10 Sprat in Division 3.a and Subarea 4 (Skagerrak, Kattegat and North Sea)

10.1 The Fishery

10.1.1 ACOM advice applicable to 2019 and 2020

There have never been any explicit management objectives for this stock. Last year, the advised TAC (July 2018 to June 2019) was set to 177 545 t for sprat in Subarea 4 and 7506 t for Division 3.a. The 2019 herring bycatch quotas are 13 190 t for the North Sea and 6659 t for Division 3.a. During the WKSPRAT benchmark meeting in 2018, sprat in Subarea 4 and Division 3.a were merged into one stock assessment model. Also a number of other modifications were made to the configurations of the assessment model (see (WKSPRAT: ICES, 2018) for further details).

10.1.2 Catches in 2018

Catch statistics for 1996–2018 for sprat in the North Sea by area and country are presented in Table 10.1.1. Catch data prior to 1996 are considered less reliable (see Stock Annex). The small catches of sprat from the fjords of Norway are not included in the catch tables (Table 10.1.1–10.1.2). The WG estimate of total catches for the North Sea and Division 3.a in 2018 were 191 184 t (total official catches amounted to 190 159 t). This is a 49% increase compared to 2017, but still not far from the average for the time series. The Danish catches represent 87% of the total catches.

The spatial distribution of landings was similar to 2017 (Figure 10.1.1). As in previous years, a low percentage (12% in 2018) of the catches were landed in the first and second quarter of 2018 (Table 10.1.2).

10.1.3 Regulations and their effects

The Norwegian vessels have a maximum vessel quota of 550 t when fishing in the North Sea. A herring by-catch of up to 10% in biomass is allowed in Norwegian sprat catches.

Most sprat catches are taken in an industrial fishery where catches are limited by herring by-catch quantities. By-catches of herring are practically unavoidable except in years with high sprat abundance or low herring recruitment. By-catch is especially considered to be a problem in area 4.c. This led to the introduction of a closed area (sprat box) to ensure that sprat catches were not taken close to the Danish west coast where large by-catches were expected.

ICES evaluated the effectiveness of the sprat box in 2017 (ICES, 2017). The evaluation concluded that fishing inside the sprat box would be expected to reduce unwanted catches of herring (by weight) and that other management measures are sufficient to control herring bycatch. The sprat box was removed in 2017.

10.1.4 Changes in fishing technology and fishing patterns

No major changes in fishing technology and fishing patterns for the sprat fisheries in the North Sea have been reported. From about 2000, Norwegian pelagic trawlers were licensed to take part in the sprat fishery in the North Sea. In the first years, the Norwegian catches were mainly taken

by purse seine, and the catches taken by trawl were low. In recent years, the share of the total Norwegian catches taken by trawl has increased (2018: 92% taken by trawl).

10.2 Biological composition of the catch

Only data on by-catch from the Danish fishery were available to the Working Group (Table 10.2.1). The Danish sprat fishery was conducted with a 4.4% and 7.8% by-catch of herring in 2018 in the North Sea and Division 3.a, respectively. The total amount of herring caught as by-catch in the sprat fishery has mostly been less than 10%.

The estimated quarterly landings at age in numbers for the period 1974–2018 are presented in Table 10.2.2. In the model year 2018 (1 July 2018–30 June 2019), one-year old sprat contributed 55% of the total landings, which is lower compared to the 1990–2018 average (62%) and the lowest since 2011 (45%). 2-year olds contributed 23% in 2018 (model year), which corresponds to the 1990–2018 average (23%). 0-year olds contributed 17% of the total landings, which is higher than the 1990–2018 average (9%).

Denmark, Sweden and Norway provided age data of commercial landings in 2018 (Table 10.2.4). Quarters 1, 3 and 4 were covered. The sample data were used to raise the landings data from the North Sea. The landings by the Netherlands, UK-England, UK-Scotland, Germany and Belgium were minor and unsampled. The sampling level has been greatly improved since 2014 because of the implementation of a sampling programme for collecting haul based samples from the Danish sprat fishery. The sampling level in 2018 (model year) was 1.5 samples per 2000 t. The required sampling level in the EU directive for the collection of fisheries data (Commission Regulation 1639/2001) is 1 sample per 2000 tonnes (see also the Stock Annex). This level was met by Denmark, Sweden and Norway, thus the total sampling level was above the EU directive required minimum level.

The number of samples used for the assessment, both length and age-length samples, is shown in Table 10.2.4–5 and Figure 10.2.1.

10.3 Fishery Independent Information

10.3.1 IBTS Q1 and Q3

Table 10.3.1 and Figure 10.3.1 gives the time series of IBTS indices by age (calculated using a delta-GAM model formulation; see WKSPRAT-report (WKSPRAT: ICES, 2018) for further details). The data source is the IBTS Q1 data from 1983–2019. The index for IBTS Q1 1-year olds in 2018 (age-0 in the model and the table, serving as a recruitment index) was the fifth highest in the time series, 58% of last year's index. There has been a tendency for an increase in the IBTS age 0 in the time series since 1990. IBTS Q3 survey indices were also used in the assessment, and the 2018 values were 33% lower for age-1 and 8% and 16% higher for age-2 and age-3, respectively, compared to 2017. To track changes in Subarea 4 and Division 3.a, separately, IBTS indices for roundfish areas 6–9 are shown in Figure 10.3.2a (stratified averages downloaded directly from ICES DATRAS database).

10.3.2 Acoustic Survey (HERAS)

Abundance indices were provided by WGIPS (ICES, 2019 (see Section 1.4.2)). The abundance indices for Subarea 4 and Division 3.a were summed (Table 10.3.2 and Figure 10.3.2.b). The 2018 values were 286%, 276%, and 53% (age-1, age-2, and age-3, respectively) of the 2017-values. Compared to the long-term average, the 2018 values were 283%, 69%, and 23% higher. To track

changes in Subarea 4 and Division 3.a separately, IBTS indices for roundfish areas 6–9 are shown in Figure 10.3.3 (stratified averages downloaded directly from ICES DATRAS database).

10.4 Mean weights-at-age and maturity-at-age

Mean weights-at-age in catches are given in Table 10.2.3 and Figure 10.4.1. Mean weights in model season 1 and 2 (S1,2; quarter 3 and 4), where most of the catches are taken, show a declining trend over the past decade. In 2018, the mean weights of age-1 and age-2 fish in S1 was the lowest observed for two decades. Mean weight-at-age was also very low in S2; among the lowest observed for two decades (Figure 10.4.1).

Proportion of mature fish was derived from IBTSQ1, following the benchmark procedure. Long-term average maturity ogives were used in the assessment model (0.0, 0.41, 0.87, and 0.95 for age-0 to age-3+). More details about the maturity staging are given in Section 4.5.3.2 in the WKSPRAT 2013 report (ICES, 2013).

10.5 Recruitment

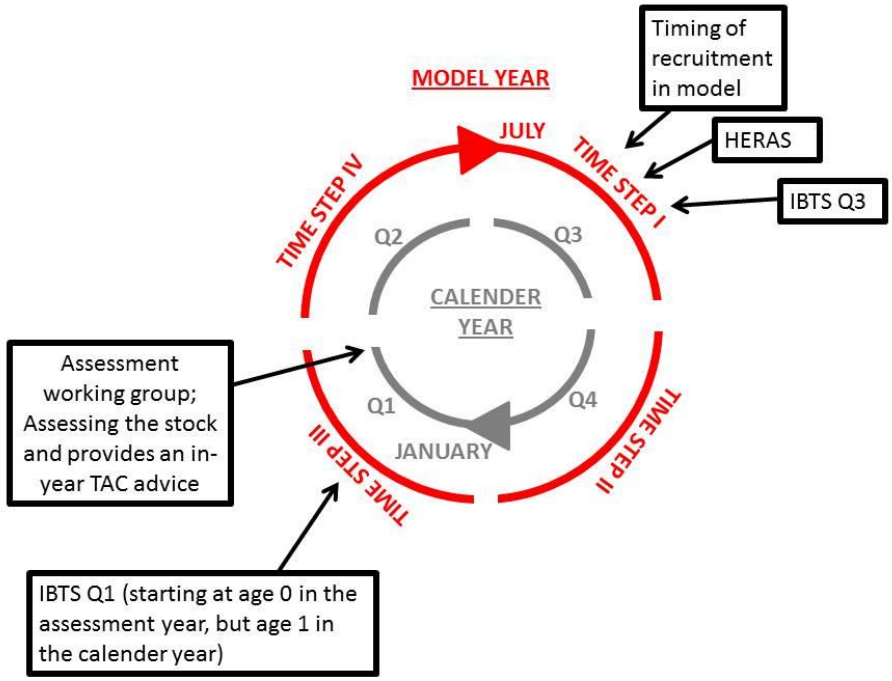
The IBTS Q1 age-1 index (age-0 in the model) (Table 10.3.1) is used as a recruitment index for this stock. The 2019 value, indicative of the 2018 recruitment, was the fifth highest in the time series, although only 58% of last year's index. The recruitment estimated by the model for 2018 is 83% of the recruitment in 2017 (after updating the 2017 recruitment) and 48% higher than the 1990–2018 average. After the latest benchmark it was decided to implement a power model (directly within the assessment model) to the age-0 IBTS Q1 index to dampen the effect of very high index values. This was done to reduce the retrospective bias on recruitment (see WKSPRAT report (WKSPRAT: ICES, 2018) for further details).

10.6 Stock Assessment

The stock assessment was benchmarked in November 2018 (WKSPRAT: ICES, 2018). During the WKSPRAT benchmark meeting in 2018, sprat in Subarea 4 and Division 3.a were merged into one stock assessment model. Also a number of other modifications were made to the configuration of the assessment model (see WKSPRAT report (ICES, 2018) for further details).

In-year advice is the only possible type of advice for this short-lived species with a fishery dominated by 1- and 2-year-old fish. This, however, requires information about incoming 1-year-old fish. In order to meet this requirement and to come up with a model that logically matches the natural life cycle of sprat, the annual time-step in the model was shifted, relative to the calendar year, to a time-step going from July to June (see text table below). SSB and recruitment was estimated at 1 July. In figures and tables with assessment output and input, the years refer to the shifted model year (July to June) and in each figure and table it is noted whether model year or calendar year apply (when the model year is given the year refers to the year at the beginning of the model year; for example: 2000 refers to the model year 1 July 2000 to 30 June 2001). The following schematic illustrates the shifted model year relative to the calendar year and provides an overview of the timing of surveys etc.

Model year		Calendar year	
2000	Season 1	2000	Quarter 3
2000	Season 2	2000	Quarter 4
2000	Season 3	2001	Quarter 1
2000	Season 4	2001	Quarter 2



10.6.1 Input data

10.6.1.1 Catch data

Information on catch data is provided in Tables 10.1.1–2 and in Figures 10.1.13 and 10.6.1. Sampling effort is presented in Table 10.2.5 and Figure 10.2.1.

Since catches in quarter 2 (season 4 in the model) are often less than 5000 tonnes, these are poorly estimated by the model and the number of samples from these catches are low (sometimes no samples). Furthermore, at the time of the assessment working group, S4 catches are unknown. Therefore, during the latest benchmark it was decided to move S4 catches into S1 in the following model year.

10.6.1.2 Weight at age

The mean weights at age observed in the catch are given in Table 10.2.3 and Figure 10.4.1 by season. It is assumed that the mean weights in the stock are the same as in the catch. Note that it is the mean weight at age of S1 that is used to calculated SSB.

10.6.1.3 Surveys

Three surveys were included (Tables 10.3.1–3), IBTS Q1 (1975–present), IBTS Q3 (1991–present) and HERAS (Q3) (2003–present). 0-group (young-of-the-year) sprat is unlikely to be fully recruited by the time of IBTS Q3 and HERAS, and for this reason these age indices were excluded from runs. Internal consistency in survey data and external consistency between surveys are presented in Figures 10.3.1–5.

10.6.1.4 Natural mortality

New natural mortalities were available from the 2017 North Sea key run from WGSAM (ICES, 2017). The major changes were changes to the mackerel consumption leading to a much lower M of 0-group in the second half of the year. HAWG reviewed stock recruitment plots based on the old and new M's and considered that updating the entire time series of Ms did not affect the stock recruitment plot substantially, and did not lead to a change in the perception of B_{lim}/B_{pa}. Therefore, the new M's were used. Variable mortality is applied as three year averages up till 2015, and after this the average mortality for 2013–2015 is used. Natural mortalities used in the model are given in Table 10.6.2.

10.6.1.5 Proportion mature

Proportion of mature fish was derived from IBTSQ1, following the benchmark procedure. Long-term average maturity ogives were used in the assessment model (0.0, 0.41, 0.87, and 0.95 for age-0 to age-3+). More details about the maturity staging are given in Section 4.5.3.2 in the WKSPRAT 2013 report (ICES, 2013).

10.6.2 Stock assessment model

The assessment was made using SMS (Lewy and Vinther, 2004) with quarterly time steps (referred to as season S1–S4). Three surveys were included, IBTS Q1 ages 1–4+, IBTS Q3 ages 1–3 and HERAS (Q3) ages 1–3. 0-group sprat is unlikely to be fully recruited to the IBTSQ3 or HERAS in Q3 and these age indices were excluded from runs. External consistency between IBTS Q1, IBTS Q3 and HERAS can be found in the benchmark report (WKSPRAT: ICES, 2018).

The model converged and fitted the catches of the main ages caught in the main seasons reasonably (ages 1–2, seasons 1 and 2, Table 10.6.2). All surveys had low CVs (Table 10.6.2). There were no patterns in the residuals raising concern. Although, there appears to be a periodic cycling (on a decadal time scale) between positive and negative residuals in the IBTS Q3 survey and the catches (Figures 10.6.2–3). Common CVs were estimated for the groups: 1 to 3-year olds in IBTS Q1 and 2 and 3-year olds in IBTS Q3 and HERAS.

The retrospective analyses showed a tendency to overestimate recruitment (5 years mohn´s rho = 0.22) (Figure 10.6.5). As 41% of the recruiting year class contributes to the SSB at the end of the year, there is a similar large retrospective pattern in SSB (5 year mohn´s rho = 0.27). However, the assessment model has been improved with this respect and mohn´s rho reduced by roughly a factor of 3 during the last benchmark.

The final outputs detailing trends in mean F, SSB and recruitment are given in Figures 10.6.4–7 and Tables 10.6.3–4.

10.7 Reference points

A B_{lim} of 94 000 t (Figure 10.7.1) and B_{pa} of 125 000 t were agreed at the most recent benchmark. B_{pa} is defined as the upper 90% confidence interval of B_{lim} and calculated based on a terminal SSB CV of 0.173.

10.8 State of the stock

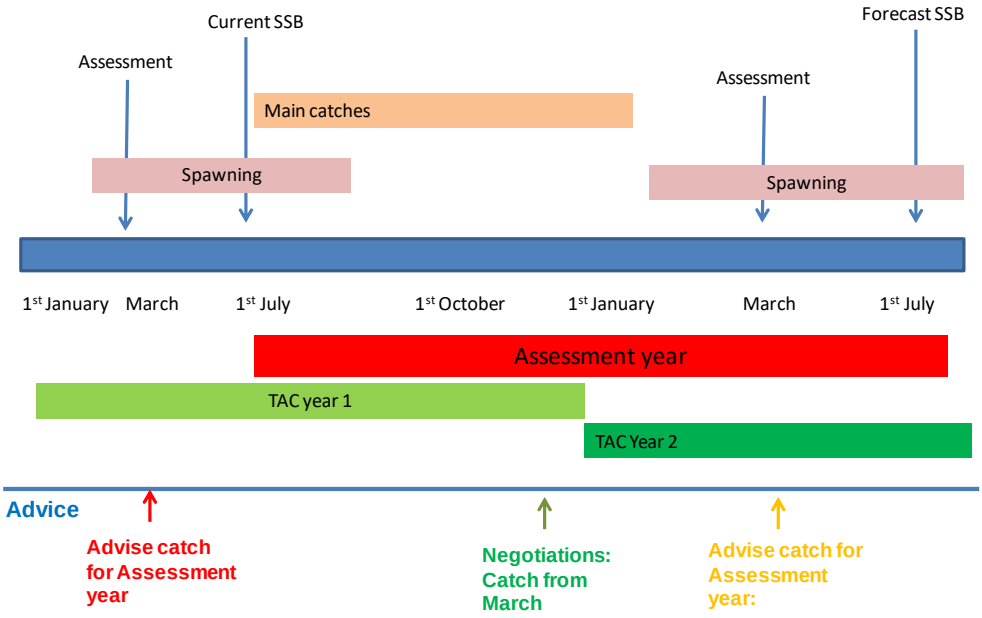
The sprat stock appears to be abundant judged by all the surveys and by the assessment output. The stock appears to have been well above B_{pa} since 2013 and above B_{lim} since 1991. The current SSB is more than twice the B_{lim}, and among the six highest since 1980. Fishing mortality has been above the long-term average for the last 4 years. The advised TAC was based on the predicted catch at F equal to F_{cap} (0.69). A large overshoot of F_{cap} is seen in simulations applying the escapement strategy on very large incoming year classes, and this is the rationale for implementing an F_{cap} as otherwise, the escapement strategy is unprecautionary at large stock sizes.

A stock summary from the assessment output can be found in Table 10.6.4 and Figure 10.6.7.

10.9 Short-term projections

Management strategy evaluations for this stock were made in December 2018 (WKSPRATMSE: ICES, 2018). These evaluations clearly show that the current management strategy ($B_{escapement}$) is not precautionary unless an additional constraint is imposed on the fishing mortality (referred to as F_{cap}). During the WKSPRATMSE (ICES, 2018) 0.69 was found to be the optimal F_{cap} value (from both a full MSE and a shortcut MSE, see the WKSPRATMSE report (WKSPRATMSE: ICES, 2018) for further details), which is a revision of the previous value of 0.7. This means, that the fishing mortality ($F_{bar}(1–2)$) derived from the $B_{escapement}$ strategy, should not exceed 0.69.

Since the catch projections are based on an assessment year from 1 July to 30 June each year rather than the calendar TAC years of 1 January to 31 December, the following figure (see below) illustrates the timing of steps in the process in relation to the spawning and fisheries of North Sea sprat.



SSB in 2019 is expected to be above the long-term average and well above B_{pa}. Using the input and assumptions detailed above, the projection for an F = 0 is an SSB in July 2020 of 361 000 t (Table 10.9.2). The F_{MSY} approach prescribes the use of an F value of 0.69 (F_{cap}, see explanation above) and results in a TAC advice of 138 726 t (July 2019–June 2020), which is anticipated to result in an SSB of 271 000 t in July 2020, well above B_{pa}.

10.10 Quality of the assessment

The data used within the assessment, the assessment methods and settings were carefully scrutinized during the 2018 benchmark (ICES, 2018). A complete overview of the choices made during the benchmark can be found in the WKSPRAT report (ICES, 2018) and these are also described in the Stock Annex for sprat in Division 3.a and Subarea 4.

The assessment shows medium to high CVs for the catches but low CVs for surveys. The CVs of F, SSB and recruitment are genrally low (see Table 10.6.2 and Figure 10.6.4). The model converged and fitted the catches of the main ages caught in the main seasons (the periods with most samples) reasonably well (ages 1–2, season 2, Table 10.6.2). There is a small retrospective bias in SSB and recruitment (5 years mohn´s rho of 0.27 and 0.22, respectively).

10.11 Management Considerations

A management plan needs to be developed. Sprat is an important forage fish, thus also multispecies considerations should be made.

The sprat stock in the North Sea is dominated by young fish. The stock size is mostly driven by the recruiting year class. Thus, the fishery in a given year will be dependent on that year's incoming year class.

In the forecast table for North Sea herring, industrial fisheries are allocated a bycatch of 13 190 t and 6659 t of juvenile herring in 2019 in the North Sea and Division 3.a, respectively. It is important to continue monitoring bycatch of juvenile herring to ensure compliance with this allocation.

10.11.1 Stock units

After the latest benchmark, sprat in the Subarea 4 and Division 3.a is considered to be one cohesive stock. This is documented in the WKSPRAT report (ICES, 2018). In addition, there are several peripheral areas of the North Sea and Division 3.a where there may be populations of sprat that behave as separate stocks from the main stock. Local depletion of sprat in such areas can be an issue of ecological concern.

10.12 Ecosystem Considerations

Sprat is an important prey species in the North Sea ecosystem. Many of the plankton-feeding fish, including sprat, recruited strongly in 2016 (e.g. sandeel, Norway pout). This is in contrast to a previous period of poor recruitment. The implications of the environmental change for sprat and the influence of the sprat fishery on other fish species and sea birds are at present unknown.

In the North Sea, the key predators consuming sprats are included in the stock assessment, using SMS estimates of sprat consumption for each predatory fish stock, and estimates for seabirds. Impacts of changes in zooplankton communities and consequent changes in food densities for sprats are not included in the assessment, but it may be useful to explore the possibility of including this, or a similar proxy bottom-up driver, in future assessments. However, the effect of changes in productivity is included in the observed quarterly weight at age and in the estimated recruitment, as a decline in e.g available food can lead to lower observed weights and lower estimated recruitment even in the absence of a causal link in the model.

10.13 Changes in the environment

Temperatures in this area have been increasing over the last few decades. This may have implications for sprat, although the correlation between temperature and recruitment from the model has been found to be low (see WKSPRAT: ICES, 2018).

Table 10.1.1. North Sea & 3.a sprat. Landings (' 000 t) 1996–2018. See ICES CM 2006/ACFM:20 for earlier data. Catch in coastal areas of western Norway excluded. Data provided by Working Group members. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		Division 27.4.a																					
Denmark	0.3			0.7		0.1	1.1		*		*	0.8	*	*					*	*	0.1	0.1	
Norway														*		*							
Sweden						0.1																	
UK (Scotland)																0.5						0.0	0.0
Germany																				*	*		
Netherlands																				*			
Total	0.3			0.7		0.2	1.1		*		*	0.8	*	*		0.5			*	*	0.1	0.1	0.0
		Division 27.4.b																					
Denmark	76.5	93.1	119.3	160.3	162.9	143.9	126.1	152.9	175.9	204.0	79.5	55.5	51.4	115.6	80.8	90.9	65.7	44.7	121.3	234.4	177.6	100.6	156.5
Norway	52.8	3.1	15.3	13.1	0.9	5.9	*		0.1		0.8	3.7	1.3	4.0	8.0	0.1	6.2	*	8.9	0.3	19.6	9.7	9.3
Sweden	0.5		1.7	2.1		1.4				0.0				0.3	0.6	1.1	1.8	0.1	3.9	5.5	11.7	8.1	7.6
UK(Scotland)				1.4								0.1		2.5	1.1	1.9	0.7						0.0
UK(Engl.&Wales)														*								0.0	0.0
Germany																3.3	0.5	0.6	1.5	3.1	5.4	6.0	3.7
Netherlands																1.1	2.7	0.4	2.4	1.2	1.0	1.6	1.6
Faroe Islands																					4.7	1.0	1.0

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	129.8	96.2	136.3	176.9	163.8	151.2	126.1	152.9	176.0	204.1	80.3	59.3	52.7	122.4	90.4	98.4	77.5	45.8	138.0	244.6	220.0	127.0	179.7
		Division 27.4.c																					
Denmark	3.9	5.7	11.8	3.3	28.2	13.1	14.8	22.3	16.8	2.0	23.8	20.6	8.1	8.2	48.5	20.0	3.2	15.4	2.2	34.0	18.7	1.5	6.2
Norway		0.1	16.0	5.7	1.8	3.6					9.0	2.9		1.8	3.2	9.9	3.0	1.7	0.1	8.8	0.6		0.5
Sweden														0.6	0.6	0.2	0.4	1.3		1.2	0.4	8.1	
UK(Scotland)													0.2			0.4					*		
UK(Engl.&Wales)	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3	1.5	1.6	0.5	0.3	*	*	0.8	0.6	0.5	*	*	*	*	0.0	0.1
Germany																*	*	1.0		0.6	0.2		
Netherlands				0.2												4.2	1.0	0.7	*	1.2	0.8	0.0	0.7
Belgium																*		*	*	*	*	0.0	
France																				*		0.0	
Total	6.5	7.2	28.0	10.8	32.0	18.7	16.4	23.6	18.3	3.6	33.4	23.8	8.4	10.6	53.0	35.2	8.0	20.1	2.3	45.8	20.6	1.6	7.5
		Division 27.3.a																					
Denmark	10.4	11.6	11.2	17.2	12.8	20.2	13.4	10.2	14.4	31.9	7.8	9.9	5.8	6.9	8.4	8.0	8.4	1.9	16.7	11.7	6.7	1.0	2.9
Sweden	6.6	3.8	6.2	9.3	6.4	7.6	4.3	5.5	6.5	7.7	4.4	4.2	2.4	1.6	1.4	2.0	1.5	1.1	1.5	1.3	1.1	0.2	1.1
Germany																			0.0				0.0
Faroe Islands																					0.0		
Total	17.0	15.4	17.4	26.5	19.2	27.7	17.7	15.7	20.9	39.6	12.2	14.1	8.2	8.5	9.8	10.0	9.9	3.0	18.3	13.0	7.9	1.2	4.0

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		Total North Sea & Skagerrak-Kattegat																					
Denmark	91.1	110.4	142.3	181.5	203.9	177.3	155.4	185.4	207.1	237.9	111.2	86.7	65.4	130.7	137.7	119.0	77.4	62.1	140.2	280.1	203.1	103.3	165.6
Norway	52.8	3.2	31.3	18.8	2.7	9.5	*		0.1		9.8	6.7	1.3	5.8	11.1	10.0	9.1	1.7	9.0	9.1	20.2	9.7	9.8
Sweden	7.1	3.8	7.9	11.4	6.4	9.1	4.3	5.5	6.5	7.8	4.4	4.2	2.4	2.5	2.6	3.3	3.7	2.5	5.4	8.1	13.2	8.3	8.7
UK(Scotland)				1.4								0.1	0.2	2.5	1.1	2.8	0.7				*	0.0	0.0
UK(Engl.&Wales)	2.6	1.4	0.2	1.6	2.0	2.0	1.6	1.3	1.5	1.6	0.5	0.3	*	*	0.8	0.6	0.5	*	*	*	*	0.0	0.1
Germany																3.3	0.5	1.6	1.6	3.7	5.6	6.0	3.7
Netherlands				0.2												5.3	3.7	1.1	2.4	2.4	1.8	1.6	2.3
Faroe Islands																					4.7	1.0	1.0
Belgium																*		*	*	*	*	0.0	
France																				*		0.0	
Total	136.6	103.4	164.3	188.4	195.9	170.2	143.6	176.5	194.3	207.7	113.7	83.8	61.1	133.1	143.5	133.6	85.6	65.9	140.4	290.4	240.7	128.7	191.2
* < 50 t										207.6	0.036												
		Total North Sea																					
Denmark	80.7	98.8	131.1	164.3	191.144	157.141	141.958	175.179	192.738	206.029	103.367	76.829	59.5854	123.774	129.295	110.968	68.929	60.1777	123.474	268.4	196.376	102.27	
Norway	52.8	3.2	31.3	18.8	2.706	9.536	*		0.056		9.807	6.673	1.266	5.83	11.121	10.0278	9.137	1.666	9.014	9.064	20.1521	9.74246	
Sweden	0.5		1.7	2.1		1.51				*				0.87	1.2	1.24	2.223	1.365	3.872	6.75715	12.094	8.1	
UK(Scotland)				1.4								0.07	0.19187	2.54943	1.07534	2.75865	0.651				*	0.00121	
UK(Engl.&Wales)	2.6	1.4	0.2	1.6	2.027	1.996	1.633	1.31022	1.48	1.60524	0.543	0.25	*	*	0.79409	0.5729	0.48503	*	*	*	*	0.04699	

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Germany																3.26	0.471	1.583	1.544	3.70483	5.55025	5.99381	
Netherlands				0.2												5.288	3.66881	1.10066	2.444	2.42085	1.76696	1.58357	
Faroe Islands																					4.711	0.9625	
Belgium																*		*	*	*	*	2.8E-05	
France																				*		1.2E-05	
Total	136.6	103.4	164.3	188.4	195.877	170.183	143.604	176.489	194.274	207.67	113.717	83.822	61.083	133.072	143.485	133.608	85.5648	65.8924	140.378	290.38	240.673	128.66	

* < 50 t

Table 10.1.2. North Sea & 3.a sprat. Catches (tonnes) by quarter. Catches in coastal areas of Norway excluded. Data for 1996–1999 in ICES CM 2007/ACFM:11.

Year	Quarter	Division				Total	Year	Quarter	Division				Total
		27.4.a	27.4.b	27.4.c	27.3.a				27.4.a	27.4.b	27.4.c	27.3.a	
2000	1		18 126	28 063		46 189	2010	1		10 976	17 072	1 462	29 510
	2		1 722	45		1 767		2		3 235	3	648	3 886
	3		131 306	1 216		132 522		3		14 220		3 405	17 625
	4		12 680	2 718		15 398		4		62 006	35 973	4 278	102 257
	Total		163 834	32 042		195 876		Total		90 437	53 048	9 793	153 278
2001	1	115	40 903	9 716		50 734	2011	1		3 747	21 039	3 216	28 002
	2		1 071			1 071		2		2 067	3	617	2 687
	3		44 174	481		44 655		3		22 309	451	2 311	25 072
	4	79	65 102	8 538		73 719		4	8	70 256	13 759	3 887	87 910
	Total	194	151 249	18 735		170 177		Total	8	98 380	35 252	10 031	143 671
2002	1	1 136	2 182	2 790		6 108	2012	1		81	1 649	4 668	6 399
	2		435	93		528		2		2 924	0	909	3 832
	3		70 504	647		71 151		3		26 779	307	1 631	28 717
	4		52 942	12 911		65 853		4		47 765	6 060	2 728	56 553
	Total	1 136	126 063	16 441		143 640		Total		77 549	8 016	9 936	95 501
2003	1		11 458	7 727	5 217	24 402	2013	1		1 281	3 158	1 296	5 734
	2		625	26	1 397	2 049		2		32	0	443	474

Year	Quarter	Division				Total
		27.4.a	27.4.b	27.4.c	27.3.a	
	3		56 207	165	1 720	58 092
	4		84 629	15 651	7 349	107 629
	Total		152 919	23 570	15 683	192 172
2004	1		827	1 831	4 456	7 113
	2	7	260	16	1 510	1 793
	3		54 161	496	4 138	58 794
	4		120 685	15 937	10 775	147 397
	Total	7	175 932	18 280	20 879	215 097
2005	1		11 538	2 457	8 148	22 143
	2		2 515	123	4 722	7 360
	3		107 530		19 418	126 948
	4		82 474	1 033	7 296	90 803
	Total		204 057	3 613	39 584	247 254
2006	1	47	13 713	33 534	8 105	55 399
	2		190	8	324	522
	3		40 051	8	1 440	41 499
	4	2	26 579	77	2 335	28 993

Year	Quarter	Division				Total
		27.4.a	27.4.b	27.4.c	27.3.a	
	3		25 577	720	211	26 509
	4		18 892	16 276	943	36 110
	Total		45 781	20 154	2 893	68 827
2014	1		59	125	384	568
	2		11 631	3	1 415	13 050
	3	1	88 457	1 428	9 622	99 507
	4	7	37 851	822	6 905	45 586
	Total	8	137 999	2 378	18 327	158 711
2015	1	*	14 816	16 972	1 442	33 230
	2		16 843	107	619	17 568
	3		124 512	335	6 528	131 375
	4	25	88 395	28 375	4 389	121 184
	Total	25	244 566	45 789	12 978	303 358
2016	1	68	18 487	5 969	746	25 250
	2		8 927	51	669	9 647
	3	*	158 522	111	4 664	163 297
	4	2	34 070	14 466	1 764	50 301

Year	Quarter	Division				Total	Year	Quarter	Division				Total
		27.4.a	27.4.b	27.4.c	27.3.a				27.4.a	27.4.b	27.4.c	27.3.a	
	Total	49	80 533	33 627	12 204	126 413		Total	70	220 007	20 596	7 843	248 516
2007	1		582	247	2 646	3 475	2017	1	1	3 432	1 220	92	4 745
	2		241	3	1 291	1 535		2		1 327	0	33	1 360
	3		16 603		5 357	21 960		3	0	92 885	217	227	93 329
	4	769	41 850	23 531	4 761	70 911		4	94	29 310	174	849	30 426
	Total	769	59 276	23 781	14 055	97 881		Total	95	126 954	1 611	1 200	129 860
2008	1		2 872	43	2 890	5 805	2018	1	0	8 994	1 628	168	10 790
	2		52	*	1 017	1 069		2		11 898	0	224	12 122
	3		21 787		636	22 423		3		112 361	1	1 328	113 690
	4		27 994	8 334	3 672	40 001		4		46 411	5 922	2 249	54 582
	Total		52 706	8 377	8 215	69 298		Total	0	179 664	7 551	3 969	191 184
2009	1		36	1 268	2 600	3 904							
	2		2 526	1	300	2 827							
	3	22	41 513		3 300	44 835							
	4		78 373	9 336	2 400	90 109							
	Total	22	122 448	10 604	8 600	141 675							

* < 0.5 t

Table 10.2.1. North Sea & 3.a sprat. Species composition in Danish sprat fishery in tonnes and percentage of the total catch. Left: North Sea, right: Division 3.a.

	Year	Sprat	Herring	Horse mack.	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
Tonnes	1998	129 315	11 817	573	673	6	220	11	2 174	1 187	145 978
Tonnes	1999	157 003	7 256	413	1 088	62	321	7	4 972	635	171 757
Tonnes	2000	188 463	11 662	3 239	2 107	66	766	4	423	1 911	208 641
Tonnes	2001	136 443	13 953	67	1 700	223	312	4	17 020	1 141	170 862
Tonnes	2002	140 568	16 644	2 078	2 537	27	715	0	4 102	801	167 471
Tonnes	2003	172 456	10 244	718	1 106	15	799	11	5 357	3 504	194 210
Tonnes	2004	179 944	10 144	474	334	0	4 351	3	3 836	1 821	200 906
Tonnes	2005	201 331	21 035	2 477	545	4	1 009	16	6 859	974	234 251
Tonnes	2006	103 236	8 983	577	343	25	905	4	5 384	576	120 033
Tonnes	2007	74 734	6 596	168	900	6	126	18	6	253	82 807
Tonnes	2008	61 093	7 928	26	380	10	367	0	23	1 735	71 563
Tonnes	2009	112 721	7 222	44	307	3	116	1	1 526	407	122 345
Tonnes	2010	112 395	4 410	11	119	2	18	0	1 236	577	118 769
Tonnes	2011	109 376	8 073	35	191	0	127	0	1 881	345	120 026
Tonnes	2012	67 263	8 573	2	354	0	246	0	93	411	76 943
Tonnes	2013	55 792	5 176	47	445	0	277	2	1	369	62 109
Tonnes	2014	123 180	11 402	0	897	0	70	16	16	1 700	137 280
Tonnes	2015	265 356	4 568	5	1 809	0	527	0	147	3 311	275 723
Tonnes	2016	192 718	11 107	18	4 223	0	439	0	46	2 093	210 643
Tonnes	2017	100 833	5 130	1	1 344	0	197	0	503	12 386	120 394
Tonnes	2018	161 536	7 528	174	716	0	366	0	24	344	170 687
Percent	1998	88.6	8.1	0.4	0.5	0.0	0.2	0.0	1.5	0.8	100.0
Percent	1999	91.4	4.2	0.2	0.6	0.0	0.2	0.0	2.9	0.4	100.0
Percent	2000	90.3	5.6	1.6	1.0	0.0	0.4	0.0	0.2	0.9	100.0
Percent	2001	79.9	8.2	0.0	1.0	0.1	0.2	0.0	10.0	0.7	100.0
Percent	2002	83.9	9.9	1.2	1.5	0.0	0.4	0.0	2.4	0.5	100.0
Percent	2003	88.8	5.3	0.4	0.6	0.0	0.4	0.0	2.8	1.8	100.0
Percent	2004	89.6	5.0	0.2	0.2	0.0	2.2	0.0	1.9	0.9	100.0
Percent	2005	85.9	9.0	1.1	0.2	0.0	0.4	0.0	2.9	0.4	100.0
Percent	2006	86.0	7.5	0.5	0.3	0.0	0.8	0.0	4.5	0.5	100.0
Percent	2007	90.3	8.0	0.2	1.1	0.0	0.2	0.0	0.0	0.3	100.0
Percent	2008	85.4	11.1	0.0	0.5	0.0	0.5	0.0	0.0	2.4	100.0
Percent	2009	92.1	5.9	0.0	0.3	0.0	0.1	0.0	1.2	0.3	100.0
Percent	2010	94.6	3.7	0.0	0.1	0.0	0.0	0.0	1.0	0.5	100.0
Percent	2011	91.1	6.7	0.0	0.2	0.0	0.1	0.0	1.6	0.3	100.0
Percent	2012	87.4	11.1	0.0	0.5	0.0	0.3	0.0	0.1	0.5	100.0
Percent	2013	89.8	8.3	0.1	0.7	0.0	0.4	0.0	0.0	0.6	100.0
Percent	2014	89.7	8.3	0.0	0.7	0.0	0.1	0.0	0.0	1.2	100.0
Percent	2015	96.2	1.7	0.0	0.7	0.0	0.2	0.0	0.1	1.2	100.0
Percent	2016	91.5	5.3	0.0	2.0	0.0	0.2	0.0	0.0	1.0	100.0
Percent	2017	83.8	4.3	0.0	1.1	0.0	0.2	0.0	0.4	10.3	100.0
Percent	2018	94.6	4.4	0.1	0.4	0.0	0.2	0.0	0.0	0.2	100.0

	Year	Sprat	Herring	Horse mack.	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
Tonnes	1998	9 143	3 385	230	467	54	0	49	7	2 866	16 202
Tonnes	1999	16 603	8 470	138	1 026	210	5	75	3 337	2 896	32 760
Tonnes	2000	12 578	8 034	5	1 062	308	8	52	13	3 556	25 617
Tonnes	2001	18 236	8 196	75	1 266	50	13	35	4 281	1 271	33 423
Tonnes	2002	11 451	12 982	21	1 164	3	6	30	606	2 280	28 541
Tonnes	2003	8 182	4 928	340	252	4	4	4	1	567	14 282
Tonnes	2004	13 374	4 620	97	976	18	24	27	116	2 155	21 408
Tonnes	2005	30 157	6 171	244	871	63	18	20	746	1 758	40 047
Tonnes	2006	6 814	2 852	215	276	13	3	45	1	232	10 451
Tonnes	2007	7 116	2 043	34	190	31	8	4	1	469	9 896
Tonnes	2008	4 805	1 948	14	285	0	0	11	462	39	7 563
Tonnes	2009	4 839	3 016	37	169	15	0	1	53	47	8 177
Tonnes	2010	2 851	2 134	25	142	6	1	2	135	171	5 466
Tonnes	2011	4 754	2 461	0	43	0	7	1	141	40	7 447
Tonnes	2012	5 707	5 495	9	149	7	10	5	0	228	11 610
Tonnes	2013	1 143	1 751	2	46	0	0	1	1	27	2 971
Tonnes	2014	16 751	3 777	5	343	1	20	5	12	888	21 801
Tonnes	2015	11 448	5 831	0	565	0	29	8	1	154	18 036
Tonnes	2016	7 001	2 140	0	335	1	19	3	0	78	9 579
Tonnes	2017	963	328	0	172	0	19	1	0	32	1 515
Tonnes	2018	2 872	257	2	150	1	11	0	0	12	3 304
Percent	1998	56.4	20.9	1.4	2.9	0.3	0.0	0.3	0.0	17.7	100.0
Percent	1999	50.7	25.9	0.4	3.1	0.6	0.0	0.2	10.2	8.8	100.0
Percent	2000	49.1	31.4	0.0	4.1	1.2	0.0	0.2	0.1	13.9	100.0
Percent	2001	54.6	24.5	0.2	3.8	0.2	0.0	0.1	12.8	3.8	100.0
Percent	2002	40.1	45.5	0.1	4.1	0.0	0.0	0.1	2.1	8.0	100.0
Percent	2003	57.3	34.5	2.4	1.8	0.0	0.0	0.0	0.0	4.0	100.0
Percent	2004	62.5	21.6	0.5	4.6	0.1	0.1	0.1	0.5	10.1	100.0
Percent	2005	75.3	15.4	0.6	2.2	0.2	0.0	0.0	1.9	4.4	100.0
Percent	2006	65.2	27.3	2.1	2.6	0.1	0.0	0.4	0.0	2.2	100.0
Percent	2007	71.9	20.6	0.3	1.9	0.3	0.1	0.0	0.0	4.7	100.0
Percent	2008	63.5	25.8	0.2	3.8	0.0	0.0	0.1	6.1	0.5	100.0
Percent	2009	59.2	36.9	0.5	2.1	0.2	0.0	0.0	0.6	0.6	100.0
Percent	2010	52.2	39.0	0.5	2.6	0.1	0.0	0.0	2.5	3.1	100.0
Percent	2011	63.8	33.0	0.0	0.6	0.0	0.1	0.0	1.9	0.5	100.0
Percent	2012	49.2	47.3	0.1	1.3	0.1	0.1	0.0	0.0	2.0	100.0
Percent	2013	38.5	58.9	0.1	1.6	0.0	0.0	0.0	0.0	0.9	100.0
Percent	2014	76.8	17.3	0.0	1.6	0.0	0.1	0.0	0.1	4.1	100.0
Percent	2015	63.5	32.3	0.0	3.1	0.0	0.2	0.0	0.0	0.9	100.0
Percent	2016	73.1	22.3	0.0	3.5	0.0	0.2	0.0	0.0	0.8	100.0
Percent	2017	63.6	21.6	0.0	11.4	0.0	1.2	0.1	0.0	2.1	100.0
Percent	2018	86.9	7.8	0.1	4.5	0.0	0.3	0.0	0.0	0.4	100.0

Table 10.2.2. North Sea & 3.a sprat. Catch in numbers by age (1000's) by season and year. (Model year)

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
1974	1	0	16101061	2155723	475613
1974	2	1884146	11544114	866399	48228
1974	3	2842702	11091303	1336036	34534
1974	4	1302331	2511315	359117	14822
1975	1	250931	27723510	10052550	260182
1975	2	1179567	14541887	4378415	166807
1975	3	5240024	4755878	2206781	66186
1975	4	0	0	0	0
1976	1	2143211	42209830	2888653	180913
1976	2	7439656	18762732	1613139	88604
1976	3	7703416	6925346	267638	8289
1976	4	0	0	0	0
1977	1	2690194	12786056	5181867	109712
1977	2	2520082	4904593	3679153	67688
1977	3	15857197	1843468	2200876	37836
1977	4	0	0	0	0
1978	1	454090	32184524	427473	96435
1978	2	5517665	10344970	1209584	116695
1978	3	6154606	4973568	1119045	29941
1978	4	0	0	0	0
1979	1	3579389	36866800	644042	117139
1979	2	1052920	11355949	2152261	63386
1979	3	3882781	6399259	332781	25964
1979	4	0	0	0	0
1980	1	0	14237558	17421360	1481066
1980	2	0	9415158	11520576	979415

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
1980	3	2536060	3866612	389674	8724
1980	4	0	0	0	0
1981	1	428776	12322431	1483241	130805
1981	2	40632	3540737	3025289	202048
1981	3	374254	3854059	319763	9835
1981	4	0	0	0	0
1982	1	545769	6350511	601581	64879
1982	2	818525	5021082	1070960	55333
1982	3	2530673	401839	46913	3525
1982	4	0	0	0	0
1983	1	5613728	2819244	969599	155653
1983	2	2375763	1334333	588678	91112
1983	3	1697718	596857	7271	0
1983	4	0	0	0	0
1984	1	954757	6475021	417235	2532
1984	2	521866	2535354	247654	4803
1984	3	405095	612407	10648	1053
1984	4	0	0	0	0
1985	1	0	1304457	1972027	37680
1985	2	0	576004	870780	16638
1985	3	84760	215856	150819	14916
1985	4	0	0	0	0
1986	1	0	177780	452745	347620
1986	2	0	156913	399604	306818
1986	3	580936	58710	740	0
1986	4	0	0	0	0
1987	1	2236	2250587	128512	2525

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
1987	2	49451	1790264	267597	978
1987	3	209788	826994	34626	32980
1987	4	0	0	0	0
1988	1	4082942	2096911	2830054	42364
1988	2	1163964	314106	527986	11526
1988	3	1817700	637489	129384	5491
1988	4	0	0	0	0
1989	1	12451	1706824	3613841	5716
1989	2	783	76415	88925	342
1989	3	469458	416920	34789	12751
1989	4	0	0	0	0
1990	1	1568	2633068	2234213	342514
1990	2	1225	2058041	1746290	267714
1990	3	291837	62050	1941	429
1990	4	0	0	0	0
1991	1	40504	1684266	2416750	8159
1991	2	1552315	2936717	614233	9587
1991	3	208352	64565	1036	99
1991	4	0	0	0	0
1992	1	18948	9695465	1315325	177584
1992	2	222991	1185132	132166	16491
1992	3	1279875	1583952	259251	5821
1992	4	0	0	0	0
1993	1	264173	3026867	5339043	247839
1993	2	1441317	4911453	1324444	31435
1993	3	1867838	1819506	338969	43965
1993	4	0	0	0	0

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
1994	1	445326	40720484	516854	100737
1994	2	1856101	7146622	1455656	142774
1994	3	818875	2936362	559871	22813
1994	4	0	0	0	0
1995	1	170693	24466578	3192395	371759
1995	2	612010	8620522	2863267	505875
1995	3	1797666	4488224	533786	128194
1995	4	0	0	0	0
1996	1	299367	233497	816511	286503
1996	2	1083655	776795	2208631	911256
1996	3	1670742	289815	113580	49534
1996	4	0	0	0	0
1997	1	6447	2286585	130593	202822
1997	2	148657	4395265	1078225	277615
1997	3	596223	728240	181187	46667
1997	4	0	0	0	0
1998	1	86124	3567341	1498339	258993
1998	2	5465889	2665032	1451844	326463
1998	3	1615982	1096547	489541	241493
1998	4	0	0	0	0
1999	1	830	15939248	477815	69219
1999	2	90557	2456063	254931	44836
1999	3	1967130	3351942	641059	183015
1999	4	0	0	0	0
2000	1	6101	9822669	1767256	70160
2000	2	81906	801375	384854	49827
2000	3	1093613	2807143	1310052	176418

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
2000	4	0	0	0	0
2001	1	13056	5767627	315550	7694
2001	2	550512	3967343	1528712	498496
2001	3	143017	531588	59709	13418
2001	4	0	0	0	0
2002	1	63416	6586442	594557	108679
2002	2	927294	4326530	661656	59022
2002	3	1182692	1199165	296900	65718
2002	4	0	0	0	0
2003	1	197639	4003316	594498	68144
2003	2	2785630	6826281	1115905	218400
2003	3	713229	39824	29774	26427
2003	4	0	0	0	0
2004	1	229309	4217281	731500	78913
2004	2	24806798	4735686	264373	53425
2004	3	5233945	309955	44145	15707
2004	4	0	0	0	0
2005	1	97602	13409729	479222	88858
2005	2	839944	7903545	228337	22051
2005	3	1089274	5408581	230703	38557
2005	4	0	0	0	0
2006	1	0	1987696	1401797	295158
2006	2	319709	493221	1003837	235542
2006	3	176742	129541	176585	10933
2006	4	0	0	0	0
2007	1	0	1693273	189551	67672
2007	2	609939	4186796	1681648	254768

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
2007	3	404452	329724	19675	20964
2007	4	0	0	0	0
2008	1	11590	422430	1447939	329770
2008	2	2087187	1901763	1006626	260966
2008	3	893785	131774	41692	21858
2008	4	0	0	0	0
2009	1	0	4776947	219922	39037
2009	2	231412	8163927	554425	137328
2009	3	168362	3385107	519516	88967
2009	4	0	0	0	0
2010	1	12414	1732171	689166	90040
2010	2	349703	3105417	3011291	2157387
2010	3	298472	2412405	683264	90603
2010	4	0	0	0	0
2011	1	2469	1847215	1105017	281708
2011	2	420004	4234059	2917969	999295
2011	3	57320	250247	95834	42266
2011	4	0	0	0	0
2012	1	147896	2527701	729427	121665
2012	2	187098	3756225	1690250	281071
2012	3	78240	463743	86910	30157
2012	4	0	0	0	0
2013	1	10002	1973364	411558	72705
2013	2	462029	2176971	745578	144434
2013	3	193678	1554	2447	4794
2013	4	0	0	0	0
2014	1	2640874	9499013	627237	105519

Catch at age used as input for the assessment model (years refer to the model years)

Note that all catches in S4 has been moved to S1 in the following year

Year	Season	age 0	age 1	age 2	age 3
2014	2	1215080	4046244	323320	92685
2014	3	1755944	2496884	177328	21685
2014	4	0	0	0	0
2015	1	1682642	12947813	2926867	161595
2015	2	615375	10862082	1632428	226924
2015	3	374504	1926029	733105	90223
2015	4	0	0	0	0
2016	1	4450616	12775033	4537366	439570
2016	2	3593237	1451842	1251213	301252
2016	3	533954	47715	7358	2718
2016	4	0	0	0	0
2017	1	1767809	9076648	738627	88295
2017	2	1302514	2796713	182538	82806
2017	3	658881	807010	184005	68052
2017	4	0	0	0	0
2018	1	4350565	11667334	2940924	279993
2018	2	2025377	2923947	1574333	527760
2018	3	120913	978572	267657	6437
2018	4	0	0	0	0

Table 10.2.3. North Sea & 3.a sprat. Mean weight at age (kg) in catches by season and year. (Model year)

Catch at age used as input for the assessment model (years refer to the model years)					
Note that weights in S4 are not used since there is no catches in S4					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
1974	1	0.0063	0.0083	0.0135	0.0184
1974	2	0.0058	0.0089	0.0150	0.0197
1974	3	0.0050	0.0077	0.0150	0.0197
1974	4	0.0066	0.0107	0.0183	0.0163
1975	1	0.0048	0.0086	0.0129	0.0172
1975	2	0.0075	0.0111	0.0168	0.0216
1975	3	0.0048	0.0106	0.0154	0.0192
1975	4	0.0062	0.0116	0.0170	0.0171
1976	1	0.0049	0.0070	0.0113	0.0134
1976	2	0.0043	0.0090	0.0153	0.0190
1976	3	0.0022	0.0059	0.0104	0.0126
1976	4	0.0034	0.0057	0.0085	0.0106
1977	1	0.0054	0.0082	0.0126	0.0180
1977	2	0.0059	0.0110	0.0146	0.0196
1977	3	0.0023	0.0080	0.0106	0.0138
1977	4	0.0025	0.0063	0.0083	0.0122
1978	1	0.0038	0.0069	0.0122	0.0146
1978	2	0.0044	0.0103	0.0155	0.0196
1978	3	0.0031	0.0089	0.0123	0.0166
1978	4	0.0020	0.0052	0.0087	0.0094
1979	1	0.0050	0.0058	0.0087	0.0113
1979	2	0.0057	0.0105	0.0150	0.0173
1979	3	0.0032	0.0077	0.0129	0.0165
1979	4	0.0029	0.0106	0.0121	0.0153
1980	1	0.0063	0.0052	0.0068	0.0083
1980	2	0.0051	0.0052	0.0069	0.0083
1980	3	0.0032	0.0086	0.0131	0.0168

Catch at age used as input for the assessment model (years refer to the model years)

Note that weights in S4 are not used since there is no catches in S4

Year	Season	age 0	age 1	age 2	age 3
1980	4	0.0046	0.0073	0.0105	0.0101
1981	1	0.0038	0.0099	0.0129	0.0156
1981	2	0.0082	0.0126	0.0153	0.0194
1981	3	0.0049	0.0089	0.0157	0.0194
1981	4	0.0060	0.0139	0.0191	0.0192
1982	1	0.0085	0.0089	0.0171	0.0155
1982	2	0.0071	0.0110	0.0160	0.0219
1982	3	0.0029	0.0075	0.0115	0.0174
1982	4	0.0044	0.0078	0.0114	0.0160
1983	1	0.0044	0.0092	0.0128	0.0152
1983	2	0.0042	0.0124	0.0169	0.0211
1983	3	0.0034	0.0094	0.0174	0.0163
1983	4	0.0038	0.0093	0.0127	0.0156
1984	1	0.0060	0.0081	0.0121	0.0166
1984	2	0.0053	0.0122	0.0168	0.0164
1984	3	0.0093	0.0135	0.0197	0.0197
1984	4	0.0093	0.0135	0.0197	0.0197
1985	1	0.0063	0.0093	0.0135	0.0197
1985	2	0.0051	0.0093	0.0135	0.0197
1985	3	0.0073	0.0099	0.0166	0.0166
1985	4	0.0073	0.0099	0.0166	0.0166
1986	1	0.0063	0.0073	0.0099	0.0166
1986	2	0.0051	0.0073	0.0099	0.0166
1986	3	0.0083	0.0164	0.0228	0.0163
1986	4	0.0084	0.0156	0.0208	0.0156
1987	1	0.0066	0.0086	0.0117	0.0153
1987	2	0.0060	0.0093	0.0112	0.0165

Catch at age used as input for the assessment model (years refer to the model years)

Note that weights in S4 are not used since there is no catches in S4

Year	Season	age 0	age 1	age 2	age 3
1987	3	0.0064	0.0125	0.0175	0.0206
1987	4	0.0068	0.0125	0.0167	0.0189
1988	1	0.0042	0.0088	0.0115	0.0138
1988	2	0.0046	0.0085	0.0113	0.0137
1988	3	0.0052	0.0132	0.0208	0.0158
1988	4	0.0063	0.0117	0.0155	0.0175
1989	1	0.0054	0.0086	0.0099	0.0170
1989	2	0.0044	0.0082	0.0109	0.0130
1989	3	0.0048	0.0077	0.0125	0.0155
1989	4	0.0046	0.0086	0.0115	0.0129
1990	1	0.0046	0.0070	0.0092	0.0115
1990	2	0.0038	0.0069	0.0092	0.0113
1990	3	0.0044	0.0099	0.0133	0.0156
1990	4	0.0048	0.0089	0.0119	0.0135
1991	1	0.0128	0.0143	0.0154	0.0168
1991	2	0.0048	0.0146	0.0189	0.0168
1991	3	0.0052	0.0101	0.0147	0.0172
1991	4	0.0062	0.0118	0.0152	0.0186
1992	1	0.0081	0.0099	0.0124	0.0148
1992	2	0.0058	0.0121	0.0153	0.0178
1992	3	0.0035	0.0096	0.0141	0.0179
1992	4	0.0042	0.0078	0.0104	0.0118
1993	1	0.0065	0.0109	0.0123	0.0138
1993	2	0.0075	0.0107	0.0135	0.0164
1993	3	0.0022	0.0080	0.0116	0.0152
1993	4	0.0023	0.0128	0.0154	0.0134
1994	1	0.0068	0.0067	0.0095	0.0129

Catch at age used as input for the assessment model (years refer to the model years)

Note that weights in S4 are not used since there is no catches in S4

Year	Season	age 0	age 1	age 2	age 3
1994	2	0.0087	0.0104	0.0125	0.0151
1994	3	0.0030	0.0082	0.0097	0.0140
1994	4	0.0038	0.0068	0.0090	0.0131
1995	1	0.0032	0.0082	0.0117	0.0121
1995	2	0.0051	0.0101	0.0133	0.0155
1995	3	0.0084	0.0096	0.0129	0.0158
1995	4	0.0058	0.0107	0.0142	0.0161
1996	1	0.0071	0.0108	0.0142	0.0175
1996	2	0.0079	0.0115	0.0150	0.0169
1996	3	0.0029	0.0062	0.0087	0.0103
1996	4	0.0031	0.0057	0.0077	0.0086
1997	1	0.0071	0.0128	0.0148	0.0163
1997	2	0.0058	0.0120	0.0161	0.0199
1997	3	0.0071	0.0097	0.0122	0.0147
1997	4	0.0052	0.0095	0.0127	0.0144
1998	1	0.0056	0.0139	0.0166	0.0186
1998	2	0.0050	0.0124	0.0153	0.0177
1998	3	0.0043	0.0061	0.0095	0.0094
1998	4	0.0039	0.0073	0.0097	0.0110
1999	1	0.0053	0.0097	0.0115	0.0121
1999	2	0.0046	0.0116	0.0135	0.0164
1999	3	0.0036	0.0094	0.0118	0.0138
1999	4	0.0052	0.0097	0.0129	0.0146
2000	1	0.0067	0.0122	0.0148	0.0185
2000	2	0.0062	0.0149	0.0174	0.0183
2000	3	0.0051	0.0105	0.0131	0.0150
2000	4	0.0036	0.0046	0.0080	0.0135

Catch at age used as input for the assessment model (years refer to the model years)

Note that weights in S4 are not used since there is no catches in S4

Year	Season	age 0	age 1	age 2	age 3
2001	1	0.0078	0.0109	0.0118	0.0159
2001	2	0.0048	0.0116	0.0136	0.0166
2001	3	0.0062	0.0127	0.0150	0.0162
2001	4	0.0065	0.0120	0.0161	0.0181
2002	1	0.0073	0.0109	0.0141	0.0154
2002	2	0.0077	0.0122	0.0142	0.0158
2002	3	0.0047	0.0101	0.0133	0.0145
2002	4	0.0060	0.0116	0.0129	0.0155
2003	1	0.0042	0.0125	0.0146	0.0228
2003	2	0.0058	0.0108	0.0145	0.0167
2003	3	0.0049	0.0115	0.0135	0.0141
2003	4	0.0050	0.0092	0.0123	0.0139
2004	1	0.0088	0.0116	0.0139	0.0154
2004	2	0.0041	0.0094	0.0126	0.0153
2004	3	0.0030	0.0097	0.0112	0.0130
2004	4	0.0044	0.0093	0.0115	0.0129
2005	1	0.0076	0.0097	0.0130	0.0154
2005	2	0.0066	0.0103	0.0115	0.0141
2005	3	0.0055	0.0080	0.0114	0.0138
2005	4	0.0047	0.0087	0.0115	0.0130
2006	1	0.0063	0.0108	0.0133	0.0152
2006	2	0.0055	0.0143	0.0158	0.0180
2006	3	0.0041	0.0095	0.0129	0.0134
2006	4	0.0050	0.0093	0.0124	0.0139
2007	1	0.0063	0.0119	0.0131	0.0149
2007	2	0.0065	0.0101	0.0127	0.0151
2007	3	0.0045	0.0075	0.0106	0.0126

Catch at age used as input for the assessment model (years refer to the model years)

Note that weights in S4 are not used since there is no catches in S4

Year	Season	age 0	age 1	age 2	age 3
2007	4	0.0048	0.0089	0.0118	0.0133
2008	1	0.0088	0.0103	0.0114	0.0131
2008	2	0.0044	0.0076	0.0126	0.0142
2008	3	0.0034	0.0076	0.0082	0.0085
2008	4	0.0044	0.0068	0.0090	0.0081
2009	1	0.0063	0.0096	0.0123	0.0142
2009	2	0.0046	0.0095	0.0130	0.0160
2009	3	0.0043	0.0077	0.0103	0.0135
2009	4	0.0087	0.0096	0.0105	0.0141
2010	1	0.0066	0.0080	0.0097	0.0137
2010	2	0.0047	0.0094	0.0114	0.0148
2010	3	0.0050	0.0072	0.0094	0.0130
2010	4	0.0038	0.0071	0.0095	0.0107
2011	1	0.0052	0.0085	0.0101	0.0134
2011	2	0.0044	0.0089	0.0114	0.0145
2011	3	0.0042	0.0102	0.0128	0.0171
2011	4	0.0050	0.0092	0.0123	0.0139
2012	1	0.0085	0.0087	0.0106	0.0150
2012	2	0.0072	0.0087	0.0119	0.0152
2012	3	0.0040	0.0069	0.0113	0.0146
2012	4	0.0047	0.0087	0.0117	0.0132
2013	1	0.0061	0.0096	0.0120	0.0150
2013	2	0.0043	0.0097	0.0124	0.0156
2013	3	0.0026	0.0051	0.0071	0.0084
2013	4	0.0022	0.0094	0.0128	0.0153
2014	1	0.0086	0.0086	0.0104	0.0168
2014	2	0.0070	0.0079	0.0116	0.0139

Catch at age used as input for the assessment model (years refer to the model years)

Note that weights in S4 are not used since there is no catches in S4

Year	Season	age 0	age 1	age 2	age 3
2014	3	0.0053	0.0083	0.0116	0.0119
2014	4	0.0065	0.0099	0.0101	0.0115
2015	1	0.0076	0.0082	0.0104	0.0150
2015	2	0.0072	0.0088	0.0109	0.0155
2015	3	0.0038	0.0078	0.0107	0.0153
2015	4	0.0044	0.0082	0.0109	0.0123
2016	1	0.0041	0.0077	0.0112	0.0145
2016	2	0.0051	0.0074	0.0118	0.0145
2016	3	0.0073	0.0143	0.0199	0.0235
2016	4	0.0076	0.0141	0.0188	0.0212
2017	1	0.0064	0.0083	0.0103	0.0139
2017	2	0.0038	0.0078	0.0099	0.0162
2017	3	0.0042	0.0064	0.0098	0.0130
2017	4	0.0076	0.0141	0.0188	0.0212
2018	1	0.0046	0.0066	0.0086	0.0123
2018	2	0.0053	0.0074	0.0097	0.0132
2018	3	0.0042	0.0066	0.0097	0.0128
2018	4	0.0076	0.0141	0.0188	0.0212

Table 10.2.4. North Sea & 3.a sprat. Sampling for biological parameters in 2018. This table only shows age-length samples, and therefore the number of samples may differ from Table 10.2.5.

Country	Quarter	Landings ('000 tonnes)	No. samples	No. measured	No. aged
Denmark	1	9.81	8	790	348
	2	11.90	6	762	287
	3	98.60	61	8 002	2 972
	4	45.32	47	5 351	2 312
	Total	165.62	122	14905	5919
Norway	1	0.78	1	100	50
	2				
	3	5.92	5	369	213
	4	3.07	3	305	107
	Total	9.78	9	774	370
Sweden	1	0.13	3	107	107
	2				
	3	5.92			
	4	2.62	10	840	840
	Total	8.67	13	947	947
All countries	1	10.79	12	997	505
	2	12.12	6	762	287
	3	113.69	66	8371	3185
	4	54.58	60	6496	3259
Total North Sea	Total	191.18	144	16 626	7 236

Table 10.2.5. North Sea & 3.a sprat. Number of biological samples taken from 1991 and onward. The number of samples may differ from Table 8.2.4, since this table shows both length and age-length samples. These are the samples used to generate the catch-at-age matrix for the assessment model (Model year).

Year	S1	S2	S3	S4
1974	15	31	102	25
1975	67	46	40	11
1976	54	70	53	16
1977	37	51	32	18
1978	52	78	47	22
1979	86	55	90	9
1980	0	0	49	28
1981	61	32	29	14
1982	27	48	13	16
1983	11	44	27	8

Year	S1	S2	S3	S4
1984	9	23	29	7
1985	4	4	0	4
1986	4	1	0	1
1987	16	15	4	3
1988	8	4	9	1
1989	13	0	7	2
1990	4	0	13	1
1991	6	56	15	8
1992	42	35	24	4
1993	21	30	24	7
1994	42	50	32	5
1995	40	47	41	4
1996	2	12	8	3
1997	9	34	12	1
1998	25	38	16	3
1999	41	25	25	1
2000	29	23	22	14
2001	23	9	17	4
2002	26	37	28	7
2003	12	60	17	2
2004	26	43	24	15
2005	77	56	56	2
2006	23	7	13	0
2007	34	40	13	4
2008	10	9	14	5
2009	33	36	18	5
2010	35	28	15	3
2011	28	57	20	3
2012	37	88	15	3

Year	S1	S2	S3	S4
2013	31	23	2	10
2014	116	19	19	13
2015	165	47	21	2
2016	90	30	3	0
2017	69	21	11	6
2018	65	60	11	0

Table 10.3.1. North Sea sprat. Abundance indices by age from IBTS Q1

IBTS Q1 survey index (sa 4 and 3a combined; years and ages apply to the model year)				
Index is calculated using a delta GAM model formulation (see Stock Annex)				
Year	**Age 0**	**Age 1**	**Age 2**	**Age 3**
1982	252619	551262	574173	47111
1983	619180	553686	100186	25687
1984	374594	292408	75083	19254
1985	116338	137304	39250	9993
1986	503284	86061	25143	9769
1987	248663	789924	77117	15148
1988	744970	154929	114877	11326
1989	360108	185946	47580	21180
1990	1412224	176334	33438	7582
1991	1882139	281520	36961	9645
1992	1863182	1224852	103248	10709
1993	1195289	887347	132008	8288
1994	2258852	2257140	263386	10391
1995	604673	967027	199658	28253
1996	599335	270098	168138	27513
1997	1072937	1104108	180777	16056
1998	5183400	583736	73757	5308
1999	2017439	1164352	150449	25036

IBTS Q1 survey index (sa 4 and 3a combined; years and ages apply to the model year)				
Index is calculated using a delta GAM model formulation (see Stock Annex)				
Year	**Age 0**	**Age 1**	**Age 2**	**Age 3**
2000	1997862	1309083	239142	13995
2001	1191954	968965	87712	10393
2002	2493114	589410	66441	5540
2003	4084377	685280	106637	9076
2004	8918279	675529	29062	2718
2005	1230441	1416990	58676	7654
2006	1917763	1035569	162880	12506
2007	1526985	803061	47400	8526
2008	4133598	312030	34043	3833
2009	3288300	2489705	118665	17586
2010	1078333	926246	206207	47562
2011	3356603	3143308	245116	36666
2012	1137772	1116849	203191	29306
2013	3886605	443621	50655	9871
2014	7727188	3460669	317090	26651
2015	2112309	3409890	675849	37763
2016	10317128	1707447	128002	15146
2017	10440866	1547476	94598	11384
2018	6097175	2511994	226057	9585

Table 10.3.1. North Sea sprat. Abundance indices by age from IBTS Q3

IBTS Q3 survey index (sa 4 and 3a combined; years and ages apply to the model year and calendar year)			
Index is calculated using a delta GAM model formulation (see Stock Annex)			
Year	**Age 1**	**Age 2**	**Age 3**
1992	14555861	2633020	104865
1993	5767651	3015219	217792
1994	16468664	1326478	95089
1995	30622687	7433288	454582
1996	2317117	2219591	215543
1997	13080865	1171944	200385
1998	2676263	1107920	117795
1999	13792780	1719505	82599
2000	8212868	3228536	133847
2001	8998081	2277278	187452
2002	10011480	1319291	102476
2003	11610320	1272970	66231
2004	14371331	1945227	122791
2005	52835449	2266372	102272
2006	9340785	5459057	155440
2007	10549586	1552282	184767
2008	7894186	2085499	130785
2009	35252950	3032568	337850
2010	35355908	9422666	428224
2011	16742275	8341042	1191533
2012	11469646	5231406	575643
2013	9052264	3060010	414534
2014	63182232	3573736	215965
2015	59775893	18619852	653613
2016	27891385	4266699	482295
2017	27754797	2886164	173266
2017	18709889	3123833	200733

Table 10.3.2. North Sea & 3.a sprat. HERAS survey index.

HERAS abundance index (sa 4 and 3.a summed), data is from WGIPS (2019)			
Years and ages apply to the model year and calendar year			
Year	**Age 1**	**Age 2**	**Age 3**
2006	21923	21368	1413
2007	42862	5837	2252
2008	17188	7868	840
2009	47690	16920	2815
2010	20328	14087	1174
2011	26581	14207	3412
2012	22036	12831	4693
2013	9347	6342	2049
2014	59020	20274	3982
2015	27082	22676	10142
2016	58604	33989	8160
2017	38135	3664	1465
2018	109180	10113	779

Table 10.6.1. North Sea & 3.a sprat. Natural mortality input (Model year). From multi-species SMS (WKSAM: ICES, 2015) 2015 key run.

Year	Season	age 0	age 1	age 2	age 3
1974	1	0.483	0.456	0.402	0.280
1974	2	0.327	0.235	0.217	0.188
1974	3	0.297	0.275	0.175	0.175
1974	4	0.445	0.409	0.318	0.318
1975	1	0.518	0.492	0.422	0.237
1975	2	0.289	0.220	0.200	0.169
1975	3	0.329	0.299	0.218	0.218
1975	4	0.474	0.442	0.423	0.423
1976	1	0.490	0.466	0.415	0.290
1976	2	0.318	0.242	0.225	0.195

Year	Season	age 0	age 1	age 2	age 3
1976	3	0.364	0.332	0.240	0.240
1976	4	0.485	0.443	0.421	0.421
1977	1	0.441	0.411	0.368	0.312
1977	2	0.373	0.245	0.227	0.199
1977	3	0.380	0.351	0.248	0.248
1977	4	0.490	0.440	0.432	0.432
1978	1	0.411	0.398	0.385	0.330
1978	2	0.347	0.230	0.218	0.192
1978	3	0.382	0.356	0.208	0.208
1978	4	0.445	0.396	0.374	0.374
1979	1	0.436	0.424	0.419	0.405
1979	2	0.416	0.252	0.245	0.227
1979	3	0.393	0.366	0.232	0.232
1979	4	0.444	0.389	0.377	0.377
1980	1	0.470	0.464	0.444	0.415
1980	2	0.447	0.261	0.257	0.230
1980	3	0.388	0.355	0.232	0.232
1980	4	0.419	0.372	0.336	0.336
1981	1	0.501	0.486	0.448	0.360
1981	2	0.409	0.271	0.267	0.232
1981	3	0.361	0.314	0.222	0.222
1981	4	0.376	0.330	0.267	0.267
1982	1	0.511	0.431	0.377	0.245
1982	2	0.331	0.231	0.217	0.177
1982	3	0.305	0.231	0.182	0.182
1982	4	0.318	0.277	0.205	0.205
1983	1	0.532	0.429	0.349	0.224
1983	2	0.336	0.235	0.217	0.194
1983	3	0.296	0.207	0.173	0.173

Year	Season	age 0	age 1	age 2	age 3
1983	4	0.312	0.259	0.168	0.168
1984	1	0.539	0.425	0.287	0.182
1984	2	0.397	0.236	0.209	0.189
1984	3	0.309	0.239	0.177	0.177
1984	4	0.321	0.274	0.197	0.197
1985	1	0.549	0.502	0.373	0.198
1985	2	0.482	0.277	0.251	0.210
1985	3	0.323	0.249	0.178	0.178
1985	4	0.318	0.269	0.165	0.165
1986	1	0.590	0.534	0.422	0.254
1986	2	0.452	0.313	0.288	0.227
1986	3	0.346	0.258	0.188	0.188
1986	4	0.335	0.284	0.169	0.169
1987	1	0.596	0.484	0.443	0.256
1987	2	0.470	0.315	0.299	0.232
1987	3	0.356	0.217	0.190	0.190
1987	4	0.338	0.281	0.185	0.185
1988	1	0.622	0.502	0.455	0.258
1988	2	0.493	0.342	0.316	0.270
1988	3	0.371	0.238	0.220	0.220
1988	4	0.361	0.301	0.233	0.233
1989	1	0.603	0.509	0.433	0.214
1989	2	0.525	0.332	0.294	0.261
1989	3	0.356	0.228	0.221	0.221
1989	4	0.374	0.312	0.281	0.281
1990	1	0.518	0.489	0.402	0.244
1990	2	0.496	0.331	0.283	0.261
1990	3	0.337	0.260	0.249	0.249
1990	4	0.387	0.319	0.287	0.287

Year	Season	age 0	age 1	age 2	age 3
1991	1	0.462	0.423	0.320	0.263
1991	2	0.396	0.269	0.232	0.211
1991	3	0.310	0.264	0.223	0.223
1991	4	0.389	0.320	0.287	0.287
1992	1	0.410	0.360	0.281	0.255
1992	2	0.312	0.227	0.204	0.180
1992	3	0.294	0.275	0.212	0.212
1992	4	0.371	0.299	0.270	0.270
1993	1	0.456	0.414	0.340	0.303
1993	2	0.238	0.209	0.190	0.173
1993	3	0.272	0.253	0.192	0.192
1993	4	0.347	0.274	0.244	0.244
1994	1	0.502	0.446	0.348	0.337
1994	2	0.292	0.223	0.197	0.182
1994	3	0.258	0.219	0.190	0.190
1994	4	0.318	0.248	0.223	0.223
1995	1	0.512	0.460	0.338	0.308
1995	2	0.290	0.223	0.195	0.182
1995	3	0.222	0.191	0.178	0.178
1995	4	0.265	0.211	0.190	0.190
1996	1	0.504	0.395	0.263	0.214
1996	2	0.363	0.227	0.202	0.177
1996	3	0.215	0.171	0.151	0.151
1996	4	0.238	0.195	0.156	0.156
1997	1	0.451	0.293	0.210	0.155
1997	2	0.298	0.204	0.187	0.154
1997	3	0.227	0.193	0.171	0.171
1997	4	0.269	0.214	0.171	0.171
1998	1	0.430	0.283	0.226	0.190

Year	Season	age 0	age 1	age 2	age 3
1998	2	0.362	0.197	0.176	0.145
1998	3	0.252	0.209	0.173	0.173
1998	4	0.318	0.245	0.197	0.197
1999	1	0.421	0.287	0.232	0.214
1999	2	0.291	0.191	0.169	0.152
1999	3	0.275	0.241	0.191	0.191
1999	4	0.335	0.267	0.242	0.242
2000	1	0.406	0.342	0.253	0.219
2000	2	0.355	0.199	0.180	0.170
2000	3	0.254	0.213	0.157	0.157
2000	4	0.279	0.236	0.192	0.192
2001	1	0.409	0.328	0.233	0.190
2001	2	0.299	0.213	0.202	0.195
2001	3	0.266	0.225	0.191	0.191
2001	4	0.306	0.258	0.213	0.213
2002	1	0.434	0.321	0.240	0.171
2002	2	0.315	0.223	0.214	0.206
2002	3	0.252	0.206	0.194	0.194
2002	4	0.323	0.262	0.218	0.218
2003	1	0.419	0.269	0.215	0.168
2003	2	0.295	0.229	0.208	0.204
2003	3	0.259	0.229	0.226	0.226
2003	4	0.383	0.308	0.286	0.286
2004	1	0.436	0.276	0.231	0.192
2004	2	0.278	0.216	0.193	0.185
2004	3	0.231	0.212	0.208	0.208
2004	4	0.376	0.302	0.278	0.278
2005	1	0.442	0.321	0.227	0.216
2005	2	0.309	0.219	0.181	0.174

Year	Season	age 0	age 1	age 2	age 3
2005	3	0.220	0.201	0.179	0.179
2005	4	0.367	0.291	0.225	0.225
2006	1	0.504	0.315	0.226	0.215
2006	2	0.265	0.212	0.172	0.166
2006	3	0.217	0.197	0.172	0.172
2006	4	0.364	0.277	0.202	0.202
2007	1	0.480	0.312	0.204	0.184
2007	2	0.287	0.222	0.170	0.166
2007	3	0.210	0.175	0.152	0.152
2007	4	0.312	0.237	0.175	0.175
2008	1	0.478	0.307	0.187	0.166
2008	2	0.269	0.203	0.157	0.151
2008	3	0.200	0.173	0.167	0.167
2008	4	0.304	0.225	0.197	0.197
2009	1	0.444	0.362	0.233	0.162
2009	2	0.327	0.200	0.158	0.150
2009	3	0.190	0.170	0.163	0.163
2009	4	0.293	0.215	0.190	0.190
2010	1	0.527	0.412	0.312	0.170
2010	2	0.395	0.217	0.179	0.164
2010	3	0.207	0.182	0.159	0.159
2010	4	0.309	0.226	0.197	0.197
2011	1	0.511	0.437	0.386	0.182
2011	2	0.381	0.239	0.193	0.179
2011	3	0.229	0.202	0.179	0.179
2011	4	0.338	0.254	0.224	0.224
2012	1	0.509	0.432	0.344	0.176
2012	2	0.368	0.238	0.191	0.178
2012	3	0.219	0.176	0.145	0.145

Year	Season	age 0	age 1	age 2	age 3
2012	4	0.292	0.225	0.180	0.180
2013	1	0.399	0.367	0.285	0.150
2013	2	0.271	0.209	0.164	0.158
2013	3	0.206	0.175	0.148	0.148
2013	4	0.270	0.221	0.178	0.178
2014	1	0.367	0.335	0.245	0.140
2014	2	0.257	0.198	0.167	0.154
2014	3	0.211	0.181	0.153	0.153
2014	4	0.272	0.227	0.184	0.184
2015	1	0.365	0.339	0.249	0.139
2015	2	0.237	0.194	0.164	0.149
2015	3	0.212	0.177	0.149	0.149
2015	4	0.278	0.224	0.181	0.181
2016	1	0.377	0.347	0.260	0.143
2016	2	0.255	0.200	0.165	0.153
2016	3	0.212	0.177	0.149	0.149
2016	4	0.278	0.224	0.181	0.181
2017	1	0.377	0.347	0.260	0.143
2017	2	0.255	0.200	0.165	0.153
2017	3	0.212	0.177	0.149	0.149
2017	4	0.278	0.224	0.181	0.181
2018	1	0.377	0.347	0.260	0.143
2018	2	0.255	0.200	0.165	0.153
2018	3	0.212	0.177	0.149	0.149
2018	4	0.278	0.224	0.181	0.181

Table 10.6.2. North Sea sprat. Assessment diagnostics.

Date: 03/15/19 Start time:16:38:31 run time:1 seconds

objective function (negative log likelihood): 266.022

Number of parameters: 137

Maximum gradient: 0.0264053

Akaike information criterion (AIC): 806.044

Number of observations used in the likelihood:

Catch	CPUE	S/R	Stomach	Sum
720	268	45	0	1033

objective function weight:

Catch	CPUE	S/R
1.00	1.00	0.10

unweighted objective function contributions (total):

Catch	CPUE	S/R	Stom.	Stom N.	Penalty	Sum
365.3	-100.5	11.8	0.0	0.0	0.00	277

unweighted objective function contributions (per observation):

Catch	CPUE	S/R	Stomachs
0.51	-0.37	0.26	0.00

contribution by fleet:

IBTS Q1 total: -49.835 mean: -0.337

IBTS Q3 total: -41.144 mean: -0.508

Acoustic total: -9.508 mean: -0.244

F, season effect:

---

age: 0

1974-2018: 0.033 0.212 0.394 0.250

age: 1

1974-2018: 0.521 0.539 0.218 0.250

age: 2

1974-2018: 0.245 0.491 0.136 0.250

age: 3

1974-2018: 0.215 0.496 0.319 0.250

F, age effect:

	0	1	2	3
1974-2018:	0.038	0.417	1.480	1.480

Exploitation pattern (scaled to mean F=1)

		0	1	2	3
1974-2018	season 1:	0.001	0.189	0.315	0.277
	season 2:	0.007	0.196	0.633	0.639
	season 3:	0.013	0.079	0.176	0.412
	season 4:	0.008	0.091	0.322	0.322

sqrt(catch variance) ~ CV:

---

	season			
age	1	2	3	4
0	1.414	1.414	1.155	0.100
1	0.861	0.693	1.414	0.100
2	1.035	1.063	1.414	0.100
3	1.035	1.063	1.414	0.100

Survey catchability:

---

	age 0	age 1	age 2	age 3
IBTS Q1	0.000	1.470	2.827	4.487
IBTS Q3		0.772	0.997	0.932
Acoustic		1.045	2.333	6.072

Stock size dependent catchability (power model)

		age 0	age 1	age 2	age 3
IBTS Q1	1.58	1.00	1.00	1.00	
IBTS Q3		1.00	1.00	1.00	
Acoustic		1.00	1.00	1.00	

sqrt(Survey variance) ~ CV:

	age 0	age 1	age 2	age 3
IBTS Q1	0.47	0.42	0.42	0.42
IBTS Q3		0.46	0.32	0.32
Acoustic		0.45	0.49	0.49

Recruit-SSB		alfa	beta	recruit s2	recruit s
Sprat	Hockey stick -break.:	1392.285	9.000e+004	0.621	0.788

Table 10.6.3. North Sea & 3.a Sprat. Assessment output: Stock numbers (thousands) (years, seasons, and age refer to the model year).

Year/Age Quarter	A00S1	A00S2	A00S3	A00S4	A01S1	A01S2	A01S3	A01S4	A02S1	A02S2	A02S3	A02S4	A03S1	A03S2	A03S3	A03S4
1974	533667000	328875000	235319000	172346000	138012000	70385100	44432900	30828200	10746300	5006380	1948140	1336540	485584	267092	106286	55619
1975	712689000	423481000	312599000	219115000	109421000	45596200	24606900	15548000	18451300	6383020	1448740	815527	699739	314887	72750	25385
1976	330409000	202020000	144894000	98009200	136460000	57750600	30179300	18354400	9997240	3423270	731948	399113	550925	231443	50329	16791
1977	631497000	405708000	275921000	184392000	60321000	28383400	15579900	9496200	11785000	4598860	1160670	657922	273059	120807	31009	11452
1978	1033370000	684142000	479393000	322208000	113014000	60452900	37928900	24138700	6117920	2846870	1067060	701460	434619	223763	85446	42267
1979	534780000	345451000	226623000	151382000	206526000	116443000	77560800	50529400	16239200	8330960	3957680	2733000	511616	274342	132104	75735
1980	328622000	204788000	128468000	84170100	97069800	36530600	16528300	9344830	34233600	9322120	1290550	634258	1926640	598756	83726	21669
1981	94281300	57064600	37548000	25738500	55360000	26534100	15623400	10283000	6440630	2713730	900184	571346	468557	226575	77223	35885
1982	49287200	29542100	21035300	15261800	17665200	9127130	5717620	4122110	7390680	3457780	1292650	870694	464976	260023	100318	50762
1983	66959800	39231000	27634600	20018500	11104800	4923770	2613990	1809790	3125200	1160900	257741	151580	750389	341225	76568	27864
1984	33535900	19546000	13041000	9432390	14649500	7681260	4832080	3471250	1396220	725586	281622	192142	151643	91497	35957	18636
1985	23326400	13445100	8209920	5824610	6839640	3062280	1698140	1166720	2638750	1097510	310481	196274	173042	91146	26601	11533
1986	79160700	43826900	27626500	19215400	4236710	1933460	1090380	758119	891230	384686	124529	81724	176193	94570	32251	15474
1987	40836300	22491100	14007900	9752320	13743100	7783180	5201730	4042630	570443	318041	177599	135739	82060	56091	33415	22978
1988	60893000	32651900	19729300	13333700	6956140	3123930	1629070	1132460	3052250	1176030	315312	191624	131958	65750	18265	7644
1989	54629700	29865400	17615500	12279100	9290040	5202980	3469820	2680900	837769	482840	284187	213304	157917	114954	69761	47948
1990	73835200	43904700	26400500	18398600	8446340	3636000	1810980	1203860	1962720	727217	167490	93938	197178	91909	21398	7716
1991	112582000	70847800	47414200	34374200	12494900	6941390	4471330	3205800	875415	482868	220587	151345	76309	46071	21370	11937
1992	104251000	69105100	50226800	36950400	23299100	13428700	8783870	6158140	2327630	1277310	549667	372199	122524	71764	31415	16760
1993	150399000	95169800	73966900	54926500	25504900	11620100	6414900	4261430	4566470	1745690	414980	242167	296851	126945	30293	11106
1994	128713000	77807400	57739600	44133500	38804300	21109200	14272500	10706400	3238940	1744190	831909	591407	198449	111713	53804	31233
1995	36331900	21729500	16051000	12557300	32119400	14373200	8048530	5756720	8356860	3352310	869562	528148	498233	220989	57464	22700
1996	60863800	36695200	25224200	19911700	9637460	4723710	2708550	1997540	4661890	2108050	594150	380068	455689	230805	66007	28393
1997	49103400	31231700	22995800	18030300	15695400	9265190	5929210	4431900	1643930	901345	341263	231379	349417	212301	82476	41750
1998	109864000	71336600	48968100	37069100	13776800	7010460	3832230	2638020	3577060	1480310	332721	194197	230196	106922	24470	8744
1999	77583000	50844100	37734700	28274200	26976200	16457600	10979000	7913680	2064240	1158330	488975	333190	166699	99329	42360	22293
2000	73316900	48756100	33757500	25594900	20233400	10242100	5908950	4142240	6058510	2670250	715873	446259	278978	136317	36524	14907
2001	61396800	40712300	29793800	22276100	19371100	9770820	5458710	3752460	3272560	1429950	354083	209889	380576	186540	45976	17464
2002	82225000	53134800	38226500	28962100	16398800	8158960	4422480	3073410	2897880	1215670	278086	161287	183700	89144	20305	7359
2003	106874000	70149900	51684600	39112300	20974800	11998400	7073870	4982780	2365920	1176690	362314	220858	135640	74963	22963	9752
2004	188359000	121451000	90500900	69706900	26678000	13037300	6660790	4482050	3661390	1395120	263657	142258	173259	75000	14076	4385
2005	66445300	42649800	30958400	24323500	47872200	25646200	15050800	10842400	3312600	1590730	480232	302627	111011	57305	17251	7442
2006	84862900	51157500	38706300	30343500	16855200	8364420	4538870	3171110	8102270	3394780	784029	460667	247597	113392	26016	9439
2007	60934300	37622400	27838800	21995300	21079400	10639200	5801840	4169550	2403350	1054130	256226	155750	383995	185232	44644	17067
2008	140415000	86918600	65670600	52607200	16094600	8654010	5102970	3763230	3288200	1614890	482581	305066	145069	77530	23063	9854
2009	114653000	73449500	52569800	42860200	38817500	22096800	14683700	11389300	3003660	1700030	739763	520872	258635	163644	71266	39024
2010	120614000	71099600	47474800	38000000	31989500	16772500	10603800	8015450	9183040	4554560	1743150	1196510	463153	277415	106974	54881
2011	91679800	54947800	37252500	29212000	27899900	14583000	9226180	6897860	6391570	3051960	1237290	849219	1027860	628130	256428	135101
2012	72997200	43789300	29940400	23531200	20832900	9811780	5542980	4063920	5352700	2219540	625012	400794	786532	411606	116141	49862
2013	171319000	114754000	86593100	69081200	17576200	9153830	5530910	4120100	3244730	1515520	494954	327263	376562	213405	69459	32167
2014	188465000	130470000	100361000	80484300	52737100	32955200	23497300	18530400	3303640	2063630	1110610	840083	300737	214462	116448	74407
2015	101492000	70318500	54818100	43363000	61321400	31590100	18613200	13612000	14766000	6703480	1922850	1225490	761030	411571	118504	50400
2016	133857000	91534100	69562200	54278400	32842100	13738700	6535470	4394740	10876500	3496870	512233	270939	1065150	427885	62297	17123
2017	190734000	130571000	99935700	79012000	41109200	20854500	12112400	8830090	3511540	1557500	435192	275428	240482	128182	35827	14990
2018	158389000	108428000	82982800	65601000	59841900	30306600	17571700	12800900	7055540	3120640	867067	547900	242449	128913	35827	14935
2019	0				49684700				10228400				469869			

Table 10.6.4. North Sea & 3.a Sprat. Assessment output: Estimated recruitment, spawning stock biomass (SSB), average fishing mortality (F), and landings weight (Yield). All estimates refers to the model year.

Year	Recruits (in 1000s)	SSB (tonnes)	F (ages 1–2)	Yield (tonnes)
1974	533516203	605615	1.148	463344
1975	713005719	605010	1.609	732312
1976	330461262	497325	1.653	628598
1977	631747281	337729	1.442	385257
1978	1033275820	388481	0.957	458804
1979	534584303	619706	0.626	463638
1980	328484431	425491	2.158	387434
1981	94300778	302549	1.049	280582
1982	49278577	180954	0.963	162357
1983	66986389	87378	1.615	115440
1984	33531639	65578	0.925	113444
1985	23324153	60355	1.269	62514
1986	79161450	23040	1.054	27520
1987	40832954	55492	0.356	53942
1988	60915609	57412	1.255	103652
1989	54624879	42531	0.296	58420
1990	73809647	41940	1.487	78180
1991	112560341	86163	0.692	125815
1992	104218478	121297	0.802	156471
1993	150428734	166542	1.564	208848
1994	128700686	135402	0.682	424206
1995	36324391	198590	1.448	446555
1996	60854724	108120	1.335	95496
1997	49081856	108662	0.983	125174
1998	109891052	134457	1.651	188907
1999	77593949	130092	0.869	243158
2000	73294784	184241	1.425	222027
2001	61404888	125492	1.498	153321

Year	Recruits (in 1000s)	SSB (tonnes)	F (ages 1–2)	Yield (tonnes)
2002	82227471	111302	1.582	174713
2003	106856781	139944	1.216	174988
2004	188385320	173338	1.848	231352
2005	66452635	228891	1.275	280275
2006	84901303	172474	1.622	78028
2007	60915609	135402	1.561	99902
2008	140399151	102539	1.318	69892
2009	114604772	187963	0.846	170934
2010	120601225	188151	0.98	145415
2011	91696980	166542	0.89	122472
2012	73002190	134592	1.35	96030
2013	171312512	108228	1.198	60207
2014	188385320	219476	0.568	190268
2015	101442227	349759	1.361	298227
2016	133819174	224583	2.203	227169
2017	190659562	174207	1.393	135824
2018	158457979	217510	1.4	190052
2019		216305		

Table 10.9.1. North Sea & 3.a Sprat. Input to forecast (years and age refer to the model year).

Age	Age 0	Age 1	Age 2	Age 3
Stock numbers(2019) (millions)	126950	49685	10228	470
Exploitation pattern Q1	0.002	0.292	0.487	0.428
Exploitation pattern Q2	0.011	0.302	0.978	0.987
Exploitation pattern Q3	0.020	0.122	0.272	0.636
Exploitation pattern Q4	0.000	0.002	0.008	0.008
Weight in the stock Q1 (gram)	5.042	7.552	10.003	13.592
Weight in the catch Q1 (gram)	5.04	7.55	10.00	13.59
Weight in the catch Q2 (gram)	4.72	7.53	10.45	14.66
Weight in the catch Q3 (gram)	5.23	9.09	13.15	16.42
Weight in the catch Q4 (gram)	7.60	14.07	18.76	21.17
Proportion mature(2019)	0.00	0.41	0.87	0.95
Proportion mature(2020)	0.00	0.41	0.87	0.95
Natural mortality Q1	0.38	0.35	0.26	0.14
Natural mortality Q2	0.26	0.20	0.16	0.15
Natural mortality Q3	0.21	0.18	0.15	0.15
Natural mortality Q4	0.28	0.22	0.18	0.18

Table 10.9.2. Sprat North Sea & 3.a. Short-term predictions options table.

Catch options. Landings and SSB are in thousands of tonnes.					
3-year average weight-at-age was used to calculate SSB. Recruitment(2019) = geom average 2008–2017.					
Basis	F(2019)	Landings(2019)	SSB(2020)	%SSB change	%TAC change
F_{cap}	0.69	139	271	8.83%	not applicable
$F_{(status\ quo)}$	1.4	229	217	-12.95%	not applicable
F=0	0	0	361	44.94%	not applicable
F=0.1	0.1	25	344	38.35%	not applicable
F=0.2	0.2	48	329	32.30%	not applicable
F=0.3	0.3	69	315	26.73%	not applicable
F=0.4	0.4	89	303	21.60%	not applicable
F=0.5	0.5	107	291	16.86%	not applicable
F=0.6	0.6	124	280	12.49%	not applicable
F=0.7	0.7	140	270	8.43%	not applicable
F=0.8	0.8	155	260	4.68%	not applicable
F=0.9	0.9	170	252	1.19%	not applicable
F=1.0	1	183	244	-2.05%	not applicable
$B_{escapement}$ without F_{cap}	5.187	418	125	-49.76%	not applicable

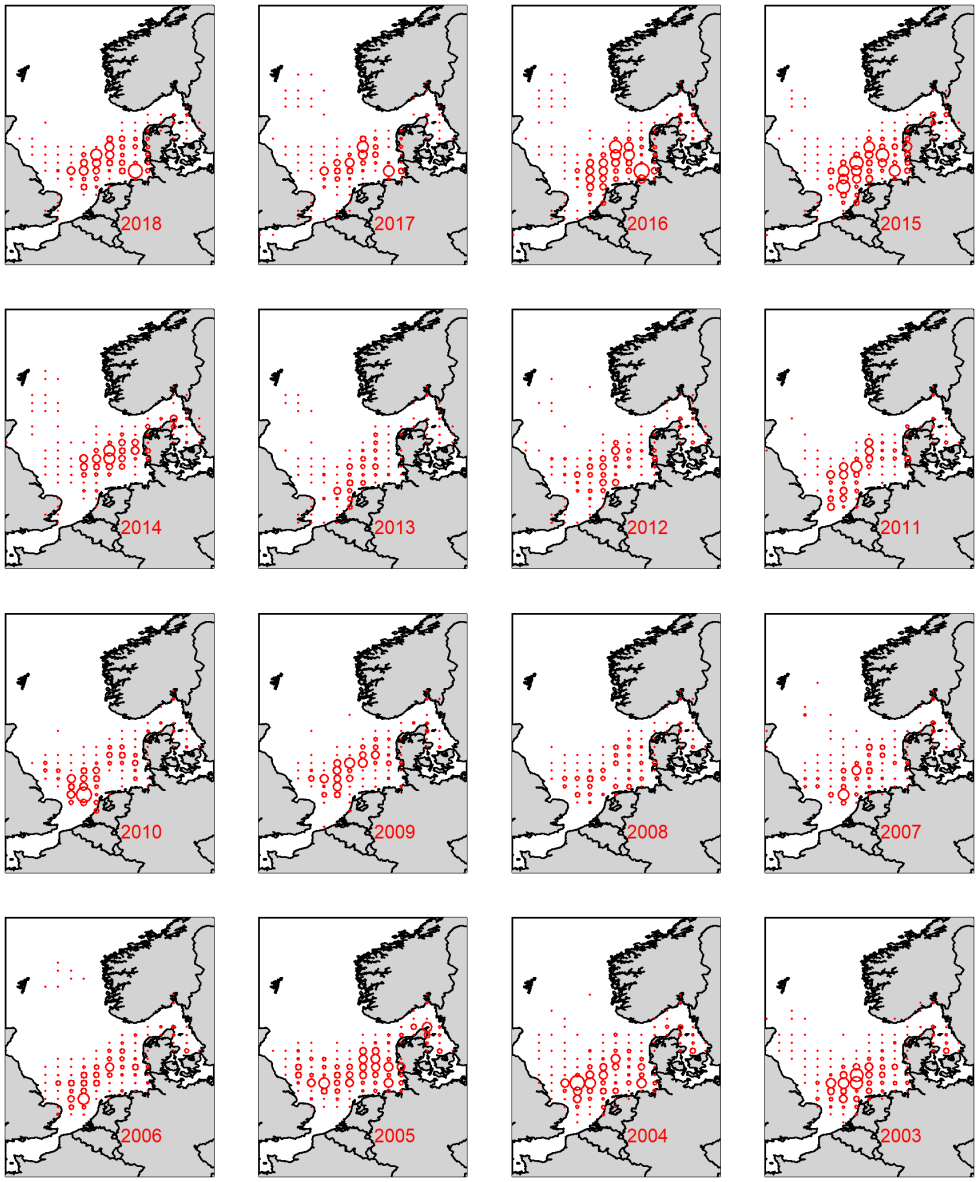


Figure 10.1.1. North Sea & 3.a sprat. Sprat catches in the North Sea and Division 3.a (in tonnes) for each calendar year by statistical rectangle.

Figure 10.2.1. North Sea & 3.a sprat. Number of samples taken in the North Sea and Division 3.a for each calendar year by statistical rectangle.

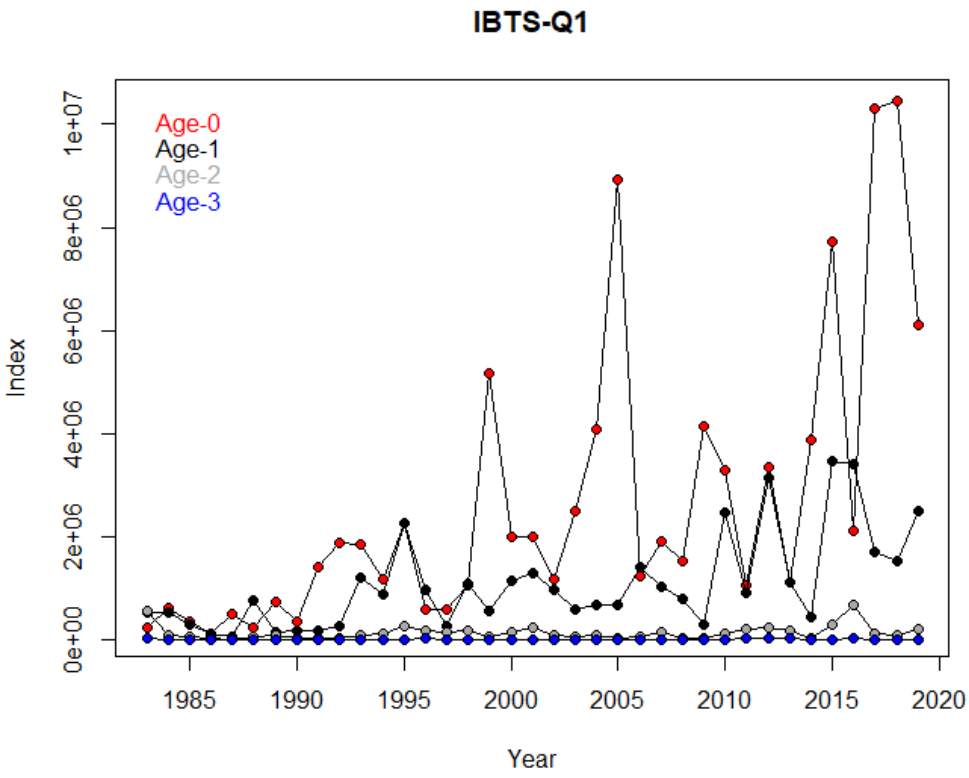


Figure 10.3.1. North Sea & 3.a sprat. IBTS Q1 survey index for Subarea 4 and Division 3.a combined. The index is calculated using a delta-GAM model formulation (see WKSPRAT report (ICES, 2018) for details). Years refer to the calendar year.

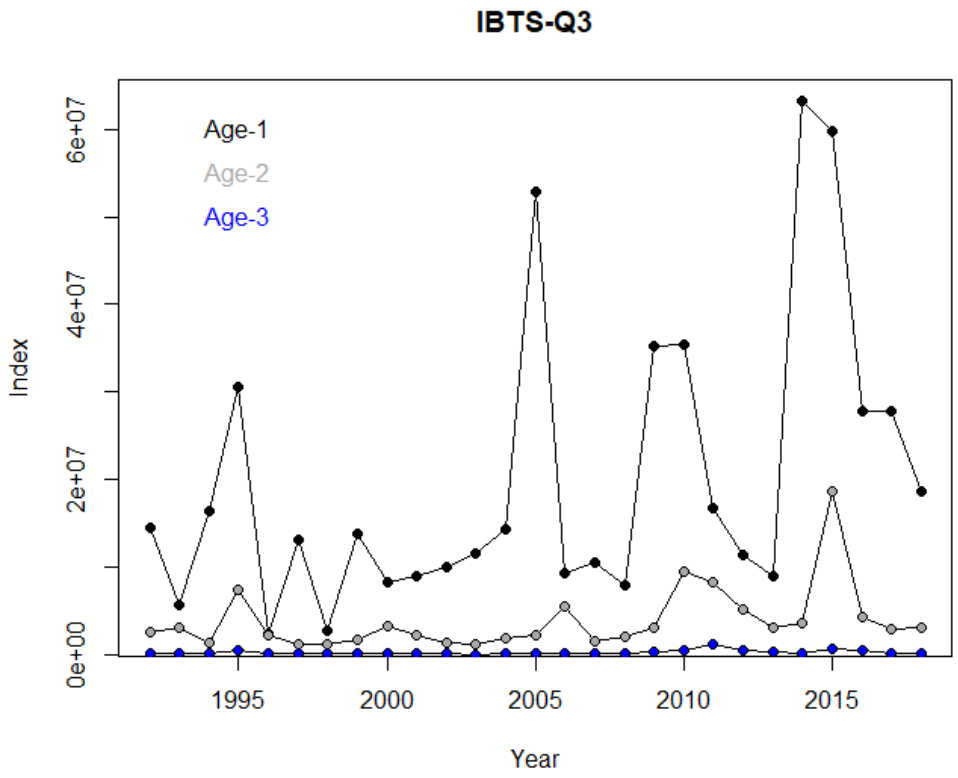


Figure 10.3.2a. North Sea & 3.a sprat. IBTS Q3 survey index for Subarea 4 and Division 3.a combined. The index is calculated using a delta-GAM model formulation (see WKSPRAT report (ICES, 2018) for details). Years refer to the calendar year.

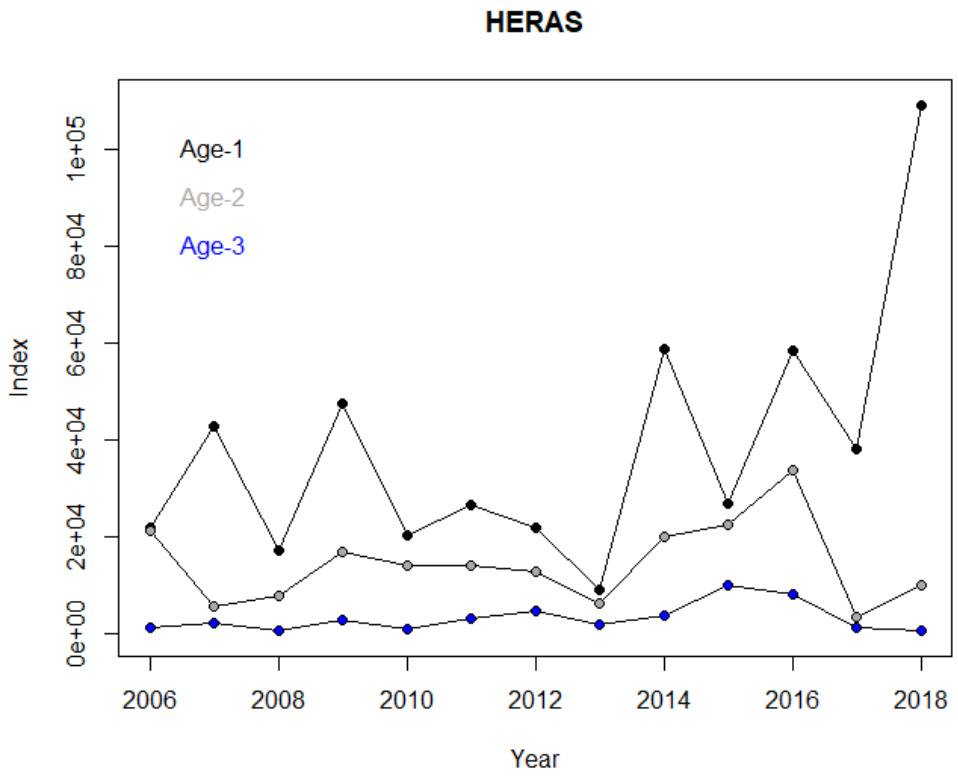


Figure 10.3.2b. North Sea & 3.a sprat. HERAS survey index for Subarea 4 and Division 3.a combined (sum of abundance indices published by WGIPS). Years refer to the calendar year.

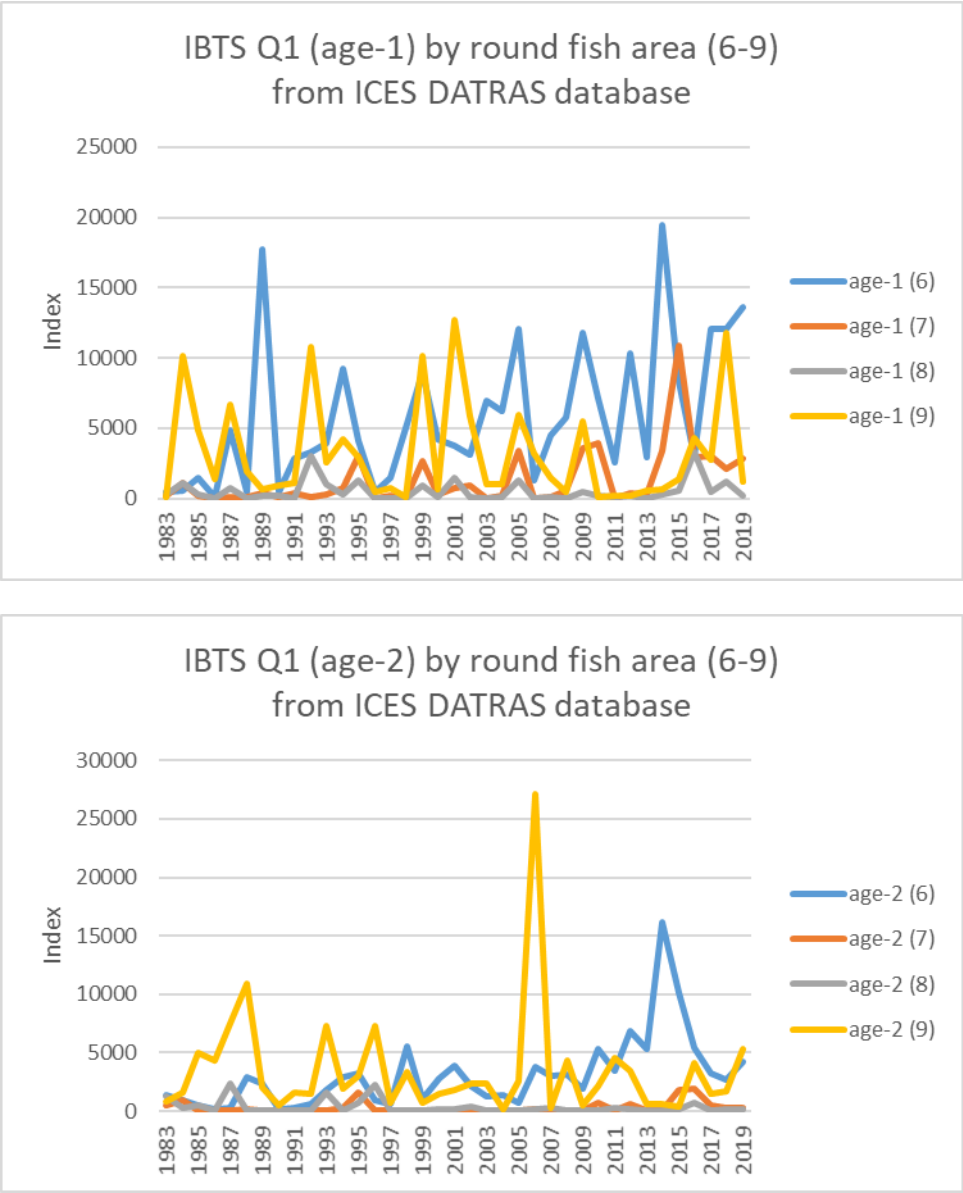
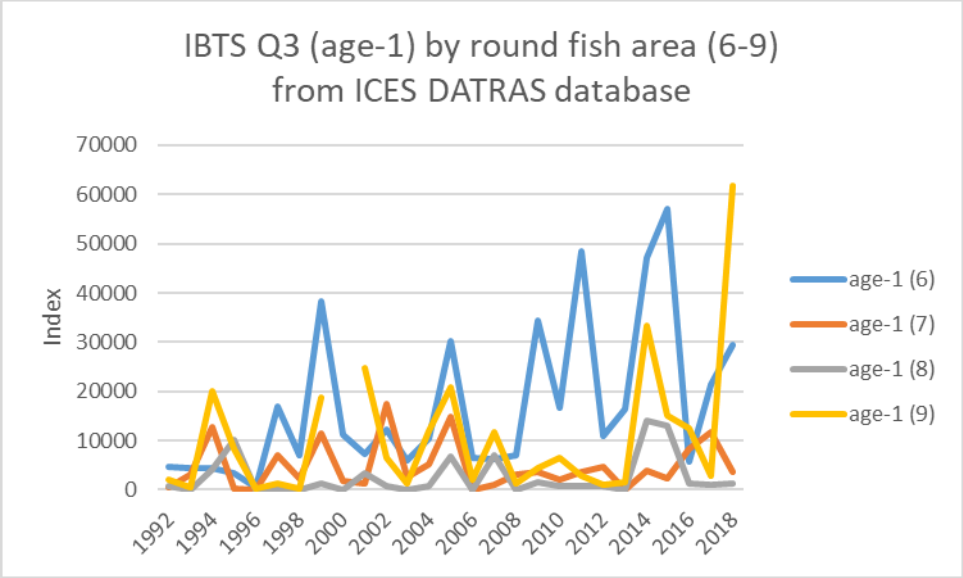


Figure 10.3.2c. North Sea & 3.a sprat. IBTS Q1 indices for round fish areas 6–9 (6 and 7 belong to Subarea 4, and 8 and 9 belongs to Division 3.a) for age 1 (top figure) and age-2 (bottom figure), respectively. Data were downloaded from the ICES DATRAS database. Years and age refer to the calendar year.



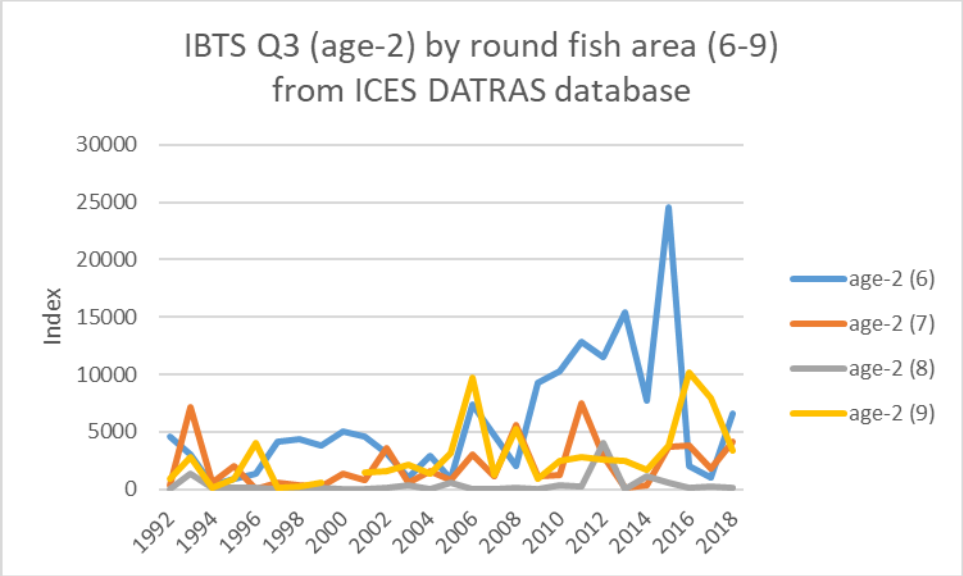
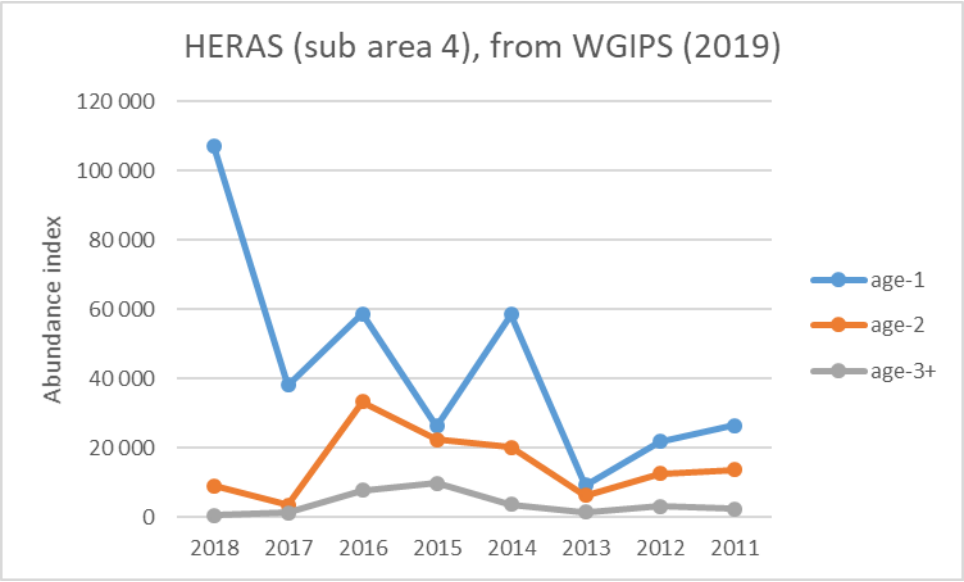


Figure 10.3.3. North Sea & 3.a sprat. IBTS Q3 indices for round fish areas 6–9 (6 and 7 belong to Subarea 4 and 8, and 9 belongs to Division 3.a) for age 1 (top figure) and age-2 (bottom figure), respectively. Data were downloaded from the ICES DATRAS database. Years and age refer to the calendar year.



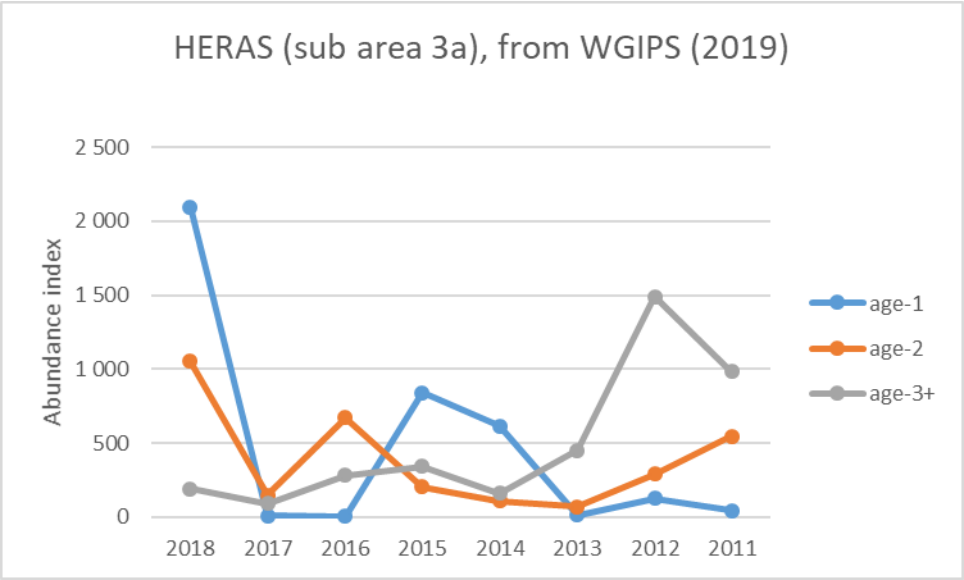


Figure 10.3.4. North Sea & 3.a sprat. HERAS survey index (abundance) for Subarea 4 and Division 3.a, respectively. Data were taken from the most recent WGIPS report.

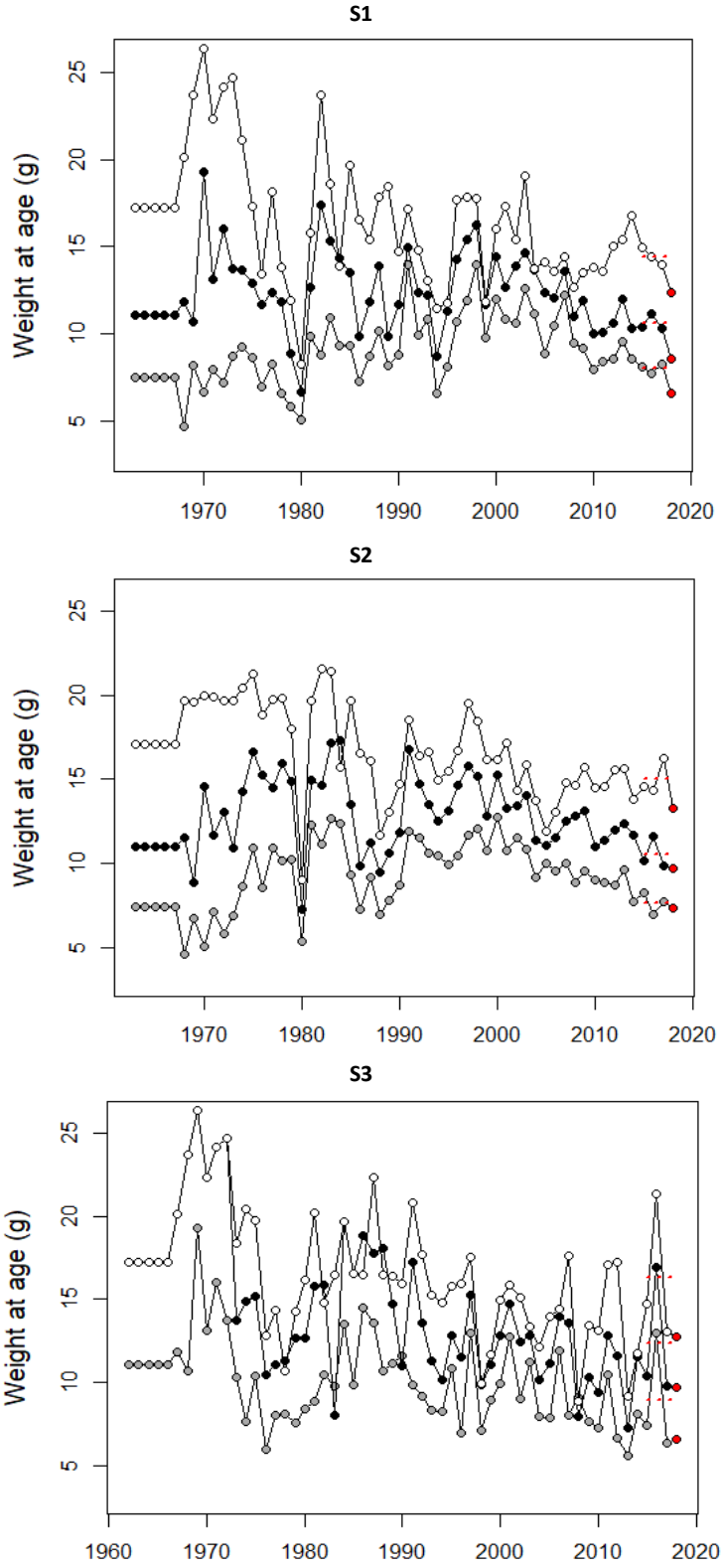


Figure 10.4.1. North Sea & 3.a sprat. Top: Mean weight at age in season 1 (years refer to the model year). Age 1 (grey), age 2 (black), age 3 (white). Red dot is the status quo weight and the red dashed line refer to the 3-year average used in the forecast last year. Middle: Mean weight at age in season 2 (years refer to the model year). Age 1 (grey), age 2 (black), age 3 (white). Red dot is the status quo weight and the red dashed line refer to the average of the three previous years. Bottom: Mean weight at age in season 3 (years refer to the model year). Age 1 (grey), age 2 (black), age 3 (white). Red dot is the status quo weight and the red dashed line refer to the average of the three previous years.

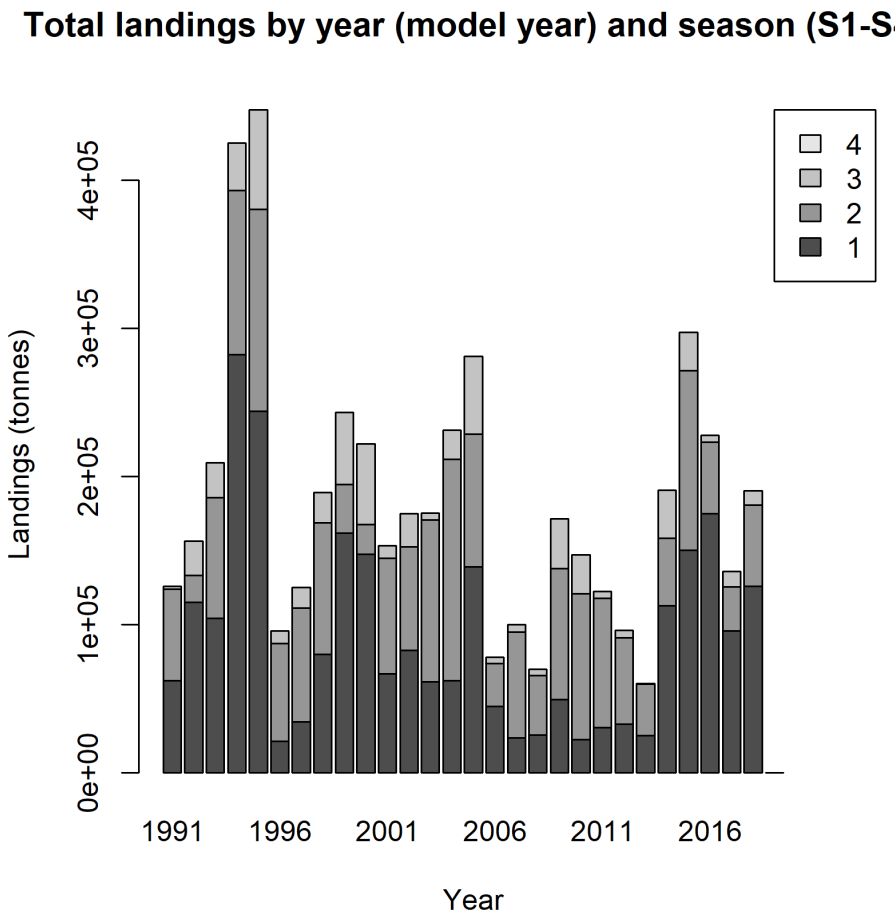


Figure 10.6.1. North Sea & 3.a sprat. Seasonal distribution of catches (Calendar year). Year and season 1-4 refer to the time steps of the model. Note that since the model year of 2018 is not yet finished, the 2018 column will be updated next year. Also note that there are no catches shown for S4, since these are moved to S1 in the following year (see WKSPRAT report (ICES, 2018) for details).

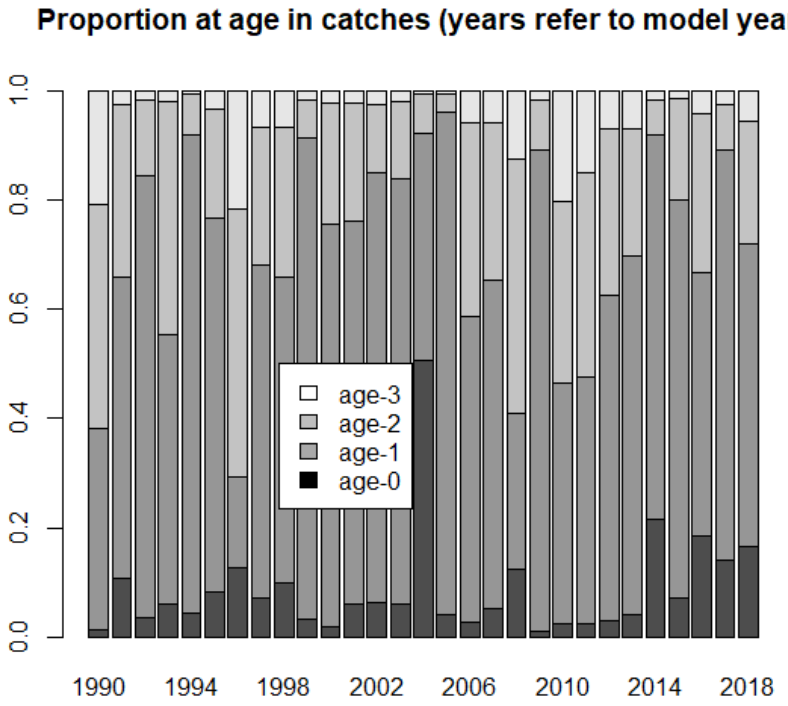


Figure 10.6.1. North Sea & 3.a sprat. Proportion of each age group in the catches. Year and age refer to the model year.

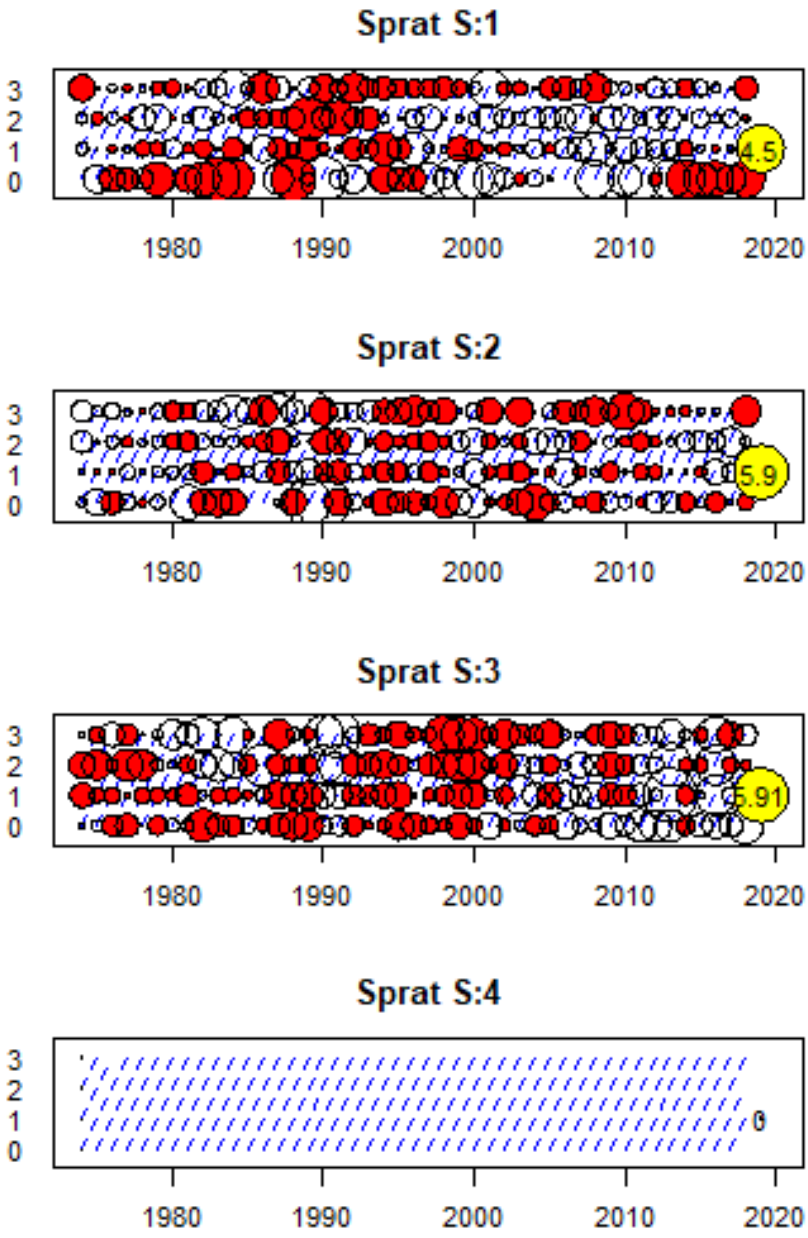


Figure 10.6.2. North Sea & 3.a sprat. Catch residuals by age. (Model year)

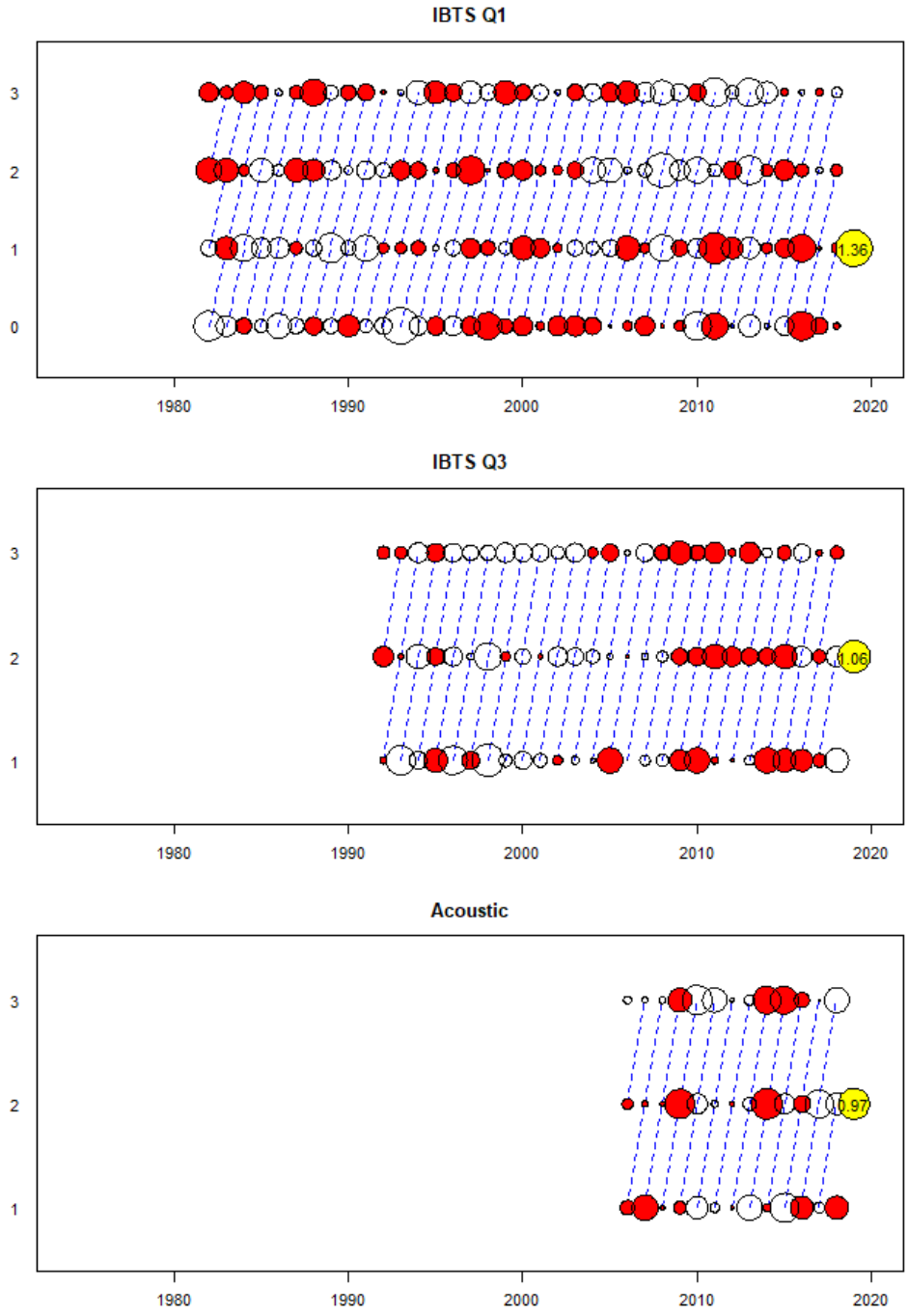


Figure 10.6.3. North Sea & 3.a sprat. Survey residuals by age. (Model year)

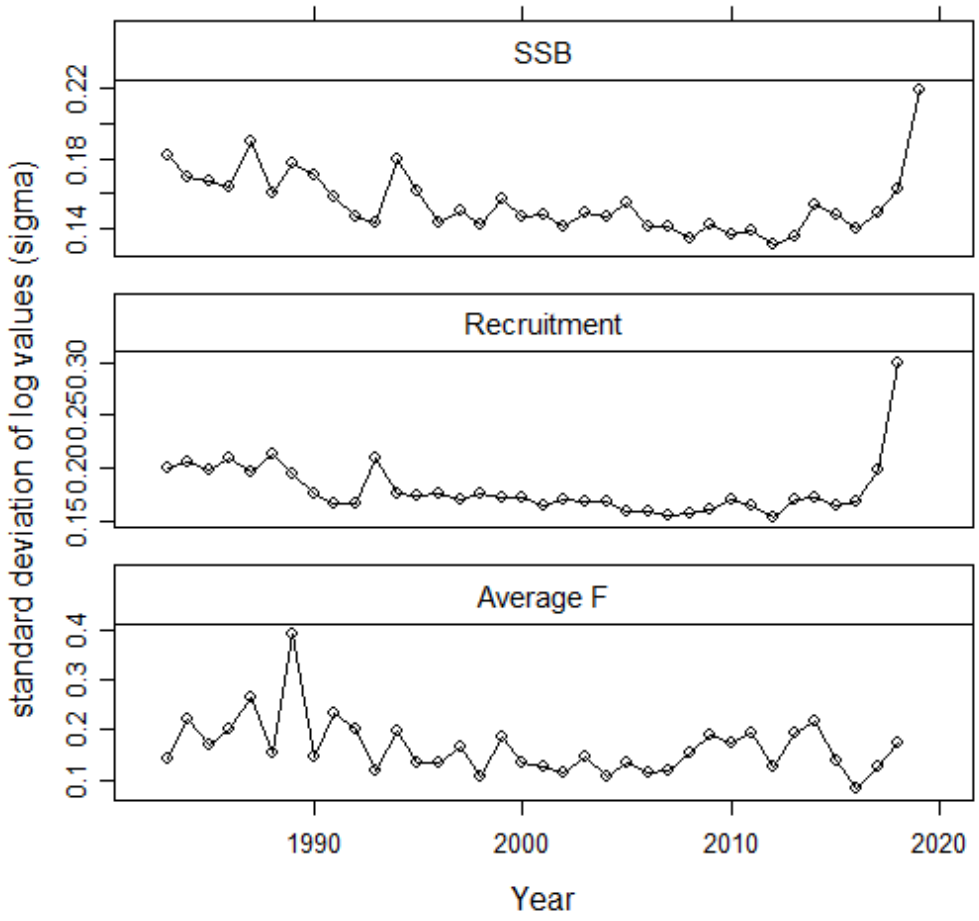


Figure 10.6.4. North Sea & 3.a sprat. Coefficients of variance (Model year).

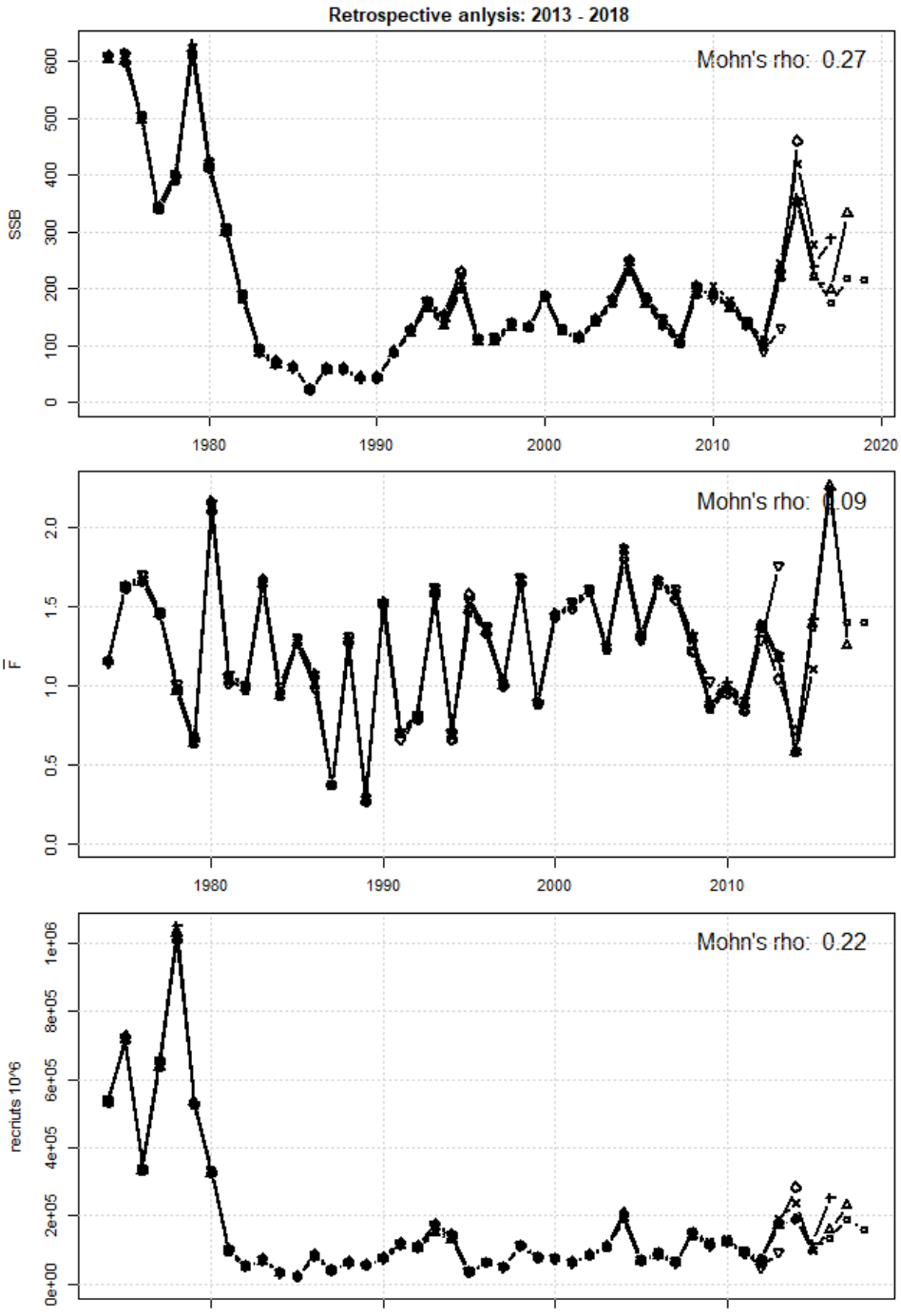


Figure 10.6.5. North Sea & 3.a sprat. Retrospective analysis (Model year)

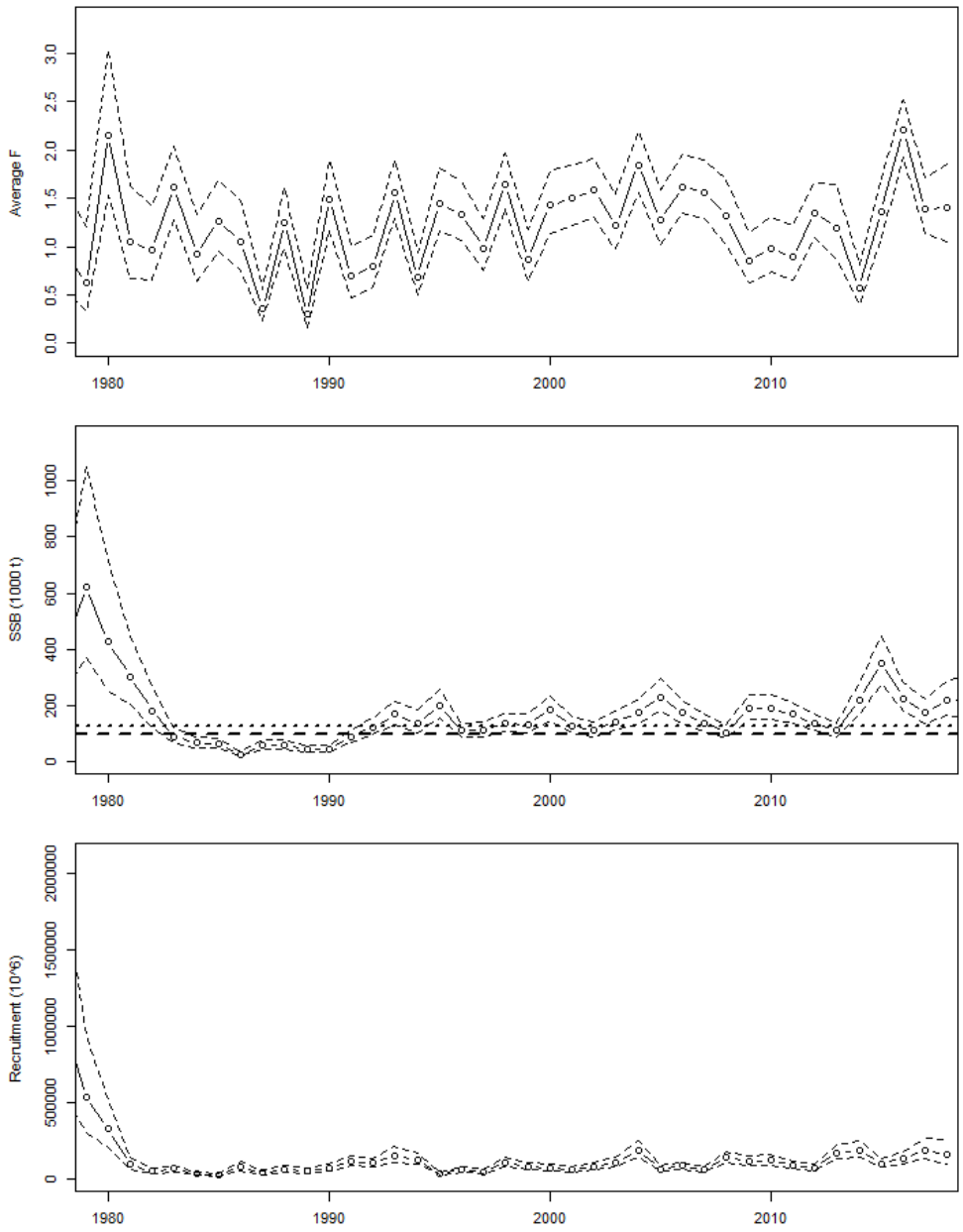


Figure 10.6.6. North Sea & 3.a sprat. Temporal development in Mean F, SSB and recruitment. Hatched lines are 95% confidence intervals (Model year).

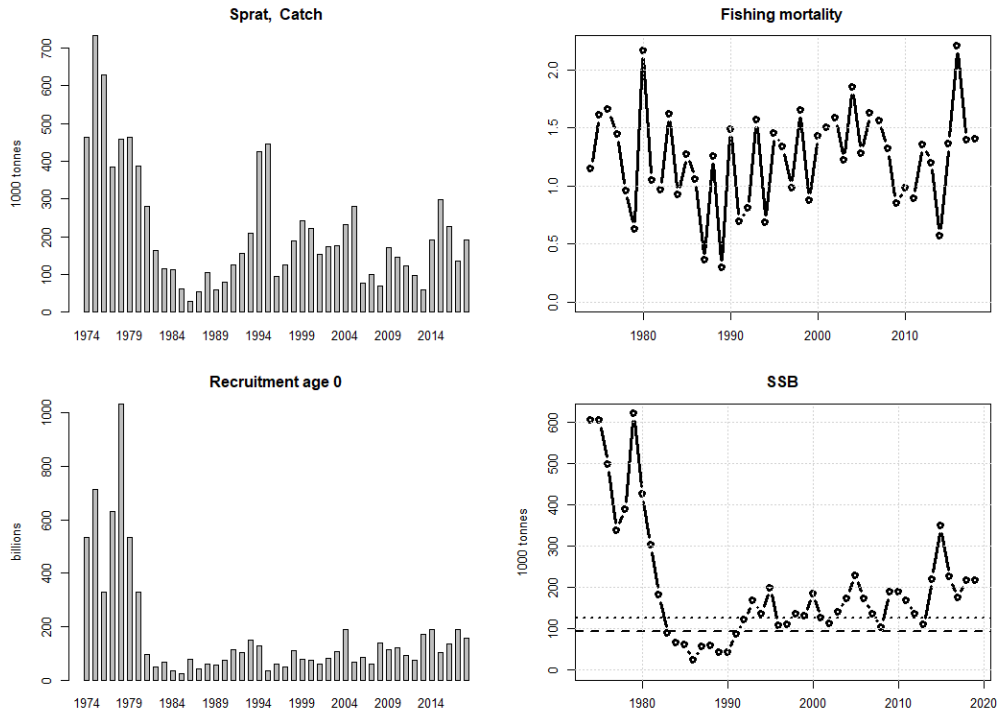


Figure 10.6.7. North Sea & 3.a sprat. Assessment summary (Model year)

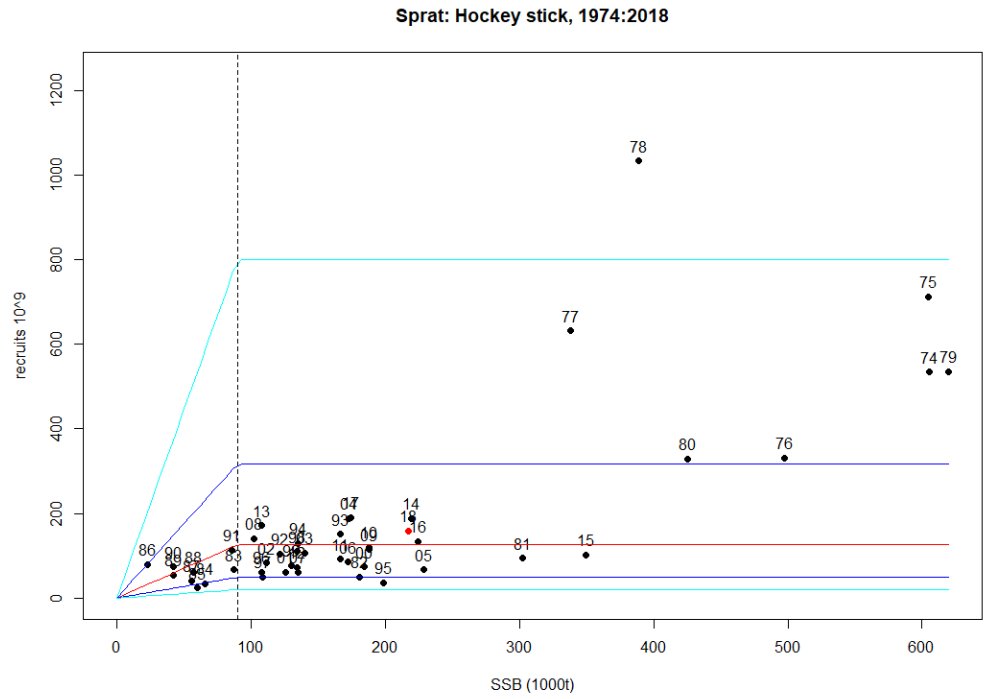


Figure 10.7.1. North Sea & 3.a sprat. Stock-recruitment relationship (Model year).

10.14 Audit of spr.27.3a4 (Sprat in the North Sea)

Working Group: **HAWG**

Stock Name: **Sprat (*Sprattus sprattus*) in Division 3.a and Subarea 4 (Skagerrak, Kattegat and North Sea)**

Date: 20/03/2019
Auditor: Henrik Mosegaard, Christophe Loots, Florian Berg

General

During the last benchmark in 2018 the stock unit was re-defined, combining division 3.a and subarea 4.

For single stock summary sheet advice:

1) **Assessment type:** Update
2) **Assessment**: Analytical assessment
3) **Forecast**: presented
4) **Assessment model**: SMS in quarterly steps. Tuning data IBTS Q1 (age 0-3), IBTS Q3 (age 1-3), HERAS (age 1-3)
5) **Data issues:** No data issues
6) **Consistency**: First assessment for the re-defined stock
7) **Stock status**: B>Bescapement, F is higher than Fcap (0.69).
8) **Management Plan**: No management plan has been developed.

Technical comments

There is no technical issue with this stock

Conclusions
The assessment has been performed correctly