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

Fw

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

The WG noted that the use of “age”, “winter rings”, “rings” and “ringers” still causes confusion outside the group (and sometimes even among WG members). The WG tries to avoid this by consequently using “rings”, “ringers”, “winter ringers” or “wr” instead of “age” throughout this section. However, if the word “age” is used, it is qualified in brackets with one of the ring designations. It should be observed that, for autumn and winter spawning stocks, there is a difference of one year between “age” and “rings”, which is not the case for the spring spawners. Further elaboration on the rationale behind this, specific to the 6.a, 7.b and 7.c autumn, winter and spring spawners, can be found in the Stock Annex. It is the responsibility of any user of age-based data for any of these herring stocks to consult the stock annex and if in doubt, consult a relevant member of the Working Group.

4.1 The Fishery

4.1.1 Advice applicable to 2016–2019

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 The management plans in place for either stock were no longer applicable for the combined stocks.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).

4.1.2 Changes in the fishery

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

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

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

4.1.3 Regulations and their affects

The 4° 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 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 2019

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

4.2 Biological Composition of the Catch

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

The 2013 year class (age 5-wr) dominates both the catches and the survey indices in 2019. This year class was already strongly represented at-age 3 wr in the 2017 catches. 2019 is the first time since 2012 that there was a reasonable proportion of 1 wr fish in the catch-at-age data. Previously strong cohorts are less influential in the stock with small amounts of older fish present.

4.3 Fishery-independent Information

4.3.1 Acoustic surveys

An acoustic survey has been carried out in Division 6.aN by Marine Scotland Science in June–July since 1991. It originally covered an area bounded by the 200 m depth contour in the north and west, to the 4°W in the east and extended south to 56°N; it had provided an age-disaggregated index of abundance as the sole tuning index for the analytical assessment of 6.aN herring since 2002. In 2008, it was decided that this survey should be expanded into a larger coordinated summer survey on recommendation from WESTHER, HAWG and SGHERWAY (Hatfield *et al.*, 2007; HAWG ICES, 2007; HAWG ICES, 2010a). The Scottish 6.aN survey was augmented with the participation of the Irish Marine Institute and the area was expanded to cover all of ICES divisions 6.a and 7.b. The Malin Shelf Herring Acoustic Survey (MSHAS), as it is now known, has covered this increased geographical area in the period 2008 to 2019 as well as maintaining coverage of the original survey area in 6.aN.

The Malin Shelf herring estimate of SSB for 2019 is 128 000 tonnes and 740million individuals (Table 4.3.1.2), a decrease compared to the 159 000 tonnes and 925 million herring estimate in 2018. The estimate is still very low in the time-series (Table 4.3.1.3). In 2019, 55% 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 76 000 tonnes and 406 million individuals (Table 5.2.4), a large decrease compared to the 152 000 tonnes and 875 million herring estimate 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 66 500 tonnes compared to 34 900t in 2018.

There was a decrease in the 2019 estimates for the Malin Shelf and West of Scotland (6.a.N) compared to 2018, and the estimates since 2016 are the lowest in the time-series. The distribution of herring schools was similar to 2017 with more herring distributed south of 56°N line of latitude (Figure 5.3a). There were some strong herring marks found to the west and northwest of the Outer Hebrides and around St Kilda in 2019 again. In 2018, large aggregations of juvenile herring were observed around the Northern end of the Hebrides, around the Butt of Lewis and the North Minch. In 2019, juvenile herring were mainly found south of 56°N and to the west of the Hebrides, but in much smaller numbers compared to 2018 (Figures 5.3 and 5.17). Herring has in the past been found in high densities to the east of the 4°W line in association with a specific bathymetric feature and the occurrence of these herring west of the line in some years has the ability to strongly influence the annual estimate of abundance of the Malin Shelf/West of Scotland estimates. There 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 2012- and 2013-year classes (age 5 and 6 winter rings in 2019) are still strong in the stock and comprised 29% of total abundance and 35% of the biomass. The stock is otherwise dominated by 2- and 3 winter ringers (2015 and 2016 year classes), making up 50% of the abundance and 41% 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 2016–2019 industry acoustic surveys of herring during the spawning and prespawning period were undertaken as part of the monitoring fishery on this stock. The surveys covers known active spawning grounds in both 6.aN and 6.aS,7b at spawning time and aims to provide estimates of minimum spawning stock size in each of the areas. Full results from the surveys can be found in (WGIPS ICES, 2020) and a summary for each of the components is in Section 05 of this report. Consistent with observations from other surveys, the industry acoustic/trawl survey in 6aN recorded juvenile herring in several hauls, but noticeably less than observed in 2018. (Figure 4.3.1.1.1)

4.3.2 Scottish Bottom-trawl surveys

Marine Scotland Science carries out two annual bottom-trawl surveys in western waters covering the herring stocks in ICES Division 6.a. The Scottish West Coast 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). Historic retrospectives for the index calculations for Q1 and Q4 are given in Figures 4.3.2.5 and 4.3.2.6, For both Q1 and Q4 the indices calculated for 2019 and 2020 assessments are nearly identical with the only difference the extra added year in 2020.

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 5 wr in 2019 is still prominent 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 2019 the catch weights have continued to decreased for most age classes.

4.4.2 Maturity ogive

The maturity ogive is obtained from the acoustic survey (Table 4.3.1.2, Figure 4.4.2.1). The Malin Shelf Acoustic Survey (MSHAS) provides estimated values for the period 2008 to 2019 (cf. Table 4.6.5). For earlier years, the maturity ogive is as per the 6.aN stock, and from 1991 is taken from the geographically split west of Scotland acoustic survey. The proportion mature of ages 2, 3- and 4-wr in 2019 were lower than in 2016 and 2017 (Figure 4.4.2.1). A greater proportion of immature fish were encountered in the survey in 2019 than in previous years.

4.4.3 Natural mortality

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

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

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

4.5 Recruitment

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

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

The assessment presented here follows the procedure agreed by the recent interbenchmark (IBPher6a7bc, ICES 2019). The tool for the assessment of herring in 6.a and 7.b–c is a 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 and 2019 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 lower in 2019 compared to 2018. 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 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 1957–2019. 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 - 2020 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 2020 assessment of SSB is -0.17, down from -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 2019 is estimated to be at a very low level. Recruitment has been low with no big cohorts evident in recent years. Recent catches have been 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 2020, exploratory forecasts were carried out with different catches assumed in the intermediate year (2020).

The two scenarios considered were

1. Full Uptake of the monitoring TAC (4840 t) in the intermediate year (2020).
2. Partial uptake of the monitoring TAC (3100 t) in the intermediate year (2020). This assumes full uptake in 6aS, 7b-c (1360 t) and uptake based on the 2019 catches in 6aN (1740 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 2021. Under the zero TAC option a further 6% increase in SSB in 2022 is forecast Full uptake of the monitoring TAC will see SSB remain unchanged, while a partial uptake of the monitoring TAC will result in an SSB increase of 2% in 2022.

4.7.2 Yield-per-recruit

No yield-per-recruit analysis was conducted at HAWG 2020.

4.8 Precautionary and Yield Based Reference Points

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

4.9 Quality of the Assessment

This assessment combines two separate stocks, as estimation of independent stock sizes was not possible. These stocks are 6.aN herring and 6.aS/7.b–c herring. The stock went through an interbenchmark in 2019. Improvements were made to the input data. The IBTS dataseries 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. Recruitment in 2019 was stronger than any year since 2010, however there is considerable uncertainty about this estimate. 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 were seen in 2019.

The assessment shows a similar perception of the stock to the 2019 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 are not the same size and managers are advised to ensure that any exploitation pattern imposed in this area ensures that the smaller, more vulnerable, stock is not overexploited. There is a clear need to determine the relative stock sizes and to ensure that the smaller/weaker stock is adequately assessed and protected from 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 is currently underway to assess the identity of herring stocks in this area through genetic, morphometric and otolith shape analysis. The project also aims to develop methods, which can be used in future to discriminate the stocks even during times of mixing. The final results of this project are expected at the end of 2020. It is anticipated that when these results are available it will be possible to carry out a full benchmark on these stocks.

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

Observers monitor some of the fleets. Herring fisheries tend to be clean with little bycatch of other fish. Scottish pelagic discard observer programs since 1999 and more recently Dutch observers indicate that discarding of herring in these directed fisheries is at a low level. The Irish observer programme has not recorded any discards from this area in recent years. The Scottish pelagic discard observer programme has recorded occasional catches of seals and zero catches of cetaceans in the past. Unfortunately, the Scottish pelagic discard observer programme is no longer active.

4.12 Changes in the Environment

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

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

Table 4.3.1.2. Herring in Divisions 6.a (combined) and 7.b–c. Total numbers (millions) and biomass (thousands of tonnes) of Malin Shelf herring (6.a.N-S, 7.b and 7.c) June–July 2019. 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	24	1.7	0.00	69.4	20.0
2	231	27.0	0.43	116.7	23.2
3	225	33.9	0.90	151.0	25.2
4	123	20.9	1.00	170.4	26.4
5	169	32.8	1.00	194.0	27.6
6	95	19.3	1.00	202.3	28.0
7	14	3.1	1.00	216.9	29.0
8	17	3.8	1.00	223.0	29.3
9+	21	4.6	1.00	216.7	29.0

Immature	180	19		105.0	22.5
Mature	740	128		173.3	26.5
Total	920	147	0.80	159.9	25.7

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 2019.

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

2013	0	209	434	672	195	71	61	29	37	282
2014	1012	278	242	502	534	148	33	19	13	285
2015	0	212	397	747	423	476	90	24	2	430
2016	0	30	108	88	112	79	62	6	1	88
2017	0	25	339	155	106	110	47	13	5	145
2018	1289	447	106	343	153	52	72	27	13	159
2019	24	231	225	123	169	95	14	17	21	128

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

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

year

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

year

age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	247	2692	36740	13304	81923	2207	40794	33768	19463	1708	6216
2	142	279	77961	250010	77810	188778	68845	154963	65954	119376	36763
3	77	95	105600	72179	92743	49828	148399	86072	45463	41735	109501
4	19	51	61341	93544	29262	35001	17214	118860	32025	28421	18923
5	13	13	21473	58452	42535	14948	15211	18836	50119	19761	18109

6	8	9	12623	23580	27318	11366	6631	18000	8429	28555	7589
7	4	8	11583	11516	14709	9300	6907	2578	7307	3252	15012
8	1	1	1309	13814	8437	4427	3323	1427	3508	2222	1622
9	0	0	1326	4027	8484	1959	2189	1971	5983	2360	3505

year

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

year

age	2001	2002	2003	2004	2005	2006	2007	2008
1	147.07	992.20	56.11	0.00	182.50	132.46	130.75	0.00
2	83318.40	38481.61	33331.96	7235.79	9632.71	6691.49	34326.00	7898.43
3	15368.56	93975.05	46865.58	23483.32	23236.71	9186.07	17754.83	13039.08
4	9569.99	9014.40	53766.66	29421.79	20602.39	13644.88	6555.14	5427.59
5	25175.08	18113.71	7462.98	48394.28	10237.93	41067.79	14264.99	3219.52
6	9544.89	28016.08	4344.55	4151.94	9783.17	27781.86	30566.16	5688.56
7	6813.78	9040.10	12818.38	8100.36	1014.99	20972.98	21517.07	14832.27
8	4741.98	1547.87	9187.62	9023.67	1194.95	3041.71	13585.45	8142.31
9	1028.78	1422.68	1407.96	4265.93	1430.76	5088.99	4242.60	8968.60

year

age	2009	2010	2011	2012	2013	2014	2015	2016
1	1923.62	10074.12	1667.19	979.53	0.00	0.00	231.18	12

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

	year		
age	2017	2018	2019
1	0.00	0.00	1504.48
2	1122.16	1508.98	1333.57
3	11929.71	3215.53	1035.12
4	4082.50	6873.26	2007.72
5	2075.35	5253.61	3100.51
6	1443.79	3068.25	1003.19
7	1416.35	844.50	214.54
8	767.37	852.31	79.03
9	273.34	680.89	42.01

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

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

	year											
age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	135	883	1001	6423	3374	7360	16613	4485	10170	5919	2856	1620
2	35114	6177	28786	40390	29406	41308	29011	44512	40320	50071	40058	22265

3	26007	7038	20534	47389	41116	25117	37512	13396	27079	19161	64946	41794
4	13243	10856	6191	16863	44579	29192	26544	17176	13308	19969	25140	31460
5	3895	8826	11145	7432	17857	23718	25317	12209	10685	9349	22126	12812
6	40181	3938	10057	12383	8882	10703	15000	9924	5356	8422	7748	12746
7	2982	40553	4243	9191	10901	5909	5208	5534	4270	5443	6946	3461
8	1667	2286	47182	1969	10272	9378	3596	1360	3638	4423	4344	2735
9	1911	2160	4305	50980	30549	32029	15703	4150	3324	4090	5334	5220

year

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	748	1517	2794	9606	918	12149	0	2241	878	675	2592	191
2	18136	43688	81481	15143	27110	44160	29135	6919	24977	34437	15519	20562
3	17004	49534	28660	67355	27818	80213	46300	78842	19500	27810	42532	22666
4	28220	25316	17854	12756	66383	41504	41008	26149	151978	12420	26839	41967
5	18280	31782	7190	11241	14644	99222	23381	21481	24362	100444	12565	23379
6	8121	18320	12836	7638	7988	15226	45692	15008	20164	17921	73307	13547
7	4089	6695	5974	9185	5696	12639	6946	24917	16314	14865	8535	67265
8	3249	3329	2008	7587	5422	6082	2482	4213	8184	11311	8203	7671
9	2875	4251	4020	2168	2127	10187	1964	3036	1130	7660	6286	6013

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	11709	284	4776	7458	7437	2392	4101	2316	4058	1731	1401	209
2	56156	34471	24424	56329	72777	51254	34564	21717	32640	32819	15122	28123
3	31225	35414	69307	25946	80612	61329	38925	21780	37749	28714	32992	30896
4	16877	18617	31128	38742	38326	34901	30706	17533	18882	24189	19720	26887
5	21772	19133	9842	14583	30165	10092	13345	18450	11623	9432	9006	10774
6	13644	16081	15314	5977	9138	5887	2735	9953	10215	5176	4924	5452
7	8597	5749	8158	8351	5282	1880	1464	1741	2747	2525	1547	1348
8	31729	8585	12463	3418	3434	1086	690	1027	1605	923	975	858
9	10093	14215	6472	4264	2942	949	1602	508	644	303	323	243

year

age	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	598	76	483	202	1271	121	5142	61	34	22	69	30	6
2	22036	24577	12265	12574	13507	14207	12844	3118	465	1320	1983	1051	1567
3	36700	43958	19661	12077	20127	9315	16387	4532	8825	994	4252	5241	1838
4	30581	23399	28483	12096	6541	9114	4042	12238	6735	2291	1369	4078	3280
5	21956	13738	11110	12574	7588	3386	1776	1665	12146	1886	3025	1025	2288
6	9080	5474	5989	5239	6780	3780	553	1792	2406	663	2085	2250	613
7	2418	1825	2738	2040	2563	2871	541	425	1045	107	824	1061	700
8	832	231	745	853	661	980	103	382	437	23	43	480	260
9	369	131	267	17	189	95	21	202	204	10	9	76	29

year

age	2019
1	1995
2	2627
3	3259
4	1509
5	1895
6	1166

7	381
8	464
9	171

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

Units : kg

, , area = 6.aN

age \ year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
2	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104	0.104
3	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
4	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
5	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164
6	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
7	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
8	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183	0.183
9	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185	0.185

age \ year	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.079	0.079	0.079	0.079	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
2	0.104	0.104	0.104	0.104	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121
3	0.130	0.130	0.130	0.130	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
4	0.158	0.158	0.158	0.158	0.175	0.175	0.175	0.175	0.175	0.175	0.175	0.175
5	0.164	0.164	0.164	0.164	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186
6	0.170	0.170	0.170	0.170	0.206	0.206	0.206	0.206	0.206	0.206	0.206	0.206
7	0.180	0.180	0.180	0.180	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218
8	0.183	0.183	0.183	0.183	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224
9	0.185	0.185	0.185	0.185	0.224	0.224	0.224	0.224	0.224	0.224	0.224	0.224

age \ year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.090	0.080	0.080	0.080	0.069	0.113	0.073	0.080	0.082	0.079	0.084	0.091
2	0.121	0.140	0.140	0.140	0.103	0.145	0.143	0.112	0.142	0.129	0.118	0.119
3	0.158	0.175	0.175	0.175	0.134	0.173	0.183	0.157	0.145	0.173	0.160	0.183
4	0.175	0.205	0.205	0.205	0.161	0.196	0.211	0.177	0.191	0.182	0.203	0.196
5	0.186	0.231	0.231	0.231	0.182	0.215	0.220	0.203	0.190	0.209	0.211	0.227
6	0.206	0.253	0.253	0.253	0.199	0.230	0.238	0.194	0.213	0.224	0.229	0.219
7	0.218	0.270	0.270	0.270	0.213	0.242	0.241	0.240	0.216	0.228	0.236	0.244
8	0.224	0.284	0.284	0.284	0.223	0.251	0.253	0.213	0.204	0.237	0.261	0.256
9	0.224	0.295	0.295	0.295	0.231	0.258	0.256	0.228	0.243	0.247	0.271	0.256

age \ year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.089	0.083	0.106	0.081	0.089	0.097	0.076	0.0834	0.0490	0.1066	0.0609
2	0.128	0.142	0.142	0.134	0.136	0.138	0.130	0.1373	0.1398	0.1464	0.1448
3	0.158	0.167	0.181	0.178	0.177	0.159	0.158	0.1637	0.1628	0.1625	0.1593
4	0.197	0.190	0.191	0.210	0.205	0.182	0.175	0.1829	0.1828	0.1728	0.1690
5	0.206	0.195	0.198	0.230	0.222	0.199	0.191	0.2014	0.1922	0.1595	0.1852
6	0.228	0.201	0.214	0.233	0.223	0.218	0.210	0.2147	0.1959	0.1780	0.1997

7	0.223	0.244	0.208	0.262	0.219	0.227	0.225	0.2394	0.2047	0.1863	0.1942
8	0.262	0.234	0.227	0.247	0.238	0.212	0.223	0.2812	0.2245	0.2449	0.1854
9	0.263	0.266	0.277	0.291	0.263	0.199	0.226	0.2526	0.2716	0.2802	0.2938

	year									
age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	0.0000	0.1084	0.0908	0.1152	0.0000	0.1121	0.0818	0.0613	0.0725	0.0000
2	0.1541	0.1327	0.1580	0.1667	0.1705	0.1726	0.1549	0.1550	0.1469	0.1441
3	0.1732	0.1632	0.1676	0.1881	0.2060	0.2141	0.1883	0.1894	0.1894	0.1746
4	0.1948	0.1845	0.1929	0.1968	0.2310	0.2379	0.2129	0.2178	0.2076	0.1965
5	0.2160	0.2108	0.2076	0.2105	0.2309	0.2457	0.2337	0.2340	0.2161	0.2020
6	0.2197	0.2258	0.2251	0.2214	0.2489	0.2535	0.2394	0.2388	0.2261	0.2124
7	0.1986	0.2341	0.2443	0.2161	0.2529	0.2599	0.2369	0.2470	0.2408	0.2304
8	0.1885	0.2556	0.2615	0.2618	0.2840	0.2549	0.2400	0.2463	0.2817	0.2343
9	0.3030	0.2496	0.2750	0.3030	0.2877	0.2730	0.2549	0.2522	0.2467	0.2476

	year					
age	2014	2015	2016	2017	2018	2019
1	0.0000	0.0769	0.100	0.000	0.000	0.089
2	0.1451	0.1425	0.144	0.137	0.126	0.129
3	0.1877	0.1795	0.178	0.167	0.151	0.148
4	0.2030	0.2059	0.204	0.187	0.174	0.182
5	0.2279	0.2136	0.219	0.204	0.190	0.199
6	0.2449	0.2307	0.229	0.213	0.208	0.210
7	0.2608	0.2386	0.237	0.221	0.218	0.220
8	0.2614	0.2454	0.251	0.233	0.238	0.257
9	0.2835	0.2685	0.257	0.249	0.246	0.244

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

year

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

year

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

year

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

year

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

year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.105	0.106	0.118	0.111	0.077	0.104	0.094	0.090	0.083	0.105	0.090	0.090
2	0.135	0.137	0.144	0.148	0.146	0.131	0.122	0.134	0.121	0.139	0.113	0.125
3	0.150	0.141	0.145	0.150	0.171	0.168	0.141	0.179	0.141	0.136	0.145	0.149

4	0.162	0.158	0.168	0.166	0.194	0.189	0.174	0.196	0.170	0.155	0.152	0.163
5	0.174	0.169	0.179	0.175	0.200	0.201	0.193	0.214	0.181	0.168	0.161	0.182
6	0.188	0.178	0.189	0.185	0.207	0.212	0.202	0.237	0.196	0.175	0.168	0.188
7	0.200	0.199	0.197	0.194	0.211	0.218	0.217	0.228	0.202	0.184	0.176	0.190
8	0.237	0.221	0.233	0.199	0.218	0.226	0.218	0.243	0.226	0.183	0.185	0.210
9	0.296	0.243	0.237	0.241	0.275	0.229	0.246	0.236	0.226	0.187	0.188	0.201

	year		
age	2017	2018	2019
1	0.072	0.085	0.063
2	0.106	0.101	0.099
3	0.132	0.127	0.127
4	0.145	0.144	0.147
5	0.159	0.155	0.159
6	0.168	0.166	0.164
7	0.172	0.172	0.180
8	0.179	0.170	0.174
9	0.183	0.174	0.172

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

Units : kg

	year											
age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
2	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164
3	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208
4	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233
5	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246
6	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
7	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258
8	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269
9	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292

	year											
age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
2	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164
3	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208
4	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233
5	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246
6	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252
7	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258
8	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269
9	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292

	year											
age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.068
2	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.152
3	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.208	0.186
4	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.233	0.206
5	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.246	0.233

6	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.252	0.253
7	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.258	0.273
8	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.299
9	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.302

year

age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.073	0.052	0.042	0.045	0.054	0.066	0.054	0.062	0.062	0.062	0.064	0.059
2	0.164	0.150	0.144	0.140	0.142	0.138	0.137	0.141	0.132	0.153	0.138	0.138
3	0.196	0.192	0.191	0.180	0.180	0.176	0.166	0.173	0.170	0.177	0.176	0.159
4	0.206	0.220	0.202	0.209	0.199	0.194	0.188	0.183	0.190	0.198	0.190	0.180
5	0.225	0.221	0.225	0.219	0.213	0.214	0.203	0.194	0.198	0.212	0.204	0.189
6	0.234	0.233	0.227	0.222	0.222	0.226	0.219	0.204	0.212	0.215	0.213	0.202
7	0.253	0.241	0.247	0.229	0.231	0.234	0.225	0.211	0.220	0.225	0.217	0.213
8	0.259	0.270	0.260	0.242	0.242	0.225	0.235	0.222	0.236	0.243	0.223	0.214
9	0.276	0.296	0.293	0.263	0.263	0.249	0.245	0.230	0.254	0.259	0.228	0.206

year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.0751	0.075	0.075	0.055	0.059	0.068	0.057	0.066	0.06366667	0.064
2	0.1296	0.135	0.168	0.172	0.151	0.162	0.132	0.150	0.15500000	0.108
3	0.1538	0.166	0.183	0.191	0.206	0.194	0.160	0.183	0.16500000	0.158
4	0.1665	0.185	0.191	0.208	0.223	0.227	0.208	0.189	0.20200000	0.180
5	0.1802	0.192	0.195	0.214	0.233	0.239	0.236	0.206	0.21000000	0.206
6	0.1911	0.204	0.195	0.214	0.231	0.248	0.245	0.217	0.23600000	0.214
7	0.2125	0.211	0.202	0.221	0.232	0.258	0.238	0.214	0.24300000	0.231
8	0.2030	0.224	0.203	0.224	0.232	0.226	0.222	0.218	0.24500000	0.244
9	0.2284	0.231	0.214	0.238	0.238	0.212	0.253	0.215	0.25400000	0.264

year

age	2015	2016	2017	2018	2019
1	0.06373333	0.0638	0.0638	0.0478	0.0638
2	0.15500000	0.1370	0.1350	0.1100	0.1170
3	0.18300000	0.1400	0.1700	0.1550	0.1500
4	0.19500000	0.1750	0.1810	0.1761	0.1790
5	0.20400000	0.2020	0.1980	0.1901	0.1960
6	0.21100000	0.2080	0.1990	0.2097	0.2050
7	0.21700000	0.2090	0.2140	0.2094	0.2170
8	0.21500000	0.2100	0.2230	0.2180	0.2240
9	0.22000000	0.2420	0.2360	0.2222	0.2180

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

Units : NA

year

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
1	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
3	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
5	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
7	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
9	**0.306805**	**0.306805**	**0.306805**	**0.306805**	**0.306805**	**0.306805**	**0.306805**

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

Units : NA

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
1	0.00	0.00	0.00
2	0.95	0.40	0.43
3	1.00	0.85	0.90
4	1.00	0.98	1.00
5	1.00	0.98	1.00
6	1.00	1.00	1.00
7	1.00	1.00	1.00
8	1.00	1.00	1.00
9	1.00	1.00	1.00

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

Units : NA

	year														
age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
2	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
3	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
4	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67

```
   5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
   9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
    year
age 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
    year
age 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
    year
age 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
  1 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  2 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  3 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  4 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  5 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  6 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  7 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  8 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
  9 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67 0.67
    year
age 2017 2018 2019
  1 0.67 0.67 0.67
  2 0.67 0.67 0.67
  3 0.67 0.67 0.67
  4 0.67 0.67 0.67
  5 0.67 0.67 0.67
  6 0.67 0.67 0.67
  7 0.67 0.67 0.67
  8 0.67 0.67 0.67
  9 0.67 0.67 0.67
```

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

Units : NA

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

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

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

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

age	2017	2018	2019
1	0.67	0.67	0.67

2	0.67	0.67	0.67
3	0.67	0.67	0.67
4	0.67	0.67	0.67
5	0.67	0.67	0.67
6	0.67	0.67	0.67
7	0.67	0.67	0.67
8	0.67	0.67	0.67
9	0.67	0.67	0.67

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

MS_HERAS - Configuration

Malin Shelf assessment . Imported from VPA file.

min	max	plusgroup	minyear	maxyear	startf	endf
1.00	9.00	9.00	1991.00	2019.00	0.52	0.57

Index type : number

MS_HERAS - Index Values

Units : NA

year

age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	338312	74310	2357	494150	441200	41220	792320	1221700	534200	447600
2	294484	503430	579320	542080	1103400	576460	641860	794630	322400	316200
3	327902	210980	689510	607720	473300	802530	286170	666780	1388000	337100
4	367830	258090	688740	285610	450300	329110	167040	471070	432000	899500
5	488288	414750	564850	306760	153000	95360	66100	179050	308000	393400
6	176348	240110	900410	268130	187200	60600	49520	79270	138700	247600
7	98741	105670	295610	406840	169200	77380	16280	28050	86500	199500
8	89830	56710	157870	173740	236700	78190	28990	13850	27600	95000
9	58043	63440	161450	131880	201700	114810	24440	36770	35400	65000

year

age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	313100	424700	438800	564000	50200	112300	-1	50389	772520	132551
2	1062000	436000	1039400	274500	243400	835200	126000	267367	265151	375304
3	217700	1436900	932500	760200	230300	387900	294400	995596	273910	373804
4	172800	199800	1471800	442300	423100	284500	202500	719782	443603	242388
5	437500	161700	181300	577200	245100	582200	145300	363484	380436	173333
6	132600	424300	129200	55700	152800	414700	346900	331462	225046	145891
7	102800	152300	346700	61800	12600	227000	242900	743706	192866	101960

age										
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
1	62834	796012	-1	1012160	-1	-1	-1	1287728	24011
2	257258	548481	209403	277504	212467	29593	25426	447304	231310
3	899637	832257	434425	241674	396545	108126	338563	106491	224691
4	484732	517267	671507	502471	747121	87773	155357	342609	122704
5	212913	249024	194706	534431	423139	111676	105728	153194	169202
6	227515	114507	70507	148259	476249	79130	110226	51928	95226
7	205093	111385	61392	32565	90102	62045	47158	72276	14485
8	113298	56526	28597	18677	23931	5530	13069	26636	16839
9	263837	104571	37398	13003	2086	957	4721	12887	21113

IBTS_Q1 - Configuration

Malin Shelf assessment . Imported from VPA file.

min	max	plusgroup	minyear	maxyear	startf	endf
2.00	9.00	9.00	1994.00	2019.00	0.00	0.25

Index type : number

IBTS_Q1 - Index Values

Units : NA

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	48916	361539	103941	106164	8303	79971	83144	88012	39795	111751	103573
3	84580	130176	165901	181522	49449	332296	132467	78484	152044	124480	338773
4	27477	98612	51093	86306	34470	207818	174263	57418	39363	126704	199851
5	25776	12012	55200	28614	16584	88314	68885	102377	14797	20421	193740
6	37978	28659	29673	20481	5902	39971	61817	55319	42601	16411	53898
7	24660	12440	12958	11595	6823	26566	33225	40904	13511	29962	48427
8	9351	21396	19755	27427	2580	18838	9441	17852	13914	13026	54985
9	4248	12641	44457	26393	7220	30831	17792	19066	15377	17169	48066

year

age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

```
  2 126936 269691 26361 27579  42619 14892  91514   8800  53738  9345  5384
  3 142233 326840 80689 33711  85158 41494 101279 122882  54054 35886  9159
  4 277516 142145 50894 34804  81747 20980  80783  47115 112942 25946 22710
  5 213430 377803 44262 26715  78610 19777  38776  25393  45629 41795 10193
  6 207622 375914 79950 24147  59040 21267  47698  14100  38312  8242 12583
  7  29038 218536 59987 29606  54827 22751  34237  13146  25973  5288  3627
  8  60557  36598 32683 33947  96454 18507  25997  10734  22398  4999  3095
  9  53780 105408 29206 20641 114446 38999  70578  28747  32892  4699   916
   year
age  2016  2017   2018   2019
  2 12747  6228   6934   8623
  3 19427 59281  29901  19883
  4  6647 23366 199126  30037
  5 14227 10905  44740 109572
  6 18106 11950  35069  13117
  7  5914 10555  17171   9048
  8  1335  5619  13907   5997
  9   563  3014   5172   5557
```

```
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   2019.00      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 16899 13478 12467  6660 5476 32780 9993 14583 16007 5204 6830 6841 3022
  3 15930  8696 10015 15398 4105  6623 7709  9939 18289 3718 2388 4088 3722
  4  6494  6633  7986 10441 9837  6995 1125 15310 13046 6991 3038 2657 3526
  5  5023  4094 10757  9474 4237 14248 1666  2227  8795 8534 6130 4789 2048
```

6	2164	2928	6098	8826	5473	10018	3257	3170	2096	5863	7628	3557	2796
7	1994	757	1891	4285	3203	6267	2220	3323	2729	878	4302	4233	5457
8	3978	1680	837	1386	2191	3049	1714	2032	1422	2094	1023	1208	3412
9	5458	1652	3568	3157	1601	1585	797	2178	1103	2359	1805	451	3725

	year										
age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2	7121	-1	10248	2148	-1	3379	6210	13260	5609	3832	2437
3	3659	-1	4473	5865	-1	8058	6054	11055	32224	4559	1990
4	3440	-1	3676	3437	-1	6488	9756	11245	16854	13044	2428
5	4514	-1	2171	3686	-1	11270	11307	13730	22646	6196	4391
6	1667	-1	2089	2600	-1	2845	5069	14251	11412	3580	2463
7	1903	-1	792	2462	-1	890	618	6170	8330	2312	1757
8	2141	-1	519	806	-1	902	566	1358	3115	1607	696
9	**3095**	**-1**	**2235**	**5281**	**-1**	**234**	**442**	**567**	**598**	**213**	**696**

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

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
1	**9**	**9**	**1957**	**2019**	**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 ).  Sun Mar 22 15:38:44 2020
range  :  min       max plusgroup   minyear   maxyear   minfbar   maxfbar
range  :  1          9          9      1957      2019          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 6.a (combined) and 7.b–c. FLR, R SOFTWARE VERSIONS.

FLSAM.version	2.1.0
FLCore.version	2.6.10
R.version	R version 3.6.0 (2019-04-26)
platform	x86_64-w64-mingw32
run.date	2020-03-22 15:44:40

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

Year	Recruits Mean Age 0 (Thousands)	Total biomass (tonnes) Mean	Spawing biomass (tonnes) Mean	Landings (tonnes) Mean	Mean F ages 3-6 Mean	SoP (%)
1957	1621421	760610	352222	35835	0.1531	0.7531
1958	2859152	826033	359341	48886	0.1963	0.7733
1959	3984464	963532	361490	48181	0.1801	0.7446
1960	1625674	885284	439611	39546	0.1272	0.6012
1961	2663844	905583	454996	30935	0.0912	0.6332
1962	3583033	998662	428768	47183	0.1332	0.7990
1963	3601652	1060802	456247	38677	0.1023	0.7245
1964	2445571	1036438	512094	39542	0.0963	0.6145
1965	10273513	1701640	516010	47009	0.1000	0.8730
1966	1824773	1607430	774544	73816	0.1247	1.0130
1967	3826869	1626802	882810	74657	0.1236	0.8399
1968	5117656	1708100	837018	63398	0.0958	0.8364
1969	3766356	1637206	811465	94305	0.1480	0.7945
1970	4127747	1562292	733236	126673	0.2143	0.7750
1971	8430310	1821978	558383	223160	0.4247	1.0255
1972	3295333	1521519	631085	139114	0.2572	1.0349
1973	1999872	1262774	590989	222624	0.3925	1.0331
1974	2161105	936662	376422	203325	0.5638	1.1069
1975	2325273	710539	246896	129876	0.5238	0.9806
1976	1487959	552103	195485	104787	0.5183	0.9888
1977	1807505	478341	172173	55486	0.3373	0.9200
1978	2519527	547111	179849	38419	0.2278	0.9961
1979	2803895	653099	234322	20194	0.1169	0.9380
1980	1797651	680336	311155	26523	0.1209	1.0375
1981	2396988	732711	307641	70932	0.2545	0.9699
1982	1914809	675944	264623	111193	0.3786	1.0235
1983	4855259	864178	229168	95471	0.3819	1.0182
1984	2516884	862919	318228	82232	0.2660	0.9756
1985	2913606	905088	384576	59651	0.2257	1.0078
1986	2610120	901706	387424	94108	0.2615	1.0389
1987	4570075	1034508	361865	95119	0.2819	1.0148
1988	1996258	939249	420356	70014	0.2204	1.0126
1989	1651209	844616	440688	65515	0.1928	1.0086
1990	1286884	722176	376711	79613	0.2384	0.9933
1991	1015941	577248	303714	65733	0.2252	1.0315
1992	1530360	472797	224182	61868	0.2457	1.0024
1993	1272803	438747	226691	55372	0.2549	0.9932
1994	2075166	408728	171365	52472	0.2737	0.9999
1995	1624282	391207	137344	55320	0.2901	0.9748
1996	1784161	384553	183131	53691	0.2936	1.0233
1997	2046565	416007	156501	68273	0.4268	1.0033
1998	1040343	384053	184506	69324	0.4691	0.9994
1999	917831	307230	148918	50331	0.3445	0.9998
2000	2665809	378029	118332	40867	0.3035	0.9990
2001	1809202	414044	200432	42511	0.2836	1.0028
2002	1954526	474657	232267	53640	0.3295	0.9998
2003	1109916	414119	216047	45756	0.2725	1.0021

2004	939122	338316	186184	45275	0.2540	1.0119
2005	955248	306398	161690	31010	0.1800	1.0021
2006	857048	295001	146763	45440	0.2794	0.9990
2007	548152	254537	143380	42235	0.2945	0.9990
2008	666243	210174	116958	29883	0.2354	1.0008
2009	734076	202112	96095	30513	0.2754	1.0312
2010	1182492	232555	96444	28612	0.3306	0.9960
2011	528627	188423	80767	25297	0.2790	0.9992
2012	535945	183904	92739	23194	0.2617	1.0017
2013	268023	151904	65160	26719	0.3807	0.9978
2014	342446	110736	43384	25897	0.4329	1.0091
2015	552207	113071	37414	21243	0.5237	0.9982
2016	227371	89132	53783	6876	0.1758	1.0011
2017	254278	90994	54601	6382	0.1489	0.9986
2018	337515	86700	40274	6114	0.1499	0.9978
2019	708296	111872	41978	3611	0.0814	0.9978

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

Units : f

, , area = 6.aN

year

age	1957	1958	1959	1960	1961	1962
1	0.01300610	0.01588731	0.01586657	0.01372754	0.01213297	0.01748142
2	0.05737177	0.07255302	0.07135615	0.05903161	0.04944641	0.07447207
3	0.10359862	0.12791864	0.11544142	0.08544025	0.06436973	0.09511861
4	0.12441160	0.15871846	0.14946084	0.10356466	0.07270284	0.10834575
5	0.15131402	0.19724642	0.18779583	0.13342121	0.08871037	0.13188354
6	0.16681494	0.22098351	0.20211114	0.13604915	0.08366047	0.13281665
7	0.20225122	0.28557149	0.26223326	0.17291678	0.10173090	0.16061399
8	0.20413008	0.30307148	0.28331832	0.18476536	0.10863075	0.17492860
9	0.20413008	0.30307148	0.28331832	0.18476536	0.10863075	0.17492860

year

age	1963	1964	1965	1966	1967	1968
1	0.01455650	0.01397382	0.01343381	0.01746162	0.01624413	0.01306106
2	0.05783939	0.05275309	0.04831915	0.06434454	0.05858288	0.04538743
3	0.07553008	0.06971697	0.06606280	0.08176783	0.07697802	0.06054233
4	0.08320456	0.07861748	0.08162304	0.10106339	0.09546516	0.07105890
5	0.09744350	0.08730364	0.09094144	0.11173731	0.10606581	0.07703909
6	0.10050977	0.09349011	0.09700370	0.12212768	0.12161926	0.08992343
7	0.12125072	0.11958698	0.12737859	0.15173849	0.15462566	0.11855647
8	0.13919759	0.14653027	0.16349671	0.19457739	0.19522155	0.14722677
9	0.13919759	0.14653027	0.16349671	0.19457739	0.19522155	0.14722677

year

age	1969	1970	1971	1972	1973	1974
1	0.01752461	0.02739944	0.05672079	0.03493807	0.04731501	0.05504408
2	0.06638373	0.11669639	0.29165881	0.16613201	0.25077400	0.31482913
3	0.09772110	0.17925860	0.44353484	0.23804359	0.35227515	0.43203729
4	0.11587680	0.19106299	0.42284404	0.22507759	0.34566819	0.46686611

```
  5 0.13046727 0.18891383 0.37655379 0.21000402 0.32700000 0.47934104
  6 0.15374550 0.19548643 0.35021220 0.20239253 0.31751404 0.52218673
  7 0.21488684 0.24791949 0.38519108 0.21214338 0.29487434 0.48221353
  8 0.26913668 0.29649661 0.42656720 0.22242162 0.28436494 0.44004821
  9 0.26913668 0.29649661 0.42656720 0.22242162 0.28436494 0.44004821
   year
age       1975       1976       1977       1978          1979          1980
  1 0.04832045 0.04583597 0.02646915 0.01513312 0.00007673234 0.00008442354
  2 0.28488090 0.28514151 0.15740593 0.08591427 0.00015281035 0.00018494133
  3 0.36448367 0.34946194 0.19860714 0.10463885 0.00016758152 0.00019240411
  4 0.37835898 0.34234415 0.19759860 0.10926232 0.00015553947 0.00017745472
  5 0.40146544 0.34546975 0.19048702 0.09635807 0.00013248412 0.00014858605
  6 0.47565192 0.45295585 0.25830187 0.12393257 0.00016531901 0.00017461969
  7 0.46145545 0.47279786 0.28446449 0.14158955 0.00019818255 0.00021477146
  8 0.41188435 0.42147870 0.24524194 0.12395656 0.00016520615 0.00017219710
  9 0.41188435 0.42147870 0.24524194 0.12395656 0.00016520615 0.00017219710
   year
age       1981       1982       1983      1984        1985       1986
  1 0.01809899 0.02500109 0.01824766 0.0113440 0.008980115 0.01060749
  2 0.13735475 0.22643722 0.17103472 0.1064722 0.086956171 0.11625626
  3 0.15533683 0.26677545 0.21598618 0.1375689 0.110403475 0.14388071
  4 0.15208625 0.27122274 0.22640128 0.1410874 0.109408469 0.14132478
  5 0.14038462 0.27784581 0.25931468 0.1612174 0.126232581 0.15938541
  6 0.16207498 0.32194373 0.31225975 0.1828648 0.143092598 0.16910995
  7 0.19157830 0.39073054 0.39615859 0.2167419 0.156306559 0.16269403
  8 0.15040596 0.35076981 0.39616786 0.2214356 0.161218173 0.16727503
  9 0.15040596 0.35076981 0.39616786 0.2214356 0.161218173 0.16727503
   year
age       1987       1988        1989        1990       1991        1992
  1 0.00714191 0.00546276 0.004621874 0.005677982 0.00449154 0.004953834
  2 0.07913010 0.06273204 0.055383231 0.076944089 0.06335851 0.079706238
  3 0.10016069 0.08008579 0.070792492 0.097403125 0.07842238 0.094826904
  4 0.10602795 0.08291400 0.070474209 0.101176918 0.08003071 0.089787993
  5 0.13291393 0.10404407 0.088009355 0.128762653 0.09940707 0.105911465
  6 0.15540284 0.11724983 0.097383784 0.147628743 0.11613173 0.123518661
  7 0.17429180 0.13421216 0.120276848 0.188829839 0.14506501 0.152999751
  8 0.20697089 0.16784458 0.161796151 0.270599963 0.19750341 0.200297800
  9 0.20697089 0.16784458 0.161796151 0.270599963 0.19750341 0.200297800
   year
age       1993        1994        1995        1996       1997        1998
  1 0.00508641 0.004122491 0.003962916 0.002577273 0.00394952 0.003713296
  2 0.09192440 0.080690283 0.086023165 0.055547004 0.10082123 0.099691444
  3 0.10337596 0.096000768 0.107154474 0.073195961 0.14364500 0.146806650
  4 0.08750930 0.080464500 0.097542374 0.076337310 0.17747810 0.182710502
  5 0.10064640 0.091199131 0.109191256 0.099676701 0.26758915 0.272739483
  6 0.11573346 0.105019836 0.119872838 0.119095539 0.34741371 0.347433823
  7 0.16137906 0.161285506 0.196155061 0.206457239 0.56263296 0.524265611
  8 0.20719217 0.219277405 0.256343530 0.264746998 0.56900705 0.471019282
  9 0.20719217 0.219277405 0.256343530 0.264746998 0.56900705 0.471019282
   year
```

age	1999	2000	2001	2002	2003	2004
1	0.003139443	0.002527381	0.001901076	0.00196423	0.001431607	0.001118418
2	0.087740066	0.073757907	0.057072745	0.06311133	0.045276881	0.034306754
3	0.133134213	0.120657512	0.101864824	0.12600570	0.098426023	0.078835549
4	0.145879953	0.135497137	0.117204579	0.15220133	0.126692014	0.112508036
5	0.190493497	0.180479148	0.173818688	0.23615979	0.195915057	0.192987046
6	0.212992906	0.194579836	0.196979920	0.25767364	0.209797927	0.224129189
7	0.281922409	0.246970054	0.265427040	0.33596979	0.302996749	0.324786688
8	0.243655167	0.211051736	0.237000711	0.29717971	0.302589797	0.362240839
9	0.243655167	0.211051736	0.237000711	0.29717971	0.302589797	0.362240839

year

age	2005	2006	2007	2008	2009	2010
1	0.0007849355	0.001076413	0.00149224	0.001059136	0.001679001	0.00217531
2	0.0228294934	0.033848314	0.05006011	0.032425480	0.055600876	0.07526371
3	0.0495012338	0.071630806	0.09175573	0.057072107	0.097828927	0.12888810
4	0.0601355920	0.096047235	0.10841709	0.064498892	0.119436455	0.15956140
5	0.0894361025	0.168920036	0.18260669	0.098339437	0.168359759	0.22690593
6	0.1026390570	0.229681833	0.26485167	0.144253151	0.219730105	0.26980539
7	0.1354931805	0.335071252	0.39380731	0.224645192	0.312778704	0.34598762
8	0.1493566920	0.397418369	0.49973936	0.306600236	0.430766960	0.48450289
9	0.1493566920	0.397418369	0.49973936	0.306600236	0.430766960	0.48450289

year

age	2011	2012	2013	2014	2015	2016
1	0.001983087	0.002002146	0.002332183	0.002246735	0.00256438	0.0008203486
2	0.067685194	0.069452474	0.084973023	0.082604573	0.09861846	0.0248490880
3	0.115278868	0.123730933	0.162834537	0.165541983	0.21140435	0.0545626210
4	0.142993000	0.157574514	0.240358201	0.260489404	0.33563326	0.0865862346
5	0.202831526	0.227194104	0.361075350	0.413013490	0.53408880	0.1308226469
6	0.239764229	0.280307757	0.477842489	0.568025644	0.83863423	0.2023116761
7	0.295347159	0.331008011	0.585516148	0.714353720	1.09636879	0.2709740410
8	0.428101628	0.502750283	1.000338491	1.243470361	1.65507517	0.4104019567
9	0.428101628	0.502750283	1.000338491	1.243470361	1.65507517	0.4104019567

year

age	2017	2018	2019
1	0.0006882971	0.0007750034	0.0003591785
2	0.0196694562	0.0222356081	0.0085751533
3	0.0461833346	0.0524898345	0.0190345915
4	0.0713228315	0.0859695370	0.0311034954
5	0.0989837791	0.1233108464	0.0389919079
6	0.1320752467	0.1523263451	0.0400577606
7	0.1447800666	0.1290489839	0.0270912436
8	0.2044354331	0.1597818284	0.0273919927
9	0.2044354331	0.1597818284	0.0273919927

, , **area = 6aS7bc**

Year

Age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.007	0.008	0.007	0.006	0.007	0.007	0.005	0.005	0.005	0.006	0.007	0.007	0.008	0.009

3	0.013	0.015	0.013	0.011	0.012	0.013	0.01	0.01	0.011	0.014	0.016	0.015	0.016	0.018
4	0.014	0.018	0.015	0.012	0.013	0.015	0.012	0.013	0.015	0.019	0.022	0.02	0.022	0.023
5	0.018	0.022	0.017	0.013	0.014	0.016	0.013	0.014	0.017	0.021	0.025	0.023	0.025	0.027
6	0.021	0.026	0.02	0.015	0.016	0.02	0.017	0.019	0.022	0.028	0.032	0.028	0.031	0.035
7	0.031	0.038	0.03	0.021	0.023	0.029	0.026	0.029	0.033	0.041	0.046	0.037	0.04	0.044
8	0.031	0.045	0.03	0.017	0.02	0.03	0.024	0.028	0.034	0.046	0.053	0.034	0.036	0.039
9	0.031	0.045	0.03	0.017	0.02	0.03	0.024	0.028	0.034	0.046	0.053	0.034	0.036	0.039

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0	0	0.001	0.002	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.001	0.002	0.001
2	0.009	0.014	0.023	0.038	0.052	0.064	0.054	0.05	0.045	0.045	0.036	0.031	0.042	0.034
3	0.017	0.025	0.039	0.062	0.083	0.102	0.086	0.082	0.078	0.08	0.067	0.062	0.084	0.071
4	0.023	0.033	0.049	0.078	0.107	0.133	0.114	0.107	0.103	0.107	0.09	0.083	0.113	0.096
5	0.028	0.041	0.06	0.094	0.127	0.158	0.138	0.13	0.127	0.132	0.111	0.102	0.14	0.119
6	0.038	0.055	0.08	0.121	0.158	0.19	0.167	0.159	0.159	0.165	0.14	0.129	0.177	0.155
7	0.049	0.073	0.103	0.152	0.194	0.225	0.192	0.185	0.188	0.194	0.163	0.148	0.198	0.177
8	0.046	0.087	0.152	0.273	0.386	0.463	0.332	0.301	0.311	0.324	0.235	0.19	0.286	0.232
9	0.046	0.087	0.152	0.273	0.386	0.463	0.332	0.301	0.311	0.324	0.235	0.19	0.286	0.232

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.004
2	0.030	0.030	0.043	0.032	0.029	0.033	0.038	0.044	0.049	0.061	0.06	0.07	0.072	0.093
3	0.063	0.065	0.094	0.074	0.066	0.073	0.083	0.095	0.107	0.129	0.129	0.147	0.147	0.185
4	0.088	0.092	0.135	0.106	0.095	0.104	0.114	0.128	0.144	0.174	0.176	0.199	0.195	0.239
5	0.112	0.118	0.174	0.137	0.122	0.131	0.143	0.151	0.163	0.194	0.196	0.216	0.206	0.246
6	0.15	0.156	0.23	0.18	0.162	0.171	0.187	0.194	0.198	0.226	0.225	0.244	0.224	0.257
7	0.173	0.179	0.256	0.2	0.181	0.187	0.205	0.209	0.211	0.23	0.221	0.235	0.216	0.244
8	0.218	0.218	0.375	0.241	0.206	0.212	0.252	0.261	0.263	0.307	0.277	0.299	0.252	0.306
9	0.218	0.218	0.375	0.241	0.206	0.212	0.252	0.261	0.263	0.307	0.277	0.299	0.252	0.306

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0
2	0.074	0.063	0.055	0.053	0.045	0.041	0.045	0.06	0.057	0.058	0.047	0.048	0.035	0.022
3	0.147	0.128	0.116	0.114	0.098	0.091	0.1	0.136	0.132	0.136	0.112	0.115	0.085	0.054
4	0.183	0.155	0.144	0.145	0.121	0.109	0.116	0.158	0.155	0.166	0.138	0.143	0.107	0.066
5	0.181	0.151	0.142	0.144	0.121	0.105	0.105	0.138	0.134	0.15	0.132	0.144	0.111	0.068
6	0.185	0.15	0.142	0.143	0.119	0.103	0.097	0.118	0.109	0.125	0.114	0.135	0.112	0.07
7	0.173	0.137	0.124	0.12	0.096	0.081	0.074	0.084	0.071	0.079	0.072	0.091	0.081	0.055
8	0.175	0.119	0.096	0.086	0.056	0.039	0.031	0.034	0.022	0.023	0.019	0.029	0.027	0.015
9	0.175	0.119	0.096	0.086	0.056	0.039	0.031	0.034	0.022	0.023	0.019	0.029	0.027	0.015

	2013	2014	2015	2016	2017	2018	2019
1	0	0	0	0	0	0	0
2	0.020	0.019	0.011	0.014	0.015	0.012	0.014
3	0.051	0.054	0.030	0.038	0.041	0.033	0.037
4	0.067	0.074	0.040	0.050	0.053	0.04	0.043
5	0.076	0.090	0.048	0.063	0.066	0.049	0.051
6	0.086	0.107	0.058	0.078	0.087	0.063	0.066
7	0.073	0.096	0.054	0.074	0.086	0.065	0.069
8	0.029	0.050	0.02	0.034	0.049	0.032	0.037

9	0.029	0.050	0.020	0.034	0.049	0.032	0.037

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

Units : NA

age	1957	1958	1959	1960	1961	1962
1	1621420.73	2859151.85	3984463.95	1625673.66	2663844.39	3583033.16
2	1787827.76	729724.44	1346307.82	1901326.98	701152.24	1215003.13
3	609895.19	1164652.80	471679.91	885776.41	1209233.08	391997.82
4	262815.37	352747.36	713202.03	321242.88	593230.95	773075.06
5	291883.17	175375.29	195960.74	403792.94	230292.61	412313.20
6	133364.47	173433.37	108533.36	109020.06	243897.87	160546.60
7	58515.32	79174.73	92998.82	66881.60	67846.79	170069.38
8	10834.30	34780.97	40467.62	48873.19	41659.72	45330.53
9	34113.83	27280.01	32241.55	37178.89	48903.10	59271.90

age	1963	1964	1965	1966	1967	1968
1	3601652.43	2445571.21	10273513.15	1824772.69	3826869.38	5117655.98
2	1661261.68	1703147.45	1042857.42	5411402.27	737183.48	1761662.03
3	736214.47	1079559.40	1112094.75	678959.31	3806679.72	452798.38
4	221922.73	441010.11	714877.76	724799.24	445571.12	2709152.88
5	474400.01	136994.67	273194.38	448303.89	459611.38	273301.76
6	274008.95	309114.72	88694.61	172923.76	276499.49	294361.62
7	101263.48	183736.12	204280.95	59344.81	103839.12	166007.35
8	106284.92	66498.65	119354.15	126157.66	37388.11	60728.54
9	64712.82	112421.60	115567.29	145622.35	158522.29	111667.29

age	1969	1970	1971	1972	1973	1974	1975
1	3766355.8	4127746.7	8430309.65	3295333.37	1999872.33	2161104.6	2325272.56
2	2381024.4	1674979.4	1833231.58	4003373.83	1430626.29	850644.7	937017.17
3	1101687.3	1579248.7	972307.04	951722.79	2458945.04	707193.1	403172.18
4	290894.7	698820.4	906340.39	404254.45	517135.48	1223715.6	299293.77
5	1853492.5	186130.6	397691.60	411383.68	229995.27	250015.9	512684.77
6	180917.5	1145904.3	111892.88	190753.11	233589.33	116383.1	100922.63
7	195138.4	110563.3	672535.25	56799.04	107478.91	115293.1	43644.39
8	103617.3	109006.3	60941.63	329705.34	30974.25	55270.9	45651.87
9	106326.9	110907.8	113857.09	80892.66	221590.35	119825.6	64743.46

age	1976	1977	1978	1979	1980	1981
1	1487959.34	1807505.24	2519526.92	2803894.98	1797651.11	2396987.77

2	1037500.05	628258.06	808263.32	1152167.82	1320957.48	787820.36
3	443459.75	493819.09	336971.80	478168.34	745639.71	851512.19
4	182350.09	191258.61	262737.37	198046.12	310221.81	487758.75
5	131783.10	81319.11	100654.88	139492.35	133934.29	194091.42
6	220771.84	57600.03	42419.40	59541.95	88373.12	90127.28
7	38562.41	86746.86	25618.65	23334.93	37333.55	60131.95
8	16408.90	14093.41	39793.11	13262.03	13716.80	21475.95
9	37306.49	15966.53	12760.38	24935.33	20533.08	18041.30

year

age	1982	1983	1984	1985	1986	1987
1	1914809.42	4855259.06	2516884.01	2913606.23	2610119.59	4570075.48
2	1119048.06	836906.14	2393660.83	1131375.41	1325994.40	1168895.30
3	428583.99	595880.44	448803.23	1522431.64	698597.98	756290.67
4	469685.11	213975.69	305820.36	242312.87	947632.81	403404.45
5	272337.59	230004.90	108085.72	171061.25	143033.77	546956.01
6	108863.88	134117.26	106571.84	59025.31	101662.78	76862.41
7	48487.02	51596.65	59617.62	55196.98	31299.44	53560.47
8	32638.60	21323.38	20946.40	29581.07	28294.06	17056.02
9	19817.58	23035.31	16338.51	17257.55	23059.43	26964.80

year

age	1988	1989	1990	1991	1992	1993
1	1996257.95	1651209.32	1286884.22	1015940.78	1530360.33	1272803.34
2	2215851.31	906074.30	757999.08	589529.93	448282.41	727589.93
3	689946.73	1480494.86	593609.55	459697.09	361300.37	253358.23
4	430944.63	403751.33	917823.12	394387.60	283659.61	212391.48
5	230094.10	246580.25	249426.59	501394.69	278131.74	168195.59
6	294516.00	132046.73	139811.17	140648.74	261730.18	180055.49
7	36858.67	155587.92	79595.76	72818.99	76183.84	129752.17
8	24796.19	19027.08	80753.49	43294.63	37250.63	40164.36
9	18034.37	21232.16	20106.43	42467.42	39731.15	35832.53

year

age	1994	1995	1996	1997	1998	1999
1	2075165.69	1624282.11	1784160.64	2046565.12	1040343.039	917830.932
2	593239.66	982801.97	771013.37	832542.35	977542.179	454477.441
3	417157.70	334781.03	550958.83	459040.34	476260.366	651963.512
4	130939.79	223964.79	181797.22	266101.14	245093.955	237739.046
5	122867.68	70090.46	104026.06	101994.57	126279.938	114587.224
6	99290.82	71119.02	40718.23	55878.14	48255.265	50157.352
7	103210.22	53659.26	37474.19	21268.33	22605.731	19578.068
8	63131.92	54528.40	28782.67	21255.36	7315.885	7136.538

```
  9   36232.19   44143.08   44818.08   28529.03   17084.472   8797.788
   year
age        2000        2001       2002       2003      2004      2005
  1 2665808.796 1809201.594 1954526.08 1109916.12 939121.78 955248.10
  2  394698.303 1311957.432  837613.18  927897.46 511921.32 424926.10
  3  256577.829  212098.004  838516.61  503685.32 582403.71 315666.82
  4  375524.698  136776.474  107700.00  462189.80 306595.22 372539.30
  5  118852.113  206281.002   78397.09   56137.15 236516.77 198696.33
  6   58147.831   64221.376  114199.94   41792.54  28222.18 119868.35
  7   25185.335   31882.167   34906.69   52932.51  27545.86  13369.76
  8    8821.889   12659.914   15288.72   16892.39  23349.90  15569.23
  9    7805.991    8625.599   10955.10   12993.48  15565.91  17205.72
   year
age       2006      2007      2008      2009       2010       2011       2012
  1 857047.698 548152.21 666242.74 734076.46 1182492.30 528627.111 535945.174
  2 457430.274 411740.87 254910.51 313108.52  332840.02 571840.264 237246.761
  3 241275.944 276144.16 235981.11 156716.64  189342.56 195458.395 372060.843
  4 177547.622 125033.35 147925.25 126017.26   85689.07 100536.931 108353.557
  5 241025.205 100931.25  66909.13  82487.74   68080.71  44101.053  51466.620
  6 137353.721 127940.44  53115.30  39024.21   39855.24  33785.132  24067.923
  7  72383.587  75699.51  67598.39  30235.90   20961.67  17348.157  16939.841
  8   8375.511  34676.38  34935.18  36970.04   15366.91   9765.047   7574.562
  9  20023.870  13441.10  22668.28  30717.56   33041.36  22297.694  15243.376
   year
age       2013       2014       2015        2016       2017       2018
  1 268022.814 342445.895 552206.764 227371.2386 254278.029 337514.820
  2 244457.111 119459.563 156743.836 277013.1899 102209.239 117668.819
  3 157270.960 147378.757  73764.617  93841.9096 206224.192  72299.939
  4 223739.445 100122.708  83409.177  43973.1995  64214.826 137570.990
  5  57171.739 117600.510  54105.219  38348.6113  29137.574  43741.427
  6  25131.530  25858.218  45586.277  23675.2651  21308.322  17840.587
  7  13748.991  10051.983   8997.215  12200.1982  13008.928  11627.187
  8   8156.232   5617.871   3835.775   2140.5257   5249.835   7287.326
  9   9951.675   4383.980   1747.460    769.4412   1458.965   3380.045
   year
age       2019
  1 708296.430
  2 155160.975
  3  78498.895
  4  53078.670
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5  85670.432
6  26951.191
7  10284.000
8   6459.892
9   5988.174
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Table 4.6.18. Herring in 6.a (combined) and 7.b-c. PREDICTED INDEX-AT-AGE catch N 6.aN and 6.aS/7.bc.

Units : NA

age	1957	1958	1959	1960	1961	1962	1963
1	14641.620	31497.830	43838.357	15489.523	22448.437	43403.553	36376.560
2	82650.504	42338.394	76894.587	90393.246	28038.213	72325.385	77463.933
3	50370.960	117324.829	43165.252	60889.014	63205.058	29833.240	44960.547
4	25996.437	43753.929	83761.776	26737.474	35140.275	67065.116	14979.172
5	34938.477	26750.088	28638.727	43072.995	16666.811	43433.610	37568.900
6	17492.384	29334.415	16979.176	11864.230	16713.047	17041.503	22372.851
7	9146.243	16772.992	18350.894	9096.193	5605.480	21527.133	9869.904
8	1707.060	7732.898	8544.823	7077.290	3669.751	6207.912	11803.815
9	5374.996	6065.199	6807.871	5383.848	4307.811	8117.151	7186.891

age	1964	1965	1966	1967	1968	1969	1970
1	23717.560	95805.995	22079.995	43099.304	46406.897	45735.20	78030.37
2	72611.156	40800.400	279689.630	34768.640	64773.734	126742.68	153079.98
3	61019.981	59633.971	44678.487	236147.395	22272.332	85913.74	217507.49
4	28178.421	47316.240	58755.223	34160.068	156495.710	26817.84	102568.07
5	9760.971	20221.014	40289.408	39247.513	17201.049	192494.92	27223.56
6	23533.808	6984.516	16899.651	26865.102	21501.577	21903.51	172791.68
7	17652.538	20786.181	7086.905	12593.626	15755.806	32076.58	20622.21
8	7733.208	15323.803	18901.524	5601.638	7073.749	20858.74	23848.78
9	13073.644	14837.610	21817.813	23750.449	13007.167	21404.19	24264.79

age	1971	1972	1973	1974	1975	1976	1977
1	325744.17	79167.104	64703.653	81038.27	76733.20	46610.039	32983.703
2	387019.89	508179.554	262827.140	189452.80	190148.32	209644.388	74508.748
3	294753.85	168934.497	610323.883	205862.62	100992.83	106367.178	72433.372
4	265605.58	68533.451	126662.812	379308.54	77135.42	42707.901	27789.472
5	106552.81	65847.734	53930.658	79260.57	138807.13	31026.278	11402.210
6	28163.31	29413.402	53086.347	39123.26	31023.90	64370.473	10519.361
7	182952.99	9095.882	22743.019	36025.89	12935.63	11502.268	17109.660
8	18054.29	54734.545	6215.821	15244.56	11379.76	4041.154	2294.340
9	33730.79	13429.031	44468.107	33049.75	16138.77	9187.771	2599.276

age	1978	1979	1980	1981	1982	1983	1984
1	26419.900	150.087093	105.875766	30036.551	33049.324	61329.953	19827.347
2	54140.374	143.079682	198.607366	82941.628	186944.174	107747.162	198220.895
3	27221.630	65.021900	116.287145	100451.012	82804.136	94414.444	47192.572
4	22034.954	24.894498	44.416664	56267.438	91889.179	35170.272	32806.293
5	7475.834	14.907383	16.016958	20764.478	54429.820	42544.077	13103.232
6	3959.143	7.843519	12.265434	10907.014	24498.246	28797.208	14317.732
7	2687.493	3.647714	6.306812	8429.307	12786.041	13472.634	9290.869
8	3498.368	1.634647	1.751462	2330.929	7721.602	5363.533	3248.220
9	1121.815	3.073470	2.621816	1958.142	4688.420	5794.141	2533.661

age	1985	1986	1987	1988	1989	1990	1991
1	18190.323	19235.226	22703.756	7593.004	5316.215	5087.318	3178.379
2	77365.995	119610.818	72563.349	110407.667	40062.850	46017.876	29581.420
3	130496.492	76792.758	58258.673	43291.127	82775.650	44965.840	28149.274
4	20522.313	101986.738	32461.127	27760.469	22348.841	71622.690	24465.907
5	16549.530	17165.198	54020.629	18331.165	16850.835	24383.380	38137.903
6	6332.612	12703.590	8595.924	25836.268	9787.876	15297.528	12192.104

7	6383.004	3746.845	6603.495	3651.596	14018.142	10892.517	7744.946
8	3450.956	3415.015	2338.691	2973.083	2238.728	15113.240	5999.531
9	2013.283	2783.209	3697.366	2162.336	2498.179	3762.974	5884.901

year

age	1992	1993	1994	1995	1996	1997	1998
1	5278.944	4507.427	5957.286	4482.879	3203.664	5627.858	2688.773
2	28010.644	52024.048	37223.898	65596.850	33548.049	64349.506	74044.971
3	26401.492	20004.488	30385.555	27070.533	30654.719	48570.224	50564.942
4	19528.220	14162.607	7948.343	16337.241	10370.788	33796.368	31364.030
5	22392.210	12824.857	8410.272	5691.423	7675.067	18846.225	23321.442
6	23971.561	15478.137	7685.250	6244.938	3523.594	12884.323	10968.077
7	8499.709	15201.421	11979.390	7490.778	5445.922	7300.812	7261.224
8	5207.825	5786.570	9391.637	9455.733	5087.136	7250.928	2103.827
9	5554.615	5162.474	5389.976	7654.821	7921.284	9732.224	4912.976

year

age	1999	2000	2001	2002	2003	2004	2005
1	2006.948	4695.147	2397.925	2676.645	1108.261	732.7391	523.1486
2	30718.627	22685.083	59023.145	41580.670	33442.038	14075.4383	7802.8883
3	64226.857	23236.924	16444.474	79622.739	38103.821	35716.2972	12266.4489
4	25305.749	37768.697	12052.776	12128.945	44297.315	26409.6953	17510.3819
5	15761.795	15768.668	26536.107	13315.148	8136.199	34058.2755	13895.8424
6	7644.673	8290.208	9291.399	21031.859	6468.708	4670.6192	9623.8122
7	3863.690	4491.570	6095.574	8203.919	11502.282	6398.6086	1415.1386
8	1236.409	1376.898	2215.983	3281.579	3733.627	6061.4063	1840.9705
9	1524.221	1218.339	1509.819	2351.408	2871.875	4040.7586	2034.4752

year

age	2006	2007	2008	2009	2010	2011	2012
1	643.4501	570.454	492.1991	859.6033	1793.578	731.1442	748.5002
2	12304.8679	16281.879	6579.3723	13779.7841	19641.028	30634.5184	13109.6692
3	13211.2459	19228.569	10365.1536	11709.3727	18357.237	17284.6197	35685.0582
4	12863.5067	10181.468	7274.7161	11335.2192	10090.818	10863.4293	13061.0824
5	30255.7850	13637.883	5019.6449	10353.0092	11158.507	6626.1211	8734.5964
6	23077.2987	24509.050	5807.1425	6312.4219	7670.053	5916.8814	4929.4301
7	17245.2184	20773.945	11366.3875	6826.9742	5117.205	3711.8843	4045.7550
8	2353.8509	11781.899	7922.3850	11173.7383	5080.880	2926.2698	2593.0755
9	5627.5020	4566.845	5140.5728	9284.0029	10924.717	6681.9001	5218.4169

year

age	2013	2014	2015	2016	2017	2018	2019
1	435.9744	536.6468	987.6602	130.1891	122.1645	182.5792	177.6021
2	16427.2201	7812.7080	12198.7541	5612.1823	1642.1072	2137.2649	1092.7287
3	19523.3659	18553.8513	11744.0097	4126.3357	7695.9691	3069.1775	1225.0921
4	39608.2664	18978.7999	20008.2151	3029.7054	3665.2371	9457.5207	1352.4408
5	14481.7872	33111.9090	19040.7015	3924.8700	2285.6511	4260.8148	2741.5104
6	7994.3006	9330.1759	22174.1800	3611.9574	2182.3412	2110.0752	881.7531
7	5162.9206	4325.1936	5193.8723	2429.4314	1456.8138	1180.3933	229.3586
8	4500.4833	3484.0517	2761.9493	617.5747	821.7244	917.0071	147.8521
9	5491.1810	2718.8261	1258.2584	221.9957	228.3627	425.3310	137.0556

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

Units : NA

age \ year	1957	1958	1959	1960	1961
1	3.8568573860562307	0.0453761341075674	1.86167133	-2.08950943	-0.01844039
2	4.0616251067254199	0.0000116176110546	0.46430180	0.89574449	-1.17084310
3	0.0064368284001618	5.3119217944512105	-0.07711011	-0.03546531	-0.04815150
4	0.0199692719062901	0.0000000006717216	1.42715700	0.03887262	0.13472593
5	0.0241085032815805	-5.5358432232915984	-0.71332877	-0.06419766	2.44061538
6	2.9101418533669925	-0.0000001557575647	0.19958087	-1.49559780	-0.95948607
7	2.3781625396949164	-0.0636613679482962	-0.80011851	0.24128848	0.01388837
8	6.2451529345019674	-5.0621584256128180	-0.39389634	-0.40656936	1.04689001
9	-0.0000000001014859	-0.0000009296279224	-0.07712294	-1.50207846	-1.63976676

age \ year	1962	1963	1964	1965	1966	1967
1	1.545099480	-0.516475139	0.76287531	2.3935189	1.85544152	0.6213707536
2	0.009476424	0.075756984	0.03402867	-1.2709774	1.77029621	-1.8970657780
3	-2.464396761	-0.153084489	0.05978380	1.4537493	-2.26615669	2.5502759655
4	0.717015467	-2.220218473	-1.51972666	0.8657217	-0.16731562	0.8237496532
5	1.051325364	-0.004498869	-0.95252072	-0.3144383	-0.30901196	0.0008340735
6	1.984823319	1.119859549	0.30361898	-1.4091777	-0.04414642	0.1734715744
7	0.484870684	-0.294753434	0.66079352	0.2242580	-1.00886349	-0.4837526964
8	0.499331126	0.786040741	0.77749143	0.6309373	-0.31431420	0.0734702780
9	0.459005155	0.445137820	0.84048164	0.8568612	0.52314377	0.1947302892

age \ year	1968	1969	1970	1971	1972	1973
1	1.3683782	-0.31222483	0.82749726	0.8671359	0.88141094	-1.27795207
2	-0.0952595	0.08660013	-0.48766717	0.3773392	0.66169086	-0.01712888
3	-1.2199634	0.35707818	2.02204047	0.4779510	-0.63232540	2.12674099
4	0.4090388	0.22472129	-0.09276519	-0.1388656	-1.61671568	0.02845389
5	-1.1265921	1.27403725	-0.42893253	-0.7593279	0.08471802	0.45334101
6	0.2745077	0.12027720	-1.23197229	-0.2969515	-0.28022913	-0.01685711
7	-0.2424793	1.19476052	-0.42889321	-0.9299338	0.18519077	-1.26845868
8	-0.5309662	0.24940725	-0.25523339	-0.2174633	-0.15296005	-0.47191804
9	-0.2437463	0.26944822	-0.42245281	-0.4211988	1.39398015	-0.86348571

age \ year	1974	1975	1976	1977	1978	1979
1	0.22543951	0.05873452	-0.46026097	-0.8702947	-0.46990926	-2.5366587
2	-0.94845570	-0.14247940	0.53082321	-0.7392238	-0.08593096	-3.1469993
3	-0.32902405	-1.10248271	-1.25034038	0.8892728	-1.15649344	-2.2884123
4	2.44654846	-0.71258675	-0.66417264	-0.7067195	1.71626448	-2.3735802
5	0.58369702	0.95188517	-0.73153330	-0.2249700	-1.15147174	-1.6288268
6	1.42065622	0.01227114	0.96994773	0.6280251	-0.72759619	-0.2747566
7	-0.08395961	-0.16420139	0.03363985	0.8550266	-1.09089452	0.2375054
8	0.63185309	0.10003919	-0.37075466	-0.1616905	1.02025455	-1.5913961
9	-1.08071137	-0.25430355	0.29597530	-1.9173316	-0.04820941	0.0000000

age \ year	1980	1981	1982	1983	1984	1985
1	1.1382326	2.113197	-0.82177068	0.1119016	-1.6310932	0.03709153
2	-0.1414857	3.379273	1.82742603	-0.7827524	1.9017430	-0.21245440
3	-1.0945453	2.786957	-0.95129125	0.1487972	-0.7588799	0.81455393
4	0.3278985	1.755068	0.01930639	-0.8001218	-0.7966717	-1.76422780
5	-0.2483017	1.212084	0.70399820	0.2534354	-0.2252956	-0.13867320
6	-1.0788572	1.282808	-0.21870205	-0.2097654	-1.6754379	0.08553977

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  7  1.0309544  1.438358 -0.32021922  0.2741895 -0.7836584 -0.55614107
  8 -1.2810676 -1.142957  2.36034876  1.3388076  0.4194853 -0.18624208
  9  0.0000000 -1.418447 -0.35196246  0.4090843 -1.3639428 -0.59691768
   year
age       1986       1987       1988        1989         1990        1991
  1 -0.1097627 -0.3595781 -1.5065555 -0.52735359  0.076674668  0.30882663
  2  0.5925513 -0.1025166  1.3757884  0.06045297  0.002778193 -0.76104137
  3  0.1378614 -0.6356554 -0.5740236  1.29357195  0.445442859 -0.06256543
  4  0.4242240  0.6849545 -0.3310720 -1.40248879  0.391831906  1.33566215
  5 -0.2541080  0.5191536  0.1807160 -0.25376628  0.281924360 -0.82715860
  6  0.3051730  0.1414218 -0.1924166 -0.85872294 -0.569644593  0.35778717
  7 -2.7209967  0.9460878 -0.7817801  0.40943929  0.483444306 -0.38281648
  8 -1.4327516  1.7251967 -0.3627803 -0.08094913  0.863865617  0.52876124
  9 -1.3935545  0.8789557 -0.3132126  0.38557779 -0.074660436 -1.69866395
   year
age        1992         1993        1994       1995        1996       1997
  1 -0.38463924  0.578093669 -0.77011290 -1.9053599 -0.58037882 -0.7599113
  2  0.03909353  1.443151791  1.09328482  2.0539545  0.54030945  1.1327188
  3  0.26661709 -1.429141510 -0.10254355 -0.2443528 -0.91030967 -0.2593485
  4  0.76976324 -0.661101072 -1.78403645  0.5067692 -0.11494366  0.4851624
  5  0.69611779  0.455236802 -0.08941103 -0.6445548 -0.02044922  1.8612794
  6  0.24406932  0.685245364  0.52016313 -1.0472959  0.32373435  1.6890381
  7 -0.90412208  1.128429120  0.72841429  1.2730232  0.68957744  1.0827754
  8 -0.36194108 -0.007505752  0.89274380  0.1612683  1.81380931 -0.7432733
  9  0.09428022 -0.055622223  1.61035585  1.0807988  3.12110370 -0.4547529
   year
age        1998        1999        2000       2001       2002       2003
  1  0.01612008 -0.13448681 -0.15792767 -1.7937331 -0.6716607 -2.1647547
  2  0.07688598 -0.56501841 -0.43119599  2.0119793  0.5063049  1.1959030
  3 -0.76486570  2.18616560  0.39332770 -1.2988624  0.8527155  0.5441333
  4  0.55499823 -1.40318257  1.38081479 -0.6570912 -1.2713718  0.4286503
  5 -0.03842348 -1.25006253 -0.25000065  0.7472909  1.4060218 -0.5960918
  6  1.03470072 -1.15391859  0.03527172  0.6585792  0.5290751 -0.9532226
  7  0.06879730 -1.04039006 -0.54263089  0.9630438 -0.1306426  0.6117949
  8  0.23353415 -0.23042055  0.40514825  1.6372313 -1.7871608  2.4688726
  9 -0.43458117 -0.06354671 -1.38531183 -0.9792775 -0.8709374 -1.3478524
   year
age        2004        2005         2006        2007        2008         2009
  1  0.00000000 -0.90982267 -0.568201996 -0.55041324  0.00000000  0.976734437
  2 -0.75618621  0.27646458  0.545152938  2.12291916  0.08599671 -0.042461927
  3  0.33237571  0.75795997 -0.899861119 -1.43664071 -0.58065718 -0.306459185
  4  1.68871919 -0.93172677  1.138202581 -2.10502160 -1.26078571  1.205471226
  5  1.20803368 -1.72974399  2.238575404  0.24460131 -1.56566376 -1.046577702
  6 -0.04731515 -0.52988716  2.058961009  0.89876810  0.21679251 -0.663872144
  7  1.88669966 -2.00625762  1.136531308  0.43398285  1.21764795 -0.285456038
  8  0.72427675 -0.03913166  1.082558276  0.57693454  0.35908927  0.018002923
  9  0.16975671 -0.71713201  0.001524909  0.08917023  1.67270348  0.001275926
   year
age       2010        2011       2012       2013       2014       2015
  1  1.3092960  0.01554273 -0.1430627  0.0000000  0.0000000 -0.4151762
  2 -0.5969578  0.32215449 -0.2395992 -0.4524899 -0.3138966  0.4164945
  3 -0.3388688 -0.78207215  1.2385907  1.3286381  0.2013840  0.6248313
  4  0.1054613 -0.14209151 -1.1105250  1.6330545  1.5437756 -0.7095938
  5  0.8646664  0.22417776 -0.2152577 -0.8793781  0.8217508  0.4152537
  6 -1.5426722 -0.38659918  1.3169795 -0.3563523 -0.9955322 -0.1282641
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7	-0.9176793	-1.19693575	-0.5284426	0.7996665	-1.1353218	0.3544624
8	0.2190244	-0.19346345	-2.0580577	0.2316324	0.1587301	-0.7280533
9	0.4997740	0.42304579	-0.1722264	-0.2967277	-0.4048166	-1.4260896

age \ year	2016	2017	2018	2019
1	-1.88404846	0.000000000	0.00000000	1.4072985
2	1.10041924	-0.751567916	0.02531965	-1.2270259
3	-1.73558106	2.312874400	0.49250309	-1.3919800
4	0.25544760	-0.252463684	-0.40158801	1.3728579
5	-1.55631727	-0.697096641	1.52575911	-0.8485570
6	-0.06665280	-2.050051138	0.84763368	-0.9359209
7	0.01265813	-1.242124075	-2.78018900	-1.9734107
8	-0.02617118	-1.684404692	-1.17487547	-2.9611571
9	0.72243864	0.002070352	-0.20139867	-3.1631557

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

Units : NA

age \ year	1957	1958	1959	1960	1961	1962	1963
1	184.2950	410.0886	506.2807	170.4285	314.1660	432.1417	277.8675
2	9376.2644	4539.9760	7522.7505	9154.6550	3725.0069	6661.8858	6649.7179
3	6109.5469	13618.2471	4844.7753	7743.9368	11800.3463	4126.0460	5986.8193
4	3016.8939	4866.2701	8371.6752	3087.6144	6398.8945	9417.5724	2181.0410
5	4130.4698	2933.7434	2621.4056	4115.0045	2597.0494	5383.8562	5147.9734
6	2249.7244	3493.7370	1720.3841	1295.2239	3221.6868	2565.7623	3784.7962
7	1381.6009	2223.8985	2064.5650	1126.1791	1274.7327	3939.0126	2096.8100
8	262.6796	1157.7795	898.2497	662.7010	659.6197	1049.0919	2039.9215
9	827.0957	908.0895	715.6576	504.1310	774.3079	1371.7394	1242.0301

age \ year	1964	1965	1966	1967	1968	1969	1970
1	175.8823	813.7241	193.4867	486.0397	633.8954	574.9209	733.1722
2	6542.9598	4330.2827	27561.7183	4267.1038	9939.4847	15420.3315	11908.7376
3	8761.8994	10059.6696	7617.9125	48334.7312	5388.2584	14260.8805	21318.1282
4	4545.8368	8438.1260	10841.5966	7745.4219	43470.2865	4981.9839	12336.4415
5	1614.7932	3710.8454	7743.4059	9260.6853	5025.4443	37128.3522	3942.4760
6	4725.9428	1582.9791	3863.1436	7069.7915	6634.8957	4448.5284	30686.5804
7	4229.5934	5421.2430	1927.4786	3727.6836	4965.6025	6038.2238	3678.0769
8	1489.4030	3217.1098	4495.6014	1518.4363	1647.2347	2786.5616	3125.0418
9	2517.9621	3115.0376	5189.2211	6438.0357	3028.9254	2859.4301	3179.5545

age \ year	1971	1972	1973	1974	1975	1976	1977
1	1499.017	1076.958	1301.944	2751.959	4555.581	3800.845	3653.620
2	11920.263	42248.203	23916.731	22750.921	34726.294	46707.429	25355.185
3	11406.697	17774.826	66930.599	29451.712	23134.832	30904.210	31345.984
4	14237.969	9898.192	18026.962	63527.650	21822.687	16593.227	15975.913
5	7996.859	12770.963	9924.324	15569.011	43742.751	14210.578	8246.357
6	3028.610	8008.090	13317.917	9050.256	10309.044	27030.138	6790.521
7	23366.280	3109.820	7960.990	11354.078	5430.063	5476.607	11548.619
8	1951.204	21509.673	3316.725	9473.663	10677.483	4441.964	3107.818
9	3645.429	5277.363	23727.912	20538.614	15142.803	10099.034	3520.872

age \ year	1978	1979	1980	1981	1982	1983	1984
1	4534.748	4364.727	2627.318	2494.290	1625.710	5919.649	2367.545
2	31301.943	42515.252	47858.921	21535.172	25920.551	26457.074	64083.613

```
  3 21237.036 30165.227 48366.525 43440.317 19172.821 36563.811 24239.018
  4 21489.278 16536.938 26739.844 33279.803 28188.301 17627.543 22241.552
  5 10059.520 14264.906 14188.064 16375.300 20032.848 22941.831  9707.733
  6  5085.736  7547.834 11558.534  9427.336  9832.863 16283.402 12173.434
  7  3505.195  3459.140  5697.417  7155.743  4846.910  6731.246  7583.720
  8  8488.880  3072.666  3297.766  3642.984  4173.149  3878.584  3405.980
  9  2722.112  5777.241  4936.524  3060.360  2533.862  4189.974  2656.716
   year
age      1985      1986      1987      1988      1989       1990       1991
  1  2262.725  1979.913  5493.778  1617.443  1106.996   989.4307   923.9451
  2 26524.274 30739.971 39321.423 56929.695 20649.081 19495.3379 17757.5298
  3 75036.995 34904.845 54956.453 39945.433 76830.127 33606.0691 29782.4463
  4 16465.979 66348.463 41265.537 35591.862 30096.309 73657.1327 34917.0624
  5 14726.444 12750.388 70801.052 24053.320 23328.768 24740.5383 54754.9896
  6  6632.929 11746.929 12694.739 39757.497 16299.685 17729.4086 19606.7371
  7  7072.103  4123.128  9714.400  5450.486 21151.924 10786.9462 10925.9248
  8  4666.784  4459.464  4238.577  4260.802  2854.324 11820.5128  7649.0237
  9  2722.594  3634.427  6701.001  3098.899  3185.117  2943.1334  7502.8773
   year
age      1992      1993      1994      1995      1996      1997      1998
  1  1630.227  1499.672  3228.989  2440.676  3276.843  3901.900  2747.270
  2 15433.635 27611.054 27959.645 45879.466 42131.316 45803.891 68808.024
  3 26586.471 20609.064 40682.533 32703.209 61676.859 49644.906 63689.730
  4 27932.590 23369.773 17150.404 29470.915 27006.946 37120.768 40971.782
  5 31869.784 20829.055 17856.873 10226.127 16641.973 14489.365 21020.501
  6 37683.317 26498.425 16554.900 11725.921  7221.479  8294.526  8128.192
  7 11606.299 19831.652 17113.255  8430.464  6211.661  2802.984  3381.644
  8  6784.195  7336.425 13168.692 10220.144  5753.484  3216.235  1366.720
  9  7235.955  6545.173  7557.675  8273.644  8958.868  4316.844  3191.641
   year
age       1999       2000       2001       2002       2003       2004
  1  1770.2588  4039.2047  2204.9158  2239.0026   986.2229   709.6275
  2 25970.0058 19382.8594 56382.8169 35028.5745 33285.5607 16920.8005
  3 70992.8910 24614.2913 18679.3638 71792.9844 37789.0645 41137.8150
  4 31682.9917 43105.8883 14848.4667 11555.9154 42388.2555 25567.3986
  5 14972.6243 13167.9786 21727.7169  8141.0734  5030.9752 18514.1815
  6  6630.5928  6382.0370  6697.6998 11652.2763  3674.6327  2145.4023
  7  2366.5573  2491.0641  2851.2653  2934.2268  3662.3174  1593.9159
  8   889.3917   778.7635   900.7033   953.1003   685.1154   651.9796
  9  1096.4251   689.0838   613.6775   682.9421   526.9850   434.6338
   year
age       2005       2006       2007       2008       2009       2010
  1   763.1957   964.2935   558.8803   694.8931   584.8458   989.4075
  2 15350.7635 21811.9802 18520.3761 11757.7011 11649.4671 12536.2020
  3 24836.2624 25162.7579 27733.8751 24709.0062 13424.3710 16345.7177
  4 33748.7191 21193.9273 14598.4218 18727.2278 13136.6162  9068.5398
  5 16321.8385 24726.6914 10002.5002  7676.6258  8089.7815  7070.6361
  6  9087.0360 11895.5784 10052.6993  5022.3622  3278.4256  3844.0811
  7   769.8549  4317.7432  3752.3943  3990.9277  1568.9298  1338.6236
  8   378.7280   201.2017   518.4225   606.3055   481.2873   299.9599
  9   418.5362   481.0258   200.9485   393.4115   399.8906   644.9625
   year
age       2011       2012       2013       2014       2015       2016
  1   297.5865  168.52934    71.0223   88.42882   63.32991   37.47301
  2 15857.9873 4143.62089  3782.4004 1839.27811 1298.88145 3097.42672
```

3	12750.2914	15461.83143	6135.8224	6041.67382	1647.20272	2885.82674
4	8158.3488	5446.07622	11070.6655	5400.95264	2363.45560	1765.50255
5	3635.4709	2622.01624	3048.1096	7206.11439	1715.92294	1878.20870
6	2753.9539	1236.76180	1442.1495	1752.89585	1526.36655	1390.39874
7	1021.8895	669.50934	645.1744	578.70420	253.47214	659.66408
8	181.5010	79.53506	132.4734	140.39475	33.16150	51.81054
9	414.4427	160.05979	161.6350	109.55891	15.10735	18.62400

age \ year	2017	2018	2019
1	47.02509	48.47454	130.2557
2	1247.42726	1175.76814	1825.0202
3	6788.94562	1905.75674	2352.1785
4	2742.11052	4441.23117	1876.7499
5	1531.57336	1692.64623	3568.0359
6	1429.74791	878.79643	1450.3490
7	866.78735	593.32179	580.8844
8	196.66721	182.07359	197.2603
9	54.65514	84.45031	182.8558

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

Units : NA

age \ year	1957	1958	1959	1960	1961	1962
1	0.0000000000	-0.08515360890	1.205695220	0.10940606	0.3523910	-0.8009565
2	0.0176355987	5.16229674448	1.876701505	2.05274646	-0.2923889	-0.4814406
3	-0.3653573283	-0.00002616155	-0.009514356	-0.02009563	0.5298422	0.1610676
4	0.0110348638	0.76974964907	0.160261436	0.90398081	0.7618430	0.4970246
5	0.0052478881	0.44299368151	-1.557566897	-2.93854818	0.3900659	0.5355414
6	1.1878666958	0.61468478909	-0.023483747	-1.23891963	0.2165232	1.5062561
7	2.7642791979	1.92222827905	-0.144776093	0.08974163	-0.4550517	0.8688716
8	0.0000151865	0.01054187585	-0.630216939	-0.06221864	0.5491187	1.2380725
9	-5.3520041042	0.24299380431	-0.542299244	-1.36910939	-0.4224173	0.6356603

age \ year	1963	1964	1965	1966	1967	1968
1	-1.0360411	-0.93420483	0.04731996	0.00000000	0.0000000	0.22972079
2	-0.5835777	0.21666249	0.30175335	0.05711769	-2.0783943	0.11818792
3	-0.8797072	-0.46607666	0.58551162	2.11301955	1.5717207	-0.61145341
4	-0.4796221	0.13628813	0.44338718	0.33704646	1.5969751	1.49443053
5	-1.0680630	1.15093425	-0.91672320	0.10063371	0.1608330	-0.17672032
6	0.5503309	0.02292908	1.10512426	-0.35158963	-0.4159321	-1.24729469
7	0.6389502	0.33734391	0.43615555	2.07816197	-0.4369440	-1.91885294
8	-0.2277244	0.50199577	-0.30060762	-0.89438209	1.3964391	-1.63712311
9	1.5575025	0.67870327	0.52914684	0.18609493	-0.1785971	-0.07519291

age \ year	1969	1970	1971	1972	1973	1974
1	1.04019513	-0.93520070	0.30980208	0.022773483	1.6323240	0.7542648
2	0.52799267	1.84298766	-2.23346755	0.964206741	0.7031316	0.4327145
3	-0.47281031	-0.32334248	-2.56589931	0.355429263	-0.4691261	0.6569663
4	-0.40664219	-0.42494961	-0.12228670	-0.919337011	0.1093625	-0.8004945
5	1.16388687	0.02916102	0.93238409	0.001149381	-0.4714843	0.3759125
6	0.47750381	0.93727054	1.34028630	0.855052653	-0.1462350	-0.4044232
7	-1.02089563	-0.21791730	1.15996572	0.671278298	0.3557636	-0.2365391
8	-0.82335774	-1.02115135	0.24967940	1.622009501	-0.3134155	0.3954253
9	0.02187337	-0.55972277	-0.09848908	-0.129992332	1.5789814	0.8956188

```
   year
age      1975      1976        1977        1978       1979        1980
  1  0.7015174  0.8764790  0.12287259  0.84467430  0.1207658 -0.69262358
  2 -0.3129001 -1.6047644 -0.09741132 -0.09228866 -0.2447029 -0.67863361
  3 -0.2668195 -0.1044923 -3.19562082  0.01046039 -1.2276329  1.12575464
  4  0.5325000  0.9435838 -0.31029757 -2.14536382  0.7664517 -0.16797863
  5 -1.7154499  1.0859277  0.54729991 -0.08800496 -1.2309013  1.23925628
  6 -0.3042665 -2.1993770  0.09695843 -0.11968974  0.3951990 -0.90987601
  7 -0.3665658 -0.7502357 -1.81848578 -0.12566307  0.4312896 -0.05181516
  8 -0.1722669 -0.6333160 -1.73562001 -1.30363297  0.7630806  0.63356851
  9  1.1806868  0.2720190  0.01340043  0.21197807 -0.8736560 -0.40935855
   year
age      1981        1982       1983       1984       1985        1986
  1 -0.4135949 -0.64802281  0.1679160  0.2101728  0.9047697 -0.37753750
  2 -0.8351560 -0.49329432  1.6148608  0.6131774 -1.2668815 -0.22850023
  3 -0.4950135 -0.18965216  0.8909815 -0.4372249  0.1700262  0.09849959
  4 -0.3803710 -0.07768042  0.6684658 -1.2474034 -0.5140175  0.60475421
  5 -0.9820765 -0.46358946  0.1424927 -1.2462621 -0.3983343  0.47655323
  6  0.5846104 -0.53275795 -0.2022382 -0.1997021  0.3042568 -1.10439554
  7 -1.2575699 -0.25699987 -0.3700954 -0.5403286  0.3358458  0.42602655
  8 -0.2314272 -0.43921094 -0.3907094 -0.8844804  0.5185528  0.18277097
  9  0.3592862 -0.10685687 -0.3470458  0.3281008 -0.8887103 -1.60361517
   year
age        1987        1988        1989        1990        1991        1992
  1  1.411388897  0.00000000  0.23571226 -0.10443262 -0.36736308  0.51646569
  2  0.688890908 -0.99792360 -1.59716276  1.01808849  1.33993292 -0.01065358
  3  1.458281202  0.11193335  0.47829381 -0.38019213 -0.08938402  1.24286242
  4  0.428616841  0.01257401 -0.13294301  1.80579747 -1.78230480  0.19756199
  5  1.025321686 -0.46579946 -0.34263323 -0.19886761  1.33824090 -1.26635880
  6  0.305220312 -0.11103551  0.02418483 -0.01305428 -0.29615332  1.36537255
  7  0.079446790 -0.20526538 -0.09031681  0.35756341  0.21340778 -0.33708988
  8  0.374984482 -1.29168122  0.52061033 -0.94412954  1.04026719  0.29705888
  9 -0.003025288 -1.38901680 -0.75978945 -1.91128532 -0.38925200 -0.21918095
   year
age       1993        1994        1995        1996        1997        1998
  1 -1.84016777  1.82444984 -1.25111027  0.94091592  1.11989755  0.53764173
  2 -0.09481056  1.46000890  0.26719658  0.01825497  0.88871567  0.64758550
  3  0.50867868 -1.11875813  0.24928751  0.55365915 -1.29214529  1.02999964
  4  2.12218570 -0.07798071 -1.04155175  0.47583737 -0.33998873 -0.14417067
  5  0.62884531  0.74554650  1.52294544 -1.71408624 -0.25158008  0.64785235
  6 -0.80728955 -0.11860586  1.08561357  2.00338272 -1.25382301 -0.02074245
  7  1.76125643 -0.82535173 -0.68174456  0.37395769  1.57106371  0.53009709
  8  0.16894881  1.31173008 -0.01777539  1.26903334  0.71226429  1.33223742
  9  0.08427876  0.31076642  0.95406525 -0.51911606  0.08056047  0.24430741
   year
age       1999       2000        2001       2002       2003        2004
  1 -0.45299697  0.3724039 -0.01836632  0.5982263  0.1899438  0.27394774
  2  0.30037566  0.4040205 -0.99919495  0.2945073  0.3116245  0.37792536
  3 -0.34060260  0.6037636  0.16547829 -1.2539910 -0.7628464 -0.04604046
  4 -0.26788455 -1.1061176  0.59127044  1.1088524 -1.4646344 -0.62112370
  5 -1.29207352 -0.3047355 -0.14557271  0.7067992  1.4735540 -2.08717930
  6 -0.78561410 -2.0338747  1.15170485 -0.3222620  1.0333394  1.85797920
  7 -0.33929187 -0.6854198 -0.88782487 -0.1977563 -1.0089110  0.15623767
  8  0.05568918 -0.3370283 -0.38963739  0.1912542 -0.5646110 -0.38738570
  9  0.08520665  1.2916629 -0.57610332 -0.6549397 -1.3835393 -0.96780074
```

year

age	2005	2006	2007	2008	2009	2010
1	-1.13212461	0.10017627	-1.96430019	-0.23100049	-0.8699317	0.306439254
2	0.81834622	1.15550261	0.00790073	-0.24478168	0.1730668	-0.342865256
3	0.40813878	1.23055284	0.96938963	-0.97013803	-0.5541320	0.289150285
4	-0.05711068	1.01551309	0.95430756	1.05501158	-0.9684546	-1.095849971
5	-0.31188732	0.06891095	0.67231877	1.25256463	0.9630540	0.009542082
6	-1.38712899	-0.29847337	-1.67935864	0.76701935	1.3083624	1.404574405
7	0.77722329	-0.92927537	-1.03848014	-0.33883602	0.4928059	1.445228460
8	0.87719224	1.28978077	-1.91459455	-0.04926314	0.1655225	1.573214060
9	-1.63959285	-1.27483314	-0.85262051	-0.64025774	-4.6032952	-1.403103645

year

age	2011	2012	2013	2014	2015	2016
1	-1.4578144	1.9485437	-0.95793743	-0.7597163	-0.7490450	0.6309935
2	-0.5598460	0.0587202	-0.55051836	-2.0210903	-0.2609784	0.1520280
3	-1.0702930	-1.1428407	-0.07031460	1.8010348	-1.9709028	1.3870802
4	-0.1506917	-1.8601337	0.38949639	1.1185456	-0.6557979	-0.3745685
5	-0.5748640	-1.8856349	-0.94262200	1.3918420	-0.2609456	1.2030116
6	0.5648173	-2.3063704	0.97968897	0.5896923	-2.8437588	1.2429940
7	1.3654229	-0.3283035	0.07502605	0.7266797	-1.5183747	-0.0866015
8	2.3455981	0.4949629	2.56258306	1.6439995	-0.1137952	-0.1943473
9	-2.2362705	-2.5139494	0.56781266	-0.3427825	-0.9813287	-0.9846470

year

age	2017	2018	2019
1	0.03126845	-1.00491952	2.49301826
2	0.30734744	1.13276381	0.17920577
3	-0.13166589	-0.09862757	0.71922264
4	1.01596591	-1.05222646	-0.80097257
5	-0.90450021	0.15354717	-1.77880737
6	1.04262273	-1.66084055	-0.46421582
7	0.38972737	0.07373696	-0.47477384
8	1.19600244	0.26922207	1.43431518
9	0.59574716	-1.94309973	-0.08297567

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	189299.7	285044.5	237033.9	386546.5	302598.2	332547.4	381150.25	193665.93
2	480484.6	360963.5	580435.1	473105.9	781693.7	620262.3	652723.29	758201.25
3	741881.7	573965.0	398219.8	650457.1	518587.7	860995.0	690499.33	700475.96
4	885599.0	628692.0	467236.8	284592.0	481654.3	390622.4	542238.67	486277.31
5	1264019.7	695644.1	418973.0	302623.8	170710.9	251928.2	226689.08	273827.47
6	420181.2	775624.1	534697.9	292077.7	207649.1	117711.8	144233.90	122281.34
7	250767.1	260614.7	441453.9	347385.9	178140.8	122723.4	57974.22	61963.97
8	167383.6	143084.3	153550.5	233991.5	201370.4	104525.6	67093.06	23658.21
9	164185.5	152612.3	136989.7	134290.6	163017.9	162759.0	90052.57	55248.01

age	1999	2000	2001	2002	2003	2004	2005
1	171008.52	497015.27	337502.36	364620.62	207158.78	175329.26	178366.35
2	358393.65	315546.32	1063356.86	677163.89	760832.53	423149.40	352737.46
3	986152.25	394887.01	331972.78	1296758.98	797668.10	935698.56	512688.12
4	496172.73	800304.60	296063.52	228643.61	1007928.41	678337.95	844882.12
5	269216.03	285430.30	499476.27	183277.99	135859.17	578410.48	514090.99
6	142294.12	169830.40	188122.05	323503.52	123090.60	83208.06	378847.01
7	63674.94	85127.79	107432.63	113434.54	177406.95	92009.34	49705.71
8	28051.62	36389.82	52138.71	61267.19	68636.42	92672.23	69705.85
9	34581.51	32199.30	35523.75	43900.88	52794.56	61778.75	77032.64

age	2006	2007	2008	2009	2010	2011	2012
1	159963.90	102295.26	124360.21	137002.1	220624.12	98660.33	100044.53
2	374355.25	334556.61	209011.31	255024.1	268054.62	465729.18	194418.62
3	379604.35	430682.90	374308.95	246307.1	292173.86	308819.61	595254.04
4	385848.04	270309.57	325661.79	273331.1	181346.33	218954.43	239489.19
5	586527.83	244336.09	168072.32	201504.9	160018.25	106901.50	126035.16
6	400355.75	367789.62	161636.25	114632.3	112618.89	98300.05	70054.87
7	240034.84	244818.95	238723.19	102159.0	68851.04	58870.98	57200.10
8	32698.78	128875.83	144133.76	142930.8	57380.60	37643.31	28205.73
9	78175.08	49954.25	93523.61	118757.9	123377.62	85955.46	56762.43

age	2013	2014	2015	2016	2017	2018	2019
1	50024.57	63918.43	103064.574	42475.553	47504.723	63054.24	132349.18
2	198898.55	97328.15	127214.084	233638.803	86391.324	99466.15	131988.22
3	246636.77	230439.70	113987.177	157222.221	346600.440	121636.30	134205.88
4	472325.65	208267.76	169699.005	101868.980	149766.538	320563.32	127242.68
5	129602.49	257194.36	113322.568	99277.456	76596.526	114550.00	234678.74
6	65118.86	63079.04	98552.016	71609.100	66649.913	55889.59	89638.20
7	40009.73	26936.88	20032.856	42132.167	47795.098	43588.89	40673.25
8	22981.34	13709.45	7603.876	8295.811	22584.099	32423.98	30811.85
9	28040.26	10698.35	3464.090	2982.042	6276.273	15039.06	28561.88

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

Units : NA

age	1991	1992	1993	1994	1995	1996
1	-0.31789629	-0.51856379	-2.3887969	0.35621968	0.72072306	-0.97148663
2	-1.35507211	0.59213294	1.0989824	-0.04352356	0.58966986	0.66401906
3	-1.06396056	-1.65163721	0.9812206	-0.48031493	-0.62626734	-0.38324502
4	0.09138311	0.44163117	0.5872829	0.23894442	-0.06203747	-0.44996976
5	-1.68913388	1.98051221	0.4975203	0.46066207	-0.08792389	-2.77256254
6	-0.11539009	-3.04862443	1.9002732	0.19891634	0.84871240	0.82246659
7	-0.23645749	1.14234980	-3.0191905	0.71377396	0.15994484	0.67513480
8	0.53217142	-0.01372692	1.5245734	-1.41582757	1.13322911	0.71971113
9	-1.51942514	0.09255816	0.5830900	0.65978510	0.22977149	-0.08579458

age	1997	1998	1999	2000	2001	2002
1	0.584453075	0.57977455	0.4618739	0.52598799	0.42341233	0.3662734
2	-0.112704071	-0.25639401	-0.6638800	-0.16716148	0.89621025	-0.2345921
3	-1.436989863	-0.19849407	1.3456264	-0.04425266	-1.01743339	0.5106388
4	-2.317070455	-0.12339231	-1.1368138	1.30100691	-0.29477675	-1.3174552
5	-0.527065137	-1.29159376	1.0638225	0.67606338	0.96181390	-0.0946855
6	0.008734436	0.01716245	-0.3544561	0.80170734	-0.72539070	1.2695030
7	-0.062356632	-0.51976284	1.2751385	1.09325274	0.84181223	0.2430176
8	2.091120622	1.14393265	-0.3829840	0.43446294	-0.08427963	-0.4176122
9	-1.616550569	1.16216337	1.0533572	0.16596796	0.19440726	0.4695344

age	2003	2004	2005	2006	2007	2008
1	0.59290235	0.76570753	-0.6783187	0.09327829	0.0000000	-0.4657875
2	0.73310713	-0.27412963	-0.8541867	1.55046429	-1.9061779	0.2258437
3	0.14573277	0.02733675	-1.4737669	-0.75352027	-0.4732398	1.2225766
4	0.75775751	-0.91770074	0.9764640	-0.91238712	0.1449243	0.1359520
5	-0.17511830	0.56583764	0.3576153	1.21475830	-0.4673486	0.4917576
6	-0.04913032	-1.18923556	-1.3050080	0.71364857	1.2570493	0.1834716
7	0.88146605	0.85491754	-1.1304443	-0.42308324	0.6622199	1.1688701
8	-0.05667747	-0.35778717	1.9800728	-0.75520713	0.5432993	0.3037819
9	0.15131628	1.07261109	-1.6712548	0.32030525	-1.3131906	0.8930639

age	2009	2010	2011	2012	2013	2014
1	1.09153113	-0.443652324	-0.61130576	0.594501387	0.0000000	2.034343467
2	-0.17467621	0.076296959	-0.62482794	0.357102908	0.4937117	1.230406967
3	0.04560381	-0.004202706	1.97335587	0.230279322	1.2593532	-0.507232668
4	0.42010532	0.006436707	-0.54586512	1.305651696	-1.1829367	2.164257518
5	0.94044056	-0.928405239	-0.28565158	-0.217131062	-0.1449073	-0.884666451
6	0.62174749	0.109648743	0.34767835	-0.374675546	-1.6626767	-0.007792834
7	0.13790905	0.862679835	0.44450031	-0.001276356	0.9450319	-2.024333546
8	1.80330447	0.418931283	-0.04871148	-0.475558094	-1.6565902	-0.840817760
9	1.29363104	1.152590980	0.83052928	0.221695792	-0.4024217	-1.820432760

age	2015	2016	2017	2018	2019
1	0.00000000	0.00000000	0.00000000	2.1893343	-1.2415658
2	1.50064412	-2.14573082	-1.05893253	1.6048300	0.7364493
3	2.21754478	0.12799053	0.78940476	-0.7001441	0.8388555

4	1.46367745	0.61178503	-0.02610948	0.4890236	-1.0214429
5	0.33482523	0.25240384	0.93652088	0.2652293	-1.0326681
6	0.55312675	-0.04642609	-0.02223953	-1.2890020	0.7473329
7	-0.69255525	-0.27719242	-1.34736735	1.2423347	-2.4698329
8	0.03018824	-1.47207141	-2.15743499	-1.6501774	0.1641111
9	-4.37472586	-1.90547860	0.91426877	-0.4849192	0.6475178

TABLE 4.6.24 Herring in 6a and 7bc. PREDICTED INDEX AT AGE IBTS_Q1

Units : NA

age \ year	1994	1995	1996	1997	1998	1999	2000
2	57966.99	95973.44	75488.47	81032.34	94910.792	44293.864	38588.79
3	133070.79	106632.11	175841.95	145229.21	149902.263	206527.912	81602.29
4	54500.29	92993.58	75469.59	109131.53	99902.718	98036.258	155599.54
5	59852.50	34055.57	50478.38	48527.69	59743.448	55217.766	57561.88
6	71198.16	50909.78	29081.38	38885.02	33438.593	35668.503	41627.51
7	88387.31	45808.12	31891.23	17353.78	18468.609	16634.958	21589.15
8	78596.70	67829.11	35666.00	25505.16	8827.464	9005.254	11255.75
9	45107.62	54910.57	55536.26	34233.12	20614.397	11101.505	9959.58

age \ year	2001	2002	2003	2004	2005	2006	2007
2	128671.67	82101.74	91246.62	50433.96	41904.15	44962.59	40405.11
3	67716.88	266977.79	161245.90	187062.50	101641.81	77124.20	88093.13
4	56876.24	44586.33	192522.73	128134.31	156579.97	73897.66	51978.29
5	100093.15	37735.36	27236.15	115026.41	97890.20	117086.12	48972.17
6	46006.56	81183.83	29976.54	20247.73	87380.25	98284.81	91258.74
7	27310.49	29653.61	45286.36	23548.52	11713.80	61776.99	64236.78
8	16146.77	19377.73	21478.33	29529.45	20241.45	10552.20	43197.76
9	11001.31	13885.07	16520.95	19685.43	22369.03	25227.82	16744.12

age \ year	2008	2009	2010	2011	2012	2013	2014
2	25067.03	30742.98	32595.91	56146.08	23327.028	23996.550	11730.109
3	75572.69	50082.65	60254.96	62539.08	119387.361	50234.526	47042.837
4	61751.54	52426.71	35448.63	41865.28	45273.365	92505.573	41256.070
5	32740.85	40106.56	32810.15	21404.45	25037.850	27325.082	55746.287
6	38384.66	27973.86	28316.51	24165.36	17216.530	17504.135	17762.776
7	58531.54	25916.23	17850.93	14884.58	14517.679	11387.905	8169.847
8	44575.40	46473.80	19163.82	12267.13	9440.134	9535.344	6354.744
9	28923.50	38614.02	41205.34	28011.00	18997.733	11634.372	4959.009

age \ year	2015	2016	2017	2018	2019
2	15377.578	27417.5183	10121.209	11652.294	15387.238
3	23481.923	30432.3132	66925.636	23468.794	25575.135
4	34194.934	18572.4468	27163.603	58182.034	22594.830
5	25394.503	18895.4206	14407.433	21609.609	42762.858
6	30458.981	17085.4371	15496.151	12978.896	19877.801
7	7008.353	10509.7682	11366.750	10206.538	9138.975
8	4136.910	2692.2935	6763.038	9460.681	8521.279
9	1884.648	967.7816	1879.494	4388.102	7899.032

TABLE 4.6.25 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS IBTS_Q1

Units : NA

age	1994	1995	1996	1997	1998	1999
2	-0.1829313	1.3670993	0.5467289	0.3674468	-2.3751155	0.3135545
3	-1.0438316	-1.6765102	-1.0975534	0.3211505	0.4061874	1.1296883
4	-0.7779780	-0.4326752	-1.0438023	-1.4980082	-0.5249343	1.2316291
5	-0.4313325	-2.7157826	1.2779566	-0.6979957	-0.9439962	-0.3333163
6	0.6150367	1.2313403	0.0447305	-0.4508570	-1.4344771	-0.6743566
7	-1.6924980	-1.8362119	-2.1551100	0.4637272	1.2426839	1.1333942
8	-2.4829406	0.2041542	0.5089139	1.6533422	-0.4975443	0.9012445
9	-1.3441432	-1.0892881	0.7547257	-0.6105879	0.6186270	1.5225571

age	2000	2001	2002	2003	2004	2005
2	0.6749014	0.22562768	-0.3611687	0.40406463	1.0776721	0.8032212
3	0.5123974	0.16806507	-0.6737929	-1.00667258	0.4307706	-0.4634357
4	-0.5164044	0.02949048	0.5313389	-0.68840913	-0.0708595	1.3769058
5	0.1157768	-0.13099129	-2.0825981	0.08081449	-0.2217524	1.3413230
6	0.8392316	0.52026343	0.2653108	-0.35161134	1.4933175	0.2042288
7	0.2272111	0.56312443	-0.4411188	-0.40027806	0.3388006	0.5961194
8	-1.4964488	-0.74767479	0.8675265	-0.21299195	-0.7306063	0.8473689
9	1.8897196	1.20376143	0.7525260	1.29600105	0.9252764	-0.1191697

age	2006	2007	2008	2009	2010	2011
2	1.8128233	-0.6269243	-0.12977642	0.35355775	-1.084362179	0.450995801
3	0.5365593	0.2665350	-2.59264946	0.61939801	-0.004533023	-0.124583116
4	-1.1118603	0.1421153	0.30955849	-0.65121471	-0.762989366	0.533799271
5	1.7399315	0.1965468	0.80196116	0.82374150	-0.372603839	-0.067326052
6	1.1161439	-0.1904948	-0.63334321	0.46045600	0.092492451	0.078169546
7	0.2469107	0.4686867	-0.69287692	0.51657058	1.369756022	-0.029756290
8	0.4903037	-0.6582938	0.88778410	-0.02726446	-0.618236981	0.004149665
9	0.9529176	2.1242689	-0.07908953	1.38749151	-0.086350828	0.862863388

age	2012	2013	2014	2015	2016	2017
2	-1.59217500	0.93745890	-0.1017717	-0.75258235	-0.04605137	0.01303056
3	1.97748569	-0.84371521	-0.2542730	-1.02406150	-0.65829849	0.24104341
4	-0.20833977	-0.09066976	-1.3075953	0.83674613	-1.63855469	-0.22375449
5	-0.27632934	0.53398105	-0.2478679	-1.35393143	1.01127225	-0.47855960
6	-0.49806297	0.57560751	-1.6874104	-0.77016861	0.81056570	-0.67898569
7	-0.31457694	0.22928912	0.3350899	0.08094631	-2.36392855	0.29626558
8	-0.03305704	-0.32898698	-0.1719776	1.04008457	-0.01994092	-0.72922680
9	0.81859880	0.24352928	-0.7386997	-0.86443969	0.47950128	1.68034417

age	2018	2019
2	-0.5606058	-0.9414582
3	1.7283664	0.3932879
4	2.5945174	1.6886344
5	-1.1136356	1.8961459

6	0.8592042	-3.4218439
7	-1.1937230	1.1396233
8	-0.1702131	-1.1743939
9	-0.7796666	-0.1261550

TABLE 4.6.26 Herring in 6a and 7bc. PREDICTED INDEX AT AGE IBTS_Q4

Units : NA

age \ year	1996	1997	1998	1999	2000	2001	2002
2	14691.411	15220.930	17565.7451	8386.899	7445.724	25300.698	16087.025
3	14353.724	11248.499	11256.7399	16118.829	6522.644	5539.631	21482.159
4	7260.513	9760.188	8612.5646	9061.309	14801.783	5527.577	4218.951
5	6918.381	5909.958	7033.0764	7258.622	7798.711	13714.965	4926.734
6	3733.136	4270.975	3580.7159	4461.580	5419.565	6013.989	10134.299
7	3854.718	1629.467	1747.4895	1991.680	2725.521	3433.253	3546.314
8	3637.419	2144.784	767.4484	1024.106	1367.890	1958.007	2263.044
9	5663.899	2878.737	1792.1892	1262.499	1210.368	1334.052	1621.580

age \ year	2003	2004	2005	2006	2007	2008	2009
2	18230.060	10188.562	8515.095	8959.429	7972.249	5008.003	6085.868
3	13405.619	15862.964	8748.933	6354.373	7171.352	6296.695	4120.431
4	18903.357	12833.725	16225.864	7221.252	5042.961	6142.820	5109.463
5	3729.387	15978.313	14694.508	16154.099	6708.273	4718.859	5562.767
6	3948.030	2670.500	12681.423	12760.405	11624.555	5287.962	3670.828
7	5650.972	2924.777	1685.883	7596.842	7631.582	7848.710	3270.032
8	2556.565	3403.112	2753.508	1188.864	4548.047	5418.610	5166.024
9	1966.488	2268.641	3042.930	2842.294	1762.893	3515.957	4292.331

age \ year	2010	2011	2012	2013	2014	2015	2016
2	6353.288	11113.686	4656.7678	4743.4690	2323.0540	3029.30593	5694.6196
3	4833.727	5182.705	10065.7613	4120.4711	3842.9714	1887.42187	2733.9193
4	3339.879	4103.090	4528.2178	8685.7413	3795.8270	3051.66101	1981.7205
5	4315.510	2937.337	3484.5350	3419.4907	6640.1199	2850.11611	2838.6875
6	3522.634	3129.690	2230.9500	1932.7389	1805.0383	2621.22926	2334.0798
7	2166.490	1889.398	1830.2515	1169.9529	749.3307	498.13807	1366.5867
8	2030.740	1358.170	996.5538	685.8290	375.0199	183.40556	300.2845
9	4366.420	3101.272	2005.5078	836.8015	292.6518	83.55388	107.9414

age \ year	2017	2018	2019
2	2108.4160	2427.6273	3233.704
3	6038.5389	2120.4587	2362.470
4	2925.4097	6258.1801	2527.146
5	2210.5761	3298.3006	6943.858
6	2217.0398	1860.8503	3094.658
7	1609.5028	1485.8945	1432.176
8	870.7981	1275.9869	1264.680
9	242.0007	591.8348	1172.329

TABLE 4.6.27 Herring in 6a and 7bc. INDEX AT AGE RESIDUALS IBTS_Q4

Units : NA

age	1996	1997	1998	1999	2000	2001
2	0.53703931	-0.01871330	-0.28957285	-0.7871583	-0.62744758	1.5189712
3	-0.56443768	-0.38875024	0.04879698	1.2315611	0.03362382	-1.6188243
4	-0.79719997	-0.94092738	0.02411076	1.0567989	0.66018766	0.7055256
5	-0.57733096	0.25810781	1.70266908	0.5368667	-0.82832846	-0.7079804
6	-0.41771990	-0.03010505	0.75075965	1.2449427	1.23746698	1.0858928
7	-0.06555809	-0.57542090	-0.55847817	0.5562037	0.27546492	0.2405192
8	1.54135920	1.66364717	0.75500444	-0.5000621	0.74996827	-0.1053495
9	-0.16515903	-0.42513140	1.82884711	1.6971225	-0.25764801	-0.4294703

age	2002	2003	2004	2005	2006	2007
2	-0.1663632	-0.1277635	1.34955578	-1.47109069	-0.5183951	-0.5511455
3	-1.6291962	-0.1859696	-1.29769647	0.05468044	-2.1328263	-0.8045835
4	-2.2714538	0.1394682	-0.40615558	0.70462882	1.2302088	-0.4039749
5	0.6564804	-1.0263687	-2.39308054	1.14602822	-0.4723353	1.2230023
6	-0.6821673	0.8769626	0.49625332	-0.84813296	0.7816596	-1.9419365
7	1.2285021	-1.1785554	0.83414318	0.07542936	-0.3323446	1.1460417
8	0.1091658	0.5015769	-2.20876759	0.58747244	0.7436146	-1.6751811
9	-1.1841263	0.6460912	-0.08308126	-0.05790931	-0.7454526	-0.5311810

age	2008	2009	2010	2011	2012	2013	2014
2	-1.4845186	0.3275879	0	-0.2369361	-2.06981582	0	0.8133270
3	0.5488510	-1.0550507	0	-0.6329160	1.28139689	0	0.6589181
4	-0.0919621	-2.0114113	0	-0.1165497	0.60964570	0	-1.5821433
5	-1.0201665	0.2948684	0	-0.7882604	0.68687644	0	-0.6598157
6	0.1591594	-1.3435981	0	-0.7775760	0.20111043	0	-0.4521064
7	0.5476805	0.4294156	0	-1.7210506	-0.09573438	0	-0.8119929
8	-0.2788177	-1.0276160	0	-0.7229742	-1.64395208	0	0.3901004
9	1.0625184	0.8691068	0	0.8980930	2.20161716	0	-2.8947472

age	2015	2016	2017	2018	2019
2	1.7102126	2.6331228	2.5321666	0.9732747	-0.99978904
3	0.6290165	-0.1972227	0.6070622	0.6205781	0.82512142
4	-0.3955789	2.0477797	0.4149535	-0.7310537	0.92280931
5	1.2993983	-0.6306314	2.0505484	-0.3311534	-1.50422282
6	-1.6120910	0.9773852	-1.0340517	0.1483890	0.31727254
7	-0.7425485	-0.4794324	0.4152114	-0.4476619	0.93178627
8	2.4624083	0.9832754	-0.4470517	-0.2421891	-1.75539933
9	1.6437110	1.0738173	-0.3249602	-2.7401721	-0.08946237

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

name	value	std.dev

1	logFpar	-1.25906190	0.34770416
2	logFpar	0.06040514	0.14261439
3	logFpar	0.76040213	0.11692583
4	logFpar	1.09943650	0.11658790
5	logFpar	1.23068250	0.11757306
6	logFpar	1.43039282	0.12086034
7	logFpar	1.59434871	0.15330833
8	logFpar	1.76434140	0.16326693
9	logFpar	-2.25997151	0.20613453
10	logFpar	-1.07006221	0.14107729
11	logFpar	-0.80242201	0.14029490
12	logFpar	-0.64369728	0.14042129
13	logFpar	-0.25198384	0.14870181
14	logFpar	-0.06772748	0.15294688
15	logFpar	0.32329662	0.16833187
16	logFpar	-3.51416319	0.12413633
17	logFpar	-3.14356475	0.17239707
18	logFpar	-2.68326045	0.17245981
19	logFpar	-2.15466639	0.17384398
20	logFpar	-1.79726945	0.17731853
21	logFpar	-1.61919896	0.18972168
22	logFpar	-1.30639400	0.20073339
23	logSdLogFsta	-0.87593122	0.24264385
24	logSdLogFsta	-1.21163168	0.17713719
25	logSdLogFsta	-1.30393983	0.14464550
26	logSdLogFsta	-0.77646159	0.18655921
27	logSdLogFsta	0.06214891	0.17076928
28	logSdLogFsta	0.24661454	0.08984386
29	logSdLogN	-0.52272168	0.12728535
30	logSdLogN	-2.10054077	0.12948604
31	logSdLogObs	0.17920610	0.10593187
32	logSdLogObs	-0.58903127	0.11433054
33	logSdLogObs	-0.90854682	0.06118920
34	logSdLogObs	-0.41646711	0.06747122
35	logSdLogObs	0.35761583	0.11085405
36	logSdLogObs	-0.96301619	0.14516596
37	logSdLogObs	-1.33198579	0.07722850
38	logSdLogObs	-0.80441949	0.09840191
39	logSdLogObs	0.50966789	0.14630509
40	logSdLogObs	-0.34341182	0.13553671
41	logSdLogObs	-0.56674495	0.10425378
42	logSdLogObs	-0.31459947	0.11004938
43	logSdLogObs	0.01112219	0.13881439
44	logSdLogObs	-0.40075367	0.12043951
45	logSdLogObs	-0.34656904	0.11823900
46	logSdLogObs	-0.29067441	0.11707574
47	logSdLogObs	-0.70042105	0.16241588
48	logSdLogObs	-0.27725125	0.13343657
49	logSdLogObs	-0.24075096	0.13314416
50	transfIRARdist	0.52715193	0.39938159

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51 transfIRARdist -1.37668651 0.24006773
52 transfIRARdist -1.36077587 0.24386848
53 transfIRARdist -1.83143472 0.54554807
54 transfIRARdist -3.05772748 0.50954683
55 transfIRARdist -2.01959224 0.44579574
56 transfIRARdist -1.19537427 0.31799135
57     itrans_rho  2.79857126 0.18724958
58     itrans_rho  1.71304289 0.20841593
```

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

```
1598.27716333424
```

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
$F_{ages\ (wr)\ 3\text{–}6}$ (2020)	F corresponding to the assumed total catch for 2020
$R_{age\ (wr)\ 1}$ (2020-2022)	Geometric mean 2015 - 2019
SSB (2020)	Tonnes; Calculated in the short-term forecast based on the assumptions for the intermediate year
Total catch (2020)	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 (2021)	% SSB change 2021 relative to 2020	% SSB change 2022 relative to 2021	% TAC change 2021 relative to 2020
Precautionary approach: zero catch	0	+15%	+6%	-100%
Other scenarios				
TAC=Monitoring TAC	4840	+9%	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
$F_{ages\ (wr)\ 3\text{–}6}$ (2020)	F corresponding to the assumed total catch for 2020
$R_{age\ (wr)\ 1}$ (2020-2022)	Geometric mean 2015 - 2019

SSB (2020)	Tonnes; Calculated in the short-term forecast based on the assumptions for the intermediate year
Total catch (2020)	Tonnes; Monitoring TAC 3100 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 (2021)	% SSB change 2021 relative to 2020	% SSB change 2022 relative to 2021	% TAC change 2021 relative to 2020
Precautionary approach: zero catch	0	+15%	+5%	-100%
Other scenarios				
TAC=Partial uptake of the Monitoring TAC	3100	+12%	+2%	-26%

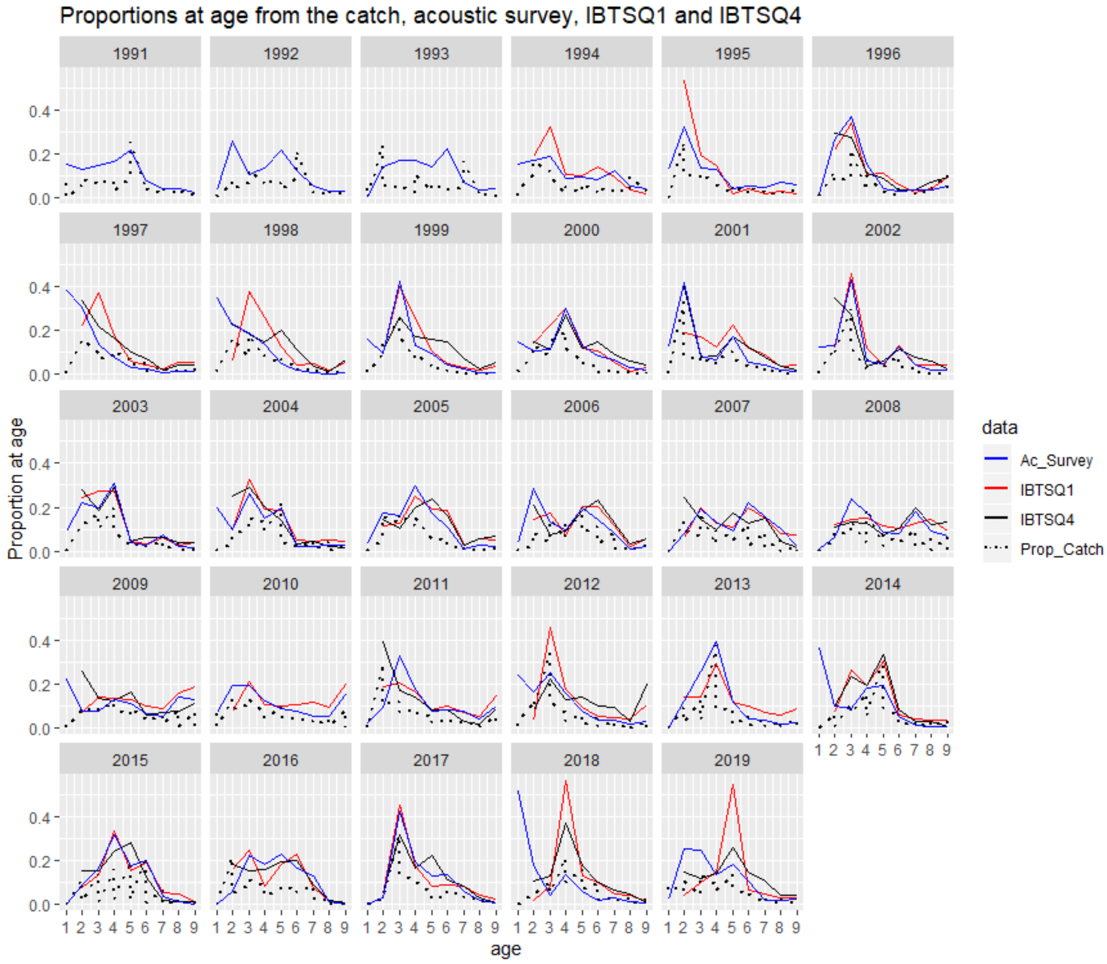


Figure 4.3.1.1. Herring in 6.a (combined) and 7.b–c. Comparison of the proportions-at-age, by age (-wr), of the catch, acoustic survey (WOS MSHAS), IBTS Q1 and IBTSQ4.

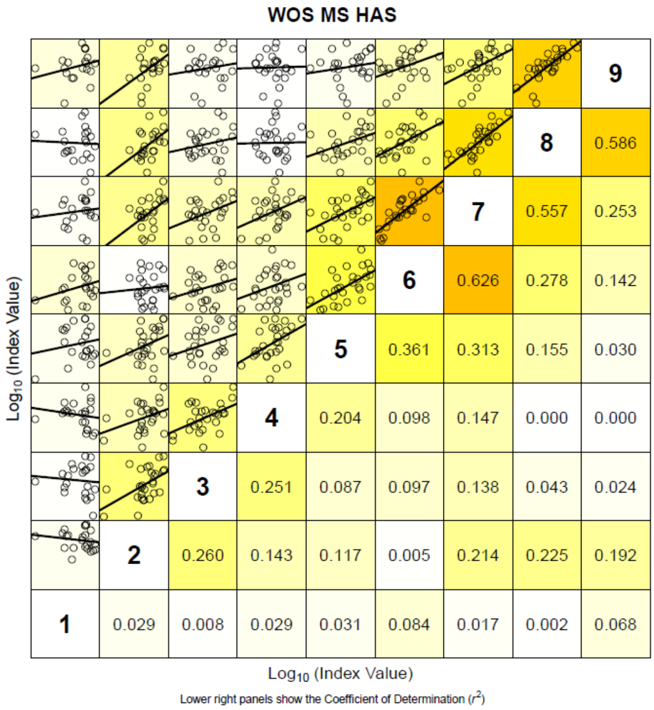


Figure 4.3.1.2. Herring in 6.a (combined) and 7.b–c. Internal consistency between ages (rings) in the WoS_MSHAS herring acoustic survey time-series (1991–2019).

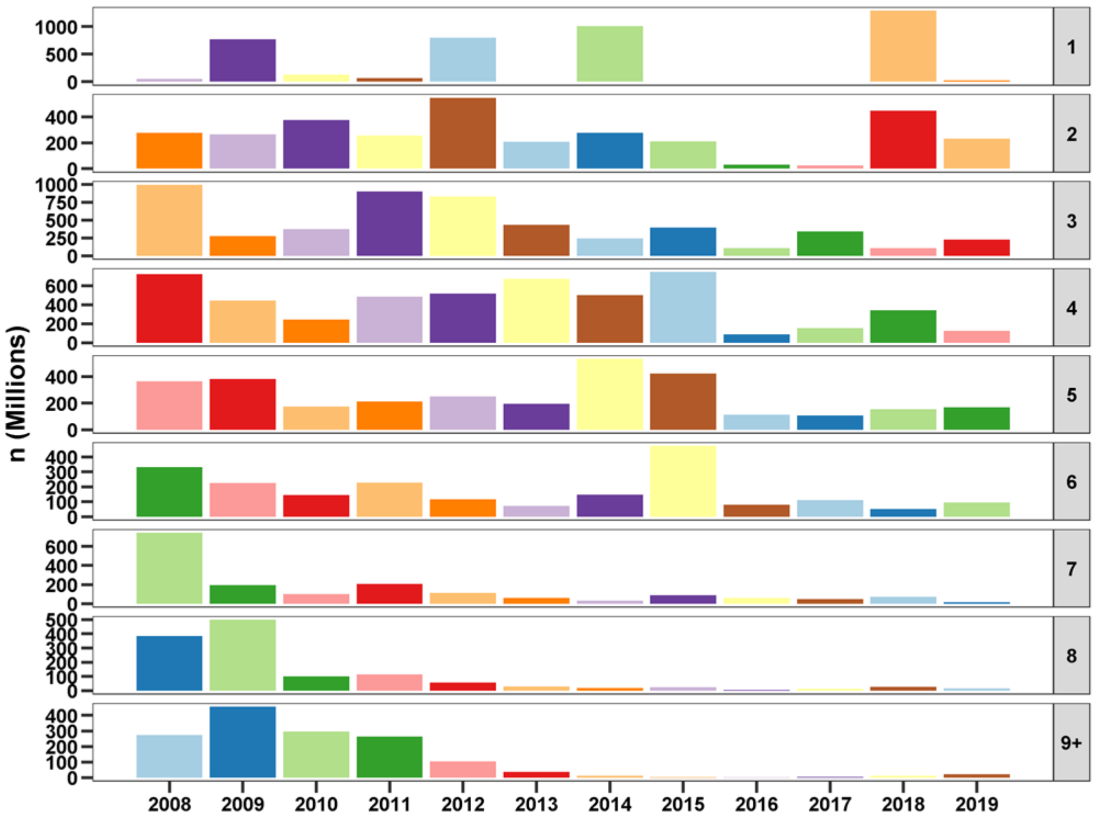


Figure 4.3.1.3 Herring in Divisions 6.a (combined) and 7.b–c. Catch numbers-at-age from Malin Shelf herring acoustic survey combined with West of Scotland acoustic survey (WoS_MSHAS) (6.a.N-S, 7.b and 7.c) time-series. Age (rings) from acoustic surveys 1991 to 2019.

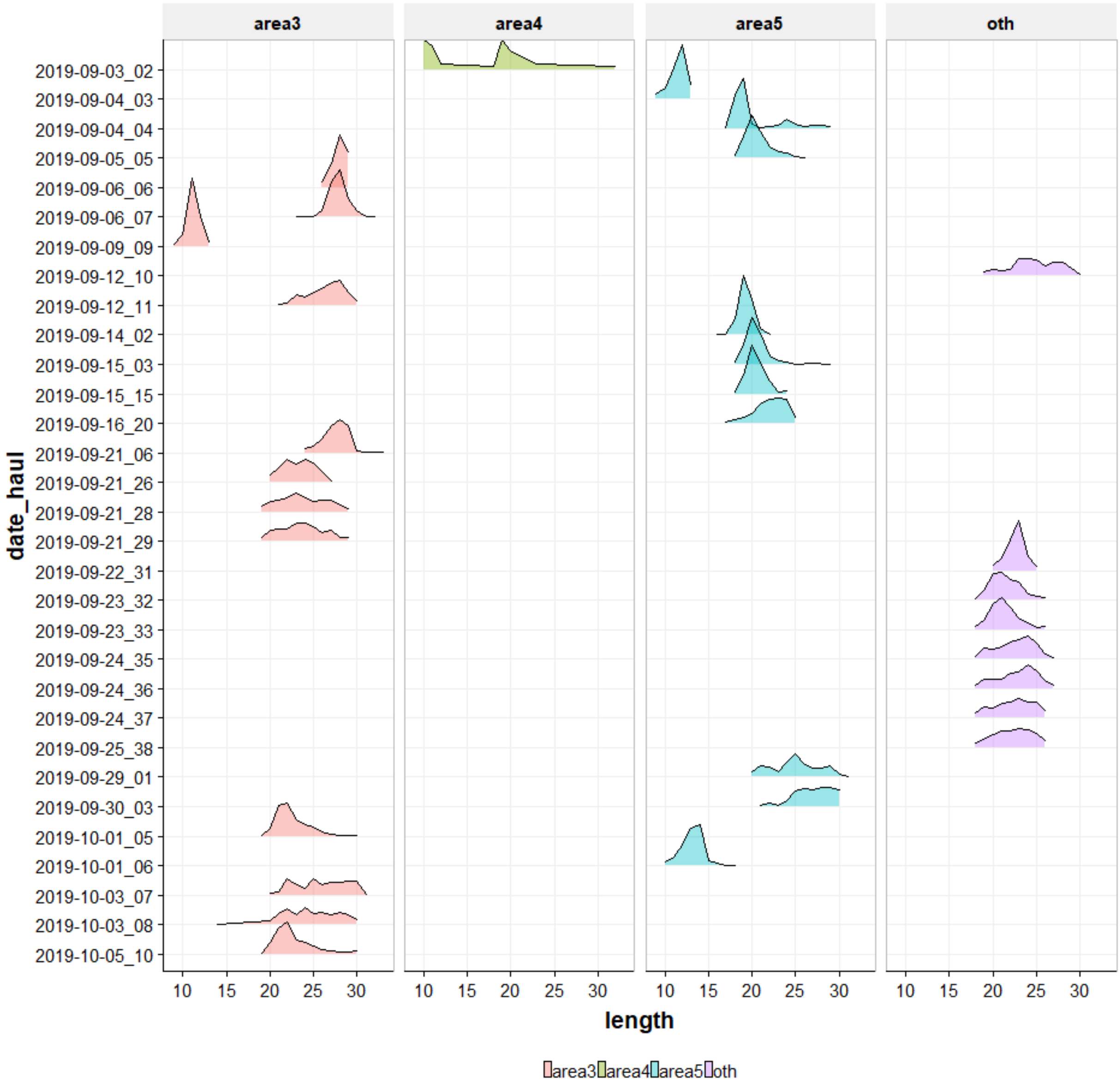


Figure 4.3.1.1.1 Relative Length-frequency distributions recorded from industry survey samples in 6aN.

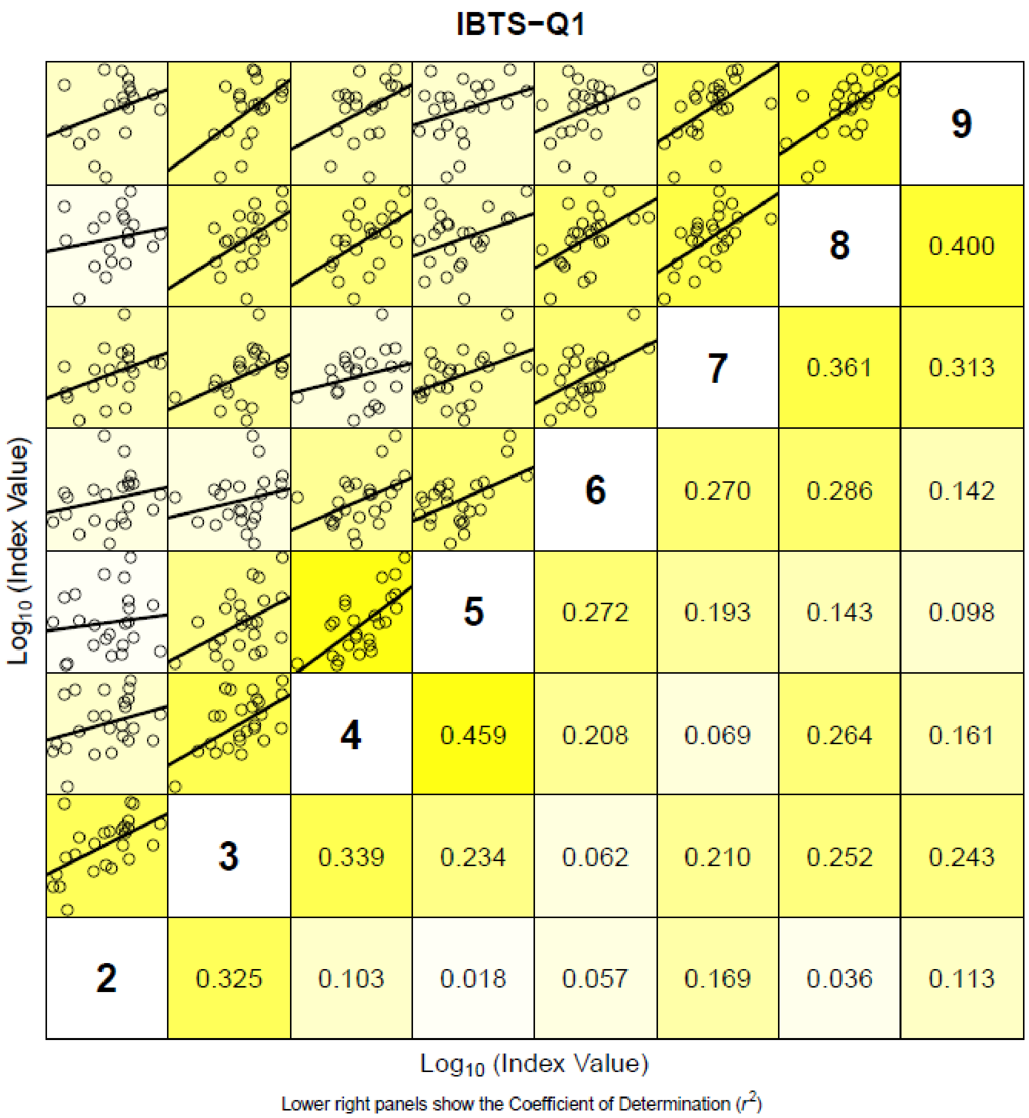


Figure 4.3.2.1. Herring in divisions 6.a (combined) and 7.b–c. Internal consistency plot of the quarter 1 Scottish bottom-trawl survey (1994–2019). Above the numbered diagonal the linear regression is shown including the observations (in points) while under the numbered diagonal the r^2 value that is associated with the linear regression is given.

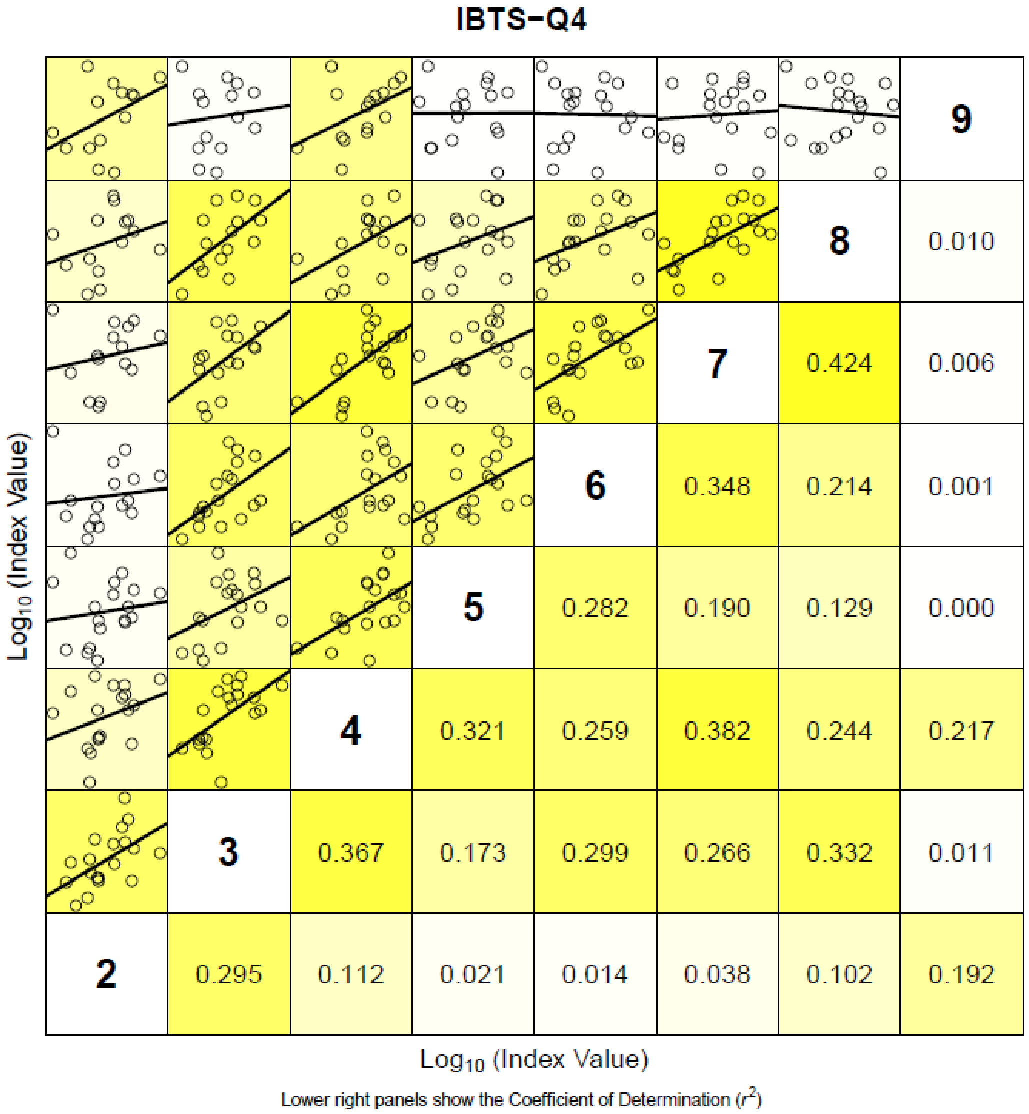


Figure 4.3.2.2. Herring in divisions 6.a (combined) and 7.b–c. Internal consistency plot of the quarter 4 Scottish bottom-trawl survey in (1996–2019). Above the numbered diagonal the linear regression is shown including the observations (in points) while under the numbered diagonal the r^2 value that is associated with the linear regression is given.

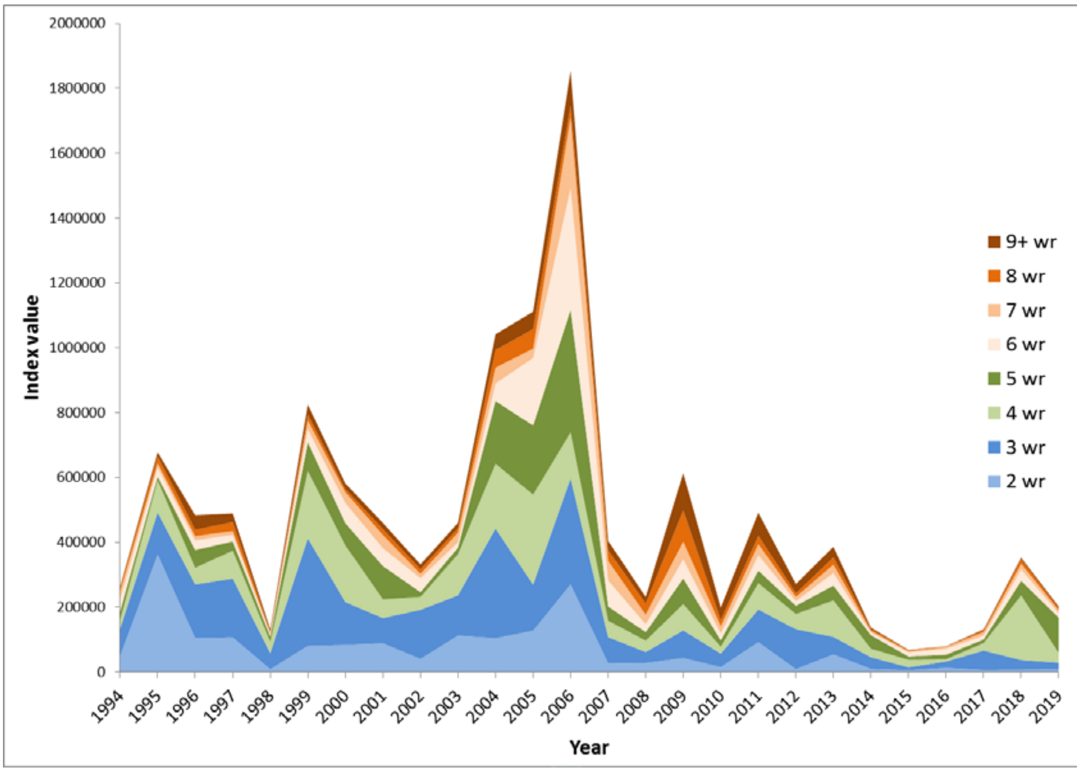


Figure 4.3.2.3. Herring in 6.a (combined) and 7.b-c. Trends in stock composition from abundance-at-age index from Scottish groundfish survey in Quarter 1.

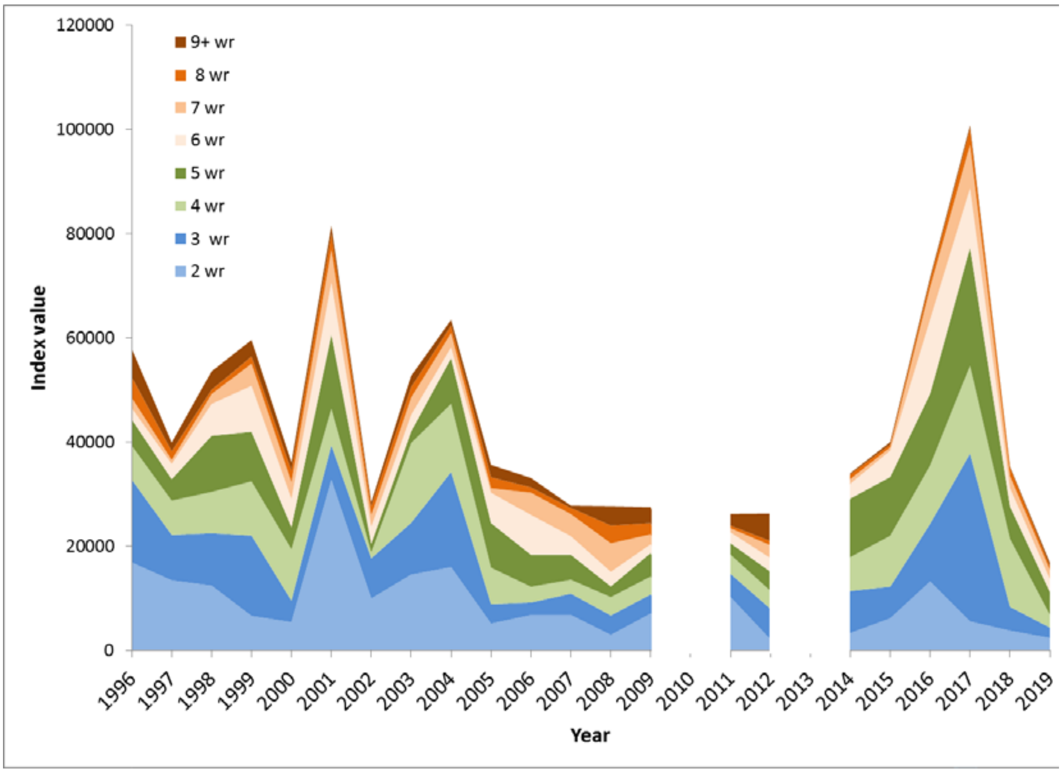


Figure 4.3.2.4. Herring in 6.a (combined) and 7.b-c. Trends in stock composition from abundance-at-age index from Scottish groundfish survey in Quarter 4. There was no survey in 2010 and in 2013 only half of the survey was completed and the data were not used for the index.

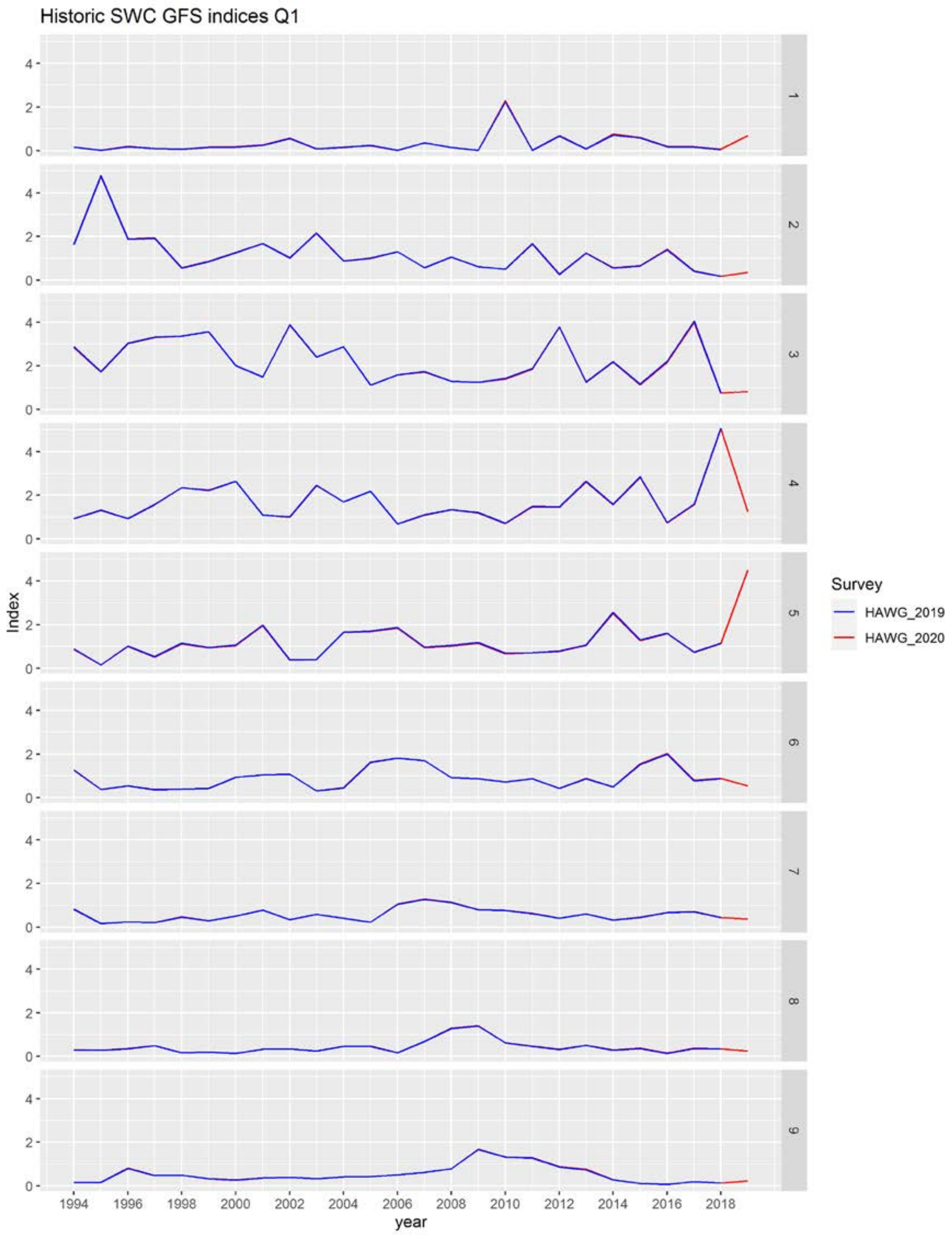


Figure 4.3.2.5 Herring in 6.a (combined) and 7.b–c. Abundance-at-age index from Scottish groundfish survey in Quarter 1 from HAWG 2019 and HAWG 2020. Each index was mean standardized by year.

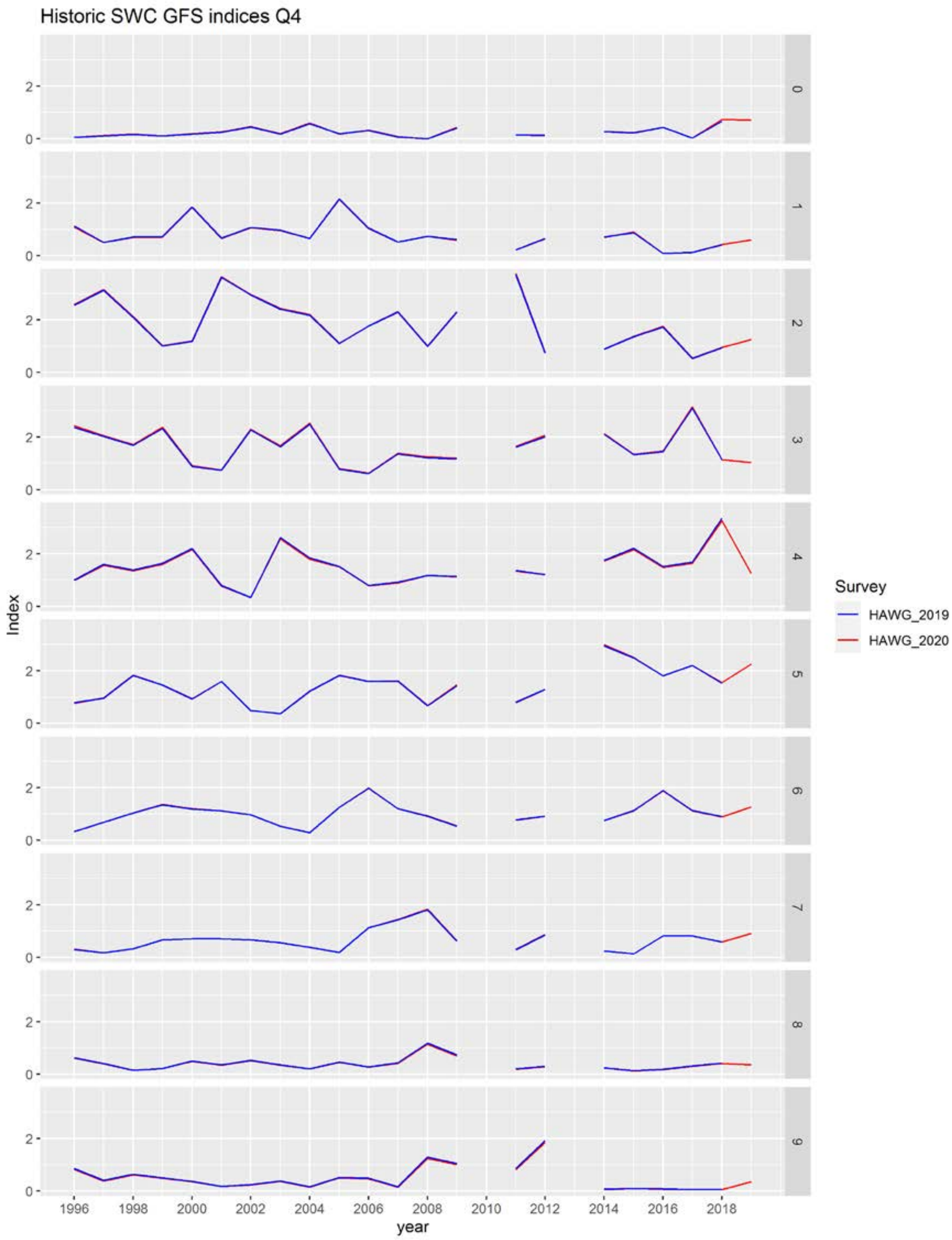


Figure 4.3.2.6 Herring in 6.a (combined) and 7.b–c. Abundance-at-age index from Scottish groundfish survey in Quarter 4 from HAWG 2019 and from HAWG 2020. Each index was mean standardized by years.

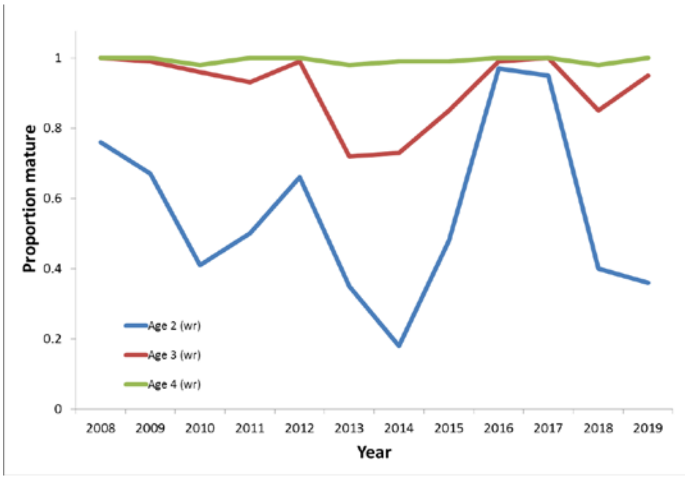


Figure 4.4.2.1. Herring in 6.a (combined) and 7.b–c. Maturity-at-ages 2–4 wr for the years 2008 to 2019.

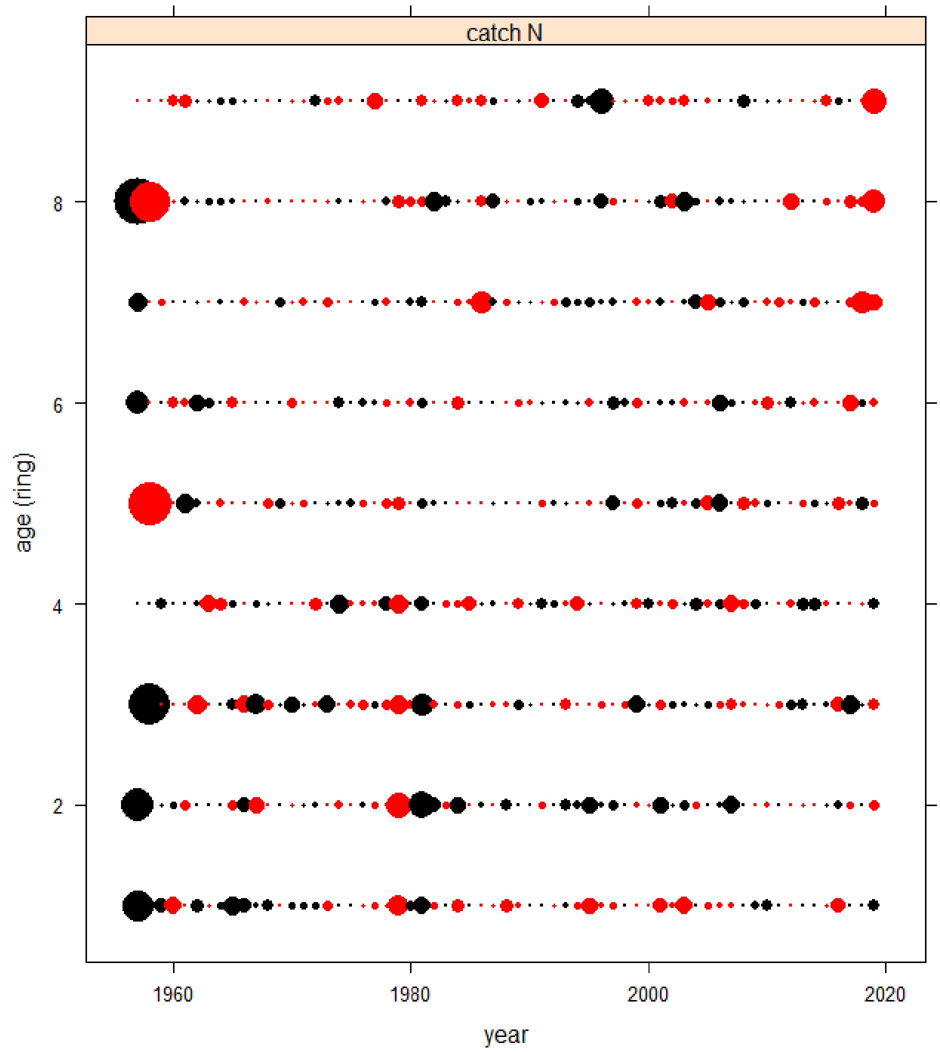


Figure 4.6.1. Herring in 6.a (combined) and 7.b–c. Bubble plot of catch N residuals (1957–2019).

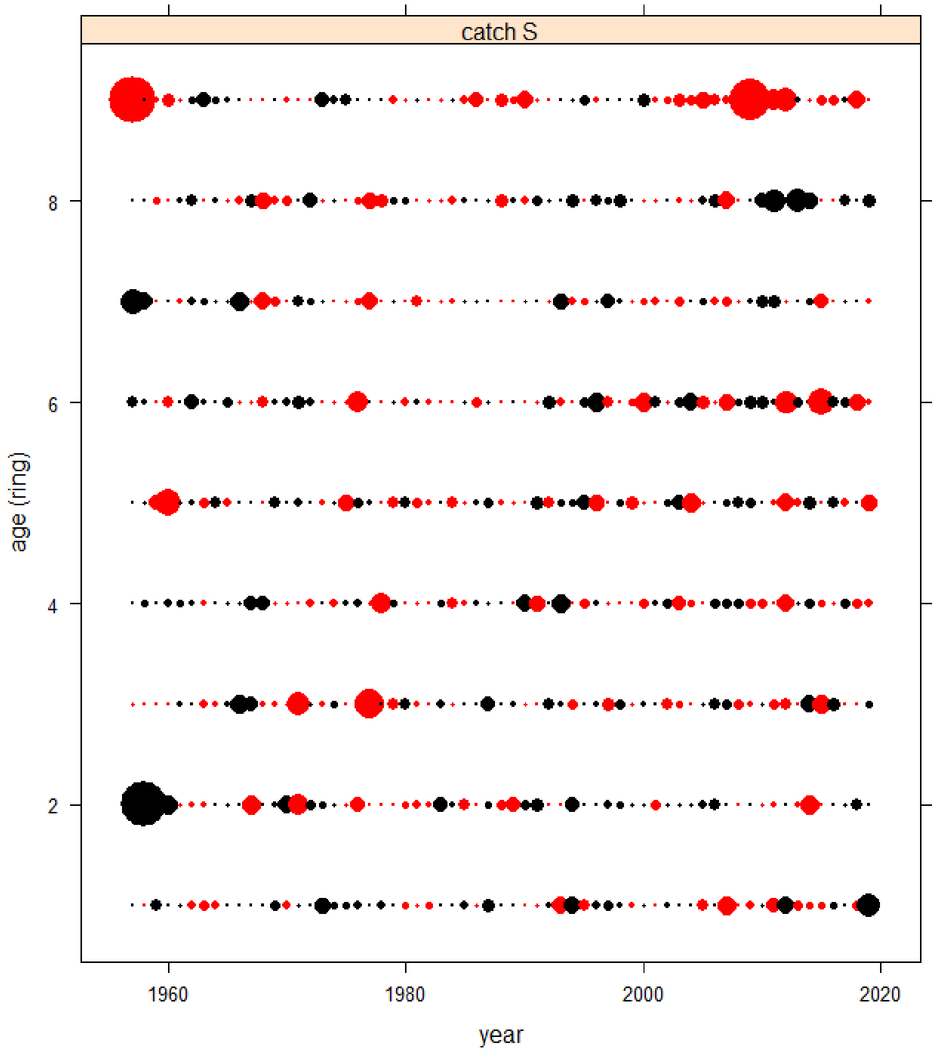


Figure 4.6.2. Herring in 6.a (combined) and 7.b–c. Bubble plot of catch S residuals (1957–2019).

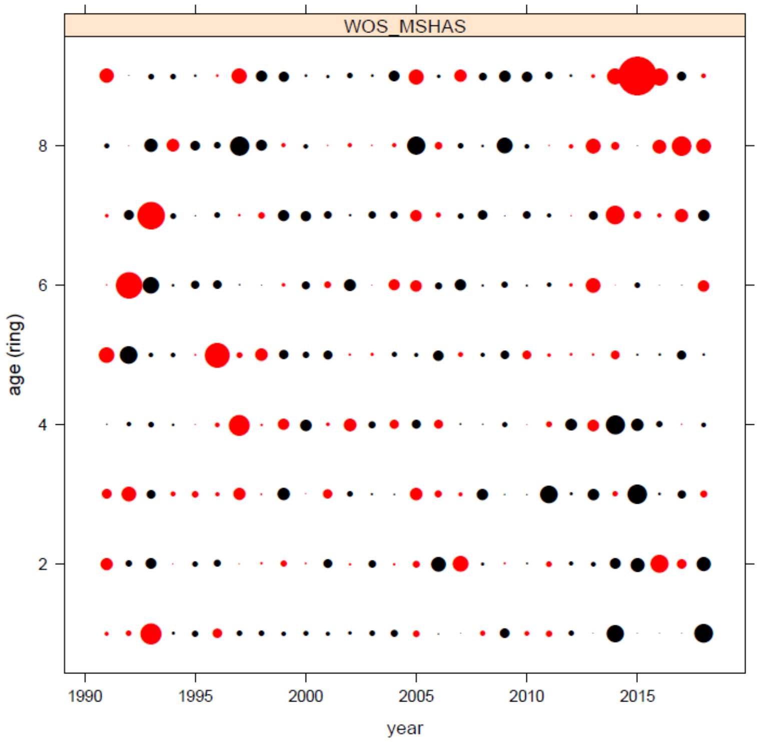


Figure 4.6.3. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardized survey residuals from the WoS_MSHAS acoustic survey (1991–2019).

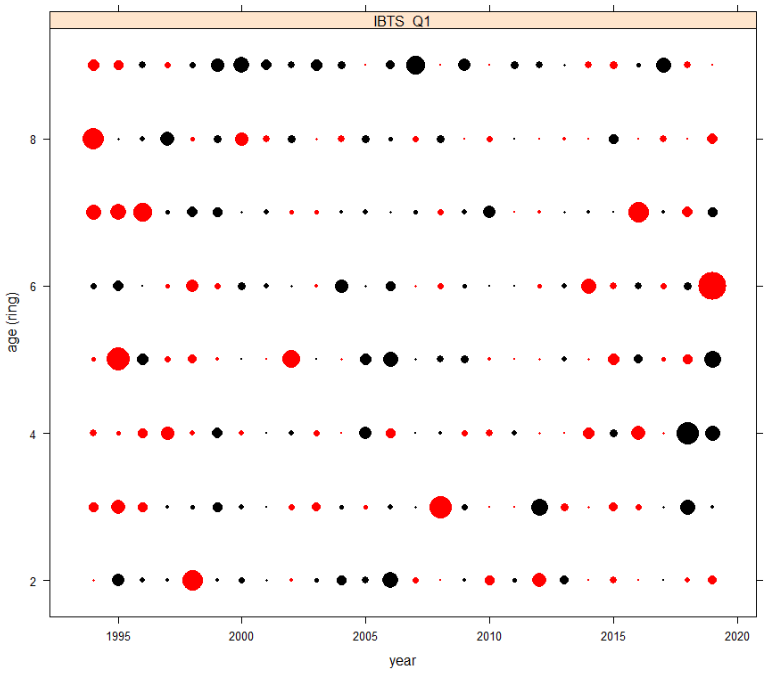


Figure 4.6.4. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardized survey residuals from the Scottish bottom-trawl survey in quarter 1 (1994–2019).

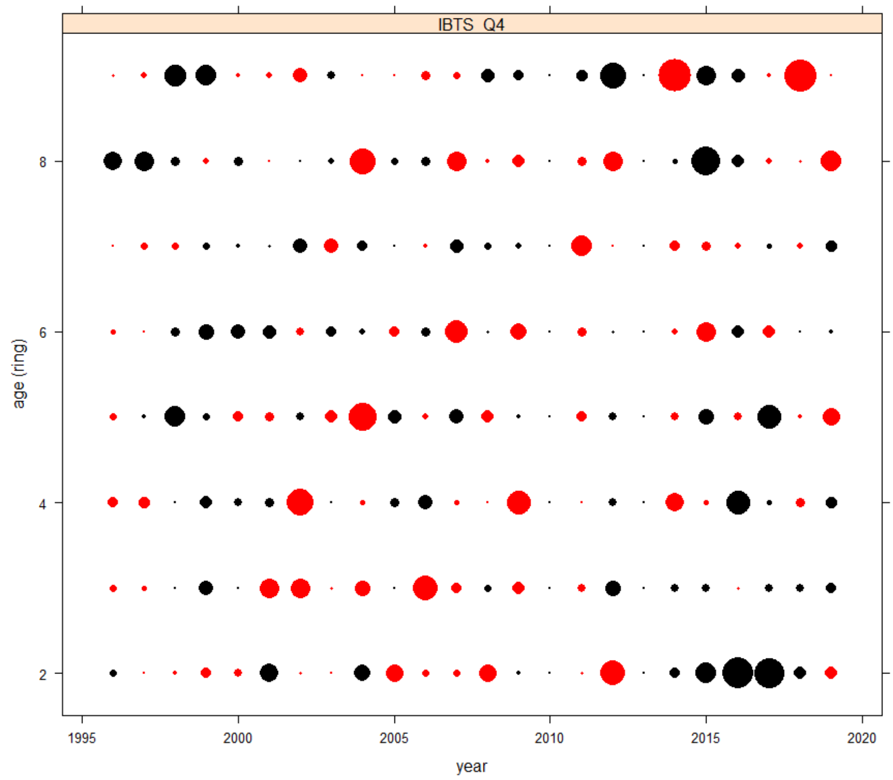


Figure 4.6.5. Herring in 6.a (combined) and 7.b–c. Bubble plot of standardized survey residuals from the Scottish bottom-trawl survey in quarter 4 (1996–2019).

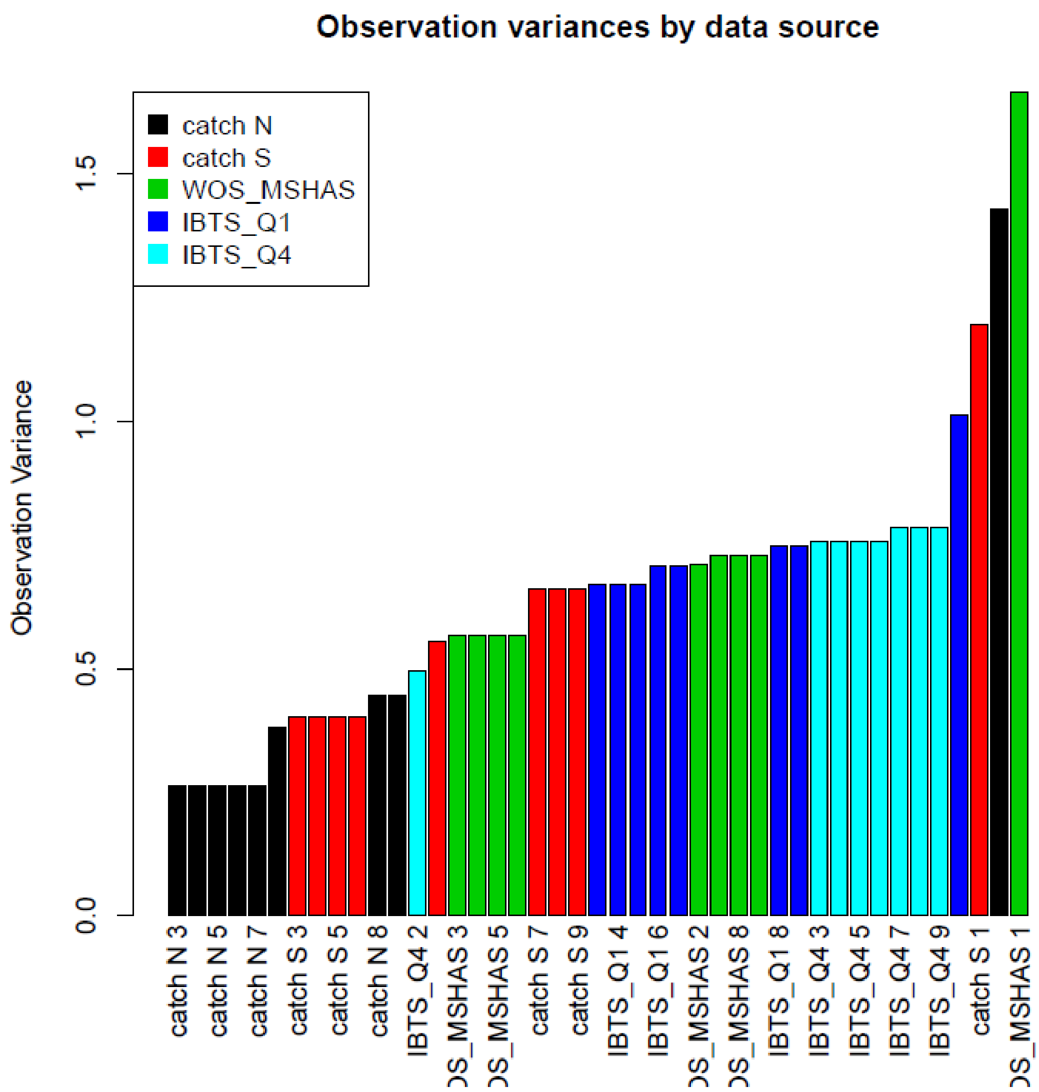


Figure 4.6.6. Herring in 6.a (combined) and 7.b–c. Observation variance by data source, ordered from least (left) to most (right). Colours indicate the different data sources. In cases where parameters are bound, observation variances have equal values.

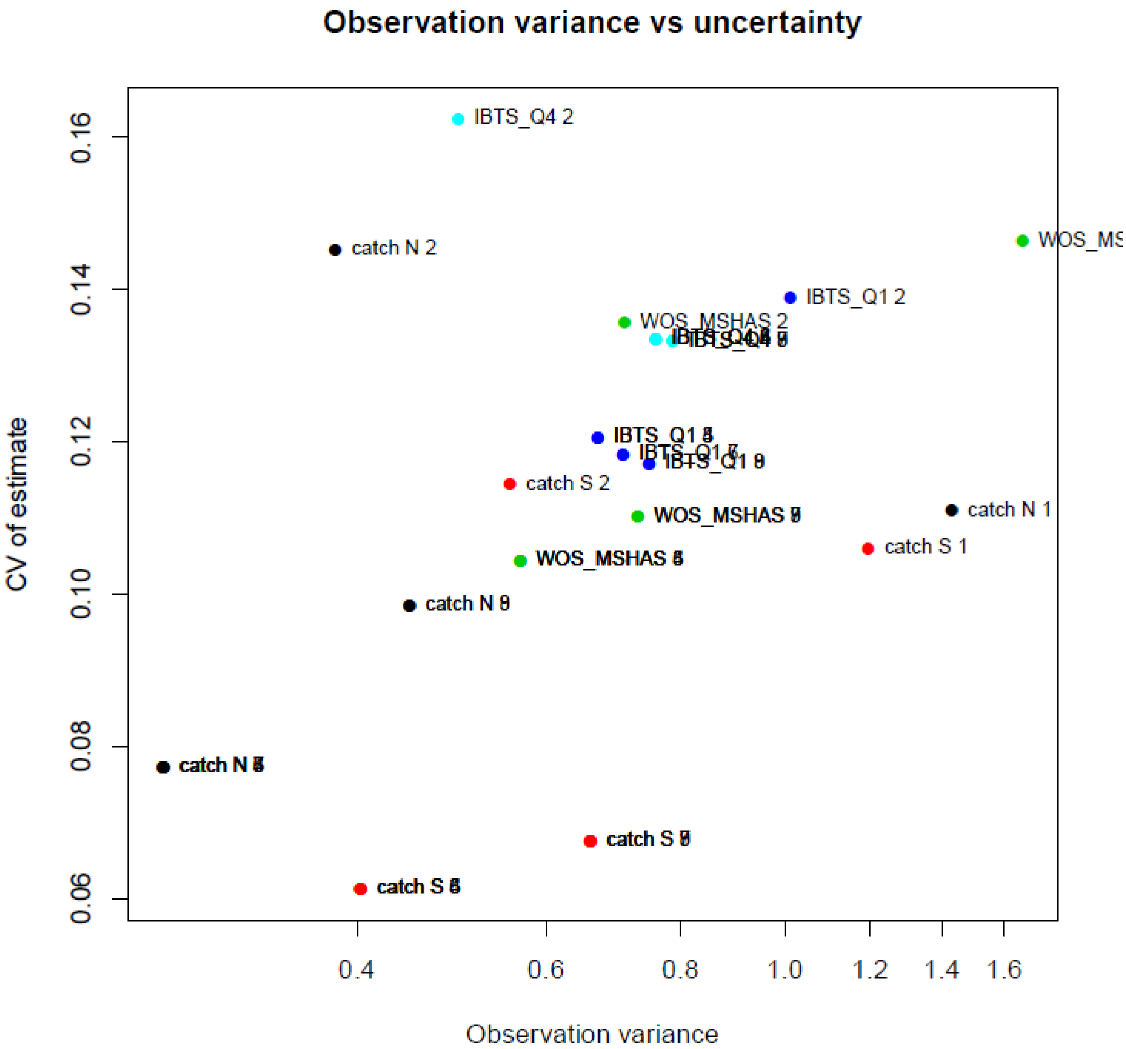


Figure 4.6.7. Herring in 6.a (combined) and 7.b–c. Observation variance by data source as estimated by the assessment model plotted against the CV estimate of the observation variance parameter.

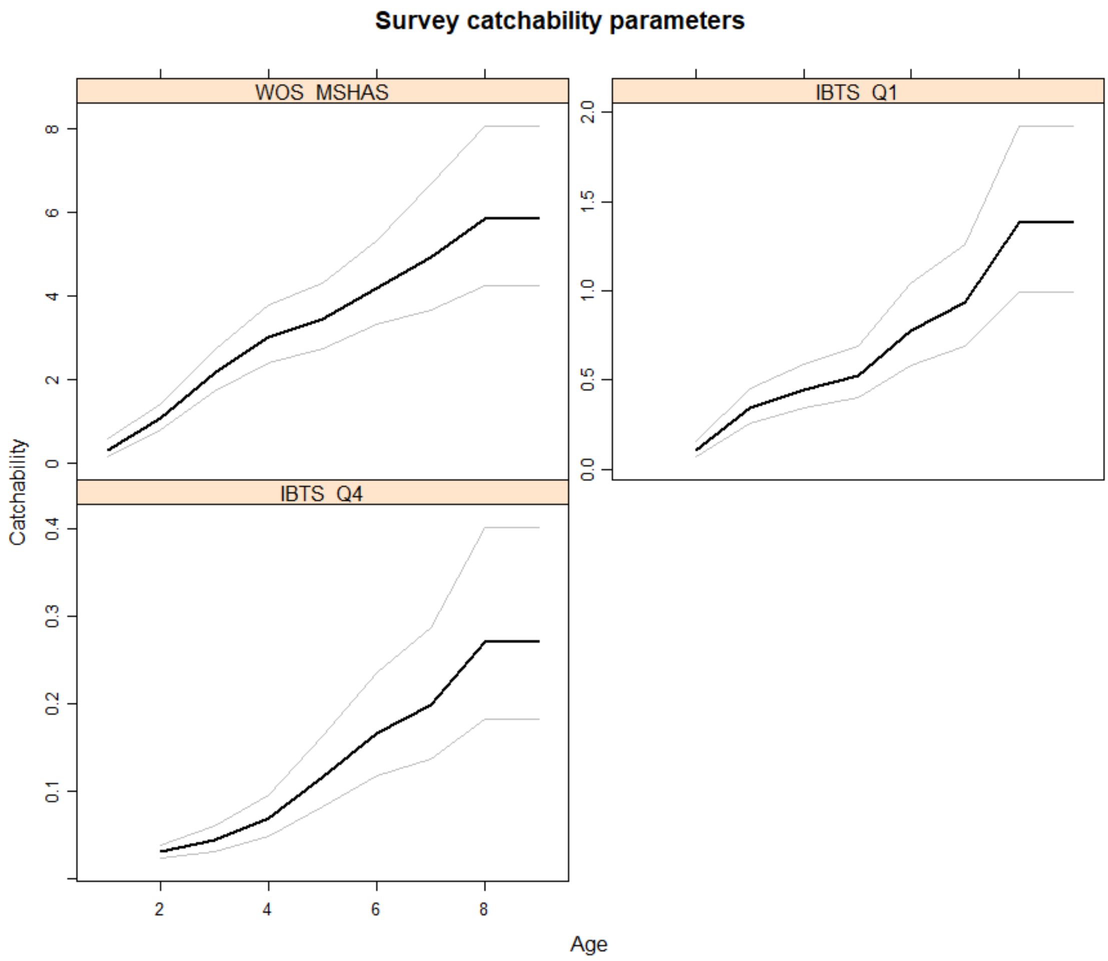


Figure 4.6.8. Herring in 6.a (combined) and 7.b–c. Survey catchability parameters from the WOS_MSHAS acoustic survey (topleft), Scottish groundfish survey index quarter 1 (IBTS_Q1, topright) and Scottish groundfish survey index quarter 4 (IBTS_Q4, bottomleft).

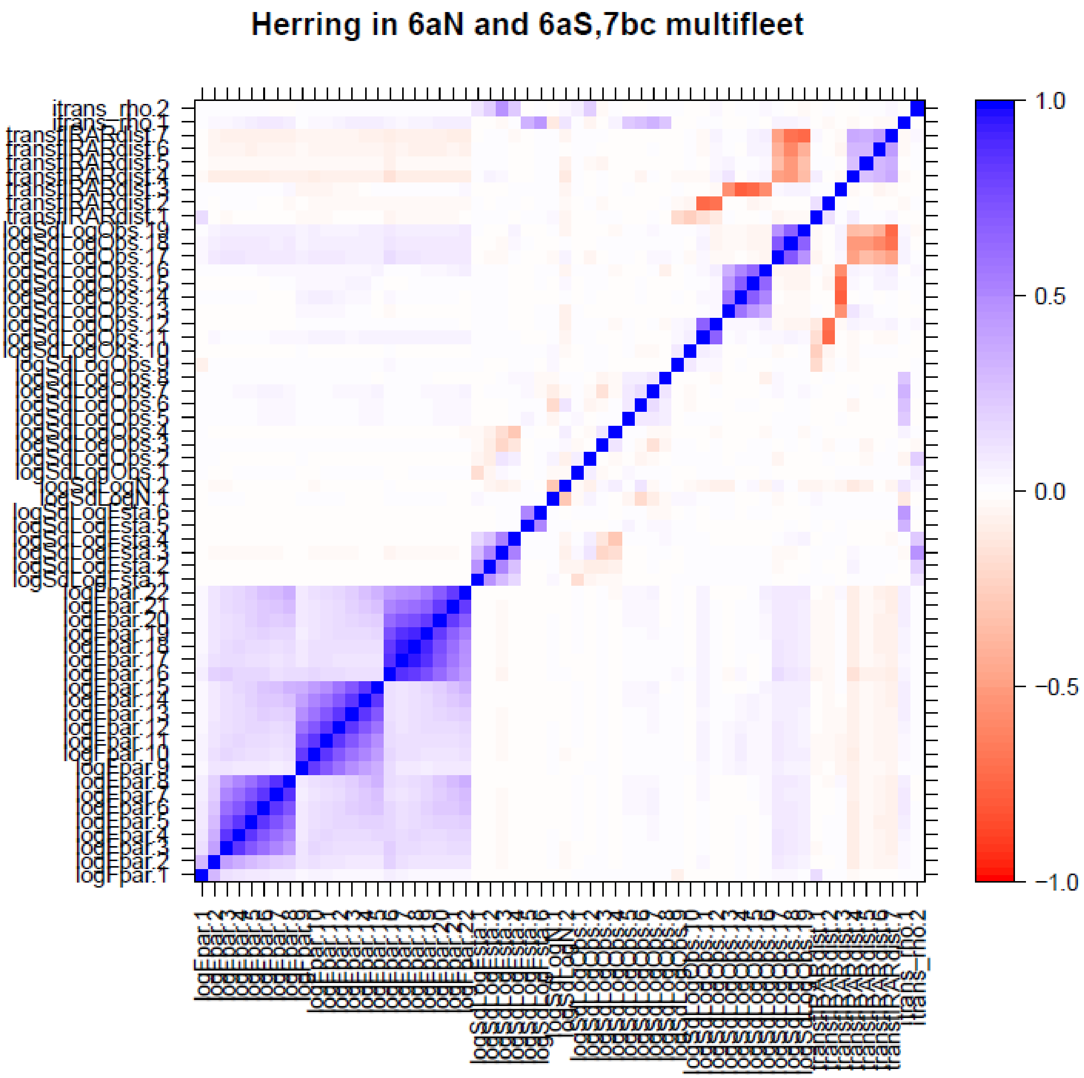


Figure 4.6.9. Herring in 6.a (combined) and 7.b–c. Correlation plot of the parameters estimated in the model. The horizontal and vertical axes show the parameters fitted by the model (labelled with names stored and fitted by FLSAM). The colouring of each pixel indicates the Pearson correlation between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

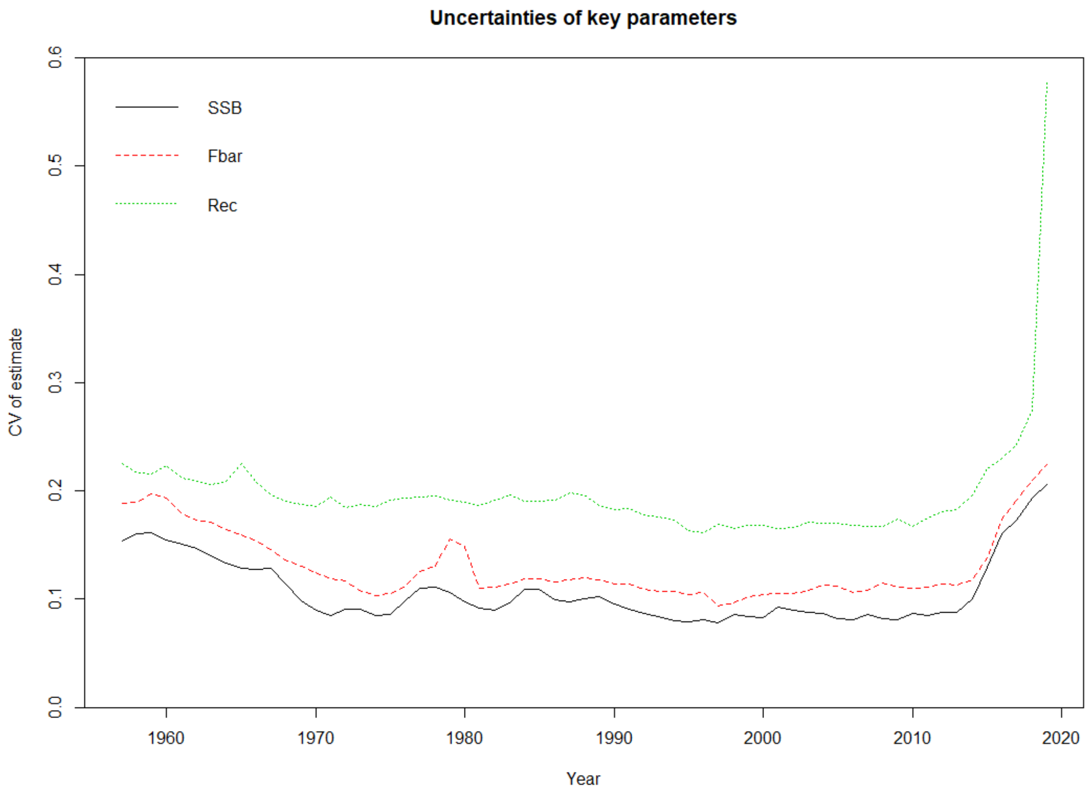


Figure 4.6.10. Herring in 6.a (combined) and 7.b–c. Uncertainty estimates in SSB, F_{bar} and recruitment parameters (1957–2019).

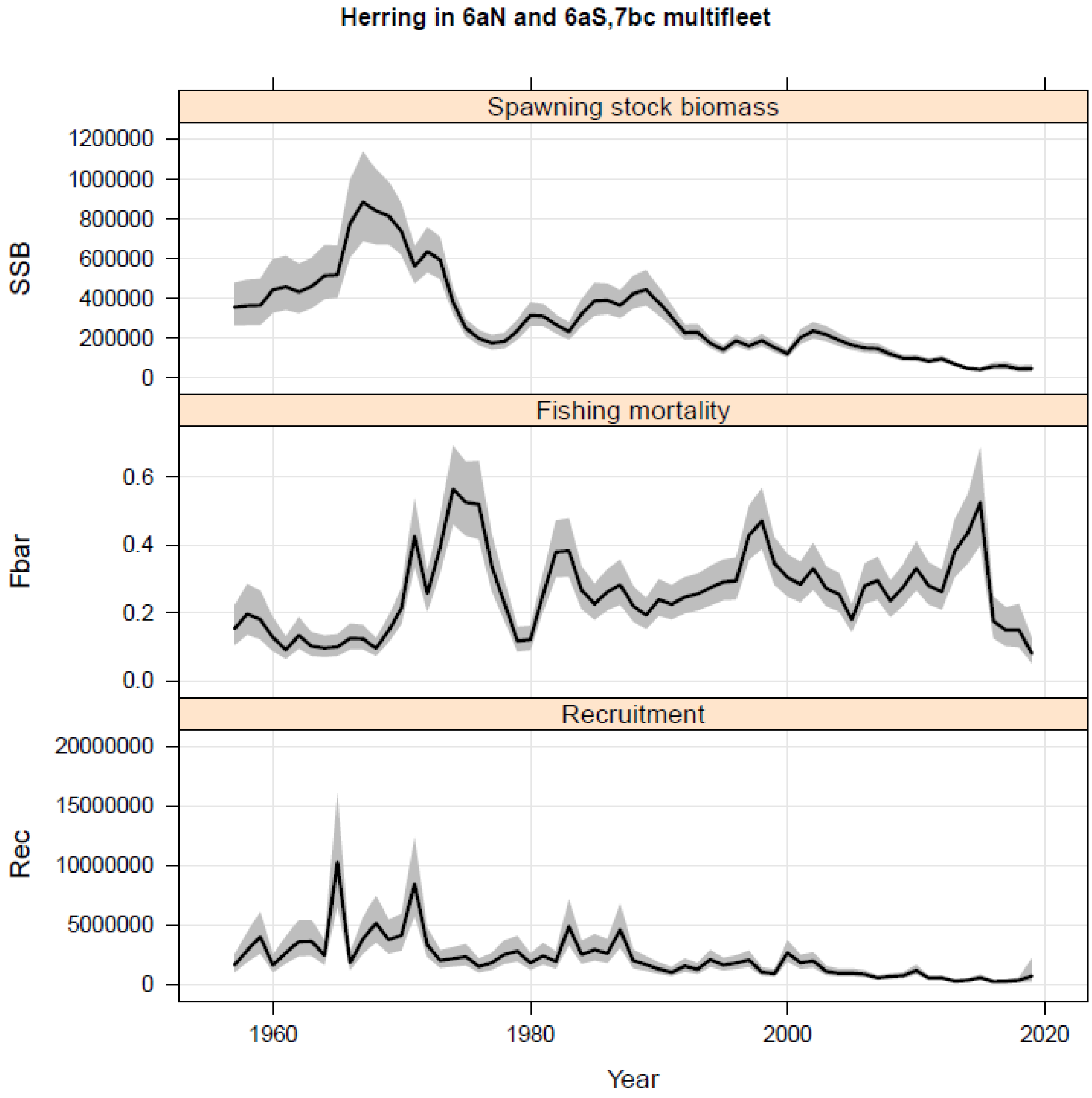


Figure 4.6.11. Herring in 6.a (combined) and 7.b–c. Stock summary plot with associated uncertainty for SSB (top panel), F ages 3–6 (middle panel) and recruitment (bottom panel).

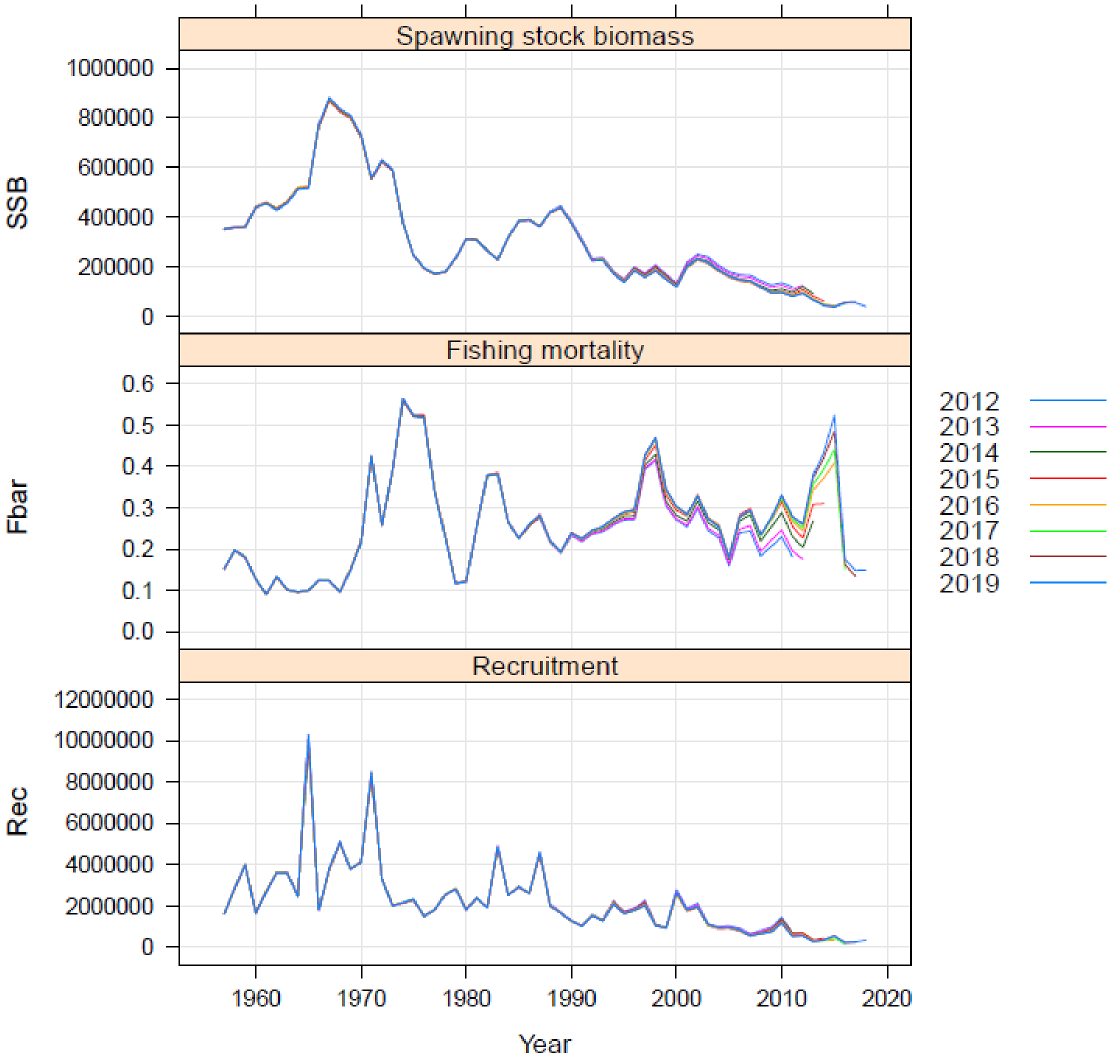


Figure 4.6.12. Herring in 6.a (combined) and 7.b–c. Analytical retrospective of the estimated spawning–stock biomass (top panel), fishing mortality (middle panel) and recruitment (bottom panel) as estimated over the years 2011–2019.

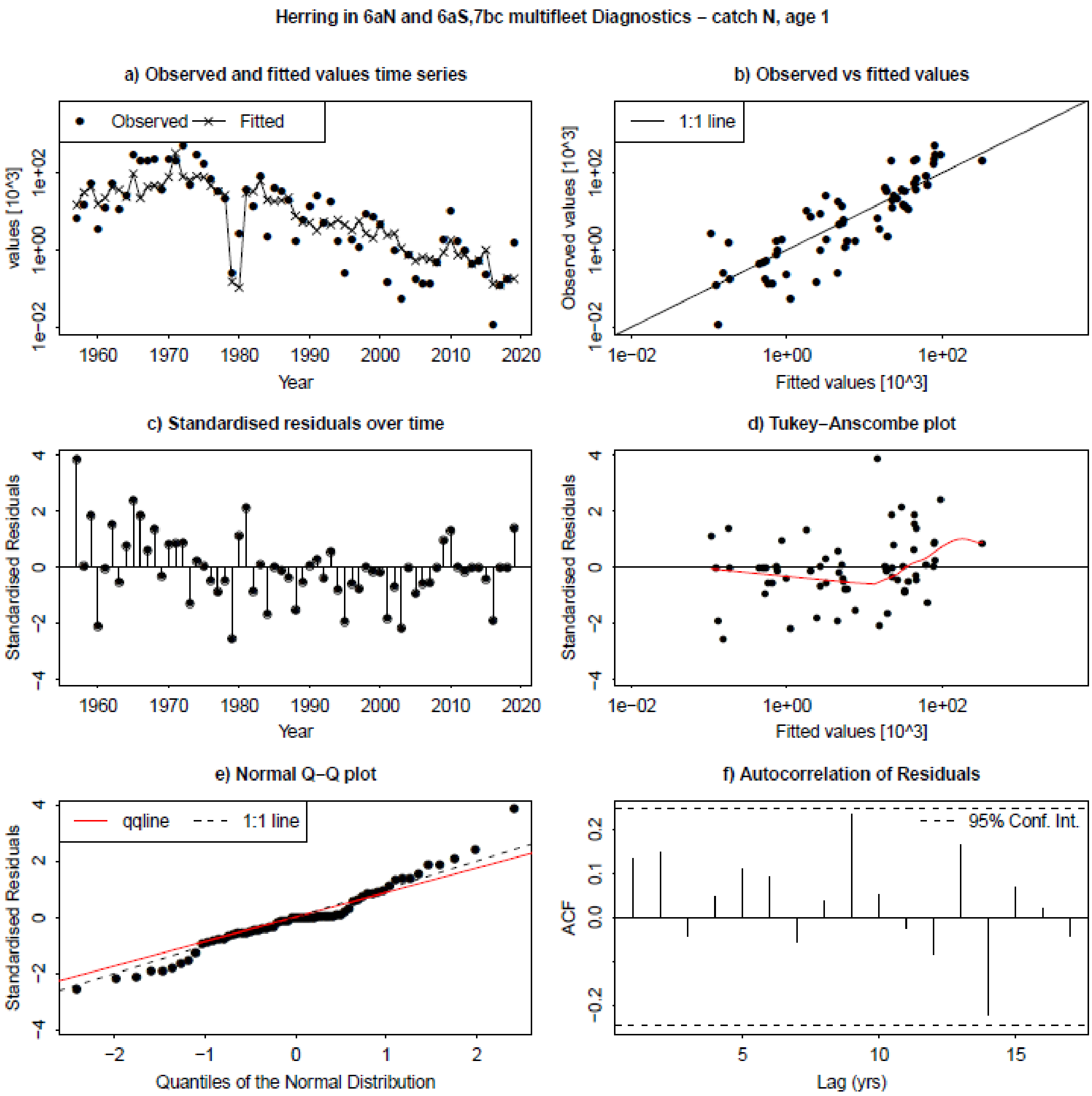


Figure 4.6.13. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from catch abundance at 1-winter ring. Top right: scatterplot of catch observations vs. assessment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

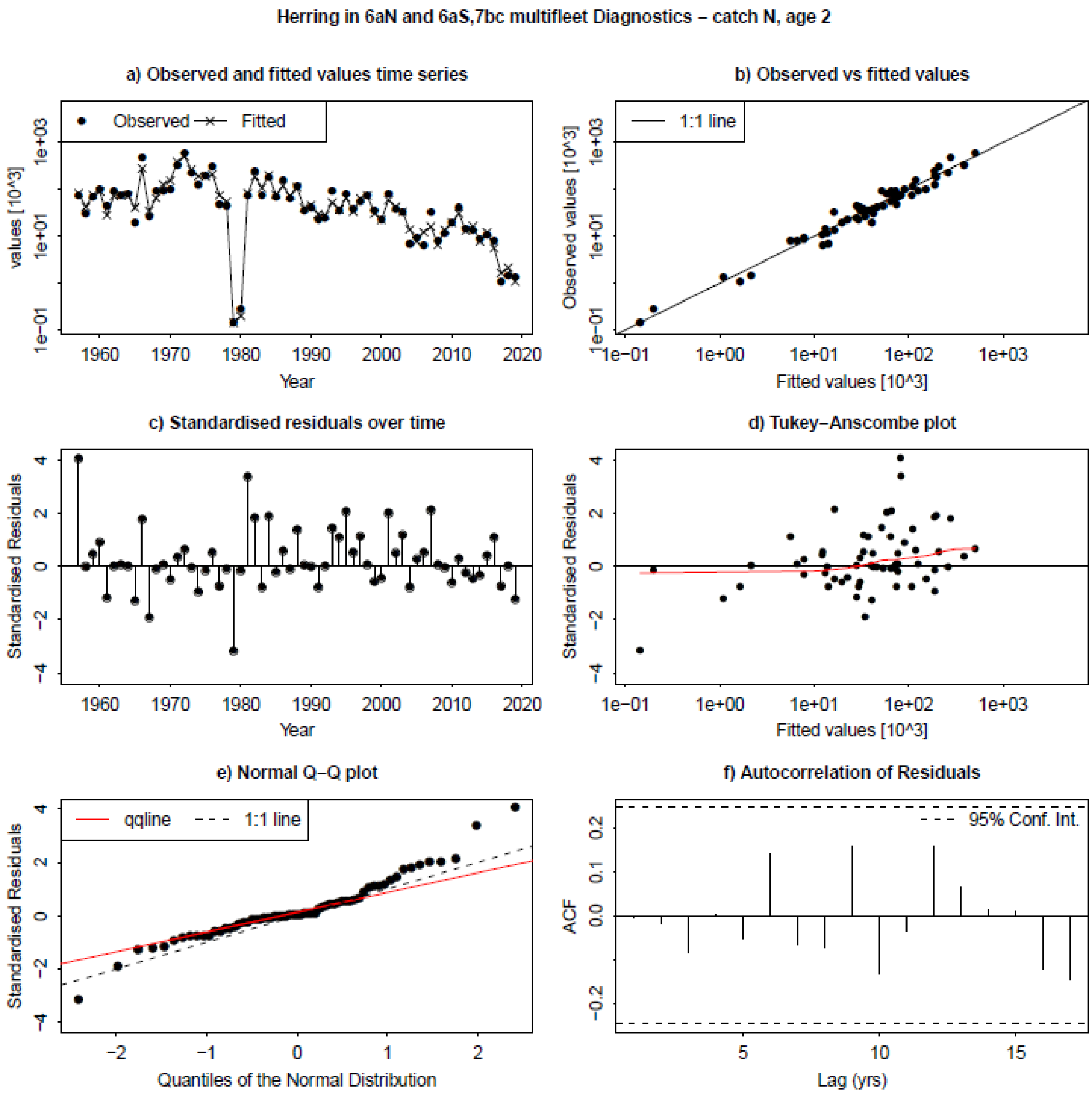


Figure 4.6.16. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from catch abundance at 2-winter ring. Top right: scatterplot of catch observations vs. assessment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

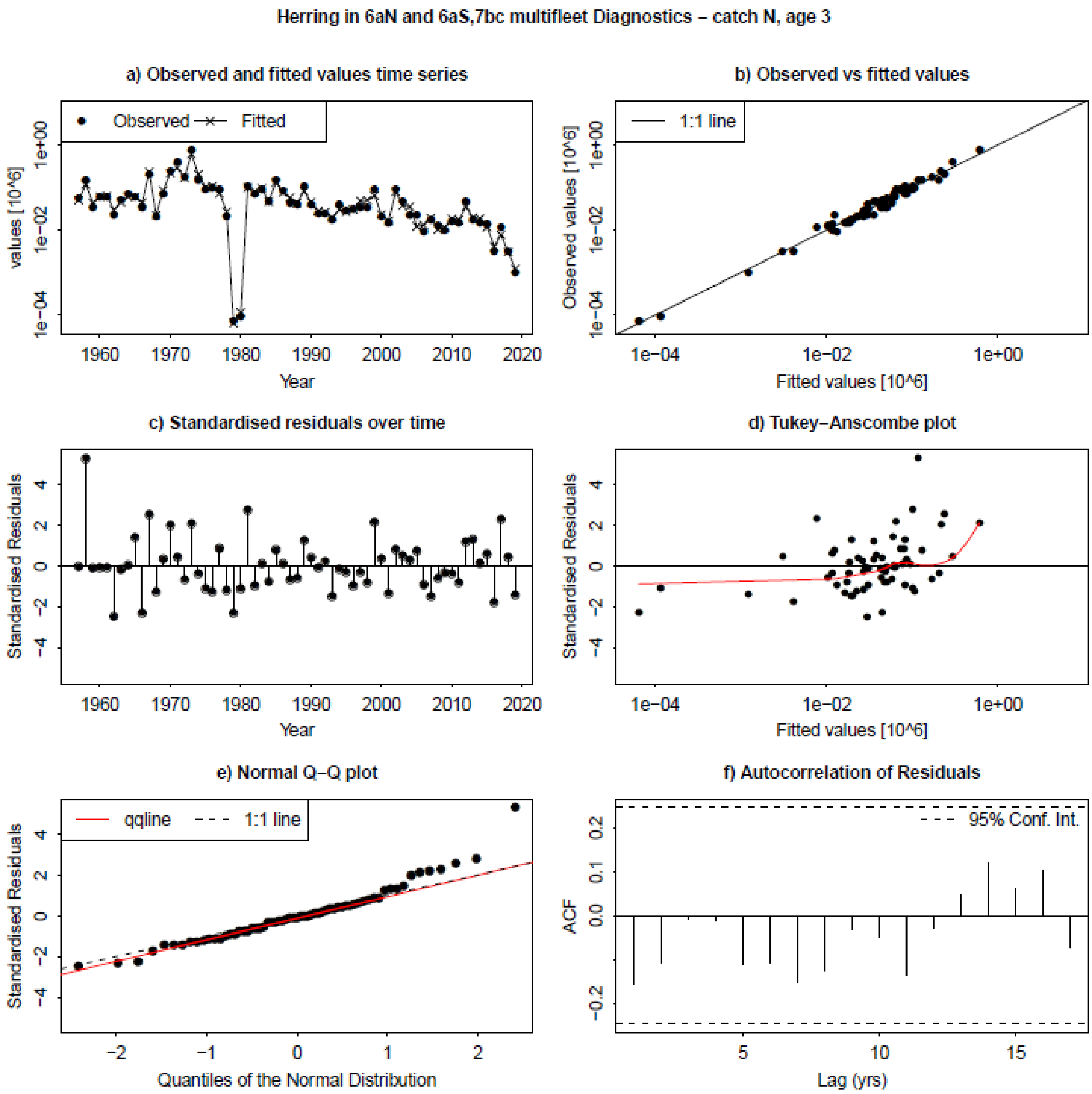


Figure 4.6.17. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from catch abundance at 3-winter ring. Top right: scatterplot of catch observations vs. assessment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

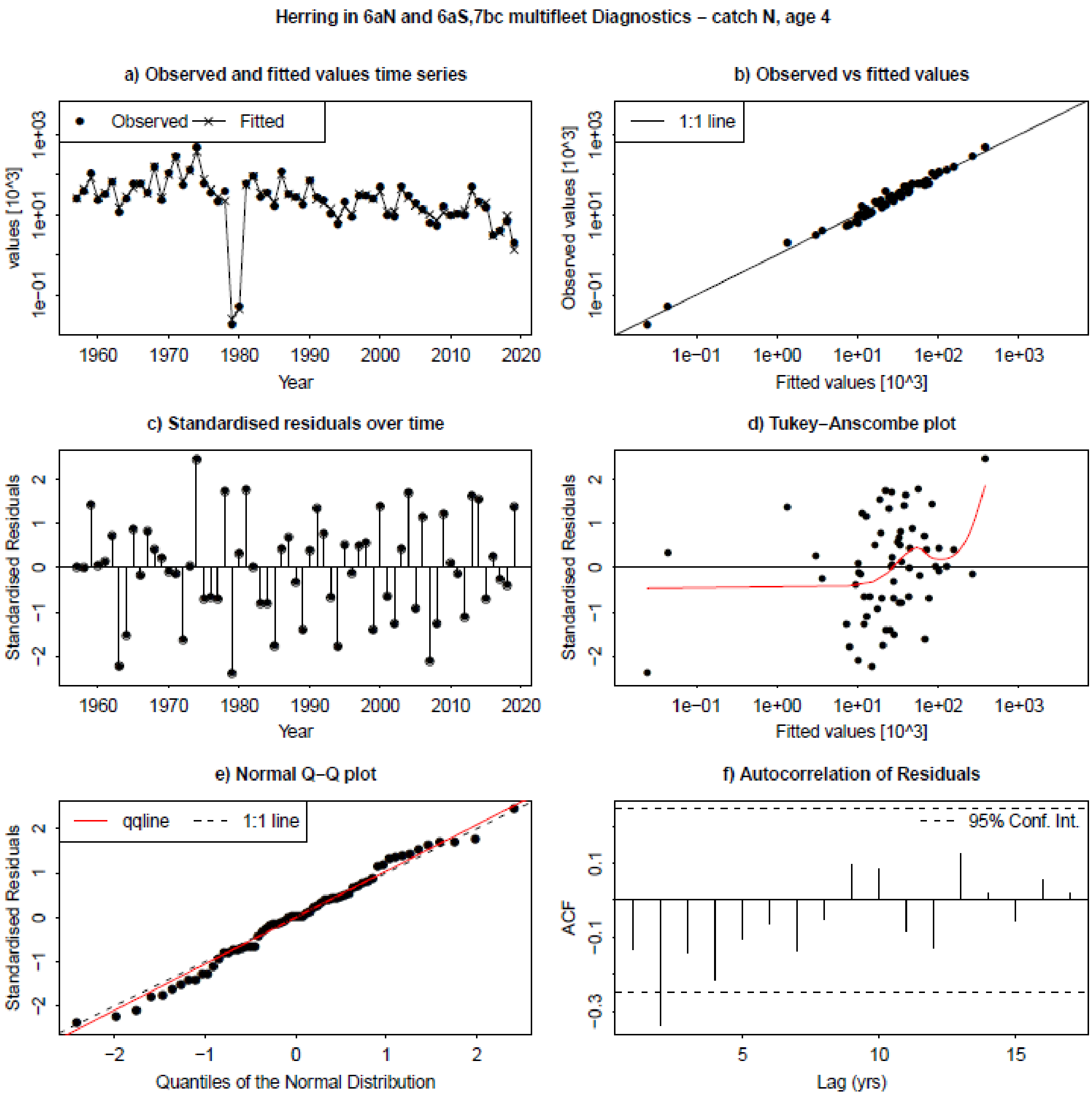


Figure 4.6.18. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from catch abundance at 4-winter ring. Top right: scatterplot of catch observations vs. assessment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

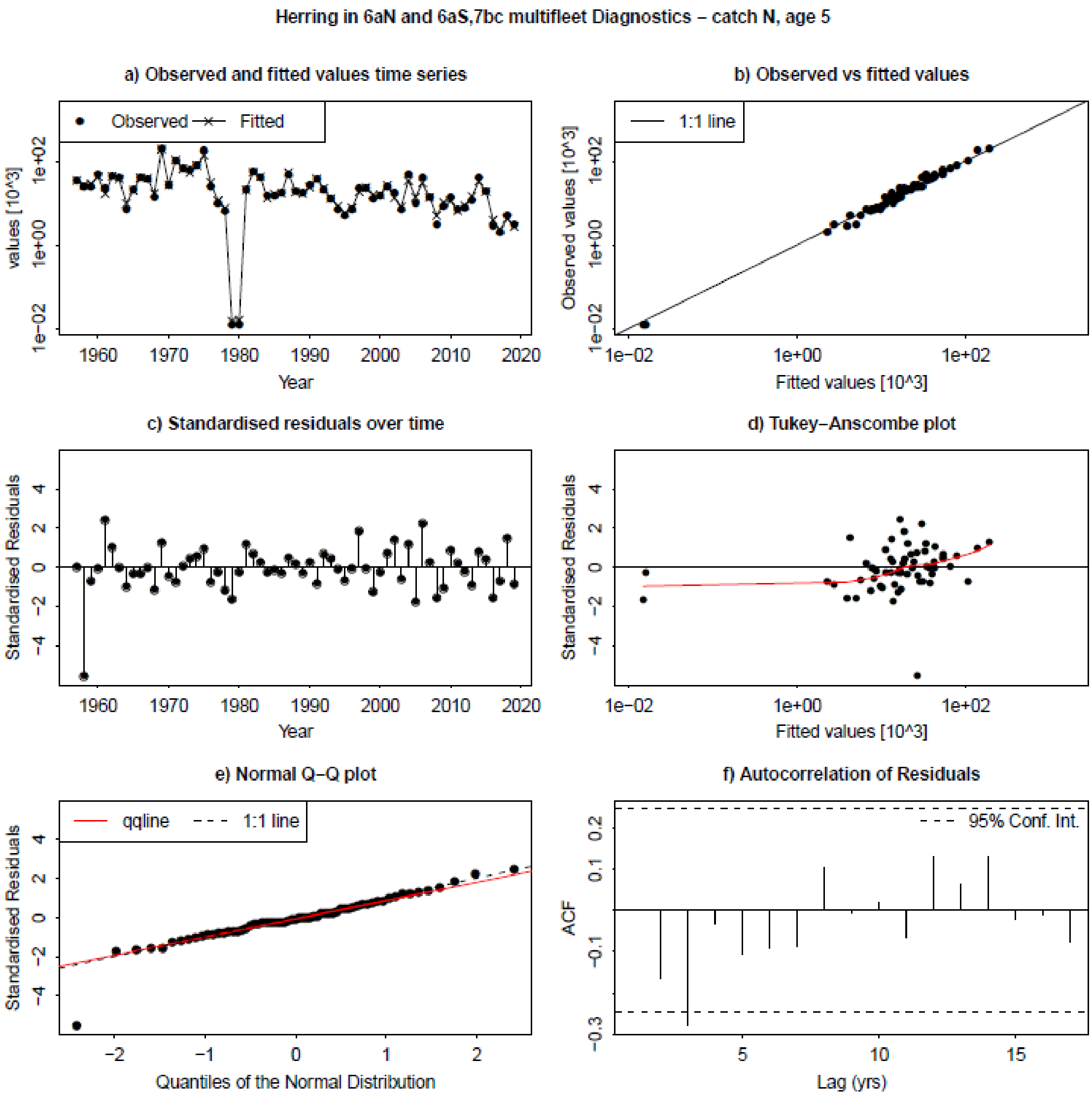


Figure 4.6.19. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from catch abundance at 5-winter ring. Top right: scatterplot of catch observations vs. assessment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

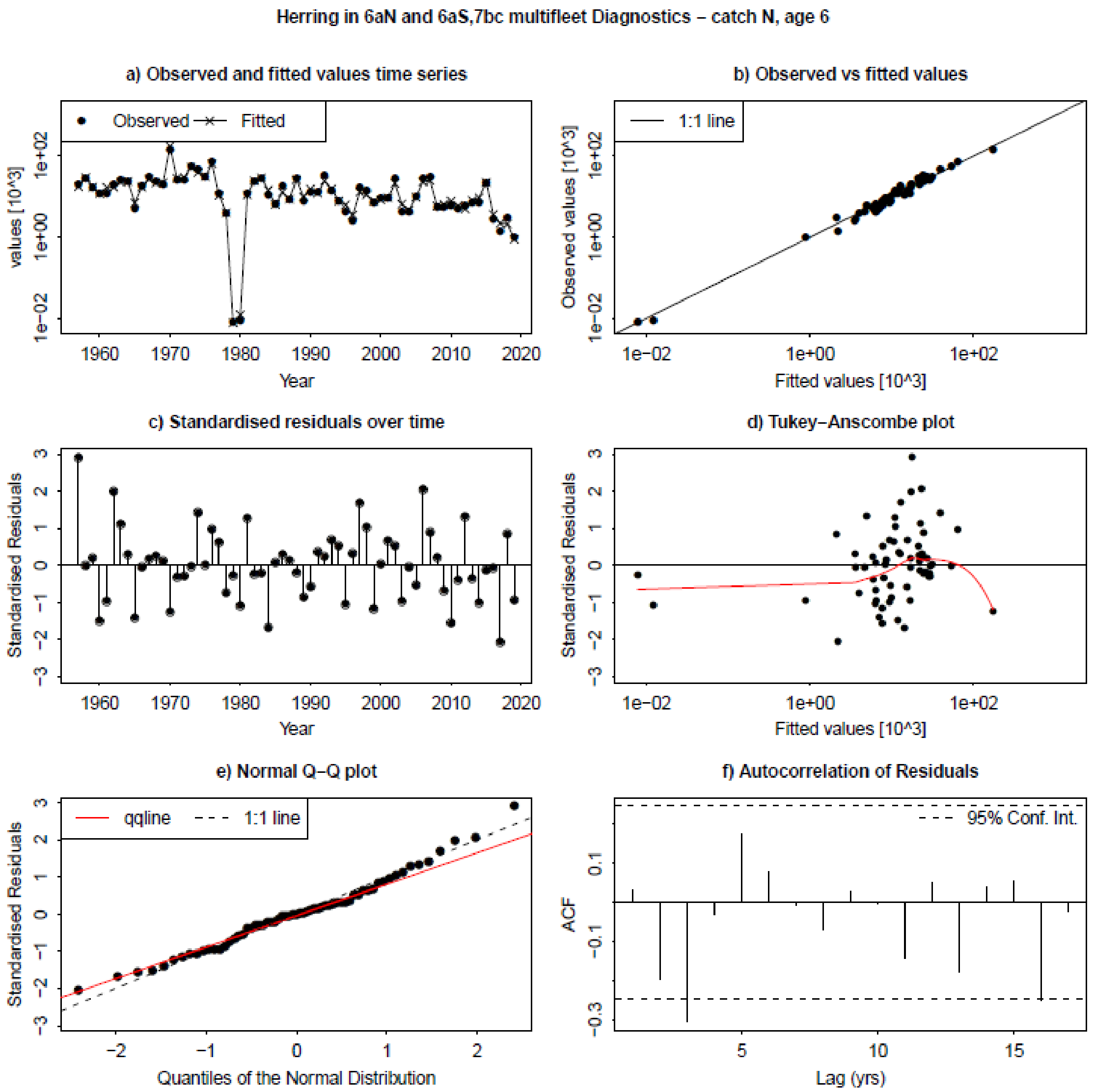


Figure 4.6.20. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from catch abundance at 6-winter ring. Top right: scatterplot of catch observations vs. assessment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

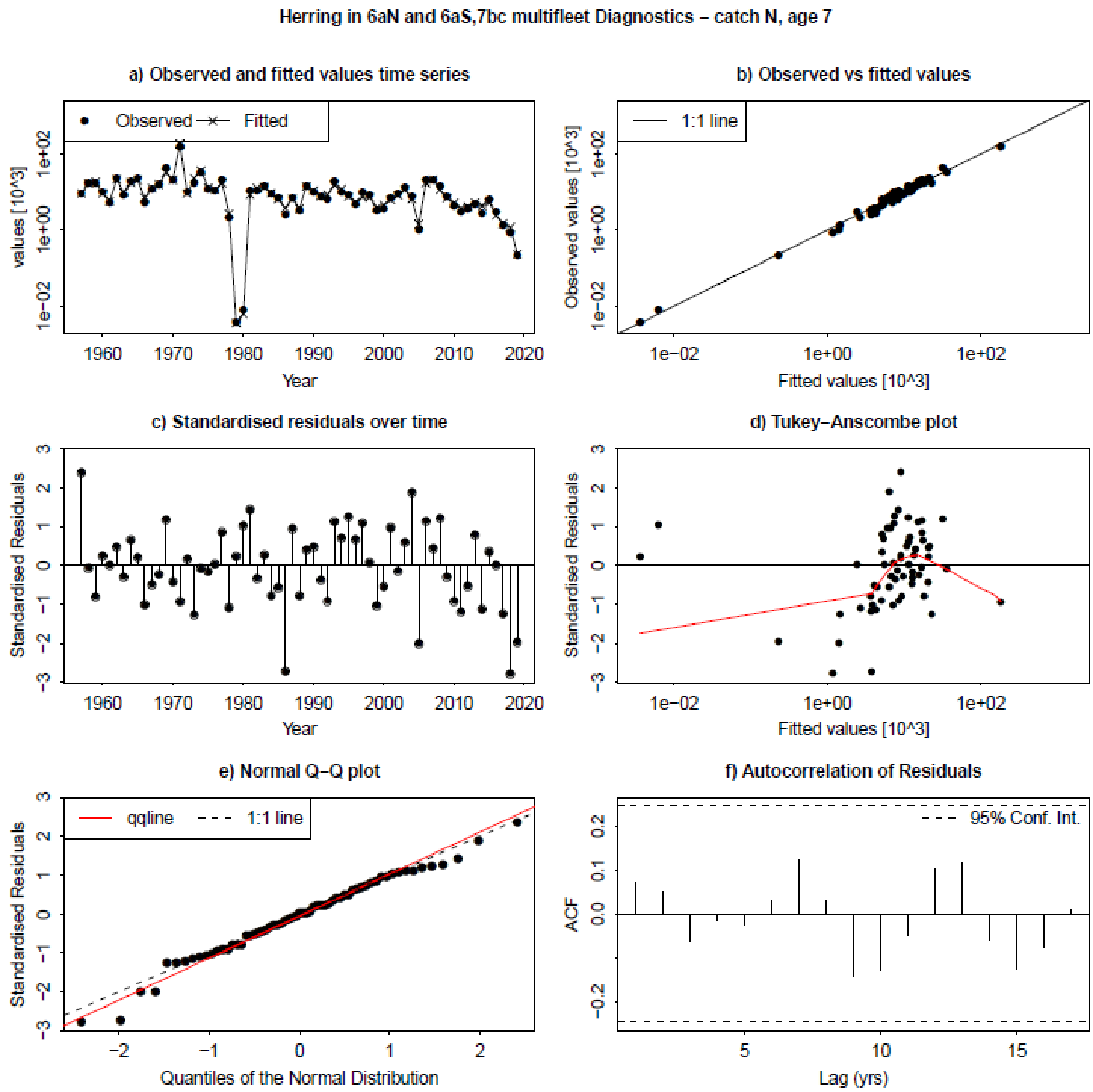


Figure 4.6.21. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from catch abundance at 7-winter ring. Top right: scatterplot of catch observations vs. assessment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

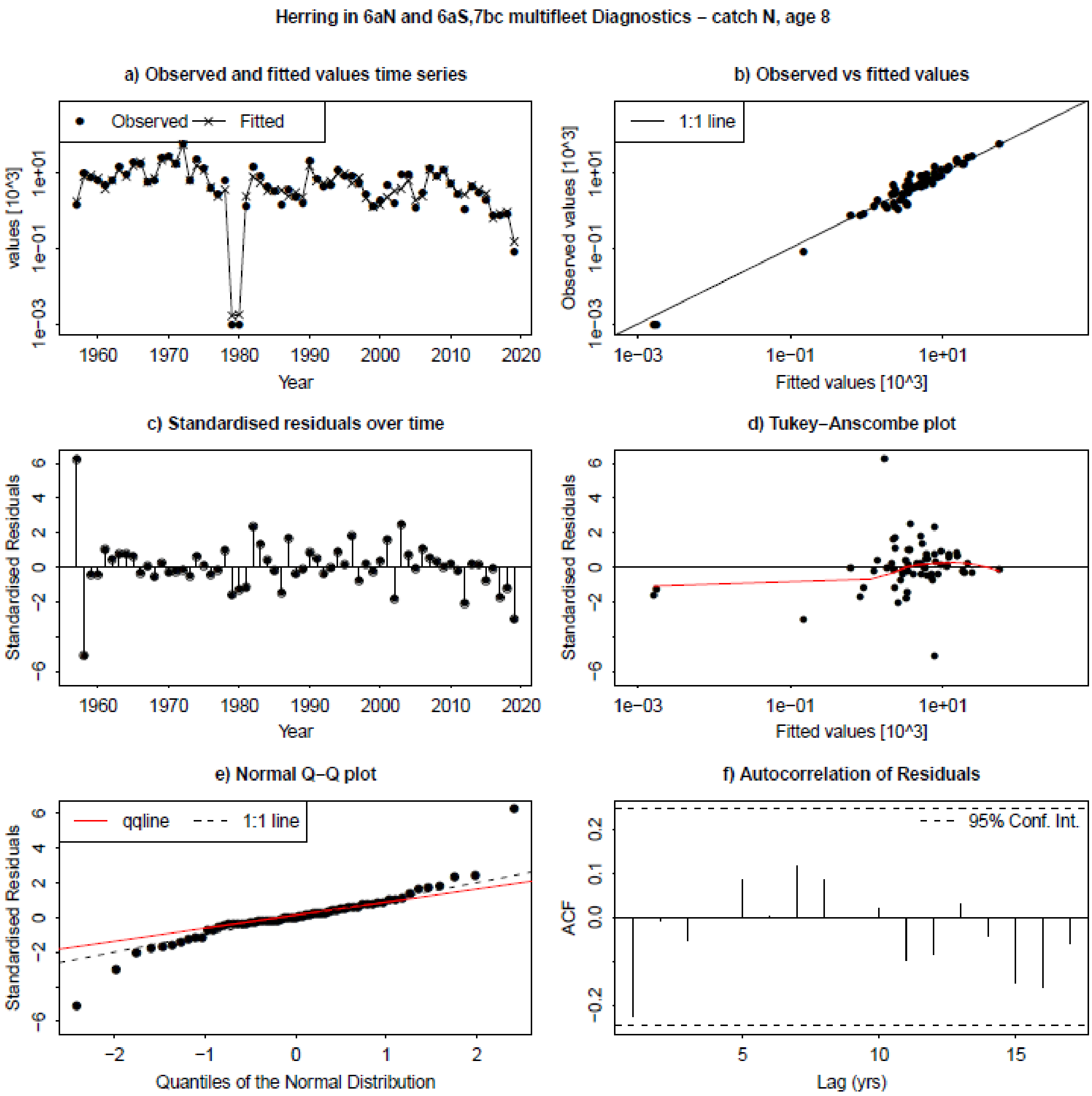


Figure 4.6.22. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from catch abundance at 8-winter ring. Top right: scatterplot of catch observations vs. assessment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

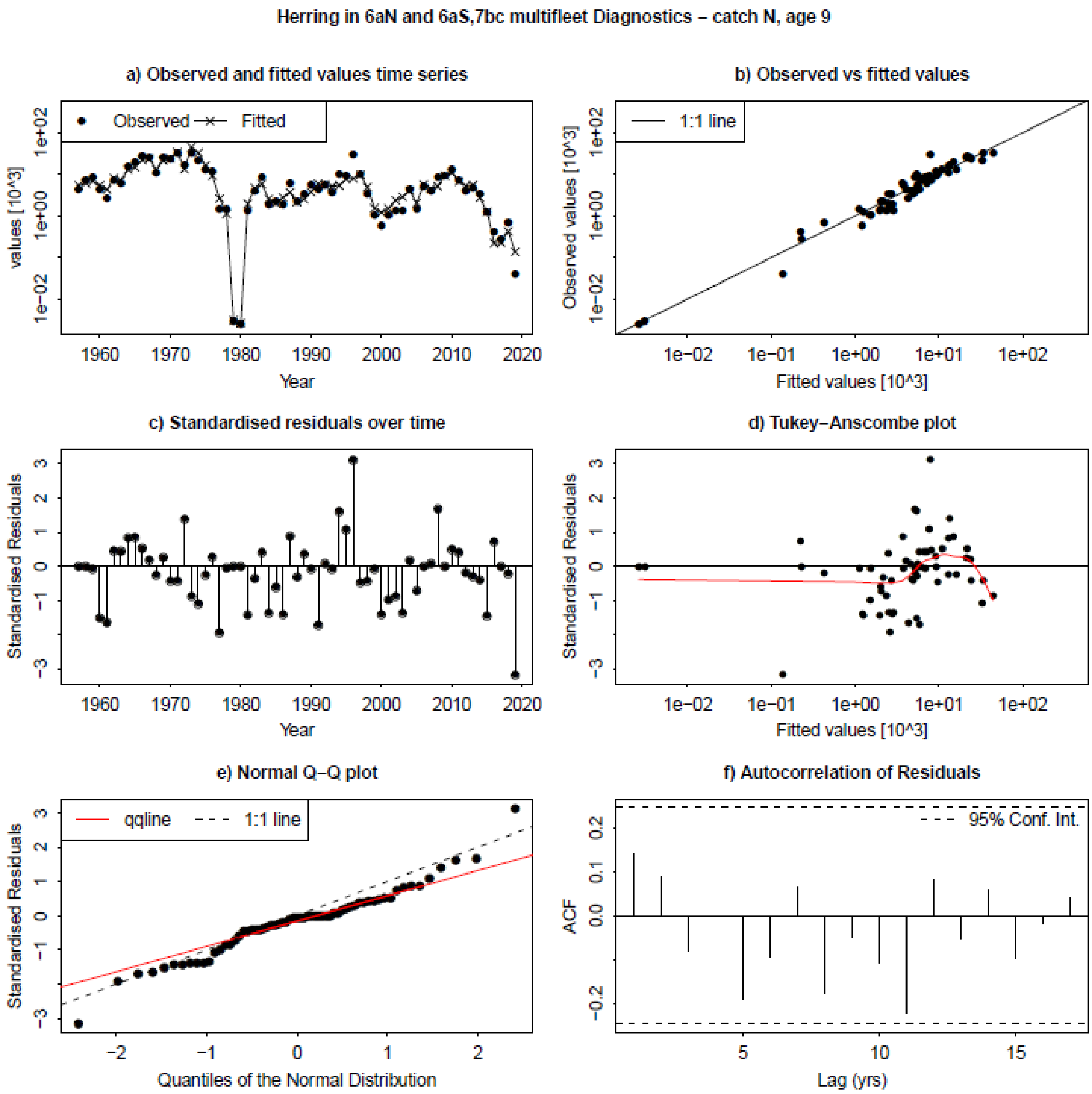


Figure 4.6.23. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from catch abundance at 9-winter ring. Top right: scatterplot of catch observations vs. assessment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

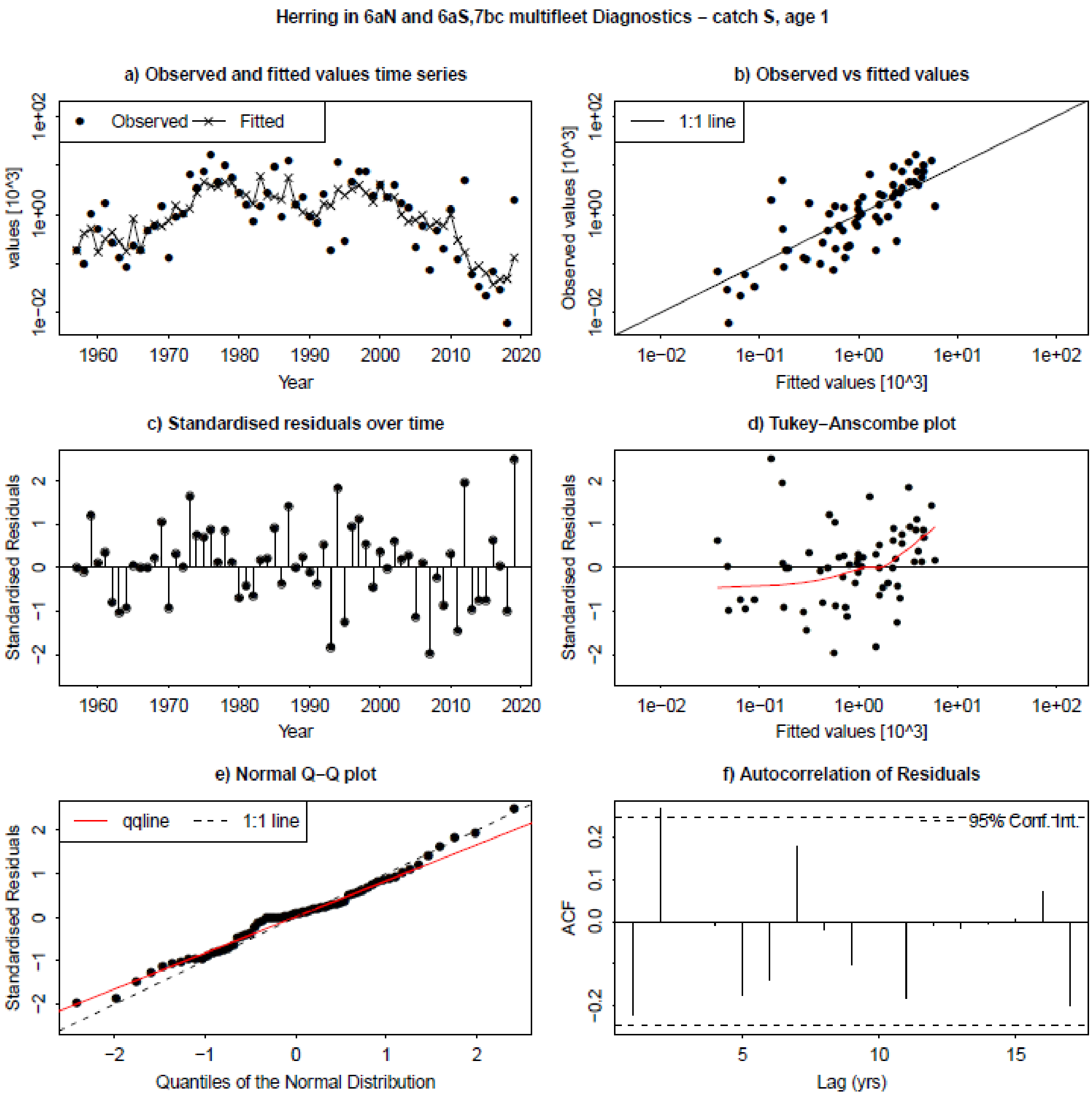


Figure 4.6.24. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from catch abundance at 1-winter ring. Top right: scatterplot of catch observations vs. assessment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

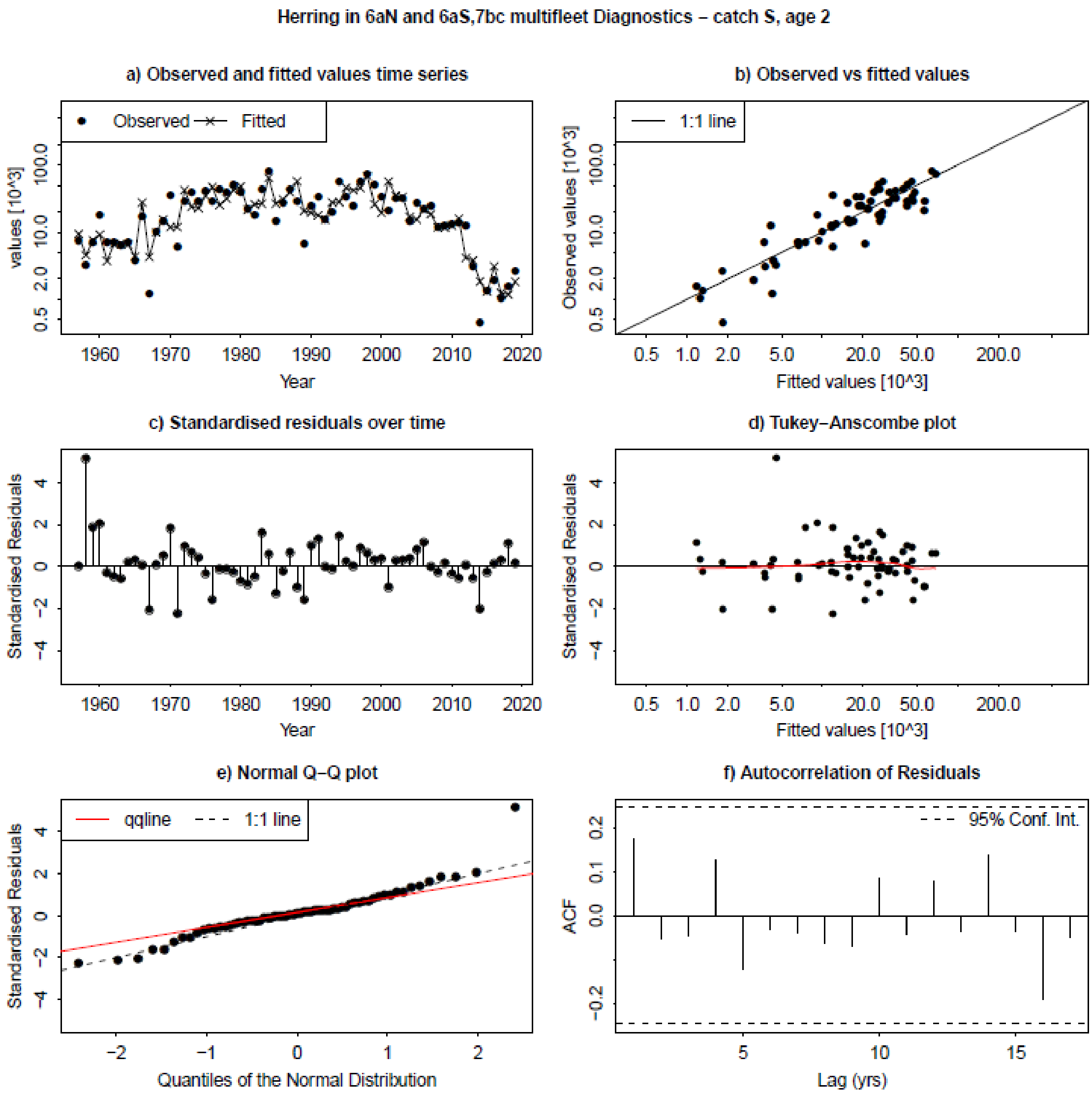


Figure 4.6.25. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from catch abundance at 2-winter ring. Top right: scatterplot of catch observations vs. assessment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

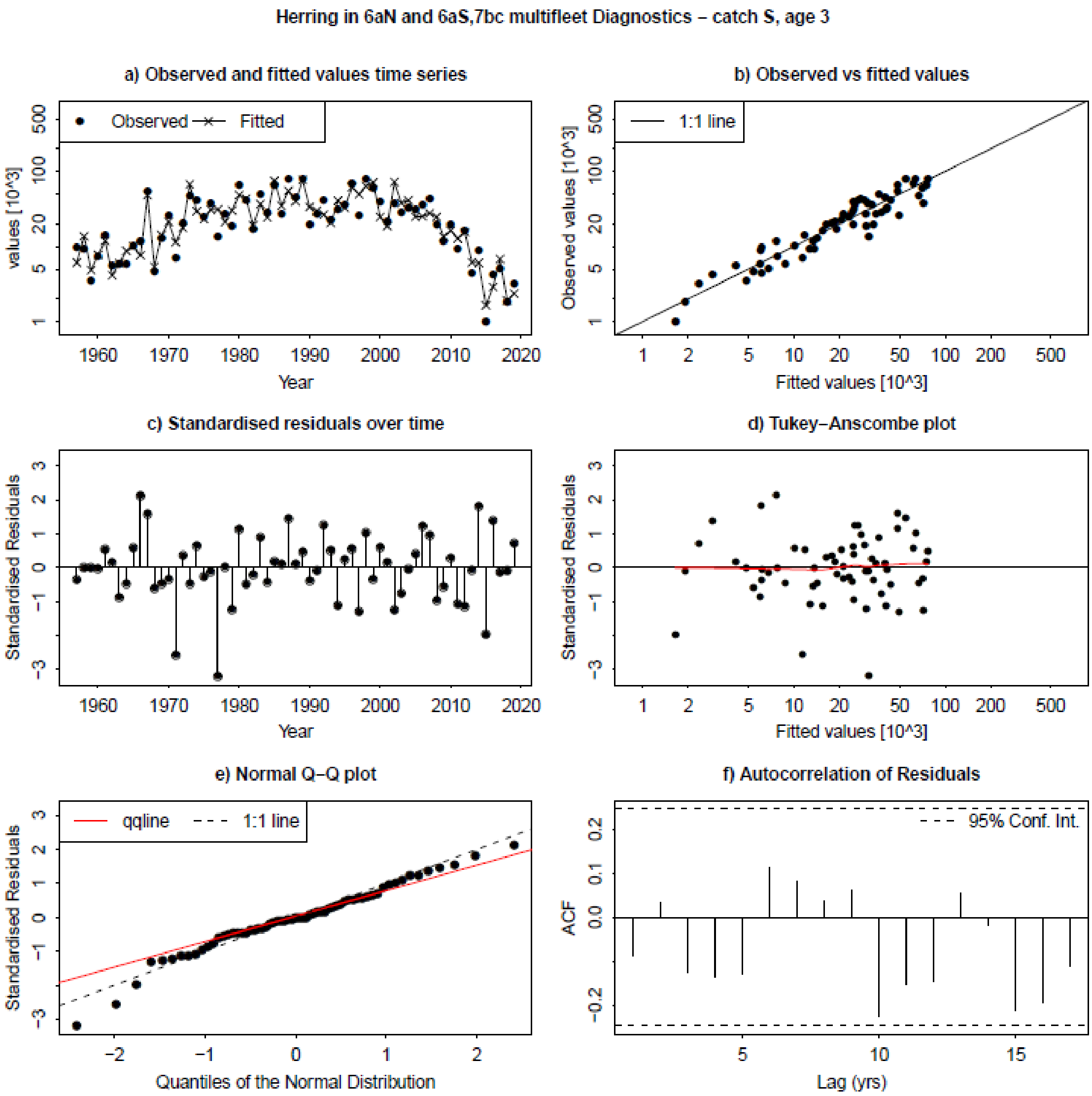


Figure 4.6.26. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from catch abundance at 3-winter ring. Top right: scatterplot of catch observations vs. assessment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

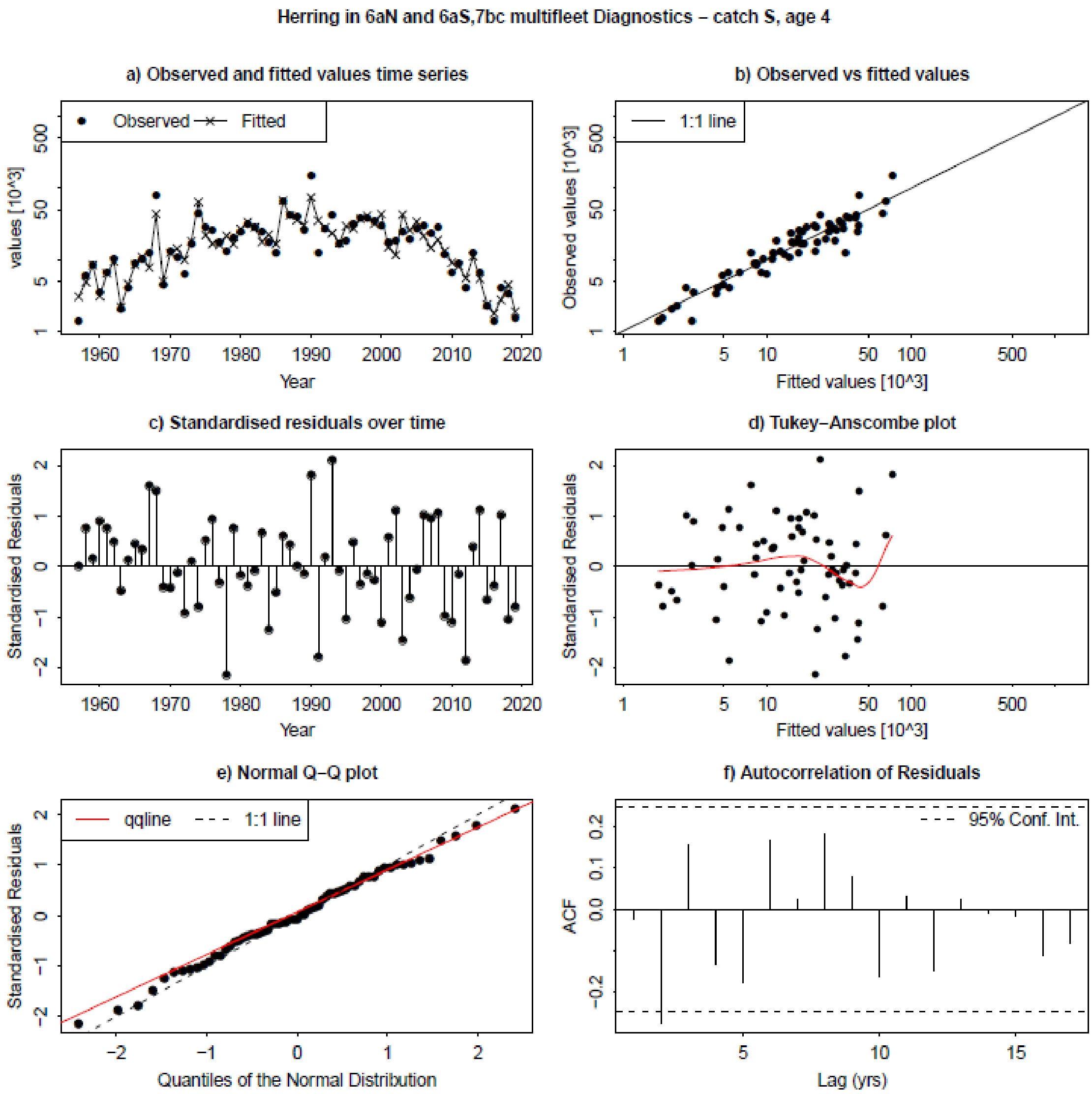


Figure 4.6.27. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from catch abundance at 4-winter ring. Top right: scatterplot of catch observations vs. assessment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

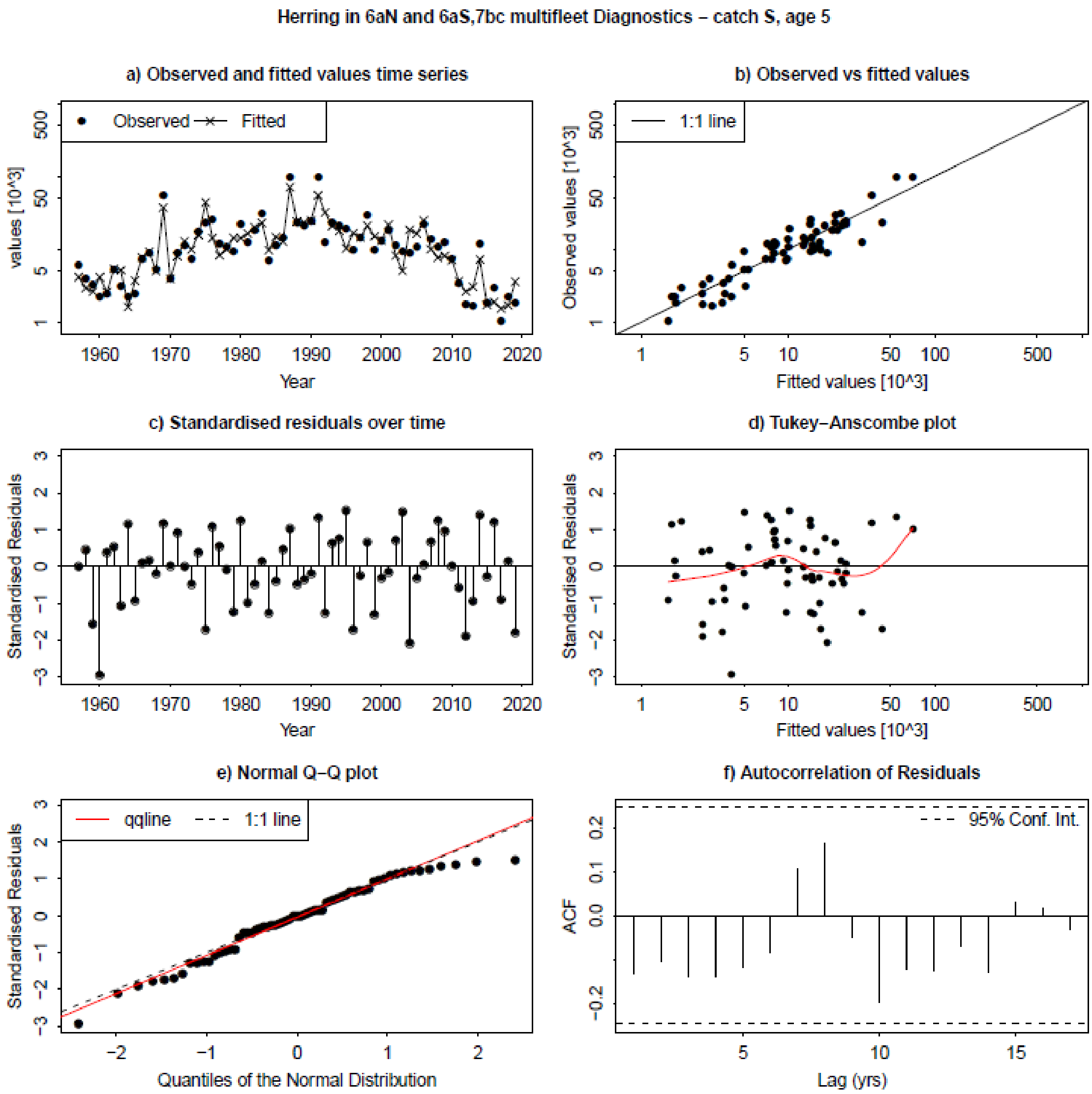


Figure 4.6.28. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from catch abundance at 5-winter ring. Top right: scatterplot of catch observations vs. assessment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

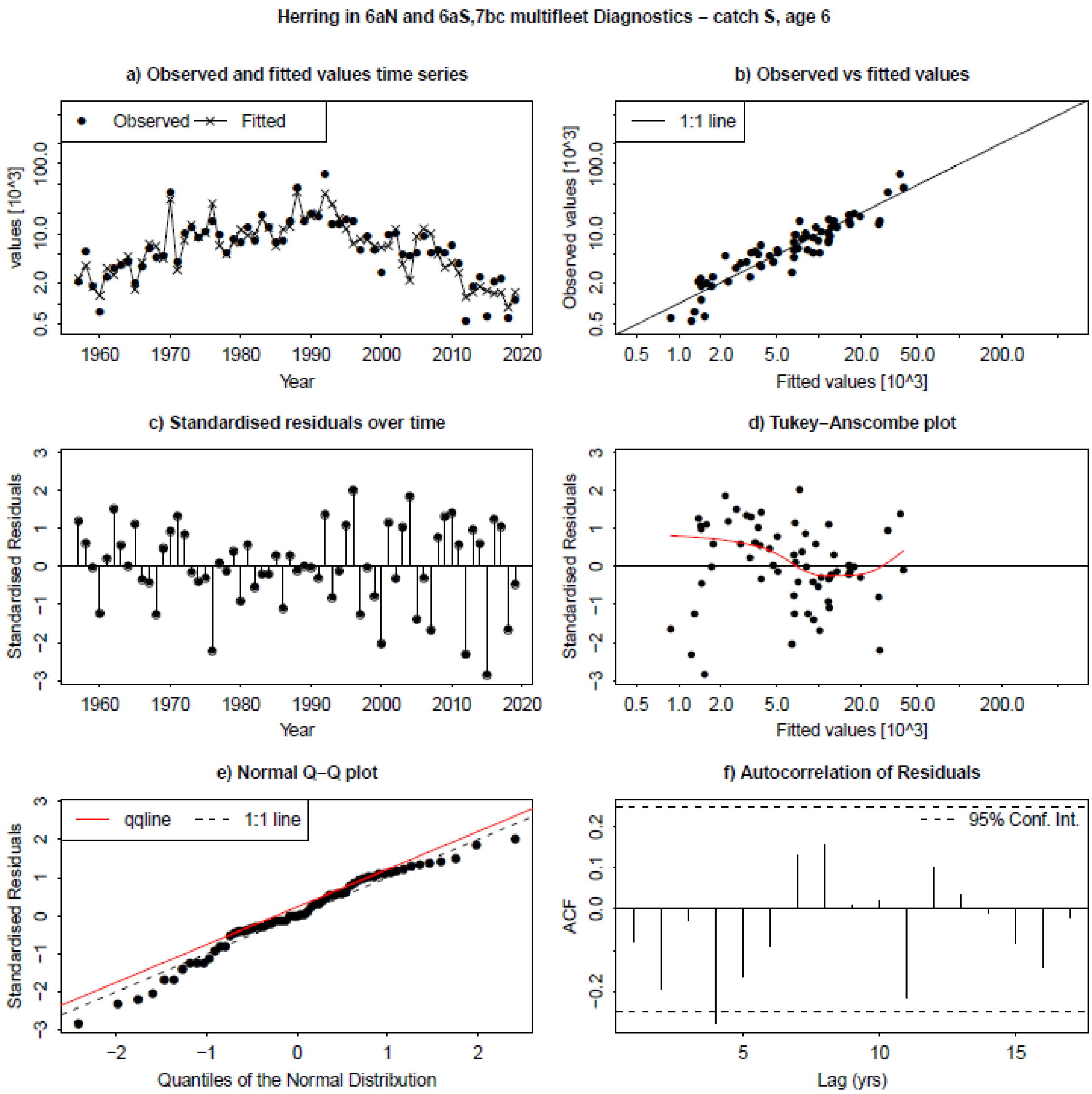


Figure 4.6.29. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from catch abundance at 6-winter ring. Top right: scatterplot of catch observations vs. assessment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

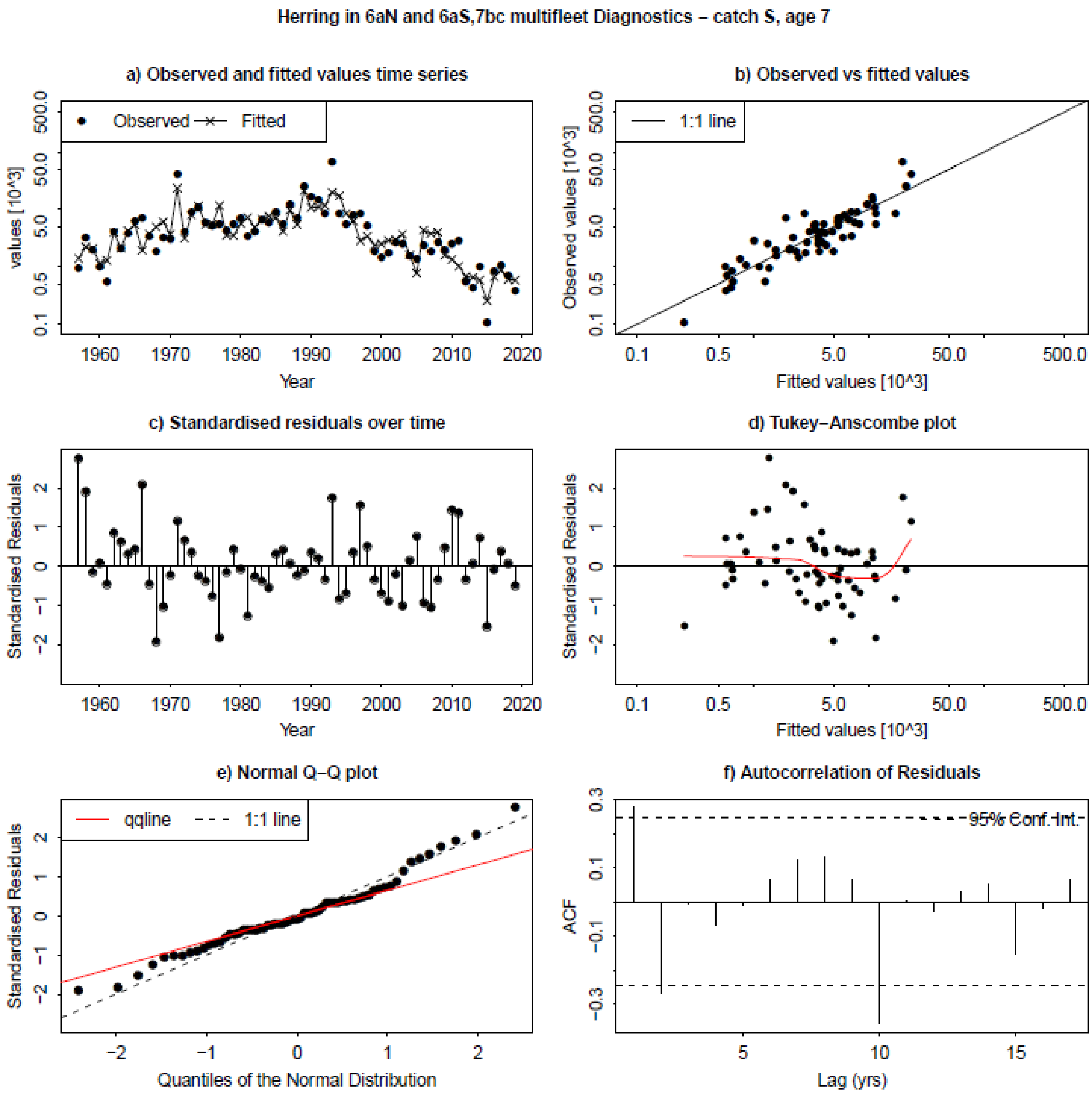


Figure 4.6.30. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from catch abundance at 7-winter ring. Top right: scatterplot of catch observations vs. assessment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

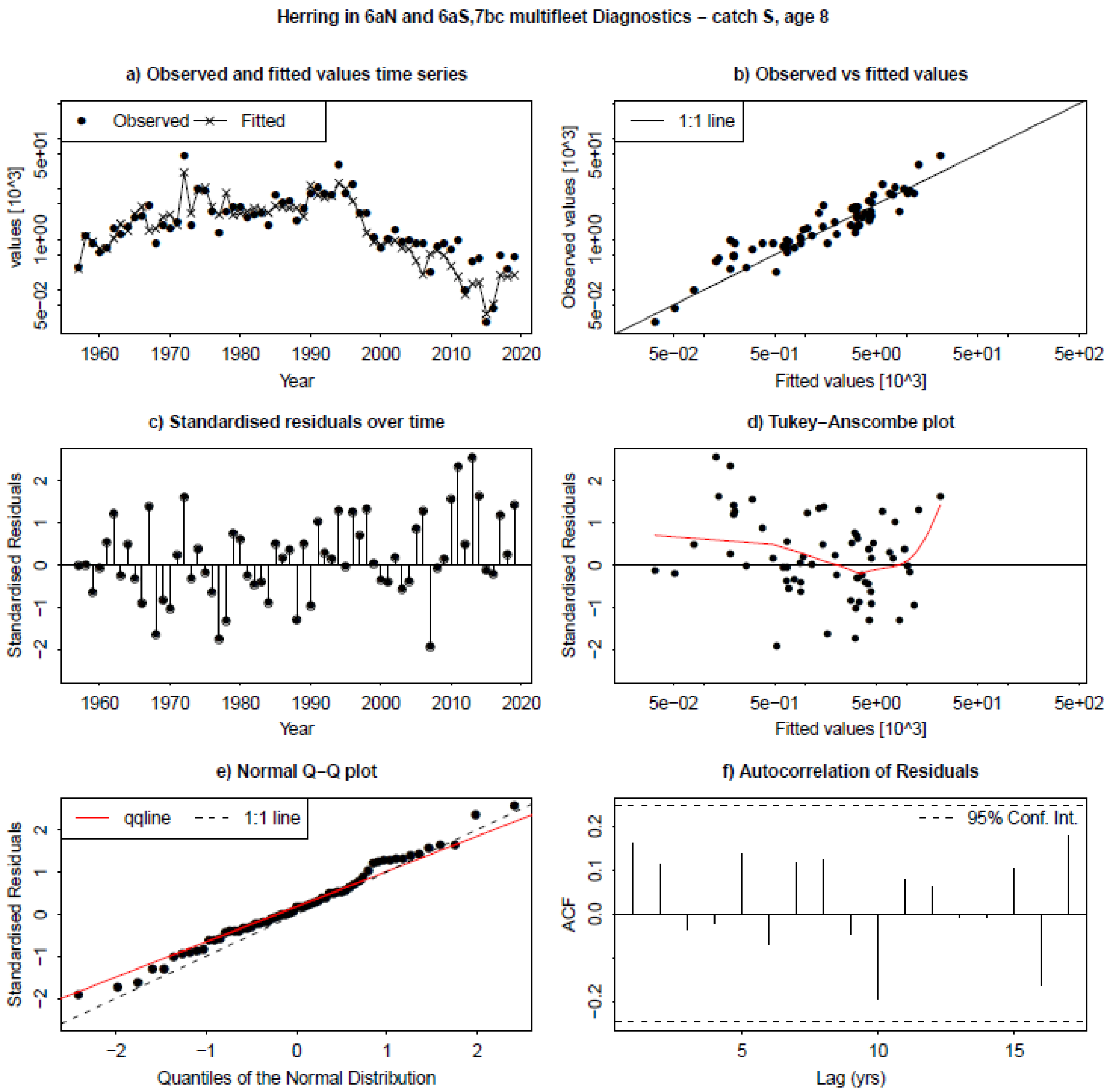


Figure 4.6.31. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from catch abundance at 8-winter ring. Top right: scatterplot of catch observations vs. assessment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

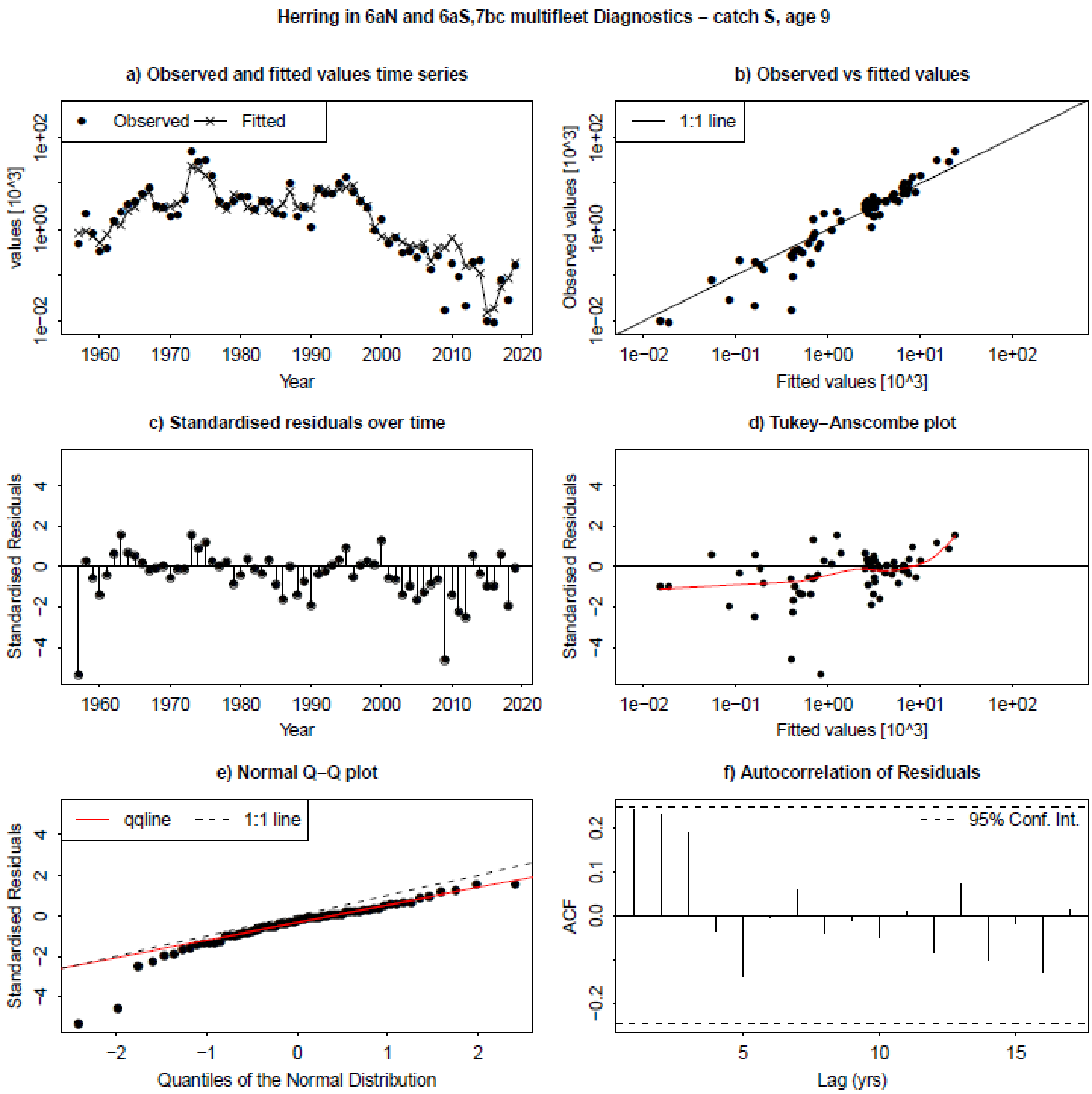


Figure 4.6.32. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the catch at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from catch abundance at 9-winter ring. Top right: scatterplot of catch observations vs. assessment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

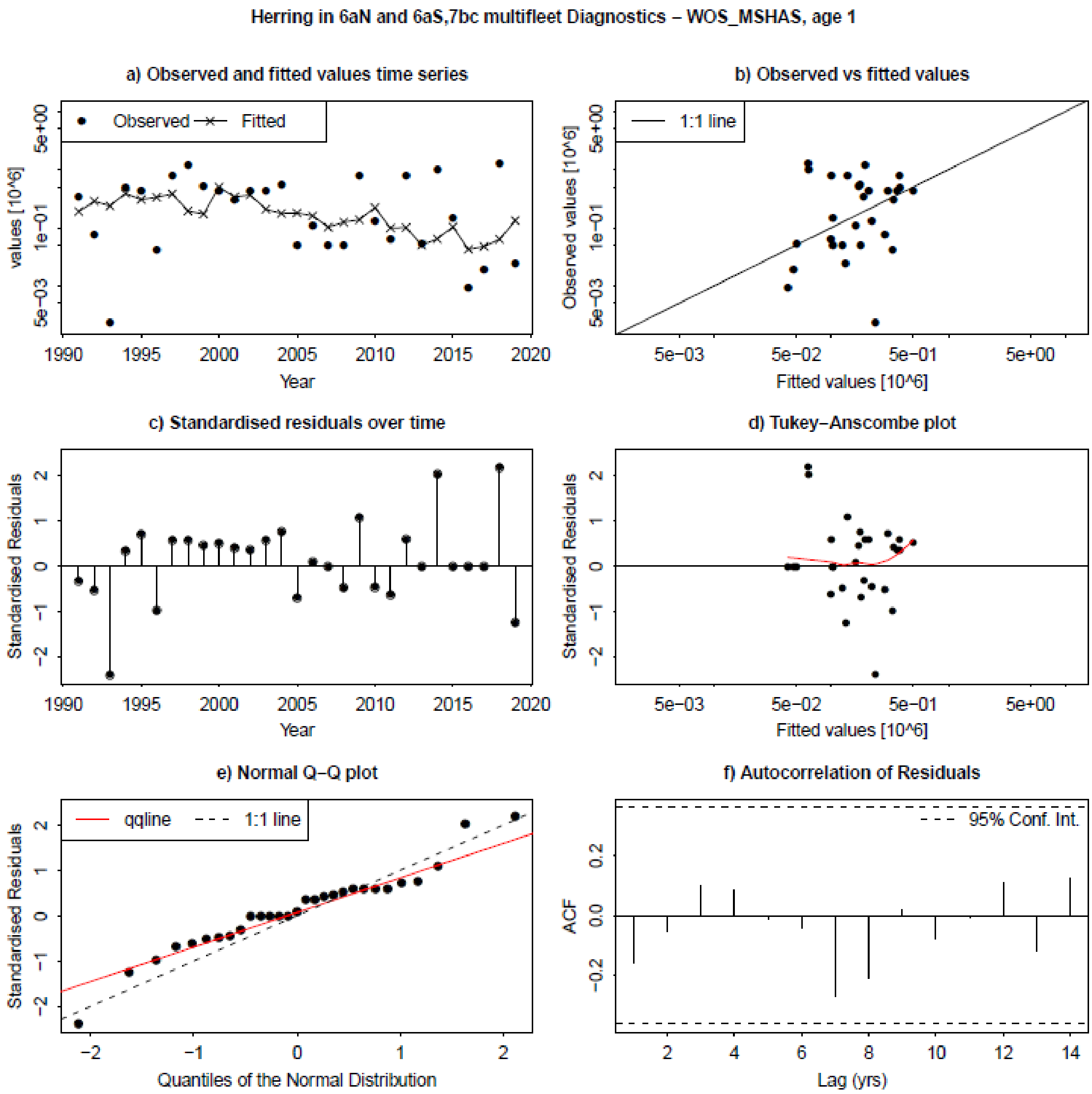


Figure 4.6.33. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 1-winter ring time-series. Top left: Estimates of numbers at 1-winter ring (line) and numbers predicted from index abundance at 1-winter ring. Top right: scatterplot of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

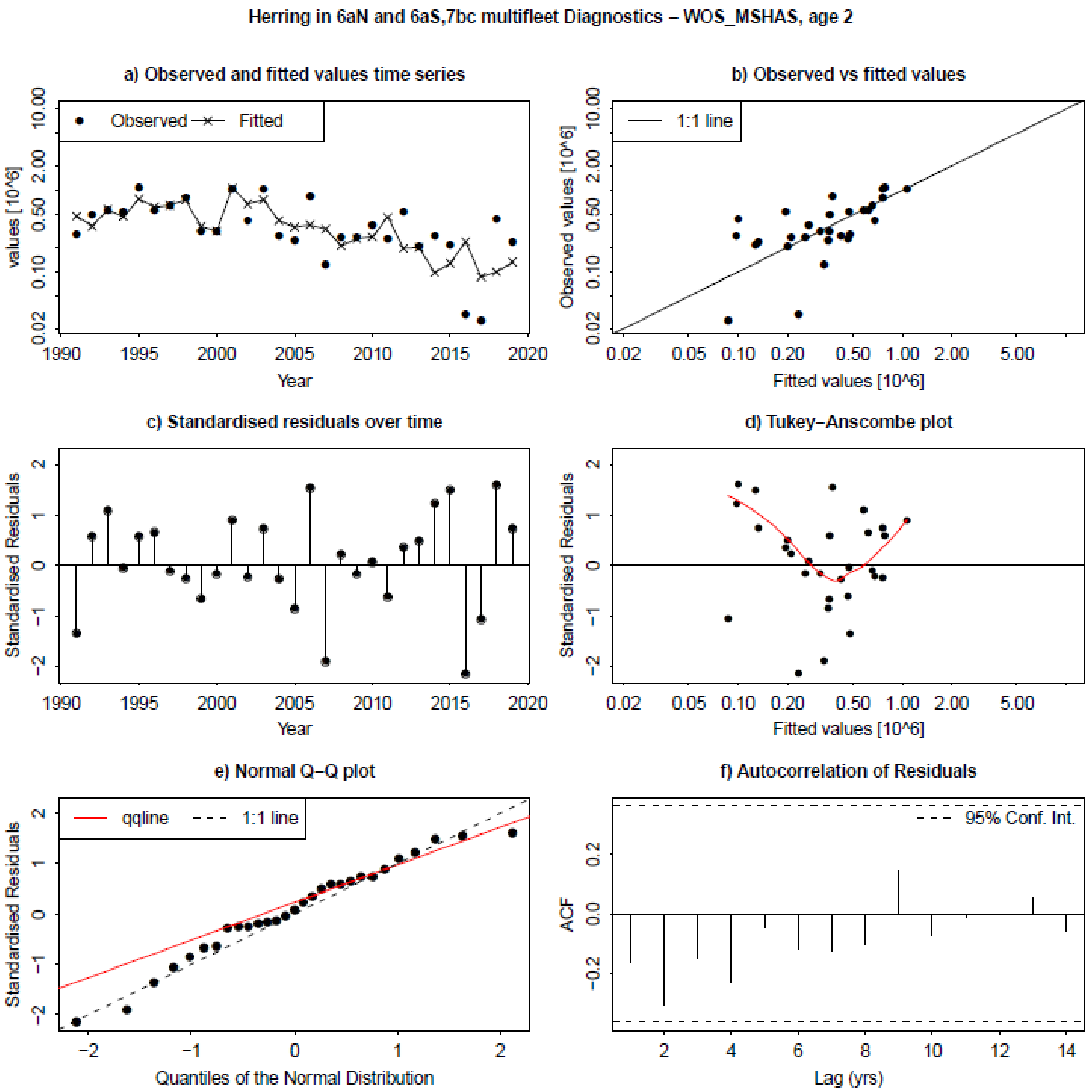
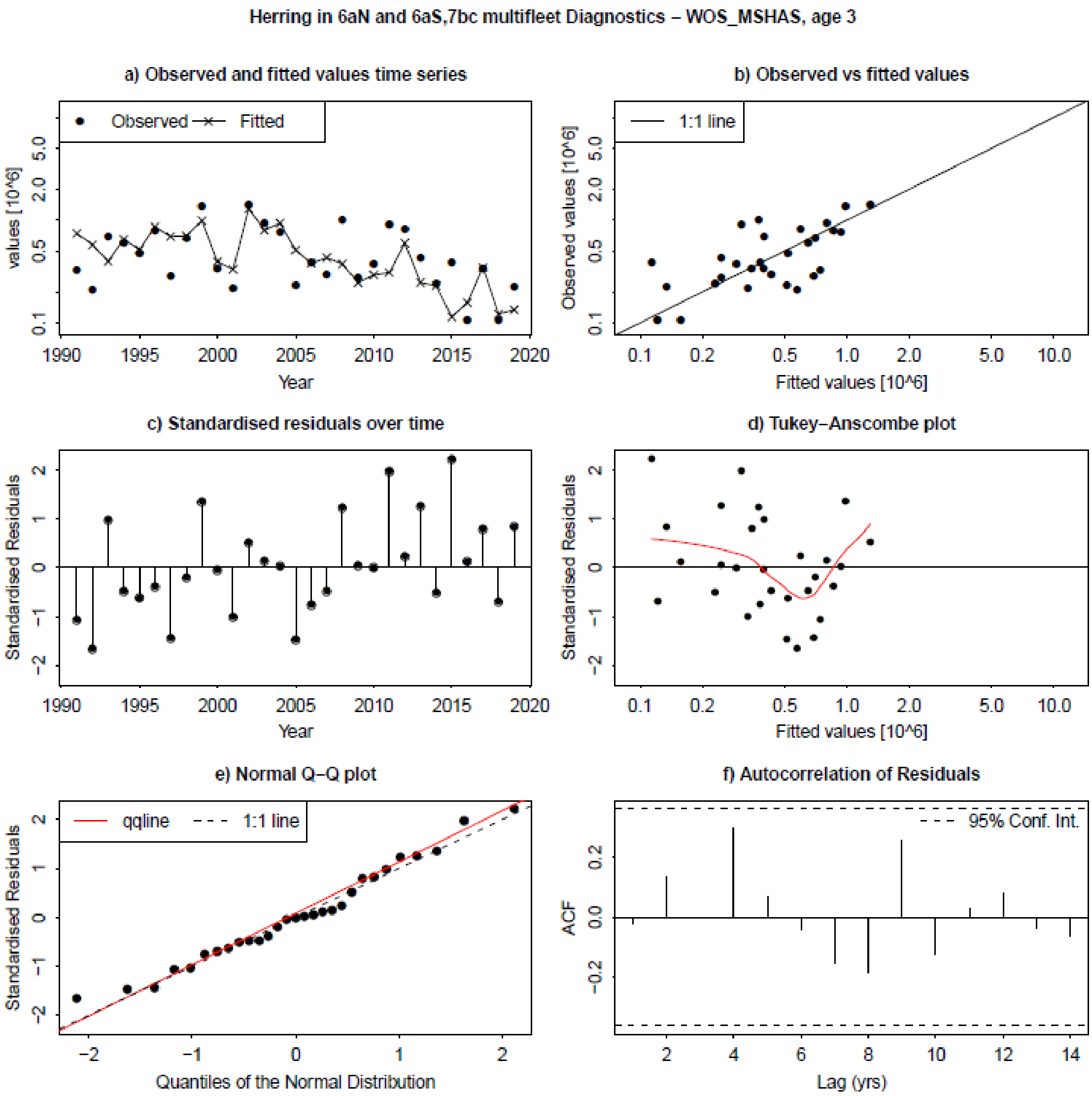


Figure 4.6.34. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: scatterplot of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


Herring in 6aN and 6aS,7bc multifleet Diagnostics – WOS_MSHAS, age 3
a) Observed and fitted values time series
Observed
Fitted
values [10^6]
Year
b) Observed vs fitted values
1:1 line
Observed values [10^6]
Fitted values [10^6]
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey–Anscombe plot
Standardised Residuals
Fitted values [10^6]
e) Normal Q–Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

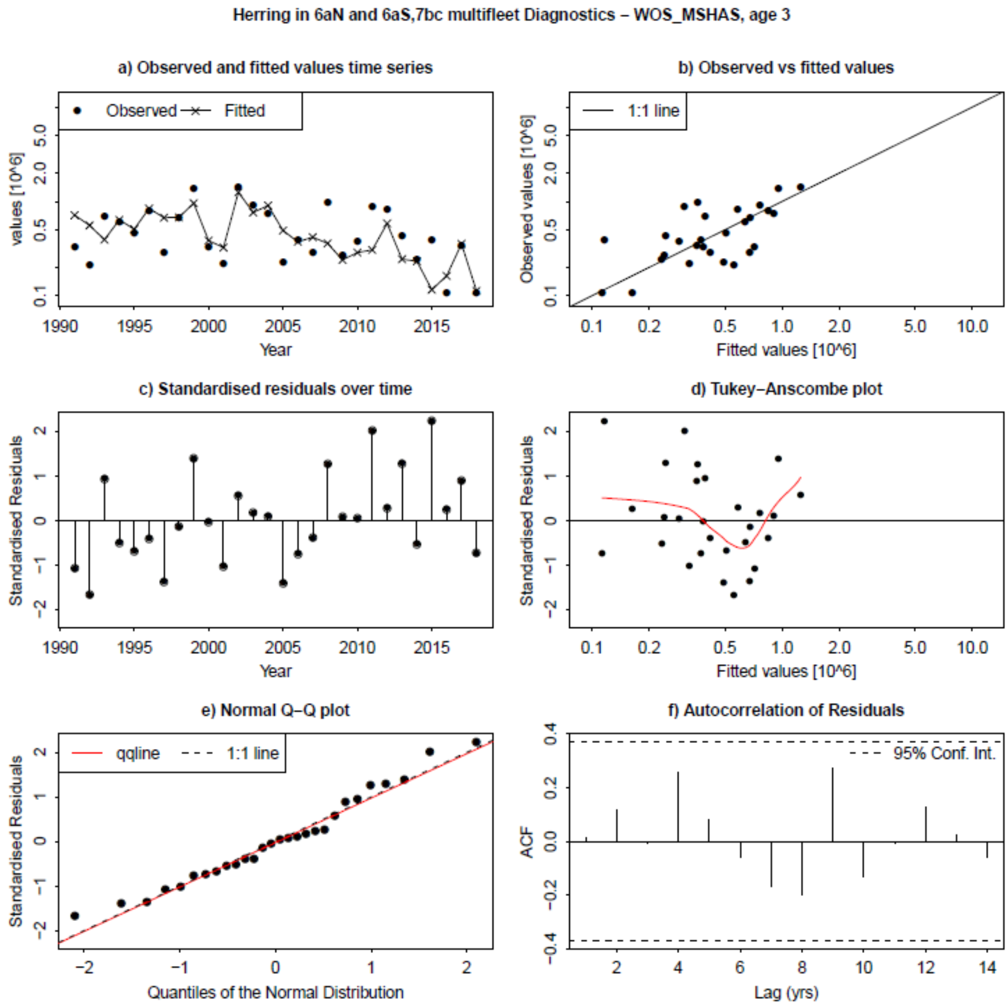


Figure 4.6.35. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: scatterplot of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

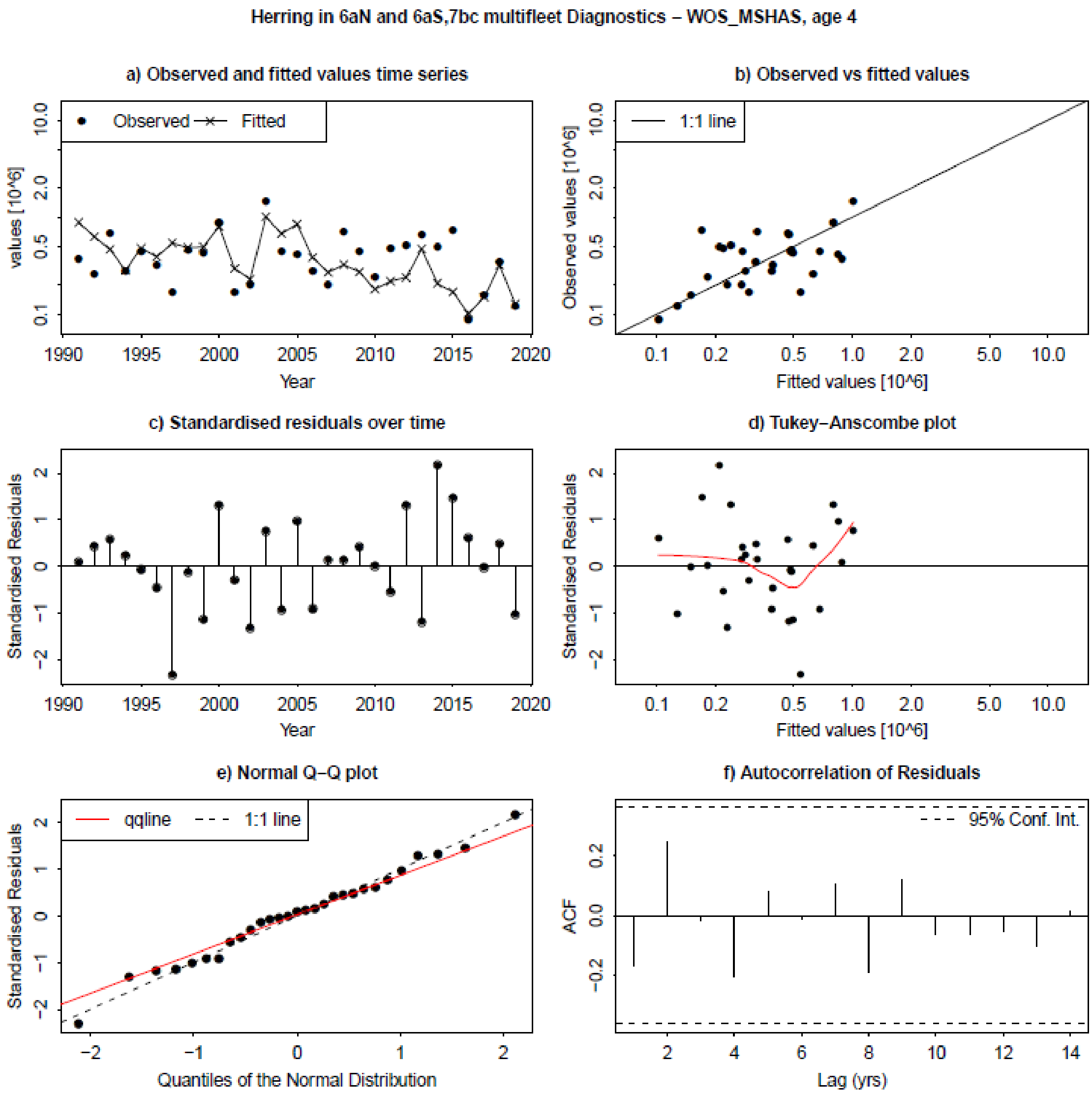


Figure 4.6.36. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: scatterplot of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

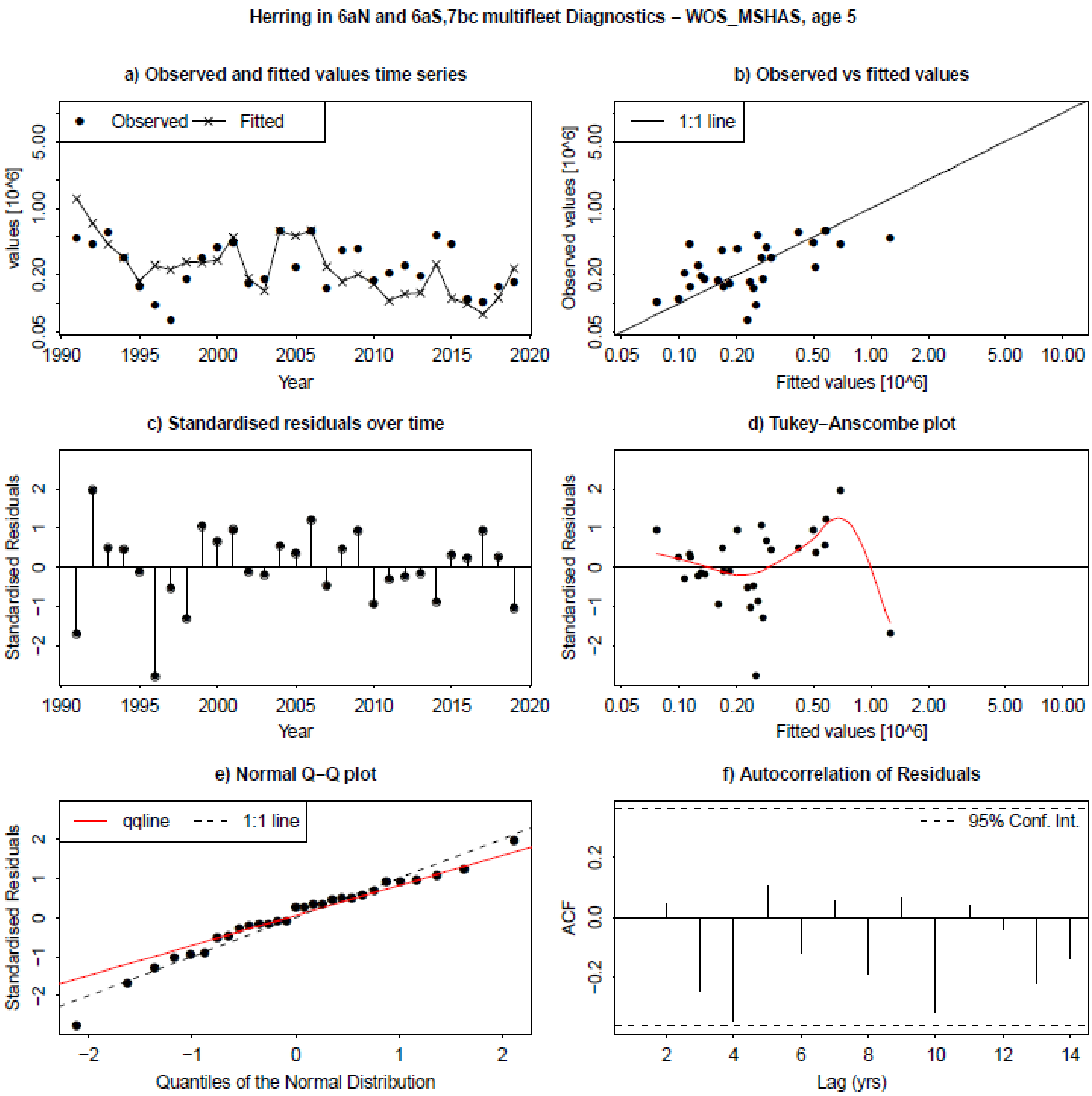


Figure 4.6.37. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: scatterplot of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

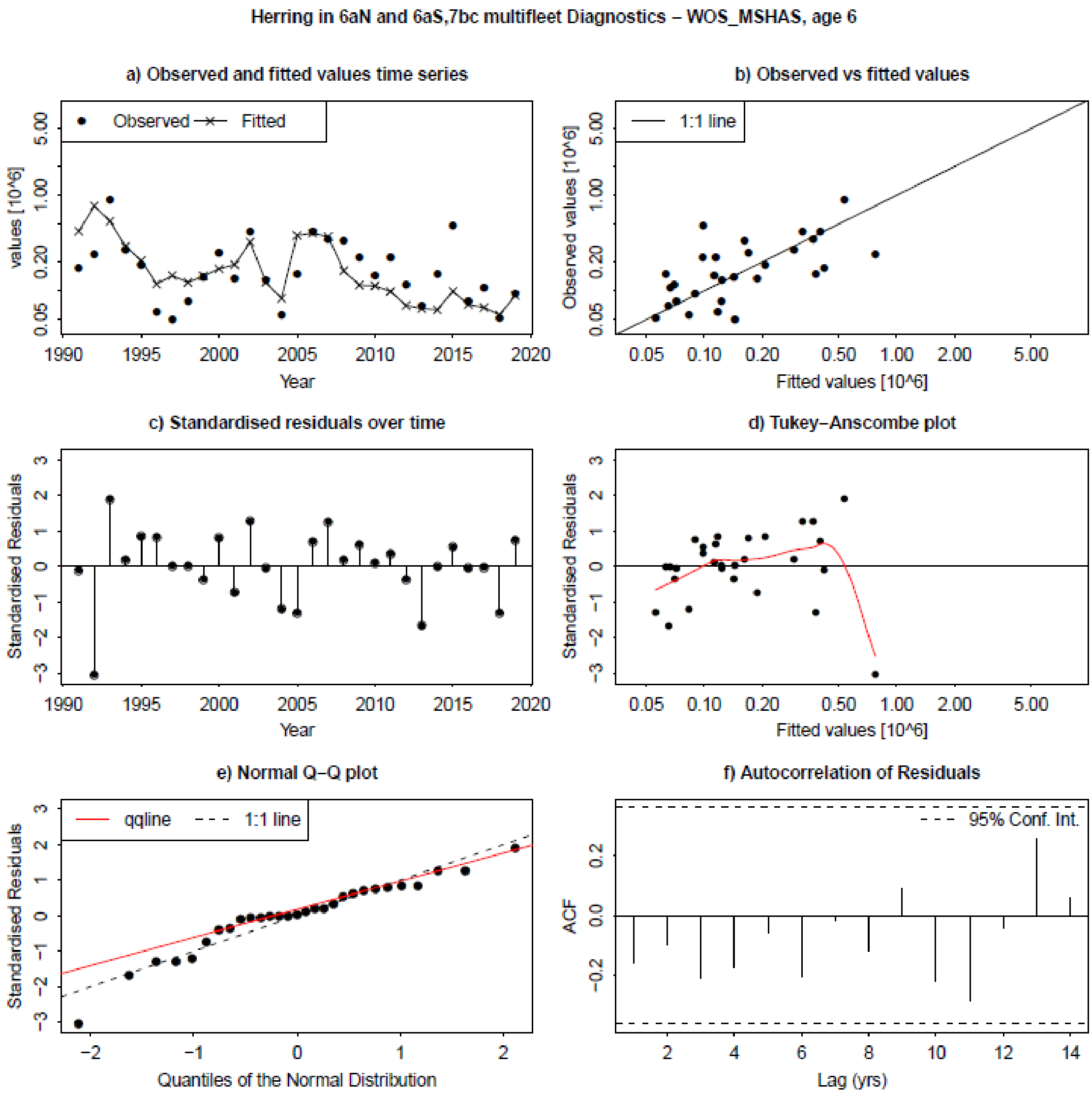


Figure 4.6.38. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: scatterplot of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

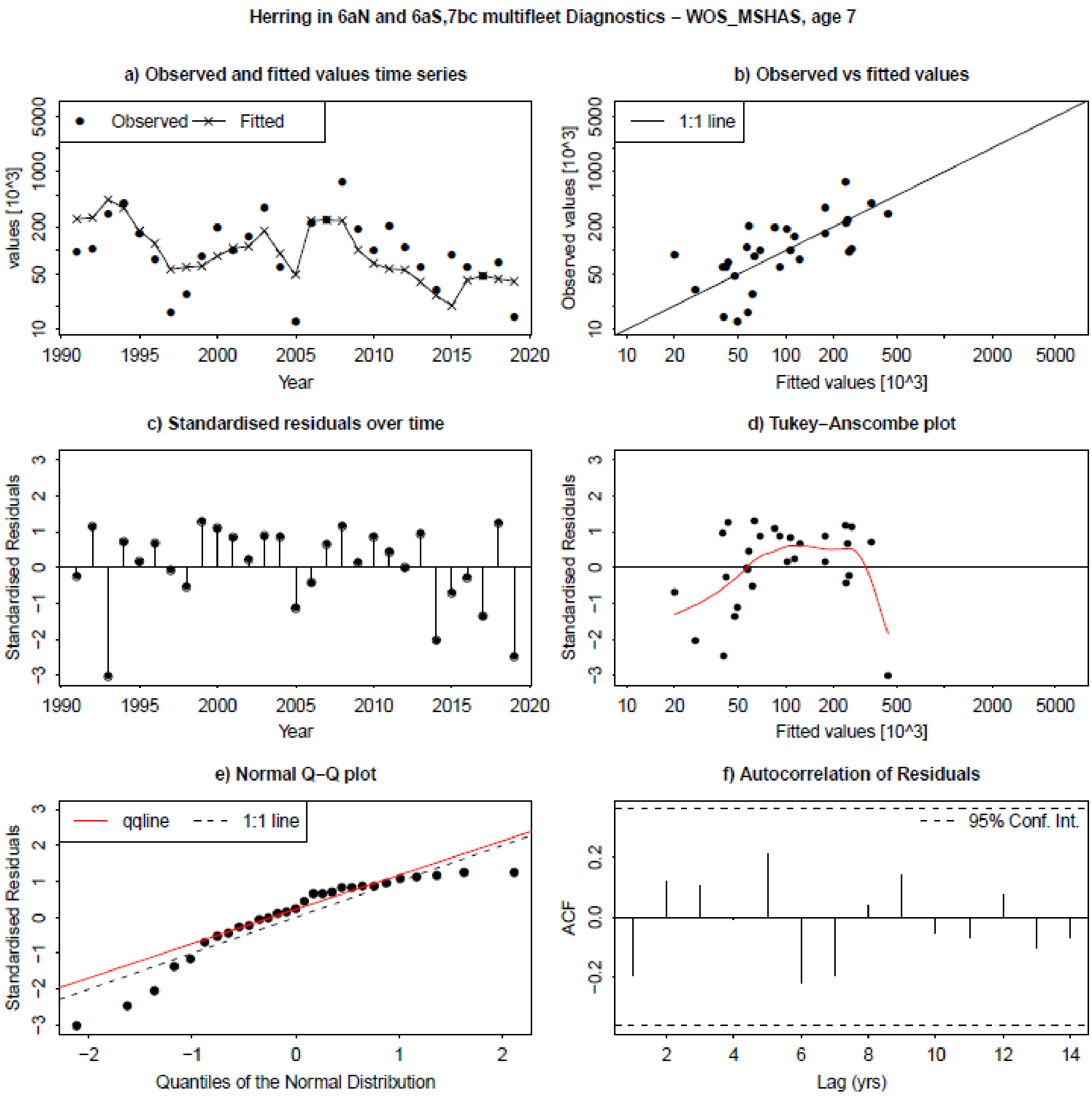


Figure 4.6.39. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: scatterplot of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

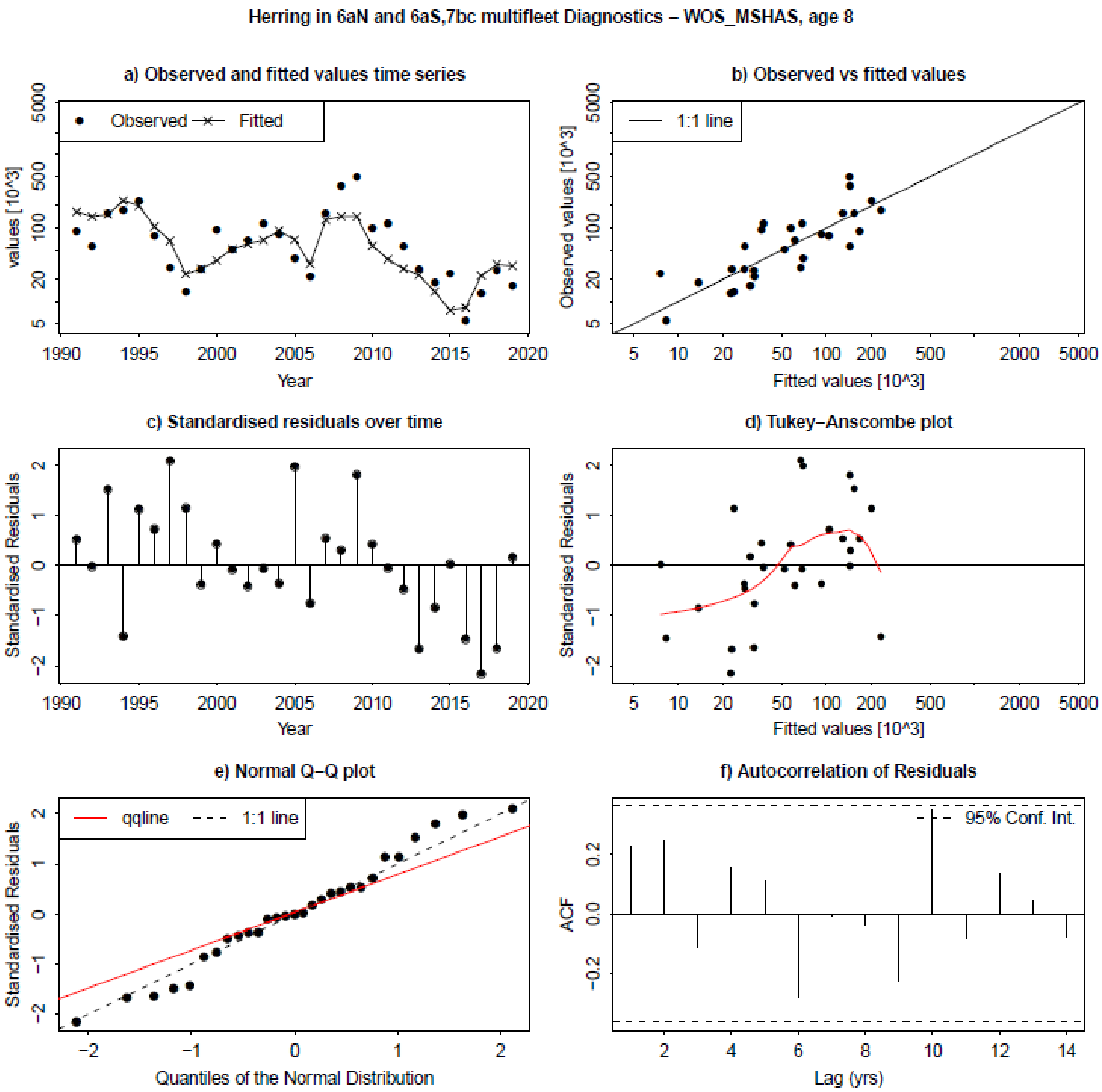


Figure 4.6.40. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: scatterplot of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

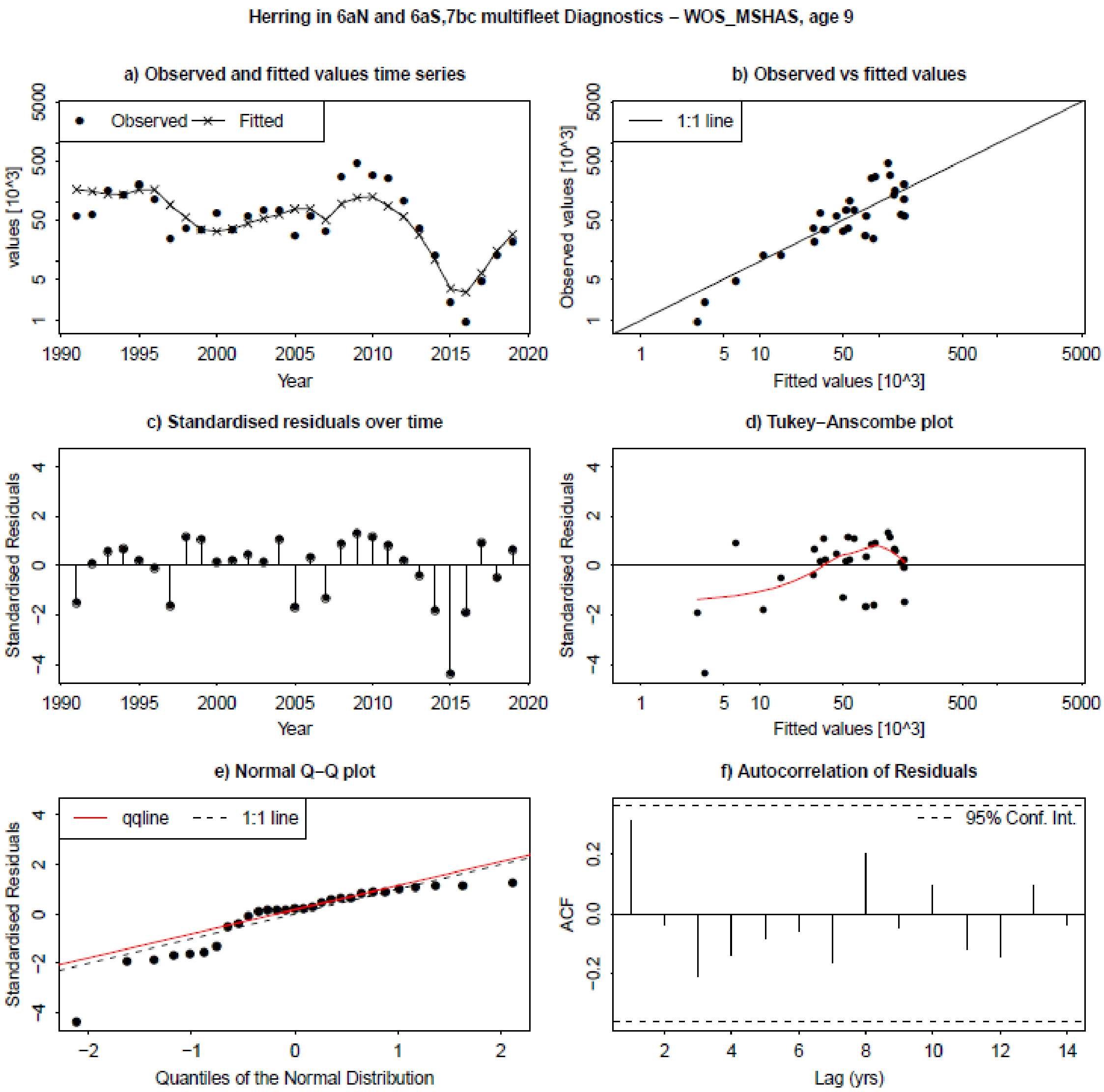


Figure 4.6.41. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the WoS_MSHAS acoustic survey index at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: scatterplot of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

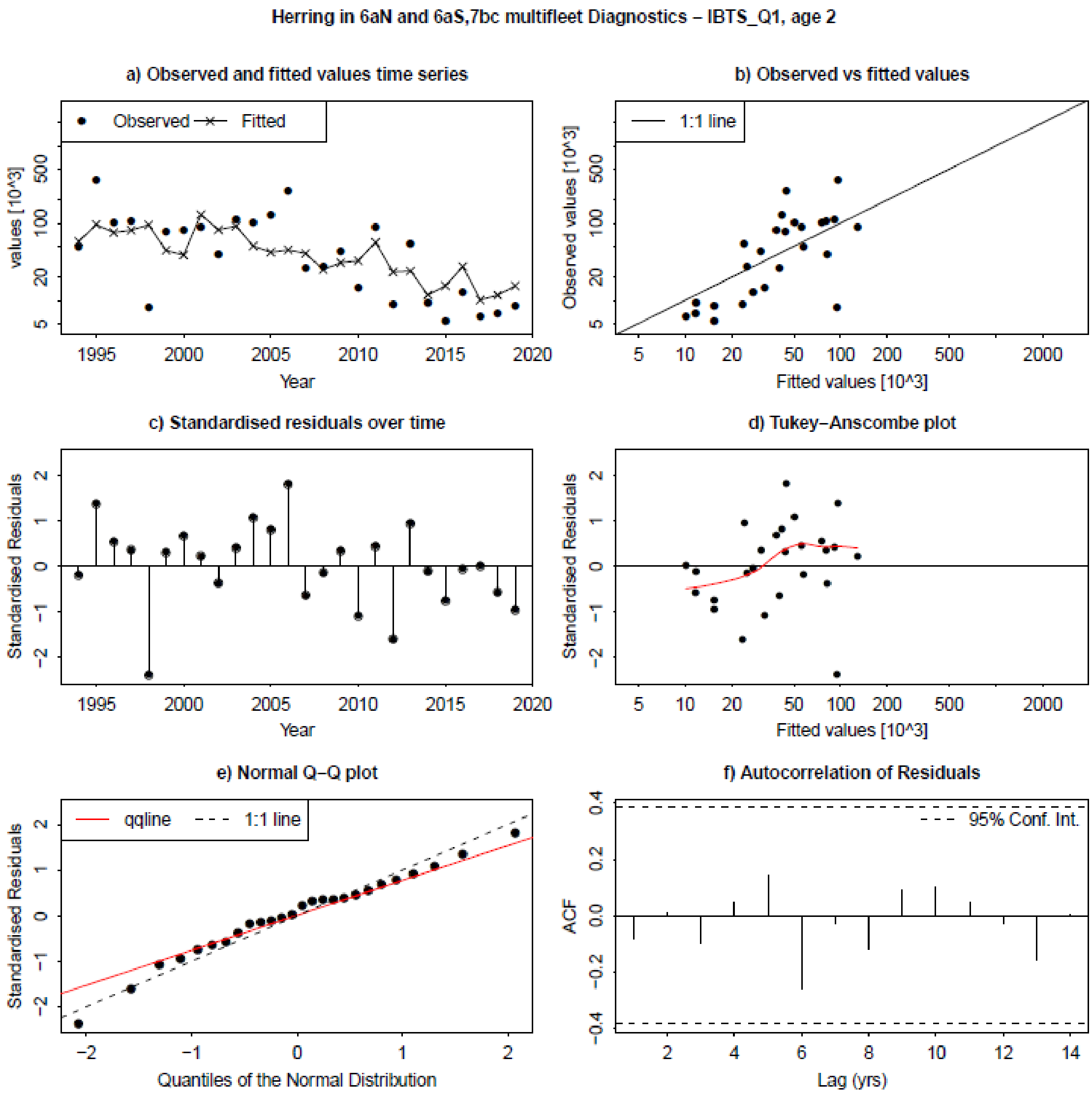


Figure 4.6.42. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: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

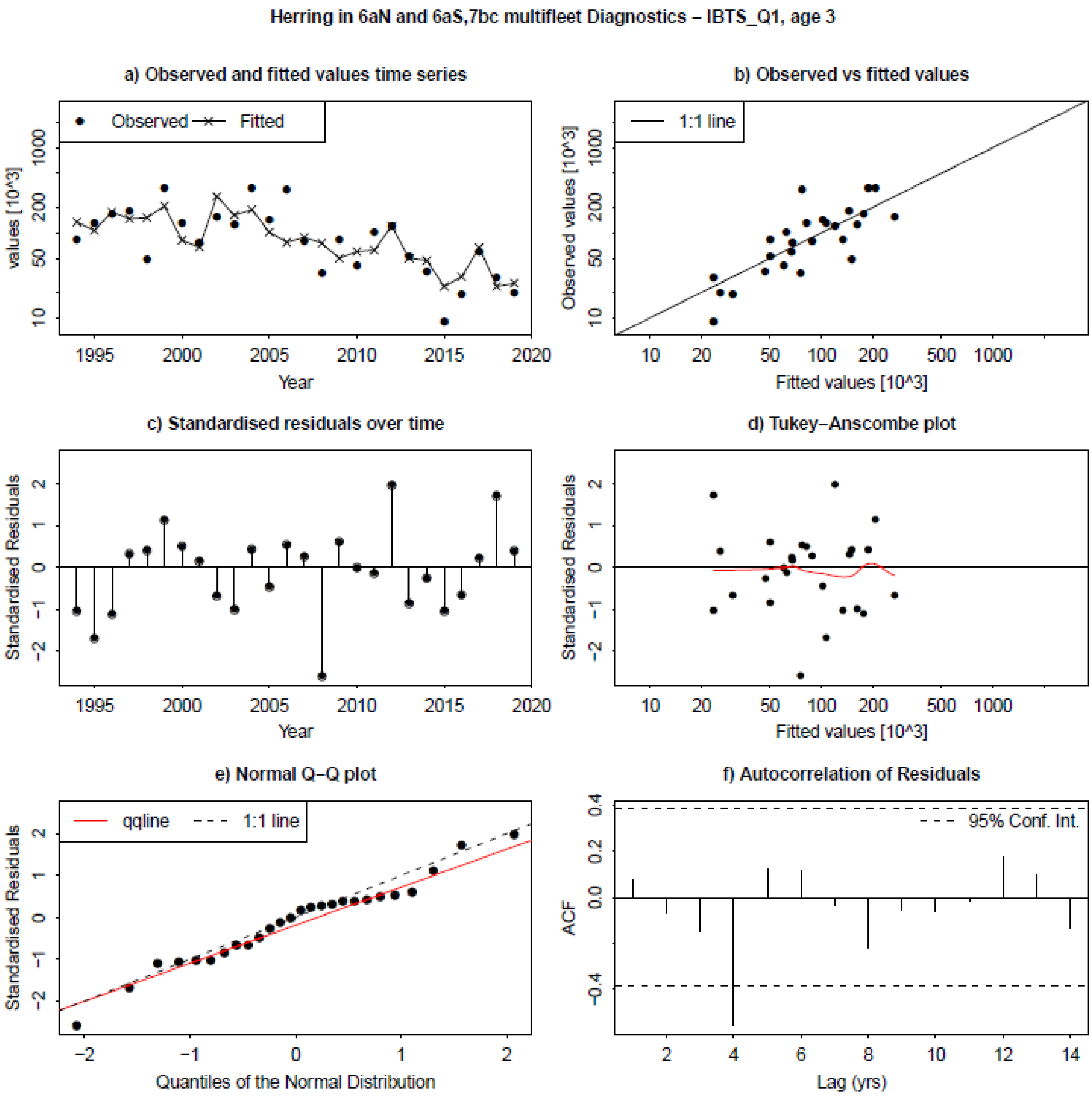


Figure 4.6.43. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: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

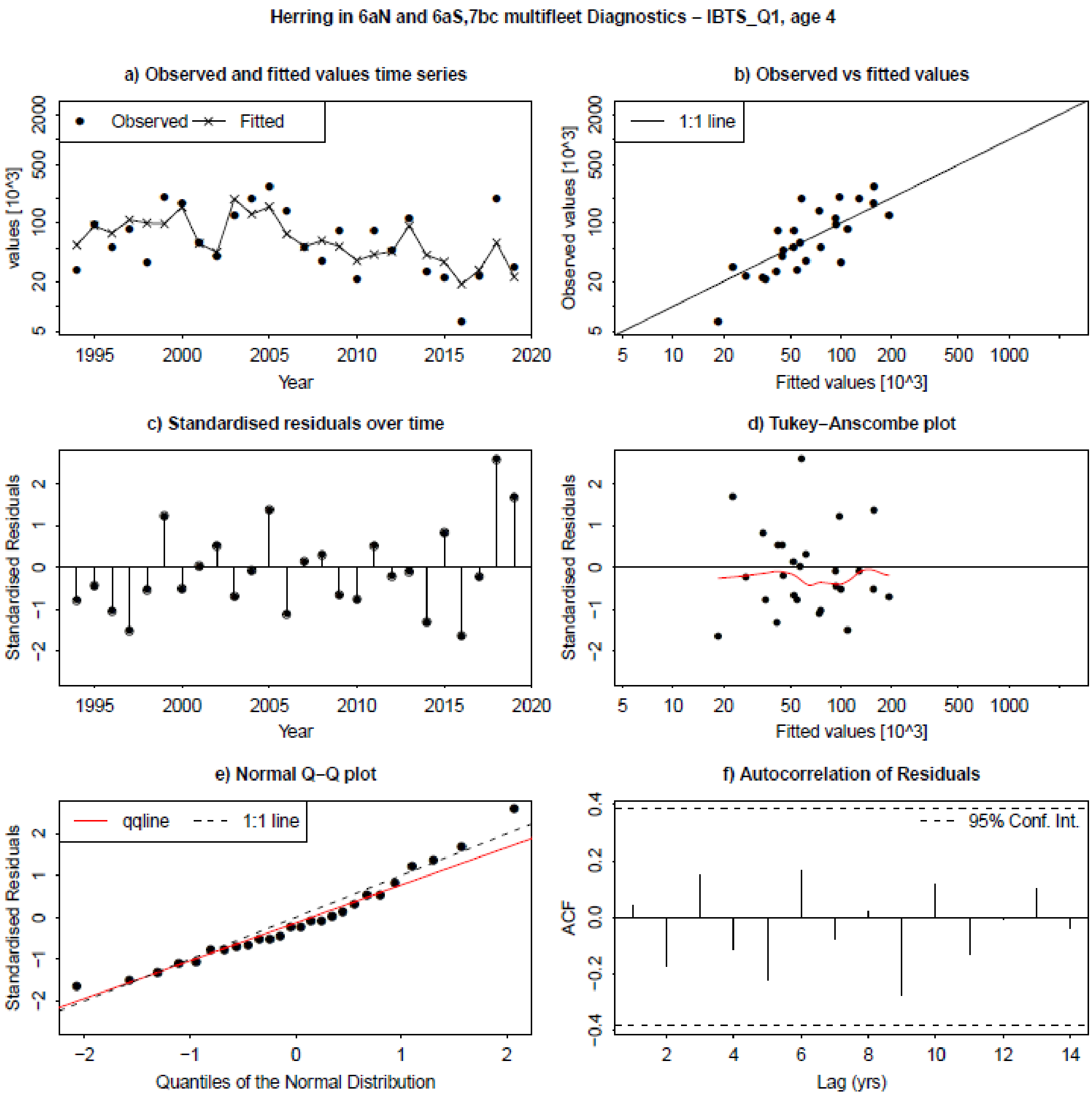


Figure 4.6.44. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: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

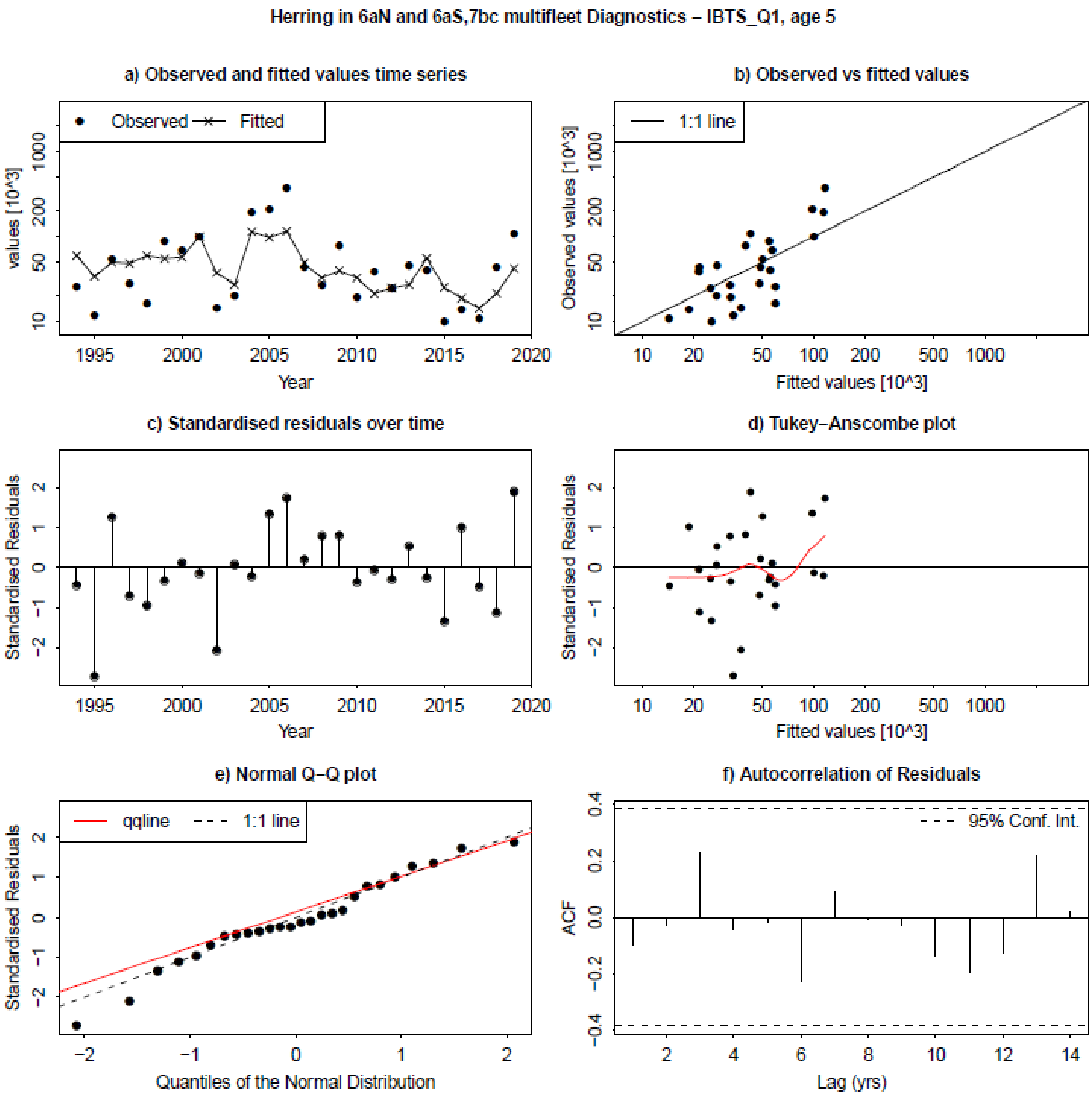


Figure 4.6.45. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: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

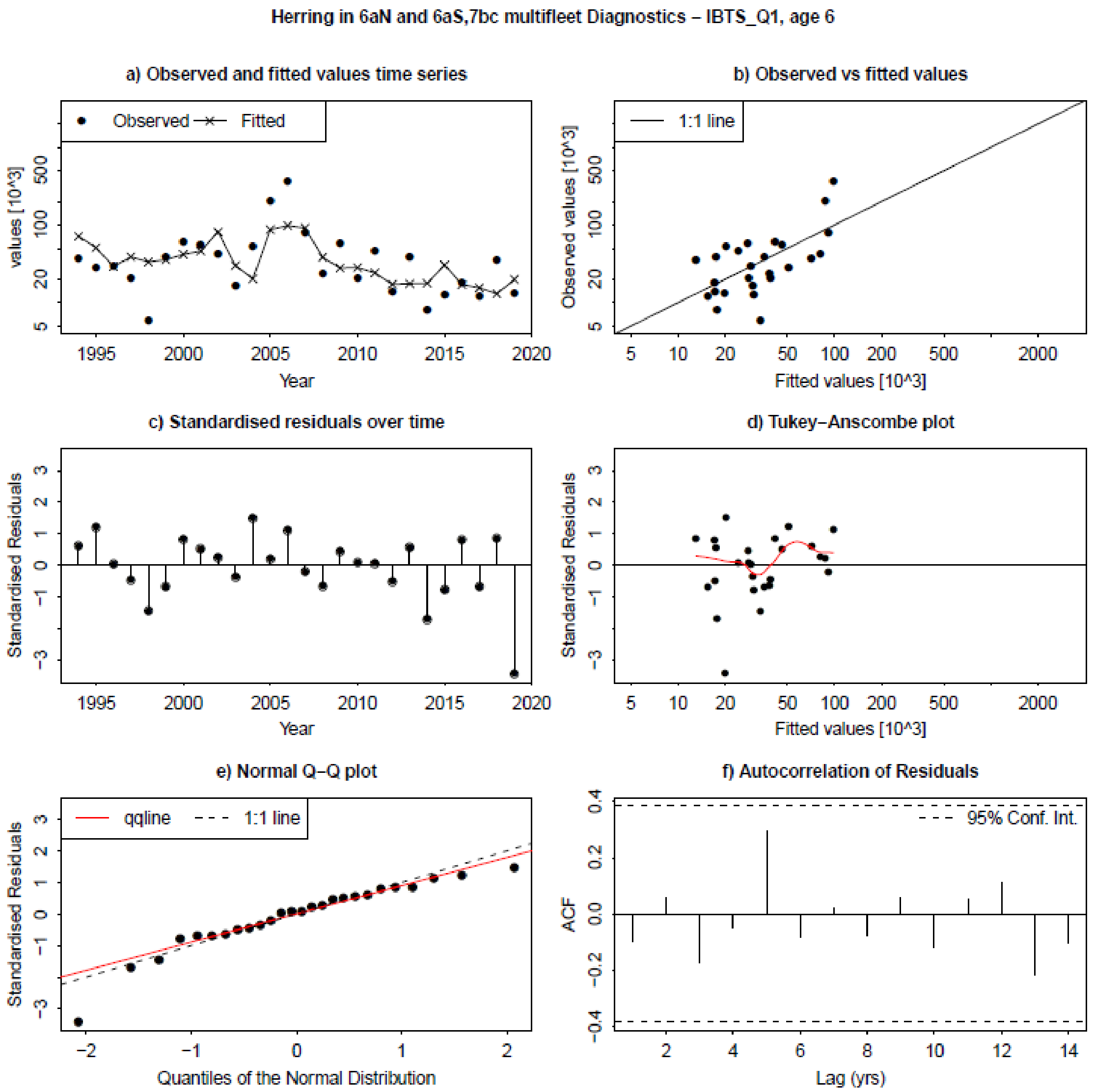


Figure 4.6.46. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: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

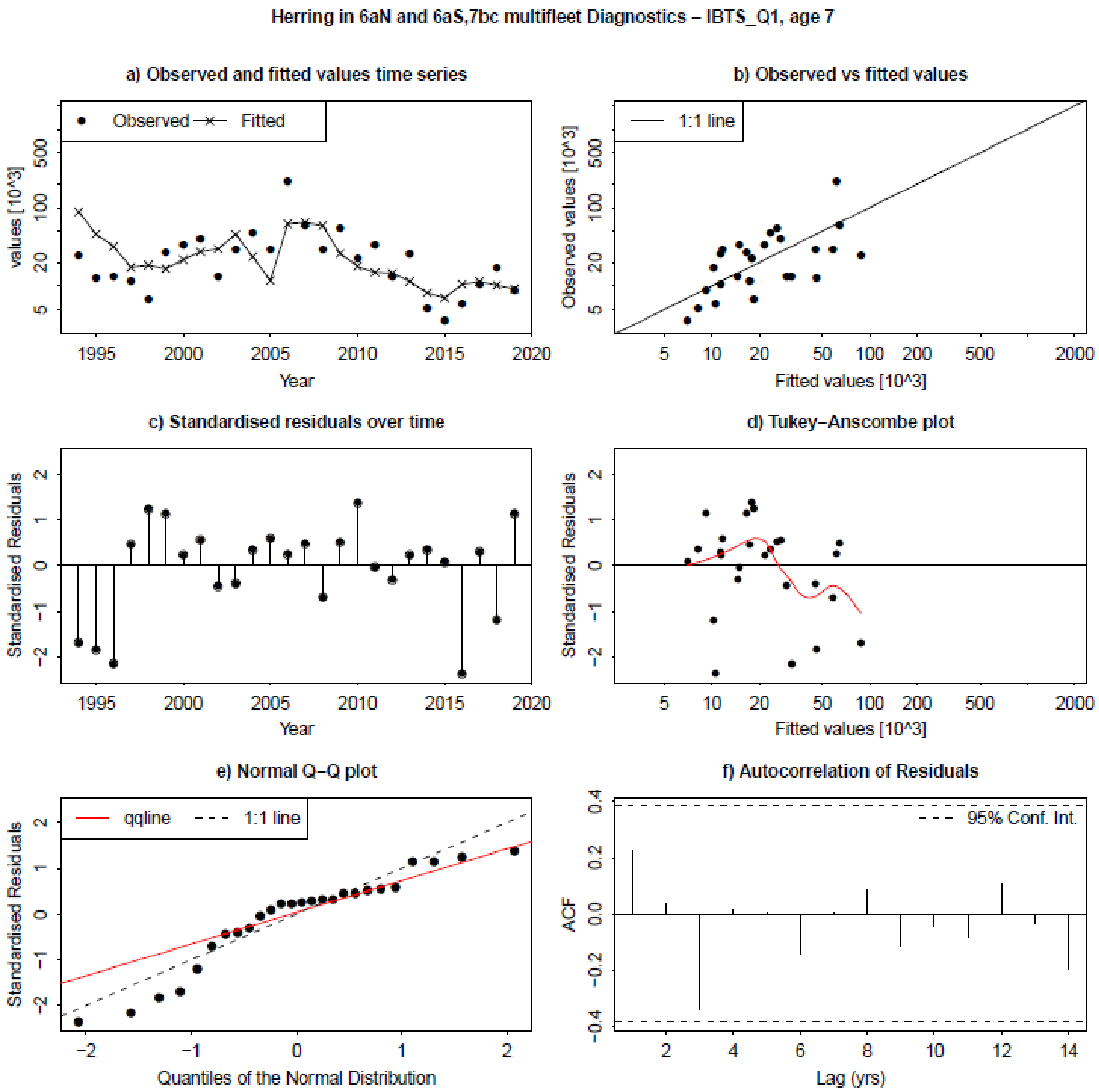


Figure 4.6.47. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: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

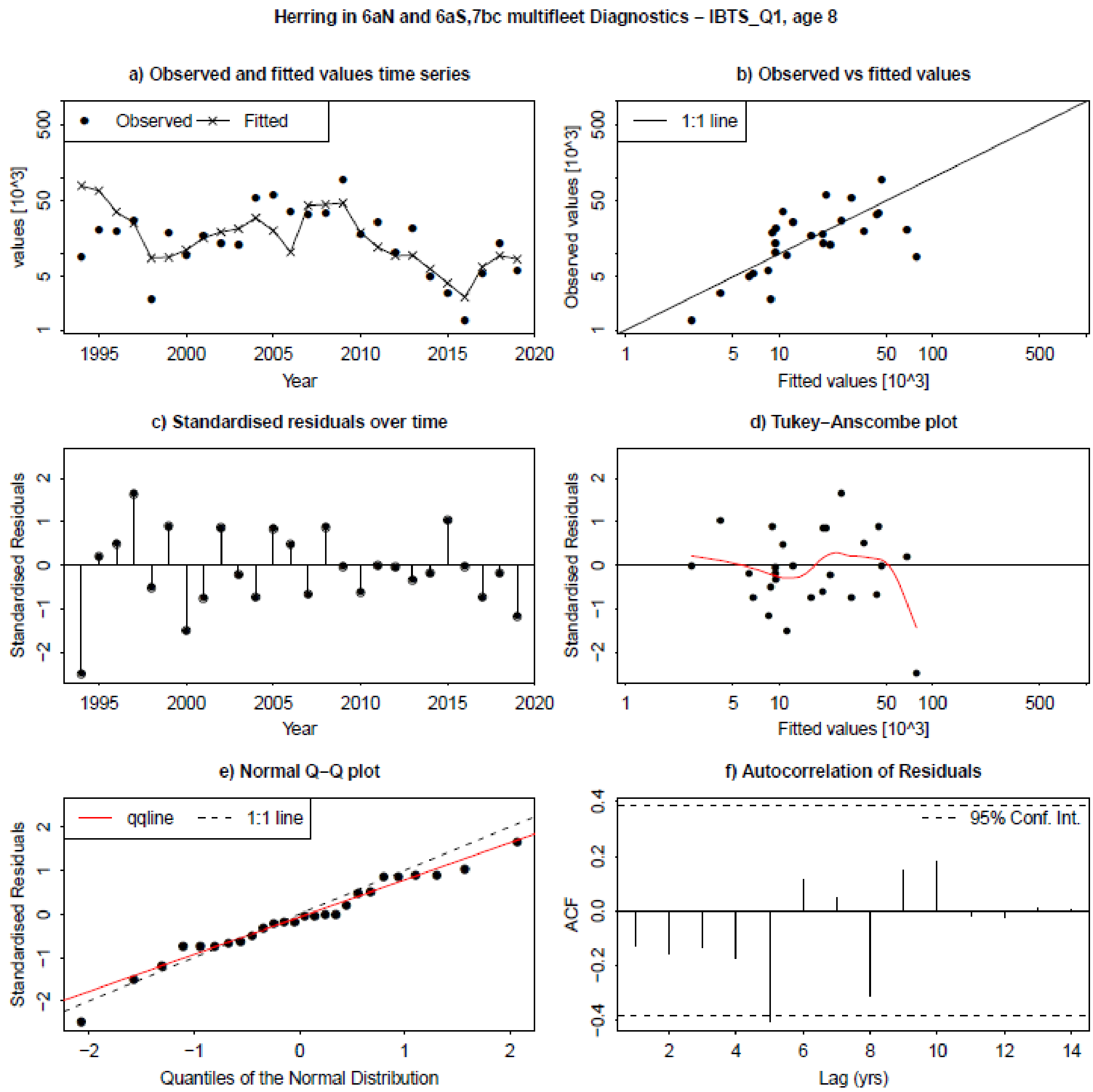


Figure 4.6.48. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: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

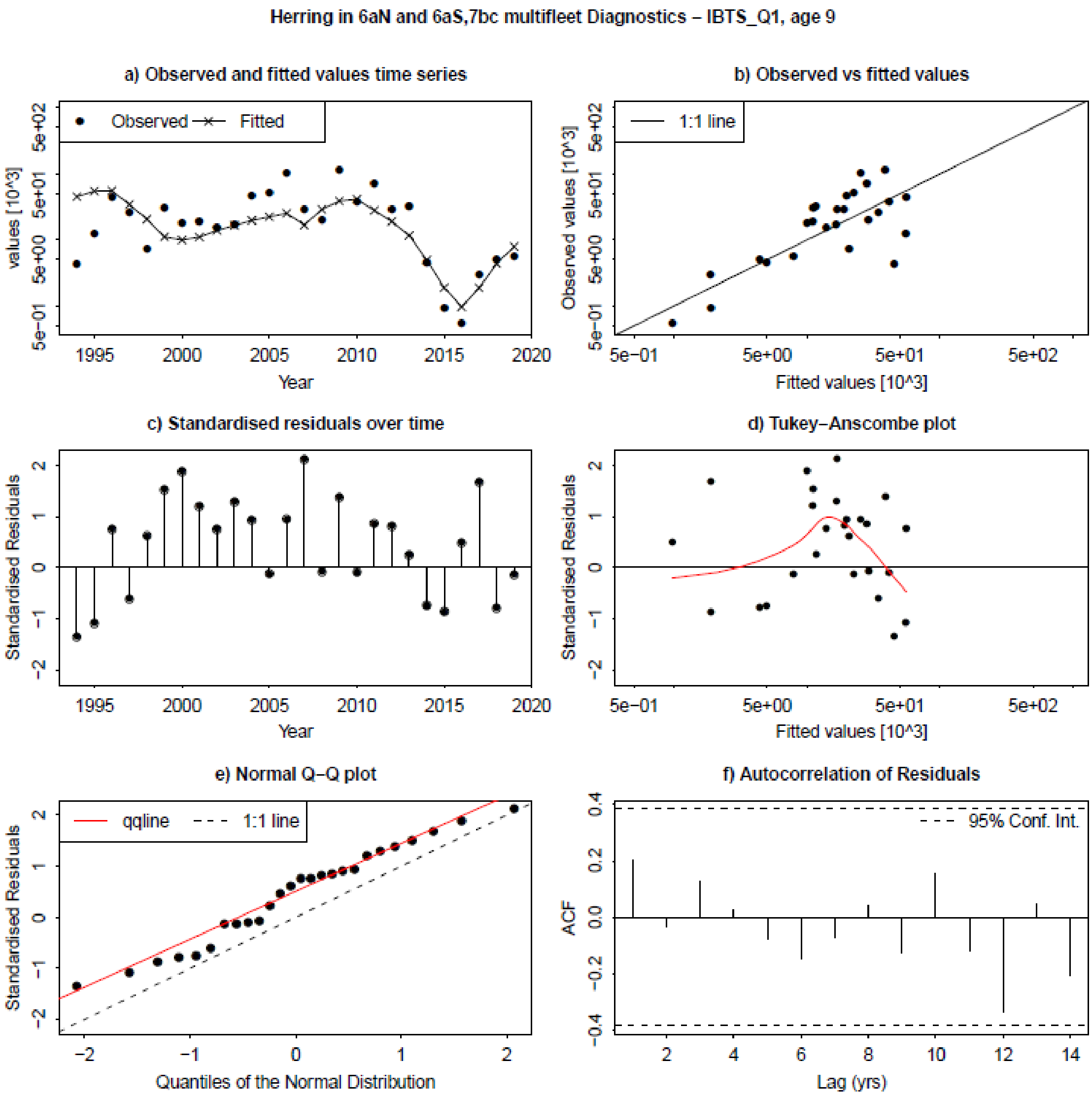


Figure 4.6.49. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 1 at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: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

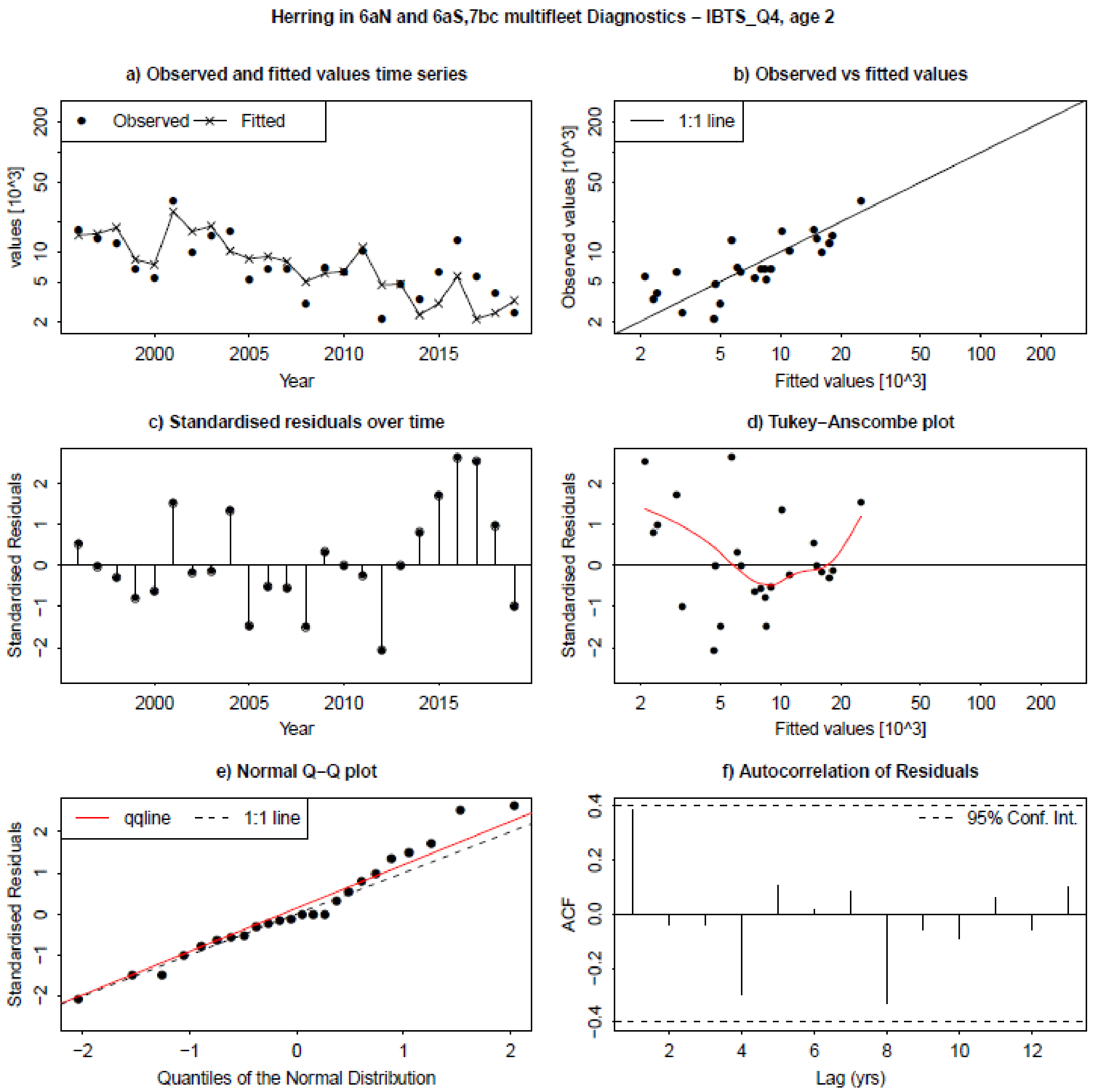


Figure 4.6.50. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 2-winter ring time-series. Top left: Estimates of numbers at 2-winter ring (line) and numbers predicted from index abundance at 2-winter ring. Top right: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

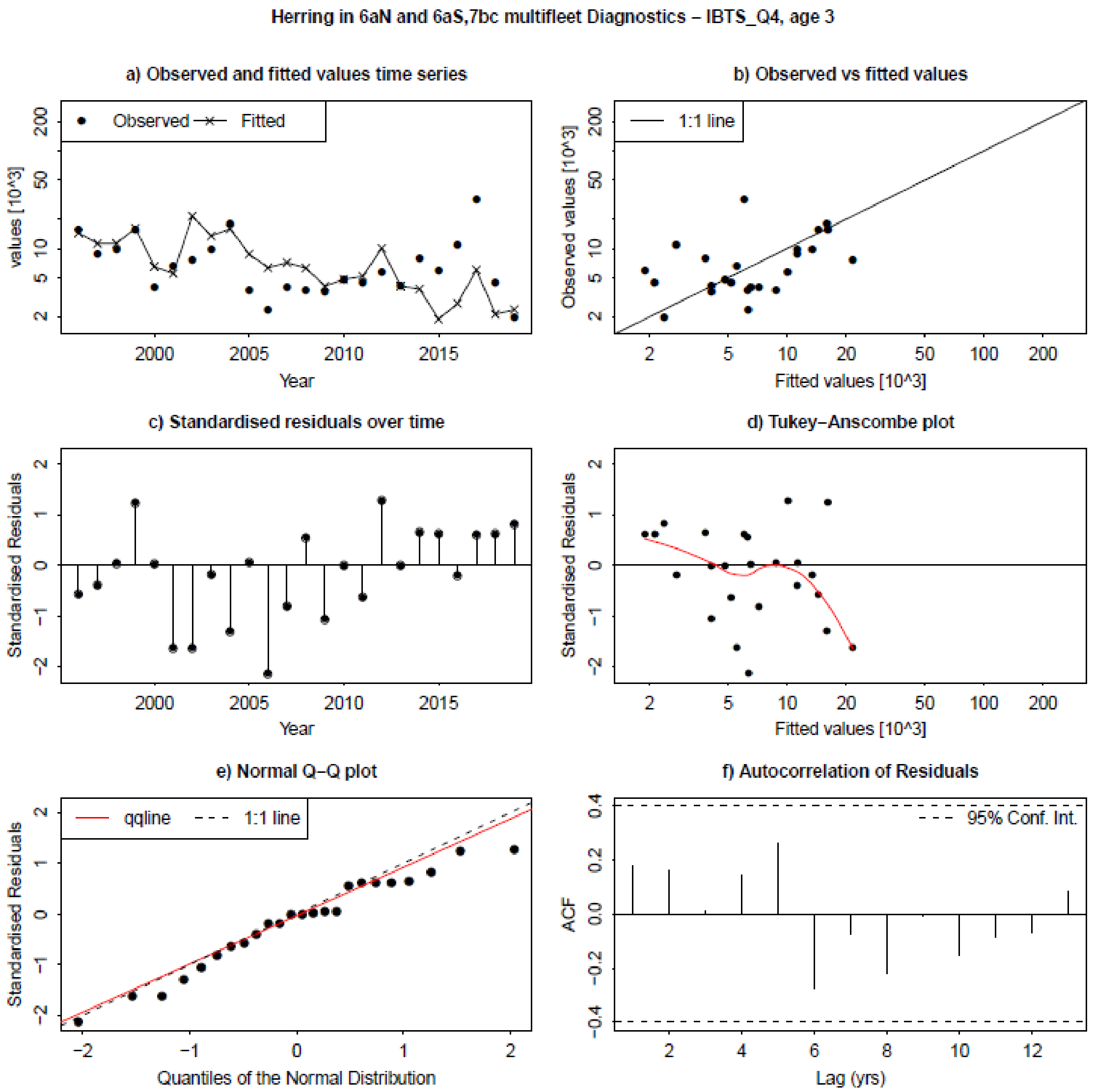


Figure 4.6.51. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 3-winter ring time-series. Top left: Estimates of numbers at 3-winter ring (line) and numbers predicted from index abundance at 3-winter ring. Top right: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

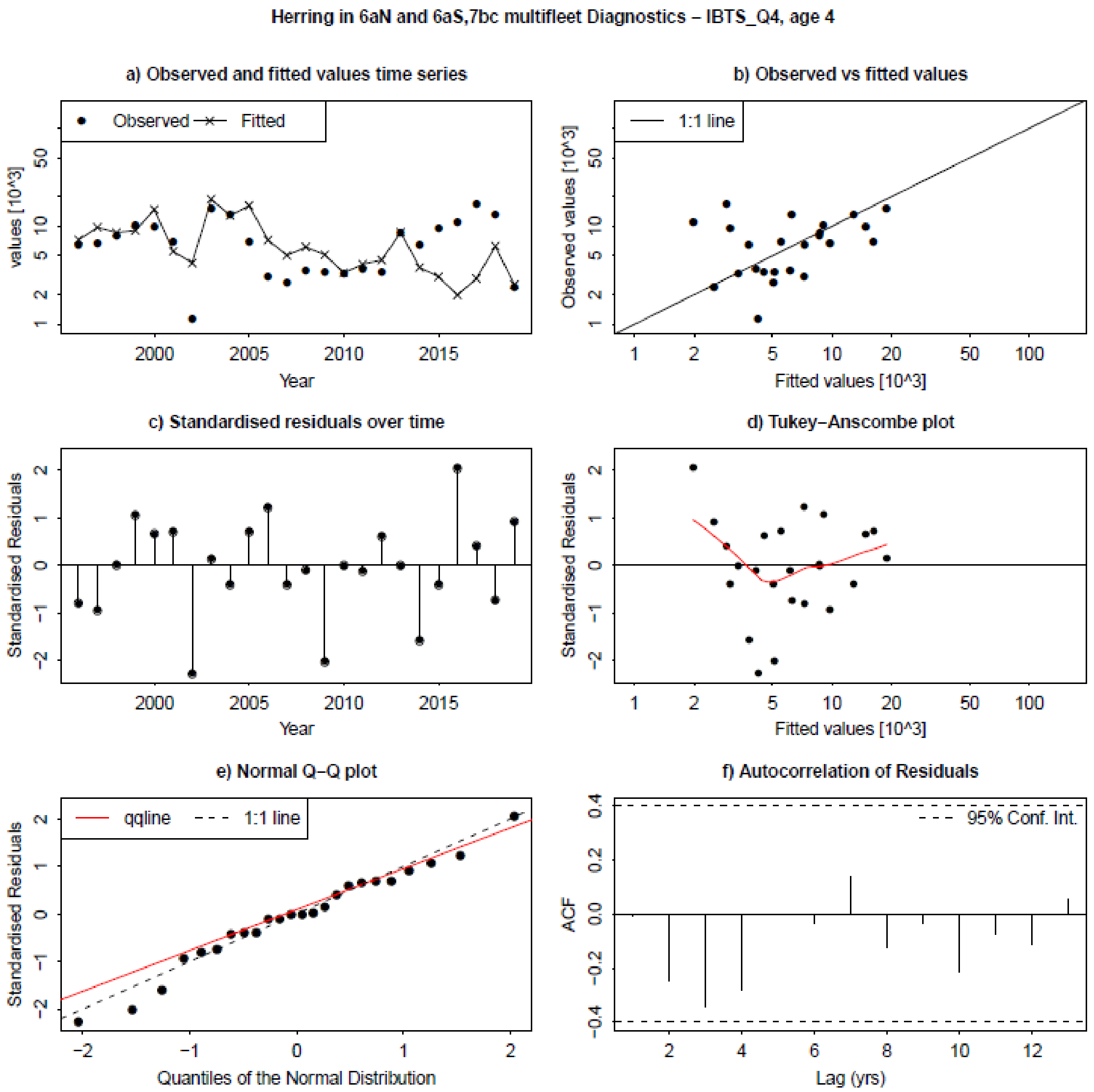


Figure 4.6.52. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 4-winter ring time-series. Top left: Estimates of numbers at 4-winter ring (line) and numbers predicted from index abundance at 4-winter ring. Top right: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

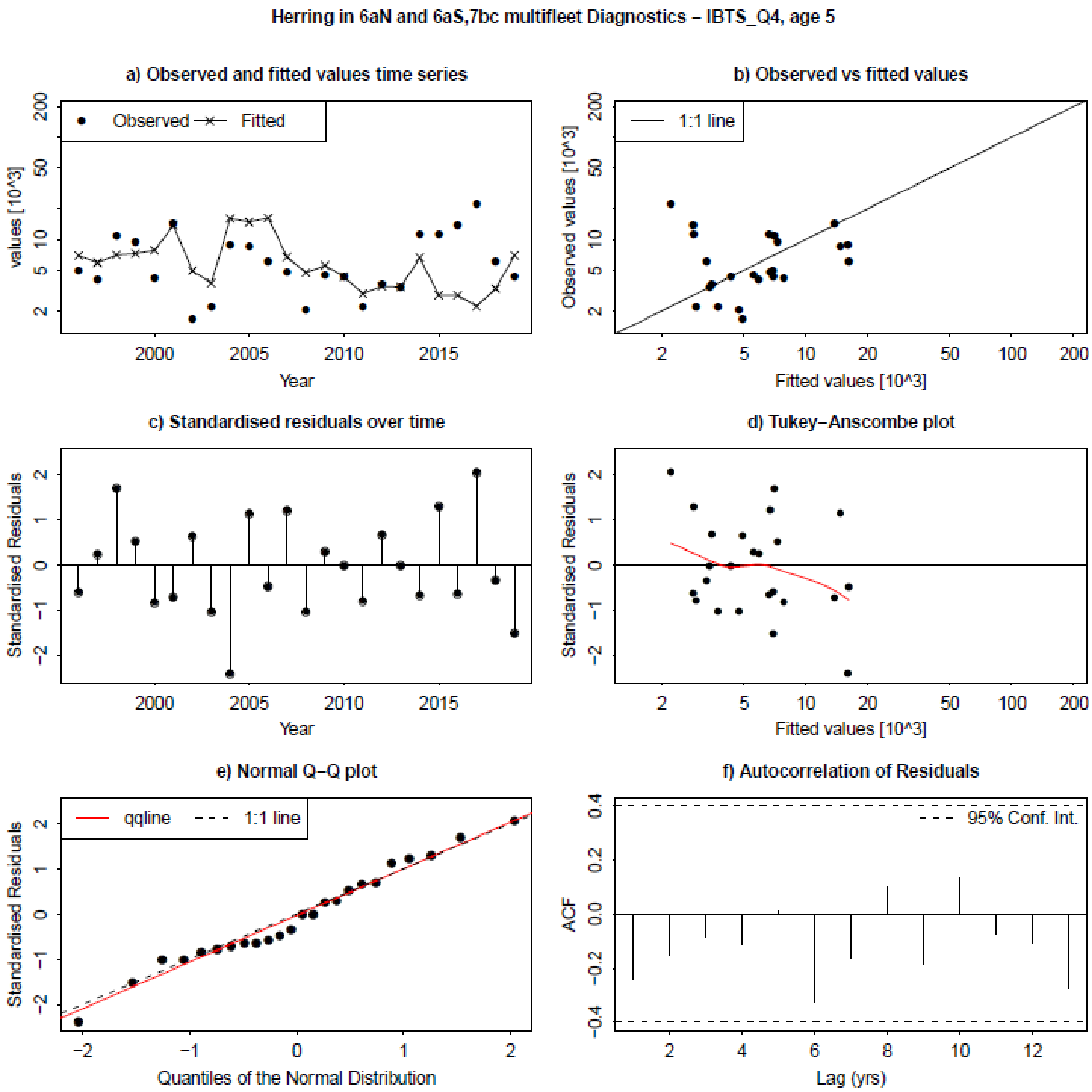


Figure 4.6.53. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 5-winter ring time-series. Top left: Estimates of numbers at 5-winter ring (line) and numbers predicted from index abundance at 5-winter ring. Top right: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

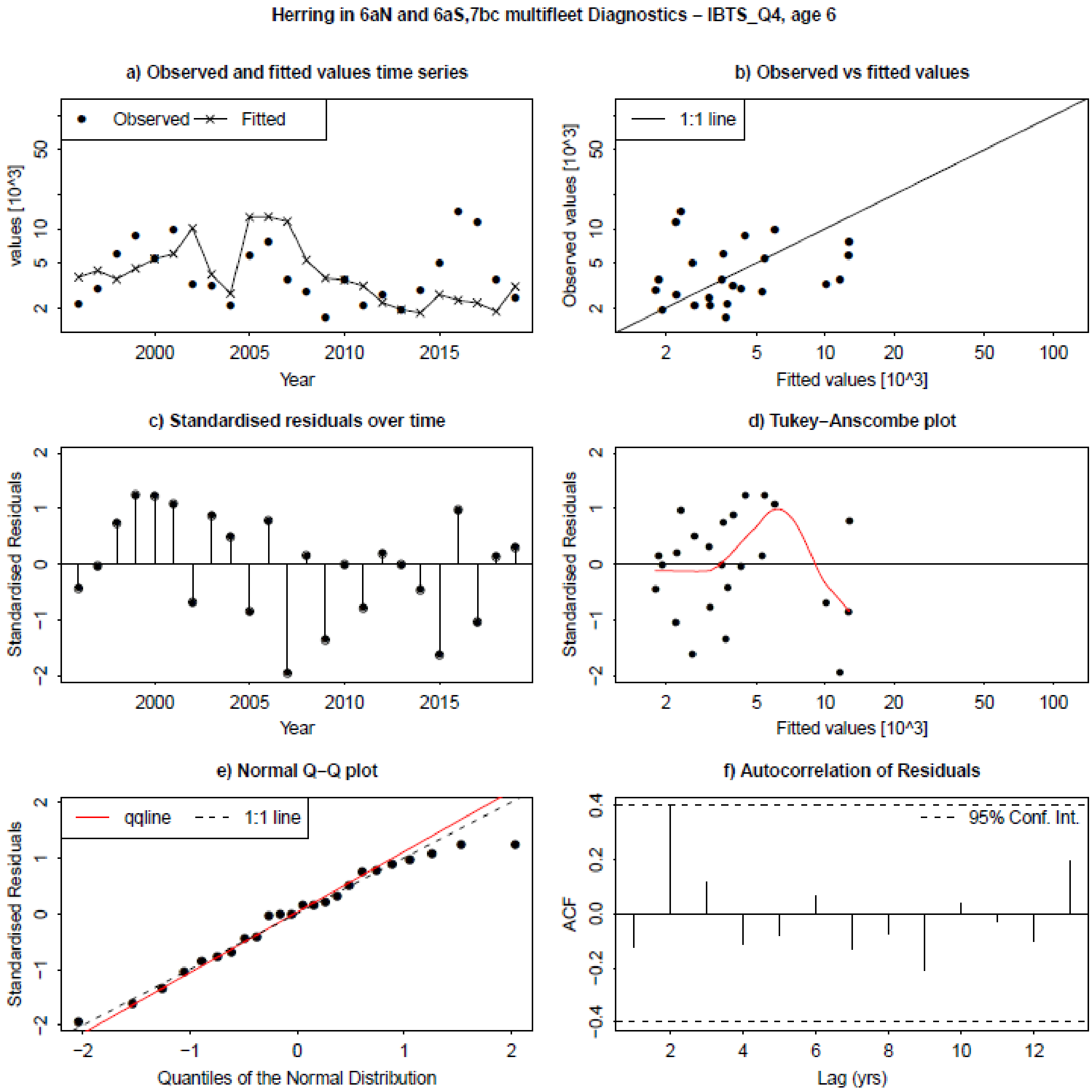


Figure 4.6.54. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 6-winter ring time-series. Top left: Estimates of numbers at 6-winter ring (line) and numbers predicted from index abundance at 6-winter ring. Top right: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

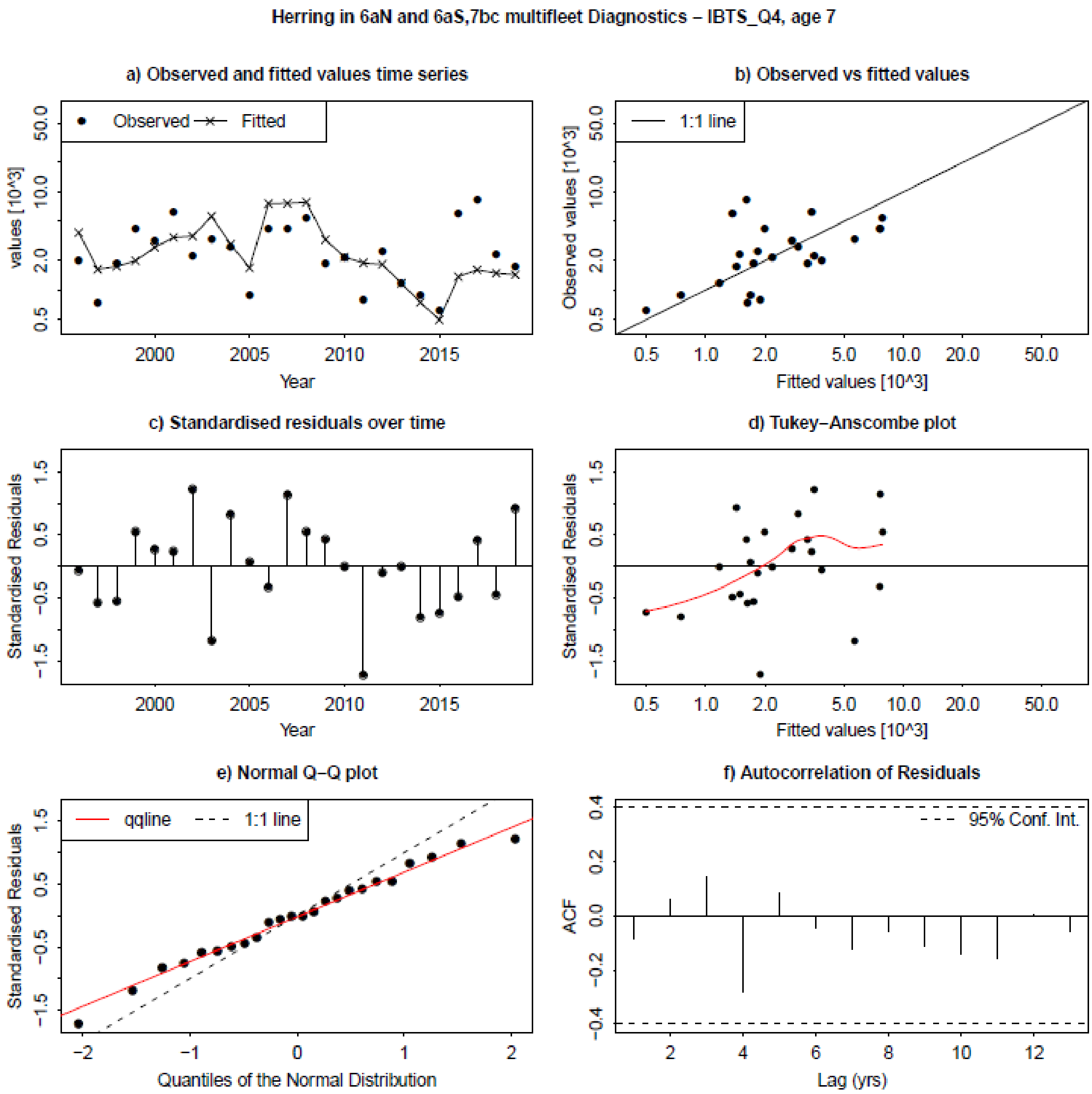


Figure 4.6.55. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 7-winter ring time-series. Top left: Estimates of numbers at 7-winter ring (line) and numbers predicted from index abundance at 7-winter ring. Top right: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

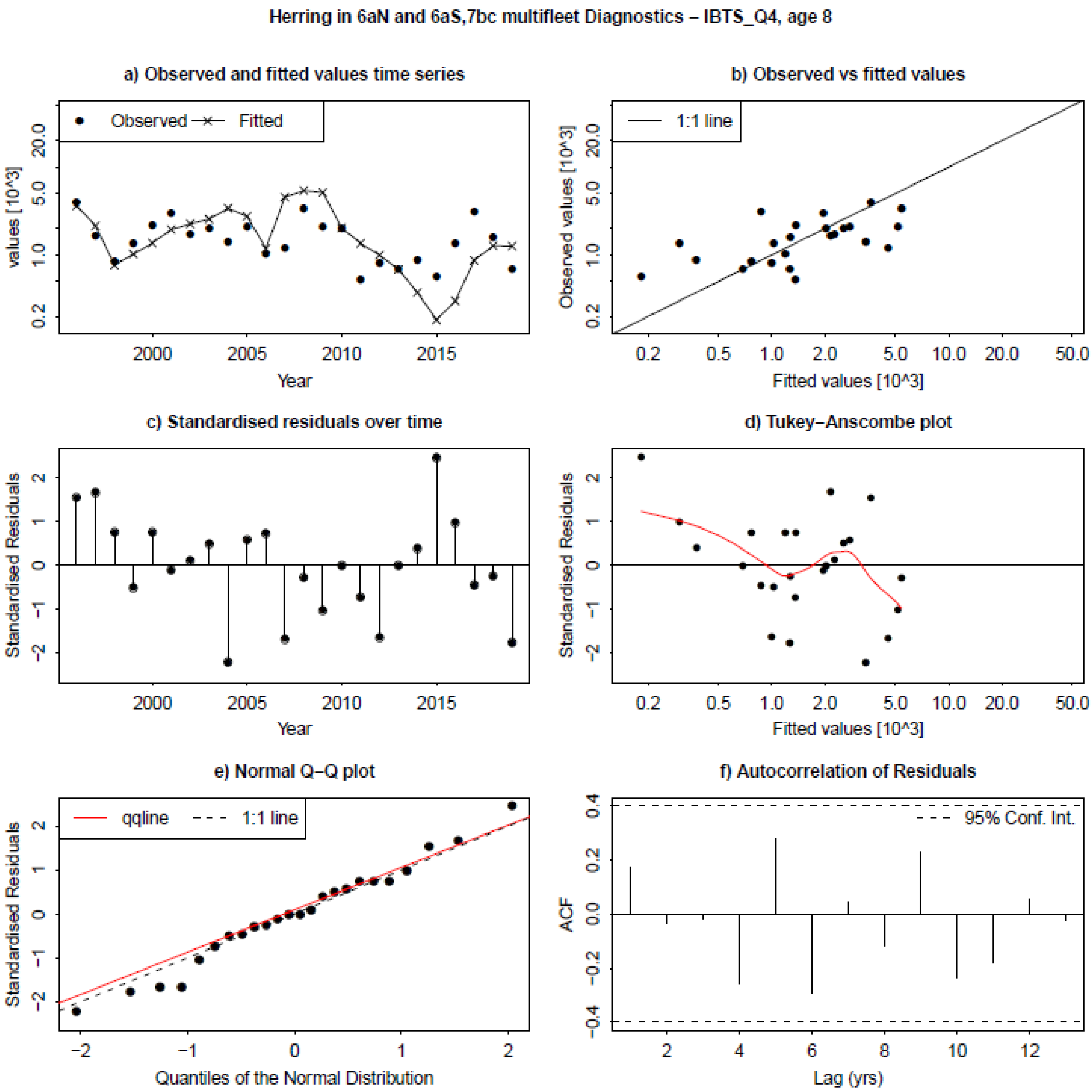


Figure 4.6.56. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 8-winter ring time-series. Top left: Estimates of numbers at 8-winter ring (line) and numbers predicted from index abundance at 8-winter ring. Top right: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

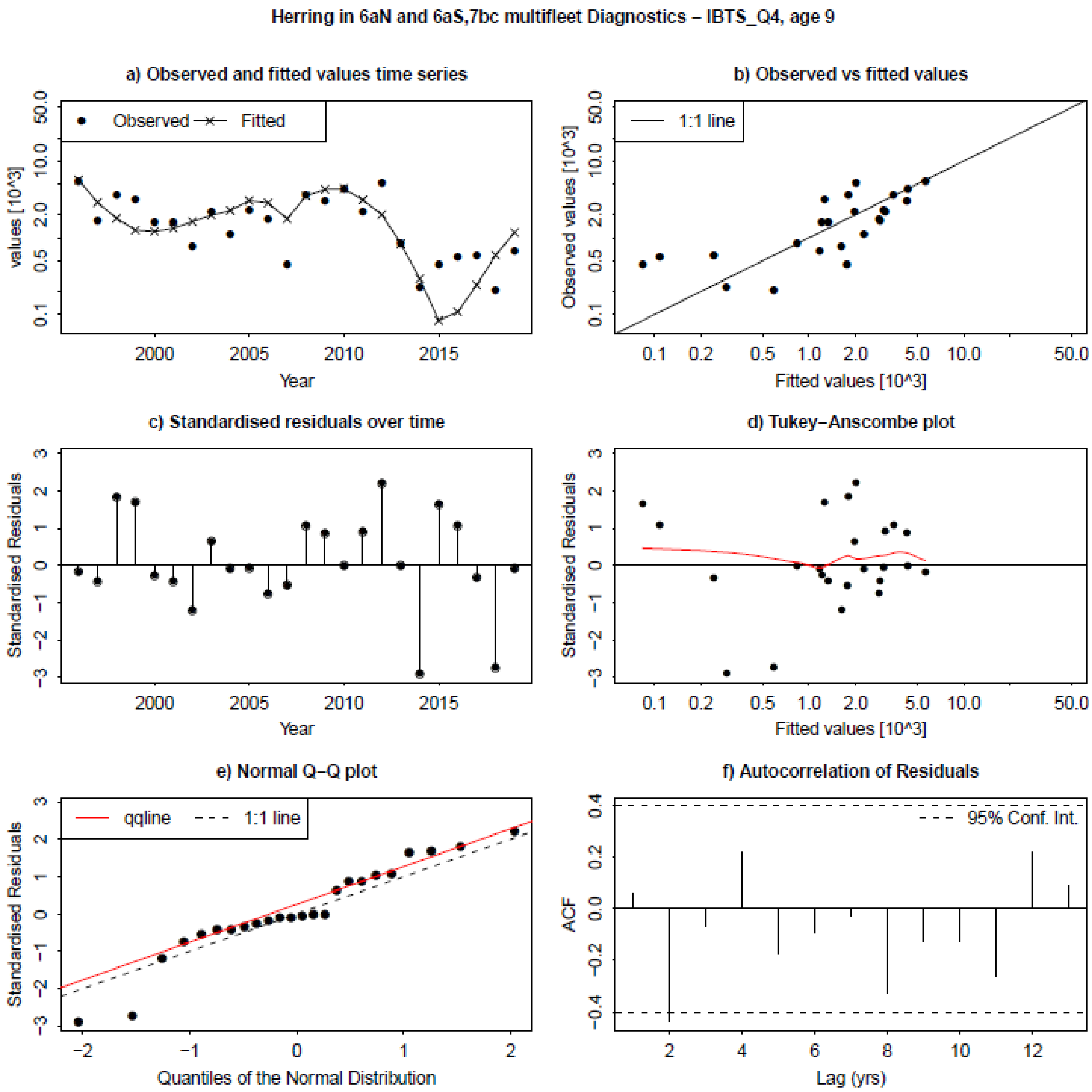


Figure 4.6.57. Herring in 6.a (combined) and 7.b–c. Diagnostics of the assessment model fit to the Scottish bottom-trawl survey index in quarter 4 at 9-winter ring time-series. Top left: Estimates of numbers at 9-winter ring (line) and numbers predicted from index abundance at 9-winter ring. Top right: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