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4 Herring (*Clupea harengus*) in subareas 1, 2, and 5, and in divisions 4.a and 14.a, (Northeast Atlantic) (Norwegian Spring Spawning)

4.1 ICES advice in 2016

ICES noted that the stock was declining and was estimated to be 5.023 million tonnes in 2016 which is close to MSY $B_{trigger}$ (5 million tonnes). Since 1998 four large year classes have been produced (1998, 1999, 2002, and 2004). Year classes 2005–2012 are estimated to be small. The estimates of the year classes coming after the 2012 year class are uncertain. Fishing mortality in 2015 was well below F_{MSY} (0.15).

A long-term management plan agreed by the EU, Faroe Islands, Iceland, Norway and Russia, is operational since 1999. ICES evaluated the plan and concludes that it is in accordance with the precautionary approach. The management plan implies maximum catches of 646 075 t in 2017.

4.2 The fishery in 2016

4.2.1 Description and development of the fisheries

The distribution of the 2016 Norwegian spring-spawning herring (NSSH) fishery for all countries by ICES rectangles per year is shown in Figure 4.2.1.1 and for annual quarter in Figure 4.2.1.2. The 2016 herring fishing pattern was fairly similar to recent years. The fishery began in January on the Norwegian shelf and focused on overwintering, pre-spawning, spawning and post-spawning fish (Figure 4.2.1.2 quarter 1). In the second quarter, the fishery was insignificant (Figure 4.2.1.2 quarter 2). In summer, the fishery had moved into Faroese, Icelandic and Greenlandic waters (Figure 4.2.1.2 quarter 3). In autumn, the fishery had shifted to the central part of the Norwegian Sea and the overwintering area in the fjords and oceanic areas north of Tromsø (Figure 4.2.1.2 quarter 4). The landings in the 1st quarter constituted 32% of the total landings and the largest proportion of the landings were in the 4th quarter (52%).

4.3 Stock Description and management units

4.3.1 Stock description

A description of the stock is given in the Stock Annex.

4.3.2 Changes in migration

Generally, it is not clear what drives changes in the migration of the stock, but the biomass and production of zooplankton is a likely factor, as well as feeding competition with other pelagic fish species (e.g. mackerel) and oceanographic conditions (e.g. limitations due to cold areas). Beside environmental forces, the age distribution in the stock is also likely to influence the migration. Changes in migration pattern of NSSH, as well as of other herring stocks, are often linked to large year classes entering the stock and them initiating a different migration pattern, which subsequent year classes will follow. No large year classes have entered the stock since 2004, although the 2013 year class appears to be above average. Thus, at present the stock consists mainly of old individuals, with also some younger fish. The largest fish move farthest west, and the stock is presently concentrated in the western areas during the feeding season, as could be expected when the stock is dominated by old individuals. A more north-easterly concentration of the stock could be expected when strong year-classes join the adult stock from the nursery areas in the Barents Sea.

4.4 Input data

4.4.1 Catch data

Catches in tones by ICES division, ICES rectangle and quarter in 2016 were available from Denmark, Faroe Islands, Germany, Greenland, Iceland, Ireland, The Netherlands, Norway, Russia and the United Kingdom (UK). The total working group catch in 2016 was 383 174tonnes (Table 4.4.1.1) compared to the ICES-recommended catch of maximum 316 876tonnes. The majority of the catches (83%) were taken in area 2.a as in previous years. Samples were not provided by Greenland, the United Kingdom, Ireland or the Netherlands (7.1 % of the total catch were taken by these countries). Sampled catches accounted for 91% of the total catches, which on a similar level as in previous years. The sampling levels of catch in 2016 in total, by country and by ICES division is shown in Table 4.4.1.2, 4.4.1.3 and 4.4.1.4. Catch by nation, ICES division and quarter are shown in Table 4.4.1.5. The software SALLOC (ICES, 1998) was used to calculate total catches in numbers at age and mean weight at age representing the total catch. Samples allocated (termed fill-in in SALLOC) to cells (nation, ICES division and quarter) without sampling information are shown in Table 4.4.1.2.

4.4.2 Discards

In 2008, the Working Group noted that in this fishery an unaccounted mortality caused by fishing operations and underreporting probably exists (ICES, 2008). It has not been possible to assess the magnitude of these extra removals from the stock, and considering the large catches taken after the recovery of the stock, the relative importance of such additional mortality is probably low. Therefore, no extra mortality to account for these factors has been added since 1994. In previous years, when the stock and the quotas were much smaller, an estimated amount of fish was added to the catches.

The Working Group has not had access to comprehensive data to estimate discards of the herring. Although discarding may occur on this stock, it is considered to be low and a minor problem to the assessment. This is confirmed by estimates from sampling programmes carried out by some EU countries in the Data Collection Framework. Estimates on discarding in 2008 and 2009 of about 2% in weight were provided for the trawl fishery carried out by the Netherlands. In 2010 and 2012, this metier was sampled by Germany. No discarding of herring was observed (0%) in either of the two years. An investigation on fisheries induced mortality carried out by IMR with EU partners on fisheries induced and unreported mortality in mackerel and herring fisheries in the North Sea concluded with an estimated level of discarding at around 3%.

In order to provide information on unaccounted mortality caused by fishing operations in the Norwegian fishery, Ipsos Public Affairs, in cooperation with IMR and the fishing industry, conducted a survey in January/February 2016. The survey was done by phoning skippers and interviewing them. A total of 146 herring skippers participated in the survey, 31 skippers representing the bigger vessel group and 115 skippers representing the smaller vessel group. The data provided an indication that there have been periods of increased occurrence of net bursting. This was seen especially in the period 2007–2010. There was, however, no trend in the size of catches where bursting has occurred.

When it comes to slipping, the data showed a steady increase in the percentage that has slipped herring from 2004–2012, and then a significant decline in recent years. The variations in the proportion that have slipped herring were largely driven by the skippers on smaller coastal purseseiners. Average size of purse-seine hauls slipped seems to be relatively steady over the period. However, the average size of net hauls slipped was lowest in the recent period. An attempt to estimate the level of slipping/bursting (in tones) based on these data is planned.

4.4.3 Age composition of the catch

The estimated catch at age in numbers by years are shown in Table 4.4.3.1. The numbers are calculated using the SALLOC software. In 2016, about 16% of the catches (in numbers) were taken from both the 2004 year class and the 2006 year class, followed by the 2009 (15%) and 2011 (11%) year classes.

Catch curves were made on the basis of the international catch at age (Figure 4.4.3.1). For comparison, lines corresponding to Z=0.3 are drawn in the background. The big year classes, in the periods of relatively constant effort, show a consistent decline in catch number by cohort, indicating a reasonably good quality of the catch at age data. Catch curves for year classes 2005 onwards show a more flat curve than for previous year classes indicating a lower F or a changed exploitation pattern. For year classes 2012 and younger these curves provide hardly any information.

4.4.4 Weight at age in catch and in the stock

The weight-at-age in the catches in 2016 was computed from the sampled catches using SALLOC. Trends in weight-at-age in the catch are presented in Figure 4.4.4.1 and Table 4.4.4.1. The mean weights at age for most of the age groups have generally been increasing in 2010–2013 but leveled off in 2014. A similar pattern is observed in weight-at-age in the stock which is presented in Figure 4.4.4.2 and Table 4.4.4.2. These data have been taken from the survey in the wintering area until 2008. The mean weight at age in the stock for age groups 4–11 in the years 2009–2017 was derived from samples taken in the fishery in the same area and at the same time as the wintering surveys were conducted in.

4.4.5 Maturity at age

In 2010 the method for estimating maturity-at-age in the stock assessment of NSSH was changed based on work done by the "workshop on estimation of maturity ogive in Norwegian spring-spawning herring" (WKHERMAT; ICES, 2010a). The method which was adopted by WGWIDE in 2010 (ICES, 2010b) is based on work by Engelhard *et al*. (2003) and Engelhard and Heino (2004). They developed a method to back-calculate age at maturity for individual herring based on scale measurements, and used this to construct maturity ogives for the year classes 1930–1992.

The NSSH has irregular recruitment pattern with a few large year classes dominating in the stock when it is on a high level. Most of the year classes are, however, relatively small and referred to as "normal" year classes. The back calculation dataset indicates that maturation of the large year classes is slower than for "normal" year classes.

WKHERMAT and WGWIDE considered the dataset derived by back calculation as a suitable potential candidate for use in the assessment because it is conceived in a consistent way over the whole period and can meet standards required in a quality controlled process. However, the back calculation estimates cannot be used for recent years since all year classes have to be fully matured before included. Therefore, assumptions have to be made for recent year classes. For recent year classes, WGWIDE (2010) decided to use average back-calculated maturity for "normal" and "big" year classes, respectively and thereby reducing maturity-at-age for ages 4, 5 and 6 when strong year classes enter the spawning stock. The default maturity ogives used for "normal" and "big" year classes are given in the text table below.

AGE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
normal ycl	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
strong ycl	0	0	0	0	0.1	0.6	0.9	1	1	1	1	1	1	1	1	1

The maturity ogives used in the present assessment are presented in Table 4.4.5.1.

4.4.6 Natural mortality

In this year's assessment (2016), the natural mortality M=0.15 was used for ages 3 and older and M=0.9 was used for ages 0–2. These levels of M are in accordance to previous years and their justification is provided in the stock annex. Information about deviations from these levels in the time series, e.g. due to diseases, are also provided in the stock annex.

4.4.7 Survey data

The surveys available for the assessment are described in the stock annex. Only two of the available surveys are used in the final assessment and will therefore be dealt with in this section:

1) The International Ecosystem Survey in the Nordic Seas (IESNS) in May. The survey covers the entire stock during its migration on the feeding grounds, the adults in the Norwegian Sea and adjacent waters ("Fleet 5") and the juveniles in the Barents Sea ("Fleet 4").

2) The Norwegian acoustic survey on the spawning grounds ("Fleet 1") in February.

The cruise reports from the IESNS and spawning survey in 2017 are available as working documents to this report. Both surveys were successfully conducted in 2017.

The abundance estimates from "Fleet 1" are shown in Table 4.4.7.1 and Figure 4.4.7.2; from "Fleet 4" in Table 4.4.7.2 and Figure 4.4.7.1 and "Fleet 5" in Table 4.4.7.3and Figure 4.4.7.1.

Catch curves were made on the basis of the abundance estimates from the surveys "Fleet 1" (Figure 4.4.7.3) and "Fleet 5" (Figure 4.4.7.4). The same arguments are valid for the interpretation of the catch curves from the surveys as from the catches. In 2010, the number of all age groups decreased suddenly in "Fleet 5" and this is seen as a drop in the catch curves that year. This drop has continued for some of the year classes and the year classes 1998 and 1999 are disappearing faster from the stock than expected. This observed fast reduction in these age classes may also be influenced by the changes in "Fleet 5" catchability, with seemingly higher catchability in years 2006—2009. Like for the catch data these provide hardly any information for year classes 2010 and younger. As "Fleet 1" was not conducted in the years 2009–2014, there is a gap in the catch curves, making it difficult to interpret them.

4.4.8 Sampling error in catches and surveys

Sampling errors for Norwegian catch at age for the years 2010-2016 is estimated using ECA (Salthaug and Aanes 2015, Hirst *et al.* 2012). Using the Taylor function (Aanes 2016a) to model the sampling variance of the catches yields a very good fit ($R^2_{adj} = 0.93$) and using this function to impute missing sampling variances for catch at age yields relative standard errors shown in Table 4.4.8.1. It is assumed that the relative standard errors in the total catches are equal to the

Norwegian catches (which comprise ~60% of the total catches). Sampling errors for survey indices are estimated using StoX (http://www.imr.no/forskning/prosjekter/stox/nb-no). For Fleet 1 estimates are available for the years 1988–1989, 1994–1996, 1998–2000, 2005–2008, and 2015–2017, for Fleet 4 estimates of sampling errors are available for 2009–2017, and for Fleet 5 for 2008–2017. Missing values for sampling variances are imputed using the Taylor function which provides goods fits (R^2_{adj}'s are 0.93, 0.97, 0.95, respectively). The resultant relative standard errors are given in Tables 4.4.8.2-4.4.8.4. Due to the very good fits of the Taylor functions, estimates of relative standard where empirical estimates are available, are also replaced by the model predicted values to reduce potential effects of imprecise estimates of errors.

4.4.9 Information from the fishing industry

No information is made available for the working group.

4.5 Stock assessment

The first benchmark of the NSSH took place in 2008. The assessment tool TASACS was then chosen to be the standard assessment tool for the stock. The second benchmark took place in 2016 (ICES2016c) where three assessment models were explored, TASACS, XSAM and one separable model. WKPELA accepted XSAM as the standard assessment tool for the NSSH.

4.5.1 XSAM final assessment 2017

The XSAM model is documented in Aanes 2016a and 2016b. XSAM includes the option to utilize the prediction of total catch in the assessment year (typically sum of national quotas) along with the precision of the prediction. During the benchmark and WGWIDE 2016 it was shown that this results in an improved estimate of fishing mortality in the assessment year whereas the effect on stock sizes and biomasses in the assessment were marginal (ICES 2016a, ICES 2016b). For all cases explored until WGWIDE 2017, the model predicts the total catch in the assessment year close to the prediction made by WGWIDE, and was therefore brought forward directly to the short-term forecast. Using the same procedure in 2017 we find that the model predicts highly variable total catches for 2017 (95% confidence interval ranging from ~277 000 to 1 000 000 tons) with a mean which is significantly lower (~650 000 tons) compared to the working groups prediction (sum of national quotas; ~805 000 tons with a relative standard error of ~6%). In addition, the selection patterns changes somewhat abruptly in the prediction from 2017 and onwards from young to older fish (see Figure 4.5.1.1a). The abrupt change in the selection pattern was not fully understood by the working group, but the effect was less pronounced if not using the catch prediction from the model for 2017. Here we see that the selection still is moving from younger to older individuals, but the change is more gradual(Figure 4.5.1.1b) and more in line with the current knowledge about the fishery. It is important to notice that this change has marginal effect on the assessment, but larger effects on the prediction and short term forecast. Therefore, it was decided to not utilize the prediction of total catches in 2017 when fitting the model to data (i.e. the assessment) and consequently in the short term forecast.

Apart from this, this year's XSAM assessment was performed with the same model options as in 2016. In summary this means that the model was fitted with time varying selectivity and effort according to AR(1) models in the model for fishing mortality; the recruitment was modelled as a process with constant mean and variance; the standard errors for all input data was predetermined using sample data (Tables 4.4.8.1–4.4.8.4), but estimating a scaling constant common for all input data to allow additional variability in the input data that is not controlled by sampling. Other details in settings are given in the Stock Annex.

The same input data over the same age ranges was used as in 2016. At the 2016 benchmark, data from 1988 and onwards was used, the considered age-span was 3–12+ with input data catch at age, Fleet 1 and Fleet 5 and in WGWIDE 2016 it was decided to start the model at age 2 to enable short term predictions with reasonable levels of variability. To achieve this, age 2 from Fleet 4, and age 2 in catch at age is included in input data. Evaluation of diagnostics including lower ages than 2 and/or other fleets resulted in excluding lower ages than 2 and other fleets for the final assessment. Input data is listed in Table C.1.1 in the Stock Annex.

The parameter estimates are shown in Table 4.5.1.1. For a precise definition of the parameters it is referred to Aanes 2016a in ICES (2016). Note that the variance components σ_1^2 (variability in the separable model for F) and σ_R^2 (variability in recruitment) is rather imprecise. The estimate of the scaling constant h is larger than 1 showing that the model adds additional variability on the observation errors than explained by the sampling errors alone.

The catchabilities for all the fleets are on average positively correlated indicating some uncertainty due to a common scaling of all surveys to the total abundances although the correlations in general are small (Figure 4.5.1.2). There is a slight negative correlation between σ_1^2 and σ_2^2 (variability in the AR process for time varying selectivity) indicating little contrast in data for separating variability in the separable model from variability due to changes in selection pattern. The slopes in the multivariate AR model for time-varying selectivity gradually changes from negative to positive, but is expected as it is imposed due to the sum to zero constraint for the selection (see Aanes 2016a for details).

The weights each datum is given in the model fit (inverse of the sampling variance) is proportional to the empirical weights derived from sampling variances (Tables 4.4.8.1–4.4.8.4) which shows that the strong year-classes in general is given larger weight to the model than weak year-classes, and the ordering of the average weights (from high to low) is Catch at age, Fleet 5, Fleet 1 and Fleet 4 (Figure 4.5.1.3).

Two types of residuals are considered for this model. The first type is the model prediction (based on all data) versus the data. In such time series models, the residuals based on the prediction which uses all data points will be serially correlated although useful as they explain the unexplained part of the model (cf Harvey 1990 p 258).This means that patterns in residuals over time is to be expected and questions the use of e.g. qq-plots as an additional diagnostic tools to assess distributional assumptions. To obtain residuals which follow the assumptions about the data in the observation models (e.g. serially uncorrelated) single joint sample residuals are extracted (ICES 2017). In short these are obtained by sampling predicted values from the conditional distribution of values given the observations. This sample corresponds to a sample from the joint distribution of latent variables and observations. The third approach could have been to extract the one step ahead observation residuals which are standard for diagnostics for regular state-space models (cf Harvey 1990). This is not done here.

The negative residuals tracing the 1983 year-class for catch-at-age represents low fishing mortalities examining the type 1 residuals (Figure 4.5.1.4). This effect is less pronounced considering the type 2 residuals. The type 2 residuals are qualitatively comparable with the type 1 residuals but generally display more mixed residuals as predicted by the theory. Otherwise the residuals for catch at age appears fairly mixed apart for some serial correlation for age 2 and 3 (which are very low), and some negative residuals for the plus group the most recent years. The residuals for Fleet 1 in 1994 and 2015 for young and old ages are all of the same signs and may appear as year effects. Also note that the residuals for Fleet 1 for ages 10+ in 2015 and 2016 are all positive (Figure 4.5.1.4) which shows that the abundance indices from Fleet 1 displays a larger stock size over these ages and years compared to the assessment using all input data. However, these data points are given low weights (Figure 4.5.1.3) as they are found imprecise (Tables 4.4.8.1–4.4.8.4). Some serial correlation for residuals for ages 3 and 4 in Fleet 1 can also be detected, but is down weighted by the same reasons. Serial correlation in residuals for age 2 in Fleet 4 can also be detected indicating trends over time in mismatch between estimates and observations of abundance at age 2. Residuals for Fleet 5 appears adequate compared to previous years although some serial correlations can be detected also here.

The residuals for small values are bigger than residuals for the larger values since smaller values in general have higher variances than larger values (Tables 4.4.8.1–4.4.8.4) (Figure 4.5.1.5).The qq-plots for the standardized residuals show that the distributional assumptions on the observation errors are adequate, except for the smallest and largest values of catch at age and indices from Fleet 1. As qq-plots for residuals of type 1 may be questioned (see above) it is noted that qq-plots for residuals of type 2 is more relevant and generally shows a significantly better fit based on a visual inspection compared to using type 1.

The marginal likelihood and the components for each data source (see Aanes 2016b for details) are profiled over a range of the common scaling factor h for all input data (Figure 4.5.1.6). It is apparent that the optimum of the marginal likelihood is clearly defined. The catch component is decreasing with decreasing values of h indicating that the model puts more weight on the catch component than indicated by the comparing sampling errors for all input data. This is in line with the findings in Aanes (2016a and 2016b) who showed that these types of models tends to put too much weight on the catch data if the weighting is not constrained. However, the likelihood component for the catch is overruled by the information in Fleet 1, 4 and 5 such that the optimum for the marginal likelihood is clearly defined. The point estimates of SSB and F is insensitive to different values of h.

The retrospective runs for this model shows estimates which is within the estimated levels of precision (Figure 4.5.1.7). The indices from Fleet 1 indicate, on average, a relatively larger abundance than the indices from Fleet 5 in the last three years which is supported by the positive residuals for ages 9–10+ (Figure 4.5.1.4). Consequently, the increased estimates of SSB and decreased estimates of F after 2014 is a response to the indices from Fleet 1 which not was conducted in the years 2009–2014. Note that the retrospective estimates are remarkably stable from 2015 and onwards. To illustrate the conflict in data and increased uncertainty in estimates the most recent years, the abundance indices are scaled to the absolute abundance by the estimated catchabilities. Then the spawning stock biomass based on each survey index is calculated using the stock weights at age and proportion mature at age (Figure 4.5.1.8). Here we see a fairly good temporal match between the model estimate of SSB and the survey SSBs except for the years 2015 and 2016 for Fleet 1, which display a significantly faster reduction in the stock compared to Fleet 5 which shows a more flat trend in the same years. It is worth noticing that although the point estimate of SSB based on Fleet 1 appear very much higher than Fleet 5 in 2015 and 2016, the uncertainty in the estimates are very high, such that the respective estimates do not appear as significantly different. However, the effect on the final assessment is to lift the point estimate of SSB and increase the uncertainty which is in accordance with the data used (Figure 4.5.1.9).

The final assessment results are shown in Figure 4.5.1.9. The estimates of fishing mortality is highly imprecise, but below both F_{mp} and F_{pa} with a high probability. The spawning stock shows a declining trend since 2009, and the 95% confidence interval of the stock level in 2017 ranges from ~3.9 to ~5.8 million tonnes which envelopes B_{mp}=5 million tonnes, such that the probability of the stock being above B_{lim}=2.5 million tonnes is high. Note the rather large uncertainty in the absolute levels since the peak in 2009 with the further increase in the most recent years. This high uncertainty is a result of the conflicting signals in data concerning the degree of decrease in the stock over this time period.

The final results of the assessment are also presented in Tables 4.5.1.2 (stock in numbers), 4.5.1.3 (fishing mortality) and Table 4.5.1.4 is the summary table of the assessment.

4.5.2 Exploratory assessments

4.5.2.1 TASACS

TASACS was run according to the benchmark in 2008 using the VPA population model in the TASACS toolbox with the same model options as the benchmark (see Stock Annex). The information used in the TASACS run is catch data and survey data from eight surveys. The analysis was restricted to the years 1988—2017. The model was run with catch data from 1988 to 2016, and projected forwards through 2017 assuming Fs in 2017 equal to those in 2016, to include survey data from 2017. The larval survey (SSB fleet) was discontinued in 2017 and no new information is therefore available from this survey.

Following the procedure outlined in the 2008 benchmark when TASACS was introduced, data points from surveys which creates large residuals particularly on older ages should be given weight zero in the tuning. This year, a large negative residual was observed on age 15 in fleet 5 and this value was therefore given zero weight.

The model fit to the tuning data is shown with Q-Q plots in Figure 4.5.2.1.1. Surveys 1, 2, 3 and 7 seem to fit rather well to the assumed linear relationship in the TASACS model, but surveys 4, 6 and 8 have rather poor fit. In the 2016 and 2017 TASACS run Q-Q plots for fleet 5 shows a poorer fit compared to earlier assessments. This is mainly caused by a change in estimated catchability in 2016 and 2017.

Particularly Survey 8 (larval survey) seems to have a poor fit. This can also be seen as a block of positive residuals for this surveys in later years (Figure 4.5.2.1.2). The residual plot for survey 5 (IESNS) also shows some pattern with consecutive series of negative and positive residuals indicating year-effects.

The results from TASACS are compared to those from XSAM and TISVPA in Figure 4.5.2.1.3.The time series of SSB show similar trends for all three models and for most of the years, the estimates from TASACS and TISVPA are mostly within the confidence limits estimated by XSAM. The SSB on 1 January 2017 is estimated by TASACS to be 4.379milliontonnes, which is lower than the estimated value from TISVPA and lower than the point estimate from XSAM, but within the 95% confidence interval estimated by XSAM.

4.5.2.2 ISVPA

The TISVPA model was applied using the age range from 0 to 15+ and all available 8 surveys. No data points were down-weighted. Two-parametric selection pattern used in the model revealed some obvious peculiarities in the interaction between the stock and the fishery.

Rather clear signals about the stock biomass in 2017 were obtained from just catch-at-age and surveys 1, 2, 5 and 7. All of them, as well as the overall objective function of the model, indicate the SSB value in 2016 about 5 million tonnes (see WD 4).

The results from TISVPA are compared to those from XSAM and TASACS in Figure 4.5.2.1.3.

4.6 NSSH reference points

ICES reviewed the reference points of Norwegian spring spawning herring in 2013 in combination with the NEAFC request to evaluate of alternative management plans for this stock (ICES

2013d). ICES concluded that B_{lim} should remain unchanged at 2.5 million tonnes. B_{pa} is not to be revised as it is defined based on B_{lim}. ICES has evaluated F_{MSY} and considers it should remain unchanged at F_{MSY} = 0.15[1].

The reference points were to be evaluated at WKPELA 2016. Due to time constraint only B_{lim} was evaluated. The conclusion was that it should remain unchanged at 2.5 million tonnes. An evaluation of the reference points was conducted in 2017 and presented during WGWIDE 2017, but it was concluded that further work needed to be done and the reference points will be reviewed before WGWIDE 2018.

4.6.1 PA reference points

The PA reference points for the stock originate from an analysis carried out in 1998, as detailed in the stock annex. According to it, ICES considers the precautionary reference points B_{lim}=2.5 million t and proposes that B_{pa}=5.0 million t. and F_{pa}=0.150.

4.6.2 MSY reference points

The MSY reference points originate from an analysis carried out by WGWIDE in 2010 and confirmed by reanalysis by WKBWNSSH in 2013 (ICES, 2013d). A detailed report of the analysis is provided in the stock annex. F_{MSY} is estimated at 0.15 and is based on the weighted mean of age groups 5—14. In the ICES MSY framework B_{pa} is proposed/adopted as the default trigger biomass $B_{trigger}$.

4.6.3 Management reference points

In the long term management plan the Coastal States have then agreed a target reference point defined at F_{target}=0.125 when the stock is above B_{pa}. If the SSB is below $B_{pa,}$ a linear reduction in the fishing mortality rate will be applied from 0.125 at B_{pa} to 0.05 at $B_{lim.}$

4.7 State of the stock

The SSB on 1 January 2017 is estimated by XSAM to be 4.828 million tonnes which is just below B_{pa}. The stock is declining and the SSB time series from the 2017 assessment is in line with the SSB time series from the 2016 assessment.. In the last 15 years, five large year classes have been produced (1998, 1999, 2002, 2003, and 2004). The available information indicates that year classes after 2004 have all been small, except for the 2013 year-class which is estimated to be close to the average in the time series (from 1988). Fishing mortality in 2016 is estimated to be 0.074 which is below F_{pa}, $F_{MSY,}$ and the management plan F.

4.8 NSSH Catch predictions for 2018

4.8.1 Input data for the forecast

Forecasting was conducted using XSAM according to the method described in the Stock Annex and by Aanes (2016c). WGWIDE 2016 decided to use the point estimates from this forecast as

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1 Norwegian spring spawning herring management plan operates on F values weighted with stock numbers, thus the unweighted F_{msy} is likely higher than 0.15.

basis for the advice. In short the forecast is made by applying the point estimates of the stock status as input to set TAC, then based on the TAC a stochastic forecast were performed to determine levels of precision in the forecast. Table 4.8.1.1 list the point estimates of the starting values for the forecast. The input stock numbers at age 2 and older were taken from the final assessment. The catch weight-at-age, used in the forecast, is the average of the observed catch weights over the last 3 years (2014—2016).

For the weight-at-age in the stock, the values for 2017 were obtained from the commercial fisheries in the wintering areas in January. For the years 2018 and 2019 the average of the last 3 years (2015 —2017) was used.

Standard values for natural mortality were used. Maturity at age was based on the information presented in Section 4.4.5. For all year classes born after 2004 the default maturity ogive for normal year classes were used.

The exploitation pattern used in the forecast is taken from the predictions made by the model (see Aanes 2016c for details). The resultant mean annual exploitation pattern is shown in Figure 4.5.1.1b and displays a shift towards older fish in the recent years and further in the prediction. Prediction of recruitment at age 2 is obtained by the model with a mean that in practice represents the long term (1988-2017) estimated mean recruitment (back-transformed mean at log scale) and variance the corresponding recruitment variability over the period. Forecasted values of recruits are highly imprecise but have little influence on the short term forecast of SSB as the herring starts to mature at age 4.

The average fishing mortality defined as the average over the ages 5 to 11 is weighted over the population numbers in the relevant year

$$\bar{F}_y = \sum_{a=5}^{11} N_{a,y} F_{a,y} \Big/ \sum_{a=5}^{11} N_{a,y}$$

where $F_{a,y}$and $N_{a,y}$ are fishing mortalities and numbers by age and year. This procedure is in accordance with previous years for this stock.

There was no agreement of a TAC for 2017. To obtain an estimate of the total catch to be used as input for the catch-constraint projections for 2018, the sum of the unilateral quotas was used. In total, the expected outtake from the stock in 2017 amounts to 805 142.4 tonnes. F in 2017 is estimated by XSAM on the basis of this catch.

4.8.2 Results of the forecast

The Management Options Table with the results of the forecast is presented in Table 4.8.2.1. Assuming a total catch of 805 142.4 tonnes tones is taken in 2017, it is expected that the SSB will decline from 4.809 million tonnes (95% confidence interval 3.881 to 5.737 million tonnes) on 1 January in 2017 to 4.364 million tonnes in 2018 (95% confidence interval 3.447 to 5.450 million tonnes). The 95% confidence interval for weighted F over ages 5-11 in 2017 ranges from 0.102 to 0.255 with a mean of 0.163.

As the point estimate of spawning stock biomass in 2018 is 4.364 million tonnes, below the trigger reference point of 5 million tonnes, paragraph 3 of the management plan applies (see Section 4.10). Thus the resulting point estimate for fishing mortality used for setting the TAC in 2017 is 0.106 and the corresponding TAC in 2018 is 546 472 tonnes. Note that the 95% confidence interval of the realized fishing mortality ranges from 0.087 to 0.232. The 95% confidence interval of the remaining SSB on 1 January in 2019 ranges from 3.137 to 5.328 million tonnes, with a mean below the trigger point of 4.132 million tonnes. The effects on the different management options on SSB is also summarized in Figure 4.8.2.1.

4.9 Comparison with previous assessment

A comparison between the assessments 2008—2017 is shown in Figure 4.9.1. In the years 2008—2015 the assessments were made with TASACS, whereas in 2016 and 2017 XSAM has been applied, as accepted by WKPELA 2016. With the change of the assessment tool in 2016 the age of the recruitment changed from 0 to 2 and the age span in the reference F changed from 5—14 to 5—11.

The table below shows the SSB (thousand tonnes) on 1 January in 2016 and weighted $F_{5\text{-}11}$ in 2015 as estimated in 2016 and 2017.

	ICES 2016	WG 2017	%DIFFERENCE
SSB(2016)	5 023	4 972	-1%
Weighted F5-11(2015)	0.060	0.062	3%

The stock is declining and estimated just belowB_{pa}in 2017.

4.10 Management plans and evaluations

The long-term management plan of Norwegian spring spawning herring aims for exploitation at a target fishing mortality below F_{pa} and is considered by ICES in accordance with the precautionary approach (WKBWNSSH, ICES, 2013d). The management plan in use contains the following elements:

Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level (B_{lim}) of 2 500 000 t.

For 2012 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of less than 0.125 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of this fishing mortality rate.

Should the SSB fall below a reference point of 5 000 000 t (B_{pa}), the fishing mortality rate, referred under Paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing to ensure a safe and rapid recovery of the SSB to a level in excess of 5 000 000 t. The basis for such adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at B_{pa} (5 000 000 t) to 0.05 at B_{lim} (2 500 000 t).

The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

A brief history of it is in the stock annex. In general, the stock has been managed in compliance with the management plan.

Following the 2016 benchmark on NSSH, an evaluation of the management plan was done before WGWIDE and the management plan was still found to be in accordance with the precautionary approach.

4.11 Management considerations

Perception of the stock has not changed since last year's assessment (estimated SSB in 2016 is 1% lower in this year's assessment). Results of exploratory runs by other models match with those of XSAM.

Historically, the size of the stock has shown large variations and dependency on the irregular occurrence of very strong year classes. Between 1998 and 2004 the stock produced a number of strong year classes which lead to an increase in SSB until 2009. Since then, SSB has declined due to absence of strong year classes after 2004 and is expected to decline further until 2018. The short term prognoses indicate that SSB in 2017 of 4.83 which is below $B_{trigger}$ = B_{pa}= 5 million tonnes will decline further in 2018 and 2019, respectively, assuming that declared catches will be taken in 2017 and exploitation in 2018 is according the management plan. In that situation, article 3 of the management plan applies to set TACs for 2018 and future years as long as SSB remains below B_{pa}. Given the relatively low recruitment in recent years, it is expected that SSB will remain below B_{pa} in the short term. This situation will continue until large year classes recruit to the spawning stock. This year's assessment indicate that the 2013 year class is close to the average recruitment in the time series since 1988.

The results of the evaluation of a management plan are conditional on a number of assumptions which have to be made in any modelling exercise. The expected recruitment is one of these assumptions. In general, it is assumed that future recruitment patterns are similar as observed in the past. Under this assumption, the present management plan for Norwegian spring spawning herring is considered precautionary. In the ICES advice, released in 2013, on the NEAFC request to evaluate possible modifications of the management plan, an evaluation was presented of the expected dynamics of the stock under continued poor recruitment conditions. This evaluation indicates that in the absence of strong year classes entering SSB, under the present management plan, SSB is expected to fluctuate around 4 million tonnes and catches will vary between 300 and 400 thousand tonnes.

Since 1999 catches have been regulated through an agreed management plan, which is considered to be precautionary. However, since 2013, a lack of agreement by the Coastal States on their share in the TAC has led to unilaterally set quotas which together are higher than the TAC indicated by the management plan resulting in steeper reduction in the SSB than otherwise.

4.12 Ecosystem considerations

NSS herring juveniles and adults are an important part of the ecosystems in the Barents Sea, along the Norwegian coast, in the Norwegian Sea and in adjoining waters. This refers both to predation on zooplankton by herring and herring being a food resource to higher trophic levels (e.g. cod, saithe, seabirds, and marine mammals). The predation intensity of and on herring have seasonal, spatial and temporal variation as a consequence of variation in migration pattern, prey density, stock size, size of year classes and stock sizes of competing stocks for resources and predators. Recent features of some of these ecosystem factors of relevance for the stock are summarized below.

- The stock's more westerly feeding distribution in recent years (ICES 2017a; 2017b) might be due to better feeding opportunities there or a response to feeding competition with mackerel but the consequence is a less spatial overlap of herring and mackerel in Norwegian Sea and adjoining waters since around 2014 (Nøttestad et al., 2014; ICES, 2015b; 2016b; 2017b).
- Where herring and mackerel overlap spatially they compete for food to some extent (Bachiller et al., 2015; Debes et al., 2012; Langøyet al., 2012; Óskarssonet al., 2015) but studies showing mackerel being more effective feeder might indicate that the herring is forced to the western and northern fringe of Norwegian Sea, although higher zooplankton biomass there could also attract the herring (Nøttestadet al., 2014; ICES, 2015b; 2016b).
- Results of stomach analyses of mackerel on the Norwegian coastal shelf (between about 66°N and 69°N) suggest that mackerel fed opportunistically on herring larvae,

and that predation pressure therefore largely depends on the degree of overlap in time and space (Skaret et al., 2015).

- Lack of large recruiting year classes since 2004 results in small amount of herring feeding in the north-eastern part of the Norwegian Sea.
- Herring growth (i.e. length-at-age) varied over the period 1994-2015 and was negatively related to stock size (Homrum et al., 2016), which indicates interaction between fish density and prey availability.
- Time-series of zooplankton density in May over the years 1995-2016 indicates rather stable low levels in the Norwegian Sea since (Section 1.12.5).
- The last three years, the temperatures have been lower compared to the twenty year mean (1995-2015) along the southwestern boundary of the distribution area of herring in May, where as temperatures have been higher in the northwestern parts of the Nordic Seas (ICES, 2015a; 2016a; 2017a).

4.13 Changes in fishing patterns

The fishery for Norwegian spring spawning herring has generally been described as progressing clockwise in the Nordic Seas as the year progresses. In the recent years this pattern has changed, because there has been an extended fishery in the south and southwestern areas in the Norwegian Sea in the 3rd and 4th quarters. The majority of the catches in the 4th quarter are now taken in the central parts of the Norwegian Sea, whereas in the preceding years there was a more significant fishery in northeastern areas (outside northern Norway and southwest of the Bear Island).

4.14 Recommendation

Since around 2014 there have been concerns regarding the age reading of NSS herring in the IESNS survey. In 2015 there was a workshop, which could not resolve all the problems, and it was decided to aim for a follow up workshop with larger samples of otoliths and scales from the same individuals. For further information see section 1.7.3. It is recommended that a workshop should be held for NSS herring age readers, based on the scale and otolith exchange that has taken place during 2016 and 2017.

4.15 References

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Table 4.4.1.1 Total landings (ICES estimate) of Norwegian spring-spawning herring (tons) since 1972. Data provided by Working Group members.

YEAR	NORWAY	USSR/ RUSSIA	DENMARK	FAROES	ICELAND	IRELAND	NETHERLANDS	GREENLAND	UK	GERMANY	FRANCE	POLAND	SWEDEN	TOTAL
1972	13161	-	-	-	-	-	-	-	-	-	-	-	-	13161
1973	7017	-	-	-	-	-	-	-	-	-	-	-	-	7017
1974	7619	-	-	-	-	-	-	-	-	-	-	-	-	7619
1975	13713	-	-	-	-	-	-	-	-	-	-	-	-	13713
1976	10436	-	-	-	-	-	-	-	-	-	-	-	-	10436
1977	22706	-	-	-	-	-	-	-	-	-	-	-	-	22706
1978	19824	-	-	-	-	-	-	-	-	-	-	-	-	19824
1979	12864	-	-	-	-	-	-	-	-	-	-	-	-	12864
1980	18577	-	-	-	-	-	-	-	-	-	-	-	-	18577
1981	13736	-	-	-	-	-	-	-	-	-	-	-	-	13736
1982	16655	-	-	-	-	-	-	-	-	-	-	-	-	16655
1983	23054	-	-	-	-	-	-	-	-	-	-	-	-	23054
1984	53532	-	-	-	-	-	-	-	-	-	-	-	-	53532
1985	167272	2600	-	-	-	-	-	-	-	-	-	-	-	169872
1986	199256	26000	-	-	-	-	-	-	-	-	-	-	-	225256
1987	108417	18889	-	-	-	-	-	-	-	-	-	-	-	127306
1988	115076	20225	-	-	-	-	-	-	-	-	-	-	-	135301
1989	88707	15123	-	-	-	-	-	-	-	-	-	-	-	103830
1990	74604	11807	-	-	-	-	-	-	-	-	-	-	-	86411
1991	73683	11000	-	-	-	-	-	-	-	-	-	-	-	84683
1992	91111	13337	-	-	-	-	-	-	-	-	-	-	-	104448
1993	199771	32645	-	-	-	-	-	-	-	-	-	-	-	232457
1994	380771	74400	-	2911	21146	-	-	-	-	-	-	-	-	479228
1995	529838	101987	30577	57084	174109	-	7969	2500	881	556	-	-	-	905501
1996	699161	119290	60681	52788	164957	19541	19664	-	46131	11978	-	-	22424	1220283

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Netherlands	Greenland	UK	Germany	France	Poland	Sweden	Total
1997	860963	168900	44292	59987	220154	11179	8694	-	25149	6190	1500	-	19499	1426507
1998	743925	124049	35519	68136	197789	2437	12827	-	15971	7003	605	-	14863	1223131
1999	740640	157328	37010	55527	203381	2412	5871	-	19207	-	-	-	14057	1235433
2000	713500	163261	34968	68625	186035	8939	-	-	14096	3298	-	-	14749	1207201
2001	495036	109054	24038	34170	77693	6070	6439	-	12230	1588	-	-	9818	766136
2002	487233	113763	18998	32302	127197	1699	9392	-	3482	3017	-	1226	9486	807795
2003*	477573	122846	14144	27943	117910	1400	8678	-	9214	3371	-	-	6431	789510
2004	477076	115876	23111	42771	102787	11	17369	-	1869	4810	400	-	7986	794066
2005	580804	132099	28368	65071	156467	-	21517	-	-	17676	0	561	680	1003243
2006*	567237	120836	18449	63137	157474	4693	11625	-	12523	9958	80	-	2946	968958
2007	779089	162434	22911	64251	173621	6411	29764	4897	13244	6038	0	4333	0	1266993
2008	961603	193119	31128	74261	217602	7903	28155	3810	19737	8338	0	0	0	1545656
2009	1016675	210105	32320	85098	265479	10014	24021	3730	25477	14452	0	0	0	1687371
2010	871113	199472	26792	80281	205864	8061	26695	3453	24151	11133	0	0	0	1457015
2011	572641	144428	26740	53271	151074	5727	8348	3426	14045	13296	0	0	0	992997
2012	491005	118595	21754	36190	120956	4813	6237	1490	12310	11945	0	0	705	826000
2013	359458	78521	17160	105038	90729	3815	5626	11788	8342	4244	0	0	23	684743
2014	263253	60292	12513	38529	58828	706	9175	13108	4233	669	0	0	0	461306
2015	176321	45853	9105	33031	42625	1400	5255	12434	55	2660	0	0	0	328740
2016	197501	50455	10384	44727	50418	2048	3519	17508	4031	2582	0	0	0	383174

***In 2003 the Norwegian catches were raised of 39433 to account for changes in percentages of water content.**

Table 4.4.1.2 Norwegian spring-spawning herring. Sampling coverage by year.

Year	TOTAL CATCH	% catch covered by sampling programme	No. samples	No. Measured	No. Aged
2000	1207201	86	389	55956	10901
2001	766136	86	442	70005	11234
2002	807795	88	184	39332	5405
2003	789510	71	380	34711	11352
2004	794066	79	503	48784	13169
2005	1003243	86	459	49273	14112
2006	968958	93	631	94574	9862
2007	1266993	94	476	56383	14661
2008	1545656	94	722	81609	31438
2009	1686928	94	663	65536	12265
2010	1457015	91	1258	124071	12377
2011	992.997	95	766	79360	10744
2012	825.999	93	649	59327	14768
2013	684.743	91	402	33169	11431
2014	461.306	89	229	18370	5813
2015	328.739	92	177	25156	5039
2016	383.174	91	203	39120	5892

Table 4.4.1.3 Norwegian spring-spawning herring. Sampling coverage by country in 2016.

COUNTRY	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	10384.32	80	2	230	103
Faroe Islands	44726.71	90	13	791	687
Germany	2582.49	100	23	3674	229
Greenland	17507.80	0	0	0	0
Iceland	50418.00	100	57	2410	1669
Ireland	2048.14	0	1	51	33
Norway	197500.94	99	92	2425	2425
Russia	50455.00	100	15	29539	746
The Netherlands	3519.35	0	0	0	0
UK_England	131.16	0	0	0	0
UK_Scotland	3899.82	0	0	0	0
Total for Stock	383173.75	91	203	39120	5892

Table 4.4.1.4 Norwegian spring-spawning herring. Sampling coverage by ICES Division in 2016.

Area	Official Catch	No Samples	No Aged	No Measured	No Aged/ 1000 tonnes	No Measured/ 1000 tonnes
2.a	317199	151	4391	36917	14	116
4.a	369	0	0	0	0	0
5.a	43472	52	1501	2203	35	51
5.b	4636	0	0	0	0	0
14.a	17498	0	0	0	0	0
Total	383174	203	5892	39120	15	102

Table 4.4.1.5 Norwegian spring-spawning herring. Catch data provided by working group members and samples allocated to unsampled catches in SALLOC.

Country	Div.	Q.	Catch (t)	Samples allocated ('fill in')
DE	2a	4	2582	
DK	2a	1	8271	
DK	2a	4	2113	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4
FO	2a	2	17	FO_2a_q3
FO	2a	3	2649	
FO	2a	4	37535	
FO	5b	3	792	FO_2a_q3
FO	5b	4	3733	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4, IS_5a_q4
GL	14a	3	17491	FO_2a_q3, RU_2a_q3, IS_2a_q3, IS_5a_q3
GL	14a	4	7	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4, IS_5a_q4
GL	5a	3	10	IS_5a_q3
IR	2a	1	281	NO_2a_q1, DK_2a_q1
IR	2a	4	1767	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4
IS	2a	3	1439	
IS	2a	4	5517	
IS	5a	3	25385	
IS	5a	4	18077	
NL	2a	4	3267	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4
NL	4a	4	153	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4
NL	5b	3	99	FO_2a_q3, RU_2a_q3, IS_2a_q3, IS_5a_q3

Country	Div.	Q.	Catch (t)	Samples allocated ('fill in')
NO	2a	1	110338	
NO	2a	2	502	NO_2a_q1
NO	2a	3	724	NO_2a_q4
NO	2a	4	85721	
NO	4a	1	1	NO_2a_q1
NO	4a	2	18	NO_2a_q1
NO	4a	4	197	NO_2a_q4
RU	2a	2	61	
RU	2a	3	11066	
RU	2a	4	39316	
RU	5b	3	12	
UK_England	2a	3	22	FO_2a_q3, RU_2a_q3, IS_2a_q3
UK_England	2a	4	109	DE_2a_q4, IS_2a_q4, NO_2a_q4, RU_2a_q4
UK_Scotland	2a	1	3900	NO_2a_q1, DK_2a_q1

Table 4.4.3.1. Norwegian spring spawning herring. Catch in numbers (thousands).

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1950	5112600	2000000	600000	276200	184800	185500	547000	628600	79500	88600	109500	86900	194500	368300	66400	344300
1951	1635500	7607700	400000	6600	383800	172400	164400	515600	602000	77100	82700	103100	107600	253500	348000	352500
1952	13721600	9149700	1232900	39300	60500	602300	136300	204500	380200	377900	79200	85700	107700	106800	186500	564400
1953	5697200	5055000	581300	740100	46600	100900	355600	81900	110900	314100	394900	61700	91200	94100	98800	730400
1954	10675990	7071090	855400	266300	1435500	142900	236000	490300	128100	199800	440400	460700	88400	100600	133000	803200
1955	5175600	2871100	510100	93000	276400	2045100	114300	189600	274700	85300	193400	295600	203200	58700	84600	580600
1956	5363900	2023700	627100	116500	251600	314200	2555100	110000	203900	264200	130700	198300	272800	163300	63000	565100
1957	5001900	3290800	219500	23300	373300	153800	228500	1985300	72000	127300	182500	88400	121200	149300	131600	281400
1958	9666990	2798100	666400	17500	17900	110900	89300	194400	973500	70700	123000	200900	98700	77400	70900	255600
1959	17896280	198530	325500	15100	26800	25900	146600	114800	240700	1103800	88600	124300	198000	88500	77400	235900
1960	12884310	13580790	392500	121700	18200	28100	24400	96200	73300	203900	1163000	85200	129700	153500	56700	168900
1961	6207500	16075600	2884800	31200	8100	4100	15000	19400	61600	49200	136100	728100	49700	45000	63000	60100
1962	3693200	4081100	1041300	1843800	8000	3100	7200	20200	11900	59100	52600	117000	813500	44200	54700	152300
1963	4807000	2119200	2045300	760400	835800	5300	1800	3600	18300	9300	107700	92500	174100	923700	79600	185300
1964	3613000	2728300	220300	114600	399000	2045800	13700	1500	3000	24900	29300	95600	82400	153000	772800	336800
1965	2303000	3780900	2853600	89900	256200	571100	2199700	19500	14900	7400	19100	40000	100500	107800	138700	883100
1966	3926500	662800	1678000	2048700	26900	466600	1306000	2884500	37900	14300	17400	26200	11000	69100	72100	556700
1967	426800	9877100	70400	1392300	3254000	26600	421300	1132000	1720800	8900	5700	3500	8500	8900	17500	104400
1968	1783600	437000	388300	99100	1880500	1387400	14220	94000	134100	345100	2000	1100	830	2500	2600	17000
1969	561200	507100	141900	188200	800	8800	4700	700	11700	33600	36000	300	200	200	200	2400
1970	119300	529400	33200	6300	18600	600	3300	3300	1000	13400	26200	28100	300	100	200	2000
1971	30500	42900	85100	1820	1020	1240	360	1110	1130	360	4410	6910	5450	0	20	120
1972	347100	41000	20400	35376	3476	3583	2481	694	1486	198	0	494	593	593	0	0

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1973	29300	3500	1700	2389	25200	651	1506	278	178	0	0	0	0	0	180	0
1974	65900	7800	3900	100	241	24505	257	196	0	0	0	0	0	0	0	0
1975	30600	3600	1800	3268	132	910	30667	5	2	0	0	0	0	0	0	0
1976	.20100	2400	1200	23248	5436	0	0	13086	0	0	0	0	0	0	0	0
1977	43000	6200	3100	22103	23595	336	0	419	10766	0	0	0	0	0	0	0
1978	20100	2400	1200	3019	12164	20315	870	0	620	5027	0	0	0	0	0	0
1979	32600	3800	1900	6352	1866	6865	11216	326	0	0	2534	0	0	0	0	0
1980	6900	800	400	6407	5814	2278	8165	15838	441	8	0	2688	0	0	0	0
1981	8300	1100	11900	4166	4591	8596	2200	4512	8280	345	103	114	964	0	0	0
1982	22600	1100	200	13817	7892	4507	6258	1960	5075	6047	121	37	37	121	0	0
1983	127000	4680	1670	3183	21191	9521	6181	6823	1293	4598	7329	143	40	143	860	0
1984	33860	1700	2490	4483	5388	61543	18202	12638	15608	7215	16338	6478	0	0	0	1650
1985	28570	13150	207220	21500	15500	16500	130000	59000	55000	63000	10000	31000	50000	0	0	2640
1986	13810	1380	3090	539785	17594	14500	15500	105000	75000	42000	77000	19469	66000	80000	0	2470
1987	13850	6330	35770	19776	501393	18672	3502	7058	28000	12000	9500	4500	7834	6500	7000	450
1988	15490	2790	9110	62923	25059	550367	9452	3679	5964	14583	8872	2818	3356	2682	1560	540
1989	7120	1930	25200	2890	3623	5650	324290	3469	800	679	3297	1375	679	321	260	0
1990	1020	400	15540	18633	2658	11875	10854	226280	1289	1519	2036	2415	646	179	590	480
1991	100	3370	3330	8438	2780	1410	14698	8867	218851	2499	461	87	690	103	260	540
1992	1630	150	1340	12586	33100	4980	1193	11981	5748	225677	2483	639	247	1236	0	0
1993	6570	130	7240	28408	106866	87269	8625	3648	29603	18631	410110	0	0	0	0	0
1994	430	20	8100	32500	110090	363920	164800	15580	8140	37330	35660	645410	2830	460	100	2070
1995	0	0	1130	57590	346460	622810	637840	231090	15510	15850	69750	83740	911880	4070	250	450
1996	0	0	30140	34360	713620	1571000	940580	406280	103410	5680	7370	66090	17570	836550	0	0

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1997	0	0	21820	130450	270950	1795780	1993620	761210	326490	60870	20020	32400	90520	19120	370330	300
1998	0	0	82891	70323	242365	368310	1760319	1263750	381482	129971	42502	25343	3478	112604	5633	108514
1999	0	0	5029	137626	35820	134813	429433	1604959	1164263	291394	106005	14524	40040	7202	88598	63983
2000	0	0	14395	84016	560379	34933	110719	404460	1299253	1045001	216980	71589	16260	22701	23321	71811
2001	0	0	2076	102293	160678	426822	38749	95991	296460	839136	507106	73673	23722	3505	3356	22164
2002	0	0	62031	198360	643161	255516	326495	29843	93530	264675	663059	339326	52922	12437	7000	10087
2003	0	3461	4524	75243	323958	730468	175878	167776	22866	74494	217108	567253	219097	38555	8111	6192
2004	125	1846	43800	24299	92300	429510	714433	111022	137940	26656	52467	169196	401564	210547	28028	11883
2005	0	442	20411	447788	94206	170547	643600	930309	121856	123291	37967	65289	139331	344822	126879	15697
2006	0	1968	45438	75824	729898	82107	171370	726041	772217	88701	77115	30339	57882	133665	142240	49128
2007	0	4475	8450	224636	366983	1804495	152916	242923	728836	511664	47215	25384	15316	24488	64755	58465
2008	0	39898	123949	36630	550274	670681	2295912	199592	256132	586583	369620	29633	36025	23775	25195	63176
2009	0	3468	113424	192641	149075	1193781	914748	1929631	142931	262037	423972	238174	45519	9337	10153	70538
2010	0	75981	61673	101948	209295	189784	1064866	711951	1421939	175010	180164	340781	179039	12558	11602	49773
2011	0	126972	249809	61706	104634	234330	210165	755382	543212	642787	90515	117230	136509	45082	6628	11638
2012	0	2680	13083	211630	49999	119627	281908	263330	747839	314694	357902	53109	44982	64273	12420	3604
2013	0	1	20715	60364	276901	71287	112558	283658	242243	591912	169525	145318	24936	10614	9725	2299
2014	0	265	1441	28301	57838	257529	50424	71721	194814	147083	381317	83050	57315	12746	1809	7501
2015	0	647	3244	16139	55749	52369	152347	34046	65728	156075	103393	201141	24310	49373	3369	6397
2016	0	197	2351	45483	43416	112147	85937	164454	52267	73576	174655	96476	179051	38546	32880	8379

Table 4.4.4.1. Norwegian spring spawning herring. Weight at age in the catch (kg).

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1950	0.007	0.025	0.058	0.110	0.188	0.211	0.234	0.253	0.266	0.280	0.294	0.303	0.312	0.32	0.323	0.334
1951	0.009	0.029	0.068	0.130	0.222	0.249	0.276	0.298	0.314	0.330	0.346	0.357	0.368	0.377	0.381	0.394
1952	0.008	0.026	0.061	0.115	0.197	0.221	0.245	0.265	0.279	0.293	0.308	0.317	0.327	0.335	0.339	0.349
1953	0.008	0.027	0.063	0.120	0.205	0.230	0.255	0.275	0.290	0.305	0.320	0.330	0.34	0.347	0.351	0.363
1954	0.008	0.026	0.062	0.117	0.201	0.225	0.250	0.269	0.284	0.299	0.313	0.323	0.333	0.341	0.345	0.356
1955	0.008	0.027	0.063	0.119	0.204	0.229	0.254	0.274	0.289	0.304	0.318	0.328	0.338	0.346	0.350	0.362
1956	0.008	0.028	0.066	0.126	0.215	0.241	0.268	0.289	0.304	0.320	0.336	0.346	0.357	0.365	0.369	0.382
1957	0.008	0.028	0.066	0.127	0.216	0.243	0.269	0.290	0.306	0.322	0.338	0.348	0.359	0.367	0.371	0.384
1958	0.009	0.030	0.070	0.133	0.227	0.255	0.283	0.305	0.321	0.338	0.355	0.366	0.377	0.386	0.390	0.403
1959	0.009	0.030	0.071	0.135	0.231	0.259	0.287	0.310	0.327	0.344	0.360	0.372	0.383	0.392	0.397	0.409
1960	0.006	0.011	0.074	0.119	0.188	0.277	0.337	0.318	0.363	0.379	0.360	0.420	0.411	0.439	0.450	0.447
1961	0.006	0.010	0.045	0.087	0.159	0.276	0.322	0.372	0.363	0.393	0.407	0.397	0.422	0.447	0.465	0.452
1962	0.009	0.023	0.055	0.085	0.148	0.288	0.333	0.360	0.352	0.350	0.374	0.384	0.374	0.394	0.399	0.414
1963	0.008	0.026	0.047	0.098	0.171	0.275	0.268	0.323	0.329	0.336	0.341	0.358	0.385	0.353	0.381	0.386
1964	0.009	0.024	0.059	0.139	0.219	0.239	0.298	0.295	0.339	0.350	0.358	0.351	0.367	0.375	0.372	0.433
1965	0.009	0.016	0.048	0.089	0.217	0.234	0.262	0.331	0.360	0.367	0.386	0.395	0.393	0.404	0.401	0.431
1966	0.008	0.017	0.040	0.063	0.246	0.260	0.265	0.301	0.410	0.425	0.456	0.460	0.467	0.446	0.459	0.472
1967	0.009	0.015	0.036	0.066	0.093	0.305	0.305	0.310	0.333	0.359	0.413	0.446	0.401	0.408	0.439	0.430
1968	0.010	0.027	0.049	0.075	0.108	0.158	0.375	0.383	0.364	0.382	0.441	0.410		0.517	0.491	0.485
1969	0.009	0.021	0.047	0.072		0.152	0.296		0.329	0.329	0.341					0.429
1970	0.008	0.058	0.085	0.105	0.171		0.216	0.277	0.298	0.304	0.305	0.309				0.376
1971	0.011	0.053	0.121	0.177	0.216	0.250		0.305	0.333		0.366	0.377	0.388			
1972	0.011	0.029	0.062	0.103	0.154	0.215	0.258		0.322							

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	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1973	0.006	0.053	0.106	0.161	0.213		0.255									
1974	0.006	0.055	0.117			0.249										
1975	0.009	0.079	0.169	0.241			0.381									
1976	0.007	0.062	0.132	0.189	0.250			0.323								
1977	0.011	0.091	0.193	0.316	0.350				0.511							
1978	0.012	0.100	0.210	0.274	0.424	0.454				0.613						
1979	0.010	0.088	0.181	0.293	0.359	0.416	0.436				0.553					
1980	0.012			0.266	0.399	0.449	0.460	0.485				0.608				
1981	0.010	0.082	0.163	0.196	0.291	0.341	0.368	0.380	0.397							
1982	0.010	0.087	0.159	0.256	0.312	0.378	0.415	0.435	0.449	0.448						
1983	0.011	0.090	0.165	0.217	0.265	0.337	0.378	0.410	0.426	0.435	0.444					
1984	0.009	0.047	0.145	0.218	0.262	0.325	0.346	0.381	0.400	0.413	0.405	0.426				0.415
1985	0.009	0.022	0.022	0.214	0.277	0.295	0.338	0.360	0.381	0.397	0.409	0.417	0.435			0.435
1986	0.007	0.077	0.097	0.055	0.249	0.294	0.312	0.352	0.374	0.398	0.402	0.401	0.410	0.410		0.410
1987	0.010	0.075	0.091	0.124	0.173	0.253	0.232	0.312	0.328	0.349	0.353	0.370	0.385	0.385	0.385	
1988	0.008	0.062	0.075	0.124	0.154	0.194	0.241	0.265	0.304	0.305	0.317	0.308	0.334	0.334	0.334	
1989	0.010	0.060	0.204	0.188	0.264	0.260	0.282	0.306			0.422	0.364				
1990	0.007		0.102	0.230	0.239	0.266	0.305	0.308	0.376	0.407	0.412	0.424				
1991		0.015	0.104	0.208	0.250	0.288	0.312	0.316	0.330	0.344						
1992	0.007		0.103	0.191	0.233	0.304	0.337	0.365	0.361	0.371	0.403			0.404		
1993	0.007		0.106	0.153	0.243	0.282	0.320	0.330	0.365	0.373	0.379					
1994			0.102	0.194	0.239	0.280	0.317	0.328	0.356	0.372	0.390	0.379	0.399	0.403		
1995			0.102	0.153	0.192	0.234	0.283	0.328	0.349	0.356	0.374	0.366	0.393	0.387		
1996			0.136	0.136	0.168	0.206	0.262	0.309	0.337	0.366	0.360	0.361	0.367	0.379		
1997			0.089	0.167	0.184	0.207	0.232	0.277	0.305	0.331	0.328	0.344	0.343	0.397	0.357	

							AGE									
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1998			0.111	0.150	0.216	0.221	0.249	0.277	0.316	0.338	0.374	0.372	0.366	0.396	0.377	0.406
1999			0.096	0.173	0.228	0.262	0.274	0.292	0.307	0.335	0.362	0.371	0.399	0.396	0.400	0.404
2000			0.124	0.175	0.222	0.242	0.289	0.303	0.310	0.328	0.349	0.383	0.411	0.410	0.419	0.409
2001			0.105	0.166	0.214	0.252	0.268	0.305	0.308	0.322	0.337	0.363	0.353	0.378	0.400	0.427
2002			0.056	0.128	0.198	0.255	0.281	0.303	0.322	0.323	0.334	0.345	0.369	0.407	0.410	0.435
2003		0.062	0.068	0.169	0.218	0.257	0.288	0.316	0.323	0.348	0.354	0.351	0.363	0.372	0.376	0.429
2004	0.022	0.066	0.143	0.18	0.227	0.26	0.29	0.323	0.355	0.375	0.383	0.399	0.395	0.405	0.429	0.439
2005		0.092	0.106	0.181	0.235	0.266	0.290	0.315	0.344	0.367	0.384	0.372	0.384	0.398	0.402	0.413
2006		0.055	0.102	0.171	0.238	0.268	0.292	0.311	0.330	0.365	0.374	0.376	0.388	0.396	0.398	0.407
2007	0.000	0.074	0.137	0.162	0.228	0.271	0.316	0.332	0.342	0.358	0.361	0.381	0.390	0.400	0.405	0.399
2008	0.000	0.026	0.106	0.145	0.209	0.254	0.296	0.318	0.341	0.353	0.363	0.367	0.395	0.396	0.386	0.413
2009		0.040	0.156	0.184	0.220	0.251	0.291	0.311	0.338	0.347	0.363	0.375	0.382	0.375	0.375	0.387
2010		0.059	0.107	0.177	0.218	0.261	0.279	0.311	0.325	0.343	0.362	0.370	0.388	0.391	0.376	0.441
2011		0.011	0.098	0.200	0.257	0.273	0.300	0.316	0.340	0.348	0.365	0.371	0.387	0.374	0.403	0.401
2012		0.034	0.126	0.211	0.272	0.301	0.308	0.331	0.335	0.351	0.354	0.370	0.389	0.389	0.382	0.388
2013		0.048	0.163	0.237	0.276	0.300	0.331	0.339	0.351	0.357	0.370	0.373	0.394	0.391	0.389	0.367
2014		0.057	0.179	0.233	0.271	0.293	0.322	0.342	0.353	0.367	0.365	0.374	0.375	0.378	0.418	0.371
2015		0.059	0.146	0.203	0.272	0.323	0.331	0.358	0.370	0.372	0.383	0.382	0.392	0.386	0.383	0.391
2016		0.048	0.111	0.212	0.255	0.290	0.333	0.339	0.361	0.367	0.370	0.381	0.378	0.388	0.383	0.395

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Table 4.4.4.2. Norwegian spring spawning herring. Weight at age in the stock (kg).

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1950	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1951	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1952	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1953	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1954	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1955	0.001	0.008	0.047	0.100	0.195	0.213	0.260	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1956	0.001	0.008	0.047	0.100	0.205	0.230	0.249	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1957	0.001	0.008	0.047	0.100	0.136	0.228	0.255	0.262	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1958	0.001	0.008	0.047	0.100	0.204	0.242	0.292	0.295	0.293	0.305	0.315	0.330	0.340	0.345	0.352	0.363
1959	0.001	0.008	0.047	0.100	0.204	0.252	0.260	0.290	0.300	0.305	0.315	0.325	0.330	0.340	0.345	0.358
1960	0.001	0.008	0.047	0.100	0.204	0.270	0.291	0.293	0.321	0.318	0.320	0.344	0.349	0.370	0.379	0.378
1961	0.001	0.008	0.047	0.100	0.232	0.250	0.292	0.302	0.304	0.323	0.322	0.321	0.344	0.357	0.363	0.368
1962	0.001	0.008	0.047	0.100	0.219	0.291	0.300	0.316	0.324	0.326	0.335	0.338	0.334	0.347	0.354	0.358
1963	0.001	0.008	0.047	0.100	0.185	0.253	0.294	0.312	0.329	0.327	0.334	0.341	0.349	0.341	0.358	0.375
1964	0.001	0.008	0.047	0.100	0.194	0.213	0.264	0.317	0.363	0.353	0.349	0.354	0.357	0.359	0.365	0.402
1965	0.001	0.008	0.047	0.100	0.186	0.199	0.236	0.260	0.363	0.350	0.370	0.360	0.378	0.387	0.390	0.394
1966	0.001	0.008	0.047	0.100	0.185	0.219	0.222	0.249	0.306	0.354	0.377	0.391	0.379	0.378	0.361	0.383
1967	0.001	0.008	0.047	0.100	0.180	0.228	0.269	0.270	0.294	0.324	0.420	0.430	0.366	0.368	0.433	0.414
1968	0.001	0.008	0.047	0.100	0.115	0.206	0.266	0.275	0.274	0.285	0.350	0.325	0.363	0.408	0.388	0.378
1969	0.001	0.008	0.047	0.100	0.115	0.145	0.270	0.300	0.306	0.308	0.318	0.340	0.368	0.360	0.393	0.397
1970	0.001	0.008	0.047	0.100	0.209	0.272	0.230	0.295	0.317	0.323	0.325	0.329	0.380	0.370	0.380	0.391
1971	0.001	0.015	0.080	0.100	0.190	0.225	0.250	0.275	0.290	0.310	0.325	0.335	0.345	0.355	0.365	0.390
1972	0.001	0.010	0.070	0.150	0.150	0.140	0.210	0.240	0.270	0.300	0.325	0.335	0.345	0.355	0.365	0.390
1973	0.001	0.010	0.085	0.170	0.259	0.342	0.384	0.409	0.404	0.461	0.520	0.534	0.500	0.500	0.500	0.500

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1974	0.001	0.010	0.085	0.170	0.259	0.342	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1975	0.001	0.010	0.085	0.181	0.259	0.342	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1976	0.001	0.010	0.085	0.181	0.259	0.342	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1977	0.001	0.010	0.085	0.181	0.259	0.343	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1978	0.001	0.010	0.085	0.180	0.294	0.326	0.371	0.409	0.461	0.476	0.520	0.543	0.500	0.500	0.500	0.500
1979	0.001	0.010	0.085	0.178	0.232	0.359	0.385	0.420	0.444	0.505	0.520	0.551	0.500	0.500	0.500	0.500
1980	0.001	0.010	0.085	0.175	0.283	0.347	0.402	0.421	0.465	0.465	0.520	0.534	0.500	0.500	0.500	0.500
1981	0.001	0.010	0.085	0.170	0.224	0.336	0.378	0.387	0.408	0.397	0.520	0.543	0.512	0.512	0.512	0.512
1982	0.001	0.010	0.085	0.170	0.204	0.303	0.355	0.383	0.395	0.413	0.453	0.468	0.506	0.506	0.506	0.506
1983	0.001	0.010	0.085	0.155	0.249	0.304	0.368	0.404	0.424	0.437	0.436	0.493	0.495	0.495	0.495	0.495
1984	0.001	0.010	0.085	0.140	0.204	0.295	0.338	0.376	0.395	0.407	0.413	0.422	0.437	0.437	0.437	0.437
1985	0.001	0.010	0.085	0.148	0.234	0.265	0.312	0.346	0.370	0.395	0.397	0.428	0.428	0.428	0.428	0.428
1986	0.001	0.010	0.085	0.054	0.206	0.265	0.289	0.339	0.368	0.391	0.382	0.388	0.395	0.395	0.395	0.395
1987	0.001	0.010	0.055	0.090	0.143	0.241	0.279	0.299	0.316	0.342	0.343	0.362	0.376	0.376	0.376	0.376
1988	0.001	0.015	0.050	0.098	0.135	0.197	0.277	0.315	0.339	0.343	0.359	0.365	0.376	0.376	0.376	0.376
1989	0.001	0.015	0.100	0.154	0.175	0.209	0.252	0.305	0.367	0.377	0.359	0.395	0.396	0.396	0.396	0.396
1990	0.001	0.008	0.048	0.219	0.198	0.258	0.288	0.309	0.428	0.370	0.403	0.387	0.440	0.440	0.440	0.44
1991	0.001	0.011	0.037	0.147	0.210	0.244	0.300	0.324	0.336	0.343	0.382	0.366	0.425	0.425	0.425	0.425
1992	0.001	0.007	0.030	0.128	0.224	0.296	0.327	0.355	0.345	0.367	0.341	0.361	0.430	0.470	0.470	0.46
1993	0.001	0.008	0.025	0.081	0.201	0.265	0.323	0.354	0.358	0.381	0.369	0.396	0.393	0.374	0.403	0.4
1994	0.001	0.010	0.025	0.075	0.151	0.254	0.318	0.371	0.347	0.412	0.382	0.407	0.410	0.410	0.410	0.41
1995	0.001	0.018	0.025	0.066	0.138	0.230	0.296	0.346	0.388	0.363	0.409	0.414	0.422	0.410	0.410	0.426
1996	0.001	0.018	0.025	0.076	0.118	0.188	0.261	0.316	0.346	0.374	0.390	0.390	0.384	0.398	0.398	0.398
1997	0.001	0.018	0.025	0.096	0.118	0.174	0.229	0.286	0.323	0.370	0.378	0.386	0.360	0.393	0.391	0.391

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1998	0.001	0.018	0.025	0.074	0.147	0.174	0.217	0.242	0.278	0.304	0.310	0.359	0.340	0.344	0.385	0.369
1999	0.001	0.018	0.025	0.102	0.150	0.223	0.240	0.264	0.283	0.315	0.345	0.386	0.386	0.386	0.382	0.395
2000	0.001	0.018	0.025	0.119	0.178	0.225	0.271	0.285	0.298	0.311	0.339	0.390	0.398	0.406	0.414	0.427
2001	0.001	0.018	0.025	0.075	0.178	0.238	0.247	0.296	0.307	0.314	0.328	0.351	0.376	0.406	0.414	0.425
2002	0.001	0.010	0.023	0.057	0.177	0.241	0.275	0.302	0.311	0.314	0.328	0.341	0.372	0.405	0.415	0.438
2003	0.001	0.010	0.055	0.098	0.159	0.211	0.272	0.305	0.292	0.331	0.337	0.347	0.356	0.381	0.414	0.433
2004	0.001	0.010	0.055	0.106	0.149	0.212	0.241	0.279	0.302	0.337	0.354	0.355	0.360	0.371	0.400	0.429
2005	0.001	0.010	0.046	0.112	0.156	0.234	0.267	0.295	0.330	0.363	0.377	0.414	0.406	0.308	0.420	0.452
2006	0.001	0.010	0.042	0.107	0.179	0.232	0.272	0.297	0.318	0.371	0.365	0.393	0.395	0.399	0.415	0.428
2007	0.001	0.010	0.036	0.086	0.155	0.226	0.265	0.312	0.310	0.364	0.384	0.352	0.386	0.304	0.420	0.412
2008**	0.001	0.010	0.044	0.077	0.146	0.212	0.269	0.289	0.327	0.351	0.358	0.372	0.411	0.353	0.389	0.393
2009***	0.001	0.010	0.044	0.077	0.141	0.215	0.270	0.306	0.336	0.346	0.364	0.369	0.411	0.353	0.389	0.393
2010****	0.001	0.01	0.044	0.077	0.188	0.22	0.251	0.286	0.308	0.333	0.344	0.354	0.373	0.353	0.389	0.393
2011	0.001	0.01	0.044	0.118	0.185	0.209	0.246	0.277	0.310	0.322	0.339	0.349	0.364	0.363	0.389	0.393
2012	0.001	0.01	0.044	0.138	0.185	0.256	0.273	0.290	0.305	0.330	0.342	0.361	0.390	0.377	0.389	0.393
2013	0.001	0.01	0.044	0.138	0.204	0.267	0.305	0.309	0.320	0.328	0.346	0.350	0.390	0.377	0.389	0.393
2014	0.001	0.01	0.044	0.138	0.198	0.274	0.301	0.326	0.333	0.339	0.347	0.344	0.362	0.362	0.389	0.393
2015	0.001	0.01	0.044	0.138	0.187	0.243	0.299	0.326	0.319	0.345	0.346	0.354	0.382	0.376	0.389	0.393
2016	0.001	0.01	0.054	0.115	0.186	0.247	0.293	0.320	0.334	0.353	0.354	0.352	0.361	0.370	0.380	0.388
2017	0.001	0.01	0.054	0.115	0.190	0.247	0.282	0.322	0.338	0.351	0.359	0.361	0.361	0.368	0.380	0.386

**** mean weight at ages 11 and 13 are mean of 5 previous years at the same age. These age groups were not present in the catches of the wintering survey from which the stock weight are derived.**

***** derived from catch data from the wintering area north of 69°N during December 2008 – January 2009 for age groups 4—11.**

******derived from catch data from the wintering area north of 69°N during January 2010 for age groups 4—12.**

Table 4.4.5.1. Norwegian Spring-spawning herring. Mature at age. The time series was provided by WKHERMAT in 2010 and are used in the assessment since 2010.

AGE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year	0	0	0	0	0,2	0,8		1	1	1	1	1	1	1	1	1	1
1950	0	0	0	0	0,2	0,8		1	1	1	1	1	1	1	1	1	1
1951	0	0	0	0	0,1	0,6		1	1	1	1	1	1	1	1	1	1
1952	0	0	0	0	0,3	0,4		0,9	1	1	1	1	1	1	1	1	1
1953	0	0	0	0	0,1	0,7		0,9	1	1	1	1	1	1	1	1	1
1954	0	0	0	0,1	0,4	0,4		1	1	1	1	1	1	1	1	1	1
1955	0	0	0	0	0,5	0,7		0,6	1	1	1	1	1	1	1	1	1
1956	0	0	0	0	0,3	0,8		0,8	0,7	1	1	1	1	1	1	1	1
1957	0	0	0	0	0,3	0,5		0,9	0,9	1	1	1	1	1	1	1	1
1958	0	0	0	0	0,7	0,8		1	0,9	1	1	1	1	1	1	1	1
1959	0	0	0	0	0,3	0,9		0,9	1	1	1	1	1	1	1	1	1
1960	0	0	0	0	0,1	0,8		1	0,9	1	1	1	1	1	1	1	1
1961	0	0	0	0	0,1	0,7		1	1	1	1	1	1	1	1	1	1
1962	0	0	0	0	0,1	0,4		1	1	1	1	1	1	1	1	1	1
1963	0	0	0	0	0,1	0,4		0,8	1	1	1	1	1	1	1	1	1
1964	0	0	0	0	0,5	0,4		0,9	0,8	1	1	1	1	1	1	1	1
1965	0	0	0	0	0,5	0,7		0,9	1	1	1	1	1	1	1	1	1
1966	0	0	0	0	0,3	0,8		1	1	1	1	1	1	1	1	1	1
1967	0	0	0	0	0	0,7		0,9	1	1	1	1	1	1	1	1	1
1968	0	0	0	0,1	0,2	0,3		1	1	1	1	1	1	1	1	1	1
1969	0	0	0	0	0,4	0,3		0,4	1	1	1	1	1	1	1	1	1
1970	0	0	0	0	0,1	0,7		1	1	1	1	1	1	1	1	1	1
1971	0	0	0	0	0,4	0,3		1	1	1	1	1	1	1	1	1	1
1972	0	0	0	0,1	0,6	1		1	1	1	1	1	1	1	1	1	1
1973	0	0	0	0	0,6	0,9		1	1	1	1	1	1	1	1	1	1
1974	0	0	0	0,1	0,5	0,9		1	1	1	1	1	1	1	1	1	1
1975	0	0	0	0,1	0,9	0,9		1	1	1	1	1	1	1	1	1	1
1976	0	0	0	0,3	0,8	1		1	1	1	1	1	1	1	1	1	1
1977	0	0	0	0,2	0,9	1		1	1	1	1	1	1	1	1	1	1
1978	0	0	0	0,1	0,9	1		1	1	1	1	1	1	1	1	1	1
1979	0	0	0	0,1	0,9	1		1	1	1	1	1	1	1	1	1	1
1980	0	0	0	0,1	1	1		1	1	1	1	1	1	1	1	1	1
1981	0	0	0	0,1	0,8	1		1	1	1	1	1	1	1	1	1	1
1982	0	0	0	0,1	0,9	1		1	1	1	1	1	1	1	1	1	1
1983	0	0	0	0,1	0,7	1		1	1	1	1	1	1	1	1	1	1
1984	0	0	0	0,1	0,8	0,9		1	1	1	1	1	1	1	1	1	1
1985	0	0	0	0	0,5	0,9		0,9	1	1	1	1	1	1	1	1	1
1986	0	0	0	0	0,1	0,8		0,9	0,9	1	1	1	1	1	1	1	1
1987	0	0	0	0	0,2	0,7		0,9	1	1	1	1	1	1	1	1	1
1988	0	0	0	0	0,4	0,8		1	1	1	1	1	1	1	1	1	1
1989	0	0	0	0,2	0,5	0,9		1	1	1	1	1	1	1	1	1	1
1990	0	0	0	0	0,2	0,8		1	1	1	1	1	1	1	1	1	1

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1991	0	0	0	0	0,9	0,9		1	1	1	1	1	1	1	1	1	1
1992	0	0	0	0	0,8	1		1	1	1	1	1	1	1	1	1	1
1993	0	0	0	0	0,5	1		1	1	1	1	1	1	1	1	1	1
1994	0	0	0	0	0,1	0,9		1	1	1	1	1	1	1	1	1	1
1995	0	0	0	0	0	0,6		1	1	1	1	1	1	1	1	1	1
1996	0	0	0	0	0	0,5		0,9	1	1	1	1	1	1	1	1	1
1997	0	0	0	0,1	0	0,4		0,9	1	1	1	1	1	1	1	1	1
1998	0	0	0	0	0,6	0,4		0,9	1	1	1	1	1	1	1	1	1
1999	0	0	0	0	0,3	0,9		0,9	1	1	1	1	1	1	1	1	1
2000	0	0	0	0	0,2	0,8	1	1	1	1	1	1	1	1	1	1	1
2001	0	0	0	0	0,3	0,9	0,9	1	1	1	1	1	1	1	1	1	1
2002	0	0	0	0	0,1	0,9	1	1	1	1	1	1	1	1	1	1	1
2003	0	0	0	0	0,2	0,7	1	1	1	1	1	1	1	1	1	1	1
2004	0	0	0	0	0,3	0,9	1	1	1	1	1	1	1	1	1	1	1
2005	0	0	0	0	0,2	0,8	1	1	1	1	1	1	1	1	1	1	1
2006	0	0	0	0	0,2	0,8	1	1	1	1	1	1	1	1	1	1	1
2007	0	0	0	0	0,2	0,8	1	1	1	1	1	1	1	1	1	1	1
2008	0	0	0	0	0,1	0,7	0,9	1	1	1	1	1	1	1	1	1	1
2009	0	0	0	0	0,1	0,4	0,9	1	1	1	1	1	1	1	1	1	1
2010	0	0	0	0	0,2	0,4	0,7	1	1	1	1	1	1	1	1	1	1
2011	0	0	0	0	0,4	0,7	0,8	0,9	1	1	1	1	1	1	1	1	1
2012	0	0	0	0	0,4	0,8	1	1	1	1	1	1	1	1	1	1	1
2013	0	0	0	0	0,4	0,8	1	1	1	1	1	1	1	1	1	1	1
2014	0	0	0	0	0,4	0,8	1	1	1	1	1	1	1	1	1	1	1
2015	0	0	0	0	0,4	0,8	1	1	1	1	1	1	1	1	1	1	1
2016	0	0	0	0	0,4	0,8	1	1	1	1	1	1	1	1	1	1	1
2017	0	0	0	0	0,4	0,8	1	1	1	1	1	1	1	1	1	1	1

Table 4.4.7.1. Norwegian Spring-spawning herring. Estimated indices (with StoX) from the acoustic surveys on the spawning grounds in February-March. Numbers in millions. Biomass in thousand tonnes. "Fleet 1"

YEAR	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	TOTAL	BIOMASS
1988	0	368	290	7773	83	32	11	36	21	40	0	0	0	0	8654	1572
1989	181	18	357	93	4323	114	13	9	64	0	4	43	0	9	5232	1273
1990	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1991	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1992*	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1993*	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1994	43	99	48	851	480	73	15	152	43	1838	3	3	0	0	3669	1215
1995	3	333	3850	2890	1861	281	17	0	136	72	2216	0	0	0	12166	2633
1996	74	96	1306	4994	1525	582	188	0	0	84	0	1187	0	0	10036	2166
1997*	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1998	29	154	618	1701	6375	4597	1095	392	139	16	0	189	0	669	15976	3700
1999	76	1089	245	789	1450	4778	3824	891	283	68	0	0	169	200	13875	3349
2000	1030	494	1983	76	363	881	3185	2250	425	40	2	0	14	173	10915	2522
2001**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2002**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2003**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2004**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2005	30	194	492	1507	3919	5515	450	319	127	75	355	715	371	5	14074	3495
2006	25	93	5375	407	721	2687	2599	110	62	13	65	50	176	57	12438	2789
2007	31	360	1482	10767	542	611	2597	2901	134	218	33	175	256	493	20603	4678
2008	14	59	2150	2486	8396	479	434	1466	1463	145	88	44	129	132	17484	4214
2009	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2010	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		

YEAR	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	TOTAL	BIOMASS
2011	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2012	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2013	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2014	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2015	230	516	2748	768	3223	377	650	2868	720	7251	336	1733	50	229	21712	6390
2016	17	218	253	539	404	2288	242	569	2792	681	4144	197	982	107	13433	4338
2017	13	95	1078	666	868	411	1376	176	231	1903	295	2600	74	697	10483	3295

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Table 4.4.7.2. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June from IESNS. Values in the years 2009–2016 are estimated with StoX. "Fleet 4"

	AGE				
Year	1	2	3	4	5
1991	24.3	5.2			
1992	32.6	14	5.7		
1993	102.7	25.8	1.5		
1994	6.6	59.2	18	1.7	
1995	0.5	7.7	8	1.1	
1996*	0.1	0.25	1.8	0.6	0.03
1997**	2.6	0.04	0.4	0.35	0.05
1998	9.5	4.7	0.01	0.01	0
1999	49.5	4.9	0	0	0
2000	105.4	27.9	0	0	0
2001	0.3	7.6	8.8	0	0
2002	0.5	3.9	0	0	0
2003***					
2004***					
2005	23.3	4.5	2.5	0.4	0.3
2006	3.7	35.0	5.3	0.87	0
2007	2.1	3.7	12.5	1.9	0
2008^					
2009	0.286	0.286	0.215	0.072	0
2010	5.121	1.366	0	0	0
2011	1.079	3.802	0.039	0	0
2012	0.884	0.015	0	0	0
2013	0.132	1.982	0.264	0.088	0
2014	3.727	3.055	1.797	0.131	0.044
2015	0.33	11.471	1.218	0.198	0
2016	1.677	5.463	1.668	0.103	0.042
2017	14.658	3.266	0	0	0

***Average of Norwegian and Russian estimates**

****Combination of Norwegian and Russian estimates as described in 1998 WG report, since then only Russian estimates**

*****No surveys**

^Not a full survey

Table 4.4.7.3. Norwegian spring-spawning herring. Estimates from the international acoustic survey on the feeding areas in the Norwegian Sea in May (IESNS). Numbers in millions. Biomass in thousands. Values in the years 2008-2016 are estimated indices by StoX. "Fleet 5"

	Age															Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	Biomass
1996	0	0	4114	22461	13244	4916	2045	424	14	7	155	0	3134			50514	8532
1997	0	0	1169	3599	18867	13546	2473	1771	178	77	288	190	60	2697		44915	9435
1998	24	1404	367	1099	4410	16378	10160	2059	804	183	0	0	35	0	492	37415	8004
1999	0	215	2191	322	965	3067	11763	6077	853	258	5	14	0	158	128	26016	6299
2000	0	157	1353	2783	92	384	1302	7194	5344	1689	271	0	114	0	75	20758	6001
2001	0	1540	8312	1430	1463	179	204	3215	5433	1220	94	178	0	0	6	23274	3937
2002	0	677	6343	9619	1418	779	375	847	1941	2500	1423	61	78	28	0	26089	4628
2003	32073	8115	6561	9985	9961	1499	732	146	228	1865	2359	1769		287	0	75580	6653
2004	0	13735	1543	5227	12571	10710	1075	580	76	313	362	1294	1120	10	88	48704	7687
2005	0	1293	19679	1353	1765	6205	5371	651	388	139	262	526	1003	364	115	39114	5109
2006	0	19	306	14560	1396	2011	6521	6978	679	713	173	407	921	618	243	35545	9100
2007	0	411	2889	5877	20292	1260	1992	6780	5582	647	488	372	403	1048	1010	49051	12161
2008	0	1240	631	10809	8271	14827	1513	2257	4848	2734	449	149	151	270	491	48665	10558
2009	0	144	1669	2159	12300	8994	9527	2147	1435	2466	1411	188	193	123	231	43082	9728
2010	234	125	542	2334	1781	8351	5988	5601	869	882	983	578	90	72	57	28622	6633
2011	0	1205	977	1528	3607	2564	9420	4542	4298	825	892	712	261	37	39	30917	7395
2012	0	378	2895	412	670	1646	2560	4226	2026	2097	298	607	315	155	47	18331	4435
2013	0	205	776	3955	434	1211	2036	3070	4652	2767	1873	692	805	186	83	22747	5888
2014	17	517	1231	798	2790	749	1065	2681	2285	2842	1119	778	350	76	198	17505	4555
2015	0	385	468	1299	1176	3548	1399	1160	3178	2523	4350	712	788	262	194	21443	5846
2016	0	75	3549	1508	2215	1779	2683	929	1143	1770	1851	2877	928	439	136	21889	5419
2017	15	152	711	4251	1544	1635	1342	1688	430	832	1016	1784	1670	491	149	17710	4198

Table 4.4.8.1 Norwegian spring-spawning herring. Relative standard error of estimated catch at age used by XSAM.

Year/Age	2	3	4	5	6	7	8	9	10	11	12+
1988	0.338	0.197	0.255	0.107	0.335	0.436	0.381	0.296	0.341	0.47	0.349
1989	0.254	0.467	0.438	0.387	0.124	0.443	0.669	0.701	0.45	0.575	0.589
1990	0.291	0.277	0.478	0.314	0.322	0.137	0.585	0.559	0.515	0.491	0.525
1991	0.448	0.345	0.472	0.571	0.296	0.341	0.139	0.486	0.781	1.247	0.551
1992	0.579	0.309	0.235	0.401	0.598	0.313	0.385	0.137	0.487	0.713	0.563
1993	0.361	0.246	0.169	0.179	0.343	0.437	0.243	0.277	0.116	NA	NA
1994	0.349	0.237	0.168	0.12	0.15	0.291	0.349	0.228	0.231	0.102	0.39
1995	0.607	0.202	0.122	0.103	0.103	0.136	0.291	0.289	0.191	0.181	0.093
1996	0.242	0.233	0.099	0.08	0.092	0.116	0.171	0.386	0.359	0.194	0.095
1997	0.265	0.16	0.131	0.077	0.075	0.098	0.124	0.198	0.271	0.237	0.111
1998	0.182	0.191	0.135	0.12	0.077	0.085	0.119	0.16	0.219	0.254	0.137
1999	0.399	0.158	0.23	0.159	0.115	0.079	0.087	0.128	0.17	0.297	0.142
2000	0.297	0.181	0.106	0.232	0.168	0.117	0.084	0.089	0.139	0.19	0.159
2001	0.512	0.172	0.151	0.115	0.225	0.175	0.127	0.095	0.109	0.188	0.207
2002	0.197	0.142	0.102	0.133	0.124	0.242	0.176	0.131	0.102	0.123	0.182
2003	0.411	0.187	0.124	0.099	0.147	0.149	0.261	0.188	0.139	0.106	0.13
2004	0.218	0.257	0.177	0.115	0.099	0.168	0.158	0.25	0.207	0.149	0.102
2005	0.27	0.113	0.176	0.149	0.102	0.092	0.163	0.163	0.227	0.195	0.103
2006	0.215	0.187	0.099	0.182	0.148	0.099	0.097	0.179	0.186	0.241	0.118
2007	0.345	0.138	0.12	0.077	0.153	0.135	0.099	0.109	0.213	0.254	0.151
2008	0.163	0.229	0.107	0.101	0.072	0.142	0.133	0.105	0.12	0.243	0.155
2009	0.167	0.144	0.154	0.086	0.093	0.075	0.156	0.132	0.115	0.135	0.159
2010	0.198	0.172	0.14	0.144	0.089	0.1	0.082	0.148	0.146	0.122	0.133
2011	0.134	0.198	0.17	0.136	0.14	0.098	0.107	0.102	0.178	0.165	0.142
2012	0.305	0.14	0.21	0.164	0.129	0.132	0.098	0.125	0.121	0.206	0.162
2013	0.269	0.199	0.13	0.19	0.167	0.129	0.135	0.105	0.149	0.155	0.213
2014	0.567	0.246	0.201	0.132	0.209	0.19	0.143	0.155	0.119	0.182	0.184
2015	0.452	0.288	0.203	0.207	0.153	0.234	0.194	0.152	0.171	0.142	0.182
2016	0.494	0.215	0.218	0.167	0.18	0.15	0.207	0.188	0.148	0.174	0.132
2017	0.325	0.214	0.189	0.172	0.171	0.182	0.202	0.212	0.227	0.29	0.244

Table 4.4.8.2 Norwegian spring-spawning herring. Relative standard error of Fleet 1 used by XSAM.

Year/Age	3	4	5	6	7	8	9	10	11	12
1988	0.329	0.347	0.161	0.465	0.581	0.745	0.565	0.641	0.552	NA
1989	0.664	0.331	0.453	0.185	0.432	0.717	0.781	0.494	NA	0.51
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1991	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1994	0.445	0.529	0.27	0.309	0.479	0.683	0.403	0.542	0.226	0.859
1995	0.336	0.19	0.203	0.225	0.35	0.673	NA	0.415	0.481	0.216
1996	0.45	0.245	0.179	0.236	0.295	0.384	NA	NA	0.464	0.25
1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1998	0.403	0.291	0.23	0.169	0.182	0.255	0.324	0.412	0.683	0.27
1999	0.255	0.361	0.275	0.239	0.181	0.19	0.267	0.349	0.487	0.328
2000	0.307	0.222	0.473	0.33	0.268	0.199	0.215	0.318	0.552	0.384
2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2005	0.381	0.307	0.237	0.189	0.175	0.314	0.34	0.421	0.476	0.239
2006	0.453	0.176	0.321	0.281	0.207	0.208	0.436	0.498	0.717	0.333
2007	0.33	0.237	0.15	0.3	0.292	0.208	0.203	0.416	0.371	0.263
2008	0.504	0.218	0.21	0.158	0.309	0.316	0.238	0.238	0.408	0.324
2009	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2010	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2011	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2012	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2013	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2015	0.304	0.206	0.277	0.198	0.327	0.288	0.204	0.281	0.164	0.213
2016	0.371	0.359	0.301	0.322	0.215	0.362	0.297	0.205	0.285	0.175
2017	0.451	0.256	0.286	0.269	0.32	0.242	0.39	0.366	0.224	0.192

Table 4.4.8.3 Norwegian spring-spawning herring. Relative standard error of Fleet 4 used by XSAM.

Year/age	2
1991	0.328
1992	0.314
1993	0.263
1994	0.402
1995	0.6
1996	0.77
1997	0.465
1998	0.38
1999	0.294
2000	0.262
2001	0.65
2002	0.6
2003	NA
2004	NA
2005	0.331
2006	0.44
2007	0.48
2008	NA
2009	0.654
2010	0.418
2011	0.533
2012	0.549
2013	0.738
2014	0.439
2015	0.64
2016	0.497
2017	0.355

Table 4.4.8.4 Norwegian spring-spawning herring. Relative standard error of Fleet 5 used by XSAM.

Year/Age	3	4	5	6	7	8	9	10	11	12
1996	0.206	0.138	0.156	0.198	0.243	0.353	0.792	0.933	0.448	0.22
1997	0.278	0.213	0.144	0.156	0.233	0.252	0.434	0.529	0.387	0.223
1998	0.366	0.282	0.203	0.149	0.167	0.243	0.304	0.431	NA	0.336
1999	0.24	0.377	0.291	0.221	0.161	0.188	0.299	0.397	1.011	0.384
2000	0.269	0.226	0.507	0.362	0.271	0.181	0.194	0.255	0.393	0.428
2001	0.175	0.265	0.264	0.433	0.42	0.219	0.193	0.275	0.505	0.431
2002	0.186	0.169	0.266	0.306	0.364	0.3	0.247	0.232	0.265	0.441
2003	0.185	0.167	0.167	0.262	0.311	0.455	0.409	0.249	0.235	0.243
2004	0.26	0.195	0.158	0.165	0.284	0.328	0.531	0.38	0.367	0.232
2005	0.142	0.269	0.252	0.187	0.194	0.319	0.361	0.46	0.396	0.245
2006	0.382	0.153	0.267	0.244	0.185	0.182	0.316	0.312	0.437	0.24
2007	0.224	0.19	0.141	0.273	0.245	0.183	0.192	0.32	0.342	0.225
2008	0.322	0.164	0.175	0.152	0.261	0.238	0.199	0.227	0.349	0.284
2009	0.255	0.24	0.159	0.171	0.169	0.241	0.265	0.233	0.266	0.31
2010	0.333	0.236	0.252	0.175	0.189	0.192	0.298	0.297	0.29	0.304
2011	0.29	0.261	0.213	0.231	0.17	0.202	0.204	0.302	0.296	0.285
2012	0.224	0.356	0.317	0.256	0.231	0.205	0.244	0.242	0.384	0.281
2013	0.306	0.208	0.351	0.276	0.244	0.221	0.2	0.227	0.249	0.252
2014	0.275	0.304	0.226	0.309	0.284	0.228	0.237	0.225	0.281	0.266
2015	0.345	0.271	0.278	0.214	0.266	0.278	0.219	0.232	0.204	0.246
2016	0.214	0.262	0.239	0.252	0.228	0.293	0.279	0.252	0.249	0.203
2017	0.313	0.205	0.26	0.257	0.269	0.255	0.352	0.301	0.287	0.207

Table 4.5.1.1. Norwegian spring-spawning herring. Parameter estimates of the final XSAM model fit. The estimates from last year's assessment (2016) are also shown.

Parameter	Estimate	Std. Error	CV	Estimate 2016	Std. Error 2016
$\log(N_{3,1988})$	7.115	0.168	0.024	7.106	0.168
$\log(N_{4,1988})$	6.653	0.205	0.031	6.643	0.204
$\log(N_{5,1988})$	9.601	0.076	0.008	9.600	0.078
$\log(N_{6,1988})$	4.922	0.362	0.074	4.896	0.356
$\log(N_{7,1988})$	3.616	0.499	0.138	3.599	0.485
$\log(N_{8,1988})$	3.275	0.553	0.169	3.261	0.536
$\log(N_{9,1988})$	4.237	0.453	0.107	4.231	0.447
$\log(N_{10,1988})$	3.446	0.667	0.194	3.446	0.652
$\log(N_{11,1988})$	3.207	0.698	0.218	3.175	0.689
$\log(N_{12,1988})$	3.696	0.72	0.195	3.675	0.704
$\log(q_3^{F1})$	-9.783	0.208	0.021	-9.782	0.217
$\log(q_4^{F1})$	-8.304	0.148	0.018	-8.302	0.157
$\log(q_5^{F1})$	-7.76	0.135	0.017	-7.764	0.142
$\log(q_6^{F1})$	-7.594	0.135	0.018	-7.596	0.142
$\log(q_7^{F1})$	-7.487	0.151	0.02	-7.487	0.158
$\log(q_8^{F1})$	-7.161	0.107	0.015	-7.159	0.111
$\log(q_2^{F4})$	-14.452	0.184	0.013	-14.366	0.179
$\log(q_3^{F5})$	-7.611	0.118	0.016	-7.605	0.119
$\log(q_4^{F5})$	-7.156	0.106	0.015	-7.166	0.107
$\log(q_5^{F5})$	-6.938	0.104	0.015	-6.937	0.105
$\log(q_6^{F5})$	-6.797	0.107	0.016	-6.788	0.108
$\log(q_7^{F5})$	-6.716	0.114	0.017	-6.719	0.114
$\log(q_8^{F5})$	-6.533	0.121	0.018	-6.490	0.122
$\log(q_9^{F5})$	-6.521	0.136	0.021	-6.492	0.137
$\log(q_{10}^{F5})$	-6.478	0.153	0.024	-6.456	0.155
$\log(q_{11}^{F5})$	-6.528	0.155	0.024	-6.487	0.159
$\log(\sigma_1^2)$	-5	1.418	0.284	-5.000	1.524
$\log(\sigma_2^2)$	-2.521	0.251	0.1	-2.490	0.260
$\log(\sigma_4^2)$	-2.205	0.322	0.146	-2.158	0.320
$\log(\sigma_R^2)$	-0.075	0.269	3.572	-0.073	0.274
$\log(h)$	1.568	0.072	0.046	1.549	0.075
μ_R	9.356	0.185	0.02	9.395	0.189
α_Y	-0.438	0.303	0.692	-0.411	0.308
β_Y	0.849	0.108	0.128	0.862	0.110
α_{2U}	-1.234	0.175	0.142	-1.246	0.179
α_{3U}	-0.607	0.103	0.17	-0.610	0.106
α_{4U}	-0.203	0.069	0.342	-0.203	0.072
α_{5U}	0.056	0.061	1.073	0.054	0.063

Parameter	Estimate	Std. Error	CV	Estimate 2016	Std. Error 2016
α_{6U}	0.193	0.065	0.335	0.186	0.067
α_{7U}	0.251	0.069	0.274	0.262	0.071
α_{8U}	0.323	0.075	0.233	0.327	0.077
α_{9U}	0.368	0.081	0.22	0.375	0.083
α_{10U}	0.42	0.087	0.206	0.426	0.089
β_{U}	0.61	0.054	0.089	0.608	0.055

Table 4.5.1.2 Norwegian spring-spawning herring. Point estimates of Stock in numbers (millions).

Year/Age	2	3	4	5	6	7	8	9	10	11	12
1988	654	1231	775	14779	137	37	26	69	31	25	40
1989	1169	253	995	650	12236	113	30	20	49	21	48
1990	4320	470	214	843	546	10203	94	24	16	37	55
1991	11456	1750	399	181	710	456	8530	77	20	12	75
1992	18459	4653	1498	340	153	597	383	7121	63	16	73
1993	49293	7499	3990	1272	286	128	499	319	5897	52	73
1994	58913	20024	6427	3364	1037	232	105	405	257	4679	98
1995	15466	23925	17158	5414	2633	775	178	82	314	194	3543
1996	5641	6273	20455	14370	4125	1751	502	129	60	217	2297
1997	2005	2283	5329	16916	10982	2761	1115	326	91	41	1385
1998	10731	809	1889	4286	12864	7623	1705	643	201	55	751
1999	6504	4332	663	1453	3302	9396	5316	1081	394	116	449
2000	33358	2634	3606	517	1111	2458	6676	3569	675	232	296
2001	29407	13524	2205	2688	389	821	1764	4578	2214	394	262
2002	11708	11928	11476	1756	1967	292	612	1273	3186	1467	435
2003	6807	4742	10082	9273	1292	1377	213	431	867	2125	1273
2004	59759	2761	4018	8342	7290	953	1009	156	303	584	2236
2005	25196	24255	2347	3351	6751	5623	710	731	113	213	1761
2006	45300	10222	20522	1936	2687	5186	3999	486	497	74	1156
2007	12529	18378	8699	17004	1562	2111	3820	2758	337	345	731
2008	17686	5076	15603	7176	13110	1191	1557	2620	1845	229	746
2009	6832	7135	4299	12888	5575	9215	848	1081	1689	1180	661
2010	4211	2738	5974	3537	10023	4004	6060	576	681	1024	1165
2011	18477	1688	2280	4913	2828	7620	2821	3844	366	426	1236
2012	5147	7422	1408	1870	3965	2221	5799	1947	2615	243	1087
2013	8905	2082	6224	1162	1504	3147	1710	4316	1395	1868	956
2014	5918	3608	1755	5126	934	1192	2456	1287	3204	1025	2239
2015	14276	2402	3072	1466	4186	757	957	1935	993	2447	2637
2016	5406	5797	2051	2589	1212	3436	617	765	1529	773	4103
2017	9893	2195	4947	1724	2126	978	2782	485	593	1167	3835

Table 4.5.1.3 Norwegian spring-spawning herring. Point estimates of Fishing mortality.

Year/Age	2	3	4	5	6	7	8	9	10	11	12
1988	0.048	0.063	0.027	0.039	0.046	0.05	0.132	0.191	0.275	0.156	0.156
1989	0.011	0.021	0.016	0.024	0.032	0.036	0.068	0.094	0.128	0.072	0.072
1990	0.004	0.013	0.014	0.022	0.029	0.029	0.048	0.067	0.09	0.055	0.055
1991	0.001	0.005	0.011	0.018	0.024	0.024	0.031	0.041	0.053	0.035	0.035
1992	0.001	0.004	0.013	0.024	0.028	0.028	0.032	0.039	0.052	0.044	0.044
1993	0.001	0.004	0.021	0.055	0.06	0.055	0.06	0.066	0.081	0.093	0.093
1994	0.001	0.004	0.022	0.095	0.141	0.112	0.095	0.103	0.131	0.149	0.149
1995	0.002	0.007	0.027	0.122	0.258	0.284	0.173	0.166	0.218	0.337	0.337
1996	0.005	0.013	0.04	0.119	0.251	0.302	0.282	0.205	0.237	0.446	0.446
1997	0.008	0.039	0.068	0.124	0.215	0.332	0.401	0.335	0.358	0.491	0.491
1998	0.007	0.048	0.113	0.111	0.164	0.211	0.306	0.339	0.399	0.434	0.434
1999	0.004	0.033	0.099	0.118	0.145	0.192	0.248	0.32	0.378	0.496	0.496
2000	0.003	0.028	0.144	0.135	0.152	0.182	0.227	0.327	0.388	0.55	0.55
2001	0.002	0.014	0.078	0.162	0.137	0.145	0.177	0.212	0.261	0.261	0.261
2002	0.004	0.018	0.063	0.157	0.207	0.165	0.201	0.234	0.255	0.252	0.252
2003	0.002	0.016	0.04	0.091	0.155	0.161	0.165	0.2	0.245	0.269	0.269
2004	0.002	0.012	0.031	0.061	0.11	0.144	0.172	0.173	0.203	0.321	0.321
2005	0.002	0.017	0.042	0.071	0.114	0.191	0.229	0.237	0.265	0.385	0.385
2006	0.002	0.011	0.038	0.065	0.091	0.156	0.222	0.216	0.214	0.371	0.371
2007	0.003	0.014	0.042	0.11	0.121	0.155	0.227	0.252	0.235	0.216	0.216
2008	0.008	0.016	0.041	0.102	0.203	0.19	0.215	0.289	0.297	0.24	0.24
2009	0.014	0.028	0.045	0.101	0.181	0.269	0.238	0.312	0.351	0.308	0.308
2010	0.014	0.033	0.046	0.074	0.124	0.2	0.305	0.303	0.319	0.422	0.422
2011	0.012	0.031	0.048	0.064	0.092	0.123	0.221	0.235	0.26	0.275	0.275
2012	0.005	0.026	0.043	0.068	0.081	0.111	0.145	0.183	0.187	0.18	0.18
2013	0.003	0.021	0.044	0.068	0.083	0.098	0.134	0.148	0.158	0.082	0.082
2014	0.002	0.011	0.03	0.052	0.061	0.069	0.089	0.109	0.119	0.063	0.063
2015	0.001	0.008	0.021	0.04	0.048	0.054	0.075	0.086	0.101	0.064	0.064
2016	0.001	0.009	0.024	0.047	0.065	0.061	0.091	0.103	0.12	0.09	0.09
2017	0.002	0.009	0.025	0.049	0.069	0.071	0.098	0.109	0.126	0.106	0.106

Table 4.5.1.4 Norwegian spring spawning herring. Final stock summary table.

Year	Recruitment (Age 2)	High	Low	Stock Size: SSB	High	Low	Catches	Fishing Pressure: F	High	Low
	millions			thousnd tonnes			million tonnes	Ages 5-11		
1988	654	955	353	2173	2483	1863	135	0.04	0.058	0.023
1989	1169	1641	698	3360	3839	2880	104	0.032	0.047	0.017
1990	4320	5393	3246	3641	4150	3133	86	0.029	0.042	0.016
1991	11456	13529	9383	3412	3888	2937	85	0.03	0.044	0.016
1992	18459	21401	15517	3437	3891	2983	104	0.037	0.053	0.021
1993	49293	55350	43235	3401	3809	2994	232	0.074	0.101	0.048
1994	58913	65701	52125	3528	3934	3122	479	0.126	0.161	0.092
1995	15466	18010	12921	3580	3969	3190	906	0.181	0.226	0.136
1996	5641	6823	4459	4109	4500	3719	1220	0.168	0.202	0.133
1997	2005	2544	1466	5314	5778	4850	1427	0.186	0.219	0.153
1998	10731	12642	8820	5843	6353	5333	1223	0.184	0.218	0.15
1999	6504	7813	5195	5715	6248	5181	1235	0.205	0.244	0.167
2000	33358	37919	28797	4764	5253	4275	1207	0.247	0.294	0.199
2001	29407	33631	25182	3973	4414	3532	766	0.2	0.242	0.158
2002	11708	13854	9562	3526	3939	3113	808	0.221	0.268	0.174
2003	6807	8227	5387	4200	4671	3730	790	0.139	0.169	0.109
2004	59759	67466	52052	5338	5920	4755	794	0.102	0.126	0.078
2005	25196	29262	21129	5491	6111	4871	1003	0.144	0.178	0.111
2006	45300	52183	38417	5501	6126	4876	969	0.155	0.192	0.118
2007	12529	15081	9977	7134	7926	6342	1267	0.147	0.178	0.116
2008	17686	21205	14167	7274	8130	6417	1546	0.191	0.232	0.151
2009	6832	8552	5112	7308	8248	6369	1687	0.194	0.233	0.154
2010	4211	5453	2970	6536	7479	5594	1457	0.192	0.235	0.149
2011	18477	23065	13889	6195	7183	5206	993	0.142	0.176	0.109
2012	5147	6843	3452	6028	7057	4999	826	0.13	0.162	0.098
2013	8905	11942	5868	5657	6662	4652	685	0.116	0.146	0.086
2014	5918	8455	3380	5494	6505	4483	461	0.08	0.101	0.058
2015	14276	20811	7740	5211	6195	4227	329	0.062	0.08	0.044
2016	5406	9773	1039	4946	5882	4009	383	0.073	0.096	0.05
2017	9893	21727	0	4809	5737	3881				
Average	16848	20242	13518	4897	5543	4251	800	0.13	0.162	0.098

Approximately lower 95% confidence interval

Table 4.8.1.1 Norwegian Spring-spawning herring. Input to short-term prediction. Stock size is in millions and weight in kg.

Input for	2017							
	Stockno.	Natural	Maturity	Proportion of M	Proportion of F	Weight	Exploitation	Weight
age	1-Jan.	mortality	ogive	before spawning	before spawning	in stock	pattern	in catch
2	9893	0.9	0	0	0	0.054	0.003	0.145
3	2195	0.15	0	0	0	0.115	0.018	0.216
4	4947	0.15	0.4	0	0	0.19	0.049	0.266
5	1724	0.15	0.8	0	0	0.247	0.096	0.302
6	2126	0.15	1	0	0	0.282	0.135	0.328
7	978	0.15	1	0	0	0.322	0.138	0.347
8	2782	0.15	1	0	0	0.338	0.19	0.361
9	485	0.15	1	0	0	0.351	0.213	0.369
10	593	0.15	1	0	0	0.359	0.245	0.373
11	1167	0.15	1	0	0	0.361	0.206	0.379
12	3835	0.15	1	0	0	0.374	0.206	0.381
INPUT FOR	2018 AND 2019							
	Stockno.	Natural	Maturity	Proportion of M	Proportion of F	Weight	Exploitation	Weight
age	1-Jan.	mortality	ogive	before spawning	before spawning	in stock	pattern	in catch
2	11567	0.9	0	0	0	0.051	0.013	0.145
3		0.15	0	0	0	0.123	0.072	0.216
4		0.15	0.4	0	0	0.188	0.201	0.266
5		0.15	0.8	0	0	0.246	0.392	0.302
6		0.15	1	0	0	0.291	0.552	0.328
7		0.15	1	0	0	0.323	0.594	0.347
8		0.15	1	0	0	0.33	0.777	0.361
9		0.15	1	0	0	0.35	0.871	0.369
10		0.15	1	0	0	0.353	1	0.373
11		0.15	1	0	0	0.356	0.91	0.379
12		0.15	1	0	0	0.378	0.91	0.381

Table 4.8.2.1 Norwegian spring spawning herring. Short term prediction.

Basis:	
SSB (2017):	4.809 (3.881, 5,737) * million t
Landings(2017):	805 142.4 t (sum of national quotas)
SSB(2018):	4.364 (3.447,5.450)* million t
Fw(2017):	0.163 (0.102, 0.255)*
Recruitment(2017-2019):	9.893 (0,21.727)*, 11.586 (0.800,49.000)*, 11.586 (0.800,49.000)*

The catch options:

Rationale	Catches (2018)	Basis	FW(2018)	SSB2019	P(SSB2019 <Blim)	% SSB change	%TAC change***
Zero Catch	0	F=0	0	4.613 (3.661,5.810)*	0	6 (-1,17)*	-100
Status quo	813228	F=0.163	0.163 (0.087,0.232)*	3.899 (2.978,5.106)*	0.002	-11 (-18,1)*	1
Managenent plan	546472	F=0.106	0.106 (0.056,0.15)*	4.132 (3.137,5.328)*	0	-5 (-12,7)*	-32
MSY	665779	F=0.131	0.131 (0.069,0.185)*	4.028 (3.053,5.308)*	0	-8 (-15,2)*	-17
Fpa	754509	F=0.15	0.15 (0.081,0.214)*	3.950 (3.020,5.217)*	0.001	-9 (-17,2)*	-6
F=0.125	637841	F=0.125	0.125 (0.069,0.177)*	4.052 (3.078,5.145)*	0.001	-7 (-15,6)*	-21
SSB2019=5**	---	---	---	---	---	---	---
SSB2019=2.5	2437455	F=0.624	0.624 (0.393,0.962)*	2.500 (1.538,3.672)*	0.49	-43 (-57,-28)*	203

***95% confidence interval**

**** 0 catch in 2018 will give a SSB which is lower than Bpa**

*****compared to sum of national quotas in 2017, not advice for 2017**

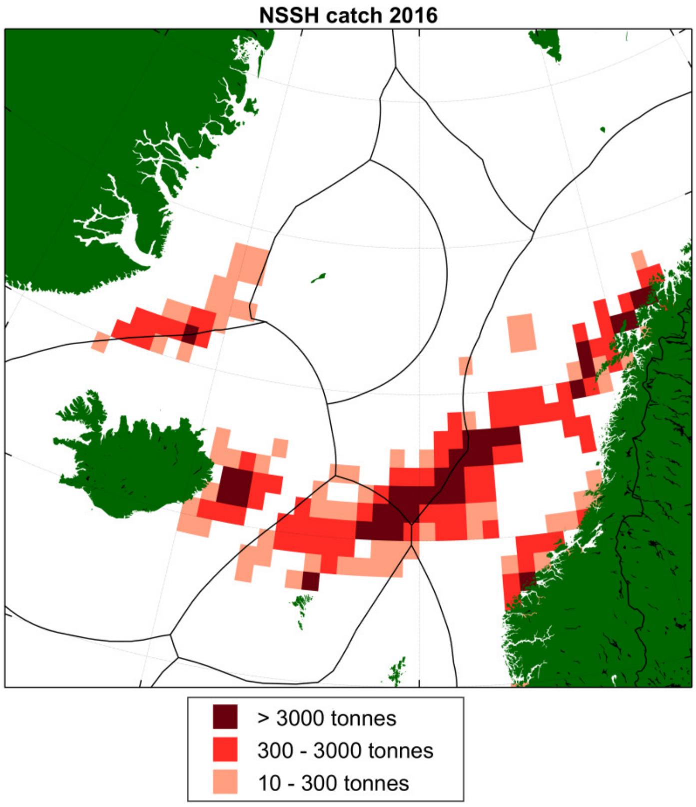

Figure 4.2.1.1. Total reported landings (ICES estimates) of Norwegian spring-spawning herring in 2016 by ICES rectangle. Landings below 10 tonnes per statistical rectangle are not included. The landings with information on statistical rectangle constitute 99% of the reported landings.

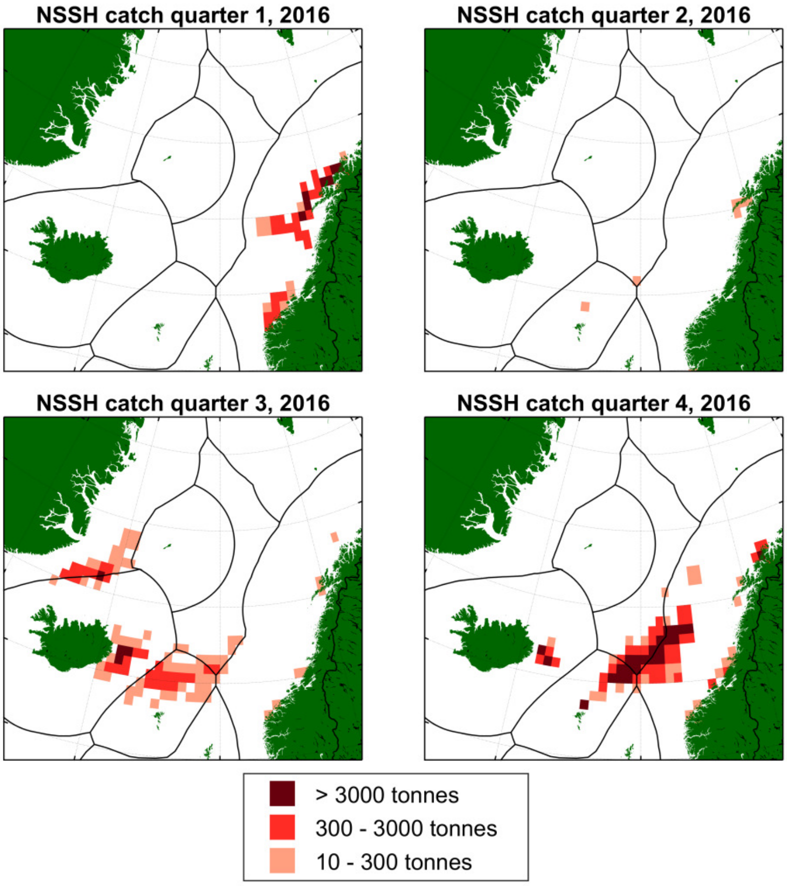

Figure 4.2.1.2. Total reported landings (ICES estimates) of Norwegian spring-spawning herring in 2016 by quarter and ICES rectangle. Landings below 10 tonnes per statistical rectangle are not included. The landings with information on statistical rectangle constitute 99% of the reported landings.

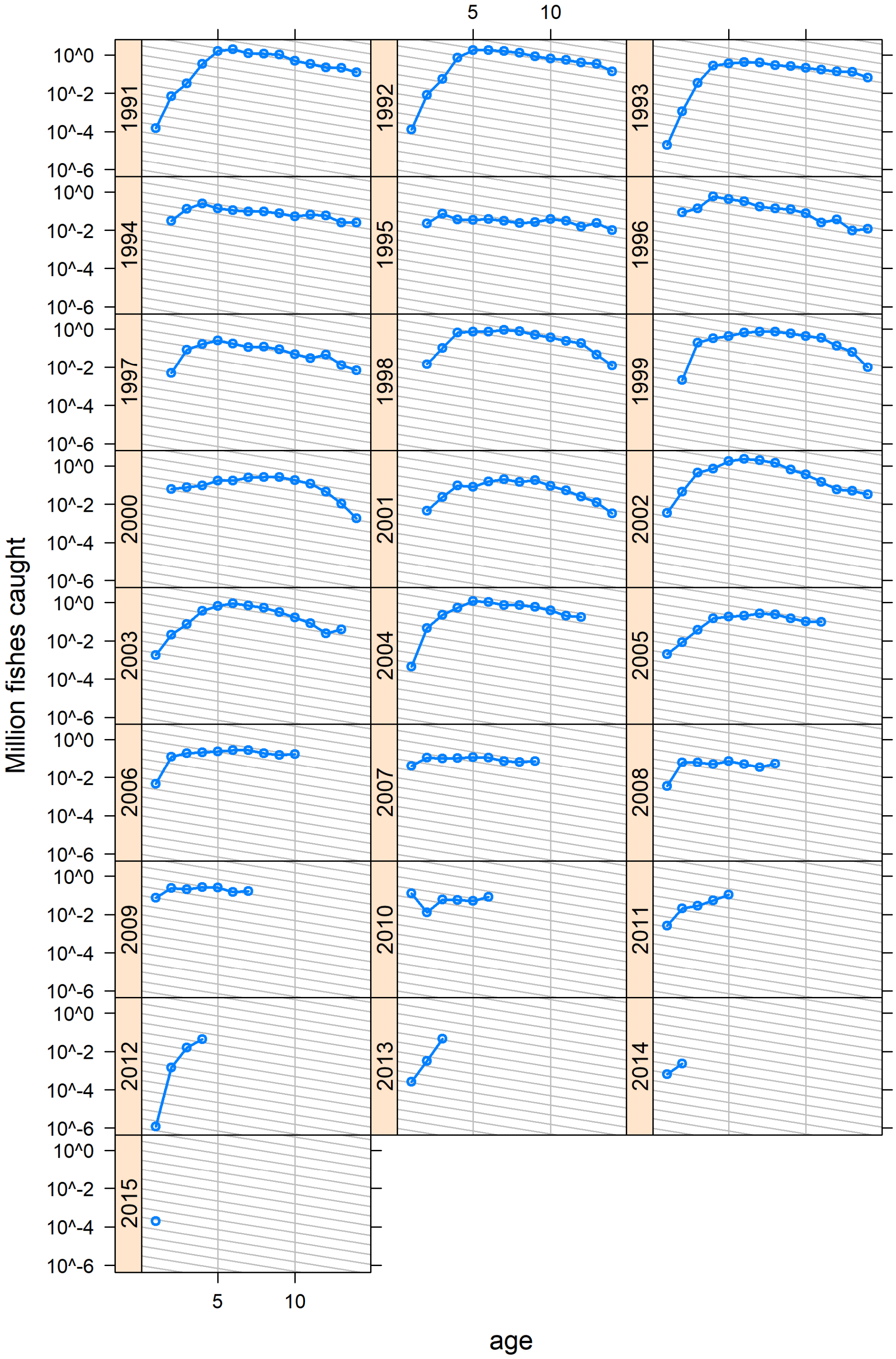

Figure 4.4.3.1. Norwegian spring spawning herring.Age disaggregated catch in numbers plotted on a log scale. Age is on x-axis.The labels indicate year classes and grey lines correspond to Z = 0.3.

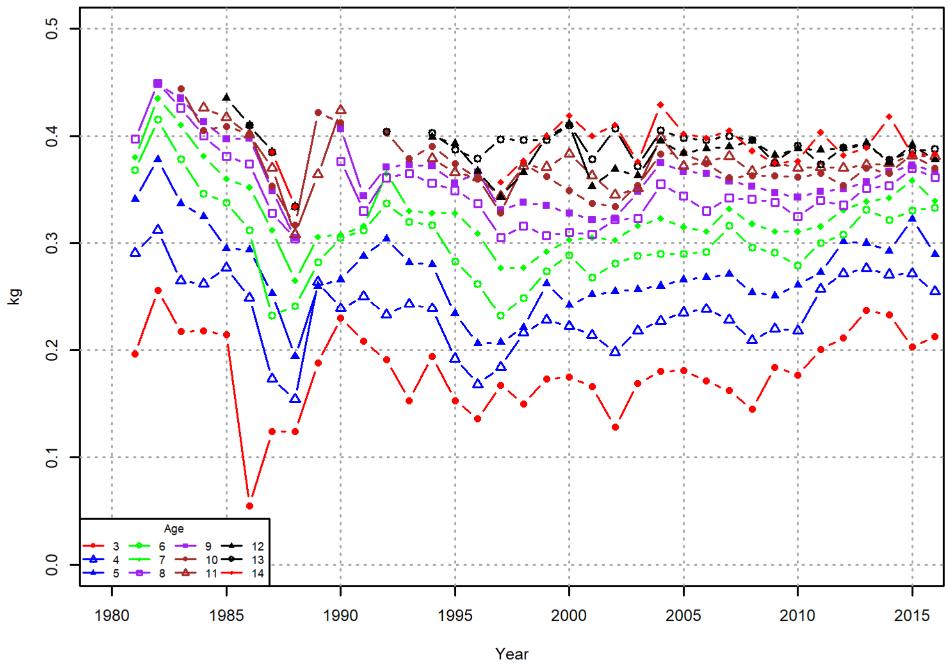

Figure 4.4.4.1.Norwegian spring spawning herring. Mean weight at age by age groups 3—14 in the years 1981—2016 in the catch (weight at age for zero catch numbers were omitted).

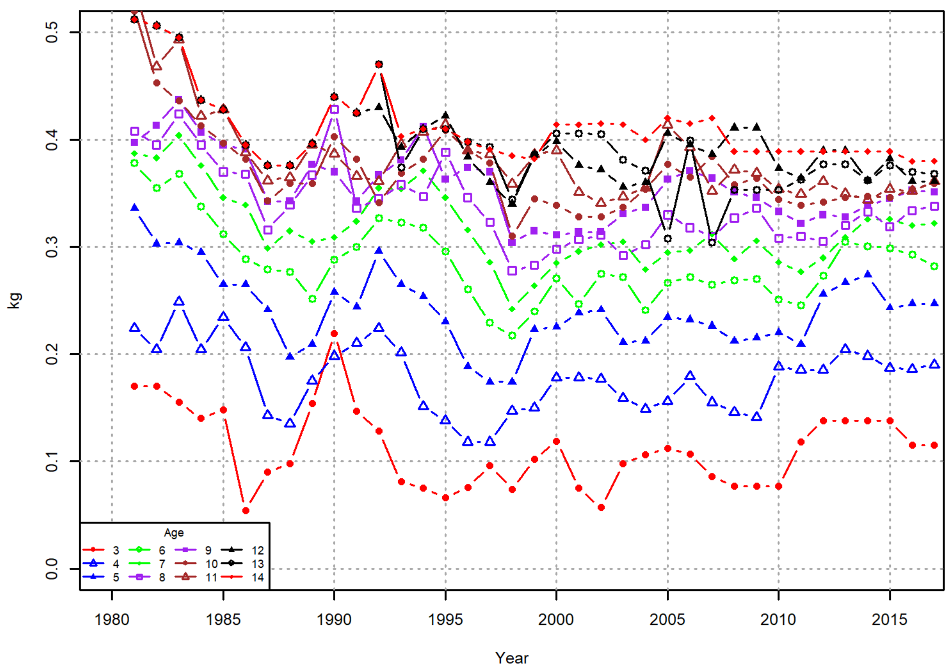

Figure 4.4.4.2.Norwegian spring-spawning herring.Mean weight at age in the stock 1981—2017.

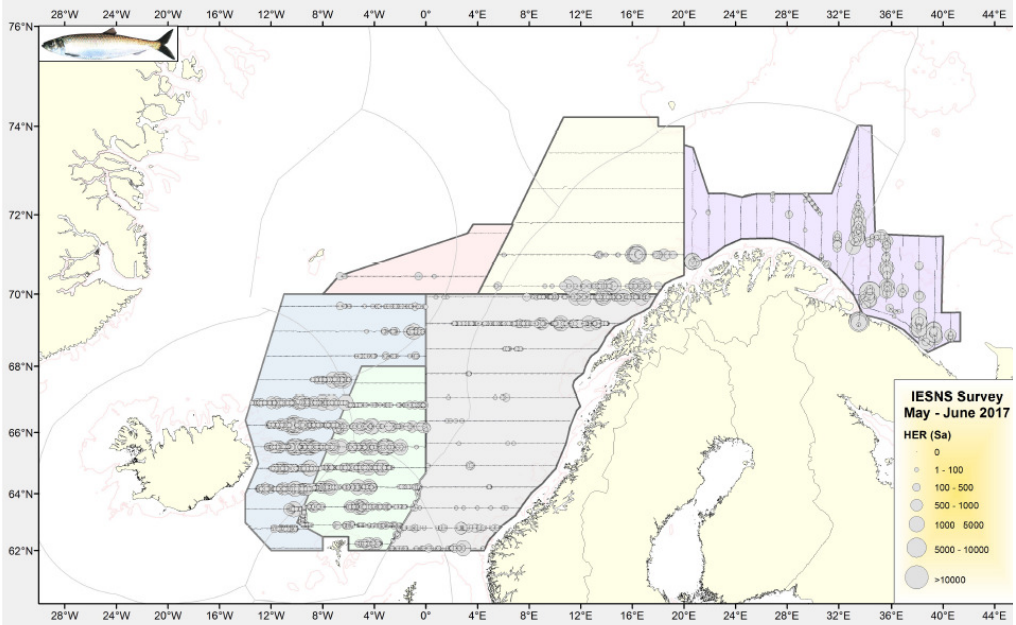

Figure 4.4.7.1..Distribution of Norwegian spring-spawning herring as measured during the IESNS survey in April-June 2017 in terms of NASC values (m²/nm²) for every 1 nautical mile in Norwegian Sea (upper panel) and in the Barents Sea (lower panel). The stratification of the survey area is shown on the maps.

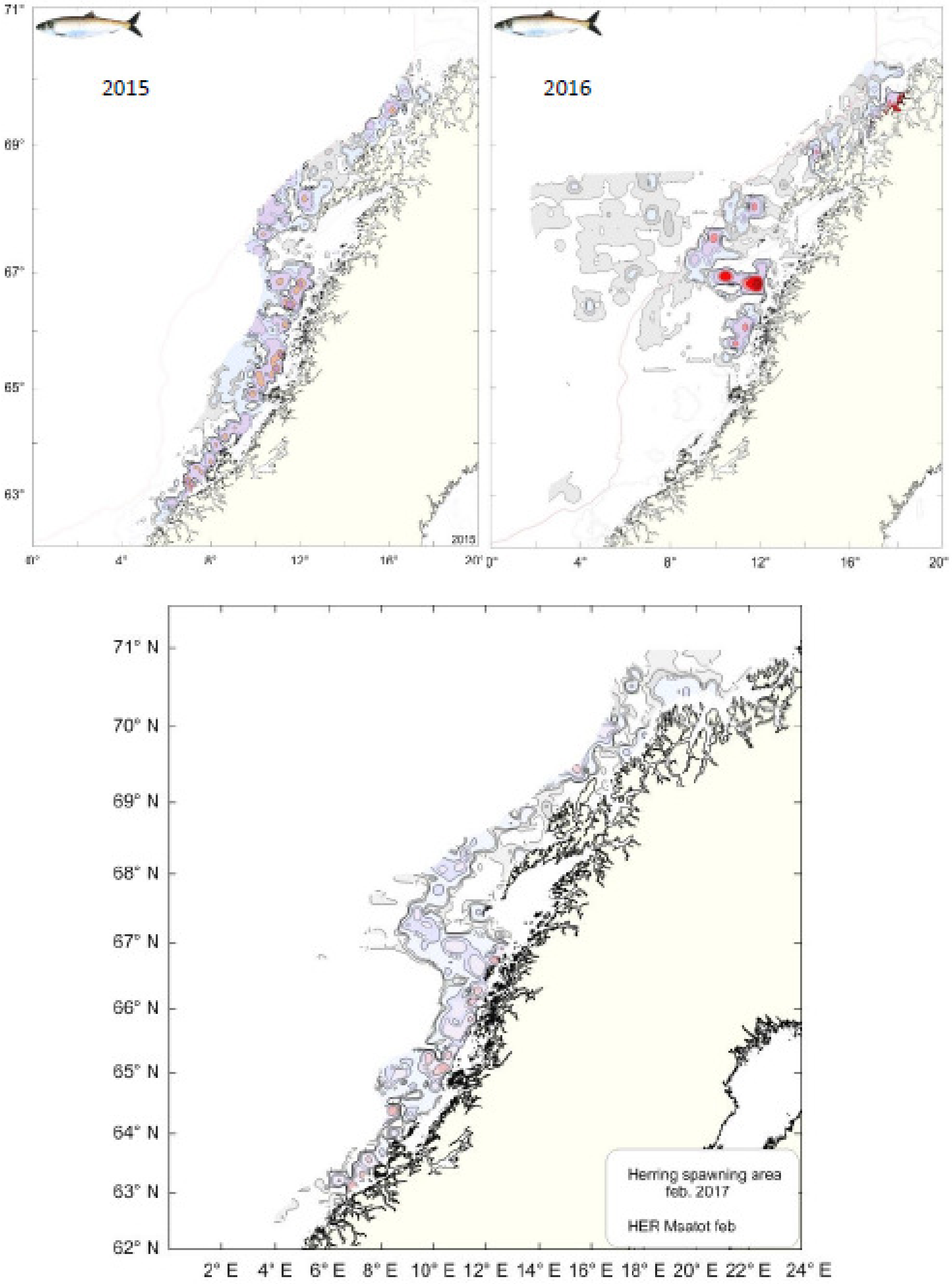

Figure 4.4.7.2. Norwegian acoustic survey on the NSSH spawning grounds. Distribution and acoustic density of herring recorded in 2015, 2016 and 2017.

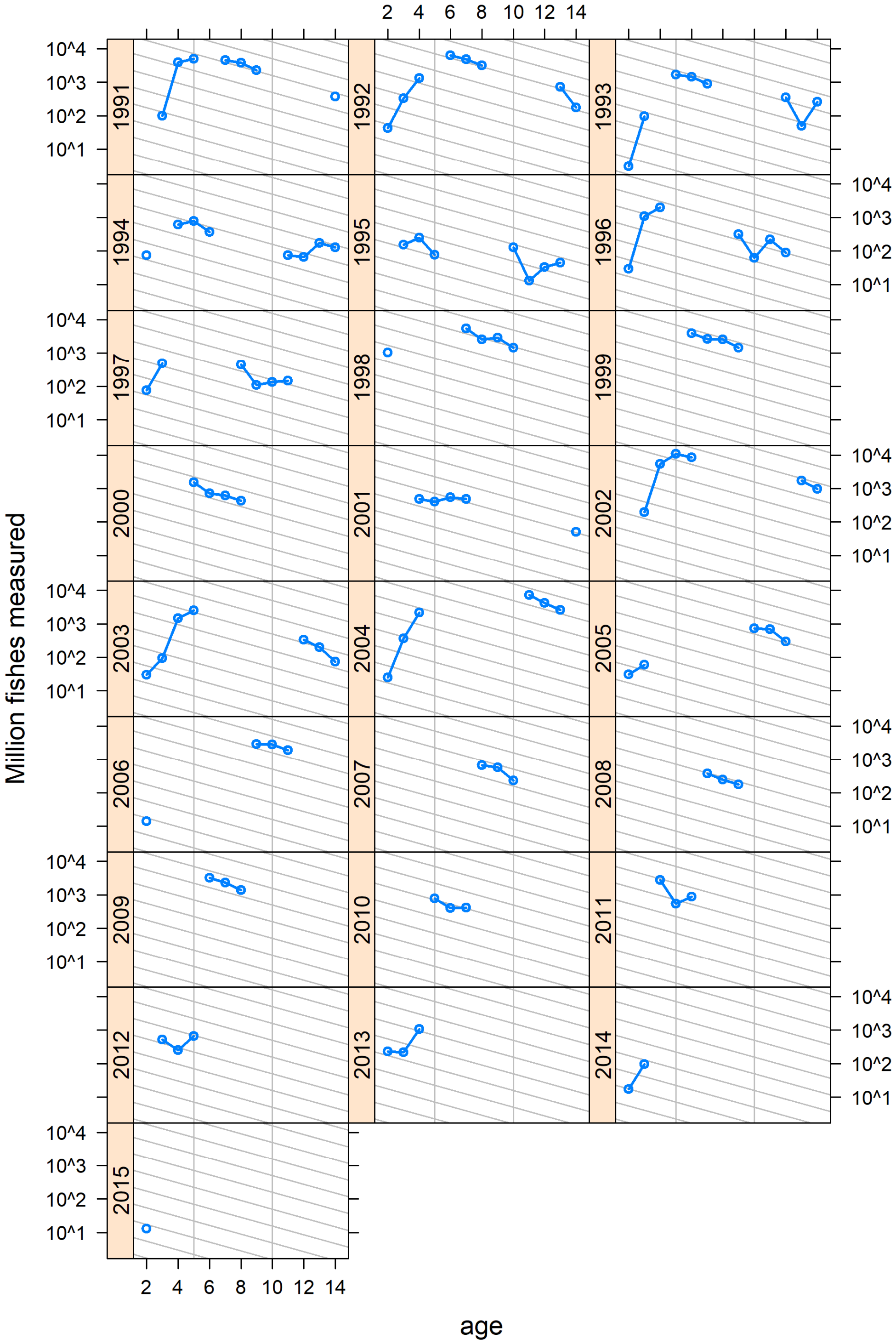

Figure 4.4.7.3. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the spawning area in February-March (survey 1) plotted on a log scale. The labels indicate year classes and grey lines correspond to Z = 0.3. Age is on x-axis. The labels indicate year classes and grey lines correspond to Z = 0.3.

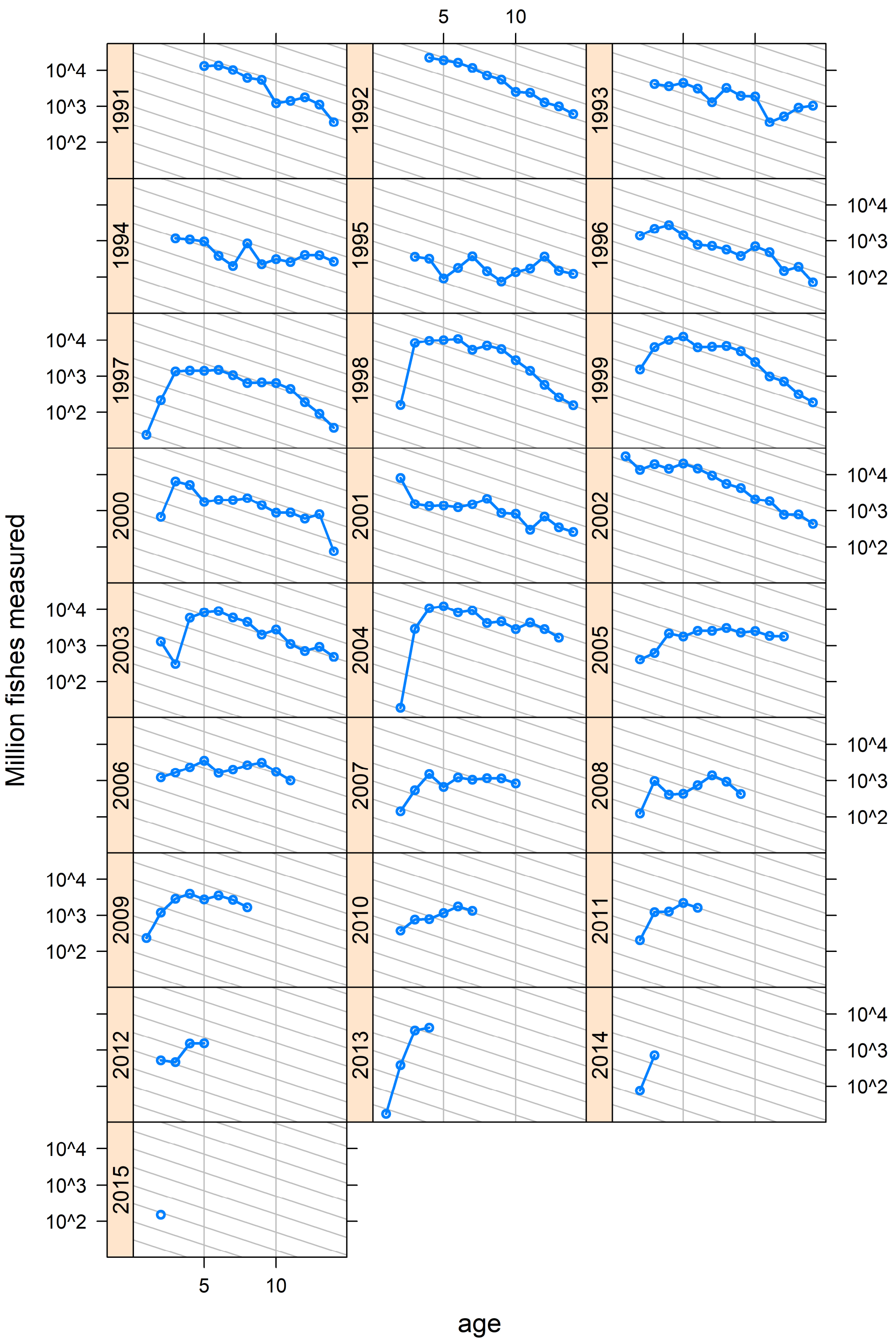

Figure 4.4.7.4.Norwegian spring spawning herring.Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale.The labels indicate year classes and grey lines correspond to Z = 0.3.

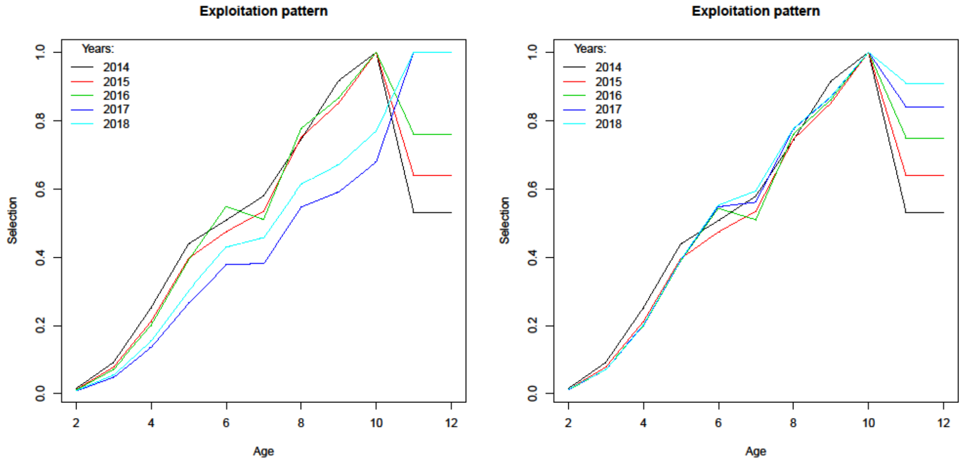

Figure 4.8.1.1.Estimated mean exploitation pattern for the years 2014-2016 and predicted means for 2017 and 2018 by the XSAM model fit and forecast by including information about total catches in 2017 (i.e. sum of national quotas) in the likelihood (left panel) compared to not including information about total catches (i.e. final assessment, right panel).

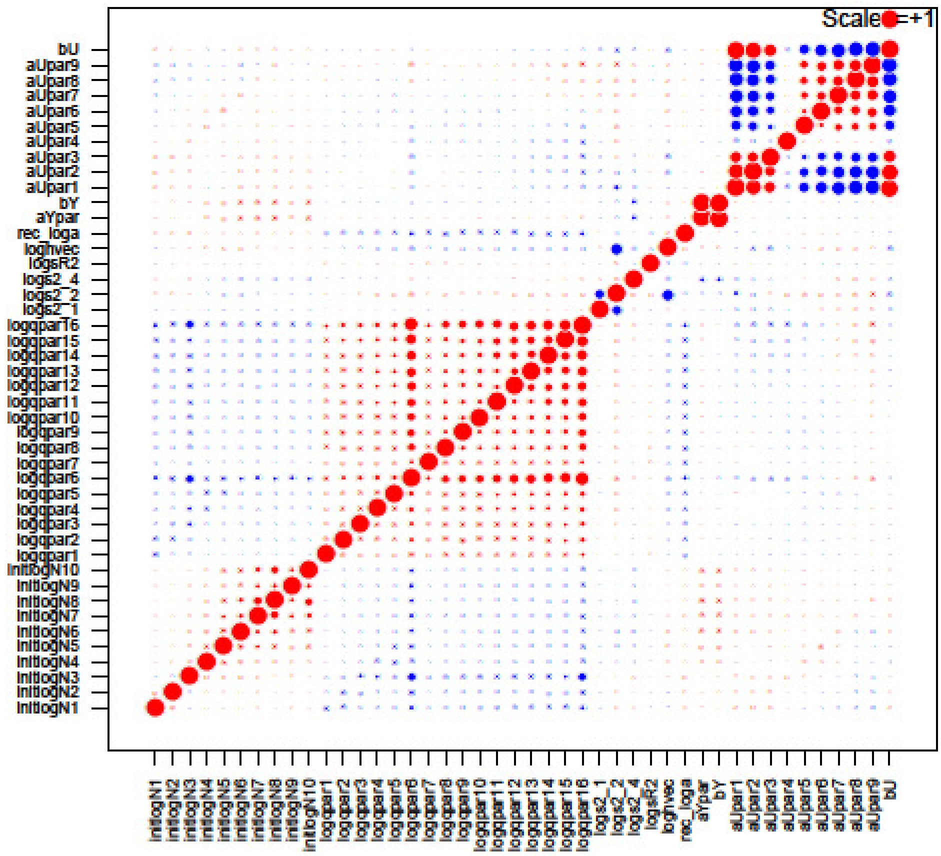

Figure 4.5.1.2. Norwegian spring spawning herring. Correlation between estimated parameters in the final XSAM model fit.

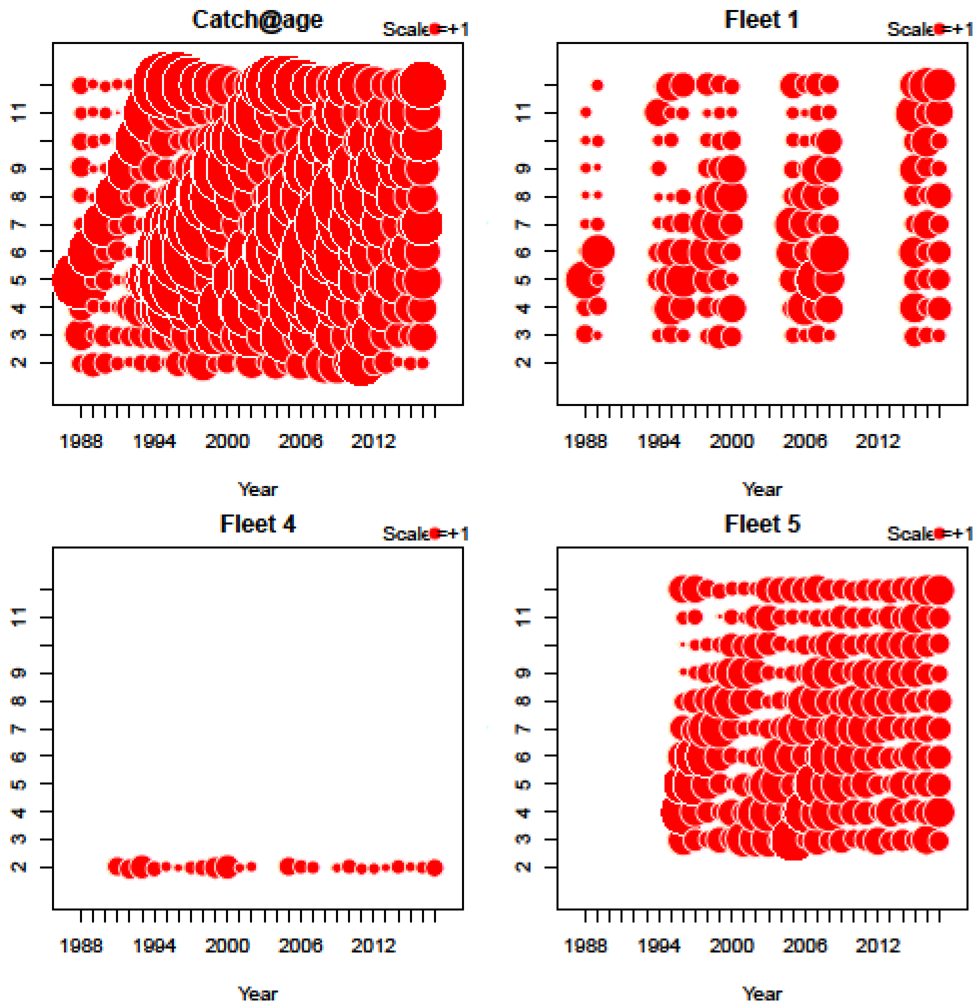

Figure 4.5.1.3. Norwegian spring spawning herring. Weights (inverse of variance) of data-input of the final XSAM model fit.

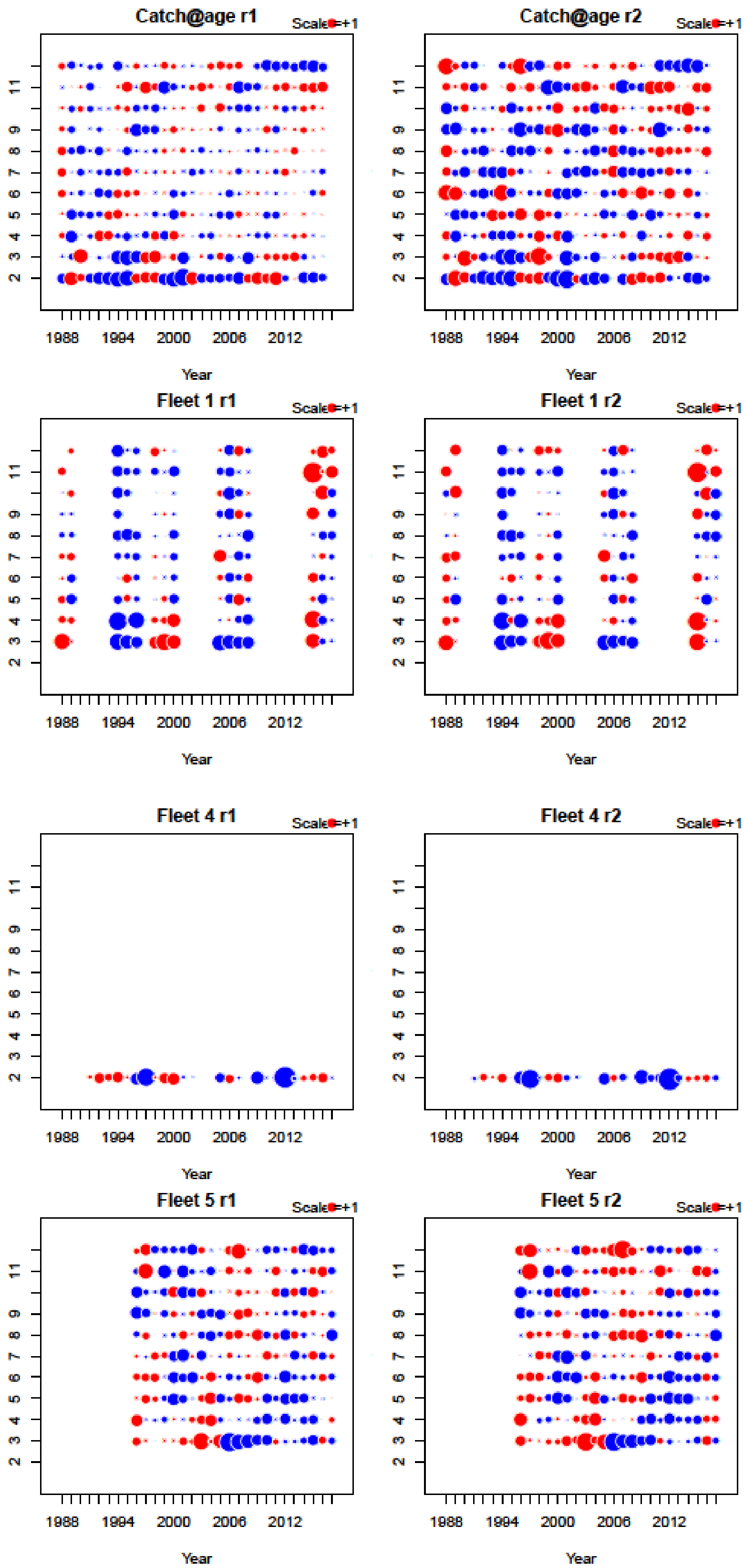

Figure 4.5.1.4. Norwegian spring spawning herring. Standardized residuals type 1 (left) and type 2 (right) (see text) of data-input of the final XSAM model fit.

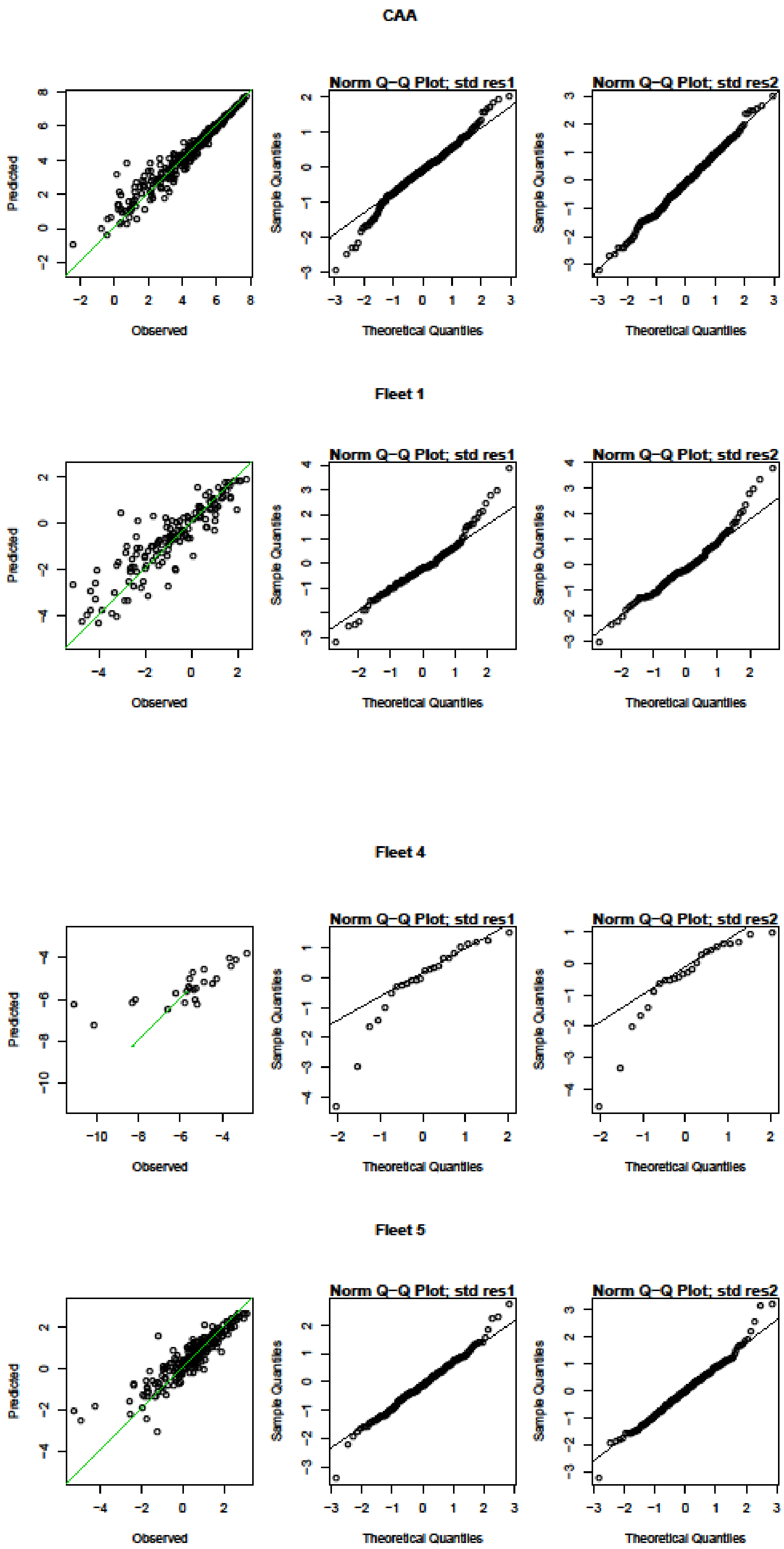
CAA
Fleet 1
Fleet 4
Fleet 5
Norm Q–Q Plot; std res1
Norm Q–Q Plot; std res2
Predicted
Observed
Sample Quantiles
Theoretical Quantiles

Figure 4.5.1.5. Norwegian spring spawning herring. Observed versus predicted values (left column) and qq-plot based on type 1 (middle) and type 2 (right) residuals (see text) based on the final XSAM model fit.

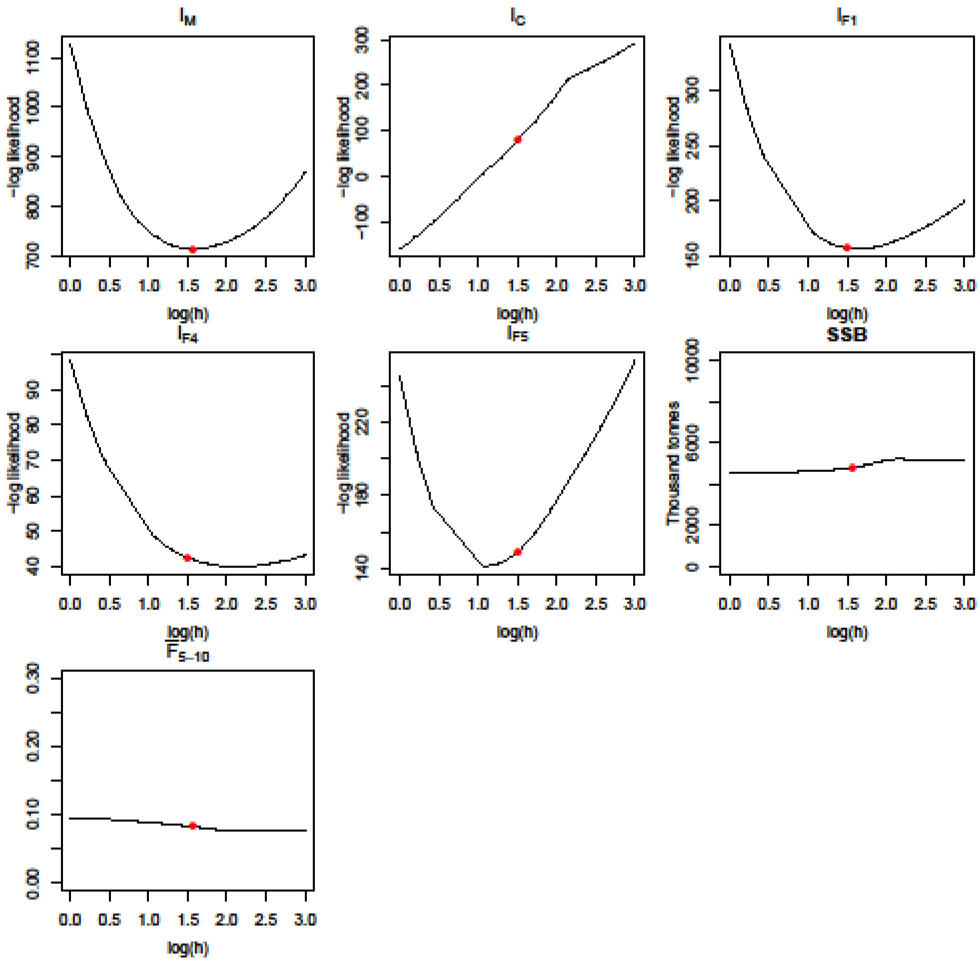

Figure 4.5.1.6. Norwegian spring spawning herring. Profiles of marginal log-likelihood l_M, the catch component l_C, Fleet 1 component l_{F1}, Fleet 4 component l_{F4}, Fleet 5 component l_{F5}, point estimate of SSB and average F (ages 5-12+) in 2017 over the common scaling factor for variance in data h for the final XSAM fit. The red dots indicate the value of the respective scaling factors for which the log-likelihood is maximized.

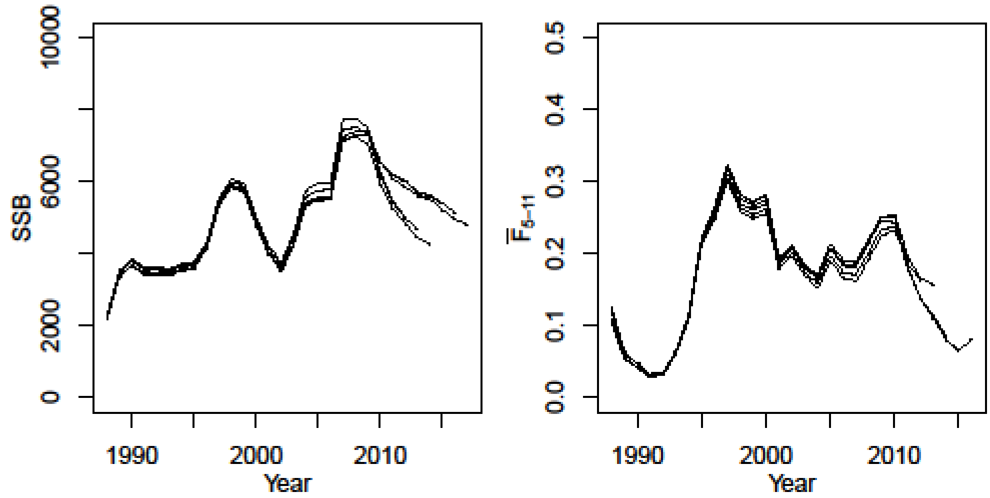

Figure 4.5.1.7. Norwegian spring spawning herring. Retrospective XSAM model fits of SSB and weighted average of fishing mortality ages 5-11 for the years 2012-2017.

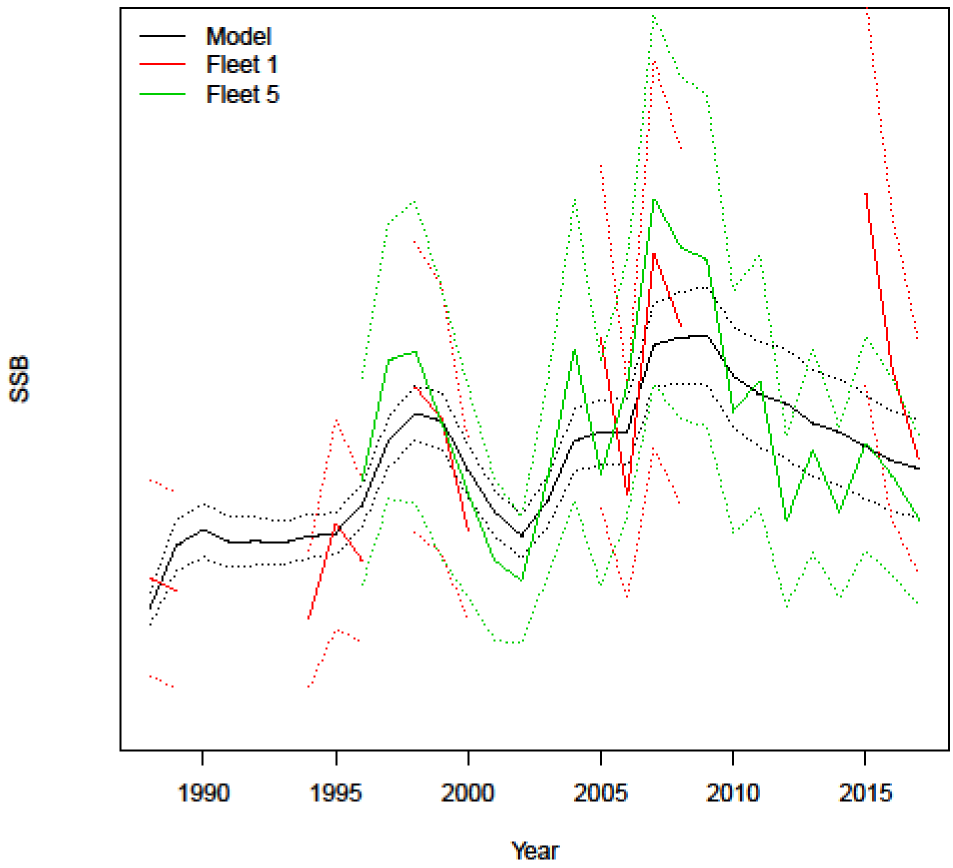

Figure 4.5.1.8. Norwegian spring spawning herring. Point estimates of Spawning stock biomass by years 1988-2017 from model (black lines) and by survey indices from Fleet 1 (red) and Fleet 5 (green). Dotted lines are approximate 95% confidence interval.

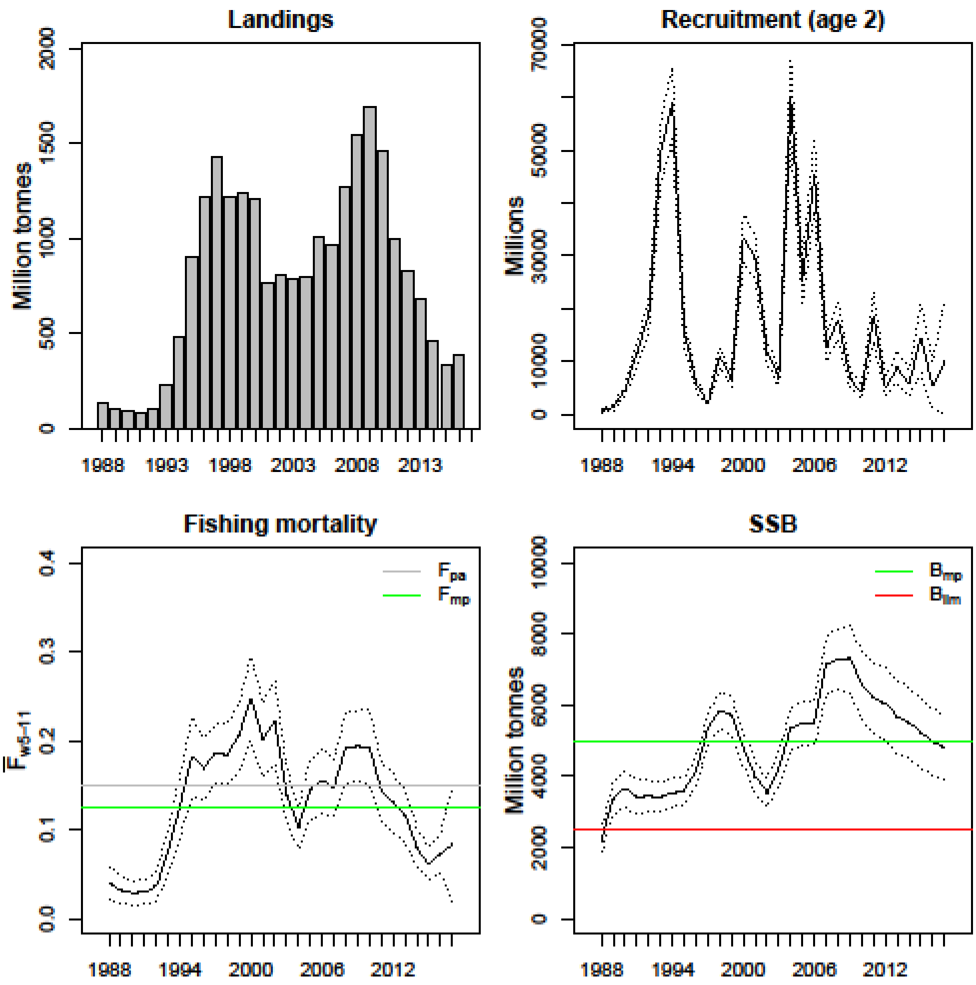

Figure 4.5.1.9. Total reported landings 1988-2016, estimated recruitment, weighted average of fishing mortality (ages 5-11) and spawning stock biomass for the years 1988-2017 based on the final XSAM model fit. The broken lines are approximate 95% confidence limits.

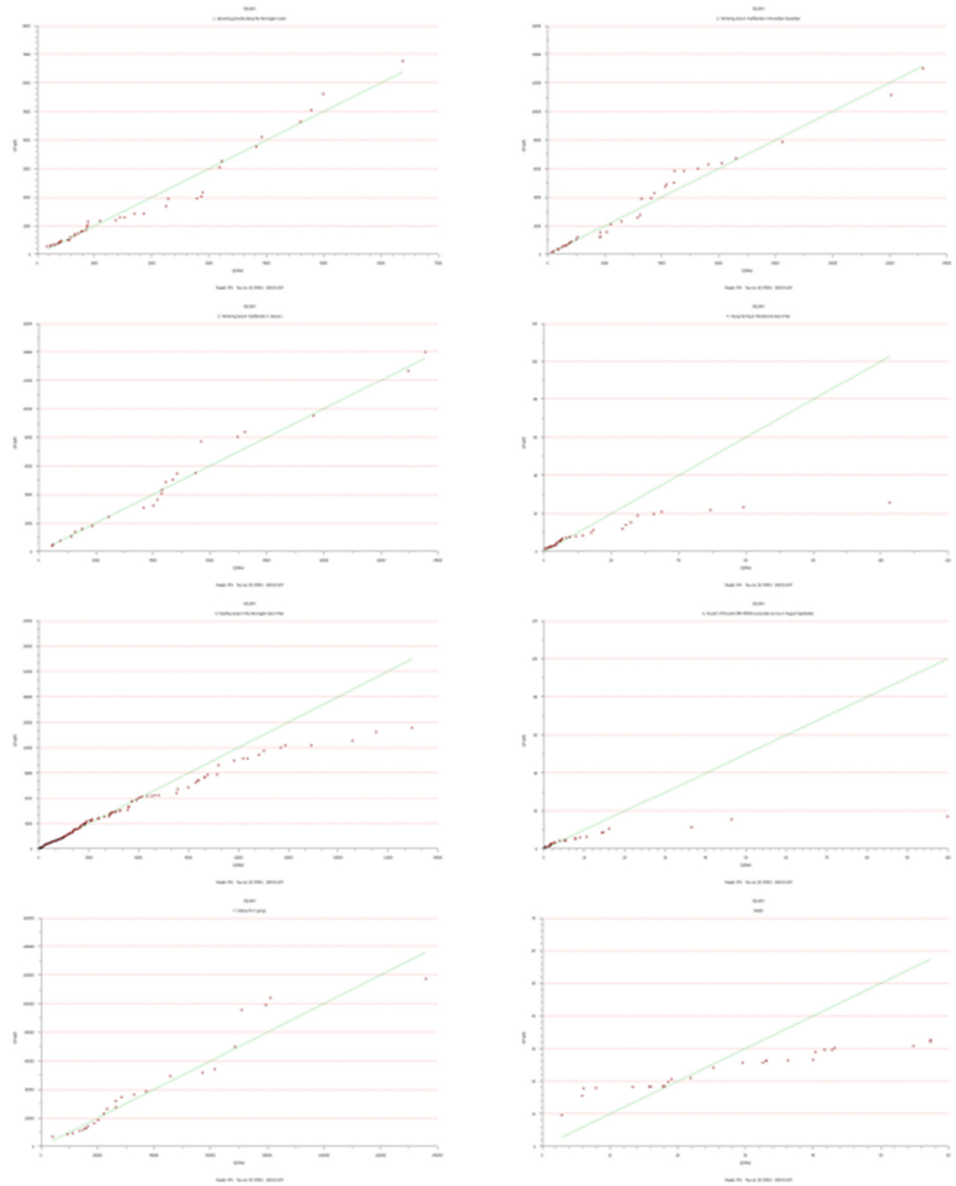

Figure 4.5.2.1.1. Norwegian spring spawning herring. Q-Q plot from the eight different surveys used in tuning in TASACS. First row starts with survey 1 and the last one in row four is larval survey.

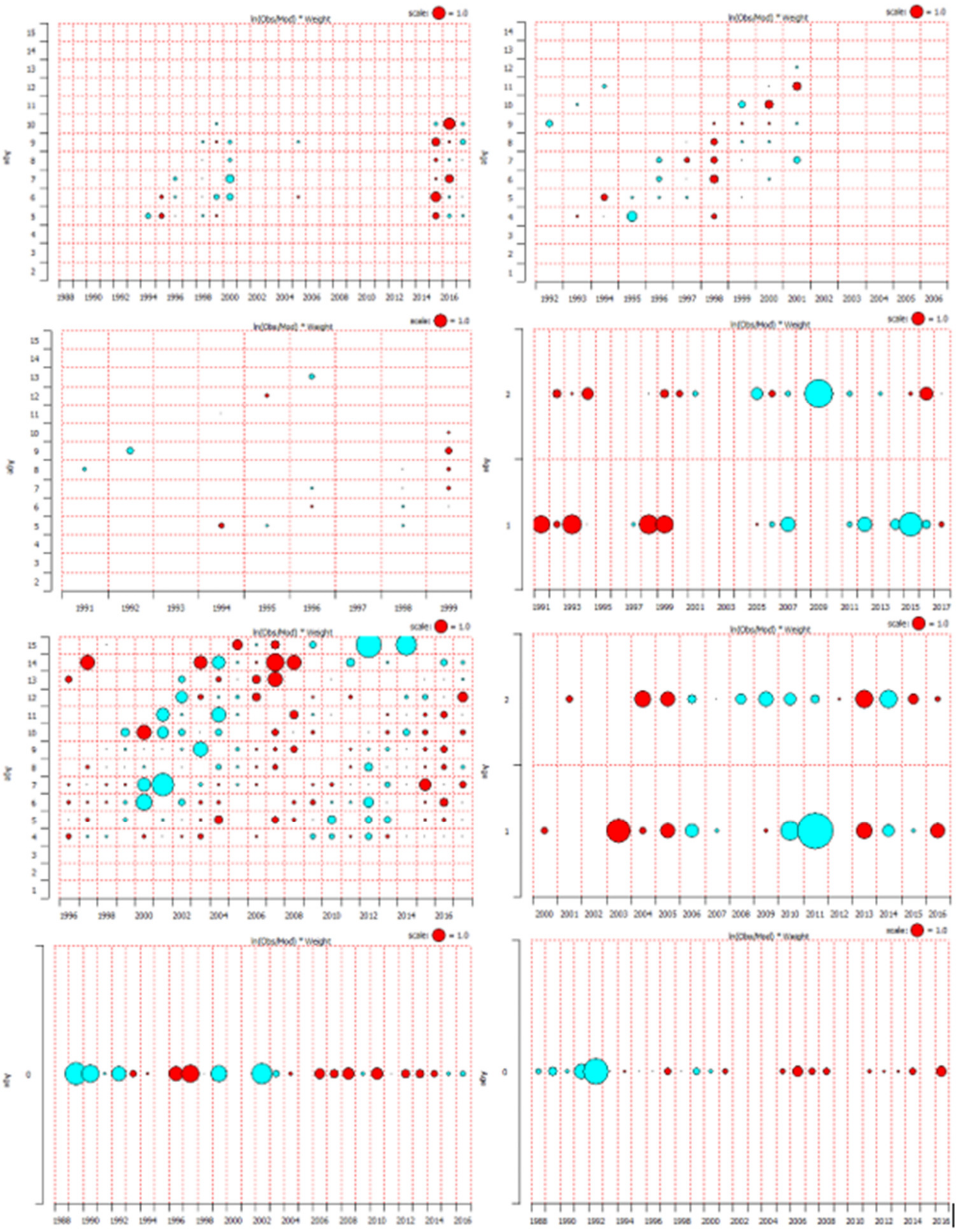

Figure 4.5.2.1.2. Norwegian spring-spawning herring. Residual sum of squares in the surveys separately from TASACS. First row starts with survey 1 and the last one in row four is larval survey.

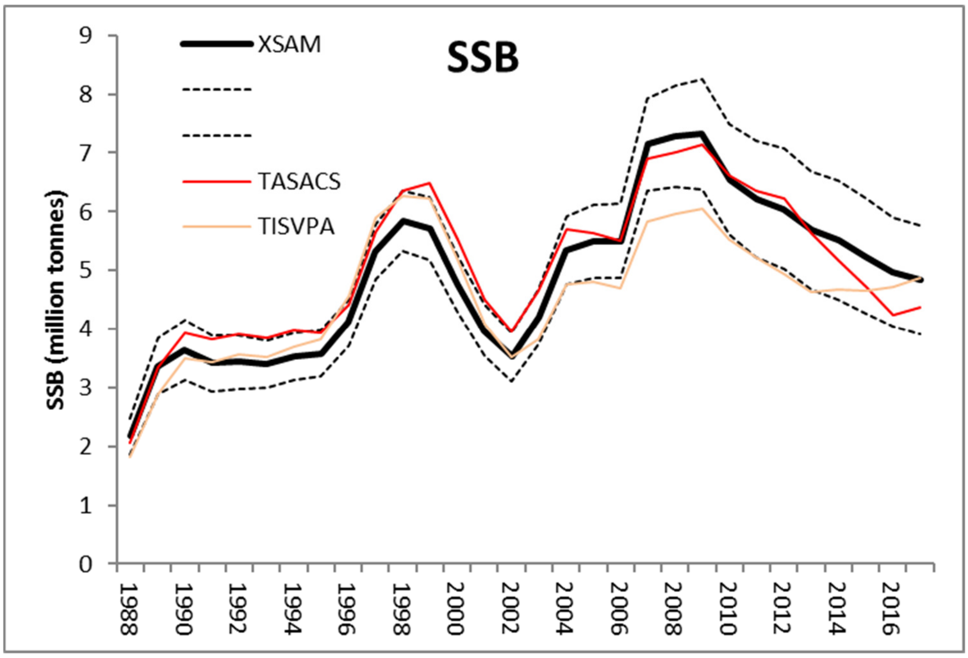

Figure 4.5.2.1.3. Comparison of SSB time series from the final assessment from XSAM and exploratory runs from TASACS (following the 2008 benchmark procedure) and TISVPA. 95% confidence intervals from the XSAM final assessment are shown.

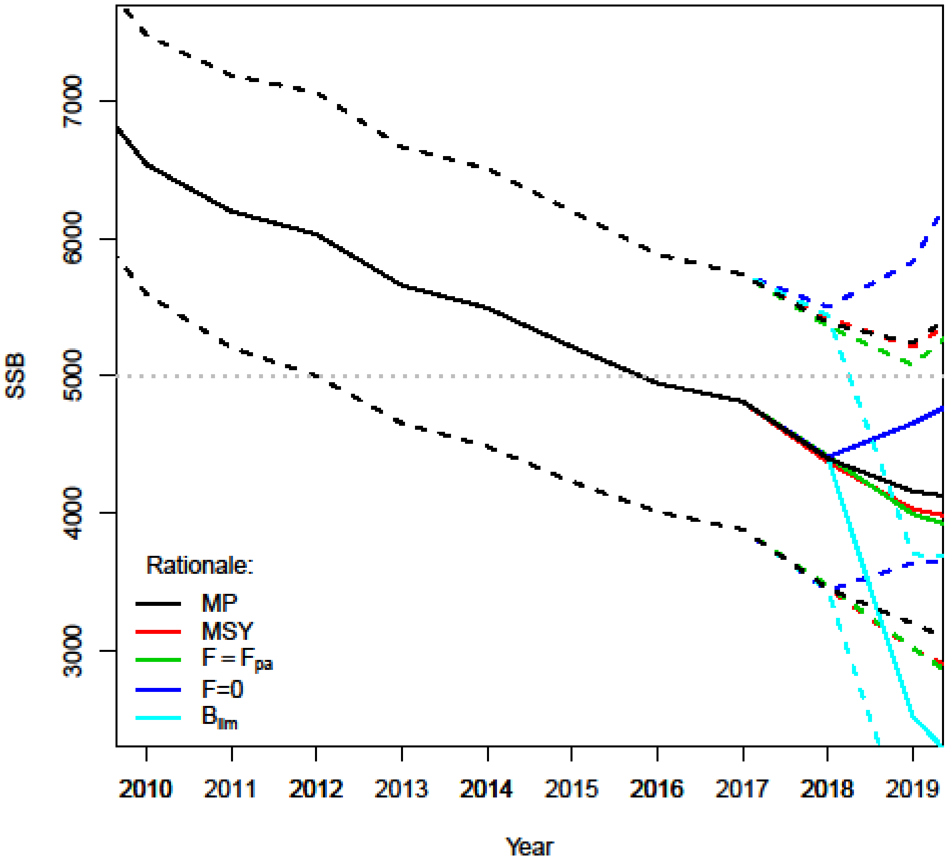

Figure 4.8.2.1. Predicted effect on the size of the spawning stock after implementing catch options according to the managementplan (black), MSY (red), a fishing mortality according to Fpa=0.15 (green) and zero catch (blue). Approximate 95% confidence intervals are shown by the broken lines.

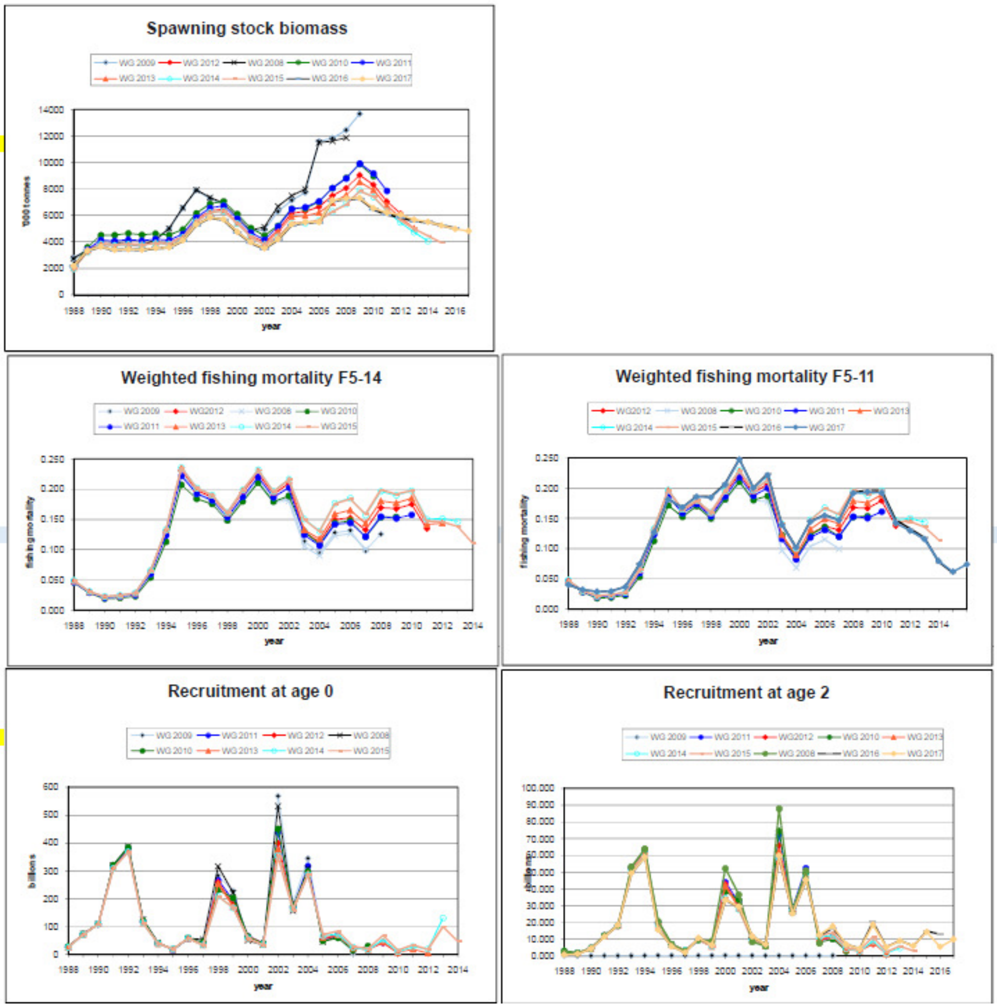

Figure 4.9.1. Norwegian spring spawning herring. Comparisons of spawning stock; weighted fishing mortality F5—14 and F5-11; and recruitment at age 0 and age 2 with previous assessments. In 2016 the proportion mature in the years 2006-2011 was changed; recruitment age changed from 0 to 2 and fishing mortality is calculated over ages 5 to 11.