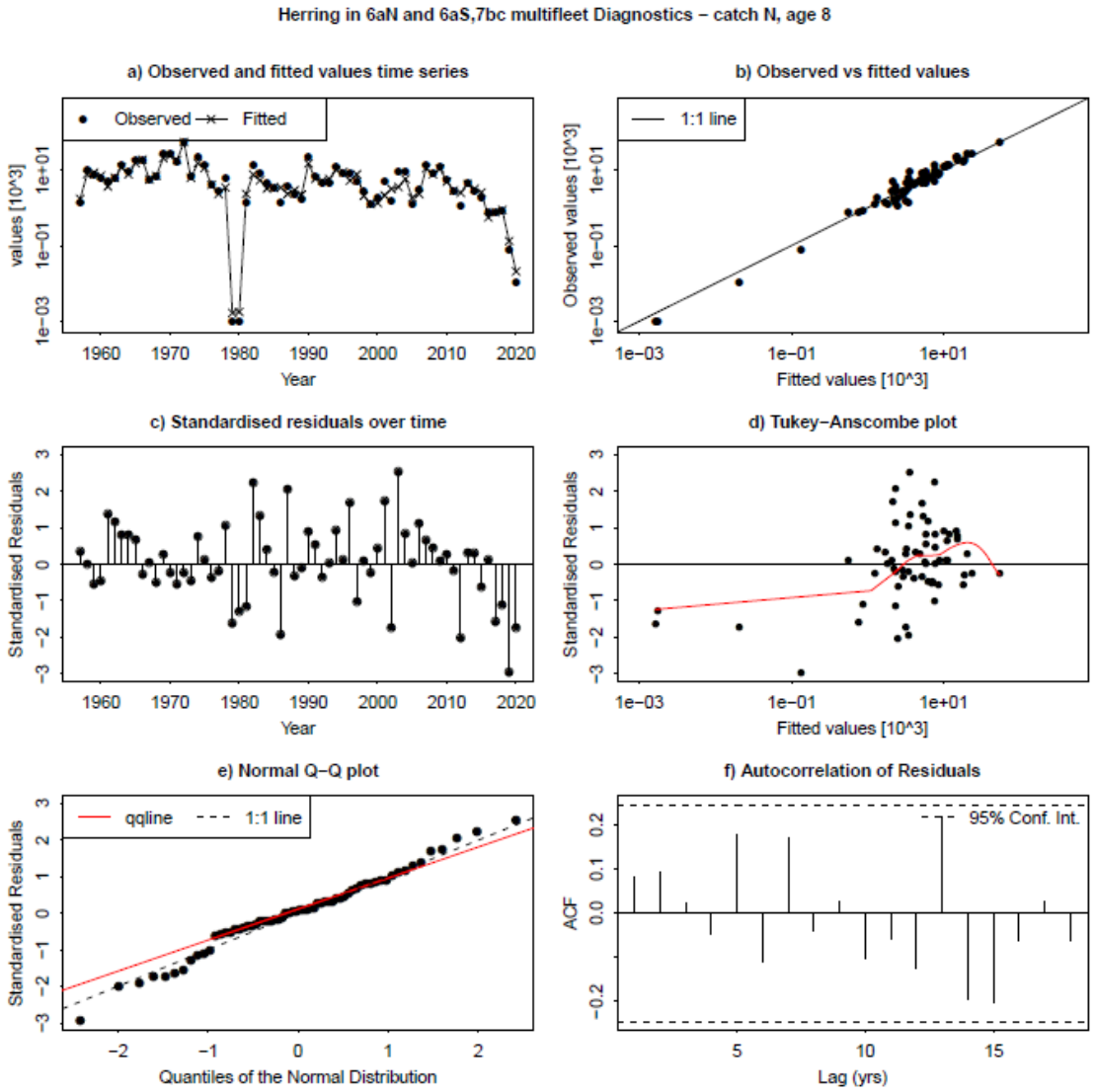

Figure 4.6.22. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from catch abundance at 8-winter ring. Top right: scatterplot of catch observations vs. assessment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

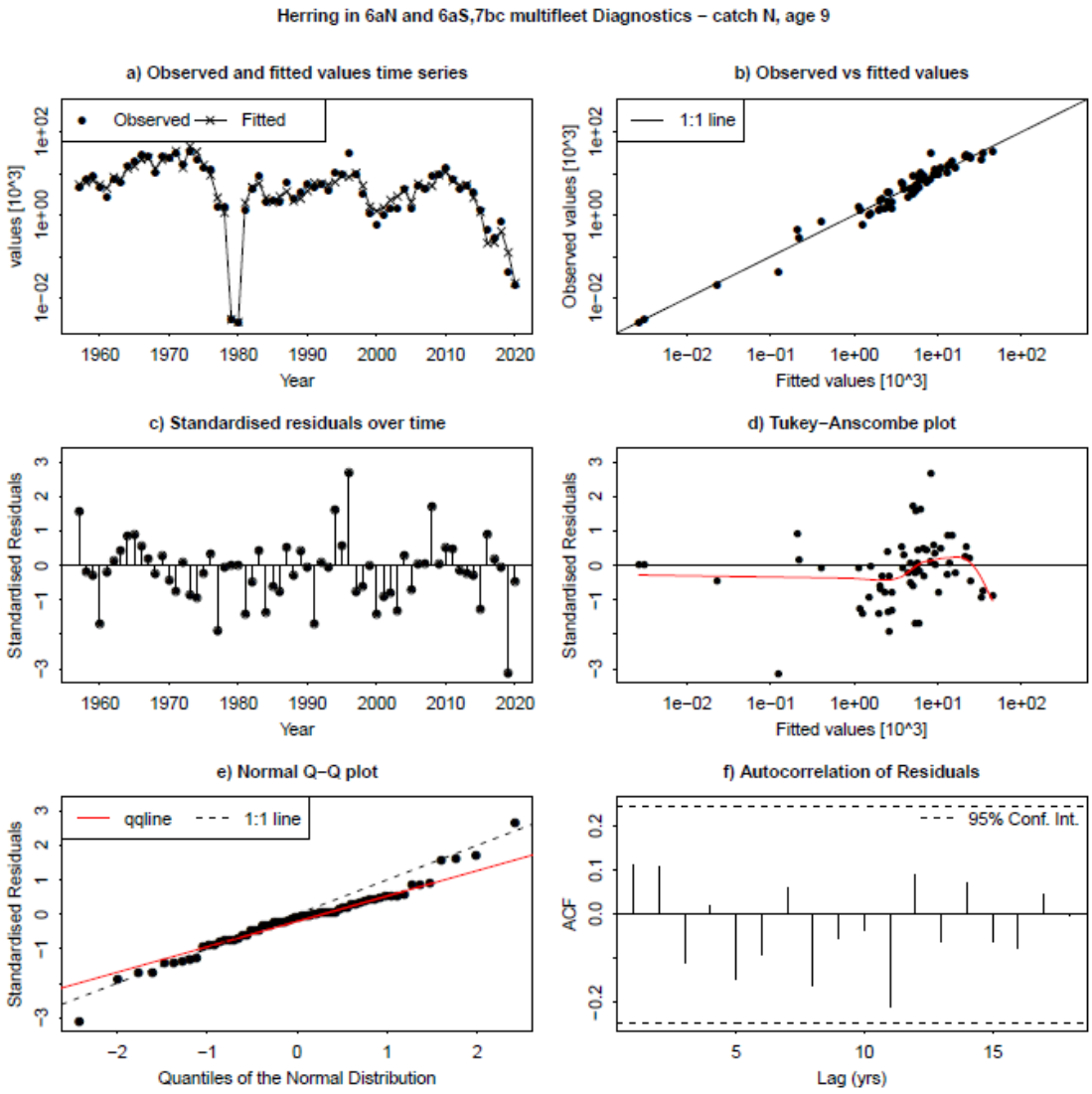

Figure 4.6.23. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from catch abundance at 9-winter ring. Top right: scatterplot of catch observations vs. assessment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

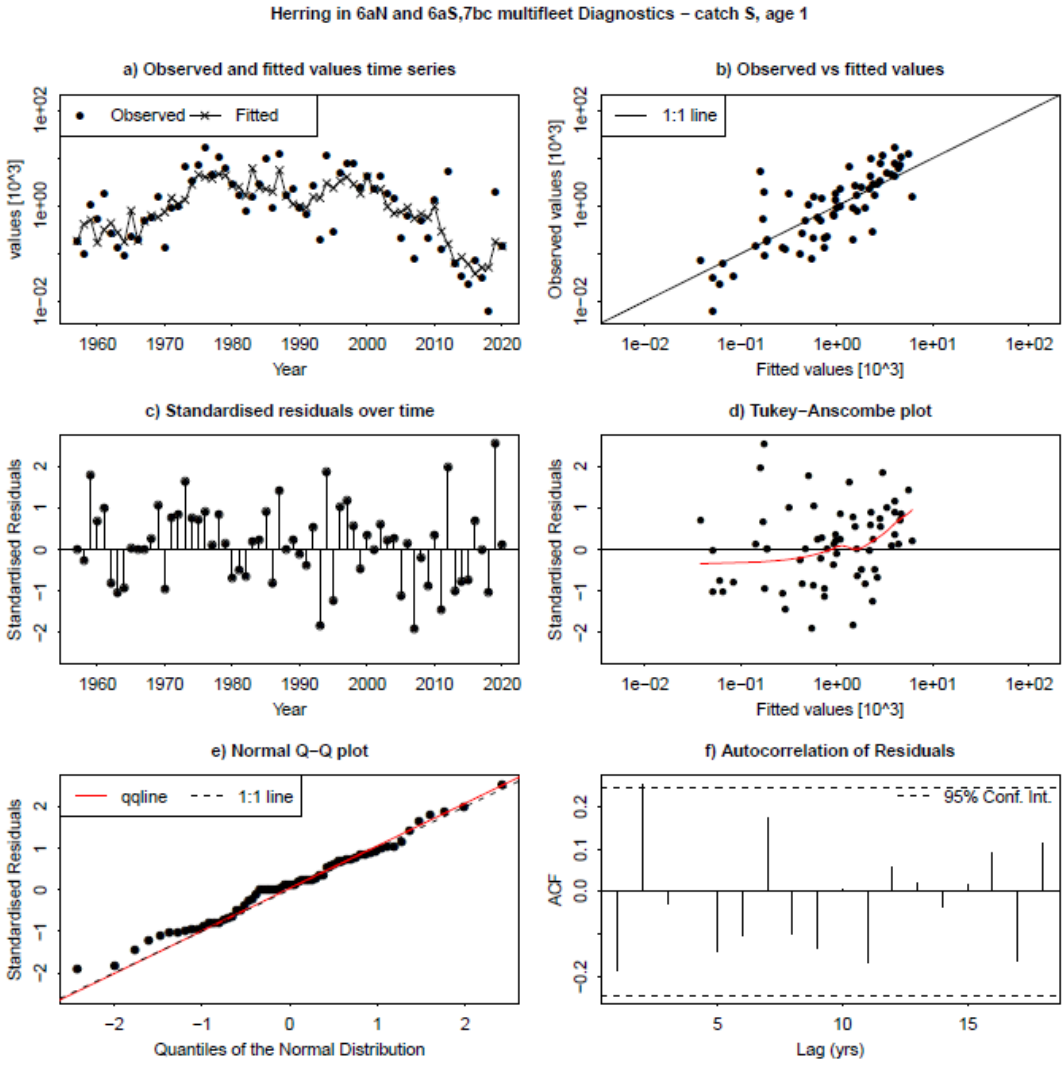

Figure 4.6.24. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from catch abundance at 1-winter ring. Top right: scatterplot of catch observations vs. assessment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

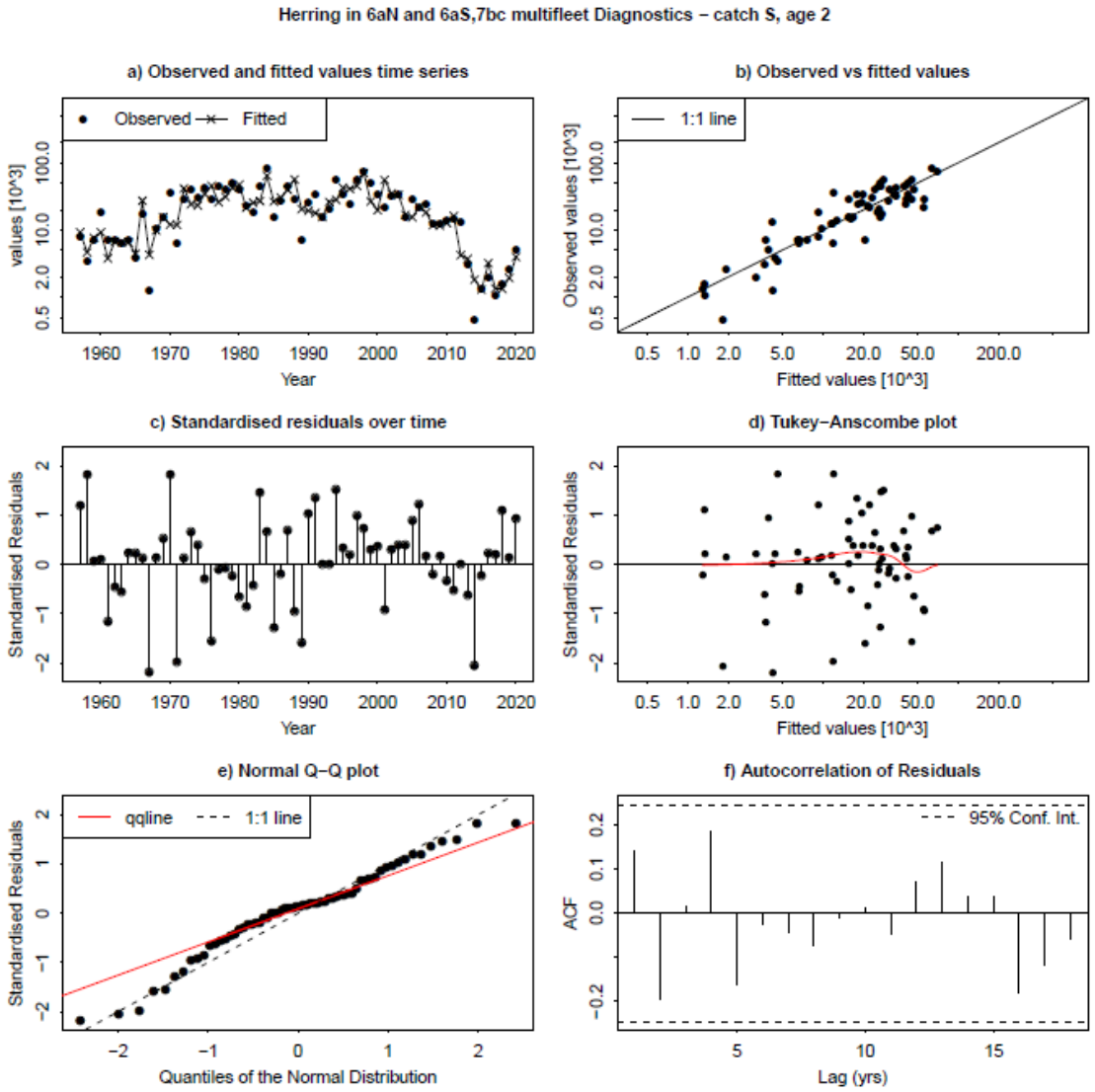

Figure 4.6.25. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from catch abundance at 2-winter ring. Top right: scatterplot of catch observations vs. assessment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

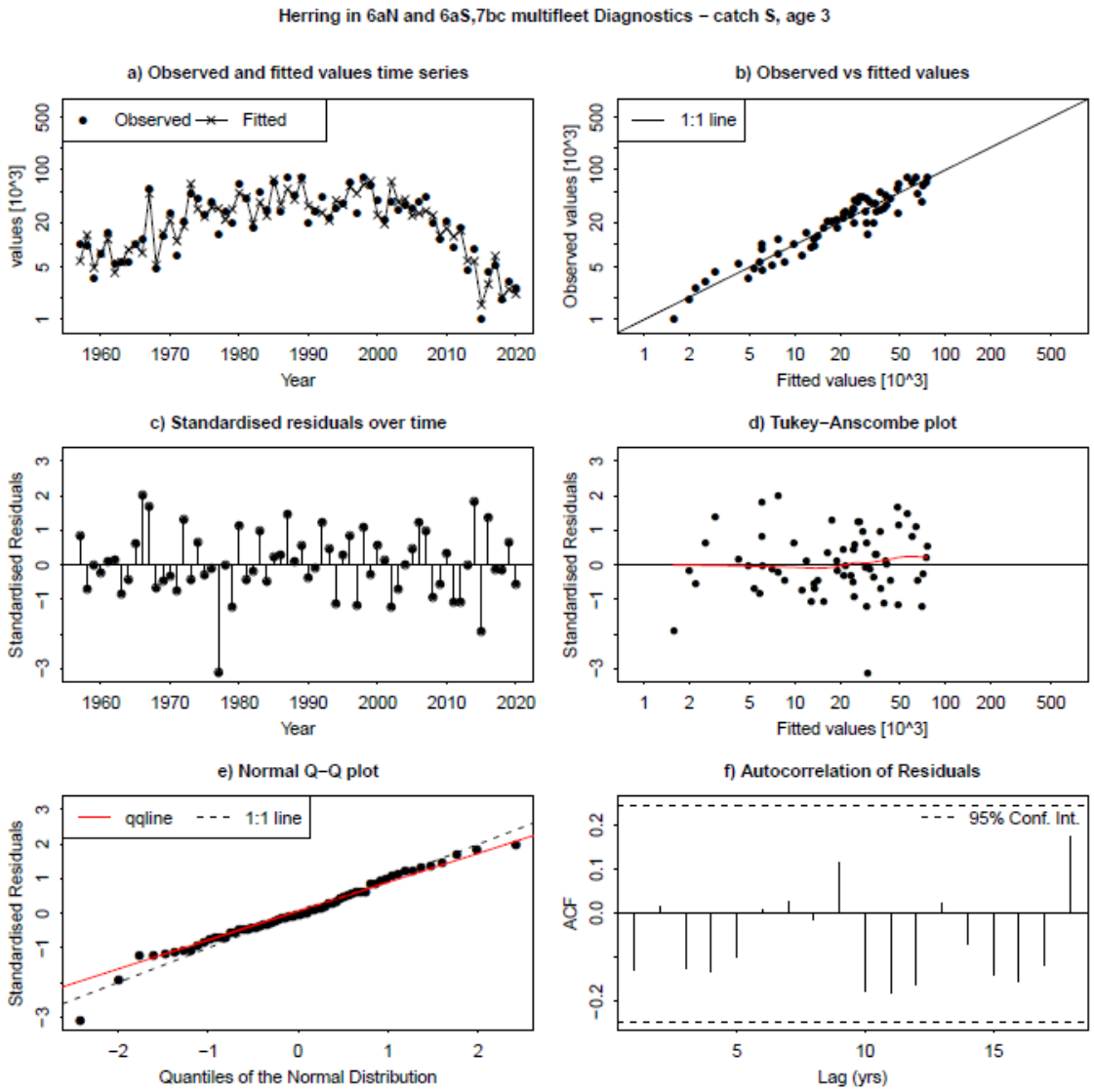

Figure 4.6.26. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from catch abundance at 3-winter ring. Top right: scatterplot of catch observations vs. assessment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

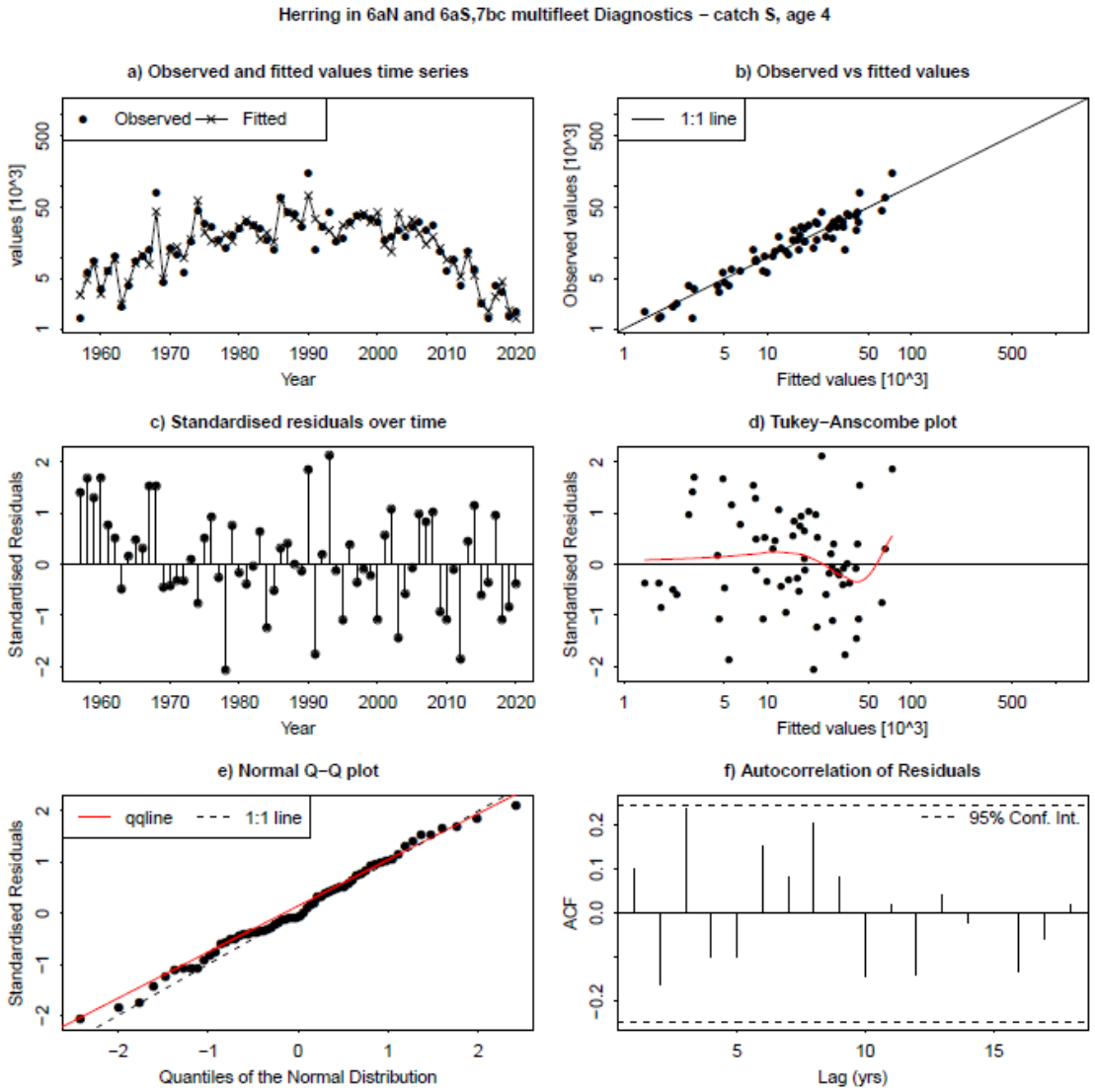

Figure 4.6.27. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from catch abundance at 4-winter ring. Top right: scatterplot of catch observations vs. assessment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

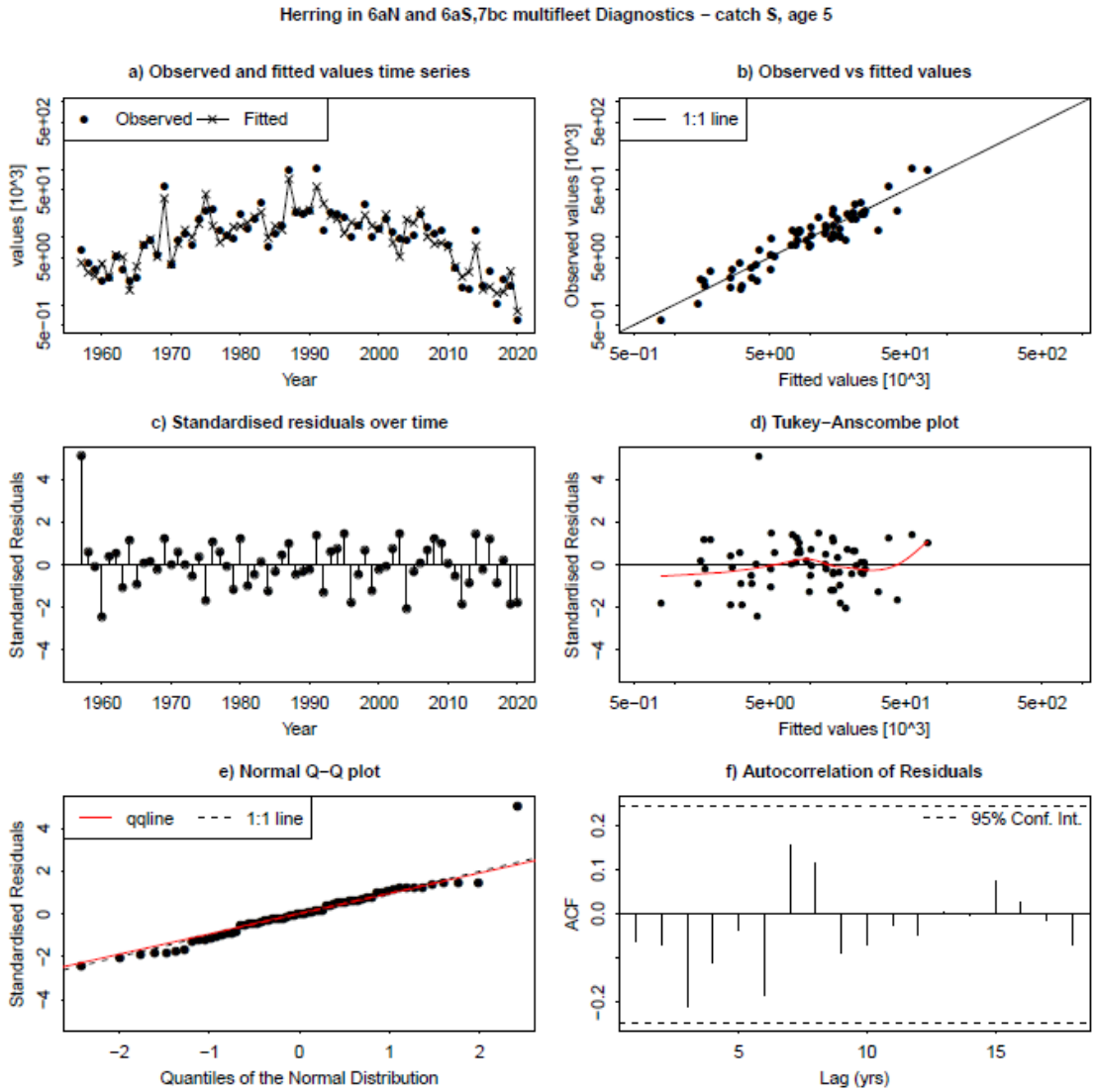

Figure 4.6.28. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from catch abundance at 5-winter ring. Top right: scatterplot of catch observations vs. assessment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

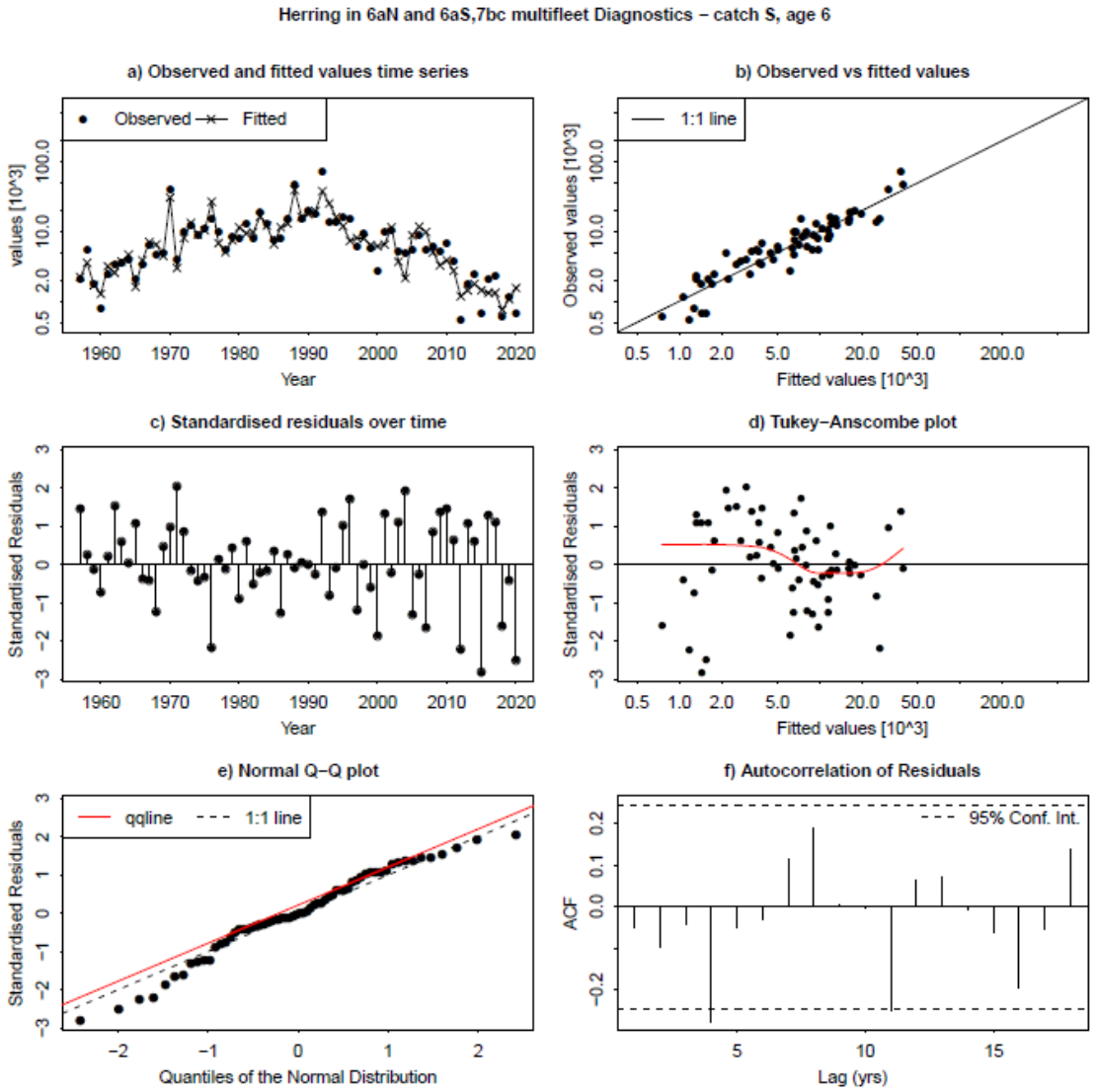

Figure 4.6.29. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from catch abundance at 6-winter ring. Top right: scatterplot of catch observations vs. assessment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

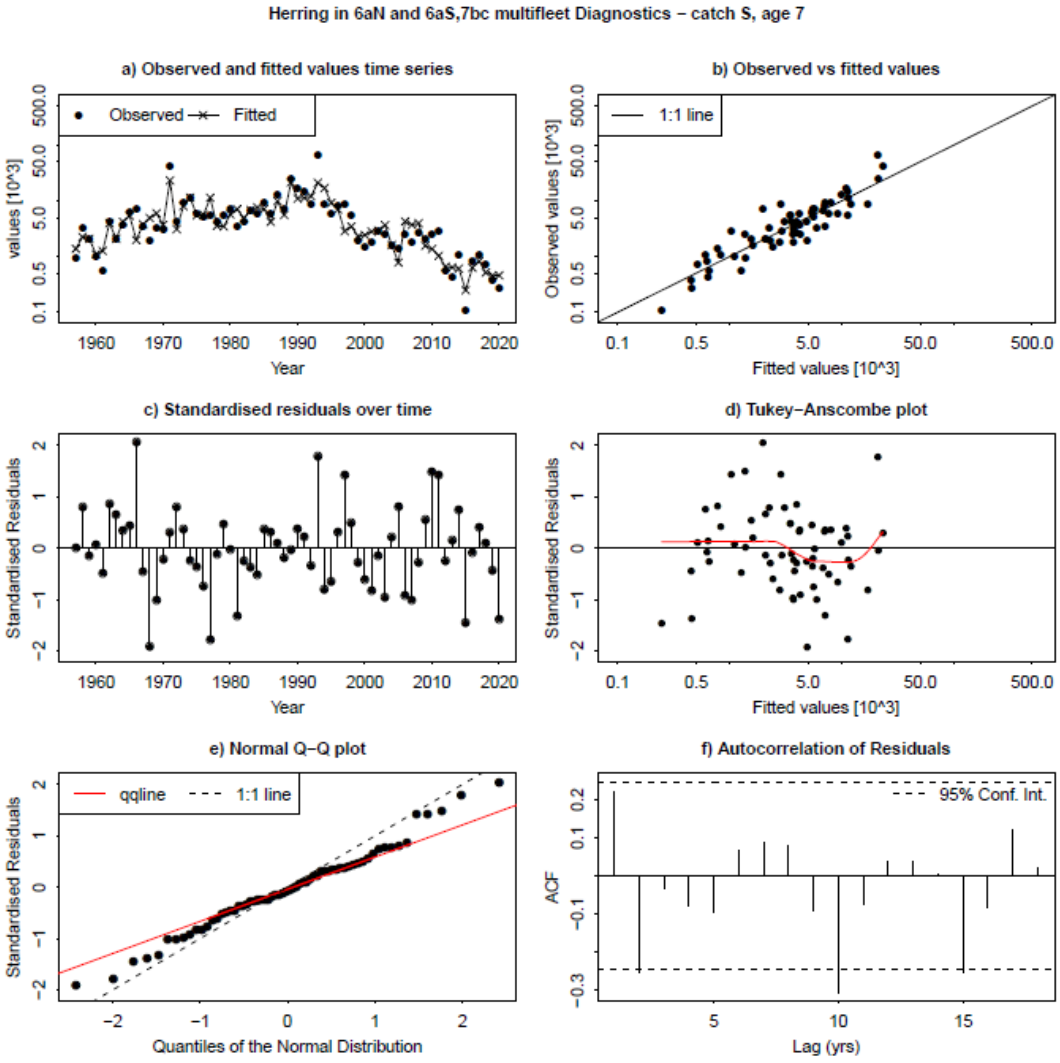

Figure 4.6.30. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from catch abundance at 7-winter ring. Top right: scatterplot of catch observations vs. assessment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

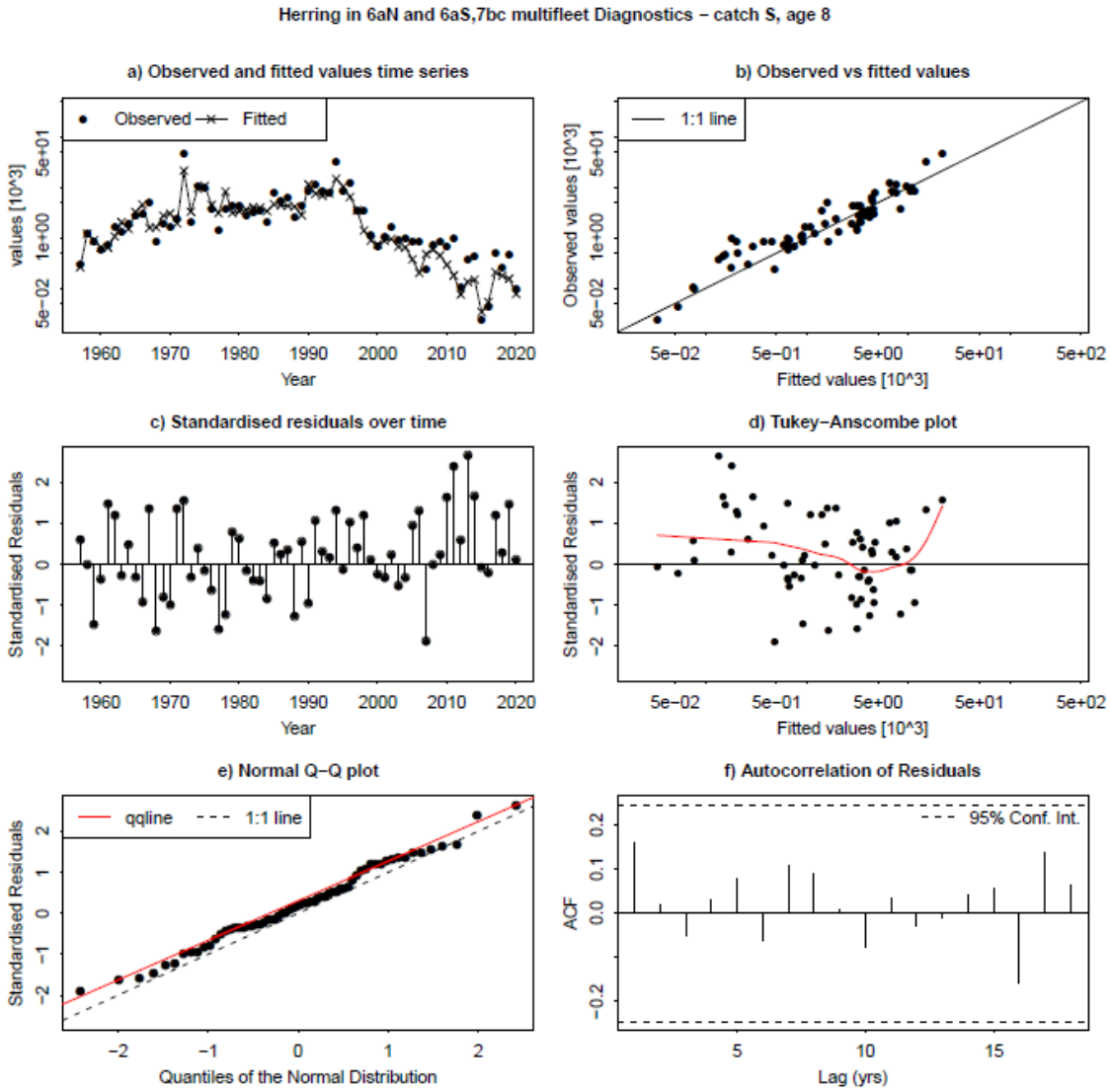

Figure 4.6.31. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from catch abundance at 8-winter ring. Top right: scatterplot of catch observations vs. assessment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

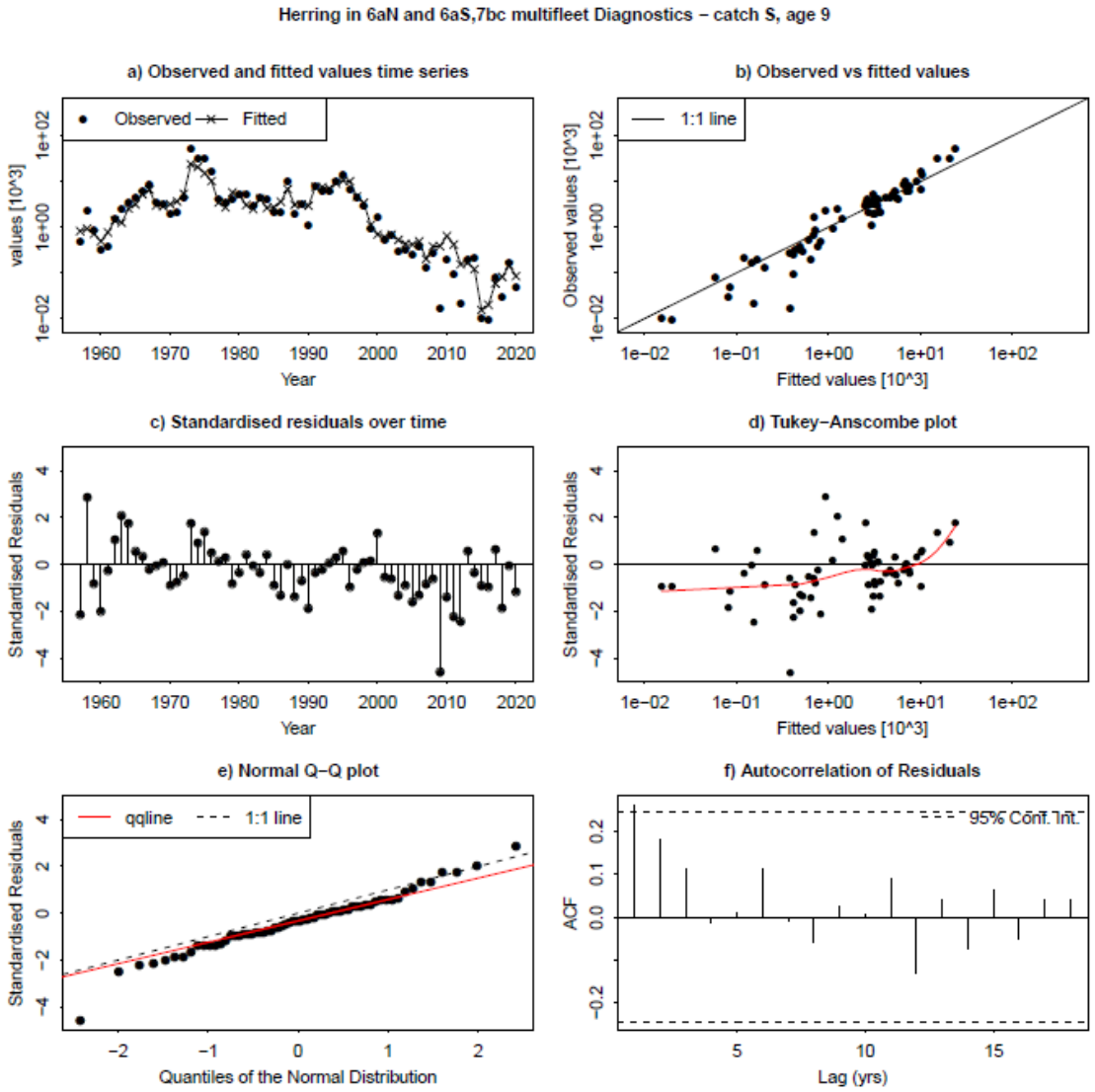

Figure 4.6.32. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from catch abundance at 9-winter ring. Top right: scatterplot of catch observations vs. assessment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

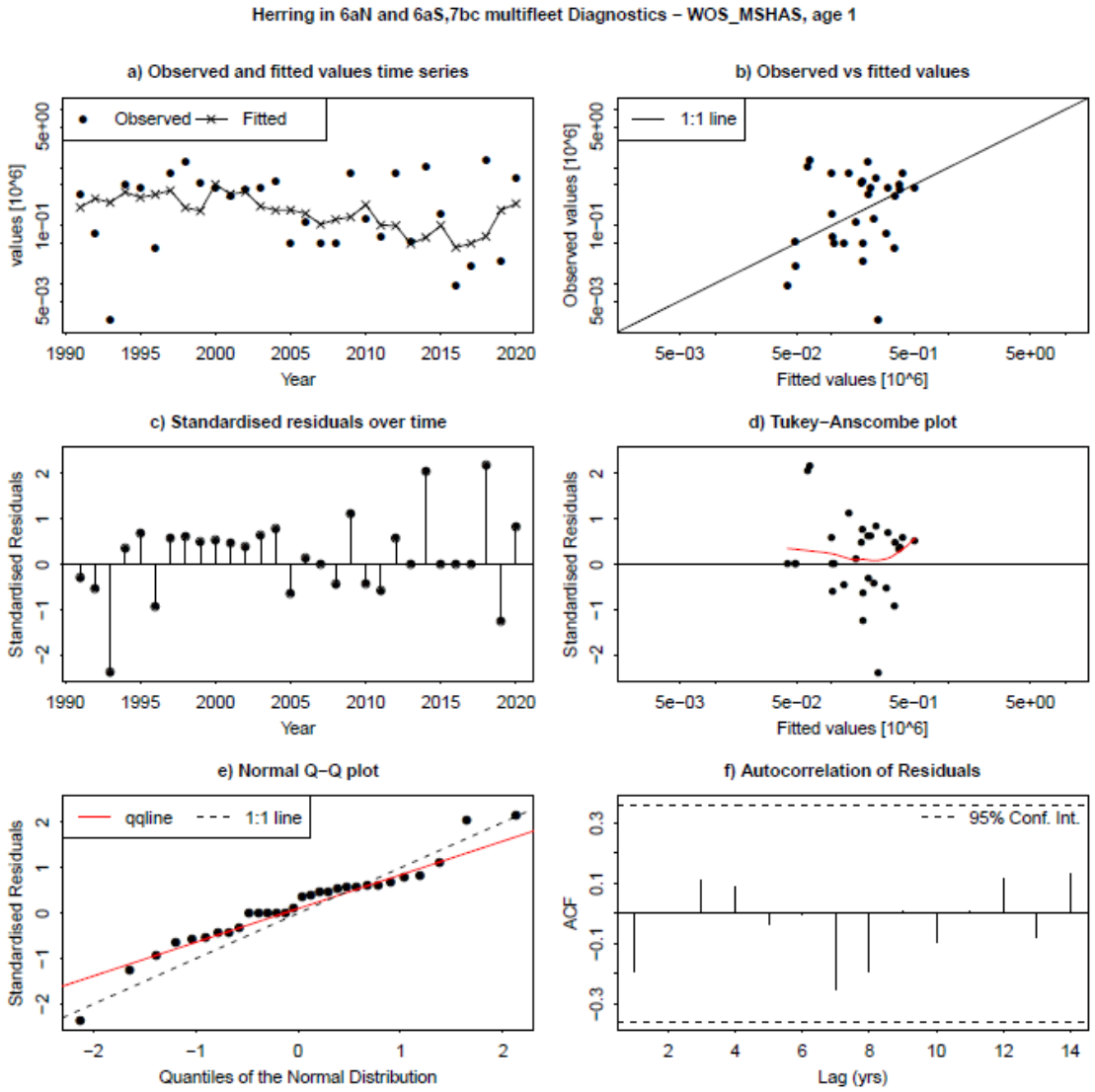

Figure 4.6.33. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from index abundance at 1-winter ring. Top right: scatterplot of index observations vs. 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 vs. 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.

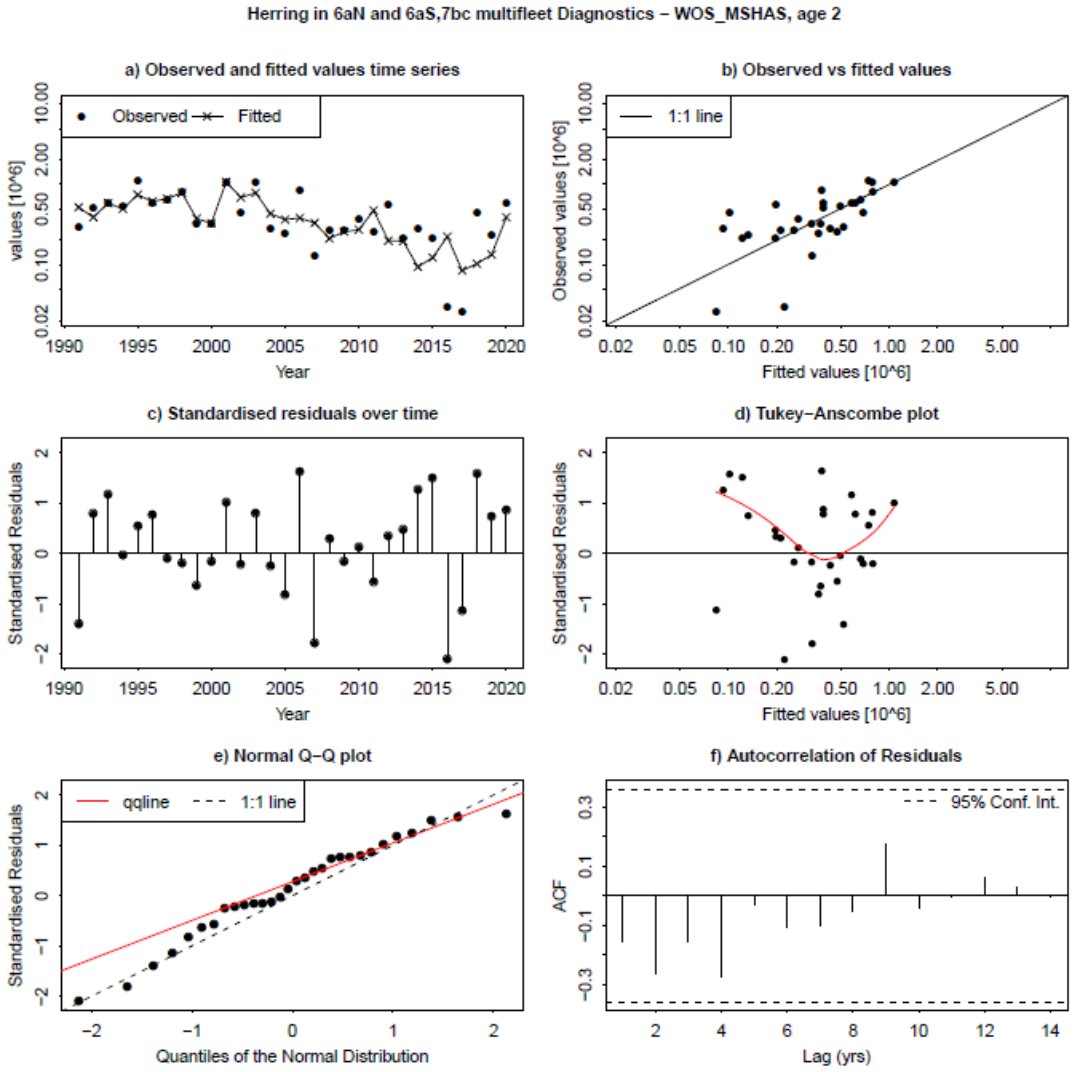

Figure 4.6.34. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: scatterplot of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

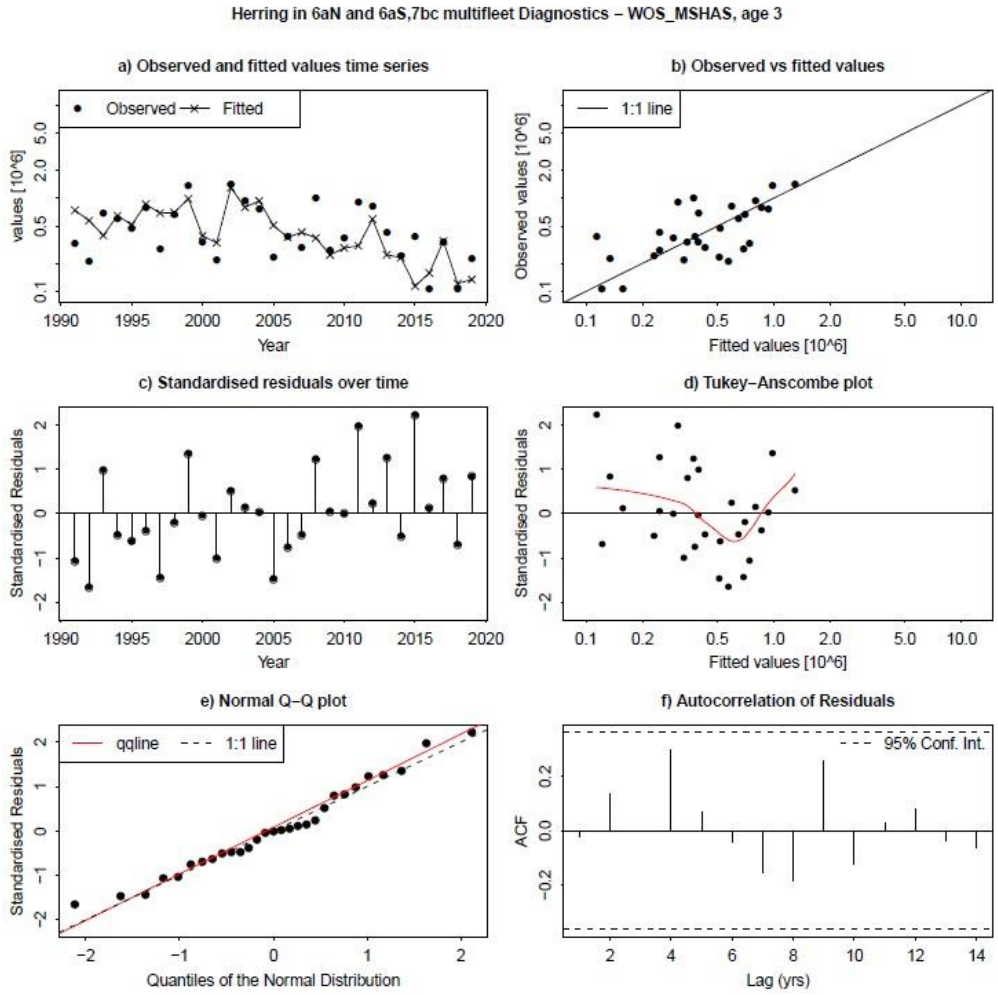

Figure 4.6.35. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: scatterplot of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

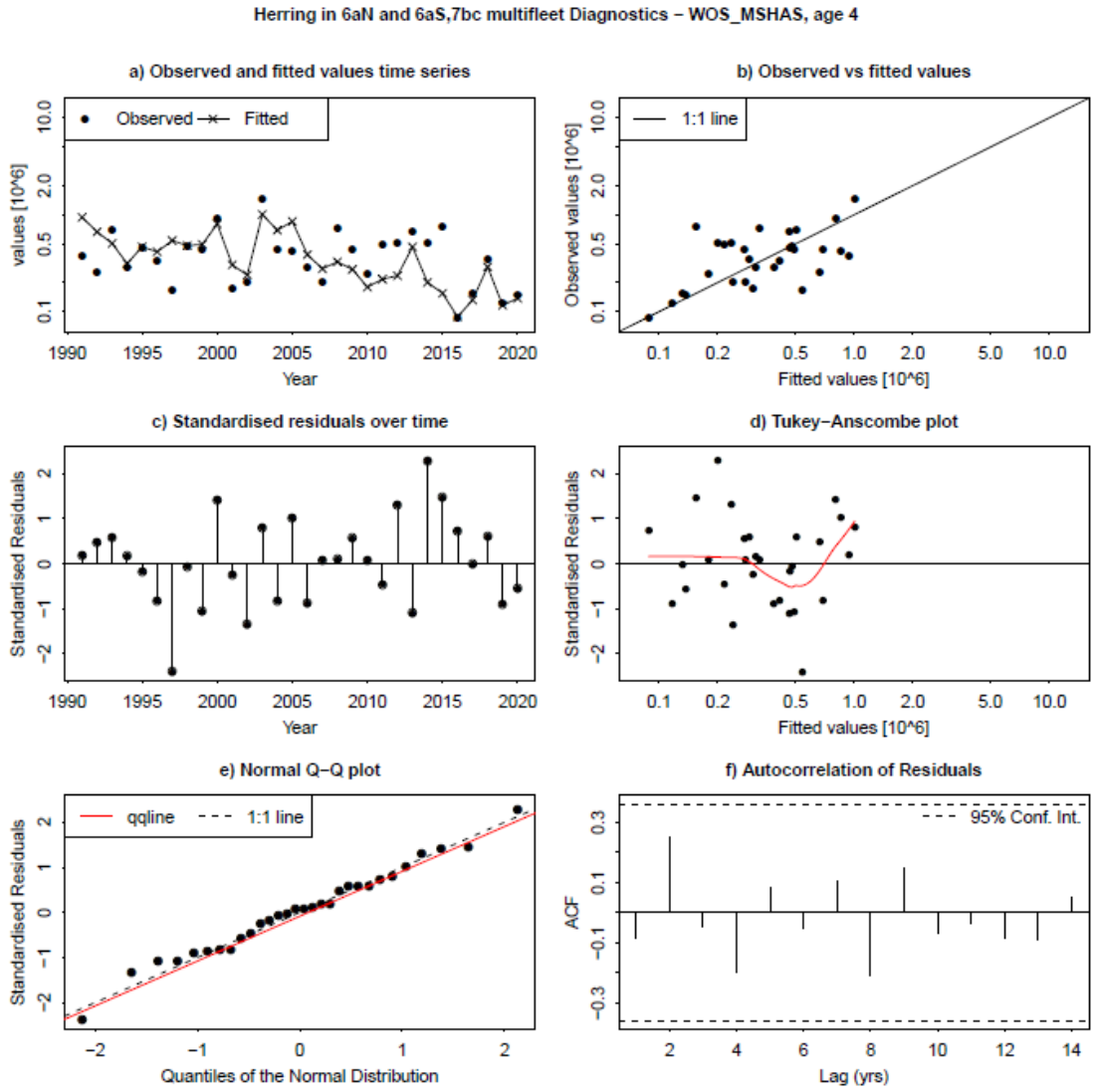

Figure 4.6.36. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: scatterplot of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

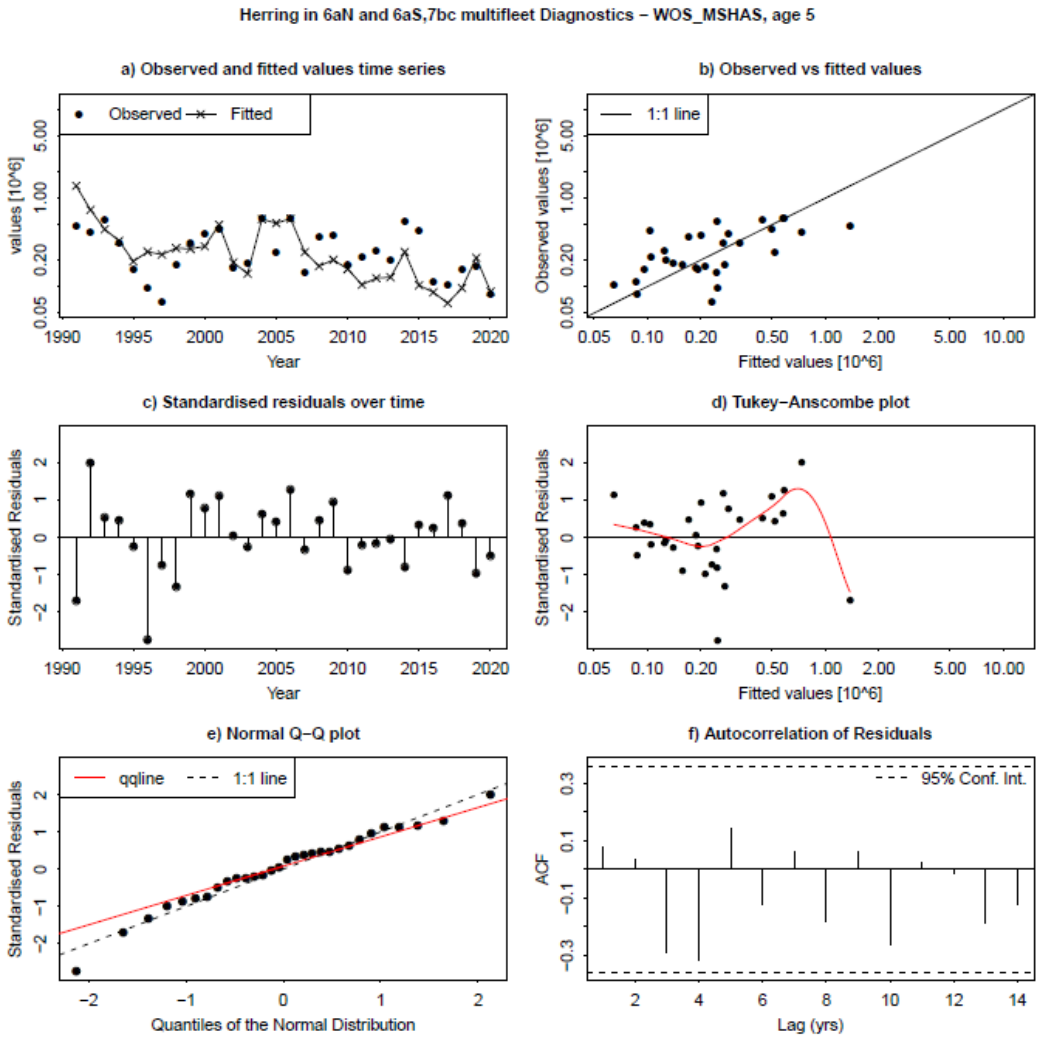

Figure 4.6.37. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: scatterplot of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

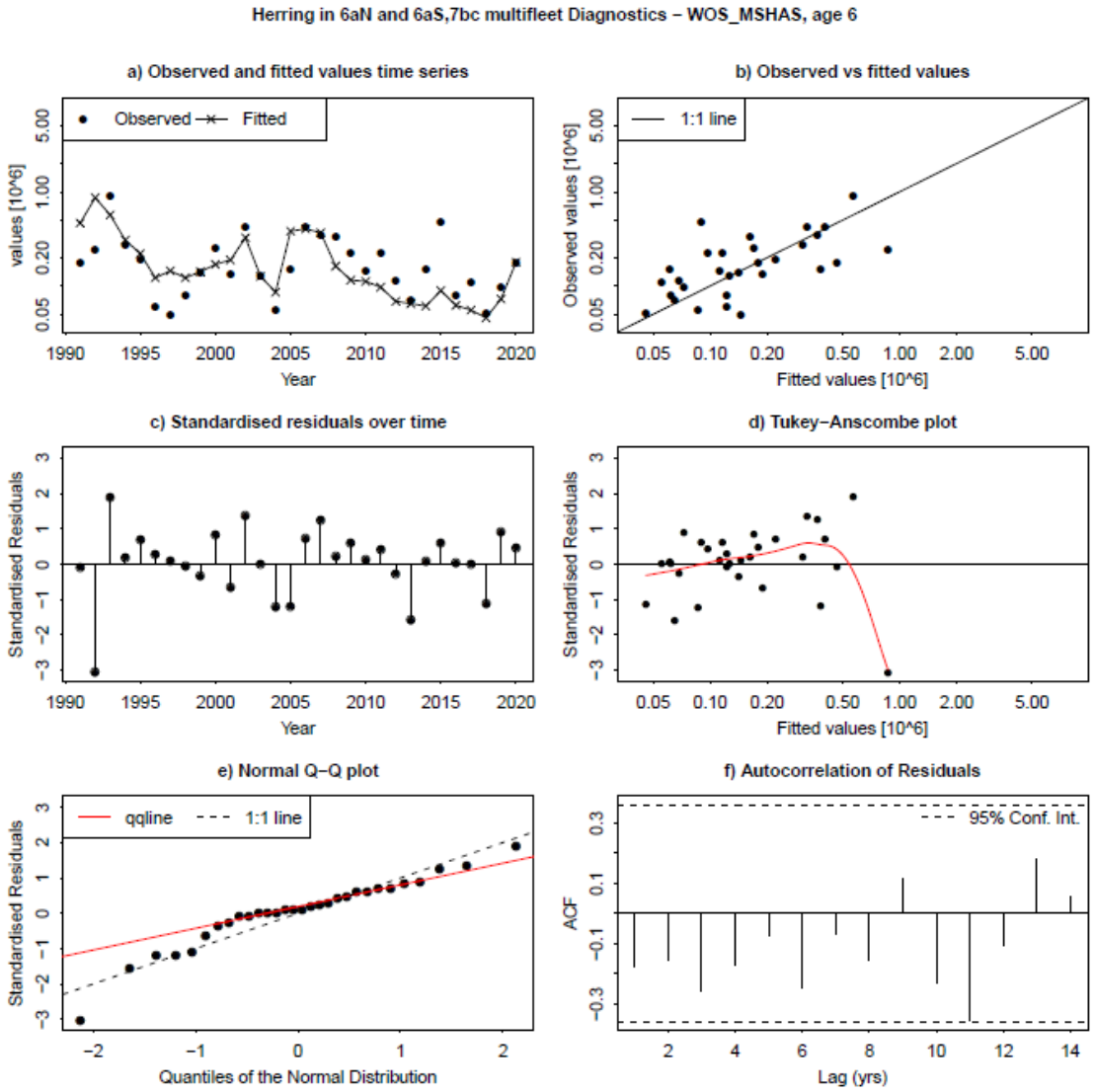

Figure 4.6.38. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: scatterplot of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

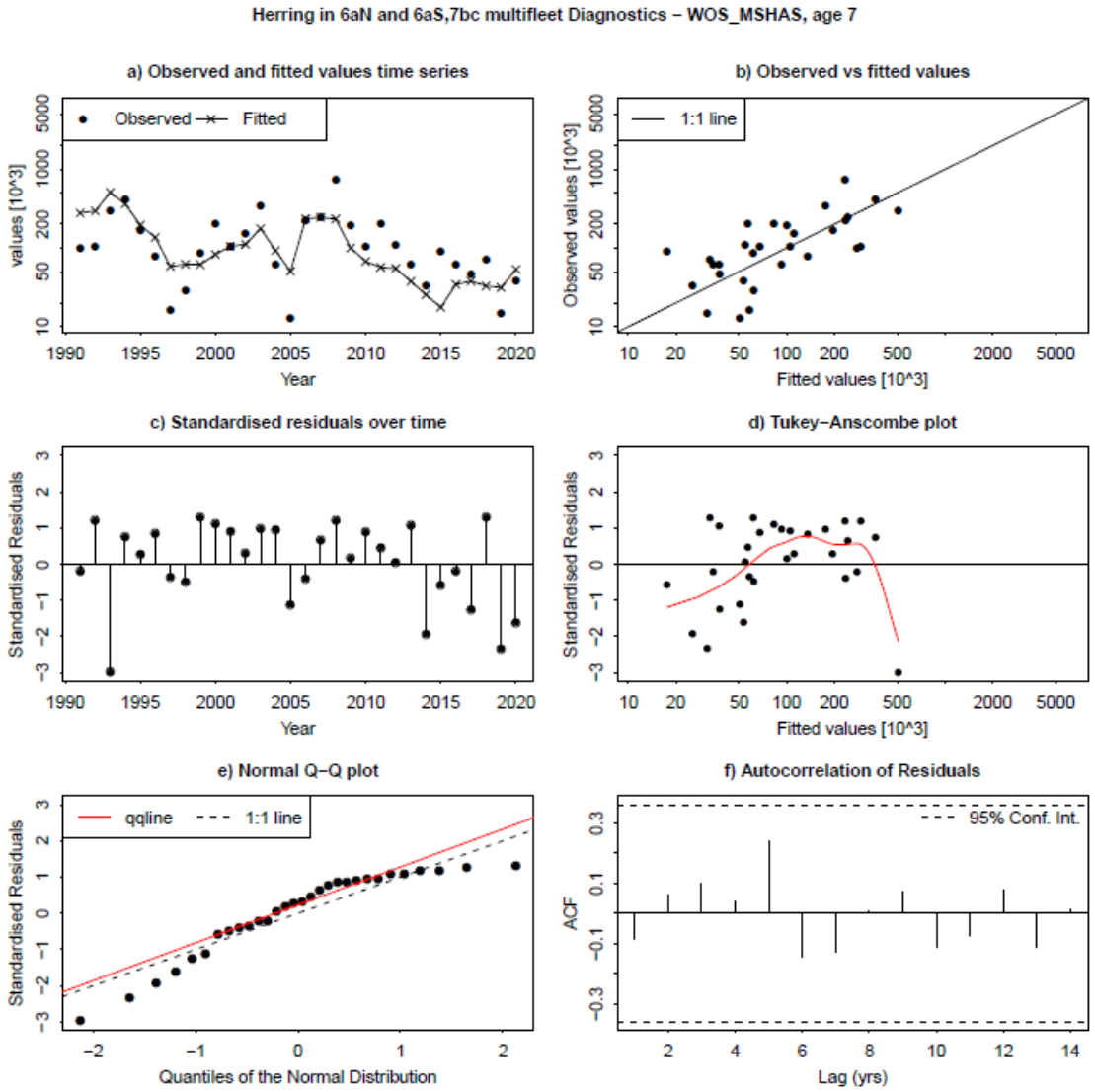

Figure 4.6.39. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: scatterplot of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

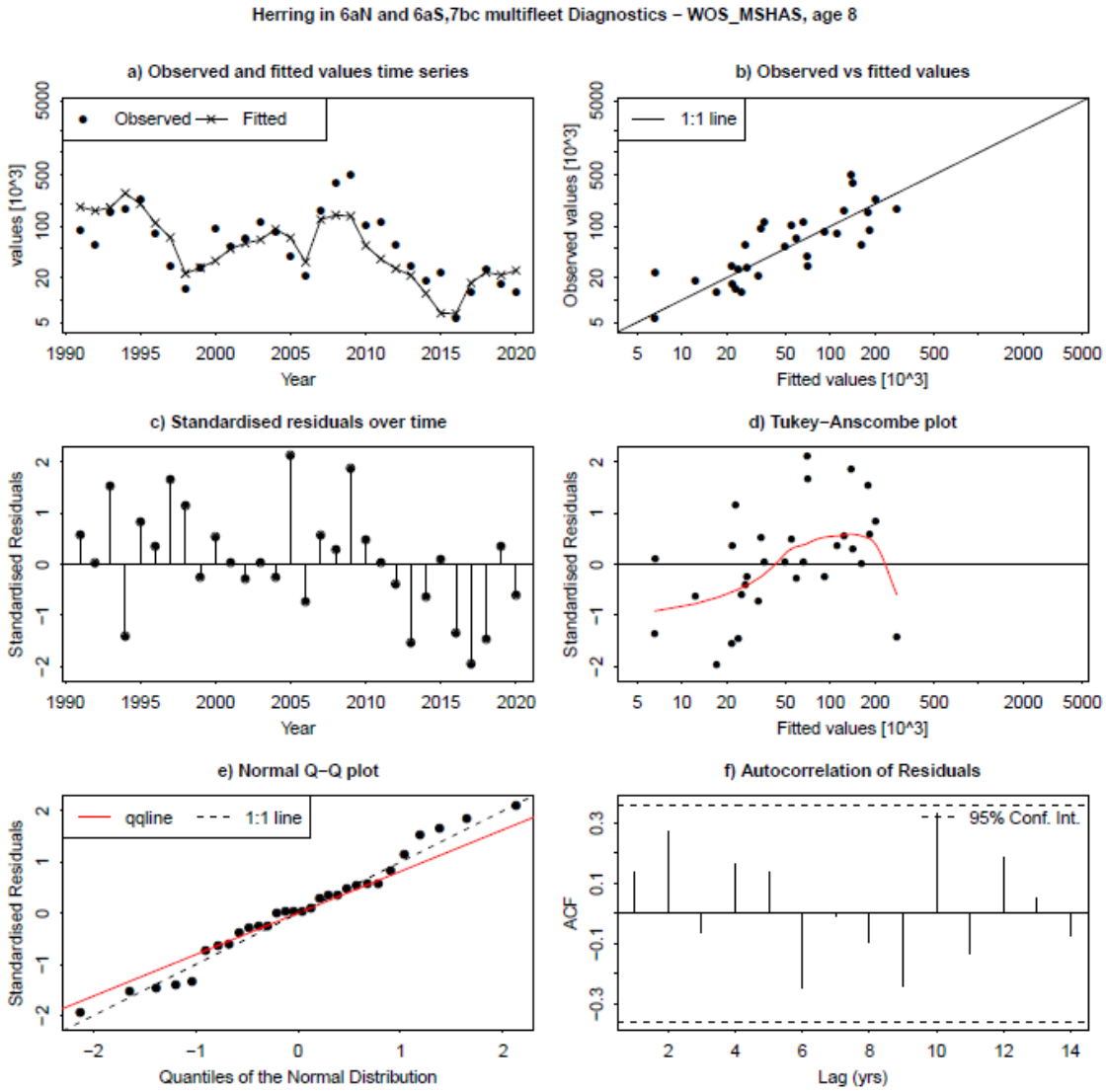

Figure 4.6.40. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: scatterplot of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

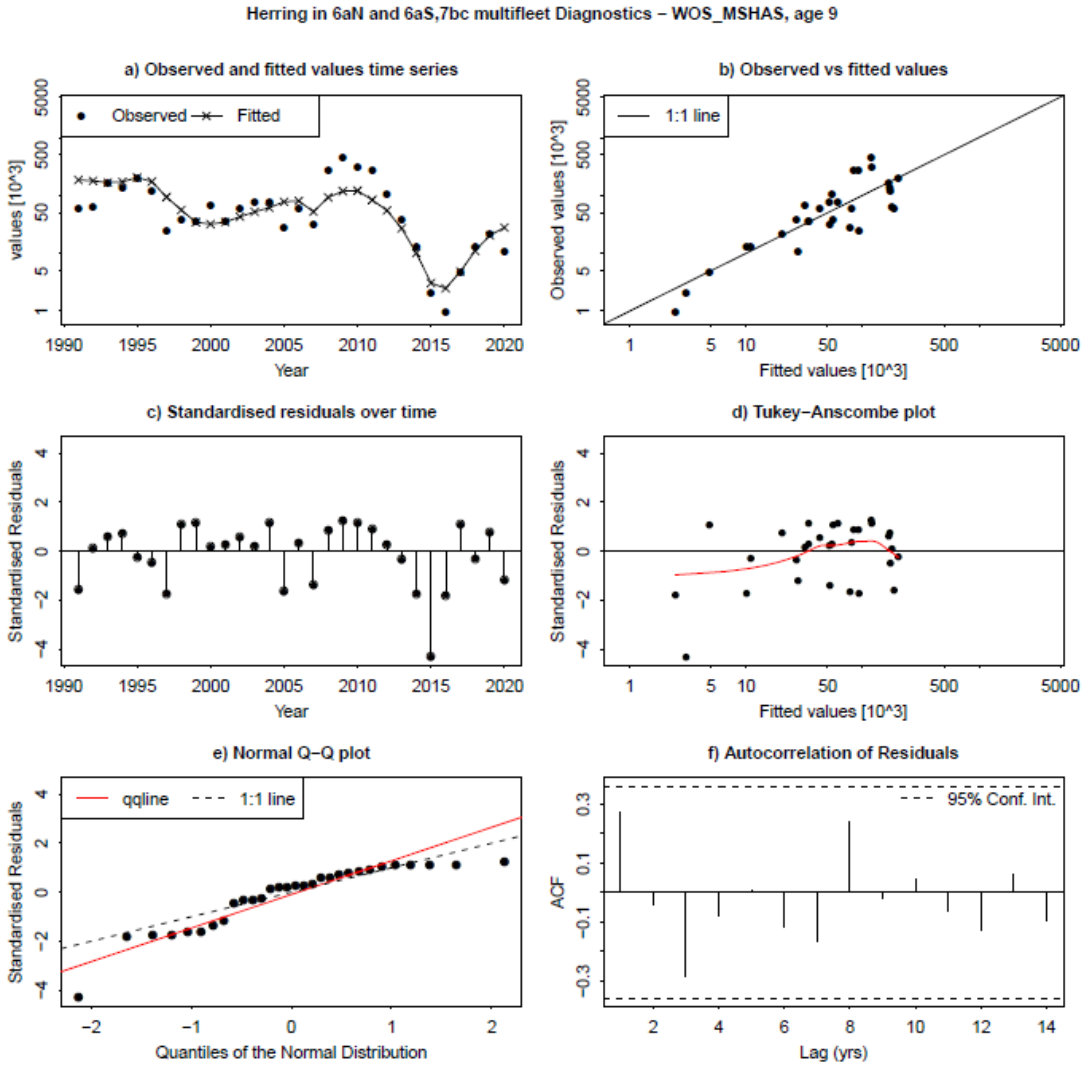

Figure 4.6.41. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: scatterplot of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

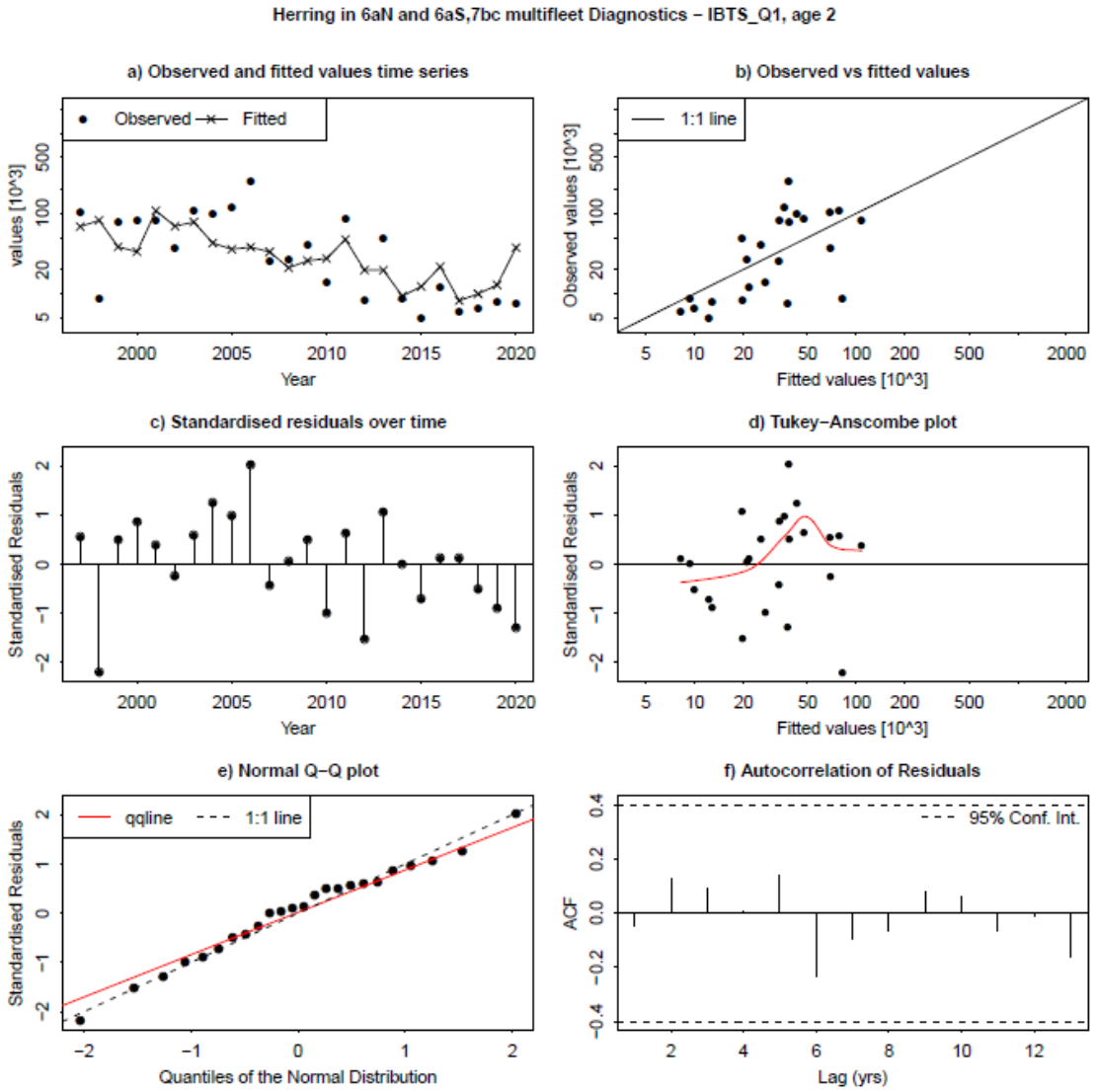

Figure 4.6.42. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: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

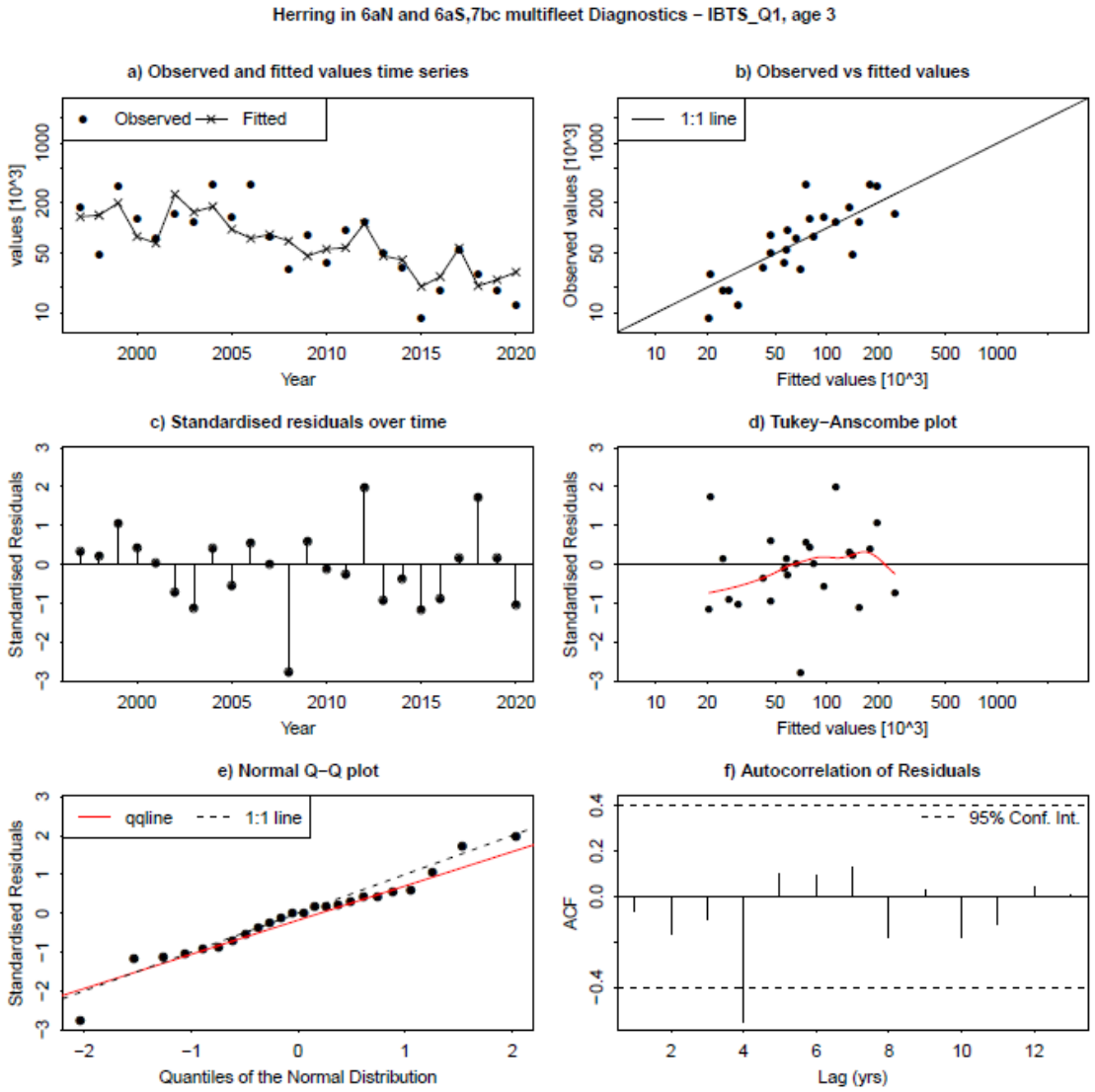

Figure 4.6.43. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: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

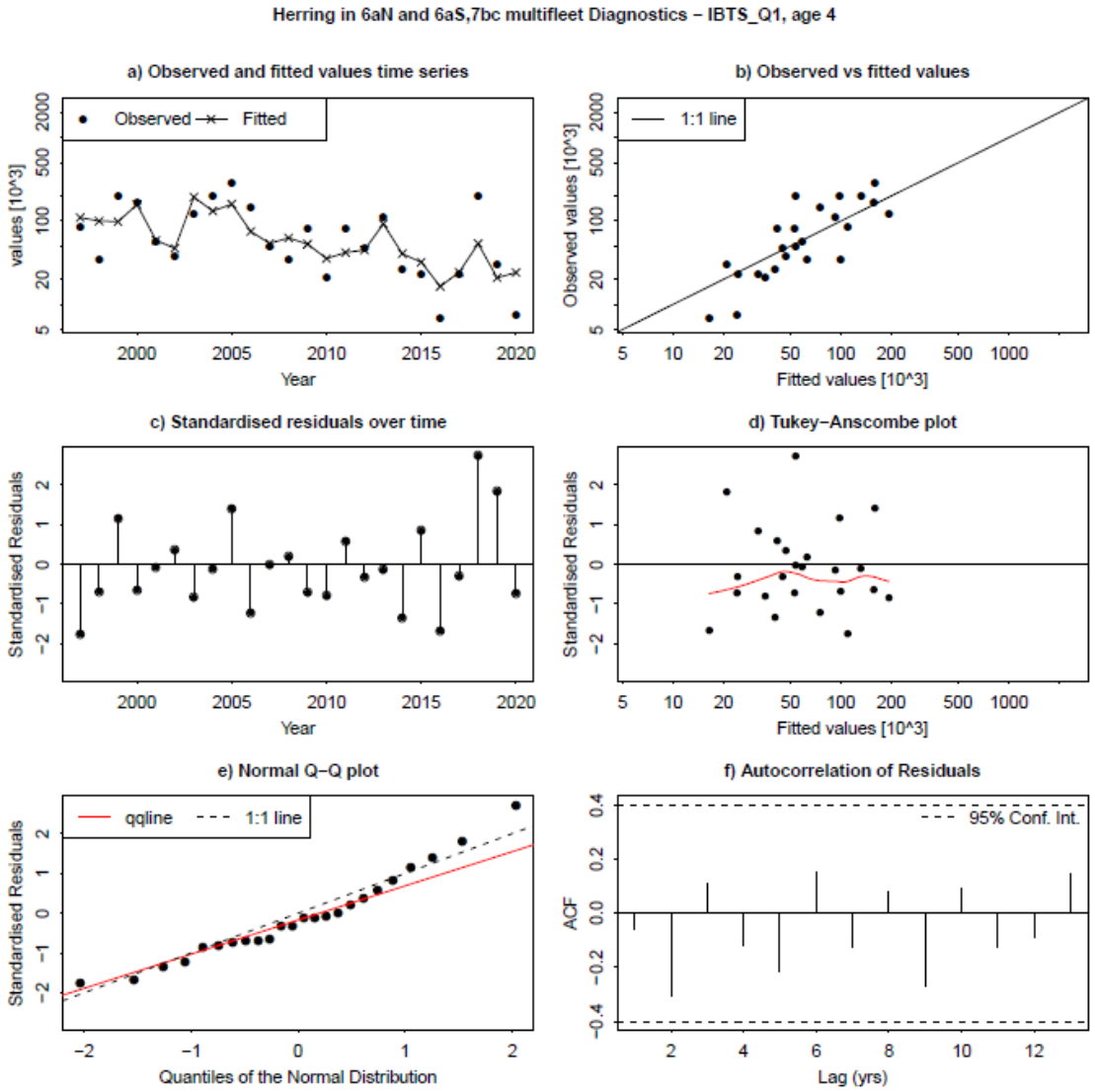

Figure 4.6.44. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: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

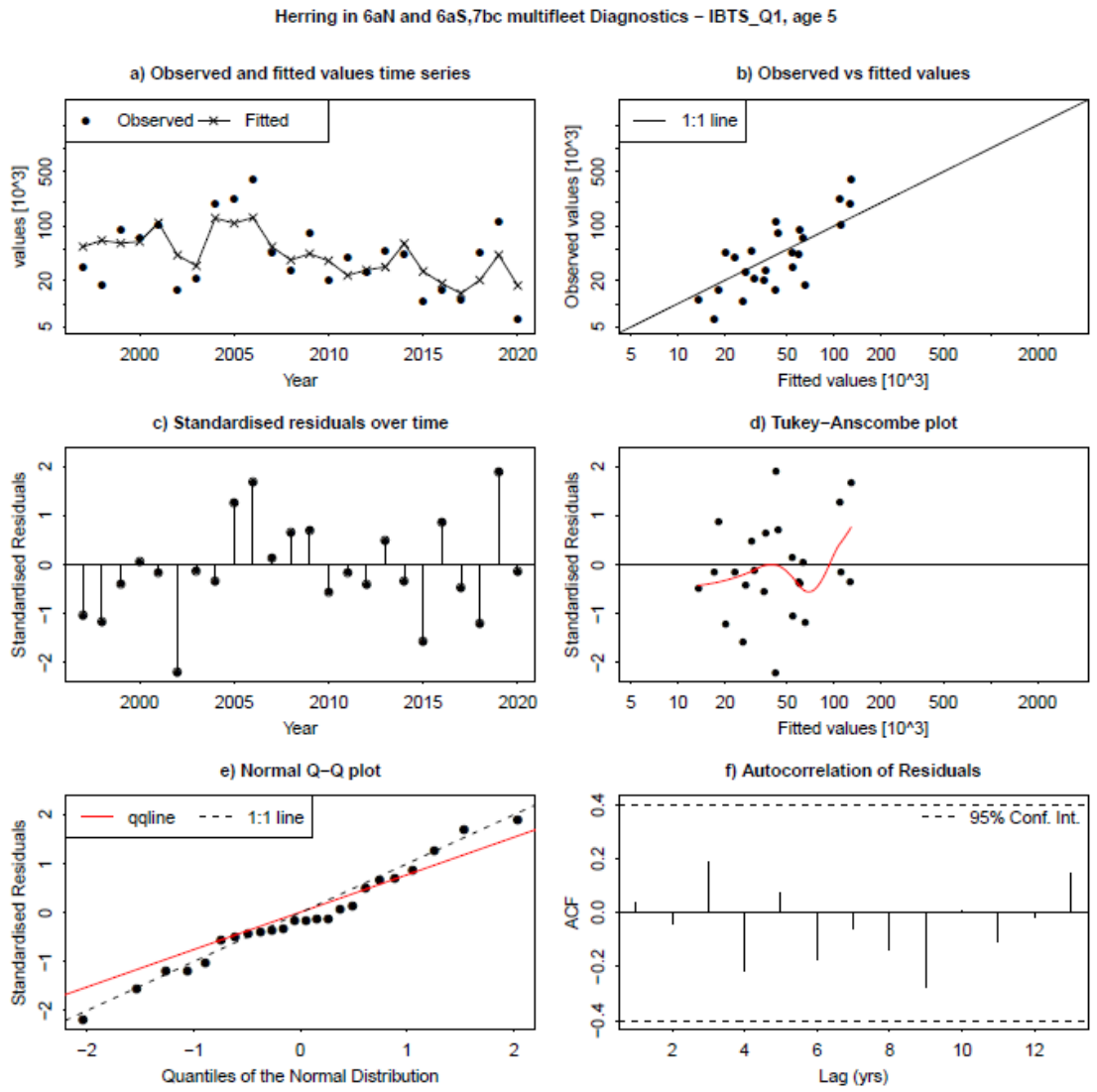

Figure 4.6.45. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: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

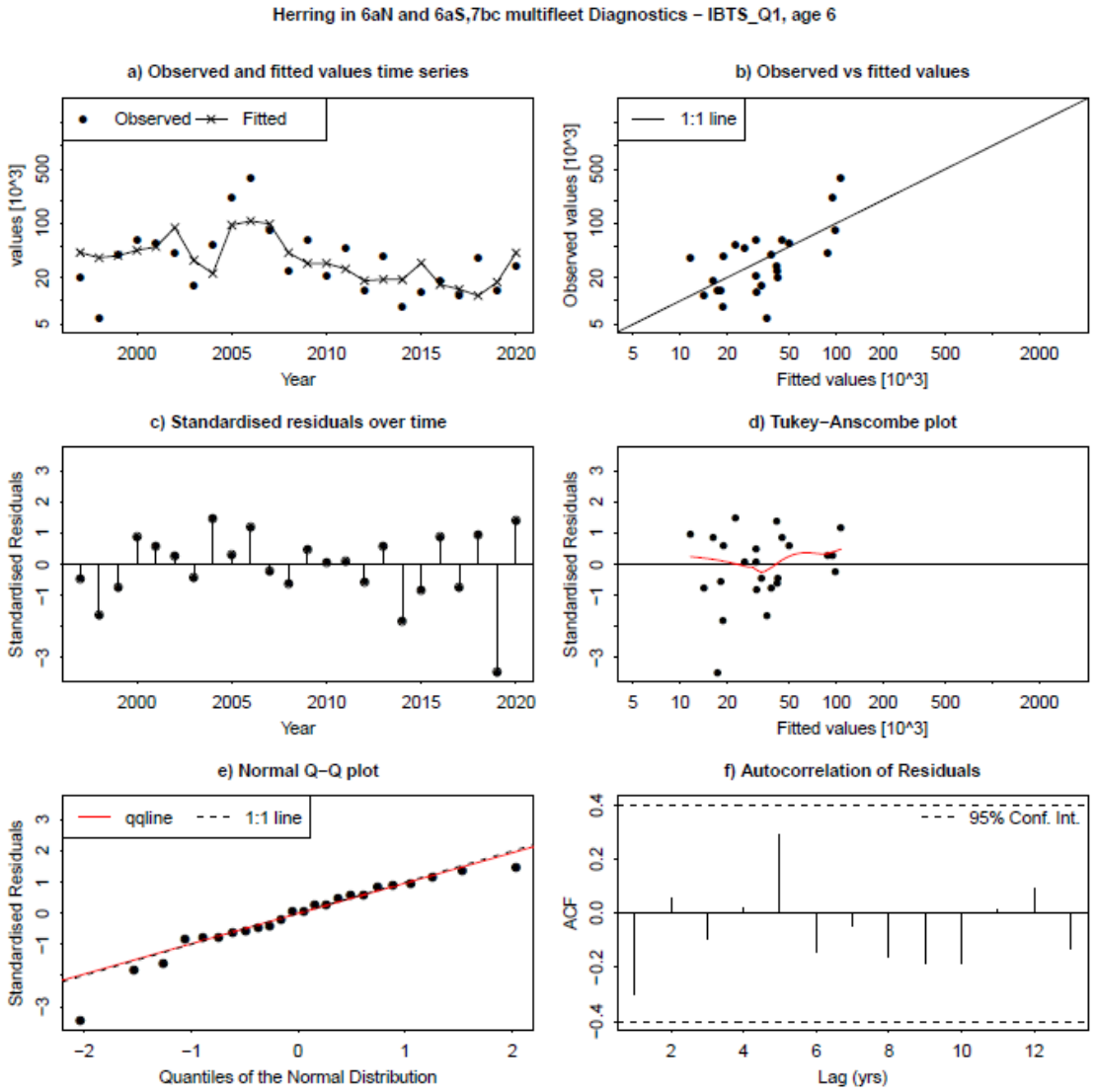

Figure 4.6.46. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: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

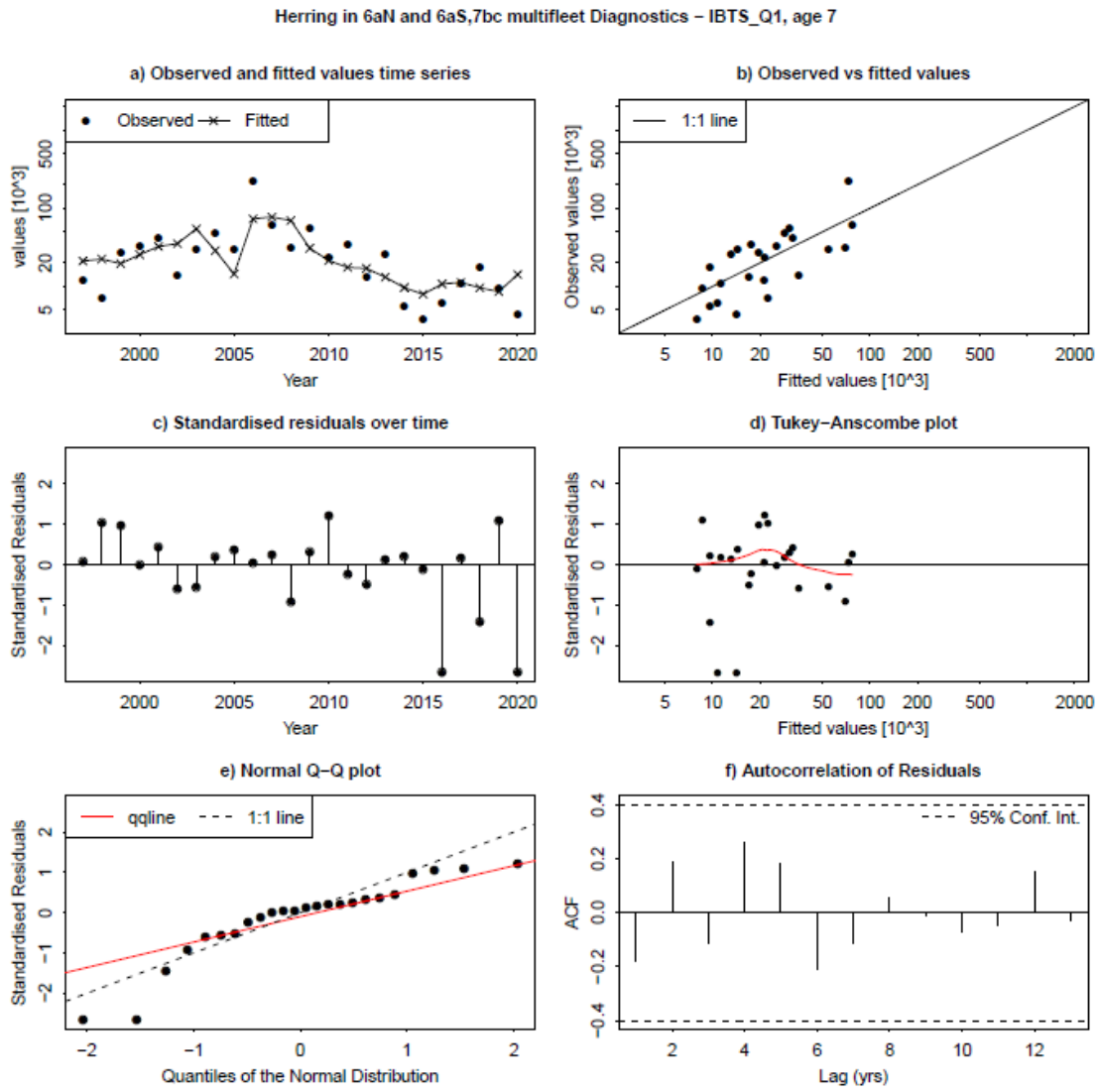

Figure 4.6.47. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: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

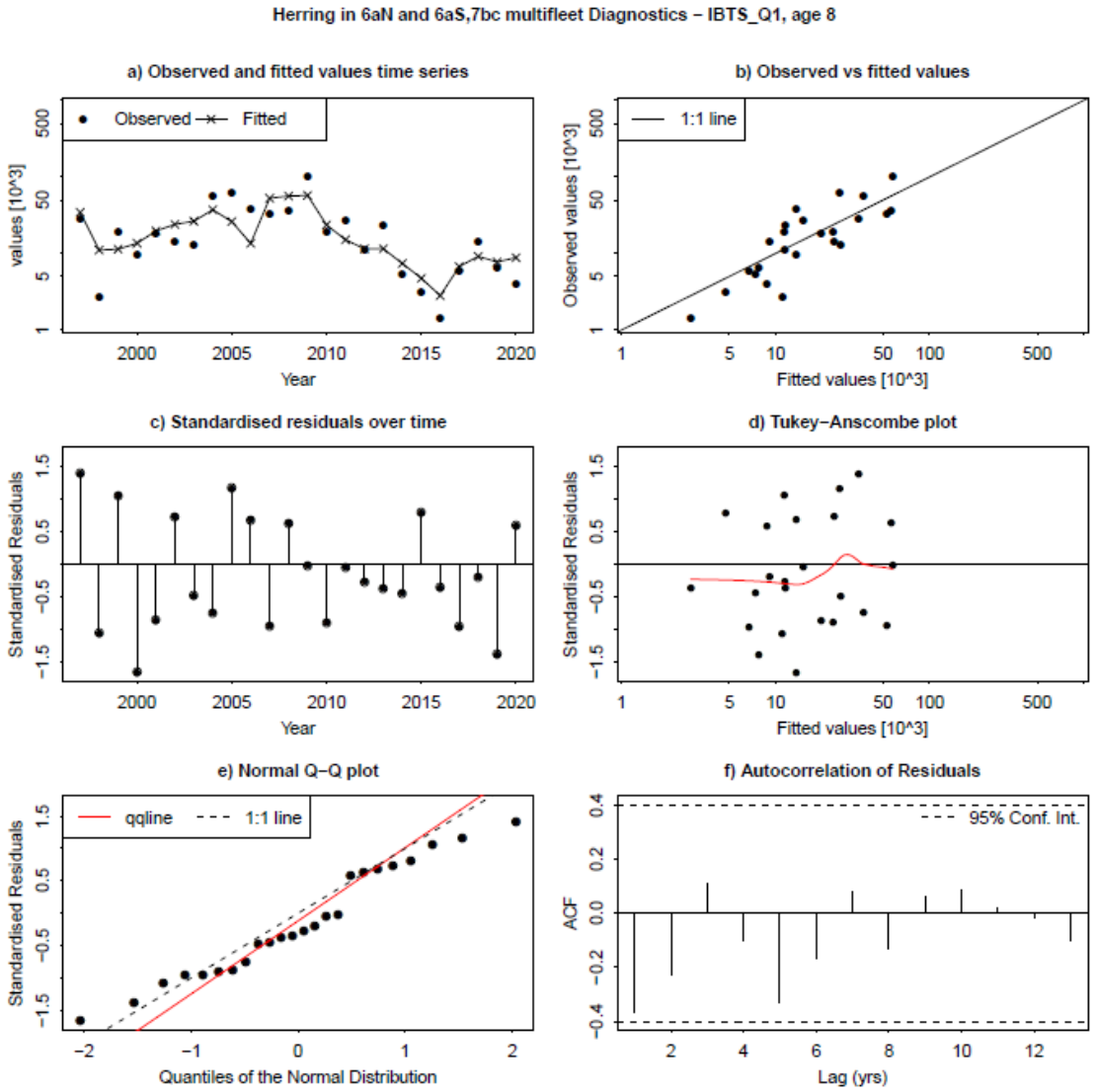

Figure 4.6.48. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: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

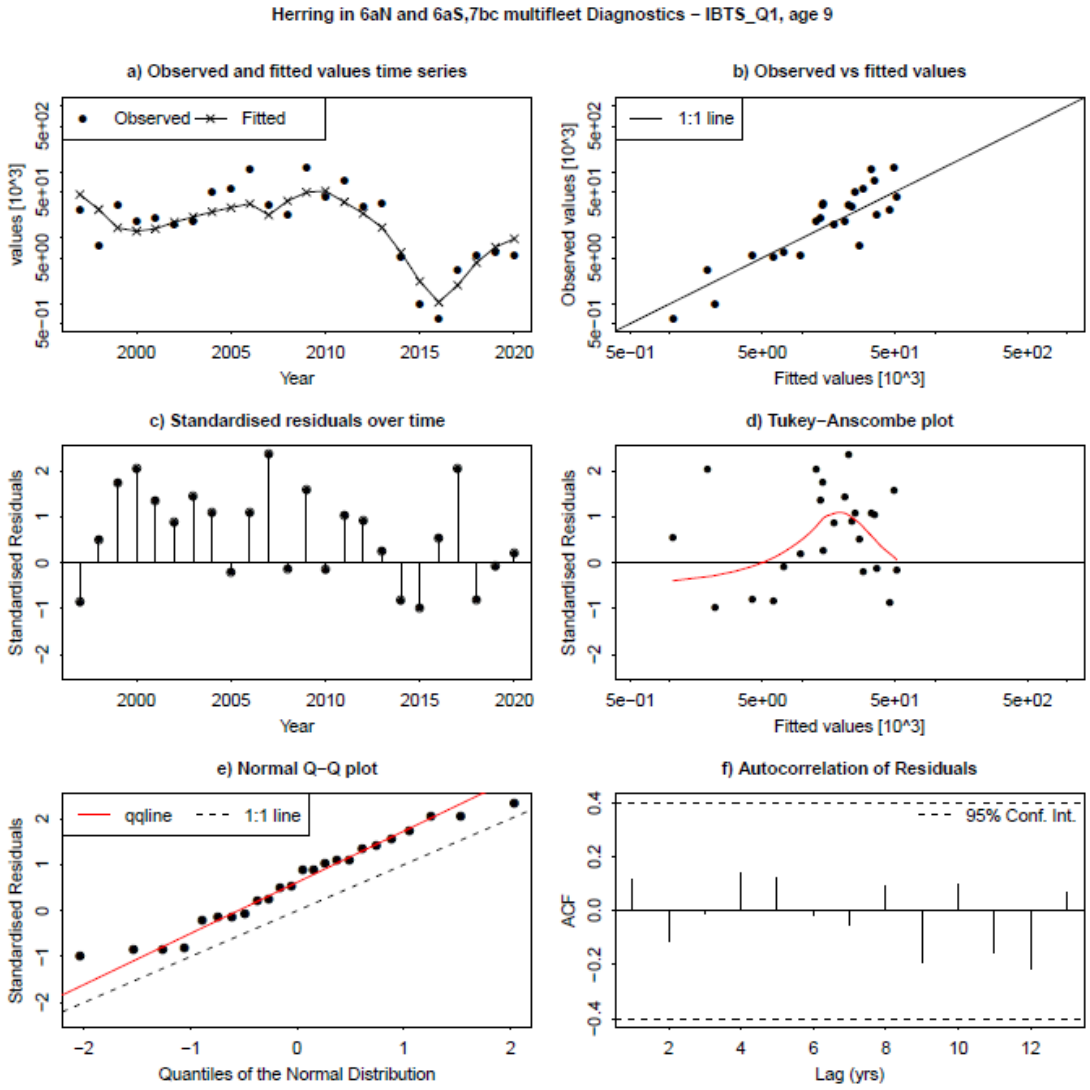

Figure 4.6.49. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: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

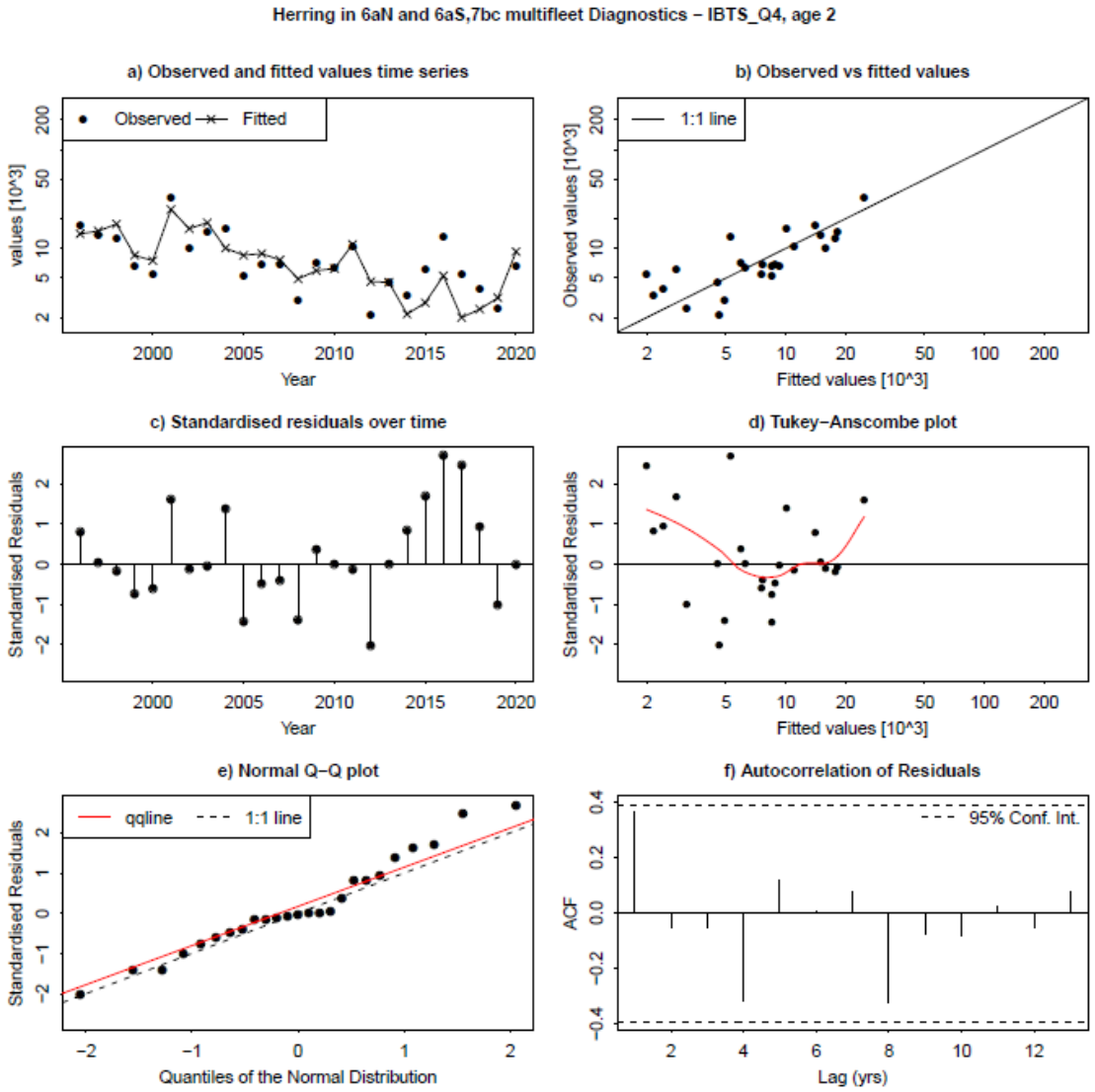

Figure 4.6.50. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: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

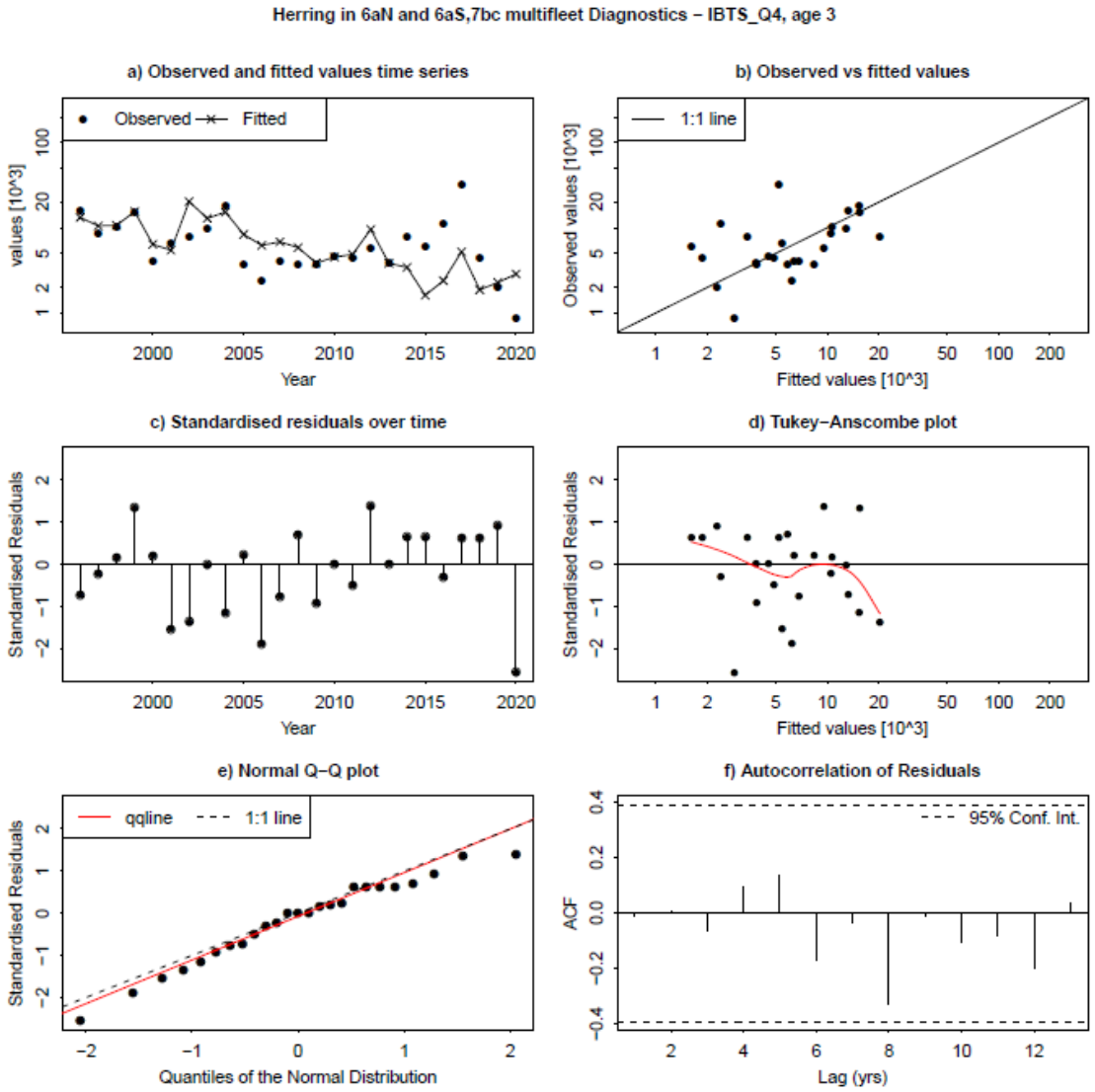

Figure 4.6.51. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: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

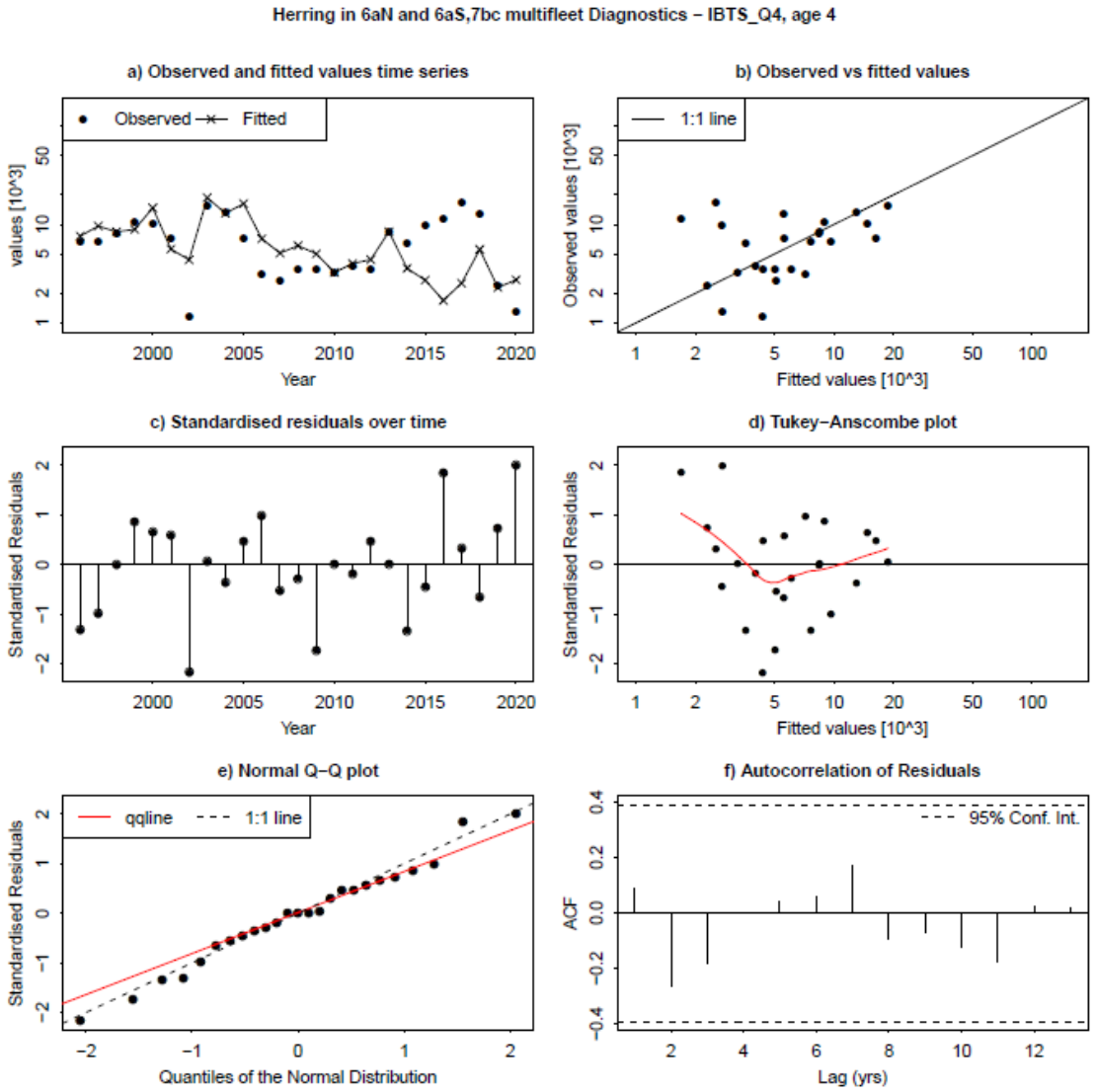

Figure 4.6.52. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: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

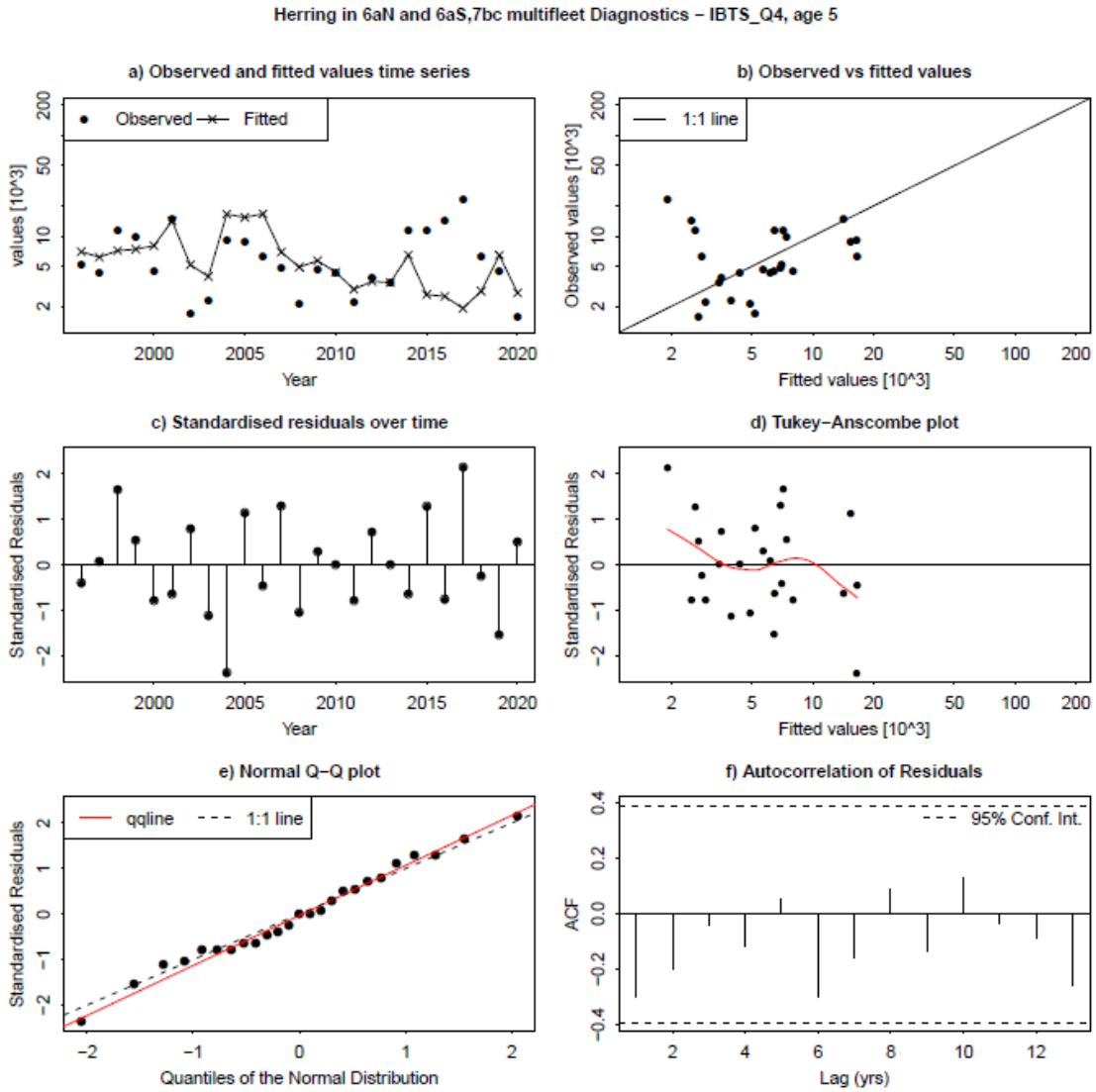

Figure 4.6.53. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: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

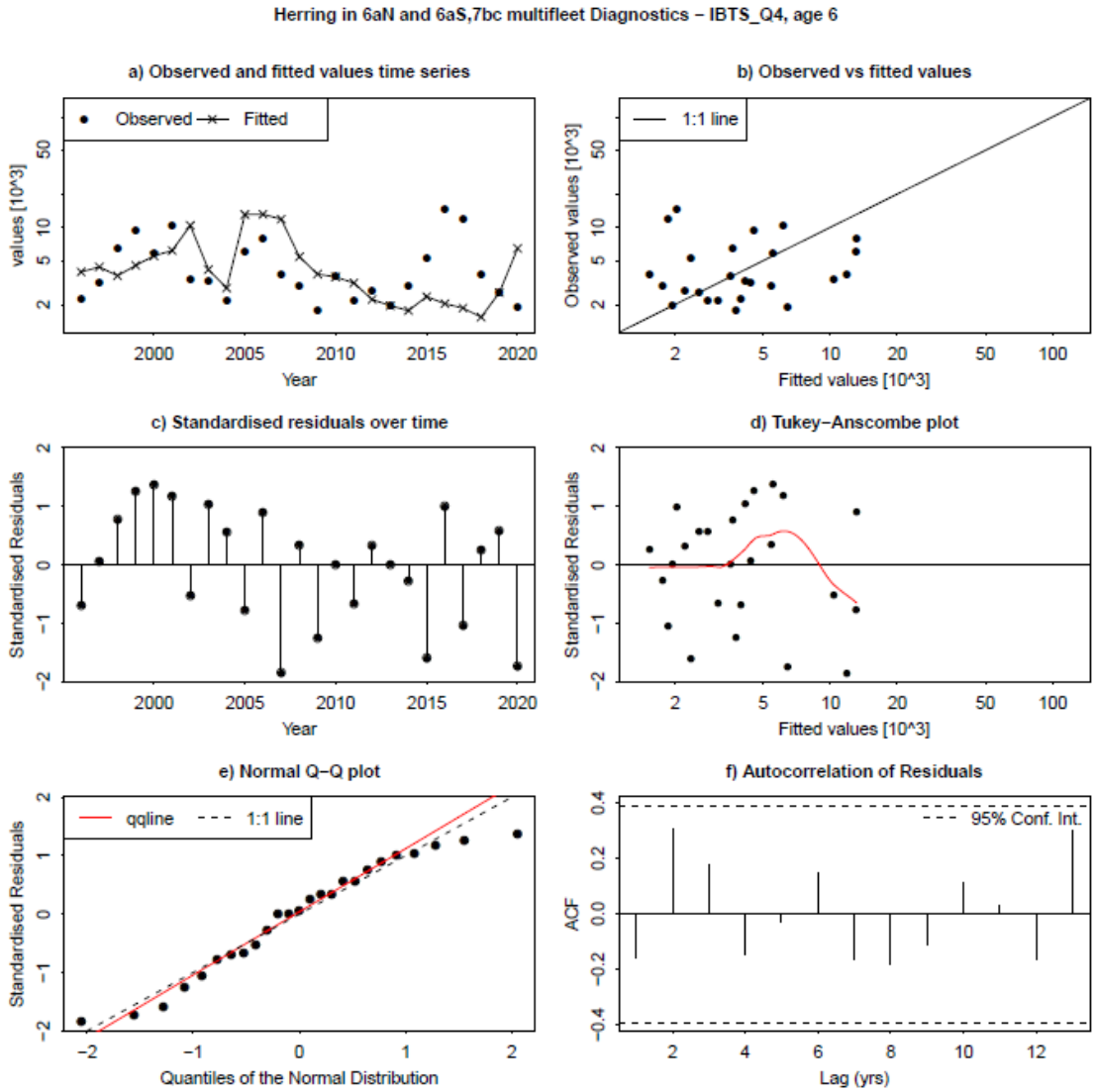

Figure 4.6.54. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: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

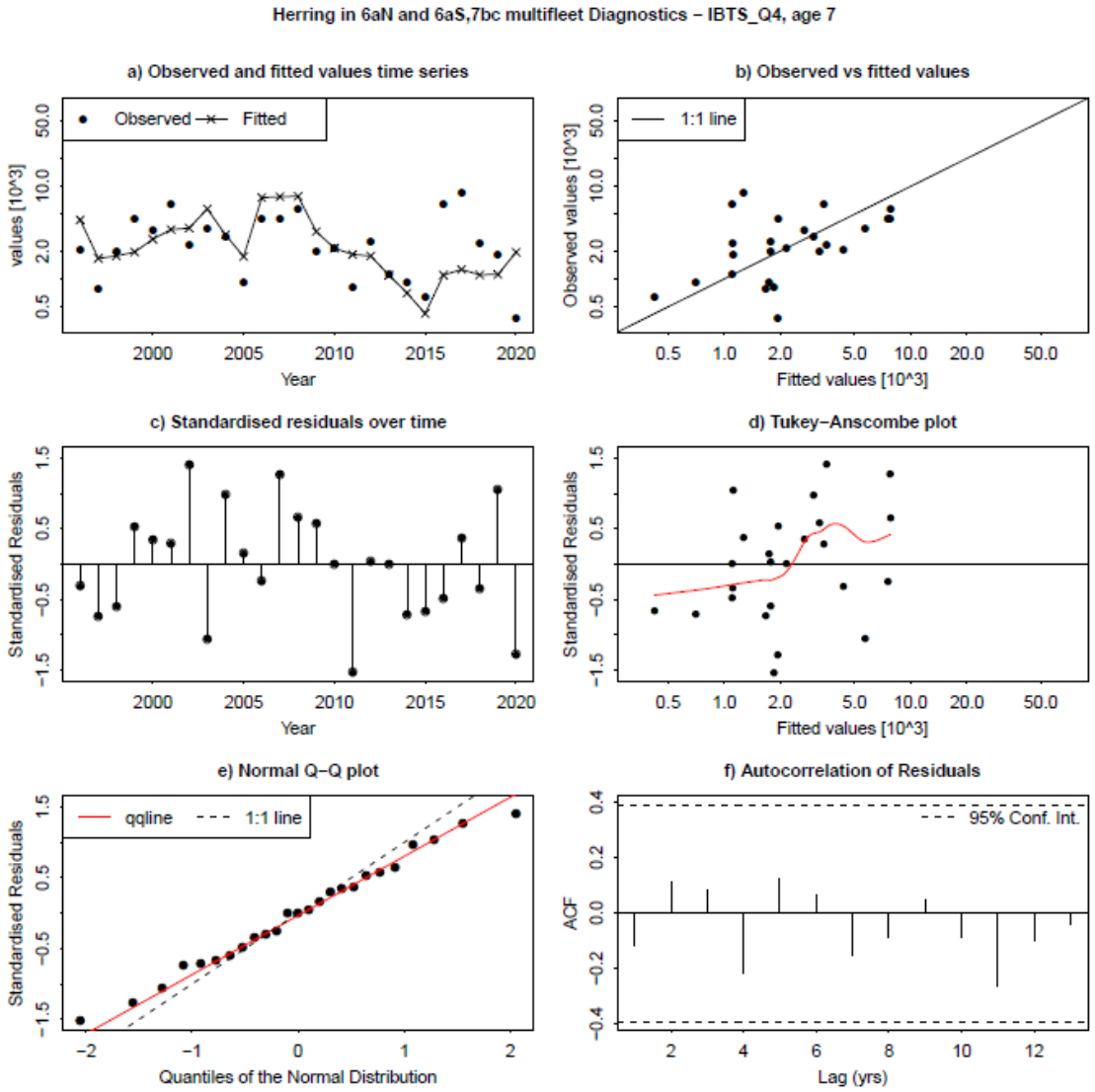

Figure 4.6.55. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: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

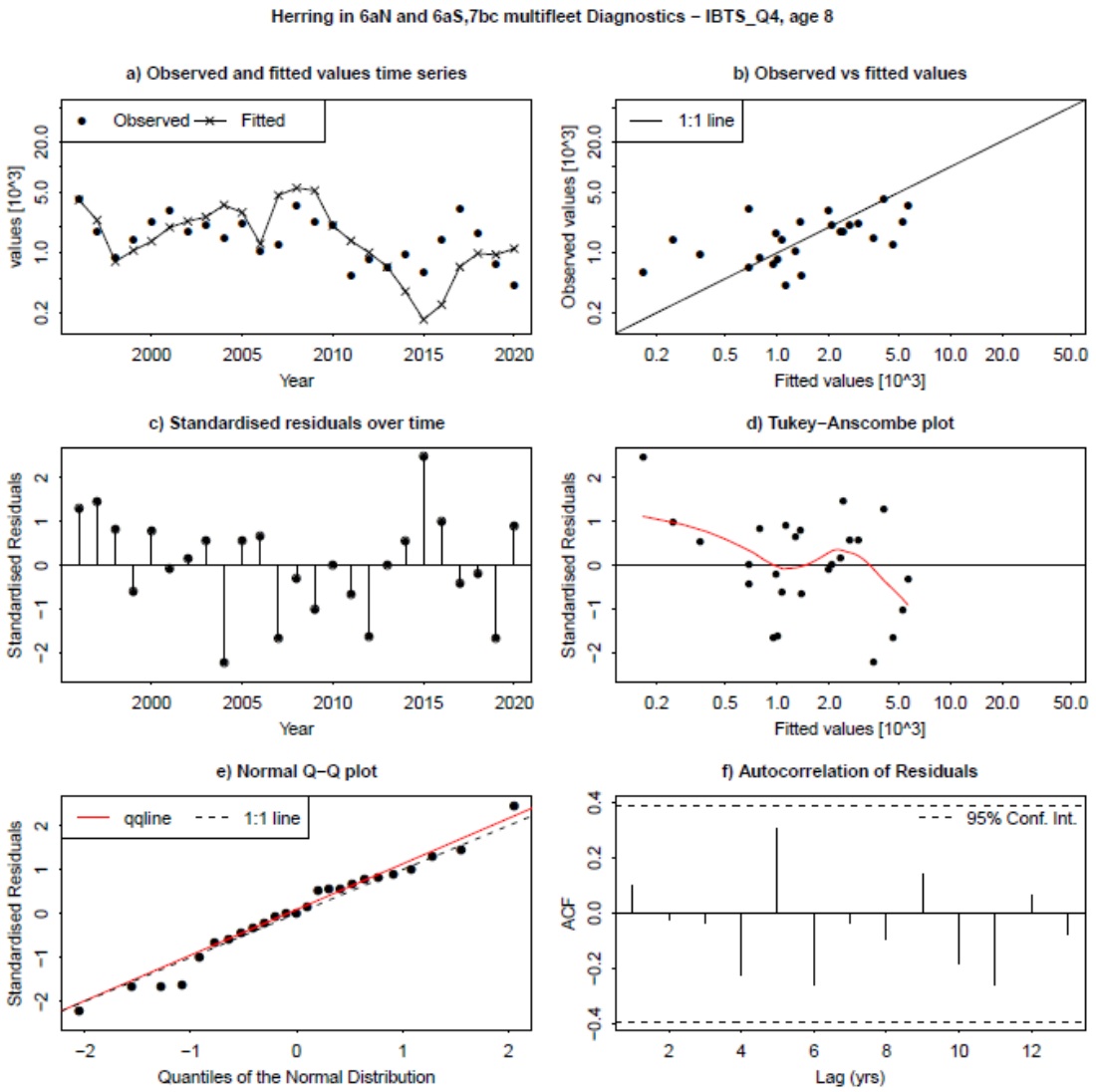

Figure 4.6.56. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: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

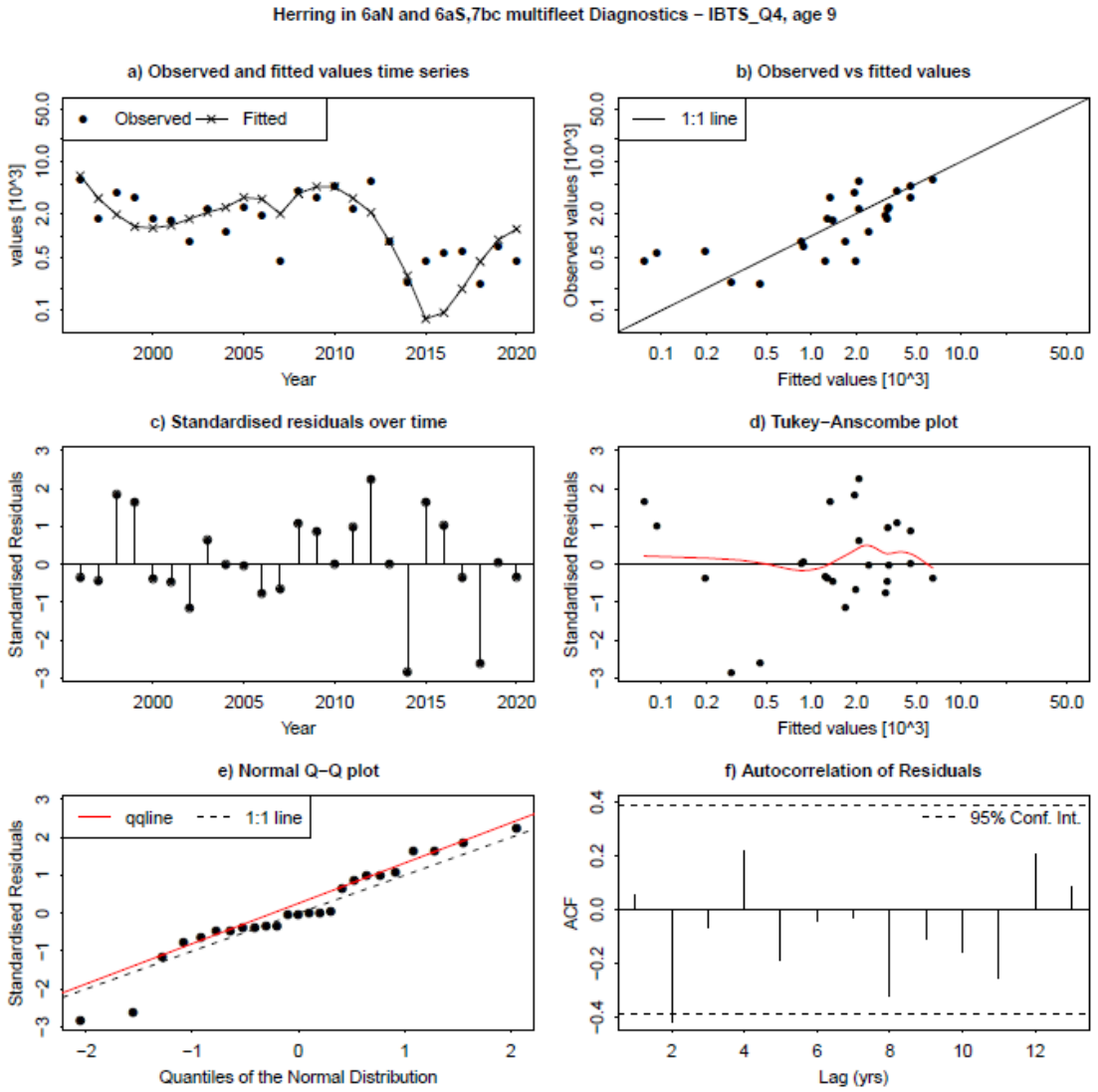

Figure 4.6.57. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: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