7 Norwegian Spring Spawning Herring

7.1 ICES advice in 2013

Based on the most recent estimates of fishing mortality in 2011, ICES stated that the stock is being harvested below F_{MSY} but above the management target. The SSB is declining but still above B_{pa} and MSY $B_{trigger}$ in 2012. Presently three large year classes (2002, 2003, and 2004) dominate the stock. All year classes from 2005 onwards have been small, generally less than half the geometric mean.

A long term management plan, agreed by the EU, Faroe Islands, Iceland, Norway and Russia, is operational since 1999. ICES has evaluated the plan and concludes that it is in accordance with the precautionary approach. The management plan implies maximum catches of 619000 t in 2013.

7.2 Management in 2013 and 2014

EU, Faroe Islands, Iceland, Norway, and Russia agreed in 1996 to implement a long-term management plan for Norwegian spring-spawning herring. The management plan was part of the international agreement on total quota setting and sharing of the quota during the years 1997—2002. In the years 2003—2006 there was no agreement between the Coastal States regarding the allocation of the quota. In this period quotas were set unilaterally and in some countries quota were raised during the course of a year. In the years 2007—2012 the Coastal States have agreed to set a TAC in accordance with the management plan. For the fishing years 2013 and 2014, Faroe Islands have withdrawn from the Coastal States agreement on the allocation of the quota.

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 2500000 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 5000000 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 5000000 t. The basis for such adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at B_{pa} (5000000 t) to 0.05 at B_{lim} (2500000 t).
- The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

The agreed TAC for 2013[1] was 619000 tonnes. The agreed shares of the Parties (excluding the Faroe Islands) are 40297 tonnes for the European Community, 89817 tonnes for Iceland, 377590 tonnes for Norway and 79356 tonnes for the Russian Federation. In

1 Agreed record of conclusions of fisheries consultations on the management of the Norwegian spring-spawning (Atlanto-scandian) herring stock in the north-east Atlantic for 2013 (London, 23 January 2013).

addition the Parties agreed to set aside a quantity of 31940 tonnes for the Faroe Islands based on the sharing arrangement agreed between the Parties in Oslo 18 January 2007.

Unilaterally, the Faroe Islands has decided[2] to fix a national catch ceiling at 17 per cent of the TAC of 619000 tonnes as advised by ICES for 2013. This corresponds to 105230 tonnes in 2013.

The agreed TAC for 2014[3] was 418487 tonnes. The agreed shares of the Parties (excluding the Faroe Islands) are 27244 tonnes for the European Community, 60722 tonnes for Iceland, 255277 tonnes for Norway and 53650 tonnes for the Russian Federation. In addition the Parties agreed to set aside a quantity of 21594 tonnes for the Faroe Islands based on the sharing arrangement agreed between the Parties in Oslo 18 January 2007.

Unilaterally, the Faroe Islands has decided[4] to fix a national catch ceiling at 40000 tonnes in 2014.

Each Party may transfer unutilised quantities of up to 10% of the quota allocated to the Party for 2014 to the quota allocated to that Party for 2015. Such transfer shall be an addition to the quota allocated to that Party for 2015. Each Party may also authorise fishing by its vessels of up to 10% beyond the quota allocated. All quantities fished beyond the allocated quota for 2014 shall be deducted from the Party's allocation for 2015. Further arrangements, including arrangements for access and other conditions for fishing in the respective zones of fisheries jurisdiction of the Parties, are regulated by bilateral arrangements.

7.3 The fishery in 2013

7.3.1 Description and development of the fisheries

Distribution of the 2013 Norwegian spring-spawning herring fishery for all countries by ICES rectangles per year is shown in Figure 7.3.1.1 and for annual quarter in Figure 7.3.1.2.

The 2013 herring fishing pattern was similar to recent years, i.e. clockwise movement of the fishing fleet in the Norwegian Sea as the year progressed. The fishery began in January on the Norwegian shelf and focused on pre-spawning, spawning and post-spawning fish (Figure 7.3.1.2 quarter I). By spring, fishing effort had shifted south to especially Faroese waters (Figure 7.3.1.2 quarter II). In summer the fishery expanded into Icelandic waters and north to Jan Mayen and Svalbard, hence, covering the whole western part of the Norwegian Sea (Figure 7.3.1.2 quarter III). In autumn, the fishery shifted to the eastern part of the Norwegian Sea (Figure 7.3.1.2 quarter IV). The largest proportion of the catches was taken in the fourth quarter (51 %).

The NSSH changed wintering areas from fjordic to oceanic during the years 2002—2006. The new wintering pattern caused a large change in fishing pattern as more catches were taken during the spawning migration and spawning instead of during

---

2 Press release by the Faroese Ministry of Fisheries 26-03-2013 | The Faroese fishery for Atlanto-Scandian herring in 2013

3 Agreed record of conclusions of fisheries consultations on the management of the Norwegian spring-spawning (Atlanto-scandian) herring stock in the north-east Atlantic for 2014 (Reykjavík, 28 March 2014).

4 Press release by the Faroese Ministry of Fisheries 12-06-2014 | Prime Minister welcomes understanding to resolve dispute on EU's economic measures

the wintering period. These changes apply mostly to the Norwegian fleet and are described in section 7.3.1.8. A further change in recent years, is that before 2010 the fishery in fourth quarter tended to be primarily in the wintering area in the Norwegian zone, but in the last years there have also been fisheries in the international (<68°N), Icelandic and Faroese EEZs.

In 2013, there were limitations by some countries to enter the EEZs of other countries regarding Norwegian spring-spawning herring. Therefore, the fisheries do not necessarily depict the distribution of herring in the Norwegian Sea and the preferred fishing pattern of the fleets given free access to all zones.

7.3.1.1 Denmark

The Danish fishery of Norwegian spring spawning herring in 2013 took place in IIa during January and February, by purse seiners and trawlers. A total sum of 17160 tonnes was caught, corresponding to 99.9% of the Danish quota. All catches were from Norwegian EEZ.

7.3.1.2 Germany

The vessels targeting Norwegian spring spawning herring belong to the pelagic freezer trawler fleet owned by a Dutch company and operating under the German flag. Depending on season and the economic situation these vessels are targeting other pelagic species in European and international waters. This fleet consists of four large pelagic freezer-trawlers with power ratings between 4200 and 12000 hp and crews of about 35 to 40 men. The vessels are purpose built for pelagic fisheries. The catch is pumped into large storage tanks filled with cool water to keep the catch fresh until it is processed. The reported landings in 2013 were 4244 tonnes taken in IIa and IIb.

7.3.1.3 Greenland

The bulk of the catches was taken in Division IIa in fourth quarter, while the remaining was caught in both Division Va (fourth quarter) and Subarea XIV (late summer), partly as an exploratory fishery.

7.3.1.4 Faroe Islands

Faroese vessels landed 105 038 of Norwegian spring spawning herring in 2013. The majority of the landings were caught within the Faroese EEZ (93 %), and the rest in international waters (7 %). Approximately two thirds of the catches were taken in May to September in a mixed fishery for Norwegian spring spawning herring and mackerel. The remaining catches were taken in the direct herring fishery, which occurred in autumn (October to November). Herring was caught within the Faroese EEZ from May to November but the location of the fishery shifted between seasons. In early summer, the fishery was concentrated between latitudes 62 °N to 65 °N, just north of the Faroe Islands. In August the fishery was across the Faroese EEZ around 63 °N. In autumn the fishery shifted to the north eastern part of the Faroese EEZ and, to a lesser extent, the international zone in the Norwegian Sea. Faroese fishing vessels did not catch any herring in winter (January – April).

The 2013 herring fishing season in Faroese waters lasted six months – from May to November. This trend of prolonged herring fishery in the Faroese EEZ has been observed since 2008.

7.3.1.5 Iceland

The Icelandic TAC for Norwegian spring spawning herring in 2013 was set at 90000 tonnes. The majority of the catch, 64000 tonnes, was caught, as in last years, within the Icelandic EEZ in the period July to October. The prolonged existence of the stock on feeding grounds in the west into the autumn in recent years therefore continues, whereas in the years before the fishery moved to International or Norwegian waters already in September-October. The remaining catch of 18200 tonnes was caught within the Faeroese EEZ and 8500 tonnes in International waters in September to November. The total catch of the Icelandic fleet in 2013 came to 90729 t.

Since 2007 the entire fishery of the Icelandic summer-spawning herring has been west and south off Iceland and therefore Norwegian spring-spawning herring was not caught in that fishery, different from the east coast fishery during 2004—2005.

7.3.1.6 Ireland

The Irish fishery for Norwegian spring spawning herring took place in February off the Norwegian coast. A total of 7 vessels (23—63 m) participated in the fishery and recorded landings of 3815 tonnes. Norwegian spring spawning herring from the Irish fleet are landed primarily for reduction to fishmeal and processed for human consumption. All landings were made into Norwegian ports.

7.3.1.7 Netherlands

Two Dutch freezer trawlers participated in the fishery for Norwegian spring spawning herring in 2013. The fishery took place in late October to early November, in ICES Division II. The Dutch catch of 5626 tonnes was taken in 2 trips. The fishery is carried out with large pelagic trawls.

7.3.1.8 Norway

The Norwegian quota for 2013 was shared with about 50% to the large oceanic purse seiners, 10% to trawlers and 40% to smaller coastal purse seiners. The total catch during the first quarter in 2013 was 130323 tonnes. The Norwegian fleet hardly fish herring in the oceanic feeding area during the second quarter. There are some catches reported from the coastal areas during this period, amounting to 1005 tonnes in 2013. This herring consists of a mix of NSSH, a summer spawning oceanic stock and local fjordic herring stocks, of which the two latter are allocated to the Norwegian spring spawning herring quota for practical reasons. The Norwegian fishery in quarter 3 was 2802 tonnes. The fisheries in the fourth quarter took place in the migration route from the feeding areas in the Norwegian Sea to the wintering areas west and northwest of Vesterålen and in fjords in Troms, and the total catch was 225322 tonnes.

7.3.1.9 Russia

The Russian fishery started within the wintering area of the Norwegian spring spawning herring (approximately 10—13°E) in the Vesteralen (Norwegian EEZ) at the beginning of January, then progressed in the south-western direction along the Norwegian coast and was finished on south banks of the Norwegian shallow water (approximately 63°N) at the second half of February. In January-February the total catch was 8511 t.

During the II quarter the Russian fleet did not target fishery of herring almost. Major part of herring was caught in the mackerel fishery. But several vessels started target fishery at the end of June. The total catch was 670 t.

In III quarter, Russian fishery started at the beginning of July. The vessels caught herring in the international water and in areas of Spitsbergen and Jan-Mayen westward from 17° E. 29648 t of herring was taken in the III quarter.

In IV quarter, the fishery was continued in area of Spitsbergen, Jan-Mayen and international water. At the end of October the Russian fishery started in the Norwegian EEZ. Catch was finished in December. 39692 t was taken in that period.

The Russian fishery is carried out by different types of trawl vessels. Total Russian catch of Norwegian spring spawning herring was 78521 t. The entire Russian catch was utilized for human consumption.

7.3.1.10 UK (Scotland)

UK vessels (all of which were Scottish) landed 1965 tonnes of Norwegian spring spawning herring from Division IIa into Scotland in 2013. Scottish vessels also landed 6377 tonnes of herring from Division IIa into Norway. The fishery took place in first quarter only. In total ten Scottish trawlers ranging in size from 62—73m, participated in the fishery.

7.3.2 Information on by-catch

In recent years the Faroes have reported on problems with mackerel caught as by-catch in the directed herring fishery north of the Faroes. However, since 2010 the fishery has been directed towards herring and mackerel in the Faroese zone, and has thus been a result of legal activity.

7.4 Stock Description and management units

7.4.1 Stock description

A description of the stock is given in section A.1.1 in the stock annex.

7.4.2 Changes in migration

A characteristic feature of this herring stock is a very flexible and varying migration pattern. A detailed description of the migration pattern is given in the stock annex.

Information about changes in migration of the stock in recent years is mainly derived from the ecosystem surveys Nordic Seas in May (ICES 2014c) and July/August (Nøttestad *et al.* 2014). The May survey takes place when the stock is still, in part, migrating to the feeding grounds and there are no major changes in migration pattern and distribution of the stock observed in recent years. The main concentration has been in the mid Norwegian Sea with a tail reaching southwest into Faroese and Icelandic waters and typically a smaller concentration further north towards Lofoten in Norway. The July/August survey shows a further westwards and northwards migration, with the main concentrations in the south-western to north-western fringes of the Norwegian Sea and herring being relatively absent from the mid Norwegian Sea. However, the main changes in the stock's migration pattern observed in recent times derive from information from the commercial fishery. They indicate that herring have prolonged the stay on the feeding grounds in the western part, with fishery ongoing in Faroese and Icelandic waters reaching into November in recent three years, in contrast to September and October earlier. Such indications resulting from fishing activity have to be interpreted carefully as the behaviour of the fleet can also have changed, causing the changes in distribution of catch from one year to another.

It is not clear what drives the changes in the migration, 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 features (e.g. limitations due to cold areas). However, it should be noted that beside the environmental forces the age distribution in the stock is also likely to influence the centre of gravity of the stock during summer (Figure 7.4.2.1). At present the stock consists of old individuals due to poor recruitment in a number of years, and as the largest fish move farthest west, the stock should be in the western areas at the time being while the opposite should be expected when rich year-classes join the adult stock from the nursery areas in the Barents Sea.

7.5 Data available

7.5.1 Catch data

Catches in tonnes by ICES division, ICES rectangle and quarter in 2013 were available from Denmark, Faroe Islands, Germany, Greenland, Iceland, Ireland, The Netherlands, Norway, Russia, Scotland and Sweden. The total working group catch in 2013 was 684743 tonnes (Table 7.5.1.1) compared to the ICES-recommended catch of 619000 tonnes.

Table 7.5.1.2 shows catches and number of age samples by country, ICES division and quarter together with the samples used as fill-in for unsampled catches (when calculating the catch and weight at age). Sampled catches accounted for 91% of the total catches, which is similar to previous years. The majority of the catches (>80 %) were taken in division IIa.

This year Intercatch was used for the first time to calculate age and size distributions, so all countries were requested to deliver catch and sample data both as the old data delivery sheets and as Intercatch files. Table 7.5.1.3 shows a comparison of catch at age and weight at age in 2013 estimated with the SALLOC software and with Intercatch. The differences are negligible. However, a problem with intercatch is that it is not possible to record catch data from the same species and two different stocks in the same area. This problem applies to catches of Norwegian spring spawning herring in area IVa as catches of North Sea herring are also recorded from this area. The solution to the problem was to sum all the countries catches in IVa and allocate this total catch to area XIVa and to use “other” as country code.

7.5.2 Discards

In 2008, the Working Group noted that in this fishery an unaccounted mortality caused by fishing operations and underreporting probably exists. It was not possible to assess the magnitude of these extra removals from the stock, and taking into account the large catches taken in recent years, the relative importance of such additional mortality is probably low. Therefore, no extra amount to account for these factors has been added in 1994 and later years. 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 no 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.

During the Norwegian fishery in the first quarter the stock is migrating fast southward in dense aggregations. This is a challenge to the fleet by increasing the risk of slipping of the catch or breaking of the net during fishing operations due to extremely large catches. There are no data to estimate the amount of slipping. However, the Coast-guard maintains a close presence with the pelagic fishing fleet during the season with several vessels and a plane. IMR has cooperation with a number of reference vessels in the pelagic fleet, primarily for the purposes of biological sampling but also recording losses through gear damage or slipping. These data indicate that the frequency of slipping and the total quantities of fish slipped are low and, although the quantity remains unknown, are too small to have a significant effect on the reliability of the assessment.

7.5.3 Length and age composition of the catch

The catch at age data are given in Table 7.5.3.1. The numbers are calculated with Intercatch for 2013 and SALLOC before 2013. In 2013, about 30% of the catches (in numbers) were taken from the 2004 year class, followed by the 2006 and 2009 year classes that each contributed around 15%. Lengths at age data are not used in the assessment.

7.5.4 Weight at age in catch and in the stock

The weight-at-age in the catches in 2013 was computed from the sampled catches in 2013 using Intercatch. SALLOC was used for the years before 2013. Trends in weight-at-age in the catch are presented in Figure 7.5.4.1 and Table 7.5.4.1. The mean weights at age for most of the age groups have generally been increasing from 2011 onwards.

A similar pattern is observed for some age groups (age 5—9) in weight-at-age in the stock which is presented in Figure 7.5.4.2 and Table 7.5.4.2. These data have been taken from the survey in the wintering area until the year 2008. The mean weight at age in the stock for age groups 4—11 in the years 2009—2014 was derived from samples taken in the fishery in the same area and at the same time as the wintering surveys were conducted in.

7.5.5 Maturity at age

The maturity data used in the assessment were revised in 2010 following a recommendation from WKHERMAT[5]. This Workshop evaluated the existing maturity at age data because they were not available or considered in the benchmark assessment in 2008.

WGWIDE adopted the maturity ogives derived from back calculation of scales for the historical time period (years 1950-2007) in the assessment. WGWIDE recommends that this data set remains updated in future years. For the years after 2007 for which no data are available from this method (including the years considered in the forecast) the following default maturity ogives will be assumed. For 'normal' classes (average, median and weak year classes), an average maturity at age will be assumed from the periods 1983—2007 from the back calculation data set excluding the strong year classes 1983, 1991, 1992, 1998, 1999, 2002. For year classes which are considered strong, preliminary estimates will be assumed to be the average of the recent strong year classes 1983, 1991, 1992, 1998, 1999, 2002 in the data set.

5 Report of the Workshop on estimation of maturity ogive in Norwegian spring spawning herring (WKHERMAT). 1-3 March 2010 Bergen, Norway. ICES CM 2010/ACOM:51 REF. PGCCDBS

The default maturity o-gives used for ’normal’ and strong 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 yc	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
strong yc	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 7.7.5.1.

7.5.6 Natural mortality

In this year’s (2013) assessment, 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.

7.5.7 Survey data updated

The description of the surveys and use of them for tuning in the assessment are given in the Stock Annex 2. This section contains and discusses the survey results from some recent years. Several surveys were stopped many years ago, but are still used for tuning of the assessment models because they were included in the benchmark. The influence of these surveys on the assessment and the need to use them in the future should be investigated in the next benchmark assessment.

7.5.7.1 Survey 1 Norwegian acoustic survey on spawning grounds in February/March (NASF)

No new information but the years 1994—2005 are used in the tuning (see stock annex 2).

7.5.7.2 Survey 2 Norwegian acoustic survey in November/December (NASN)

No new information but the years 1992—2001 are used in the tuning (see stock annex 2).

7.5.7.3 Survey 3 Norwegian acoustic survey in January (NASJ)

No new information but the years 1991—1999 are used in the tuning (see stock annex 2).

7.5.7.4 Survey 4 and 5 International ecosystem survey in the Nordic Seas (IESNS)

The international ecosystem survey in the Nordic Seas aims for exploring the pelagic ecosystem, with a special focus on herring, blue whiting, zooplankton and hydrography. Survey coverage in the Norwegian Sea was considered adequate in 2014 and in line with previous years. It is therefore recommended that the results can be used for assessment purpose. The herring distribution in 2014 was similar to the 2013 distribution. (Figure 7.5.7.4.1). The highest concentrations were found in the central to southwestern part of the Norwegian Sea and consisted mainly of older part of the stock (age 8 and older). A dense concentration was also found in the northeast (around 69°N and 5°E) and consisted of a mixture of all age classes from age 2—14. Overall the herring density was relatively low and herring was never observed in big schools. In 2014, like in previous three years, almost no herring were observed north of 70°N, while it was found further north in 2010. The center of gravity of the acoustic recordings of herring reflects the distribution and shifted in a southwesterly direction compared to 2013.

As in previous years the smallest fish were found in the eastern area of the Norwegian Sea whereas size and age were found to increase to the west and south. Correspondingly, it was mainly older herring that appeared in the southwestern areas (area III).

The herring stock is now dominated by 10 year old herring (2004 year class) in numbers but 5, 8, 9, 11 and 12 year old herring (the 2009, 2006, 2005, 2003 and 2002 year classes) are also numerous (Table 7.5.7.4.2), which is similar to previous years. (Figure 7.5.7.4.2). The 2009 year class appears to be the largest of the younger age groups even it appears to be only around 50% of average size of five year olds in the times series since 1997. The six year classes from 2002 to 2006 and 2009 contribute to 6%, 10%, 22%, 14%, 12% and 14%, respectively, of the total biomass.

The total biomass estimate of herring in the Norwegian Sea from the 2014 survey was 5.1 million tons. This estimate is 0.3 million tons lower than in 2013. The biomass estimates in the last six years has fluctuated, with 10.7 million tons in 2009, 5.8 million tons in 2010, 7.4 million tons in 2011, 4.6 million tons in 2012, 5.4 million tons in 2013 and now 5.1 million tons in 2014.

The investigations of herring in the Barents Sea covered the area from 44°E to the 20°30′ E. The total abundance estimate was higher than in the last two years, with 5876 million individuals of age 1 (mean length of 11.5 cm and weight of 8.7 g), 2185 million individuals of age 2 (mean length of 17.8 cm and mean weight of 32.4 g), 2156 million individuals of age 3 herring (mean length of 23.8 cm and mean weight of 76.3 g) and 242 million individuals of age 4 herring (mean length of 25.7 cm and mean weight of 95.9 g). Only very few older herring were observed.

The total number of herring recorded in the Norwegian Sea was 9.6 billion in the northeastern area and 10.4 billion in the southwestern area, compared to 12.8 and 13.0 billion in the northeastern and 7.2 and 7.4 billion in the southwestern area in 2012 and 2013, respectively.

The age-disaggregated time-series of abundance for the Barents and Norwegian Sea are presented in Table 7.5.7.4.1 and 7.5.7.4.2, respectively.

7.5.7.5 Survey 6 and 7 Ecosystem survey in the Barents Sea (Eco-NoRu-Q3 (Aco))

The age groups 1 and 4 are used in the assessment. The log index of 0–group herring has been used in the assessment up to 2004 and then replaced by a new abundance index, which was included in the assessment since 2006.

The results from these surveys on 0–group herring are given in Table 7.5.7.5.2; those of the 1 to 4 age groups are given in Table 7.5.7.5.1.

The total abundance of herring aged 1-4 years covered during the survey was estimated at 12.8 billion individuals (about 3 times higher than the value estimated in 2012). The biomass of 0.5 million tonnes is about 80% higher than in 2012, since the overall mean weight is much lower this year. This is first of all an effect of a younger age distribution in 2013. During recent years, the amount of young herring entering the Barents Sea has been low, and the estimated stock size in 2013, though being much higher than last year, is only about half of the average stock size during the period 1999 to 2013.

In 2013, only very scattered concentrations of herring were found from Nordkapp eastwards to Novaya Zemlya. Herring of ages between 1 and 4 was registered, with 1-year-olds being dominant in numbers and 2-year-olds in biomass. The distribution of young herring is shown in Figure 7.5.7.5.1. 0-group herring were distributed as in 2012 from southeast to northwest of the Barents Sea in 2013. However, herring has widely distribution in the central part of the sea in comparison to 2012. The main dense concentration of herring was located in the central area: between 71—75° N and 24—35° E. Distribution of 0–group herring is presented in Figure 7.5.7.5.2.

7.5.7.6 Survey 8 Norwegian herring larvae survey on the Norwegian shelf (NHLS)

A description of this survey is given in stock annex 4. Two indices are available from this survey (Table 7.5.7.6.1). The "Index 1" is used in the assessment as representative for the size of the spawning stock except for 2003 and 2009 due to incomplete coverage in these years.

In 2014 the survey was carried out from 31 March to 14 April. The number of herring larvae was estimated to be $75.6*10^{12}$. The number of larvae is slightly higher than last year (Table 7.5.7.6.1).

As shown in figure (Figure 7.5.7.6.1), herring larvae were observed throughout the sampling area. Zero values were found on the southernmost and northernmost sections. The offshore extent of the larval distributions were found on all transects. The highest abundance of herring larvae were found relatively close inshore, on the northern part of the Møre spawning grounds and northward to Sklinnabanken. Relatively low concentrations of larvae were found on the northern spawning banks of Lofoten, Vesterålen and Troms.

7.5.7.7 Survey 9 International ecosystem survey in the Norwegian Sea in July-August (IESSNS)

The IESSN survey (formerly called “Norwegian ecosystem survey and SALSEA salmon project in the Norwegian Sea in July-August”) has been carried out on the Norwegian shelf since 2004 for the exception 2008 but was extended to the whole Norwegian Sea, Icelandic waters, and Faroese waters in 2009. The objectives of the survey are to obtain estimates of abundance, spatiotemporal distribution, aggregation and feeding ecology of Northeast Atlantic mackerel, Norwegian spring-spawning herring, blue whiting and Atlantic salmon in relation to oceanographic conditions, prey communities and marine mammals.

The survey has not been used in the assessment of NSS herring but the results from the surveys, with regards to herring, plankton and hydrographical investigation, has been presented to the WG every year. Four vessels from Norway (2), Iceland (1) and Faroe Island (1) participated in the survey in 2014 during 2 July to 12 August. The acoustic estimate of NSSH in the survey came to only 4.6 million tonnes compared to 8.6 million tonnes in 2013, 7.3 million tonnes in 2012, 10.7 million tonnes in 2010 and 13.6 million tonnes in 2009. There is no estimate from 2011 due to insufficient coverage. There are two likely explanations for the drop in the biomass index in 2014. First, the survey did probably not cover the whole distribution area of the stock, especially north of Iceland and west of Jan Mayen. Secondly, there is a strong indication that herring were in the acoustic dead-zone above the transducer or in the surface 10—15m, (e.g. in the Jan Mayen area).

7.6 Methods

7.6.1 TASACS stock assessment

This year's assessment was classified as an update assessment and 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 4). The information used in the assessment is catch data and survey data from eight surveys. The analysis was restricted to the years 1988—2014, which is regarded as the period representative of the present production and exploitation regimes, and is presumed to be of main interest for the management.

As a result of the data exploration WGWIDE in 2013 implemented an updated algorithm for calculating the terminal F-values for last age classes where no data supporting the estimate of terminal stock numbers was available. The same procedure was used this year.

The model was run with catch data 1988—2013, and projected forwards through 2014 assuming Fs in 2014 equal to those in 2013, to include survey data from 2014.

7.6.2 Short-term forecast

A detailed description of the short term forecast procedure is given in the stock annex. Since the standard software cannot cope with Management Option Tables based on average fishing mortality weighted over stock numbers, calculations are carried out using a spread sheet.

7.7 Data Exploration

7.7.1 Catch curve analyses

Figure 7.7.1.1 shows the age disaggregated catch in numbers by years. In the years 2009—2011 the year classes from 2002—2004 were the most prominent year classes in the catches, whereas in 2012 and 2013 it is the 2004 year class. Figure 7.7.1.2 shows the disaggregated catch in numbers plotted on a log scale. For comparison, lines corresponding to Z=0.3 are drawn in the background. It is tempting to draw the conclusion that the catch curves shows the exploitation of the big year classes in the periods of relatively constant effort, but the poor year classes exhibit just noise. For year classes 2005 and younger these curves provide hardly any information.

For survey 5 Figure 7.7.1.3 shows the age disaggregated abundance indices in numbers plotted on a log scale. The same arguments are valid for the interpretation of the catch curves from the survey as from the catches. In 2010 the number of all age groups decreased suddenly 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 the Survey 5 catchability, with seemingly higher catchability in years 2006—2009. Like for the catch data these provide hardly any information for year classes 2005 and younger.

7.7.2 data exploration with TISVPA

WGWIDE 2014 carried out some exploratory assessments with the TISVPA model, using the same version which was used by the Working Group in 2006 and later years. The main model settings were the same as in previous assessments.

The surveys data are the same as in the TASACS model run: the survey on spawning grounds along the Norwegian coast (survey 1); in wintering area in Vestfjorden in November-December (survey 2); in wintering area in Vestfjorden in January (survey 3); of young herring in the Barents Sea in May (survey 4); in feeding areas in the Norwegian Sea in May (survey 5); joint IMR-PINRO ecosystem survey in August-September (survey 6); Indices for 0 group (survey 7); and larvae index of SSB (survey 8). In contrast to the benchmark assessment, no data points were down-weighted.

Profiles of the components of the TISVPA loss function with respect to SSB in 2014 are shown on Figure 7.7.2.1. The same way as in previous years, only catch-at-age data and survey 5 give any clear indications about the SSB value in 2014: about 5.5 million tons from catch-at-age data, while survey 5 gives two local minima corresponding to 4 and 5.8 million tons. When information from catches and survey 5 are used the SSB is estimated to be around 5.8 million tones (Table 7.7.2.1). Survey 7 (indices for 0-group) a weak indication for SSB in 2014 to be between 3 and 5 million tons. The remaining surveys give unclear and contradicting indications. When input from all data sources are used the overall objective function indicates the SSB in 2013 to be about 6 million tones (curve 9 in figure 7.7.2.1).

Since surveys 1—3 were not conducted in recent years and their influence on the solution is rather indirect and weak, the same way as in last year assessment these three surveys were excluded from the consideration, as well as the other surveys giving no proper indication about the stock in 2014. When only catch-at-age and survey 5 are retained in the objective function of the model, the indication for SSB value in 2014 is dubious the same way as the signal from survey 5: 4 or 5.8 million tones (curve 10 in figure 7.7.2.1), but minimum corresponding to SSB(2014)=5.8 million tones is somewhat lower.

Retrospective runs made using inputs only from catch-at-age and survey 5 data again reveal a historical bias in the results of the assessment by TISVPA (figure 7.7.2.2), generally similar to what is observed in the TASACS results.

As it was shown in previous (2013) assessment, the above mentioned historical bias in the stock biomass estimates can be somewhat diminished if the survey 5 data are used as the only source of auxiliary data and if only one component is included in the objective function of the model. This component corresponds to the median of the distribution of weighted squared residuals between logarithmic age proportions in the data of the survey 5 and the respective values, coming from the cohort part of the model. Using proportions of the stock at age rather than of survey derived abundance values helps to diminish the impact of possible year-to-year changes in survey catchability (see figure 7.7.2.3)

The same way as in the previous assessment (2013), negative residuals are prevailing for survey 5 in the final years, especially in the terminal year (see figure 7.7.2.4), which supports the suggestion that the “effective” catchability for this survey continues to rise in the recent years due to, for example, a more compact stock distribution, which is easier to survey, as a result of lower number of different age classes in the stock. Estimates of average catchability from retrospective runs are shown in figure 7.7.2.5

The above mentioned can also suggest that the option of triple-separabilization used by default (reflecting within-year “selection-redistribution”) may not be optimal for this case and it could be better to change it into the option of “gain in selection”. For Norwegian spring-spawning herring the traditionally used option assumed that in each year more fishing-attractive cohorts borrow some amount of fishing effort from other cohorts by increasing its selection at the expense of diminished selections for other age groups in this year. The suggested settings assumes that some cohorts has increased (or reduced) selections, but it does not cause direct change in selections for others.

The profiles of the components of the objective function for this modified model are shown in figure 7.7.2.6. In comparison to figure 7.7.2.1, it can be seen that in figure 7.7.2.6 for survey 5 the indication of SSB(2014) to be about 4 million tons is more strong, as well as for survey 7, and even for survey 3, which diminishes contradictions among signals from different sources of data

In general, the results of the TISVPA runs support the conclusions drown from previous investigations of the bias in historical runs of the TASACS model.

7.7.3 TASACS assessment

7.7.3.1 Update benchmark assessment

This year's assessment was classified as an update assessment and 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 4). Relatively strong retrospective pattern has, however, been observed in the NSSH assessment since the assessment year 2010. In WGWIDE 2013, an updated algorithm to estimate terminal F-values for weak year-classes was implemented in TASACS which improved the consistency of the assessment (ICES, 2013). This algorithm was used also in this year's assessment.

7.7.3.2 data exploration with TASACS

The model fit to the tuning data is shown with Q-Q plots in Figure 7.7.3.2.1. Surveys 2—3 seem to fit rather well to the assumed linear relationship assumed in the TASACS model but surveys 4 and 6—8 have rather poor fit. In addition, the fitting of survey data to the model in different assessment years is not in all cases very good. Particularly Surveys 7 (0-group) and 8 (larval survey) seems to disagree a lot with the assessment (Figure 7.7.3.2.1). This can also be seen as a block of negative residuals for these surveys in later years (Figure 7.7.3.2.2). The residual plot for survey 5 (IESNS) also shows some pattern with a series of negative residuals during the early 2000s followed by a period of positive residuals. This was thoroughly discussed in last year's WGWIDE report.

During the benchmark in 2008, exploration of the survey data was carried out in order to investigate whether the survey contributes information to the assessment or whether there is no or little information in the survey data. Within TASACS, the development of the individual cohorts (year classes) was explored for each survey separately. This was done cohort by cohort by translating each survey index into population numbers. This allows comparing what each survey indicates that the population numbers should be, and thus identify conflicting signals between surveys and outliers in the survey data. This was done year class by year class. Included in this analysis was also catch data at age, translated into N-values assuming a separable model for the fishing mortalities. Such comparisons allow identification of outliers in the surveys, contradicting signals, or may indicate that the survey provides mostly noise (Figure 7.7.3.2.3). This year, no new survey data were excluded from further analysis.

This year, new information was available for surveys 4, 5, 6, 7 and 8.

7.7.3.3 Final assessment

The final results of the assessment are presented in Tables 7.7.3.3.1 (stock in numbers) and 7.7.3.3.2 (fishing mortality) and Figures 7.7.3.3.1 . Table 7.7.3.3.3 is the summary table of the assessment.

The assessment indicates that the fishing mortality (F5—14weighted weighted by stock numbers) in recent years has fluctuated between 0.13 and 0.20 and is estimated in 2013 at 0.146. The SSB in 2014 is estimated to 4.1 million tonnes.

7.7.4 Bootstrap

The uncertainty of the assessments was examined by bootstrap (1000 replicas). For the data where residuals are generated by the modelling, the bootstrap was made by adding randomly drawn residuals from the same source of data to the modelled observations. For catches at age in the VPA, log-normally distributed random noise with a CV of 0.1 was added to the observations. The results are shown in Figure 7.7.4.1.

7.7.5 Retrospective analyses

The retrospective analyses of the final assessment are shown in Figure 7.7.5.1. It shows that there is a retrospective pattern since the 2009 assessment, but the retrospective pattern previously observed in the earlier parts of the SSB time series has been considerably improved with the implementation of the new algorithm for terminal F-values in 2013.

7.8 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[6].

7.8.1 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.

7.8.2 MSY reference points

The MSY reference points originate from an analysis carried out by WGWIDE in 2010 and confirmed by reanalysis by WKBWNNSH 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 $B_{trigger}$.

7.8.3 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

---

6 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.

linear reduction in the fishing mortality rate will be applied from 0.125 at B_{pa} to 0.05 at B_{lim}.

7.9 State of the stock

The stock is declining and below B_{pa} in 2014. 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 born in 2004—2012 have all been small. However, the 0-group index from the Barents Sea in 2013 was well above the average of the time series. Fishing mortality in 2013 is slightly below F_{pa} and F_{MSY}, but above the management plan F.

7.10 NSSH Catch predictions for 2013

7.10.1.1 Input data for the forecast

The input stock numbers at age 1 and older have been taken from the final assessment as last year. No attempt was made to estimate recent year classes separately because the available information of these year classes from surveys had already be included in the VPA. It should be noted that recent year classes are estimated poor and have little influence on predicted catches and SSB. For age 0 a geometric mean (1988—2010) has been used as in previous years.

The catch weight-at-age, used in the forecast, is the average of the observed catch weights over the last 3 years (2011——2013). For the weight-at-age in the stock, the values for 2014 were obtained from the commercial fisheries in the wintering areas. For the years 2015 and 2016 the average of the last 3 years (2012—2014) was used.

Standard values for natural mortality were used. Maturity at age was based on the information presented in section 7.4.5. For all year classes born after 2004 the default maturity ogive for normal year classes were used

Like in 2013 the exploitation pattern used in the forecast was taken as the average of the last 5 years (2009—2013). The average fishing mortality defined as the average over the ages 5 to 14 and is weighted over the population numbers in the relevant year.

$$\overline{F}_y = \sum_{a=5}^{a=14} F_{y,a} N_{y,a} / \sum_{a=5}^{a=14} N_{y,a}$$

Where $F_{y,a}$ and $N_{y,a}$ are fishing mortalities and numbers by year and age. This procedure is the same as applied in previous years for this stock.

Input data for the short term forecast are given in Table 7.10.1.1.

7.10.2 Results of the forecast

The Management Options Table with the results of the forecast is presented in Table 7.10.2.1. Detailed output of the forecast, with options corresponding to the management plan is given in Table 7.10.2.2. Assuming a total catch of 436893 tonnes is taken in 2013, it is expected that the SSB will decline from 4.1 million tonnes in 2014 to 3.5 million tonnes in 2015. The assumed catch in 2014 takes account for the fact that the Coastal States did not agree on a share of the stock resulting in catches higher than the TAC indicated by the management plan. Furthermore, it does not account for possible catches taken by Greenland.

As the spawning stock biomass in 2015 is below the trigger reference point of 5 million tonnes, paragraph 3 of the management plan applies. This paragraph states that "*Should the SBB fall below the reference point of 5 million tonnes, the fishing mortality rate* *referred to 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 million tonnes. The basis for such adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at B_{pa} to 0.05 at B_{lim}"*. The resulting fishing mortality used for predicting the TAC in 2015 = 0.080 and the corresponding TAC in 2015 is 283013 tonnes. The expected remaining SSB in 2016 is about 3.2 million tonnes.

Due to the quota flexibility in the management plan each Party may transfer up to 10% of the quota allocated to the Party in 2014 to 2015. Both EU and Norway indicated that they might use this clause in 2014. Therefore two additional catch options for the year 2014 are presented along with the standard option described above. It was assumed the Faroes, Iceland and Russia would take their quotas in 2014, and that EU and Norway would have the possibility to use this clause. A transfer of 10% of the catches for EU and Norway in 2014 corresponds to a decrease of 6% of the total assumed catches in 2014. Just for exploration a transfer of 20% for the same Parties was assumed, corresponding to a 13% decrease of the total assumed catches in 2014. Both of these options had only minor influence on the TAC in 2015 and the SSB in 2016 (table 7.10.2.2 b and c).

7.11 Uncertainties in assessment and forecast

7.11.1 Uncertainty in the assessment

The population dynamics of Norwegian spring spawning herring is characterized by occasional strong year classes that at turns dominate the stock. The occurrence of such high recruitment is impossible to foresee, and this increases the uncertainty in the assessment of this stock. This characteristic population structure also seems to have consequences for how well the surveys represent the overall stock – in the presence of strong year classes they are also dominating the survey sampling. There seems to be marked changes in the survey catchability, the stock at times appearing to be more easily available for the survey leading to discrepancies between the signal given by the survey and the one given by catch statistics. This obviously increases the uncertainty in the assessment. Exploratory runs conducted (ICES, 2013) where the survey 5 catchability was changed for the period where we have a reason to assume higher catchability show smaller retrospective pattern in the latest years, which can be considered as decreasing the uncertainty of the assessment.

Final assessment in 2014 includes an updated algorithm for estimating the terminal F values for year classes where no supporting data is available, according to a decision made in WGWIDE 2013. In these cases there is no information from the surveys and the catch statistics have a lot of stochastic noise. This update significantly reduced the uncertainty in the assessment, as it makes it more robust to the noise caused by small year classes entering age 14.

7.11.2 Uncertainty in the forecast

In the past, the retrospective behaviour of the assessment, which is the basis for the forecast, has contributed to the uncertainty in the forecast and predicted catches have been taken with a higher fishing mortality than intended. This retrospective behaviour of the assessment is still present but is less between in the assessments in 2012 and 2013 compared to previous years. The present assessment is quite similar to last years.,

There is little uncertainty about the fact that year classes 2011-2012 are low. The 0-group survey in the Barents Sea in the autumn 2013 indicated an abundant 2013 year class but the first reliable survey estimates of the strength of the year class can not be expected to appear until surveyed at age-1 in the autumn 2014. However, recent recruitment estimates do not have a large influence on the predicted yields and SSBs in the short-term forecasts. The fishery is mainly concentrating on the older age groups, which is apparent from the catch composition and the exploitation patterns in recent years. Assumptions on the actual size of recent year classes have little impact on the prediction of the catch and the SSB in the projected period.

Uncertainty in the forecast arises from the assumption of the catch which will be taken in the intermediate year in the forecast (2014). In previous years it was assumed that the agreed TAC, following from the management plan, will be taken in the intermediate year. This assumption appeared to be realistic. In 2013 and 2014, however, the Coastal States did not agree on a share of the stock with the consequence that the sum of the quota of all participants in the fishery was higher than the TAC indicated by the management plan. In the forecast it has been assumed that the sum of the national quota will be taken in 2014.

7.12 Comparison with previous assessment and forecast

A comparison between the assessments 2008—2014 is shown in Figure 7.12.1. The assessment in 2014 was conducted in the same way as last year.

This year's assessment is consistent with last years' assessment. Fishing mortality is estimated slightly higher and SSB slightly lower tan last year. The table below shows the SSB (thousand tones) in 2013 and F in 2012 estimated in 2013 and 2014.

	ICES2013	WG2014	%difference
SSB(2013)	5 006	4 726	-6%
F(2012)	0.144	0.147	+2%

The observed decline in the stock is consistent with previous assessments and forecasts. Last year it was expected that the SSB in 2014 would decline to 4.123 million tonnes compared to this year's estimate of 4.066 million tonnes. In the forecast for 2015, paragraph 3 of the Management Agreement has been applied for the 2nd time. This paragraph applies when the SSB is estimated below B_{pa}.

7.13 Management plans and evaluations

The long term management plan of Norwegian spring spawning herring (re-evaluated in 2013) 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 present management plan is described in section 7.2. A brief history of it is in the stock annex. In general, the stock has been managed in compliance with the management plan. However, the realized fishing mortalities have been higher than intended under the plan due to the persistent overestimation of the stock during the last years, on average by 20% (ICES 2013d OR section 7.11.1). It is estimated that with the current management plan, the short-term probability of SSB < B_{lim} increases from 0.061 with no bias to 0.6 when a 20% bias is included (WKBWNSSH 2013).

7.14 Management considerations

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 has produced a number of strong year classes which lead to an increase in SSB. The SSB for the year 2009 was estimated at its highest level in the last 20 years. Since 1999 catches have been regulated through an agreed management plan. The management plan is considered to be precautionary. However, since 2013, total declared catches are higher than the management plan.

In the absence of strong year classes after 2004, the stock has declined since 2009 and is expected to decline further in the near future even when fishing according to the management plan. Norwegian spring spawning herring mature between age 4 and 6. This means that it will take at least 4 years after they are born until they can contribute to an increase in the SSB. Surveys carried out in recent years in the Norwegian Sea and Barents Sea show no signs of new strong year classes in the period 2005—2012. The 0-group index from the Barents Sea in 2013 was well above average, but there is high uncertainty associated with this index.

The short term prognoses indicate a decline of SSB from 4 million tonnes in 2014 to 3.5 and 3.3 million tonnes in 2015 and 2016, respectively, assuming that declared catches will be taken in 2014 and exploitation in 2015 is according the management plan. SSB in 2015 is below B_{pa} and $B_{trigger}$. In that situation, article 3 of the management plan will be applied, to set TACs for 2015 and future years as long as SSB remains below B_{pa}. Given the 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 appear and recruit in the spawning stock.

The results of the evaluation of a management plan are conditional to 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. However, the present extended period of low recruitment is an exceptional situation for this stock but may continue for a number of years. 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 2013, a lack of agreement by the Coastal States on their share in the TAC has lead to unilateral set quota's which together are higher than the TAC indicated by the management plan. If this situation continues, the high catches will accelerate the present decline of the stock and increase the risk of a depletion of the stock.

In recent years the distribution area of mackerel has expanded to the north and west and overlaps the distribution area of the herring in summer. As a consequence mackerel catches have been taken in that area as by-catch in the herring fisheries and in directed and mixed fisheries.

7.15 Regulations and their effects

The NSSH has been fished moderately for the last six years with an intended fishing mortality of 0.125. This is in accordance with the international management plan and below F_{pa}. Thus the stock is moderately harvested as compared to most other stocks.

7.16 Ecosystem considerations

The Norwegian spring-spawning herring is characterized by large dynamics with regard to migration pattern. This applies to the wintering, spawning and feeding area. Juvenile and adults of this stock form an important part of the ecosystems in the Barents Sea, the Norwegian Sea, and the Norwegian coast. The herring stock is a significant part of the ecosystem in Nordic Seas, both as predator on zooplankton but also as food resource to higher trophic levels (e.g. cod, saithe, seabirds, and marine mammals).

Compare to the early 2000s, the older part of the herring stock have had more westerly feeding migration pattern in recent years according to the IESNS survey in May (ICES 2014c), which has been more pronounced in July/August according to the IESSNS survey (Nøttestad *et al.* 2014). With the absent of large recruiting year classes in the stock in recent years and thereby small amount of young herring, less amount have been feeding in the northeastern part of the Norwegian Sea. Thus herring have been mainly found in the fringe of the Norwegian Sea; i.e. from north of the Faroese, the east and northeast Icelandic area and north in the Jan Mayen area, with negligible concentrations in the central areas and small in the eastern areas. Whether this distribution pattern is a response to feeding competition with mackerel, which is distributed over the whole Norwegian Sea and adjacent waters (Nøttestad *et al.* 2014), is unknown. A spatial overlap of herring and mackerel has been, large in the southern most areas of the herring distribution, but less further north (e.g. in the Jan Mayen area), even if the overlap was less pronounced 2014 compared to preceding two years (Nøttestad *et al.* 2014). Spatial overlap between herring and mackerel causes bycatch of mackerel in the targeted herring fishery and vice versa in the mackerel fishery. In addition, fishery patterns suggest that herring appears to reside longer through out the autumn in the south-western area close to Faroe Islands.

Analyses of stomach content of herring and mackerel overlapping spatially show that they are competing for food to some extent (Debes *et al.* 2012; Langøy *et al.* 2012; Óskarsson *et al.* 2012). Since mackerel is more effective feeder as for example indicated by the stomach content weight, herring might be partly outcompeted by the faster and more efficient mackerel in areas where they co-exist. Thus, the competition could be forcing the herring to the fringe of Norwegian Sea, though also higher zooplankton biomass there (Nøttestad *et al.* 2014) could attract the herring.

The average biomass of zooplankton in the total area in May had a decreasing trend from around 2002 until 2009, but an upward trend since then and is now at similar level as prior to the decline (ICES 2014c). An upward trend of zooplankton abundance is also observed in the IESSNS surveys in the Norwegian Sea for the years 2011—2014 (Nøttestad *et al.* 2014). At the same time (2011—2014), weight-at-age (this report) and length-at-age (ICES 2014b) in the stock are showing increasing trend. Thus, there are neither signs that the Norwegian Sea is being overgrazed at present by the pelagic fish stocks in the area, nor that the herring stock is suffering from a lack of food. If the increase in zooplankton is related to decreasing stock size of herring is unknown but will be explored further by WGINOR. Further work on the zooplankton index is also needed and is planned to be addressed by WGINOR (ICES 2014b) as well as exploring the biological and stock related variables of herring and other pelagic fish stocks in relation to environmental and ecological variables. It involves revision of the data and producing indices for the different areas, as well as explorations of their relation to growth, abundance and spatial distribution of pelagic fish stocks feeding in the area.

7.17 Changes in fishing patterns

No major changes were observed in the fishing patterns in 2013 relative to recent years (see section 7.3). Minor changes observed include an extended period of the fishery in the southern and south-western areas in the Norwegian Sea during in 3rd and especially 4th quarters. Minor changes observed include more easterly distributed catches in the fourth quarter.

Mixture of mackerel and herring was again apparent in the 2013 summer fishery of the Icelandic and Faroese fleets, but the preliminary information from the fishery in 2014 suggests less overlap between the two species.

7.18 Changes in the environment

In the Norwegian Sea, where the herring stock is grazing, the two main features of the circulation are the Norwegian Atlantic Current (NWAC) and the East Iceland Current (EIC). The NWAC with its offshoots forms the northern limb of the North Atlantic current system and carries relatively warm and salty water from the North Atlantic into the Nordic Seas. The EIC, on the other hand, carries Arctic waters.

The Arctic front is a central feeding area for Norwegian spring-spawning herring. During periods when the Arctic front is shifted westwards it is likely that the part of the stock feeding in the western Norwegian Sea will also be shifted westward. In May 2014, the Arctic front was encountered slightly below 65°N east of Iceland extending eastwards towards the 0° Meridian where it turned almost straight northwards up 70°N. The front was visible throughout the observed water column. The warmer North Atlantic water formed a broad tongue that stretched far northwards along the Norwegian coast with temperatures > 7 °C to 70° N in the surface layers and to 68 ° N at 200 m depth (ICES 2014c).

Relative to a 19 years long-term mean, from 1995 to 2013, the temperature at 20 m depth northeast of Iceland was considerable higher in 2014 compared to the long-term mean, or up to 2°C warmer. At deeper depths the difference between 2014 and the long term mean was smaller. In general, at 200 m and shallower depths the western part of the Norwegian Sea and the Iceland Sea was somewhat warmer than the long-term mean (ICES 2014c). This general pattern was also observed in IESSNS in July-August 2014 from CTD data (Nøttestad *et al.* 2014). Moreover, SST anomaly for July (satellite data relative to a 20 year average) showed that the surface layer in the northeastern part of the North Atlantic was warm in 2014. The SST was more than 3°C warmer north of Iceland and between 2—2.5°C warmer in the central Norwegian Sea. This is in contrast to 2013 when the surface layer was close to the long-term average. The anomaly pattern in 2014 resembles that of 2012 with the exception that in 2012 the Irminger Sea was considerably (more than 3°C) warmer than the average (Nøttestad *et al.* 2014).

Relative to an 16 years long-term mean, from 1995 to 2010, the average temperatures 0—200 m depth north of Iceland and northeast of the Faroese were considerable higher (~1°C) in 2013 compared to the long-term mean (ICES 2013c). At the surface this difference was larger north of Iceland but was less northeast of the Faroese. At larger depths, the anomaly northeast of the Faroese was higher or up to 2°C at 300m depth. In the central Norwegian Sea the temperature was mainly close to or lower than the long term mean at all depths. A comparison of the sea temperatures in 2013 and 2012 showed particularly warmer waters northeast of the Faroese in 2013, while colder waters (0.5° - 0°C) in the central Norwegian Sea.

7.19 Recommendation

In the last years there have been concerns regarding age reading of herring, because the age distribution from the different participants have showed differences. This is also the case in 2014. Partly, the differences may reflect differing spatial distribution of age groups, and partly, they may reflect variable growth conditions for the stock, and consequently growth rate as seen on the fish scales and otoliths. In spring 2014 an otolith and scale exchange was conducted, as was suggested by the IESNS survey group in last year's survey report to address these issues. The otolith exchange was done in spring 2014 and reported in June 2014 (Godiksen 2014).

The results show that the percentage agreement in all the comparisons in the exchange was quite low compared to what could be expected. The results comparing age readings of the readers reading for assessment purposes the percent agreement was 69.1% with a CV of 9.4%. Further there was a trend by most readers in underestimating the otoliths older than 9 years modal age, while scale readings tend to overestimate these age classes. They concluded that it was important to continue this type of as a large scale exchange including both images and the real structures of both otoliths and scales from the same fish. The WGWIDE recommends that an age reading workshop as stated above on NSS herring be held as soon as possible.

7.20 References

Debes, H., Homrum, E., Jacobsen, J. A., Hátún, H., and Danielsen, J. 2012. The feeding ecology of pelagic fish in the southwestern Norwegian Sea – Inter species food competition between herring (*Clupea harengus*) and mackerel (*Scomber scombrus*). ICES CM 2012/M:07. 19 pp.

Godiksen, J.A. 2014. Report of the international Norwegian spring spawning herring (Clupea harengus) otolith and scale exchange 2014. Institute of Marine Research, Bergen, Norway.

ICES 2014c. International ecosystem survey in the Nordic Sea (IESNS) in April-June 2014. Working document to Working Group on International Pelagic Surveys (WGIPS). Copenhagen, Denmark, June 2014. 30 pp.

ICES. 2013d. Report of the Blue Whiting/Norwegian Spring-Spawning (Atlanto-Scandian) Herring Workshop (WKBWNSSH). ICES 2013/ACOM:69

Langøy, H., Nøttestad, L., Skaret, G., Broms, C. and Fernö, A. 2012. Overlap in distribution and diets of Atlantic mackerel (*Scomber scombrus*), Norwegian spring- spawning herring (*Clupea harengus*) and blue whiting (*Micromesistius poutassou*) in the Norwegian Sea during late summer. Marine biology research, 8: 442-460.

Nøttestad, L., Salthaug, A., Johansen, G.O., Utne, K.R., Anthonypillai, R., Tangen, Ø., Óskarsson, G.J., Sveinbjörnsson, S., Jónsson, S., Debes, H., Mortensen, E., Smith, L, Ólafsdóttir, A., and Jacobsen, J.A., 2014. Cruise report from the coordinated ecosystem survey (IESSNS) with M/V "Brennholm", M/V "Vendla", M/V "Finnur Fríði" and R/V "Arni Fridriksson" in the Norwegian Sea and surrounding waters, 2 July - 12 August 2014. Working Document to the ICES WGWIDE 2014. 49 pp.

Óskarsson G.J., Sveinbjörnsson, S., Guðmundsdóttir, Á. and Sigurðsson, Þ. 2012. Ecological impacts of recent extension of feeding migration of NE-Atlantic mackerel into the ecosystem around Iceland. ICES CM 2012/M:03. 25 pp.

Table 7.5.1.1 Total catch 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 (Scotland)	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
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

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Netherlands	Greenland	UK (Scotland)	Germany	France	Poland	Sweden	Total
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

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

Table 7.5.1.2. Norwegian spring spawning herring. Catch and sample data provided by Working Group members, and samples allocated to unsampled catches in Intercatch.

Country	Div.	Quarter	Catch (t)	No of age samples	Samples allocated ('fill-in')
DE	2a	3	1444.3		RU_2a_q3, IS_2a_q3, FO_2a_q3
DE	2a	4	477.9		IS_2a_q4, NO_2a_q4, RU_2a_q4, DK_2a_q4, FO_2a_q4
DE	2b	4	2321.6	4	
DK	2a	1	14759.8	2	
DK	2a	3	0.9		RU_2a_q3, IS_2a_q3, FO_2a_q3
DK	2a	4	2398.8	1	
FO	2a	2	1673.1	1	
FO	2a	3	43094.1	6	
FO	2a	4	30273.3	2	

Country	Div.	Quarter	Catch (t)	No of age samples	Samples allocated ('fill-in')
FO	4a	2	33.0		FO_2a_q2, IS_2a_q2
FO	5a	2	30.0		IS_5b_q2, IS_5a_q2
FO	5b	1	0.0		IS_5b_q2, IS_5a_q2
FO	5b	2	3784.8		IS_5b_q2, IS_5a_q3
FO	5b	3	15048.6		IS_5a_q3
FO	5b	4	11101.0		IS_5a_q4
GL	2a	3	830.0		RU_2a_q3, IS_2a_q3, FO_2a_q3
GL	2a	4	7780.0		IS_2a_q4, NO_2a_q4, RU_2a_q4, DK_2a_q4, FO_2a_q4
GL	5a	1	2.5		IS_5b_q2, IS_5a_q2
GL	5a	4	1300.0		IS_5a_q4
GL	XIVa	3	1368.9		IS_5a_q3
GL	XIVa	4	506.3		IS_5a_q4
IE	2a	1	3593.6	2	
IE	4a	4	221.2		IS_2a_q4, NO_2a_q4, RU_2a_q4, DK_2a_q4, FO_2a_q4
IS	2a	2	342.0	1	
IS	2a	3	22571.0	18	
IS	2a	4	23279.0	11	
IS	5a	2	442.0	1	
IS	5a	3	41434.0	62	
IS	5a	4	2602.0	6	
IS	5b	2	59.0	1	
NL	2a	4	2338.5	6	
NL	2b	4	3287.4		NL_2a_q4
NO	2a	1	127180.0	73	
NO	2a	2	1005.0		NO_2a_q1
NO	2a	3	2802.0	21	
NO	2a	4	225322.0	50	
NO	4a	1	3143.0		NO_2a_q1
NO	4a	2	6.0		FO_2a_q2, IS_2a_q2
RU	1	2	16.0		RU_2b_q3
RU	2a	1	8510.0	12	

Country	Div.	Quarter	Catch (t)	No of age samples	Samples allocated ('fill-in')
RU	2a	2	655.0	12	
RU	2a	3	13269.0	65	
RU	2a	4	22776.0	17	
RU	2b	3	15225.0	4	
RU	2b	4	16856.0	24	
RU	XIVa	3	1154.0		IS_5a_q3
RU	XIVa	4	60.0		IS_5a_q4
SE	2a	3	23.0		RU_2a_q3, IS_2a_q3, FO_2a_q3
UKS	2a	1	8342.1		NO_2a_q1, DK_2a_q1

Table 7.5.1.3. Norwegian spring spawning herring. Comparison of catch at age and weight at age in 2013 estimated with the SALLOC software and Intercatch.

	Catch numbers (thousands)			Catch weights (kg)		
	SALLOC	Intercatch	Difference (%)	SALLOC	Intercatch	Difference (%)
1	1.2	1.20	-0.34	0.0476	0.0476	0.04
2	20715.36	20715.41	0.00	0.1631	0.1631	-0.01
3	60565.76	60364.15	0.33	0.2372	0.2370	0.08
4	276568.56	276900.65	-0.12	0.2763	0.2762	0.04
5	71069.05	71286.51	-0.31	0.3002	0.3000	0.05
6	112419.29	112558.25	-0.12	0.3315	0.3313	0.07
7	283440.97	283657.85	-0.08	0.3391	0.3389	0.06
8	242017.33	242242.93	-0.09	0.3514	0.3511	0.08
9	591719.69	591912.14	-0.03	0.3574	0.3572	0.06
10	169468.3	169524.71	-0.03	0.3703	0.3700	0.09
11	145271.31	145317.75	-0.03	0.3733	0.3731	0.06
12	25010.84	24936.17	0.30	0.3938	0.3937	0.04
13	10631.47	10613.94	0.16	0.3906	0.3905	0.02
14	9733.47	9725.22	0.08	0.3888	0.3888	0.00
15	2293.78	2299.15	-0.23	0.3675	0.3674	0.03

Table 7.5.3.1. 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
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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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

Table 7.5.4.1. 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							
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								

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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	
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

	age														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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	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	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	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	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	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

Table 7.5.4.2. 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
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

	AGE														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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

**** 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 7.5.7.4.1. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. No survey in 2003, 1990—2002. See footnotes. Shaded data are not used in the TASACS assessment. ***Survey 4.***

	survey 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[1]	0.1	0.25	1.8	0.6	0.03
1997[2]	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[3]					
2004[3]					
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[4]	0.043	0.38	0.2	0.28	0
2009	0.19	0.47	0.67	0.39	0.41
2010	7.724	1.966	0.091	0	0
2011	0.6	3.6	0.02	0	0
2012	0.370	0.120	0	0	0
2013	0.036	1.912	0.377	0.024	
2014	5.876	2.185	2.156	0.242	0.045

[1] Average of Norwegian and Russian estimates

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

[3] No surveys

[4] Not a full survey

Table 7.5.7.4.2. Norwegian spring spawning herring. Estimates from the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions. Biomass in thousands. Biomass in thousands. Shaded data are not used in the TASACS assessment. ***Survey 5.***

	survey 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	1193	587	8332	8270	16345	1381	1920	3958	2500	416	242	159	217	408	45928	9996
2009	0	410	2316	2314	13545	8937	12025	1335	1334	2696	1488	208	175	65	232	47080	10406
2010	81	364	1195	3329	2156	8282	4146	4519	390	513	804	331	45	17	25	26857	5777
2011	0	1058	1576	1753	4550	2692	8693	2879	4830	572	898	837	281	13	34	30666	7298
2012	0	1588	2995	415	844	1835	2321	4346	1890	2338	329	615	344	112	54	20026	4629
2013	0	395	653	2900	496	1120	1923	2794	4311	2600	1782	538	573	209	62	20356	5291
2014	62	673	1632	1106	3146	548	930	2161	2357	3667	1656	1062	489	192	193	19874	5064

Table 7.5.7.5.1. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in August-October. Data in black boxes used in the assessment. *Survey 6.*

survey 6			
	Age		
Year	1	2	3
2000	14.7	11.5	0
2001	0.5	10.5	1.7
2002	1.3	0	0
2003	99.9	4.3	2.5
2004	14.3	36.5	0.9
2005	46.4	16.1	7.0
2006	1.6	5.5	1.3
2007	3.9	2.6	6.3
2008	0.03	1.62	3.99
2009	1.5	0.4	
2010	1.0	0.3	
2011	0.10	1.50	0.01
2012	2.0	1.1	
2013	7.7	5.0	

Table 7.5.7.5.2. Norwegian spring-spawning herring. Abundance indices for 0-group herring since 1980 in the Barents Sea, August-October. This index has been recalculated since 2006. Data in shaded cells are not used in the assessment *Survey 7*.

survey 7	
Year	Abundance index
1980	4
1981	3
1982	202
1983	40557
1984	6313
1985	7237
1986	7
1987	2
1988	8686
1989	4196
1990	9508
1991	81175
1992	37183
1993	61508
1994	14884
1995	1308
1996	57169
1997	45808
1998	79492
1999	15931
2000	49614
2001	844
2002	23354
2003	28579
2004	133350
2005	26332
2006	66819
2007	22481
2008	15727
2009	18916
2010	20367
2011	13674
2012	26480
2013	70972

Table 7.5.7.6.1. Norwegian Spring-spawning herring. The indices for herring larvae on the Norwegian shelf for the period 1981-2007 ($N*10^{-12}$). Data in shaded cells are not used in the assessment. ***Survey 8.***

survey 8		
Year	Index1	Index 2
1981	0.3	
1982	0.7	
1983	2.5	
1984	1.4	
1985	2.3	
1986	1	
1987	1.3	4
1988	9.2	25.5
1989	13.4	28.7
1990	18.3	29.2
1991	8.6	23.5
1992	6.3	27.8
1993	24.7	78
1994	19.5	48.6
1995	18.2	36.3
1996	27.7	81.7
1997	66.6	147.5
1998	42.4	138.6
1999	19.9	73
2000	19.8	89.4
2001	40.7	135.9
2002	27.1	138.6
2003*	3.7	18.8
2004	56.4	215.1
2005	73.91	196.7
2006	98.9	389.0
2007**	90.6	
2008	107.9	393.3
2009	8.4	53.8
2010	42.7	140.2
2011	73.4	192.1
2012	65.6	224.4
2013	71.6	345.3
2014	75.9	

Index 1. The total number of herring larvae found during the cruise.

Index 2. Back-calculated number of newly hatched larvae with 10% daily moratlity. The larval age is estimated from the duration of the yolksac stages and the size of the larvae.

*** Poor weather conditions and survey was late in April**

**** only representative for the area 62-66°N**

Table 7.7.5.1. 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															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1950	0	0	0	0	0.2	0.8	1	1	1	1	1	1	1	1	1	1
1951	0	0	0	0	0.2	0.8	1	1	1	1	1	1	1	1	1	1
1952	0	0	0	0	0.1	0.6	1	1	1	1	1	1	1	1	1	1
1953	0	0	0	0	0.3	0.4	0.9	1	1	1	1	1	1	1	1	1
1954	0	0	0	0	0.1	0.7	0.9	1	1	1	1	1	1	1	1	1
1955	0	0	0	0.1	0.4	0.4	1	1	1	1	1	1	1	1	1	1
1956	0	0	0	0	0.5	0.7	0.6	1	1	1	1	1	1	1	1	1
1957	0	0	0	0	0.3	0.8	0.8	0.7	1	1	1	1	1	1	1	1
1958	0	0	0	0	0.3	0.5	0.9	0.9	1	1	1	1	1	1	1	1
1959	0	0	0	0	0.7	0.8	1	0.9	1	1	1	1	1	1	1	1
1960	0	0	0	0	0.3	0.9	0.9	1	1	1	1	1	1	1	1	1
1961	0	0	0	0	0.1	0.8	1	0.9	1	1	1	1	1	1	1	1
1962	0	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1
1963	0	0	0	0	0.1	0.4	1	1	1	1	1	1	1	1	1	1
1964	0	0	0	0	0.1	0.4	0.8	1	1	1	1	1	1	1	1	1
1965	0	0	0	0	0.5	0.4	0.9	0.8	1	1	1	1	1	1	1	1
1966	0	0	0	0	0.5	0.7	0.9	1	1	1	1	1	1	1	1	1
1967	0	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1
1968	0	0	0	0	0	0.7	0.9	1	1	1	1	1	1	1	1	1
1969	0	0	0	0.1	0.2	0.3	1	1	1	1	1	1	1	1	1	1
1970	0	0	0	0	0.4	0.3	0.4	1	1	1	1	1	1	1	1	1
1971	0	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1
1972	0	0	0	0	0.4	0.3	1	1	1	1	1	1	1	1	1	1
1973	0	0	0	0.1	0.6	1	1	1	1	1	1	1	1	1	1	1
1974	0	0	0	0	0.6	0.9	1	1	1	1	1	1	1	1	1	1
1975	0	0	0	0.1	0.5	0.9	1	1	1	1	1	1	1	1	1	1
1976	0	0	0	0.1	0.9	0.9	1	1	1	1	1	1	1	1	1	1
1977	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1	1
1978	0	0	0	0.2	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	0.9	1	1	1	1	1	1	1	1	1	1	1
1981	0	0	0	0.1	1	1	1	1	1	1	1	1	1	1	1	1
1982	0	0	0	0.1	0.8	1	1	1	1	1	1	1	1	1	1	1
1983	0	0	0	0.1	0.9	1	1	1	1	1	1	1	1	1	1	1
1984	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1	1
1985	0	0	0	0.1	0.8	0.9	1	1	1	1	1	1	1	1	1	1
1986	0	0	0	0	0.5	0.9	0.9	1	1	1	1	1	1	1	1	1
1987	0	0	0	0	0.1	0.8	0.9	0.9	1	1	1	1	1	1	1	1
1988	0	0	0	0	0.2	0.7	0.9	1	1	1	1	1	1	1	1	1
1989	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
1990	0	0	0	0.2	0.5	0.9	1	1	1	1	1	1	1	1	1	1

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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
2001	0	0	0	0	0.3	0.9	0.9	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
2003	0	0	0	0	0.2	0.7	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
2005	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1
2006	0	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1
2007	0	0	0	0	0.1	0.7	0.9	1	1	1	1	1	1	1	1	1
2008	0	0	0	0	0.1	0.6	0.9	1	1	1	1	1	1	1	1	1
2009	0	0	0	0	0.4	0.6	0.9	1	1	1	1	1	1	1	1	1
2010	0	0	0	0	0.4	0.8	0.9	1	1	1	1	1	1	1	1	1
2011	0	0	0	0	0.4	0.8	1	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
2013	0	0	0	0	0.4	0.8	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

Table 7.7.2.1. Norwegian spring-spawning herring. The stock summary of the exploratory TISVPA run. (R(0): recruits at age 0 in millions, B(0+) and SSB in thous. tonnes)

year	R(0)	B(0+)	SSB	F(5-14) weighted by abundance
1986	12605	1916	344	0.975
1987	10456	3311	385	0.268
1988	25613	3636	2113	0.044
1989	67814	4335	3425	0.028
1990	124850	4909	4093	0.020
1991	332243	5602	4018	0.022
1992	382331	6687	4092	0.025
1993	116671	7773	3968	0.060
1994	38173	8923	4096	0.125
1995	12234	9799	4121	0.210
1996	53194	9884	4739	0.176
1997	32777	9802	6114	0.168
1998	164100	8487	6796	0.142
1999	155360	9045	6985	0.173
2000	58368	8466	5893	0.200
2001	40268	7003	4783	0.173
2002	302522	6875	4062	0.189
2003	140437	8082	4369	0.154
2004	278988	9542	5159	0.134
2005	90019	9979	5097	0.185
2006	96853	10722	5086	0.198
2007	40757	10044	5348	0.181
2008	27902	10001	5705	0.234
2009	164567	9530	6746	0.214
2010	87549	8843	6618	0.216
2011	122801	8193	5870	0.151
2012	37	8314	5413	0.144
2013		8289	5395	0.126
2014		8003	5854	

Table 7.7.3.3.1. Norwegian spring spawning herring. Stock in numbers (billions).

	Age (in years)															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1988	26.068	4.006	1.627	3.494	0.731	14.032	0.046	0.013	0.012	0.027	0.012	0.008	0.006	0.004	0.003	0.001
1989	71.488	10.589	1.627	0.656	2.949	0.606	11.567	0.030	0.008	0.005	0.010	0.002	0.004	0.002	0.001	0.001
1990	109.322	29.060	4.304	0.645	0.562	2.535	0.516	9.655	0.023	0.006	0.004	0.005	0.001	0.003	0.002	0.002
1991	308.608	44.446	11.815	1.740	0.538	0.481	2.171	0.434	8.100	0.019	0.004	0.001	0.002	0.000	0.002	0.002
1992	367.743	125.471	18.068	4.801	1.490	0.461	0.413	1.855	0.366	6.769	0.014	0.003	0.001	0.001	0.000	0.003
1993	113.032	149.512	51.013	7.345	4.121	1.252	0.392	0.354	1.585	0.309	5.617	0.010	0.002	0.001	0.000	0.002
1994	38.651	45.951	60.787	20.736	6.296	3.448	0.996	0.329	0.301	1.337	0.249	4.454	0.008	0.002	0.001	0.002
1995	19.595	15.714	18.682	24.709	17.817	5.317	2.630	0.705	0.269	0.252	1.116	0.181	3.235	0.004	0.001	0.002
1996	58.595	7.967	6.389	7.595	21.214	15.014	3.998	1.672	0.392	0.217	0.202	0.896	0.078	1.938	0.000	0.002
1997	33.527	23.823	3.239	2.578	6.505	17.597	11.465	2.569	1.062	0.242	0.182	0.167	0.710	0.051	0.892	0.001
1998	208.090	13.631	9.686	1.303	2.098	5.348	13.480	8.019	1.505	0.611	0.151	0.138	0.114	0.527	0.026	0.425
1999	167.194	84.603	5.542	3.885	1.056	1.581	4.261	9.969	5.729	0.941	0.406	0.091	0.095	0.095	0.349	0.299
2000	57.634	67.976	34.397	2.250	3.216	0.876	1.236	3.269	7.091	3.851	0.540	0.251	0.065	0.045	0.075	0.406
2001	34.588	23.432	27.637	13.976	1.859	2.248	0.722	0.961	2.439	4.898	2.345	0.263	0.149	0.041	0.017	0.275
2002	355.123	14.063	9.527	11.235	11.934	1.451	1.539	0.585	0.738	1.824	3.437	1.548	0.158	0.107	0.032	0.200
2003	163.350	144.382	5.717	3.834	9.486	9.675	1.012	1.022	0.476	0.548	1.324	2.344	1.018	0.087	0.080	0.152
2004	286.094	66.413	58.699	2.322	3.230	7.864	7.650	0.708	0.724	0.388	0.403	0.938	1.491	0.673	0.039	0.178
2005	67.518	116.317	27.001	23.837	1.976	2.694	6.370	5.921	0.506	0.495	0.310	0.298	0.651	0.911	0.384	0.043
2006	73.226	27.451	47.291	10.965	20.102	1.613	2.161	4.886	4.233	0.322	0.312	0.231	0.196	0.431	0.464	0.236
2007	26.620	29.772	11.159	19.198	9.367	16.625	1.312	1.701	3.532	2.927	0.195	0.197	0.171	0.115	0.247	0.403
2008	16.645	10.823	12.101	4.532	16.316	7.722	12.635	0.988	1.239	2.364	2.045	0.124	0.146	0.133	0.076	0.401

	Age (in years)															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2009	53.913	6.767	4.375	4.841	3.867	13.532	6.024	8.745	0.665	0.828	1.490	1.417	0.079	0.092	0.092	0.265
2010	10.159	21.919	2.749	1.706	3.988	3.190	10.540	4.336	5.737	0.440	0.470	0.889	0.999	0.026	0.071	0.271
2011	28.169	4.130	8.863	1.078	1.374	3.238	2.569	8.084	3.072	3.618	0.216	0.237	0.449	0.694	0.011	0.242
2012	19.187	11.453	1.598	3.444	0.871	1.086	2.570	2.016	6.257	2.140	2.518	0.102	0.096	0.260	0.555	0.074
2013	130.288	7.801	4.655	0.642	2.768	0.703	0.823	1.950	1.491	4.692	1.550	1.835	0.039	0.041	0.164	0.529
2014		52.971	3.172	1.879	0.496	2.126	0.539	0.604	1.416	1.059	3.489	1.177	1.445	0.010	0.025	0.558

Table 7.7.3.3.2. Norwegian spring spawning herring. Fishing mortality.

	Age (in years)															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1988	0.001	0.001	0.009	0.020	0.038	0.043	0.253	0.360	0.750	0.875	1.475	0.500	0.920	1.221	0.897	0.897
1989	0.000	0.000	0.025	0.005	0.001	0.010	0.031	0.131	0.116	0.160	0.458	0.934	0.201	0.184	0.312	0.312
1990	0.000	0.000	0.006	0.032	0.005	0.005	0.023	0.026	0.062	0.316	0.928	0.682	1.856	0.070	0.557	0.557
1991	0.000	0.000	0.000	0.005	0.006	0.003	0.007	0.022	0.030	0.157	0.141	0.079	0.392	-1.000	0.131	0.131
1992	0.000	0.000	0.000	0.003	0.024	0.012	0.003	0.007	0.017	0.037	0.218	0.279	0.316	-1.000	0.140	0.140
1993	0.000	0.000	0.000	0.004	0.028	0.078	0.024	0.011	0.020	0.067	0.082	0.000	0.000	0.000	0.060	0.060
1994	0.000	0.000	0.000	0.002	0.019	0.121	0.196	0.052	0.030	0.031	0.168	0.170	0.469	0.375	0.226	0.226
1995	0.000	0.000	0.000	0.003	0.021	0.135	0.303	0.436	0.064	0.070	0.070	0.690	0.362	-1.000	0.336	0.336
1996	0.000	0.000	0.007	0.005	0.037	0.120	0.293	0.304	0.335	0.029	0.040	0.083	0.277	0.626	0.295	0.295
1997	0.000	0.000	0.011	0.056	0.046	0.117	0.208	0.385	0.403	0.317	0.127	0.235	0.148	0.517	0.593	0.593
1998	0.000	0.000	0.014	0.060	0.133	0.077	0.152	0.186	0.319	0.260	0.361	0.221	0.034	0.262	0.262	0.262

1999	0.000	0.000	0.001	0.039	0.037	0.096	0.115	0.191	0.247	0.406	0.331	0.189	0.605	0.086	0.318	0.318
2000	0.000	0.000	0.001	0.041	0.208	0.044	0.102	0.143	0.220	0.346	0.568	0.368	0.316	0.794	0.407	0.407
2001	0.000	0.000	0.000	0.008	0.098	0.229	0.060	0.114	0.141	0.204	0.265	0.359	0.188	0.098	0.232	0.232
2002	0.000	0.000	0.010	0.019	0.060	0.211	0.260	0.057	0.147	0.170	0.233	0.270	0.447	0.135	0.270	0.270
2003	0.000	0.000	0.001	0.021	0.038	0.085	0.208	0.195	0.053	0.158	0.195	0.302	0.264	0.648	0.116	0.116
2004	0.000	0.000	0.001	0.011	0.031	0.061	0.106	0.185	0.230	0.077	0.151	0.216	0.343	0.412	1.473	1.473
2005	0.000	0.000	0.001	0.021	0.053	0.071	0.115	0.186	0.301	0.313	0.142	0.269	0.262	0.525	0.441	0.441
2006	0.000	0.000	0.002	0.008	0.040	0.056	0.089	0.175	0.219	0.352	0.310	0.153	0.383	0.407	0.401	0.401
2007	0.000	0.000	0.001	0.013	0.043	0.124	0.134	0.167	0.252	0.209	0.302	0.150	0.102	0.261	0.333	0.333
2008	0.000	0.006	0.016	0.009	0.037	0.098	0.218	0.246	0.252	0.311	0.217	0.297	0.310	0.214	0.440	0.440
2009	0.000	0.001	0.042	0.044	0.042	0.100	0.179	0.272	0.264	0.417	0.366	0.200	0.962	0.116	0.126	0.126
2010	0.000	0.006	0.036	0.067	0.058	0.066	0.115	0.195	0.311	0.561	0.533	0.533	0.215	0.730	0.195	0.195
2011	0.000	0.049	0.045	0.064	0.086	0.081	0.092	0.106	0.212	0.213	0.601	0.760	0.397	0.073	1.075	1.075
2012	0.000	0.000	0.013	0.069	0.064	0.126	0.126	0.152	0.138	0.173	0.166	0.824	0.708	0.310	0.024	0.024
2013	0.000	0.000	0.007	0.107	0.114	0.116	0.159	0.171	0.193	0.146	0.126	0.089	1.198	0.332	0.066	0.066

Negative fishing mortality -1 means that the fishing mortality was not defined, see TASACS manual

Table 7.7.3.3.3 Norwegian spring spawning herring. Final stock summary table.

Summary	output					
Run	id:	20140828	114812.1			
Process:	Ordinary	assessment				
Model:	VPA					
Year	Recruit	TSB	SSB	Landings	Unweighted	Weighted F with stock numbers
	Age 0 in billions	Million tonnes	Million tonnes	tonnes	F5-14	WF5-14
1988	26.068	3.416	1.996	135301	0.730	0.049
1989	71.488	4.073	3.244	103830	0.254	0.031
1990	109.322	4.605	3.823	86411	0.452	0.022
1991	308.608	5.245	3.732	84683	0.107	0.024
1992	367.743	6.284	3.814	104448	0.114	0.028
1993	113.032	7.355	3.761	232457	0.034	0.066
1994	38.651	8.406	3.890	479228	0.184	0.133
1995	19.595	9.197	3.849	905501	0.274	0.236
1996	58.595	9.284	4.326	1220283	0.240	0.202
1997	33.527	9.171	5.537	1426507	0.305	0.190
1998	208.090	7.984	6.218	1223131	0.213	0.161
1999	167.194	8.808	6.334	1235433	0.258	0.199
2000	57.634	8.285	5.378	1207201	0.331	0.232
2001	34.588	6.869	4.371	766136	0.189	0.196
2002	355.123	7.077	3.786	807795	0.220	0.216
2003	163.350	8.508	4.392	789510	0.222	0.150
2004	286.094	10.318	5.389	794066	0.325	0.131
2005	67.518	10.841	5.419	1003243	0.262	0.176
2006	73.226	11.732	5.631	968958	0.255	0.185
2007	26.620	11.140	6.294	1266993	0.203	0.157
2008	16.645	11.017	6.872	1545656	0.260	0.196
2009	53.913	10.224	7.884	1687373	0.300	0.190
2010	10.159	8.724	7.388	1457014	0.345	0.198
2011	28.169	7.177	6.302	992998	0.361	0.150
2012	19.187	6.298	5.466	825999	0.275	0.151
2013	130.288	5.604	4.726	684743	0.260	0.147
2014		5.171	4.066			

The GM recruitment over the years 1988-2010 is 72 billion

Table 7.10.1.1 Norwegian Spring-spawning herring. Input to short-term prediction. Stock size is in millions and weight in kg.

2014								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of M bef. spaw.	Prop. of F bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	72000	0.90	0	0	0	0.001	0.000	0.000
1	52971	0.90	0	0	0	0.010	0.011	0.031
2	3172	0.90	0	0	0	0.044	0.028	0.129
3	1879	0.15	0	0	0	0.138	0.070	0.216
4	496	0.15	0.4	0	0	0.198	0.073	0.268
5	2126	0.15	0.8	0	0	0.274	0.098	0.291
6	539	0.15	1	0	0	0.301	0.134	0.313
7	604	0.15	1	0	0	0.326	0.179	0.328
8	1416	0.15	1	0	0	0.333	0.223	0.342
9	1059	0.15	1	0	0	0.339	0.302	0.352
10	3489	0.15	1	0	0	0.347	0.358	0.363
11	1177	0.15	1	0	0	0.344	0.481	0.371
12	1445	0.15	1	0	0	0.362	0.696	0.390
13	10	0.15	1	0	0	0.362	0.312	0.385
14	25	0.15	1	0	0	0.389	0.297	0.391
15	558	0.15	1	0	0	0.393	0.297	0.386

2015 and 2016								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of M bef. spaw.	Prop. of F bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	72000	0.90	0	0	0	0.001	0.000	0.000
1		0.90	0	0	0	0.010	0.011	0.031
2		0.90	0	0	0	0.044	0.028	0.129
3		0.15	0	0	0	0.138	0.070	0.216
4		0.15	0.4	0	0	0.196	0.073	0.268
5		0.15	0.8	0	0	0.266	0.098	0.291
6		0.15	1	0	0	0.293	0.134	0.313
7		0.15	1	0	0	0.308	0.179	0.328
8		0.15	1	0	0	0.319	0.223	0.342
9		0.15	1	0	0	0.332	0.302	0.352
10		0.15	1	0	0	0.345	0.358	0.363
11		0.15	1	0	0	0.352	0.481	0.371
12		0.15	1	0	0	0.381	0.696	0.390
13		0.15	1	0	0	0.372	0.312	0.385
14		0.15	1	0	0	0.389	0.297	0.391
15		0.15	1	0	0	0.393	0.297	0.386

Table 7.10.2.1. Norwegian spring spawning herring. Short term prediction.

a)
Basis:
SSB(2014)=4.066 million t
Landings (2014)=436 thous. t (sum of national quota)
Fw(2014)=0.107
SSB(2015)=3.502 million t
The fishing mortality applies according to the agreed management plan (F(management plan)) is 0.08

Rationale	Catch (2015)	Basis	F(2015)	SSB(2016)	%SSB char	%TAC change
Zero catch	0	F=0	0.000	3.437	-2	-100
Status quo	373	F(2014)	0.107	3.115	-11	-11
Agreed Management Plan	181	Management plan, if SSB < 2.5 mt	0.050	3.280	-6	-57
	216		0.060	3.250	-7	-48
	251		0.070	3.219	-8	-40
	283	Management plan	0.080	3.192	-9	-32
	318		0.090	3.162	-10	-24
	350		0.100	3.134	-11	-16
	434	Management plan, if SSB > 5.0 mt	0.125	3.062	-13	4
	512		0.150	2.995	-14	22
MSY	367	0.7*Fmsy	0.105	3.120	-11	-12

b)
Basis:
SSB(2014)=4.066 million t
Landings (2014)=409 thous. (sum of national quota decreased by 6%)*
Fw(2014)=0.100
SSB(2015)=3.527 million t
The fishing mortality applies according to the agreed management plan (F(management plan)) is 0.081

Rationale	Catch (2015)	Basis	F(2015)	SSB(2016)	%SSB char	%TAC change
	289		0.081	3210	-9	-31

*see chapter 7.4.2

c)
Basis:
SSB(2014)=4.066 million t
Landings (2014)=380 thous. (sum of national quota decreased by 13%)*
Fw(2014)=0.092
SSB(2015)=3.552 million t
The fishing mortality applies according to the agreed management plan (F(management plan)) is 0.082

Rationale	Catch (2015)	Basis	F(2015)	SSB(2016)	%SSB char	%TAC change
	293		0.082	3228	-9	-30

*see chapter 7.4.2

Landings weights in thousand tonnes, stock biomass weight in million tonnes.

F_w=Fishing mortality weighted by population numbers (age groups 5-14).

Table 7.10.2. 2 Norwegian spring-spawning herring. Detailed short term prediction

2014

Age	Stockno.	Stockno.	Biomass	Biomass	SSB	SSB	F	Catches in	Catches in
	1-Jan.	spawning time	1-Jan	spawning time	1-Jan	spawning time		numbers	weight
0	72000	72000	72	72	0	0	0.000	0	0
1	52971	52971	530	530	0	0	0.004	129	4
2	3172	3172	140	140	0	0	0.009	20	3
3	1879	1879	259	259	0	0	0.023	40	9
4	496	496	98	98	39	39	0.024	11	3
5	2126	2126	582	582	466	466	0.032	63	18
6	539	539	162	162	162	162	0.044	22	7
7	604	604	197	197	197	197	0.059	32	11
8	1416	1416	471	471	471	471	0.074	93	32
9	1059	1059	359	359	359	359	0.100	93	33
10	3489	3489	1211	1211	1211	1211	0.118	362	131
11	1177	1177	405	405	405	405	0.159	161	60
12	1445	1445	523	523	523	523	0.230	276	108
13	10	10	4	4	4	4	0.103	1	0
14	25	25	10	10	10	10	0.098	2	1
15	558	558	219	219	219	219	0.098	48	19
	142965	142965	5242	5242	4066	4066	0.107	1353	437
	(millions)	(millions)	(thous.)	(thous.)	(thous.)	(thous.)	WF5-14	(millions)	(thous.)

2015

Age	Stockno.	Stockno.	Biomass	Biomass	SSB	SSB	F	Catches in	Catches in
	1-Jan.	spawningtime	1-Jan	spawningtime	1-Jan	spawningtime		numbers	weight
0	72000	72000	72	72	0	0	0.000	0	0
1	29273	29273	293	293	0	0	0.003	50	2
2	21457	21457	944	944	0	0	0.007	93	12
3	1277	1277	176	176	0	0	0.016	19	4
4	1581	1581	309	309	124	124	0.017	25	7
5	417	417	111	111	89	89	0.023	9	3
6	1771	1771	519	519	519	519	0.031	50	16
7	444	444	137	137	137	137	0.042	17	6
8	490	490	157	157	157	157	0.052	23	8
9	1132	1132	376	376	376	376	0.070	71	25
10	825	825	285	285	285	285	0.083	61	22
11	2668	2668	938	938	938	938	0.112	262	97
12	864	864	329	329	329	329	0.161	120	47
13	988	988	368	368	368	368	0.072	64	25
14	8	8	3	3	3	3	0.069	0	0
15	455	455	179	179	179	179	0.069	28	11
	135651	135651	5195	5195	3502	3502	0.080	893	283
	(millions)	(millions)	(thous.)	(thous.)	(thous.)	(thous.)	WF5-14	(millions)	(thous.)

2016

Age	Stockno.	Stockno.	Biomass	Biomass	SSB	SSB	F	Catches in	Catches in
	1-Jan.	spawningtime	1-Jan	spawningtime	1-Jan	spawningtime		numbers	weight
0	72000	72000	72	72	0	0	0.000	0	0
1	29273	29273	293	293	0	0	0.002	44	1
2	11871	11871	522	522	0	0	0.006	45	6
3	8666	8666	1196	1196	0	0	0.014	113	24
4	1082	1082	212	212	85	85	0.015	15	4
5	1338	1338	355	355	284	284	0.020	24	7
6	351	351	103	103	103	103	0.027	9	3
7	1478	1478	456	456	456	456	0.036	49	16
8	367	367	117	117	117	117	0.045	15	5
9	401	401	133	133	133	133	0.061	22	8
10	908	908	313	313	313	313	0.072	59	21
11	653	653	230	230	230	230	0.097	56	21
12	2054	2054	782	782	782	782	0.141	251	98
13	633	633	235	235	235	235	0.063	36	14
14	791	791	308	308	308	308	0.060	43	17
15	372	372	146	146	146	146	0.060	20	8
	132237	132237	5473	5473	3192	3192	0.071	800	253
	(millions)	(millions)	(thous.)	(thous.)	(thous.)	(thous.)	WF5-14	(millions)	(thous.)

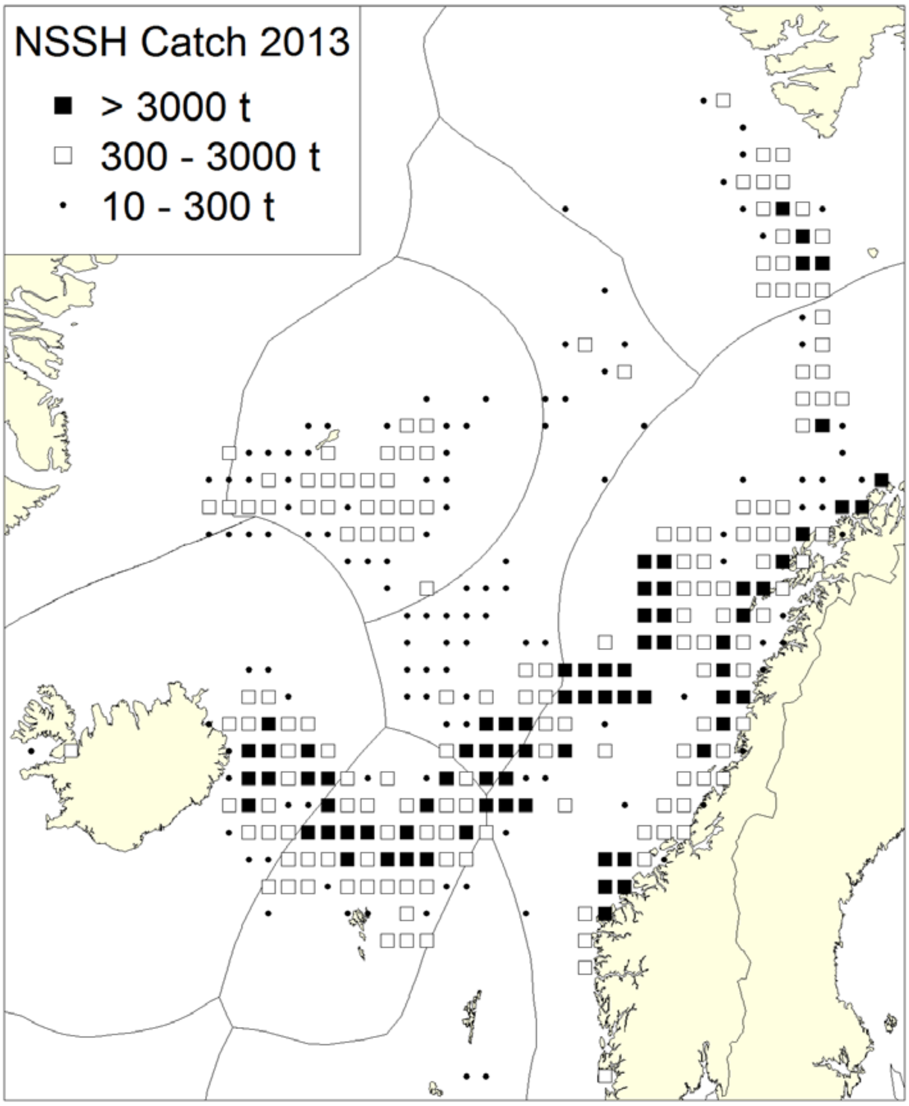


Figure 7.3.1.1. Total reported catches of Norwegian spring-spawning herring in 2013 by ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300–3000 t, and black squares > 3000 t.

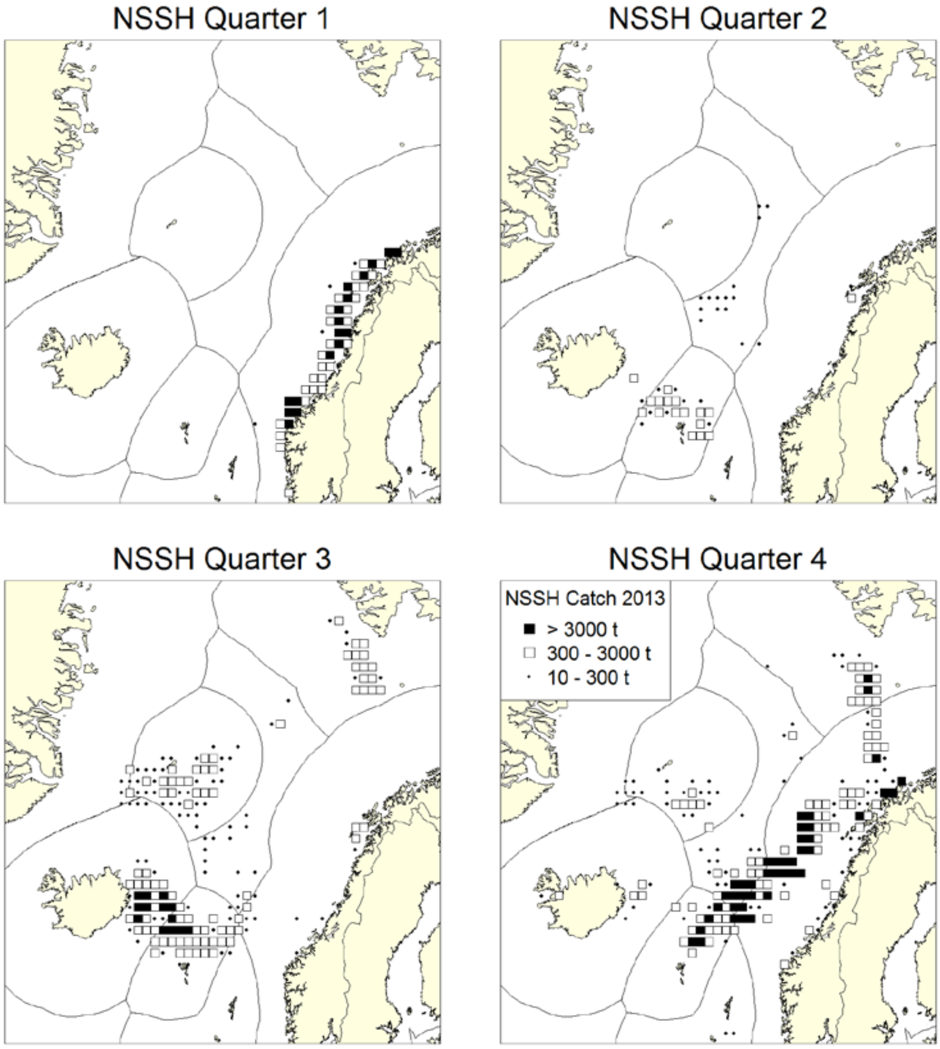


Figure 7.3.1.2. Total reported catches of Norwegian spring-spawning herring in 2013 by quarter and ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300–3000 t, and black squares > 3000 t.

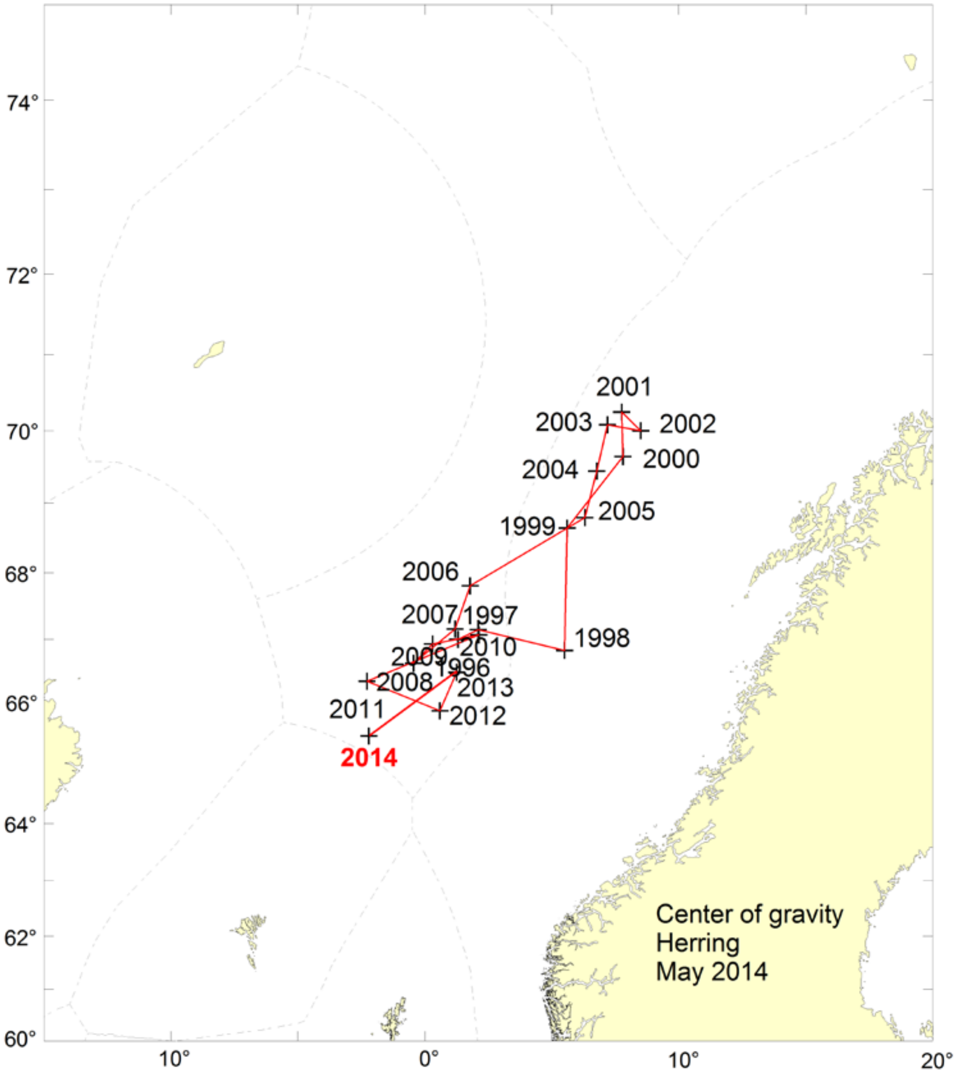


Figure 7.4.2.1 Norwegian spring spawning herring: Centre of gravity of herring during the period 1996-2014 derived from acoustic. Acoustic data from area II and III only, i.e. west of 20°E.

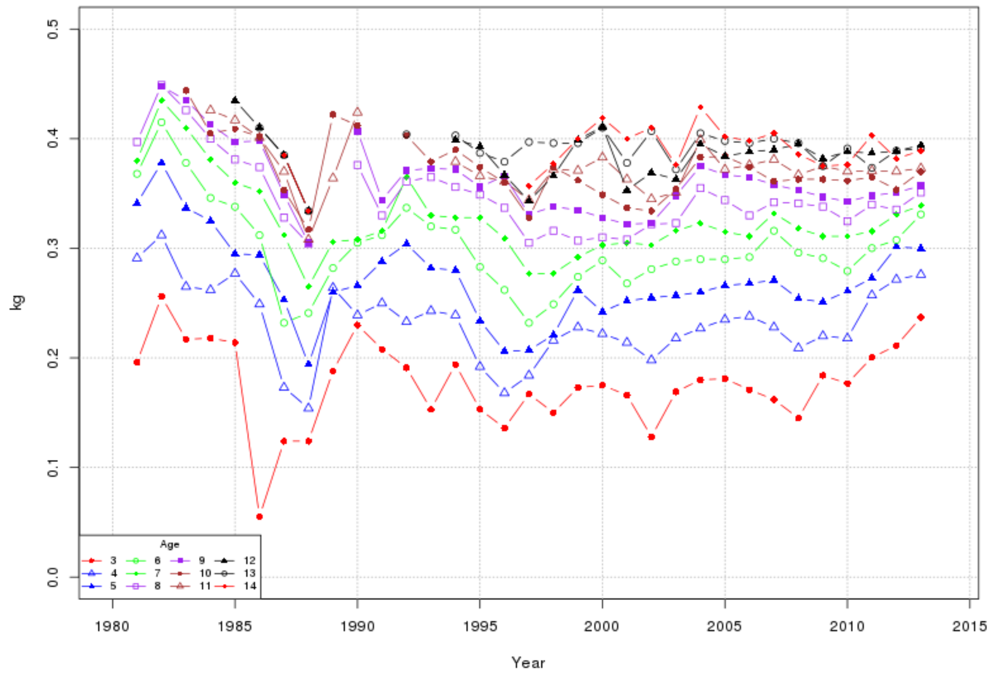


Figure 7.5.4.1. Norwegian spring spawning herring. Mean weight at age by age groups 3-14 in the years 1980-2013 in the catch (weight at age for zero catch numbers were omitted).

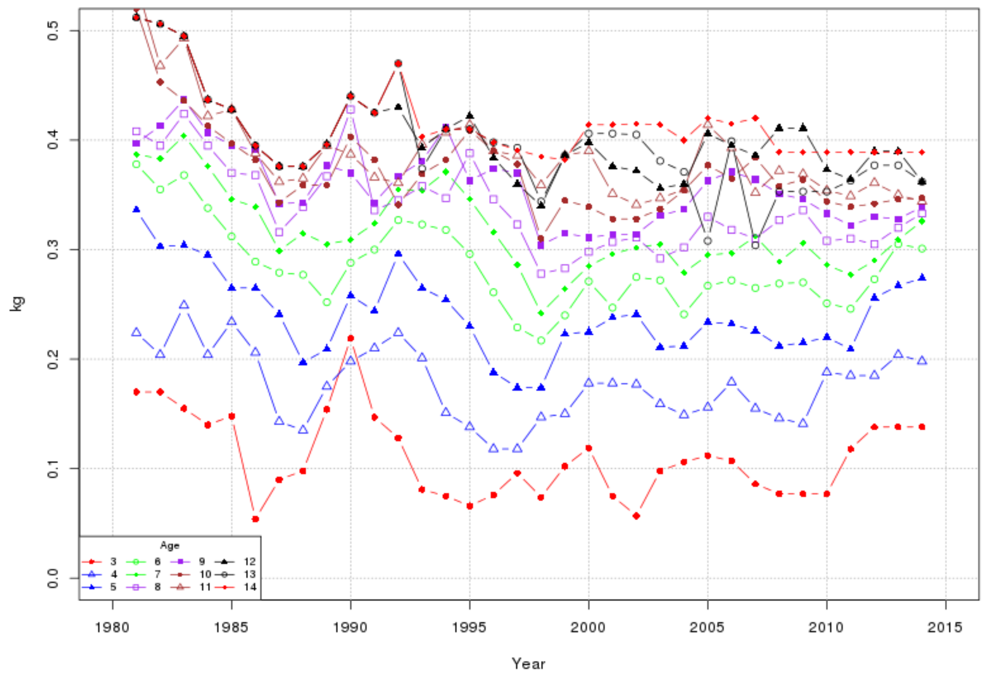


Figure 7.5.4.2. Norwegian spring-spawning herring. Mean weight at age in the stock 1981-2014.

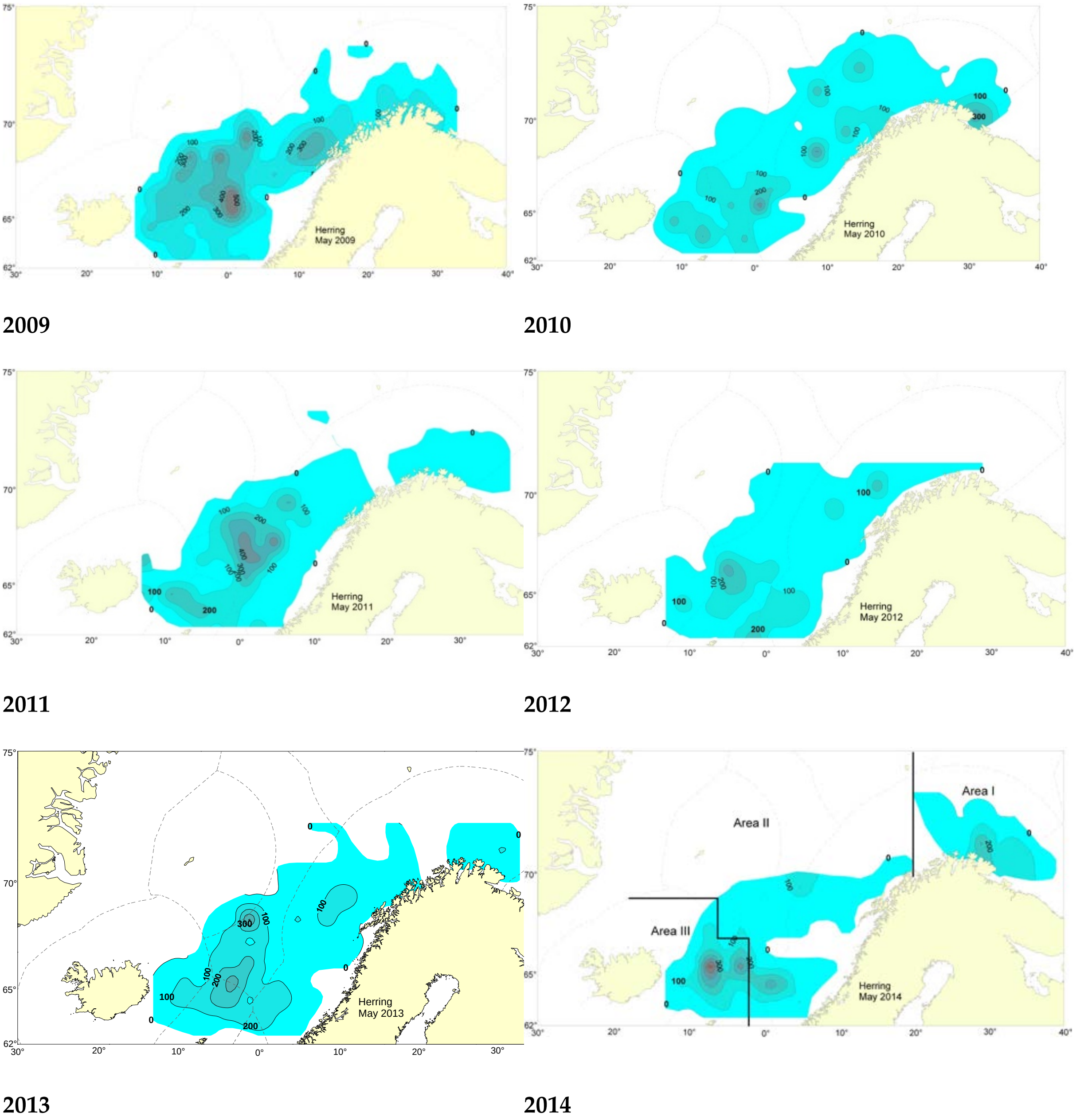


Figure 7.5.7.4.1. Norwegian Spring-Spawning herring. Schematic map of herring acoustic density (sA, m^2/nm^2) found during the survey in May 2009 to 2014.

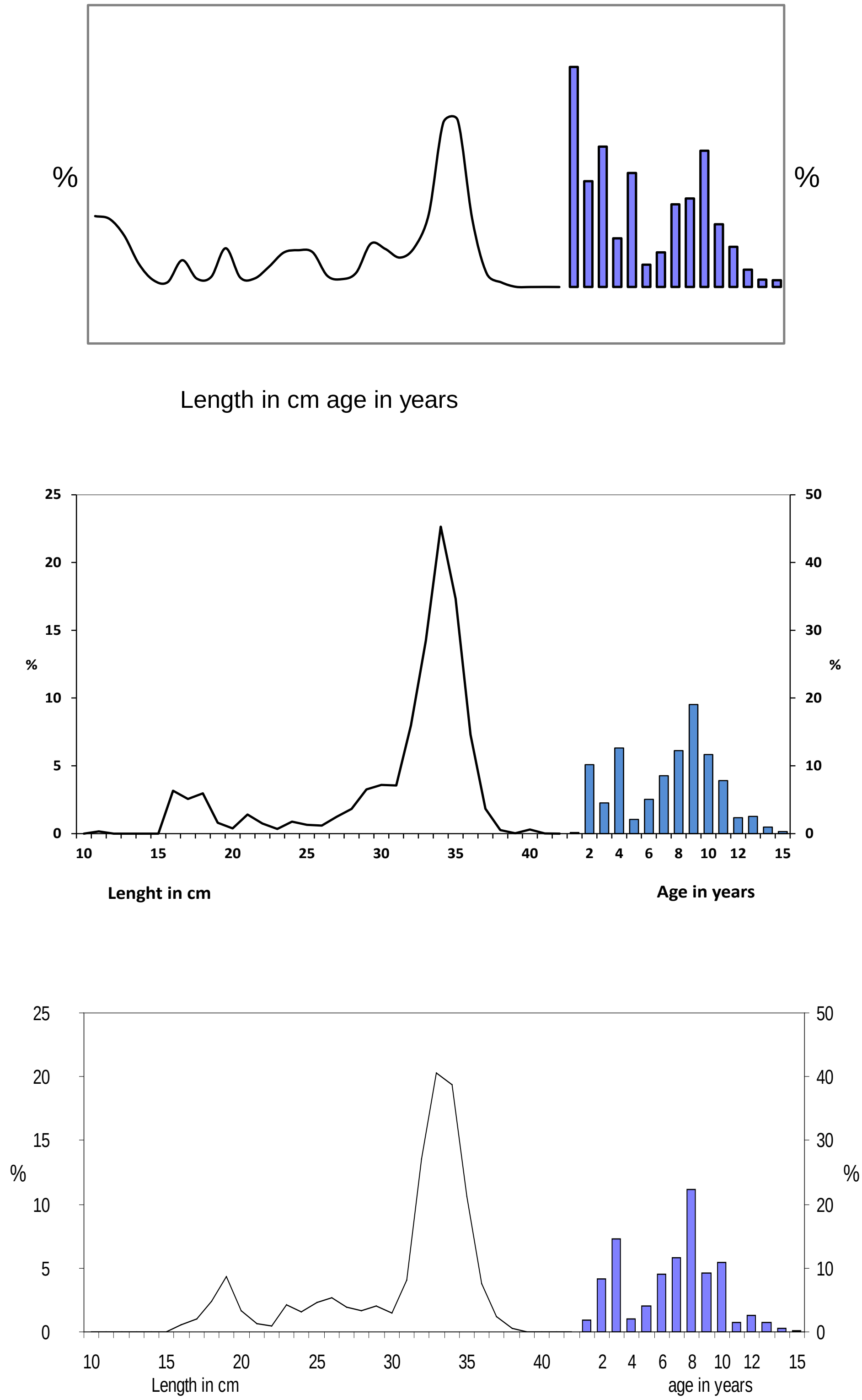


Figure 7.5.7.4.2. Length and age distribution of Norwegian spring spawning herring in the area in the Norwegian Sea and Barents Sea in May 2014 (upper most panel), in 2013 (mid panel) and in 2012 (lowest panel).

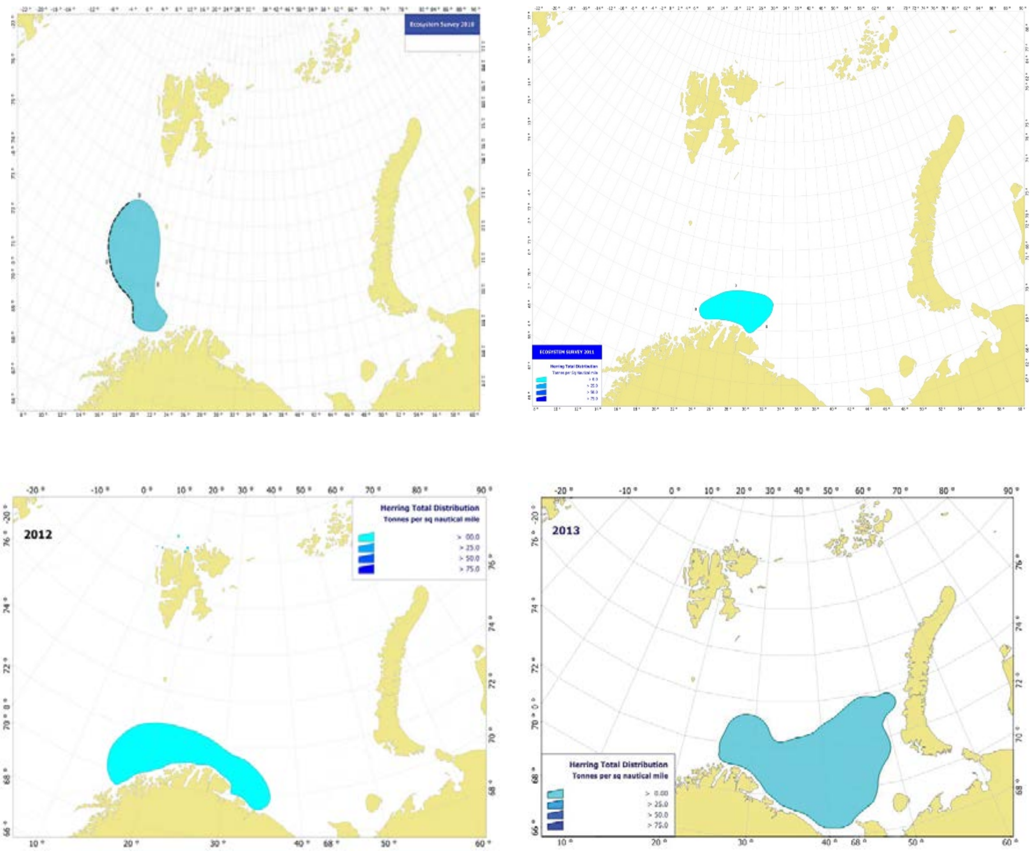


Figure 7.5.7.5.1. Norwegian Spring-Spawning herring. Estimated total density of herring (tonnes/nautical mile²) in August-September 2010 (upper left panel), 2011 (upper right panel) and 2012 (lower left panel), 2013 (lower right panel) in Barents Sea. *Survey 6*.

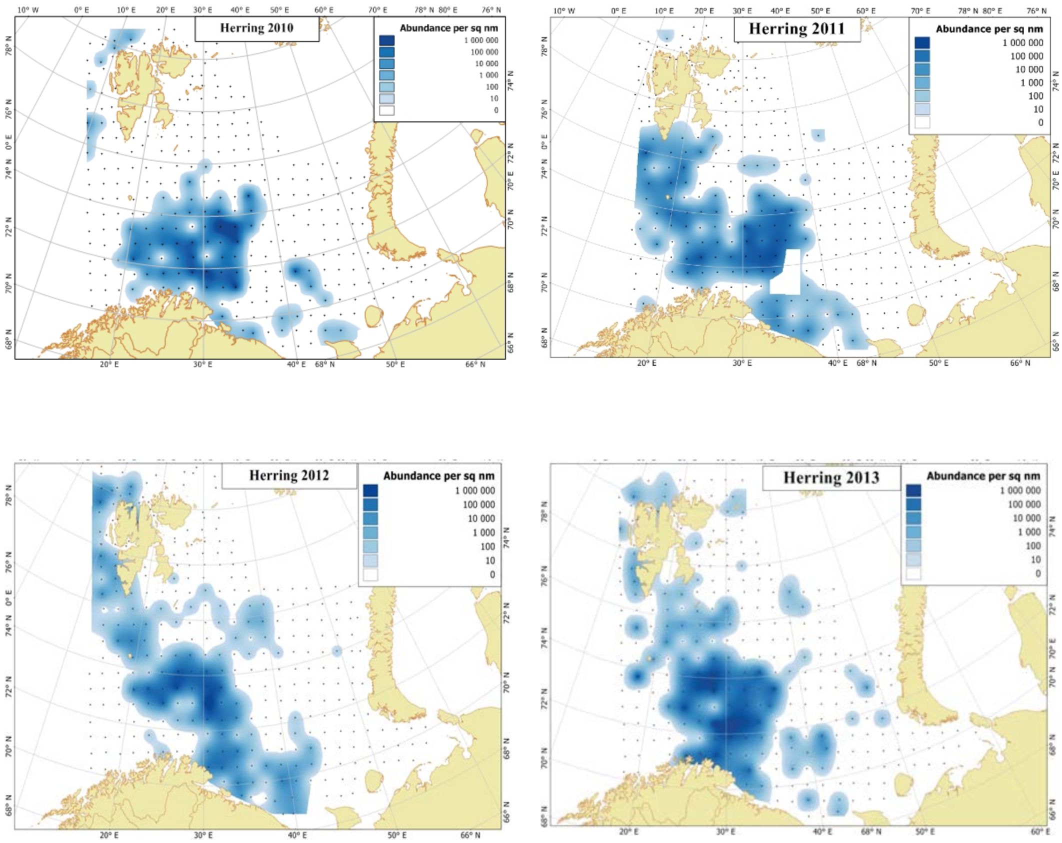


Figure 7.5.7.5.2. Norwegian Spring-Spawning herring. O–group surveys in August/September in the Barents Sea in 2010 to 2013. ***Survey 7.***

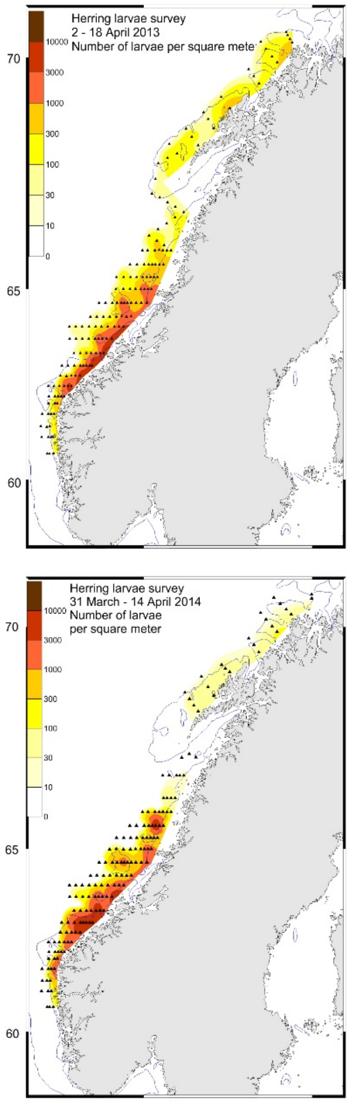


Figure 7.5.7.6.1. Norwegian Spring-Spawning herring. Distribution of herring larvae on the Norwegian shelf in 2013 (left panel) and 2014 (right panel). The 200 m depth line is also shown. ***Survey 8.***

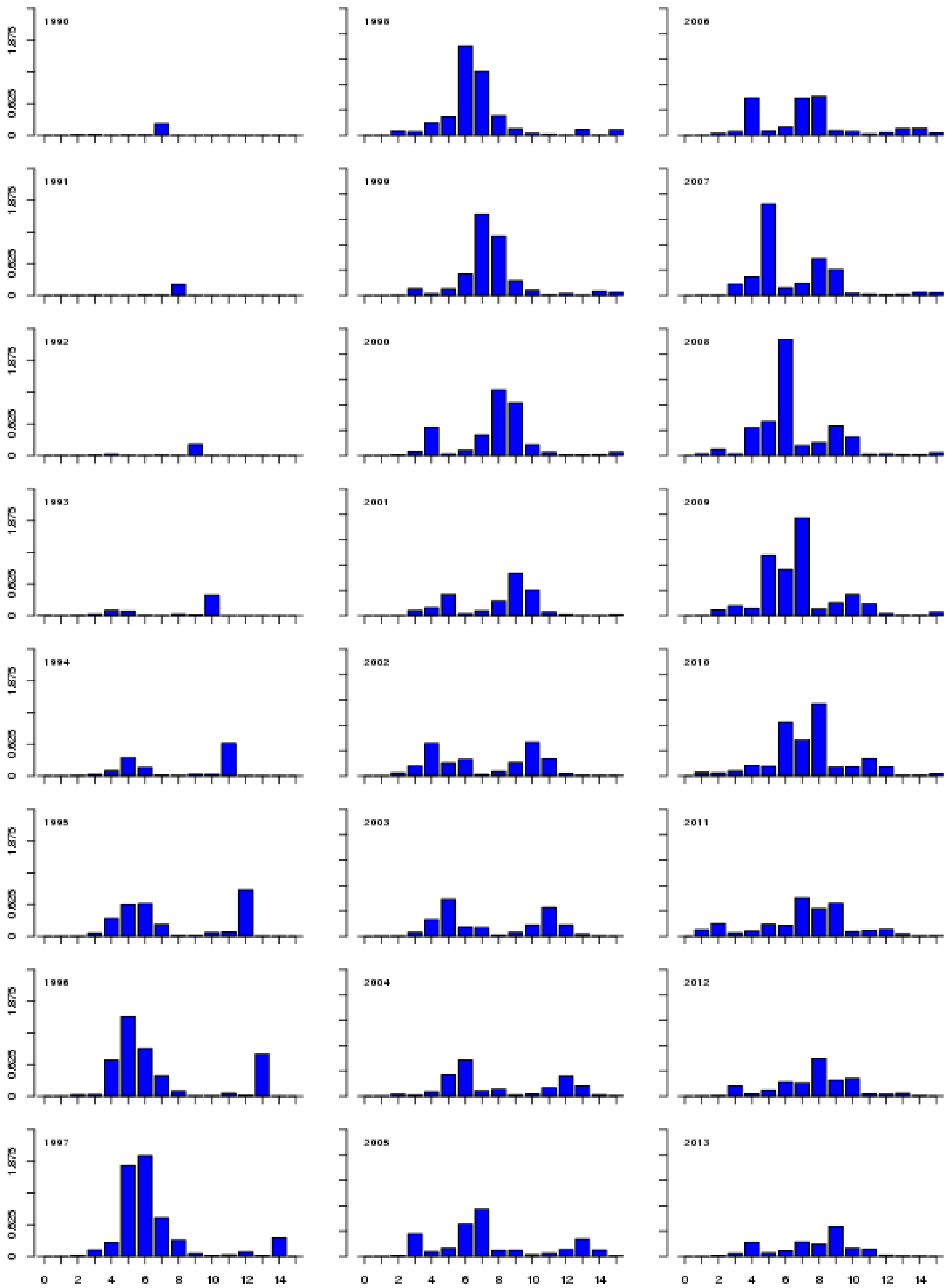


Figure 7.7.1.1. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted. Age is on x-axis. The labels indicate years.

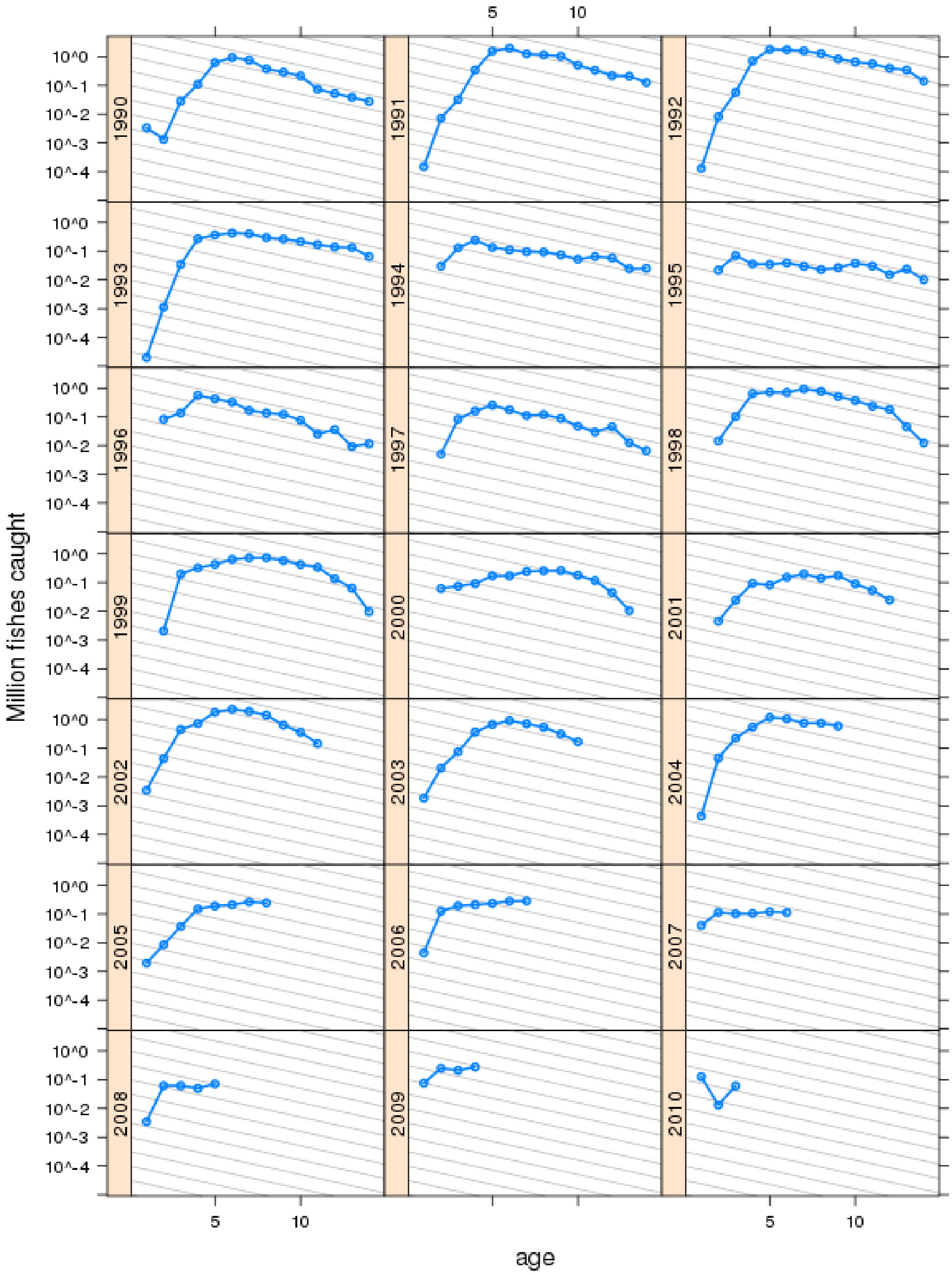


Figure 7.7.1.2. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted on a log scale. Age is on x-axis. The labels indicate year classes and grey lines correspond to Z=0.3.

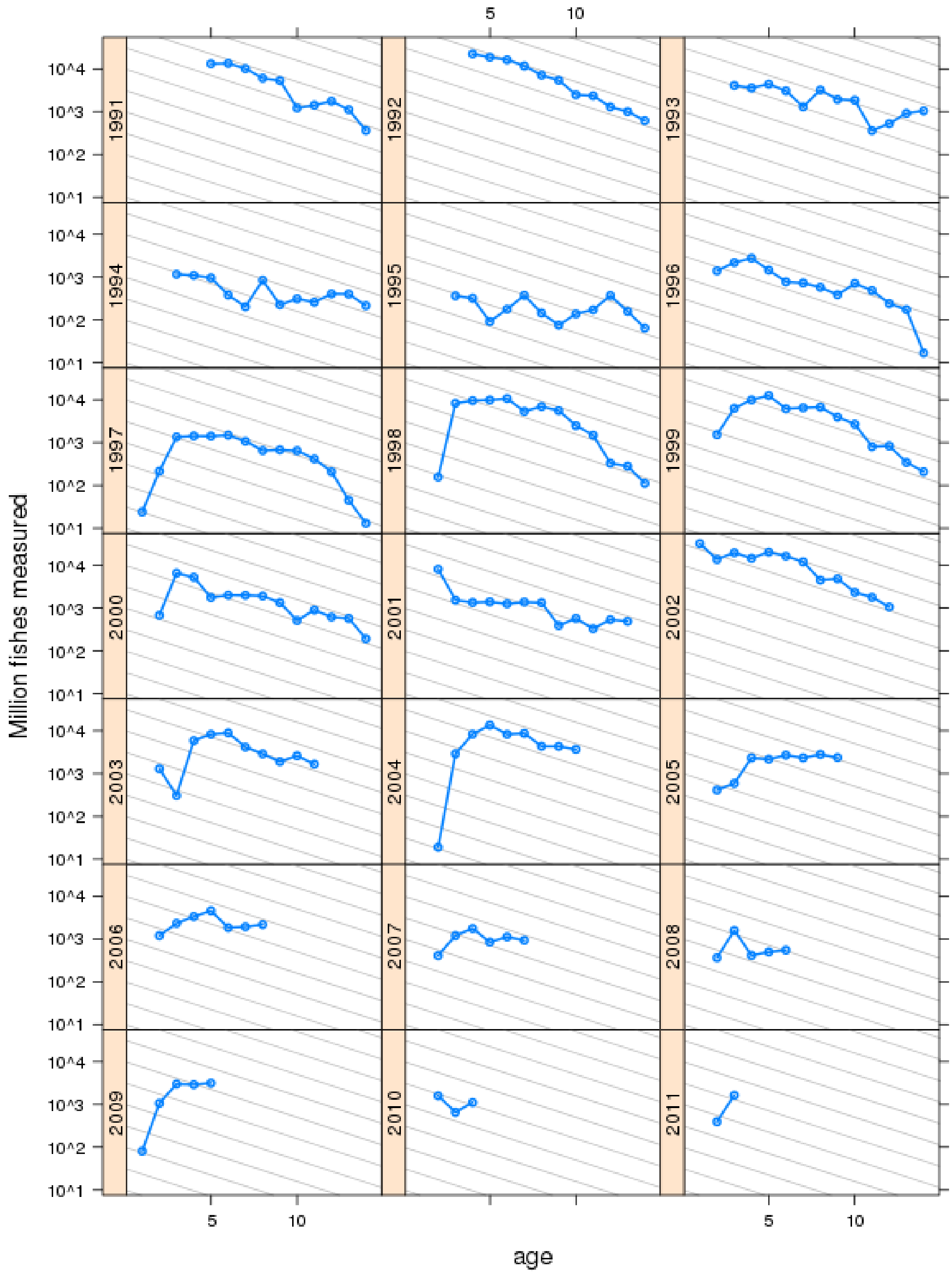
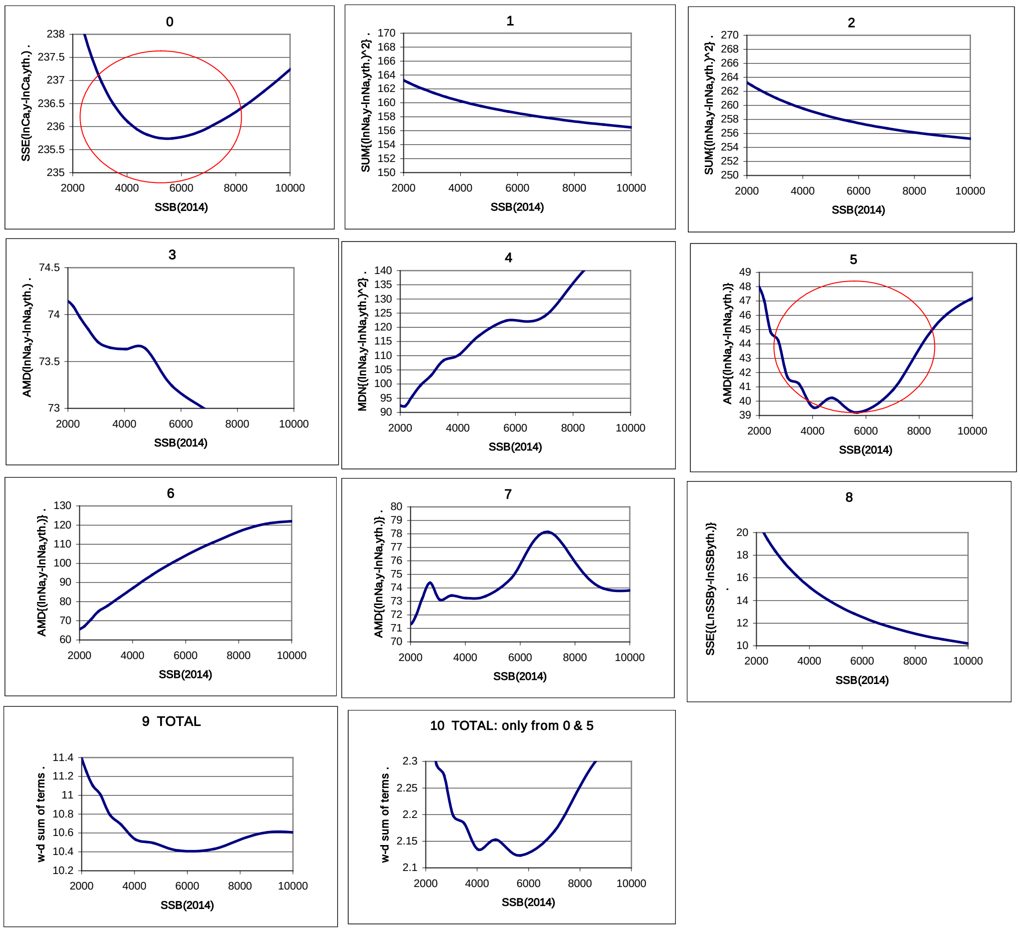


Figure 7.7.1.3. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale. The labels indicate year classes and grey lines correspond to Z=0.3.



0- catch-at-age
1- spawning grounds acoustic in Febr.-March
2-acoust. surv. in wint. area Nov.-December
3- acust. in wintering areas, January
4- Young herring in the Barents Sea (June)
5- Feeding areas, May
6-Young herring in the Barents Sea, September survey
7-index for 0-group
8-SSB indices
9-All data
10-catch-at-age + survey 5

Figure 7.7.2.1. Norwegian spring spawning herring. Profiles of components of the TISVPA objective function : 0 - signal from catch-at-age alone; 1-8 - signals from "surveys" from 1 to 8 respectively.

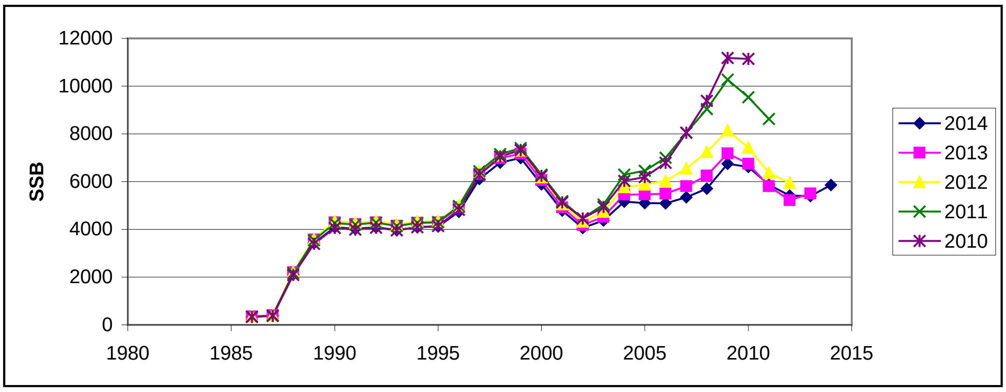


Figure 7.7.2.2. Norwegian spring spawning herring. Results of the TISVPA retrospective runs obtained when inputs only from catch-at-age and survey 5 were used.

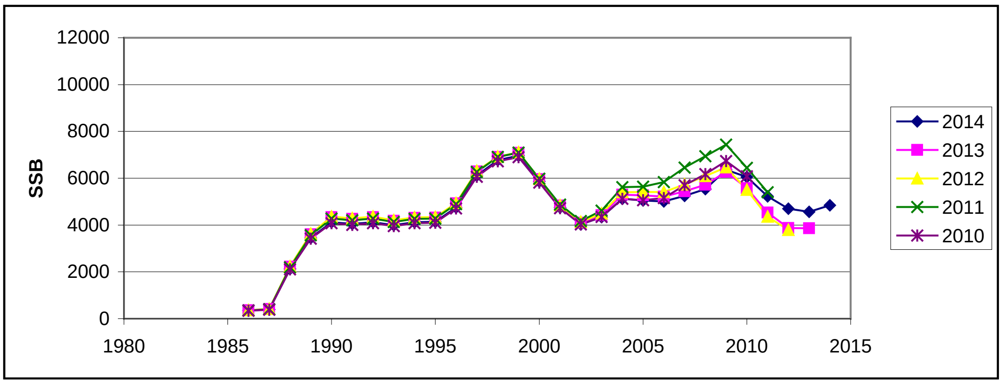


Figure 7.7.2.3. Norwegian spring spawning herring. Results of the TISVPA retrospective runs obtained when input only from age proportions in the data of survey 5 was used.

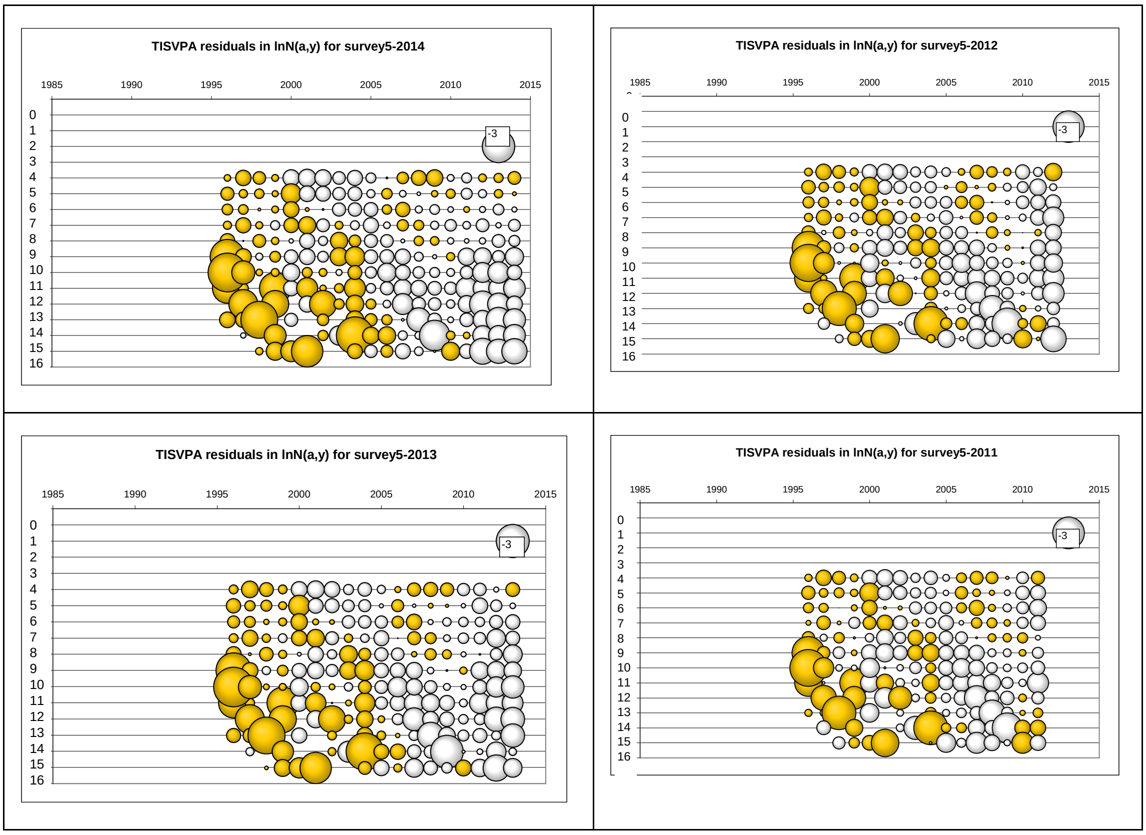


Figure 7.7.2.4. Norwegian spring spawning herring. Residuals of the TISVPA retrospective runs obtained when the model was tuned only at age proportions of survey 5.

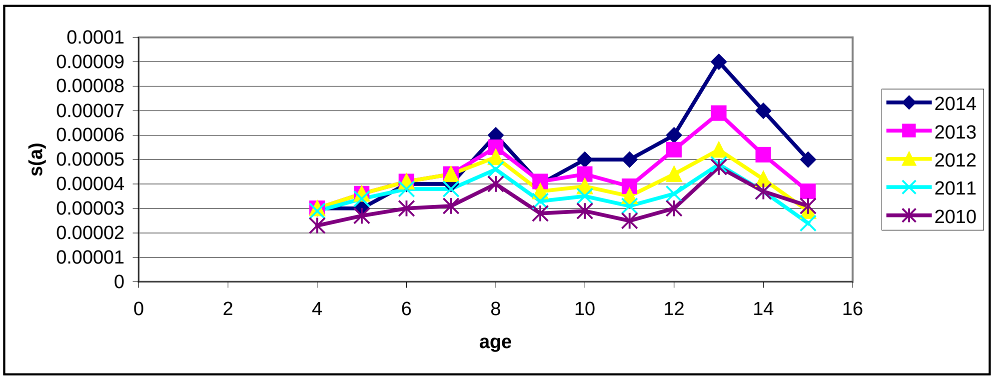
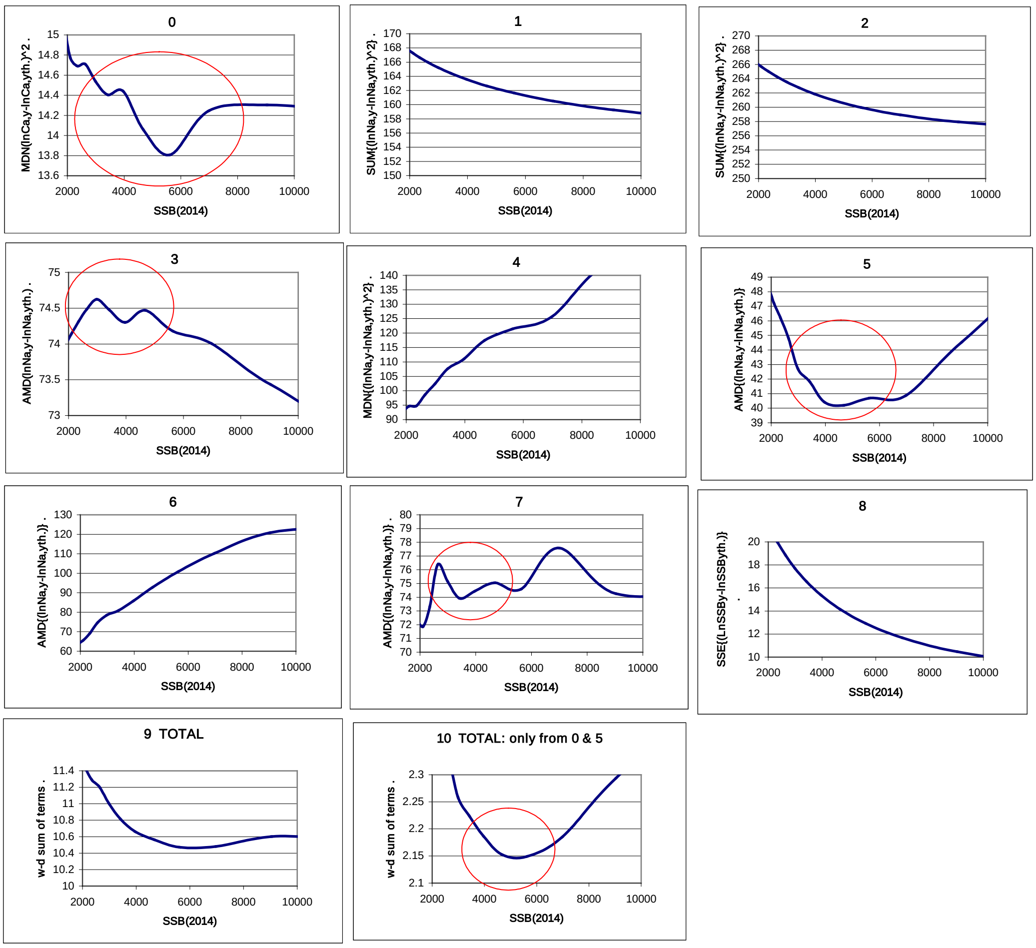
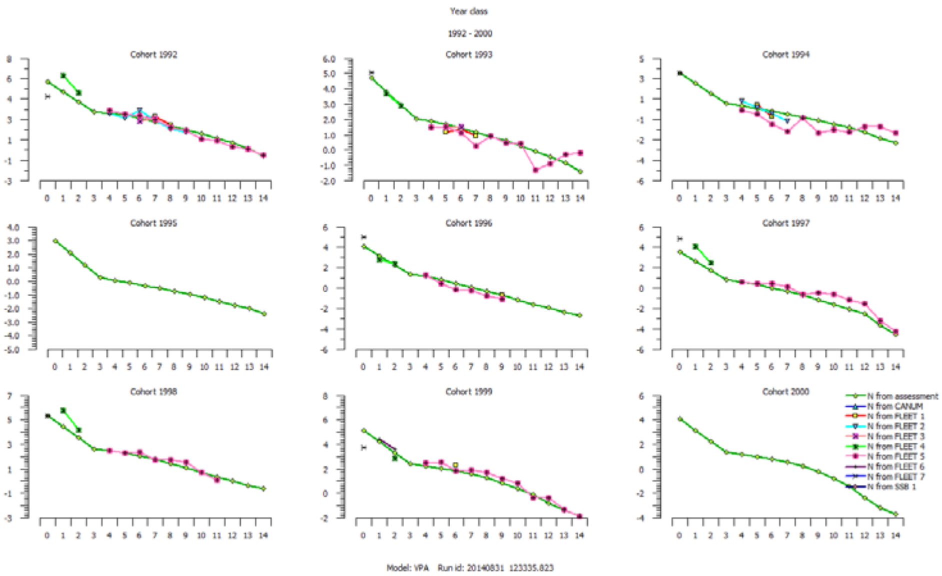


Figure 7.7.2.5. Norwegian spring spawning herring. The TISVPA-derived estimates of average catchability by ages for survey 5 obtained in retrospective runs.



0- catch-at-age
1- spawning grounds acoustic in Febr.-March
2-acoust. surv. in wint. area Nov.-December
3- acust. in wintering areas, January
4- Young herring in the Barents Sea (June)
5- Feeding areas, May
6-Young herring in the Barents Sea, September survey
7-index for 0-group
8-SSB indices
9-All data
10-catch-at-age + survey 5

Figure 7.7.2.6. Norwegian spring spawning herring. Profiles of components of the TISVPA objective function with modified model of "triple-separabilization" : 0 - signal from catch-at-age alone; 1-8 - signals from "surveys" from 1 to 8 respectively.



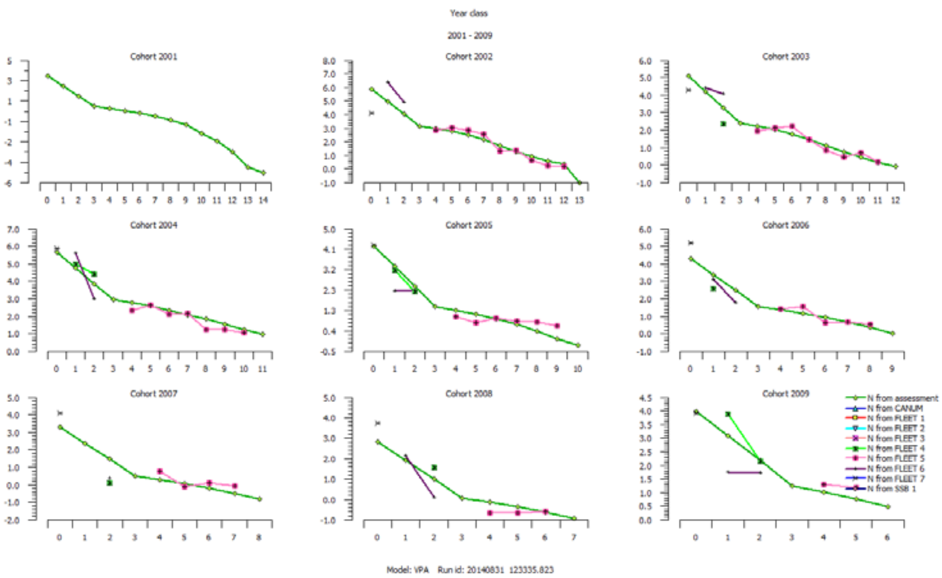


Figure 7.7.3.2.3 Norwegian spring spawning herring. Year class Ns, excluding values with zero weight.

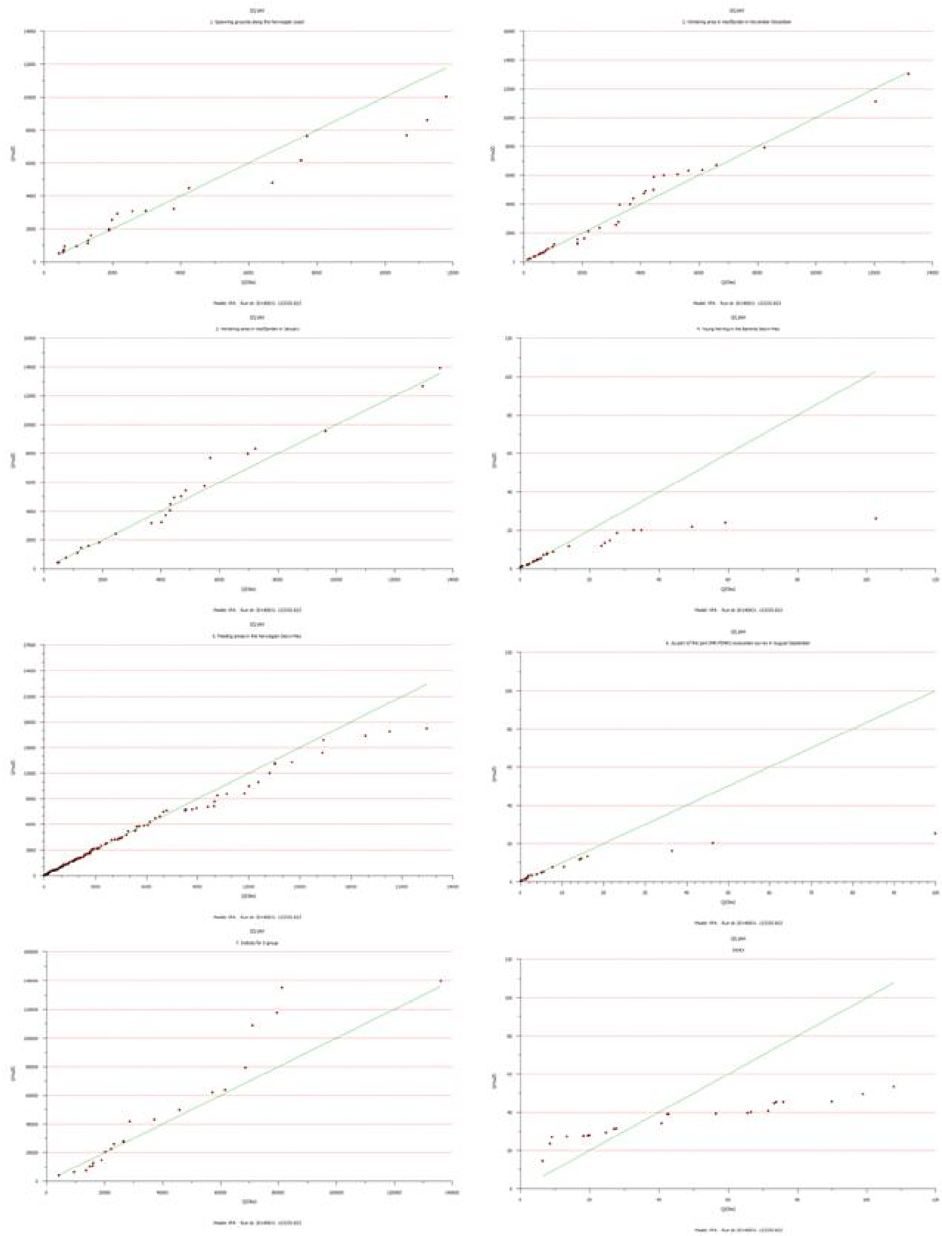


Figure 7.7.3.2.1. Norwegian spring spawning herring. Q-Q plot from the eight different surveys used in tuning in TASACS. First row starts with survey 1 and the last one in row four is larval survey.

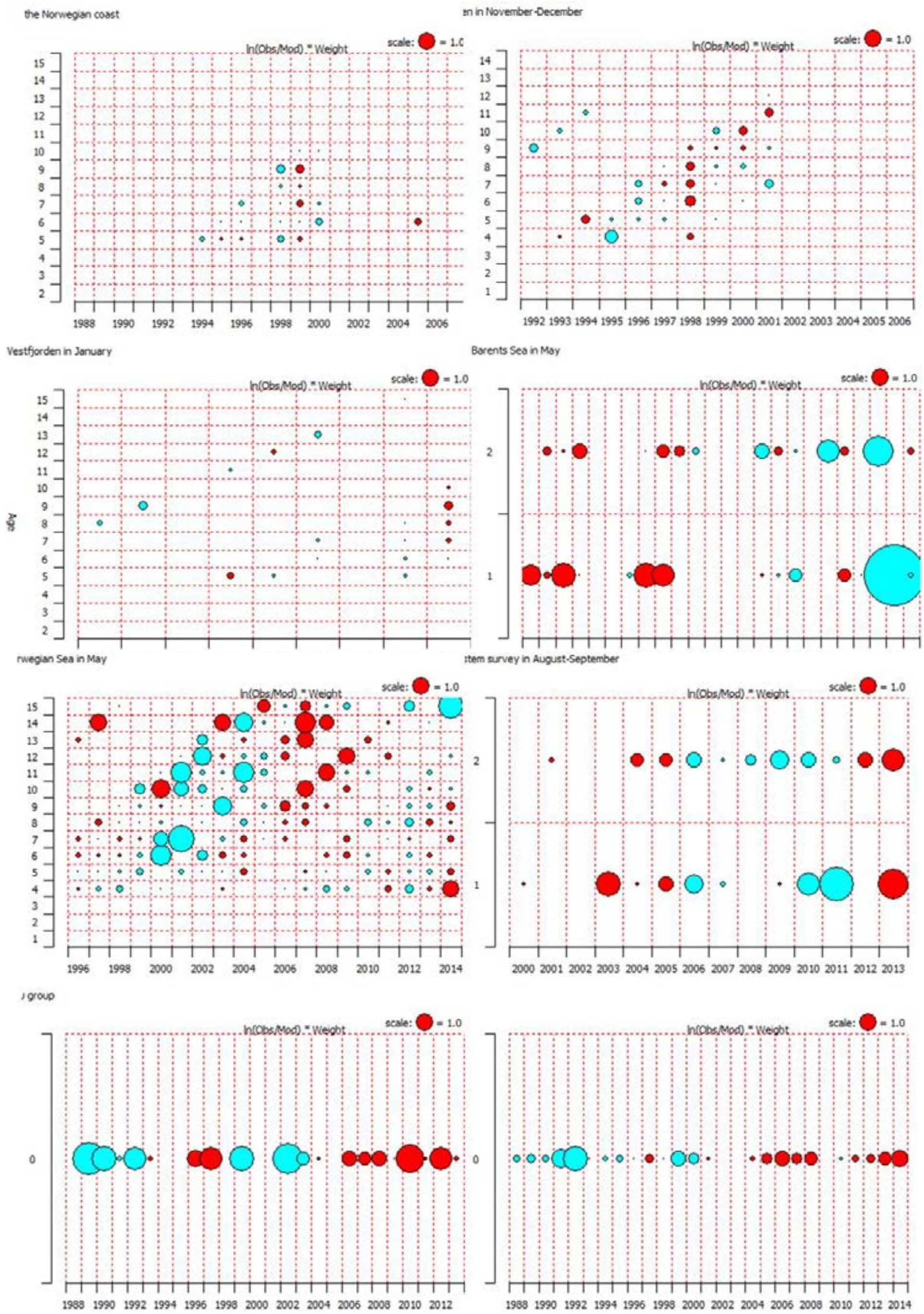


Figure 7.7.3.2.2. Norwegian spring-spawning herring. Residual sum of squares in the surveys separately from TASACS. First row starts with survey 1 and the last one in row four is larval survey.

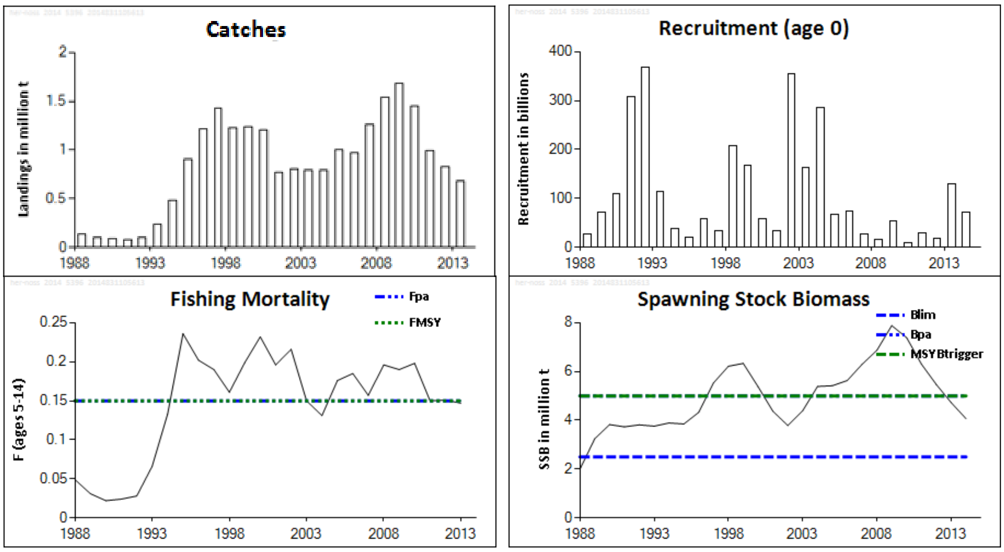


Figure 7.7.3.3.1. Norwegian spring-spawning herring. Standard plots from final assessment (TASACS VPA) in 2014.

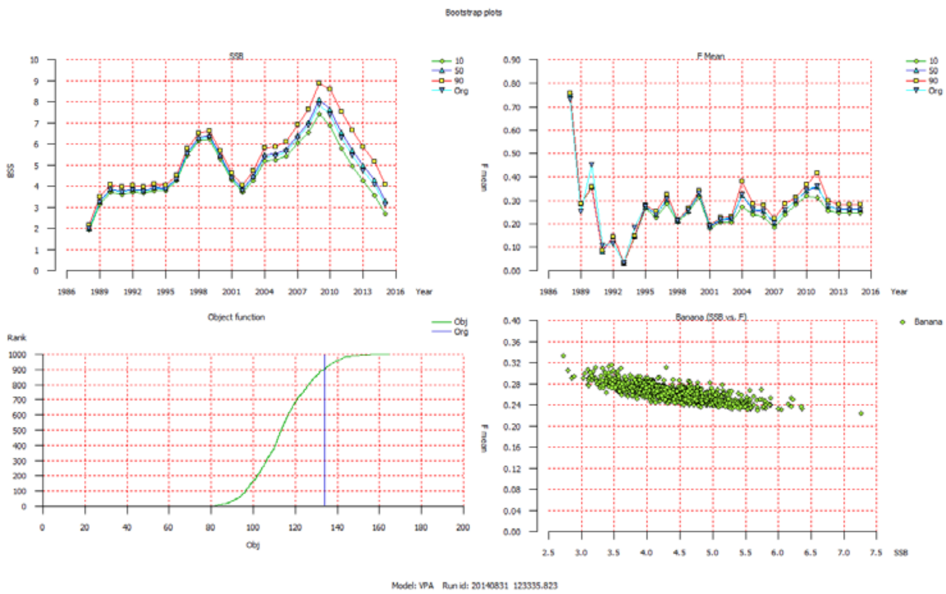
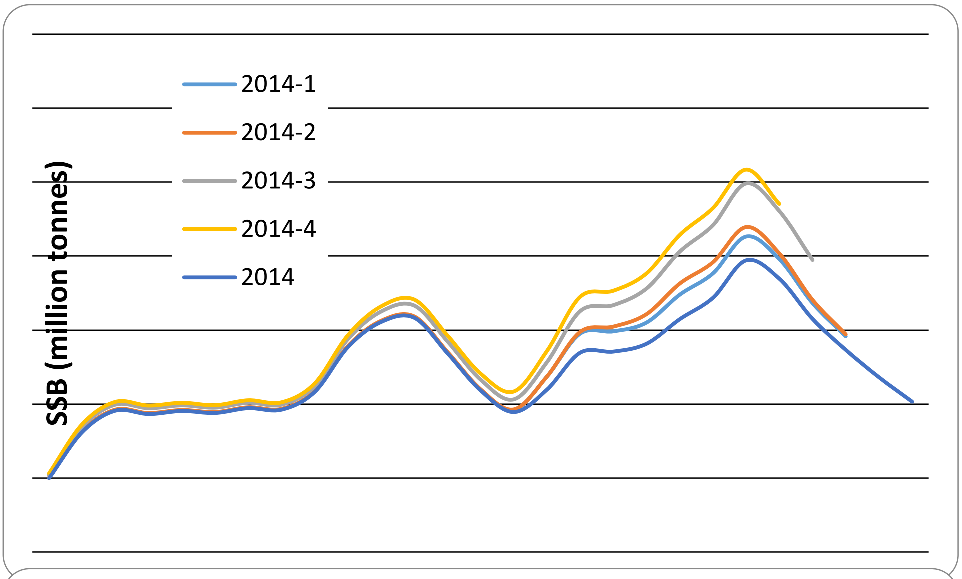


Figure 7.7.4.1. Norwegian spring-spawning herring. Percentiles for spawning stock biomass (top left), mean F 5-10 (top right), SSQ (bottom left) and "Banana"-plot (bottom right) from bootstrap results for final assessment.



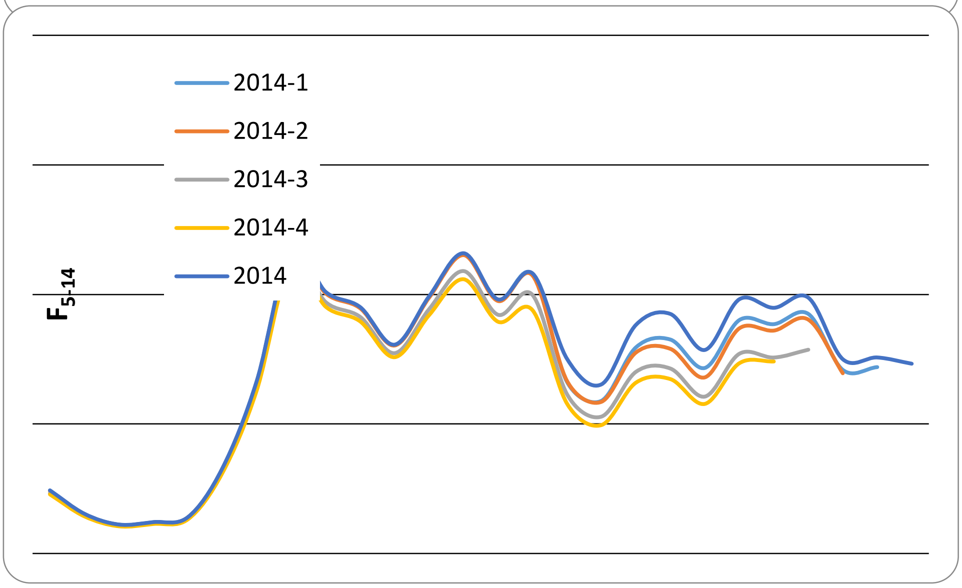


Figure 7.7.5.1 Norwegian spring-spawning herring. Retrospective run for SSB and F.

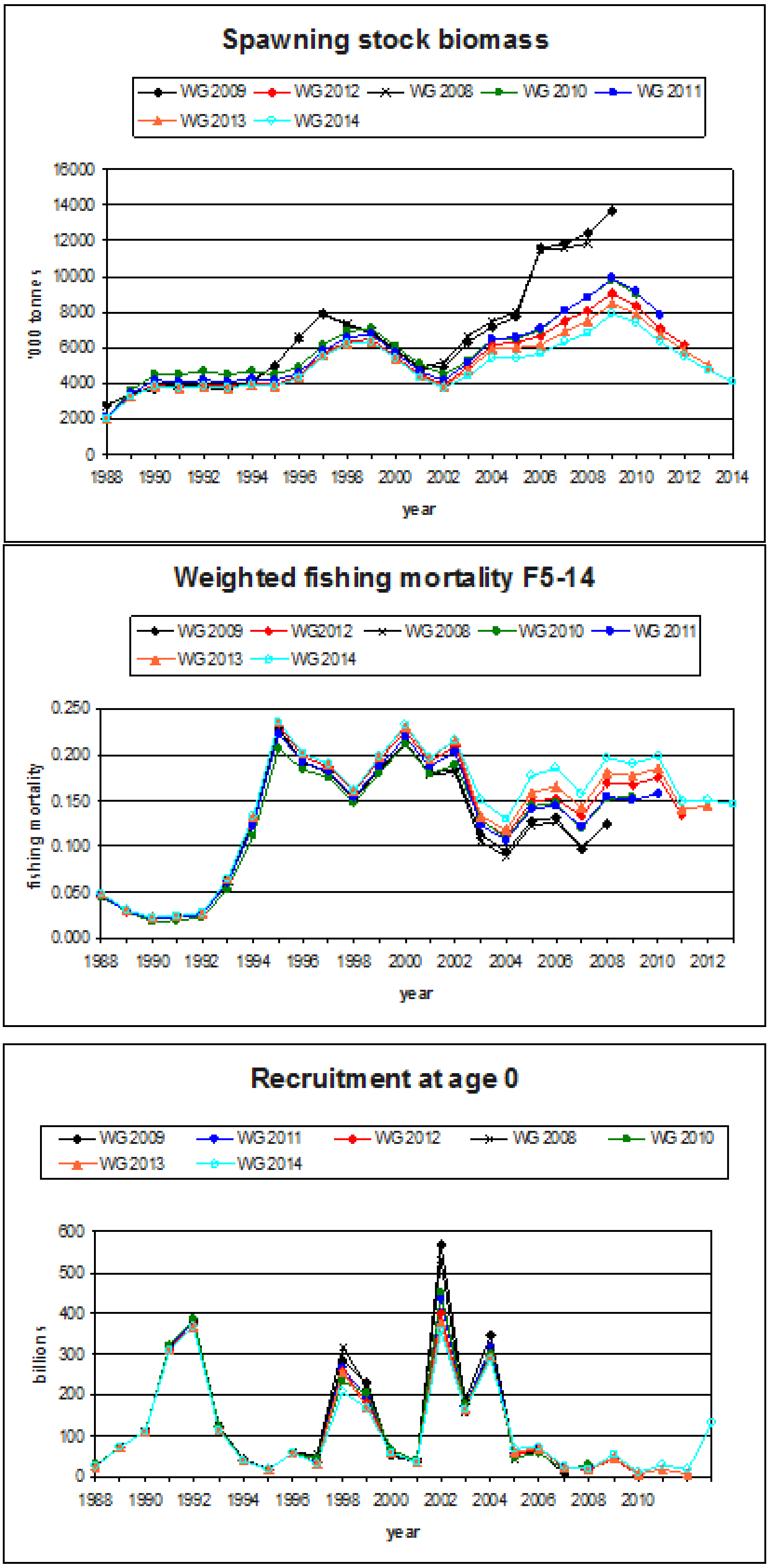


Figure 7.12.1. Norwegian spring spawning herring. Comparisons of spawning stock, weighted fishing mortality F5-14 and recruitment at age 0 with previous assessments.