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 2020 and 2021

There have never been any explicit management objectives for this stock. Last year, the advised TAC (July 2020 to June 2021) was set to 207 807 t for sprat in Subarea 4 and Division 3.a. The 2020 herring bycatch quotas were 8 954 t for the North Sea and 6 659 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 2020

Catch statistics for 1997–2020 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 2020 were 179 399 t (total official catches amounted to 179 746 t). This is a 22% increase compared to 2019, but not far from the average for the time-series. The Danish catches represent 84% of the total catches.

The spatial distribution of landings was similar to 2019 (Figure 10.1.1). A very low percentage (0.5% in 2020) of the catches were landed in the first and second quarter of 2020 (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 bycatch 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 bycatch quantities. Bycatches of herring are practically unavoidable except in years with high sprat abundance or low herring recruitment. Bycatch 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 bycatches were expected.

ICES evaluated the effectiveness of the sprat box in 2017 (ICES, 2017). The evaluation showed that fishing inside the sprat box would be expected to reduce unwanted catches of herring by weight but not in number and concluded 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 (2020: 92% taken by trawl).

10.2 Biological composition of the catch

Only data on bycatch from the Danish fishery were available to the Working Group (Table 10.2.1). The Danish sprat fishery was conducted with a 4.1% and 5.3 % bycatch of herring in 2020 in the North Sea and Division 3.a, respectively. The total amount of herring caught as bycatch in the sprat fishery has mostly been less than 10%. From 1st of April 2020 the Danish methodology behind the by-catch estimation in the fisheries for reduction. Before, the Danish fishery control regularly sampled the landings for reduction, and afterwards a species composition was estimated per month, square and fishery. Now, each and every landing for reduction into Denmark is subsampled by independent companies and the estimated species composition is reported directly in the sale slips.

The estimated quarterly landings at age in numbers for the period 1974–2020 are presented in Table 10.2.2. In the model year 2020 (1 July 2020–30 June 2021), one-year old sprat contributed 68% of the total landings, which is close to the 1990–2019 average (62%). 2-year olds contributed 26% in 2019 (model year), which is above the 1990– 2019 average (23%). 0-year olds contributed 0.8% of the total landings, which is higher than the 1990–2019 average (9%).

Denmark, Sweden, and Norway provided age data of commercial landings in 2020 (Table 10.2.4). All quarters were covered. Quarter 1 in 2020 and 2021 had very low catches and low number of samples. The sample data were used to raise the landings data from the North Sea, Skagerrak, and Kattegat. The landings by UK-Scotland (2 467 t), Germany (10 144 t) and Belgium (<1 t) were 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. However, the sampling level in 2020 (model year) was substantially reduced with only 0.6 samples taken per 2000 t. The low level of sampling in 2020 is caused by a not fully implemented change in the Danish sampling program. The Danish self-sampling program for sprat has been based on voluntary participation and in first years after implementation a lot of vessels participated. During the last couple of years, the number of vessels delivering samples has decreased dramatic, resulting in a more and more clustered sampling. The clustering was further accelerated by the fact that a lot of the hauls (samples) often came from the same trip. As mentioned above all landings for reduction into Denmark are now subsampled by a 3rd party companies and the Danish institute is able to get samples from most of them. Therefore, Denmark introduced a new sampling strategy in 2020, where vessels above 24 meters are sampled with a higher frequency than vessel below. Vessels above 24 meters are still being encouraged to deliver self-samples, but if not, a 3rd party sample is used as a substitute. All samples from vessels below 24 meters comes from the 3rd party companies.

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 and 10.3.2 give the time-series of IBTS indices by age (calculated using a delta-GAM model formulation; see WKSPRAT report (2018) for further details). The data source is the IBTS Q1 data from 1983–2021. The index for IBTS Q1 1-year old in 2020 (age-0 in the model and the table, serving as a recruitment index) was 19% above average but 55% lower than 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 2020 values were 34% higher for age-1 and 100% higher for age-2, compared to 2019.

10.3.2 Acoustic Survey (HERAS)

Abundance indices were provided by WGIPS (ICES, 2020) (see Section 1.4.2). The abundance indices for Subarea 4 and Division 3.a were summed (Table 10.3.2 and Figure 10.3.2b). The 2020 values were 49% lower, 36% lower, and 71% lower (age-1, age-2, and age-3, respectively) compared to the 2019-values.

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 and S2; quarter 3 and 4), where most of the catches are taken, show a declining trend over the past decade. In 2019, the mean weights of age-1 and age-3 fish in S1 were the lowest observed for nearly two decades but in 2020 this decline was arrested and the mean weight at age 1 in season 1 was restored to the same level as in 2013. Mean weight of age-2 in 2020 was the highest since 2007. Mean weight-at-age was also restored to 2007 level in S2 (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

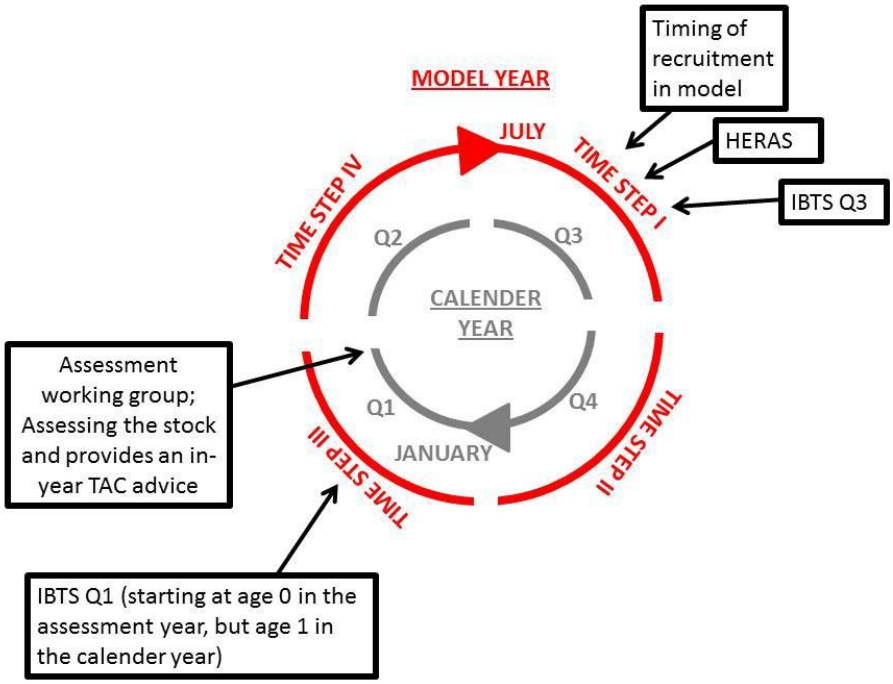
The IBTS Q1 age-1 index (age-0 in the model) (Table 10.3.1) is used as a recruitment index for this stock. The 2021 value, indicative of the 2020 recruitment, was 20% above average, corresponding to 45% of the recruitment index in the previous year. The recruitment estimated by the model for 2020 is 41% lower than the recruitment in 2019 and just below the 2011-2020 geometric mean (65% of the mean) (Table 10.6.4). At the most recent 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 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 are provided in Tables 10.1.1–2 and in Figures 10.1.1 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. In 2021, only 478 t were taken in quarter 1 and no age samples was taken. To avoid the resulting high uncertainty in the age distribution of these catches, they were transferred to 2021 quarter 4, leading to a total catch of 35 853 t in this quarter.

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. 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 the model.

10.6.1.4 Natural mortality

New natural mortalities were available from the 2020 North Sea key run from WGSAM (ICES, 2017). The major changes were changes to mean weight of whiting leading to lower mortalities particularly in the early part of the time series. HAWG reviewed stock assessments based on the old and new M's. The new mortalities reduced AIC of the model from 865 to 859, indicating a substantially improved fit. CVs for the catches decreased by up to 3% while survey CVs changed by -4 to +5% (average +0.2%). The CV on the terminal SSB increased by 9%. For comparison, the change from the 2019 to the 2020 assessment, both using old mortalities, was an increase in CVs for the catches of up to 4% while survey CVs changed by -5 to +20% (average +6%). The CV on the terminal SSB decreased by 20%). In summary, the AIC of the assessment using new mortalities was substantially improved and changes to estimated parameters were within the range observed in annual updates. The change in average recruitment, SSB and F over the past 20 years were 2%, -4% and +1% (new compared to old). The change to selection pattern was between -2 and 5% for age groups 1 and 2 (the F-bar ages). The group inspected the stock-recruitment plot and found no substantial changes. According to benchmark guidelines, no substantial changes in stock parameters or stock-recruitment plot would lead to the adoption of new mortalities in the assessment. However, the recent guidance from ACOM LS requires that reference points are re-estimated and an inter-benchmark process conducted when new M's are introduced. Given the strict time schedule for advice on this stock and the fact that the reference points according to the benchmark are estimated in a full (time consuming) MSE model, the group did not consider it feasible to conduct an inter-benchmark in time for the 2021 advice. Further, the group felt that they could not guarantee that using new mortalities would not lead to changes in reference points if these were re-estimated. Therefore, the old mortalities were used in the 2021 assessment. 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 10.6.1.

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 (WKSPRAT2018: 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 = 0.25) (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 = 0.28). The assessment model was improved with this respect during the last benchmark and Mohn´s rho was reduced by roughly a factor of 3 due to the improvement.

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 is abundant judging by all the surveys and by the assessment output. The stock has been well above B_{pa} since 2013 and above B_{lim} since 1991. The current SSB is 29% above B_{pa}. Fishing mortality has fluctuated without a trend. 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 not precautionary 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.

SSB in 2022 is expected to be higher than 2021 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 2022 of 274 265 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 106 715 t (July 2021–June 2022), which is expected to result in an SSB of 208 733 t in July 2022, 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 generally 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). The retrospective pattern in SSB and recruitment (5 years Mohn´s rho of 0.28 and 0.25, respectively) is below the advised limit of 0.3 discussed in WKFORBIAS (2019).

There appears to be a systematic pattern in the catch residuals of model season 1 (quarter 3), which remains unexplained.

10.11 Management Considerations

A management plan needs to be developed for this stock. 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.

Industrial fisheries are allocated a bycatch of 7 750 t and 6 659 t of juvenile herring in 2021 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. The influence of the sprat fishery on other fish species and seabirds are at present not documented to be substantial.

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 though this information is as described under natural mortality not up to date. 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 WKSPRAT2018: ICES, 2018).

Table 10.1.1. North Sea & 3.a sprat. Landings (' 000 t) 1997–2020. See ICES CM 2006/ACFM:20 for earlier data. Catch in coastal areas of 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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Division 27.4.a																								
Denmark			0.7		0.1	1.1		*		*	0.8	*	*					*	*	0.1	0.1		*	0.5
Norway													*		*								0.1	*
Sweden					0.1																			
UK (Scot- land)															0.5						*	*		
Germany																			*	*				
Nether- lands																			*					
Total			0.7		0.2	1.1		*		*	0.8	*	*		0.5			*	*	0.1	0.1	*	0.1	0.5
Division 27.4.b																								
Denmark	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	110.3	138.4
Norway	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	10.0	9.3
Sweden		1.7	2.1		1.4				*				0.3	0.6	1.1	1.8	0.1	3.9	5.5	11.7	8.1	7.6	7.5	3.5
UK (Scotland)			1.4								0.1		2.5	1.1	1.9	0.7						*	1.3	1.7
UK (Engl.& Wales)													*								*	*		
Germany															3.3	0.5	0.6	1.5	3.1	5.4	6.0	3.7	3.4	10
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		
Total	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	132.6	163.0
Division 27.4.c																								
Denmark	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	8.9	2.4
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	0.6	0.7
Sweden													0.6	0.6	0.2	0.4	1.3		1.2	0.4				

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
UK(Scotland)												0.2			0.4						*				0.7
UK (Engl.& Wales)	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	*	*	*	*	*	0.1	0.2		
Germany															*	*	1.0		0.6	0.2					0.1
Netherlands			0.2												4.2	1.0	0.7	*	1.2	0.8	*	0.7			
Belgium															*		*	*	*	*	*		*	*	
France																			*		*				
Total	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	9.6		3.9
Division 27.3.a																									
Denmark	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	3.9		9.5
Sweden	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	1.7		2.4
Germany																			*				*		
Faroe Islands																					*				
Total	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	5.6		11.9
Total North Sea and Skagerrak-Kattegat																									
Denmark	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	123.1		150.9
Norway	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	10.6		10
Sweden	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	9.2		5.9
UK(Scotland)			1.4								0.1	0.2	2.5	1.1	2.8	0.7					*	*	*	1.3	2.5
UK (Engl.& Wales)	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	*	*	*	*	*	*	0.2		
Germany															3.3	0.5	1.6	1.6	3.7	5.6	6.0	3.7	3.4		10.1
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															*		*	*	*	*	*		*	*	
France																			*		*				
Total	118.8	181.7	214.9	215.1	197.9	161.3	192.2	215.2	247.3	125.9	97.9	69.3	141.6	153.3	144.1	95.5	68.9	158.7	303.3	248.5	129.9	191.2	147.8		179.4

* < 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 27.4.a	27.4.b	27.4.c	27.3.a	Total
2000	1		18 126	28 063		46 189
	2		1722	45		1767
	3		131 306	1216		132 522
	4		12 680	2718		15 398
	Total		163 834	32 042		195 876
2001	1	115	40 903	9716		50 734
	2		1071			1071
	3		44 174	481		44 655
	4	79	65 102	8538		73 719
	Total	194	151 249	18 735		170 177
2002	1	1 136	2182	2790		6108
	2		435	93		528
	3		70 504	647		71 151
	4		52 942	12 911		65 853
	Total	1 136	126 063	16 441		143 640
2003	1		11 458	7727	5217	24 402
	2		625	26	1397	2049
	3		56 207	165	1720	58 092
	4		84 629	15 651	7349	107 629
	Total		152 919	23 570	15 683	192 172
2004	1		827	1831	4456	7113
	2	7	260	16	1510	1793
	3		54 161	496	4138	58 794
	4		120 685	15 937	10 775	147 397
	Total	7	175 932	18 280	20 879	215 097

Year	Quarter	Division 27.4.a	27.4.b	27.4.c	27.3.a	Total
2010	1		10 976	17 072	1462	29 510
	2		3235	3	648	3886
	3		14 220		3405	17 625
	4		62 006	35 973	4278	102 257
	Total		90 437	53 048	9793	153 278
2011	1		3747	21 039	3216	28 002
	2		2067	3	617	2687
	3		22 309	451	2311	25 072
	4	8	70 256	13 759	3887	87 910
	Total	8	98 380	35 252	10 031	143 671
2012	1		81	1649	4668	6399
	2		2924	0	909	3832
	3		26 779	307	1631	28 717
	4		47 765	6060	2728	56 553
	Total		77 549	8016	9936	95 501
2013	1		1281	3158	1296	5734
	2		32	0	443	474
	3		25 577	720	211	26 509
	4		18 892	16 276	943	36 110
	Total		45 781	20 154	2893	68 827
2014	1		59	125	384	568
	2		11 631	3	1415	13 050
	3	1	88 457	1428	9622	99 507
	4	7	37 851	822	6905	45 586
	Total	8	137 999	2378	18 327	158 711

Year	Quarter	Division 27.4.a	27.4.b	27.4.c	27.3.a	Total
2005	1		11 538	2457	8148	22 143
	2		2515	123	4722	7360
	3		107 530		19 418	126 948
	4		82 474	1033	7296	90 803
	Total		204 057	3613	39 584	247 254
2006	1	47	13 713	33 534	8105	55 399
	2		190	8	324	522
	3		40 051	8	1440	41 499
	4	2	26 579	77	2335	28 993
	Total	49	80 533	33 627	12 204	126 413
2007	1		582	247	2646	3475
	2		241	3	1291	1535
	3		16 603		5357	21 960
	4	769	41 850	23 531	4761	70 911
	Total	769	59 276	23 781	14 055	97 881
2008	1		2872	43	2890	5805
	2		52	*	1017	1069
	3		21 787		636	22 423
	4		27 994	8334	3672	40 001
	Total		52 706	8377	8215	69 298
2009	1		36	1268	2600	3904
	2		2526	1	300	2827
	3	22	41 513		3300	44 835
	4		78 373	9336	2400	90 109
	Total	22	122 448	10 604	8600	141 675

Year	Quarter	Division 27.4.a	27.4.b	27.4.c	27.3.a	Total
2015	1	*	14 816	16 972	1442	33 230
	2		16 843	107	619	17 568
	3		124 512	335	6528	131 375
	4	25	88 395	28 375	4389	121 184
	Total	25	244 566	45 789	12 978	303 358
2016	1	68	18 487	5969	746	25 250
	2		8927	51	669	9 647
	3	*	158 522	111	4664	163 297
	4	2	34 070	14 466	1764	50 301
	Total	70	220 007	20 596	7843	248 516
2017	1	1	3432	1220	92	4 745
	2		1327	0	33	1 360
	3	*	92 885	217	227	93 329
	4	94	29 310	174	849	30 426
	Total	95	126 954	1611	1200	129 860
2018	1	*	8994	1628	168	10 790
	2		11 898	0	224	12 122
	3		112 361	1	1328	113 690
	4		46 411	5922	2249	54 582
	Total	*	179 664	7551	3969	191 184
2019	1		389	9 592	627	10 609
	2	2	3 606	11	379	3 999
	3	2	95 829	7	2 249	98 087
	4	49	32 750	3	2 296	35 098
	Total	53	132 574	9 614	5 551	147 793
2020	1	368	3	190	376	937

Year	Quarter	Division 27.4.a	27.4.b	27.4.c	27.3.a	Total

* < 0.5 t

Year	Quarter	Division 27.4.a	27.4.b	27.4.c	27.3.a	Total
	2	173		19 430	*	19 603
	3	4 268	2	119 883	*	124 153
	4	7 087	520	23 540	3 559	34 706
	Total	11 896	526	163 043	3 934	179 399

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
t	1998	129 315	11 817	573	673	6	220	11	2 174	1 187	145 978
t	1999	157 003	7 256	413	1 088	62	321	7	4 972	635	171 757
t	2000	188 463	11 662	3 239	2 107	66	766	4	423	1 911	208 641
t	2001	136 443	13 953	67	1 700	223	312	4	17 020	1 141	170 862
t	2002	140 568	16 644	2 078	2 537	27	715	0	4 102	801	167 471
t	2003	172 456	10 244	718	1 106	15	799	11	5 357	3 504	194 210
t	2004	179 944	10 144	474	334	0	4 351	3	3 836	1 821	200 906
t	2005	201 331	21 035	2 477	545	4	1 009	16	6 859	974	234 251
t	2006	103 236	8 983	577	343	25	905	4	5 384	576	120 033
t	2007	74 734	6 596	168	900	6	126	18	6	253	82 807
t	2008	61 093	7 928	26	380	10	367	0	23	1 735	71 563
t	2009	112 721	7 222	44	307	3	116	1	1 526	407	122 345
t	2010	112 395	4 410	11	119	2	18	0	1 236	577	118 769
t	2011	109 376	8 073	35	191	0	127	0	1 881	345	120 026
t	2012	67 263	8 573	2	354	0	246	0	93	411	76 943
t	2013	55 792	5 176	47	445	0	277	2	1	369	62 109
t	2014	123 180	11 402	0	897	0	70	16	16	1 700	137 280
t	2015	265 356	4 568	5	1 809	0	527	0	147	3 311	275 723
t	2016	192 718	11 107	18	4 223	0	439	0	46	2 093	210 643
t	2017	100 833	5 130	1	1 344	0	197	0	503	12 386	120 394
t	2018	161 536	7 528	174	716	0	366	0	24	344	170 687
t	2019	118 302	2 757	1	897	1	176	0	3	503	122 639
t	2020	140 954	6 227	19	898	93	1 188	0	11	724	150 114
%	1998	88.6	8.1	0.4	0.5	0	0.2	0	1.5	0.8	100
%	1999	91.4	4.2	0.2	0.6	0	0.2	0	2.9	0.4	100
%	2000	90.3	5.6	1.6	1	0	0.4	0	0.2	0.9	100
%	2001	79.9	8.2	0	1	0.1	0.2	0	10	0.7	100
%	2002	83.9	9.9	1.2	1.5	0	0.4	0	2.4	0.5	100

	Year	Sprat	Herring	Horse mack	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
t	1998	9 143	3 385	230	467	54	0	49	7	2 866	16 202
t	1999	16 603	8 470	138	1 026	210	5	75	3 337	2 896	32 760
t	2000	12 578	8 034	5	1 062	308	8	52	13	3 556	25 617
t	2001	18 236	8 196	75	1 266	50	13	35	4 281	1 271	33 423
t	2002	11 451	12 982	21	1 164	3	6	30	606	2 280	28 541
t	2003	8 182	4 928	340	252	4	4	4	1	567 14	14 282
t	2004	13 374	4 620	97	976	18	24	27	116	2 155	21 408
t	2005	30 157	6 171	244	871	63	18	20	746	1 758	40 047
t	2006	6 814	2 852	215	276	13	3	45	1	232 10	10 451
t	2007	7 116	2 043	34	190	31	8	4	1	469 9	9 896
t	2008	4 805	1 948	14	285	0	0	11	462	39 7	7 563
t	2009	4 839	3 016	37	169	15	0	1	53	47 8	8 177
t	2010	2 851	2 134	25	142	6	1	2	135	171 5	5 466
t	2011	4 754	2 461	0	43	0	7	1	141	40 7	7 447
t	2012	5 707	5 495	9	149	7	10	5	0	228 11	11 610
t	2013	1 143	1 751	2	46	0	0	1	1	27 2	2 971
t	2014	16 751	3 777	5	343	1	20	5	12	888 21	21 801
t	2015	11 448	5 831	0	565	0	29	8	1	154 18	18 036
t	2016	7 001	2 140	0	335	1	19	3	0	78 9	9 579
t	2017	963	328	0	172	0	19	1	0	32 1	1 515
t	2018	2 872	257	2	150	1	11	0	0	12 3	3 304
t	2019	3 429	351	0	59	0	2	0	0	8 3	3 850
t	2020	9 494	551	4	249	5	41	1	0	27 10	10 372
%	1998	56.4	20.9	1.4	2.9	0.3	0	0.3	0	17.7	100
%	1999	50.7	25.9	0.4	3.1	0.6	0	0.2	10.2	8.8	100
%	2000	49.1	31.4	0	4.1	1.2	0	0.2	0.1	13.9	100
%	2001	54.6	24.5	0.2	3.8	0.2	0	0.1	12.8	3.8	100
%	2002	40.1	45.5	0.1	4.1	0	0	0.1	2.1	8	100

	Year	Sprat	Herring	Horse mack	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
%	2003	88.8	5.3	0.4	0.6	0	0.4	0	2.8	1.8	100
%	2004	89.6	5	0.2	0.2	0	2.2	0	1.9	0.9	100
%	2005	85.9	9	1.1	0.2	0	0.4	0	2.9	0.4	100
%	2006	86	7.5	0.5	0.3	0	0.8	0	4.5	0.5	100
%	2007	90.3	8	0.2	1.1	0	0.2	0	0	0.3	100
%	2008	85.4	11.1	0	0.5	0	0.5	0	0	2.4	100
%	2009	92.1	5.9	0	0.3	0	0.1	0	1.2	0.3	100
%	2010	94.6	3.7	0	0.1	0	0	0	1	0.5	100
%	2011	91.1	6.7	0	0.2	0	0.1	0	1.6	0.3	100
%	2012	87.4	11.1	0	0.5	0	0.3	0	0.1	0.5	100
%	2013	89.8	8.3	0.1	0.7	0	0.4	0	0	0.6	100
%	2014	89.7	8.3	0	0.7	0	0.1	0	0	1.2	100
%	2015	96.2	1.7	0	0.7	0	0.2	0	0.1	1.2	100
%	2016	91.5	5.3	0	2	0	0.2	0	0	1	100
%	2017	83.8	4.3	0	1.1	0	0.2	0	0.4	10.3	100
%	2018	94.6	4.4	0.1	0.4	0	0.2	0	0	0.2	100
%	2019	96.5	2.2	0	0.7	0	0.1	0	0	0.4	100
%	2020	93.9	4.1	0	0.6	0.1	0.8	0	0	0.5	100

	Year	Sprat	Herring	Horse mack	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
%	2003	57.3	34.5	2.4	1.8	0	0	0	0	4	100
%	2004	62.5	21.6	0.5	4.6	0.1	0.1	0.1	0.5	10.1	100
%	2005	75.3	15.4	0.6	2.2	0.2	0	0	1.9	4.4	100
%	2006	65.2	27.3	2.1	2.6	0.1	0	0.4	0	2.2	100
%	2007	71.9	20.6	0.3	1.9	0.3	0.1	0	0	4.7	100
%	2008	63.5	25.8	0.2	3.8	0	0	0.1	6.1	0.5	100
%	2009	59.2	36.9	0.5	2.1	0.2	0	0	0.6	0.6	100
%	2010	52.2	39	0.5	2.6	0.1	0	0	2.5	3.1	100
%	2011	63.8	33	0	0.6	0	0.1	0	1.9	0.5	100
%	2012	49.2	47.3	0.1	1.3	0.1	0.1	0	0	2	100
%	2013	38.5	58.9	0.1	1.6	0	0	0	0	0.9	100
%	2014	76.8	17.3	0	1.6	0	0.1	0	0.1	4.1	100
%	2015	63.5	32.3	0	3.1	0	0.2	0	0	0.9	100
%	2016	73.1	22.3	0	3.5	0	0.2	0	0	0.8	100
%	2017	63.6	21.6	0	11.4	0	1.2	0.1	0	2.1	100
%	2018	86.9	7.8	0.1	4.5	0	0.3	0	0	0.4	100
%	2019	89.1	9.1	0	1.5	0	0.1	0	0	0.2	100
%	2020	91.5	5.3	0	2.4	0	0.4	0	0	0.3	100

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
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

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**
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
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

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**
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
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
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

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**
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
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

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**
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
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	4548741	11562002	2878462	310552
2018	2	2090509	2888456	1516387	534059
2018	3	157673	1090798	254223	15776
2018	4	0	0	0	0
2019	1	2420231	9775216	3342785	163695.6
2019	2	799272.1	2399200	1041391	139590
2019	3	121303.8	19818.84	2252.614	237.2071
2019	4	0	0	0	0
2020	1	206247.2	10088069	3408125	426753.1
2020	2	72133.58	2538201	379017.1	142238.1
2020	3	0	0	0	0
2020	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)

Weight-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
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

Weight-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**
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
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

Weight-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**
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
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
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

Weight-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**
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
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

Weight-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**
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
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	0.00664	0.0086	0.0126
2018	2	0.0053	0.0074	0.0097	0.0134
2018	3	0.0041	0.0067	0.0095	0.0136
2018	4	0.0057	0.0065	0.00762	0.0129
2019	1	0.003435	0.006394	0.008787	0.011583
2019	2	0.004131	0.00764	0.009757	0.014115
2019	3	0.005802	0.009995	0.013033	0.016454
2019	4	0.006432	0.007847	0.010513	0.015719
2020	1	0.004874	0.009325	0.012186	0.016226
2020	2	0.007139	0.010805	0.014431	0.017161
2020	3	0.005747	0.010002	0.014331	0.016495
2020	4	0.006462	0.010266	0.013371	0.016135

Table 10.2.4. North Sea and Division 3.a sprat. Sampling for biological parameters in 2020. 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	0.9	2	194	99
	2	19.6	12	1427	609
	3	103.9	23	2383	1138
	4	26.5	15	1499	746
	Total	150.9	52	5503	2592
Norway	1				
	2	0.0			
	3	7.9	4	379	172
	4	2.1	3	300	149
	Total	10.0	7	679	321
Sweden	1	0.0	4	79	78
	2	0.0			
	3	3.5			
	4	2.3	12	626	626
	Total	5.9	16	705	704
All countries	1	0.9	6	273	177
	2	19.6	12	1427	609
	3	124.2	27	2762	1310
	4	34.7	30	2425	1521
Total		179.4	75	6887	3617

Table 10.2.5. North Sea and Division 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
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

Year	S1	S2	S3	S4
2012	37	88	15	3
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	20	5
2019	65	45	2	12
2020	27	28	0	0

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

IBTS Q1 survey index (area 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**
1983	252619	551262	574173	47111
1984	619180	553686	100186	25687
1985	374594	292408	75083	19254
1986	116338	137304	39250	9993
1987	503284	86061	25143	9769
1988	248663	789924	77117	15148
1989	744970	154929	114877	11326
1990	360108	185946	47580	21180
1991	1412224	176334	33438	7582
1992	1882139	281520	36961	9645
1993	1863182	1224852	103248	10709
1994	1195289	887347	132008	8288
1995	2258852	2257140	263386	10391
1996	604673	967027	199658	28253
1997	599335	270098	168138	27513
1998	1072937	1104108	180777	16056
1999	5183400	583736	73757	5308
2000	2017439	1164352	150449	25036
2001	1997862	1309083	239142	13995
2002	1191954	968965	87712	10393
2003	2493114	589410	66441	5540
2004	4084377	685280	106637	9076
2005	8918279	675529	29062	2718
2006	1230441	1416990	58676	7654
2007	1917763	1035569	162880	12506
2008	1526985	803061	47400	8526

IBTS Q1 survey index (area 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**
2009	4133598	312030	34043	3833
2010	3288300	2489705	118665	17586
2011	1078333	926246	206207	47562
2012	3356603	3143308	245116	36666
2013	1137772	1116849	203191	29306
2014	3886605	443621	50655	9871
2015	7727188	3460669	317090	26651
2016	2112309	3409890	675849	37763
2017	10317128	1707447	128002	15146
2018	10440866	1547476	94598	11384
2019	6097175	2511994	226057	9585
2020	7316245	2219294	421523	40023
2021	3308192.90	1977916.75	196830.97	16693.94

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

IBTS Q3 survey index (area 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
2018	18709889	3123833	200733
2019	40210818	8468920	521293
2020	53930015.69	16906066.30	1479519.10

Table 10.3.2. North Sea and Division 3.a sprat. HERAS survey index.

HERAS abundance index (area 4 and 3.a summed), data are 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
2019	93775	28020	5275
2020	38415.20	17993.10	2055.10

Table 10.6.1. North Sea and Division 3.a sprat. Natural mortality input (Model year). From multispecies SMS (WKSAM: ICES, 2017) 2017 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
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
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

Year	Season	age 0	age 1	age 2	age 3
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
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

Year	Season	age 0	age 1	age 2	age 3
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
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
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

Year	Season	age 0	age 1	age 2	age 3
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
2019	1	0.377	0.347	0.260	0.143
2019	2	0.255	0.200	0.165	0.153
2019	3	0.212	0.177	0.149	0.149
2019	4	0.278	0.224	0.181	0.181
2020	1	0.377	0.347	0.260	0.143
2020	2	0.255	0.200	0.165	0.153
2020	3	0.212	0.177	0.149	0.149
2020	4	0.278	0.224	0.181	0.181

Table 10.6.2. North Sea sprat. Assessment diagnostics.

Date: 04/06/21 Start time:13:38:50 run time:5 seconds

objective function (negative log likelihood): 291.264
Number of parameters: 141
Maximum gradient: 0.240436
Akaike information criterion (AIC): 864.528
Number of observations used in the likelihood:

Catch	CPUE	S/R	Stomach	Sum
752	288	47	0	1087

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
397.3	-107.2	11.5	0.0	0.0	0.00	302

unweighted objective function contributions (per observation):

Catch	CPUE	S/R	Stomachs
0.53	-0.37	0.25	0.00

contribution by fleet:

IBTS Q1	total: -65.594	mean: -0.420
IBTS Q3	total: -33.129	mean: -0.381
Acoustic	total: -8.449	mean: -0.188

F, Year effect:

1974:	1.000
1975:	1.759
1976:	1.828
1977:	1.586
1978:	1.043
1979:	0.676
1980:	2.405
1981:	1.175
1982:	1.060
1983:	1.745
1984:	1.020
1985:	1.412
1986:	1.184
1987:	0.388
1988:	1.358
1989:	0.381
1990:	1.595
1991:	0.818
1992:	0.904

1993: 1.682
1994: 0.812
1995: 1.495
1996: 1.490
1997: 1.071
1998: 1.835
1999: 0.940
2000: 1.572
2001: 1.672
2002: 1.734
2003: 1.351
2004: 2.103
2005: 1.395
2006: 1.741
2007: 1.779
2008: 1.575
2009: 0.917
2010: 1.128
2011: 1.000
2012: 1.484
2013: 1.437
2014: 0.650
2015: 1.415
2016: 2.450
2017: 1.531
2018: 1.539
2019: 1.219
2020: 2.183

F, season effect:
---
age: 0
1974-2020: 0.036 0.206 0.387 0.250
age: 1
1974-2020: 0.533 0.535 0.206 0.250
age: 2
1974-2020: 0.250 0.491 0.125 0.250
age: 3
1974-2020: 0.226 0.541 0.312 0.250

F, age effect:
---
0 1 2 3
1974-2020: 0.037 0.410 1.473 1.473

Exploitation pattern (scaled to mean F=1)
---
0 1 2 3
1974-2020 season 1: 0.001 0.193 0.325 0.293
season 2: 0.007 0.193 0.637 0.702
season 3: 0.013 0.074 0.163 0.404

season 4: 0.008 0.090 0.324 0.324

sqrt(catch variance) ~ CV:

	season			
age	1	2	3	4
0	1.414	1.414	1.185	0.100
1	0.854	0.726	1.414	0.100
2	1.016	1.078	1.414	0.100
3	1.016	1.078	1.414	0.100

Survey catchability:

	age 0	age 1	age 2	age 3
IBTS Q1		0.000	1.546	2.989	5.229
IBTS Q3			0.837	1.087	1.039
Acoustic			1.114	2.433	6.329

Stock size dependent catchability (power model)

	age 0	age 1	age 2	age 3
IBTS Q1	1.64	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		0.44	0.39	0.39	0.39
IBTS Q3			0.47	0.39	0.39
Acoustic			0.45	0.53	0.53

Average F:

	sp. 1
1974:	1.124
1975:	1.697
1976:	1.784
1977:	1.596
1978:	1.040
1979:	0.681
1980:	2.262
1981:	1.108
1982:	0.987
1983:	1.596
1984:	0.972
1985:	1.293
1986:	1.081
1987:	0.360

1988: 1.256
1989: 0.366
1990: 1.515
1991: 0.809
1992: 0.897
1993: 1.578
1994: 0.765
1995: 1.367
1996: 1.378
1997: 1.032
1998: 1.754
1999: 0.931
2000: 1.484
2001: 1.612
2002: 1.670
2003: 1.365
2004: 2.057
2005: 1.357
2006: 1.668
2007: 1.688
2008: 1.514
2009: 0.874
2010: 1.048
2011: 0.927
2012: 1.348
2013: 1.331
2014: 0.622
2015: 1.328
2016: 2.258
2017: 1.429
2018: 1.437
2019: 1.145
2020: 1.770

Recruit-SSB		alfa	beta	recruit s2	recruit s
Sprat	Hockey stick -break.:	1354.122	9.000e+04	0.601	0.775

Table 10.6.3. North Sea and Division 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	536170000	330380000	236466000	173242000	138697000	70606100	44792700	31279000	10662600	4933560	1924920	1343460	519368	281566	105187	55798
1975	710021000	421816000	311549000	218527000	109995000	45761800	24952400	15956900	18750600	6426120	1473200	855972	704628	309834	64402	23096
1976	329110000	201180000	144353000	97681200	136094000	57230000	30083100	18489500	10260200	3452130	734199	411931	575923	234572	44981	15282
1977	632579000	406329000	276463000	184839000	60119200	28182900	15577400	9589000	11871700	4576260	1156550	673137	280484	121122	28045	10563
1978	1049300000	694613000	486908000	327404000	113288000	60579000	38265800	24533700	6177700	2861730	1081260	724679	443921	225641	81098	40827
1979	537150000	346960000	227678000	152144000	209856000	118454000	79357100	51977100	16504900	8461420	4058780	2841760	526598	280591	130497	75893
1980	331153000	206300000	129470000	84846600	97558800	36263300	16466200	9423750	35214400	9307940	1262610	641877	2001350	593680	69414	18242
1981	90046800	54492800	35861400	24583000	55805000	26552600	15641200	10350600	6495020	2691450	880217	567317	471551	222480	69182	32300
1982	46704700	27990700	19936200	14468400	16872200	8692670	5468830	3968310	7439300	3450160	1289510	883778	459146	252512	90827	46535
1983	61661900	36121200	25462700	18463200	10527500	4680880	2522050	1770330	3008600	1115400	253816	154666	757601	338860	69491	26235
1984	32596500	18996200	12677400	9171790	13511300	7063650	4460940	3224340	1365780	703563	272823	189235	152874	90742	33312	17466
1985	23169700	13352400	8155380	5786850	6650670	2957160	1643900	1137730	2451060	1002370	280524	180955	169694	87017	22889	10021
1986	73957600	40939400	25809600	17951200	4209240	1905320	1074110	750648	869084	368398	117253	78091	161923	84684	26260	12638
1987	39337600	21664700	13495000	9396710	12838900	7269290	4869860	3794930	564821	314310	175964	135445	76599	52099	30332	20989
1988	58120800	31161400	18839100	12741400	6702490	3015330	1589960	1116980	2865230	1101540	300644	187755	130060	63938	16537	7115
1989	51217800	27997000	16508000	11499000	8877360	4908780	3239050	2496100	826319	465531	263410	196782	154433	109837	62468	42037
1990	69271000	41185100	24784000	17290300	7909760	3421930	1731840	1167010	1827430	678590	161141	93567	180247	83050	17953	6730
1991	106179000	66807900	44700300	32387000	11742200	6431060	4104830	2942860	848615	455685	199907	137455	75290	44089	18601	10219
1992	100264000	66453500	48303100	35533100	21952200	12566300	8212390	5778660	2136720	1155300	489794	335224	110813	63576	25829	13794
1993	134538000	85120900	66207600	49216300	24526600	11223000	6295430	4240870	4285070	1639530	401331	242730	266369	112382	24726	9425
1994	118861000	71839600	53296500	40709500	34770200	18626200	12463700	9344240	3223320	1686630	769554	547635	197573	107702	47016	26773
1995	35762400	21387800	15817300	12397600	29627500	13493200	7773350	5661760	7293600	2995840	835090	530314	459638	205534	52086	21948
1996	60740900	36613900	25174500	19874800	9514960	4626550	2657820	1974700	4584990	2034270	565546	369319	456859	224710	57457	24932
1997	47922800	30477500	22449000	17609800	15666300	9246550	5959610	4488880	1625130	887184	338882	234415	337261	202291	73892	38101

Year/Age Quarter	A00S1	A00S2	A00S3	A00S4	A01S1	A01S2	A01S3	A01S4	A02S1	A02S2	A02S3	A02S4	A03S1	A03S2	A03S3	A03S4
1998	108113000	70183200	48193500	36491800	13455500	6789760	3725780	2589810	3623050	1468230	326058	195475	229679	103117	20660	7486
1999	76081800	49855900	37015700	27749700	26556100	16223500	10907900	7920410	2026520	1135710	485610	337241	166716	98440	39976	21452
2000	73216300	48680200	33718500	25575500	19858100	10007100	5808380	4110430	6063670	2636770	705981	451434	281497	134130	32362	13445
2001	59548200	39477700	28897900	21608700	19356400	9673330	5413970	3752290	3247430	1388350	338190	205112	383640	181874	39492	15139
2002	79517900	51375600	36980300	28034400	15907500	7892720	4316670	3034150	2897750	1202090	276619	165343	177962	84266	17225	6398
2003	102412000	67209100	49531000	37489600	20303000	11543300	6825270	4842380	2335690	1144000	349226	217135	138129	74459	20686	8877
2004	174458000	112451000	83796400	64515900	25571200	12249800	6219050	4213470	3558220	1301030	234270	129096	169805	69635	10837	3354
2005	64052400	41107600	29852300	23466600	44307200	23698400	14017300	10193200	3114100	1483540	450952	291315	100267	50793	14045	6188
2006	82060000	49460600	37453100	29394600	16261400	8112150	4478760	3175650	7617150	3198360	763300	465721	237563	107404	22712	8594
2007	58147300	35891500	26557800	20974700	20420200	10126400	5488390	3965850	2406790	1018130	236948	146521	387433	178330	36587	13886
2008	128823000	79715900	60194600	48153200	15347800	8002000	4619650	3401570	3127560	1450310	396328	250798	134652	67514	16541	6794
2009	106801000	68413200	48982900	39954300	35530900	20241800	13546400	10580500	2715000	1533320	674375	483467	211553	132564	54936	30622
2010	111529000	65731400	43886200	35112600	29820700	15423600	9688560	7341490	8530860	4118260	1520780	1052880	425261	246370	85069	43213
2011	89718700	53764800	36454300	28585200	25780000	13380900	8461860	6353590	5854150	2752360	1099530	764036	900300	538150	202651	107013
2012	68928300	41341400	28278600	22235200	20385900	9571220	5444330	4029280	4930350	2022340	570907	375387	696021	356270	91401	40002
2013	155911000	104400000	78736700	62729500	16608200	8401680	4974320	3698770	3217070	1423630	427125	282422	347095	185316	50365	22451
2014	177282000	122715000	94392600	75683800	47888100	29714000	21125000	16688400	2965800	1826330	965356	734362	255089	178653	91262	58081
2015	96607400	66930000	52231000	41383700	57663800	30139800	18202000	13529800	13298100	6151850	1875530	1244330	659464	358271	99946	44976
2016	137568000	94042200	71500800	55807800	31343100	12959300	6193150	4218170	10810800	3377110	486027	266322	1076340	412906	50252	14057
2017	167918000	114932000	88003500	69609500	42267600	21368500	12496500	9198070	3370460	1477750	413687	268625	234068	121910	30864	13166
2018	167007000	114307000	87519900	69219000	52720600	26607200	15533300	11425700	7349570	3213020	894354	579900	235247	122204	30745	13068
2019	158211000	108334000	83150300	66068600	52424900	28375100	17770700	13429100	9129520	4490730	1575570	1083750	495025	286012	92842	45703
2020	94106900	64355100	49030400	39652400	50038800	21937700	11119100	9313420	10730300	3699940	646402	556926	942898	395419	59573	51327
2021	0				30031800				7441740				507785			

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 refer to the model year.

Year	Recruitment	High	Low	SSB	High	Low	Catches	F ages 1-2	High	Low
	(thousands)			(tonnes)			(tonnes)	(per year)		
1974	536170000	952463587	301825994	607475	980398	376404	443039	1.135	1.784	0.723
1975	710021000	1236886331	407579749	610393	978228	380872	731782	1.583	2.413	1.026
1976	329110000	566535718	191185461	499002	803640	309844	629980	1.646	2.44	1.096
1977	632579000	1068754769	374413479	338213	518539	220597	385214	1.428	2.162	0.925
1978	1049300000	1959229159	561971266	390121	611605	248844	459295	0.939	1.646	0.519
1979	537150000	939377602	307150311	630106	1071834	370425	464139	0.609	1.224	0.285
1980	331153000	518996660	211296754	432865	728812	257093	387443	2.165	3.036	1.536
1981	90046800	133815694	60593985	304926	450169	206544	280227	1.058	1.646	0.674
1982	46704700	66759109	32674627	178741	266747	119770	163008	0.954	1.396	0.649
1983	61661900	83818794	45362021	84056	113334	62341	115430	1.571	1.948	1.266
1984	32596500	46187809	23004594	61532	80166	47229	113527	0.918	1.309	0.639
1985	23169700	31655740	16958536	57379	74895	43959	62514	1.271	1.643	0.982
1986	73957600	102969648	53119795	22533	29494	17215	27520	1.066	1.449	0.783
1987	39337600	53434042	28959943	52143	70296	38678	53976	0.349	0.538	0.225
1988	58120800	82847863	40773863	54619	69968	42637	103655	1.222	1.551	0.961
1989	51217800	70180667	37378713	40925	54749	30591	58442	0.343	0.667	0.172
1990	69271000	93616860	51256488	39137	52261	29309	78254	1.436	1.828	1.125
1991	106179000	138966498	81127323	81366	106479	62176	125815	0.736	1.071	0.499
1992	100264000	132698924	75756980	113659	143615	89951	156472	0.814	1.138	0.577
1993	134538000	200667428	90201353	158825	202183	124765	209083	1.514	1.834	1.248
1994	118861000	158684269	89031745	124251	174829	88305	425104	0.731	1	0.532
1995	35762400	47667352	26830718	178926	237897	134573	447604	1.345	1.688	1.071
1996	60740900	80418066	45878459	106678	133732	85097	95522	1.341	1.663	1.079
1997	47922800	63600076	36109937	108100	136940	85334	125227	0.964	1.279	0.722
1998	108113000	144965821	80628804	133319	166819	106546	189063	1.652	1.97	1.382
1999	76081800	100068068	57845029	127979	166750	98222	243188	0.846	1.169	0.606
2000	73216300	96221572	55711276	182422	230855	144150	222089	1.414	1.768	1.127
2001	59548200	77537383	45732626	125252	158126	99212	153321	1.505	1.86	1.215
2002	79517900	105004649	60217300	108990	136592	86966	175008	1.561	1.891	1.285
2003	102412000	135303427	77516276	136243	173166	107193	175253	1.216	1.558	0.942
2004	174458000	228555156	133165203	166717	211947	131139	231221	1.892	2.239	1.595
2005	64052400	82595370	49672396	212407	271900	165931	280861	1.256	1.578	0.995
2006	82060000	105774346	63662351	164011	205707	130767	78114	1.567	1.91	1.283
2007	58147300	75383943	44851839	132225	165116	105886	99904	1.601	1.933	1.323
2008	128823000	165473206	100290347	97626	121726	78298	69970	1.418	1.772	1.13
2009	106801000	138032550	82635969	171358	214572	136847	171230	0.825	1.132	0.598
2010	111529000	150694551	82542585	175073	217646	140828	147208	1.016	1.331	0.774

Year	Recruitment	High	Low	SSB	High	Low	Catches	F ages 1-2	High	Low
	(thousands)			(tonnes)			(tonnes)	(per year)		
2011	89718700	117091578	68744869	152787	193212	120820	122537	0.901	1.231	0.658
2012	68928300	88143162	53902202	127752	157647	103526	96182	1.335	1.644	1.084
2013	155911000	207962710	116887493	103778	128902	83551	60313	1.293	1.704	0.978
2014	177282000	237044941	132586283	198774	256369	154118	190700	0.585	0.834	0.408
2015	96607400	127401734	73256379	322777	416576	250098	297105	1.273	1.601	1.01
2016	137568000	178485317	106030876	219369	278939	172521	227902	2.206	2.522	1.929
2017	167918000	217686883	129527578	176860	223327	140061	135544	1.378	1.701	1.115
2018	167007000	222100886	125579589	200477	251249	159965	191543	1.385	1.703	1.124
2019	158211000	218135627	114748429	212573	269822	167471	136794	1.097	1.494	0.802
2020	94106900	146340271	60517235	319474	414196	246414	179386	1.671	2.128	1.308
2021	127373950*			161888	220639	118781				

* Geometric mean recruitment (2011–2020)

Table 10.9.1. North Sea and Division 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(2021) (millions)	127374	30032	7442	508
Exploitation pattern Q1	0.002	0.267	0.450	0.406
Exploitation pattern Q2	0.009	0.268	0.883	0.972
Exploitation pattern Q3	0.018	0.103	0.225	0.560
Exploitation pattern Q4	0.000	0.000	0.000	0.000
Weight in the stock Q1 (gram)	4.286	7.444	9.850	13.462
Weight in the catch Q1 (gram)	4.29	7.44	9.85	13.46
Weight in the catch Q2 (gram)	5.54	8.62	11.29	14.89
Weight in the catch Q3 (gram)	5.23	8.90	12.29	15.53
Weight in the catch Q4 (gram)	6.21	8.20	10.49	14.89
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 Division 3.a. Short-term predictions options table. Years refer to the model year.

Catch options. Catches and SSB are in thousands of tonnes.

3-year average weight-at-age was used to calculate SSB. Recruitment(2021) = geom average 2011–2020.

Basis	Catches(2021)	F(2021)	SSB(2022)	%SSB change*	%TAC change**
F_{cap}	106.715	0.69	208.733	29%	-49%
F=0	0	0	274.265	69%	-100%
F=0.1	19.645	0.1	261.836	62%	-91%
F=0.2	37.606	0.2	250.598	55%	-82%
F=0.3	54.067	0.3	240.415	49%	-74%
F=0.4	69.189	0.4	231.167	43%	-67%
F=0.5	83.115	0.5	222.751	38%	-60%
F=0.6	95.970	0.6	215.075	33%	-54%
F=0.7	107.864	0.7	208.059	29%	-48%
F=0.8	118.893	0.8	201.634	25%	-43%
F=0.9	129.142	0.9	195.736	21%	-38%
F=1.0	138.689	1	190.313	18%	-33%
$B_{escapement}$ without F_{cap}	271.609	3.859	125.000	-23%	31%

* SSB in July 2022 relative to SSB in July 2021

** catch (July 2021-June 2021) relative to the sum of the TACs (207807 tonnes) for July 2020–June 2021 in Subarea 4 and Division 3.a.

Figure 10.1.1. North Sea and Division 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 and Division 3.a sprat. Number of samples taken in the North Sea and Division 3.a for each calendar year by statistical rectangle.

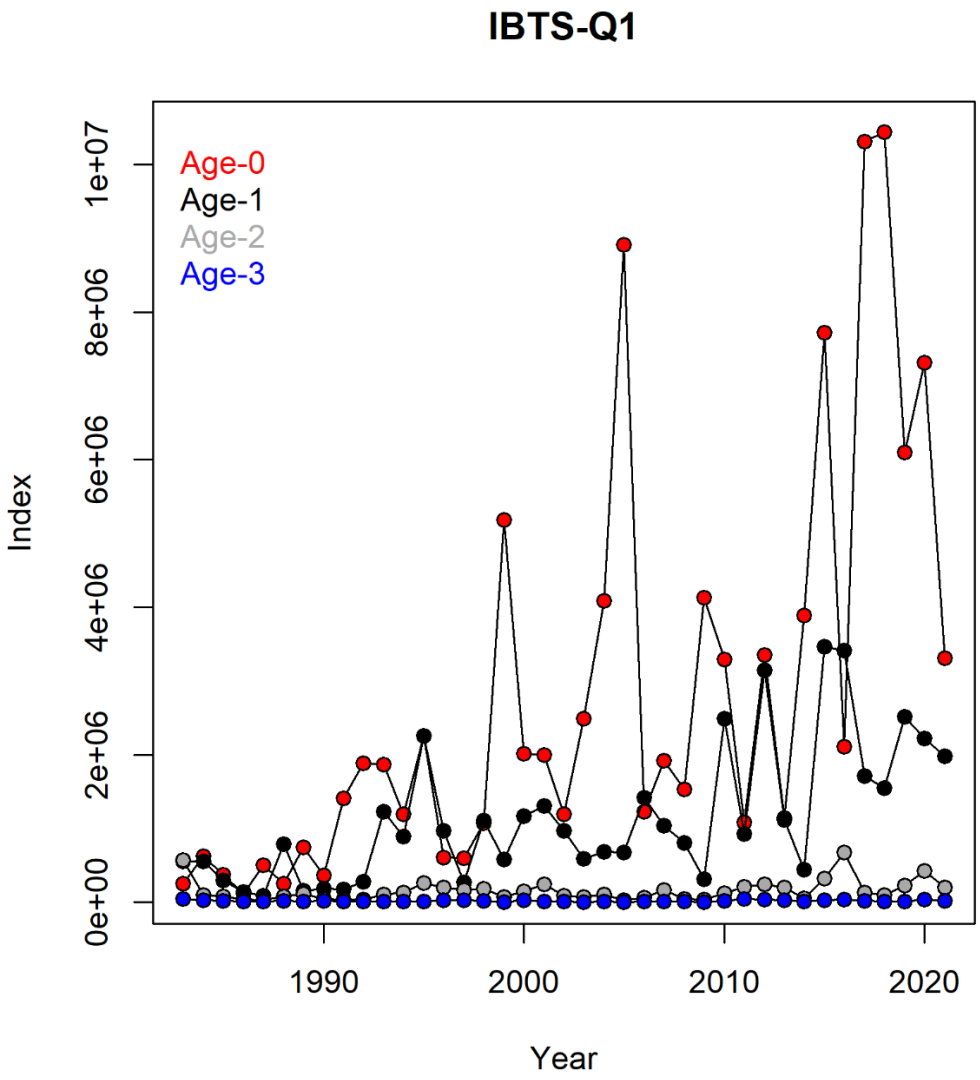


Figure 10.3.1. North Sea and Division 3.a sprat. IBTS Q1 survey index for Subarea 4 and Division 3.a combined. The index is calculated using a delta-GAM model formulation (see WKSPRAT report (ICES, 2018) for details). Years refer to the calendar year.

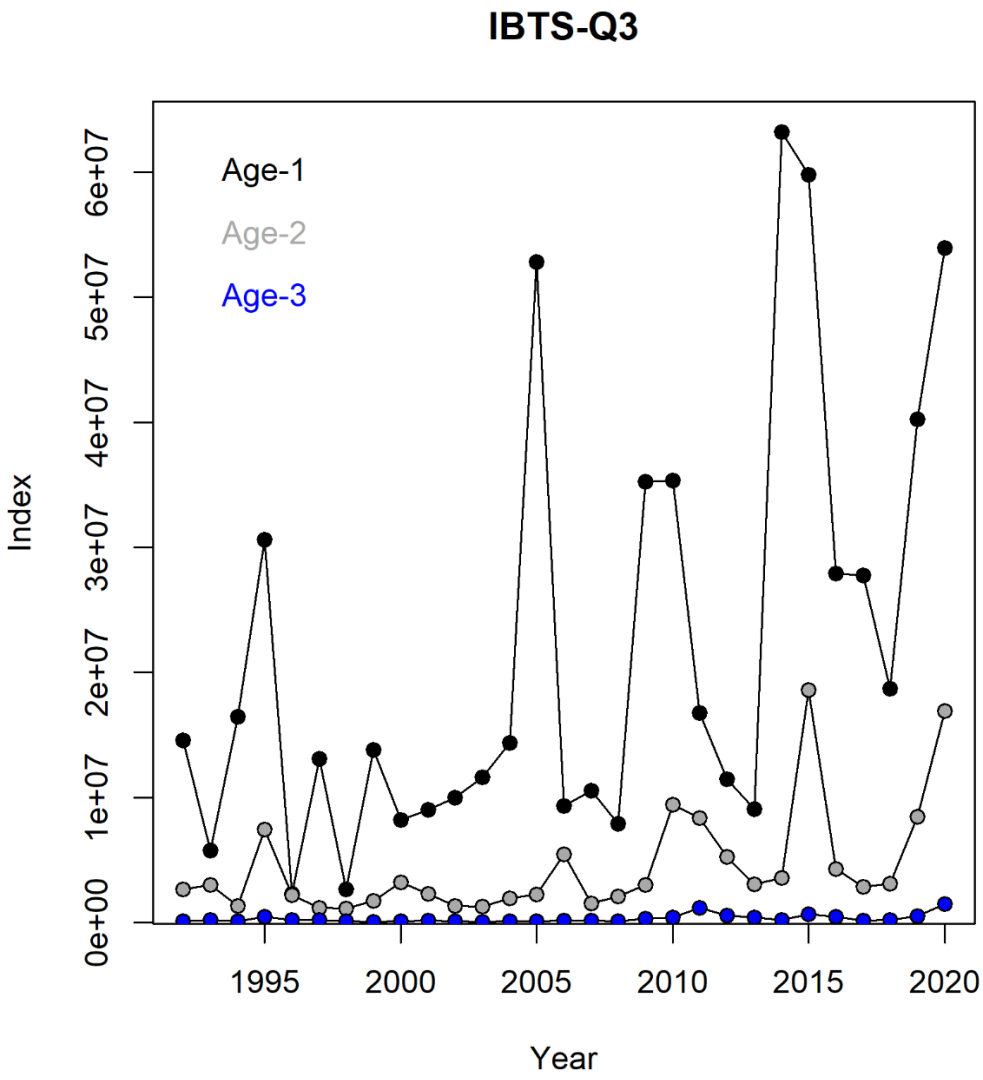


Figure 10.3.2a. North Sea and Division 3.a sprat. IBTS Q3 survey index for Subarea 4 and Division 3.a combined. The index is calculated using a delta-GAM model formulation (see WKSPRAT report (ICES, 2018) for details). Years refer to the calendar year.

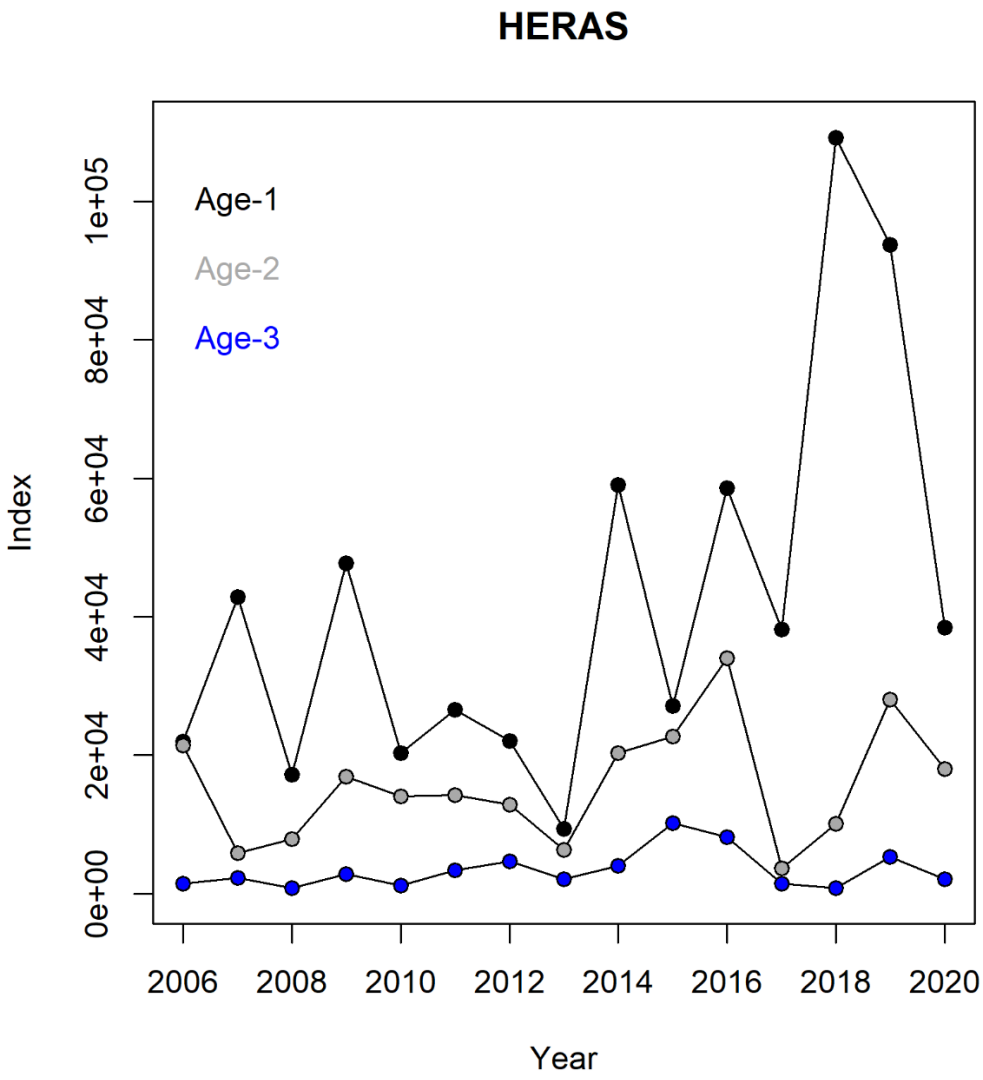
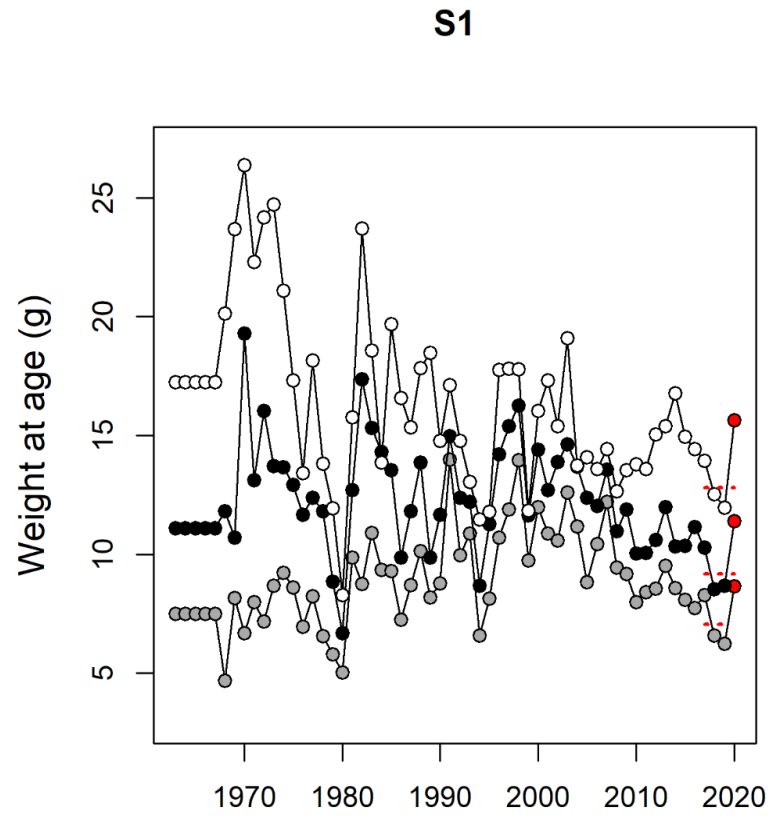
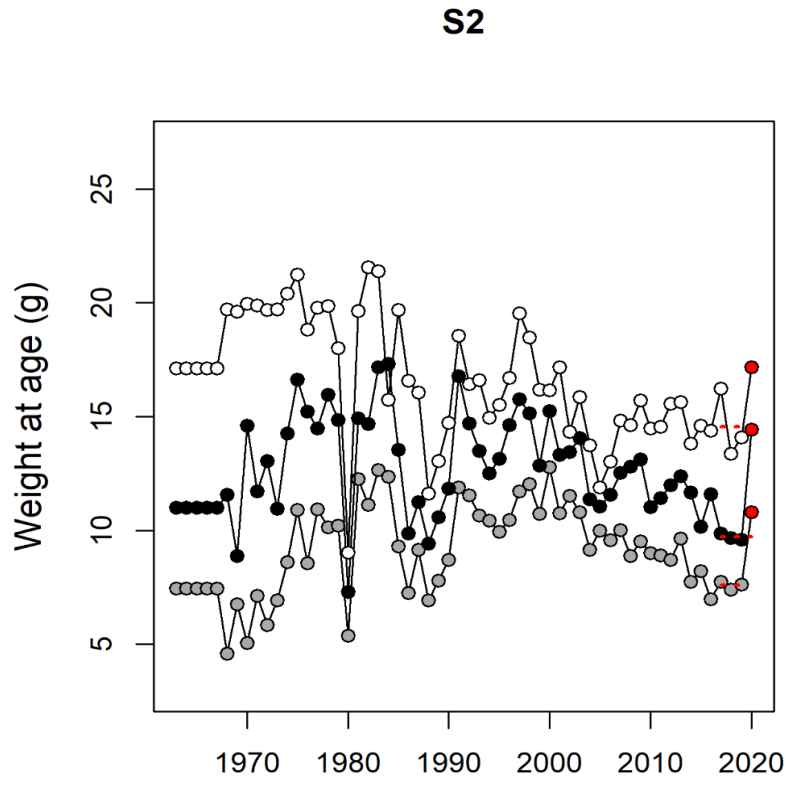


Figure 10.3.2b. North Sea and Division 3.a sprat. HERAS survey index for Subarea 4 and Division 3.a combined (sum of abundance indices published by WGIPS). Years refer to the calendar year.


S1
Weight at age (g)
5
10
15
20
25
1970
1980
1990
2000
2010
2020


S2
Weight at age (g)
5
10
15
20
25
1970
1980
1990
2000
2010
2020

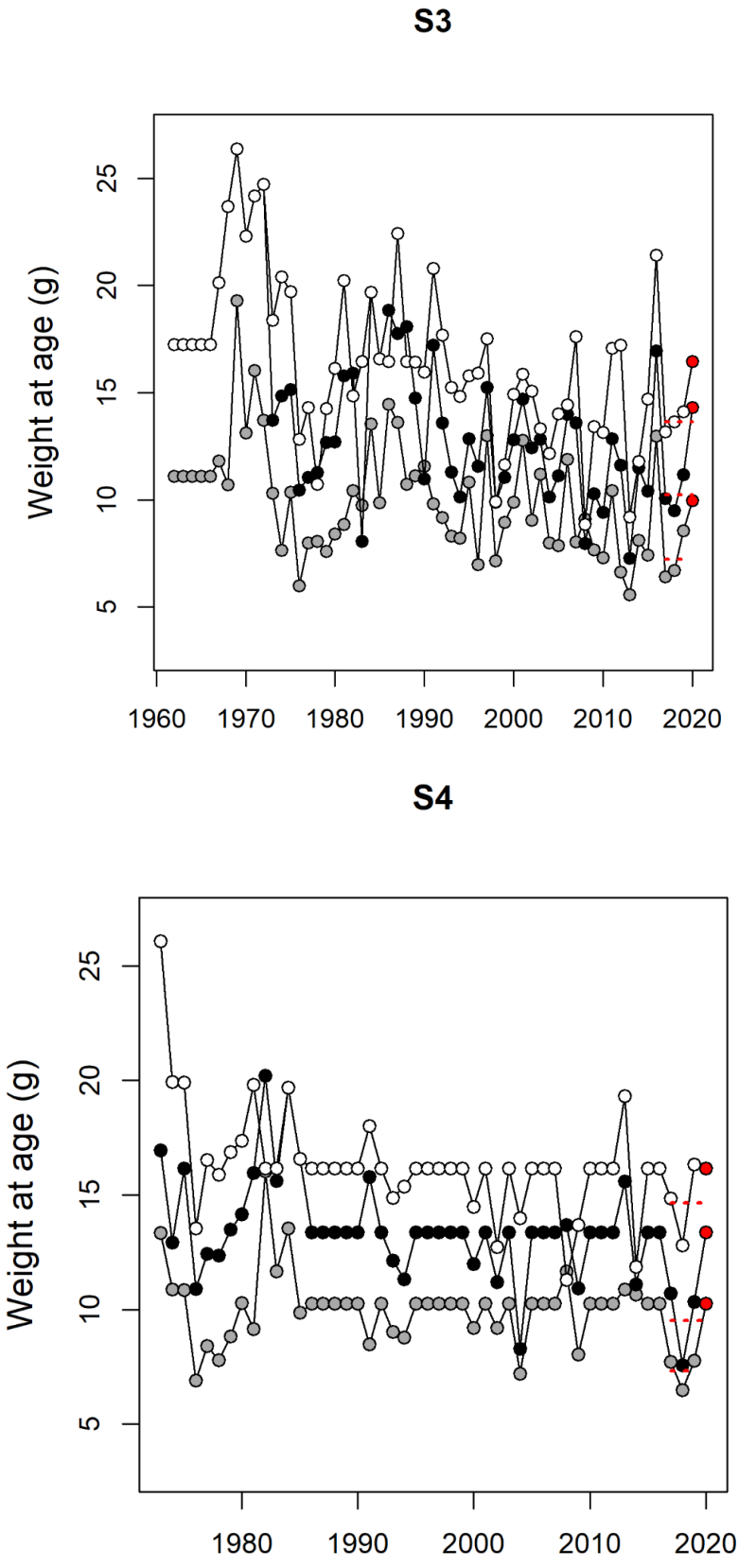


Figure 10.4.1. North Sea & 3.a sprat. Mean weight at age in season 1-4 (S1-S4) (years refer to the model year). Age 1 (grey), age 2 (black), age 3 (white). Red dot is the status quo weight and the red dashed line refer to the 3-year average used in the forecast last year.

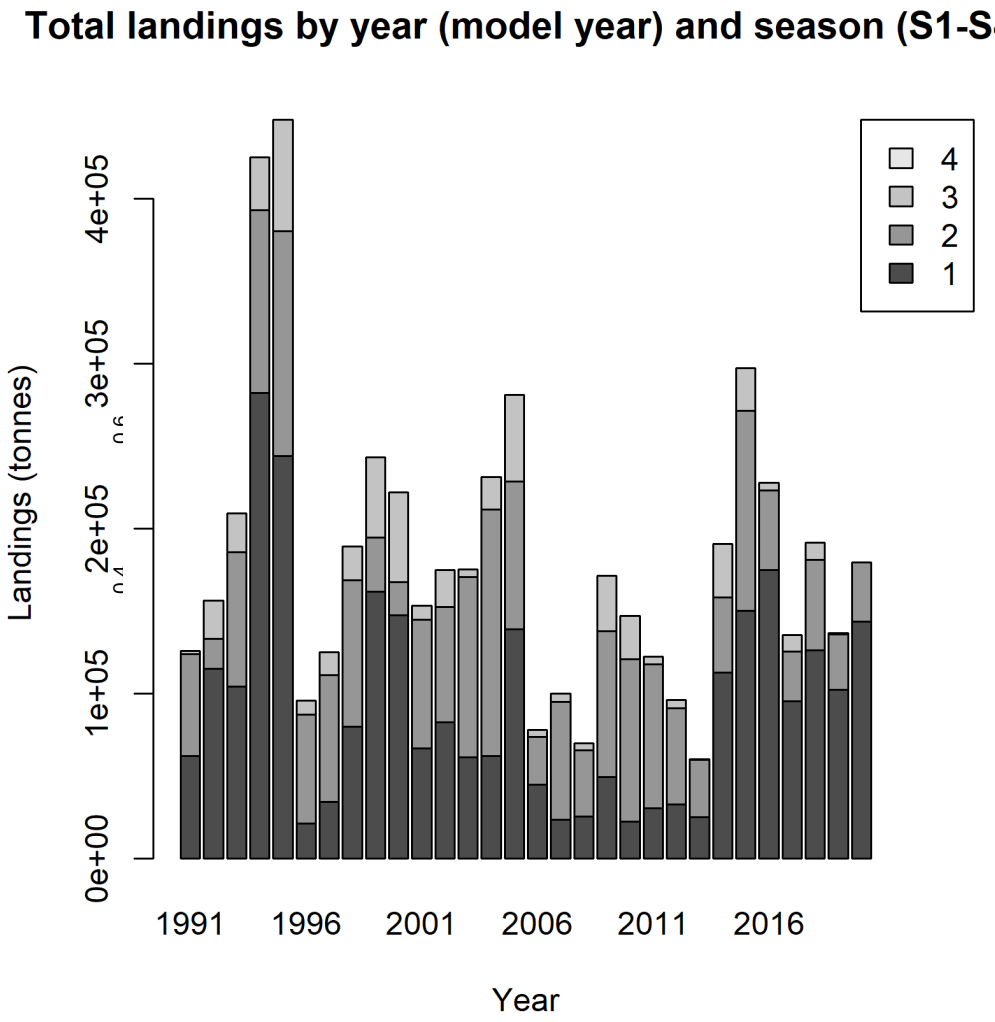


Figure 10.6.1a. North Sea & 3.a sprat. Seasonal distribution of catches (Calendar year). Year and season 1-4 refer to the time-steps of the model. Note that since the model year of 2020 is not yet finished, the 2020 column will be updated next year. Also note that there are no catches shown for S4, since these are moved to S1 in the following year (see WKSPRAT 2018 report (ICES, 2018) for details).

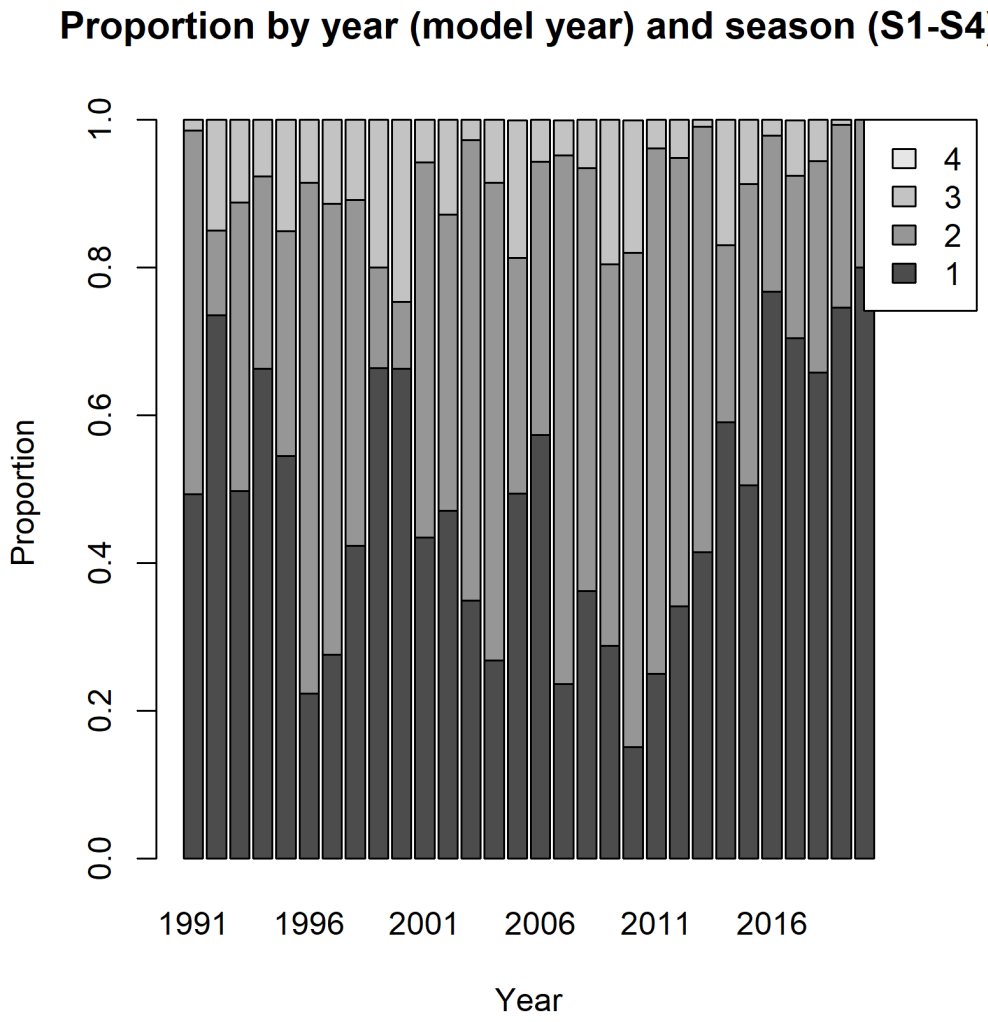


Figure 10.6.1b. North Sea & 3.a sprat. Proportion of each age group in the catches. Year and age refer to the model year.

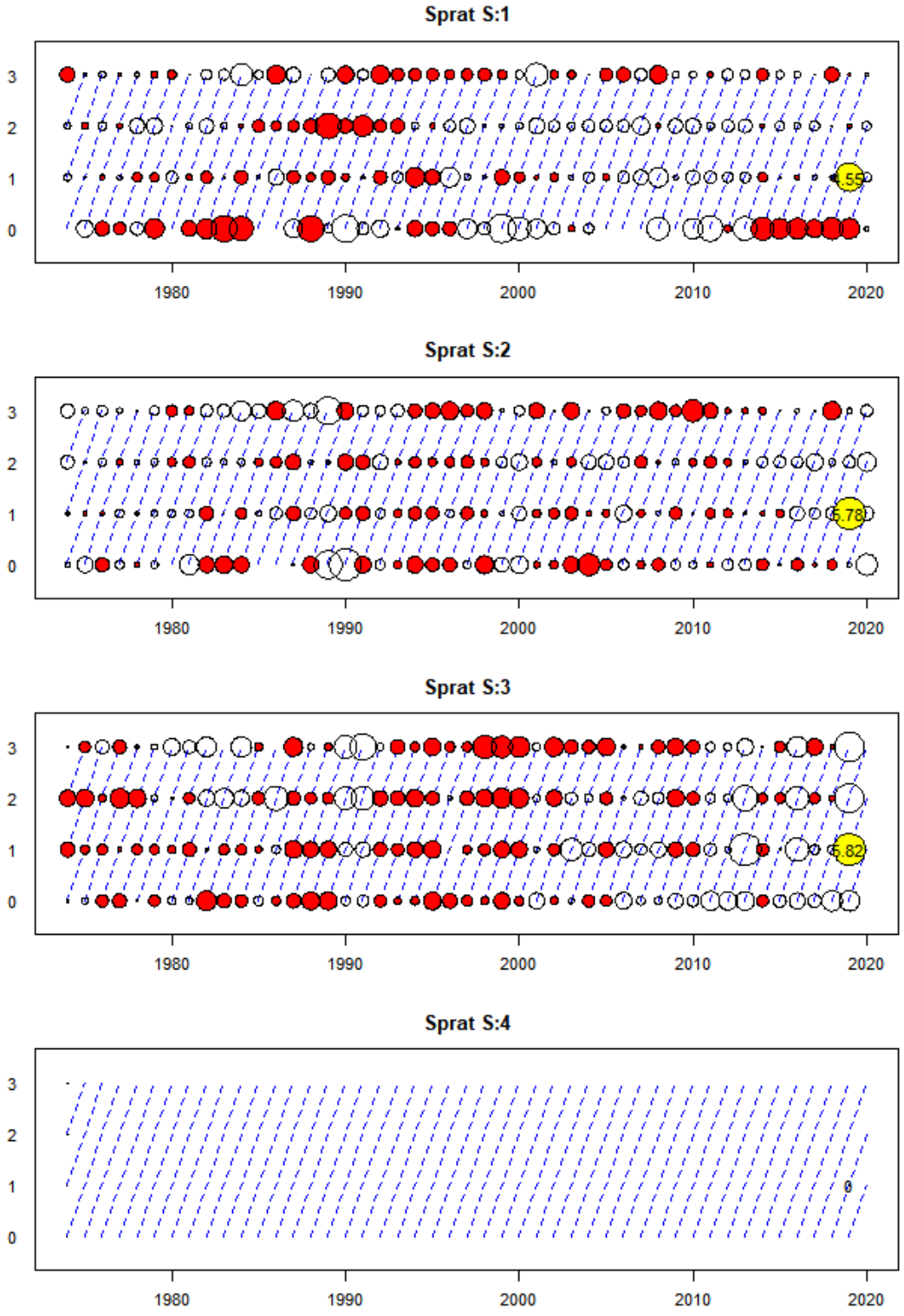


Figure 10.6.2. North Sea & 3.a sprat. Catch residuals by age. (Model year)

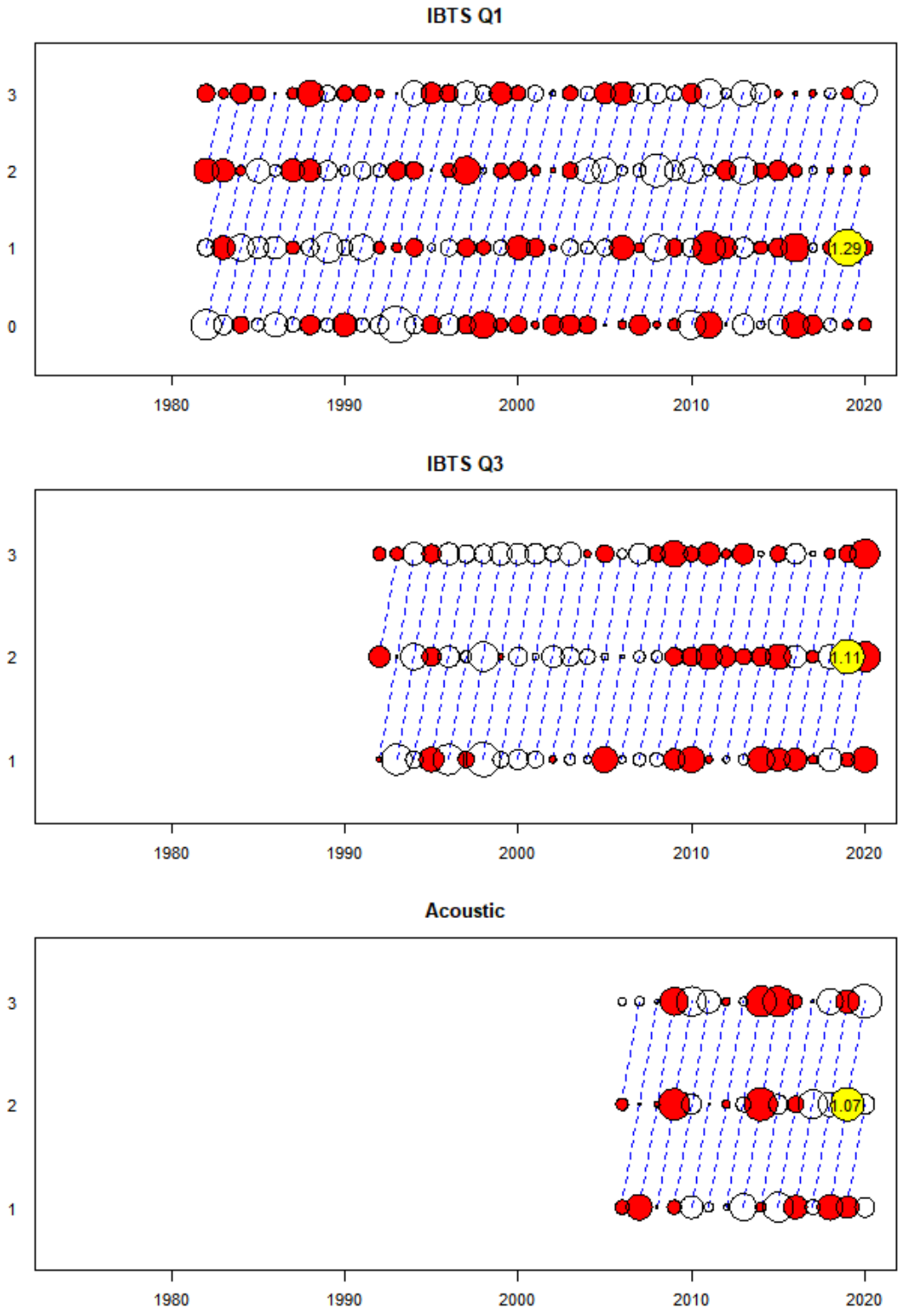


Figure 10.6.3. North Sea & 3.a sprat. Survey residuals by age. (Model year)

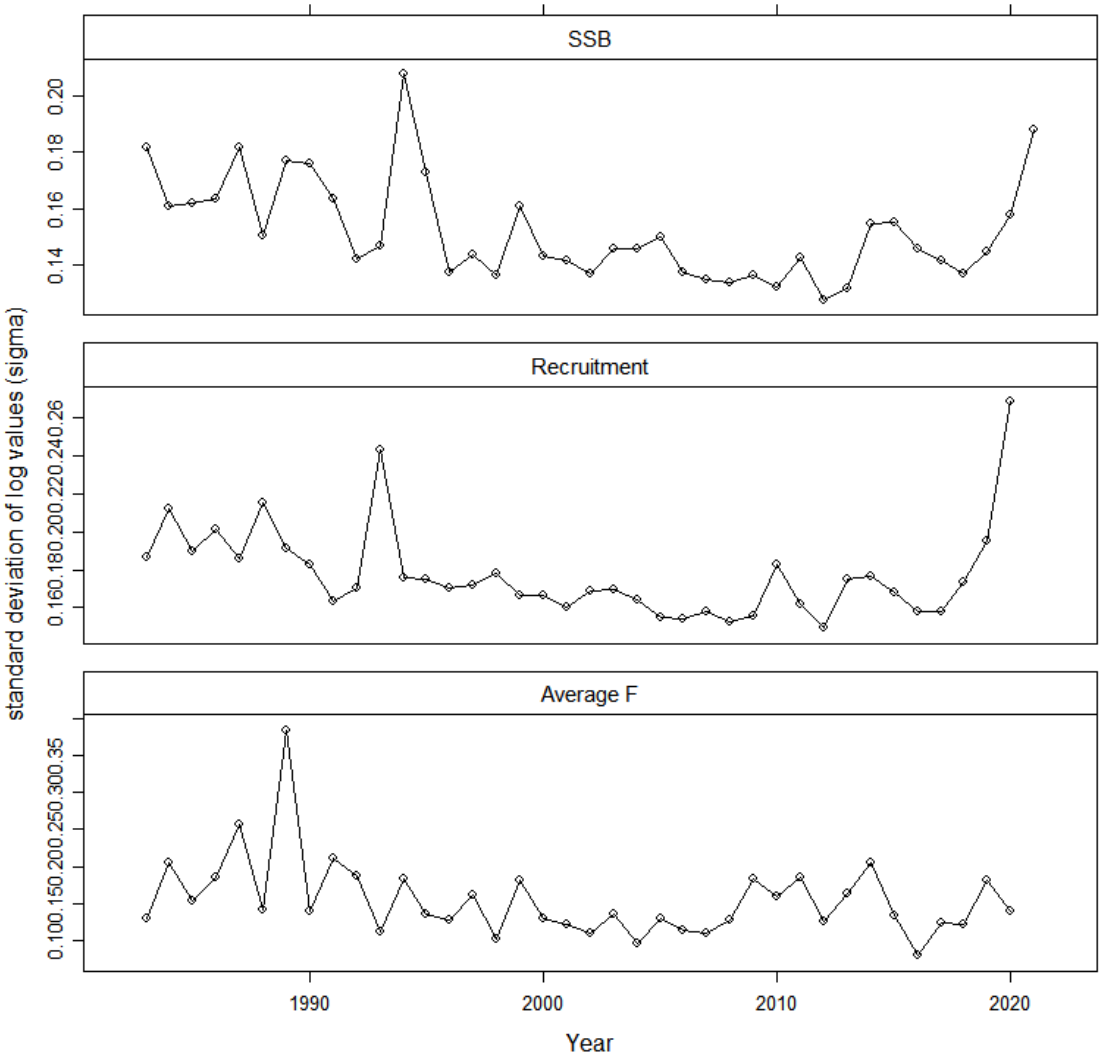


Figure 10.6.4. North Sea & 3.a sprat. Coefficients of variance (Model year).

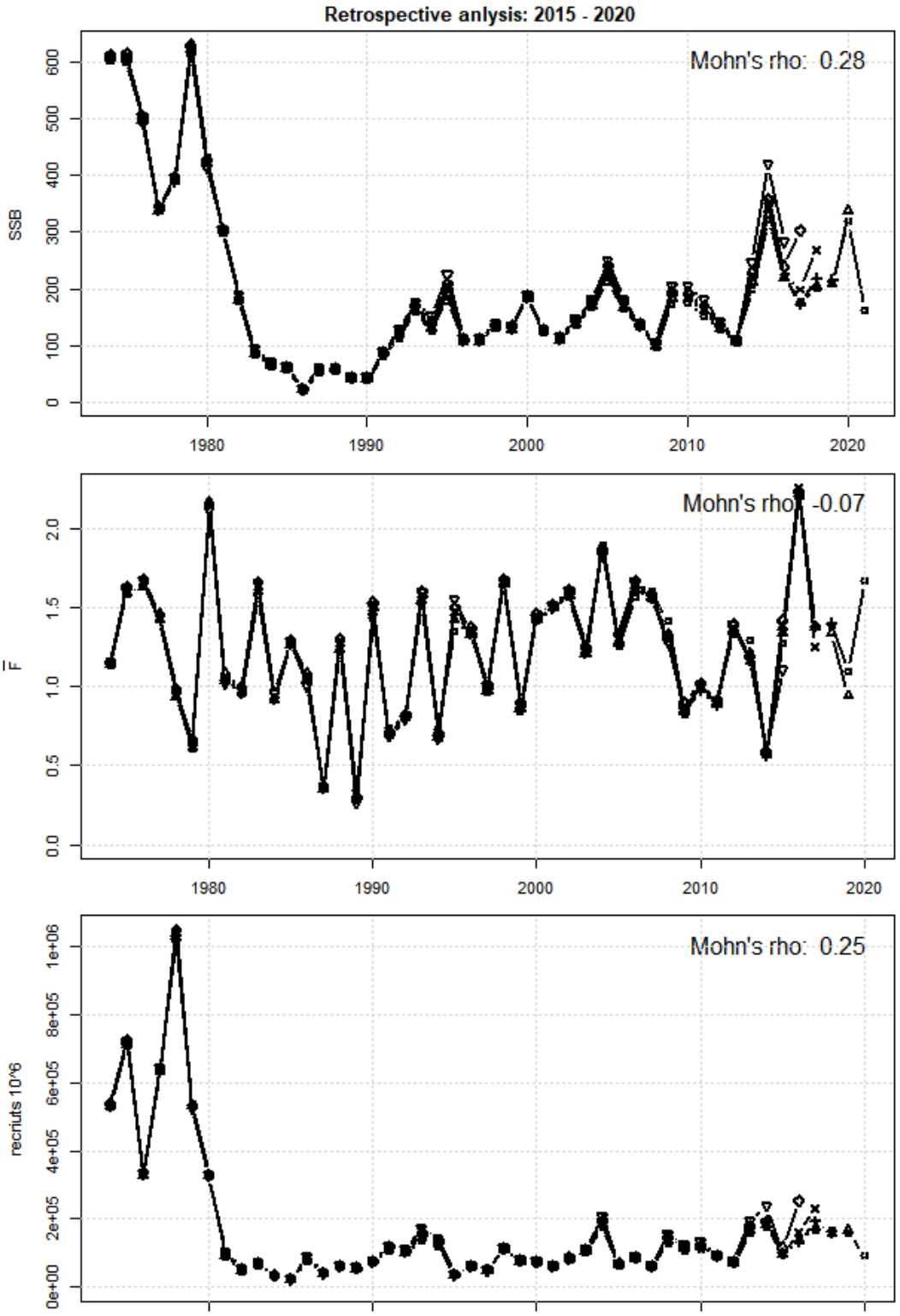


Figure 10.6.5. North Sea & 3.a sprat. Retrospective analysis (Model year)

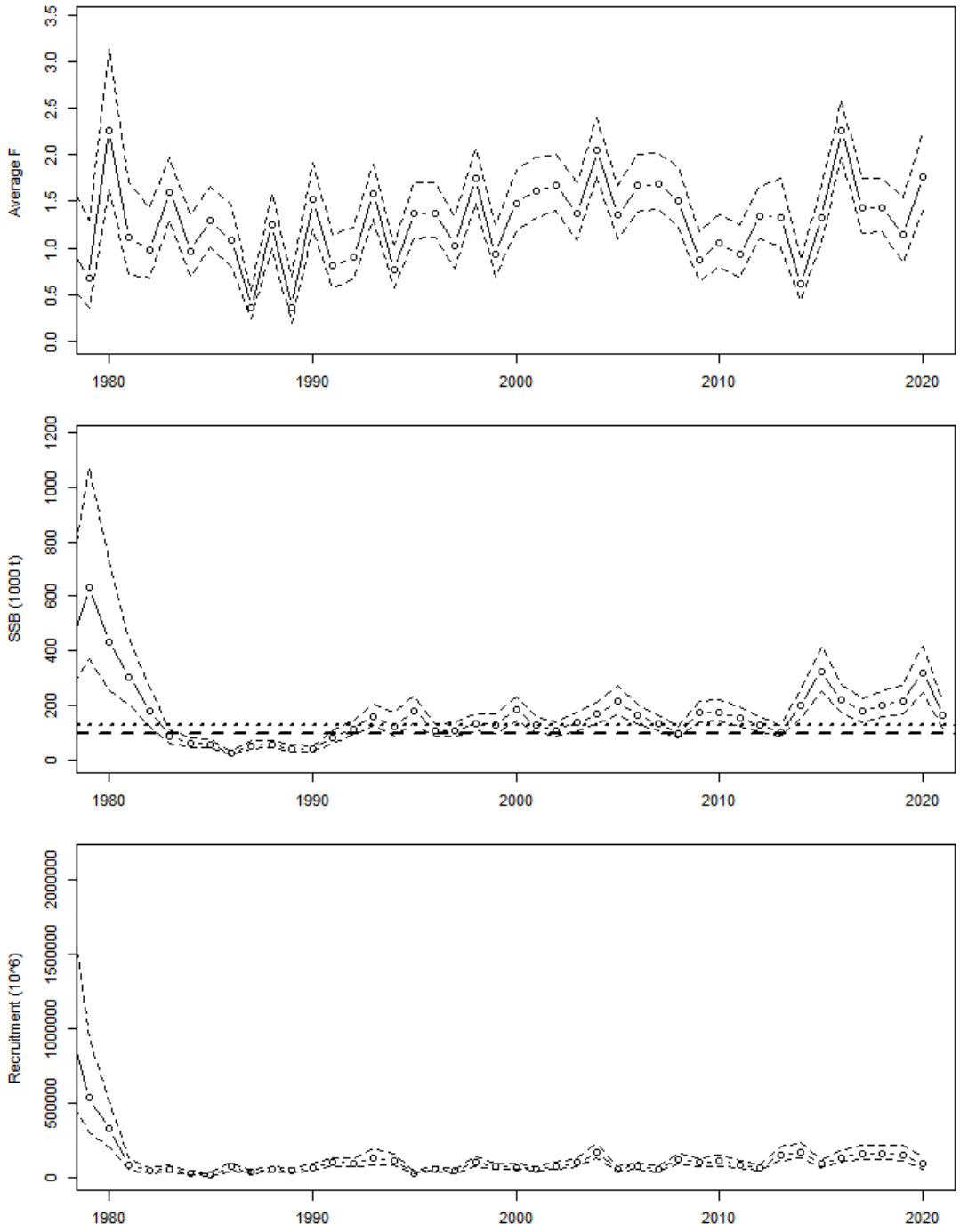


Figure 10.6.6. North Sea & 3.a sprat. Temporal development in Mean F, SSB and recruitment. Hatched lines are 95% confidence intervals (Model year).

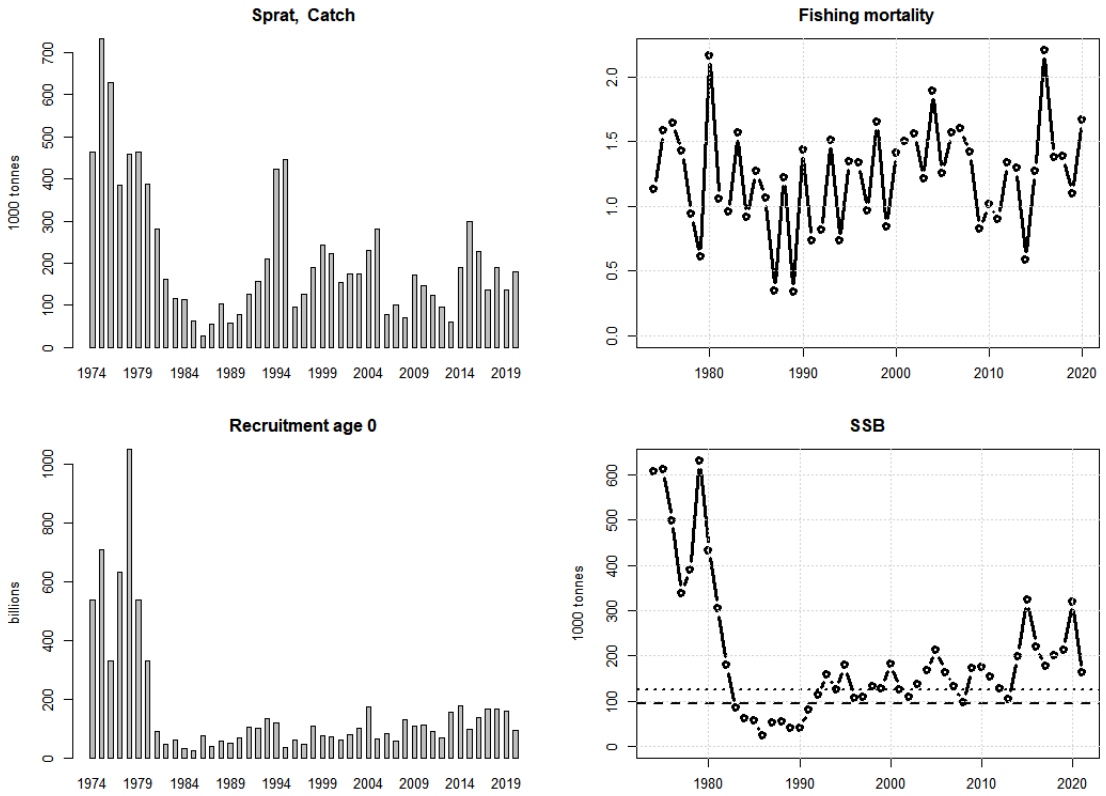


Figure 10.6.7. North Sea & 3.a sprat. Assessment summary (Model year).

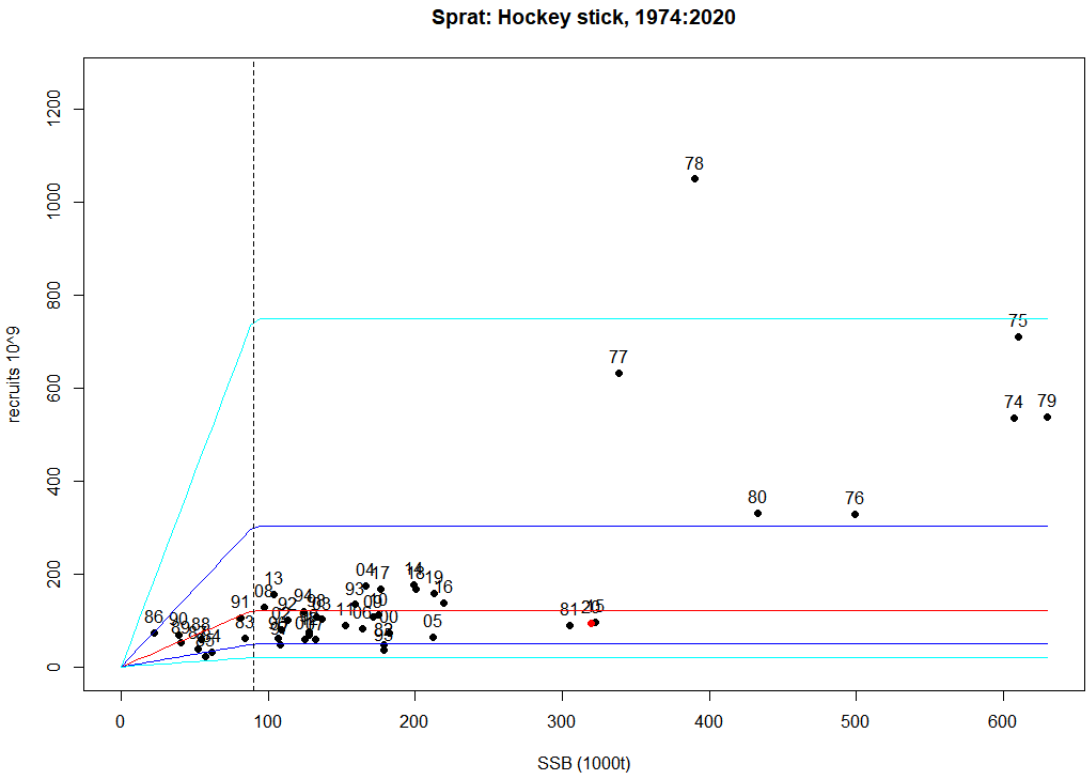


Figure 10.7.1. North Sea & 3.a sprat. Stock-recruitment relationship (Model year).

10.14 References

WKSPRAT 2013. Report of the Benchmark Workshop on Sprat Stocks. ICES CM 2013/ACOM:48

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