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 2022 and 2023

There have never been any explicit management objectives for this stock. Last year, the advised TAC (July 2022 to June 2023) was set to 68 690 t for sprat in Subarea 4 and Division 3.a. Sprat catches often have some herring as bycatch. There is a herring bycatch quota, and the sprat fishery may be limited by this quota. The 2022 herring bycatch quotas were 8 174 t for the North Sea and 6 659 t for Division 3.a. For 2022 EU agreed to only fish 969 t of herring in total in Division 3.a, including both the directed fishery and bycatch. During the WKSPRAT benchmark meeting in 2018, sprat in Subarea 4 and Division 3.a were merged into one stock assessment model. Also, several other modifications were made to the configurations of the assessment model (see (WKSPRAT: ICES, 2018a) for further details).

10.1.2 Catches in 2022

Catch statistics for 2000–2022 for sprat in the North Sea and Division 3.a by area and country are presented in Table 10.1.1. Catch data prior to 1996 are considered less reliable due to uncertainty of potential bycatches of North Sea herring (see Stock Annex). The small catches of sprat from the fjords of Norway are neither included in the catch tables nor the assessment (Table 10.1.1–10.1.2). The WG estimate of total catches for the North Sea and Division 3.a in 2022 was 90 105t (total official catches amounted to 90 038t). This is a 12% increase compared to 2021. The Danish catches represent 89% of the total catches.

The spatial distribution of landings was overall like recent years, although smaller catches were seen close to the coast (Figure 10.1.1). Compared to last year, 22% of the catches were landed in the first and second quarter of 2022 (Table 10.1.2).

10.1.3 Regulations and their effects

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.

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.

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 4.6% and 5.6% bycatch of herring in 2022 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 changed. 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 the buyer and the estimated species composition is reported directly in the sale slips. Many of the buyers use independent companies, 3rd party, for sampling.

The estimated quarterly landings at age in numbers for the period 1974–2022 and the mean weights-at-age are presented in Table 10.2.2-3. In the model year 2022, 1-year-old sprat so far has contributed 74% of the total landings, which is more than the 1990–2020 average (66%). 2-year-olds contributed 11%, which is below the 1990–2020 average (15%). 0-year-olds contributed 12% of the total landings, which is close to the 1990–2020 average (16%).

Denmark and Sweden provided age data of commercial landings in 2022 (Table 10.2.4). Quarters 1, 3 and 4 were covered. Quarter 1 in 2022 had very low catches and no sampling. The sample data were used to raise the landings data from the North Sea, Skagerrak, and Kattegat. The landings by Germany (2 360 t), the Netherlands (374 t), UK-Scotland (379 t), UK-England and Wales (304 t) and Belgium (<1 t) were unsampled and Norway didn't catch the stock in 2022. 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 was caused by a not fully implemented change in the Danish sampling program. Since the introduction of the new by-catch estimation method in 2020, mentioned above, the Danish institute has been able to get samples from most of the buyers / 3rd party companies. Therefore, the Danish institute introduced a new sampling strategy in 2020, where vessels above 24 meters are sampled with a higher frequency than smaller vessels. 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 new sampling strategy has secured a high level of sampling in 2022.

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

Tables 10.3.1a-b and Figures 10.3.1-2a give the time-series of IBTS indices by age (calculated using a delta-GAM model formulation; see WKSPRAT report (ICES, 2018a) for further details). The

data source is the IBTS Q1 data from 1983–2023. The index for IBTS Q1 1-year-old in 2022 (age-0 in the model and the table, serving as a recruitment index) was the fourth highest in the time-series, being 205% above the long-term average and 366% higher than last year's index. There has been a tendency for an increase in the IBTS Q1 age-0 in the time-series since 1990. Furthermore, older age-groups of age-1 and age-2 increased by 122% and 62% compared to the year before. The coverage of the survey was good and the CV for the index was reported to be similar to the average. Spatial pattern in residuals was checked and did not raise any concerns. The model is designed to handle issues of varying coverage to some extent. IBTS Q3 survey indices were also used in the assessment for older age-groups, and the 2022 values were 36% above and below the indices for 2021 for age-1 and age-2, respectively.

10.3.2 Acoustic Survey (HERAS)

Abundance indices were provided by WGIPS (ICES, 2022) (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 2022 values were 28%, 130%, and 91% higher (age-1, age-2, and age-3, respectively) compared to 2021. In 2022, one of the 12 strata relevant for sprat (131 in central North Sea) was not covered. This stratum has on average contributed 7% to the total HERAS sprat abundance in the period 2016-2021 (Lusseau et al. 2022).

10.4 Mean weights- 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, has shown 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 since 2020 this decline was arrested. In 2021-2022 mean weights increased in both S1 and S2, where the largest increase happened 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, 2014).

10.5 Recruitment

The IBTS Q1 age-1 index (age-0 in the model) (Table 10.3.1a) is used as a recruitment index for this stock. 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 (ICES, 2018) for further details). In 2023, it was noticed that the model had issues with convergence (revealed by a very high maximum gradient of 81.52). The problem was tracked back to the 2019 assessment, when the power model was implemented for the first time. Basically, SMS has convergence problems when the catchability parameters are very different in magnitude. This is solved in SMS by scaling all numbers by a fixed factor per survey. Therefore, a small hack was applied to achieve an acceptable maximum gradient (<0.001) for the model, by splitting the IBTS Q1 into two fleets: one for the recruiting fish, IBTS Q1 Rec, and one for all other ages, IBTS Q1. The two fleets were scaled differently, $0.1e^{-7}$ and 0.1, respectively. Scaling has no effect on model results or forecast otherwise. The 2023 IBTS Q1 Rec value, indicative of the 2022 recruitment, was the fourth highest in the time-series, being 205% above the long-term average and 366% higher than

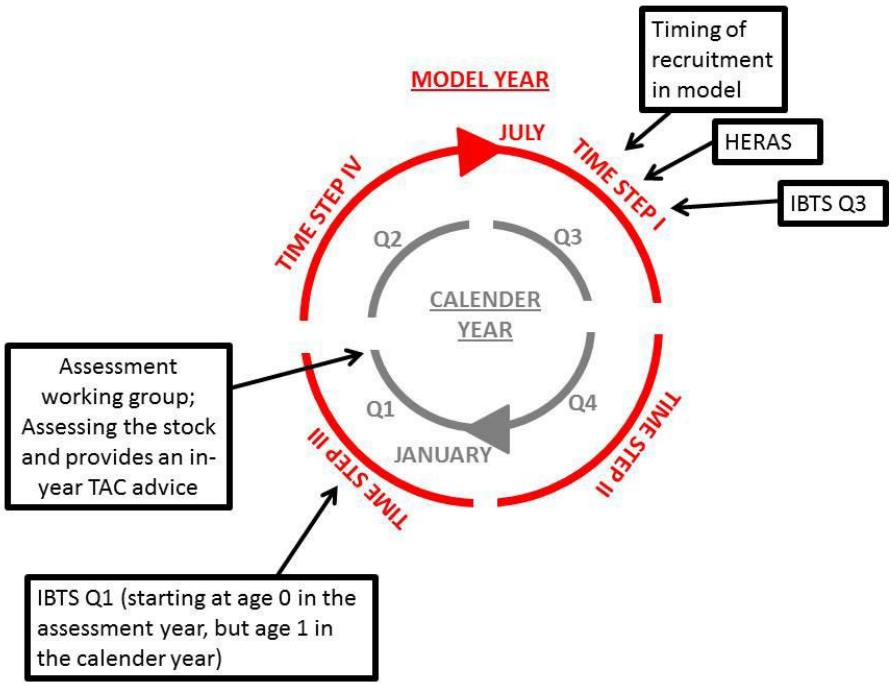
the 2022 index. The 2022 recruitment estimated by the model is 98% higher than the 2021 recruitment and 35% above the 2012-2021 geometric mean (Table 10.6.4).

10.6 Stock Assessment

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

In-year advice is the only possible type of advice for this short-lived species with catches dominated by 1- and 2-year-old fish. This, however, requires information about incoming 1-year-old fish. 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 were estimated at 1st 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 applies (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 1st July 2000 to 30th 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


Timing of recruitment in model
MODEL YEAR
JULY
HERAS
TIME STEP I
IBTS Q3
TIME STEP IV
Q2
Q3
CALENDER YEAR
Assessment working group; Assessing the stock and provides an in-year TAC advice
Q1
Q4
JANUARY
TIME STEP III
TIME STEP II
IBTS Q1 (starting at age 0 in the assessment year, but age 1 in the calender year)

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 10.6.1ab. 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 the model year 2022, only 586 kg were taken in S3, i.e., quarter 1 2023, and no age samples taken. To avoid the resulting high uncertainty in the age distribution of these catches, they were transferred to 2022 S2, i.e., quarter 4 2022, leading to a total catch of 17 290 t in this quarter in the model.

10.6.1.2 Weight-at-age

The mean weight-at-age by season for all age-groups observed in the catch are given in Table 10.2.3 and Figure 10.4.1. It is assumed that the mean weights in the stock are the same as in the catch. The mean weight-at-age of S1 is used to calculate SSB 1st of July.

10.6.1.3 Surveys

Three surveys, divided into four fleets as described below, were included (Tables 10.3.1ab–2), IBTS Q1 (1983–present), IBTS Q3 (1992–present), and HERAS (Q3) (2006–present). The IBTS Q1 indices were divided into two fleets in the model: IBTS Q1 Rec age-1 representing recruitment, i.e., age-0 in the model, and IBTS Q1 for all other age-groups. 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, 2021b). The major changes were changes to mean weight of whiting leading to lower mortalities particularly in the early part of the time series. HAWG 2021 (ICES, 2021a) 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 Ms 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 use of the old

mortalities from the 2017 North Sea key run (ICES, 2018b) was continued in the assessments onwards. 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+, respectively). More details about the maturity staging are given in Section 4.5.3.2 in the WKSPRAT 2013 report (ICES, 2014).

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 divided into four fleets were included, IBTS Q1 Rec age 1, IBTS Q1 ages 2 to 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, 2018a). As described above in more detail, it was noticed that the model had issues with convergence after the introduction of the power model for the recruitment index, and therefore two different scaling estimators were used for IBTS Q1 Rec and IBTS Q1 in order to attain acceptable values for the maximum gradient. The model hack by scaling has no effect on model results and forecast otherwise.

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). The CVs for the catches were high, possibly hitting upper boundaries set in the model. As such, the model has difficulties in following the catches and therefore catches add little information to the assessment. All surveys had low CVs (<0.55), with IBTS Q1 Rec hitting the lower CV boundary of 0.3 (Table 10.6.2). There were no patterns in the residuals raising concern (Figures 10.6.2–3). Although, there appears to be a periodic cycling (on a decadal timescale) between positive and negative residuals in the IBTS Q3 survey and the catches (Figures 10.6.2–3). Common CVs were estimated for the following groups: 1- to 3-year-olds in IBTS Q1 and 2- and 3-year-olds in IBTS Q3 and HERAS.

The retrospective analyses have shown a tendency to overestimate recruitment (Figure 10.6.5). As 41% of the recruiting year class mature in their first year and thus contributes to the SSB at the end of the year, there is a similar large retrospective pattern in SSB (5-year Mohn´s rho = 0.25). 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. In 2023, the retrospective patterns were further improved for both the recruitment and SSB, where 5-years Mohn´s rhos were 0.12 and 0.14 respectively, compared to >0.24 in 2022.

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 stock has been well above B_{pa} since 2013 and above B_{lim} since 1991, with the exception of 2022 when it is estimated to be below B_{pa}. The stock is now estimated to be above B_{pa} again. The current SSB is estimated to be 65% above B_{pa}. Fishing mortality has fluctuated without a trend, but the F of 2.169 in 2021 was the third highest in the time-series. The advised TAC was based on the predicted catch at F equal to F_{cap} (0.69). A large overshoot of the F used as basis for advice is often seen in simulations applying the escapement strategy on large incoming year classes, where the uncertainty on absolute numbers and hence the TAC matching a given F is large. This trait is the reason for implementing F_{cap} as otherwise, the escapement strategy is not precautionary when incoming recruitment is estimated to be large.

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, 2019). 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}). The optimal F_{cap} value was found to be 0.69 (from both a full MSE and a shortcut MSE - see WKSPRATMSE report 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.

The forecast input is given in Table 10.9.1.

SSB in 2024 is expected to be higher than in 2023, above the long-term average and well above B_{pa} (+101%). Using the input and assumptions detailed above, the F = 0 catch option projects an SSB in July 2024 of 332 077 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 catch advice of 143 598 t (July 2023–June 2024), which is expected to result in an SSB of 250 950 t in July 2024, i.e., 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 WKSPRAT benchmark (ICES, 2018a). A complete overview of the choices made during the benchmark can be found in the report (ICES, 2018a) 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 0.12 and 0.14, respectively) is below the advised limit of 0.3 discussed in WKFORBIAS (ICES, 2020).

There appears to be a systematic pattern in the catch residuals in model season 1 (quarter 3), which remains unexplained. Furthermore, the model gets very little information from the catches (as shown by the high CVs). This should be investigated further.

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 7716 t and 6659 t of juvenile herring in 2023 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, 2018a). 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 sprat 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, 2018a).

10.14 Tables and Figures

Table 10.1.1. North Sea & 3.a sprat. Landings (' 000 t) 2000–2022. See ICES (2006) 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	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Division 27.4.a																							
Denmark		0.1	1.1		*		*	0.8	*	*					*	*	0.1	0.1		*	0.5	*	*
Norway										*		*								0.1	*		
Sweden		0.1																					
UK (Scotland)												0.5						*	*				
Germany																*	*						*
Netherlands																*							
France																							*
Total		0.2	1.1		*		*	0.8	*	*		0.5			*	*	0.1	0.1	*	0.1	0.5	*	*
Division 27.4.b																							
Denmark	162.9	143.9	126.1	152.9	175.9	204	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	66	79.7
Norway	0.9	5.9	*		0.1		0.8	3.7	1.3	4	8	0.1	6.2	*	8.9	0.3	19.6	9.7	9.3	10	9.3		
Sweden		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	5.9	6.6
UK (Scotland)								0.1		2.5	1.1	1.9	0.7						*	1.3	1.7	*	0.4
UK (Engl. & Wales)										*								*	*		0.1		0.2
Germany												3.3	0.5	0.6	1.5	3.1	5.4	6	3.7	3.4	10	3.6	2.4
Netherlands												1.1	2.7	0.4	2.4	1.2	1	1.6	1.6		0.5		0.4
Faroe Islands																	4.7	1	1		1		
Total	163.8	151.2	126.1	152.9	176	204.1	80.3	59.3	52.7	122.4	90.4	98.4	77.5	45.8	138	244.6	220	127	179.7	132.6	164.7	75.5	89.6
Division 27.4.c																							
Denmark	28.2	13.1	14.8	22.3	16.8	2	23.8	20.6	8.1	8.2	48.5	20	3.2	15.4	2.2	34	18.7	1.5	6.2	8.9	2.4	2.7	
Norway	1.8	3.6					9	2.9		1.8	3.2	9.9	3	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					1.1	
UK (Scotland)									0.2			0.4					*				0.7	0.1	
UK (Engl. & Wales)	2	2	1.6	1.3	1.5	1.6	0.5	0.3	*	*	0.8	0.6	0.5	*	*	*	*	*	0.1	0.2	0.1	*	0.1
Germany												*	*	1		0.6	0.2				0.1		
Netherlands												4.2	1	0.7	*	1.2	0.8	*	0.7		1.6	0.1	*
Belgium												*		*	*	*	*	*		*	*	*	*
France																*		*					
Total	32	18.7	16.4	23.6	18.3	3.6	33.4	23.8	8.4	10.6	53	35.2	8	20.1	2.3	45.8	20.6	1.6	7.5	9.6	5.6	4	0.1

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Division 27.3.a																							
Denmark	12.8	20.2	13.4	10.2	14.4	31.9	7.8	9.9	5.8	6.9	8.4	8	8.4	1.9	16.7	11.7	6.7	1	2.9	3.9	9.5	0.6	0.3
Sweden	6.4	7.6	4.3	5.5	6.5	7.7	4.4	4.2	2.4	1.6	1.4	2	1.5	1.1	1.5	1.3	1.1	0.2	1.1	1.7	2.4	0.7	0.0
Germany															*				*				
Faroe Islands																	*						
Total	19.2	27.7	17.7	15.7	20.9	39.6	12.2	14.1	8.2	8.5	9.8	10	9.9	3	18.3	13	7.9	1.2	4	5.6	11.9	1.3	0.4
Total North Sea and Skagerrak-Kattegat																							
Denmark	203.9	177.3	155.4	185.4	207.1	237.9	111.2	86.7	65.4	130.7	137.7	119	77.4	62.1	140.2	280.1	203.1	103.3	165.6	123.1	150.9	69.3	80.1
Norway	2.7	9.5	*		0.1		9.8	6.7	1.3	5.8	11.1	10	9.1	1.7	9	9.1	20.2	9.7	9.8	10.6	10		
Sweden	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	7.6	6.6
UK (Scotland)								0.1	0.2	2.5	1.1	2.8	0.7				*	*	*	1.3	2.5	0.1	0.4
UK (Engl. & Wales)	2	2	1.6	1.3	1.5	1.6	0.5	0.3	*	*	0.8	0.6	0.5	*	*	*	*	*	*	0.2	0.2	*	0.3
Germany												3.3	0.5	1.6	1.6	3.7	5.6	6	3.7	3.4	10.1	3.6	2.4
Netherlands												5.3	3.7	1.1	2.4	2.4	1.8	1.6	2.3		2.1	0.1	0.4
Faroe Islands																	4.7	1	1		1		
Belgium												*		*	*	*	*	*		*	*	*	*
France																*		*					*
Total	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	182.7	80.8	90.1

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 (2006).

Year	Quarter	Div. 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

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

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

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

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

Year	Quarter	Div. 27.4.a	27.4.b	27.4.c	27.3.a	Total
	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	3	298	1 076	378	1 746
	2		19 430	*	173	19 603
	3	2	120 890	*	4 268	125 160
	4	520	24 049	4 489	7 087	36 145
	Total	526	164 667	5 566	11 896	182 654
2021	1	0	137	236	445	818
	2	*	326	1	11	338
	3	1	63 401	902	57	64 361
	4	1	11 601	2 850	791	15 244
	Total	2	75 464	3 989	1 305	80 761
2022	1		82	85	331	499
	2		19 449		16	19 465
	3	*	52 852			52 852
	4	8	17 237	8	36	17 289
	Total	8	89 620	94	383	90 105
2023	1**		*		1	1

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

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

* < 0.5 t

** Until the 1st of March

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	1 1	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	22 3	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	1 1	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	1 6	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	1 8	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	1 6	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
t	2021	68 492	5 518	39	1 064	34 5	747	0	3	602	76 809
t	2022	78 825	3 854	2	439	10 6	400		4	192	83 823
%	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
%	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

	Year	Sprat	Herring	Horse mack	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
t	1998	9 143	3 385	230	467	54	0	4 9	7	2 866	16 202
t	1999	16 603	8 470	138	1 026	21 0	5	7 5	3 337	2 896	32 760
t	2000	12 578	8 034	5	1 062	30 8	8	5 2	13	3 556	25 617
t	2001	18 236	8 196	75	1 266	50	1 3	3 5	4 281	1 271	33 423
t	2002	11 451	12 982	21	1 164	3	6	3 0	606	2 280	28 541
t	2003	8 182	4 928	340	252	4	4	4	1	567	14 282
t	2004	13 374	4 620	97	976	18	2 4	2 7	116	2 155	21 408
t	2005	30 157	6 171	244	871	63	1 8	2 0	746	1 758	40 047
t	2006	6 814	2 852	215	276	13	3	4 5	1	232	10 451
t	2007	7 116	2 043	34	190	31	8	4	1	469	9 896
t	2008	4 805	1 948	14	285	0	0	1 1	462	39	7 563
t	2009	4 839	3 016	37	169	15	0	1	53	47	8 177
t	2010	2 851	2 134	25	142	6	1	2	135	171	5 466
t	2011	4 754	2 461	0	43	0	7	1	141	40	7 447
t	2012	5 707	5 495	9	149	7	1 0	5	0	228	11 610
t	2013	1 143	1 751	2	46	0	0	1	1	27	2 971
t	2014	16 751	3 777	5	343	1	2 0	5	12	888	21 801
t	2015	11 448	5 831	0	565	0	2 9	8	1	154	18 036
t	2016	7 001	2 140	0	335	1	1 9	3	0	78	9 579
t	2017	963	328	0	172	0	1 9	1	0	32	1 515
t	2018	2 872	257	2	150	1	1 1	0	0	12	3 304
t	2019	3 429	351	0	59	0	2	0	0	8	3 850
t	2020	9 494	551	4	249	5	4 1	1	0	27	10 372
t	2021	638	82	0	13	1	1	0	0	32	767
t	2022	302	20	0	1	0	1	0	0	32	356
%	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
%	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

	Year	Sprat	Herring	Horse mack	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
%	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
%	2021	90.0	6.3	0.1	1.4	0.5	1.0	0.0	0.0	0.8	100
%	2022	94.0	4.6	0.0	0.5	0.1	0.5	0.0	0.0	0.2	100

	Year	Sprat	Herring	Horse mack	Whiting	Haddock	Mackerel	Cod	Sandeel	Other	Total
%	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
%	2021	83.1	10.7	0.0	1.6	0.2	0.1	0.0	0.0	4.2	100
%	2022	84.8	5.6	0.0	0.3	0.0	0.4	0.0	0.0	8.9	100

Table 10.2.2. North Sea & 3.a sprat. Catch in numbers by age (1000's) by season and year. (Model year, e.g., 2021 = July 2021–June 2022)

Catch-at-age used as input for the assessment model (years refer to the model years)					
Note that all catches in S4 have 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

Catch-at-age used as input for the assessment model (years refer to the model years)					
Note that all catches in S4 have been moved to S1 in the following year					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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

Catch-at-age used as input for the assessment model (years refer to the model years)					
Note that all catches in S4 have been moved to S1 in the following year					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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

Catch-at-age used as input for the assessment model (years refer to the model years)					
Note that all catches in S4 have been moved to S1 in the following year					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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

Catch-at-age used as input for the assessment model (years refer to the model years)					
Note that all catches in S4 have been moved to S1 in the following year					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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	163696
2019	2	799272	2399200	1041391	139590
2019	3	211007	34475	3918	413
2019	4	0	0	0	0
2020	1	207574	10153348	3429492	429318
2020	2	69142	2695178	385767	137741
2020	3	28346	78759	8459	1779

Catch-at-age used as input for the assessment model (years refer to the model years)					
Note that all catches in S4 have been moved to S1 in the following year					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
2020	4	0	0	0	0
2021	1	539434	5840604	1505982	255540
2021	2	233794.6	803967.8	392200.2	138805.2
2021	3	50586.52	9703.778	711.0113	7.420633
2021	4	0	0	0	0
2022	1	362861.6	7104276	814121.1	99399.03
2022	2	791194.7	269013.3	338847.8	106443
2022	3	0	0	0	0
2022	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, e.g., 2021 = July 2021–June 2022)

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 are 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

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 are no catches in S4					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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

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 are no catches in S4					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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

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 are no catches in S4					
Year	**Season**	**age 0**	**age 1**	**age 2**	**age 3**
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
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

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 are 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
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

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 are no catches in S4

Year	Season	age 0	age 1	age 2	age 3
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	0.0034	0.0063	0.0088	0.0116
2019	2	0.0041	0.0076	0.0098	0.0141
2019	3	0.0058	0.0010	0.0130	0.0165
2019	4	0.0064	0.0078	0.0105	0.0157
2020	1	0.0049	0.0093	0.0122	0.0162
2020	2	0.0071	0.0108	0.0144	0.0172
2020	3	0.0057	0.0100	0.0143	0.0165
2020	4	0.0065	0.0103	0.0134	0.0161
2021	1	0.0061	0.0071	0.0110	0.0131
2021	2	0.0061	0.0087	0.0117	0.0158
2021	3	0.0072	0.0124	0.0161	0.0203
2021	4	0.0070	0.0088	0.0103	0.0157
2022	1	0.0062	0.0084	0.0109	0.0135
2022	2	0.0078	0.0127	0.0171	0.0188
2022	3	0.0058	0.0100	0.0143	0.0165
2022	4	0.0065	0.0102	0.0132	0.0160

Table 10.2.4. North Sea and Division 3.a sprat. Sampling for biological parameters in 2022. 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	0.4	0	0	0
	2	18.0	9	891	370
	3	47.1	41	4065	1933
	4	14.5	19	1905	951
	Total	80.1	69	6831	3254
Norway	1	0.0	0	0	0
	2	0.0	0	0	0
	3	0.0	0	0	0
	4	0.0	0	0	0
	Total	0.0	0	0	0
Sweden	1	0.0	0	0	0
	2	0.0	0	0	0
	3	4.3	0	0	0
	4	2.3	8	599	596
	Total	6.6	8	599	596
All countries	1	0.5	0	0	0
	2	19.5	9	891	370
	3	52.9	41	4065	1933
	4	17.3	27	2504	1547
Total		90.1	77	7460	3850

Table 10.2.5. North Sea and Division 3.a sprat. Number of biological samples taken from 1974 and onward. The number of samples may differ from Table 10.2.4, 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, e.g., 2021 = July 2021–June 2022).

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	30	6	0
2021	85	22	0	8
2022	41	26	0	NA

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

IBTS Q1 survey index (area 4 and 3a combined; years apply to the calendar year and ages 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

IBTS Q1 survey index (area 4 and 3a combined; years apply to the calendar year and ages the model year)				
Index is calculated using a delta GAM model formulation (see Stock Annex)				
Year	**Age 0**	**Age 1**	**Age 2**	**Age 3**
2007	1917763	1035569	162880	12506
2008	1526985	803061	47400	8526
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	1977916	196830	16693
2022	1810546	769303	57700	6537
2023	84401712	1710545	93914	7639

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 both 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

IBTS Q3 survey index (area 4 and 3a combined; years and ages apply to both 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**
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	16906066	1479519
2021	21858420	5602150	519985
2022	29786037	3579909	464099

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 both 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	17993	2055
2021	46918	7051	1509
2022	60224	16200	2882

Table 10.6.1. North Sea and Division 3.a sprat. Natural mortality input (Model year, e.g., 2021 = July 2021–June 2022). From multispecies SMS (WKSAM: ICES, 2018b) 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
2021	1	0.377	0.347	0.260	0.143
2021	2	0.255	0.200	0.165	0.153
2021	3	0.212	0.177	0.149	0.149
2021	4	0.278	0.224	0.181	0.181
2022	1	0.377	0.347	0.260	0.143
2022	2	0.255	0.200	0.165	0.153
2022	3	0.212	0.177	0.149	0.149
2022	4	0.278	0.224	0.181	0.181

Table 10.6.2. North Sea sprat. Assessment diagnostics.

Date: 03/15/23 Start time:14:56:48 run time:2 seconds

objective function (negative log likelihood): 334.326

Number of parameters: 145

Maximum gradient: 0.000235226

Akaike information criterion (AIC): 958.652

Number of observations used in the likelihood:

Catch	CPUE	S/R	Stomach	Sum
784	308	49	0	1141

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
448.7	-115.5	10.8	0.0	0.0	0.00	344

unweighted objective function contributions (per observation):

Catch	CPUE	S/R	Stomachs
0.57	-0.37	0.22	0.00

contribution by fleet:

IBTS Q1 Rec total: -32.068 mean: -0.782

IBTS Q1 total: -50.983 mean: -0.414

IBTS Q3 total: -23.901 mean: -0.257

Acoustic total: -8.541 mean: -0.167

F, Year effect:

1974: 1.000

1975: 1.787

1976: 1.854

1977: 1.619

1978: 1.038

1979: 0.648

1980: 2.531

1981: 1.296

1982: 1.095

1983: 1.780

1984: 0.981

1985: 1.420

1986: 1.385

1987: 0.409

1988: 1.382

1989: 0.441

1990: 1.684

1991: 0.922

1992: 0.997

1993: 1.682

1994: 0.846

1995: 1.339

1996: 1.525

1997: 1.128

1998: 1.869

1999: 1.007

2000: 1.661

2001: 1.731

2002: 1.780

2003: 1.407

2004: 2.203

2005: 1.445

2006: 1.769

2007: 1.812

2008: 1.692

2009: 0.989

2010: 1.169

2011: 1.014

2012: 1.469

2013: 1.569

2014: 0.708

2015: 1.342

2016: 2.437

2017: 1.555

2018: 1.620

2019: 1.326

2020: 2.081

2021: 2.104

2022: 1.719

F, season effect:

---

age: 0

1974-2022: 0.038 0.203 0.345 0.250

age: 1

1974-2022: 0.568 0.525 0.186 0.250

age: 2

1974-2022: 0.243 0.477 0.105 0.250

age: 3

1974-2022: 0.228 0.600 0.326 0.250

F, age effect:

	0	1	2	3
1974-2022:	0.037	0.403	1.494	1.494

Exploitation pattern (scaled to mean F=1)

		0	1	2	3
1974-2022	season 1:	0.001	0.206	0.327	0.307
	season 2:	0.007	0.190	0.641	0.806
	season 3:	0.012	0.068	0.142	0.438
	season 4:	0.008	0.091	0.336	0.336

sqrt(catch variance) ~ CV:

---

season

---

age	1	2	3	4
0	1.414	1.414	1.314	0.100
1	0.880	0.856	1.414	0.100
2	0.983	1.070	1.414	0.100
3	0.983	1.070	1.414	0.100

Survey catchability:

---

	age 0	age 1	age 2	age 3
IBTS Q1 Rec	0.845			
IBTS Q1		1.690	3.196	7.059
IBTS Q3		0.941	1.202	1.205
Acoustic		1.309	2.662	7.091

Stock size dependent catchability (power model)

---

	age 0	age 1	age 2	age 3
IBTS Q1 Rec	1.91			
IBTS Q1		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 Rec		0.30		
IBTS Q1		0.40	0.40	0.40
IBTS Q3		0.53	0.44	0.44
Acoustic		0.47	0.54	0.54

Average F:

---

	sp. 1
1974:	1.106
1975:	1.689
1976:	1.773
1977:	1.596
1978:	1.015
1979:	0.640
1980:	2.328
1981:	1.195
1982:	0.998
1983:	1.593
1984:	0.916
1985:	1.274
1986:	1.236
1987:	0.372
1988:	1.253
1989:	0.415
1990:	1.566
1991:	0.891

1992: 0.966

1993: 1.545

1994: 0.780

1995: 1.203

1996: 1.379

1997: 1.062

1998: 1.745

1999: 0.975

2000: 1.531

2001: 1.631

2002: 1.676

2003: 1.389

2004: 2.104

2005: 1.373

2006: 1.657

2007: 1.680

2008: 1.585

2009: 0.920

2010: 1.062

2011: 0.920

2012: 1.307

2013: 1.418

2014: 0.662

2015: 1.233

2016: 2.197

2017: 1.419

2018: 1.477

2019: 1.215

2020: 1.884

2021: 1.904

2022: 1.396

Recruit-SSB		alfa	beta	recruit s2	recruit s
Sprat	Hockey stick -break.:	1287.509	9.000e+04	0.572	0.75

Table 10.6.3. North Sea and Division 3.a Sprat. Assessment output: Stock numbers (thousands) (years, seasons (S1-S4), and age (A0-A3+) refer to the model year, e.g., 2021 = July 2021–June 2022)

Year /Age Quarter	A0_S1	A0_S2	A0_S3	A0_S4	A1_S1	A1_S2	A1_S3	A1_S4	A2_S1	A2_S2	A2_S3	A2_S4	A3+_S1	A3+_S2	A3+_S3	A3+_S4
1974	536673000	33066500	23669500	173689000	140026000	70559500	45126000	31803600	10118000	4705470	1855070	1330460	586582	315322	106576	54978
1975	707297000	42012500	31029300	218183000	110281000	44776100	24617000	15965900	19098700	6537050	1495880	907761	693924	297743	50604	17043
1976	330657000	20209100	14500800	98380200	135880000	55759200	29586300	18458000	10266000	3454320	735280	431867	605887	240887	37600	11990
1977	627792000	40318700	27430300	183785000	60549400	27718300	15409700	9601550	11851500	4550370	1141780	690270	291411	122767	23543	8348
1978	108775 0000	72001400	50478900	340017000	112641000	59660900	38042600	24635000	6185790	2885690	1105900	763118	453607	228906	74430	36479
1979	562257000	36317300	23838600	159531000	217941000	12296700	83330600	55038300	16573100	8614050	4246140	3041760	550050	294245	131184	75906
1980	331334000	20633800	12940400	84993600	102295000	36049900	16252000	9420180	37288300	9531500	1211840	644871	213850	595484	48890	11300
1981	799109 00	48346300	31791200	21800000	55901700	25561800	14815800	9821200	6492560	2589740	786246	513331	468731	210082	52088	22184
1982	387725 00	23233800	16545700	12022900	14962100	75650400	47650 50	34824 60	7058800	3249950	1197950	840454	410060	220858	69241	33861
1983	566390 00	33172800	23382400	16994600	87480800	37903400	20557 90	14625 70	2640250	9749 82	2202 98	1399 94	711999	310035	51726	18282
1984	366870 00	21379600	14273800	10348900	12436600	64923600	41683 70	30502 80	1128350	5926 40	2388 21	1713 67	133755	797 67	27384	14222
1985	252418 00	14544800	88845 10	6317940	7504210	32833700	18432 70	12917 10	2318740	9525 23	2690 78	1801 68	152363	770 05	17468	7325
1986	633568 00	35058100	22071000	15340400	45955500	19627700	10706 00	74506 2	9867008	3911 18	1091 84	7276 0	158969	768 54	17675	7462
1987	405890 00	22352600	13921900	9697370	10971600	61579400	41200 30	32170 50	5606168	3102 20	1717 93	1332 00	67728	455 88	25055	16977
1988	643553 00	34499300	20856400	14132100	69169500	30521900	16188 80	11495 50	2428930	9320 95	2536 20	1637 34	124858	601 83	13298	5445
1989	516425 00	28226000	16636100	11586400	98463300	53497900	34964 20	26918 00	8504008	4697 11	2556 90	1911 98	134072	931 31	48325	31253
1990	749412 00	44545400	26792700	18718200	79698900	33242100	16725 40	11361 50	1970700	7143 66	1619 03	9682 3	167894	740 48	12602	4327
1991	962726 00	60561800	40492700	29337700	12711900	67417600	42373 00	30369 70	8261766	4289 38	1761 94	1218 67	75931	426 17	15090	7702
1992	867680 00	57496900	41767700	30733600	19885300	11043100	71293 80	50236 50	2205050	1158250	4641 16	3208 79	97227	536 41	18327	9124
1993	934526 00	59119000	45991600	34281000	21213800	95422800	54259 60	37123 30	3725200	1437650	3581 37	2267 66	251856	104759	19478	7084
1994	997954 00	60309700	44735200	34199900	24218700	12768300	85391 30	64337 80	2821590	1464530	6579 12	4761 36	183231	980 68	38295	20972
1995	388581 00	23241800	17211500	13550000	24890000	11569400	69719 10	52091 30	5021860	2199610	6958 96	4717 08	397783	185219	46472	20262
1996	551554 00	33241600	22853300	18077200	10399400	49400000	28507 20	21415 70	4218440	1861680	5124 65	3465 68	406982	195286	41666	17046

Year /Age Quarter	A0_S1	A0_S2	A0_S3	A0_S4	A1_S1	A1_S2	A1_S3	A1_S4	A2_S1	A2_S2	A2_S3	A2_S4	A3+_S1	A3+_S2	A3+_S3	A3+_S4
1997	50673700	3222170	2372620	1863000	1424940	8210400	527336	399413	176247	94746	35127	24792	31105	1813	56511	27502
1998	11483100	7453050	5117580	3884750	1423500	6995820	386850	272799	322372	13026	28784	18045	23213	1014	16410	5557
1999	75668400	4957670	3679330	2760050	2827040	1684310	112485	819699	213464	11728	48251	34013	15279	874	30424	15388
2000	74044000	4921840	3407400	2588070	1975140	9597250	553627	394850	627541	26630	68009	44757	27901	1272	24219	9222
2001	58811500	3898110	2852690	2137260	1958740	9495420	532044	372833	311950	13167	31304	19688	37697	1727	30104	10705
2002	80273300	5185340	3731820	2835270	1573370	7589360	416854	296699	287925	11850	26868	16715	16773	770	12705	4396
2003	10222800	6707640	4941930	3745930	2053350	1136760	671479	480340	228390	11036	32823	20987	13797	721	16645	6693
2004	16130000	1039380	7741190	5972470	2555040	1170800	591867	405769	352957	12576	21545	12375	16270	6334	7298	2028
2005	61186300	3926120	2850490	2244320	4101670	2138250	126562	928763	299896	14129	42049	27996	9521	468	10775	4456
2006	78291800	4718120	3572630	2810770	1555230	7573210	421538	303089	694042	29104	69326	44157	22710	1002	17360	6173
2007	60113700	3709850	2744930	2173150	1952620	9437020	515247	377526	229707	96885	22429	14483	36570	1636	27326	9711
2008	11558700	7150510	5395620	4320730	1590160	7944380	453226	335659	297726	13341	34109	22122	12970	616	11630	4319
2009	98347200	6298710	4507790	3678940	3188150	1770150	117551	920967	267910	14811	62491	45419	18523	1123	39852	20912
2010	89665300	5283800	3527130	2825640	2745850	1390980	874230	667337	742562	35526	12895	91473	39301	2226	66149	31924
2011	93113000	5579350	3783000	2970640	2074610	1062560	675450	511338	532139	25022	10007	71273	77760	4587	15439	78759
2012	66617700	3995200	2733570	2154920	2118550	9830710	567714	426419	396795	16484	47771	32786	63245	3213	72009	30456
2013	12561200	8408680	6336290	5051180	1609570	7785080	453457	338299	340463	14465	40099	26995	29938	1509	31560	12674
2014	14754200	1021160	7851860	6297500	3856100	2345620	165600	131037	271260	16410	83803	64302	23651	1615	73403	44601
2015	82155700	5691760	4444890	3533100	4798090	2513500	155922	118066	104417	49951	16280	11355	57223	3149	81391	36478
2016	13870400	9480270	7210540	5651130	2675890	1082370	529078	368957	943385	29984	44685	26230	97840	3693	35588	9357
2017	16092300	1101280	8432370	6684280	4280040	2118860	124834	930262	294810	12916	36127	24368	22677	1157	24599	9940
2018	13770800	9423190	7211680	5711860	5062520	2469120	143477	106396	743311	31808	84914	56690	21173	1056	21186	8294
2019	13179700	9022440	6920380	5501900	4326030	2256590	139530	105779	850143	40472	13328	93160	48018	2647	69106	31211
2020	82959600	5673080	4326520	3406420	4167020	1828670	963816	690362	845208	30577	58743	36478	80373	3425	45433	14208

Year /Age Quarter	A0_S1	A0_S2	A0_S3	A0_S4	A1_S1	A1_S2	A1_S3	A1_S4	A2_S1	A2_S2	A2_S3	A2_S4	A3+_S1	A3+_S2	A3+_S3	A3+_S4
2021	74991900	5128050	3910180	30777200	25799500	11262900	5907610	4224250	5516230	197915	374106	231429	316354	13378	1738	537 6
2022	148669000	1017180	7787800	62909400	23309900	11114900	6325240	5298050	3375320	139324	346705	298714	197691	95346	17506	15082
2023	0				47646100				4233320				261965			

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, e.g., 2022 = July 2022–June 2023.

Year	Recruitment	High	Low	SSB	High	Low	Catches	F ages 1-2	High	Low
	(thousands)			(tonnes)			(tonnes)	(per year)		
1974	536673000	975214801	295337918	606751	995848	369682	463344	1.106	1.734	0.706
1975	707297000	1259146982	397307902	615149	999320	378666	732312	1.689	2.517	1.134
1976	330657000	580527309	188335760	498822	817360	304423	628598	1.773	2.572	1.222
1977	627792000	1077142496	365896617	339628	527433	218695	385257	1.596	2.331	1.092
1978	1087750000	2068720591	571947738	388524	616186	244976	458804	1.015	1.731	0.596
1979	562257000	1014386372	311649429	650101	1125002	375672	463638	0.64	1.248	0.328
1980	331334000	526496916	208514459	456364	782266	266237	387434	2.328	3.21	1.689
1981	79910900	119083654	53624084	305247	457447	203686	280582	1.195	1.816	0.787
1982	38772500	49131157	30597829	165424	248814	109982	162357	0.998	1.434	0.694
1983	56639000	71825291	44663603	72603	92743	56836	115440	1.593	1.956	1.298
1984	36687000	47758155	28182328	55173	67631	45010	113444	0.916	1.272	0.66
1985	25241800	33230366	19173682	58741	73147	47171	62514	1.274	1.628	0.997
1986	63356800	80266356	50009547	24647	31238	19447	27520	1.236	1.587	0.963
1987	40589000	52376425	31454360	45388	56283	36603	53942	0.372	0.57	0.242
1988	64355300	82780081	50031416	50938	62239	41689	103652	1.253	1.566	1.003
1989	51642500	66385031	40173933	44220	54920	35604	58420	0.415	0.767	0.225
1990	74941200	94059587	59708783	40318	50564	32148	78180	1.566	1.93	1.27
1991	96272600	120346871	77014163	86753	106909	70397	125815	0.891	1.23	0.645
1992	86768000	108201767	69580064	105823	128769	86966	156471	0.966	1.28	0.729
1993	93452600	118040615	73986301	137855	166959	113825	208848	1.545	1.85	1.291
1994	99795400	125097892	79610629	91894	112198	75263	424206	0.78	1.035	0.588
1995	38858100	49134440	30731030	139212	168755	114841	446555	1.203	1.485	0.974
1996	55155400	69001085	44087976	105229	127623	86764	95496	1.379	1.692	1.125
1997	50673700	63548870	40407074	102068	124036	83991	125174	1.062	1.378	0.818
1998	114831000	143361985	91978069	132016	160048	108894	188907	1.745	2.055	1.483
1999	75668400	94638560	60500781	135732	165977	110998	243158	0.975	1.296	0.733
2000	74044000	92469917	59289703	184584	224264	151925	222027	1.531	1.869	1.254
2001	58811500	73312807	47178558	124865	151563	102870	153321	1.631	1.975	1.346
2002	80273300	100293920	64249186	107840	130753	88942	174713	1.676	2.002	1.403
2003	102228000	127751565	81803804	136758	166493	112333	174988	1.389	1.726	1.118
2004	161300000	203130063	128083897	166168	201959	136720	231352	2.104	2.437	1.816
2005	61186300	75855248	49354045	197987	244683	160203	280275	1.373	1.687	1.118
2006	78291800	97039310	63166215	152849	186454	125301	78028	1.657	1.984	1.384
2007	60113700	74382202	48582279	126320	152647	104534	99902	1.68	1.996	1.414
2008	115587000	143555273	93067669	98402	118582	81656	69892	1.585	1.91	1.316
2009	98347200	122135968	79191838	156305	189722	128774	170934	0.92	1.222	0.692

Year	Recruitment	High	Low	SSB	High	Low	Catches	F ages 1-2	High	Low
	(thousands)			(tonnes)			(tonnes)	(per year)		
2010	89665300	111842363	71885695	157604	190313	130517	145415	1.062	1.362	0.828
2011	93113000	115498812	75065973	129007	155055	107335	122472	0.92	1.23	0.689
2012	66617700	82291789	53929050	120790	145076	100570	96030	1.307	1.607	1.062
2013	125612000	157830966	99970081	103055	124269	85462	60207	1.418	1.778	1.131
2014	147542000	187486718	116107647	163494	199985	133662	190268	0.662	0.913	0.48
2015	82155700	102938333	65568956	263242	323604	214139	298227	1.233	1.536	0.99
2016	138704000	172975735	111222534	190090	232612	155341	227169	2.197	2.5	1.93
2017	160923000	202551977	127849712	174785	214447	142458	135824	1.419	1.726	1.166
2018	137708000	174613624	108602598	195150	238926	159395	190779	1.477	1.781	1.224
2019	131797000	166208265	104510141	183614	225959	149205	137489	1.215	1.559	0.947
2020	82959600	103413467	66551247	260337	320587	211410	181990	1.884	2.209	1.607
2021	74991900	95911286	58635280	131539	160395	107874	80266	1.904	2.254	1.609
2022	148669000	201874078	109486427	114861	141104	93499	89605	1.396	1.83	1.064
2023	109840549*			206581	268259	159084				

* Geometric mean recruitment (2012–2021)

Table 10.9.1. North Sea and Division 3.a Sprat. Input to forecast (years and age refer to the model year, e.g., 2022 = July 2022–June 2023).

Age	Age 0	Age 1	Age 2	Age 3
Stock numbers(2023) (millions)	109841	47646	4233	262
Exploitation pattern S1	0.00	0.48	0.77	0.72
Exploitation pattern S2	0.02	0.45	1.50	1.89
Exploitation pattern S3	0.03	0.16	0.33	1.02
Exploitation pattern S4	0.00	0.00	0.00	0.00
Weight in the stock S1 (gram)	5.71	8.27	11.34	14.27
Weight in the catch S1 (gram)	5.71	8.27	11.34	14.27
Weight in the catch S2 (gram)	7.00	10.70	14.30	17.12
Weight in the catch S3 (gram)	6.39	10.36	13.73	16.88
Weight in the catch S4 (gram)	6.64	9.73	12.27	15.93
Proportion mature(2021)	0.00	0.41	0.87	0.95
Proportion mature(2022)	0.00	0.41	0.87	0.95
Natural mortality S1	0.38	0.35	0.26	0.14
Natural mortality S2	0.26	0.20	0.16	0.15
Natural mortality S3	0.21	0.18	0.15	0.15
Natural mortality S4	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, e.g., 2023 = July 2023–June 2024.

Catch options. Catches and SSB are in thousands of tonnes.					
3-year average weight-at-age was used to calculate SSB. Recruitment(2022) = geometric average 2012–2021.					
Basis	**Catches(2023)**	**F(2023)**	**SSB(2024)**	**SSB change***	**TAC change****
F_{cap}	143598	0.69	250950	21%	109%
F=0.0	0	0.0	332077	61%	-100%
F=0.1	25441	0.1	317464	54%	-63%
F=0.2	49069	0.2	303974	47%	-29%
F=0.3	71051	0.3	291502	41%	3%
F=0.4	91533	0.4	279954	36%	33%
F=0.5	110645	0.5	269245	30%	61%
F=0.6	128506	0.6	259301	26%	87%
F=0.7	145220	0.7	250055	21%	111%
F=0.8	160881	0.8	241448	17%	134%
F=0.9	175575	0.9	233425	13%	156%
F=1.0	189376	1.0	225938	9%	176%
$B_{escapement}$ with-out F_{cap}	394098	4.14	125000	-39%	474%

* SSB 1st July 2024 relative to SSB 1st July 2023

** Catch (July 2023-June 2024) relative to the sum of the TACs (68 690 tonnes) for July 2022–June 2023 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.

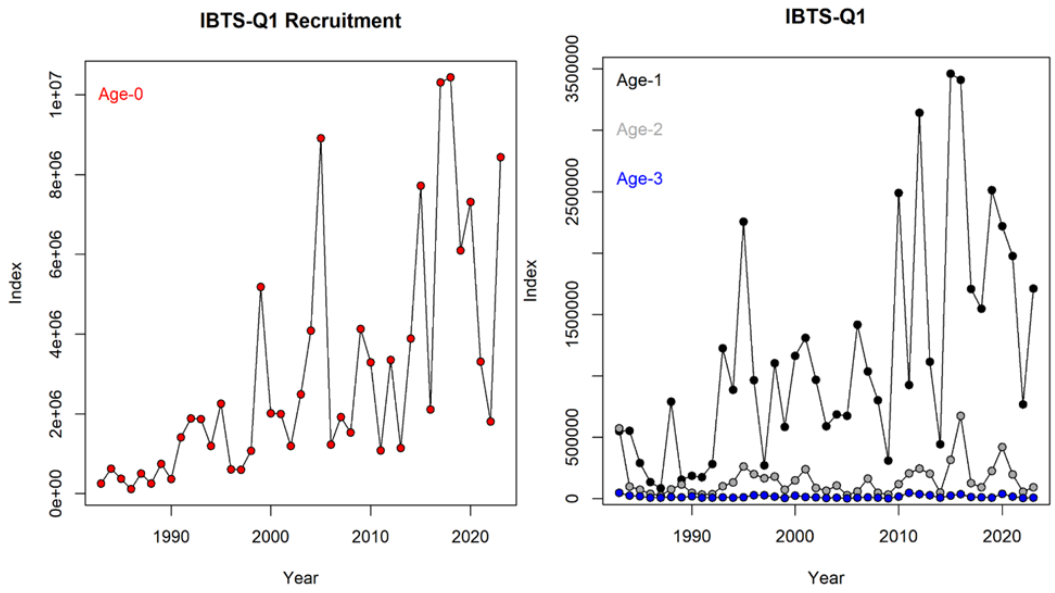


Figure 10.3.1. North Sea and Division 3.a sprat. IBTS Q1 survey index for Subarea 4 and Division 3.a combined. The index is calculated using a delta-GAM model formulation (see WKSPRAT report (ICES, 2018a) for details). Years refer to the calendar year.

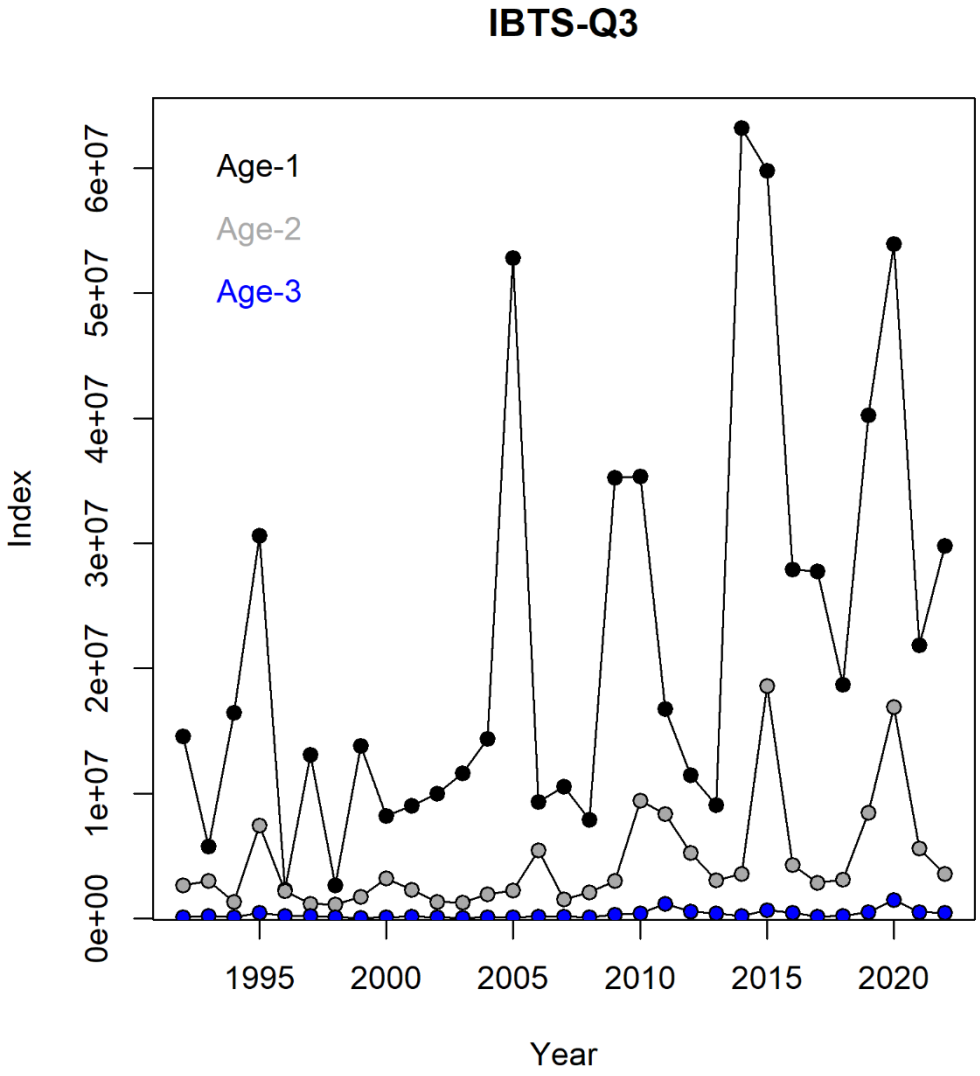


Figure 10.3.2a. North Sea and Division 3.a sprat. IBTS Q3 survey index for Subarea 4 and Division 3.a combined. The index is calculated using a delta-GAM model formulation (see WKSPRAT report (ICES, 2018a) for details). Years refer to the calendar year.

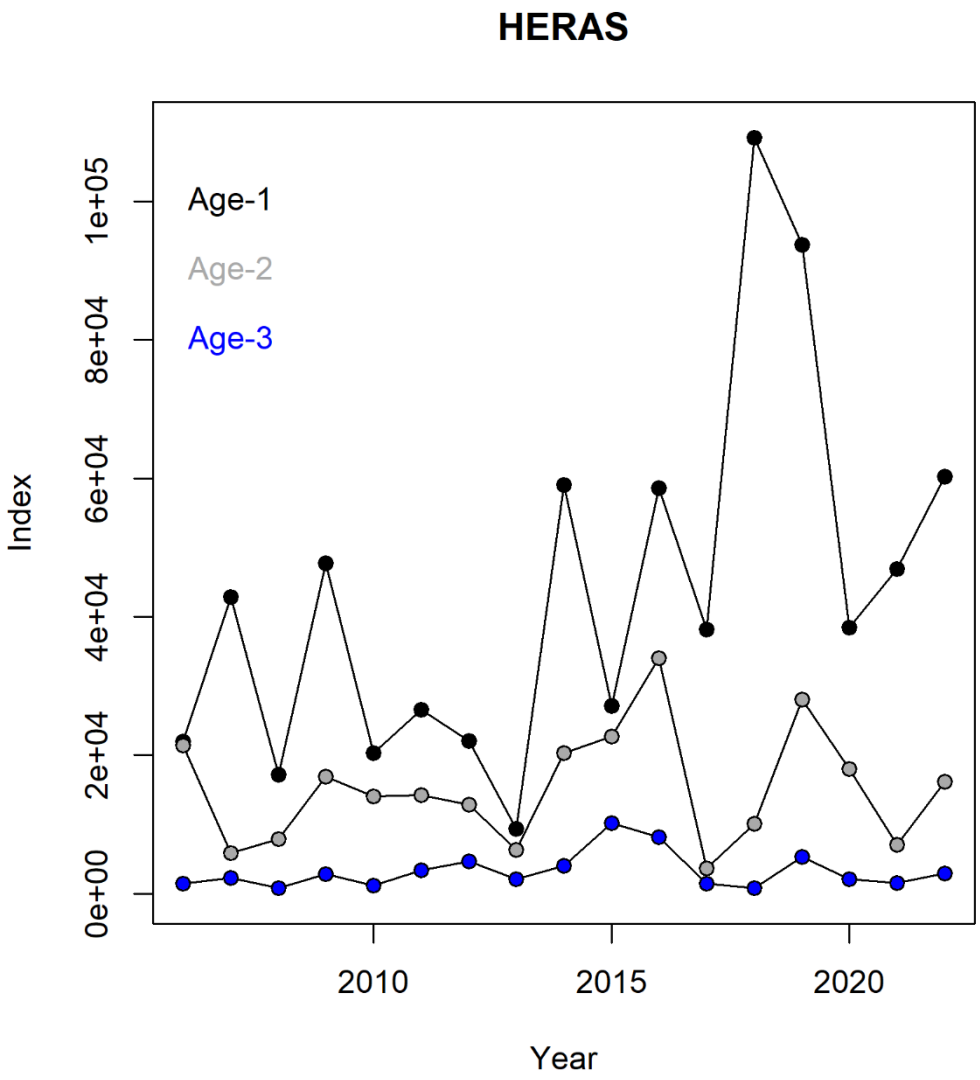
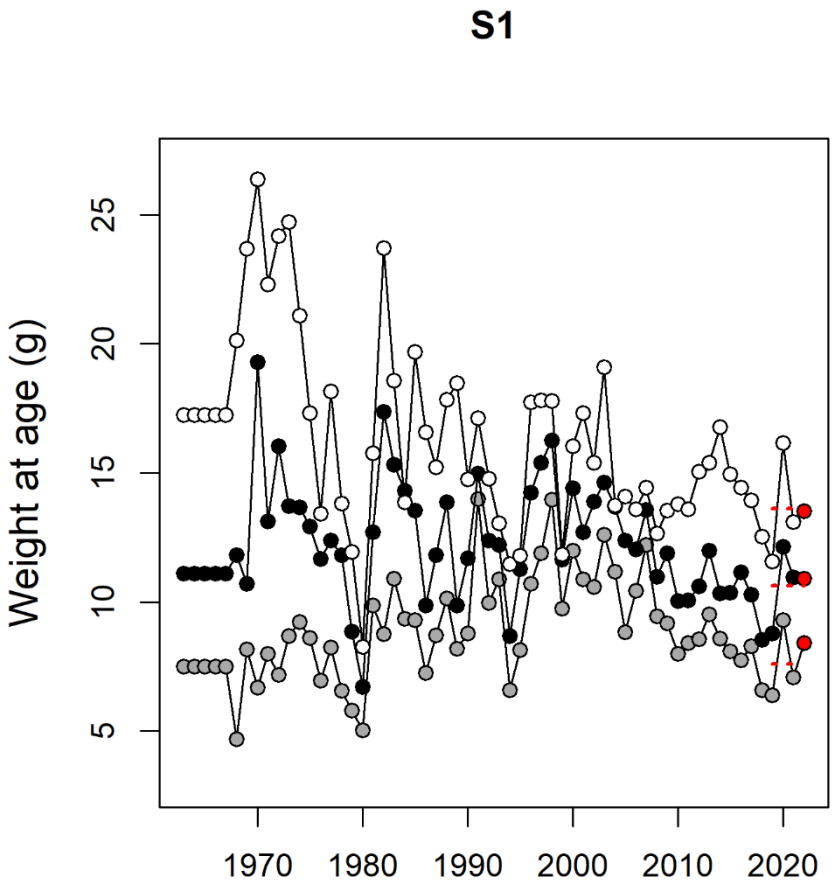
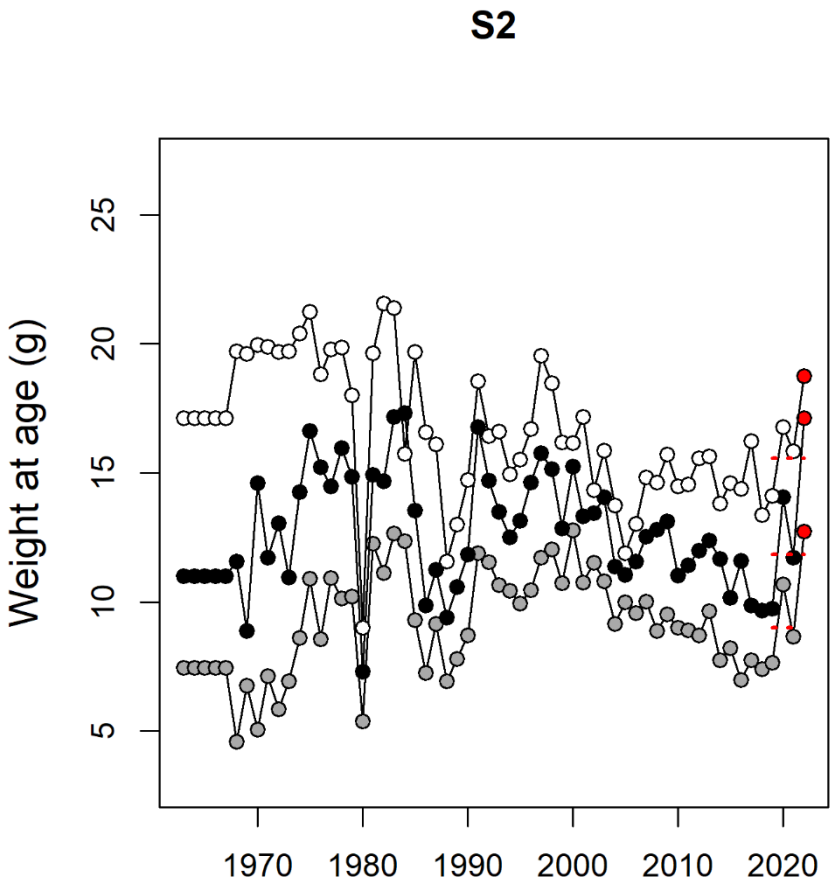
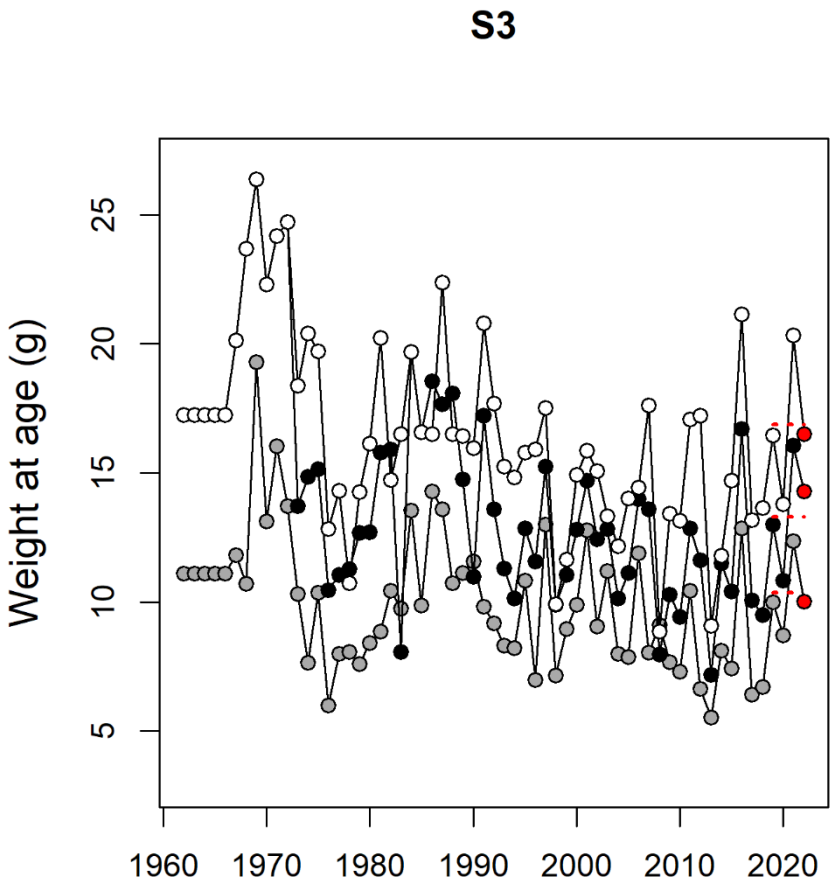


Figure 10.3.2b. North Sea and Division 3.a sprat. HERAS survey index for Subarea 4 and Division 3.a combined (sum of abundance indices published by WGIPS [ICES *in press*]). Years refer to the calendar year.


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


S3
Weight at age (g)
5
10
15
20
25
1960
1970
1980
1990
2000
2010
2020

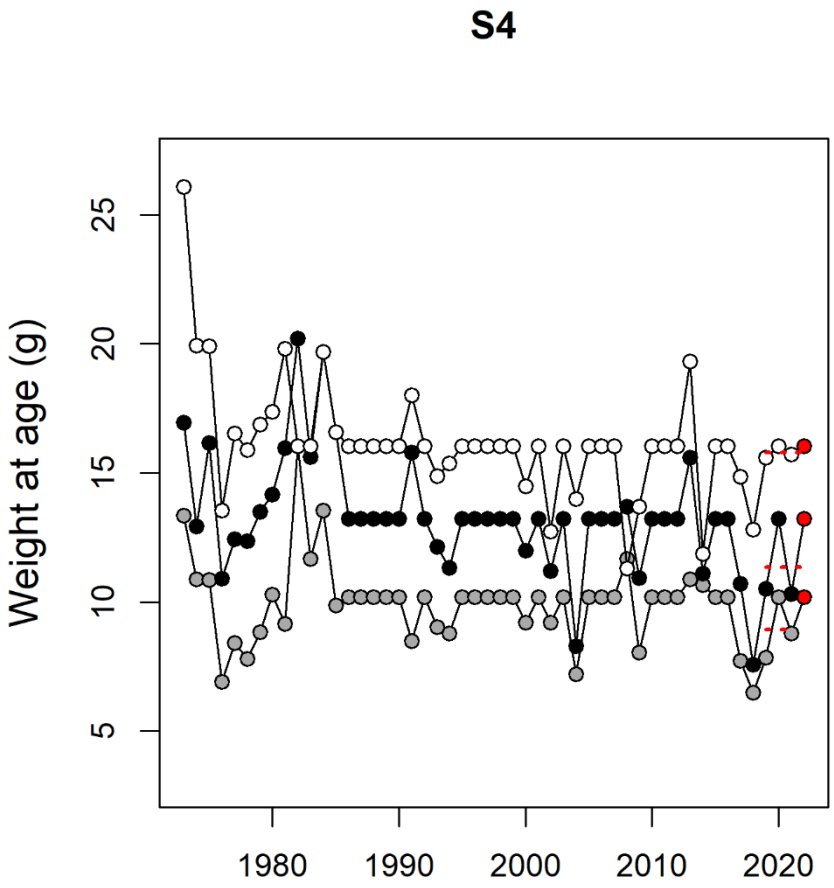


Figure 10.4.1. North Sea & 3.a sprat. Mean weight at age in season 1–4 (S1–S4) (years refer to the model year, e.g., 2021 = July 2021–June 2022). Age 1 (grey), age 2 (black), age 3 (white). Red dot is the status quo weight and the red dashed line refer to the 3-year average used in the forecast last year.

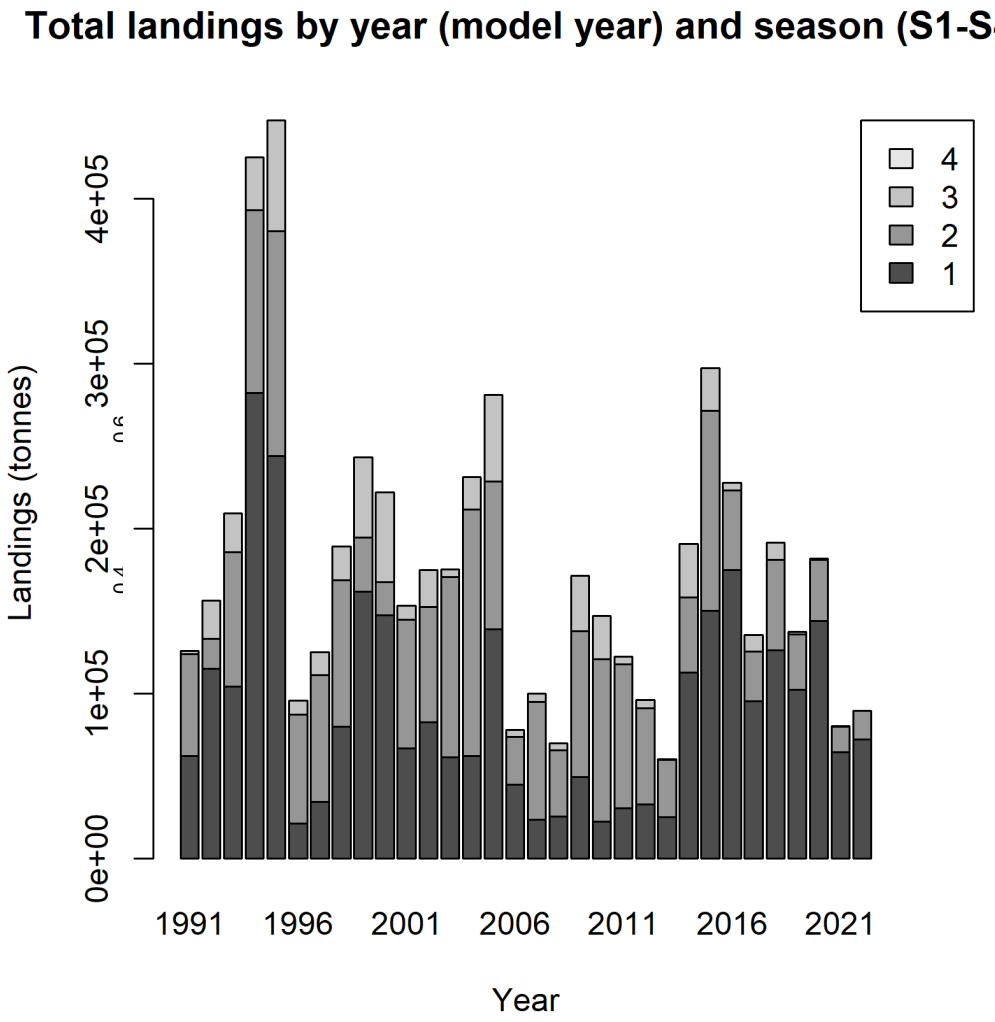


Figure 10.6.1a. North Sea & 3.a sprat. Seasonal distribution of catches. Year and season 1-4 refer to the time-steps of the model (e.g., 2021 = July 2021–June 2022). Note that since the model year of 2022 is not yet finished, the 2022 column will be updated next year. Also note that there are no catches shown for S4, since these are moved to S1 in the following year (see WKSPRAT 2018 report (ICES, 2018a) for details).

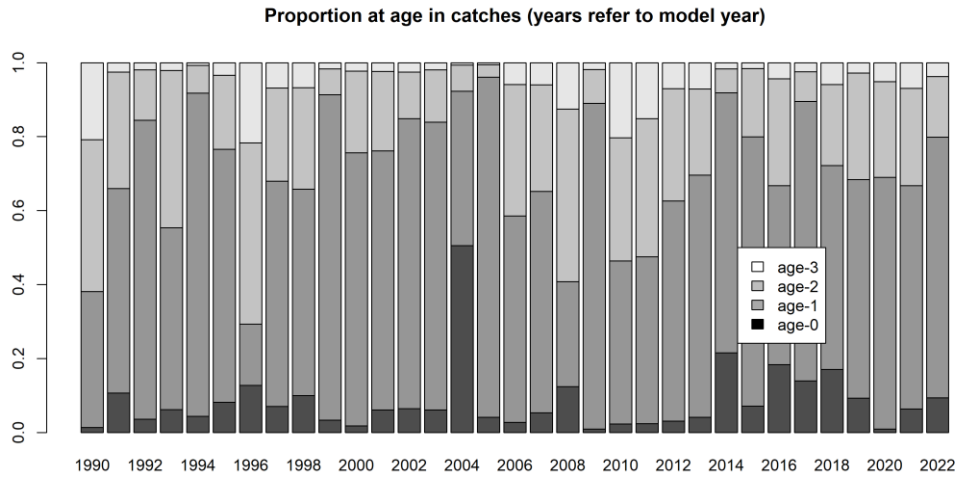


Figure 10.6.1b. North Sea & 3.a sprat. Proportion of each age group in the catches. Year and age refer to the model year (e.g., 2021 = July 2021–June 2022).

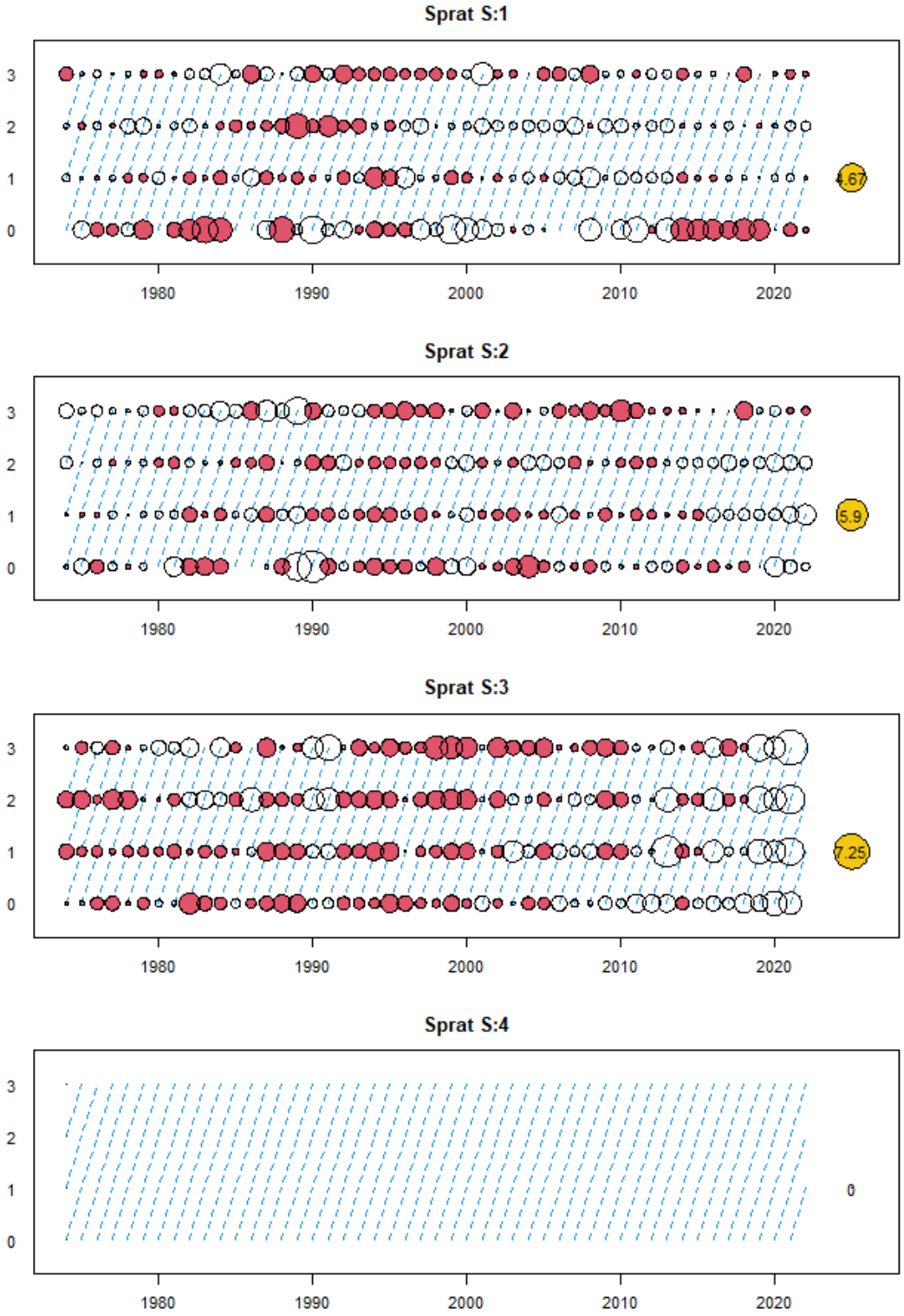


Figure 10.6.2. North Sea & 3.a sprat. Catch residuals by age. (Model year, e.g., 2021 = July 2021–June 2022)

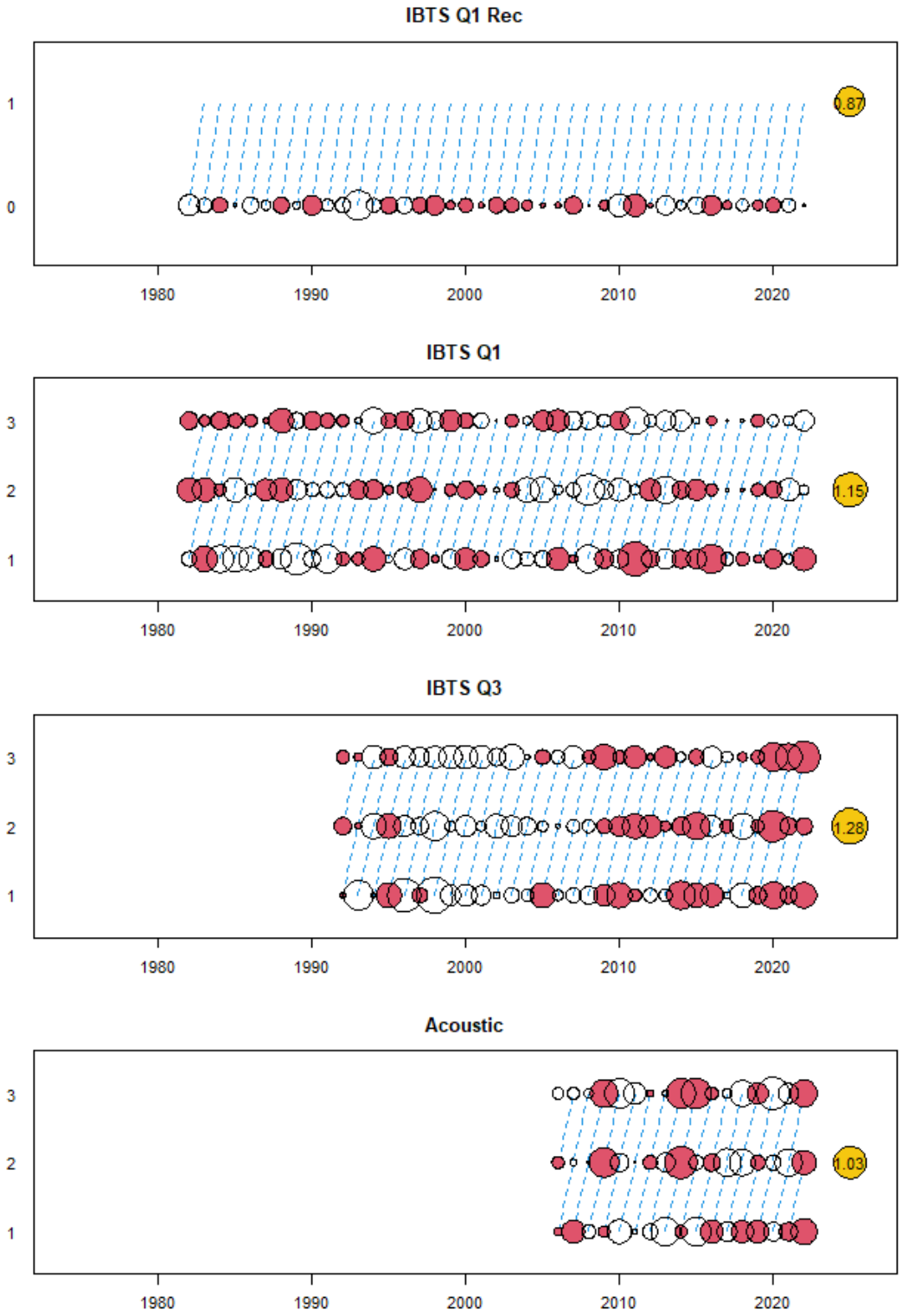


Figure 10.6.3. North Sea & 3.a sprat. Survey residuals by age. (Model year, e.g., 2021 = July 2021–June 2022)

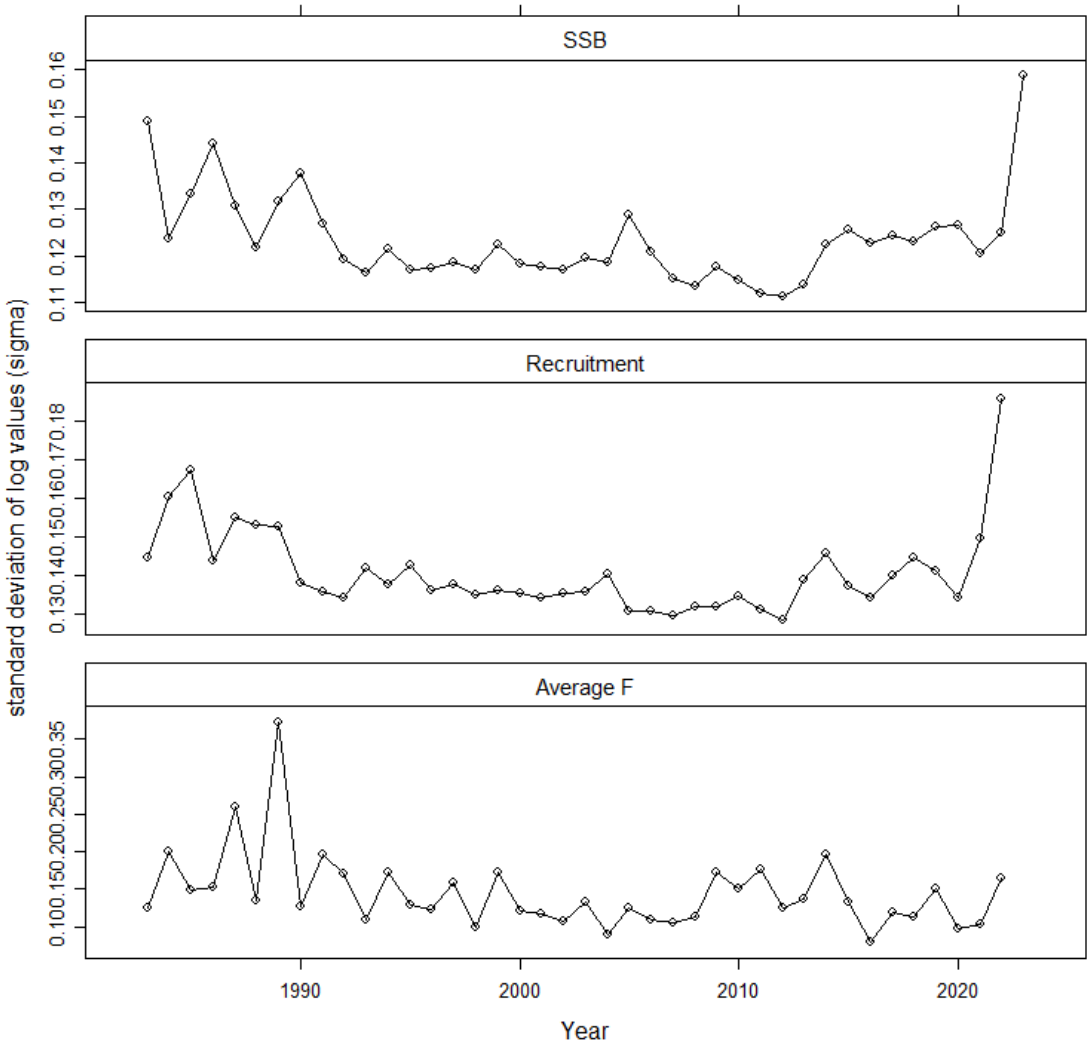


Figure 10.6.4. North Sea & 3.a sprat. Coefficients of variance (Model year, e.g., 2021 = July 2021–June 2022).

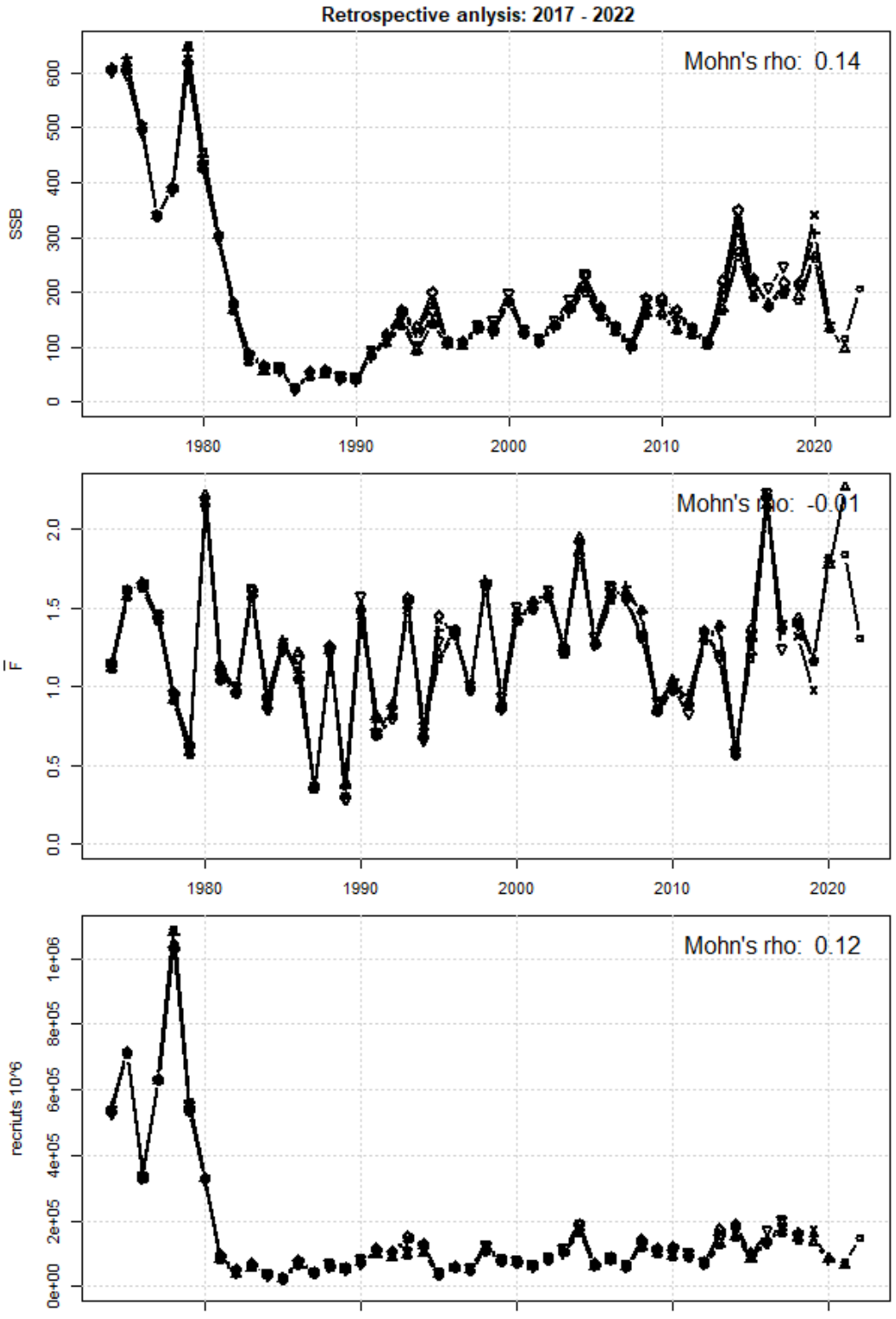


Figure 10.6.5. North Sea & 3.a sprat. Retrospective analysis (Model year, e.g., 2021 = July 2021–June 2022)

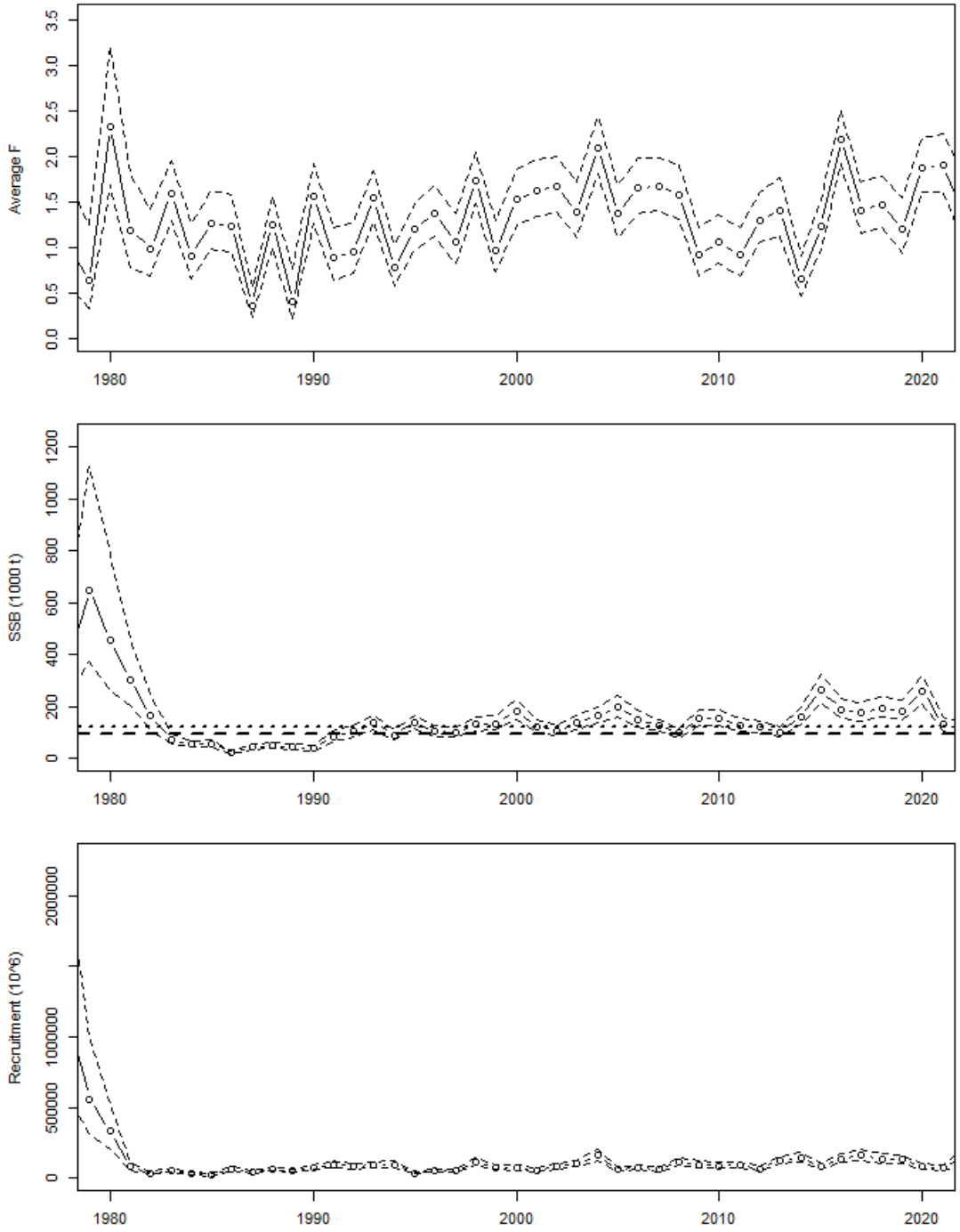


Figure 10.6.6. North Sea & 3.a sprat. Temporal development in Mean F, SSB and recruitment. Hatched lines are 95% confidence intervals (Model year, e.g., 2021 = July 2021–June 2022).

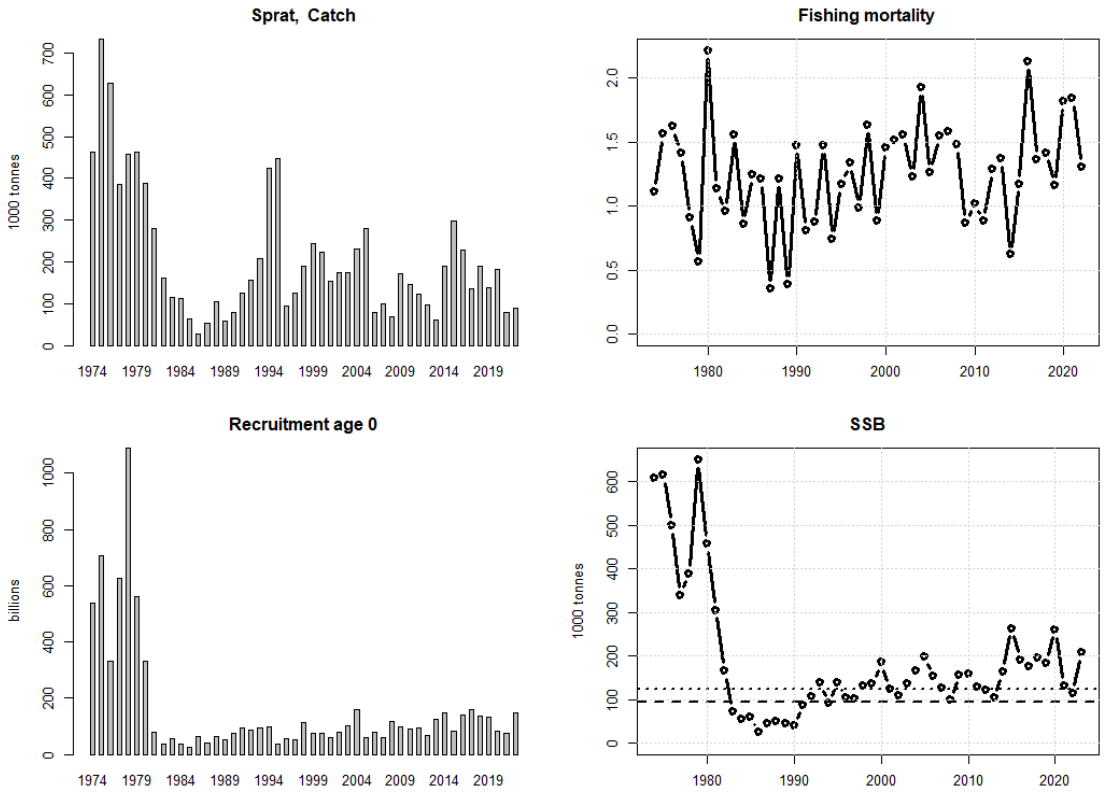


Figure 10.6.7. North Sea & 3.a sprat. Assessment summary (Model year, e.g., 2021 = July 2021–June 2022).

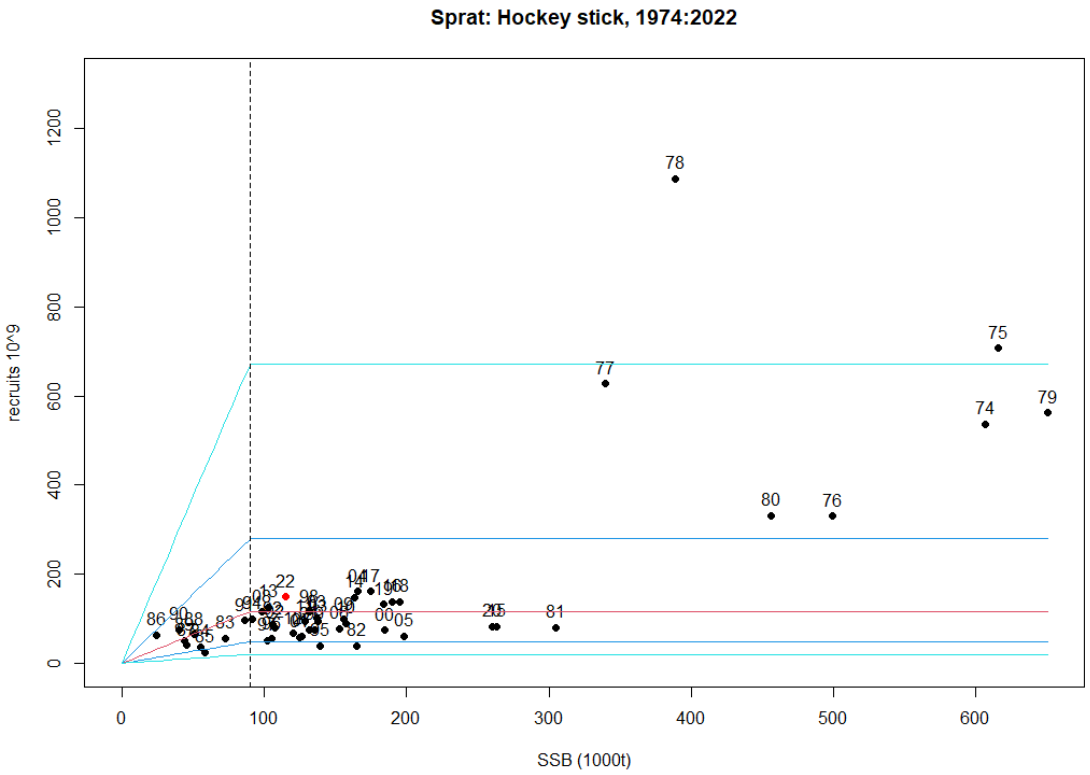


Figure 10.7.1. North Sea & 3.a sprat. Stock-recruitment relationship (Model year, e.g., 2021 = July 2021–June 2022).

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