ICES WGBFAS REPORT 2018

ICES ADVISORY COMMITTEE

ICES CM 2018/ACOM:11

Baltic Fisheries Assessment Working Group (WGBFAS)

6 –13 April 2018

ICES HQ, Copenhagen, Denmark

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Executive Summary

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) met 6-13 April 2018 (Chair: Tomas Gröhsler, Germany), represented by 38 participants from 9 countries. The objective of WGBFAS was to assess the status of the following stocks:

- Sole in Division 3.a, SDs 20–24
- Cod in Kattegat, Cod in SDs 22–24, Cod in SDs 25–32
- Herring in SDs 25–27, 28.2, 29 and 32
- Herring in SD 28.1 (Gulf of Riga)
- Herring in SDs 30-31 (Gulf of Bothnia)
- Sprat in SDs 22–32
- Plaice in SDs 21–23, Plaice in SDs 24–32
- Turbot in SDs 22–32

It was not obligatory to assess the following stocks in 2018 as no advice was needed:

- Flounder in SDs 22–23
- Flounder in SDs 24–25
- Flounder in SDs 26+28
- Flounder in SDs 27+29–32
- Brill in SDs 22–32
- Dab in SDs 22–32

However, it was decided by WGBFAS to compile and update the input data for 2017 and thereby also conducting an update assessment for these stocks.

WGBFAS also identified the data needed for next year's data call with some suggestions for improvements in the data call, and stock-specific research needs.

The report contains an introduction with the summary of other WGs relevant for the WGBFAS, reply to two special requests, methods used, and ecosystem considerations. The results of the analytical stock assessment or survey trends for the species listed above are then presented with all the stocks with the same species in the same sections. The report ends with references, recommendations, links to Stock Annexes and list of Working Documents.

The main analytical models used for the stock assessments were XSA and SAM.

For most flatfishes and cod in SDs 25–32 (data limited stocks), CPUE trends from bottom trawl surveys were used in the assessment (except plaice in SDs 24–25 for which relative SSB from SAM was used).

Proxy reference points were estimated for the following data limited stocks:

- Turbot in SDs 22-32 (based on length-based indicators)
- Cod in SDs 25-32 and plaice in SDs 24-32 (both using the SPiCT model).

For cod in SDs 25–32, data compilation/benchmark work for 2018/2019 was planned to allow returning to an analytical stock assessment during the benchmark process at the beginning of 2019.

Ecosystem changes have been analytically considered in the following stock assessments: Herring in SD 25–27, 28.2, 29 and 32, and Sprat in SD 22–32, in form of cod predation mortality.

Contents

1 Introduction

1.1 List of participants

Name	Country
Amosova, Victoria	Russia
Artemenkov, Dmitriy	Russia
Berg, Casper	Denmark, part time
Bergenius, Mikaea	Sweden
Boje, Jesper	Denmark
Casini, Michele	Sweden, part time
Carlshamre, Sofia	Sweden
Degel, Henrik	Denmark
Diernaes, Laura	Denmark
Eero, Margit	Denmark
Gröhsler, Tomas (chair)	Germany
Hjelm, Joakim	Sweden, part time
Holmgren, Noél	Sweden,
Hommik, Kristiina	Estonia
Horbowy, Jan	Poland
Jounela, Pekka	Finland
Kaljuste, Olavi	Estonia
Karpushevskaya, Anastassia	Russia
Kornilovs, Georgs	Latvia
Krumme, Uwe	Germany
Lövgren, Johan	Sweden
Mirny, Zuzanna	Poland,
Mosegaard, Henrik	Denmark, part time
Neuenfeldt, Stefan	Denmark,
Nielsen, Anders	Denmark, part time
Pekcan-Hekim, Zeynep	Sweden
Pönni, Jukka	Finland
Plikshs, Maris	Latvia
Öhman, Kristin	Sweden
Raid, Tiit	Estonia, part time
Raitaniemi, Jari	Finland
Rodriguez-Tress, Paco	Germany, part time
Schade, Franziska	Germany, part time
Smolinski, Szymon	Poland, part time
Statkus, Romas	Lithuania
Stoetera, Sven	Germany
Storr-Paulsen, Marie	Denmark
Strehlow, Harry	Germany, part time
Ustups, Didzis	Latvia, part time

Contact details for each participant are given in Annex 1.

1.2 Terms of reference

2017/2/ACOM11 The Baltic Fisheries Assessment Working Group (WGBFAS), chaired by Tomas Gröhsler, Germany, and co-chaired by Maris Plikshs*, Latvia, will meet at ICES HQ, Copenhagen, Denmark, 6–13 April 2018 to:

a) Address generic ToRs for Regional and Species Working Groups

b) Review the main result from WGIAB, WGSAM, SGSPATIAL with main focus on the biological processes and interactions of key species in the Baltic Sea;

c) Review progress of the intersessional work agreed in 2017 to improve the assessment of the Baltic cod stocks; and update as appropriate

d) Advise on how the results of the intersessional work can be applied in the assessment of the Baltic Sea cod stocks.

e) Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2018:
   a. Update the MSY proxy reference points for those category 3 and 4 stocks with existing proxy reference points using most recent data. For those stocks without reference points listed below, collate necessary data and information in order to estimate MSY proxy reference points prior to the Expert Group meeting. The official ICES data call included a call for length and life history parameters for each stock in the table below;
   b. Propose appropriate MSY proxies for each of these stocks by using methods provided in the ICES Technical Guidelines (ICES, 2017) along with available data and expert judgement

f) Collate and summarize available information on the pelagic fishery and provide a description of the pelagic fisheries in the Baltic Sea including the degree of mixing of herring and sprat by season, area and metier.

g) Identify possible data gaps and draft a proposal for a data call to address these gaps.

Stock Code	Stock name description	EG	Data Category
cod.27.21	Cod (*Gadus morhua*) in Subdivision 21 (Kattegat)	WGBFAS	3
cod.27.24–32	Cod (*Gadus morhua*) in subdivisions 24–32, eastern Baltic stock (eastern Baltic Sea)*	WGBFAS	3
dab.27.22-32	Dab (*Limanda limanda*) in subdivisions 22–32 (Baltic Sea)	WGBFAS	3
ple.27.24–32	Plaice (*Pleuronectes platessa*) in subdivisions 24–32 (Baltic Sea, excluding the Sound and Belt Seas)	WGBFAS	3
tur.27.22-32	Turbot (*Scophthalmus maximus*) in subdivisions 22–32 (Baltic Sea)	WGBFAS	3

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group on the dates specified in the 2018 ICES data call.

WGBFAS will report by 20 April 2018 for the attention of ACOM.

2017/2/ACOM05 The following ToRs apply to: AFWG, HAWG, NWWG, NIPAG, WGWIDE, WGBAST, WGBFAS, WGNSSK, WGCSE, WGDEEP, WGBIE, WGEEL, WGEF, WGHANSA and WGNAS.

The working group should focus on:

a) Consider and comment on ecosystem and fisheries overviews where available;

b) For the aim of providing input for the Fisheries Overviews, consider and comment for the fisheries relevant to the working group on:

   i) descriptions of ecosystem impacts of fisheries

   ii) descriptions of developments and recent changes to the fisheries

   iii) mixed fisheries overview, and

   iv) emerging issues of relevance for the management of the fisheries;

c) Conduct an assessment to update advice on the stock(s) to be addressed in 2018 using the method (analytical, forecast or trends indicators) as described in the stock annex and produce a brief report of the work carried out regarding the stock, summarising where the item is relevant:

   i) Input data and examination of data quality;

   ii) Where misreporting of catches is significant, provide qualitative and where possible quantitative information and describe the methods used to obtain the information;

   iii) For relevant stocks (i.e., all stocks with catches in the NEAFC area) estimate the percentage of the total catch that has been taken in the NEAFC Regulatory Area in the last year.

   iv) The developments in spawning stock biomass, total stock biomass, fishing mortality, catches (wanted and unwanted landings and discards) using the method described in the stock annex;

   v) The state of the stocks against relevant reference points;

   vi) Catch options for next year(s) for the stocks for which ICES has been requested to provide advice on fishing opportunities;

   vii) Historical and analytical performance of the assessment and catch options and brief description of quality issues with these;

d) Produce a first draft of the advice on the fish stocks and fisheries under considerations according to ACOM guidelines.

e) Review progress on benchmark processes of relevance to the expert group;

f) Prepare the data calls for the next year update assessment and for the planned data evaluation workshops;

g) Identify research needs of relevance for the expert group.

Information of the stocks to be considered by each Expert Group is available here.

1.2.1 Working Group response to special requests

1.2.1.1 Mixed fisheries descriptions by country

ToR a) Collate and summarize available information on the pelagic fishery and provide a description of the pelagic fisheries in the Baltic Sea including the degree of mixing of herring and sprat by season, area and metier.

1.2.1.1.1 DENMARK

Mixed Fisheries in the industrial fishery

Summary

An analysis was carried out for 2015 and 2016 data on the mixed fisheries in the Baltic. The logbooks from the directed herring fishery in the Baltic show that more than 80% of the trips are catching herring without any bycatch of sprat. Denmark has presently a high utilization of the sprat quota however

Landings

Of the 271 Danish trips registered in the Baltic in 2015 with more than 70% herring in the logbook (pelagic trawlers only), 20% had registered sprat in the logbook accounting to 9% of the total catch in the directed herring fishery. In 2016 in the directed herring fishery, 18% of the trips had registered sprat in the logbook accounting for 4% of the total catch.

All though herring and sprat is fished within the same area there is a tendency towards more sprat caught in the northern part of the Baltic and a large part of the herring caught close to Bornholm in SD 23-25.

Landings of sprat and herring by SD in 2015 by Denmark

Area SD	Sprat in t	% Sprat of total	Herring in t	% Herring of total
22	4989	94	303	6
23	0	0	154	100
24	299	9	2900	91
25	99	13	652	87
26	2932	100	0	0
27	2076	100	0	0
28	9709	100	24	0
29	3175	99	18	1
30	226	1	0	0
Total	23504	85	4050	15

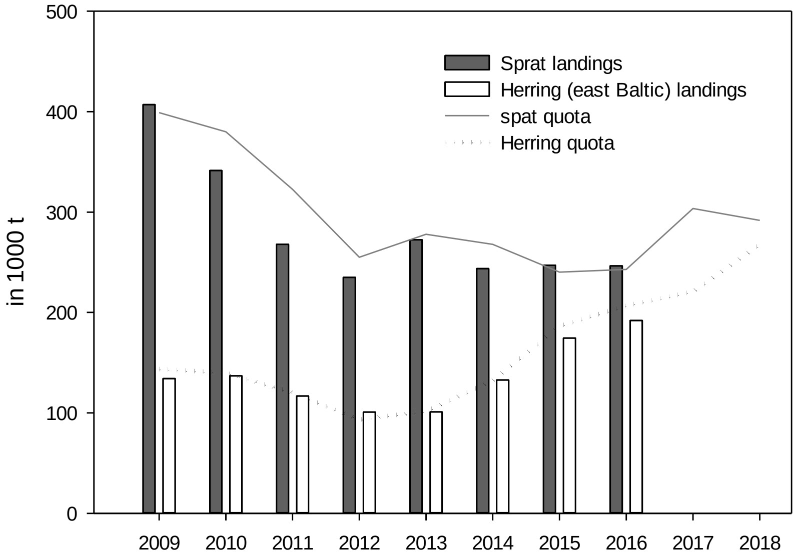
Landings of sprat and herring by SD in 2016 by Denmark

Area SD	Sprat in t	% Sprat of total	Herring in t	% Herring of total
22	2715	99	21	1
23	0	0	257	100
24	1063	16	5477	84
25	2837	68	1326	32
26	975	87	145	13
27	1791	72	708	28
28	454	63	270	37
29	6113	80	1533	20
30	0	0	0	0
Total	15949	62	9736	38

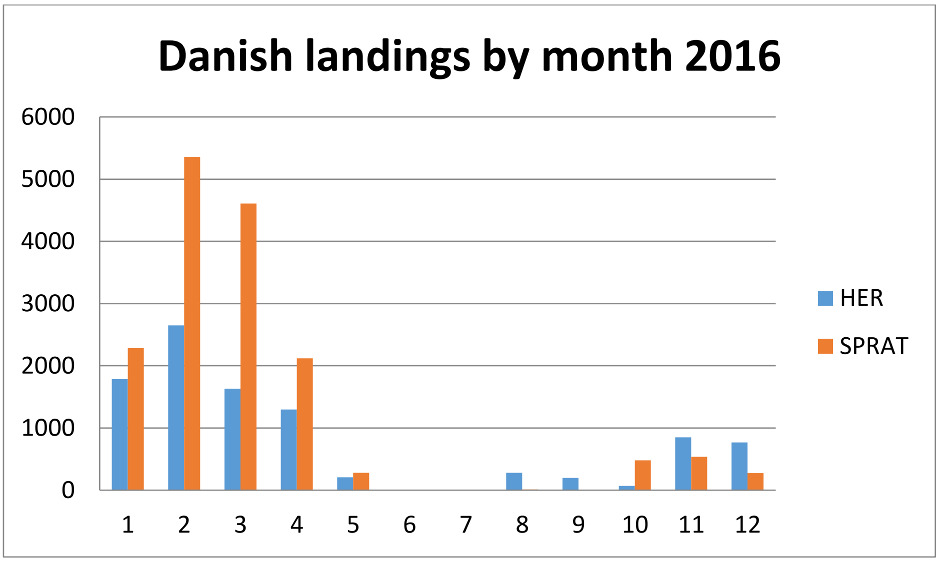
Utilization of quota

In 2015 and 2016, close to 95% of the Danish sprat quota was fished in the Baltic (SD 22–30).

In 2015, 86% of the Danish herring quota was utilized in the western Baltic (SD 22–24) and 14% in eastern Baltic (SD 25–32). In 2016 this picture changed and a larger part of the Danish herring quotas were utilized. For herring 92% of the Danish quota was utilized in the western Baltic (SD 22–24) and 90% eastern Baltic (SD 25–32).



The international landings and quota of herring and sprat in the Baltic



Landings of sprat and herring by month

Correction of species caught

The calculation of bycatches is only done on fishery for correction of the species composition in the catch according to biological samples collected in the harbors., since it is required that all other landings are reported with precise quantities for all species. Fisheries are stratified by catch area and species, and bycatch calculation is done for each stratum separately. The catch area in the Baltic Sea is divided by ICES sub area division.

To determine the quantities, both the logbooks and the sales notes are used. The logbooks contain information on ICES rectangles, whereas the sales notes contain information on the sold species. Furthermore the quota figures are calculated from sales notes.

The procedure is basically divided in two.

1. Firstly, a species distribution is calculated for each ICES rectangle using a 9 square technique on all available samples. The species distribution is used to calculate the bycatches.
2. This figure is adjusted with figures from the sales notes on fishery. In this calculation, the Baltic Sea is divided in the Eastern and Western Baltic Sea.

Definitions

There are two procedures for fishery to be corrected for species composition, one for the sales notes and one for the logbooks.

Procedure for the logbooks species correction:

- The majority of the catch on the whole trip is a species which is mainly caught in fishery for reduction. Furthermore it is caught with a mesh size below 32 mm. (Blue whiting and boarfish are exceptions, and is treated separate)

Procedure for the sales notes species correction:

- The majority of a landing is a species which is mainly caught in fishery for reduction. Furthermore the presentation should be 'Fish for Reduction'.

Samples

The end product for the processing of the samples is a percentual corrected species composition in every month, in every type of fishery on every ICES rectangle. The calculation is based on 'square-samples', which is summarized to 'super-samples' on every ICES rectangle. In order to have sufficient samples, samples from the two surrounding months are used as a rule (samples from January and March are used in the calculation of February).

A square-sample is a simple average of all available samples with regard to percentage of species. To avoid that samples of very big landings are too dominant, each sample have equal weight in the calculation of square-samples.

A super-sample is an average of the square sample, and the 8 surrounding square-samples, as illustrated below (T, U and S are three species):

Square-samples			**Super-sample**		
U: 100			**U: 75** **T: 25**	**U: 75** **T: 25**	**U: 50** **T: 50**
	U: 50 T: 50		U: 75 T: 25	U: 58 T: 40 S: 2	T: 60 U: 37 S: 3
		T: 70 U: 24 S: 6	U: 50 T: 50	T: 60 U: 37 S: 3	T: 60 U: 37 S: 3

In some cases, the super-sample will not be influenced by all the surrounding samples. This is due to the following two rules:

1. A super-sample will not be influenced by surrounding samples, if two ICES rectangles do not share a common water frontier.
2. Biologists have emphasized a great difference between deep and shallow waters in the North Sea and Skagerrak. Therefore square-samples from shallow ICES rectangles are not used in deep water super-samples and vice versa.

It is decided that a super-sample should be based on at least three samples. If this is not the case, an average of the whole area is used as samples. If for instance the super-sample is based on 2 samples, an average of the super-sample (counting 2/3) and the average for the whole area (counting 1/3) is used to calculate a new super-sample.

If there is not a sample available for the whole area, a non bycatch is assumed.

Quantities

When a super-sample for all ICES-rectangles is calculated, it is matched with logbooks from relevant journeys on the level of ICES rectangles in every type of fishery (see definitions). This is the logbook figures.

Lastly, we convert the data to sales note figures. A figure on quantity of fish for reduction is calculated from the sales notes *and* the logbooks. This is calculated on catch areas (although Baltic Sea is only divided in Eastern and Western Baltic). The two figures are used to calculate an adjustment factor, which is used on the logbook figures.

1.2.1.1.2 ESTONIA

Development of landing figures in relation to the TAC, fleets operating, gears used, usage of landings, spatial and temporal distribution of the landings (2015–2017)

From 2015 to 2017 the herring total landings in SD 28.1, 28.2, 29 and 32 increased by 8%, mostly due to the increase in Central Baltic herring TAC. The catches of the Gulf of Riga herring decreased at the same time due to the TAC reductions by 17%

The Estonian fishing fleet in the Baltic consists of two parts:

- Coastal fleet with undecked vessels (boats ≤ 10 m and engine power ≤ 100 HP). The fishing is mostly conducted with passive gears (gillnet and trapnet, which are exclusively catching herring.
- Trawlers with total lengths between 12 m and 40 m. The fishing is mainly carried out with pelagic trawls (single or pair trawlers) catching herring mixture of herring and sprat (minimum mesh-size 17–20 mm). The Estonian fishing fleet decreased substantially in 2004–2012 as a result of the EU scrapping program, and stabilized since then. At present most of the Baltic trawl fleet consists stern trawlers >=300 HP

On average, 25% of herring catches was taken with coastal fixed gears and 75% with trawls in 2015–2017.

The main fishing season for herring was in spring (quarter 1: 40 % and quarter 2: 30–35%), but also the 4th quarter- 20–25%. The fishery in 1st quarter can be hampered by ice.
Most herring catches originated from SD 28.1 (40–52%), and from SD 32 (26%) in 2015–2017.

Sprat catches have shown slight increase in 2017 compared to two previous years due to increase in TAC. Like in case of herring, the most of the sprat catches are taken in first hafyear and in the 4th quarter in mixed trawl fishery. Main areas of sprat fishery were the SD 32 (53–65%) and SD 29 (20–38%) in 2015–2017.

No discarding takes place in Estonian herring and sprat fishery.

The allocated quota for herring and sprat were almost fully exploited (88–96% for herring and 86–99% for sprat).

Both herring and sprat are mostly used for human consumption, only a minor part ofsprat is used for industrial purposes (fish meal).

2015						
	Area	1Q	2Q	3Q	4Q	Total
Herring	Sd 28.1	7824	7928	296	453	16501
	Sd 28.2	172	85	2	450	709
	Sd 29	943	326	375	1683	3327
	Sd 32	3533	3736	427	3792	11488
	Total	12472	12075	1100	6378	32025
Sprat	Sd 28.1					0
	Sd 28.2	293.5	152.6	97.1	834.6	1378
	Sd 29	2565	339.4	494.4	3408.1	6807
	Sd 32	4786.6	2176.6	664.8	7445.4	15073
	Total	7645	2669	1256	11688	23258
	H+S	20117	14744	2356	18066	55283

2016						
	Area	1Q	2Q	3Q	4Q	Total
Herring	Sd 28.1	6938	8512	48	316	15814
	Sd 28.2	1595	343	16	995	2949
	Sd 29	1366	653	101	871	2992
	Sd 32	3238	1746	308	6167	11460
	Total	13137	11255	474	8350	33216
Sprat	Sd 28.1	188	3.6	0.9	0.6	193
	Sd 28.2	2640	169	54	1724	4587
	Sd 29	2790	595	120	1197	4702
	Sd 32	5327	889	377	6974	13566
	Total	10945	1657	552	9895	23048
	H+S	24081	12912	1025	18245	56263

2017						
	Area	1Q	2Q	3Q	4Q	Total
Herring	Sd 28.1	6157	7401	10.9	204	13773
	Sd 28.2	1050	398	36	164	1648
	Sd 29	3033	768	423	2459	6683
	Sd 32	3793	3085	1420	4084	12382
	Total	14033	11652	1890	6911	34486
Sprat	Sd 28.1					0
	Sd 28.2	1589	259	77	386	2310
	Sd 29	3791	709	612	4607	9719
	Sd 32	3721	1372	2136	6411	13640
	Total	9101	2340	2825	11404	25669
	H+S	23134	13992	4714	18315	60155

Purpose of Estonian pelagic landings (t) in 2014–2016

Official national monitoring system of the herring and sprat landing statistics

Information on the Estonian fishery is derived from logbooks and sales slips. This information is sent to the Ministry of Rural Affairs which is compiling the annual catch information and makes it open on its website. The data are compiled according to the type of fishery, fish species, and the fishing area and are submitted monthly, quarterly and annually to the EU Commission (DGXIV).

In the Baltic region, German fishing vessels ≥ 8 m are obliged to fill in a logbook. The logbooks contain fishing information on quoted fish species (date, gear used, rectangle, and landings in kg). Catches of fishing vessels < 8 m are required to provide monthly sales slips, which are submitted to the respective fishery department.

Catches and landings of trawlers are permanently monitored (incl. the species composition), in all landing harbors by inspectors of Environmental Inspectorate. This information is compared with the logbooks.

Data source

Estonian Ministry of Rural Affairs. The data correspond to Estonian landings in SD 28.1, 28.2, 29 and 32.

Does species misreporting occur in the Estonian pelagic fishery?

All catches taken with gillnet and trapnet are exclusively catching herring with no bycatch of sprat. Therefore some misreporting can occur in trawl fishery only (with exception of the Gulf of Riga (SD 28.1) with very low abundance of sprat.

The logbooks information are cross-checked and, when necessary, corrected on the basis of information from fisheries inspectors and the corresponding sales slips. Landing data based on sales slips are fairly reliable because it is based on the sorting and weighing process carried out in the factories with standardized equipment.

The scientific sampling programme for herring and sprat, which covers the all pelagic trawlers, (randomly chosen) catching herring and sprat in SDs 28.1, 28.2, 29 and 32- 1 unsorted catch sample (10 kg) per trip. Altogether about 3–5 trips are sampled per month and SD.

The above allow to conclude that species misreporting is not a big issue at the moment when both sprat and herring quotas are big enough to use full capacity of the fleet.

1.2.1.1.3 FINLAND

The Finnish offshore fleet comprises of around 60 vessels between 12–40 m in the Baltic Sea main basin, the Archipelago Sea, the Gulf of Bothnia and the Gulf of Finland. The main target is Baltic herring stocks (with sprat taken usually as bycatch) with pelagic trawls.

The catch statistics in Finland are based on logbooks. The catches are reported to coastal Centres for Economic Development, Transport and the Environment (ELY-Centres), who are also responsible for the monitoring of the catch compositions. These catches are not, however, monitored regularly, but only occasionally, and in cases when there is some reason to suspect misreporting. Intentional misreporting has not been shown to be a common phenomenon, and misreporting as such is not considered to be a problem in the Finnish fisheries.

The species composition in catches varies between subdivisions and seasons with the share of sprat being highest in the Gulf of Finland (SD 32), being 54% in 2009–2017 on average, and lowest in the Bothnian bay (SD 31), 0%. Seasonal variation in sprat abundance is the highest in SD 29: There are high concentrations of sprat in the 1st and the 4th year quarters in the northern Baltic Sea. Most of the Finnish herring catches (70–75%) are fished from the Bothnian Sea (SD 30) with the highest catches in quarter 2, when there are low bycatches of sprat (on average 22% of the total annual catch from the area). In SD 30 the share of sprat in annual catches has been 4% on average. The annual share of pelagic catches in the Finnish fishery from SD's 25–28 is only a few per cents at its highest, and therefore they are not considered here.

The Finnish sprat quota is only 5.87% of the Baltic sprat TAC, which has caused restrictions to trawl fishery in SD's 29 and 32 in recent years, in order to help fully utilize the SD 30 herring quota.

1.2.1.1.4 GERMANY

Development of landing figures in relation to the TAC, fleets operating, gears used, usage of landings, spatial and temporal distribution of the landings (2014–2016)

From 2014 to 2016 the herring landings in SD 22–29 increased by 57%. The German herring fisheries mostly followed the corresponding TAC/quota system, where the fishing fleet tried to compensate quota restrictions of herring by means of quota transfer with other countries around the Baltic Sea. The landings of sprat reached during 2014-2016 about the same level of about 10 200 t – 10 900 t. A part of the German sprat quota was year by year transferred to other countries around the Baltic (2014: 3900 t, 2015: 2800 t, 2016: 1700 t).

The German fishing fleet in the Baltic consists of two parts (all catches for herring and sprat are taken in a directed fishery):

- Coastal fleet with undecked vessels (rowing/motor boats ≤ 12 m and engine power ≤ 100 HP). The fishing is mostly conducted with passive gears (gillnet and trapnet, which are exclusively catching herring.
- Cutter fleet with decked vessels and total lengths between 12 m and 40 m. The fishing is mainly carried out with pelagic trawls (pair trawlers) catching herring (minimum mesh-size >32 mm in SDs 22–27 and >16 mm in SDs 28–32) and sprat (minimum mesh-size >16 mm).

Within the herring fishery 71, 26, and3 % of the total catches were taken by trawl, gillnet and trapnet fishery, respectively. All sprat were caught as usual in the trawl fishery.

The main fishing season for herring was in spring (quarter 1: 71% and quarter 2: 16%), a minor part was taken in quarter 4 (13%). Most of the sprat catches were taken in the first quarter (80%); quarter 2 (16%) and quarter 4 (4%) were of minor importance.

Most herring landings originated from SD 24 (78%, SD 22: 3%, SD 25: 5%, SD 26: 3%, SD 27: 1%, SD 28: 6%, SD 29: 4%). The fishing activities are in accordance to the quota system, which allocates more than 93% of the herring quota to SD 22–24. The German herring fishery involves several hundred fishing vessels. The highest fishing activities for sprat were recorded in SD 28 (33%), followed by SD 25 (21%), SD 29 (20%), SD 26 (17%), SD 22 (5%), SD 27 (3%) and SD 24 (1%). The sprat fishery in these areas was mainly conducted by four larger fishing vessels.

The allocated quota for herring and sprat (incl. overall positive or negative quota transfer from other countries) were almost fully exploited (96 – 99%).

Virtually all sprat catches were landed abroad (94%, in Skagen, DK and in Grenaa, DK), whereas only about 20% of all herring catches were landed in foreign ports (e.g. Köge, DK).

Herring is mostly used for human consumption, only a minor part is used for industrial purposes (2014: 0.1%, 2015: 0.6%, 2016: 11%, see text table below). Sprat show in 2014-2016 an increase in the proportions of industrial landings (fishmeal and mink food for Finland), which reach the highest amount of 73% in 2016 (2014: 3%, 2015: 9% + 55 % unknown purpose). Only a small part is used for human consumption, at least in 2016.

Purpose of German pelagic landings (t) in 2014–2016

in tonnes		2014				2015				2016			
Species	Area	Human	Industrial	unknown	Total	Human	Industrial	unknown	Total	Human	Industrial	unknown	Total
Herring	SD 22	586.0	0.6	68.6	655.2	404.8	5.5	66.3	476.6	197.4	0.0	48.4	245.8
	SD 24	9319.5	8.6	257.9	9585.9	12600.8	6.6	204.3	12811.7	13841.8	0.5	338.5	14180.8
	SD 25	485.5	0.0	0.0	485.5	216.5	0.0	948.4	1164.9	445.8	210.7	0.0	656.5
	SD 26	264.8	0.0	0.0	264.8	285.0	0.0	56.6	341.6	558.4	321.5	0.0	879.9
	SD 27	233.0	0.0	0.0	233.0	180.0	0.0	32.0	212.0	0.0	5.4	0.0	5.4
	SD 28	224.6	0.0	0.0	224.6	443.4	31.8	313.7	789.0	986.7	977.7	0.0	1964.4
	SD 29	523.5	0.0	0.0	523.5	293.6	61.2	54.4	409.2	269.4	564.2	0.0	833.6
	Total	11636.8	9.2	326.5	11972.4	14424.1	105.0	1675.9	16205.1	16299.6	2079.9	386.9	18766.4
Sprat	SD 22	597.4	0.0	2.0	599.4	655.8	0.0	1.4	657.2	394.0	0.0	0.4	394.4
	SD 24	37.6	0.2	0.1	38.0	70.9	0.0	0.0	70.9	72.0	0.0	3.0	75.0
	SD 25	2297.0	326.7	0.0	2623.7	287.8	346.0	2045.9	2679.7	708.1	458.4	0.0	1166.5
	SD 26	2201.3	0.0	0.0	2201.3	412.3	0.0	438.6	850.9	553.1	1825.0	0.0	2378.0
	SD 27	648.5	0.0	0.0	648.5	221.7	0.0	72.3	294.1	0.0	10.2	0.0	10.2
	SD 28	1488.8	0.0	0.0	1488.8	1608.5	196.3	2865.7	4670.6	915.4	3268.5	0.0	4183.9
	SD 29	2566.1	0.0	0.0	2566.1	549.8	333.7	184.2	1067.7	250.7	2447.5	0.0	2698.2
	Total	9836.8	327.0	2.1	10165.8	3806.8	876.1	5608.1	10291.0	2893.4	8009.5	3.4	10906.2
He.&Sp.	Total	21473.5	336.1	328.6	22138.3	18230.9	981.1	7284.0	26496.0	19193.0	10089.4	390.3	29672.7
% tonnes		2014				2015				2016			
Species	Area	Human	Industrial	unknown	Total	Human	Industrial	unknown	Total	Human	Industrial	unknown	Total
Herring	SD 22	89.4%	0.1%	10.5%	100.0%	84.9%	1.1%	13.9%	100.0%	80.3%	0.0%	19.7%	100.0%
	SD 24	97.2%	0.1%	2.7%	100.0%	98.4%	0.1%	1.6%	100.0%	97.6%	0.0%	2.4%	100.0%
	SD 25	100.0%	0.0%	0.0%	100.0%	18.6%	0.0%	81.4%	100.0%	67.9%	32.1%	0.0%	100.0%
	SD 26	100.0%	0.0%	0.0%	100.0%	83.4%	0.0%	16.6%	100.0%	63.5%	36.5%	0.0%	100.0%
	SD 27	100.0%	0.0%	0.0%	100.0%	84.9%	0.0%	15.1%	100.0%	0.0%	100.0%	0.0%	100.0%
	SD 28	100.0%	0.0%	0.0%	100.0%	56.2%	4.0%	39.8%	100.0%	50.2%	49.8%	0.0%	100.0%
	SD 29	100.0%	0.0%	0.0%	100.0%	71.7%	15.0%	13.3%	100.0%	32.3%	67.7%	0.0%	100.0%
	Total	97.2%	0.1%	2.7%	100.0%	89.0%	0.6%	10.3%	100.0%	86.9%	11.1%	2.1%	100.0%
Sprat	SD 22	99.7%	0.0%	0.3%	100.0%	99.8%	0.0%	0.2%	100.0%	99.9%	0.0%	0.1%	100.0%
	SD 24	99.1%	0.6%	0.3%	100.0%	100.0%	0.0%	0.0%	100.0%	96.0%	0.0%	4.0%	100.0%
	SD 25	87.5%	12.5%	0.0%	100.0%	10.7%	12.9%	76.3%	100.0%	60.7%	39.3%	0.0%	100.0%
	SD 26	100.0%	0.0%	0.0%	100.0%	48.5%	0.0%	51.5%	100.0%	23.3%	76.7%	0.0%	100.0%
	SD 27	100.0%	0.0%	0.0%	100.0%	75.4%	0.0%	24.6%	100.0%	0.0%	100.0%	0.0%	100.0%
	SD 28	100.0%	0.0%	0.0%	100.0%	34.4%	4.2%	61.4%	100.0%	21.9%	78.1%	0.0%	100.0%
	SD 29	100.0%	0.0%	0.0%	100.0%	51.5%	31.3%	17.3%	100.0%	9.3%	90.7%	0.0%	100.0%
	Total	96.8%	3.2%	0.0%	100.0%	37.0%	8.5%	54.5%	100.0%	26.5%	73.4%	0.0%	100.0%
He.&Sp.	Total	97.0%	1.5%	1.5%	100.0%	68.8%	3.7%	27.5%	100.0%	64.7%	34.0%	1.3%	100.0%

Official national monitoring system of the herring and sprat landing statistics

Information on the German fishery is derived from sales slips and logbooks. This information is sent to the fishery department of the corresponding federal states (Länder). After checking the reported catch and landing data, they are forwarded to the national state authority (Federal Centre for Agriculture and Food, BLE) and stored in a computer system. The data are compiled according to the type of fishery, fish species, and the fishing area and are submitted monthly, quarterly and annually to the EU Commission (DGXIV) (catch report A). Other EU member states (MS) report their landings by submitting logbook sheets and sales slips directly to the authority of the responsible state. These catches are compiled and transferred monthly to the EU Commission (catch report B). Catch data from German fishing vessel landings in other MS are transferred by the states to the responsible state authority in Germany.

In January 2012 a new regulation has been implemented, replacing the previous reporting system (catch reports A and B). The new regulation requires all MS to sample the entire information regarding their national fishing fleets; this now also includes the landings of the national fleet in foreign ports.

In the Baltic region, German fishing vessels ≥ 8 m are obliged to fill in a logbook. The logbooks contain fishing information on quoted fish species (date, gear used, rectangle, and landings in kg). Catches of fishing vessels < 8 m are required to provide monthly sales slips, which are submitted to the respective fishery department.

Catches and landings are monitored at sea, by control vessels of the federal and state governments of Schleswig-Holstein and Mecklenburg-Vorpommern (fishery board, customs, marine police)

In harbours, the control is carried out by the port control of the state fishery board (13 check points along the Baltic coast) and by the fishmaster.

Data source
National state authority (Federal Centre for Agriculture and Food, BLE). The data correspond to German landings in SDs 22–29.

Does species misreporting occur in the German pelagic fishery?

- All catches taken with gillnet and trapnet are exclusively catching herring with no bycatch of sprat (mean gillnet and trapnet catches in 2014–2016: 28% of the total herring landings in SDs 22–29). However, some species mixing of herring and sprat may occur in the trawl fishery.
- The landings in the herring fishery are mainly taken in SD 24 (2014–2016: 78% of the total herring landings in SDs 22–29). There is some spatial overlap with the fishing activities for sprat, which is mainly conducted in SDs 25–26 and 28–29 (mean 2014–2016: 91%).
- The logbooks are cross-checked and, when necessary, corrected by the BLE using information from the corresponding sales slips. Landing data based on sales slips are fairly reliable because it is based on the sorting and weighing process carried out in the factories with standardized equipment. The product weight is also used for cross-checking by applying a correction factor to get an estimate of the original landing figure. The quota is charged for the final landing species composition of a trip.
- The German quota for herring and sprat from the Baltic was almost fully taken during the last years. This may have resulted in incentives for misreporting. However, the low spatial overlap of the herring and sprat fishery - where herring is mainly caught in SD 24 and sprat in SDs 25–26 and 28–29 - is not supporting the incentives of misreporting on a larger scale.
- The scientific self-sampling programme for sprat, which covers the two major pelagic trawlers catching herring and sprat in SDs 25–29 involves 1 unsorted catch sample (5 kg) per trip since their entire catches are landed abroad. However, the analysis of species composition of these sampled sprat landings, which contained only a minor proportion of herring, suggests that no correction of the official landings statistics of sprat is needed.
- Since most herring landings are used for human consumption, the trawl fishery intends to catch pure samples of herring with minor bycatch of sprat. This also guarantees the highest landing prices.

1.2.1.1.5 Latvia

Development of landing figures in relation to the TAC, fleets operating, gears used, usage of landings, spatial and temporal distribution of the landings (2016–2017)

In Latvia the TAC for pelagic species is utilized above 90% and in some years is fully utilized.
In the Baltic Proper the pelagic fishes are mainly caught by pelagic trawls and this is mainly sprat directed fishery with some bycatch of herring. The fishery takes place all year-around with exception of July-August when many vessels stop fishery. The majority of the catches is taken in the Latvian economic zone and is landed in the Latvian ports. In 2017 the catches taken in the economic zones of other EU countries was below 10%. Probably some part of these catches is landed abroad. The fishery in the coastal zone by gill-nets and trap-nets is of minor importance.
In the Gulf of Riga there are two main fisheries – herring directed trawl fishery in which some bycatch of sprat is possible and trap-net fishery in the coastal zone which has only herring catches. The proportion of latter is around 15–20% from the total herring catches in the Gulf of Riga. The catches are landed in the Latvian ports. The fishery takes place all year-around with exception of 30 days trawl-fishery ban in May-June and with low fishing effort in summer months. The trap-net fishery takes place in April-June period.

Purpose of pelagic landings in Latvia
The major part of the landings is used for human consumption although the utilization of pelagic fishes for industrial purposes has increased in recent years. The development in the nearest future will depend on the demand from the processing industry.

Data source
The information on landings is obtained from logbooks. The electronic access is also available for Institute of Food Safety, Animal Health and Environment BIOR that provides the landing information for ICES working groups. In recent years the official information has not been changed.

Official national monitoring system of the herring and sprat landing statistics
There is in place regular check of pelagic landings by control inspection that estimates the proportion of herring and sprat in the landings and compares it with the records in the logbooks. In frames of Fisheries Data Collection Program Institute of Food Safety, Animal Health and Environment BIOR performs monthly random onboard sampling of pelagic fisheries in the Baltic Proper where mainly sprat targeted fishery takes place. During sampling the proportion of herring and sprat is estimated in the catches and biological samples of both species are taken.

Does species misreporting occur in the Latvia pelagic fishery?
The proportion of herring and sprat in trawl fishery that is estimated in onboard sampling is similar to the proportion of the total landings of these two species. All fishermen who perform pelagic fishery have quotas for both species thus misreporting by species could be possible only when quota for one of the species is utilized.

1.2.1.1.6 LITHUANIA

Development of landing figures in relation to the TAC, fleets operating, gears used, usage of landings, spatial and temporal distribution of the landings (2017)

The Lithuania fishing fleet in the Baltic consists of two parts:

- Coastal fleet with boats ≤ 8 m and small vessels 12–15 m). Small pelagic fishery is conducted with passive gears (gillnets and trapnets), which are exclusively catching herring.
- Trawlers with total lengths between 24 m and 40 m. The fishing is mainly carried out with pelagic trawls (single or pair trawlers) fishing on exclusively herring or sprat or mixture of both in different proportions (mesh-size varies from 16 to 32 mm).

Nearly 60% of herring and 52% of sprat are caught by OTM (Table 1.1). Landings of herring and sprat from demersal fishery (OTB) come as a bycatch.

Table 1.1. Landings of herring and sprat (in tonnes and % accordingly) by gear

Gear	**FIX**		**GNS**		**OTB**		**OTM**		**PTM**	
Herring	42.1	1.0	24.5	0.6	79.8	2.0	2438.9	60.4	1451.6	36.0
Sprat	0.0	0.0	0.0	0.0	333.2	2.7	6462.3	51.8	5684.5	45.5

Most herring catches originated from SD 28.1 (~48 %) while catches of sprat come from SD25 (~25%), SD26 (~28%) and SD28 (~35%) (Table 1.2).

Table 1.2. Landings of herring and sprat (in tonnes and % accordingly) by Subdivision

subdivisions	**25**		**26**		**27**		**28**		**29**	
Herring	645.5	16.2	770.6	19.4	279.9	7.0	1898.1	47.7	442.8	11.1
Sprat	3106.9	24.9	3444.0	27.6	526.3	4.2	4406.4	35.3	996.5	8.0

Lithuanian small pelagic fleet operates and does land the fish in economic exclusive zones of 7 member states. Nearly 91% of herring and 100% of sprat have been caught and landed in foreign ports (Table 1.3).

Table 1.3. Lithuanian landings of herring and sprat (in tonnes and % accordingly) in different countries

	DNK		**EST**		**FIN**		**LTU**		**LVA**		**POL**		**SWE**	
Herring	2278.1	57.3	144.6	3.6	319.6	8.0	110.7	2.8	492.3	12.4	21.4	0.5	608.6	15.3
Sprat	9996.8	80.1	131.7	1.1	447.2	3.6	0.0	0.0	620.0	5.0	32.3	0.3	1251.9	10.0

Only 28% of herring and 12% of sprat are used for human consumption. The major part of the landings are utilized for industrial purposes (fish meal) (Table 1.4).

Table 1.4. Lithuanian landings of herring and sprat (in tonnes and % accordingly) in different countries

Purpose of catches	**Animal Feed**	**Industrial use**	**Human Consumption**
Herring	3.5	68.0	28.5
Sprat	3.4	84.4	12.2

Official national monitoring system of the herring and sprat landing statistics

Information on the Lithuanian fishery is derived from logbooks and sales slips. This information is stored in the database of Fisheries Service. The data includes information on fishing effort, monitoring system, sales, catches, etc.

In the Baltic region, Lithuanian fishing both vessel groups bellow and above 8 m are obliged to fill in a logbook. The paper logbooks contain fishing information on quoted and non-quoted commercially important fish species (date, gear used, rectangle and landings in kg (and numbers in case of salmonids)) which are submitted to the respective fishery division.

Catches and landings of trawlers are permanently monitored (incl. the species composition), in all landing harbors by inspectors of Fisheries Service. This information is compared with the logbooks. The logbooks information are cross-checked and, when necessary, corrected on the basis of information from fisheries inspectors and the corresponding sales slips.

1.2.1.1.7 POLAND

General characteristics of commercial fishing fleet focused on clupeids catches

In 2015–2017, the Polish commercial fishing fleet, operated in the Baltic Sea, was composed by adequately 682, 672 and 631 active small vessels, *i.e.* motor and rowing boats (SSF, coastal fisheries) <12 m length and 190, 167 and 161, respectively vessels with size between 12–35 m length (mainly offshore fisheries). The larger vessels (>18.5 m) use mainly pelagic trawls (OTM, PTM) for fishing sprat and herring, destined for both human consumption and industrial purposes, while smaller vessels (10–18.5 m) use mainly bottom trawls (OTB) and gillnets (GNS) and focus on Baltic cod, flounder and sandeel exploitation. Fishing occurs mainly in the ICES subdivisions 24, 25 and 26 and these species form about 97% of the total annual catch, with sprat dominating by weight in landings since 1997. Other target fish species having local/seasonal importance in the Polish fishery are salmon, sea-trout, turbot, plaice and eel. In some inshore parts of the Polish marine waters, the seasonal importance in small vessels commercial landings also have roach, perch, bream, pike-perch, whiting, whitefish, rasorfish, crucian carp and garfish. It should be underlined that the annual (2014–2016) share of vessels' <8 m length in the total national fish catches, originated from the Baltic, was around 2%. More one-fact concerns the Polish SSF should be emphasised, *i.e.* on 13.07.2017, some changes in the Polish Marine Fisheries Act were implemented. According to the new national regulation, vessels of length less than 8 m are no longer obliged to report catch composition information in the monthly reports. However, the information on the fishing effort is still available in the a.m. reports. In the case of clupeids, the mentioned change concern herring fishing only, however in a minor scale. The new method of estimation of catch composition in SSF was described in the ICES WGCATCH Report–2017.

The pelagic trawls from many years play an important role in the Polish commercial fish catches, especially in a case of clupeids, with applied for herring catches following mètier: OTM_SPF_16-89_0_0, OTM_SPF_32-104_0_0, PTM_SPF_32-89_0_0, PTM_SPF_32-104_0_0, OTB_SPF_32-104_0_0, GNS_SPF_16-109_0_0 and FPO_SPF_>0_0_0. The Baltic sprat catches was realised mostly with the following mètier: OTM_SPF_16-31_0_0, PTM_SPF_16-31_0_0 and OTB_SPF_16-31_0_0. The mean annual share of various types of fishing gears in the Polish nominal catches of sprat in 2015–2017 is listed in Table 1.10. In the years 2015–2017, the mean share of OTM and PTM in the Polish annual catches of Baltic sprat according to ICES subdivisions was fluctuated adequately, from 80.4 to 100.0% (96.3% on average) and from 0.3 to 10.2% (4.8% on average). In the case of herring catches, the mean share of OTM and PTM was 86.1 and 3.0%, respectively.

Cutters with the length ranged from 20 to 27–m and very limited by number larger vessels (up to 35–m) are involved in the pelagic catches of sprat (partly mixed with herring and to some extent with cod) for both, human consumption and the industrial purposes. The efficiency of Polish catches of Baltic sprat is very dependent from vessels size involved in this fishery, e.g. in 2016, 19, 1347, 1142, 7029, 12 715, **31 641**, and 6176 tonnes was fished by vessels with length: <12 m, 12–14.99 m, 15–18.49 m, 18.5–20.49 m, 20.5–25.49 m, **25.5–30.49 m** and ≥30.5 m, respectively. The share of cutters with length of 25.5–30.49 m in the Polish catches of sprat (in 2016) was 55%, on average. Such catches with small-meshed pelagic trawls are realized mostly in offshore waters of the Baltic, from intention - separately for sprat and herring. Accordingly, to the above-mentioned species fisheries, the above-mentioned smaller and larger métier is applied. Pelagic trawls are used for herring-like fisheries during whole year with considerable intensity in February-May and October-December - in a case of sprat and in March-April and September-October - in a case of herring.

Herring landings in the years 2015–2017

Most of the herring landings in the period 2015–2017 originated from ICES subdivisions 25 and 26 - on average about 52 and 39%, respectively (Table 1.5). The trawl fishery conducted by cutters dominated in the total herring landings (89.7% on average). The lower meaning had herring landings from passive gears used by boats: 6.2 and 4.1% on average from trapnets and gillnets, respectively. In the period of 2015–2017, 89.5% of annual herring catches were designated for human consumption and 10.5% for industrial purposes.

Table 1.5. The Polish total landings (t) of Baltic herring in 2015–2017, acc. to purposes of catches.

Year >	2015		2016		2017		Overall
ICES Subdiv.	Human	Industrial	Human	Industrial	Human	Industrial	Total
27.3.d.24	2227	415	2838	79	3137	193	8889
27.3.d.25	18539	2868	20448	2227	19692	4001	67775
27.3.d.26	15950	1447	16997	381	15913	668	51356
27.3.d.27	0	0	154	7	47	0	208
27.3.d.28	132	39	21	670	646	545	2053
27.3.d.29	42	0	54	40	31	126	293
Total	36890	4769	40512	3404	39466	5533	130574

Sprat landings in the years 2015–2017

In 2015–2017, the Polish commercial fishery directed on Baltic sprat was realized mostly in the ICES subdivisions 27.3.d.25 and 27.3.d.26 and next in ICES Subdivision 27.3.d.24 and in much lower degree in the ICES subdivisions 27.3.d.27–27.3.d.29 (Table 1.6.). Sprat catches realized in three recent years, in 5.5; 40.4; 50.8; 0.5; 2.7 and 0.6% (on average) originated from the ICES subdivisions 27.3.d.24 – 27.3.d.29, respectively. Sprat was landed mostly in the domestic sea-ports and harbors and in lesser degree in foreign ports, i.e. principally in Danish ports, and in some extent in Swedish and Latvian ports (for details see the ICES WGCATCH Report–2017). Clupeids caught by the Polish fleet in 2015–2017 and landed abroad were temporary sampled directly at sea by the Polish scientific observers. Sprat and herring dominated in the fraction of seven main commercial fish species landed abroad by the Polish fishermen, and both species originated from catches accomplished in the ICES subdivisions 27.3.d.24 – 27.3.d.29. In 2016, the mean share of the annual Polish landings of sprat and herring in foreign ports vs. the total national landings of given species from particular ICES Subdivision, ranged from 0.6 to 14.3% and from 0.02 to 8.0%, respectively. The highest Polish landings of sprat and herring, landed in foreign ports, originated from catches in the ICES Subdivision 27.3.d.25.

The Polish total annual nominal landings of Baltic sprat (with bycatch of herring mostly) in 2015–2017 was 64172.7, 60051.7 and 69971.5 tonnes, respectively. In the above-mentioned period 72.3 and 27.7% on average of sprat catches was designated for human consumption and industrial purposes, respectively (Table 1.7). The Polish total annual actual landings of Baltic sprat (bycatch of herring excluded) in the recent three years was 62 228.6, 59 257.8 and 68 430.3 tonnes, respectively (Table 1.8). The bycatch of herring in the Polish nominal landings of sprat in 2015–2017 was 1944.1, 1219.9 and 1541.2 tonnes, successively (Table 1.9). In the above-mentioned years the mean share (by weight) of herring in the Polish annual catches of Baltic sprat was 3.0; 2.0 and 2.2%, respectively.

In 2015–2017, the highest amount of sprat landings, obtained by the Polish fishermen, was noticed in the first quarter, and it composed of 42.7; 47.9 and 59.0% of annual landings of given species (Table 1.8). The second quarter of 2015–2017 play somewhat lower role in the Polish annual catches of sprat. In the third quarter the Polish sprat landings were the lowest within given year (2015–2017) and contributed from 3.1 to 5.1% (on average) to the annual national landings.

The Polish annual quota of Baltic sprat landings was utilized in 94, 97 and 89%, successively in 2015, 2016 and 2017. In many recent years Poland take the first place in the international sprat annual catches in the Baltic Sea, and e.g. in 2015 and 2016, the mean share of Poland in the mentioned catches was 25.2 and 24.0%, respectively.

Table 1.6. The Polish nominal landings (t) of Baltic sprat in 2015–2017, acc. to purposes of catches and ICES subdivisions; abbreviations used: HCN - for human consumption, IND - for industrial purposes (fishmeal, fish oil, etc.), ANF - animal food.

Year >	2015		2016		2017		Overall (tonnes)		
ICES Subdiv.	HCN	IND+ANF	HCN	IND+ANF	HCN	IND+ANF	HCN	IND+ANF	Total
27.3.d.24	2327.7	386.8	3418.4	358.6	3966.0	230.3	9712.1	975.8	10687.9
27.3.d.25	12965.2	14147.6	15343.3	9274.1	14575.4	11312.7	42883.9	34734.5	77618.4
27.3.d.26	29513.7	4443.4	23153.0	6333.7	31625.4	3514.7	84292.1	14291.8	98583.8
27.3.d.27	1.0	0.0	242.0	3.0	599.8	143.4	842.8	146.4	989.2
27.3.d.28	358.5	28.8	203.1	1165.8	1811.4	1594.1	2373.0	2788.7	5161.7
27.3.d.29	0.0	0.0	0.0	556.6	254.3	344.0	254.3	900.6	1154.9
Total	45166.1	19006.6	42359.8	17691.9	52832.2	17139.3	140358.1	53837.8	194196.0

Table 1.7. The share (%) of Polish nominal landings (2015–2017) of Baltic sprat, purposed for humane consumptions and industrial aims, acc. to ICES Subdivision.

Year >	2015		2016		2017		Overall (%)		
ICES Subdiv.	HCN	IND+ANF	HCN	IND+ANF	HCN	IND+ANF	HCN	IND+ANF	Total
27.3.d.24	85.8	14.2	90.5	9.5	94.5	5.5	90.9	9.1	100.0
27.3.d.25	47.8	52.2	62.3	37.7	56.3	43.7	55.2	44.8	100.0
27.3.d.26	86.9	13.1	78.5	21.5	90.0	10.0	85.5	14.5	100.0
27.3.d.27	100.0	0.0	98.8	1.2	80.7	19.3	85.2	14.8	100.0
27.3.d.28	92.6	7.4	14.8	85.2	53.2	46.8	46.0	54.0	100.0
27.3.d.29	0.0	0.0	0.0	100.0	42.5	57.5	22.0	78.0	100.0
Total	70.4	29.6	70.5	29.5	75.5	24.5	72.3	27.7	100.0

Table 1.8. The Polish actual landings (tonnes) of Baltic sprat (bycatch of herring excluded) in 2015–2017, acc. to ICES subdivisions and quarters.

		ICES subdivisions							
Year	Quarter	27.3.d.24	27.3.d.25	27.3.d.26	27.3.d.27	27.3.d.28	27.3.d.29	Total (tonnes)	Total (%)
2015	1	822.7	9602.9	16091.4	0.0	63.4		26580.4	42.7
	2	954.8	14708.8	9359.2	1.0	89.8		25113.5	40.4
	3	449.0	781.6	921.7	0.0	0.0		2152.3	3.5
	4	488.0	1028.5	6631.8	0.0	234.1		8382.4	13.5
	total	2714.5	26121.8	33004.1	1.0	387.3	0.0	62228.6	100.0
2016	1	1121.2	8505.6	17231.8	310.0	804.0	425.0	28397.5	47.9
	2	1825.5	13895.9	7555.7	0.0	263.9	0.0	23541.0	39.7
	3	598.4	1242.6	972.0	0.0	218.5	0.0	3031.5	5.1
	4	157.6	976.2	2715.4	3.0	300.6	135.0	4287.8	7.2

	total	3702.7	24620.3	28474.8	313.0	1587.0	560.0	59257.8	100.0
2017	1	1306.5	14091.2	22758.4	170.4	1772.4	254.3	40353.2	59.0
	2	1655.5	8374.9	8137.2	554.7	73.9	0.0	18796.1	27.5
	3	187.9	1077.8	628.2	0.0	224.2	0.0	2118.1	3.1
	4	1046.4	1355.7	3063.6	18.2	1335.0	344.0	7162.8	10.5
	total	4196.3	24899.6	34587.4	743.3	3405.4	598.3	68430.3	100.0

Table 1.9. The bycatch of herring (tonnes) in the Polish nominal landings of Baltic sprat in 2015–2017, acc. to ICES subdivisions and quarters.

		ICES subdivisions							
Year	Quarter	27.3.d.24	27.3.d.25	27.3.d.26	27.3.d.27	27.3.d.28	27.3.d.29	Total (tonnes)	Total (%)
2015	1	-	399.6	223.0	-	-	-	622.6	2.29
	2	-	591.4	730.1	-	-	-	1321.6	5.00
	3	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-
	total	-	991.0	953.2	-	-	-	1944.1	3.03
2016	1	-	-	590.4	-	-	-	590.4	2.04
	2	-	157.0	288.1	-	1.6	-	446.8	1.86
	3	-	-	-	-	-	-	-	-
	4	-	-	180.7	-	-	-	180.7	4.04
	total	-	157.0	1059.3	-	1.6	-	1217.9	2.01
2017	1	-	570.3	212.2	-	-	-	782.4	1.90
	2	-	418.3	70.9	-	-	-	489.1	2.54
	3	-	-	-	-	-	-	-	-
	4	-	-	269.6	-	-	-	269.6	3.63
	total	-	988.5	552.7	-	-	-	1541.2	2.20

Table 1.10. The mean annual share (in %) of various types of fishing gears in the Polish nominal catches of Baltic sprat in 2015–2017, acc. to ICES subdivisions.

Year	Types of fishing gears	ICES subdivisions					
		27.3.d.24	27.3.d.25	27.3.d.26	27.3.d.27	27.3.d.28	27.3.d.29
2015	OTM	80.37	98.98	88.16	100.00	100.00	-
	PTM	-	0.94	10.19	-	-	-
	OTB	19.63	0.08	0.03	-	-	-
	PTB	-	-	1.61	-	-	-
2016	OTM	91.37	99.10	89.92	100.00	100.00	100.00
	PTM	-	0.81	8.68	-	-	-
	OTB	8.63	0.10	1.19	-	-	-
	PTB	-	-	0.21	-	-	-
2017	OTM	98.13	99.48	91.56	100.00	100.00	100.00
	PTM	-	0.30	7.96	-	-	-
	OTB	1.87	0.23	0.47	-	-	-
	PTB	-	-	0.001	-	-	-

Possible misreporting in the Polish pelagic fishery

The main tools to estimate the official Baltic fish landing statistics in Poland are logbooks (in paper and electronic format) and sales slips. Information concerns fishing activities of each commercial vessel are successively submitted to the Fisheries Monitoring Centre in Gdynia, where are verified, compiled and stored in the electronic format of annual database. Information derived from catches realized by vessels >12 m length, based on an electronic format of logbook, are promptly transferred after fishing process is ended. Owners of the smaller vessels (10–12 m length) are oblige to send the paper format of logbook sheets two times per week, and owners of vessels with length <10 m are responsible for submission of catches-report after one month of activities at sea.

The species misreporting may occur in the Polish pelagic fishery. Affected by misreporting is mostly industrial sprat trawl fishery, mainly in the ICES subdivisions 25 and 26 and the period March-May, when the highest catches occur. Because only part of this type of fishery is temporary monitored by the NMFRI (Gdynia) scientific observers, in consequence the data about herring bycatch in sprat fishery are limited in time and area. Results of sampling are used to correct official reports on the ICES Subdivision and quarter level. Sampling may be insufficient in a case of far areas (ICES subdivisions 27, 28, 29) and for cutters not entering the Polish ports for the longer time. In this case, only the quantity of landing is reported to WGBFAS, based only on logbooks. However, Polish catches in these areas are relatively low. Bycatch of herring in sprat fishery is evaluated by the NMFRI (Gdynia) experts, based on set of data collected by scientific observers present on board of surveying vessels and in ports. Polish quantities of clupeids landings (submitted to ICES-WGBFAS) are the joint official landings of herring and sprat, distributed into species by national experts based on biological samples.

In the clupeids catches for the human consumption, species are well separated by using different mesh size of codend in the catches dedicated to herring and sprat (minimum mesh size > 32 mm, and 16 mm, respectively) and use of mechanical sorting equipment. Statistics of these landings and their sampling are of good precision. However, the problem of bycatch of juvenile herring in sprat landings exists, thus biological sampling both in harbour landings and at sea is conducted to address these issues. As the result, the official quantity of herring landings received from logbooks is increased by its bycatch in sprat landings and official sprat landings are decreased by this quantity.

Clupeids landings for industrial purposes are mixed catches, using trawl with sprat codend mesh size, and are not sorted by species. These landings are done as industrial sprat and noted in logbook under the sprat species. Only in few logbooks, shares of herring and sprat are estimated. As was above mentioned, majority of these landings, done by Polish vessels, take place in Danish harbours and in lesser degree in Sweden. The statistics, concerning this type of fishery, is created based on landings documents (sales slips).
It should be underlined that catches taken with gillnet and trapnet are exclusively catching herring with no bycatch of sprat. Small meshed bottom trawls (OTB, PTB) are rather occasionally used for sprat fishing and bycatch of herring is marginal taking account the annual level.

1.2.1.1.8 RUSSIA

Overview of the Russian pelagic Fishery in 2017

The species composition of the mixed catches is defined from logbooks, by observers of AtlantNIRO (Kaliningrad) on board of commercial vessels and checked by fishery inspection in harbors.

The main fleet, targeting sprat for the human consumption, during I-IV quarters, has average bycatches of herring between 13 – 64% in **SD 26**. As usually, during summer this fleet targets sprat for the animal food and bycatches of herring is increased. The vessels fleet MRTK operates mainly within 12 NM limit over the year. Mesh size in the trawl bag is 10 mm opening. The catches of sprat in quarter I can reach 81.2%, in quarter II – 86.8%, in quarter III – 35.6%, in quarter IV – 77.9%. Russian fishermen utilized their sprat (in 26 SD) and herring (in SD 26+32) quotas on 90.8% and 75.7% respectively. Basic parameters of work of a pelagic trawl fleet in SD 26 represent in Table 1.11 and Figure 1.3 (the data from Russian Centre of Fishery Monitoring System and Communications).

Table 1.11. Parameters of pelagic trawl fleet in 2017 (SD 26)

Parameters of pelagic trawl fleet	Quarter				For year
	I	II	III	IV	
The number of fishing days (the sum for all vessels)	1161	878	458	740	3237
Landing of one vessel for 1 day, t (average)	20.2	17.7	9.53	18.3	16.0
Sprat in catches, %	81.2	86.8	35.6	77.9	68.0
Herring in catches, %	18.8	13.1	64.0	21.6	32.0

Pound net fleet

This type of fishery exists in the Vistula Lagoon (SD 26). This fishery is targeting herring mainly in I and II quarters. The herring catch in this area from the total Russian catch (SD 26+32) in 2017 was about 12%.

Eastern part of Gulf of Finland (SD 32)

The vessels fleet MRTK operates mainly in I, II, and IV quarters and were orientated to herring. The herring catch in SD 32 from the total Russian catch (SD 26+32) in 2017 was about 39%. Basic parameters of work of a pelagic trawl fleet in SD 32 represent in Table 1.12 and Figure 1.4 (the data from Russian Centre of Fishery Monitoring System and Communications).

Table 1.12. Parameters of pelagic trawl fleet in 2017 (SD 32)

Parameters of pelagic trawl fleet	Quarter				For year
	I	II	III	IV	
The number of fishing days (the sum for all vessels)	65	138	-	265	468
Herring landing of one vessel for 1 day, t (average)	24.3	18.4	-	17.4	18.6

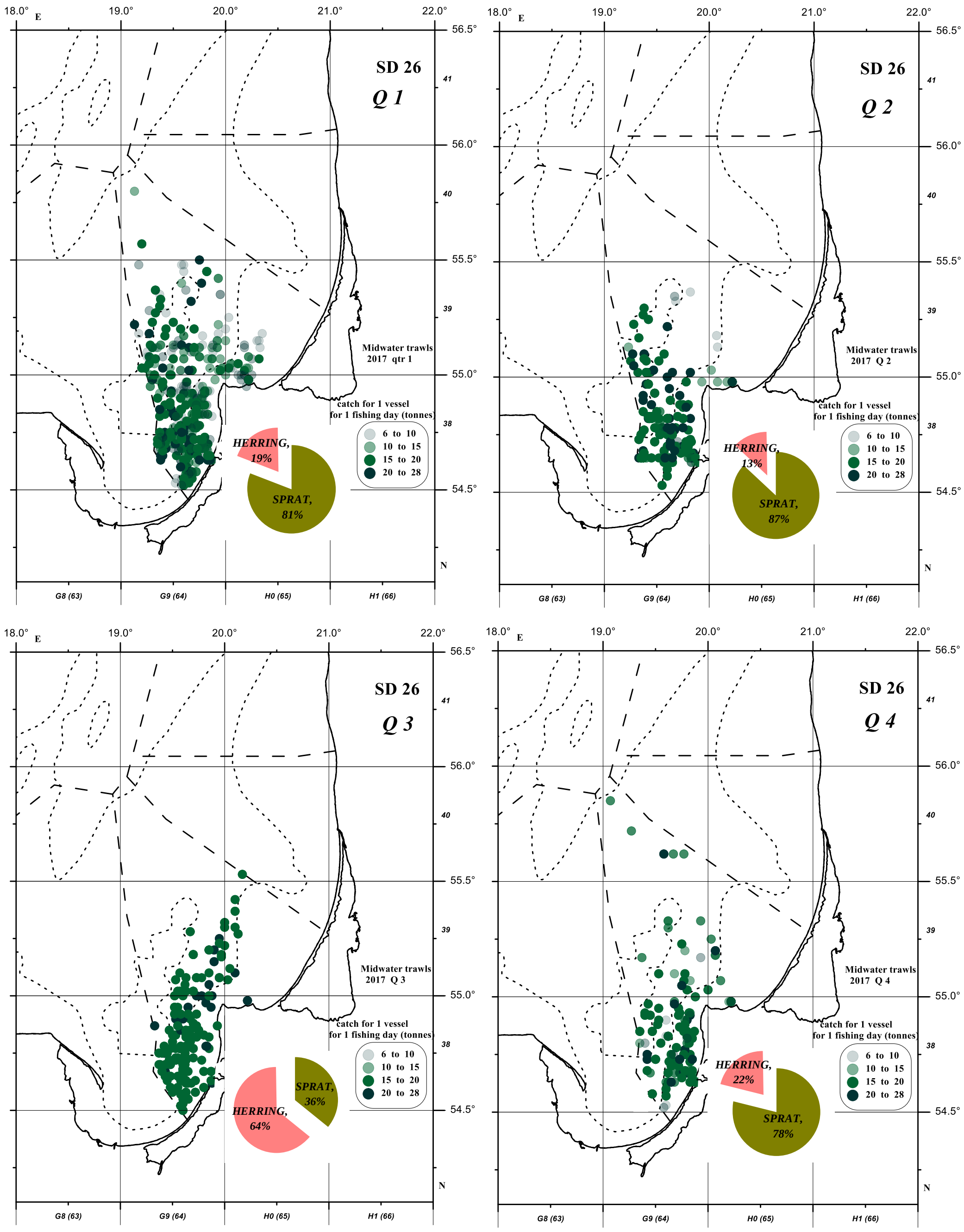


Figure 1.3. SD 26. Russian midwater trawls by quarter in 2017. Effort in catch for 1 vessel for 1 fishing day (tonnes).

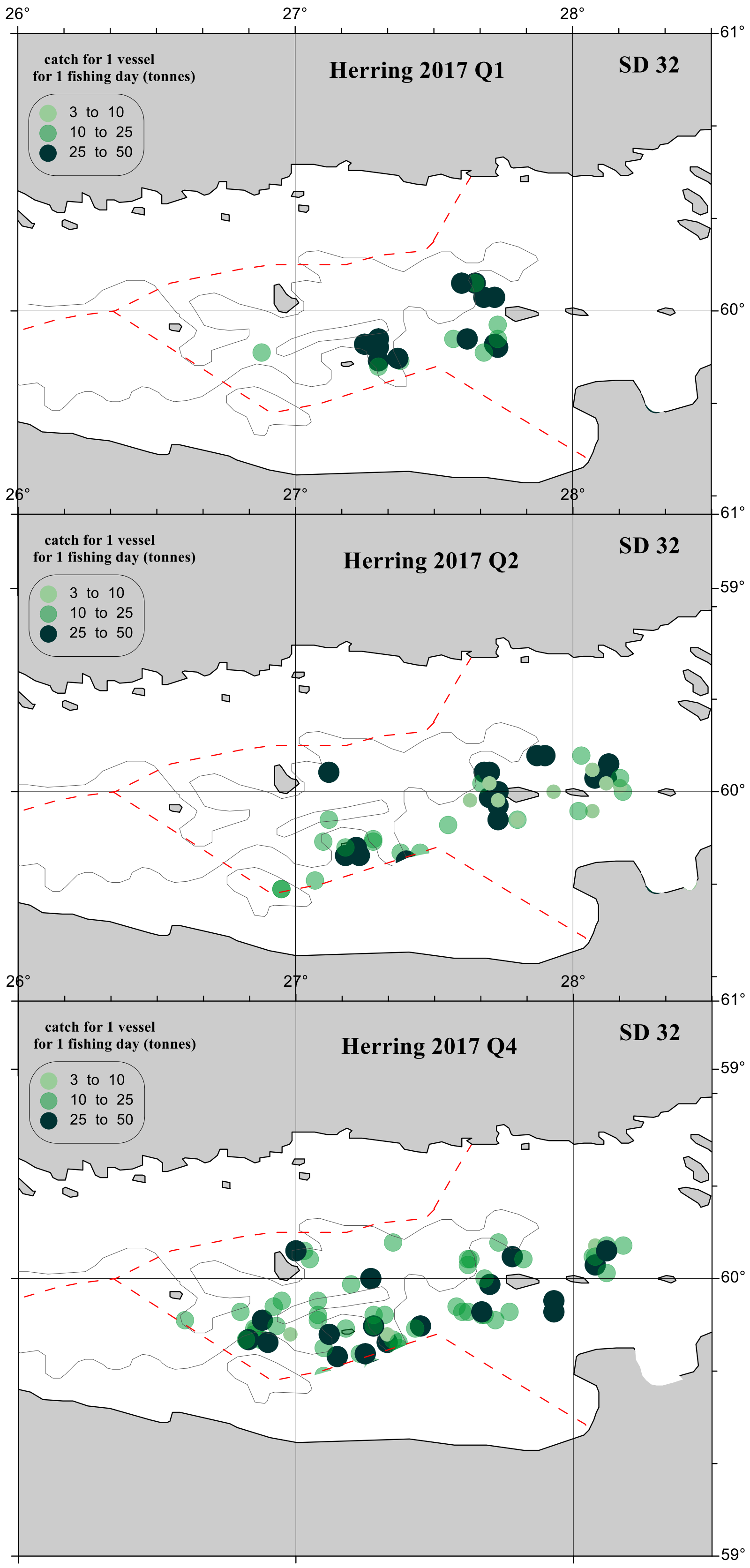


Figure 1.4. SD 32. Russian midwater trawls by quarter in 2017. Effort in herring catch for 1 vessel for 1 fishing day (tonnes).

1.2.1.1.9 SWEDEN

Mixed fisheries: Swedish sampling program of herring and sprat and species misreporting

Background

In November 2017 DG Mare sent a special advice request to ICES regarding mixed fisheries and stocks in the Baltic. As the request specifies “mixed fisheries considerations are important for the decision process for fishing opportunities as well as the development and implementation of regional multi annual plans (MAPs)”. ICES is therefore requested to further develop their ongoing work on mixed fisheries advice, by increasing the number of stocks included in the Celtic Sea mixed fisheries consideration and develop mixed-fisheries considerations for pelagic stock in the Baltic Sea, namely herring and sprat.

As part of this request ICES is asked to describe the mixed sprat and herring fisheries in the Baltic Sea and to develop a mixed fisheries model for these fisheries. To meet these requirements ICES decided that a data call should be issued to all Baltic countries to get an understanding of the degree of mixing. In preparation for the formulation of this data call, an overview of the sampling scheme and description of the fishery should be produced by each country. This working document therefore summarizes the Swedish fishery, sampling program and available data.

The production of mixed fisheries advice requires reliable data on levels of mixing. In Sweden reliable data on the mixing of herring and sprat are missing. Both the control agency and the industry state that there is a systematic misreporting of herring and sprat made in the logbooks and landing declarations. There is no onboard sampling to verify the reported landings with the catch. The control agency in both Denmark and Sweden undertake inspections of Swedish landings however, and make corrections to the landings accordingly when deducting from the Swedish quota. The number of trips inspected however, are few compared to the total number during the year. For a few (so far unknown number of) years Sweden has corrected logbook data for input into the assessment based on a “known” species composition from the BIAS survey (WKPELA 2013). This correction stopped three years ago due to the lack of appropriate data. The second part of this working document presents some preliminary analyses of Swedish and Danish control data from 2017 undertaken to get a perception on the extent of the current problems of misreporting.

Swedish logbook information

The Swedish logbook for fishing information conforms to the EU fishing logbook. It also provides information on hauls, positions, effort and applied gear on a more detailed basis. The estimation of effort for pair trawling boats is not entirely straightforward from the logbook data provided to SLU Aqua. However, methods to approximate effort are developed and used yearly in the reporting of effort to STECF.

Swedish sampling of herring and sprat

Table 1.13. Summary of Swedish sampling of herring and sprat.

	SD	Gear	Origin	Sampling interval	Variables measured
Her	24	Midwater trawl	Fisheries	Quarterly in Q1 and Q4	Length, weight, sex, maturity, age
Spr	24	Midwater trawl	Fisheries	*Quarterly in Q1 and Q4	Length, weight, sex, **maturity, age
Her	25-29, 32	Midwater trawl	Fisheries	Quarterly/SD	Length, weight, sex, maturity, age
Spr	25-29, 32	Midwater trawl	Fisheries	Quarterly/SD	Length, weight, sex, **maturity, age
Her	30	Her trawls	Fisheries	Monthly/SD	Length
Her	30-31	Gillnets	Fisheries	Monthly/SD in Q2-3	Length, weight, sex, maturity, age
Her	31	Bottom trawl***	Fisheries	3 times during 5 weeks in Q3-4	Length, weight, sex, maturity, age
Her	25-29, 30	Midwater trawl	BIAS survey	Q4	Length, weight, sex, maturity, age
Spr	25-29, 30	Midwater trawl	BIAS survey	Q4	Length, weight, sex, age

*In SD24 number of sprat sampled are usually very low
**Maturity for sprat is collected in Q1-2
***Seasonal fishery for vendace

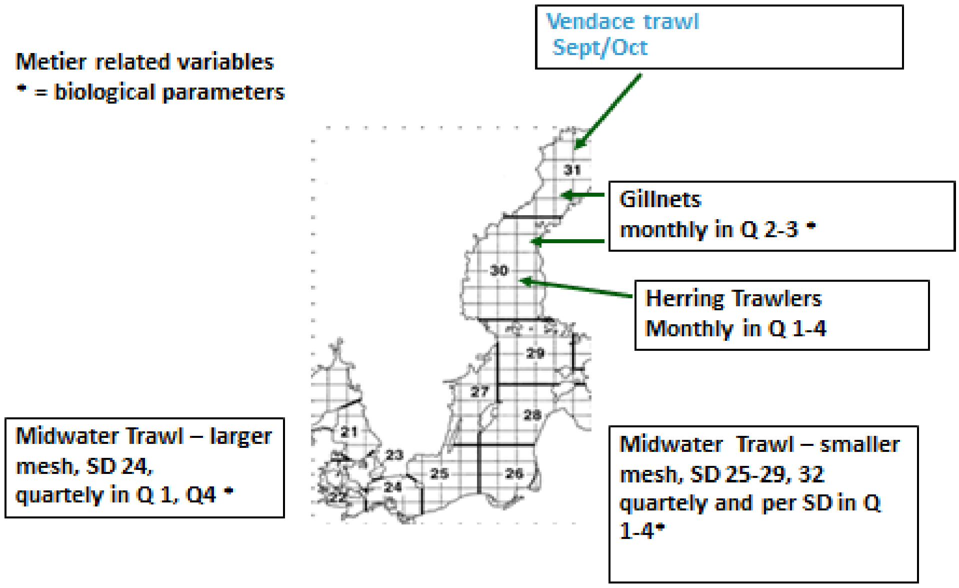


Figure 1.5. Sampling of commercial landings of herring and sprat in Sweden. For all, métier related variables (length distributions and total weights) are generally measured, for those with a *, also biological parameters (age, weight, sex ratio and maturity) are collected.

Fishery and sampling in SD 22–24

Trawl fisheries targeting small pelagic fish (mainly PTM_SPF_32_104_0_0)

In 2017 the total annual landing from the métier was 2443 tonnes. The landings constitutes exclusively (>96%) of the target species herring and sprat (89 and 6%, respectively according to the logbooks). The majority of the landings are for human consumption but there are also landings for industrial purposes. Discard rates are estimated to be below 10%. The fisheries are conducted all year around but are less intense during summer. The fishery is nationally managed by transferable individual quotas, limiting the allowed landing by vessel. The majority of the catches (84% in 2008) is taken by pair trawlers using a mesh size of 32–104 mm. However, to some extent other trawls and mesh sizes are used within the fisheries. The métiers PTM_SPF_16-31_0_0, PTM_SPF_32-104_0_0, OTM_SPF_32-6104_0_0, OTM_SPF_16-31_0_0, OTB_SPF_32-104_0_0 and OTB_SPF_16-31_0_0 are thereby merged.

Sampling

The métier was included in the sea sampling programme 1996–2001. The métier is sampled concurrently in harbours/at markets by purchasing unsorted samples. Sampling is stratified by quarter and Subdivision. The assumption for the planned number of trips is that the fishery is conducted in quarter 1 and 4 in SD 24. There is no Swedish sampling of herring or sprat in SD 22–23.

For western Baltic herring (SD 24), main basin herring (SD 25–29), and sprat (IIIb-d) individuals are collected from randomly selected fishing vessels. Samples of about 10 kg are purchased from different landing ports (Simrishamn, Nogersund, Västervik and Rånehamn on Gotland). From this sample, 50 to 100 individuals are collected randomly from about 6 – 10 kg of landed fish. All samples are transported to SLU for analysis. Information on age, length, weight, sex and gonadal maturity is collected routinely from each individual sampled. The samples are too small to provide information on the species composition of the catch.

Derogations

Set gillnet fisheries targeting small pelagic fish (GNS_SPF_32-109_0_0)
A gillnet fishery targeting herring is carried out in SD 23 during the second part of the year. In 2017 the total landing from the métier was 356 tonnes. The landings consist of more than 99 % of herring. Discard rate is assumed to be low. The métier is picked only due to effort. Catch composition is achieved through logbooks and monthly fishing journals. It is not considered cost-effective to sample this fishery and Sweden thereby asks for derogation.

Fishery and sampling in SD 25-29, 32

Trawl fisheries targeting small pelagic fish (mainly PTM_SPF_16_31_0_0)
In 2017 the total annual landing from the métier was 89 585 tonnes. The landings constitutes exclusively (>99%) of the target species herring and sprat (53 and 47%, respectively according to the logbooks). The majority of the landings are for industrial purposes, in which herring is caught as a bycatch, but there are also landings for human consumption. Discard rates are estimated to be below 10 %. The fisheries are conducted all year around but are much less intense during summer. The fishery is nationally managed by transferable individual quotas, limiting the allowed landing by vessel. The majority of the catches (759% in 2017) were taken by midwater trawlers using a mesh size of 16–31, and 10–104 mm. However, to some extent other trawls and mesh sizes are used within the fisheries. The métiers PTM_SPF_16-31_0_0, PTM_SPF_16-104_0_0, PTM_SPF_32-104_0_0, OTM_SPF_32-104_0_0, OTM_SPF_16-31_0_0, OTM_SPF_16-104_0, OTB_SPF_32-104_0_0, OTB_SPF_16-104_0_0, OTB_SPF_16-31_0_0, PTB_SPF_32-104_0_0 and PS_SPF_32-104_0_0 are thereby merged.

Sampling
The métier was included in the sea sampling programme 1996-2001. The métier is sampled concurrently in harbours/at marketed by purchasing unsorted samples. The sampling is stratified by quarter and Subdivision. The assumption for the planned number of trip is that the fishery is conducted all year around in all the main SDs (25-29).

For western Baltic herring (SD 24), main basin herring (SD 25-29), and sprat (IIIb-d) individuals are collected from randomly selected fishing vessels. Samples of about 10 kg are purchased purchased from different landing ports (Simrishamn, Nogersund, Västervik and Rånehamn on Gotland). Individuals of different species used to be separated and information on total weight per species recorded. Such recordings are not taken anymore. From this sample, 50 to 100 individuals are collected randomly from about 6 – 10 kg of landed fish. All samples are transported to SLU for analysis. Information on age, length, weight, and sex is collected routinely from each individual sampled. Gonadal maturity is recorded for all individuals of herring, while for sprat maturity is collected in 1st and 2nd quarter due to the typical spawning activity of Baltic sprat in the 2nd quarter. The samples are too small to provide information on the species composition of the catch.

During the Baltic International Acoustic Survey (covering SD 25, 27, 28, 29, 30) conducted in the 4th quarter, information on age, length, and sex are collected for both herring and sprat. Maturity is collected only for herring during the survey. During the time period of the survey the species composition can be estimated in time and space.

Derogations

Set gillnet fisheries targeting small pelagic fish (GNS_SPF_32-109_0_0)
A small scale gillnet fishery targeting herring is carried out in SD 25–29. In 2017 the total landing from the métier was 12 tonnes. The landings consist of more than 99% of herring. Discard rate is assumed to be low. The métier was picked only due to effort. Catch composition is achieved through logbooks and monthly fishing journals. It is not considered cost-effective to sample this fishery and Sweden thereby asks for derogation.

Fishery and sampling in SD 30-31

Trawl fisheries targeting small pelagic fish (mainly PTM_SPF_16_31_0_0)
The herring stock in subdivisions 30–31 is mainly exploited by the Finnish trawl fishery (95% of the landings). In 2017 the total landing from the métier was 10 180 tonnes. The landings consist of more than 99% of herring. The main fishing season on trawl fisheries targeting herring for human consumption is in quarter 2, but some fishing takes place throughout the year. The fishery is concentrated to SD 30, where most of the landings are normally taken. The estimated amount of bycatch is low, as evident from previous sampling within this métier.

Set gillnet targeting small pelagic fish (GNS_SPF_<110_0_0)
A small-scale gillnet fishery targeting herring (*Clupea harengus*) for human consumption is conducted in near-shore areas. The major proportion of the fishery is conducted in SD 30 and 31. The fishery mainly takes place during the peak reproductive period of herring in the spring and in some cases also during a second reproductive peak in the autumn. Landings are recorded in monthly fishing journals, which provide information of species composition and weight by species. In 2017 the total landing from the métier was 613 tonnes. The landings consist of more than 99% of herring. The amount of bycatch is estimated as low. The métier was selected due to high effort.

Sampling
For herring from SD 30–31 samples are collected by purchasing a random sample of about 20 kg of the unsorted catch, including bycatches and discard, directly from the fishing vessel. Because of restricting weather conditions for trawling in quarter 1, trawl fishing might be limited in quarter 1. Similarly, because of restricting weather conditions for gill net fishing in quarters 1 and 4, sampling of gill nets is restricted to quarters 2 and 3. Samples are taken from three different vessels in each quarter (1–4) from trawls and in quarters 2–3 from gill nets. Samples are analyzed by staff at ICR

in Öregrund. The catch is sorted and weighted by species and commercial category, and the lengths of all individuals are registered.

For herring from SD 30 and SD 31, stock specific data on age, weight, sex, and maturity is collected from two sources, the Swedish sampling from herring gillnets (SD 30 and 31), the Baltic International Acoustic Survey (SD 30; 4th quarter).

Sampling for stock specific data from Swedish catches in herring gillnets amount to 400 individuals per stock (SD 30 and 31), collected in quarters 2 and3. The samples are collected by length stratification using 20 individuals per half centimeter. Sweden and Finland apply task sharing for sampling this stock so that Sweden is sampling 3100 individuals in total, *ca*. 1500 from the BIAS and 1600 from the commercial gillnets.

Trawl fisheries targeting vendace (PTB_FWS_0_0_0)
A seasonal small-meshed trawl fishery with small-sized pair-trawlers is conducted in SD 31 (Bothnian Bay). The fishery occurs within the Swedish territorial zone and is nationally regulated by effort (license permits), area closures and technical measures (selective grids). The fishery is only allowed during six weeks each autumn. Target species is vendace (*Coregonus albula*), which primarily is fished for the roe. In 2016 the total landing from the métier was 1457 tonnes. The overall landing consisted of ~80% vendace. The major bycatch consists of herring (*Clupea harengus*) (17% in weight) but minor catches of whitefish (*Coregonus lavaretus*) and other fresh-water species are common. Catches including bycatches are landed unsorted and recorded by census methods (logbooks and specific fishing journals). The métier was selected due to high economical value.

Sampling
Self-sampling of the catches occur after each fishing day at which juvenile and mature vendace are counted, as well as bycatch species.

Unsorted samples (10 liters) are also taken by authorities of the catch in 5 areas 3 times during the fishing season (first, third and fifth week). All species are sorted and individuals are length measured. A sample of 65–70 vendace individuals is taken from the sample for which weight, age and maturity information is collected.

Preliminary results of inspection reports
This part of the report is not completed for distribution yet.

1.2.1.2 Further development of ICES mixed fisheries considerations

ToR g) Identify possible data gaps and draft a proposal for a data call to address these gaps.
Prepare the data calls for the next year update assessment and for the planned data evaluation workshops.

GENERAL

In November 2017, DG Mare sent a special advice request to ICES regarding mixed fisheries and stocks in the Baltic. As the request specifies "mixed fisheries considerations are important for the decision process for fishing opportunities as well as the development and implementation of regional multi annual plans (MAPs)". ICES is therefore requested to further develop their ongoing work on mixed fisheries advice, by increasing the number of stocks included in the Celtic Sea mixed fisheries consideration and develop mixed-fisheries considerations for pelagic stock in the Baltic Sea, namely herring and sprat.

As part of this request ICES is asked to describe the mixed sprat and herring fisheries in the Baltic Sea and to develop a mixed fisheries model for these fisheries. To meet these requirements ICES decided that a data call should be issued to all Baltic countries to get an understanding of the degree of mixing. In preparation for the formulation of this data call, an overview of the sampling scheme and description of the fishery should be produced by each country. This section therefore summarises the different countries fishery, sampling program and available data, which is given in detail by country in section 1.2.1.1.

Poland

Fishery

Vessels with size between 12–35 m length (mainly offshore fisheries). The larger vessels (>18.5 m) use mainly pelagic trawls (OTM, PTM) for fishing sprat and herring, destined for both human consumption and industrial purposes. Sprat dominating by weight in landings since 1997. Cutters with the length ranged from 20 to 27 m and very limited by number larger vessels (up to 35 m) are involved in the pelagic catches of sprat (partly mixed with herring and to some extent with cod) for both, human consumption and the industrial purposes.

In the period of 2015–2017, 89.5% of annual herring catches were designated for human consumption and 10.5% for industrial purposes.

The Polish total annual actual landings of sprat (bycatch of herring excluded) in the recent three years was 62 228.6, 59 257.8 and 68 430.3 tonnes, respectively. The by-catch of herring in the Polish nominal landings of sprat in 2015–2017 was 1944.1, 1219.9 and 1541.2 tonnes, successively. In the above-mentioned years the mean share (by weight) of herring in the Polish annual catches of Baltic sprat was 3.0; 2.0 and 2.2%, respectively.

Possible misreporting

The main tools to estimate the official landing statistics in Poland are logbooks (in paper and electronic format) and sales slips.

The species misreporting may occur in the Polish pelagic fishery. Misreporting is mostly among industrial sprat trawl fishery. Only a part of this type of fishery is temporary monitored by the NMFRI (Gdynia) scientific observers, in consequence the data about herring bycatch in sprat fishery are limited in time and area. Sampling may be insufficient in a case of far areas (ICES subdivisions 27, 28, 29) and for cutters not entering the Polish ports for the longer time.

Clupeids landings for industrial purposes are mixed catches, using trawl with sprat codend mesh size, and are not sorted by species. These landings are done as industrial sprat and noted in logbook under the sprat species. Only in few logbooks, shares of herring and sprat are estimated.

Results of sampling are used to correct official landings on the ICES Subdivision and quarter level.

Latvia

Fishery

In Latvia the TAC for pelagic species is utilized above 90% and in some years is fully utilized. In 2017 the catches taken in the economic zones of other EU countries was below 10%.

In the Baltic Proper the pelagic fishes are mainly caught by pelagic trawls and this is mainly sprat directed fishery with some bycatch of herring. In the Gulf of Riga there are two main fisheries – herring directed trawl fishery in which some bycatch of sprat is possible and trap-net fishery in the coastal zone which has only herring catches. The proportion of latter is around 15–20% from the total herring catches in the Gulf of Riga.

The major part of the landings is used for human consumption although the utilization of pelagic fishes for industrial purposes has increased in recent years.

There is in place regular check of pelagic landings by control inspection that estimates the proportion of herring and sprat in the landings and compares it with the records in the logbooks. In frames of Fisheries Data Collection Program Institute of Food Safety, Animal Health and Environment BIOR performs monthly random onboard sampling of pelagic fisheries in the Baltic Proper where mainly sprat targeted fishery takes place. During sampling the proportion of herring and sprat is estimated in the catches and biological samples of both species are taken.

Possible misreporting

The proportion of herring and sprat in trawl fishery that is estimated in onboard sampling is similar to the proportion of the total landings of these two species. All fishermen who perform pelagic fishery have quotas for both species thus misreporting by species could be possible only when quota for one of the species is utilized.

No information if results of sampling are used to correct official landings on the ICES Subdivision and quarter level.

Germany

Fishery

The German herring fisheries mostly followed the corresponding TAC/quota system, where the fishing fleet tried to compensate quota restrictions of herring by means of quota transfer with other countries around the Baltic Sea.

The main fleet is a cutter fleet with total lengths between 12 m and 40 m. The fishing is mainly carried out with pelagic trawls (pair trawlers) catching herring (minimum mesh-size >32 mm in SDs 22–27 and >16 mm in SDs 28–32) and sprat (minimum mesh-size >16 mm).

Catches and landings are monitored at sea, by control vessels of the federal and state governments of Schleswig-Holstein and Mecklenburg-Vorpommern (fishery board, customs, marine police) In harbors, the control is carried out by the port control of the state fishery board (13 check points along the Baltic coast) and by the fishmaster. All catches taken with gillnet and trapnet are exclusively catching herring with no bycatch of sprat. The landings in the herring fishery are mainly taken in SD 24 (2014–2016), but there is some spatial overlap with the fishing activities for sprat, which is mainly conducted in SDs 25–26 and 28–29.

Information on the German fishery is derived from sales slips and logbooks. This information is sent to the fishery department of the corresponding federal states (countries). After checking the reported catch and landing data, they are forwarded to the national state authority (Federal Centre for Agriculture and Food, BLE).

Possible misreporting

The logbooks are cross-checked and, when necessary, corrected by the BLE using information from the corresponding sales slips. Landing data based on sales slips are fairly reliable because it is based on the sorting and weighing process carried out in the factories with standardized equipment. The product weight is also used for cross-checking, by applying a correction factor, to get an estimate of the original landing figure. The quota is charged for the final landing species composition of a trip.

The German quota for herring and sprat from the Baltic was almost fully taken during the last years. This may have resulted in incentives for misreporting. However, the low spatial overlap of the herring and sprat fishery - where herring is mainly caught in SD 24 and sprat in SDs 25–26 and 28–29 - is not supporting the incentives of misreporting on a larger scale.

The scientific self-sampling program for sprat, which covers the two major pelagic trawlers catching herring and sprat in SDs 25–29, involves 1 unsorted catch sample (5 kg) per trip since their entire catches are landed abroad. However, the analysis of species composition of these sampled sprat landings, which contained only a minor proportion of herring, suggests that no correction of the official landings statistics of sprat is needed.

Since most herring landings are used for human consumption, the trawl fishery intends to catch pure samples of herring with minor bycatch of sprat. This also guarantees the highest landing prices.

Sweden

Fishery

The Swedish logbook for fishing information conforms to the EU fishing logbook. It also provides information on hauls, positions, effort and applied gear on a more detailed basis.

In 2017 the total annual landing from the metier was 2 443 tonnes. The landings constitutes exclusively (>96%) of the target species herring and sprat (89 and 6%, respectively according to the logbooks). The majority of the landings are for human consumption but there are also landings for industrial purposes. The fishery is nationally managed by transferable individual quotas, limiting the allowed landing by vessel.

A gillnet fishery targeting herring is carried out in SD 23 and in 2017 the total landing from this métier was 356 tonnes. The landings consist of more than 99% of herring. Discard rate is assumed to be low. Catch composition is achieved through logbooks and monthly fishing journals. It is not considered cost-effective to sample this fishery and Sweden thereby asks for derogation.

In 2017 the total annual landing from the metier was 89 585 tonnes. The landings constitutes exclusively (>99%) of the target species herring and sprat (53 and 47%, respectively according to the logbooks). The majority of the landings are for industrial purposes, in which herring is caught as a bycatch, but there are also landings for human consumption. Discard rates are estimated to be below 10%. The fisheries are conducted all year around but are much less intense during summer. The fishery is nationally managed by transferable individual quotas, limiting the allowed landing by vessel. The majority of the catches (79% in 2017) were taken by midwater trawlers using a mesh size of 16–31, and 10–104 mm. However, to some extent other trawls and mesh sizes are used within the fisheries.

Sampling

For herring and sprat from SD 22–32 except SD 30–31, the metier was included in the sea sampling programme 1996–2001. The metier is sampled concurrently in harbours/at marketed by purchasing unsorted samples. The sampling is stratified by quarter and Subdivision. The assumption for the planned number of trip is that the fishery is conducted all year around in all the main SDs (25–29). All samples are transported to SLU for analysis. Information on age, length, weight, and sex is collected routinely from each individual sampled. Gonadal maturity is recorded for all individuals of herring, while for sprat maturity is collected in 1st and 2nd quarter due to the typical spawning activity of Baltic sprat in the 2nd quarter. The samples are too small to provide information on the species composition of the catch.

For herring from SD 30–31 samples are collected by purchasing a random sample of about 20 kg of the unsorted catch, including bycatches and discard, directly from the fishing vessel. Samples are taken from three different vessels in each quarter (1–4) from trawls and in quarters 2–3 from gill nets. Samples are analyzed in Öregrund.

A seasonal small-meshed trawl fishery targeting vendace (*Coregonus albula*) with small-sized pair-trawlers is conducted in SD 31 (Bothnian Bay). The fishery occurs within the Swedish territorial zone and is nationally regulated by effort (license permits), area closures and technical measures (selective grids). The fishery is only allowed during six weeks each autumn. The overall landing consisted of ~80% vendace. The major bycatch consists of herring (*Clupea harengus*) (17% in weight) but minor catches of whitefish (*Coregonus lavaretus*) and other fresh-water species are common. Catches including bycatches are landed unsorted and recorded by census methods (logbooks and specific fishing journals). Self-sampling of the catches occur after each fishing day at which juvenile and mature vendace are counted, as well as bycatch species. Unsorted samples (10 liters) are also taken by authorities of the catch in 5 areas 3 times during the fishing season (first, third and fifth week).

Possible misreporting

No description available.

Finland

Fishery

The Finnish offshore fleet comprises of around 60 vessels between 12–40 m in the Baltic Sea main basin, the Archipelago Sea, the Gulf of Bothnia and the Gulf of Finland. The main target is Baltic herring stocks (with sprat taken usually as bycatch) with pelagic trawls.

The catch statistics in Finland is based on logbooks. The catches are reported to coastal Centres for Economic Development, Transport and the Environment (ELY-Centres), who are also responsible for the monitoring of the catch compositions. These catches are not, however, monitored regularly, but only occasionally, and in cases when there is some reason to suspect misreporting. Intentional misreporting has not been shown to be a common phenomenon, and misreporting as such is not considered to be a problem in the Finnish fisheries.

The species composition in catches varies between subdivisions with the share of sprat being highest in the Gulf of Finland (SD 32), and lowest in the Bothnian bay (SD 31). Most of the Finnish herring catches (70–75%) are fished from the Bothnian Sea (SD 30) when there are low bycatches of sprat (on average 22 %). In SD 30 the share of sprat in annual catches has been 4% on average. The annual share of pelagic catches in the Finnish fishery from SD’s 25–28 is only a few per cents at its highest, and therefore they are not considered here.

Possible misreporting

The Finnish sprat quota is only 5.87% of the Baltic sprat TAC, which has caused restrictions to trawl fishery in SD’s 29 and 32 in recent years, in order to help fully utilize the SD 30 herring quota.

Estonia

Fishery

The Estonian fishing fleet in the Baltic consists of two parts: Coastal fleet with vessels ≤ 10 m and engine power ≤ 100 HP. The fishing is mostly conducted with passive gears (gillnet and trapnet, which are exclusively catching herring. Trawlers with total lengths between 12 m and 40 m fishing is mainly carried out with pelagic trawls (single or pair trawlers) catching herring mixture of herring and sprat (minimum mesh-size 17–20 mm). On average, 25% of herring catches was taken with coastal fixed gears and 75% with trawls in 2015–2017.

Most herring catches originated from SD 28.1 (40–52%), and from SD 32 (26%) in 2015–2017. Sprat catches have shown slight increase in 2017 compared to two previous years due to increase in TAC.

Possible misreporting

No discarding takes place in Estonian herring and sprat fishery. All catches taken with gillnet and trapnet are exclusively catching herring with no bycatch of sprat.

Some misreporting can occur in trawl fishery only (with exception of the Gulf of Riga (SD 28.1) where there is a very low abundance of sprat.

The logbooks information are cross-checked and, when necessary, corrected on the basis of information from fisheries inspectors and the corresponding sales slips. Landing data based on sales slips are fairly reliable because it is based on the sorting and weighing process carried out in the factories with standardized equipment.

The scientific sampling program for herring and sprat, which covers the all pelagic trawlers, (randomly chosen) catching herring and sprat and covers the unsorted catch sample (10 kg) per trip. Altogether about 3–5 trips are sampled per month and SD.

The logbook information is cross-checked and, when necessary, corrected on the basis of information from fisheries inspectors and the corresponding sales slips. Landing data based on sales slips are fairly reliable because it is based on the sorting and weighing process carried out in the factories with standardized equipment.

Denmark

Fishery

The logbooks from the directed herring fishery in the Baltic show that more than 80% of the trips are catching herring without any bycatch of sprat. Denmark has presently a high utilization of the sprat quota however. Of the 271 Danish trips registered in the Baltic in 2015 with more than 70% herring in the logbook, 20% had registered sprat in the logbook accounting to 9% of the total catch in the directed herring fishery. In 2016 in the directed herring fishery, 18% of the trips had registered sprat in the logbook accounting for 4% of the total catch.

All though herring and sprat is fished within the same area there is a tendency towards more sprat caught in the northern part of the Baltic and a large part of the herring caught close to Bornholm in SD 23–25.

In 2015 and 2016, close to 95% of the Danish sprat quota was fished in the Baltic and in 2015, 86% of the Danish herring quota was utilized in the western Baltic (SD 22–24) and 14% in eastern Baltic (SD 25–32). In 2016 this picture changed and a larger part of the Danish herring quotas were utilized. For herring 92% of the Danish quota was utilized in the western Baltic (SD 22–24) and 90% eastern Baltic (SD 25–32).

The calculation of bycatches is only done on fishery for correction of the species composition in the catch according to biological samples collected in the harbors. Landings are reported with precise quantities for all species. To determine the quantities, both the logbooks and the sales notes are used. The logbooks contain information on ICES-rectangles, whereas the sales notes contain information on the sold species.

The procedure is basically divided in two.

1. Firstly, a species distribution is calculated for each ICES rectangle using a 9 square technique on all available samples. The species distribution is used to calculate the bycatches.

2. This figure is adjusted with figures from the sales notes on fishery. In this calculation, the Baltic Sea is divided in the Eastern and Western Baltic Sea.

Possible misreporting
The procedure above adjusts landings declarations but don't include all catches.

Lithuania

Fishery
The Lithuania fishing fleet in the Baltic consists of two parts: coastal fleet with boats ≤ 8 m and small vessels 12–15 m). A small pelagic fishery is conducted with passive gears (gillnets and trapnets), which are exclusively catching herring. Trawlers with total lengths between 24 m and 40 m. which are mainly fishing exclusively on herring or sprat or mixture of both in different proportions (mesh-size varies from 16 to 32 mm). Nearly 60% of herring and 52% of sprat are caught by OTM. Landings of herring and sprat from demersal fishery (OTB) come as a bycatch. Only 28% of herring and 12% of sprat are used for human consumption. The major part of the landings is utilized for industrial purposes (fishmeal).
Information on the Lithuanian fishery is derived from logbooks and sales slips. The data includes information on fishing effort, monitoring system, sales, catches, etc. In the Baltic region, Lithuanian fishing both vessel groups below and above 8 m are obliged to fill in a logbook.
Catches and landings of trawlers are permanently monitored (incl. the species composition), in all landing harbors by inspectors of Fisheries Service. This information is compared with the logbooks. The logbooks information is cross-checked and, when necessary, corrected on the basis of information from fisheries inspectors and the corresponding sales slips.

Possible misreporting
NA

Russia

Fishery
The main fleet operates mainly within 12-NM limit over the year. The main fleet, targeting sprat for the human consumption, during I-IV quarters, has on average bycatches of herring between 13 – 64% in SD 26. Russia utilized their sprat (in 26 SD) and herring (in SD 26+32) quotas 90.8% and 75.7% respectively. There is a fishery in the Vistula Lagoon (SD 26) and this fishery is targeting herring. The herring catch in this area was about 12% in 2017 compared to the total Russian catch (SD 26+32). There are vessels that operates in SD32 which are orientated to herring. The herring catch in SD 32 from the total Russian catch (SD 26+32) in 2017 was about 39%.

Possible misreporting
NA

RECOMMENDATIONS/COMMENTS/CONCLUSIONS

Sampling pelagic catches are extremely difficult. The reason is the often large catches and the fact that different species and sizes of fish are separated in different layers in the storage tanks. Hence, a representative sample is difficult to retrieve.

The different countries control of the pelagic fishery is very different. What is also clear is that there are differences between how countries use the control information, if it shows a disparity compared to the logbook, to correct the national landing statistics. This fact suggests that a common approach should be developed that describes how landing statistics should be corrected.

Most biologists from countries around the Baltic have an impression that there is no problem with the landing statistics for sprat and herring even though some acknowledge that there might be a problem. In contrast, Swedish biologists suggest that there is probably a problem with species misreporting. The biologists from Sweden have access to the data from the Swedish fishery control which strengthens the view that there is a problem with species misreporting. It is unclear if biologists from other countries have access to fishery control data. Danish control agencies adjust the misreporting for Danish landings, the misreporting can at times be substantial. The fact that most countries utilize their quota of sprat and herring countries almost to 100% year after year even though the stock development for sprat and herring has changed dramatically suggests that there are instances with species misreporting. The European fisheries control agency has controlled pelagic landings in the Baltic, which suggests that there exists independent data that could confirm if there is a problem with species misreporting, but as far as we have understood, this information is not publicly available. We suggest that this data should be made public and available to the WG.

1.2.1.2.1 Request on the role of TACs

ICES is requested to analyse for a list of stocks (as specified below) the role of the Total Allowable Catch instrument. It is asked to assess the risks of removing TAC for each case analysed in light of the requirement to ensure that the stock concerned remains within safe biological limits in the short and middle term. ICES is further requested to assess the potential contribution of the application of other conservation tools in absence of TACs to the requirement that the stock concerned remains within safe biological limits.
In cases where the uses of TAC should be continued, ICES is asked to analyse a possible approach to contribute to inter-annual stability of TACs.

The qualitative evaluation of the risk of having no TAC was based on evaluating the following six questions:

(1) Was the TAC restrictive in the past?
(2) Is there a targeted fishery for the stock or are the species mainly discarded?
(3) Is the stock of large economic importance or are the species of high value?
(4) How are the most important fisheries for the stock managed?
(5) What are the fishing effort and stock trends over time?
(6) What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

Stocks covered by the WGBFAS:

- Cod in Kattegat
- Plaice in 21–23
- Plaice 24–32

1.2.1.2.2 Cod In Kattegat

Was the TAC restrictive in the past?
The Kattegat cod TAC has been restrictive in most years since 1999 as the TAC has been low since the collapse of the cod stock in the late 1999 (Figure 1.6). The low TAC dramatically changed the exploitation pattern of cod. Historically there was a large fishery in the first quarter targeting spawning aggregations of cod in the southeast

Kattegat. Since the early 2000 the low quotas followed by a zero catch advice from ICES (Tables 1.14 and 1.15) the targeted spawning fishery has decreased and the catches of cod has mainly been as bycatch and discard (Figure 1.7) in trawl fishery targeting Norway lobster (*Nephrops norvegicus)* and trawl fishery targeting Sole (*Solea solea*).

The mixed fishery problem has forced the fishing fleet to adapt to selective gears with low (SELTRA) and no catches of cod (Sorting grid). The high uptake of selective gears in the fishing fleet would not have been achieved without the restraining quotas of Kattegat cod. However, in order to further protect the collapsed cod stock, additional measures was introduced.In 2009, Denmark and Sweden, introduced protected areas on historically important spawning grounds in South East Kattegat. The protected zone consists of three different areas in which the fisheries are either completely forbidden or limited to certain selective gears (Sorting grid and Danish SELTRA) during all or different periods of the year.

Table 1.14. Kattegat cod landings, TAC and % utilization of the TAC in 1999–2017.

Year	Landings	TAC	% utilized
1999	6608	6300	1.05
2000	4897	7000	0.70
2001	3960	6200	0.64
2002	2470	2800	0.88
2003	2045	2300	0.89
2004	1403	1363	1.03
2005	1070	1000	1.07
2006	876	850	1.03
2007	645	731	0.88
2008	449	673	0.67
2009	197	505	0.39
2010	155	379	0.41
2011	145	190	0.76
2012	94	133	0.71
2013	92	100	0.92
2014	108	100	1.08
2015	106	100	1.06
2016	299	370	0.81
2017	293	525	0.55

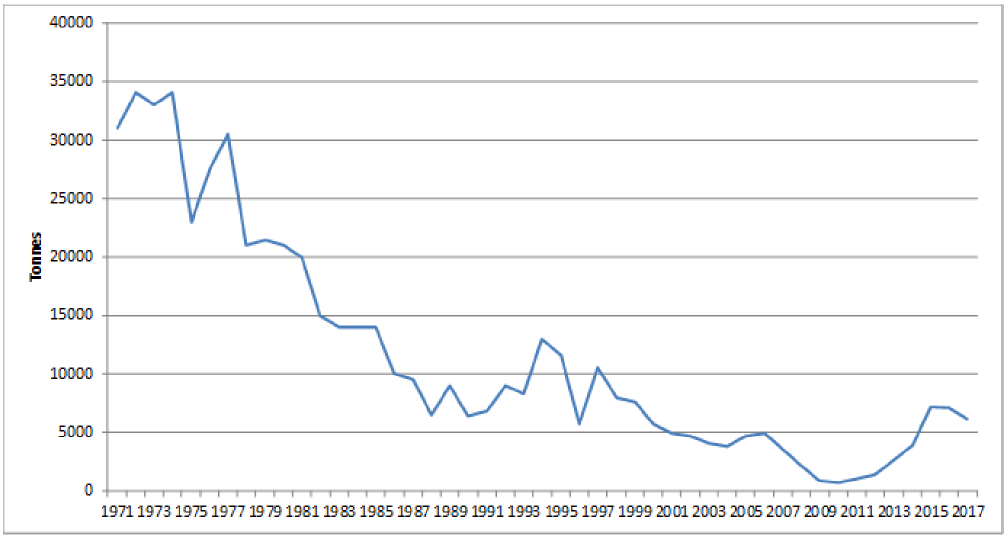


Figure 1.6. Spawning stock biomass (SSB) of Kattegat cod in 1971–2017.

Table 1.15. ICES Advice; corresponding Total Allowable Catch (TAC) and reported catches in 1999–2017

Year	Ices Advice (t)	TAC (t)	Reported catch (t)
1999	4500	6300	7372
2000	6400	7000	5550
2001	4700	6200	4617
2002	0	2800	3290
2003	0	2300	2661
2004	0	1363	2488
2005	0	1000	1964
2006	0	850	1783
2007	0	731	1269
2008	0	673	605
2009	0	505	264
2010	0	379	325
2011	0	190	356
2012	0	133	251
2013	0	100	447
2014	0	100	456
2015	0	100	584
2016	130	370	521
2017	129	525	561

Is there a targeted fishery for the stock or are the species mainly discard.

Historically there has been a large targeted fishery during spawning in the first quarter, later years the major fishing mortality source is from bycatch and to a high extent as discard(60–80% of landings) (Figure 1.7). The decrease of the targeted fishery of cod is directly related to the restricted TAC. There is a potential for an extensive targeted fishery on cod especially during spawning season and also, to a less degree, during other periods of the season when the stock is re-built.

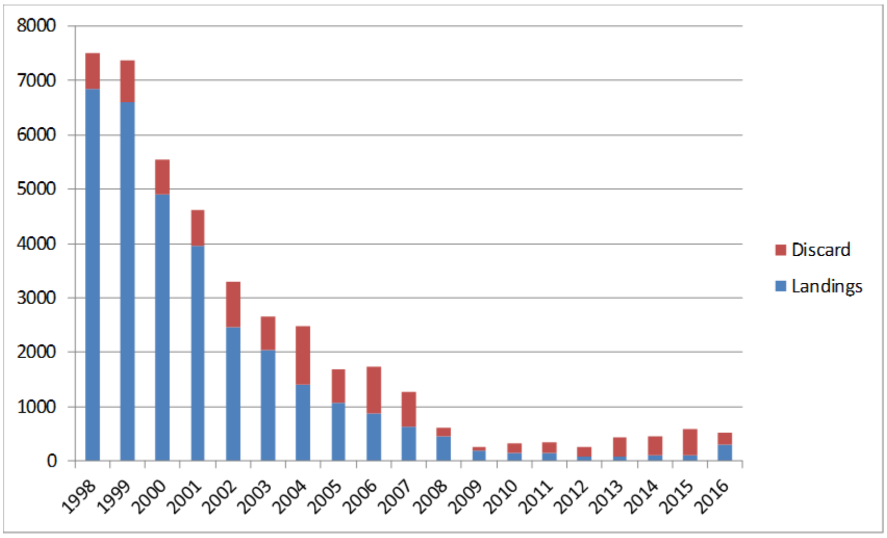


Figure 1.7. Kattegat cod landings and discard in 1998–2016.

Is the stock of large economic importance or are the species of high value?

Historically the cod fishery was an important economic fishery in Kattegat with landings of 20 000 tonnes in the 1970's (Figure 1.8), since the collapse of the cod stock in Kattegat the economic value has been low, the major economic species in the Kattegat presently is Norway lobster (*Nephrops norvegicus)* followed by sole (*Solea solea).*

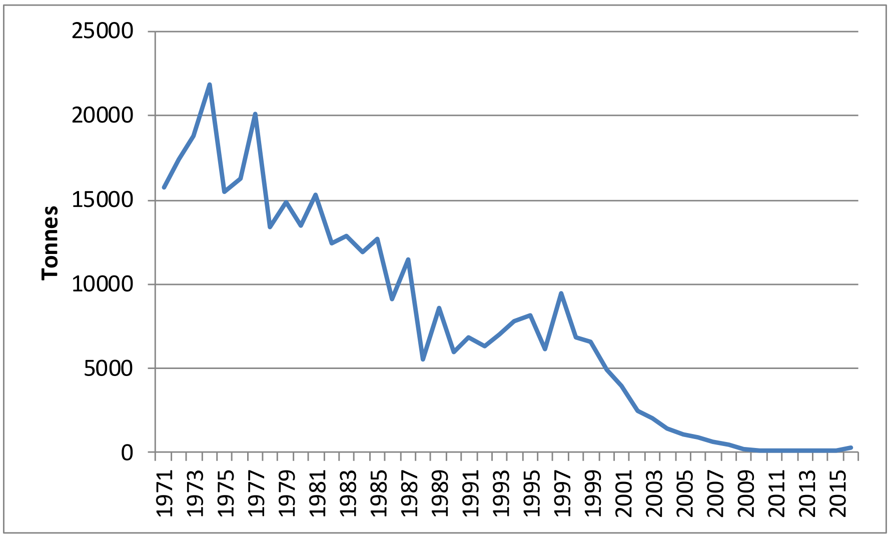


Figure. 1.8. Landings of Kattegat cod (tonnes) in 1971–2016

How are the most important fisheries for the stock managed?
The most economic important fisheries in Kattegat, is the Norway lobster fishery and the sole fishery both managed by TAC regulations. Both Danish and Swedish fisherman are operating under a system of Individual quotas, were each fisherman owns a proportion of the TAC. There are no effort limitations at place in Kattegat since 2016. Furthermore, the closed areas and season are used as management of the cod stock.

What are the fishing effort and stock trends over time?
The fishery in Kattegat is dominated by trawling, at present primarily within the TR2 gear category (mesh sizes at 90–99 mm).The gear group TR2 are responsible for 90% of the catches (Landings and discard) of Kattegat cod. A major shift in fishing gears occurred between 2003 and 2004 when the use of 70–89 mm trawls without sorting grids was banned. The overall TR2 effort has decreased by 50 % since 2003. In 2009 after the introduction of the protected zone with areas were the fishery only was allowed with certain selective gears (sorting grid and Seltra) the usage of these increased dramatically (Figure 1.9), The proportion of effort deployed in the Kattegat 2016 constitutes to 90% of selective gears (Figure 1.9)

SSB of cod in the Kattegat steadily declined from around 35 000 tonnes in the late 1970s to a level of less than 1000 tonnes in 2010. Good recruitment in 2011 and 2012 gave some hope that the cod recovery measured set down to allow for a rebuilding of the stock was successful. However after a peak in SSB 2015 the stock has started to decline again. (Figure 1.10.)

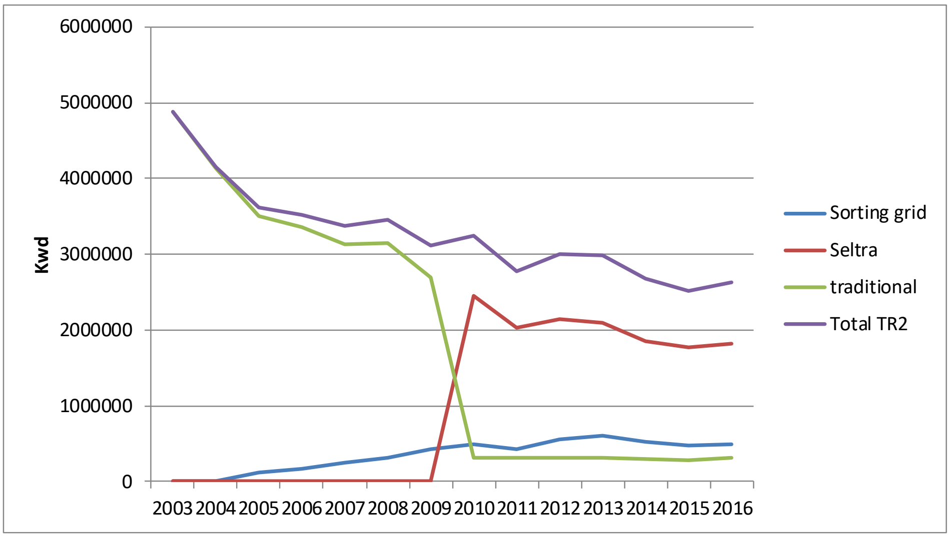


Figure 1.9. Effort of TR2 (trawls mesh size 90-99 mm) in Kattegat for the years 2003–2016. The figure shows effort trends for trawls with high catchability of cod (traditional), modified trawls with low catchability of cod (Seltra) and modified trawls with no catches of cod (Sorting grid). The use of the traditional trawl in 2016 is from the use of Danish fisherman fishing sole in the last quarter of the year.

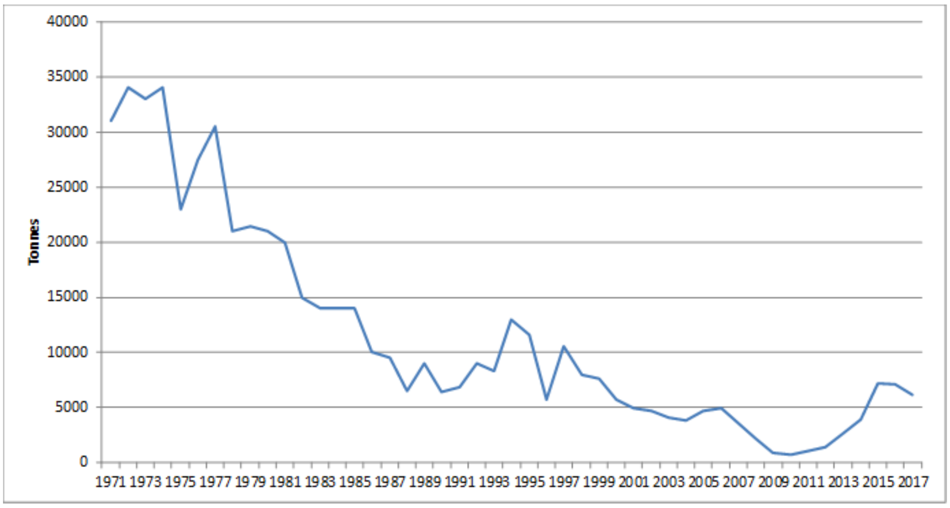


Figure 1.10. Spawning stock biomass of Kattegat cod in 1971–2017.

What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort

The quota uptake of the Norway lobster TAC has only been 40% the last years, hence there is a potential for a much higher effort in order to be utilize the Norway lobster quota. With the removal of the effort system 2016, there are no upper limits in how much effort that can be deployed in Kattegat. If the TAC of cod is removed, a huge incitement for using selective gears is removed and the mortality of the cod stock would increase to dangerously high levels. In fact the risk of extinction of Kattegat cod is emergent.

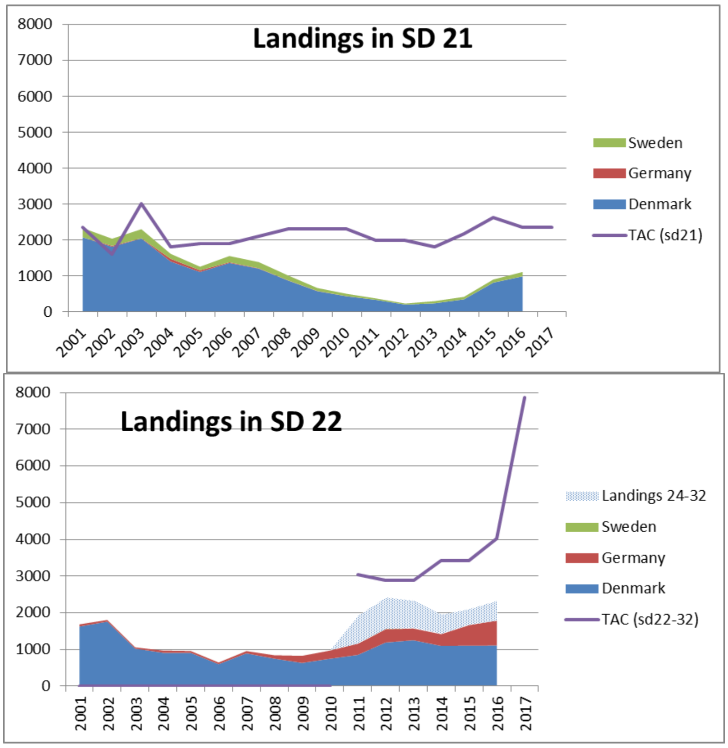
1.2.1.2.3 Plaice in SDs 21–23

Was the TAC restrictive in the past?

As shown in the figures below the TAC has not been restrictive in the period from 2001 to present. The landings and discards of plaice from SD 27.23 are insignificant

The issue is complicated by the fact that the plaice stock definition (SD 27.21–23) differs from the management units (27.21 and 27.22-32). This gives the problem that the TAC for SD 27.22–32 covers part of plaice stock ple.27.21-23 and ple. 27.22-32, which might differ in stock dynamics. The sum of the landings of plaice in SD 27.22, 27.23 and the total landings of ple.27.24-32 does not exceeds the TAC for SD 27.22-32.

Until 2013 SD 27.21 (Kattegat) was assessed together with SD 27.20 (Skagerrak).

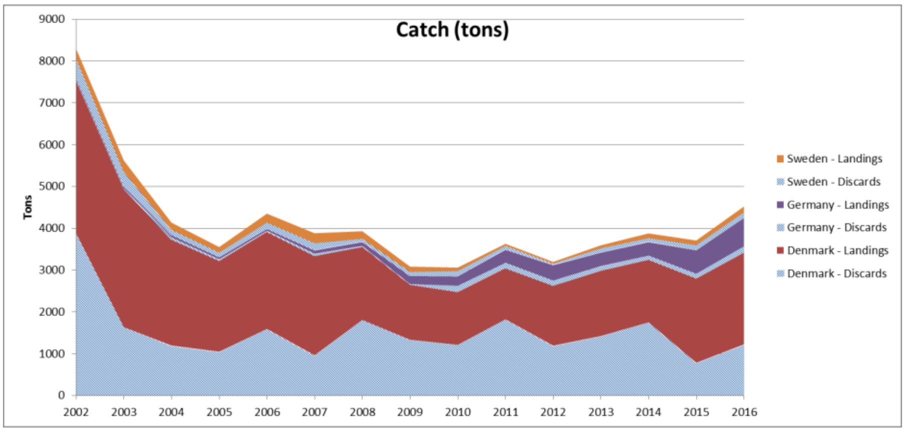


Landings in SD 21 and SD 22 (and 24–32) and the TAC in SD 21 and 22-32 respectively.

Is there a targeted fishery for the stock or are the species mainly discarded?

The plaice is an important fishery in periods as a supplement to the trawl fishery targeting *Nephrops* in Kattegat and targeting cod in the western Baltic. In Kattegat many vessels are fishing *Nephrops* during night time and fishing plaice during day time. In western Baltic, plaice are fished in periods where the cod are not available. Here, the bigger trawlers are fishing plaice mainly during the closed period for cod fishery (Feb- March), while the smaller trawlers carry out plaice directed fishery when needed throughout the year. The same gear is used for catching both species respectively in Kattegat and eastern Baltic.

In general, about 50 percent (weight) of the catch is discarded (2002–2016).



Catch of ple.27.22-23 by country split into landings and discard

Is the stock of large economic importance or are the species of high value?

-

How are the most important fisheries for the stock managed?

-

What are the fishing effort and stock trends over time?

Effort trend

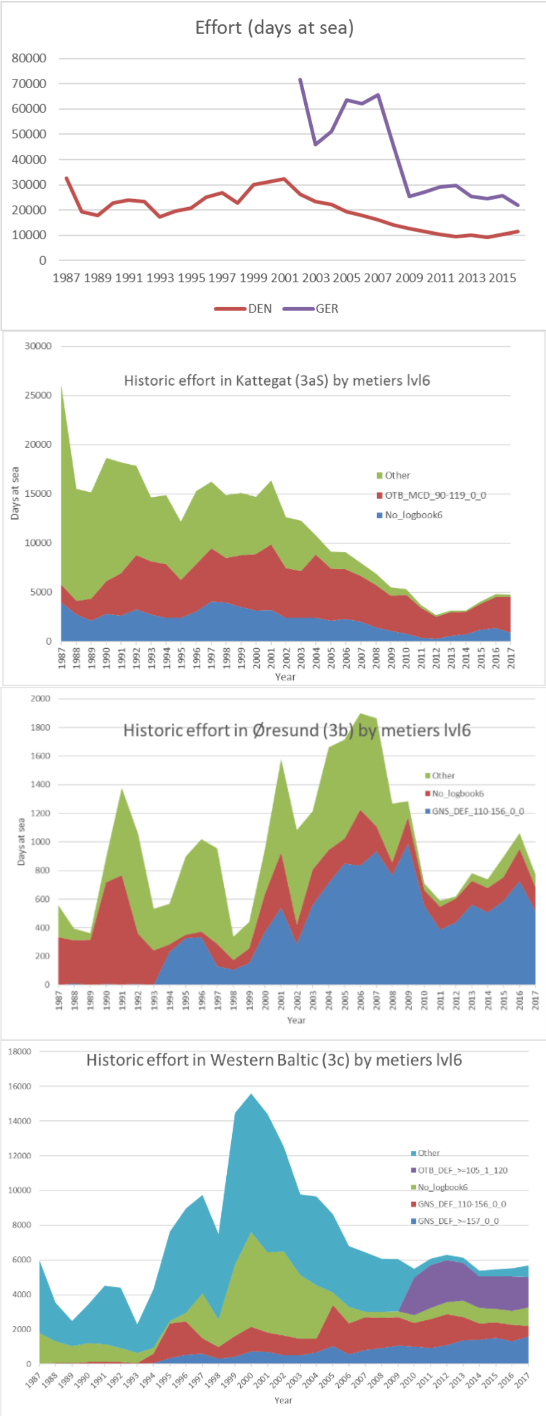
The fishing effort targeting plaice is linked to the effort for the cod fishery.

Effort for the plaice fishery from Germany is available from 2002 to 2008 on lvl5 and from 2009 to 2016 on lvl6. From Denmark, effort data are available from 1987 to 2017 on level6. A trip is evaluated to be included in the Danish effort statistics for plaice if the total landing of plaice from the trip is > 20 kg. Trips without logbooks are assumed to be one day-at-sea each.

In the German statistics, the effort is assigned to plaice fishery based on the métier on lvl6/lvl5 (including all demersal fisheries to the plaice fishery).

The German métier assignment to the plaice fishery is not regarded of a quality, which allow it to be used for showing the historical métier specific composition in the plaice fishery because it is strongly correlated to the cod fishery. The effort German effort statistics are regarded as less reliable before 2009.

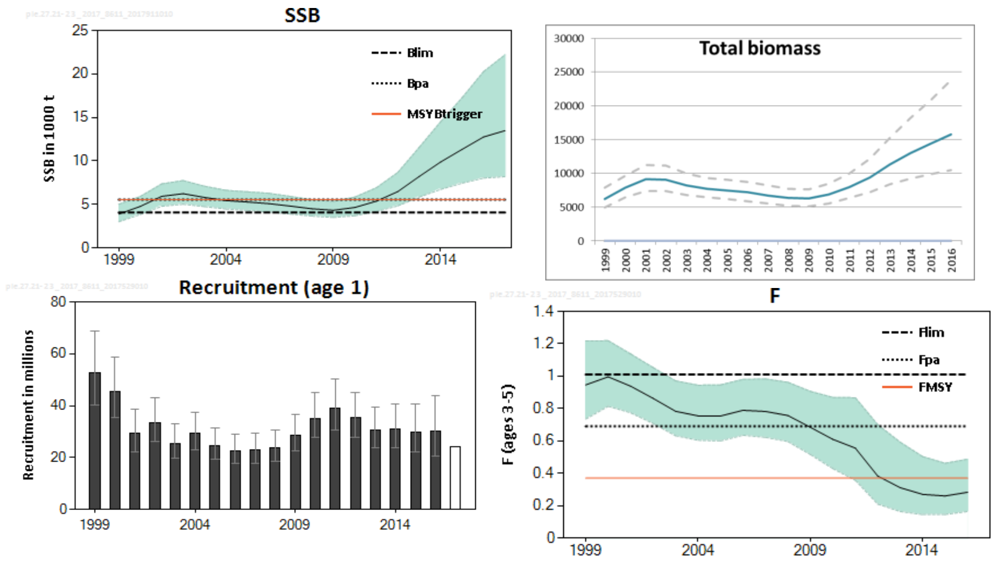
Swedish effort statistic is not included due to its insignificance.



Danish historical fishing effort (days-at-sea) by the top métiers targeting plaice. All graphs include only Danish effort except the upper.

Stock trend

As shown below, the SSB has increased since 2010 although the confident interval is rather high due to the relative short time series available. F has decreased since 2000 and is now stable since 2014 close to F_{msy} (0.37). Recruitment has been more or less stable in the whole period. In general, the confident intervals are rather high in all the estimates due to the relative short time series available. Despite the short time series, the assessment as such seems to be quite robust.



Stock trends as expressed in the stock assessment for 2017.

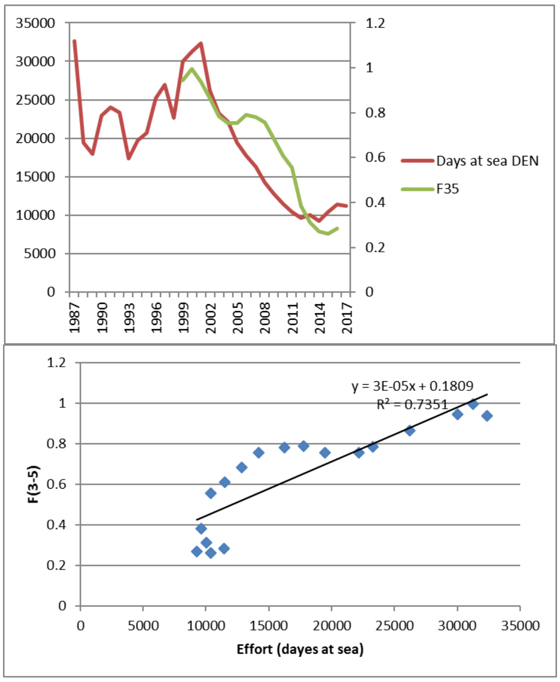
What maximum effort of the main fleets can be expected under management based on FMSY (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort

Fishing mortality [F(3-5)] – Effort relationship [Days at sea] and Estimated effort equal to F_{MSY}

Several approaches can be selected due to the incompleteness of the effort data.

There seems to be a quite good correlation between the Danish effort and the total F(3-5) as shown below ($r^2 = 0.7351$) . This indicates that the effort equal to F_{msy} can be estimated based on the Danish effort statistics alone plus the mean German effort for the period of reliable effort statistics (2009–2016). The German mean effort in the plaice fishery for the period 2009–2016 = 25 671 days-at-sea. This approach allows that the whole time series for F(3-5) to be used (1999–2016).

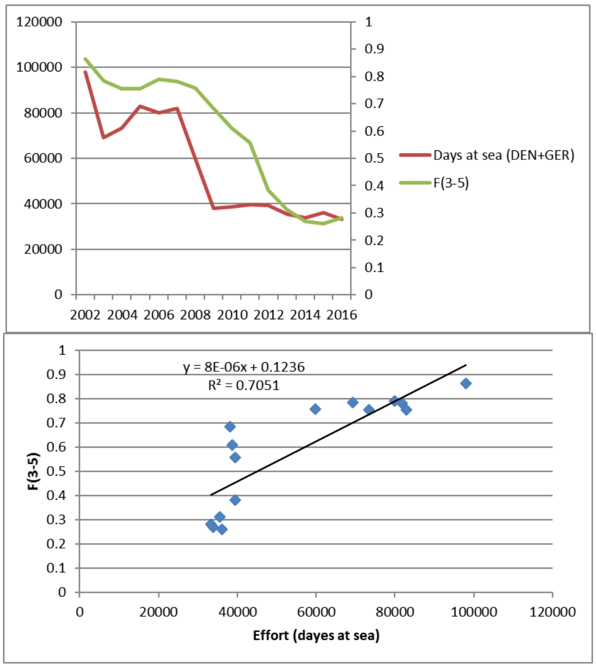
This method estimates the total effort for the main fisheries targeting plaice equal to $F(3\text{-}5)_{MSY}$ (= 0.37) to be 31 974 days-at-sea.



Historical Danish effort and stock fishing mortality (top) and the relation between them (bottom).

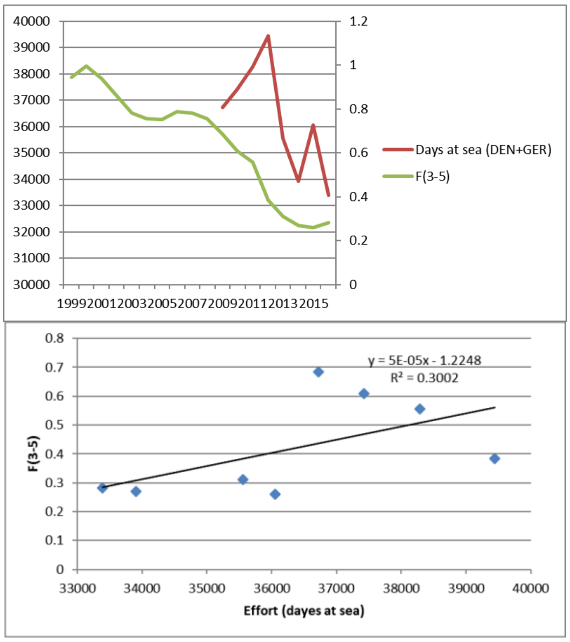
An alternative approach is if the sum of the Danish effort lvl6 and German effort (lvl5) is used for the regression. The correlation is almost as good as above ($r^2 = 0.7051$) even though the time series is shorter (2002–2016) than above.

This method estimates the total effort for the main fisheries targeting plaice equal to $F(3\text{-}5)_{MSY}$ (= 0.37) to be 30 800 days-at-sea.



Historical Danish + German effort and stock fishing mortality (top) and the relation between them (bottom).

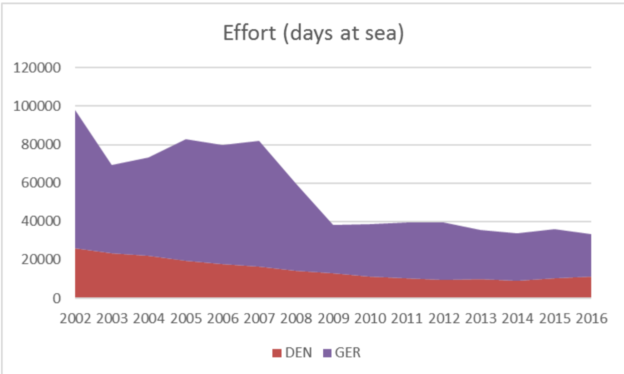
If only the reliable regarded German effort time series (2009–2016) and the Danish for the same period is used, the correlation is not significant ($r^2 = 0.3002$).



Historical Danish + German effort (2009–2016) and stock fishing mortality (top) and the relation between them (bottom).

Experienced similar levels of fishing effort for the stock

The historical effort of the main fisheries targeting plaice in the Western Baltic and Kattegat (ple.27.21-23) is shown below



Historical Danish + German effort (2002–2016).

The present (2016) level of effort for the main fisheries targeting plaice is 33 000 days-at-sea, which means that the present level of effort is approximately on the level of the estimated effort equal to $F(3\text{-}5)_{MSY}$ for both suggested estimation methods. This has to be seen in the light of the increasing SSB in the stock assessment (2017), which is far above SSB_{PA}, which suggests that the stock might be able to sustain a bit more effort than estimated. On the other hand, the assessment (including the SSB) is associated with quite high uncertainty due to the relative short time series on which the assessment is based.

1.2.1.2.4 Plaice in SDs 24–32

Was the TAC restrictive in the past?

The management area differs from the stock area since 2013. That means that although an advice on TAC is given for ple.27.2432, it is combined with the advice for ple.27.2223 (which in turn is separated from the stock area ple.27.2023).

However, the total catch in the eastern Baltic (27.3.d.24–32) was not above the recommended TAC for the same area and hence not "restrictive". It has however been restrictive for the total stock (covering 27.3.c.22 – 27.3.d.32) in the past.

Is there a targeted fishery for the stock or are the species mainly discarded?

Yes, plaice is targeted by the fishery, although mainly in a "mixed flatfish fisheries" (see also WGBFAS reports), also targeting flounder and dab. Plaice is caught by demersal trawlers and set-netter (coastal).

Plaice is also caught as a bycatch in cod-directed fisheries.

Is the stock of large economic importance or are the species of high value?

Plaice in the eastern Baltic has a higher value compared to other flatfishes (depending on the season and fishing gear. Plaice caught by passive fisheries usually has a better value). Together with the other flatfishes it has an economic importance, especially for small-scale coastal fisheries.

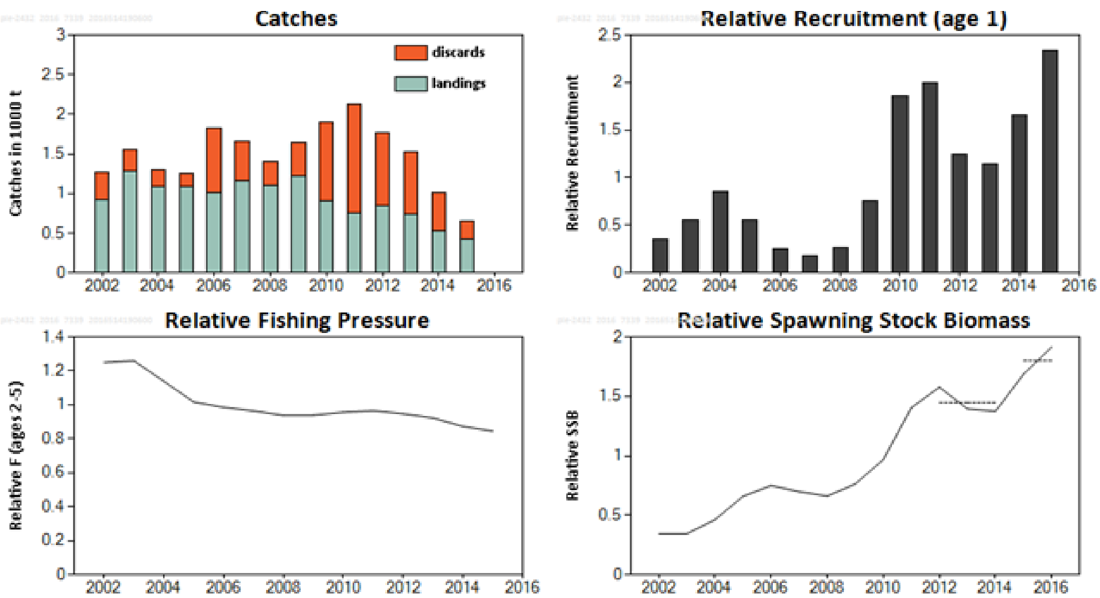
In 2017, the sales price ranged between €1.80/kg (€1.20 to €4.00 per kg) in the first quarter to around €0.70/kg (€0.60 to €0.80 per kg) in the fourth quarter. Flounder in comparison was sold for €1.30/kg to €1.40/kg (stable during the year).

How are the most important fisheries for the stock managed?

The most important fisheries are demersal trawlers and demersal set-netters. They are managed by quota, which are assigned according to the TAC share of the respective country. TAC can be traded between fishing organizations in case it becomes restrictive.

What are the fishing effort and stock trends over time?

Time series are available back to 2002. The commercial effort is fluctuating, but more or less stable. The relative fishing pressure is slightly decreasing, while also the catch is decreasing since 2011.



What maximum effort of the main fleets can be expected under management based on FMSY (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort

The stock does not have an F_{MSY}, it is later combined with the advice of plaice in the western Baltic to give a F_{MSY} for the whole Baltic Sea.

1.2.1.2.5 Conclusion

Cod in Kattegat

If the TAC of cod is removed, a huge incitement for using selective gears is removed and the mortality of the cod stock would increase to dangerously high levels. In fact the risk of extinction of Kattegat cod is emergent.

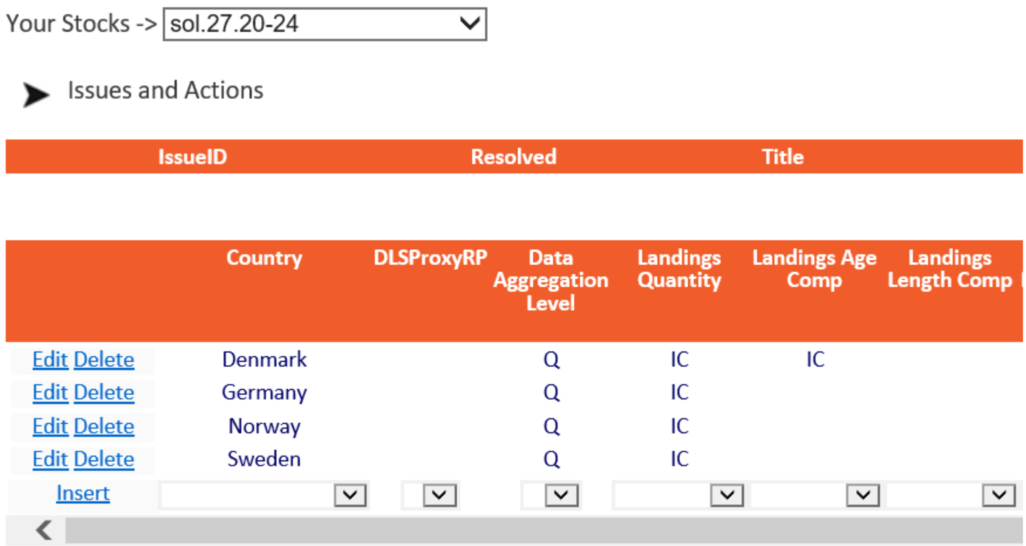
For Both the Plaice stocks (SDs 21–23 and SDs 24–32):

The TAC is not restrictive; removing the TAC has no impact on the stock given the current effort and stock size.

1.2.2 Data call 2019

A Data Call subgroup discussed the online interface prepared by ICES for 2018 that is to be completed by the stock coordinators/assessors. There the stock coordinators should categorize the any data transmission issues (e.g. data not on time, not the right format), approve the data needs and provide comments to data submitters. The interface is accessible for stock coordinators and accessors via http://sid.ices.dk/manage/datacalls.aspx

The screenshot given below shows an example of the layout of the online interface.



In addition, the ICES data call for WGBFAS 2019 was discussed. Since the designated benchmarks of the two Baltic cod stocks will result in changes in the data call for WGBFAS 2019, only minor changes were suggested (mainly concerning to the pelagic stocks).

1.2.3 Identify research needs of relevance for the expert group

General

The WG recognizes that the core lies in understanding the productivity of marine ecosystems. Ecosystems productivity will change in response to many factors, including human pressures, and the impacts of climate change on marine ecosystems, and it is the roll of WGBFAS to handle these science needs with scientific and innovative solutions. Furthermore, there is a widespread agreement about the need to move towards an ecosystem approach to fisheries management that takes into account species inter- actions which require that the quantity and quality of data used in fish stock assessment have increased to be used in the new advanced stock assessment methods. The variable ecological situation in the Baltic Sea and urgent need for ecological under- standing to support the assessment, the ecosystem working groups in ICES provide regular updates on selected environmental and lower trophic level indicators, including those related to fish recruitment, and regional descriptions of ecosystem changes (ICES WGIAB 2012, 2014). However, recent ICES initiatives to bring together ecosystem and stock assessment scientists in seeking solutions to the Eastern Baltic cod assessment and management revealed that there is lack of up-to-date ecosystem process understanding, essential for stock assessment and management advice. This could possibly also affect other stocks but currently there is also a challenge related to mismatch between what is available from science and what is needed for stock assessment and management advice.

Below is list of the most important parameters for a reliable stock assessment, which are all are dependent on up-to-date ecosystem process understanding:

- *Reliable recruitment estimates*
  Important for the development of the stock and for the forecast,
- *Reliable growth estimates*
  Important for stock development and health of the stock,
- *Accurate age determination*
  Vital for age base stock assessment models,
  Needed to accurately determine growth,
- *Catchability in the fishery*
  Shift in catchability will affect our perception of the stock development ,
- *Quality assured survey indices*
  Will affect our perception of the stock,
- *Ecosystem dependent estimates of natural mortality*
  Will affect our perception of the stock,
- *Accurate discard information*
  Accurate catch numbers and weight are central for stock assessment and are also important for the evaluation of the landing obligation,
- *Spatial distribution and migration between management areas*
  Integrated ecosystem knowledge is important to determine ecosystem advice,
- *Nutritional condition development*
  Important indicator of the ecosystem health and also possibly for information of infections,
- *Development of alternative stock assessment models that can include new information*
  The present variable ecological situation in the Baltic Sea and the need to integrate ecosystem factors in traditional assessment models demands alternative models,

Stock specific research needs

1. Sole in SD 20-24

Abundance and distribution of juveniles: Will enlighten whether the present recruitment index age 1 from the sole survey is appropriate as a measure of recruitment to the stock; if not the outcome could be to either change R to age 2 (if more coherent with older age groups) or suggest new surveys conducted in identified nursery grounds. The last suggestion will not give rise to a benchmark in 2019 but only after a number of years when a new index series has been established.

The present high variability in growth between ages is sought to be improved by calibration procedures between age readers. Also sex specific growth (age-length) will be exploited as an option for input to the assessment. Analyses are being conducted and expected to be evaluated in August 2018.

Stock structure - genetics; genotyping spawning fish in order to identify stock structure in the entire stock assessment area SD 20–24 and also to evaluate main migration patterns. In case that results show a stock ID in conflict with the present perception, data input to the assessment needs revision and coordination with neighbouring sole stocks. The benchmark will require additional participation of other sole assessors. Hardly possible in 2019.

Survey design has been changed continuously the last 4 years due to financial problems and in order to cover the fishery more appropriately. A comprehensive analysis of the fishery distribution along with the surveys selective powers will be basis for the future design of the survey. Will be finalized prior to the next survey in November 2018. A redesign might impact the calculation of the historic indices. Results will be relevant for a benchmark in 2019.

2. Cod in Kattegat

The issues identified at WKBALT (2017) that could explain the unallocated removals estimated; inflow of recruits from the North Sea and their return migration when they become mature is needed to be analyzed in order to determine unallocated removals. This is still relevant and this has not been resolved. This could be explored by analyzing historical samples to determine stock origin. This will need to be dome in steps, starting with; determine stock origin for 1+ individuals 10 years (200 individuals per year) back in time. These can then be analyzed with the newly developed SAM-model that can handle migration rates (Winther, 2017). The second step is to gather genetic samples from the whole size range of cod, in order to split the different cohorts. The second step allows using other models than newly developed SAM-model including the traditional SAM and SS3. Alternative stock assessment models are also something that needs to be developed.

WKBALT (2017) also highlighted the need to explore additional mortality factors like seal predation. This is still relevant.

3. **Plaice in 21–23**
   none
4. **Plaice in 24–32**
   none
5. **Flounder in 26+28**
   none
6. **Flounder in 27+29–32**
   none
7. **Flounder in 24–25**
   none
8. **Flounder in 22–23**
   none

9. **Plaice in 21–23**
   none
10. **Turbot in 22–32**
    none
11. **Brill in 22–32**
    none
12. **Dab in 22–32**
    none
13. **Herring in 25–27, 28.2, 29 and 32**
    none
14. **Herring in 28.1 (GoR)**
    none
15. **Herring in 30 and 31**
    none
16. **Sprat in 22–32**
    none
17. **Cod in 22–24**
    There is work in progress, but see issue list.
18. **Cod in 25–32**
    There is work in progress that focuses on reliable growth estimates and accurate age determination. Another on-going task is exploring alternative stock assessment models. There will be a data compilation October 2018 and a benchmark 2019. But see issue list.

1.2.4 Benchmark process

1.2.4.1 Consider and propose stocks to be benchmarked

Issues relating to the sole benchmark are presently in progress under the umbrella of a project at DTU Aqua running till the end of 2018. The most WPs within the project are expected to be finalized over summer – early autumn 2018. An expected time schedule for the individual WPs and their potential impact/use in a benchmark early 2019 is as follows:

- *Abundance and distribution of juveniles; identification of nursery grounds and evaluation of their importance for recruitment to the stock.*
    - Will enlighten whether the present recruitment index age 1 from the sole survey is appropriate as a measure of recruitment to the stock; if not the outcome could be to either change R to age 2 (if more coherent with older age groups) or suggest new surveys conducted in identified nursery grounds. The last suggestion will not give rise to a benchmark in 2019 but only after a number of years when a new index series has been established.
- *Growth and recruitment; improvement of ageing by means of otolith calibration between readers and otolith structure to validate age.*
    - The present high variability in growth between ages is sought to be improved by calibration procedures between age readers. Also sex specific growth (age-length) will be exploited as an option for input to the assessment. Analyses are being conducted and expected to be evaluated in August 2018.

- *Stock structure - genetics; genotyping spawning fish in order to identify stock structure in the entire stock assessment area SD 20–24 and also to evaluate main migration patterns.*
  - ➢ Will be finalised summer 2019. In case that results show a stock ID in conflict with the present perception, data input to the assessment needs revision and coordination with neighbouring sole stocks. The benchmark will require additional participation of other sole assessors. Hardly possible in 2019.
- *Survey coverage – design; analysis of appropriate survey coverage with respect to the stock distribution. In 2016 survey area was already extended into Skagerrak and the Belts and this scheme will be evaluated.*
  - ➢ Survey design has been changed continuously the last 4 years due to financial problems and in order to cover the fishery more appropriately. A comprehensive analysis of the fishery distribution along with the surveys selective powers will be basis for the future design of the survey. Will be finalized prior to the next survey in November 2018. A redesign might impact the calculation of the historic indices. Results will be relevant for a benchmark in 2019.
- *Improvement of biological data sampling - reference fleet; sampling from the fishery is difficult due to small and scattered landings; since 2016 agreements with specific fishermen were initiated to improve biological sampling.*
  - ➢ A reference fleet have been established although only few vessels have continued their sampling. Overall the sampling has improved and the result from this expansion in sampling is being used in the present assessment. Therefore this issue is not relevant for an upcoming benchmark.
- *Selectivity in various gears – SELTRA; introduction of new selective devices in fishing gears have caused selectivity to change substantially. In order to quantify this change experimental sole fishery will be conducted with the most used devices.*
  - ➢ Gear trials have been conducted and analyses of SELTRA and related gear's selectivity is expected to be finalized summer 2019. The outcome in terms of selectivity parameters will be sought incorporated into the SAM assessment model. Relevant for a benchmark in 2019.
- *Improvement of assessment; the effect of revising a number of input data and assumptions in the assessment due to the above mentioned work packages will be evaluated with respect to estimation of the stock and fishing pressure.*
  - ➢ See above. As commented, some of the issued are obviously not relevant for a benchmark and other will most likely not be ready to implement in a revised assessment in a benchmark in 2019. Therefore the decision of a benchmark is pending of the progress of the work over the next 5 month and a final decision of conducting the benchmark in early 2019 will be taken in September 2018.

In addition, this year's assessment has shown a high instability of the assessment as seen from the retrospective analyses. This pattern has created high variability in final estimation of F and SSB with the consequence of changing of advice between years up to 90%. The retrospective pattern is presently indicating underestimation of F and overestimation of SSB. The causes for this pattern need to be enlightened prior to a benchmark.

1.2.5 Review progress of the intersessional work agreed in 2016 to improve the assessment of the Baltic cod stocks; and update as appropriate

WGBFAS 2017 recommended an inter-benchmark to take place before WGBFAS 2018, mainly to evaluate whether the production model (SPICT), developed for EB cod and presented at WGBFAS 2017 in relation to MSY Proxy reference points could be used directly to provide catch advice corresponding to MSY. Additionally, the inter-benchmark was intended to address the method for modelling survey indices, as an alternative to the present indices calculated from DATRAS. However, through intersessional consultations among the stock experts and ACOM leadership after WGBFAS 2017 it was decided to replace the originally suggested inter-benchmark by a Workshop on Evaluation of Input data to Eastern Baltic Cod Assessment (WKIDEBCA). The main reason for this is that adopting a production model (SPICT) for the stock would imply that any possible achievements in relation to age/length based models (which are generally preferred to a production model) would not be possible to implement until the next benchmark (in ca 3–4 years). Thus, one of the main goals of WKIDEBCA was to evaluate whether it is realistic to establish an age/length based assessment for WB cod within the next few years.

The TORs for WKIDEBCA were the following:

a) Assemble and review updates and new quantitative information on current and past growth (length/weight at age) and natural mortality of Eastern Baltic cod, which was not considered at WKBEBCA workshop in 2017.
b) Evaluate and conclude on the possible approaches/assumptions to inform growth in age/length based stock assessment models, based on the present scientific knowledge available. This includes proxies, e.g. based on changes in potential drivers for growth etc.
c) Evaluate and conclude on the possible approaches/assumptions to inform natural mortality in age/length based stock assessment models, based on the present scientific knowledge available.
d) Evaluate and conclude on the most appropriate method for calculating time series of survey indices for age/length based stock assessment purposes, with specific focus on standardization across different gears, and considering the stock component in SD 24.
e) Agree upon and document the most appropriate approaches to derive stock assessment input data concerning growth, natural mortality and survey indices, addressed in a-d), to be taken forward to future benchmark assessment on Eastern Baltic cod.
f) Based on the conclusions from e), recommend the timing for future benchmark assessment on Eastern Baltic cod and develop corresponding workplan.

The main conclusions from WKIDEBCA were the following:

Growth

There was an overall agreement that growth has declined since the 1990s. For smaller/younger fish (< 3 years old) this was directly estimated from daily increments and length frequency distributions. For larger/older fish, due to the lack of trustful ageing after 2006, the changes in growth between 2006–2017 could not be directly estimated. Proxies for growth (based on earlier observed changes in growth corresponding to changes in condition, anoxic areas, length at maturity) were suggested to be used to inform the change in growth during this period to construct ALKs or estimate VBG parameters in stock assessment models. This was seen as a way forward in present situation, until direct measurement of growth (from tagging, otolith microchemistry) may become available in future. It was also suggested to explore whether some country's age readings for later years would provide similar change in growth as the proxy approach, and thus could possibly be used as well. This was followed up in WGBFAS 2018 (see below).

Natural mortality

The quantitative and qualitative information suggested that natural mortality has increased. Independent analyses based on biological information and modelling suggest that natural mortality for adult cod could currently be as high as 0.5. Further analyses were suggested concerning M for small cod due to cannibalism, which was followed up in WGBFAS 2018 (see below).

Survey indices

Two different approaches based on statistical modeling were presented. For stock assessment, it was concluded that for the historical period (<1990) the GAM model published by Orio et al. (2017) will be used. For the BITS period (after 1990), either the GAM or the LGCP, with aggregated abundance and size composition, will be used. Intersessional work with refining the survey modelling approach is continued. Additionally, the use of biomass and recruitment indices based on ichthyoplankton surveys in stock assessment is being considered.

1.2.6 Advice on how the results of the intersessional work can be applied in the assessment of the Baltic Sea cod stocks

WKIDEBCA recommended proceeding with benchmark for Eastern Baltic cod in 2019, with the aim to re-establish a quantitative assessment for the stock.

It is recognized that validated growth information will likely not be available for this benchmark, and at best case only preliminary indication from ongoing tagging experiments will be available. Nevertheless, the WKIDEBCA group suggested moving on with an age/length assessment based on reasonable agreed assumptions on the magnitude of change in growth, which can be verified and improved in future when direct measurements of growth may become available. The suggestion for benchmark in 2019 remained unchanged after WGBFAS 2018.

WGBFAS 2018 followed up on growth and natural mortality issues. For growth, new analyses were presented comparing the proxy ALK constructed based on changes in drivers/indicators of growth with indications of growth changes from traditional age readings. A few plausible options for informing growth in stock assessment models were defined that will be further explored at the benchmark.

For natural mortality, new analyses on cannibalism were presented that will be used to inform natural mortality of small cod in stock assessment models.

The stock mixing issue was also discussed at WGBFAS 2018, and an intersessional workshop before the Data Evaluation workshop for benchmark was suggested to agree on methods and data used for splitting EB and WB cod in SD 24, both in surveys and fisheries catch.

As a next step, Stock Synthesis model for Eastern Baltic cod will be explored at a SS workshop in 21–26 May, Ponza, Italy. The work that will be conducted at this workshop will provide direct input to the benchmark.

At WGBFAS 2018, also the benchmark procedure was discussed, suggesting Data Evaluation meeting for Eastern Baltic cod in parallel to the Data Evaluation meeting for Western Baltic cod, with a joint day to mainly finalise the issues of stock mixing. At the Data Evaluation meeting for EB cod, all input data for Eastern Baltic cod stock assessment are expected to be finalised and documented. WGBFAS 2018 suggested a joint benchmark meeting for EB and WB cod, where the focus for EB cod will be mainly on stock assessment models and reference points.

Issue list for the Eastern Baltic cod benchmark in 2019 was compiled at WGBFAS 2018.

1.2.7 Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2018

For each of the stocks listed below methods provided in the ICES Technical Guidelines (*i.e.* peer-reviewed methods that were developed by WKLIFE V, WKLIFE VI, and WKProxy) were used to provide updated MSY proxy reference points:

Stock Code	Stock name description	EG	Data Category	Details are given in stock report section
cod-kat	Cod (*Gadus morhua*) in Subdivision 3.a.21 (Kattegat)	WGBFAS	3.2	2
cod-2532	Cod (*Gadus morhua*) in subdivisions 25–32, eastern Baltic stock (eastern Baltic Sea)	WGBFAS	3.2	2
ple-2432	Plaice (*Pleuronectes platessa*) in subdivisions 24–32 (Baltic Sea, excluding the Sound and Belt Seas)	WGBFAS	3.2	5
tur-2232	Turbot (*Scophthalmus maximus*) in subdivisions 22–32 (Baltic Sea)	WGBFAS	3.2	8

1.3 Working Groups response to recommendations from other ICES groups

ID	EG	Year	Recommendation	Status
219	WKDEICE2	2017	3. Establish EG/WK where proposed approch (EBFM_MSE) coud be developed and tested within ICES advisory process	communicated to all WGBFAS members in 2018, *see text below
246	WKDEICE2	2017	1. Critically review the proposed approach (ecological as well as bioeconomic) and give a feedback to WKDEICE chairs.	communicated to all WGBFAS members in 2018, *see text below
247	WKDEICE2	2017	2. Establish intersessional collaboration to develop proposed approach practically for ICES Advice framework.	communicated to all WGBFAS members in 2018, *see text below
276	WKSIDAC	2017	For the purposes of identifying mixing and stock identification of Western Baltic and Central Baltic herring, initiate the collection of data and samples for implementing genetic studies to determine the genetic origin of individuals used in the length separation method i.e. validate the length separation method.	communicated to all WGBFAS members in 2018, **see text below
279	WKSIDAC	2017	For the purposes of testing the validity of using shape analysis for discriminating individual herring to their spawning stock, otoliths and samples for genetic analyses to be obtained from spawning fish on their spawning grounds from the Northeast Atlantic (areas 2, 3, 4, 5, 6 and 7) to characterise all spawning stocks which are likely to occur in surveys and catches in any of the areas where herring occur.	communicated to all WGBFAS members in 2018, **see text below
280	WKSIDAC	2017	In order to test the efficacy of using otolith shape analyses for the separation of mixed herring stocks to their stock of origin, representative sets of otoliths from surveys in the	communicated to all WGBFAS members in 2018, **see text below

			northeast Atlantic are to be collected.	

*WGBFAS appreciate the initiated communication from WKDEICE. WGBFAS suggest that intersessional meetings are established between WKDEICE, WGBFAS, WGIAB and WGSAM. During these meetings, feedback can be given across groups. The proposed changes to ICES advisory process is an issue for ACOM and SCICOM.

**The WG discussed the request from WKSIDAC 2017 related to mixing and stock identification of herring in the Baltic. The request suggested initiation of collection of relevant data, e.g. data allowing genetics and otolith shape analysis.

The group shortly discussed the material and analyses of this phenomenon conducted so far. It were indicated and discussed evidences of stock mixing based published material on differences in fish size (length separation function), infection with *Anisakis simplex* larvae, and morphometric analyses.
The WG is of the opinion that the mixing may be marked and requires detailed analyses as it may seriously affect management of western and central Baltic herring stocks. The best way for discussing the problem, develop the program of collection of relevant data and further analyses would be to set a workshop discussing the problem and initializing relevant sampling and analyses. Such a workshop (chaired by J. Horbowy, Poland) could be held in Gdynia, Poland, in 11–13 September, 2018.

1.4 Reviews of groups or work important for WGBFAS

1.4.1 WebEx Meeting for the Chairs of Assessment Expert Groups (WGCHAIRS)

WGBFAS was not represented by the WGCHAIRS meeting in January 2018. However, WGBFAS was informed by the WebEx on assessment EG chairs in March 2018. A range of topics where presented and discussed and only those of direct relevance to the work of WGBFAS are reported here.

The *format of the upcoming advice* was presented, and changes in format as well as procedures were highlighted: Multi Annual Plans (MAPs) have been developed and are in place for the Baltic, and the MAP for the North Sea and Western Waters is in draft; non-target stocks with a TAC, where previously advice was based on the MSY principle, will be given Precautionary Approach advice in 2018; For stocks without a TAC, only the stock status will be provided in the advice.

Audit system: This is an important step in the quality assurance of the production of the advice and it was stressed that improved audit processes that go through each step of the audit should be followed. It was proposed to start in the advice sheet and work back through the report and assessment code.

1.4.2 Baltic International fish survey Working Group (WGBIFS)

The presentation of WGBIFS 2018 was composed from three parts focused on the:

a) Baltic acoustic-trawl surveys (BIAS, BASS) in 2017,

b) BITS surveys in 2017-Q4 and 2018-Q1,

c) new ICES acoustic-trawl data base.

The Baltic International Acoustic Survey (BIAS) in September-October 2017 was completed according to the plan. The geographical distribution of herring and sprat abundance at age 1+ and age 0, and cod in the Baltic Sea, calculated per the ICES rectangles in 2017 was demonstrated in consecutive graphs. In September-October

2017, the highest concentrations of herring (age 1+) were detected in the ICES SDs 29, 32 and in the Bothnian Sea (SD 30). During the same survey, the geographical distribution of age 0 herring abundance in the Baltic was limited mainly to the eastern part of the Gulf of Finland, western part of the ICES SD 29 and SD 27. Sprat (age 1+) dense shoals were more distributed in the eastern and north-eastern part of the Baltic Proper and in the Gulf of Finland (SD 32). Considerable abundance of age 0 sprat was recorded in the northern part of the Baltic Proper, western part of Gulf of Finland (SD 32) and in the Lithuanian EEZ. Cod was concentrated mostly in the south-western part of Baltic Proper. The BIAS-dataset, including the valid data from 2017 can be used in the assessment of the CBH (herring) and sprat stocks in the Baltic Sea with the restriction that the years 1993, 1995 and 1997 (when the monitored area coverage was poor) are excluded from the index series. The current BIAS index series can be used in assessment of the Bothnian Sea herring with the restriction that the year 1999 is excluded from the dataset. The abundance indices for age groups 0 and 1 should be handled with caution.

The Baltic Acoustic Spring Survey (BASS) in May 2017 was completed. In the May survey, the sprat was distributed quite evenly across the entire surveyed area. Somewhat higher concentrations of sprat were distributed in the south-eastern part of the Baltic Proper. The BASS-dataset can be used in the assessment of the sprat stock in the Baltic Sea with restriction that the year 2016 is excluded from the dataset.

The realization of valid ground trawl hauls vs. planned during the Baltic International Trawl Survey BITS-Q4/2017 and the BITS-Q1/2018 was on the level of 96 and 97% (by numbers), respectively and was considered by the WGBIFS-2018 as appropriate tuning series data for the assessment of Baltic and Kattegat cod and flatfish stocks. Somewhat lower coverage of some depth strata in both BITS surveys has been due to the restrictions enforced by the Swedish military. It was decided that the Russian data obtained during the 4th quarter 2017 BITS are included in the calculation of survey indices for the relevant cod and flatfish stocks, even though the survey period is significantly outside the agreed survey period.

Additionally a short overview about the new ICES acoustic-trawl survey data base was presented by the WGBIFS chair. In this new data base, the scrutinized acoustic data and biological data from trawl samples are available from the last year BIAS and BASS surveys. WGBIFS will continue to upload the survey data to that data base and will perform exercises to calculate the acoustic survey indices using the StoX software and the data from the new data base. These exercises will also include the comparisons between the new and old calculation methods.

Moreover, the WGBIFS-2018 response to the recommendation made by the WGBFAS (Estimation of catch selection curve from the BITS survey, to see what size we should base on our stock abundance indices) was also presented. WGBIFS is trying look at the possibility to estimate these catch selection curves based on the historical intercalibration data of the BITS gears. Additionally WGBIFS will forward this request to WGFTFB to perform new studied on this topic.

1.4.3 Workshop on Developing Integrated Advice for Baltic Sea ecosystem-based fisheries management (WKDEICE)

The working group of WGDEICE has explored several ways to include ecosystem information and bio-economic information in the advice for stocks in the Baltic Sea. They suggested that the following factors' consequences on advice are given priority: stock distributions, environmental changes, species interactions and mixed fisheries.

The WGDEICE suggests a new step in the advice chain called "integrated advice evaluation" during which the consequences of ecological and bio-economic factors are evaluated.

WKDEICE addressed three recommendations to WGBFAS, ACOM and SCICOM:

i. Critically review the proposed approach (ecological as well as bioeconomic) and give a feedback to WKDEICE chairs.
ii. Establish intersessional collaboration to develop proposed approach practically for ICES Advice framework.
iii. Establish EG/WK where proposed approach (EBFM_MSE) could be developed and tested within ICES advisory process.

WGBFAS appreciate the initiated communication from WKDEICE. WGBFAS suggest that intersessional meetings are established between WKDEICE, WGBFAS, WGIAB and WGSAM. During these meetings, feedback can be given across groups. The proposed changes to ICES advisory process is an issue for ACOM and SCICOM.

1.4.4 Working Group on Multispecies Assessment Methods (WGSAM)

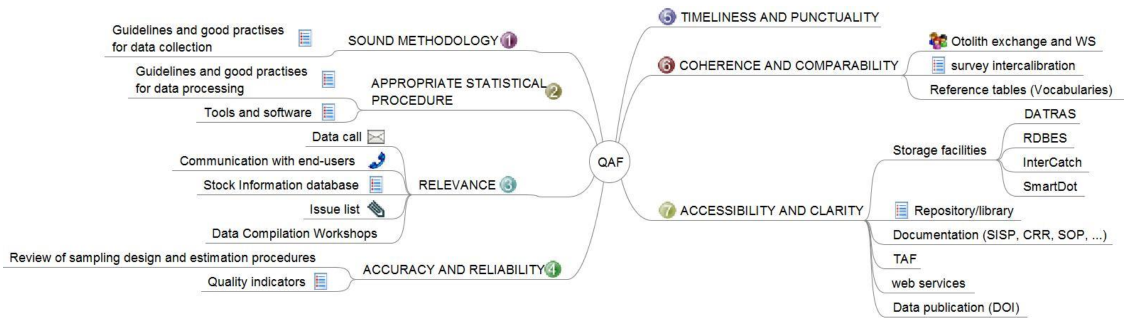
The updated model with intra- and inter species density dependence perform better than the previous models, supporting the theory that density dependence in clupeid growth influences the systemA multispecies model for cod, herring and sprat in the Baltic Sea for 1974–2013 was implemented in Gadget and presented in the Working Group on Multispecies Assessment Methods (WGSAM). The model is able to reproduce the decrease in the proportion of *Saduria enthomon* and *Mysis spp*. in the diet as cod grows. The model also captures the general patterns observed for the two clupeids. However, the length composition of herring in the stomachs is poorly represented and additional work is required on the parameters controlling the length selection of herring by cod. Furthermore, the MSI-SOM model was updated to take density dependent growth in the clupeids into consideration. The updated model with intra- and inter species density dependence performed better in estimating Nash equilibrium reference points in the Baltic Sea than the previous models, supporting the theory that density dependence in clupeid growth influences the system.

1.4.5 Working Group on Integrated Assessments of the Baltic Sea (WGIAB)

The ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB) i) continued with the trait-based integrated trend analysis across multiple trophic levels and scope the possibility to extend the spatial range to cover multiple basins, to ii) explored new statistical tools to analyse spatio-temporal dynamics, and iii) continued developing conceptual models that integrate the social dimension. The study on changes in the Baltic Sea ecosystems and functional traits composition in relation to external drivers is expected to feed into the development of methods to assess the environmental status of food webs, and to ecosystem-based advice for fisheries management. The work to develop integrated assessments of social-ecological systems is anticipated to feed into integrated management towards the objectives of the common fisheries policy and the Marine Strategy Framework Directive (MSFD).

1.4.6 Working Group on Data Needs for Assessments and Advice (PGDATA)

PGDATA was this year held in France 13 – 16 February 2018. One of the tasks during this working group was to define the future task of the group and how this best could be implemented. Of special interest for the assessment working group is the quality assurance and the end user feedback. This can be improved with the data call where both assessment working groups as WGBFAS and the data provider can improve the data call by only ask for data needed for the assessment and make the data call more clear but also inform the working group on available data presently not used by the assessment working groups. The issue list is to be compiled before a data compilation workshop in the benchmark process and is a good way to improve the communication and data quality as the intention by ICES is to make the issue list public and give the data providers a possibility to comment on the data asked for by the assessment group. It is important to remember not only to ask for new or missing data but also to look into existing data to analysis if the quality could be improved.



1.4.7 Interaction between WGBFAS, WGIAB, WKDEICE and WGSAM

The WGBFAS is of the opinion that an increased interaction with the groups named would benefit the development of ecosystem considerations in the advice. The different groups have their own ToR:s and reports, which tend to isolate the groups. The recently decided ecosystem over-views can provide a basis for a specific meeting which includes chairs and key-members of the WGs/WK. The overview can be a platform for initiating free discussions to understand the ecosystem and its exploitation, and as such improving synergies across WGs/WK. The meeting can report their conclusions in supplements to the overview. The over-view and supplements should among other things include traffic light plots over ecosystem indicators, and trends in ecosystem parameters. Effort should be devoted to identify patterns and explore ideas of functional relationships. Burning issues should be identified and listed to focus future work and develop ToRs of the WGs/WK.

1.5 Methods used by the Working Group

1.5.1 Analysis of catch-at-age data

Full analytical assessment of fish stock with following short term forecasts was done for the following stocks in the Baltic:

- Cod in the subdivisions 22—24
- Sole in Division 3.a + SDs 22—24
- Plaice in subdivisions 21—23
- Herring in the subdivisions 25—29 and 32, excluding Gulf of Riga
- Herring in the Gulf of Riga (Subdivision 28.1)
- Herring in subdivisions 30 and 31
- Sprat in the subdivisions 22—32.

No analytical assessment but a trend-based assessment was carried out for the following stocks:

- Cod in the Kattegat
- Cod in subdivisions 25–32
- Plaice in subdivisions 24–32

No analytical assessment but a trend-based assessment was carried out for the following stocks (no advice in 2018, as minimum in 2018 only update of input data conducted):

- Flounder in subdivisions 22–23,
- Flounder in subdivisions 24–25,
- Flounder in subdivisions 26 and 28,
- Flounder in subdivisions 27, 29–32,
- Brill in subdivisions 22–32,
- Dab in subdivisions 22–32,
- Turbot in subdivisions 22–32.

The main tools for the assessment of the state of stocks and catch-at-age was the stochastic state-space model (SAM) (Nielsen, ICES 2008) and VPA tuned using the (Extended Survival Analysis) XSA method (Darby and Flatman, 1994).

SAM was used for assessment of cod in Kattegat, cod in SDs 22–24, plaice in SDs 21–23, herring in SD's 30 and 31 and sole in Division 3.a+ SDs 22–24. The model allows estimation of possible bias (positive or negative) in the data on removals from the stock in specific years. Settings of the model were used as specified in Stock Annex. Details on model configuration, including all input data and the results can be viewed at www.stockassessment.org.

Generalized Additive Models (GAM) with a delta-Gamma distribution (zeroes and positive catches are modelled separately) were used for plaice in SDs 21-23 to calculate two survey indices. The use of a modeling approach has the consequence that the whole survey series are recalculated every time a new data year is added to the series. Compared to the result of traditional index calculation methods not using models, the results of the GAM model shows a more robust result with less residual patterns.

The results of analyses are presented in corresponding sections of stocks.

1.5.2 Assessment Software

Overview of used versions of software:

Software	Purpose	Version
MSVPA	Outout for further assessment	
XSA	Historical assessment	VPA95
RETVPA	Retrospective analysis	
RCT3	Recruitment estimates	
MFDP	Short-term prediction	
SAM	Historical and exploratory assessment	

1.5.3 Methods applied in subsequent assessments

Assessment classifications:

Stock	Classification in 2017	Assessment in 2018
Cod in Kattegat	Trend based	Trend based
Cod in SD 22–24	Update	Update

STOCK	CLASSIFICATION IN 2017	ASSESSMENT IN 2018
Cod in SD 25–32	Trend based	Trend based
Sole in SDs 20–24	Update	Update
Flounder in SD 22–23	Trend based	Not obligatory
Flounder in SD 24–25	Trend based	Not obligatory
Flounder in SD 26–28	Trend based	Not obligatory
Flounder in SD 27–32	Trend based	Not obligatory
Plaice SD 21–23	Update	Update
Plaice SD 24–320	Trend based	Trend based
Dab SD 22–32	Trend based	Not obligatory
Brill SD 22–32	Trend based	Not obligatory
Turbot SD 22–32	Trend based	Trend based
Herring in SD 25–27, 28.2, 29 &32	Update	Update
Herring in GOR (SD 28.1)	Update	Update
Herring in SD’s 30 and 31 (Gulf of Bothnia)	Update	Update
Sprat in SD 22–32	Update	Update

1.6 Stock annex

A table containing links to the stock annexes covered by WGBFAS is found in Annex 4 of this report.

1.7 Ecosystem considerations

The WGBFAS recognizes the importance of considering ecosystem variability and trends in the stock assessments, and to assess the effects of fishing activities on the ecosystem as a whole. To this end, we have used the reports of the Study Group/Working Group on Spatial Analyses for the Baltic Sea (SGSPATIAL/WKSPATIAL), the Working Group on Integrated Assessments of the Baltic Sea (WGIAB), the Working Group on Multi-species Assessment Methods (WGSAM), as well as peer-reviewed publications and other analyses presented at WGBFAS as input to the sections below. We list the details of how ecosystem variability has been accounted for and in which stock assessments. We also propose measures and further development of methods to account for ecosystem variability and fisheries-induced ecosystem effects in stock assessments.

1.7.1 Abiotic factors

The ecosystem changes in the Baltic Sea are synthesized by the ICES WGIAB (2008 and subsequent reports) in Integrated Ecosystem Assessments (IEA) conducted for seven sub-regions of the Baltic Sea: i) the Sound (ÖS), ii) the Central Baltic Sea (CBS), encompassing the three deep basins, Bornholm Basin, Gdansk Deep and Gotland Basin; iii) the Gulf of Riga (GoR), iv) the Gulf of Finland (GoF), v) the Bothnian Sea (BoS), vi) the Bothnian Bay (BOB) and a coastal site in the southwestern Baltic Sea (COAST). The updated IEA (ICES WGIAB, 2015) corroborated the correlation between temperature and salinity, and included 2014 values for the abiotic factors being tracked.

The main drivers of the observed ecosystem changes vary somewhat between sub-regions, but they all include the increasing temperature and decreasing salinity (Figure 1.11). These are influenced by large-scale atmospheric processes illustrated by the

Baltic Sea Index (BSI), a regional calibration of the North Atlantic Oscillation index (NAO) (Lehmann *et al.*, 2002). The change from a generally negative to a positive index for both BSI and NAO in the late eighties was associated with more frequent westerly winds, warmer winter and eventually a warmer climate over the area (Figure 1.11). Further, the absence of major inflow events has been hypothesized to be related to the high NAO period (Hänninen *et al.*, 2000). An indication of this is that only two major inflows to the Baltic Sea have been recorded during the high BSI-period since the late 1980s. Contrary to what occurred in surface waters, salinity in deeper waters has increased after the early 1990s to levels as high as in 1960s–1970s (Figure 1.11).00

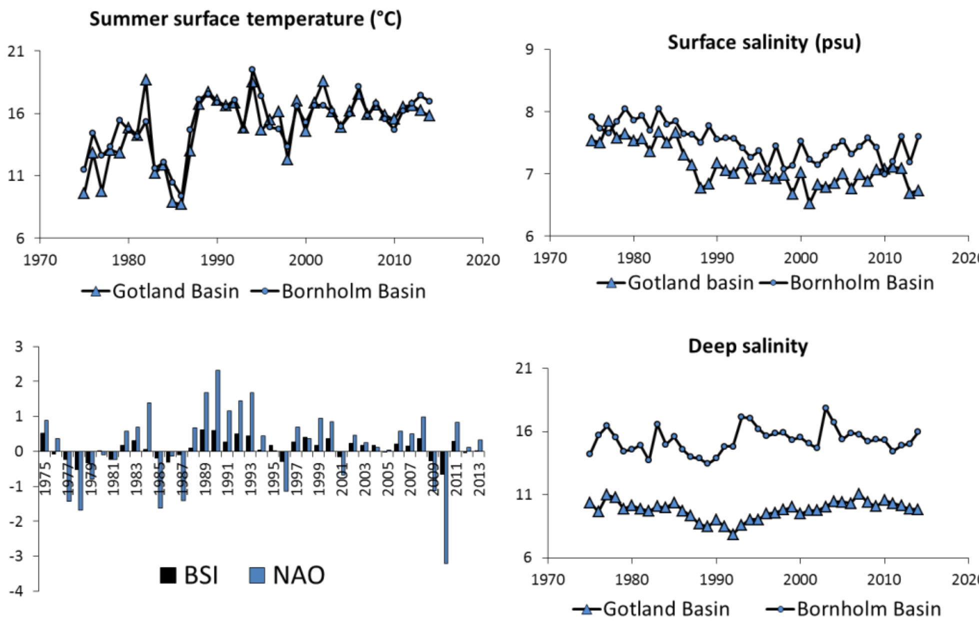


Figure 1.11. Time-series in summer surface temperature and surface salinity (top panels), BSI (Baltic Sea Index) and NAO (North Atlantic Oscillation index) and deep salinity (lower panel) in the Gotland Basin and Bornholm Basin.

In addition to temperature and salinity, fishing pressure was identified as an important driver for CBS and BoS. For the highly eutrophicated GoF, also nutrient loads were found to be an important driver. Trends in nutrient concentration and loading vary between the sub-regions; the concentrations of DIN and DIP decreases in ÖS and CBS, whereas in GoR and GoF DIP concentration is increasing because of internal loading. In contrast, in BoS and BoB DIN concentration is increasing, and in BoB and COAST the total DIP loading from run-off is also increasing. Although the long-term decrease in salinity is apparent in all sub-regions, the recent trends in salinity differ. In GoR, as in the CBS, salinity has increased since 2003, whereas in COAST salinity is continuing to decrease due to the increased freshwater input from runoff.

The suggested driving forces of the observed regime shift in all sub-regions, decreasing salinity and increasing temperature, are both consequences of climate change. However, it must be underlined that the population changes observed in several trophic levels (fish and plankton) in many areas are also the result of top-down regulation and trophic cascades (Casini *et al.*, 2008, 2009), emphasizing the role of fishing pressure on ecosystem changes.

Moreover, the reversal of abiotic factors back to the values as observed in the 1970s–1980s did not produce a parallel reversal of the biotic conditions, this likely confirming that currently the Baltic Sea is strongly controlled by other mechanisms, as for ex. trophic interactions (Casini *et al.*, 2009, 2010; Möllmann *et al.*, 2009)

A particular feature of the Baltic Sea since the mid-1990s has been a drastic increase in the extent of anoxic and hypoxic areas, likely due to lack of strong water inflows from the North Sea and potentially increased biological oxygen consumption on seafloor (Figure 1.12).

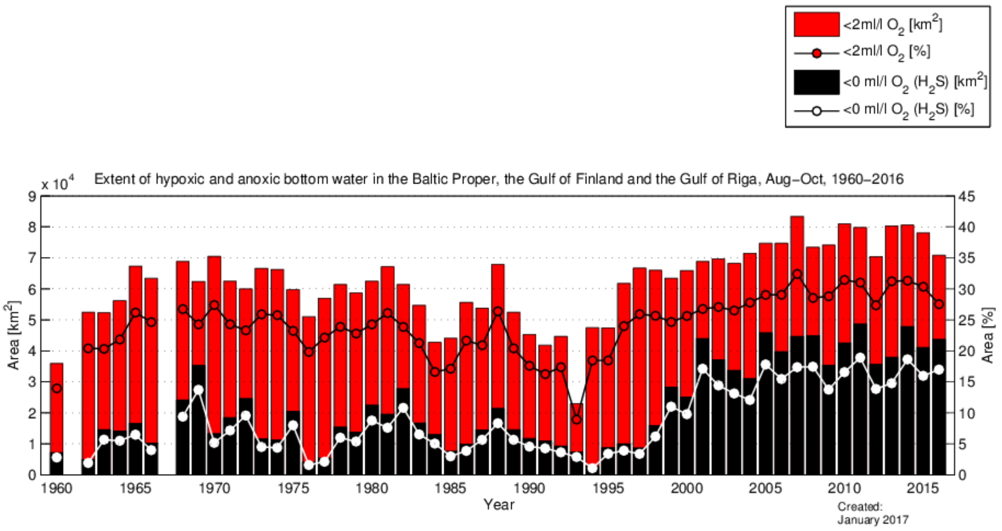


Figure 1.12. Time-series of anoxic and hypoxic seabed in the entire Baltic Proper. From the Swedish Meteorological and Hydrological Institute (SMHI) annual report.

The underlying processes leading to a certain stock status and furnishes an easy-to-understand way to communicate the results to the stakeholders and managers (Working Document 6 in the WGBFAS 2010 report). The approach has recently been further developed to provide a visually effective way to track changes in the performance of drivers of fish stock dynamics (Eero *et al.*, 2012). In a changing environment, the status of individual fish populations and consequently the fishing possibilities can change rapidly, not always for reasons directly related to fisheries. In order to take the ecosystem context into account in the management process and achieve consensus concerning fishing possibilities among stakeholders, it is important that the status of various drivers influencing fish stocks, and their relative impacts are broadly understood.

An overview of the dynamics of the eastern Baltic cod, sprat and central Baltic herring SSB and recruitment together with the dynamics of drivers influencing the dynamics of biomass and recruitment is presented in Figure 1.13.

Environmental conditions for Eastern Baltic cod recruitment of year-classes 2010–2011 were assessed by the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (ICES WGIAB, 2013). This assessment was made based on an indicator of the limiting abiotic conditions for cod egg survival, the reproductive volume, found to be the most encompassing indicator of the significant indicators of environmental conditions of cod recruitment (as assessed by models on SSB-recruitment residuals; WGIAB, 2013). The reference value of reproductive volume distinguishing positive from negative environmental influence on cod recruitment

(Figure 1.14) was derived using the quantitative relationship between recruitment residuals and reproductive volume (WGIAB, 2013).

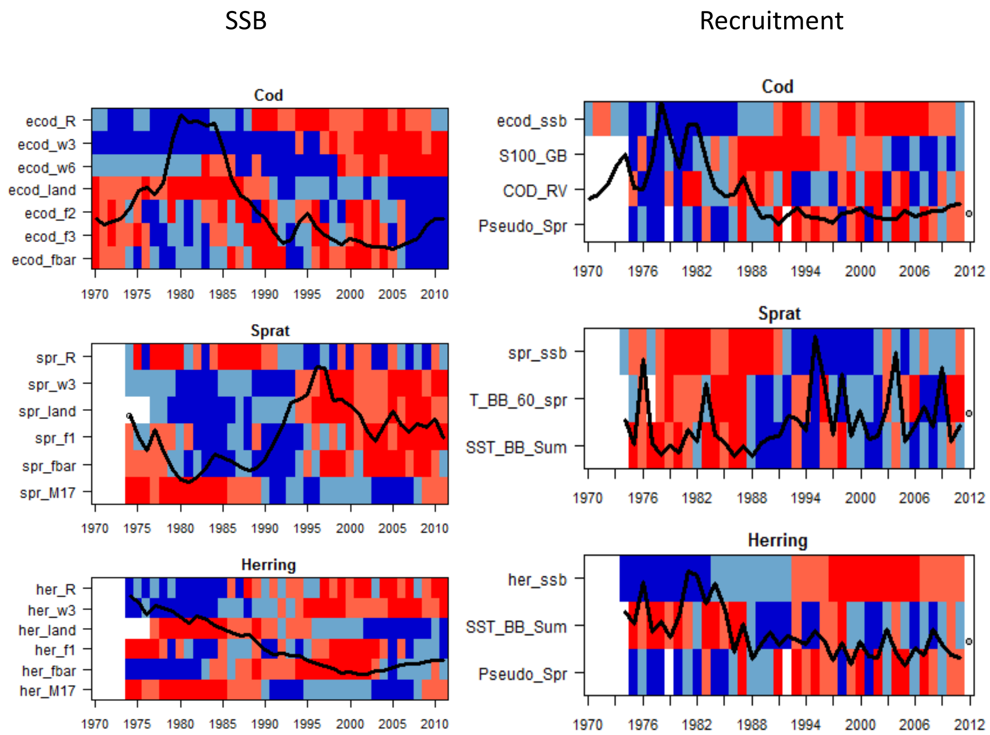


Figure 1.13. Temporal changes in indicators influencing the SSB and recruitment of the eastern Baltic cod, sprat and central Baltic herring. The colours refer to quartiles of the values observed in the time series, high values are marked with blue and low values with red colours, except for mortality where the colours are inversed. The lines show the trends in SSB and Recruitment of the stocks, the dost for recruitment in the final years show the values used in short-term forecast (R-recuitment; w-weight-at-age; land-landings, f-fishing mortality at age; M-natural mortality (average of ages 1–7); S100_GB- salinity at 100 m depth in Gotland Basin; COD_RV- cod reproductive volume, Pseudo_Spr-abundance of *Pseudocalanus* in spring; T-BB-60_spr- temperature at 60 m depth in spring in Bornholm Basin; SST_BB_Sum- Sea surface temperature in summer in Bornholm Basin).

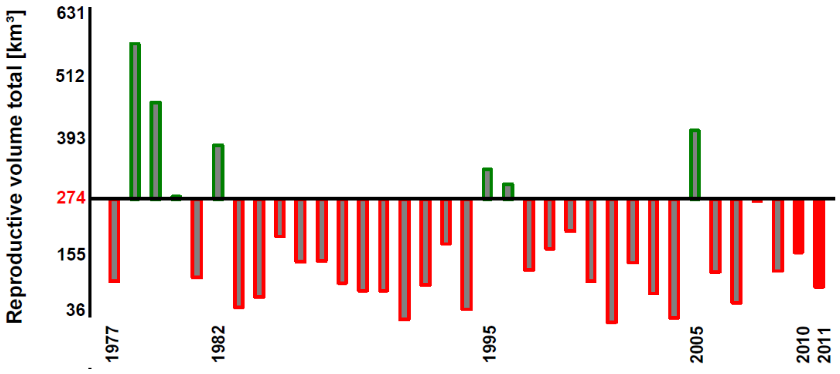


Figure 1.14. Time series of reproductive volume for Eastern Baltic cod (summed across the three deep basins in the Baltic Sea), assembled by WGIAB 2013. Relationships between each variable and residuals from cod recruitment (back shifted) vs. cod SSB were derived during WGIAB 2013, using linear models of first or second-order polynomials for year-classes 1977–2009. Bars indicate the values relative to the reference value of each variable (derived from the fitted relationships on cod recruitment residuals, as the point where there is no environmental effect on recruitment); green bars indicate beneficial environmental conditions and red bars poor conditions for cod egg survival. This shows the poor conditions for cod recruitment for the year-classes 2010–2011 (corresponding to recruitment of age 2 in 2012–2013).

1.7.2 Biotic factors

1.7.2.1 Changes in Spatial distributions

Fish distribution has changed considerably during the past decades. The Eastern Baltic cod, in parallel with the decrease in its stock size, contracted its distribution to the southern areas since the mid-1980s. The sprat stock on the other hand, increased mostly in the northern areas of the Baltic Proper (Figure 1.15), which has been interpreted as a spatial predation release effect (Casini *et al.*, 2011). As a consequence of the spatial relocation of the sprat stock to more northern areas, the growth of sprat decreased mostly in these areas (Figure 1.16), indicating a spatial density-dependent effect (Casini *et al.*, 2011). These results show the importance of spatial analyses to deepen the knowledge on Baltic resources. The current low spatial overlap between predator (cod) and prey (sprat), at least in some seasons, implies changes in the strength of the predator-prey relationship from the 1970s–1980s. Moreover, the reallocation of the sprat population in the northern Baltic proper implies a spatial differentiation in the strength of intra-specific and inter-specific competition among clupeids.

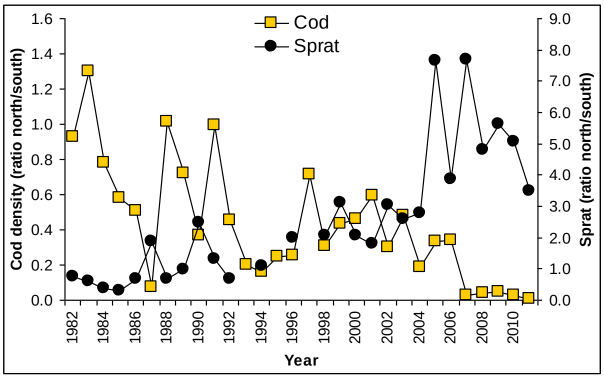


Figure 1.15. Ratio between sprat stock in northern Baltic Proper (SDs 27–29) and southern areas (SDs 25–26) as calculated by acoustic surveys, and ratio between cod stock in the northern Baltic Proper (SDs 27–28) and southern areas (SDs 25–26) from bottom trawl surveys. Modified from Casini *et al.* (2011).

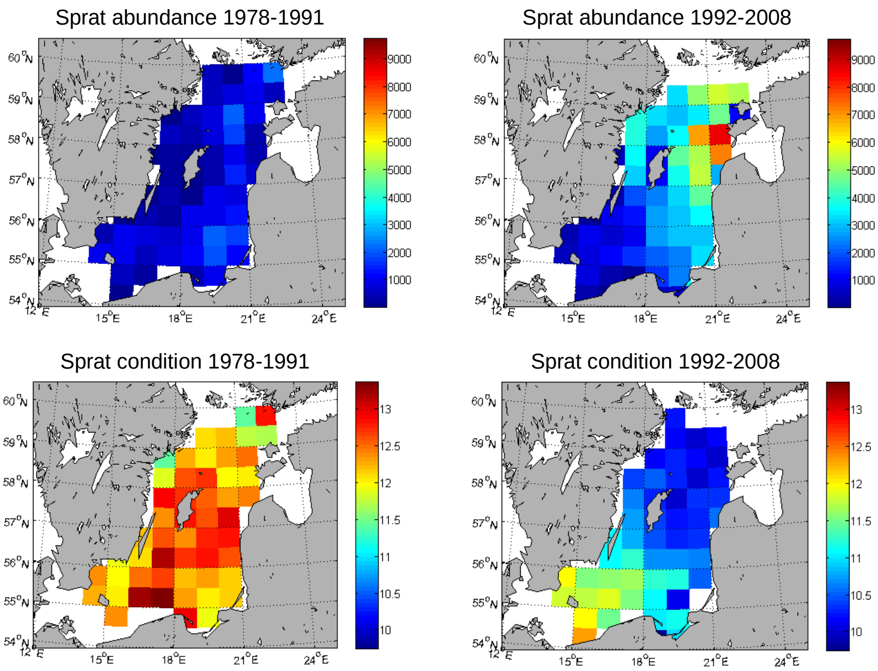


Figure 1.16. Spatial patterns in mean sprat abundance and clupeid condition in 1984–1991 and 1992–2008, from autumn acoustic survey. Only years with at least 10 individuals per rectangle were used in the condition calculation. From Casini *et al.* (2011).

1.7.2.2 SGSPATIAL and WKSPATIAL work on the link between cod feeding and growth/condition

The work of ICES SGSPATIAL 2014 and WKSPATIAL 2015,2016 (ICES, 2016) was focused on finalizing the stomach database from the data collated during the EU stomach tender running between 2012–2014 (Huwer *et al.*, 2014). Preliminary analyses of the data showed a decrease in the consumption rate and food intake of Eastern Baltic cod since the early 1990s (Figure 1.17). The proportion in weight of benthic vs. pelagic prey in the stomachs also decreased during the same time period, potentially due to increase in hypoxic areas. This indicates a decrease in feeding success and a change in the feeding habits of cod during the past 20 years, which could suggest a decrease in growth and explain the simultaneous decrease in cod condition.

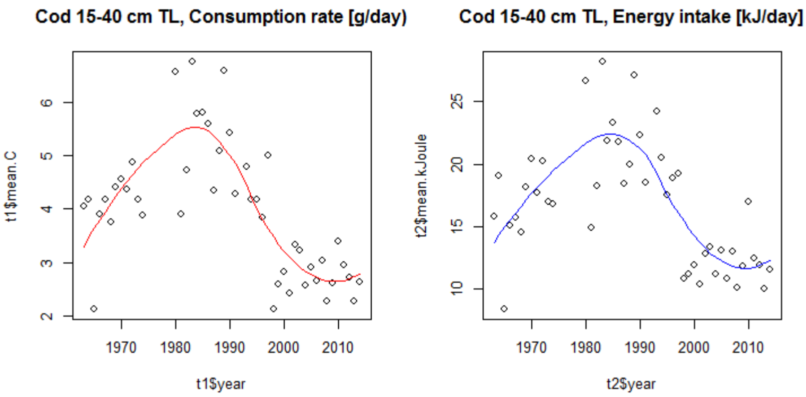


Figure 1.17. Temporal changes in consumption rate and energy intake for cod 15–40 cm (WKSPATIAL 2016).

1.7.2.3 Baltic cod body condition is related to hypoxic areas, density dependence and food limitation

Investigating the factors regulating fish condition is crucial in ecology and the management of exploited fish populations. The body condition of cod (*Gadus morhua*) in the Baltic Sea has dramatically decreased during the past two decades, with large implications for the fishery relying on this resource. We characterized the changes in the Baltic cod condition during the past 40 year. Moreover, we statistically investigated the potential drivers of the Baltic cod condition during the past 40 years using newly compiled fishery-independent biological data and hydrological observations (Casini *et al.*, 2016).

The results showed that cod condition increased between mid-1970s to early 1990s, followed by a drop until the late 2010s. After that the condition stabilized at low levels. The same pattern was observed for all the ICES subdivisions and all the length classes investigated (Figures 1.18).

The statistical analyses evidenced a combination of different factors operating before and after the ecological regime shift that occurred in the Baltic Sea in the early 1990s. The changes in cod condition related to feeding opportunities, driven either by density-dependence or food limitation, along the whole period investigated and to the fivefold increase in the extent of hypoxic areas in the most recent 20 years (Figures 1.19–1.20). Hypoxic areas can act on cod condition through different mechanisms related directly to species physiology, or indirectly to behaviour and trophic interactions (Figure 1.21). Our analyses found statistical evidence for an effect of the hypoxia-induced habitat compression on cod condition possibly operating via crowding and density-dependent processes (Casini *et al.*, 2016). These results furnish novel insights into the population dynamics of Baltic Sea cod that can aid the management of this currently threatened population.

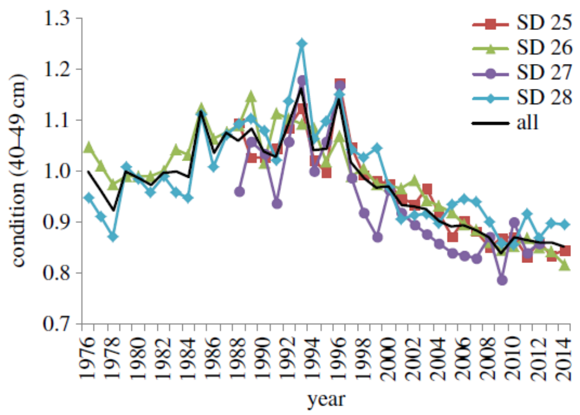


Figure 1.18. Temporal developments of mean cod condition in the different subdivisions (SDs) of the Central Baltic Sea for cod 40–49 cm. The black thick line is the average between the SDs. From Casini *et al.* 2016.

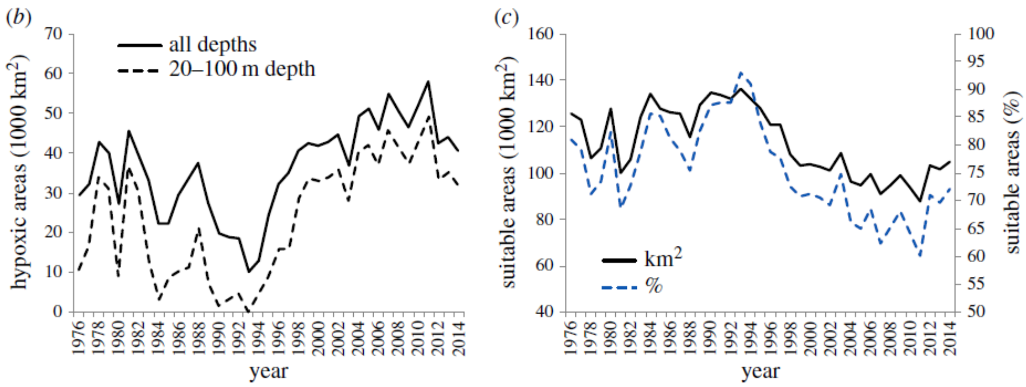


Figure 1.19. (b) time-series of total hypoxic areas (all depths), and hypoxic areas between 20–100 m depth, the latter used as predictors to explain cod condition in the GAMs; c) time series of suitable areas for cod (> 1 ml/l oxygen concentration) between 20–100 m depth, in absolute values and in percentage. The time-series refer to the Central Baltic Sea (SDs 25-28). From Casini *et al.* 2016.

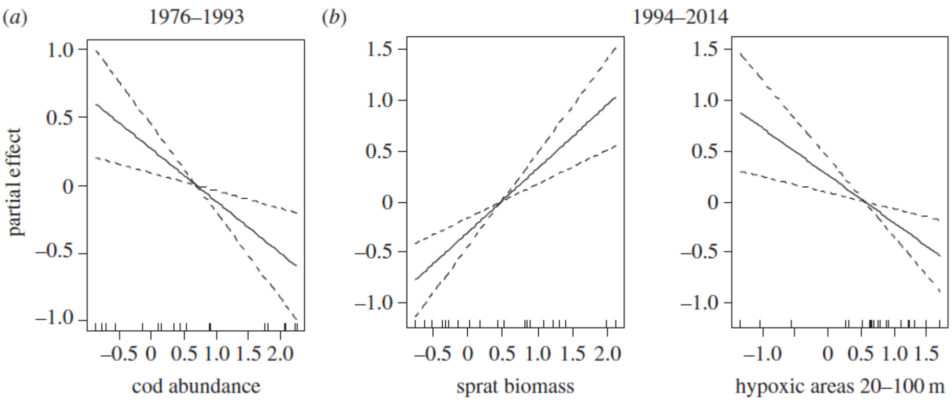


Figure 1.20. Results of the GAM (final model) for the two separated time periods (1976–1993 and 1994–2014). The partial effects of each predictor on cod condition are shown. From Casini *et al.* 2016.

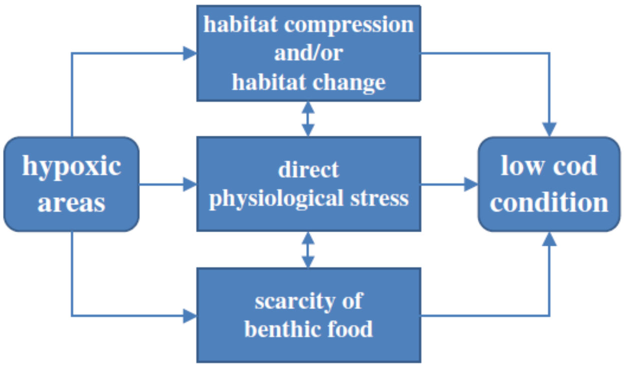


Figure 1.21. Schematic representation of the mechanisms potentially explaining the negative relationship between hypoxic areas and cod condition. From Casini *et al.* 2016.

1.7.2.4 Condition factor and feeding conditions in the Gotland Basin

The present available biological and fishery industry information reveal several changes in the structure and the biology of the cod stock in the Baltic. (i) Mean weight at age of cod decreasing since 2005. The decrease started earlier in the elder ages than the younger ones. (ii) There are observations from fishery that cod body condition in recent years has decreased. (iii) The deoxygenation and extension of hypoxic areas of Baltic Sea basins are increasing. This is to a large extent related to change of periodicity of major Baltic inflows. (iv) Cod stock in the Gotland basin remains very low although temporary increases were observed.

Based on these stock and ecosystem changes we tried to identify the main abiotic and biotic drivers that have led to the change in body condition of cod. As a test area we selected the Gotland basin, in which environmental and cod stock biological data have been collected since 1974. The results show that the temporal decrease in cod condition is mainly related to the extension of hypoxic area and oxygen saturation in water layers above the halocline. Extension of hypoxic area is also associated with change of cod diet. Since 1990's the share of benthic invertebrates and fishes has decreased significantly. The dominant species in the cod diet were clupeid fishes. Significant relation was found with herring abundance only, which has a more demersal distribution than sprat.

Fisheries industry indicated that cod body condition were quite sufficient in coastal areas (depths below 30 m) to compare with the deeper parts of the basin. We assume that this due to an expansion of invasive round goby in the coastal areas that total abundance since 2005 till 2013 has increased almost 100 times. Round goby is very easily accessible food item for cod in areas where the distribution is overlapping.

The main conclusions from the analyses are (i) The decrease of condition factor is determined by regime changes in the Eastern Baltic that depends from water exchange with North Sea; (ii) Main factors affecting condition factor from these analyses is hypoxia area and oxygen content; (iii) Although the sprat abundance is increasing the utilization of sprat may be insufficient due to prey and predator distribution (overlap) differences in time and space in the Gotland Basin; (iv) There were no stock density effects revealed on cod growth and condition.

1.7.2.5 Analyses of cod stomachs, biological and hydrological components

A study regarding recent (1999–2013) changes in cod physiological parameters of different size groups, which are related to food and maturation rates, and, to a certain extent, to an attempt to identify possible causes, factors and interactions that have formed the current environmental uncertainties and risks when assessing abundance, biomass of Eastern Baltic cod and prospects of this fishery type. The results of our research in the ICES SD 26 confirm trends in growth and early maturation of the Eastern cod stock. Thus, at the present time the size composition of the cod stock is characterized by the dominance of small-sized fish, and the average length of 50% matured females decreased to 32 cm, males - up to 21 cm.

Energy and plastic resources of liver provide generative processes. According to our data, hepatosomatic indices (HPI) of all size groups of cod fell by 2013 in comparison with the beginning of the 2000's. Statistically significant HPI correlations between all parameters are found only in component 2, which characterizes the inter-annual variability of this index with a tendency to reduce its values. This fact is also proved by our analysis of cod energy level dynamics while studying the liver fat (% fat content in chemical composition – Figure 1.22).

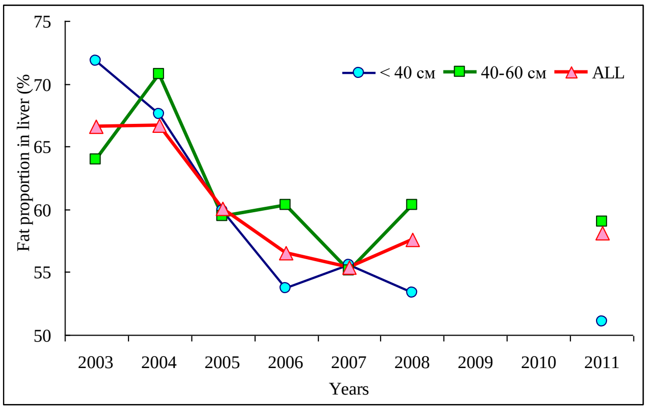


Figure 1.22. Fat proportion in liver of different cod size groups (in %) based on chemical analysis (data obtained by L.I. Perova and M.L. Vinokur, technological direction of AtlantNIRO: Reports on the research work "Investigation of nutrition and biological value of commercial and non-commercial fishes of the Atlantic Ocean and the Baltic Sea based on the catches for the period of 2003–2011").

Taking into account the decrease of liver energy resources of all cod size groups in recent years, increasing of the fed state degree by sprat and reducing of the feeding rate by crustaceans, it can be assumed that abundance of *Saduria entomon* and *Mysis mixta*, especially during the fish fattening, *i.e.*, in the autumn-winter season, is the main biotic driver that influence the physiological state of all cod size groups.

Changes in living conditions cause an adaptive response of cod, the biological essence of which is to preserve the species in the new environment. Based on the data presented, taking into account the results of the work showed that a size decrease of different species in aquatic systems is a universal or very general ecological response to warming, it can be concluded that the current increase in water temperature in the Baltic Sea, along with the expansion of waters with oxygen deficiency (in particular, through the influence of the latter factor in the narrowing of cod prey items spectrum) are the main abiotic drivers determining the structural changes in the population of Eastern Baltic cod in recent years.

1.7.3 Ecosystem and multispecies models

During the last two years, three papers have been published regarding Nash Equilibrium, a new management target to level off conflicts between interacting species. The Nash Equilibirum (NE) is defined as the multispecies state of fishing mortalities at which none of the species' yields can increase by changing the fishing effort. This is an optimum defined in general terms by John Nash (Nash, 1951), but not until now proposed as a management target in line with the MSY and ecosystem-based framework of the EU's common fishery policy (CFP).

A management strategy evaluation of NE was performed by Farcas and Rossberg (2016) comparing 9 other management options, including single-species MSY plans to achieve MSY from multiple (9-38) in silico stocks. Most plans outperformed (long-term yields) single-species management plans with pressure targets that were set without considering multispecies interactions. Nash equilibrium plans produced total yields comparable to plans aiming to maximize total harvested biomass, and were more robust to structural instability. They were concerned that implementation of the CFP, without "the systematic conservatism" of a NE, is in particular sensitive to structural instability. Expected yields are therefore comparably low, predicting the transition to MSY will lower rather than raise total long-term yields.

Norrström, Casini & Holmgren (2017) independently suggests NE as the multi-species MSY reference point. They analysed the NE for the cod, the herring and the sprat in the Baltic Sea main basin using an age-structured model capturing the ecological interactions between the species supported by ICES data. The study was also presented at WGSAM (ICES, 2017). Since the publication, an update has been made introducing density-dependent effects of herring and sprat on clupeid growth. The effect on the NE was higher yields on cod and herring, and lower yields on sprat (Table 1.16). This raised the B_{MSY} for herring above B_{pa}, which was already achieved for cod and sprat.

Table 1.16. Nash equilibrium reference points for herring and sprat according to Norrström *et al.* (2017), denoted P in the table. Updated values including density-dependence of clupeid growth is denoted U. For the update, also the F_{MSY} ranges are shown. ICES current single-species MSY, MSY ranges, B_{lim} and B_{pa} are shown for comparison. Yield and biomasses in thousand tonnes.

	FMSY		Ranges			BMSY				MSY	
	P	U	ICES	U	ICES	P	U	Blim	Bpa	P	U
Cod	0.47	0.45		.32-.63		211	295	63	89	76	102
Herring	0.3	0.27	0.22	.17-.43	.16-.28	460	733	430	600	115	167
Sprat	0.54	0.59	0.26	.45-.73	.19-.27	794	663	400	560	402	371

Nash equilibrium has now also been calculated for the North Sea by Thorpe, Jennings and Dolder (2017). They included 21 interacting species and took into account the existing mixed fisheries putting constraints on the set of Fs defining the NE. F-ranges for the NE were calculated, and the risk of stock collapse was analyzed across the range. The greatest collective long-term benefits from mixed multispecies fisheries will be achieved when F-PGY is close to or below F_{MSY} as defined at the Nash equilibrium.

1.7.4 Ecosystem considerations in the stock assessments

The WGBFAS recognises the importance of the changes in the ecosystem for the development of the Kattegat and Baltic Sea fish stocks, and has therefore when possible accounted for these in the stock assessments.

The changes in cod predation pressure on clupeids are accounted for in the assessments of herring in SD 25–27, 28.2, 29 and 32 and sprat SD 22-32 stocks by using SMS estimates of natural mortality up to 2012 (WKBALT 2013), and extrapolated using Eastern Baltic cod SSB index the year after.

The results of the spatial distribution analysis are included in the advice sheet for sprat. Recommendations include directing fishing efforts targeting sprat to areas where the abundance of sprat is high and the abundance of cod is low.

1.7.5 Conclusions and recommendations

As shown above, there are important ecosystem changes that need to be considered in the assessments. WGBFAS has accounted for the impact of climatic factors as well as of other species, from both lower and higher trophic levels, on the assessed stocks. However, WGBFAS wishes to further advance this matter during future work. To this end, WGBFAS needs input from the following working groups:

1) **WGIAB**: within the current stock assessment framework, ecosystem considerations necessarily are simplified to include interactions between two or at most three species, and/or one or at most two environmental variables. WGBFAS therefore highly appreciates the work done by the WGIAB to develop methods for integrated assessments of the ecosystem state and development. WGBFAS suggests WGIAB to update annually the time-series of abiotic and biotic conditions acknowledged affecting the stocks dealt by WGBFAS.

2) **WGSAM**: continue to develop multispecies models for the Baltic Sea region and to benchmark models for different use in the assessment.

3) **WKDEICE**: continue to develop strategies for integrating environmental and economic information in fish stock advice.

1.8 Stock Overviews

In WGBFAS, a total of 3 cod stocks, 1 sole stock, 3 herring stocks, 1 sprat stock and 10 flatfish stocks, are considered. In 2018 analytical assessments were carried out for, cod in SD 22–24, herring in SD 25–29, 32 (excl. GoR), herring in GoR, herring in SD 30-31, sole in SD 20-24 and sprat in SD 22–32, plaice in 21–23. Spawning stock trends are given for cod in Kattegat and plaice in 24–32. Survey trends are given for cod in 25–32, brill in 22–32, turbot in 22–32 and the four flounder stocks. Results of the assessments are presented in the subsequent sections of the WG report.

Cod in Kattegat

The reported catches of cod in Kattegat have declined from more than 15 000 tonnes in the 1970ies, 10 000 tonnes in the late 1990ies. In 2017, reported landings were 294 t. The SSB has decreased from historical high levels in the 1997. There were some signs of a recovery in the 2015 but the SSB level is approaching the historical low levels again in 2017. The mortality has decreased since 2008 to historically low levels. The recruitment the last 4 years has been below average.

Cod in subdivisions 22–24 (Western Baltic cod)

The cod stock in the Western Baltic has historically been much smaller than the neighbouring Eastern Baltic stock, from which it is biologically distinct. It appears to be a highly productive stock, which has sustained a very high level of fishing mortality for many years. In SD 24 there is a mixing between the eastern and western Baltic cod stock, which is taken in account in the present assessment. Recreational fishery is for this stock a rather large and increasing proportion of the total catch and amounted for close to 20% in 2017. Recruitment is rather variable and the stock is highly dependent upon the strength of incoming year-classes, the 2015 year class was estimated to be very low, however the 2016 class is presently estimated to be very large.

The 2017 spawning stock biomass was estimated around 11 500 t (which is below B_{lim}, 27 400 t). However, with the large incoming 2016 year class and the predicted low F in 2018, due to a large reduction in TAC in 2017, it is estimated that the stock will increase to close to 25 000 t. in 2018 and even further up in 2019.

Cod in subdivisions 25–32 (Eastern Baltic cod)

The Eastern Baltic cod stock is biologically distinct from the adjacent Western Baltic (subdivisions 22–24) stock although there is mixing of the two stocks in SD 24 that is taken into account in present assessment. The biomass increased in the end of the 1970s to the historically highest level during 1982–1983 and thereafter declined to the lowest level on record in 2004 and 2005. In the late 2000s the stock was estimated to have increased and fishing pressure declined. However, since 2012, the biomass index has declined again and the 2018 value is the lowest observed in surveys since 2003. Furthermore, abundance of larger (> 40 cm) cod has drastically declined since 2013, and the stock presently mainly consists of small individuals. The average condition of cod (weight-at-length) has been decreasing since the 1990s to present historic low level. At the same time, size at first maturity is declined from ca 35 cm to 20 cm. The decline in condition is likely caused by many factors such as a general decrease in food availability (benthos, pelagic fish and other food items), density dependence of cod, increased parasites induced by seals, increased anoxic areas etc. Last stronger year classes occurred in 2011–2012. Analytical assessment is presently not available, and the assessment is based on survey trends.

Sole in subdivisions 20–24

The landings of sole in SD20–24 fluctuated between 200 and 500 t annually prior to the mid-1980s. Landings increased to a maximum of 1400 t in 1993 and have since then been lower but increased again since 2015 to 550 t in 2017. Sole has mainly been caught in a mixed fishery as a valuable bycatch; the trawl fishery for *Nephrops* and a gillnet fishery for cod and plaice. During 2002–2004 the fishery was increasingly limited by quota restrictions, increasing the incentive for misreporting. After 2005 the fishery has been less restricted, however, the effort regulations on kw-days that was put in force in 2009 might potentially have restricted the effort on sole although the precise vessel behavior in relation to the many regulation is poorly known. The closed area in Kattegat to protect spawning cod might also restrict trawl fisheries for sole. Spawning stock biomass peaked at about 4000 t in 1992–1994 and also in 2005. Since then the SSB have decreased and have been between B_{pa}/$B_{trigger}$ (2600 t) and B_{lim} (1850 t) in the past decade. Fishing mortality has decreased continuously since the mid-1990s and but has in 2017 increased well above F_{pa} (0.37). Despite the recent low fishing mortality the stock has not recovered to levels above the trigger biomass (MSY $B_{trigger}$). This might be due to low recruitment since 2004 with a historic low in 2012. This changed biological regime with lower productivity is therefore used as basis for the recently defined MSY reference points.

Plaice in subdivisions 21–23

Plaice is caught all year round, mainly from winter to spring. In Subdivision 22 plaice are mostly taken in mixed fisheries together with cod. In Subdivision 21 plaice is almost exclusively a bycatch in the combined *Nephrops*–sole fishery. Information on discard indicates that discard in weight was close to 50% of the total catch throughout the whole time serial even though the discard in recent years has decreased. The SSB in the plaice stock has increased since 2009 and is in 2017 estimated to have increased 4 fold in the time series (starting in 1999). At the same time the relative trend in F has decreased in is estimated to be in a low level present. Discard information is considered reliable since 2001.

Plaice in subdivisions 24–32

Plaice is mainly caught in the area of Arkona and Bornholm basin (subdivisions 24 and 25). ICES Subdivision 24 is the main fishing area with Denmark and Germany being the main fishing countries. Subdivision 25 is the second most important fishing area. Denmark, Sweden and Poland are the main fishing countries there. Minor catches occur in the rest of the Eastern Baltic. The stock size indicator from surveys has increased steadily since the early 2000s about five fold since the start of the survey time series in 2001. Especially the years 2017 and 2018 (Q1) display a strong increase in plaice abundance. The average stock size indicator in the last two years (2016–2017) is 27% higher than the abundance indices in the three previous years (2013–2015). In 2014 discard data was for the first time included in the advice of the stock. Discard was estimated to be relatively high for this stock – close to 45% in 2014 and about 38% in 2017. Discards in 2016 were exceptional high (~67%). Since 2017, plaice is under a landing obligation, resulting in an additional landings of 7 tonnes of "unwanted catch" (BMS landings).

Flounder in the Baltic

In January 2014 the flounder stocks in the Baltic were benchmarked. As a result four different stocks of flounder were identified (WKBALFLAT, ICES 2014). Flounder (*Platichthys flesus*) is the most widely distributed among all flatfish species in the Baltic Sea.

Flounder in subdivisions 22–23 (no advice)

The stock size indicator from surveys has increased steadily since 2005 about four fold. The average stock size indicator (biomass-index) in the last two years (2016–2017) is 13% lower than the biomass-indices in the three previous years (2013–2015), due to a weak abundance in the BITS Q4 survey in 2016.ICES Subdivision 22 is the main fishing area for this stock with Denmark and Germany being the main fishing countries. Subdivision 23 is only of minor importance (around 10% of the total landings of the stock). Discards of flounder are known to be high with ratios around 30–50% of the total catch of vessels using active gears. Passive fishing gears have lower discards, varying between 10 to 20% of the total catch. Depending on market-prices and quota of target-species (e.g. cod), discards vary between quarter and years. The discarded fraction can cover all length-classes and rise up to 100% of a catch.

Flounder in subdivisions 24–25 (no advice)

This stock is the largest flounder stock in the Baltic. The biomass index from surveys has been increasing over the time series. The average stock size indicator (biomass-index) in the last two years (2015–2016) is 63% higher than the biomass-indices in the three previous years (2012–2014).

Landings in SD 25 are substantially higher than in SD 24. The main fishing nations in SD 24 are Poland and Germany and in SD 25 – Poland and Denmark. The majority of landing is taken by Poland.

The discard ratio in both subdivisions varies between countries, gear types, and quarters. Discarding practices are controlled by factors such as market price and cod catches. Despite the high variability in discard ratios, discard estimates since 2014 have been used in the advice because discards reporting has improved.

Flounder in subdivisions 26 and 28 (no advice)

Flounder is taken as bycatch in demersal fisheries and, to a minor extent, in a directed fishery. The main countries landing flounder from subdivisions 26 and 28 are Latvia, Russia, Poland and Lithuania. Flounder landings in both subdivisions are dominated by active gears, taking in average 80% of total landings. Discards are considered to be substantial and determined by cod fishery and market capacity. The stock showed a decreasing trend from the beginning of the century although the estimated indices in last four years are on stable level. The stock abundance is estimated to have slight increase by 0.7% between 2013–2015 (average of the three years) and 2016–2017 (average of the two years).

Flounder in subdivisions 27, 29–32 (no advice)

Flounder is taken both as bycatch in demersal fisheries and in a directed fishery. Landings mainly originate from passive gears such as gillnets (80–90% of landings). Discard patterns are unknown. In Estonia, discards are not allowed. Flounder in the northern Baltic Sea is also caught to a great extent in recreational fishery; estimates from surveys collated by ICES (2014d) suggest recreational landings of around 30% of the total landings.

The ICES BITS survey do not cover the Northern Baltic area and the survey conducted are local surveys close to the coast. The indices are very variable between years and no uniform trend is evident between the surveys. The total stock size indicator value seems to show a slight increasing trend from 2012 onwards. However, this trend is largely thrived by one survey in SD29 (Küdema survey, Estonia).

Dab in subdivisions 22–32 (no advice)

Dab (*Limanda limanda*) is distributed mainly in the western part of the Baltic Sea. The eastern border of its occurrence is not clearly identified. There are indications of three dab populations in the Baltic Sea: one in the Belt Sea (subdivisions 22 and 24W), one in the Sound (Subdivision 23), and one in the Arkona and Bornholm basins (subdivisions 24E and 25). Nursery grounds of the latter are located in shallow coastal areas and spawning only takes place in the western Arkona basin. The main dab landings are taken by Denmark (subdivisions 22 and 24) and Germany (mainly in Subdivision 22). The landings of dab are mostly bycatches of the directed cod fishery. Discard are substantial for this stock and estimated to be close to 50%. The stock size indicator from surveys has increased steadily since 2001 nearly threefold. The survey index varied around 106 kg hour^{-1} between 2010 and 2017 in SD 22– 24 and remains stable.

Brill in subdivisions 22–32 (no advice)

Brill is distributed mainly in the western part of the Baltic Sea and Brill fishery is dominated by Denmark in SD 22 (95% of the catches in 1985–2017). Yearly landings within the Baltic Sea have varied between 27 and 105 tonnes during the last ten years. The eastern border of its occurrence is not clearly described. Additional information has been available based on the international coordinated Baltic International Trawl Survey (BITS) since 2001 where standard gear was applied and common survey design was used. The stock size indicator from surveys was the highest in 2011 and varied around 1.1 individuals hour-1 larger or equal to 20 cm between 2012 and 2017 in SDs 22– 24.

Turbot in subdivisions 22–32

Turbot is a coastal species commonly occurring from Skagerrak up to the Sea of Åland. Turbot spawns in shallow waters (10–40 m, 10–15 m in central Baltic) and the metamorphosing postlarvae migrate close to shore to shallow water (down to one meter depth). Turbot fishery is concentrated on the westerly parts of the Baltic Sea (SD 22– 26) and mean annual landings are around 200 tonnes since 2013. Biological and fishery data of turbot were available from all national fisheries. For turbot the genetic data show no structure within the Baltic Sea (Nielsen *et al.*, 2004, Florin and Höglund, 2007), although the former discovered a difference between Baltic Sea and Kattegat with a hybrid zone in SD 22. Spatial distributions of turbot during BITS suggest that the turbot stock SD 22–32 is probably related with turbot in SD 21. The stock size indicator from surveys varied around 2.90 individuals/hour larger or equal to 20 cm in the last five year in SD 22–28 and increased to 3.5–3.9 individuals/hour in the two last recent years.

Herring in subdivisions 25–29 & 32 excl. Gulf of Riga (Central Baltic herring)

Is one of the largest herring stock assessed by the WG and it comprises a number of spawning components. This stock complex experienced a high biomass level in the early 1970s but has declined since then. The proportion of the various spawning components has varied in both landings and in stock. The southern components, in which individuals are growing to a relatively larger size, has declined and during the last years the more northerly components, in which individuals reach a maximum size of only about 18–20 cm, are dominating in the landings. The latest stronger year-classes were the 2002, 2007, 2011 and 2014 year-class, respectively. The 2014 year class is estimated to be the highest of the whole time series. The spawning stock size has shown an increasing trend, with minor fluctuations, since the beginning of the 2000´s. The present SSB estimate for 2017 is above the long-term average (1974–2016). The amount of reported landings taken within the small meshed industrial fisheries may be uncertain as it is mostly caught in mixed fisheries together with sprat. F is in 2017 estimated to 0.20 and is thereby below F_{MSY} (0.22).

Gulf of Riga herring

The stock is classified to have a full reproduction capacity. The spawning stock biomass of the Gulf of Riga herring has been rather stable at the level of 40 000–60 000 t in the 1970s and 1980s. The SSB started to increase in the late 1980s, reaching the record high level of 120 000 t in 1994. Since then the SSB has been the range of 71 000–124 000 t. The year class abundance of this stock is significantly influenced by hydro- meteorological conditions (by the severity of winter, in particular). Mild winters in the second half of 1990s have supported the formation of series of rich year-classes and increase of SSB. Due to low and only occasional presence of sprat in the Gulf, there is no mixed pelagic fishery in the Gulf of Riga.

Herring in subdivisions 30 and 31

The spawning stock of Gulf of Bothnia herring was at relatively low level of 200 000 t in the beginning of the 1980s, from which it started to increase and peaked in 1994. A new increasing development started in the first half of the 2000s. Although recruitment has been on average much higher during the high biomass period, favourable environmental conditions have contributed to the production of abundant year classes. The most abundant year classes have hatched in very warm summers like 2002, 2006, 2011, or 2014. In the biomass estimates from the acoustic surveys in 2007–2017, there is no trend in SSB, Z at age or change in the age distribution of the stock. This suggests that the recent exploitation has not impacted the state of the stock. SSB in 2017 is estimated to have decreased from its highest peak in 2014, but it is still regarded to be clearly above the $MSYB_{trigger}$ like it has been since the end of the 1980s.

Sprat in subdivisions 22–32

The spawning stock biomass of sprat has been low in the first half of 1980s, when cod biomass was high. At the beginning of 1990s the stock started to increase rapidly and in 1996–1997 it reached the maximum observed SSB of 1.9 million t. The stock size increased due to the combination of strong recruitments and declining natural mortality (effect of quickly decreasing cod biomass). The increase in stock size was followed by large increase in catches, which reached record high level of over half million t. in 1997. High catches in following years led to stock decline and fluctuations of SSB at the level of about 1 million t. since the beginning of 2000s. Spawning stock biomass for over 30 years was higher than precautionary levels, while fishing mortality has fluctuated between F_{pa} and F_{lim} since 2000. Recently F has declined towards F_{msy}. Due to strong year- class of 2014, the stock has increased in recent years and is predicted to stay at high level till 2020. During recent two decades the stock distribution has been changing with tendency to increase density in north-eastern Baltic.

1.9 Recommendations

See Annex 2.

2 Cod in the Baltic Sea

2.1 Cod in subdivisions 25–32

2.1.1 The fishery

A description of eastern Baltic fisheries development is presented in the Stock Annex.

2.1.1.1 Landings

From 2015 there is a landing obligation for cod in the Baltic Sea. Thus there is no minimum landing size, but a minimum conservation reference size (MCRS) of 35 cm is in force, which is a change from earlier years minimum landings size (MLS) of 38 cm. Cod below MCRS cannot be sold for human consumption and has to be landed as a separate fraction of the catch. The landed cod below MCRS is here referred to as 'BMS landings' (BMS = Below Minimum Size).

There were two different options for submission of BMS landings data to InterCatch:

1) Landings, discards and BMS landings were submitted separately.

2) BMS landings were included in the discard estimate and were only reported as "Official landings" to InterCatch (The "Official landings" field is merely informative and is not included in the catch estimate when data are extracted). This option could be used if the design of the discard sampling does not allow discards and BMS to be separated in the discard estimation, for example when an observer effect on the discard pattern is suspected. In this case the estimate provided as discards is actually an estimate of "unwanted catch" and includes all cod that was not landed for human consumption.

Regardless of how BMS landings were provided in IC, for the statistics on BMS landings presented in this report, these should be derived from logbook data (or other official data sources) and not estimated from sampling.

BMS landings were provided separately from discards by Latvia, Lithuania, Germany, Estonia and Sweden. Poland and Denmark included BMS landings in the discard estimate in the data submission and provided separate information on BMS only as "official landings". In order to quantify the different catch categories in such case, BMS landings of cod reported only as "official landings" are included in the BMS landings and subtracted from the discard estimates in this report. However, this could not be done for number of fish by length, and therefore tables showing length distribution by catch category show BMS landings and discards together as "unwanted catch".

For 2015–2016, official BMS landings are not possible to show separately, due to inconsistencies in data reporting and submission in different countries. The available information indicates that BMS landings in these years were a very small fraction of total landings, similar to 2017 (see WGBFAS 2017 report).

National landings of cod from the eastern Baltic management area (Subdivisions 25–32) by year are given in Table 2.1.1 as provided by the Working Group members. Landings by country, fleet and subdivision in 2017 are shown in Table 2.1.2. The total provided landings in SD 25–32 in 2017 summed up to 25 496 t, whereof 99% were above MCRS and only 179 t were BMS landings (Table 2.1.3).

The total landings in the management area in 2017 were 13% lower compared to 2016. The available TAC for eastern Baltic cod has not been taken since 2009. In 2017, 77% of the TAC was caught, BMS landings and discards included (Fig.2.1.1)

Part of the landings of Eastern Baltic cod stock is taken in SD 24, i.e. the management area of Western Baltic cod (Fig. 2.1.2). The total landings in SD 24 are divided between the two stocks using stock identification information derived from otolith shape analyses combined with genetics (ICES WKBALTCOD 2015). Approximately 10–15 % of total landings of Eastern Baltic stock are estimated to have been taken in SD 24 in 2014–2016. In 2017, only 7 % of EB cod landings were taken in SD 24 (Fig.2.1.2; Table 2.1.4).

2.1.1.2 Unallocated landings

For 2017, similar to 2010–2016, information on unreported landings was not available and the Working Group was not in a position to quantify them. Unallocated landings have been a significant problem during 1993–1996 and 2000–2007 when the unreported landings have been 35–40%. More detailed information of unreported landings is given in Stock Annex. Misreporting significantly declined in 2008–2009 and amounted to 6–7%. The decrease of unreported landings in recent years obviously is related to a decreasing fishing fleet due to EU vessel scrapping program and improvement of fishing control. Since the TAC has not been taken since 2009, misreporting is considered a minor problem in recent years.

2.1.1.3 Discards

In addition to landings above MCRS and BMS landings, discard estimates were also submitted from most countries. Even though there is a landing obligation in the Baltic Sea from 2015, discards were still estimated from on-board sampling by most countries (Denmark, Finland, Germany, Latvia, Poland and Sweden). The total discards in 2017, in subdivision 25–32, were estimated to 3 238 t (not including any BMS landings), which constituted 11% of the total catch in weight. This was at the same level as in 2016. 93% of the estimated discards in weight were caught by active gears. As no adjustments for misreporting in landings were made, no adjustments of the discards were made.

Since some countries provided discards and BMS landings together as one estimate in terms of number of fish at length (see section 2.1.1.1 for further information on how BMS data/discards were submitted), it was not possible to show length distributions for BMS landings and discards separately. Therefore, length distributions can only be separated by wanted (landings above MCRS) and unwanted (BMS + discards) catch.

The most abundant length class of the unwanted catch in 2017 was length class 30–34 cm (52% in numbers) followed by length classes 35–37 cm and 25–29 cm 4 (28% and 12%, respectively) (Table 2.1.5).

The annual estimations of discards (and thus also the variation in discard figures from year to year) must be taken with caution because of the generally low sampling intensity, of particularly passive gears, and thus large uncertainties in the estimates. Since 2015 discard estimation for Eastern Baltic cod has been further complicated by the fact that discarding under the landing obligation is illegal, which increases the risk of an observer effect on discard patterns in sampled trips and can also lead to increased difficulties for observers to be allowed on board fishing vessels.

The total discards in tonnes estimated for SD 24 were divided between eastern and western Baltic cod using the same stock splitting information as for landings, which resulted in 214 tonnes of estimated discards of eastern Baltic stock in SD 24 in 2017 (Table 2.1.4). This results in estimated discard rate of 11 % in weight, for the entire eastern Baltic stock, including both the SDs 25–32 and the fraction of the stock in SD24.

2.1.1.4 Effort and CPUE data

No data on commercial CPUEs was presented at WGBFAS. The effort data from EU STECF (2016) shows a decline in kw-days both for trawls and gill-nets in the central Baltic Sea in 2012–2015.

2.1.2 Biological information for catch

2.1.2.1 Catch in numbers of the stock

Catch numbers at length of the fraction of the Eastern Baltic cod stock distributed in SD 24 were derived by upscaling the numbers at length estimated for SD 25 by the fraction of catch originating from SD 24, separately for landings and discards. The catch numbers for SDs 25–32 were derived from compilation of biological information submitted to InterCatch.

2.1.2.2 Length composition of catch

The most abundant length class in the total catch 2017 was 38–44 cm (47% in numbers), followed by 35–37 cm (18%) and 30–34 cm (15%) (Table 2.1.5). Table 2.1.6 gives the estimated mean weight per length class and gear in the landings and discards 2017.

Due to issues with age reading of eastern Baltic cod (ICES WKBALTCOD 2015) information on age structure of catches is not available.

2.1.2.3 Quality of biological information from catch

Due to issues with age determination of eastern Baltic cod, only numbers and mean weight at length were requested from commercial catches for the data year 2017. All countries biological data was estimated nationally before being uploaded and further processed in InterCatch. Numbers and mean weight at length were provided for 76% of the total landings (>MCRS) in weight, 80% of the BMS landings and 68% of the estimated discards. This was an increase from 2016 when only 68% of the landings and 61% of the discards were covered with sample data. Length distributions for discards should be considered more uncertain than length distributions for landings due to a lower sampling coverage, especially for passive gears that are poorly sampled in many strata. As in previous years since 2013, the input data for SDs 25–32 were prepared solely using InterCatch. The use of only one reporting format (in this case InterCatch) provides a more transparent way to record how the input data for assessment have been calculated. However, due to the large methodological differences in the data reporting and preparation, some inconsistencies could be expected between the data compiled in 2013–2017 and the data compiled in previous years.

2.1.3 Fishery independent information on stock status

The main source of fishery independent information on the stock is the Baltic International Trawl survey (BITS) conducted in Q1 and Q4 that is used for stock assessment. The following sections summarize the available biological information on stock status.

Stock distribution

Data from BITS surveys indicate that cod is mainly distributed in ICES SDs 25 and 26 (Fig. 2.1.3). Relatively high CPUE values are recorded also in SD 24 that is a mixing area for eastern and western Baltic cod; in the easternmost areas of SD 24 most of the cod are of eastern origin. The CPUE values further north-east (SD 27–28) are generally very low indicating that the bulk of the stock is concentrated in southern Baltic Sea, i.e. in SDs (24)25–26. Time series of CPUE by size-groups of cod shows that in 2017 Q4 relatively high CPUE values of smallest (<25 cm) cod were recorded at the eastern coast, including SD 28. For largest cod (>40 cm), higher CPUE values were seen in Gdansk Deep (SD 26) compared to Bornholm Basin (SD 25) in surveys in 2017 Q4 and 2018 Q1, which is a change from earlier years when highest abundances have generally been recorded in SD 25. Coverage in SD 26 has substantially improved in latest surveys in 2017 and 2018, when Russia has participated in the survey (Fig. 2.1.3).

Nutritional condition

Nutritional condition (Fulton K) of eastern Baltic cod has substantially declined since the 1990s in all SDs 24–28 and has been at a relatively stable low level since 2010 (Fig. 2.1.4). The proportion of cod at 40–60cm in length with very low condition (Fulton K <0.8) in samples from Q1 surveys has been increasing from below 5% in the 1990s and early 2000s to close to 20% in 2013–2014, and is around 15% in latest years. In Q4, condition is generally lower than in Q1, and the value for 2017 is the lowest observed in the time series (Fig. 2.1.5).

Growth and natural mortality

It is hypothesized that growth of EB cod has reduced since the 1990s, especially due to reduced size at maturation, poor condition of cod, hypoxia, and parasite infestation (ICES WKBEBCA 2017, WKIDEBCA 2018). Natural mortality of different size-classes of cod is considered to be driven by different processes, such as low condition, early maturation, and possibly parasite infestation. The M for the main part of the adult cod could presently be as high as 0.5 (ICES WKIDEBCA 2018).

Maturity

Size at first maturation has substantially declined in the period from the 1990s to 2000s. The L_{50} (50% percent mature and contributing to spawning) has been estimated at around 35–40 cm in the early 1990s and has declined to around 20 cm since late 2000s (WKIDEBCA 2018).

Recruitment

Larval abundances from ichthyoplankton surveys suggest that last stronger year-classes occurred in 2011 and 2012 (Köster *et al.* 2016), which are also visible in length frequency data from BITS surveys. The CPUE of <25 cm cod has been variable over time, the most recent value from 2017 Q4 BITS survey was relatively high compared to three previous years. However, the CPUE of this size group in subsequent Q1 survey in 2018 was at a similar low level as in previous three years (Fig. 2.1.6).

Adult biomass and size distribution

Relative abundance of cod follows similar trends in Q1 and Q4 surveys (Fig. 2.1.6). Since 2013, relative abundance of larger (>45 cm) cod has been very low and the main part of the survey catch consists of 20–40 cm cod.8

2.1.4 Assessment

No quantitative assessment for the stock is presently available, mainly due to uncertainties in age information, and presumed changes in growth and natural mortality, which have not been quantified. The challenges for analytical assessment for this stock are described in Eero et al. (2015).

2.1.4.1 Stock trends from BITS survey

The assessment is based on trends in BITS survey index. An index of SSB was produced using the combined time-series of BITS Q1 and Q4 surveys.

CPUE (No./h) per length-class by quarter and SD was derived from the DATRAS database. CPUE in weight (Kg/h) was estimated by Quarter and SD and year using length-weight relationships based on individual fish data from the DATRAS database. Mean CPUE (Kg/h) for Q1 and Q4 for the whole stock were thereafter obtained as a weighted average over SDs, by using area size of SDs as weightings. The CPUEs (Kg/h) from Q1 and Q4 were combined as a geometric mean (Q1 raw and Q4 shifted 1 year ahead) to produce an index of SSB from 2003 to 2018 (Fig. 2.1.7, 2.1.8). The index used for assessment is based on cod >= 30 cm. The index based on SD 25–28 is considered to represent the relative dynamics of the entire EB cod stock (i.e. representing the relative dynamics of EB cod also in SD 24).

After a steep increase between 2005 and 2010, the SSB index (for cod >30 cm) abruptly decreased between 2012 and 2013, and remained relatively stable for 2013–2015 with an average of 140 Kg/h. In 2016, CPUE increased to around 180 Kg/h, but declined sharply to 96 Kg/h in 2017 and further down to 70 kg/hour in 2018.

The average CPUE of the last two years (2017–2018) was 55% of the average CPUE of the previous three years (2014–2016).

2.1.4.2 Harvest rate

Time-series of harvest rates between 2003 and 2017 were created as ratio between total catches for the stock (including landings and discards and the proportion of EB cod catch taken in SD 24) and the biomass index for >=30 cm cod (Fig. 2.1.8). The harvest rate was highest in 2004, followed by a substantial reduction. Between 2009–2011, the harvest rate was stable at the lowest level in the time series since 2003. Thereafter, harvest rate increased again from 2011 to 2015, though is still considerably lower compared to the level in mid 2000s. Since 2015, the harvest rate fluctuates without a trend (Fig. 2.1.8).

2.1.5 Short term forecast and management options

No short-term forecast was performed for the stock.

2.1.6 Reference points

There are no reference points defined for Eastern Baltic cod, in terms of absolute values.
SPiCT model is used to evaluate stock status relative to MSY Proxy reference points.

SPiCT stands for a stochastic surplus production model in continuous time (Pedersen and Berg, 2016). SPiCT does not need to separate between growth and natural mortality of the fish, which is a strong advantage in situations where these cannot be separated, like is presently the case for Eastern Baltic cod. A specific version of SPiCT was applied for Eastern Baltic cod, to allow taking into account a potential change in surplus production over time. The time period with a separate productivity "regime" was estimated in the model, based on maximum likelihood value, thus not making explicit assumption on when the productivity change should take place and by which level. The new productivity regime was estimated in SPiCT to start from 2010 (giving the best likelihood value). This is in line with the trends in major drivers considered to affect productivity changes (in terms of growth and natural mortality), which were levelling off in the late 2000s.

SPiCT operates internally with absolute values, but produces output, including the uncertainties also in relative terms (F/F_{MSY} and B/B_{MSY}), because the relative estimates are considerably more certain compared to the absolute ones. This is because the same parameters are included in both numerator and denominator of the relative values, which reduces the uncertainty in the relative estimates. Therefore, the absolute values for F, B, F_{MSY} and B_{MSY} are not recommended to be used. The relative values for F/F_{MSY} and B/B_{MSY} are reasonably well estimated in the model for Eastern Baltic cod and can be used to define the stock status relative to the reference points. Further explanations and description of the SPICT model applied for EB cod are provided in WGBFAS 2017 report Annex 2.1.

SPICT estimates the fishing mortality of the stock above F_{MSY} Proxy in 2017 and the biomass below B_{MSY} as well as B_{MSY} trigger proxy in 2018 (Figure 2.1.9) The diagnostics of SPICT model is shown in Figure 2.1.10.

2.1.7 Quality of the assessment

The presumable decrease in growth may have affected the catchability of the BITS surveys. Survey coverage in SD 26 has been relatively poor in some years, with few stations in areas with relatively high abundance of cod, which could affect the CPUE estimates for these years. The coverage in SD 26 is considerably improved in latest surveys (2017 Q4 and 2018 Q1). The survey index used as a basis for assessment is based on SD 25–28 only, thus assuming that the EB cod component in SD24 is following a similar trend as the cod in SD 25–28.

2.1.8 Comparison with previous assessment

The assessment is based on survey index following the same approach as in last year. Thus, the perception of the stock status for earlier years has not changed. New data points are added to survey series, and respective trends are described in section 2.1.4.

2.1.9 Management considerations

Reported BMS landings in 2017 were very low and discarding still occurs, with estimated discard rate at 11% for the Eastern Baltic stock.

The present distribution pattern of cod, sprat and herring (cod mainly concentrated in Subdivision 25 and 26, and clupeids in the more northern subdivisions), implies that an increase in F on cod, not necessarily will result in increasing the Baltic clupeid stock sizes. Conversely, a decrease in F on cod will not necessarily result in a decrease of the Baltic clupeid stock size if it will not be accompanied by a cod expansion to northern areas. A reduction of clupeid F in subdivisions 25–26 can possibly improve growth and condition of cod as well as reduce cannibalism. However, as the relative contribution of different factors to poor condition of cod is not fully understood, the potential effect of reduced clupeid F on cod condition and growth is unclear.

Table 2.1.1 Cod SDs 25–32. Total landings (tonnes) by country (Includes BMS landings which are related to landing obligation implemented since 2015).

Year	Denmark	Estonia	Finland	German Dem.Rep.**	Germany Fed. Rep.	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands^	Norway	Unallocated***	Total
1965	35313		23	10680	15713			41498		21705	22420				147352
1966	37070		26	10589	12831			56007		22525	38270				177318
1967	39105		27	21027	12941			56003		23363	42980				195446
1968	44109		70	24478	16833			63245		24008	43610				216353
1969	44061		58	25979	17432			60749		22301	41580				212160
1970	42392		70	18099	19444			68440		17756	32250				198451
1971	46831		53	10977	16248			54151		15670	20910				164840
1972	34072		76	4055	3203			57093		15194	30140				143833
1973	35455		95	6034	14973			49790		16734	20083				143164
1974	32028		160	2517	11831			48650		14498	38131				147815
1975	39043		298	8700	11968			69318		16033	49289				194649
1976	47412		287	3970	13733			70466		18388	49047				203303
1977	44400		310	7519	19120			47702		16061	29680				164792
1978	30266		1437	2260	4270			64113		14463	37200				154009
1979	34350		2938	1403	9777			79754		20593	75034	3850			227699
1980	49704		5962	1826	11750			123486		29291	124350	1250			347619
1981	68521		5681	1277	7021			120901		37730	87746	2765			331642
1982	71151		8126	753	13800			92541		38475	86906	4300			316052
1983	84406		8927	1424	15894			76474		46710	92248	6065			332148
1984	90089		9358	1793	30483			93429		59685	100761	6354			391952
1985	83527		7224	1215	26275			63260		49565	78127	5890			315083
1986	81521		5633	181	19520			43236		45723	52148	4596			252558
1987	68881		3007	218	14560			32667		42978	39203	5567			207081
1988	60436		2904	2	14078			33351		48964	28137	6915			194787
1989	57240		2254	3	12844			36855		50740	14722	4520			179178
1990	47394		1731		4691			32028		50683	13461	3558			153546
1991	39792	1810	1711		6564	2627	1865	25748	3299	36490		2611			122517
1992	18025	1368	485		2793	1250	1266	13314	1793	13995		593			54882
1993	8000	70	225		1042	1333	605	8909	892	10099		558		18978	50711
1994	9901	952	594		3056	2831	1887	14335	1257	21264		779		44000	100856
1995	16895	1049	1729		5496	6638	4513	25000	1612	24723		777	293	18993	107718
1996	17549	1338	3089		7340	8709	5524	34855	3306	30669		706	289	10815	124189
^1997	9776	1414	1536		5215	6187	4601	31396	2803	25072		600			88600
1998	7818	1188	1026		1270	7765	4176	25155	4599	14431					67428
1999	12170	1052	1456		2215	6889	4371	25920	5202	13720					72995
2000	9715	604	1648		1508	6196	5165	21194	4231	15910				23118	89289
2001	9580	765	1526		2159	6252	3137	21346	5032	17854				23677	91328
2002	7831	37	1526		1445	4796	3137	15106	3793	12507				17562	67740
2003	7655	591	1092		1354	3493	2767	15374	3707	11297				22147	69476
2004	7394	1192	859		2659	4835	2041	14582	3410	12043				19563	68578
2005	7270	833	278		2339	3513	2988	11669	3411	7740				14991	55032
2006	9766	616	427		2025	3980	3200	14290	3719	9672				17836	65532
2007	7280	877	615		1529	3996	2486	8599	3383	9660				12418	50843
2008	7374	841	670		2341	3990	2835	8721	3888	8901				2673	42235
2009	8295	623			3665	4588	2789	10625	4482	10182				3189	48439
2010	10739	796	826		3908	5001	3140	11433	4264	10169					50277
2011	10842	1180	958		3054	4916	3017	11348	5022	10031					50368
2012	12102	686	1405		2432	4269	2261	14007	3954	10109					51225
2013	6052	249	399		541	2441	1744	11760	2870	5299					31355
2014	6035	166	350		676	1999	1088	11026	3444	4125					28908
2015	9652	189	388		1477	2586	1974	12937	3845	4628					37676
2016	6756	2	57		918	2717	1698	9583	3392	4189					29313
2017*	6140	1	191		347	2079	1726	6483	4124	4405					25496

* Provisional data.

** Includes landings from October to December 1990 of Fed. Rep. Germany.

*** Working group estimates. No information available for years prior to 1993.

^ Landings for 1997 were not officially reported – estimated by ICES.

Table 2.1.2. Cod in SD 25–32. Total landings (tonnes) by fleet, country and subdivision in 2017. Official reported BMS landings are included.

Subdivision		25	26	27	28	29	30	31	32	Total 25–32
Fleet	Country									
Active	Denmark	2974	2907	79		0				5961
	Estonia	0	0		0	0			0	0
	Finland	12	113		24		0			149
	Germany	333	14							347
	Latvia	87	1398		438					1922
	Lithuania	26	1311		143					1480
	Poland	2440	2528	0	0	0				4968
	Russia		3748							3748
	Sweden	2682	1394	0	0			0		4076
Total Active gears		8554	13413	80	605	0	0	0	0	22651
Passive	Denmark	149	30	0		0				179
	Estonia				0	0			0	1
	Finland					41	0	0	0	42
	Latvia	7	121		29					157
	Lithuania	50	196							245
	Poland	1357	159	0	0	0				1515
	Russia		376							376
	Sweden	262		17	1	49	1			329
Total Passive gears		1824	881	17	31	90	1	0	0	2844
Total All gears		10378	14295	97	636	91	1	0	0	25496

Table 2.1.3. Cod in SD 25–32. Total landings (tonnes) by country in 2017, separated between landings for human consumption (above MCRS) and the reported BMS landings.

Country	Landings for human consumption (t)	BMS landings (t)
Denmark	6 109	31
Estonia	1	
Finland	191	
Germany	337	10
Latvia	2 058	21
Lithuania	1712	14
Poland	6468	15
Russia	3594	
Sweden	4316	89
Total	24786	179

Table 2.1.4. Eastern Baltic cod stock in subdivisions 25–32 and Subdivision 24. History of ICES estimates of landings, discards, and catch by area. Landings obligation is in place since 2015, though landings above and below minimum conservation reference size (AMS and BMS) was only possible to separate for 2017. Weights in tonnes.

Year	Eastern Baltic cod stock in SD 25–32						Eastern Baltic cod stock in Subdivision 24			Eastern Baltic cod stock in subdivisions 24+25–32		
	Un allocated*	Landings AMS	Landings BMS	Total landings	Discards	Catch	Total landings	Discards	Catch	Total landings	Discards	Total catch
1965				147352		147352						
1966				177318	8735	186053						
1967				195446	11733	207179						
1968				216353	9700	226053						
1969				212160	10654	222814						
1970				198451	7625	206076						
1971				164840	5426	170266						
1972				143833	8490	152323						
1973				143164	7491	150655						
1974				147815	7933	155748						
1975				194649	9576	204225						
1976				203303	4341	207644						
1977				164792	2978	167770						
1978				154009	9875	163884						
1979				227699	14576	242275						
1980				347619	8544	356163						
1981				331642	6185	337827						
1982				316052	11548	327600						
1983				332148	10998	343146						
1984				391952	8521	400473						
1985				315083	8199	323282						
1986				252558	3848	256406						
1987				207081	9340	216421						
1988				194787	7253	202040						
1989				179178	3462	182640						
1990				153546	4187	157733						
1991				122517	2741	125258						
1992				54882	1904	56786						
1993	18978			50711	1558	52269						

Year	**Eastern Baltic cod stock in SD 25–32**						**Eastern Baltic cod stock in Subdivision 24**			**Eastern Baltic cod stock in subdivisions 24+25–32**		
	Un allocated*	Landings AMS	Landings BMS	Total landings	Discards	Catch	Total landings	Discards	Catch	Total landings	Discards	Total catch
1994	44000			100856	1956	102812	1784	166	1950	102640	2122	104762
1995	18993			107718	1872	109590	4041	541	4582	111759	2413	114172
1996	10815			124189	1443	125632	10210	1087	11297	134399	2530	136929
1997**				88600	3462	92062	6615	629	7244	95215	4091	99306
1998				67428	2299	69727	4588	630	5218	72016	2929	74945
1999				72995	1838	74833	6338	588	6926	79333	2426	81759
2000	23118			89289	6019	95308	6694	1153	7847	95983	7172	103155
2001	23677			91328	2891	94219	7261	383	7644	98589	3274	101863
2002	17562			67740	1462	69202	4566	548	5114	72306	2010	74316
2003	22147			69477	2024	71501	6569	854	7423	76046	2878	78924
2004	19563			68578	1201	69779	4925	184	5109	73503	1385	74888
2005	14991			55032	1670	56702	5191	1808	6999	60223	3478	63701
2006	17836			65531	4644	70175	6279	142	6421	71810	4786	76596
2007	12418			50843	4146	54989	7876	856	8733	58719	5002	63722
2008	2673			42234	3746	45980	8934	768	9702	51168	4514	55682
2009	3189			48438	3328	51766	8456	474	8930	56894	3802	60696
2010				50276	3543	53819	6479	559	7037	56755	4102	60856
2011				50368	3850	54218	7487	521	8009	57855	4371	62227
2012				51225	6795	58020	8419	564	8982	59644	7359	67002
2013				31355	5020	36375	5226	1331	6557	36581	6351	42932
2014				28909	9627	38536	5439	1268	6707	34348	10895	45243
2015				37675	5995	43670	5047	912	5959	42722	6907	49629
2016				29313	3620	32933	4430	293	4723	33743	3913	37656
2017		25316	179	25496	3238	28734	1942	214	2156	27438	3452	30889

*ICES estimates. No information available for years prior to 1993 or after 2009.

**For 1997 landings were not officially reported – estimated by ICES

Table 2.1.5. Cod in SD 25–32. Numbers (in thousands) of cod by length-groups in landings for wanted (human consumption landings) and unwanted catch (includes both BMS landings and estimated discards) in SDs 25–32 in 2017.

Length class (cm)	Wanted catch	Unwanted catch	Total
<20		19	19
20–24	61	156	217
25–29	247	1 158	1 405
30–34	1 632	5 261	6 893
35–37	5 650	2 769	8 418
38–44	21 483	592	22 075
45–49	5 743	74	5 816
>=50	2 434	17	2 451
Total	37 249	10 044	47 294

Table 2.1.6 **Cod in SD 25–32. Mean weight (g) by length class and catch category for cod in SDs 25–32, in 2017.**

Gear	Length class	Landings (human consumption)	BMS landings	Discards	Total catch
Active	<20			54	54
	20–24	102	182	110	108
	25–29	212	211	195	198
	30–34	344	312	311	318
	35–37	443	406	403	430
	38–44	619	456	543	617
	45–49	882		941	882
	>=50	1409	680	1397	1409
Passive	<20			50	50
	20–24	111	109	111	111
	25–29	189	198	189	189
	30–34	371	296	306	331
	35–37	485	391	453	473
	38–44	727	434	545	726
	45–49	981	523	795	978
	>=50	1413			1413

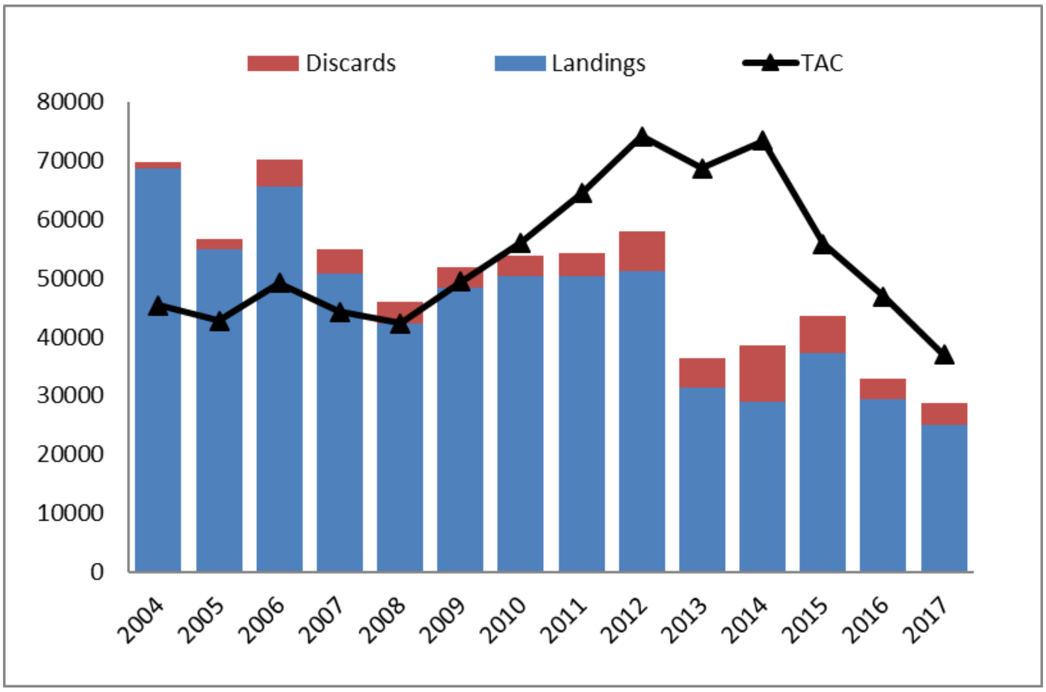


Figure 2.1.1 EB cod in SD 24–32. Total landings (incl. unallocated for years before 2010), estimated discards and TAC for management area of SDs 25–32.

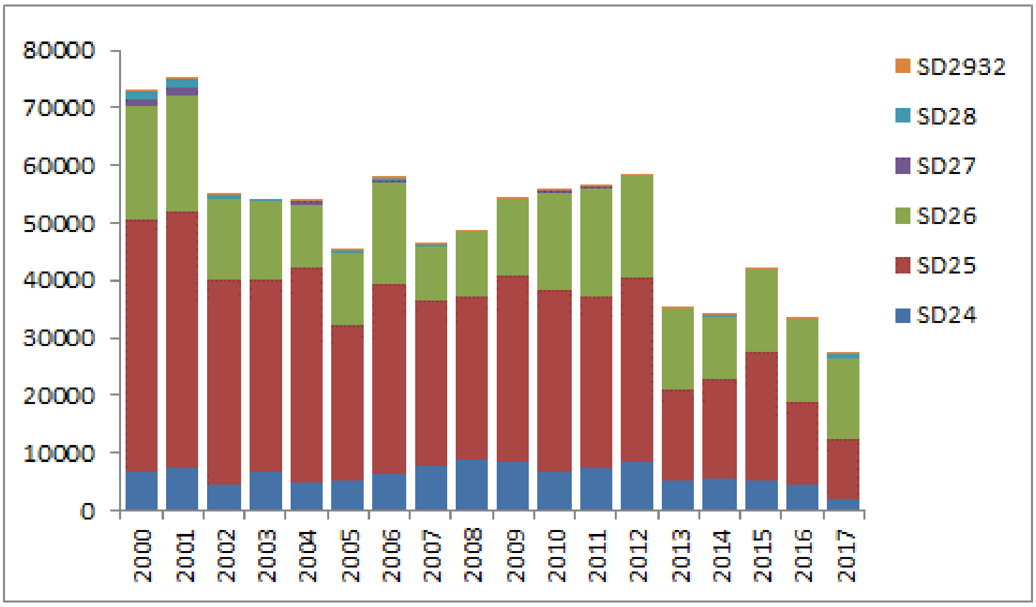


Figure 2.1.2 EB cod in SD 24–32. Landings of eastern Baltic cod stock by SD, including the fraction of landings taken in SD 24.

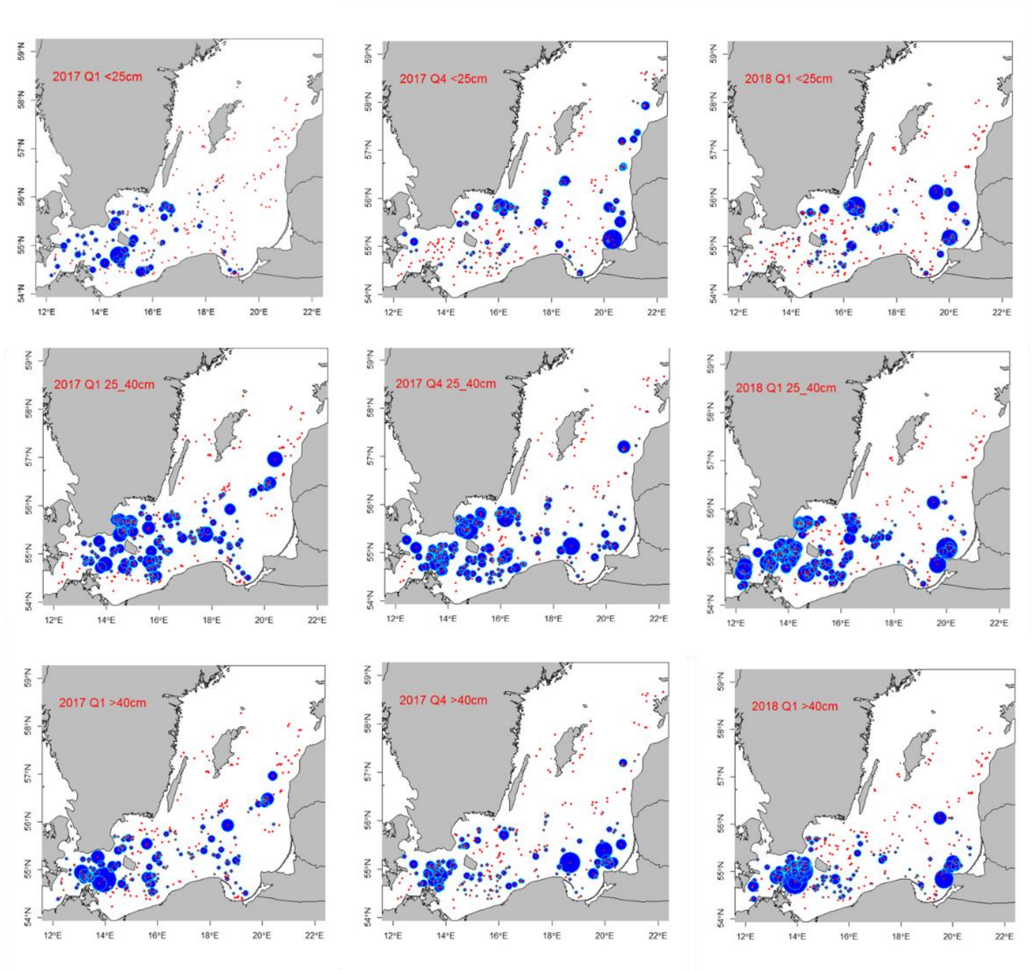


Figure 2.1.3. EB cod in SD 24–32. Distribution of cod from BITS surveys in Q1 and Q4 in 2017 and Q1 in 2018, by 3 size-groups (<25cm, 25–40cm and >40cm cod). The scale is comparable between surveys within a size group, but not between size-groups.

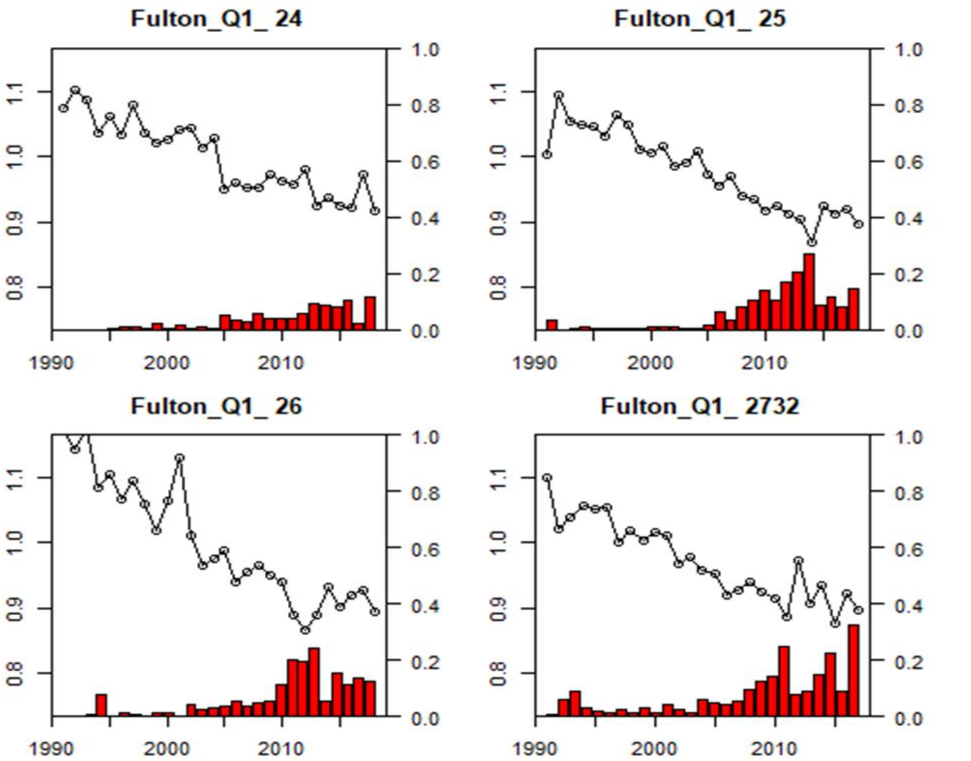


Figure 2.1.4. EB cod in SD 24–32. Condition (Fulton K) of cod at 40–60cm in length in Q1 BITS survey, by SDs. The lines show mean values for Fulton K, the bars show the proportion of cod at Fulton K <0.8.

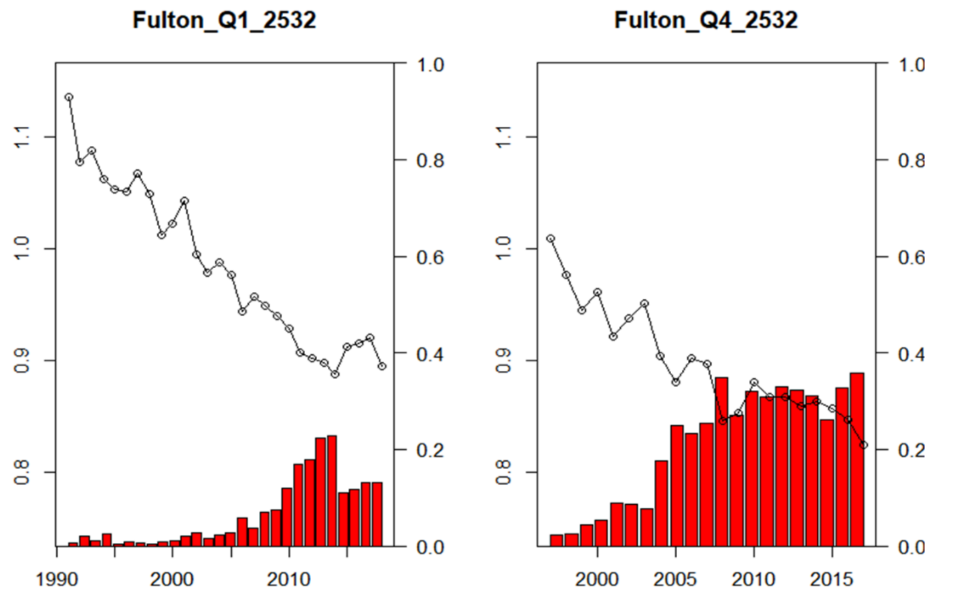


Figure 2.1.5. EB cod in SD 24–32. Average condition (Fulton K) of cod at 40–60 cm in length in Q1 and Q4 BITS survey in SD 25–32. The lines show mean values for Fulton K, the bars show the proportion of cod at Fulton K <0.8.

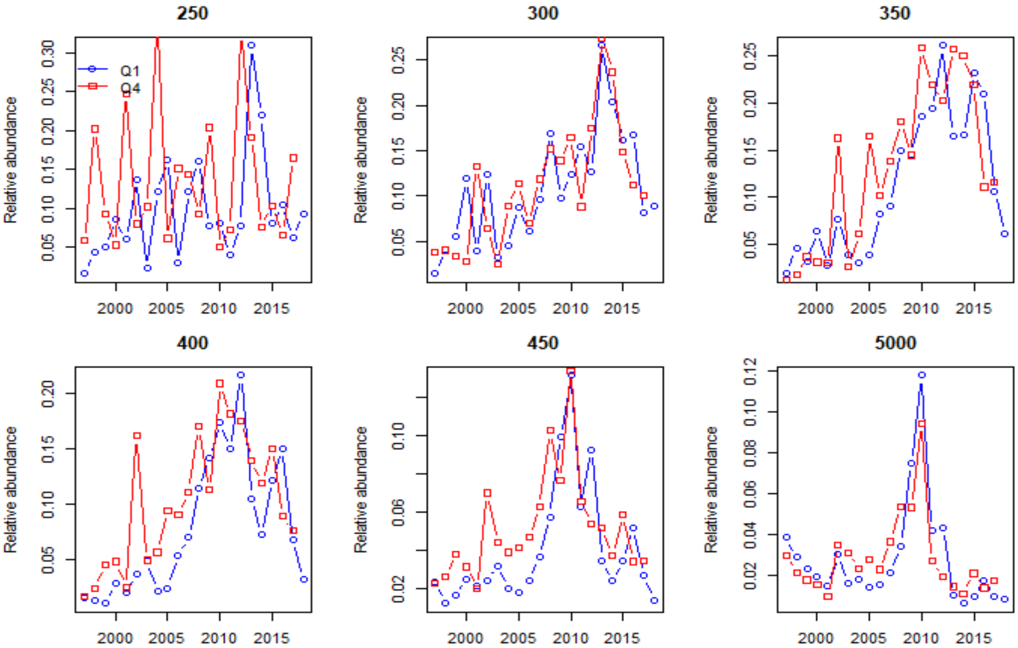


Figure 2.1.6. EB cod in SD 24–32. CPUE of cod by size-groups (<250, 250–300, 300–350, 350–400, 400–450 and >450 mm) in Q1 and Q4, in SD 25–32.

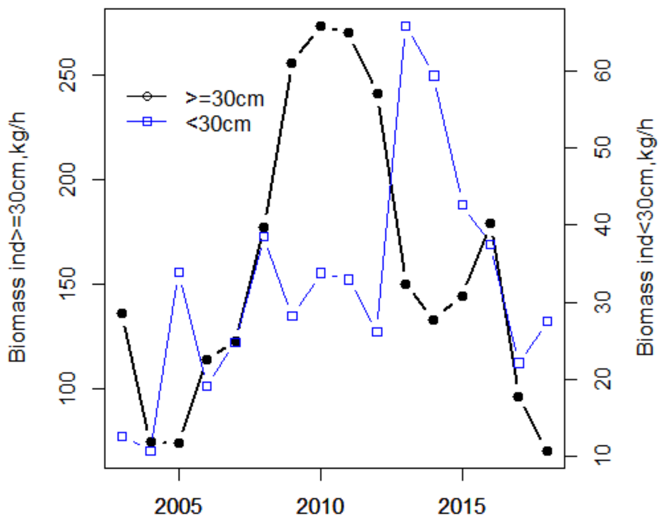


Figure 2.1.7. EB cod in SD 24–32. Relative biomass index of >=30 cm and <30 cm cod, estimated from Q1 and Q4 BITS surveys combined.

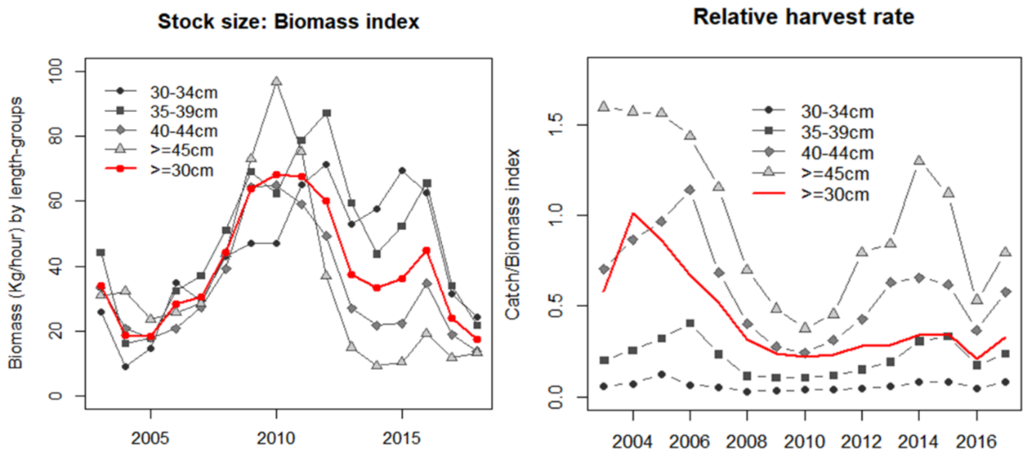


Figure 2.1.8. EB cod in SD 24–32. Relative biomass for cod by length groups, for Q1 and Q4 combined (left panel). Exploitation rate (catch divided by combined survey index for Q1 and Q4) by length groups, compared to the average exploitation rate for the stock (total catch divided by survey index for >=30 cm cod; red line).

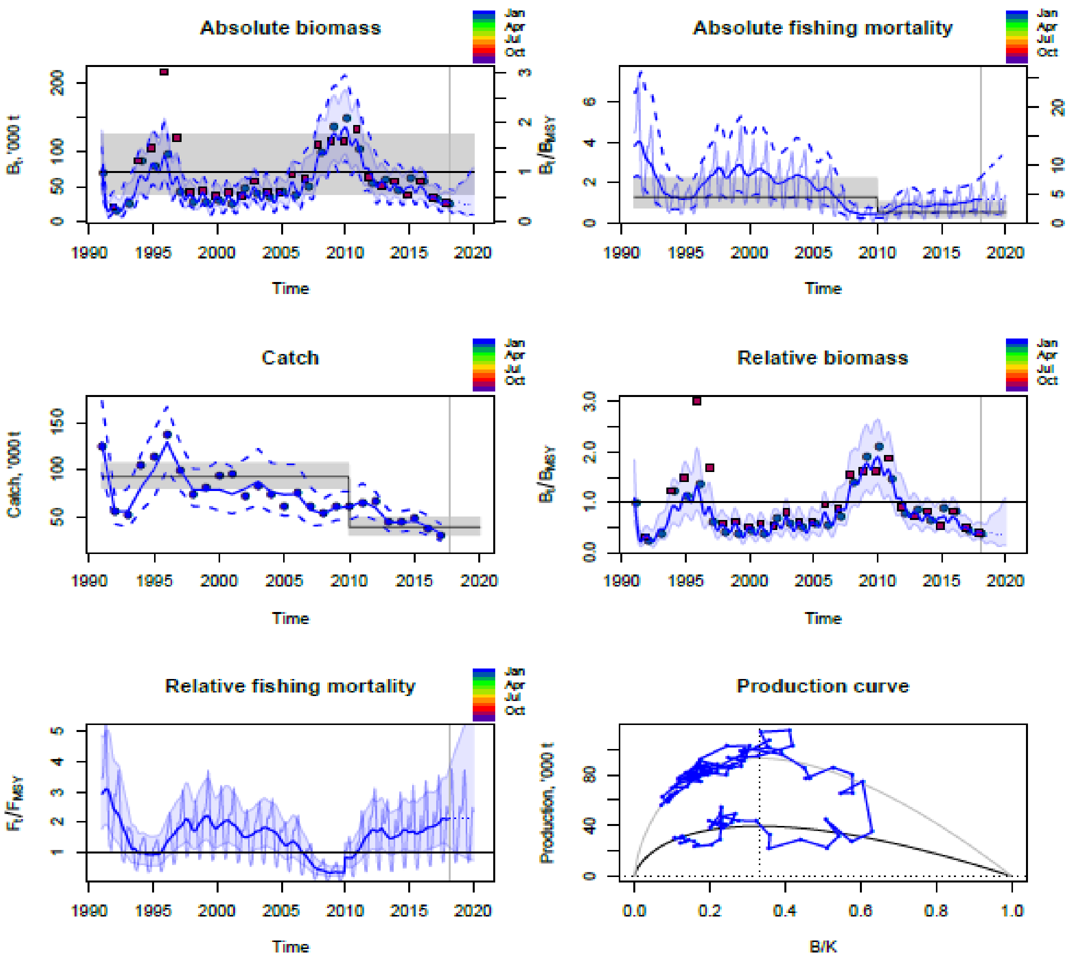


Figure 2.1.9. EB cod in SD 24–32. Results of SPICT model.

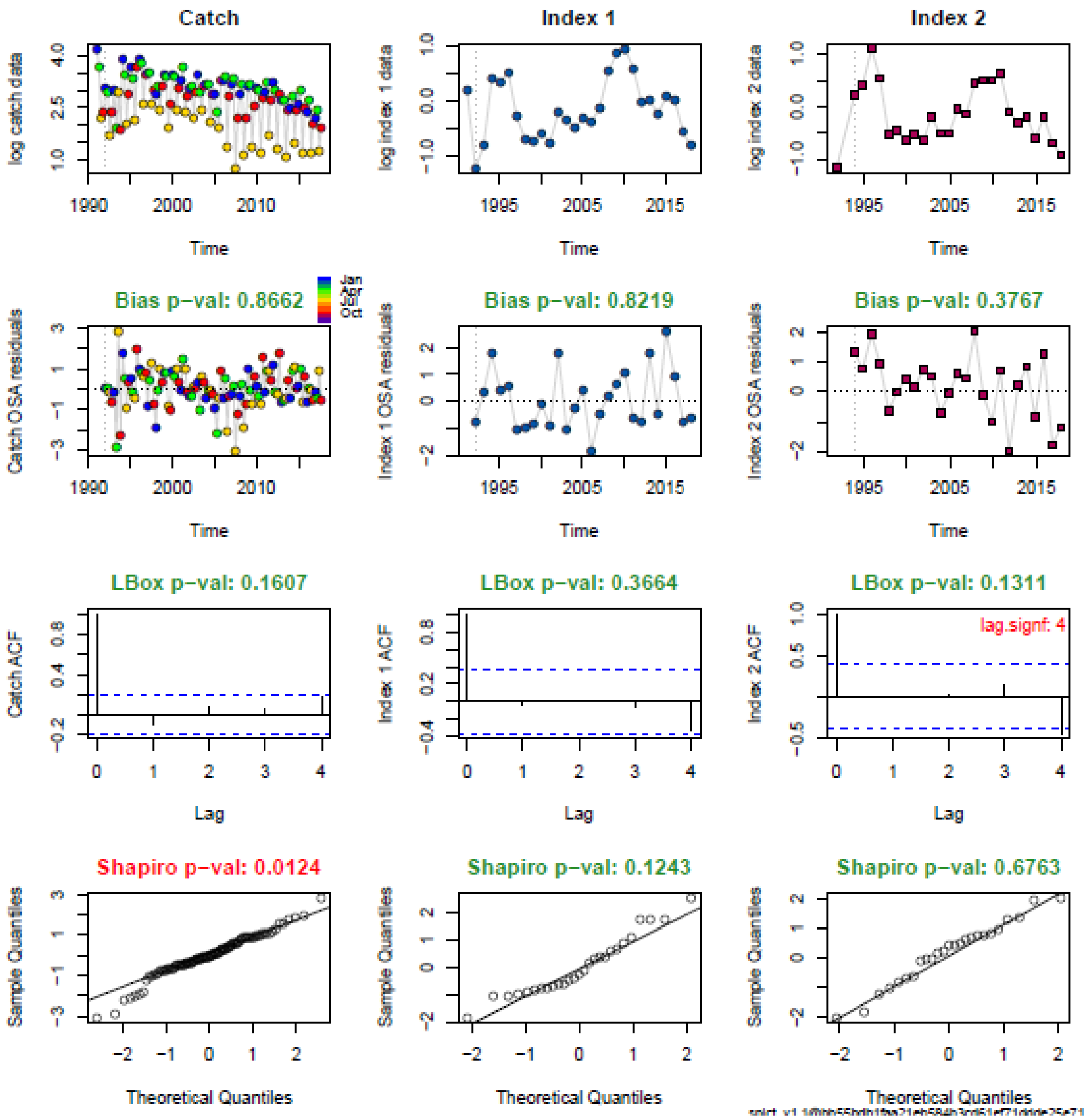


Figure 2.1.10. EB cod in SD 24–32. Diagnostics of SPICT model.

2.2 Cod in Kattegat

2.2.1 The fishery

2.2.1.1 Recent changes in fisheries regulations

TAC is mainly regulating the fishing in Kattegat since the effort limitation was stopped in 2016. The effort system was introduced in the first cod recovery plan (EC No. 423/2004). Effort was limited by allowed number of fishing days for individual fishing vessels. In 2009, following the introduction of the new cod management plan (EC No. 1342/2008) for North Sea (incl. Kattegat), a new effort system was introduced. In this system each Member State was given kWdays for different gear groups. It is then the MS responsibility to distribute the kWdays among fishing vessels. MS could apply for derogation from the kWdays system if the catches in a certain part of the fleet was shown to consist of less than 1.5% cod (article 11(2)(b)) or avoid cuts (or part of cuts) if they introduce highly selective gear and cod avoidance plans (article 13). Sweden has used this derogation from the kWday system for the part of the fishery using sorting grids. This fishery constituted since 2010 more than half of the Swedish effort. Denmark introduced in 2010 a cod recovery plan covering their entire Kattegat fishery. As a part of this plan, since 2011 it is mandatory in Danish fisheries to use a SELTRA trawl with at least 180 mm panel.

In 2009, as a part of the attempts to rebuild of the cod stock in Kattegat, Denmark and Sweden, introduced protected areas on historically important spawning grounds in South East Kattegat. The protected zone consists of three different areas in which the fisheries are either completely forbidden or limited to certain selective gears (Swedish grid and Danish SELTRA 300 trawl) during all or different periods of the year. Since 2012 the cod quota in Kattegat was considered to be a by-catch-quota where the landings of cod should constitute of 50% of the total landings.

The main fishery mortality for Kattegat cod is as bycatch in the *Nephrops* fishery. The decrease in minimal landings size in *Nephrops* enforced in 2015 (from 40 mm carapace to 32 mm carapace) might have an effect on the exploitation pattern for *Nephrops* (new areas exploited, new temporal trends in the fishery pattern) etc. These potential changes will most certainly affect the Kattegat cod stock development. Additionally, the termination of the effort system may also affect the fishery mortality for Kattegat cod. The effect of these changes on cod mortality is however hard to foresee.

2.2.1.2 Trends in landings

Agreed TACs and reported landings have been significantly reduced since 2000 to the present historical low level. The reported landings of cod in the Kattegat in 2017 were 293 tonnes, higher levels as last year (Table 2.2.1)

2.2.1.3 Discards

Both Sweden and Denmark implemented the TAC regulation through a ration-period system until 2007. The ration sizes were reduced substantially since 2000—2001 and the rations in the Kattegat were lower than those in adjacent areas, giving incentives for misreporting of catches by area (Hovgård, 2006), which could potentially have biased landings statistics for these years.

Discard estimates were available from Sweden for 1997—2017 and from Denmark for 2000—2017. The estimated discard numbers by age and total discards in tonnes are presented in Table 2.2.2. The sampling levels are shown in Table 2.2.3.

In 2016, the estimated discards formed about 46 percent of the catch weight and the proportion of discards in catch has decreased the last year compared to the previous years (Figure 2.2.1). In numbers, the available data indicates that close to 92% of the cod caught in the Kattegat is discarded. Discarding has in previous years mostly affected ages 1–2 but in 2015 and 2016 it also included both age 3 and 4. The year class of 2016 was a higher than the previous years (although below average) and is now constituting to 66% of the total numbers of cod in Kattegat 2018 (Figure 2.2.4). The large amount of 1 year cod 2017, increased the discard in numbers as the discard was constituting of mainly one year old fish (Figure 2.2.2, 2.2.4)

2.2.1.4 Unallocated removals

Unreported catches have historically been considered to be an issue for this stock, estimated as part of unallocated removals within the assessment model. Last benchmark (WKBALT 2017) concluded the catch data to be of reasonable quality from 2011 onwards. Major issues identified at WKBALT (2017) that could explain the unallocated removals estimated in the model include inflow of recruits from the North Sea cod and their return migration when they become mature, as well as possibly increased natural mortality due to seal predation.

2.2.2 Biological composition of the landings

2.2.2.1 Age composition

Historical total landings in numbers by age and year are given in Table 2.2.6.

2.2.2.2 Maturity at age

The historical time series of visual based maturity estimations used in the assessment are presented in Table 2.2.9. The estimates are based on IBTS 1st quarter survey. Due to low number of cod in the survey, the maturities in recent years are based on a running mean of 3 years.

2.2.2.3 Natural mortality

A constant natural mortality of 0.2 was assumed for all ages for the entire time series.

2.2.2.4 Quality of the biological data

Both Danish and Swedish sampling data were available from the commercial fishery in 2017. Danish and Swedish commercial sample sizes are shown in Table 2.2.3. and Table 2.2.4. Landings were allocated to age groups using the Danish and Swedish age information as shown in Table 2.2.5. The catch numbers followed the same procedure as the landings and catch in numbers by age is presented in Table 2.2.6)

Mean weight at age in the landings in 2017, presented in Table 2.2.7, and was provided by Sweden and Denmark. Historical weight-at-age in the landings is given in Table 2.2.7 for all years included in the assessment.

Mean weight at age in the stock is based on the IBTS 1st quarter survey for age-groups 1—3. Due to low number of cod in the survey, the weights in the stock in recent years are based on a running mean of 3 years. The weight of ages 4—6+ were set equal to the mean weights in the landings. The historical time series of mean weight-at-age in the stock is given in Table 2.2.8.

2.2.3 Fishery independent information

The CPUE-values used were from IBTS 1st and 3rd quarter surveys from the BITS surveys in the 1st quarter (Danish R/V Havfisken) and from the Cod survey 4th Quarter. The internal consistency of surveys (numbers at age plotted against numbers at age+1 of the same cohort in the following year) are shown in Figure 2.2.3a–d. The survey indices available for the Working Group are presented in Table 2.2.10,

The tuning series available for assessment:

Fleet	Details
BITS-1Q	Danish survey, 1st quarter, R/V Havfisken (age 1–5) (1997–2018)
IBTS-3Q	International Bottom Trawl Survey, 3rd quarter, Kattegat (age 1–6) (1997–2017)
IBTS-1Q	International Bottom Trawl Survey, 1st quarter, Kattegat; (Ages 1–6) (1997–2018)
CODS-4Q	Cod survey, 4th Quarter, Kattegat, (ages 1–6). (2008–2017)

2.2.4 Assessment

2.2.4.1 State-space model (SAM)

A stochastic state-space model (SAM) (Nielsen, 2008, 2009) was used for assessment of cod in the Kattegat link to the model. The model allows estimation of possible bias (positive or negative) in the data on removals from the stock in specific years. Settings of the model were used as specified in the Stock Annex. Two runs was performed

Catch (landings and discards) from 1997—2017 with estimating total removals from 2003—2017 within the model based on survey information. (SPALY _Scaling)

Catch (landings and discards) from 1997—2017 without estimating total. (SPALY _)

Unallocated removals were estimated separately for the years 2003—2017, but common for all age-groups within a year. The scaling factors estimated for 2005—2017 were significant for all the years in the SAM run with landings and total removals estimated. For the SAM run with discard and total removals estimated all years(except for 2003 and 2004) significant. The total removals were estimated several fold higher than reported landings, and are not explainable by the estimated discard data only (Figure 2.2.12).

Estimates of recruitment, SSB and mortality (Z-0.2) with confidence intervals from the two runs with total removals estimated are presented in figures 2.2.7—2.2.9 and tables 2.2.11—2.2.12. All information about the residuals and results from the two SAM runs (Figures 2.2.11; 2.2.13; 2.2.14; 2.215-2.2.15.)

2.2.4.2 Conclusions on recruitment trends

The absolute values of recruitment estimated from the assessment analyses are considered uncertain, mainly due to mixing with North Sea cod and possibly also uncertain natural mortality estimates. Additionally, discards are associated with uncertainties; at least for part of the time series. The year classes of 2014 and 2015 are the lowest in the times serie (Figures 2.2.5, 2.2.6). The year-class of 2016 is higher that the low recruitment the years after 2012, but still below average. (Figures 2.2.5, 2.2.6).

2.2.4.3 Conclusions on trends in SSB and fishing mortality

The assessment is indicative of trends only, and shows that spawning-stock biomass (SSB) has decreased from historical high levels in the 1997. There were some signs of a recovery in the 2015 but the SSB level are approaching the historical low levels again in 2017.

The increase in SSB trend in 2013–2015 was solely due to the strong year classes of 2011 and 2012. The decrease in SSB since 2015 is due getting progressively eroded under the lack of new good incoming year classes.

The mortality has decreased since 2008 to historically low levels. . However, the exact level of fishing mortality can still not be reliably estimated. The runs that estimated total removals show estimated mortality (Z-0.2) in the interval of 0.35 to 0.86. In contrast the run without estimating total removals in the interval of 0.1 to 0.3. However, the overall perception is that the total mortality has gone down since 2008 (Tables 2.2.11—2.2.12, Figure 2.2.8).

A minor error was detected in 2017 years assessment. In one of the survey - Bits q1 - the survey indices for the last two years (2015,2016) were not the correct values. The difference between the corrected and uncorrected values was minor and did not affect the assessment results at all.

2.2.5 Short term forecast and management options

No short term forecast was produced in this year’s assessment.

2.2.6 Reference points

Reference points are not defined or updated for this stock (see Stock Annex for further explanation).

During the assessment in 2017 two different approaches of proxy reference points was explored

The reference points was evaluated by the proxy reference group in 2017 they concluded :

1) *“The EG concluded that the proxies for MSY estimated using both LBI and SPiCT were unreliable. The EG notes that, should the problem with stock mixing be resolved, the SPiCT model would likely be useful in determining proxy reference points. The RG does not have sufficient information to comment on the conditions of the stock based on the given information and proxy reference points. Discussions of model sensitivity to changes in parameterization would have been beneficial.*
2) *The RG suggests, in the future, the suite of methods for establishing proxy reference points be reviewed and, for each method, the strengths and weaknesses of the method for the stock being considered should be discussed to justify why each method was accepted or rejected.*

Although the Reference group suggested future elaboration on the proxy reference point during the assessment 2018, because of time limitation, no further elaboration was performed this year.

2.2.7 Quality of the assessment

Indices from for different surveys that provide information on cod in the Kattegat were used in the assessment. All available survey indices are relatively noisy, however contain information that is to a certain extent consistent between years in single surveys and agrees on the same level with the estimates from other surveys. In

2003—2017, the survey data indicates significantly higher total removals from the stock than can be explained by the reported catch data.

WKBALT 2017 concluded that the unallocated removals can largely be explained by mixing with North Sea cod and potentially increased natural mortality. Also, uncertainties in catch numbers at least for some years in the time series likely contribute to this miss-match.

Therefore, current level of fishing mortality cannot be reliably estimated and are in the range of 0.86–0.1 in the SPALY runs. The highest estimate of the amount of unallocated removals was found in the year 2001 (Figure 2.2.12).

The exact estimates of SSB are considered uncertain, however all available information consistently indicates that SSB is at historical low levels in 2017, in the vicinity of 2 157 to 1 746 tonnes.

2.2.8 Comparison with previous assessment

The input data were updated from the time series used in last year's assessment, besides the changes made to input data at WKBALT 2017 (revised discard time series and excluding BITS Q4 survey). The assessment was performed using state-space assessment model (SAM) as in last year. The results from this year's assessment can be found in tables 2.2.11 and 2.2.12.

2.2.9 Management considerations

The stock has declined by more than 50% the last couple of years and the current perception of the stock is among the lowest observed. There are no reference points applicable in the current situation of high unallocated removals observed in the model, which are a result of stock mixing, migration, and mortality (ICES, 2017a). The stock is mainly consisting of the 2016 year-class, as no older year classes are present in the stock.

The major scope for management would be to reduce the mortality to an absolute minimum. Also considering that a portion of these individuals have a North Sea origin migrate back as they reach the age of 4. (ICES, 2017a), which would further decrease in the SSB even if the fishing mortality is kept close to zero.

There is no targeted cod fishery in Kattegat presently and cod is mainly taken as bycatch in the *Nephrops* fishery. This implies that the mortality of the stock is strongly correlated with the uptake of the *Nephrops* quota and the effort directed to the *Nephrops* fishery. The *Nephrops* catches in Kattegat has historically been limited by either effort or the TAC. However, the effort system is no longer present and the *Nephrops* TAC increased substantially as the MLS of *Nephrops* was lowered in 2017.

Given the present situation in Kattegat, there is an emergent need for alternative technical regulations in order to keep the fishing mortality as close to zero as possible because a lower TAC *per se* is not enough. The technical regulations would preferably minimize bycatch of cod in the main *Nephrops* fishery. This could be achieved by only allowing the use of trawls with species selective devices. Alternatively, a development of current closed areas or seasons can be implemented to reduce fishing mortality.

2.2.10 Future plans

The issues identified at WKBALT (2017) that could explain the unallocated removals estimated in SAM include inflow of recruits from the North Sea and their return migration when they become mature. WKBALT 2017 suggested intersessional work to be continued looking into possibilities to take migration more explicitly into account in the SAM model, to be able to separate fishing mortality from migration. A modified version of SAM model was presented at WGBFAS 2017, incorporating proportions of juvenile North Sea and Kattegat cod, estimated in the model, and assuming return migration to take place when the fish become mature (WD by Vinther, M. WGBFAS 2017).

WGBFAS concluded that data on the proportions of juvenile cod in the Kattegat originating from North Sea are needed; to be incorporated in the model, or used to validate the values estimated in the model. The first step would be to analyze historical samples to determine stock origin for individuals at age 1, for the latest 10 years (200 individuals per year). These data could then be included in the new version on SAM model, to account for the North Sea component in the Kattegat. The time-line for this work to be completed is considered to be 2 years.

A longer term step would be to gather genetic samples from the whole size range of cod, and also analyses the samples back in time that would be needed in order to split the different cohorts between North Sea and Kattegat cod, to assess the developments in Kattegat stock alone. This could be done using the traditional SAM or possibly other models (e.g. SS3).

Table 2.2.1 Cod in the Kattegat. Landings (in tonnes) 1971–2017.

Year	Kattegat			Total
	Denmark	Sweden	Germany[1]	
1971	11748	3962	22	15732
1972	13451	3957	34	17442
1973	14913	3850	74	18837
1974	17043	4717	120	21880
1975	11749	3642	94	15485
1976	12986	3242	47	16275
1977	16668	3400	51	20119
1978	10293	2893	204	13390
1979	11045	3763	22	14830
1980	9265	4206	38	13509
1981	10693	4380	284	15337
1982	9320	3087	58	12465
1983	9149	3625	54	12828
1984	7590	4091	205	11886
1985	9052	3640	14	12706
1986	6930	2054	112	9096
1987	9396	2006	89	11491
1988	4054	1359	114	5527
1989	7056	1483	51	8590
1990	4715	1186	35	5936
1991	4664	2006	104	6834
1992	3406	2771	94	6271
1993	4464	2549	157	7170
1994	3968	2836	98	7802 [2]
1995	3789	2704	71	8164 [3]
1996	4028	2334	64	6126 [4]
1997	6099	3303	58	9460 [5]
1998	4207	2509	38	6835
1999	4029	2540	39	6608
2000	3285	1568	45	4897
2001	2752	1191	16	3960
2002	1726	744	3	2470
2003	1441	603 [7]	1	2045
2004	827	575	1	1403
2005	608	336	10	1070 [6]
2006	540	315	21	876
2007	390	247	7	645
2008	296	152	1	449
2009	134	62	0.3	197
2010	117	38	0.3	155
2011	102	42	1.4	145
2012	63	31	0.0	94
2013	60	32	0.0	92
2014	75	32	0.0	108
2015	68	38	0.0	106
2016	185	114	0.0	299
2017	208	85	0.0	293

[1] Landings statistics incompletely split on the Kattegat and Skagerrak.

[2] Including 900 t reported in Skagerrak.

[3] Including 1.600 t misreported by area.

[4] Excluding 300 t taken in Sub-divisions 22–24.

[5] Including 1.700t reported in Sub-division 23.

[6] Including 116 t reported as pollack

[7] the catch reported to the EU exceeds the catch reported to the WG (shown in the table) by 40%

Table 2.2.2 Cod in the Kattegat. Estimates of discard in numbers (in thousands) by ages and total weight (t). The estimation of total discards is not entirely consistent between the years.

Denmark

Year	age 1	age 2	age 3	age 4	age 5	age 6
1997						
1998						
1999						
2000	880	1634	22	3	0	0
2001	1365	386	3	0	0	0
2002	2509	1226	290	0	0	0
2003	114	876	40	0	0	0
2004	2562	352	58	0	0	0
2005	616	1285	0	0	0	0
2006	614	752	203	0	0	0
2007	135	1098	259	20	0	0
2008	20	99	57	4	1	0
2009	210	41	2	0	0	0
2010	367	224	14	0	0	0
2011	559	354	22	0	0	0
2012	707	161	10	0	0	0
2013	517	322	8	3	0	0
2014	431	621	22	4	2	0
2015	120	86	82	19	7	0
2016	9	40	17	33	13	4
2017	819	99	32	1	3	1

Sweden

Year	age 1	age 2	age 3	age 4	age 5	age 6
1997	567	678	212	13	0	0.0
1998	684	641	157	8	0	0.0
1999	579	663	177	10	0	0.0
2000	922	876	153	19	2	0.0
2001	745	720	142	17	2	0.0
2002	667	419	93	12	1	0.0
2003	514	715	49	3	1	0.2
2004	982	583	533	2	2	0.3
2005	237	464	6	5	0	0.0
2006	784	448	182	7	3	0.3
2007	534	278	32	12	0	0.1
2008	148	48	10	0.1	0	0.0
2009	179	14	0.1	0.1	0	0.0
2010	63	58	0	0	0	0
2011	71	51	9	0	0	0
2012	180	54	5	0	0	0
2013	550	190	21	1	2	0
2014	79	174	20	1	2	0
2015	119	57	58	24	4	4
2016	7	43	11	5	3	1
2017	270	16	1	0	0	0

DK and SWE discard numbers combined							Total discards
Year	age 1	age 2	age 3	age 4	age 5	age 6	(t)
1997	1398	2102	478	26	0.4	0.1	881
1998	1369	1454	284	23	0.3	0.0	664
1999	1158	1964	314	18	0.5	0.0	764
2000	1802	2510	175	22	1.9	0.0	653
2001	2110	1105	146	17	1.7	0.0	657
2002	3176	1645	383	12	1.3	0.0	820
2003	628	1591	89	3	0.9	0.2	616
2004	3544	934	591	2	2.1	0.3	1089
2005	853	1749	6	5	0.0	0.0	624
2006	1398	1200	386	7	2.6	0.3	862
2007	668	1377	291	32	0.5	0.1	624
2008	168	147	67	4	1	0	156
2009	389	55	2	0	0	0	67
2010	430	282	14	0	0	0	170
2011	631	405	31	0	0	0	211
2012	887	215	15	0	0	0	157
2013	1067	512	29	4	2	0	355
2014	510	795	42	5	4	0	348
2015	239	143	140	43	11	4	481
2016	16	83	28	38	16	5	222
2017	1089	115	33	1	3	1	258

Table 2.2.3. Cod in the Kattegat. Numbers of discard samples by years and countries.

Country /Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark				52	68	43	30	47	33	22	10
Sweden	45	50	55	63	40	63	38	26	48	66	72
Total	45	50	55	115	108	106	68	73	81	88	82

Country /Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Denmark	24	38	34	43	48	58	55	46	37	61
Sweden	50	49	58	48	41	44	39	40	40	51
Total	74	87	92	91	89	102	94	86	77	112

Table 2.2.4a Cod in Kattegat. Sampling of Danish landings in 2017.

Quarter	n. of size distributions sampled	n. of cod aged	n. of cod weighed	n. of cod measured
1	16	332	332	332
2	15	351	351	351
3	24	400	400	400
4	8	205	205	205
Total	63	1288	1288	1288

Table 2.2.4b Cod in Kattegat. Sampling of Swedish landings in 2017.

Quarter	n. of size distributions sampled	n. of cod aged	n. of cod weighed	n. of cod measured
1	3	185	185	185
2	1	62	62	62
3	5	92	92	92
4	9	247	247	247
Total	18	586	586	586

Table 2.2.5. Cod in the Kattegat. Landings numbers and mean weight at age by quarter and country for 2017.

Subdivision 21		Year	2017	Quarter	1	
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	0.170215	744.5			0.17	744.5
3	10.58146	1627.0	1.867	1531.0	12.45	1612.6
4	8.19837	2765.3	0.942	2060.4	9.14	2692.6
5	3.492427	3792.3	2.176	3074.5	5.67	3516.7
6	1.036599	6130.6	1.67	3627.6	2.71	4586.2
7			0.381	4385.1	0.38	4385.1
8			0.142	4511.4	0.14	4511.4
9			0.03	6926.4	0.03	6926.4
10						
SOP (t)	59.61			20.05	79.67	
Landings (t)	54.96			19.58	74.54	
Subdivision 21		Year	2017	Quarter	2	
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	0.498505	712.2	0.197	532.35	0.70	661.3
3	5.525921	2310.2	2.165	791.2	7.69	1882.6
4	3.334814	2958.4	1.735	2591.1	5.07	2832.7
5	1.135801	4998.3	2.814	2929.8	3.95	3524.6
6	0.156279	7569.0	2.107	3560.8	2.26	3837.6
7			0.814	3913.9	0.81	3913.9
8			0.079	3321.7	0.08	3321.7
9						
10						
SOP (t)	29.85			25.51	55.36	
Landings (t)	29.71			24.03	53.74	
Subdivision 21		Year	2017	Quarter	3	
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1			0.133	569.4		
2	0.243929	912.6	0.196	699.51993	0.44	817.7
3	3.857123	2585.1	0.956	1497.8	4.81	2369.1
4	1.639312	3350.5	1.627	1970.4	3.27	2663.0
5	4.18426	3835.2	3.015	3043.1	7.20	3503.4
6	0.503981	4451.3	1.922	3545.5	2.43	3733.7
7	0.55	4641.03	0.358	3729.3	0.91	4282.2
8			0.057	4105.2	0.06	4105.2
9						
10						
SOP (t)	36.54			22.41	58.87	
Landings (t)	35.57			20.90	56.47	
Subdivision 21		Year	2017	Quarter	4	
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1	0.82	596.78	0.085	737.1	0.90	609.97
2	1.659153	1015.1	0.445	1143.9555	2.10	1042.3
3	9.768114	2486.0	0.948	1732.2	10.72	2419.3
4	8.195478	3539.4	1.524	2630.8	9.72	3397.0
5	7.622676	4046.2	2.363	3157.5	9.99	3835.9
6	1.05377	5503.5	1.519	3220.6	2.57	4155.7
7			0.456	4999.1	0.46	4999.1
8			0.117	3536.1	0.12	3536.1
9	0.06	1527.00	0.01	6809.4	0.07	2394.5
10						
SOP (t)	92.20			21.35	113.55	
Landings (t)	88.20			20.64	108.84	
Subdivision 21		Year	2017	Quarter	All	
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1	0.82	596.78	0.218	737.1	1.04	626.28
2	2.571803	1015.1	0.838	1143.9555	3.41	1046.8
3	29.73261	2585.1	5.936	1732.2	35.67	2443.1
4	21.36797	3539.4	5.828	2630.8	27.20	3344.7
5	16.43516	4998.3	10.368	3157.5	26.80	4286.2
6	2.75063	7569.0	7.218	3627.6	9.97	4715.2
7	0.55	4641.03	2.009	4999.1	2.56	4922.0
8			0.395	4511.4	0.46	4111.8
9	0.06	1527.00	0.04	6926.4	0.04	6926.4
10						
SOP (t)	261.21			95.54	358.97	
Landings (t)	208.00			85.16	293.16	

Table 2.2.6 Cod in the Kattegat. Catches (Landings +Discards) in numbers (in thousands) by year and age. In the assessment the plus-group is defined as 6+.

	Age					
Year	1	2	3	4	5	6
1997	1456	2540	5137	891	222	88
1998	1499	3587	1595	1908	283	76
1999	1201	3859	3972	455	409	77
2000	1819	3942	2346	1027	125	103
2001	2166	2012	2034	703	187	45
2002	3190	2161	1062	391	85	40
2003	628	2441	650	184	65	16
2004	3547	1077	1195	206	65	39
2005	854	2169	121	167	21	12
2006	1406	1305	796	36	33	9
2007	668	1446	383	190	16	26
2008	175	191	136	40	33	7
2009	400	92	30	22	9	4
2010	433	361	33	8	4	2
2011	631	445	84	6	2	1
2012	889	231	30	13	2	0
2013	1068	533	49	12	3	1
2014	510	804	66	20	6	0
2015	239	144	167	56	15	6
2016	16	95	68	75	38	13
2017	1090	119	68	28	30	14

Table 2.2.7 Cod in the Kattegat. Weight-at-age (kg) in the landings by year and age. In the assessment the plus-group is defined as 6+.

Year	Age 1	2	3	4	5	6	7	8+
1971	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1972	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1973	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1974	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1975	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1976	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1977	0.699	0.880	1.069	1.673	2.518	3.553	5.340	6.635
1978	0.699	0.880	1.170	1.690	2.860	4.120	5.180	6.900
1979	0.708	0.868	1.086	1.890	2.215	3.382	7.314	6.101
1980	0.691	0.893	0.951	1.440	2.478	3.157	3.526	6.903
1981	0.604	0.799	1.123	1.432	2.076	3.532	4.420	4.644
1982	0.600	0.784	1.233	1.391	2.078	2.911	3.698	6.480
1983	0.595	0.752	1.129	1.943	3.348	3.141	5.301	6.325
1984	0.711	0.745	1.133	1.687	2.798	3.022	5.273	7.442
1985	0.606	0.839	0.986	1.614	2.575	4.090	6.847	7.133
1986	0.671	0.705	1.253	1.955	2.956	4.038	7.100	7.290
1987	0.483	0.716	1.118	1.972	2.868	4.200	5.185	8.288
1988	0.541	0.784	1.099	1.792	2.880	4.283	5.852	7.073
1989	0.621	0.921	1.269	2.296	3.856	5.733	5.166	6.527
1990	0.618	0.973	1.584	2.323	3.288	5.383	6.412	10.337
1991	0.578	0.861	1.533	2.986	4.548	4.179	9.127	12.055
1992	0.610	0.707	1.291	2.662	4.048	5.888	7.067	7.895
1993	0.567	0.862	1.583	2.321	4.970	7.566	9.391	8.705
1994	0.549	0.783	1.276	2.652	3.526	7.279	9.793	10.130
1995	0.598	0.799	1.121	1.947	2.404	3.537	9.973	10.708
1996	0.469	0.669	1.088	1.771	2.638	3.773	4.677	7.871
1997	0.450	0.621	0.959	1.950	2.806	3.877	5.756	7.213
1998	0.623	0.697	0.853	1.680	2.497	4.317	6.669	8.948
1999	0.496	0.624	0.911	1.616	2.588	4.665	5.376	8.040
2000	0.487	0.611	0.868	1.332	2.779	3.944	5.069	9.020
2001	0.466	0.646	0.901	1.585	2.597	4.693	7.117	7.691
2002	0.546	0.711	1.120	2.052	3.539	4.814	6.915	7.833
2003	0.550	0.700	1.370	2.460	3.750	5.920	7.840	10.890
2004	0.570	0.700	1.010	1.630	2.700	3.920	6.180	9.420
2005	0.428	0.854	1.623	2.343	3.584	5.442	6.439	8.307
2006	0.480	0.880	1.519	3.130	3.995	4.222	5.264	6.713
2007	0.48	0.802	1.482	2.275	3.344	3.829	1.802	7.897
2008	0.574	1.075	1.837	3.210	4.097	4.437	5.552	5.827
2009	0.717	0.976	1.493	2.651	4.069	4.693	4.870	5.792
2010	0.412	0.879	1.910	3.081	4.038	3.592	4.252	6.404
2011	0.444	0.915	1.498	2.695	3.372	4.997	4.059	7.569
2012	0.545	1.191	1.769	3.174	4.004	5.224	4.305	6.921
2013	0.488	0.888	1.702	2.545	3.726	3.310	5.100	NA
2014	0.434	1.007	1.907	2.523	3.938	5.431	NA	NA
2015	0.434	1.343	1.879	2.597	3.726	3.777	NA	NA
2016	0.434	1.267	2.472	2.534	2.793	3.665	NA	NA
2017	0.434	0.915	1.996	2.942	3.453	3.921	NA	NA

Table 2.2.8 Cod in the Kattegat. Weight-at-age (kg) in the stock by year and age. In the assessment the plus-group is defined as 6+.

Year	Age 1	2	3	4	5	6	7	8+
1971	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1972	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1973	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1974	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1975	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1976	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1977	0.059	0.355	0.919	1.673	2.518	3.553	5.34	6.635
1978	0.059	0.355	1.006	1.69	2.86	4.12	5.18	6.9
1979	0.059	0.35	0.934	1.89	2.215	3.382	7.314	6.101
1980	0.058	0.361	0.817	1.44	2.478	3.157	3.526	6.903
1981	0.051	0.323	0.965	1.432	2.076	3.532	4.42	4.644
1982	0.05	0.317	1.06	1.391	2.078	2.911	3.698	6.48
1983	0.05	0.304	0.971	1.943	3.348	3.141	5.301	6.325
1984	0.06	0.301	0.974	1.687	2.798	3.022	5.273	7.442
1985	0.051	0.339	0.848	1.614	2.575	4.09	6.847	7.133
1986	0.056	0.285	1.077	1.955	2.956	4.038	7.1	7.29
1987	0.041	0.289	0.961	1.972	2.868	4.2	5.185	8.288
1988	0.045	0.317	0.945	1.792	2.88	4.283	5.852	7.073
1989	0.052	0.372	1.091	2.296	3.856	5.733	5.166	6.527
1990	0.052	0.393	1.362	2.323	3.288	5.383	6.412	10.337
1991	0.06	0.415	1.799	2.986	4.548	4.179	9.127	12.055
1992	0.052	0.34	1.191	2.662	4.048	5.888	7.067	7.895
1993	0.056	0.353	1.086	2.321	4.97	7.566	9.391	8.705
1994	0.035	0.269	1.225	2.652	3.526	7.279	9.793	10.13
1995	0.032	0.148	1.31	1.947	2.404	3.537	9.973	10.708
1996	0.027	0.22	0.496	1.771	2.638	3.773	4.677	7.871
1997	0.034	0.179	0.743	1.95	2.806	3.877	5.756	7.213
1998	0.049	0.213	0.442	1.68	2.497	4.317	6.669	8.948
1999	0.046	0.207	0.625	1.616	2.588	4.665	5.376	8.04
2000	0.046	0.176	0.624	1.332	2.779	3.944	5.069	9.02
2001	0.065	0.269	0.72	1.585	2.597	4.693	7.117	7.691
2002	0.045	0.29	1.334	2.052	3.539	4.814	6.915	7.833
2003	0.066	0.224	1.054	2.46	3.75	5.923	7.835	10.891
2004	0.052	0.407	1.007	1.63	2.7	3.916	6.181	9.423
2005	0.058	0.349	1.187	2.343	3.584	5.442	6.439	8.307
2006	0.064	0.280	1.083	3.130	3.995	4.222	5.264	6.713
2007	0.058	0.289	1.060	2.275	3.344	3.829	1.802	7.897
2008	0.045	0.335	1.010	3.210	4.097	4.437	5.552	5.827
2009	0.053	0.300	1.069	2.651	4.069	4.693	4.870	5.792
2010	0.052	0.285	1.171	3.081	4.038	3.592	4.252	6.404
2011	0.051	0.269	0.905	2.695	3.372	4.997	4.059	7.569
2012	0.044	0.251	0.923	3.174	4.004	5.224	4.305	6.921
2013	0.041	0.255	1.043	2.545	3.726	3.310	5.100	NA
2014	0.049	0.285	1.050	2.541	3.869	5.431	NA	NA
2015	0.055	0.311	1.036	2.023	3.385	2.873	NA	NA
2016	0.045	0.338	1.041	2.448	2.72	3.665	NA	NA
2017	0.037	0.275	0.993	2.91	3.353	3.858	NA	NA

Table 2.2.9 Cod in the Kattegat. Proportion mature-at-age (combined sex).In the assessment the plus-group is defined as 6+.

Year	Age 1	2	3	4	5	6	7	8+
1971	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1972	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1973	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1974	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1975	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1976	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1977	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1978	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1979	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1980	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1981	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1982	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1983	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1984	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1985	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1986	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1987	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1988	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1989	0.02	0.37	0.78	0.97	1.00	1.00	1.00	1.00
1990	0.02	0.61	0.62	0.99	0.93	1.00	1.00	1.00
1991	0.02	0.62	0.64	0.88	1.00	1.00	1.00	1.00
1992	0.07	0.51	0.99	1.00	1.00	1.00	1.00	1.00
1993	0.03	0.49	0.73	0.95	0.87	1.00	1.00	1.00
1994	0.01	0.60	0.96	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.12	0.97	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.29	0.57	0.95	1.00	1.00	1.00	1.00
1997	0.00	0.19	0.90	1.00	1.00	1.00	1.00	1.00
1998	0.00	0.38	0.65	1.00	1.00	1.00	1.00	1.00
1999	0.02	0.58	0.87	1.00	1.00	1.00	1.00	1.00
2000	0.02	0.42	0.92	1.00	1.00	1.00	1.00	1.00
2001	0.02	0.44	0.91	1.00	1.00	1.00	1.00	1.00
2002	0.00	0.57	0.92	0.99	1.00	1.00	1.00	1.00
2003	0.00	0.54	1.00	1.00	1.00	1.00	1.00	1.00
2004	0.00	0.74	0.86	1.00	1.00	1.00	1.00	1.00
2005	0.01	0.53	0.83	0.92	1.00	1.00	1.00	1.00
2006	0.00	0.59	0.81	1.00	1.00	1.00	1.00	1.00
2007	0.00	0.60	0.89	0.93	1.00	1.00	1.00	1.00
2008	0.00	0.35	1.00	1.00	1.00	1.00	1.00	1.00
2009	0.00	0.54	0.90	0.95	1.00	1.00	1.00	1.00
2010	0.00	0.48	0.94	1.00	1.00	1.00	1.00	1.00
2011	0.00	0.60	0.90	1.00	1.00	1.00	1.00	1.00
2012	0.00	0.49	0.87	0.92	1.00	1.00	1.00	1.00
2013	0.00	0.37	0.46	0.91	1.00	1.00	1.00	1.00
2014	0.00	0.37	0.59	0.83	1.00	1.00	1.00	1.00
2015	0.00	0.51	0.57	0.83	1.00	1.00	1.00	1.00
2016	0.00	0.59	0.72	0.82	1.00	1.00	1.00	1.00
2017	0.00	0.52	0.77	0.85	1.00	1.00	1.00	1.00

Table 2.2.10 Cod in the Kattegat. Tuning data (from trawl surveys).

Havfisken_SD21_Q1				
1997	2018			
1	1	0	0.25	
1	3			
	1	104.5521	24.10579	16.37002
	1	-9	-9	-9
	1	464.8633	25.74058	8.849065
	1	97.61678	44.32915	5.524313
	1	25.78994	30.09901	11.12194
	1	98.273	16.65293	3.154041
	1	8.341221	47.24216	5.778205
	1	175.0556	11.18347	5.333215
	1	83.14981	86.67933	2.545501
	1	122.1756	39.54309	10.57858
	1	28.87485	46.52737	8.608119
	1	13.09734	6.648041	1.012895
	1	16.21239	0.908864	0
	1	38.50059	21.42233	1.388748
	1	46.24852	15.00446	14.26268
	1	86.61548	10.8254	1.844459
	1	212.3437	51.34188	10.25782
	1	98.78039	781.8792	12.40911
	1	37.3475	17.53	15.1715
	1	1.09	4.59	1.2
	1	52.1	2.13	1.43
	1	2.2	8.58	0.72

IBTS_Q3					
1997	2017				
1	1	0.75	0.83		
1	4				
	1	141.86	32.69	14.63	0.78
	1	141.92	38.42	1.57	0.92
	1	85.73	6.18	1.64	0.2
	1	-9	-9	-9	-9
	1	6.03	2.11	0.46	0.12
	1	46.53	1.51	0.26	0.19
	1	1.7	4.5	0.13	0.05
	1	67.12	2.28	2.43	0.08
	1	12.17	10.94	0.08	0.26
	1	25.69	4.2	2.94	0.17
	1	5.33	4.22	1.15	0.62
	1	1.94	0.47	0.07	0.15
	1	19.49	0.13	0	0.08
	1	2.5	1.28	0	0.08
	1	8.348	1.59	0.45	0
	1	8.29	1.25	0.05	0.583
	1	9.95	6.78	1.08	0.05
	1	3.646	9.836	7.433	0.812
	1	4.71	2.12	7.361	3.229
	1	0.376	0.654	1.63	2.17
	1	12.38	0.007	0.46	0.29

IBTSQ1_1-6							
1997	2018						
1	1	0	0.25				
1	6						
	1	174.47	54.179	108.874	6.336	1.379	1.052
	1	199.37	470.649	47.071	24.617	2.672	1.321
	1	237.68	167.799	62.984	2.257	3.114	0.583
	1	74.85	233.688	47.39	14.025	1.313	1.16
	1	47.05	46.059	24.373	5.276	1.692	0.748
	1	93.05	20.843	15.715	14.689	3.273	1.066
	1	2.34	52.554	3.58	2.626	1.713	0.375
	1	91.02	14.122	32.847	6.007	2.051	2.649
	1	19.99	86.948	5.061	10.697	1.2	0.388
	1	67.31	21.883	27.47	2.661	2.247	0.987
	1	41.61	41.937	7.399	7.523	0.766	0.828
	1	8.392	2.409	2.224	0.858	0.583	0.417
	1	25.383	0.925	0.442	2.042	0	0.333
	1	14.636	22.46	0.242	0.333	0.529	0.542
	1	43.727	24.426	17.362	0.6	0.177	0.125
	1	46.955	9.528	2.019	4.056	0	0.083
	1	31.394	14.16	3.62	0.88	1.41	0.27
	1	3.45	30.82	9.95	3.21	0.47	0.21
	1	18.334	10.184	27.36	9.498	4.189	2.151
	1	0.522	14.551	4.311	18.679	5.759	3
	1	23.69	0.8	0.93	1.92	6.2	15.4
	1	1.36	9.22	0.08	0.99	0.42	1.16

CODS_Q4						
2008	2017					
1	1	0.83	0.92			
1	6					
1	52.8	17.8	11.3	7.3	4.3	2.3
1	166.3	8.2	2.1	2	2.2	1
1	113.2	64.3	2.4	0.4	0.5	0.1
1	91.1	54	24.4	5.1	0.8	0.2
1	-9	-9	-9	-9	-9	-9
1	207.9	209.5	63.1	30.4	5.4	0.8
1	144.5	277.3	231.7	93.6	41.3	17.7
1	92.6	126.7	125.2	105.6	68.9	38.7
1	57.5	37.1	48.9	48.7	42.9	43.3
1	110.6	111.6	71.81	15.73	14.67	17.44

Table 2.2.11 Cod in the Kattegat. Sam results with scaling.

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	15967	10789	23630	12645	11159	14328	10503	9180	12016	1.131	0.965	1.326
1998	13623	9041	20527	10503	9375	11766	7955	7021	9015	1.26	1.091	1.455
1999	13395	8775	20446	9412	8407	10537	7539	6751	8418	1.301	1.13	1.498
2000	7536	5064	11216	7150	6448	7928	5752	5177	6391	1.395	1.218	1.597
2001	6588	4509	9625	6216	5620	6875	4950	4454	5501	1.485	1.291	1.709
2002	11827	8197	17063	6001	5388	6683	4780	4257	5367	1.233	1.06	1.435
2003	2874	1919	4303	5061	4549	5631	4184	3758	4659	1.088	0.917	1.292
2004	17742	12248	25701	5310	4699	6002	3855	3413	4354	1.058	0.901	1.243
2005	8966	6200	12966	7361	6537	8288	4838	4321	5417	1.119	0.953	1.313
2006	9609	6532	14137	6996	6193	7903	5120	4529	5789	1.094	0.937	1.276
2007	2654	1751	4022	4484	4036	4980	3607	3239	4015	1.286	1.108	1.492
2008	1475	1016	2143	2464	2240	2711	2190	1976	2427	1.464	1.271	1.686
2009	4632	3197	6712	1266	1134	1415	904	814	1003	1.404	1.208	1.633
2010	4490	3105	6492	1338	1173	1528	775	688	874	1.093	0.895	1.336
2011	5469	3767	7939	1690	1472	1940	1105	959	1275	0.745	0.59	0.942
2012	12243	8359	17932	2253	1911	2657	1396	1179	1653	0.634	0.496	0.811
2013	17920	12098	26546	4075	3474	4780	2444	2058	2902	0.496	0.379	0.65
2014	5502	3599	8411	6357	5357	7544	3482	2906	4172	0.459	0.349	0.605
2015	3100	2095	4588	7789	6146	9873	5640	4392	7242	0.594	0.431	0.82
2016	672	387	1165	5342	3959	7207	4435	3221	6105	0.752	0.5	1.132
2017	5720	3344	9784	2972	2025	4362	2421	1577	3718	0.546	0.347	0.856
2018							2157	1213	3835			

Table 2.2.12 Cod in the Kattegat. Sam results without scaling.

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	13976	8034	24314	11690	9183	14882	9734	7516	12607	1.255	0.95	1.657
1998	13260	7450	23602	9818	7908	12190	7350	5742	9407	1.394	1.084	1.794
1999	11603	6705	20077	8375	6766	10366	6720	5379	8396	1.457	1.136	1.867
2000	6227	3633	10675	6481	5302	7923	5241	4225	6501	1.523	1.194	1.943
2001	3993	2260	7056	5307	4333	6500	4352	3502	5407	1.656	1.293	2.121
2002	8315	5163	13390	4810	3923	5899	3936	3175	4880	1.511	1.169	1.954
2003	1127	611	2081	3167	2617	3832	2653	2179	3229	1.232	0.944	1.609
2004	9594	5898	15607	3581	2734	4691	2721	2032	3642	1.377	0.984	1.927
2005	2999	1851	4858	2992	2293	3904	2006	1528	2635	0.952	0.613	1.478
2006	4607	2797	7590	3019	2271	4013	2211	1622	3013	0.844	0.503	1.419
2007	1387	802	2400	2227	1603	3094	1797	1270	2543	1.123	0.61	2.065
2008	505	312	816	911	637	1302	820	556	1208	1.002	0.508	1.978
2009	1675	1013	2769	455	298	694	332	198	556	0.761	0.356	1.629
2010	1274	793	2049	513	354	745	322	203	510	0.547	0.255	1.175
2011	1771	1067	2941	726	449	1173	523	304	900	0.298	0.139	0.64
2012	2932	1775	4843	865	549	1361	633	370	1084	0.174	0.085	0.354
2013	3697	2279	5998	1540	989	2398	1108	671	1830	0.116	0.061	0.219
2014	1305	782	2177	2785	1698	4567	1749	1034	2959	0.094	0.048	0.186
2015	975	588	1616	4690	2576	8540	3628	1956	6730	0.108	0.056	0.209
2016	126	66	240	3776	2095	6808	3294	1796	6041	0.145	0.081	0.26
2017	2417	1350	4329	2558	1557	4203	2262	1338	3824	0.179	0.104	0.31
2018							1746	955	3191			

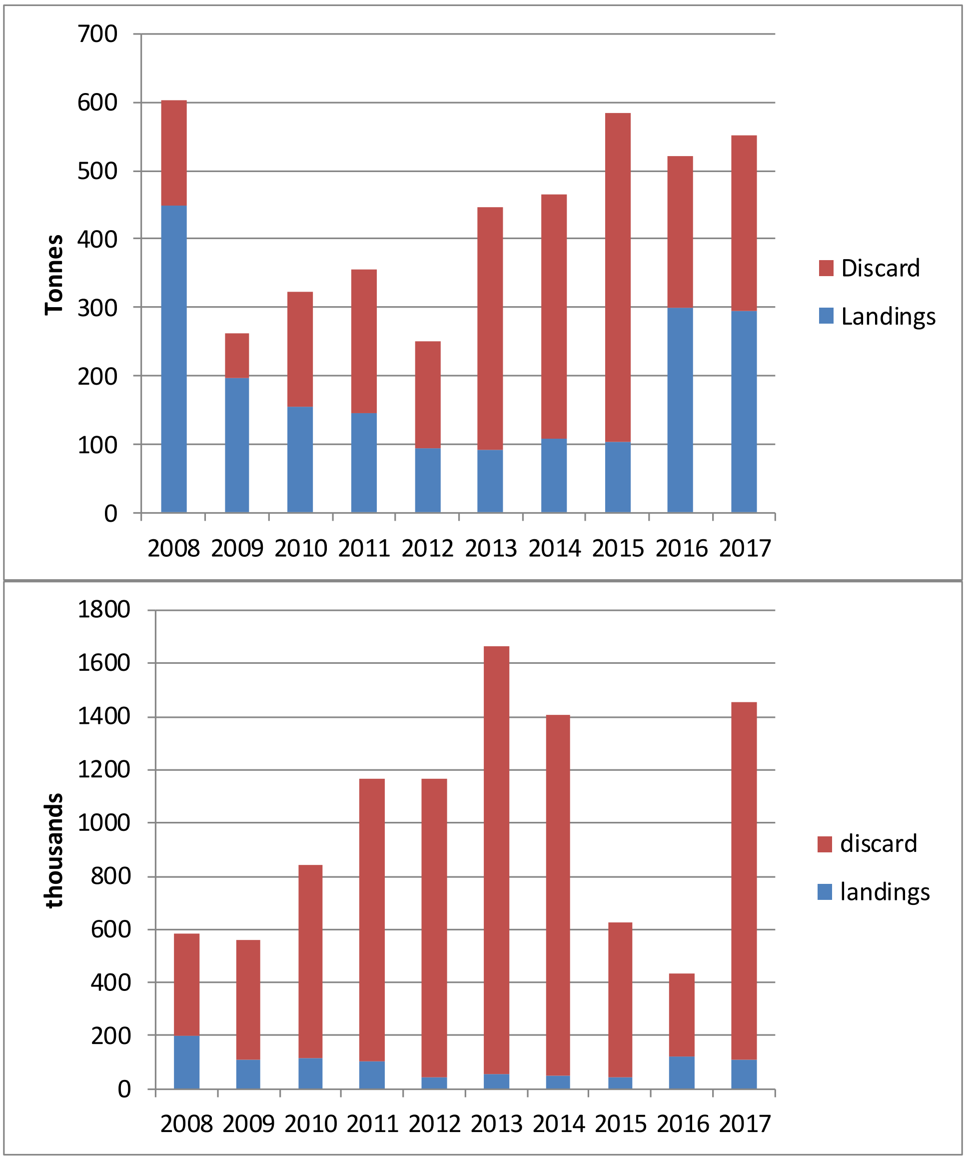


Figure 2.2.1 **Cod in the Kattegat. Estimates of discards (Denmark and Sweden combined) compared to reported landings, both in tonnes (upper panel) and in numbers (lower panel).**

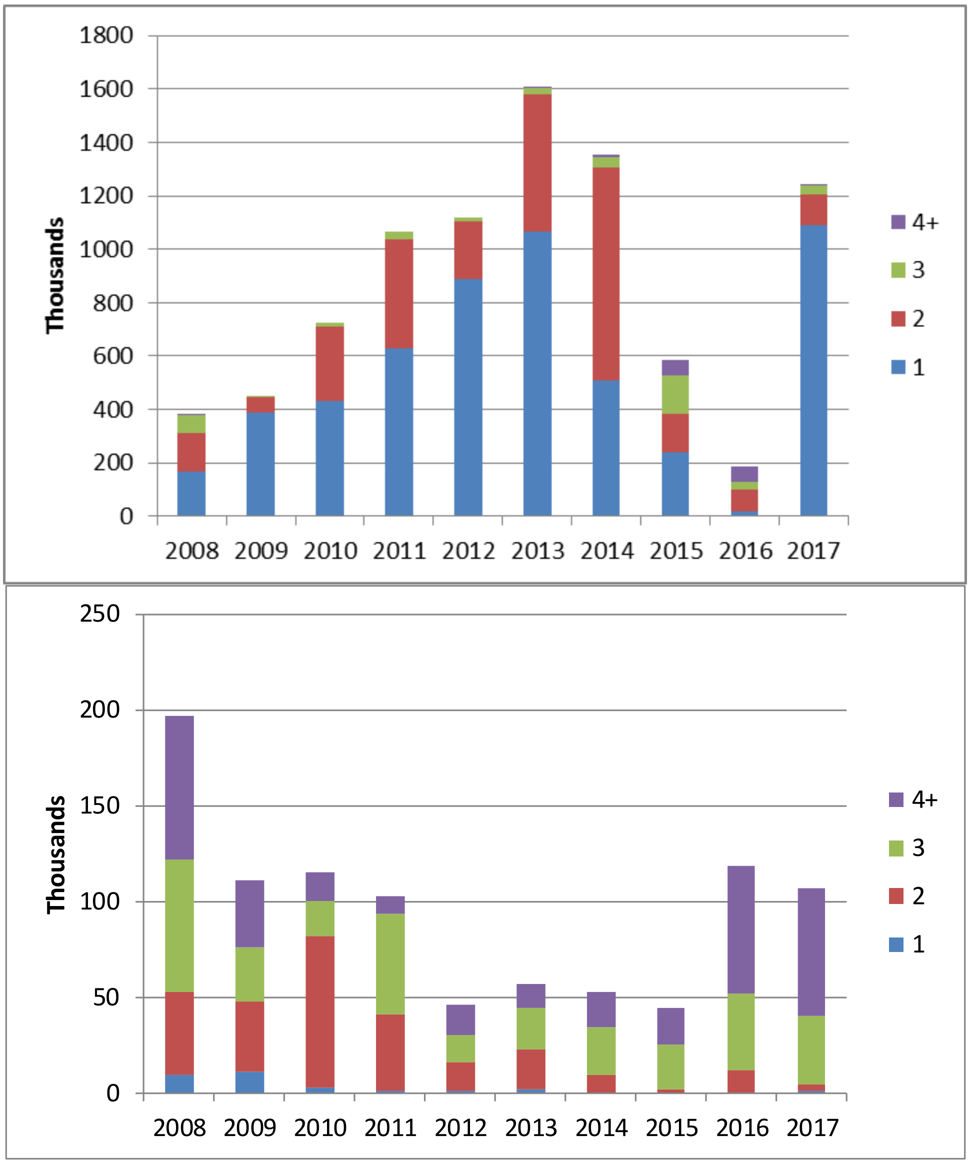
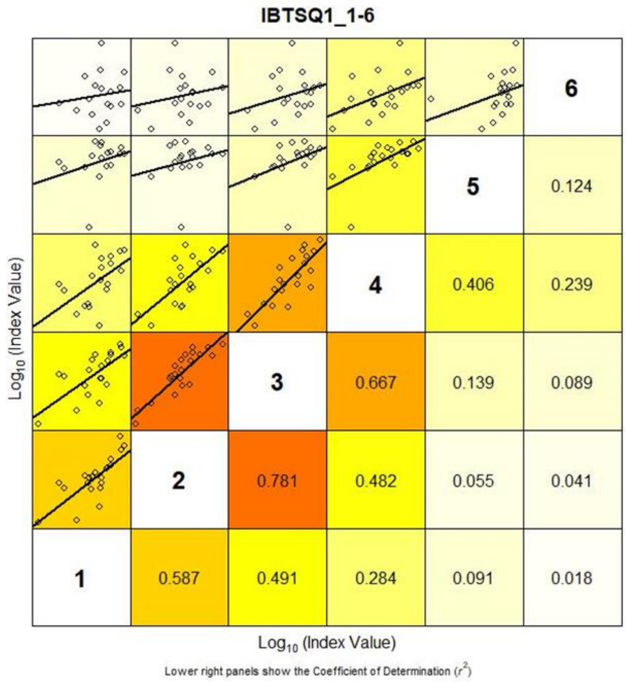
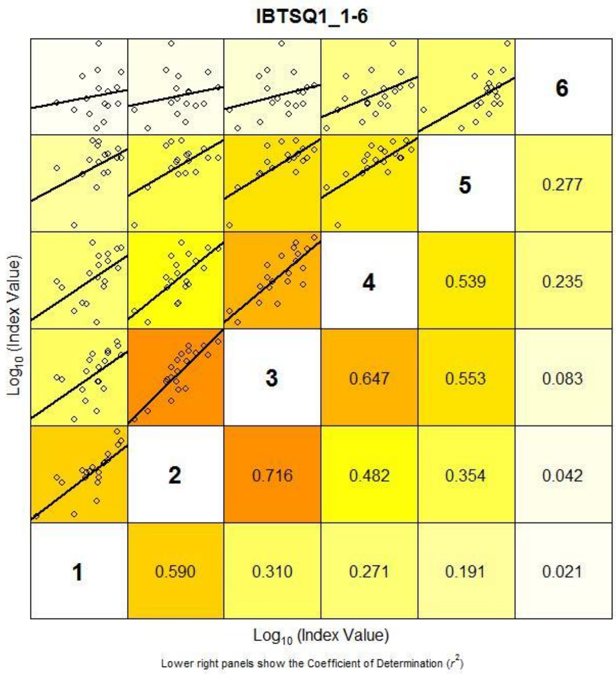


Figure 2.2.2 **Cod in the Kattegat. Estimates of discards age in numbers by upper panel. Landings in numbers by age lower panel (Sweden and Denmark combined).**

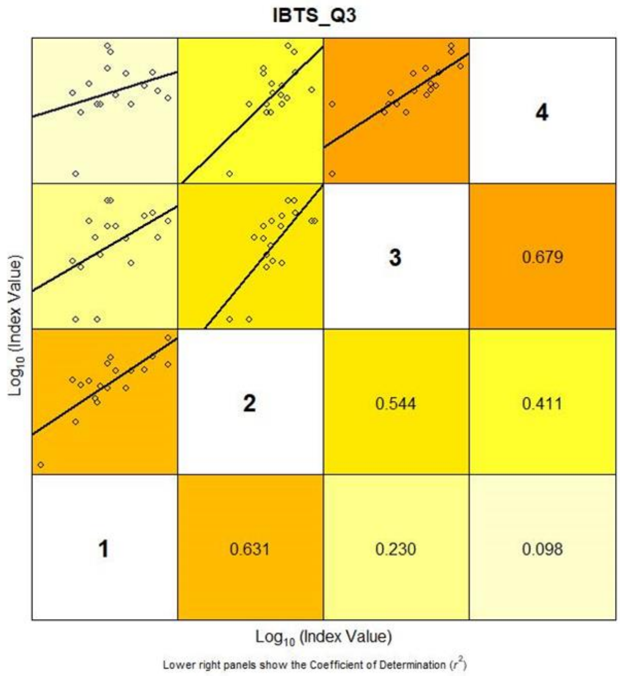


2017

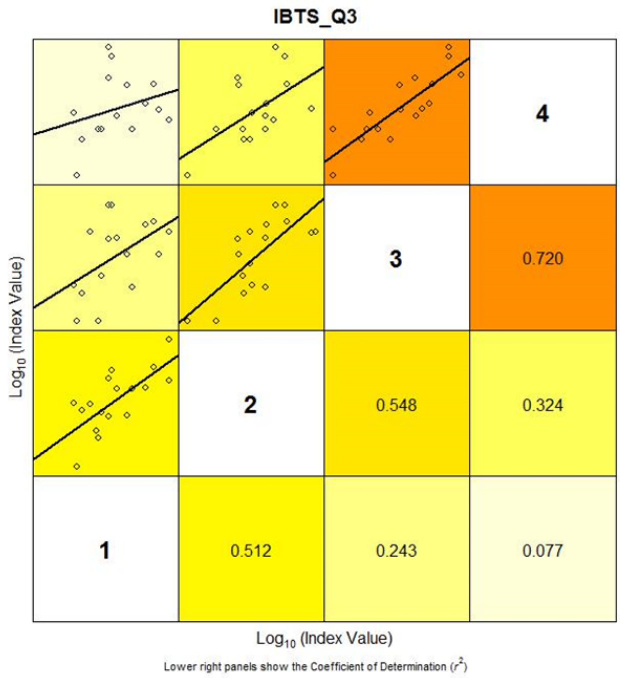


2016

Figure 2.2.3a **Cod in Kattegat. IBTS 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000–2017. Upper 2017 and lower 2016.**

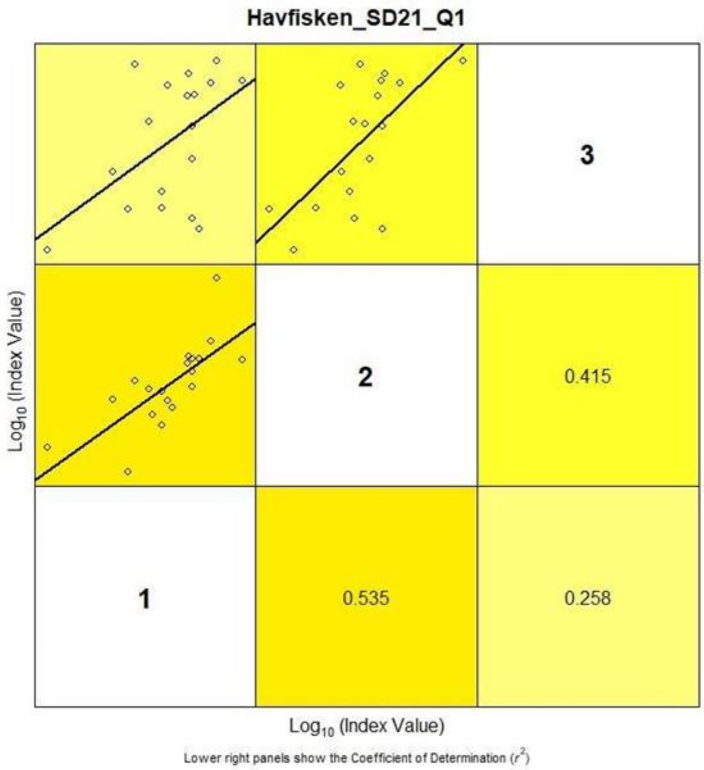


2017

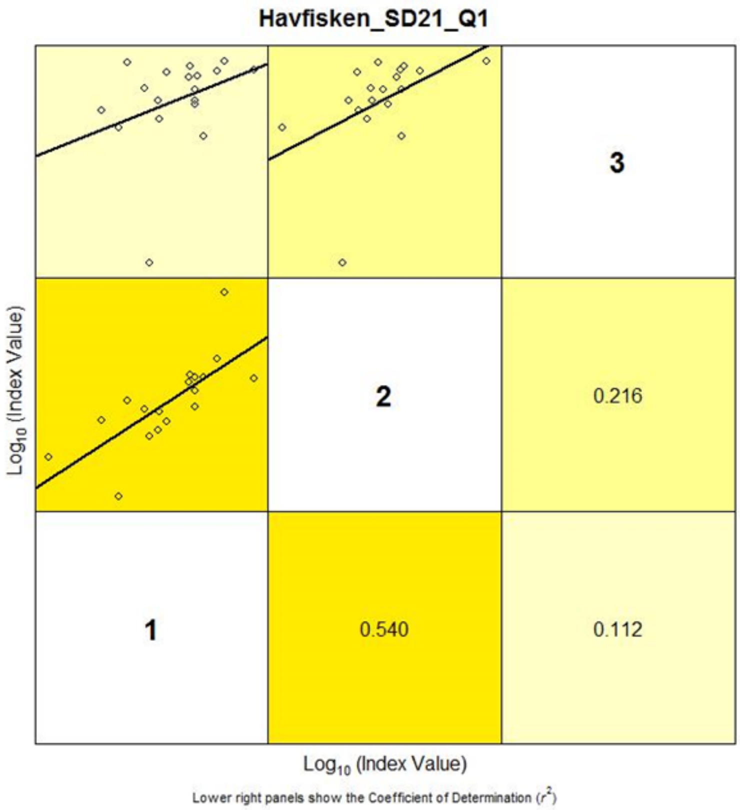


2016

Figure 2.2.3b **Cod in Kattegat. IBTS 3rd quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000–2017. Upper 2017 and lower 2016.**

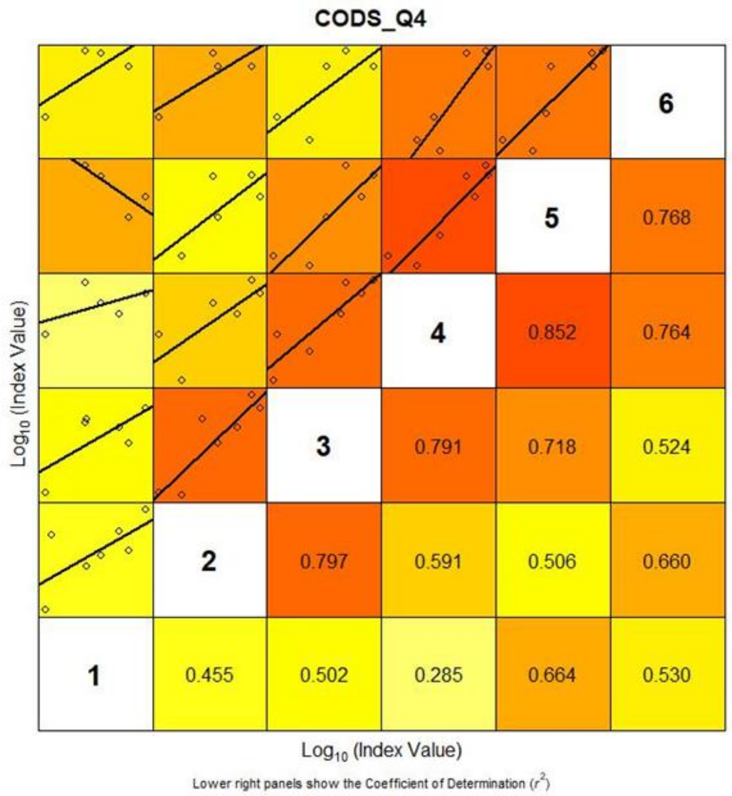


2017

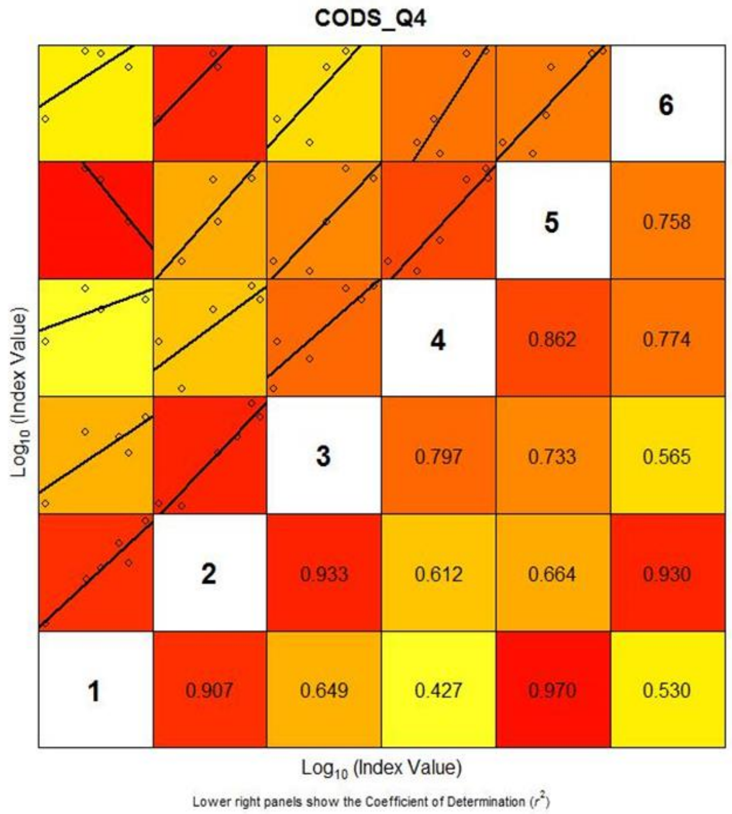


2016

Figure 2.2.3c **Cod in Kattegat. Havfisken 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000–2017. Upper 2017 and lower 2016.**



2017



2016

Figure 2.2.3d **Cod in Kattegat. Cod survey quarter 4 survey numbers-at-age vs numbers-at-age +1 of the same cohort in the following year in the period 2008–2015. Individual points are given by year-class. Red dots highlight the information from the latest year. Upper plot 2017, lower plot 2016.**

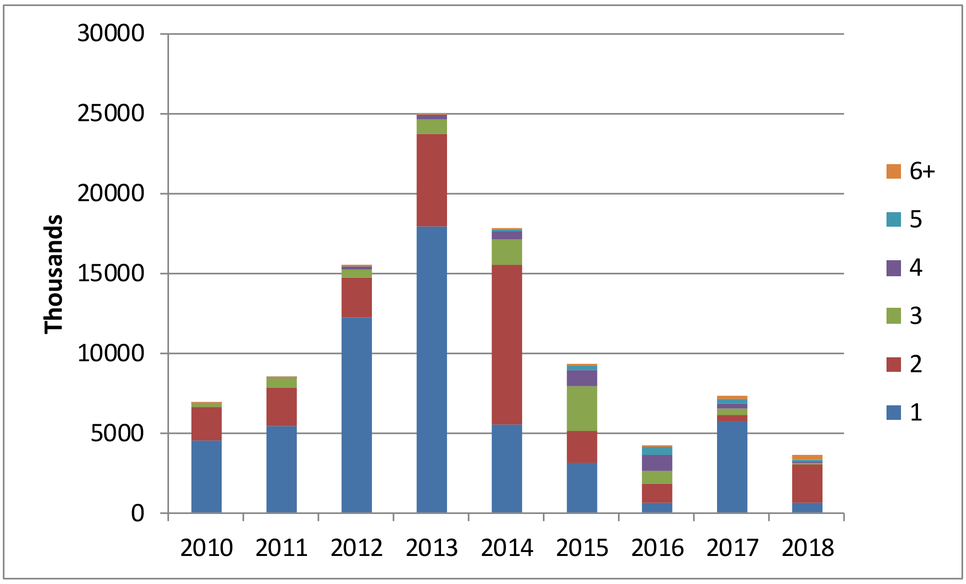


Figure 2.2.4 **Cod in Kattegat. Stock numbers by age 2010–2018 from SAM output.**

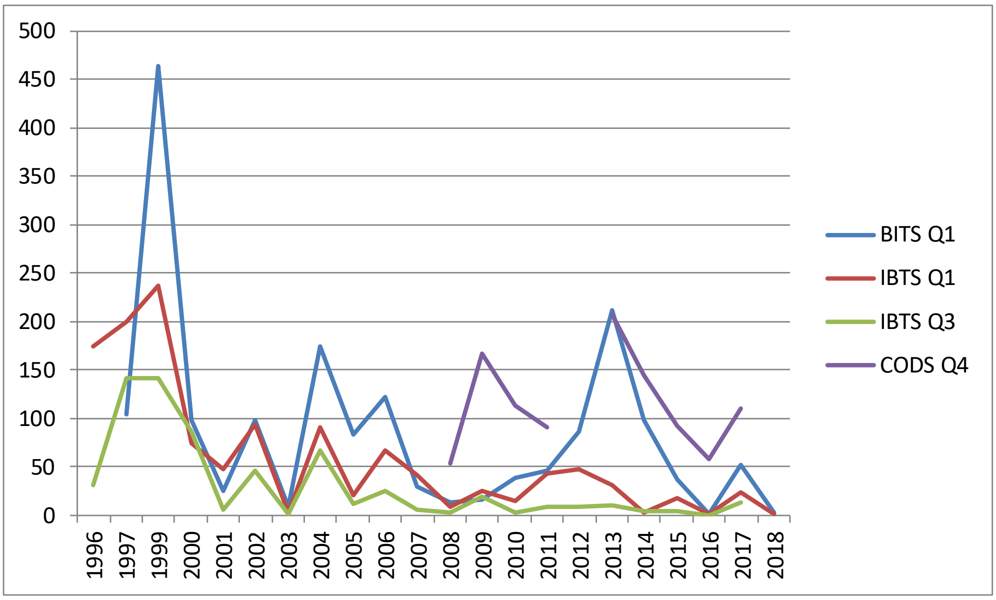


Figure 2.2.5 **Cod in Kattegat. Trends in recruitment index (Age 1) from different surveys.**

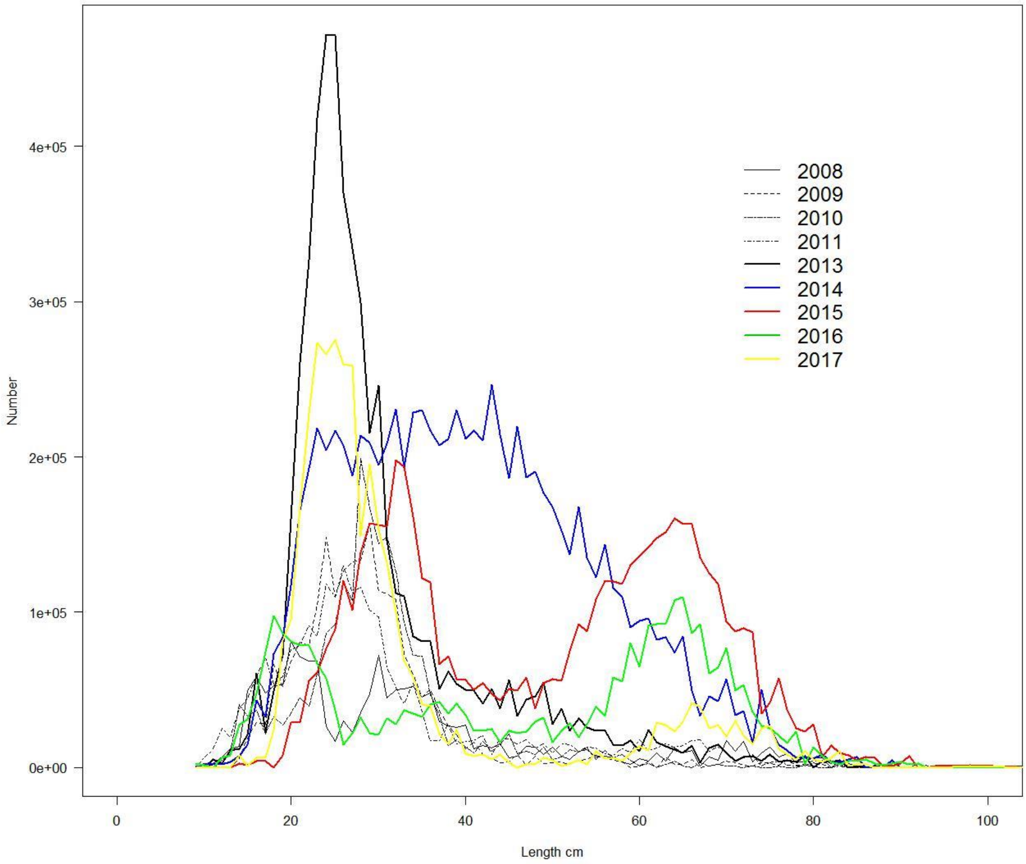


Figure 2.2.6 Cod in Kattegat. Length distributions from the Cod survey 2008-2017.

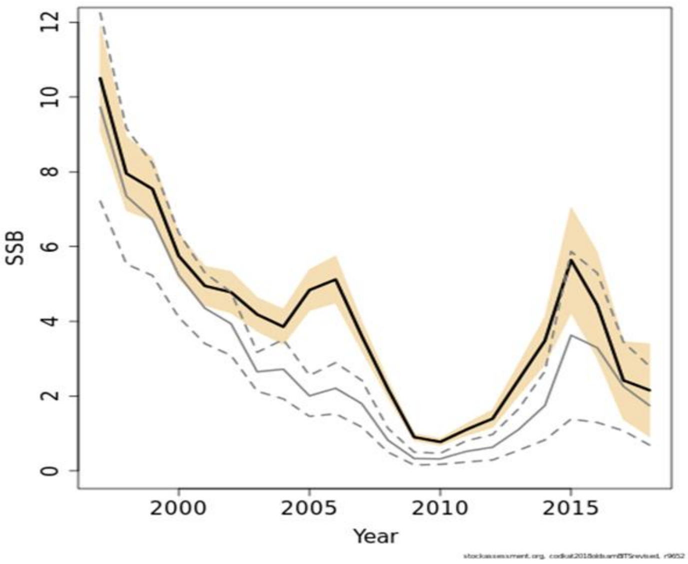


Figure 2.2.7 Cod in Kattegat. SAM results (SSB) without scaling (grey lines) and Sam run with scaling (black line with brown 95 % confidence interval).

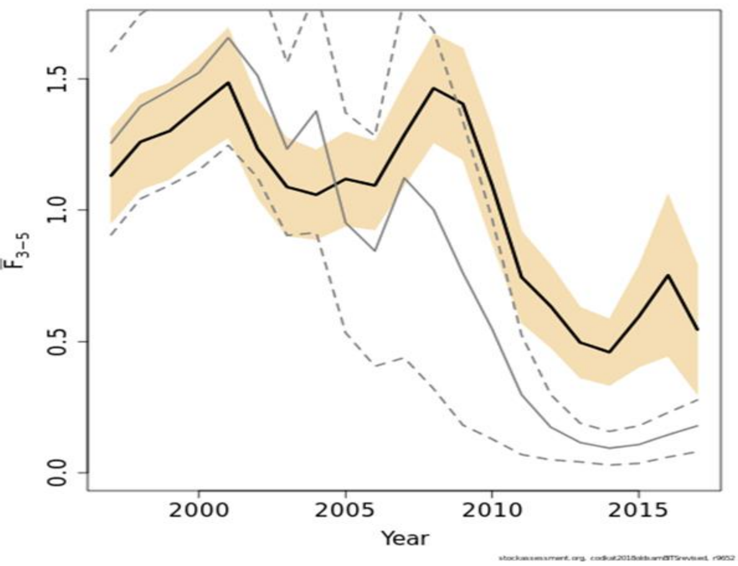


Figure 2.2.8 **Cod in Kattegat. SAM results (Unallocated mortality (Z-0.2)) without scaling (grey lines) and Sam run with scaling (black line with brown 95 % confidence interval)**

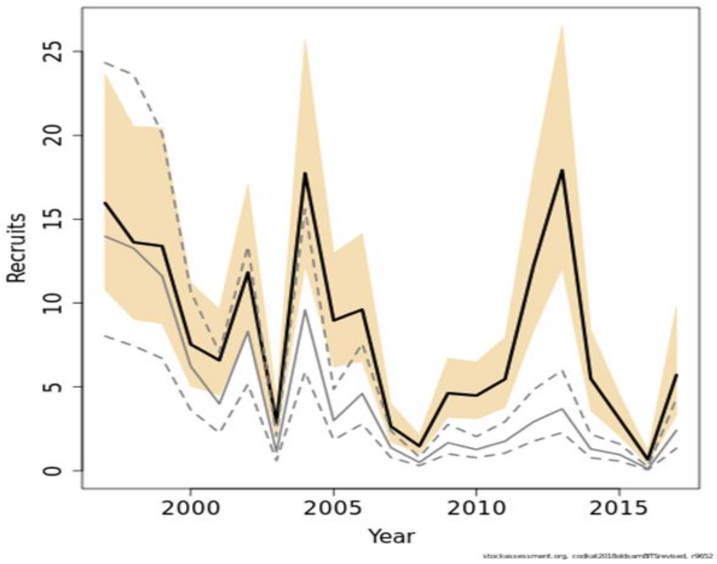
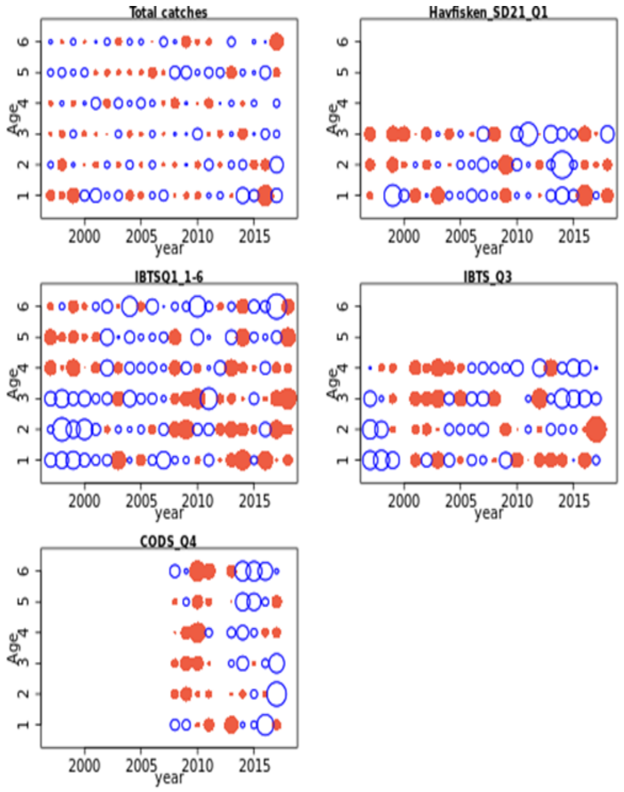


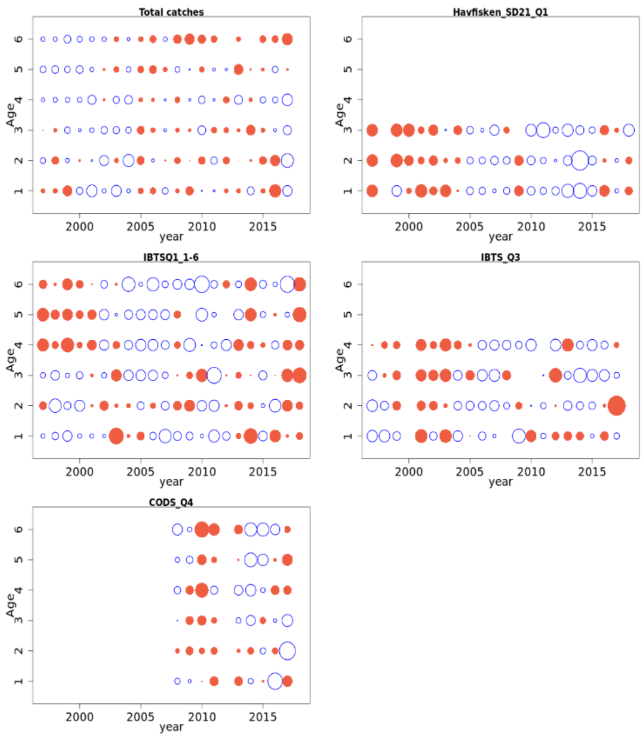
Figure 2.2.9 **Cod in Kattegat. SAM results (Recruitment) without scaling (grey lines) and Sam run with scaling.(black line with brown 95 % confidence interval).**

Year	Catch multiplier
2003	1.4
2004	1.1
2005	2.9
2006	2.8
2007	2.1
2008	3.4
2009	4.1
2010	3.6
2011	3.7
2012	6.3
2013	6.8
2014	7.8
2015	7.2
2016	6.3
2017	3.0

Figure 2.2.10 Cod in Kattegat. Catch multiplier/scaling factor by year from the SAM run with scaling.



a)



b)

Figure 2.2.11 **Cod in Kattegat. Residuals: a) SPALY with scaling b) SPALY without scaling. (The figures show normalized residuals for the current run. Blue circles indicate positive residuals (larger than predicted) and filled red circles indicate negative residuals (lower than predicted).**

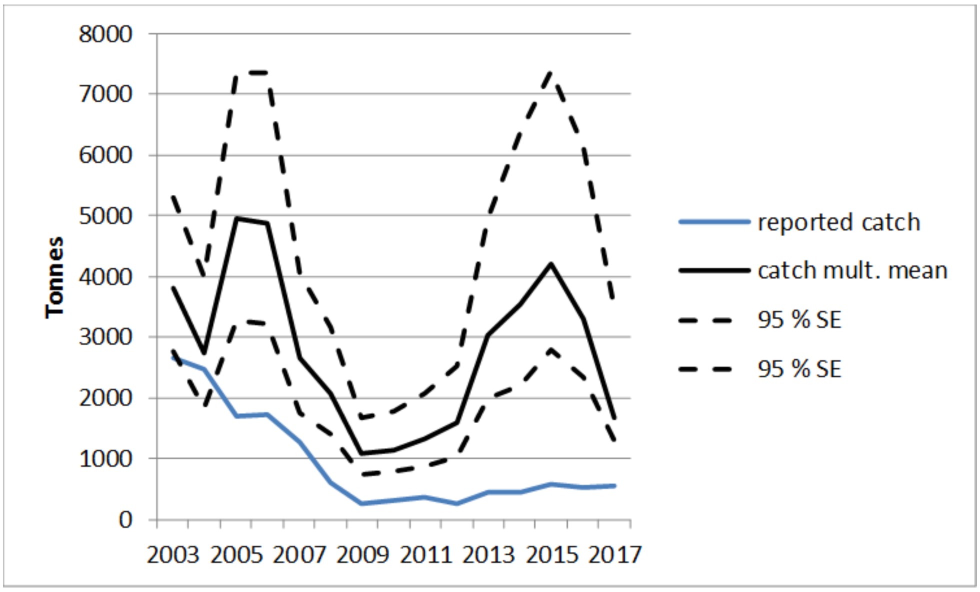


Figure 2.2.12 **Cod in Kattegat. Reported catch and the catch achieved by using the multiplier , mean and upper and lower 95 % confidence limits.**

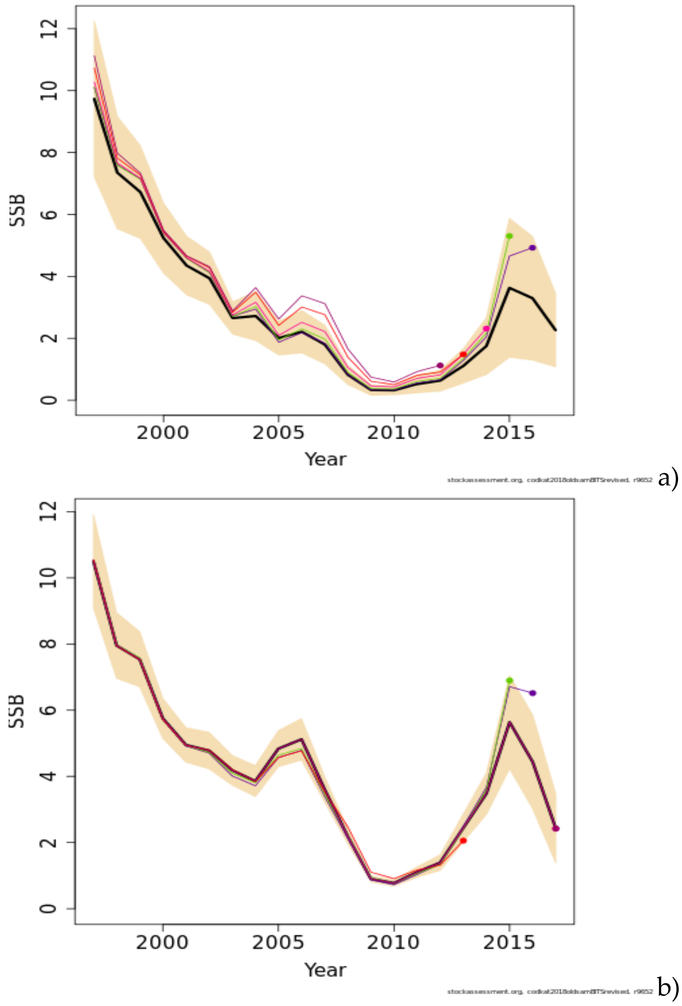
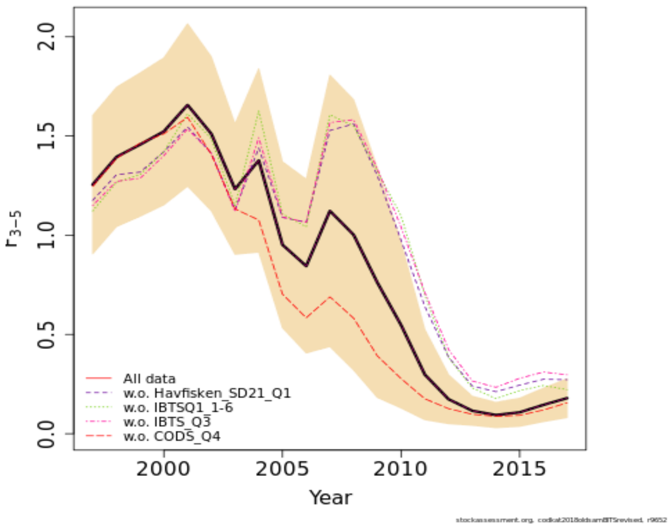
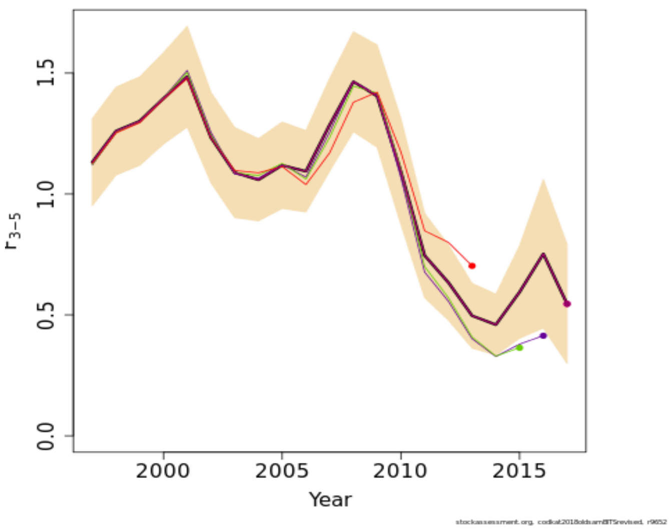


Figure 2.2.13 **Cod in Kattegat. Retrospective runs (SSB): a) with scaling b) without scaling.**



a)



b)

Figure 2.2.14 **Cod in Kattegat. Retrospective runs (Z): a) with scaling b) without scaling.**

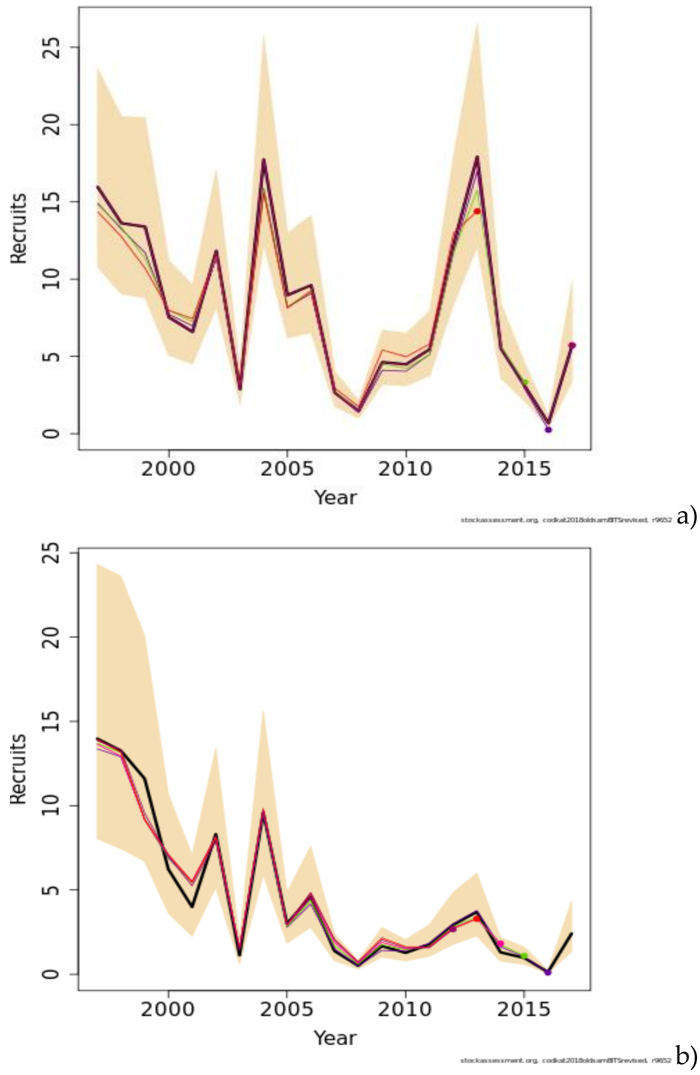


Figure 2.2.15 **Cod in Kattegat. Retrospective runs (recruitment): a) with scaling b) without scaling.**

2.3 Western Baltic cod (update assessment)

1) Assessment type: Update assessment
2) Assessment: Analytical
3) Forecast: SAM
4) Assessment model: SAM
5) Stock status: SSB < Blim in 2018. F (3–5) is in 2017 estimated to be 0.60.
6) Management plan. A new multi annual Baltic management plan has been implemented in 2016

2.3.1 The Fishery

Commercial catches are mainly taken by trawlers and gillnetters; and to a small degree by Danish Seines on the transitional area between subdivisions 22 and 24 (eastern Mecklenburg Bight/Darss sill). There is a trawling ban in place in subdivision SD 23 (the Sound) since 1932, but a small area in the north of SD 23 is open for trawlers in January; however, gillnetters are taking the major part of the commercial cod catches in SD 23. In SD 22 and 24 the main part of the catches are taken by trawlers. Overall catches are predominantly Danish, German and Swedish, with smaller amounts from Poland and occasionally reported by other Baltic coastal states, mainly from SD 24. Time series of total cod landings by SD in the management area of SD 22–24 are given in Table 2.3.1 In 2017 landing numbers include the BMS fraction, which was 32 t. Landings by SD, passive and active gear in 2017 are given in Table 2.3.2 (both include eastern Baltic cod landings in SD 24).

The total commercial landings of 5867 t resulted from a TAC reduction of -56% from 2016 to 2017. The last 10 years the major part of western Baltic cod stock landings has been fished in SD 24. Nevertheless, the proportion of cod landed in SD 22–23 increased from 41% in 2016 to 56% in 2017 (Table 2.3.1). Given the reduced TAC and stunted length distribution and higher discard rate in SD24, the absolute reduction in landings from SD 24 was greatest so that the main part of the TAC was taken in SD 22–23 (Figure 2.3.1).

32 t of BMS (below minimum conservation reference size) cod was landed in 2017, or 0.5% of the total landings in the management area SD 22–24, the main part in SD 24. Furthermore, it is legal to discard damaged cod if it is registered in the logbook, however, no logbook registered discards were reported for SD 22–24 in 2017.

As the western and eastern cod stock is mixing in SD 24, a splitting factor (based on genetics and otolith shape analysis) has been applied to the commercial cod landings in SD 24 to include only those fish belonging to the WB cod stock (Table 2.3.10). To do this, a weighted average of the proportions of WB cod in SD 24 in the two sub-areas was applied (Area 1 and Area 2 in Figure 2.3.5 for separation between the stocks). The weightings for each year represented relative proportions of commercial Danish and German cod landings (main part of fisheries in SD 24) taken in areas 1 and 2.

2.3.1.1 Regulation

Since 01.01.2015, the EU landing obligation has been in place in the Baltic, obliging the fisheries to land the entire catch of cod. There is a “minimum conservation reference size” of ≥ 35 cm, i.e. cod below this size cannot be sold for human consumption but has to be landed whole.

In 2017 the spawning closure in the western Baltic (SD 22–24) covered an 8 weeks period, from 1st of February to 31st of March. Vessels >15 m were not allowed to fish for cod during the spawning closure (use of cod ends with ≥105 mm mesh size) while vessel <15 m were allowed to fish for cod if they could prove that fishing took place in areas shallower than 20 m (e.g. using logbooks). In the beginning of the spawning closure, German vessels >15 m were allowed to use cod ends (≥90 mm mesh size), used to target flatfish. Some fishers were taking advantage of this national regulation and fished for cod in areas deeper than 20 m, and after a few weeks the demersal trawl fishery was totally closed for vessels >15 m LOA until the end of the spawning closure.

2.3.1.2 Discards

All relevant countries uploaded their discard data to InterCatch. Discard data from at-sea observer programs for 2017 were available from Germany, Sweden, Denmark and Poland for SD 22–24. Denmark does not sample and report discards of passive gears, assuming very low discards, these assumptions are confirmed by the Danish last haul data available from the control agency since 2016. Discards of the passive gear of Denmark were raised using mainly discard ratios from Germany and Sweden (Table 2.3.4). Besides the sample level showed in table 2.3.3, several observer trips have been conducted in SD 24, however due to the mixing of the eastern and western Baltic cod stock in this area otoliths are only used for stock ID and not age reading.

The discard rate of the active and passive gear in SD 22 and SD 23 was estimated to be 4.1% and 3.6%, respectively. This is an increased discard rate compared to the previous year probably due to the strong incoming 2016 cohort. For cod in SD 24, the discard rate of the active and passive gear was estimated to be 17.5% and 6.6%, respectively. Catches of long-liners (LLS) was very low in 2017 (only 7.7 t, 18.2 t and 0.021 t landed by Denmark, Sweden and Germany, respectively) and therefore, this fleet was not considered separately in the raising process. The effort reduction in this fleet is most likely due to the landing obligation since this gear is linked to relatively high discard rates (one order of magnitude higher than gillnetters).

The discard weights at age for SD 22 and SD 23 for 2017 were included in the catch-at-age weights, and were also applied for the discard estimates in SD 24 (see section 2.3.2.3).

2.3.1.3 Recreational catch

At the benchmark 2013 (WKBALT 2013), recreational catches were included in the assessment, which was confirmed and updated in the 2015 benchmark (WKBALTCOD 2015). Currently the recreational catch included in the assessment represents German data only, the amount varying between 930–3200 t in the years 2005–2017. The earlier years are extrapolated based on the estimates for the recent period (WKBALT 2013). German recreational catches are mainly taken by private and charter boats and to a small degree by land-based fishing methods. The amount in 2017 is estimated to be 932 t, the lowest in the time series. The low value is considered to be a combined effect on the bag limitation introduced in 2017 and the low stock level.

Since 2009, an investigation of the Danish recreational fishery was initiated (Sparrevohn and Storr-Paulsen 2010). Danish and Swedish recreational data are currently not included in the assessment, but efforts to incorporate these data are ongoing. A preliminary estimate from the Danish recreational fishery in 2017 is 612 t a 37% decrease compared to 2016. No recreational data was available from Sweden for 2016 and 2017. The amount of German recreational catch included in the assessment compared to commercial landings and discards is shown in Figure 2.3.2 and Table 2.3.6.

All German recreational cod caught in SD 22–24 is assumed to be WB cod (WKBALTCOD, 2015).

2.3.1.4 Unallocated removals

German recreational fisheries data are included in the assessment. Danish and Swedish recreational fisheries data are not yet included but are under preparation (see above). Another potential source of unallocated removals is the passive gear fishing fleet without the obligation to keep a daily logbook or where official sale notes are not available (Part-time fishers and German vessels < 8 m). However, reliable estimates of the potentially unallocated removals are not available for this fleet segment.

In 2015, Germany included for the first time cod discard estimates from the German pelagic trawl fishery targeting herring in SD24 (PTB_SPF); in 2017, the estimate was 29.5 t.

2.3.1.5 Total catch

Total catches of the western Baltic cod stock (SD 22–24), including commercial landings (including reported BMS), discards and German recreational catches, were estimated to be 5046 t in 2017. Landings and discards of eastern Baltic cod in SD 24 is estimated to be 2156 t and are shown in Table 2.3.6. By management area the total catch is estimated to be 7202 t.

2.3.1.6 Data quality

Denmark, Germany and Sweden provided quarterly landings, LANUM and WELA by gear type (active, gillnets set) for SD 22–23 (Table 2.3.3, Table 2.3.7). Poland provided discard ratios for SD 24. Unlike previous years, Finland and Latvia did not report landings from SD 24 because none of their national vessels had been fishing there.

All data were successfully uploaded to and processed in InterCatch. There was no national filling of empty strata prior to upload to InterCatch so that bias due to undocumented national extrapolations could be reduced. The list of unsampled strata and their allocated sampled strata in 2017 (i.e. the allocation overview) applied in InterCatch is given for landings and discards in Table 2.3.4

In 2015 a landing obligation was introduced in the Baltic and therefore the observer trips conducted by the national institutes have changed from observing a mandatory behaviour towards observing an illegal act. This could have an influence on the fishers´ behaviour and give more biased estimates. However, Denmark (only active gear), Sweden (passive gear) and Germany (both active and passive) have been able to conduct observer trips on board commercial vessels in 2017. Sweden had no active gear fishery in SD 22–24 in 2017 because the national TAC was provided exclusively to the passive gear fleet.

In Sweden, on passive gear trips both landings and discards are sampled. Germany samples catches (i.e. both landings and discards) via at-sea observers and purchased samples from commercial vessels. The German catch sampling program samples length distributions of catches and uses a knife-edge approach to separate the catch into landings and discards (i.e. presently 35 cm). Poland has an at-sea observer program (where both discards and landings are sampled) and a harbour sampling for landings. Sampling levels of commercial catch in 2017 are given in Table 2.3.3. Denmark samples landings via harbour-sampling with harbour trips being the primary sampling unit and discard via at-sea sampling with a random selection of all active vessels above 10 meter.

The Danish port sampling scheme (where commercial size sorting categories are sampled) result in national raising of passive and active gear landings strata with the same data sets. Both Denmark and Sweden are sampling boxes as the secondary sampling unit. In Denmark this is presently done under the assumption that the age and length distribution within a box do not depend on the gear that caught the fish. Information on the number of boxes per size sorting category and strata would be very important to assess the quality of the data submitted to the assessment. However, presently size sorting category data cannot be hold within InterCatch. If these data were to be assessed in the future, the data would have to be provided outside InterCatch, e.g. in the RDB which can contain this information.

The different sampling units (number of harbour days, number of trips) render between-country comparisons difficult. While Denmark has 44% of the TAC, they contributed to 35% of the discard trips, 11% of the length measurements and 22% of age readings (Table 2.3.9), in SD 22–23. Not shown are the otolith samplings that all countries conducted in SD 24, were presently only Danish otoliths are used for shape analysis and split of stock. Possible effects of the differences between national sampling levels on data quality of the international data set have not been assessed.

The reported numbers of age 5 cod in Q1 in SD 22 by Denmark was remarkably higher than by Germany, which, however, was in line with the differences in size sorting categories between countries (not shown) and also reflects previous landings patterns of Denmark. This suggests the presence of a targeted fishery for spawning cod in Danish despite the spawning closure and low SSB.

Sampling levels in German recreational fisheries are shown in Tables 2.3.8 and 2.3.9.

2.3.2 Biological data

2.3.2.1 Proportion of WB cod in SD 22–24

Time series of estimated proportions of eastern and western Baltic cod within SD 24 are available from 1996 onwards from otolith shape analyses, using genetically validated baselines (WKBALTCOD 2015). Systematic differences in the proportion of mixing were found by sub-areas within SD 24, with a higher proportion of eastern Baltic cod closer to SD 25. Thus, the proportions of eastern and western cod in SD 24 were estimated separately for 2 sub-areas, marked as Area 1 (Darss sill and entrance of SD 23) and Area 2 (Arkona basin, Rönnebank, Oderbank) in Figure 2.3.3.

In 2017, 62% of cod in SD 24 was found to be WB cod in Area 1 and 20% in Area 2 based on the otolith shape of 1859 cod (Table 2.3.10). The split is conducted on the cod otoliths sampled from the commercial Danish trawl fisheries in SD 24. Samples for otolith shape analysis were collected during all four quarters. The spilt is weighted with landings from both Germany and Denmark based on landings by ICES square in SD 24.

Germany analysed the mixing proportions using >14 000 otoliths from the quarter 4 BITS surveys conducted annually between 1992 and 2017 in SD 24. A genetically validated baseline from 2015/16 was used to assign otoliths shapes. The mixing proportions were similar to Danish estimates from commercial trawl samples in recent years.

2.3.2.2 Catch in numbers

Time series of the western Baltic stock commercial landings, discards, recreational catch and total catch at age are shown in Tables 2.3.11, 2.3.12, 2.3.13 and 2.3.14, respectively. Given the aging issues with EB cod that have a major contribution in SD 24, age composition information is only used from SD 22–23 (WKBALTCOD, 2015). Commercial catch at age for the entire western cod stock (i.e. including western Baltic cod in SD 24) were obtained by upscaling the catch at age in SD 22 by the catch of WB cod taken in SD 24 compared to SD 22. Catch at age in SD 23 were subsequently added, to obtain the catch at age of WB cod stock for SD 22–24.

The major part of commercial landings in 2017 was age-group 3. However, it was not as abundant as two years ago where the relatively large 2012 year class was present as age 3. The share of age 2 cod in terms of numbers is 5%, due to the very low 2015 year class (Figure 2.3.6). However, the strong 2016 year class is very large in the discard and recreational catches accounting for 12% of the total share. (Figure 2.3.4 and 2.3.5).

2.3.2.3 Mean weight at age

Mean weight at age in commercial landings, discards and in total catch is shown in Tables 2.3.15, 2.3.16 and 2.3.17, respectively. This is based on data from SD 22–23. The mean weight at age in total catch is estimated as a weighted average of mean weights at age in commercial landings, discards and recreational catch, weighted by the respective catch numbers.

Weight-at-age in the stock for ages 1–3 is obtained from BITS 1st quarter survey data for SD 22–23. Weights at ages 4–7 in the stock were set equal to the annual mean weights in the catch (Table 2.3.18).

2.3.2.4 Maturity ogive

The maturity ogive estimations are based on data from BITS 1st quarter surveys in SD 22–23 (Table 2.3.19) and represent spawning probability (see Stock Annex and WKBALT 2013 for details). A moving average over 3 years is applied.

Spawning stock biomass is calculated at the start of the year, i.e. the proportion of fishing and natural mortality before spawning is assumed to be zero for all years and ages.

2.3.2.5 Natural mortality

Natural mortality at age 0 was assumed to be 0.8. The natural mortality values for cod at age 1 incorporate predation mortalities derived from an earlier MSVPA key run. These predation mortalities have not been updated since 1997; and presently the value 0.242 is applied for age 1. A constant value of 0.2 is used for older ages in the entire time series (Table 2.3.20).

2.3.3 Fishery independent information

In the western Baltic area two vessels are contributing to the BITS survey quarter 1 and quarter 4 used in the assessment, the German "Solea" and the Danish "Havfisken". Both vessels are part of the international coordinated BITS (Baltic international trawl survey). In 2016 the old Danish vessel Havfisken was replaced by a new Havfisken. A calibration study was conducted in connection to the survey and a working document #9 on calibration has been provided on the subject in report from 2016 .

BITS Q1 and Q4

The tuning series used in the assessment are BITS Q1 and BITS Q4 surveys. The years and age-groups included in the assessment are shown in the table below and the time series of CPUE indices in Table 2.3.21. Internal consistency of all tuning series is presented in Figure 2.3.6 and the time series in Figure 2.3.7.

The CPUE by age from all tuning series are shown in Figure 2.3.8. Survey indices are calculated using a model-based approach and the area included in the indices is SD 22–23 and the western part of SD 24 (longitude 12° to 13°). Presently the area covering the eastern part of the SD 24 is not included in the index.

FLEET	YEAR RANGE	AGE RANGE
BITS, Q4, SD22–24W (12–13 degrees)	2001–2017	age 0–4
BITS, Q1, SD22–24W (12–13 degrees)	2001–2018	age 1–4

2.3.3.1 Recruitment estimates

The moderately strong 2012 year class can be followed in the survey as age 3 in 2015 and age 4 in 2016. The 2015 year class was very weak and among the lowest in the time series. In contrast to 2015, a very strong year class was detected in the Q4 BITS 2016 (as age 0) and in both the German and Danish pound net in SD 22. The strong 2016 year class was confirmed in Q1 BITS 2017 as age 1 cod (Figure 2.3.10, 2.3.10) and reencountered in Q4 BITS 2017 and as age 2 cod in Q1 BITS 2018 and is indicated to be among the largest since 1989.

In contrast, the 2017 year class was as weak as the 2015 cohort (Figure 2.3.8 and 2.3.9). Possible reasons for this are the low SSB in spring 2017, which may have resulted in a relatively low number of fertilized eggs. Even if egg production was not an issue, the extraordinary large number of very small age 1 cod from the 2016 cohort in spring 2017 (smallest individuals had only 10 cm total length in April/May; determined by age readings from pound net samples) may have led to food limitation for the settling year class 2017. The weak 2017 year class was also encountered in the samples from German commercial pound nets in autumn 2017 in Fehmarn. In summary, a weak 2015 year class was followed by a very strong 2016 year class, which was then followed by the weakest year class in the time series (Figure 2.3.9).

2.3.4 Assessment

A stochastic state-space model (SAM) is used for assessment of cod in the western Baltic Sea.

The configuration of the model used in the assessment is specified in the Stock Annex.

Exploratory runs leaving out one tuning series at a time were conducted (Figure 2.3.10), which indicated relatively consistent influence of both surveys on the SSB. The 1st quarter survey showed a very positive trend in 2018, and in the leave one out plot for F, it can be seen that F will increase without the information from this survey. Also the residuals (Figure 2.3.13) show that the 1st quarter survey is more positive than can been seen in the catch matrix.

As in last year's assessment there is some retrospective pattern in the catches estimated by the model, indicating that the model every year believes catches a higher than the observations (Figure 2.3.11)

The summaries for SSB, Recruitment and F from the final run are shown in Figure 2.3.12 and Table 2.3.22. Stock number and fishing mortalities are presented in Tables 2.3.23 and 2.3.24, respectively. The residuals of the final run are presented in Figure 2.3.13. The standard deviation of the different estimates used in the model is shown in Figure 2.3.14.

The retrospective analysis (Figure 2.3.15) indicates that in former years there was an overestimation of SSB, however last year that was not the case. For F, the retrospective pattern is also large but does not seem to be biased and Mohn rho is -0.006.

The input data and settings and final run are visible in www.stockassessment.org, the stock is "WBcod_2018".

2.3.5 Short-term forecast and management options

The short term forecast is based on the SAM short term forecast module.

From the assessment model the final estimates with a full dataset of fishing mortality and stock numbers is used, and their estimation variances and co-variances. These quantities are then simulated forward in time for a number of specified scenarios. The uncertainties are propagated forward in time, and the process variation (as estimated from the historic period) is added. These uncertainties are propagated all the way through the calculations.

The simulation is carried out at logarithmic scale, and medians are used as main summary statistic on the untransformed scale.

The input data for short-term forecast are shown in Table 2.3.25. Last year a TAC (catch) constraint was used in the intermediate year. This was derived from the splitting factor (0.66) applied to the TAC (5597 t) and recreational catches added (1754 t). This gives a total catch of 5612 t in 2018 and an F at 0.20.

The recreational catch in the intermediate year was derived by using a 3 year mean in catch 2014–2016 (2654 t) where the assumed reduction in catch due to the introduced bag limitation of a maximum of 5 cod per angler per day has been introduced in 2017. The bag limitation of 5 cod per angler per day has been estimated to reduce the catch by approximately 900 t (Strehlow 2016, unpublished data). In 2017 932 t cod were caught in the recreational German fisheries. The low number was thought to be a combination of the low SSB in 2017 and the bag limitation. As the stock is predicted to increase in 2018, the level was estimated to be too low for the intermediate year. As the regulation was in place in 2017, a 3 year mean did not seem to be an appropriate solution. Given the lack of a valid estimate for the intermediate year 2018, the same value as in 2017 was applied for the intermediate year.

As in last years´ advice calculations have been conducted on how the stock advice can be transformed into an area management advice. The assumption for this calculation is that the relative catch distribution between subdivisions is stable. The total commercial catch of WB cod stock commercial catch have on average in the most recent three years been quite stable between subdivisions 22–23 and Subdivision 24, amounting to 73% and 27%, respectively. However as the western Baltic cod stock is increasing with the large 2016 yearclass and the eastern Baltic cod is decreasing this could change in the coming years. In the most recent three years, the overall ratio EB cod /WB cod in the commercial catch in Subdivision 24 has been 2.38. This means that every time one WB cod is caught in SD 24, 2.38 eastern Baltic cod is caught at the same time. The advice based on the management plan indicates that the total catch (excluding the recreational fishery at 1754 t) can be 13 267 t for the western Baltic cod stock in 2019. From these 27% will be caught in SD 24 (if the distribution is similar as in the former year), making a catch of west Baltic cod at 3582 t. To this value the eastern Baltic cod fraction can be applied (2.38) giving a catch of eastern Baltic cod of 8520 t. This would altogether give a total catch in the western Baltic management area of 21787 t in 2019.

2.3.6 Reference points

In 2016, a Baltic multiannual management plan has been introduced with F ranges (0.15–0.26 and 0.26–0.45) depending on the SSB in the intermediate year compared to the MSY B-trigger level.

Biomass reference points B_{lim}= 27.4kt and B_{pa} at 38.4kt (WKBALT COD 2015). B_{pa} is considered to correspond to B_{MSY} trigger.

F_{lim} and F_{pa} were estimated using EqSim with the same settings and dataset as used for the FMSY calculation, however, calculated without trigger and Fcv=0, F_{phi}=0. This estimation gave a F_{lim} at 1.01 and an F_{pa} at 0.74.

2.3.7 Quality of assessment

The uncertainty on the catch matrix is relativity high in this assessment and the model seems to consistently overestimate the catches in the last year. Two possible reasons for the high uncertainty could be the splitting factor applied in SD 24, and the recreational catches.

Mixing of the eastern and western Baltic cod stocks is a major issue in SD 24. The stock mixing within SD 24 is variable spatially and possibly between seasons and age-groups of cod. This introduces uncertainty to the stock separation keys presently applied in the assessment. Also, for some years in the time series the stock separation keys are based on extrapolations from other years. Further, the preparation of assessment input data to separate between western and eastern Baltic stock involves a number of additional assumptions which introduces uncertainty to the assessment. However, separating the western Baltic cod (SD 22–23 + the component of western Baltic cod in SD 24) within the management area SD 22–24 after WKBALTCOD (2015) removed several sources of uncertainty characterizing the previous years´ assessments (e.g. age reading issues, higher discards in SD 24). Therefore, despite the uncertainties mentioned above, this years´ assessment is considered to provide a relatively reliable perspective of the stock status of the western Baltic cod stock. Furthermore, an age reading calibration has been conducted between Denmark and Germany in 2015 and the agreement is now 94%, which is considered very well.

Recreational fishery catches have been included from Germany and used in the assessment not only as topping up the catches but as an age-based input in the catch and weight matrix. In 2017 German recreational catches for this stock were close to 18% of the total catch and can therefore not be ignored in the assessment. The present lack of the Danish and Swedish recreational fishery adds to uncertainty in the assessment; however, it is the plan to include the Danish and Swedish recreational data at the next benchmark when the data have been verified by on-site studies and include biological data such as length and weight.

Issue list:

The stock has been suggested as a candidate for a next benchmark in 2019 and a relatively long issue list was compiled and is present at the SharePoint. Among the most important things to look at are:

- Apply the stock split on the survey using German otolith shape data from 1992 to present, and then test if it is possible to include a larger part of the survey area in SD 24.
- Extend and complete the otolith shape analyses of the German surveys in SD24 back to the late 1970s to cover the peak period of Baltic cod (relevant for reference points); and provide more years with genetic validation
- Include Danish and German and preferably Swedish and Polish data on otolith shape to conduct the split on commercial data.
- Include Danish and Swedish recreational data, including biological data
- Reconsider the reference point, especially the breaking point
- Assess the number of boxes per size sorting category and strata from the port samples and compare in detail the age, weight and length distributions with German sampling data.
- Include Swedish data from survey in SD 23 (IBTS).
- Consider German pound net data for an additional cod recruitment index from the commercial fisheries (since 2011)

2.3.8 Comparison with previous assessment

Before 2015, the assessment was conducted for the area of SD 22–24 that includes a significant fraction of the eastern Baltic cod stock. Since then, the assessment has been conducted for the western Baltic cod stock only. The assessment this year has downscaled the 2017 SSB by 8% compared to last year. The very large 2016 recruitment was upscaled with 31%, and the F was downscaled with 35%. The very large 2016 year class has a large influence on the short term forecast, but also the historic low 2017 is included in the forecast.

2.3.9 Management considerations

The management area of SD 22–24 contains a mixture of eastern and western Baltic cod populations, particularly in SD 24. This has been shown by genetic analyses. Thus, part of the catches taken in the management area of SD 22–24 is cod that genetically is eastern Baltic cod but lives in SD 24.

Given the poor recruitment in 2015 and 2017, the commercial fisheries in 2019 and the present stock status are mainly based on the 2016 cohort. Further, stronger year classes are needed to ensure continuance of a commercial fishery. A spawning closure is presently in place from 1st of February to 31th of March and has in 2016 produced a record high year class and in 2017 a record low year class. An evaluation of the spawning closure is still considered too early.

Table 2.3.1. Cod in management area of SD 22–24. Total landings (tonnes) and discard of cod in the ICES subdivisions 22, 23, 24 (includes eastern Baltic cod landings in SD 24).

Table 2.3.1 Cod in SD 22-24. Total landings (tons) of COD in the ICES Sub-divisions 22, 23, 24.

	Denmark			Finland	German Dem.Rep.[1]	Germany, FRG		Estonia		Lithuania	Latvia	Poland	Sweden			Total for managment area: Human consumption landings (HC)							
	22	23	22+24	24	22+24	22	22+24	22	24	24	24	24	22	23	22+24	22	23	24	HC (SD22-24)	BMS	Discard	Unalloc.	Total catch
1965			19457		9705		13350								2182	27867		17007	44874				44874
1966			20500		8393		11448								2110	27864		14587	42451				42451
1967			19181		10007		12884								1996	28875		15193	44068				44068
1968			22593		12360		14815								2113	32911		18970	51881				51881
1969			20602		7519		12717								1413	29082		13169	42251				42251
1970			20085		7996		14589								1289	31363		12596	43959				43959
1971			23715		8007		13482								1419	32119		14504	46623				46623
1972			25645		9665		12313								1277	32808		16092	48900				48900
1973			30595		8374		13733								1655	38237		16120	54357				54357
1974			25782		8459		10393								1937	31326		15245	46571				46571
1975			23481		6042		12912								1932	31867		12500	44367				44367
1976		712	29446		4582		12893								1800	33368	712	15353	49433				49433
1977		1166	27939		3448		11686							550	1516	29510	1716	15079	46305				46305
1978		1177	19168		7085		10852							600	1730	24232	1777	14603	40612				40612
1979		2029	23325		7594		9598							700	1800	26027	2729	16290	45046				45046
1980		2425	23400		5580		6657							1300	2610	22881	3725	15366	41972				41972
1981		1473	22654		11659		11260							900	5700	26340	2373	24933	53646				53646
1982		1638	19138		10615		8060							140	7933	20971	1778	24775	47524				47524
1983		1257	21961		9097		9260							120	6910	24478	1377	22750	48605				48605
1984		1703	21909		8093		11548							228	6014	27058	1931	20506	49495				49495
1985		1076	23024		5378		5523							263	4895	22063	1339	16757	40159				40159
1986		748	16195		2998		2902							227	3622	11975	975	13742	26692				26692
1987		1503	13460		4896		4256							137	4314	12105	1640	14821	28566				28566
1988		1121	13185		4632		4217							155	5849	9680	1276	18203	29159				29159
1989		636	8059		2144		2498							192	4987	5738	828	11950	18516				18516
1990		722	8584		1629		3054							120	3671	5361	842	11577	17780				17780
1991		1431	9383				2879							232	2768	7184	1663	7846	16693				16693
1992		2449	9946				3656							290	1655	9887	2739	5370	17996				17996
1993		1001	8666				4084							274	1675	7296	1275	7129	15700			5528	21228
1994		1073	13831				4023							555	3711	8229	1628	13336	23193		2235	7502	32930
1995		2547	18762	132			9196				15			611	2632	16936	3158	13801	33895		3684		37579
1996		2999	27946	50			12018		50		32			1032	4418	21417	4031	23097	48545		7984	2300	58829
1997		1886	28887	11			9269		6			263		777	2525	21966	2663	18995	43624		4623		48247
1998		2467	19192	13			9722		8		13	623		607	1571	15093	3074	16049	34216		6207		40423
1999		2839	23074	116			13224		10		25	660		682	1525	20409	3521	18225	42155		4978		47133
2000		2451	19876	171			11572		5		84	926		698	2564	18934	3149	16264	38347		4947		43294
2001		2124	17446	191			10579		40		46	646		693	2479	14976	2817	16451	34244		2839		37083
2002		2055	11657	191			7322				71	782		354	1727	11968	2409	9781	24158		1958		26116
2003		1373	13275	59			6775				124	568		551	1899	9573	1925	13127	24624		4336		28960
2004		1927	11386				4651				221	538		393	1727	9091	2320	9430	20841		2377	13	23231
2005		1902	9867	2			7002	72	67		476	1093		720	835	8729	2621	10686	22036		4994	9	27039
2006		1899	9761	242			7516		91		586	801			1855	9979	1914	10858	22751		1831		24582
2007		2169	8975	220			6802		69		273	2371		534	2322	7840	2713	13183	23736		2199		25935
2008		1612	8582	159			5489		134		30	1361		525	2189	5687	2139	12256	20082		1123		21205
2009		567	7871	259			4020		194		23	529		269	1817	3451	839	11259	15549		815		16364
2010		689	6849	203			4250			9	159	319		490	1151	3925	1179	9016	14120		1371		15491
2011		783	7799	149			4521				24	487		414	2153	5493	1198	9641	16332		780		17112
2012		733	8381	260			4522		3		11	818		390	1955	4896	1123	11053	17072		905		17977
2013		580	6566	50			3237				128	708		380	1317	4675	960	7333	12968		2250		15218
2014	2206	795	6804	7		2109	3243				39	854	1	565	1231	4316	1361	7862	13538		2135		15673
2015	2781	738	6623	28		2213	2915				7	755		493	1858	4994	1232	7193	13419		1361		14780
2016	1576	675	4881	29		1617	2390					657	1	448	1550	3193	1123	6313	10629		449		11078
2017 [2]	1167	506	2352			1029	1267					926		435	348	2195	941	2697	5834	33	405		6272

[1] Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.

[2] German landings data preliminary

Table 2.3.2. Cod in management area of SD 22–24. Total landings (t) by Sub-division (includes Eastern Baltic cod in SD 24) sorted by column "22–24".

Year: 2017 Gear: **Active and passive gear combined**

Sub-div.	**22**	**23**	**24**	**22-24**
Country:				
Denmark	1167	506	1185	2858
Germany	1029	0	238	1267
Sweden	0	435	348	783
Poland	0	0	926	926
Finland	0	0	0	0
Latvia	0	0	0	0
Estonia	0	0	0	0
Lithuania	0	0	0	0
Russia	0	0	0	0
Total	2195	941	2697	5834

Year: 2017 Gear: **Active gear**

Sub-div.	**22**	**23**	**24**	**22-24**
Country:				
Denmark	522	118	981	1622
Germany	682	0	107	789
Sweden	0		51	51
Poland	0	0	610	610
Finland	0	0	0	0
Estonia	0	0	0	0
Lithuania	0	0	0	0
Russia	0	0	0	0
Latvia	0	0	0	0
Total	1204	118	1749	3071

Year: 2017 Gear: **Passive gear**

Sub-div.	**22**	**23**	**24**	**22-24**
Country:				
Denmark	645	388	204	1237
Germany	347	0	131	478
Sweden	0	435	297	732
Poland		0	316	316
Latvia	0	0	0	0
Estonia	0	0	0	0
Finland	0	0	0	0
Lithuania	0	0	0	0
Russia	0	0	0	0
Total	991	823	948	2762

Table 2.3.3. Cod in subdivisions 22–23 only. Overview of the number of samples (number of trips, harbor visits or number of boxes), number of length measurements and number of otoliths available per stratum in 2017 (upper, middle and lower table, respectively). Color codes indicate sampling coverage (see legend below). Also SD 24 has otolith and length samples.

SD 22-23 ONLY

Table.2.3.9. Cod 22-24. Number of samples by quarter for 2017 available to the Working Group (SD22-23 samples only).

			Area	Season									
Number of samples			27,3,c,22				27,3,b,23				Total	Country sum	%
Country	Catch Categor	Fleets	1	2	3	4	1	2	3	4			
Denmark	Discards *1	Active	11		3	5					19		
TAC 44%		Gillnets set										64	**41%**
		Longline set											
	Landings *2	Active	6	7	9	15		2	2	4	45		
		Gillnets set									--		
		Longline set									--		
Germany	Discards *1	Active	5	2							7		
TAC 21%		Gillnets set	12								12	57	**37%**
		Longline set											
	Landings *1	Active	8	3	3	1					15		
		Gillnets set	11		4	8					23		
		Longline set											
Sweden	Discards *1	Active											
TAC 16%		Passive					3	5	5	4	17		
	Landings *1	Active										34	**22%**
		Passive					3	5	5	4	17		
Total			47	5	10	14	6	10	10	8	155		

*1: number of sampled trips; *2: habor days

			Area	Season									
Number of length measurements			27,3,c,22				27,3,b,23				Total	Country sum	%
Country	Catch Categor	Fleets	1	2	3	4	1	2	3	4			
Denmark	Discards	Active	6		18	7					31		
TAC 44%		Gillnets set										894	**11%**
		Longline set											
	Landings	Active	112	94	132	329		23	53	120	863		
		Gillnets set									--		
		Longline set									--		
Germany	Discards	Active	128	299							427		
TAC 21%		Gillnets set	66								66	5916	**75%**
		Longline set											
	Landings	Active	3192	277	337	2					3808		
		Gillnets set	720		465	430					1615		
		Longline set											
Sweden	Discards	Active										1027	**13%**
TAC 16%		Passive					8	9	123	134	274		
	Landings	Active											
		Passive					147	214	179	213	753		
Total			4112	576	820	439	155	223	302	347	7837		

Number of otoliths age-read											Total	Country sum	%
Country	Catch Categor	Fleets	1	2	3	4	1	2	3	4			
Denmark	Discards	Active	6		20	7					33		
TAC 44%		Gillnets set										897	**22%**
		Longline set											
	Landings	Active	112	94	133	329		23	53	120	864		
		Gillnets set									--		
		Longline set									--		
Germany	Discards	Active	100	285							385		
TAC 21%		Gillnets set	8								8	2240	**54%**
		Longline set											
	Landings	Active	500	248	309	2					1059		
		Gillnets set	216		340	232					788		
		Longline set											
Sweden	Discards	Active											
TAC 16%		Passive					8	9	123	134	274	1027	**25%**
	Landings	Active											
		Passive					147	214	179	213	753		
Total			830	533	669	241	155	223	302	347	4164		

Table 2.3.4. Cod 22–23. Unsampled landing and discard strata and allocated sampled strata in 2017. 1/5

DE_27.3.c.22_2_Gillnets set_L,DE_27.3.c.22_1_Gillnets set_L,X
DE_27.3.c.22_2_Gillnets set_L,DK_27.3.b.23_2_Gillnets set_L,X
DE_27.3.c.22_2_Gillnets set_L,DK_27.3.c.22_1_Gillnets set_L,X
DE_27.3.c.22_2_Gillnets set_L,DK_27.3.c.22_2_Gillnets set_L,X
DE_27.3.c.22_2_Gillnets set_L,SE_27.3.b.23_1_Passive_L,X
DE_27.3.c.22_2_Gillnets set_L,SE_27.3.b.23_2_Passive_L,X
DE_27.3.c.22_2_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X
DE_27.3.c.22_2_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DE_27.3.c.22_2_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DE_27.3.c.22_2_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DE_27.3.c.22_2_Longline set_L,SE_27.3.b.23_4_Passive_L,X
DK_27.3.b.23_1_Active_L,DE_27.3.c.22_1_Active_L,X
DK_27.3.b.23_1_Active_L,DE_27.3.c.22_2_Active_L,X
DK_27.3.b.23_1_Active_L,DK_27.3.b.23_2_Active_L,X
DK_27.3.b.23_1_Active_L,DK_27.3.c.22_1_Active_L,X
DK_27.3.b.23_1_Active_L,DK_27.3.c.22_2_Active_L,X
DK_27.3.b.23_1_Gillnets set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.b.23_1_Gillnets set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.b.23_1_Gillnets set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.b.23_1_Gillnets set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.b.23_1_Gillnets set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.b.23_1_Gillnets set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.b.23_1_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DK_27.3.b.23_1_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X

continued

Table 2.3.4. Cod 22–23. Unsampled landing and discard strata and allocated sampled strata in 2017. 2/5

DK_27.3.b.23_1_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.b.23_1_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.b.23_1_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DK_27.3.b.23_1_Longline set_L,SE_27.3.b.23_4_Passive_L,X
DK_27.3.b.23_4_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X
DK_27.3.b.23_4_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.b.23_4_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.b.23_4_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DK_27.3.b.23_4_Longline set_L,SE_27.3.b.23_4_Passive_L,X
DK_27.3.c.22_1_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_1_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.c.22_1_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.c.22_1_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DK_27.3.c.22_1_Longline set_L,SE_27.3.b.23_4_Passive_L,X
DK_27.3.c.22_2_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_2_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X

continued

Table 2.3.4. Cod 22–23. Unsampled landing and discard strata and allocated sampled strata in 2017. 3/5

DK_27.3.c.22_2_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.c.22_2_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.c.22_2_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DK_27.3.c.22_2_Longline set_L,SE_27.3.b.23_4_Passive_L,X
DK_27.3.c.22_3_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_3_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.c.22_3_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.c.22_3_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DK_27.3.c.22_3_Longline set_L,SE_27.3.b.23_4_Passive_L,X
DK_27.3.c.22_4_Longline set_L,DE_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DE_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DE_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.b.23_2_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.b.23_2_Longline set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.b.23_3_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.b.23_3_Longline set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.b.23_4_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.c.22_1_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.c.22_2_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.c.22_3_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,DK_27.3.c.22_4_Gillnets set_L,X
DK_27.3.c.22_4_Longline set_L,SE_27.3.b.23_1_Passive_L,X
DK_27.3.c.22_4_Longline set_L,SE_27.3.b.23_2_Passive_L,X
DK_27.3.c.22_4_Longline set_L,SE_27.3.b.23_3_Passive_L,X
DK_27.3.c.22_4_Longline set_L,SE_27.3.b.23_4_Passive_L,X

continued

Table 2.3.4. Cod 22–23. Unsampled landing and discard strata and allocated sampled strata in 2017. 4/5

DE_27.3.c.22_2_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DE_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DE_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DE_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DE_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DE_27.3.c.22_2_Longline set_D,DE_27.3.c.22_1_Gillnets set_D,X
DE_27.3.c.22_2_Longline set_D,SE_27.3.b.23_1_Passive_D,X
DE_27.3.c.22_2_Longline set_D,SE_27.3.b.23_2_Passive_D,X
DE_27.3.c.22_2_Longline set_D,SE_27.3.b.23_3_Passive_D,X
DE_27.3.c.22_2_Longline set_D,SE_27.3.b.23_4_Passive_D,X
DE_27.3.c.22_3_Active_D,DE_27.3.c.22_1_Active_D,X
DE_27.3.c.22_3_Active_D,DE_27.3.c.22_2_Active_D,X
DE_27.3.c.22_3_Active_D,DK_27.3.c.22_1_Active_D,X
DE_27.3.c.22_3_Active_D,DK_27.3.c.22_3_Active_D,X
DE_27.3.c.22_3_Active_D,DK_27.3.c.22_4_Active_D,X
DE_27.3.c.22_3_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DE_27.3.c.22_3_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DE_27.3.c.22_4_Active_D,DE_27.3.c.22_1_Active_D,X
DE_27.3.c.22_4_Active_D,DE_27.3.c.22_2_Active_D,X
DE_27.3.c.22_4_Active_D,DK_27.3.c.22_1_Active_D,X
DE_27.3.c.22_4_Active_D,DK_27.3.c.22_3_Active_D,X
DE_27.3.c.22_4_Active_D,DK_27.3.c.22_4_Active_D,X
DE_27.3.c.22_4_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DE_27.3.c.22_4_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.b.23_1_Active_D,DK_27.3.c.22_3_Active_D,X
DK_27.3.b.23_1_Active_D,DK_27.3.c.22_4_Active_D,X
DK_27.3.b.23_1_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.b.23_1_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.b.23_1_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.b.23_1_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_1_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.b.23_2_Active_D,DK_27.3.c.22_3_Active_D,X
DK_27.3.b.23_2_Active_D,DK_27.3.c.22_4_Active_D,X
DK_27.3.b.23_2_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.b.23_2_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.b.23_2_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.b.23_2_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_2_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.b.23_2_Longline set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.b.23_2_Longline set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.b.23_2_Longline set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.b.23_2_Longline set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_2_Longline set_D,SE_27.3.b.23_4_Passive_D,X

continued

Table 2.3.4. Cod 22–23. Unsampled landing and discard strata and allocated sampled strata in 2017. 5/5

DK_27.3.b.23_2017_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.b.23_2017_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.b.23_2017_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.b.23_2017_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_2017_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.b.23_3_Active_D,DE_27.3.c.22_1_Active_D,X
DK_27.3.b.23_3_Active_D,DE_27.3.c.22_2_Active_D,X
DK_27.3.b.23_3_Active_D,DK_27.3.c.22_1_Active_D,X
DK_27.3.b.23_3_Active_D,DK_27.3.c.22_3_Active_D,X
DK_27.3.b.23_3_Active_D,DK_27.3.c.22_4_Active_D,X
DK_27.3.b.23_3_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.b.23_3_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_3_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.b.23_3_Longline set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.b.23_3_Longline set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.b.23_3_Longline set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.b.23_3_Longline set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_3_Longline set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.b.23_4_Active_D,DE_27.3.c.22_1_Active_D,X
DK_27.3.b.23_4_Active_D,DE_27.3.c.22_2_Active_D,X
DK_27.3.b.23_4_Active_D,DK_27.3.c.22_1_Active_D,X
DK_27.3.b.23_4_Active_D,DK_27.3.c.22_3_Active_D,X
DK_27.3.b.23_4_Active_D,DK_27.3.c.22_4_Active_D,X
DK_27.3.b.23_4_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.b.23_4_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.b.23_4_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.c.22_1_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.c.22_1_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.c.22_1_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.c.22_1_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.c.22_1_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.c.22_2_Active_D,DK_27.3.c.22_3_Active_D,X
DK_27.3.c.22_2_Active_D,DK_27.3.c.22_4_Active_D,X
DK_27.3.c.22_2_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.c.22_2_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.c.22_2017_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.c.22_2017_Gillnets set_D,SE_27.3.b.23_1_Passive_D,X
DK_27.3.c.22_2017_Gillnets set_D,SE_27.3.b.23_2_Passive_D,X
DK_27.3.c.22_2017_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.c.22_2017_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X
DK_27.3.c.22_3_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.c.22_3_Gillnets set_D,SE_27.3.b.23_3_Passive_D,X
DK_27.3.c.22_4_Gillnets set_D,DE_27.3.c.22_1_Gillnets set_D,X
DK_27.3.c.22_4_Gillnets set_D,SE_27.3.b.23_4_Passive_D,X

Table 2.3.5. Cod 22–23. 2017. Discard (Number * 1000) by quarter and gear type.

Sum of DISCARD	Quarter				Grand Total
Gear type	1	2	3	4	
Passive gears	20	21	14	41	96
Active gears	45	109	45	21	220
Grand Total	67	130	89	79	365

Table 2.3.6. Western Baltic cod. Catches in the WB management area (SD 22–24) for WB and EB stocks (in tonnes). Recreational catch: German data only.

Year	WB cod stock					EB cod stock			Managment area 22-24				
	Landings	Discards	Recreational catch	% of comm. catch in SD 22-23	% of comm. catch in SD 24	Landings in SD 24	Discards in SD24	% of catch in SD 24	Total landings	Discard	Recreational catch**	total catch	EBC / WBC stock Comm catch in SD 24
1994	21409	2069	1828	0.46	0.54	1784	166	2	23193	2235	1828	27256	0.15
1995	29854	3143	2133	0.66	0.34	4041	541	4	33895	3684	2133	39712	0.41
1996	38335	6897	2190	0.68	0.32	10210	1087	8	48545	7984	2190	58719	0.79
1997	37009	3994	2280	0.67	0.33	6615	629	7	43624	4623	2280	50526	0.53
1998	29628	5577	2372	0.63	0.37	4588	630	7	34216	6207	2372	42795	0.40
1999	35817	4390	2243	0.68	0.32	6338	588	8	42155	4978	2243	49376	0.53
2000	31653	3794	2386	0.68	0.32	6694	1153	8	38347	4947	2386	45680	0.70
2001	26983	2456	2494	0.67	0.33	7261	383	8	34244	2839	2494	39576	0.79
2002	19592	1410	2215	0.72	0.28	4566	548	7	24158	1958	2215	28331	0.88
2003	18055	3482	2361	0.66	0.34	6569	854	9	24624	4336	2361	31321	1.00
2004	15916	2193	2284	0.74	0.26	4925	184	7	20841	2377	2284	25503	1.09
2005	16845	3186	2835	0.63	0.37	5191	1808	11	22036	4994	2835	29866	0.94
2006	16472	1689	1887	0.74	0.26	6279	142	8	22751	1831	1887	26468	1.37
2007	15859	1344	1698	0.66	0.34	7876	855	14	23736	2199	1698	27634	1.48
2008	11148	355	1513	0.69	0.31	8934	768	17	20082	1123	1513	22717	2.69
2009	7093	341	1921	0.60	0.40	8456	474	15	15549	815	1921	18285	3.02
2010	7641	814	2287	0.67	0.33	6479	557	12	14120	1371	2287	17778	2.55
2011	8845	272	1794	0.75	0.25	7487	508	13	16332	780	1794	18907	3.48
2012	8654	349	2657	0.69	0.31	8419	556	13	17072	905	2657	20634	3.20
2013	7742	945	2029	0.70	0.30	5226	1305	15	12968	2250	2029	17248	2.48
2014	8099	867	2485	0.67	0.33	5439	1268	15	13538	2135	2485	18158	2.25
2015	8372	449	3161	0.71	0.29	5047	912	12	13419	1361	3161	17941	2.35
2016	6233	156	2316	0.68	0.32	4430	293	13	10663	449	2316	13428	2.31
2017*	3923	191	932	0.79	0.21	1942	214	7	5865	405	932	7202	2.47
Average 3 yr				0.73	0.27								2.38
* in 2017 Landings includes BMS													
** only German data													

Table 2.3.7. Cod in SD 22–23. Numbers at age (LANUM) and mean weight at age (WELA) in commercial landings by Sub-division, quarter and gear in 2017. 1/2

Year:		Gear:	Trawl, gillnet and longlines combined			
Year:	**2017**	**Quarter:**	**1**			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1		693		693		693
2	17	755	6	864	23	805
3	179	1479	130	1393	309	1440
4	142	2441	59	1987	201	2235
5	87	3060	20	2830	107	2955
6	10	3881	6	3432	15	3677
7	6	4590	4	4226	11	4425
8		7213	1	6550	1	6739
9		7626		6747		6998
10		6669		6669		6669
SOP [t]	913		360		1273	
Landings (t)	904		356		1261	

Year:	**2017**	**Quarter:**	**2**			
Sub-div,	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1	0.001	693				693
2	15	796	0.6	1007	69	884
3	131	1634	26	1375	279	1526
4	70	2564	10	1862	135	2272
5	32	3634	15	2640	20	3220
6	10	4180	6	2729	11	3520
7	5	5614	0.08	3640	5	5120
8	0.3	7209	0.2	6640	2	7067
9	3	7435	0.001	6534	0.2	7210
10	0.001	6669	0.001	6669		6669
SOP [t]	561		116		677	
Landings (t)	556		114		670	

Year:	**2017**	**Quarter:**	**3**			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	weight [g]	*10-3	weight [g]	*10-3	weights [g]
1	0.8	571	0.3	746	1.0	606
2	6	914	6	1030	12	960
3	40	1792	71	1448	111	1636
4	28	2899	9	1974	38	2479
5	22	4098	15	2465	36	3355
6	5	4343	4	3021	9	3742
7	2	6846	0.3	4119	2	5482
8	0.7	7968	0.001	7619	0.7	7868
9	0.2	8250	0.001	6534	0.2	7564
10		6669	0.001	6669	0.001	6669
SOP [t]	312		181		493	
Landings (t)	309		179		488	

continued

Table 2.3.7. Cod in SD 22–23. Numbers at age (LANUM) and mean weight at age (WELA) in commercial landings by Sub-division, quarter and gear in 2017. 2/2

Year:	**2017**	**Quarter:**	**4**			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	w eight [g]	*10-3	w eight [g]	*10-3	w eights [g]
1	72	738	16	737	88	737
2	34	1119	21	1170	55	1144
3	51	2240	93	1610	144	1925
4	25	3250	18	2226	44	2785
5	18	4835	17	2743	34	3884
6	2	5482	3	2761	5	4121
7	0.6	5188	0.8	4023	1.4	4541
8		7213	0.04	5639	0.04	6268
9	0.1	9404	0.001	6603	0.08	8203
10		6669	0.001	6669	0.001	6669
SOP [t]	431		294		725	
Landings (t)	426		291		718	

Year:	**2017**	**Quarter:**	**All**			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*10-3	w eight [g]	*10-3	w eight [g]	*10-3	w eights [g]
1	73	665	16	731	89	688
2	72	883	34	1017	106	942
3	401	1761	320	1457	721	1623
4	265	2780	96	2012	361	2439
5	158	3896	67	2669	225	3351
6	26	4428	19	2986	45	3757
7	13	5534	5	4066	19	4877
8	1.0	7463	1.3	6515	2	7042
9	3	8149	0.2	6640	4	7478
10		6669	0.01	6669	0.01	6669
SOP [t]	2217		950		3168	
Landings (t)	2195		941		3136	

Table 2.3.8. Western Baltic Cod. Overview of the numbers of on-site surveys and interviewed anglers, 2005–2017.

Year	Angling method	Number ofon-site surveys	Numbers of interviews
2005	Charter boat angling	93	1114
	Boat angling		200
	Trolling		13
	Shore angling	90	130
	Wading		37
	Total	183	1494
2006	Charter boat angling	89	1905
	Boat angling		316
	Trolling		4
	Shore angling	79	115
	Wading		46
	Total	168	2386
2007	Charter boat angling	80	1256
	Boat angling		202
	Trolling		4
	Shore angling	82	353
	Wading		73
	Total	162	1888
2008	Charter boat angling	81	786
	Boat angling		128
	Trolling		6
	Shore angling	48	89
	Wading		43
	Total	129	1052
2009	Charter boat angling	204	1690
	Boat angling		346
	Trolling		29
	Shore angling	49	172
	Wading		51
	Total	253	2288
2010	Charter boat angling	233	1730
	Boat angling		366
	Trolling		40
	Shore angling	57	173
	Wading		50
	Total	290	2359
2011	Charter boat angling	283	2181
	Boat angling		411
	Trolling		7
	Shore angling	58	166
	Wading		51
	Total	341	2816
2012	Charter boat angling	258	1465
	Boat angling		358
	Trolling		24
	Shore angling	58	111
	Wading		25
	Total	316	1983
2013	Charter boat angling	240	1116
	Boat angling, Trolling		287
	Shore angling, Wading	84	184
	Total	324	1587
2014	Charter boat angling	231	1143
	Boat angling, Trolling		217
	Shore angling, Wading	84	175
	Total	315	1535
2015	Charter boat angling	236	1072
	Boat angling, Trolling		231
	Shore angling, Wading	87	166
	Total	323	1469
2016	Charter boat angling	252	1195
	Boat angling, Trolling		244
	Shore angling, Wading	77	165
	Total	329	1604
2017	Charter boat angling	228	897
	Boat angling, Trolling		253
	Shore angling, Wading	96	242
	Total	324	1392

Table 2.3.9. Western Baltic cod. Overview of the number of samples and length measurements of cod from recreational fishing events (charter vessels trips & shore fishing), boat and trolling self-measurements, as well as charter vessel sampling, 2005–2017.

Year	Sample Type	Number of Samples	Harvest n	Release n
2005	Boat, charter boat angling	13	435	
	Shore angling	4	1026	
	Total	**17**	**1461**	
2006	Boat, charter boat angling	5	352	
	Shore angling	1	10	
	Total	**6**	**362**	
2007	Charter boat angling	1	18	8
	Shore angling	5	498	
	Total	**6**	**516**	**8**
2008	Boat, charter boat angling, trolling	24	275	7
	Shore angling	8	345	26
	Total	**32**	**620**	**33**
2009	Boat, charter boat angling, trolling	84	1351	885
	Shore angling	3	3	10
	Total	**87**	**1354**	**895**
2010	Charter vessel sampling – survey agent	74	2567	1604
	Shore fishing – self-measurement	13	1067	31
	Total	**87**	**3634**	**1635**
2011	Boat, charter boat angling, trolling	65	4089	1089
	Shore angling	15	584	13
	Total	**80**	**4673**	**1102**
2012	Boat, charter boat angling, trolling	32	1546	533
	Shore angling			
	Total	**32**	**1546**	**533**
2013	Boat, charter boat angling, trolling	47	2257	1345
	Shore angling			
	Total	**47**	**2257**	**1345**
2014	Boat, charter boat angling, trolling	42	3318	1104
	Boat angling – self-measurement	3	403	
	Total	**45**	**3721**	**1104**
2015	Boat, charter boat angling, trolling	42	2853	949
	Total	**42**	**2853**	**949**
2016	Boat, charter boat angling, trolling	53	2521	398
	Total	**53**	**2521**	**398**
2017	Boat, charter boat angling, trolling	45	937	1269
	Total	**45**	**937**	**1269**

Table 2.3.10. Western Baltic cod. Percentage of western cod in Area 1 (W: western part of SD 24, 12– 13 degrees longitude) and Area 2 (E: eastern part of SD 24, from 13 -15 degrees longitude); and weighted average of those percentages applied to extract the WB cod landings in SD 24.

year	Area 1 _ W	Area 2 E	Procent west cod in ladnings for SD 24
1994	90	85	87
1995	80	65	71
1996	66	49	56
1997	69	60	65
1998	72	71	71
1999	72	60	65
2000	71	49	59
2001	65	48	56
2002	63	45	53
2003	62	43	50
2004	61	40	48
2005	59	48	51
2006	58	34	42
2007	57	34	40
2008	46	20	27
2009	51	21	25
2010	55	21	28
2011	51	15	22
2012	52	19	24
2013	53	23	29
2014	51	25	31
2015	50	23	30
2016	58	24	30
2017	62	20	29

Table 2.3.11. Western Baltic cod. Landings (in numbers (000)) by year and age for the western Baltic cod stock.

age	a1	a2	a3	a4	a5	a6	a7+
1994	861	4813	14354	2167	78	18	15
1995	713	11353	4891	5607	1204	130	3
1996	95	23493	17313	717	2059	107	2
1997	1828	1996	28790	2559	322	324	77
1998	2412	18594	2129	5720	654	105	76
1999	658	23476	12518	1597	1214	244	92
2000	809	6454	20432	3065	126	244	47
2001	1409	10463	6630	4812	793	46	89
2002	437	8189	8295	1581	878	258	17
2003	649	10155	4551	1310	231	192	66
2004	65	1510	8780	1909	337	122	83
2005	267	8381	1666	2982	342	91	50
2006	259	1549	10879	513	570	77	15
2007	58	3311	2617	3638	411	219	33
2008	20	601	2599	946	871	257	128
2009	177	444	1497	981	506	184	81
2010	185	3320	1022	609	429	133	54
2011	72	864	3439	1285	288	81	41
2012	113	1307	1270	1929	525	60	14
2013	287	600	1729	806	738	313	68
2014	42	2662	1079	821	139	145	24
2015	172	940	3012	376	226	34	61
2016	1	889	1398	1046	142	56	35
2017	118	132	865	456	281	54	31

Table 2.3.12. Western Baltic cod. Discard (in numbers (000)) by year and age for the for the western Baltic cod stock.

age	a1	a2	a3	a4	a5	a6	a7+
1994	3680	1787	758	10	0	0	0
1995	3690	5106	313	30	0	0	0
1996	22714	2418	10	0	0	0	0
1997	15255	0	0	0	0	0	0
1998	17009	2709	121	0	0	0	0
1999	2670	9026	303	0	0	0	0
2000	2719	4456	2523	0	0	0	0
2001	1987	4475	306	49	0	0	0
2002	1526	2266	219	16	0	0	0
2003	1067	7605	415	13	0	0	0
2004	2244	866	2375	0	0	0	0
2005	945	7455	43	0	0	0	0
2006	873	2637	764	43	2	0	0
2007	281	2502	511	40	5	0	0
2008	76	574	204	4	0	0	0
2009	191	484	179	12	0	0	0
2010	218	915	475	303	7	0	0
2011	6	151	105	256	77	1	0
2012	30	268	204	231	42	0	0
2013	37	705	469	701	170	5	0
2014	691	1649	50	8	0	0	0
2015	229	862	315	24	0	0	0
2016	44	307	54	1	0	0	0
2017	484	107	58	13	1	0	0

Table 2.3.13. Western Baltic cod. German recreational catch (in numbers (000)) by year and age for the western Baltic cod stock.

age	a1	a2	a3	a4	a5	a6	a7+
1994	464	801	726	86	14	2	1
1995	448	1219	608	233	34	3	1
1996	265	1371	683	158	32	3	1
1997	715	713	900	142	24	4	1
1998	490	1251	540	225	29	3	1
1999	213	1336	639	168	31	4	1
2000	463	1075	775	168	27	3	1
2001	370	1168	530	280	31	2	1
2002	472	1236	613	94	61	11	1
2003	220	1324	662	148	19	7	1
2004	623	970	822	88	23	3	2
2005	96	2169	406	324	9	1	1
2006	82	445	1232	57	30	1	1
2007	9	753	681	262	55	3	2
2008	1	327	870	147	50	1	0
2009	235	1482	484	225	42	14	4
2010	213	1693	235	142	41	9	19
2011	149	517	1178	27	8	0	1
2012	336	1083	399	550	22	3	1
2013	942	758	657	51	30	0	0
2014	279	2041	511	171	9	2	0
2015	146	1067	1393	134	33	2	1
2016	67	799	824	246	52	6	2
2017	499	181	365	161	25	2	2

Table 2.3.14. Western Baltic cod. Catch in numbers ('000) at age (incl. Landing, discards, recreational catch) for the western Baltic cod stock.

age	a1	a2	a3	a4	a5	a6	a7+
1994	5005	7401	15838	2263	92	20	16
1995	4851	17678	5812	5870	1237	133	4
1996	23074	27282	18006	875	2090	111	3
1997	17798	2709	29690	2701	345	328	78
1998	19911	22553	2790	5946	683	108	77
1999	3541	33839	13461	1765	1246	248	93
2000	3992	11984	23730	3233	153	247	49
2001	3766	16106	7467	5140	824	48	90
2002	2436	11691	9128	1692	939	269	18
2003	1937	19085	5628	1471	250	198	67
2004	2932	3346	11977	1997	361	125	85
2005	1307	18005	2115	3305	351	92	50
2006	1214	4631	12876	612	602	78	15
2007	348	6566	3808	3939	472	222	35
2008	98	1502	3674	1098	921	258	128
2009	603	2410	2160	1218	549	198	85
2010	617	5928	1732	1054	477	142	72
2011	226	1533	4722	1568	373	82	42
2012	478	2658	1874	2709	589	63	15
2013	1266	2063	2855	1558	938	318	69
2014	1012	6351	1640	999	148	147	24
2015	547	2870	4719	534	259	35	63
2016	112	1995	2277	1293	194	62	37
2017	1101	421	1288	631	307	56	32

Table 2.3.15. Western Baltic cod. Mean weight at age in commercial landings.

age	a1	a2	a3	a4	a5	a6	a7+
1994	0.445	0.834	1.367	2.378	4.491	6.436	5.659
1995	0.398	0.792	1.215	2.112	3.643	6.064	11.622
1996	0.442	0.685	1.086	2.091	2.879	5.544	8.372
1997	0.503	0.753	0.993	1.685	2.195	4.043	6.407
1998	0.524	0.737	1.155	1.915	2.960	3.940	6.444
1999	0.528	0.666	1.133	1.405	3.141	3.920	4.978
2000	0.509	0.707	0.957	1.655	3.479	5.174	7.302
2001	0.519	0.688	1.082	1.756	3.181	5.090	7.026
2002	0.512	0.716	1.124	1.701	3.386	4.079	6.586
2003	0.593	0.810	1.092	2.002	3.679	5.162	7.224
2004	0.517	0.776	1.008	1.487	3.376	4.179	6.131
2005	0.599	0.738	1.270	2.207	3.362	4.875	6.868
2006	0.217	0.625	1.086	2.485	3.674	4.205	5.730
2007	0.412	0.862	1.186	2.093	3.185	4.747	6.421
2008	0.437	0.906	1.347	2.187	3.234	4.352	6.955
2009	0.768	0.702	1.158	1.794	3.120	4.979	4.985
2010	0.807	0.944	1.111	1.805	2.924	3.384	4.306
2011	0.955	1.212	1.292	1.382	1.905	2.551	2.117
2012	0.902	0.976	1.189	2.000	2.610	2.506	3.504
2013	0.832	1.035	1.288	1.843	2.517	3.301	3.534
2014	0.859	0.988	1.467	2.793	3.857	5.577	5.453
2015	0.625	0.807	1.585	2.601	4.759	4.507	6.926
2016		1.027	1.239	2.488	3.273	4.947	6.309
2017	0.796	1.059	1.423	2.265	3.650	4.274	5.480

Table. 2.3.16. Western Baltic cod. Mean weight at age in discards.

age	a1	a2	a3	a4	a5
1994-2014	0.082	0.262	0.391	0.531	0.469
2015	0.082	0.155	0.333	0.363	0.352
2016	0.082	0.297	0.371	0.487	0.962
2017	0.082	0.221	0.405	0.649	0.789

Table 2.3.17. Western Baltic cod. Mean weight at age in catch (combined for commercial landings, discards, recreational catch).

age	a1	a2	a3	a4	a5	a6	a7+
1994	0.309	0.711	1.314	2.369	4.322	6.189	5.582
1995	0.287	0.669	1.162	2.086	3.620	6.009	9.181
1996	0.262	0.660	1.088	2.033	2.872	5.494	6.699
1997	0.297	0.754	0.996	1.697	2.226	4.041	6.372
1998	0.296	0.699	1.171	1.901	2.950	3.938	6.408
1999	0.313	0.595	1.123	1.454	3.120	3.918	4.970
2000	0.325	0.597	0.919	1.676	3.338	5.158	7.220
2001	0.369	0.611	1.082	1.763	3.181	5.057	6.995
2002	0.332	0.654	1.113	1.702	3.343	4.097	6.527
2003	0.384	0.641	1.073	1.981	3.654	5.136	7.178
2004	0.301	0.680	0.927	1.504	3.375	4.195	6.093
2005	0.334	0.598	1.256	2.165	3.377	4.874	6.833
2006	0.260	0.500	1.053	2.298	3.621	4.215	5.700
2007	0.293	0.674	1.044	2.029	3.030	4.736	6.331
2008	0.303	0.672	1.226	2.105	3.191	4.354	6.952
2009	0.405	0.454	1.144	1.816	3.081	4.852	4.977
2010	0.410	0.814	1.006	1.514	2.865	3.450	4.625
2011	0.484	0.974	1.228	1.239	1.618	2.542	2.177
2012	0.538	0.830	1.139	1.868	2.450	2.558	3.538
2013	0.634	0.704	1.133	1.220	2.134	3.258	3.536
2014	0.294	0.749	1.350	2.590	3.750	5.547	5.453
2015	0.355	0.635	1.443	2.458	4.433	4.448	6.900
2016	0.363	0.827	1.219	2.377	3.120	4.836	6.281
2017	0.310	0.716	1.283	2.020	3.519	4.232	5.402

Table 2.3.18. Western Baltic cod. Mean weight (kg) at age in stock.

age	a0	a1	a2	a3	a4	a5	a6	a7+
1994	0.005	0.063	0.301	0.874	2.369	4.322	6.189	5.582
1995	0.005	0.063	0.301	0.874	2.086	3.620	6.009	9.181
1996	0.005	0.057	0.259	0.990	2.033	2.872	5.494	6.699
1997	0.005	0.050	0.327	0.896	1.697	2.226	4.041	6.372
1998	0.005	0.081	0.316	0.735	1.901	2.950	3.938	6.408
1999	0.005	0.042	0.285	0.801	1.454	3.120	3.918	4.970
2000	0.005	0.059	0.234	0.801	1.676	3.338	5.158	7.220
2001	0.005	0.043	0.388	0.895	1.763	3.181	5.057	6.995
2002	0.005	0.043	0.433	1.117	1.702	3.343	4.097	6.527
2003	0.005	0.054	0.321	1.032	1.981	3.654	5.136	7.178
2004	0.005	0.067	0.536	0.870	1.504	3.375	4.195	6.093
2005	0.005	0.051	0.350	1.038	2.165	3.377	4.874	6.833
2006	0.005	0.043	0.310	0.795	2.298	3.621	4.215	5.700
2007	0.005	0.073	0.411	0.908	2.029	3.030	4.736	6.331
2008	0.005	0.043	0.465	1.019	2.105	3.191	4.354	6.952
2009	0.005	0.051	0.559	1.327	1.816	3.081	4.852	4.977
2010	0.005	0.066	0.369	1.082	1.514	2.865	3.450	4.625
2011	0.005	0.045	0.360	0.767	1.239	1.618	2.542	2.177
2012	0.005	0.050	0.301	0.882	1.868	2.450	2.558	3.538
2013	0.005	0.049	0.391	0.866	1.220	2.134	3.258	3.536
2014	0.005	0.039	0.345	0.965	2.590	3.750	5.547	5.453
2015	0.005	0.055	0.409	0.924	2.458	4.433	4.448	6.900
2016	0.005	0.047	0.341	0.690	2.377	3.120	4.836	6.281
2017	0.005	0.031	0.195	1.022	2.020	3.519	4.232	5.402

Table 2.3.19. Western Baltic cod. Proportion mature at age (spawning probability).

age	a1	a2	a3	a4	a5	a6	a7+
1994	0.03	0.35	0.74	0.78	1.00	1.00	1.00
1995	0.03	0.35	0.74	0.78	1.00	1.00	1.00
1996	0.03	0.35	0.74	0.78	1.00	1.00	1.00
1997	0.03	0.35	0.74	0.78	1.00	1.00	1.00
1998	0.03	0.35	0.74	0.78	1.00	1.00	1.00
1999	0.03	0.35	0.74	0.78	1.00	1.00	1.00
2000	0.04	0.52	0.83	0.81	1.00	1.00	1.00
2001	0.01	0.49	0.82	0.92	1.00	1.00	1.00
2002	0.01	0.40	0.79	0.82	1.00	1.00	1.00
2003	0.02	0.39	0.72	0.77	1.00	1.00	1.00
2004	0.02	0.46	0.77	0.79	1.00	1.00	1.00
2005	0.02	0.53	0.79	0.92	1.00	1.00	1.00
2006	0.01	0.70	0.88	0.98	1.00	1.00	1.00
2007	0.02	0.79	0.91	0.98	1.00	1.00	1.00
2008	0.03	0.81	0.87	0.95	1.00	1.00	1.00
2009	0.03	0.70	0.85	0.88	1.00	1.00	1.00
2010	0.17	0.69	0.80	0.84	1.00	1.00	1.00
2011	0.14	0.67	0.86	0.88	1.00	1.00	1.00
2012	0.19	0.67	0.81	0.89	1.00	1.00	1.00
2013	0.10	0.67	0.86	0.88	1.00	1.00	1.00
2014	0.08	0.67	0.81	0.89	1.00	1.00	1.00
2015	0.05	0.65	0.83	0.89	1.00	1.00	1.00
2016	0.08	0.71	0.85	0.83	1.00	1.00	1.00
2017	0.06	0.64	0.84	0.83	1.00	1.00	1.00

Table 2.3.20. Western Baltic cod. Natural mortality at age.

age	a0	a1	a2	a3	a4	a5	a6	a7+
1994	0.8	0.266	0.2	0.2	0.2	0.2	0.2	0.2
1995	0.8	0.286	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.8	0.286	0.2	0.2	0.2	0.2	0.2	0.2
1997-2017	0.8	0.242	0.2	0.2	0.2	0.2	0.2	0.2

Table 2.3.21. Western Baltic cod. Tuning fleets BITS Q4 and Q1.

BITS Q4	a0	a1	a2	a3	a4
2001	16918	966	440	45	95
2002	2164	2394	320	85	16
2003	21485	1555	899	35	49
2004	6943	13557	1047	141	36
2005	5746	3044	1833	56	81
2006	3020	4417	364	347	89
2007	666	479	190	90	329
2008	26135	62	63	41	88
2009	3483	2848	72	56	27
2010	12920	1060	622	15	14
2011	4573	1990	141	94	9
2012	20575	1973	457	51	64
2013	9732	4654	216	46	26
2014	7751	1942	871	77	69
2015	395	1098	356	125	61
2016	56756	442	101	14	129
2017	272	19680	98	45	66

contiuned

Table 2.3.21. Western Baltic cod. Tuning fleets BITS Q4 and Q1.

BITS Q1	a1	a2	a3	a4
2001	5255	7223	2041	798
2002	11982	4259	3085	154
2003	959	5972	852	213
2004	10433	2196	3931	83
2005	7403	46297	2192	919
2006	11052	8383	13096	181
2007	2078	13719	3902	1887
2008	103	1439	1952	409
2009	7481	1043	1480	378
2010	2800	14873	632	204
2011	10324	10475	24796	77
2012	1935	4922	2828	1452
2013	7094	4187	4108	316
2014	4348	6922	1118	279
2015	2843	7587	3269	195
2016	86	2269	1644	784
2017	21049	1478	2530	403
2018	361	41329	2352	862

Table 2.3.22. Western Baltic cod. Estimated recruitment (millions), spawning stock biomass (SSB) (tonnes), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits age 1	Low	High	SSB	Low	High	F35	Low	High	Catch	Low	High
1994	64280	32961	125357	31039	21673	44454	1,151	0,912	1,453	38716	25704	58313
1995	90944	46758	176886	30516	23283	39995	1,315	1,044	1,656	38177	28605	50954
1996	25926	12308	54609	32991	25365	42910	1,172	0,96	1,43	41648	30702	56496
1997	86077	44846	165215	34996	25357	48300	1,163	0,954	1,418	35990	25909	49994
1998	117595	61719	224058	27228	21107	35125	1,169	0,954	1,432	36975	27567	49594
1999	37609	19906	71057	31793	24528	41210	1,339	1,098	1,632	48050	35076	65824
2000	39144	21245	72124	36171	26870	48690	1,297	1,076	1,562	37347	27444	50823
2001	24416	13997	42592	29525	23449	37176	1,36	1,129	1,639	28567	21953	37173
2002	41564	24752	69797	22652	17950	28586	1,306	1,082	1,577	22049	16930	28714
2003	13679	7903	23675	17532	14222	21612	1,178	0,975	1,423	20056	15333	26234
2004	69703	41383	117404	19561	15108	25326	1,137	0,936	1,381	17787	13402	23606
2005	23133	13845	38650	26609	21135	33500	1,049	0,854	1,288	23459	17809	30900
2006	23981	13965	41180	30122	23274	38985	0,883	0,68	1,146	21621	15616	29933
2007	6889	4114	11538	31163	24535	39582	0,937	0,756	1,161	18981	14664	24569
2008	3138	1572	6267	21256	17171	26313	0,997	0,813	1,223	13873	10851	17737
2009	28653	16768	48961	14109	11502	17309	1,025	0,838	1,254	8848	7040	11122
2010	10971	6535	18418	13216	10614	16456	1,016	0,827	1,247	10314	7864	13529
2011	16480	9553	28429	13068	9966	17134	0,959	0,778	1,183	11929	8681	16392
2012	11474	6816	19315	15373	11979	19730	0,926	0,738	1,162	11379	8794	14723
2013	31039	18162	53045	12331	9852	15434	1,138	0,864	1,499	10454	7855	13911
2014	17183	10064	29338	14962	12095	18510	0,959	0,752	1,222	11786	9192	15113
2015	10608	6147	18306	16362	12858	20821	0,857	0,631	1,164	12359	9237	16536
2016	2939	1566	5516	13019	9647	17570	0,758	0,496	1,16	8944	6833	11707
2017	85991	39783	185869	11533	7450	17855	0,601	0,302	1,199	6673	4766	9343
2018	1633*	418*	6112*	25317*	12595*	48535*						

Table 2.3.23. Western Baltic cod. Estimated stock numbers (SAM).

Year\Age	0	1	2	3	4	5	6	7+
1994	195048	64280	18283	30273	4444	216	24	20
1995	62069	90944	45071	8386	9013	1390	65	8
1996	186652	25926	68118	21059	1833	2411	260	9
1997	250446	86077	12073	35031	4760	559	541	82
1998	86595	117595	55994	5470	8487	1222	159	149
1999	85991	37609	79937	23624	1574	2015	315	94
2000	55994	39144	25540	33356	5268	296	407	81
2001	89769	24416	27584	10098	7048	1354	66	112
2002	28883	41564	18139	11359	2055	1489	344	33
2003	140505	13679	33725	7591	2270	490	338	93
2004	51226	69703	10431	16741	2097	551	147	117
2005	48582	23133	54666	4926	4738	558	127	67
2006	15856	23981	15632	24860	1678	1296	145	40
2007	6996	6889	16170	7870	7376	765	428	59
2008	66703	3138	5070	7006	2527	1780	286	165
2009	24860	28653	3993	3647	2138	806	387	123
2010	40055	10971	22181	3002	1456	616	199	118
2011	26823	16480	7713	12223	1601	502	130	70
2012	72186	11474	11276	4339	4564	739	136	41
2013	40864	31039	7619	5909	1619	1401	255	64
2014	25489	17183	20839	3691	1766	320	293	57
2015	6395	10608	11098	9769	1214	486	79	105
2016	171271	2939	6924	4961	3106	394	139	63
2017	3595	85991	2588	4049	1914	971	133	71
2018		1636	69355	1959	2040	866	406	86

Table 2.3.24. Western Baltic cod. Estimated fishing mortalities by age from SAM.

Year\Age	1	2	3	4	5+
1994	0.106	0.561	1.117	1.067	1.269
1995	0.118	0.633	1.279	1.224	1.44
1996	0.113	0.597	1.184	1.102	1.229
1997	0.111	0.593	1.179	1.109	1.201
1998	0.11	0.603	1.188	1.129	1.189
1999	0.119	0.682	1.357	1.304	1.356
2000	0.115	0.677	1.336	1.261	1.293
2001	0.117	0.712	1.41	1.326	1.345
2002	0.108	0.676	1.348	1.276	1.294
2003	0.094	0.594	1.193	1.152	1.189
2004	0.083	0.539	1.108	1.112	1.193
2005	0.074	0.486	0.999	1.021	1.128
2006	0.062	0.414	0.843	0.854	0.952
2007	0.062	0.425	0.877	0.91	1.023
2008	0.06	0.422	0.895	0.968	1.129
2009	0.058	0.413	0.888	0.999	1.187
2010	0.054	0.388	0.853	0.994	1.2
2011	0.049	0.358	0.801	0.945	1.132
2012	0.048	0.352	0.788	0.921	1.069
2013	0.057	0.424	0.967	1.137	1.309
2014	0.051	0.376	0.841	0.956	1.079
2015	0.047	0.345	0.767	0.85	0.954
2016	0.042	0.308	0.683	0.751	0.841
2017	0.034	0.244	0.539	0.593	0.671

Table 2.3.25. Western Baltic Cod. Input to short-term forecast.

2018									
Age	N	M	Mat	PF	PM	SWt*	Sel	CWt	LWt
1	1633	0.242	0.06	0	0	0.04	0.04	0.34	0.71
2		0.2	0.67	0	0	0.32	0.30	0.73	0.96
3		0.2	0.84	0	0	0.88	0.66	1.31	1.42
4		0.2	0.85	0	0	2.47	0.73	2.29	2.45
5		0.2	1.00	0	0	3.77	0.82	3.69	3.89
6		0.2	1.00	0	0	4.94	0.82	4.51	4.58
7		0.2	1.00	0	0	6.21	0.82	6.19	6.24
2019									
Age	N	M	Mat	PF	PM	SWt*	Sel	CWt	LWt
1	15685	0.242	0.06	0	0	0.04	0.04	0.34	0.71
2		0.2	0.67	0	0	0.32	0.30	0.73	0.96
3		0.2	0.84	0	0	0.88	0.66	1.31	1.42
4		0.2	0.85	0	0	2.47	0.73	2.29	2.45
5		0.2	1.00	0	0	3.77	0.82	3.69	3.89
6		0.2	1.00	0	0	4.94	0.82	4.51	4.58
7		0.2	1.00	0	0	6.21	0.82	6.19	6.24
2020									
Age	N	M	Mat	PF	PM	SWt*	Sel	CWt	LWt
1	15240	0.242	0.06	0	0	0.04	0.04	0.34	0.71
2		0.2	0.67	0	0	0.32	0.30	0.73	0.96
3		0.2	0.84	0	0	0.88	0.66	1.31	1.42
4		0.2	0.85	0	0	2.47	0.73	2.29	2.45
5		0.2	1.00	0	0	3.77	0.82	3.69	3.89
6		0.2	1.00	0	0	4.94	0.82	4.51	4.58
7		0.2	1.00	0	0	6.21	0.82	6.19	6.24

Input units are thousands and kg -
M = Natural Mortality
Mat = Maturity ogive
PF = Proportion of F before spawning
PM = Proportion of M before spawning
SWt = Weight in stock (Kg);
Sel = Exploitation pattern
CWt = Weight in catch (Kg)
LWt = Weight in commercial landings (Kg)

Natural mortality (M): Constant
Weight in the landing, catch (LWt, CWt): average of 2015–2017
Weight in the stock (SWt): average of 2015–2017
Exploitation pattern (Sel.): average of 2017

Table 2.3.26. Western Baltic Cod. Short-term intermediate year (2018).

Variable	Value	Notes
$F_{ages\ 3–5}$ (2018)	0.20	Based on catch constraint for 2018.
SSB (2019)	48734	Based on catch constraint for 2018. In tonnes.
R_{age1} (2018)	1633	SAM assessment (in thousands).
R_{age1} (2019)	15 685	Sampled from the last ten years (in thousands).
R_{age1} (2020)	15 240	Sampled from the last ten years (in thousands).
Total catch (2018)	5612	Based on catch constraint. Calculated as the 2017 TAC (5597 t) plus an assumed discard ratio as in 2017 (4.8%), and accounting for the proportion of western Baltic cod in commercial catches in subdivisions 22–24 in 2017 (66%), and assumed recreational catch for 2017 (1754 t) – based on bag limitation*
Commercial landings (2018)	3673	Based on total catch minus recreational catch. The 2017 discard ratio (4.8%) was used to split the commercial catch into landings and discards.
Commercial discards (2018)	185	Based on total catch minus recreational catch. The 2017 discard ratio (4.8%) was used to split the commercial catch into landings and discards.
Recreational catches (2018)	1754	3 years average (2014–2016) of recreational catch (2654 t) minus the estimated reduction (900 t) due to the introduction of the bag limit in 2017*. As it is unclear how the baglimited will effect the fisheries in 2018 same value has been apllied as in last years forecast. Due to the change in management system in 2017 an average can not be used

Table 2.3.27. Western Baltic Cod. Output of short-term forecast.

Total catch 2019*	Commercial catch, assuming a recreational catch of 1754 tonnes	Basis	F_{total} 2019	SSB 2020	%SSB change^	Unwanted Catch 2019	Wanted Catch	%change in advice
15021	13267	F_{MSY}	0.26	75334	55	635	12632	184
1754	0	Zero commercial catch	0.03***	91905	89	0	0	-67
9094	7340	lower	0.15	82691	70	351	6989	72
23992	22238	upper	0.45	63804	31	1064	21174	353
35123	33369	F_{pa}	0.74	49290	1	1597	31772	563
43288	41534	F_{lim}	1.01	39365	-19	1988	39546	718
53332	51578	B_{lim}	1.46	27400	-44	2469	49109	907
44086	42332	$B_{trigger}$	1.04	38401	-21	2026	40306	733
12067	10313	$F=F_{2018}$	0.2	78916	62	494	9819	128

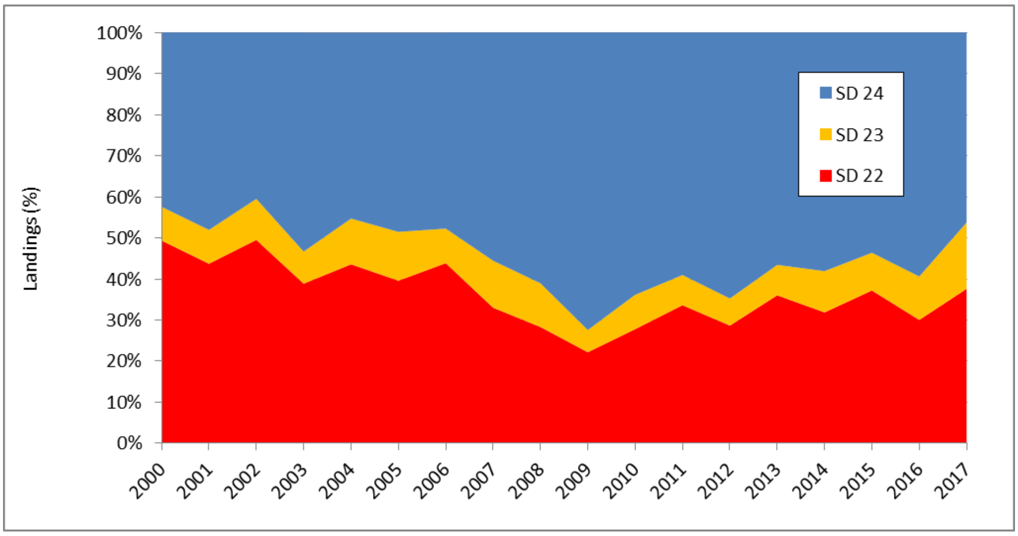


Figure 2.3.1. **Western Baltic cod. Relative landings by SD (tonnes) for the western Baltic management area (both east and west cod included).**

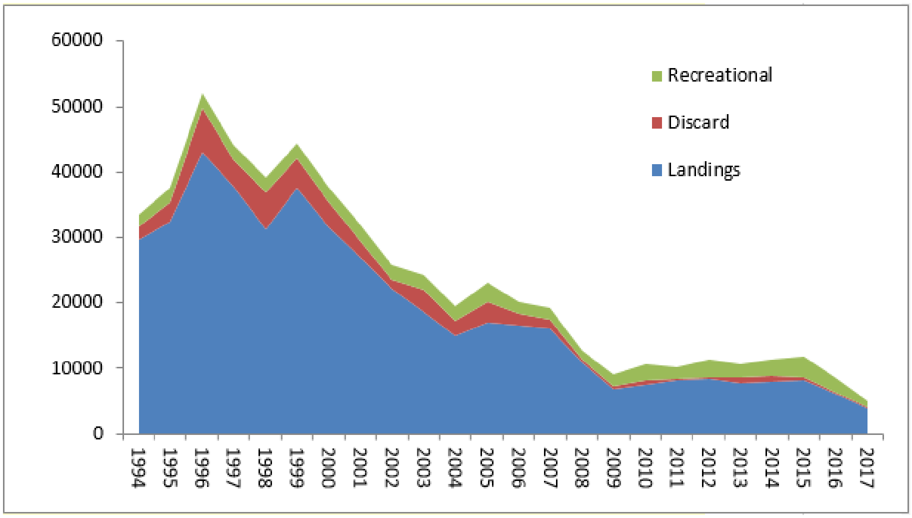


Figure 2.3.2. **Western Baltic cod. Commercial landings, discard and recreational catch (tonnes).**

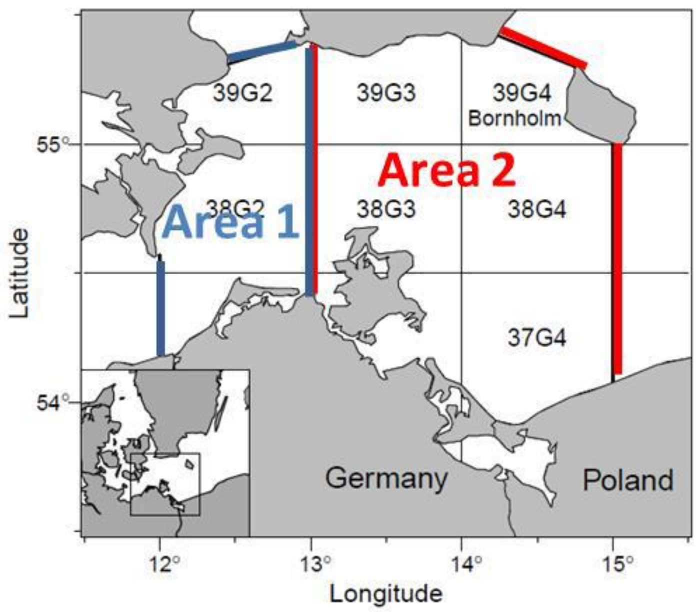


Figure 2.3.3. Western Baltic cod. Subareas (Area 1 and Area 2 within SD 24) for which different keys for splitting between eastern and western Baltic cod catches in SD 24 were applied.

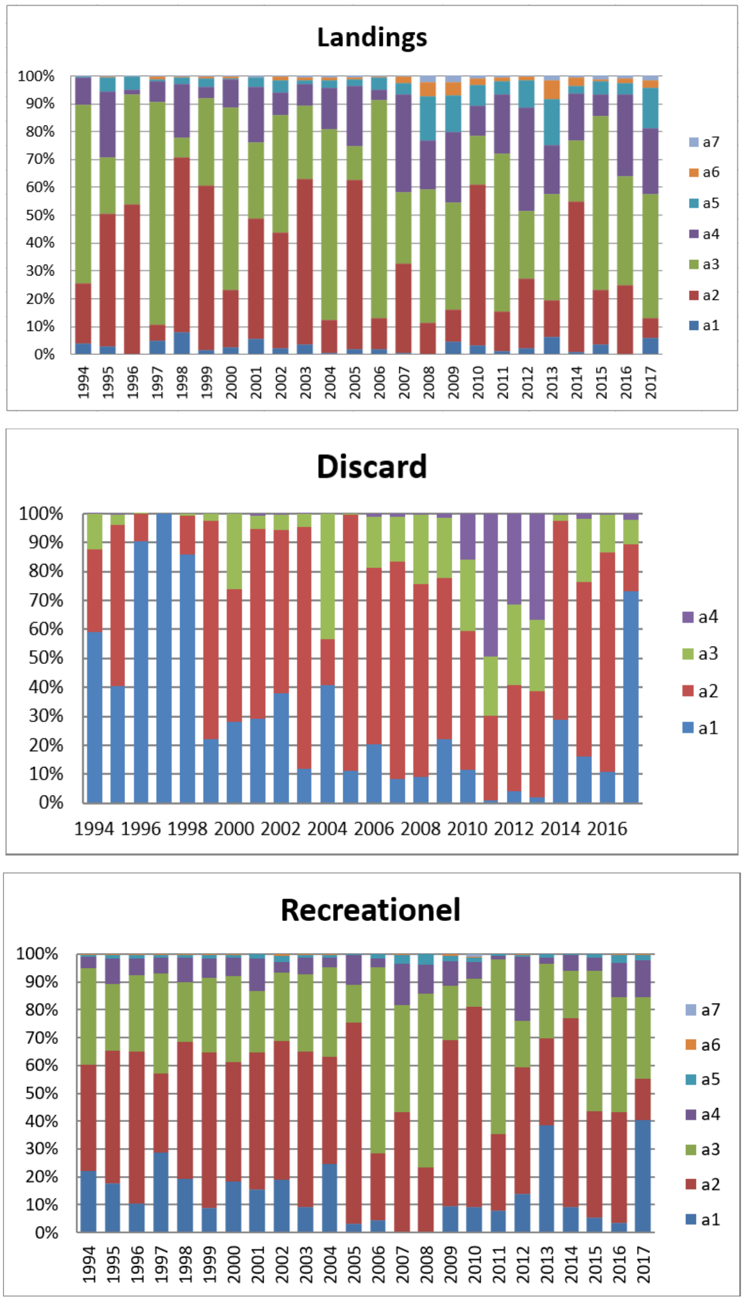


Figure 2.3.4. Western Baltic cod. Number at age distribution of cod in commercial landings, discards and recreational catch (relative proportions).

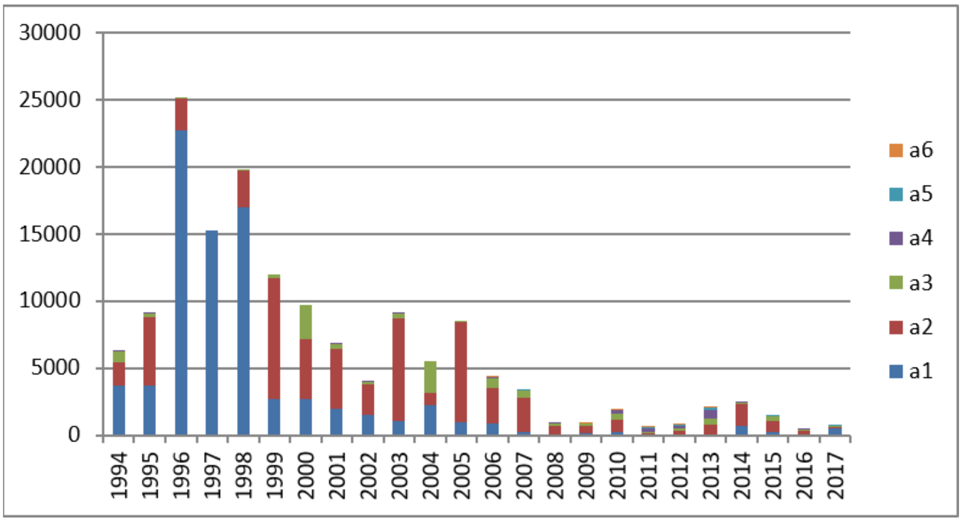


Figure 2.3.5. Western Baltic cod. Commercial discards in numbers by age (absolute values).

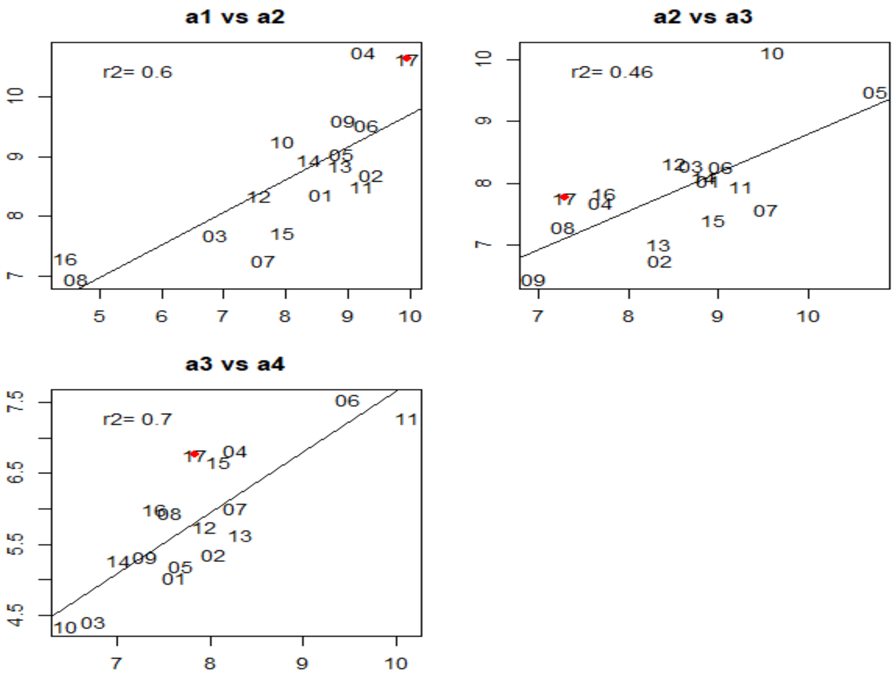


Figure 2.3.6. Western Baltic cod. CPUE at age i vs numbers at age i +1 in the following year, in BITS Q1 survey. Red dots highlight the information from the latest year.

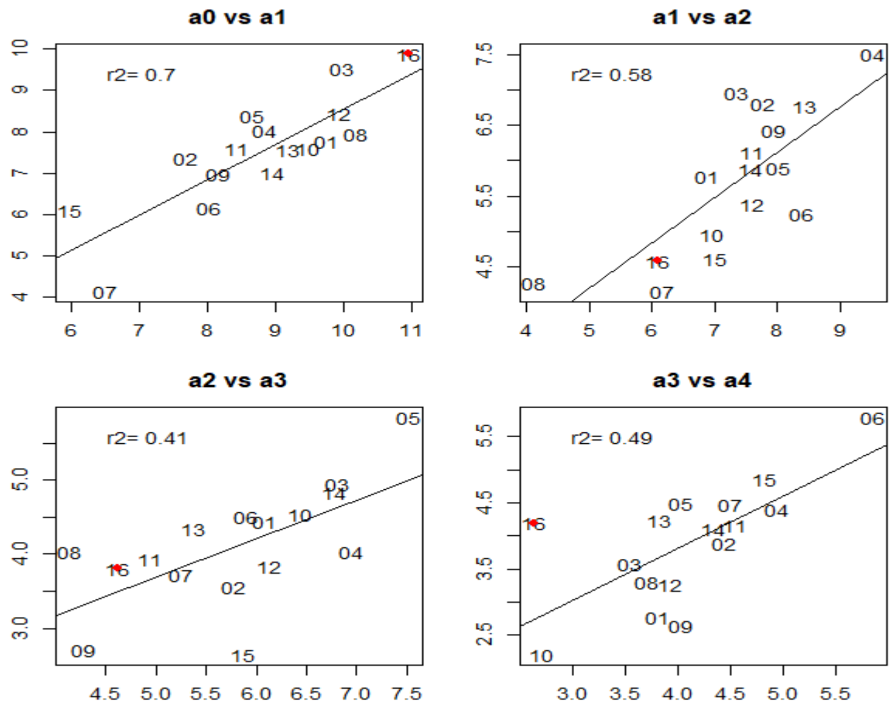


Figure 2.3.7. **Western Baltic cod. CPUE at age i vs numbers at age i +1 in the following year, in BITS Q4 survey. Red dots highlight the information from the latest year.**

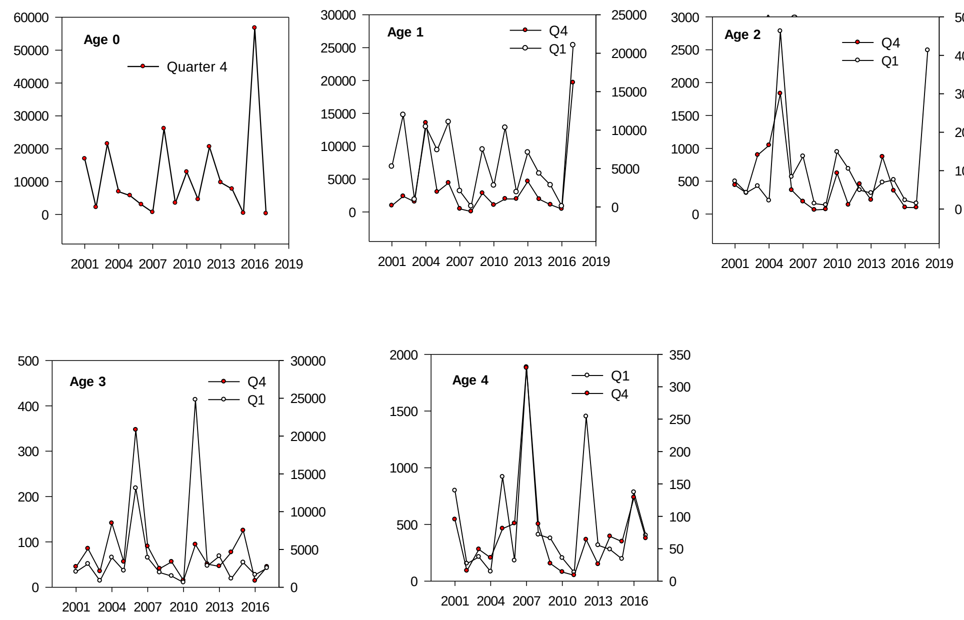


Figure 2.3.8. **Western Baltic cod. Time series of BITS Q1 and BITS Q4 in numbers by age groups.**

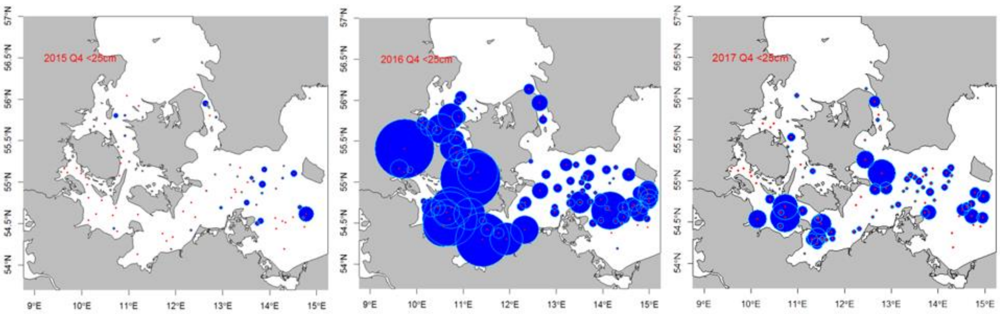


Figure 2.3.9. **Western Baltic cod. Distribution of cod<25 cm from BITS Q4 2015, 2016 and 2017.**

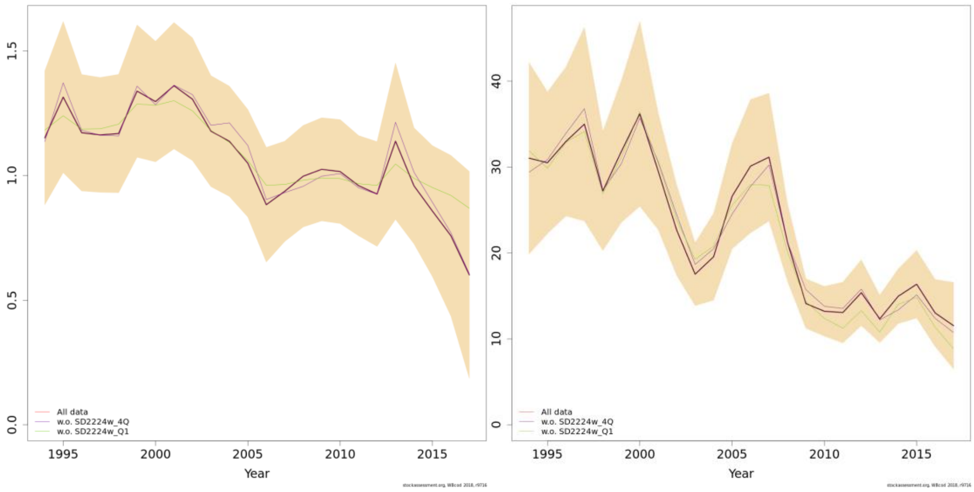


Figure 2.3.10. **Western Baltic cod. The SSB and F from exploratory runs leaving out one tuning series at a time.**

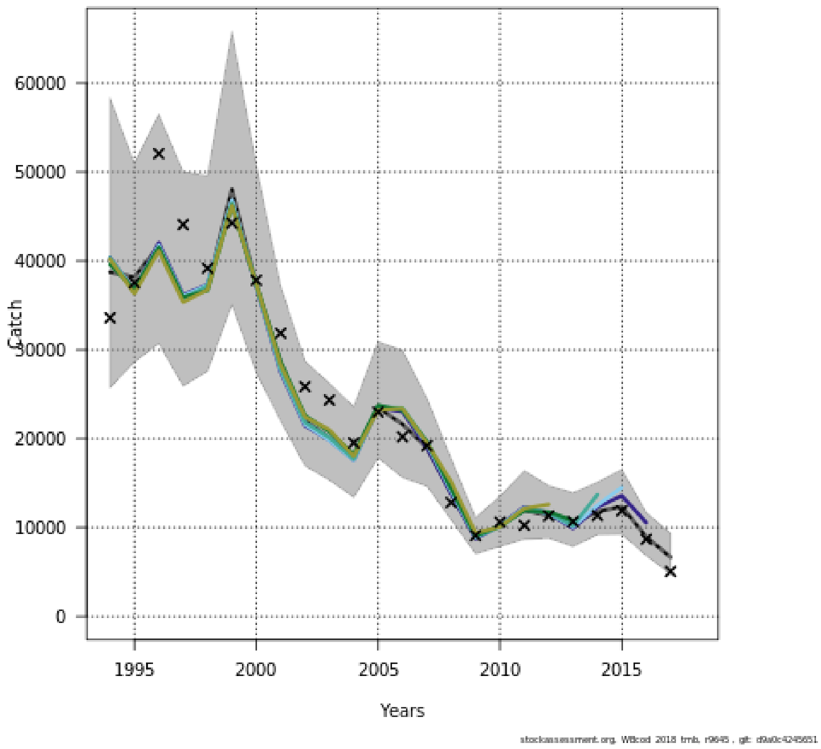


Figure 2.3.11. **Western Baltic cod. The retro of the estimated catches within SAM**

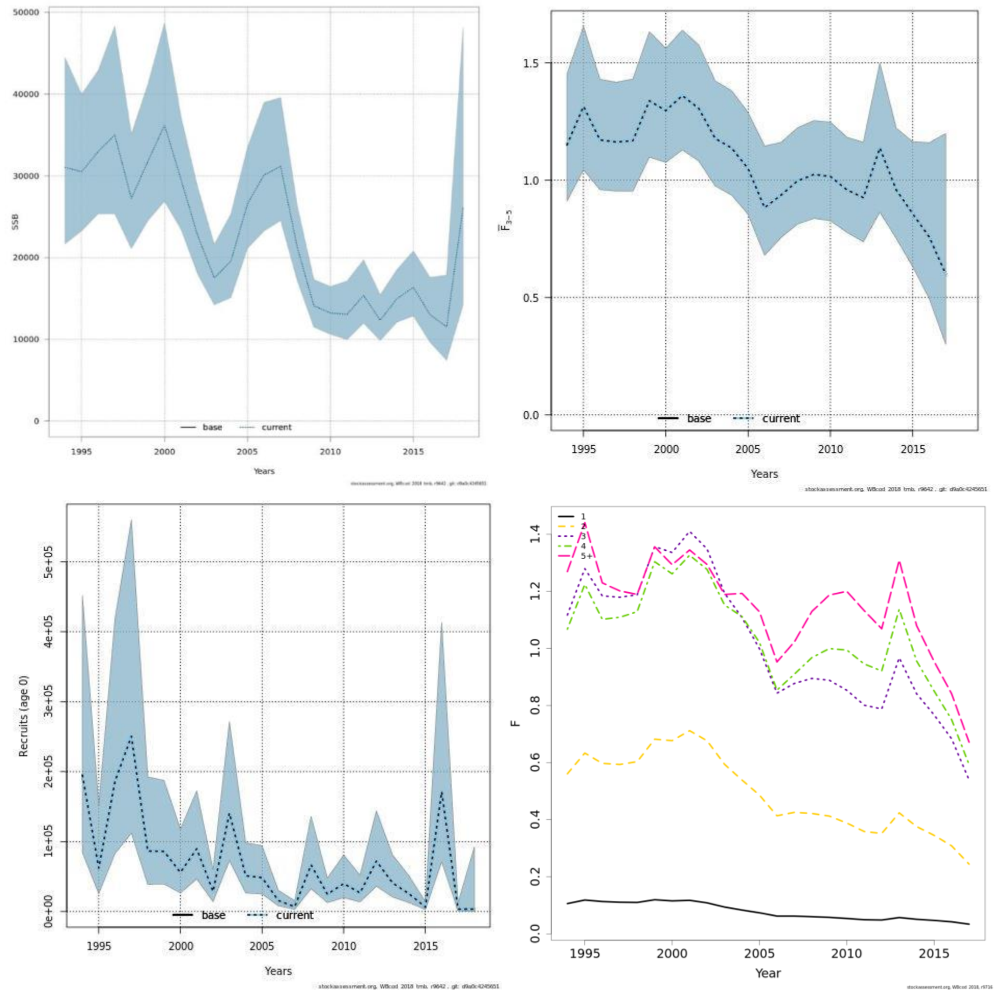


Figure 2.3.12. Western Baltic cod. SSB (upper left), F (3–5) (upper right) and stock numbers at age 0 (lower left) and F by age groups (lower right) from the final assessment.

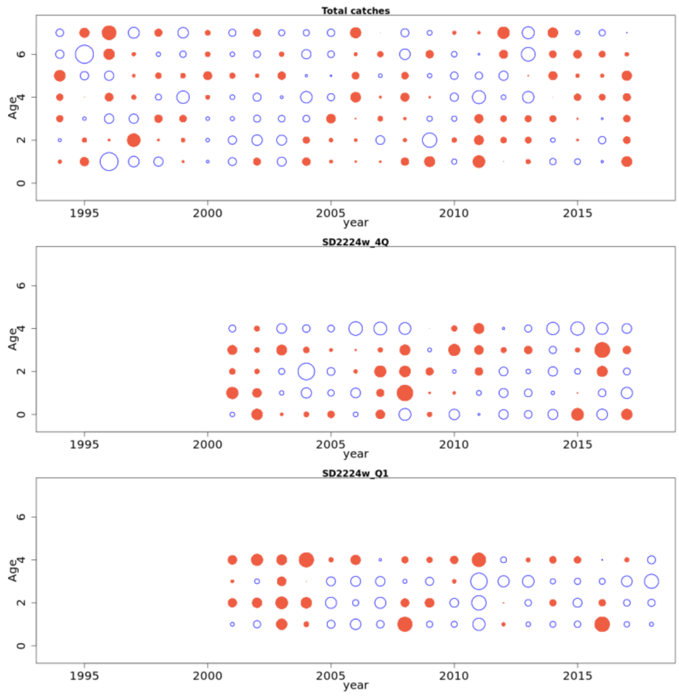


Figure 2.3.13. **Western Baltic cod. Standardized residuals from the final SAM run where open circles are positive and filled circles are negative residuals.**

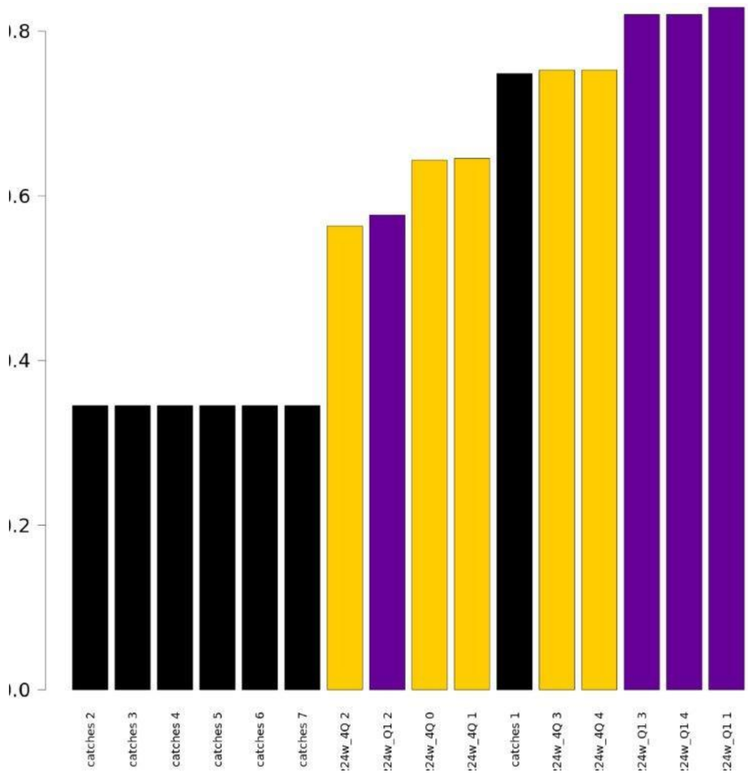


Figure 2.3.14. **Western Baltic cod. SD of log observations from catch data and surveys by age, Y scale is from 0.0 to 0.8.**

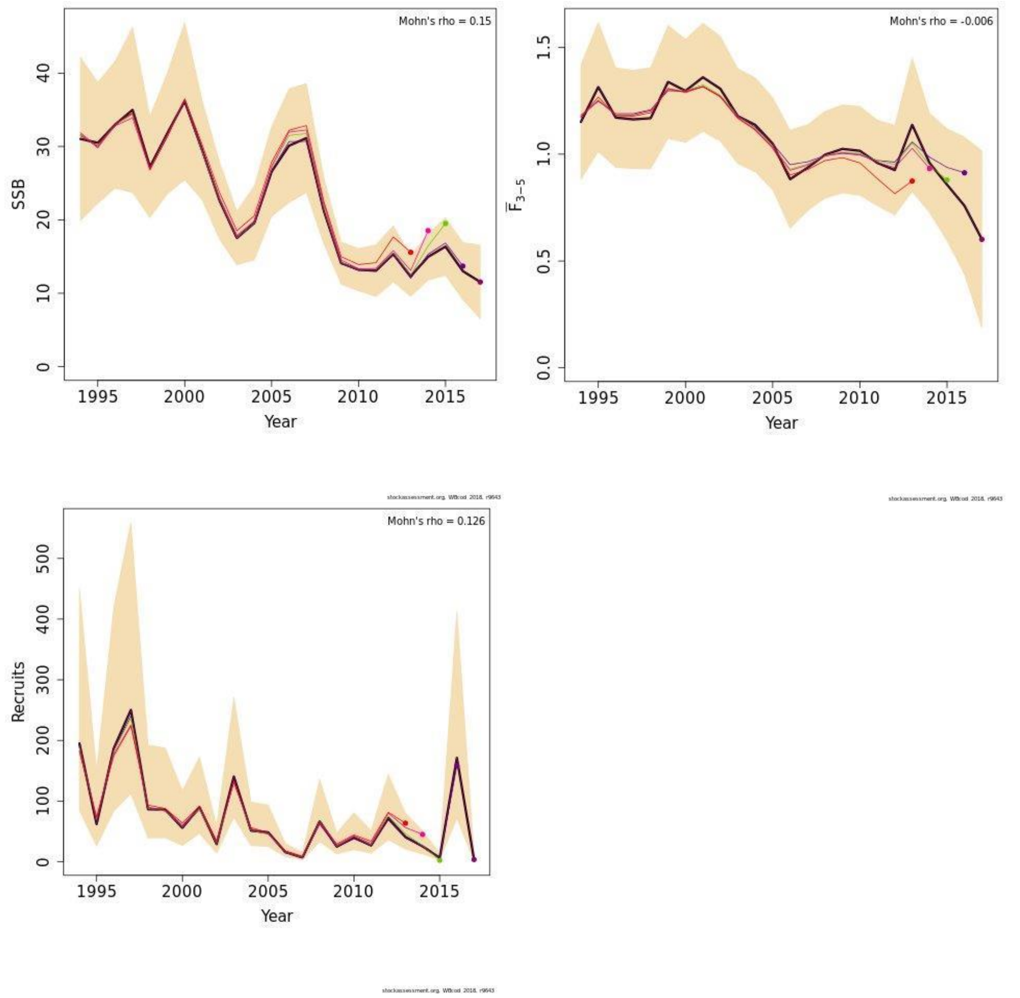


Figure 2.3.15. Western Baltic cod. Retrospective analyses of SSB, F(3–5) and recruitment (age 0).

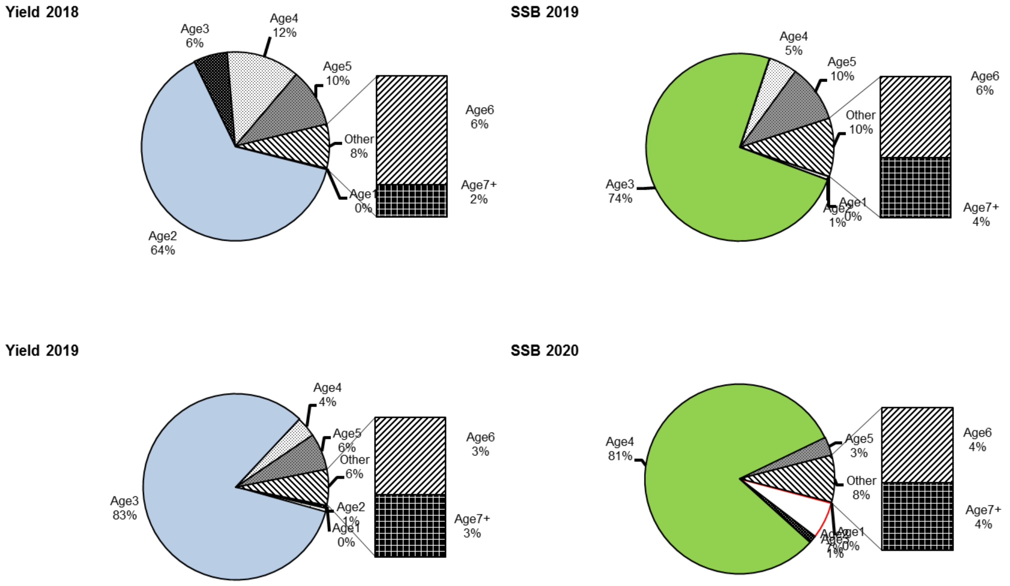


Figure 2.3.16. **Cod stock in SD 22–24. Short-term forecast for 2018–2020. Yield and SBB at-age 1–7+.**

3 Flounder in the Baltic

3.1 Introduction

3.1.1 WKBALFLAT – Benchmark

In January 2014 the flounder stocks in the Baltic were benchmarked. As a result four different stocks of flounder were identified - fle(WKBALFLAT 2014). Flounder (*Platichthys flesus*) is the most widely distributed among all flatfish species in the Baltic Sea.

There are significant disparities between two sympatric flounder populations in the Baltic Sea, the pelagic and the demersal spawners. They differ in their spawning habitat, egg characteristics (Nissling *et al.*, 2002; Nissling and Dahlman, 2010) and genetics (Florin and Höglund, 2008; Hemmer-Hansen *et al.*, 2007a), although they utilize the same feeding grounds in summer - autumn (Nissling and Dahlman, 2010).

Demersal spawners produce small and heavy eggs which develop at the bottom of shallow banks and coastal areas in the northern part of the Baltic Proper. They were established as a one stock/assessment unit comprised of SDs 27, and 29–32, but they also inhabit SD28 (Nissling and Dahlman, 2010).

Pelagic spawners are distributed in the southern and the deeper eastern part of the Baltic Sea and spawn at 70–130 m depth. The activation of their spermatozoa and fertilisation occurs at an average of 10–13 psu, whereas an average salinity required to obtain neutral egg buoyancy is 13.9–26.1 psu (Nissling *et al*., 2002).

There are also differences within the pelagic spawners, which led to the designation of three stocks/assessment units at the DCWKBALFLAT: SD 22 and 23; SD 24 and 25; SD 26 and 28 (ICES, 2014). There is evidence of a differentiation between SD 22 and 23 from SD 24 and 25 based on egg buoyancy (Nissling *et al.*, 2002), length at maturity, and to some extent genetics (Hemmer-Hansen *et al.,* 2007b). Even though there is no physical connection between SD 22 and SD23, flounder in these areas are assumed to be connected through the western part of SD 24.

Flounder in SD 24 and 25 are also different from flounder in SD 26 and 28 based on separate spawning areas, and tagging data indicate no dispersal between these areas (Cieglewicz, 1963; Otterlind, 1967; Vitinsh, 1976). Trends in survey CPUE are inconclusive and the extent of exchange of early life stages between the areas is unknown. Therefore, the distinction between these two stocks should be further examined, e.g. whether a more consistent assessment with lower uncertainty would be obtained in merging these two units. For the time being, it was decided to assume two separate stocks.

The migrations between the mature flounder stocks are limited. Details can be found in Annex 07.

3.1.2 Discard

During WKBALFLAT the quality of the estimations of discards were questioned. The main problem was very high flounder discards variability, which exceed the landings or sometimes are even 100% of the catch. Within InterCatch, it is not possible to raise discard data properly, when discard data are available for particular stratum and there is no landing of flounder assigned, then the discard is estimated as zero (see introduction section on IC for further comments).

Because the discard ratio in both subdivisions is significantly different between countries, fleets, vessels and even individual hauls of the same vessel and trip, a common discard ratio cannot be applied. Discarding practices are, in fact, controlled by factors such as market price and cod catches.

According the call for data submission for ICES WGBFAS, new method for estimated the discards was recommended and should be applied to all flounder stocks, here the main issue was that the discard should be raised by total landings or effort and not by the landings of flounders:

$$\text{Discard Rate}_{\text{Time,SD,fleet segment,Species}} = \frac{\sum \text{Weight of discard}_{\text{Trip,Haul,Time,SD,Fleet segment,Species}}}{\sum \text{Weight of landing}_{\text{Trip,Haul,Time,SD,Fleet segment}}}$$

$$\text{Discard (ton)}_{\text{Time,SD,Fleet segment,Species}} = \text{Landings (ton)}_{\text{Time,SD,fleet segment}} \times \text{Discard Rate}_{\text{Time,SD,fleet segment,Species}}$$

WKBALFLAT recommended, that the quantitative assessment cannot be provided until discards recalculation by using better approach, which avoid the underestimation of discards.

3.1.3 Tuning fleet

Since 2001 the Baltic International Trawl Survey (BITS) has been carried out using a new (stratified random) design and a new standard gear (TV3). BITS surveys are performed twice a year, in 1st and 4th quarter.

For the northern Baltic Sea flounder the surveys used were four national gillnet surveys since the BITS survey was deemed inappropriate for this stock (not covering shallow areas, not covering Northern Baltic Sea). From Estonia two surveys were available and from Sweden two surveys were available as well.

3.1.4 Effort

Time series from 2009/2016 was available from ICES WGBFAS data call where countries submitted flatfish effort data by fishing fleet and subdivision. Effort data was asked to report as days at sea. However, different calculation methods were used by countries. Some countries reported all of fishing days when flounder were landed, some countries reported number of fishing days were significant amount of flounder were landed, while some countries reported fishing days for whole demersal fleet. It was discussed than in the future more specific description about methodology should be given.

Standardisation and weighting factor was applied for submitted effort data to calculate a common effort index for whole population. First, every country data were standardised using proportion for given year from the national average. Standardised effort data were weighted by demersal fish landings for every country and year and final effort for whole population was calculated summing all countries efforts.

3.1.5 Biological data

Because of the major age determination problems in flounder, WGBFAS decided in 2006 that age data from whole otoliths shall not be used for assessment (ICES, 2006; see also Gardmark, *et al*., 2007; ICES, 2007a).

3.1.6 Survival rate

Survival rate for the discarded flounder is unknown. However, the relatively wide range of survival rates was obtained from several studies conducted in the Baltic Sea (see WKBALFLAT 2014, WD 2.1). During WKBALFLAT the precautionary level of survival rate was assumed as 50% in I and IV quarter and 10% in II and III quarter (ICES, 2014b).

3.1.7 Reference points

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (ICES, 2015). Commercial landings were used to estimate length distribution and average weight by length groups. Biological parameters: L_{inf} and L_{mat} were calculated using survey data from DATRAS. For estimating L_{inf} data from Q1 and Q4 were taken unsorted by sex. In the case of L_{mat} data were derived from only from Q1 and females, as distinguishing between mature and immature fish were possible only for this time of the year.

3.2 Flounder in subdivisions 22 and 23 (Belts and Sound)

3.2.1 The fishery

The landing data of flounder in the Western Baltic (fle.27.2223) according to ICES subdivisions and countries are presented in Table 3.2.1. The trend and the amount of the landings of this flatfish are shown in Figure 3.2.1.

Flounder is mainly caught in the area of Belt Sea (SD 22) with Denmark and Germany being the main fishing countries. The Sound (SD 23) is of minor importance for the contribution to the total landings (Table 3.2.2). Denmark and Sweden are the main fishing countries there.

Flounder are caught mostly by trawlers and gillnetters. The minimum landing size is 23 cm. Active gears provide most of the landings in SD 22 (ca. 70%), whereas landings from passive gears are low. However, in SD 23, passive gears provide around 85% of total flounder landings (for Swedish fleet 98–100%) in this area. Flounder is caught as a bycatch-species in cod targeting fisheries (i.e. mostly trawlers) and in a mixed flatfish fishery (i.e. mostly gillnetters).

3.2.2 Landings

The highest total landings of flounder in subdivisions 22 and 23 were observed at the end of the seventies (3790 t in 1978). Landings decreased in the period between 1989 and 1993. Since 1993 the landings increased again and reached a moderate temporal maximum in 2000 (2597 t). After 2000 the landings decreased to 866 t in 2006. Landings slightly increased since 2006 and vary between 1400 and 1000 tonnes since then. Landings in 2017 were about 1158 tonnes.

3.2.2.1 Unallocated removals

Unallocated removals might take place but are considered minor and are not reported from the respective countries. Recreational fishery on flounder might take place with unknown removals, but is also considered to be of minor influence.

3.2.2.2 Discards

Discards of flounder are known to be high with ratios around 20–50% of the total catch of vessels using active gears (e.g. trawling). Passive fishing gears have lower discards, varying between 10 to 20% of the total catch. Depending on market prices and quota of target species (e.g. cod), discards vary between quarters and years. The discarded fraction can cover all length-classes and rise up to 100% of a catch.

The available data on discards are incomplete for all subdivisions. In 2017, discard-data from the passive-gear segment of the commercial fisheries is considered limited and therefore not sampled by Denmark. The quality of the discard data increased in recent years, as more estimation was given by the national data submitters. In strata not having landings assigned, no discard-information was given.

Subdivision 22 (the Belt) shows a very good sampling coverage that allows reasonable discard estimations at least for the last four years. Subdivision 23 (Sound) is sampled less; only a few biological samples are available. However, discard estimations provided by national data submitters are given in many strata.

Sampling intensity has increased steadily in the last years; therefore less discard ratio were borrowed. Table 3.2.3 gives an overview of total landings and the estimated discard weights and empty strata. Before 2006, sampling intensity was too low to give a reasonable estimation, especially in the passive segment, where almost no data are available. The discard in 2017 is estimated to be around 249 tonnes, which would result in a discard ratio of 18% of the total catch, which is lower than in the previous five years, where about 25–30% of the total catch was discarded.

3.2.2.3 Effort and CPUE Data

The CPUE was calculated as standardized fishing effort for both, the demersal active and passive fleet. National fleet effort (days-at-sea) per SD is transformed into a standard catch (effort per stratum and country divided by average effort per country over the period 2009–2017). Standard catches were weighted by the mean of cod landings by country and fleet.

Fishing effort in subdivisions 22 and 23 decreased from 2004 to 2010 with 50% and has remained stable since then. No significant change in effort was found in the time-period 2009 to 2016 for active gears (Figure 3.2.3). Passive gears show a slight, but continuous decrease since 2012. While the total effort (as day-at-sea) is in line with the past years (showing a steady, more or less stable decrease), the strong reduction in cod catches in 2017 (caused by a prolonged closure period in the Western Baltic and reduced TAC) resulted in a higher decrease of the respective standardized effort in the recent year.

3.2.3 Biological composition of the catch

Length distributions from commercial fisheries sampling are available from Germany, Denmark and Sweden in the time-period from 2000 onwards. However, the available length-sampling do not cover all strata in the given period of 2000 to 2017.

These gaps in sampling (e.g. non-sampled length distribution in quarter for a given fishing gear by a country) were filled by the stock-coordinator by borrowing/extrapolating from similar strata. The resulting length-distributions were tested for their internal consistency.

Age-data are considered to be applicable only when the ageing was conducted using new method (*i.e.* breaking and burning of otoliths) as recommended by ICES WKARFLO (2007; 2008) and ICES WKFLABA (2010).

From commercial fisheries samples, age information for catch numbers ate age (CANUM) and mean weights in the catch (WECA) are available from Germany (2009 onwards) and Denmark (2012 onwards). CANUM and WECA per length are available from 2014 to the recent year and used to calculate MSY proxy reference points.

In years where only numbers-at-length are available (but no age-data), preliminary analyses applying statistical slicing method using the von-Bertalanffy growth-equation have been conducted. Further development and validation of this approach, for example comparison with real age reading data for later years, is encouraged.

The calculated age-based CANUM for the period 2000 onwards were only used for exploratory analyses during the benchmark in 2014 and 2015, due to issues with sampling-coverage and data-quality before 2009. Further, the age distributions derived from slicing methods should be verified against real age readings for years when these are available.

3.2.3.1 Catch in numbers

The catch in numbers per length for the three most recent years is given in Figure 3.2.4. Almost no flounder above 35 cm are caught (Figure 3.2.4).

3.2.3.2 Mean weights-at-age

Mean weight per length class was almost only available from German sampling-program (commercial fisheries, Figure 3.2.5). Germany has no fishery in SD 23, therefore, no weight-information were available. Calculated weights from SD 22 were assumed to be the same as SD 23. It is however unlikely, that mean-weights are similar, since the fishing pattern and timing is different between the subdivisions. SD 23 shows almost no active fisheries; almost 90% of the catches come from passive gears. Passive gears often catch larger fishes and have a lower discard-rate. Recent years show a decrease in the average weight for almost all age classes.

3.2.3.3 Maturity-at-age

The maturity ogive was taken from the BIT survey. Both quarters from the period 2000 to 2017 were combined and an average maturity-at-age was calculated:

Age	1	2	3	4	5	6	7	8	9	10
Maturity	0.18	0.51	0.70	0.85	0.94	0.97	0.97	0.99	0.98	0.99

The benchmark in 2015 (ICES, 2015) additionally recommended that sex-ratios should be available at least in a pilot study to determine whether it has an influence on the assessment or both sexes can be combined in future assessments.

3.2.3.4 Natural mortality

No further information or studies on natural mortality are available. The average natural mortality for all age classes is set at 0.2 as a default.

3.2.4 Fishery independent information

The "Baltic International Trawl Survey" (BITS) is covering the area of the flounder stock in SD 22–23. The survey is conducted twice a year (1st and 4th quarter) by the member states having a fishery in this area. Survey design and gear is standardized. Due to a change in trawling gear in 2000, only first and fourth quarter BITS since 2001 are considered. Effort and biomass-index are calculated from the catches. The BITS-Index is calculated as:

Average number of flounder >= 20 cm weighted by the area of each depth stratum which all together covers the area covered by the stock. These are multiplied with the average weight of the length-class (Figure 3.2.6).

In 2012, one haul in the Q4 survey was excluded from the calculations in SD 23 as it was clearly an outlier, providing values ten times higher than in all other years in this area.

3.2.5 Assessment

The flounder stock in SD 22–23 is categorized as a data-limited-stock (DLS). Especially data from the beginning of the time-period (2000–2006) is considered as very poor with a low sampling-coverage in time and space. More than half of the strata (landings and discards) from that period were filled with borrowed data (extrapolated length-distributions and mean weights per length-class). Any analytical assessment using this data-matrix can only be used as an exploratory assessment, but not for reasonable advice.

Following the instructions of the ICES DLS Guidance Report (2012), the stock is assessed as

"Category 3: Stocks for which survey-based assessments indicate trends"

This category includes stocks for which survey indices (or other indicators of stock size such as reliable fishery-dependent indices; e.g. lpue, CPUE, and mean length in the catch) are available that provide reliable indications of trends in stock metrics such as mortality, recruitment, and biomass.

Stock trends are suggested to be estimated using the weighted index from BITS-Survey (i.e. a relative index, calculated from standardized methods and gears).

Both 1st and 4th quarter surveys are aggregated into one index value for a given year (using geometric mean between quarters). For advice, the relative change in the average index in the last two years is compared to the average of the three years before.

Additionally, trends in commercial landings and standardized effort have to be taken into account. Length based indicators are used to assess the stock status in terms of over-exploitation of immatures and/or large individuals following the guidelines provided by WKLIFE V (2015). The 3 year average (2015–2017) absolute value of $L_{F=M}$ was used as a F_{MSY} Proxy.

Survey trends have increased steadily since the early 2000s. The average stock size indicator (kg/hour) in the last two years (2016–2017) is 10% higher than the biomass index in the three previous years (2013–2015; Figure 3.2.7). This would imply a catch advice of no more than 4443 tonnes in 2019 (i.e. the advised catch of 2017 x index factor).

3.2.6 Reference points

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (2015). CANUM and WECA of commercial catches from 2014–2017 were taken from InterCatch. Biological parameters were calculated using survey data from DATRAS:

- L_{inf}: average of 2002–2017, both quarter and sexes → L_{inf} = 33.2 cm
- L_{mat}: average of 2002–2017, quarter 1, only females → L_{mat} = 23 cm

The results were compared to standard length-based reference values to estimate the status of the stock (Table 3.2.4).

The results of LBI (Table 3.2.5) show that stock status of fle.27.2223 is above possible reference points (Table 2). $L_{max5\%}$ is well above the lower limit of 0.80 (*i.e.* 1.20 in 2017), some truncation in the length distribution in the catches might take place. Over proportional amounts of mega spawners occur, as P_{mega} is larger than 75% of the catch. This might very well be an artefact produced by a relative small L_{inf}, which would also explain the overfishing of immatures (L_c/L_{mat}) Catch is close to the theoretical length of L_{opt} and L_{mean} is stable over time and close to 1, indicating fishing close to the optimal yield. Exploitation consistent with F_{MSY} proxy (LF=M).

Table 3.2.1. fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Total landings (tonnes) by country and subdivision.

Year/SD	Denmark		Germ. Dem. Rep.	Germany, FRG	Sweden	
	22	23	22	22	22	23
1970						
1971						
1972						
1973	1983		181	349		
1974	2097		165	304		
1975	1992		163	469		
1976	2038		174	392		
1977	1974		555	393		
1978	2965		348	477		
1979	2451		189	259		
1980	2185		138	212		
1981	1964		271	351		
1982	1563	104	263	248		
1983	1714	115	280	418		
1984	1733	85	349	371		
1985	1561	130	236	199		
1986	1525	65	127	125		
1987	1208	122	71	114		
1988	1162	125	92	133		
1989	1321	83	126	122		
1990	941		52	183		
1991	925			246		
1992	713	185		227		
1993	649	194		235		26
1994	882	181		44		84
1995	859	231		286		58
1996	1041	227		189	2	58
1997	1356			655		42
1998	1372			411		61
1999	1473			510		37
2000	1896			660		41
2001	2030			458		52
2002	1490			317		42
2003	1063			241		33
2004	952			315		31
2005	725	184		94		38
2006	620	182		34		30
2007	585	233		406		26
2008	554	199		627		47
2009	505	113		521		37
2010	557	91		376		29
2011	441	78		497	0.2	28
2012	530	98		569		22
2013	639	83		713		19
2014	513	68		589	0	23
2015	361	73		679	0	16
2016	436	63		641		15
2017	508	61		575	0	13

Table 3.2.2. fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Total landings (tonnes) by subdivision.

Year	Total by SD		Total
	22	23	SD 22-23
1970			
1971			
1972			
1973	2513		2513
1974	2566		2566
1975	2624		2624
1976	2604		2604
1977	2922		2922
1978	3790		3790
1979	2899		2899
1980	2535		2535
1981	2586		2586
1982	2074	104	2178
1983	2412	115	2527
1984	2453	85	2538
1985	1996	130	2126
1986	1777	65	1842
1987	1393	122	1515
1988	1387	125	1512
1989	1569	83	1652
1990	1176		1176
1991	1171		1171
1992	940	185	1125
1993	884	220	1104
1994	926	265	1191
1995	1145	289	1434
1996	1232	285	1517
1997	2011	42	2053
1998	1783	61	1844
1999	1983	37	2020
2000	2556	41	2597
2001	2488	52	2540
2002	1807	42	1849
2003	1304	33	1337
2004	1267	31	1298
2005	819	222	1041
2006	654	212	866
2007	991	259	1250
2008	1181	246	1427
2009	1026	150	1176
2010	933	120	1053
2011	938	106	1044
2012	1099	120	1219
2013	1352	102	1454
2014	1103	91	1193
2015	1040	90	1130
2016	1077	78	1155
2017	1083	74	1158

Table 3.2.3. **fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Overview of ampling intensity and discard estimations (no additional survival rate is added to this calculation).**

YEAR	LANDINGS	ESTIMATES DISCARD	RATIO	TOTAL STRATA*	UNSAMPLED STRATA
2006	1452	532	0.27	29	20
2007	1287	629	0.33	28	19
2008	1421	447	0.24	29	14
2009	1172	1027	0.47	29	15
2010	1051	536	0.34	31	16
2011	1040	534	0.34	31	7
2012	1220	563	0.32	29	12
2013	1453	502	0.26	26	13
2014	1193	540	0.31	26	11
2015	1130	314	0.22	28	14
2016	1153	495	0.30	28	10
2017	1158	249	0.18	31	13

Table 3.2.4 **fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system.**

INDICATOR	CALCULATION	REFERENCE POINT	INDICATOR RATIO	EXPECTED VALUE	PROPERTY
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above Lopt + 10%	0.3–0.4	P_{mega}	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > Lc	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{maxy}	Length class with maximum biomass in catch	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > Lc	$L_{F=M}$ = ($0.75L_c+0.25L_{inf}$)	L_{mean} / $L_{F=M}$	≥ 1	MSY

Table 3.2.5 fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Indicator status for the most recent three years.

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max\,5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2014	0.54	1.13	1.2	0.87	1.33	1.67
2015	0.54	1.17	1.19	0.9	1.33	1.66
2016	0.46	1.22	1.21	0.95	1.38	1.89

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max\,5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2015	0.54	1.15	1.30	0.95	1.44	1.71
2016	0.41	1.20	1.31	0.99	1.50	2.05
2017	1.07	1.20	1.33	0.99	1.54	1.19

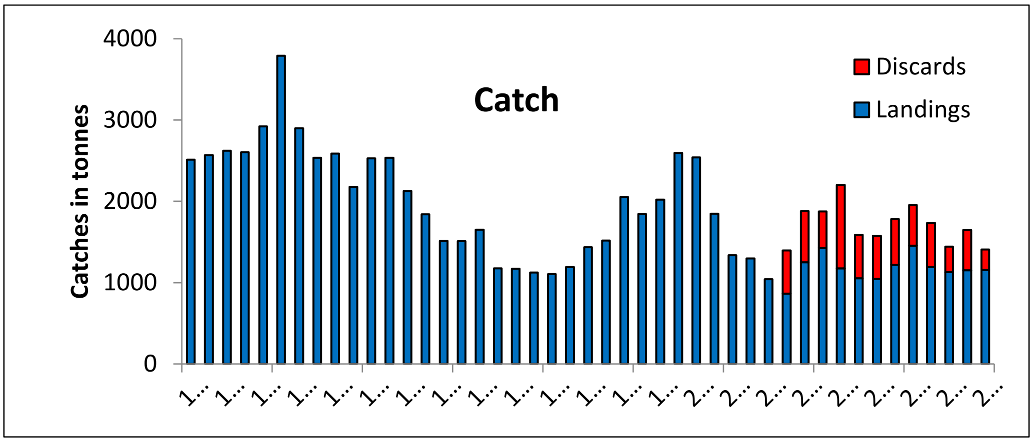


Figure 3.2.1. fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Total landings of flounder in tonnes for subdivisions SD 22–23 (Western Baltic Sea). ICES discard estimates are included from 2006 onwards.

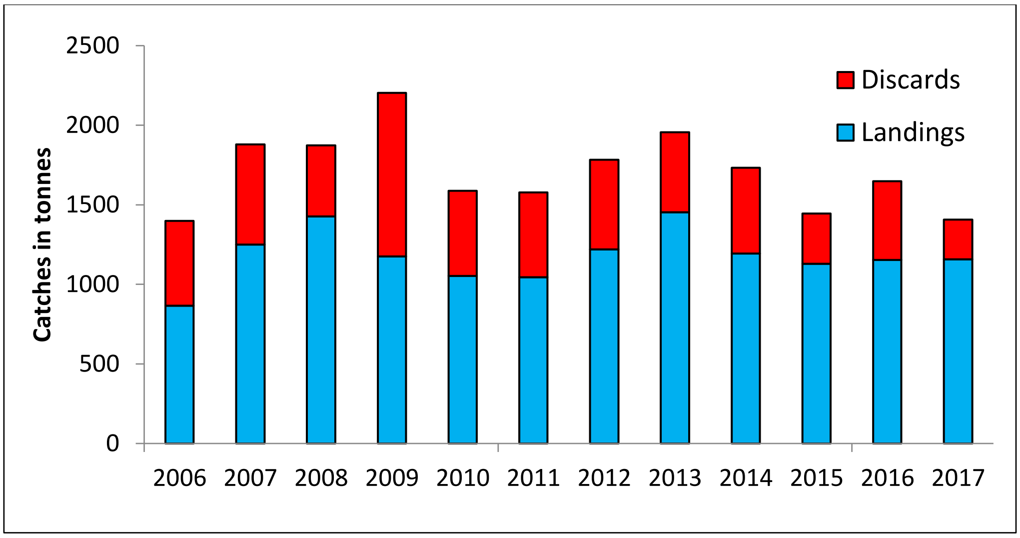


Figure 3.2.2. fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Total landings and calculated discards (in tonnes) of flounder for subdivisions SD 22–23 (Western Baltic Sea).

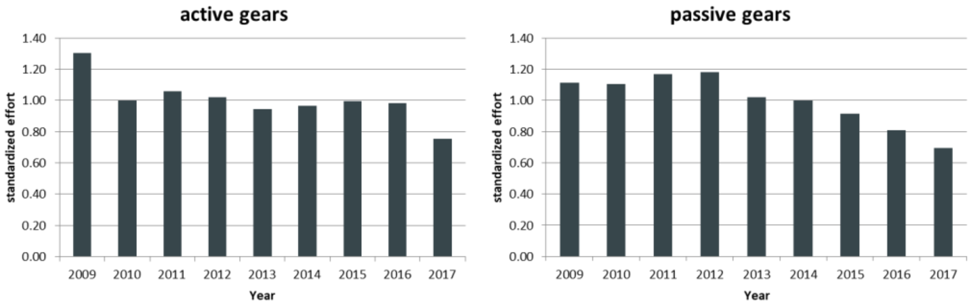


Figure 3.2.3. **fle.27.2223. Standardized effort for active and passive fleet in Subdivision 22 and 23 (Belts and Sound). Standard catches (effort per strata and country divided by average effort per country) were weighed by national cod landings.**

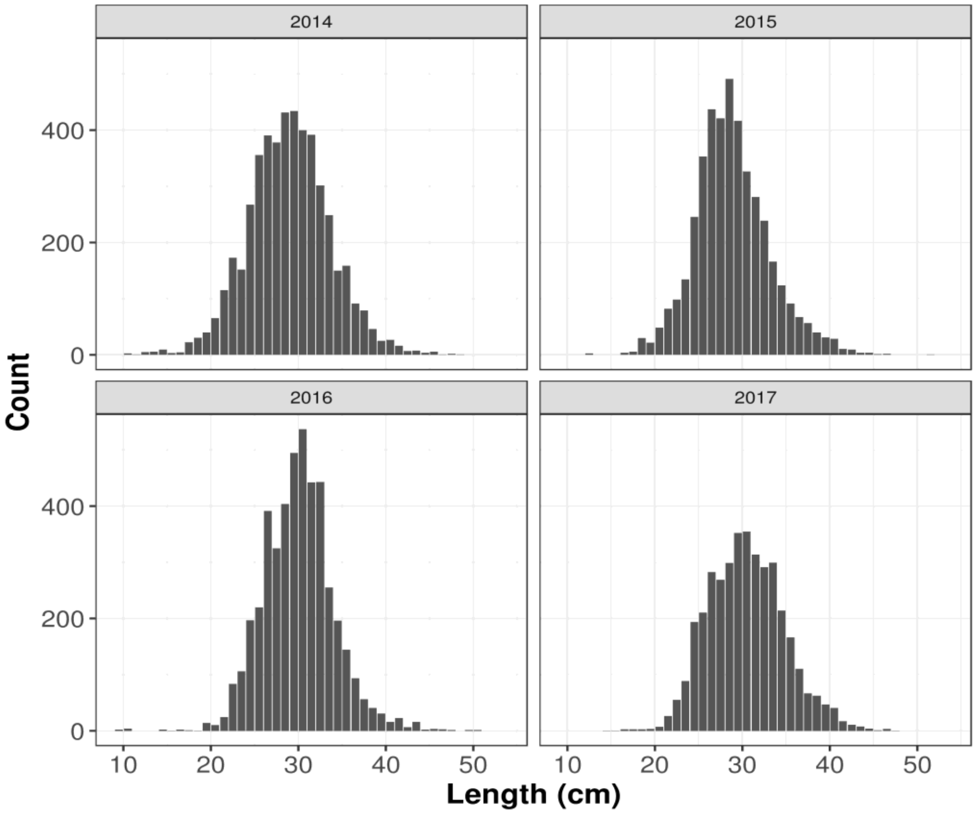


Figure 3.2.4. **fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Catch in numbers per length class in Subdivision 22 and 23 (Belts and Sound). All countries and fleets were combined.**

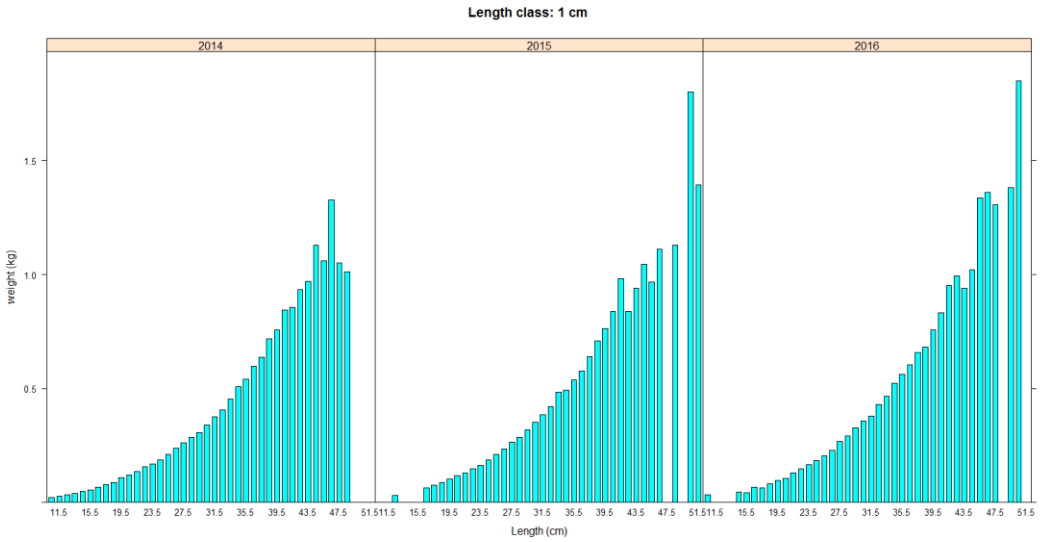


Figure 3.2.5. **fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Average weight-at-length for all length classes in subdivisions 22 and 23 (Belts and Sound) in the recent three years. All countries and fleets were combined.**

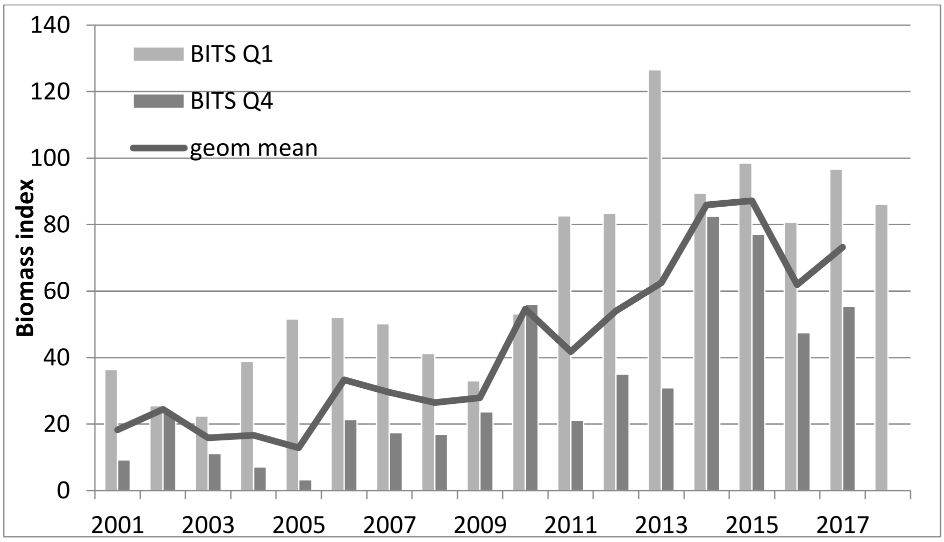


Figure 3.2.6. **fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Survey-biomass-index (BITS) for Q1 and Q4 from 2002 to 2017 and geometric mean (line). 2018 values (for Q1) are preliminary.**

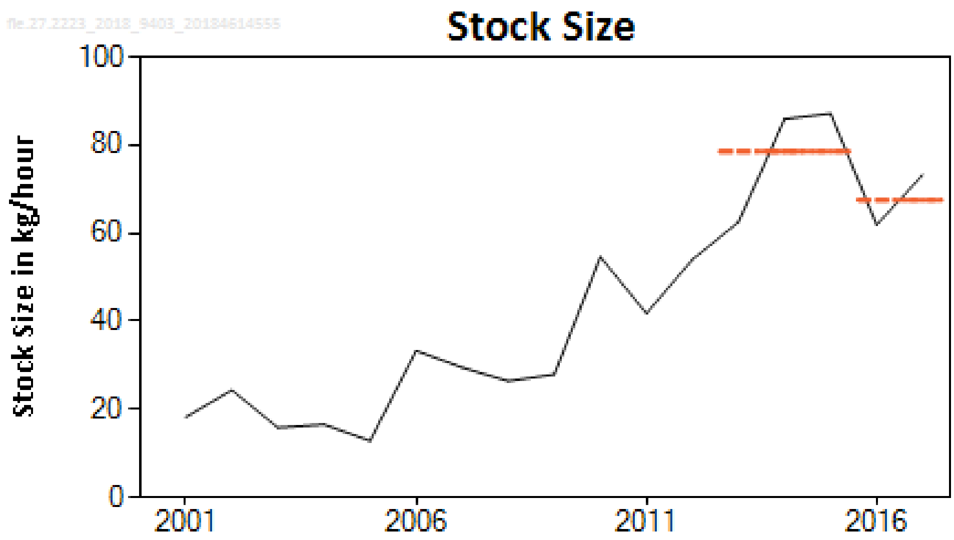


Figure 3.2.7. **fle.27.2223/Flounder in subdivisions 22 and 23 (Belts and Sound). Survey-biomass-index (BITS). Dashed lines indicate the average values used for advice (i.e. avg. of the last two years and the avg. of the three years before).**

3.3 Flounder in subdivisions 24 and 25

ICES SD 24 and 25 were defined as a new assessment unit for flounder at a Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT; ICES, 2014) in 2014.

There are significant disparities between two sympatric flounder populations in the Baltic Sea, demersal and pelagic-spawning (the group to which flounder in SDs 24–25 belong). There are also differences within the pelagic-spawning flounder, which led to the designation of three stocks/assessment units at the WKBALFLAT (ICES, 2014): SD 22 and 23; SD 24 and 25; SD 26 and 28.

3.3.1 The Fishery

3.3.1.1 Landings

Landings from SD 25 are substantially higher than in SD 24 (Figure 3.3.1). The main fishing nations in SD 24 are Poland and Germany and in SD 25 – Poland and Denmark. The majority of landings in both SD's is taken by Poland (Figure 3.3.2, Table 3.3.1a).

Flounder landings in both SD's are dominated by active gears, taking around 75% of total landings in 2017 (Figure 3.3.3).

In 2017 landings were 10 855 tonnes (2 865 tonnes and 7 990 tonnes for SD 24 and SD 25, respectively). Since 2014 the discard has been estimated according to the new methodology suggested during WKBALFLAT (ICES, 2014). The total catch for flounder in subdivisions 24–25 reached 17 055 tonnes in 2017 (Figure 3.3.4).

3.3.1.2 Discards

During WKBALFLAT (ICES, 2014) the quality of the estimated discards was questioned and new method for discards estimation was recommended:

$$\text{Discard Rate}_{\text{Time,SD,fleet segment,Species}} = \frac{\sum \text{Weight of discard}_{\text{Trip,Haul,Time,SD,Fleet segment,Species}}}{\sum \text{Weight of landing}_{\text{Trip,Haul,Time,SD,Fleet segment}}}$$

$$\text{Discard (ton)}_{\text{Time,SD,Fleet segment,Species}} = \text{Landings (ton)}_{\text{Time,SD,fleet segment}} \times \text{Discard Rate}_{\text{Time ,SD,fleet segment,Species}}$$

Not every stratum has discards estimates, in that case discard rate was borrowed from other strata according to allocation scheme considering differences in discard patterns between subdivisions, countries, gear types and quarters (Table 3.3.2). Then the discard rate was raised by demersal fish landings. Such discard estimations have been performed since 2014. The highest discards in subdivisions 24 and 25 can be assigned to Denmark and Sweden. Germany and Poland have the moderate discards, although the discard rate for Poland is relatively low (Table 3.3.1b; Figure 3.3.5).

The discard rate for 2017 is 0.36 with discard equal to 6201 tonnes.

3.3.1.3 Effort and CPUE data

Effort data back to 2009 is available for all countries. As countries have not used the same approach, the effort was standardized within each country and weighted by the national demersal fish landings from SD 24–25. Although the effort in 2017 is the lowest over the time series (Figure 3.3.6), the catches are similar as in 2015 (Figure 3.3.4).

3.3.2 Biological information

3.3.2.1 Age composition

Because of the major age determination problems in the case of flounder, age-data are considered to be applicable only when the ageing was conducted using recommended methods (slicing and staining or breaking and burning techniques) established by WKARFLO (ICES, 2007; ICES, 2008) and WKFLABA (ICES, 2010). Age readings achieved by using the new methodology are available for survey (Table 3.3.3) and for commercial data (Table 3.3.4).

The mean weight at age remains relatively stable over the years. (Figure 3.3.7). Although in 2017 mean weight of fish at age 2 was almost as high as age group 5 and higher than age group 3 and 4. That was due to low number for age 2 group.

3.3.2.2 The most abundant age group 4 from 2015 is visible in 2016 as age 5 and in 2017 as age 6. (Figure 3.3.8). Quality of catch and biological data

The number of sampled fish in SD 24 is slightly higher than in SD 25, even though the landings in SD 25 are much higher (Figure 3.3.9). Most of the samples in SD 24 are analyzed by Germany and in SD 25 by Poland.

Although the discard ratio in both subdivisions varies between countries, gear types, and quarters and additionally discarding practices are controlled by factors such as market price and cod catches, the quality of the catch is improving, as discard reporting is increasing. Sampling coverage of discards differs between years and subdivisions and has slightly improved in 2017 (Figure 3.3.10). Flounder discard in SD 24 and SD 25 is sampled mainly by Germany, Sweden and Denmark.

3.3.3 Fishery independent information

Since 2001 the Baltic International Trawl Survey (BITS) has been carried out using a new (stratified random) design and a new standard gear (TV3). BITS surveys are conducted twice a year, in 1st and 4th quarter. BITS surveys in SD 24 are performed by Germany and since 2016 also by Poland and in SD 25 by Poland, Denmark and Sweden. Number of stations is higher in SD 25 compared to SD 24 (Table 3.3.5).

3.3.4 Assessment

The flounder stock in SD 24–25 belongs to category 3.2.0: Stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES, 2012).

Stock trend is estimated using the Biomass Index from BITS-Q1 and BITS-Q4 surveys. The index is calculated by length-classes for the fish bigger or equal to 20 cm, and covers the period from 2001 onwards.

Both BITS-Q1 and BITS-Q4 surveys (Figure 3.3.11) are aggregated into one annual index value for a given year (using geometric mean between quarters). The Biomass-Index is calculated for each year. The advice is based on a comparison of the average from two most recent index values with the three preceding values (Figure 3.3.12). The advice index for this year is 1.40.

Stock trends from Baltic International Trawl Survey (BITS) for SD 24 and 25 have been increasing during the last 10 years, even though the landings are also increasing (Figure 3.3.1 and 4.3.6).

3.3.5 Reference points

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (ICES, 2015). Commercial landings from InterCatch from 2014–2017 were used to estimate CANUM (Figure 3.3.4.13). Whereas the biological parameters: L_{inf} and L_{mat} were calculated using survey data from DATRAS. For estimating L_{inf} data from 2012–2018 (as the recommended ageing technique was implemented by all of the countries since 2012 onwards) from Q1 and Q4 were taken. In the case of L_{mat} data were derived from 2001–2018, only from Q1, as distinguishing between mature and immature fish were possible only for this time of the year. Biological parameters were calculated for both sexes (Table 3.3.6).

Average $L_{F=M}$ for 2014 – 2017 is equal to 21.9 cm and L_{mean} - 27.1 cm. The results from all runs were giving similar results in terms of $F_{MSY\ proxy}$ (L_{mean} / $L_{F=M}$) indicator, which was used for stock status assessment. According to this indicator the fishing pressure for this stock for the last three years were at the safe level.

Table 3.3.1a. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Total landings (tonnes) 1973–2017 by Subdivision and country.

Year	Denmark			Estonia			Finland			Germany			Latvia			Lithuania			Poland			Sweden			Total
	SD 24	SD 25	SD24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24–25
1973			386									3144									1580			502	5612
1974			2578									2139									1635			470	6822
1975			1678									1876									1871			400	5825
1976			482									2459									1549			400	4890
1977			389									3808									2071			416	6684
1978			415									2573									996			346	4330
1979			405									2512									1230			315	4462
1980			286									2776									1613			62	4737
1981			548									2596									1151			51	4346
1982			257									3203									2484			55	5999
1983			450									3573									1828			180	6031
1984			306									2720									2471			45	5542
1985			649									3257									2063			40	6009
1986			1558									2848									3030			51	7487
1987			1007									2107									2530			43	5687
1988			990									2986									1728			58	5762
1989			1062									3618									1896			56	6632
1990			1389									1632									1617			120	4758
1991			1497									1814									2008			55	5374
1992			975									1972									1877			129	4953
1993			635									1230									3276			90	5231
1994			1016									4262									3177			38	8493
1995			2110			8						2825									7437			214	12594
1996			2306						1			1322									6069			819	10517
1997			2452			15			1			1982									3877			370	8697
1998			2393			10			2			1729			2						4215			236	8587
1999			1206			8						1825									4015			111	7165
2000	825	923	1748				14	4	18	1809	171	1979							605	3765	4370	49	123	172	8288

Year	Denmark			Estonia			Finland			Germany			Latvia			Lithuania			Poland			Sweden			Total
	SD 24	SD 25	SD24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24–25
2001	1026	1976	3002				9	68	77	1468	299	1766							531	4962	5493	30	95	125	10464
2002	995	1877	2872				5	34	39	1910	154	2064							1288	6577	7865	30	111	141	12982
2003	750	1052	1802				2	7	8	1165	389	1553							758	5087	5845	45	106	152	9360
2004	1114	1753	2866							1307	275	1582	1	6	7				1177	5633	6810	19	86	105	11370
2005	853	1445	2298				1	2	3	881	43	924	2		2				2194	7192	9386	26	58	84	12696
2006	513	1518	2031				2	3	5	973	7	979		11	11				1782	5959	7741	23	61	84	10852
2007	620	623	1243				2	8	10	1455	215	1670	8	7	15		11	11	3016	5840	8856	27	59	86	11891
2008	422	313	736							1601	238	1840		74	74		4	4	2094	5569	7663	29	66	95	10410
2009	325	199	524				41		41	1175	29	1204		155	155		31	31	2378	5802	8180	27	65	92	10227
2010	333	368	701		16	16	13	2	16	953	31	983		31	31		19	19	1833	7665	9498	21	64	85	11348
2011	310	226	536		20	20	3	2	5	1529	147	1676		39	39		15	15	1567	6666	8233	26	60	86	10610
2012	290	250	540		19	19	20	17	36	904	151	1055		8	8		24	24	1331	7325	8657	23	67	90	10430
2013	572	1889	2460		10	10	1	9	10	771	332	1103	4	76	80		54	54	2104	8118	10222	35	344	379	14318
2014	349	1324	1673		83	83		0	0	751	212	963	3	288	291		74	74	1537	9821	11358	22	146	168	14610
2015	169	1614	1783		39	39	1	4	4	635	181	815	2	6	8		7	7	1122	7247	8370	24	40	64	11090
2016	135	84	219	0	0	0	2	0	2	630	246	876	0	81	81	0	9	9	2238	11157	13395	16	41	56	14637
2017	97	112	209	0	0	0	1	0	1	619	423	1042	0	2	2	0	2	2	2143	7383	9525	5	68	73	10855

Table 3.3.1b. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Estimated discards (tonnes) 2014–2017 by Subdivision and country.

Year	Denmark			Estonia			Finland			Germany			Latvia			Lithuania			Poland			Sweden			Total
	SD 24	SD 25	SD24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24	SD 25	SD 24–25	SD 24–25
2014	1402	2450	3852	0	0	0	0	0	0	171	15	185	2	35	37	0	7	7	29	128	157	187	1117	1303	5542
2015	1186	3900	5086	0	0	0	0	0	0	199	35	234	0	0	0	0	1	1	80	307	387	98	157	255	5965
2016	664	2880	3544	0	0	0	2	0	2	298	63	360	0	8	8	0	0	0	235	390	625	386	216	602	5143
2017	467	3915	4382	0	0	0	0	1	1	121	177	298	0	6	6	0	0	0	144	767	911	390	212	602	6201

Table 3.3.2. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Discard allocation scheme for 2017

24		2017							
fleet	quarter	Denmark	Germany	Poland	Sweden	Finland	Estonia	Latvia	Lithuania
Active	1			DE_A_1_24	DK_A_1_24	DE_A_1_24			
	2			DE_A_2_24	DK_A_2_24				
	3				DK_A_3_24				
	4			DE_A_3_24	DK_A_4_24				
Passive	1	SE_P_1_24	SE_P_1_24						
	2	SE_P_2_24		PL_P_1_24					
	3	SE_P_3_24		DE_P_3_24					
	4	SE_P_4_24	SE_P_4_24	SE_P_4_24					

25		2017							
fleet	quarter	Denmark	Germany	Poland	Sweden	Finland	Estonia	Latvia	Lithuania
Active	1					PL_A_1_25		PL_A_1_25	
	2								
	3		SE_A_3_25	PL_A_3_24					
	4			SE_A_4_25		SE_A_4_25		SE_A_4_25	
Passive	1	SE_P_1_25		PL_P_1_24				PL_P_1_24	
	2	SE_P_2_25		SE_P_2_25				PL_P_1_24	
	3	SE_P_3_25		DE_P_3_24					
	4	SE_P_4_25		SE_P_4_25					

Table 3.3.3. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Available survey age data determined with a new method.

Country	SD 24	SD 25
Denmark		since 2012
Germany	since 2009	
Poland		2000–2002 only 1st quarter 2004–2010 only 1st quarter since 2011 1st and 4th quarter
Sweden		since 2007

Table 3.3.4. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Available commercial age data determined with a new method.

Country	SD 24	SD 25
Denmark	since 2012	
Germany	since 2008	since 2008
Latvia		2010
Poland	2000–2010 only 1st quarter since 2011 1st and 4th quarter	2000–2010 only 1st quarter since 2011 1st and 4th quarter
Sweden		since 2009

Table 3.3.5. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Number of BITS-stations in SD 24 and SD 25.

	SD 24		SD 25	
	Q1	Q4	Q1	Q4
2001	66	40	96	52
2002	55	46	57	75
2003	48	46	97	61
2004	50	47	112	63
2005	43	46	113	81
2006	43	44	95	72
2007	45	41	88	81
2008	35	47	97	62
2009	45	53	104	81
2010	50	31	80	77
2011	44	50	105	77
2012	52	47	102	74
2013	54	38	102	75
2014	52	49	97	73
2015	50	38	97	73
2016	53	47	85	81
2017	49	48	107	99
2018	53		110	
average	49	46	97	72

Table 3.3.6. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic -West). Biological parameters (L_{inf} and L_{mat}) calculated for Females, Males and both sexes.

	Females	Males	Both
L_{inf} [mm]	346	289	329
L_{mat} [mm]	230	170	170

Table 3.3.7. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic -West). Description of the selected LBI

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	P_{mega}	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > Lc	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{maxy}	Length class with maximum biomass in catch	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > L_c	LF=M = $(0.75L_c+0.25L_{inf})$	L_{mean} / LF=M	≥ 1	MSY

Table 3.3.8. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic – West).Indicator status for the most recent three years. Linf and Lmat calculated using both sexes. . Linf = 33.0 cm and Lmat = 19.0 cm.

	Conservation				Optimizing Yield	MSY
Year	Lc / Lmat	L25% / Lmat	Lmax 5 / Linf	Pmega	Lmean / Lopt	Lmean / LF = M
2014	0.72	1.2	1.06	0.73	1.21	1.39
2015	0.68	1.2	1.06	0.75	1.22	1.46
2016	1.12	1.25	1.06	0.77	1.25	1.09
2017	1.18	1.32	1.06	0.78	1.25	1.09

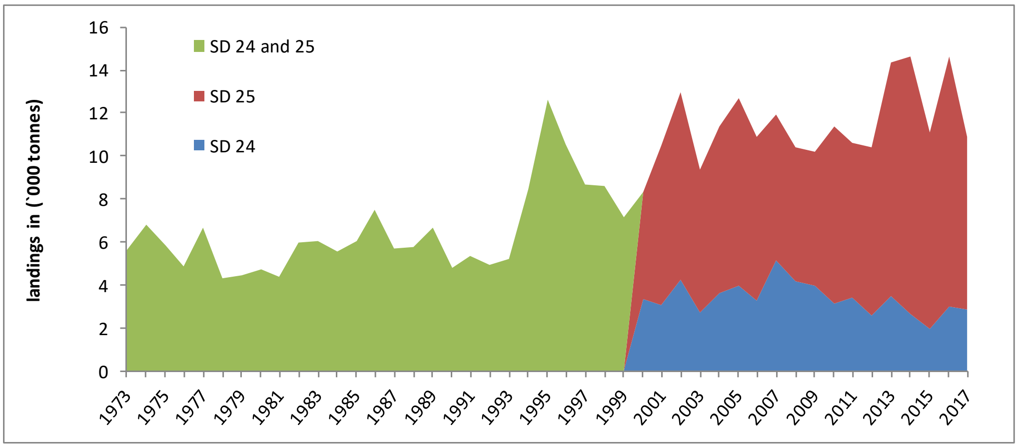


Figure 3.3.1. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Landings in thousand tonnes.

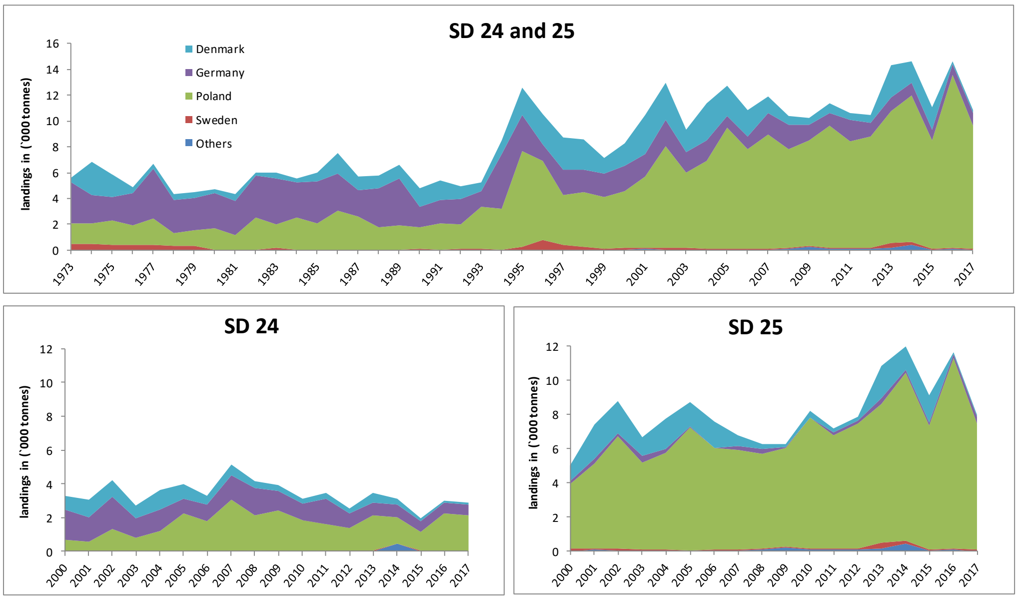


Figure 3.3.2. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Landings by country in thousand tonnes (for merged SD 24–25 – upper plot and separately for SD 24 and SD 25 – lower plots).

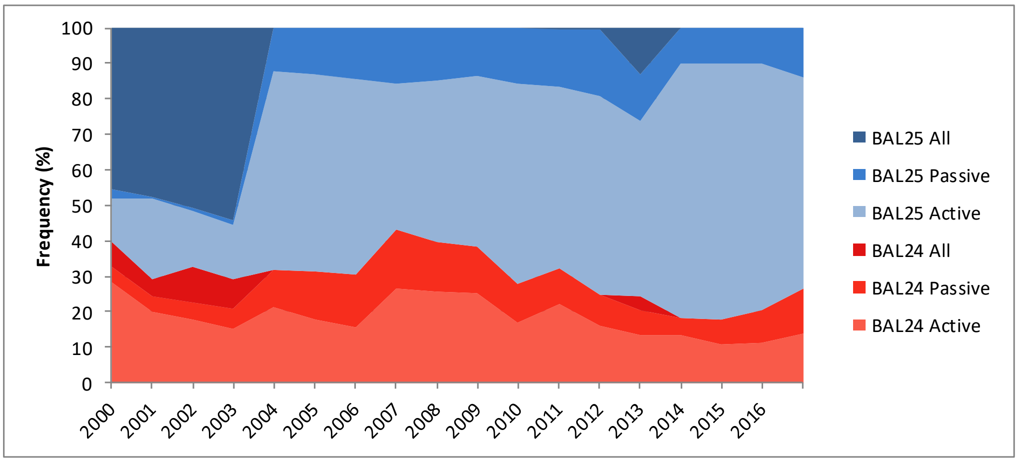


Figure 3.3.3. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Landings by fleet type in thousand tonnes (SD 24 - reddish colors, SD 25 – bluish).

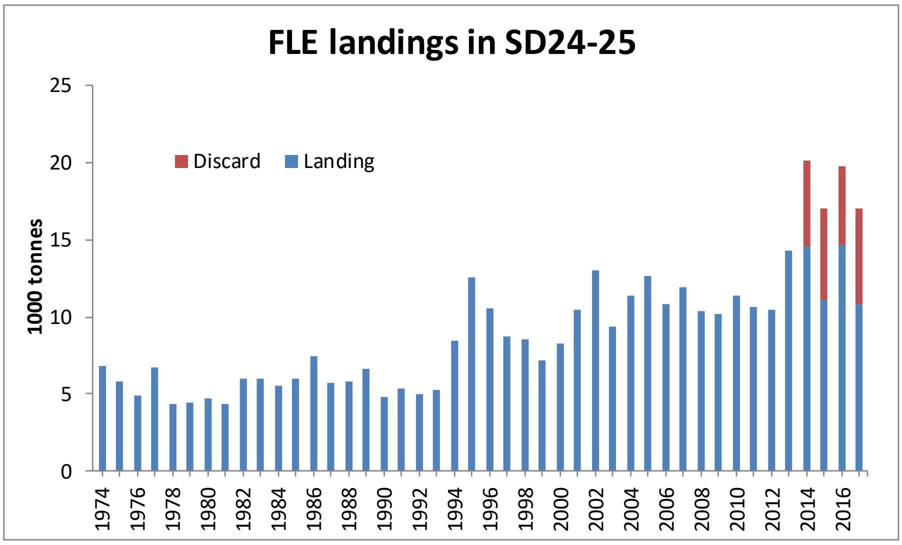


Figure 3.3.4. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Landings in thousand tonnes (discards available since 2014).

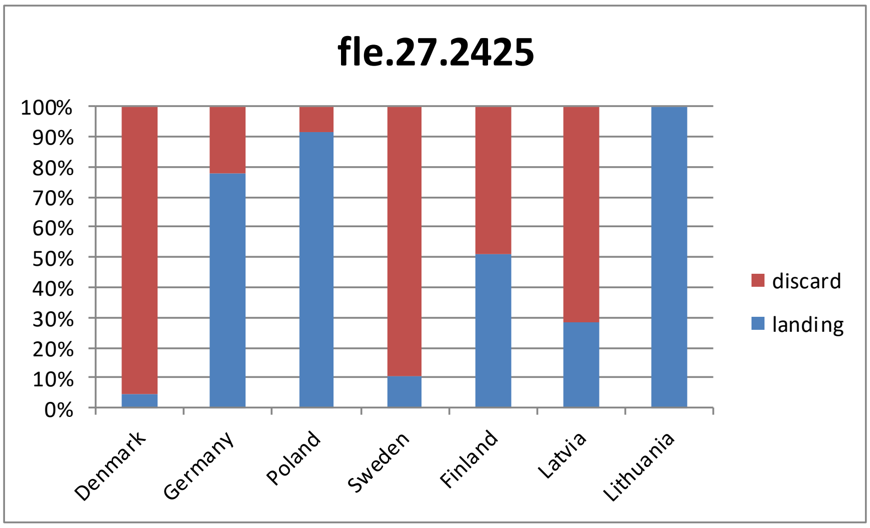


Figure 3.3.5. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Discard and landing proportion in 2017 catches in countries.

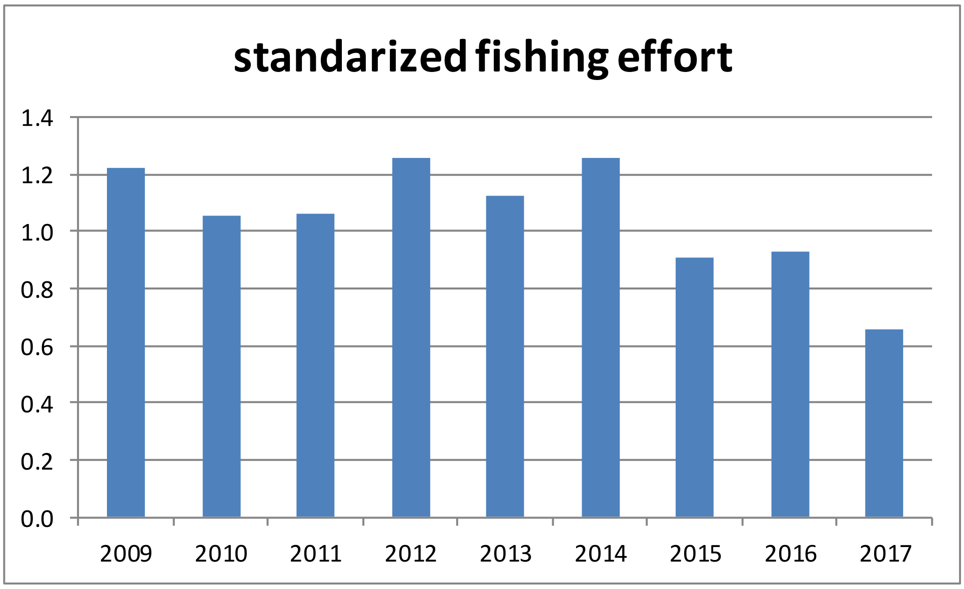


Figure 3.3.6. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Standardized fishing effort (days at sea standardized within each country and weighted by the national demersal fish landings from SD 24–25).

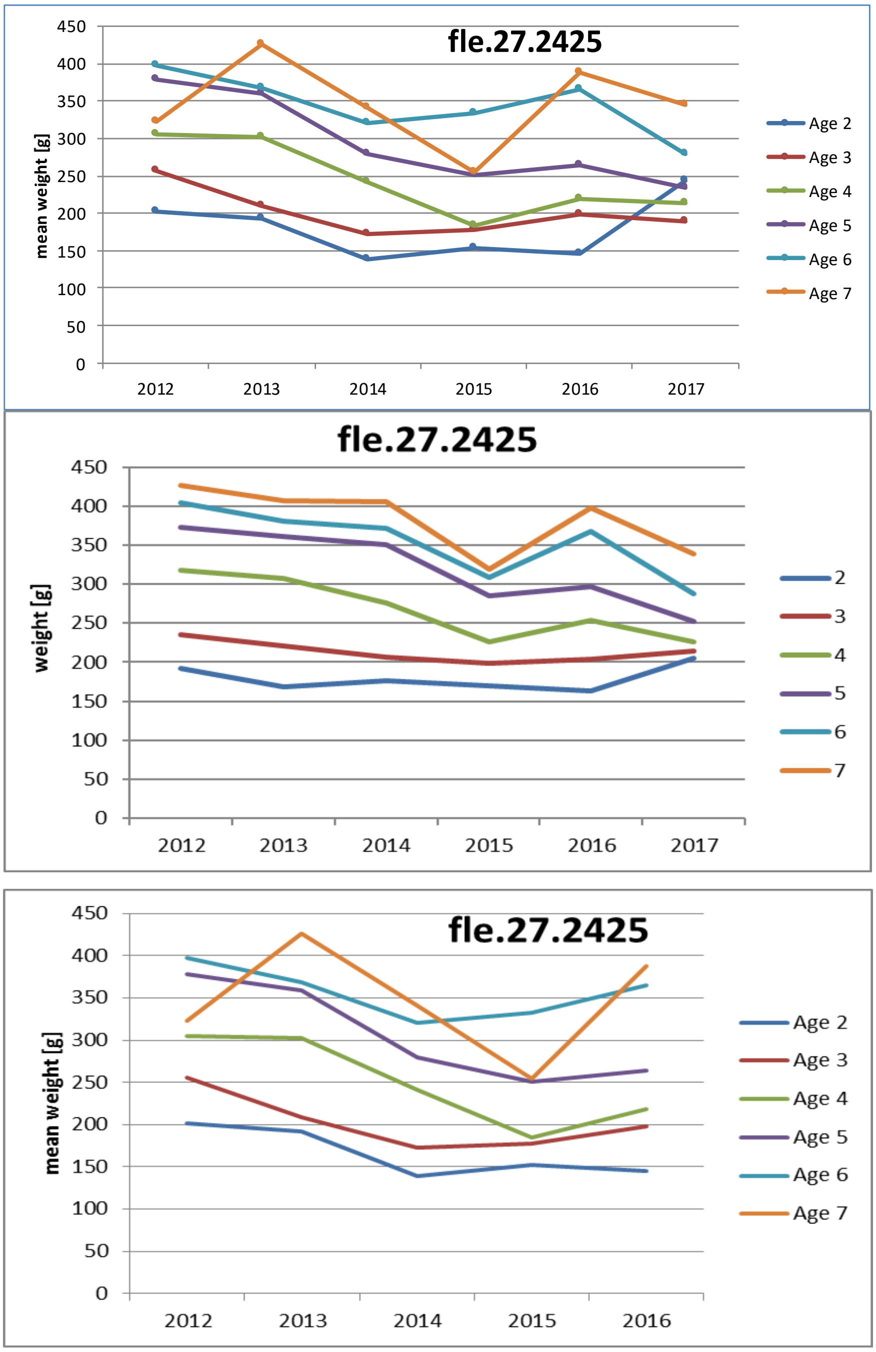


Figure 3.3.7. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Mean weight-at-age in grams.

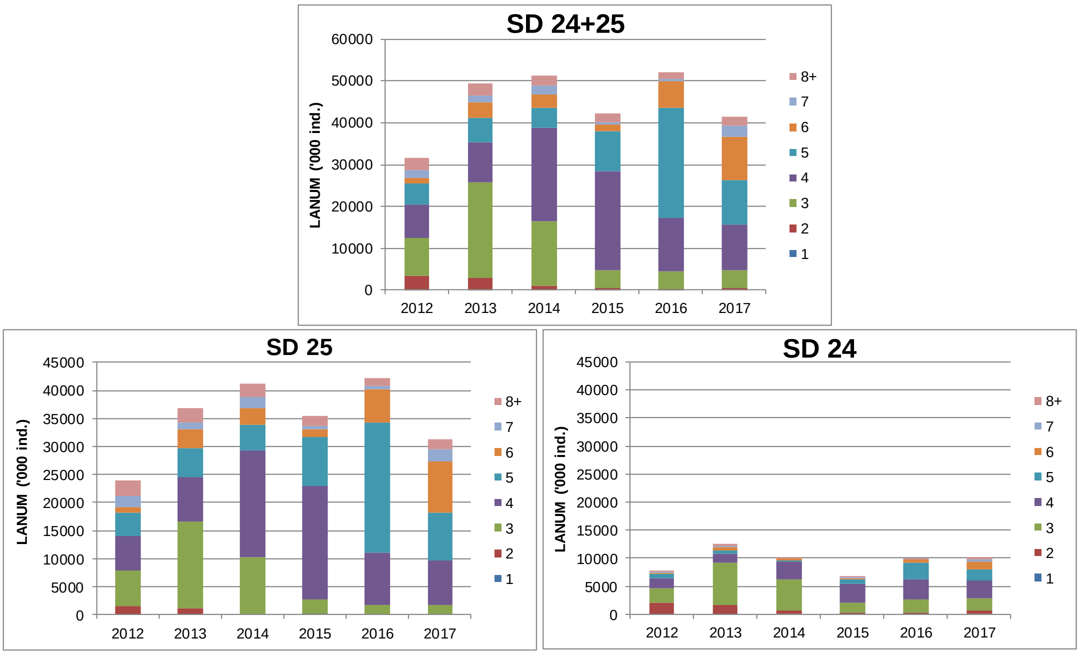
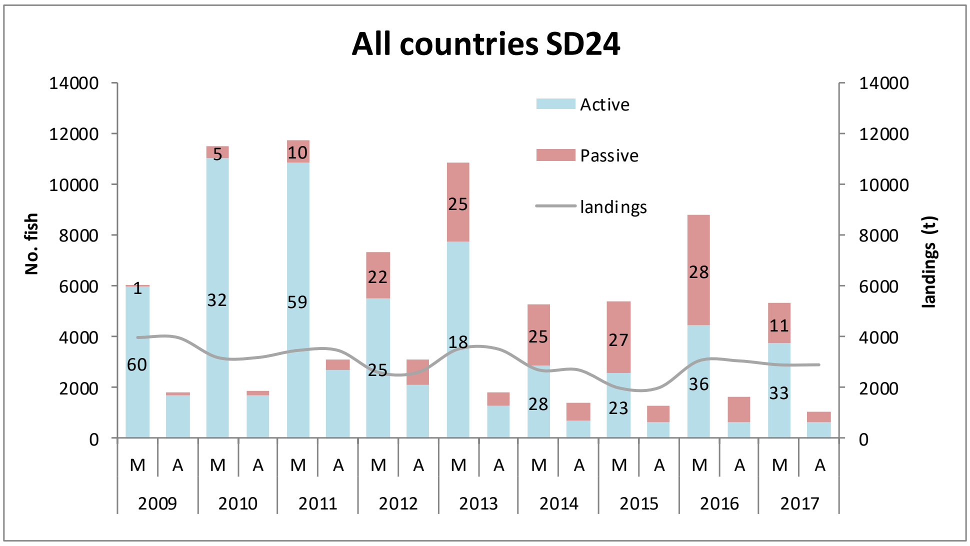


Figure 3.3.8. **Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Landings-at-age in numbers (thousands individuals).**



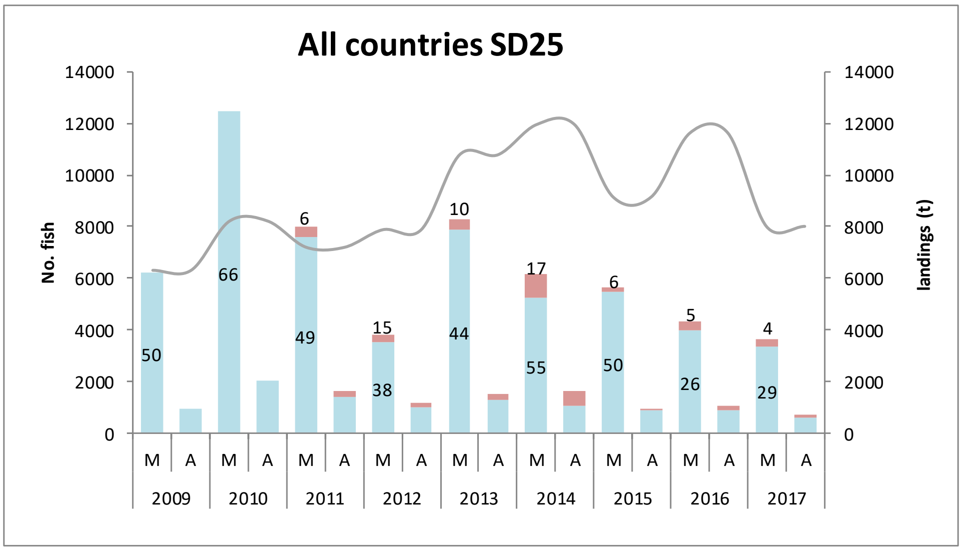
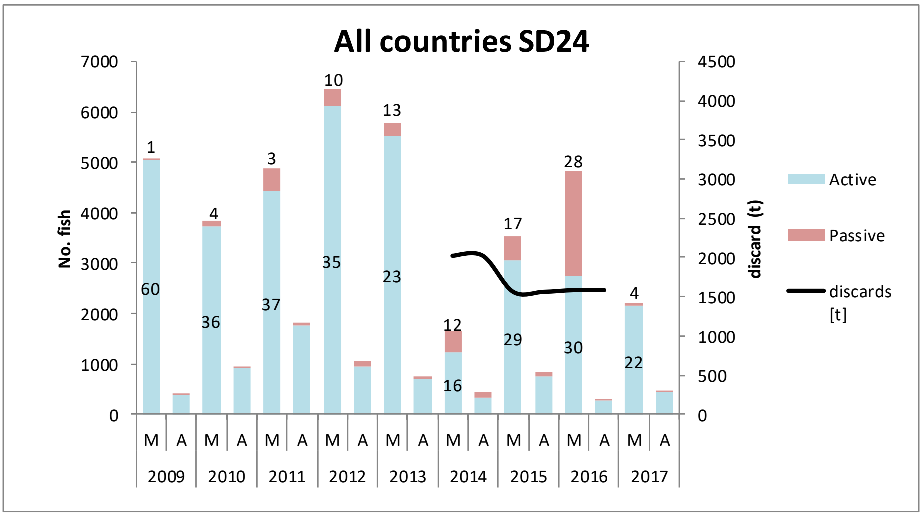


Figure 3.3.9. **Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). The coverage of sampled landing in subdivisions 24 and 25 (first column of each year presents number of measured fish, second – number of aged fish; numbers on the columns are number of samples of: passive fleet - upper value and active fleet – lower value; the additional axis shows landing values – gray line).**



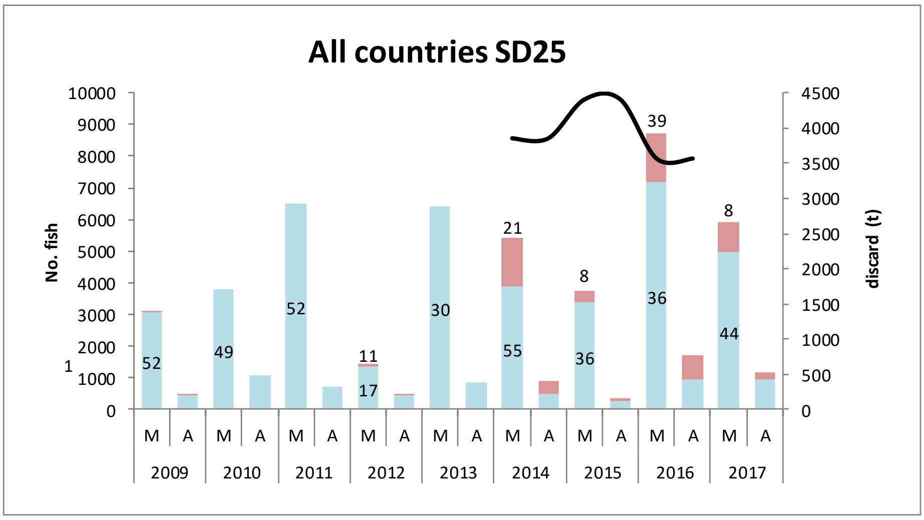


Figure 3.3.10. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). The coverage of sampled discards in subdivisions 24 and 25 (first column of each year presents number of measured fish, second – number of aged fish; numbers on the columns are number of samples of: passive fleet - upper value and active fleet – lower value; the additional axis shows discard values – black line).

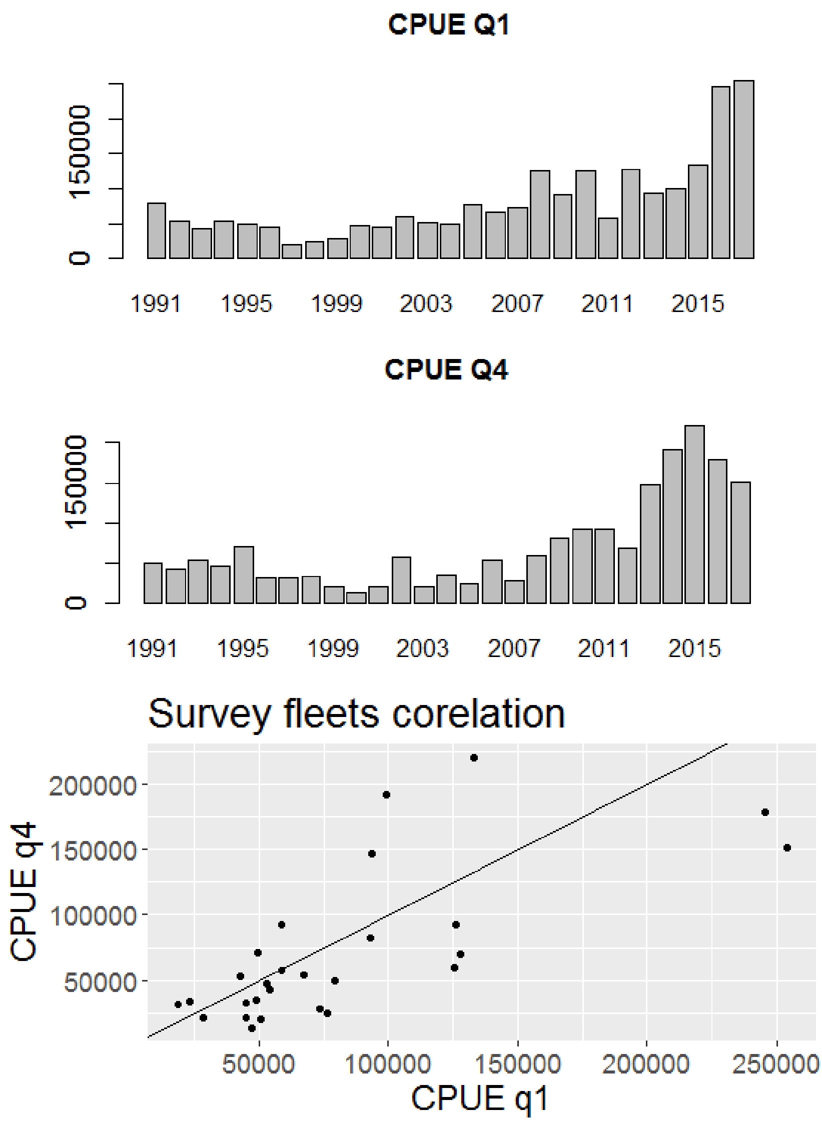


Figure 3.3.11. Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Stock trends from Baltic International Trawl Survey (BITS) for SD 24 and 25.

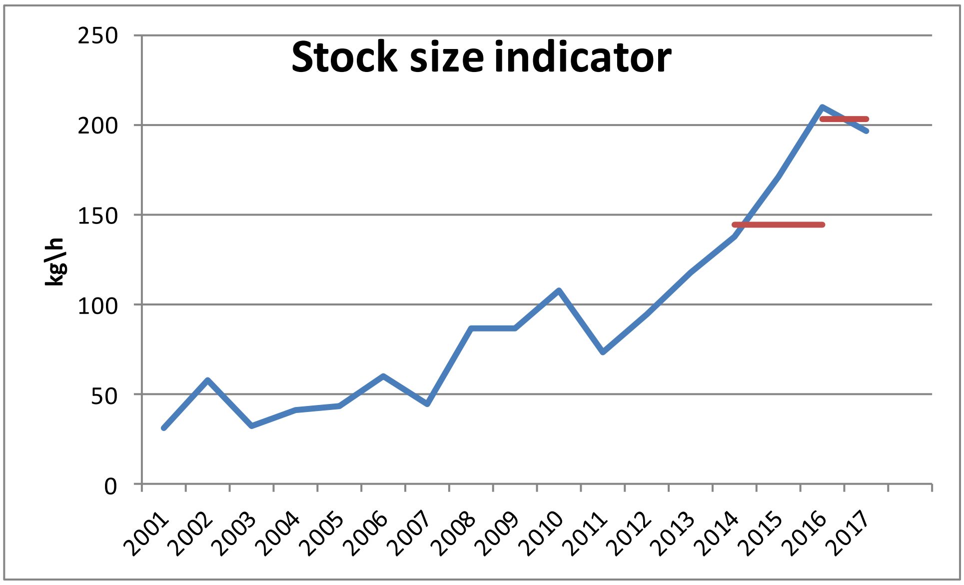


Figure 3.3.12. **Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Biomass index (blue line indicates geometric mean of the biomass index from the first and fourth quarter).**

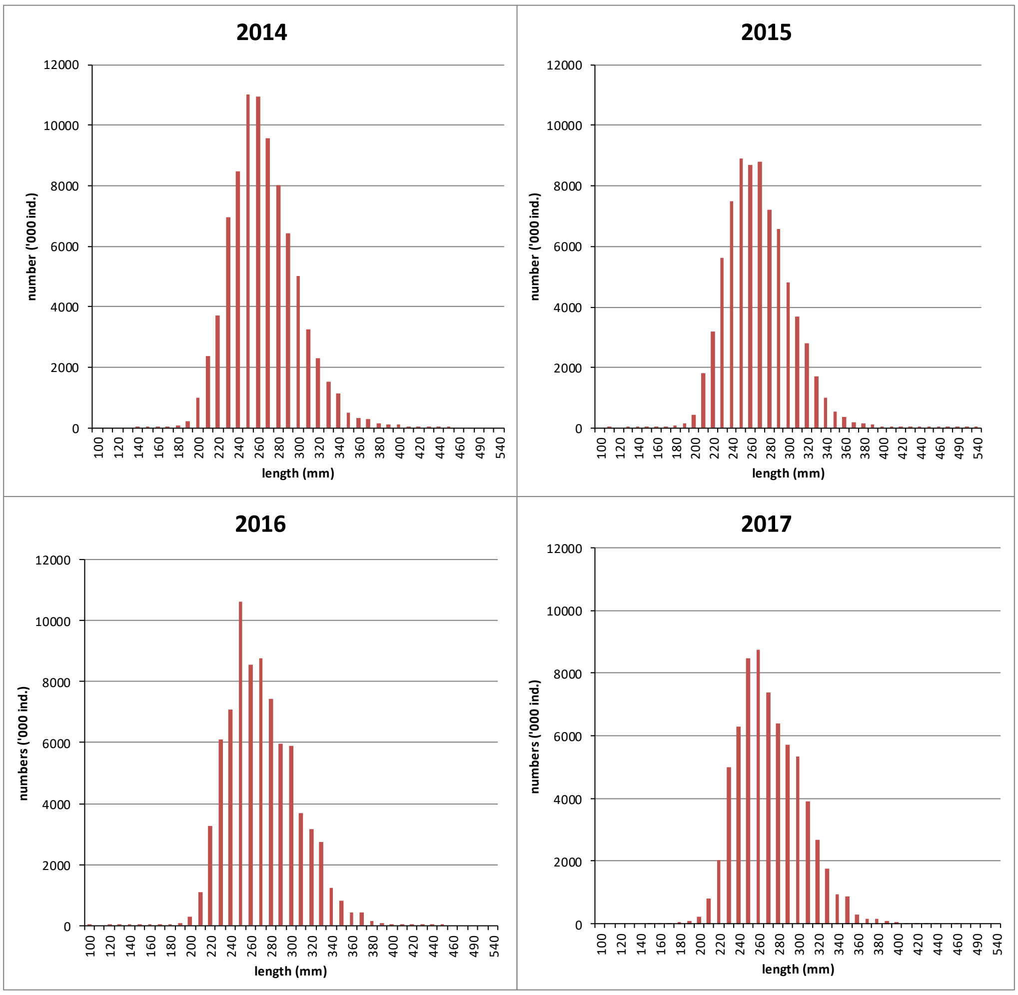


Figure 3.3.13. **Flounder in subdivisions 24–25 (West of Bornholm, Southern Central Baltic –West). Catch number (CANUM) per length classes**

3.4 Flounder in subdivisions 26–28 (Eastern Gotland and Gulf of Gdansk)

3.4.1 Fishery

The main fishing countries in Subdivision 26 are Latvia, Poland, Russia and Lithuania while in Subdivision 28 – Latvia (Table 3.4.1). In the previous years the Polish fishery was mainly a gillnet fishery targeting flounder along the coast whereas the Latvian, Russian and Lithuanian landings were mainly in a bottom trawl mix-fishery.

3.4.1.1 Landings

Landings by countries and subdivisions are presented in Table 3.4.1.

The total landings in SD 26 and 28 combined continued to decrease in 2017 and were 3907 tonnes. Decrease of landings was observed since 2014. (Figure 3.4.1., 3.4.2.). The highest landings were recorded in Latvia (1576 tonnes), Russia (1304 tonnes) and Poland (701 tonnes). The major part of the landings was realised with active fishing gears (3317 tonnes).

Major part of the landings was taken in Subdivision 26 (62.8%) and in trawl fishery (84.9%). The total landings in Subdivision 28 amounted to about 1545, what was lowe than one year before but still a remarkable higher than long term average. The landings in Subdivision 28 started to increase from 2011 and last four years are more than 1000 tonnes. The Latvian landings were 1386 tonnes (increased 5 to 10 times comparing to 10 years ago). Latvian landings were mainly taken by the trawl fishery.

Due to unfavourable cod fishing conditions and market limitation for sprat, in some countries (Latvia, Russia) specialized flounder fishery was performed in the last years.

3.4.1.2 Unallocated removals

There is no information about unallocated removals for this stock.

3.4.1.3 Discards

The first discard estimates were calculated in WKBALFLAT in InterCatch data base in 2014. It was found that raising procedure in InterCatch for such by-cach species as flounder gives underestimated and imprecise discard estimates. Therefore WK decided that discard raising should be performed outside of InterCatch.

Discard data of flounder from 2015 according to ICES Data Call were submitted in InterCatch. Discards rates from Denmark, Latvia, Lithuania and Poland were reported in InterCatch. In Russia and Estonia discarding of flounder is forbidden and therefore 0 discard was applied for those countries.

Estimated discard ratio varied significantly by countries, fleets and quarters. The highest discards (by weight) were observed in Poland (354 t) and Lithuania (45 t) (Table 3.4.2) wat was significantly higher than one year ago. Significant decrease of discard was observed in Latvia where major part of flounder was landed. Weighted average of flounder discard in subdivisions 26 and 28 in 2016 was estimated 9.7 % what is significantly higher than estimate for 2016 (4.3%).

3.4.1.4 Effort and CPUE data

Time series from 2009–2016 were available from ICES WGBFAS data call where countries were asked to submit flatfish effort data by fishing fleet and subdivision. It should be mentioned that different calculation methods were used by countries to estimate a fishing effort. Some countries reported all of fishing days when flounder were landed; some countries reported number of fishing days were significant amount of flounder were landed, while some countries reported fishing days for whole demersal fleet.

Standardisation and weighting factor were applied for submitted effort data to calculate a common effort index for the stock. First, every country's data were standardised using proportion for given year from the national average. Standardised effort data were weighted by cod and flounder landings for every country and year and final effort for stock was calculated summing all countries efforts.

According to new effort estimates a decreasing trend of effort was observed in previous years with some increase in the last year (Figure 3.4.3). In general, fishing effort is fluctuated without any trend. A decrease in effort in last three years was observed in Latvia, while stays in high level in Lithuania (Figure 3.4.4).

The highest landings per unit effort in 2017 were registered in Latvia, Poland, Russia (Figure 3.4.5) which indicated a target flounder fishery in those countries. Flounder landings per day at sea in other countries were less than 100 kg which indicated that flounder is typically bycatch in the fishery.

3.4.2 Biological information

3.4.2.1 Catch in numbers

In total, 2511 otoliths were collected from the catch (2285 from landings and 226 from discards, Table 3.4.3) . Otoliths from Estonia, Latvia, Poland and Russia covering landings, while otoliths from discards were available from Latvia, Poland.

3.4.3 Fishery independent information

Catch per unit of effort (kg per hour) from the BITS Survey in 1st and 4th quarters was used to calculate an index representing flounder abundance by weight, as the stock is defined as a Data limited stock by ICES. Data were compiled from the ICES DATRAS output format "*CPUE_per_length_per_haul*" where the data base provides CPUE by length in numbers. Weight-at-length was estimated as an average weight-at-length for data from 1991–2013, separately for 1st and 4th quarter and subdivisions 26+28. Next, to such data weight-length relationships of the form w=a L^b were fitted, were: a = 0.0154 and b = 2.91 for 1st quarter and a = 0.0158 and b = 2.90 for 4th quarter. Next, biomass for fish longer than 20 cm were summed to get total biomass index by quarters. All fish with length < 20 cm were excluded from the calculations, as flounder nurseries are located in shallow coastal areas and are not covered in BITS surveys. For the final index the geometric mean of 1st and 4th quarter indices was used.

3.4.4 Assessment

No analytical assessment can be presented for this stock. Therefore, detailed management options cannot be presented. ICES is in the process of compiling existing data and testing assessment models.

The ICES framework for category 3 stocks was applied. The Baltic International Trawl Survey (BITS – Q1+Q4) was used as the index of stock development. The assessment is based on a comparison of the two latest index values (index A) with the three preceding values (index B).

The stock showed a decreasing trend from the beginning of the century although the estimated indices in last four years are on stable level (Figure 3.4.6, Table 3.4.4). The stock abundance is estimated to have slight increase by 0.7% between 2013–2015 (average of the three years) and 2016–2017 (average of the two years). For this stock scientific advice was not produced in 2018.

3.4.5 Reference points

No new reference points for the stock were calculated in 2018. New reference points will be calculated together with next Advice on 2020.

Table 3.4.1. Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Total ICES landings (tonnes) by Subdivision and country.

Country	1996			1997			1998			1999			2000		
	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total
Denmark			0	10		10			0			0	8	0	9
Finland			0			0			0			0	0		0
Germany	10	9	19	12	4	16	2		2			0			0
Poland	2.556		2.556	1.730		1.730	1.370		1.370	1.435		1.435	721		721
Sweden	48	31	79	31	370	401	18	117	135	47		47	0	27	28
Estonia		44	44		101	101		146	146		92	92		65	65
Latvia	74	215	289	78	284	362	88	274	362	140	365	505	113	302	415
Lithuania	316		316	554		554	737		737	547		547	575		575
Russia	740		740	1.001		1.001	1.188		1.188	964		964	1.236	0	1.236
Total	3.744	299	4.043	3.416	759	4.175	3.403	537	3.940	3.133	457	3.590	2.654	395	3.049

Country	2001			2002			2003			2004			2005		
	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total
Denmark	1	14	15	42	0	42	1		1	1		1	0		0
Finland			0	0		0	0		0			0	0		0
Germany			0			0			0			0			0
Poland	548		548	626		626	648		648	1.955		1.955	1.743		1.743
Sweden	3	179	182	4	48	52		17	17		18	18	0	124	124
Estonia		100	100		91	91		122	122		89	89		133	133
Latvia	201	412	613	221	375	596	281	392	673	169	600	769	383	1.333	1.716
Lithuania	1.127		1.127	1.077		1.077	1.066		1.066	834		834	949		949
Russia	1.355		1.355	1.314		1.314	1.402		1.402	1.277		1.277	1.393		1.393
Total	3.235	706	3.941	3.284	514	3.798	3.399	531	3.929	4.236	707	4.943	4.468	1.590	6.058

Country	2006			2007			2008			2009			2010		
	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total
Denmark	4		4	2		2			0			0	0		0
Finland	0	0	0	1	0	2			0			0			0
Germany			0			0			0			0			0
Poland	1.675		1.675	1.829		1.829	1.451		1.451	1.472		1.472	1.727		1.727
Sweden	1	20	22	1	18	20	0	18	19	0	17	17	0	15	15
Estonia		83	83		92	92		91	91		77	77	0	93	93
Latvia	317	838	1.155	166	877	1.043	203	374	577	52	312	364	25	225	250
Lithuania	355		355	268		268	601	27	629	472	27	499	407	55	462
Russia	1.231		1.231	2.650		2.650	1.960		1.960	969		969	1.030		1.030
Total	3.583	941	4.524	4.917	987	5.905	4.216	512	4.727	2.964	433	3.398	3.189	388	3.577

Country	2011			2012			2013			2014			2015		
	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total
Denmark	1		1	0		0	22		22	0.87	0	1	0	0	0
Finland	1		1	10		10	8		8	0.46	0	0	0	0	0
Germany			0			0	0		0			0			
Poland	1.437		1.437	1.501		1.501	1.578	3	1.581	1210	0	1.210	981	0	981
Sweden	1	20	20	2	13	14	21	24	45	0.27	0	0	0	17	18
Estonia	15	74	89	11	70	81	24	52	76	25.5	53.8	79	2	53	55
Latvia	114	166	280	378	244	622	780	619	1.399	299	1279	1.578	281	1.744	2.025
Lithuania	418	0	418	640	12	651	947	1	949	698	0	698	258	0	258
Russia	1.139		1.139	1.079		1.079	1.010		1.010	1047	0	1.047	1.106	0	1.106
Total	3.127	260	3.387	3.620	339	3.959	4.391	698	5.089	3.281	1.333	4.614	2.628	1.815	4.443

Country	2016			2017		
	SD 26	SD 28	Total	SD 26	SD 28	Total
Denmark	0	0	0	0	0	0
Finland			0	0	0	0
Germany	1	0	1	0	0	0
Poland	912	0	912	701	0	701
Sweden	3	14	16	2	10	12
Estonia	0	52	52	0	59	59
Latvia	161	1683	1.843	190	1386	1.576
Lithuania	295	0	295	255	0	255
Russia	1133	0	1.133	1304	0	1.304
Total	2503	1748	4.252	2.453	1.455	3.908

Table 3.4.2. Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Estimated discard rate by countries for flounder in the Baltic Sea, subdivisions 26 and 28 in 2017.

Country	Landings	Discards	Discard ratio
Denmark	0.6	0.1	82.2
Estonia	0.0	58.6	0.0
Finland	0.0	0.3	11.9
Germany	0.0	0.5	8.4
Latvia	16.3	1576.3	1.0
Lithuania	45.7	255.0	15.2
Poland	354.7	700.7	33.6
Russia	0.0	1303.9	0.0
Sweden	0.3	12.2	2.2
Total	417.7	3907.5	

Table 3.4.3. Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Number of collected otoliths from flounder catch in Subdivisions 26 and 28.

Country	Discards	Landings	Total
Estonia		135	135
Latvia	200	313	513
Poland	26	253	279
Russia		1584	1584
Total	226	2285	2511

Table 3.4.4. Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Catch per unit of effort (kg per hour) from BITS Survey in 1st and 4th Quarters, Subdivision 26 and 28.

Biomass index (kg hour–1)			
Year	1st quarter	4th quarter	Combined index
1991	124.2		124.2
1992	51.1		51.1
1993	91.3	48.4	66.5
1994	60.5	30.2	42.8
1995	117.7	68.3	89.7
1996	127.7	30.2	62.1
1997	143.7	80.9	107.9
1998	96.4	67.9	80.9
1999	102.3	73.7	86.8
2000	197.9	65.2	113.6
2001	278.9	404.1	335.8
2002	238.2	316.5	274.6
2003	159.9	143.3	151.4
2004	145.6	366.0	230.9
2005	128.5	307.0	198.6
2006	103.8	150.2	124.8
2007	238.7	223.2	230.8
2008	330.1	198.8	256.2
2009	160.9	146.0	153.2
2010	242.2	196.4	218.1
2011	230.4	209.9	219.9
2012	211.7	134.2	168.5
2013	132.7	175.8	152.8
2014	82.7	63.5	72.5
2015	97.3	72.4	83.9
2016	132.6	55.1	85.5
2017	128.7	116.1	122.2

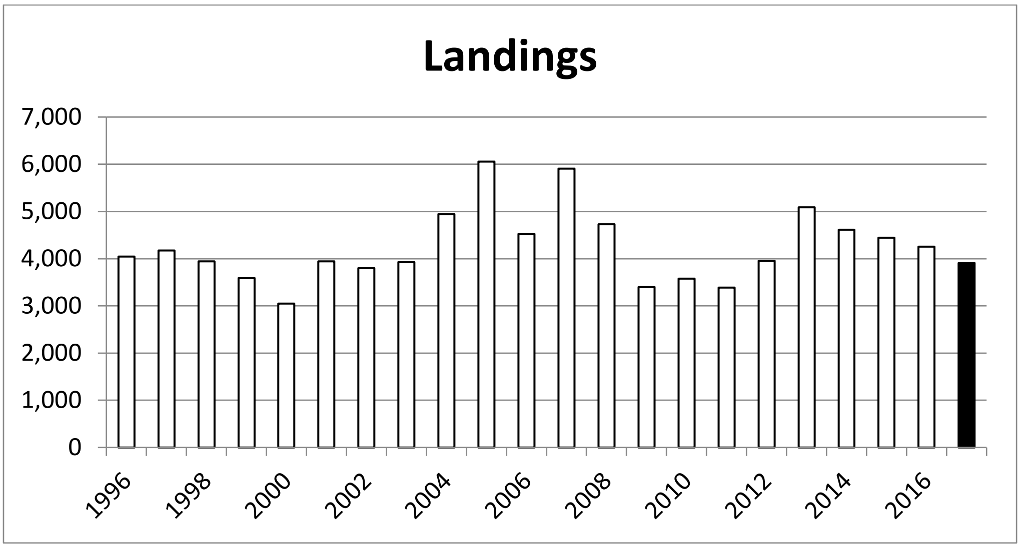


Figure 3.4.1. **Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). ICES landings of flounder in subdivisions 26 and 28.**

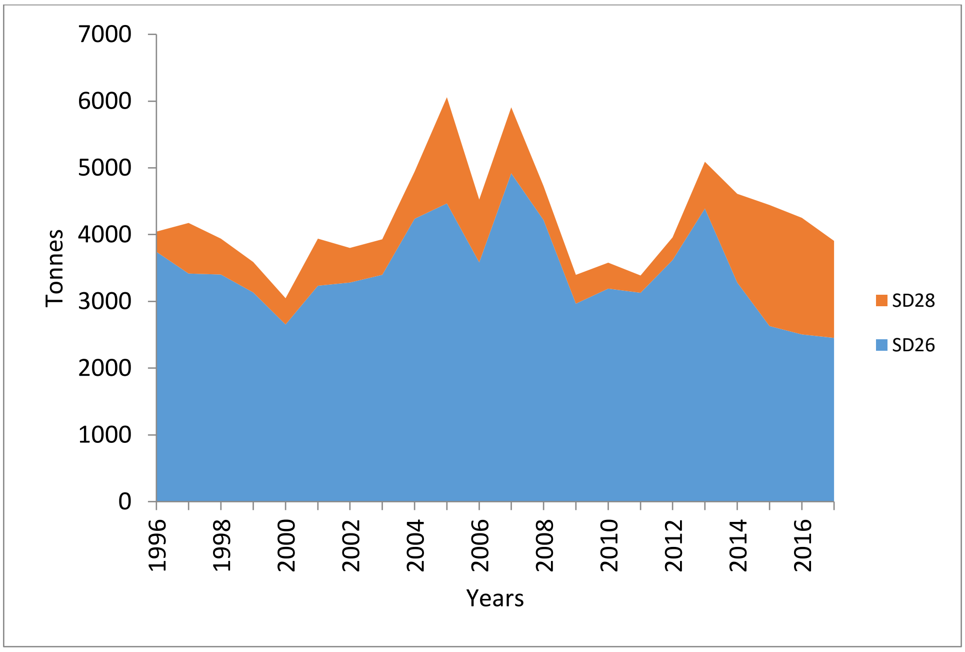


Figure 3.4.2. **Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). ICES landings of flounder by subdivisions.**

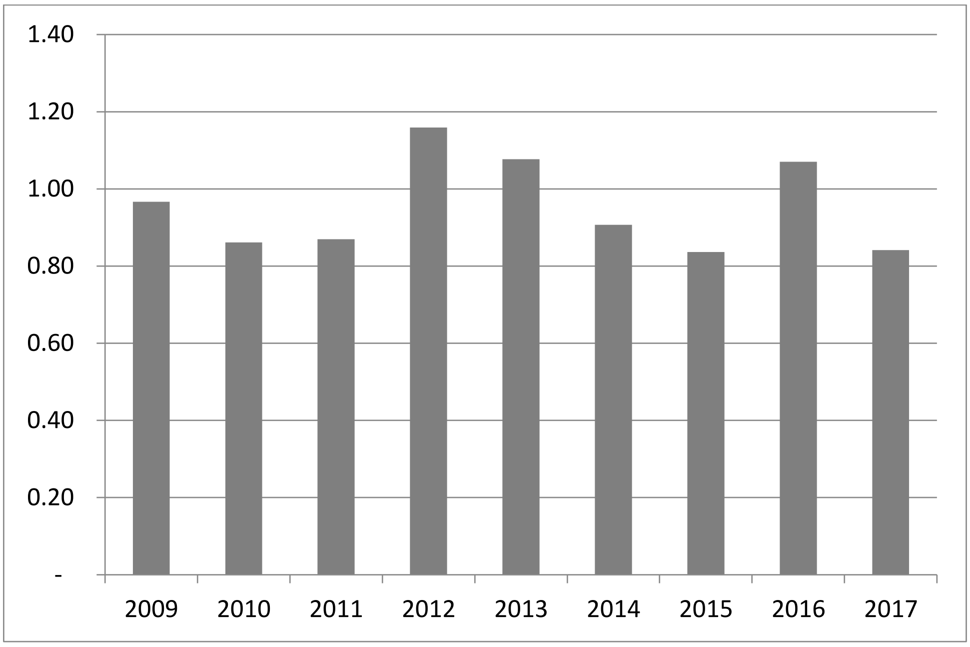


Figure 3.4.3. **Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Effort data (days-at-sea) of flounder in subdivisons 26 and 28 (days-at-sea).**

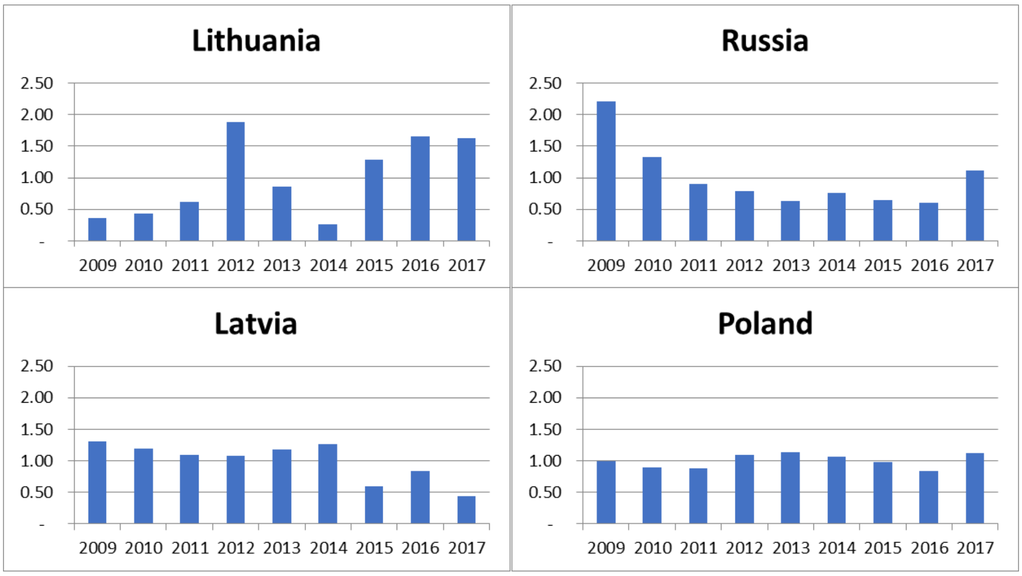


Figure 3.4.4. **Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Effort data of flounder in subdivisions 26 and 28 by main fishing countries (days-at-sea).**

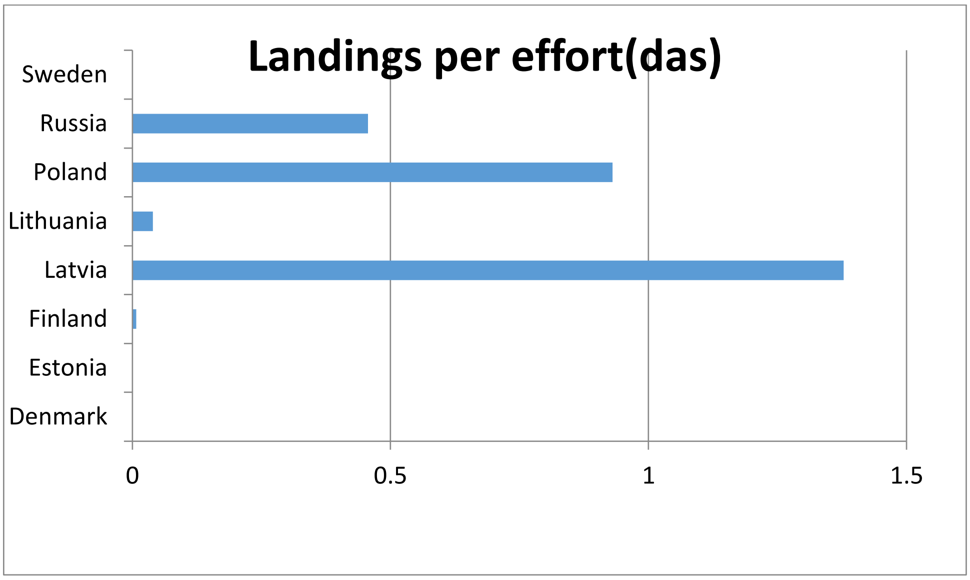


Figure 3.4.5. **Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Landings of flounder per days-at-sea by country in subdivisions 26 and 28.**

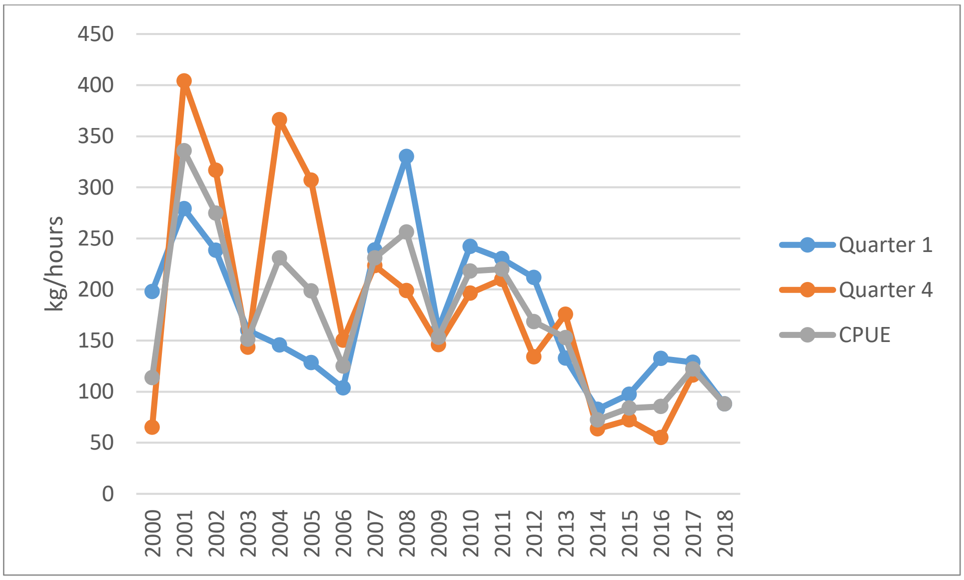


Figure 3.4.6. **Flounder in subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Catch per unit of effort (kg per hour) from BIT Survey in 1st and 4th Quarters, subdivisions 26 and 28.**

3.5 Flounder in Subdivision 27, 29-32 (Northern flounder)

Based on the decision by Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT; 26—28 Nov 2013; 27—31 Jan 2014) flounder with demersal eggs inhabiting mainly the Northern Baltic Proper (SD 27, 29—32) is treated as a separate flounder stock. In the rest of the Baltic Sea flounder with pelagic eggs dominate

Flounder with demersal eggs spawn in the shallow water down to salinities of 5—7 psu. This means that, flounder in the SDs 31 and 32 are at the border of its distribution area. Eggs are demersal, small (diameter < 1 mm) and relatively heavy. There are probably local spatially distinctive populations in the different coastal areas, and the migration between these areas is limited. Flounder with demersal eggs inhabit also the Central Baltic Sea; however, it is not possible to separate the landings of the two spawning types and in SD 28 presumably pelagic spawning type dominates. Therefore, SD 28 is not included in this stock.

3.5.1 Fishery

3.5.1.1 Landings

In subdivisions 27 and 29—32 flounder is caught mainly in the SDs 29 and 32. The majority (>85%) of the catches are taken with passive gears, mostly gillnets. Yearly total landings have been around 200 tonnes the last eight years but were above 1000 tonnes in the 1980s (Figure 3.5.1). Estonia is the major fishing nation, standing for more than 80% of the catches followed by Sweden with a share of 15% and the rest is taken by Finland and in some years also Poland (Table 3.5.1).

3.5.1.2 Discards

Discards probably take place, the extent depending on market price, but the amount is unknown. In the major fishing country, Estonia, discard is not allowed. Survival rate of flounder in discards is unknown for passive gears but can probably be high under certain conditions. In Sweden no discard sampling is made for this stock. Swedish discard rate is calculated using estimates from SD 25 and scaled up to total landings of demersal fish species in the fished strata (passive gear per quarter and SD). Swedish discard can be almost up to the same level as landings, in 2017 the total discard is estimated 24 tonnes. Estimated discard in Finland is low, scaling up to total landings of demersal fish species landings from the three sampled stratum gives a total amount of discard below 1 tonne for years 2016 and 2017.

3.5.1.3 Recreational fishery

In the northern Baltic Sea the importance of recreational fishery is substantial. Recreational catches are estimated by Estonia and Finland (Table 3.5.2). In Sweden flounder is not distinguished from the rest of flatfishes, which complicates the catch estimates for recreational fishery. Although the species composition is unknown the majority of this is ought to be flounder. Rough calculations have shown that recreational fishery catches for Sweden can be three times higher as commercial landings, same seems to be true for Finland. In Estonia the reported recreational catch is on average equivalent to 20–30% of the commercial landings. Using the estimates from WKBALFLAT (2014) total recreational catches in this area are up to 40% of the commercial landings, however the quality of the estimates is not well known and the data is therefore not included in the advice.

3.5.1.4 Effort

The exploitation status of the stock is unknown, since effort data from the most important fishery, passive gears, is lacking from the dominating fishing nation Estonia (Table 3.5.3). In addition, there is no data on effort for the recreational fishery which could be up to a magnitude of 50% of the commercial landings (calculation made using 2017-year data).

3.5.2 Biological information

Age data are considered to be applicable only when the ageing was conducted using new method (i.e. breaking and burning of otoliths technique) as recommended by ICES WKARFLO (2007; 2008) and ICES WKFLABA (2010).

3.5.2.1 Catch in numbers

Age information from commercial catches is very limited. Catch in numbers-at-age (CANUM) and mean weight-at-age are available from Estonian commercial trap nets between 2011–2016 in SD29 and 32. Age data was not sampled in commercial landings in Finland, for Sweden age data exists only for the years 2009–2010.

Estonia commercial landings length distribution is available only form trap nets and some extent from Danish seine landings. In addition, from 2017 gillnet catches from SD29 and 32 are sampled during main fishing months (quarter 2 and 3). Most of the fish (~80%) is caught with gillnets and the selectivity of these gears is quite different, gillnets having a narrower selectivity (Figure 3.5.2). In Sweden the minimum legal size for flounder is 21 cm and fisherman use mainly 60–70 mm mesh sizes. For Estonia the situation is more complicated, minimum legal size in SD29–32 is 18 cm and most of the gillnet landings are caught with mesh sizes ≥ 55 mm; however, depending on the year up to 15% of landings with gillnets are caught with nets with smaller mesh size then 55 mm. It was decided that data from Küdema survey (SD29) mesh sizes 50, 60 mm would be representative for the length composition of commercial fishery. To incorporate the effect of catching fish with gears such as trap nets, Danish seine and smaller mesh size gillnets (<55 mm), length data from 38 mm mesh size gillnets were added to the length distribution from mesh sizes 50, 60 mm, according to the rate of the landings that were caught with not gillnets. Corresponding results of catch in numbers by length class and year can be seen in Figure 3.5.3.

3.5.2.2 Mean weights-at-age

Mean weights-per-age were available only for Estonia commercial trap net landings. The mean weight per age strongly fluctuates. The high fluctuation of weights per age could be the product of small sample size, especially for older ages. Mean weights-per-age are also available for survey in SD29. The survey weight data seems to be more stable compared to commercial data (Figure 3.5.4).

3.5.3 Fishery independent data

Fishery independent data is gathered form four national gillnet surveys since the BITS survey was deemed inappropriate for this stock (not covering shallow areas, not covering Northern Baltic Sea). From Estonia two surveys were available, one in Muuga bay near Tallinn (mesh size 40—60 mm bar length) in SD 32 ongoing since since 1993, and one in Küdema bay in SD 29 since 2000 (mesh size 21.5, 30, 38, 50 and 60 mm bar length). In Muuga the survey is done weekly from May to October while in Küdema six fixed stations are fished during six nights in October/November in depths 14—20 m. Data was restricted to October for the Muuga survey index.

From Sweden two surveys were available using the same gear as in Küdema and the same time of year September/October in two areas in the southern and the northern part of SD

27, Kvädöfjärden (data from 1989) and Muskö (data from 1992) respectively. In Kvädöfjärden six fixed stations are fished during six nights at 15—20 m depth while in Muskö eight fixed stations are fished during six nights at 16—18 m depth.

CPUE in biomass (kg per fishing station and fishing day) was used as biomass index for all four surveys. The arithmetic mean of the two surveys in SD 27 was combined with the biomass indices in 29 and 32. The stock size indicator could be calculated from year 2000 and onwards. For this the indices from these SD-s were combined using the total commercial landings of flounder per SD as a weighting factor (Table 3.5.4).

3.5.4 Assessment

Assessment method of category 3 for stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES, 2012) was used. From 2017 ICES does not give any catch advice for stock without TAC (*total allowable catch*).

Stock trends are calculated based on national gillnet surveys: two surveys in SD 27, one survey in SD 29 and one survey in SD 32 (Figure 3.5.5). Extremely high CPUE value for Küdema bay in 2015 is probably not representative, although consistent increase in all survey biomasses (except Muuga bay) is evident for years before 2015. There will be no further attempt to correct the 2015 Küdema bay biomass index value. The stock size indicator value seems to show slight increasing trend from 2012 onwards.

3.5.5 MSY proxy reference points

Year 2017 MSY proxy reference points were calculated for this stock using two different methods, length-based indicators and length-based spawning potential ratio (LB-SPR; Hordyk *et al*., 2015). In the end it was decided that only length- based indicators are used for providing MSY proxy reference points. Based on MSY proxy reference points flounder stock in subdivision 27, 29–32 is not overfished. For detailed description of results look ICES (2017a).

Table 3.5.1. Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Total landings (tonnes) by Subdivision and country.

Year	Country	SD 27	SD 29	SD 30	SD 31	SD 32	Total
1980	Finland*		27	14	1	11	53
	Sweden	20	32				52
	USSR		334			1 080	1 414
	Total	20	393	14	1	1 091	1 519
1981	Finland*		67	4		7	78
	Sweden	21	34				55
	USSR		445			1 078	1 523
	Total	21	546	4	0	1 085	1 656
1982	Finland*		38	6		6	50
	Sweden	65	3				68
	USSR		615			1 121	1 736
	Total	65	656	6	0	1 127	1 854
1983	Finland*		28	7		3	38
	Sweden	212	9				221
	USSR		497			1 114	1 611
	Total	212	534	7	0	1 117	1 870
1984	Finland*		27	10		6	43
	Sweden	53	2				55
	USSR		286			1 226	1 512
	Total	53	315	10	0	1 232	1 610
1985	Finland*		21	9		7	37
	Sweden	47	2				49
	USSR		265			806	1 071
	Total	47	288	9	0	813	1 157
1986	Finland*		36	11		5	52
	Sweden	60	3				63
	USSR		281			556	837
	Total	60	320	11	0	561	952
1987	Denmark	1					1
	Finland*		37	18		3	58
	Sweden	51	2				53
	USSR		279			397	676
	Total	52	318	18	0	400	788
1988	Finland*		43	21		5	69
	Sweden	68	3				71
	USSR		257			331	588
	Total	68	303	21	0	336	728
1989	Finland*		39	24		6	69
	Sweden	66	3				69
	USSR		214			214	428
	Total	66	256	24	0	220	566
1990	Finland*		35	19		4	58
	USSR		144			141	285
	Total	0	179	19	0	145	343
1991	Finland*		53	17		5	75
	Sweden	88					88
	Estonia		135			51	186
	Total	88	188	17	0	56	349
1992	Finland*		48	10		5	63
	Sweden	86	3				89
	Estonia		47			46	93

Year	Country	SD 27	SD 29	SD 30	SD 31	SD 32	Total
	Total	86	98	10	0	51	245
1993	Finland*		52	26		5	83
	Sweden	83					83
	Estonia		86			55	141
	Total	83	138	26	0	60	307
1994	Denmark	9					9
	Finland*		47	24		8	79
	Sweden	33	10				43
	Estonia		3			4	7
	Total	42	60	24	0	12	138
1995	Denmark		1				1
	Finland*		54	29		6	89
	Sweden	81					81
	Estonia		52			35	87
	Total	81	107	29	0	41	258
1996	Finland*		47	36		9	92
	Sweden	114					114
	Estonia		99			145	244
	Total	114	146	36	0	154	450
1997	Finland*		35	32		13	80
	Sweden	105					105
	Estonia		96			125	221
	Total	105	131	32	0	138	406
1998	Finland*		36	21		14	71
	Sweden	70					70
	Estonia		79			87	166
	Total	70	115	21	0	101	307
1999	Denmark	0	1				1
	Finland*		43	22	2	9	76
	Sweden	15					15
	Estonia		150			164	314
	Total	15	194	22	2	173	406
2000	Denmark	1					1
	Finland*		34	13	0	9	56
	Sweden	73					73
	Estonia**		166			126	292
	Total	74	200	13	0	135	422
2001	Denmark	10					10
	Finland*		28	14	0	7	50
	Sweden	85			3		88
	Estonia**		135			220	355
	Total	100	164	14	3	227	503
2002	Finland*		16	8		11	35
	Sweden	90		5			95
	Estonia**		166			226	392
	Total	90	182	13	0	247	523
2003	Denmark	1					1
	Finland*	0	16	9	0	7	31
	Sweden	57					57
	Estonia****		156			128	284
	Total	57	172	9	0	135	374
2004	Finland*		13	18	0	4	34
	Sweden	45					45
	Estonia**		127			167	294

Year	Country	SD 27	SD 29	SD 30	SD 31	SD 32	Total
	Total	45	140	18	0	171	373
2005	Finland*		11	10	0	3	23
	Sweden	47	2	0			49
	Estonia		144			114	258
	Total	47	157	10	0	117	330
2006	Finland*		11	4.166	0	2	17
	Sweden	33					33
	Estonia		165			129	294
	Total	33	176	4	0	131	344
2007	Finland*		6	1	0	2	9
	Sweden	39	0	0	0		39
	Estonia**		110			104	214
	Total	39	116	1	0	107	263
2008	Finland		5	1	0	5	11
	Sweden	49	0	0			49
	Estonia**		103			86	189
	Total	49	108	1	0	89	249
2009	Finland		6	1	0	3	10
	Sweden	41	0	0			41
		Estonia**	109			102	210
	Total	41	115	1	0	105	262
2010	Finland	0	6	1	0	3	10
	Sweden	36	0	0			36
	Estonia**		85			96	180
	Total	36	91	1	0	99	227
2011	Finland	0	5	1	0	2	9
	Sweden	34	0	0	1		35
	Estonia**	0	94	0	0	83	177
	Total	34	99	1	1	85	221
2012****	Finland		3	0	0	1	5
	Poland***		3				3
	Sweden	36	0		0		36
	Estonia**		79			67	147
	Total	36	85	0	0	69	190
2013	Finland		3	1	0	1	5
	Poland		3				3
	Sweden	31	0				31
	Estonia		123			75	198
	Total	31	129	1	0	77	237
2014	Finland		2	0	0	1	4
	Poland		0				
	Sweden	29	0				29
	Estonia		85			65	150
	Total	29	87	0	0	67	183
2015	Finland		3	0	0	1	4
	Poland		0				0
	Sweden	26	0	0			27
	Estonia		81			64	145
	Total	26	85	0	0	64	176
2016	Finland		2	0	0	1	3
	Poland						0
	Sweden	22	0				22
	Estonia		96			52	148
	Total	22	98	0	0	53	173

Year	Country	SD 27	SD 29	SD 30	SD 31	SD 32	Total
2017	Finland		3	0	0	1	4
	Poland						0
	Sweden	18	0				18
	Estonia		95			33	128
	Total	18	98	0	0	34	150

* Finland 1980–2007: Catches of SDs 27–28 are included in SD 29 and catches of SD 31 are included in SD 30
** Data Corrected for Estonia 2000–2004, 2007–2012 with figures from Estonian Ministry of Environment, older data includes recreational fishery
*** Poland 2012 corrected

Zero values equal to landings under 0.5 tonnes

Table 3.5.2. Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Recreational fishery catch estimate for Estonia and Finland.

	Estonia		Finland			
	SD32	SD29	SD32	SD29	SD30	SD31
2000			156	187	30	1
2001						
2002			14	78	63	0
2003						
2004			12	64	3	0
2005						
2006			25	48	2	0
2007						
2008			6	27	7	0
2009						
2010			1	9	0	1
2011						
2012	16.6	15.0	13	24	1	0
2013	19.6	16.9				
2014	16.6	15.0	1	9	1	0
2015	28.0	15.7	1	9	1	0
2016	20.0	15.0	6	5	0	0
2017	13.1	12.9	6	5	0	0

Table 3.5.3. Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Fishing effort (days-at-sea) per country and gear type (passive/active).

	SWE Active	SWE Passive	EE Active	FI Passive
2009	4	3029	46	9030.8
2010	11	2265	22	10067.6
2011	6	2250	3	8290.0
2012	4	2119	14	6120.0
2013	8	2037	77	5510.4
2014	3	2004	56	4466.7
2015	16	2177	50	2814.0
2016	19	1985	72	3028.0
2017	6	1394	59	2826.0

Table 3.5.4. Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Biomass index for the surveys (kg per number of gillnet stations times number of fishing days) Muuga Bay (SD 32), Küdema Bay (SD 29), Muskö (SD 27), and Kvädöfjärden (SD 27) and combined index.

SD	**32**	**29**	**27**			
Survey	Muuga-Q4	Kudema-Q4	Kvädöfjärden-Q4[1)]	Muskö-Q4[1)]	Combined for SD27[2)]	**Combined[3)]**
	(kg gear-night-1)	(kg gear-night-1)	(kg gear-night-1)	(kg gear-night-1)	(kg gear-night-1)	kg gear-night-1)
1989			1.21			
1990			1.79			
1991			0.57			
1992			1.97	5.20	3.58	
1993	0.49		1.99	4.84	3.42	
1994	0.20		1.29	1.26	1.28	
1995	0.43		1.18	0.97	1.07	
1996	0.40		0.60	0.18	0.39	
1997	0.47		0.74	0.64	0.69	
1998	0.73		1.24	0.71	0.97	
1999	0.28		0.90	0.20	0.55	
2000	0.25	3.45	1.51	1.12	1.32	2.01
2001	0.65	2.32	1.42	1.17	1.29	1.34
2002	0.17	1.01	1.46	0.60	1.03	0.63
2003	0.30	2.89	0.54	1.14	0.84	1.60
2004	0.47	1.37	0.51	0.89	0.70	0.86
2005	0.39	1.70	0.20	0.55	0.37	1.03
2006	0.42	1.57	0.32	1.09	0.70	1.04
2007	0.10	2.24	0.60	2.61	1.60	1.27
2008	0.11	2.68	1.33	4.67	3.00	1.80
2009	0.36	0.86	0.20	2.19	1.19	0.71
2010	0.14	0.79	0.45	1.04	0.75	0.50
2011	0.24	0.97	0.16	0.50	0.33	0.59
2012	0.13	1.03	0.14	0.48	0.31	0.56
2013	0.13	2.03	0.32	0.95	0.63	1.22
2014	0.09	2.35	0.43	0.98	0.70	1.26
2015	0.07	8.70	0.53	1.32	0.92	4.36
2016	0.11	1.90	0.43	0.76	0.60	1.18
2017	0.16	2.72	0.58	0.50	0.54	1.88

1) Biomass prior to 2009 is estimated from numbers and length distribution

2) Arithmetic mean

3) Weighted mean with the respective SDs landings.

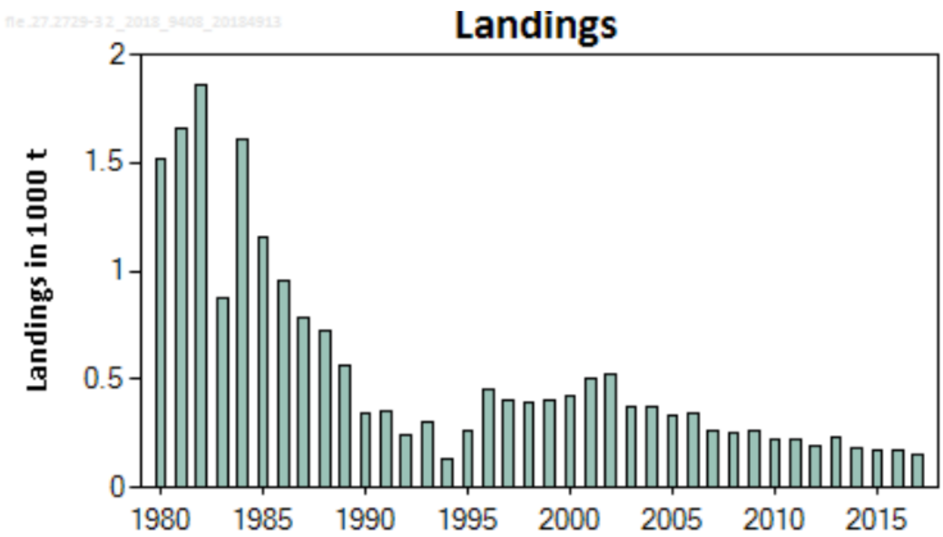


Figure 3.5.1. **Flounder landings in subdivisions (SDs) 27 and 29–32.**

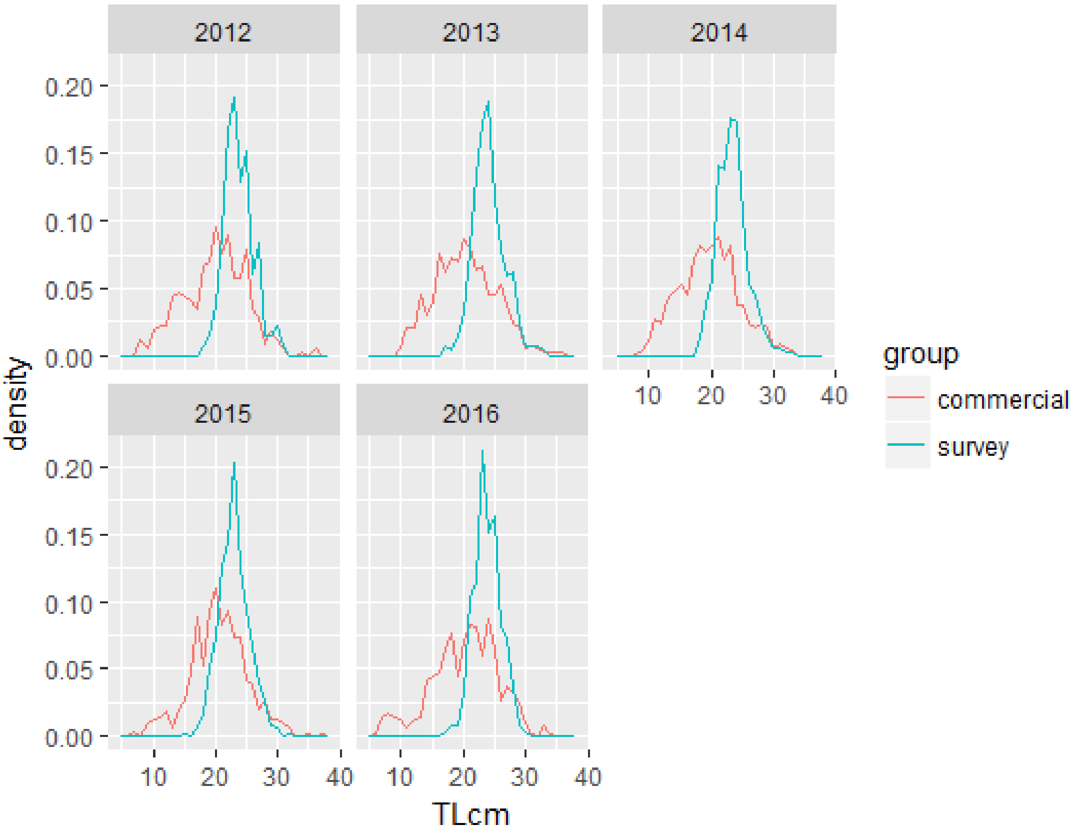


Figure 3.5.2. **Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Comparison of commercial trap net length distribution with SD29 survey length distribution (mesh sizes 50 – 60 mm).**

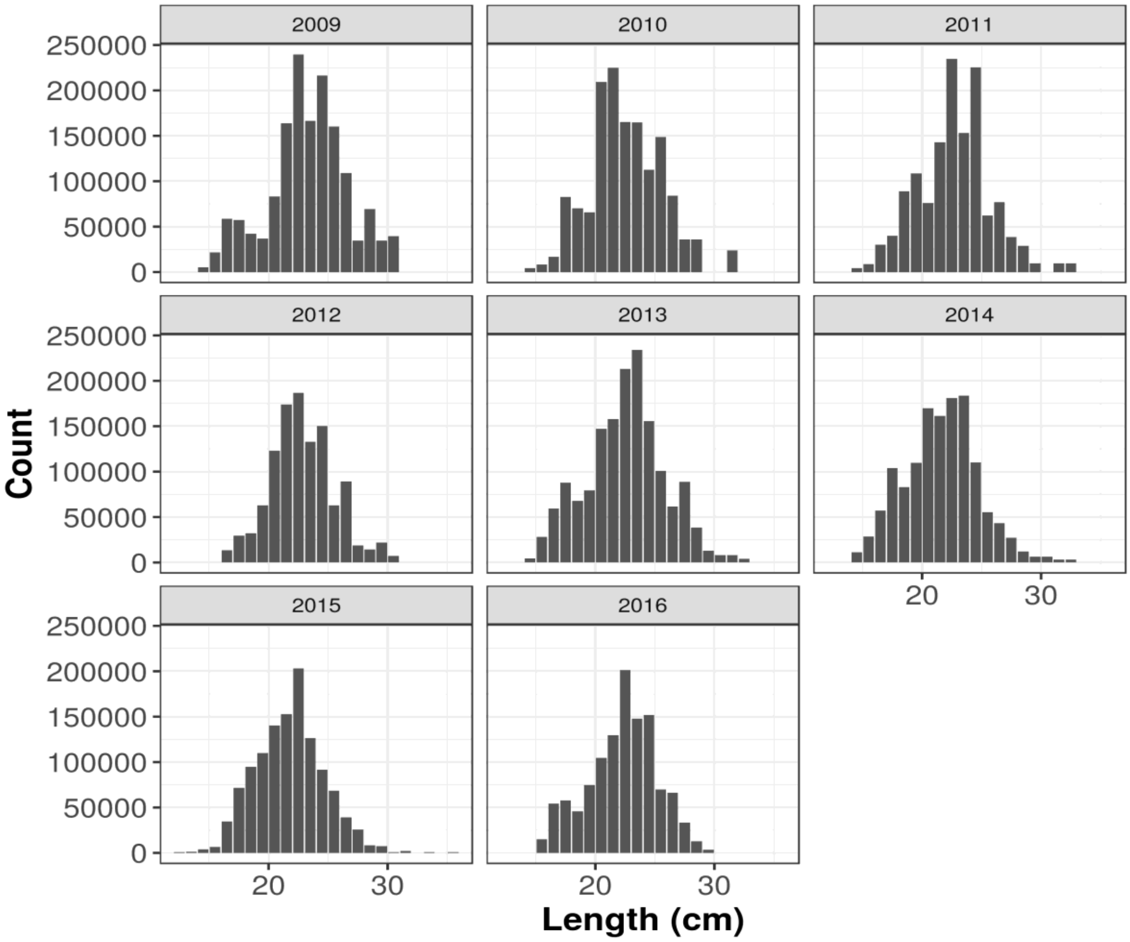


Figure 3.5.3. **Flounder in subdivisions 27 and 29–32 (Norther Baltic Sea). Representative catch in numbers by length class for flounder commercial landings in subdivisions 27 and 29–32.**

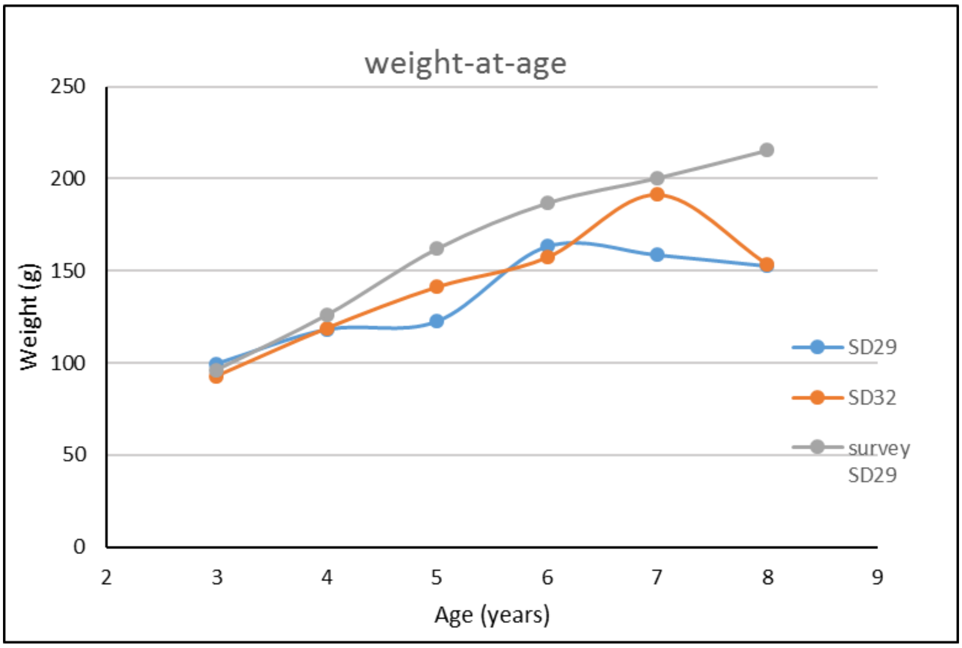


Figure 3.5.4. **Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Mean weights per age for Estonian commercial trap net landings per Subdivision (Q3+4) and for survey in SD29 (Küdema bay).**

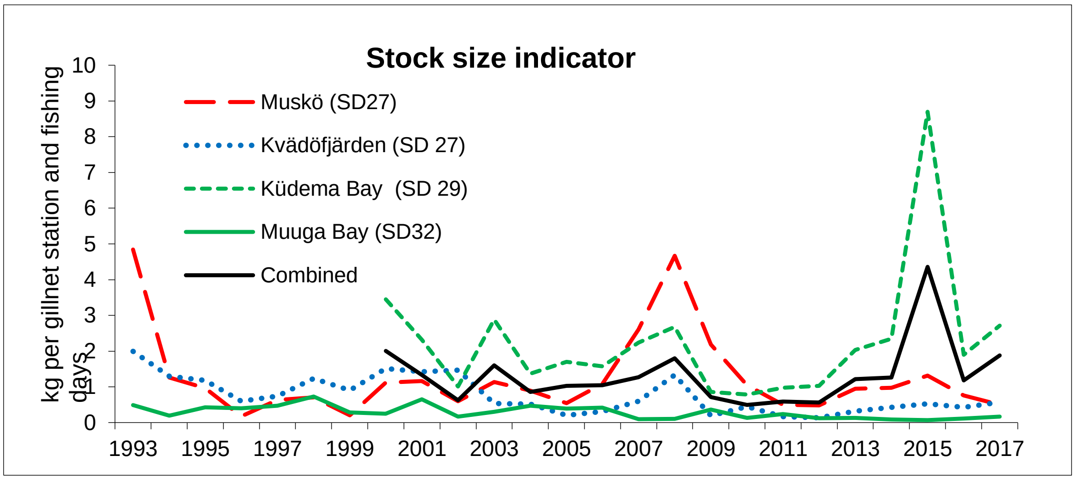


Figure 3.5.5. **Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea). Biomass indices of Muuga Bay (SD 32) (solid green line), Küdema Bay (SD 29) (dashed green line), Muskö (SD 27) (red dash line), Kvädöfjärden (SD 27) (dotted blue line) surveys and combined index (kg per gillnet station and fishing days).**

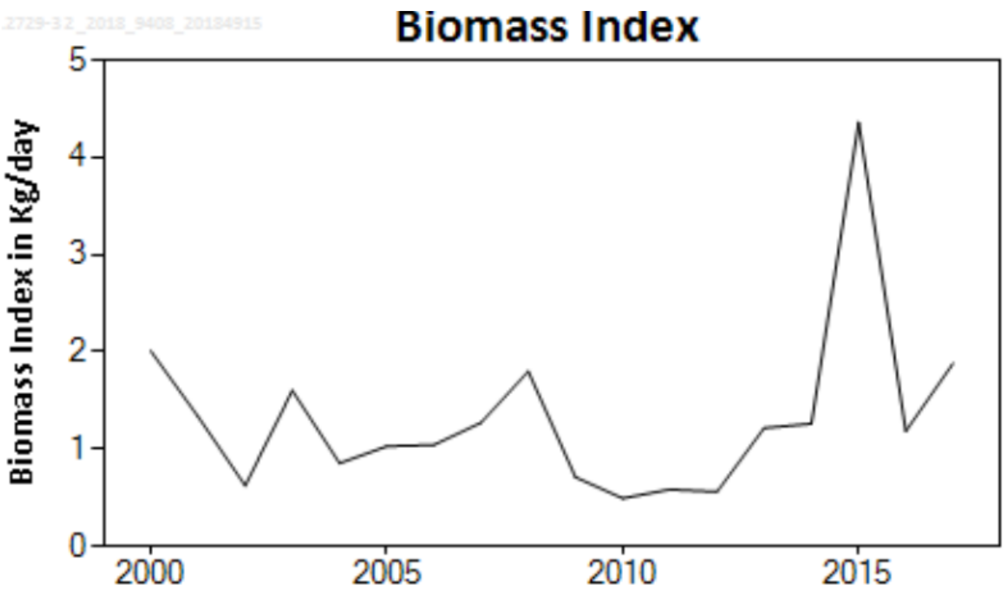


Figure 3.5.6. **Flounder in subdivisions 27 and 29–32 (Northern Baltic Sea) Combined biomass index of four surveys (Muuga Bay (SD 32), Küdema Bay (SD 29), Muskö (SD 27), and Kvädöfjärden (SD 27)) (kg × gillnet fishing station−1).**

4 Herring in the Baltic Sea

4.1 Introduction

4.1.1 Pelagic Stocks in the Baltic: Herring and Sprat

Descriptions of the fisheries for pelagic species and other species are found in Section 1.4 Fisheries Overview.

The distribution by subdivision of reported landings of herring and sprat in 2017 is given in Table 4.1.1.

In Table 4.1.2 the proportion of herring in landings is given by country, subdivision and quarter for 2017 together with the proportion of herring in the acoustic survey in the fourth quarter. It is tacitly assumed that the acoustic survey would yield a reasonably good picture of the spatial distribution of the pelagic stocks. Consequently some resemblance with the distribution of landings of the two species could be expected.

Table 4.1.3 shows the total reported landings of herring by quarter for 2017, along with the number of samples, the number of fish measured and the number of fish aged.

4.1.1.1 Mixed pelagic fishery and its impact on herring

Pelagic stocks in the Baltic Proper (subdivisions 25–29, 32) are mainly taken in pelagic trawl fisheries, of which the majority take herring and sprat simultaneously. According to the national data submitters the mixing of pelagic species in the landings are variably taken care of before submitting input data. It is recommended that this issue is explored further.

4.1.2 Fisheries Management

4.1.2.1 Management units

Sprat is managed in the Baltic Sea by two quotas: one EC and one Russian quota.

Herring has in former time been managed by three TAC's:

- SD 22–29S and 32 (excl. Gulf of Riga),
- Gulf of Riga (SD 28.1),
- SD 29N, 30, 31.

The units were changed in 2005 to be:

- SD 22–24,
- SD 25–27, 28.2, 29 and 32 (EC and Russian quotas),
- Gulf of Riga (SD 28.1),
- SD 30, 31.

The historical development of agreed TACs and reported landings for these management units are illustrated in Figure 4.1.1.

Management 2017 and 2018 herring – sprat

The stock status, recommendations from ICES and the TAC decided are presented for the pelagic stocks. The stock status is expressed in relation to the MSY and precautionary reference levels.

Stock	Stock status ACOM 2017 in relation to SSB	Stock status ACOM 2017 in relation to F	ICES Advice for 2018 (Basis) (t)	TAC 2018 (t)
SPRAT				
SD 22-32	Above trigger & Full reproductivity	Above target & Harvested sustainably	219 152 – 301 722 (MAP applied)	*304 910
HERRING				
SD 25–29&32 (excl. GOR)	Above trigger & Full reproductivity	Above target & Harvested sustainably	200 236 – 331 510 (MAP applied)	*258 855
SD 28.1 (Gulf of Riga)	Above trigger & Full reproductivity	At target & Harvested sustainably	19 396 – 29 195 (MAP applied)	28 999
SD 30–31 (Bothnian Sea)	Above trigger & Full reproductivity	Above target & Increased risk	95 566 (MSY approach)	84 599

***EC + Russian quotas**

4.1.3 Catch options by management unit for herring

The herring assessed in SD 25–29 and 32 is also caught in the Gulf of Riga; likewise the Gulf herring assessed in the Gulf of Riga is caught in SD 28 outside the Gulf. These allocations may be based on proportions of landed amounts in the areas.

Proportion of the Western Baltic Spring Spawning Herring (WBSSH) stock (her.27.20-24) caught in SD 22–24.

Year	WBSSH** caught in SD 22–24 (1000 tonnes)*	Total catches of the WBSSH stock (1000 tonnes)*	% of WBSSH caught in SD 22–24
2000	53.9	109.9	49.0%
2001	63.7	105.8	60.2%
2002	52.7	106.2	49.6%
2003	40.3	78.3	51.5%
2004	41.7	76.8	54.3%
2005	43.7	88.4	49.4%
2006	41.9	90.5	46.3%
2007	40.5	69.0	58.7%
2008	43.1	68.5	62.9%
2009	31.0	67.3	46.1%
2010	17.9	42.2	42.4%
2011	15.8	27.8	57.0%
2012	21.1	38.7	54.5%
2013	25.5	43.8	58.2%
2014	18.3	37.4	48.9%
2015	22.1	37.5	58.9%
2016	25.1	51.3	48.9%
2017	26.5	46.3	57.2%
Mean	34.7	65.9	53.0%

***Finnish data not included.**

**** In SD 22–26 the herring stocks are known to be mixed, but the degree of this mixing is not yet quantified.**

Proportion of Central Baltic herring (CBH) stock (her.27.25-2932) caught in the Gulf of Riga (SD 28.1).

Year	CBH caught in Gulf of Riga (SD 28.1) (1000 tonnes)	Total catches of the CBH stock (SD 25–27, 28.2,29 &32) (1000 tonnes)	% of CBH caught in Gulfof Riga (SD 28.1)
2000	4.6	175.6	2.6%
2001	2.9	148.4	2.0%
2002	3.5	129.2	2.7%
2003	4.3	113.6	3.8%
2004	3.3	93.0	3.5%
2005	2.3	91.6	2.5%
2006	3.2	110.4	2.9%
2007	1.5	116.0	1.3%
2008	6.1	126.2	4.8%
2009	4.9	134.1	3.7%
2010	5.2	136.7	3.8%
2011	5.5	116.8	4.7%
2012	3.8	101.0	3.8%
2013	4.1	101.0	4.1%
2014	4.5	132.7	3.4%
2015	5.0	174.4	2.8%
2016	4.3	192.1	2.2%
2017	3.9	202.5	1.9%
Mean	4.1	133.1	3.1%

Proportion of the Gulf of Riga herring (GORH) stock (her.27.28) caught outside the Gulf of Riga in SD 28.2 (only Latvian catches).

Year	GORH caught outside Gulf of Riga in SD 28.2 (1000 tonnes)	Total stock GORH catches (1000 tonnes)	% GORH caught outside Gulf of Riga in SD 28.2
2000	1.9	34.7	5.5%
2001	1.2	38.8	3.1%
2002	0.4	39.7	1.0%
2003	0.4	40.8	1.0%
2004	0.2	39.1	0.5%
2005	0.5	32.2	1.6%
2006	0.4	31.2	1.3%
2007	0.1	33.7	0.3%
2008	0.1	31.1	0.3%
2009	0.1	32.6	0.3%
2010	0.4	30.2	1.3%
2011	0.1	29.7	0.3%
2012	0.2	28.1	0.7%
2013	0.3	26.5	1.0%
2014	0.2	26.3	0.8%
2015	0.3	32.9	1.0%
2016	0.3	30.9	0.9%
2017	0.2	28.1	0.8%
Mean	0.4	32.5	1.2%

The two tables above are used for the calculation of the fishing quotas in SD 25–27, 28.2, 29 and 32 and in the Gulf of Riga (SD 28.1).

4.1.4 Assessment units for herring stocks

The herring in the Central Baltic Sea is assessed as two units:

- Herring in SD 25–27, 28.2, 29 and 32
- Gulf of Riga herring (SD 28.1)

The herring in the Gulf of Bothnia are assessed as one stock. It includes two subdivisions:

- Herring in SD 30
- Herring in SD 31

The herring in SW Baltic (SD 22–24) is assessed together with the spring spawners in Kattegat and Skagerrak (Division 3.a) within ICES Herring Assessment Working Group for the Area South of 62° N (HAWG).

Table 4.1.1. Pelagic landings ('000 t) and species composition (%) in 2017 by subdivision and quarter.

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
SD 25	Landings ('000 t)	34.50	20.10	12.13	12.17	**78.90**
	Herring (%)	26.59	29.65	88.06	79.24	**44.94**
	Sprat (%)	73.41	70.35	11.94	20.76	**55.06**
SD 26	Landings ('000 t)	83.29	36.13	9.22	19.31	**147.96**
	Herring (%)	23.00	19.31	73.96	42.72	**27.85**
	Sprat (%)	77.00	80.69	26.04	57.28	**72.15**
SD 27	Landings ('000 t)	23.09	5.13	0.36	6.17	**34.75**
	Herring (%)	44.76	44.66	82.49	70.39	**49.69**
	Sprat (%)	55.24	55.34	17.51	29.61	**50.31**
SD 28*	Landings ('000 t)	52.89	24.98	13.21	38.16	**129.25**
	Herring (%)	45.52	70.21	52.96	51.11	**52.70**
	Sprat (%)	54.48	29.79	47.04	48.89	**47.30**
SD 29	Landings ('000 t)	36.16	7.19	2.66	28.29	**74.30**
	Herring (%)	59.77	86.43	53.62	53.47	**59.73**
	Sprat (%)	40.23	13.57	46.38	46.53	**40.27**
SD 30	Landings ('000 t)	37.92	38.79	10.44	16.37	**103.52**
	Herring (%)	95.34	99.14	99.70	98.61	**97.72**
	Sprat (%)	4.66	0.86	0.30	1.39	**2.28**
SD 31	Landings ('000 t)	0.00	2.49	0.59	0.11	**3.20**
	Herring (%)	100.00	100.00	100.00	99.25	**99.97**
	Sprat (%)	0.00	0.00	0.00	0.75	**0.03**
SD 32	Landings ('000 t)	12.07	7.10	5.26	20.61	**45.03**
	Herring (%)	61.31	80.10	45.28	59.93	**61.77**
	Sprat (%)	38.69	19.90	54.72	40.07	**38.23**
Total	Landings ('000 t)	**279.93**	**141.91**	**53.88**	**141.20**	**616.91**
	Herring (%)	**45.69**	**60.33**	**73.51**	**60.54**	**54.89**
	Sprat (%)	**54.31**	**39.67**	**26.49**	**39.46**	**45.11**

* Gulf of Riga included

Table 4.1.2. Proportion of herring in landings 2017.

COUNTRY	QUARTER	SUBDIVISION 25	26	27	28*	29	30	31	32
DEN	1	0.11	0.26	0.28	0.26	0.26			
	2	0.03							
	3			0.50					
	4	0.26	0.10		0.49	0.53			
EST*	1				0.82	0.44			0.50
	2				0.97	0.52			0.31
	3				0.38	0.41			0.60
	4				1.00	0.35			0.61
FIN	1	0.88	0.88	0.48	0.77	0.83	0.95	1.00	0.32
	2		0.29	0.63	0.20	0.95	0.99	1.00	0.39
	3				0.88	0.61	1.00	1.00	0.44
	4	0.89	0.89	0.58	0.68	0.69	0.98	0.98	0.33
GER	1	0.29	0.21		0.25	0.32			
	2	0.20	0.19						
	3								
	4					0.25			
LAT*	1	0.09	0.15		0.43	1.00			
	2	0.28	0.15		0.48				
	3	0.80	0.73		0.39				
	4		0.24		0.41	1.00			
LIT	1	0.17	0.21	0.33	0.25	0.00			
	2	0.17	0.16	0.39	0.20				
	3		1.00		0.45				
	4	0.45	1.00		0.33	0.00			
POL	1	0.21	0.16	0.11	0.11	0.11			
	2	0.31	0.21	0.04	0.04				
	3	0.87	0.85		0.11				
	4	0.85	0.66	0.00	0.42	0.27			
RUS	1		0.24						0.00
	2		0.21						0.00
	3		0.64						
	4		0.22						0.00
SWE	1	0.35	0.34	0.50	0.43	0.53	0.99		
	2	0.52	0.10	0.45	0.64	1.00	1.00	1.00	
	3	0.91	0.09	0.82	0.86	1.00	1.00	1.00	
	4	0.63	0.68	0.74	0.71	0.31	1.00	1.00	
Total	1	0.27	0.23	0.45	0.45	0.60	0.95	1.00	0.45
	2	0.30	0.19	0.45	0.66	0.86	0.99	1.00	0.31
	3	0.88	0.74	0.82	0.53	0.54	1.00	1.00	0.55
	4	0.79	0.42	0.70	0.51	0.53	0.99	1.00	0.52
Acoust. Stock*	4	0.58	0.37	0.67	0.32	0.34	0.98		0.44

* Gulf of Riga included

** SD 32 was covered by the acoustic survey only very partially (only the westermost part)

Table 4.1.3. Herring in subdivisions 25–32. Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.

Subdivision	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Subdivision 25	1	9.174	17	1.343	898
	2	5.959	16	2.159	908
	3	10.678	16	1.582	751
	4	9.645	17	3.119	975
	Total	35.456	66	8.203	3.532
Subdivision 26	1	19.155	30	4.156	1.470
	2	6.976	34	8.360	2.054
	3	6.821	14	4.872	805
	4	8.248	16	4.098	603
	Total	41.200	94	21.486	4.932
Subdivision 27	1	10.338	9	567	566
	2	2.290	1	25	25
	3	298	1	112	112
	4	4.343	1	37	37
	Total	17.269	12	741	740
Subdivision 28*	1	23.603	38	4.431	3.020
	2	14.664	62	7.064	5.151
	3	6.975	14	2.245	940
	4	19.213	19	2.871	1.193
	Total	64.457	133	16.611	10.304
Subdivision 29	1	21.612	18	2.499	1.132
	2	6.211	15	2.699	906
	3	1.428	3	614	122
	4	15.127	11	1.632	795
	Total	44.378	47	7.444	2.955
Subdivision 30	1	36.151	15	5.782	288
	2	38.460	22	6.990	550
	3	10.406	21	5.924	400
	4	16.145	19	6.544	2.771
	Total	101.162	77	25.240	4.009
Subdivision 31	1	0	0	0	0
	2	2.488	12	3918	500
	3	594	9	2815	457
	4	114	2	604	148
	Total	3.195	23	7.337	1.105
Subdivision 32	1	7.400	25	2.590	1.054
	2	5.685	59	6.536	2.145
	3	2.381	11	2.156	724
	4	12.350	61	4.586	1.429
	Total	27.816	156	15.868	5.352
Subdivisions 25-32	**1**	**127.434**	**152**	**21.368**	**8.428**
	2	**82.734**	**221**	**37.751**	**12.239**
	3	**39.582**	**89**	**20.320**	**4.311**
	4	**85.184**	**146**	**23.491**	**7.951**
	Total	**334.933**	**608**	**102.930**	**32.929**

* Gulf of Riga included

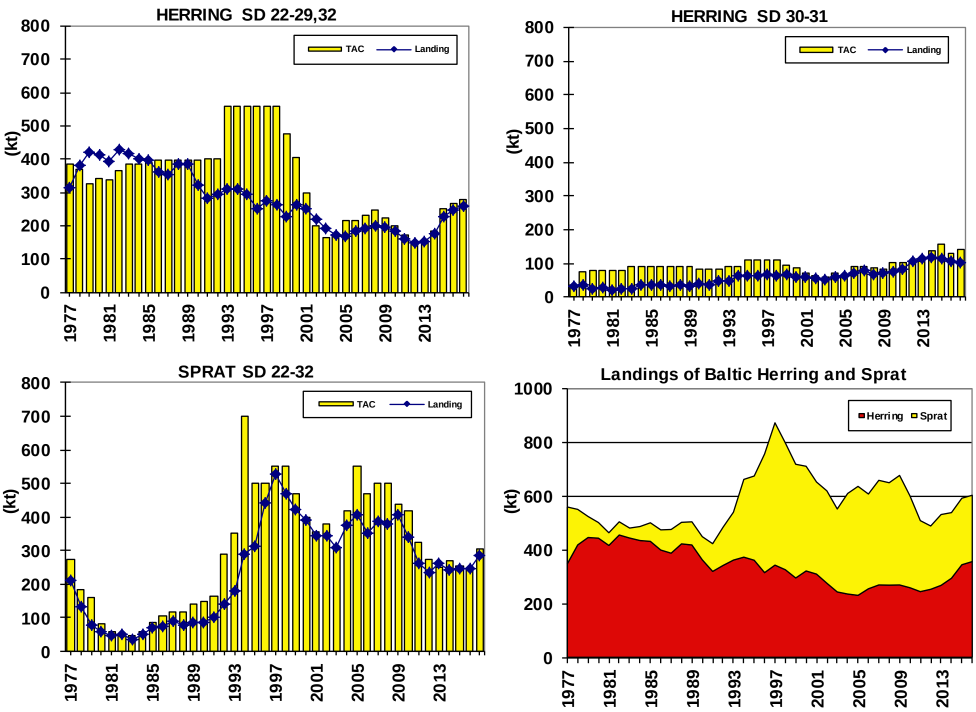


Figure 4.1.1. Reported landings of herring and sprat and agreed TACs in the Baltic Sea. (since 2007 TACs for herring and sprat: EC quota + Russian TAC).

4.2 Herring in subdivisions 25–27, 28.2, 29 and 32

4.2.1 The Fishery

4.2.1.1 Landings

The total reported catches by country, which also include the fraction of the Central Baltic Herring that is caught in the Gulf of Riga (SD 28.1, see Section 4.1.3), are given in Table 4.2.1. Catches in 2017 amounted to 202 517 t, which is 10% higher than last year. Catches increased for Denmark (131%), Estonia (16%), and Finland (41%), but decreased for Germany (-17%), Latvia (-5%), Lithuania (-22%), Poland (-2%), Russia (-8%), and Sweden (-9%). The largest part of the catches in 2017 was taken by Sweden (25%), followed by Finland (20%) and Poland (20%).

Catches by country and subdivision are presented in tables 4.2.2–4.2.3 (incl. Central Baltic Herring caught in SD 28.1, see Section 4.1.3). The spatial distribution of catches shows that in the last few years most catches were taken in 26, 28.2 and 29. In 2017 the distribution of catches was as follows: 22% in SD 29, 20% in SD 26 and 18% in SD 28.2.

4.2.1.2 Discards

There were only two countries, Sweden and Finland, reporting logbook registered discard of 23 t (0.01% of total catch) in 2017. No discards have been reported before 2016. Discarding at sea is regarded to be negligible.

4.2.1.3 Unallocated removals

A working document was presented in 2013 with a compilation on species measurement error for mixed pelagic species (ICES CM 2012/ACOM:10: WD 5 Walther *et al.*). The conclusion was that it is hard to make an accurate estimate on the proportion of herring and sprat in the catches from industrial trawl fisheries with small meshed trawls. In area 24–26 misreporting of herring exists and is accounted for by Denmark and Poland. Some catches are hard to sample because they are landed in foreign ports.

This was followed up by a questionnaire sent out before the benchmarking WKBALT in 2013 (ICES CM 2013/ACOM:43: WD 5 Krumme, Gröhsler). The result of this questionnaire was that, at the time of the questionnaire, countries that seemingly have problems estimating the proportion of herrings in the catches are dealing with this on a national level with additional sampling and correct the input figures for assessment to assure as high accuracy as possible. The correction by country for this misreporting is however variable from year to year and thus misreporting can in recent years (in the years after the benchmark) be a potential problem and should be investigated further.

4.2.1.4 Effort and CPUE data

Data on commercial effort and CPUE were not used in the assessment.

4.2.2 Biological information

4.2.2.1 Catch in numbers

Most countries provided age composition of their major catches (caught in their waters by quarter and subdivision). The catches for which age composition was missing represented about 10% of the total catches in 2017. All German catches, which only represent a minor part (2%) of the total catches, were landed in foreign ports and therefore no age composition of catches could be provided from Germany.

The compilation of 2017 national data was done by subdivision and quarter, but not by fishery (Table 4.2.4). The non-sampled catches were assumed to have the same age composition as those sampled in the same subdivision and quarter.

Herring of age groups 1–4 constitute in 2017 over 68% of the catches in numbers (Figure 4.2.1) which is the same proportions as in 2016. The strong year class of 2014 is now 3 years old and contributes to the fishery with 36% of the catches in numbers. The internal consistency of the catch-at-age in numbers was checked by plotting catch-at-age against the catch of the same cohort at age 1 year younger (Figure 4.2.2). Table 4.2.3 gives catches, catch numbers-at-age and mean weight-at-age by subdivision, whereas Table 4.2.4 shows catches by subdivision and by quarter.

4.2.2.2 Mean weights-at-age

The mean weights-at-age were compiled by subdivision and quarter for 2017 (Table 4.2.4) and then combined to give the mean weight-at-age for the whole catch. The marked decrease in mean weights at age that started in the early 1980s ceased around the mid-1990s and remains at this low level. When a particular strong year class occurs, like the 2002, 2007 and 2014, there may be density dependent effects (Figure 4.2.3). The increased sprat stock size has most likely also contributed to the low herring weight-at-age during the past 25 years. The marked geographical differences in growth patterns are shown in Table 4.2.4. The mean weight is higher in subdivisions 25 and 26 than in the more northern subdivisions. As consequence, the observed variation in average weight (total catches in tonnes/total numbers) could be due not only to a real decrease in growth, but also on where the larger proportion of herring are caught (Figure 4.2.4). In 2009–2012 there has been a small but steady increase of catches in 25 and 26. This increase stopped in 2013 and catches were decreasing in these SDs. From 2014 the catches in 25 and 26 have increased and decreased every other year with a small decrease in 2017. Since 2013 catches in 25 have decreased until it stopped in 2016. In SD 26 the catches followed the variations of 25 and 26 combined, since 2011. In SD 29 catches increased between 2011 and 2013, but since 2014 catches have been decreasing, until 2017 when it increased again. In SD 28 catches have increased since 2014 until 2016, but in 2017 they decreased. The notable decrease in mean weight-at-age since 2012 is therefore likely explained by the decreased catches in the south and increased catches in the north (with the exception of SD 29) where the herrings are smaller at age. As in the years before, the mean weight in the catch was also used as the mean weight in the stock. There is no survey information in the first quarter available, which could be used to calculate the mean weight in the stock (ICES CM 2013/ACOM:43). The mean weights in the catch from the first quarter could also be a candidate to be taken as mean weight in the stock. However, no corresponding data were available when conducting the benchmark in 2013 (ICES CM 2013/ACOM:43).

4.2.2.3 Maturity at age

The constant maturity ogive used by the WG is based on data between 1974–2011, based on the work of the Study Group on Baltic Herring and Sprat Maturity (ICES, 2002).

Source	Age 1	Age 2	Age 3	Age 4	Age 5+
Mean	0.016	0.67	0.90	0.94	0.97
WG ogive	0	0.70	0.90	1.00	1.00

An attempt to update the maturity ogive was done before the benchmark group (see Section 4.2.2.2 and ICES CM 2013/ACOM:43). The new maturity ogive was however not used due to inconsistencies in some parts of the data, a very high maturity at age 1 with a notable year and country effect. The new maturity ogive was also, apart from inconsistencies mentioned, similar to the old ogive and therefore it was decided to keep the old maturity ogive static between 1974–2011 (Table 4.2.8).

4.2.2.4 Natural mortality

In the benchmarking assessment (ICES CM 2013/ACOM:43) a new data series of M was introduced from the Stochastic Multi-Species model (SMS) covering the years 1974–2011 (ICES CM 2012/SSGSUE:10). In general that the new M values give higher estimates for age 2–8+, except for the values in the early period at the beginning of the time series, which are similar or even lower (age 1) than the previously ones. The new M values were explored during the benchmark process in 2013. The new M values however, resulted in a more optimistic view of the stock status (higher SSB/Recruitment and lower F) (for further background see ICES CM 2013/ACOM:43). For the assessments between 2012 and up to 2014 therefore, final estimates of M in 2014 were chosen as 2011 from the SMS model (ICES CM 2015/ACOM:10). In the last three year's assessment it was decided to use M values for 2012–2017 estimated from the regression of M values taken from SMS against cod SSB in 1974–2011 (Figure 4.2.5a). As analytical estimates of cod SSB in recent years are not available due to difficulties with the cod assessment, and index of cod SSB obtained from the BITS surveys, used as the basis for the cod advice, was rescaled to approximate analytical estimates of SSB. The rescaling was based on the relationship between both series in 2003–2011 (Figure 4.2.5b). SSB of cod from last accepted analytical assessment and rescaled BITS index are shown in Figure 4.2.5c. The final values of M are given in Table 4.2.7.

4.2.2.5 Quality of catch and biological information

The level and frequency of herring sampling in subdivisions 25–29 and 32 (excl. GoR) in the Baltic for 2017 is compiled in Table 4.2.2. The overall frequency was 2.4 samples, 336 fishes measured and 138 fishes aged per 1000 tonnes landed. In 2017, sampling was most frequent in SD 32 followed by SD 26 and SD 28. Compared to 2016 the sampling has decreased and sampling could be improved for catches in foreign ports.

Recent investigations indicated a mixing of Central Baltic herring (CBH) and Western Baltic spring spawning herring (WBSSH) in SDs 24–26 (ICES CM 2012/ACOM:10: WD 6 Gröhsler *et al*.; ICES HAWG 2018, ICES WKPELA 2018). Growth curve analyses of both WBSSH and CBH from survey data showed that a significant difference in growth parameters can be used to allocate an individual herring of unknown stock to either WBSSH or CBH based on a Stock Separation Function (SF) with length-at-age as measure (Gröhsler *et al.*, 2013). It is recommended to estimate the degree the mixing of WBSSH and CBH in SD 24–26. For this it is needed that all countries catching herring in this area apply the SF. To verify and improve the quality of assignment of stock identity, novel methods (e.g. genetic) should be additionally applied.

Mixed fisheries are generally not considered a problem in the Baltic Sea. However the catch data are regarded as uncertain for this fishery, particularly from 1992 and onwards due to the mixing of sprat and herring in the catches. Analysis of a questionnaire answered by all Baltic countries during 2012 revealed that misreporting is mainly an issue of the industrial trawl fishery targeting sprat-herring mix in near shore waters, e.g. archipelago area of Sweden or the Kolobrzeg-Darlowo fishing ground off Poland (further details see Annex H3 of WKBALT 2013/ICES CM 2013/ACOM:43). Countries with major proportions of sprat catches used for industrial purposes are Sweden, Poland and Denmark. Countries with major proportions of herring catches used for industrial purposes are Finland and Sweden. At the time of the questionnaire, countries that seemingly have problems estimating the proportion of herrings in the catches were dealing with this on a national level with additional sampling and correct the input figures for assessment to assure as high accuracy as possible. The correction by country for this misreporting is however variable from year to year and there are again indications that misreporting is a problem in some nations (Hentati-Sundberg *et al*. 2014). The lack of appropriate information to account for this in the reporting of official catch figures can thus be a potential problem for the perception of these stocks. The possibility to find a method to correct for this should be investigated further.

The maturity ogive used was investigated before the last benchmarking of the stock (ICES CM 2013/ACOM:43). Data on herring maturity from Denmark, Finland, Poland, Lithuania, Russia and Sweden were provided from 1984–2012. Data provided showed that the maturity at age 1 that was unusually high. It was not possible at this stage to evaluate the maturity at age 1 and to exclude parts of the data. Using the old maturity ogive may result in a slight underestimation of the spawning stock biomass. The conclusion from the group was however to keep the old maturity ogive.

4.2.3 Fishery independent information

As in the last year, the stock abundance estimates from the Baltic International Acoustic October Survey (BIAS) were available to tune the XSA (1991–latest year, ages 1–8+). The tuning index covers the area of SD 25–27, 28.2 and 29. All available data covering the southern and northern part of SD 29 are used within the compilation. As in previous years, the estimates for the years 1993, 1995 and 1997 were excluded due to an incomplete coverage of the standard survey area. Year 2016 of the index was updated in 2017 by the WGBIFS working group. The new estimates of numbers-at-age differed by no more than 0.3% compared to the estimates as of last year (WD02_CBH_Evaluation of corrected M & BIAS index_MBergenius180119_final.doc), and the updated estimates were therefore used since the 2016 assessment (using data from 1974 to 2016). The final BIAS index for ages 1–8+ is given in Table 4.2.11.

The consistency of the survey data at-age was checked by plotting survey numbers at each given age against the numbers of the same year class at age 1 (Figure 4.2.6). Including the 2017 data did not have major impacts on the strength of the internal consistency compared to last year.

The survey has been undertaken yearly since 1991 in ICES subdivisions SDs 25–29, excluding Gulf of Riga. The survey was extended into the SD 32 in 1999, but estimates from this subdivision have so far not been included in the tuning index used for assessment. The development of herring numbers by age in SDs 25–29, excluding Gulf of Riga, in the assessment has subsequently been assumed to reflect also herring numbers in SD 32. As the number of herring has increased in SD 32 in the last few years (Figure 2 in WD06_Evaluation of CBH acoustic time-series_OKaljuste_GKruk_2017.10.20.doc; Figure 1, 2 in WD02_CBH_Evaluation of BIAS index incl SD 32_MBergenius 180213_final.doc), the evaluation of a shortened (in years) but spatially more appropriate, index has become even more pertinent.

On request from the Baltic Fisheries Assessment Working Group (WGBFAS) in fall 2017, the Fish Survey Working Group (WGBIFS) therefore computed a new tuning index including SD 32. The consequences of the inclusion of this index to the perception of the CBH stock was evaluated and the results presented in WD02_CBH_Evaluation of BIAS index incl SD 32_MBergenius 180213_final. doc.

The summary and conclusion of this work were as follows: There were minor differences in the diagnostics between the different assessment runs, including or not including SD 32 in the BIAS index. There were, however, differences in the estimated SSB, Fbar and recruitment between the assessment including and not including SD 32. The difference however, seems to be due to the length of the tuning index, rather than the inclusion of SD 32. The retrospective patterns were also significantly worse when the tuning index was shortened. The differences in the absolute biomass and harvest estimates and the worsened retrospective patterns suggest that some further analyses are needed before the proposed tuning index including SD 32 is accepted. In order not to lose the length of the time series in the index, it could be possible to use another stock assessment model, such as SS3, that can include the index in two fractions, before and after the inclusion of SD 32. It was therefore proposed that the standard BIAS tuning index is kept in the assessment, until the issue is revisited in time for the next benchmark.

4.2.4 Assessment

4.2.4.1 Recruitment estimates

The data series of 0 group herring from the acoustic surveys in subdivisions 25–27, 28.2 and 29 (including southern and northern data) in 1991–2017 was used in a RCT3 analysis to estimate the year class 2017 at age 1 for 2018. The RCT3 input and result are presented in tables 4.2.17 and 4.2.18. The estimate of the year class 2017 (Age 1 in 2017: 17 383 mill.) is close to the estimated average recruitment of the time series (1974–2017).

4.2.4.2 Exploration of SAM

During the benchmark assessment in 2013 (ICES CM 2013/ACOM:43) the state-space assessment model SAM was explored as an alternative method to assess the central Baltic herring stock. This year's final but still preliminary configuration of SAM is given in Table 4.2.16. The assessment run and the software internal code are available at https:/www.stockassessment.org, CHB_2018_001. Results of SAM compared to XSA are presented in figure 4.2.11. In general SAM produces lower estimates of SSB and recruitment (age 1), whereas it shows higher fishing mortality (F3–6). The retrospective pattern of SAM in the last two years is different to the XSA output showing a tendency to underestimate fishing mortality and overestimate spawning stock biomass (Figure 4.2.12).

4.2.4.3 XSA

The assessment performed this year is an update XSA assessment.

The XSA settings were established in the benchmark assessment performed in 2013 and were decided to be i.e. catchability dependent on stock size at age < 2 and independent of age > = 6, but with the application of a weak shrinkage (S.E. = 1.5).

As the last update of the natural mortalities provided by WGSAM 2012 only cover data for the years 1974–2011, it was in 2016 decided to use estimates of M for the year after 2011, i.e. 2012–2017, based on the regression of M against the Eastern Baltic cod SSB (see Section 4.2.2.4 on natural mortality above).

The input data for catch-at-age analysis are found in Tables 4.2.5–4.2.11, containing catches in numbers-at-age, mean weights at age in the catch and in the stock, tuning fleet and natural mortality by age and year, proportion of F and M before spawning time and proportion mature fish by age. As in previous years the mean weight in the stock was taken as the mean weight in the catch.

The diagnostics of the final XSA run, which converged after 63 iterations, are shown in Table 4.2.12. Including the latest acoustic estimates for 2017 led the same regression statistics as last year. Fishing mortalities and stock number are given in Table 4.2.13 and Table 4.2.14, respectively. The summary is presented in Table 4.2.15.

The development of herring biomass as estimated by the acoustic surveys and by XSA is illustrated in Figure 4.2.7. The 2017 acoustic SSB and total biomass show a small decrease, whereas the XSA estimates showed a small increase the last year. The acoustic estimates have been highly variable over the time series.

A retrospective analysis for the whole time series is given in Figure 4.2.8. Fishing mortality has been underestimated in the last year. Spawning stock biomass has been overestimated the last three years. This retrospective pattern is the opposite of last year's assessment, indicating that the model estimates are sensitive to the variable BIAS index (see below).

The log catchability residuals show some year effects with variable positive and negative residuals. Like last year, this was apparent especially for ages 2, 3 and 5, where negative trends were apparent in the beginning of the time series (Figure 4.2.9). The catchability residuals show year effects in particular since the incoming large year class of 2014. This indicates that the survey either overestimated population numbers of 1 year olds in 2015 or underestimated 2 and 3 year olds in later surveys years. Because of this, the retrospective model bias will be larger between assessment years in the years of a variable index. Residuals were however overall small and therefore considered acceptable.

Important to note is that the XSA assessment do not present uncertainty estimates, while the exploratory SAM assessment does. The exploratory SAM SSB estimates show similar retrospective bias between this and last year's assessment as the XSA assessment does, and the SAM results indicate that the bias is within the model uncertainty estimates.

The variance ratio between the internal (within fleet) and external standard (among fleet) errors were within the acceptable range (< 3 and > 0.3).

The abundance by age group of the tuning fleet was plotted against the estimated stock numbers (Figure 4.2.10). The regression analyses gave R (squared) values in the range 0.4–0.9, which is slightly worse than last year's estimates.

4.2.4.4 Historical stock trend

A slow but steady increase of SSB was observed since 2001 (Figure 4.2.13). The SSB in 2017 is estimated to be 10% under the long-term mean. The assessment estimates this year of SSB 2016 are downscaled by 25% (see explanation in section 4.2.4. and 3 under the quality of assessment section 4.2.7) The general trend in the stock development has not changed however. The historical decrease in SSB is believed to be partly caused by a shift in fishing area from SD 25 and 26 to SD 28.2 and 29 where the average mean weight is lower. Holmgren *et al.* 2012 showed that with the current growth rate and continuous low cod abundance, the herring stock will not reach equilibrium state until 2030. During the last three years the catches in SD 25 and 26 has increased slightly, where the mean weight-at-age are higher and this can influence the estimation of SSB. In numbers the metrics shows a spawning stock that varies around 25–30 billion fish in the period 1982–1996. The stock starts to decrease in 1997, to reach a value of 18 billion fish in 2003 which is the lowest value of the time series. In 2004 the spawning stock numbers starts to increase to 2014 after which the stock declined again for two years, after which it increased slightly again to 837 900 t in 2017s (Figure 4.2.14).

A major cause for decreasing trends in stock development is the drastic decrease in mean weight (size) at-age during the period of assessment (Figure 4.2.3). One of the reasons is that slow-growing herring, emanating from the north-eastern parts of the Baltic, have been dominating the catches over the recent years. These fish are also caught - outside the spawning time - in other parts of the Baltic, thereby decreasing the overall mean weights. However, mean weight decreased in all the areas of the Baltic Sea, likely indicating a real change in growth rate. Simultaneously, a decrease in body condition for herring was also observed, which was attributed to a decreased salinity (Möllmann *et al*., 2003; Rönkkönen *et al*., 2004; Casini *et al*., 2010) and increased competition with large sprat stock (Cardinale and Arrhenius, 2000; Casini *et al*., 2006; Casini *et al*., 2010), both factors decreasing the availability of the main prey of herring, the copepod *Pseudocalanus* spp.

Similar to the downscaling of SSB, fishing mortality (F) has been upscaled for the last few years in this year's assessment. F in 2016 was estimated to be 25% lower in last year's assessment compared to this year's assessment. The reasons for this are probably that the catches have increased the last years and the stock size (driven by the survey index) has been overestimated. F more than doubled over the assessment period, but showed a declining trend starting in 2002. After two years with record low F in 2012 and 2013 (F = 0.12 and 0.11 respectively) it has increased to 0.28 in 2017 (Figure 4.2.13). The large proportion of slow-growing herring may have contributed to the increase in fishing mortality in the 1990s and early 2000, as a given catch in tonnes of these small and slow-growing herring will contain many more individuals and thus cause a higher fishing mortality.

Recruitment-at-age 1 was high in the beginning of the 1980s, but being on a low level for some years afterwards (Figure 4.2.13). Since the mid-1980s recruitment has varied between 8 and 26 billion, without a clear trend. The 2014 year class is however, estimated to be more than 200 percent higher than the last strong 2007 year class, and is the greatest year class in the time series (45 954 million). Recruitment-at-age 1 in 2017 was slightly higher than in 2016, but 18% lower than the average recruitment of the time series.

4.2.5 Short-term forecast and management options

The input data of the short-term prediction are presented in Table 4.2.19. The mean weights at age in the prediction, for both catch and stock, were the average of 2015–2017. The estimate of recruitment of age 1 for 2018 was taken from the RCT3 analysis (tables 4.2.17–4.2.18), whereas recruits in 2019 and 2020 were the GM for 1988–2016 , 14 844 millions). The natural mortalities at age were assumed as the average of 2015–2017. The exploitation pattern was taken as the average over 2015–2017. The TAC constraint of 262 935 t (EU quota of 229 355 t + EU/Russian quota of 29 500 t + CBH caught in GOR 4 340 t (mean 2012–2016) – GoR herring caught in the Central Baltic area 260 t) was used in the predictions in the intermediate year 2018 since the total TAC in 2017 was almost fully exploited. This resulted in a fishing mortality of 0.35 (Table 4.2.20), which lies above the present estimated F in 2017 of 0.28. The SSB is expected to decrease slightly to 808 714 t in 2018.

It is important to note that the large 2014 year class will be the main contributor to the yield in 2019 and 2020 and SSB in 2019 and 2020, and no substantial new incoming year classes are predicted (Figure 4.2.15). It is uncommon to see such large contribution of one year class to the SSB as seen in the short term prediction for 2019 and 2020. This makes the stock more vulnerable to over exploitation.

4.2.6 Reference points

During the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks in 2014 (WKMSYREF3/ICES CM 2014/ACOM:64) the F_{MSY} reference points were revised. The new estimate of F_{MSY} is 0.22. The F_{MSY} ranges were in 2016 adopted as part of the multiannual plan for the stocks of cod, herring and sprat in the Baltic Sea ((EU) 2016/1139). Further ranges of F_{MSY} are provided in the text table below.

Stock	MSY F_{LOWER}	F_{MSY}	MSY F_{UPPER} with AR	MSY $B_{TRIGGER}$ (1000 t)	MSY F_{UPPER} with no AR
Herring in subdivisions 25–27, 28.2, 29 and 32	0.16	0.22	0.28	600	0.22

AR = Advice rule

4.2.7 Quality of assessment

The assessment has been benchmarked in 2013 (ICES CM 2013/ACOM:43).

As described above the estimated SSB was downscaled in the assessment this year and F was upscaled. One likely reason for this downscaling is the variable survey index, due to large year classes entering and exiting the population, and which makes the model estimates less precise (but still within the uncertainty estimates of stochastic models as explained above). It has been noted from preliminary investigations that the catchability of the survey may vary depending of the size of the year class, causing the over- or underestimation some ages depending on the strength of the year class. This issue needs to be investigated further at the next benchmark of central Baltic herring.

The assessment is based on catch data and on an international acoustic survey (BIAS), where the early period of the years 1982–1990 were excluded from the data series in 2013 (ICES CM 2013/ACOM:43). The acoustic index for the years 1991–2013 is consistently based on area-corrected estimates and is considered an important step forward in the quality of the assessment. The downscaled SSB estimates in this year's assessment may, however, be due to the potential migration of individual in to SD 32 which is currently not a part of the survey index (see section 4.2.3 and WD02_CBH_Evaluation of BIAS index incl. SD 32_MBergenius 180213_final. doc), meaning that individuals of some age classes may be underrepresented in the assessment. Currently, it is assumed that herring individuals are distributed evenly across the management area. Preliminary analyses by WGBIFS suggests that in years of strong dominating year classes, herring individuals distribute differently, and to a larger degree into SD 32, than when no dominating year classes are present. As described in WD02_CBH_Evaluation of BIAS index incl. SD 32_MBergenius 180213_final.doc), analyses including SD 32 will give higher values on SSB than when SD 32 is not included. A similar analysis was done at this year's assessment and including SD 32 similarly to the results presented in the working document gave higher SSB estimates, indicating that a significant proportion of individuals are missed by not including this subdivision. It should be noted however, that these analyses are preliminary and needs to be investigated further by WGBIFS and with different models, as the length of the index time series in itself, have large effects on the stock SSB estimates (WD02_CBH_Evaluation of BIAS index incl. SD 32_MBergenius 180213_final.doc).

The natural mortality was provided from multi-species models for the years 1974–2011, and from a regression of M against the Eastern Baltic cod SSB in 2012–2016.

Recruitment data are derived from a 0-group acoustic index, which were revised in 2013 (ICES CM 2013/SSGESST:08) and since then includes area corrected values.

Catches of central Baltic spring-spawning herring taken in the Gulf of Riga are included in the assessment.

ICES has been stating for several years that the pelagic fisheries take a mixture of herring and sprat and this causes uncertainties in catch levels. The extent to which species misreporting has occurred is however not well known. Analysis of a questionnaire answered by all Baltic countries during 2012 revealed that misreporting is mainly an issue of the industrial trawl fishery targeting sprat-herring mix in nearshore waters (ICES CM 2013/ACOM:43: WD 5 Krumme, Gröhsler, see also section 4.2.2.5). Countries with major proportions of sprat catches used for industrial purposes are Sweden, Poland and Denmark. Countries with major proportions of herring catches used for industrial purposes are Finland and Sweden. The official catch figures of both sprat and herring are modified by Poland and Denmark, but not currently in Sweden. A worst case scenario using the permitted margin of tolerance of 10% in the logbooks of the quantities by species on board (EU 1224/2009) revealed that sprat catches may be underestimated by 5% and that herring catches may be underestimated by 4%. It was therefore concluded at the time after the questionnaire that that species misreporting could be regarded of minor importance. However, as Sweden is not currently correcting for this misreporting and preliminary analyses by Sweden suggests that misreporting of herring and sprat is significantly worse than 5 and 4%, this issue needs to be investigated as soon as possible and when data available addressed in a benchmark. Significant misreporting can potentially be a large problem with regards to our perception of these stocks.

Likewise important to investigate further is the mixing of Central Baltic herring (CBH) and Western Baltic spring spawning herring (WBSSH) in SDs 24–26 (see also section 4.2.2.5). Depending on the degree of mixing it could have significant impacts on our perception of both herring stocks. A working group has been initiated to look further into this issue.

4.2.8 Comparison with previous assessment

Compared to last year, the present assessment resulted in 21% less SSB for 2015. $F_{(3-6)}$ in 2015 was estimated to be 28% higher compared to last year's assessment and recruitment-at-age 1 in 2015 (year class 2014) was estimated to be 22% less in this year's assessment.

Category	Parameter	Assessment 2017*	Assessment 2018	Diff. (+/-) %
Data input	Maturity ogives	age 1 – 0%, age 2 and 3 – 70% age 4 and older 100%	age 1 – 0%, age 2 and 3 – 70% age 4 and older 100%	No
	Natural mortality	M in 1974–2011 estimated in SMS, M_{2012}– M_{2016} estimated from regression of M against cod SSB	M in 1974–2011 estimated in SMS, M2012–M2017 estimated from regression of M against cod SSB	No
XSA input	Catchability dependent on year class strength	Age < 2	Age < 2	No
	Catchability independent on age	Age > = 6	Age > = 6	No
	SE of the F shrinkage mean	1.5	1.5	No
	Time weighting	Tricubic, 20 years	Tricubic, 20 years	No
	Tuning data	International acoustic autumn	International acoustic autumn	No
XSA results	SSB 2015 (1000 t)	1046	828	-21%
	TSB 2015 (1000 t)	1716	1370	-20%
	F(3–5) 2015	0.18	0.23	+28%
	Recruitment (age 1) 2015 (billions)	59	46	-22%

*Small revision of the assessment (WGBFAS 2017) in 2018.

4.2.9 Management considerations

The stock shows a total Biomass and SSB that is in line with the levels of the end of 1980s. The SSB has been steadily increasing since 2001, but is again decreasing since 2014. Fishing mortality (F3–6; 0.28) is higher than the adopted F_{MSY} of 0.22 (ICES CM 2015/ACOM:64). It can be noted that several year classes above the long term mean have contributed to the stock in the last 10 years (2007, 2008, 2011, 2012 and 2014). It is also important to note that the large 2014 year class will be the main contributor to the yield in 2019 and 2020 and SSB in 2019 and 2020, and no substantial new incoming year classes are predicted (Figure 4.2.15). It is uncommon to see such large contribution of one year class to the SSB as seen in the short term prediction for 2019 and 2020. This makes the stock more vulnerable to over exploitation.

The fluctuations of the eastern cod stock and sprat stock (see also WKREFBAS 2008/ICES CM 2008/ACOM:28) should be taken into account in herring management. Currently the cod stock is concentrated in SD 25 and 26 and shows bad growth conditions probably due to lack of food. This may be related to low abundance of herring in this area (WGBIFS 2016). WGBFAS is performing short-term forecasts using the latest cod predation mortality estimates (SMS, ICES CM 2012/SSGSUE:10; Section 4.2.2.4 on natural mortality), in this way taking in account the predation by the cod stock.

Table 4.2.1 Herring in SD 25–29, 32 (excl. GoR). Catches by country (1000 t) (incl. central Baltic herring caught in GoR, see Section 4.1.3).

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia**	Sweden	Total
1977	11.9		33.7				57.2	112.8	48.7	264.3
1978	13.9		38.3	0.1			61.3	113.9	55.4	282.9
1979	19.4		40.4				70.4	101.0	71.3	302.5
1980	10.6		44.0				58.3	103.0	72.5	288.4
1981	14.1		42.5	1.0			51.2	93.4	72.9	275.1
1982	15.3		47.5	1.3			63.0	86.4	83.8	297.3
1983	10.5		59.1	1.0			67.1	69.1	78.6	285.4
1984	6.5		54.1				65.8	89.8	56.9	273.1
1985	7.6		54.2				72.8	95.2	42.5	272.3
1986	3.9		49.4				67.8	98.8	29.7	249.6
1987	4.2		50.4				55.5	100.9	25.4	236.4
1988	10.8		58.1				57.2	106.0	33.4	265.5
1989	7.3		50.0				51.8	105.0	55.4	269.5
1990	4.6		26.9				52.3	101.3	44.2	229.3
1991	6.8	27.0	18.1		20.7	6.5	47.1	31.9	36.5	194.6
1992	8.1	22.3	30.0		12.5	4.6	39.2	29.5	43.0	189.2
1993	8.9	25.4	32.3		9.6	3.0	41.1	21.6	66.4	208.3
1994	11.3	26.3	38.2	3.7	9.8	4.9	46.1	16.7	61.6	218.6
1995	11.4	30.7	31.4	0.0	9.3	3.6	38.7	17.0	47.2	189.3
1996	12.1	35.9	31.5	0.0	11.6	4.2	30.7	14.6	25.9	166.7
1997	9.4	42.6	23.7	0.0	10.1	3.3	26.2	12.5	44.1	172.0
1998	13.9	34.0	24.8	0.0	10.0	2.4	19.3	10.5	71.0	185.9
1999	6.2	35.4	17.9	0.0	8.3	1.3	18.1	12.7	48.9	148.7
2000	15.8	30.1	23.3	0.0	6.7	1.1	23.1	14.8	60.2	175.1
2001	15.8	27.4	26.1	0.0	5.2	1.6	28.4	15.8	29.8	150.2
2002	4.6	21.0	25.7	0.3	3.9	1.5	28.5	14.2	29.4	129.1
2003	5.3	13.3	14.7	3.9	3.1	2.1	26.3	13.4	31.8	113.8
2004	0.2	10.9	14.5	4.3	2.7	1.8	22.8	6.5	29.3	93.0
2005	3.1	10.8	6.4	3.7	2.0	0.7	18.5	7.0	39.4	91.6
2006	0.1	13.4	9.6	3.2	3.0	1.2	16.8	7.6	55.3	110.4
2007	1.4	14.0	13.9	1.7	3.2	3.5	19.8	8.8	49.9	116.0
2008	1.2	21.6	19.1	3.4	3.5	1.7	13.3	8.6	53.7	126.2
2009	1.5	19.9	23.3	1.3	4.1	3.6	18.4	***11.8	50.2	134.1
2010	5.4	17.9	21.6	2.2	3.9	1.5	25.0	9.1	50.0	136.7
2011	1.8	14.9	19.2	2.7	3.4	2.0	28.0	8.5	36.2	116.8
2012	1.4	****11.4	18.0	0.9	2.6	1.8	25.5	13.0	26.2	101.0
2013	3.4	12.6	18.2	1.4	3.5	1.7	20.6	10.0	29.5	101.0
2014	2.7	15.3	27.9	1.7	4.9	2.1	27.3	15.9	34.9	132.7
2015	0.3	18.8	31.6	2.9	5.7	4.7	39.0	20.9	50.6	174.4
2016	4.0	20.1	28.9	4.3	8.4	5.2	41.0	24.2	56.0	192.1
*2017	9.3	23.3	40.7	3.6	7.9	4.0	40.1	22.3	51.2	202.5

*** Preliminary**

**** In 1977–1990 sum of catches for Estonia, Latvia, Lithuania and Russia**

***** Updated in 2011**

****** Updated in 2013 from 8.3 kt to 11.4 kt and included in 2014 assessment (WGBFAS 2014).**

Table 4.2.2 Herring in SD 25–29, 32 (excl. GoR). Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.

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	Country	Quarter	Catches in tons	Number of samples	Number of fish meas.	Number of fish aged
Subdivision 25	Denmark	1	619	2	11	11
		2	28	0	0	0
		3				
		4	21	0	0	0
		Total	668	2	11	11
	Finland	1	2 457	0	0	0
		2				
		3				
		4	118	0	0	0
		Total	2 575	0	0	0
	Germany	1	84	0	0	0
		2	205	0	0	0
		3				
		4				
		Total	289	0	0	0
	Latvia	1	168	0	0	0
		2	239	0	0	0
		3	184	0	0	0
		4				
		Total	591	0	0	0
	Lithuania	1	141	0	0	0
		2	483	0	0	0
		3				
		4	21	0	0	0
		Total	645	0	0	0
	Poland	1	3 829	10	765	327
		2	3 802	8	1 584	337
		3	7 363	3	1 032	203
		4	7 683	5	2 503	361
		Total	22 677	26	5 884	1 228
	Sweden	1	1 876	5	567	560
		2	1 202	8	575	571
		3	3 131	13	550	548
		4	1 801	12	616	614
		Total	8 010	38	2 308	2 293
	Total	1	9 174	17	1 343	898
		2	5 959	16	2 159	908
		3	10 678	16	1 582	751
		4	9 645	17	3 119	975
		Total	35 456	66	8 203	3 532

(cont').

Table 4.2.2 Herring in SD 25–29, 32 (excl. GoR). Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.

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Subdivision	Country	Quarter	Catches in tons	Number of samples	Number of fish meas.	Number of fish aged
Subdivision 26	Denmark	1	2 550	3	10	10
		2				
		3				
		4	80	0	0	0
		Total	2 631	3	10	10
	Finland	1	91	0	0	0
		2	40	0	0	0
		3				
		4	133	0	0	0
		Total	264	0	0	0
	Germany	1	1 031	0	0	0
		2	800	0	0	0
		3				
		4				
		Total	1 831	0	0	0
	Latvia	1	173	0	0	0
		2	109	0	0	0
		3	350	0	0	0
		4	127	0	0	0
		Total	760	0	0	0
	Lithuania	1	407	3	724	412
		2	354	2	336	218
		3	3	0	0	0
		4	6	0	0	0
		Total	771	5	1 060	630
	Poland	1	4 331	6	502	206
		2	2 197	8	4 914	441
		3	3 538	6	1 698	385
		4	5 964	3	262	82
		Total	16 030	23	7 376	1 114
	Russia	1	5 587	12	2 846	769
		2	3 187	24	3 110	1 395
		3	2 929	8	3 174	420
		4	1 873	13	3 836	521
		Total	13 575	57	12 966	3 105
	Sweden	1	4 985	6	74	73
		2	289	0	0	0
		3	1	0	0	0
		4	65	0	0	0
		Total	5 339	6	74	73
	Total	1	19 155	30	4 156	1 470
		2	6 976	34	8 360	2 054
		3	6 821	14	4 872	805
		4	8 248	16	4 098	603
		Total	41 200	94	21 486	4 932

(cont').

Table 4.2.2 Herring in SD 25–29, 32 (excl. GoR). Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.

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Subdivision 27

Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Denmark	1	1 341	1	19	19
	2				
	3				
	4	337	0	0	0
	Total	1 679	1	19	19
Finland	1	344	0	0	0
	2	760	0	0	0
	3				
	4	190	0	0	0
	Total	1 294	0	0	0
Lithuania	1	192	0	0	0
	2	87	0	0	0
	3				
	4				
	Total	280	0	0	0
Poland	1	22	0	0	0
	2	25	0	0	0
	3				
	4				
	Total	47	0	0	0
Sweden	1	8 438	8	548	547
	2	1 418	1	25	25
	3	298	1	112	112
	4	3 816	1	37	37
	Total	13 969	11	722	721
Total	1	10 338	9	567	566
	2	2 290	1	25	25
	3	298	1	112	112
	4	4 343	1	37	37
	Total	17 269	12	741	740

(cont').

Table 4.2.2 Herring in SD 25–29, 32 (excl. GoR). Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.

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Subdivision 28.2 (includes landings of Central Baltic Herring from Gulf of Riga)

Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Denmark	1	1 155	3	25	25
	2				
	3				
	4	1 618	0	0	0
	Total	2 774	3	25	25
Estonia	1	1 050	6	449	446
	2	3 004	5	500	400
	3	36	1	43	40
	4	164	8	632	632
	Total	4 254	20	1 624	1 518
Finland	1	81	0	0	0
	2	85	0	0	0
	3	572	0	0	0
	4	1 236	0	0	0
	Total	1 974	0	0	0
Germany	1	725	0	0	0
	2				
	3				
	4				
	Total	725	0	0	0
Latvia	1	1 810	13	2 452	1 481
	2	1 336	36	4 363	3 605
	3	746	10	1 945	900
	4	2 670	12	2 196	1 094
	Total	6 561	71	10 956	7 080
Lithuania	1	533	0	0	0
	2	44	0	0	0
	3	106	0	0	0
	4	1 215	0	0	0
	Total	1 898	0	0	0
Poland	1	209	0	0	0
	2	3	0	0	0
	3	28	0	0	0
	4	952	0	0	0
	Total	1 192	0	0	0
Sweden	1	5 983	5	410	404
	2	1 124	4	550	545
	3	2 871	3	257	257
	4	7 042	6	575	569
	Total	17 020	18	1 792	1 775
Total	1	11 546	27	3 336	2 356
	2	5 595	45	5 413	4 550
	3	4 360	14	2 245	1 197
	4	14 897	26	3 403	2 295
	Total	36 398	112	14 397	10 398

(cont').

Table 4.2.2 **Herring in SD 25–29, 32 (excl. GoR). Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.**

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	Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Subdivision 29	Denmark	1	582	0	0	0
		2				
		3				
		4	1 009	0	0	0
		Total	1 591	0	0	0
	Estonia	1	3 033	9	737	737
		2	768	8	532	532
		3	424	1	18	18
		4	2 459	8	632	625
		Total	6 684	26	1 919	1 912
	Finland	1	11 075	5	1 536	169
		2	5 406	7	2 167	374
		3	992	2	596	104
		4	10 431	3	1 000	170
		Total	27 903	17	5 299	817
	Germany	1	235	0	0	0
		2				
		3				
		4	514	0	0	0
		Total	749	0	0	0
	Lithuania	1	55	0	0	0
		2				
		3				
		4	388	0	0	0
		Total	443	0	0	0
	Poland	1	30	0	0	0
		2				
		3				
		4	126	0	0	0
		Total	156	0	0	0
	Sweden	1	6 602	4	226	226
		2	38	0	0	0
		3	12	0	0	0
		4	200	0	0	0
		Total	6 852	4	226	226
	Total	1	21 612	18	2 499	1 132
		2	6 211	15	2 699	906
		3	1 428	3	614	122
		4	15 127	11	1 632	795
		Total	44 378	47	7 444	2 955

(cont').

Table 4.2.2 Herring in SD 25–29, 32 (excl. GoR). Samples of commercial catches by quarter and subdivision for 2017 available to the Working Group.

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Subdivision	Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Subdivision 32	Estonia	1	3 793	15	1 417	851
		2	3 085	18	1 799	1 799
		3	1 420	6	570	570
		4	4 084	13	1 081	1 081
		Total	12 382	52	4 867	4 301
	Finland	1	1 993	1	312	55
		2	64	4	1 256	136
		3	961	5	1 586	154
		4	3 663	3	893	130
		Total	6 682	13	4 047	475
	Russia	1	1 614	9	861	148
		2	2 536	37	3 481	210
		3				
		4	4 602	45	2 612	218
		Total	8 752	91	6 954	576
	Total	1	7 400	25	2 590	1 054
		2	5 685	59	6 536	2 145
		3	2 381	11	2 156	724
		4	12 350	61	4 586	1 429
		Total	27 816	156	15 868	5 352
SD 25-32 (excl. 28.1 & 30-31)	**Total**	**Quarter**	**Catches in tons**	**Number of samples**	**Number of fish meas.**	**Number of fish aged**
		1	**79 225**	**126**	**14 491**	**7 476**
		2	**32 716**	**170**	**25 192**	**10 588**
		3	**25 967**	**59**	**11 581**	**3 711**
		4	**64 609**	**132**	**16 875**	**6 134**
		Total	**202 517**	**487**	**68 139**	**27 909**

Table 4.2.3. Herring in SD 25–29, 32 (excl. GoR).
Catch by country and SD and mean weight by SD in 2017.

CATCH (1000 T) BY COUNTRY AND SD							
Country	Total	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
Denmark	9.342	0.668	2.631	1.679	2.774	1.591	0.000
Estonia	23.320	0.000	0.000	0.000	4.254	6.684	12.382
Finland	40.692	2.575	0.264	1.294	1.974	27.903	6.682
Germany	3.594	0.289	1.831	0.000	0.725	0.749	0.000
Latvia*	7.912	0.591	0.760	0.000	6.561	0.000	0.000
Lithuania	4.037	0.645	0.771	0.280	1.898	0.443	0.000
Poland	40.102	22.677	16.030	0.047	1.192	0.156	0.000
Russia	22.327	0.000	13.575	0.000	0.000	0.000	8.752
Sweden	51.191	8.010	5.339	13.969	17.020	6.852	0.000
Total	202.517	35.456	41.200	17.269	36.398	44.378	27.816
*Catches in SD 28.2 include 1 289.8 t of CBH taken in GoR (SD 28.1)							
Catch in numbers (thousands)							
AGE	Total	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
0	466354	18732	21197	21808	153	170257	234207
1	983743	10863	19169	107909	12966	665079	167758
2	823614	49163	78791	110046	56400	288278	240936
3	2898360	125580	222081	462495	415835	873266	799104
4	840730	114572	193775	58907	142539	181430	149507
5	923686	125093	170173	80694	240229	237785	69712
6	527598	98743	117253	45744	142198	91742	31919
7	248465	51856	79428	7809	57488	42647	9237
8	284251	51705	59473	7675	49351	92553	23494
9	59538	18804	21771	0	16456	2007	500
10+	68029	11827	22951	0	24841	8210	200
Total N	8124369	676937	1006061	903087	1158456	2653254	1726574
CATON	202.517	35.456	41.200	17.269	36.398	44.378	27.816
Mean weight (g)							
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
0	4.9	14.3	10.1	4.1	7.1	4.3	4.2
1	10.9	28.7	19.6	10.6	17.3	10.5	10.0
2	19.2	41.3	33.3	15.9	23.9	14.7	16.0
3	20.8	43.7	31.6	18.1	23.9	17.4	17.9
4	32.1	52.8	38.8	24.6	32.2	21.5	23.3
5	34.7	51.3	43.0	29.0	35.2	24.4	25.0
6	40.3	56.8	46.6	29.8	37.5	28.9	26.7
7	48.2	65.2	53.4	46.5	43.8	28.2	28.1
8	47.8	66.8	59.3	46.6	43.6	37.0	28.4
9	61.2	75.9	63.5	0.0	45.5	34.1	37.6
10+	60.6	90.0	71.0	0.0	46.4	32.3	40.0

CATON is given in 1000 tons

Table corrected and republished on 10 October 2018.

Table 4.2.4. Herring in SD 25–29, 32 (excl. GoR). Catch in number-at-age (millions) per SD and quarter in 2017. CATON in 1000 t).

1/2

Quarter:	1						
AGE	Sum	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	0.082	0.082	0.000	0.000	0.000	0.000	0.000
1	336.075	4.022	6.325	49.041	1.397	220.321	54.969
2	336.023	13.626	23.167	58.002	8.315	180.429	52.484
3	1513.678	18.232	135.988	308.065	119.730	618.171	313.492
4	358.200	28.588	110.406	37.795	35.464	104.945	41.003
5	436.744	38.829	89.570	64.355	87.176	136.642	20.172
6	227.048	23.062	63.618	28.152	56.209	44.935	11.071
7	124.203	13.954	46.607	6.926	23.808	29.862	3.046
8	122.709	21.200	29.221	6.926	22.335	37.955	5.071
9	24.584	7.526	6.573	0.000	9.232	1.252	0.000
10+	23.935	6.413	5.540	0.000	8.017	3.966	0.000
Total N	3503.280	175.533	517.015	559.264	371.683	1378.478	501.306
CATON	79.225	9.174	19.155	10.338	11.546	21.612	7.400
Quarter:	2						
AGE	Sum	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	0.037	0.000	0.000	0.037	0.000	0.000	0.000
1	87.248	0.396	1.430	6.580	0.923	61.909	16.011
2	116.628	4.190	30.191	15.774	9.686	22.310	34.477
3	450.587	13.128	32.192	51.261	68.560	58.167	227.279
4	159.464	19.608	33.793	8.483	14.208	41.113	42.260
5	179.851	22.341	21.435	13.257	47.038	57.998	17.782
6	112.283	18.669	18.001	16.326	35.619	17.065	6.602
7	38.103	11.196	10.409	0.508	8.340	6.325	1.323
8	63.147	10.227	6.445	0.499	11.487	33.541	0.948
9	15.599	5.579	4.775	0.000	4.642	0.403	0.200
10+	24.655	3.113	4.813	0.000	14.818	1.712	0.200
Total N	1247.602	108.446	163.484	112.724	215.322	300.542	347.084
CATON	32.716	5.959	6.976	2.290	5.595	6.211	5.685
Quarter:	3						
AGE	Sum	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	18.631	0.000	5.324	0.491	0.000	11.016	1.800
1	66.618	2.483	4.522	2.576	7.290	30.200	19.547
2	67.593	17.627	9.635	2.205	19.238	9.848	9.040
3	251.869	50.862	31.766	6.754	110.296	12.631	39.561
4	92.954	37.341	21.611	0.613	18.743	0.271	14.376
5	79.695	29.721	25.554	0.734	13.120	2.396	8.169
6	66.969	29.390	21.995	0.242	5.363	3.932	6.048
7	26.475	11.100	13.382	0.120	0.369	0.361	1.143
8	30.024	8.958	8.539	0.000	1.424	1.205	9.898
9	8.087	2.587	5.400	0.000	0.000	0.000	0.100
10+	4.984	0.913	3.768	0.000	0.000	0.303	0.000
Total N	713.899	190.982	151.494	13.735	175.842	72.163	109.682
CATON	25.967	10.678	6.821	0.298	4.360	1.428	2.381
Quarter:	4						
AGE	Sum	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	447.605	18.650	15.873	21.279	0.153	159.242	232.407
1	493.802	3.962	6.892	49.712	3.356	352.649	77.231
2	303.371	13.719	15.798	34.066	19.162	75.692	144.934
3	682.225	43.358	22.135	96.415	117.249	184.296	218.772
4	230.111	29.036	27.966	12.016	74.123	35.101	51.868
5	227.397	34.203	33.613	2.348	92.896	40.749	23.589
6	121.299	27.622	13.638	1.024	45.007	25.810	8.198
7	59.684	15.605	9.030	0.254	24.970	6.098	3.726
8	68.371	11.320	15.268	0.250	14.105	19.852	7.577
9	11.268	3.111	5.023	0.000	2.582	0.352	0.200
10+	14.455	1.389	8.831	0.000	2.006	2.230	0.000
Total N	2659.589	201.975	174.068	217.364	395.609	902.071	768.502
CATON	64.609	9.645	8.248	4.343	14.897	15.127	12.350

Table 4.2.4. Herring in SD 25–29, 32 (excl. GoR). Mean weight-at-age per SD and quarter in 2017. Mean weight (g).

2/2

Quarter:	1						
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	8.0	8.0	NA	NA	NA	NA	NA
1	5.5	16.5	9.5	4.7	6.1	5.5	4.9
2	14.0	30.6	29.2	12.9	18.8	11.7	11.1
3	17.5	38.7	28.0	17.0	19.5	15.7	15.2
4	27.9	46.8	34.9	22.7	29.1	19.7	20.2
5	31.4	51.8	38.1	27.9	34.3	22.4	22.3
6	37.2	55.4	44.0	28.5	37.3	26.5	24.9
7	44.3	67.5	49.7	47.9	43.6	26.4	28.0
8	45.9	60.5	53.8	47.7	44.9	34.4	27.1
9	56.6	74.6	52.3	NA	48.4	32.4	NA
10+	68.0	96.7	70.8	NA	61.4	30.8	NA
Quarter:	**2**						
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	10.5	NA	NA	10.5	NA	NA	NA
1	7.1	19.0	16.4	4.5	4.9	7.8	4.6
2	17.8	31.6	31.6	11.5	17.3	13.0	10.0
3	18.8	37.9	36.3	16.2	18.4	16.5	16.5
4	28.5	48.0	38.3	24.4	24.7	21.7	20.2
5	32.3	52.6	47.8	34.6	27.5	24.8	23.4
6	37.7	57.2	48.8	32.3	30.6	29.5	25.4
7	49.9	66.9	55.9	36.7	38.8	31.0	24.4
8	46.4	69.1	62.8	36.6	34.7	41.1	26.3
9	61.1	79.4	67.2	NA	36.4	30.7	38.8
10+	49.0	76.6	74.8	NA	36.5	36.0	40.0
Quarter:	**3**						
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	6.7	NA	10.0	10.5	NA	5.3	4.6
1	15.8	35.8	25.8	15.8	18.1	13.4	13.9
2	30.4	45.8	37.3	21.3	22.6	24.4	18.1
3	29.9	48.0	36.4	23.5	23.7	25.7	21.2
4	42.7	57.6	41.2	25.2	27.9	82.0	25.4
5	44.4	54.5	45.8	28.5	31.0	36.3	28.5
6	51.0	60.7	50.3	27.5	33.2	42.2	28.6
7	60.3	68.1	56.5	31.0	50.4	78.8	29.2
8	56.3	80.9	61.5	36.6	39.6	76.1	29.5
9	72.7	82.9	68.5	NA	NA	NA	33.4
10+	83.9	98.0	85.0	NA	NA	27.2	NA
Quarter:	**4**						
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	4.8	14.3	10.1	4.0	7.1	4.2	4.2
1	14.5	37.7	25.5	17.0	23.8	13.8	13.7
2	23.1	49.0	40.1	22.7	30.7	20.9	19.0
3	26.0	42.6	39.8	22.2	31.9	22.9	22.5
4	36.9	55.8	53.1	30.9	36.1	25.8	27.7
5	39.6	47.2	51.0	27.9	40.4	29.6	27.4
6	42.7	53.3	50.4	28.4	43.6	30.7	28.5
7	49.6	60.0	64.6	36.7	45.5	31.1	29.1
8	48.6	65.2	67.0	36.6	49.0	32.8	28.2
9	63.4	67.4	69.4	NA	51.4	44.1	38.6
10+	59.9	83.6	63.0	NA	59.6	33.0	NA

Table 4.2.5. Herring in SD 25–29, 32 (excl. GoR). XSA input: Catch in numbers (thousands).

CANUM: Catch in numbers (Total International Catch) (Total) (Thousands)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	SOPCOF %
1974	2436300	1553800	1090600	1347900	483100	343500	619000	285100	99.5
1975	1861800	1229200	1405600	829900	870700	364000	274800	546800	100.2
1976	2093100	1114800	1034000	907300	476800	558500	246500	494400	100.0
1977	1258500	1825900	773600	608300	621700	365300	284000	545400	99.9
1978	1044000	1298700	1575100	436800	355100	370700	186800	478300	100.0
1979	405300	1195500	873200	1159500	338900	278700	281200	478500	100.0
1980	1037000	907100	977400	524600	654900	182500	204400	550500	100.0
1981	1325500	1523500	680000	615000	343600	436300	146600	527500	100.2
1982	867000	2277000	810100	334200	312000	188100	250500	420700	99.6
1983	744300	1698700	1875700	625300	233100	245700	162500	433400	100.3
1984	822000	1177900	1282900	1145700	374300	165500	166300	421100	100.0
1985	1237800	2124100	1076100	867300	707200	240300	131000	346900	99.9
1986	552824	1733617	1601914	838843	614707	320221	114772	208901	100.4
1987	920000	726000	1445000	1237000	607000	461000	238000	194000	100.1
1988	474000	2091300	746300	1009600	849400	354300	254200	210100	100.1
1989	792900	540600	1988300	580000	840700	695100	266500	336600	99.9
1990	643300	1194800	585500	1245900	419400	541100	370500	306000	100.4
1991	372900	1571700	1286100	512700	807700	278400	265900	238200	100.1
1992	1112600	1139400	1696900	702900	324100	422300	157700	218600	100.7
1993	826300	1852600	1503000	1473400	615700	274000	197500	140100	99.8
1994	486870	1138560	1559930	1068900	1057400	495520	213790	282450	100.5
1995	820500	960200	1742700	1555400	645700	440400	205200	212100	100.5
1996	985800	1441300	1095900	1216600	798100	492000	301100	223800	99.3
1997	549200	1350300	1738700	1173900	904800	492600	244200	186100	99.9
1998	1873286	947360	1810804	1781642	813071	481770	211361	186102	100.1
1999	628815	1660328	949293	1307772	950155	340256	185943	119952	102.9
2000	1842170	940000	1682170	818970	864530	567220	191280	185030	99.9
2001	1052466	1930067	605055	1010660	375834	391122	303247	199646	99.4
2002	1034640	1012975	1339851	456838	522442	179710	169851	230139	98.6
2003	1347364	782607	687478	686673	261252	226812	89925	202367	101.1
2004	656630	1242941	673629	568055	384598	162350	119700	129883	100.0
2005	326272	753498	1187077	557148	378447	219723	82530	159318	101.2
2006	808387	505592	754016	1104978	409059	264865	154493	147666	100.8
2007	457582	920291	630258	703185	823805	268661	135977	112019	101.2
2008	789388	735511	968418	461494	485798	711012	165897	215625	99.4
2009	653043	1395081	745935	855049	302486	340499	486075	239340	100.0
2010	546352	645269	1357314	661735	630229	283763	283721	362390	101.0
2011	293118	568892	770797	1130531	415505	312765	128881	235287	101.0
2012	333355	317009	416640	517743	642002	234424	160708	208441	100.0
2013	470327	655679	260040	410703	467439	403588	172879	224139	100.0
2014	470062	902642	1003705	385671	488077	409753	285297	250759	100.0
2015	1415576	745130	1264634	1252762	378036	384811	369954	473420	100.0
2016	602141	3014945	934748	1188734	838456	331740	465961	629002	100.0
2017	983743	823614	2898360	840730	923686	527598	248465	411819	100.0

Table 4.2.6. Herring in SD 25–29, 32 (excl. GoR). XSA input: Mean weight in the catch and in the stock (Kilograms).

		WECA (= WEST): Mean weight in Catch (Total International Catch) (Total) (Kilograms)						
Year	**Age 1**	**Age 2**	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8+**
1974	0.0300	0.0350	0.0430	0.0460	0.0710	0.0790	0.0830	0.0750
1975	0.0300	0.0340	0.0520	0.0520	0.0540	0.0790	0.0780	0.0790
1976	0.0230	0.0380	0.0400	0.0600	0.0580	0.0570	0.0800	0.0810
1977	0.0290	0.0310	0.0500	0.0580	0.0690	0.0610	0.0720	0.0910
1978	0.0270	0.0440	0.0430	0.0560	0.0620	0.0730	0.0730	0.0810
1979	0.0240	0.0420	0.0590	0.0530	0.0660	0.0720	0.0770	0.0860
1980	0.0240	0.0370	0.0540	0.0680	0.0630	0.0770	0.0800	0.0940
1981	0.0260	0.0350	0.0530	0.0700	0.0790	0.0770	0.0860	0.1000
1982	0.0220	0.0390	0.0530	0.0650	0.0750	0.0840	0.0800	0.1010
1983	0.0180	0.0310	0.0560	0.0590	0.0770	0.0870	0.0910	0.1030
1984	0.0160	0.0300	0.0460	0.0650	0.0670	0.0820	0.0890	0.1010
1985	0.0160	0.0230	0.0420	0.0580	0.0670	0.0750	0.0850	0.1020
1986	0.0180	0.0250	0.0330	0.0510	0.0630	0.0690	0.0790	0.0990
1987	0.0150	0.0330	0.0380	0.0450	0.0590	0.0640	0.0710	0.0920
1988	0.0200	0.0260	0.0470	0.0510	0.0530	0.0650	0.0710	0.0900
1989	0.0230	0.0360	0.0370	0.0520	0.0570	0.0590	0.0670	0.0820
1990	0.0180	0.0310	0.0420	0.0390	0.0600	0.0620	0.0640	0.0770
1991	0.0230	0.0240	0.0350	0.0490	0.0410	0.0600	0.0560	0.0690
1992	0.0130	0.0230	0.0310	0.0420	0.0570	0.0500	0.0670	0.0710
1993	0.0130	0.0210	0.0320	0.0350	0.0440	0.0510	0.0500	0.0660
1994	0.0160	0.0210	0.0280	0.0380	0.0420	0.0520	0.0610	0.0640
1995	0.0110	0.0210	0.0240	0.0320	0.0410	0.0420	0.0490	0.0540
1996	0.0110	0.0170	0.0240	0.0280	0.0330	0.0370	0.0400	0.0510
1997	0.0110	0.0170	0.0220	0.0260	0.0300	0.0350	0.0400	0.0440
1998	0.0100	0.0180	0.0210	0.0280	0.0330	0.0370	0.0410	0.0460
1999	0.0130	0.0160	0.0220	0.0250	0.0290	0.0360	0.0390	0.0540
2000	0.0130	0.0230	0.0260	0.0280	0.0310	0.0360	0.0410	0.0460
2001	0.0140	0.0190	0.0290	0.0300	0.0340	0.0370	0.0440	0.0470
2002	0.0133	0.0216	0.0271	0.0330	0.0366	0.0392	0.0438	0.0454
2003	0.0094	0.0242	0.0298	0.0355	0.0388	0.0446	0.0501	0.0549
2004	0.0086	0.0143	0.0265	0.0304	0.0389	0.0418	0.0474	0.0540
2005	0.0122	0.0152	0.0193	0.0292	0.0356	0.0434	0.0481	0.0561
2006	0.0120	0.0234	0.0237	0.0263	0.0339	0.0435	0.0486	0.0553
2007	0.0123	0.0215	0.0254	0.0300	0.0330	0.0427	0.0497	0.0603
2008	0.0133	0.0222	0.0257	0.0302	0.0370	0.0335	0.0439	0.0498
2009	0.0112	0.0199	0.0268	0.0295	0.0354	0.0418	0.0357	0.0464
2010	0.0120	0.0183	0.0258	0.0322	0.0332	0.0385	0.0450	0.0450
2011	0.0125	0.0215	0.0246	0.0317	0.0375	0.039	0.0474	0.0475
2012	0.0142	0.0291	0.0268	0.0329	0.0417	0.0458	0.0511	0.0597
2013	0.0120	0.0210	0.0351	0.0324	0.0386	0.0480	0.0505	0.0566
2014	0.0118	0.0201	0.0294	0.0390	0.0350	0.0446	0.0492	0.0553
2015	0.0071	0.0217	0.0272	0.0331	0.0399	0.0403	0.0471	0.0512
2016	0.0086	0.0123	0.0256	0.0293	0.0339	0.0374	0.0407	0.047
2017	0.0109	0.0192	0.0208	0.0321	0.0347	0.0403	0.0482	0.0518

Table 4.2.7. Herring in SD 25–29, 32 (excl. GoR). XSA input: Natural mortality.

NATMOR: Natural Mortality (Total International Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.3167	0.2941	0.2553	0.2280	0.2185	0.2265	0.2138	0.2046
1975	0.3392	0.3140	0.2799	0.2463	0.2296	0.2406	0.2228	0.2065
1976	0.3096	0.2862	0.2614	0.2424	0.2293	0.2347	0.2234	0.2072
1977	0.3322	0.3001	0.2681	0.2462	0.2377	0.2462	0.2321	0.2127
1978	0.4203	0.2903	0.2903	0.2513	0.2482	0.2382	0.2199	0.2199
1979	0.4685	0.2739	0.2376	0.2463	0.2463	0.2291	0.2184	0.2148
1980	0.4969	0.4011	0.3281	0.2384	0.2860	0.2220	0.2111	0.2072
1981	0.4612	0.4013	0.3459	0.3020	0.2663	0.2850	0.2135	0.2065
1982	0.5024	0.4168	0.3529	0.3155	0.2662	0.2380	0.2466	0.2078
1983	0.4725	0.4300	0.3636	0.3337	0.2631	0.2334	0.2210	0.2162
1984	0.3962	0.3720	0.3459	0.2882	0.2882	0.2263	0.2155	0.2098
1985	0.3621	0.3405	0.3148	0.2808	0.2491	0.2364	0.2283	0.2042
1986	0.3327	0.3160	0.2994	0.2662	0.2575	0.2399	0.2230	0.2069
1987	0.3176	0.2838	0.2755	0.2755	0.2491	0.2264	0.2183	0.2119
1988	0.3084	0.2980	0.2709	0.2635	0.2635	0.2301	0.2252	0.2136
1989	0.2917	0.2777	0.2777	0.2657	0.2525	0.2381	0.2197	0.2140
1990	0.2622	0.2551	0.2482	0.2518	0.2377	0.2354	0.2284	0.2295
1991	0.2433	0.2387	0.2316	0.2239	0.2288	0.2186	0.2219	0.2176
1992	0.2432	0.2387	0.2291	0.2244	0.2143	0.2201	0.2096	0.2088
1993	0.2488	0.2481	0.2422	0.2398	0.2316	0.2224	0.2224	0.2127
1994	0.2510	0.2499	0.2457	0.2428	0.2404	0.2329	0.2273	0.2318
1995	0.2516	0.2508	0.2473	0.2445	0.2445	0.2445	0.2359	0.2273
1996	0.2464	0.2457	0.2457	0.2445	0.2431	0.2405	0.2389	0.2315
1997	0.2556	0.2556	0.2543	0.2522	0.2496	0.2496	0.2496	0.2496
1998	0.2611	0.2596	0.2596	0.2570	0.2542	0.2496	0.2496	0.2364
1999	0.2713	0.2713	0.2699	0.2641	0.2641	0.2585	0.2585	0.2554
2000	0.2685	0.2672	0.2624	0.2624	0.2585	0.2585	0.2528	0.2492
2001	0.2626	0.2613	0.2590	0.2590	0.2521	0.2491	0.2454	0.2454
2002	0.2710	0.2710	0.2639	0.2597	0.2597	0.2499	0.2499	0.2437
2003	0.2422	0.2411	0.2389	0.2323	0.2352	0.2323	0.2288	0.2260
2004	0.2436	0.2436	0.2369	0.2369	0.2331	0.2272	0.2239	0.2239
2005	0.2495	0.2495	0.2469	0.2432	0.2348	0.2269	0.2269	0.2168
2006	0.2585	0.2505	0.2505	0.2505	0.2505	0.2342	0.2342	0.2231
2007	0.2630	0.2540	0.2540	0.2540	0.2495	0.2361	0.2361	0.2141
2008	0.2705	0.2687	0.2625	0.2625	0.2584	0.2584	0.2499	0.2437
2009	0.2962	0.2892	0.2892	0.2851	0.2793	0.2695	0.2793	0.2635
2010	0.3191	0.3117	0.3069	0.3069	0.3010	0.2964	0.2807	0.2886
2011	0.3346	0.3306	0.3279	0.3279	0.3249	0.3202	0.3036	0.3120
*2012	0.2985	0.2782	0.2644	0.2525	0.2453	0.2368	0.2296	0.2230
*2013	0.2877	0.2696	0.2574	0.2468	0.2403	0.2327	0.2264	0.2205
*2014	0.2857	0.2680	0.2560	0.2457	0.2394	0.2320	0.2258	0.2200
*2015	0.2870	0.2691	0.2569	0.2464	0.2400	0.2325	0.2262	0.2203
*2016	0.2910	0.2723	0.2595	0.2485	0.2418	0.2340	0.2274	0.2213
*2017	0.2813	0.2645	0.2532	0.2433	0.2374	0.2304	0.224	0.219

1971–2011 based on latest MSVPA/SMS-data provided by WGSAM 2012

*** 2012–2017 based on the regression of M against Eastern Baltic cod SSB**

Table 4.2.8. Herring in SD 25–29, 32 (excl. GoR). XSA input: Proportion mature at year start.

MATPROP: Proportion of Mature at Year Start (Total international Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2017	0.0	0.7	0.9	1.0	1.0	1.0	1.0	1.0

Table 4.2.9. Herring in SD 25–29, 32 (excl. GoR). XSA input: Proportion of M before spawning.

MPROP: Proportion of M before Spawning (Total International Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2017	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Table 4.2.10. Herring in SD 25–29, 32 (excl. GoR). XSA input: Proportion of F before spawning.

FPROP: Proportion of F before Spawning (Total international Catch) (Total)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2017	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35

Table 4.2.11. Herring in SD 25–29, 32 (excl. GoR). XSA input: Tuning Fleet/International Acoustic Survey.

Fleet: International Acoustic Survey (Catch: Millions)

Year	Fish. Effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1991	1	6943	20002	11964	4148	9643	2511	2280	2453
1992	1	7417	9156	13178	7156	4108	2274	1540	1167
*1993	1	-11	-11	-11	-11	-11	-11	-11	-11
1994	1	3924	11881	20304	11527	5653	2099	941	829
*1995	1	-11	-11	-11	-11	-11	-11	-11	-11
1996	1	3985	13762	9989	7361	4533	2359	1179	777
*1997	1	-11	-11	-11	-11	-11	-11	-11	-11
1998	1	4285	2171	6617	6521	2584	1524	791	430
1999	1	1754	4742	3194	4251	3680	1428	833	630
2000	1	10151	2560	9874	4838	5200	3234	3007	2061
2001	1	4029	8194	3286	4661	1567	1238	861	464
2002	1	2687	4242	6508	2842	2326	870	741	455
2003	1	16704	9116	10643	6690	2320	1778	755	1156
2004	1	4914	13229	6789	4672	2500	1132	604	680
2005	1	1920	8251	15345	7123	4356	2541	1096	1129
2006	1	7317	8060	12700	21121	7336	3068	1701	1212
2007	1	5401	6587	2975	4191	7093	1697	883	807
2008	1	6842	6822	7589	3613	4927	3563	877	807
2009	1	6409	12141	6820	5551	2059	2969	2089	614
2010	1	3829	8279	12048	5006	3543	1685	1902	1600
2011	1	2339	5668	10993	12669	5525	3257	1448	2242
2012	1	14948	3630	7545	9345	9200	2685	2262	2082
2013	1	6896	9160	3855	6934	7127	7272	2154	3489
2014	1	5086	10114	15409	5916	7370	6664	4933	3653
2015	1	36179	9812	15273	15549	5486	4873	3648	4362
**2016	1	6830	27755	7212	7277	4050	2032	1493	1471
2017		4454	5362	20367	3945	3663	1824	628	1210

*not used due to incomplete coverage

**Data for 2016 include small revisions since last years assessment (WGBFAS 2018)

Table 4.2.12. Herring in SD 25–29, 32 (excl. GoR). Output from XSA final run: Diagnostics. 1/2

```
FLR XSA Diagnostics 2018-04-09 16:46:11
CPUE data from indices
Catch data for 44 years 1974 to 2017. Ages 1 to 8.
                                  fleet first age last age first year last year alpha beta
1 BIAS SD 25-27&28.2&29S+N (April 2017)         1        7       1991      2017  <NA> <NA>
 Time series weights :
    Tapered time weighting applied
   Power =   3 over  20 years
 Catchability analysis :
     Catchability independent of size for ages >   1
     Catchability independent of age for ages >   5
 Terminal population estimation :
     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.
    S.E. of the mean to which the estimates are shrunk =   1.5
    Minimum standard error for population
    estimates derived from each fleet =  0.3
    prior weighting not applied
Regression weights
     year
age    2008 2009  2010  2011  2012  2013 2014  2015 2016 2017
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1

 Fishing mortalities
   year
age  2008  2009  2010  2011  2012  2013  2014  2015  2016  2017
  1 0.035 0.040 0.047 0.042 0.023 0.031 0.042 0.036 0.054 0.083
  2 0.088 0.088 0.056 0.071 0.065 0.063 0.084 0.094 0.110 0.106
  3 0.148 0.131 0.128 0.099 0.075 0.075 0.139 0.174 0.175 0.157
  4 0.185 0.205 0.183 0.170 0.098 0.105 0.161 0.272 0.262 0.249
  5 0.194 0.192 0.255 0.190 0.151 0.127 0.184 0.246 0.311 0.352
  6 0.311 0.218 0.308 0.219 0.170 0.139 0.163 0.225 0.371 0.344
  7 0.279 0.394 0.311 0.250 0.181 0.188 0.143 0.225 0.485 0.549
  8 0.279 0.394 0.311 0.250 0.181 0.188 0.143 0.225 0.485 0.549
 XSA population number (Thousand)
      age
year         1        2        3       4       5       6       7       8
  2008 26055248 10038257  8007983 3112089 3127905 3030558  772164  995240
  2009 19420327 19190571  7029922 5309850 1988860 1988719 1715622  834381
  2010 14094909 13878558 13163838 4618936 3251233 1241140 1221333 1543655
  2011  8414568  9778440  9609748 8520727 2830664 1863993  678098 1225462
  2012 16955522  5773708  6543521 6268959 5179053 1692233 1086772 1401610
  2013 17582712 12292679  4095693 4658195 4413744 3484555 1127176 1453113
  2014 13247366 12779486  8814741 2937575 3276409 3056413 2401871 2100986
  2015 45954446  9547747  8985686 5940748 1956559 2145846 2058696 2617772
  2016 13209638 33263007  6643792 5837747 3535795 1203796 1358111 1812756
  2017 14168516  9353807 22702785 4304265 3503426 2033378  657527 1076515

 Estimated population abundance at 1st Jan  2018
      age
year   1       2       3        4       5       6       7      8
  2018 0 9839928 6458432 15071119 2630352 1942854 1144812 303283
 Fleet:  BIAS SD 25-27&28.2&29S+N (April 2017)
 Log catchability residuals.
   year
age   1991   1992 1993   1994 1995   1996 1997   1998   1999   2000   2001   2002  2003   2004   2005
  1  0.071 -0.018   NA -0.187   NA -0.245   NA -0.127 -0.138  0.246  0.050 -0.094 0.232 -0.015 -0.161
  2  0.679  0.124   NA  0.301   NA  0.253   NA -0.818 -0.354 -0.424  0.203 -0.208 0.560  0.153  0.113
  3  0.514  0.208   NA  0.794   NA  0.119   NA -0.230 -0.403  0.490 -0.197  0.020 0.635  0.173  0.184
  4 -0.042  0.169   NA  0.591   NA  0.107   NA -0.190 -0.318  0.398  0.130 -0.108 0.255 -0.014  0.393
  5  0.862  0.245   NA  0.130   NA  0.154   NA -0.488 -0.241  0.496 -0.228 -0.017 0.040 -0.411  0.248
  6  0.244  0.010   NA -0.015   NA  0.073   NA -0.195 -0.528  0.339 -0.205 -0.237 0.304 -0.210  0.023
  7  0.238  0.234   NA -0.139   NA -0.253   NA -0.192 -0.154  0.741 -0.231 -0.040 0.137 -0.232  0.181
   year
age  2006   2007   2008   2009   2010   2011   2012   2013  2014  2015   2016   2017
  1 0.065  0.018 -0.309 -0.131 -0.134 -0.005  0.327 -0.039 0.018 0.055  0.156 -0.071
  2 0.490 -0.240 -0.076 -0.130 -0.196 -0.196 -0.164 -0.004 0.073 0.343  0.151 -0.234
  3 0.427 -0.590 -0.187 -0.156 -0.201  0.015 -0.051 -0.260 0.411 0.415 -0.031 -0.243
  4 0.655 -0.529 -0.227 -0.295 -0.260  0.063 -0.059 -0.059 0.289 0.647 -0.102 -0.425
  5 0.784 -0.106 -0.048 -0.452 -0.328  0.219  0.024 -0.096 0.283 0.557 -0.281 -0.341
  6 0.385 -0.175 -0.242 -0.072 -0.068  0.130 -0.080  0.165 0.228 0.322  0.150 -0.507
  7 0.052 -0.404 -0.310 -0.118  0.059  0.342  0.195  0.113 0.146 0.068 -0.187 -0.275
 Regression statistics
 Ages with q dependent on year class strength
[1] "0.663833965601687" "10.5759287506063"
```

continued
Table 4.2.12 Herring in SD 25–29, 32 (excl. GoR). Output from XSA final run: Diagnostics. 2/2

```
 Terminal year survivor and F summaries:

 ,Age 1 Year class =2016
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.660   8835284  2016
fshk                                      0.029  22379743  2016
nshk                                      0.311  11461770  2016

 ,Age 2 Year class =2015
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.957   5111852  2015
fshk                                      0.043   8287208  2015

 ,Age 3 Year class =2014
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.949  11822590  2014
fshk                                      0.051  18664867  2014

 ,Age 4 Year class =2013
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.927   1719645  2013
fshk                                      0.073   3757351  2013

 ,Age 5 Year class =2012
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.921   1380880  2012
fshk                                      0.079   3605282  2012

 ,Age 6 Year class =2011
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.947    689179  2011
fshk                                      0.053   1962570  2011

 ,Age 7 Year class =2010
source
                                      scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.935    230266  2010
fshk                                      0.065    594664  2010
```

Table 4.2.13. Herring in SD 25–29, 32 (excl. GoR). Fishing Mortality (F) at age.

Terminal Fs derived using XSA (With F shrinkage)

year	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8+
1974	0.1715	0.127	0.1707	0.2264	0.1685	0.1724	0.19	0.19
1975	0.1809	0.1385	0.1782	0.201	0.231	0.1911	0.2088	0.2088
1976	0.0973	0.1772	0.1823	0.1786	0.177	0.2361	0.1982	0.1982
1977	0.1175	0.1289	0.1953	0.1645	0.1867	0.2085	0.1875	0.1875
1978	0.0856	0.1932	0.1736	0.1719	0.1434	0.1687	0.1621	0.1621
1979	0.0407	0.1565	0.2066	0.2015	0.2066	0.1668	0.1926	0.1926
1980	0.0737	0.1549	0.2071	0.1922	0.1798	0.1698	0.1814	0.1814
1981	0.055	0.1937	0.2015	0.2212	0.1968	0.1919	0.2043	0.2043
1982	0.0391	0.1634	0.1812	0.1657	0.1826	0.1664	0.1725	0.1725
1983	0.0436	0.1329	0.2433	0.2435	0.1838	0.2263	0.219	0.219
1984	0.0346	0.1137	0.1722	0.2653	0.2551	0.2021	0.2422	0.2422
1985	0.0671	0.1412	0.1685	0.191	0.2815	0.2778	0.2516	0.2516
1986	0.0584	0.1467	0.1713	0.2123	0.2171	0.2083	0.2137	0.2137
1987	0.0528	0.1137	0.1948	0.2136	0.2504	0.2635	0.2439	0.2439
1988	0.0607	0.1834	0.1783	0.219	0.2409	0.237	0.2337	0.2337
1989	0.0669	0.1006	0.2947	0.2211	0.3064	0.3376	0.2902	0.2902
1990	0.0394	0.1473	0.1615	0.3282	0.2616	0.3489	0.3151	0.3151
1991	0.0293	0.1348	0.2459	0.2161	0.3861	0.2868	0.2982	0.2982
1992	0.073	0.123	0.2192	0.2124	0.2105	0.3687	0.2653	0.2653
1993	0.0587	0.1759	0.248	0.3134	0.3016	0.2829	0.3013	0.3013
1994	0.0379	0.1131	0.2323	0.2945	0.4092	0.4421	0.3849	0.3849
1995	0.0482	0.103	0.2678	0.4052	0.3065	0.3125	0.344	0.344
1996	0.0694	0.1178	0.1728	0.3204	0.3963	0.4281	0.3847	0.3847
1997	0.0658	0.1353	0.2153	0.2999	0.4456	0.4845	0.4137	0.4137
1998	0.1492	0.1645	0.2896	0.3825	0.3741	0.484	0.4205	0.4205
1999	0.0894	0.206	0.2659	0.3787	0.3893	0.2815	0.3707	0.3707
2000	0.145	0.202	0.3604	0.4199	0.5028	0.4605	0.2692	0.2692
2001	0.1143	0.2396	0.2076	0.4131	0.3706	0.4796	0.5146	0.5146
2002	0.1182	0.165	0.2803	0.2559	0.4196	0.3226	0.4201	0.4201
2003	0.0752	0.1308	0.1709	0.2388	0.2403	0.3417	0.2771	0.2771
2004	0.057	0.0964	0.1658	0.2174	0.2116	0.2391	0.3148	0.3148
2005	0.0424	0.09	0.1318	0.2103	0.2292	0.1856	0.1892	0.1892
2006	0.0606	0.0902	0.129	0.1841	0.2484	0.2586	0.1992	0.1992
2007	0.0392	0.0964	0.1641	0.1807	0.2151	0.2694	0.2128	0.2128
2008	0.0353	0.0875	0.1484	0.1852	0.1945	0.3106	0.279	0.279
2009	0.0398	0.0877	0.1308	0.2054	0.1922	0.218	0.3942	0.3942
2010	0.0465	0.0559	0.1281	0.1828	0.2553	0.3081	0.311	0.311
2011	0.0421	0.0711	0.0993	0.17	0.1896	0.2193	0.25	0.25
2012	0.0231	0.0652	0.0754	0.0984	0.151	0.1695	0.1814	0.1814
2013	0.0314	0.063	0.075	0.1051	0.1272	0.1394	0.1884	0.1884
2014	0.0418	0.0842	0.1386	0.1607	0.1838	0.1632	0.1427	0.1427
2015	0.0362	0.0935	0.1744	0.2725	0.2457	0.2249	0.2247	0.2247
2016	0.0542	0.1097	0.1746	0.2621	0.3114	0.3707	0.4852	0.4852
2017	0.0833	0.1059	0.1565	0.2492	0.3522	0.3441	0.5495	0.5495

Table 4.2.14. Herring in SD 25–29, 32 (excl. GoR). Stock number-at-age (Number*10-4).**

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	18113439	15088923	7893928	7457062	3475396	2429026	3980773	1823814
1975	13328497	11117026	9902976	5155396	4734073	2360156	1629989	3224180
1976	26357070	7923057	7070597	6263226	3296169	2986617	1532708	3056466
1977	13398355	17546325	4984946	4536853	4111280	2195599	1865182	3561003
1978	15699258	8545326	11425850	3136093	3008913	2689461	1393455	3550214
1979	12852771	9465931	5269002	7184690	2053995	2033909	1790339	3029846
1980	18709550	7724411	6155478	3379314	4591034	1305950	1368928	3668326
1981	31182196	10574280	4429872	3604216	2196869	2881435	882629	3158403
1982	29084783	18608680	5832417	2562501	2135928	1382496	1788526	2985552
1983	22117019	16924115	10417307	3419074	1583722	1363614	922691	2446028
1984	29432137	13200985	9639219	5677892	1919768	1012985	861123	2166880
1985	22861666	19129787	8122176	5741400	3264266	1115011	660040	1735754
1986	11512725	14883771	11817628	5009280	3582094	1920119	666751	1206281
1987	20979742	7786350	9370905	7380775	3104236	2228446	1226545	993403
1988	9385674	14486112	5232521	5855268	4525610	1883842	1365301	1121148
1989	14180038	6488651	8951261	3339045	3613965	2732737	1180831	1480583
1990	18987100	9907090	4444794	5050261	2052097	2066543	1536651	1258843
1991	14566106	14043603	6624678	2950678	2827560	1245551	1152077	1024304
1992	17837719	11090168	9666581	4109645	1900358	1528901	751404	1034882
1993	16412629	13001608	7723969	6174099	2655290	1242622	848557	597368
1994	14849303	12067871	8508451	4730961	3550770	1557969	749673	981166
1995	19786861	11123643	8394581	5275347	2764397	1854376	793224	812513
1996	16624113	14661877	7809140	5015377	2754688	1593391	1062432	781827
1997	9806995	12122032	10193207	5138762	2850920	1453452	816523	615360
1998	15396681	7111732	8199625	6373313	2958453	1422544	697598	607339
1999	8423950	10214564	4653667	4734486	3362118	1578361	683076	435953
2000	15608640	5873267	6337746	2723415	2489600	1749141	919823	882406
2001	11115702	10322461	3673660	3399681	1376589	1162782	852256	553877
2002	10624693	7625560	6255128	2303853	1736052	738515	561072	751686
2003	20989359	7199037	4930768	3630028	1375715	880165	416612	930590
2004	13391691	15280840	4963008	3272874	2266180	855116	495774	533697
2005	8899602	9915091	10876732	3317780	2077926	1452696	536408	1029597
2006	15642078	6646478	7060617	7447891	2108164	1306550	961642	913502
2007	13579922	11368580	4727623	4830815	4822628	1280116	798151	653266
2008	26055248	10038257	8007983	3112089	3127905	3030558	772164	995240
2009	19420327	19190571	7029922	5309850	1988860	1988719	1715622	834381
2010	14094909	13878558	13163838	4618936	3251233	1241140	1221333	1543655
2011	8414568	9778440	9609748	8520727	2830664	1863993	678098	1225462
2012	16955522	5773708	6543521	6268959	5179053	1692233	1086772	1401610
2013	17582712	12292679	4095693	4658195	4413744	3484555	1127176	1453113
2014	13247366	12779486	8814741	2937575	3276409	3056413	2401871	2100986
2015	45954446	9547747	8985686	5940748	1956559	2145846	2058696	2617772
2016	13209638	33263007	6643792	5837747	3535795	1203796	1358111	1812756
2017	14168516	9353807	22702785	4304265	3503426	2033378	657527	1076515

Table 4.2.15. Herring in SD 25–29, 32 (excl. GoR). Output from XSA: Stock Summary.

Summary (without SOP correction)

Year	RECRUITS Age 1	TOTALBIO	TOTSPBIO	FBAR 3- 6
1974	18113439	2659816	1683199	0.185
1975	13328497	2384811	1577243	0.200
1976	26357070	2297512	1368713	0.193
1977	13398355	2320827	1521763	0.189
1978	15699258	2238980	1441563	0.164
1979	12852771	2078123	1409790	0.195
1980	18709550	2141152	1358669	0.187
1981	31182196	2455085	1288090	0.203
1982	29084783	2562232	1433825	0.174
1983	22117019	2284335	1407419	0.224
1984	29432137	2186595	1320444	0.224
1985	22861666	2015386	1269393	0.230
1986	11512725	1755034	1204273	0.202
1987	20979742	1764123	1148973	0.231
1988	9385674	1669046	1152968	0.219
1989	14180038	1632310	1015712	0.290
1990	18987100	1479057	872894	0.275
1991	14566106	1374370	785359	0.284
1992	17837719	1267819	805439	0.253
1993	16412629	1211719	757457	0.286
1994	14849303	1247699	766079	0.345
1995	19786861	1095501	663649	0.323
1996	16624113	992198	607555	0.329
1997	9806995	867945	568069	0.361
1998	15396681	839425	518262	0.383
1999	8423950	698191	438376	0.329
2000	15608640	797485	438584	0.436
2001	11115702	713632	402051	0.368
2002	10624693	702752	414221	0.320
2003	20989359	811914	474095	0.248
2004	13391691	740917	478235	0.208
2005	8899602	786667	538093	0.189
2006	15642078	932003	595604	0.205
2007	13579922	969331	625795	0.207
2008	26055248	1169891	638154	0.210
2009	19420327	1197940	731833	0.187
2010	14094909	1191623	784462	0.219
2011	8414568	1091122	773620	0.170
2012	16955522	1223079	812923	0.124
2013	17582712	1240621	836820	0.112
2014	13247366	1272252	896159	0.162
2015	45954446	1370051	828008	0.229
2016	13209638	1169225	779717	0.280
2017	14168516	1235385	837924	0.276

Table 4.2.16. Herring in SD 25–29, 32 (excl. GoR). Configuration settings of SAM.

```
# Min Age (should not be modified unless data is modified accordingly)
1
# Max Age (should not be modified unless data is modified accordingly)
8
# Max Age considered a plus group (0=No, 1=Yes)
1
# The following matrix describes the coupling
# of fishing mortality STATES
# Rows represent fleets.
# Columns represent ages.
1	2	3	4	5	6	7	7
0	0	0	0	0	0	0	0
# Use correlated random walks for the fishing mortalities
# ( 0 = independent, 1 = correlation estimated)
1
# Coupling of catchability PARAMETERS
0	0	0	0	0	0	0	0
1	2	3	4	5	6	7	8
# Coupling of power law model EXPONENTS (if used)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
# Coupling of fishing mortality RW VARIANCES
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
# Coupling of log N RW VARIANCES
1	2	2	2	2	2	2	2
# Coupling of OBSERVATION VARIANCES
1	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
# Stock recruitment model code (0=RW, 1=Ricker, 3=BH, ... more in time)
0
# Years in which catch data are to be scaled by an estimated parameter
0
# first the number of years
# Then the actual years
# Them the model config lines years cols ages
# Define Fbar range
3	6
```

Table 4.2.17. Herring in SD 25–29, 32 (excl. GoR). Input for RCT3 analysis.

Yearclass VPA Age 1 (thousands)		Acoustic (SD 25-29S+N) Age 0 (thousands)
year	rec xsa sh	bias 0yo
1991	17838	13733
1992	16413	1608
1993	14849	-11
1994	19787	6122
1995	16624	-11
1996	9807	336
1997	15397	-11
1998	8424	508
1999	15609	2591
2000	11116	1319
2001	10625	2123
2002	20989	16046
2003	13392	9067
2004	8900	1587
2005	15642	5568
2006	13580	1990
2007	26055	12197
2008	19420	8673
2009	14095	3366
2010	8415	1178
2011	16956	10098
2012	17583	11141
2013	13247	3068
2014	45954	35061
2015	13210	7662
2016	-11	2957
2017	-11	7184

Table 4.2.18. Herring in SD 25–29, 32 (excl. GoR). Output from RCT3 analysis.

Analysis by RCT3 ver3.1 of data from file : rect3in.txt
Herring 25-29, 32 (excl. GOR). RCT3 input data.
Data for 1 surveys over 27 years: 1991 - 2017
Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Yearclass			2011						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.39	6.33	.22	0.751	17	9.22	9.96	0.262	0.643
					VPA	Mean =	9.54	0.351	0.357
Yearclass			2012						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.39	6.33	.21	0.758	18	9.32	9.97	0.249	0.657
					VPA	Mean =	9.56	0.345	0.343
Yearclass			2013						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.39	6.34	.20	0.767	19	8.03	9.45	0.227	0.689
					VPA	Mean =	9.58	0.338	0.311
Yearclass			2014						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.39	6.27	.19	0.775	20	10.46	10.4	0.251	0.627
					VPA	Mean =	9.58	0.326	0.373
Yearclass			2015						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.47	5.63	.22	0.828	21	8.94	9.85	0.249	0.769
					VPA	Mean =	9.68	0.454	0.231
Yearclass			2016						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.50	5.38	.24	0.794	22	7.99	9.35	0.276	0.723
					VPA	Mean =	9.68	0.445	0.277
Yearclass			2017						
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BIAS 0	.51	5.30	.24	0.801	22	8.88	9.79	0.275	0.731
					VPA	Mean =	9.69	0.453	0.269

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA
2011	18223	9.81	0.21	0.2	0.95	16956
2012	18554	9.83	0.2	0.2	0.95	17584
2013	13187	9.49	0.19	0.06	0.11	13248
2014	24212	10.09	0.2	0.4	4	45955
2015	18270	9.81	0.22	0.07	0.11	13210
2016	12621	9.44	0.23	0.15	0.39	
2017	17383	9.76	0.24	0.04	0.04	

Table 4.2.19. Herring in SD 25–29, 32 (excl. GoR). Input data for short-term predictions.

MFDP version 1a
Run: v2
Time and date: 08:11 07/04/2018
Fbar age range: 3-6

2018

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	17383000	0.2864	0	0.35	0.3	0.0089	0.0781	0.0089
2	9839671	0.2686	0.7	0.35	0.3	0.0177	0.1390	0.0177
3	6458412	0.2565	0.9	0.35	0.3	0.0245	0.2272	0.0245
4	15071230	0.2461	1	0.35	0.3	0.0315	0.3524	0.0315
5	2630322	0.2397	1	0.35	0.3	0.0362	0.4088	0.0362
6	1942822	0.2323	1	0.35	0.3	0.0393	0.4224	0.0393
7	1144764	0.2260	1	0.35	0.3	0.0453	0.5662	0.0453
8	303259	0.2202	1	0.35	0.3	0.0500	0.5662	0.0500

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	14843754	0.2864	0	0.35	0.3	0.0089	0.0781	0.0089
2		0.2686	0.7	0.35	0.3	0.0177	0.1390	0.0177
3		0.2565	0.9	0.35	0.3	0.0245	0.2272	0.0245
4		0.2461	1	0.35	0.3	0.0315	0.3524	0.0315
5		0.2397	1	0.35	0.3	0.0362	0.4088	0.0362
6		0.2323	1	0.35	0.3	0.0393	0.4224	0.0393
7		0.2260	1	0.35	0.3	0.0453	0.5662	0.0453
8		0.2202	1	0.35	0.3	0.0500	0.5662	0.0500

2020

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	14843754	0.2864	0	0.35	0.3	0.0089	0.0781	0.0089
2		0.2686	0.7	0.35	0.3	0.0177	0.1390	0.0177
3		0.2565	0.9	0.35	0.3	0.0245	0.2272	0.0245
4		0.2461	1	0.35	0.3	0.0315	0.3524	0.0315
5		0.2397	1	0.35	0.3	0.0362	0.4088	0.0362
6		0.2323	1	0.35	0.3	0.0393	0.4224	0.0393
7		0.2260	1	0.35	0.3	0.0453	0.5662	0.0453
8		0.2202	1	0.35	0.3	0.0500	0.5662	0.0500

Input units are thousands and kg - output in tonnes

M =	Natural mortality
MAT =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWT =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWT =	Weight in catch (kg)

N_{2016} Age 1:	Output form RCT3 Analysis (Table 6.2.17)
N_{2016} Age 2-8+:	Output from VPA (Table 6.2.14)
$N_{2017/2018}$ Age 1:	Geometric Mean from VPA-Output of age 1 (Table 6.2.15) for the years 1988-2015
Natural Mortality (M):	Average of 2015-2017
Weight in the Catch/Stock (CWt/SWt)	Average of 2015-2017
Expoitation pattern (Sel):	Average of 2015-2017

Table 4.2.20. Herring in SD 25–29, 32 (excl. GoR). Output from short-term predictions with management option table for *'TAC constraint' in 2018. 1/2

MFDP version 1a Run: v2 herring cbd Prediction Time and date: 08:42 12/04/2018 F

2018				
Biomass	SSB	FMult	FBar	Landings
1200416	808714	0.9999	0.3527	262935

2019					2020	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1064038	791368	0	0	0	1200258	916969
	782065	0.1	0.0353	27076	1172133	880801
	772888	0.2	0.0705	53220	1144977	846367
	763833	0.3	0.1058	78467	1118751	813576
	754899	0.4	0.1411	102853	1093418	782338
	746085	0.5	0.1764	126413	1068944	752572
	737388	0.6	0.2116	149177	1045294	724200
	728807	0.7	0.2469	171178	1022437	697149
	720340	0.8	0.2822	192444	1000341	671348
	711985	0.9	0.3174	213004	978978	646733
	703741	1	0.3527	232886	958319	623242
	695607	1.1	0.388	252115	938337	600816
	687580	1.2	0.4232	270717	919005	579401
	679659	1.3	0.4585	288715	900300	558945
	671843	1.4	0.4938	306132	882196	539398
	664130	1.5	0.5291	322991	864673	520714
	656518	1.6	0.5643	339312	847706	502849
	649007	1.7	0.5996	355115	831276	485763
	641594	1.8	0.6349	370421	815362	469415
	634279	1.9	0.6701	385248	799946	453769
	627059	2	0.7054	399613	785008	438790

TAC constraint in 2018	
EU	229355
+EU/Russia	29500
+CBH in GOR	4340
–GORH	260
Total	262935
Mean catches in 2012–2016	

continued

Table 4.2.20. Herring in SD 25–29, 32 (excl. GoR). Output from short-term predictions with management option table for *'TAC constraint' in 2018. 2/2

Basis	Total catch (2018)	Ftotal (2018)	SSB (2019)	SSB (2020)	% SSB change *	% Advice change **
ICES advice basis						
EU MAP^ : FMSY	155333	0.22	735005	716594	-3%	-42%
Other options						
F = 0	0	0	791368	916969	16%	-100%
Fpa	263813	0.41	690577	587317	-15%	-1%
Flim	318710	0.52	666102	525436	-21%	19%
SSB (2019) = Blim	408365	0.731	622595	429752	-31%	53%
SSB (2019) = Bpa	254003	0.3915	694799	598630	-14%	-5%
SSB (2019) = MSY Btrigger	254003	0.3915	694799	598630	-14%	-5%
F = F2018	232886	0.3527	703741	623242	-11%	-13%
F = MAP FMSY lower	115591	0.16	750157	766194	2%	-42.27%***
F = MAP FMSY lower differing by 0.01	122381	0.1702	747607	757638	1%	-54%
F = MAP FMSY lower differing by 0.02	129103	0.1805	745067	749200	1%	-52%
F = MAP FMSY lower differing by 0.03	135758	0.1907	742536	740878	0%	-49%
F = MAP FMSY lower differing by 0.04	142348	0.2009	740016	732671	-1%	-47%
F = MAP FMSY lower differing by 0.05	148873	0.2111	737505	724577	-2%	-44%
F = MAP FMSY lower differing by 0.07	161730	0.2316	732513	708721	-3%	-40%
F = MAP FMSY lower differing by 0.08	168064	0.2418	730032	700955	-4%	-37%
F = MAP FMSY lower differing by 0.09	174336	0.2521	727560	693295	-5%	-35%
F = MAP FMSY lower differing by 0.10	180547	0.2623	725098	685740	-5%	-33%
F = MAP FMSY lower differing by 0.11	186697	0.2725	722645	678287	-6%	-30%
F = MAP FMSY upper	192787	0.2827	720202	670935	-7%	-41.85%****
-20% tac change^^	210703	0.3134	712928	649472	-9%	-21%

* SSB 2020 relative to SSB 2019.

** Advice value in 2019 relative to Advice value for EU MAP: F_{MSY} 2018 (267 745t).

*** Advice value for in 2019 relative to Advice value for EU MAP: F_{lower} 2018 (115 593t).

**** Advice value for in 2019 relative to Advice value for EU MAP: F_{upper} 2018 (192 789t).

^ MAP multiannual plan (EU, 2016).

^^ TAC = TAC in 2018: EU share 229 355 t + Russian quota 29 500 t + central Baltic herring stock caught in Gulf of Riga 4 340 t (mean 2012–2016) – Gulf of Riga herring stock caught in central Baltic Sea 260 t (mean 2012–2016) = 262 935 t.

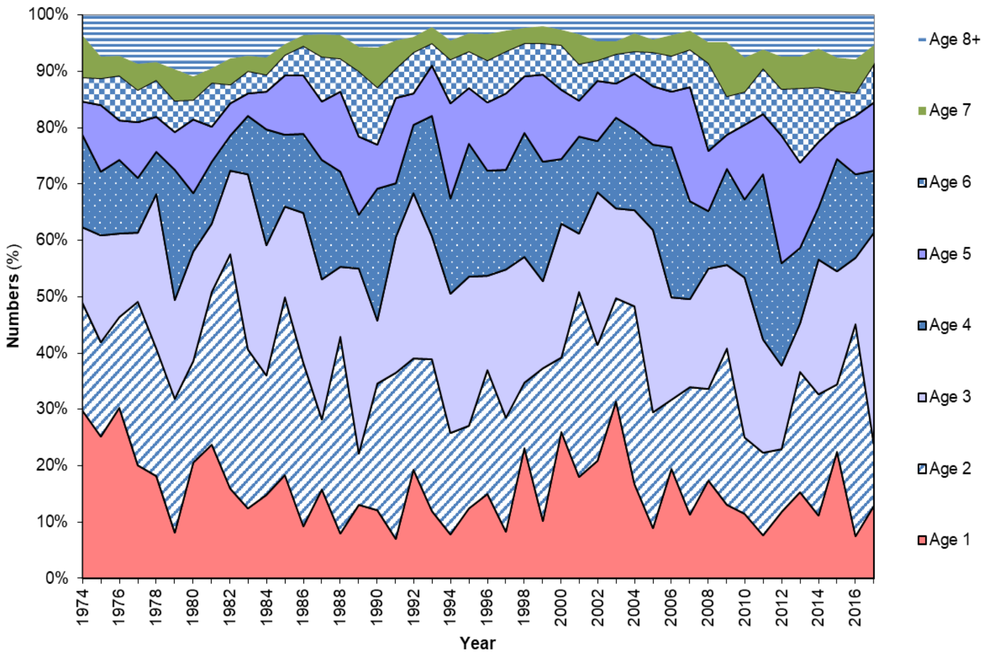


Figure 4.2.1. **Herring in SD 25–29, 32 (excl. GoR). Proportions of age groups (numbers) in total catch (CANUM).**

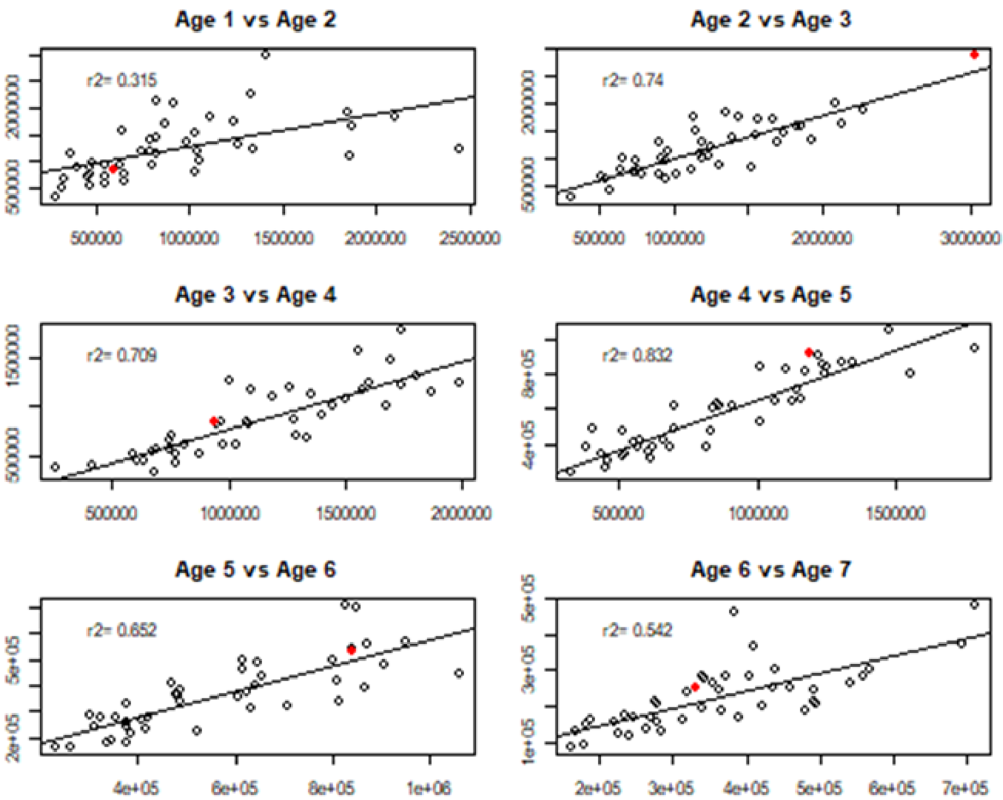


Figure 4.2.2. **Herring in SD 25–29, 32 (excl. GoR). Catch in numbers (thousands) at age vs. numbers-at-age +1 of the same cohort in the following year in the period 1974–2017.**

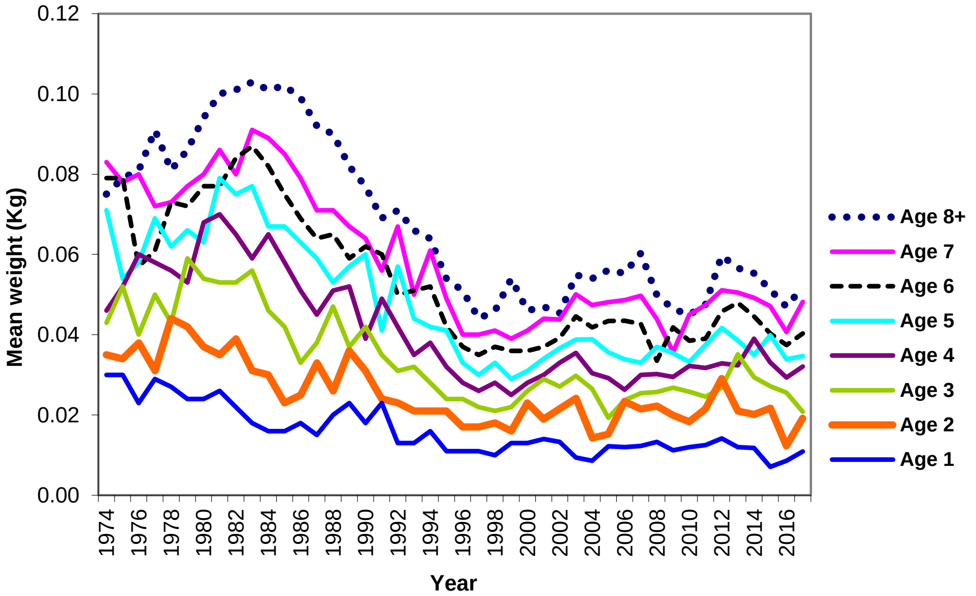


Figure 4.2.3. **Herring in SD 25–29, 32 (excl. GoR). Trends in the mean weights at age (kg) in the catch (WECA).**

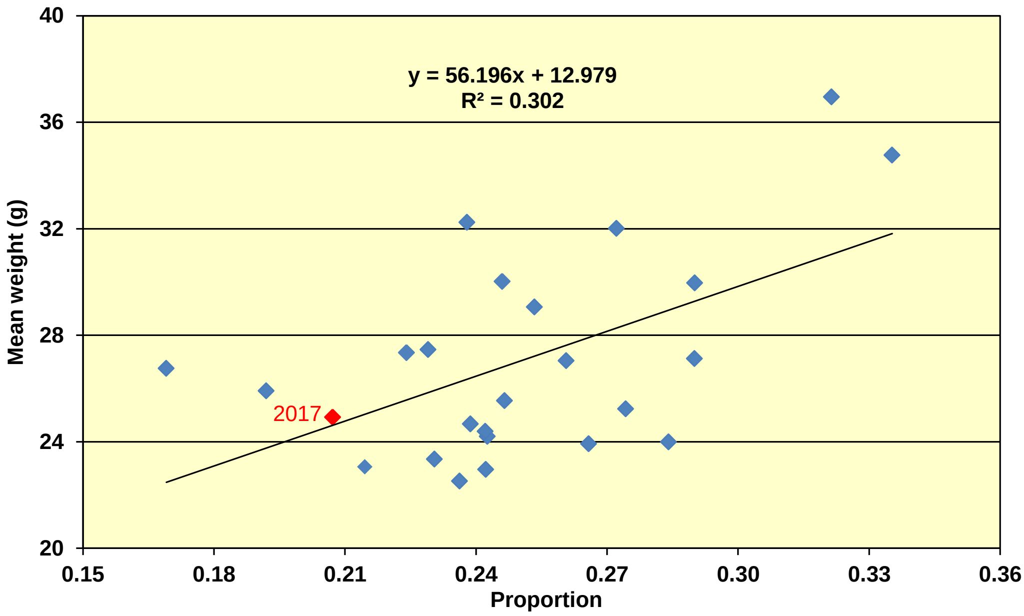


Figure 4.2.4. **Herring in SD 25–29, 32 (excl. GoR).Average individual weight in catches vs. the proportion of catches taken in SD 25 and 26 (1993–2017).**

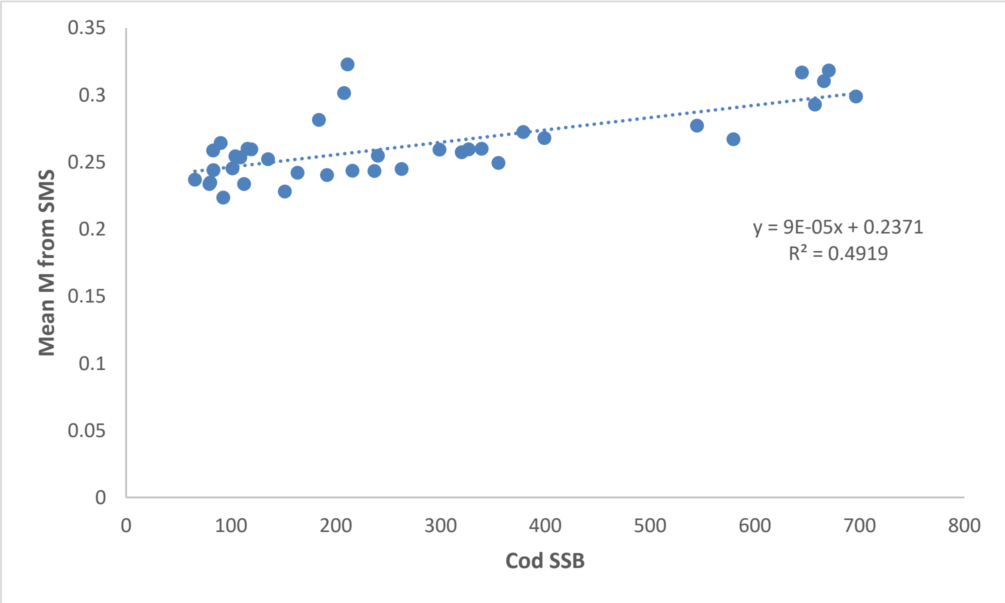


Figure 4.2.5a. **Herring in SD 25–29, 32 (excl. GoR). The dependence of average M for herring on cod SSB.**

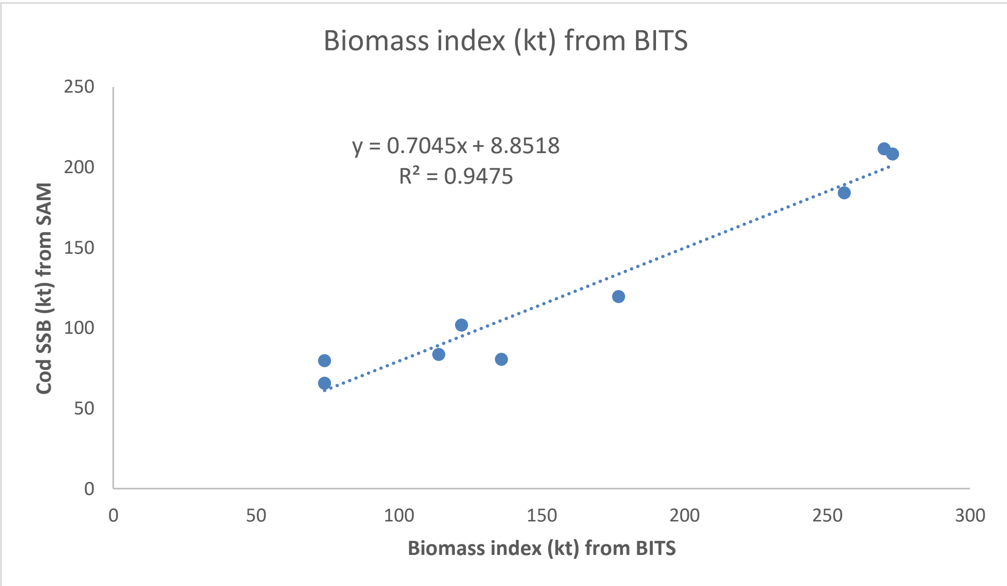


Figure 4.2.5b. **Herring in SD 25–29, 32 (excl. GoR). The relationship between cod SSB and biomass index from BITS (years 2003–2011).**

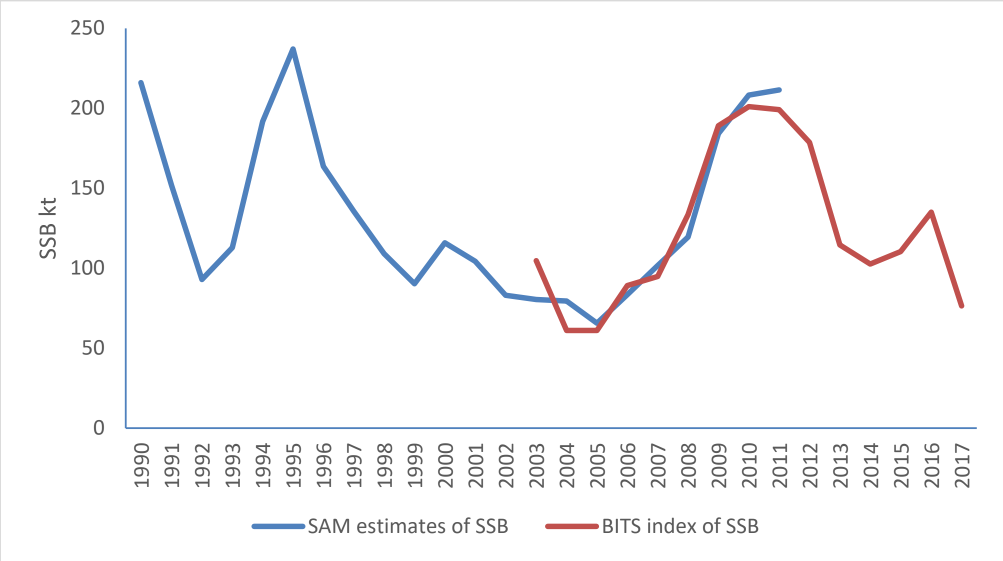


Figure 4.2.5c. Herring in SD 25–29, 32 (excl. GoR). The biomass index from BITS rescaled to level of cod SSB from last accepted assessment (2012).

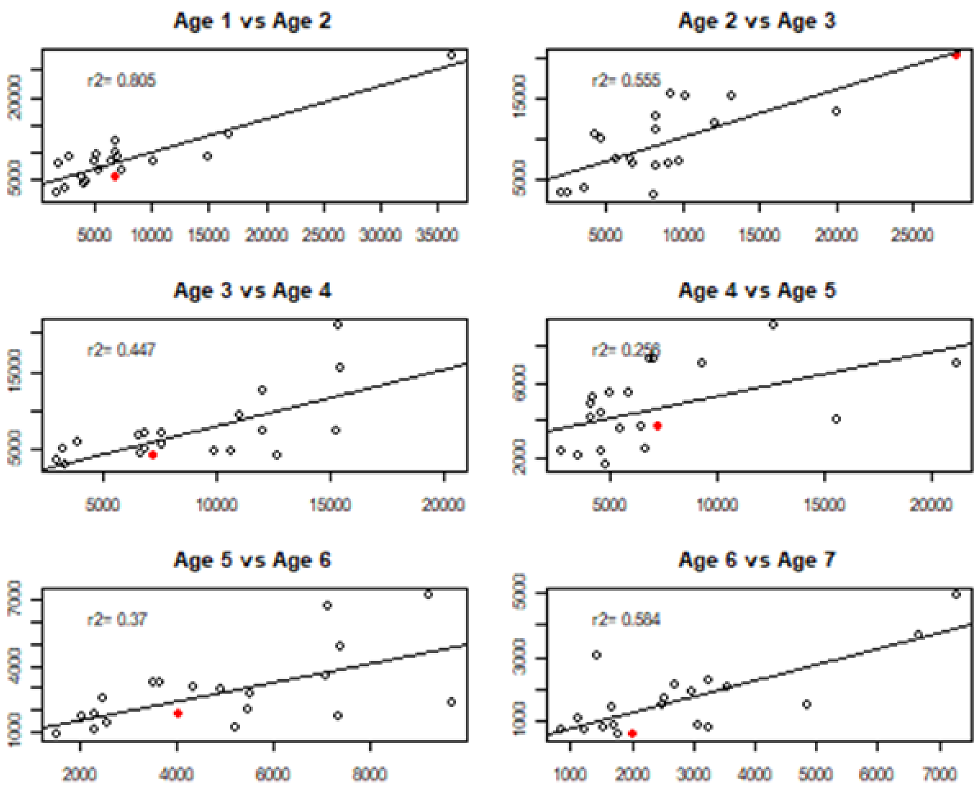


Figure 4.2.6. Herring in SD 25–29, 32 (excl. GoR). Acoustic survey numbers-at-age vs. numbers-at-age +1 of the same cohort in the following year in the period 1991–2016 (STANDARD INDEX). Years 1993, 1995, and 1997 were excluded.

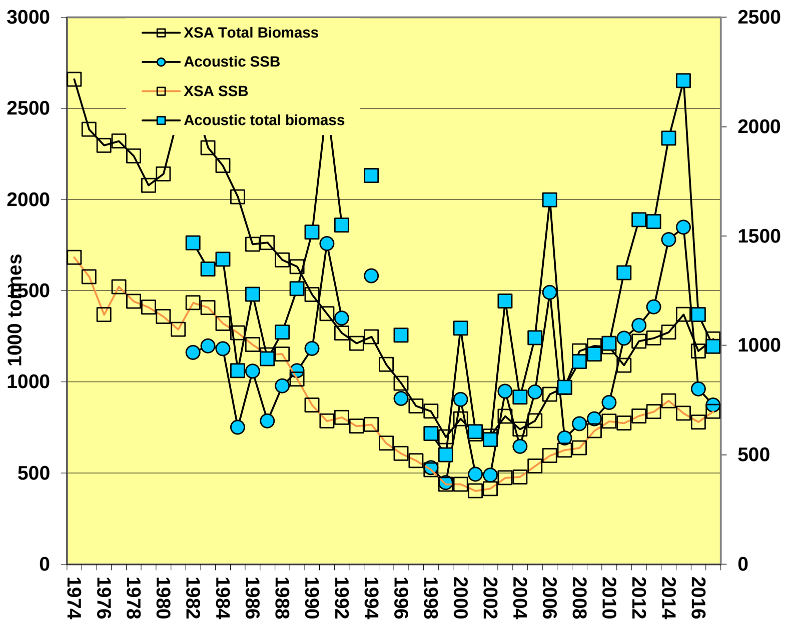


Figure 4.2.7. Herring in SD 25–29, 32 (excl. GoR). Estimates of biomass and SSB from acoustic surveys (BIAS) and from XSA. Acoustic biomasses = Acoustic abundance x WECA; Acoustic SSB = Acoustic abundance x WECA x MATPROP

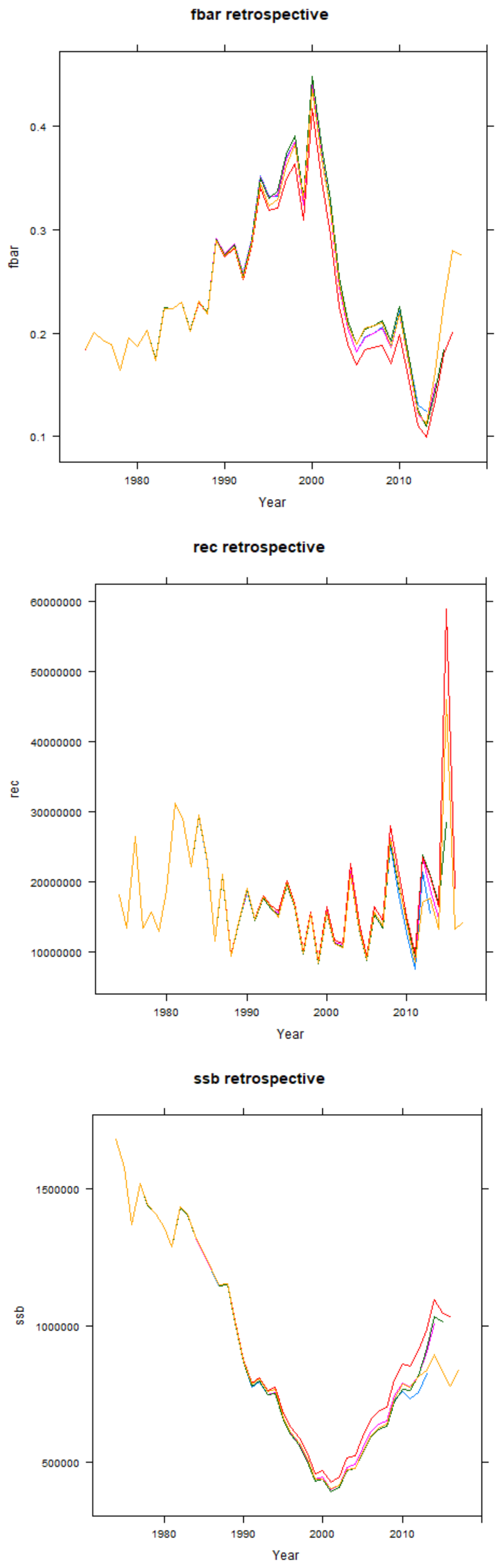
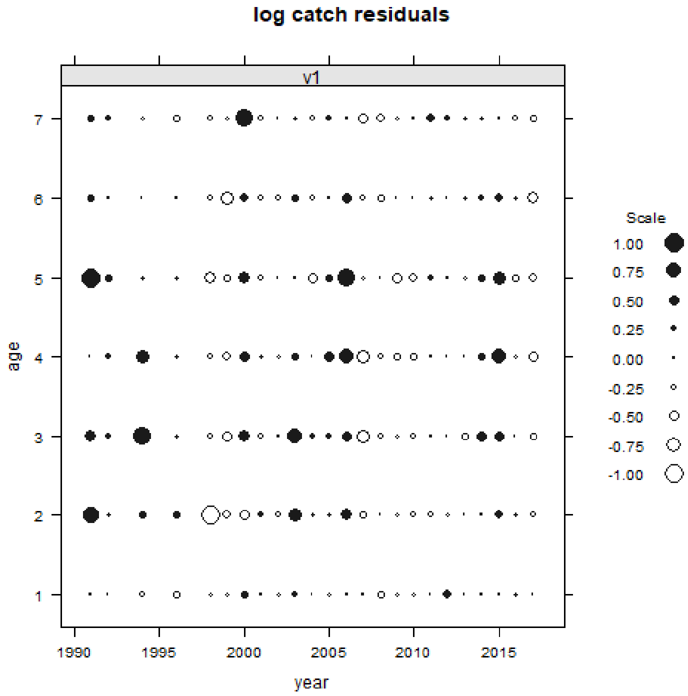


Figure 4.2.8. Herring in SD 25–29, 32 (excl. GoR). Retrospective Analysis.



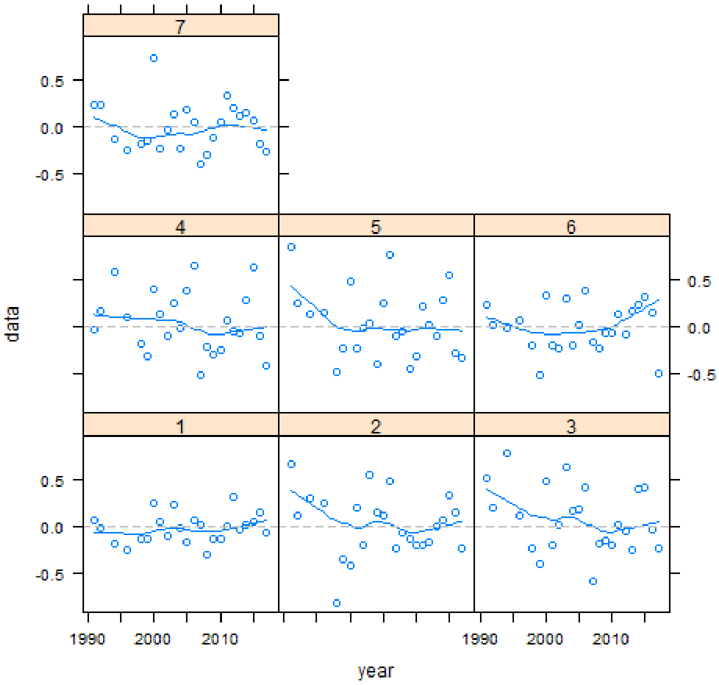


Figure 4.2.9. **Herring in SD 25–29, 32 (excl. GoR). International Acoustic Survey (Ages 1–7): Log Catchability residuals. Standardized log catchability residuals (top figure). Observed (circles) vs predicted (line) numbers (bottom figure).**

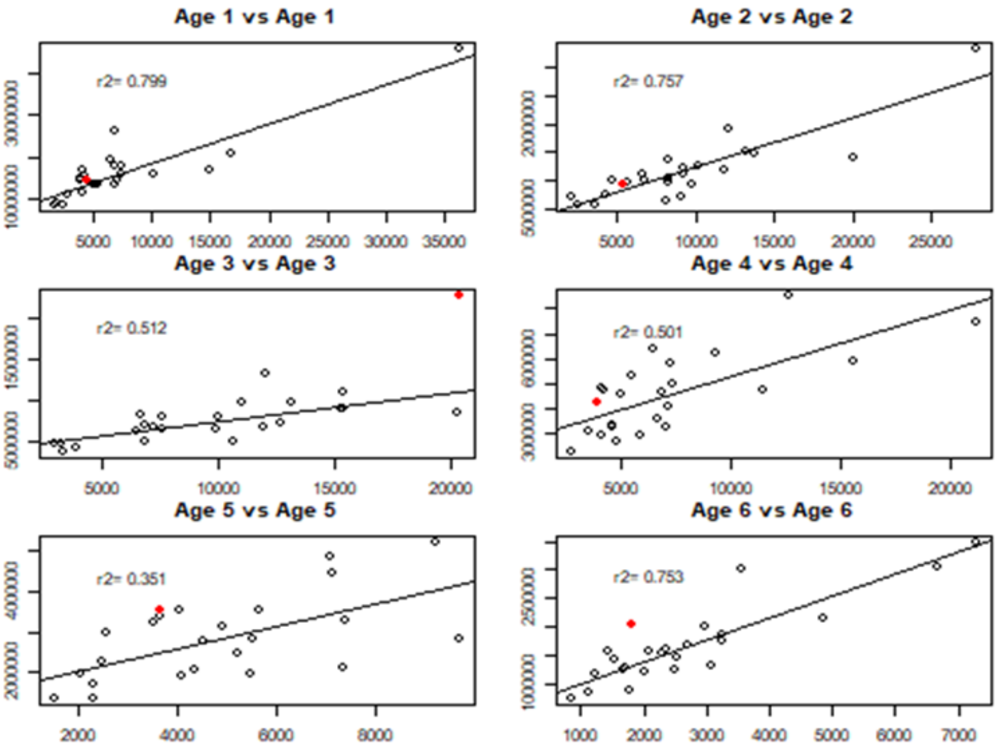


Figure 4.2.10. **Herring in SD 25–29, 32 (excl. GoR). Regression of XSA population vs. acoustic survey population numbers. x-axis = Acoustic estimates; y-axis = XSA.**

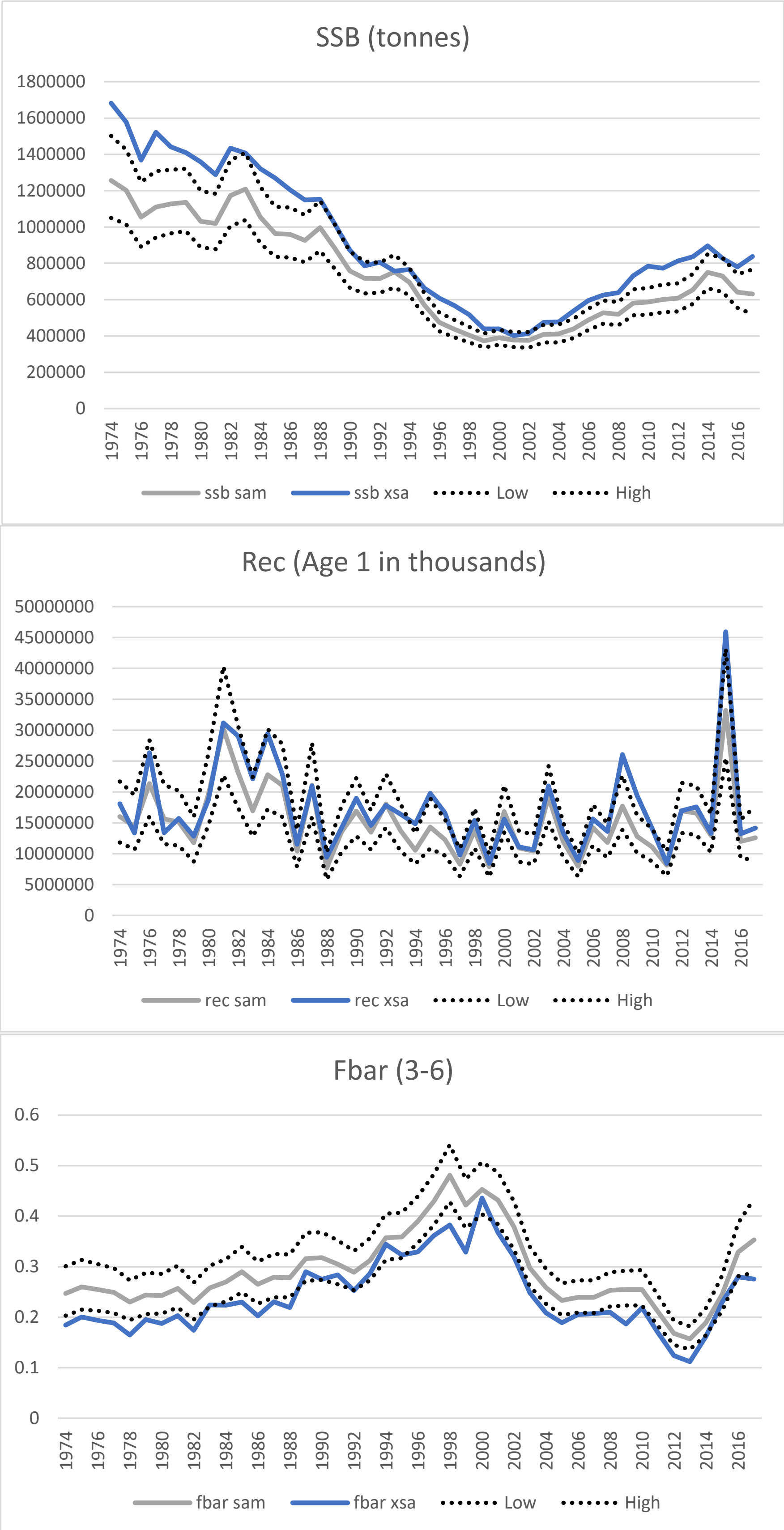


Figure 4.2.11. **Herring in SD 25–29, 32 (excl. GoR). Comparison of fishing mortality (F_{3-6}), spawning stock biomass (SSB) and recruitment (age 1) from XSA and SAM (dotted line represents the 95% confidence intervals of the SAM results).**

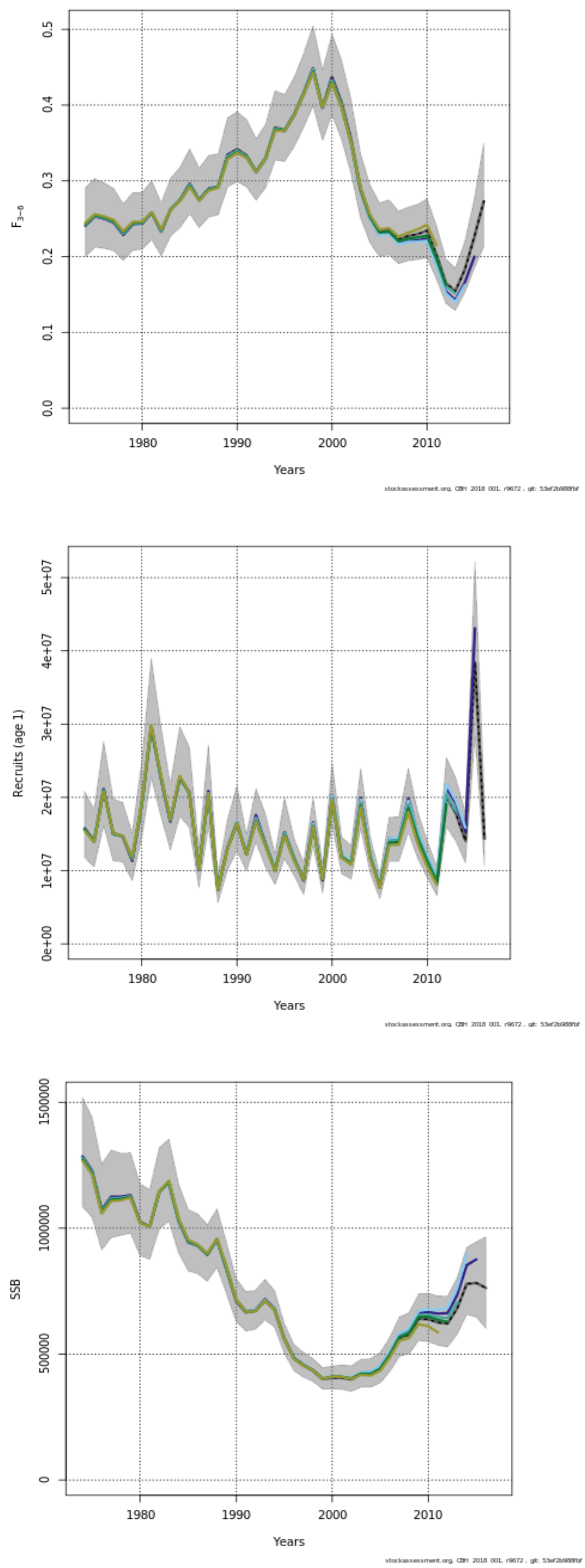


Figure 4.2.12. Herring in SD 25–29, 32 (excl. GoR). Retrospective of SAM.

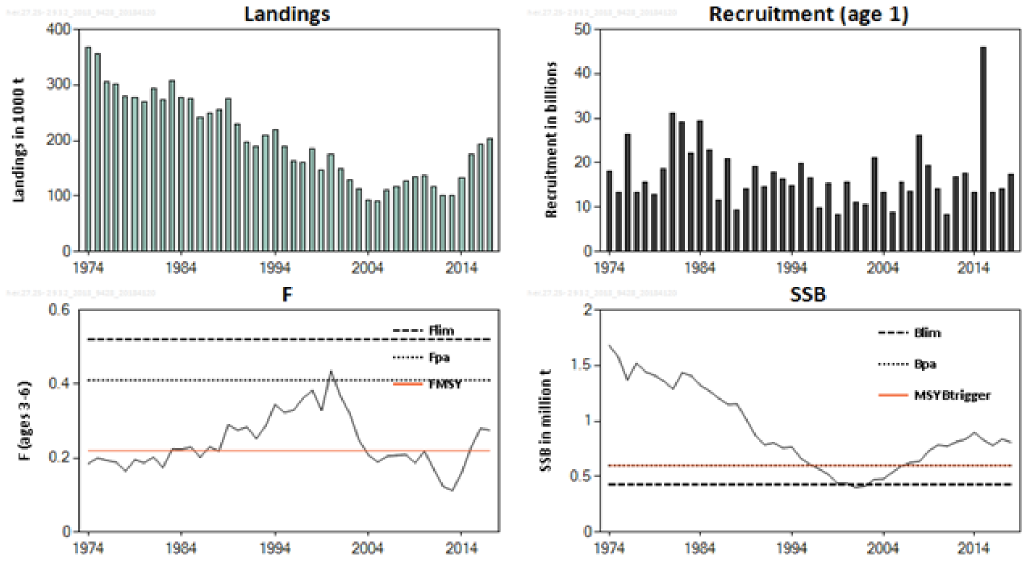


Figure 4.2.13. Herring in SD 25–29, 32 (excl. GoR). Summary sheet plots: Catches, fishing mortality, recruitment (age 1) and SSB. (Recruitment in 2017 from RCT3 & SSB in 2016 predicted)

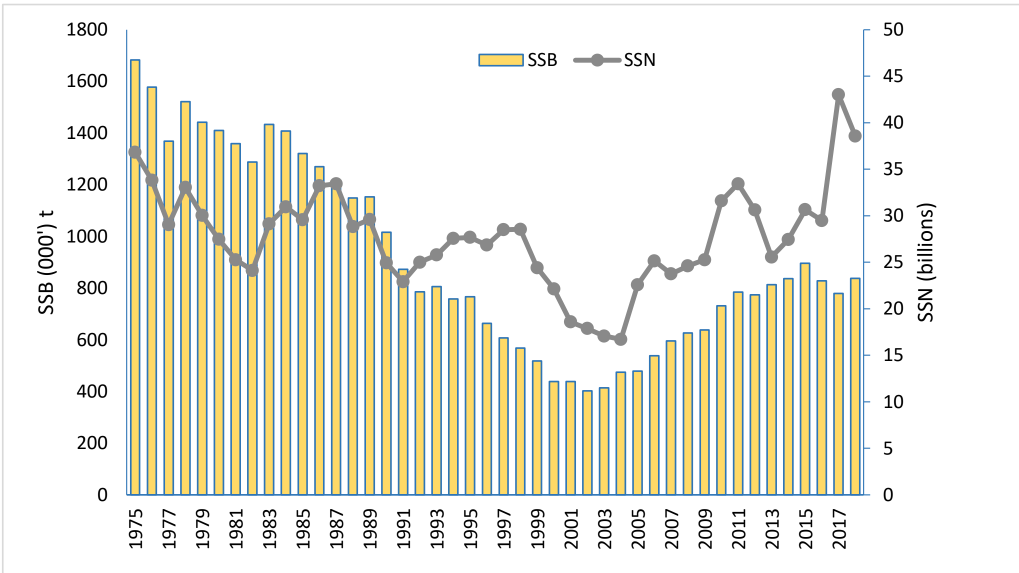


Figure 4.2.14. Herring in SD 25–29, 32 (excl. GoR). SSB (000' t) and Spawning Stock in Numbers (SSN) (billions).

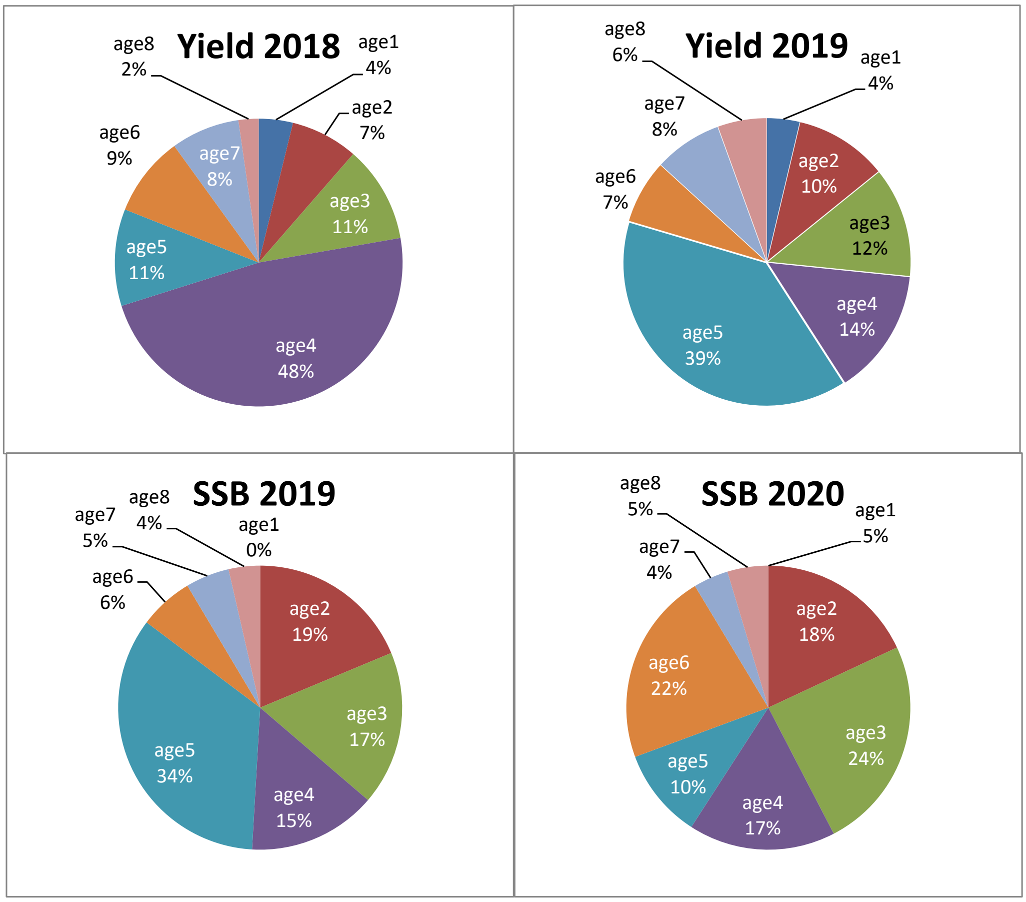


Figure 4.2.15. **Herring in SD 25–29, 32 (excl. GoR). Yield and SSB at age 1-8+ as estimated in the short-term forecast for 2018-2020 under the TAC constraint 2018.**

4.3 Gulf of Riga herring (Subdivision 28.1) (update assessment)

Gulf of Riga herring is a separate population of Baltic herring (*Clupea harengus membras*) that is met in the Gulf of Riga (ICES Subdivision 28.1). It is a slow-growing herring with one of the smallest length and weight-at-age in the Baltic and thus differs considerably from the neighbouring herring stock in the Baltic Proper (Subdivisions 25–28.2, 29 and 32) (ICES, 2001; Kornilovs, 1994). The differences in otolith structure serve as a basis for discrimination of Baltic herring populations (ICES, 2005, Ojaveer *et al.* 1981, Raid *et al.* 2005). When fishes are aged they are also assigned their population belonging, The stock does not migrate into the Baltic Proper; only minor part of the older herring leaves the gulf after spawning season in summer –autumn period but afterwards returns to the gulf. There is evidence, that the migrating fishes mainly stay close to the Irbe Strait region in Subdivision 28.2 and do not perform longer trips. The extent of this migration depends on the stock size and the feeding conditions in the Gulf of Riga. In 1970s and 1980s when the stock was on a low level the amount of migrating fishes was considered negligible. In the beginning of 1990s when the stock size increased also the number of migrating fishes increased and the catches of Gulf of Riga herring outside the Gulf of Riga in Subdivision 28.2 were taken into account in the assessments.

4.3.1 The Fishery

Herring fishery in the Gulf of Riga is performed by Estonia and Latvia, using both trawls and trap-nets. Herring catches in the Gulf of Riga include the local Gulf herring and the open-sea herring, entering the Gulf of Riga for spawning. Discrimination between the two stocks is based on the different otolith structure due to different feeding conditions and growth of herring in the Gulf of Riga and the Baltic Proper (ICES, 2005). The Latvian fleet also takes gulf herring outside the Gulf of Riga in Subdivision 28.2. In 2017 these catches were 234 t, while the average catches in the last five years were 251 t. These catches are included in the total Gulf herring landings (Table 4.3.1b) and CATON (Table 4.3.4).

4.3.1.1 Catch trends in the area and in the stock

The catches have shown a sharp increase in the 1990s after being at a record low level during the 1980s. After the considerable decrease of catches in 1998 as a result of the decline in market conditions, the total catches of herring in the Gulf of Riga have gradually increased till 44 694 t in 2003. In 2005 the total herring landings decreased to 33 915 t and since then have been rather stable following the changes of TAC which is usually almost fully utilised. In 2015 the catches considerably increased to 37 503 t being the highest in the last 11 years. In 2017 the total catches of herring in the Gulf of Riga were 31 720 t (Table 4.3.1a).

The landings of the Gulf of Riga herring stock showed similar pattern as the total caches of herring in the Gulf of Riga. They were the highest in the beginning of 2000s and then gradually decreased. In 2016 and 2017 the catches of the Gulf of Riga herring stock were 30 865 t and 28 058 t respectively.

The landings of open-sea herring in the Gulf of Riga were 3896 t in 2017 (Table 4.3.1b). The average catch of open-sea herring in the last five years was 4363 t.

The trap-net catches of Gulf herring were 8874 t in 2017 being 1468 t lower than in 2016. The fishing effort in trap-net fishery remained the same as in 2016. The trap-net catches comprised 28.0% of the total catches of herring in 2017.

4.3.1.2 Unallocated landings

According to the information (interviews) on the level of misreporting in the commercial fishery, since 1993 till 2010 unallocated landings were added to the official landings. In the recent years it was stated that the level of misreporting is gradually decreasing due to scrapping of the fishing vessels. Thus in Latvia the trawl fishing fleet has decreased almost three times, therefore it is considered that the fishing capacities now are more or less balanced with the fishing possibilities and no unallocated landings were assumed in 2011–2017. The level of misreporting in Estonian herring fishery has been low in 1995–2017 and therefore the official catch figures were used in the assessment.

4.3.1.3 Discards

The discards of herring in the Gulf of Riga are assumed very rare and have not been recorded by observers working on the fishing vessels.

4.3.1.4 Effort and CPUE data

The number of trap-nets used in herring fishery increased up to 2001 and slightly decreased since then, however in 2005 the decrease was more substantial especially in the Estonian coastal fishery. In 2017 the number of trap-nets remained at the same level as in the previous year (Table 4.3.8). Until the beginning of 2000 the trawl fishery has been permanently performed by 70 Latvian and 5–10 Estonian vessels with 150–300 HP engines. A considerable increase (more than 270%) in trawl catches of gulf herring was observed in Estonia in 2002–2003 and remained the same in 2004 but was substantially reduced in 2005–2017. In Latvia the number of trawl fleet vessels is gradually decreasing due to scrapping and there were 23 active vessels in 2017. A number of protection measures have been implemented by the authorities in management of the Gulf of Riga herring fishery. The maximum number and engine power of trawl vessels operating in the Gulf of Riga are limited. Additionally, the summer ban (from mid- June to September) in the Estonian part of the gulf and the 30-day ban for trawl fishery during the main spawning migrations of herring (April–May) in both Latvia and Estonia are implemented in the Gulf of Riga. No historical time-series of CPUE data are available.

4.3.2 Biological composition of the catch

4.3.2.1 Age composition

The quarterly catches of Gulf herring from Estonian and Latvian trawl and trap-net fishery were compiled to get the annual catch in numbers (Table 4.3.3, Figure 4.3.1). The available catch-at-age data are for ages 1–8+. In XSA ages 1–8+ and in tuning fleets ages 1–8 are used.

4.3.2.2 Quality of catch and biological data

The sampling of biological data from commercial trawl and trap-net catches was performed by Estonia and Latvia on monthly basis (from trap-nets on weekly basis). The sampling intensity of both countries is described in Table 4.3.2. The check of consistency of catch-at-age data is shown in Figure 4.3.2. In 2017 the sample number per 1000 t was as follows: in Estonia 2.1 samples and in Latvia 3.4 samples.

4.3.2.3 Mean weight-at-age

The annual mean weights by age groups used for assessment were compiled from quarterly data on the trap-net and trawl fishery of Estonia and Latvia (Table 4.3.6,

Figure 4.3.3.). The mean weights-at-age in the stock were assumed to be equal to the mean weights in catches because it was not possible to obtain the historical mean weight-at-age at the spawning time. Besides since the gears used in the herring fishery are not selective the weight in the catch should correspond to the weight in the stock.

A decreasing trend in mean weight-at-age of Gulf of Riga herring was observed since the mid−1980s. Since 1998 the mean weight-at-age has started to increase and in 2000 was at the level of the beginning of the 1990s, but was still considerably lower than in the 1980s. Since 2000 the mean weight-at-age was fluctuating without clear trend and probably depended on feeding conditions in the specific year. Thus the most unfavourable feeding conditions in 2003 resulted in a decrease of mean weight-at-age for most of the age groups. Particularly low weight was recorded for 1-year-old herring (abundant year-class of 2002), that was the lowest on record. In 2009 the mean weight-at-age decreased in the most of the age groups in comparison with the previous year and stayed low also in 2010. In 2011–2013 the feeding conditions in the Gulf of Riga were favourable for herring and the mean weight-at-age increased in all age groups while the average Fulton's condition factor of herring in autumn of 2011 was the highest in the last 20 years (Putnis *et al*., 2011). In 2017 the mean weight-at age was close to the values of the previous years (Figure 4.3.3.)

4.3.2.4 Maturity at age

As no special surveys on herring maturity are performed in the Gulf of Riga it was decided to use the same maturity ogives as in previous years (Table 4.3.5).

4.3.2.5 Natural mortality

Since the cod stock has remained at a low level in the Gulf of Riga, the natural mortality was taken to be the same as that used in the previous years - 0.2 (Table 4.3.7). Constant natural mortality M = 0.20 is used for all the years except for the period 1979–1983 when a value of M = 0.25 is used due to presence of cod in the Gulf of Riga.

4.3.3 Fishery independent information

Two tuning fleets were available: from trap-net fishery (1996–present) and from joint Estonian-Latvian hydro-acoustic survey in the Gulf of Riga which has been carried out in the end of July-beginning of August since 1999. The tuning data are given in tables 4.3.8–4.3.9. The check of internal consistency of tuning data is shown in figures 4.3.4 and 4.3.5.

In trap-net fleet (Figure 4.3.4) the correlation was high and in 2017 was similar to the previous year. In acoustic fleet the correlation did not changed much in comparison with the previous year. In some age groups it improved while in other it became slightly worse (Figure 4.3.5.).

4.3.4 Assessment (update assessment)

4.3.4.1 Recruitment estimates

The historical dynamics of the recruitment (age 1) reveal a trend rather similar to that of the spawning stock biomass. The recruitment fluctuated between 500−3000 millions in the 1970s and 1980s mainly having the values at the lower end. In the 1990s the reproduction of Gulf of Riga herring improved and recruitment had values above long-term average in most of the years (Table 4.3.13). In 2000s three record high year classes appeared reaching values over 6000 million at age 1 in the beginning of the year.

Till 2011 the values of mean water temperature of 0–20 m water layer and the biomass of *Eurytemora affinis* in May (factors which significantly influence the year class strength of Gulf herring, ICES 1995/J:10) were regressed to the 1-group from the XSA using the RCT3 program. It was considered that year-class strength of the Gulf of Riga herring was strongly influenced by the severity of winter, which determines the water temperature, and abundance of zooplankton in spring. The higher water temperature in spring favours a longer spawning period and more even distribution of herring spawning activity. After mild winters the abundance of zooplankton is higher thus ensuring better conditions for the feeding of herring larvae. However, it was found in the previous years that RCT3 poorly predicts the rich year classes. In 2011 the analysis of factors determining year-class strength was performed and a paper at ICES Annual science conference in Gdansk was presented (Putnis *et al.*, 2011). Two additional significant relationships were found for the herring year-class strength. It was shown that since 2000 the year-class strength strongly depend on the feeding conditions during the feeding season of the adult (1+) herring. The feeding conditions were characterised as the average Fulton's condition factor for ages 2–5. In 2012 RCT3 analysis was done for the prediction of recruitment using the biomass of *Eurytemora affinis* in May and average Fulton's condition factor. However, this estimate was not accepted due to high variation ratio. In 2012 it was decided to use for the short-term forecast geometric mean of year classes over the period from 1989 corresponding to period of improved reproduction conditions and prevalence of mild winters. The corresponding estimate for this year short-term forecast is 3057.5 million of age group 1 in the beginning of 2018, which is the geometric mean value for 1989–2015 year-classes. The same value for recruitment was used also for year-classes 2018 and 2019.

4.3.4.2 Assessment (Update)

The assessment was performed with the same settings in XSA as in the previous year and in accordance with the stock annex. The tuning used in the assessment were the effort in the commercial trap-nets directed at the Gulf herring in the Estonian and Latvian trap-net fishery and the corresponding abundance of Gulf herring in trap-net catches and the data from the hydro-acoustic survey (Tables 4.3.8 and 4.3.9). The catchability was assumed to be independent of stock size for all ages, and the catchability independent of age for age >=5 was selected. The default level of shrinkage (SE=0.5) was used in terminal population estimation. The diagnostics from XSA is presented in Table 4.3.10 and the XSA results are shown in tables 4.3.11–4.3.13. In general the diagnostics were similar to the last year, but they slightly improved for the trap-net fleet. Log catchability residuals for both fleets are shown in Figure 4.3.6. For acoustic fleet some year effect is seen in 2010–2011. The retrospective analysis is shown in Figure 4.3.7. In comparison with assessment of the previous year this year assessment produced higher SSB estimate (11.0%) and lower fishing mortality estimate (-12.2%). The recruitment estimate of 2015 year-class was 2.1% lower than obtained in 2017 (Table 4.3.11).

4.3.4.3 Historical stock trends

The resulting estimates of the main stock parameters (Table 4.3.13, Figure 4.3.8) show that the spawning stock biomass of the Gulf of Riga herring has been rather stable at the level of 40 000–50 000 t in the 1970s and 1980s. The SSB started to increase in the late 1980s, reaching the record high level of 124 663 t in 1994. The increase of SSB was connected with the regime shift which started in 1989 and manifested itself as a row of mild winters that was very favourable for the reproduction of Gulf of Riga herring. After mild winters the abundance of zooplankton in spring is usually higher thus ensuring better feeding conditions for herring larvae and evidently higher survival of them. Beginning with 1989, most of the year-classes were abundant or above the long-term average and only in few years when the winters were severe (1996, 2003, 2006, 2010, 2013) the recruitment was poor. Afterwards due to rather high fishing mortality SSB decreased and was fluctuating at the level below 100 000 t. In 2005–2006 SSB decreased to the level of 70 000 t that is below the long-term mean, but the SSB has increased since then. After appearance of very rich year classes in 2011 and 2012 the SSB reached 128 714 t in 2014 but has decreased since then. In 2016–2017 the SSB stayed stable at the level of 96 000 t. The mean fishing mortality in age groups 3–7 has been rather high in 1970s and 1980s fluctuating between 0.35 and 0.71. It has decreased below 0.4 in 1989 and stayed on this level till 1996. Afterwards the fishing mortality increased to levels above 0.4 that was regarded as F_{pa}. Since 2010 the fishing mortality has decreased below 0.4 and in 2013–2014 even below 0.3. In 2017 the fishing mortality was 0.32 that is at the level of F_{msy}.

4.3.5 Short-term forecast and management options

The input data and summary of short-time forecast with management options are presented in the tables 4.3.14 and 4.3.15. For prediction the mean weights-at-age were taken to be equal to the average of the last three years 2015−2017. The exploitation pattern has been taken equal to the average of 2015–2017 and is not scaled to the last year. Since the cod abundance is still at a very low level in the eastern Baltic and absent in the Gulf of Riga, the natural mortality was assumed to remain at the level of 0.2. The abundance of 1 year age group in 2018–2020 (year-classes of 2017, 2018, 2019) were taken to be equal to the geometric mean of year classes over the period 1989–2015. Taking into account that the herring TAC for the Gulf of Riga is usually almost utilised the catch constraint of 24 919 t for the intermediate year was used. The value is equal with the ICES last year's advice for the Gulf of Riga herring which was accepted by the managers. The SSB in 2018 would be 90.1 thousand t (according to the 2017 prediction 89.9 thousand t). In 2019–2020 SSB will slightly increase and will be above 90 thousand t. The catch corresponding to F_{MSY} (0.32) would be 26.9 thousand t in 2019. In 2018 the catches will be dominated by year-class of 2015 and by older 6+ age groups, respectively 22% and 35%. The SSB in 2019 will be dominated by year classes of 2015–2017 and in 2020 will be dominated by the younger age groups of 2 and 3 year-old herring (Figure 4.3.9). The share of younger age groups (1–3) in the yield of 2018–2019 will be respectively 51% and 52% respectively that is similar to the previous years. The yield-per-recruit summary is presented in Table 4.3.16.

4.3.6 Reference points

The biological reference points for the Gulf of Riga herring were estimated at WGBFAS meeting in 2015 (ICES, 2015) and in 2018 were not recalculated.

The B_{lim} value was obtained estimating the stock-recruitment relationship and the knowledge about fisheries and stock development of the Gulf of Riga herring. It was considered that Gulf of Riga herring belongs to the stocks with no evidence that recruitment has been impaired or that a relation exists between stock and recruitment for which B_{lim}=B_{loss} is applied. The corresponding value is B_{lim}=40 800 t. The B_{pa} value was obtained from the following equation: $B_{pa} = B_{lim} \times \exp(\sigma \times 1.645) = B_{lim} x1.4$= 57 100 t.

F_{lim} was then derived from B_{lim} in the following way. R/SSB was calculated at B_{lim} , and the slope of the replacement line at B_{lim}, and then it was inverted to give SSB/R. This SSB/R was used to derive F_{lim} from the curve of SSB/R against F. The obtained value

F_{lim} = 0.88. The F_{pa} value was obtained from the equation $F_{lim}=F_{pa}/1.4$ and was F_{pa}=0.63.

Instead of MBAL estimate of 50,000 t used previously the $B_{trigger}$ value of 60 000 t selected at the Workshop on Multi-annual Management of Pelagic Fish Stocks in the Baltic (ICES, 2009) was used.

4.3.7 Quality of assessment

The catches are estimated on the basis of the national official landing statistics of Latvia and Estonia. The stock is well sampled and the number of measured and aged fish has been historically high (Table 4.3.2.). Since 1993 the total landings of Latvia were increased according to information on misreporting. There was no information on unallocated catches of herring since 2011. Due to scrapping of fishing vessels the fishing fleet in the Gulf of Riga has been considerably reduced and the fishing capacity could be in balance with the fishing possibilities. The number of trap-nets directed at the Gulf herring in the Estonian and Latvian trap-net fishery and the corresponding abundance of Gulf herring in trap-net catches are used for tuning VPA. These data could be very sensitive to changes in market demand and could be affected by fishery regulation. Therefore, the joint Estonian-Latvian hydro-acoustic surveys were started in 1999 to obtain the additional tuning data, which were implemented for the first time in 2004 assessment. The Mohn's Ro index (average for last 9 years) for fishing mortality, SSB and recruitment is -0.069, 0.038 and 0.091 respectively.

4.3.8 Comparison with the previous assessment

The comparison between main input parameters for assessment and the results of XSA and predictions from 2017 and 2018 are presented in the text table below.

Comparison of XSA settings from assessments performed in 2017 and 2018

Category	Parameter	Assessment 2017	Assessment 2018	Diff.
XSA Setting	Catchability dependent on stock	Independent for all ages	Independent for all ages	No
	Catchability independent of age	>=5	>=5	No
	Survivor estimates shrinkage towards mean F of	Final 5 years, 3 oldest ages	Final 5 years, 3 oldest ages	No
	S.E. of the mean for shrinkage	0.5	0.5	No
Tuning fleet	Trap-nets	1996–2016	1996–2017	No
	Acoustic survey	1999–2016	1999–2017	No

Comparison of SSB and F estimates from assessments performed in 2017 and 2018

Assessment year	Tuning fleet	SSB (2016) (t)	FBAR3-7 (2016)
2017 (update)	Trap-nets+acoustics	86 654	0.3998
2018 (update)	Trap-nets+acoustics	96 144	0.3512
Diff. (+/-)%		+11.0%	-12.2%

Comparison of prediction results performed in 2016 and 2017 Parameter	Prediction 2017	Prediction 2018	Actual yield 2017 (t)	Diff. (+/-)%
Yield 2017 (t)	26 723		28 058	+5.0
SSB 2018 (t)	89 931	90 051		+0.1
Yield 2018 (t)	24 919	24 919		0.0

4.3.9 Management considerations

There are no explicit management objectives for this stock. The International Baltic Sea Fisheries Commission (IBSFC) started to treat Gulf of Riga herring as a separate management unit in 2004 and a separate TAC for the Gulf of Riga was established. Since then the TAC is divided into catch quotas of Estonia and Latvia. Thus the danger of overshooting the ICES advice for the Gulf of Riga herring, that was present when this stock was managed together with herring stock in the Central Baltic, has been reduced. It should be taken into account that some amount of herring from Subdivisions 25–27, 28.2, 29, 32 is taken in the Gulf of Riga (Subdivision 28.1) and some amount of Gulf of Riga herring is taken in Subdivision 28.2. This is taken into account when setting TAC for the Gulf of Riga herring and herring in Sub-divisions 25–27, 28.2, 29, 32.

Table 4.3.1a **Total catches of herring in the Gulf of Riga by nation (official landings + unallocated landings '000 t).**

Year	Estonia	Latvia	Unallocated landings	Total
1991	7.420	13.481	-	20.901
1992	9.742	14.204	-	23.946
1993	9.537	13.554	3.446	26.537
1994	9.636	14.05	3.512	27.198
1995	16.008	17.016	3.401	36.425
1996	11.788	17.362	3.473	32.623
1997	15.819	21.116	4.223	41.158
1998	11.313	16.125	3.225	30.663
1999	10.245	20.511	3.077	33.833
2000	12.514	21.624	3.244	37.382
2001	14.311	22.775	3.416	40.502
2002	16.962	22.441	3.366	42.769
2003	19.647	21.78	3.267	44.694
2004	18.218	20.903	3.136	42.257
2005	11.213	19.741	2.961	33.915
2006	11.924	19.186	2.878	33.988
2007	12.764	19.425	2.914	35.103
2008	15.877	19.290	1.929	37.096
2009	17.167	18.323	1.832	37.322
2010	15.422	17.751	1.775	34.948
2011	14.721	20.203	-	35.024
2012	13.789	17.944	-	31.733
2013	11.898	18.462	-	30.360
2014	10.561	20.065	-	30.626
2015	16.501	21.002	-	37.503
2016	15.814	19.078	-	34.892
2017	17.948	13.773	-	31.721

Table 4.3.1b **Herring caught in the Gulf of Riga and Gulf of Riga herring catches in the Central Baltic ('000 t).**

Year	Catches in the Gulf of Riga			Gulf of Riga herring catches	
	Gulf of Riga herring	Central Baltic herring	Total	In the Central Baltic	Total
1977	24.2	2.4	26.6	-	24.2
1978	16.7	6.3	23	-	16.7
1979	17.1	4.7	21.8	-	17.1
1980	15.0	5.7	20.7	-	15
1981	16.8	5.9	22.7	-	16.8
1982	12.8	4.7	17.5	-	12.8
1983	15.5	4.8	20.3	-	15.5
1984	15.8	3.8	19.6	-	15.8
1985	15.6	4.6	20.2	-	15.6
1986	16.9	1.3	18.2	-	16.9
1987	12.9	4.8	17.7	-	12.9
1988	16.8	3.0	19.8	-	16.8
1989	16.8	5.9	22.7	-	16.8
1990	14.8	6.0	20.8	-	14.8
1991	14.8	6.1	20.9	-	14.8
1992	20.5	3.5	23.9	1.3	21.8
1993	22.2	4.3	26.5	1.2	23.4
1994	22.2	5.0	27.2	2.1	24.3
1995	30.3	6.1	36.4	2.4	32.7
1996	28.2	4.4	32.6	4.3	32.5
1997	36.9	4.3	41.2	2.9	39.8
1998	26.6	4.1	30.7	2.8	29.4
1999	29.5	4.3	33.8	1.9	31.4
2000	32.8	4.6	37.4	1.9	34.7
2001	37.6	2.9	40.5	1.2	38.8
2002	39.2	3.5	42.8	0.4	39.7
2003	40.4	4.3	44.7	0.4	40.8
2004	38.9	3.3	42.3	0.2	39.1
2005	31.7	2.3	33.9	0.5	32.2
2006	30.8	3.2	34.0	0.4	31.2
2007	33.6	1.5	35.1	0.1	33.7
2008	31.0	6.1	37.1	0.1	31.1
2009	32.4	4.9	37.3	0.1	32.6
2010	29.7	5.2	34.9	0.4	30.2
2011	29.6	5.5	35.0	0.1	29.7
2012	27.9	3.8	31.7	0.2	28.1
2013	26.3	4.1	30.4	0.3	26.6
2014	26.1	4.5	30.6	0.2	26.3
2015	32.5	5.0	37.5	0.3	32.8
2016	30.6	4.3	34.9	0.3	30.9
2017	27.8	3.9	31.7	0.2	28.0

Table 4.3.2. Sampling of herring landings in the Gulf of Riga in 2017.

Country	Quarter	Landings	Samples	Measured	Aged
Estonia	I	6157	11	1095	1093
	II	7401	17	1651	1146
	III	11	0	0	0
	IV	204	1	100	99
	Total	13772	29	2846	2338
Latvia	I	6376	9	1739	977
	II	4541	33	3864	3275
	III	2628	9	1745	803
	IV	4403	9	1600	781
	Total	17948	60	8948	5836
Total	I	12533	20	2834	2070
	II	11942	50	5515	4421
	III	2639	9	1745	803
	IV	4607	10	1700	880
Grand total	Total	31720	89	11794	8174

Table 4.3.3 Gulf of Riga herring. Catch in numbers 1977–2016 in thousands.

Year	1	2	3	4	5	6	7	8+
1977	69500	885100	141400	109700	35300	15700	16000	600
1978	112000	97300	403900	39200	35900	9300	3200	5700
1979	76700	176500	103800	342500	22100	19300	6800	5500
1980	101000	125900	99600	55400	133100	10500	8600	2500
1981	62500	172500	112000	83000	51400	71700	7400	3500
1982	80000	96000	116900	68800	43000	29900	24500	3300
1983	49700	225300	138300	77700	38900	23300	15500	9600
1984	44000	152100	255100	96300	56700	32500	14700	11900
1985	23200	283900	203900	121700	31800	23700	8000	6100
1986	9200	106700	246900	110600	66500	19600	8000	5800
1987	70000	49000	110000	205000	75000	32000	5000	2000
1988	6000	197700	112700	112400	144600	38700	27800	5900
1989	61100	47400	492700	143000	76300	53900	6500	5400
1990	88100	83100	67100	263500	66800	27600	14600	4100
1991	119500	234000	94500	40800	180500	40500	35400	40800
1992	150300	339100	369300	91300	33200	157400	19000	47600
1993	192200	381400	298100	224400	66800	19000	78800	26900
1994	164230	288440	368870	263500	192700	46080	9410	56150
1995	232400	316900	363000	426900	277200	170900	39300	51500
1996	428800	450100	281400	247600	291000	183800	105600	57000
1997	204200	930700	559700	345400	242800	186700	90600	61100
1998	239360	282060	505410	274890	172470	114020	90230	67650
1999	361890	446500	157050	316480	157200	83650	60670	81050
2000	259030	552300	359430	123730	258070	83980	35120	53370
2001	819480	461570	378160	261040	81170	120980	56040	70710
2002	304160	1182680	360540	202120	118950	36310	48060	44940
2003	596730	396180	922840	231180	107440	70510	19990	58640
2004	166760	1342020	306210	505770	129160	64390	33200	62270
2005	383307	197546	873585	171434	186054	50952	27898	28826
2006	787870	600120	113610	467380	100900	70420	16470	20010
2007	305070	1145970	441270	83890	303940	59690	33710	24170
2008	599430	340150	707460	166050	21870	112520	11600	26250
2009	284970	787100	206390	505640	109220	20860	101490	29430
2010	469190	407890	515480	109990	275720	55630	7760	75000
2011	94610	346460	325910	398850	86030	168030	35030	44130
2012	458920	123970	276010	196090	245430	39330	90650	33980
2013	435220	596630	95600	143650	86850	128500	21350	57920
2014	76960	553760	443440	68530	115750	62060	80660	58830
2015	277380	141080	575230	394950	68160	82500	63190	117450
2016	467310	287890	110350	427240	291430	43770	50850	94760
2017	291780	449000	219830	59410	251400	183300	24030	94910

Table 4.3.4. Gulf of Riga herring. Catch in tonnes. (CATON).

Year	Catch
1977	24 186
1978	16 728
1979	17 142
1980	14 998
1981	16 769
1982	12 777
1983	15 541
1984	15 843
1985	15 575
1986	16 927
1987	12 884
1988	16 791
1989	16 783
1990	14 931
1991	14 791
1992	20 000
1993	22 200
1994	24 300
1995	32 656
1996	32 584
1997	39 843
1998	29 443
1999	31 403
2000	34 069
2001	38 785
2002	39 701
2003	40 803
2004	39 115
2005	32 225
2006	31 232
2007	33 742
2008	31 139
2009	33 376
2010	30 174
2011	29 443
2012	28 115
2013	26 511
2014	26 253
2015	32 535
2016	30 865
2017	28 058

Table 4.3.5. Gulf of Riga herring. Proportion of mature at year start in 1977–2016.

Period	1	2	3	4	5	6	7	8+
1977–2017	0	0.93	0.98	0.98	1	1	1	1
Period	1	2	3	4	5	6	7	8+
1977–2017	0	0.93	0.98	0.98	1	1	1	1

Table 4.3.5. Gulf of Riga herring. Weights in catch and stock in 1977–2017, kg.

Year	Age 1	2	3	4	5	6	7	8+
1977	0.0132	0.0160	0.0227	0.0269	0.0295	0.0312	0.0294	0.0508
1978	0.0098	0.0177	0.0219	0.0273	0.0311	0.0304	0.0381	0.0504
1979	0.0122	0.0162	0.0234	0.0276	0.0298	0.0340	0.0368	0.036
1980	0.0145	0.0201	0.0241	0.0321	0.0393	0.0456	0.0533	0.0711
1981	0.0121	0.0216	0.0288	0.0334	0.0390	0.0439	0.0499	0.0595
1982	0.0141	0.0214	0.0287	0.0357	0.0372	0.0451	0.0503	0.06837
1983	0.0138	0.0193	0.0276	0.0379	0.0416	0.0509	0.0610	0.0913
1984	0.0100	0.0150	0.0215	0.0281	0.0343	0.0391	0.0491	0.0559
1985	0.0129	0.0172	0.0208	0.0278	0.0358	0.0487	0.0531	0.0665
1986	0.0126	0.0198	0.0256	0.0314	0.0402	0.0462	0.0639	0.0709
1987	0.0101	0.0154	0.0197	0.0263	0.0303	0.0379	0.0431	0.0905
1988	0.0117	0.0186	0.0210	0.0273	0.0368	0.0434	0.0586	0.075
1989	0.0120	0.0148	0.0166	0.0196	0.0230	0.0315	0.0382	0.0364
1990	0.0146	0.0178	0.0198	0.0269	0.0306	0.0331	0.0522	0.0554
1991	0.0119	0.0154	0.0178	0.0199	0.0214	0.0225	0.0269	0.0336
1992	0.0112	0.0136	0.0177	0.0215	0.0236	0.0250	0.0264	0.0359
1993	0.0125	0.0136	0.0161	0.0201	0.0247	0.0263	0.0275	0.0352
1994	0.0112	0.0146	0.0162	0.0188	0.0215	0.0252	0.0263	0.03
1995	0.0104	0.0136	0.0164	0.0179	0.0209	0.0229	0.0263	0.0291
1996	0.0105	0.0125	0.0157	0.0177	0.0189	0.0215	0.0235	0.028
1997	0.0097	0.0124	0.0149	0.0178	0.0191	0.0196	0.0212	0.0242
1998	0.0101	0.0133	0.0169	0.0182	0.0203	0.0213	0.0225	0.024
1999	0.0131	0.0155	0.0189	0.0221	0.0231	0.0245	0.0265	0.0289
2000	0.0125	0.0165	0.0201	0.0229	0.0254	0.0264	0.0282	0.0296
2001	0.0102	0.0160	0.0205	0.0230	0.0245	0.0277	0.0283	0.0307
2002	0.0100	0.0153	0.0193	0.0236	0.0250	0.0271	0.0280	0.0309
2003	0.0075	0.0153	0.0199	0.0223	0.0248	0.0263	0.0268	0.0276
2004	0.0086	0.0101	0.0165	0.0210	0.0242	0.0268	0.0271	0.0331
2005	0.0120	0.0142	0.0159	0.0204	0.0244	0.0260	0.0298	0.0308
2006	0.0086	0.0132	0.0178	0.0191	0.0228	0.0266	0.0275	0.0296
2007	0.0089	0.0117	0.0154	0.0202	0.0196	0.0237	0.0271	0.0278
2008	0.0098	0.0148	0.0173	0.0204	0.0238	0.0233	0.0286	0.0327
2009	0.0092	0.0140	0.0176	0.0191	0.0218	0.0207	0.0244	0.0294
2010	0.0091	0.0138	0.0169	0.0194	0.0209	0.0237	0.0231	0.026
2011	0.0118	0.0153	0.0184	0.0211	0.023	0.0255	0.0262	0.0324
2012	0.0094	0.0159	0.0203	0.0232	0.0258	0.0277	0.0299	0.0334
2013	0.0097	0.0146	0.0197	0.0227	0.0257	0.0282	0.0295	0.0319
2014	0.0098	0.0138	0.0176	0.0216	0.0236	0.0253	0.0271	0.0302
2015	0.0089	0.0150	0.0182	0.0211	0.0230	0.0252	0.0272	0.0295
2016	0.0086	0.0152	0.0181	0.0204	0.0223	0.0239	0.0260	0.0283
2017	0.0087	0.0147	0.0185	0.0209	0.0225	0.0241	0.0248	0.0276

Table 4.3.7. Gulf of Riga herring. Natural mortality.

Year	Age 1	2	3	4	5	6	7	8	9+
1977–1978	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
1979	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1980	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1981	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1982	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1983	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
1984–2017	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 4.3.8. Gulf of Riga herring. Tuning fleet: trap-nets (effort number of trap-nets).

Year	Effort	Age2	Age3	Age4	Age5	Age6	Age7	Age8*
1996	94.0	84.40	87.40	88.80	95.60	67.90	33.40	8.70
1997	101.0	115.50	115.70	85.10	68.20	46.70	18.80	12.40
1998	70.0	65.38	122.80	65.70	36.40	20.80	20.20	6.60
1999	78.0	34.56	21.36	101.42	51.14	25.81	18.47	18.49
2000	84.0	91.12	89.00	27.79	114.19	31.05	5.96	5.12
2001	100.0	124.13	149.34	118.20	37.23	59.59	27.53	10.40
2002	90.0	207.06	107.78	61.26	39.47	8.93	12.12	6.11
2003	86.0	77.79	265.91	72.98	23.36	25.15	3.17	6.07
2004	68.0	109.49	79.51	114.20	29.77	15.85	7.43	1.68
2005	51.0	23.01	162.65	31.30	51.30	13.68	6.04	4.31
2006	49.0	81.76	27.33	101.11	34.88	23.22	6.76	3.77
2007	57.0	126.63	108.24	24.53	91.65	16.98	9.91	2.59
2008	50.0	64.97	179.19	48.29	7.15	37.46	1.92	6.85
2009	60.0	159.17	45.13	165.51	40.41	7.13	35.53	4.37
2010	45.0	44.1	98.18	21.26	67.95	15.61	2.1	13.44
2011	45.0	40.8	62.4	96.73	15.04	44.65	7.68	3.3
2012	43.0	19.42	49.24	47.99	54.99	7.76	21.69	3.78
2013	45.0	107.13	26.36	37.23	26.01	35.77	4.71	11.23
2014	45.0	148.61	119.84	17.15	22.46	8.66	15.28	1.82
2015	43.0	15.96	128.17	76.97	9.93	11.83	8.64	19.22
2016	43.0	50.18	25.23	117.5	92.86	10.77	12.14	6.08
2017	43.0	59.77	57.57	14.58	85.75	56.75	5.08	6.19

Table 4.3.9. Gulf of Riga herring. Tuning fleet: Hydroacoustic survey.

Year	Effort	Age1	Age2	Age3	Age4	Age5	Age6	Age7	Age8*
1999	1	5292	4363	1343	1165	457	319	208	61
2000	1	4486	4012	1791	609	682	336	151	147
2001	1	7567	2004	1447	767	206	296	58	66
2002	1	3998	5994	1068	526	221	87	165	34
2003	1	12441	1621	2251	411	263	269	46	137
2004	1	3177	10694	675	1352	218	195	84	25
2005	1	8190	1564	4532	337	691	92	75	62
2006	1	12082	1986	213	937	112	223	36	33
2007	1	1478	3662	1265	143	968	116	103	24
2008	1	9231	2109	4398	816	134	353	16	23
2009	1	6422	4703	870	1713	284	28	223	10
2010	1	5353	2432	1813	256	618	111	13	50
2011	1	3162	5289	2503	2949	597	865	163	58
2012	1	5957	758	1537	774	1035	374	308	134
2013	1	9435	5552	592	1240	479	827	187	318
2014	1	1109	3832	2237	276	570	443	466	46
2015	1	3221	539	1899	1110	255	346	181	197
2016	1	4542	1081	504	1375	690	152	113	40
2017	1	3231	3442	874	402	1632	982	137	459

* Age 8 is true age group

Table 4.3.10. Gulf of Riga herring. XSA diagnostics. 1/5

Lowestoft VPA Version 3.1
12/03/2018 11:20
Extended Survivors Analysis
Herring Gulf of Riga,
CPUE data from file c:\documents\vpa\herg\fleet1.txt
Catch data for 41 years. 1977 to 2017. Ages 1 to 8.

Fleet	First Year	Last year	First age	Last age	Alpha	Beta
Trap-nets	1996	2017	2	7	0.330	0.580
Acoustics	1999	2017	1	7	0.550	0.600

Time series weights :
  Tapered time weighting applied
  Power = 3 over 20 years
Catchability analysis:
  Catchability independent of stock size for all ages
  Catchability independent of age for ages >=5
Terminal population estimation :
  Survivor estimates shrunk towards the mean F
  of the final 5 years or the 3 oldest ages.
  S.E. of the mean to which the estimates are shrunk =0.500
  Minimum standard error for population
  estimates derived from each fleet =0.300
  Prior weighting not applied
Tuning converged after 33 iterations
Regression weights
0.751 0.820 0.877 0.921 0.954 0.976 0.990 0.997 1.000 1.000

Fishing mortalities

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	0.130	0.115	0.203	0.096	0.101	0.090	0.093	0.148	0.161	0.148
2	0.323	0.244	0.250	0.227	0.177	0.185	0.158	0.247	0.227	0.230
3	0.300	0.321	0.258	0.325	0.286	0.201	0.205	0.245	0.311	0.271
4	0.329	0.355	0.292	0.326	0.332	0.236	0.216	0.284	0.291	0.274
5	0.293	0.367	0.343	0.392	0.342	0.239	0.304	0.347	0.350	0.278
6	0.273	0.493	0.329	0.363	0.312	0.303	0.269	0.369	0.394	0.389
7	0.441	0.416	0.350	0.357	0.340	0.278	0.316	0.484	0.410	0.392

XSA population numbers (Thousands)

	AGE						
YEAR	1	2	3	4	5	6	7
2008	5.43E+06	1.36E+06	3.02E+06	6.55E+05	9.52E+04	5.21E+05	3.59E+04
2009	2.79E+06	3.90E+06	8.08E+05	1.83E+06	3.86E+05	5.81E+04	3.25E+05
2010	2.82E+06	2.04E+06	2.50E+06	4.80E+05	1.05E+06	2.19E+05	2.91E+04
2011	1.14E+06	1.88E+06	1.30E+06	1.58E+06	2.93E+05	6.10E+05	1.29E+05
2012	5.27E+06	8.47E+05	1.23E+06	7.68E+05	9.36E+05	1.62E+05	3.47E+05
2013	5.59E+06	3.90E+06	5.81E+05	7.55E+05	4.51E+05	5.44E+05	9.73E+04
2014	9.57E+05	4.18E+06	2.65E+06	3.89E+05	4.89E+05	2.91E+05	3.29E+05
2015	2.22E+06	7.14E+05	2.92E+06	1.77E+06	2.57E+05	2.95E+05	1.82E+05
2016	3.47E+06	1.57E+06	4.57E+05	1.87E+06	1.09E+06	1.48E+05	1.67E+05
2017	2.35E+06	2.42E+06	1.02E+06	2.74E+05	1.15E+06	6.29E+05	8.20E+04

continued

Table 4.3.10. Gulf of Riga herring. XSA diagnostics. 2/5

Estimated population abundance at 1st Jan 2018
0.00E+00 1.66E+06 1.57E+06 6.39E+05 1.71E+05 7.10E+05 3.49E+05
Taper weighted geometric mean of the VPA populations:
2.79E+06 2.05E+06 1.29E+06 7.83E+05 4.86E+05 2.45E+05 1.19E+05

Standard error of the weighted Log(VPA populations) :
0.6344 0.6647 0.6997 0.7376 0.7262 0.7223 0.7897 1

Log catchability residuals.
Fleet: Trap-nets

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	No data for this fleet at this age									
2	0.38	-1.01	-0.07	0.10	0.02	-0.01	-0.62	0.16	0.27	-0.27
3	-0.20	-0.97	-0.25	0.21	0.04	0.27	0.19	-0.02	0.33	0.37
4	-0.20	-0.11	-0.38	0.33	-0.04	0.15	0.31	0.05	-0.04	0.59
5	-0.15	-0.09	0.45	0.28	-0.05	-0.50	0.12	0.50	0.80	0.15
6	-0.50	0.15	-0.04	0.41	-0.24	0.20	0.06	0.44	0.47	0.87
7	-0.25	-0.08	-0.66	0.35	-0.28	-0.53	0.03	0.12	0.45	0.10

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	No data for this fleet at this age									
2	0.50	0.13	-0.22	-0.23	-0.15	-0.01	0.24	-0.14	0.21	-0.05
3	0.07	-0.16	-0.26	-0.02	-0.18	-0.14	-0.14	-0.11	0.15	0.15
4	0.14	0.17	-0.28	0.05	0.12	-0.20	-0.32	-0.26	0.11	-0.06
5	0.00	0.18	-0.02	-0.23	-0.07	-0.18	-0.38	-0.49	0.30	0.14
6	-0.05	0.40	0.07	0.11	-0.29	-0.02	-0.83	-0.44	0.16	0.38
7	-0.27	0.25	0.09	-0.10	-0.01	-0.34	-0.37	-0.22	0.17	0.00

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7
Mean Log q	-14.1262	-13.4871	-13.3252	-13.1841	-13.1841	-13.1841
S.E(Log q)	0.2516	0.1958	0.2423	0.3303	0.4307	0.2537

Regression statistics:
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.03	-0.247	14.11	0.87	20	0.27	-14.13
3	1.10	-1.138	13.43	0.92	20	0.21	-13.49
4	1.01	-0.110	13.32	0.90	20	0.26	-13.33
5	0.93	0.566	13.18	0.85	20	0.32	-13.18
6	1.18	-0.848	13.27	0.69	20	0.51	-13.14
7	1.01	-0.135	13.25	0.91	20	0.26	-13.23

continued

Table 4.3.10. Gulf of Riga herring. XSA diagnostics. 3/5

Fleet: Acoustics

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	99.99	0.14	0.05	-0.24	0.11	0.08	0.70	0.49	0.09	-0.74
2	99.99	0.61	0.57	-0.09	0.25	-0.10	0.60	0.74	-0.22	-0.44
3	99.99	0.72	0.38	0.29	-0.02	0.08	-0.25	0.44	-0.53	0.08
4	99.99	0.11	0.56	0.24	-0.02	-0.23	0.46	-0.21	-0.51	-0.16
5	99.99	-0.06	0.17	0.10	-0.40	-0.13	-0.16	0.53	-0.64	0.04
6	99.99	0.52	0.25	0.12	-0.03	0.52	0.29	-0.22	0.11	0.38
7	99.99	0.18	0.50	-0.81	0.27	0.11	0.24	0.06	-0.51	-0.03

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	0.06	0.35	0.21	0.53	-0.37	0.03	-0.35	-0.09	-0.18	-0.14
2	0.31	0.02	0.01	0.86	-0.32	0.15	-0.30	-0.45	-0.55	0.18
3	0.37	0.08	-0.35	0.67	0.21	-0.04	-0.23	-0.47	0.10	-0.18
4	0.29	0.02	-0.58	0.69	0.08	0.51	-0.34	-0.42	-0.26	0.42
5	0.31	-0.30	-0.54	0.73	0.10	-0.01	0.13	-0.01	-0.46	0.31
6	-0.44	-0.65	-0.69	0.36	0.81	0.39	0.37	0.17	0.05	0.47
7	-0.76	-0.34	-0.81	0.24	-0.13	0.61	0.33	0.07	-0.36	0.54

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7
Mean Log q	-6.2452	-6.4848	-6.6161	-6.6731	-6.5902	-6.5902	-6.5902
S.E(Log q)	0.3561	0.4354	0.3420	0.4148	0.3855	0.4691	0.4594

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.06	-0.345	5.69	0.74	19	0.40	-6.25
2	0.95	0.235	6.86	0.72	19	0.43	-6.48
3	1.00	0.011	6.63	0.81	19	0.36	-6.62
4	1.02	-0.103	6.55	0.75	19	0.44	-6.67
5	1.14	-0.779	5.65	0.74	19	0.45	-6.59
6	0.83	1.079	7.45	0.81	19	0.37	-6.46
7	0.84	1.10	7.44	0.83	19	0.38	-6.63

Terminal year survivor and F summaries:

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2016

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	1	0.00	0.00	0.00	0	0.00	0.00
Acoustics	1436925	0.371	0.00	0.00	1	0.611	0.169
F shrinkage mean	2084637	0.50				0.389	0.119

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1660657	0.30	0.23	2	0.777	0.148

continued

Table 4.3.10. Gulf of Riga herring. XSA diagnostics. **4/5**

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2015

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	1499591	0.30	0.00	0.00	1	0.408	0.240
Acoustics	1532695	0.288	0.18	0.63	2	0.407	0.235
F shrinkage mean	1839074	0.50				0.185	0.200

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1571176	0.19	0.08	4	0.425	0.230

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2014

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	763869	0.213	0.027	0.13	2	0.476	0.231
Acoustics	503529	0.226	0.124	0.55	3	0.399	0.333
F shrinkage mean	698092	0.50				0.125	0.251

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
639496	0.15	0.10	6	0.678	0.271

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	168384	0.178	0.083	0.47	3	0.527	0.277
Acoustics	173434	0.205	0.195	0.95	4	0.364	0.270
F shrinkage mean	171150	0.50				0.108	0.273

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
170508	0.13	0.08	8	0.636	0.274

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	780851	0.160	0.068	0.42	4	0.527	0.256
Acoustics	647366	0.186	0.153	0.82	5	0.376	0.301
F shrinkage mean	606616	0.50				0.097	0.318

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
710142	0.12	0.08	10	0.641	0.278

continued

Table 4.3.10. Gulf of Riga herring. XSA diagnostics. **5/5**

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	369652	0.156	0.127	0.82	5	0.508	0.371
Acoustics	304098	0.182	0.163	0.90	6	0.374	0.435
F shrinkage mean	422091	0.50				0.118	0.331

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
349023	0.12	0.09	12	0.782	0.389

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5
Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	39990	0.150	0.089	0.60	6	0.553	0.434
Acoustics	51216	0.181	0.132	0.73	7	0.334	0.354
F shrinkage mean	58629	0.50				0.113	0.315

Weighted prediction:

Survivors, at end of year	Int s.e	Ext s.e	N	Var Ratio	F
45356	0.12	0.08	14	0.667	0.392

Table 4.3.11 Gulf of Riga herring. XSA output: Fishing mortality at-age.

Run title: Herring Gulf of Riga
At 12/03/2018 11:21
Terminal Fs derived using XSA (with F shrinkage)

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Age 1	0.0849	0.1222	0.0932	0.1088	0.0812	0.0552	0.046	0.0243	0.0187	0.0091
Age 2	0.4228	0.1644	0.2963	0.2304	0.2904	0.1824	0.2295	0.1988	0.2153	0.1118
Age 3	0.6604	0.3472	0.2727	0.2875	0.351	0.347	0.4624	0.4555	0.4464	0.2946
Age 4	0.618	0.3809	0.5812	0.2419	0.4407	0.403	0.437	0.7187	0.4098	0.4665
Age 5	0.6456	0.4184	0.3965	0.4997	0.3946	0.4594	0.4468	0.6948	0.552	0.4125
Age 6	0.8246	0.3452	0.4304	0.3523	0.5949	0.4485	0.5205	0.8899	0.7179	0.8088
Age 7	0.7027	0.384	0.474	0.3678	0.4815	0.4411	0.4727	0.7755	0.5646	0.5673
Age 8+	0.7027	0.384	0.474	0.3678	0.4815	0.4411	0.4727	0.7755	0.5646	0.5673
FBAR 3- 7	0.6903	0.3751	0.431	0.3498	0.4525	0.4198	0.4679	0.7069	0.5381	0.5099
YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age 1	0.0199	0.0119	0.0537	0.0271	0.0365	0.0393	0.0676	0.0676	0.0771	0.1074
Age 2	0.0614	0.0719	0.1227	0.0962	0.0934	0.1379	0.1326	0.1372	0.1802	0.2101
Age 3	0.1612	0.1961	0.2572	0.2559	0.151	0.2091	0.1729	0.1834	0.2563	0.241
Age 4	0.4269	0.2464	0.409	0.2127	0.2441	0.2137	0.1894	0.2279	0.3348	0.2789
Age 5	0.6779	0.6139	0.2635	0.3401	0.221	0.3212	0.2394	0.2469	0.3989	0.4021
Age 6	0.3568	0.9446	0.4876	0.1429	0.3566	0.3057	0.3076	0.2586	0.3614	0.5058
Age 7	0.491	0.6069	0.3893	0.233	0.2754	0.2818	0.2467	0.2457	0.3674	0.3983
Age 8+	0.491	0.6069	0.3893	0.233	0.2754	0.2818	0.2467	0.2457	0.3674	0.3983
FBAR 3- 7	0.4228	0.5216	0.3613	0.2369	0.2496	0.2663	0.2312	0.2325	0.3438	0.3652
YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age 1	0.1538	0.1004	0.149	0.1148	0.1614	0.1604	0.0987	0.1995	0.1442	0.1345
Age 2	0.3575	0.3293	0.2754	0.3559	0.3075	0.3692	0.3242	0.3354	0.3849	0.3518
Age 3	0.4386	0.3355	0.3082	0.3736	0.4424	0.4207	0.5545	0.4485	0.3811	0.4001
Age 4	0.5252	0.4008	0.3638	0.4267	0.5138	0.4513	0.5271	0.6854	0.4894	0.3611
Age 5	0.4866	0.5471	0.4222	0.5744	0.5558	0.4682	0.4626	0.6416	0.5841	0.605
Age 6	0.4908	0.4456	0.5645	0.4197	0.5877	0.5211	0.5661	0.563	0.5682	0.4569
Age 7	0.5048	0.4684	0.4539	0.4927	0.5534	0.4911	0.6159	0.5761	0.511	0.3596
Age 8+	0.5048	0.4684	0.4539	0.4927	0.5534	0.4911	0.6159	0.5761	0.511	0.3596
FBAR 3- 7	0.4892	0.4395	0.4225	0.4574	0.5306	0.4705	0.5452	0.5829	0.5067	0.4365
YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Age 1	0.1845	0.1301	0.115	0.2034	0.0963	0.1013	0.09	0.0931	0.1484	0.1613
Age 2	0.2955	0.3229	0.2442	0.2503	0.2274	0.1765	0.1854	0.1583	0.2466	0.2266
Age 3	0.4758	0.3001	0.3208	0.2582	0.325	0.2856	0.2007	0.2045	0.2455	0.3108
Age 4	0.5865	0.3286	0.3552	0.2922	0.3263	0.3316	0.2359	0.2164	0.2835	0.2909
Age 5	0.4239	0.293	0.367	0.3428	0.3919	0.3424	0.2392	0.3036	0.3474	0.3502
Age 6	0.9177	0.2727	0.4933	0.3294	0.363	0.3118	0.3026	0.269	0.3694	0.3943
Age 7	0.4134	0.4414	0.416	0.3498	0.3567	0.3402	0.2779	0.316	0.4842	0.4101
Age 8+	0.4134	0.4414	0.416	0.3498	0.3567	0.3402	0.2779	0.316	0.4842	0.4101
FBAR 3- 7	0.5635	0.3272	0.3905	0.3145	0.3526	0.3223	0.2513	0.2619	0.346	0.3512

	2017	FBAR
Age 1	0.1475	0.1524
Age 2	0.23	0.2344
Age 3	0.2708	0.2757
Age 4	0.2741	0.2828
Age 5	0.2779	0.3252
Age 6	0.3888	0.3842
Age 7	0.3917	0.4287
Age 8+	0.3917	
FBAR 3- 7	0.3206	

Table 4.3.12 Gulf of Riga Herring. XSA output: Stock numbers-at-age (start of year) (104).

Herring Gulf of Riga/At 12/03/2018 11:21/Terminal Fs derived using XSA (with F shrinkage)

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Age 1	94322	107648	97694	111033	90841	168894	125362	202703	138756	111999
Age 2	283694	70936	78001	69315	77560	65232	124475	93246	161978	111504
Age 3	32331	152182	49273	45171	42872	45180	42331	77058	62581	106928
Age 4	26299	13676	88050	29214	26389	23505	24870	20762	40008	32787
Age 5	8202	11606	7650	38348	17863	13227	12234	12512	8285	21744
Age 6	3090	3521	6253	4007	18119	9375	6507	6095	5113	3906
Age 7	3503	1109	2041	3167	2194	7784	4663	3011	2049	2042
Age 8+	130	1960	1631	911	1025	1036	2852	2403	1546	1464
TOTAL	451570	362636	330592	301166	276864	334234	343293	417790	420315	392374

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age 1	392640	56063	129109	364072	368454	431059	324877	277554	346350	465344
Age 2	90865	315132	45357	100177	290105	290852	339321	248596	212382	262539
Age 3	81638	69960	240120	32847	74499	216345	207446	243302	177434	145209
Age 4	65205	56886	47081	152012	20821	52444	143713	142870	165822	112425
Age 5	16836	34836	36404	25607	100615	13355	34676	97357	93129	97136
Age 6	11785	6998	15437	22901	14921	66044	7930	22346	62273	51166
Age 7	1424	6753	2228	7762	16252	8552	39830	4773	14126	35521
Age 8+	564	1417	1836	2168	18615	21289	13519	28320	18368	19016
TOTAL	660956	548045	517572	707546	904283	1099940	1111312	1065119	1089884	1188357

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age 1	392640	56063	129109	364072	368454	431059	324877	277554	346350	465344
Age 2	90865	315132	45357	100177	290105	290852	339321	248596	212382	262539
Age 3	81638	69960	240120	32847	74499	216345	207446	243302	177434	145209
Age 4	65205	56886	47081	152012	20821	52444	143713	142870	165822	112425
Age 5	16836	34836	36404	25607	100615	13355	34676	97357	93129	97136
Age 6	11785	6998	15437	22901	14921	66044	7930	22346	62273	51166
Age 7	1424	6753	2228	7762	16252	8552	39830	4773	14126	35521
Age 8+	564	1417	1836	2168	18615	21289	13519	28320	18368	19016
TOTAL	660956	548045	517572	707546	904283	1099940	1111312	1065119	1089884	1188357

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age 1	158274	276810	288956	264012	607658	226777	701634	101900	315524	691676
Age 2	342192	111107	204974	203832	192717	423358	158147	520455	68339	223646
Age 3	174222	195950	65445	127418	116909	116018	239603	93632	304682	38076
Age 4	93425	91997	114699	39371	71798	61500	62365	112668	48953	170407
Age 5	69642	45237	50448	65271	21039	35164	32063	30142	46481	24567
Age 6	53198	35049	21431	27079	30088	9881	18027	16530	12991	21221
Age 7	25260	26661	18378	9977	14572	13688	4804	8379	7707	6026
Age 8+	16865	19802	24328	15014	18189	12674	13927	18323	7884	7266
TOTAL	933078	802613	788659	751974	1072969	899059	1230571	902029	812561	1182885

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Age 1	200110	543083	279008	281774	113875	526518	558586	95653	222281	346641
Age 2	495007	136232	390400	203613	188243	84672	389552	417952	71350	156890
Age 3	128805	301586	80759	250372	129796	122772	58106	264953	292084	45651
Age 4	20894	65529	182904	47975	158345	76779	75542	38923	176801	187089
Age 5	97227	9516	38625	104984	29327	93552	45118	48851	25667	109016
Age 6	10984	52101	5812	21909	61005	16226	54387	29081	29522	14847
Age 7	11002	3592	32475	2906	12904	34743	9726	32901	18194	16706
Age 8+	7822	8059	9333	28145	16137	12925	26221	23831	33491	30869
TOTAL	971851	1119698	1019318	941679	709633	968187	1217239	952144	869390	907708

YEAR	2017	2018	GMST	AMST
Age 1	235076	0	226439	278433
Age 2	241522	166065	169967	209155
Age 3	102401	157118	108573	134510
Age 4	27391	63950	60602	76813
Age 5	114517	17051	31259	41399
Age 6	62885	71014	15778	22418
Age 7	8195	34902	7620	11864
Age 8+	32105	22303		
TOTAL	824091	532403		

Table 4.3.13. Gulf of Riga Herring. XSA output: Summary.

Run title: Herring Gulf of Riga
At 12/03/2018 11:21
Terminal Fs derived using XSA (with F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1977	943220	76734	54522	24186	0.4436	0.6903
1978	1076480	66256	49356	16728	0.3389	0.3751
1979	976940	66130	46738	17142	0.3668	0.431
1980	1110334	69530	46712	14998	0.3211	0.3498
1981	908414	65531	47221	16769	0.3551	0.4525
1982	1688937	72904	42757	12777	0.2988	0.4198
1983	1253616	76283	50857	15541	0.3056	0.4679
1984	2027027	66155	39913	15843	0.3969	0.7069
1985	1387559	77471	51933	15575	0.2999	0.5381
1986	1119991	86747	64272	16927	0.2634	0.5099
1987	3926396	97574	51509	12884	0.2501	0.4228
1988	560628	116272	96656	16791	0.1737	0.5216
1989	1291088	86049	63255	16783	0.2653	0.3613
1990	3640722	139050	77267	14931	0.1932	0.2369
1991	3684542	141442	87174	14791	0.1697	0.2496
1992	4310588	166966	105988	20000	0.1887	0.2663
1993	3248769	175405	120558	22200	0.1841	0.2312
1994	2775540	169970	124663	24300	0.1949	0.2325
1995	3463500	166470	116307	32656	0.2808	0.3438
1996	4653443	167407	105376	32584	0.3092	0.3652
1997	1582739	133538	103082	39843	0.3865	0.4892
1998	2768097	119994	81498	29443	0.3613	0.4395
1999	2889559	136147	83560	31403	0.3758	0.4225
2000	2640118	132246	83312	34069	0.4089	0.4574
2001	6076576	156492	78901	38785	0.4916	0.5306
2002	2267766	143369	100265	39701	0.396	0.4705
2003	7016345	156232	85886	40803	0.4751	0.5452
2004	1018996	120499	91893	39115	0.4257	0.5829
2005	3155239	124412	73152	32225	0.4405	0.5067
2006	6916760	143385	70683	31232	0.4419	0.4365
2007	2001097	126598	90923	33742	0.3711	0.5635
2008	5430831	157123	89557	31137	0.3477	0.3272
2009	2790077	149727	105530	32554	0.3085	0.3905
2010	2817743	140483	99486	30174	0.3033	0.3145
2011	1138748	130443	100694	29639	0.2943	0.3526
2012	5265180	149027	86633	28115	0.3245	0.3223
2013	5585865	177819	107259	26511	0.2472	0.2513
2014	956525	157090	128714	26253	0.204	0.2619
2015	2222806	149121	112536	32851	0.2919	0.346
2016	3466410	141026	96144	30865	0.321	0.3512
2017	2350759	132439	96906	28058	0.2895	0.3206
Arith. Mean	2790390	125062	83162	25876	0.3197	0.4111
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 4.3.14. Gulf of Riga Herring. Short-term forecast input.

MFDP version 1a
Run: HerGoR_01
Time and date: 12:41 15.03.2018
Fbar age range: 3-7

2018								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	3057539	0.2	0	0.2	0.3	0.0087	0.1524	0.0087
2	1660650	0.2	0.93	0.2	0.3	0.0150	0.2344	0.0150
3	1571180	0.2	0.98	0.2	0.3	0.0183	0.2757	0.0183
4	639500	0.2	0.98	0.2	0.3	0.0208	0.2828	0.0208
5	170510	0.2	1	0.2	0.3	0.0226	0.3252	0.0226
6	710140	0.2	1	0.2	0.3	0.0244	0.3842	0.0244
7	349020	0.2	1	0.2	0.3	0.0260	0.4287	0.0260
8	223030	0.2	1	0.2	0.3	0.0285	0.4287	0.0285
2019								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	3057539	0.2	0	0.2	0.3	0.0087	0.1524	0.0087
2	.	0.2	0.93	0.2	0.3	0.0150	0.2344	0.0150
3	.	0.2	0.98	0.2	0.3	0.0183	0.2757	0.0183
4	.	0.2	0.98	0.2	0.3	0.0208	0.2828	0.0208
5	.	0.2	1	0.2	0.3	0.0226	0.3252	0.0226
6	.	0.2	1	0.2	0.3	0.0244	0.3842	0.0244
7	.	0.2	1	0.2	0.3	0.0260	0.4287	0.0260
8	.	0.2	1	0.2	0.3	0.0285	0.4287	0.0285
2020								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	3057539	0.2	0	0.2	0.3	0.0087	0.1524	0.0087
2	.	0.2	0.93	0.2	0.3	0.0150	0.2344	0.0150
3	.	0.2	0.98	0.2	0.3	0.0183	0.2757	0.0183
4	.	0.2	0.98	0.2	0.3	0.0208	0.2828	0.0208
5	.	0.2	1	0.2	0.3	0.0226	0.3252	0.0226
6	.	0.2	1	0.2	0.3	0.0244	0.3842	0.0244
7	.	0.2	1	0.2	0.3	0.0260	0.4287	0.0260
8	.	0.2	1	0.2	0.3	0.0285	0.4287	0.0285

Input units are thousands and kg

M = Natural Mortality
Mat = Maturity ogive
PF = Proportion of F before spawning
PM = Proportion of M before spawning
SWt = Weight in stock (Kg)
Sel = Exploitation pattern
CWt = Weight in catch (Kg)

$N_{2018\text{-}2020}$ Age 1: Geometric mean from XSA-estimates at age 1 for the years 1989-2015
N_{2018} Age 2-8+: Survivors estimates from XSA
Natural Mortality (M): average 2015-2017
Weight in the Catch/Stock (CWt/SWt): average 2015-2017
Expoitation pattern (Sel): average 2015-2017

Table 4.3.15. Gulf of Riga Herring. Short-term results.

MFDP version 1a
Run: HerGoR_01
Herring Gulf of Riga
Time and date: 12:41 15.03.2018

Fbar age range: 3-7, not scaled, catch constraint

2018				
Biomass	SSB	FMult	FBar	Landings
130163	90051	0.862	0.2925	24919

2019					2020	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
132860	97030	0	0	0	162399	124349
	96446	0.1	0.0339	3211	158962	120445
	95866	0.2	0.0679	6331	155622	116676
	95289	0.3	0.1018	9363	152376	113035
	94717	0.4	0.1357	12310	149221	109518
	94147	0.5	0.1697	15174	146153	106122
	93582	0.6	0.2036	17958	143172	102840
	93020	0.7	0.2375	20664	140273	99670
	92461	0.8	0.2714	23295	137454	96606
	91906	0.9	0.3054	25854	134713	93646
	91355	1	0.3393	28342	132047	90785
	90807	1.1	0.3732	30761	129455	88019
	90262	1.2	0.4072	33114	126934	85346
	89721	1.3	0.4411	35402	124481	82761
	89183	1.4	0.475	37628	122095	80262
	88649	1.5	0.509	39793	119774	77845
	88118	1.6	0.5429	41900	117516	75508
	87591	1.7	0.5768	43950	115319	73248
	87067	1.8	0.6108	45945	113181	71062
	86546	1.9	0.6447	47886	111100	68947
	86028	2	0.6786	49775	109075	66901

Input units are thousands and kg - output in tonnes

Table 4.3.16. Gulf of Riga herring. Yield-per-recruit input.

MFYPR version 2a
Run: HerGoRYPR_01
Herring Gulf of Riga,ANON,COMBSEX,PLUSGROUP
Time and date: 17:11 15.03.2018
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
1	0.2	0	0.2	0.3	0.0087	0.1524	0.0087
2	0.2	0.93	0.2	0.3	0.0150	0.2344	0.0150
3	0.2	0.98	0.2	0.3	0.0183	0.2757	0.0183
4	0.2	0.98	0.2	0.3	0.0208	0.2828	0.0208
5	0.2	1	0.2	0.3	0.0226	0.3252	0.0226
6	0.2	1	0.2	0.3	0.0244	0.3842	0.0244
7	0.2	1	0.2	0.3	0.0260	0.4287	0.0260
8	0.2	1	0.2	0.3	0.0285	0.4287	0.0285

Weights in kilograms

Table 4.3.17. Gulf of Riga herring. Yield-per-recruit results.

MFYPR version 2a
Run: HerGoRYPR_01
Time and date: 17:11 15.03.2018
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	Spwn NosJan	SSBJan	Spwn NosSpwn	SSBSpwn
0	0	0	0	5.5167	0.1103	4.435	0.1003	4.1767	0.0944
0.1	0.0339	0.1275	0.0027	4.8815	0.0935	3.8019	0.0835	3.5569	0.078
0.2	0.0679	0.2197	0.0045	4.423	0.0816	3.3453	0.0716	3.1102	0.0665
0.3	0.1018	0.2901	0.0058	4.0732	0.0727	2.9975	0.0627	2.7702	0.0579
0.4	0.1357	0.3461	0.0067	3.7955	0.0657	2.7217	0.0558	2.5008	0.0512
0.5	0.1697	0.3919	0.0074	3.5684	0.0602	2.4963	0.0503	2.2808	0.0459
0.6	0.2036	0.4303	0.0079	3.3781	0.0556	2.3078	0.0458	2.0971	0.0415
0.7	0.2375	0.4632	0.0083	3.2157	0.0518	2.1471	0.042	1.9407	0.0379
0.8	0.2714	0.4917	0.0086	3.0751	0.0485	2.0081	0.0387	1.8055	0.0348
0.9	0.3054	0.5167	0.0089	2.9518	0.0457	1.8863	0.036	1.6872	0.0321
1	0.3393	0.5389	0.0091	2.8425	0.0433	1.7785	0.0335	1.5827	0.0298
1.1	0.3732	0.5588	0.0092	2.7447	0.0411	1.6822	0.0314	1.4895	0.0277
1.2	0.4072	0.5768	0.0094	2.6567	0.0392	1.5956	0.0295	1.4058	0.0259
1.3	0.4411	0.593	0.0095	2.5769	0.0375	1.5172	0.0278	1.3301	0.0243
1.4	0.475	0.6079	0.0096	2.5042	0.036	1.4458	0.0263	1.2613	0.0229
1.5	0.509	0.6216	0.0096	2.4375	0.0346	1.3804	0.0249	1.1983	0.0216
1.6	0.5429	0.6342	0.0097	2.3762	0.0333	1.3203	0.0237	1.1406	0.0204
1.7	0.5768	0.6458	0.0097	2.3195	0.0321	1.2648	0.0225	1.0874	0.0193
1.8	0.6108	0.6566	0.0098	2.267	0.031	1.2134	0.0215	1.0382	0.0183
1.9	0.6447	0.6667	0.0098	2.2181	0.0301	1.1656	0.0205	0.9926	0.0174
2	0.6786	0.6761	0.0098	2.1724	0.0291	1.1211	0.0196	0.9501	0.0166

Reference point	F multi-plier	Absolute F
Fbar(3-7)	1	0.3393
FMax	2.4853	0.8433
F0.1	0.7168	0.2432
F35%SPR	0.8627	0.2927

Weights in kilograms

Table 4.3.18. Gulf of Riga herring. Short-term prediction results as used in ICES advice.

Basis	Total catch (2019)	F total (2019)	SSB (2019)	SSB (2020)	%SSB change*	%Advice change**
ICES advice basis						
EU MAP: F_{MSY}	26 932	0.32	91 669	92 404	0.8%	8.08%
EU MAP: F_{MSY} lower***	20 664	0.24	93 020	99 670	7.1%	-17.08%
EU MAP: F_{MSY} upper	31 237	0.38	90 698	87 477	-3.6%	25.35%
Other options						
ICES MSY approach: F_{MSY}	26 932	0.32	91 669	92 404	0.8%	8.08%
F= 0	0	0	97 030	124 349	28.2%	-100.00%
F_{pa}	47 115	0.63	86 754	69 785	-19.6%	89.07%
F_{lim}	59 942	0.88	83 040	56 105	-32.4%	140.55%
SSB (2020) = B_{lim}	75 061	1.25	77 788	40 800	-47.5%	201.22%
SSB (2020) = F_{pa}	58 989	0.86	83 335	57 100	-31.5%	136.72%
SSB (2020) = MSY $B_{trigger}$	56 232	0.80	84 172	60 000	-28.7%	125.66%
F=F_{2018}	24 584	0.29	92 183	95 113	3.2%	-1.34%

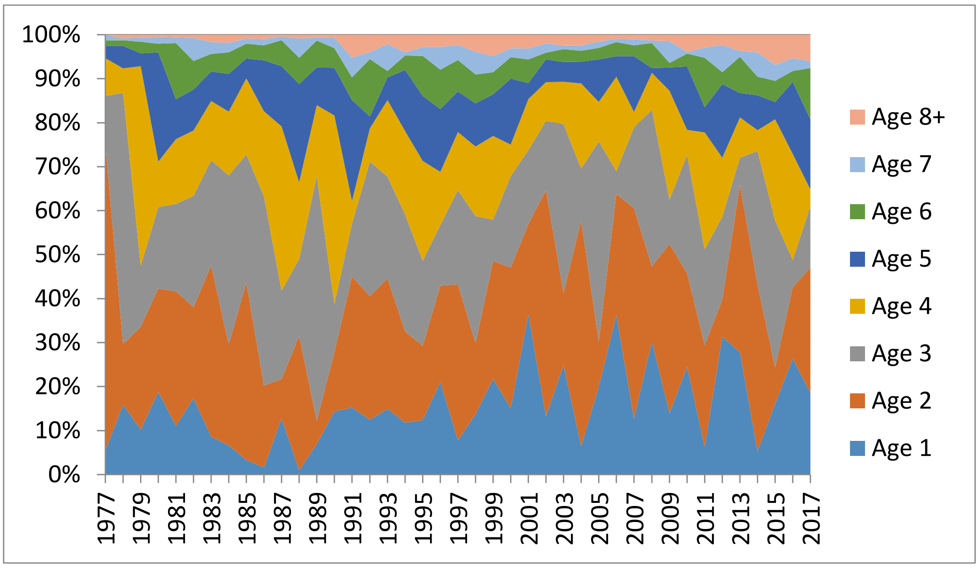


Figure 4.3.1. **Gulf of Riga herring. Relative catch-at-age in numbers in 1977–2017.**

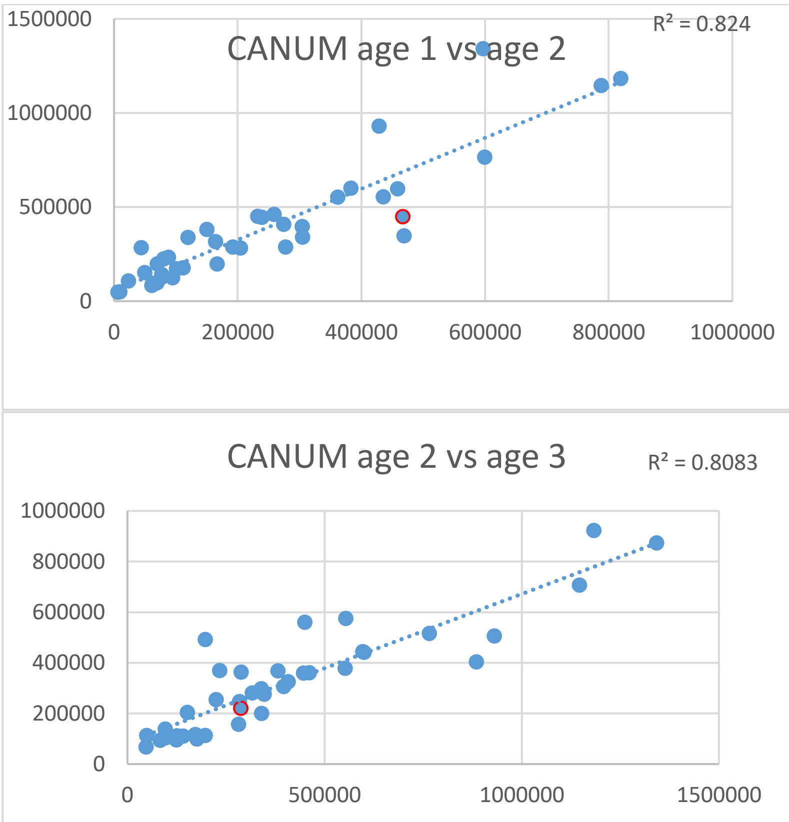
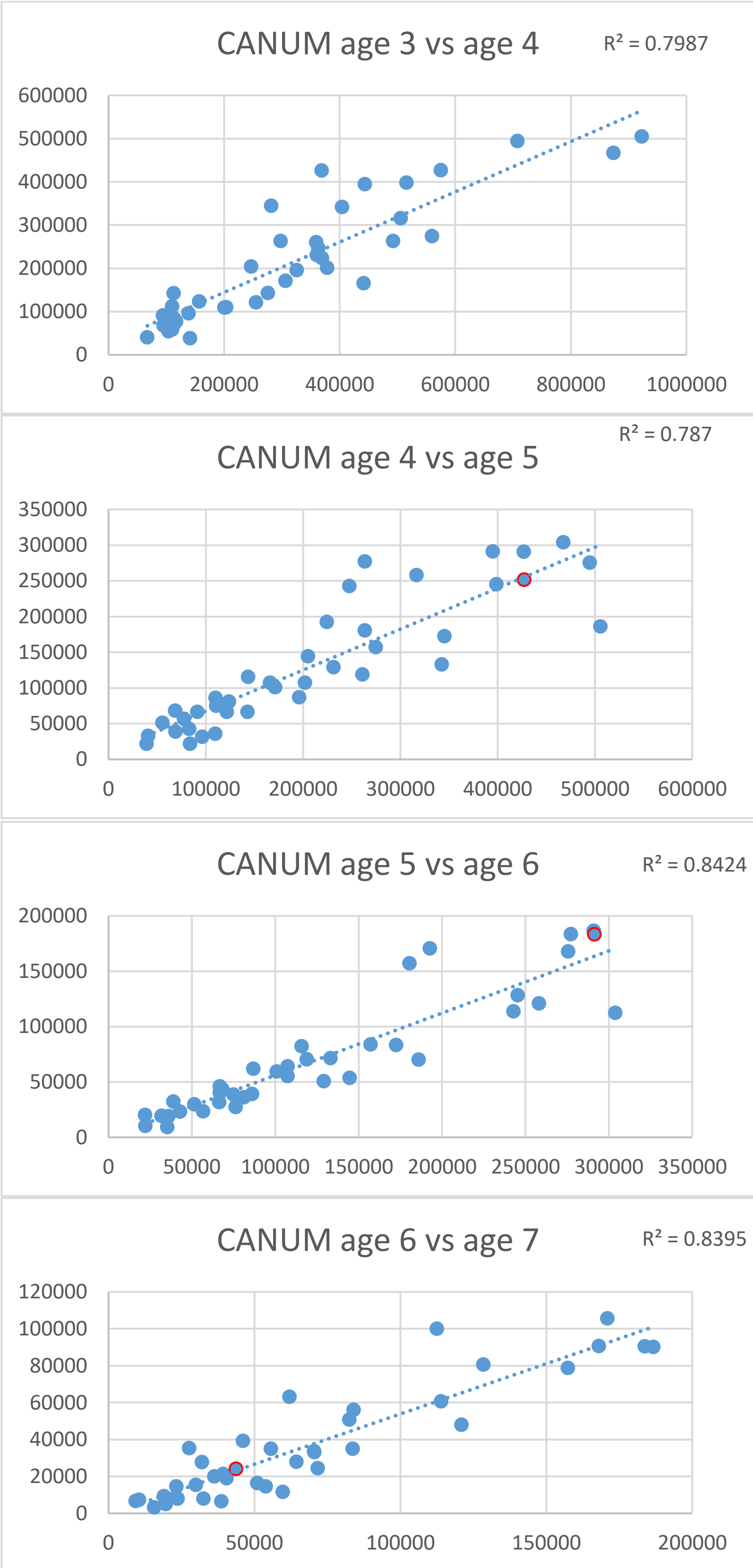


Figure 4.3.2. **Gulf of Riga herring. Check for consistency in catch-at-age data.** **1/2**



continued

Figure 4.3.2. Gulf of Riga herring. Check for consistency in catch-at-age data. 2/2

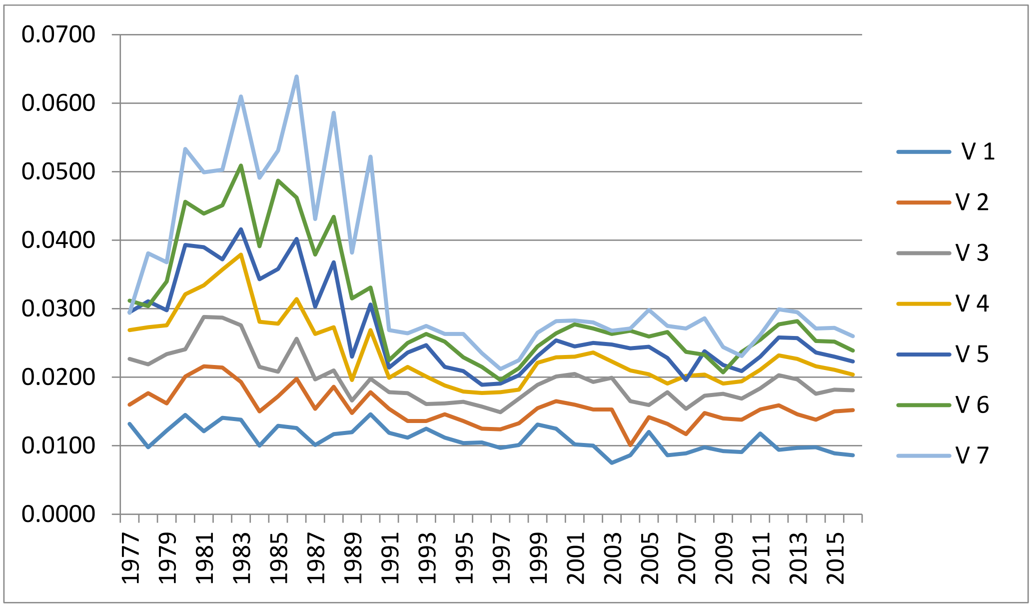


Figure 4.3.3. Gulf of Riga herring. Mean weight-at-age in the catches (kg).

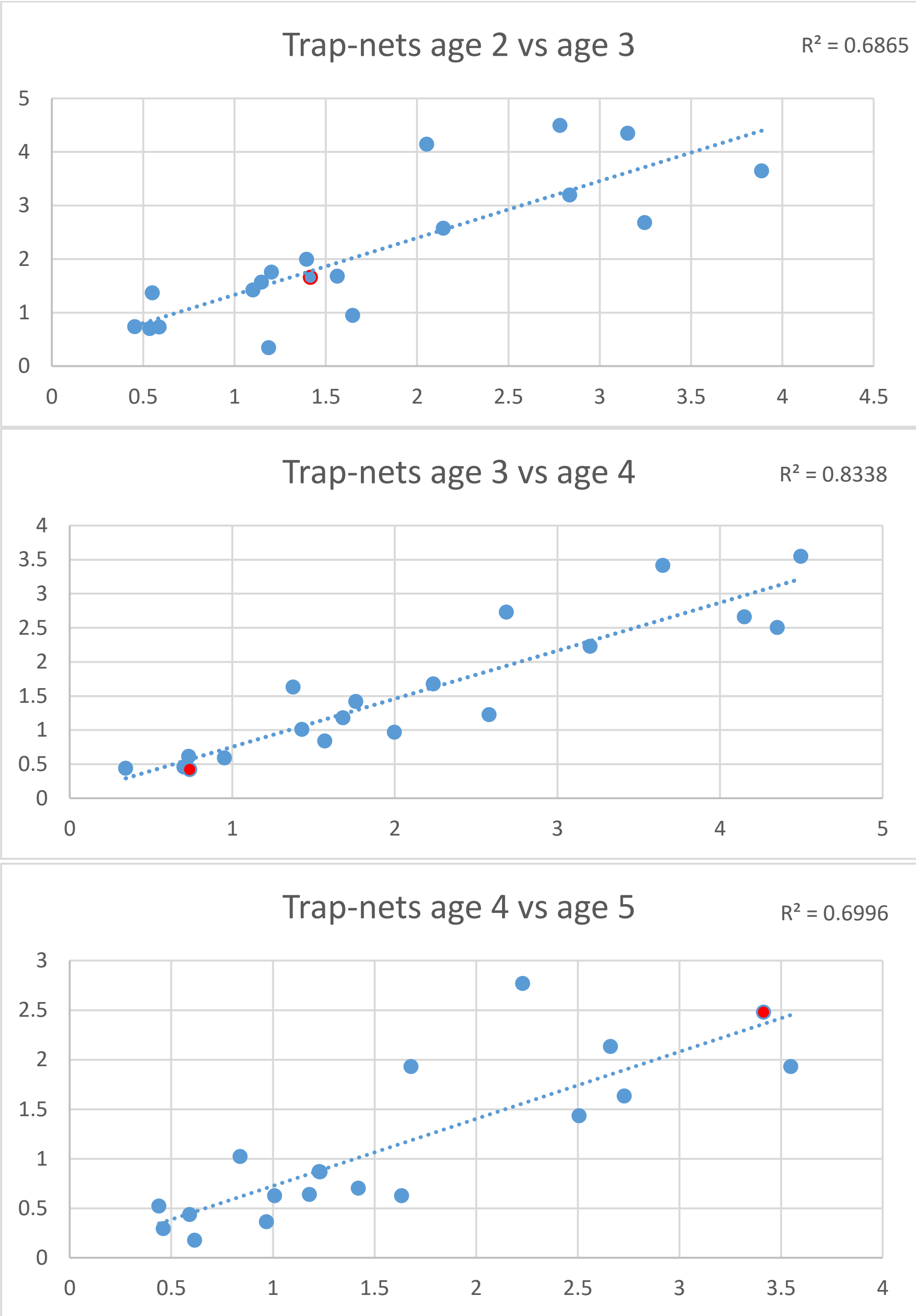
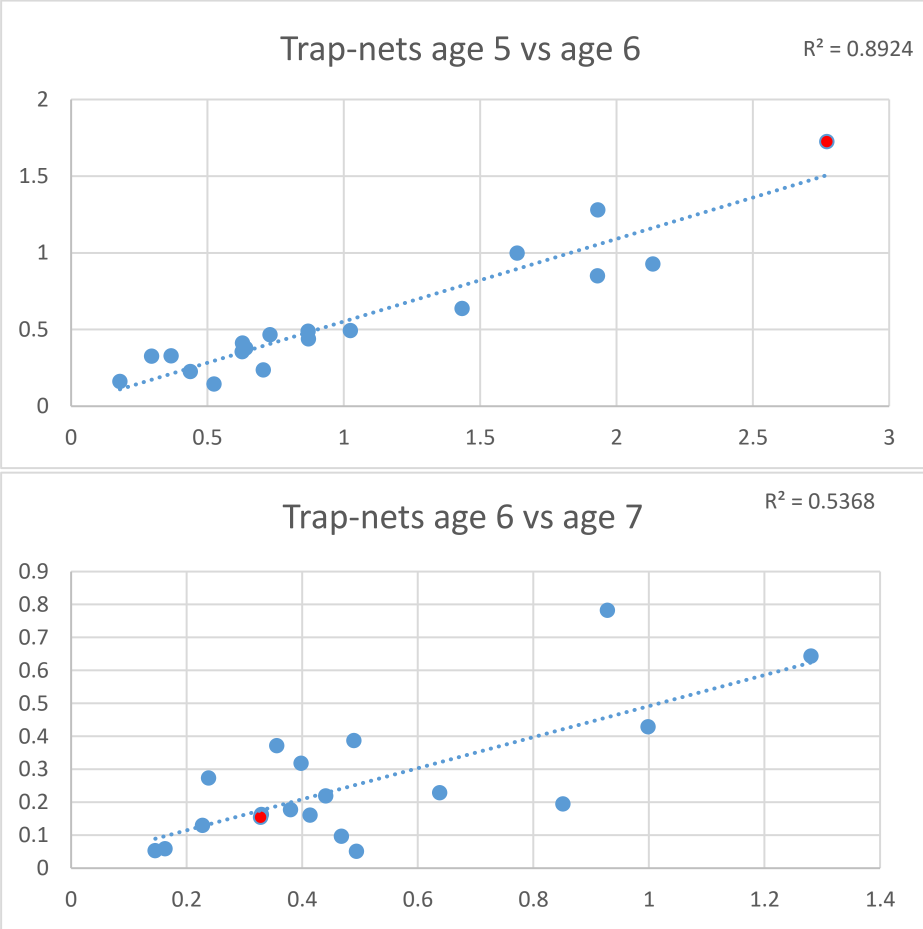


Figure 4.3.4. Gulf of Riga herring. Log catchability residuals of trap-net fleet. 1/2



continued

Figure 4.3.4. Gulf of Riga herring. Log catchability residuals of trap-net fleet. 2/2

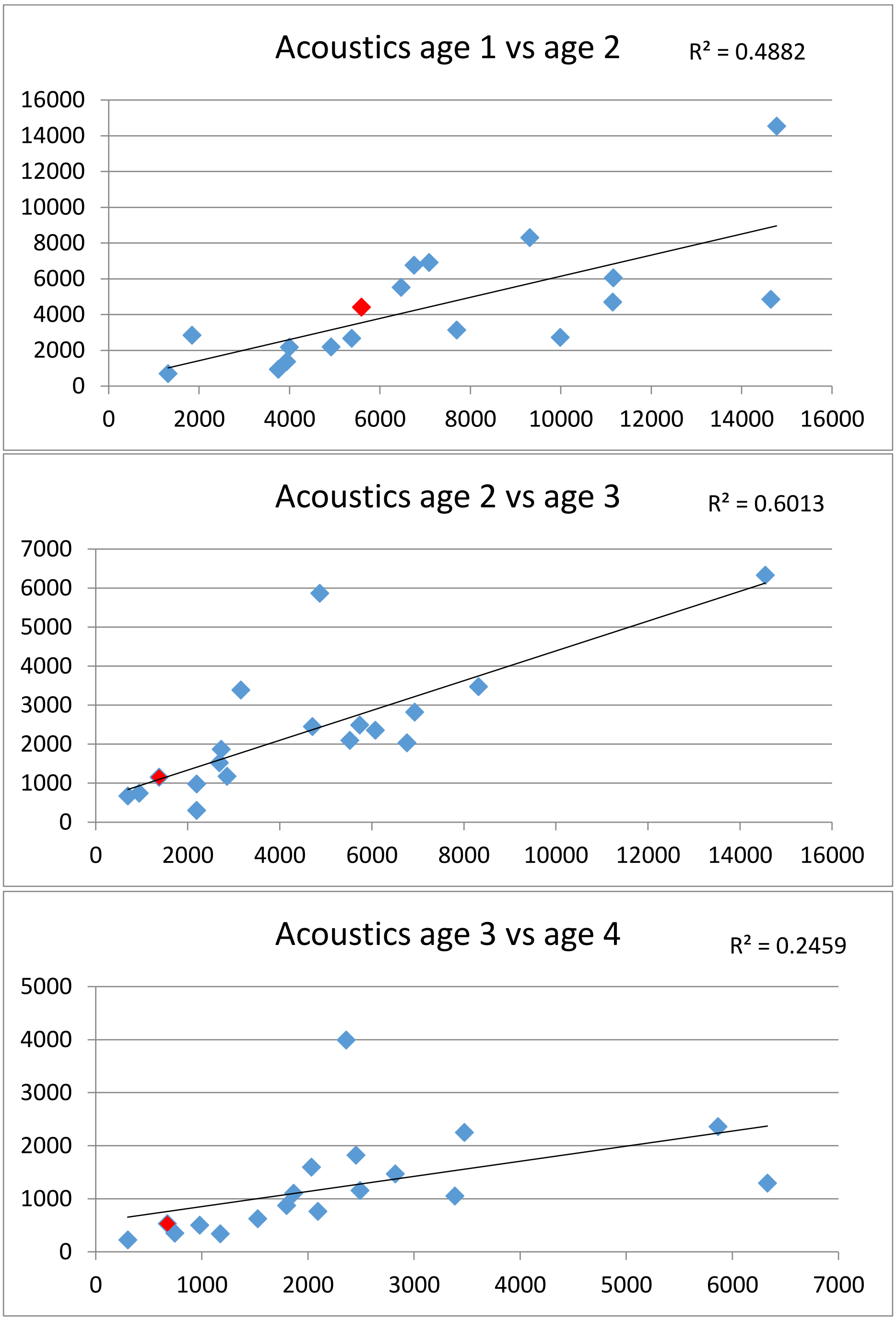
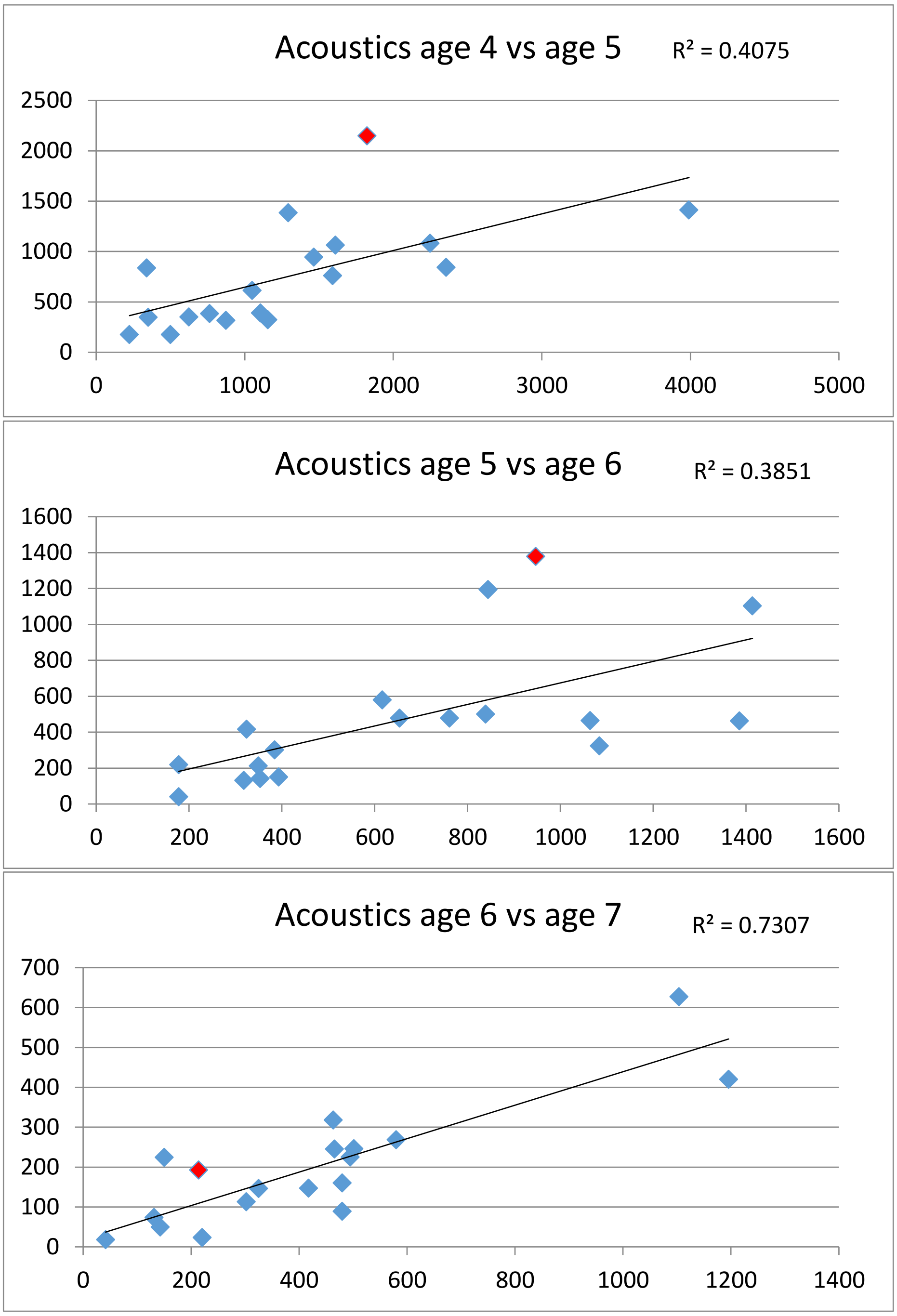


Figure 4.3.5. **Gulf of Riga herring. Check for consistency of acoustic fleet data.** **1/2**



continued

Figure 4.3.5. Gulf of Riga herring. Check for consistency of acoustic fleet data. 2/2

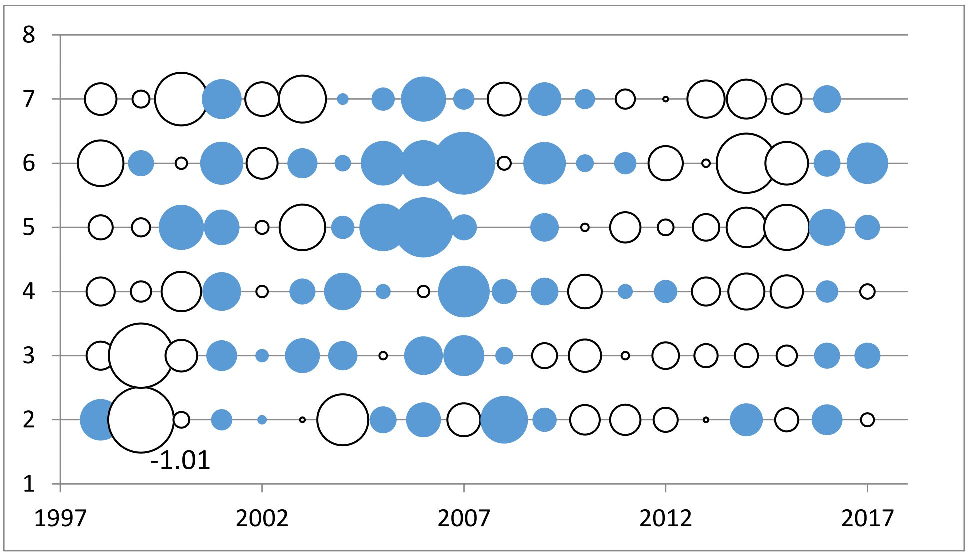


Figure 4.3.6a. **Gulf of Riga herring. Log catchability residuals of trap-net fleet.**

Figure 4.3.6b. **Gulf of Riga herring. Log catchability residuals of acoustic fleet.**

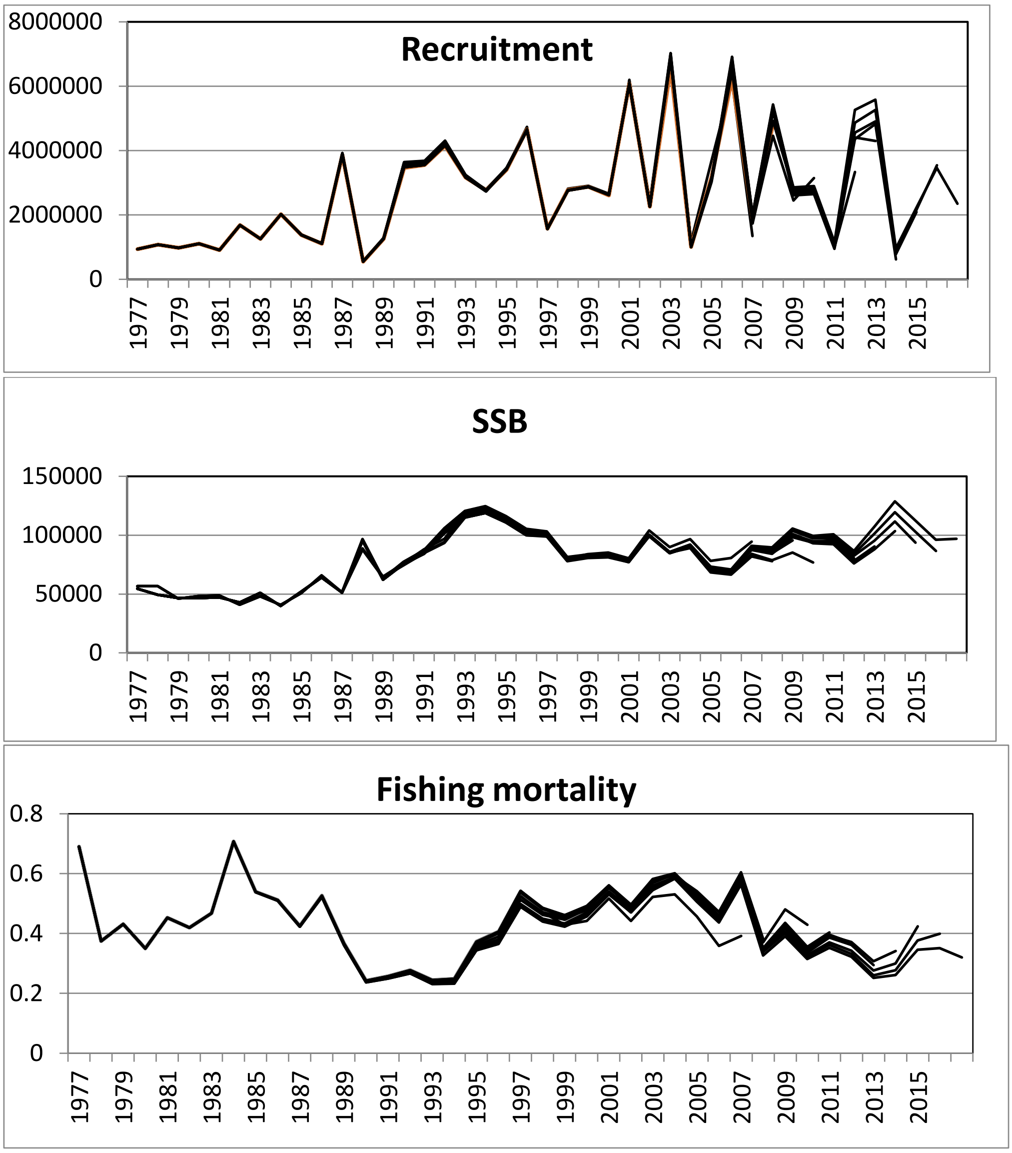


Figure 4.3.7. Gulf of Riga herring. Retrospective analysis.

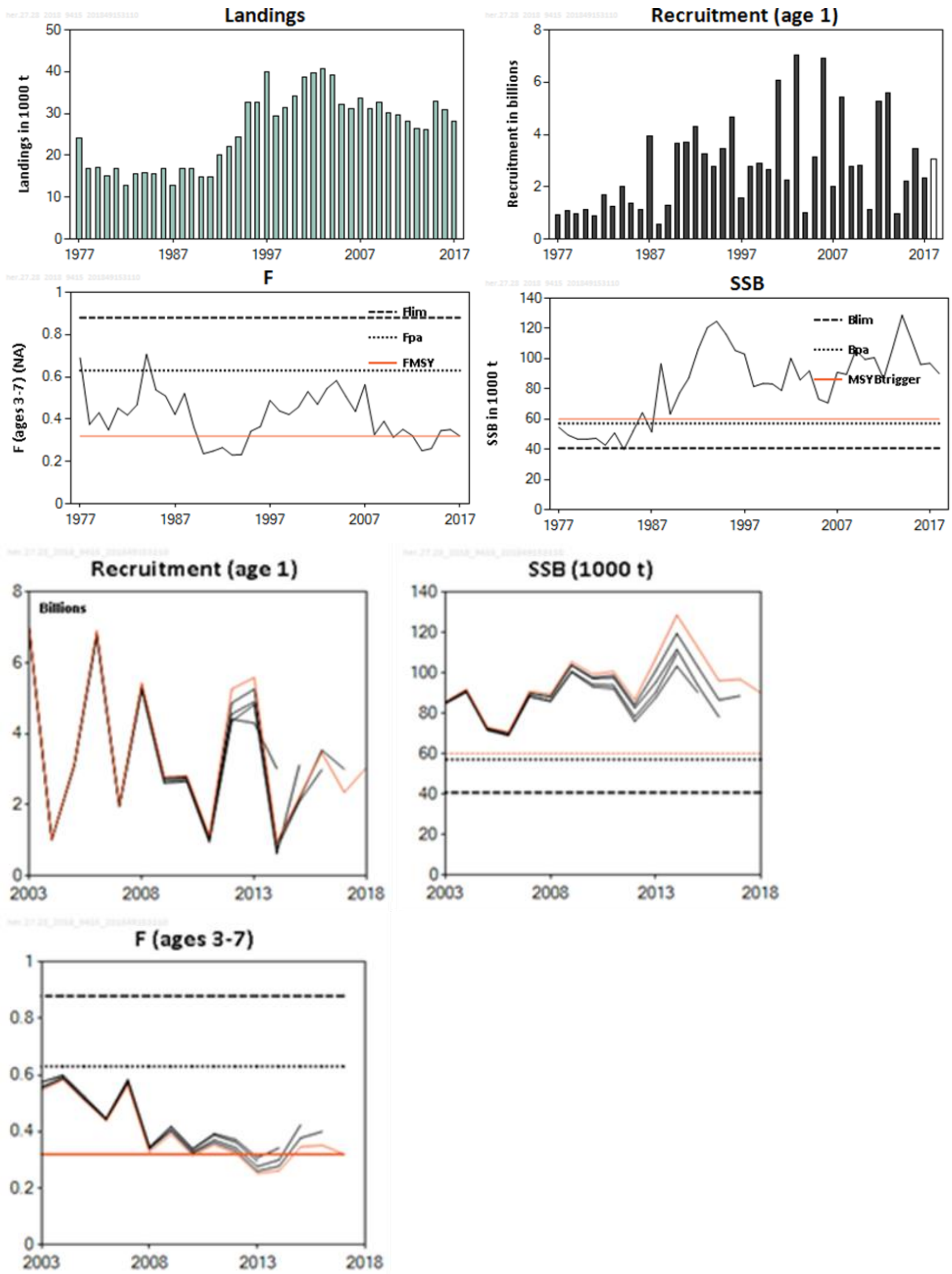


Figure 4.3.8. Gulf of Riga herring. Stock summary/Historical assessment plots.

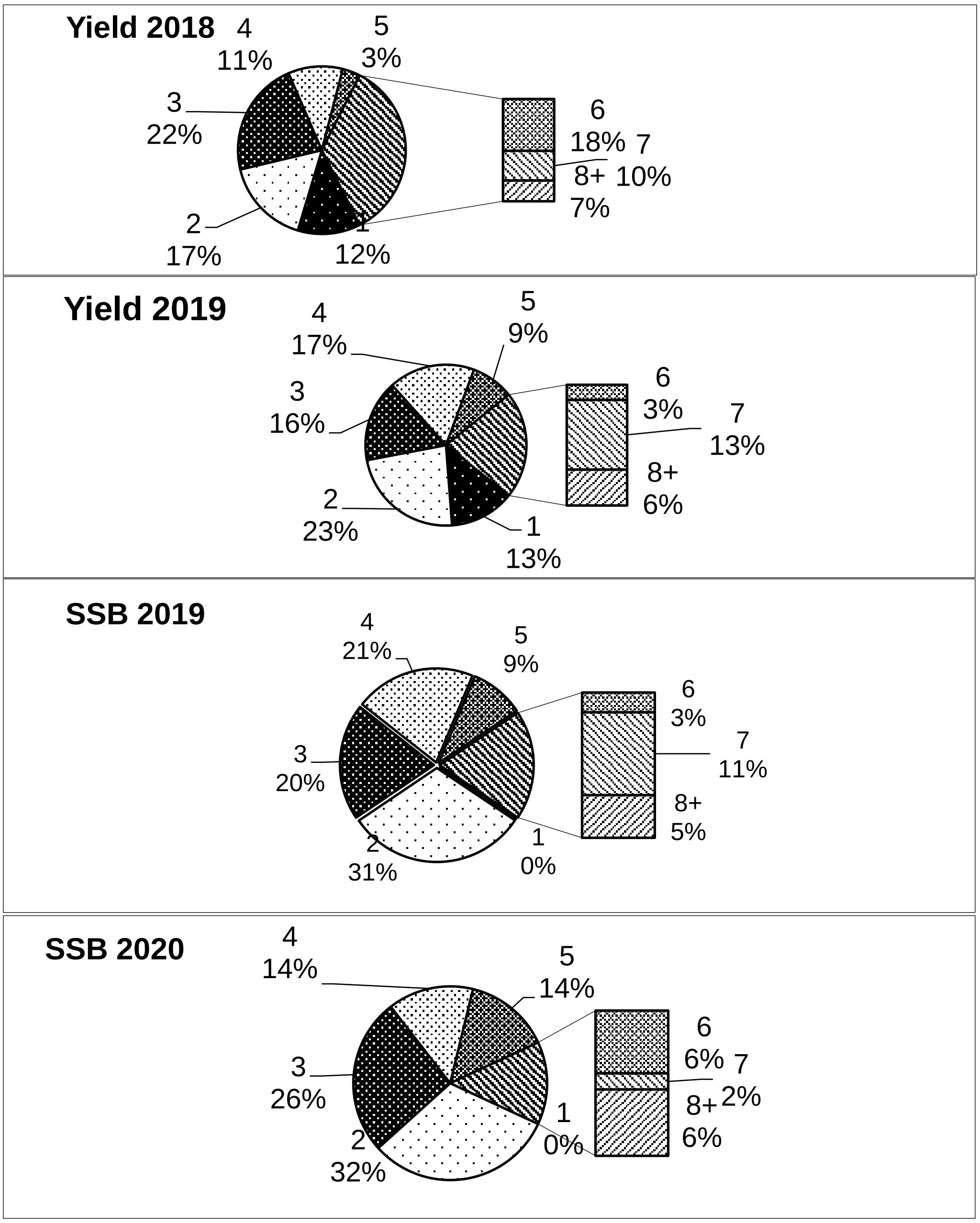


Figure 4.3.9. **Gulf of Riga herring. Short-term forecast for 2018–2020. Yield and SSB at age 1-8+ under the status quo fishing mortality.**

4.4 Herring in Subdivisions 30 and 31 (Gulf of Bothnia)

4.4.1 The Fishery

The three main fleets operating in Baltic herring fisheries in the Gulf of Bothnia (GoB) are:

- Pelagic trawling (single and pair trawling)
- Demersal trawling
- Trapnet fisheries (spawning fishery)

In the Finnish trawl fishery, the same trawls are often used in the pelagic trawling near the surface and in deeper mid-water. In 2017, 96% of the Finnish landings came from trawl fishery, 4% with trapnets, and 0.1% with gill-nets. In 2017, 94% of the Swedish catches came from trawls: 72% from pelagic trawls and 22% from demersal trawls, 4% were caught from gill-nets and other passive gears.

4.4.1.1 Landings

The total catch in Gulf of Bothnia decreased by 25 671 tonnes (20%) from 2016 to 104 358 tonnes in 2017 (Figure 4.4.1), of which 90% (93 558 tonnes) was Finnish catch and 10% (10 800 tonnes) was Swedish catch (Table 4.4.1). The Finnish catch decreased by 13% (14 245 tonnes) and the Swedish catch decreased by 51% (11 426 tonnes) compared to 2016.

4.4.1.2 Unallocated removals

No unallocated removals were reported.

4.4.1.3 Discards

Discarding rates in the Finnish fisheries are considered negligible (estimated to be few tonnes annually) and have therefore not been taken into account in assessments. Sweden is catching herring primarily for human consumption, and the preferred fish size is about 16 cm while smaller sized fish are presumably discarded. Another reason for discarding is connected with the catch amounts related to the market's demand. In gillnet and trapnet fisheries, all the fish damaged by seal (grey or ringed) predation are typically discarded. In autumn, herring is also sometimes appearing as unwanted bycatch in the vendace and whitefish fisheries. Most of the discards are reported in the herring fishery with nets. In Sweden, the interviews of fishermen indicated that they estimated the discard rate to be about 10% for the entire year.

Based on the Swedish official statistics and informal interviews 6–12% of Swedish herring catches taken from SD 30 have been discarded in the recent years. This constitutes up to 1% of the total herring catches in SD 30 and discards are therefore regarded as negligible, and not used in the assessment.

4.4.1.4 Effort and CPUE data

One commercial tuning series is used in the assessment, a trapnet CPUE time-series 1990–2006 from Bothnian Sea. In the trapnet fisheries the number of trapnets set is used as effort. Throughout the 1980s the number of trap nets decreased drastically, in 1991 the number of trapnets was only a fifth of the number in 1980, but since then their number remained more or less stable.

The trapnet-tuning fleet was renewed in 2013 according to recommendations from WKPELA 2012 (see also IBP her-30 report). It comprised of unbroken time series of catch and effort combined from three areas in Finnish coast of Bothnian Sea (rectangles 23, 42 and 47) (Figure 4.4.2). In 2015, however, the area 23 did not have a qualified trapnet fishery anymore, i.e. catch and effort were 0. The time series was further shortened from 1990–2014 to 1990–2006 because of declining trend in effort (Figure 4.4.3).

4.4.2 Biological information

4.4.2.1 Catch in numbers

During WKBALT meeting several different plus-groups (9+ to 15+) in the age-matrices of the assessment input data were examined and finally the age group 10+ was chosen to be used in the final assessment instead of the 9+, which has been previously used for both stocks (Figure 4.4.4). Finnish catches-at-age data from the Bothnian Sea has been available for the whole 1980–2017 time series and have been applied to the not sampled Swedish catches except in years 1987, 1989–1991, 1993 and 2000–2015 were Swedish biological samples were available. Also in 2016 and 2017 Swedish not sampled catches were allocated in InterCatch based on Finnish biological data sampling (Table 4.4.2). Finnish and Swedish sampling of the catches are shown in Table 4.4.3. The time–series that previously started from 1973 in SD 30 was shortened to start from 1980 to be compatible with the time–series for SD 31 due to the unavailable Finnish catch data before 1980 and Swedish data even for years before 2010. The most common age class in numbers in the 2017 catches and largest in biomass was the age-group 3, which derives from the record-high 2014 year-class. The total catch in numbers is shown in Table 4.4.4.

4.4.2.2 Mean weight-at-age

Mean weight-at-age in the catches (Table 4.4.5) was assumed similar to the mean weight in the stock. The average weight-at-age decreased for all ages since about 1990 (Figure 4.4.5), but stabilized in the beginning of the 2000. The weights have been stable for age-groups 1 to 3, slightly increased in age-groups 4 to 6 and 9 and decreased in age-groups 7, 8 and 10+ in 2017.

4.4.2.3 Maturity at-age

Constant maturity ogives have been used for period 1980–1982. Since 1983 the proportions of the mature at age have been annually updated from the samples taken before spawning time. Updated maturity ogives for 1980–2017 are shown in Table 4.4.6 and Figure 4.4.6. There is generally high variability in maturity ogives among years, which causes some noise in assessments. The annual variation in age-group 2 is usually quite large. The sensitivity of the variability in maturity ogives from year to year was evaluated in the benchmark assessment in 2012 and it was concluded that there were no grounds for discontinuation to update the maturity ogives annually (ICES, 2012).

4.4.2.4 Natural mortality

Natural mortality rate 0.15 has been used for all the age groups in all years in the stock assessment runs; respectively the proportion of natural mortality before spawning has been assumed to be 0.33 and fishing mortality before spawning 0.15 for all the years and ages.

Although the predation of seals, cormorants and cod on herring do not seem to have had a major impact on the total stock estimates (see stock annex for details), the development of the populations of these predators should be followed and their impact re-analysed at latest when the increase of the predators or the development of herring stock dynamics implicate possible effects. Particularly the effects of seals need special attention.

4.4.2.5 Quality of catch and biological information

From Finnish commercial catches, 84 length-samples and 96 age-samples were taken in 2017, and 16 length-samples and 10 age-samples from the Swedish fisheries. In total in 2017, 32 577 herring were length-measured and 1706 aged from commercial catches and 2535 from acoustic survey (Table 4.4.3).

4.4.3 Fishery independent information

A joint Swedish – Finnish hydroacoustic survey has been annually conducted in late September – early October in the Bothnian Sea, starting from 2007 until 2010 with Swedish RV Argos and continuing in 2011 and 2012 with Danish RV Dana, in years 2013-2016 with Finnish RV Aranda and in 2017 with RV Dana (the latest in late October). This survey is coordinated by ICES within the frame of the Baltic International Acoustic Surveys (BIAS). The survey covers most of the stock area, excluding only the shallow areas mainly along the Finnish coast. The survey generally tracked all age groups well, with the exception of the ages 1 and 2 (Figure 4.4.4). The survey is providing yearly estimates of abundance and biomass (Figure 4.4.7). In the 2017 benchmark the age-group 1 was included in the survey-index because it was concluded that it had similar consistency within the age-matrix as the other age groups (ICES, 2017).

In 2012 the survey was not performed according to standard coverage (60 nmi per 1000 nmi^2 = statistical rectangle), but only half of it and with half the number of control trawl hauls (normally 2 per rectangle) due to the withdrawal of the Swedish half of the total funds to the survey. In 2015 a part of the Bothnian Sea was not covered due to breakdown of the research vessel, but the acoustic index was accepted by WGBIFS to be used in assessment (ICES, 2016). In 2016 and 2017 the survey coverage was good. Acoustic surveys have shown to be essential for the assessment of this stock, and therefore they should be continued with the required effort-level.

The biological samples for ages from the surveys in 2007–2017 have been annually used for 3^{rd} and/or 4^{th} quarter ALK’s for length distributions from commercial sampling and calculations for mean weights at age in the input data.

4.4.4 Assessment

4.4.4.1 SAM

The state space assessment model (SAM) (ICES WGMG report 2009) was used in the update assessment. This stock was benchmarked at The Benchmark Workshop on Baltic Stocks (WKBALT) 2017 7–10 February 2017, and this is an update assessment of the work conducted there.

The stock assessment for her.27.3031 can be viewed at https://www.stockassessment.org (username: guest, password: guest), under the stock name: Copy_of_sam-tmb-gulf-bot-her-an-2.

The spawning stock size peaked in mid 90’s and again to similar levels in 2015. The update assessment shows a decreased SSB in 2017 (Figure 4.4.8–10). The average F has in general been increasing since 2010 and showed a peak in 2016 (0.25), declining to 0.24 in 2017. The recruitment has shown an increasing trend from 1980 to 2015, with a peak in 2015. Recruitment in 2016 and 2017 is lower compared to the record high in

2015 but still above average values. The normalised residuals in the catches are higher for age groups 6 and 7 compared to other age groups in 2017 (Figure 4.4.11.), whereas for the acoustic fleet the normalized residuals are higher for youngest and oldest age groups in 2017. (Figure 4.4.4 and 4.4.7). Consistencies of the different ages within hydroacoustic abundances, trapnet CPUE and catch data are presented in figures 4.4.12–4.4.14. In the hydroacoustic internal consistency, there are higher correlations for age 5 and older compared to younger ages in 2017. In order to test the sensitivity of the model results to different survey indices, model runs excluding one survey at a time (leave-one-out runs) were conducted (Figure 4.4.15). When excluding the trapnet tuning series and only keeping in the acoustic survey, the patterns of estimated SSB and F_{bar} are different and are somewhat outside the model uncertainty estimates of a "complete" model that uses both survey data sets. When excluding the hydroacoustics there is a 100 000 t increase in SSB in latest years. The acoustic survey is still relatively short and samples a younger part of the population compared to the size selective trap net fishery which could add to the differences in the patterns. Excluding either survey indices does not have much impact on recruitment with the exception of 2015 and 2017 where the recruitment is higher. The retrospective analysis shows an overestimated SSB (Mohn's rho=0.144) and underestimated fishing mortality during the last 3 years (Mohn's rho= 0.131). Retrospective analysis for recruits are highly unstable during the final years (Mohn's rho=0.479) (Figure 4.4.16.). The acoustic survey data based abundance index was highest in the year 2015 and lowest in the year 2016 in the survey time series. This caused major uncertainty in recruitment estimates for the years 2016 and 2017. In order to reduce the uncertainty an additional model was fitted with lower error. However, since it didn't differ from the update assessment model it was decided to go ahead with the update assessment using the initial (benchmarked) model and keep the improved model for future checks.

4.4.4.2 Recruitment estimates

As in several other Baltic pelagic stocks, the year-class 2014 was huge (22.8 times higher) and in the year 2015 still 9.1 times higher than the mean value for 2007–2012. The recruitment (age 1) for 2016 and 2017 shows lower values compared to 2015 but still above average.

According to the estimates from SAM, the recruitment of herring in the Gulf of Bothnia in 2002 was 17% higher than any other year class previously observed (Figure 4.4.10.). The year class 2013 was 13% larger than 2002 year class and the year class of 2014 97% lager. The 2014 year class was an exceptionally abundant year class in the Baltic Sea area also for other pelagic stocks. The recruitment estimates since 2002 have been over the average recruitment estimated over the period after the Baltic Sea regime shift in the late 1980s, having high year classes in most years after 2002. It should be noted however, that the confidence intervals, particularly around the more recent years, are very large.

4.4.4.3 Historical trends

The herring spawning stock biomass increased rapidly since 1981 (Table 4.4.7.). It peaked in 1994, decreased until 2002, and thereafter increased again to a record high level in 2014. However, the spawning stock biomass has shown a declining trend since 2015. The large uncertainty around the SSB estimate has reduced after the model was revised in the benchmark. During the current period of high recruitment, the spawning stock biomass is between three to four times larger than it was in the low recruitment period before the late 1980s.

4.4.5 Short-term forecast and management options

The short term forecast is based on the SAM short term forecast module and the settings for the short term forecast are as follows:

The mean weights at age were assumed to be equal to the average of the mean weights at age across the years 2015–2017. Natural mortality was set to 0.15 and we used the average fishing mortality rate in 2015–2017 scaled to the last year. Recruitment in 2018 and 2019 were estimated based on resampling from the sampled distribution in 1980–2017. The proportion of total annual natural mortality before spawning was assumed to be 33% and proportion of F before spawning 15% of the annual fishing mortality. The forecast runs are done with 2018 catch constraints because the forecasted catch without constraints overestimated the TAC for 2018. The summary of the short-term forecast with different management options are presented in the Table 4.4.8.

The short term forecast showed that with the fishing mortality at MSY (F_{MSY} = 0.21), the herring catches in the Gulf of Bothnia would be 94.0 thousand tonnes in 2019 with a decrease of SSB by -5%.

Details on the forecast scenarios and results can also be viewed at https://www.stockassessment.org (login:guest, password:guest), choose stock Copy_of_sam-tmb-gulf-bot-her-an-2.

4.4.6 Reference points

Reference points for the GoB herring stock were calculated in WKBALT (2017) with upper and lower ranges. The proposed summary table of the Gulf of Bothnia stock reference points is:

Stock	
Reference point	Value
$F_{P.05}$ (5% risk to B_{lim}) with MSY $B_{trigger}$	0.21
$F_{P.05}$ (5% risk to B_{lim}) without MSY $B_{trigger}$	0.180
F_{MSY}	0.21
F_{MSY} lower	0.151
F_{MSY} upper	0.21
F_{pa}	0.23
F_{lim}	0.29
F_{MSY} upper precautionary	0.20
F_{MSY} range with MSY $B_{trigger}$	0.15-0.21
F_{MSY} range without MSY $B_{trigger}$	0.15-0.18
MSY $B_{trigger}$	283 180 t
B_{pa}	283 180 t
B_{lim}	202 272 t

4.4.7 Quality of the assessment

The tuning is based on acoustic surveys in the Bothnian Sea since 2007 and commercial trapnet data from the Bothnian Sea herring stock assessments from the years 1990–2006. Trapnet data from later years have not been included in the assessment, because the effort decreased a lot in later years and they are regarded too unreliable. Presently the time series is too short in the acoustic survey data to be used alone (WKBALT 2017).

The results from especially the acoustic surveys of 2016 and 2017 give a very uncertain figure of the stock status, as the estimate of stock numbers decreased a lot for all age-groups compared to the previous year and this large drop is not reflected in the commercial catch data.

Several concerns regarding the trapnet tuning index have been raised in the working group. In short, it is uncertain whether the trapnet index is still representative of the stock in SD 30 and 31; the stock levels estimated by the model are very sensitive to small changes in the model used to produce the tuning index. The acoustic tuning index is showing high variation in the ages in recent years. The survey time series is still relatively short. It is anticipated that extending the acoustic survey time-series will improve the quality of the assessment.

4.4.8 Management considerations

This stock is the resource basis for the herring TAC set for Management Unit III including subdivisions 30 and 31. The current assessment unit in the two subdivisions was previously assessed as two herring stocks, which were merged at the benchmark workshop in 2017 (ICES, 2017).

Table 4.4.1 Herring in SD's 30 and 31. Landings by country (t).

Year	Finland	Sweden	Total
1980	27.657	2.152	29.809
1981	19.616	1.910	21.526
1982	24.099	2.400	26.499
1983	23.115	3.093	26.208
1984	31.550	2.995	34.545
1985	32.830	2.602	35.432
1986	32.742	2.837	35.579
1987	30.403	2.225	32.628
1988	32.979	3.439	36.418
1989	29.458	3.628	33.086
1990	36.418	2.762	39.180
1991	30.019	3.400	33.419
1992	42.510	4.100	46.610
1993	45.352	3.962	49.314
1994	59.055	2.931	61.986
1995	62.704	2.843	65.547
1996	59.452	1.851	61.303
1997	67.727	2.081	69.808
1998	59.473	3.001	62.474
1999	64.392	2.110	66.502
2000	57.365	1.487	58.852
2001	55.742	2.064	57.806
2002	49.847	4.122	53.969
2003	49.787	3.857	53.644
2004	56.067	5.356	61.423
2005	60.222	2.689	62.911
2006	69.646	1.672	71.318
2007	75.108	3.570	78.678
2008	64.065	3.849	67.914
2009	67.047	4.201	71.248
2010	70.658	1.932	72.590
2011	78.348	3.502	81.850
2012	99.454	6.553	106.007
2013	103.421	10.975	114.396
2014	102.416	12.950	115.366
2015	100.784	14.158	114.942
2016	107.803	22.226	130.029
2017	93.558	10.800	104.358

Table 4.4.2. Herring in SD's 30 and 31. Allocation of Swedish not sampled landings.

Swedish not sampled landings and discards					Allocated according to					
SD	**Q**	**Gear**	**Category**	**Tonnes**	**SD**	**Country**	**Q**	**Gear**	**Category**	**Tonnes**
30	2	Bottom Trawl	L	0.7	30	FI	2	Pelagic trawl	L	32632
30	3	Bottom Trawl	L	32	30	FI	3	Pelagic trawl	L	9707
30	4	Bottom Trawl	L	71	30	FI	4	Pelagic trawl	L	14674
30	1	Gillnet	L	8	30	SE	2	Gillnet	L	472
30	4	Gillnet	L	26	30	SE	3	Gillnet	L	88
31	4	Gillnet	L	0.2	31	SE	3	Gillnet	L	2
30	2	Gillnet	D	0.4	30	SE	2	Gillnet	L	472
30	2	Passive gears	L	2	30	FI	2	Trapnet	L	2701
30	3	Passive gears	L	0.9	30	FI	2	Trapnet	L	2701
31	2	Passive gears	L	3	31	FI	2	Trapnet	L	2701
31	3	Passive gears	L	0.2	31	FI	2	Trapnet	L	2701
31	4	Passive gears	L	0.1	31	FI	2	Trapnet	L	2701
30	1	Pelagic trawl	L	4475	30	FI	1	Pelagic trawl	L	30128
30	2	Pelagic trawl	L	1817	30	FI	2	Pelagic trawl	L	32632
30	3	Pelagic trawl	L	2	30	FI	3	Pelagic trawl	L	9707
30	4	Pelagic trawl	L	1423	30	FI	4	Pelagic trawl	L	14674
31	4	Pelagic trawl	L	0.1	31	FI	4	Pelagic trawl	L	40

Table 4.4.3 Herring in SD's 30 and 31. Landings and sampling by country in 2017.

Country	ICES Sub Division	Landings	Quarter	Number of length samples	Number of fish measured	Number of age samples	Number of fish aged
Finland	30	30129	1	14	4475	14	288
		35434	2	18	5345	13	364
		10248	3	18	4447	14	221
		14678	4	16	4676	15	236
		90490	**Total**	66	18943	56	1109
Sweden	30	6022	1	1	1307	0	0
		3026	2	4	1645	3	186
		158	3	3	1477	2	179
		1467	4	3	1868	0	0
		10672	**Total**	11	6297	5	365
Finland	31	0	1	0	0	0	0
		2467	2	9	2736	8	306
		559	3	7	1864	6	193
		43	4	2	604	2	148
		3068	**Total**	18	5204	16	647
Sweden	31	0	1	0	0	0	0
		21	2	3	1182	3	194
		35	3	2	951	2	264
		72	4	0	0	0	0
		127	**Total**	5	2133	5	458
Finland & Sweden	30 + 31	36151	4	15	5782	14	288
		40948	8	34	10908	27	1050
		10999	12	30	8739	24	857
		16259	16	21	7148	2	148
		104358	**Total**	**100**	**32577**	**67**	**2343**

SD 30 Q 4: age sampling has in addition 24 age samples with 2535 aged fish from acoustic survey.

Table 4.4.4. Herring in SD's 30 and 31. Catch in Numbers (thousands).

Year	1	2	3	4	5	6	7	8	9	10+
1980	124930	112920	61920	66620	262270	90230	96830	57120	21975	40745
1981	27570	124000	59130	48010	57110	136920	54220	40650	22597	30533
1982	26810	107840	270020	60380	49410	73080	114910	32730	32040	29280
1983	102120	191340	104320	178520	23900	32000	48610	86810	21824	34186
1984	142210	291180	209560	109520	132580	25450	25350	35000	57350	46910
1985	95150	373640	319790	144620	50160	88430	17750	15850	18317	65363
1986	19100	406380	354920	217790	100740	47350	56500	9160	11426	50994
1987	49170	77260	232130	254920	143520	69250	43370	21590	10706	35064
1988	16480	226490	86310	203000	213910	122760	52930	26270	15435	33005
1989	99380	79740	181120	70520	127840	133340	71910	28950	14631	24039
1990	199890	511580	63700	131380	47270	99210	114320	47820	17975	33175
1991	44190	224870	341910	48990	92540	58850	71890	46920	27505	29295
1992	89540	232470	463390	358030	67780	81820	74790	55710	28937	33293
1993	222810	391710	211390	348550	317940	53970	62080	40350	25885	27285
1994	84500	404060	361710	221140	347250	311050	48400	78140	34470	36160
1995	109660	249730	515960	325460	230160	287240	205880	41230	61001	49429
1996	109490	519790	247930	337900	258500	165210	203360	129180	18462	43208
1997	141310	407600	490200	274540	317290	230680	187540	150140	91849	49041
1998	296540	259230	337110	363200	238600	180210	160460	67120	53018	185492
1999	147710	694270	312710	373660	278140	163180	216350	79080	57399	140131
2000	289776	211673	433968	326427	200555	209571	118562	76728	62365	249664
2001	266243	450302	203894	460811	167923	140134	139361	92518	68976	215126
2002	308482	270574	404072	159300	216521	101917	58483	90625	82209	197092
2003	305396	425299	267888	246267	177145	185773	67146	57477	49827	210942
2004	104393	1021965	490316	243896	200519	143971	136323	65848	59707	165796
2005	172165	238898	1189611	337559	182116	161536	87738	95355	76075	163435
2006	176592	292909	132105	1061307	379704	161606	94974	128742	90335	230801
2007	552847	660118	357542	168654	1017283	275806	92438	127731	87818	179484
2008	266434	873384	327757	318645	218789	404664	186749	126807	94630	176538
2009	268319	446210	586402	414737	128103	131399	355613	143488	82792	178957
2010	297532	820306	481726	418950	286816	105453	82757	234997	86170	172487
2011	251376	634214	569108	374424	369070	174016	92440	81609	247597	307835
2012	512943	429102	696213	573553	364869	348220	183169	148802	82567	511352
2013	486237	894795	530634	396023	567340	299623	294588	182312	95551	394846
2014	434458	701891	753506	267860	427997	284267	225170	212795	118943	385511
2015	1378190	913322	725069	450623	325361	247165	222505	150439	112138	288127
2016	821289	1663093	811016	466569	337671	225412	268940	147995	125977	363110
2017	742230	859392	1172496	435129	294949	133535	101620	128330	87524	297165

Table 4.4.5. Herring in SD's 30 and 31. Mean weight in catch and in the stock (g).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	8	19	24	33	36	38	41	46	50	57
1981	11	18	27	33	40	42	45	48	55	68
1982	5	15	26	35	39	44	44	51	52	64
1983	5	15	28	36	43	48	49	54	62	68
1984	10	19	30	39	44	52	56	61	60	70
1985	7	16	29	39	45	47	60	60	58	66
1986	8	15	25	33	39	45	48	51	59	62
1987	9	21	28	34	41	46	51	58	60	66
1988	11	18	31	35	41	47	53	61	63	75
1989	10	21	32	41	47	53	57	61	68	74
1990	8	20	32	39	46	51	56	60	69	81
1991	9	20	27	37	42	49	53	55	58	69
1992	12	20	27	31	41	46	51	54	59	67
1993	13	20	27	31	34	46	50	55	60	69
1994	10	20	27	32	35	40	52	57	62	70
1995	7	18	26	29	34	38	44	53	62	77
1996	9	17	25	31	35	39	43	50	58	69
1997	9	15	23	29	34	37	43	48	55	71
1998	8	13	19	26	32	39	44	55	57	68
1999	7	12	20	26	32	40	45	51	58	68
2000	8	13	19	23	28	32	36	41	46	62
2001	8	14	21	25	29	32	39	42	43	55
2002	8	16	24	28	30	34	37	39	47	58
2003	6	15	23	27	30	36	40	40	45	59
2004	5	12	20	25	31	35	40	41	43	56
2005	7	12	18	24	29	30	39	39	42	47
2006	7	13	18	22	27	32	37	40	41	45
2007	6	13	20	22	26	29	34	36	38	49
2008	8	13	19	21	29	28	31	38	41	46
2009	9	16	21	23	30	32	35	38	43	51
2010	9	16	21	26	28	36	34	38	45	50
2011	9	15	22	25	27	29	31	37	38	46
2012	7	15	22	26	30	32	37	40	43	50
2013	10	17	23	25	30	34	37	38	47	52
2014	10	17	24	30	32	37	43	50	47	55
2015	10	16	23	29	31	38	41	45	48	54
2016	11	16	22	27	31	35	37	42	50	59
2017	9	16	23	28	33	38	38	42	50	55

Table 4.4.6. Herring in SD's 30 and 31. Proportion of mature-at-age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
1980	0	0.31	0.92	0.97	1	1	1	1	1	1
1981	0	0.31	0.93	0.97	1	1	1	1	1	1
1982	0	0.29	0.93	0.97	1	1	1	1	1	1
1983	0	0.21	0.92	0.98	1	1	1	1	1	1
1984	0	0.23	0.93	0.97	1	1	1	1	1	1
1985	0	0.2	0.92	0.99	1	1	1	1	1	1
1986	0	0.28	0.91	0.97	1	1	1	1	1	1
1987	0	0.32	0.89	0.97	1	1	1	1	1	1
1988	0	0.1	0.85	0.96	1	1	1	1	1	1
1989	0	0.23	0.97	1	1	1	1	1	1	1
1990	0	0.59	1	1	1	1	1	1	1	1
1991	0	0.59	0.94	1	1	1	1	1	1	1
1992	0	0.5	0.9	1	1	1	1	1	1	1
1993	0	0.44	0.82	0.97	1	1	1	1	1	1
1994	0	0.63	0.97	1	1	1	1	1	1	1
1995	0	0.35	0.91	0.95	1	1	1	1	1	1
1996	0	0.66	1	1	1	1	1	1	1	1
1997	0	0.32	0.84	0.97	1	1	1	1	1	1
1998	0.03	0.33	0.72	0.96	1	1	1	1	1	1
1999	0.01	0.38	0.88	0.99	1	1	1	1	1	1
2000	0.11	0.65	0.93	0.98	1	1	1	1	1	1
2001	0.01	0.61	0.97	0.97	1	1	1	1	1	1
2002	0.03	0.58	0.96	0.97	0.99	0.96	1	1	1	1
2003	0	0.56	0.94	0.97	0.96	1	1	0.89	0.89	1
2004	0.02	0.34	0.91	0.97	1	1	1	1	1	0.96
2005	0.02	0.28	0.86	0.96	0.94	0.97	1	1	1	0.96
2006	0.02	0.37	0.92	0.91	1	0.94	1	1	1	1
2007	0.02	0.56	0.87	1	0.96	1	1	0.9	1	0.97
2008	0	0.5	0.91	1	0.93	1	1	1	1	0.94
2009	0	0.51	0.91	0.95	0.95	0.91	0.97	0.97	1	1
2010	0.05	0.87	1	1	1	1	1	1	1	1
2011	0.01	0.46	1	1	1	1	1	1	1	0.97
2012	0.01	0.75	0.97	0.98	1	1	0.94	1	1	0.99
2013	0.11	0.78	0.98	1	1	1	1	1	1	0.98
2014	0.16	0.71	1	1	1	1	0.94	0.95	1	1
2015	0.13	0.8	0.98	1	1	1	1	1	1	1
2016	0.05	0.72	0.9	1	1	1	1	1	1	0.92
2017	0.11	0.76	0.98	0.99	1	1	1	1	1	0.98

Table 4.4.7. Herring in SD's 30 and 31. SAM output summary table. Historical stock trends of Gulf of Bothnia herring in 1980–2017.

Year	R(age 1)	Low	High	SSB	Low	High	Fbar(3-7)	Low	High
1980	3213213	1939404	5323665	180148	122539	264842	0.15	0.1	0.21
1981	1480723	962243	2278572	168271	115019	246176	0.14	0.1	0.2
1982	1981136	1213236	3235066	181733	126037	262040	0.14	0.1	0.2
1983	4531874	3006134	6831991	190539	132294	274427	0.14	0.1	0.19
1984	5783075	3788030	8828854	228101	161583	322002	0.14	0.1	0.19
1985	4628364	3074615	6967296	252753	185744	343936	0.13	0.1	0.18
1986	1424097	932328	2175258	268784	202809	356221	0.12	0.09	0.17
1987	3202375	2104966	4871911	302830	231354	396387	0.12	0.09	0.15
1988	1435399	929119	2217554	300929	228809	395781	0.11	0.09	0.15
1989	6447192	4217209	9856348	339524	261622	440622	0.1	0.08	0.13
1990	7898562	5216826	11958859	383314	299324	490870	0.1	0.07	0.13
1991	3195882	2059789	4958596	412041	324423	523322	0.09	0.07	0.12
1992	4738352	3202614	7010516	459516	364672	579027	0.1	0.08	0.13
1993	6828082	4528764	10294796	445858	358733	554143	0.11	0.08	0.14
1994	3339595	2288507	4873438	528187	431407	646678	0.12	0.1	0.15
1995	4401410	2983031	6494203	470411	385346	574254	0.14	0.12	0.17
1996	3746966	2572351	5457947	458661	377758	556891	0.15	0.13	0.19
1997	3491819	2398752	5082975	413779	339855	503781	0.18	0.14	0.22
1998	5847849	4028856	8488101	383822	312343	471658	0.18	0.15	0.22
1999	2899718	1985588	4234699	378617	309016	463895	0.19	0.16	0.23
2000	4948951	3416080	7169656	341768	279698	417613	0.18	0.15	0.22
2001	4416278	2998148	6505187	330726	272239	401778	0.17	0.14	0.21
2002	6209743	4296294	8975388	328833	270673	399490	0.16	0.13	0.19
2003	8779047	5498686	14016380	324075	267656	392386	0.15	0.13	0.19
2004	2609036	1796235	3789631	332848	277191	399681	0.16	0.13	0.19
2005	3641566	2526211	5249365	361673	301855	433346	0.16	0.13	0.19
2006	4483027	3083049	6518719	361099	302510	431037	0.16	0.13	0.19
2007	8156335	5683724	11704616	365352	306539	435448	0.17	0.14	0.2
2008	5122239	3655445	7177602	354177	296073	423684	0.17	0.14	0.2
2009	6233575	4309275	9017168	394085	327840	473715	0.17	0.14	0.2
2010	6067036	4330949	8499044	455259	378089	548179	0.17	0.14	0.2
2011	4742151	3383505	6646361	434679	360322	524382	0.17	0.14	0.21
2012	8248741	5805175	11720876	489648	405124	591807	0.19	0.16	0.24
2013	6739409	4842913	9378578	525336	434626	634977	0.21	0.17	0.26
2014	7405552	5182200	10582805	536560	441406	652226	0.22	0.18	0.27
2015	11671217	8329654	16353296	508461	416166	621225	0.24	0.19	0.29
2016	6489581	4476405	9408145	469577	379444	581121	0.25	0.2	0.32
2017	7492859	4354560	12892907	460805	364390	582731	0.24	0.18	0.3
	thousands			tonnes					

Table 4.4.8. Herring in SD's 30 and 31. Short-term forecast with different management options of the Gulf of Bothnia herring.

	Catch (2019)	F_{total} (2019)	SSB (2019)	SSB (2020)	% SSB change *	% TAC change **	% Advice change ***
ICES advice basis							
MSY approach: F_{MSY}	94026	0.21	446313	421976	-5	11	-2
Other scenarios							
F = 0	0	0	461089	534974	16	-100	-100
F_{pa}	101988	0.23	445020	412368	-7	21	6
F_{lim}	124878	0.29	440810	385483	-13	48	23
SSB (2020) = B_{lim}	283762	0.9	402826	201488	-50	235	66
SSB (2020) = B_{pa}	205489	0.57	422653	285729	-32	155	56
SSB (2020) = MSY $B_{trigger}$	215489	0.57	422653	285729	-32	155	56
F = F_{2018}	84336	0.186	447957	433804	-3	0	-13
F = proposed $F_{MSY\ lower}$ ^	69759	0.151	450329	451141	0	18	-37
F = proposed $F_{MSY\ upper}$ ^^	94026	0.21	446313	421976	-5	11	-2

* SSB 2020 relative to SSB 2019.

**Catch in 2019 relative to TAC in 2018 (84 599 t).

*** Advice value 2019 relative to advice value 2018.

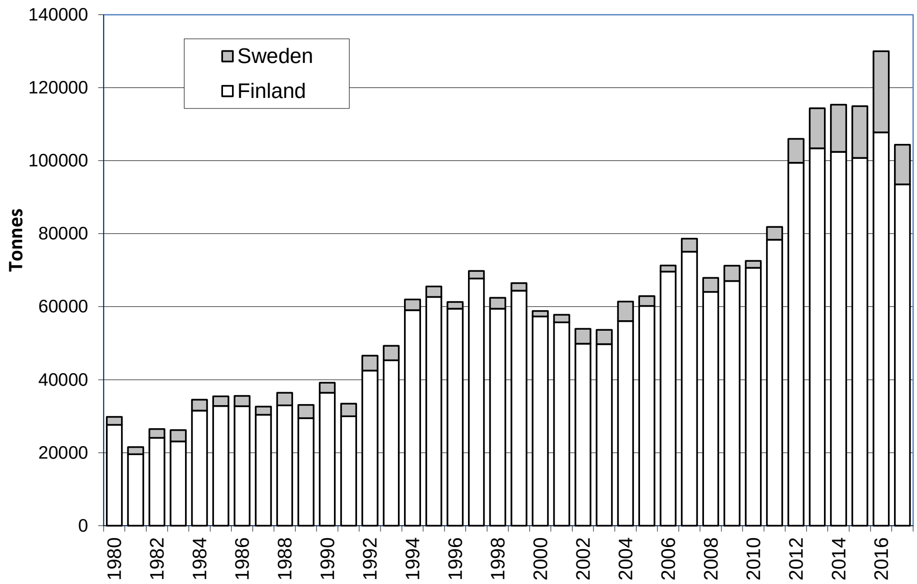


Figure 4.4.1. Herring in SD's 30 and 31. Landings by country.

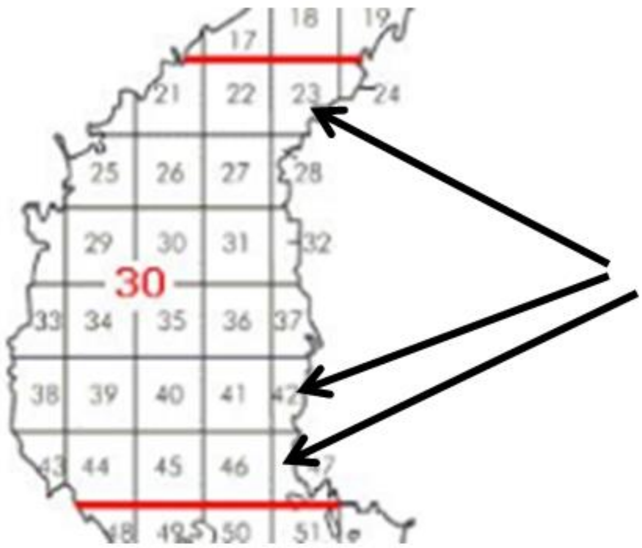


Figure 4.4.2. Herring in SD's 30 and 31. The areas of unbroken time series of catch and effort data for trapnet tuning-series.

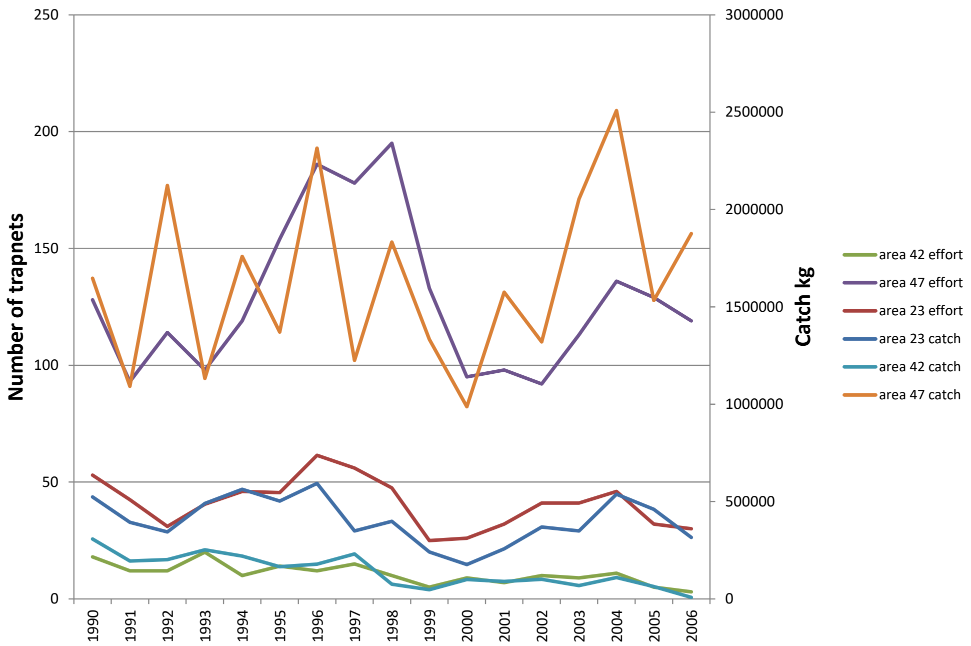


Figure 4.4.3. Herring in SD's 30 and 31. Trapnets catch (kg) and effort (number of traps) in three different areas (see map Figure 4.4.2) used to calculate the trap net tuning index for the spaly assessment.

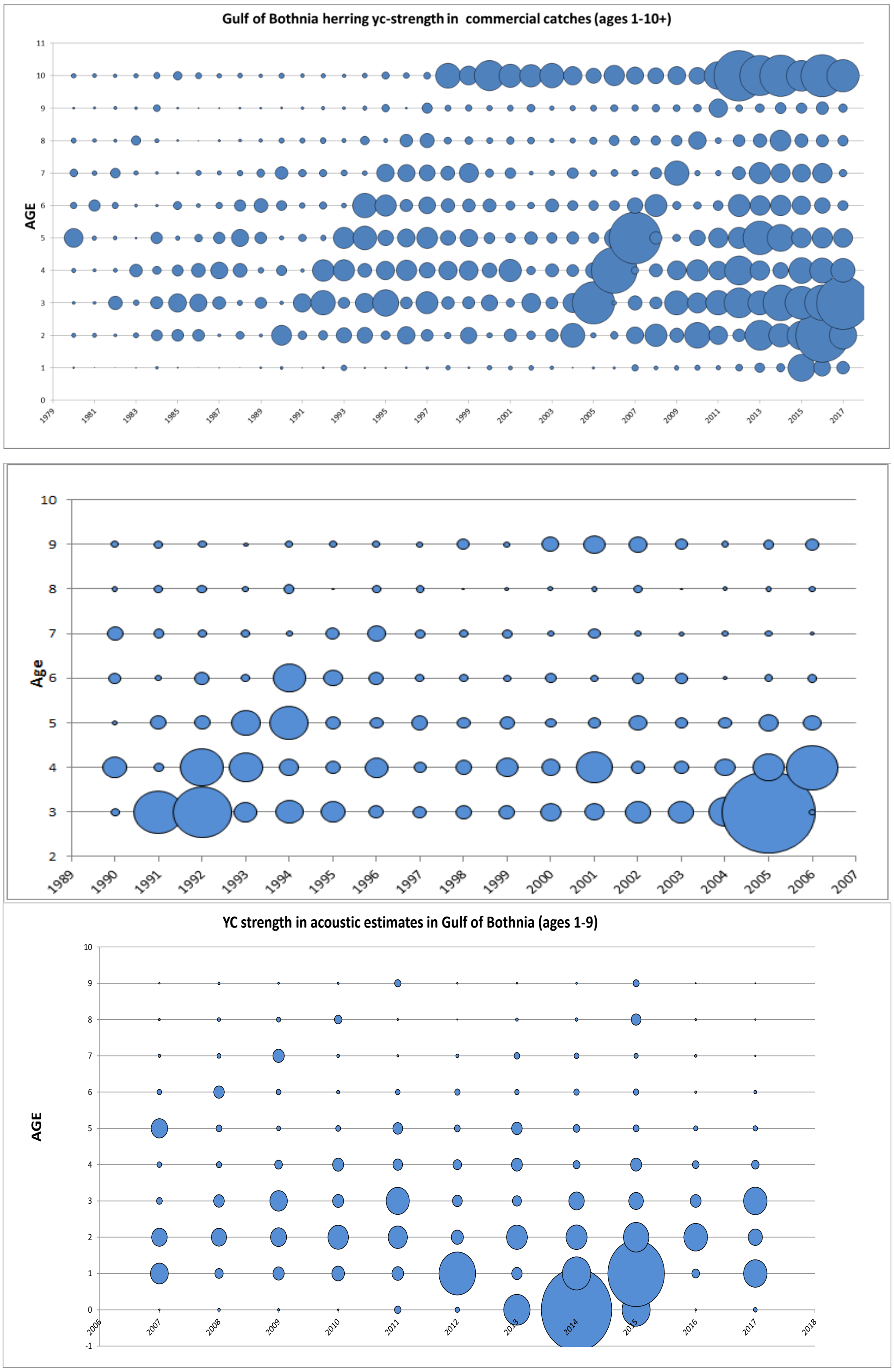


Figure 4.4.4. Herring in SD's 30 and 31. Age composition in commercial catch and CPUE by age in trapnets and acoustic survey.

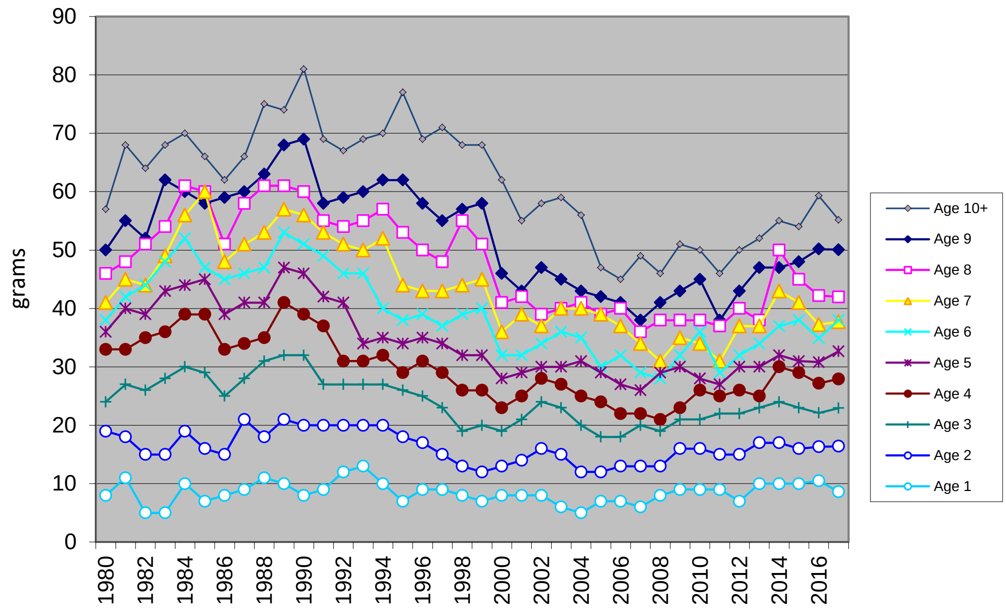


Figure 4.4.5. Herring in SD's 30 and 31. Weights-at-age in catches and in stock

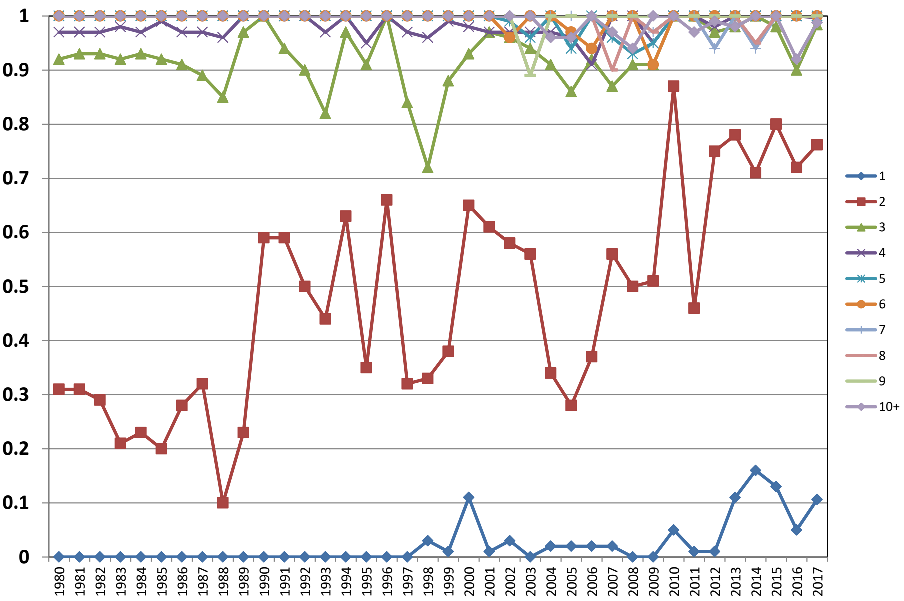


Figure 4.4.6. Herring in SD's 30 and 31. Maturity ogives.

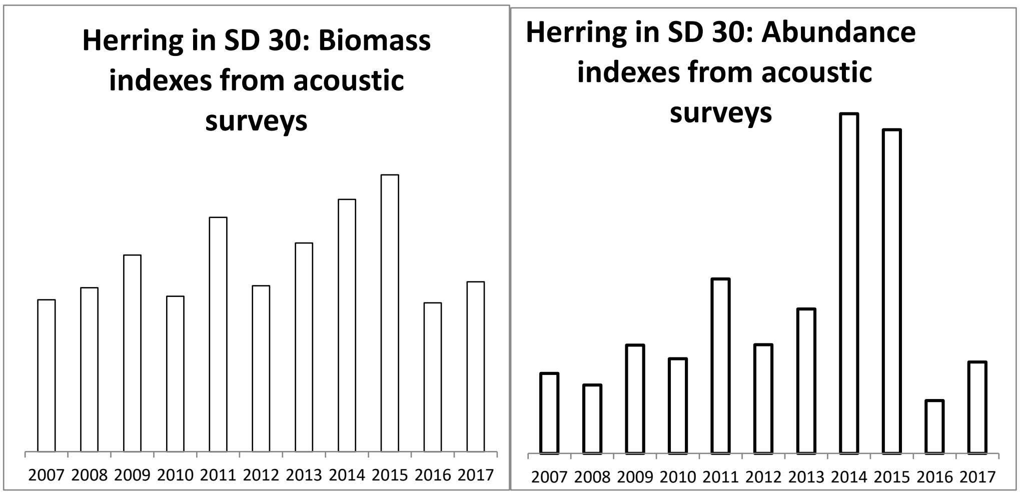
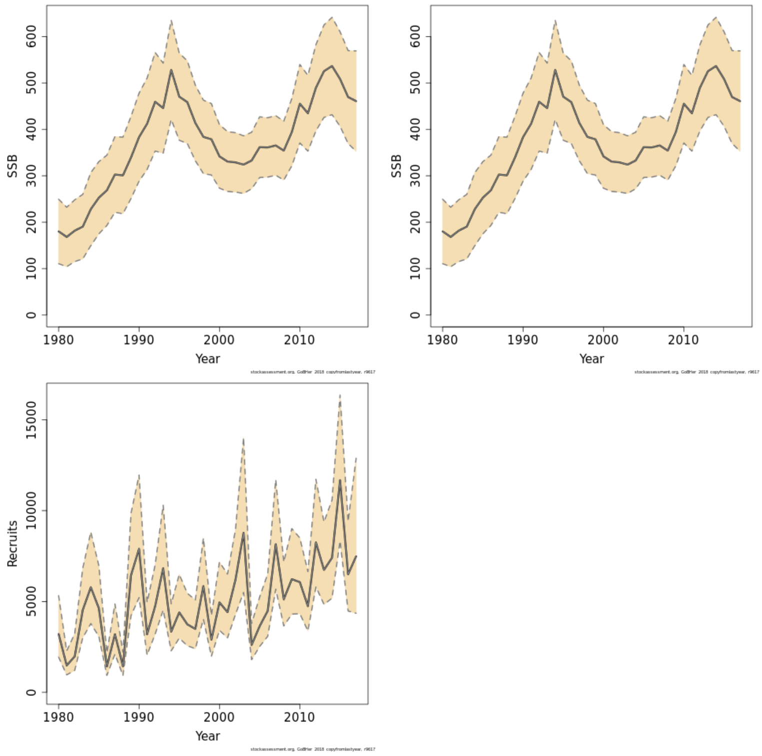


Figure 4.4.7. **Herring in SD's 30 and 31. Abundance and biomass indexes from 2007–2017 Bothnian acoustic surveys.**



Figures 4.4.8.-10. **Herring in SD's 30 and 31. Estimated SSB, F and age 1 recruitment of Gulf of Bothnia herring in 1980 – 2017.**

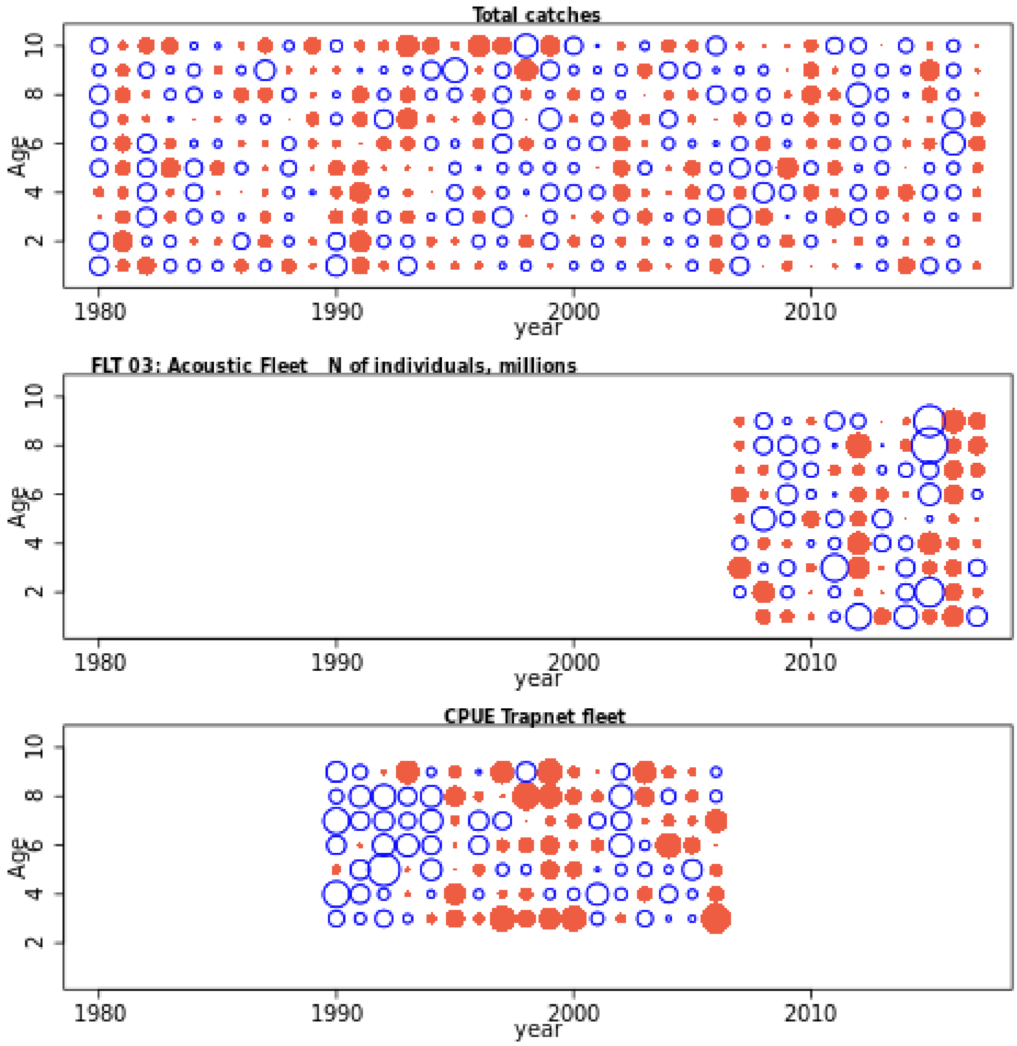
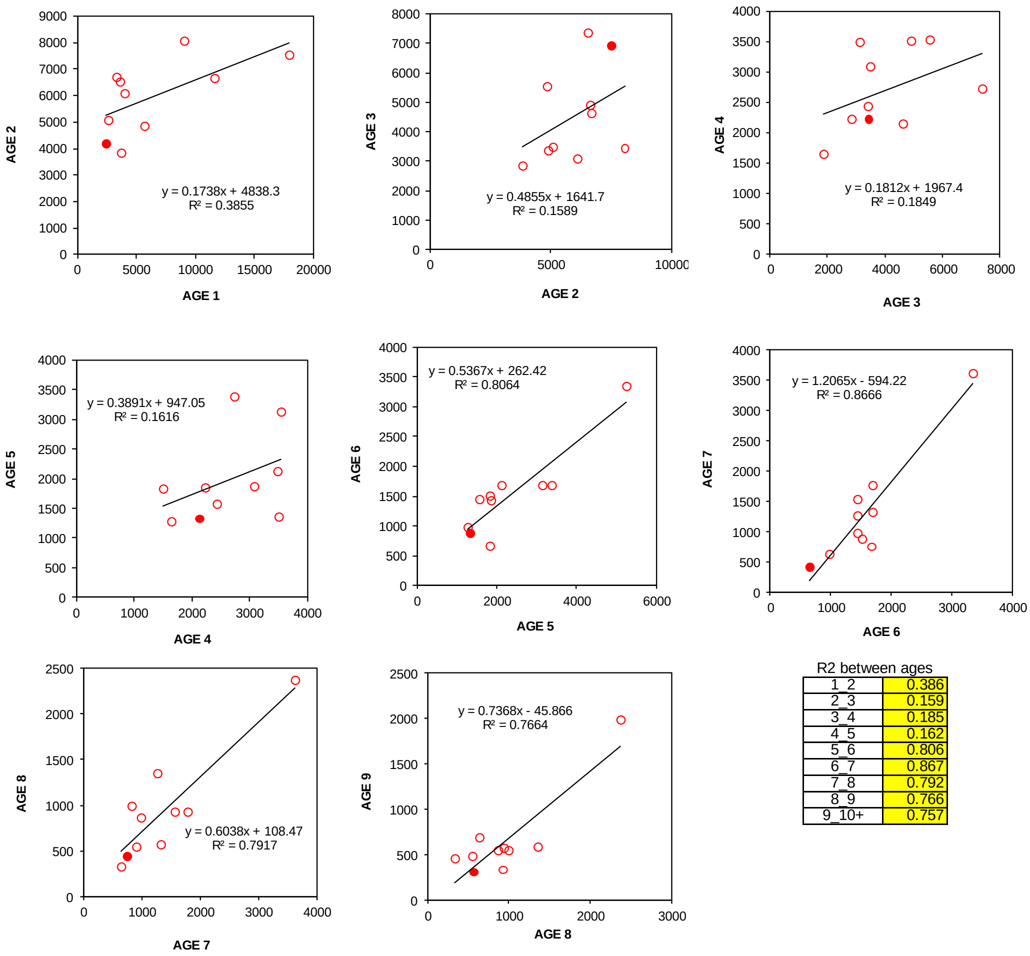


Figure 4.4.11. **Herring in SD's 30 and 31. Normalized residuals of three Gulf of Bothnia fleets in 1980 – 2017, catch data (top), acoustic index and CPUE from trapnet data. Red filled circles indicate negative residuals and blue open circles positive residuals.**



R2 between ages

1_2	0.386
2_3	0.159
3_4	0.185
4_5	0.162
5_6	0.806
6_7	0.867
7_8	0.792
8_9	0.766
9_10+	0.757

Figure 4.4.12. Herring in SD's 30 and 31. Consistencies of the different ages within Gulf of Bothnia herring hydroacoustic abundance indices. The full dot represents the latest estimates.

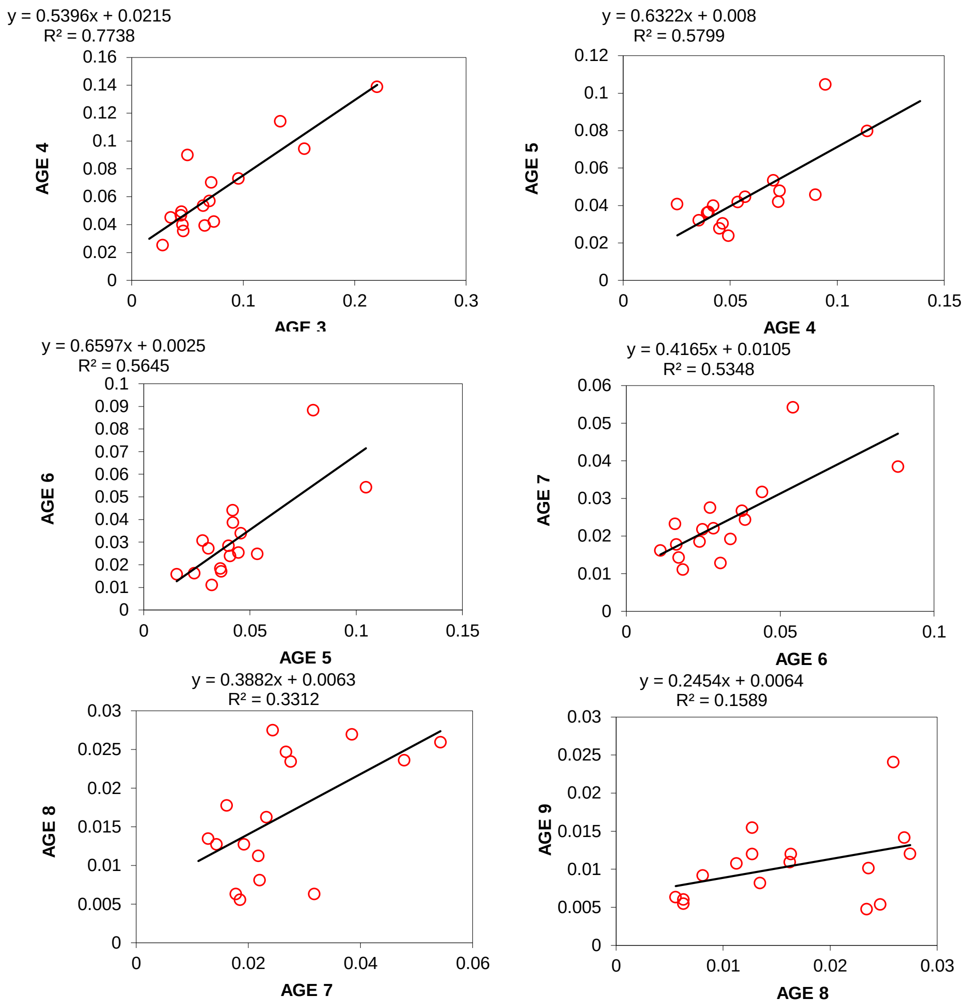
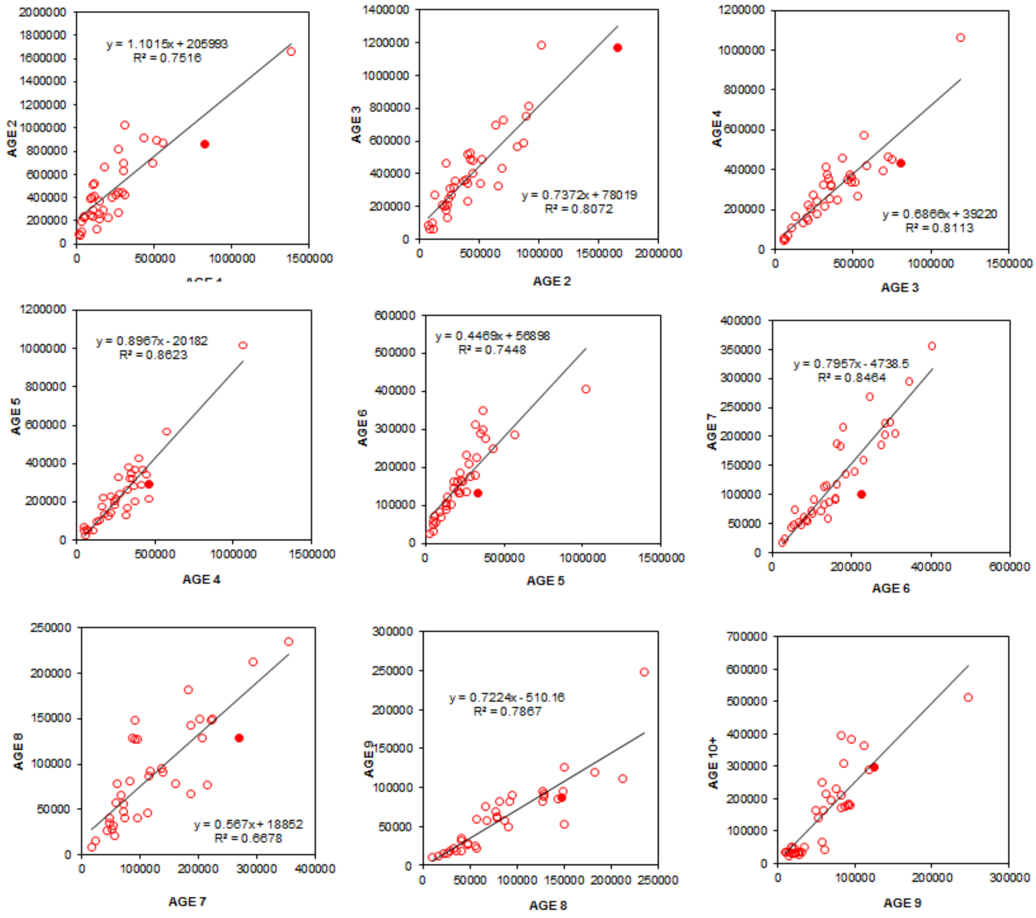


Figure 4.4.13. Herring in SD's 30 and 31. Consistencies of the different ages within Gulf of Bothnia herring trapnet abundance indices.



R2 between ages									
DATA	**1_2**	**2_3**	**3_4**	**4_5**	**5_6**	**6_7**	**7_8**	**8_9**	**9_10**
Canum	0.751	0.807	0.811	0.862	0.745	0.846	0.668	0.787	0.765

Figure 4.4.14. Herring in SD's 30 and 31. Consistencies of the different ages within Gulf of Bothnia herring catch data.

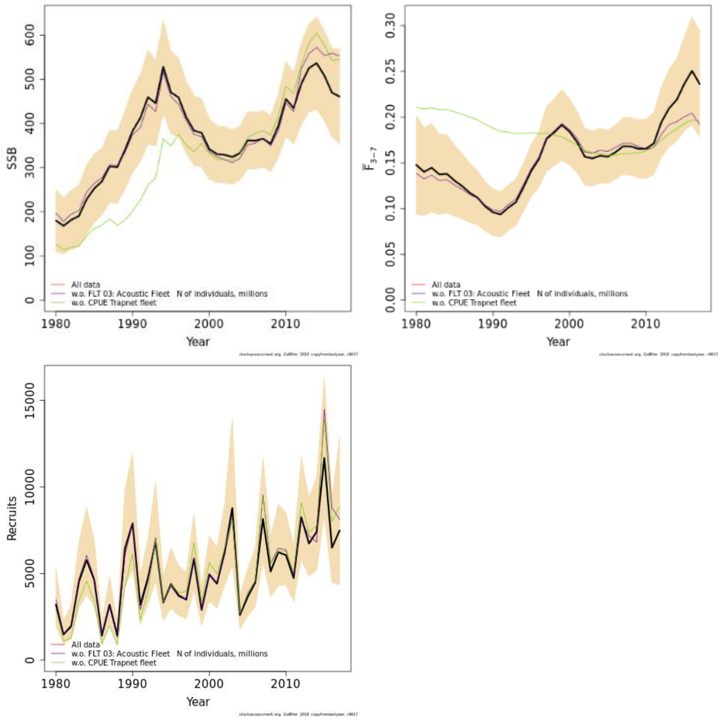


Figure 4.4.15. Herring in SD's 30 and 31. Leave-one-out runs of the Gulf of Bothnia herring stock in 1980 – 2017.

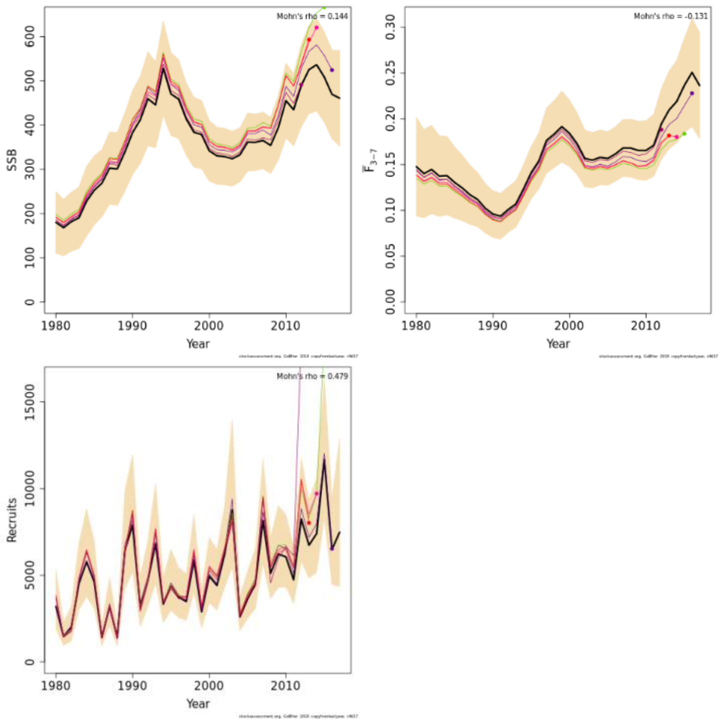


Figure 4.4.16. Herring in SD's 30 and 31. Retrospective analysis of the Gulf of Bothnia herring stock in 1980 – 2017.

5 Plaice

5.1 Introduction

5.1.1 Biology

5.1.1.1 Assessment units for plaice stocks

The plaice stocks within inner Danish waters and the Baltic consists of two stocks. One stock (ple.27.21–23) is defined by the Subdivision 21 (=Kattegat), Subdivision 23 (= the Sound) and Subdivision 22 (=Belt area and western part of the Baltic Sea). The other stock (ple.27.24–32) is defined by the area east of Bornholm in the Baltic Sea. Each stock is manages based on individual assessments. ple.27.21–23 is category 1 stock and ple.27.24–32 is a category 3 stock.

5.2 Plaice in subdivisions 27.21–23 (Kattegat, the Sound and Western Baltic)

This stock id is a result of the recommendation made by the benchmark workshop WKPLE in February 2015 (ICES, 2015) and later by the Stock Identification Method Working Group (SIMWG) in June 2015, which confirmed the revised stock structure for the plaice stocks in the North Sea, Skagerrak, Kattegat and the Baltic Sea recommendation made by ICES WKPESTO (2012). Plaice in Skagerrak is now included in the North Sea stock. Kattegat and subdivisions 22 and 23 are merged into one stock and Subdivision 24–32 is regarded as one separate stock. The stock was, as a consequence of the benchmark in February 2015 upgraded to category 1 (full analytical age-based assessment).

The SAM State Based model was used for the assessment.

5.2.1 The fishery

5.2.1.1 Technical conservation measures

Minimum Landing Size in SD 21 is 27 cm.

Minimum Landing Size in SD 22 and SD 23 is 25 cm.

The closed season for spawning females in SD 22 and SD 23 from 15/1 to 30/4, which was introduced in the mid-sixties has been given up from the beginning of 2017.

In the Sound (SD 23) trawling is only allowed in the northern-most part and as this area was also included in zone to protect spawning cod in Kattegat trawling is forbidden in February and March were the cod is on spawning migration.

In SD 22 the BACOMA exit window is implemented. This is a square mesh window inserted in the top panel of the cod-end. The mesh size in the exit panel was increased to from 110 to 120 mm in 2010.

In Kattegat the plaice fishery is very much connected to the cod fishery and as part of the Danish cod recovery plan introduced in 2011 it is mandatory in Danish fisheries to use a SELTRA trawl with 180 mm panel during the first three quarters of a year. In 2009, as a part of the attempts to rebuild of the cod stock in Kattegat, Denmark and Sweden, introduced protected areas on historically important spawning grounds in South East Kattegat. The protected zone consists of three different areas in which the fisheries are either completely forbidden or limited to certain selective gears (Swedish grid and Danish SELTRA 300 trawl) during all or different periods of the year.

From 1st of January 2017 landing obligation was introduced in SD 22 and 23. In theory, this had implications for the catches in 2017 as well as the management and catch opportunities in 2017, but because of the insignificant amount (4t) of the landings below minimum size (BMS) the impact was insignificant. For the implications of the management, please see below.

5.2.1.2 Landings

The annual landings are available since 1970 (SD 22) and 1972 (SD 21) and are given by subdivision and country separately in Table 5.2.1. The landings by subdivision are plotted in Figure 5.2.1 and by country in Figure 5.2.2. The landings by country and the TAC for each subdivision is given in Figure 5.2.3a and Figure 5.2.3b. Discard and landings (2017) by gear type and quarter is given in Table 5.2.3 and Figure 5.2.4.

5.2.1.3 Unallocated removals

No significant misreporting is believed to take place.

5.2.1.4 Discards

Discard data are only available back to 2002. SAM can handle if minor gaps exist the data series but cannot handle long periods of missing data. As discard information are only available back to 2002, the discard time series is extended three years back to 1999 (based on average discards from 2002–2004) in order to provide a time series sufficiently long for the assessment. The discard estimates are processed in InterCatch and consistent throughout the whole time series (2002–2017). Historical landings and discards by country is given in Figure 5.2.6.

Discard and landings in 2017 in tonnes by gear type, country and quarter is given in Table 5.2.4.

5.2.1.5 Effort and CPUE data

Effort data from Sweden and Denmark only is available in InterCatch back to 2013. Data from Germany is available from 2002 and on although the units are not consistent throughout the series.

5.2.2 Biological information

5.2.2.1 Age composition

Since 2004, Denmark and Sweden have put a significant amount of effort into increasing the quality of age reading for plaice in Kattegat through a series of workshops and otolith exchanges between age readers. During the WGBFAS in 2015 it was demonstrated that significant inconsistencies between readers particularly from Denmark and circulation of otoliths between the three countries were initiated. The results of the exercise were available in March 2016 and confirm the inconsistency particularly between the reading methods applied (reading of whole and sliced otoliths). No solution to solve the quality issues was provided in the report and it is not possible to introduce actions to overcome the quality issue for the time being.

Catch-at-age data were raised using ICES InterCatch database.

Relative age distributions in the discard and landing by year are presented on figures 5.2.5a and 5.2.5b.

5.2.2.2 Mean weight-at-age

Weight-at-age in catch is presented in Table 5.2.6h and in Figure 5.2.7. Mean weight in stock is obtained from Combined 1 quarter surveys but is used as an average from 2002–2017. Weight in stock is shown in Figure 5.2.8 and Table 5.2.6g.

5.2.2.3 Natural mortality

Natural mortality is assumed constant for all years and is set at 0.1 for all ages except age 1, which is set to 0.2.

5.2.2.4 Maturity-at-age

The annual maturity ogives was revised for the ICES WKPLE in 2015 and is based on the average from 2002–2017 from information from the Combined 1q survey Figure 5.2.9.

5.2.2.5 Quality of catch and biological data

The sampling of the commercial catches is relatively god except for Subdivision 23 where no sampling is made by either Sweden or Denmark (Table 5.2.2). This has to be seen in the light of the relative limited catches from that area (2.6% of total catch).

It is acknowledged that the variability of growth as well as inconsistency in age readings are important sources of uncertainty in the catch matrix.

The internal consistency of the catch matrix is quite good for age 3, 4 and 5 and less good for other ages. The plots are shown in Figure 5.2.19.

5.2.3 Fishery independent information

Only scientific tuning fleets are used. Data from two tuning series are used. These two series are constructed by the combination of 1st quarter NS-IBTS and the 1st quarter BITS and the combination of 3rd quarter NS-IBTS and 4th quarter BITS. The surveys are combined using the GAM approach (Berg *et al.* 2013) considering the uneven distributions of the two surveys. The following effects are considered using a Delta-Gamma distribution (zeroes and positive catches are modelled separately) to estimate the indices. Explanatory variables included in the model are year, spatial position, depth, gear, time of the day and haul duration. Estimation of the gear effect is possible due to some spatio-temporal overlap of sampling between BITS and NSIBTS, which use different gears. The survey index is derived by letting the model predict the catch rates by year in an ideal experimental design, i.e. in a spatial grid covering the stock area using the same gear, at the same time of day etc. Variation in catch rates caused by changes in the sampling are filtered out in this process and the influence of single hauls with large catches are also reduced.

Very few plaice aged 0 (4th quarter) are caught during the surveys and these are removed from the analysis.

Index time series at age for Combined 1st and Combined 3rd and 4th quarter are given in Figure 5.2.10–11.

The “Leave one-out analysis” shows that 1q combined survey are given significant weight (Figure. 5.2.15) more weight than the combined 3-4q. The retrospective analysis shows that F consequently is underestimated and SSB consequently is overestimated. This is considering to be caused by the relative short time series available (Figure. 5.2.13). No year effect can be seen in the residuals, which are without any expressed pattern (Figure 5.2.16).

The internal consistency for combined 1st quarter survey and 3rd +4th quarter combined survey are given in Figure 5.2.17 and Figure 5.2.18 respectively and both are acceptable considering the age interpretation problems in the stock.

5.2.4 Assessment

The stock was as a result of the WKPLE in February 2015 upgraded to Category 1 (Full annual age based analytical assessment). The State based Assessment Model (SAM) is used. The assessment is an update of the benchmark assessment (WKPLE) and the settings are according to the stock annex (ple.27.21-23). Yearly positive or negative clusters were observed in the survey residuals from the model assuming independent observations. Such yearly correlations can be accounted for in SAM by allowing the correlation structure to be estimated. This assessment takes advance of this facility.

5.2.4.1 Recruitment estimates

The recruitment in 2017 is estimated to around 60 million. This is almost the double from last year and support an increasing trend in the latest years from an otherwise, stable level during the rest of the time series. The historic trend is given in Figure 5.2.12c and Table 5.2.7.

5.2.4.2 SAM

The final run in SAM is named: PLE21_23_2018_final_run. The assessment available at “stockassessment.org” and is visible for everybody.

The input data are given in the Table 5.2.6a to Table 5.2.6i.

F and M before spawning are both set to 0.

5.2.4.3 Historical stock trends

The stock is in a very good condition. The result shows (Figure 5.2.12abc and Table 5.2.7) an increase in SSB from estimated 12 185 tonness in 2016 to 13 886 tonnes in 2017 and estimated to 16 575 tonnes in 2018.

The F in 2017 has further decreased compared to last year from 0.274 to 0.254 after showing constantly decreasing in the whole period. This is the case for all age groups (Table. 5.2.8 and Figure 5.2.14). The recruitment is regarded as constant but with significant variation. The recruitment in 2018 is estimated to 80 mill.

5.2.5 Short-term forecast and management options

The short-term forecast was made according to the stock annex using the SAM assessment software. The recruitment in 2018 is estimated by SAM based on the 1 quarter 2018 survey. The recruitment is regarded as stable in the whole time series except in the two latest years (Figure 5.2.12c) and the recruitment for 2019 and on is estimated by sampling the whole time series.

5.2.6 Reference points

All reference points were available and unchanged compared to last year. A typing error last year was source of some confusion about B_{lim} in the report and the advice. This has been corrected to 4077 t in agreement with the outcome of the benchmark I 2015.

5.2.7 Quality of assessment

The confidence limits are in general quite large. Technically the assessment performs quite well even though some patterns are shown in residuals for catch matrix and tuning series. The retrospective analysis shows a systematic underestimation of F and systematic overestimation of SSB. In both cases, the most resent retrospective values (2016) are close to the estimated value.

The survey age specific indices for 1q shows an expressed year class effect particularly in 2018 (Figure 5.2.10).

5.2.8 Comparison with previous assessment

The assessment is carried out as described in the stock annex and in line with previous years assessment except for the introduction of the SAM facility to take into account any year effect in the surveys. As some year effect were observed for the 1st q survey the settings in SAM was changed in order to take this year effect into account. The central SAM output graphs and the residual plots for the SAM run without correlation in 1st q survey are given in Figure 5.2.20 and Figure 5.2.21.

The assessment in 2018 does not change the perception of the stock from last year assessment.

5.2.9 Management issues

The management areas for plaice in the Baltic Sea (*i.e.* Subdivision 21 and subdivisions 22–32) are different from the stock areas (i.e. SDs 21–23 and 24–32). The following shows an option for calculating TAC by management area based on the catch distribution observed in 2017. This procedure was adopted in 2016 and used in 2018 without changes. The catch ratio between SD 21 and SDs 22–23 in 2017 was used to calculate a split of the advised catches for 2018, and a similar calculation was done for the landings only. The advised catch for the stock in SDs 24–32 (Section 5.3.16) was added to the calculated catch for SDs 22–23 to obtain plaice catches by management area that would be consistent with the ICES advice for the two stocks. This results in catches of no more than 4802 tonnes in SD 21 and 14 160 tonnes in SDs 22–32. The corresponding wanted catches would be no more than 2878 tonnes in SD 21 and 11 077 tonnes in SDs 22–32.

<table>
<tr><th colspan="2">Basis</th><th>Catch 2017</th><th>Wanted Catch 2017</th><th>ICES stock advice 2019 (catch)</th><th>ICES stock advice 2019 (corresponding wanted catch)</th></tr>
<tr><td rowspan="2">Stock area based</td><td>SDs 21–23</td><td>4242</td><td>3243</td><td>15237</td><td>11651</td></tr>
<tr><td>SDs 24–32</td><td>1051</td><td>650</td><td>3725</td><td>2304</td></tr>
<tr><td colspan="4">Total advised catch and corresponding wanted catch, 2018 (SDs 21–32)</td><td>18962</td><td>13955</td></tr>
<tr><td rowspan="3">Management area based</td><td>SD 21</td><td>1337</td><td>801</td><td></td><td></td></tr>
<tr><td>SDs 22–23</td><td>2905</td><td>2442</td><td></td><td></td></tr>
<tr><td>SDs 22–32</td><td>3956</td><td>3092</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td colspan="3">calculation</td><td>results</td></tr>
<tr><td colspan="2" rowspan="2">Share of SD 21 of the total catch in SDs 21-23 in 2017</td><td colspan="3">1337 t / 4242 t</td><td rowspan="2">0.315</td></tr>
<tr><td colspan="3">(catch 2017 SD 21 / catch 2017 SDs 21–23)</td></tr>
<tr><td colspan="2" rowspan="2">Catch in 2019 for SD 21</td><td colspan="3">15 237 t × 0.315</td><td rowspan="2">4802</td></tr>
<tr><td colspan="3">(ICES stock advice 2019 (catch) for SDs 21–23 × share)</td></tr>
<tr><td colspan="2" rowspan="2">Catch in 2019 for SDs 22–32</td><td colspan="3">18 962 t – 4802 t</td><td rowspan="2">14 160</td></tr>
<tr><td colspan="3">(total advised catch 2019 SDs 21–32 – catch SD 21)</td></tr>
<tr><td colspan="2" rowspan="2">Share of SD 21 of the total landings in SDs 21-23 in 2017</td><td colspan="3">801 t / 3243 t</td><td rowspan="2">0.247</td></tr>
<tr><td colspan="3">(landings 2017 SD 21 / landings 2017 SDs 21–23)</td></tr>
<tr><td colspan="2" rowspan="2">Wanted catch in 2019 for SD 21</td><td colspan="3">11651 t × 0.247</td><td rowspan="2">2878</td></tr>
<tr><td colspan="3">(ICES stock advice 2019 (wanted catch) for SDs 21–23 × share)</td></tr>
<tr><td colspan="2" rowspan="2">Wanted catch–in 2019 for SDs 22–32</td><td colspan="3">13 955 t – 2878 t</td><td rowspan="2">11 077.28</td></tr>
<tr><td colspan="3">(wanted catch 2019 SDs 21–32 – wanted catch SD 21)</td></tr>
</table>

Table 5.2 1. Plaice in SD 27.21–23. Official landings (t) by Subdivision and country. 1970–2017.

YEAR /SD	21-DENMARK	21-GERMANY	21-SWEDEN	22-DENMARK	22-GERMANY	22-SWEDEN	23-SWEDEN	23-DENMARK
1970				3 757	202			
1971				3 435	160			
1972	15 504	77	348	2 726	154			
1973	10 021	48	231	2 399	165			
1974	11 401	52	255	3 440	202			
1975	10 158	39	296	2 814	313			
1976	9 487	32	177	3 328	313			
1977	11 611	32	300	3 452	353			
1978	12 685	100	312	3 848	379			
1979	9 721	38	333	3 554	205			
1980	5 582	40	313	2 216	89			
1981	3 803	42	256	1 193	80			
1982	2 717	19	238	716	45			
1983	3 280	36	334	901	42			
1984	3 252	31	388	803	30			
1985	2 979	4	403	648	94			
1986	2 470	2	202	570	59			
1987	2 846	3	307	414	18			
1988	1 820	0	210	234	10			
1989	1 609	0	135	167	7			
1990	1 830	2	202	236	9			
1991	1 737	19	265	328	15			
1992	2 068	101	208	316	11			
1993	1 294	0	175	171	16		2	
1994	1 547	0	227	355	1		6	
1995	1 254	0	133	601	75		12	64
1996	2 337	0	205	859	43	1	13	81
1997	2 198	25	255	902	51		13	
1998	1 786	10	185	642	213		13	
1999	1 510	20	161	1 456	244	1	13	
2000	1 644	10	184	1 932	140		26	
2001	2 069		260	1 627	58		39	
2002	1 806	26	198	1 759	46		42	
2003	2 037	6	253	1024	35	0	26	
2004	1 395	77	137	911	60		35	
2005	1 104	47	100	908	51		35	145
2006	1 355	20	175	600	46		39	166
2007	1 198	10	172	894	63		69	193
2008	866	6	136	750	92	0	45	116
2009	570	5	84	633	194	0	42	139
2010	428	3	66	748	221	0	17	57
2011	328	0	40	851	310		11	46
2012	196	0	30	1189	365	7	12	54
2013	232	0	60	1253	319	0	76	14
2014	343	1	68	1097	320	0	45	57
2015	807	0	87	1103	560	0	103	26
2016	984	1	121	1108	680	0	107	20
2017	703	1	97	1424	936	0	13	70

Table 5.2.2. Plaice in SD 27.21–23. Sampling effort 2017 by country, gear type and area.

	CATON (T)	NO LENGTH SAMPLES	NO LENGTH MESURES	NO OF AGE SAMPLES	NO OF AGE READINGS
27.3.a.21					
Active					
Discards					
Denmark	38	8	466	8	75
Germany	0.135	0	0	0	0
Sweden	9	8	532	8	235
Landings					
Denmark	97	1	287	1	49
Germany	0.29	0	0	0	0
Sweden	83	0	0	0	0
Passive					
Discards					
Denmark	83	0	0	0	0
Germany	0.108	0	0	0	0
Sweden	5	0	0	0	0
Landings					
Denmark	40	1	287	1	49
Germany	0.26	0	0	0	0
Sweden	14	0	0	0	0
27.3.b.23					
Active					
Discards					
Denmark	4	0	0	0	0
Sweden	0	0	0	0	0
Landings					
Denmark	6	0	0	0	0
Sweden	0	0	0	0	0
Passive					
Discards					
Denmark	20	0	0	0	0
Sweden	3	0	0	0	0
Landings					
Denmark	64	0	0	0	0
Sweden	13	0	0	0	0
27.3.c.22					
Active					
Discards					
Denmark	136	11	737	11	107
Germany	46	8	701	8	579
Landings					
Denmark	498	5	991	5	127
Germany	325	9	2142	9	623
BMS					
Germany	4	0	0	0	0
Passive					
Discards					
Denmark	105	0	0	0	0
Germany	10	8	340	8	111
Landings					
Denmark	131	5	991	5	127
Germany	75	8	473	8	161
Sweden	0	0	0	0	0
Grand Total	1807	72	7947	72	2243

Table 5.2.3. Plaice in SD 27.21–23. Landings (tonnes) and discard (tonnes) in 2017 by Subdivision, catch category, and quarter.

	Sum of CATON (tonnes)				
Quarter	1	2	3	4	Grand Total
27.3.a.21	259	302	367	409	1337
Discards	98	162	145	131	536
Active	47	142	142	116	447
Passive	50	20	3	15	88
Landings	161	140	222	279	801
Active	120	92	170	248	631
Passive	41	47	52	30	170
27.3.b.23	14	32	40	23	109
Discards	6	10	2	8	26
Active	2	0	0	2	4
Passive	5	9	2	6	22
Landings	8	22	38	15	83
Active	4	0	0	2	6
Passive	4	22	38	13	77
27.3.c.22	1185	464	300	846	2796
Discards	183	64	79	107	433
Active	169	15	30	78	291
Passive	11	50	49	27	136
Landings	1001	399	222	737	2359
Active	796	257	82	580	1715
Passive	206	142	139	157	644
BMS	1	0	0	2	4
Active	4	0	0	5	10
Grand Total	**1459**	**798**	**707**	**1278**	**4242**

Table 5.2.4. Plaice in SD 27.21–23. Landings (tonnes) and discard (tonnes) in 2017 by Subdivision, catch category, country and quarter.

Quarter	1	2	3	4	Total
Denmark	**1010**	**621**	**563**	**798**	**2992**
27.3.a.21					
Discards					
Active	38	132	121	104	396
Passive	50	18	2	14	83
Landings					
Active	97	74	151	226	548
Passive	40	42	46	27	156
27.3.b.23					
Discards					
Active	2	0	0	2	4
Passive	4	8	2	6	20
Landings					
Active	4	0	0	2	6
Passive	3	20	30	12	64
27.3.c.22					
BMS					
Active	3			2	6
Discards					
Active	133	1	20	29	181
Passive	7	44	35	19	105
Landings					
Active	498	178	55	246	978
Passive	131	104	101	111	446
Germany	**414**	**138**	**89**	**441**	**1082**
27.3.a.21					
Discards					
Active				0	0
Passive		0	0	0	0
Landings					
Active				0	0
Passive		0	0	0	0
27.3.c.22					
BMS					
Active	1	0	0	2	4
Discards					
Active	36	14	10	51	110
Passive	4	6	14	8	31
Landings					
Active	298	79	27	333	737
Passive	75	39	39	47	198
Sweden	**35**	**38**	**55**	**40**	**169**
27.3.a.21					
Discards					
Active	9	10	21	12	52
Passive	1	2	0	1	5
Landings					
Active	23	18	19	22	83
Passive	1	5	6	3	14
27.3.b.23					
Discards					
Active				0	0
Passive	1	1	0	1	3
Landings					
Active				0	0
Passive	1	2	9	1	13
27.3.c.22					
Landings					
Passive			0		0
Grand Total	**1459**	**798**	**707**	**1278**	**4242**

Table 5.2 6a. Plaice in SD 27.21–23. Landing fraction.

YEAR	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10
*1999	0.00	0.24	0.30	0.59	0.80	0.55	0.64	0.89	0.98	0.99
*2000	0.14	0.23	0.48	0.49	0.78	0.85	0.81	0.94	0.97	0.97
*2001	0.02	0.44	0.51	0.41	0.64	0.83	0.85	0.93	0.99	0.98
2002	0.09	0.09	0.38	0.34	0.47	0.42	0.62	1.00	0.78	0.91
2003	0.06	0.24	0.50	0.67	0.74	0.67	0.59	1.00	1.00	1.00
2004	0.05	0.29	0.52	0.67	0.75	0.92	1.00	0.99	1.00	1.00
2005	0.12	0.34	0.76	0.82	0.73	0.72	0.75	0.49	0.38	0.68
2006	0.00	0.18	0.37	0.56	0.90	0.77	0.79	0.96	1.00	1.00
2007	0.02	0.37	0.44	0.68	0.80	0.67	0.55	0.57	0.78	0.98
2008	0.00	0.07	0.53	0.78	0.87	0.95	0.97	0.88	0.93	0.98
2009	0.07	0.15	0.35	0.61	0.53	0.32	0.37	0.15	1.00	0.37
2010	0.08	0.14	0.45	0.63	0.71	0.91	0.97	0.97	0.98	0.99
2011	0.07	0.15	0.28	0.42	0.56	0.55	0.73	0.73	0.86	0.98
2012	0.02	0.23	0.46	0.63	0.82	0.96	0.99	0.93	1.00	0.83
2013	0.01	0.16	0.47	0.59	0.57	0.85	0.88	0.82	1.00	0.87
2014	0.00	0.20	0.42	0.42	0.49	0.55	0.56	0.54	0.68	0.83
2015	0.00	0.20	0.50	0.58	0.74	0.85	0.93	0.88	0.84	0.82
2016	0.02	0.23	0.49	0.61	0.62	0.73	0.86	0.94	0.90	1.00
2017	0.00	0.21	0.54	0.79	0.81	0.94	0.92	0.89	0.83	0.94

* Discard component is average of 2002–2006

Table 5.2 6b. Plaice in SD 27.21–23. Maturity ogive.

	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10
Mean (2002-2017)	0.21	0.53	0.71	0.85	0.93	0.96	0.97	0.98	0.98	0.99

Table 5.2 6c. Plaice in SD 27.21–23. Landings mean weight (kg)

YEAR	1	2	3	4	5	6	7	8	9	10+
1999	0.081	0.159	0.196	0.280	0.356	0.313	0.368	0.806	0.563	1.263
2000	0.101	0.156	0.220	0.258	0.324	0.416	0.515	0.631	0.994	1.199
2001	0.084	0.184	0.215	0.248	0.311	0.371	0.432	0.578	0.843	1.172
2002	0.097	0.117	0.182	0.202	0.252	0.357	0.390	0.424	0.458	0.559
2003	0.092	0.157	0.216	0.261	0.258	0.355	0.331	0.498	0.548	0.746
2004	0.097	0.161	0.222	0.300	0.305	0.355	0.426	0.613	0.478	1.195
2005	0.104	0.180	0.248	0.293	0.319	0.340	0.397	0.570	0.881	1.432
2006	0.061	0.133	0.205	0.255	0.358	0.287	0.306	0.447	0.530	0.884
2007	0.047	0.143	0.195	0.276	0.429	0.467	0.569	0.661	0.540	0.794
2008	0.102	0.142	0.210	0.299	0.375	0.439	0.489	0.502	0.455	0.520
2009	0.096	0.137	0.189	0.268	0.306	0.280	0.322	0.267	0.644	0.556
2010	0.105	0.158	0.240	0.259	0.325	0.396	0.403	0.374	0.381	0.419
2011	0.077	0.141	0.239	0.280	0.284	0.311	0.425	0.411	0.430	0.437
2012	0.074	0.169	0.286	0.366	0.384	0.452	0.423	0.478	0.564	0.553
2013	0.076	0.138	0.259	0.366	0.446	0.511	0.540	0.503	0.647	0.804
2014	0.087	0.159	0.229	0.305	0.373	0.388	0.471	0.556	1.117	0.727
2015	0.077	0.135	0.223	0.256	0.332	0.410	0.521	0.715	0.689	0.768
2016	0.074	0.150	0.218	0.280	0.338	0.404	0.498	0.498	0.701	0.648
2017	0.073	0.146	0.238	0.307	0.367	0.435	0.448	0.586	0.609	0.753

Table 5.2 6d. Plaice in SD 27.21–23. Natural mortality.

	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10
All years	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 5.2 6e. Plaice in SD 27.21–23. Discard mean weight (kg)

Year	1	2	3	4	5	6	7	8	9	10+
1999	0.081	0.120	0.156	0.208	0.288	0.242	0.289	0.436	0.622	1.154
2000	0.081	0.120	0.156	0.208	0.288	0.242	0.289	0.436	0.622	1.154
2001	0.081	0.120	0.156	0.208	0.288	0.242	0.289	0.436	0.622	1.154
2002	0.082	0.104	0.124	0.171	0.193	0.353	0.321	0.519	0.189	0.913
2003	0.081	0.120	0.149	0.165	0.138	0.110	0.136	0.436	0.622	1.154
2004	0.089	0.127	0.175	0.297	0.249	0.159	0.294	0.168	0.622	1.154
2005	0.091	0.141	0.177	0.224	0.300	0.394	0.535	0.724	1.054	1.394
2006	0.061	0.110	0.154	0.183	0.561	0.192	0.159	0.331	0.622	1.154
2007	0.044	0.088	0.132	0.176	0.323	0.437	0.636	0.824	1.052	1.732
2008	0.102	0.136	0.157	0.287	0.365	0.388	0.111	0.104	0.126	0.132
2009	0.086	0.118	0.139	0.194	0.168	0.139	0.148	0.161	0.622	0.210
2010	0.095	0.121	0.130	0.159	0.187	0.353	0.513	0.452	0.955	0.185
2011	0.066	0.113	0.206	0.233	0.213	0.167	0.276	0.274	0.333	0.217
2012	0.070	0.131	0.244	0.320	0.298	0.183	0.181	0.643	0.178	0.586
2013	0.074	0.106	0.206	0.332	0.390	0.207	0.295	0.242	0.411	0.789
2014	0.087	0.130	0.171	0.279	0.339	0.335	0.424	0.405	1.140	0.465
2015	0.077	0.100	0.144	0.160	0.212	0.235	0.321	0.200	0.130	0.321
2016	0.070	0.107	0.140	0.175	0.275	0.376	0.281	0.182	0.246	0.305
2017	0.072	0.118	0.157	0.206	0.301	0.382	0.333	0.490	0.579	0.460

Table 5.2.6f. Plaice in SD 27.21–23. Total catches (CANUM).

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
1999	1377659	7286520	7123406	6540780	2427443	355338	167828	60681	39013	89466
2000	1610659	7179902	9714540	5232865	2256294	1057577	316913	112681	24920	39940
2001	1405659	9931207	10245755	4543348	1356553	940961	409406	92047	50314	48320
2002	4435651	8578400	20441469	12680459	1269575	292505	129360	58473	8181	5161
2003	946442	12394512	4692894	6070359	3079534	399508	101550	31089	8697	4837
2004	1015923	2702712	6024522	3791879	2375641	916596	171059	3396	1358	2795
2005	774005	7254148	3086708	2166619	991902	776303	330360	56681	3068	16163
2006	321609	4580833	9969825	2896298	1208044	867801	611949	105917	13137	11880
2007	267054	3636564	7725502	3650027	1054350	522184	97803	83092	26152	22273
2008	2147170	7356643	4817249	2517528	973474	379320	154559	41156	67899	105171
2009	681346	5923506	4454970	2925220	1266692	463083	66854	146568	516	10243
2010	1007663	6382103	4475417	1781851	574649	207700	128380	106640	74233	35767
2011	2681908	6570857	5962611	1686722	679439	490565	257862	141363	74256	70418
2012	990000	3978884	4597271	2014708	477022	150657	106988	70967	56634	67134
2013	1778988	5835653	4700512	2424381	785435	203019	81130	34499	30040	32541
2014	446667	3373311	5047504	4184430	1521451	530256	116942	40482	5390	19456
2015	268363	3195165	4417121	3785213	2402626	747101	352195	61537	15351	5859
2016	1258096	4309152	6803758	3340644	2161240	1063172	294669	152507	56218	54383
2017	1298124	2985733	4028499	3913709	1721828	1028901	623925	218615	132563	82287

Table 5.2.6g. Plaice in SD 27.21–23. Mean weight (kg) in stock by age.

	1	2	3	4	5	6	7	8	9	10+
Mean(1999–2017)	0.021	0.070	0.148	0.240	0.290	0.304	0.328	0.386	0.533	0.469

Table 5.2.6h. Plaice in SD 27.21–23. Mean weight (kg) in catch by age.

YEAR	1	2	3	4	5	6	7	8	9	10+
1999	0.081	0.159	0.196	0.280	0.356	0.313	0.368	0.806	0.563	1.263
2000	0.101	0.156	0.220	0.258	0.324	0.416	0.515	0.631	0.994	1.199
2001	0.084	0.184	0.215	0.248	0.311	0.371	0.432	0.578	0.843	1.172
2002	0.097	0.117	0.182	0.202	0.252	0.357	0.390	0.424	0.458	0.559
2003	0.092	0.157	0.216	0.261	0.258	0.355	0.331	0.498	0.548	0.746
2004	0.097	0.161	0.222	0.300	0.305	0.355	0.426	0.613	0.478	1.195
2005	0.104	0.180	0.248	0.293	0.319	0.340	0.397	0.570	0.881	1.432
2006	0.061	0.133	0.205	0.255	0.358	0.287	0.306	0.447	0.530	0.884
2007	0.047	0.143	0.195	0.276	0.429	0.467	0.569	0.661	0.540	0.794
2008	0.102	0.142	0.210	0.299	0.375	0.439	0.489	0.502	0.455	0.520
2009	0.096	0.137	0.189	0.268	0.306	0.280	0.322	0.267	0.644	0.556
2010	0.105	0.158	0.240	0.259	0.325	0.396	0.403	0.374	0.381	0.419
2011	0.077	0.141	0.239	0.280	0.284	0.311	0.425	0.411	0.430	0.437
2012	0.074	0.169	0.286	0.366	0.384	0.452	0.423	0.478	0.564	0.553
2013	0.076	0.138	0.259	0.366	0.446	0.511	0.540	0.503	0.647	0.804
2014	0.087	0.159	0.229	0.305	0.373	0.388	0.471	0.556	1.117	0.727
2015	0.077	0.135	0.223	0.256	0.332	0.410	0.521	0.715	0.689	0.768
2016	0.074	0.150	0.218	0.280	0.338	0.404	0.498	0.498	0.701	0.648
2017	0.073	0.146	0.238	0.307	0.367	0.435	0.448	0.586	0.609	0.753

Table 5.2.6i. Plaice in SD 27.21–23. Survey indices NS-IBTS and BITS combined.

1st quarter

YEAR	AGE 1	AGE2	AGE3	AGE4	AGE5
1999	1099.8594	8765.2116	3758.8044	903.9365	473.9441
2000	2833.288	22367.9658	9616.8772	1478.5552	434.2729
2001	953.7649	12837.0215	12445.4338	2766.3686	397.4275
2002	1534.024	3811.1223	9620.6215	4636.4463	959.73
2003	1494.3805	15610.3593	6712.3067	6554.8212	3288.5643
2004	993.8492	5566.814	10554.6145	4531.6882	2794.6693
2005	1126.4471	12341.3843	10312.4975	5079.0636	1715.5378
2006	280.9939	7448.2497	14999.686	5833.7092	2604,5008
2007	971.1404	6720.5256	11423.4281	8470.4172	2127.9337
2008	1431.4168	5289.0181	6465.8836	3200.4297	1029.7724
2009	913.3428	4467.8409	7090.0212	3317.4799	1174.7816
2010	3419.6011	8730.4699	11077.6172	5580.0205	1997.9285
2011	1394.2298	13472.6966	11659.7652	5663.2558	2397.9819
2012	2405.6483	12366.9692	12813.0214	4894.1796	1195.2628
2013	412.6233	6599.1565	18366.4109	8813.68	4661.0256
2014	221.9454	8220.4642	12369.7037	11644.8591	5570.6931
2015	1934.4186	13550.8964	11199.1959	8427.564	7743.5794
2016	938.8658	18366.1322	22384.8081	10743.9021	6095.3073
2017	4339.977	15355.1434	20528.6545	10601.5997	5096.5644
2018	4928.9698	19735.8374	43606.4838	21824.7725	12558.6363

3rd and 4th quarter

YEAR	AGE 1	AGE2	AGE3	AGE4	AGE5
1999	29669.5704	17037.5034	2885.4202	304.9176	392.2676
2000	14047.5364	21898.7191	7162.5129	117.3141	105.5043
2001	5060.9054	12829.3261	5353.422	1292.2995	133.4104
2002	11418.1404	5232.6411	5369.7766	3521.1165	767.1784
2003	4660.4545	13452.991	3347.3881	2502.4961	1346.3161
2004	8488.4266	7534.2365	11263.994	3329.4054	1985.0329
2005	8733.7603	10607.5855	2877.8925	1469.5738	418.713
2006	7186.6554	9407.9758	7715.444	1784.8817	919.6959
2007	6328.8846	9924.5929	3546.187	2196.2728	623.4203
2008	2967.4409	10198.9078	7730.1636	2938.9479	820.3524
2009	5743.0865	9825.5909	9400.3789	1732.2782	362.7828
2010	5738.6249	7579.5872	4658.9368	3436.9889	1098.4972
2011	14540.2602	13548.7624	7664.0217	2505.6204	570.2381
2012	11165.4353	13527.4644	10116.9663	5041.8117	1177.574
2013	5738.3254	10242.3494	9741.0913	4312.2347	2092.2291
2014	11619.3443	11284.3341	9353.6835	5358.488	3156.8114
2015	7888.2378	15644.3051	11364.4398	7990.461	4513.3445
2016	14228.7219	13927.3179	10524.4812	4571.1515	2507.0936
2017	33877.8853	15762.9638	8213.2284	4902.9548	2387.1142

Table 5.2.7. Plaice in SD 27.21–23. SAM results. Estimated recruitment, total stock biomass (TBS in tonnes), spawning stock biomass (SSB in tonnes), and average fishing mortality for ages 3 to 5 (F_{35}).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F_{35}	Low	High
1999	53187	39188	72185	7009	5574	8814	4519	3499	5836	0.978	0.771	1.241
2000	46657	35497	61325	8462	6945	10311	5318	4319	6548	1.025	0.843	1.247
2001	28034	20860	37676	9591	7856	11709	6440	5242	7912	0.974	0.804	1.180
2002	36042	25880	50194	9480	7680	11702	6689	5366	8339	0.912	0.743	1.121
2003	24336	18357	32262	8303	6876	10025	5973	4908	7268	0.811	0.663	0.992
2004	29130	22287	38076	7559	6342	9009	5432	4522	6526	0.764	0.618	0.943
2005	24685	18934	32184	7174	5986	8597	5135	4250	6204	0.755	0.603	0.946
2006	19565	14145	27062	6972	5780	8410	5040	4151	6118	0.794	0.641	0.982
2007	20655	15704	27168	6437	5345	7751	4700	3873	5702	0.770	0.616	0.962
2008	22762	16813	30816	6029	5001	7269	4354	3591	5278	0.766	0.612	0.958
2009	25611	19643	33394	5813	4795	7047	4107	3355	5028	0.707	0.549	0.909
2010	34131	25941	44907	6198	5119	7504	4260	3469	5232	0.628	0.458	0.860
2011	38271	29264	50048	7278	5954	8897	4920	3965	6107	0.586	0.405	0.848
2012	35337	26338	47411	8641	6935	10765	5979	4706	7596	0.413	0.261	0.654
2013	30649	23198	40492	10514	8235	13422	7660	5871	9996	0.342	0.209	0.558
2014	29619	21504	40796	12147	9229	15988	9278	6868	12534	0.295	0.182	0.480
2015	35094	25755	47819	13609	10054	18420	10651	7632	14865	0.273	0.170	0.439
2016	42366	29707	60419	15463	11131	21481	12185	8472	17524	0.274	0.174	0.433
2017	63701	39695	102223	17845	12579	25316	13886	9436	20433	0.254	0.155	0.416
2018	81541	40854	162748	21670	14744	31848	16575	10980	25019	0.253	0.138	0.461

Table 5.2.8. Plaice in SD 27.21–23. Estimated fishing mortality (F) at-age.

YEAR\AGE	1	2	3	4	5+
1999	0.045	0.361	0.782	1.192	0.961
2000	0.047	0.375	0.803	1.241	1.031
2001	0.048	0.373	0.762	1.156	1.005
2002	0.049	0.383	0.743	1.065	0.929
2003	0.044	0.347	0.667	0.941	0.825
2004	0.040	0.321	0.630	0.887	0.774
2005	0.039	0.310	0.619	0.881	0.766
2006	0.039	0.319	0.650	0.929	0.802
2007	0.039	0.317	0.642	0.909	0.759
2008	0.043	0.340	0.658	0.905	0.733
2009	0.042	0.330	0.625	0.836	0.660
2010	0.041	0.308	0.573	0.743	0.566
2011	0.040	0.297	0.541	0.694	0.524
2012	0.031	0.220	0.392	0.487	0.361
2013	0.027	0.191	0.332	0.402	0.290
2014	0.023	0.162	0.288	0.349	0.249
2015	0.021	0.148	0.266	0.324	0.230
2016	0.022	0.151	0.270	0.326	0.227
2017	0.020	0.139	0.249	0.301	0.211
2018	0.020	0.138	0.248	0.300	0.210

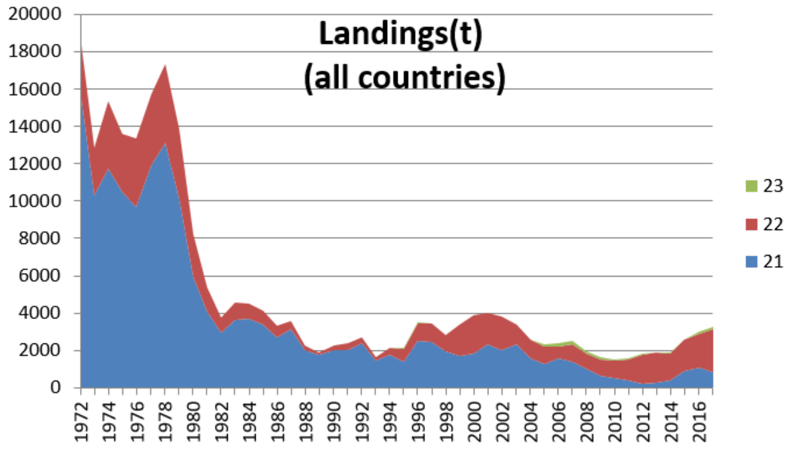


Figure 5.2.1. **Plaice in SD 27.21–23. Landings by subdivision by year.**

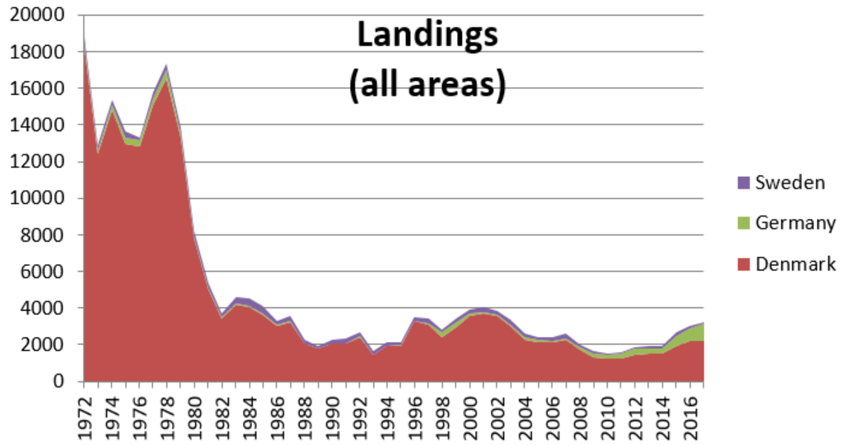


Figure 5.2.2. **Plaice in SD 27.21–23. Landings (t) by country by year.**

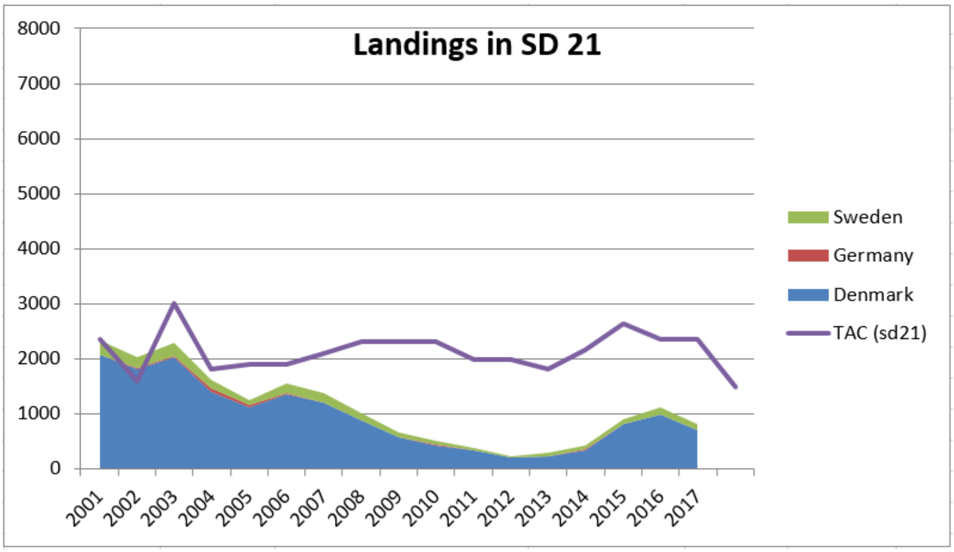


Figure 5.2.3a. **Plaice in SD 27.21–23. Landings (t) in SD 27.21 by country by year. TAC is plotted as well.**

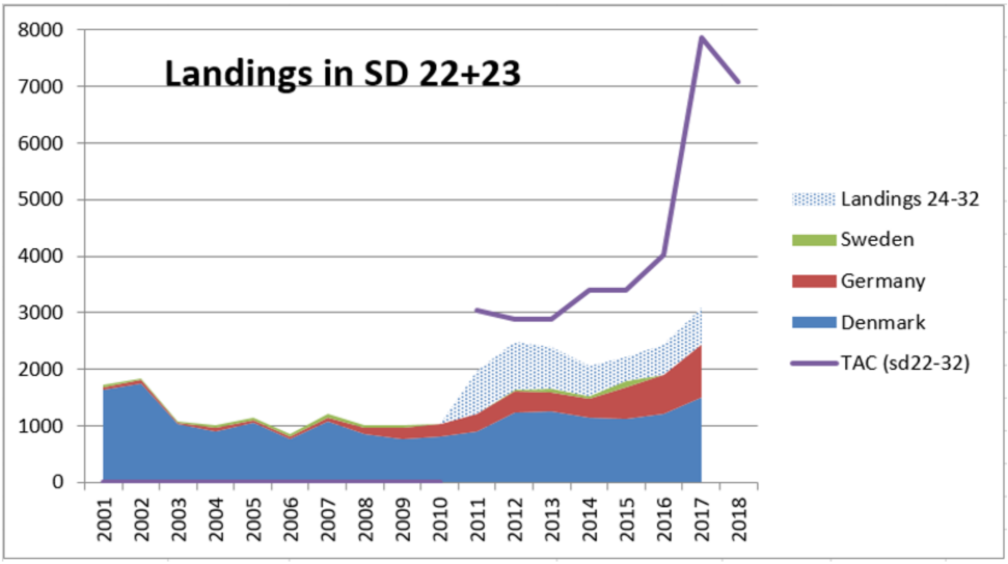


Figure 5.2.3b. **Plaice in SD 27.21–23. Landings (t) in SD 27.22+23 by country by year. TAC is plotted as well.**

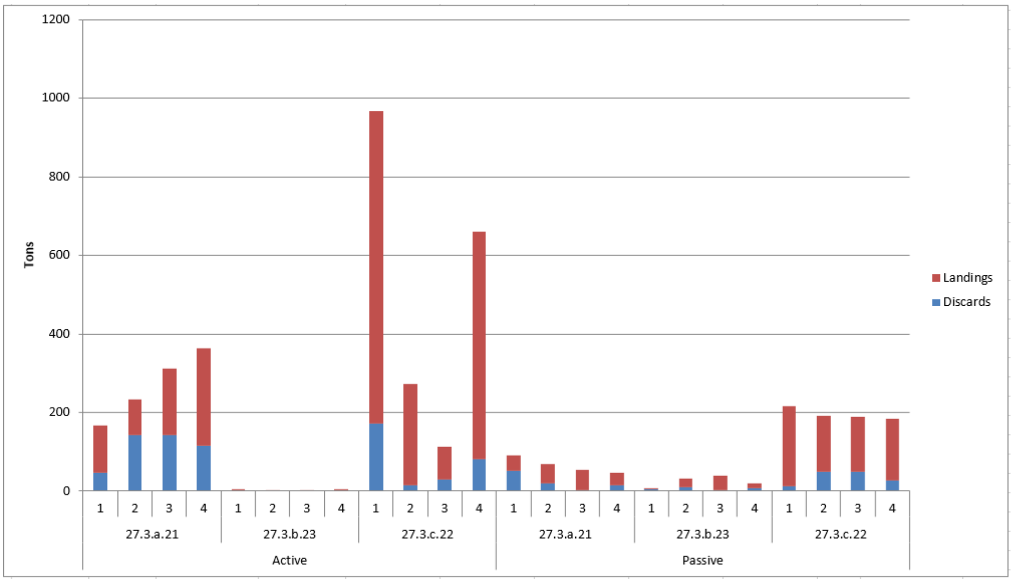


Figure 5.2.4. **Plaice in SD 27.21–23. Catches (t) in 2017 by gear type, area, quarter and catch category.**

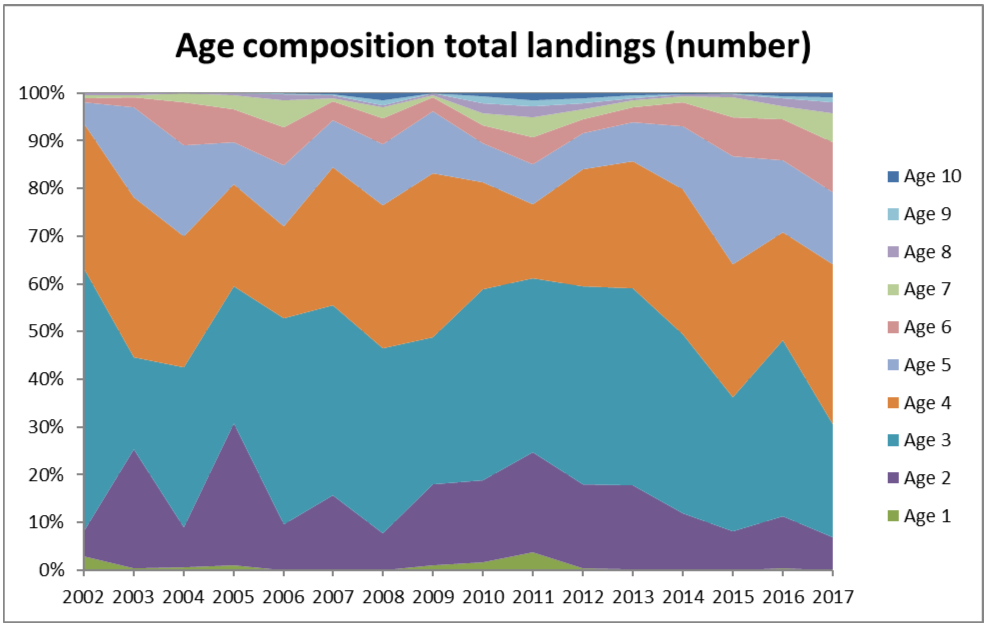


Figure 5.2.5a. Plaice in SD 27.21–23. Age composition for landings from 2002 to 2017.

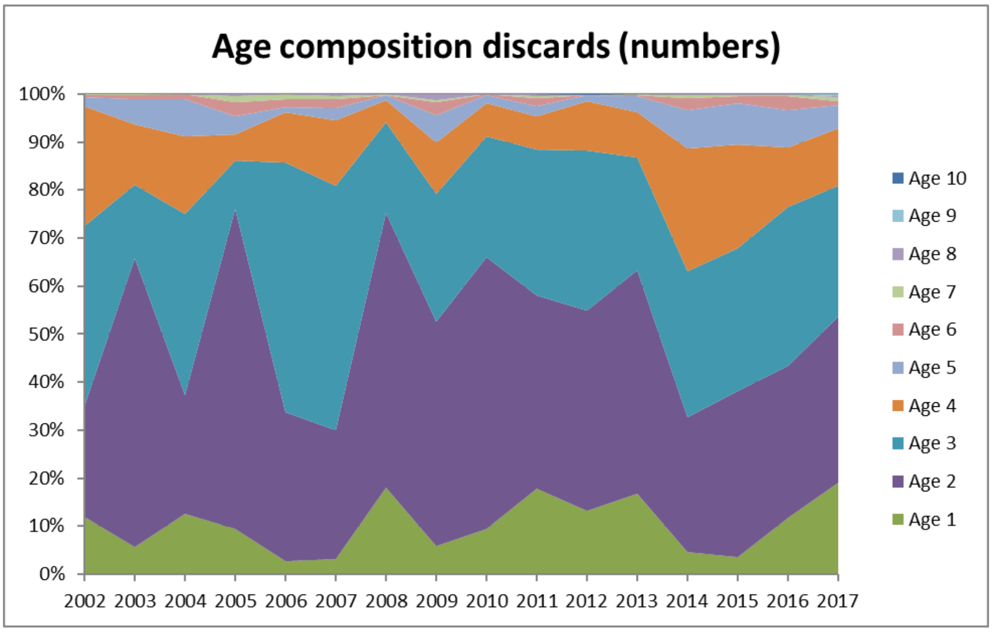


Figure 5.2.5b. Plaice in SD 27.21–23. Age composition for discards from 2002 to 2017.

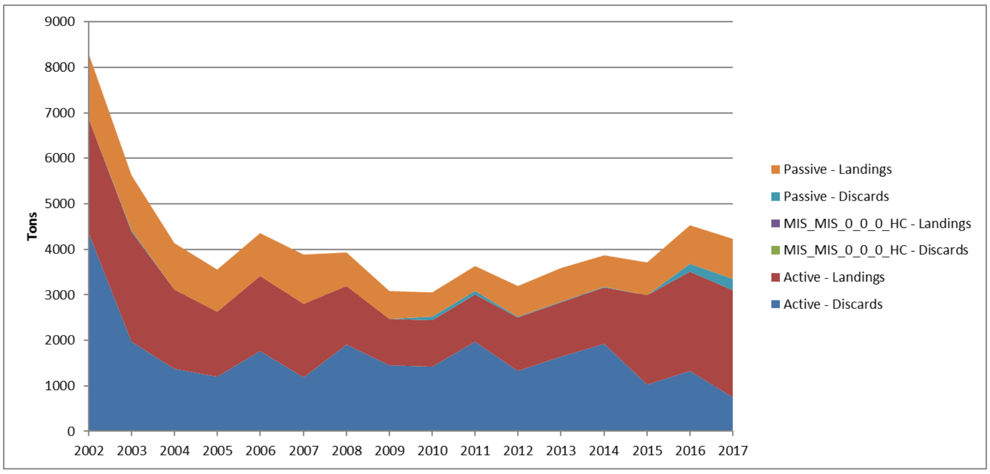


Figure 5.2.6. Plaice in SD 27.21–23. Catches (t) split into catch category and country by year. Discard indicated with similar pattern but belonging to landing right above.

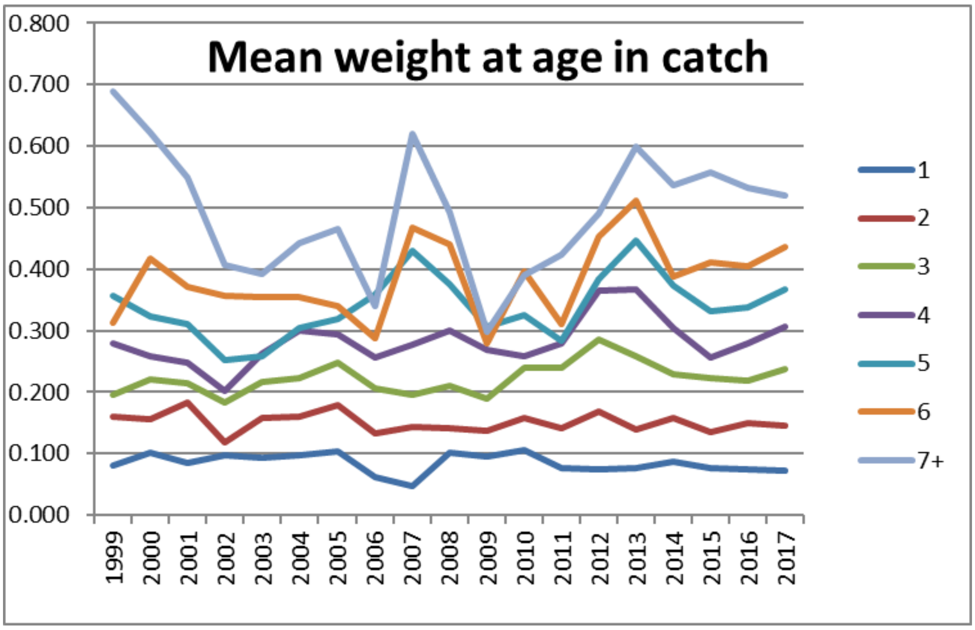


Figure 5.2.7. Plaice in SD 27.21–23. Mean weight (kg) at-age in catch.

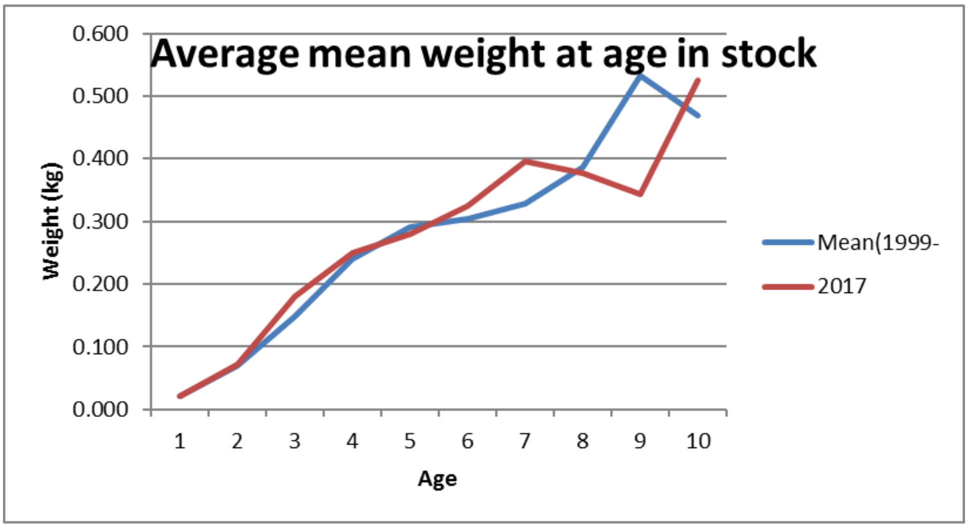


Figure 5.2.8. Plaice in SD 27.21–23. Mean weight (kg) at-age in stock.

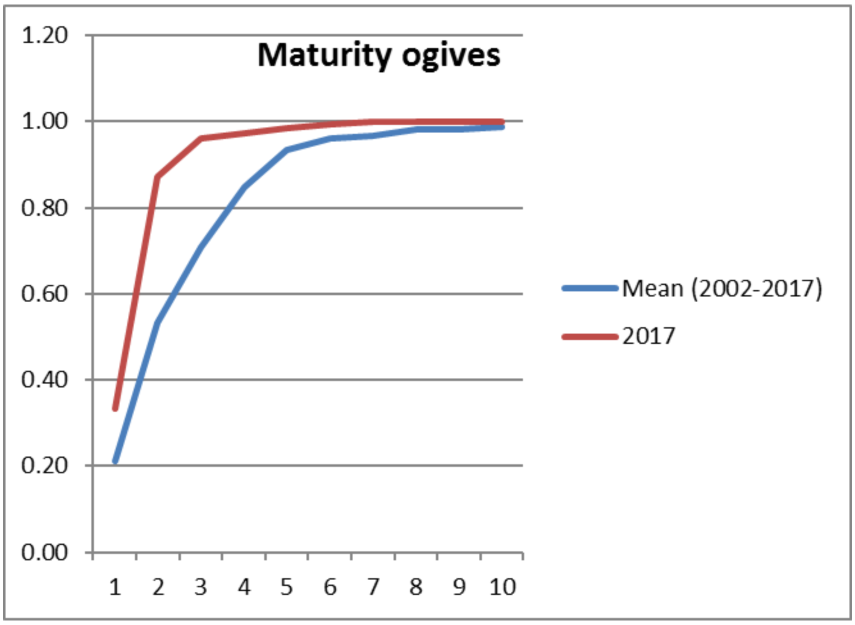


Figure 5.2.9. **Plaice in SD 27.21–23. Maturity ogive based on 2017 first quarter combined surveys compared with the mean of the series from 2002–2017.**

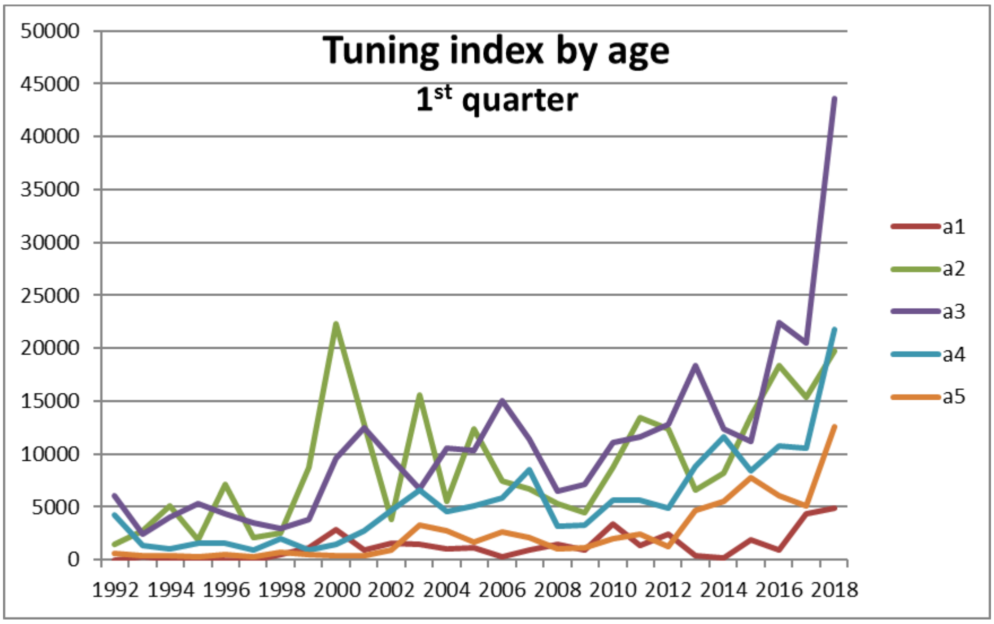


Figure 5.2.10. **Plaice in SD 27.21–23. Index by age for 1st quarter surveys.**

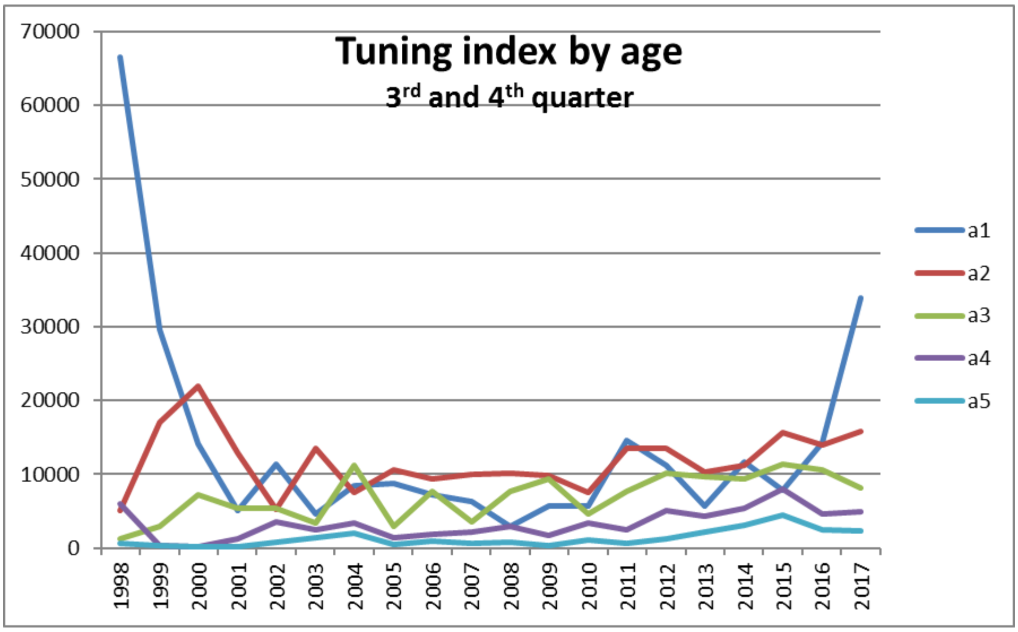


Figure 5.2.11. **Plaice in SD 27.21–23. Index by age for 3rd and 4th quarter surveys.**

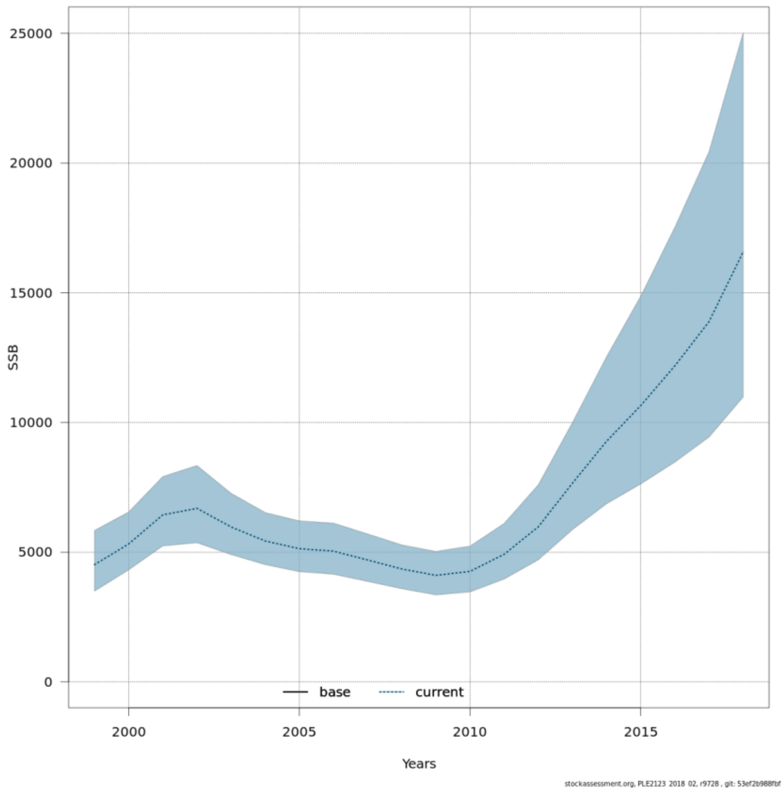


Figure 5.2.12a. **Plaice in SD 27.21–23. SSB (1000 tonnes) estimates from SAM output.**

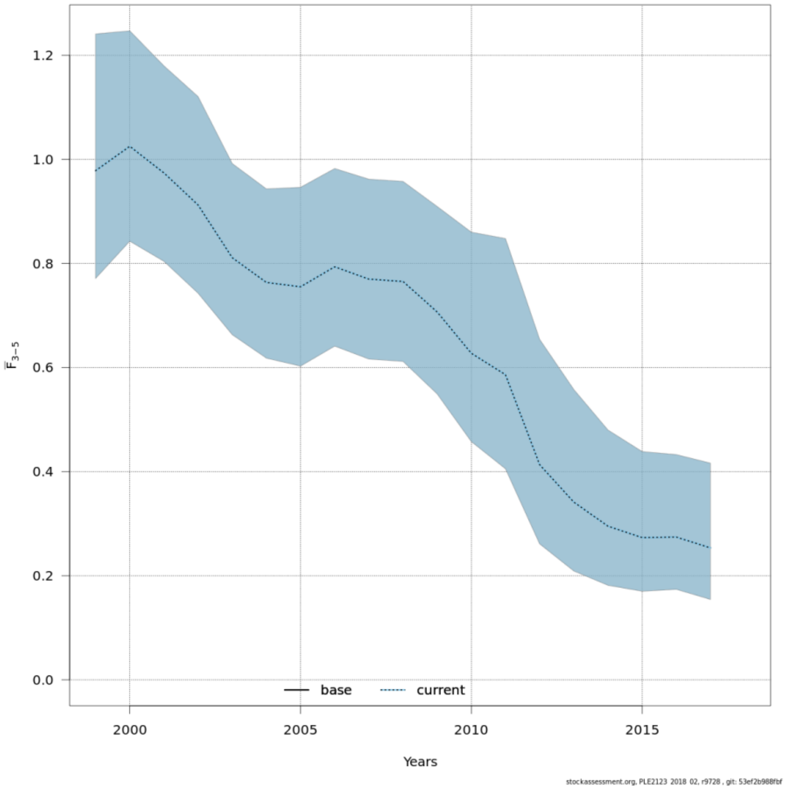


Figure 5.2.12b. **Plaice in SD 27.21–23. F(3-5) estimates from SAM output.**

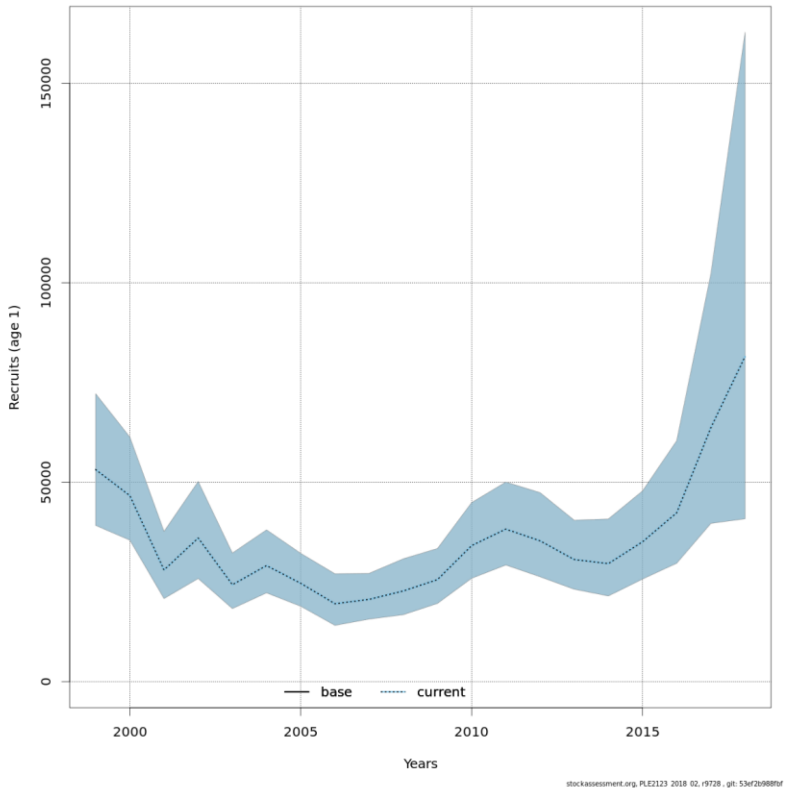


Figure 5.2.12c. **Plaice in SD 27.21–23. Recruitment ('000, numbers) estimates from SAM output.**

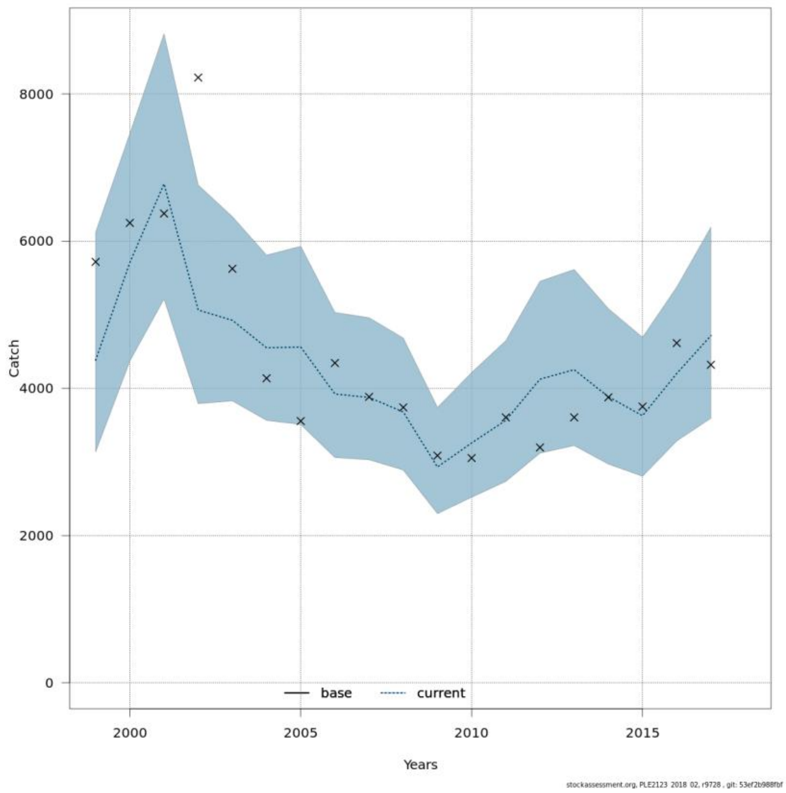


Figure 5.2.12d. **Plaice in SD 27.21–23. Catch (numbers) observed and estimates from SAM output.**

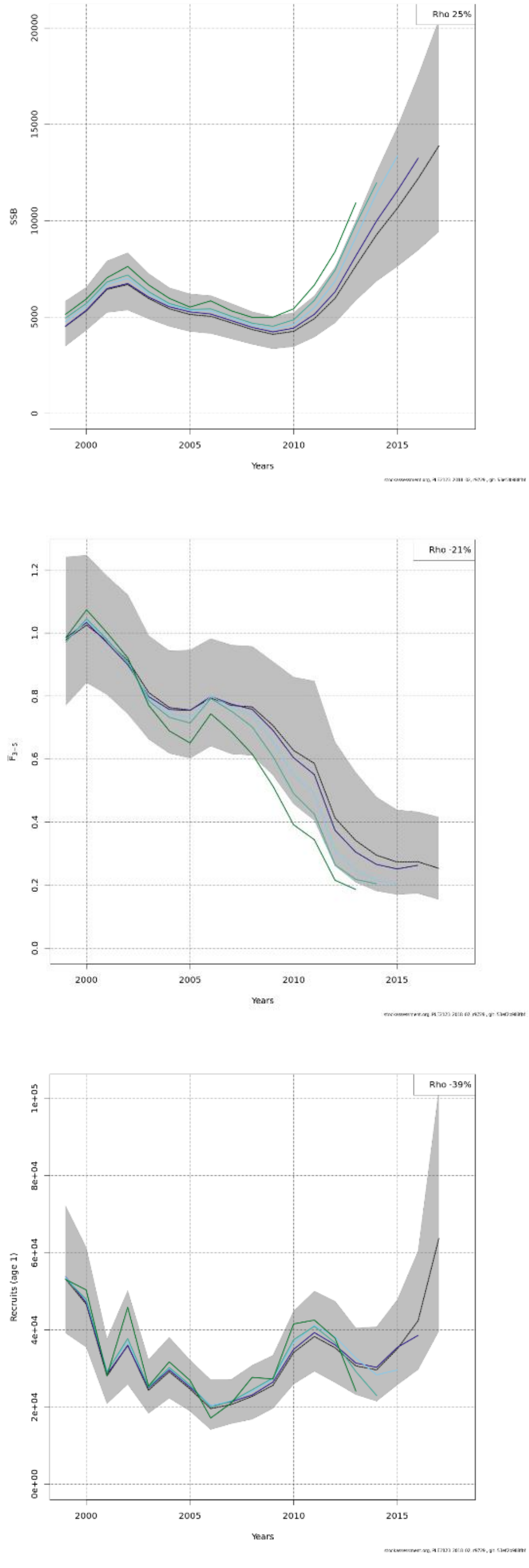


Figure 5.2.13. **Plaice in SD 27.21–23. The results of the retrospective analysis showing the SSB (1000 t). the F(3–5) and the recruitment ('000, numbers).**

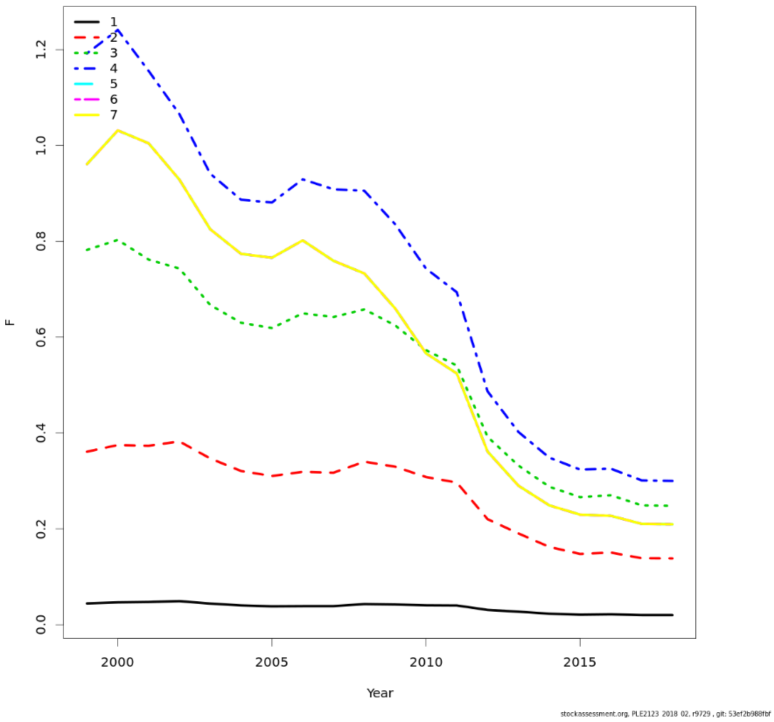


Figure 5.2.14. Plaice in SD 27.21–23. Estimated F by age group.

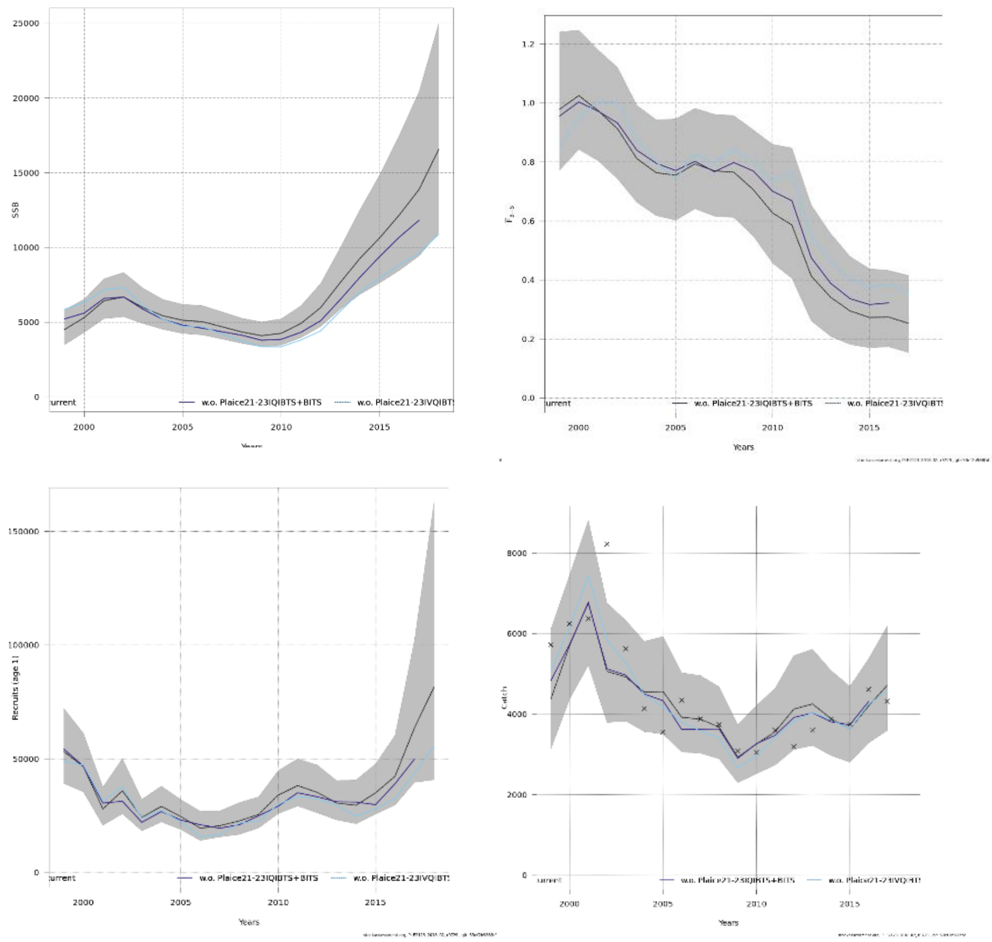


Figure 5.2.15. **Plaice in SD 27.21–23. Results of leave out analysis for SSB (1000t). F, R('000, numbers) and catch.**

Figure 5.2.16. Plaice in SD 27.21–23. Residuals for catch matrix 1st and 3rd + 4th quarter surveys.

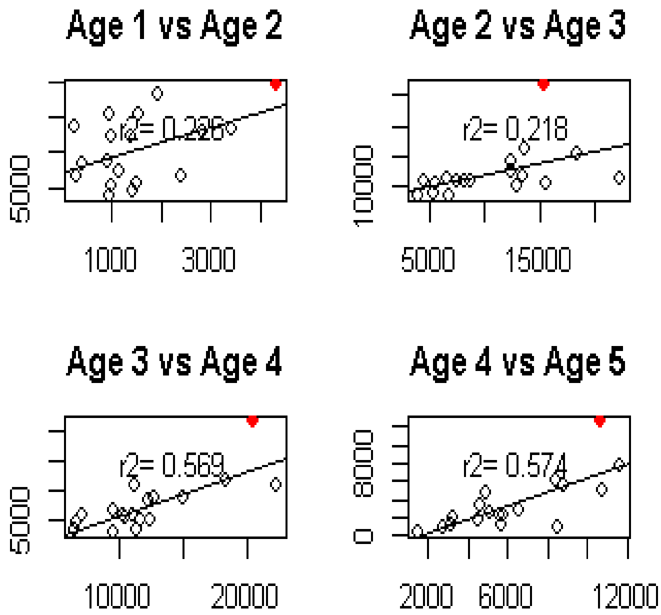


Figure 5.2.17. **Plaice in SD 27.21–23. Internal consistency for 1st quarter combined survey.**

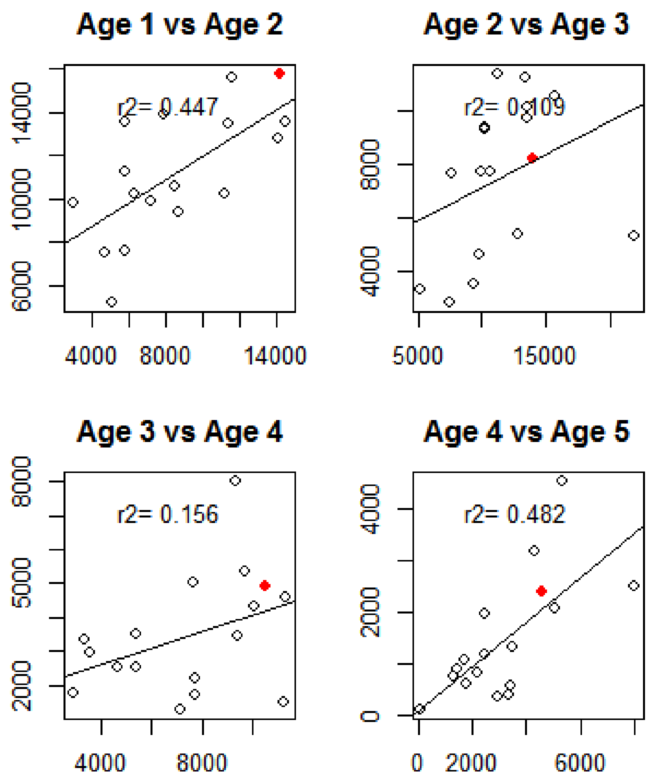


Figure 5.2.18. **Plaice in SD 27.21–23. Internal consistency for 3rd and 4th quarter combined survey.**

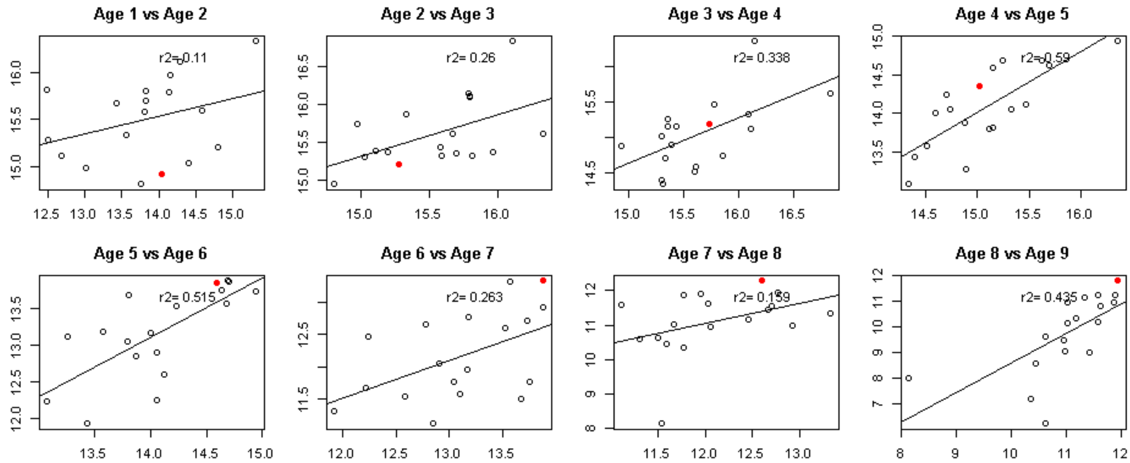


Figure 5.2.19. Plaice in SD 27.21–23. Internal consistency for catch matrix. Red dot indicates latest year value.

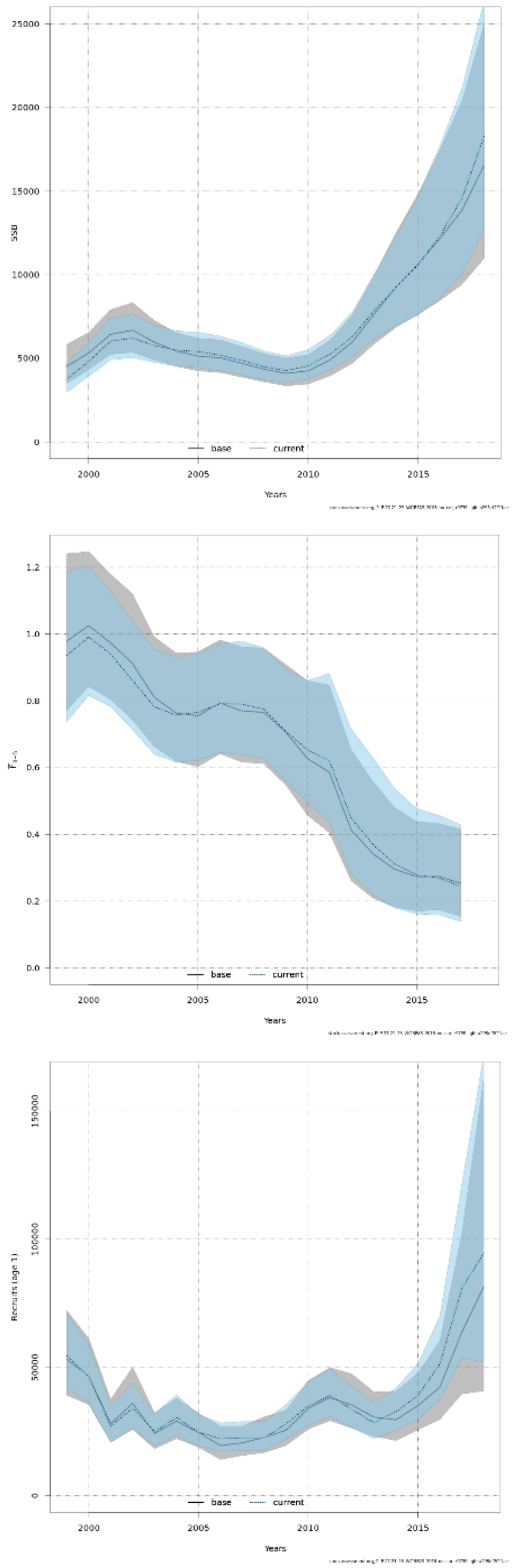


Figure 5.2.20. Plaice in SD 21–23. Central graphs showing the difference between the final run (with correlation introduced for 1q survey and an explorative SAM run without correlation introduced for 1q survey).

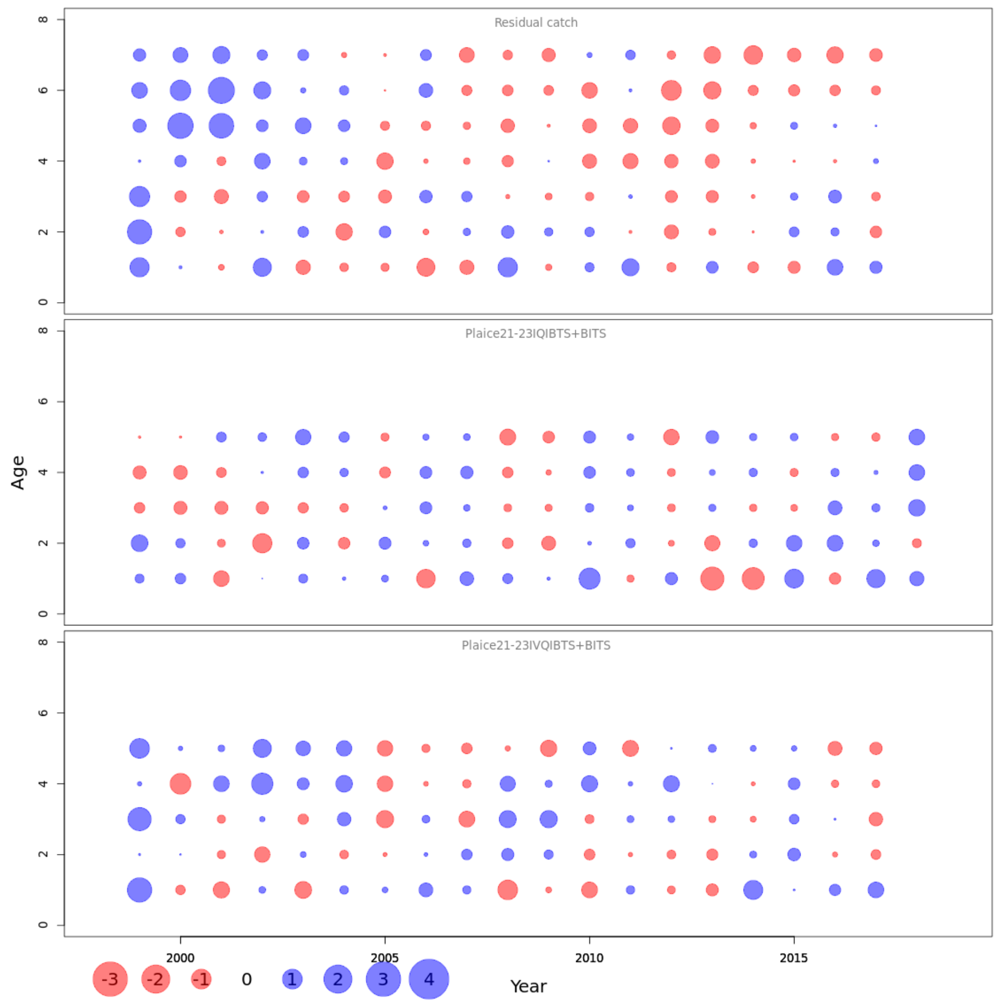


Figure 5.2.21. **Plaice in SD 21–23. Residuals for the catch, 1q survey and 3-4 q survey for the explorative SAM run without correlation introduced for 1q survey.**

5.3 Plaice in subdivisions 24–32

5.3.1 The Fishery

There are no management objectives for the stock. The management areas do not match the assessment areas. The TAC for the combined stock ple.27.22-32 in 2017 was increased to 7862 tonnes and decreased in 2018 to 7076 tonnes. The latest decrease is related to the outcome in assessment of the ple.27.21-23 stock, which is now assessed via an analytical assessment and therefore the TAC is given based on F_{MSY}. The analytical assessment of ple.27.21-23 indicated a decrease in recruitment which was considered when combining the results with ple.27.24-32.

5.3.1.1 Technical Conservation Measures

Plaice is mainly caught in the area of Arkona and Bornholm basin (SD 24 and SD 25). ICES Subdivision 24 is the main fishing area with Denmark and Germany being the main fishing countries. Subdivision 25 is the second most important fishing area. Denmark, Sweden and Poland are the main fishing countries there. Minor catches occur in Gdansk basin (SD 26). Marginal catches of plaice in other SD are found occasionally in some years, but were usually lower than 1 ton/year.

Plaice are caught by trawlers and gillnetters mostly. The minimum landing size is 25 cm in 2017, active gears provide most of the landings in SD 24 (ca. 84%) and SD 25 (ca. 75%), whereas landings from passive gears are low. However, in SD 26, passive gears provided 54% of total plaice landings in 2017.

5.3.1.2 Landings

The catch landings data of plaice in the Eastern Baltic (ple.27.24-32) according to ICES subdivisions and countries are presented in tables 5.3.1 and 5.3.2. Only Denmark, Sweden, Poland, Germany and Finland (traded quota from Sweden) have a TAC for landing plaice. The trend and the amount of the landings of this flatfish per country are shown in Figure 5.3.1.

The highest total landings of plaice in SD's 24 to 32 were observed at the end of the seventies (4530 t in 1979) and the lowest around the period between 1990 and 1994 (80 t in 1993). Since 1995 the landings increased again and reached a moderate temporal maximum in 2003 (1281 t) and again in 2009 (1226 t). After 2009 the landings are decreasing to 748 t in 2011, slightly increased in 2012 to around 848 tonnes and decreased to 427 tonnes in 2015. Landings (wanted catch) in 2017 were 643 tonnes. Since 2017, a landing obligation is in place, resulting in an additional 7 tonnes of "BMS landings" (i.e. landings of plaice below the minimum conservation reference size of 25 cm), which accounted for 0.8% of the total catch.

5.3.1.3 Unallocated removals

Unallocated removals might take place but are considered minor and are not reported from the respective countries. Recreational fishery on plaice might take place with unknown removals, but is also considered to be of minor influence.

5.3.1.4 Discards

Although a landings obligation is in place since 2017, discards in the commercial fisheries remain to be high and seems to vary greatly between countries. For example the trawl-fishery targeting cod in SD 26 may even have a 100% discard rate of plaice throughout the year. Only a few occasional landings from trawl-fisheries took place in SD 26. Countries without a TAC for plaice are assumed to have 100% discard.

However, the available data on discards are incomplete for all subdivisions. National discard estimations were missing in some strata, where countries have a cod-targeting trawl-fishery which may have some bycatch of plaice.

Sampling coverage, esp. in the passive-gear segment is low, especially on discard in SD 25 and SD 26, where often only Danish data were available. The discards in 2016 were exceptional high and estimated to be around 1050 tonnes, which would result in a discard ratio of 67% of the total catch. Discards in the most recent year (2017) were around 408 tonnes (i.e. 38% of the total catch).

5.3.1.5 Effort and CPUE data

The CPUE was calculated as standardized fishing effort for both, the demersal active and passive fleet. National fleet effort (days-at-sea) per SD is transformed into a standard catch (effort per stratum and country divided by average effort per country over the period 2009–2017). Standard catches were weighted by the mean of cod landings by country and fleet.

Fishing effort in subdivisions 24 and 25 decreased from 2004 to 2010 with 50% (see Figure 4.2.4 from STECF-report 2015) and remains stable since then. The standardized effort for active and passive gears shows a slight, but continuous decrease since 2012 (Figure 5.3.2). The strong decrease in cod catches in 2017 (due to extended closure periods and a strongly reduced TAC) however resulted in exceptional high decrease in the standardized effort, although the total days at sea did not show an uncommon decrease.

5.3.2 Biological composition of the catch

5.3.2.1 Age composition

Age class 3 is most abundant in the landing fraction of plaice. In the discard fraction, age classes 2–3 are the most abundant. Almost no plaice above age class 5 is found in the discards.

5.3.2.2 Mean weight-at-age

Recent years show a decrease in the average weight for almost all age classes (Figure 5.3.4). Age class 1 did not appear in the sampled catches after 2012. The age classes above 7 are usually not very well sampled, causing some fluctuations in the average weight. Passive gears often catch larger fishes and have a lower discard-rate.

5.3.2.3 Natural mortality

No further information or studies on natural mortality are available. The average natural mortality for age classes 1 and 2 is set at 0.2, age classes 3+ are set at 0.1 as a default.

5.3.2.4 Maturity-at-age

The maturity ogive was taken from the BITS from SD22 and SD24 (since they are more reliable and consistent than SD24+, see WKPLE 2015 report). Both quarters from the period 2002 to 2018 (2018, preliminary 1st quarter only) were combined and an average maturity-at-age was calculated:

AGE	1	2	3	4	5	6	7	8	9	10
Maturity	0.18	*0.51*	0.70	0.85	0.94	0.97	0.97	0.99	0.98	0.99

5.3.3 Fishery independent information

The "Baltic International Trawl Survey (BITS)" is covering the area of the plaice stock in SD24–32. The survey is conducted twice a year (1st and 4th quarter) by the member-states having a fishery in this area. Survey-design and gear is standardized. Due to a change in trawling gear in 2000, only first and fourth quarter BITS since 2001 are considered. The CPUE is calculated from the catches. The BITS-Index is calculated as:

Average number of plaice > = 20 cm weighted by the area of each depth stratum which all together covers the area covered by the stock. (Figure 5.3.5).

The internal consistency plots of the surveys (Figure 5.3.6.a and 5.3.6.b) indicate a good consistency between the age classes. Younger fish in Q1 show low consistency following the cohorts because the trend in some cases is defined by one outlying measuring point. The medium and older aged fish show better consistency. The latest Survey index (2017 Q4) however has a bad internal consistency, as the catch data of plaice were exceptional high, a trend that is also showing in the preliminary 2018 Q1 survey.

The internal consistency in the commercial catches is also quite good (Figure 5.3.7). Only the medium aged fishes show a lesser consistency.

5.3.4 Assessment

The stock was as a result of the WKPLE in February 2015 upgraded to Category 3.2.0 (DLS; exploratory assessment with SSB trends). The State based Assessment Model (SAM) is used. The assessment is an update of the benchmark assessment (ICES WKPLE) and the settings are according to the stock annex (ple.27.24-32).

The final run in SAM is named: ple.27.24-32_2018_v3

Age reading could not be conducted in time for the preliminary survey data of the BITS 2018 Q1, therefore a von Bertalanffy-equation was applied on the length data to compute numbers-at-age. For the equation, the same parameters as for the SPiCT model were applied:

Plus-Group -> 10, L_{inf} = 45.813, K= 0.2279, t_0 = -0.1617 (BITS data 2002–2017, both quarter and sexes)

5.3.4.1 Exploration of SAM

The stock is in a very good condition. The result shows (Figures 5.3.8a-c and Table 5.3.3) an increase in SSB from < 3000 tonnes in 2010 to 20 000 tonnes in 2017 and estimated to 26 000 tonnes in 2018. The increase is probably resulting out of the high amount of discard in 2016 and 2017 and the very high index values of the survey index and the respective higher total catch in 2017. The F in 2017 is lower than last year (0.21) and has been constantly decreasing in the whole period. This is the case for all age groups except the older age groups (7, 8, 9+), which seem to have a slight increase (Figure. 5.3.9). The recruitment is regarded as constantly increasing but with significant variation. The recruitment in 2017 is estimated to 42.6 mill. which is the highest value since 2002.

The normalized residuals show some year effects for the commercial catches in the last three years (Figure. 5.3.10). Year effects also occur in the CPUE of BITS, especially for the latest surveys, which have high numbers of plaice in the catches, resulting in a high index value. The retrospective analysis is less robust even when considering the short time series. Only the last 3 years are within the confidence intervals. The F has been estimated to be within the confidence intervals (Figure. 5.3.11).

This stock was benchmarked in 2015 (ICES WKPLE) and the basis of the advice was changed. The advice is now made based on relative SSB trends and F estimated by SAM.

Usually the factor for the catch advice is calculated as average SSB of 2 most recent years (2016–2017) divided with SSB average of the preceding three years (2013–2015) - this estimate gives an increase of 25%. Uncertainty cap is applied as the calculated trend exceeds the limit of 20% changes.

F_{SQ} is estimated to 0.60 over the period of 2010 to 2017. No F_{MSY} is available for the stock; however, an exploratory SPiCT model conducted on the stock states a $F_{MSY\ proxy}$ of 1.68.

However, a decreasing trend in total landings (and catch) appeared in the last three years. Advice will then be given based on the advised catch of the last year (2017). Advised catches for 2018 is 3725 tonnes based on the total catch and average discard ratio of the last year (2017).

Since the difference between the advised (2587 tonnes in 2017) and the taken catch (1051 tonnes in 2017) is very high and increasing with each year, it should be considered to give an advice based on the taken catch instead of advised catch of the previous year.

5.3.4.2 Historical stock trends

Before the benchmark in 2015, trends in the stock were evaluated by survey-indices only. The survey indices are shown in Figure 5.3.5. See section 5.3.1 under "Description of the fishery" for historical trend details.

5.3.5 Recruitment estimates

The recruitment in 2017 is estimated to around 42.6 mills. This is an increase since 2013 and can be considered as a stable recruitment in the whole time series (2002–2016). The historic trend is given in Figure 5.3.8 and Table 5.3.3.

5.3.6 Short-term forecast and management options

No short term forecast is given for the stock.

5.3.7 Reference points

5.3.7.1 Length based indicators (LBI)

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (2015). CANUM and WECA of commercial catches from 2014–2017 were taken from InterCatch. Biological parameters were calculated using survey data from DATRAS:

- L_{inf}: average of 2002–2017, both quarter and sexes → L_{inf} = 51.652 cm
- L_{mat}: average of 2002–2017, quarter 1, only females → L_{mat} = 27.5 cm

The output (relative descriptive values) was compared to reference values (Table 5.3.5) to estimate the status of the stock in respect to length based Indicators. Table 5.3.6 states all results in a traffic light system, where the values of the respective year and indicator are colored depending on whether they are below or above the relative reference point.

The results of LBI show that stock status of ple.27.24–32 is above possible reference points (Table 5.3.6). $L_{max5\%}$ is close to the lower limit of 0.80 (i.e. 0.82 in 2017), some truncation in the length distribution in the catches might take place. A lack of mega spawners occurs, as P_{mega} is less than 30% of the catch and indicates a truncated length distribution in the catch. Catch is close to the theoretical length of L_{opt} and L_{mean} is stable over time and close to 1, indicating fishing close to the optimal yield. Exploitation (Figure 5.3.12) is consistent with F_{MSY} proxy ($L_{F=M}$).

5.3.7.2 Surplus production model (SPiCT)

The stochastic production model in continuous time (SPiCT) was applied to the plaice stock ple.27.24–32. Input data were commercial catch (landings and discards) from 2002 to 2017 and the BITS biomass index Q1 and Q4. No reference points are defined for this stock in terms of absolute values. The SPiCT-estimated values of the ratios $F/F_{MSY\ proxy}$ and $B/B_{MSY\ proxy}$ are used to estimate stock status relative to the MSY reference points and are used in the catch advice as an additional indicator of the stock status.

The results of the assessment are stating a good status of the stock, below or above the respective reference points and thus confirming the results of the SAM assessment and the stock trend of the BITS index. The results are however uncertain with large confidence intervals (Figure 5.3.13, Table 5.3.7). The high variance might be attributed to inconsistency between catch and index time-series and missing contrast in the catch time-series, which also is only covering 15 years. From 2018, SPiCT results are used to give information on proxy reference points. The recent time-series of 15 years combined with continuously increasing data quality (in terms of spatiotemporal sampling coverage, amount of samples and error/consistency checks) and the comparison with the other stock trends (SAM, BITS) justifies the use of this model for the proxy reference points.

Despite the high variance, the model states a good stock condition in recent years and well within F_{MSY} and B_{MSY}. Following the ICES approach, a proxy for MSY $B_{trigger}$ can be calculated as 0.5 x B_{MSY}.

5.3.8 Quality of assessment

The stock is categorized as a Category 3.2 Data Limited Stock (DLS). Stock Trend analysis was made based on the results of the SAM assessment run. SSB was used as biomass index for estimating the stock trend. The calculated trend was used for calculating the catch in 2019. Even though the SAM assessment is premature, the assessment shows surprisingly robustness despite the relative short time series available. This is expressed in the retrospective analysis which looks acceptable (Figure 5.3.11), although the SSB shows a consistent overestimation. The F looks good, while the recruitment is poorly estimated. The F by-age group is shown in Figure 5.3.9. The final summary plots (F_{bar}, Spawning Stock Biomass (SSB) and recruitment) for the SAM run are shown in Figure 5.3.8.a-c. The summary output from the SAM is shown in table 5.3.4, the final numbers used for the advice are given in Table 5.3.4.

5.3.9 Comparison with previous assessment

Compared to the first year of giving a catch advice in 2015 (before that, landings advice was given based on survey trends), no major changes were found. Both, the trend of the stock and the respective catch advice are similar to 2016 and 2017. The estimated relative F for 2017 (0.36) decreased compared to 2016 (0.56); the relative recruitment estimates (3.0) increased compared to the previous assessment (2.5). The relative SSB also increased (1.62 in 2016 to 2.3 in 2017. For 2018, a SSB of 3.4 is estimated). Data quality is improving annually and with increased sampling by the member states. Commercial effort data were changed backwards to 2009. Now a standardized effort per fleet can be given which increases the quality of the advice (Figure 5.3.2).

5.3.10 Management considerations

To improve the exploratory assessment and hence the quality of the advice, more discard estimations are required by national data submitters. Additionally, more flexible tools need to be developed for InterCatch, allowing the allocation of discards also to strata with no landings attached (discard only) and extrapolation across years (to allow reasonable borrowing in years without sufficient estimations). Data handling, such as allocation and hole filling should take place in the database to allow comprehension of the methods used.

The sampling of biological data needs further enhancement, esp. in SD 25, where the number of age readings and length measurements is in no relation to the landings. The discarded fraction needs a better sampling coverage. Although all landing countries are obliged to submit biological data, not all available information was uploaded by every country. To improve the quality of the assessment, this is however mandatory.

To improve the exploratory SAM, natural mortality values should be verified, the index values of BITS should be verified as well to minimize residuals.

BMS landings should be sampled additionally to the ongoing discard-sampling to allow reasonable data extrapolation for this part of the catch.

Table 5.3.1. ple.27.24–32. Plaice in the Baltic Sea. Total landings (tonnes) by ICES Subdivision and country.

Year/SD	Denmark			Germ. Dem. Rep*	Germany, FRG		Poland		Sweden**						Finland		
Area	24(+25)	25	26+27	24	24(+25)	25	25(+24)	26	24	25	26	27	28	29	24	25	26
1970	494				16				149								
1971	314				2				107								
1972	290				2				78								
1973	203			44	1		174	30	75								
1974	126			10	2		114	86	60								
1975	184			67	1		158	142	45								
1976	178			82	3		164	76	44								
1977	221			36	2		265	26	41								
1978	681			1198	3		633	290	32								
1979	2027			1604	7		555	224	113								
1980	1652			303	5		383	53	113								
1981	937			52	31		239	27	118								
1982	393			25	6		43	64	40	6		7	1				
1983	297			12	14		64	12	133	20		24	2				
1984	166			2	8		106		23	3		4	1				
1985	771			593	40		119	49	25	4		5	1				
1986	1019			372	7		171	59	48	7		9	1				
1987	794			142	16		188	5	68	10		12	1				
1988	323			16	1		9	1	49	7		9	1				
1989	149			5			10		34	5		6	1				
1990	100			1	1		6		50								
1991	112				9		2	1	5	2		2					
1992	74				4		6		3	1		1					
1993	66				6		4		4								
1994	159						43	4	4	7							
1995	343				91		233	2	13	10	1						
1996	263				77		183	5	28	23	10	1					
1997	201				56		308	3	7	8		1					
1998	278				41		101	14	6	17		1					
1999	183				46		145	1	5	10							
2000	161				37		408	3	9	12							
2001	173				43		549	3	9	13							
2002***	153	159	0		137	7	429	3	10	15							
2003	326	299	2		68	25	480	10	16	51		0	0				
2004	167	239			50	13	292	8	6	37							
2005	164	241			90	17	511	11	16	28		0	0				
2006	82	632			173	11	52	3	17	41			0				
2007	408	490	0		151	12			41	61		0	0				
2008	450	339			150	10	29	0	45	69			0				
2009	581	359	0		96	21	42	0	43	79		0					
2010	345	295	1		66	13	93	8	22	61	1	0					
2011	291	233			109	6	37	1	33	36	0	0			1	0	0
2012	477	148	0		86	4	62	2	23	43	1	0			2	1	0
2013	382	196	0		46	1	45	5	29	33	0	0			1		
2014	231	118	0		57	<1	80	7	21	19	<1	<1	0	0	<1		
2015	145	69	0		44	1	140	5	12	12	0	0	0	0	0		
2016	187	60	1		93	2	151	3	15	10	<1	<1	0	0	0	0	0
2017	124	68	<1		143	1.4	293	3	6	12	<1	0	0	0	0	0	0

*From October to December 1990 landings from Fed. Rep. of Germany are included.

**For the years 1970–1981 and 1990 the Swedish landings of subdivisions 25–28 are included in Subdivision 24.

***From 2002 and onwards Danish and German, FRG landings in SW Baltic were separated into subdivisions 24 and 25.

Table 5.3.2. ple.27.24–32. Landings (tonnes), BMS landings (tonnes) and discard (tonnes) in 2017 by Subdivision, catch category, country and quarter.

Area	Country	CatchCategory	1	2	3	4	Total
27.3.d.24	**Denmark**	Landings	17.79	32.70	24.80	48.57	123.86
		Discards	0.06	0.94	4.44	59.23	64.67
		BMS landing	0.06	0.13	0.18	0.00	0.37
	Germany	Landings	11.76	9.95	50.09	69.82	141.61
		Discards	2.65	1.65	7.21	14.29	25.80
		BMS landing	0.21		0.11	1.42	1.74
	Poland	Landings	11.41	16.24	34.93	99.50	162.08
		Discards	2.91	14.19	5.90	24.71	47.71
		BMS landing	0.00				0.00
	Sweden	Landings	0.01	0.79	0.48	3.30	4.59
		Discards	0.01	3.91	0.37	1.22	5.51
		BMS landing		0.00		0.00	0.00
27.3.d.25	**Denmark**	Landings	20.22	0.48	1.48	45.32	67.50
		Discards	185.81	2.02	3.32	54.65	245.80
		BMS landing	0.08	0.00	0.00	0.04	0.12
	Germany	Landings	1.30				1.30
		Discards	0.19	0.11	0.24		0.53
		BMS landing	0.08				0.08
	Lithuania	Landings	0.00	0.00		0.00	0.00
		BMS landing	0.00	0.00		0.00	0.00
	Poland	Landings	32.38	10.62	51.45	33.27	127.72
		Discards	7.73	5.30	34.44	6.28	53.76
		BMS landing	0.00	0.00	0.00	0.00	0.00
	Sweden	Landings	0.56	0.93	1.82	7.51	10.81
		Discards	11.98	1.56	1.53	2.43	17.48
		BMS landing	0.00		0.00	0.00	0.00
27.3.d.26	**Denmark**	Landings	0.01	0.00	0.00	0.04	0.05
		Discards	1.38			0.27	1.65
		BMS landing	0.00	0.00	0.00	0.00	0.00
	Latvia	Discards	0.03	0.12	0.33	0.11	0.59
	Lithuania	Landings	0.00	0.00	0.00	0.00	0.00
		Discards	0.13	0.05	0.12	0.82	1.12
		BMS landing	0.00	0.00	0.00	0.00	0.00
	Poland	Landings	0.03	0.48	1.36	1.18	3.04
		Discards	0.20	1.78	1.67	1.73	5.38
	Sweden	Landings	0.06	0.00	0.00	0.06	0.12
		Discards	7.63	0.55		1.69	9.87
		BMS landing	0.00		0.00		0.00

Table 5.3.3. **ple.27.24-32. Estimated recruitment (thousands), total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 2 to 5 (F_{25}).**

YEAR	RECRUITS	LOW	HIGH	TSB	LOW	HIGH	SSB	LOW	HIGH	F_{25}	LOW	HIGH
2002	4116	2185	7754	1235	790	1932	2498	1662	3755	0.790	0.478	1.307
2003	5596	3293	9512	1220	842	1768	2547	1768	3668	1.153	0.771	1.725
2004	8267	4688	14579	1337	968	1847	3166	2220	4515	0.747	0.509	1.095
2005	6180	3616	10564	1932	1389	2686	3859	2739	5438	0.413	0.258	0.660
2006	3344	1406	7955	2532	1816	3530	4061	2972	5549	0.524	0.331	0.831
2007	2664	871	8148	2544	1868	3465	3715	2703	5107	0.605	0.387	0.946
2008	3708	1634	8412	2356	1764	3148	3563	2605	4874	0.560	0.368	0.853
2009	8703	4974	15228	2612	1908	3576	4580	3379	6207	0.549	0.368	0.818
2010	18096	9511	34428	3209	2322	4435	6882	4645	10198	0.659	0.447	0.973
2011	18952	9540	37651	4318	2900	6429	9157	5781	14505	0.731	0.493	1.083
2012	12572	6188	25543	4715	3244	6853	8860	5893	13322	0.675	0.429	1.063
2013	11879	6703	21053	4142	3012	5697	7421	5373	10249	0.672	0.369	1.221
2014	17014	8773	32994	3864	2825	5286	7826	5326	11500	0.334	0.139	0.804
2015	26491	12241	57332	5177	3706	7231	10946	7023	17061	0.308	0.155	0.611
2016	34720	17340	69520	6934	5016	9586	14543	9694	21819	0.321	0.182	0.568
2017	42630	19774	91902	9909	6773	14495	20015	12648	31672	0.207	0.102	0.418
2018	43342	15020	125065	14687	9038	23867	26752	15043	47572	0.207	0.066	0.653

Table 5.3.4. **ple.27.24-32. Final results from the assessment run, which is used for the advice.**

Year	Relative recruitment (age 1)	Relative SSB	Landings	Discards	Relative mean F (ages 2–5)
2002	0.29	0.29	915	353	1.37
2003	0.40	0.28	1281	271	1.99
2004	0.59	0.31	1081	214	1.29
2005	0.44	0.45	1081	166	0.71
2006	0.24	0.59	1012	818	0.91
2007	0.189	0.60	1167	491	1.05
2008	0.26	0.55	1102	294	0.97
2009	0.62	0.61	1226	418	0.95
2010	1.29	0.75	903	998	1.14
2011	1.35	1.01	748	1377	1.26
2012	0.89	1.10	848	917	1.17
2013	0.85	0.97	738	781	1.16
2014	1.21	0.90	534	481	0.58
2015	1.88	1.21	427	220	0.53
2016	2.5	1.62	521	1058	0.56
2017	3.0	2.3	650	408	0.36
2018		3.4			

Table 5.3.5. ple.27.24-32. Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system.

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above Lopt + 10%	0.3–0.4	P_{mega}	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > Lc	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{maxy}	Length class with maximum biomass in catch	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > Lc	$L_{F=M}$ = ($0.75L_c+0.25L_{inf}$)	L_{mean} / $L_{F=M}$	≥ 1	MSY

Table 5.3.6 ple.27.24-32. Indicator status for the most recent three years.

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	L_{max5} / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2015	0.56	0.78	0.74	0.02	0.74	1.04
2016	0.49	0.82	0.70	0.01	0.75	1.12
2017	0.75	0.82	0.73	0.02	0.77	0.93

Table 5.3.7. ple.27.24-32. Overview of SPiCT result values on catch and survey data 2002–2017.

Deterministic reference points (Drp)					
		estimate	cilow	ciupp	log.est
	Bmsyd	1080.57	511.08	2284.65	6.99
	Fmsyd	1.70	0.85	3.38	0.53
	MSYd	1835.28	1657.50	2032.13	7.51
Stochastic reference points (Srp)					
		estimate	cilow	ciupp	log.est
	Bmsys	1081.62	520.82	2246.26	6.99
	Fmsys	1.70	0.87	3.29	0.53
	MSYs	1833.94	1650.71	2037.52	7.51
States	w	0.95	CI	(inp$msytype:	s)
		estimate	cilow	ciupp	log.est
	B_2017.75	2466.01	1231.23	4939.13	7.81
	F_2017.75	0.38	0.17	0.89	-0.95
	B_2017.75/Bmsy	2.28	1.89	2.75	0.82
	F_2017.75/Fmsy	0.23	0.14	0.36	-1.48
Predictions	w	0.950	CI	(inp$msytype:	s)
		prediction	cilow	ciupp	log.est
	B_2018.00	2515.85	1251.44	5057.79	7.83
	F_2018.00	0.38	0.15	0.99	-0.96
	B_2018.00/Bmsy	2.33	1.94	2.79	0.84
	F_2018.00/Fmsy	0.23	0.12	0.43	-1.49
	Catch_2018.00	981.18	473.87	2031.63	6.89
	E(B_inf)	2649.33	NA	NA	7.88

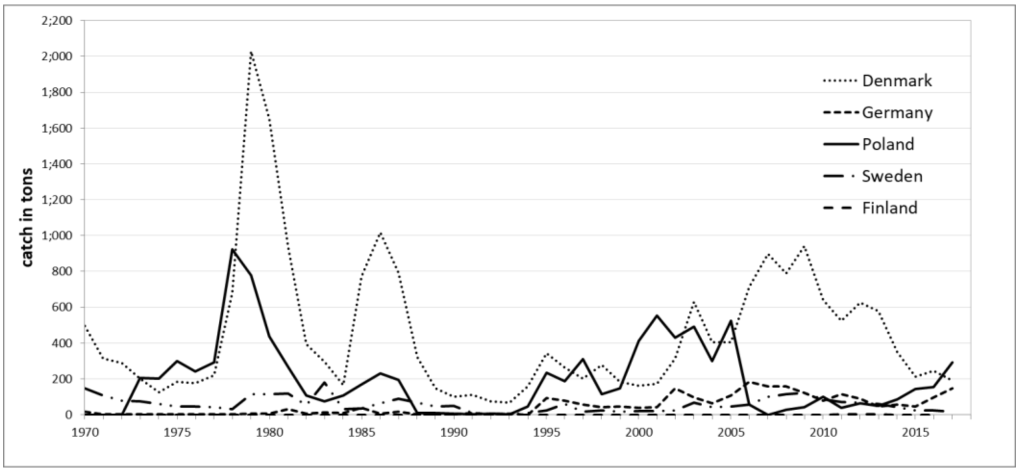


Figure 5.3.1. ple.27.24-32. Historical landings per country (in tonnes).

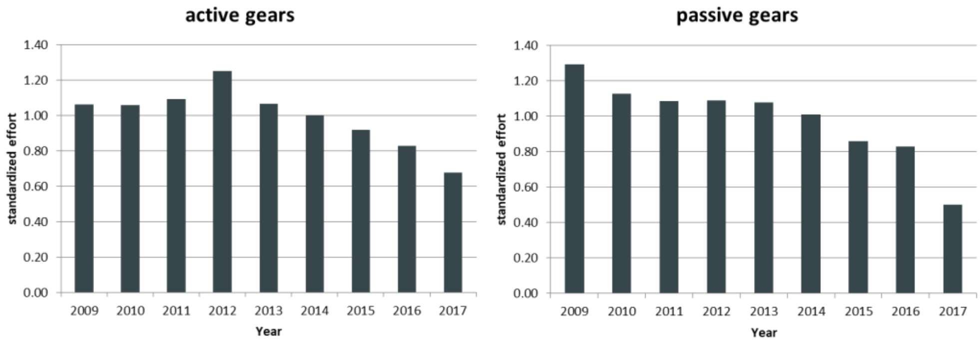


Figure 5.3.2. ple.27.24-32. Standardized effort for active and passive fleet in Subdivision 24 to 26 (no plaice landings in SD27+). Standard catches (effort per strata and country divided by average effort per country) were weighed by national cod-landings.

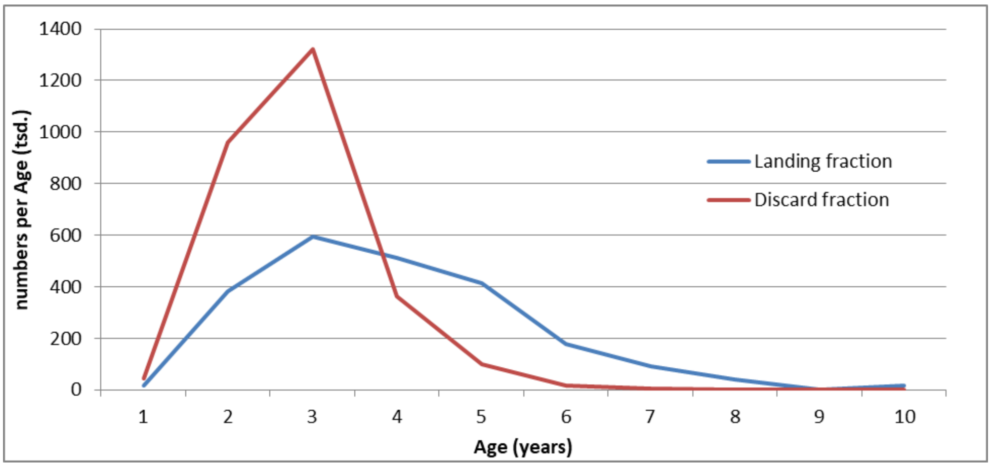


Figure 5.3.3. ple.27.24-32. Catch in numbers per age class and catch category in Subdivision 24 and 25. All countries and fleets were combined.

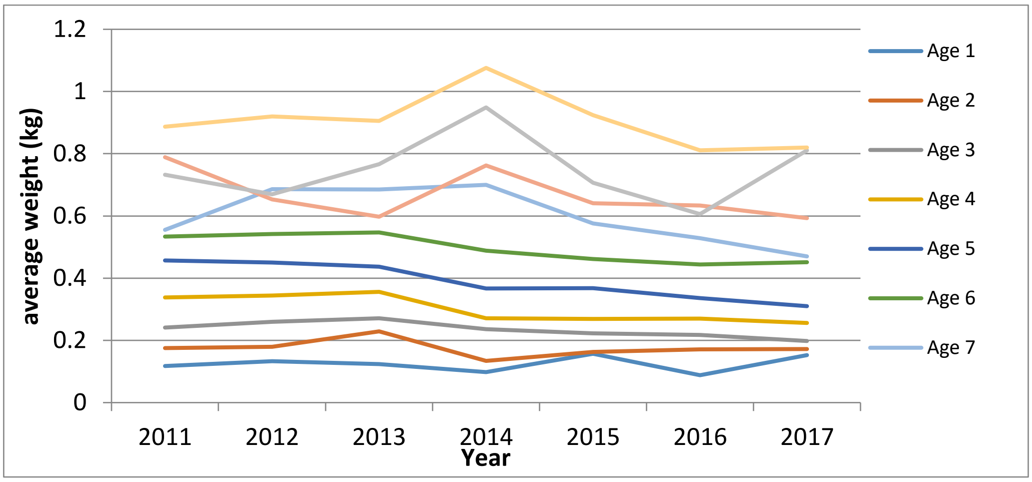


Figure 5.3.4. **ple.27.24-32. Average weight-at-age for the age classes 1 to 10 in subdivisions 24 and 25. All countries and fleets were combined.**

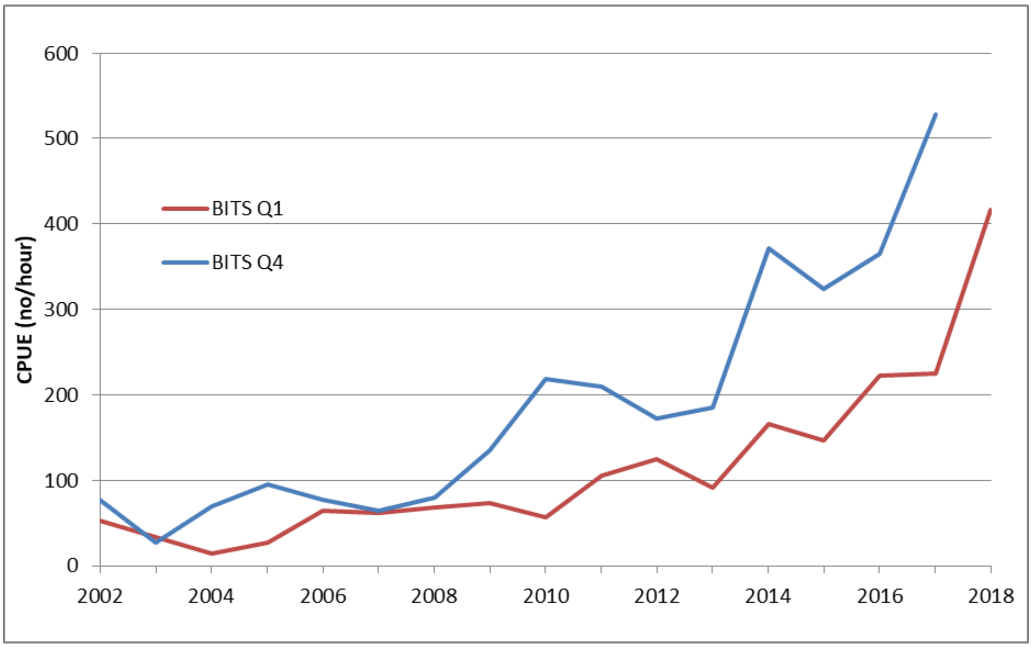


Figure 5.3.5. **ple.27.24-32. Average CPUE index from Q1 and Q4 BITS from SD24-SD26 (no plaice catches in SD27+). 2017 data (Q1) are preliminary.**

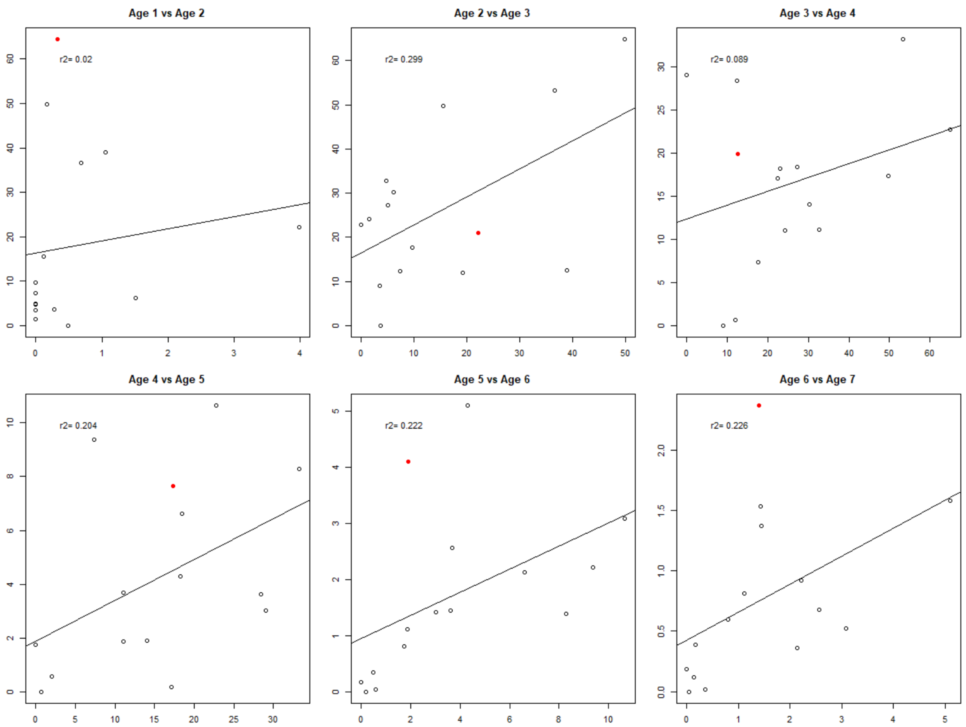


Figure 5.3.6.a. ple.27.24-32. Internal consistency of age classes 1–7 from Q1 BITS.

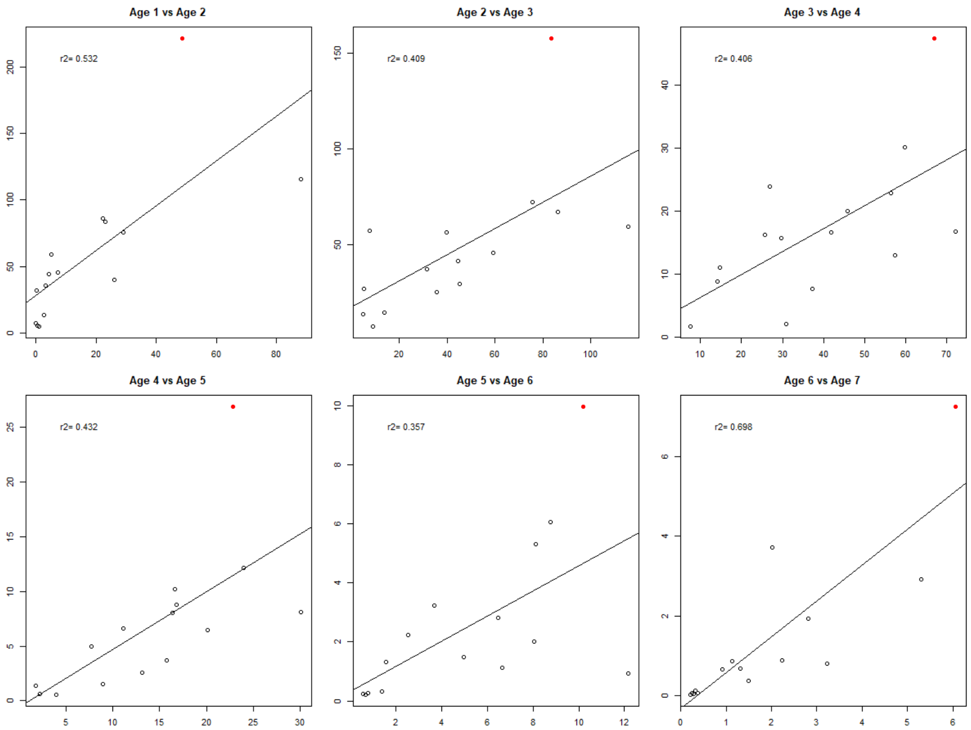


Figure 5.3.6.b. ple.27.24-32. Internal consistency of age classes 1–7 from Q4 BITS.

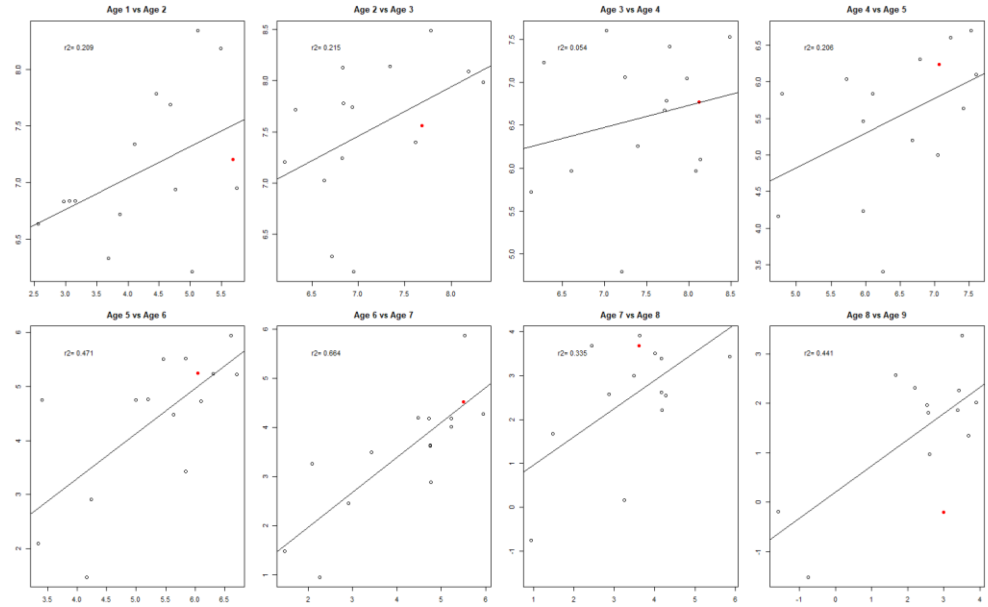


Figure 5.3.7. **ple.27.24-32. Internal consistency of age classes 1–7 from commercial catches. All fleets and countries were combined.**

Figure 5.3.8. ple.27.24-32. Results from the exploratory SAM assessment: a) total SSB, b) F (age2–5,) and c) recruitment.

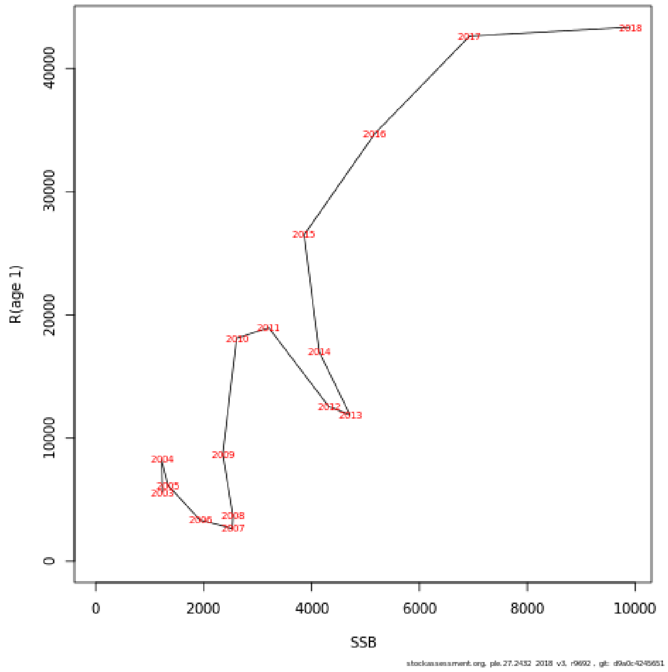


Figure 5.3.9. ple.27.24-32. Estimated recruitment as a function of spawning stock biomass.

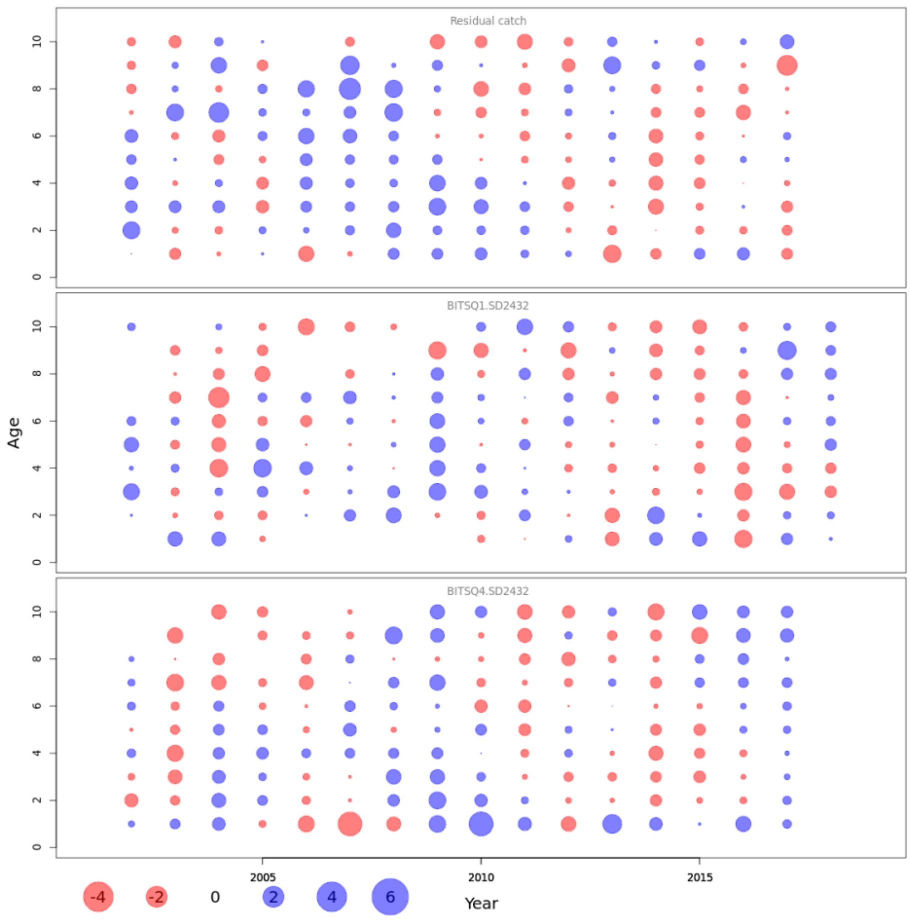


Figure 5.3.10. ple.27.24-32. Normalized residuals for the current run. Blue circles indicate positive residuals (observations larger than predicted) and filled circles indicate negative residuals.

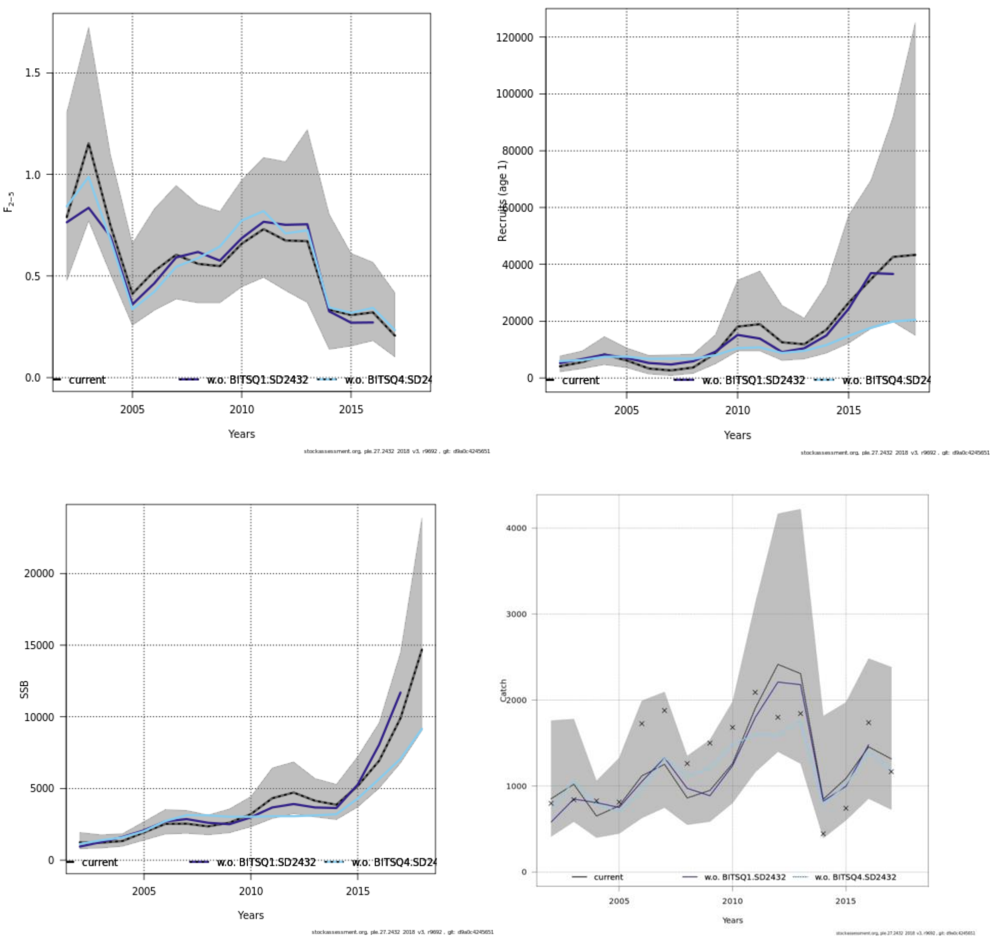


Figure 5.3.11. ple.27.24-32. The results of the retrospective analysis showing SSB, F (3–5) and recruitment.

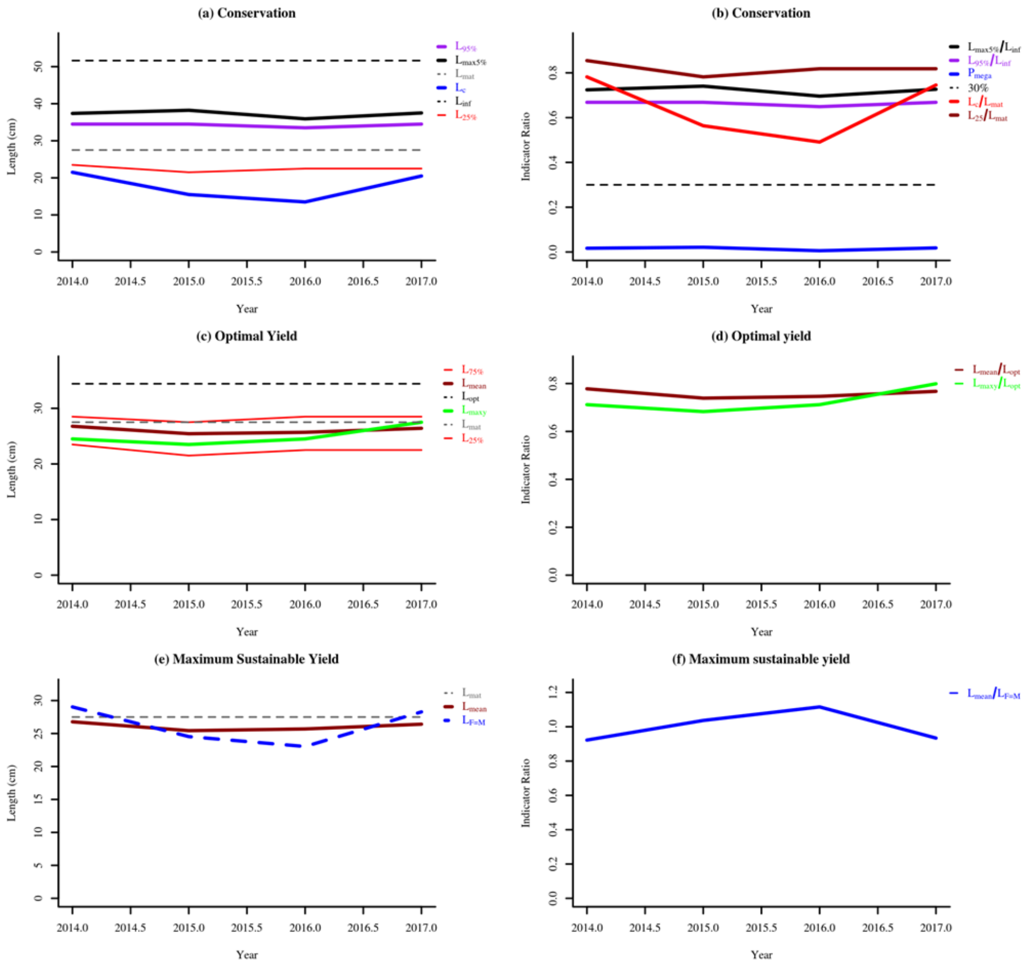


Figure 5.3.12 ple.27.24-32 Indicator trends of the Length-based Indicator calculations.

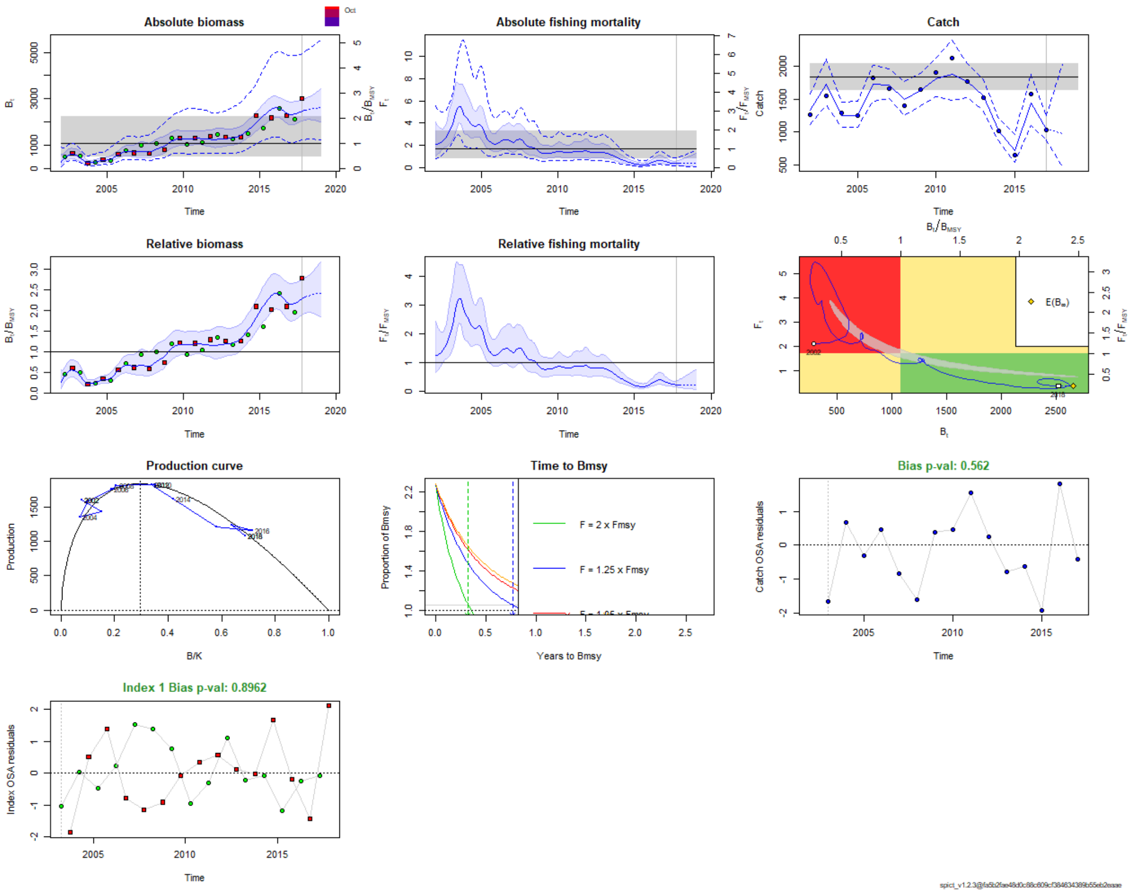


Figure 5.3.13. ple.27.2432. Overview of the results of the surplus production model (SPiCT) on catch and survey data 2002–2017.

6 Sole in Subdivisions 20–24 (Skagerrak, Kattegat, the Belts and Western Baltic)

6.1 The Fishery

Sole is economically an important species in in the Danish fisheries. For both Kattegat and Skagerrak the major part of the sole catches is taken in the mixed species trawl fishery using mesh sizes 90–105 mm and with gillnets using mesh sizes of 90–120 mm. The landings share of active and passive gears is approx. 60/40. Minimum legal landing size is 24.5 cm.

There is seasonality in sole fishery with both gill net and trawl. The low season for trawl is from May to September (Figure 6.2). The season for gill net fishery for sole is from April to September. During this season, about 80% of the gill net catches are sole. Additional information of the sole fishery can be found in the Stock Annex.

6.1.1 Landings

The officially reported landings by area, gear and country for 2017 are given in Table 6.1. Denmark took 84% of the total catch in 2017. Kattegat has traditionally been the most important area accounting for 63% of the annual catches in average, but in recent years this proportion has decreased to about 45%. The proportion of landings from the Skagerrak has been around 30-40% in recent years.

Historical catches, including the working group corrections, are given in Table 6.2 and Figure 6.1. The fishery fluctuated between 200 and 500 t annually prior to the mid-1980s and increased to a high in 1993 (1400 t). Since then, landings have decreased along with decreasing TACs. Figure 6.2 provide the Danish catches cumulated by month since 1998, indicating the main periods of fishery and the 1 quarter of 2018.

6.1.2 Discards

Danish discard sampling at sea is carried out within EU programmes that began in 1995 in both Kattegat and Skagerrak. Results indicate that the amount of sole discarded was very limited in years after 2005 when the fishery was not restricted by quotas (*i.e.*, discard levels are believed to be only a few percent when measured relative to the sole landings). Discards in 2017 amounts to 3% of the catches by weight based on sampling from trawlers(Table 6.3) and average of the recent 5 years are 4% discard by weight (used in advice).

Since the discards are overall estimated to be insignificant and rather constant over the entire time series and in addition incomplete in coverage, these data are not included in present assessment.

6.1.3 Effort and CPUE Data

Presently only private logbook data time series from selected Danish trawlers and gillnetters are kept from the past to calibrate to assessment: 1987–2008 and 1994–2007, respectively (Table 6.5).

6.2 Biological composition of the catch

6.2.1 Catch in numbers

Sampling of age structure of the catch was available only for the Danish fishery (Table 6.4). With the increased landings in 2017 and establishment of reference fleets also followed more sampled fish (415 specimens from the catches) than previously. The age structure of the Danish catch was assumed to apply to the total international catch (Table 6.6).

The age composition of the catch has mainly been composed of 3–5-year-olds since the beginning of the 1990s but in recent years older fish have a higher proportion of the catch (Table 6.6 and Figure 6.6).

6.2.2 Mean weight-at-age

Data for mean weight-at-age in the catches were derived using the same sample allocation as used in the computation of catch-at-age. The mean weight-at-age in the catch is shown in Table 6.7 and Figure 6.7. In general, weight-at-age data are highly variable between years, and this variability is not assumed to be connected to biological events but rather reflect the poor sampling, ageing problems and/or sex differentiated growth.

6.2.3 Maturity at-age

Due to insufficient biological information on maturity, the present assessment uses a fixed maturity ogive as in all assessments since 1996 (knife-edge maturity-at-age 3).

6.2.4 Natural mortality

The natural mortality is unknown and was assumed to be 0.1 per year for all ages.

6.2.5 Quality of catch and biological data

Denmark provided statistics on catch sampling for the Kattegat, Skagerrak and the Belts (Table 6.4). Sampling in 2017 remained inadequate but improved especially for Skagerrak where no sampling was achieved in previous years. However, gillnetters were not sampled in 2017 although they take approximately 40% of the catches. The small and scattered catches mainly taken as by-catch prevent proper port sampling with the present sampling intensity. The data scarcity impedes the quality of the assessment (see Section 6.2.1). Initiatives to improve sampling under the present catch level fishery are presently initiated as by means of cooperation with fishermen (reference fleet).

6.3 Fishery independent information

Since 2004 a survey conducted cooperatively by DTU Aqua and with Danish fishermen (WD04 WGBFAS 2018) was designed with fixed haul positions chosen by both scientific and fishermen. The survey takes place in November-December and covers the central part of the stock (Figure 6.4). The survey ceased in 2012–13 but resumed in 2014. Since 2016 the survey was redesigned to cover more areas in Skagerrak and also in the Belts (Figure 6.5); 20 stations in Skagerrak (Jammerbugt) and 6 stations in the Belts (northern part of Storebælt). The extended area has not been utilized in the survey index calculation, but awaits a longer time series and further evaluation. Catch rates from the additional areas in Skagerrak and the Belts was lower than for the remaining survey area in Kattegat. Based on 72 successful hauls out of 74 planned hauls in 2017, age disaggregated indices from the survey are used for the analytical assessment (Table 6.5). The index is estimated by a GAM model that takes into account spatial diversity of growth and also that the survey coverage have been reduced over time (see stock annex). The aggregated index show a decrease since 2015 (Figure 6.3 and Table 6.5).

6.4 Assessment

Since the benchmark in 2010 (WKFLAT) SAM has been used as the assessment model. Final assessment in 2018 is named 'sole2024_2018' at stockassessment.org.

6.4.1 Model residuals

Model residuals for the survey and catches are provided in Figure 6.8. Estimated standard deviations of log observations are provided by age group and fleet in Table 6.8.

6.4.2 Fleet sensitivity analysis

In order to examine the effect of the single fleet calibration indices on the F and SSB estimates, SAM runs were conducted with the single fleets left out of the analysis one at a time (Figure 6.9). The survey is virtually the only calibration to the catch matrix (the other two ceased 10 years ago) and therefore the effect of removing the survey is significant and also of limited value. However, with only the catch matrix along with the two commercial series from back in time suggests a higher fishing mortality and a lower SSB.

6.4.3 Final stock and fishery estimation

Stock summary (SSB, fishing mortality and recruitment) as estimated from the SAM model is provided in Figure 6.10. and in Table 6.11. The SSB in the past 5 years have varied between 1700 t and 2100 t and is estimated to 1871 t in 2017. The fluctuation is reflecting the variation in mean weights in the landings (Figure 6.7). Fishing mortality has since 2005 decreased continually but increased significantly in 2016 and 2017. Recruitment calculated as age 1 has since 2012 been slightly increasing but still below the average for the recent (Figure 6.10, Table 6.11).

6.4.4 Retrospective analysis

Retrospective pattern (Figure 6.11) of the SSB and F estimates show patterns of bias in especially the last years; fishing mortality is underestimated and SSB is overestimated, although the extent of the over- and underestimation is relatively small. Mohns rho calculated for SSB, F and recruitment are in the range 0.21 to -0.19 and thus within or near the suggested acceptable range (+-0.2).

6.4.5 Historical stock trends

Estimated fishing mortalities, stock numbers and recruitment are provided in Tables 6.9 and 6.10, and the stock summary is given in Table 6.11 and Figure 6.10. SSB was estimated at 1871 t in 2017 at B_{lim} and below MSY $B_{trigger}$. SSB has been estimated in the range 1800–2300 t in the past nine years with no clear trend.

Fishing mortality has decreased continuously since 2005 until 2015 but since 2016 it increased significantly from 0.22 to 0.37.

Recent recruitment (2015–2016 year-classes at age 1) was estimated to decrease after the 2014 year class (Tables 6.10–6.11).

6.5 Short-term forecast and management options

Input data to short term prediction are provided in Table 6.12.

Discards are not included in the assessment but comprise 3% in weight in 2017 (Table 6.3). The average of the discard in the recent 5 years (4%) is added to catches to derive landings. Catch options are provided in Table 6.13.

In previous two years catch assumptions for the assessment year have been TAC constrained, but prior to that F status quo assumptions were made. For a number of years in the recent decade the TAC has not been fully utilized even though TACs were constantly reduced. However in 2017 a TAC of to 555 t. was almost utilized One of the assumed main reasons for the previous low utilization of the sole TAC in recent years was that the *Nephrops* fishery in which sole is a valuable by-catch has used more effort to target *Nephrops* due to high market prices..

Due to the full utilization of the TAC in recent two years is therefore assumed that TAC of 448 t in 2018 will be caught. This corresponds to a fishing mortality of 0.33. Given this scenario, SSB in the beginning of 2019 is estimated to 1827 t which is below MSY $B_{trigger}$. With this assumption the forecast predicts that fishing at the rescaled F_{MSY} (F_{MSY}*SSB_{2019} relative to MSY $B_{trigger}$ (equal to 0.162).in 2019 will lead to yields of 246 t (Table 6.13). At this level of exploitation, spawning stock biomass is estimated at 2007 t in 2020 (for trends see Figure 6.12). Catch in 2019 and stock composition in 2019 and early 2020, is estimated to be dominated by age 3 to 5 as indicated in Figure 6.13 under the assumed conditions in 2018. However, yield in 2019 is predicted to move towards older fish, mainly ages 4 and 5 years old.

EC has in 2018 requested advice for the sole stock in SD 20–24 based on F_{MSY} ranges. Catches corresponding to F_{MSY} upper and lower range (F = 0.19–0.29) are 207–276 t.

A yield-per-recruit analysis was made with long term averages (15 years) with unscaled exploitation pattern. The yield-per-recruit curve (Figure 6.14) indicates that maximal yield per recruit is poorly estimated at $F_{4\text{–}8}$ around 0.79 and that $F_{0.1}$ is estimated to 0.19.

6.6 Reference points

Reference points were redefined under the interbenchmark, IBPSOLKAT (ICES, 2015) in November 2015 as follows:

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	2600 t	B_{pa}	ICES (2015)
	F_{MSY}	0.23	Equilibrium scenarios stochastic recruitment, short time-series 1992–2014, constrained by F_{pa}.	ICES (2015)
	F_{MSY} lower	0.19	F_{MSY} lower without AR from equilibrium scenarios	ICES (2015)
	F_{MSY} upper	0.26	F_{MSY} upper capped by Fp05 with AR from equilibrium scenarios	ICES (2015)
Precautionary approach	B_{lim}	1850 t	B_{loss} from 1992 (low productivity regime)	ICES (2015)
	B_{pa}	2600 t	B_{lim} × e 1.645σ, σ = 0.20	ICES (2015)
	F_{lim}	0.315	Equilibrium scenarios prob(SSB< B_{lim})< 50% with stochastic recruitment	ICES (2015)
	F_{pa}	0.23	F_{lim} × e -1.645σ, σ = 0.18	ICES (2015)
Management plan	SSB_{MGT}	Not defined.		
	F_{MGT}	Not defined.		

6.7 Quality of assessment

Sampling from this relatively small and spatially dispersed fishery has for a long time been a challenge and often results in few measured fish per sample. The 2017 sampling was improved from previous years by means of a so-called reference fleet, i.e. agreements with specific fisherman of self-sampling on board the vessel during the fishing trip. The initiative will be aimed continued to ensure that all areas, fleets and seasons are adequately sampled.

The assessment year has tendencies of bias in the SSB and F estimation in relation to previous years; SSB is overestimated and F is underestimated. However, this trend is not of a magnitude that is critical according to preliminary criteria for the Mohn's rho as it is within the range 0.19 to 0.21. However, the 2017 fishing mortality is estimated far higher in the present assessment than predicted according to the catches taken in 2017 (0.37 vs 0.23). This has caused the SSB in 2017 to be lower than predicted and therefore resulted in an advice for 2019 different than expected when forecasting in previous years.

6.8 Comparison with previous assessment

This year's assessment is carried out as in previous years in accordance with the procedure described in the stock annex. However, due to a retrospective pattern in estimation of SSB and F, stock and fishery perception has changed compared to last year: SSB in recent years is lower and F is higher. The stock status in relation to reference points have therefore changed so that fishing mortality is now above F_{MSY} and even F_{lim}.

6.9 Management considerations

Management of the sole fishery should take into account that particular the trawl fishery is a mixed fishery with cod and *Nephrops*. With the restricted catch opportunities of cod in SD 21, combined with the landing obligation cod is potentially being a choke species in the mixed fishery. If the mixed fishery for sole and cod could be un-coupled, management in the Kattegat would be more straightforward and sustaina-ble. Such un-coupling could be achieved by selective gears and area restrictions.

As maturity-at-age is not determined for the species but set to age 3+, SSB for the stock is uncertain. Present assumption is that maturity is constant over time. Any future adoption of an observed maturity ogive (derived from any survey) might therefore change the perception of the stock history and stock-recruitment relations. This again will have an impact on the estimates of biomass reference points. Similar-ly establishment of a weight-at-age in the stock from the survey will have implica-tions on perception of present stock biomass. Work is ongoing to improve the some of the biological parameters for sole in the assessment.

6.10 Issues relevant for a forthcoming benchmark

Issues relating to the benchmark are presently in progress under the umbrella of a project at DTU Aqua running till the end of 2018. The most WPs within the project are expected to be finalized over summer – early autumn 2018. An expected time schedule for the individual WPs and their potential impact/use in a benchmark early 2019 is as follows:

- *Abundance and distribution of juveniles; identification of nursery grounds and evaluation of their importance for recruitment to the stock.*
    - Will enlighten whether the present recruitment index age 1 from the sole survey is appropriate as a measure of recruitment to the stock; if not the outcome could be to either change R to age 2 (if more coher-ent with older age groups) or suggest new surveys conducted in iden-tified nursery grounds. The last suggestion will not give rise to a benchmark in 2019 but only after a number of years when a new index series has been established.
- *Growth and recruitment; improvement of ageing by means of otolith calibration between readers and otolith structure to validate age.*
    - The present high variability in growth between ages is sought to be improved by calibration procedures between age readers. Also sex specific growth (age-length) will be exploited as an option for input to the assessment. Analyses are being conducted and expected to be evaluated in August 2018.
- *Stock structure - genetics; genotyping spawning fish in order to identi-fy stock structure in the entire stock assessment area SD 20–24 and also to evalu-ate main migration patterns.*
    - Will be finalised summer 2019. In case that results show a stock ID in conflict with the present perception, data input to the assessment needs revision and coordination with neighbouring sole stocks. The benchmark will require additional participation of other sole asses-sors. Hardly possible in 2019.
- *Survey coverage – design; analysis of appropriate survey coverage with respect to the stock distribution. In 2016 survey area was already extended into Skagerrak and the Belts and this scheme will be evaluated.*
    - Survey design has been changed continuously the last 4 years due to financial problems and in order to cover the fishery more ap-propriately. A comprehensive analysis of the fishery distribution

along with the surveys selective powers will be basis for the future design of the survey. Will be finalized prior to the next survey in November 2018. A redesign might impact the calculation of the historic indices. Results will be relevant for a benchmark in 2019.

- *Improvement of biological data sampling - reference fleet; sampling from the fishery is difficult due to small and scattered landings; since 2016 agreements with specific fishermen were initiated to improve biological sampling.*

  - A reference fleet have been established although only few vessels have continued their sampling. Overall the sampling has improved and the result from this expansion in sampling is being used in the present assessment. Therefore this issue is not relevant for an upcoming benchmark.

- *Selectivity in various gears – SELTRA; introduction of new selective devices in fishing gears have caused selectivity to change substantially. In order to quantify this change experimental sole fishery will be conducted with the most used devices.*

  - Gear trials have been conducted and analyses of SELTRA and related gear's selectivity is expected to be finalized summer 2019. The outcome in terms of selectivity parameters will be sought incorporated into the SAM assessment model. Relevant for a benchmark in 2019.

- *Improvement of assessment; the effect of revising a number of input data and assumptions in the assessment due to the above mentioned work packages will be evaluated with respect to estimation of the stock and fishing pressure.*

  - See above. As commented, some of the issued are obviously not relevant for a benchmark and other will most likely not be ready to implement in a revised assessment in a benchmark in 2019. Therefore the decision of a benchmark is pending of the progress of the work over the next 5 month and a final decision of conducting the benchmark in early 2019 will be taken in September 2018.

In addition, this year's assessment has shown a high instability of the assessment as seen from the retrospective analyses. This pattern has created high variability in final estimation of F and SSB with the consequence of changing of advice between years up to 90%. The retrospective pattern is presently indicating underestimation of F and overestimation of SSB. The causes for this pattern need to be enlightened prior to a benchmark.

Table 6.1 **Sole 20–24. Landings (t) of sole in 2017 by area, country, quarter and gear.**

Skagerrak (SD20)	Quarter				Gear		Total
Nation	1	2	3	4	Trawl	Gillnet	
Denmark	23	82	9	56	81	87	169
Germany	0	5	0	0	0	5	5
Sweden	1	0	0	0	1	0	1
Norway	1	1	0	1	1	1	2
Netherlands	0	1	15	25	40	1	41
Total	24	88	24	82	124	94	218
Kattegat (SD21)	**Quarter**				**Gear**		**Total**
Nation	1	2	3	4	Trawl	Gillnet	
DK	32	32	33	124	157	64	221
Germany	0	2	2	11	0	15	16
Sweden	2	3	6	7	9	8	18
Total	34	37	41	142	166	88	254
Belts and Baltic (SD22-24)	**Quarter**				**Gear**		**Total**
Nation	1	2	3	4	Trawl	Gillnet	
DK	6	8	8	25	20	26	47
Germany	0	0	0	0	1	0	2
Sweden	0	0	0	0	0	0	0
Total	6	8	8	26	21	27	49

Table 6.2 Sole 20–24. Catches (tons) in the Skagerrak, Kattegat and the Belts 1952–2017 Official statistics and Expert Group corrections. For Sweden there is no information 1962–1974.

Year	Denmark			Sweden	Germany	Belgium	Netherlands	Working Group	Total
	Kattegat	Skagerrak	Belts	Skag+Kat	Kat+Belts	Skagerrak	Skagerrak	Corrections	
1952	156			51	59				266
1953	159			48	42				249
1954	177			43	34				254
1955	152			36	35				223
1956	168			30	57				255
1957	265			29	53				347
1958	226			35	56				317
1959	222			30	44				296
1960	294			24	83				401
1961	339			30	61				430
1962	356				58				414
1963	338				27				365
1964	376				45				421
1965	324				50				374
1966	312				20				332
1967	429				26				455
1968	290				16				306
1969	261				7				268
1970	158	25							183
1971	242	32			9				283
1972	327	31			12				370
1973	260	52			13				325
1974	388	39			9				436
1975	381	55		16	16		9	-9	468
1976	367	34		11	21	2	155	-155	435
1977	400	91		13	8	1	276	-276	513
1978	336	141		9	9		141	-141	495
1979	301	57		8	6	1	84	-84	373
1980	228	73		9	12	2	5	-5	324
1981	199	59		7	16	1			282
1982	147	52		4	8	1	1	-1	212
1983	180	70		11	15		31	-31	276
1984	235	76		13	13		54	-54	337
1985	275	102		19	1	+	132	-132	397
1986	456	158		26	1	2	109	-109	643
1987	564	137		19		2	70	-70	722
1988	540	138		24		4			706
1989	578	217		21	7	1			824
1990	464	128		29		2		427	1050
1991 [1]	746	216		38	+			11	1011
1992	856	372		54				12	1294
1993	1016	355		68	9			-9	1439
1994	890	296		12	4			-4	1198
1995	850	382		65	6			-6	1297
1996	784	203		57	612			-597	1059
1997	560	200		52	2				814
1998	367	145		90	3				605
1999	431	158		45	3				637
2000	399	320	13	34	11			-132 [2]	645
2001 [1]	249	286	21	25				-103 [2]	478
2002 [3]	360	177	18	15	11			281	862
2003 [3]	195	77	17	11	17			301	618
2004 [3]	249	109	40	16	18			392	824
2005 [3]	531	132	118	30	34	Norway		145	990
2006	521	114	107	38	43	9	4		836
2007	366	81	93	45	39	9	0		633
2008	361	102	113	34	35	7	3		655
2009	325	103	145	37	27	4			641
2010	273	61	125	46	26	3	3		538
2011	271	127	65	53	33	3			552
2012	154	140	28	30	0	6	0		358
2013	153	78	33	54	9	6	0		332
2014	141	104	48	36	2	3	0		335
2015	95	66	36	9	7	5	6		224
2016	164	78	56	14	17	2	16		348
2017	220.6	169	47	20	22	2	41		520

Considerable non-reporting assumed for the period 1991–1993. [2]Catches from Skagerrak were reduced by these amounts because of misreporting from the North Sea. The subtracted amount has been added to the North Sea sole catches. Total landings for these years in IIIA has been reduced by the amount of misreporting. [3]Assuming misreporting rates at 50, 100, 100 and 20% in 2002–2005, respectively.

Table 6.3 Sole 20–24. Discard from active gears as obtained from observers.

Discard in weight (kg)																
Age	Year															
	1999	2000	2001	2002	2003	2004	2005	2006-2009	2010	2011	2012	2013	2014	2015	2016	2017
1	-	7,992	-	-	-	-	-	-	616	140	128	490	3,128	1,156	5,913	254
2	-	36,918	-	4,312	24,384	-	-	-	3,136	1,767	1,326	2,392	2,492	828	2,761	2,095
3	-	119,198	-	-	7,040	-	-	-	2,646	1,105	1,782	1,872	19,126	-	1,800	9,733
4	-	4,592	-	4,171	10,366	-	-	-	2,175	972	4,032	954	1,316	1,076	3,408	1,117
5	-	-	-	1,962	-	-	-	-	2,499	888	680	510	1,785	981	14	1,404
6	-	-	-	-	588	-	-	-	166	480	928	1,232	972	264	315	692
7	-	-	-	-	158	-	-	-	1,080	714	570	1,030	1,800	-	702	315
8	-	-	-	-	123	-	-	-	291	545	248	416	1,220	296	-	603
9	-	-	-	-	-	-	-	-	1,197	306	572	708	232	-	172	345
10	-	-	-	-	158	-	-	-	117	605	393	224	-	832	1,456	379
11	-	-	-	-	-	-	-	-	-	-	345			118	-	169
Total (t)	-	169	-	10	43	-	-	-	14	8	11	10	32	6	17	17
Landings(t)	637	645	478	862	618	826	994	706	538	552	359	332	335	224	348	520
Catches	637	814	478	872	661	826	994	706	552	560	370	342	367	230	365	537
Discard %	0%	21%	0%	1%	6%	0%	0%	0%	3%	1%	3%	3%	9%	2%	5%	3%

Table 6.4 Sole 20–24. Sampling and ageing in 2017 from landings.

	Belts			Skagerrak			Kattegat			Total		
Quarter	Landings	Sampled catch (kg)	Aged	Landings	Sampled catch	Aged	Landings	Sampled catch	Aged	Landings	Sampled catch	Aged
1	6,336	4,129	-	23,922	22,651	9	33,672	22,981	7	63,930	49,761	16
2	8,053	-	-	88,259	81,619	26	36,966	-	-	133,278	81,619	26
3	7,876	260	5	24,077	8,604	8	41,323	9,643	21	73,276	18,507	34
4	25,635	-	-	81,890	55,681	66	141,798	111,683	171	249,323	167,364	237
Total	**47,899**	4,389	5	218,148	**168,555**	109	253,760	144,307	199	519,807	317,251	313

Table 6.5 Sole 20–24. Tuning fleets.

Fisherman-DTU Aqua survey meth 6

2004	2017								
1	1	0.8	1						
1	9								
1	16.96855	55.96557	49.91849	31.40997	21.65405	8.95753	7.338731	4.406735	5.974572
1	12.9165	38.55566	67.76623	36.26695	17.92207	8.103796	2.825377	1.760731	1.408326
1	34.49494	38.78022	28.75144	51.28045	25.70083	13.98718	4.847019	1.59038	5.073859
1	31.81877	33.34679	24.29132	29.50392	30.75881	20.63943	11.84293	7.085257	12.45945
1	10.10062	46.08714	28.33982	15.61443	13.14973	17.57112	7.660865	6.547051	7.49172
1	15.07643	17.49389	28.97174	11.86504	14.73342	14.04448	17.36743	6.486122	7.384532
1	13.77282	16.57213	19.58162	17.88166	7.257644	10.28202	8.609531	12.69107	14.65529
1	14.95544	29.93514	17.91332	17.04403	15.80562	10.05875	9.017387	4.136279	19.49654
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	22.08253	17.32933	19.17415	14.45406	12.31646	9.540256	4.023012	8.644736	12.26664
1	33.77455	28.74293	16.83042	15.29688	9.647302	17.50239	6.471581	4.740233	30.78858

Private logbooks Gillnet KC + KS combined

1994	2007							
1	1	0.25	0.87					
2	9							
7246	1071	8794	7892	2547	1254	268	187	60
5900	682	3284	6795	4942	1673	936	203	153
24238	4914	19748	8589	10880	6350	2872	1578	948
19939	1303	5568	8787	7036	9251	6658	4775	3280
18984	2685	3309	3816	4869	2632	3033	3443	2270
19917	10704	33215	3187	3507	2700	2176	1978	1633
23645	2336	12192	11953	1815	2285	2461	2222	2315
17755	5721	11108	9181	3953	1463	2717	812	1260
19930	17094	20860	6010	6043	6757	2384	2155	2801
13812	2029	17166	16000	4387	7051	2468	395	691
5518	547	3854	4483	2289	1391	864	523	226
9067	2827	11590	13754	5559	1832	485	455	170
9742	1495	5999	10446	8760	5434	1443	991	287
7026	1374	2638	2360	3039	1856	920	394	319

Private logbook TR KC+KS combined

1987	2008				
1	1	0.75	1		
2	6				
712	2756	5140	5562	2667	954
876	5667	7735	5361	3432	1025
933	5097	2253	3761	2825	2126
1174	16408	10277	2753	3874	1545
1809	16085	35139	14745	4452	3878
3136	56849	46507	16304	7177	1545
4035	41739	44475	19945	11105	6685
5276	9498	55455	64125	19324	12725
4969	42026	35885	41231	29359	14705
4294	24861	38831	23489	26033	16360
4027	3927	13138	14220	10668	13279
2464	12543	3357	1117	1041	1736
2142	13031	24798	3690	4268	3927
3342	9566	16153	20370	3215	2692
2268	6292	11562	6052	6953	635
1498	29987	20538	4835	5483	3963
2093	7473	21584	14949	7199	3760
3999	20124	39887	47640	18374	8401
2463	7956	34026	29590	16011	6975
3132	11878	14708	24084	19146	12809
2730	14422	11847	4636	8756	515
1281	4393	2674	2438	2735	2130

Table 6.6 Sole 20–24. Catch in numbers (thousands) by year and age.

Catch numbers at age Numbers*10**-3

YEAR	1984	1985	1986	1987
AGE				
2	64	786	258	391
3	638	594	1255	857
4	240	190	671	1018
5	117	55	210	434
6	31	60	33	174
7	33	16	36	64
8	40	8	33	31
+gp	175	69	63	87
0 TOTALNUM	1338	1778	2559	3056
TONSLAND	337	397	643	722
SOPCOF %	99	100	100	100

Catch numbers at age Numbers*10**-3

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
2	516	863	1209	530	506	523	127	272	316	54
3	1035	613	1300	1301	1178	1804	1037	622	1015	251
4	897	847	651	928	939	1251	1451	1359	537	440
5	484	592	564	334	493	826	752	1226	691	365
6	129	404	310	345	320	418	444	600	440	505
7	37	83	167	302	178	117	152	385	232	360
8	23	30	27	180	166	137	45	142	148	262
+gp	60	52	31	76	239	157	59	104	203	263
0 TOTALNUM	3181	3484	4259	3996	4019	5233	4067	4710	3582	2500
TONSLAND	706	824	1050	1011	1294	1439	1198	1297	1059	814
SOPCOF %	100	100	100	95	93	100	99	98	98	100

Catch numbers at age Numbers*10**-3

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
2	303	249	142	170	655	48	195	231	122	293
3	146	826	483	369	758	431	602	1015	400	420
4	212	150	771	360	285	480	814	1083	857	384
5	299	228	114	354	423	280	475	583	734	583
6	267	177	130	68	472	344	257	276	505	299
7	250	165	123	84	94	197	187	117	169	135
8	218	167	135	36	85	25	86	102	67	81
+gp	292	233	306	205	464	210	171	91	116	108
0 TOTALNUM	1987	2195	2204	1646	3236	2015	2787	3498	2970	2303
TONSLAND	605	638	646	476	862	619	824	990	836	633
SOPCOF %	100	100	100	99	100	100	99	98	98	97

Catch numbers at age Numbers*10**-3

YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AGE										
2	313	554	230	138	26	48	13	37	110	137
3	330	683	591	558	157	226	66	81	273	181
4	354	445	458	613	284	286	178	95	190	347
5	297	285	211	246	160	194	109	109	175	195

```
        6,        489,     139,     132,      65,     111,     137,     199,      89,
82,     186,
        7,        240,      92,      67,      28,      36,      62,     105,      81,
38,     163,
        8,        179,      29,      83,      14,      54,      23,      68,      18,
50,     120,
      +gp,        202,      88,     103,     106,     192,      96,      69,      93,
181,     301,
0    TOTALNUM,    2404,    2315,    1875,    1768,    1020,    1072,     807,     603,
1099,    1630,
    TONSLAND,     656,     640,     541,     507,     358,     332,     331,     215,
348,     520,
    SOPCOF %,     102,      98,     101,     100,     100,     109,     100,     100,
101,     100,
```

Table 6.7 Sole 20–24. Weight-at-age (kg) in the catch and in the stock.

Catch weights at age (kg)

YEAR	1984	1985	1986	1987
AGE				
2	.1830	.1740	.1650	.1600
3	.2130	.2340	.2310	.1940
4	.2570	.2830	.2870	.2450
5	.2940	.2910	.2970	.2740
6	.2970	.3350	.4090	.3190
7	.2800	.2920	.2670	.3600
8	.3210	.2790	.2620	.4170
+gp	.3680	.3640	.3830	.3610
0 SOPCOFAC	.9930	.9984	.9995	1.0027

Catch weights at age (kg)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
2	.1590	.1760	.1800	.1740	.2130	.1780	.1740	.1870	.1760	.1980
3	.1970	.2210	.2280	.2290	.2520	.2240	.2290	.2000	.2180	.2720
4	.2350	.2550	.2510	.2750	.3360	.2740	.2800	.2480	.2670	.2960
5	.2510	.2660	.3080	.2920	.4120	.3280	.3420	.2910	.3070	.3080
6	.3350	.2710	.3330	.3460	.4300	.3740	.3880	.3510	.3390	.3450
7	.3480	.3520	.4000	.3090	.4910	.4030	.4450	.3820	.4040	.3590
8	.3630	.3000	.5470	.3860	.5660	.3880	.4480	.4320	.4570	.3640
+gp	.3520	.3550	.5550	.5030	.6220	.4740	.3940	.3830	.6640	.3610
0 SOPCOFAC	1.0032	.9964	.9970	.9508	.9304	.9980	.9931	.9767	.9826	.9983

Catch weights at age (kg)

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
2	.1610	.1620	.1690	.1840	.1720	.1740	.2030	.1920	.2010	.2110
3	.2190	.2320	.2360	.2420	.2050	.2100	.2370	.2230	.2150	.2280
4	.3160	.3040	.3040	.2900	.2940	.2460	.2910	.3000	.2630	.2950
5	.3220	.3680	.3440	.3780	.3730	.3600	.3280	.3240	.3170	.3020
6	.3500	.3600	.3190	.3460	.3860	.3820	.3710	.3670	.3390	.3540
7	.3580	.3780	.3640	.3080	.2140	.4310	.4010	.3710	.3210	.3390
8	.3770	.3970	.3520	.3620	.2920	.2610	.3700	.4210	.2930	.3800
+gp	.3270	.3500	.3280	.2810	.2760	.3820	.3150	.3720	.3440	.2440
0 SOPCOFAC	1.0006	1.0041	1.0004	.9941	.9967	.9971	.9916	.9841	.9794	.9654

Catch weights at age (kg)

YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
AGE										
2	.2150	.2110	.2580	.2610	.2850	.2390	.2270	.2210	.2340	.2160
3	.2460	.2590	.2700	.2710	.2790	.2250	.2830	.2390	.2670	.2650
4	.2670	.3010	.2830	.2920	.3170	.2760	.3720	.2860	.2680	.2920
5	.2800	.3190	.3240	.2770	.3750	.3040	.4210	.3910	.2830	.2990
6	.2900	.4030	.3110	.3580	.4060	.3730	.4430	.4040	.3410	.3260
7	.2960	.4390	.3690	.4760	.4060	.3050	.4860	.3880	.3300	.3770
8	.3010	.4390	.3100	.2850	.3500	.3060	.4540	.5010	.5440	.3340
+gp	.2460	.2630	.2630	.3010	.4060	.2870	.4060	.4340	.4390	.3950
0 SOPCOFAC	1.0209	.9832	1.0103	1.0003	1.0006	1.0891	.9976	1.0043	1.0051	1.0034

Table 6.8 **Sole 20–24. SAM diagnostics. Standard deviation estimates of log observations. (fleet2: Survey, fleet3: PL gillnetters, fleet4: PL trawlers)**

Observation	Fleet	Age	sd(logObs)	low	high
1	1	2	0.63	0.46	0.87
2	1	3	0.29	0.23	0.36
3	1	4	0.29	0.23	0.36
4	1	5	0.29	0.23	0.36
5	1	6	0.29	0.23	0.36
6	1	7	0.29	0.23	0.36
7	1	8	0.29	0.23	0.36
8	1	9	0.29	0.23	0.36
9	2	1	0.41	0.24	0.70
10	2	2	0.34	0.27	0.42
11	2	3	0.34	0.27	0.42
12	2	4	0.34	0.27	0.42
13	2	5	0.34	0.27	0.42
14	2	6	0.34	0.27	0.42
15	2	7	0.34	0.27	0.42
16	2	8	0.34	0.27	0.42
17	2	9	0.34	0.27	0.42
18	3	2	0.58	0.38	0.87
19	3	3	0.35	0.27	0.44
20	3	4	0.35	0.27	0.44
21	3	5	0.35	0.27	0.44
22	3	6	0.35	0.27	0.44
23	3	7	0.35	0.27	0.44
24	3	8	0.35	0.27	0.44
25	4	2	0.48	0.34	0.68
26	4	3	0.50	0.42	0.59
27	4	4	0.50	0.42	0.59
28	4	5	0.50	0.42	0.59
29	4	6	0.50	0.42	0.59

Table 6.9 **Sole 20–24. Fishing mortality at-age from assessment (ages 6–9 assumed constant).**

Year\Age	2	3	4	5	6+
1984	0.084	0.401	0.49	0.405	0.383
1985	0.072	0.295	0.358	0.322	0.278
1986	0.084	0.313	0.41	0.389	0.342
1987	0.102	0.338	0.454	0.464	0.461
1988	0.099	0.31	0.413	0.408	0.4
1989	0.105	0.32	0.431	0.434	0.42
1990	0.098	0.301	0.412	0.415	0.372
1991	0.099	0.305	0.425	0.443	0.49
1992	0.098	0.305	0.426	0.468	0.6
1993	0.098	0.311	0.435	0.491	0.614
1994	0.081	0.26	0.362	0.415	0.453
1995	0.089	0.293	0.393	0.454	0.503
1996	0.085	0.289	0.36	0.409	0.437
1997	0.078	0.258	0.339	0.389	0.432
1998	0.074	0.239	0.318	0.382	0.412
1999	0.069	0.226	0.299	0.351	0.372
2000	0.065	0.218	0.297	0.336	0.367
2001	0.054	0.18	0.236	0.282	0.298
2002	0.062	0.199	0.264	0.329	0.427
2003	0.053	0.163	0.238	0.294	0.383
2004	0.064	0.194	0.291	0.349	0.445
2005	0.074	0.225	0.328	0.378	0.448
2006	0.076	0.232	0.325	0.383	0.381
2007	0.079	0.24	0.326	0.358	0.314
2008	0.092	0.282	0.387	0.392	0.342
2009	0.08	0.267	0.373	0.338	0.196
2010	0.073	0.27	0.377	0.331	0.176
2011	0.055	0.216	0.327	0.263	0.129
2012	0.044	0.164	0.273	0.228	0.149
2013	0.039	0.144	0.253	0.218	0.155
2014	0.032	0.107	0.208	0.193	0.161
2015	0.029	0.094	0.171	0.187	0.139
2016	0.04	0.125	0.232	0.257	0.206
2017	0.056	0.159	0.32	0.374	0.389

Table 6.10 Sole 20–24. Stock number at-age from assessment.

Year\Age	1	2	3	4	5	6	7	8	9+
1984	6141	2564	1640	516	370	131	82	126	487
1985	5238	5853	2341	916	262	223	89	45	348
1986	4882	4604	4895	1703	606	171	145	74	263
1987	4643	4388	3819	3216	1020	371	127	92	225
1988	5931	3816	3803	2684	1828	490	172	72	181
1989	7318	5428	2663	2574	1679	1150	260	99	150
1990	7365	7077	4475	1750	1583	1010	689	137	138
1991	7813	6550	5579	2882	1035	940	672	468	184
1992	6101	7813	5329	3440	1562	585	500	368	399
1993	3734	5978	6743	3572	2077	872	280	258	360
1994	3429	2959	5143	4774	2146	1185	396	135	275
1995	2404	3388	2599	3942	3119	1421	758	260	271
1996	1810	2125	2983	1840	2385	1682	828	417	378
1997	3342	1222	1419	1721	1232	1503	1101	631	553
1998	3577	3613	872	908	964	758	832	678	755
1999	3293	3400	3724	632	715	604	517	509	876
2000	4359	2646	2622	2538	424	493	367	368	955
2001	5486	4010	2196	1915	1561	293	376	203	909
2002	4392	5754	3828	1532	1492	1162	231	279	870
2003	4274	3729	4315	2754	1140	1058	629	118	651
2004	3142	4238	3714	3256	1741	755	579	335	439
2005	2726	2845	4525	3434	2184	963	364	283	330
2006	3085	2452	2261	3420	2194	1420	544	227	399
2007	3223	2625	1948	1571	2128	1057	756	341	470
2008	2414	3052	1858	1376	1049	1355	643	518	567
2009	2210	2271	2542	1223	954	665	836	344	627
2010	1985	2031	2065	1690	727	635	424	636	750
2011	1718	1829	1894	1524	1091	469	429	249	1051
2012	1493	1493	1450	1395	941	768	313	347	1031
2013	1540	1278	1333	1152	1014	675	585	217	896
2014	2211	1251	1049	964	788	772	447	489	774
2015	2513	2022	1065	886	637	604	520	279	1065
2016	2244	2175	1828	867	764	416	379	347	1117
2017	1695	2193	1736	1406	596	579	303	267	1088
2018*		1534	1877	1340	924	371	355	186	832

*Estimated by simple forward projection of 2017 stock

Table 6.11 Sole 20–24. Stock summary from SAM. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 4 to 8 (F_{48}). "Low" and "high" are lower and upper boundary of 95% confidence.

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F_{48}	Low	High
1984	6141	3731	10109	1710	1382	2116	872	696	1093	0.409	0.304	0.550
1985	5238	3429	8002	2456	1943	3105	1123	889	1420	0.303	0.227	0.405
1986	4882	3253	7327	3081	2515	3774	2028	1609	2557	0.365	0.283	0.470
1987	4643	2998	7191	3073	2584	3654	2092	1729	2531	0.460	0.358	0.591
1988	5931	3964	8876	3116	2643	3673	2153	1802	2572	0.404	0.313	0.520
1989	7318	4848	11047	3572	3024	4219	2177	1841	2576	0.425	0.332	0.543
1990	7365	4903	11063	4426	3728	5254	2710	2288	3210	0.389	0.307	0.493
1991	7813	4981	12255	4787	4046	5663	3178	2670	3783	0.468	0.374	0.585
1992	6102	3999	9310	6126	5151	7285	4096	3458	4851	0.539	0.429	0.676
1993	3734	2492	5594	5168	4381	6096	3880	3253	4627	0.553	0.435	0.703
1994	3429	2313	5084	4774	4095	5566	4053	3442	4773	0.427	0.336	0.543
1995	2404	1554	3717	4187	3629	4831	3409	2936	3959	0.471	0.372	0.595
1996	1810	1044	3138	3702	3216	4262	3220	2785	3722	0.416	0.333	0.519
1997	3342	2207	5062	3060	2664	3515	2618	2260	3034	0.405	0.324	0.506
1998	3577	2404	5322	2650	2278	3082	1854	1585	2167	0.387	0.307	0.489
1999	3293	2173	4990	2989	2531	3530	2241	1883	2665	0.353	0.281	0.444
2000	4359	2932	6481	2978	2550	3478	2269	1923	2679	0.347	0.275	0.437
2001	5486	3564	8445	3290	2806	3858	2223	1894	2609	0.282	0.221	0.360
2002	4392	2947	6545	3864	3241	4607	2611	2195	3105	0.375	0.293	0.480
2003	4274	2842	6428	3854	3307	4492	2949	2477	3510	0.336	0.255	0.444
2004	3142	2179	4532	4222	3638	4899	3173	2715	3708	0.395	0.306	0.510
2005	2727	1866	3984	4187	3567	4915	3477	2936	4118	0.410	0.320	0.524
2006	3085	2118	4493	3619	3062	4277	2941	2464	3510	0.370	0.291	0.472
2007	3223	2209	4704	3172	2712	3711	2425	2059	2857	0.325	0.251	0.422
2008	2414	1634	3567	2798	2358	3319	1997	1671	2386	0.361	0.275	0.474
2009	2210	1509	3237	2893	2399	3490	2282	1863	2794	0.260	0.194	0.347
2010	1985	1350	2920	2663	2190	3238	2019	1637	2491	0.247	0.184	0.333
2011	1718	1135	2600	2601	2096	3227	2020	1609	2536	0.196	0.144	0.266
2012	1493	944	2362	2694	2144	3385	2179	1716	2767	0.190	0.138	0.261
2013	1540	976	2431	2078	1647	2621	1680	1316	2144	0.187	0.137	0.256
2014	2211	1468	3329	2500	2010	3109	2083	1653	2625	0.177	0.130	0.242
2015	2513	1620	3899	2403	1933	2985	1805	1431	2277	0.155	0.112	0.215
2016	2244	1405	3585	2795	2241	3487	1883	1499	2365	0.222	0.163	0.302
2017	1695	841	3418	2649	2060	3408	1871	1460	2397	0.372	0.260	0.532

Table 6.12 Sole 20–24. Input to short term prediction.

2018 Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	2211	0.1	0	0	0	0.14	0	0.14
2	1537	0.1	0	0	0	0.224	0.166	0.224
3	1816	0.1	1	0	0	0.257	0.504	0.257
4	1322	0.1	1	0	0	0.282	0.966	0.282
5	904	0.1	1	0	0	0.324	1.094	0.324
6	372	0.1	1	0	0	0.357	0.98	0.357
7	350	0.1	1	0	0	0.365	0.98	0.365
8	181	0.1	1	0	0	0.46	0.98	0.46
9	829	0.1	1	0	0	0.423	0.98	0.423
2019 **Age**	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
1	2211	0.1	0	0	0	0.14	0	0.14
2	1852	0.1	0	0	0	0.224	0.166	0.224
3	1383	0.1	1	0	0	0.257	0.504	0.257
4	1563	0.1	1	0	0	0.282	0.966	0.282
5	958	0.1	1	0	0	0.324	1.094	0.324
6	552	0.1	1	0	0	0.357	0.98	0.357
7	213	0.1	1	0	0	0.365	0.98	0.365
8	199	0.1	1	0	0	0.46	0.98	0.46
9	591	0.1	1	0	0	0.423	0.98	0.423
2020 **Age**	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
1	2211	0.1	0	0	0	0.14	0	0.14
2	1847	0.1	0	0	0	0.224	0.166	0.224
3	1648	0.1	1	0	0	0.257	0.504	0.257
4	1240	0.1	1	0	0	0.282	0.966	0.282
5	1306	0.1	1	0	0	0.324	1.094	0.324
6	742	0.1	1	0	0	0.357	0.98	0.357
7	419	0.1	1	0	0	0.365	0.98	0.365
8	157	0.1	1	0	0	0.46	0.98	0.46
9	608	0.1	1	0	0	0.423	0.98	0.423

Input units are millions and kg - output in kilotonnes

M = Natural mortality
MAT = Maturity ogive
PF = Proportion of F before spawning
PM = Proportion of M before spawning
SWT = Weight in stock (kg)
Sel = Exploit. Pattern
CWT = Weight in catch (kg)

Table 6.13 Sole 20–24. Basis for forecasts and management scenarios table for short-term

Variable	Value	Notes
$F_{ages\ 4–8}$ (2018)	0.33	F corresponding to TAC of 448 t. in 2018
SSB (2019)	1827	Fishing at F=0.33 in 2018. In tonnes.
R_{age1} (2018–2019)	2210	Sampling from recent recruitment (2013–2017)
Wanted catch (2018)	431	In tonnes
Unwanted catch (2018)	4%	Mean (2013–2017) rate in weight.
Total catch (2018)	448	Corresponding to TAC of 448 t.

Basis	Total catch (2019) *	Wanted catch (2019) **	Unwanted catch (2019) **	F_{wanted} (2019)	SSB (2020)	% SSB change ***	% TAC change ^	% Advice change ^^
ICES advice basis								
MSY approach: F_{MSY} lower range* SSB2019/MSY $B_{trigger}$	207	199	8	0.134	2046	12%	-56%	NA
MSY approach: F_{MSY} upper range* SSB2019/MSY $B_{trigger}$	276	265	11	0.183	1979	8%	-41%	NA
Other scenarios								
MSY approach: F_{MSY}* SSB_{2019}/MSY $B_{trigger}$	246	237	9	0.162	2007	10%	-47%	-46%
F = 0	0	0	0	0	2248	23%	-100%	-100%
F_{pa}	338	325	13	0.23	1920	5%	-27%	-25%
F_{MSY}	338	325	13	0.23	1920	5%	-27%	-25%
F_{lim}	443	426	17	0.315	1816	-1%	-5%	-2%
SSB (2020) = B_{lim}	411	395	16	0.288	1848	1%	-12%	-9%
SSB (2020) = B_{pa}^^^	-	-	-	-	2600	-	-	-
SSB (2020) = MSY $B_{trigger}$ ^^^	-	-	-	-	2600	-	-	-
F = F_{2018}	464	446	18	0.332	1796	-2%	0%	2%

* Total catch is calculated based on wanted catch (fish that would be landed in the absence of the EU landing obligation) and 4% discard rate (in weight).

** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on discard rate estimates for 2013–2017.

*** SSB 2020 relative to SSB 2019.

^ Wanted catch in 2019 relative to TAC in 2018 (555 t).

^^ Advice value 2019 relative to advice value 2018. Where NA is indicated no comparison is possible since no advice were given in 2017 for MSY ranges and therefore.

^^^ The B_{pa} and MSY $B_{trigger}$ options were left blank because B_{pa} and MSY $B_{trigger}$ cannot be achieved in 2020 even with zero catch in 2019

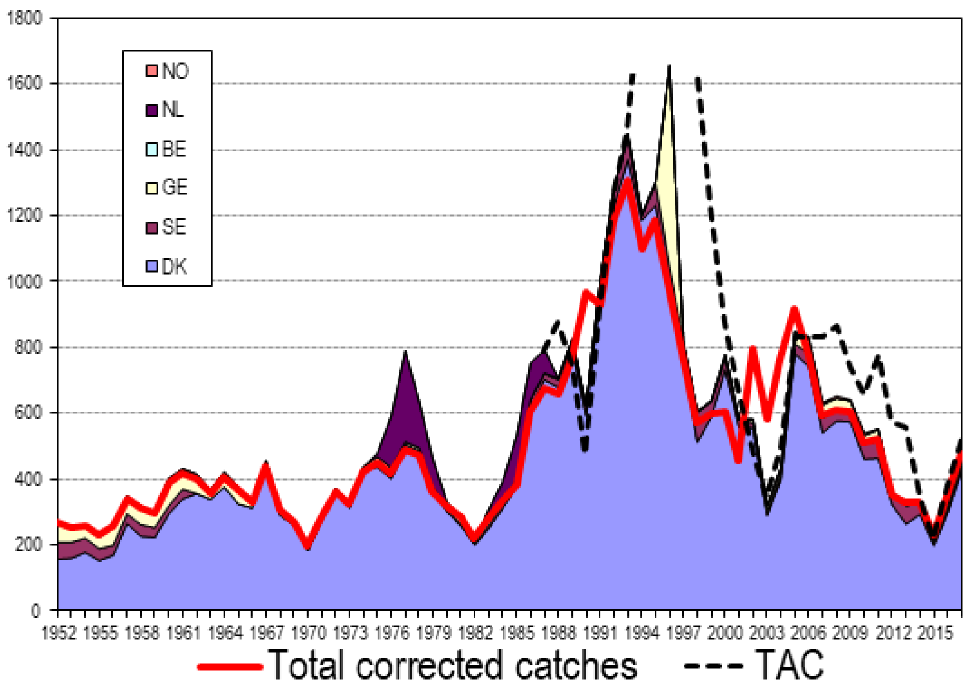


Figure 6.1 **Sole 20–24. Landings of sole in Skagerrak and Kattegat (IIIa) by nation since 1952. Bold red line indicates estimated total landings including misreportings as estimated by the WG and dashed black-bold line is TAC.**

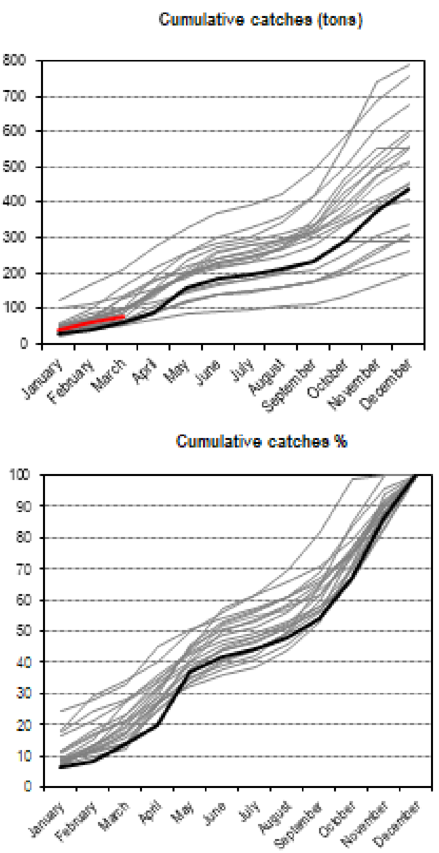


Figure 6.2 **Sole 20–24. Cumulative Danish landings of sole by month. Black bold curve is 2017 and red bold curve is 2018 including March.**

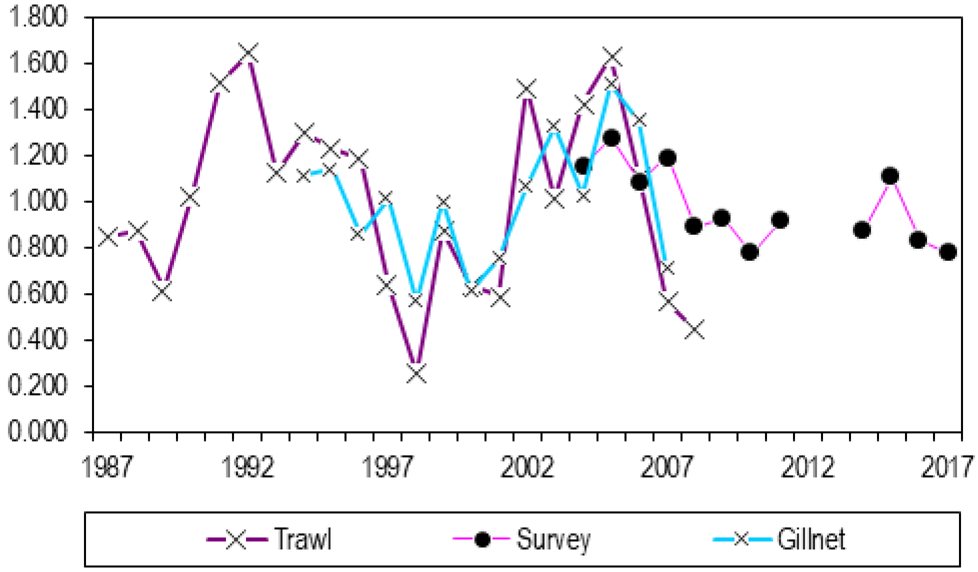


Figure 6.3 **Sole 20–24. Standardised age aggregated CPUE indices of sole from private logbooks from trawlers, private logbooks gillnetters and Fisherman/DTU Aqua survey as used in the assessment.**

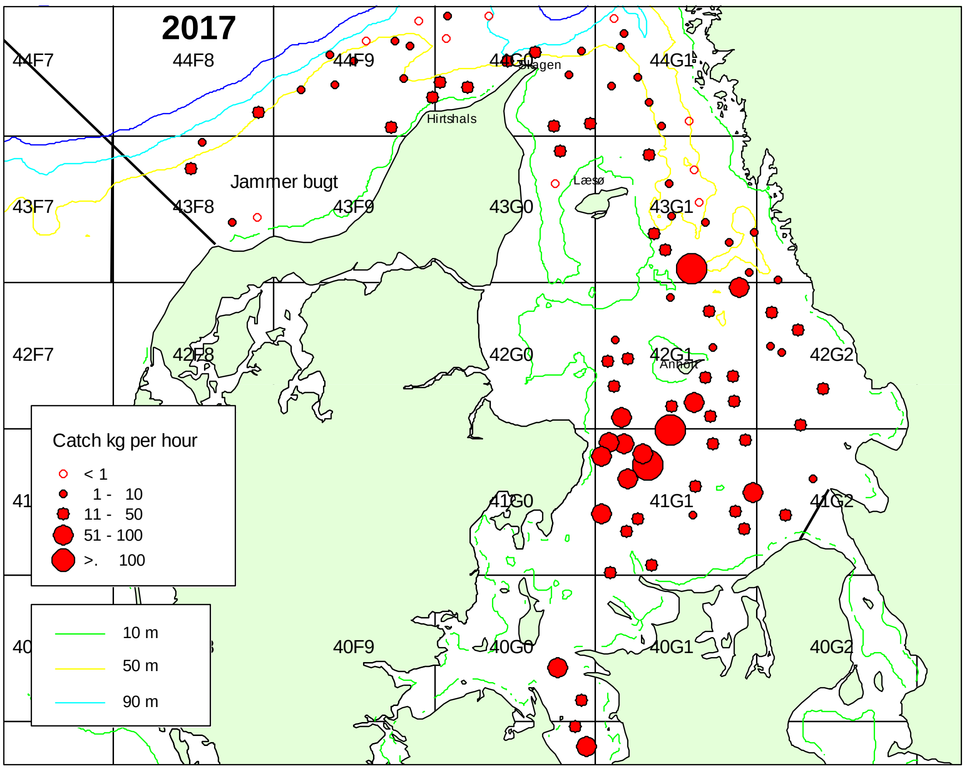


Figure 6.4 **Sole 20–24. Fisherman-DTU Aqua survey. Distribution and catch rates of stations in 2017.**

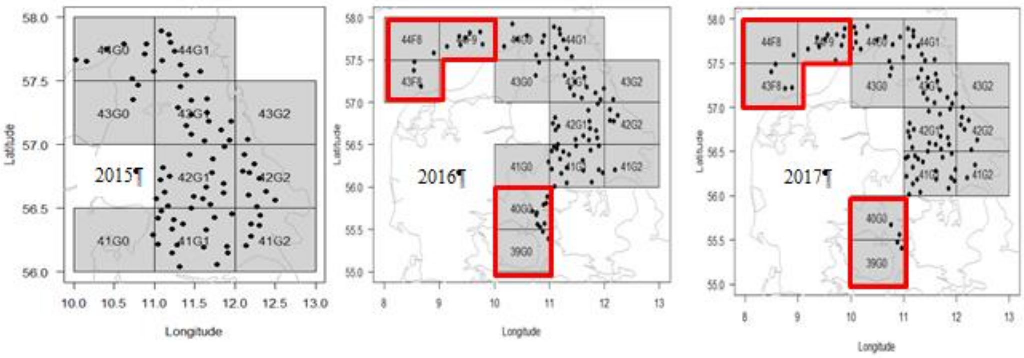


Figure 6.5 **Sole 20–24. Map of sole survey station distribution in 2015 – 2017, illustrating the extended survey area since 2016.**

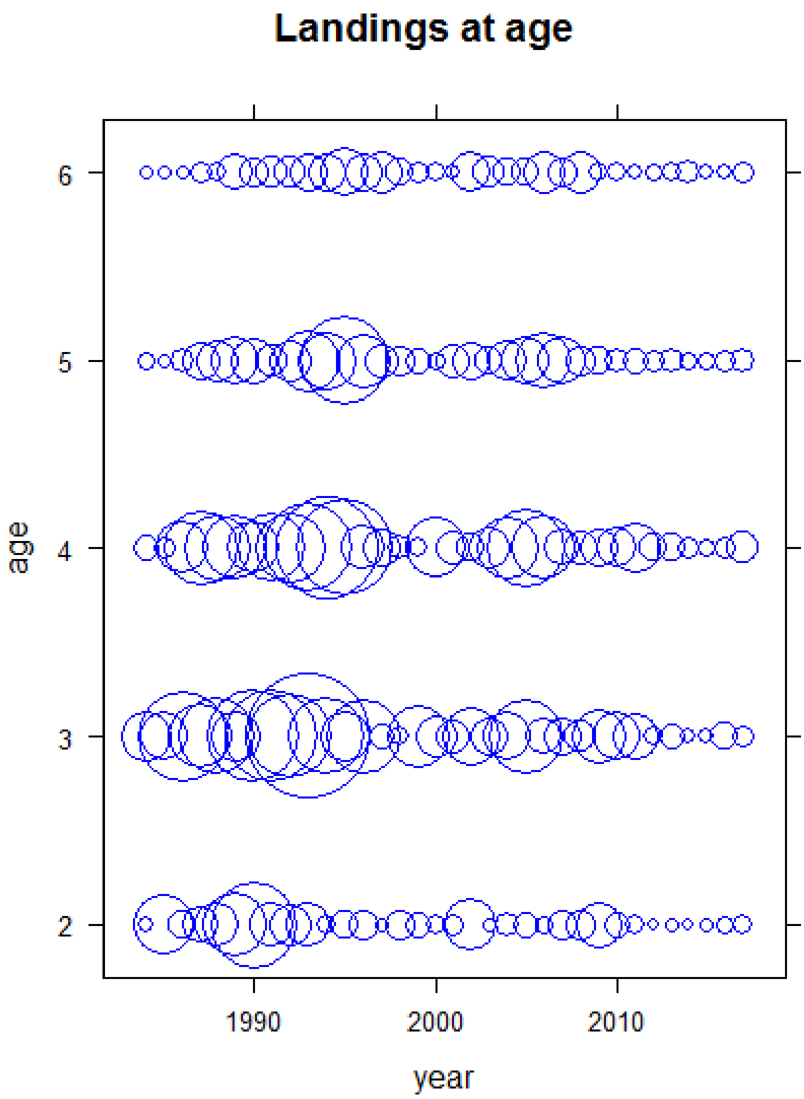


Figure 6.6 **Sole 20–24. Landing numbers at-age.**

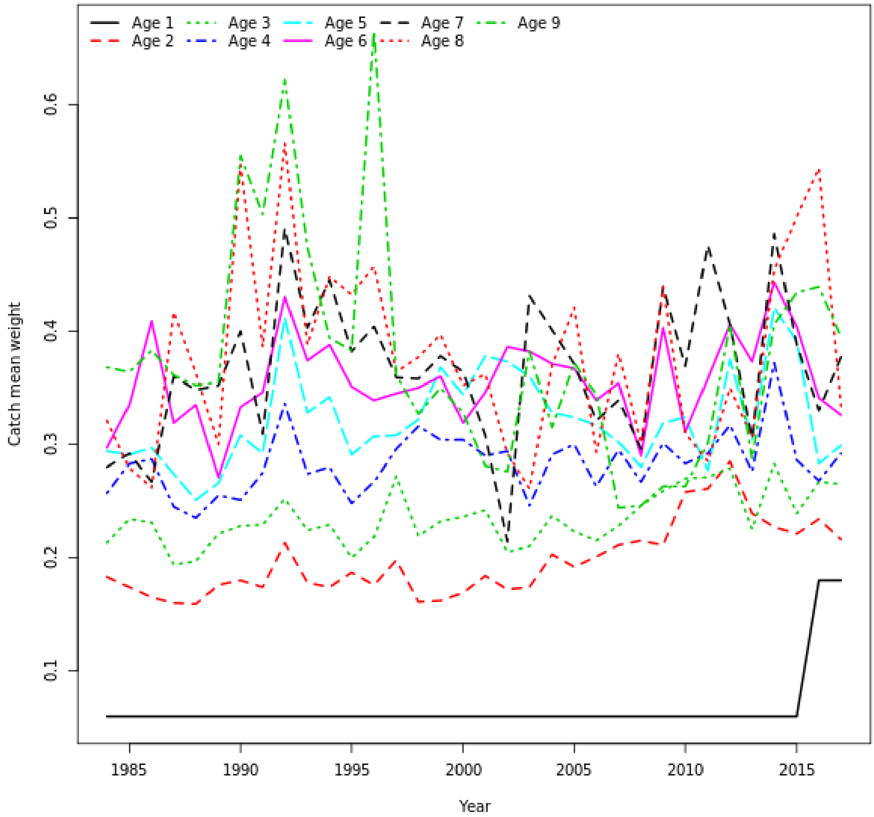


Figure 6.7 **Sole 20–24. Catch weight-at-age.**

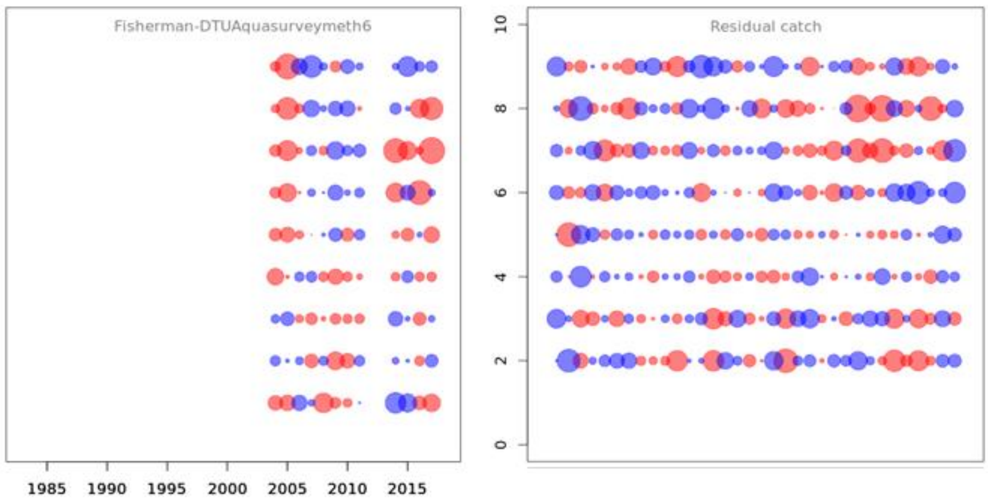


Figure 6.8 **Sole 20–24. Model residuals for survey and catch.**

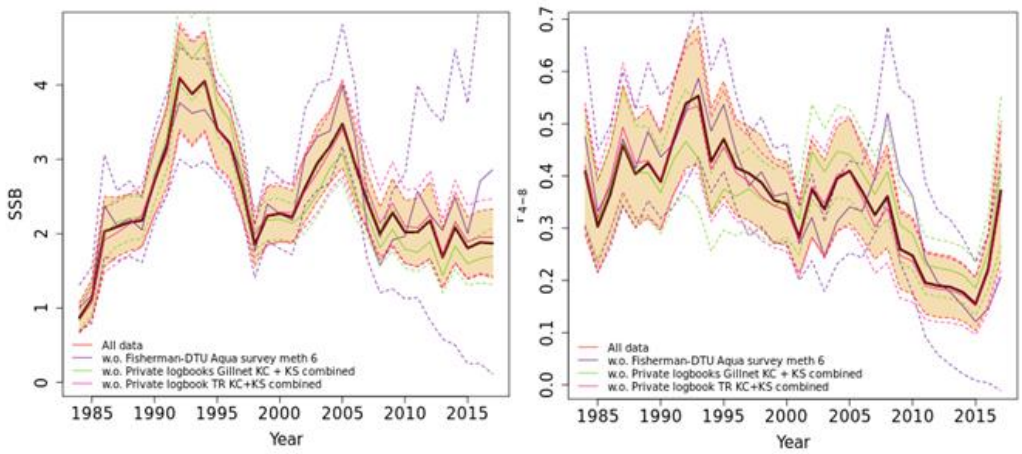


Figure 6.9 **Sole 20–24. Fleet sensitivity. Estimated SSB, and fishing mortality from runs leaving single fleets out. Recruitment (age 1) plot is not possible to provide since only the survey contains age 1 group.**

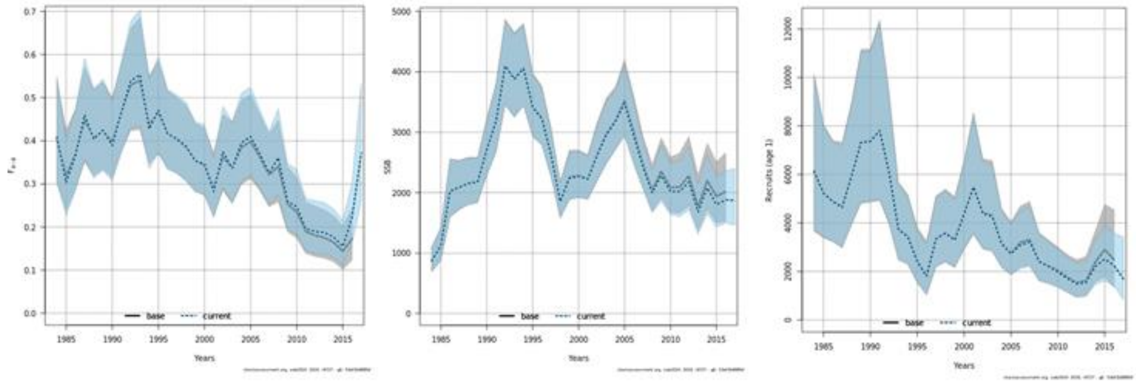


Figure 6.10 **Sole 20–24. Stock summary (F(4–8), SSB and R (age 1) compared to last year's assessment.**

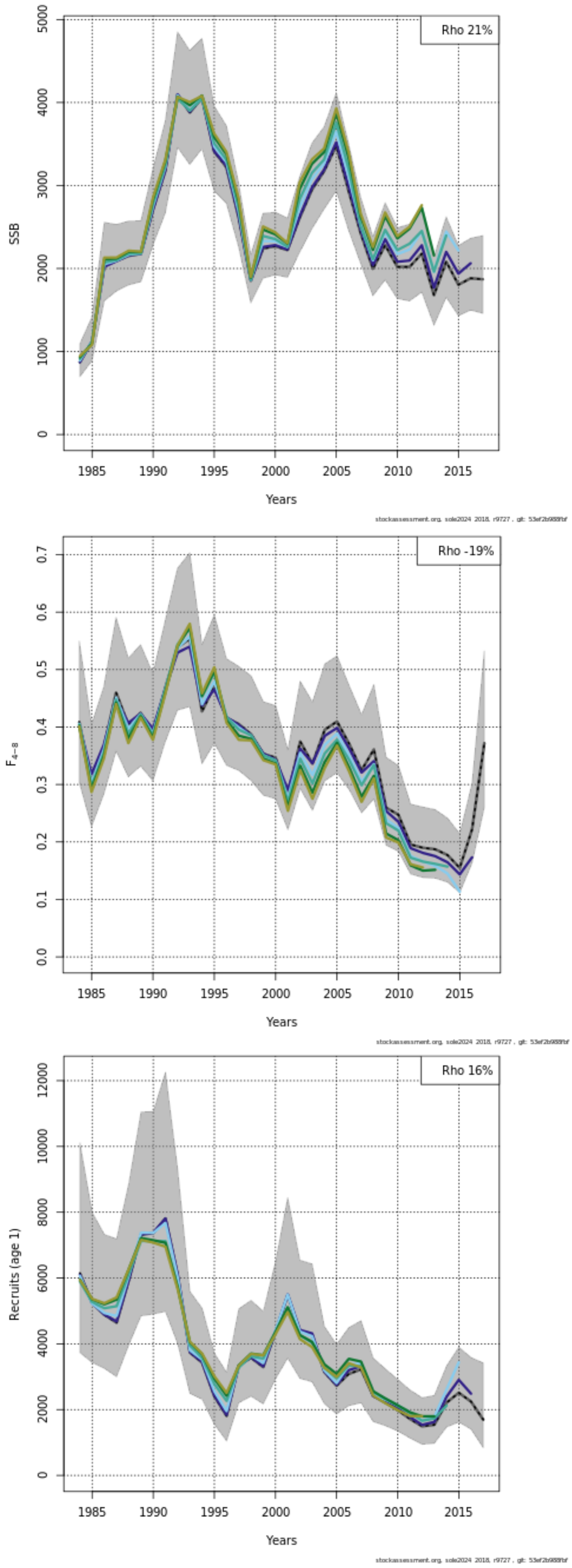


Figure 6.11 **Sole 20–24. Retrospective analyses. Upper: SSB and F, lower: Recruitment. Confidence limits are provided for the 2017 scenario.**

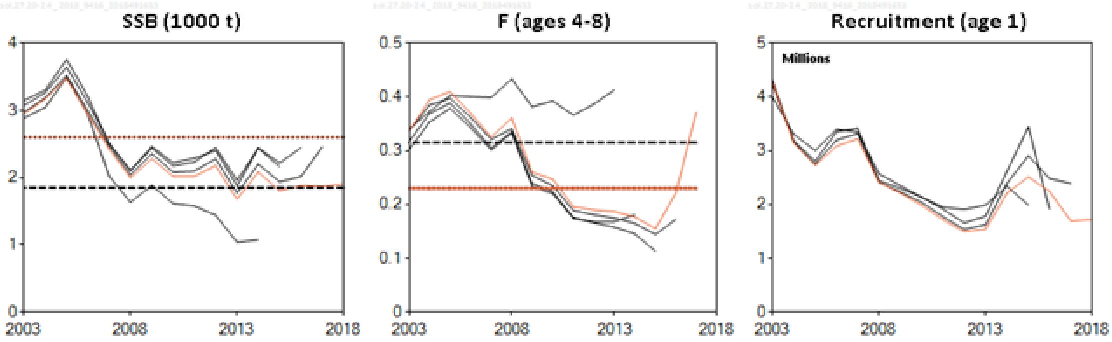


Figure 6.12 **Sole 20–24. Historical assessment performance: F, SSB and recruitment.**

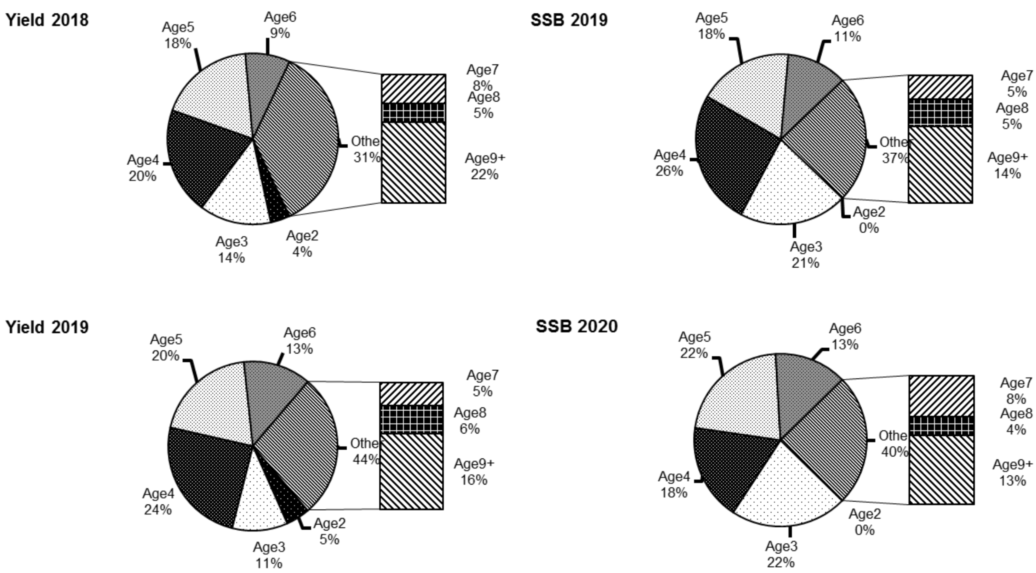


Figure 6.13 **Sole 20–24. Short-term forecast for 2018–2020. Yield and SBB at age 2-9+ for TAC constrained fishing mortality in 2018.**

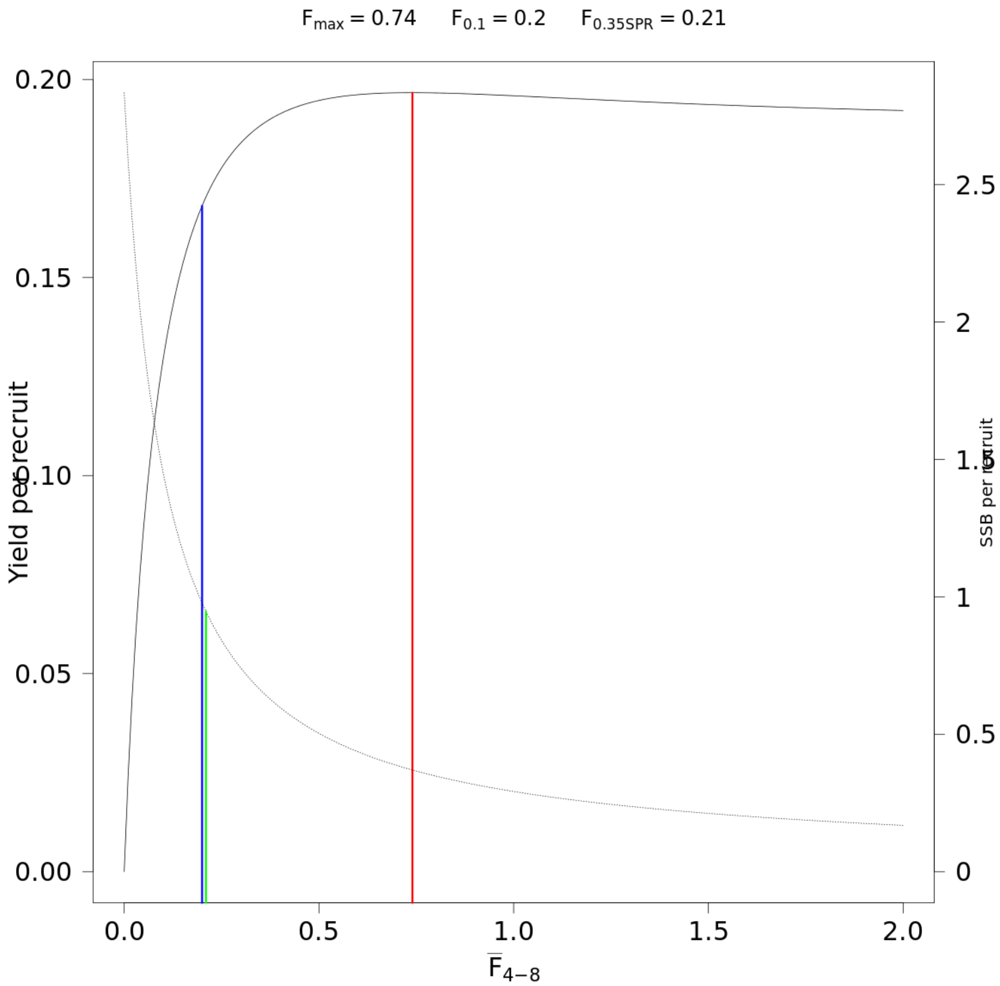


Figure 6.14 **Sole 20–24. Yield per recruit curve and reference point estimates (red=F_{max}, green=$F_{35\%SPR}$ and blue=$F_{0.1}$).**

7 Sprat in subdivisions 22–32

As in previous years sprat in the Baltic subdivisions 22–32 was assessed as a single unit. The note on assessments by „assessment units" used up to early 1990s (subdivisions 22–25, subdivisions 26+28, and subdivisions 27, 29–32) was provided in the Report from WGBFAS meeting in 2017 (ICES, 2017).

In 2013 the sprat assessment was benchmarked at WKBALT (2013) and the present assessment of sprat has been conducted following procedure agreed during the benchmark. The major change at benchmark workshop was the change of predation mortality from estimates provided by MSVPA to estimates obtained with SMS model.

In addition, at benchmark the tuning fleet from Age 0 index, in previous assessment constrained to subdivisions 26+28, was extended to cover subdivisions 22–29. In some years minor revisions were made in other tuning fleets data (May and October acoustic surveys).

Following extensive analysis of the XSA options, no reason was found to change previous settings (age 1 with catchability, q, dependent on stock size, q plateau at age 5, shrinkage SE of 0.75).

The SAM model was attempted as an alternative assessment model; it produced slightly lower SSB and higher Fs than the XSA. However, the XSA has been still considered as a main assessment model for sprat stock.

Maturity estimates were obtained from several countries but due to time constraints only simplified approach for their analysis was applied. The results did not suggest the need to change the maturity parameters used so far. However, further analysis of maturity data would be needed by employing statistical methods (e.g. GLM). For such analysis there was not enough time at benchmark workshop.

7.1 The Fishery

7.1.1 Landings

According to the data uploaded to the InterCatch, sprat catches in 2017 were 285 701 t, which is 16% more than in 2016 and 46% less than the record high value of 529 400 t in 1997. In 2017 the TAC of 260 993 t set for EU was utilized in 95%. The largest increase in catches was observed for Denmark (42%), followed by Latvia and Germany (27 and 24%, respectively). At the same time the Finnish catches decreased by 5% compared to 2016. Russian TAC 42 600 t set for 2017 was utilized in 91%.

The spatial distribution (by subdivision) of sprat catches was similar to previous years. Subdivision 26 dominated the catches with a 37% share in the sprat catch. Other important areas are subdivisions 28, 25 and 29 (21, 15 and 10%, respectively). Landings by country and subdivision are presented in tables 7.1–7.2. Figure 7.0 presents the shares of catches by subdivision in 2001–2017. Table 7.3 contains landings, catch numbers, and weight-at-age by subdivision and quarter.

7.1.2 Unallocated removals

No information on unallocated catches was presented to the group. It is expected, however, that misreporting of catches occurs, as the estimates of species composition of the clupeid catches are imprecise in some mixed pelagic fisheries.

7.1.3 Discards

According to the EC Common Fisheries Policy (adopted in 2014) in 2015, the landing obligation began to cover small and large pelagic species, industrial fisheries and the main fisheries in the Baltic. Historically, discards in most countries have probably been small because the undersized and lower quality fish can be used for production of fish meal and feeding in animal farms. In fisheries directed for human consumption, however, young fish (0 and 1 age groups) were discarded with higher rates in years when strong year classes recruit to the fishery. Recruitment to the fishery takes place in the 4th (age 0) and 1st (age 1) quarters. The amount of discarding of these age-groups was unknown. In the 2015 data call (L.27/ACB/HSL in 2015) ICES requested landings, discards, biological sample and effort data from 2014 in support of the ICES fisheries advice in 2015. Only Estonia and Germany provided the requested discard data for Baltic sprat. However, these two countries reported zero discards years 2012–2014. For year 2015 catches, there were no discard data of Baltic sprat available. Only Finland has uploaded discard data for Baltic sprat in 2016 and 2017 into the InterCatch - 563 and 482 kg, respectively from the passive gear catches.

7.1.4 Effort and CPUE data

Only Denmark and Lithuania uploaded the fishing effort data for 2014 into the InterCatch in 2015. No new fishing effort data were provided in 2016 and 2017. Russia provided the updated data on fishing effort and CPUE for Subdivision 26 in 1995–2017 (Table 7.4). These data indicate increase in CPUE in 1995–2004 and stable CPUE in 2005–2011, followed by a stable CPUE at a higher level in 2012–2017. The dynamics of this CPUE does not reflect the stock size estimates from the analytical models (XSA or SAM). Available effort and CPUE data are restricted to only some regions and years, and are not considered representative for the entire stock and therefore were not applied in the assessment.

7.2 Biological information

7.2.1 Age composition

All countries provided age distributions of their major catches (landed in their waters) by quarter and Subdivision (Table 7.5). Catches for which the age composition was missing represented only about 17% of the total. Almost all German catches (86%) were taken outside the German waters but also these were very well sampled, resulting that 80% of German total landings were sampled. The unsampled catches were distributed to ages according to overall age composition in a given Subdivision and quarter using “Allocation scheme” with CATON values as weighting keys in InterCatch. A large part of the sprat catches is taken as part of the fish meal fishery. In some fisheries the catch species composition is not very precise.

The estimated catch-at-age in numbers is presented in Table 7.3 and 7.6 and the age composition of the catches is shown in Figure 7.1. The consistency of the catch-at-age estimates was checked in bubbles-plot (Figure 7.2). The correlation between catch at a given age and the catch of the same generation 1 year later is high and exceeds 0.9 in most cases.

7.2.2 Mean weight-at-age

Almost all countries presented rather extensive data on weight-at-age in the catch by quarter and subdivision. Mean weights-at-age in the catch were obtained as averages weighted by catch in numbers. The weights-at-age have decreased by about 40% in

1992–1998 (Figure 7.3). In 1999–2005 the weights have fluctuated without a clear trend. Although, the mean weights-at-age of the year-class 2003 are significantly lower compared to other year-classes in the last decade. Since 2006 the mean weights increased somewhat, but have dropped again in last years. The mean weight of the year-class 2014 is very low; it could be a result of density dependent effect as this year-class was very abundant. Mean weights in the stock were assumed the same as mean weights in the catch (Table 7.7). The consistency of the weight-at-age estimates was explored and it is of the similar quality as consistency of catch-at-age data (the correlation between mean weight at a given age and the mean weight of the same generation 1 year later is high and exceeds 0.9 in most cases).

7.2.3 Natural mortality

As in previous years the natural mortalities used varied between years and ages as an effect of cod predation. Up to 2012 WGBFAS meeting the M estimates were based on the MSVPA model and (in years in which the MSVPA estimates were lacking) regression of predation mortality against cod SSB. In the benchmark workshop new estimates of predation mortality (covering 1974–2011) were provided from SMS model (WKMULTBAL, ICES, 2013b). They differ moderately (+/- 20%) from mortalities derived from MSVPA. The M values for 2012–2017 were estimated from the regression of M values taken from SMS against cod SSB in 1974–2011(Figure 7.4.a). However, analytical estimates of cod SSB in recent years are not available due to difficulties with cod assessment. Therefore index of cod SSB obtained from BITS surveys and used as the basis for cod advice was rescaled to analytical estimates of cod SSB from last accepted assessment. The rescaling was based on strong relationship between both series in 2003–2011 (Figure 7.4b). SSB of cod from last accepted analytical assessment and rescaled BITS index are shown in Figure 7.4c.

Final estimates of M are given in Table 7.8.

7.2.4 Maturity-at-age

The maturity estimates were kept unchanged from previous years and constant throughout the time series (Table 7.9). In 2002 the WG was provided with rather extensive maturity data by the Study Group on Herring and Sprat Maturity. These data were analysed using GLM approach and year dependent estimates were obtained (ICES, 2002). These estimates at age 1 varied markedly from year to year but the WG felt that it was necessary to continue sampling and perform more extensive analysis of the data. Thus the maturities were averaged over years in 2002 assessment. These maturities were kept the same in the assessments up to 2012.

At benchmark workshop (ICES, 2013a) maturity estimates were obtained from several countries but due to time constraints only simplified approach for their analysis was applied. The results did not suggest the need to change the maturity parameters used so far. Thus, maturities estimated in 2002 are still kept in present assessment.

Proportions of F and M before spawning are shown in tables 7.10–7.11.

7.2.5 Quality of catch and biological data

In all countries around the Baltic Sea fish catch statistics are based on log-book data. In some countries, such as Denmark and Poland, these data are supplemented by data collected in regional Marine Offices. In Denmark, Sweden, Finland, and to a lesser degree in Poland, much of the sprat catch is taken in industrial fisheries where large by-catches of other fish species (mostly herring) may occur. The species composition of these catches is not accurately known, and can create errors in annual sprat catch statistics.

The landings and sampling activity for 2017 by quarter, ICES subdivision, and country is presented in Table 7.5. These data show that generally in 2017 the sampling activity by ICES subdivision exceeded much the levels indicated in the EC regulation No. 1639/2001, i.e. at least 1 sample per 2000 t. of catch, 100 length measurements and 50 age readings per sample. On average number of samples was 4.2 times higher than indicated in the directive, and 671 length measurement and 184 age readings were recorded per 2000 t catch.

7.3 Fishery independent information

Two tuning data sets covering subdivisions 22–29 were available: from Baltic International Acoustic Survey (BIAS) in autumn in 1991–2017 and one covering subdivisions 24–26 and 28 from international Baltic Acoustic Spring Survey (BASS) in May in 2001–2017 (Tables 7.12–7.14). The survey data were corrected for area coverage (WGBIFS, ICES, 2018). However, in 2016 the May survey (BASS) only covered ca. 50% of planed areas, **so the 2016 survey estimates from BASS we not used in the assessment**. Such was also recommendation from WGBIFS (ICES, 2017).

The internal consistency of survey at age estimates and consistency between surveys was checked on graphs (Figures 7.5a-c). The correlation between CPUE at given age and the CPUE of the same generation 1 year later is high ranging between 0.7–0.9.

7.4 Assessment

7.4.1 XSA

The input data for the catch-at-age analysis are presented in tables 7.6–7.14. The settings for the parameterisation of XSA were the same as specified in the benchmark assessment (and no change from previous benchmark settings):

1) tricubic time weighting,

2) catchability dependent on year class strength at age 1 (only for this age group the slopes of regressions were significantly different from 1),

3) catchability independent of age for ages 5 and older,

4) the SE of the F shrinkage mean equal 0.75.

Table 7.15 contains the diagnostic of the run. The log q residuals are presented in Figure 7.6. The residuals are moderately noisy and slightly lower for October fleet (SE of log q = 0.3-0.45) than for the May survey (SE’s range of 0.35–0.5). The residuals from acoustic survey on age 0 (shifted to represent age 1) are rather high at the beginning of the time series but they decline at later years (regression SE about 0.3). The correlations between XSA estimates and survey indices are quite high (R^2 mostly at level of 0.6–0.8).

In previous assessments the May survey had the highest influence on survivor estimates (ca. 40–55% weight except of age 1) but in the last two assessments (following exclusion of the 2016 data from this survey) the survivors estimated by May survey have bigger variance and the October survey gets higher weight (mostly 50 – 55%). The weight of estimates resulting from shrinkage is low (up to 7%) (Figure 7.7a). The survey estimates of survivors are quite consistent at most ages – consistency is somewhat lower at age 1, where estimate based on May survey diverge from estimate using October and Age0 surveys (Figure 7.7b). The estimates based on Age0 acoustic fleet are down-weighted with increasing age.

Retrospective analysis (Figure 7.8) shows quite scattered estimates for F. The average F estimates, i.e. F(3–5), are most noisy as they are based on Fs from 3 ages only. In addition, recruitment of sprat is very variable which easily can lead to overestimation of F for weak year classes when they neighbour strong year classes, due to possible misspecification of age readings from these strong generations. The estimates of SSB in most years are relatively consistent. The retrospective analysis shows consistent estimates of recruitment. The Mohn's Rho is -0.13, 0.13, and 0.11 respectively for F, SSB, and recruitment.

The fishing mortalities, stock numbers and summary of assessment are presented in tables 7.16–7.18. Fish stock summary plots are presented in Figures 7.9 and 7.10.

7.4.2 Exploration of SAM

The SAM model was attempted at benchmark workshop as the second assessment model for sprat. Last available SAM estimates origin from assessment conducted in 2017. Results of that SAM parameterised in similar way as XSA are compared with XSA estimates in Figure 7.11a. For 2016 the SAM estimate of SSB and recruitment are lower than the XSA estimate by 16% and 42% while the fishing mortality is higher by 23% than the XSA value. The XSA estimates are contained within SAM confidence intervals. The residuals distributions for SAM model show similar patterns as in case of XSA (Figure 7.11b). The retrospective analysis is somewhat better for SAM than for XSA, especially for fishing mortality (Figure 7.11c). The assessment with SAM is available at the https://www.stockassessment.org (short name of the stock is sprat2016a).

7.4.3 Recruitment estimates

The acoustic estimates on age-0 sprat in subdivisions 22–29 (shifted to represent age 1) and XSA estimates were analysed using the RCT3 program (Tables 7.19 and 7.20, Figure 7.12). The R^2 between XSA numbers and acoustic indices are high, generally at range of 0.7–0.8. Estimates are mainly determined by survey (weight of 60–70%). The 2017 year class was estimated almost 30% above the average at 113 billion.

7.4.4 n

In the 1990s the SSB exceeded 1 million t, being record high in 1996–1997 (about 1.9 million t). These values were several times higher than the SSB estimates of 300 000 t in the early 1980s. Since 1997 the SSB has been generally decreasing, and reached 0.7 million tonnes in 2013-2014. The strong year-class 2014 has led to marked increase of stock biomass in 2016-2018. The estimate of SSB for 2018 is 1.4 million tonnes. Weight-at-age has decreased since the early 1990s, and has remained low since then. This is likely due to density-dependent effects. Autumn acoustic surveys show that in recent years the stock has been mainly concentrated in subdivisions 27–29 and 32 (Casini *et al.*, 2011, WGBIFS, 2017).

7.5 Short-term forecast and management options

The RCT3 program estimate of the 2017 year class at age 1 was used in the predictions. The 2018 and 2019 year classes were assumed as geometric mean of the recruitment at age 1 in 1991–2017 (period of recruitment fluctuations without clear trend, the 2017 value is well estimated in the assessment). The natural mortalities and mean weights-at-age were assumed as averages of 2015–2017 values. The fishing pattern was smoothed as the average F at-age in 2015–2017 scaled to the F consistent with TAC constraint in 2018 (TAC defined as EU quota of 262.3 kt and Russian quota of 42.6 kt). Input data for catch prediction are presented in Table 7.21.

Prediction results with TAC constraint are shown in Table 7.22a. In addition, prediction option with F_{sq} in 2018 was performed (Table 7.22b); that produced catches in 2018 at 319 kt, 5% higher than the TAC. The differences between two predictions are small, e.g. difference between total biomass in 2019 is below 1%. The group considers TAC constraint prediction as basis for the advice.

In Figure 7.13 the sensitivity of the projection to the assumed strength (GM) of the 2018 and 2019 year classes and the estimate of 2017 year class is presented. The assumed level of the 2018 year class contributes in 6% to the predicted catch in 2019 and with assumed level of the 2019 year class contributes in 34% to SSB in 2020.

7.6 Reference points

Up to 2012 the PA software (CEFAS, Lowestoft) was used to estimate biological reference points. The estimated $\mathbf{F}_{med}$ (used by ACFM as a basis for $\mathbf{F}_{pa}$= 0.4, value estimated in middle of 1990s) changed substantially from year to year assessment and in 2012 was estimated at unrealistically low level of 0.14.

Presently suggested BRPs were estimated at benchmark using the methodology shortly described below. Three stock-recruitment models were fitted to the entire time series data: Beverton and Holt (B&H), Ricker, and hockey-stick models. They all showed similar fits to the available range of data, explaining only about 11% of the recruitment variance. The B_{lim} was estimated as the biomass that produces half of maximal (from the model) recruitment (410 000 t; close to average of outcomes from different recruitment models) and $B_{MSYtrigger}$=B_{pa} at 574 000 t (B_{pa} = B_{lim} *1.4).

The method of equilibrium yield and biomass (Horbowy and Luzenczyk, 2012) was used to estimate the F_{MSY} reference points. The uncertainty included in the estimating procedure was from assessment errors in SSB and R, which are then used to estimate the S-R relationship. In addition, uncertainty was imposed on weight, natural mortality, selection and maturity-at-age. The CV was assumed at 0.2 for SSB, R and maturity, and it was estimated using data from most recent ten years for weight, selection and M. 1000 replications were performed to determine the distribution of the MSY parameters. The F_{MSY} was estimated at 0.29 (median from stochastic simulations, SD=0.11) and B_{MSY} at 617 thousand t (SD=161).

The biological reference points derived based on the replacement lines depend on the natural mortality, weight-at-age, and maturity data used. In recent years the natural mortalities increased markedly but the weights at age were still low. The changes in M and weights may have very large impact on estimate of the MSY reference points.

During the workshop on BRP (ICES-MYFISH Workshop to consider the basis for FMSY ranges for all stocks (WKMSYREF3; ICES, 2014)) the F_{MSY} reference points were revised and ranges for them estimated. The new estimate of F_{MSY} is 0.26, while ranges are provided in the text table below.

Stock	MSY Flower	FMSY	MSY Fupper with AR	MSY Btrigger (thousand t)	MSY Fupper with no AR
Sprat in subdivisions 22–32 (Baltic Sea)	0.19	0.26	0.27	570	0.21

7.7 Quality of assessment

In the mixed fishery for herring and sprat the reported quantities landed by each species are (could be) imprecise. These uncertainties could influence the estimates of absolute stock size and fishing mortality. The retrospective plots show quite large deviations of estimates for certain years. In case of fishing mortality the deviations are to some extent caused by F_{bar} based on three values only (F-at-age 3–5), that is sensitive to bias in F-at-age, occurring especially for weak year classes neighbouring a strong year class.

The predicted SSB for the year following the prediction year is very sensitive to the assumed (GM) year class strength. The assumed year classes contribute usually in 40–55% to the predicted SSB, this year it is less (34%) as strong 2014 year still markedly contributes to biomass and catches.

The sprat in subdivisions 22–32, now being assessed as one unit, was previously considered to be composed of three stock components: sprat in subdivisions 22–25, 26+28, and 27+29–32. An analysis of the impact of merging components on stock assessment was performed during benchmark workshop (2013) and recently within Inspire project (BONUS financial support). It showed that sum of biomass of separately assessed components is similar to biomass estimated for the whole stock.

The inputs to the assessments are catch-at-age data and age-structured stock estimates from the acoustic surveys. The survey estimates of stock numbers are internally consistent and the same applies to catch-at-age numbers. Survey are also consistent between themselves.

7.8 Comparison with previous assessment

The comparison between the results of 2017 and 2018 assessments is presented in the text table below. The XSA settings were the same in both years.

Category	Parameter	Assessment 2017	Assessment 2018	Diff. (+/-) %
Data input	Maturity ogives	age 1 – 17%, age 2 – 93%	age 1 – 17%, age 2 – 93%	No
	Natural mortality	M in 1974–2011 estimated in SMS, M2012-2016 estimated from regression of M against cod SSB	M in 1974–2011 estimated in SMS, M2012- M2017 estimated from regression of M against cod SSB	No
XSA input	Catchability dependent on year class strength	Age<2	Age<2	No
	Catchability independent on age	Age >=5	Age >=5	No
	SE of the F shrinkage mean	0.75	0.75	No
	Time weighting	Tricubic, 20 years	Tricubic, 20 years	No
	Tuning data	International acoustic autumn International Acoustic May	International acoustic autumn International Acoustic May, (2016 data excluded from May survey)	Yes
		Acoustic on age 0 (subdiv. 22–29)	Acoustic on age 0 (subdiv. 22–29)	No
XSA results	SSB 2016 (million t)	1.18	1.28	9%
	TSB 2016 (million t)	1.78	1.94	9%
	F(3-5) 2016	0.22	0.26	15%
	Recruitment (age 1) in 2016 (billions)	68.5	75.8	11%

7.9 Management considerations

There is a EU multiannual plan for sprat in the Baltic Sea (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1139&from=EN). In the plan F_{msy} ranges are defined as 0.19 – 0.26 and 0.26–0.27.

As in previous years, sprat in Baltic subdivisions 22–32 was assessed as a single unit, and this procedure shows relatively good assessment quality.

The spawning stock biomass has been low in the first half of 1980s. In the beginning of 1990s the stock started to increase rapidly and in 1996–1997 it reached the maximum observed spawning stock biomass of 1.9 million tonnes. The stock size increased due to the combination of strong recruitments and decline in natural mortality (effect of low cod biomass). Next, following high catches and varying recruitment, SSB declined to 0.7 million tonnes in 2013–14. Very strong year-class of 2014 has led to marked increase in stock size, SSB reached 1.3 million tonnes in 2016–18 and is predicted to stay at such level until 2020. After 2000 fishing mortality increased and next fluctuated, usually between F_{pa} and F_{lim}. In recent years F declined towards the F_{msy} levels. Among the year classes 2009–2017 only one (2014) was strong, which contributed to previous stock decline.

In 2019–2020 the stock is predicted to stay at recent levels of 1.3 million tonnes, if it is exploited at F_{MSY}.

The marked part of the sprat catches is taken in a mixed sprat-herring fishery, and the species composition of these catches is imprecise in some fishing areas /periods.

Table 7.1 Sprat landings in Subdivisions 22–32 (thousand tonnes).

Year	Denmark	Finland	German Dem. Rep.	Germany Fed. Rep.	Poland	Sweden	USSR	Total
1977	7.2	6.7	17.2	0.8	38.8	0.4	109.7	180.8
1978	10.8	6.1	13.7	0.8	24.7	0.8	75.5	132.4
1979	5.5	7.1	4.0	0.7	12.4	2.2	45.1	77.1
1980	4.7	6.2	0.1	0.5	12.7	2.8	31.4	58.1
1981	8.4	6.0	0.1	0.6	8.9	1.6	23.9	49.3
1982	6.7	4.5	1.0	0.6	14.2	2.8	18.9	48.7
1983	6.2	3.4	2.7	0.6	7.1	3.6	13.7	37.3
1984	3.2	2.4	2.8	0.7	9.3	8.4	25.9	52.5
1985	4.1	3.0	2.0	0.9	18.5	7.1	34.0	69.5
1986	6.0	3.2	2.5	0.5	23.7	3.5	36.5	75.8
1987	2.6	2.8	1.3	1.1	32.0	3.5	44.9	88.2
1988	2.0	3.0	1.2	0.3	22.2	7.3	44.2	80.3
1989	5.2	2.8	1.2	0.6	18.6	3.5	54.0	85.8
1990	0.8	2.7	0.5	0.8	13.3	7.5	60.0	85.6
1991	10.0	1.6		0.7	22.5	8.7	*59.7	103.2

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden	Total
1992	24.3	4.1	1.8	0.6	17.4	3.3	28.3	8.1	54.2	142.1
1993	18.4	5.8	1.7	0.6	12.6	3.3	31.8	11.2	92.7	178.1
1994	60.6	9.6	1.9	0.3	20.1	2.3	41.2	17.6	135.2	288.8
1995	64.1	13.1	5.2	0.2	24.4	2.9	44.2	14.8	143.7	312.6
1996	109.1	21.1	17.4	0.2	34.2	10.2	72.4	18.2	158.2	441.0
1997	137.4	38.9	24.4	0.4	49.3	4.8	99.9	22.4	151.9	529.4
1998	91.8	32.3	25.7	4.6	44.9	4.5	55.1	20.9	191.1	470.8
1999	90.2	33.2	18.9	0.2	42.8	2.3	66.3	31.5	137.3	422.6
2000	51.5	39.4	20.2	0.0	46.2	1.7	79.2	30.4	120.6	389.1
2001	39.7	37.5	15.4	0.8	42.8	3.0	85.8	32.0	85.4	342.2
2002	42.0	41.3	17.2	1.0	47.5	2.8	81.2	32.9	77.3	343.2
2003	32.0	29.2	9.0	18.0	41.7	2.2	84.1	28.7	63.4	308.3
2004	44.3	30.2	16.6	28.5	52.4	1.6	96.7	25.1	78.3	373.7
2005	46.5	49.8	17.9	29.0	64.7	8.6	71.4	29.7	87.8	405.2
2006	42.1	46.8	19.0	30.8	54.6	7.5	54.3	28.2	68.7	352.1
2007	37.6	51.0	24.6	30.8	60.5	20.3	58.7	24.8	80.7	388.9
2008	45.9	48.6	24.3	30.4	57.2	18.7	53.3	21.0	81.1	380.5
2009	59.7	47.3	23.1	26.3	49.5	18.8	81.9	25.2	75.3	407.1
2010	43.6	47.9	24.4	17.8	45.9	9.2	56.7	25.6	70.4	341.5
2011	31.4	35.0	15.8	11.4	33.4	9.9	55.3	19.5	56.2	267.9
2012	11.4	27.7	9.0	11.3	30.7	11.3	62.1	25.0	46.5	235.0
2013	25.6	29.8	11.1	10.3	33.3	10.4	79.7	22.6	49.7	272.4
2014	26.6	28.5	11.7	10.2	30.8	9.6	56.9	23.4	46.0	243.8
2015	22.5	24.0	12.0	10.3	30.5	11.0	62.2	30.7	44.1	247.2
2016	19.1	23.7	16.9	10.9	28.1	11.6	59.3	34.6	42.4	246.5
2017	27.1	25.3	16.1	**13.6	35.7	12.5	68.4	38.7	48.3	285.7

* Sum of landings by Estonia, Latvia, Lithuania, and Russia.

**Preliminary.

Table 7.2 Sprat landings in the Baltic Sea by country and Subdivision (thousand tonnes). 1/3

Year 2001

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**39.7**	-	-	39.7	-	-	-	-	-	-	-
Estonia	**37.5**	-	-	-	-	-	6.3	16.1	-	-	15.1
Finland	**15.4**	-	-	-	-	-	-	4.5	3.2	0.001	7.6
Germany	**0.8**	0.02	0.8	-	-	-	-	-	-	-	-
Latvia	**42.8**	-	-	1.1	7	-	34.7	-	-	-	-
Lithuania	**3**	-	-	-	3	-	-	-	-	-	-
Poland	**85.8**	-	0.4	46.3	39.1	-	-	-	-	-	-
Russia	**32**	-	-	-	29.6	-	2.3	-	-	-	-
Sweden	**85.4**	-	1	2.9	4.8	27.8	30.2	18.1	-	-	0.5
Total	**342.2**	**0.02**	**2.1**	**90**	**83.5**	**27.8**	**73.5**	**38.7**	**3.2**	**0.001**	**23.2**

Year 2002

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**42.0**	4.7	1.0	22.5	7.7	0.7	4.6	0.9	-	-	-
Estonia	**41.3**	-	-	-	-	-	7.7	17.0	-	-	16.6
Finland	**17.2**	-	0.8	2.3	0.004	0.1	0.001	3.7	4.8	-	5.5
Germany	**1.0**	0.03	-	0.1	0.4	0.1	0.1	0.2	-	-	-
Latvia	**47.5**	-	-	1.4	4.5	-	41.7	0.0	-	-	-
Lithuania	**2.8**	-	-	0.0	2.8	-	-	-	-	-	-
Poland	**81.2**	-	0.04	39.7	41.5	-	-	-	-	-	-
Russia	**32.9**	-	-	-	29.9	-	2.9	-	-	-	-
Sweden	**77.3**	-	3.0	13.3	5.6	27.2	19.9	8.3	-	-	-
Total	**343.2**	**4.8**	**4.8**	**79.3**	**92.4**	**28.1**	**76.8**	**30.1**	**4.8**	**0.0**	**22.1**

Year 2003

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**32.0**	8.2	0.7	10.4	8.9	1.8	1.7	0.3	-	-	-
Estonia	**29.2**	-	-	-	-	-	11.1	11.6	-	-	6.5
Finland	**9.0**	-	0.03	0.4	0.04	0.2	0.1	4.6	1.5	0.001	2.0
Germany	**18.0**	0.2	0.5	0.8	3.0	9.5	2.8	1.1	-	-	-
Latvia	**41.7**	-	-	0.8	7.8	-	33.2	-	-	-	-
Lithuania	**2.2**	-	-	-	2.2	-	-	-	-	-	-
Poland	**84.1**	-	0.03	26.7	57.4	-	-	-	-	-	-
Russia	**28.7**	-	-	0.0	27.2	-	1.4	-	-	-	-
Sweden	**63.4**	-	2.1	5.5	8.6	24.1	19.3	3.8	-	-	-

Year 2004

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**44.3**	16.0	5.5	16.8	0.5	0.5	3.9	1.1	-	-	-
Estonia	**30.2**	-	-	-	-	-	8.9	10.1	-	-	11.1
Finland	**16.6**	-	0.5	2.5	0.003	0.1	0.03	9.3	3.0	0.003	1.1
Germany	**28.5**	0.8	0.9	1.4	6.0	8.2	6.8	4.4	-	-	-
Latvia	**52.4**	-	-	2.3	7.5	0.2	42.4	0.0	-	-	-
Lithuania	**1.6**	-	-	-	1.6	-	-	-	-	-	-
Poland	**96.7**	-	1.4	33.6	61.6	0.04	0.02	-	-	-	-
Russia	**25.1**	-	-	-	23.9	-	1.2	-	-	-	-
Sweden	**78.3**	-	1.4	9.2	7.6	25.8	22.3	12.0	-	-	-
Total	**373.7**	**16.8**	**9.7**	**65.8**	**108.8**	**34.8**	**85.6**	**36.9**	**3.0**	**0.003**	**12.2**

Year 2005

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**46.5**	17.6	2.1	11.1	5.4	0.3	10.0	-	-	-	-
Estonia	**49.8**	-	-	-	-	-	7.1	16.6	-	-	26.0
Finland	**17.9**	-	0.1	0.6	0.6	0.1	0.3	9.0	3.2	0.005	4.0
Germany	**29.0**	1.2	0.1	0.4	4.3	10.2	6.8	6.1	-	-	-
Latvia	**64.7**	-	-	1.2	7.3	0.4	55.8	-	-	-	-
Lithuania	**8.6**	-	-	-	8.6	-	-	-	-	-	-
Poland	**71.4**	-	2.0	23.5	45.6	0.2	0.1	-	-	-	-
Russia	**29.7**	-	-	-	29.7	-	-	-	-	-	0.1
Sweden	**87.8**	-	0.7	11.1	10.3	25.1	24.5	16.2	-	-	-
Total	**405.2**	**18.8**	**5.0**	**47.9**	**111.7**	**36.2**	**104.5**	**47.9**	**3.2**	**0.005**	**30.2**

Year 2006

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	**42.1**	19.4	1.7	6.9	9.9	0.3	2.6	1.2	-	-	-
Estonia	**46.8**	-	-	0.1	-	0.3	5.5	19.2	-	-	21.6
Finland	**19.0**	-	0.2	0.5	1.1	1.9	2.0	6.8	3.5	0.007	3.0
Germany	**30.8**	1.2	0.01	1.3	8.2	12.0	4.6	3.4	-	-	-
Latvia	**54.6**	-	-	1.1	6.0	-	47.5	-	-	-	-
Lithuania	**7.5**	-	-	-	7.5	-	-	-	-	-	-
Poland	**54.3**	-	0.8	16.7	36.8	-	-	-	-	-	-
Russia	**28.2**	-	-	-	27.9	-	-	-	-	-	0.3
Sweden	**68.7**	0.0	0.7	4.6	25.3	13.7	16.6	7.6	0.0	0.0	0.2
Total	**352.1**	**20.5**	**3.4**	**31.3**	**122.8**	**28.3**	**78.9**	**38.3**	**3.5**	**0.007**	**25.1**

continued

Table 7.2 Sprat landings in the Baltic Sea by country and Subdivision (thousand tonnes). 2/3

Year 2007

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	37.6	9.6	0.7	6.4	17.0	-	3.0	0.8	-	-	-
Estonia	51.0	-	-	2.2	0.8	0.1	4.3	15.3	-	-	28.3
Finland	24.6	0.0	0.0	1.9	4.2	0.3	2.6	4.5	7.2	0.002	3.8
Germany	30.8	0.8	0.46	1.8	12.2	5.8	4.8	4.9	-	-	-
Latvia	60.5	-	-	5.1	7.4	1.4	46.5	-	-	-	-
Lithuania	20.3	-	-	1.7	11.8	-	3.6	3.2	-	-	-
Poland	58.7	-	0.8	21.4	36.4	0.04	0.06	-	-	-	-
Russia	24.8	-	-	-	24.8	-	-	-	-	-	-
Sweden	80.7	-	1.8	10.0	30.8	11.0	14.9	11.9	0.1	-	0.2
Total	**388.9**	**10.4**	**3.8**	**50.5**	**145.4**	**18.7**	**79.8**	**40.6**	**7.3**	**0.002**	**32.4**

Year 2008

Country	Total	22	24	25	26	27	28	29	30	31	32
Denmark	45.9	5.6	1.0	5.6	4.0	7.1	13.2	0.3	-	-	9.2
Estonia	48.6	-	-	0.3	0.0	-	5.3	15.6	-	-	27.3
Finland	24.3	-	-	2.1	2.1	0.2	2.3	8.6	5.2	0.0002	3.8
Germany	30.4	1.3	0.07	1.8	6.0	4.0	13.7	3.6	-	-	-
Latvia	57.2	-	-	2.1	6.3	0.2	48.6	0.005	-	-	-
Lithuania	18.7	-	0.01	5.5	6.0	0.7	4.6	1.8	-	-	-
Poland	53.3	-	3.9	25.4	23.8	0.02	0.15	-	-	-	-
Russia	21.0	-	-	-	21.0	-	-	-	-	-	-
Sweden	81.1	-	2.0	13.3	13.2	9.1	27.4	15.4	0.00005	-	0.7
Total	**380.5**	**6.9**	**7.1**	**56.0**	**82.4**	**21.4**	**115.2**	**45.3**	**5.2**	**0.0002**	**41.0**

Year 2009

Country	Total	22	23	24	25	26	27	28	29	30	31	32
Denmark	59.7	3.8	0.5	0.7	9.7	14.3	0.3	22.1	8.3	-	-	-
Estonia	47.3	-	-	-	0.6	-	-	2.5	13.7	-	-	30.5
Finland	23.1	-	-	-	0.0	2.7	0.3	2.9	7.7	4.4	0.0001	5.2
Germany	26.3	1.4	-	0.24	1.9	3.7	6.2	9.0	4.0	-	-	-
Latvia	49.5	-	-	0.0	6.0	5.0	0.5	38.0	0.008	-	-	-
Lithuania	18.8	-	-	0.45	3.3	6.4	0.5	7.2	0.9	-	-	-
Poland	81.9	-	0.3	2.1	25.4	33.9	6.60	8.40	5.2	-	-	-
Russia	25.2	-	-	-	-	25.2	-	-	-	-	-	-
Sweden	75.3	-	-	2.4	7.9	13.5	10.5	28.2	12.6	0.0014	-	0.2
Total	**407.1**	**5.2**	**0.9**	**5.9**	**54.8**	**104.6**	**24.9**	**118.3**	**52.3**	**4.4**	**0.0001**	**35.9**

Year 2010

Country	Total	22	23	24	25	26	27	28	29	30	31	32
Denmark	43.6	8.0	-	0.7	5.2	12.3	2.4	9.6	5.3	-	-	-
Estonia	47.9	-	-	-	-	-	-	2.6	16.9	-	-	28.3
Finland	24.4	-	-	-	-	1.9	0.3	5.3	6.8	3.3	0.002	6.9
Germany	17.8	1.8	-	0.05	1.3	4.7	2.8	4.5	2.7	-	-	-
Latvia	45.9	-	-	-	5.2	5.0	-	35.7	-	-	-	-
Lithuania	9.2	-	-	-	0.03	4.6	-	4.6	-	-	-	-
Poland	56.7	-	0.02	0.1	14.3	32.8	6.1	2.9	0.6	-	-	-
Russia	25.6	-	-	-	-	25.6	-	-	-	-	-	-
Sweden	70.4	-	-	1.6	5.3	8.8	22.5	19.9	12.2	0.003	-	-
Total	**341.5**	**9.8**	**0.02**	**2.5**	**31.2**	**95.7**	**34.1**	**85.0**	**44.5**	**3.3**	**0.002**	**35.2**

Year 2011

Country	Total	22	23	24	25	26	27	28	29	30	31	32
Denmark	31.4	7.1		0.426	2.4	4.0	0.13	8.9	8.1			0.3
Estonia	35.0				0.2	0.2	0.04	2.5	11.9			20.2
Finland	15.8					0.6	0.27	1.2	4.5	3.49		5.7
Germany	11.4	1.2		0.061	0.4	2.8	0.01	3.8	3.3			
Latvia	33.4			0.003	2.5	4.2	0.12	26.6				
Lithuania	9.9			0.021	1.8	5.8	0.05	1.7	0.6			
Poland	55.3			0.689	9.5	38.0	0.16	6.0	1.0			
Russia	19.5					19.5						
Sweden	56.2			1.190	5.9	8.9	11.02	15.4	11.9	0.08		1.8
Total	**267.9**	**8.3**	**0.00**	**2.4**	**22.7**	**83.8**	**11.8**	**66.1**	**41.2**	**3.6**	**0.000**	**28.0**

Year 2012

Country	Total	22	23	24	25	26	27	28	29	30	31	32
Denmark	11.4	4.73	0.00	0.23	2.5	1.4	0.13	-	2.45	-	-	-
Estonia	27.7	-	-	-	-	-	-	2.19	10.16	-	-	15.3
Finland	9.0	-	-	-	-	-	-	-	2.34	2.45	0.02	4.1
Germany	11.3	0.92		0.06	2.0	2.2	0.09	4.10	1.93	-	-	-
Latvia	30.7	-	-	-	0.1	4.7	-	25.85	0.01	-	-	-
Lithuania	11.3	-	-	-	2.8	6.6	-	2.00	-	-	-	-
Poland	62.1	-	-	3.56	24.3	30.5	0.08	2.55	1.16	-	-	-
Russia	25.0	-	-	-	-	25.0	-	-	-	-	-	-
Sweden	46.5	-	-	0.59	7.7	2.7	5.30	19.31	10.62	0.04	-	0.3
Total	**235.0**	**5.7**	**0.00**	**4.4**	**39.3**	**73.0**	**5.6**	**56.0**	**28.7**	**2.5**	**0.022**	**19.8**

continued

Table 7.2 Sprat landings in the Baltic Sea by country and Subdivision (thousand tonnes).

3/3

Year 2013												
Country	**Total**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Denmark	**25.6**	7.10		0.36	3.31	2.2	0.7	3.4	8.4			
Estonia	**29.8**							1.8	11.7			16.2
Finland	**11.1**				0.08		0.1	0.2	4.1	2.86		3.7
Germany	**10.3**	0.59		0.17	1.30	2.6	0.9	1.4	3.4			
Latvia	**33.3**				0.12	4.2		28.6	0.4			
Lithuania	**10.4**				1.35	4.6		3.1	1.3			
Poland	**79.7**			0.96	19.13	53.4	1.6	2.6	2.1			
Russia	**22.6**					22.6						
Sweden	**49.7**			0.12	8.25	4.4	10.9	8.8	16.5	0.12		0.5
Total	**272.4**	**7.7**	**0.00**	**1.6**	**33.5**	**94.0**	**14.2**	**50.0**	**47.9**	**3.0**	**0.000**	**20.5**
Year 2014												
Country	**Total**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Denmark	**26.6**	1.07		1.50	6.52	4.8	0.2	5.7	6.8			0.1
Estonia	**28.5**				0.00	0.0		1.1	9.9			17.5
Finland	**11.7**						0.2	0.1	2.8	2.80	0.001	5.8
Germany	**10.2**	0.60		0.04	2.62	2.2	0.6	1.5	2.6			
Latvia	**30.8**				0.27	2.9		27.6				
Lithuania	**9.6**				0.65	3.5	0.0	4.5	0.9			
Poland	**56.9**			1.49	21.83	31.2	0.2	2.1	0.1			
Russia	**23.4**					23.4						
Sweden	**46.0**			0.04	8.27	6.4	6.3	11.0	12.8	0.25		0.9
Total	**243.8**	**1.7**	**0.00**	**3.1**	**40.2**	**74.5**	**7.5**	**53.6**	**35.9**	**3.0**	**0.001**	**24.3**
Year 2015												
Country	**Total**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Denmark	**22.5**	4.239		0.265	0.077	2.918	2.038	9.562	3.133	0.222		
Estonia	**24.0**				0.490		0.205	1.378	6.807			15.073
Finland	**12.0**				0.354		0.482	0.082	4.396	2.027	0.0003	4.619
Germany	**10.3**	0.657		0.071	2.680	0.851	0.294	4.671	1.068			
Latvia	**30.5**				0.527	2.716		27.067	0.182			
Lithuania	**11.0**				4.355	0.782		5.117	0.749			
Poland	**62.2**			2.715	26.122	33.004	0.001	0.387				
Russia	**30.7**					30.694						
Sweden	**44.1**			0.059	5.857	0.957	13.320	11.212	12.544	0.181		
Total	**247.2**	**4.9**	**0.00**	**3.1**	**40.5**	**71.9**	**16.3**	**59.5**	**28.9**	**2.4**	**0.0003**	**19.7**
Year 2016												
Country	**Total**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Denmark	**19.1**	2.911		1.199	3.851	0.973	1.775	2.860	5.504			
Estonia	**23.7**				0.535		0.104	4.780	4.702			13.566
Finland	**16.9**				0.274		0.191	0.677	7.139	5.342		3.284
Germany	**10.9**	0.394		0.075	1.166	2.378	0.010	4.184	2.698			
Latvia	**28.1**				1.390	1.789		24.922				
Lithuania	**11.6**				4.063	1.039	0.054	5.126	1.275			
Poland	**59.3**			3.703	24.620	28.475	0.313	1.587	0.560			
Russia	**34.6**					34.588						
Sweden	**42.4**			0.032	5.506	5.862	5.719	13.958	10.919	0.435		
Total	**246.5**	**3.3**	**0.0**	**5.0**	**41.4**	**75.1**	**8.2**	**58.1**	**32.8**	**5.8**	**0.0**	**16.9**
Year 2017												
Country	**Total**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Denmark	**27.1**	1.158		1.030	5.657	8.056	3.703	4.991	2.522			
Estonia	**25.3**							1.925	9.719			13.640
Finland	**16.1**				0.353	0.127	0.959	1.008	7.766	2.307	0.001	3.576
Germany*	**13.6**	0.688		0.165	1.046	7.293		2.326	2.035			
Latvia	**35.7**				2.372	2.195		31.175				
Lithuania	**12.5**				3.107	3.444	0.526	4.406	0.996			
Poland	**68.4**			4.196	24.900	34.587	0.743	3.406	0.598			
Russia	**38.7**					38.683						
Sweden	**48.3**			0.150	6.013	12.369	11.553	11.894	6.284	0.052		
Total	**285.7**	**1.8**	**0.0**	**5.5**	**43.4**	**106.8**	**17.5**	**61.1**	**29.9**	**2.4**	**0.001**	**17.2**

*Preliminary

Table 7.3 Sprat in SD 22–32. Catch in numbers and weight-at-age by quarter and Subdivision in 2017. 1/4

Sub-division 22

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	5.2
1	12.9	30.5	4.7	6.0	54.2	5.7	5.4	12.1	10.0
2	2.1	2.8	4.8	9.1	18.8	10.9	12.6	14.0	12.0
3	13.7	9.8	11.1	11.5	46.0	12.9	12.7	14.8	14.3
4	3.8	0.0	3.5	6.0	13.3	13.6	0.0	16.7	16.0
5	2.2	0.6	1.7	2.2	6.7	15.8	17.8	17.3	16.1
6	1.7	0.0	0.0	0.2	2.0	15.5	0.0	0.0	17.1
7	0.4	0.0	0.0	0.3	0.7	20.5	0.0	0.0	18.1
8	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	18.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	36.9	43.7	25.8	85.5	191.9				
SOP	394.9	334.7	376.2	737.5	1843.3				
Catch	1724.2	87.4	262.0	1232.0	3305.7				

Sub-division 23

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0					0.0				
1					0.0				
2					0.0				
3					0.0				
4					0.0				
5					0.0				
6					0.0				
7					0.0				
8					0.0				
9					0.0				
10					0.0				
Sum	0.0	0.0	0.0	0.0	0.0				
SOP	0.0	0.0	0.0	0.0	0.0				
Catch	0.0	0.0	0.0	0.0	0.0				

Sub-division 24

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	131.8	131.8	0.0	0.0	0.0	5.2
1	64.2	11.3	2.4	15.9	93.9	5.1	6.8	12.1	10.0
2	7.8	12.4	2.4	24.0	46.6	11.3	11.6	14.0	12.0
3	52.4	54.2	5.6	30.2	142.4	13.4	14.0	14.8	14.3
4	19.9	27.8	1.7	15.9	65.3	15.9	15.3	16.7	16.0
5	8.4	11.4	0.9	5.7	26.4	16.0	17.2	17.3	16.1
6	2.9	5.2	0.0	0.6	8.8	16.3	18.0	0.0	17.1
7	1.2	2.2	0.0	0.8	4.2	17.4	18.9	0.0	18.1
8	0.8	0.6	0.0	0.3	1.7	18.3	22.4	0.0	18.1
9	0.2	0.0	0.0	0.1	0.2	20.1	0.0	0.0	20.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	157.8	125.1	13.0	225.4	521.3				
SOP	1654.6	1749.7	189.0	1943.2	5536.5				
Catch	2385.9	1842.6	598.4	182.2	5009.0				

continued

Table 7.3 Sprat in SD 22–32. Catch in numbers and weight-at-age by quarter and Subdivision in 2017. 2/4

Sub-division 25

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.9	0.0	0.3	96.4	97.5	6.0	0.0	6.3	5.2
1	160.1	67.8	11.3	21.0	260.1	4.9	6.0	12.0	11.3
2	117.1	74.5	10.9	24.8	227.4	9.7	9.5	13.3	12.6
3	1223.6	691.1	45.9	60.9	2021.5	10.6	10.7	14.0	14.2
4	447.9	241.4	19.7	22.8	731.8	12.9	13.5	15.1	15.5
5	215.1	102.8	10.2	10.1	338.2	13.9	14.6	15.3	15.7
6	69.7	32.3	2.3	2.6	106.9	14.2	15.1	15.7	15.3
7	28.0	16.2	1.2	2.0	47.3	14.6	15.9	17.0	16.7
8	16.5	6.3	0.5	1.1	24.5	15.3	14.7	15.2	16.1
9	0.9	2.3	0.4	0.5	4.2	13.0	13.2	16.0	14.6
10	0.9	0.0	0.0	0.2	1.1	16.0	0.0	0.0	12.4
Sum	2280.8	1234.8	102.6	242.3	3860.5				
SOP	25342.0	14138.1	1447.3	2528.1	43455.5				
Catch	14799.2	23730.8	1598.4	1277.9	41406.2				

Sub-division 26

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	1.1	360.1	361.2	0.0	0.0	4.1	4.0
1	982.7	465.8	31.0	315.8	1795.3	3.7	4.1	9.0	8.8
2	1632.7	1393.0	66.8	284.5	3376.9	7.9	8.0	10.5	10.4
3	4020.9	1450.7	90.5	246.9	5809.0	8.9	9.3	11.7	12.0
4	640.9	195.1	13.2	38.9	888.0	10.3	10.7	13.4	13.7
5	292.9	41.2	4.9	18.3	357.3	11.8	12.0	13.7	14.0
6	89.5	10.8	8.1	5.5	113.8	12.9	13.1	13.7	15.3
7	27.5	4.4	0.2	1.5	33.6	12.5	13.5	14.8	12.4
8	9.4	1.7	0.0	0.9	12.0	14.1	13.7	12.9	17.9
9	3.2	0.0	0.1	0.0	3.3	8.0	0.0	15.8	0.0
10	4.7	0.0	0.0	0.0	4.7	12.5	0.0	0.0	0.0
Sum	7704.4	3562.7	215.9	1272.3	12755.3				
SOP	64092.4	29351.4	2403.2	11047.8	106894.8				
Catch	41842.9	20194.6	3028.3	10038.5	75104.2				

Sub-division 27

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	3.0	0.0
1	89.1	36.1	1.1	30.3	156.6	3.4	3.4	8.2	9.1
2	292.7	87.3	1.3	34.0	415.3	6.7	5.8	9.3	9.7
3	1020.9	279.9	3.4	100.1	1404.3	7.5	6.5	9.6	10.3
4	227.9	27.1	0.3	10.9	266.2	9.0	7.4	11.3	10.6
5	43.5	6.0	0.3	4.2	54.0	10.2	7.9	12.0	12.3
6	25.0	9.0	0.1	1.2	35.3	9.6	8.2	10.5	11.0
7	11.4	0.0	0.0	0.0	11.4	9.8	0.0	13.8	0.0
8	2.3	3.0	0.0	0.6	5.9	12.0	8.0	12.8	12.6
9	2.3	0.0	0.0	0.0	2.3	11.0	0.0	15.8	0.0
10	0.0	3.0	0.0	0.0	3.0	0.0	9.9	0.0	0.0
Sum	1714.9	451.5	6.7	181.4	2354.4				
SOP	12818.5	2824.5	63.1	1825.6	17531.7				
Catch	6226.1	1658.6	6.3	276.1	8167.1				

continued

Table 7.3 Sprat in SD 22–32. Catch in numbers and weight-at-age by quarter and Subdivision in 2017. 3/4

Sub-division 28

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	97.7	97.7	0.0	0.0	0.0	3.3
1	209.5	79.7	49.5	292.4	631.1	3.2	4.1	8.3	8.3
2	654.8	129.7	92.8	274.8	1152.1	7.0	6.8	9.1	9.3
3	2251.0	484.5	337.3	1095.4	4168.2	7.7	8.2	9.7	9.8
4	323.1	113.2	111.7	107.8	655.7	9.5	9.5	10.2	10.7
5	161.8	50.7	30.1	65.4	308.0	10.4	10.5	11.6	11.7
6	74.2	32.7	12.6	38.8	158.2	10.5	10.8	11.8	11.6
7	23.2	5.0	4.8	8.8	41.9	10.8	12.0	11.8	12.5
8	37.2	22.5	1.6	15.1	76.4	11.9	11.4	11.7	12.4
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	2.1	0.0	0.2	0.0	2.3	9.0	0.0	9.3	0.0
Sum	3736.9	917.9	640.6	1996.3	7291.7				
SOP	28829.8	7458.1	6241.5	18707.3	61236.7				
Catch	36201.1	6245.5	3835.9	11811.0	58093.5				

Sub-division 29

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.3	54.7	55.0	0.0	0.0	1.5	2.9
1	153.6	6.2	28.9	155.6	344.3	2.9	2.8	7.0	7.6
2	389.1	18.3	22.2	140.3	570.0	6.1	5.9	8.2	8.6
3	1168.8	70.7	43.4	550.1	1833.1	6.8	6.4	8.3	9.0
4	183.3	12.7	7.6	155.1	358.8	8.9	7.8	9.9	10.6
5	105.1	16.0	36.7	144.6	302.4	9.8	9.3	10.7	11.2
6	53.9	4.1	1.8	89.8	149.6	10.4	10.0	10.9	11.2
7	14.6	5.0	15.8	18.4	53.8	10.4	9.6	0.0	12.1
8	33.6	4.7	21.4	102.2	161.9	10.3	8.8	0.0	11.7
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	2.8	0.0	0.0	2.8	0.0	8.8	0.0	0.0
Sum	2102.1	140.6	178.1	1410.8	3831.5				
SOP	14487.3	980.8	1232.9	13185.8	29886.9				
Catch	24701.7	2342.8	277.9	5474.2	32796.6				

Sub-division 30

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	3.1
1	4.0	0.4	0.0	2.2	6.6	2.8	2.8	7.0	10.5
2	3.4	0.5	0.3	3.4	7.6	6.1	5.9	8.2	11.1
3	59.8	7.6	0.7	8.1	76.2	6.9	6.4	8.3	12.4
4	51.4	6.8	0.3	2.3	60.8	9.4	7.8	9.9	13.2
5	35.3	11.8	1.8	0.7	49.6	9.9	9.3	10.7	14.3
6	21.4	3.5	0.1	0.7	25.6	10.7	10.0	10.9	14.9
7	6.4	3.5	0.8	0.3	11.0	10.5	9.6	0.0	14.3
8	18.3	5.9	1.1	0.8	26.1	10.3	8.8	0.0	15.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	200.1	39.9	5.1	18.8	263.9				
SOP	1762.5	335.3	31.6	228.3	2357.8				
Catch	2689.0	1195.4	97.4	1795.2	5777.0				

continued

Table 7.3 Sprat in SD 22–32. Catch in numbers and weight-at-age by quarter and Subdivision in 2017. 4/4

Sub-division 31

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0000	0.0016	0.0	0.0	0.0	0.0	3.1
1	0.0	0.0	0.0000	0.0081	0.0	0.0	0.0	7.0	10.5
2	0.0	0.0	0.0002	0.0127	0.0	0.0	0.0	8.2	11.1
3	0.0	0.0	0.0004	0.0304	0.0	0.0	0.0	8.3	12.4
4	0.0	0.0	0.0002	0.0087	0.0	0.0	0.0	9.9	13.2
5	0.0	0.0	0.0011	0.0028	0.0	0.0	0.0	10.7	14.3
6	0.0	0.0	0.0001	0.0025	0.0	0.0	0.0	10.9	14.9
7	0.0	0.0	0.0005	0.0011	0.0	0.0	0.0	0.0	14.3
8	0.0	0.0	0.0007	0.0030	0.0	0.0	0.0	0.0	15.2
9	0.0	0.0	0.0000	0.0000	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0000	0.0000	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	0.1	0.1				
SOP	0.0	0.0	0.0	0.9	0.9				
Catch	0.0	0.0	0.0	0.0	0.0				

Sub-division 32

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	1.2	30.6	31.7	0.0	0.0	1.6	2.5
1	25.6	4.8	40.1	167.2	237.6	2.6	3.0	7.2	7.8
2	107.0	34.6	45.3	139.5	326.4	6.2	6.2	8.4	8.6
3	365.7	101.5	144.9	430.8	1043.0	6.7	7.0	8.7	8.9
4	44.5	14.1	23.9	73.4	155.8	9.3	9.5	10.6	10.2
5	47.4	14.0	25.0	34.7	121.0	9.7	9.8	11.2	10.9
6	27.1	6.4	6.5	35.3	75.3	10.1	10.1	10.9	10.8
7	11.4	2.8	16.1	7.0	37.4	10.5	10.5	12.9	10.8
8	22.4	9.7	12.2	21.6	65.9	10.2	10.5	10.9	11.2
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	651.1	187.9	315.1	940.0	2094.1				
SOP	4675.6	1406.5	2876.2	8239.2	17197.5				
Catch	8269.0	889.1	379.3	7313.1	16850.4				

Sub-divisions 22-32

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.9	0.0	2.9	821.7	825.6	6.0	0.0	3.0	4.2
1	1701.8	702.7	168.9	1006.4	3579.9	3.7	4.3	8.4	8.4
2	3206.8	1753.0	246.9	934.3	6141.0	7.4	7.8	9.6	9.6
3	10176.8	3150.1	682.8	2534.0	16543.7	8.4	9.1	10.1	9.9
4	1942.7	638.1	181.9	433.0	3195.7	10.5	11.5	11.2	11.4
5	911.7	254.5	111.4	286.0	1563.6	11.6	12.5	11.8	11.8
6	365.4	103.9	31.4	174.8	675.5	11.8	12.4	12.3	11.4
7	124.0	39.2	39.0	39.1	241.3	11.9	13.5	7.4	12.4
8	140.5	54.5	36.8	142.7	374.5	11.6	11.1	4.3	11.8
9	6.5	2.3	0.5	0.6	10.0	10.1	13.2	16.0	15.5
10	7.7	5.8	0.2	0.2	13.9	12.0	9.4	9.3	12.4
Sum	18584.9	6704.0	1502.9	6372.9	33164.7				
SOP	154057.8	58579.2	14861.0	58443.5	285941.4				
Catch	138839.1	58186.8	10083.7	39400.2	246509.7				

Table 7.4 Sprat in SD 22–32. Fishing effort and CPUE data.

Year	Russia - Sub-division 26			
	Type of vessels			
	*)SRTM (51 m length, 1100 hp)		MRTK (27 m length, 300 hp)	
	Effort [h]	CPUE, [kg/h]	Effort [h]	CPUE, [kg/h]
1995	8907	647	8760	601
1996	12129	620	7810	953
1997	17140	470	10691	746
1998	13469	646	9986	782
1999	13898	869	15967	965
2000	14417	766	13501	1031
2001	12837	937	12912	1282
2002	11789	884	18979	1012
2003	5869	958	14128	1285
2004	2973	895	14751	1394
2005	1696	1323	21908	1115
2006	877	1362	16592	1406
2007			16032	1303
2008			14428	1306
2009			17966	1258
2010			14179	1276
2011			9373	1125
2012			13308	1877
2013			11988	1885
2014			11724	2000
2015			15822	1940
2016			19746	1752
2017			21092	1834

*) - vessels withdrawn from exploitation in 2007

Table 7.5 **Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 1/7**

Sub-division	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
22	Denmark	1	0.0	0	0	0
		2	300.7	1	126	49
		3	376.1	0	0	0
		4	481.0	0	0	0
		Total	1,157.9	1	126	49
	Germany	1	394.4	1	94	58
		2	35.5	0	0	0
		3	0.0	0	0	0
		4	257.8	0	0	0
		Total	687.7	1	94	58
	Total	1	394.4	1	94	58
		2	336.2	1	126	49
		3	376.1	0	0	0
		4	738.8	0	0	0
		Total	1,845.6	2	220	107

Sub-division	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
23+24	Denmark	1	191.4	0	0	0
		2	0.5	0	0	0
		3	0.0	0	0	0
		4	838.5	0	0	0
		Total	1,030.4	0	0	0
	Finland	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Germany	1	98.0	4	126	75
		2	62.0	1	72	45
		3	0.0	0	0	0
		4	5.1	0	0	0
		Total	165.1	5	198	120
	Latvia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Lithuania	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Poland	1	1,306.5	4	855	221
		2	1,655.5	10	1,930	329
		3	187.9	2	413	78
		4	1,046.4	3	295	0
		Total	4,196.3	19	3,493	628
	Sweden	1	59.1	0	0	0
		2	33.0	0	0	0
		3	1.1	0	0	0
		4	56.6	0	0	0
		Total	149.8	0	0	0
	Total	1	1,655.0	8	981	296
		2	1,751.0	11	2,002	374
		3	189.0	2	413	78
		4	1,946.6	3	295	0
		Total	5,541.6	24	3,691	748

continued

Table 7.5 Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 2/7

Sub-division	Country	Quarter	Landings	Number of	Number of fish	
25			in tons	samples	measured	aged
	Denmark	1	4,775.7	2	214	108
		2	821.1	0	0	0
		3	0.0	0	0	0
		4	59.8	0	0	0
		Total	5,656.6	2	214	108
	Estonia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Finland	1	338.2	0	0	0
		2				
		3				
		4	15.0	0	0	0
		Total	353.2	0	0	0
	Germany	1	210.6	2	508	113
		2	835.3	0	0	0
		3				
		4				
		Total	1,045.9	2	508	113
	Latvia	1	1,702.7	0	0	0
		2	621.9	0	0	0
		3	47.3	0	0	0
		4	0.0	0	0	0
		Total	2,371.9	0	0	0
	Lithuania	1	692.8	0	0	0
		2	2,388.3	0	0	0
		3				
		4	25.8	0	0	0
		Total	3,106.9	0	0	0
	Poland	1	14,091.2	39	7917	1103
		2	8,374.9	32	6423	990
		3	1,077.8	20	3757	246
		4	1,355.7	36	5822	512
		Total	24,899.6	127	23919	2851
	Sweden	1	3,518.9	5	365	364
		2	1,100.5	6	509	507
		3	323.0	8	317	316
		4	1,071.2	8	505	504
		Total	6,013.5	27	1696	1691
	Total	1	25,330.0	48	9004	1688
		2	14,141.9	38	6932	1497
		3	1,448.1	28	4074	562
		4	2,527.4	44	6327	1016
		Total	43,447.5	158	26337	4763

continued
Table 7.5 Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 3/7

Sub-division 26	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	7,352.4	3	313	104
		2				
		3				
		4	703.7	0	0	0
		Total	8,056.1	3	313	104
	Estonia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Finland	1	13.0	0	0	0
		2	98.1	0	0	0
		3	0.0	0	0	0
		4	16.0	0	0	0
		Total	127.1	0	0	0
	Germany	1	3,862.1	3	840	170
		2	3,431.4	3	780	169
		3				
		4				
		Total	7,293.4	6	1620	339
	Latvia	1	1,010.0	0	0	0
		2	643.2	0	0	0
		3	130.7	0	0	0
		4	410.9	2	416	164
		Total	2,194.8	2	416	164
	Lithuania	1	1,540.1	0	0	0
		2	1,903.9	0	0	0
		3	0.0	0	0	0
		4	0.0	0	0	0
		Total	3,444.0	0	0	0
	Poland	1	22,758.4	36	6911	1003
		2	8,137.2	32	5792	869
		3	628.2	17	2585	446
		4	3,063.6	8	1598	431
		Total	34,587.4	93	16886	2749
	Russia	1	17,948.8	7	1533	300
		2	12,263.7	20	3701	458
		3	1,637.0	13	3042	460
		4	6,834.0	12	2337	300
		Total	38,683.4	52	10613	1518
	Sweden	1	9,653.0	5	410	409
		2	2,680.8	0	0	0
		3	5.0	0	0	0
		4	30.0	0	0	0
		Total	12,368.8	5	410	409
	Total	1	64,137.7	54	10007	1986
		2	29,158.2	55	10273	1496
		3	2,400.9	30	5627	906
		4	11,058.2	22	4351	895
		Total	106,754.9	161	30258	5283

continued

Table 7.5 Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 4/7

Sub-division	Country	Quarter	Landings	Number of	Number of fish	
27			in tons	samples	measured	aged
	Denmark	1	3,368.9	1	104	52
		2				
		3				
		4	334.0	0	0	0
		Total	3,702.8	1	104	52
	Estonia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Finland	1	379.3	0	0	0
		2	442.1	0	0	0
		3	0.0	0	0	0
		4	137.7	0	0	0
		Total	959.1	0	0	0
	Germany	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Lithuania	1	388.2	0	0	0
		2	138.1	0	0	0
		3				
		4				
		Total	526.3	0	0	0
	Poland	1	170.4	0	0	0
		2	554.7	0	0	0
		3	0.0	0	0	0
		4	18.2	0	0	0
		Total	743.3	0	0	0
	Sweden	1	8,450.0	9	540	539
		2	1,702.9	1	150	150
		3	63.3	1	150	149
		4	1,336.5	2	300	299
		Total	11,552.7	13	1,140	1,137
	Total	1	12,756.8	10	644	591
		2	2,837.8	1	150	150
		3	63.3	1	150	149
		4	1,826.4	2	300	299
		Total	17,484.2	14	1,244	1,189

continued

Table 7.5 Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 5/7

Sub-division 28	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	3.305.0	5	547	278
		2				
		3				
		4	1.685.9	0	0	0
		Total	4.990.9	5	547	278
	Estonia	1	1.589.0	13	1527	1044
		2	259.0	5	487	414
		3	77.0	1	177	100
		4	-	0	0	0
		Total	1.925.0	19	2191	1558
	Finland	1	24.2	0	0	0
		2	336.0	0	0	0
		3	75.6	0	0	0
		4	572.3	0	0	0
		Total	1.008.1	0	0	0
	Germany	1	2.230.7	4	1138	219
		2				
		3				
		4	95.1	0	0	0
		Total	2325.9	4	1138	219
	Latvia	1	10.366.5	10	2105	1013
		2	5.962.6	8	1534	711
		3	5.259.3	6	1218	484
		4	9.586.4	10	2043	898
		Total	31.174.8	34	6900	3106
	Lithuania	1	1.589.9	0	0	0
		2	175.8	0	0	0
		3	128.8	0	0	0
		4	2.512.0	0	0	0
		Total	4.406.4	0	0	0
	Poland	1	1.772.4	0	0	0
		2	73.9	0	0	0
		3	224.2	0	0	0
		4	1.335.0	0	0	0
		Total	3.405.5	0	0	0
	Russia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Sweden	1	7.937.4	6	580	579
		2	632.6	0	0	0
		3	450.9	3	249	247
		4	2.873.5	3	249	247
		Total	11.894.4	12	1078	1073
	Total	1	28.815.1	38	5897	3133
		2	7.439.8	13	2021	1125
		3	6.215.8	10	1644	831
		4	18.660.2	13	2292	1145
		Total	61.130.9	74	11854	6234

continued

Table 7.5 Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 6/7

Sub-division 29	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	Number of fish aged
	Denmark	1	1,618.9	0	0	0
		2				
		3				
		4	903.3	0	0	0
		Total	2,522.2	0	0	0
	Estonia	1	3,791.0	10	2,083	1,000
		2	709.0	3	674	300
		3	612.0	3	597	300
		4	4,607.0	10	2,052	1,000
		Total	9,719.0	26	5,406	2,600
	Finland	1	2,291.0	5	1,102	0
		2	266.6	3	27	0
		3	623.4	2	420	0
		4	4,585.2	3	430	297
		Total	7,766.3	13	1,979	297
	Germany	1	505.9	2	684	112
		2				
		3				
		4	1,528.8	0	0	0
		Total	2,034.7	2	684	112
	Latvia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Lithuania	1	254.8	0	0	0
		2				
		3				
		4	741.7	0	0	0
		Total	996.5	0	0	0
	Poland	1	254.3	0	0	0
		2				
		3				
		4	344.0	0	0	0
		Total	598.3	0	0	0
	Sweden	1	5,828.5	4	502	501
		2				
		3				
		4	455.0	0	0	0
		Total	6,283.5	4	502	501
	Total	1	14,544.4	21	4,371	1,613
		2	975.6	6	701	300
		3	1,235.4	5	1,017	300
		4	13,165.0	13	2,482	1,297
		Total	29,920.5	45	8,571	3,510

continued

Table 7.5 Sprat in subdivisions 22–32. Samples of commercial catches by quarter, country and Sub-division for 2017 available to the Working Group. 7/7

Sub-division	Country	Quarter	Landings	Number of	Number of fish	
30			in tons	samples	measured	aged
	Denmark	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Finland	1	1,729.4	11	1,568	0
		2	320.8	9	723	0
		3	31.6	5	216	0
		4	225.1	10	638	318
		Total	2,307.0	35	3,145	318
	Sweden	1	35.6	0	0	0
		2	13.3	0	0	0
		3	0.1	0	0	0
		4	3.1	0	0	0
		Total	52.1	0	0	0
	Total	1	1,765.1	11	1,568	0
		2	334.1	9	723	0
		3	31.7	5	216	0
		4	228.2	10	638	318
		Total	2,359.1	35	3,145	318
Sub-division	Country	Quarter	Landings	Number of	Number of fish	
31			in tons	samples	measured	aged
	Finland	1				
		2				
		3	0.0	0	0	0
		4	0.9	0	0	0
		Total	0.9	0	0	0
Sub-division	Country	Quarter	Landings	Number of	Number of fish	
32			in tons	samples	measured	aged
	Denmark	1				
		2				
		3				
		4				
		Total	0.00	0	0	0
	Estonia	1	3,721.00	15	3,255	1,459
		2	1,372.00	9	2,358	900
		3	2,136.00	5	1,247	500
		4	6,411.00	13	2,480	1,296
		Total	13,640.00	42	9,340	4,155
	Finland	1	948.89	1	301	0
		2	40.53	0	0	0
		3	741.86	2	601	0
		4	1,844.70	1	301	0
		Total	3,575.97	4	1,203	0
	Sweden	1				
		2				
		3				
		4				
		Total	0.00	0	0	0
	Total	1	4,669.89	16	3,556	1,459
		2	1,412.53	9	2,358	900
		3	2,877.86	7	1,848	500
		4	8,255.70	14	2,781	1,296
		Total	17,215.97	46	10,543	4,155
Sub-divisions	**Total**	**Quarter**	**Landings**	**Number of**	**Number of fish**	
22-32			**in tons**	**samples**	**measured**	**aged**
		1	**154,068.50**	**207**	**36,122**	**10,824**
		2	**58,387.17**	**143**	**25,286**	**5,891**
		3	**14,838.19**	**88**	**14,989**	**3,326**
		4	**58,407.33**	**121**	**19,466**	**6,266**
		Total	**285,701.20**	**559**	**95,863**	**26,307**

Table 7.6 Sprat in SD 22–32. Catch-in-numbers (Thousands) CANUM.

CANUM: Catch in numbers (Total International Catch) (Thousands)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	2615000	6172000	3618000	1940000	1929000	933000	1213000	278000
1975	628000	2032000	5678000	2387000	790000	878000	247000	546000
1976	4682000	818000	2106000	3510000	1040000	350000	548000	422000
1977	2371000	8399000	997000	1907000	1739000	364000	140000	399000
1978	500000	3325000	4936000	480000	817000	683000	73000	189000
1979	1340000	597000	1037000	2291000	188000	150000	335000	125000
1980	369000	1476000	378000	500000	1357000	72000	67000	235000
1981	2303000	920000	405000	94000	88000	527000	13000	99000
1982	363000	2460000	425000	225000	64000	57000	231000	51000
1983	1852000	297000	531000	107000	47000	12000	18000	148000
1984	1005000	2393000	388000	447000	77000	38000	9000	83000
1985	566000	1703000	2521000	447000	271000	30000	19000	65000
1986	495000	1142000	1425000	2099000	340000	188000	16000	50000
1987	779000	394000	1320000	1833000	1805000	227000	149000	73000
1988	78000	2696000	730000	1149000	762000	760000	65000	141000
1989	2102000	290000	1772000	404000	739000	390000	398000	137000
1990	1049000	3171000	346000	952000	188000	316000	112000	200000
1991	1044000	2649000	2439000	407000	569000	106000	160000	152000
1992	1782000	2939000	3040000	1643000	444000	311000	121000	163000
1993	1832000	5685000	3244000	1898000	884000	267000	244000	257000
1994	1079000	8169000	8176000	3525000	2201000	779000	193000	208000
1995	6373000	2341000	6643000	6636000	3366000	1902000	627000	409000
1996	8389000	27675000	4704000	6517000	3323000	1499000	690000	403000
1997	1718000	23182000	23395000	6343000	4108000	1651000	683000	279000
1998	11018000	3803000	17688000	19618000	2659000	1778000	1468000	489000
1999	2082000	19901000	5832000	9972000	8836000	1180000	687000	515000
2000	10535000	2948000	14716000	2870000	4284000	4077000	707000	761000
2001	2776000	11557000	2670000	9252000	1999000	2651000	2264000	523000
2002	6648000	5429000	10781000	3835000	4308000	998000	880000	1340000
2003	9366000	7109000	4805000	5067000	2396000	1903000	833000	1383000
2004	23264000	13094000	5448000	3086000	3246000	1334000	1143000	1364000
2005	2843000	30968000	11254000	2934000	1868000	843000	659000	615000
2006	10851000	3266000	21097000	6832000	1380000	614000	405000	530000
2007	13796000	11968000	3706000	13723000	3855000	623000	301000	539000
2008	6391000	15479000	6684000	2937000	5719000	2255000	299000	362000
2009	21145000	8891000	10181000	3905000	1795000	2837000	1008000	353000
2010	4584000	21493000	5363000	4234000	1239000	881000	994000	511000
2011	8799000	4361000	12720000	2749000	1471000	549000	379000	568000
2012	5218000	5712000	2727000	7041000	1246000	736000	298000	437000
2013	6266000	9569000	4486000	2391000	3849000	682000	310000	317000
2014	4911208	7619008	6498613	2373559	1458602	1402152	352393	371808
2015	17057263	4720316	5121411	3272068	1244627	659072	584565	292838
2016	2973969	18520734	3801288	2547751	1226450	508161	406247	450644
2017	3579884	6141001	16543725	3195711	1563614	675502	241309	398356

Table 7.7 Sprat in SD 22–32. Mean weight in the catch and in the stock (kg).

WECA (=WEST): Mean weight in Catch (Kilograms)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.0066	0.0105	0.0122	0.0134	0.0139	0.0154	0.0141	0.0143
1975	0.0068	0.0112	0.0124	0.0134	0.0147	0.0143	0.0157	0.0135
1976	0.0069	0.0107	0.0127	0.0135	0.0145	0.0161	0.0147	0.0143
1977	0.0054	0.0110	0.0134	0.0140	0.0144	0.0159	0.0159	0.0158
1978	0.0051	0.0109	0.0125	0.0131	0.0141	0.0152	0.0158	0.0151
1979	0.0055	0.0127	0.0130	0.0137	0.0151	0.0158	0.0156	0.0162
1980	0.0078	0.0113	0.0143	0.0141	0.0143	0.0167	0.0158	0.0160
1981	0.0063	0.0141	0.0161	0.0180	0.0165	0.0159	0.0168	0.0161
1982	0.0088	0.0117	0.0160	0.0162	0.0167	0.0164	0.0163	0.0173
1983	0.0092	0.0145	0.0162	0.0171	0.0169	0.0170	0.0169	0.0168
1984	0.0097	0.0111	0.0146	0.0153	0.0158	0.0163	0.0169	0.0172
1985	0.0091	0.0113	0.0127	0.0140	0.0160	0.0171	0.0171	0.0158
1986	0.0079	0.0121	0.0129	0.0140	0.0148	0.0161	0.0170	0.0167
1987	0.0085	0.0117	0.0133	0.0145	0.0152	0.0164	0.0170	0.0176
1988	0.0056	0.0103	0.0122	0.0142	0.0152	0.0153	0.0166	0.0170
1989	0.0097	0.0136	0.0145	0.0158	0.0169	0.0173	0.0175	0.0181
1990	0.0104	0.0126	0.0149	0.0160	0.0175	0.0177	0.0184	0.0181
1991	0.0090	0.0129	0.0143	0.0158	0.0166	0.0175	0.0169	0.0169
1992	0.0087	0.0121	0.0147	0.0154	0.0173	0.0172	0.0181	0.0184
1993	0.0066	0.0111	0.0138	0.0146	0.0150	0.0162	0.0166	0.0166
1994	0.0080	0.0098	0.0121	0.0140	0.0145	0.0152	0.0155	0.0159
1995	0.0065	0.0106	0.0110	0.0126	0.0137	0.0141	0.0143	0.0145
1996	0.0043	0.0075	0.0103	0.0111	0.0124	0.0128	0.0127	0.0129
1997	0.0067	0.0074	0.0085	0.0101	0.0117	0.0124	0.0125	0.0127
1998	0.0046	0.0076	0.0083	0.0089	0.0104	0.0106	0.0108	0.0118
1999	0.0040	0.0078	0.0092	0.0091	0.0092	0.0106	0.0112	0.0110
2000	0.0062	0.0102	0.0100	0.0108	0.0113	0.0117	0.0128	0.0134
2001	0.0063	0.0093	0.0114	0.0108	0.0116	0.0113	0.0110	0.0118
2002	0.0069	0.0097	0.0102	0.0109	0.0111	0.0111	0.0115	0.0117
2003	0.0050	0.0099	0.0108	0.0109	0.0114	0.0111	0.0107	0.0108
2004	0.0044	0.0076	0.0105	0.0112	0.0111	0.0114	0.0111	0.0113
2005	0.0047	0.0069	0.0081	0.0107	0.0112	0.0116	0.0110	0.0113
2006	0.0049	0.0078	0.0082	0.0089	0.0108	0.0112	0.0111	0.0114
2007	0.0056	0.0077	0.0091	0.0092	0.0094	0.0109	0.0113	0.0110
2008	0.0068	0.0092	0.0098	0.0105	0.0103	0.0102	0.0112	0.0122
2009	0.0050	0.0092	0.0105	0.0109	0.0114	0.0108	0.0110	0.0120
2010	0.0052	0.0080	0.0099	0.0107	0.0110	0.0112	0.0108	0.0114
2011	0.0040	0.0091	0.0096	0.0107	0.0114	0.0114	0.0114	0.0124
2012	0.0059	0.0094	0.0111	0.0112	0.0120	0.0123	0.0123	0.0121
2013	0.0051	0.0096	0.0115	0.0125	0.0126	0.0129	0.0130	0.0125
2014	0.0052	0.0092	0.0107	0.0120	0.0127	0.0127	0.0123	0.0123
2015	0.0042	0.0095	0.0110	0.0117	0.0126	0.0132	0.0125	0.0122
2016	0.0047	0.0071	0.0099	0.0113	0.0118	0.0126	0.0123	0.0122
2017	0.0054	0.0080	0.0088	0.0108	0.0118	0.0118	0.0115	0.0109

Table 7.8 Sprat in SD 22–32. Natural Mortality.

NATMOR: Natural Mortality

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974	0.49	0.49	0.49	0.47	0.46	0.46	0.46	0.46
1975	0.53	0.53	0.53	0.51	0.50	0.50	0.49	0.49
1976	0.47	0.47	0.47	0.46	0.45	0.44	0.44	0.44
1977	0.55	0.55	0.54	0.53	0.52	0.51	0.51	0.51
1978	0.67	0.67	0.66	0.64	0.63	0.62	0.61	0.61
1979	0.78	0.78	0.77	0.75	0.73	0.72	0.71	0.71
1980	0.84	0.84	0.83	0.81	0.79	0.77	0.77	0.77
1981	0.80	0.80	0.80	0.77	0.75	0.74	0.74	0.74
1982	0.82	0.82	0.82	0.79	0.77	0.76	0.75	0.75
1983	0.76	0.76	0.76	0.74	0.72	0.71	0.70	0.70
1984	0.63	0.63	0.63	0.61	0.59	0.58	0.58	0.58
1985	0.54	0.54	0.53	0.52	0.51	0.50	0.50	0.50
1986	0.47	0.47	0.47	0.46	0.45	0.45	0.44	0.44
1987	0.43	0.43	0.43	0.42	0.41	0.40	0.40	0.40
1988	0.43	0.43	0.43	0.42	0.41	0.41	0.41	0.41
1989	0.39	0.39	0.39	0.38	0.38	0.37	0.37	0.37
1990	0.33	0.33	0.33	0.32	0.32	0.32	0.32	0.32
1991	0.28	0.28	0.28	0.28	0.28	0.27	0.27	0.27
1992	0.27	0.27	0.27	0.27	0.26	0.26	0.26	0.26
1993	0.30	0.30	0.30	0.29	0.29	0.29	0.29	0.29
1994	0.30	0.30	0.30	0.29	0.29	0.29	0.29	0.29
1995	0.30	0.30	0.30	0.29	0.29	0.29	0.29	0.29
1996	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
1997	0.30	0.30	0.30	0.30	0.29	0.29	0.29	0.29
1998	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31
1999	0.34	0.34	0.34	0.33	0.33	0.33	0.32	0.32
2000	0.34	0.34	0.34	0.33	0.33	0.33	0.32	0.32
2001	0.33	0.33	0.33	0.32	0.32	0.32	0.31	0.31
2002	0.35	0.35	0.35	0.34	0.33	0.33	0.33	0.33
2003	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
2004	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28
2005	0.30	0.30	0.30	0.30	0.29	0.29	0.29	0.29
2006	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31
2007	0.33	0.33	0.33	0.33	0.32	0.32	0.32	0.32
2008	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34
2009	0.37	0.37	0.37	0.37	0.36	0.36	0.35	0.35
2010	0.42	0.42	0.42	0.41	0.40	0.40	0.40	0.40
2011	0.45	0.45	0.45	0.44	0.43	0.43	0.42	0.42
2012	0.36	0.36	0.36	0.35	0.35	0.35	0.34	0.34
2013	0.31	0.31	0.31	0.31	0.31	0.30	0.30	0.30
2014	0.30	0.30	0.30	0.30	0.29	0.29	0.29	0.29
2015	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30
2016	0.33	0.33	0.33	0.32	0.32	0.32	0.32	0.32
2017	0.28	0.28	0.28	0.28	0.28	0.28	0.27	0.27

Table 7.9 Sprat in SD 22–32. Proportion mature at spawning time.

MATPROP: Proportion of Mature at Spawning Time

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2017	0.170	0.930	1.0	1.0	1.0	1.0	1.0	1.0

Table 7.10 Sprat in SD 22–32. Proportion of M before spawning.

MPROP: Proportion of M before Spawning

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2017	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Table 7.11 Sprat in SD 22–32. Proportion of F before spawning.

FPROP: Proportion of F before Spawning

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1974-2017	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Table 7.12 Sprat in SD 22–32. Tuning Fleet/Acoustic Survey in SD 22–29 age 0 shifted to represent age 1.

Fleet 03. Acoustic on age 0 in SD 22-29 shifted to represent age 1

Year	Fish. Effort	Age 1
1992	1	59473
1993	1	48035
1994	1	-11
1995	1	64092
1996	1	-11
1997	1	3842
1998	1	-11
1999	1	1279
2000	1	33320
2001	1	4601
2002	1	12001
2003	1	79551
2004	1	146335
2005	1	3562
2006	1	41863
2007	1	66125
2008	1	17821
2009	1	115698
2010	1	12798
2011	1	41916
2012	1	45186
2013	1	33653
2014	1	24694
2015	1	162715
2016	1	36900
2017	1	30765

Table 7.13 Sprat in SD 22–32. Tuning Fleet/ International Acoustic Survey in October (SD 22–29).

Fleet 01. International Acoustic Survey corrected by area surveyed (Catch: Millions)

Year	Fish. Effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	total
1991	1	46488	40299	43681	2743	8924	1851	1957	3117	149060
1992	1	36519	26991	24051	9289	1921	2437	714	560	102482
1993	1	-11	-11	-11	-11	-11	-11	-11	-11	-11
1994	1	12532	44588	43274	17272	11925	5112	1029	1559	137291
1995	1	-11	-11	-11	-11	-11	-11	-11	-11	-11
1996	1	69994	130760	20797	23241	12778	6405	3697	1311	268983
1997	1	-11	-11	-11	-11	-11	-11	-11	-11	-11
1998	1	100615	21975	55422	36291	8056	4735	1623	1011	229728
1999	1	4892	90050	15989	35717	38820	5231	3290	1738	195727
2000	1	58703	5285	49635	5676	13933	15835	1554	2678	153299
2001	1	12047	35687	6927	30237	4028	9606	6370	2407	107309
2002	1	31209	14415	36763	5733	18735	2638	5037	4345	118875
2003	1	99129	32270	24035	23198	8016	13163	4831	8536	213178
2004	1	119497	47027	11638	7929	4876	2450	2389	3552	199358
2005	1	7082	125148	48724	10035	5116	3011	2364	3325	204805
2006	1	36531	11774	103289	32412	7937	4583	2111	2947	201584
2007	1	51888	21665	8175	26102	9800	1067	470	1578	120745
2008	1	28805	45118	20134	5350	18820	5678	1241	1917	127063
2009	1	77343	25333	20840	6547	4667	7023	2011	1376	145140
2010	1	11638	51321	10654	6663	1684	1958	2572	1168	87658
2011	1	20620	11657	43357	9990	6747	2615	1795	2808	99589
2012	1	40516	16525	7935	18413	3494	1733	606	1368	90590
2013	1	19408	20364	11448	5684	11219	1771	759	1274	71927
2014	1	10448	8623	9735	4695	2034	3779	681	774	40768
2015	1	99618	17315	19728	11041	3426	3552	2772	1528	158981
2016	1	20531	80822	24344	9305	3725	1475	1203	1250	142656
2017	1	30171	33937	78088	13673	6372	2681	823	925	166670

Table 7.14 Sprat in SD 22–32. Tuning Fleet/ International Acoustic Survey in SD 24–28 excl. SD 27

Fleet 02. International Acoustic Survey in May corrected by area surveyed (Catch: Millions)

Year	Fish. Effort	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
2001	1	8225	35735	12971	37328	5384	4635	4526	600
2002	1	27412	18982	36814	19045	14759	2517	3670	2585
2003	1	26469	16471	8423	15533	5653	7170	1660	3607
2004	1	136162	65566	15784	11042	12655	3271	7806	6321
2005	1	4359	88830	23557	7258	3517	2781	1830	2243
2006	1	13417	7980	76703	21046	5702	1970	1526	1943
2007	1	51569	28713	6377	36006	7481	1261	533	698
2008	1	9029	40270	20164	5627	21188	4210	757	1477
2009	1	39412	26701	36255	10549	6312	14106	5341	964
2010	1	9387	58680	15199	15963	5062	1654	5566	1273
2011	1	18092	6791	66160	16689	10565	4077	2399	3382
2012	1	22700	22080	11274	35541	7515	5025	1367	2158
2013	1	24877	35333	18393	11358	14959	3385	2164	950
2014	1	10145	26907	19857	7458	6098	3810	1217	1058
2015	1	70752	24660	29744	18935	8081	4074	2581	1721
2016	1	-11	-11	-11	-11	-11	-11	-11	-11
2017	1	32701	36292	132939	20630	6790	2250	809	942

Table 7.15 Sprat in SD 22–32. Output from XSA. 1/7

Lowestoft VPA Version 3.1

2/04/2018 22:09

Extended Survivors Analysis

Sprat 22 32

CPUE data from file d:\SprDat17\Fleet3xsa.txt

Catch data for 44 years. 1974 to 2017. Ages 1 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: BIAS	1991	2017	1	7	0.75	0.85
FLT02: BASS	2001	2017	1	7	0.35	0.42
FLT03: Age0	1992	2017	1	1	0	0.01

Time series weights :

Tapered time weighting applied

Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C

Minimum of 5 points used for regression

Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F

of the final 5 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = .750

Minimum standard error for population

estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 80 iterations

Total absolute residual between iterations

79 and 80 = .00045

Final year F values

Age	1.00	2.00	3.00	4.00	5.00	6.00	7.00
Iteration 79	0.05	0.15	0.23	0.29	0.32	0.29	0.34
Iteration 80	0.05	0.15	0.23	0.29	0.32	0.29	0.34

Regression weights

1	1	1	1	1	1	1	0.997	1	1

continued
Table 7.15 Sprat in SD 22–32. Output from XSA. 2/7

Fishing mortalities

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	0	0	0	0	0	0	0	0.092	0.047	0.053
2	0	0	0	0	0	0	0	0.151	0.155	0.146
3	0.387	0.454	0.334	0.347	0.211	0.384	0.393	0.308	0.199	0.227
4	0.329	0.503	0.435	0.375	0.421	0.34	0.41	0.398	0.282	0.289
5	0.412	0.415	0.363	0.339	0.366	0.508	0.407	0.444	0.288	0.315
6	0.475	0.445	0.46	0.348	0.355	0.41	0.393	0.365	0.373	0.285
7	0.461	0.483	0.338	0.476	0.406	0.285	0.434	0.315	0.46	0.34

XSA population numbers (Thousands)

	AGE						
YEAR	1	2	3	4	5	6	7
2008	70600	66100	24800	12500	20100	7070	959
2009	184000	44400	33600	11900	6330	9460	3130
2010	55000	109000	23300	14700	4970	2920	4230
2011	58900	32400	54400	10900	6340	2320	1240
2012	68200	30500	17200	24500	4850	2940	1060
2013	61200	43000	16500	9680	11300	2360	1450
2014	59000	39400	23300	8200	5060	5000	1160
2015	227000	39400	22600	11600	4040	2510	2510
2016	75800	152000	24800	12200	5740	1910	1290
2017	80100	52000	93700	14700	6640	3130	960

Estimated population abundance at 1st Jan 2018

0	57200	33900	56300	8310	3670	1790

Taper weighted geometric mean of the VPA populations:

84200	53300	29900	14000	6810	3300	1630

Standard error of the weighted Log(VPA populations) :

0.4978	0.539	0.5681	0.4517	0.4772	0.5173	0.5517

continued
Table 7.15 Sprat in SD 22–32. Output from XSA. 3/7

Log catchability residuals.
Fleet : FLT01: International

Age	1991	1992	1993	1994	1995	1996	1997
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	0.14	-0.9	0.3	-0.12	0.49	0.45	-0.04	-0.5	0.23	0.17
2	-0.06	0.51	-1.36	0.15	-0.09	0.7	0.11	0.54	-0.42	0.01
3	0.18	-0.22	0.13	-1.06	0.51	0.62	-0.07	0.3	0.57	-0.68
4	-0.23	0.39	-0.75	0.26	-0.7	0.69	0.15	0.44	0.45	-0.13
5	-0.04	0.48	0.06	-0.56	0.4	0.25	-0.08	0.5	0.87	-0.14
6	0.12	0.17	0.31	0.46	-0.34	0.68	-0.17	0.15	1.22	-0.37
7	-0.86	0.47	-0.38	0.15	0.5	1.03	-0.39	0.62	0.44	-0.21

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	0.17	-0.06	-0.18	0.22	0.44	0.02	-0.4	-0.16	-0.19	0
2	0.44	0.23	0.08	-0.24	0.16	0.02	-0.8	-0.18	0.03	0.19
3	0.23	0.03	-0.33	0.26	-0.46	0.05	-0.46	0.21	0.25	0.08
4	-0.54	-0.13	-0.35	0.32	0.1	-0.25	-0.23	0.28	-0.02	0.15
5	0.21	-0.01	-0.8	0.35	-0.08	0.32	-0.68	0.11	-0.27	0.11
6	0.1	0.02	-0.04	0.42	-0.29	-0.04	-0.06	0.55	-0.03	-0.03
7	0.57	-0.1	-0.23	0.76	-0.29	-0.51	-0.27	0.26	0.22	0.01

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7
Mean Log q	-0.2776	0.1472	0.2359	0.3265	0.3265	0.3265
S.E(Log q)	0.3647	0.3762	0.3244	0.4281	0.3942	0.437

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.7	1.738	3.85	0.77	20	0.28	-0.69

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.8	1.223	2.35	0.79	20	0.29	-0.28
3	0.77	1.559	2.22	0.83	20	0.27	0.15
4	0.91	0.417	0.6	0.7	20	0.31	0.24
5	0.85	0.615	1.01	0.64	20	0.38	0.33
6	1.09	-0.354	-1.18	0.61	20	0.43	0.43
7	1.05	-0.202	-0.81	0.6	20	0.47	0.41

continued
Table 7.15 Sprat in SD 22–32. Output from XSA. 4/7

Fleet : FLT02: International

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	99.99	99.99	99.99	-0.22	0.61	-0.24	0.39	-0.72	-0.31	0.42
2	99.99	99.99	99.99	0	0.03	-0.13	0.32	0.04	-0.92	0.09
3	99.99	99.99	99.99	-0.58	0.23	-0.65	-0.01	-0.63	0.05	-1.11
4	99.99	99.99	99.99	0.06	0.11	-0.11	0.07	-0.31	-0.36	-0.24
5	99.99	99.99	99.99	-0.65	-0.25	-0.51	0.38	-0.37	0.11	-0.82
6	99.99	99.99	99.99	-0.71	-0.77	-0.3	-0.32	-0.32	-0.08	-0.64
7	99.99	99.99	99.99	-0.63	-0.21	-0.48	0.41	-0.1	-0.27	-0.56

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	-0.5	-0.31	-0.2	0.27	0.24	0.42	-0.25	-0.11	99.99	0.33
2	0.12	0.1	0	-0.96	0.27	0.4	0.19	0.07	99.99	0.16
3	-0.03	0.29	-0.24	0.4	-0.3	0.28	0.01	0.41	99.99	0.45
4	-0.88	-0.13	0.06	0.39	0.33	0.07	-0.16	0.42	99.99	0.22
5	-0.1	-0.15	-0.13	0.36	0.27	0.15	0.01	0.54	99.99	-0.19
6	-0.65	0.27	-0.68	0.42	0.36	0.19	-0.45	0.3	99.99	-0.56
7	-0.37	0.41	0.11	0.56	0.1	0.18	-0.11	-0.18	99.99	-0.38

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7
Mean Log q	-0.3579	0.1008	0.343	0.4436	0.4436	0.4436
S.E(Log q)	0.4119	0.4463	0.3553	0.3597	0.4768	0.3489

Regression statistics :
Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.77	0.994	3.54	0.67	16	0.39	-1.17

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.81	0.784	2.33	0.66	16	0.34	-0.36
3	0.79	1.097	2.04	0.76	16	0.35	0.1
4	1.05	-0.177	-0.8	0.62	16	0.39	0.34
5	1.48	-1.472	-4.88	0.51	16	0.5	0.44
6	1.22	-0.624	-2.16	0.47	16	0.57	0.29
7	0.84	0.998	0.85	0.81	16	0.29	0.41

continued

Table 7.15 Sprat in SD 22–32. Output from XSA. 5/7

Fleet : FLT03: Latvian/Russi

Age	1991	1992	1993	1994	1995	1996	1997
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	No data for this fleet at this age						
3	No data for this fleet at this age						
4	No data for this fleet at this age						
5	No data for this fleet at this age						
6	No data for this fleet at this age						
7	No data for this fleet at this age						

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	99.99	-1.73	-0.26	-0.78	-0.29	0.11	-0.14	-0.94	0.13	0.11
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									

Age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	-0.29	-0.07	-0.25	0.43	0.33	0.25	0.09	-0.06	0.1	-0.07
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.63	1.858	4.7	0.72	19	0.33	-0.81

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2016

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	57314	0.3	0	0	1	0.357	0.053
FLT02: Internatio	79280	0.407	0	0	1	0.194	0.038
FLT03: Latvian/Ru	53242	0.343	0	0	1	0.273	0.057
P shrinkage mea	53299	0.54				0.117	0.057
F shrinkage mea	31727	0.75				0.06	0.093

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
57244	0.18	0.11	5	0.598	0.053

continued

Table 7.15 Sprat in SD 22–32. Output from XSA. 6/7

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2015

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	32577	0.235	0.188	0.8	2	0.53	0.152
02: International	39869	0.43	0	0	1	0.163	0.125
03: Latvian/Russi	37341	0.343	0	0	1	0.245	0.133
shrinkage mean	21131	0.75				0.062	0.225

ghted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
33891	0.17	0.1	5	0.588	0.146

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2014

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	54780	0.209	0.077	0.37	3	0.551	0.233
02: International	67861	0.322	0.275	0.85	2	0.238	0.192
03: Latvian/Russi	52788	0.377	0	0	1	0.151	0.241
shrinkage mean	40815	0.75				0.061	0.302

ghted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
56297	0.16	0.08	7	0.527	0.227

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	8077	0.179	0.149	0.83	4	0.532	0.296
02: International	8870	0.239	0.133	0.56	3	0.307	0.273
03: Latvian/Russi	9136	0.347	0	0	1	0.111	0.266
shrinkage mean	6131	0.75				0.05	0.374

ghted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8312	0.13	0.08	9	0.622	0.289

continued

Table 7.15 Sprat in SD 22–32. Output from XSA. 7/7

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	3496	0.173	0.151	0.87	5	0.53	0.329
:02: International	3958	0.227	0.16	0.71	4	0.337	0.296
:03: Latvian/Russi	4733	0.347	0	0	1	0.075	0.253
F shrinkage mean	2712	0.75				0.058	0.407

ghted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3674	0.13	0.09	11	0.725	0.315

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	1793	0.174	0.124	0.71	6	0.559	0.284
:02: International	1807	0.223	0.214	0.96	5	0.325	0.282
:03: Latvian/Russi	2488	0.351	0	0	1	0.051	0.213
F shrinkage mean	1264	0.75				0.065	0.383

ghted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1787	0.13	0.1	13	0.745	0.285

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01:	522	0.183	0.049	0.27	7	0.481	0.338
:02: International	491	0.208	0.169	0.81	6	0.422	0.356
:03: Latvian/Russi	799	0.357	0	0	1	0.027	0.233
F shrinkage mean	603	0.75				0.069	0.299

ghted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
520	0.13	0.07	15	0.545	0.34

Table 7.16. Sprat in SD 22–32. Output from XSA. Fishing mortality (F) at age.

Run title : Sprat 22 32
At 2/04/2018 22:11
Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977
AGE				
1	0.069	0.044	0.031	0.076
2	0.100	0.096	0.102	0.099
3	0.299	0.175	0.190	0.245
4	0.395	0.477	0.215	0.374
5	0.292	0.387	0.562	0.216
6	0.566	0.286	0.407	0.556
7	0.426	0.391	0.402	0.390
+gp	0.426	0.391	0.402	0.390
FBAR 3-5	**0.33**	**0.35**	**0.32**	**0.28**

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0.047	0.067	0.028	0.052	0.016	0.021	0.028	0.019	0.042	0.029
2	0.227	0.126	0.188	0.178	0.137	0.029	0.055	0.089	0.064	0.055
3	0.118	0.179	0.212	0.138	0.226	0.073	0.080	0.113	0.139	0.128
4	0.275	0.125	0.233	0.140	0.201	0.150	0.134	0.187	0.178	0.355
5	0.425	0.283	0.187	0.106	0.249	0.104	0.257	0.166	0.292	0.300
6	0.183	0.212	0.308	0.189	0.168	0.118	0.187	0.220	0.225	0.426
7	0.303	0.213	0.252	0.149	0.213	0.127	0.197	0.194	0.235	0.366
+gp	0.303	0.213	0.252	0.149	0.213	0.127	0.197	0.194	0.235	0.366
FBAR 3-5	**0.27**	**0.20**	**0.21**	**0.13**	**0.23**	**0.11**	**0.16**	**0.16**	**0.20**	**0.26**

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.007	0.066	0.025	0.022	0.022	0.025	0.019	0.029	0.059	0.034
2	0.169	0.041	0.160	0.092	0.087	0.099	0.163	0.058	0.187	0.255
3	0.176	0.202	0.075	0.199	0.157	0.144	0.225	0.216	0.175	0.266
4	0.201	0.174	0.188	0.133	0.217	0.151	0.255	0.322	0.381	0.424
5	0.312	0.241	0.134	0.183	0.227	0.190	0.292	0.464	0.291	0.491
6	0.251	0.325	0.180	0.115	0.155	0.225	0.282	0.496	0.430	0.253
7	0.258	0.249	0.169	0.144	0.201	0.190	0.279	0.432	0.371	0.394
+gp	0.258	0.249	0.169	0.144	0.201	0.190	0.279	0.432	0.371	0.394
FBAR 3-5	**0.23**	**0.21**	**0.13**	**0.17**	**0.20**	**0.16**	**0.26**	**0.33**	**0.28**	**0.39**

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.080	0.045	0.131	0.069	0.155	0.094	0.125	0.070	0.174	0.163
2	0.109	0.234	0.095	0.241	0.219	0.283	0.203	0.271	0.121	0.343
3	0.360	0.281	0.321	0.135	0.441	0.355	0.408	0.300	0.342	0.225
4	0.429	0.413	0.252	0.401	0.342	0.442	0.455	0.453	0.342	0.457
5	0.357	0.407	0.365	0.324	0.383	0.427	0.637	0.627	0.455	0.381
6	0.463	0.305	0.389	0.474	0.307	0.328	0.498	0.367	0.489	0.441
7	0.423	0.374	0.350	0.451	0.327	0.522	0.368	0.551	0.339	0.550
+gp	0.423	0.374	0.350	0.451	0.327	0.522	0.368	0.551	0.339	0.550
FBAR 3-5	**0.38**	**0.37**	**0.31**	**0.29**	**0.39**	**0.41**	**0.50**	**0.46**	**0.38**	**0.35**

YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	FBAR **-**
AGE											
1	0.114	0.149	0.109	0.207	0.096	0.128	0.102	0.092	0.047	0.053	0.064
2	0.327	0.276	0.278	0.185	0.254	0.301	0.255	0.151	0.155	0.146	0.1506
3	0.387	0.454	0.334	0.347	0.211	0.384	0.393	0.308	0.199	0.227	0.2447
4	0.329	0.503	0.435	0.375	0.421	0.340	0.410	0.398	0.283	0.289	0.323
5	0.412	0.415	0.363	0.340	0.366	0.508	0.407	0.444	0.288	0.315	0.3493
6	0.475	0.445	0.460	0.348	0.355	0.410	0.393	0.365	0.373	0.285	0.3408
7	0.461	0.483	0.338	0.476	0.406	0.285	0.434	0.315	0.460	0.340	0.3715
+gp	0.461	0.483	0.338	0.476	0.406	0.285	0.434	0.315	0.460	0.340	
FBAR 3-5	**0.38**	**0.46**	**0.38**	**0.35**	**0.33**	**0.41**	**0.40**	**0.38**	**0.26**	**0.28**	

Table 7.17. Sprat in SD 22–32. Output from XSA. Stock number at age (Numbers*10^-6).

Run title : Sprat 22 32
At 13/04/2017 23:10
Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year)

YEAR		1974	1975	1976	1977
AGE					
	1	50439	18933	194493	42726
	2	83208	28853	10662	117857
	3	17887	46145	15424	6017
	4	7517	8126	22805	7975
	5	9600	3164	3030	11607
	6	2718	4528	1304	1102
	7	4401	975	2062	559
+gp		984	2099	1553	1550
TOTAL		176754	112823	251333	189394

YEAR		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE											
	1	15221	30535	20034	67762	35165	133288	50390	40544	15180	33945
	2	22850	7431	13090	8407	28904	15247	61068	26104	23195	9096
	3	61618	9314	3002	4681	3161	11098	6927	30778	13912	13594
	4	2746	28299	3607	1060	1832	1110	4827	3406	16182	7568
	5	3231	1099	11793	1271	427	680	456	2293	1680	8548
	6	5560	1125	399	4438	540	154	298	195	1167	800
	7	379	2490	443	136	1753	214	67	138	95	594
+gp		953	899	1491	1002	373	1708	606	465	292	286
TOTAL		112558	81191	53860	88757	72155	163498	124639	103924	71703	74430

YEAR		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE											
	1	13470	40021	49577	54509	94077	87259	66745	260307	169428	60507
	2	21453	8700	25367	34753	40289	70259	63066	48517	187355	119520
	3	5599	11781	5652	15548	23963	28188	47156	39689	33927	116251
	4	7778	3054	6518	3770	9631	15637	18090	27897	23685	21317
	5	3487	4179	1754	3922	2495	5916	10058	10487	15134	12235
	6	4202	1693	2247	1114	2470	1534	3662	5622	4935	8549
	7	350	2170	846	1362	757	1631	917	2067	2562	2427
+gp		748	737	1497	1286	1013	1704	978	1330	1479	979
TOTAL		57089	72335	93458	116264	174695	212129	210673	395916	438505	341787

YEAR		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
	1	168488	56678	101996	48998	55250	121105	229219	48886	79743	108234
	2	43346	112958	38585	63710	32872	33353	82516	151392	33769	48659
	3	68590	28235	63611	24977	36003	18607	18808	50417	85500	21738
	4	65985	34734	15177	32861	15692	16321	9767	9360	27664	44108
	5	10333	31198	16516	8477	15978	7934	7930	4639	4409	14266
	6	5602	5301	14937	8241	4452	7834	3913	3171	1855	2052
	7	4969	2586	2811	7281	3725	2355	4266	1798	1644	835
+gp		1631	1911	2985	1656	5597	3850	5032	1650	2124	1467
TOTAL		368943	273601	256617	196202	169570	211359	361451	271314	236707	241358

YEAR		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	GMST 74-**	AMST 74-**
AGE														
	1	70620	183629	54973	58909	68165	61206	59012	227196	75831	80090	0	63033	82068
	2	66114	44400	109265	32404	30536	43017	39399	39365	152029	52048	57244	37655	50498
	3	24834	33596	23279	54371	17179	16458	23274	22552	24830	93695	33891	20572	28651
	4	12486	11889	14744	10949	24511	9675	8199	11605	12169	14661	56297	10407	15004
	5	20075	6333	4967	6336	4845	11262	5061	4035	5745	6642	8312	5074	7456
	6	7074	9464	2919	2315	2935	2360	4997	2506	1913	3127	3674	2416	3626
	7	959	3133	4233	1235	1063	1452	1157	2514	1289	960	1787	1184	1843
+gp		1141	1076	2138	1808	1533	1469	1205	1245	1409	1568	1369		
TOTAL		203303	293521	216518	168327	150768	146900	142303	311018	275215	252791	162574		

Table 7.18 Sprat in SD 22–32. Output from XSA. Stock summary.

At 2/04/2018 22:11

Table 16 Summary (without SOP correction) **Run title : Sprat 22-32**

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 5
1974	50439	1777	1097	242	0.22	0.33
1975	18933	1288	867	201	0.23	0.35
1976	194493	2077	738	195	0.26	0.32
1977	42726	1937	1257	181	0.14	0.28
1978	15221	1283	866	132	0.15	0.27
1979	30535	859	498	77	0.15	0.20
1980	20034	604	311	58	0.19	0.21
1981	67762	750	268	49	0.18	0.13
1982	35165	779	340	49	0.14	0.23
1983	133288	1692	478	37	0.08	0.11
1984	50390	1365	691	53	0.08	0.16
1985	40544	1152	639	70	0.11	0.16
1986	15180	857	581	76	0.13	0.20
1987	33945	844	466	88	0.19	0.26
1988	13470	611	415	80	0.19	0.23
1989	40021	877	438	86	0.20	0.21
1990	49577	1137	570	86	0.15	0.13
1991	54509	1350	776	103	0.13	0.17
1992	94077	1925	1034	142	0.14	0.20
1993	87259	2142	1361	178	0.13	0.16
1994	66745	2207	1407	289	0.21	0.26
1995	260307	3266	1498	313	0.21	0.33
1996	169428	3049	1916	441	0.23	0.28
1997	60507	2785	1891	529	0.28	0.39
1998	168488	2501	1419	471	0.33	0.38
1999	56678	2077	1417	421	0.30	0.37
2000	101996	2263	1345	389	0.29	0.31
2001	48998	1832	1203	342	0.28	0.29
2002	55250	1573	942	343	0.36	0.39
2003	121105	1559	806	308	0.38	0.41
2004	229219	2179	1029	374	0.36	0.50
2005	48886	1910	1294	405	0.31	0.46
2006	79743	1712	1070	352	0.33	0.38
2007	108234	1766	941	388	0.41	0.35
2008	70620	1767	1004	381	0.38	0.38
2009	183629	2031	927	407	0.44	0.46
2010	54973	1706	1053	342	0.32	0.38
2011	58909	1305	806	268	0.33	0.35
2012	68165	1280	712	231	0.32	0.33
2013	61206	1245	736	272	0.37	0.41
2014	59012	1174	695	244	0.35	0.40
2015	227196	1843	823	247	0.30	0.38
2016	75831	1944	1282	247	0.19	0.26
2017	80090	1975	1303	286	0.2193	0.277
Arith. Mean	**81881**	**1642**	**937**	**238**	**0.24**	**0.30**
Units	(Millions)	(Thousand tonnes)	(Thousand tonnes)	(Thousand tonnes)		

Table 7.19. Sprat in SD 22–32. Input for RCT3 analysis.

Sprat 22-32: Acoustic on age 0 in subdiv. 22-29, shifted to represent age1

Year	PA, age 1	Acoustic Age 0, shifted
1992	94077	59473
1993	87259	48035
1994	66745	-11
1995	260307	64092
1996	169428	-11
1997	60507	3842
1998	168488	-11
1999	56678	1279
2000	101996	33320
2001	48998	4601
2002	55250	12001
2003	121105	79551
2004	229219	146335
2005	48886	3562
2006	79743	41863
2007	108234	66125
2008	70620	17821
2009	183629	115698
2010	54973	12798
2011	58909	41158
2012	68165	45186
2013	61206	33653
2014	59012	24694
2015	227196	162715
2016	75831	36900
2017	80090	30765
2018	-11	78167

Table 7.20. Sprat in SD 22–32. Output from RCT3 analysis.

Analysis by RCT3 ver3.1 of data from file d:\recsprl1.txt
Sprat 22-32: YFS data from international acoustic survey on age 0
Data for 1 surveys over 27 years: 1991-2017
Regression type=C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied
Final estimates shrunk towards mean
Minimum S.E for any survey taken as 0.2
Minimum of 3 points used for regression
Forecast/Hindcast variance correction used.

Yearclass = 2009

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.42	7.23	0.32	0.762	15	9.46	11.17	0.376	0.681
				VPA	Mean	=	11.46	0.548	0.319

Yearclass = 2010

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.43	7.06	0.31	0.765	16	10.63	11.63	0.365	0.69

Yearclass = 2011

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.46	6.64	0.37	0.686	17	10.72	11.62	0.432	0.603

Yearclass = 2012

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.48	6.37	0.39	0.648	18	10.42	11.43	0.446	0.567
				VPA	Mean	=	11.34	0.51	0.433

Yearclass = 2013

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.51	6.01	0.4	0.62	19	10.11	11.22	0.455	0.539
				VPA	Mean	=	11.31	0.491	0.461

Yearclass = 2014

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.54	5.69	0.39	0.617	20	12	12.2	0.485	0.488
				VPA	Mean	=	11.28	0.473	0.512

Yearclass = 2015

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.58	5.24	0.38	0.692	21	10.52	11.38	0.431	0.612
				VPA	Mean	=	11.36	0.541	0.388

Yearclass = 2016

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.61	4.95	0.35	0.703	22	10.33	11.24	0.404	0.624

Yearclass = 2017

I-----------Regression----------I I-----------Prediction---------I

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Acoust	0.63	4.71	0.33	0.718	23	11.27	11.81	0.383	0.629
				VPA	Mean	=	11.34	0.498	0.371

Year (Age 1)	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	115292	11.66	0.37	0.16	0.19	79744	11.29
2007	123388	11.72	0.37	0.25	0.45	108235	11.59
2008	86768	11.37	0.34	0.05	0.02	70621	11.17
2009	135793	11.82	0.34	0.33	0.98	183629	12.12
2010	77583	11.26	0.31	0.14	0.19	54974	10.91
2011	104905	11.56	0.3	0.1	0.11	58910	10.98
2012	100870	11.52	0.34	0.12	0.13	68166	11.13
2013	88631	11.39	0.34	0.04	0.02	61206	11.02
2014	77794	11.26	0.33	0.05	0.02	59012	10.99
2015	123624	11.73	0.34	0.46	1.84	227196	12.33
2016	86869	11.37	0.34	0.01	0	75832	11.24
2017	79150	11.28	0.32	0.05	0.03	80090	11.29
2018	**112860**	11.63	0.3	0.23	0.55		

Table 7.21 Sprat in SD 22–32. Input data for short-term prediction.

MFDP version 1a
Run: spr2018a
Time and date: 11:55 03/04/2018
Fbar age range: 3-5

2018

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	112860	0.31	0.17	0.4	0.4	0.0048	0.0544	0.0048
2	57244	0.31	0.93	0.4	0.4	0.0082	0.1280	0.0082
3	33891	0.31	1	0.4	0.4	0.0099	0.2079	0.0099
4	56297	0.30	1	0.4	0.4	0.0113	0.2745	0.0113
5	8312	0.30	1	0.4	0.4	0.0121	0.2968	0.0121
6	3674	0.30	1	0.4	0.4	0.0125	0.2896	0.0125
7	1787	0.30	1	0.4	0.4	0.0121	0.3156	0.0121
8	1369	0.30	1	0.4	0.4	0.0118	0.3156	0.0118

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	88334	0.31	0.17	0.4	0.4	0.0048	0.0544	0.0048
2		0.31	0.93	0.4	0.4	0.0082	0.1280	0.0082
3		0.31	1	0.4	0.4	0.0099	0.2079	0.0099
4		0.30	1	0.4	0.4	0.0113	0.2745	0.0113
5		0.30	1	0.4	0.4	0.0121	0.2968	0.0121
6		0.30	1	0.4	0.4	0.0125	0.2896	0.0125
7		0.30	1	0.4	0.4	0.0121	0.3156	0.0121
8		0.30	1	0.4	0.4	0.0118	0.3156	0.0118

2020

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	88334	0.31	0.17	0.4	0.4	0.0048	0.0544	0.0048
2		0.31	0.93	0.4	0.4	0.0082	0.1280	0.0082
3		0.31	1	0.4	0.4	0.0099	0.2079	0.0099
4		0.30	1	0.4	0.4	0.0113	0.2745	0.0113
5		0.30	1	0.4	0.4	0.0121	0.2968	0.0121
6		0.30	1	0.4	0.4	0.0125	0.2896	0.0125
7		0.30	1	0.4	0.4	0.0121	0.3156	0.0121
8		0.30	1	0.4	0.4	0.0118	0.3156	0.0118

Input units are millions and kg - output in kilotonnes

M =	Natural mortality
MAT =	Maturity ogive
PF =	Proportion of F before spawning
PM =	Proportion of M before spawning
SWT =	Weight in stock (kg)
Sel =	Exploit. Pattern
CWT =	Weight in catch (kg)

N_{2017} Age 1:	RCT3 estimate (Table 7.20)
N_{2017} Age 2-8+:	Survivors estimates from XSA (Table 7.16)
$N_{2018-2019}$ Age 1:	Geometric mean from XSA-estimates at age 1 for the years 1991-2017
Natural Mortality (M):	average 2015-2017
Weight in the Catch/Stock (CWt/SW	average 2015-2017
Expoitation pattern (Sel):	average 2015-2017 scaled to TAC in 2018

Table 7.22a. Sprat in SD 22–32. Output from short-term prediction with management option table for TAC constrained fishery in 2018.

MFDP version 1a
Run: spr2018a
Sprat
Time and date: 11:55 03/04/2018
Fbar age range: 3-5

2018				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
2161	1360	1.0000	0.2770	319

2019					2020	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
2127	1534	0.0	0.000	0	2368	1754
	1521	0.1	0.028	35	2334	1709
	1507	0.2	0.055	69	2301	1665
	1494	0.3	0.083	102	2268	1622
	1481	0.4	0.111	135	2237	1580
	1468	0.5	0.139	167	2206	1540
	1455	0.6	0.166	198	2175	1501
	1442	0.7	0.194	229	2146	1464
	1430	0.8	0.222	258	2117	1427
	1417	0.9	0.249	288	2089	1392
	1405	1.0	0.277	316	2061	1358
	1393	1.1	0.305	344	2034	1325
	1381	1.2	0.332	371	2007	1293
	1369	1.3	0.360	398	1982	1262
	1357	1.4	0.388	424	1956	1232
	1345	1.5	0.416	450	1932	1203
	1333	1.6	0.443	475	1907	1174
	1322	1.7	0.471	499	1884	1147
	1311	1.8	0.499	523	1860	1120
	1299	1.9	0.526	547	1838	1094
	1288	2.0	0.554	570	1815	1069

Input units are millions and kg - output in kilotonnes

Table 7.22b. Sprat in SD 22–32. Output from short-term prediction with management option table status quo fishery in 2018.

MFDP version 1a
Run: spr18TAC
Sprat
Time and date: 21:59 08/04/2018
Fbar age range: 3-5

2018				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
2161	1366	1.00	0.263	305

2019					2020	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
2141	1546	0.0	0.000	0	2379	1764
	1534	0.1	0.026	33	2347	1721
	1521	0.2	0.053	66	2315	1678
	1508	0.3	0.079	98	2284	1637
	1496	0.4	0.105	129	2253	1598
	1483	0.5	0.131	160	2224	1559
	1471	0.6	0.158	190	2195	1522
	1459	0.7	0.184	219	2166	1485
	1446	0.8	0.210	248	2138	1450
	1434	0.9	0.236	276	2111	1416
	1423	1.0	0.263	304	2084	1383
	1411	1.1	0.289	331	2058	1351
	1399	1.2	0.315	357	2033	1320
	1388	1.3	0.342	383	2007	1289
	1376	1.4	0.368	409	1983	1260
	1365	1.5	0.394	433	1959	1231
	1354	1.6	0.420	458	1935	1204
	1343	1.7	0.447	482	1912	1177
	1332	1.8	0.473	505	1890	1151
	1321	1.9	0.499	528	1867	1125
	1310	2.0	0.525	550	1846	1101

Input units are milions and kg - output in thousand tonnes

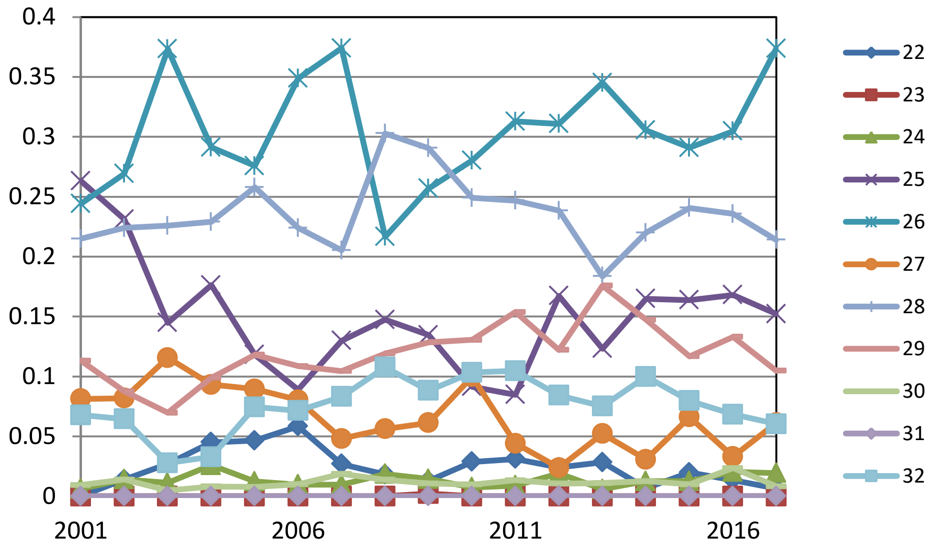


Figure 7.0 **Sprat in Subdivisions 22–32. Share of catches by Subdivision in 2001–2017.**

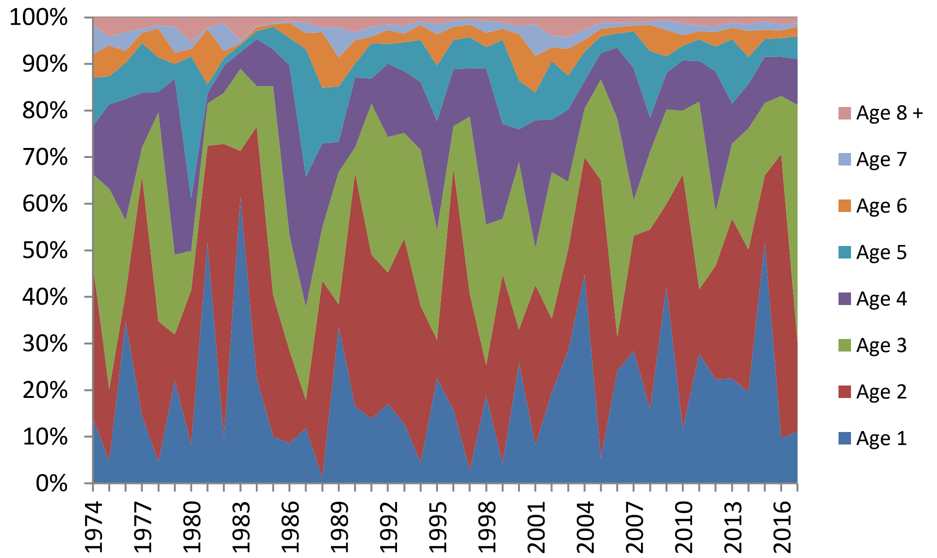


Figure 7.1 **Sprat in SD 22–32. Relative catch-at-age in numbers.**

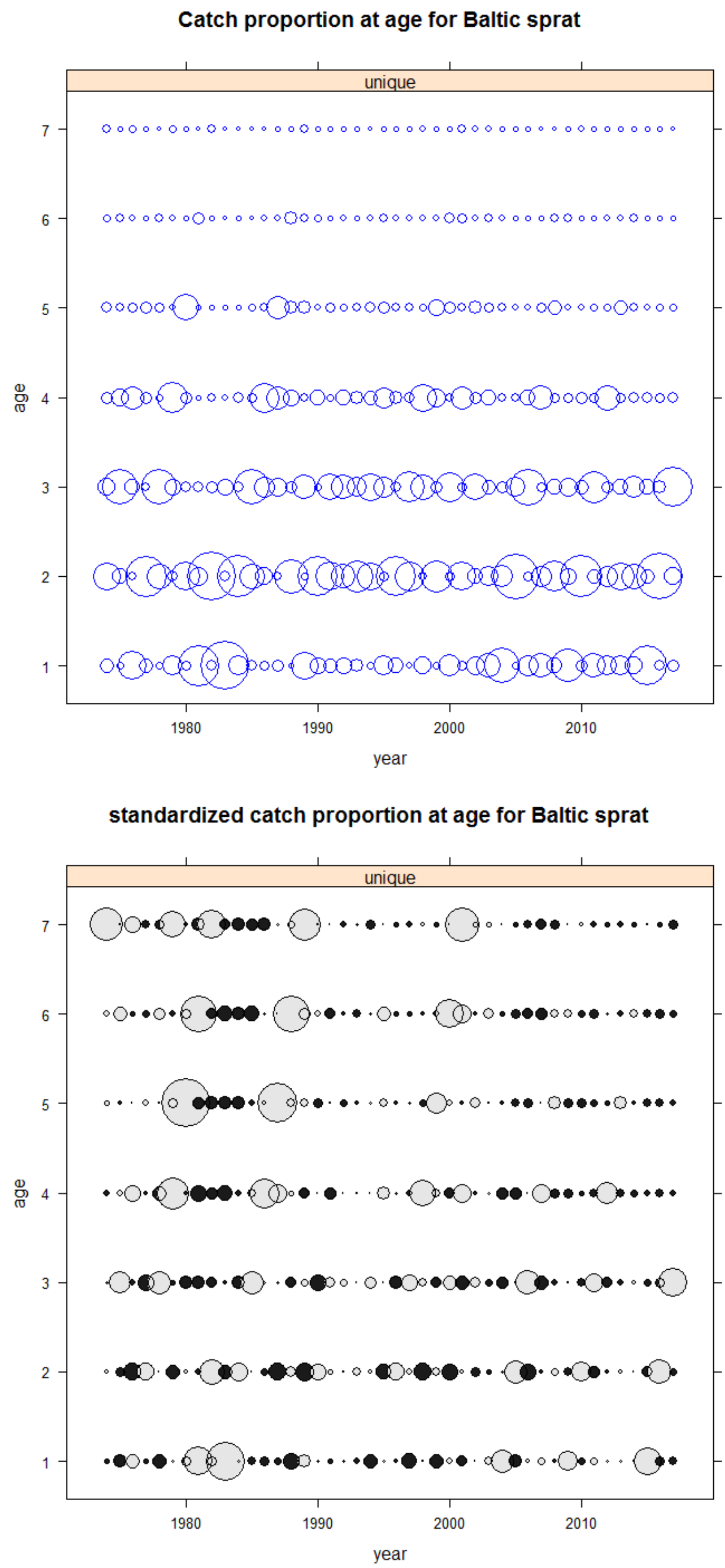
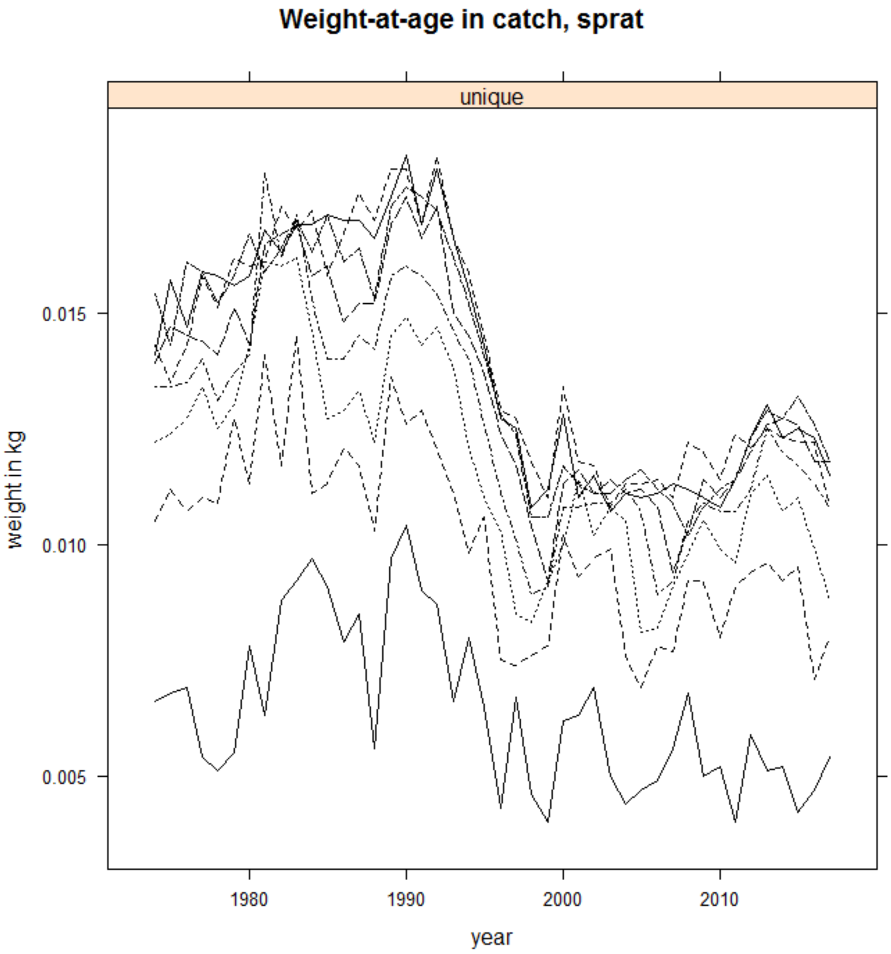


Figure 7.2 **Sprat in SD 22–32. CANUM consistency check.**



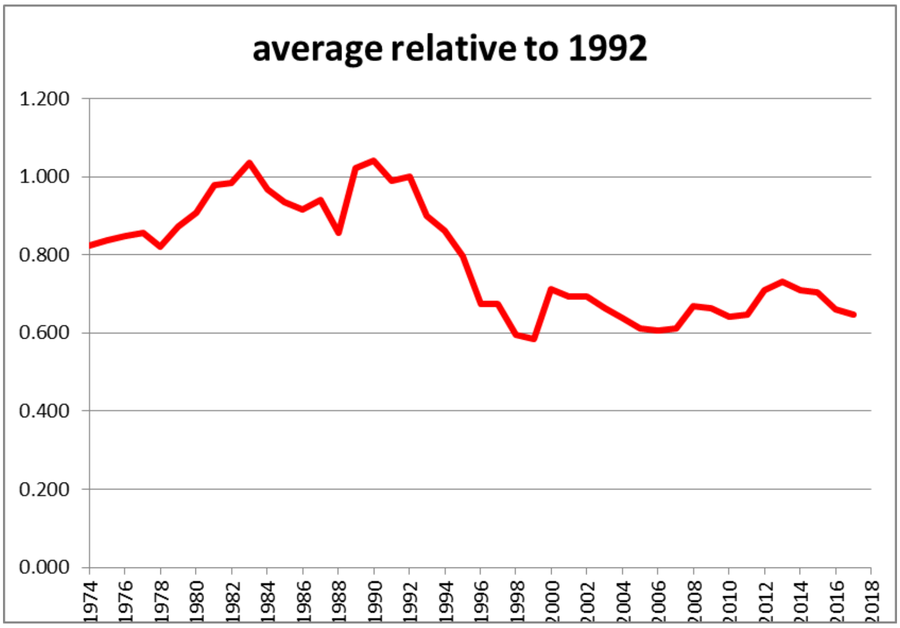


Figure 7.3 Sprat in SD 22–32. Mean weight-at-age in the catches by ages and average of relative values (weight in the stock assumed as in the catches).

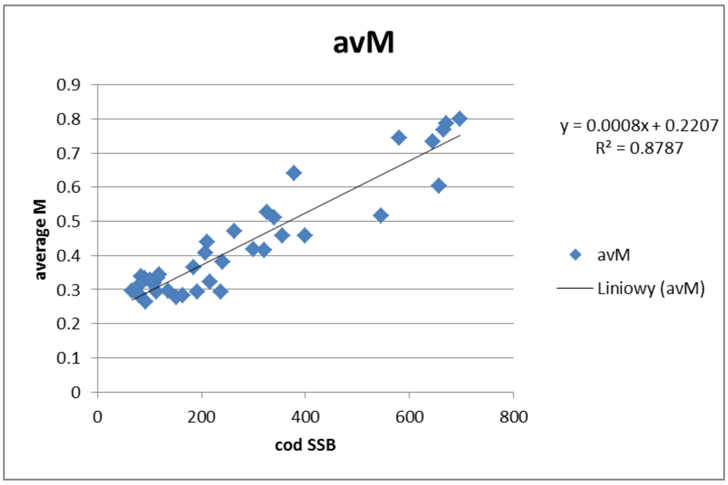


Figure 7.4a Sprat in SD 22–32. The dependence of average M for sprat on cod SSB.

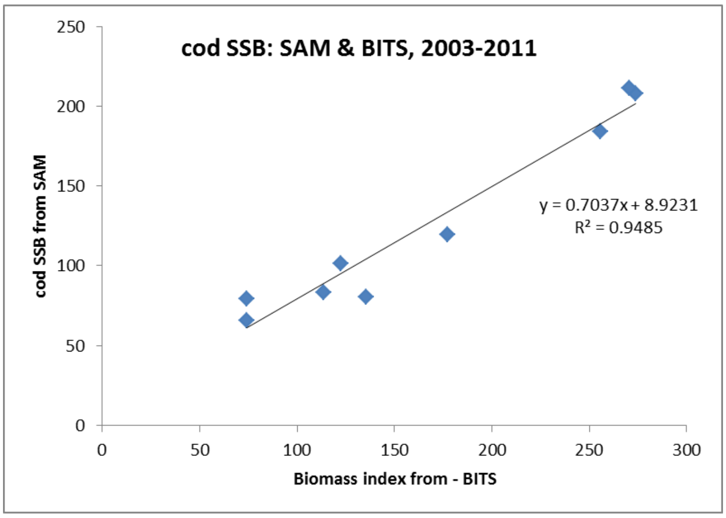


Figure 7.4b Sprat in SD 22–32. The relationship between cod SSB and biomass index from BITS (years 2003–2011).

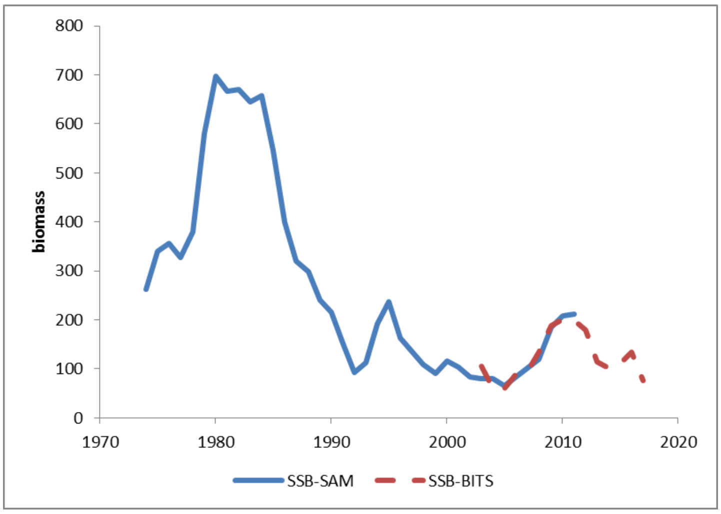


Figure 7.4c Sprat in SD 22–32. The biomass index from BITS rescaled to level of cod SSB and cod SSB from last accepted assessment (2012).

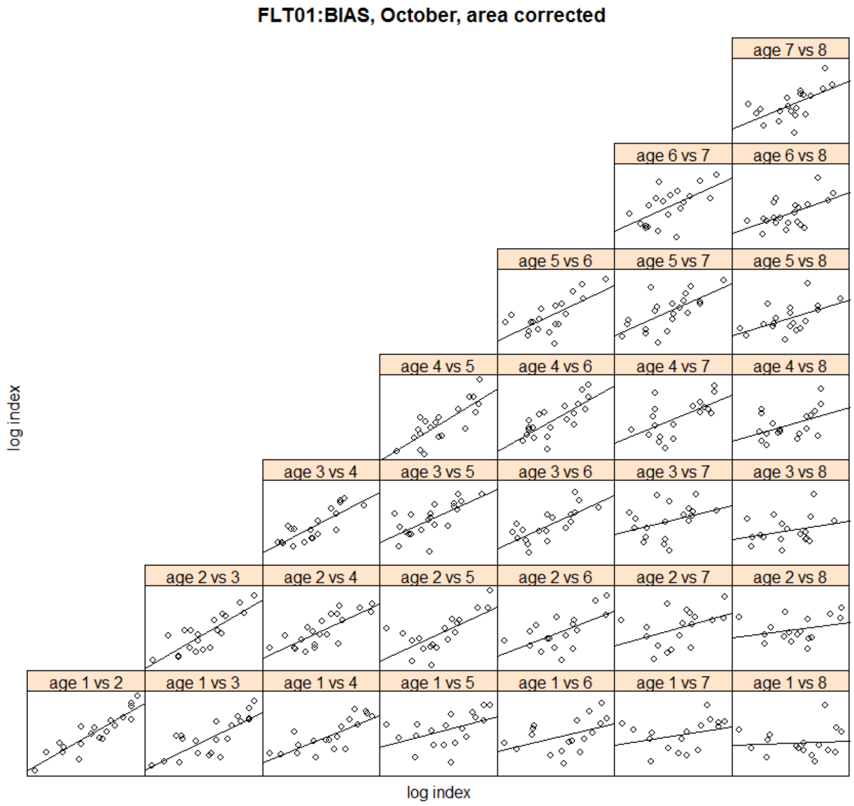


Figure 7.5a **Sprat in SD 22–32. Check for consistency in October acoustic survey estimates.**

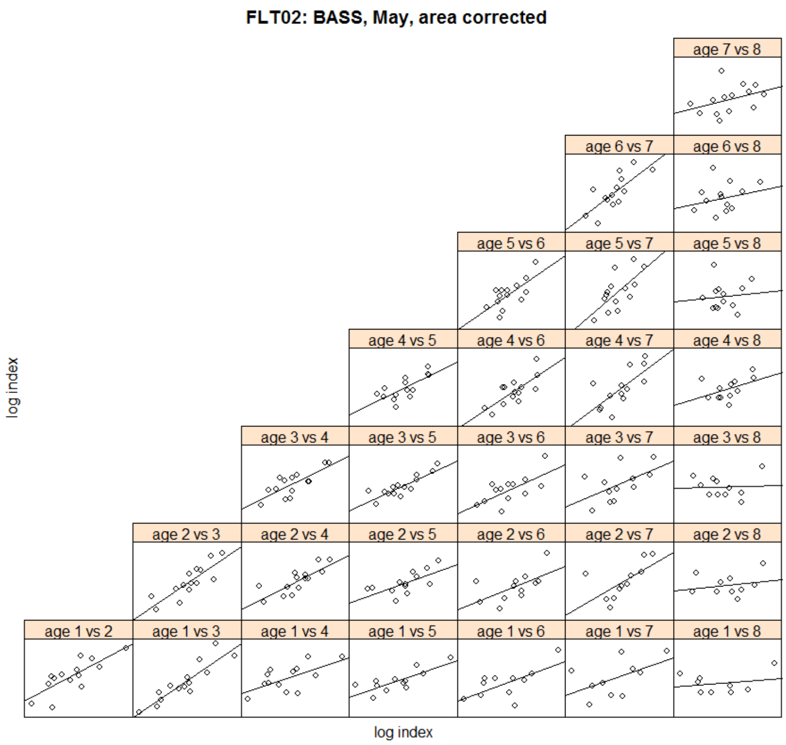


Figure 7.5b **Sprat in SD 22–32. Check for consistency in May acoustic survey estimates.**

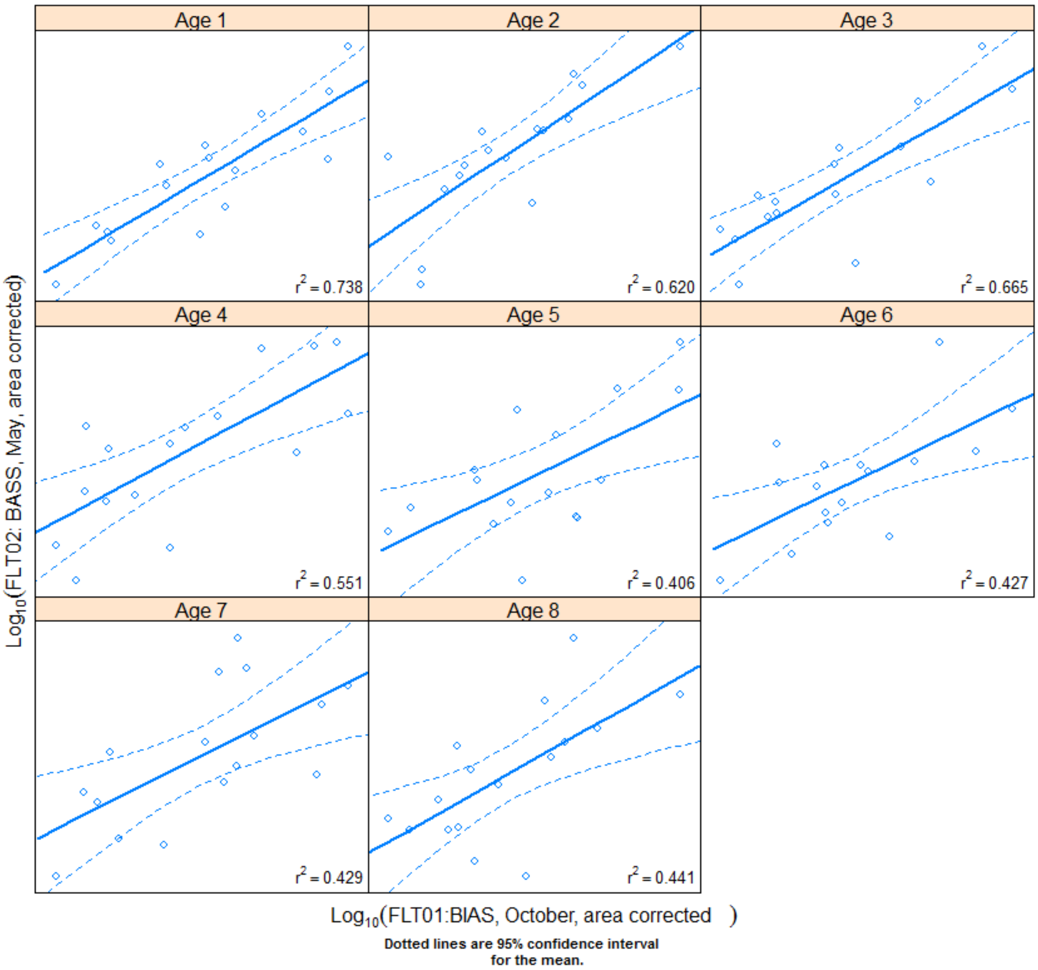


Figure 7.5c **Sprat in SD 22–32. Check for consistency between May and October surveys.**

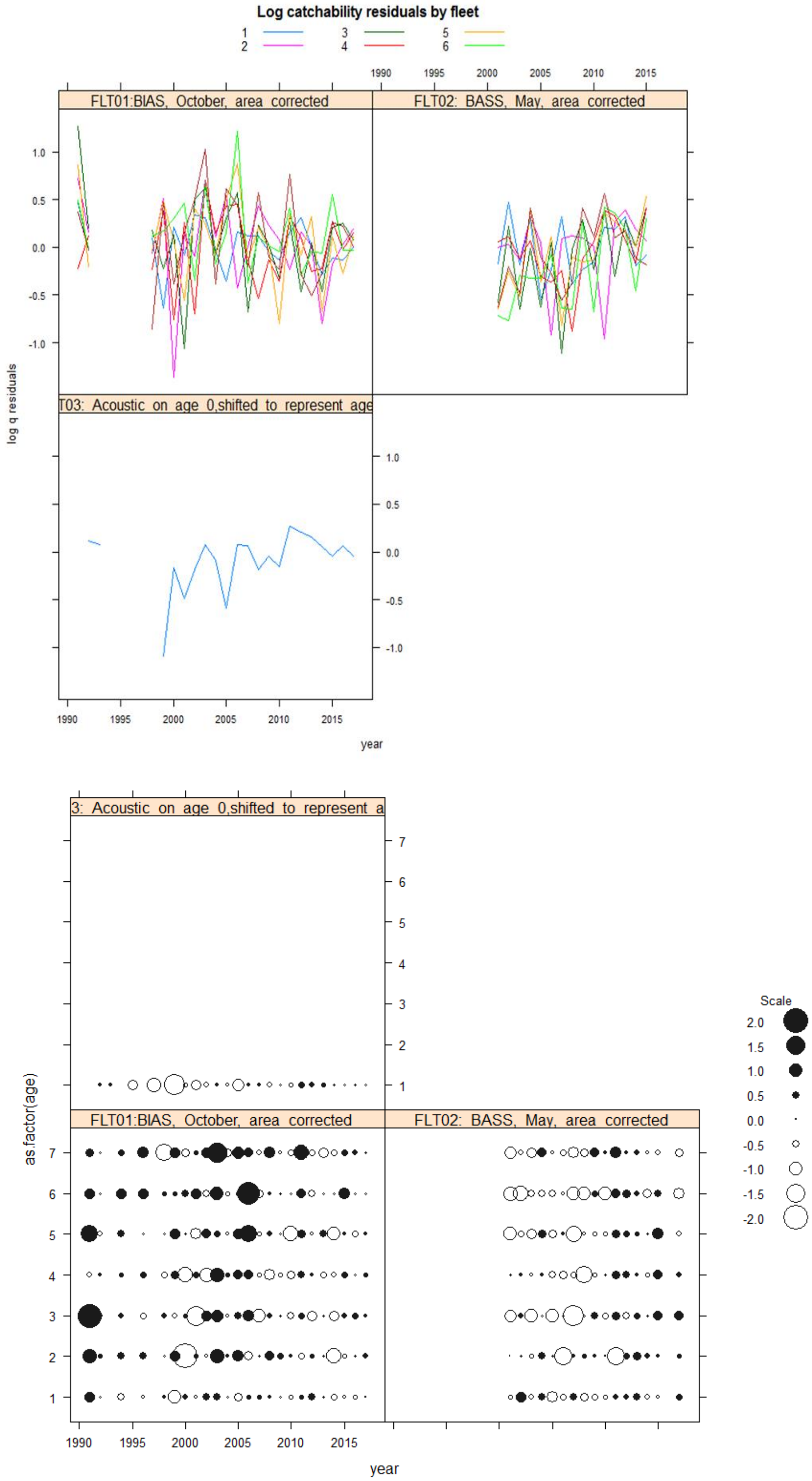


Figure 7.6 **Sprat in SD 22–32. Log catchability residuals by fleet presented in two ways.**

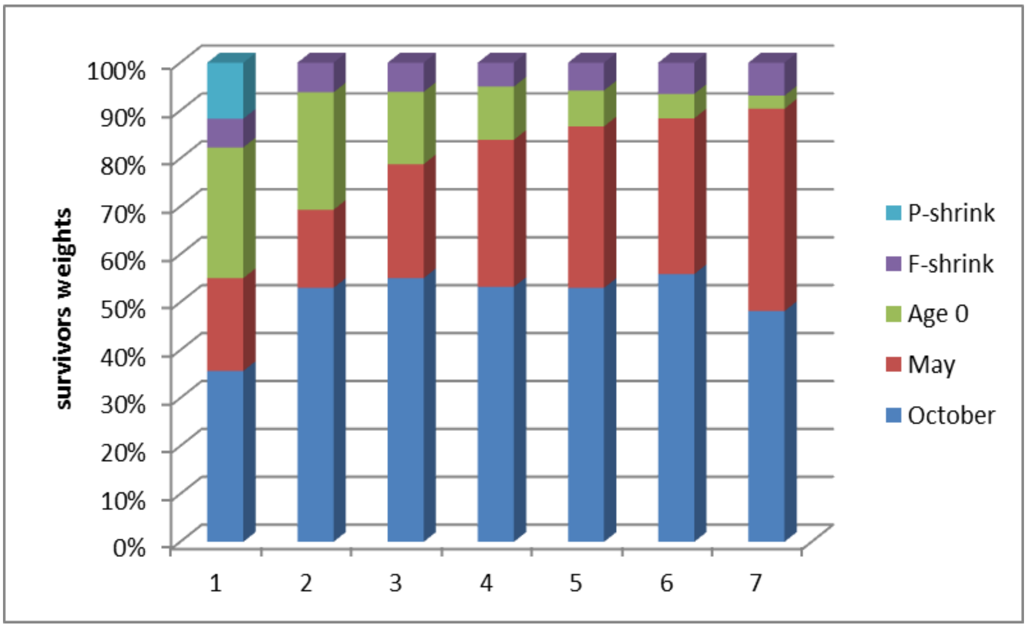


Figure 7.7a Sprat in SD 22–32. Weights of survivor estimates by fleet used to provide final survivors estimates.

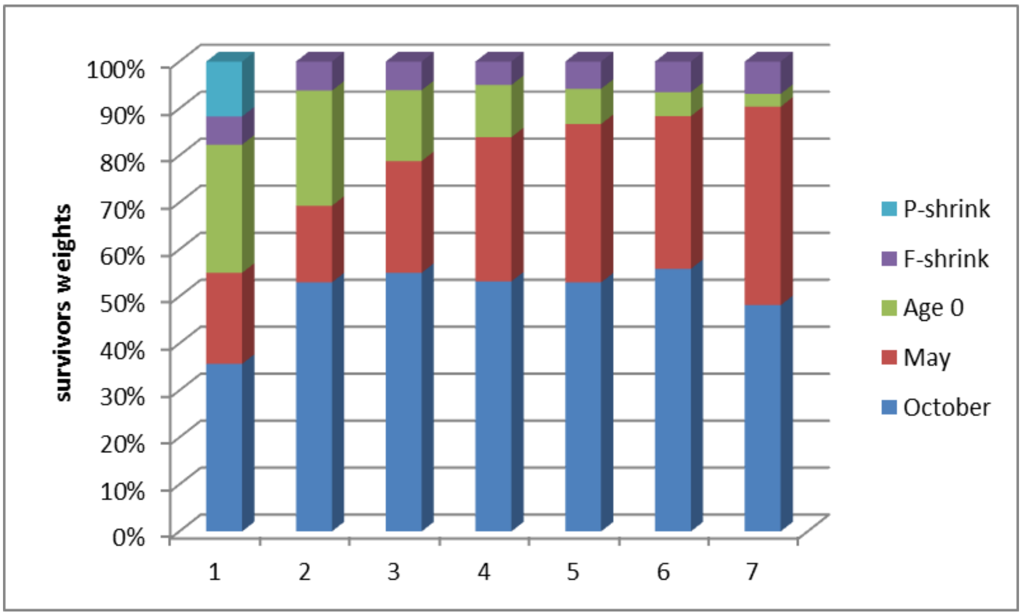


Figure 7.7b Sprat in SD 22–32. Survivors estimates by fleet and age relative to final estimate.

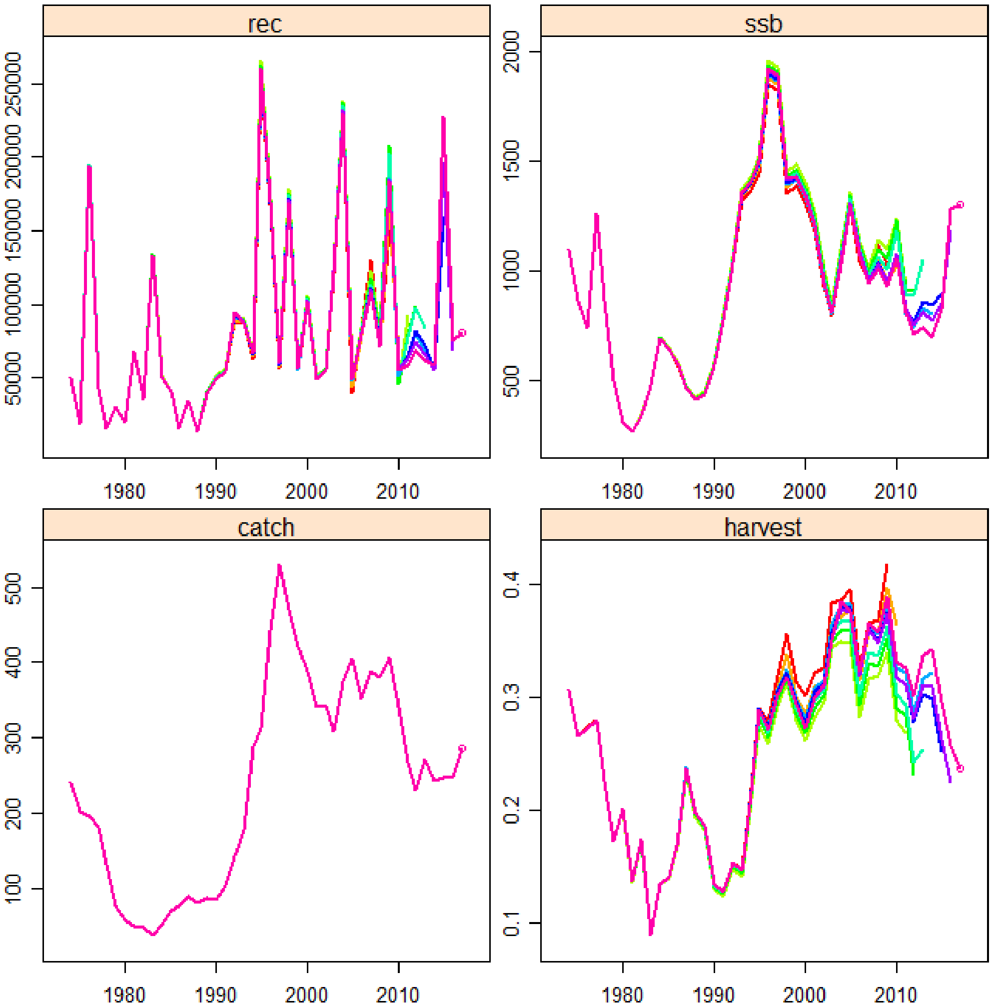


Figure 7.8 **Sprat in SD 22–32. Retrospective analysis from XSA.**

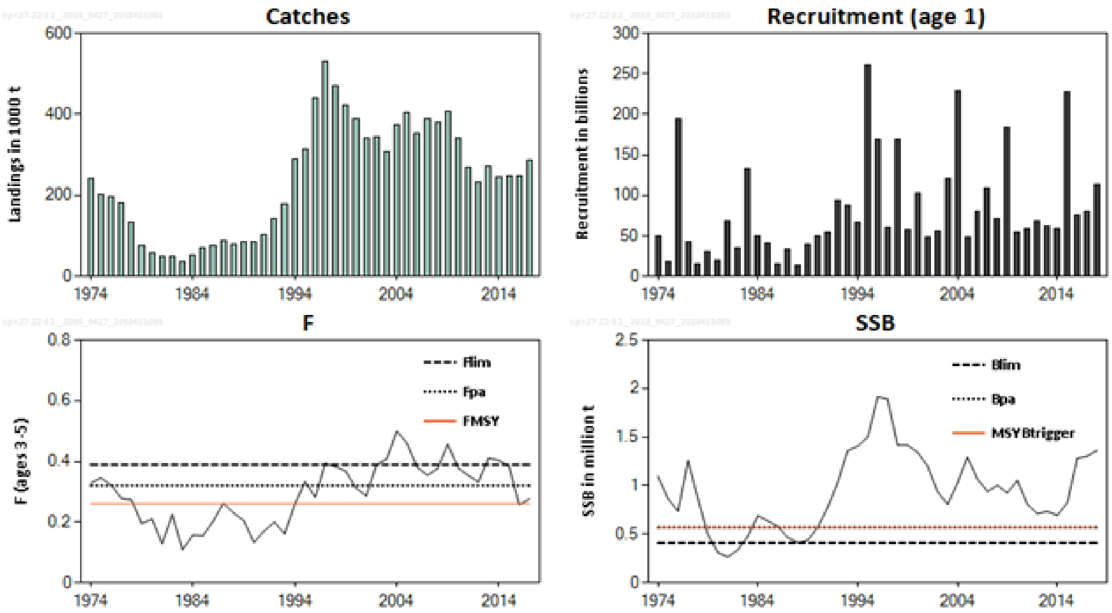


Figure 7.9 **Sprat in SD 22–32. Summary sheet plots: landings, fishing mortality, recruitment (age 1) and spawning stock biomass.**

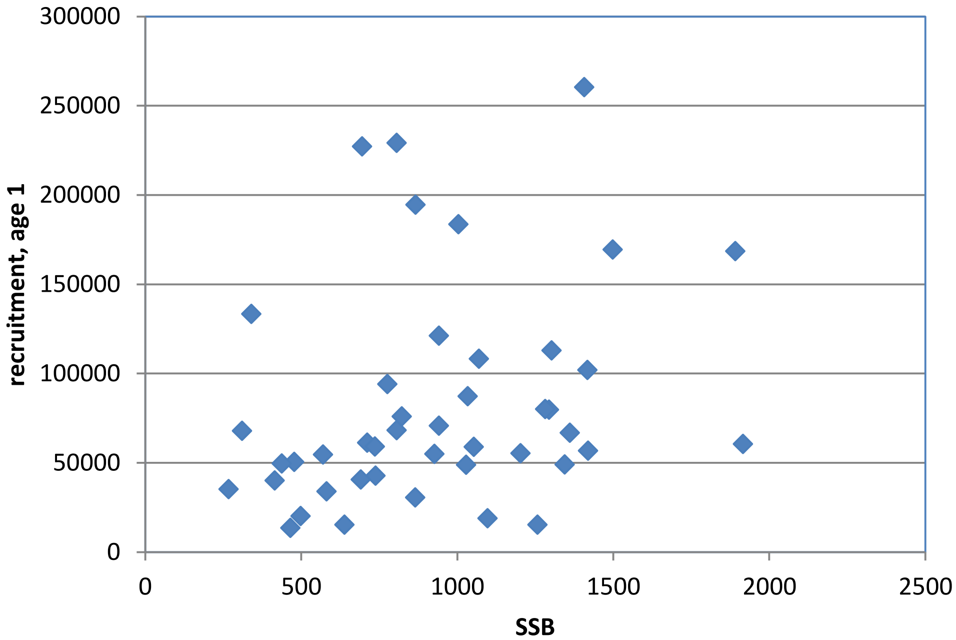


Figure 7.10 **Sprat in SD 22–32. Stock recruitment plot.**

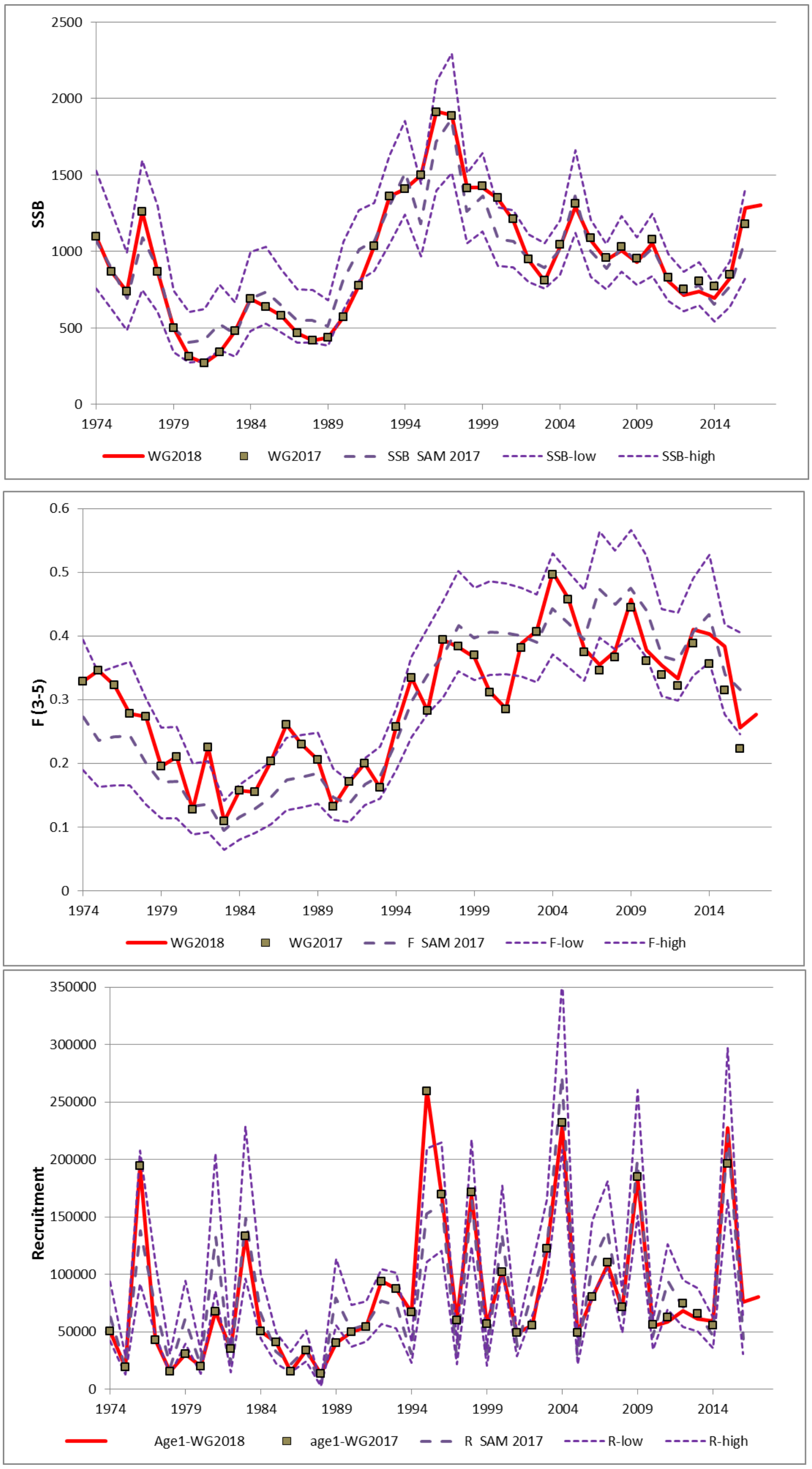


Figure 7.11a **Sprat in SD 22–32. Comparison of spawning stock biomass, fishing mortality, and recruitment (age 1) from XSA (present and 2017) with SAM. Uncertainties of SAM estimates are shown (thin, broken lines). In addition, assessment with May survey including 2017 data is shown.**

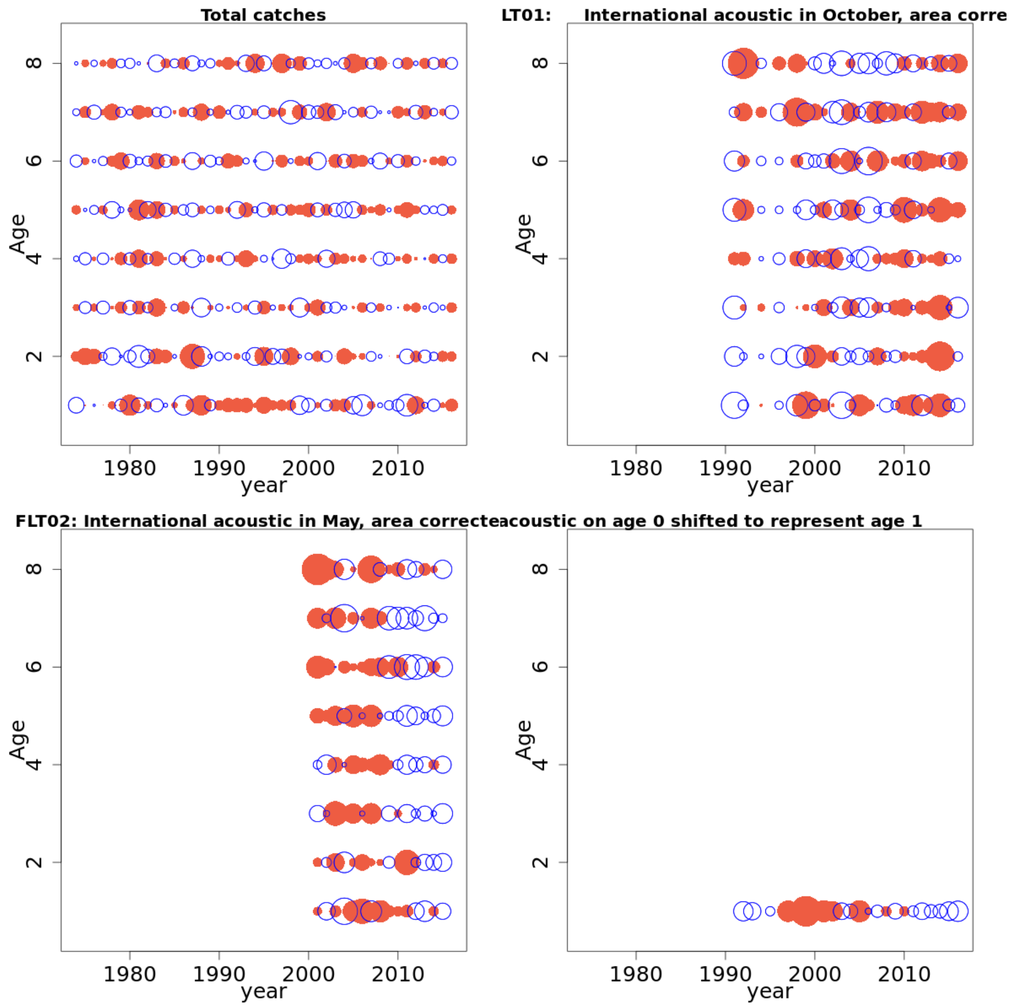
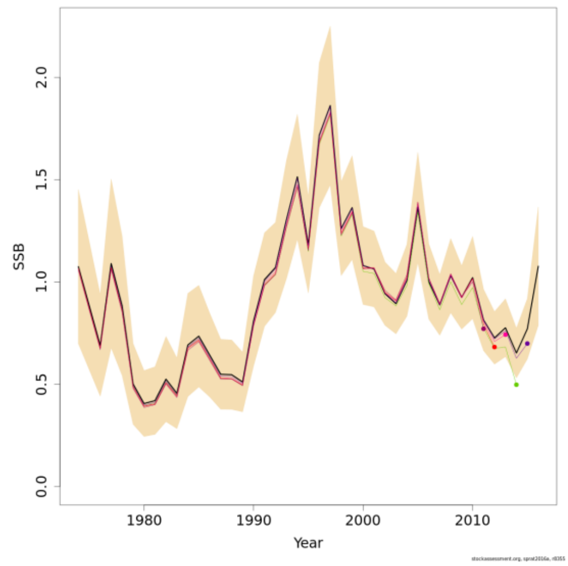
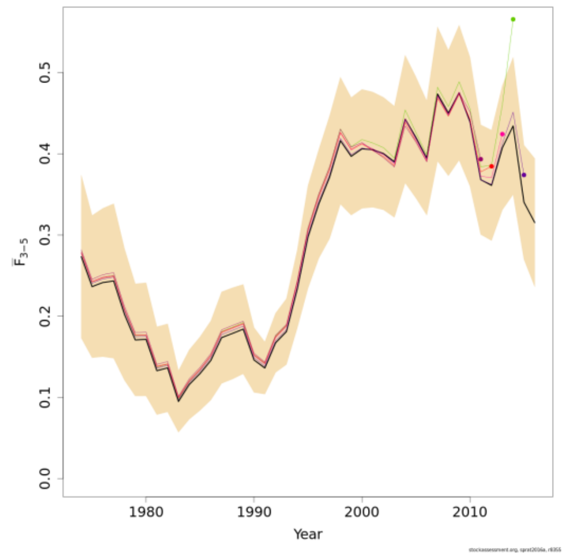


Figure 7.11b Sprat in SD 22–32. Log catchability residuals by fleet from SAM (WG 2017).





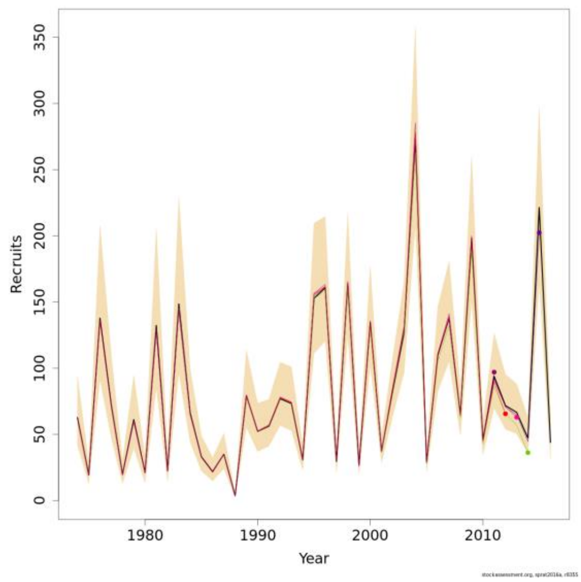


Figure 7.11c. Sprat in SD 22–32. Retrospective analysis from SAM (WG 2017).

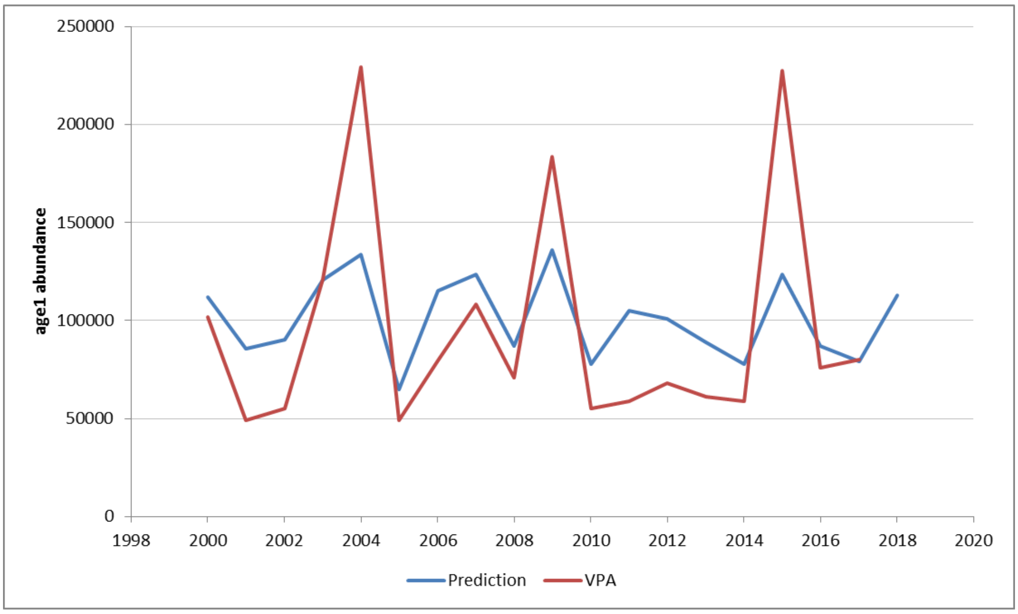


Figure 7.12 **Sprat in SD 22–32. Comparison of recruitment estimates from RCT3 (Prediction) and XSA (VPA).**

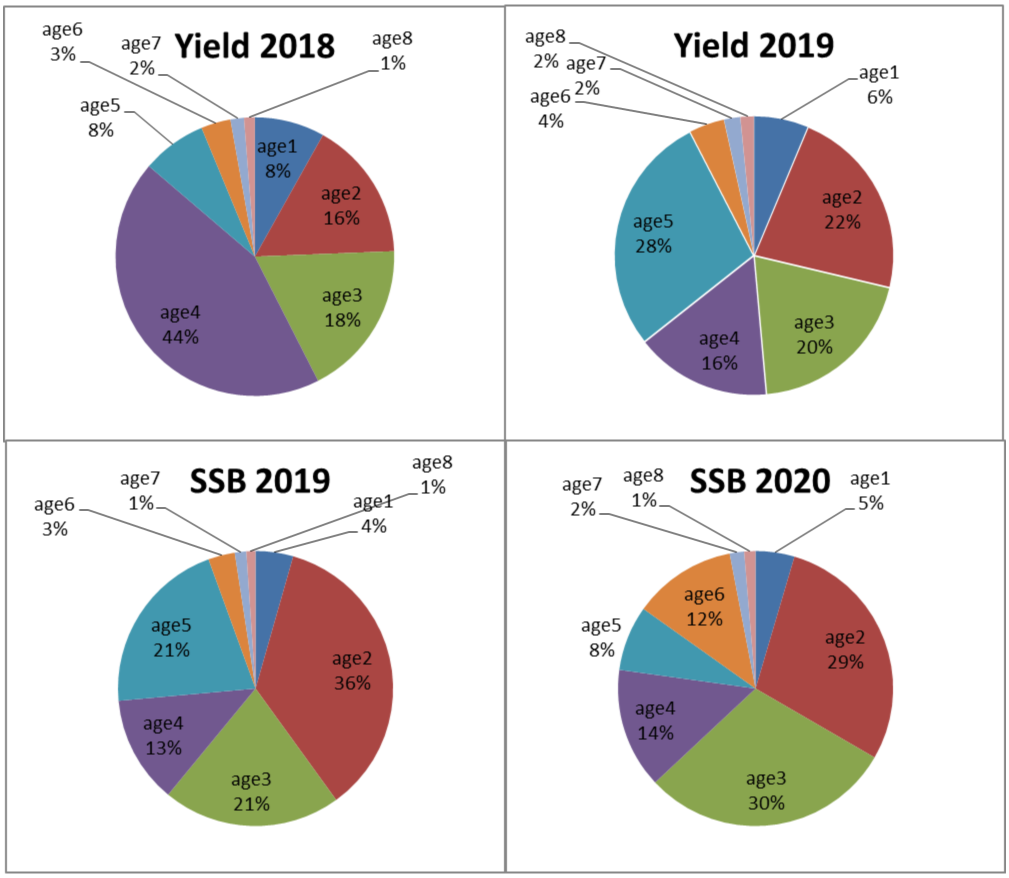


Figure 7.13 **Sprat in SD 22–32. Short-term forecast for 2016–2018. Yield and SSB at age 1–8+under the TAC constraint in 2018.**

8 Turbot, dab, and brill in the Baltic

8.1 Turbot

8.1.1 Fishery

8.1.1.1 Landings

Turbot were mainly landed in the southern and western parts of the Baltic Proper (ICES subdivisions 22–26). The total landings of turbot increased from 42 t to 1210 t from 1965 to 1996 followed by a decreased to 525 t in 2000 and a slower decrease until the minimum of 305 t in 2006 and varied between 221 t in 2012 and 394 t in 2009 with slightly negative trend between 2007 and 2016. (Table 8.1.1, Figure 8.1.1). The landings of 2001 and 2012 were slightly corrected based on the evaluation of the reported data and the calculation procedures. A successful turbot gillnet fishery started at the beginning of the 1990s in subdivisions 26 and 28. This development was caused by fishermen having more interest in turbot. Since 1990 in all eastern Baltic countries turbot was sorted out from the flatfish catches due to the better price. For example, the Polish landings of turbot increased from 33 t to 360 t from 1999 to 2003. Swedish landings are taken mainly from a gillnet fishery that reached a maximum of 250 t in 1996. Since then landings decreased and have been under 50 t for the last five years. Denmark and Germany are the main fishing countries in the Western Baltic and landed about 186 tonnes of turbot from subdivisions 22 and 24. Poland, Russia and Sweden are the main fishing countries in the Eastern and landed about 79 tonnes from subdivisions 25–28. Total landings in 2017 were about 264 tonnes. Landings are regularly exceeding the advised landings.

Due to the low stock level, fishery targeting turbot was totally closed for some years in the EEZ of Latvia and restrictions were implemented in Lithuania from 1 to 30 July according international regulations.

8.1.1.2 Discard

Estimates of discards were available from all countries from 2012 onwards. The data illustrate the high variability of the relation between landings. The mean proportion of discarded turbot in relation to total catch was 22% for the years 2012 to 2017. Due to the low sampling coverage of the discarded catch fraction, the estimates are considered too imprecise to be used for catch advice. The advice will be given for landings only.

Year	Landings (t)	Discards (t)
2012	221	139
2013	313	25
2014	253	85
2015	233	34
2016	252	100
2017	264	57

8.1.2 Biological composition of the catch

Available age data were compared during WKFLABA (2012) meeting. Results using sliced otoliths were remarkable better than using whole otoliths. These two ageing methods showed significantly different results. Applying the new method, the fishing mortality estimate declined by a factor of about two. WKFLABA did not make suggestions for turbot stocks in the Baltic Sea. Genetic information did not show any stock structure while tagging data indicated the existence of small local stocks. Further investigations, especially in the Eastern part of Baltic Sea are recommended.

8.1.3 Fishery independent information

Stock indices (CPUE) were estimated as mean catch-in-number per hour for turbot with a length of ≥ 20 cm. The CPUE values of the small TV were multiplied with a conversion factor of 1.4 (Figure 8.1.2). Stable index with low fluctuations were observed between 2007 and 2015. The index of 2017 increases compared to the previous year, but is however still on a low level (~3.97 turbot/hour).

8.1.3.1 Catch in numbers

The catch in numbers per length for the three most recent years is given in Figure 8.1.3. Almost no turbot above 35 cm are caught.

8.1.4 Assessment

The advice is base based on the data-limited approach of ICES. The mean abundance index of 2016 and 2017 were 34% higher than the mean of the abundance index from 2013–2015. Therefore, precautionary truncation was applied with a factor of 1.2. Exploitation is consistent with F_{MSY} proxy ($L_{F=M}$) and optimal yield in 2016. MSY $B_{trigger}$ is unknown. Following the ICES guidelines on DLS stocks, the precautionary buffer was not applied, as the length based indicator are stating a good stock status and the effort did not increase (Figure 8.1.4).

8.1.5 Reference points

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (2015) (Table 8.1.2). CANUM and WECA of commercial catches from 2014–2017 were taken from InterCatch. Biological parameters were calculated using survey data from DATRAS:

- L_{inf}: average of 2002–2017, both quarter and sexes → L_{inf} = 31.77 cm
- L_{mat}: average of 2002–2017, quarter 1, only females → L_{mat} = 22 cm

The results of LBI show that stock status of tur.27.22–32 is slightly above possible reference points (Table 8.1.3). Some truncation in the length distribution in the catches might take place. Over proportional amounts of mega spawners occur, as P_{mega} is larger than 75% of the catch. This might very well be an artefact produced by a relative small L_{inf}, which would also explain the overfishing of immatures (L_c/L_{mat}).Catch is close to the theoretical length of L_{opt} and L_{mean} is stable over time and close to 1, indicating fishing close to the optimal yield/exploitation consistent with F_{MSY} proxy ($L_{F=M}$).

Table 8.1.1 **Turbot in the Baltic Sea. Total landings (tonnes) by ICES Subdivision and country.**

	Denmark					Germ. Dem. Rep.		Germany, FRG				Poland		Sweden [2]							Latvia		Lithuania	Russia.	Finland						Estonia	
Year/SD	22	23	24(+25)	25	26+27	22	24	22	24	25	27	25(+24)	26	22	23	24	25	26	27	28(+29)	26	28	26	26	24	25	29	30	31	32	29	32
1965						3	39																									
1966	16		21			5	53																									
1967	14		20			7	10																									
1968	14		18			3	67																									
1969	13		13			4	57																									
1970	11		13			5	40									2																
1971	11		26			4	86									2																
1972	10		26			3	100									3																
1973	11		30			3	33					58	13			5																
1974	14		40			2	23					34	36			6																
1975	27		48			3	38	15				23	6			7																
1976	29		24				52	11				14	12			7																
1977	32		37				55	9				12	55			8																
1978	33		37			2	27	9				7	3			10																
1979	23		38			3	39	6				29	34			12																
1980	28		38				30	9				12	20			15																
1981	28		62			1	46	8				10	19			7																
1982	31		51			1	27	7				2	17			3	4		4	3												
1983	33		40			3	9	8				5	4			31	41		35	24												
1984	41		45			4	8	12				13	2			3	4		3	2												
1985	56		34			5	22	15				67	15			4	5		4	3												
1986	99		81			6	32	25				32	37			6	8		7	5												
1987	134		93			4	34	30				155	21			8	11		9	6												
1988	117		117			3	28	34				7	10			12	16		14	9												
1989	135		109			7	22	20					11			11	15		13	9												
1990	178		181			4	2	26				24	25			14																
1991	228		137					44	39			73	20			2	12		16													
1992	267		127					55	68			80	55			12	12		21	36				30								
1993	159	29	152					74	56			520	72		2	4	14		13	38				34								
1994	211	18	166					52	57	10		380	30		2	3	18	1	17	44				15								
1995	257	11	94					65	53	4		30	15		2	3	54	9	31	83	34	27	15	20								
1996	207	12	95					36	47	4	1	288	92	1	3	15	100	5	54	104	42	3	72	25								
1997	151		68					60	52	3		290	70		2	6	70	1	53	86	33	14	59	25								
1998	138		80					44	55	1		66	68		2	4	58	1	18	69	12	24	62	96								
1999	106		59					23	48			18	15		2	4	41	3	17	60	20	34	58	48								
2000	97		58					23	54			90	12		2	3	39		16	39	7	9	23	53								
2001	76		53					19	31			121	10		2	5	16		9	29	5	1	18	69								
2002	73		22	4	0			20	32	2		245	65		5	2	15		7	21	2	8	18	50								
2003	48		28	5	0			10	39	1		184	178		1	2	18		3	14	7	2	13	28								
2004	61		27	7				12	27	1		225	96		1	1	8		3	14	3	8	7	15								
2005	57	5	36	12				14	35	1		123	57		1	3	6		5	21	1	6	18	19								
2006	30	5	16	33				19	45	1		87	11		1	2	5	0	4	19	3	3	9	12								
2007	60	5	26	5	0			22	34	0		83	8		0	5	5		2	15	0	1	12	24								
2008	79	5	33	6				24	30	0		95	15		1	7	11		8	17			10	14								
2009	111	6	35	7	0			33	50	1		92	11		1	6	10	0	5	6	0	0	11	8								
2010	102	6	31	4	0			24	35	0		38	1		1	4	16	0	4	8	3	7	9	2								
2011	84	3	24	3	0			26	31	0		66	11	0	0	0	0	0	0	0	3	6	0	5	0	0	0	0	0	0	0	0
2012	43	3	16	1	0			16	27	0	0	55	11	0	0	0	0	0	0	0	5	5	14	15	0	0	0	0	0	0	0	0
2013	66	5	21	1	0			23	40	0	0	61	12	0	1	6	16	0	1	3	5	4	13	20	16	0	0	0	0	0	0	0
2014	84	5	27	1	0			35	30	0	0	25	5	0	1	3	13	0	2	4	2	5	7	6	0		0				0	
2015	84	5	22	1	0			27	19	0	0	41	8	0	0	4	9	0	1	1	0	4	4	3	0	0	0	0	0	0	0	0
2016	68	4	37	3	0			25	23	1		43	13	0	2	5	9	0	1	1	1	5	7	6	0	0	0	0	0	0	0	0
2017	76	5	18	3	0			41	33	0		55	8	0	1	2	4	0	1	1	0	1	7	7	0	0	0	0	0	0	0	0

continued

Table 8.1.1 Turbot in the Baltic Sea. Total landings (tonnes) by ICES Subdivision and country.

Year	Total by SD								Total
	22	23	24[3]	25	26	27	28(+29)	30-32	SD 22-32
1965	3	0	39	0	0	0	0		42
1966	21	0	74	0	0	0	0		95
1967	21	0	30	0	0	0	0		51
1968	17	0	85	0	0	0	0		102
1969	17	0	70	0	0	0	0		87
1970	16	0	55	0	0	0	0		71
1971	15	0	114	0	0	0	0		129
1972	13	0	129	0	0	0	0		142
1973	14	0	68	58	13	0	0		153
1974	16	0	69	34	36	0	0		155
1975	45	0	93	23	6	0	0		167
1976	40	0	83	14	12	0	0		149
1977	41	0	100	12	55	0	0		208
1978	44	0	74	7	3	0	0		128
1979	32	0	89	29	34	0	0		184
1980	37	0	83	12	20	0	0		152
1981	37	0	115	10	19	0	0		181
1982	39	0	81	6	17	4	3		150
1983	44	0	80	46	4	35	24		233
1984	57	0	56	17	2	3	2		137
1985	76	0	60	72	15	4	3		230
1986	130	0	119	40	37	7	5		338
1987	168	0	135	166	21	9	6		505
1988	154	0	157	23	10	14	9		367
1989	162	0	142	15	11	13	9		352
1990	208	0	197	24	25	0	0		454
1991	272	0	178	85	20	16	0		571
1992	322	0	207	92	85	21	36		763
1993	233	31	212	534	106	13	38		1167
1994	263	20	226	408	46	17	44		1024
1995	322	13	150	88	93	31	110		807
1996	244	15	157	392	236	55	107		1206
1997	211	2	126	363	188	53	100		1043
1998	182	2	139	125	239	18	93		798
1999	129	2	111	59	144	17	94		556
2000	120	2	115	129	95	16	48		525
2001	95	2	89	137	102	9	30		464
2002	93	5	56	266	135	7	29		591
2003	58	1	69	208	225	3	16		579
2004	73	1	55	241	121	3	22		516
2005	72	5	74	143	94	5	27	0	420
2006	49	6	63	126	35	4	22	0	305
2007	83	5	65	94	44	2	16	0	309
2008	103	6	70	113	39	8	17	0	356
2009	144	7	91	110	31	5	6	0	394
2010	126	7	70	58	15	4	15	0	295
2011	110	3	56	70	19	0	6	0	263
2012	59	3	44	57	44	0	5	0	221
2013	88	5	83	77	50	1	7	0	313
2014	119	5	60	39	19	2	9	0	253
2015	111	5	45	51	15	1	5	0	233
2016	94	6	64	56	28	1	7	0	255
2017	117	5	53	63	23	1	2	0	265

[1] From October-December 1990 landings of Germany, Fed. Rep. are included
[2] For the years 1970-1981 and 1990 catches of Subdivisions 25–28 are included in Subdivision 24
[3] For the years 1970-1981 and 1990 Swedish catches of Subdivisions 25–28 are included in Subdivision 24
[4] Preliminary data
Danish catches in 2002-2004 in SW Baltic were separated according to Subdivisions 24 and 25
In 2005 Lithuanian landings are reported for 1995 onwards

Table 8.1.2 Turbot in the Baltic Sea. Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system.

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above Lopt + 10%	0.3–0.4	P_{mega}	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/ L_{mat}	> 1	
L_{mean}	Mean length of individuals > Lc	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{maxy}	Length class with maximum biomass in catch	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > Lc	LF=M = (0.75Lc+0.25Linf)	L_{mean} / LF=M	≥ 1	MSY

Table 8.1.3 Turbot in the Baltic Sea Indicator status for the most recent three years 2015-2017.

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max\ 5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2015	0.89	1.16	1.46	0.90	1.44	1.35
2016	0.98	1.02	1.28	0.74	1.30	1.14
2017	0.61	1.30	1.33	0.98	1.50	1.76

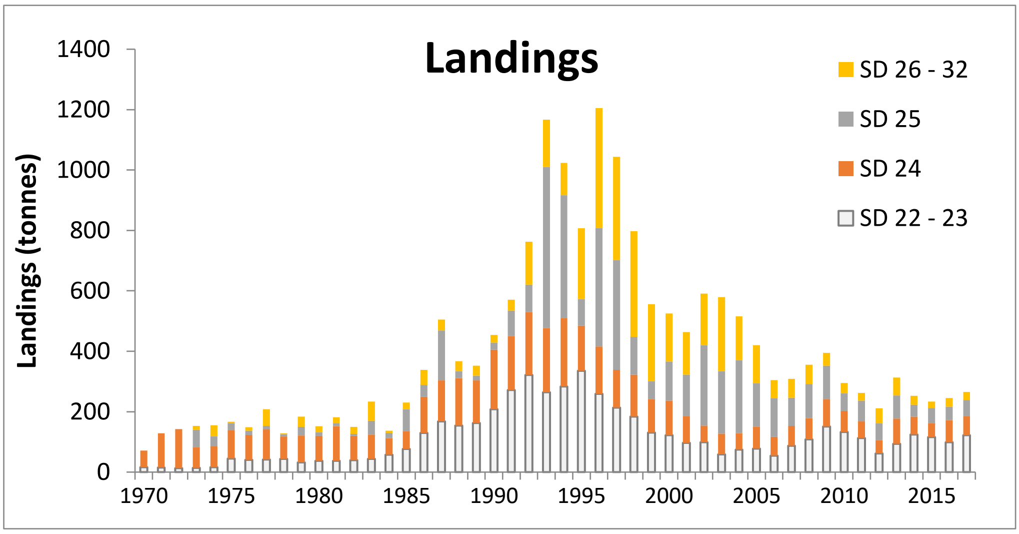


Figure 8.1.1 Turbot in the Baltic Sea. Development of turbot landings [t] from 1970 onwards by ICES subdivision (SD).

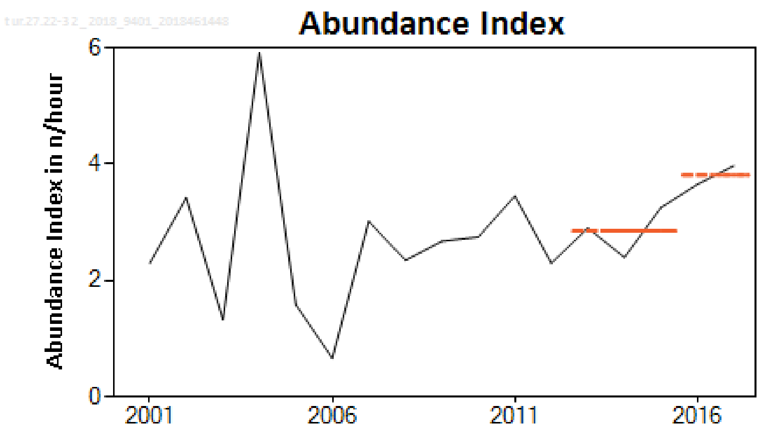


Figure 8.1.2 Turbot in the Baltic Sea. Mean CPUE (no. hr^{-1}) of turbot with L ≥ 20 cm based on arithmetic mean of the Baltic International Trawl Survey (BITS-Q1+Q4) in subdivisions (SD) 22–28.

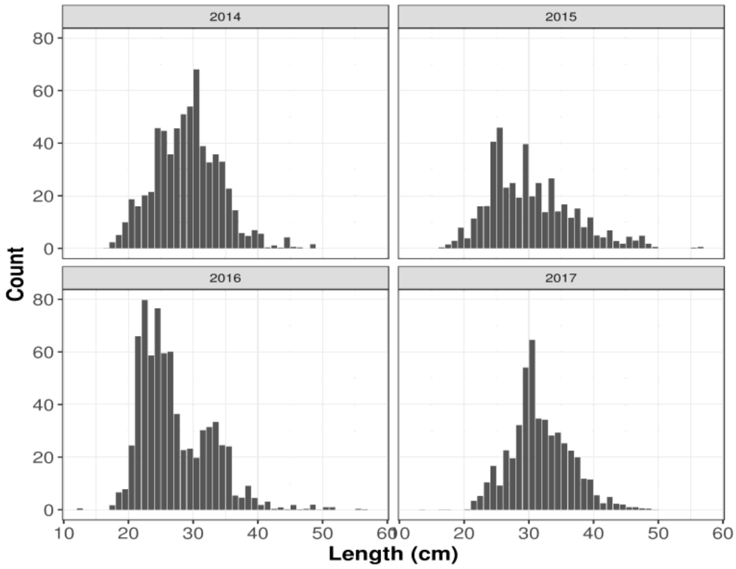


Figure 8.1.3 Turbot in subdivisions 22 to 32. Binned length frequency distributions.

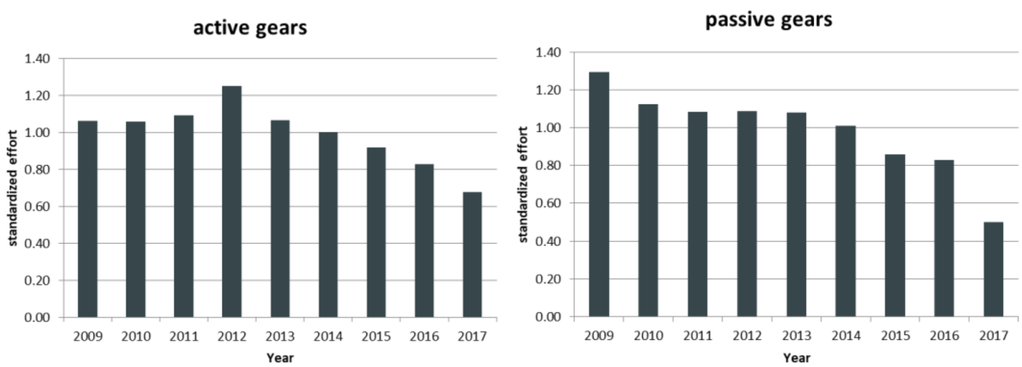


Figure 8.1.4 Turbot in subdivisions 22 to 32. Standardized effort for active and passive fleets in subdivisions 22 to 28 (main distribution range of tur.27.22–32). Standard catches (effort per strata and country divided by average effort per country) were weighted by the mean of cod landings by country.

8.2 Dab

8.2.1 Fishery

8.2.1.1 Landings

Separation of currently used stock unit SD 22–SD 32 was discussed during WKFLABA (2010). Three stock units were proposed which are SD 23, SD 22 & SD 24W and SD 24E & SD 25. Analyses of BITS and IBTS data during WKBALFLAT (2014) suggested a relation of brill in SD 21 and SD 22 and did not support the proposed three stock units. However, WGBALFLAT (2014) agreed that the current used stock definition of SD 22–32 will also be used in the future because additional analyses were not available which support the conclusions based on BITS and IBTS.

Total landings of dab were around 1000 t between 1970 and 1978 and fluctuated around 2000 t between 1979 and 1996 (Table 8.2.1). During the years 1994 to 1996 the total landings of dab were over-reported due to bycatch misreporting in cod fishery. Less than 1000 t were landed in 1997 and from 1999 to 2002. Since 2003 landings have been fluctuated around 1300 t with a maximum of 1894 t in 2004. Landings varied between 1041 t (2010) and 1495 t (2005) without trend between 2005 and 2017.

The largest amount of dab landings are reported by Denmark (subdivisions 22 and 24) and Germany (mainly in Subdivision 22, Figure 8.2.1). The German and Danish landings of dab are mostly bycatches of the directed cod fishery.

8.2.1.2 Discard

Estimates of discards were available from Denmark and Germany in 2012 to 2017.

The data illustrate the high variability of the relation between landings and discards and support the conclusion of the benchmark workshop that the application of the relation between landings and discards of one year in another year results in uncertain estimate.

Year	Landings (t)	Discards (t)
2012	1285	1191
2013	1384	1458
2014	1269	757
2015	1268	1055
2016	1356	1007
2017	1227	905

8.2.2 Biological composition of the catch

Age samples were realized from 2008 onwards by Germany and Denmark during Baltic International Trawl Survey (BITS) and commercial fishery. This indicates that age data were not available for 2000–2007. The length distributions reported for this period were transferred into age distributions by slicing of the length distributions. Two slicing methods were applied. To assess the quality of the slicing methods data of SD 22 from 2008 to 2012 were used. The length frequencies were sliced by both available methods and the estimated age frequencies were compared with the age frequencies estimated with the standard method described in the BITS manual. Unfortunately, estimated age frequencies based on age data and slicing methods were significantly different.

It was agreed during benchmark that data-limited approach based on landings and indices of BITS will also be used in the next years because the estimation of discards is uncertain and agreement was not possible concerning the method of slicing applied for dab.

It was further agreed during benchmark that the mean weight of dab ≥ 15 cm captured per hour in units of TVL is used instead of the CPUE in number. The limit of 15 cm were chosen because more than 50% of dab > 14 cm of both sexes were maturing during quarter 1 with high fluctuations from year to year. The geometric mean of the new indices of quarter 1 and quarter 4 was used as proxy of the development of the SSB.

8.2.2.1 Catch in numbers

The catch in numbers per length for the three most recent years is given in Figure 8.2.2. Almost no dab above 28 cm are caught.

8.2.3 Fishery independent information

The new stock indices, mean weight of dab ≥ 15 cm captured per hour in units of TVL, were calculated based on the mean catch in number per hour in units of TVL and the mean weight-length relation (Figure 8.2.3). The CPUE values of the small TV were multiplied with a conversion factor of 1.4. Estimates of quarter 1 and quarter 4 BITS were combined by geometric mean.

8.2.4 Assessment

Advice on dab is given biennial assessment was conducted, but no new advice is given in 2018 for the stock. The advice is based on the data-limited approach of ICES. The advice based on landings has been changed to advice based on catch in 2016 based on estimate discards of the respective last three years. The intermediate advice for 2018 is also a catch advice. The mean biomass index of 2016 and 2017 was 22% higher than the mean of the mean biomass index from 2013–2015 (Figure 8.2.3). Therefore, precautionary truncation was applied. The precautionary buffer was also not applied because the length based indicators are stating a good status of the stock. The fishing effort reported by Denmark and Germany in SD 22–24 did also not increased in 2017 (Figure 8.2.4). A precautionary buffer was applied the last time in 2013.

8.2.5 Reference points

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (2015) (Table 8.2.2). CANUM and WECA of commercial catches from 2014–2016 were taken from InterCatch. Biological parameters were calculated using survey data from DATRAS:

- L_{inf}: average of 2002–2017, both quarter and sexes → L_{inf} = 30.64 cm
- L_{mat}: average of 2002–2017, quarter 1, only females → L_{mat} = 15 cm*

*the calculated L_{mat} from the BITS sampling is slightly lower than comparable values from fishbase.org, stating a L_{mat} between 13.5 and 22.5 cm (average 17.9 cm) for females in Q1, covering the years 2008-2012.

The results of LBI show that stock status of dab.27.22-32 is slightly above possible reference points (Table 8.2.3). Some truncation in the length distribution in the catches might take place. P_{mega} is larger than 75% of the catch. Overfishing on immatures is indicated (L_c/L_{mat} < 1), but this might very well be an artefact produced by a relative high L_{mat}. Catch is close to the theoretical length of L_{opt} and L_{mean} is stable over time and close to 1, indicating fishing close to the optimal yield. Exploitation consistent with F_{MSY} proxy ($L_{F=M}$).

Table 8.2.1 Dab in the Baltic Sea: total landings (tonnes) of by Subdivision and country.

Year/SD	Denmark				Ger. Dem. Rep.[1]		Germany, FRG				Sweden[2]								Total									Total
	22	23	24(+25)	25-28	22	24	22	24	25	26	22	23	24	25	27	28	29	30	22	23	24[3]	25[5]	26	27	28	29	30	SD 22-30
1970	845		20		11		74												930	0	20	0	0	0	0	0	0	950
1971	911		26		10		64												985	0	26	0	0	0	0	0	0	1011
1972	1110		30		9		63						23						1182	0	53	0	0	0	0	0	0	1235
1973	1087		58		18		118						30						1223	0	88	0	0	0	0	0	0	1311
1974	1178		51		18		118						34						1314	0	85	0	0	0	0	0	0	1399
1975	1273		74		20		131						32						1424	0	106	0	0	0	0	0	0	1530
1976	1238		60		17		114						27						1369	0	87	0	0	0	0	0	0	1456
1977	889		32		13		89						25						991	0	57	0	0	0	0	0	0	1048
1978	928		51		19	14	128	4											1075	0	69	0	0	0	0	0	0	1144
1979	1413		50		18	25	123	1					9						1554	0	85	0	0	0	0	0	0	1639
1980	1593		21		15	25	101						3						1709	0	49	0	0	0	0	0	0	1758
1981	1601		32		24	39	164						5						1789	0	76	0	0	0	0	0	0	1865
1982	1863		50		46	38	182	4					6	5	8	6		1	2091	0	98	5	0	8	6	0	1	2209
1983	1920		42		46	28	198						24	20	32	22		2	2164	0	94	20	0	32	22	0	2	2334
1984	1796		65		30	47	175	2					4	3	5	4		1	2001	0	118	3	0	5	4	0	1	2132
1985	1593		58		52	51	187	2					3	3	5	3		1	1832	0	114	3	0	5	3	0	1	1958
1986	1655		85		36	35	185	1					1	1	1	1			1876	0	122	1	0	1	1	0	0	2001
1987	1706		93		14	87	276	4					1	1	1	1			1996	0	185	1	0	1	1	0	0	2184
1988	1846		75		22	91	281	1					1	1	1	1			2149	0	168	1	0	1	1	0	0	2320
1989	1722		48		26	19	218	1					1	1	2	1			1966	0	69	1	0	2	1	0	0	2039
1990	1743		146		14	11	252	1					8						2009	0	166	0	0	0	0	0	0	2175
1991	1731		95				340	5					1						2071	0	101	0	0	0	0	0	0	2172
1992	1406		81				409	6						1	1		4		1815	0	87	1	0	1	0	4	0	1908
1993	996		155				556	10				7	1	1			1		1552	7	166	1	0	0	0	1	0	1727
1994	1621		163				1190	80	45			5	1	1					2811	5	244	46	0	0	0	0	0	3106
1995	1510	47	127	10			1185	49	3			5	1	5		1			2695	52	177	18	0	0	1	0	0	2943
1996	913	37	128				991	134	13	2	3		3	4	1				1907	37	265	17	2	1	0	0	0	2229
1997	728		60				413	21	2			5	5	10	3	1			1141	5	86	12	0	3	1	0	0	1248
1998	569		89				280	6	2			7	3	3	1				849	7	98	5	0	1	0	0	0	960
1999	664		59				339	4				3	1	1					1003	3	64	1	0	0	0	0	0	1071
2000	612		46				212	3				2		1					824	2	49	1	0	0	0	0	0	876
2001	586		72				191	5				4	1	2					777	4	78	2	0	0	0	0	0	861
2002	502		31				173	5				4							675	4	36	0	0	0	0	0	0	715
2003	559		171				494	7	0			1	0						1053	1	179	0						1233
2004	953		185				745	10	0			1	1	0					1698	1	196	0						1894
2005	752	34	163	16			474	45	9			1	1	0					1226	35	209	25	0	0	0	0	0	1495
2006	400	23	112	161			494	24	11			1	2	0		0			894	24	138	172						1228
2007	860	40	108	7			472	18	0			0	0	0	0	0			1332	40	126	7						1504
2008	757	36	86	222			507	33	0			3	0	1	1	2			1264	39	119	223		1	2			1648
2009	521	25	97	0			587	32	0			2	0	0	1	3			1108	27	129	1		1	3			1268
2010	552	18	51	0			398	17	2			1	0	0					950	19	69	2						1041
2011	544	20	39	0			647	15	0			1	0	1	0	0			1192	21	53	1						1268
2012	481	22	69	0			692	20	0	0	0	1	0	0	0	1	0	0	1173	23	89	0						1285
2013	445	18	69	0			834	17	0	0		0	0	1	0	0	1		1279	18	86	1						1384
2014	373	11	57	0			801	25	2	0		0	0	0	0	0			1174	11	82	2						1269
2015	268	9	21	0	0	0	955	14	0	0	0	0	0	0	1	0	0	0	1223	9	35	0	0	1	0	0	0	1268
2016	268	14	21				1027	23	1	0	0	0	0	0	1	1	0	0	1295	38	23	1	0	1	1	0	0	1358
2017	276	9	15				874	50			0.0	0.1	0	0.4	0	0.6	0.7	0	1150.7	59.3	15.1	0.4	0	0	0.6	0.7	0	1227

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.

[2] For the years 1970–1981 and 1990 the catches of subdivisions 25–28 are included in Subdivision 24.

[3] For the years 1970–1981 and 1990 the Swedish catches of subdivisions 25–28 are included in Subdivision 24.

[5] In 1995 Danish landings of subdivisions 25–28 are included.

Table 8.2.2 Dab in subdivisions 22 to 32. Selected indicators for LBI screening plots. Indicator ratios in bold used for stock status assessment with traffic light system.

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	> 0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	P_{mega}	> 0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	> 1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	> 1	
L_{mean}	Mean length of individuals > Lc	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{mean}/L_{opt}	≈ 1	Optimal yield
L_{maxy}	Length class with maximum biomass in catch	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals > Lc	$L_{F=M}$ = $(0.75L_c+0.25L_{inf})$	L_{mean} / $L_{F=M}$	≥ 1	MSY

Table 8.2.3 Dab in subdivisions 22 to 32. Indicator status for the most recent three years

	Conservation				Optimizing Yield	MSY
Year	L_c / L_{mat}	$L_{25\%}$ / L_{mat}	$L_{max 5}$ / L_{inf}	P_{mega}	L_{mean} / L_{opt}	L_{mean} / $L_{F=M}$
2015	0.83	1.43	1.06	0.71	1.17	1.40
2016	1.43	1.50	1.04	0.77	1.24	1.07
2017	1.30	1.37	1.04	0.62	1.19	1.09

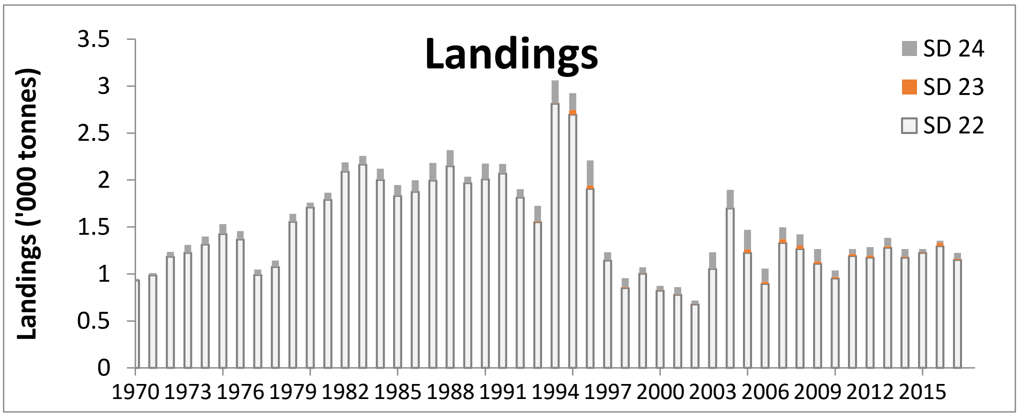


Figure 8.2.1 Dab in subdivisions 22 to 32. Development of dab landings [t] from 1970 onwards by ICES subdivision (SD).

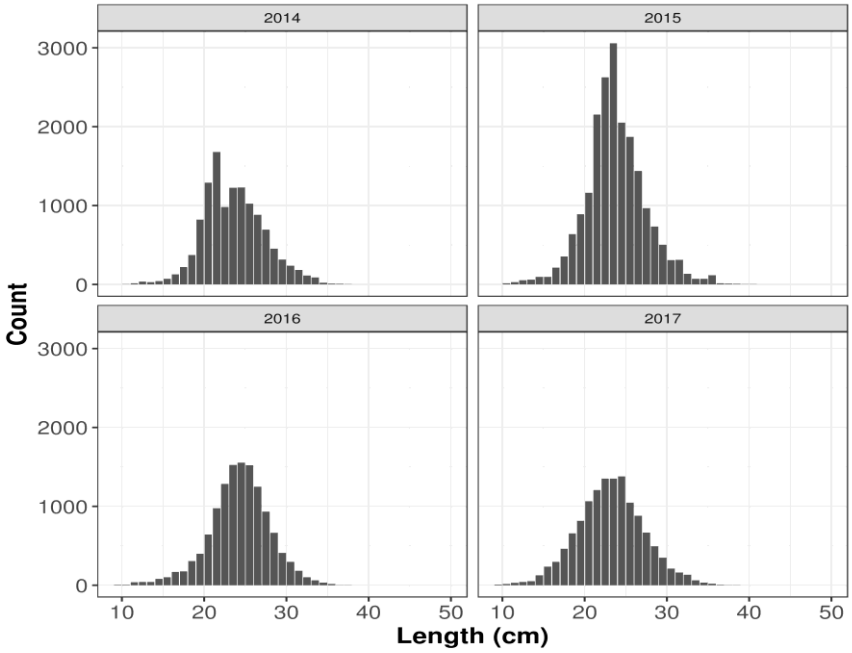


Figure 8.2.2 Dab in subdivisions 22 to 32. Catch in numbers per length for the three most recent years 2014–2016.

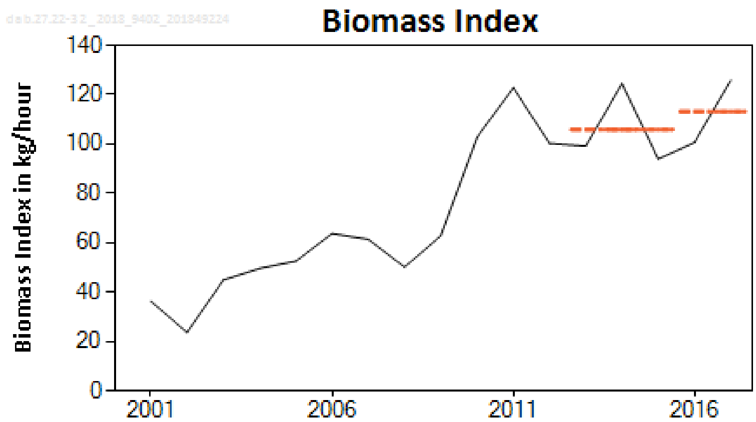


Figure 8.2.3 Dab in subdivisions 22 to 32. Mean biomass (kg hr[-1]) of dab with L ≥ 15 cm based of the Baltic International Trawl Survey (BITS-Q1+Q4) in subdivisions (SD) 22–24.

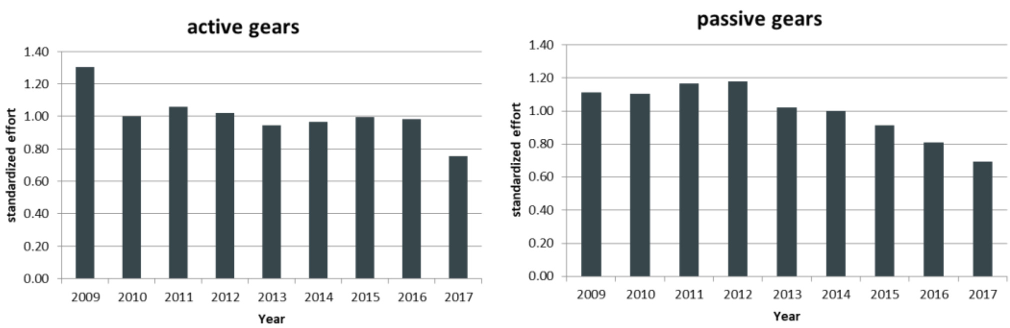


Figure 8.2.4 Dab in subdivisions 22 to 32. Standardized effort for active and passive fleets in subdivisions 22 to 24 (main distribution range of dab.27.22-32). Standard catches (effort per strata and country divided by average effort per country) were weighted by the mean of cod landings by country.

8.3 Brill

8.3.1 Fishery

8.3.1.1 Landings

Total landings of brill varied from 1 t to 160 t between 1975 and 2004 (Table 8.3.1, Figure 8.3.1). It can be assumed that the total landings of brill reported for 1994–1996 are overestimated due to species-misreporting in the landings of the directed cod fishery. The landings averaged about 25 t if the years 1994–1996 are excluded. Moderate increase of the landings was observed from 19 t in 2001 to 56 t in 2007 followed by landings of 105 t in the following year. Decreasing trend has been observed since 2009 which is continued with landings of 30 t in 2012, 31 t in 2013 and 28 t in 2014. Slightly increase of landings was reported for 2015 with 40 t, for 2016 with 39 t and finally at 39 t in 2017.

8.3.1.2 Discards

Less than 100 kg of brill was discarded in 2012. The amount of discards increased to 299 kg in 2013 and further increased to 4200 kg in 2014. Discards of brill were not reported in 2015. For 2016, 400 kg discard were reported. For 2017, 9.2 tonnes of discards have been reported. This is almost 25% of the landings. Most of these discards (7 t) have been generated in Subdivision 22, in proportion with the landings in Subdivision 22, which contribute to more than 80% of the total.

8.3.2 Biological composition of the catch

WKFLABA did not find any data concerning genetic or tagging that could be used to illuminate the stock structure of brill in the Baltic, hence no suggestions for possible assessment units based on biological information were given. Brill is bycatch species of cod fishery and fisheries directed to other flatfish.

8.3.3 Fishery independent information

Stock indices (CPUE) were estimated as weighted mean catch in number per hour for brill with a length of ≥ 20 cm. As weights applied were the sizes of the sub-areas sampled in the ICES Subdivisions. The CPUE values of the small TV were multiplied with a conversion factor of 1.4 (Figure 8.3.2).

The area data are available at http://www.ices.dk/marine-data/data-portals/Pages/DATRAS-Docs.aspx . The CPUE data were derived from DATRAS (CPUE per length per haul per hour). It was not possible to match exactly the same data as in the assessments used so far. This is probably due to some selective weightings of sub-areas done in former assessments, that has not been possible to reconstruct. However, the new and old calculation routine yield the same trends in CPUE and it is considered important from now on to derive the stock indices in a transparent and reproducible way.

Stable index with low fluctuations were observed between 2007 and 2017. CPUE values follow in general fisheries landings.

8.3.4 Assessment

ICES has not been requested to advice on fishing opportunities for this stock

8.3.5 Management considerations

Brill in ICES subdivisions 22–32 is according to survey estimation at the edge of its distributional area, with the centre of gravity being positioned in Kattegat (ICES Subdivision 21, Figure 8.3.3.). Survey CPUE (numbers per haul) have to be considered to be very low (<1, and 0 in the Eastern Baltic Sea). Hence, survey data are a weak basis for assessment and potential management reference points, and it might be worthwhile considering to combine Brill in ICES subdivisions 22–32 with Brill in Subdivision 21.

Table 8.3.1. Brill in the Baltic Sea: total landings (tonnes) by Subdivision and country.

Year	Denmark			Germany, FRG		Sweden		Total			Total
	22	23	24-28	22	24	23	24-28	22	23	24-28	SD 22-28
1970	4							4	0	0	4
1971	3							3	0	0	3
1972	7							7	0	0	7
1973	11		2					11	0	2	13
1974	25		1					25	0	1	26
1975	38		1	1				39	0	1	40
1976	45		1	2				47	0	1	48
1977	60		2	5				65	0	2	67
1978	37			3				40	0	0	40
1979	30							30	0	0	30
1980	26							26	0	0	26
1981	22			1				23	0	0	23
1982	19						17	19	0	17	36
1983	13						42	13	0	42	55
1984	12						3	12	0	3	15
1985	16						1	16	0	1	17
1986	15						3	15	0	3	18
1987	12						3	12	0	3	15
1988	5						1	5	0	1	6
1989	9						1	9	0	1	10
1990							1	0	0	1	1
1991	15							15	0	0	15
1992	28							28	0	0	28
1993	29	5	1					29	5	1	35
1994	57	4	1				1	57	4	2	63
1995	134	12	1			5	8	134	17	9	160
1996	56	6						56	6	0	62
1997	25					1		25	1	0	26
1998	21					1		21	1	0	22
1999	24					1		24	1	0	25
2000	27					1		27	1	0	28
2001	19							19	0	0	19
2002	25		0			1		25	1	0	27
2003	35		1			0		35	0	1	36
2004	39		1			1	0	39	1	1	41
2005	50	9	3			0	0	50	9	3	62
2006	42	9	2	3		0	0	45	9	2	56
2007	50			5		0	0	55	0	0	56
2008	81	9	3	11		1	1	92	10	3	105
2009	70	7	2	11		1	0	82	8	3	92
2010	65	4	1	10		0	0	76	5	1	82
2011	46	5	1	4		1	0	50	6	1	57
2012	24	4	0	2		1	0	26	4	0	31
2013	24	6	0	1	0	1	0	25	7	0	31
2014	19	5	0	2	0	1	0	21	6	0	28
2015	29	7	0	3	0	1	0	32	8	0	40
2016	28	8	0	2	0	1	0	29	9	1	39
2017	29	6	0	4	0	0	0	33	6	0	39

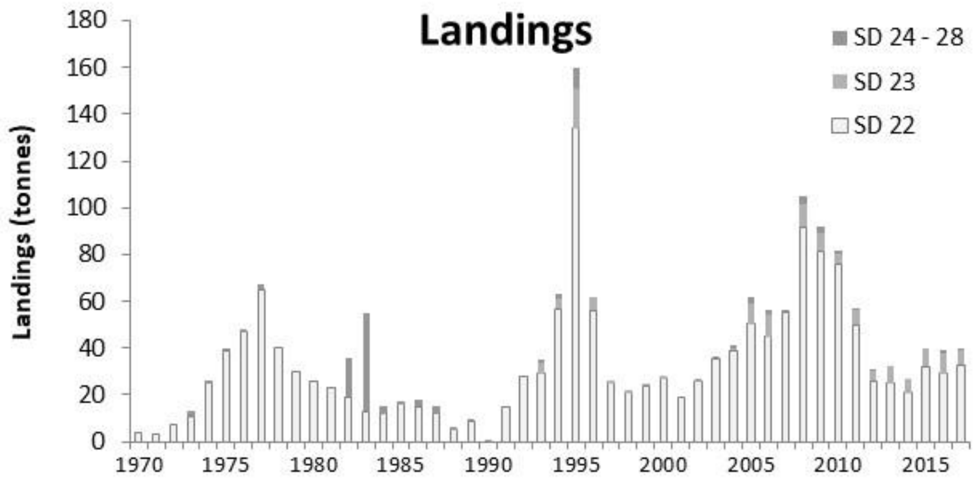


Figure 8.3.1. **Development of brill landings [t] from 1970 onwards by ICES subdivision (SD).**

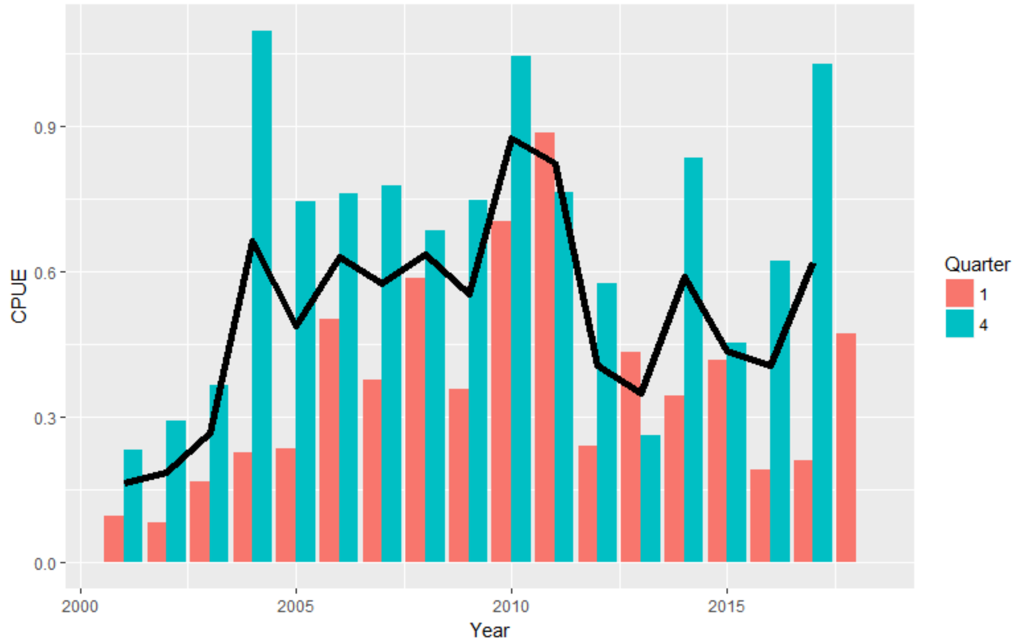


Figure 8.3.2. **Mean CPUE (no. hr^{-1}) of brill with L ≥ 20 cm 11/04/2018.**

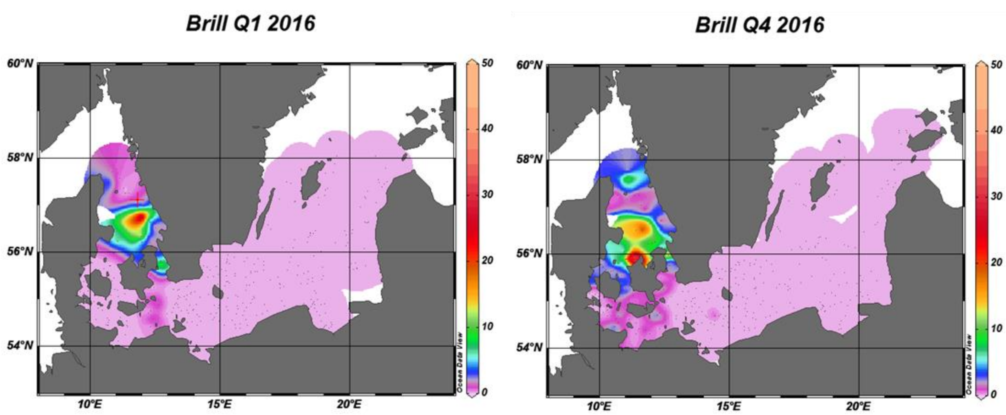


Figure 8.3.3 **Brill distribution in the Baltic Sea, CPUE in numbers per hour indicated in colour bars.**

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Annex 2: Recommendations

Recommendation	For follow up by:
Brill/Dab in ICES subdivisions 22–32 is according to survey estimation at the edge of its distributional area, with the center of gravity being positioned in Kattegat (ICES Subdivision 21). Survey CPUE (numbers per haul) are very low (<1 in the Western Baltic, and 0 in the Eastern Baltic Sea). Hence, survey data are a weak basis for assessment and potential management reference points. WGBFAS recommends SIDWG to consider to combine Brill/Dab in ICES Sub-division 22-32 with Brill/Dab in Subdivision 21. Please see report section 8.3.	SIDWG
The working group argues that it is of outmost importance that the international surveys in the Baltic and adjacent areas have a high priority nationally. It is most troublesome to hear that Sweden has problems performing their survey with the RV Dana in Swedish zone. This is especially problematic for eastern Baltic cod where the assessment is solely depending in a survey index and a large part of the stock is within Swedish territorial waters.	Swedish national delegate of ICES.
To ensure that the calibration factor from the old Havfisken to the new Havfisken (on cod and flounder) is incorporated in the index's calculation as a standard. As the surveys are conducted very close to the assessment working group data is often re-uploaded to DATRAS when ages are included. Therefore, it would be very beneficial if the stock assessor/coordinator could be informed every time changes are conducted in DATRAS for surveys relevant for the specific stock. Further, data needs to be populated automatic to the data ware house making sure that it is the new data that are available.	ICES data center:
WGBFAS propose for WGSAM to run and evaluate Nash Equilibrium reference points for multispecies and ecosystem models of the Baltic Sea	WGSAM:
WGBFAS recommend a meeting with selected members to discuss the mutual needs and ability to produce eco-system information.	WGSAM, WKDEICE, WGIAB:
The WG discussed the request from WKSIDAC 2017 related to mixing and stock identification of herring in the Baltic. The request suggested initiation of collection of relevant data, e.g. data allowing genetics and otolith shape analysis. WGBFAS recommend a workshop to initialize the sampling and the relevant analyses. WGBFAS suggest a WK in Gdynia, Poland, in 11–13 September, 2018.	ICES
The European fisheries control agency has controlled pelagic landings in the Baltic, which suggests that there exists independent data that could confirm if there is a problem with species misreporting. This information is not publicly available. WGBFAS recommends that these data must be made public and available to the WG.	European fisheries control agency
WGBFAS recommend a benchmark of cod.22-24 and cod.24-32 in 2019.	ACOM

All recommendations have been uploaded to the ICES Recommendation database.

Annex 3: Terms of Reference for the 2019 WGBFAS meeting

2018/X/ACOMXX The **Baltic Fisheries Assessment Working Group** (WGBFAS), chaired by Mikaela Bergenius, Sweden, will meet at ICES, Denmark, 8 – 15 April 2019 to:

a) Address generic ToRs for Regional and Species Working Groups

b) Review the main result from WGIAB, WGSAM, SGSPATIAL with main focus on the biological processes and interactions of key species in the Baltic Sea;

c) Estimate MSY proxy reference points for the category 3 and 4 stocks in need of new advice in 2019:

    a. Update the MSY proxy reference points for those category 3 and 4 stocks with existing proxy reference points using most recent data. For those stocks without reference points listed below, collate necessary data and information in order to estimate MSY proxy reference points prior to the Expert Group meeting. The official ICES data call included a call for length and life history parameters for each stock in the table below;

    b. Propose appropriate MSY proxies for each of these stocks by using methods provided in the ICES Technical Guidelines (ICES, 2017) along with available data and expert judgement

The assessments will be carried out on the basis of the stock annex. The assessments must be available for audit on the first day of the meeting.

Material and data relevant for the meeting must be available to the group on the dates specified in the 2019 ICES data call.

WGBFAS will report by xx April 2019 for the attention of ACOM.

Annex 4: List of Stock Annexes

Name	Title
bll-2232_SA.pdf	Stock Annex: Brill (*Scophthalmus rhombus*) in Subdivisions 22–32 (Baltic Sea)
cod-2224_SA.pdf	Stock Annex: Cod (*Gadus morhua*) in subdivisions 22–24, western Baltic stock (western Baltic Sea)
cod-2532_SA.pdf	Stock Annex: Cod (*Gadus morhua*) in subdivisions 25–32, eastern Baltic stock (eastern Baltic Sea)
cod-kat_SA.pdf	Stock Annex for Cod (*Gadus morhua*) in Division 3.a East (Kattegat)
dab-2232_SA.pdf	Stock Annex: Dab (*Limanda limanda*) in subdivisions 22–32 (Baltic Sea)
fle-2223_SA.pdf	Stock Annex: Flounder (*Platichthys flesus*) in subdivisions 22 and 23 (Belt Seas and the Sound)
fle-2425_SA.pdf	Stock Annex: Flounder (*Platichthys flesus*) in subdivisions 24 and 25 (West of Bornholm and Southwestern central Baltic)
fle-2628_SA.pdf	Stock Annex: Flounder (*Platichthys flesus*) in subdivisions 26 and 28 (east of Gotland and Gulf of Gdansk)
fle-2732_SA.pdf	Stock Annex: Flounder (*Platichthys flesus*) in subdivisions 27 and 29– 32 (northern central and northern Baltic Sea)
her-2532-gor_SA.pdf	Stock Annex: Herring (*Clupea harengus*) in subdivisions 25–29 and 32, excluding the Gulf of Riga (central Baltic Sea)
her.27.3031_SA.pdf	Stock Annex: Herring (*Clupea harengus*) in Subdivision 30 (Bothnian Sea)
her-riga_SA.pdf	Stock Annex: Herring (*Clupea harengus*) in Subdivision 28.1 (Gulf of Riga)
ple-2123_SA.pdf	Stock Annex: Plaice (*Pleuronectes platessa*) in subdivisions 21– 23 (Kattegat, Belt Seas, and the Sound)
ple-2432_SA.pdf	Stock Annex: Plaice (*Pleuronectes platessa*) in subdivisions 24–32 (Baltic Sea, excluding the Sound and Belt Seas)
sol-kask_SA.pdf	Stock Annex: Sole (*Solea solea*) in subdivisions 20–24 (Skagerrak and Kattegat, western Baltic Sea)
spr-2232_SA.pdf	Stock Annex: Sprat (*Sprattus sprattus*) in subdivisions 22–32 (Baltic Sea)
tur-2232_SA.pdf	Stock Annex: Turbot (*Scophthalmus maximus*) in subdivisions 22–32 (Baltic Sea)

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: cod.27.25-32**

Date: 19.04.2018
Auditor: Jan Horbowy

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General
Due to many data issues and methodological problems (e.g. difficulties in age determination, changes in growth and natural mortality difficult to quantify, survey catchability) the accepted analytical assessment for this stock has been lacking since 2012. However (similarly as last year), the assessment with SPiCT model (surplus production model) was presented to the WG. The model results (F and biomass) are considered reliable in relative terms (i.e., relative to Fmsy and Bmsy). The model passed typical tests of reliability (statistical assumptions, distribution of residuals, retrospective analysis).

However, the final assessment was conducted following “data poor stock” approach. It bases on indices of stock size from BITS surveys.

For single stock summary sheet advice:
Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update/SALY**
2) **Assessment**: trends: stock size indices from BITS survey
3) **Forecast**: not relevant
4) **Assessment model**: trends: stock size indices from the BITS survey.
   In addition SPiCT model was fitted and in the model change of stock productivity was considered and estimated. Two periods of stock productivity were determined: one (up to 2009) with higher and one with lower (from 2010 onwards) productivity. The estimates from SPiCT are considered reliable in relative terms, thus the ratios F/Fmsy and B/Bmsy could be used for evaluation of stock status in respect to MSY reference points.
5) **Data issues:** For a few years the analytical assessment of the stock has been lacking due to many problems with the age-structured data: difficulty in age determination, difficulty in estimation of cod growth, probably marked increases of natural mortality difficult to evaluate. Details of the problems with analytical assessments are described in Eero et al, 2015.
6) **Consistency**: no revisions in BITS index were made, so this and last year assessments are consistent by definition

7) **Stock status**: from SPiCT: F>Fmsy for several years, B<Bmsy in recent years (note change of stock productivity in 2010 estimated within SPiCT)
8) **Management Plan**: implemented but reference points for the stock have not been defined, advice is based on approach for DLS

General comments

Clear and well prepared report

Technical comments

No errors were noticed

Conclusions

The assessment has been performed similar as last year, no errors were noticed.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description? **Not relevant**

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? **Not relevant**

Have the data been used as specified in the stock annex? **Not relevant**

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? **Not relevant**

Is there any **major** reason to deviate from the standard procedure for this stock? **Not relevant**

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? **Yes, but SPiCT could also be used for advice**
It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☐ The advised value of catches should be the same as presented in the catch options table.

☐ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☐ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☐ The year is correct,

☐ The value is correct,

☐ The notes are correct and

☐ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct.

☐ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☐ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☐ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☐ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☐ For all the options given in the table calculate the percentage of change in SSB and TAC.

☐ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☐ Compare different catch options; higher F should result in lower SSB

☐ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☐ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☐ Are the units in plots correct?

☐ Are the titles in the plots correct including F (age range) recruitment (age).

☐ The red line correspond to the year of assessment (except F which is year of assessment -1)

☐ Each plot should have five lines.

☐ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☐ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☐ If there is no change from the previous year the table should be the same.

☐ Ensure there is no typos wrong acronyms for the surveys.

☐ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be “There is no available information”

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☐ Ensure that the forecast year “predicted landings or catch corres. to advice” column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☐ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read “There is no assessment for this stock”

Sources and references

☐ Ensure all references are correct.

☐ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: cod.27.22-24**

Date: 2018-04-13
Auditor: Noél Holmgren, Maris Plikshs

General

This stock exhibits mixing with the Eastern Baltic cod in subdivision 24. The recreational catches are considerable (they need to be, and are considered), and just recently incorporated into the assessment. The effects of recent changes in the management of the recreational fisheries is difficult to predict.

Despite the complex circumstances of the stock, the advice is very clear on the measures taken.

For single stock summary sheet advice:

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: SAM – tuning by 2 surveys
5) **Data issues:** the data as described in stock annex is available.
6) **Consistency**: Consistent with last year assessment; retrospective analyses with small overestimation of SSB and underestimation of F.
7) **Stock status**: B < MSY Btrigger since the beginning of the data series (1994), B < Blim since 2008. FMSY < F < Fpa since 2017, R very variable in the last three years, 2017 recruits the third highest observed, 2016 and 2018 recruits the lowest observed.
8) **Management Plan**: Agreed 2016. F-ranges related to article 4(2 & 3) 0.15 ≤ F ≤ 0.26, and related to article 4(4) 0.26 ≤ F ≤ 0.45. Minimum SSB reference points related to article 5(2) MSY Btrigger = 38 400 tonnes, and article 5(3) Blim = 27 400 tonnes. Stock is expected to comply with the goal of the management plan by 2020. To maintain the stock at the MSY goal can be a challange if the on average poor and highly variable recruitment seen during the last decade continues.

General comments

This is a very well structured an clear advice sheet. The forecast and stock SSB development is highly dependent from abundant 2016 yearclass.

Technical comments

The assessment has been undertaken according to the stock annex (SA). The forecast has been conducted according to the SA, except for recruits sampling where the last ten years were used to produce the advice, and the SA says that the last seven years should be used. This deviation has no implication on the quality of the advice.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?
Yes

Is the assessment according to the stock annex description?
yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
yes

Have the data been used as specified in the stock annex?
yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
Yes

Is there any **major** reason to deviate from the standard procedure for this stock?
No

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

Yes

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

Yes

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☐ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct.

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and TAC.

☐ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☒ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☐ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☐ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read "There is no assessment for this stock"

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: cod.27.21**

Date: 18.04.2018
Auditor: Margit Eero

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update/SALY**
2) **Assessment**: trends
3) **Forecast**: not presented
4) **Assessment model**: SAM *– tuning by 4 surveys*
5) **Data issues:** *no issues identified*
6) **Consistency**: *same process as last year*
7) **Stock status**: *not defined*
8) **Management Plan**: NA

General comments

The assessment was performed correctly according to Stock Annex.

Technical comments

The assessment was performed according to Stock Annex.

The tuning indices shown in WGBFAS 2017 report for Havfisken Q1 survey for 2016-2017 differ from the values used for these years by WGBFAS 2018.

In advice draft, the ICES landings for 2015 are shown as 103 t, while it says 106 t in the report

The values of discards in tons given in Advice (Table 7) do not match with the values in the report.

For clarity, could include an explanation how the absolute SSB, Recruitment and Mortality values derived from SAM are converted to relative values for the Advice.

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?
Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☒ The forecast should be re-run to ensure all values are correct.

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and TAC.

☒ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☒ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☒ If the stock is category 5 or 6 then it should read "There is no assessment for this stock"

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name:** her-30+31

Date:
Auditor: Joakim Hjelm and Marie Storr- Paulsen

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
  - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
  - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type:** Update/SALY
2) **Assessment**: Analytical
3) **Forecast**: Presented
4) **Assessment model**: SAM – tuning by 1 commercial fleet + acoustic survey 2007-2017 (ages 1-9) + trapnet 1992-2006 (ages 1-9)
5) **Data issues:** Data well described except the trapnet series
6) **Consistency**: A considerable downscaling of the biomass.
7) **Stock status**: Above reference points. Mohn's rho=0.479 on recruits!
8) **Management Plan**: There is an agreed MAP since 2017 but nut applicable because now perceived as one stock instead of 2.
9)

General comments

This is a well-documented, and well-ordered stock report.

Technical comments

Assessor should consider to remove the trapnet survey next benchmark even though the acoustic index is short. The assessment and the forecast are made in two different SAM versions.

Commented [MARST1]: I think the leave one out shows what will happen. The model becomes unstable.

The biological samples for ages from the surveys in 2007–2017 have been annually used for 3rd and/or 4th quarter ALK's for length distributions from commercial sampling and calculations for mean weights at age in the input data. It is generally not a good idea to use survey ages to apply to commercial samples. Especially as there are commercial age samples available for this quarters (table 6.4.3) the table has some strange quarters in the last column.

There seems to be a strong year effect in the residuals were the survey and catch matrix have opposite trends it could be beneficial to have a run in SAM tmb and test for this.

Table 6.4.1 is describing what? Many of them as well

Is reference ICES,2017 missing or is everything related to WKBALT?

Consistencies of the different ages within catch data 6.4.14 is missing (and maybe in future reports is the consistency plot of the trapnets terminated many years ago not so important)

Table 6.4.7 the summary table does not match with the final run (GoBHer_2018_copyfromlastyear)in the SAM assessment on the homepage. However the output match with the tmb version – why are they different? The summary table in the advice is also the TMB version

The short term forecast is not available (any of the 2) on the SAM versions and can therefore not be checked against the values in the advice

Shouldn't table 10 from advice sheet be in the report?

Commented [MARST2]: It is ? table 6.4.7

The data been used as specified in the stock annex.

There is no major reason to deviate from the standard procedure for this stock and the update assessment give a valid basis for advice.
A management plan exists for the area but is not fully applicable for this stock.

Conclusions

The assessment is conducted according to the SA and can be used for advice

Checklist for audit process

General aspects

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct.

Commented [MARST3]: Can not be conducted as the forecast is not avalible

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and (not TAC).

☒ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under "Other options".

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☐ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☐ Are the units in plots correct?

☐ Are the titles in the plots correct including F (age range) recruitment (age).

☐ The red line correspond to the year of assessment (except F which is year of assessment -1)

☐ Each plot should have five lines.

☐ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☐ Ensure there is no typos wrong acronyms for the surveys.

☐ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be “There is no available information”

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year “predicted landings or catch corres. to advice” column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☒ If the stock is category 5 or 6 then it should read "There is no assessment for this stock"

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: her.27.25-2932**

Date: 2018-04-20 / 2018-04-24
Auditor: Noel Holmgren (Sweden's Longest University), Jukka Pönni (Lucky Luke)

General
Very clear advice and report.

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: XSA – tuning by 1 survey
5) **Data issues:** No data issues
6) **Consistency**: Last years' assessments have been accepted.
7) **Stock status**: B > MSY Btrigger since 2007, B < Blim 2001-2002. FMSY < F < Fpa since 2015, R more variable in the last eight years, 2015 age 1 recruits the highest observed, 2011 recruits the lowest observed.
8) **Management Plan**: Agreed 2016. F-ranges related to article 4(2 & 3) 0.16 ≤ F ≤ 0.22, and related to article 4(4) 0.22 ≤ F ≤ 0.28. Minimum SSB reference points related to article 5(2) MSY Btrigger = 600 000 tonnes, and article 5(3) Blim = 430 000 tonnes. Stock is expected to comply with the goal of the management plan by 2020. To maintain the stock at the MSY goal can be a challenge if the on average poor and highly variable recruitment seen during the last decade continues.

General comments
The stock assessment and background to the advice is well documented.

Technical comments
Advice produced according stock annex.

Conclusions
The assessment has been performed correctly. The inclusion of survey data in SD32 should be reconsidered. The correlation between ages within years (year-effects) within the survey should be part of the assessment model.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?
Yes

Is the assessment according to the stock annex description?
Yes

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?
Yes

Have the data been used as specified in the stock annex?
Yes

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?
Yes

Is there any **major** reason to deviate from the standard procedure for this stock?
No

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

Yes

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol). Checked. The historical levels of F have changed in relation to ref points, therefore 2015 and 2016 Fs were below FMSY in 2017 assessment, and above in 2018 assessment.

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

<u>Basis of catch options table</u>:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

<u>Catch options table:</u>

☐ The forecast should be re-run to ensure all values are correct. (Too much).

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and TAC.

☒ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☒ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☐ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read “There is no assessment for this stock”

Sources and references

☒ Ensure all references are correct. ICES 2015 misspelled (20125)

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: Gulf of Riga Herring**

Date: 20.04.2018
Auditor: Johan Lövgren/Margit Eero

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update/SALY**
2) **Assessment**: Category 1,Analytical
3) **Forecast**: presented
4) **Assessment model**: Aged based analytical assessment, XSA; Catches from 1977-2017, One aqustic survey (BIAS) and one commercial tuning (Trapnets)
5) **Data issues:** *no issues identified*
6) **Consistency**: *same process as last year*
7) **Stock status**: Fishing pressure is at $F_{msy,}$ and below F_{pa} and $F_{lim,}$ *SSB is above Fmsy*
8) ***Management Plan****: The EU multiannual plan for stocks in the Baltic sea including heering (EU;2016).*

General comments

Report is well documented and possible to follow the assessment.

Technical comments

The assessment is performed according to the stock annex.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?
Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☒ The forecast should be re-run to ensure all values are correct.

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and TAC.

☒ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under "Other options".

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☒ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☒ If the stock is category 5 or 6 then it should read “There is no assessment for this stock”

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: ple.27.21-23**

Date: 12.04.2018
Auditor: Maris Plikshs & Kristiina Hommik

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update**
2) **Assessment**: analytical, age based
3) **Forecast**: presented
4) **Assessment model**: SAM, with two tuning series from survey data: 1) combination of 1st quarter NS-IBTS and the 1st quarter BITS and 2) the combination of 3rd quarter NS-IBTS and 4th quarter BITS. The surveys are combined using the GAM approach
5) **Data issues:** All data are made available and corresponding to stock annex. Discard data for 1999-2001 are based on average discards from 2002–2004.
6) **Consistency**: The retrospective analysis is quite consistent (for last two years).
7) **Stock status**: Assessment reveals that stock is in very good condition, SSB continues to increase and F – decrease. SSB increase is strongly dependent from high recruitment in 2017.
8) **Management Plan**: No management plan for this stock

General comments

Report is quite well documented and possible to follow the assessment.

Technical comments

The major change for stock is that advice base for this stock has been changed from MSY approach to PA approach (ACOM decision).

Conclusions

The assessment has been performed correctly, is clear and can be used for the advice.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? YES

Is the assessment according to the stock annex description? YES, except introduction in SAM of the facility to account for year effect in the survey data.

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? NO

Have the data been used as specified in the stock annex? YES

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? YES
Is there any **major** reason to deviate from the standard procedure for this stock? YES (see above change in SM settings to account for year effect in the 1st quarter survey data)

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? YES

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies. YES

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables. YES

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct.

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and TAC.

☒ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☒ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☐ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☒ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read “There is no assessment for this stock”

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: Ple27.24-32**

Date: 11.04.2018
Auditor: Georgs Kornilovs

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update/SALY**
2) **Assessment**: exploratory SAM for SSB trend analysis
3) **Forecast**: not presented
4) **Assessment model**: SAM + 2 tuning fleets
5) **Data issues:** data available as described in stock annex
6) **Consistency**: Both last year's and this year's assessments accepted
7) **Stock status**: The stock size indicator (relative SSB) and relative recruitment have been increasing significantly since 2012. The fishing pressure in 2017 is the lowest observed in the time series. The stock status and exploitation status relative to MSY and PA reference points cannot be assessed because the reference points are undefined.
8) **Management Plan**: There is no management plan for this stock

General comments

In general this was a well documented, well ordered and considered section. In some sections the required issues were not covered.

Technical comments

The author of the report for Plaice in Sd 24-32 has received the comments of the audit and has made the necessary corrections.

Conclusions

The assessment has been performed correctly

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? – Yes.

Is the assessment according to the stock annex description? – YES.

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? - NA

Have the data been used as specified in the stock annex? - Yes.

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? – Yes.

Is there any **major** reason to deviate from the standard procedure for this stock? – No.

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? – Yes.

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☐ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded. - **NA**

☐ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP. -**NA**

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☐ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable. - **NA**

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct. -**NA**

☐ Compare the input data with previous year run (previous year should be in the share point under the data folder) -**NA**

☐ The wanted catch and SSB values should be given in tonnes (t); -**NA**

☐ Confirm if the F values for the options F_{lim}; F_{pa}; are correct. - **NA**

☐ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points. - **NA**

☐ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct. - **NA**

☐ For all the options given in the table calculate the percentage of change in SSB and TAC. - **NA**

☐ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”. - **NA**

☐ Compare different catch options; higher F should result in lower SSB - **NA**

☐ Check if SSB change is in line with F. - **NA**

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☐ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.) - **NA**

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☐ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots. - **NA**

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☐ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year. - **NA**

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☐ Ensure the legend of the table reflects the year for the data given in the table. - **NA**

☐ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100% - **NA**

☐ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown. - **NA**

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read "There is no assessment for this stock" - **NA**

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: sol.27.20-24**

Date:
Auditor: Kristiina Hommik & Zuzanna Mirny

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: Age-based analytical stochastic assessment (SAM) that uses landings only in the model. Discards are included afterwards in the forecast.
   3 tuning series: DTU Aqua-Fisherman survey (2004-2017) – index estimated by GAM model; private logbooks from gillnetters (1994-2007) and private logbooks from trawlers (1987-2008).
   Fixed maturity and fixed natural mortality (0.1) for all age groups.
5) **Data issues:** All data are made available and corresponding to stock annex.
6) **Consistency**: The assessment of recent years including the 2018 assessment have been accepted.
7) **Stock status**: SSB at Blim, Bpa last three years; F> Flim,Fpa for 2017. The recent decade of recruitment is estimated to remain below the average of the time-series.
8) **Management Plan**: NA

General comments

Report is well documented and possible to follow the assessment.

Technical comments

The assessment is performed according to the stock annex.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice? *YES*

Is the assessment according to the stock annex description? *YES*

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary? *No management plan.*

Have the data been used as specified in the stock annex? *YES*

Has the assessment, recruitment and forecast model been applied as specified in the stock annex? *YES*

Is there any **major** reason to deviate from the standard procedure for this stock? *NO*

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? *YES*

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct.

☒ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☒ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☒ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☒ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☒ For all the options given in the table calculate the percentage of change in SSB and TAC.

☒ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under "Other options".

☒ Compare different catch options; higher F should result in lower SSB

☒ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☒ Each plot should have five lines.

☒ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be “There is no available information”

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year “predicted landings or catch corres. to advice” column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☐ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown. - *Small errors in “Total official landings” in years 2014, 2016 and 2017 – probably due to rounding.*

History of commercial landings table:

☒ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read "There is no assessment for this stock"

Sources and references

☒ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: spr.27.22–32**

Date: 18.4. 2018
Auditor: Jukka Pönni, Michele Casini

- *Audience to write for: ADG, ACOM, benchmark groups and EG next year.*
- *Aim is to audit (check if correct):*
    - *the stock assessment– concentrate on the input data, settings and output data from the assessment*
    - *the correct use of the assessment output in the forecast, and check if forecast settings are applied correctly*
- *Any deviations from the stock annex should be described sufficiently.*
- *By the conclusion of the working group, all update assessments should be audited successfully.*
- *Store all audits on SharePoint for future reference.*

General

Use bullet points and subheadings (Recommendations, General remarks, etc.) if needed

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM.

1) **Assessment type: update**
2) **Assessment**: Analytical XSA – tuned with 3 data series from 2 acoustic surveys: Baltic International Acoustic Survey (BIAS) in autumn in 1991–2017 covering subdivisions 22-29 and International Baltic Acoustic Spring Survey (BASS) in May 2001–2015 and 2017 covering Subdivisions 24–26 and 28. The XSA estimates have been accepted.
3) **Forecast**: Short term forecast presented
4) **Assessment model**: XSA (and SAM as an alternative assessment model)
5) **Data issues:** The data for assessment was uploaded by national laboratories and aggregated into international data in ICES InterCatch database.

   In 2016 the acoustic May survey (BASS) covered only 50% of the planned area and therefore the 2016 survey estimates are (for the second year in row) excluded from the tuning data.
6) **Consistency**: Assessment has been performed consistently and accepted last year and also this year in the WG. There were 9% higher estimates for both SSB and TSB, 16% higher estimate of F and 11% higher estimate of recruitment for 2016 in this 2018 assessment.
7) **Stock status**: SSB> MSY $B_{trigger}$ since 1991, F<Flim in 2010-2012 and 2015-2017, F<Fpa 2016-2017, F=FMSY in 2016 and slightly above in 2017. Since 2008 only year-class 2014 is strong.
8) **Management Plan**: EU Baltic multiannual plan

General comments:

This was a well documented, ordered and considered section, and easy to follow and interpret.

Technical comments:

No specific comments.

Conclusions

The assessment has been performed correctly.

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

- YES

Is the assessment according to the stock annex description?

- YES

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

- YES

Have the data been used as specified in the stock annex?

- YES

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

- YES

Is there any **major** reason to deviate from the standard procedure for this stock?

- NO

Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

- YES

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e catches; landings, recruitment age (0, 1, 2…); relative index

☒ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☒ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☒ Compare the status table with the F and SSB plots they should show the same information.

☒ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options (scenarios?) table:

☐ The forecast should be re-run to ensure all values are correct. No can-do.

☐ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☐ The wanted catch and SSB values should be given in tonnes (t);

☐ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☐ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☐ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☐ For all the options given in the table calculate the percentage of change in SSB and TAC.

☐ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☐ Compare different catch options; higher F should result in lower SSB

☐ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☒ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☒ Are the units in plots correct?

☒ Are the titles in the plots correct including F (age range) recruitment (age).

☒ The red line correspond to the year of assessment (except F which is year of assessment -1)

☐ Each plot should have five lines. ONLY 2!

☐ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☒ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☐ Assessment type- check that the standard text is used. Can't do that.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☒ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☒ Ensure the legend of the table reflects the year for the data given in the table.

☒ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☐ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☐ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☒ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read “There is no assessment for this stock”

Sources and references

☐ Ensure all references are correct.

☒ Ensure all references in the advice sheet are referenced in this section.

Advice sheet audit report and check list

Working Group: WGBFAS **Stock Name: tur.27.22–32**

Date:
Auditor:

General comments:

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

For single stock summary sheet advice:

1) **Assessment type:** survey trends
2) **Assessment**: trends
3) **Forecast**: not presented
4) **Assessment model**: LBI method
5) **Data issues:** not relevant
6) **Consistency**: not relevant
7) **Stock status**: The assessment of the stock status could not be performed because the reference points are undefined.
8) **Management Plan**: there are no management plan for this stock

General comments
This was a well documented, well ordered and considered section. It was easy to follow.

Technical comments
Values in the Table 2 and Table 6 should be rounded?
Table 5. Column "*Predicted catches corresp. to advice*" contains no value for 2019?
Table 7. Columns for 2017 must be expanded in order to see values
Table 8. Headings of columns, space between lines and size of text must be corrected

Conclusions
The assessment has been performed correctly

Checklist for audit process

General aspects

Has the EG answered those TORs relevant to providing advice?

Is the assessment according to the stock annex description?

If a management plan is used as the basis of the advice, has been agreed to by the relevant parties and has the plan been evaluated by ICES to be precautionary?

Have the data been used as specified in the stock annex?

Has the assessment, recruitment and forecast model been applied as specified in the stock annex?

Is there any **major** reason to deviate from the standard procedure for this stock?
Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

It is useful to print previous year advice sheet for comparison purposes it will make it easier to find potential errors and or inconsistencies.

Along with the spelling and structure of the text ensure that any values referenced in the text match the values or percentages shown in the tables.

All the values presented in the advice sheet should not be rounded at the WG. All rounded will be done at the ADG.

The check list below is given by section and it results from a compilation of the most frequent errors but by no means is it a complete list.

ICES stock advice

☒ Ensure the basis of the advice used is the correct one i.e Management plan; MSY approach; precautionary approach. The same as stated in the basis of advice table and history of advice table.

☒ The advised value of catches should be the same as presented in the catch options table.

☒ Check the years for which the advice is given.

Stock development over time

☒ Ensure all units used in the plots are correct (compare with previous year advice sheet).

☒ Ensure all titles of the plots are correct i.e caches; landings, recruitment age (0, 1, 2…); relative index

☐ Recruitment plot: if the intermediate years is an outcome of a model the value should be unshaded.

☐ Ensure the F and SSB reference points (RP) in the plots are the same as in the reference points table. Also, check the respective labels if they correspond with the RP.

☒ Check if the legend of the plots is consistent with what is shown in the plots.

☒ Check that the graphs match the data in table of stock assessment results.

Stock and exploitation status

☒ Compare with the previous year's advice sheet. The years in common should have the same status (symbol).

☒ Check if the labels for the years are correct.

☐ Compare the status table with the F and SSB plots they should show the same information.

☐ Does the stock have a management plan? If yes than the row for the management plan should be filled as well otherwise will read not applicable.

Catch options

Basis of catch options table:

For each of the rows in the table ensure that:

☒ The year is correct,

☒ The value is correct,

☒ The notes are correct and

☒ The sources are correct.

Catch options table:

☐ The forecast should be re-run to ensure all values are correct.

☐ Compare the input data with previous year run (previous year should be in the share point under the data folder)

☒ The wanted catch and SSB values should be given in tonnes (t);

☐ Confirm if the F values for the options F_{lim}; F_{pa}; are correct.

☐ For the options where the value of F will take SSB of the forecast year to be equal to B_{lim}; B_{pa}; $MSY_{Btrigger}$ confirm if the SSB value for the forecast year is equal or close to the reference points.

☐ For the options where a percentage is added or taken (i.e +10%; 15%, etc.) from the current TAC. Ensure that the calculated values are correct.

☐ For all the options given in the table calculate the percentage of change in SSB and TAC.

☐ In the first column (Rationale) ensure the rational of the first line is the correct basis for the advice. All other options should be under “Other options”.

☐ Compare different catch options; higher F should result in lower SSB

☐ Check if SSB change is in line with F.

Basis of the advice

☒ Ensure the basis of the advice is correct and if the same is used in the catch option table and in the ICES stock advice section.

☐ Is there a management plan? If there is one it should be stated if it has been evaluated by ICES and considered precautionary or not and also if it has been sign off by the clients(EU; Norway, Faroe Islands, etc.)

Quality of the assessment

☐ Are the units in plots correct?

☐ Are the titles in the plots correct including F (age range) recruitment (age).

☐ The red line correspond to the year of assessment (except F which is year of assessment -1)

☐ Each plot should have five lines.

☐ Ensure the reference points lines (in the SSB and F plots) are correct and match with the values in the reference point table and summary plots.

Issues relevant for the advice

☒ Along with the spelling and structure in the text ensure that any values referenced in the text match the values or percentages in the tables within the advice sheet.

Reference points

☐ Ensure all the values, technical basis and sources are correct. If new values were not calculated the table should be the same as previous year.

Basis of the assessment

☒ If there is no change from the previous year the table should be the same.

☒ Ensure there is no typos wrong acronyms for the surveys.

☒ Assessment type- check that the standard text is used.

Information from stakeholders

☒ If no information is available the standard sentence should be "There is no available information"

History of advice, and management

☒ This table should only be updated for the assessment year and forecast year except if there was revision to the previous years.

☐ Ensure that the forecast year "predicted landings or catch corres. to advice" column match the advice given in the ICES stock advice section (usually given in thousand tonnes).

History of catch and landings

Catch distribution by fleet table:

☐ Ensure the legend of the table reflects the year for the data given in the table.

☐ Ensure that the sum of the percentage values in each of the components (landings and discards) amount to 100%

☐ Ensure that the sum of the values for discards and landings are equal to the value in the catch column. However, if only landings or discards components are shown, then total catch should be unknown.

History of commercial landings table:

☐ Ensure that the values for the last row are correct check against the preliminary landings (link to be added)

Summary of the assessment

☒ This table is an output from the standard graphs. If there was any errors picked up with any of the plots, then this table should be replaced by a new version once the errors are corrected.

☐ Check if the column names are correct mainly recruitment age and age range for F.

☐ If the stock is category 5 or 6 then it should read "There is no assessment for this stock"

Sources and references

☐ Ensure all references are correct.

☐ Ensure all references in the advice sheet are referenced in this section.

Annex 06: Benchmark information

1) Western Baltic cod (SDs 22-24)

Stock	Western Baltic cod	
Stock coordinator	Name: Uwe Krumme (GER)	Email: uwe.krumme@thuenen.de
Stock assessor	Name: Marie Storr-Paulsen (DK)	Email: msp@aqua.dtu.dk

2) Eastern Baltic cod (SDs 25-32)

Stock	Eastern Baltic cod (SDs 25–32)	
Stock coordinator	Name: Sofia Carlshamme (SW)	Email: sofia.carlshamre@slu.se
Stock assessor	Name: Margit Eero (DK)	Email: mee@aqua.dtu.dk

3) Herring in Gulf of Bothnia (SDs 30-31) (Inter-Benchmark-process)

Stock	Herring in Gulf of Bothnia (SDs 30–31)	
Stock coordinator	Name: Jukka Pönni (FIN)	Email: jukka.ponni@luke.fi
Stock assessor	Name: Zeynep Pekcan-Hekim (SW)	Email:zeynep.pekcan.hekim@slu.se

Annex 07: Working documents

- **WD01**: Benchmark Issue list for Herring (Clupea harengus) in subdivisions 25–29 and 32 (central Baltic Sea, excluding Gulf of Riga): **Inclusion of BIAS data from SD 32 in the tuning index of CHB herring.**
  M. Bergenius
- **WD02:** Herring (Clupea harengus) in subdivisions 25–29 and 32 (central Baltic Sea, excluding Gulf of Riga): Consequences of mistakes in natural mortality and final year of the BIAS index to the assessment 2017.
  M. Bergenius
- WD03: German herring-sprat fisheries and assessment input data in 2017.
  T. *Gröhsler*
- WD04: Danish sole survey 2017. *O. A. Jørgensen*
- WD05: EBcod SPiCT assessment. *C. W. Berg*

WD01. Benchmark Issue list for Herring (*Clupea harengus*) in subdivisions 25–29 and 32 (central Baltic Sea, excluding Gulf of Riga): **Inclusion of BIAS data from SD 32 in the tuning index of CHB herring.**

Mikaela Bergenius

Original issue

STOCK	HER-2532-GOR / HER.27.25-2932	
Issue list	Year: 2017	As part of WGBFAS 2017
Stock coordinator	Name: Kristin Öhman	Email: kristin.ohman@slu.se
Stock assessor	Name: Mikaela Bergenius	Email: mikaela.bergenius@slu.se
Data contact	Name: Kristin Öhman	Email: kristin.ohman@slu.se

ISSUE	PROBLEM/AIM	WORK NEEDED / POSSIBLE DIRECTION OF SOLUTION	DATA NEEDED TO BE ABLE TO DO THIS: ARE THESE AVAILABLE / WHERE SHOULD THESE COME FROM?	EXTERNAL EXPERTISE NEEDED AT BENCHMARK	TIME PLAN
Tuning series	**BIAS data.** Do we have new bias data from SD 32 that could be used in the assessment? High numbers of herring have in some years been observed in SD 32.	Compare new indeces with spaly. - spaly index (SDs 25-27, 28.2 and 29) - combined spaly index and index for 32	Index produced by WGBIFS memebers	Work undertaken by WGBIFS members Olavi Kaljuste	This issue will be investigated during the autumn 2018. If the new index is the prefered option and makes a large difference to our perception of the stock, an interim benchmark will be called for. If the new index makes negligible differences a review will be called for the update assessment at WGBFAS 2018.

Background

The Baltic herring (*Clupea harengus membras* L.) consists of several local stocks displaying differences in growth, morphology and distribution patterns (Ojaveer, 1988). The different stocks mix at various temporal and spatial scales, particularly in the open sea, during the feeding period (e.g. Otterlind,1961; Aro, 1989). The degree of mixing is largely unknown however, and the lack of wide-ranging methodologies for routine discrimination of stocks prevents practical assessment and management of herring in other ways than as larger complexes, comprising of several stocks. The assessment and management units of Central Baltic Herring (CBH) have changed several times. Since 1990 the herring in ICES subdivisions (SDs) 25-29&32, excluding Gulf of Riga, has been assessed as one CBH unit stock. Herring in the central Baltic has been managed as a separate stock only since 2005 however. Prior to this, the agreed TAC concerned SDs 22-29 and 32.

Fishery independent abundance estimates of herring (and sprat) at age from the Baltic international trawl survey (BIAS) are currently used to tune the catch data in the assessment of CBH. The survey has been undertaken yearly since 1991 in ICES subdivisions SDs 25-29, excluding Gulf of Riga. The survey was extended into the SD 32 in 1999, but estimates from this subdivision has so far not been included in the tuning index used for assessment. The development of herring numbers by age in SDs 25-29, excluding Gulf of Riga, in the assessment has subsequently been assumed to reflect also herring numbers in SD 32.

On request from the Baltic Fisheries Assessment Working Group (WGBFAS) in fall 2017, the Fish Survey Working Group (WGBIFS) computed a new tuning index including SD 32. WGBIFS are recommending that this index should be tested as an alternative to the standard index. The group advices against using the first few years of the time series from SD 32 (starting in 1999), however, due to poor weather conditions and poor spatial coverage (WKPELA 2017). As the number of herring has increased in SD 32 in the last few years (Figure 2 in WKPELA 2017; Figure 1, 2), the evaluation of a shortened (in years), but spatially more appropriate, index has become even more pertinent.

The aim of this work is therefore to evaluate if a new BIAS tuning index, incorporating also estimates from SD 32, but instead covering a reduced number of years, provides a sufficiently long time series to give an improved perception of the herring stock in the central Baltic.

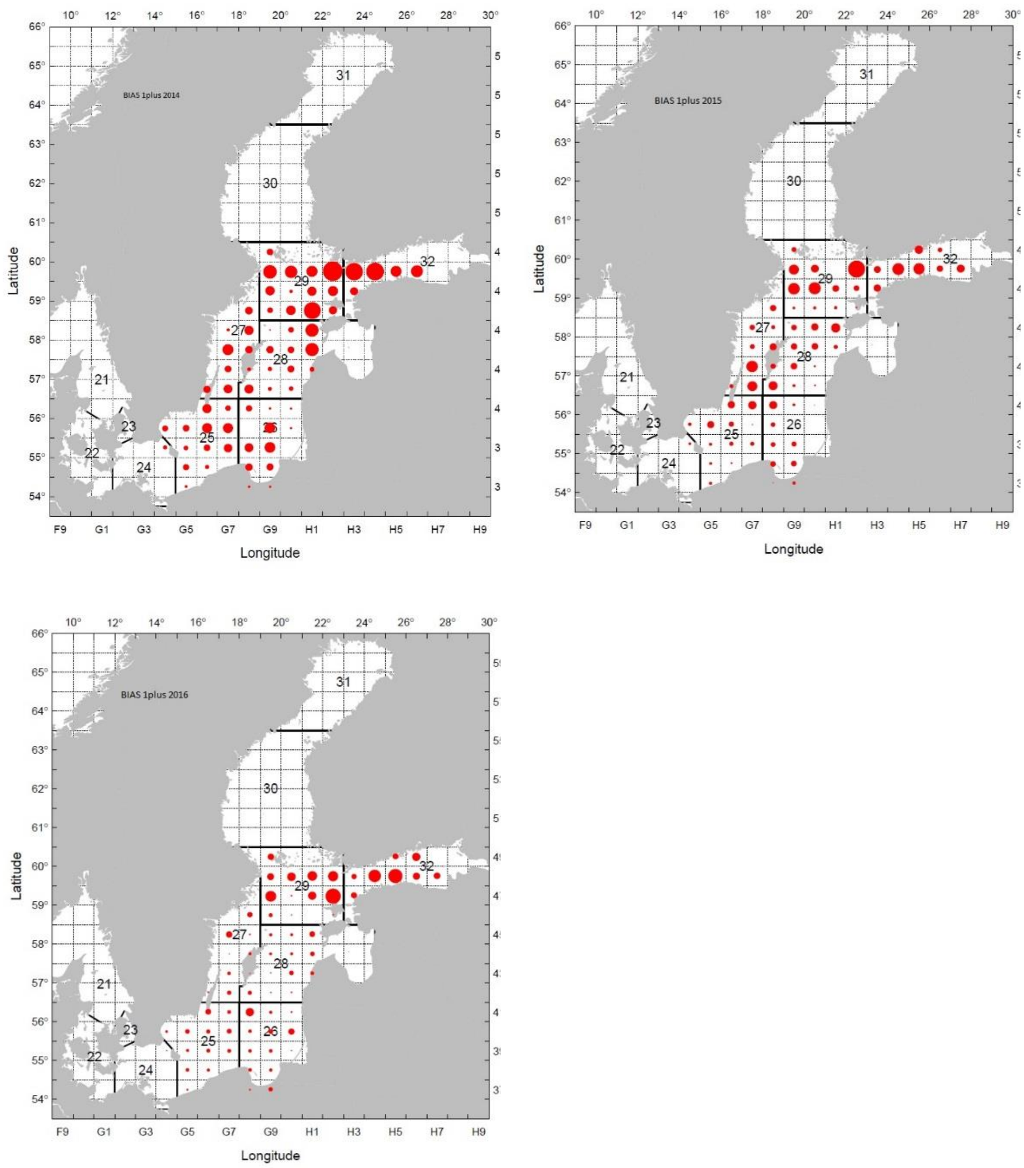

Figure 1. Herring in SDs 25–29, 32 excluding GoR. Spatial distribution of biomass/abundance of 1plus-year old central Baltic herring 2014-2016. Data from autumn Baltic International Acoustic Survey (BIAS).

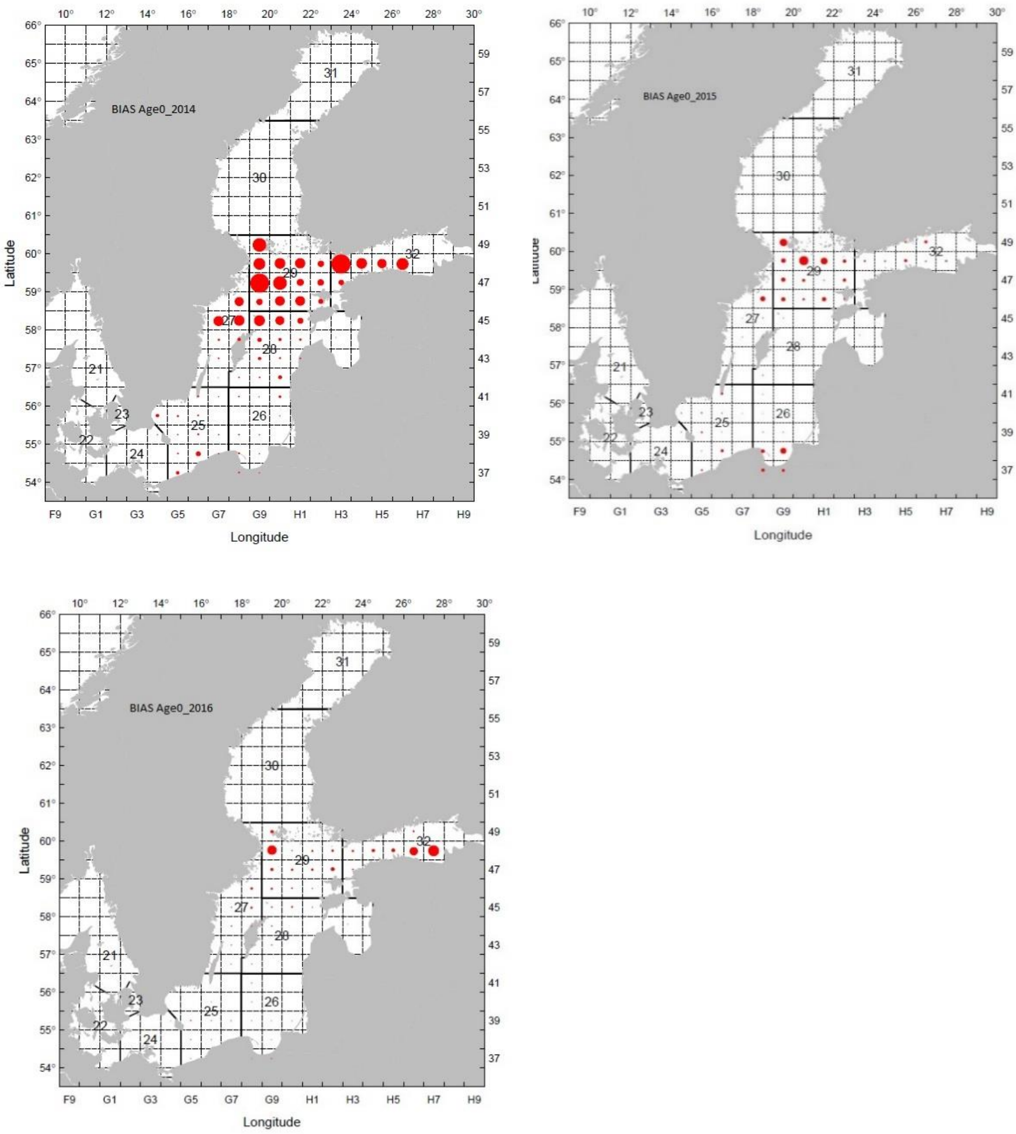

Figure 2. Herring in SDs 25–29, 32 excluding GoR. Spatial distribution of biomass/abundance of 0-year old central Baltic herring 2014-2016. Data from autumn Baltic International Acoustic Survey (BIAS).

Methods and scenarios

Since the latest assessment of Central Baltic Herring in March 2017 some mistakes were noted in the natural mortality input estimates and BIAS index year 2016. The consequences of these mistakes to the perception of the stock, short-term forecast and catch advice were evaluated in working document: Herring (*Clupea* harengus) in subdivisions 25–29 and 32 (central Baltic Sea, excluding Gulf of Riga): Consequences of mistakes in natural mortality and final year of the BIAS index to the assessment 2017. The conclusion of the evaluation was that the perception of the stock did not change due to the mistakes, and the differences to the forecast and advice were minor. Thus, the assessment used as the standard in the following working document was the March

Assessment 2017, corrected for mistakes in natural mortality and the BIAS index.

A BIAS index including SD 32

Although the time series in SD 32 starts 1999, the abundance estimates computed for the first few years (1999, 2003-2005 and 2008) are recommended not to be used by the Fish Survey Working Group (WGBIFS), due to poor weather conditions and poor spatial coverage (WKPELA 2017). Moreover, in 2002 the SD 32 was not covered by the survey. WGBFIS also recommended considering the exclusion of year 2000, in which a year effect is evident (Figure 1 in WKPELA 2017). This year effect is noted, but less prominent, also in the standard index. The years remaining to be used for tuning the assessment are therefore 2000 (although the exclusion of this year will also be tested), 2006-2007 and 2009-2016 (Figure 3). As the estimates from SD 32 are added to the other SDs, the entire index have to be shortened to the year in which SD 32 is covered, i.e. from starting in 1991 to starting in 2000, or most likely 2006.

The internal consistency of the index including SD 32 was improved for most ages when compared to the standard index truncated to the same years as the index including SD 32 (Figure 4). When compared to the internal consistency of the full time series of the standard index however, the internal consistency for the BIAS index including SD 32 was only improved for ages 1-2. 4-5 and 6-7 (Figure 4).

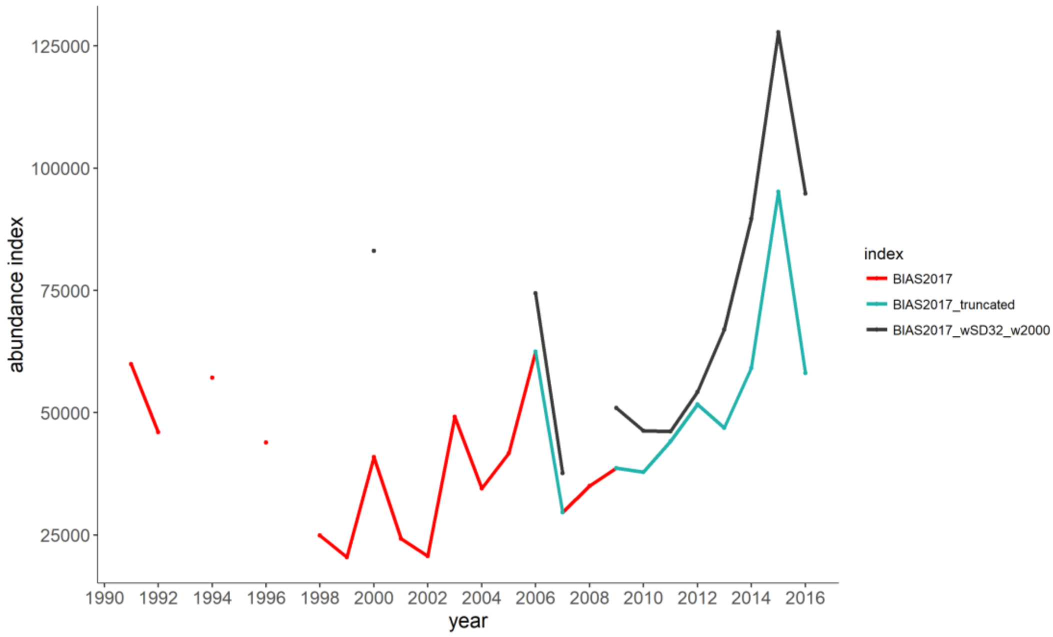

Figure 3. Herring in SDs 25–29, 32 excluding GoR. The corrected BIAS index used for the assessment 2017 (BIAS2017), the BIAS index used for the assessment 2017 but truncated to the years of the index including SD 32 (BIAS 2017_trunc). Bias index including SD 32 and year 2000 (BIAS2017_w32_w2000).

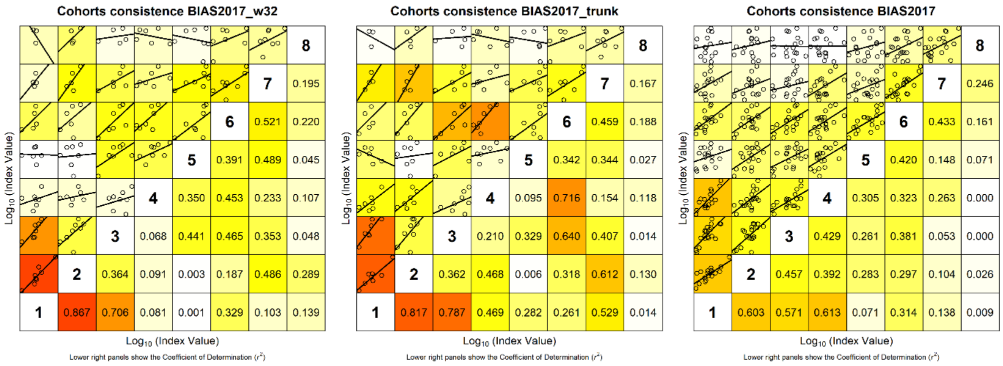

Figure 4. Herring in SDs 25–29, 32 excluding GoR. Internal consistency of the BIAS index **including SD 32 (BIAS2017_w32), the standard BIAS index truncated to the same years as BIAS2017_w32 (BIAS2017_trunk) and the standard BIAS index as used for assessment 2017 (BIAS 2017).**

WGBIFS also computed abundance estimates for SD 32 only, but it was decided not to evaluate this as a second tuning index to the standard index, i.e. both included. Since herring in the central Baltic Sea is considered one stock in the assessment, the index estimates in the different subdivisions should be combined according to the same methodology to make up a single tuning index for the stock. That is, in the current assessment herring is assumed to move around among the subdivisions and treating estimates from SD 32 separately assumes that this index represent a substock or potentially separate parts (e.g. particular ages) of the CHB stock. Moreover, the internal consistency for SD 32 only were poor (Figure 7 in WKPELA 2017), and the external consistency between ages in SD 32 and the standard index acceptable for some ages, but very poor for others (Figure 5). This supports the assumption that herring in SD 32 is not a separate entity from the rest of the CBH stock, but rather part of the larger stock, and that individuals are migrating between subdivisions.

WGBIFS also computed an index for recruitment (age 0 herring) including SD 32. The recruitment index is used in a RCT3 analysis to estimate the year class 2016 at age 1, i.e. in 2017, for input in the short term forecast. It was decided to leave the evaluation of this new recruitment index, pending the acceptance of the tuning index including SD 32 for assessment.

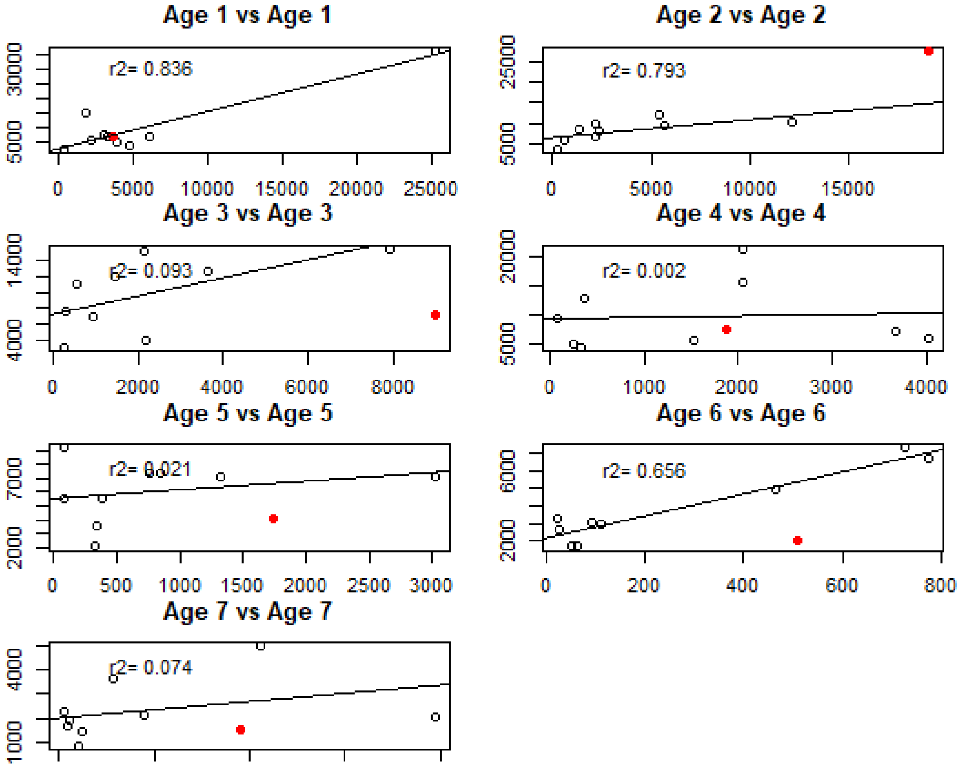

Figure 5. Herring in SDs 25–29, 32 excluding GoR. External consistency between the standard BIAS index truncated to the same year as the index based on SD32 only, against index based on SD 32 only. In red the last year of the time-series.

Standardized abundances at age are presented in Figure 6 for the different indices. The ability to follow cohorts, in particular large and small cohorts, trough time, did not change notably when including SD 32, compared to the standard index.

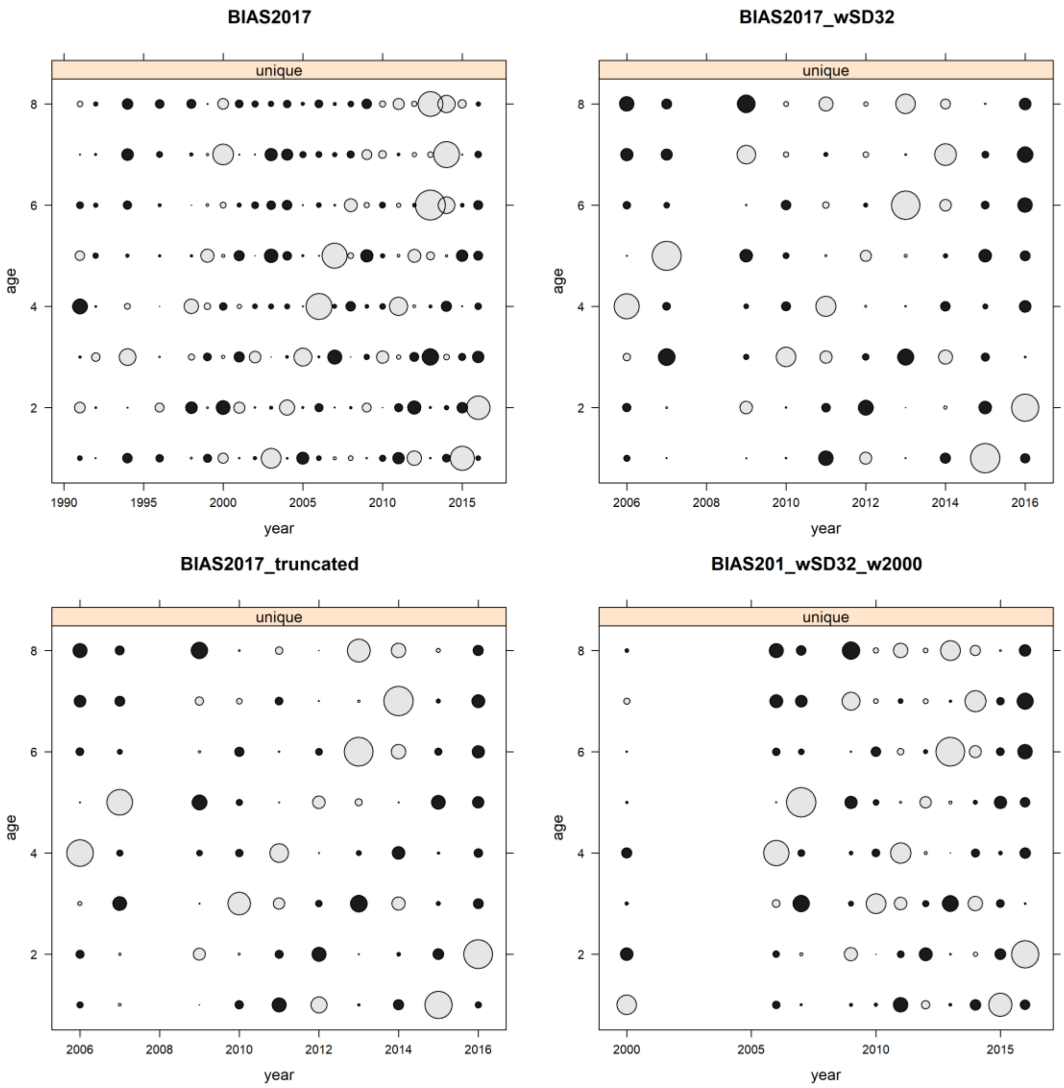

Figure 6. Herring in SDs 25–29, 32 excluding GoR. Standardized abundances at age of the corrected BIAS index used for the assessment 2017 (BIAS2017), the BIAS index used for the assessment 2017 but truncated to the years of the index including SD 32 (BIAS 2017_truncated) and the BIAS index including SD 32 and year 2000 (BIAS2017_w32_2000).

Scenarios

Four assessment scenarios were contrasted as part of the evaluation of the inclusion of SD 32 to the BIAS index.

- Ass2017: The assessment 2017 tuned with the standard BIAS index for year 2016 (Figure 3; 1991-2016)
- Ass2017_w32: The assessment 2017 tuned with the BIAS index including SD 32 (Figure 3; 2006-2007, 2009-2016).
- Ass2017_truncated: The assessment 2017 tuned with the corrected BIAS index for 2016, but truncated to the years 2006-2007, 2009-2016, to be comparable to the years of the index including SD 32 (Figure 3).

- Ass2017_w32_w2000: The assessment 2017 tuned with the BIAS index including SD 32 (Figure 3; 2000, 2006-2007, 2009-2016).

With the exception of the corrected natural mortality input file and the corrected BIAS index 2016 (WD: Herring (*Clupea* harengus) in subdivisions 25–29 and 32 (central Baltic Sea, excluding Gulf of Riga): Consequences of mistakes in natural mortality and final year of the BIAS index to the assessment 2017), all input data and model configurations were the same as for the assessment 2017, and can be found in the WGBFAS report (ICES, 2017).

Results

The assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017_w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017_truncated) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017_w32_2000) converged after 67,78,87 and 73 iterations respectively.

The standard diagnostics of the runs were very similar (Annex 1: Table 1-4). The regression statistics for all four runs were identical. The log catchability residuals were close to identical for the four runs (Figure 7). The residuals showed the same year effects with variable positive and negative residuals, but the residuals were overall small and considered acceptable. The similarities between the catchability residuals between runs are particularly apparent when comparing the residual plots from the Ass2017_truncated and Ass2017_w32 runs (Figure 7).

The variance ratio between the internal (within fleet) and external standard (among fleet) errors of the final estimate of the terminal F, were similar for the four runs, with the exception of age 2 (Figure 8). For Ass2017 and Ass2017_truncated the ratio was within the acceptable range (< 3 and > 0.3), but for Ass2017_w32 and Ass2017_w32_2000 it was high, suggesting that the estimates of F from the index and by shrinkage are inconsistent. The estimated survivors based on the index vs shrinkage were similar for the four runs, and shrinkage received little weighting in terminal estimates for all runs (Figure 9).

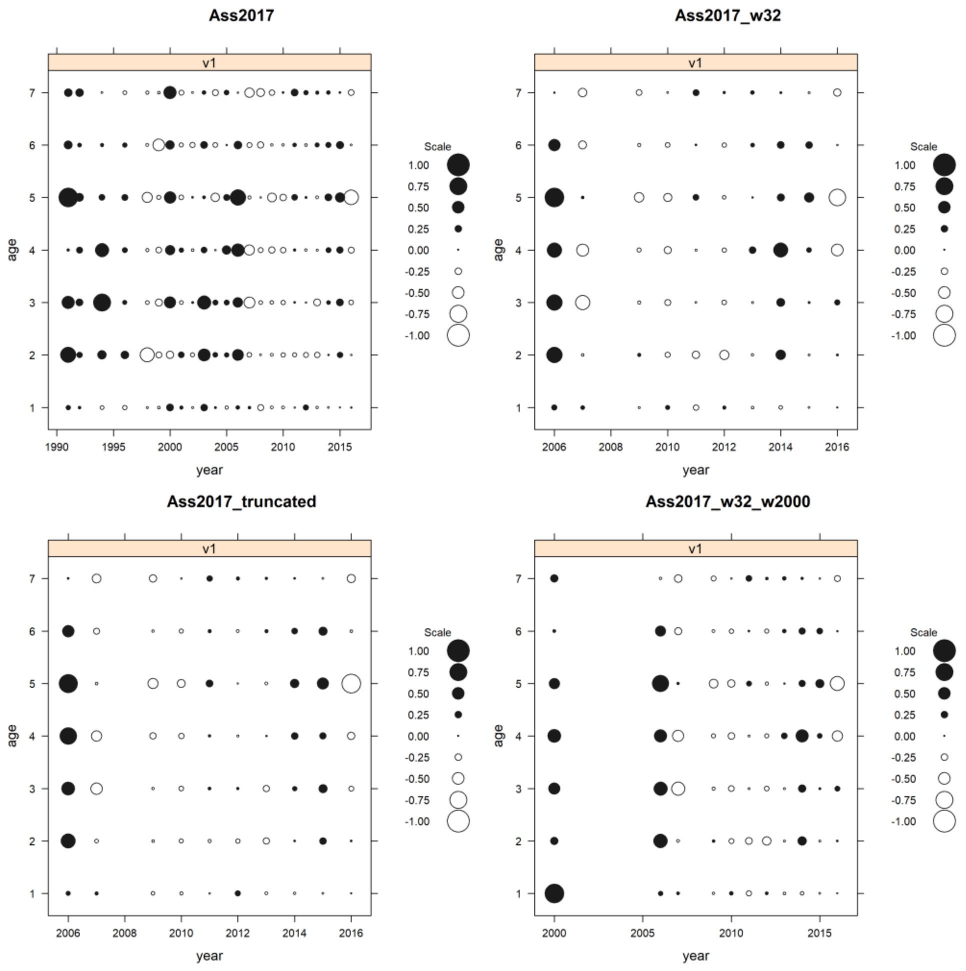

Figure 7. Herring in SDs 25–29, 32 (excl. GoR). Log catchability residuals for the assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017_w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017_truncated) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017_w32_2000).

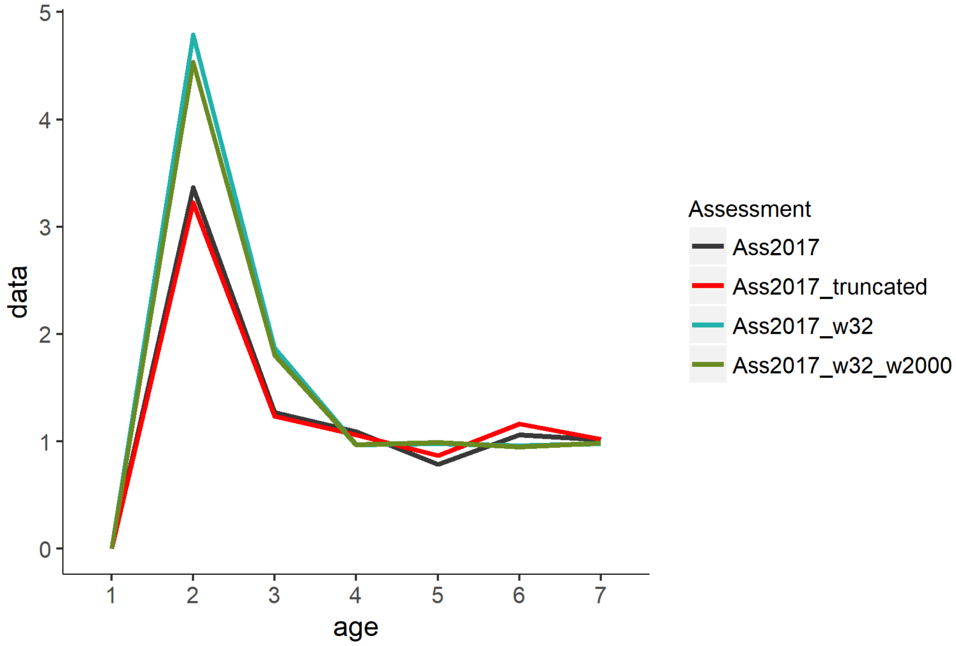

Figure 8. Herring in SDs 25–29, 32 (excl. GoR). Variance ratio between the internal (within fleet) and external (among fleet) standard errors for the assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017_w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017_truncated) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017_w32_2000).

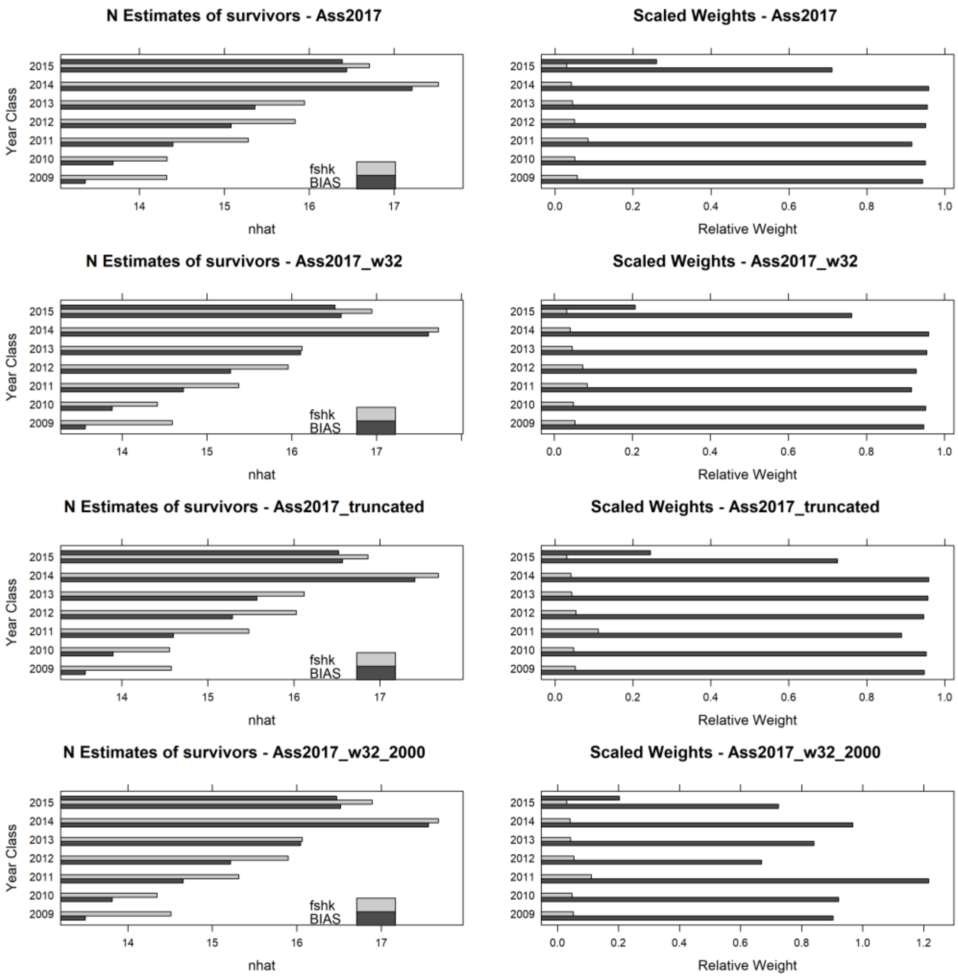

Figure 9. Herring in SDs 25–29, 32 (excl. GoR). Fleet based survivor estimates from each fleet (left column) and their scaled weights (right column) for the assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017_w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017_truncated) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017_w32_2000).

Fishing mortalities and stock numbers at age for the different runs can be delivered on request. The stock summaries of the different runs are presented in Figure 10 and Annex I (Table 5).

The stock development over time was similar between the different assessment runs, with the exception of decreasing SSB in the final two years when SD32 was included in the index (Figure 10). Adding SD 32 to the tuning index, however, did significantly influence the absolute levels of the stock in the last few years of the assessment. Recruitment, SSB and TSB in 2016 were 15, 14 and 32 percent higher when SD 32 was included in the tuning index (Figure 10). Similar differences in the absolute levels, however, were also found between the standard assessment and the assessment made with the standard, but truncated index. This is indicating that it is in fact the length of the BIAS time series that is more influential on stock estimates, rather than the addition of estimated numbers from SD 32. It is also striking how influential one year, year 2000, was on the perception of absolute stock levels in the early 1990s to the early 2000s. This may partly be explained by that when SD 32 was included in the index, the estimated numbers of older individuals were much lower than in the index without SD32 (Figure 6). However, since the perception of the stock from the other two assessment runs (Ass2017_w32 and Ass2017_truncated), in which the indices only started in 2006, was also similar to the standard assessment, the higher number of older individuals does therefore not explain the whole difference.

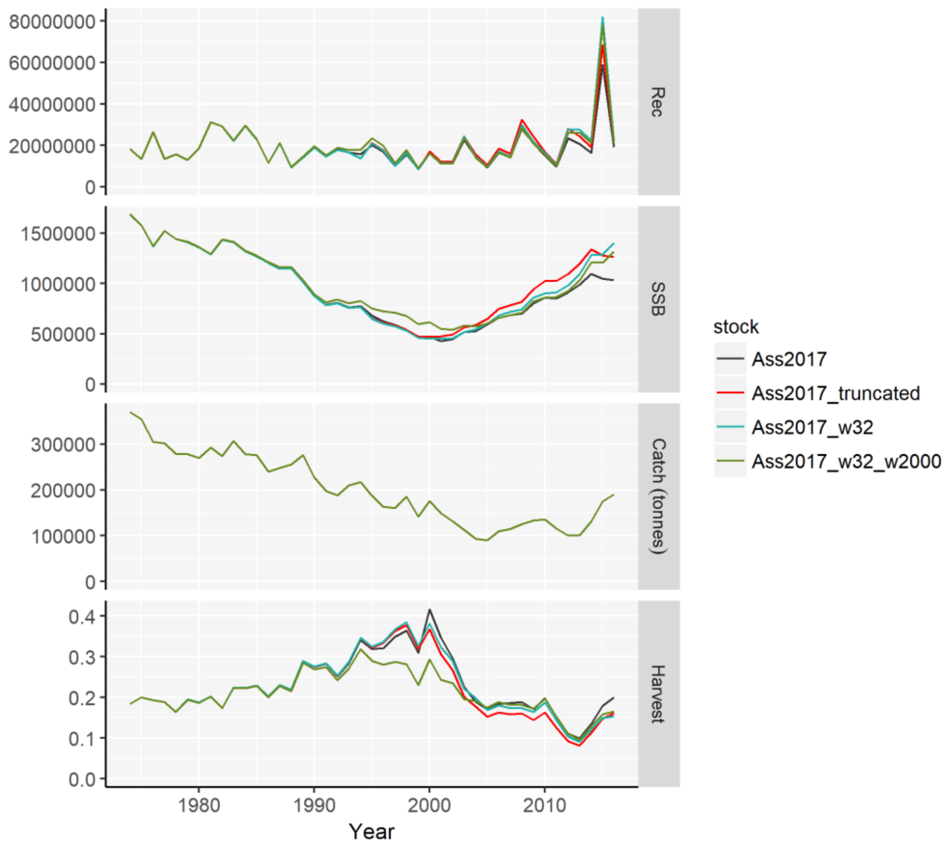

Figure 10. Herring in SDs 25–29, 32 excluding GoR. Recruitment, SSB, Catch and fbar as estimated by the assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017_w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017_truncated) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017_w32_2000).

Retrospective analyses for all four runs are presented in Figure 11. The retrospective pattern to consistently overestimate fishing mortality and underestimate SSB was significantly worse for the assessments tuned with the shorter BIAS indices (with or without SD 32 and year 2000, Figure 11). Also the retrospective pattern for recruitment was worse for these assessments.

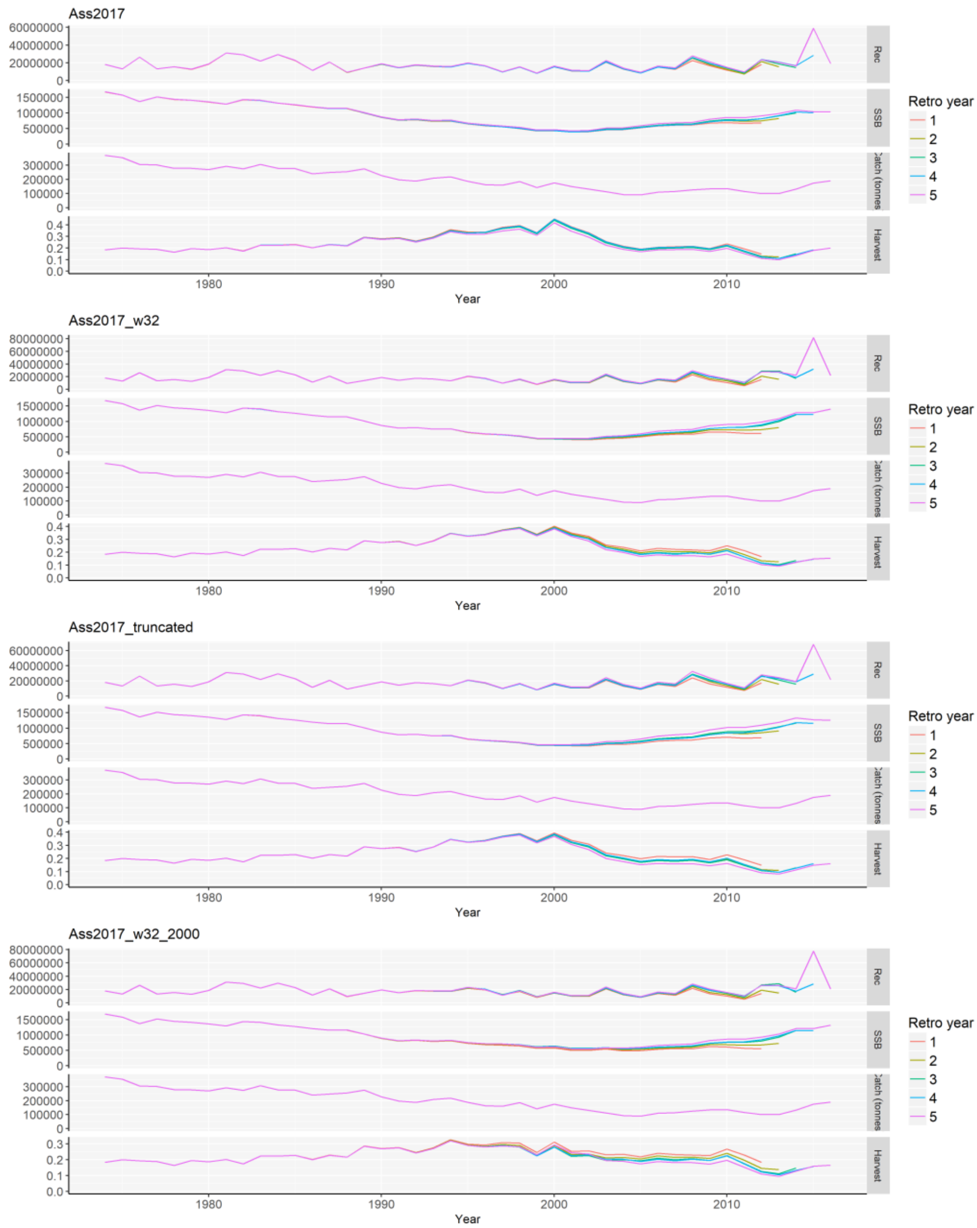

Figure 11. Herring in SDs 25–29, 32 excluding GoR. Retrospective Analysis of the assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017_w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017_truncated) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017_w32_2000).

The external consistency for the estimated numbers at age from the assessment vs the numbers at age from the BIAS index is overall the same for the analyses with and without SD 32 (Figures 12 and 13).

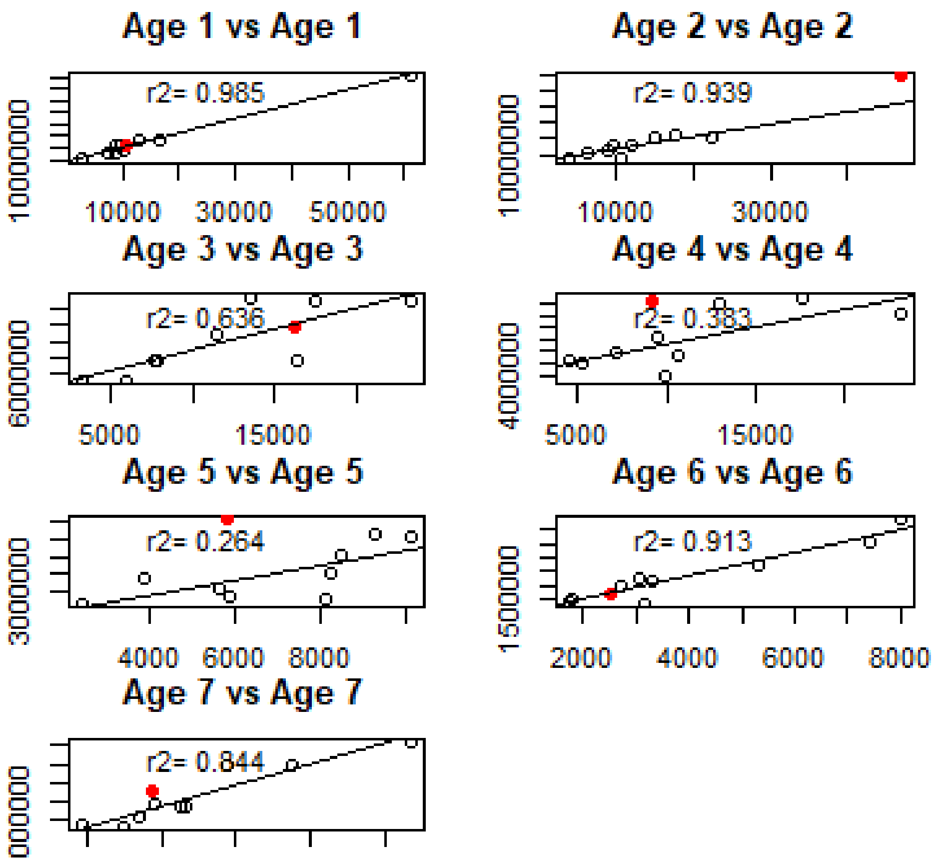

Figure 12. Herring in SDs 25–29, 32 excluding GoR. External consistency of estimated numbers at age from the assessment 2017 tuned with the BIAS index including SD 32 (Ass2017_w32) against the BIAS index including SD 32, years 2006 to 2016. In red the last year of the time-series.

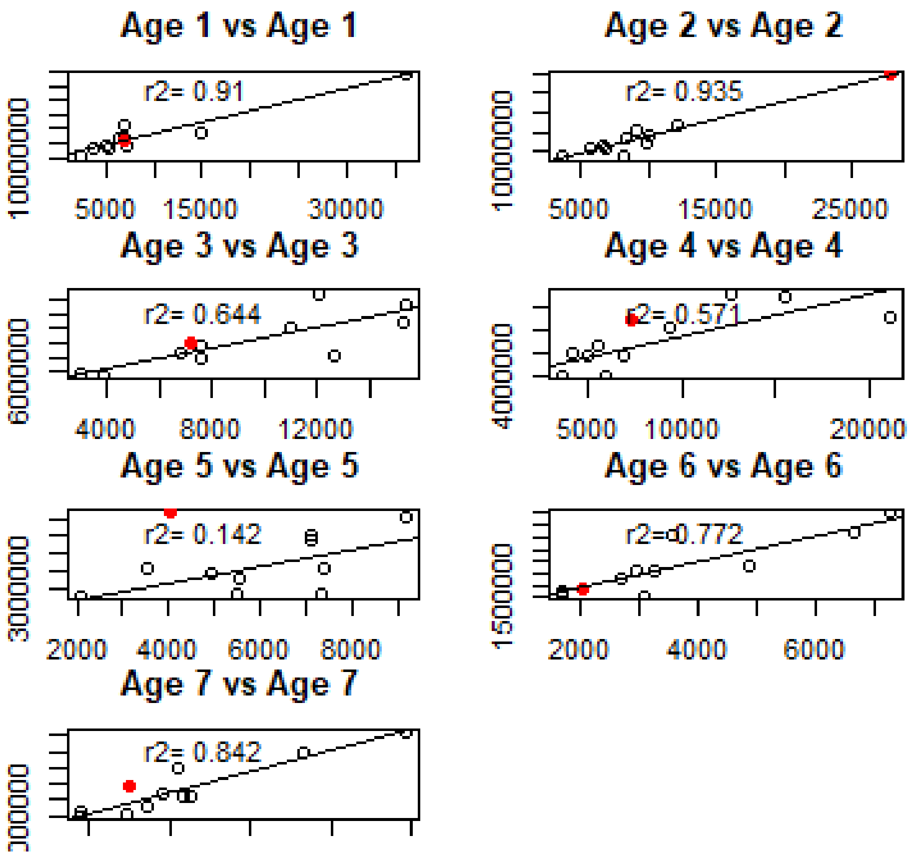

Figure 13. Herring in SDs 25–29, 32 excluding GoR. External consistency of estimated numbers at age from the assessment 2017 (Ass2017) against the standard BIAS index, year 2006 to 2016. In red the last year of the time-series.

Summary and Conclusion

In summary, there were minor differences in the diagnostics between the different assessment runs, including or not including SD 32 in the BIAS index. The regression statistics were identical, the catchability residuals and the estimated survivors very similar. Some differences were found in the variance ratio of the terminal F for two year olds, however, for unidentifiable reasons, with a high ratio for the assessment including SD 32 in the index. Although the diagnostics were similar, there were differences in the estimated ssb, fbar and recruitment between the assessment including and not including SD 32. The difference however, seems to be due to the length of the tuning index, rather than the inclusion of SD 32, as apparent in the run made on the standard index truncated to the same length as the index including the SD 32. The retrospective patterns were also significantly worse when the tuning index was shortened. The differences in the absolute biomass and harvest estimates and the worsened retrospective patterns suggests that some further analyses are needed before the proposed tuning index including SD 32 is accepted. In order not to lose the length of the time series in the index, it could be possible to use another stock assessment model, such as

SS3, that can include the index in two fractions, before and after the inclusion of SD 32. It may also be possible to, through modeling, project backwards the estimated numbers in SD 32 based on current data, in order to lengthen the time series of the index including SD 32. It is therefore proposed that the standard BIAS tuning index is kept in the assessment, until the issue is revisited in time for the next benchmark.

ANNEX I

Table 1. XSA diagnostics of assessment 2017 with the standard BIAS index.

FLR XSA Diagnostics 2018-02-13 16:58:46
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	BIAS SD 25-27&28.2&29S+N (April 2017)	1	7	1991	2016	<NA>	<NA>

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.5
Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied

Regression weights

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.037	0.033	0.037	0.044	0.037	0.017	0.027	0.034	0.028	0.037
2	0.091	0.082	0.081	0.051	0.066	0.056	0.045	0.071	0.074	0.084
3	0.154	0.139	0.122	0.118	0.090	0.070	0.064	0.096	0.143	0.135
4	0.167	0.172	0.190	0.169	0.154	0.089	0.097	0.135	0.176	0.206
5	0.190	0.178	0.176	0.232	0.172	0.135	0.113	0.167	0.199	0.180
6	0.235	0.265	0.195	0.276	0.194	0.151	0.123	0.143	0.200	0.281
7	0.179	0.233	0.317	0.270	0.216	0.157	0.165	0.123	0.192	0.413
8	0.179	0.233	0.317	0.270	0.216	0.157	0.165	0.123	0.192	0.413

XSA population number (Thousand)

year \ age	1	2	3	4	5	6	7	8
2007	14373005	12015963	5005498	5179287	5391538	1446087	932650	763852
2008	27941733	10647933	8510153	3327634	3398212	3473847	903231	1165271
2009	21060410	20629955	7495942	5696082	2154642	2197474	2057968	1002659
2010	15044542	15098188	14241739	4967920	3541656	1366523	1380772	1746841
2011	9659382	10468636	10502762	9313764	3087420	2078929	771319	1395113
2012	23427688	6664526	7039422	6912317	5750385	1877765	1242816	1603614
2013	20690377	17094575	4770173	5038882	4913541	3931605	1273588	1642590
2014	16358492	15110193	12481877	3458988	3573838	3449450	2756110	2411731
2015	58940902	11885722	10768462	8779632	2364385	2379953	2370353	3015907
2016	19055482	43009495	8430161	7216627	5754693	1524603	1543652	2063192

Estimated population abundance at 1st Jan 2017

year \ age	1	2	3	4	5	6	7	8
2017	5818697	13724105	30127107	5682550	4579125	3775902	911456	813855

Fleet: BIAS SD 25-27&28.2&29S+N (April 2017)

Log catchability residuals.

year																	
age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	0.167	0.078	NA	-0.138	NA	-0.164	NA	-0.048	-0.077	0.319	0.109	-0.042	0.294	0.044	-0.110	0.129	0.076
2	0.792	0.233	NA	0.411	NA	0.354	NA	-0.730	-0.265	-0.350	0.255	-0.157	0.612	0.189	0.170	0.551	-0.183
3	0.622	0.315	NA	0.898	NA	0.150	NA	-0.138	-0.329	0.563	-0.139	0.046	0.669	0.208	0.204	0.471	-0.544
4	0.058	0.269	NA	0.681	NA	0.199	NA	-0.115	-0.242	0.447	0.176	-0.072	0.252	-0.006	0.404	0.651	-0.506
5	0.988	0.368	NA	0.249	NA	0.267	NA	-0.509	-0.154	0.580	-0.178	0.024	0.083	-0.413	0.258	0.795	-0.110
6	0.369	0.135	NA	0.104	NA	0.174	NA	-0.097	-0.595	0.402	-0.149	-0.216	0.310	-0.188	-0.005	0.364	-0.197
7	0.363	0.358	NA	-0.021	NA	-0.144	NA	-0.104	-0.070	0.621	-0.209	-0.020	0.125	-0.268	0.181	-0.007	-0.459

year									
age	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	-0.264	-0.091	-0.087	-0.010	0.218	-0.053	-0.031	-0.002	0.004
2	-0.022	-0.090	-0.167	-0.151	-0.198	-0.231	0.012	0.226	-0.010
3	-0.144	-0.115	-0.177	0.031	-0.017	-0.310	0.139	0.319	-0.191
4	-0.200	-0.274	-0.240	0.066	-0.060	-0.041	0.208	0.279	-0.257
5	-0.015	-0.416	-0.304	0.247	0.036	-0.085	0.312	0.457	-0.751
6	-0.287	-0.062	-0.062	0.129	-0.070	0.159	0.220	0.327	-0.033
7	-0.376	-0.236	0.031	0.314	0.170	0.101	0.121	0.029	-0.247

Regression statistics
Ages with q dependent on year class strength
[1] "0.676421720196874" "10.6080666516976"

Terminal year survivor and F summaries:
,Age 1 Year class =2015

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.710	13807260	2015
fshk	0.029	18046270	2015
nshk	0.260	13086683	2015

,Age 2 Year class =2014

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.958	29824838	2014
fshk	0.042	40609982	2014

,Age 3 Year class =2013

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.955	4692644	2013
fshk	0.045	8410760	2013

,Age 4 Year class =2012

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.95	3541190	2012
fshk	0.05	7514367	2012

,Age 5 Year class =2011

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.915	1782510	2011
fshk	0.085	4336030	2011

,Age 6 Year class =2010

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.95	881905	2010
fshk	0.05	1664877	2010

,Age 7 Year class =2009

source	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.943	635833	2009
fshk	0.057	1660922	2009

Table 2. XSA diagnostics of assessment 2017 with the BIAS index including SD 32.

```
FLR XSA Diagnostics 2018-02-13 16:58:46
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.
                              fleet first age last age first year last year alpha beta
1 BIAS SD 25-27&28.2&29S+N (Dec 2017)         1         7       2006      2016  <NA> <NA>
 Time series weights :
   Tapered time weighting applied
  Power =   3 over  20 years
 Catchability analysis :
    Catchability independent of size for ages >   1
    Catchability independent of age for ages >   5
 Terminal population estimation :
    Survivor estimates shrunk towards the mean F
   of the final   5 years or the  3 oldest ages.
   S.E. of the mean to which the estimates are shrunk =   1.5
    Minimum standard error for population
   estimates derived from each fleet =  0.3
   prior weighting not applied
Regression weights
    year
age    2007 2008  2009  2010  2011  2012 2013  2014 2015 2016
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1

 Fishing mortalities
   year
age  2007  2008  2009  2010  2011  2012  2013  2014  2015  2016
  1 0.036 0.031 0.036 0.040 0.033 0.014 0.020 0.025 0.020 0.032
  2 0.088 0.081 0.076 0.050 0.060 0.051 0.038 0.052 0.054 0.059
  3 0.148 0.134 0.119 0.109 0.088 0.063 0.058 0.080 0.103 0.094
  4 0.164 0.164 0.182 0.164 0.142 0.086 0.087 0.121 0.144 0.141
  5 0.166 0.174 0.166 0.219 0.167 0.122 0.109 0.148 0.176 0.142
  6 0.215 0.224 0.190 0.256 0.181 0.146 0.110 0.137 0.174 0.240
  7 0.201 0.209 0.255 0.261 0.198 0.144 0.158 0.109 0.182 0.341
  8 0.201 0.209 0.255 0.261 0.198 0.144 0.158 0.109 0.182 0.341

 XSA population number (Thousand)
     age
year        1        2        3        4       5       6       7       8
  2007 14660992 12419097  5200770  5263695 6105210 1565769  841243  688698
  2008 29769125 10869321  8822860  3479106 3463686 4029933  997744 1287858
  2009 21659563 22024252  7665165  5936593 2271142 2248039 2487426 1213639
  2010 16381515 15543740 15285875  5094645 3722506 1454634 1419391 1796048
  2011 10519905 11440352 10828996 10081961 3180655 2212772  836828 1514315
  2012 27515554  7280338  7737592  7147348 6303821 1945136 1339987 1729396
  2013 27520577 20127486  5236431  5574844 5096126 4364651 1326754 1711390
  2014 22306966 20232751 14798066  3819433 3992584 3593033 3099252 2712731
  2015 81849000 16355929 14686747 10572690 2646310 2709547 2484207 3161341
  2016 21887048 60202291 11845698 10247207 7156165 1746373 1804872 2415554
 Estimated population abundance at 1st Jan  2017
     age
year       1        2        3       4       5       6       7       8
  2017 6476460 15841057 43222989 8317664 6943125 4876524 1086982 1021976

 Fleet:  BIAS SD 25-27&28.2&29S+N (Dec 2017)
 Log catchability residuals.
   year
age  2006   2007 2008   2009   2010   2011   2012   2013   2014   2015   2016
  1 0.173  0.105   NA -0.033  0.124 -0.181  0.080 -0.062 -0.100 -0.026  0.003
  2 0.641 -0.058   NA  0.084 -0.176 -0.269 -0.361 -0.044  0.367 -0.040  0.029
  3 0.634 -0.585   NA -0.087 -0.215 -0.028 -0.151 -0.037  0.298  0.032  0.170
  4 0.582 -0.489   NA -0.119 -0.258 -0.036 -0.128  0.234  0.574  0.149 -0.474
  5 0.781  0.065   NA -0.368 -0.309  0.192 -0.094  0.010  0.259  0.356 -0.679
  6 0.459 -0.293   NA -0.087 -0.145  0.027 -0.136  0.104  0.248  0.230 -0.015
  7 0.012 -0.326   NA -0.193 -0.028  0.213  0.053  0.099  0.039 -0.031 -0.272

 Regression statistics
 Ages with q dependent on year class strength
[1] "0.730792783099964" "9.93713320456833"
```

```
 Terminal year survivor and F summaries:
  ,Age 1 Year class =2015
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.762  15897543  2015
fshk                           0.031  22813920  2015
nshk                           0.207  14791223  2015

 ,Age 2 Year class =2014
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.959  44505028  2014
fshk                           0.041  49940472  2014

 ,Age 3 Year class =2013
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.954   9859823  2013
fshk                           0.046  10010692  2013

 ,Age 4 Year class =2012
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.927   4321118  2012
fshk                           0.073   8499272  2012

 ,Age 5 Year class =2011
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.916   2472791  2011
fshk                           0.084   4755550  2011

 ,Age 6 Year class =2010
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.952   1071083  2010
fshk                           0.048   1820120  2010

 ,Age 7 Year class =2009
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.947    778763  2009
fshk                           0.053   2172476  2009
```

Table 3. XSA diagnostics of assessment 2017 with the BIAS index truncated to the same years as the BIAS index including SD 32.

FLR XSA Diagnostics 2018-02-13 16:58:46
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	BIAS SD 25-27&28.2&29S+N (April 2017)	1	7	2006	2016	<NA>	<NA>

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.5
Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied

Regression weights

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.033	0.028	0.032	0.039	0.032	0.014	0.023	0.029	0.024	0.033
2	0.081	0.073	0.069	0.044	0.059	0.050	0.037	0.060	0.063	0.072
3	0.133	0.122	0.107	0.099	0.078	0.061	0.056	0.079	0.119	0.113
4	0.147	0.145	0.163	0.146	0.126	0.075	0.084	0.116	0.141	0.166
5	0.165	0.153	0.144	0.192	0.145	0.108	0.094	0.143	0.168	0.138
6	0.190	0.223	0.163	0.216	0.154	0.124	0.095	0.117	0.166	0.227
7	0.165	0.180	0.253	0.217	0.160	0.120	0.131	0.093	0.151	0.322
8	0.165	0.180	0.253	0.217	0.160	0.120	0.131	0.093	0.151	0.322

XSA population number (Thousand)

year \ age	1	2	3	4	5	6	7	8
2007	16025243	13485104	5732681	5825910	6130003	1744482	1008749	826416
2008	32463422	11918077	9649753	3891704	3899792	4049252	1138875	1470889
2009	24123767	24079994	8466805	6572578	2588483	2584837	2502346	1220967
2010	16854208	17376218	16825344	5694964	4200728	1694642	1676625	2123751
2011	10875660	11783907	12170738	11214585	3622323	2566693	1015273	1838967
2012	28046344	7534925	7984433	8113986	7119803	2264286	1596935	2061987
2013	24271643	20521295	5429191	5764336	5847065	5003133	1578611	2037291
2014	19078658	17796094	15098812	3968448	4140633	4183565	3605179	3156509
2015	68318363	13929894	12822929	10805510	2762862	2826077	2952467	3759442
2016	21548296	50047390	9992045	8805646	7338139	1838057	1897228	2540093

Estimated population abundance at 1st Jan 2017

year \ age	1	2	3	4	5	6	7	8
2017	8317664	15587859	35488272	6887632	5818697	5019420	1159553	1095561

Fleet: BIAS SD 25-27&28.2&29S+N (April 2017)
Log catchability residuals.

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.135	0.084	NA	-0.102	-0.083	-0.009	0.177	-0.079	-0.054	-0.021	0.002
2	0.607	-0.117	NA	-0.065	-0.123	-0.086	-0.136	-0.230	0.029	0.247	0.018
3	0.560	-0.493	NA	-0.045	-0.155	0.077	0.054	-0.242	0.139	0.328	-0.176
4	0.725	-0.441	NA	-0.241	-0.197	0.056	-0.033	0.014	0.255	0.240	-0.291
5	0.812	-0.060	NA	-0.427	-0.310	0.263	-0.002	-0.076	0.343	0.474	-0.830
6	0.487	-0.223	NA	-0.052	-0.129	0.083	-0.081	0.094	0.204	0.325	-0.066
7	0.019	-0.351	NA	-0.287	-0.009	0.191	0.087	0.056	0.026	-0.026	-0.331

Regression statistics
Ages with q dependent on year class strength
[1] "0.676104116393643" "10.73307841019"

Terminal year survivor and F summaries:

,Age 1 Year class =2015
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.725	15629759	2015
fshk	0.030	21000080	2015
nshk	0.245	14911536	2015

,Age 2 Year class =2014
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.959	36132807	2014
fshk	0.041	47518419	2014

,Age 3 Year class =2013
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.957	5777345	2013
fshk	0.043	10009282	2013

,Age 4 Year class =2012
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.946	4349610	2012
fshk	0.054	9114675	2012

,Age 5 Year class =2011
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.889	2189180	2011
fshk	0.111	5263587	2011

,Age 6 Year class =2010
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.952	1085093	2010
fshk	0.048	2095669	2010

,Age 7 Year class =2009
source

	scaledWts	survivors	yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)	0.948	786727	2009
fshk	0.052	2137386	2009

Table 4. XSA diagnostics of assessment 2017 with the BIAS index including SD 32 and year 2000.

```
FLR XSA Diagnostics 2018-02-13 16:42:31
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.
                          fleet first age last age first year last year alpha beta
1 BIAS SD 25-27&28.2&29S+N (Dec 2017)         1         7      2000      2016  <NA> <NA>
 Time series weights :
    Tapered time weighting applied
   Power =   3 over  20 years
 Catchability analysis :
     Catchability independent of size for ages >   1
     Catchability independent of age for ages >   5
 Terminal population estimation :
     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  3 oldest ages.
    S.E. of the mean to which the estimates are shrunk =   1.5
    Minimum standard error for population
    estimates derived from each fleet =  0.3
    prior weighting not applied

Regression weights
     year
age    2007 2008  2009  2010  2011  2012 2013  2014 2015 2016
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1

 Fishing mortalities
   year
age  2007  2008  2009  2010  2011  2012  2013  2014  2015  2016
  1 0.037 0.032 0.037 0.041 0.035 0.015 0.021 0.026 0.021 0.034
  2 0.091 0.084 0.079 0.052 0.063 0.054 0.040 0.055 0.057 0.062
  3 0.153 0.139 0.124 0.114 0.092 0.066 0.061 0.085 0.109 0.100
  4 0.172 0.170 0.190 0.172 0.149 0.090 0.091 0.128 0.154 0.150
  5 0.174 0.183 0.174 0.231 0.176 0.129 0.116 0.156 0.187 0.154
  6 0.228 0.237 0.202 0.271 0.194 0.155 0.117 0.146 0.185 0.260
  7 0.215 0.225 0.274 0.283 0.212 0.156 0.170 0.117 0.197 0.370
  8 0.215 0.225 0.274 0.283 0.212 0.156 0.170 0.117 0.197 0.370

 XSA population number (Thousand)
      age
year         1        2        3       4       5       6       7       8
  2007 14179900 12032183  5048735 5060467 5851602 1483872  791414  647726
  2008 28696270 10499485  8522734 3361173 3306044 3832324  933070 1203975
  2009 20780046 21205666  7382472 5705758 2180437 2126294 2334815 1138676
  2010 15774419 14889698 14672867 4882947 3548932 1386032 1326407 1677566
  2011 10074423 10999113 10350105 9630955 3024903 2084314  785824 1421508
  2012 26009486  6961540  7420565 6802338 5978901 1832590 1246726 1608674
  2013 26172329 19010089  4995055 5331473 4828103 4110411 1237939 1596456
  2014 21112876 19221583 13944726 3632835 3802439 3382262 2897795 2536016
  2015 77841321 15458584 13913297 9912085 2500361 2559884 2317077 2947851
  2016 20683783 57194482 11160067 9648986 6639829 1631566 1686257 2255577

 Estimated population abundance at 1st Jan  2017
      age
year         1        2        3       4       5       6      7      8
  2017 15587859 14941474 40931848 7788670 6476460 4471033 996114 927472

 Fleet:  BIAS SD 25-27&28.2&29S+N (Dec 2017)
 Log catchability residuals.
   year
age  2000 2001 2002 2003 2004 2005   2006   2007 2008   2009   2010   2011   2012   2013   2014   2015   2016
  1 0.892   NA   NA   NA   NA   NA  0.150  0.083   NA -0.049  0.106 -0.201  0.078 -0.071 -0.107 -0.029 -0.001
  2 0.314   NA   NA   NA   NA   NA  0.619 -0.075   NA  0.074 -0.183 -0.279 -0.365 -0.036  0.369 -0.032  0.032
  3 0.506   NA   NA   NA   NA   NA  0.617 -0.608   NA -0.102 -0.226 -0.035 -0.163 -0.044  0.306  0.035  0.179
  4 0.595   NA   NA   NA   NA   NA  0.562 -0.505   NA -0.134 -0.270 -0.046 -0.137  0.220  0.568  0.161 -0.468
  5 0.462   NA   NA   NA   NA   NA  0.768  0.048   NA -0.387 -0.317  0.185 -0.101  0.004  0.249  0.357 -0.660
  6 0.086   NA   NA   NA   NA   NA  0.452 -0.293   NA -0.087 -0.150  0.031 -0.133  0.105  0.251  0.231  0.004
  7 0.312   NA   NA   NA   NA   NA -0.047 -0.319   NA -0.179 -0.008  0.223  0.069  0.113  0.047 -0.014 -0.245
```

```
 Regression statistics
 Ages with q dependent on year class strength
[1] "0.736020164336676" "9.82439282882645"

 Terminal year survivor and F summaries:

 ,Age 1 Year class =2015
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.757  14917705  2015
fshk                          0.031  21675188  2015
nshk                          0.212  14223337  2015

 ,Age 2 Year class =2014
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.959  42257888  2014
fshk                          0.041  47417987  2014

 ,Age 3 Year class =2013
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.951   9311267  2013
fshk                          0.049   9478274  2013

 ,Age 4 Year class =2012
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.925   4056955  2012
fshk                          0.075   8015057  2012

 ,Age 5 Year class =2011
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.916   2311716  2011
fshk                          0.084   4472826  2011

 ,Age 6 Year class =2010
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.951   1000204  2010
fshk                          0.049   1697972  2010

 ,Age 7 Year class =2009
source
                          scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (Dec 2017)     0.945    726160  2009
fshk                          0.055   2001306  2009
```

Table 5. Herring in SDs 25–29, 32 excluding GoR. Stock summaries of average fishing mortality at age 3 to 6 (fbar), recruitment (rec), spawning stock biomass (ssb) and total biomass (totbiom) for the the assessment 2017 (Ass2017), assessment 2017 with the BIAS index including SD 32 (Ass2017w32), assessment 2017 with the BIAS index truncated to the years of the index including SD 32 (Ass2017trunc) and the assessment 2017 with BIAS index including SD 32 and year 2000 (Ass2017w32 _2000).

	Ass2017				Ass2017w32				Ass2017trunc				Ass2017w32_2000			
year	fbar	rec	ssb	totbiom	fbar	rec	ssb	totbiom	fbar	rec	ssb	totbiom	fbar	rec	ssb	totbiom
1974	0,1845	18115059	1683337	2660028	0,1845	18112508	1683120	2659694	0,1845	18113102	1683171	2659772	0,1844	18127146	1684366	2661612
1975	0,2003	13329725	1577402	2385036	0,2004	13327792	1577151	2384681	0,2003	13328241	1577210	2384764	0,2002	13338882	1578593	2386718
1976	0,1935	26360528	1368880	2297784	0,1935	26355084	1368616	2297355	0,1935	26356349	1368678	2297455	0,1933	26386313	1370130	2299815
1977	0,1887	13400204	1521990	2321152	0,1888	13397293	1521633	2320641	0,1887	13397969	1521716	2320760	0,1885	13413988	1523683	2323571
1978	0,1644	15701910	1441815	2239348	0,1644	15697736	1441419	2238769	0,1644	15698706	1441511	2238903	0,1642	15721671	1443691	2242094
1979	0,1953	12855965	1410081	2078539	0,1954	12850937	1409623	2077885	0,1954	12852104	1409729	2078037	0,195	12879761	1412250	2081639
1980	0,1872	18714122	1359010	2141660	0,1873	18706923	1358473	2140860	0,1873	18708594	1358598	2141046	0,1868	18748163	1361555	2145449
1981	0,2028	31191638	1288477	2455787	0,2029	31176784	1287868	2454682	0,2029	31180236	1288010	2454939	0,2023	31261979	1291357	2461016
1982	0,1739	29098550	1434337	2563174	0,174	29076875	1433532	2561691	0,174	29081900	1433719	2562035	0,1734	29200950	1438150	2570194
1983	0,2241	22130640	1408049	2285372	0,2243	22109176	1407058	2283740	0,2242	22114147	1407288	2284118	0,2234	22231964	1412738	2293089
1984	0,2236	29452849	1321209	2187861	0,2238	29420363	1320005	2185869	0,2237	29427955	1320284	2186332	0,2226	29607557	1326902	2197297
1985	0,2295	22881856	1270323	2016838	0,2298	22849982	1268859	2014553	0,2297	22857309	1269199	2015083	0,2283	23031154	1277252	2027636
1986	0,2021	11528951	1205378	1756658	0,2024	11503288	1203639	1754099	0,2023	11509208	1204042	1754691	0,2007	11649743	1213596	1768741
1987	0,2303	21003029	1150339	1766096	0,2307	20967126	1148187	1762999	0,2306	20975800	1148686	1763721	0,2283	21179676	1160495	1780819
1988	0,2185	9413196	1154638	1671567	0,219	9368559	1152016	1667584	0,2189	9378135	1152627	1668497	0,216	9608619	1167095	1690189
1989	0,2894	14218158	1017778	1635667	0,2903	14157088	1014513	1630335	0,2901	14171238	1015261	1631557	0,2854	14507812	1033041	1660595
1990	0,2743	19054574	875324	1483195	0,2755	18960136	871468	1476849	0,2752	18987057	872352	1478398	0,2689	19599309	893354	1514731
1991	0,2827	14676146	788302	1380483	0,2843	14472749	783772	1370341	0,2839	14503042	784870	1372383	0,2751	15299229	810652	1422201
1992	0,2515	17928008	809797	1274356	0,2534	17795739	802730	1263831	0,2529	17838191	804238	1266203	0,2425	18801926	840570	1322867
1993	0,2844	16516035	762716	1219329	0,2878	16526985	754208	1209352	0,2871	16593941	756102	1212510	0,2708	17812656	801438	1283015
1994	0,3413	15787995	772807	1270534	0,3465	13640542	763807	1226457	0,3453	13732080	766564	1231259	0,3189	17822277	828408	1370196
1995	0,3191	20071558	679473	1120340	0,3244	21036895	649395	1088179	0,3228	21272210	652890	1095040	0,29	23535819	751756	1247495
1996	0,3211	16834222	626109	1016841	0,3364	17476503	603068	1000014	0,3339	17696725	608325	1009115	0,2806	19775851	722933	1169343
1997	0,3488	10042646	587664	892670	0,3677	10059103	574754	883123	0,3635	10263995	581970	894282	0,2875	11467465	707528	1052982
1998	0,3641	15715444	539547	866518	0,3854	16304748	531714	865125	0,3787	16669235	541324	880153	0,2819	17809124	678311	1045340
1999	0,3092	8712373	459257	725794	0,3277	8408277	460289	725146	0,3194	8709401	472117	743359	0,2308	8983696	597543	887292

2000	0,4169	16352213	470249	842958	0,3819	16166535	452661	820865	0,368	17168205	469407	853893	0,294	16139004	616500	1001012
2001	0,3466	11705606	426346	751470	0,3231	11304700	449029	768417	0,3065	12039369	475416	811800	0,244	11086153	551805	875911
2002	0,2953	11199775	445218	747710	0,2885	11614467	455165	761365	0,267	12233702	491715	814103	0,2356	11330699	541164	848520
2003	0,2258	22510054	516307	875459	0,2217	24417697	515994	894630	0,2011	24483969	564310	951577	0,1958	23739804	581776	956421
2004	0,1892	14124701	524400	802579	0,1978	14302253	545425	833696	0,1773	15484869	587871	890409	0,1906	13874764	571510	855010
2005	0,1697	9357742	591325	853658	0,1694	9679691	600222	870195	0,1523	10556663	648172	936485	0,1748	9429027	602011	866568
2006	0,1838	16480430	657470	1011923	0,1804	17002482	682022	1046669	0,1634	18382946	744900	1137143	0,189	16501434	659418	1014392
2007	0,1866	14373005	687145	1049731	0,1732	14660992	717478	1089020	0,1591	16025243	782828	1184175	0,1815	14179900	687466	1048012
2008	0,1885	27941733	700174	1267005	0,1739	29769125	743476	1340140	0,1606	32463422	817642	1465062	0,1823	28696270	710305	1286917
2009	0,1709	21060410	803289	1303460	0,1644	21659563	860518	1380906	0,1444	24123767	946029	1515845	0,1725	20780046	821550	1323153
2010	0,1985	15044542	860300	1295172	0,1873	16381515	903682	1363737	0,163	16854208	1022790	1513432	0,1971	15774419	860271	1303931
2011	0,1528	9659382	851682	1199117	0,1444	10519905	909582	1280626	0,1258	10875660	1023304	1415615	0,1527	10074423	864822	1221817
2012	0,1113	23427688	909226	1427719	0,1043	27515554	979559	1568769	0,092	28046344	1095527	1703761	0,1104	26009486	927342	1487582
2013	0,0992	20690377	988182	1473630	0,091	27520577	1091245	1687427	0,0824	24271643	1192763	1760414	0,0962	26172329	1030355	1597886
2014	0,1352	16358492	1093929	1546512	0,1217	22306966	1281424	1856408	0,1135	19078658	1338293	1864943	0,1289	21112876	1207157	1753889
2015	0,1796	58940902	1046103	1716218	0,1491	81849000	1287981	2179136	0,1483	68318363	1277007	2049459	0,1588	77841321	1208748	2057648
2016	0,2004	19055482	1033264	1532054	0,1542	21887048	1403303	2027108	0,1608	21548296	1261889	1828808	0,1659	20683783	1316427	1910539

WD02. Herring (*Clupea* harengus) in subdivisions 25–29 and 32 (central Baltic Sea, excluding Gulf of Riga): **Consequences of mistakes in natural mortality and final year of the BIAS index to the assessment 2017.**

Mikaela Bergenius

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Summary

An error was discovered in the natural mortality (M) input file for the assessment of Central Baltic Herring performed in March 2017. An error was also noted in the BIAS index for the year 2016. The following working document evaluate the consequences of these errors to the perception of the stock, short term forecast and resulting catch advice.

The differences in the diagnostics of the assessment with the new M estimates and BIAS index and the March 2017 assessment were negligible. The perception over time of the herring stock did was the same irrespective of assessment run. The estimates of F, Rec, and SSB differed by a maximum of 1, 6 and 2 percent respectively, between the different assessments for the time period.

The F_{MSY} catch advice based on the M and BIAS corrected assessment (268 695 tonnes) differed by 0.3 percent compared to the published F_{MSY} catch advice in March 2017 (267 745 tonnes).

Introduction and methods

The XSA assessment of herring in the central Baltic is tuned with abundances at age estimates derived from the BIAS survey covering SD 25-29, excluding Gulf of Riga. On request from the WGBFAS group in fall 2017 WGBIFS computed a new index, now including also SD 32 (which will be evaluated at a later stage).

In the process of performing a preliminary evaluation of this new survey index, SD 25–29, 32 (excl. GoR) a small error was noted in the natural mortality (M) input file of the herring assessment performed in March 2017. According to the agreed procedure, M values for 2012–2016 were estimated from the regression of M values, taken from multispecies modelling (SMS), against the cod SSB 1974-2011 (ICES, 2017). M for the sprat assessment is estimated in a similar way, and during discussions regarding a consistent procedure for the steps of estimating these values and exchange of files, a mistake was made in the herring M input file for the years 2012-2016 (Table 1). The correct M at age estimates are in fact, presented in the WGBFAS report (ICES, 2017), but not used in the assessment. An evaluation of the consequences of this mistake to the perception of the stock and short term forecast is presented below.

In preparing the new BIAS index, a small error was also noted by WGBIFS in the computation of year 2016 in the BIAS index that was used for the assessment 2017 (Table 2, Figure 1, WKPELA 2018). When extracting the data from the database, it was discovered that the method to calculate “the rectangle-mean for the abundance and mean individual weight at multiple covered rectangles” was not set according to the same principle as previous years (WKPELA 2017). The evaluation of the consequences of this mistake to the perception of the stock is also presented below.

Table 1. Herring in SD 25–29, 32 excluding GoR. Natural mortality estimates used for the assessment 2017 and the corrected estimates. .

Year	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
Used for assessment 2017								
2012	0.3126	0.2894	0.2737	0.2601	0.2518	0.2421	0.2339	0.2263
2013	0.3045	0.2829	0.2683	0.2557	0.248	0.239	0.2314	0.2244
2014	0.3029	0.2817	0.2673	0.2549	0.2473	0.2384	0.231	0.224
2015	0.3039	0.2825	0.268	0.2554	0.2478	0.2388	0.2313	0.2243
2016	0.307	0.2849	0.27	0.257	0.2492	0.24	0.2322	0.225
Corrected for assessment 2017								
2012	0.2985	0.2782	0.2644	0.2525	0.2453	0.2368	0.2296	0.223
2013	0.2877	0.2696	0.2574	0.2468	0.2403	0.2327	0.2264	0.2205
2014	0.2857	0.268	0.256	0.2457	0.2394	0.232	0.2258	0.22
2015	0.287	0.2691	0.2569	0.2464	0.24	0.2325	0.2262	0.2203
2016	0.291	0.2723	0.2595	0.2485	0.2418	0.234	0.2274	0.2213
Ratio of Used for assessment 2017 and corrected for assessment 2017								
2012	0.9549	0.9613	0.966	0.9708	0.9742	0.9781	0.9816	0.9854
2013	0.9448	0.953	0.9594	0.9652	0.969	0.9736	0.9784	0.9826
2014	0.9432	0.9514	0.9577	0.9639	0.9681	0.9732	0.9775	0.9821
2015	0.9444	0.9526	0.9586	0.9648	0.9685	0.9736	0.978	0.9822
2016	0.9479	0.9558	0.9611	0.9669	0.9703	0.975	0.9793	0.9836

Table 2. Herring in SD 25–29, 32 excluding GoR. BIAS index year 2016. The "original 2016" index was used for the assessment 2017. The original index was "corrected 2016" according to WKPELA (2017). Note that only ages 1-8+ are used in the assessment. Age 0 is used in the RCT3 analyses to predict 1-year olds for 2017.

Index	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+		AGE 0
original 2016	6816	27756	7191	7275	4046	2032	1492	1471		2940
corrected 2016	6830	27755	7212	7277	4050	2032	1493	1471		2957
Ratio original/ corrected	0.998	1.000	0.997	1.000	0.999	1.000	0.999	1.000		0.994

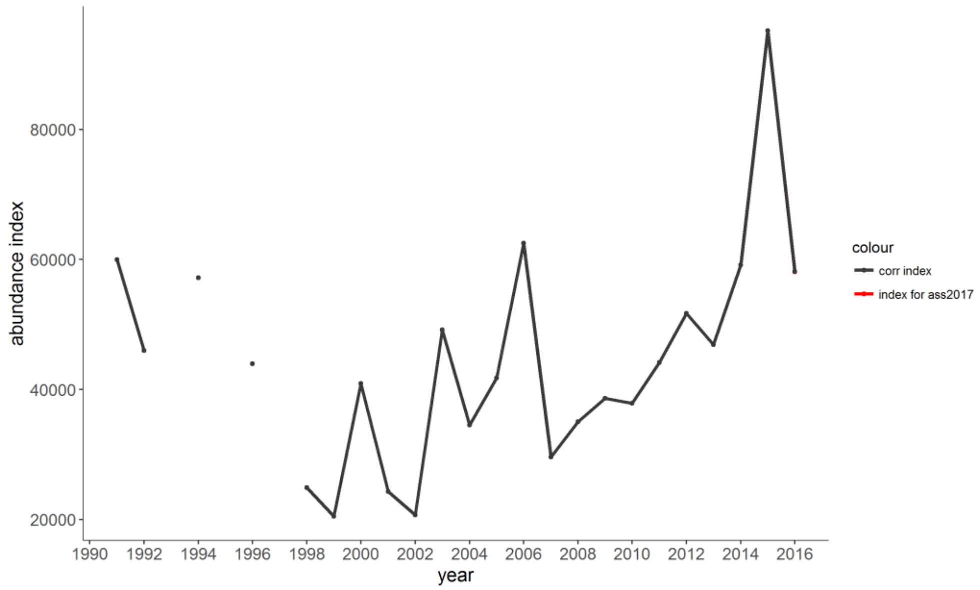


Figure 1. Herring in SD 25–29, 32 excluding GoR. BIAS index used for the assessment 2017 and the corrected BIAS index. The red line illustrating the index used for the assessment 2017 is so close to the corrected index, illustrated by the black line, and therefore not seen in the figure.

Four assessment scenarios were contrasted as part of the evaluation of the errors to M and BIAS index.

- Assessment 2017 as WGBFAS 2017 (ass2017)
- Assessment 2017 including the corrected M values for 2012-2016 (ass2017_newM)
- Assessment 2017 including the corrected BIAS index for 2016 (ass2017_newI)
- Assessment 2017 including the corrected M values and BIAS index for 2016 (ass2017_newMI)

With the exception of the corrected natural mortality input file (Table 1) and the corrected BIAS index 2016 (Table 2) presented above, all input data and model configurations were the same as for the assessment 2017, and can be found in the WGBFAS report (ICES, 2017).

For the short term forecast, the correct average M estimates had been used in March 2017. Since other input to the short term forecast also depend on the assessment output however, the short term forecast was rerun and the results are presented below.

Results

Assessment

All four XSA assessments (ass2017, ass2017_newM, ass2017_newI and ass2017_newMI) converged after 67 iterations. The standard diagnostics of the runs are very similar and presented in Annex I.

The regression statistics for all four runs are identical (Annex 1: Table 1 and 2). The log catchability residuals were close to identical for both runs, and showed the same year effects with variable positive and negative residuals (Figure 2). Negative trends were apparent in the beginning of the time series, but the residuals were overall small and considered acceptable. The variance ratio between the internal (within fleet) and external standard (among fleet) errors were similar for the four runs and within the acceptable range (< 3 and > 0.3) for ages 3 to 7, and somewhat high for age 2 (Figure 3). The estimated survivors from based on the index vs shrinkage were similar, and shrinkage received little weighting in terminal estimates for both runs (Figure 4).

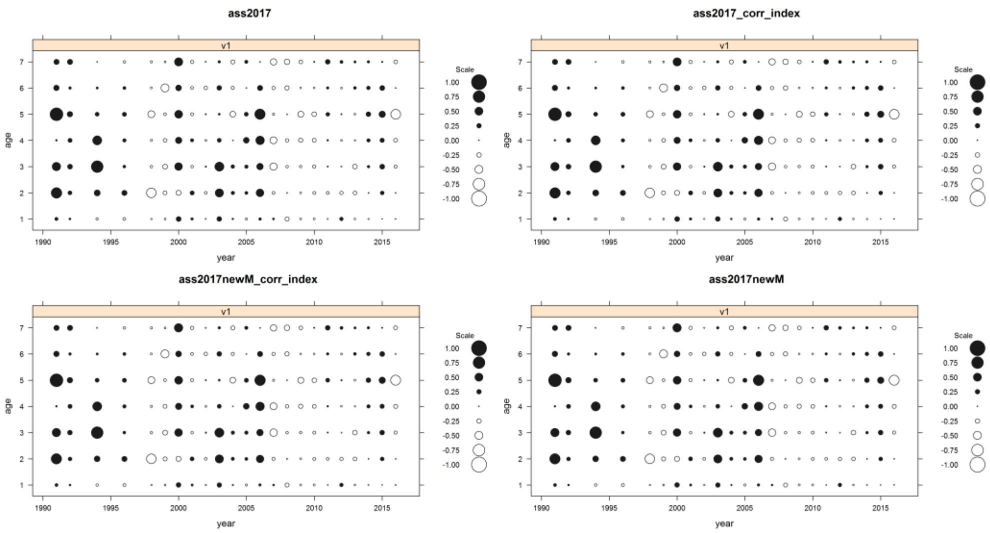


Figure 2. Herring in SD 25–29, 32 (excl. GoR). Log catchability residuals for the assessment 2017 (ass2017), assessment 2017 with the corrected BIAS for 2016 (ass2017_corr_index), the assessment 2017 with the corrected M and corrected BIAS index (ass2017_newM_corr_index) and the assessment 2017 with corrected M (ass2017newM).

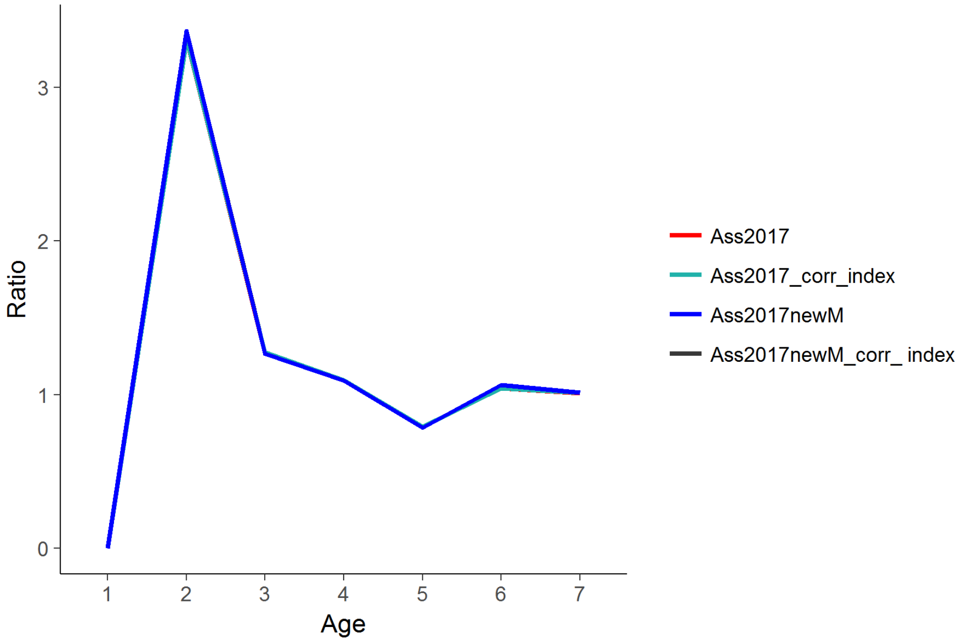


Figure 3. Herring in SD 25–29, 32 (excl. GoR). Variance ratio between the internal (within fleet) and external (among fleet) standard errors for the assessment 2017 (ass2017), assessment 2017 with the corrected BIAS for 2016 (ass2017_corr_index), the assessment 2017 with the corrected M and corrected BIAS index (ass2017_newM_corr_index) and the assessment 2017 with corrected M (ass2017newM).

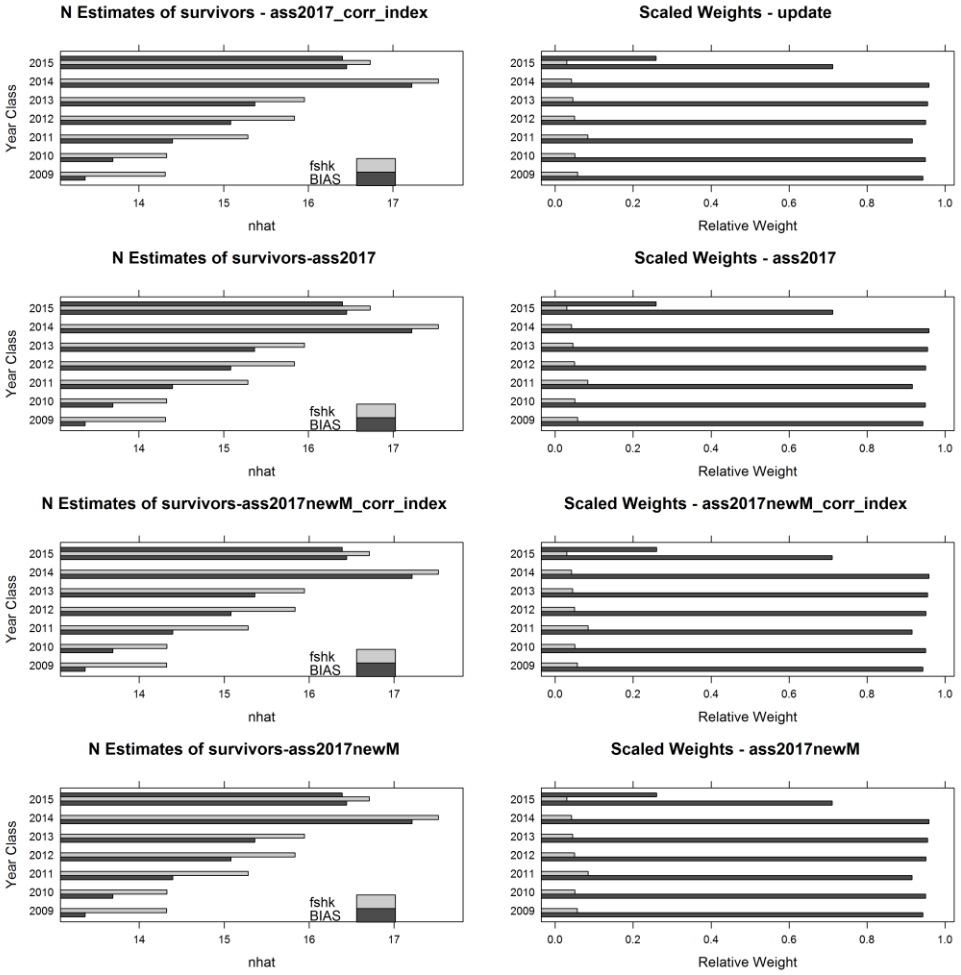


Figure 4. Herring in SD 25–29, 32 (excl. GoR). Fleet based survivor estimates from each fleet (left column) and their scaled weights (right column) for the assessment 2017 with the corrected BIAS for 2016 (ass2017_corr_index), assessment 2017 (ass2017), the assessment 2017 with the corrected M and corrected BIAS index (ass2017_newM_corr_index) and the assessment 2017 with corrected M (ass2017newM).

Fishing mortalities and stock numbers at age for the mortality corrected run can be delivered on request. The stock summaries for the different runs are presented in Figure 5 and Annex I: Table 5.

There were minor differences in the fbar, recruitment and ssb estimated from the different assessment runs (Figure 5, Annex I: Table 5). Estimates of fbar between the assessment with the corrected M values and BIAS index and the assessment 2017 differed at the most by +/-1%, in the last 10 years (Annex I: Table 5). Estimates of recruitment differed by a maximum of - 6% for the years 2012-2015, and by - 3% for the final year. Estimates of SSB differed by a maximum of - 2% for any given year and by 1% in the final year of assessment 2016 (Annex I: Table 5).

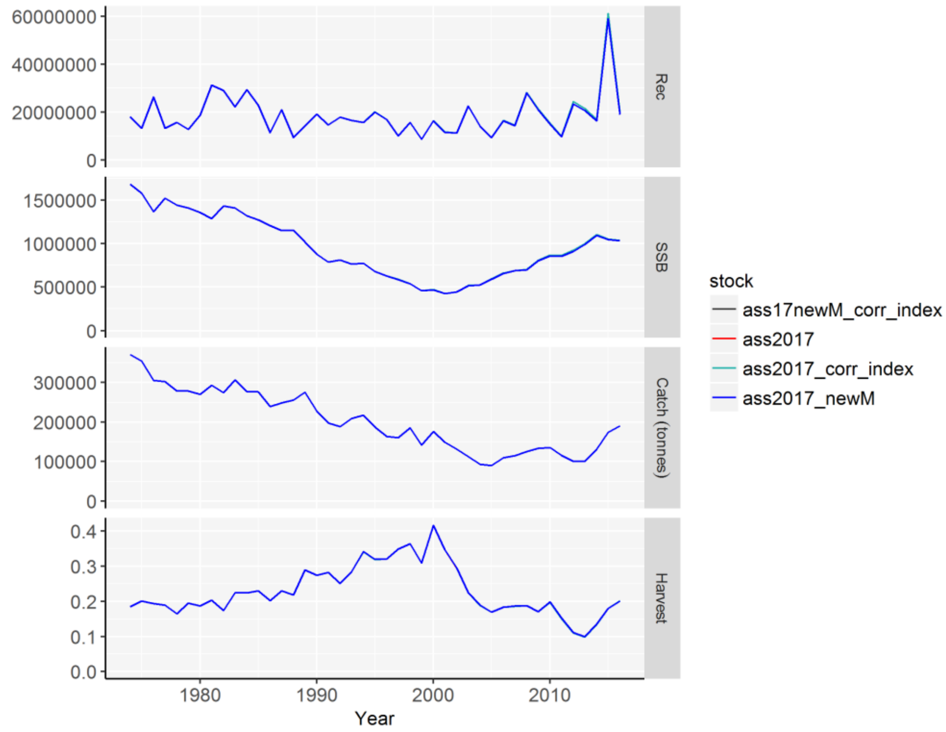


Figure 5. Herring in SD 25–29, 32 excluding GoR. Recruitment, SSB, Catch and fbar as estimated by the assessment 2017 with the corrected M and corrected BIAS index (ass2017_newM_corr_index), the assessment 2017 (ass2017), the assessment 2017 with the corrected BIAS for 2016 (ass2017_corr_index), and the assessment 2017 with corrected M (ass2017newM).

Retrospective analyses for all three runs are presented in Figure 6. There is no notable difference in the retrospective pattern for either recruitment, SSB or fishing mortality. Irrespective of the difference in the natural mortality input or the slightly changed BIAS index in 2016, there has been a tendency to slightly overestimate fishing mortality in recent years. Spawning stock biomass has consistently been underestimated.

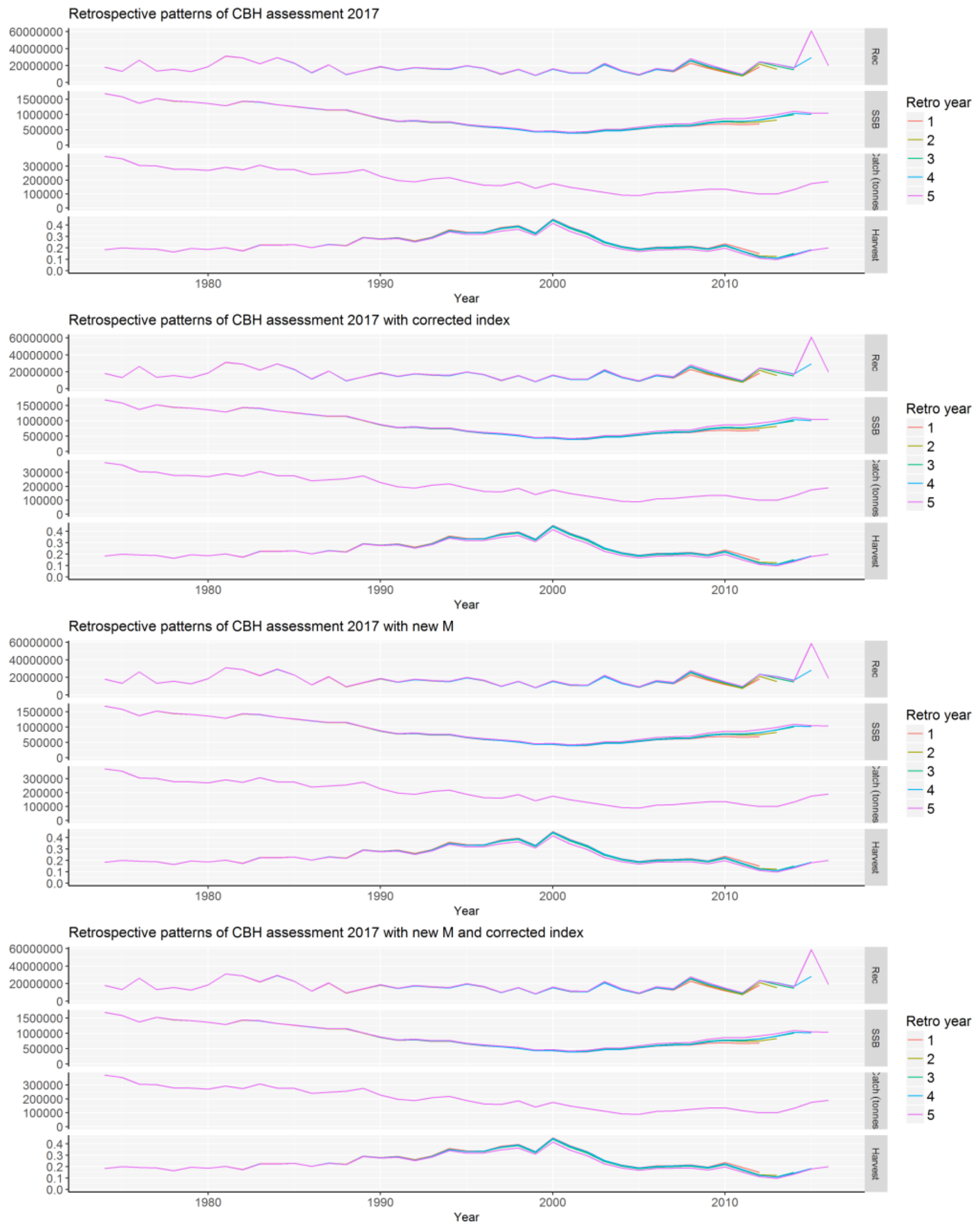


Figure 7. Herring in SD 25–29, 32 excluding GoR. Retrospective Analysis of the assessment 2017, of assessment with the corrected BIAS for 2016, of the assessment 2017 with the new M and the assessment 2017 with the new M and corrected BIAS index.

In conclusion, there were minor differences between the different assessment runs, and most importantly between the assessment performed in March 2017 and the assessment with the corrected M and Bias index (Table 3). The assessment with the corrected M and BIAS index was used for the short-term forecast below.

Table 3. Herring in SD 25-29, 32 (excl. GOR). Comparison of assessment 2017 and assessment with the corrected M and Bias index.

CATEGORY	PARAMETER	ASSESSMENT 2017	ASSESSMENT 2017 CORR	DIFF. (+/-) %
XSA results	SSB 2016 (1000 t)	1037	1033	-0.35%
	TSB 2016 (1000 t)	1547	1532	-0.99.%
	F(3–6 2016	0.20	0.20	-0.54%
	Recruitment (age 1) in 2016 (billions)	19.6	19.1	-2.70%

Short-term forecast and management options

The input data of the short-term prediction are presented in Table 5 and are derived from the 2017 XSA assessment with the corrected M values and BIAS index for 2016. The mean weights at age in the prediction, for both catch and stock, were the average of 2014–2016. The estimate of recruitment of age 1 in 2017 was taken from the RCT3 analysis (Input data for the analyses are shown in Table 3 and output data in Table 4), whereas recruits in 2018 and 2019 were taken as the GM for 1988–2015, 15 968 millions.). The natural mortalities were assumed as the average of 2014–2016. The exploitation pattern was taken as the average over 2014–2016. The TAC constraint of 224 989 t (EU quota of 191 129 t + EU/Russian quota of 29 500 t + CBH caught in GOR 4 580 t (mean 2011–2015) – GoR herring caught in the Central Baltic area 220 t) was used in the predictions in the intermediate year 2017 since the total TAC in 2016 was almost fully exploited. This resulted in a fishing mortality of 0.19 (Table 7), which lies below the present estimated F in 2016 of 0.20. The SSB is expected to increase to 1348052 t in 2017.

Consequences for advice

The ICES stock advice published 31 May 2017 stated:

"ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2018 that correspond to the F ranges in the plan are between 200 236 tonnes and 331 510 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (267 745 tonnes) can only be taken under conditions specified in the MAP. This advice applies to all catches from the stock, including those taken in Subdivision 28.1."

With the corrected natural mortality values and BIAS index for 2016 the advice would be:

ICES advises that when the EU multiannual plan (MAP) is applied, catches in 2018 that correspond to the F ranges in the plan are between 201 121 tonnes and 332 520 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (268 695 tonnes) can only be taken under conditions specified in the MAP. This advice applies to all catches from the stock, including those taken in Subdivision 28.1.

The F_{MSY} advice with the corrected assessment differs with 0.3 percent compared to the published advice in March 2017.

Table 4. Herring in SD 25-29, 32 (excl. GOR). Input for RCT3 analysis

Yearclass	VPA Age 1 (thousands)	Acoustic (SD 25-29S+N) Age 0 (thousands)
1991	17928	13733
1992	16516	1608
1993	15788	
1994	20072	6122
1995	16834	
1996	10043	336
1997	15715	
1998	8712	508
1999	16352	2591
2000	11706	1319
2001	11200	2123
2002	22510	16046
2003	14125	9067
2004	9358	1587
2005	16480	5568
2006	14373	1990
2007	27942	12197
2008	21060	8673
2009	15045	3366
2010	9659	1178
2011	23428	10098
2012	20690	11141
2013	16358	3068
2014	58941	35061
2015		7662
2016		2957

Table 5. Herring in SD 25-29, 32 (excl. GOR). Output from the RCT3 analysis

Data for 1 surveys over 26 years: 1991 - 2016

Regression type = C

Tapered time weighting applied

power = 3 over 20 years

Survey weighting not applied

Final estimates shrunk towards mean

Minimum S.E. for any survey taken as .20

Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass **2010**

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.38	6.52	0.22	0.736	16	7.07	9.2	0.266	0.615
					VPA	Mean =	9.63	0.335	0.385

Yearclass **2011**

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.39	6.43	0.21	0.764	17	9.22	10.02	0.252	0.658
					VPA	Mean =	9.6	0.349	0.342

Yearclass **=** **2012**

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.4	6.32	0.2	0.791	18	9.32	10.07	0.239	0.697
					VPA	Mean =	9.64	0.363	0.303

Yearclass **=** **2013**

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights

BIAS	0.4	6.32	0.19	0.807	19	8.03	9.54	0.214	0.738
					VPA	Mean =	9.67	0.359	0.262

Yearclass = 2014

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.41	6.25	0.18	0.801	20	10.46	10.54	0.246	0.662
					VPA	Mean =	9.69	0.344	0.338

Yearclass = 2015

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.51	5.41	0.23	0.834	21	8.94	9.99	0.266	0.776
					VPA	Mean =	9.81	0.494	0.224

Yearclass = 2016

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.52	5.34	0.23	0.844	21	7.99	9.5	0.267	0.78
					VPA	Mean =	9.83	0.503	0.22

Year Class	**Weighted Average Prediction**	**Log WAP**	**Int Std Error**	**Ext Std Error**	**Var Ratio**	**VPA**	**Log VPA**
2010	11704	9.37	0.21	0.21	0.98	9659	9.18
2011	19476	9.88	0.2	0.2	0.97	23428	10.06
2012	20771	9.94	0.2	0.2	0.99	20691	9.94
2013	14378	9.57	0.18	0.06	0.11	16359	9.7
2014	28426	10.26	0.2	0.41	4.1	58942	10.98
2015	20970	9.95	0.23	0.08	0.11		
2016	14345	9.57	0.24	0.14	0.33		

Table 6. Herring in SD 25-29, 32 (excl. GOR). Input data for the short-term predictions

MFDP version 1a
Run: v2
Time and date: 16:36 4/24/2017
Fbar age range: 3-6

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	14345000	0.2879	0	0.35	0.3	0.0092	0.0368	0.0092
2	13824672	0.2698	0.7	0.35	0.3	0.0180	0.0851	0.0180
3	30427726	0.2575	0.9	0.35	0.3	0.0274	0.1392	0.0274
4	5752584	0.2469	1	0.35	0.3	0.0338	0.1924	0.0338
5	4745140	0.2404	1	0.35	0.3	0.0363	0.2030	0.0363
6	3772542	0.2328	1	0.35	0.3	0.0408	0.2322	0.0408
7	981049	0.2265	1	0.35	0.3	0.0457	0.2709	0.0457
8	965590	0.2205	1	0.35	0.3	0.0512	0.2709	0.0512

2018

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	15967943	0.2879	0	0.35	0.3	0.0092	0.0368	0.0092
2	.	0.2698	0.7	0.35	0.3	0.0180	0.0851	0.0180
3	.	0.2575	0.9	0.35	0.3	0.0274	0.1392	0.0274
4	.	0.2469	1	0.35	0.3	0.0338	0.1924	0.0338
5	.	0.2404	1	0.35	0.3	0.0363	0.2030	0.0363
6	.	0.2328	1	0.35	0.3	0.0408	0.2322	0.0408
7	.	0.2265	1	0.35	0.3	0.0457	0.2709	0.0457
8	.	0.2205	1	0.35	0.3	0.0512	0.2709	0.0512

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	15967943	0.2879	0	0.35	0.3	0.0092	0.0368	0.0092
2	.	0.2698	0.7	0.35	0.3	0.0180	0.0851	0.0180
3	.	0.2575	0.9	0.35	0.3	0.0274	0.1392	0.0274
4	.	0.2469	1	0.35	0.3	0.0338	0.1924	0.0338
5	.	0.2404	1	0.35	0.3	0.0363	0.2030	0.0363
6	.	0.2328	1	0.35	0.3	0.0408	0.2322	0.0408
7	.	0.2265	1	0.35	0.3	0.0457	0.2709	0.0457
8	.	0.2205	1	0.35	0.3	0.0512	0.2709	0.0512

Input units are thousands and kg - output in tonnes

M = Natural mortality
MAT = Maturity ogive
PF = Proportion of F before spawning
PM = Proportion of M before spawning
SWT = Weight in stock (kg)
Sel = Exploit. Pattern
CWT = Weight in catch (kg)

N_{2016} Age 1: Output form RCT3 Analysis (Table 3)

N_{2016} Age 2-8+: Predicted from XSA Output
$N_{2017/2018}$ Age 1: Geometric Mean from XSA-Output of age 1 for the years 1988-2015

Natural Mortality (M): Average of 2014-2016
Weight in the Catch/Stock (CWt/SWt): Average of 2014-2016
Expoitation pattern (Sel): Average of 2014-2016

Table 7. Herring in SD 25-29, 32 (excl. GOR). Output from short-term predictions with management option table for *'TAC constraint' in 2017.

MFDP version 1a Run: v2 herring cbd Prediction Time and date: 15:11 1/17/2018 Fbar age range: 3–6

2017

Biomass	SSB	FMult	FBar	Landings
1829049	1348052	1	0.1917	224989

2018					**2019**	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1718239	1383163	0	0	0	1786744	1444654
.	1374104	0.1	0.0192	25772	1760759	1411186
.	1365108	0.2	0.0383	51069	1735261	1378588
.	1356175	0.3	0.0575	75899	1710241	1346836
.	1347304	0.4	0.0767	100272	1685688	1315908
.	1338495	0.5	0.0959	124198	1661594	1285778
.	1329747	0.6	0.115	147685	1637949	1256427
.	1321061	0.7	0.1342	170741	1614744	1227832
.	1312434	0.8	0.1534	193377	1591969	1199973
.	1303868	0.9	0.1725	215599	1569617	1172829
.	1295361	1	0.1917	237417	1547679	1146380
.	1286913	1.1	0.2109	258838	1526147	1120608
.	1278524	1.2	0.23	279871	1505011	1095494
.	1270194	1.3	0.2492	300522	1484266	1071020

.	1261921	1.4	0.2684	320800	1463901	1047168
.	1253705	1.5	0.2876	340712	1443911	1023922
.	1245547	1.6	0.3067	360265	1424287	1001265
.	1237445	1.7	0.3259	379466	1405022	979180
.	1229399	1.8	0.3451	398323	1386108	957653
.	1221409	1.9	0.3642	416842	1367540	936669
.	1213475	2	0.3834	435029	1349310	916211

TAC constraint in 2017	
EU	**191 129**
+EU/Russia	**29 500**
+CBH in GOR	**4580**
–GORH	**220**
Total	**224 989**

Mean catches in 2011–2015

Table 7 cont. Herring in SD 25-29, 32 (excl. GOR). Output from short-term predictions with management option table for *'TAC constraint' in 2017.

Basis	Total catch (2018)	Ftotal (2018)	SSB (2018)	SSB (2019)	% SSB change *	% Advice change **	% TAC change ***
ICES advice basis							
EU MAP : FMSY	268695	0.22	1282994	1108815	86%	24%	22%
Other options							
F = 0	0	0	1383163	1444654	104%	-100%	-100%
Fpa	459729	0.41	1202556	888672	74%	113%	108%
Flim	555594	0.52	1158502	784506	68%	157%	152%
SSB (2019) = Blim	921253	1.085	957825	430392	45%	326%	318%
SSB (2019) = Bpa	736442	0.7639	1066843	600368	56%	241%	234%
SSB (2019) = MSY Btrigger	736442	0.7639	1066843	600368	56%	241%	234%
F = F2017	237417	0.1917	1295361	1146380	88%	10%	8%
F = MAP FMSY lower	201121	0.16	1309460	1190491	91%	-7%	-9%
F = MAP FMSY lower differing by 0.01	212654	0.17	1305009	1176415	90%	-2%	-4%
F = MAP FMSY lower differing by 0.02	224077	0.1799	1300574	1162528	89%	4%	2%
F = MAP FMSY lower differing by 0.03	235392	0.1899	1296155	1148827	89%	9%	7%
F = MAP FMSY lower differing by 0.04	246599	0.1999	1291752	1135310	88%	14%	12%
F = MAP FMSY lower differing by 0.05	257700	0.2098	1287365	1121973	87%	19%	17%
F = MAP FMSY lower differing by 0.07	279587	0.2298	1278638	1095832	86%	29%	27%
F = MAP FMSY lower differing by 0.08	290375	0.2397	1274299	1083022	85%	34%	32%

F = MAP FMSY lower differing by 0.09	301062	0.2497	1269975	1070383	84%	39%	36%
F = MAP FMSY lower differing by 0.10	311647	0.2597	1265666	1057912	84%	44%	41%
F = MAP FMSY lower differing by 0.11	322133	0.2697	1261374	1045607	83%	49%	46%
F = MAP FMSY upper	332520	0.2796	1257096	1033465	82%	54%	51%

* SSB 2019 relative to SSB 2018.

** Wanted catch in 2018 relative to Advice in 2017 (216 227 t).

*** Wanted catch in 2018 relative to TAC in 2017 (220629 t).

References

ICES. 2017. Report of the Baltic Fisheries Assessment Working Group (WGBFAS), 19–26 April 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM:11.

Annex I

Table 1. Herring in SD 25–29, 32 (excl. GoR). Diagnostics XSA assessment 2017.

FLR XSA Diagnostics 2018-01-09 11:23:28
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	BIAS SD 25-27&28.2&29S+N (April 2017)	1	7	1991	2016	<NA>	<NA>

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.5
Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied
Regression weights

	year									
age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

	year									
age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.037	0.033	0.036	0.043	0.035	0.016	0.026	0.033	0.027	0.037
2	0.091	0.082	0.081	0.050	0.065	0.055	0.044	0.069	0.073	0.083
3	0.154	0.138	0.121	0.117	0.089	0.069	0.063	0.095	0.142	0.135
4	0.167	0.172	0.189	0.167	0.152	0.088	0.095	0.134	0.176	0.207
5	0.189	0.177	0.175	0.230	0.171	0.133	0.113	0.166	0.199	0.181
6	0.233	0.264	0.194	0.274	0.193	0.150	0.122	0.143	0.201	0.283
7	0.178	0.232	0.315	0.268	0.215	0.156	0.164	0.123	0.193	0.416
8	0.178	0.232	0.315	0.268	0.215	0.156	0.164	0.123	0.193	0.416

XSA population number (Thousand)

	age							
year	1	2	3	4	5	6	7	8
2007	14457857	12058001	5019922	5197059	5411159	1453181	937402	767759
2008	28194423	10713162	8542761	3338823	3411997	3489136	908833	1172537
2009	21372087	20822757	7545801	5721162	2163247	2208120	2069775	1008461
2010	15382382	15329962	14386121	5005258	3560514	1373031	1388903	1757202
2011	9954930	10714179	10672468	9419990	3114890	2092885	776158	1403919
2012	24392292	6876028	7215842	7034579	5826914	1897615	1252949	1616495
2013	21540883	17558878	4873867	5124730	4968876	3963789	1281888	1653047
2014	16964240	15482325	12663091	3499546	3607047	3464586	2763017	2417407
2015	61114865	12127025	10897362	8814742	2372607	2385457	2365995	3009771
2016	19584250	43882753	8495548	7229440	5725380	1517875	1537219	2053937

Estimated population abundance at 1st Jan 2017

	age							
year	1	2	3	4	5	6	7	8
2017	30127355	13891168	30390309	5668843	4545850	3722488	899831	803864

Fleet: BIAS SD 25-27&28.2&29S+N (April 2017)
Log catchability residuals.

	year																		
age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.180	0.091	NA	-0.129	NA	-0.154	NA	-0.038	-0.070	0.334	0.119	-0.034	0.310	0.054	-0.104	0.140	0.085	-0.259	-0.089
2	0.803	0.243	NA	0.422	NA	0.365	NA	-0.720	-0.254	-0.340	0.264	-0.148	0.620	0.197	0.178	0.560	-0.175	-0.017	-0.089
3	0.629	0.322	NA	0.905	NA	0.157	NA	-0.131	-0.323	0.569	-0.134	0.051	0.674	0.212	0.208	0.475	-0.540	-0.141	-0.115
4	0.062	0.273	NA	0.685	NA	0.203	NA	-0.111	-0.238	0.450	0.179	-0.070	0.254	-0.004	0.405	0.652	-0.505	-0.199	-0.274
5	0.991	0.372	NA	0.252	NA	0.269	NA	-0.507	-0.152	0.582	-0.177	0.025	0.083	-0.414	0.258	0.794	-0.111	-0.017	-0.417
6	0.372	0.138	NA	0.107	NA	0.176	NA	-0.095	-0.594	0.403	-0.148	-0.216	0.310	-0.189	-0.006	0.363	-0.200	-0.289	-0.064
7	0.366	0.361	NA	-0.018	NA	-0.141	NA	-0.103	-0.070	0.621	-0.209	-0.021	0.124	-0.269	0.179	-0.009	-0.462	-0.381	-0.240

	year						
age	2010	2011	2012	2013	2014	2015	2016
1	-0.093	-0.022	0.212	-0.062	-0.038	-0.003	0.003
2	-0.172	-0.164	-0.210	-0.236	0.009	0.227	-0.009
3	-0.181	0.021	-0.028	-0.316	0.141	0.323	-0.186
4	-0.244	0.057	-0.068	-0.046	0.208	0.287	-0.247
5	-0.308	0.240	0.030	-0.087	0.312	0.464	-0.735
6	-0.065	0.124	-0.074	0.159	0.224	0.334	-0.018
7	0.026	0.310	0.168	0.101	0.126	0.039	-0.233

```
 Regression statistics
 Ages with q dependent on year class strength
[1] "0.680963082893183" "10.5850675178679"

 Terminal year survivor and F summaries:
  ,Age 1 Year class =2015
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.712  13953433  2015
fshk                                0.030  18452307  2015
nshk                                0.259  13283281  2015

 ,Age 2 Year class =2014
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.958  30108330  2014
fshk                                0.042  41190120  2014

 ,Age 3 Year class =2013
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.955   4706249  2013
fshk                                0.045   8476248  2013

 ,Age 4 Year class =2012
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95   3552126  2012
fshk                                 0.05   7546380  2012

 ,Age 5 Year class =2011
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.916   1784054  2011
fshk                                0.084   4347902  2011

 ,Age 6 Year class =2010
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95    883638  2010
fshk                                 0.05   1667041  2010

 ,Age 7 Year class =2009
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.943    636678  2009
fshk                                0.057   1643586  2009
```

Table 2. Herring in SD 25–29, 32 (excl. GoR). Diagnostics XSA assessment 2017 with corrected M values.

FLR XSA Diagnostics 2018-01-09 11:23:28
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	BIAS SD 25-27&28.2&29S+N (April 2017)	1	7	1991	2016	<NA>	<NA>

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.5
Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied

Regression weights

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.037	0.033	0.037	0.044	0.037	0.017	0.027	0.034	0.028	0.037
2	0.091	0.082	0.081	0.051	0.066	0.056	0.045	0.071	0.074	0.084
3	0.154	0.139	0.122	0.118	0.090	0.070	0.064	0.096	0.143	0.135
4	0.167	0.172	0.190	0.169	0.154	0.089	0.097	0.135	0.176	0.206
5	0.190	0.178	0.176	0.232	0.172	0.135	0.113	0.167	0.199	0.180
6	0.235	0.265	0.195	0.275	0.194	0.151	0.123	0.143	0.200	0.280
7	0.179	0.233	0.317	0.270	0.216	0.157	0.165	0.123	0.192	0.413
8	0.179	0.233	0.317	0.270	0.216	0.157	0.165	0.123	0.192	0.413

XSA population number (Thousand)

year \ age	1	2	3	4	5	6	7	8
2007	14374197	12017160	5006146	5179696	5392092	1446196	932757	763940
2008	27944486	10648849	8511081	3328137	3398529	3474279	903317	1165382
2009	21062456	20632056	7496642	5696796	2155028	2197719	2058302	1002823
2010	15044265	15099709	14243312	4968445	3542192	1366815	1380959	1747079
2011	9660220	10468435	10503876	9314922	3087806	2079326	771536	1395508
2012	23427974	6665126	7039277	6913120	5751219	1878044	1243104	1603987
2013	20689350	17094787	4770627	5038771	4914164	3932257	1273808	1642874
2014	16346025	15109423	12482039	3459339	3573752	3449940	2756627	2412185
2015	58941336	11876353	10767873	8779757	2364660	2379884	2370742	3016403
2016	19037129	43009821	8423002	7216172	5754791	1524819	1543598	2063119

Estimated population abundance at 1st Jan 2017

year \ age	1	2	3	4	5	6	7	8
2017	30127355	13710385	30127355	5677028	4578769	3775979	911627	813812

Fleet: BIAS SD 25-27&28.2&29S+N (April 2017)
Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	0.167	0.078	NA	-0.138	NA	-0.164	NA	-0.048	-0.077	0.319	0.109	-0.042	0.294	0.044	-0.110	0.129	0.076	-0.264	-0.091
2	0.792	0.233	NA	0.411	NA	0.354	NA	-0.730	-0.265	-0.350	0.254	-0.157	0.612	0.189	0.169	0.551	-0.183	-0.022	-0.090
3	0.622	0.315	NA	0.898	NA	0.150	NA	-0.138	-0.329	0.563	-0.139	0.046	0.669	0.208	0.204	0.471	-0.544	-0.144	-0.115
4	0.058	0.269	NA	0.681	NA	0.199	NA	-0.115	-0.242	0.447	0.176	-0.072	0.252	-0.006	0.404	0.651	-0.506	-0.200	-0.274
5	0.988	0.369	NA	0.250	NA	0.267	NA	-0.509	-0.154	0.580	-0.178	0.024	0.083	-0.413	0.258	0.796	-0.109	-0.015	-0.416
6	0.369	0.135	NA	0.104	NA	0.174	NA	-0.097	-0.595	0.402	-0.149	-0.216	0.310	-0.188	-0.005	0.364	-0.197	-0.287	-0.062
7	0.363	0.359	NA	-0.021	NA	-0.144	NA	-0.104	-0.070	0.621	-0.209	-0.020	0.125	-0.268	0.181	-0.007	-0.459	-0.376	-0.236

age \ year	2010	2011	2012	2013	2014	2015	2016
1	-0.087	-0.010	0.218	-0.053	-0.030	-0.002	0.004
2	-0.167	-0.151	-0.198	-0.231	0.012	0.226	-0.010
3	-0.177	0.031	-0.017	-0.310	0.139	0.319	-0.193
4	-0.240	0.065	-0.060	-0.041	0.208	0.279	-0.257
5	-0.304	0.247	0.036	-0.085	0.312	0.457	-0.751
6	-0.062	0.129	-0.070	0.159	0.220	0.327	-0.033
7	0.031	0.314	0.170	0.101	0.121	0.029	-0.247

```
 Regression statistics
 Ages with q dependent on year class strength
[1] "0.67642221432812" "10.6080719711122"


 Terminal year survivor and F summaries:

 ,Age 1 Year class =2015
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.710  13788030  2015
fshk                                    0.029  18043187  2015
nshk                                     0.260  13086446  2015

 ,Age 2 Year class =2014
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.958  29825262  2014
fshk                                    0.042  40601899  2014

 ,Age 3 Year class =2013
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.955   4679951  2013
fshk                                    0.045   8410907  2013

 ,Age 4 Year class =2012
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95   3540583  2012
fshk                                     0.05   7514944  2012

 ,Age 5 Year class =2011
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.915   1781105  2011
fshk                                    0.085   4336512  2011

 ,Age 6 Year class =2010
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95    882087  2010
fshk                                     0.05   1665105  2010

 ,Age 7 Year class =2009
source
                                    scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.943    635533  2009
fshk                                    0.057   1661019  2009
```

Table 3. Herring in SD 25–29, 32 (excl. GoR). Diagnostics XSA Assessment 2017 with the corrected BIAS index for year 2016.

FLR XSA Diagnostics 2018-01-03 09:21:58
CPUE data from indices
Catch data for 43 years 1974 to 2016. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	BIAS SD 25-27&28.2&29S+N (April 2017)	1	7	1991	2016	<NA>	<NA>

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.5
Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied

Regression weights

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.037	0.033	0.036	0.043	0.035	0.016	0.026	0.033	0.027	0.036
2	0.091	0.082	0.081	0.050	0.065	0.055	0.044	0.069	0.073	0.083
3	0.154	0.138	0.121	0.117	0.089	0.068	0.063	0.095	0.142	0.134
4	0.167	0.172	0.189	0.167	0.152	0.088	0.095	0.134	0.176	0.207
5	0.189	0.177	0.175	0.230	0.171	0.134	0.113	0.166	0.199	0.181
6	0.233	0.264	0.194	0.274	0.193	0.150	0.122	0.143	0.201	0.283
7	0.178	0.232	0.315	0.268	0.215	0.156	0.164	0.123	0.193	0.416
8	0.178	0.232	0.315	0.268	0.215	0.156	0.164	0.123	0.193	0.416

XSA population number (Thousand)

year \ age	1	2	3	4	5	6	7	8
2007	14456656	12056805	5019278	5196643	5410607	1453071	937294	767670
2008	28191650	10712239	8541834	3338323	3411675	3488705	908747	1172425
2009	21369996	20820641	7545096	5720448	2162863	2207871	2069443	1008298
2010	15382657	15328408	14384537	5004730	3559978	1372741	1388713	1756959
2011	9954077	10714379	10671329	9418824	3114502	2092488	775942	1403525
2012	24392123	6875417	7215986	7033759	5826074	1897334	1252660	1616122
2013	21541931	17558755	4873410	5124839	4968244	3963136	1281668	1652761
2014	16977190	15483098	12662998	3499197	3607131	3464092	2762503	2416956
2015	61114966	12136591	10897945	8814671	2372336	2385523	2365606	3009274
2016	19603338	43882828	8502760	7229887	5725324	1517663	1537271	2054007

Estimated population abundance at 1st Jan 2017

year \ age	1	2	3	4	5	6	7	8
2017	0	13905211	30390365	5674348	4546195	3722445	899664	803906

Fleet: BIAS SD 25-27&28.2&29S+N (April 2017)
Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.180	0.091	NA	-0.129	NA	-0.154	NA	-0.038	-0.070	0.335	0.119	-0.034	0.310	0.054	-0.104
2	0.803	0.243	NA	0.422	NA	0.365	NA	-0.720	-0.254	-0.340	0.264	-0.148	0.620	0.197	0.178
3	0.629	0.322	NA	0.904	NA	0.156	NA	-0.132	-0.323	0.569	-0.134	0.051	0.674	0.212	0.208
4	0.062	0.273	NA	0.685	NA	0.203	NA	-0.111	-0.238	0.450	0.179	-0.070	0.254	-0.004	0.405
5	0.991	0.371	NA	0.252	NA	0.269	NA	-0.507	-0.153	0.581	-0.177	0.025	0.083	-0.414	0.258
6	0.372	0.137	NA	0.107	NA	0.176	NA	-0.095	-0.594	0.403	-0.148	-0.216	0.310	-0.189	-0.006
7	0.366	0.361	NA	-0.019	NA	-0.142	NA	-0.103	-0.070	0.621	-0.209	-0.021	0.125	-0.269	0.179

age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.140	0.085	-0.259	-0.089	-0.093	-0.022	0.212	-0.062	-0.039	-0.003	0.003
2	0.560	-0.175	-0.017	-0.089	-0.172	-0.164	-0.210	-0.236	0.009	0.226	-0.009
3	0.474	-0.540	-0.141	-0.116	-0.181	0.021	-0.028	-0.316	0.141	0.323	-0.184
4	0.652	-0.505	-0.199	-0.274	-0.244	0.057	-0.068	-0.047	0.208	0.287	-0.247
5	0.794	-0.111	-0.017	-0.417	-0.308	0.240	0.030	-0.087	0.312	0.464	-0.735
6	0.363	-0.200	-0.290	-0.064	-0.065	0.124	-0.074	0.159	0.224	0.333	-0.018
7	-0.009	-0.462	-0.381	-0.240	0.026	0.310	0.168	0.101	0.126	0.039	-0.233

```
 Regression statistics
 Ages with q dependent on year class strength
[1] "0.680972725789167" "10.5849715586152"

 Terminal year survivor and F summaries:

 ,Age 1 Year class =2015
source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.712  13973045  2015
fshk                                  0.030  18455512  2015
nshk                                   0.259  13283537  2015

,Age 2 Year class =2014

source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.958  30107940  2014
fshk                                  0.042  41198388  2014

 ,Age 3 Year class =2013
source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.955   4719014  2013
fshk                                  0.045   8476109  2013

 ,Age 4 Year class =2012
source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95   3552737  2012
fshk                                   0.05   7545820  2012

 ,Age 5 Year class =2011
source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.916   1785463  2011
fshk                                  0.084   4347421  2011

 ,Age 6 Year class =2010
source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95    883456  2010
fshk                                   0.05   1666814  2010

 ,Age 7 Year class =2009
source
                                   scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.943    636980  2009
fshk                                  0.057   1643495  2009
```

Table 4. Herring in SD 25–29, 32 (excl. GoR). Diagnostics XSA Assessment 2017 with the corrected BIAS index for year 2016 and corrected M values.

FLR XSA Diagnostics 2018-01-03 09:21:58
CPUE data from indices

Catch data for 43 years 1974 to 2016. Ages 1 to 8.

	fleet	first age	last age	first year	last year	alpha	beta
1	BIAS SD 25-27&28.2&29S+N (April 2017)	1	7	1991	2016	<NA>	<NA>

Time series weights :
Tapered time weighting applied
Power = 3 over 20 years
Catchability analysis :
Catchability independent of size for ages > 1
Catchability independent of age for ages > 5
Terminal population estimation :
Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 1.5
Minimum standard error for population
estimates derived from each fleet = 0.3
prior weighting not applied
Regression weights

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.037	0.033	0.037	0.044	0.037	0.017	0.027	0.034	0.028	0.037
2	0.091	0.082	0.081	0.051	0.066	0.056	0.045	0.071	0.074	0.084
3	0.154	0.139	0.122	0.118	0.090	0.070	0.064	0.096	0.143	0.135
4	0.167	0.172	0.190	0.169	0.154	0.089	0.097	0.135	0.176	0.206
5	0.190	0.178	0.176	0.232	0.172	0.135	0.113	0.167	0.199	0.180
6	0.235	0.265	0.195	0.276	0.194	0.151	0.123	0.143	0.200	0.281
7	0.179	0.233	0.317	0.270	0.216	0.157	0.165	0.123	0.192	0.413
8	0.179	0.233	0.317	0.270	0.216	0.157	0.165	0.123	0.192	0.413

XSA population number (Thousand)

year \ age	1	2	3	4	5	6	7	8
2007	14373005	12015963	5005498	5179287	5391538	1446087	932650	763852
2008	27941733	10647933	8510153	3327634	3398212	3473847	903231	1165271
2009	21060410	20629955	7495942	5696082	2154642	2197474	2057968	1002659
2010	15044542	15098188	14241739	4967920	3541656	1366523	1380772	1746841
2011	9659382	10468636	10502762	9313764	3087420	2078929	771319	1395113
2012	23427688	6664526	7039422	6912317	5750385	1877765	1242816	1603614
2013	20690377	17094575	4770173	5038882	4913541	3931605	1273588	1642590
2014	16358492	15110193	12481877	3458988	3573838	3449450	2756110	2411731
2015	58940902	11885722	10768462	8779632	2364385	2379953	2370353	3015907
2016	19055482	43009495	8430161	7216627	5754693	1524603	1543652	2063192

Estimated population abundance at 1st Jan 2017

year \ age	1	2	3	4	5	6	7	8
2017	0	13724105	30127107	5682550	4579125	3775902	911456	813855

Fleet: BIAS SD 25-27&28.2&29S+N (April 2017)
Log catchability residuals.

age \ year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.167	0.078	NA	-0.138	NA	-0.164	NA	-0.048	-0.077	0.319	0.109	-0.042	0.294	0.044	-0.110
2	0.792	0.233	NA	0.411	NA	0.354	NA	-0.730	-0.265	-0.350	0.255	-0.157	0.612	0.189	0.170
3	0.622	0.315	NA	0.898	NA	0.150	NA	-0.138	-0.329	0.563	-0.139	0.046	0.669	0.208	0.204
4	0.058	0.269	NA	0.681	NA	0.199	NA	-0.115	-0.242	0.447	0.176	-0.072	0.252	-0.006	0.404
5	0.988	0.368	NA	0.249	NA	0.267	NA	-0.509	-0.154	0.580	-0.178	0.024	0.083	-0.413	0.258
6	0.369	0.135	NA	0.104	NA	0.174	NA	-0.097	-0.595	0.402	-0.149	-0.216	0.310	-0.188	-0.005
7	0.363	0.358	NA	-0.021	NA	-0.144	NA	-0.104	-0.070	0.621	-0.209	-0.020	0.125	-0.268	0.181

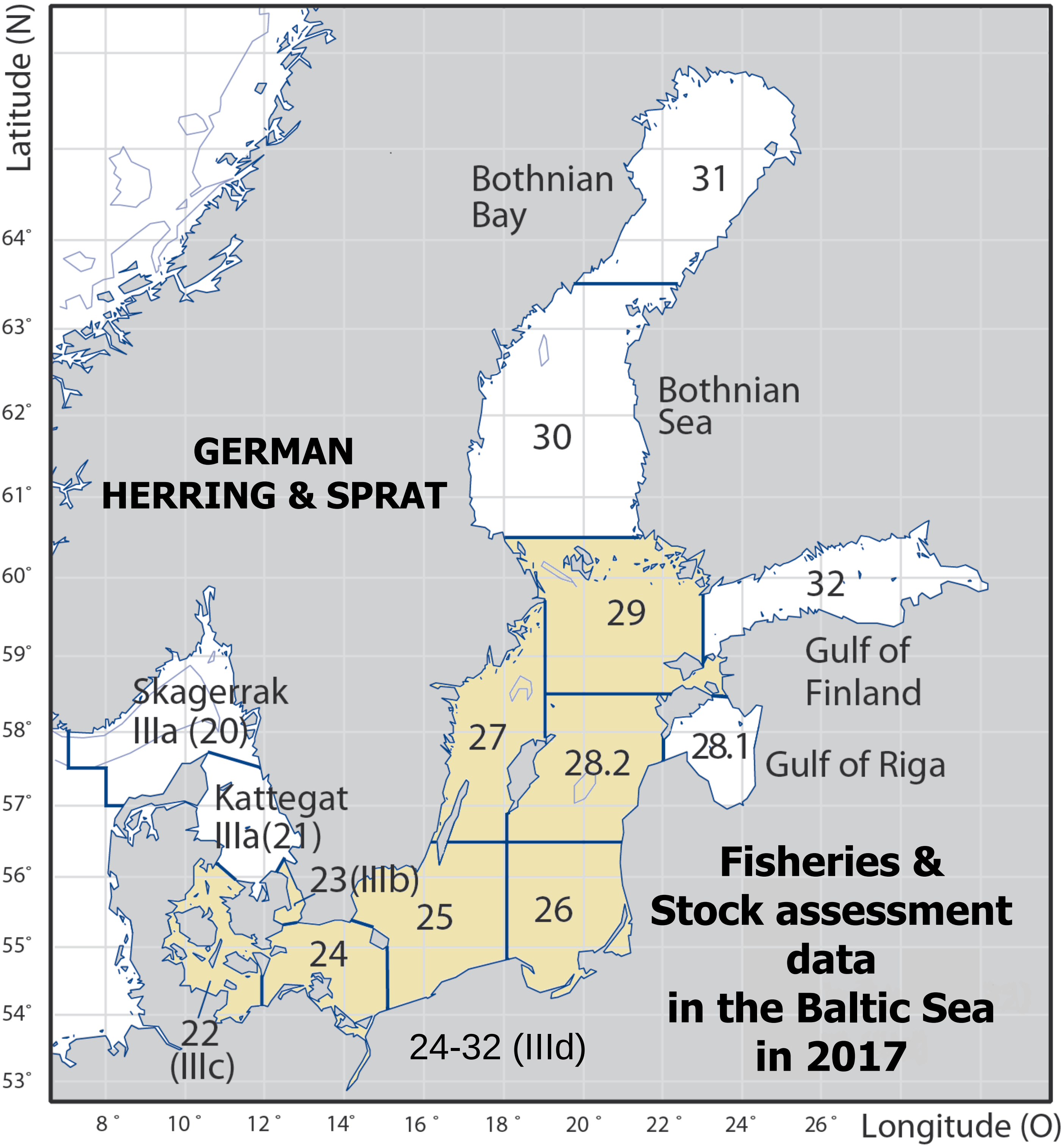
age \ year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	0.129	0.076	-0.264	-0.091	-0.087	-0.010	0.218	-0.053	-0.031	-0.002	0.004
2	0.551	-0.183	-0.022	-0.090	-0.167	-0.151	-0.198	-0.231	0.012	0.226	-0.010
3	0.471	-0.544	-0.144	-0.115	-0.177	0.031	-0.017	-0.310	0.139	0.319	-0.191
4	0.651	-0.506	-0.200	-0.274	-0.240	0.066	-0.060	-0.041	0.208	0.279	-0.257
5	0.795	-0.110	-0.015	-0.416	-0.304	0.247	0.036	-0.085	0.312	0.457	-0.751
6	0.364	-0.197	-0.287	-0.062	-0.062	0.129	-0.070	0.159	0.220	0.327	-0.033
7	-0.007	-0.459	-0.376	-0.236	0.031	0.314	0.170	0.101	0.121	0.029	-0.247

```
 Regression statistics
 Ages with q dependent on year class strength
[1] "0.676421720196874" "10.6080666516976"

 Terminal year survivor and F summaries:

 ,Age 1 Year class =2015
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.710  13807260  2015
fshk                                  0.029  18046270  2015
nshk                                   0.260  13086683  2015

 ,Age 2 Year class =2014
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.958  29824838  2014
fshk                                  0.042  40609982  2014

 ,Age 3 Year class =2013
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.955   4692644  2013
fshk                                  0.045   8410760  2013

 ,Age 4 Year class =2012
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95   3541190  2012
fshk                                   0.05   7514367  2012

 ,Age 5 Year class =2011
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.915   1782510  2011
fshk                                  0.085   4336030  2011

 ,Age 6 Year class =2010
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)      0.95    881905  2010
fshk                                   0.05   1664877  2010

 ,Age 7 Year class =2009
source
                                  scaledWts survivors yrcls
BIAS SD 25-27&28.2&29S+N (April 2017)     0.943    635833  2009
fshk                                  0.057   1660922  2009
```

Table 5. Herring in SD 25–29, 32 (excl. GoR). Diagnostics XSA assessment 2017, with the corrected BIAS index for year 2016 and corrected M values.

	Assessment 2017				Assessment 2017 with new M				Asssessment 2017 with new I				Asssessment 2017 with new M and I			
year	fbar	rec	ssb	totbiom	fbar	rec	ssb	totbiom	fbar	rec	ssb	totbiom	fbar	rec	ssb	totbiom
1974	0.18449	18115116	1683342	2660035	0.184491	18115062	1683337	2660028	0.18449	18115113	1683342	2660035	0.184491	18115059	1683337	2660028
1975	0.200319	13329768	1577408	2385044	0.200319	13329728	1577403	2385037	0.200319	13329766	1577408	2385044	0.200319	13329725	1577402	2385036
1976	0.193465	26360651	1368886	2297794	0.193466	26360536	1368880	2297785	0.193465	26360643	1368886	2297793	0.193466	26360528	1368880	2297784
1977	0.188711	13400270	1521998	2321163	0.188712	13400208	1521990	2321152	0.188711	13400266	1521997	2321162	0.188712	13400204	1521990	2321152
1978	0.164388	15702005	1441824	2239361	0.164389	15701916	1441815	2239349	0.164388	15701999	1441823	2239360	0.164389	15701910	1441815	2239348
1979	0.195332	12856079	1410091	2078554	0.195334	12855972	1410081	2078540	0.195332	12856072	1410090	2078553	0.195334	12855965	1410081	2078539
1980	0.187195	18714285	1359022	2141678	0.187197	18714132	1359011	2141661	0.187195	18714275	1359022	2141677	0.187197	18714122	1359010	2141660
1981	0.202791	31191975	1288491	2455812	0.202793	31191659	1288478	2455788	0.202791	31191954	1288490	2455810	0.202794	31191638	1288477	2455787
1982	0.173879	29099041	1434355	2563208	0.173881	29098581	1434338	2563176	0.173879	29099010	1434354	2563206	0.173881	29098550	1434337	2563174
1983	0.224094	22131126	1408071	2285409	0.224097	22130671	1408050	2285374	0.224094	22131096	1408070	2285406	0.224097	22130640	1408049	2285372
1984	0.223562	29453591	1321236	2187907	0.223567	29452896	1321211	2187864	0.223563	29453544	1321234	2187904	0.223567	29452849	1321209	2187861
1985	0.229528	22882573	1270356	2016890	0.229533	22881901	1270325	2016841	0.229528	22882527	1270354	2016887	0.229534	22881856	1270323	2016838
1986	0.202073	11529532	1205417	1756716	0.20208	11528988	1205381	1756662	0.202074	11529495	1205415	1756713	0.20208	11528951	1205378	1756658
1987	0.230292	21003876	1150388	1766167	0.230301	21003083	1150342	1766101	0.230292	21003822	1150384	1766162	0.230301	21003029	1150339	1766096
1988	0.218473	9414139	1154698	1671656	0.218484	9413256	1154642	1671572	0.218474	9414079	1154694	1671651	0.218485	9413196	1154638	1671567
1989	0.289382	14219555	1017851	1635787	0.289401	14218246	1017783	1635675	0.289384	14219467	1017847	1635779	0.289402	14218158	1017778	1635667
1990	0.274275	19057155	875410.4	1483346	0.2743	19054737	875329.1	1483205	0.274276	19056993	875404.9	1483337	0.274301	19054574	875323.6	1483195
1991	0.282616	14679230	788409.5	1380685	0.282651	14676344	788309.1	1380496	0.282618	14679032	788402.7	1380672	0.282653	14676146	788302.4	1380483
1992	0.251421	17932210	809945.8	1274590	0.251463	17928274	809806.7	1274371	0.251424	17931945	809936.4	1274575	0.251466	17928008	809797.2	1274356
1993	0.28435	16521728	762902.7	1219629	0.284415	16516385	762727.4	1219348	0.284354	16521379	762890.9	1219610	0.284419	16516035	762715.5	1219329
1994	0.341169	15800551	773069.4	1271050	0.341278	15788856	772823.1	1270568	0.341177	15799692	773052.9	1271016	0.341285	15787995	772806.5	1270534
1995	0.318942	20081061	679844.8	1120911	0.319084	20072150	679497.3	1120377	0.318952	20080471	679820.7	1120874	0.319093	20071558	679473.2	1120340

1996	0.320901	16842346	626540.5	1017447	0.321116	16834606	626136.7	1016878	0.320916	16841963	626512.6	1017409	0.321131	16834222	626108.7	1016841
1997	0.348477	10049377	588136.4	893293.4	0.348798	10043066	587693	892708.2	0.348499	10048960	588107.1	893255.2	0.348819	10042646	587663.6	892669.9
1998	0.363685	15724393	540088.1	867222.4	0.36409	15715888	539580.3	866560.6	0.363712	15723948	540054.9	867180.3	0.364117	15715444	539546.9	866518.5
1999	0.308827	8724032	459795.2	726563.3	0.309195	8712887	459289.1	725837.1	0.308851	8723520	459763.3	726520.4	0.309219	8712373	459257.2	725794
2000	0.41627	16372756	470974.8	844074.7	0.416828	16353319	470290.4	843020.1	0.416303	16371653	470933.4	844012.9	0.416861	16352213	470249	842958.2
2001	0.345911	11726445	427120.8	752696.5	0.346539	11706072	426386.8	751526	0.345945	11725971	427079.9	752640.7	0.346573	11705606	426345.8	751470.2
2002	0.294586	11224354	446227.1	749254.6	0.295224	11200153	445262.5	747766.7	0.294622	11223975	446182.4	749197.6	0.29526	11199775	445217.8	747709.8
2003	0.22517	22562502	517700	877611.7	0.225775	22511535	516361.4	875533.2	0.225199	22561026	517645.9	877537.2	0.225803	22510054	516307.3	875458.7
2004	0.188546	14162085	525969.4	804794.5	0.189144	14125561	524451.2	802647	0.188568	14161209	525917.9	804726.4	0.189166	14124701	524399.8	802579.1
2005	0.169103	9381523	593317.2	856277.8	0.169684	9358809	591386.2	853741.6	0.16912	9380460	593256	856194.4	0.169701	9357742	591325	853658.3
2006	0.183034	16534868	659796	1015256	0.183754	16481979	657544.6	1012029	0.18305	16533319	659721.7	1015150	0.18377	16480430	657470.4	1011923
2007	0.185787	14457857	689863.6	1054000	0.186555	14374197	687218.2	1049834	0.185806	14456656	689790.2	1053897	0.186575	14373005	687145	1049731
2008	0.187623	28194423	703641.4	1274620	0.188426	27944486	700254.2	1267136	0.187648	28191650	703560.9	1274487	0.188451	27941733	700173.9	1267005
2009	0.169972	21372087	808876.9	1314304	0.170842	21062456	803391	1303608	0.169996	21369996	808774.5	1314155	0.170866	21060410	803288.9	1303460
2010	0.197077	15382382	868744	1310104	0.198418	15044265	860410.7	1295302	0.197111	15382657	868631.9	1309972	0.198453	15044542	860299.6	1295172
2011	0.151229	9954930	863526.3	1217855	0.152823	9660220	851788.9	1199246	0.151252	9954077	863418.7	1217724	0.152847	9659382	851682	1199117
2012	0.109924	24392292	923726.7	1461709	0.111265	23427974	909337.9	1427848	0.109937	24392123	923614.4	1461580	0.111279	23427688	909226.4	1427719
2013	0.09823	21540883	1001657	1504699	0.099179	20689350	988272.5	1473717	0.09824	21541931	1001568	1504614	0.09919	20690377	988182.4	1473630
2014	0.134476	16964240	1103797	1570540	0.135226	16346025	1094000	1546437	0.134484	16977190	1103727	1570623	0.135234	16358492	1093929	1546512
2015	0.179492	61114865	1050468	1741588	0.179638	58941336	1046010	1716057	0.179496	61114966	1050563	1741758	0.179642	58940902	1046103	1716218
2016	0.201472	19584250	1036926	1547450	0.200402	19037129	1033107	1531709	0.20145	19603338	1037089	1547808	0.20038	19055482	1033264	1532054



compiled by
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1 HERRING

1.1 Fisheries

The catch statistics for 2017 supplied by the German national state authority (Federal Central for Agriculture and Food, BLE) are only provisional.

In 2017 the total German herring landings from the Western Baltic Sea in **Subdivisions (SD) 22 and 24** amounted to 14,694 t, which represents an increase of 2 % compared to the landings in 2016 (14,427 t). This increase was caused by an increase of the TAC/quota (German quota for SDs 22 and 24 in 2017: 15,670 t + quota-transfer of 1,070 t = 16,740 t). The German quota in 2017 was only used by 88 % (2016: 98 %, 2015: 99 %). The fishing activities in one of the main fishing areas, the Greifswald Bay (SD 24) could not start earlier than in March due to a cold period in February with ice coverage. The main German fishery stopped their activities at the end of April.

Only a small part of the total German landings was taken **in Subdivisions 25-29** (2017: 3,594 t, 2016: 4,340 t). The landings taken in the herring fisheries exceeded the existing TAC/quota (2017: 1,115 t) by means of quota transfer (+ 2,505 t) with other countries around the Baltic Sea. The consequent total quota of 3,620 t was finally used by 99 %. All landings in this area were taken by the trawl fishery. Almost all herring was landed in foreign ports (2017: 99.6 %).

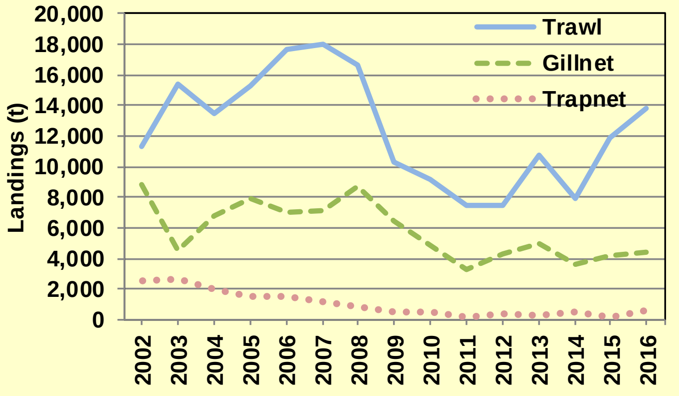
The landings (t) by quarter and Subdivision (SD) including information about the landings in foreign ports are shown in the table below:

Quarter	SD 22	SD 24	SD 25	SD 26	SD 27	SD 28.2	SD 29	(1) Total SD 25-29	% (1)/(2)	(2) Total SD 22-29	% (2)
I	191.624	10,540.877	84.466	1,030.858	-	724.773	235.363	2,075.460	16.2%	**12,807.961**	70.0%
	54.250	346.809	84.466	1,030.858	-	724.773	235.363	2,075.460	83.8%	2,476.519	60.2%
II	37.970	1,965.704	204.658	800.231	-	-	-	1,004.889	33.4%	**3,008.563**	16.5%
	6.500	119.868	192.008	800.231	-	-	-	992.239	88.7%	1,118.607	27.2%
III	1.001	1.326	-	-	-	-	-	0.000		**2.327**	0.0%
	0.000	0.040	-	-	-	-	-	0.000		0.040	0.0%
IV	77.579	1,878.350	-	-	-	-	513.914	513.914	20.8%	**2,469.843**	13.5%
	1.075	5.242	-	-	-	-	513.914	513.914	98.8%	520.231	12.6%
Total	**308.174**	**14,386.257**	**289.124**	**1,831.089**	**0.000**	**724.773**	**749.277**	**3,594.263**	**19.7%**	**18,288.694**	**100.0%**
	61.825	471.959	276.474	1,831.089	0.000	724.773	749.277	3,581.613	87.0%	4,115.397	100.0%

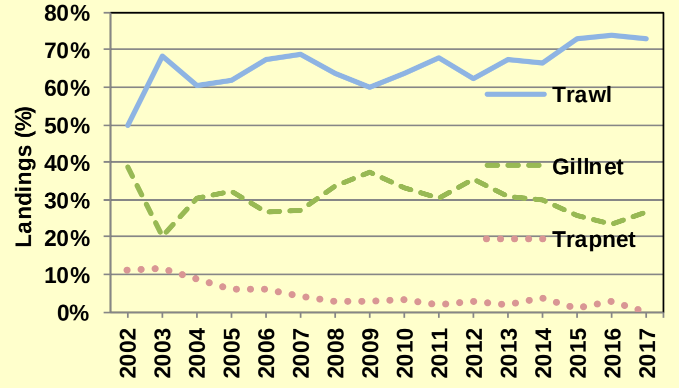
= Fraction of total landings (t) in foreign ports	99.6%	22.5%
	2017/2016:	**2017/2016:**
= Fraction of total landings (t)	82.8%	97.5%
= Fraction of total landings (t) in foreign ports	82.5%	89.7%

The main fishing season was during spring time as in former years. About 85 % of all herring (SDs 22-29) was caught between January and April (2016: 87 %). The majority of the German herring landings (78 %) were taken in Subdivision 24 (2016: 76 %). The German herring fishery in the Baltic Sea is conducted with gillnets, trapnets and trawls. Almost all landings in the area of the Central Baltic Sea are taken by the trawl fishery. Discards (also since 2015: BMS/logbook registered landings) have never been reported. Until 2000 the dominant part of herring was caught in the passive fishery by gillnets and trapnets. Since 2001 the activities in the trawl fishery increased. The total amount of herring, which was caught by trawls, reached 73 % in 2017 (2016: 74 %). The significant change in fishing pattern was caused by the perspective of a new fish factory on the Island of Rügen, which finally started the production in autumn 2003. This factory can process up to 50,000 t fish per year.

Landings in Subdivisions 22-29 (t)				
Year/Gear	Trawl	Gillnet	Trapnet	Total
2002	11,317.813	8,783.392	2,559.662	22,660.867
2003	15,433.154	4,545.312	2,658.148	22,636.614
2004	13,429.394	6,796.747	2,016.542	22,242.683
2005	15,277.320	7,924.007	1,551.530	24,752.857
2006	17,604.485	6,959.530	1,539.467	26,103.482
2007	18,044.233	7,077.135	1,133.806	26,255.174
2008	16,640.802	8,760.611	789.005	26,190.418
2009	10,305.056	6,403.312	523.998	17,232.366
2010	9,216.880	4,804.818	452.182	14,473.880
2011	7,424.844	3,301.890	189.673	10,916.407
2012	7,491.038	4,252.694	322.308	12,066.040
2013	10,768.220	4,933.173	304.427	16,005.820
2014	7,959.719	3,562.980	449.724	11,972.423
2015	11,839.151	4,183.129	183.533	16,205.813
2016	13,834.307	4,362.550	569.558	18,766.415
2017	13,370.750	4,898.840	19.104	18,288.694



Landings in Subdivisions 22-29 (% t)				
Year/Gear	Trawl	Gillnet	Trapnet	Total
2002	50%	39%	11%	100%
2003	68%	20%	12%	100%
2004	60%	31%	9%	100%
2005	62%	32%	6%	100%
2006	67%	27%	6%	100%
2007	69%	27%	4%	100%
2008	64%	33%	3%	100%
2009	60%	37%	3%	100%
2010	64%	33%	3%	100%
2011	68%	30%	2%	100%
2012	62%	35%	3%	100%
2013	67%	31%	2%	100%
2014	66%	30%	4%	100%
2015	73%	26%	1%	100%
2016	74%	23%	3%	100%
2017	73%	27%	0%	100%



1.2 Fishing fleet

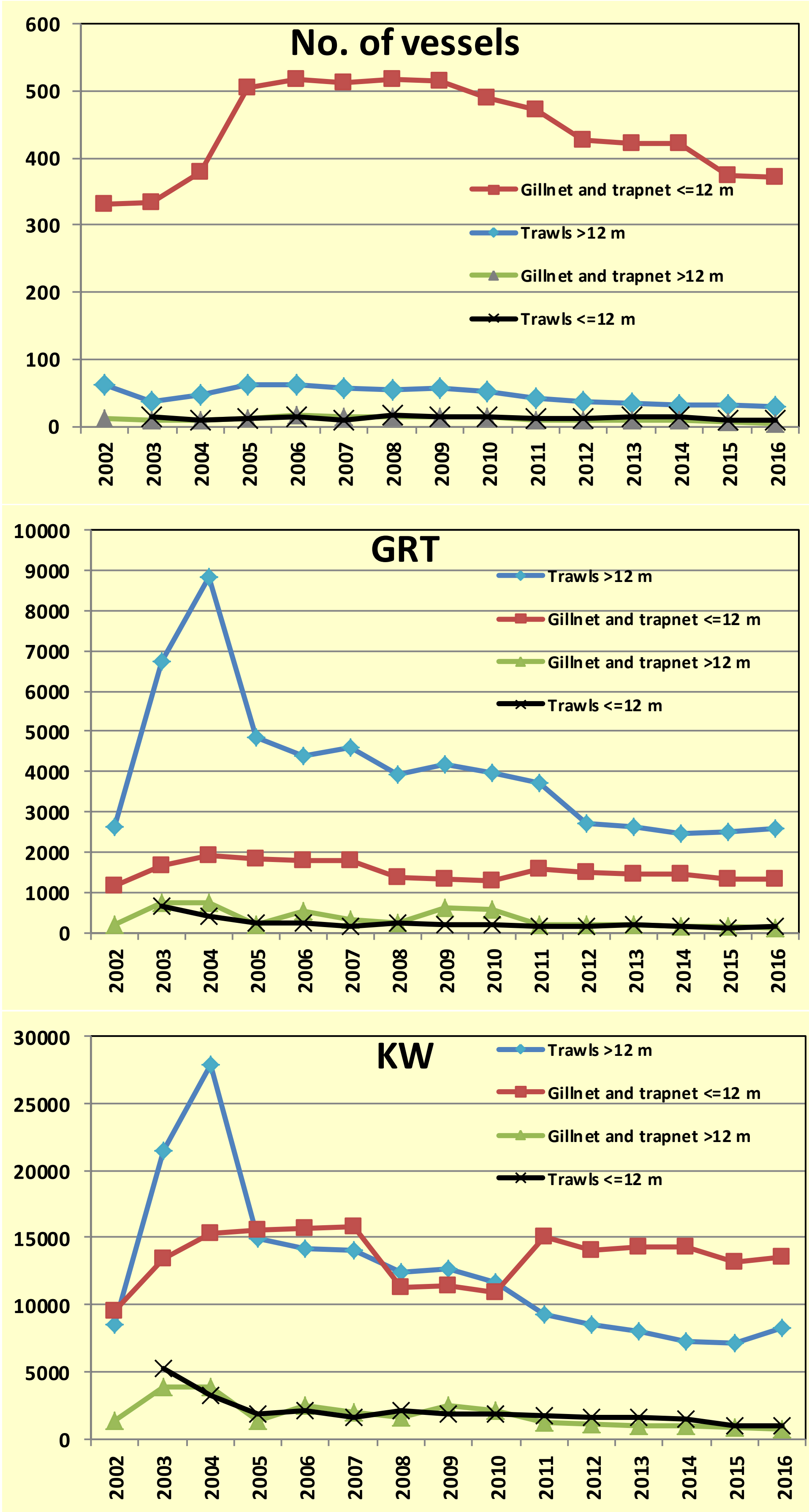
The herring fishing fleet in the Baltic Sea, where all catches are taken in a directed fishery, consists of a:

- coastal fleet with undecked vessels (rowing/motor boats <=12 m and engine power <=100 HP)
- cutter fleet with decked vessels and total lengths between 12 m and 40 m.

In the years from 2009 until 2016 (no update available for 2017) the following types of fishing vessels carried out the herring fishery in the Baltic (only referring to vessels, which are contributing to the overall total landings per year with more than 20 %):

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2009	Fixed gears (gillnet and trapnet)	<=12	515	1,344	11,382
		>12	14	602	2,443
	Trawls	<=12	13	205	1,849
		>12	56	4,172	12,623
	TOTAL		**598**	**6,323**	**28,297**
2010	Fixed gears (gillnet and trapnet)	<=12	491	1,280	10,884
		>12	13	551	2,121
	Trawls	<=12	14	193	1,830
		>12	53	3,988	11,708
	TOTAL		**571**	**6,012**	**26,543**
2011	Fixed gears (gillnet and trapnet)	<=12	473	1,566	15,020
		>12	10	185	1,215
	Trawls	<=12	12	171	1,666
		>12	43	3,710	9,325
	TOTAL		**538**	**5,632**	**27,226**
2012	Fixed gears (gillnet and trapnet)	<=12	426	1,485	14,105
		>12	9	184	1,125
	Trawls	<=12	12	170	1,573
		>12	38	2,712	8,480
	TOTAL		**485**	**4,551**	**25,283**
2013	Fixed gears (gillnet and trapnet)	<=12	421	1,459	14,289
		>12	9	186	1,005
	Trawls	<=12	14	173	1,557
		>12	35	2,638	7,960
	TOTAL		**479**	**4,456**	**24,811**
2014	Fixed gears (gillnet and trapnet)	<=12	421	1,443	14,351
		>12	8	149	970
	Trawls	<=12	13	170	1,502
		>12	31	2,469	7,205
	TOTAL		**473**	**4,231**	**24,028**
2015	Fixed gears (gillnet and trapnet)	<=12	375	1,341	13,163
		>12	7	133	802
	Trawls	<=12	9	122	991
		>12	31	2,503	7,148
	TOTAL		**422**	**4,099**	**22,104**
2016	Fixed gears (gillnet and trapnet)	<=12	371	1,341	13,532
		>12	5	103	699
	Trawls	<=12	8	137	997
		>12	30	2,599	8,205
	TOTAL		**414**	**4,180**	**23,433**

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2017	Fixed gears (gillnet and trapnet)	<=12	No update		
		>12			
	Trawls	<=12			
		>12			
	TOTAL				


No. of vessels
600
500
400
300
200
100
0
Gillnet and trapnet <=12 m
Trawls >12 m
Gillnet and trapnet >12 m
Trawls <=12 m
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
GRT
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Trawls >12 m
Gillnet and trapnet <=12 m
Gillnet and trapnet >12 m
Trawls <=12 m
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
KW
30000
25000
20000
15000
10000
5000
0
Trawls >12 m
Gillnet and trapnet <=12 m
Gillnet and trapnet >12 m
Trawls <=12 m
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

1.3 Species composition of landings

The catch composition from gillnet and trapnet consists of nearly 100 % of herring.
The results from the species composition of German trawl catches, which were sampled in **Subdivision 22** of quarter 1 in 2017, are given below:

SD 22/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
January	1	42.5	1.0	0.0	0.1	43.6	97.5	2.3	0.0	0.2
	2									
	3									
	Mean	42.5	1.0	0.0	0.1	43.6	97.5	2.3	0.0	0.2
February	1									
	2									
	3									
	Mean									
March	1									
	2									
	3									
	Mean									
Q I	Mean									

The results from the species composition of German trawl catches, which were sampled in **Subdivision 24** of quarter 1, 2 and 4 in 2017, are given below:

SD 24/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
January	1	58.3	0.1	0.0	0.0	58.4	99.8	0.2	0.0	0.0
	2	52.8	0.1	0.3	0.2	53.3	99.0	0.1	0.6	0.3
	3									
	Mean	55.6	0.1	0.2	0.1	55.9	99.4	0.1	0.3	0.1
February	1	79.8	0.0	0.0	0.0	79.8	100.0	0.0	0.0	0.0
	2	61.3	0.0	0.0	0.0	61.3	100.0	0.0	0.0	0.0
	3									
	Mean	70.5	0.0	0.0	0.0	70.5	100.0	0.0	0.0	0.0
March	1	78.4	1.1	0.0	0.0	79.6	98.6	1.4	0.0	0.0
	2	104.5	0.4	0.0	0.0	104.9	99.6	0.4	0.0	0.0
	3									
	Mean	91.5	0.8	0.0	0.0	92.2	99.1	0.9	0.0	0.0
Q I	Mean	72.5	0.3	0.1	0.0	72.9	99.5	0.3	0.1	0.0

SD 24/Quarter II		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
April	1	64.8	0.9	0.0	0.0	65.7	98.6	1.4	0.0	0.0
	2									
	3									
	Mean	64.8	0.9	0.0	0.0	65.7	98.6	1.4	0.0	0.0
May	1									
	2									
	3									
	Mean									
June	1									
	2									
	3									
	Mean									
Q II	Mean	64.8	0.9	0.0	0.0	65.7	98.6	1.4	0.0	0.0

SD 24/Quarter IV		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
Octob.	1									
	2									
	3									
	Mean									
Novemb.	1	66.3	0.0	0.0	0.0	66.3	100.0	0.0	0.0	0.0
	2	70.5	0.0	0.0	0.0	70.5	100.0	0.0	0.0	0.0
	3									
	Mean	68.4	0.0	0.0	0.0	68.4	100.0	0.0	0.0	0.0
Decemb.	1	50.6	0.0	0.0	0.0	50.6	100.0	0.0	0.0	0.0
	2									
	3									
	Mean	50.6	0.0	0.0	0.0	50.6	100.0	0.0	0.0	0.0
Q IV	Mean	59.5	0.0	0.0	0.0	59.5	100.0	0.0	0.0	0.0

The officially reported total trawl landings of herring in Subdivision 24 (see chapter 2.1) in combination with the detected mean species composition in the samples (see above) results in the following differences:

Subdiv.	Quarter	Trawl landings (t)	Mean Contribution of Herring (%)	Total Herring corrected (t)	Difference (t)
22	I	**145**	97.5	142	-4
24	I	**6,873**	99.5	6,838	-34
	II	**846**	98.6	834	-12
	IV	**1,867**	100.0	1,867	0

The officially reported trawl landings in Subdivision 22 and 24 (see 2.1) and the referring assessment input data (see 2.2 and 2.3) were as in last years not corrected since the results would only result in overall small changes of the official statistics (total trawl landings in Subdivision 22 and 24 of 9,776 t – 50 t -> 1 % difference).

1.4 Logbook registered discards/BMS landings

No logbook registered discards or BMS landings (both new catch categories since 2015) of herring have been reported in the German herring fisheries in 2017 (no BMS landing have been reported in 2015 - 2016 and no discards have been reported before 2016).

1.5 Central Baltic herring

In the western Baltic, the distribution areas of two stocks, the Western Baltic Spring Spawning herring (WBSSH) and the Central Baltic herring (CBH) overlap. German autumn acoustic survey (GERAS) results indicated in the recent years that in SD 24, which is part of the WBSSH management area, a considerable fraction of CBH is present and correspondingly erroneously allocated to WBSSH stock indices (ICES, 2013). Accordingly, a stock separation function (SF) based on growth parameters in 2005 to 2010 has been developed to quantify the proportion of CBH and WBSSH in the area (Gröhsler et al., 2013, Gröhsler et al., 2016). The estimates of the growth parameters based on baseline samples of WBSSH and CBH support the applicability of SF in 2011-2017 (Oeberst et al., 2013, WD Oeberst et al., 2014, WD Oeberst et al., 2015; WD Oeberst et al., 2016; WD Oeberst et al., 2017; WD Gröhsler, T. and Schaber, M., 2018). SF (slightly modified by commercial samples) was employed in the years 2005-2011 to identify the fraction of Central Baltic Herring in German commercial herring landings from SD 22 and 24 (WD Gröhsler et al., 2013). Results showed a rather low share of CBH in landings from all métiers but indicated that the actual degree of mixing might be underrepresented in commercial landings as German commercial fisheries target pre-spawning and spawning aggregations of WBSSH.

1.6 References

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1.7 Landings (tons) and sampling effort

1.7.1 Subdivisions 22 and 24

Gear	Quarter	SUBDIVISION 22				SUBDIVISION 24				TOTAL SUBDIVISIONS 22 & 24			
		Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	145.468	1	426	113	6,872.757	6	3,027	675	7,018.225	7	3,453	788
	Q 2	13.103	0	0	0	845.949	1	690	109	859.052	1	690	109
	Q 3	0.000	0	-	-	0.000	0	-	-	no landings	0	0	0
	Q 4	32.118	0	0	0	1,867.092	3	1,552	334	1,899.210	3	1,552	334
	Total	190.689	1	426	113	9,585.798	10	5,269	1,118	9,776.487	11	5,695	1,231
GILLNET	Q 1	46.152	3	1,163	203	3,649.020	6	2,206	368	3,695.172	9	3,369	571
	Q 2	24.867	2	808	125	1,119.755	4	1,491	273	1,144.622	6	2,299	398
	Q 3	1.001	0	0	0	1.326	0	0	0	2.327	0	0	0
	Q 4	45.461	0	0	0	11.258	1	332	56	56.719	1	332	56
	Total	117.481	5	1,971	328	4,781.359	11	4,029	697	4,898.840	16	6,000	1,025
TRAPNET	Q 1	0.004	1	467	95	19.100	1	386	86	19.104	2	853	181
	Q 2	0.000	-	-	-	0.000	-	-	-	no landings	0	0	0
	Q 3	0.000	-	-	-	0.000	-	-	-	no landings	0	0	0
	Q 4	0.000	-	-	-	0.000	-	-	-	no landings	0	0	0
	Total	0.004	1	467	95	19.100	1	386	86	19.104	2	853	181
TOTAL	Q 1	191.624	5	2,056	411	10,540.877	13	5,619	1,129	10,732.501	18	7,675	1,540
	Q 2	37.970	2	808	125	1,965.704	5	2,181	382	2,003.674	7	2,989	507
	Q 3	1.001	0	0	0	1.326	0	0	0	2.327	0	0	0
	Q 4	77.579	0	0	0	1,878.350	4	1,884	390	1,955.929	4	1,884	390
	Total	308.174	7	2,864	536	14,386.257	22	9,684	1,901	14,694.431	29	12,548	2,437

1.7.2 Subdivisions 25-29

All herring was caught in this area by trawls. ***No samples could be taken since all herring was landed in foreign ports*.**

Gear	Quarter	SUBDIVISION 25				SUBDIVISION 26				SUBDIVISION 27			
		Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	84.466	0	0	0	1,030.858	0	0	0	0.000			
	Q 2	204.658	0	0	0	800.231	0	0	0	0.000			
	Q 3	0.000				0.000				0.000			
	Q 4	0.000				0.000				0.000			
	Total	289.124	0	0	0	1,831.089	0	0	0	0.000	0	0	0

Gear	Quarter	SUBDIVISION 28.2				SUBDIVISION 29				SUBDIVISION 25-29			
		Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	724.773	0	0	0	235.363	0	0	0	2,075.460	0	0	0
	Q 2	0.000				0.000				1,004.889	0	0	0
	Q 3	0.000				0.000				0.000	0	0	0
	Q 4	0.000				513.914	0	0	0	513.914	0	0	0
	Total	724.773	0	0	0	749.277	0	0	0	3,594.263	0	0	0

1.8 Catch in numbers (millions)

1.8.1 Subdivisions 22 and 24

Gear	W-rings	SUBDIVISION 22 Q1	SUBDIVISION 22 Q2	SUBDIVISION 22 Q3	SUBDIVISION 22 Q4	SUBDIVISION 24 Q1	SUBDIVISION 24 Q2	SUBDIVISION 24 Q3	SUBDIVISION 24 Q4	SUBDIVISIONS 22+24 Q1	SUBDIVISIONS 22+24 Q2	SUBDIVISIONS 22+24 Q3	SUBDIVISIONS 22+24 Q4
TRAWL	0				0.0002				0.010				0.010
	1	0.010	0.001		0.005	0.200	0.052		0.297	0.210	0.053		0.302
	2	0.020	0.006		0.067	0.699	0.400		3.882	0.719	0.406		3.949
	3	0.486	0.024		0.059	6.569	1.562		3.409	7.055	1.586		3.468
	4	0.407	0.077		0.093	25.625	4.965		5.414	26.032	5.042		5.507
	5	0.292	0.022		0.024	11.041	1.389		1.376	11.333	1.411		1.400
	6	0.189	0.008		0.014	6.653	0.494		0.787	6.842	0.501		0.800
	7	0.029	0.000		0.004	2.295	0.026		0.208	2.324	0.027		0.212
	8+	0.025	0.002		0.001	1.835	0.123		0.078	1.860	0.125		0.080
	Sum	1.459	0.140		0.266	54.917	9.011		15.462	56.376	9.150		15.728
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GILLNET	0												
	1												
	2												
	3	0.007	0.0036	0.000	0.007	0.035	0.029	0.000	0.002	0.042	0.033	0.000	0.009
	4	0.081	0.015	0.001	0.063	4.496	1.301	0.002	0.016	4.576	1.315	0.002	0.078
	5	0.044	0.087	0.004	0.089	4.403	0.885	0.001	0.022	4.447	0.972	0.005	0.111
	6	0.093	0.039	0.002	0.041	5.700	1.685	0.002	0.010	5.792	1.724	0.004	0.051
	7	0.034	0.011	0.000	0.039	4.350	1.426	0.002	0.010	4.384	1.437	0.002	0.049
	8+	0.030	0.006	0.000		1.848	1.472	0.002		1.878	1.477	0.002	
	Sum	0.288	0.161	0.006	0.239	20.832	6.798	0.008	0.059	21.119	6.959	0.015	0.298
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAPNET	0												
	1												
	2	0.000001				0.0004				0.0004			
	3	0.000027				0.0113				0.0113			
	4	0.000017				0.1168				0.1168			
	5	0.000004				0.0193				0.0193			
	6	0.000003				0.0094				0.0094			
	7					0.0045				0.0045			
	8+					0.0004				0.0004			
	Sum	0.000052				0.1620				0.1621			
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TOTAL	0				0.0002				0.010				0.010
	1	0.010	0.001		0.0051	0.200	0.052		0.297	0.210	0.053		0.302
	2	0.0199	0.006		0.0668	0.700	0.400		3.882	0.720	0.406		3.949
	3	0.493	0.028	0.000	0.0659	6.615	1.591	0.000	3.411	7.108	1.619	0.000	3.477
	4	0.488	0.092	0.001	0.1560	30.237	6.266	0.002	5.429	30.725	6.357	0.002	5.585
	5	0.336	0.109	0.004	0.1127	15.463	2.275	0.001	1.398	15.799	2.383	0.005	1.511
	6	0.282	0.047	0.002	0.0543	12.362	2.179	0.002	0.797	12.644	2.226	0.004	0.851
	7	0.063	0.011	0.000	0.0429	6.650	1.452	0.002	0.218	6.712	1.464	0.002	0.261
	8+	0.055	0.007	0.000	0.0013	3.684	1.595	0.002	0.078	3.739	1.602	0.002	0.080
	Sum	1.746	0.301	0.006	0.5052	75.911	15.809	0.008	15.521	77.657	16.109	0.015	16.026

REPLACEMENT OF MISSING SAMPLES:

SUBDIVISION 22					SUBDIVISION 24				
Missing		Replacement by			Missing		Replacement by		
Gear	Quart.	Area	Gear	Quart.	Gear	Quart.	Area	Gear	Quart.
Trawl	2	24	Trawl	2	Gillnet	3	24	Gillnet	2
Trawl	4	24	Trawl	4					
Gillnet	3	22	Gillnet	2					
Gillnet	4	24	Gillnet	4					

1.8.2 Subdivisions 25-29

No sampling.

1.9 Mean weight in the catch (grams)

1.9.1 Subdivisions 22 and 24

Gear	W-rings	SUBDIVISION 22 Q1	Q2	Q3	Q4	SUBDIVISION 24 Q1	Q2	Q3	Q4	SUBDIVISIONS 22+24 Q1	Q2	Q3	Q4
TRAWL	0				14.0				14.0				14.0
	1	27.6	16.3		45.8	16.4	16.3		45.8	17.0	16.3		45.8
	2	43.9	52.6		84.7	47.0	52.6		84.7	46.9	52.6		84.7
	3	78.1	79.1		119.2	85.9	79.1		119.2	85.4	79.1		119.2
	4	90.4	95.5		137.5	119.5	95.5		137.5	119.1	95.5		137.5
	5	115.5	107.1		142.8	133.2	107.1		142.8	132.8	107.1		142.8
	6	139.5	108.5		158.1	151.9	108.5		158.1	151.6	108.5		158.1
	7	169.1	154.2		183.7	171.6	154.2		183.7	171.6	154.2		183.7
	8+	178.9	161.0		191.6	182.0	161.0		191.6	181.9	161.0		191.6
	Sum	99.7	93.9		120.8	125.1	93.9		120.8	124.5	93.9		120.8
GILLNET	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	0												
	1												
	2												
	3	138.8	126.8	126.8	159.5	141.1	107.7	107.7	159.5	140.7	109.9	123.2	159.5
	4	147.9	140.6	140.6	180.3	158.8	145.8	145.8	180.3	158.6	145.8	144.4	180.3
	5	157.8	153.5	153.5	190.4	170.0	156.8	156.8	190.4	169.9	156.5	154.2	190.4
	6	163.2	155.9	155.9	199.6	176.7	166.1	166.1	199.6	176.4	165.8	161.6	199.6
	7	170.2	173.1	173.1	200.5	187.2	170.5	170.5	200.5	187.1	170.5	171.0	200.5
	8+	183.8	176.2	176.2		194.7	180.2	180.2		194.5	180.2	179.7	
	Sum	160.5	154.4	154.4	190.0	175.2	164.7	164.7	190.0	175.0	164.5	160.1	190.0
TRAPNET	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	0												
	1												
	2	35.7				59.5				59.5			
	3	63.0				80.7				80.7			
	4	83.5				118.6				118.6			
	5	103.2				113.9				113.9			
	6	109.2				137.8				137.8			
	7					166.7				166.7			
	8+					176.2				176.2			
	Sum	74.9				117.9				117.9			
TOTAL	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	0				14.0				14.0				14.0
	1	27.6	16.3		45.8	16.4	16.3		45.8	17.0	16.3		45.8
	2	43.9	52.6		84.7	47.0	52.6		84.7	46.9	52.6		84.7
	3	78.9	85.3	126.8	123.6	86.2	79.6	107.7	119.2	85.7	79.7	123.2	119.3
	4	99.9	102.8	140.6	154.7	125.4	106.0	145.8	137.6	125.0	105.9	144.4	138.1
	5	121.1	144.3	153.5	180.4	143.7	126.4	156.8	143.5	143.2	127.2	154.2	146.3
	6	147.3	148.2	155.9	189.2	163.3	153.0	166.1	158.6	163.0	152.9	161.6	160.6
	7	169.7	172.4	173.1	199.1	181.8	170.2	170.5	184.4	181.7	170.2	171.0	186.9
	8+	181.6	172.3	176.2	191.6	188.4	178.7	180.2	191.6	188.3	178.7	179.7	191.6
	Sum	109.7	126.3	154.4	153.6	138.9	124.3	164.7	121.0	138.2	124.4	160.1	122.0

REPLACEMENT OF MISSING SAMPLES:

SUBDIVISION 22					SUBDIVISION 24				
Missing		Replacement by			Missing		Replacement by		
Gear	Quart.	Area	Gear	Quart.	Gear	Quart.	Area	Gear	Quart.
Trawl	2	24	Trawl	2	Gillnet	3	24	Gillnet	2
Trawl	4	24	Trawl	4					
Gillnet	3	22	Gillnet	2					
Gillnet	4	24	Gillnet	4					

1.9.2 Subdivisions 25 and 29

No sampling.

1.10 Mean length in the catch (cm)

1.10.1 Subdivisions 22 and 24

Gear	W-rings	SUBDIVISION 22 Q1	Q2	Q3	Q4	SUBDIVISION 24 Q1	Q2	Q3	Q4	SUBDIVISIONS 22+24 Q1	Q2	Q3	Q4
TRAWL	0				13.3				13.3				13.3
	1	16.9	14.1		19.2	14.1	14.1		19.2	14.2	14.1		19.2
	2	19.0	20.2		22.9	19.6	20.2		22.9	19.6	20.2		22.9
	3	22.4	22.6		25.1	23.1	22.6		25.1	23.0	22.6		25.1
	4	23.3	24.0		26.2	25.3	24.0		26.2	25.3	24.0		26.2
	5	25.2	24.9		26.4	26.1	24.9		26.4	26.1	24.9		26.4
	6	26.7	25.0		27.3	27.2	25.0		27.3	27.2	25.0		27.3
	7	28.4	28.3		29.1	28.4	28.3		29.1	28.4	28.3		29.1
	8+	29.6	28.8		29.3	29.0	28.8		29.3	29.1	28.8		29.3
	Sum	23.9	23.8		25.1	25.6	23.8		25.1	25.5	23.8		25.1
GILLNET	0												
	1												
	2												
	3	26.0	25.2	25.2	27.1	25.9	24.3	24.3	27.1	25.9	24.4	25.0	27.1
	4	26.7	26.1	26.1	28.4	27.4	26.9	26.9	28.4	27.4	26.9	26.7	28.4
	5	27.4	27.1	27.1	29.0	28.3	27.7	27.7	29.0	28.3	27.7	27.3	29.0
	6	27.8	27.4	27.4	29.6	28.8	28.4	28.4	29.6	28.7	28.4	27.9	29.6
	7	28.3	29.0	29.0	29.7	29.5	28.8	28.8	29.7	29.5	28.8	28.8	29.7
	8+	29.4	29.5	29.5		30.0	29.5	29.5		30.0	29.5	29.5	
	Sum	27.6	27.3	27.3	29.0	28.6	28.3	28.3	29.0	28.6	28.3	27.9	29.0
TRAPNET	0												
	1												
	2	19.1				20.8				20.7			
	3	21.4				23.0				23.0			
	4	23.2				25.9				25.9			
	5	25.0				25.5				25.5			
	6	25.9				27.5				27.5			
	7	28.0				29.1				29.1			
	8+	27.6				30.3				30.3			
	Sum	22.6				25.8				25.8			
TOTAL	0				13.3				13.3				13.3
	1	16.9	14.1		19.2	14.1	14.1		19.2	14.2	14.1		19.2
	2	19.0	20.2		22.9	19.6	20.2		22.9	19.6	20.2		22.9
	3	22.5	22.8	25.2	25.3	23.1	22.6	24.3	25.1	23.0	22.6	25.0	25.1
	4	23.9	24.4	26.1	27.1	25.6	24.6	26.9	26.2	25.6	24.6	26.7	26.3
	5	25.4	27.2	27.1	28.5	26.7	26.0	27.7	26.5	26.7	26.0	27.3	26.6
	6	27.0	27.8	27.4	29.1	27.9	27.6	28.4	27.3	27.9	27.6	27.9	27.4
	7	28.3	28.7	29.0	29.6	29.1	28.7	28.8	29.1	29.1	28.7	28.8	29.2
	8+	29.5	29.3	29.5	29.3	29.5	29.5	29.5	29.3	29.5	29.5	29.5	29.3
	Sum	24.5	26.2	27.3	27.0	26.4	25.7	28.3	25.1	26.4	25.7	27.9	25.2

REPLACEMENT OF MISSING SAMPLES:

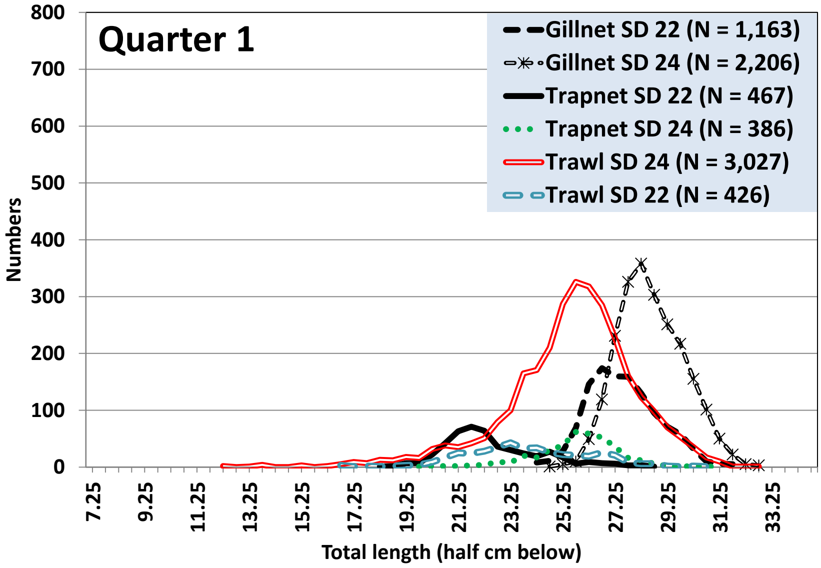
SUBDIVISION 22 Missing Gear	Quart.	Replacement by Area	Gear	Quart.	SUBDIVISION 24 Missing Gear	Quart.	Replacement by Area	Gear	Quart.
Trawl	2	24	Trawl	2	Gillnet	3	24	Gillnet	2
Trawl	4	24	Trawl	4					
Gillnet	3	22	Gillnet	2					
Gillnet	4	24	Gillnet	4					

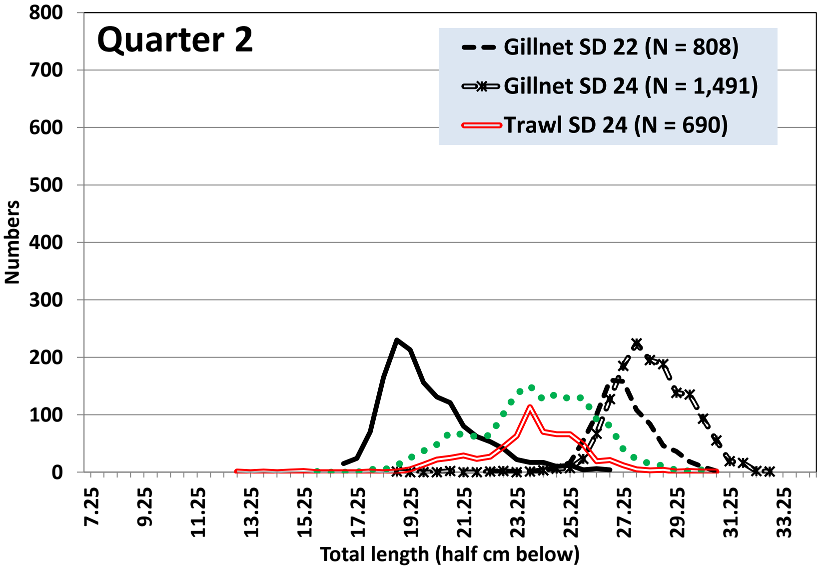
1.10.2 Subdivisions 25 and 29

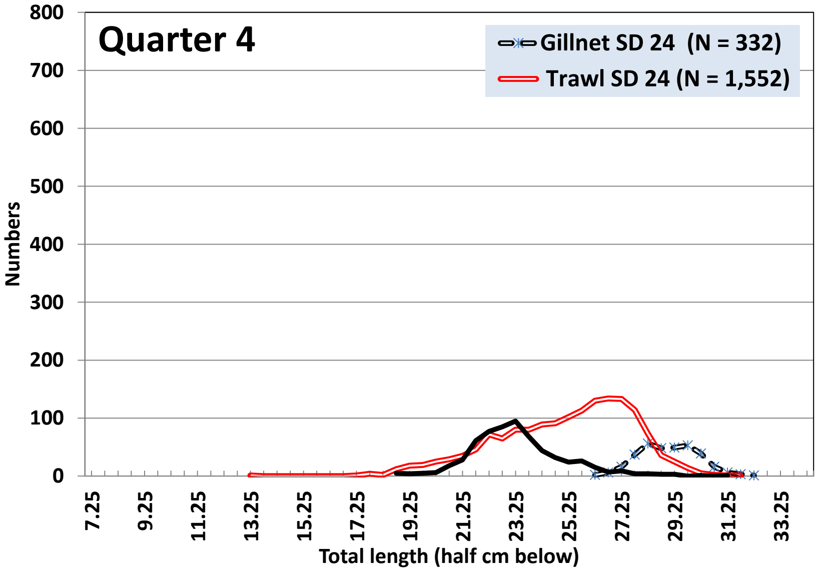
No sampling.

1.11 Sampled length distributions by Subdivision, quarter and type of gear

1.11.1 Subdivisions 22 and 24







1.11.2 Subdivisions 25 and 29

No sampling.

2 SPRAT

2.1 Fisheries

The catch statistics for 2017 supplied by the German national state authority (Federal Central for Agriculture and Food, BLE) are only provisional.

The sprat landings in Subdivisions 22-29 in 2017 reached according to the

(a) share of the EU quota (2017: 16,310 t) and

(b) further transfer of quota (overall 1,816 t were transferred to other Baltic countries)

13,553 t, which represents a final utilization of the overall 2017 quota of 14,495 t of 93.5 % (2016: 10,907 t = 99.5 % of total quota of 10,966 t (12,644 t – quota transfer of 1,678 t)).

As in previous years most sprat was

- landed in foreign ports (2017: 86 %, 2016: 96 %)
- caught in the first quarter (2017: 54 %, 2016: 82 %),
- caught in Subdivisions 25-29 (2017: 94 %, 2016: 96 %). These catches in 2017 were mostly landed in foreign ports (2017: 91 %, 2010-2016: 100%).

The landings (t) by quarter and Subdivision including information about the landings in foreign ports are shown in the table below:

Quarter	SD 22	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	(1) Total SD 25-29	% (1)/(2)	(2) Total SD 22-29	% (2)
I	394.415	98.030	210.587	3,862.051	0.000	2,230.731	505.912	6,809.281	93.3%	7,301.726	53.9%
	49.250	-	166.784	3,862.051	0.000	2,230.731	505.912	6,765.478	99.3%	6,814.728	58.4%
II	35.500	61.992	835.321	3,431.362	-	-	-	4,266.683	97.8%	4,364.175	32.2%
	5.250	0.000	502.069	3,431.362	-	-	-	3,933.431	99.9%	3,938.681	33.8%
III	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
IV	257.766	5.123	-	-	-	95.147	1,528.803	1,623.950	86.1%	1,886.839	13.9%
	25.500	0.000	-	-	-	0.000	889.534	889.534	97.2%	915.034	7.8%
Total	**687.681**	**165.145**	**1,045.908**	**7,293.413**	**0.000**	**2,325.878**	**2,034.715**	**12,699.914**	**93.7%**	**13,552.740**	100.0%
	80.000	0.000	668.853	7,293.413	0.000	2,230.731	1,395.446	11,588.443	99.3%	11,668.443	86.1%

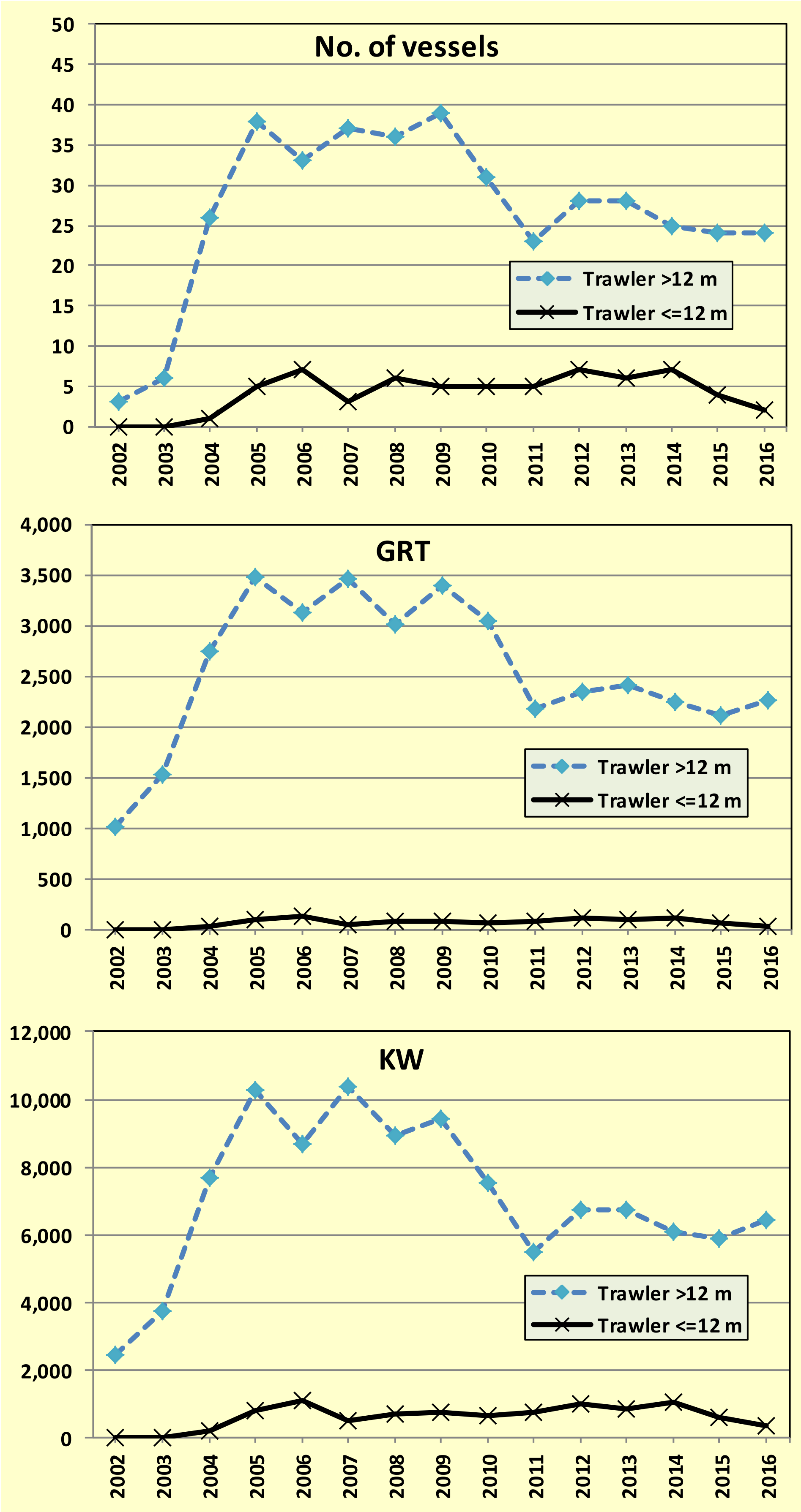
2.2 Fishing fleet

The German fishing fleet in the Baltic Sea consists of only one fleet where all catches for sprat are taken in a directed trawl fishery:

- cutter fleet of total length <= 12 m
- cutter fleet of total length > 12 m

In the years 2010 – 2016 (no update available for 2017) the following type of fishing vessels were available to carry out the sprat fishery in the Baltic Sea (only referring to vessels, which are contributing to the overall total landings per year with more than 20 %):

Year	Vessel length (m)	No. of vessels	GRT	kW
2010	<=12	5	69	664
	>12	31	3,041	7,525
2011	<=12	5	74	756
	>12	23	2,174	5,494
2012	<=12	7	107	1.007
	>12	28	2.345	6.727
2013	<=12	6	94	868
	>12	28	2,411	6,728
2014	<=12	7	112	1,019
	>12	25	2,241	6,070
2015	<=12	4	69	596
	>12	24	2,119	5,892
2016	<=12	2	37	345
	>12	24	2,254	6,424
2017	<=12	no update		
	>12			


No. of vessels
50
45
40
35
30
25
20
15
10
5
0
Trawler >12 m
Trawler <=12 m
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
GRT
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Trawler >12 m
Trawler <=12 m
KW
12,000
10,000
8,000
6,000
4,000
2,000
0
Trawler >12 m
Trawler <=12 m

2.3 Species composition of landings

The results from the species composition of German trawl catches, which were sampled in **Subdivision 25 of quarter 1** in 2017, are given below:

SD 25/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January										
	Mean									
February	1	7.4	0.7	0.0	0.0	8.1	91.7	8.3	0.0	0.0
	2	5.6	1.2	0.0	0.0	6.8	82.7	17.3	0.0	0.0
	Mean	6.5	0.9	0.0	0.0	7.4	87.2	12.8	0.0	0.0
March										
	Mean									
Q I	Mean	6.5	0.9	0.0	0.0	7.4	87.2	12.8	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 26 of quarter 1 and quarter 21** in 2017, are given below:

SD 26/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January	1	7.5	0.6	0.0	0.0	8.1	93.0	7.0	0.0	0.0
	Mean	7.5	0.6	0.0	0.0	8.1	93.0	7.0	0.0	0.0
February	2	5.8	1.2	0.0	0.0	7.0	82.7	17.3	0.0	0.0
	Mean	5.8	1.2	0.0	0.0	7.0	82.7	17.3	0.0	0.0
March		6.6	0.0	0.0	0.0	6.6	99.4	0.6	0.0	0.0
	Mean	6.6	0.0	0.0	0.0	6.6	99.4	0.6	0.0	0.0
Q I	Mean	6.6	0.6	0.0	0.0	7.2	91.7	8.3	0.0	0.0

SD 26/Quarter II		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
April	1	7.5	0.0	0.0	0.0	7.5	100.0	0.0	0.0	0.0
	2	7.0	0.0	0.0	0.0	7.0	99.9	0.1	0.0	0.0
	Mean	7.3	0.0	0.0	0.0	7.3	100.0	0.0	0.0	0.0
May										
	Mean									
June										
	Mean									
Q II	Mean	7.3	0.0	0.0	0.0	7.3	100.0	0.0	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 28 of quarter 1** in 2017, are given below:

SD 28/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January	1	6.3	0.9	0.0	0.0	7.2	87.4	12.6	0.0	0.0
	Mean	6.3	0.9	0.0	0.0	7.2	87.4	12.6	0.0	0.0
February	1	8.1	0.0	0.0	0.0	8.1	99.6	0.4	0.0	0.0
	2	9.0	0.0	0.0	0.0	9.0	100.0	0.0	0.0	0.0
	Mean	8.5	0.0	0.0	0.0	8.5	99.8	0.2	0.0	0.0
March	1	7.8	0.3	0.0	0.0	8.2	96.0	4.0	0.0	0.0
	2									
	Mean	7.8	0.3	0.0	0.0	8.2	96.0	4.0	0.0	0.0
Q I	Mean	7.6	0.4	0.0	0.0	8.0	94.4	5.6	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 29 of quarter 1** in 2017, are given below:

SD 29/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January	1	7.8	0.8	0.0	0.0	8.6	90.6	9.4	0.0	0.0
	2	7.9	0.0	0.0	0.0	7.9	99.6	0.4	0.0	0.0
	Mean	7.8	0.4	0.0	0.0	8.2	95.1	4.9	0.0	0.0
February										
	Mean									
March										
	Mean									
Q I	Mean	7.8	0.4	0.0	0.0	8.2	95.1	4.9	0.0	0.0

The officially reported total trawl landings of sprat in Subdivisions 25-29 (see 2.1) in combination with the noticed mean species composition in the samples (see above) would result in the following differences:

Subdiv.	Quarter	Trawl landings (t)	Mean Contribution of Sprat (%)	Total Sprat corrected (t)	Difference (t)
25	I	211	87.2	184	-27
26	I	3,862	91.7	3,542	-321
	II	3,431	100.0	3,431	0
28	I	2,231	94.4	2,106	-125
29	I	506	95.1	481	-25

The overall difference amounted to -497 t, which would represent a change of the total landing value for Germany in 2017 of -4 % (total landings in SD 22-29 in 2017 of 13,553 t – 497 t ->13,056 t; 2016: -11 %, 2015: -14 %; 2014: -7 %, 2013: -6 %). The officially reported trawl landings (see 2.1) and the referring assessment input data (see 2.5 and 2.6) were not corrected for these small differences in 2017.

2.4 Logbook registered discards/BMS landings

No logbook registered discards or BMS landings (both new catch categories since 2015) of sprat have been reported in the German herring fisheries in 2017 (no BMS landing have been reported in 2015 - 2016 and no discards have been reported before 2016).

2.5 Landings (tons) and sampling effort

Even so most of the sprat was landed in foreign port in 2017 (86 %, 2016: 96 %), it was possible to sample 80 % (10,795 t, 2016: 87 %) of the total landings:

Gear	Quarter	SUBDIVISION 22[1] Landings (tons)	No. samples	No. measured	No. aged	SUBDIVISION 24[2] Landings (tons)	No. samples	No. measured	No. aged	SUBDIVISION 25[3] Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	* 394.415	1	94	58	* 98.030	* 4	126	75	210.587	2	508	113
	Q 2	35.500	0	0	0	61.992	* 1	72	45	835.321	0	0	0
	Q 3	0.000	-	-	-	0.000	-	-	-	0.000	-	-	-
	Q 4	257.766	0	0	0	5.123	0	0	0	0.000	-	-	-
	Total	687.681	1	94	58	165.145	5	198	120	1,045.908	2	508	113

Gear	Quarter	SUBDIVISION 26[3] Landings (tons)	No. samples	No. measured	No. aged	SUBDIVISION 27[3] Landings (tons)	No. samples	No. measured	No. aged	SUBDIVISION 28[3] Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	3,862.051	3	840	170	0.000		-	-	2,230.731	4	1,138	219
	Q 2	3,431.362	3	780	169	0.000	-	-	-	0.000	-	-	-
	Q 3	0.000	-	-	-	0.000	-	-	-	0.000	-	-	-
	Q 4	0.000	-	-	-	0.000	-	-	-	95.147	0	0	0
	Total	7,293.413	6	1,620	339	0.000	0	0	0	2,325.878	4	1,138	219

Gear	Quarter	SUBDIVISION 29[3] Landings (tons)	No. samples	No. measured	No. aged	SUBDIVISIONS 22-29[4] Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	505.912	2	684	112	7,301.726	16	3,390	747
	Q 2	0.000	-	-	-	4,364.175	4	852	214
	Q 3	0.000	-	-	-	0.000	0	0	0
	Q 4	1,528.803	0	0	0	1,886.839	0	0	0
	Total	2,034.715	2	684	112	13,552.740	20	4,242	961

*samples taken as by-catch in the herring trawl fishery

Fraction of landings in foreign ports:
[1]SD 22: 80 t (11.6 %)
[2]SD 24: 0 %
[3]SD 25-29: 11,588 t (91.2 %)
[4]SD 22-29: 11,668 t (86.1 %)

2.6 Catch in numbers (millions)

	Age	SUBDIVISION 22 *Q1	Q2	Q3	Q4	SUBDIVISION 24 *Q1	*Q2	Q3	Q4	SUBDIVISION 25 Q1	Q2	Q3	Q4	SUBDIVISION 26 Q1	Q2	Q3	Q4
TRAWL	0																
	1	12.950				0.996	1.240			1.887				52.311	54.835		
	2	2.119				0.965	1.515			2.690				72.446	84.918		
	3	13.656				3.578	1.887			9.650				239.554	260.269		
	4	3.846				1.674	0.248			2.859				25.764	36.425		
	5	2.198				0.168	0.069			1.341				25.933	8.553		
	6	1.727								0.136				3.853	1.145		
	7	0.392								0.081				4.888			
	8+									0.074					0.573		
	Sum	36.887				7.382	4.960			18.719				424.748	446.717		

	Age	SUBDIVISION 27 Q1	Q2	Q3	Q4	SUBDIVISION 28 Q1	Q2	Q3	Q4	SUBDIVISION 29 Q1	Q2	Q3	Q4	SUBDIVISIONS 22-29 Q1	Q2	Q3	Q4
TRAWL	0																
	1					30.718				7.409				106.270	56.075		
	2					90.420				13.510				182.150	86.434		
	3					160.136				39.997				466.571	262.156		
	4					12.037				2.215				48.396	36.673		
	5					2.294				0.474				32.408	8.621		
	6					0.261								5.976	1.145		
	7					1.013								6.374			
	8+													0.074	0.573		
	Sum					296.880				63.605				848.220	451.677		

*samples taken as by-catch in the herring trawl fishery

2.7 Mean weight in the catch (grams)

		SUBDIVISION 22				SUBDIVISION 24				SUBDIVISION 25				SUBDIVISION 26			
	Age	*Q1	Q2	Q3	Q4	*Q1	*Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0																
	1	5.7				5.6	6.0			5.5				4.6	3.1		
	2	10.9				12.6	13.1			10.6				8.4	7.2		
	3	12.9				14.2	15.3			11.3				9.2	8.3		
	4	13.6				15.9	17.9			13.2				13.0	10.0		
	5	15.8				17.6	19.7			15.0				13.8	11.4		
	6	15.5								16.2				14.9	13.4		
	7	20.5								17.2				12.7			
	8+									18.0					12.4		
	Sum	10.7				13.3	12.5			11.3				9.1	7.7		
		SUBDIVISION 27				SUBDIVISION 28				SUBDIVISION 29				SUBDIVISIONS 22-29			
	Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0																
	1					3.3				3.3				4.3	3.1		
	2					7.4				7.3				7.9	7.3		
	3					8.0				8.7				8.9	8.4		
	4					10.9				13.0				12.6	10.1		
	5					12.1				14.4				13.9	11.5		
	6					13.0								15.0	13.4		
	7					11.8								13.1			
	8+													18.0	12.4		
	Sum					7.5				8.0				8.6	7.7		

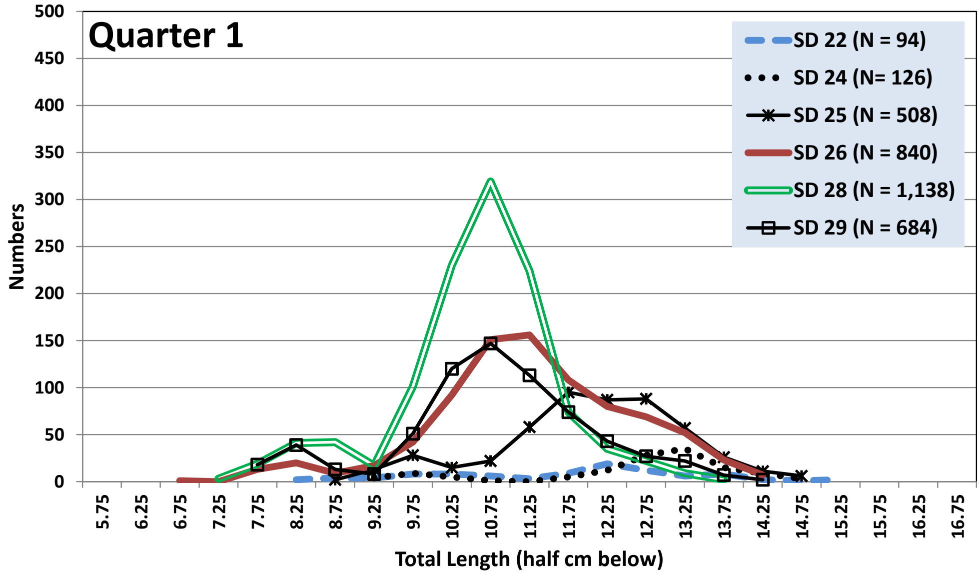
*samples taken as by-catch in the herring trawl fishery

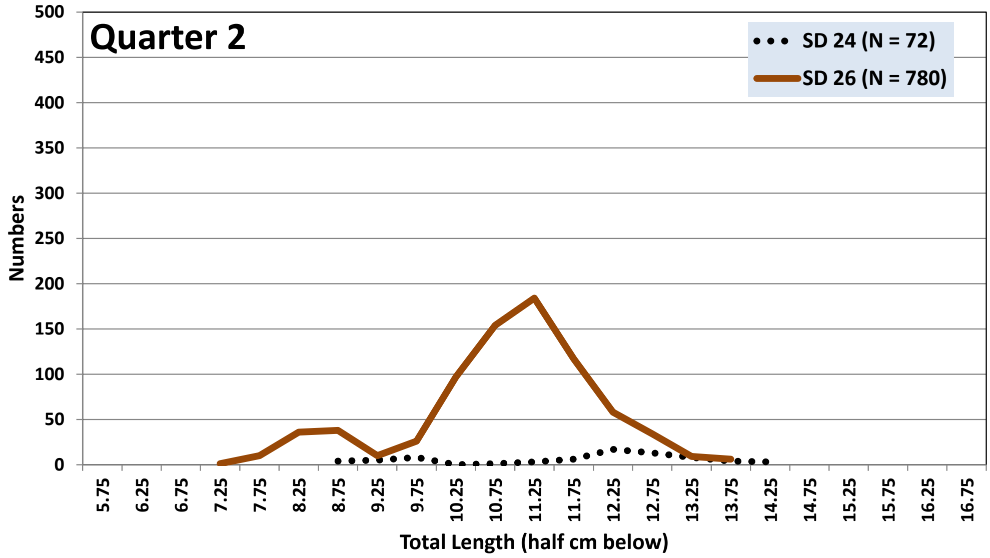
2.8 Mean length in the catch (cm)

		SUBDIVISION 22				SUBDIVISION 24				SUBDIVISION 25				SUBDIVISION26			
	Age	*Q1	Q2	Q3	Q4	*Q1	*Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0																
	1	9.8				9.8	10.0			9.7				9.2	8.5		
	2	11.8				12.4	12.7			11.8				11.1	10.7		
	3	12.6				13.0	13.3			12.1				11.4	11.2		
	4	12.9				13.5	14.2			12.8				12.8	12.0		
	5	13.6				14.1	14.8			13.4				13.1	12.7		
	6	13.6								13.9				13.5	13.5		
	7	15.3								14.3				12.7			
	8+														13.3		
	Sum	11.7				12.6	12.3			12.0				11.3	10.9		
		SUBDIVISION 27				SUBDIVISION 28				SUBDIVISION 29				SUBDIVISIONS 22-29			
	Age	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0																
	1					8.4				8.4				9.0	8.5		
	2					10.6				10.5				10.8	10.7		
	3					10.8				11.2				11.2	11.3		
	4					12.3				12.9				12.7	12.0		
	5					12.8				13.3				13.1	12.7		
	6					13.3								13.5	13.5		
	7					12.8								12.9			
	8+													0.0	13.3		
	Sum					10.6				10.8				11.1	10.9		

*samples taken as by-catch in the herring trawl fishery

2.9 Sampled length distributions of sprat by Subdivision and quarter





Working paper no 4 ICES WGBFAS April 2018

Joint fisheries research/fishing industry survey for sole in Skagerrak and Kattegat, November-December 2017

by

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Abstract

A survey series targeting sole in Kattegat and Skagerrak was initiated in 2004 in order to establish a time series of catch and effort data independent of the commercial fishery. The number of stations was reduced from 116 to 80 in 2011 but this did not change the overall trends for the most common commercial species. CPUE for sole was stable during 2004-2007 but decreased gradually after then until 2010. In 2011 CPUE increased slightly and was back at the 2009 level. There were no surveys in 2012 and 2013. The surveys were resumed in 2014. The CPUE in kg/hr increased slightly between 2011 and 2014 while the CPUE in numbers/hr decreased to the lowest observed level in the time series. The CUE increased again in 2015 and remained at the 2015 level in 2016 to increase again in 2017 to 174,6 specimens hr $^{-1}$ and 27.9 kg hr^{-1} which is the highest level seen since 2008. The length distribution had a mode around 23 cm as in previous years but with slightly more large sole than previous. The working paper also includes information on CPUE, biomass and length distribution of cod, plaice and Norway lobster.

Introduction

In 2004 National Institute of Aquatic Resources (DTU Aqua) initiated a survey series targeting sole in Skagerrak and Kattegat in cooperation with The Danish Fishermen's Association. The purpose is to establish a time series of catch and effort data independent of the commercial fishery in order to strengthen the scientific advice on the sole stock in ICES Div. IIIa. However, data on all commercial species are recorded. There were no surveys in 2012 and 2013, but the annual surveys were resumed in 2014.

The survey was originally designed in order to establish fisheries independent CPUE indices by means of fishing at 120 fixed stations where 60 of the positions of the hauls were selected by the skippers on the two commercial vessels participating in the survey, while 60 positions were selected randomly by DTU AQUA.

In 2005 the survey design was changed slightly. The number of stations selected by the fishermen was reduced by 10 from 60 to 50, while the number of stations selected randomly by DTU AQUA was increased by 10. Originally the DTU AQUA stations were placed mainly outside the area where the fishermen have placed their stations. The new stations are primarily placed in the area with the fishermen’s stations and distributed according to the principles used for the other 60 DTU AQUA stations. These 70 randomly distributed stations allow an estimation of the trawlable biomass and abundance for the entire survey area.

In 2011 DTU-Aqua took over a significant proportion of the expenses to the survey from NaturErhvervstyrelsen and the number of planned stations was reduced from 116 to 80 stations.

In 2016 and 2017 the survey was expanded with 20 stations in Jammerbugt and 6 stations in the northern part of Storebælt. The survey was expanded to test if a better coverage of the fishing grounds would improve the input to the assessment of sole. The expansion will be evaluated after the survey in 2017. The project is a part of an EFMM project: “Forbedring af den biologiske rådgivning om tunger i de indre danske farvande” (Improvement of the biological advice on sole in Danish waters).

In 2016 it was not possible to get permission to conduct the survey in Swedish waters and 10 stations were not covered (St, 40, 89,106, 107, 108, 109, 113, 126, 127,128). Six stations (106, 109, 113, 126, 127 and 128 in Swedish waters were skipped in 2017).

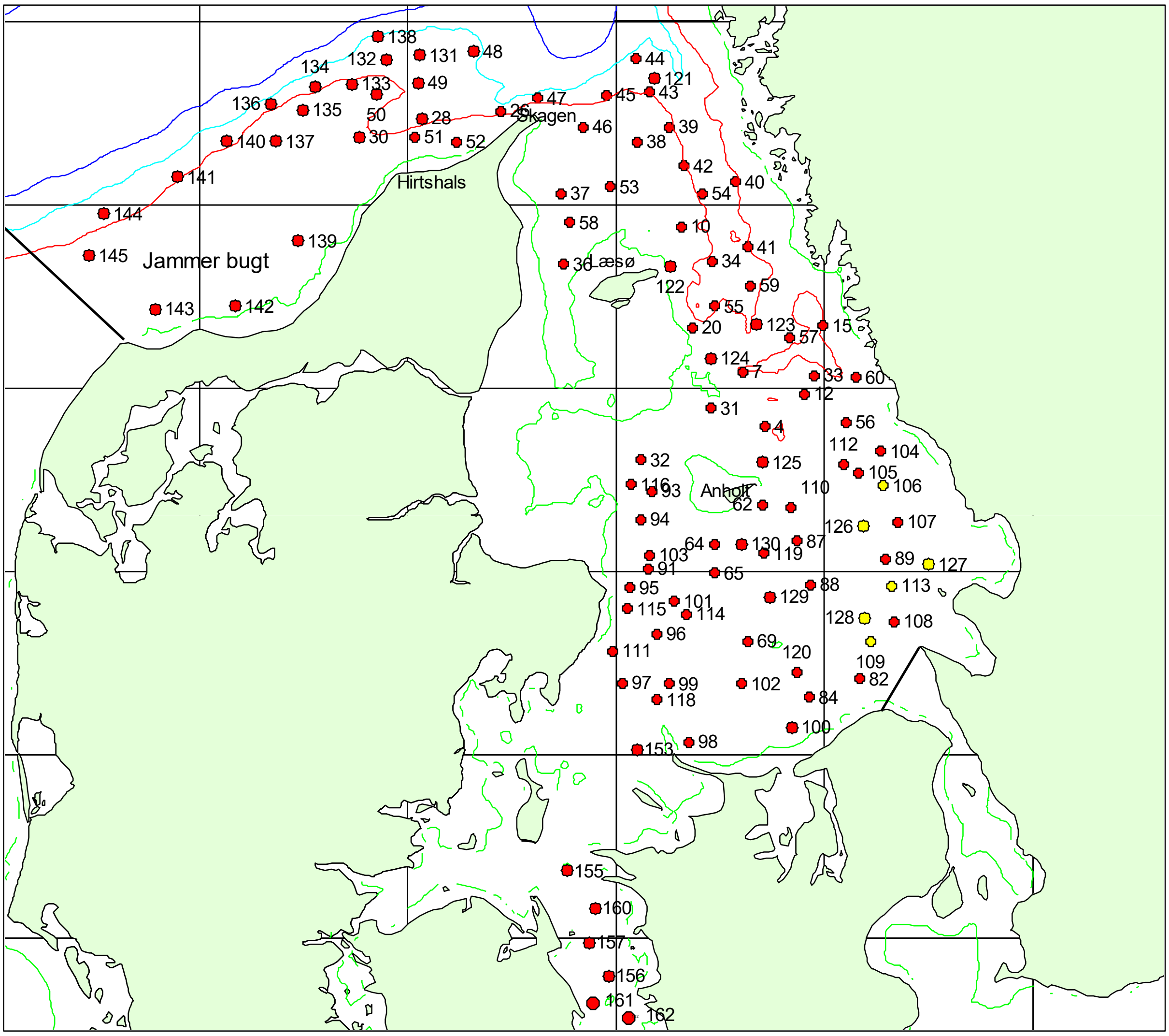


Fig 1. Distribution of stations in 2017. Yellow stations skipped.

One commercial trawler and DTUAQUAS “Havfisken” conducted the survey in 2017 without any restrictions in the vessels quota and with dispensation from all by-catch regulations. There was staff from DTU Aqua on board the vessels during the survey.

Materials and Methods

The survey has been conducted by a number of different trawlers throughout the time series but they have all been in the same size class. In 2016 and 2017 the surveys were conducted by:

Vessel	1	2
Engine (hp):	501	457
Tonnage:	105 BRT	48.0 BRT
Length (m):	17.2	17.5

Time
The survey in 2017 was conducted during 20/11 - 7/12, the same time as in previous years.

Survey area
The traditional survey area is restricted by a line 10 mile west of Hirtshals, northwards by the 100 m depth contour line and a line at 58°N, south-eastwards by a line between Gilleleje and Kullen and south-westwards by a line between Gniben og Hassensør on Djursland. Further, the area is restricted by the 10 m depth contour line. In 2016 and 2017 stations were also placed in Jammerbugt and northern part of Storebælt (Fig.1).

Distribution of hauls

The survey was originally designed in order to establish fisheries independent CPUE indices by means of annual fishing at 120 fixed stations, 60 stations were placed by the fishermen and 60 by DTU-Aqua. In 2010 Stations 30, 48, 49 and 50 in the northern area were excluded from the survey and the total number of stations reduced to 116. In 2011 the survey was reduced further to 80 stations, all included in the originally set up. In 2016 and 2017 further 20 stations were placed in Jammerbugt and 6 stations in the northern part of Storebælt but they are not included in the estimation of the CPUE etc. (Fig. 1).

The reduction in stations in 2011has decreased the overall number (and kg) of sole caught per hour, but the trend in the CPUE series has not changed (Fig.2). (It is the trend in the CPUE series, not the actual values that is used in the assessment of sole).

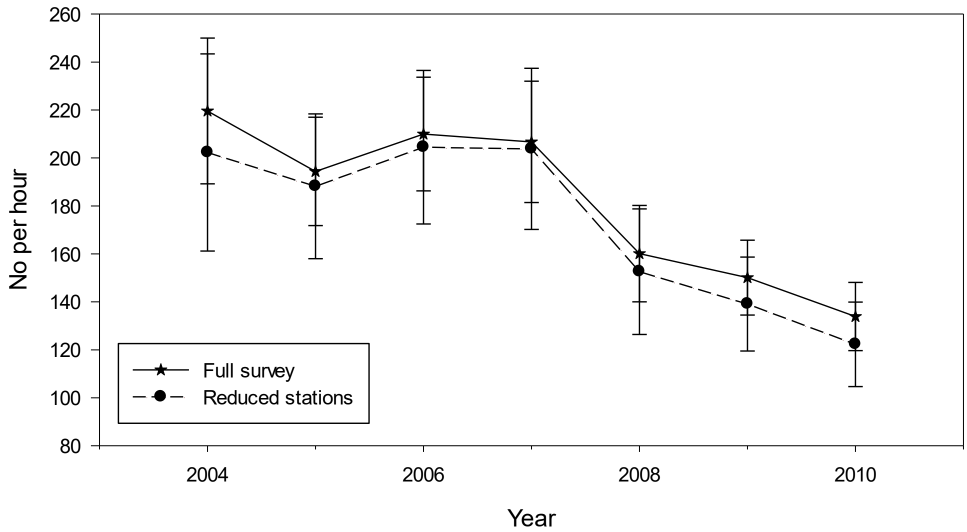


Fig. 2. Catch of Sole in numbers per hour in the “full survey” (116 stations) and the “reduced” survey (80 stations), respectively, with S.E.

The estimated trawlable biomass and abundance is based on the 80 stations. Hence no stations were deeper than 90 m the biomass and abundance has been estimated for depths between 10 and 90 m. The survey area has been stratified in ICES squares and the area between 10 and 90 m has been estimated (Table 4).

There is at least 5 mile between each station in order to spread out the stations (there are a few stations with lesser distance between, but then there is great difference in the depth).

Trawl and trawling procedure

Both vessels used the same trawl (twin trawl + 1 spare trawl) provided by DTU AQUA. The trawls are checked yearly by a net maker. The fishermen provide the otter boards.

Trawl: Twin "Icelandic-sole-trawl" with 140 mm mesh and rockhopper type ground gear with 150 mm rubber discs.
Mesh size in the cod end: 55 mm stretch mesh
Otter boards: 66" "Thyborøn".
Warp: 13 mm.

The otter boards are mounted directly on the tips of the wings without bridles.
Wing spread (otter board spread) is app. 44 m.

Trawl procedure:
Towing time: Traditionally towing time has been 60 min (towing time down to 20 min is accepted). In 2016 towing time was reduced to 30 min on 25% of the traditional stations and in 2017 the rowingtime was reduced to 30 on 50% of the stations. Towing time was 30 min on all new stations in Jammerbugt and Storebælt.
Towing speed: 2.5 kn. over the seabed.
Hauls start: when the trawl is considered going stable on the bottom.
Haul end: when hauling starts.
Warp length: The depth varies from station to station and so does the warp length. The warp length was recorded at each station in 2004 and this warp length is used at the station in 2005 and onwards.

Each station is fished in the same direction each year if wind and current allows.

Fishing takes place during night time from app. 5 pm to 7 am.

Handling of the catch
After each haul the catch is sorted by species and weighed to nearest 0.1 kg and the number of specimens recorded. Most fish species are measured as total length (TL) to 1.0 cm below. Norway lobster is measured in mm carapace length.

CPUE

CPUE for sole cod, plaice and Norway lobster is estimated as mean catch (kg or numbers) per hour with Standard Error based on the Standard Stations (i.e. not including the stations in Jammerbugt and Storebælt).

Biomass and abundance
The traditional survey area has been stratified in ICES squares (Fig 3, Table 4).

Biomass and abundance estimates is obtained by applying the swept area method (estimated trawling speed * wing spread * trawling time) using the recorded speed, wing spread and trawling time and the stratum area as weighting factor. The catchability coefficient is assumed to be 1.0.

All catches are standardized to 1 km^2 swept prior to further calculations.

Over all S.E. is estimated using the stratum area as weighting factor. In strata with one haul only STD=biomass (or abundance).

Results

Sole

The catches in the 30 min hauls (*2) were slightly higher than in the 60 min haul but the difference was not statistically significant:

	30 min		60 min	
	Wight	Number	Weight	Number
Mean	30.31663	188.0263	23.97979	148.2979
95 Con	10.86019	73.11566	10.28998	73.78826
N (hauls)	38		33	

One haul on 46 min excluded

In 2017 72 of the 74 planned stations were successfully covered and sole were caught at 70 of the stations. The catches ranged from 0 kg to 135 kg per hour. The greatest catches were generally taken south of Anholt (Fig. 3). The CPUE, biomass and abundance indices have generally been stable during 2004 – 2007 but all indices showed a decline on roughly 25% between 2007 and 2008. The indices declined further during 2009 and 2010 but have been slightly increasing since then.

All the 20 planned stations in Jammerbugt and 5 of 6 planed stations in Storebælt were conducted successfully.

CPUE.

The CPUE based on the standard stations has been increasing gradually but statistically insignificant (95% level) between 2010 and 2017 from 122.3 to 174.6 specimens and 17.4 to 27.9 kg per hour, respectively. (Table 1, Fig. 4 and 5).

CPUE in Jammerbugt increased in numbers from 16.8 (SE 5.9) in 2016 to 29.0 (SE 7.3) in 2017 and from 4.8 kg (SE 1.6) to 7.9 kg (SE 2.1). n= 12 and 20, respectively.

In Storebælt CPUE increased from 250.8 (SE 53.3) specimens in 2016 to 299.2 (SE 62.1) in 2017 and from 48.6 kg (SE 7.9) to 53.5kg (SE10.1). n=5.

Table 1. CPUE (catch per hour) of sole in number and weight with SE in the traditional survey area. n: number of hauls

Year	Number	SE_Number	Weight	SE_Weight	n
2004	202.3	41.1	30.0	5.0	69
2005	188.2	30.2	27.6	3.9	78
2006	204.5	32.0	28.0	3.5	79
2007	203.8	33.6	28.9	4.0	75
2008	152.6	26.2	21.5	3.2	80
2009	139.1	19.6	20.2	2.4	78
2010	122.3	17.6	17.4	2.3	79
2011	140.2	24.5	19.0	2.7	80
2014	121.6	16.3	19.2	2.3	77
2015	166.7	36.4	24.1	4.2	78
2016	159.2	24.5	25.9	3.8	69
2017	174.6	25.7	27.9	3.7	72

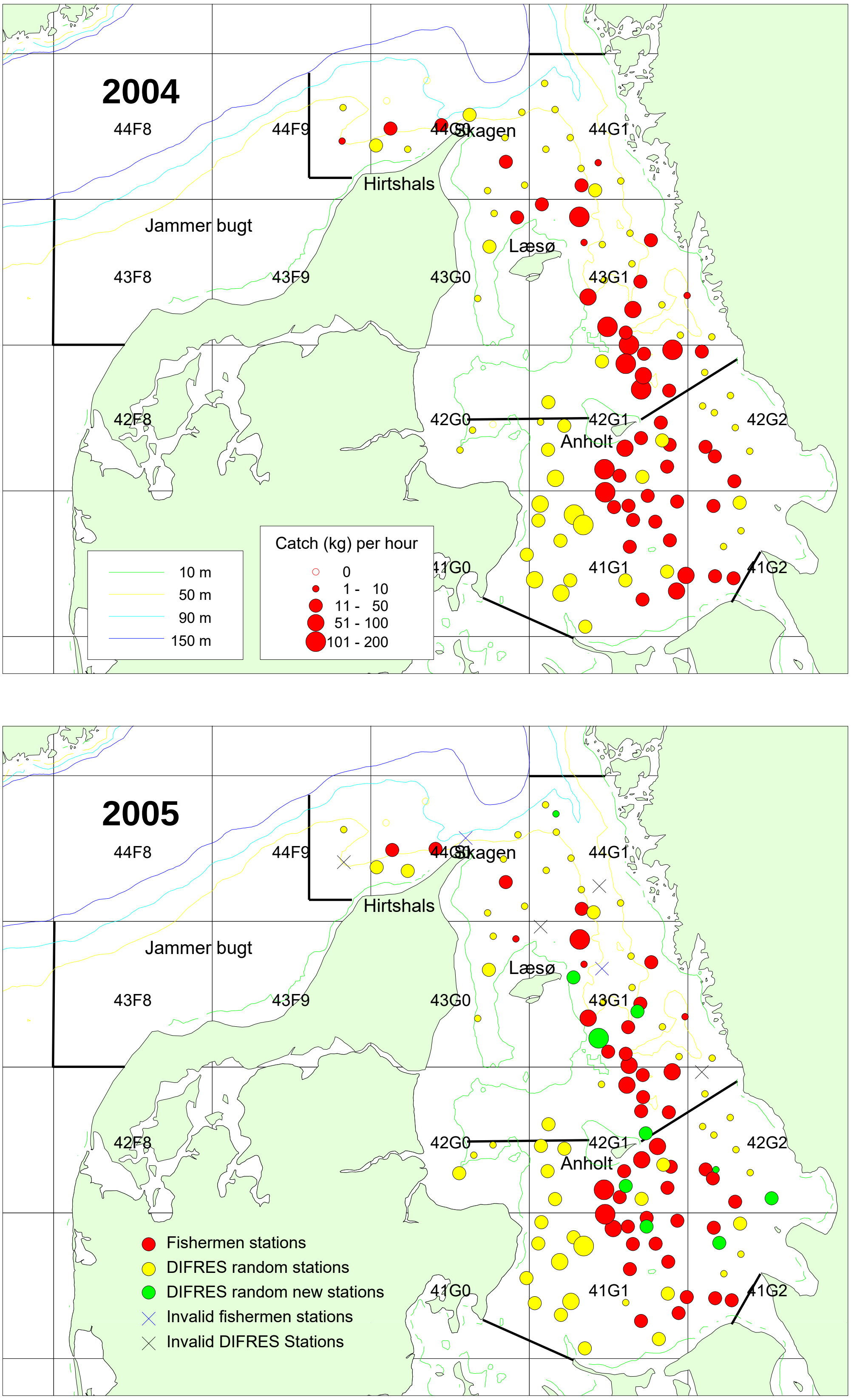


Fig. 3. Catch of sole (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.

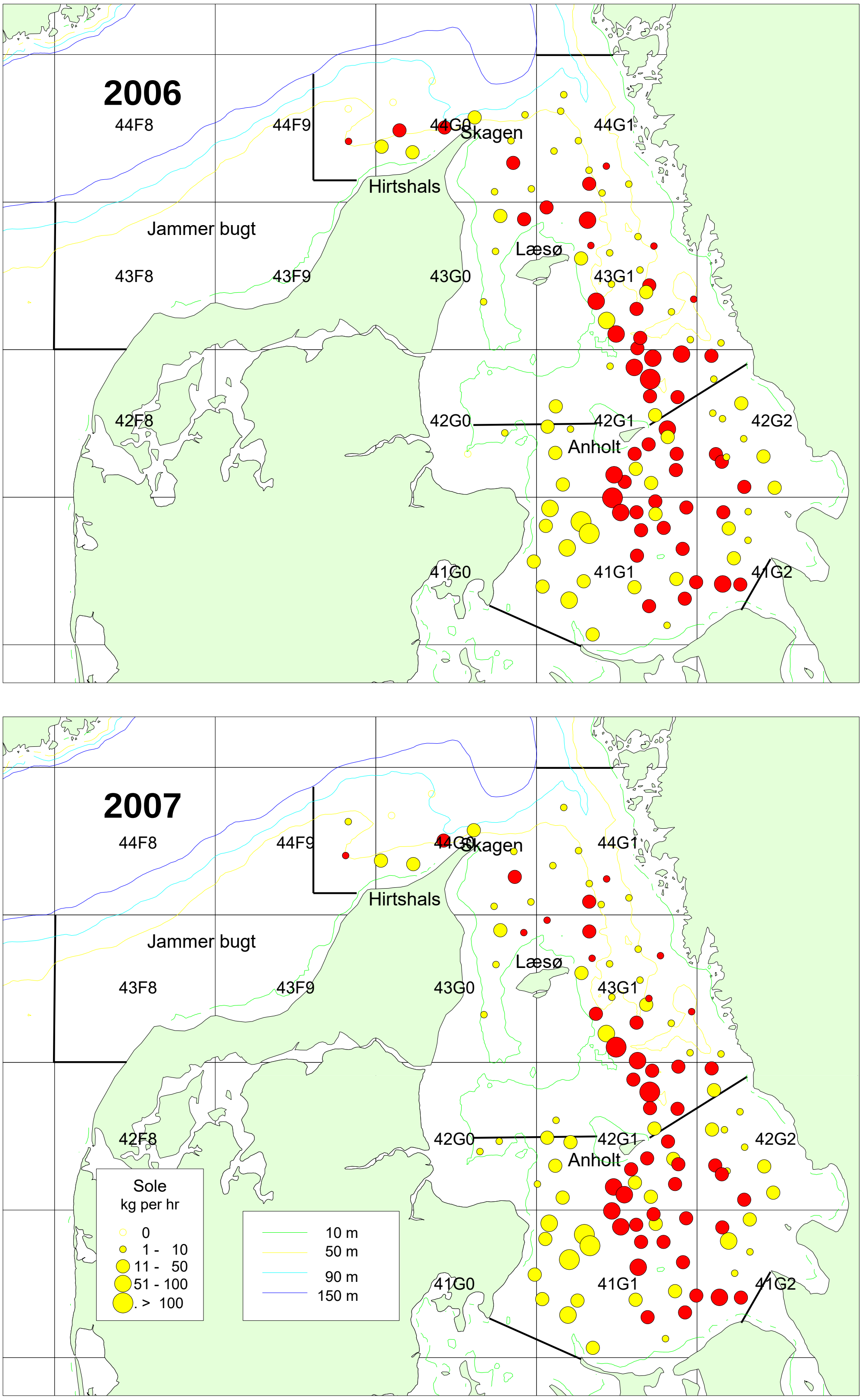


Fig. 3 cont. Catch of sole (kg per hour) 2006 - 2007. ● DTU AQUA stations ● Fishermen's stations.

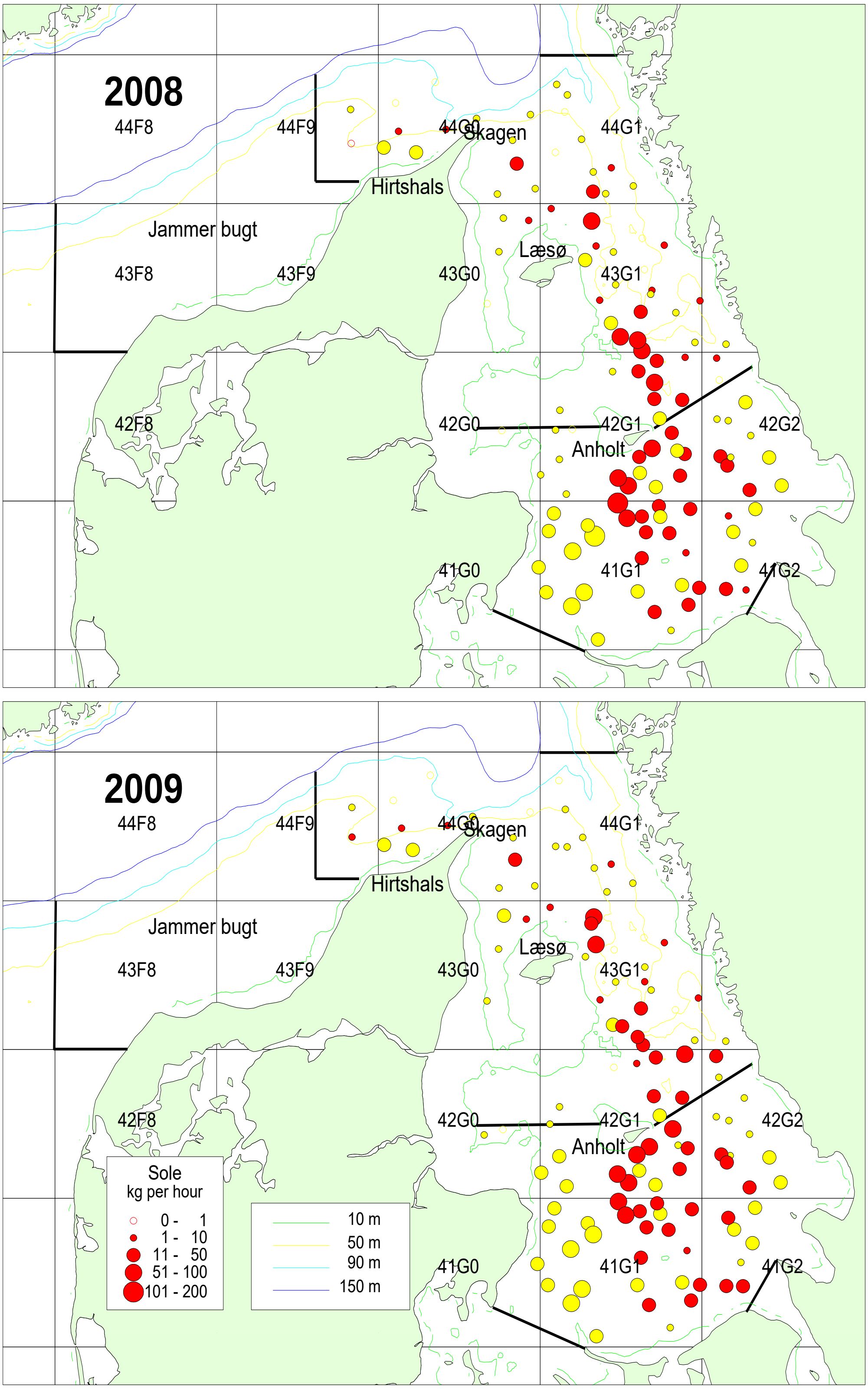
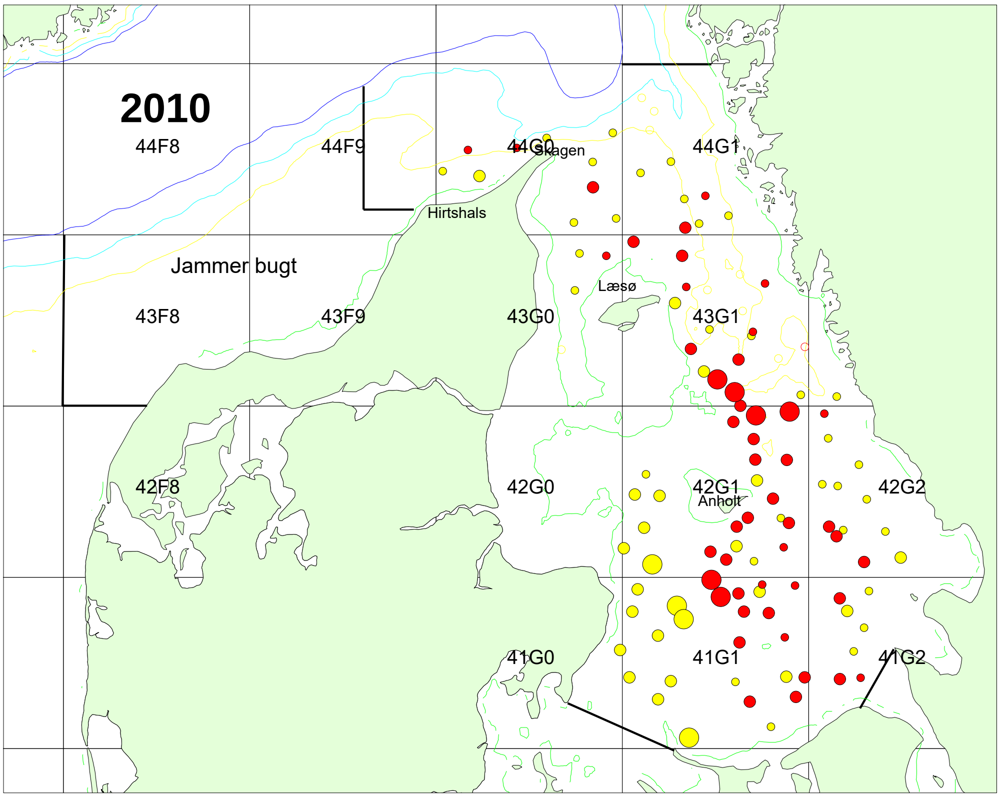


Fig. 3 cont. Catch of sole (kg per hour) 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.



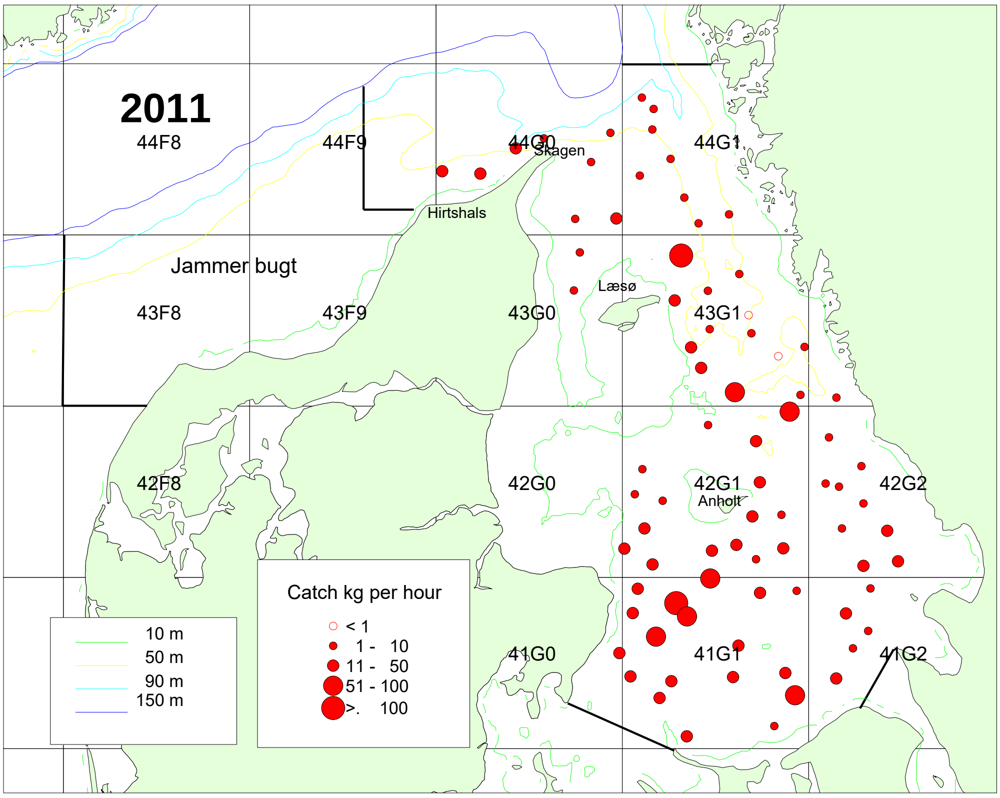


Fig.3 cont. Catch of sole (kg per hour) in 2010 and 2011. 2010 ● DTU AQUA stations ● Fishermen’s stations.

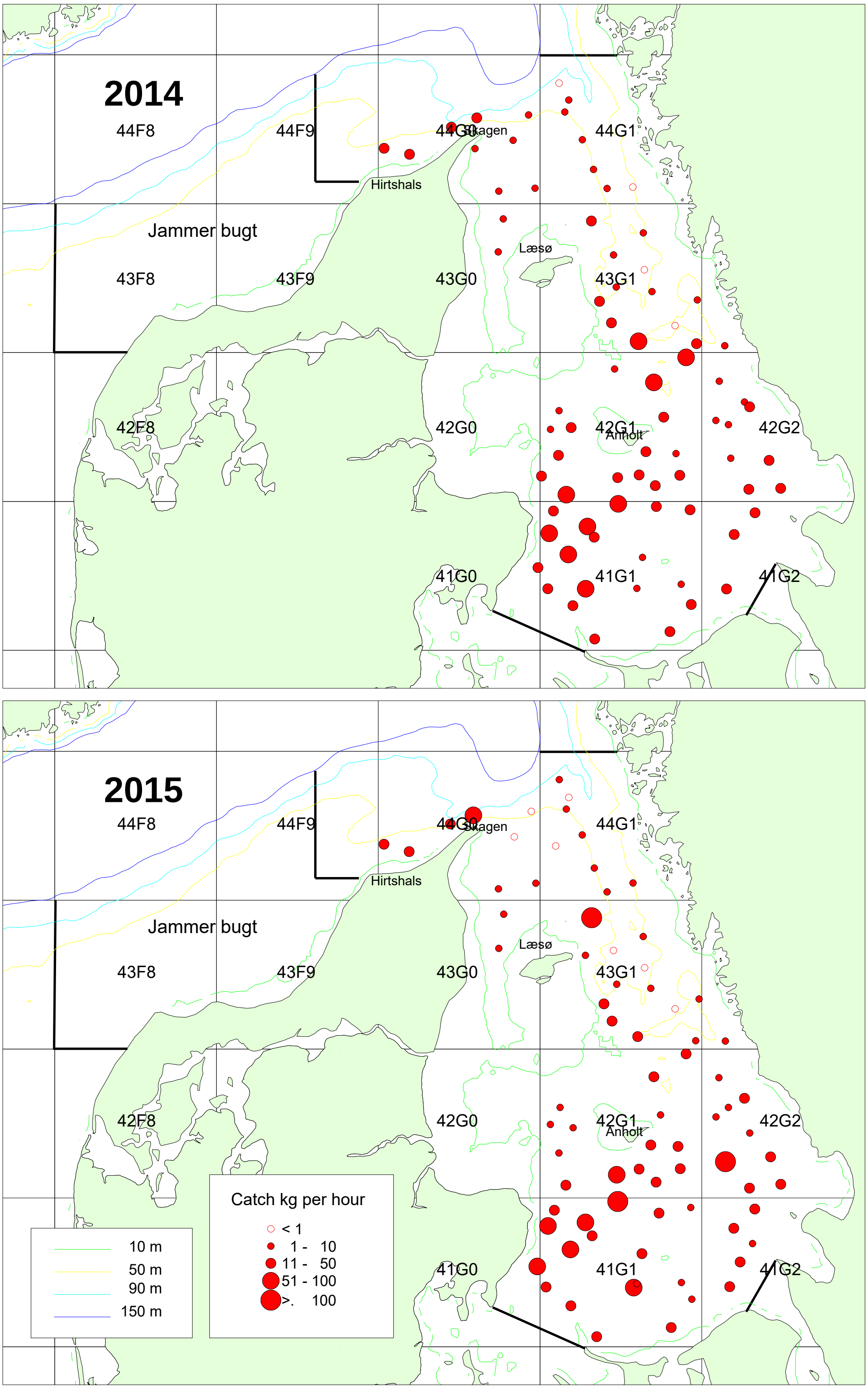
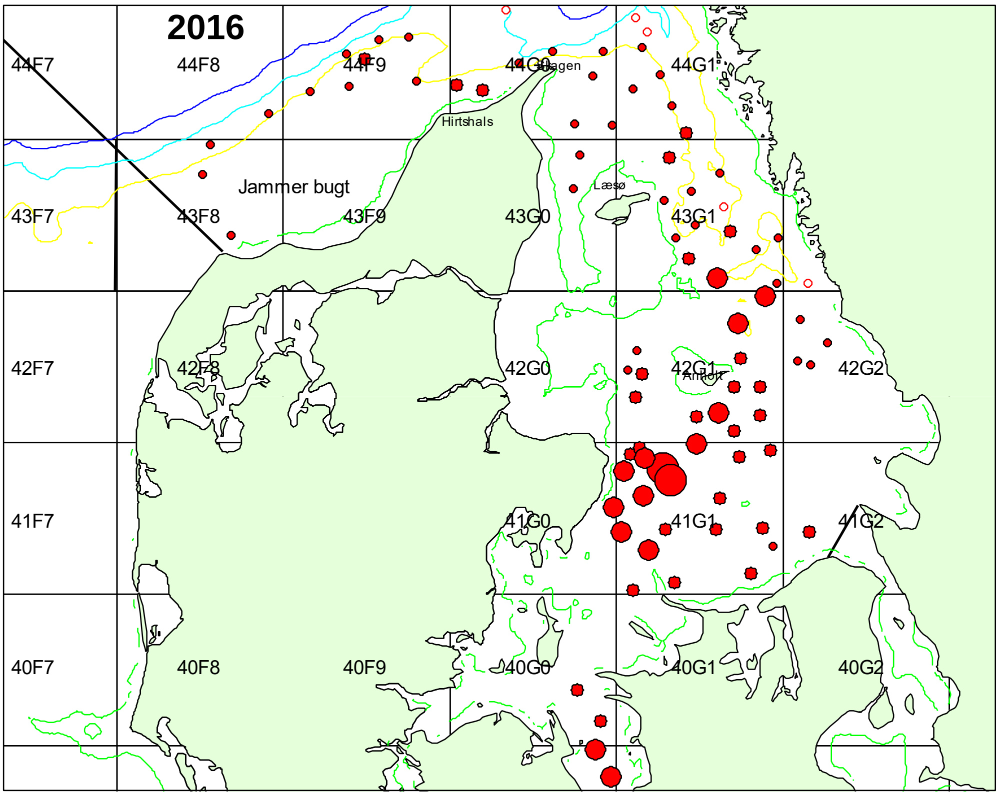


Fig. 3 cont. Catch of sole (kg per hour) in 2014 and 2015.



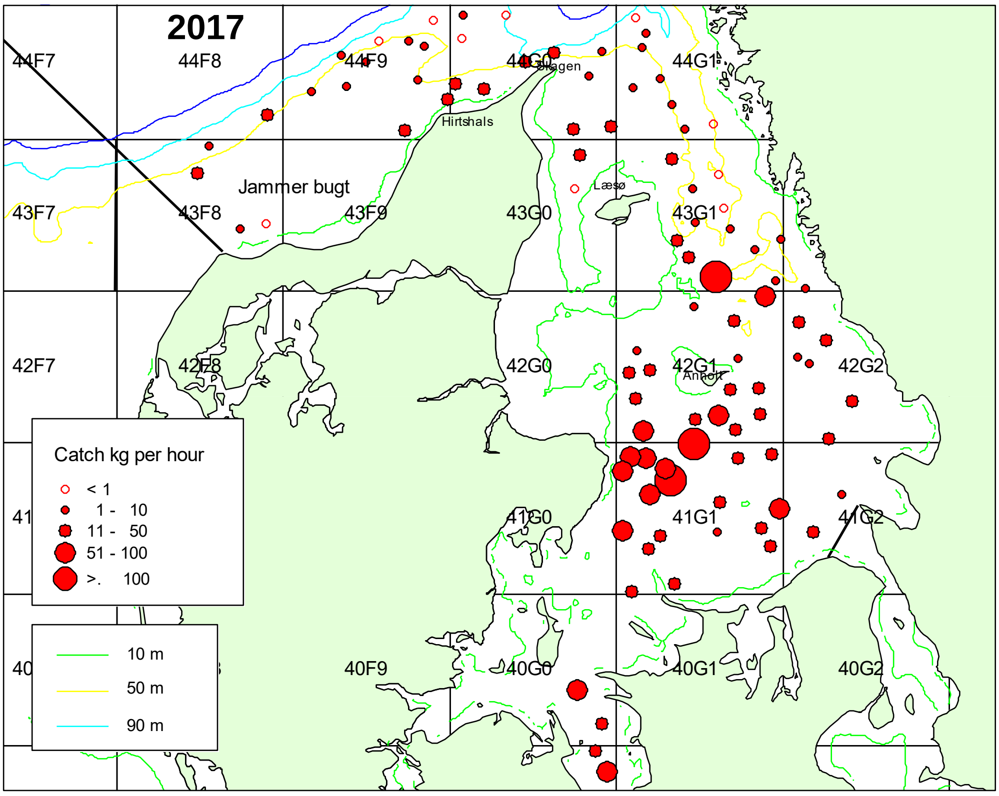


Fig. 3 cont. Catch of sole (kg per hour) in 2016 and 2107.

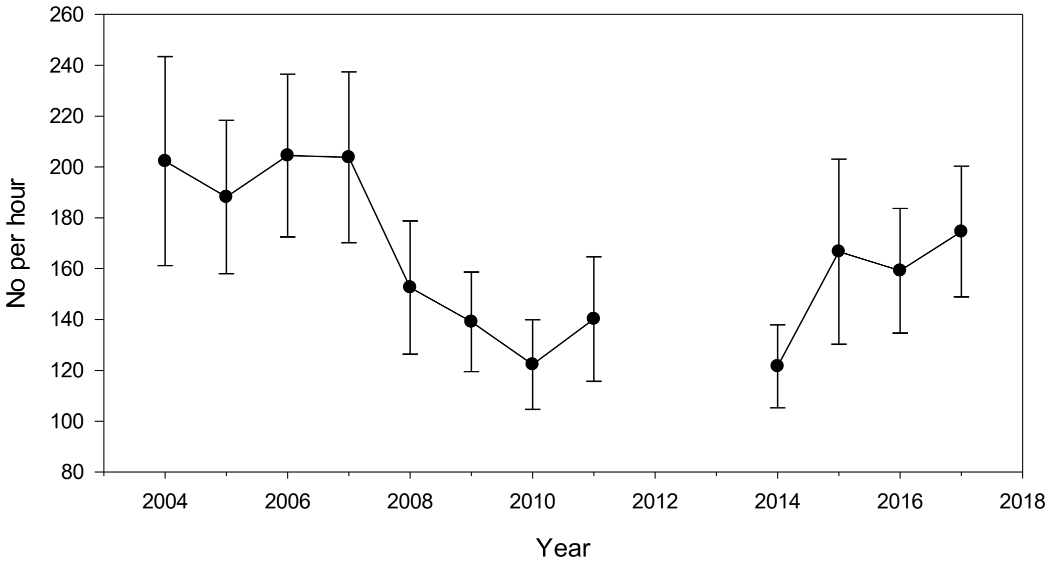


Fig. 4. Catch of sole in number per hour with 1* S.E.

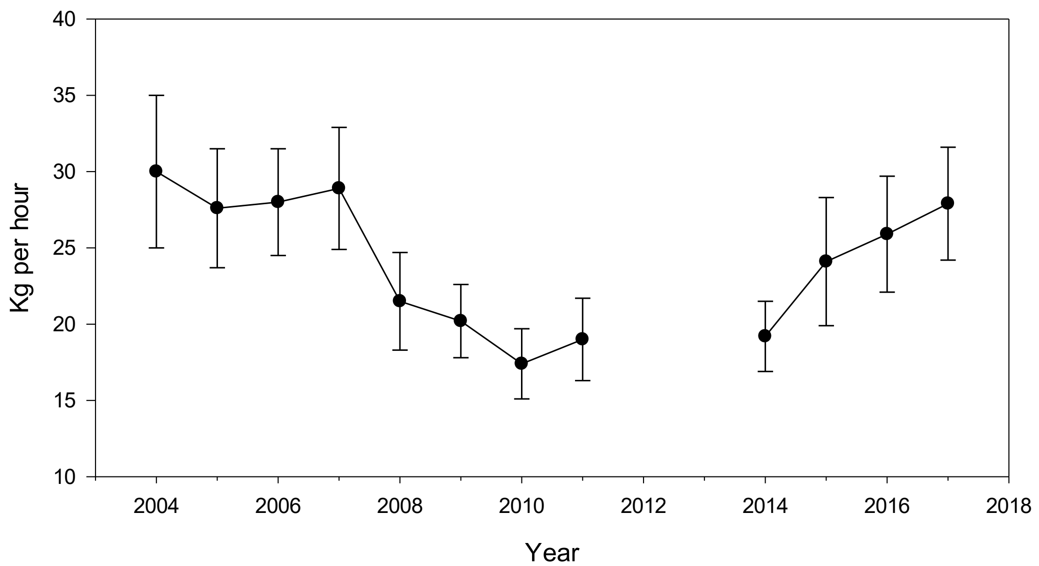


Fig. 5. Catch of sole in kg per hour with 1* S.E.

Length distribution

In 2017 the length ranged from 11to 43 cm with a mode at 23 cm as in most of the recent years (Fig. 6). In 2016 and 2017 there were somewhat more fish > 26 cm than seen in 2008-2015. Prior to 2008 the mode was at 22 cm. The length distribution has not changed despite the reduction in stations.

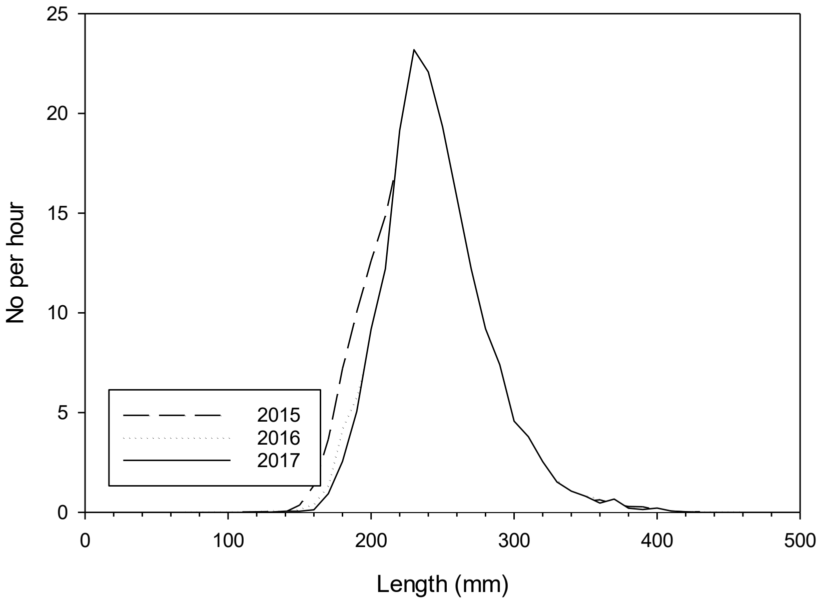


Fig. 6. Length distribution (mm) of sole standardized to number caught per hour in 2015 - 2017.

Biomass and abundance

The biomass of sole was estimated at 1744.7 tons in 2017 which is a slight increase from 2016 and the second largest since 2007, but the estimate is still approximately 25% below the level during 2004-2007 (Table 3).

Table 3. Swept area biomass and abundance of sole with 1* S.E. and number of hauls. Including 5 new stations from Jammerbugt in 2016.

Year	BIOMASS	SE BM	ABUNDAN	SE AB	Haul
2004	2391.5	363.4	15935791.3	2969937.0	68
2005	2201.8	284.4	14910144.9	2191447.5	77
2006	2300.8	245.4	16561209.2	2243489.8	78
2007	2254.2	263.3	15653952.9	2196027.4	75
2008	1717.5	215.0	12082628.3	1782711.1	80
2009	1676.0	175.8	11487877.7	1428147.2	78
2010	1379.8	145.0	9660045.5	1138982.9	79
2011	1471.6	193.6	10746623.2	1695182.3	80
2014	1499.7	170.6	9452928.7	1136106.2	77
2015	1762.6	296.2	12108682.6	2456275.6	78
2016	1635.4	233.4	9972025.3	1498233.9	74
2017	1744.7	189.3	10690488.6	1293869.9	72

The abundance decreased from 12.1 mill. in 2015 to 9.9 mill. in 2016 to increase again in 2017 to 10.6 mill, which is at the level seen since 2010 but still approximately 25% below the level seen during 2004-2010 level, although the difference is not statistically significant (95% level) (Table 3).

The largest total biomass and total abundance and largest densities were found in ICES area 41G1 as in 2006 - 2016 (Fig. 3, Table 4).

Table 4. Sole biomass 2017. Area, number of hauls, mean biomass per km^2 (tons), biomass (tons) and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Biomass	SE
41G1	3357.6	18	0.2287	767.8	127.7
41G2	1421.2	2	0.0895	127.1	76.2
42G1	3039.6	15	0.1192	362.2	57.9
42G2	2003.8	6	0.0614	123.0	28.4
43G0	721.5	2	0.0335	24.2	22.2
43G1	2460.9	12	0.0757	186.3	89.0
43G2	331.3	1	0.0203	6.7	.
44G0	1881.5	8	0.0686	129.1	31.8
44G1	1914.9	8	0.0095	18.2	8.8
All			0.1018	1744.7	189.3

Table 5. Sole abundance, 2017. Area, number of hauls, mean abundance per km^2, abundance and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Abundace	SE
41G1	3357.6	18	1544.4	5185475.2	926148.4
41G2	1421.2	2	524.4	745312.1	583147.4
42G1	3039.6	15	746.3	2268599.1	430235.2
42G2	2003.8	6	293.5	588185.9	122227.0
43G0	721.5	2	154.4	111409.4	100076.2
43G1	2460.9	12	433.7	1067277.5	491509.3
43G2	331.3	1	101.6	33673.0	.
44G0	1881.5	8	316.2	594854.0	146934.7
44G1	1914.9	8	50.0	95702.5	43880.4
All			624.0	10690488.6	1293869.9

Cod.

In 2017 cod was caught at all 72 stations (Fig. 8).

CPUE

The CPUE of cod increase between 2010 and 2011 from 26.0 to 190.9 specimens and 4.5 kg to 27.0 kg per hour, respectively (Table 6, Fig. 9 and 10). The increase, especially in weight, was, however, to a large extent driven by one large catch (st. 26: 4720.9 specimens, 1368.6 kg). If this station is exclude from the analysis the CPUE increased (statistically insignificant, 95% level) from 4.5 to 10.1 kg per hour while CPUE in numbers increased from 26.0 to 133.6 specimens per hour (statistically significant, 95% level). The CPUE in numbers decreased in 2014 to 57.1 hr^{-1} and further to 39 hr^{-1} in 2015 while the CPUE in weight increased to 31.0 kg hr^{-1} in 2014 and further to 38.5 kg hr^{-1} in 2015, which is the largest estimates in the time series. The CPUE in weight decreased slightly in 2016 to 32 kg hr^{-1} to decrease further in 2017 to 13.5 kg hr^{-1}. The CPUE in number decreased from 86.3 specimens hr^{-1} in 2016 to 61.7 specimens hr^{-1} in 2017(Table 6, Fig. 9 and 10).

Table 6. CPUE of cod by year in number and kg and number per hour with S.E and number of valid hauls.

Year	Number	SE Number	Weight	SE Weight	n
2004	43.5	7.3	15.9	3.1	69
2005	37.5	3.7	13.0	1.6	78
2006	53.6	11.8	16.9	2.4	76
2007	21.7	4.4	7.4	1.1	75
2008	28.7	5.2	5.5	0.7	80
2009	45.1	13.9	8.6	1.7	78
2010	26.0	4.4	4.5	0.6	79
2011	190.9	63.3	27.0	17.0	80
2011*	133.6	27.1	10.1	9.8	79
2014	57.1	9.9	31.0	5.4	77
2015	39.0	3.9	38.5	4.5	78
2016	86.3	21.8	32.0	3.2	69
2017	61.7	12.8	13.5	2.2	72

* Excluding one large haul on 1368 kg.

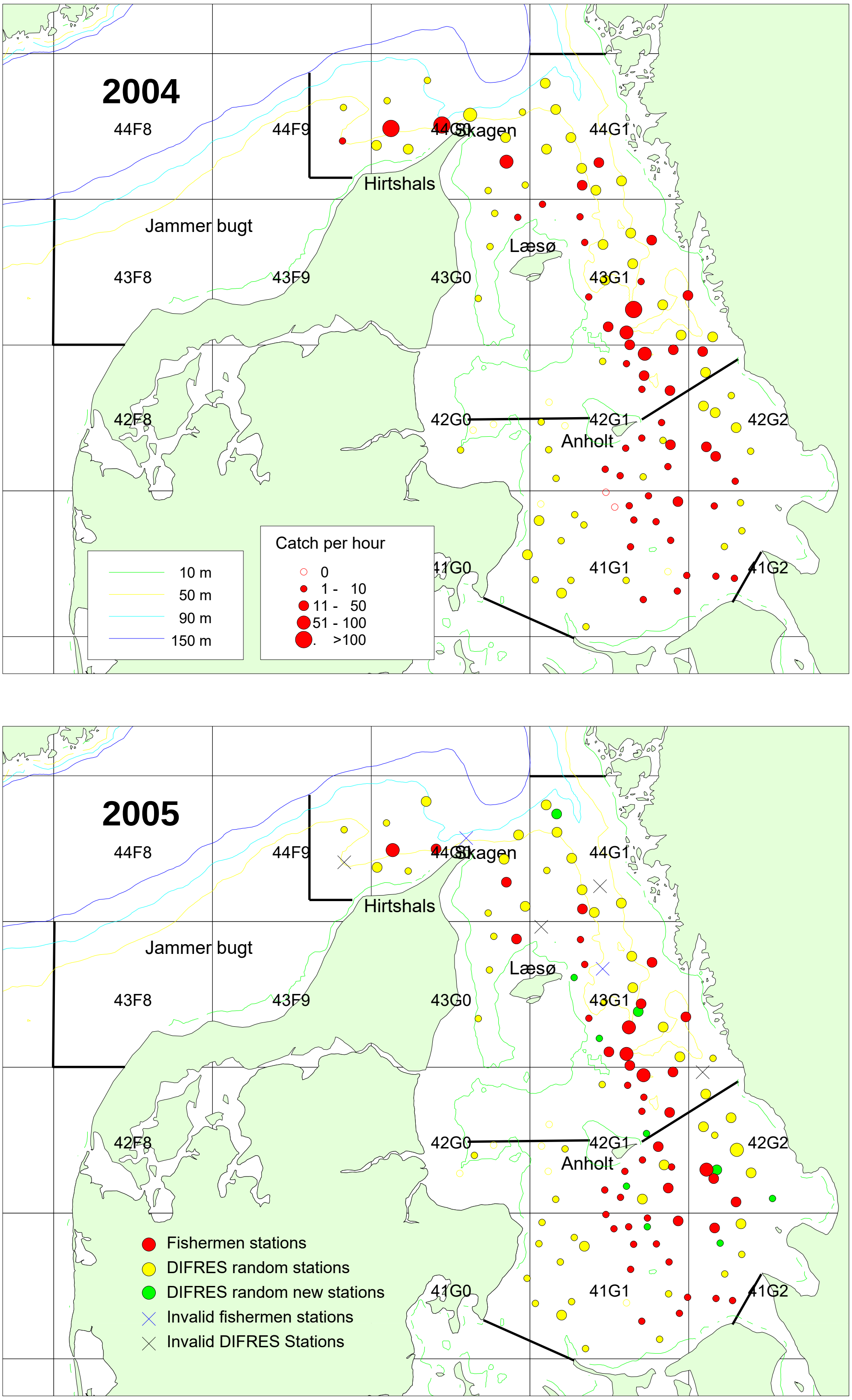


Fig. 8. Catch of cod (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.

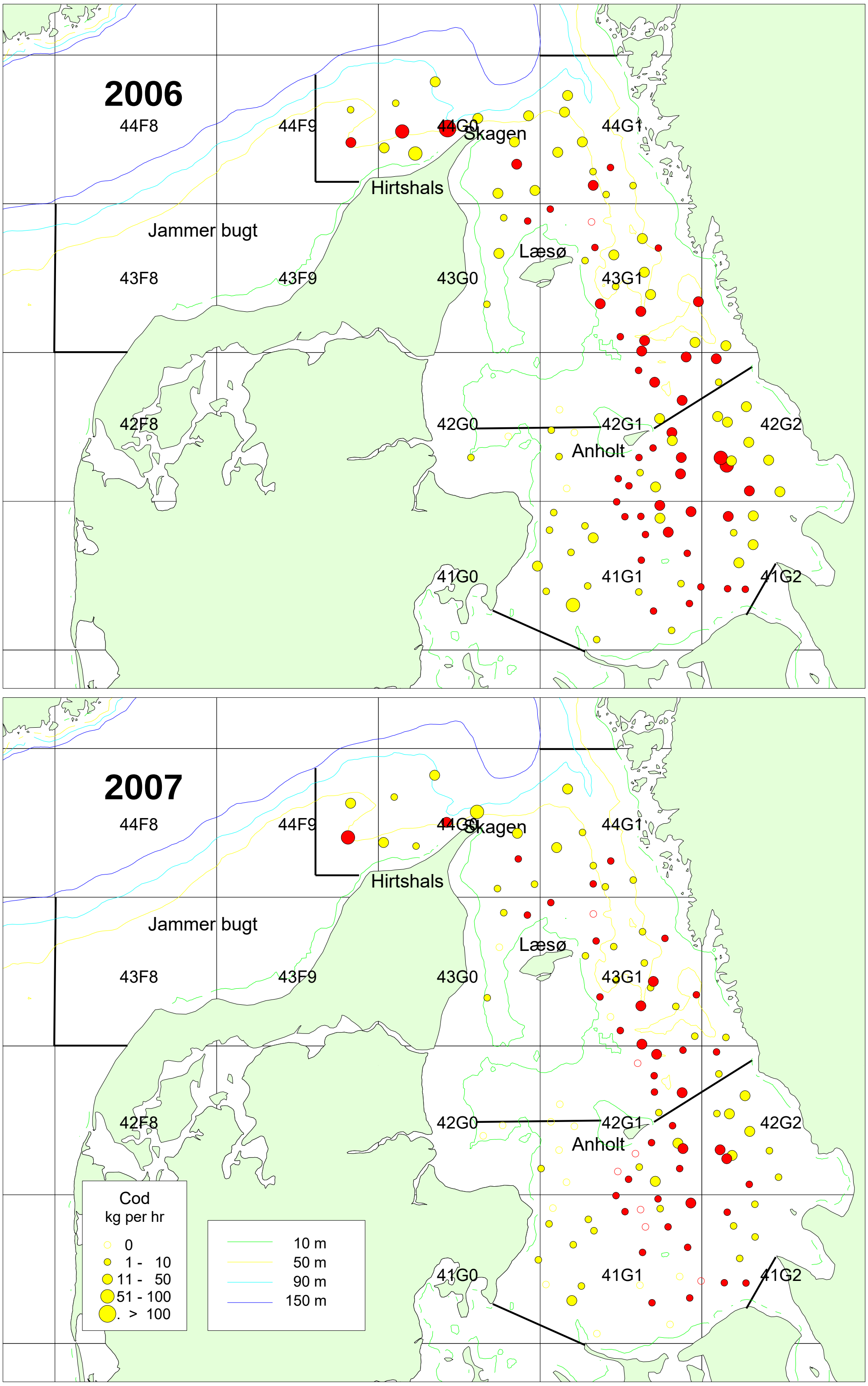


Fig. 8 cont. Catch of cod (kg per hour) in 2006 - 2007. ● DTU AQUA stations ● Fishermen's stations.

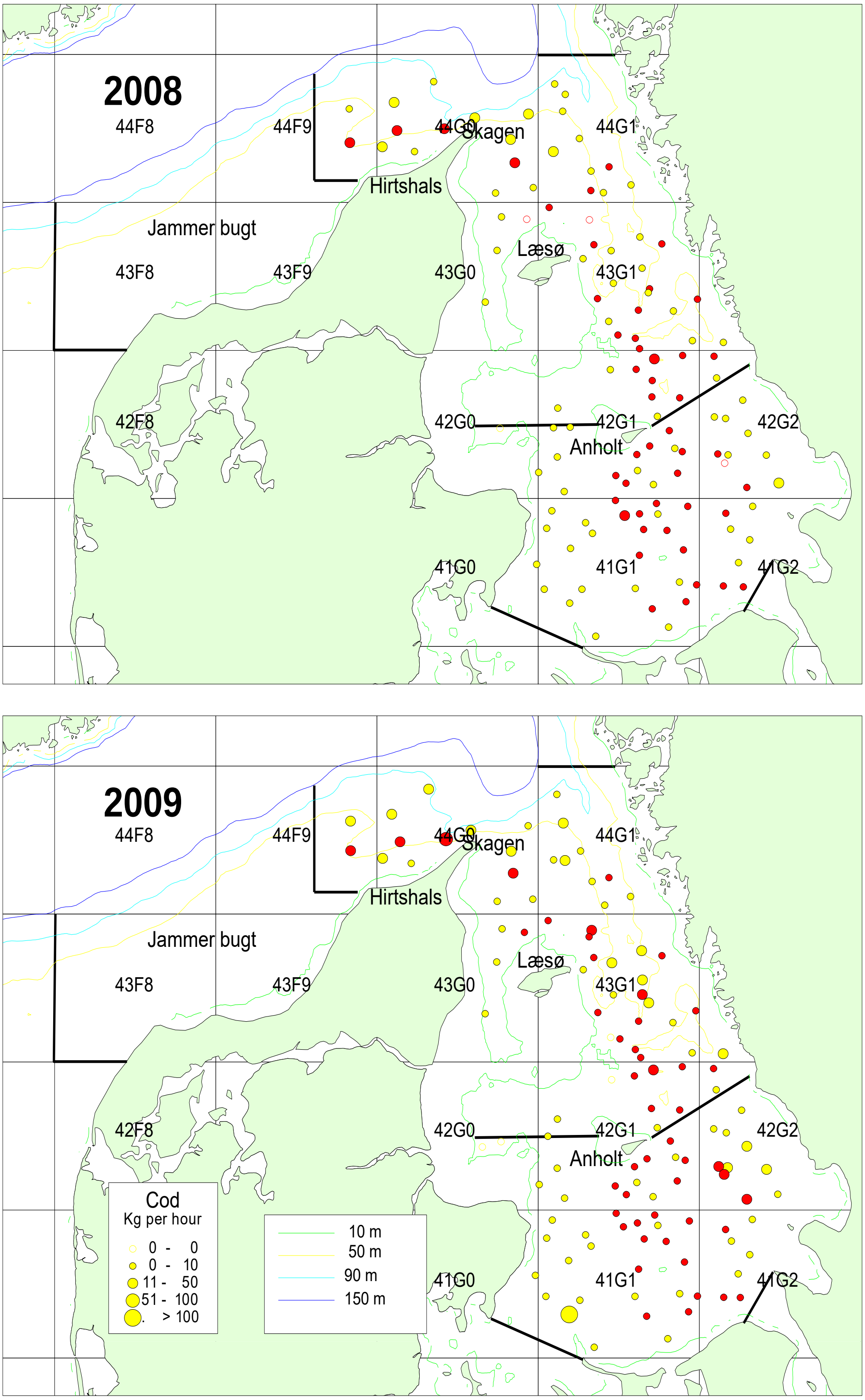
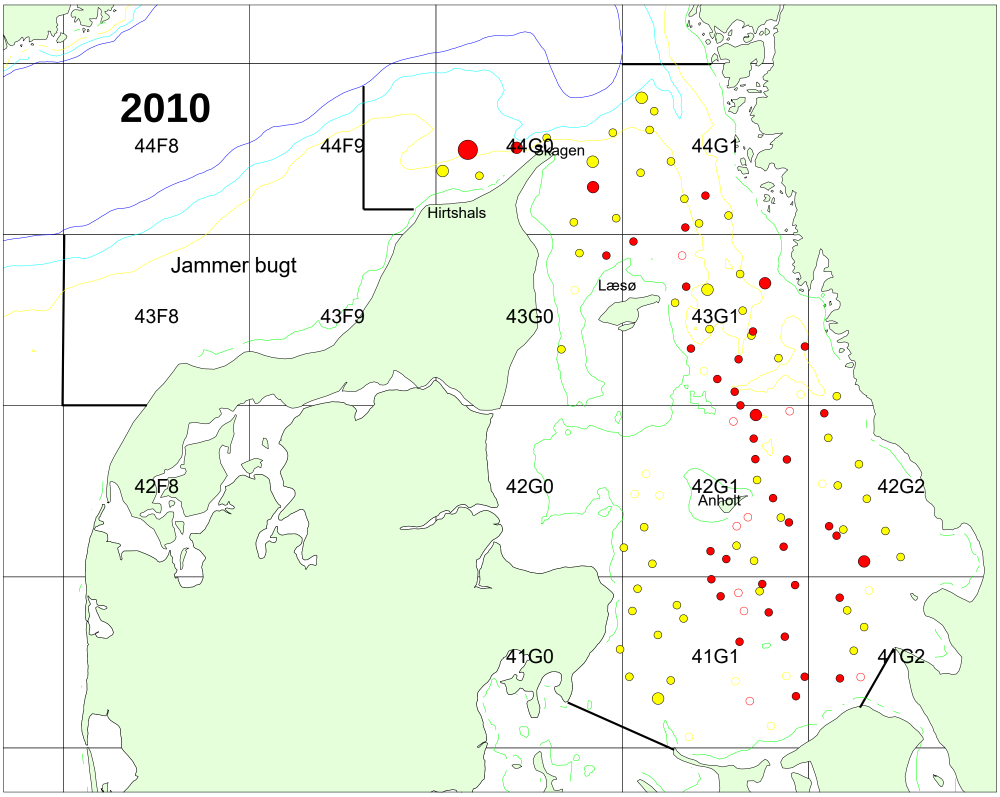


Fig. 8 cont.. Catch of cod (kg per hour) in 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.



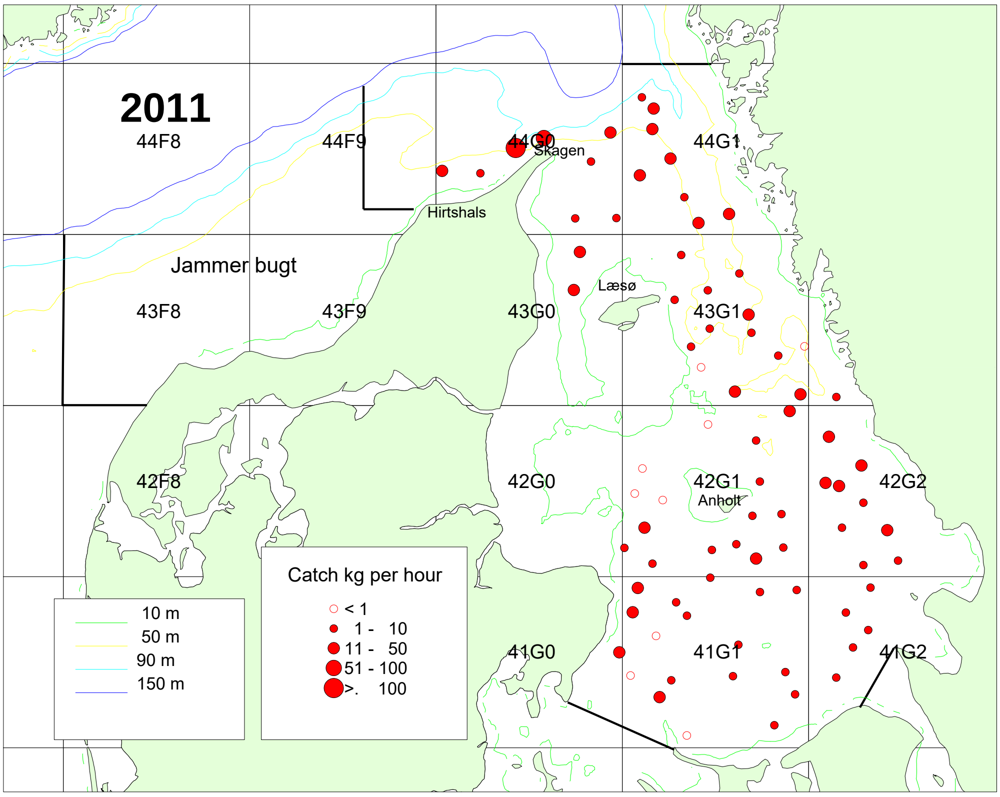
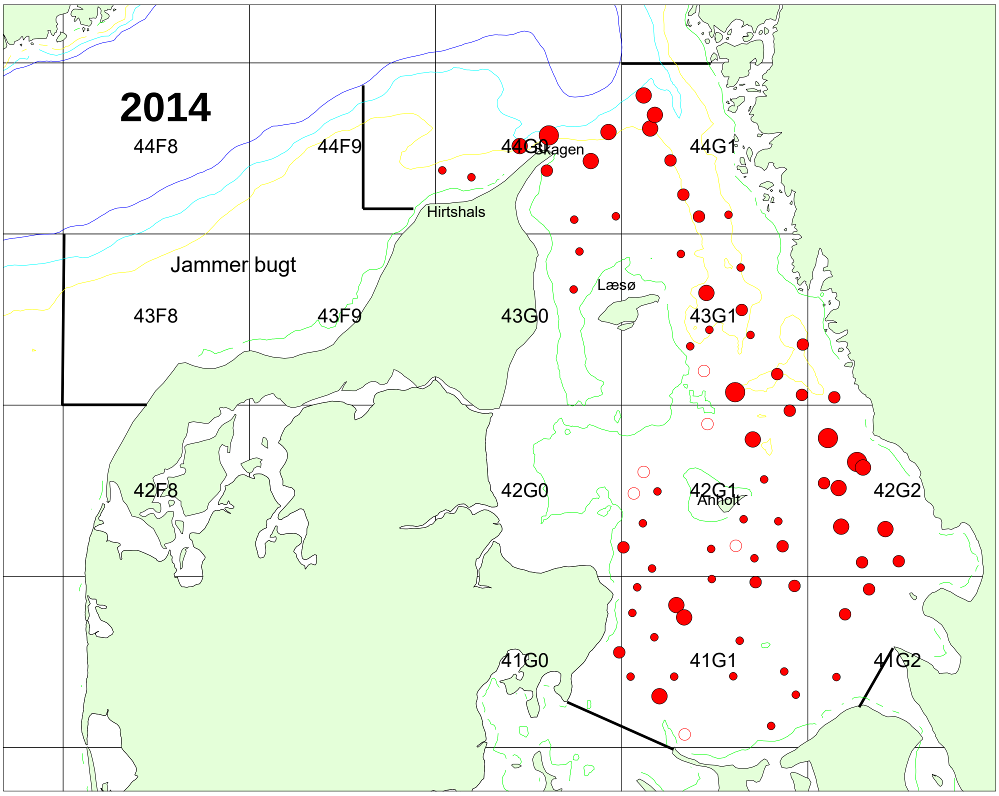


Fig. 8 cont.. Catch of cod (kg per hour) in 2010 and 2011. ● DTU AQUA stations ● Fishermen's stations.



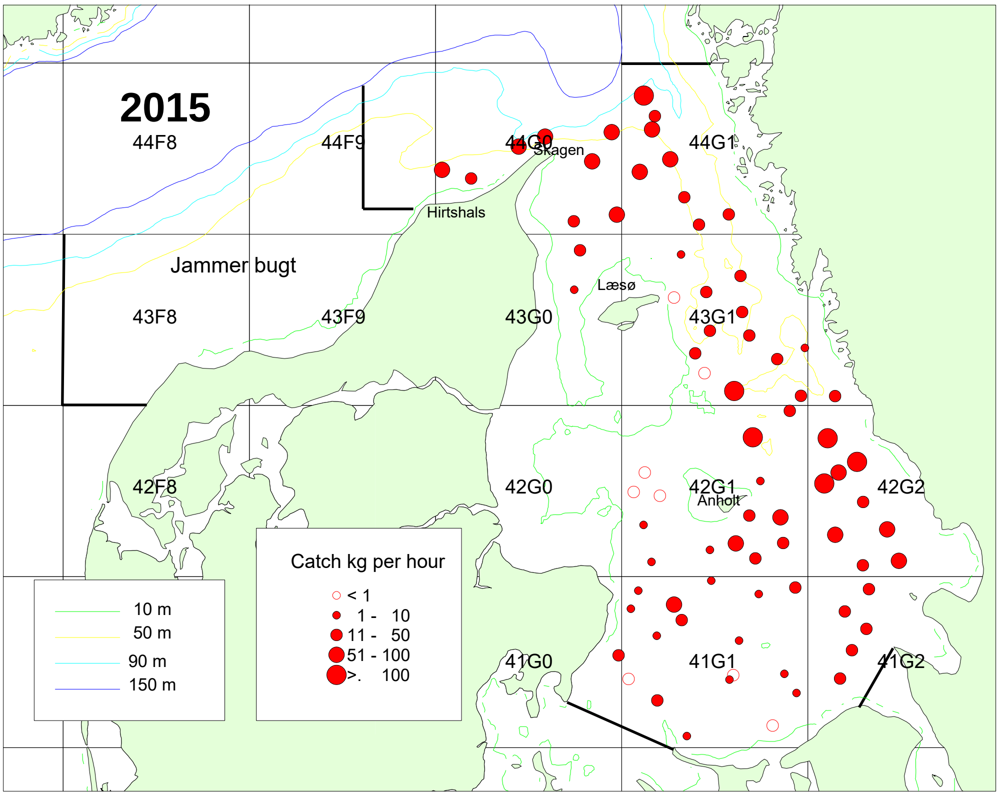


Fig. 8 cont. Catch of cod (kg per hour) in 2014 and 2015.

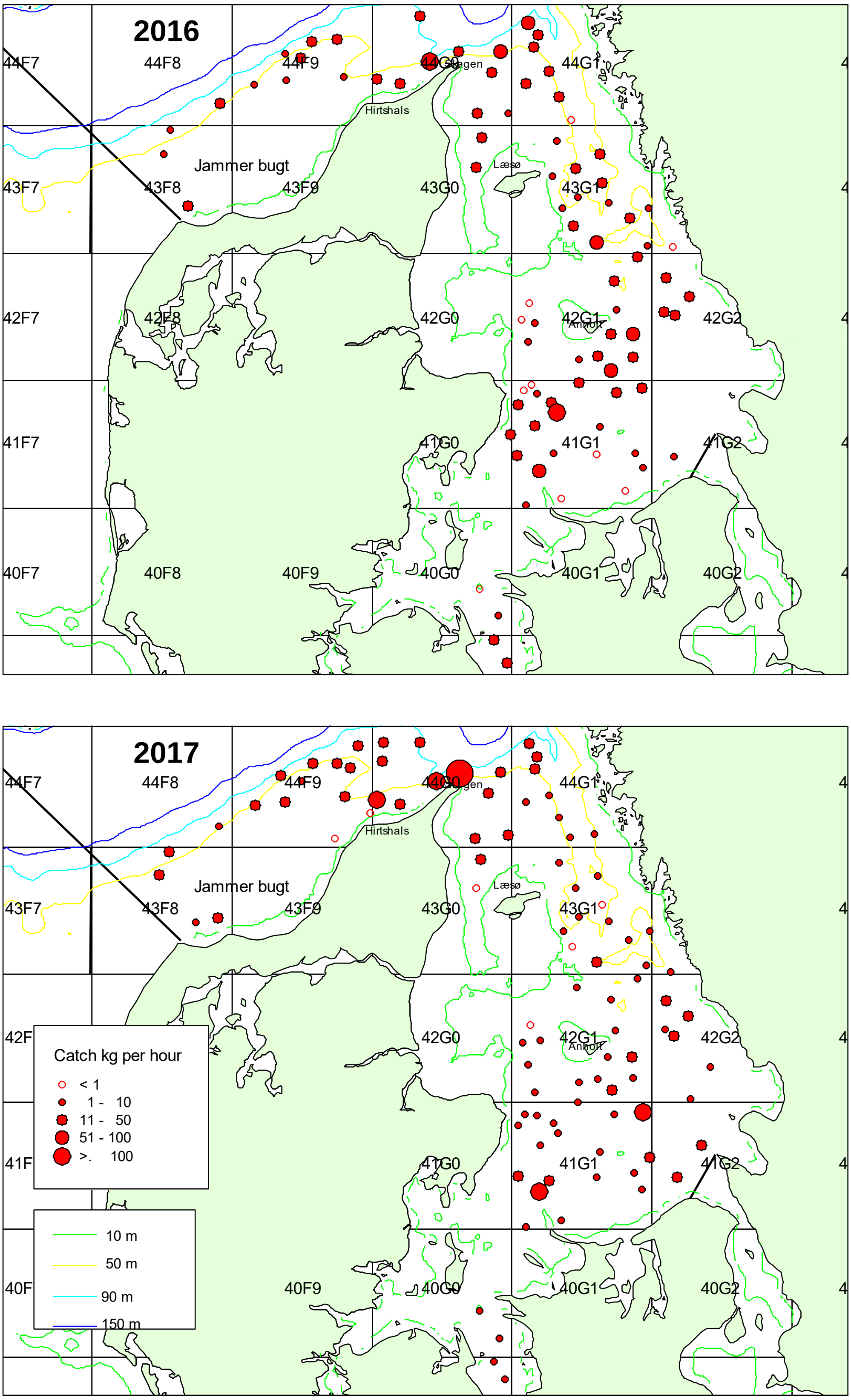


Fig. 8 cont. Catch of cod (kg per hour) in 2016 and 2017.

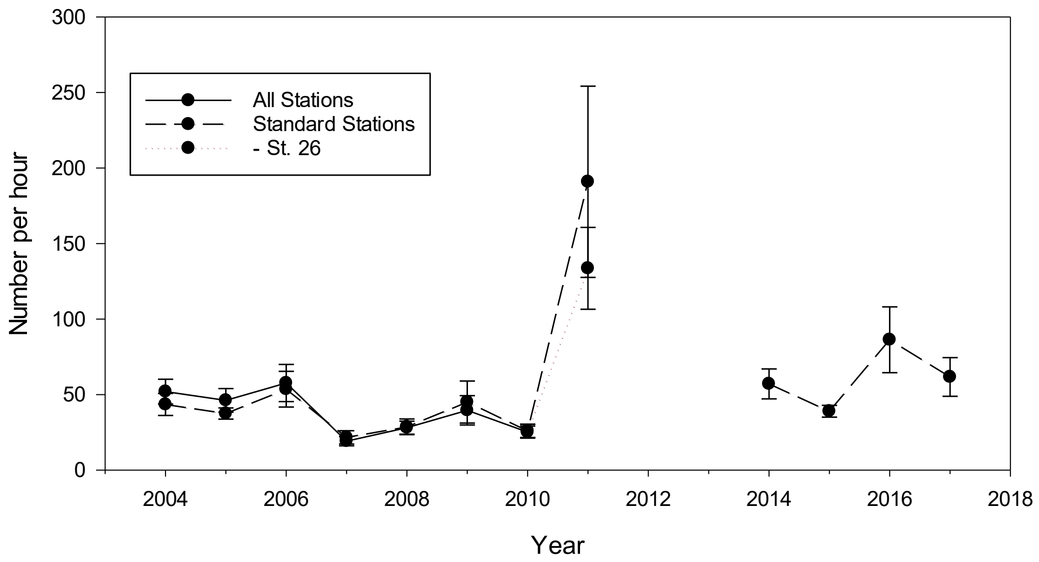


Fig. 9. Catch of cod in number per hour based on 116 stations and Standard Stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

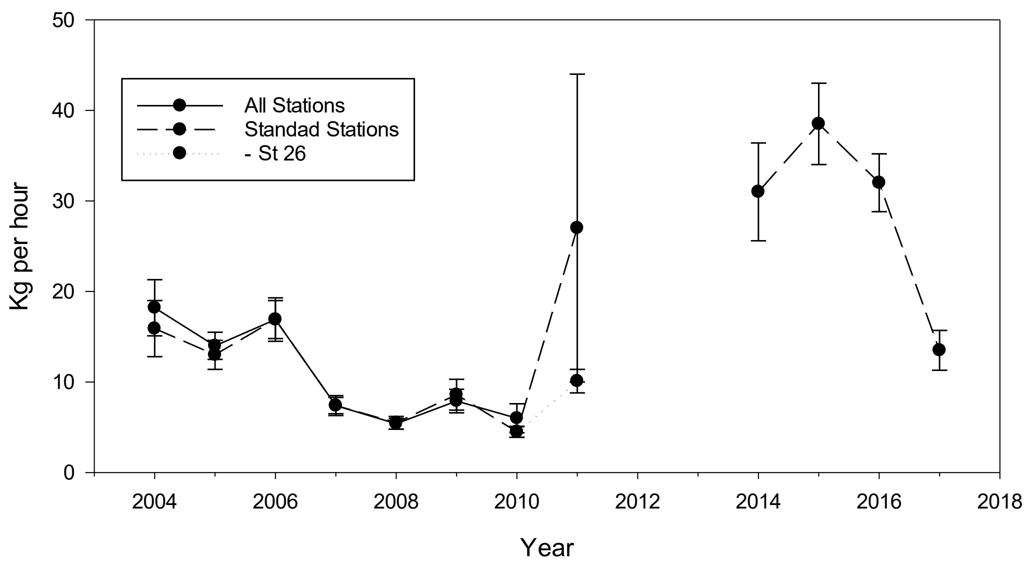


Fig. 10. Catch of cod in kg per hour based on 116 stations and standard stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

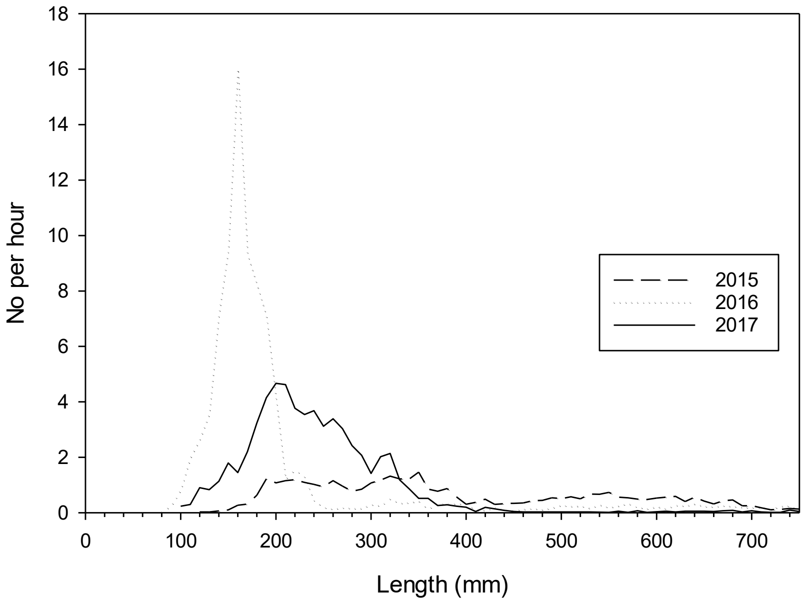


Fig 11. Length distribution of cod standardized to number caught hour^{-1}.

Length distribution
The length ranged from 10 to 87 cm with broad mode around 20 cm, probably the remains of the good recruitment at 16 cm seen in 2016 (Fig. 11).

Biomass and abundance
The biomass of cod increased from record low 373.8 tons in 2010 to record high 2308.1 tons in 2011. A similar increase was seen for the abundance from 2.1 mill. to 16.4 mill. (Table 8). The increase in both biomass and abundance was to a large extent driven by the large catch at st. 26. This station is located in Division 44G0 where about ¾ of the biomass and ½ abundance was located (Table 9 and 10), but there was seen an increase in both biomass and abundance in all Divisions between 2010 and 2011. The biomass remained at the 2011 level in 2014 (2538.6 tons) and 2015 (2812.2 tons) but declined to 1497. 3 tons in 2016, while the abundance almost doubled between 2015 and 2016 to 5.4 mill. (Table 8). In 2017 the biomass decreased to 962.6 tons and the abundance to 4.1 mill.

The highest biomass and abundance and densities both in kg and numbers were found in 44G0 (Table 9 and 10).

Table 8. Swept area biomass and abundance of cod with 1* S.E. and number of hauls. Including 5 new stations from Jammerbugt in 2016.

Year	BIOMASS	SE BM	ABUNDAN	SE AB	Haul
2004	1479.9	284.2	4021655.9	688225.4	68
2005	1106.7	111.0	3279389.4	294383.8	77
2006	1418.6	161.4	4527585.5	864192.6	78
2007	677.2	92.0	2144422.9	311316.0	75
2008	469.6	50.7	2483771.1	410041.5	80
2009	723.0	133.8	3874034.2	1051067.6	78
2010	373.8	50.1	2096501.5	296055.9	79
2011	2308.1	1465.7	16417225.3	5076904.6	80
2014	2538.6	397.4	4711426.1	755373.0	77
2015	2812.2	261.4	2883636.9	249315.9	78
2016	1497.3	186.7	5483120.6	1225055.4	74
2017	962.6	131.4	4095684.5	676784.3	72

Table 9. Cod 2017. Area, number of hauls, mean biomass per km^2 (tons), biomass (tons) and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Biomass	SE
41G1	3357.6	18	0.0612	205.4	66.3
41G2	1421.2	2	0.0660	93.9	20.9
42G1	3039.6	15	0.0261	79.2	18.2
42G2	2003.8	6	0.0458	91.7	21.1
43G0	721.5	2	0.0330	23.8	21.9
43G1	2460.9	12	0.0206	50.7	10.9
43G2	331.3	1	0.0161	5.3	.
44G0	1881.5	8	0.1857	349.4	104.3
44G1	1914.9	8	0.0330	63.2	12.5
All			0.0562	962.6	131.4

Table 10. Cod 2017. Area, number of hauls, mean abundance per km^2, abundance and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Abundace	SE
41G1	3357.6	18	331.2	1112143.9	566380.8
41G2	1421.2	2	121.3	172418.7	1329.2
42G1	3039.6	15	115.0	349651.6	66784.0
42G2	2003.8	6	156.7	313915.4	42006.5
43G0	721.5	2	125.6	90615.0	70781.9
43G1	2460.9	12	97.3	239399.3	45566.4
43G2	331.3	1	110.1	36479.1	.
44G0	1881.5	8	739.4	1391264.3	343311.5
44G1	1914.9	8	203.6	389797.3	68872.7
All			239.1	4095684.5	676784.3

Plaice

In 2017 plaice were caught at all 72 valid stations (Fig. 12). The largest catches were generally taken east of Djursland.

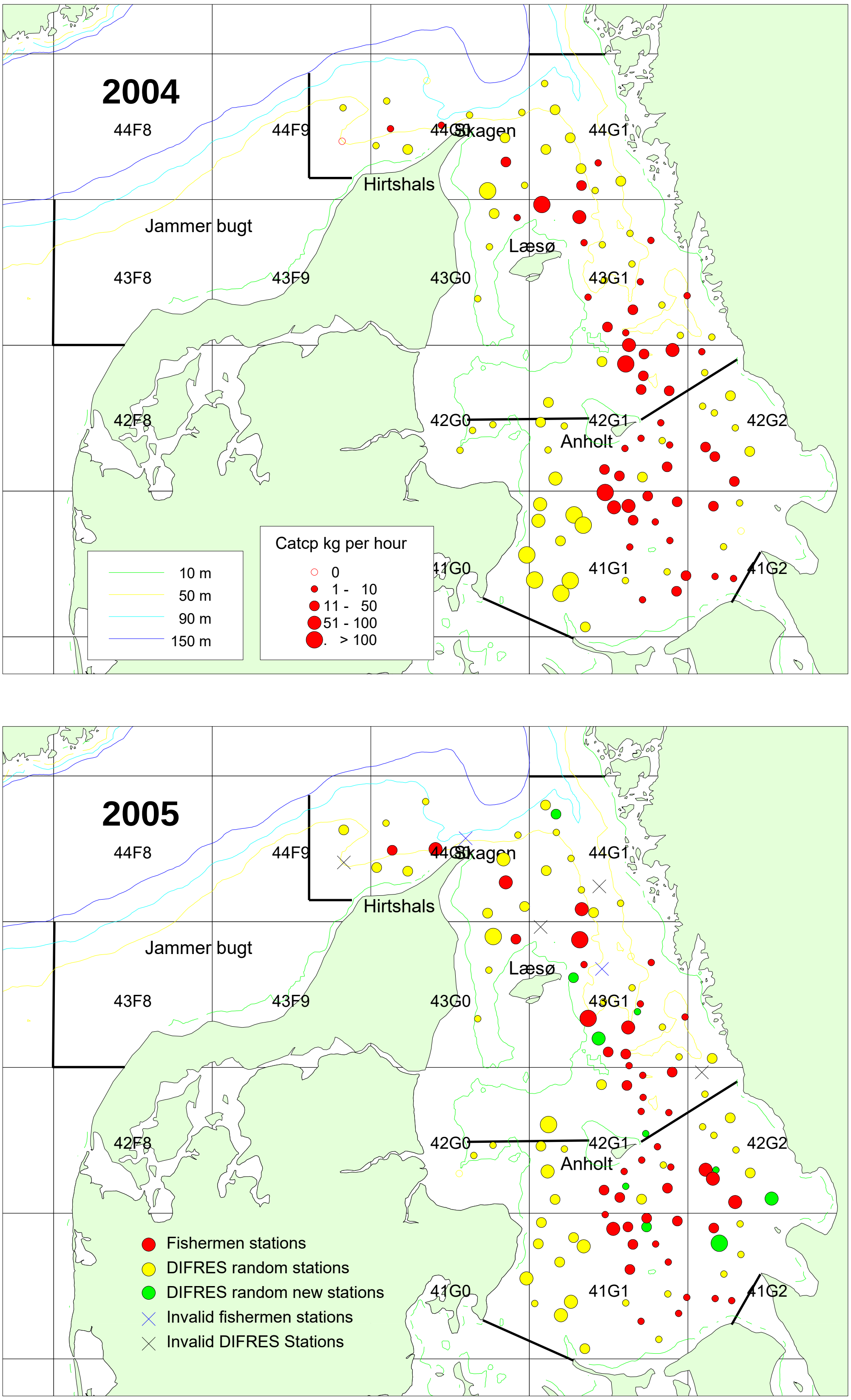


Fig. 12. Catch of plaice (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.

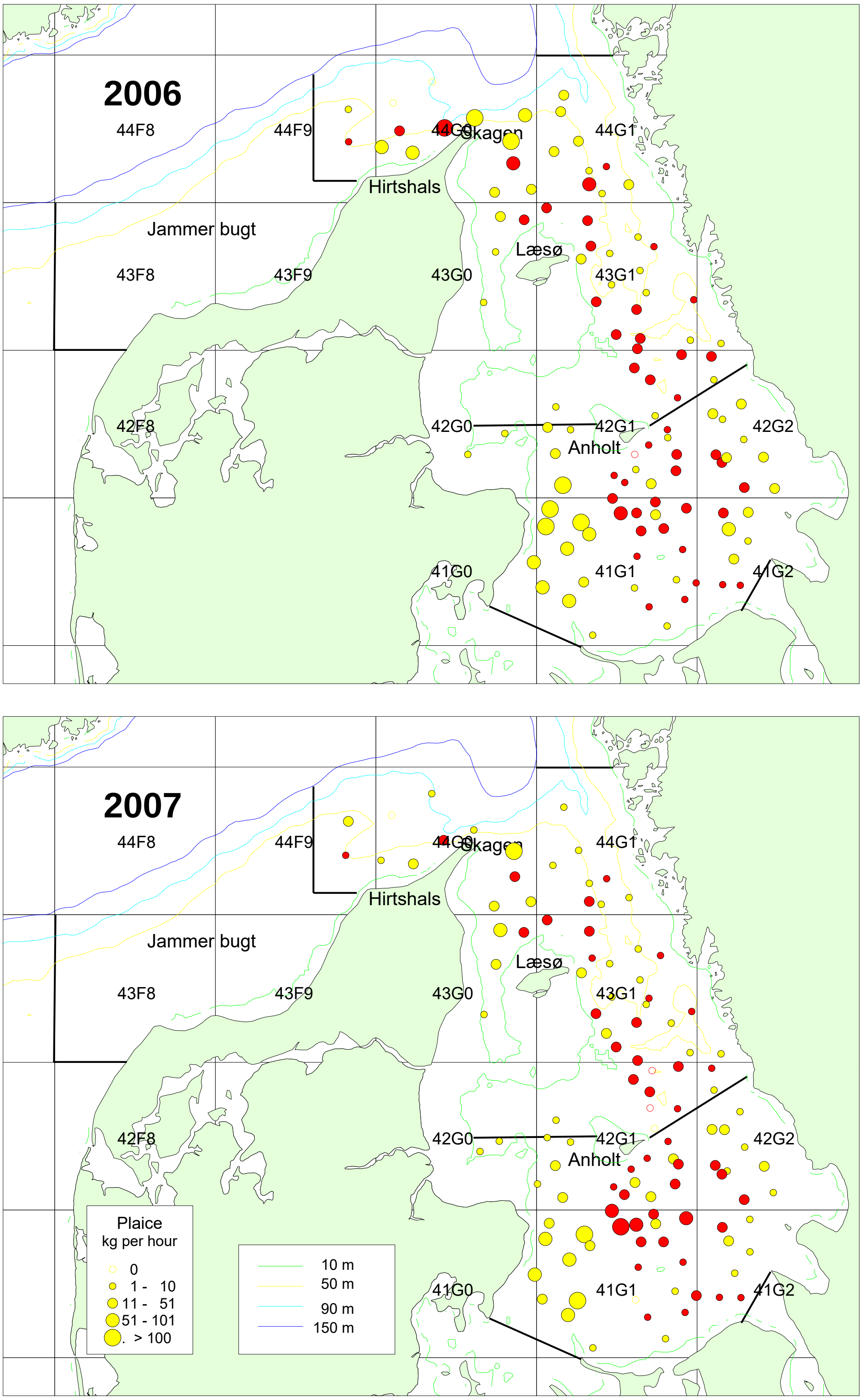


Fig. 12 cont.. Catch of plaice (kg per hour) in 2006 - 2007. ● DTU AQUA stations ● Fishermen's stations.

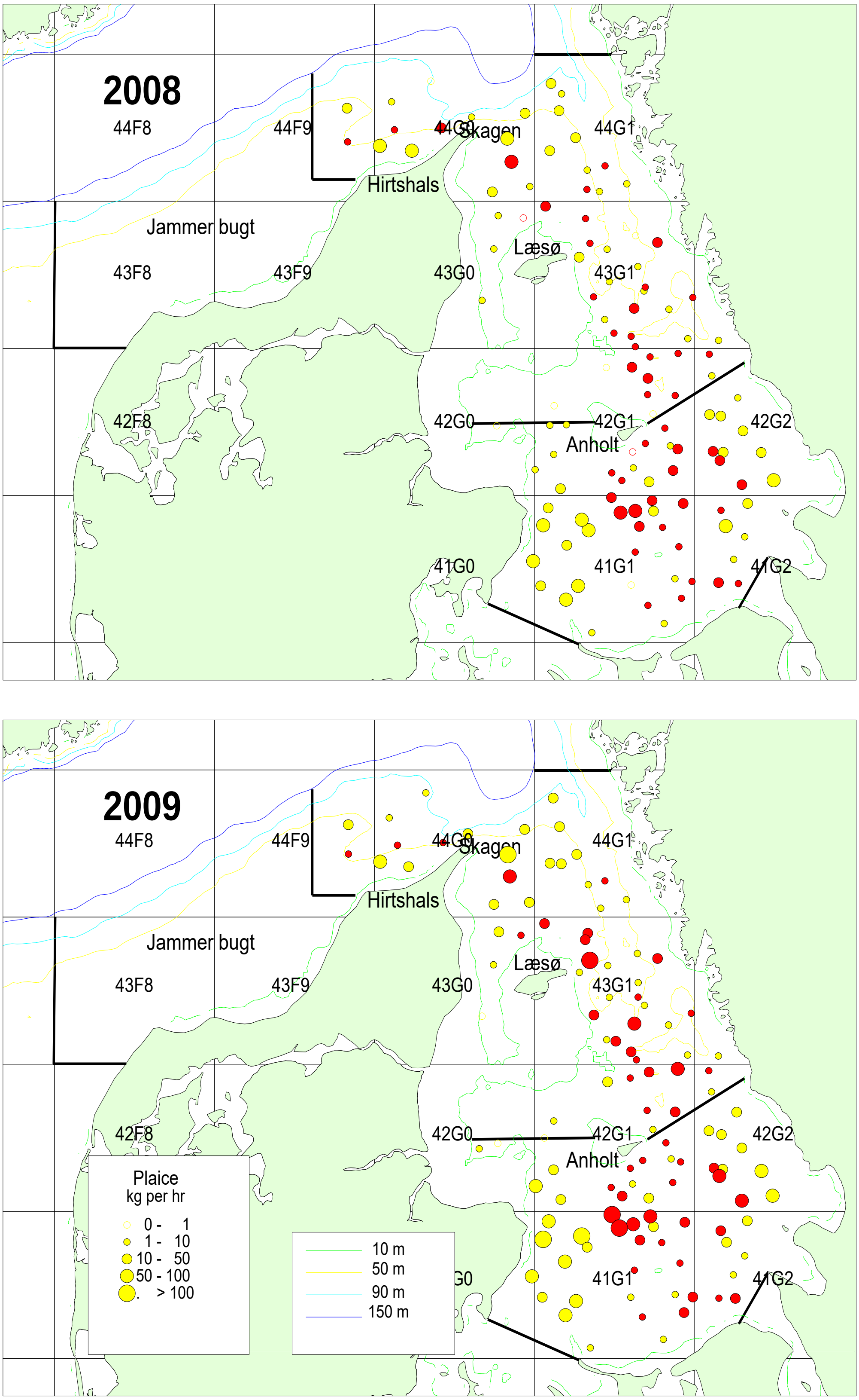


Fig. 12 cont.. Catch of plaice (kg per hour) in 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.

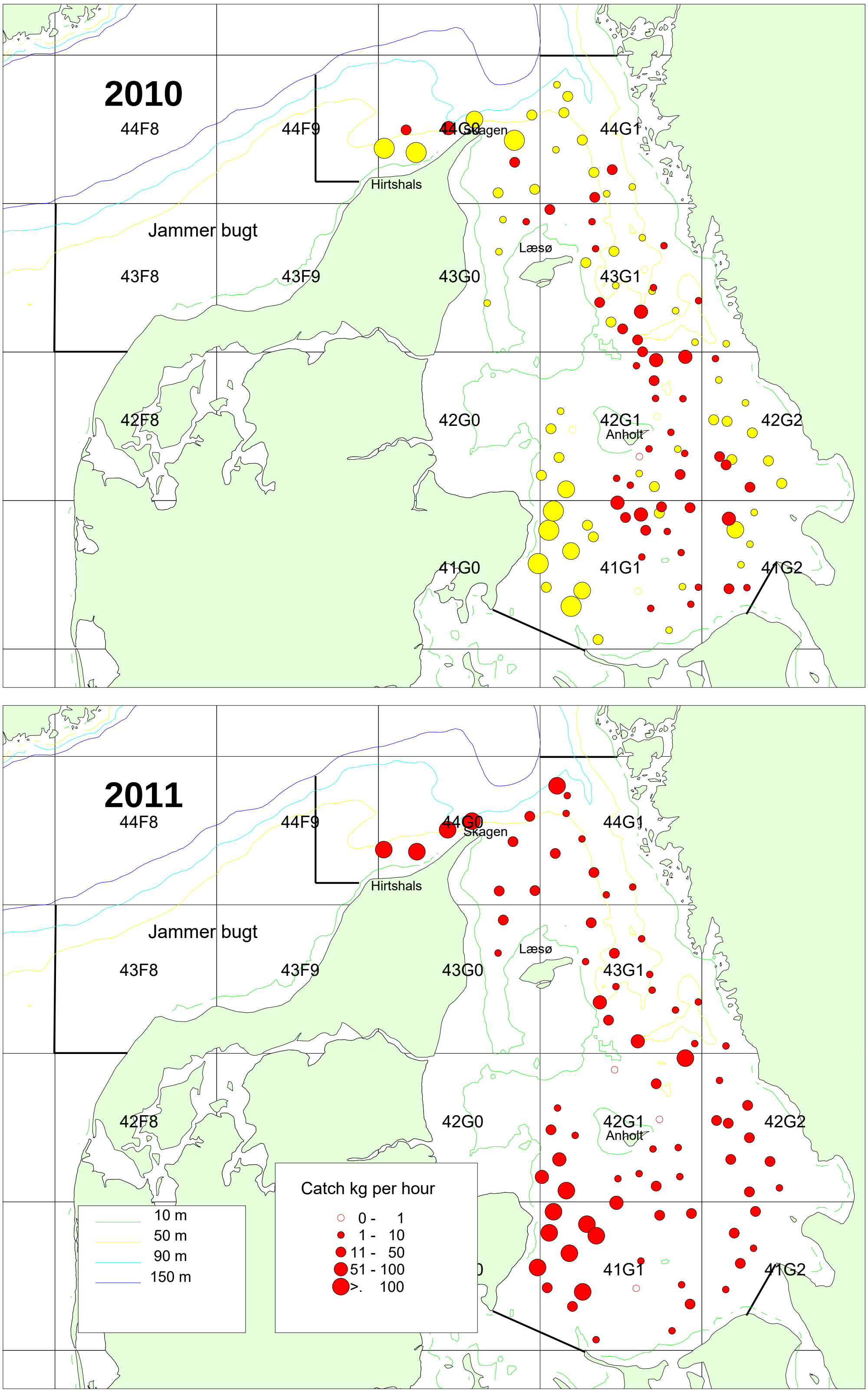
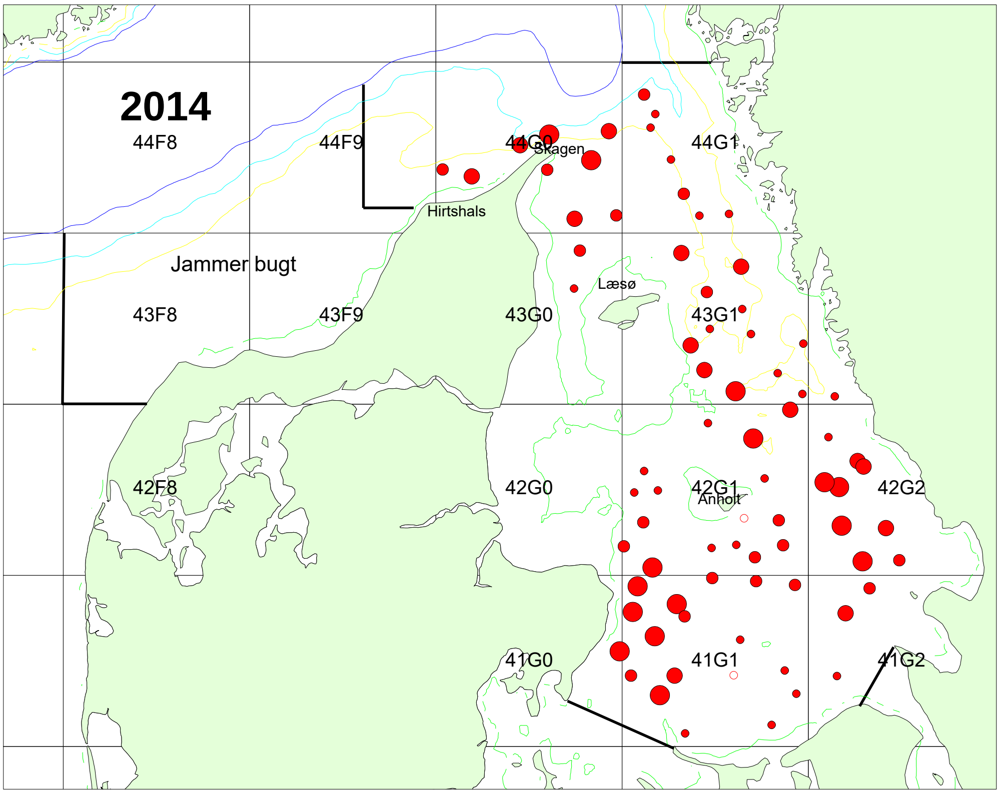


Fig. 12 cont.. Catch of plaice (kg per hour) in 2010 and 2011. 2010 ● DTU AQUA stations ● Fishermen's stations.



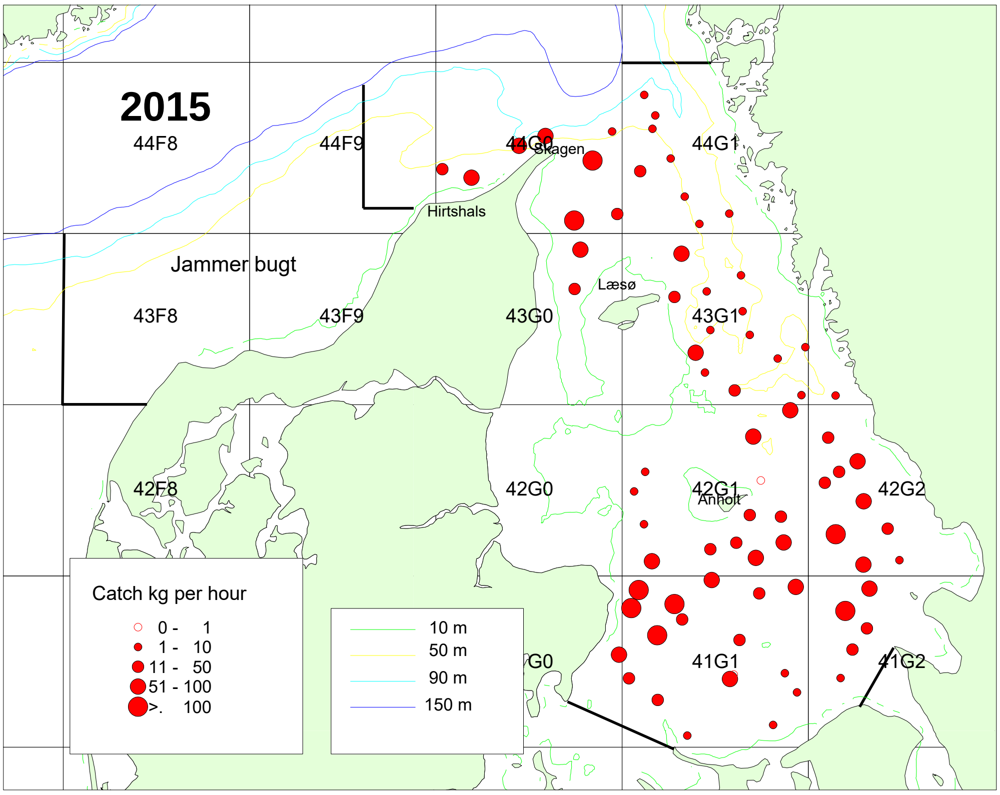
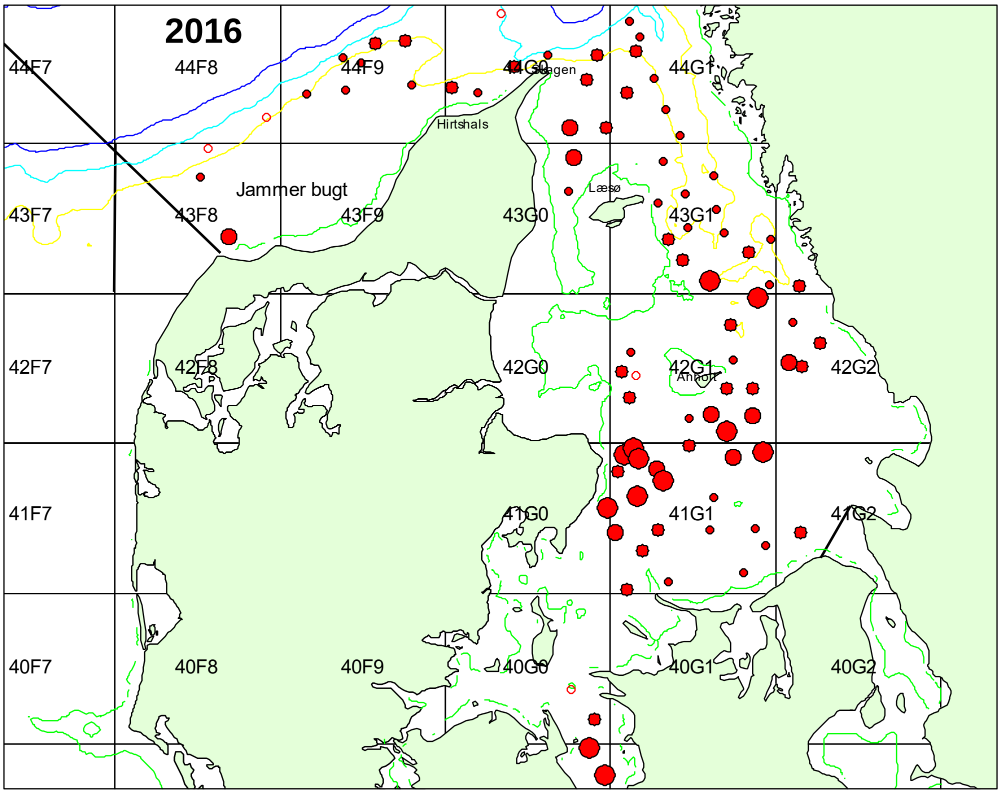


Fig. 12 cont.. Catch of plaice (kg per hour) in 2014 and 2015.



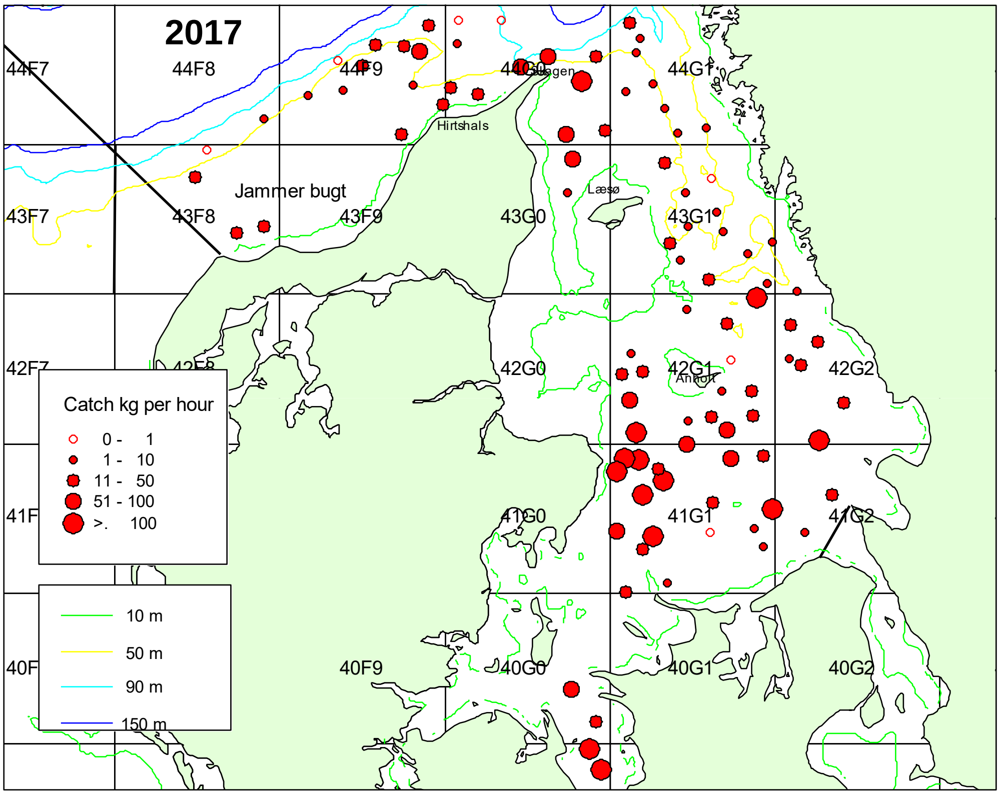


Fig. 12 cont.. Catch of plaice (kg per hour) in 2016 and 2017.

CPUE

CPUE of plaice was relatively stable between 2004 and 2006 but decreased between 2006 and 2007. Since 2008 the CPUE has been gradually increasing and was 70.2 kg hour^{-1} and 449.5 specimens hour^{-1} in 2011, which is the highest level in the time series (Table 11, Fig. 13 and 14). The increase in CPUE was, however, to some extend driven by one large haul (st. 26 1546.2 kg / 5413.8 specimens). If that haul is excluded the CPUE was 51.5 kg and 386.7 specimens, respectively, which is, however, still the highest in the time series. In 2014 the CPUE in numbers decreased compared to 2011 while the CPUE in weight increased. The CPUE in numbers and weight decreased in 2015 to 221 hr $^{-1}$ and 45.4 kg hr $^{-1}$ to a level slightly above average for the time series.The CPUE both in number and weight increased again in 2016 to the second largest level to 353.3 hr $^{-1}$ and 66.2 kg hr $^{-1}$. The CPUE in number in 2017 remained at the same level as in 2016 (384.4 hr^{-1}, but CPUE in weigh decreased to 55. 6 kg hr^{-1} in 2017 (Table 11 and Fig. 13-14).

Table 11. CPUE of plaice by year in number and kg per hour with S.E and number of valid hauls.

Year	Number	SE Number	Weight	SE Weight	n
2004	206.5	41.6	32.1	5.9	69
2005	213.1	41.1	30.6	4.8	78
2006	224.6	47.3	42.3	9.7	76
2007	139.0	25.2	24.5	4.4	75
2008	151.9	31.8	28.0	7.3	80
2009	209.7	33.5	29.5	4.5	78
2010	267.1	65.1	43.8	14.2	79
2011	449.5	100.0	70.2	21.0	80
2011	386.7*	78.9	51.5	9.9	79
2014	296.2	49.3	58.4	9.0	77
2015	221.9	42.7	45.4	7.0	77
2016	353.3	94.2	66.2	15.4	69
2017	384.6	84.9	55.6	11.3	72

*Excluding one large haul.

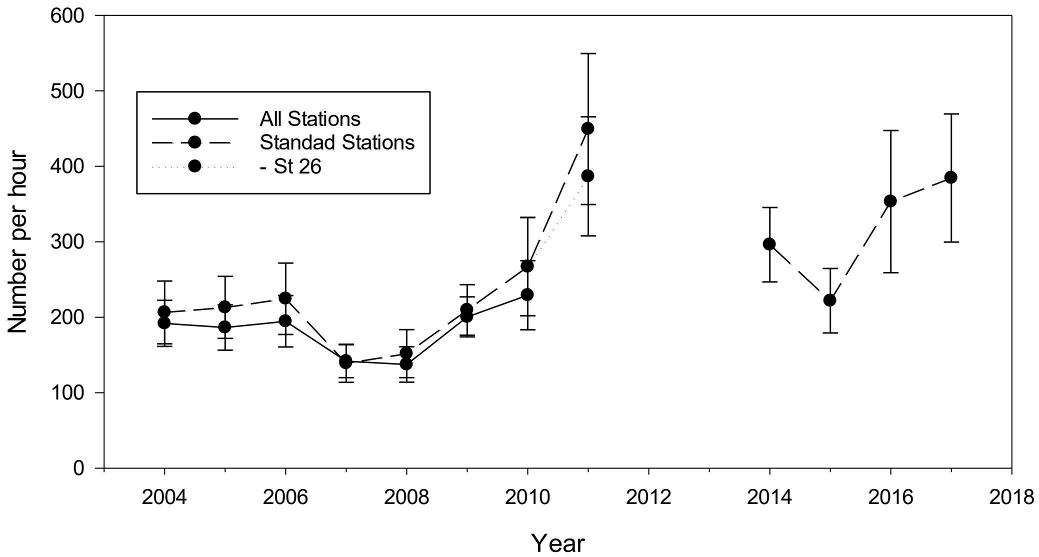


Fig. 13. Catch of plaice in number per hour based on 116 stations and standard Stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

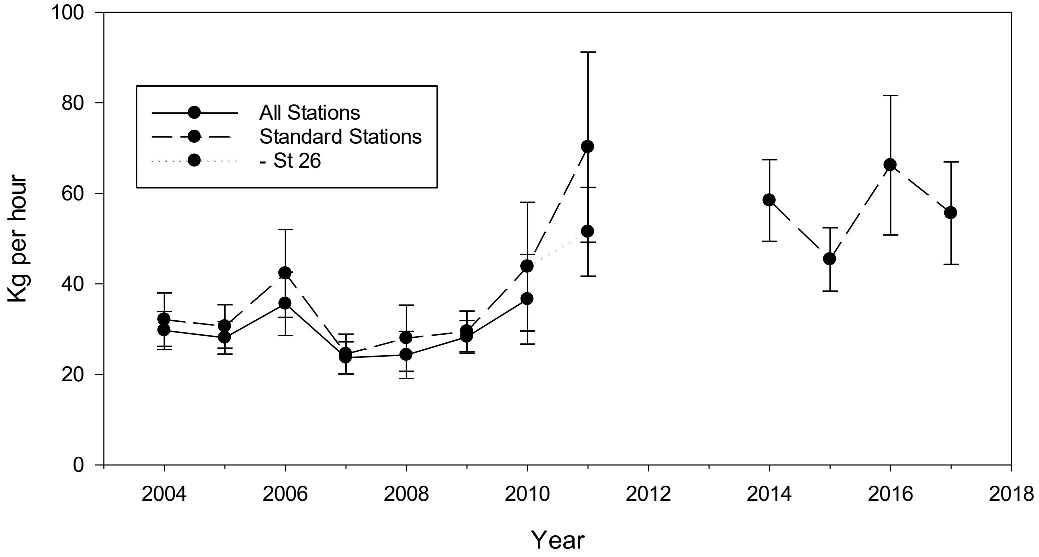


Fig. 14 Catch of plaice in kg per hour based on 116 stations and standard stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

Length distribution

The length ranged from 10 to 47 cm in 2017 with modes at 18, 21 and 23 cm and the plaice were generally smaller than in previous years and with few fish larger than 30 cm (Fig. 15).

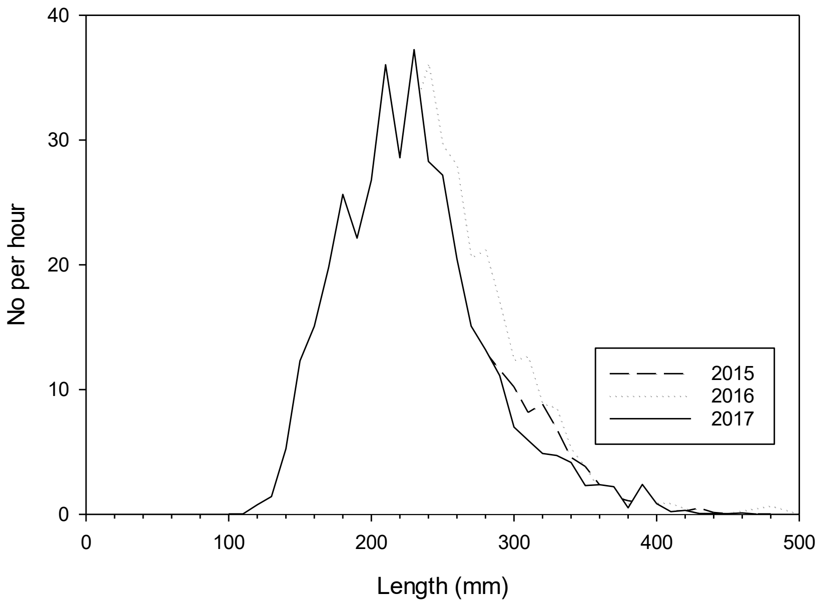


Fig. 15. Length distribution (mm) of plaice standardized to number caught per hour.

Biomass and abundance

The biomass of plaice was in 2011 estimated at 5813.8 tons which was the highest level observed. The biomass has decreased gradually since then and was in 2015 3387.3 tons which is close to the average of the time series. The biomass increased again in 2016 to 4336.5 tons but was back at the 2015 level in 2017 (3389.8 tons) (Table 12). The largest biomass and highest density was found in 41G as in previous years (Table 13).

Table 12. Swept area biomass and abundance of plaice with 1* S.E. and number of hauls. Including 5 new stations from Jammerbugt in 2016.

Year	BIOMASS	SE BM	ABUNDAN	SE AB	Haul
2004	2532.7	408.7	16162955.2	2826347.1	68
2005	2751.5	477.3	19585025.6	3976342.1	77
2006	3533.3	702.5	18873722.8	3621595.3	78
2007	2008.0	329.9	11296519.2	1819460.1	75
2008	2356.3	571.6	13296773.3	2744645.7	80
2009	2494.1	359.3	17794393.5	2653356.0	78
2010	3766.7	1172.5	22864506.7	5303737.9	79
2011	5813.8	1696.4	37275267.2	7769397.6	80
2014	4689.7	719.6	23654483.8	3832580.1	77
2015	3387.3	495.9	16536570.9	2943734.2	77
2016	4336.5	1084.2	23217565.1	6852968.8	74
2017	3398.8	602.4	23594609.7	4609664.2	72

The abundance was estimated at 32.3 mill. in 2011 but has been declining gradually since then to 16. 5 mill which is slightly below the average for the time series. The abundance increased again in 2016 to 23.2 mill. and remained at that level in 2017 (23.6 mill). The highest densities and abundance were found in 41G1 (Table 14).

Table 13. Plaice 2017. Area, number of hauls, mean biomass per km^2 (tons), biomass (tons) and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Biomass	SE
41G1	3357.6	18	0.5266	1768.2	492.9
41G2	1421.2	2	0.0648	92.2	39.3
42G1	3039.6	15	0.1556	473.1	163.2
42G2	2003.8	6	0.1281	256.7	161.8
43G0	721.5	2	0.1137	82.0	72.9
43G1	2460.9	12	0.0314	77.2	23.3
43G2	331.3	1	0.0136	4.5	.
44G0	1881.5	8	0.3166	595.6	244.0
44G1	1914.9	8	0.0258	49.5	13.0
All			0.1984	3398.8	602.4

Table 14. Plaice 2017. Area, number of hauls, mean abundance per km^2, abundance and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Abundace	SE
41G1	3357.6	18	3793.3	12736375.1	3765587.4
41G2	1421.2	2	332.3	472252.5	130073.6
42G1	3039.6	15	1025.3	3116562.7	1291626.8
42G2	2003.8	6	499.0	999982.0	625512.2
43G0	721.5	2	1672.6	1206807.2	1107641.7
43G1	2460.9	12	303.0	745627.7	281808.9
43G2	331.3	1	110.1	36479.1	.
44G0	1881.5	8	2090.2	3932725.1	1918798.3
44G1	1914.9	8	181.6	347798.2	58880.6
All			1377.2	23594609.7	4609664.2

Norway lobster (Nephrops)

In 2017 Norway lobster was caught at 56 of the 72 valid stations. The largest catches were taken east and south of Anholt, but the catches were generally low (Fig. 19).

Table 15. CPUE of Norway lobster by year in number and kg per hour with 1*S.E and number of valid hauls.

Year	Number	SE Number	Weight	SE Weight	n
2004	60.6	14.4	3.1	0.7	69
2005	146.1	34.9	5.0	1.0	78
2006	122.9	30.5	4.5	1.0	76
2007	77.8	16.2	3.1	0.5	75
2008	213.4	57.3	7.8	1.9	80
2009	149.3	28.7	7.4	1.4	78
2010	426.0	91.8	17.5	3.5	79
2011	1037.0	291.0	33.2	7.9	80
2014	121.3	31.2	6.0	1.4	77
2015	21.8	6.1	1.4	0.4	77
2016	48.6	16.7	2.4	0.8	69
2017	150.0	48.3	5.9	1.7	72

CPUE

CPUE in kg of Norway lobster peaked in 2011 where the CPUE was estimated as 33.2.1 kg hr^{-1} and 1037.0 specimens hr^{-1}, respectively (Table 15). Since then the CPUE is gradually reduced to mere 1.4 kg and 21.8 specimens hr^{-1} in 2015, respectively, by far the lowest estimate in the time series. The CPUE in both number and weight increased slightly in 2016 to 46.6 and 2.4 kg hr^{-1} but it was still the second lowest estimate in the time series. CPUE increased further in 2017 to 150.0 specimens hr^{-1} and 5.9 kg hr^{-1} (Fig. 16 and 17).

Length distribution

The length of Norway lobster ranged in 2017 from 19 to 71 mm (carapac length), with a clear mode at 34 mm and several other less distinct modes (Fig. 18).

Biomass and abundance

The biomass of Norway lobster was estimated at 2751.45 tons in 2011which is by far the highest estimate in the time series (Table 16). The increase in biomass was almost exclusively seen in Division 44G1 where about of ½ the biomass was located. The biomass decreased to 501.6 tons in 2014, and further to record low 107.4 t in 2015. The decrease in biomass was seen in all Divisions. The biomass increased slightly in 2016 to143.5 tons, to increase again to 414.2 tons in 2017. The highest biomass and densities were found in 43G2, but this estimate is based on one haul only. The second largest estimates were found in 43G1 (Table 17).

Table 16. Swept area biomass and abundance of Norway lobster with 1* S.E. and number of hauls.

Year	BIOMASS	SE BM	ABUNDAN	SE AB	Haul
2004	278.1	48.6	5366356.8	1065200.6	68
2005	438.8	84.9	12791042.7	3092800.0	77
2006	404.7	98.6	11013886.3	2913561.2	78
2007	279.4	54.5	7267886.6	1854763.6	75
2008	627.2	148.6	16889547.2	4367587.2	80
2009	636.0	122.8	13380444.5	2810844.7	78
2010	1407.8	242.5	34238366.5	6813404.0	79
2011	2761.4	613.3	87259234.4	22841241.5	80
2014	501.6	114.2	9570857.6	2242593.5	77
2015	107.4	28.1	1640162.4	429712.2	77
2016	143.5	41.5	2841449.4	888079.2	74
2017	414.2	115.3	10116265.1	3124260.9	72

The abundance was estimated at 87.3 mill. in 2011 which is an almost tripling compared to 2010 and by far the highest in the time series (Table 16). Almost all the increase in abundance was seen Division 44G1. The abundance in 2014 decreased to about 1/10 of the estimate in 2011 (9.571 mill). The abundance decreased further to record low 1.6 mill. in 2015. The reduction in abundance was seen in all Divisions (Table 18). The abundance increased slightly in 2016 to 2.8 mill, and increased further to 10.1 mill. in 2017.

The highest abundance and densities were found in 43G2, but this estimate is based on one haul only. The second largest estimates were found in 43G1 (Table 18).

There is no immediate explanation for the great increase in biomass and abundance between 2009 and 2010, but it is probably caused by a change in catchability. The increase between 2010 and 2011 was primarily seen in Division 44G1 and could be caused be a change in the distribution. There is no immediate explanation for the great decrease in biomass and abundance between 2011 and 2015, but it is probably caused by a change in catchability and poor recruitment.

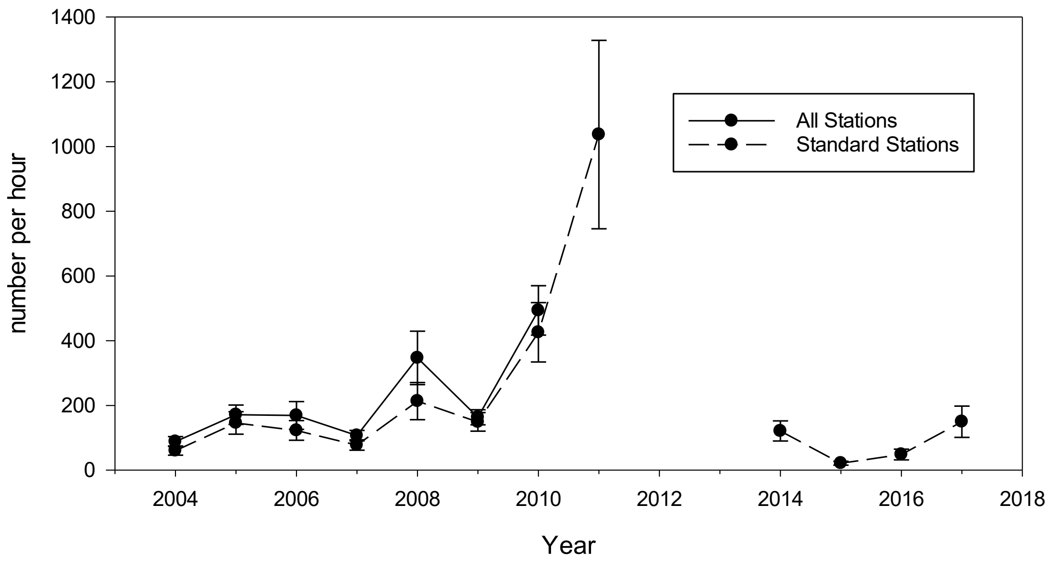


Fig. 16 Catch of Norway lobster in number per hour based on 116 stations and Standard Stations, respectively, with 1* S.E.

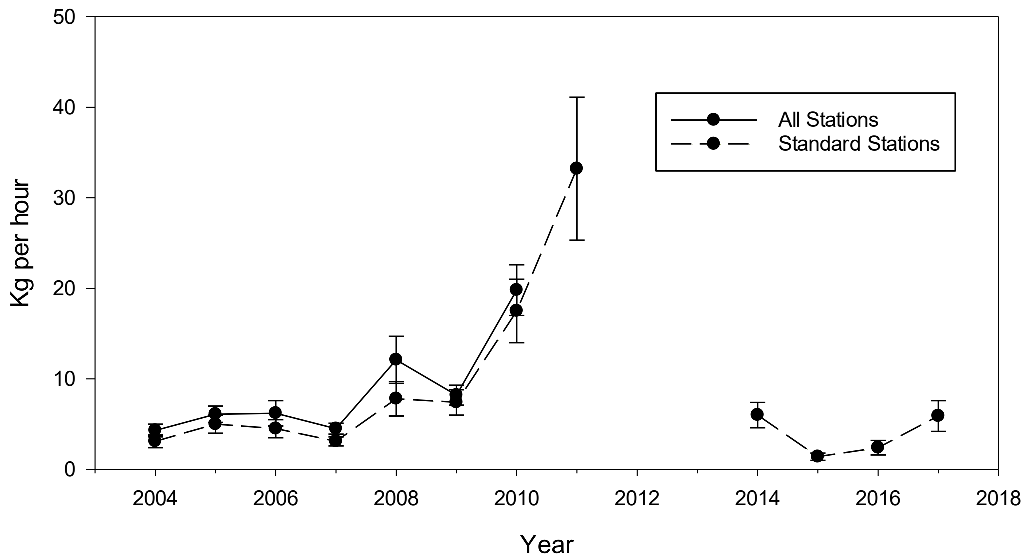


Fig. 17. Catch of Norway lobster kg per hour based on 116 stations and Standard Stations, respectively, with 1* S.E.

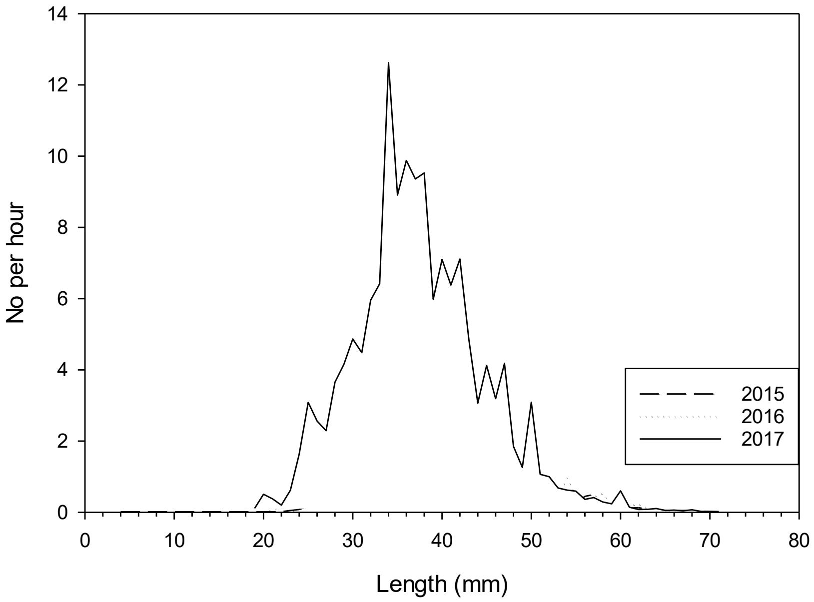
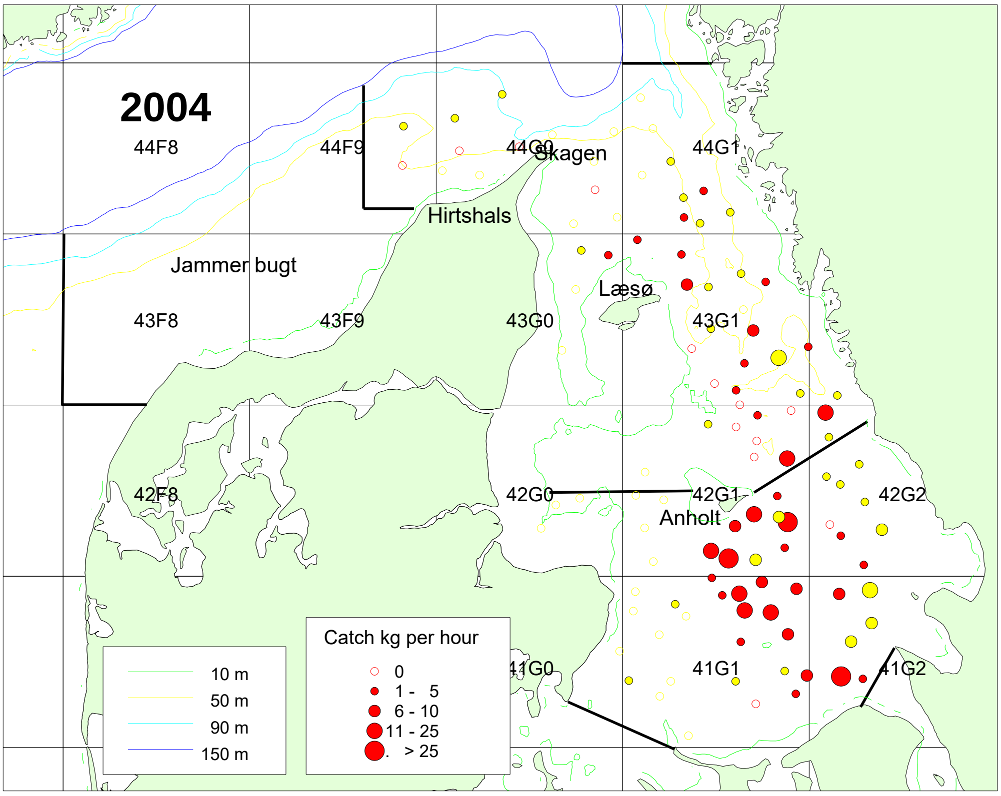


Fig.18. Length distribution (carapac length, mm) of Norway lobster standardized to number caught per hour 2015 - 2017.



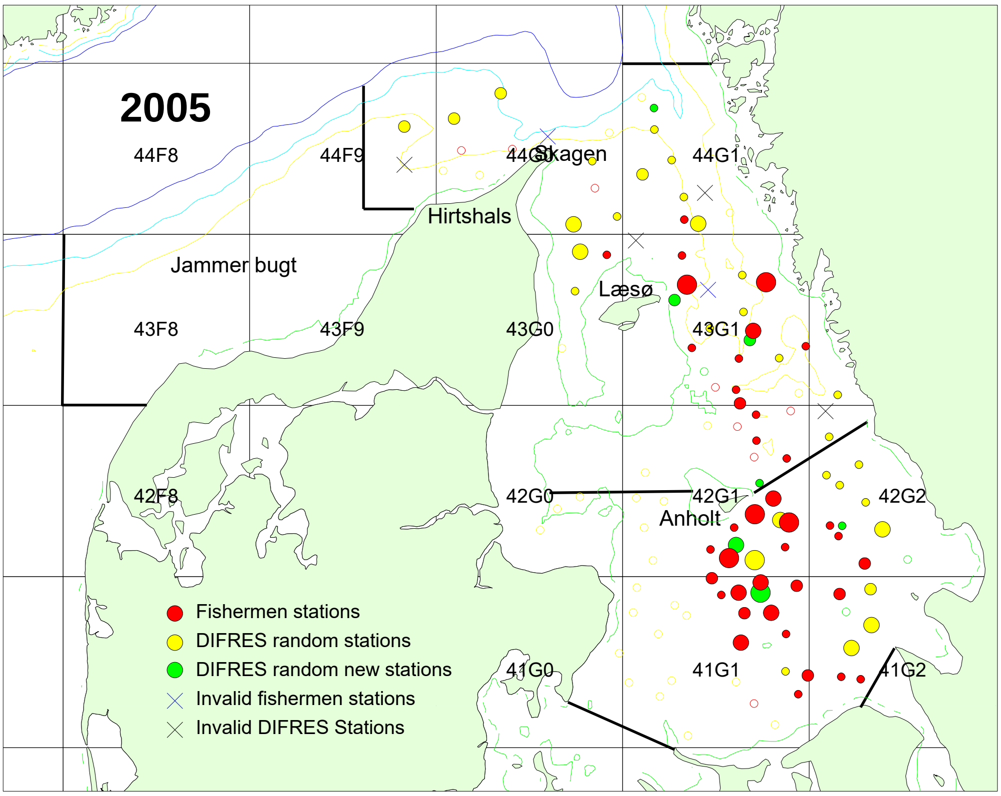
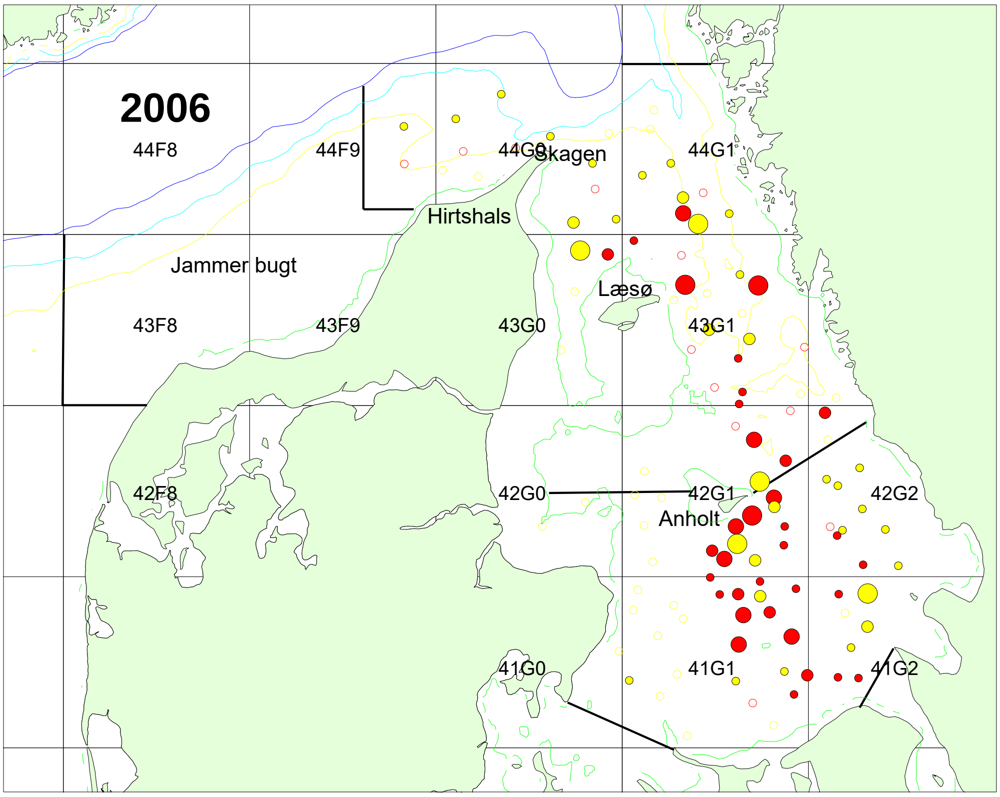


Fig. 19. Catch of Norway lobster (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.



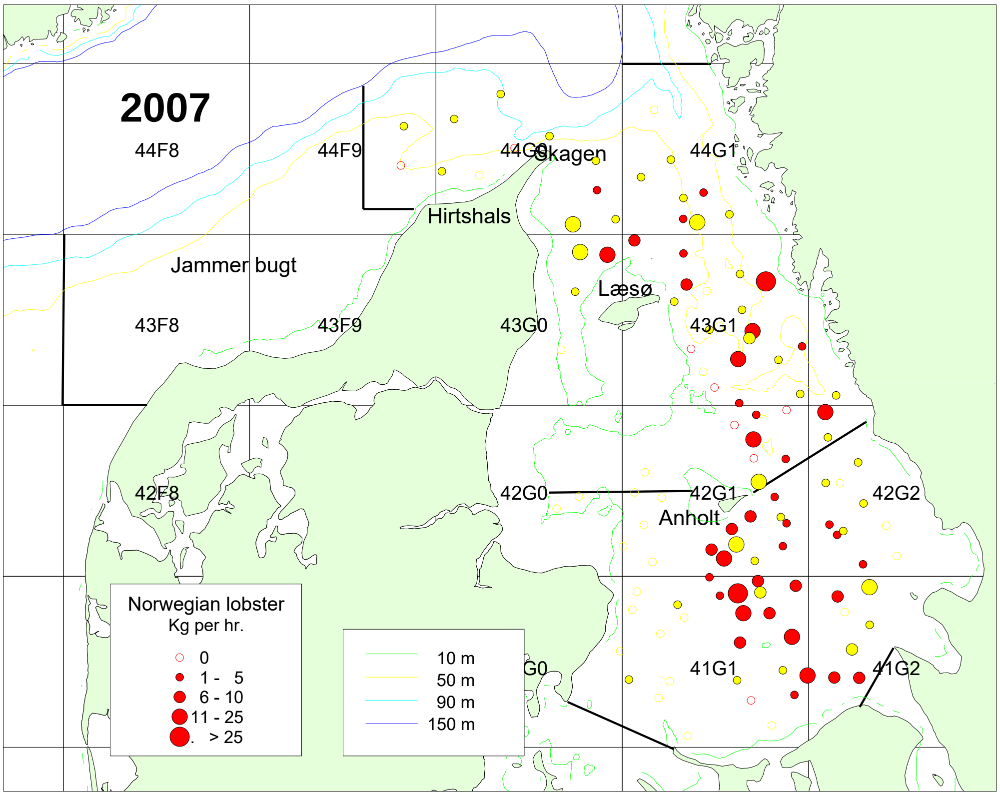
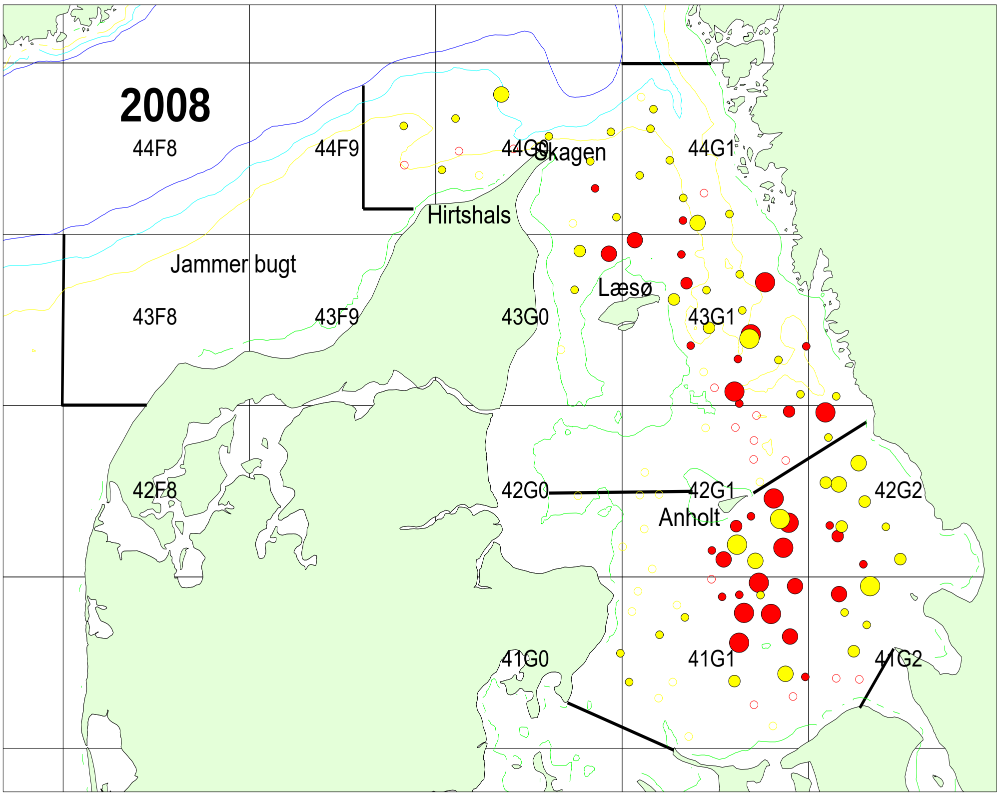


Fig. 19 cont. Catch of Norway lobster (kg per hour) in 2006 2007. ● DTU AQUA stations ● Fishermen's stations.



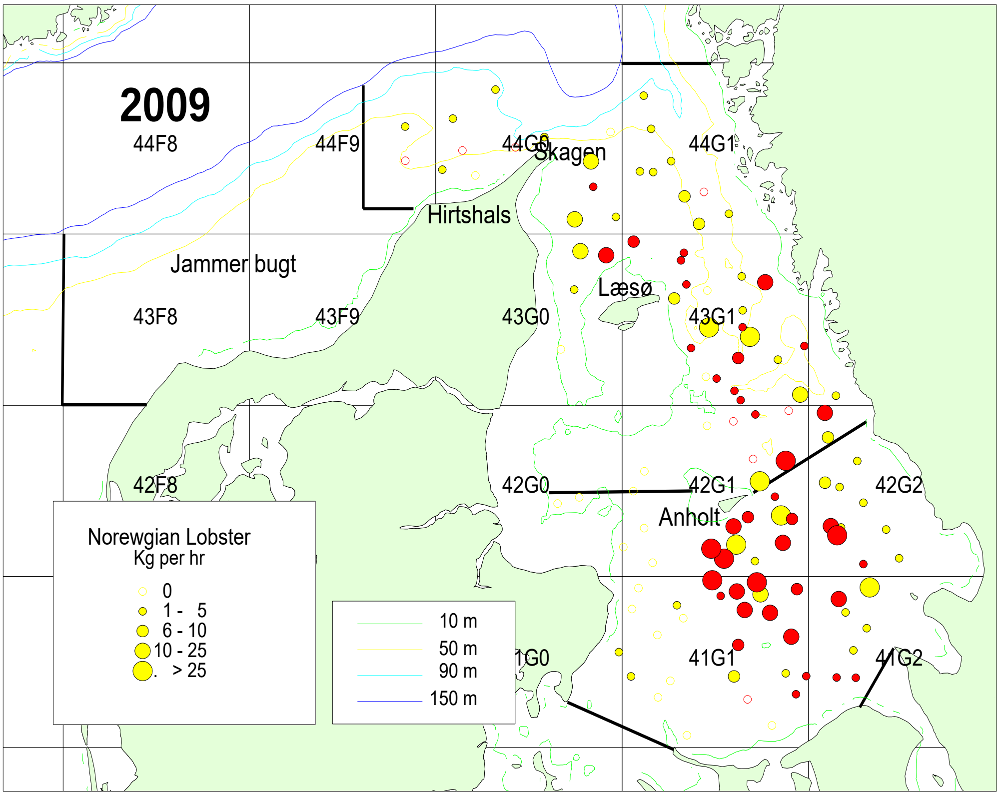
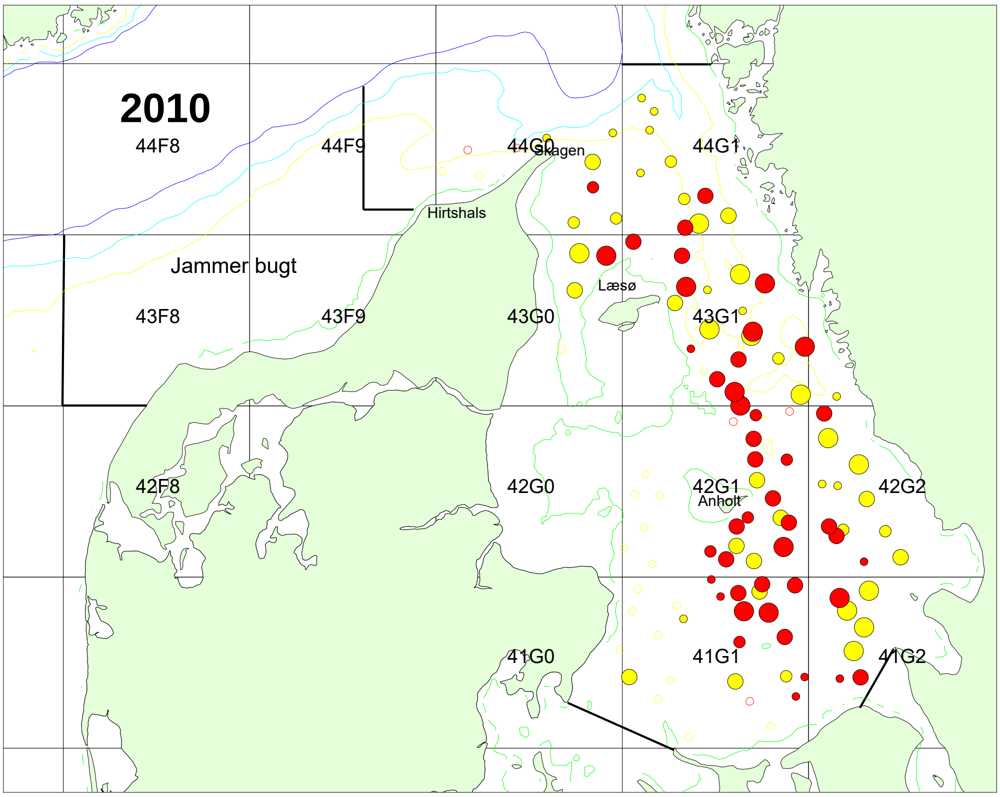


Fig. 19 cont. Catch of Norway lobster (kg per hour) in 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.



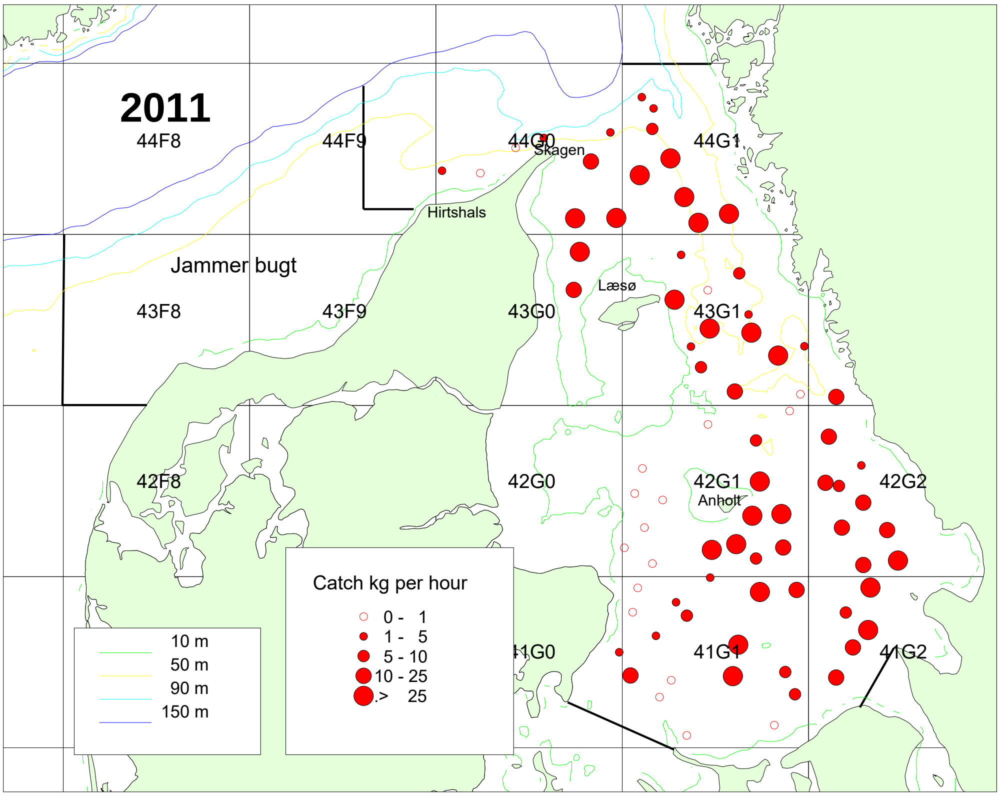


Fig. 19 cont. Catch of Norway lobster (kg per hour) in 2010 and 2011. 2010● DTU AQUA stations ● Fishermen’s stations.

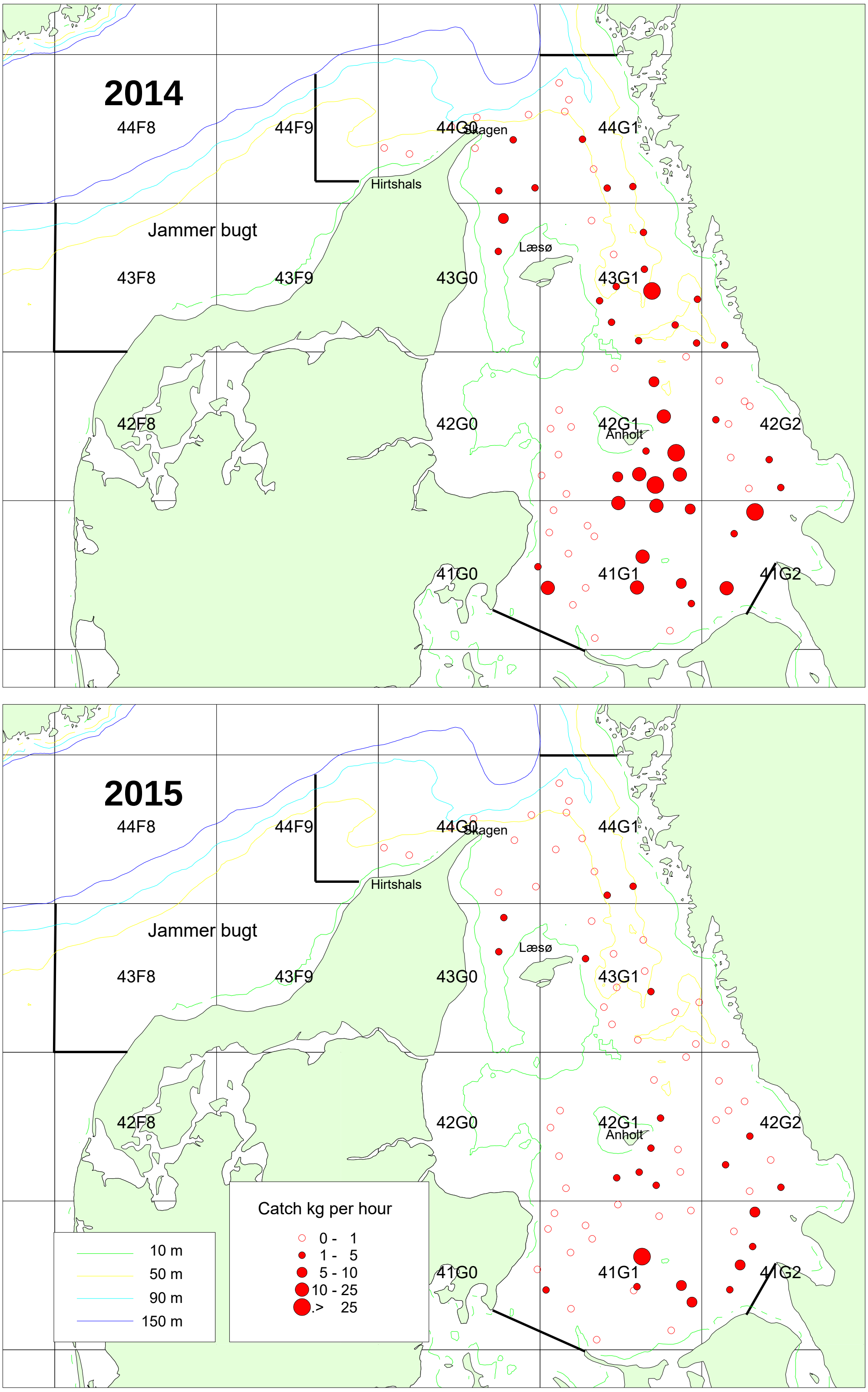


Fig. 19 cont. Catch of Norway lobster (kg per hour) in 2014 and 2015.

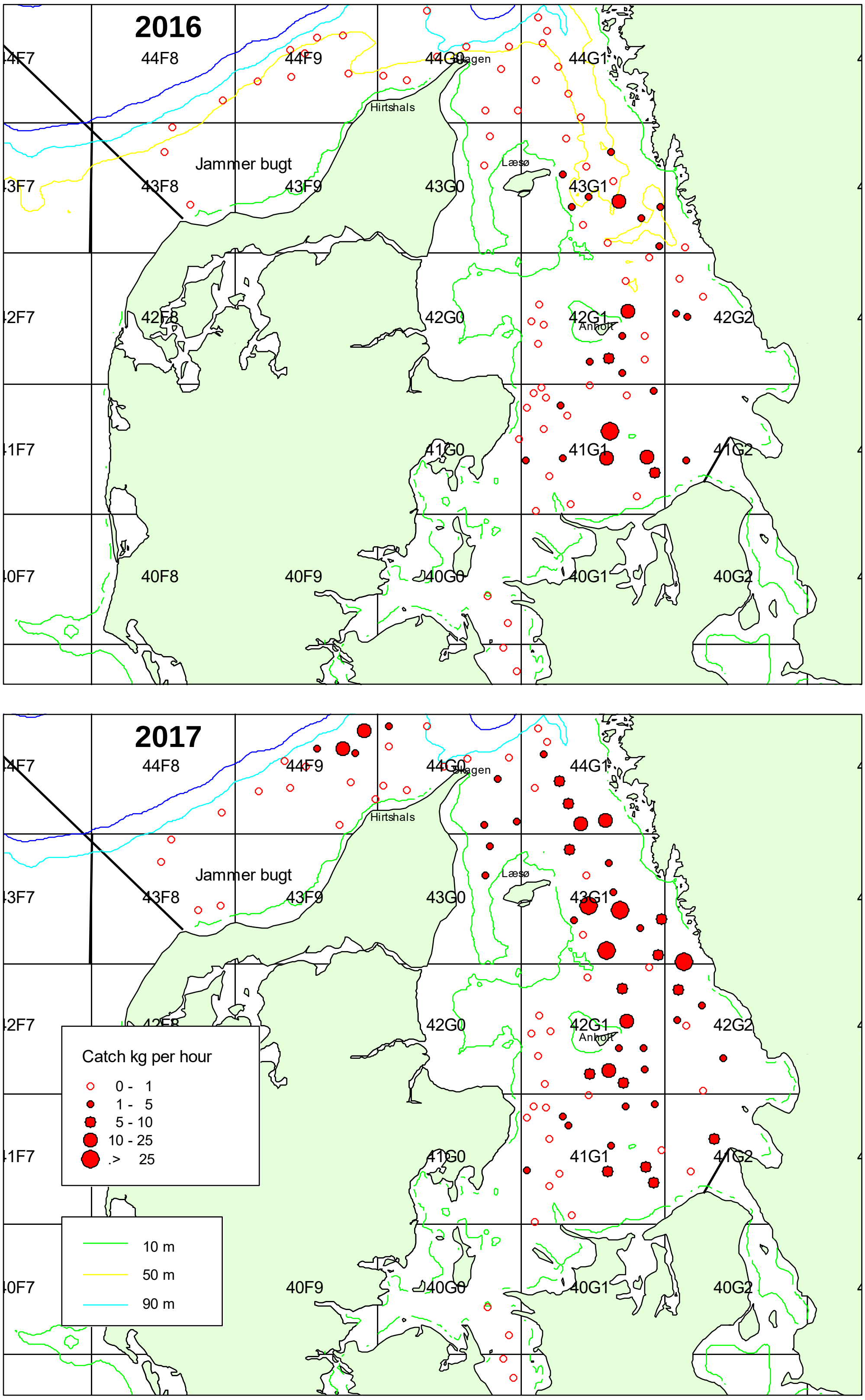


Fig. 19 cont. Catch of Norway lobster (kg per hour) in 2016 and 2017.

Table 17. Norway lobster 2017. Area, number of hauls, mean biomass per km^2 (tons), biomass (tons) and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Biomass	SE
41G1	3357.6	18	0.0081	27.3	8.7
41G2	1421.2	2	0.0174	24.8	24.8
42G1	3039.6	15	0.0178	54.0	19.1
42G2	2003.8	6	0.0106	21.2	8.1
43G0	721.5	2	0.0071	5.2	1.0
43G1	2460.9	12	0.0674	165.8	85.7
43G2	331.3	1	0.2038	67.5	.
44G0	1881.5	8	0.0036	6.8	3.0
44G1	1914.9	8	0.0217	41.6	16.4
All			0.0242	414.2	115.3

Table 18. Norway lobster 2017. Area, number of hauls, mean abundance per km^2, abundance and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Abundace	SE
41G1	3357.6	18	109.5	367510.3	130993.8
41G2	1421.2	2	38.7	55020.2	55020.2
42G1	3039.6	15	477.3	1450755.9	732195.1
42G2	2003.8	6	225.5	451771.4	172832.3
43G0	721.5	2	144.2	104022.6	14976.0
43G1	2460.9	12	1849.4	4551214.1	2418722.4
43G2	331.3	1	5356.9	1774737.0	.
44G0	1881.5	8	107.9	202951.3	88673.7
44G1	1914.9	8	604.9	1158282.3	408462.4
All			590.5	10116265.1	3124260.9

Eastern Baltic Cod assessment using seasonal data and SPiCT.

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1 Introduction

This document describes a new assessment of Eastern Baltic Cod using quarterly resolved commercial catch data using the production model called SPiCT [3], which was slightly extended, among other things to deal with regime shifts in surplus production. The first part documents how the survey indices are calculated, the second part concerns the extensions to the SPiCT model and the results of running the assessment.

2 Survey Indices

Survey indices are calculated using data from BITS Quarters 1 and 4.

2.1 ESB correction

Since SPiCT does not model the size distribution of the population, actions should be taken to ensure that surveys and commercial data are covering the same (exploitable) part of the population. This usually entails down-weighting the smallest length groups in the survey data. The factor used to downweight (ESB correction) can be estimated by considering ratio of commercial to survey total catch by length group (only commercial catches from quarters 1 and 4, since this is when the surveys are conducted). Rather than using the raw ratios by length group, a shape constrained GAM is fitted to these ratios as a smooth function of length in order to smooth out some of the sampling error:

```
library(scam)
m <- scam( log(com / surv )  ~ s(length,bs="mpi"), data=d )
```

The ratios are assumed to be lognormal distributed and the GAM is constrained to be increasing, which results in an S-shaped curve (see Figure 2). The estimated curve is then simply multiplied with the observed length distribution in the survey for every haul, such that the overall length distributions are close to identical. Because the same ESB correction is used for all years, then this will not change the relative index for a given length group, it will only change how each length group is weighted when combining all the length groups into a biomass index.

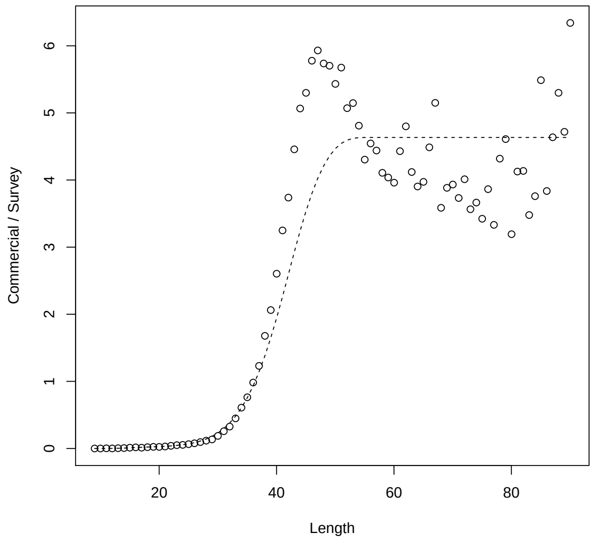


Figure 1: Ratio of commercial to survey total catch at length. Only data from quarters 1 and 4 are considered here.

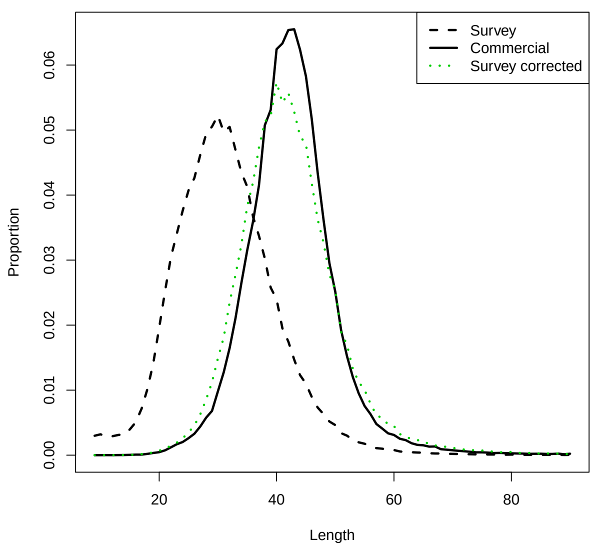


Figure 2: Length distributions in the survey and commercial data, and the ESB corrected survey length distribution obtained when using the correction factor shown in figure 1.

2.2 Index standardization

Once the ESB correction has been applied, numbers-at-length in the survey are converted to biomass by fitting a length-weight relationship

$$log(W) = log(a) + log(b)W + \epsilon$$

for each combination of year and quarter. Biomass-at-length are the aggregated into two size groups, above and below 38 cm, and standardized indices are calculated using Delta-GAM models with biomass in those size groups as the response variable. Independent models are estimated for each combination of quarter and size group. The grouping into two size groups is done in order to allow for different gear effects to be estimated for different size groups.

Survey indices by size group are calculated using the methodology described in [1], although we consider a broader class of equations describing the observed abundance in each haul. While [1] considered a time-invariant spatial effect and a data set consisting almost exclusively of 30 min hauls, the following model classes contains a space-time smoother, which allows for smooth changes in the spatial distribution of each age group over time, as well as haul duration effect.

$$g(\mu_i) = \text{Year(i)} + \text{Gear(i)} + f_1(\text{Year}_i, \text{lon}_i, \text{lat}_i) \quad (1)$$

$$+ f_2(\text{depth}_i) + f_3(\text{time}_i) + \log(HaulDur_i) \quad (2)$$

where Gear(i) maps the ith haul to a categorical gear effect for each size group and similarly for years. An offset is used for the effect of haul duration ($HaulDur$), i.e. the coefficient is not estimated but taken to be 1.

f_1 is a 3-dimensional tensor product spline (a 2D thin-plate spline for space $\times$ a 1D cubic spline for time), f_2 is a 1-dimensional thin plate spline for the effect of bottom depth, and f_3 is a cyclic cubic regression spline on the time of day (i.e. with same start end end point). The function g is the link function, which is taken to be the logit function for the binomial model. The Lognormal part of the delta-Lognormal model is fitted with a log link. Each combination of quarter size group are estimated separately. The fitted models are then used to sum the expected catches over a fine grid by year,size, and subarea to obtain the survey index. Nuisance variable such as gear, time-of-day and haul duration are corrected for in this process.

The final biomass index is obtained simply by adding the estimated biomass indices for the two size groups. Uncertainties on the calculated indices are estimated using parametric bootstrapping.

3 SPiCT assessment

Details about the SPiCT model can be found in [3]. Briefly, the model is based on a reparameterized version of the Pella-Tomlinson model [2] formulated as a stochastic differential equation such that it includes process noise:

$$dB_t = \left(\gamma m \frac{B_t}{K} - \gamma m \left[\frac{B_t}{K}\right]^n - F_t B_t\right) dt + \sigma_B B_t dW_t, \tag{3}$$

where $\gamma = n^{n/(n-1)}/(n-1)$. K represents the carying capacity, m represents the maximum sustainable yield (maximum attainable surplus production), and n determines the shape of the production curve. σ_B is the standard deviation of the process noise, and W_t is Brownian motion.

In addition, the fishing mortality is also modelled as a stochastic process

$$F_t = S_t G_t \tag{4}$$

$$d \log G_t = \sigma_F dV_t \tag{5}$$

where dV_t is standard Brownian motion and σ_F is the standard deviation of the noise. If only annual data are available it is not possible to estimate within-year dynamics and therefore $S_t = 1$ and consequently $F_t = G_t$. In the case of seasonal data F_t follows the model

$$F_t = \exp(D_{s(t)}) G_t \tag{6}$$

where $D_{s(t)}$ is a cyclic B-spline with a period of one year with $s(t) \in [0; 1]$ being a mapping from t to the proportion of the current year that has passed. The possible annual variation allowed by the cyclic B-spline is determined by a chosen number of so-called knots. The number of knots must be smaller than or equal to the number of catch observations per year (e.g. quarterly catches can at most accommodate four temporally equidistant knots). The values of the cyclic B-spline is defined by the parameter vector ϕ of length equal to the number of knots minus one. In the case of annual data (one knot) the cyclic B-spline reduces to a constant ($D_{s(t)} = 1$) and ϕ has zero length and is therefore not estimated. Note that the seasonal pattern represented by the spline remains constant in time. Thus, a spline-based model is not able to adapt to changes in amplitude and timing (phase) of the real seasonal fishing pattern. Such variations in the fishing pattern would, when fitted with a spline-based model, likely lead to autocorrelated catch residuals.

3.1 Seasonal extension

[3] presents an alternative solution to using a cyclic spline for the seasonal fishing pattern in terms of two coupled SDEs which have an oscillating stationary distribution. This can accomodate changes in the fishing pattern over time, however using this solution for EBcod did not converge to a realistic solution, while significant autocorrelation in the catch residuals was detected when using the cyclic spline. To circumvent these problems an extension to SPiCT was developed, which adds an autocorrelated (discrete-time) process A on top of the cyclic spline S and the diffusion component G. Since the A-process is formulated in discrete time, the model cannot technically be written in SDE form, however, numerically the model is well defined and with slight abuse of notation we have,

$$F_t = S_t G_t \exp(A_{q(t)}) \tag{7}$$

$$d \log G_t = \sigma_F dV_t \tag{8}$$

where $A_{q(t)}$ is a discrete time mean zero autoregressive process $A_{q(t)} = \varphi_A A_{q(t-1)} + \varepsilon_{A,q(t)}$, and q maps t to a quarter, i.e. q equals 1 for all $t \in [0; 0.25[$, q=2 for all $t \in [0.25; 0.5[$ etc. The A-process is thus a step-function that is constant within quarters and auto-correlated with a lag one year, and may be thought of as deviations from the mean seasonal pattern described by S_t.

3.2 Regime shift

The SPiCT model is further extended to deal with changes in surplus production over time. This is implemented by allowing different values of the m parameter to be estimated in different time-periods rather than having just one constant value. The break-point may be chosen a priori, but it may also be estimated by varying the break-point and choosing the one with the maximum likelihood value (or equivalently minimum AIC). In both cases the magnitude of change in production is estimated by the model, and in the latter case time of the break-point is also estimated from the data. This was done for the EBcod and there was strong evidence for a drop in surplus production (ΔAIC > 15) at the optimum break-point year, which was found to be in 2010 (Figure 4). The MSY was estimated to be reduced from around 92 ktonnes in the period before 2010 to 43 ktonnes in the period after.

3.3 Commercial catch CV

Some of the years before 2010 have incomplete catch reporting. To prevent bias due to this the missing catches have been imputed, and the percentage of imputed catches are shown below for each year. For years with more than 10% imputed catch we increase the standard deviation to twice the value of the other years (StdevFac) in order to account for these data points being more uncertain relative to the other.

Year	Add	StdevFac
1991	0.00	1
1992	0.00	1
1993	0.36	2
1994	0.43	2
1995	0.17	2
1996	0.09	1
1997	0.00	1
1998	0.00	1
1999	0.00	1
2000	0.24	2
2001	0.25	2
2002	0.25	2
2003	0.31	2

2004	0.28	2
2005	0.26	2
2006	0.25	2
2007	0.23	2
2008	0.06	1
2009	0.06	1
2010	0.00	1

4 Results

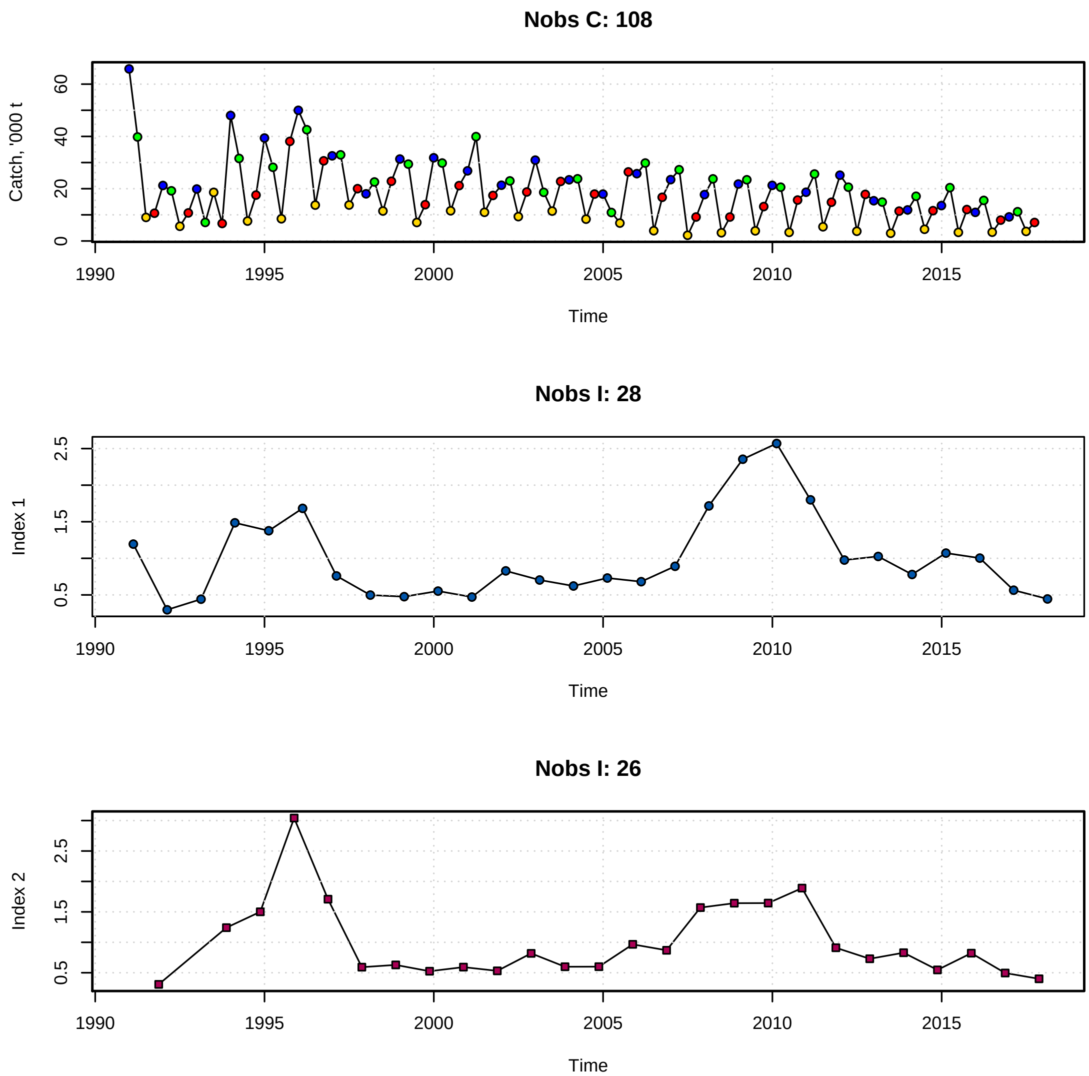


Figure 3: Input data.

Model summary:

```
Convergence: 0  MSG: relative convergence (4)
Objective function at optimum: 60.0231937
Euler time step (years):  1/16 or 0.0625
Nobs C: 108,  Nobs I1: 28,  Nobs I2: 26
Catch/biomass unit: '000 t
```

```
Residual diagnostics (p-values)
    shapiro   bias    acf   LBox shapiro bias acf LBox
 C   0.0124 0.8662 0.0801 0.1607       *    -   .    -
 I1  0.1243 0.8219 0.0829 0.3664       -    -   .    -
 I2  0.6763 0.3767 0.0235 0.1311       -    -   *    -

Priors
     logn  ~  dnorm[log(2), 2^2]
 logalpha  ~  dnorm[log(1), 2^2]
  logbeta  ~  dnorm[log(1), 2^2]

Model parameter estimates w 95% CI
           estimate      cilow       ciupp    log.est
 alpha1   1.0755230  0.2913526   3.9702735  0.0728070
 alpha2   1.4022964  0.4160138   4.7268514  0.3381112
 beta     0.4958044  0.3228355   0.7614466 -0.7015738
 r        1.0581268  0.3190958   3.5087652  0.0565002
 r        0.4502542  0.1320042   1.5357758 -0.7979429
 rc       2.6104531  1.5223310   4.4763363  0.9595238
 rc       1.1108003  0.5755567   2.1437979  0.1050807
 rold     5.5892213  0.0366237 852.9837338  1.7208400
 rold     2.3783260  0.0159683 354.2283216  0.8663969
 m1      92.9917759 80.8279853 106.9860935  4.5325111
 m2      39.5698689 31.3848158  49.8895561  3.6780679
 K      215.8838710 97.1516202 479.7227845  5.3747406
 q1       0.0171775  0.0109043   0.0270598 -4.0641531
 q2       0.0141668  0.0092234   0.0217597 -4.2568529
 n        0.8106844  0.3247159   2.0239513 -0.2098765
 sdb      0.1790778  0.0728195   0.4403882 -1.7199348
 sdf      0.3248858  0.2302412   0.4584358 -1.1242814
 sdi1     0.1926023  0.1076060   0.3447359 -1.6471278
 sdi2     0.2511202  0.1574960   0.4003997 -1.3818236
 sdc      0.1610798  0.1276567   0.2032539 -1.8258552
 phi1     0.8758068  0.4217406   1.8187425 -0.1326097
 phi2     1.8123371  1.1374034   2.8877755  0.5946172
 phi3     0.1492272  0.0709543   0.3138464 -1.9022853
 SARphi   0.8209624  0.5535178   0.9443213  1.5228815
 SdSAR    0.1911197  0.1201292   0.3040623 -1.6548551

Deterministic reference points (Drp)
          estimate      cilow      ciupp    log.est
 Bmsyd1 71.2456963 40.7144062 124.672069  4.2661344
 Bmsyd2 71.2456963 40.7144062 124.672069  4.2661344
 Fmsyd1  1.3052266  0.7611655   2.238168  0.2663766
```

```
 Fmsyd2  0.5554001  0.2877783   1.071899 -0.5880665
 MSYd1  92.9917759 80.8279853 106.986093  4.5325111
 MSYd2  39.5698689 31.3848158  49.889556  3.6780679
Stochastic reference points (Srp)
          estimate      cilow      ciupp    log.est rel.diff.Drp
 Bmsys1 70.4339852 39.9559011 124.160541  4.2546759 -0.011524425
 Bmsys2 69.9254988 39.7544947 122.994278  4.2474304 -0.018880059
 Fmsys1  1.3013877  0.7657405   2.211728  0.2634311 -0.002949829
 Fmsys2  0.5566936  0.2891559   1.071767 -0.5857403  0.002323489
 MSYs1  91.6588044 79.4804510 105.703180  4.5180730 -0.014542755
 MSYs2  38.9287826 30.9574063  48.952748  3.6617339 -0.016468183

States w 95% CI (inp$msytype: d)
                  estimate      cilow     ciupp    log.est
 B_2018.12      27.4865404 16.2741895 46.423811  3.3136964
 F_2018.12       1.1702407  0.5878333  2.329680  0.1572094
 B_2018.12/Bmsy  0.3857993  0.2569527  0.579255 -0.9524380
 F_2018.12/Fmsy  2.1070227  1.1796318  3.763500  0.7452759

Predictions w 95% CI (inp$msytype: d)
                prediction      cilow     ciupp    log.est
 B_2020.00      27.7787891  9.9701823 77.396892  3.3242727
 F_2020.00       1.1702409  0.3852739  3.554519  0.1572096
 B_2020.00/Bmsy  0.3899013  0.1393617  1.090853 -0.9418617
 F_2020.00/Fmsy  2.1070230  0.7393450  6.004702  0.7452761
 Catch_2019.00  30.2921815 18.7790667 48.863784  3.4108896
 E(B_inf)       32.0135926         NA        NA  3.4661606
```

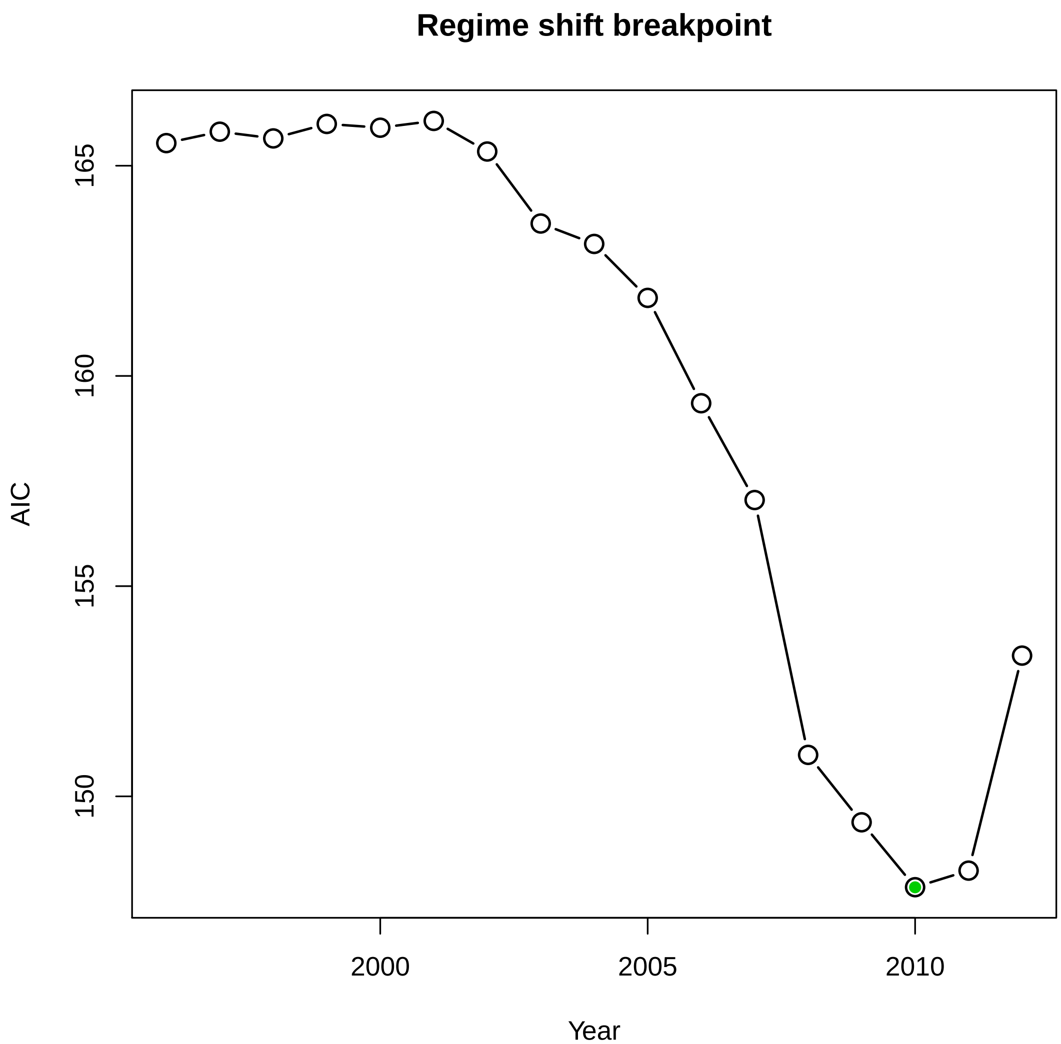


Figure 4: AIC as a function of regime shift break-point (with 2017 as last data year).

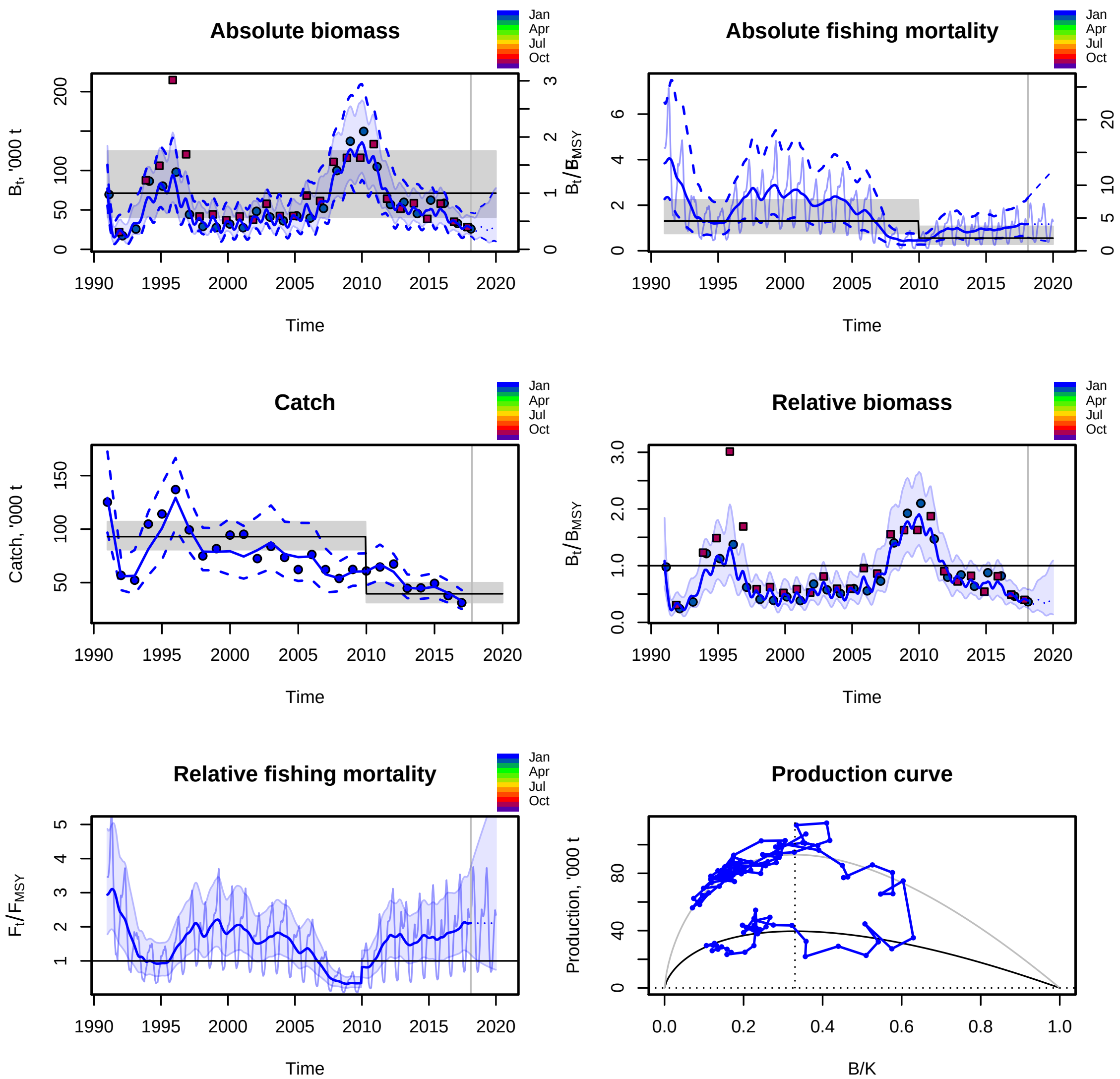


Figure 5: Results using seasonal data and break-point in 2010.

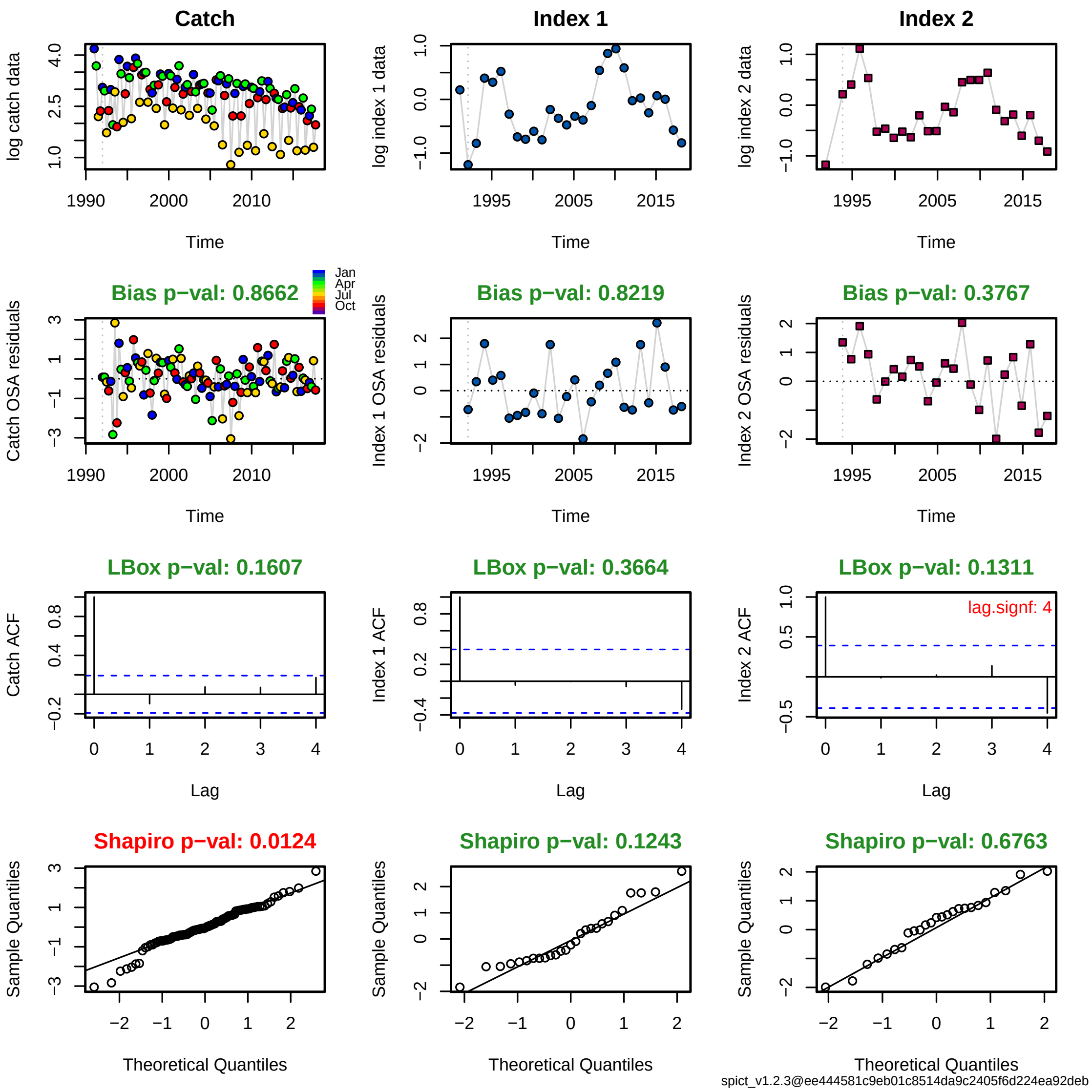


Figure 6: Diagnostics using seasonal data and break-point in 2010.

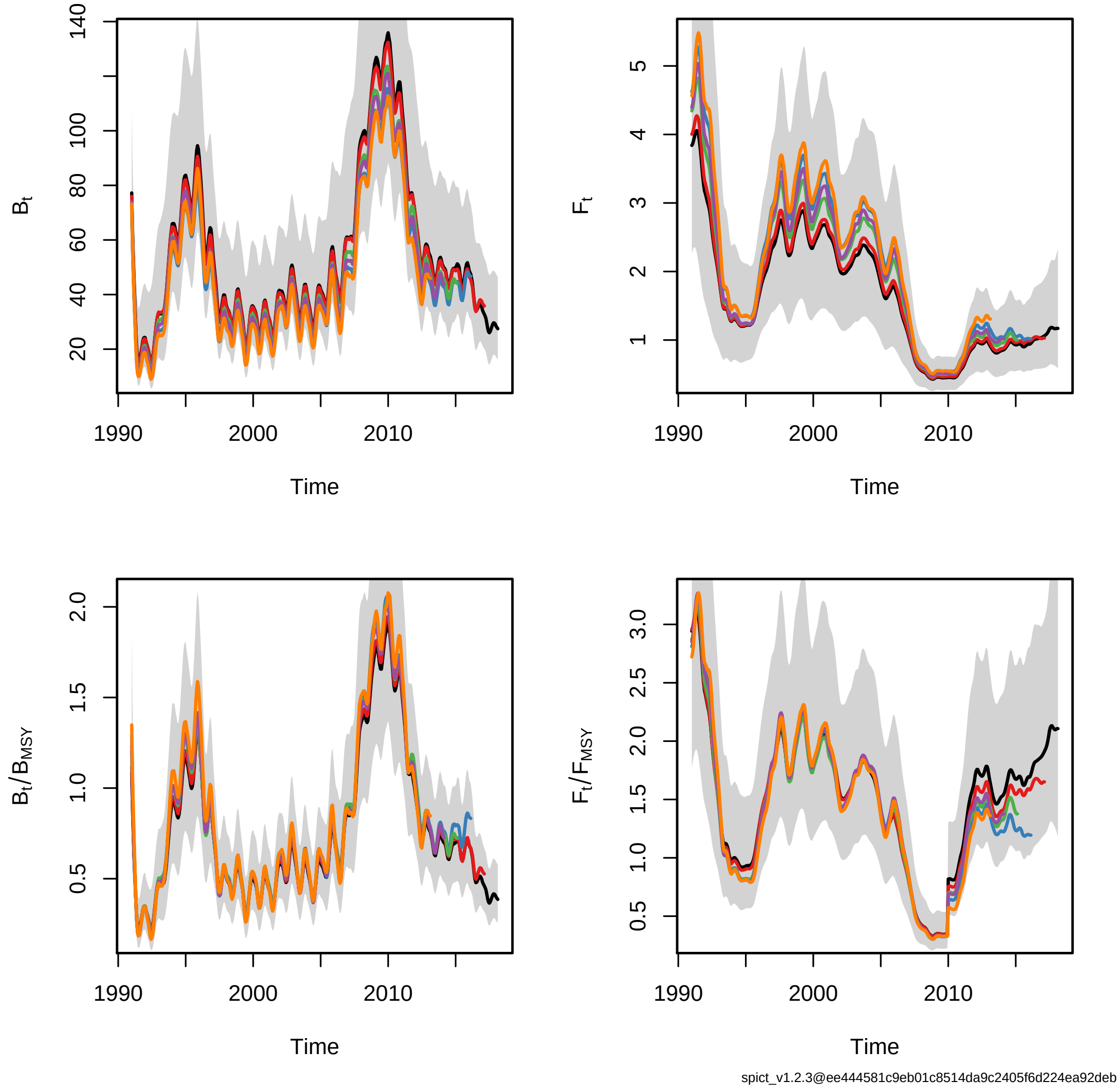


Figure 7: Retrospective analysis using seasonal data and break-point in 2010.

	Year	F/F_{MSY}	B/B_{MSY}
1	1991.00	2.942	1.084
2	1992.00	2.404	0.340
3	1993.00	1.472	0.469
4	1994.00	0.986	0.925
5	1995.00	0.929	1.175
6	1996.00	1.278	1.267
7	1997.00	1.804	0.792
8	1998.00	1.829	0.510
9	1999.00	2.163	0.540
10	2000.00	1.818	0.500
11	2001.00	2.028	0.493
12	2002.00	1.535	0.581
13	2003.00	1.680	0.661
14	2004.00	1.785	0.563
15	2005.00	1.398	0.589
16	2006.00	1.360	0.737
17	2007.00	0.843	0.856
18	2008.00	0.426	1.362
19	2009.00	0.339	1.747
20	2010.00	0.818	1.907
21	2011.00	1.047	1.545
22	2012.00	1.708	0.977
23	2013.00	1.714	0.778
24	2014.00	1.528	0.718
25	2015.00	1.674	0.698
26	2016.00	1.690	0.685
27	2017.00	1.884	0.479
28	2018.00	2.104	0.398

Table 1: Estimated stock status relative to reference points. All estimates are reported at the beginning of the year, however, F/F_{MSY} estimates are corrected for seasonal variability, but B/B_{MSY} is not. F/F_{MSY} is calculated based on F_t less the mean of the seasonal components S_t and A_t.

5 Source code

The source code for the SPiCT model is available online at https://github.com/mawp/spict/tree/regimeshift. The script and data used to produce the SPiCT output figures and tables in this report are available in the "Software" folder on the ICES sharepoint (https://community.ices.dk/ExpertGroups/WGBFAS/SitePages/HomePage.aspx)

References

[1] Casper W Berg, Anders Nielsen, and Kasper Kristensen. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. *Fisheries Research*, 151:91–99, 2014.

[2] RI Fletcher. On the restructuring of the pella-tomlinson system. *Fish. Bull*, 76(3):515–521, 1978.

[3] Martin W Pedersen and Casper W Berg. A stochastic surplus production model in continuous time. *Fish and Fisheries*, 2016.

Annex 08: Survey input issue on Herring in Gulf of Bothnia

After the 2018 WGBFAS meeting and just before the start of ADGBS in May 2018 a mistake was discovered in the input for assessment of Herring in Gulf of Bothnia (GoB) in subdivisions 30 and 31. The year 2015 SD 30 acoustic index-values differed significantly from the ones issued by ICES WGBIFS (Table 1), and it was revealed that they had been wrong since the last Benchmark assessment in WKBALT, February 2017, where the mistake was traced down to.

Table 1. Acoustic indices in 2018 GoB herring assessment inputs and the difference between the indices.

Herring in Sub-division 30 Bothnian Sea
102
FLT 03: Acoustic Fleet **N of individuals, millions**
2007 2017
1 1 0.8 0.85
1 9

The input to 2018 Assessment in WGBFAS: WRONG values										SUM
	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	
2007	5671	4916	1846	1508	5254	1441	826	633	431	
2008	2670	4846	3386	1649	1825	3344	1266	988	692	
2009	3573	5090	5559	2438	1283	1518	3616	1353	553	
2010	3990	6535	3501	3536	1577	982	891	2370	590	
2011	3700	6101	7384	3086	3134	1442	642	542	1994	
2012	11648	3842	3109	2734	1868	1693	987	330	487	
2013	3306	6646	2843	3486	3386	1435	1771	869	456	
2014	9008	6686	4905	2235	2127	1692	1551	936	557	
2015	5985	10912	3159	1796	1487	2410	1531	3079	1928	32287
2016	2462	7523	3436	2143	1349	656	755	567	334	
2017	7470	4503	7474	2399	1427	940	447	471	333	

The input to corrected Assessment: RIGHT values										SUM
	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	
2007	5671	4916	1846	1508	5254	1441	826	633	431	
2008	2670	4846	3386	1649	1825	3344	1266	988	692	
2009	3573	5090	5559	2438	1283	1518	3616	1353	553	
2010	3990	6535	3501	3536	1577	982	891	2370	590	
2011	3700	6101	7384	3086	3134	1442	642	542	1994	
2012	11648	3842	3109	2734	1868	1693	987	330	487	
2013	3306	6646	2843	3486	3386	1435	1771	869	456	
2014	9008	6686	4905	2235	2127	1692	1551	936	557	
2015	17997	8079	4637	3507	1844	1682	1331	1364	854	41296
2016	2462	7523	3436	2143	1349	656	755	567	334	
2017	7470	4503	7474	2399	1427	940	447	471	333	

DIFFERENCE (%) to 2018 WGBFAS assessment										DIFFE-RENCE
	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	
2007	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2008	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2009	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2010	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2011	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2012	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2013	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2014	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2015	201 %	-26 %	47 %	95 %	24 %	-30 %	-13 %	-56 %	-56 %	28 %
2016	0%	0%	0%	0%	0%	0%	0%	0%	0%	
2017	0%	0%	0%	0%	0%	0%	0%	0%	0%	

A new run with corrected input data and forecast were made with the state space assessment model (SAM), which is used in the GoB herring stock assessment. However, there were concerns regarding the residuals and Mohn's rho values in this new run. This was due to the configuration that had been used to fit the data which was not appropriate. A new run with slightly adjusted configuration of SAM was also performed to compare the model outputs.

The run with the incorrect 2015 survey data used in the assessment in 2018, the run with the correct 2015 survey data and the run with the correct 2015 survey data and revised configuration are shown for SSB, F3-7 and age 1 Recruits in figures 1, 2 and 3, respectively.

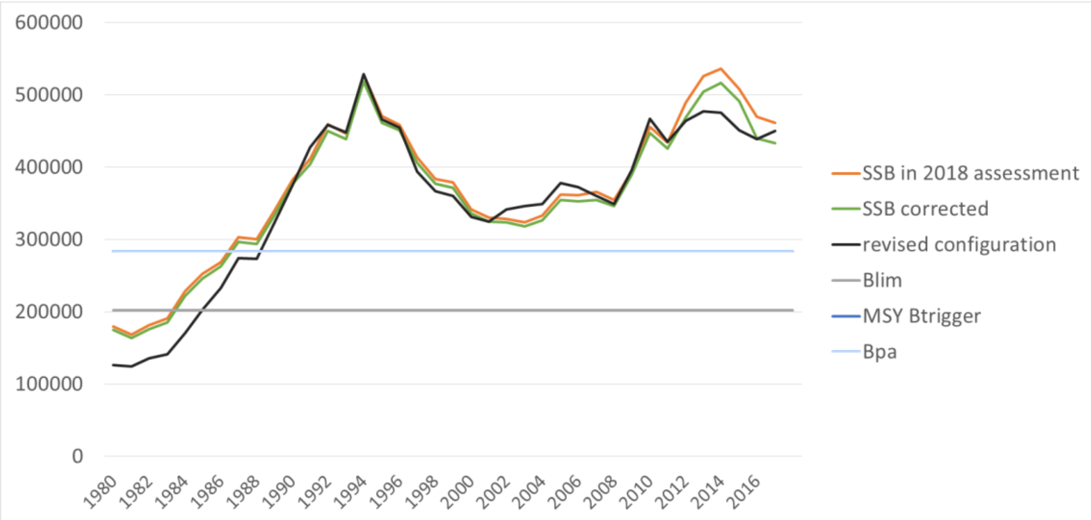


Figure 1. SSB estimates from the three runs.

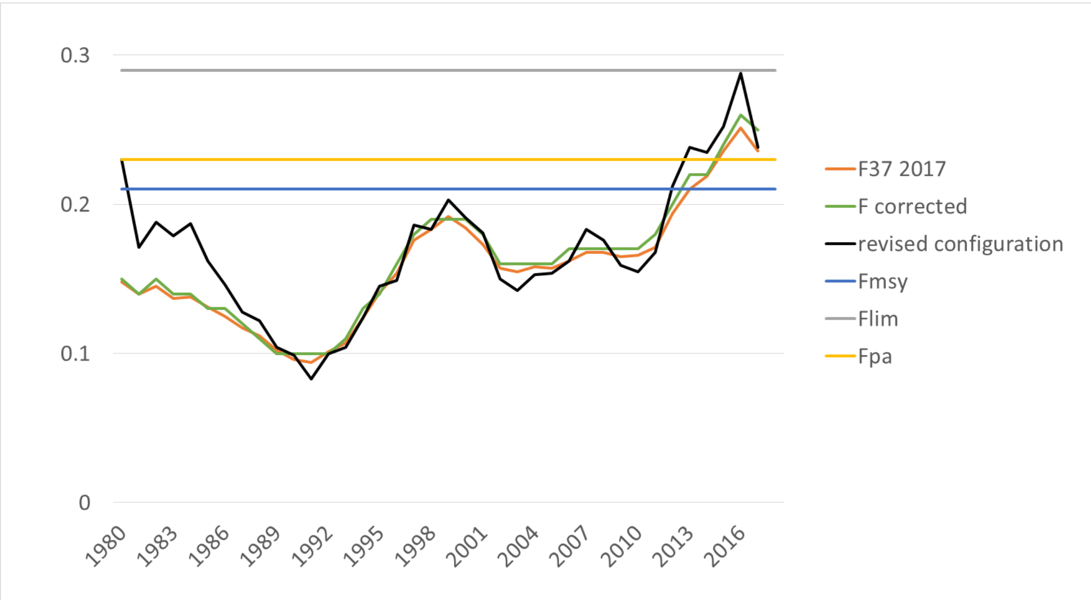


Figure 2. F3-7 estimates from the three runs

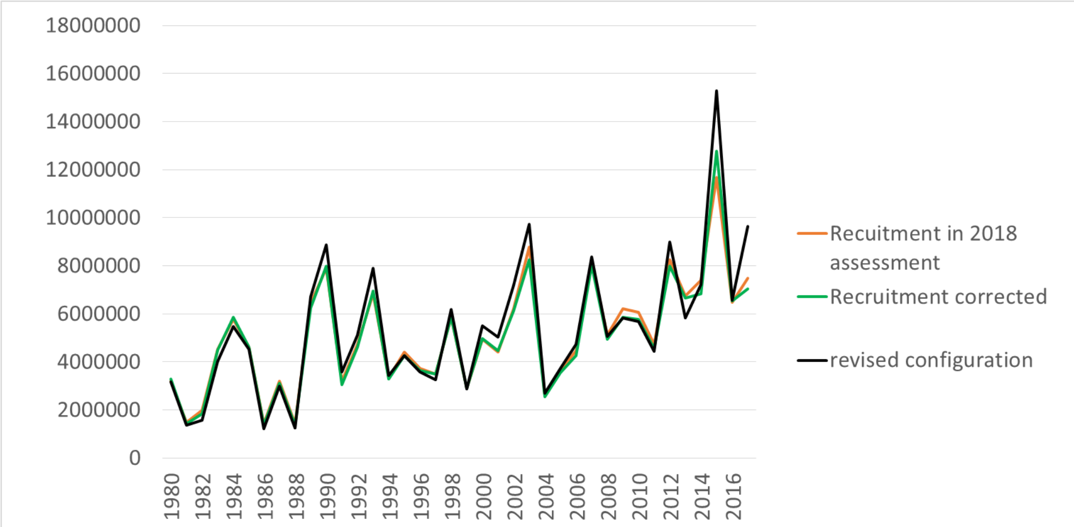


Figure 3. Recruitment estimates from the three runs.

The final decision from the ADG Baltic Sea was to use the same configuration setting from the benchmark settings for SAM and the corrected survey input data for the assessment in 2018 (*i.e.* green lines in figures 1, 2 and 3). An inter-benchmark process will be initiated for the stock in which the SAM configuration will be looked at and new reference points may be set. Results from the inter-benchmark should be available before the next WGBFAS 2019.

The differences between the estimates of SSB, F3-7 and age 1 Recruits from the three runs are shown in Table 2. The complete tables for assessment results for SSB, F and R are shown in tables 3, 4 and 5.

Table 2. The differences between the estimates of SSB, F3-7 and age 1 Recruits for the runs; incorrect 2015 survey data from the assessment in 2018 (BFAS 2018), the run with the correct 2015 survey data (Corrected) and the run with the correct 2015 survey data and revised configuration (Revised conf.) are shown for SSB, F3-7 and age 1 Recruits in years 2015, 2016 and 2017.

Year	Run	SSB			F 3-7			Age 1 Recruitment		
		BFAS 2018	CORRECTED	REVISED CONF.	BFAS 2018	CORRECTED	REVISED CONF.	BFAS 2018	CORRECTED	REVISED CONF.
2015	BFAS 2018	0.0 %			0.0 %			0.0 %		
	CORRECTED	-3.4 %	0.0 %		1.7 %	0.0 %		8.6 %	0.0 %	
	REVISED CONF.	-12.8 %	-9.0 %	0.0 %	6.3 %	4.8 %	0.0 %	23.6 %	16.4 %	0.0 %
2016	BFAS 2018	0.0 %			0.0 %			0.0 %		
	CORRECTED	-6.9 %	0.0 %		3.5 %	0.0 %		0.6 %	0.0 %	
	REVISED CONF.	-7.0 %	-0.1 %	0.0 %	12.8 %	19.8 %	0.0 %	1.3 %	0.7 %	0.0 %
2017	BFAS 2018	0.0 %			5.6 %			0.0 %		
	CORRECTED	-6.4 %	0.0 %		5.6 %	0.0 %		-6.2 %	0.0 %	
	REVISED CONF.	-2.4 %	3.7 %	0.0 %	0.8 %	-5.0 %	0.0 %	22.4 %	26.9 %	0.0 %

Assessment run after 2018 WGBFAS with corrected 2015 survey input data

The input data for year 2015 SD 30 acoustic index-values were corrected and the assessment was re-run with the correct input data in stockassessment.org for her.27.3031. The corrected run can be viewed under "**RevisedHer30312018**" and the final advice is based on this run. The SSB, F (ages 3-7) and Age 1 recruitment for the corrected run can be seen in Figure 4. The normalised residuals for the three fleets 1980 – 2017, catch data (top), acoustic index and CPUE from trapnet data found in Figure 5. The leave-one-out runs and the retrospectives are in figure 6 and 7, respectively. The Mohn rho's values for SSB is 0.244312, F_{bar} (3–7) is -0.202717, and R(age 1) is 0.713116. The reason the Mohn rho's values are bad is that the runs were kept with an inappropriate model configuration.

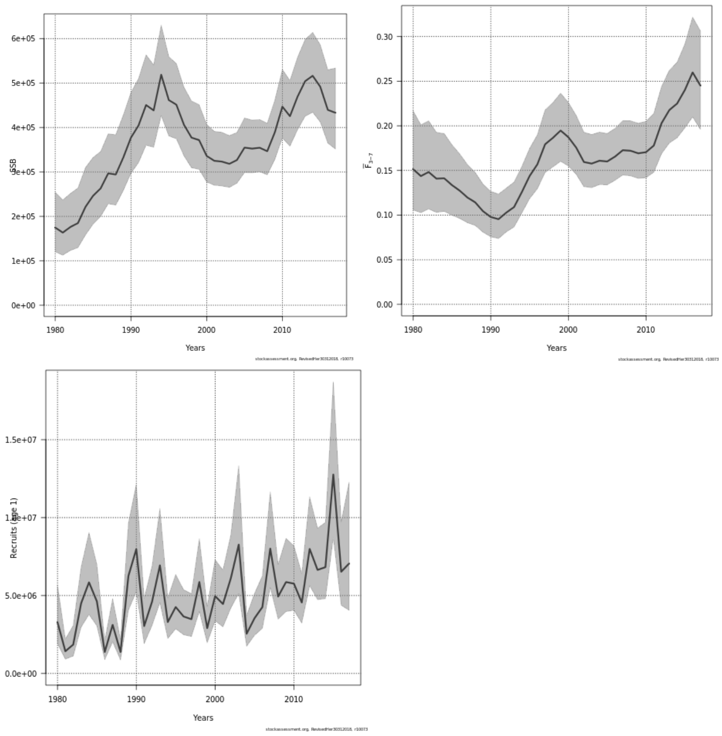


Figure 4. **Herring in SD's 30 and 31. Estimated SSB, F and age 1 recruitment of Gulf of Bothnia herring in 1980 – 2017 with the corrected input survey index.**

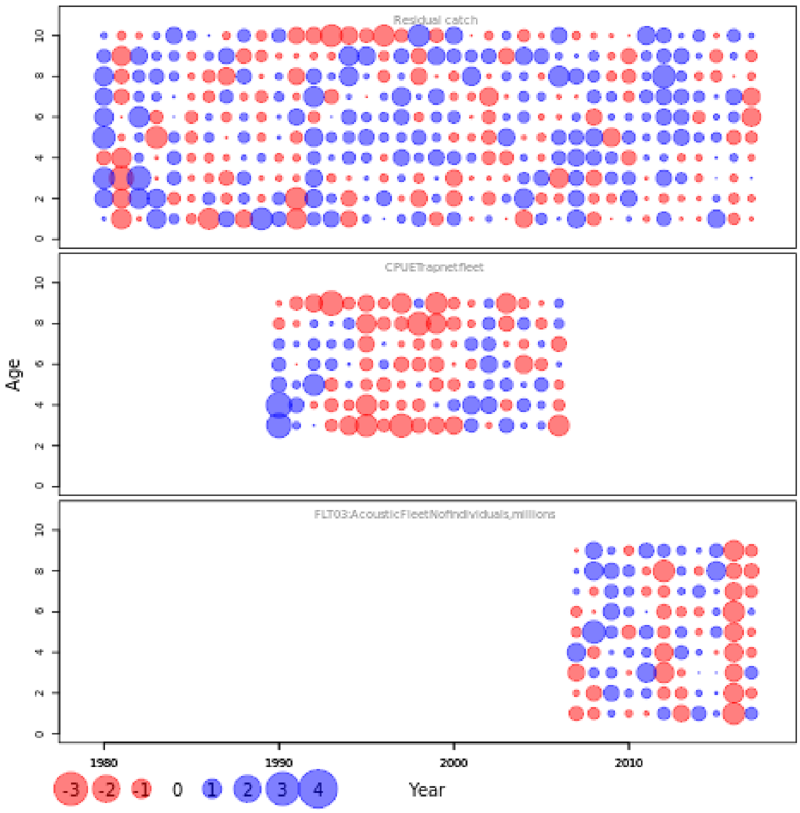


Figure 5. **Herring in SD's 30 and 31. Normalized residuals of three Gulf of Bothnia fleets in 1980 – 2017, catch data (top), acoustic index and CPUE from trapnet data. Red filled circles indicate negative residuals and blue open circles positive residuals.**

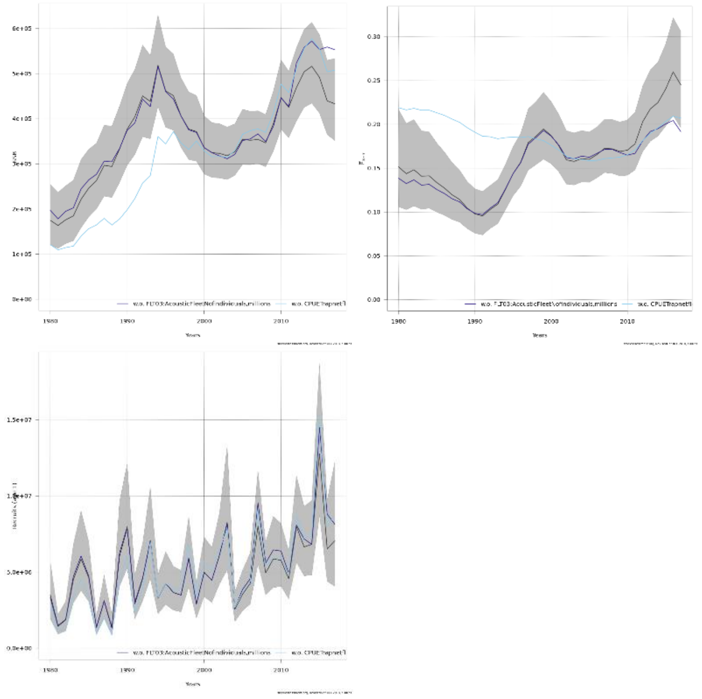


Figure 6. Herring in SD's 30 and 31. Leave-one-out runs of the Gulf of Bothnia herring stock in 1980 – 2017 with the corrected input survey index.

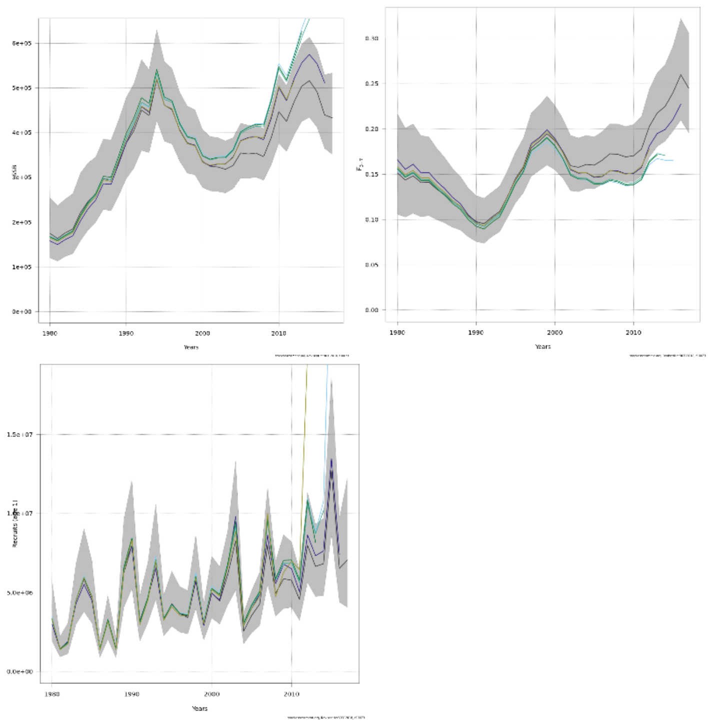


Figure 7. Herring in SD's 30 and 31. Retrospective analysis of the Gulf of Bothnia herring stock in 1980 – 2017.

Table 3. Estimates of SSB, Fbar 3-7 and Age 1 Recruitment in the assessment made in 2018 WGBFAS.

2018 Assessment									
Year	**Recruits**	**Low**	**High**	**SSB**	**Low**	**High**	**F(3-7)**	**Low**	**High**
1980	3213914	1939809	5324876	180052	122475	264697	0.148	0.103	0.213
1981	1480662	962202	2278482	168215	114983	246092	0.140	0.100	0.198
1982	1980777	1213016	3234484	181680	126000	261963	0.145	0.104	0.202
1983	4533478	3007200	6834405	190422	132214	274257	0.137	0.100	0.189
1984	5780496	3786376	8824831	227977	161497	321824	0.138	0.101	0.188
1985	4629688	3075506	6969263	252711	185713	343877	0.131	0.097	0.176
1986	1424028	932291	2175132	268606	202675	355984	0.125	0.094	0.166
1987	3201084	2104103	4869978	302852	231372	396416	0.117	0.089	0.154
1988	1435466	929164	2217653	300740	228667	395529	0.112	0.086	0.146
1989	6446191	4216517	9854906	339422	261545	440489	0.102	0.079	0.133
1990	7897051	5215784	11956672	383080	299144	490568	0.096	0.074	0.125
1991	3194688	2059019	4956746	412091	324461	523389	0.094	0.072	0.122
1992	4737405	3201980	7009101	459549	364696	579071	0.101	0.079	0.129
1993	6831125	4530759	10299439	445967	358821	554277	0.107	0.085	0.136
1994	3338393	2287660	4871732	528078	431318	646546	0.124	0.100	0.153
1995	4399494	2981747	6491343	470241	385207	574046	0.141	0.116	0.173
1996	3745254	2571192	5455419	458630	377733	556854	0.154	0.126	0.188
1997	3492052	2398898	5083345	413743	339826	503738	0.176	0.144	0.216
1998	5850280	4030496	8491702	383847	312363	471691	0.183	0.150	0.224
1999	2899358	1985339	4234179	378511	308927	463768	0.192	0.156	0.234
2000	4950504	3417159	7171892	341806	279730	417659	0.184	0.151	0.224
2001	4417127	2998732	6506420	330711	272226	401761	0.173	0.142	0.210
2002	6212041	4297913	8978649	328733	270589	399369	0.157	0.129	0.191
2003	8780114	5499347	14018101	324162	267728	392493	0.155	0.127	0.188
2004	2607754	1795367	3787740	332701	277068	399504	0.158	0.131	0.191
2005	3641841	2526385	5249797	361855	302007	433564	0.157	0.130	0.189
2006	4483883	3083636	6519968	361132	302537	431076	0.162	0.135	0.194
2007	8153844	5682035	11700943	365492	306657	435616	0.168	0.140	0.202
2008	5121716	3655049	7176914	354336	296205	423874	0.168	0.139	0.203
2009	6230705	4307292	9013013	393958	327735	473563	0.165	0.137	0.201
2010	6064726	4329315	8495779	455431	378232	548388	0.166	0.136	0.201
2011	4742144	3383496	6646361	434521	360190	524191	0.171	0.140	0.209
2012	8252279	5807612	11726010	489432	404945	591546	0.194	0.159	0.237
2013	6736156	4840555	9374089	525445	434716	635109	0.210	0.171	0.257
2014	7407474	5183546	10585546	536596	441435	652270	0.219	0.178	0.269
2015	11675463	8332716	16359184	508388	416108	621133	0.236	0.190	0.294
2016	6491473	4477700	9410908	469771	379603	581357	0.251	0.198	0.317
2017	7489406	4352583	12886876	460929	364485	582894	0.236	0.185	0.302

Table 4. Estimates of SSB, Fbar 3-7 and Age 1 Recruitment in the assessment with corrected survey input.

CORRECTED									
Year	**R(age 1)**	**Low**	**High**	**SSB**	**Low**	**High**	**F(3-7)**	**Low**	**High**
1980	3300940	1919636	5676183	174870	120129	254555	0.150	0.110	0.220
1981	1429817	922169	2216923	163465	112786	236917	0.140	0.100	0.200
1982	1856906	1118758	3082078	176018	123197	251487	0.150	0.110	0.210
1983	4502842	2970371	6825943	184797	129433	263843	0.140	0.100	0.190
1984	5851774	3786624	9043215	221382	158203	309792	0.140	0.100	0.190
1985	4626922	3056566	7004072	246283	182423	332498	0.130	0.100	0.180
1986	1382123	894807	2134832	262924	199849	345907	0.130	0.100	0.170
1987	3122030	2031440	4798107	296765	228356	385667	0.120	0.090	0.160
1988	1380877	870669	2190062	294119	225389	383808	0.110	0.090	0.150
1989	6255469	4055781	9648176	332719	258439	428348	0.100	0.080	0.130
1990	7980319	5247951	12135305	376991	296944	478616	0.100	0.080	0.130
1991	3044951	1919664	4829871	404399	320700	509943	0.100	0.070	0.120
1992	4606695	3082227	6885166	450459	360101	563489	0.100	0.080	0.130
1993	6940168	4551061	10583453	438417	355472	540716	0.110	0.090	0.140
1994	3302312	2248563	4849881	518654	426795	630282	0.130	0.100	0.150
1995	4266330	2864307	6354618	461665	381017	559383	0.140	0.120	0.170
1996	3659363	2489999	5377887	451226	374510	543656	0.160	0.130	0.190
1997	3487345	2376061	5118376	406142	336211	490619	0.180	0.150	0.220
1998	5872662	3987884	8648235	377166	309472	459667	0.190	0.150	0.230
1999	2911969	1972586	4298705	371586	305838	451469	0.190	0.160	0.240
2000	4966313	3378240	7300922	335992	277388	406978	0.190	0.150	0.230
2001	4458773	2994000	6640166	325075	270007	391375	0.180	0.150	0.210
2002	6118013	4204591	8902193	323244	268500	389151	0.160	0.130	0.190
2003	8269178	5130931	13326880	318171	265150	381794	0.160	0.130	0.190
2004	2549248	1743853	3726614	326800	274650	388853	0.160	0.130	0.190
2005	3545010	2446454	5136863	354655	298564	421285	0.160	0.130	0.190
2006	4262309	2898857	6267049	352442	298091	416701	0.170	0.140	0.200
2007	8014125	5512195	11651656	354372	300544	417842	0.170	0.140	0.210
2008	4939559	3488716	6993762	346598	293367	409488	0.170	0.140	0.210
2009	5869288	3975888	8664365	388950	327894	461374	0.170	0.140	0.200
2010	5770320	4060201	8200724	446839	376386	530478	0.170	0.140	0.210
2011	4554014	3233581	6413644	425372	357870	505607	0.180	0.150	0.210
2012	7993952	5637136	11336123	469134	394607	557735	0.200	0.170	0.240
2013	6650375	4743079	9324637	503974	424982	597649	0.220	0.180	0.260
2014	6823909	4801884	9697389	516274	434253	613788	0.220	0.190	0.270
2015	12767596	8712905	18709202	491636	412262	586292	0.240	0.200	0.290
2016	6530521	4382898	9730483	439588	364757	529771	0.260	0.210	0.320
2017	7054394	4055373	12271245	433092	351499	533624	0.250	0.200	0.310

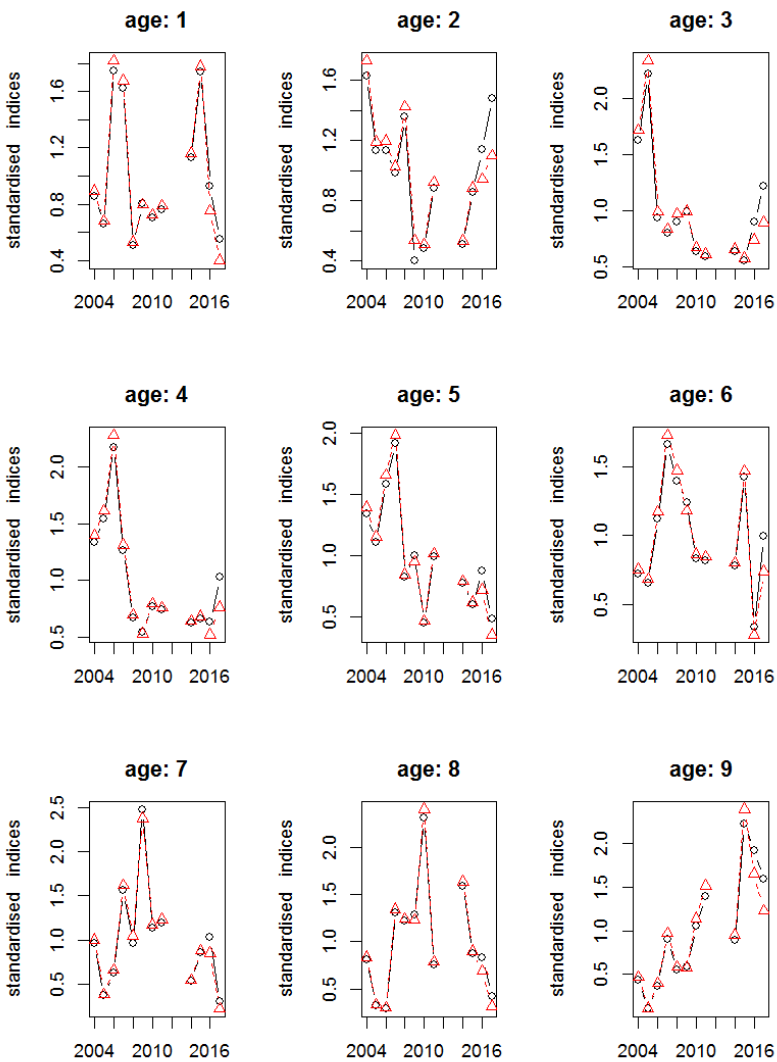
Table 5. Estimates of SSB, Fbar 3-7 and Age 1 Recruitment in the assessment with corrected survey input and revised configuration.

Revised Configuration									
Year	R (age 1)	Low	High	SSB	Low	High	F(3-7)	Low	High
1980	3161765	2071450	4825971	125850	90047	175888	0.268	0.172	0.416
1981	1366832	906009	2062042	123996	86120	178529	0.200	0.125	0.318
1982	1580067	1057850	2360080	135401	92524	198148	0.210	0.131	0.336
1983	4016708	2621835	6153685	141528	93931	213244	0.195	0.119	0.321
1984	5464655	3523217	8475905	169898	110660	260846	0.203	0.121	0.342
1985	4534093	2891045	7110924	203277	130613	316366	0.176	0.101	0.307
1986	1213537	777801	1893379	232684	147818	366275	0.158	0.088	0.284
1987	2982236	1904256	4670451	274501	171268	439956	0.140	0.076	0.258
1988	1238199	800968	1914107	272947	164367	453254	0.132	0.071	0.245
1989	6732275	4418129	10258535	322707	194288	536010	0.109	0.058	0.205
1990	8865272	5830805	13478937	375120	230608	610191	0.103	0.056	0.192
1991	3576790	2437162	5249313	427349	275086	663890	0.087	0.048	0.160
1992	5132183	3594862	7326931	458027	304057	689967	0.100	0.057	0.174
1993	7913279	5567000	11248426	448113	309870	648032	0.099	0.059	0.164
1994	3434613	2465410	4784830	528747	381960	731946	0.118	0.075	0.186
1995	4271404	3071531	5939998	465966	344472	630310	0.137	0.092	0.205
1996	3572995	2579925	4948321	455015	344941	600214	0.136	0.094	0.197
1997	3266377	2367154	4507193	394078	299544	518445	0.169	0.121	0.236
1998	6176737	4487856	8501180	366735	275887	487499	0.169	0.122	0.232
1999	2884758	2095794	3970727	360066	276013	469714	0.190	0.140	0.258
2000	5503964	3996057	7580879	331378	254708	431126	0.188	0.138	0.255
2001	5030299	3645683	6940788	324864	251132	420245	0.185	0.136	0.253
2002	7183914	5198928	9926781	341096	265099	438880	0.161	0.118	0.220
2003	9721065	6960453	13576575	346632	273803	438831	0.157	0.116	0.212
2004	2697781	1956979	3719010	349430	280709	434975	0.170	0.128	0.226
2005	3738530	2721910	5134851	377574	305827	466152	0.174	0.132	0.228
2006	4752262	3436145	6572479	372203	301347	459721	0.187	0.143	0.244
2007	8386155	6288483	11183555	360296	292295	444117	0.203	0.155	0.264
2008	5065909	3765704	6815041	348917	282228	431362	0.195	0.149	0.255
2009	5822108	4322246	7842435	396216	319424	491470	0.176	0.134	0.231
2010	5689160	4247366	7620380	467200	378743	576316	0.167	0.127	0.219
2011	4438943	3311548	5950150	434693	352582	535925	0.187	0.143	0.243
2012	8981453	6635815	12156231	464353	377090	571809	0.240	0.185	0.312
2013	5822226	4302175	7879343	477087	387307	587679	0.270	0.206	0.352
2014	7218470	5259376	9907319	475601	380558	594381	0.268	0.202	0.356
2015	15275770	1.1E+07	21372405	450885	354720	573119	0.278	0.205	0.377
2016	6577971	4476115	9666797	439137	332194	580508	0.322	0.226	0.460
2017	9645810	6064282	15342567	449921	317321	637932	0.271	0.179	0.412

Annex 08: New assessment run sol.27.20-24

June 27, 2018

After the April WGBFAS meeting in 2018 an error was found in the estimation procedure of survey indices for the sole stock. The DTU Aqua –Fisherman survey is the single index up to date that is used to calibrate the stock assessment. The survey has gradually changed haul duration from 1 hour to ½ hour, with 25% of the hauls in 2016 and 50% of the hauls in 2017 of an ½ hour duration. This change in hauling time was not accounted for in the standardization process of catch rates from the survey. Therefore a corrected survey index has been calculated taking into account the reduction in hauling duration. This changes the 2016 and especially the 2017 index by age to higher numbers as shown in the figure below.



Plot of standardized index by age from the DTU Aqua – Fisherman survey. The triangles represents the former index without considering hauling time and the circles are the indices corrected for hauling time.

The SAM assessment and forecast has been updated with the correct survey indices and is visible at assessment.org as the run “sole2024_newidx”. Below are figures and tables from the WGBFAS report that are affected by this correction.

A revised advice sheet has been produced in accordance with these corrections.

Table 6.5. Sole 20-24. Tuning fleets.

```
Fisherman-DTU Aqua survey meth 6
2004     2017
1        1        0.8      1
1        9
```

1	16.817	55.632	49.862	31.467	21.696	9.003	7.380	4.445	6.001
1	12.938	38.614	67.953	36.366	18.027	8.164	2.848	1.775	1.420
1	34.500	38.786	28.759	51.300	25.712	13.995	4.850	1.591	5.077
1	32.048	33.685	24.554	29.830	31.055	20.810	11.946	7.202	12.665
1	10.062	46.303	27.801	15.749	13.386	17.462	7.388	6.722	7.693
1	15.820	13.823	30.478	12.871	16.294	15.528	18.999	7.126	8.195
1	13.923	16.654	19.711	18.019	7.321	10.389	8.676	12.764	14.765
1	15.054	30.230	18.147	17.383	16.106	10.184	9.124	4.182	19.676
1	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1	22.367	17.571	19.509	14.706	12.539	9.710	4.090	8.794	12.482
1	34.300	29.304	17.145	15.579	9.772	17.800	6.589	4.828	31.371
1	18.246	38.895	27.629	14.880	14.228	4.174	7.880	4.589	27.060
1	10.796	50.547	37.525	24.329	7.884	12.438	2.319	2.339	22.416

```
Private logbooks Gillnet KC + KS combined
1994     2007
1        1        0.25     0.87
2        9
 7246     1071      8794      7892      2547      1254       268       187        60
 5900      682      3284      6795      4942      1673       936       203       153
24238     4914     19748      8589     10880      6350      2872      1578       948
19939     1303      5568      8787      7036      9251      6658      4775      3280
18984     2685      3309      3816      4869      2632      3033      3443      2270
19917    10704     33215      3187      3507      2700      2176      1978      1633
23645     2336     12192     11953      1815      2285      2461      2222      2315
17755     5721     11108      9181      3953      1463      2717       812      1260
19930    17094     20860      6010      6043      6757      2384      2155      2801
13812     2029     17166     16000      4387      7051      2468       395       691
 5518      547      3854      4483      2289      1391       864       523       226
 9067     2827     11590     13754      5559      1832       485       455       170
 9742     1495      5999     10446      8760      5434      1443       991       287
 7026     1374      2638      2360      3039      1856       920       394       319
Private logbook TR KC+KS combined
1987     2008
1        1        0.75     1
2        6
 712      2756      5140      5562      2667       954
 876      5667      7735      5361      3432      1025
 933      5097      2253      3761      2825      2126
1174     16408     10277      2753      3874      1545
1809     16085     35139     14745      4452      3878
3136     56849     46507     16304      7177      1545
4035     41739     44475     19945     11105      6685
5276      9498     55455     64125     19324     12725
4969     42026     35885     41231     29359     14705
4294     24861     38831     23489     26033     16360
4027      3927     13138     14220     10668     13279
2464     12543      3357      1117      1041      1736
2142     13031     24798      3690      4268      3927
3342      9566     16153     20370      3215      2692
2268      6292     11562      6052      6953       635
1498     29987     20538      4835      5483      3963
2093      7473     21584     14949      7199      3760
3999     20124     39887     47640     18374      8401
```

2463	7956	34026	29590	16011	6975
3132	11878	14708	24084	19146	12809
2730	14422	11847	4636	8756	515
1281	4393	2674	2438	2735	2130

Table 6.8. Sole 20-24. SAM diagnostics. Standard deviation estimates of log observations. (fleet2: Survey, fleet3: PL gillnetters, fleet4: PL trawlers)

Observation	Fleet	Age	sd(logObs)	low	high
1	1	2	0.64	0.46	0.88
2	1	3	0.29	0.24	0.37
3	1	4	0.29	0.24	0.37
4	1	5	0.29	0.24	0.37
5	1	6	0.29	0.24	0.37
6	1	7	0.29	0.24	0.37
7	1	8	0.29	0.24	0.37
8	1	9	0.29	0.24	0.37
9	2	1	0.35	0.20	0.62
10	2	2	0.34	0.27	0.42
11	2	3	0.34	0.27	0.42
12	2	4	0.34	0.27	0.42
13	2	5	0.34	0.27	0.42
14	2	6	0.34	0.27	0.42
15	2	7	0.34	0.27	0.42
16	2	8	0.34	0.27	0.42
17	2	9	0.34	0.27	0.42
18	3	2	0.58	0.38	0.87
19	3	3	0.35	0.28	0.44
20	3	4	0.35	0.28	0.44
21	3	5	0.35	0.28	0.44
22	3	6	0.35	0.28	0.44
23	3	7	0.35	0.28	0.44
24	3	8	0.35	0.28	0.44
25	4	2	0.48	0.34	0.68
26	4	3	0.50	0.42	0.59
27	4	4	0.50	0.42	0.59
28	4	5	0.50	0.42	0.59
29	4	6	0.50	0.42	0.59

Table 6.9. Sole 20-24. Fishing mortality at age (age 6-9 assumed constant).

Year\Age	2	3	4	5	6+
1984	0.082	0.399	0.488	0.401	0.38
1985	0.073	0.3	0.363	0.327	0.281
1986	0.084	0.313	0.411	0.391	0.342
1987	0.101	0.332	0.448	0.46	0.458
1988	0.099	0.309	0.412	0.407	0.4
1989	0.105	0.317	0.428	0.431	0.416
1990	0.098	0.301	0.412	0.416	0.37
1991	0.098	0.303	0.423	0.441	0.488
1992	0.097	0.302	0.421	0.464	0.597
1993	0.096	0.306	0.428	0.482	0.605
1994	0.08	0.259	0.361	0.414	0.45
1995	0.088	0.289	0.387	0.447	0.494
1996	0.084	0.288	0.356	0.404	0.431
1997	0.078	0.256	0.337	0.385	0.428
1998	0.073	0.237	0.314	0.378	0.407
1999	0.068	0.225	0.296	0.347	0.368
2000	0.064	0.215	0.294	0.331	0.361
2001	0.054	0.181	0.236	0.282	0.297
2002	0.061	0.197	0.26	0.324	0.423
2003	0.052	0.163	0.238	0.295	0.385
2004	0.062	0.191	0.288	0.345	0.441
2005	0.072	0.22	0.322	0.371	0.44
2006	0.074	0.227	0.319	0.377	0.374
2007	0.077	0.235	0.319	0.351	0.305
2008	0.087	0.27	0.371	0.374	0.326
2009	0.077	0.258	0.36	0.325	0.185
2010	0.07	0.26	0.362	0.317	0.166
2011	0.052	0.208	0.316	0.252	0.122
2012	0.04	0.155	0.26	0.217	0.14
2013	0.035	0.133	0.236	0.203	0.144
2014	0.029	0.097	0.19	0.177	0.148
2015	0.025	0.082	0.152	0.167	0.124
2016	0.031	0.1	0.189	0.211	0.168
2017	0.041	0.116	0.239	0.281	0.292

Table 6.10. Sole 20-24. Stock number at age from assessment.

Year Age	1	2	3	4	5	6	7	8	9
1984	6204	2579	1633	514	369	132	82	126	485
1985	5258	5877	2338	917	263	223	89	46	349
1986	4888	4637	4911	1689	602	172	145	73	264
1987	4595	4409	3853	3231	1012	369	126	92	225
1988	5949	3805	3816	2703	1844	492	174	72	182
1989	7415	5440	2681	2584	1687	1157	262	100	151
1990	7463	7120	4479	1760	1589	1016	694	139	139
1991	8026	6630	5614	2888	1039	943	673	469	185
1992	6237	7947	5389	3478	1573	588	504	370	398
1993	3735	6066	6826	3615	2100	879	282	259	363
1994	3466	2993	5202	4821	2178	1201	403	137	281
1995	2388	3406	2624	3965	3140	1436	764	263	275
1996	1763	2119	2983	1859	2409	1707	841	423	379
1997	3420	1221	1436	1734	1244	1515	1113	633	555
1998	3627	3659	881	925	976	769	843	685	757
1999	3284	3429	3728	638	723	610	522	517	885
2000	4418	2662	2655	2552	429	499	371	370	963
2001	5636	4057	2209	1939	1579	296	379	207	914
2002	4481	5814	3844	1549	1502	1165	231	280	868
2003	4419	3820	4373	2768	1148	1062	634	119	652
2004	3173	4366	3773	3292	1757	760	584	340	442
2005	2752	2895	4592	3450	2210	978	371	288	339
2006	3259	2500	2305	3469	2210	1436	554	231	409
2007	3416	2734	1994	1609	2173	1081	778	351	481
2008	2381	3196	1926	1418	1081	1393	662	537	586
2009	2308	2209	2645	1274	996	697	881	367	666
2010	2106	2119	2061	1755	757	664	446	670	793
2011	1855	1937	1962	1547	1141	492	454	266	1109
2012	1629	1608	1541	1459	973	812	334	368	1092
2013	1724	1400	1427	1229	1073	706	625	234	965
2014	2651	1406	1157	1041	856	826	475	525	846
2015	3268	2416	1212	997	709	674	576	306	1189
2016	3036	2873	2247	1032	904	492	451	407	1316
2017	2241	3016	2353	1804	754	728	378	336	1362

Table 6.11. Sole 20-24. Stock summary from SAM.

Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 4 to 8 (F48). "Low" and "high" are lower and upper boundary of 95% confidence limits as indicated on plots.

YEAR	R(AGE1)	LOW	HIGH	SSB	LOW	HIGH	FBAR(4-8)	LOW	HIGH	TSB	LOW	HIGH
1984	6204	3784	10172	870	696	1086	0.406	0.303	0.544	1714	1389	2114
1985	5258	3443	8029	1124	892	1415	0.307	0.231	0.408	2462	1954	3102
1986	4888	3259	7331	2027	1611	2550	0.366	0.285	0.469	3085	2525	3771
1987	4595	2972	7104	2099	1736	2536	0.457	0.356	0.585	3080	2594	3656
1988	5949	3971	8914	2165	1815	2582	0.404	0.315	0.519	3127	2658	3679
1989	7415	4920	11177	2189	1854	2585	0.422	0.331	0.537	3592	3046	4235
1990	7463	4978	11188	2721	2302	3217	0.388	0.307	0.491	4451	3755	5275
1991	8026	5163	12476	3192	2685	3795	0.465	0.373	0.58	4827	4089	5697
1992	6237	4105	9477	4132	3495	4885	0.535	0.427	0.67	6199	5228	7350
1993	3735	2494	5593	3924	3296	4671	0.545	0.431	0.691	5227	4441	6154
1994	3466	2335	5143	4104	3491	4825	0.425	0.335	0.538	4833	4152	5625
1995	2388	1553	3671	3436	2962	3987	0.463	0.368	0.584	4217	3658	4861
1996	1763	1035	3004	3250	2813	3754	0.411	0.33	0.511	3728	3242	4289
1997	3420	2255	5189	2640	2280	3057	0.401	0.322	0.5	3087	2690	3543
1998	3627	2437	5397	1876	1606	2192	0.383	0.304	0.482	2683	2309	3118
1999	3284	2166	4979	2257	1900	2681	0.35	0.279	0.438	3009	2552	3549
2000	4418	2973	6567	2291	1942	2702	0.342	0.272	0.43	3005	2575	3508
2001	5636	3690	8608	2245	1914	2632	0.282	0.221	0.36	3329	2843	3898
2002	4481	3008	6675	2624	2208	3119	0.371	0.291	0.474	3893	3266	4639
2003	4419	2939	6644	2972	2501	3532	0.337	0.257	0.443	3902	3351	4544
2004	3173	2211	4553	3210	2747	3750	0.391	0.304	0.503	4286	3694	4974
2005	2752	1895	3997	3519	2976	4162	0.403	0.315	0.514	4240	3616	4972
2006	3259	2230	4762	2982	2502	3553	0.363	0.286	0.462	3680	3116	4345
2007	3416	2344	4978	2483	2104	2930	0.317	0.245	0.411	3264	2785	3826
2008	2381	1609	3523	2061	1721	2467	0.345	0.262	0.453	2891	2432	3436
2009	2308	1588	3354	2391	1948	2934	0.248	0.185	0.332	2995	2481	3616
2010	2106	1443	3075	2086	1691	2573	0.236	0.175	0.317	2759	2269	3354
2011	1855	1238	2781	2101	1678	2632	0.187	0.138	0.253	2718	2196	3364
2012	1629	1036	2560	2295	1811	2909	0.18	0.131	0.246	2851	2275	3573
2013	1724	1099	2703	1789	1407	2277	0.174	0.128	0.237	2227	1772	2800
2014	2651	1781	3944	2254	1791	2838	0.163	0.12	0.221	2733	2200	3394
2015	3268	2128	5018	2017	1596	2549	0.138	0.1	0.19	2747	2208	3417
2016	3036	1926	4783	2248	1776	2845	0.181	0.133	0.246	3466	2763	4349
2017	2241	1163	4318	2406	1866	3101	0.279	0.197	0.397	3460	2684	4461
2018	2308			2693								

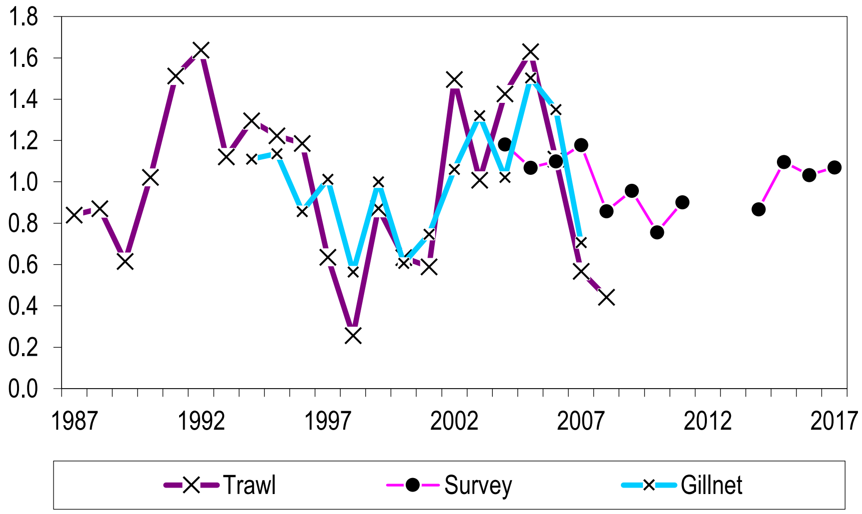


Figure 6.3 . Sole 20-24. Standardised age aggregated CPUE indices of sole from private logbooks from trawlers , private logbooks gillnetters and Fisherman/DTU Aqua survey as used in the assessment.

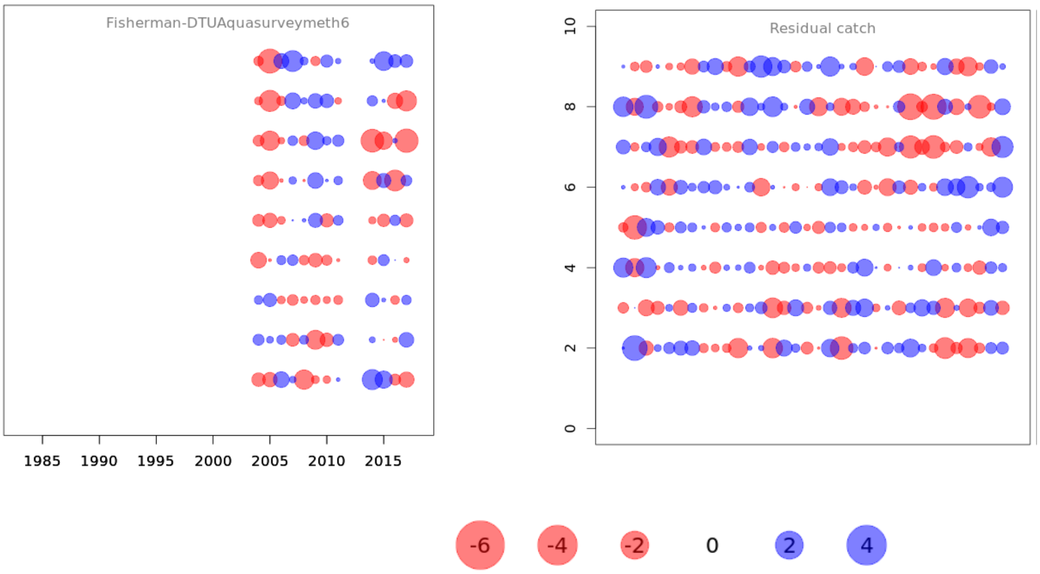


Figure 6.8. Sole 20-24. Model residuals for survey and landings.

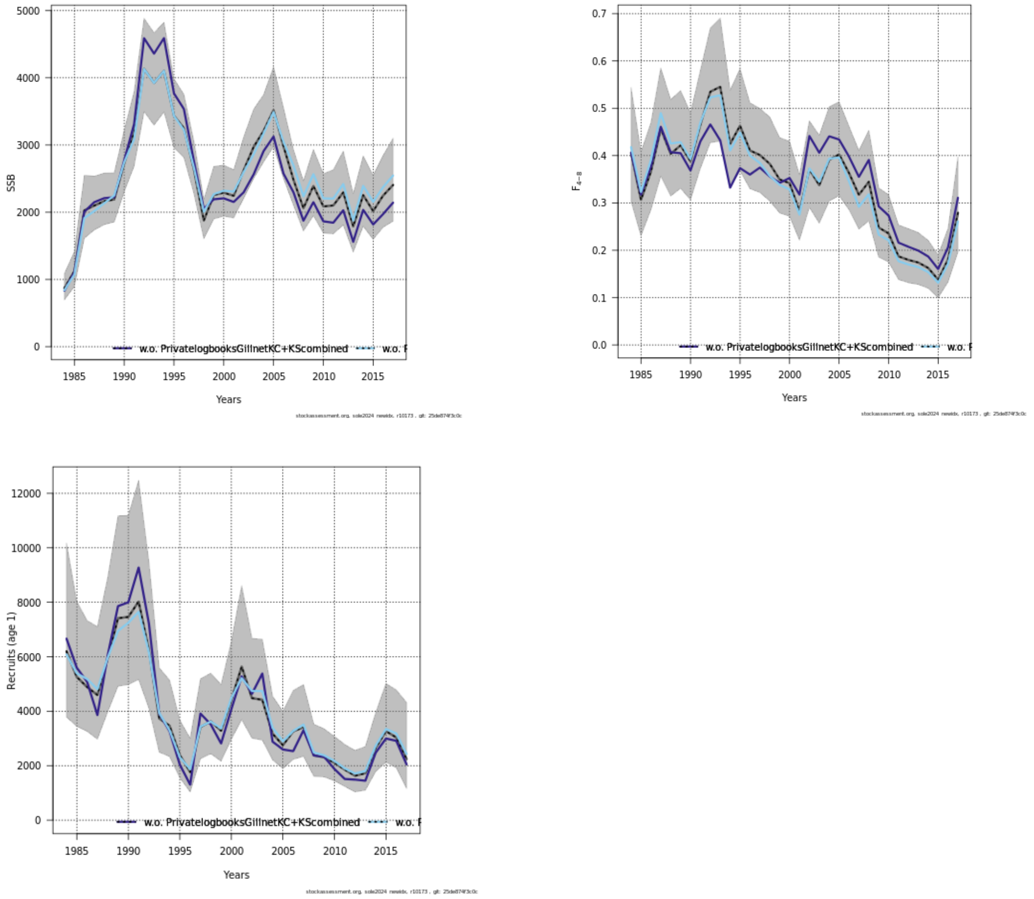


Figure 6.9. 20-24. Fleet sensitivity. Estimated SSB, fishing mortality and recruitment (age1) from runs leaving single fleets out.

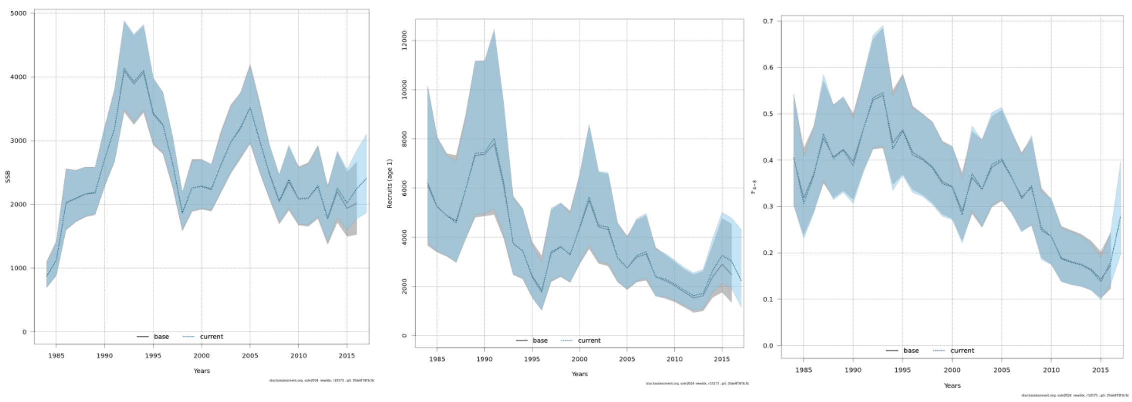


Figure 6.10. Sole 20-24. Stock summary. SSB, F(4-8) and R (age 1) compared to last year's assessment.

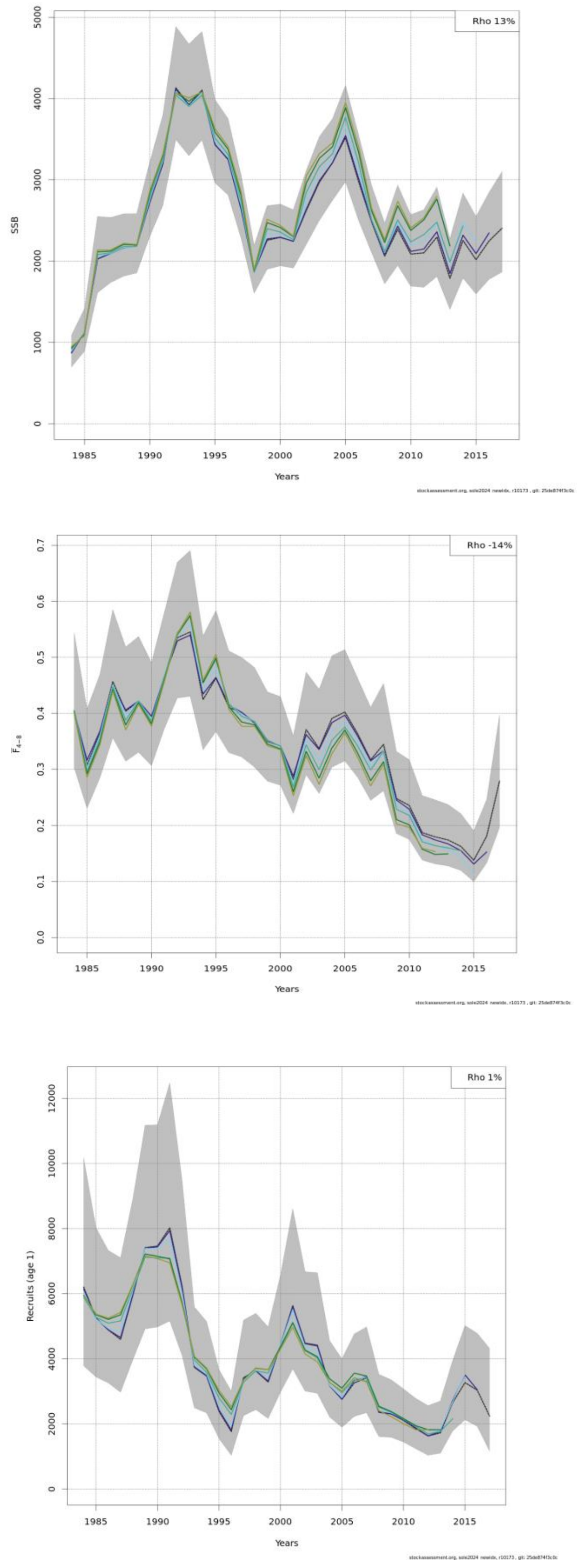


Figure 6.11. Sole 20-24. Retrospective analyses. Upper: SSB and F, lower: R. Confidence limits (95%) are provided for the 2017 scenario.

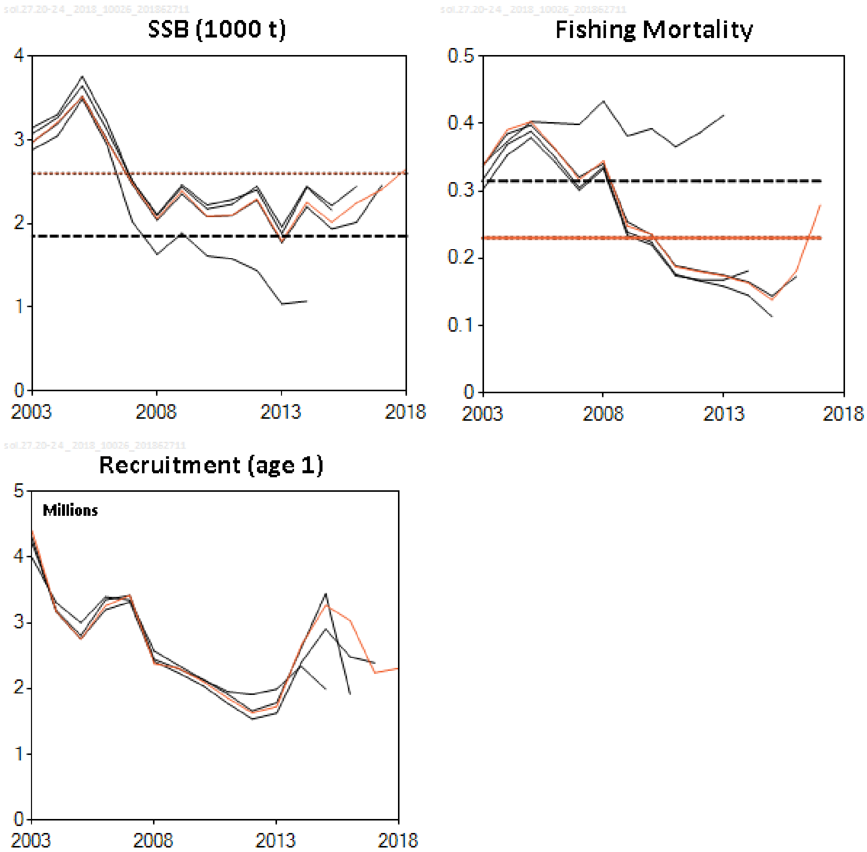


Figure 6.12. Sole 20-24. Historical performance of F, SSB and recruitment.

Annex 10: Revision of the contribution of TACs to fisheries management and stock conservation

A. Kattegat cod

Was the TAC restrictive in the past?

The Kattegat cod TAC has been restrictive in most years since 1999 as the TAC has been low since the collapse of the cod stock in the late 1999 (Figure1). The low TAC dramatically changed the exploitation pattern of cod. Historically there was a large fishery in the first quarter targeting spawning aggregations of cod in the southeast Kattegat. Since the early 2000 the low quotas followed by a zero catch advice from ICES (Table 1 and 2) the targeted spawning fishery has decreased and the catches of cod has mainly been as bycatch and discard (Fig.2) in trawl fishery targeting Norway lobster (*Nephrops norvegicus*) and trawl fishery targeting sole (*Solea solea*).

The mixed fishery problem has forced the fishing fleet to adapt to selective gears with low (SELTRA) and no catches of cod (Sorting grid). The high uptake of selective gears in the fishing fleet would not have been achieved without the restraining quotas of Kattegat cod. However, in order to further protect the collapsed cod stock, additional measures was introduced. In 2009, Denmark and Sweden, introduced protected areas on historically important spawning grounds in South East Kattegat. The protected zone consists of three different areas in which the fisheries are either completely forbidden or limited to certain selective gears (Sorting grid and Danish SELTRA) during all or different periods of the year.

Table 1. Kategatt cod landings, TAC and % utilization of the TAC 1999–2017

Year	Landings	TAC	% utilized
1999	6608	6300	1.05
2000	4897	7000	0.70
2001	3960	6200	0.64
2002	2470	2800	0.88
2003	2045	2300	0.89
2004	1403	1363	1.03
2005	1070	1000	1.07
2006	876	850	1.03
2007	645	731	0.88
2008	449	673	0.67
2009	197	505	0.39
2010	155	379	0.41
2011	145	190	0.76
2012	94	133	0.71
2013	92	100	0.92
2014	108	100	1.08
2015	106	100	1.06
2016	299	370	0.81
2017	293	525	0.55

Figure 1. Spawning stock biomass (SSB) of Kattegat Cod 1971-2017.

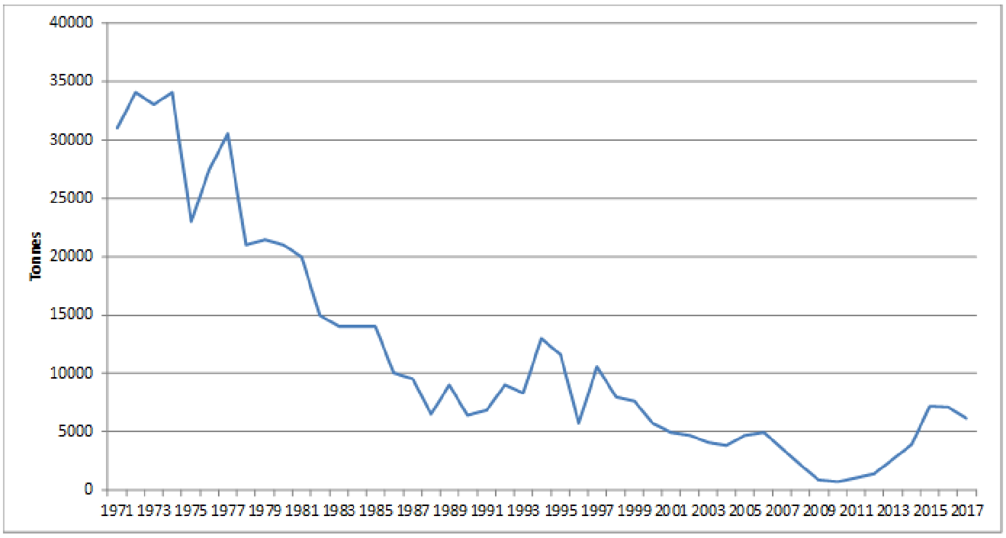


Table 2.Ices Advice; corresponding Total allowable catch (TAC) and reported Catch 1999-2017

Year	Ices Advice (t)	TAC (t)	Reported catch (t)
1999	4500	6300	7372
2000	6400	7000	5550
2001	4700	6200	4617
2002	0	2800	3290
2003	0	2300	2661
2004	0	1363	2488
2005	0	1000	1964
2006	0	850	1783
2007	0	731	1269
2008	0	673	605
2009	0	505	264
2010	0	379	325
2011	0	190	356
2012	0	133	251
2013	0	100	447
2014	0	100	456
2015	0	100	584
2016	130	370	521
2017	129	525	561

Is there a targeted fishery for the stock or are the species mainly discard?

Historically there has been a large targeted fishery during spawning in the first quarter, later years the major fishing mortality source is from bycatch and to a high extent as discard(60–80 % of landings) (Figure 2). The decrease of the targeted fishery of cod is directly related to the restricted TAC. There is a potential for an extensive targeted fishery on cod especially during spawning season and also, to a less degree, during other periods of the season when the stock is re-built.

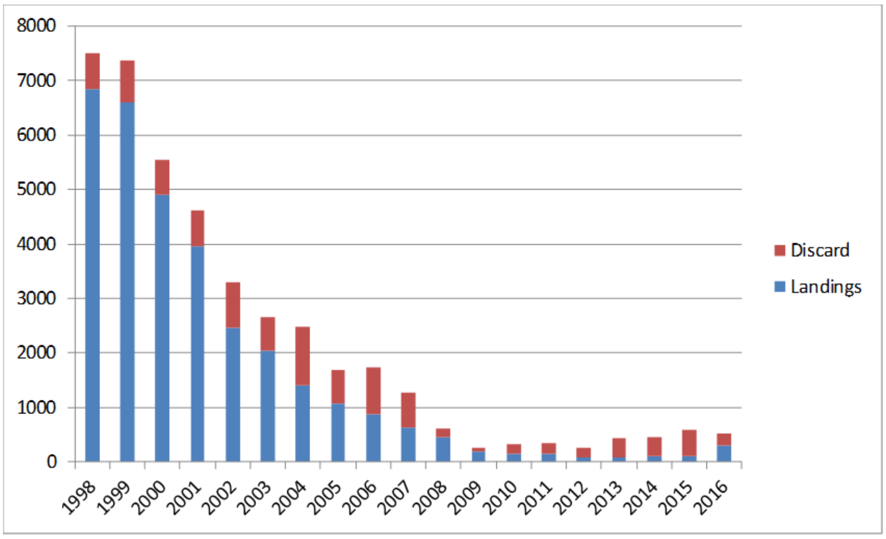


Figure 2. Kattegat cod landings and discard of 1998–2016

Is the stock of large economic importance or are the species of high value?

Historically the cod fishery was an important economic fishery in Kattegat with landings of 20 000 tonnes in the 1970's (Figure 3), since the collapse of the cod stock in Kattegat the economic value has been low, the major economic species in the Kattegat presently is Norway lobster (*Nephrops norvegicus*) followed by sole (*Solea solea*).

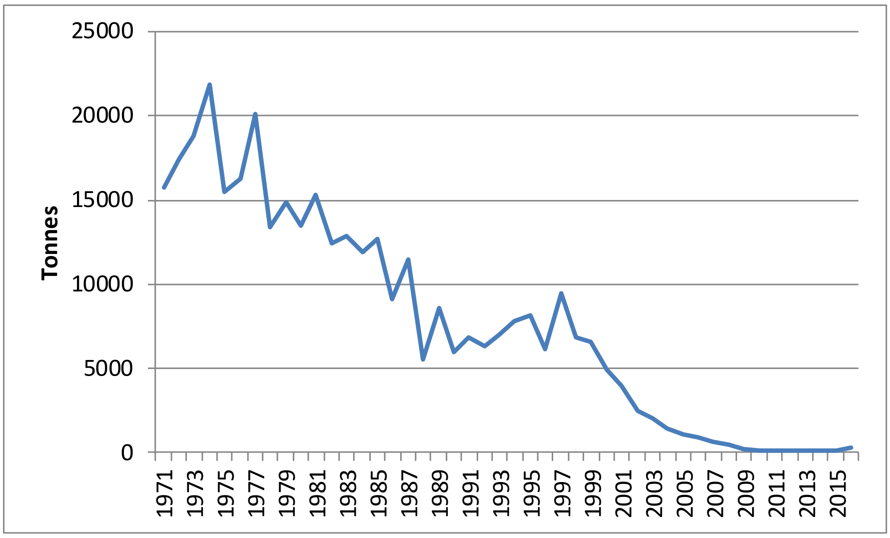


Figure. 3 Landings of Kattegat cod (tonnes) 1971–2016

How are the most important fisheries for the stock managed?

The most economic important fisheries in Kattegat, is the Norway lobster fishery and the Sole fishery both managed by TAC regulations. Both Danish and Swedish fisherman are operating under a system of Individual quotas, were each fisherman owns a proportion of the TAC. There are no effort limitations at place in Kattegat since 2016. Furthermore, the closed areas and season are used as management of the cod stock.

What are the fishing effort and stock trends over time?

The fishery in Kattegat is dominated by trawling, at present primarily within the TR2 gear category (mesh sizes at 90–99 mm).The gear group TR2 are responsible for 90 % of the catches (Landings and discard) of Kattegat cod. A major shift in fishing gears occurred between 2003 and 2004 when the use of 70–89 mm trawls without sorting grids was banned. The overall TR2 effort has decreased by 50 % since 2003. In 2009 after the introduction of the protected zone with areas were the fishery only was allowed with certain selective gears (sorting grid and Seltra) the usage of these increased dramatically (Figure 4), The proportion of effort deployed in the Kattegat 2016 constitutes to 90 % of selective gears (Fig.4)

SSB of cod in the Kattegat steadily declined from around 35 000 tonnes in the late 1970s to a level of less than 1000 tonnes in 2010. Good recruitment in 2011 and 2012 gave some hope that the cod recovery measured set down to allow for a rebuilding of the stock was successful. However after a peak in SSB 2015 the stock has started to decline again. (Figure 5.)

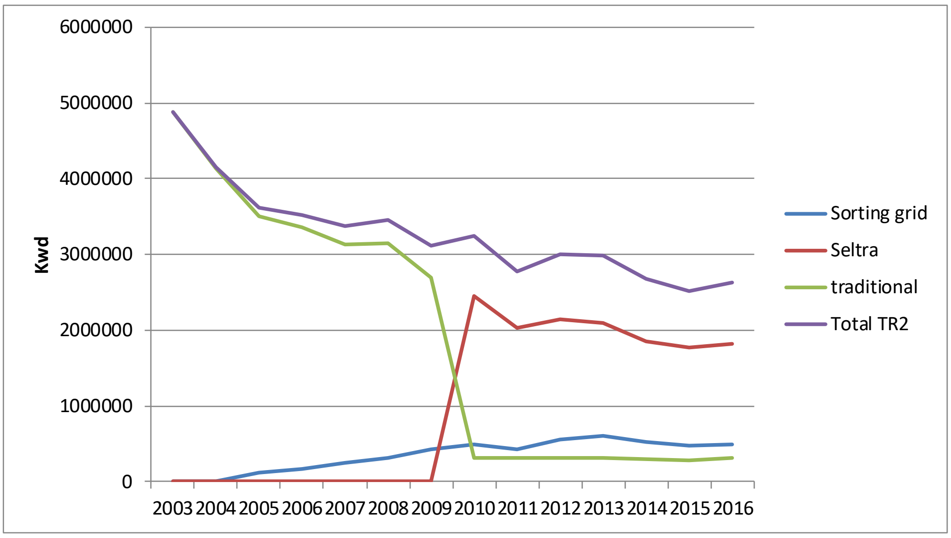


Figure 4. Effort of TR2 (trawls mesh size 90-99 mm) in Kattegat for the years 2003-2016. The figure shows effort trends for trawls with high catchability of cod (traditional), modified trawls with low catchability of cod (Seltra) and modified trawls with no catches of cod (Sorting grid). The use of the traditional trawl in 2016 is from the use of Danish fisherman fishing sole in the last quarter of the year.

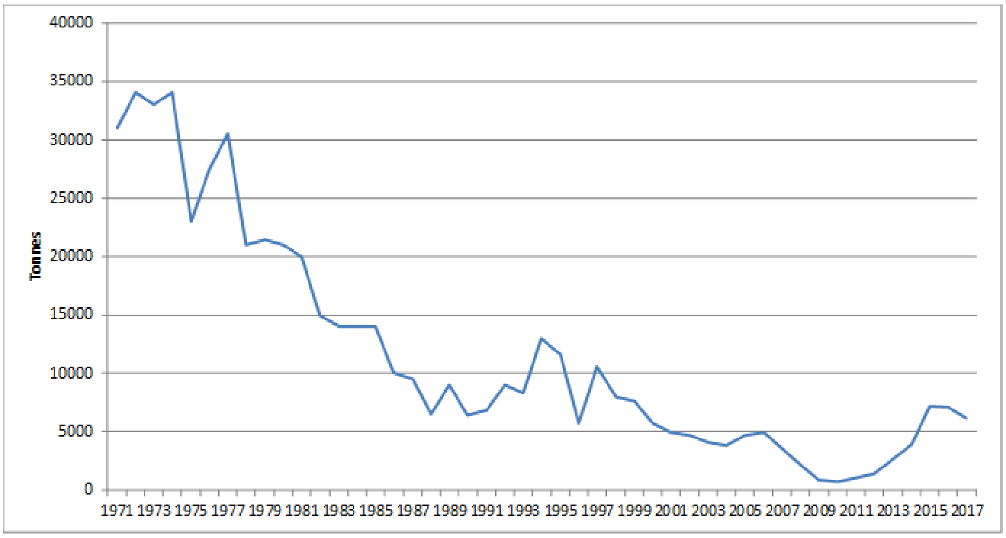


Figure 5. Spawning stock biomass of Kattegat Cod 1971–2017.

What maximum effort of the main fleets can be expected under management based on FMSY (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort

The quota uptake of the Norway lobster TAC has only been 40% the last years, hence there is a potential for a much higher effort in order to be utilize the Norway lobster quota. With the removal of the effort system 2016, there are no upper limits in how much effort that can be deployed in Kattegat. If the TAC of cod is removed, a huge incitement for using selective gears is removed and the mortality of the cod stock would increase to dangerously high levels. In fact the risk of extinction of Kattegat cod is emergent.

Conclusion

If the TAC of cod is removed, a huge incitement for using selective gears is removed and the mortality of the cod stock would increase to dangerously high levels. In fact the risk of extinction of Kattegat cod is emergent.

B. Baltic Plaice

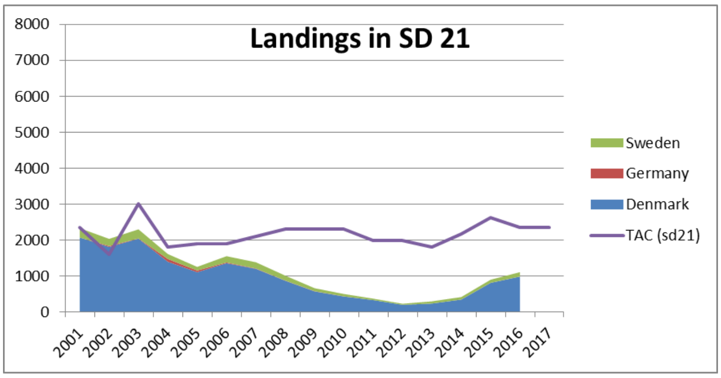
B.1 Plaice in Kattegat and western Baltic Sea (ple.27.21-23)

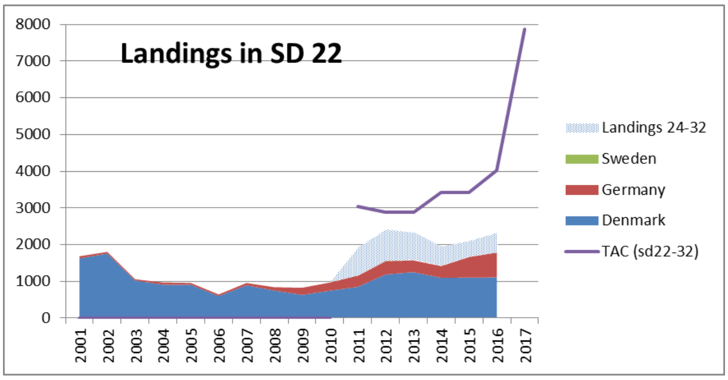
Was the TAC restrictive in the past?

As shown in the figures below the TAC has not been restrictive in the period from 2001 to present. The landings and discards of plaice from SD 27.23 are insignificant.

The issue is complicated by the fact that the plaice stock definition (SD 27.21-23) differs from the management units (27.21 and 27.22-32). This gives the problem that the TAC for SD 27.22-32 covers part of plaice stock PLE 27.21-23 and PLE 27.22-32, which might differ in stock dynamics. The sum of the landings of plaice in SD 27.22, 27.23 and the total landings of PLE 27.24-32 does not exceeds the TAC for SD 27.22-32.

Until 2013 SD 27.21 (Kattegat) was assessed together with SD 27.20 (Skagerrak).



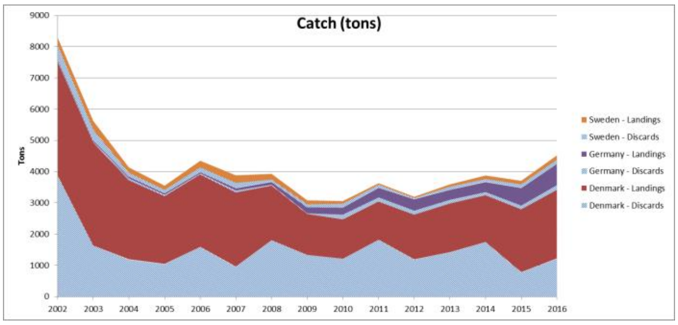


Landings in SD 21 and SD 22 (and 24-32) and the TAC in SD 21 and 22-32 respectively.

Is there a targeted fishery for the stock or are the species mainly discarded?

The plaice is an important fishery in periods as a supplement to the trawl fishery targeting *Nephrops* in Kattegat and targeting cod in the western Baltic. In Kattegat many vessels are fishing *Nephrops* during night time and fishing plaice during day time. In western Baltic, plaice are fished in periods where the cod are not available. Here, the bigger trawlers are fishing plaice mainly during the closed period for cod fishery (Feb-March), while the smaller trawlers carry out plaice directed fishery when needed throughout the year. The same gear is used for catching both species respectively in Kattegat and eastern Baltic.

In general, about 50 percent (weight) of the catch is discarded (2002–2016).



Catch of PLE27.22-23 by country split into landings and discard

What are the fishing effort and stock trends over time?

Effort trend

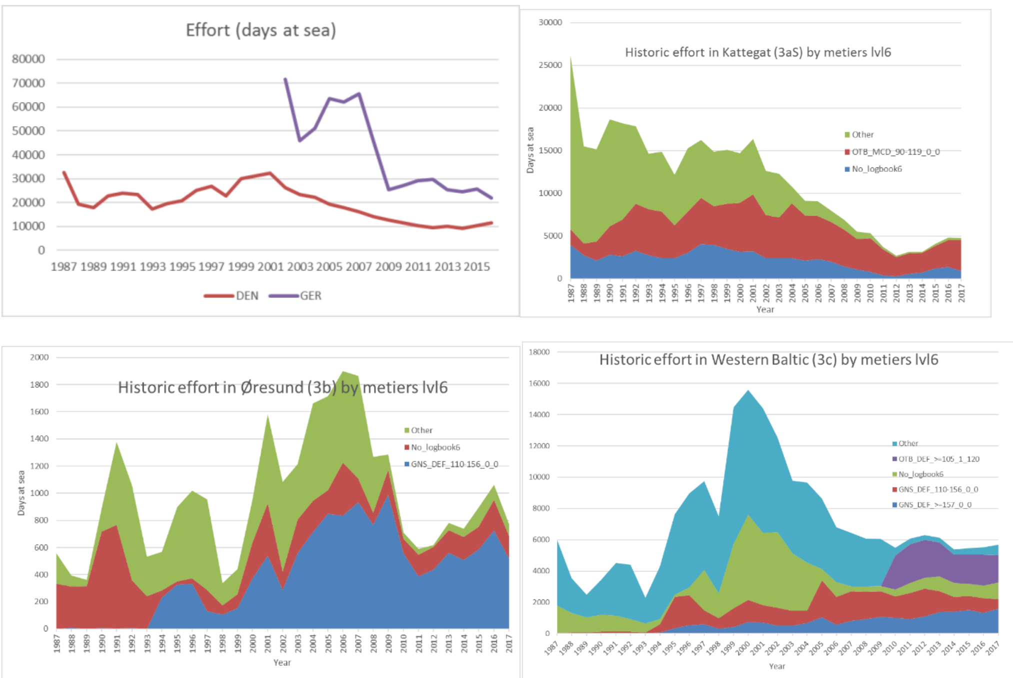
The fishing effort targeting plaice is linked to the effort for the cod fishery.

Effort for the plaice fishery from Germany is available from 2002 to 2008 on lvl5 and from 2009 to 2016 on lvl6. From Denmark, effort data are available from 1987 to 20017 on level6. A trip is evaluated to be included in the Danish effort statistics for plaice if the total landing of plaice from the trip is >20 kg. Trips without logbooks are assumed to be one day-at-sea each.

In the German statistics, the effort is assigned to plaice fishery based on the métier on lvl6/lvl5 (including all demersal fisheries to the plaice fishery).

The German métier assignment to the plaice fishery is not regarded of a quality, which allow it to be used for showing the historical métier specific composition in the plaice fishery because it is strongly correlated to the cod fishery. The effort German effort statistics are regarded as less reliable before 2009.

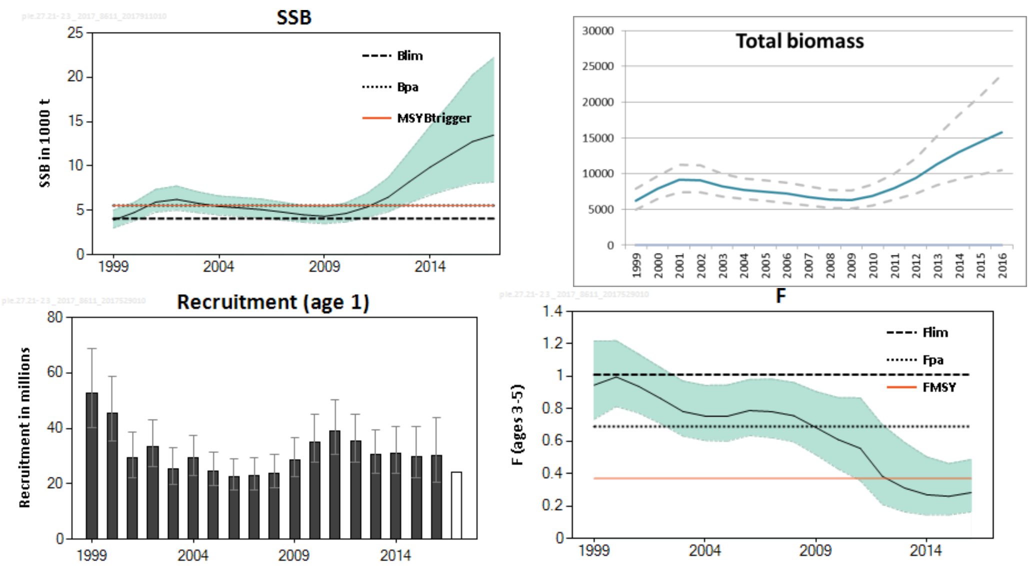
Swedish effort statistic is not included due to its insignificance.



Danish historical fishing effort (days-at-sea) by the top métiers targeting plaice. All graphs include only Danish effort except the upper left.

Stock trend

As shown below, the SSB has increased since 2010 although the confident interval is rather high due to the relative short time series available. F has decreased since 2000 and is now stable since 2014 close to F_{msy} (0.37). Recruitment has been more or less stable in the whole period. In general, the confident intervals are rather high in all the estimates due to the relative short time series available. Despite the short time series, the assessment as such seems to be quite robust.



Stock trends as expressed in the stock assessment for 2017.

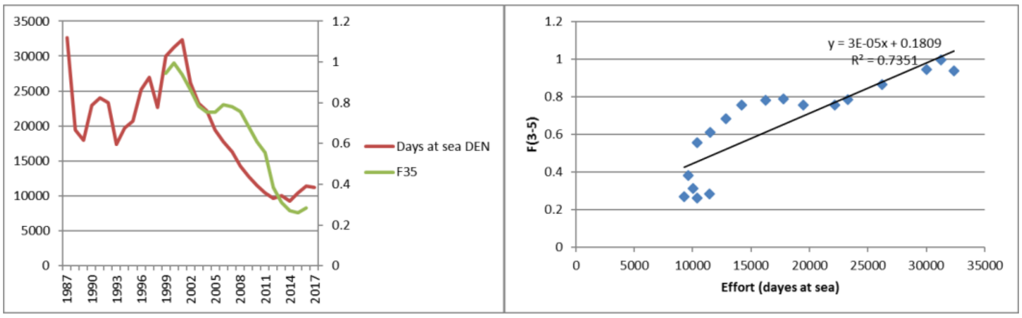
What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort

Fishing mortality [F(3-5)] – Effort relationship [Days at sea] and Estimated effort equal to F_{MSY}

As Several approaches can be selected due to the incompleteness of the effort data.

There seems to be a quite good correlation between the Danish effort and the total F(3-5) as shown below (r2=0.7351) . This indicates that the effort equal to F_{msy} can be estimated based on the Danish effort statistics alone plus the mean German effort for the period of reliable effort statistics (2009–2016). The German mean effort in the plaice fishery for the period 2009-2016= 25 671 days at sea. This approach allows that the whole time series for F(3-5) to be used (1099–2016).

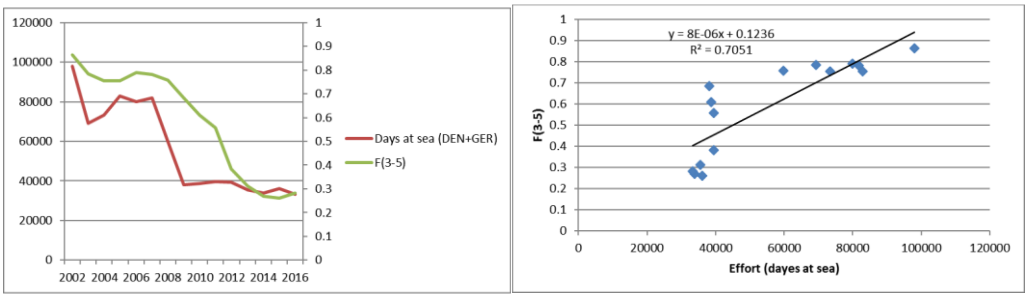
This method estimates the total effort for the main fisheries targeting plaice equal to $F(3\text{-}5)_{MSY}$ (=0.37) to be 31 974 days-at-sea.



Historical Danish effort and stock fishing mortality (left) and the relation between them (right).

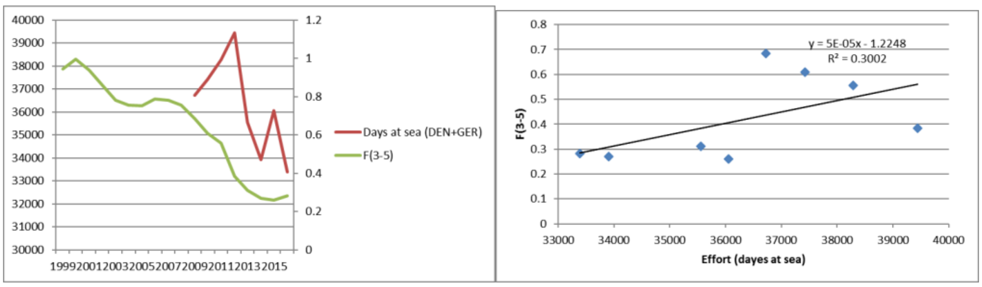
An alternative approach is if the sum of the Danish effort lvl6 and German effort (lvl5) is used for the regression. The correlation is almost as good as above (r2=0.7051) even though the time series is shorter (2002–2016) than above.

This method estimates the total effort for the main fisheries targeting plaice equal to F(3-5)$_{MSY}$ (=0.37) to be 30 800 days-at-sea.



Historical Danish + German effort and stock fishing mortality (left) and the relation between them (right).

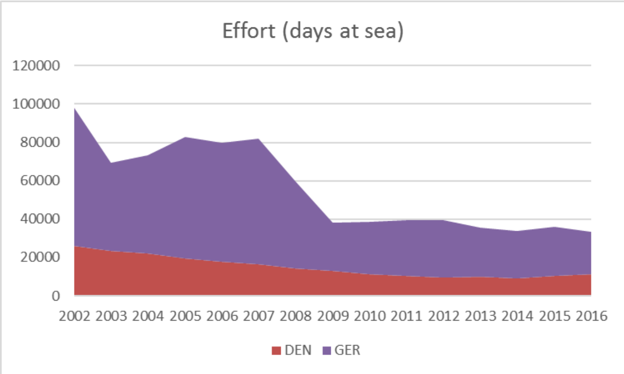
If only the reliable regarded German effort time series (2009–2016) and the Danish for the same period is used, the correlation is not significant (r2=0.3002).



Historical Danish + German effort (2009–2016) and stock fishing mortality (left) and the relation between them (right).

Experienced similar levels of fishing effort for the stock

The historical effort of the main fisheries targeting plaice in the Western Baltic and Kattegat (PLE27.21-23) is shown below



Historical Danish + German effort (2002–2016).

The present (2016) level of effort for the main fisheries targeting plaice is 33 000 days-at-sea, which means that the present level of effort is approximately on the level of the estimated effort equal to $F(3\text{-}5)_{MSY}$ for both suggested estimation methods. This has to be seen in the light of the increasing SSB in the stock assessment (2017), which is far above SSB_{PA}, which suggests that the stock might be able to sustain a bit more effort than estimated. On the other hand, the assessment (including the SSB) is associated with quite high uncertainty due to the relative short time series on which the assessment is based.

B.2. Plaice in subdivisons 24-32 (ple.27.2432)

Was the TAC restrictive in the past?

The management area differs from the stock area since 2013. That means that although an advice on TAC is given for ple.27.2432, it is combined with the advice for ple.27.2223 (which in turn is separated from the stock area ple.27.2023).

However, the total catch in the eastern Baltic (27.3.d.24-32) was not above the recommended TAC for the same area and hence not „restrictive". It has however been restrictive for the total stock (covering 27.3.c.22 – 27.3.d.32) in the past.

Is there a targeted fishery for the stock or are the species mainly discarded?

Yes, plaice is targeted by the fishery, although mainly in a „mixed flatfish fisheries" (see also WGBFAS reports), also targeting flounder and dab. Plaice is caught by demersal trawlers and set-netter (coastal).

Plaice is also caught as a bycatch in cod-directed fisheries.

Is the stock of large economic importance or are the species of high value?

Plaice in the eastern Baltic has a higher value compared to other flatfishes (depending on the season and fishing gear. Plaice caught by passive fisheries usually has a better value). Together with the other flatfishes it has an economic importance, especially for small-scale coastal fisheries.

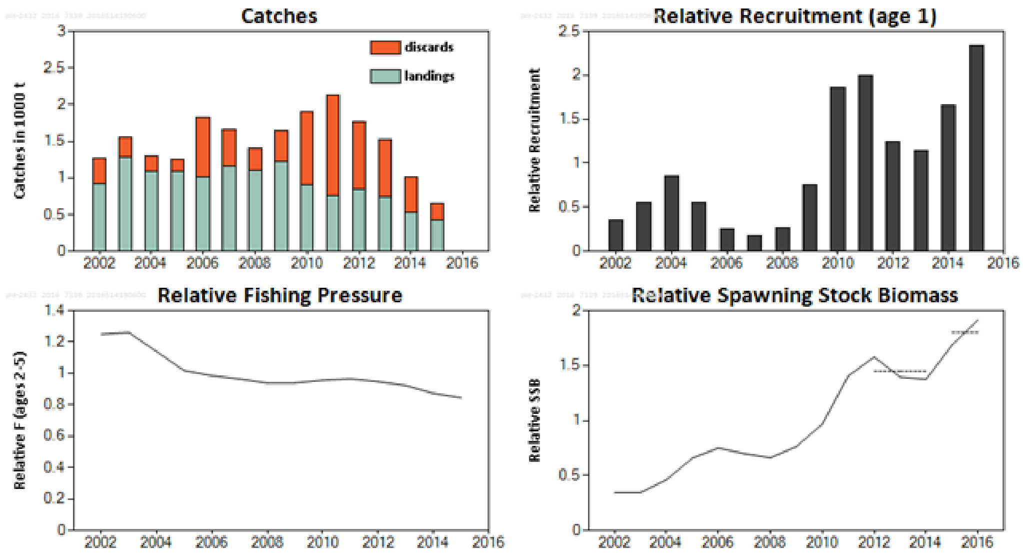
In 2017, the sales price ranged between €1.80/kg (€1.20 to €4.00 per kg) in the first quarter to around €0.70/kg (€0.60 to €0.80 per kg) in the fourth quarter. Flounder in comparison was sold for €1.30/kg to €1.40/kg (stable during the year).

How are the most important fisheries for the stock managed?

The most important fisheries are demersal trawlers and demersal set-netters. They are managed by quota, which are assigned according to the TAC share of the respective country. TAC can be traded between fishing organizations in case it becomes restrictive.

What are the fishing effort and stock trends over time?

Time series are available back to 2002. The commercial effort is fluctuating, but more or less stable. The relative fishing pressure is slightly decreasing, while also the catch is decreasing since 2011.



What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort

The stock does not have an F_{MSY}, it is later combined with the advice of plaice in the western Baltic to give a F_{MSY} for the whole Baltic Sea.

Conclusions for both the Plaice stocks(21-23 and 24-32)

The TAC is not restrictive; removing the TAC has no impact on the stock given the current effort and stock size.

Reviews

Review 1

Review report of provision of advice on a revision of the contribution of TACS to fisheries management and stock conservation:

Executive Summary

ICES requested that a list of species be analysed in terms of the risk (whether it is biologically safe in the short and medium term) of removing TACs for each case and to assess the potential use of other conservation tools in the place of TACs. Specific questions to be addressed were:

- A general impression of the evaluation method (questions asked, data looked at)
- Stock by stock impression of whether the summary of the questions and data provide a solid background to say y/n to lifting TAC
- Any thoughts on additional comments from experts (valid concerns, etc.)
- The EC have set which species are target/bycatch; is this definition critical to the outcome of the evaluation?

The review report follows the above structure and addressed each question below.

A GENERAL IMPRESSION OF THE EVALUATION METHOD (QUESTIONS ASKED, DATA LOOKED AT)

The following questions were addressed for each stock:

1. Was the TAC restrictive in the past?
2. Is there a targeted fishery for the stock or are the species mainly discarded?
3. Is the stock of large economic importance or are the species of high value?
4. How are the most important fisheries for the stock managed?
5. What are the fishing effort and stock trends over time?
6. What maximum effort of the main fleets can be expected under management based on F_{MSY} (ranges) for the target stocks, and has the stock experienced similar levels of fishing effort before?

Although these questions are very informative, how these questions link to the key issue at hand (removing the TAC) is important. Therefore, for this review, a few high-level queries to synthesise the conclusions were added to provide a consistent process and summary approach:

1. Has the species/stock/group (hereafter just called stock) got characteristics that places it at high relative risk?
   - In terms of its general biology e.g. aggregating, sex change, long lived, low productivity, forage fish, ecosystem importance
   - In terms of its catchability e.g. degree of population overlap with key fisheries, presence of refuges, ability to be directly targeted

2. Is the present TAC/management influenced by past unsustainable practices?
   - If yes, are those fisheries still active?
   - Was the stock targeted?
3. Can these or new unsustainable practices return if the TAC is removed?
   - Can they be targeted with the present fleet?
   - Are they heavily discarded?
   - Is the stock valuable?
4. Are there alternatives to a TAC to manage this stock?
   - Can they be managed as companion species through target TACs (if applicable)?
   - Can they be spatially managed?
   - Any other mechanism? E.g. Multi-Year TACs (MYTAC).
5. Comment on the conclusions

As can be seen from these points, most of the questions posed within the report inform the high-level queries well, except for the companion species component. To help the reviewer, the information from the 6 question was added to the 5 questions above to see whether the information provided could address the issues therein.

The report addressed the removal of TACs on a single species case-by-case basis. In reality, the issue of removing a TAC can be much more complex. For example, there is a distinction between a low or zero TAC being removed to reduce administrative overheads compared to its removal to avoid choke TACs. It was not clear to this reviewer why this particular list was chosen on a species by species basis. There may be value in sequencing the questions a bit differently. This may reflect a non-ICES reviewer needing more background information than may be the case for a reviewer more familiar with ICES history.

Similarly, adding a web link to the latest ICES advice (if available) would be useful. Many of the reports added more information, including figures and tables that comprehensively addressed this question. This approach did not assume a certain level of knowledge from the reader.

On the other hand, few reports provided biological information and the overall relative riskiness of the species and their interactions with the fisheries. This would have helped place the riskiness of making a potentially incorrect decision to keep a TAC or not in context.

The authors struggled with question 6. This question did get placed in the form of reference points which would be difficult for several to address. Several of the species provided an analysis comparing fishing effort on the key target species with the catch on the stock of concern. This was very useful, but there would be several caveats to this work (also presented in many of the reports). The key one being that the relationship between target effort and associated stock landings were linear (in most cases) and would remain the same if the TAC is lifted. Without a full assessment and fleet dynamics models it would be difficult to suggest more sophisticated approaches. On the other hand, looking at alternative management approaches and their pros and cons (as was done for skates and rays, for example) would be useful here, so perhaps the question was more complicated than it needed to be.

Finally, there is a policy issue highlighted by some small inconsistencies in the final recommendations that should be discussed. As an example, two overfished and overfishing stocks had opposite recommendations (keep the TAC, and no risk to removing TAC). The difference was that the landings for the one species was being restricted by the TAC whereas for the other, landings were well below the TAC. In both cases, discarding was large and not prohibited. Superficially one would agree that the one TAC is restrictive but not the other. However, in terms of total catch neither are restrictive and therefore nor is fishing mortality (F). Is the difference not therefore about the relative value of the stock concerned rather than the effectiveness of the TAC? i.e. the one stock is worth keeping at least until the TAC is met and then it is discarded, whereas the other is not worth keeping at all. In the case where the TAC was recommended not to be kept, alternative input control measures were not successful, yet F did need to be reduced on the species to ensure recovery. In this case, therefore, one would want to discuss adding effective management measures either by making the TAC work through restricting discarding (and allowing the stock to become a potential choke species) or clearly articulating workable alternatives.

On a related point, most of the MSY reference points provided were based on single species assessments. It is now becoming clear that not all stocks in an ecosystem can reach their single species MSY together and at the same time, so another question not addressed one species at a time is the ecosystem interactions between these species and whether all species in the present system can be sustainably managed at single species MSY levels. Although it was pleasing to see the inclusion of more companion species work and analyses attempting to address how useful the management of one bycatch stock is through the management of the target stock, this work needs much further research.

SPECIES: STOCK BY STOCK IMPRESSION OF WHETHER THE SUMMARY OF THE QUESTIONS AND DATA PROVIDE A SOLID BACKGROUND TO SAY Y/N TO LIFTING TAC.

Kattegat cod

1. Has the species/stock/group (hereafter referred to as stock) got characteristics that places it at high relative risk?

- In terms of its general biology e.g. aggregating, sex change, long lived, low productivity, forage fish, ecosystem important
- In terms of its catchability e.g. degree of population overlap with key fisheries, presence of refuges, ability to be directly targeted

Not much information is provided about the biology of the species although this is known, but evidence is provided that the stock has been unsustainably fished through providing plots of SSB. Evidence is also provided that highlights that gear type used is important in determining how catchable the species is, that targeting occurred during spawning aggregations and that the most selective gear has been replaced with less selective gear due to TAC restrictions and other management in the past. The key species aggregates during spawning, has high catchability and can be easily targeted. They are a slow- growing, long- lived species. Therefore; YES

2. Is the present TAC/management influenced by past unsustainable practices?

- If yes, are those fisheries still active?
- Was the stock targeted?

SSB plots are provided showing that the resource has collapsed with slight recovery since as described in the report.

The key species aggregates during spawning and can be targeted. Several lines of evidence that targeting has occurred are provided, of which the most compelling is a plot of gear type changes that can be compared with the landings and TAC information.

3. Can these or new unsustainable practices return if the TAC is removed?

- Can they be targeted with present fleet?
- Are they heavily discarded?
- Is the stock valuable?

The landings have often exceeded the TAC over time, it is valuable and easily targeted. It is likely to be targeted if the TAC is removed and not replaced with another mechanism.

Information provided that the quota uptake of the Norway lobster has been about 40% in the last few years, providing key information that highlights that removing the TAC without alternative strong measures would provide great incentives to relieve the implied choke effect of cod on lobster.

4. Are there alternatives to a TAC to manage this stock?

- Can they be managed as companion species through target TACs (if applicable)?
- Can they be spatially managed?
- Any other mechanism? E.g. Multi-Year TACs (MYTAC).

Spatial and gear management are in place. Landings still exceed TACs in most years highlighting that alternative mechanisms are probably not entirely effective without a TAC. This issue has not been directly addressed, but the answer can be inferred from the information provided.

5. Conclusion

This section provides valuable information and a clear recommendation. As stated above, alternative measures are not addressed but can be inferred. Removal from the

TAC system is not recommended in the report. This review supports the view that removal of a TAC could increase the risk to the resource given compelling information set out in the report.

Plaice in Kattegat and western Baltic Sea (PLE 27.21-23)

1. Has the species/stock/group (hereafter referred to as stock) got characteristics that places it at high relative risk?

- In terms of its general biology e.g. aggregating, sex change, long lived, low productivity, forage fish, ecosystem important
- In terms of its catchability e.g. degree of population overlap with key fisheries, presence of refuges, ability to be directly targeted

No information is provided on the biology of the species that would highlight any of the characteristics in the first dot point above. Although this is known, it would be useful to provide a section on this in all reports or links to web sites where this is provided. Strong evidence is provided in the report that links plaice effort with cod in Kattegat effort.

2. Is the present TAC/management influenced by past unsustainable practices?

- If yes, are those fisheries still active?
- Was the stock targeted?

The stock is important in periods where cod is not available and as a supplement to the trawl fishery targeting nephrops in Kattegat and cod in the western Baltic. Targeting for plaice does occur.

Output from an uncertain stock assessment is provided that shows the resource to be sustainable for most of the time series. As stated, this uncertainty is due to the short time period of the data. Despite this uncertainty, it is likely that the resource is healthy and fishing mortality is low.

3. Can these or new unsustainable practices return if the TAC is removed?

- Can they be targeted with present fleet?
- Are they heavily discarded?
- Is the stock valuable?

Based on the information provided, the stock is not heavily discarded, probably because the TAC is generally not met. Under the present management system, fleets can target plaice and it is an important alternative to cod.

4. Are there alternatives to a TAC to manage this stock?

- Can they be managed as companion species through target TACs (if applicable)?
- Can they be spatially managed?
- Any other mechanism? E.g. Multi-Year TACs (MYTAC).

The TAC is not limiting and the resource is not overfished, which implies that other measures are in place that are restricting effort. Plots of correlations to fishing mortality are provided showing that historical Danish effort and less so Danish and German effort correlates with fishing mortality. It is unclear to this reviewer whether this provides alternative mechanisms, but does highlight where these management alternatives should be directed.

5. Conclusion

No Conclusion is provided in the report, although the key questions are addressed in the report. It is difficult to arrive at a conclusion other than that effort is low and that the stock is in good condition given the stock assessment provided. There is an important interaction with the cod TAC request for this stock. The TAC has not been restrictive from 2001 to present

Plaice in subdivisons 24-32 (ple.27.2432)

1. Has the species/stock/group (hereafter referred to as stock) got characteristics that places it at high relative risk?

- In terms of its general biology e.g. aggregating, sex change, long lived, low productivity, forage fish, ecosystem important
- In terms of its catchability e.g. degree of population overlap with key fisheries, presence of refuges, ability to be directly targeted

No biology of the species is provided although it is known. Although the stock is targeted, it is caught in a mix of flatfishes.

2. Is the present TAC/management influenced by past unsustainable practices?

- If yes, are those fisheries still active?
- Was the stock targeted?

No information is provided to be able to judge whether unsustainable practices have been applied in the past. Relative SSB plots are provided but are not well explained or described, including what the SSB is relative to i.e. what an index value of 1 is (BMSY?). Since 2002, the stock has been consistently increasing and fishing mortality slowly declining (the latter slower than the former presumably due to good recruitment).

The stock has been targeted and is a bycatch of the cod fishery.

3. Can these or new unsustainable practices return if the TAC is removed?

- Can they be targeted with present fleet?
- Are they heavily discarded?
- Is the stock valuable?

No evidence was supplied of past unsustainable practices. The present fleet can target the species. Discards have at time been larger than the landings, however it is not the norm. The stock is reasonably valuable compared to other flatfishes given information provided in the report.

4. Are there alternatives to a TAC to manage this stock?

- Can they be managed as companion species through target TACs (if applicable)?
- Can they be spatially managed?
- Any other mechanism? E.g. Multi-Year TACs (MYTAC).

The TAC is not binding so other mechanisms are presently in place to control the catch. These are not described and would be of added value to the report.

5. Conclusion

The conclusion is clear and concise with recommendations provided for both plaice stocks (21-23 and 24- 32). It is unclear whether this stock has the same interaction with cod management as that in Kattegat. If so, the inclusion of this information would be beneficial. The recommendations appear sound, although a watching rule (e.g. a catch trigger) should be added in case the present indirect control mechanisms change.

Review 2

The key question here is whether total allowable catches (TACs) can be removed for any of the stocks in question, or should be retained for all stocks. The disparate documents would be improved by an overall grammar check, and efforts to ensure that the data provided are in similar formats to allow decisions to be made fairly across stocks. I first make some overall points, and then summarize my thoughts on individual stocks.

1. Overall, I am skeptical that removing TACs for any stock is a good idea. Any stock with no TAC can be targeted with unlimited catches, and the EU has a large amount of latent fishing effort combined with ready markets. In such circumstances, a new market, technology, or stock can lead to rapid deployment of latent effort, leading to stock collapses in a short period of time. If the current TACs are too precautionary, TACs should be increased rather than abolished. For pilot fisheries, TACs could be set at levels that are economically viable but low enough to avoid substantial and rapid depletion.
2. TACs should be set separately for each species. TACs set on species complexes (such as "skates") risk targeting on the most valuable species within the complex, resulting in overfishing of that species even as TACs are not exceeded.
3. TACs should be set for management areas that correspond to stock boundaries. In a few instances, the TACs are set for areas that include portions of two stocks, rather than separate TACs being set for each stock. It is, of course, reasonable to set TACs for subareas of a single stock to ensure that catches are not concentrated in a single part of the stock range.
4. A major weakness in the current approach is that TACs are applied only to landings, not to total catch (landings + discards). In a multispecies fishery managed by TACs on individual species, some species will become choke species that constrain landings of other species. When discards are not accounted for in TAC advice, and are not measured, this provides incentives to discard catches that are over the TAC (or over individual quotas), and this is especially true for those stocks at lowest levels that currently have a "zero" TAC. A key part of management should be measuring and holding fishers accountable for discards, and then setting TACs for total catches instead of just for landings.
5. In a few cases, the bulk of catches, biomass, and habitat is outside EU waters, but TACs are still set at very low levels inside EU waters. These nominal TACs could be increased for stocks that are not targeted, have little EU commercial value, and are currently managed by TACs that are so low as to have a negligible impact on stock status. Increasing TACs would ensure that bycatch does not constrain catches of more valuable target species.
6. In cases where choke species are healthy, and current catches do not constitute overfishing, but catches are close to TACs, the TACs could be increased so that fewer fishers are constrained by catches of these choke species.
7.

A stock-by-stock review follows.

Kattegat cod

TACs are clearly needed here: the stock is rebuilding from very low levels, and the advice has consistently been to set zero TACs for many years starting in 2002. Indeed the main issue for concern here is the very long period of time to reduce the actual TACs to close to zero after scientific advice was to set them to zero: five years before TACs were reduced to below 1000 t from 7000 t; 10 years to reduce them below 200 t. Undoubtedly the delay in reduction of TACs and corresponding delay in reduction in catches led directly to a prolonged period of low biomass.

Minor: Table 1 final column is listed as "% utilized" but it is clear that the numbers are ratios since they are close to 1, not 100.

Recommendation: maintain TACs. The low TACs are clearly necessary to both remove incentives for directed fisheries, and also because cod is an important constraining species for the Norway lobster fishery, resulting in catches below TACs for that species. Removing the cod TAC would likely double Norway lobster effort, resulting in higher cod catches.

Plaice in Kattegat and western Baltic Sea (PLE 27.21-23)

This stock appears to be in good shape: effort has declined, catches have declined, biomass is increasing and well above all management reference points, fishing mortality is currently low and well below reference points, and recent catches are well below TACs.

The current TACs are clearly not constraining. They should be retained and not reduced, since in a multispecies fishery, the fewer constraints there are, the more likely that TACs for the most valuable target species will be fully caught. The main change here (and for the PLE 27.24-32) is that the TAC for the management area should be aligned with the stock area, since currently TACs are applied to areas containing two stocks, which makes little sense.

Plaice in subdivisions 24-32 (PLE 27.24-32)

Similar advice applies as for plaice in 27.21-23, although I disagree with the authors that removing the TAC for these two stocks would have no impact on the stock. It is possible that technology could change to better target plaice in these two regions, or that market prices increase, resulting in increased targeting. Instead of removing the TAC advice, it would be better to have an interim TAC that is higher than management advice (to allow for easier use of individual quota in multispecies fisheries), with the proviso to revisit the TAC should catches come close to it in the future.