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Report of the Baltic Fisheries Assessment Working Group (WGBFAS)

14–21 April 2015

ICES HQ, Copenhagen, Denmark

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Executive Summary

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) met 14-21 April 2015 (Chair: Mare Storr-Paulsen, Denmark), with 28 participants and 9 countries represented. The objective of WGBFAS was to assess the status of the following stocks:

1) Sole in Division IIIa, SDs 20-22
2) Cod in Kattegat, Cod in SD 22-24, Cod in SD 25-32
3) Herring in SD 25-27, 28.2, 29 and 32, Herring in SD 28.1 (Gulf of Riga), Herring in SD 30, Herring SD 31.
4) Sprat in SD 22-32
5) Plaice 21-23, Plaice 2425
6) Flounder 22-23; 24-25; 26+28 and 27+29-32, Brill 2232, Dab 2232, and Turbot 2232 (survey trends)

WGBFAS also identified the data needed, for next year's data call with some suggestions for improvements in the data call as well as in InterCatch.

The report contains an introduction with the summary of other WGs relevant for the WGBFAS, country specific fishery description, the 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, list of Working Documents, recommendations and Stock Annexes.

In first quarter 2015 the Baltic cod stocks and the plaice stocks were benchmarked. As a result the Baltic cod stocks now have to apply a splitting key in SD 24 were both stocks are present. This has changed the assessment from being an area based assessment to now being a stock based assessments and has implications for the advice.

The principle analytical models used for the stock assessments were XSA and SAM. For most flatfishes, CPUE trends from bottom trawl surveys were presented (except plaice 2425 and her31 using relative SSB from SAM and XSA, respectively).

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. Last year a very large retrospective pattern in the Eastern Baltic cod stock caused that the WG rejected the analytic assessment. Several uncertainties in the data lead to this conclusion i.a age reading problems with large inconsistency between and within nations as well as a change in growth and natural mortality. However, even though a data compilation workshop and a benchmark have been conducted in the intermediate time it was not possible to solve the main issue on growth. The lack of knowledge on growth caused to that even the length based data required in the data call was very uncertain for the models and in the end the WG was not able to produce a better model than was presented last year which is based on survey trends.

The Her-30 (Herring in the Botnian Sea) was by the working group down scaled from a category 1 stock to a category 3 stock due to the commercial tuning fleet used in the assessment having very uncertain estimates in the last couples of years. However, during the Baltic ADG an alternative assessment was suggested were the stock is still considered a category 1 stock but the last 8 years of the commercial tuning fleet was terminated. This assessment was conducted after the working group but has been included in the report.

1 Introduction

1.1 List of participants

Name	Country
Bergenius, Mikaela	Sweden
Boje, Jesper	Denmark
Casini, Michele	Sweden
Degel, Henrik	Denmark
Eero, Margit	Denmark
Florin, Ann-Britt	Sweden – by WebEx
Gasyukov, Pavel	Russia
Grygiel, Wlodzimierz	Poland
Gröhsler, Tomas	Germany
Hjelm, Joakim	Sweden
Horbowy, Jan	Poland
Holmgren, Noel	Sweden
Nicklas, Norrstrom	Sweden
Kaljuste, Olavi	Estonia
Karpushevskiyi, Igor	Russia
Karpushevskaia, Anastasiia	Russia
Kornilovs, Georgs	Latvia
Krumme, Uwe	Germany
Luzenczyk, Anna	Polen
Lövgren, Johan	Sweden
Pönni, Jukka	Finland
Oeberst, Rainer	Germany
Raid, Tiit	Estonia
Raitaniemi, Jari	Finland
Statkus, Romas	Lithuania
Stoetera, Sven	Germany
Storr-Paulsen, Marie (chair)	Denmark
Ustups, Didzis	Latvia
Walther, Yvonne	Sweden

Contact details for each participant are given in Annex 1.

1.2 Terms of reference

WGBFAS – Baltic Fisheries Assessment Working Group

2014/2/ACOM11 The **Baltic Fisheries Assessment Working Group** (WGBFAS), chaired by Marie Storr-Paulsen, Denmark, will meet at ICES Headquarters, 14—21 April 2015 to:

a) Address generic ToRs for Regional and Species Working Groups (see table below);

b) Assess the outcome on the benchmark of WKPLE (plaice 21—23 and plaice 24—-32) and the outcome of WKSIBCA (cod 22—24 and cod 25—32)

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

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

An ICES data call will be sent out with a detailed description of the data needed and the deadline of data delivery. A first draft of the assessment should be available at the start of the meeting.

WGBFAS will report by 30 April 2015 for the attention of ACOM.

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date. Exempt from this are BITS data as the survey ends only a few days prior to the start of the WGBFAS meeting.

All countries upload official landing statistics, effort statistics and biological sampling data, for metiers relevant for cod catches into InterCatch

Fish Stock	Stock Name	Stock Coord.	Assess. Coord. 1	Assessment 2015
bll-2232	Brill (Scophthalmus rhombus) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment IF*
cod-2224	Cod (Gadus morhua) in Subdivisions 22–24 (Western Baltic Sea)	Uwe Krumme	Margit Eero	New Assessment
cod-2532	Cod (Gadus morhua) in Subdivisions 25–32 (Eastern Baltic Sea)	Christian von Dorrien	Henrik Degel	New Assessment
cod-kat	Cod (Gadus morhua) in Division IIIa East (Kattegat)	Johan Løvgren	Johan Løvgren	New Assessment
dab-2232	Dab (Limanda limanda) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment
fle-2223	Flounder (Platichtys flesus) in Subdivisions 22 and 23 (Belt Sea and Sound)	Sven Stoetera	Sven Stoetera	New Assessment

Fish Stock	Stock Name	Stock Coord.	Assess. Coord. 1	Assessment 2015
bll-2232	Brill (Scophthalmus rhombus) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment IF*
cod-2224	Cod (Gadus morhua) in Subdivisions 22–24 (Western Baltic Sea)	Uwe Krumme	Margit Eero	New Assessment
cod-2532	Cod (Gadus morhua) in Subdivisions 25–32 (Eastern Baltic Sea)	Christian von Dorrien	Henrik Degel	New Assessment
cod-kat	Cod (Gadus morhua) in Division IIIa East (Kattegat)	Johan Løvgren	Johan Løvgren	New Assessment
dab-2232	Dab (Limanda limanda) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment
fle-2425	Flounder (Platichtys flesus) in Subdivisions 24 and 25 (West of Bornholm, Southern Central Baltic - West)	Zuzanna Mirny	Anna Luzenczyk	New Assessment
fle-2628	Flounder (Platichtys flesus) in Subdivisions 26 and 28 (East of Gotland, Gulf of Gdansk)	Didzis Ustups	Didzis Ustups	New Assessment
fle-2732	Flounder (Platichtys flesus) in Subdivisions 27 and 29-32 (Northern Central and Northern Baltic Sea)	Ann-Britt Florin	Ann-Britt Florin	New Assessment
her-2532-gor	Herring (Clupea harengus) in Subdivisions 25–29 and 32 (Central Baltic Sea, excluding Gulf of Riga)	Yvonne Walther	Tomas Grohsler	New Assessment
her-30	Herring (Clupea harengus) in Subdivision 30 (Bothnian Sea)	Jukka Pönni	Jukka Pönni	New Assessment
her-31	Herring (Clupea harengus) in Subdivision 31 (Bothnian Bay)	Jari Raitaniemi	Jari Raitaniemi	New Assessment
her-riga	Herring (Clupea harengus) in Subdivision 28.1 (Gulf of Riga)	Georgs Kornilows	Georgs Kornilows	New Assessment
ple-2123	Plaice (Pleuronectes platessa) in Subdivisions 21-23 (Kattegat, Belt Sea, Sound)	Henrik Degel	Henrik Degel	New Assessment
ple-2432	Plaice (Pleuronectes platessa) in Subdivisions 24-32 (Baltic Sea excluding Sound and Belt Sea)	Sven Stoetera	Sven Stoetera	New Assessment

Fish Stock	Stock Name	Stock Coord.	Assess. Coord. 1	Assessment 2015
bll-2232	Brill (Scophthalmus rhombus) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment IF*
cod-2224	Cod (Gadus morhua) in Subdivisions 22–24 (Western Baltic Sea)	Uwe Krumme	Margit Eero	New Assessment
cod-2532	Cod (Gadus morhua) in Subdivisions 25–32 (Eastern Baltic Sea)	Christian von Dorrien	Henrik Degel	New Assessment
cod-kat	Cod (Gadus morhua) in Division IIIa East (Kattegat)	Johan Løvgren	Johan Løvgren	New Assessment
dab-2232	Dab (Limanda limanda) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment
sol-kask	Sole (Solea solea) in Division IIIa and Subdivisions 22–24 (Skagerrak and Kattegat, Western Baltic Sea)	Jesper Boje	Jesper Boje	New Assessment
spr-2232	Sprat (Sprattus sprattus) in Subdivisions 22–32 (Baltic Sea)	Olavi Kaljuste	Jan Horbowy	New Assessment
tur-2232	Turbot (Scophthalmus maximus) in Subdivisions 22–32 (Baltic Sea)	Rainer Oeberst	Rainer Oeberst	New Assessment IF*

Generic ToRs for Regional and Species Working Groups

2014/2/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 overviews where available

b) For the fisheries considered by the working group consider and comment on:

  i) Descriptions of ecosystem impacts of fisheries where available

  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) 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 (including information from the fishing industry and NGO that is pertinent to the assessments and projections);

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

  iii) or relevant stocks estimate the percentage of the total catch that has been taken in the NEAFC regulatory area by year in the recent three years.

  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;

  vii) Historical 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.

The working group is furthermore requested to:

e) Propose specific actions to be taken to improve the quality and transmission of the data (including improvements in data collection);

f) <u>Prepare the data calls for the next year update assessment and for the planned data compilation workshops</u>

g) Update, quality check and report relevant data for the stock:

  i) Load fisheries data on effort and catches into the INTERCATCH database by fisheries/fleets;

  ii) Abundance survey results;

  iii) Environmental drivers.

h) Produce an overview of the sampling activities on a national basis based on the INTERCATCH database or, where relevant, the regional database.

i) Identify research needs of relevance for the working group.

1.3 Working Groups response to recommendations from other ICES groups

1.3.1 Recommendations from ICES groups

WKBALPLAT

1. Documentation of discards (for flounder and dab) is needed, where did the samples actually come from, and what the countries have extrapolated themselves already. In general, only data for these strata where it is sampled should be provided, with extra information/advice how to fill gaps. (e.g if zero landings of flounder, should the discards be estimated based on cod landings, etc). [specify by data call sent by ICES to Baltic Member states]

2. Investigate by correspondence the evidence for mixing of dab in SD21 and dab in SD22-32. Then WGBFAS and WGNEW can evaluate whether the evidence justifies a specific workshop to look into stock units for dab

3. Re-aging of old Baltic flounder otoliths with new method as recommended by WGFLABA 2012

WGBIFS

4. Recommends that, the BIAS-dataset, including the valid data from 2013 (Annex 5: Tables 1—4), can be used in the assessment of the herring and sprat stocks in the Baltic Sea with the restriction that the following years are excluded from the index series: 1993, 1995 and 1997.

5. That the alternative indices, calculated by excluding all existing data of SD 29 North (Annex 5: Tables 6 and 7) should be evaluate during the next benchmark assessment of Central Baltic Herring.

6. That the current BIAS index series can be used in the assessment of the Bothnian Sea herring with the restriction that the year 1999 is excluded from the dataset. Second, year 2012 should be treated with caution due to half of the coverage and reduced number of samples in 2012.

7. The BASS-dataset with the valid data of 2013 can be used in the assessment of the sprat stock in the Baltic Sea

8. the DATRAS indices, including the results of the BITS 4th quarter 2013 and BITS 1st quarter surveys 2014, can be used in the assessment of the cod stocks and the flatfish stocks in the Baltic Sea.

PGCCDB

9. Proposed Age Calibration Exchanges for 2016 and Beyond. The last workshop on Sprat in the Baltic Sea, Skaggerrak-Kattegat, Celtic Sea and West of Scotland was in 2008. Sprat in Irish sea has not had an exchange or workshop before. It is recommended to have an exchange on the age reading of these sprat stocks as soon as possible. PGCCDBS/WGBIOP would like to have feedback from the assessment EG on the need for this exchange

PGSPATIAL

10. WKBALTCOD (Benchmark Workshop on Baltic Cod Stocks) and WGBFAS are recommended to consider the results from SGSPATIAL 2014 in the discussion of the drivers of cod condition

Feedback to recommendations from WGBFAS,

WKBALPLAT:

1) The new data call (annex 2 and 3) has documentation of the discard sampling programs. It was also specified within the data call that data should not have been extrapolated in advance.

2) The WGBFAS has not received any new information on the stock mixing in dab

3) Not all countries are aging according to the guidelines

4) The data set has been used in the recommended years

5) The alternative indices will be evaluated at the next benchmark

6) The BIAS index has as recommended been used for the HER 30 assessment

7) The BASS data set has as recommended been used for sprat

8) The DATRAS indices for cod and flatfishes has been used for COD2532 and for CODKAT, PLE2123, PLE2425, FLE2223, FLE2425, FLE2628, BLL2232, DAB2232 and TUR2232. However, WGBFAS do not considered BITS to be appropriate for sole, FLE2732 and an alternative index (based on the same data) was used for cod 2224.

9) Sprat otoliths have been exchanged in 2015 ??? – however, we would very much like plaice to be part of an exchange

10) SGSPATIAL was very much contributing to the WKBALTCOD meeting and the report.

1.3.2 Tor E: Propose specific actions to be taken to improve the quality and transmission of the data (including improvements in data collection).

Feedback to the data call and InterCatch

Data for stock assessment are collected, processed, raised and submitted by national institutes. The joint platforms for data submission are InterCatch and/or the Regional DataBase FishFrame, and DATRAS, all maintained and hosted by ICES.

InterCatch is used to compile data from the commercial fisheries. DATRAS is used for fisheries-independent survey data. The Regional Database FishFrame (RDB), developed by DTU Aqua, is hosted by ICES since 2014 but presently only used for data uploads for analyses done by the Regional Coordination Meeting (RCM Baltic). InterCatch and the RDB are to ensure data quality, documentation and transparency on the commercial data.

In terms of commercial fisheries data, stock coordinators (SC) connect between national data submitters (NDS) and stock assessment. They receive an automatic email that data for their stock have been uploaded to InterCatch. Then the SC fills strata without discard samples and strata without biological sampling (gap-filling or allocation of sampled strata to unsampled strata).

Presently, SC have to cope with errors not detected earlier at the NDS level, shortcomings of InterCatch and time pressure imposed by the stock assessors that need the processed data for stock assessment calculations. Every error detected by a SC has to be fixed by the NDS, usually after the data submission deadline. This produces causes additional workload, is often time-consuming and hence, reduces time which should be available for the SC to check data quality, prepare data tables for the assessment report and for chapter writing.

ICES initiated a common data call for all assessment groups in 2015 and WGBFAS has several concerns and suggestions for improvements related to this data call.

Data call

Prior to the official data call, ICES should distribute a preliminary version to all national data submitters (NDS) and stock coordinators (SC) (e.g. 1 or 2 weeks prior to the official data call) using an updated contact list. This would ensure that everybody can provide comments and express possible concerns and that the final result is a data call which has the agreement of all participating parties.

Requests of data usually not used in the stock assessment (e.g. effort data for small pelagics) should be explained so that countries, national fisheries laboratories and NDS understand why they have to submit additional data.

The use of examples would simplify the work of NDS because examples illustrate the way the data have to be processed (e.g. discard calculations, reporting of zero catches per strata).

The instructions in the data call should be clearly formulated and easy to follow, tailored to and accounting for the specific requirements of each stock.

It should be emphasized in the data call that NDS should closely follow the given instructions given. This applies for example to the use of file name templates. It is highlighted that the major responsibility of data quality assurance (e.g. checking for outliers, consistency in age reading, discard ratios, weight-at-age) and timely submission of data is with the national fisheries laboratories and especially the NDS.

The data call could be structured by fish stocks (e.g. spr-2232, her-30, …) and not by requested variables like discards, efforts, …. This would result in clearer requests as exemplified in Table 1.3.2.1 which shows how the requested information could be specified in a data call.

Table 1.3.2.1. Possible parameters to be requested via a data call for fish stocks of the Baltic Sea region (M: mandatory, O: optional; 1: Landings, discard, biological sampling).

	STOCK	EFFORT	DISCARDS	LANDINGS	AGE DATA	LENGTH DATA	MATURITY	GAP FILLING SUGGESTIONS	FULL DATA SET 1	LANDINGS ONLY	SIZE SORTING CATEGORY
1	cod-21	M	M	M	M			M	DK, SWE	GER	O
2	cod-2224	M	M	M	M			O	DK, SWE, GER, POL	FI, EST, LAT, LITH	O
3	cod-2532	M	M	M	M	M		M	DK, SWE, GER, POL, LAT, LIT, EST, RUS	FI	O
4	sol-IIIa	M	M	M	M			M	DK, SWE		
5	ple-2123	M	M	M	M			M	DK, SWE, GER		O
6	ple-2432	M	M	M	M			O	DK, SWE, GER, POL, LAT, LIT, EST, RUS	FI	O
7	fle-2223	M	M	M				M	DK, SWE, GER		O
8	fle-2425	M	M	M				M	DK, SWE, GER, POL	LAT, EST, LIT	O
9	fle-2628	M	M	M				M	DK, SWE, POL, LAT, LIT, EST, RUS	FI	O
10	fle-2732	M	M	M				M	SWE	FI	O
11	dab-2132	M	M	M				O	DK, SWE, GER	FI	O
12	tur-2232	M	M	M				O	DK, SWE, GER, POL, LAT, LIT, EST, RUS	FI	O
13	brl-2232	M	M	M				O	DK, SWE, GER	FI	O
14	spr-2232			M	M			O	DK, SWE, GER, POL, LAT, LIT, EST, RUS, FI		
15	her-GOR			M	M			O	EST, LAT		
16	CBH			M	M			O	DK, SWE, POL, LAT, LIT, EST, RUS	GER	
17	her-30			M	M		M	O	FI, SWE		
18	her-31			M	M			O	FI, SWE		

Effort data: It should be clearly specified what type of effort data is needed - e.g. only trips with the target species in the landings or discards (i.e. exclusion of trips targeting small pelagics if effort data are requested for a demersal species such as cod or flounder - and vice versa). The unit of effort needs to be specified and defined, i.e. what is meant with "fishing days"; an unambiguous formula should be provided to ensure a standardized calculation approach.

Discard data and discard sampling programme evaluation: In the fisheries for small pelagics in the Baltic Sea (i.e. herring and sprat), discards are considered negligible and are therefore not sampled and discard data cannot be submitted to SC. Consequently, an evaluation of a discard sampling programme for herring and sprat stocks in the Baltic Sea is not useful.

Gap filling: It should be explicitly clarified that empty strata should be submitted as empty strata, i.e. no national borrowing from sampled strata to unsampled strata should take place before data upload to InterCatch. Only sampled strata should be uploaded. The gap-filling in InterCatch is the responsibility of the SC because the documentation of allocation schemes is a central service of InterCatch and ensures full documentation of the allocation procedures used for a stock in a given year. This is then reported in the WG report.

Annex 1 and 2: The group decided not comment on the discard sampling programme evaluation because at the time of WGBFAS 2015 the evaluations from many countries were still missing. This task is forwarded to PGDATA.

EU size sorting categories by weight: WGBFAS agreed to request a new parameter. Countries that can provide such data should submit landings data by EU size sorting categories (by weight). This will be used as an independent measure to characterize the approximate size composition of the landings and for comparisons with survey information. It will be requested for demersal stocks only. For instance for cod, the EU size sorting categories are: 1: 7 kg and more, 2: 4—7 kg, 3: 2—4 kg, 4: 1—2 kg, 5: 0,3—1 kg. The WGBFAS chair should assign the task to collect and compile the international data set to a few selected SCs prior to the official data call. It is important that the countries submit the data to the nominated SC in a standardized format. Here is an example for cod:

country	year	quarter	area	square	fleet	species	sizesorting	kg
DK	2008	1	24	38G4	Passive	Gadus morhua	1	80,66
EE	2008	1	24	38G4	Active	Gadus morhua	2	1988,545651
…	…	…	…	…	…	…	…	…

There are also issues related to the instructions for NDS related to InterCatch that should be clarified prior to a data call. Many cells from InterCatch are not usable at present; for instance, the "number of samples used for length or age measurements" or "sampled catch" are interpreted differently between countries, and between harbour sampling and at-sea sampling. Therefore, a clear definition of "what is a sample?" is needed (e.g. box, haul, trip). For "sampled catch", each country should also uses a different unit (e.g. total commercial landing, true weight sampled, zero, -9) and it should be decided whether "sampled catch" should contain the true weight sampled by stratum, i.e. per quarter, subdivision and gear type. There is a special field in InterCatch where comments to the SC can be provided.

InterCatch

WGBFAS recommends to Data Information Group (WGDIG) or WKCATCH that a transition to the FishFrame/Regional Database (RDB) platform is considered with a clear timeline for implementation. It is the opinion of WGBFAS that a database with access to raw data is preferred (a similar access function already exists in RDB FishFrame, see Fig. 1.3.2.1). Several functions requested below are available in RDB. Data handling for benchmarks and exploration of data would be enhanced by having access to raw data. Many of the improvements suggested below are already available in the RDB. Therefore, WGBFAS agreed that the **supply of a fully functional RDB by ICES should have highest priority**. Further improvements on InterCatch should not be carried out if they detract effort that can be used to advance the development of the RDB.

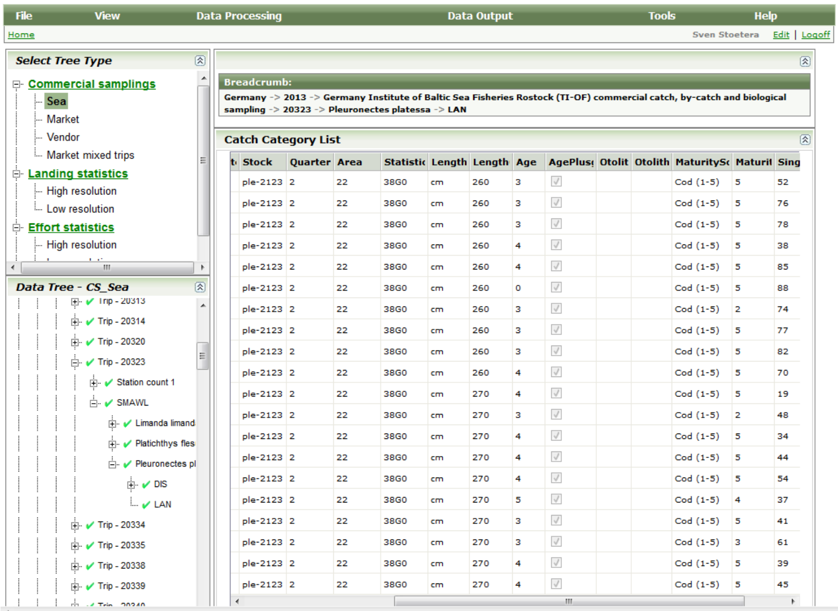


Fig. 1.3.2.1: Data tree in RDB FishFrame; this allows viewing the raw (biological) data of a submitting country down to a haul-wise resolution for LAN/DIS.

Meanwhile the following requests for updates and improvements in InterCatch are forwarded:

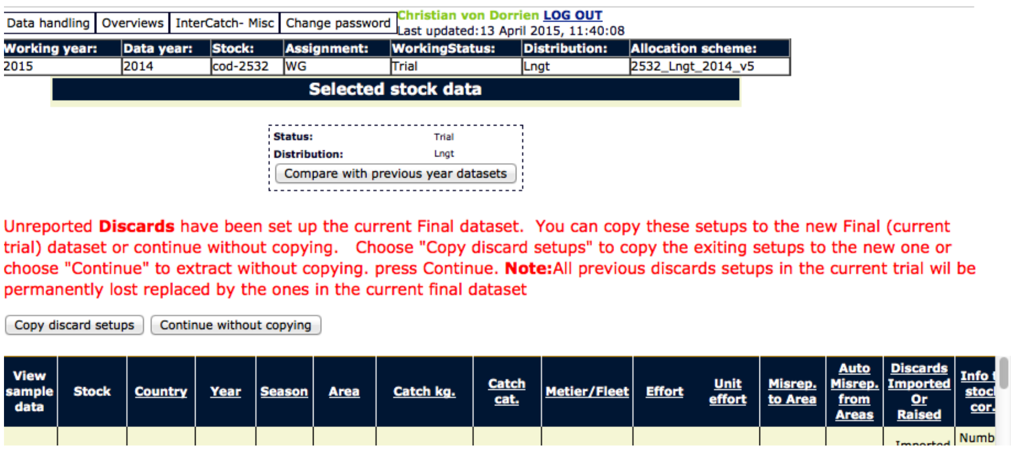
Data quality

- **Check functions** should be provided by InterCatch to NDS after having uploaded the data. This could be in the form of a table with landings uploaded per area (e.g. Subdivision and Quarter. The NDS should check the correctness of landings.
- Countries with two NDS (one for discards, one for landings) of course have to ensure that a consistent data set is submitted. But additional checks could help both the NDS and the SC. In fact, the RDB already contains sophisticated checking procedures.
- A comparison (plot function) of landings of current year vs. previous year could also be provided.
- **Re-uploading data** should be followed by a message to Stock coordinator on the details of the changes.
- In cases with **zero landings but discards**, a function should be applied to raise discard data to all landings, a function which is already available in RDB FishFrame (see Fig. 1). This is important for some flatfish stocks.
- **Saving of discard allocation scheme** should be possible.
- The evaluation of the **data quality of harbor sampling programmes** could be improved by changing the way the sampling is reported. The number of boxes sampled per EU size sorting category per stratum should be reported, not only the total number of boxes sampled. This can be cross-checked with the landings information of EU size sorting category level which will be requested in the data call (see above).
- Member countries are collecting data at the métier level 6 according to the DCF regulations (e.g. OTB_DEF_>=105_1_120) and upload this information

to the RDB. The **métier level is merged to the very coarse level of active/passive gear type when submitting data to InterCatch**. It may therefore be considered to implement merged métiers in InterCatch in order to provide the best available data to the stock assessments, to reduce the amount of available information that is presently lost each year and to account for fundamental differences in the input data (e.g. when discard rates of OTB vs OTM or PTB vs PTM are merged into "active gear" in InterCatch; GNS and GTR have significantly lower discard rates compared to LLS, all of which are summed under "passive gear").

Functionality

- Data **of different formats** (e.g. different CANUM types) for the same strata should be able to be stored so that they can be used for different assessment models, e.g. length and age based data for Eastern Baltic Cod.
- **Interface** should be more user-friendly, for instance all windows should be made resizeable to view full data on larger screens.
- The order of working steps in the menu should follow the order of execution (e.g. the "Finalize" step should come at the end).
- Easy downloads of multi-annual data (e.g. CANUM, CATON by quarter, fleet, subdivision for several years back in time) should be possible, e.g. to facilitate the preparatory work of SC prior to benchmarks.
- **Language** of instructions and warning messages should be checked for correctness and easiness of understanding. See figure 1 for an example of an unclear message.



Example of an error message where wording as well as instructions to solve the issue are hard to understand.

- Sorting of **viewed** data should be possible directly in interface, e.g. allowing to view and delete double entries.
- Output tables and standard graphs should be developed in accordance to the need of the AWG. This might be developed similar to RDB FishFrame, where a Pivoting function exists (see Figure 1.3.2.2), as well as a select-tree to generate graphs and tables in an efficient and fast way directly within the database (no downloads beforehand and imports in Excel of *.txt files are required).

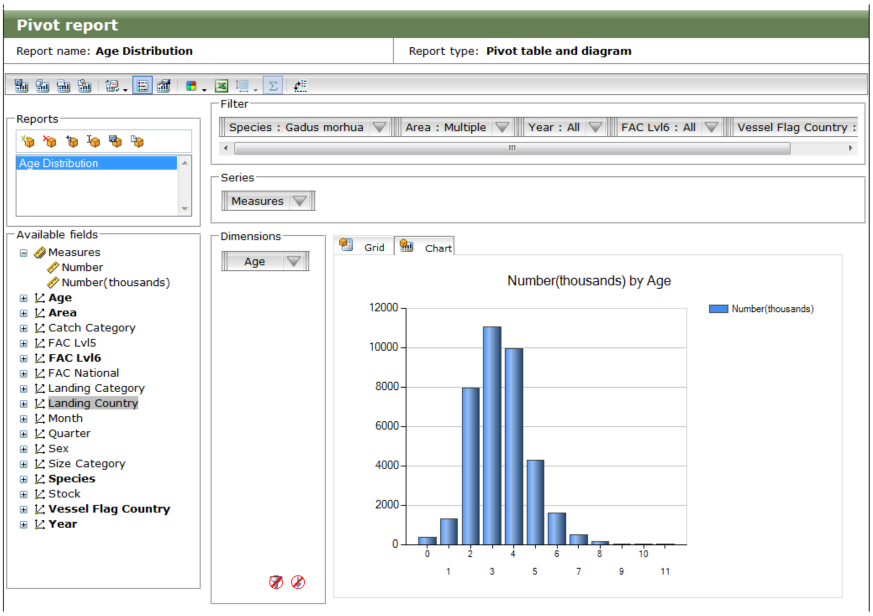


Fig. 1.3.2.2: Example of the Pivot report function in RDB (here: Age-distribution of cod-2224 for all countries and years combined). Left hand selection tree enables multiple possibilities for further exploration of data (e.g. ages per country and quarter in a given SD or size- and landing category)

- Estimation of landings data should be possible on rectangle basis. This is important for the cod 22-24 where landings and discard from SD24 have to be split into a western and eastern component according to rectangle.
- Improvements required facilitating the separation between CBH in her GOR and vice versa??? Olavi/Georg/Tomas?
  - It should be possible to work with more than one final version of data, e.g. in cases of sensitivity analyses.
  - A function is needed that allows holding and merging of more than one data set (stratum) per year, together with the possibility to select the needed strata when extracting data. This possibility would be required for sensitivity analyses, e.g. alternative data sets with discards twice or three-times those reported, age information raised by data from only one country, landings raised by data from one country
  - It should be possible to de-activate selected sampled strata when the data from a country are considered unreliable (e.g. due to poor sampling or peculiar data) in order to allow the allocation of data from sampled strata from other countries which a more reliable sampling scheme. These changes of course have to be documented by the program.
- It should be possible to raise Discards using more than the ratio of the LAN/DIS of the same species in the same stratum (e.g. effort and all species, as already provided in FishFrame RDB, see Fig. 1). This is especially important in stocks, where the discard ratio is independent of the landed amount.

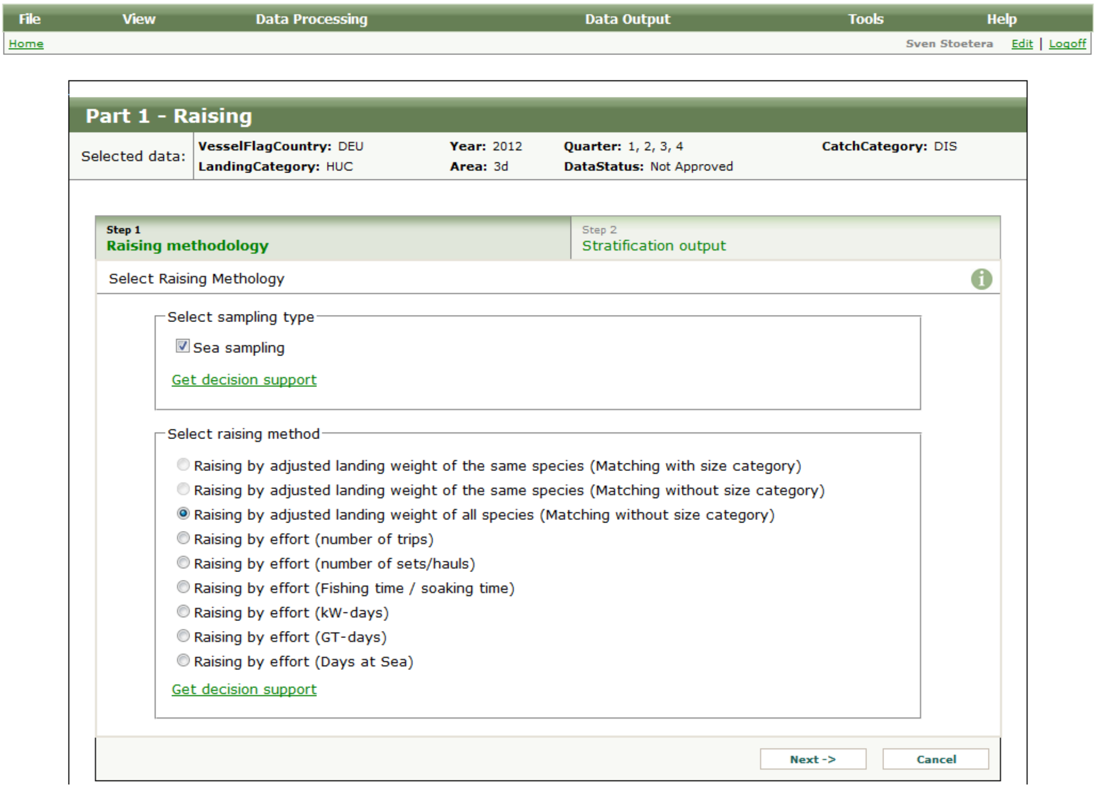


Fig. 1.3.2.3. Example demonstrating a variety of borrowing options for discard raising in RDB

- Overview plots should be provided, giving an overview of missing information (e.g. discard weights or age samples) and a rough differentiation in the amount of biological samples (e.g. above/below 20 ages in a given stratum). This could be done using a traffic-light plot (Fig. 2).

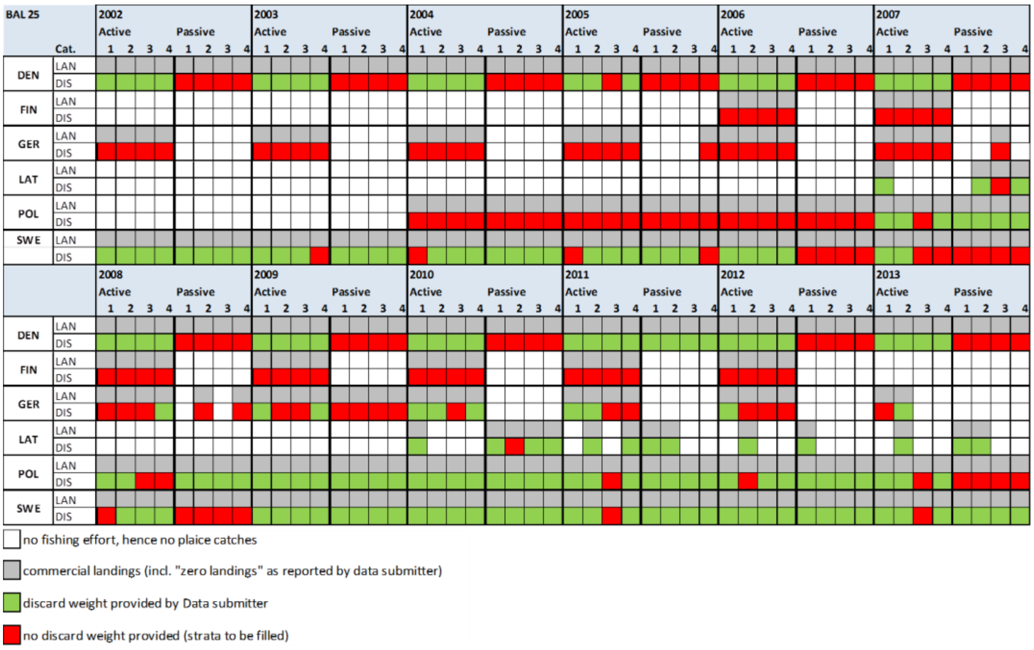


Fig. 1.3.2.4. Example for a traffic light plot to give an overview about sampling coverage in discard estimations.

In conclusion, the above examples show that several of the general functionalities requested by WGBFAS are already available in the RDB/FishFrame. The urgent need to have a fully functional RDB/FishFrame was highlighted and re-iterated by RCM Baltic in the last years. Further details from DIG – Yvonne on Monday?

A possible step forward would be a test run where data from one stock are processed, comparing and documenting the procedure and problems when using both InterCatch and RDB/FishFrame. This could be done readily with past years data (e.g. using a simple stock like cod-21) because RDB/FishFrame already contains the national raw data of all Baltic member states since 2009 (completeness depending on country).

1.4 Generic Tor B – Fisheries overview

The reformed CFP (EU regulation 1380/2013) requires that fisheries for salmon, cod and fisheries for small pelagics in the Baltic will be subject to a landings obligation by 1 January 2015. The Member States with an interest in fisheries in the Baltic region have worked to produce a joint recommendation for implementing the discard ban in the region, the BALTFISH plan. This will have a large effect on data collection and in the final end on the advice.

However, at present the collection, management and use of data in the fisheries sector required for assessment purposes is based on Commission Decision 2010/93/EC adopting a multiannual Community programme pursuant to Council Regulation (EC) N° 199/2008 and Commission Regulation 665/2008.

The general view today is a wish to develop advice towards mixed species and mulitfleet forecasts. The aim is to implement sampling programmes with emphasis on precision and take bias into account rather than average landings and focus on a fishery based approach to management. ICES advice will be changed in several aspects, as outlined in the new MoU between the European Community and ICES. The objectives of the new advice are:

- changing the advice from mainly landings advice to catch advice
- changing the advice from mainly short-term to long-term – Fmsy approach
- transformation of the traditional stock based advice to fisheries based advice
- fisheries advice be revised to include long-term considerations of management targets relating to inter alia yield by:
    - → developing concepts for management targets,
    - → identifying targets for individual stocks,
    - → developing methods to evaluate Harvest Control Rules (HCR) and recovery plans,
    - → developing an advisory framework based upon long-term advice with short-term implications.

1.4.1 General overview of the Baltic Sea fisheries

The main target species in commercial fishery are cod, herring and sprat. They constitute about 95% of the total catch. Other target fish species having either local economic importance or ecosystem importance are salmon, plaice, flounder, dab, brill, turbot, pike-perch, pike, perch, vendace, whitefish, turbot, eel and sea-trout.

The main fisheries for cod in the Baltic use demersal trawls, gillnets and pelagic trawls. There was a substantial increase in gillnet fisheries in the 1990s and because of the change in stock age composition in late 1990's and early 2000.

Pelagic trawlers catching a mixture of herring and sprat dominate pelagic fisheries in the Baltic. The proportion of the two species in the catches varies according to area and season. To a minor extent, a predominantly herring fishery is carried out with trap-nets/pound-nets and gill nets in coastal areas as well as with bottom trawls. Pelagic fishery targeting vendace takes place in the northern part of Bay of Bothnia during the spawning period October-November.

The catches of the pelagic species are used for human consumption, reduction to oil and meal and to animal fodder. The allocation of the catches into these categories differs not only by country, but also over time. The usage is to a large extent driven by the market conditions.

While feeding in the sea, salmon are caught by long lines (as drift nets have been banned in the Baltic) and during the spawning run they are caught along the coast, mainly in trap nets and fixed gillnets. Where fisheries are allowed in the river mouths, set gill nets and traps nets are used.

The coastal fisheries target a variety of species with a mixture of gears including fixed gears (e.g. gill, pound and trap nets, and weirs) and Danish seines. The main species exploited are herring, salmon, sea trout, flounder, turbot, cod and freshwater and migratory species (e.g. whitefish, perch, pikeperch, pike, smelt, vendace, eel and burbot. In addition, there are demersal trawling activities for herring, cod and flatfishes in some parts of the Baltic, although the trawling is forbidden in the coastal zone in most of the countries. Most of the flatfish fishery is conducted in the western part of the Baltic. Coastal fisheries are conducted along the entire Baltic coastline.

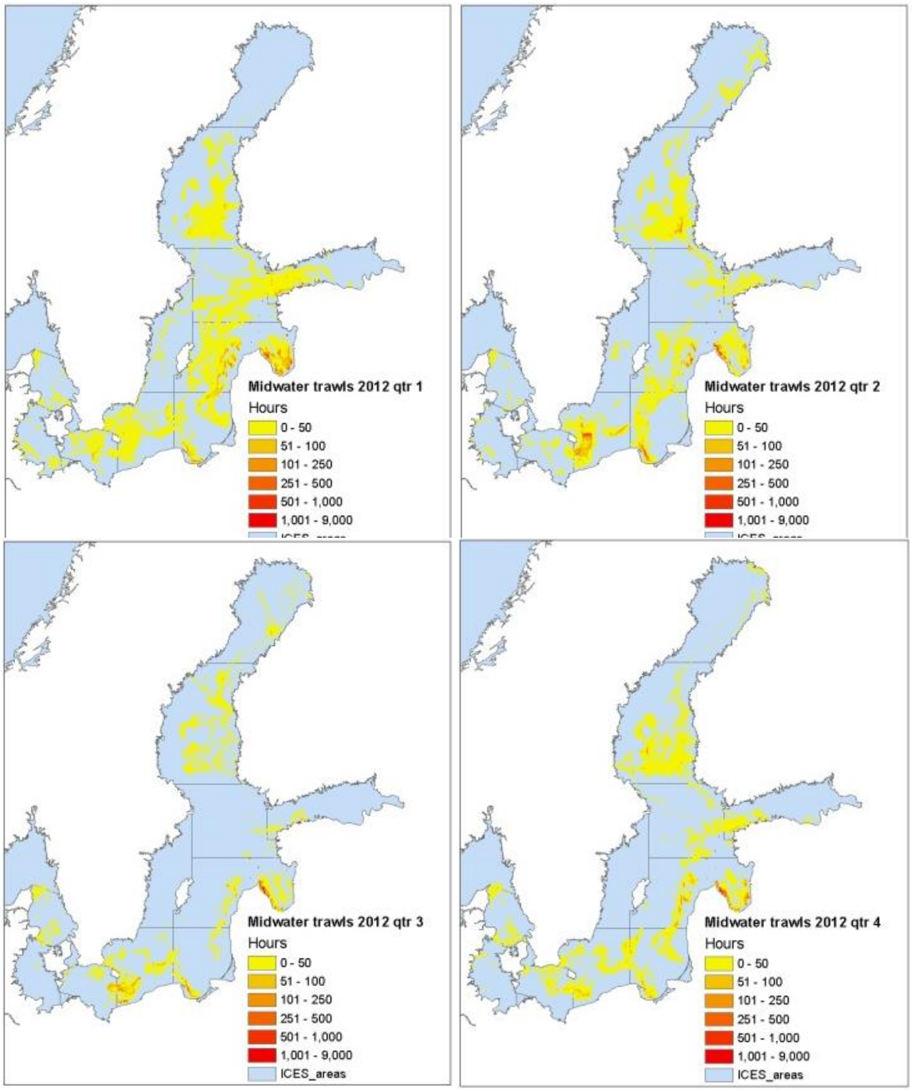


Figure 1.4.1.1. Effort in hours for midwater trawls by quarter in 2012. From WGSFD 2014.

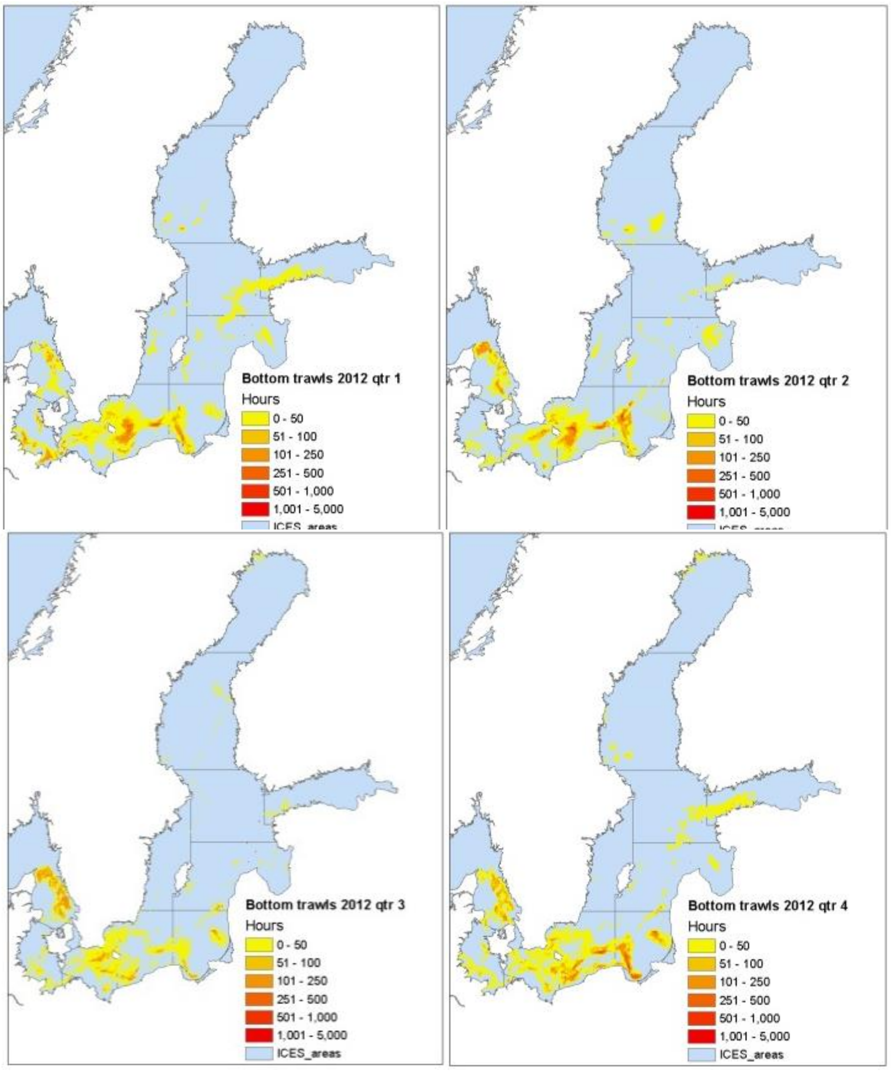


Figure 1.4.1.2. Effort in hours for bottom trawls by quarter in 2012. From WGSFD 2014.

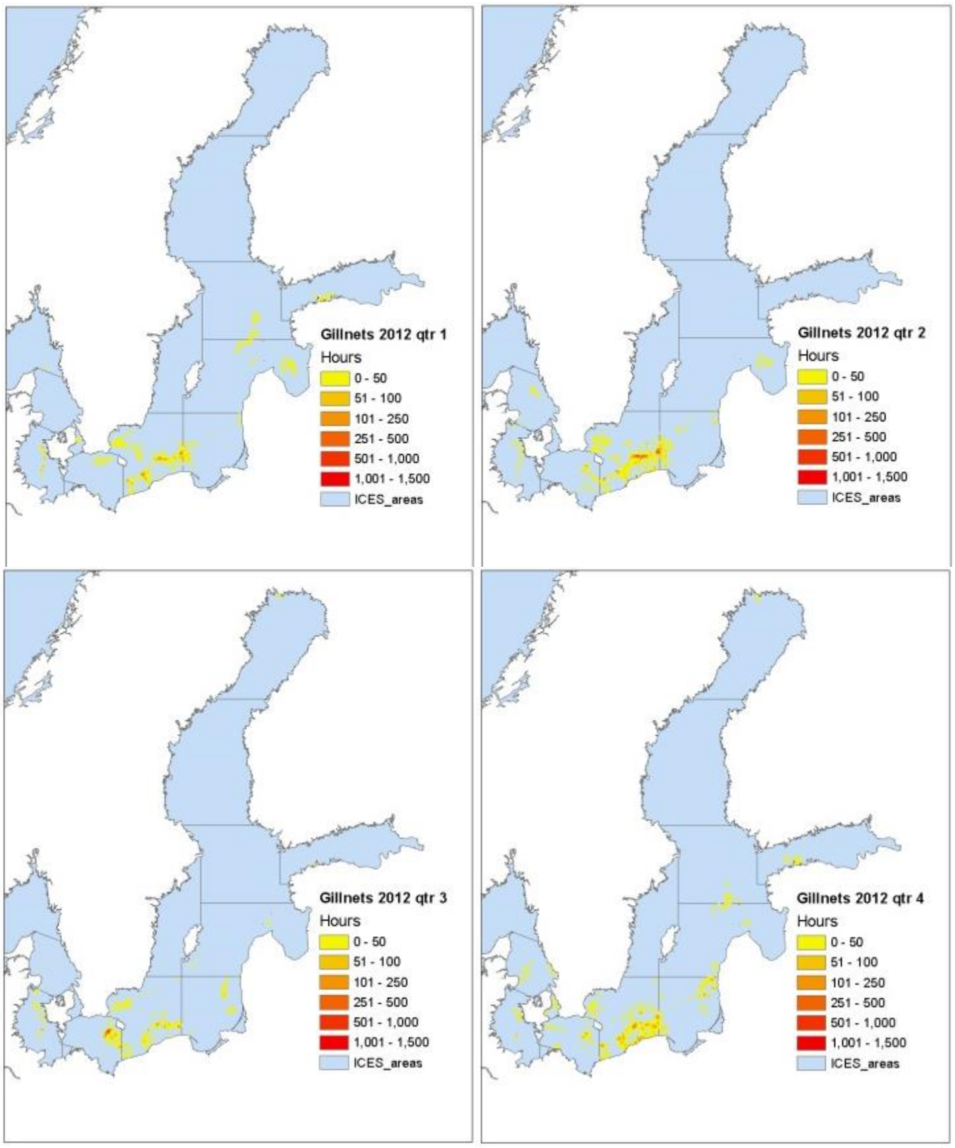


Figure 1.4.1.3. Effort in hours for gillnetters in by quarter 2012. From WGSFD 2014.

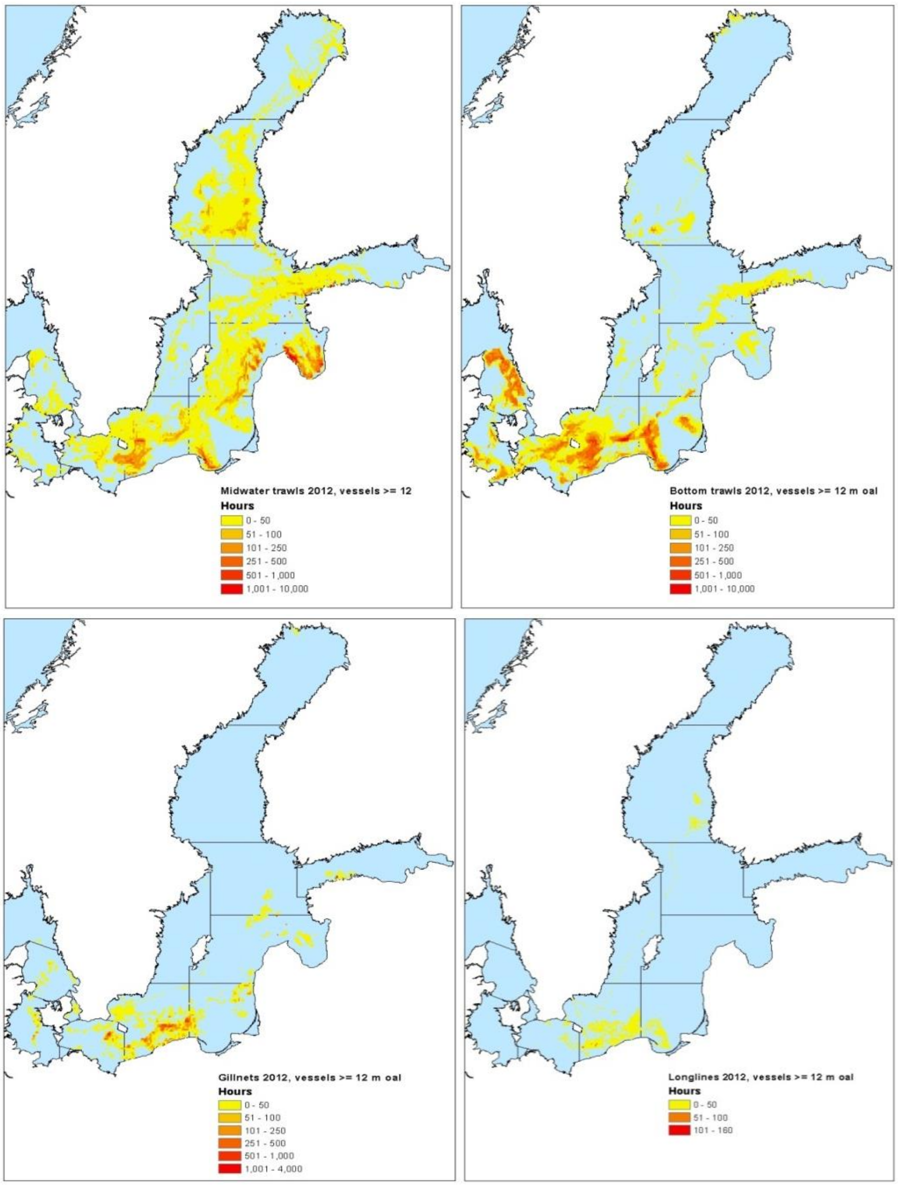


Figure 1.4.1.4. Total effort in hours for midwater trawl, bottom trawl, gillnetters and longliners in 2012. From WGSFD 2014.

1.4.2 Detailed information on fisheries by countries

1.4.2.1 Denmark

The Danish fisheries in Kattegat

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. The protected zone consists of three different areas in Kattegat in which the fisheries are either completely forbidden or limited to certain selective gears (Swedish grid and Danish SELTRA trawl) during all or different periods of the year. During recent years, in Danish Kattegat fisheries, cod is only caught as a by-catch species in the *Nephrops* fishery and landings are distributed throughout a year. The total nominal effort (kWdays) of Danish fleet in the Kattegat has decreased by half between the years 2000-2008 (STECF Sub-group EWG 11-11).

The Danish fisheries in Kattegat can be divided into trawling, gillnetting and to a smaller degree Danish seine fleet categories by the gears and mesh sizes used as follows:

Trawl fisheries in Kattegat

The trawl fisheries can be divided into three groups:

a) Industrial fisheries targeting mixed clupeids, sandeel and Norway pout. This fishery is carried out using a mesh size of <32 mm in the cod end. Most vessels in this fishery are smaller trawlers (12—16 m).

b) A human consumption herring fishery using mesh sizes of >32 mm in the cod end. This fishery is mainly carried out by the larger trawlers (>20 m).

c) A trawl fishery targeting ***Nephrops*** using a 90 mm mesh size. This fishery is mainly carried out by trawlers between 12—16 m. The major season for this fishery is the 2nd and 3rd quarter of the year but tent to be less seasonal in recent years. Since 2011 large selection panels have been mandatory to protect the cod. In this fishery an important by catch is sole, plaice and cod – although the cod has decreased the importance in later years.

In Kattegat the importance of the species has changed over time.

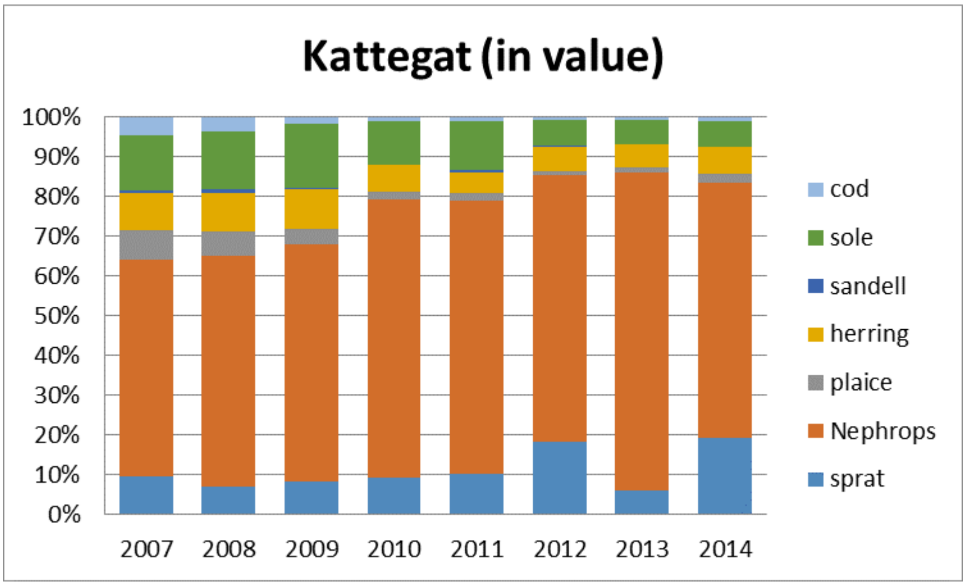


Figure 1.4.2.1. The relative value of 7 most economic important species caught by Danish fishermen with in Kattegat.

Since 2007 *Nephrops* has by far been the most economic important species in the bottom contact fishery and the importance has increased to close to 65% in 2014 (Figure 1.4.2.1). However, the amount of *Nephrops* landed has been very stable since 2007, close to 1300 t. This indicates that the increased importance of *Nephrops* mainly is caused by the decreasing landings of cod, plaice and sole. Where the amount landed in 2014 compared to the amount landed in 2007 for cod drop nearly 85%, for sole to ~65%, and for plaice 70% of the level in 2007. Denmark has historically had higher part of the sole quota and sole and plaice is considered an important by- catch species in Denmark.

The amount of kWdays for gear groups catching cod will be subject to yearly cuts as long as the cod stock is below reference points in the management plan. MS can apply for derogation from the kWdays system if the catches in a certain part of the fleet can be shown (after evaluation by STECF) to consist of less than 1.5% cod (article 11(2)(b)). Denmark introduced such a cod avoidance plan in 2010. As a part of this plan, since 2011 it is mandatory in Danish fisheries to use a SELTRA trawl with 180 mm panel during the first three quarters of a year.

Gillnet fisheries in Kattegat

Gillnets varying in mesh-sizes from 90 to about 200 mm are used in Kattegat. The species composition of the catches depends on the mesh size with the smaller mesh sizes (90 to 110 mm) being used when targeting sole and the larger mesh sizes is for catching plaice and cod. Typically it is the smaller boats (<l4 m) which engage in the gillnet fishery.

Danish seines in Kattegat

The Danish seine fishery is of relatively limited importance in Kattegat accounting for a catch value of about a fifth of that taken by the human consumption trawling fleet. This fishery mainly target flatfish (plaice, flounder and dab) but also catches a fair amount of cod in former times. The typical seine fishing vessel is about 12 to 16 m.

The Danish fishery in the Baltic

At present the Danish landings of cod, herring and sprat from the Baltic area can be divided into the following categories:

1) Cod landings from the trawl fishery where a minimum mesh size of 105 mm in codend and a BACOMA exit windows with 120 mm. mounted. This fishery is in the eastern Baltic considered a relative clean fishery although discard and by-catch of flounder in periods can be substantial. In the western Baltic the fishery is more a cod fishery with a large by catch fishery of flatfishes; plaice, sole, turbot, brill and flounder.

2) Cod landings from the gill net fishery using a minimum mesh size of 120 mm.

3) Herring landings from a directed fishery for human consumption carried out by trawlers using a minimum mesh size of 32 mm. The main part of the Danish herring fishery is conducted in the western Baltic

4) Sprat landings from a directed fishery for industrial purposes using a mesh size of 16mm.

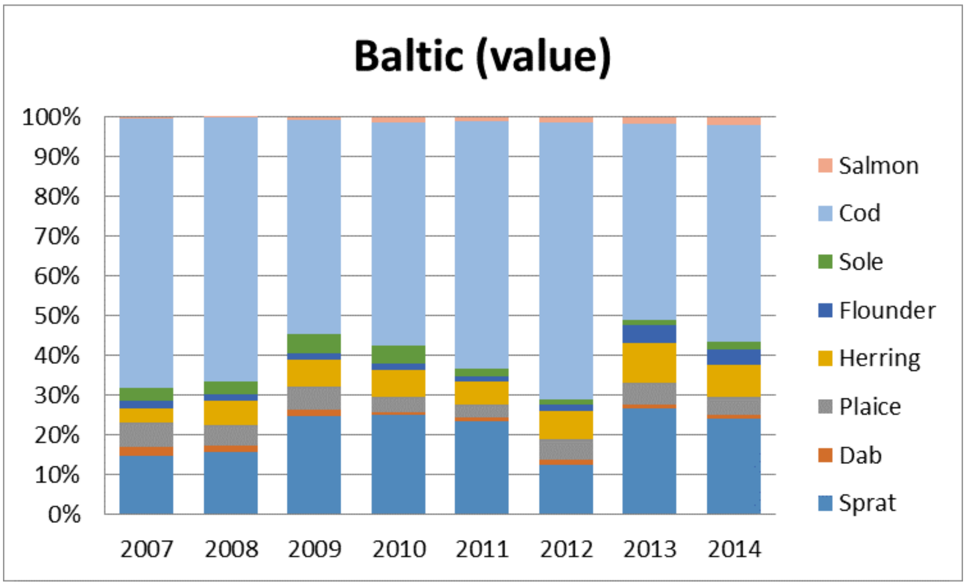


Figure 1.4.2.2. The relative distribution of 8 most important species (by value) landed by Danish fishermen with in the Baltic (SD 22–32).

1.4.2.2 Estonia

Herring and sprat fishery

Estonian Baltic sea fishery is, in general, a trawl fishery and is directed mainly on herring and sprat. Pelagic trawls took, depending on region, from 40 to 99 % of total landings in 2014. The rest were taken as trap net catch of herring at the spawning grounds of herring. The Estonian fishing fleet has been decreasing in 2004-2012 as a result of the EU scrapping program, and stabilised since then. At present most of the Baltic trawl fleet consists stern trawlers >=300 HP, the coastal fishery is supported by the small boats <12m. The overview of Estonian fishing fleet is available in the Registry of Estonian Fishing Vessels, which can be found at the website of Estonian Ministry of Agriculture (http://www.agri.ee/fisheries/).

The total Estonian herring landings from the main fishing areas in the Baltic were slightly above 23 000 t in 2014. 419 t were taken from the Sub-division 28-2, 10 600 t in the Gulf of Riga (Sd. 28—1), 3400t in Sub-division 29 and 8800 t in the Sub-division 32. There have been no big changes in the proportion of catches between the Sub-divisions during the recent decade.

Altogether, 15 600 t were taken by pelagic trawl fishery and 7500 t by the pound-net fishery on spawning grounds. The Gulf of Riga traditionally was the most important area of pound-net fishery (6100t).

The discarding does not occur in the Estonian pelagic fishery.

Sprat fishery

All sprat landings are coming from the pelagic trawl fishery. Total catch of sprat was almost 28 500 t. in 2014. Most of the catch was taken in the Sub-divisions 29 and 32-9900 and 17 500 t, respectively. Only 1100 t were taken in Sub-division 28—2. . The information on species composition of mixed sprat/herring catches is obtained from the logbooks, and from the observations of environmental inspectors, regularly visiting the landing sites. No discarding and sorting take place in herring and sprat fishery.

The protection measures enforced in pelagic fisheries: closed season for trawl fishery for 1 month in the Gulf of Riga (in April-May, (dates are depending on the ice conditions), and ban for use of trawls in coastal areas (below 20 m).

Flounder fishery

Flounder fishery is generally coastal fishery where gillnets and trap nets are used. Bottom (Danish) seine is used in SD 28 and 29 in the depth up to 40 m. 204.0 t flounder were taken by commercial fishers and 35.2 t by recreational fishers in 2014 in Estonian waters. 108.2 t were taken in SD 25 and 26 by cod trawling. 57.4 t (53.8 t commercial, 3.6t recreational) were taken in Sub~-division 28, 99.7 t (84.7 t commercial, 15.0 recreational) in the Sub-division 29, 82.1 t 8 (65.6 t commercial, 16.6 t recreational) in the Gulf of Finland (Sd. 32), 82.7 t in SD 25, and 25.5 t in Sd 26..

Cod fishery

At present the abundance of cod is low in the Estonian EEZ. Therefore the landings are coming mostly from the South-eastern Baltic Sea. According to official statistics, the total catch of cod was 166 t by commercial fishers and 0.9 t recreational in 2014, and was taken by cod trawlers mostly in the Sd. 25 (94.4 t) and Sd. 26 (63.6 t). The total catch in Sub-divisions 28—2, 29 and 32 was 7.1 t by commercial and 0.9 t by recreational fishers.

1.4.2.3 Finland

The Finnish fleet is mainly targeting Baltic herring, sprat, salmon and cod. For fisheries, flounder and coastal freshwater species have local importance. In coastal areas as well as in archipelagos, freshwater species such as European whitefish (*Coregonidae*), pikeperch, perch, pike, and turbot are targeted. Of these, whitefish, pikeperch, and perch have the highest local importance.

The gears used in the fishery statistics are as follows:

- herring trap nets
- salmon trap nets
- European whitefish trap nets
- big trap nets (for Baltic herring)
- pound nets (for Baltic herring)
- gill nets for herring and sprat
- gill net traps
- less than 36 mm gill nets
- 36–45 mm gill nets
- 46–50 mm gill nets
- 51–60 mm gill nets
- more than 60 mm gill nets
- salmon long line
- other long line or hook
- pelagic trawls (single and pairs)
- demersal trawls (single and pairs)
- rod and line or trolling gear
- winter seine and beach seine.

Fishing information is recorded by statistical rectangles (roughly 55 km x 55 km) and fishing operations.

The number of vessels is given in the text table below. The data are from the Fishing Vessel Register held by **ELY-centres** and Åland provincial government (last update **31.12.2013**).

The total number of fishing vessels has been round **3200** in commercial fisheries in the Baltic in recent years. Most of the vessels are shorter than 12 meters and used in coastal fisheries. During the last decade, the total commercial Finnish catches in the Baltic has fluctuated between 80 000 and **138 000** tonnes.

Trawling

In pelagic trawl and demersal trawl categories, fishing vessels overlap. Many of the vessels use both pelagic trawl and demersal trawl or the same gear is used in both fisheries. In Baltic herring fishery, pelagic trawl fishery exploits younger part of the Baltic herring stock and demersal trawling is directed to more adult part of the stock.

Pelagic Trawls

Pelagic trawling is used to exploit Baltic herring stocks in the Baltic Main Basin, the Archipelago Sea, the Gulf of Bothnia and the Gulf of Finland. Only few vessels are exploiting directly sprat stock, and sprat is the main by-catch in Baltic herring fishery. In recent years, there has not been any by-catch of cod in pelagic trawl fishery. Usually Baltic herring fishing is conducted as a single trawling. At certain times of the year, vessels may switch to demersal trawling. In autumn, early winter, and spring pelagic pair trawling is used for industrial purposes.

Common to pelagic trawlers, many vessels transfer between the Bothnian Bay (SD 31) and the Bothnian Sea (SD 30), the Bothnian Sea and the Åland Sea (SD 29), and between the Gulf of Finland (SD 32) and the Åland Sea depending on fishing possibilities and ice cover during the winter.

Demersal Trawls

Demersal trawls are used both for Baltic herring and cod. The main target is Baltic herring. Some demersal trawl vessels are targeting Baltic cod and they are mainly fishing in the Main Basin (SDs 24—25). There are some vessels using heavy ground gear but these have declined in numbers, and represent only a small part of the fleet.

Similarly to pelagic trawlers, the demersal trawlers shift between fishing grounds, depending on fishing possibilities and ice cover.

Trap-nets

Trap-net fishery include a variety of trap-net types for Baltic herring, Baltic salmon and European whitefish (*Coregonidae*). Fishery is conducted near the coast and inside archipelagos. Trap-net fishery for Baltic herring is conducted mainly during the spawning season in spring and early summer (May-June), targeting spawning component of Baltic herring stock.

Anchored gill nets

Anchored gill nets are used in Baltic herring, cod, flounder, and freshwater fish fishery along the Finnish coast. This gill net fishery is a predominantly mixed fishery located near the coast, conducted by small vessels except those few vessels targeting cod in the Baltic Main Basin.

Text table 1. Number of Finnish fishing vessels by category in 2013.

ELY-centre	Offshore vessels	Coastal vessels	Total
Uusimaa – Nyland – Uusimaa	9	322	331
Varsinais-Suomi – Egentliga Finland – Varsinais-Suomi	25	1084	1 109
Kaakkois-Suomi – Sydöstra Finland – Southeastern Finland	8	146	154
Pohjanmaa – Österbotten – Ostrobothnia	10	805	815
Kainuu – Kajanaland – Kainuu	18	383	401
Lappi – Lappland – Lapland	2	98	100
Ahvenanmaa – Åland – Åland	4	296	300
Yhteensä – Totalt – Total	76	3 134	3 210

Lähde: Maa- ja metsätalousministeriö
Källa: Jord- och skogsbruksministeriet
Source: Ministry of Agriculture and Forestry

1.4.2.4 Germany

Sprat and herring fishing fleet

For the German sprat and herring fishery, see section 6.01.

Cod fleet

In the years 2005 to 2014 the following types and numbers of vessels fished for cod in the Baltic Sea (i.e. total landings with more than 20% cod):

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2005	Gillnets	<12	601	2 041	18 719
		>=12	19	463	2 954
	Trawls	<12	30	465	4 165
		>=12	96	6 928	21 877
		Total	746	9 897	47 715
2006	Gillnets	<12	598	2 117	19 781
		>=12	22	948	4 197
	Trawls	<12	33	455	4 226
		>=12	95	6 432	20 603
		Total	748	9 952	48 807
2007	Gillnets	<12	581	1 978	18 605
		>=12	25	1 399	5 323
	Trawls	<12	27	391	3 773
		>=12	95	6 368	20 548
		Total	728	11 037	48 429
2008	Gillnets	<12	575	1351	12111
		>=12	26	1307	4950
	Trawls	<12	30	416	3895
		>=12	86	5330	16777
		Total	717	8404	37726
2009	Gillnets	<12	567	1310	11919

Year	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
		>=12	24	1499	5146
	Trawls	<12	26	361	3460
		>=12	76	4286	14683
		Total	693	7456	35208
2010	Gillnets	<12	577	1265	11349
		>=12	22	1337	4545
	Trawls	<12	26	360	3426
		>=12	76	4613	15026
		Total	701	7575	34346
2011	Gillnets	<12	525	1630	16372
		>=12	16	1262	3515
	Trawls	<12	25	332	3055
		>=12	65	3999	13103
		Total	631	7223	36045
2012	Gillnets	<12	462 9 55	1502	14913
		>=12	9	195	1202
	Trawls	<12	55	603	5878
		>=12	118	9600	26097
		Total	644	11900	48090
2013	Gillnets	<12	458	1.516	15.614
		>=12	11	264	1.670
	Trawls	<12	41	453	4.274
		>=12	56	3.331	10.768
		Total	566	5564	32326
2014	Gillnets	<12	460	1485	15413
		>=12	5	96	674
	Trawls	<12	38	443	4129
		>=12	56	3787	11515
		Total	559	5811	31731

In general, the German trawl fishery is a mixed fishery targeting cod, but with a bycatch of flounder (Subdivisions 24 and 25), dab (Subdivision 22), plaice (Subdivisions 22 and 24) and other flatfishes such as turbot, brill. The temporal distribution of the cod fisheries in recent years displayed the following pattern:

- in Subdivision 22 mainly quarter 1, and less in quarter 4,
- in Subdivision 24 throughout the year, but mainly in quarter 1 and 4 , and
- in Subdivision 25 mainly in quarter 2 (from April to June) on pre-spawning concentrations in the Bornholm Basin, and less in quarter 1.

In 2002 and 2003 the landings taken by gillnets amounted to 30 % and 40 %, respectively. In contrast to previous years when gill netting was mainly conducted in the western areas (Subdivision 22, federal state of Schleswig-Holstein), the share of gill netting increased substantially to about 30% in Subdivision 24 (federal state of Mecklenburg-Vorpommern) in 2004. Since 2006 the share of gill netting has stabilized on that level.

For the years 2004—2014, the percentage distribution of cod landings taken by passive gear (mainly gillnets) (percentage landing taken by passive gear from landing taken by all gear) is shown in the table below:

Year	Quarter	Sub-division 22	Sub-division 24
2004	1	19	38
	2	48	18
	3	29	16
	4	46	42
	Average	28	33
2005	1	23	31
	2	30	24
	3	28	18
	4	53	28
	Average	33	24
2006	1	18	33
	2	28	20
	3	24	3
	4	57	54
	Average	27	36
2007	1	14	27
	2	21	11
	3	22	18
	4	63	56
	Average	22	33
2008	1	20	22
	2	36	29
	3	42	15
	4	78	46
	Average	35	36
2009	1	25	25
	2	48	26
	3	30	6
	4	77	31
	Average	34	26
2010	1	26	13
	2	61	16
	3	52	47
	4	29	27
	Average	36	28
2011	1	33	5

Year	Quarter	Sub-division 22	Sub-division 24
	2	15	14
	3	16	19
	4	36	63
	Average	25	25
2012	1	15	4
	2	39	8
	3	58	13
	4	70	38
	Average	45	16
2013	1	14	69
	2	62	21
	3	27	25
	4	73	37
	Average	44	38
2014	1	12	2
	2	23	23
	3	32	43
	4	75	44
	Average	35	28

Flatfish fleet

German flounder landings are mostly taken as by-catch in the cod-directed trawl fishery (see cod fleet structure above) but there is also a directed fishery for plaice (Subdivision 22, active gear, quarter 1) and flounder (Subdivision 24, active and passive gear). From 2007 to 2010 in SD 22 about half of the flounder landings were reported for passive gear. In SD 24 a trawl fishery directed to flounder is mainly conducted in the 3rd and in the 4th quarter. The share of that fishery is estimated to be about 35% of the total flounder landings. In Subdivision 24 only a small amount of flounder was caught by passive gear before 2007, and about 85% of flounder have been caught by trawl from 1995 to 2007. In 2008 and 2009 the share of the active gear dropped to 70% and 65%, respectively, such that the passive fishery became more important. In SD 25 virtually all flounder is taken by trawls. Since 2004, a trawl fishery targeting dab in Sub-division 22 yielded stable landings of about 500 t yearly, which in 2010 decreased to about 400 t.

The percentage of flounder taken by passive gear from the overall flounder landings (active and passive fleet combined) in 2007—2014 is given in the table below:

Year	Quarter	Sub-division 22	Sub-division 24
2007	1	18	15
	2	65	33
	3	66	27
	4	36	7
	Average	44	17
2008	1	23	17
	2	87	67
	3	97	43
	4	59	18
	Average	51	30
2009	1	31	15
	2	92	57
	3	96	49
	4	42	24
	Average	53	35
2010	1	17	4
	2	90	29
	3	91	35
	4	21	7
	Average	43	23
2011	1	13	11
	2	84	46
	3	98	17
	4	41	8
	Average	39	15
2012	1	20	4
	2	67	47
	3	94	50
	4	40	15
	Average	57	29
2013	1	7	31
	2	70	44
	3	91	58
	4	26	16
	Average	49	37
2014	1	12	3
	2	66	47
	3	88	49
	4	19	25
	Average	46	31

1.4.2.5 Latvia

Latvia cod fishery

In 2014 Latvian fishing fleet catching cod in direct fishery consisted of 34 vessels. Twenty two of the vessels having length of more than 24 m were catching cod using trawls only. The trawlers were catching cod mainly with bottom trawls (92% of their catches). Other 8 ships were fishing mainly with gillnets because those ships were specially equipped only for that type of fishing. Four ships from this group were small boats with less than 10 m operating outside the coastal area. The other gillnetters were vessels with length of more than 24 m. It is not possible to determine how many boats is involved in cod direct fishery since coastal logbooks are not linked up with boats register data.

Data about cod fishery fleet gross register tons (GT); main engines (KW) are included in following table.

Segment	Year	Number	Total GT	Total KW
Trawlers >24 m	2014	22	2698	6544
Gill-netters >24m	2014	8	765	1539
Boats < 10m	2014	4	26	189

1.4.2.6 Lithuania

Fleet structure and fishery distribution

Lithuanian fleet in 2013 operated in ICES Subdivisions 25, 26, 28 and 29. In 2013 there were 25 active vessels (24 trawlers and 1 gillnetter > 24 m length) operating in open sea. Among trawlers there are 2 vessels over 40 m length using exclusively PTM and 25 vessels of >24 m length using OTM and/or OTB. Within Lithuanian EEZ there were 8 gillneters under 15 m length fishing in coastal area.

The landings by ordinal scale of total volume are: sprat (67.4%), herring (15.9%), cod (11.0%), and flounder (5.7%).

Cod

Distribution of landings by subdivisions of cod is presented in Table 1.4.2.6.1. 84% of cod catches are landed in Lithuania. 89% of cod is caught in SD 26. The share of landed cod from gillnetters is around 13%. Share of cod landings by gear is presented in 1.4.2.6.2.3**Error! Reference source not found.**.

Table 1.4.2.6.1. Distribution of cod landings (tons) in 2013 by Subdivisions and quarter

Subdivision	Quarter I	II	III	IV	Total
25	25	7			33
26	564	614	136	338	1652
28		15			15

Table 1.4.2.6.2.3. Distribution of landed cod (in tons and percentage) by gear in 2013

Landings	Gear			Total
	OTB	OTM	GNS	
Tones	1253	9	186	1700
%	86.5	0.6	12.9	

Flounder

In general demersal trawl fishery is targeting a mixture of cod and flounder with different proportions. Direct flounder fishery performed closer to coastal area when quota on cod by some vessels is nearly or completely utilized or if there is a special demand on flounder. Distribution of landings (%) by subdivisions of flounder is presented in Table 1.4.2.6.4. More than half of catches of flounder observed in the IVth quarter. Nearly 100% of landed flounder is caught in SD 26 by demersal trawls (Table 1.4.2.6.4**Error! Reference source not found.**). 62% of flounder catches are landed in Lithuania.

Table 1.4.2.6.4. Distribution of flounder landings (tons) in 2013 by Subdivisions and quarter

Subdivision	Quarter				Total
	I	II	III	IV	
26	42	64	263	514	883
28	0	1	0	0	1

Table 1.4.2.6.4. Distribution of landed flounder (in tons and percentage) by gear in 2013

Landings	Gear			Total, t
	OTB	OTM	GNS	
Tones	868	12	2	884
%	98.2	0.5	1.3	

Herring

Herring mainly in 2013 was caught in SD 25 (2%), SD 26 (57%), SD 28 (27%) and SD 29 (15%) (Table 1.4.2.6.5**Error! Reference source not found.**). Almost 73% of herring was caught by pelagic pair trawl and 27% by pelagic otter trawl. In general this is a mixed pelagic fishery when herring and sprat are caught together in different proportions dependently on season, gear and fishing ground. 90% of Lithuanian herring catches are landed in foreign ports. Share of herring landings by gear is presented in Table **Error! Reference source not found.**1.4.2.6.6.

Table 1.4.2.6.5. Distribution of cod landings (tons) in 2013 by Subdivisions and quarter

Subdivision	Quarter				Total
	I	II	III	IV	
25	5	34	-	-	39
26	1046	303	11	22	1382
28	313	65	23	257	657
29	-	-	-	365	365

Table 1.4.2.6.6. Distribution of landed herring (in tons and percentage) by gear in 2013

Landings	Gear			Total, t
	PTM	OTM	Other	
Tones	1780	650	14	2443
%	72.8	26.6	0.6	

Sprat

Sprat mainly in 2013 was caught in SD 25 (12.7%), SD 26 (43.4%), SD 28 (31.2%) and SD 29 (12.7%) (Table 1.4.2.6.7**Error! Reference source not found.**). The landings are used for both industrial (PTM) and human consumption (OTM) purposes. Almost 68% of sprat was caught by pelagic pair trawl and 32% by pelagic otter trawl (Table 1.4.2.6.7**Error! Reference source not found.**). In general this is a mixed pelagic fishery when herring and sprat are caught together in different proportions dependently on season, gear and fishing ground. In sprat fishery the bycatch oh herring makes up to 20% of total catch volume. 98.7% of Lithuanian sprat catches were landed in foreign ports.

Table 1.4.2.6.7. Distribution of cod landings (tons) in 2013 by Subdivisions and quarter

Subdivision	Quarter				Total
	I	II	III	IV	
25	77	1241	-	-	1318
26	2773	1339	47	349	4508
28	1234	583	70	1348	3235
29	-	-	-	1323	1323

Table 1.4.2.6.8. Distribution of landed sprat (in tons and percentage) by gear

Landings	Gear		Total, t
	PTM	OTM	
Tones	7055	3330	10385
%	67.9	32.1	

1.4.2.7 Poland

In December 2014 the Polish fleet consisted of 870 registered vessels, by 4% more than in 2013 (Table 2.4.2.7.1). The number of fishing boats up to 8 m increased markedly (by 34 boats). Also increased the number of vessels of the fleet segment 18.5-20.49 m (by 11%). Since Poland joined the EU, the fleet capacity is strictly limited. Thus, new vessel can only be registered following the withdrawal from exploitation of another vessel. In this way new boats up to 8 m were registered. As the power of boat engines and their tonnage (GT) is low, therefore withdrawal of one larger fishing vessel results in registering of a few new small boats. Most of the new boats registered in 2014 was possible due to withdrawal of two 17 m and two 24 m vessels. The increase in number of vessels from the length segment 18.5-20.49 m is the example of adaptation (total length increase/decrease) to changing rules of individual catch quota allocation.

Table 2.4.2.7.1. Polish Baltic fleet structure in December 2013 and 2014 r.

	2013			2014			2014/2013		
	number	GT	kW	number	GT	kW	number	GT	kW
0-8 m	298	601	5 559	332	630	5 716	11%	5%	3%
8-9,99 m	211	1 008	9 239	211	993	9 143	0%	-2%	-1%
10-11,99 m	134	1 486	9 094	137	1 528	9 374	2%	3%	3%
12-14,99 m	53	1 336	6 693	51	1 309	6 467	-4%	-2%	-3%
15-18,49 m	46	1 751	6 408	42	1 584	5 805	-9%	-10%	-9%
18,5-20,49 m	27	1 264	6 068	30	1 390	6 463	11%	10%	7%
20,5-25,49 m	29	2 572	8 059	29	2 529	8 001	0%	-2%	-1%
>=25,5 m	37	6 618	15 674	38	6 820	15 978	3%	3%	2%
Total	835	16 635	66 796	870	16 783	66 947	4%	1%	0%

Data source: Fishing vessel register of the Ministry of Agriculture and Rural Development.

The Polish fleet spent a total of around 67 thousand days at sea in 2012. The total number of days at sea in 2013 amounted to 71 thousand days, 6% higher than in 2012. The increase can be explained by a greater effort deployed by demersal fleet targeting mostly cod and flatfish but that has reallocated their effort towards pelagic species (sprat and herring) attracted by prices increase. On the other hand deteriorated cod CPUE (caused by poor condition of stocks) made the fleet spend more time at sea in order to keep the revenues at acceptable level. Significant increase of small scale vessels (PG VL0010) effort did as well contributed to a growth in total days at sea number. In addition to mentioned unfavourable cod condition, this was also a consequence of growing number of vessels in the segment.

The total amount of Baltic Sea fleet landings in 2014 was 118 thousand tonnes, with a landed value of €47.5 million. The total landings weight and value of the Baltic Sea fleet decreased by 11% and 16% respectively between 2014 and 2013. The reason behind that deterioration was TAC cut for sprat (-11%) and again by poor physical condition of Baltic cod influencing prices obtained by fishermen for that fish.

In 2014 sprat generated the highest landed value in the Baltic fisheries (€14.5 million), followed by cod (€13 million), herring (€10 million), and flounder (€4 million). In terms of landings weight, in 2014 sprat landings were 58.4 thousand tonnes, cod 11.9 thousand tonnes and herring 28.3 thousand tonnes. The major factor causing the changes in landings weight and value in 2014 compared to 2013 was decreased TAC for sprat and cod and increased for herring as well as lower prices for all these species.

Sprat accounted for 39% of the total landings value obtained by the Polish fleet in 2013, decreasing to 30.5% of total income in 2014, while cod increased from 26% in 2013 to 27% in 2014. This was mainly due to deteriorated prices of sprat (10% decrease compared to 2013 prices) and smaller landings. At the same time, cod prices decreased by 6.5% as a result of deteriorating physical condition of individual fish. Increased supply of imported cod in the Polish market was another reason for price decreases.

Small-scale fleet

The total weight landed by the small-scale fleet in 2014 was 12.8 thousand tonnes of fish, with a landed value of €11 million. The total weight of landings decreased slightly (-2%) between 2013 and 2014, however landed value decreased by 8% as a result of lower prices for cod, perch and perch. In 2014, cod generated the highest landed value

(€3.5 million), followed by perch (€1.8 million), herring (€1.7 million), pike perch (€1.1 million), european flounder (€0.8 million). In terms of landings weight, herring landings 4.1 thousand tonnes, cod 2.9 thousand tonnes and flounder amounted to 2.5 thousand tonnes. Landings of these three top species changed slightly (-2%) compared to 2013.

The Polish small-scale fleet's gross profit decreased sharply (by 75%) which can be explained by significant increase of labour costs by 17% (€1 million) the other cost items increased as well however did not contributed to cost structure substantially. The other reason explaining the deteriorated condition of the fleet was smaller landing income. The small-scale fisheries is highly subsidized compared to other fleet segments. In 2012 vessels belonging to a passive gear 0—10 m segment benefited from subsidies for voluntary reducing of fishing effort (mainly in form of temporary cessation of fishing activities). Subsidies of €7.7 (40% more than in 2011) were paid out to the fleet in 2012. Vessels belonging to small-scale fisheries (those under 8 meters length) kept benefiting from no individual limit restrictions in 2012.

Pelagic trawl 24–40 m

The fleet targets a variety of species but in particular pelagic species, such as sprat and herring. The economic condition of the segment deteriorated in 2013 compared to 2008-2012 mainly due to high increase in crew, fuel and depreciation costs. The number of vessels and employment in the segment changed (-9% and +14% respectively). No substantial changes in catch composition took place except for a significant decrease of cod landings (this species however doesn't play an important role in the segment landings). In 2013 the segment continued benefiting from high sprat prices however prices for herring dropped by 16%. In order to avoid over-utilisation of the TAC, a new management policy was introduced in 2011 regarding the quota allocation system for Baltic sprat (ICES 22—32) and Western Baltic herring stocks (ICES 22—24). Individual maximum allowable catch limits were established for these two stocks. Individual limitation was introduced for Central Baltic herring (ICES 25—27) in 2012. Maximum allowable catches for a single vessel was set at a level of 800 tonnes for herring and 3400 tonnes for sprat in 2013. Due to intensive catches and possibility of quotas over-utilisation the sprat and herring (central stock) fisheries had to be closed in July and September 2011 respectively.

1.4.2.8 Russia

The fleet, targeting sprat for the human consumption, during I–IV quarters, has average by-catches of herring between 15.6—36.5%. As usually, during summer and fall this fleet targets sprat for the animal food and by-catches of small herring is increased. The species composition of the mixed catches is defined from logbooks and, partly, by observers of AtlantNIRO (Kaliningrad), on board of larger commercial vessels. The small vessels fleet MRTK operates mainly within 12-NM limit over the year. Mesh size in the trawl bag is 20 mm opening. The catches of sprat in quarter I can reach 71.7%, in quarter II – 84.4%, in quarter III – 80.3%, in quarter IV – 63.5%. The species composition of this mixed fishery defined from logbooks and sporadically checked by fishery inspection in harbours. Russian fishermen utilized their sprat and herring quotas in SD 26 on 82,0% and 81,3% respectively. The basic parameters of the pelagic trawl fleet are represented in Table 1.4.2.8.1.

Table 1.4.2.8.1. Parameters of pelagic trawl fleet in 2014

Parameters of pelagic trawl fleet	Quarter				For
	I	II	III	IV	year
The number of fishing days (the sum for all vessels)	745	459	430	485	2119
Landing of one vessel for 1 day, t (average)	17,6	11,6	12,2	18,7	15,0
Sprat in catches, %	64,1	66,5	54,4	85,8	68,9
Herring in catches, %	35,9	33,5	45,6	14,2	31,1

Demersal trawl fleet

This fishery targets for cod and flounder. Cod and flounder are fished mainly by vessels type MRTK and MRTR with engine power up to 300 h.p. up to 27 m length. These commercial vessels are fishing with bottom trawls using the BACOMA windows (120 mm mesh opening) in the cod-ends. Russian fishermen utilized their cod and flounder quotas in SD 26 on 45.9% and 85.8% respectively. The basic parameters of the demersal trawl fleet are represented in Table 1.4.2.8.2.

Table 1.4.2.8.2. Parameters of demersal trawl fleet in 2014

Parameters of demersal trawl fleet	Quarter				For
	I	II	III	IV	year
The number of fishing days (the sum for all vessels)	267	306	217	571	1361
Landing of one vessel for 1 day, t (average)	3,2	2,2	2,6	3,4	2,9
Cod in catches, %	67,8	84,5	59,8	79,3	72,9
Flounder in catches, %	32,2	15,5	40,2	20,7	27,1

Gillnet fleet

This fishery targets for cod with by catch of flounder. Cod and flounder are fished mainly by vessels type TB, SCHS, PTS with engine power up to 225 h.p. This vessels are using the anchored gillnets with mesh opening of 110—115 mm. The basic parameters of the gillnet fleet is represented in Table 1.4.2.8.3.

Table 1.4.2.8.3. Parameters of work of gillnet fleet in 2014

Parameters of gillnet fleet	Quarter				For
	I	II	III	IV	year
The number of fishing days (the sum for all vessels)	95	151	88	261	595
Landing of one vessel for 1 day, t (average)	0,46	0,81	0,75	0,62	0,66
Cod in catches, %	90,7	93,2	84,9	97,2	93,1
Flounder in catches, %	9,3	6,8	15,1	2,8	6,9

Pound net fleet

This type of fishery exists in the Vistula Lagoon and Eastern part of Gulf of Finland. This fishery is targeting herring. Methods used to determine species compositions for officially reported landings. Species composition defines based on logbooks, landing declarations and sporadically checked by fishery inspectors in harbours and on ships.

1.4.2.9 Sweden

The Swedish fishing fleet

The Kattegat fishery

The demersal fishery in the Kattegat targets *Nephrops*, cod and flatfishes (plaice and sole). Back in the 1950s and 1960s there was also developed fishery on haddock and pollack, but due to the decline of these stocks the fishery on haddock and pollack is more or less non-existing at the present.

The cod has mostly been fished during the spawning period in the first quarter of the year by a trawl fishery directed on the spawning grounds, however this fishery has ceased due to protection measures. At present, such spawning grounds are found in the south-eastern part of the Kattegat, although several more spawning ground, located in other parts of the Kattegat, have been exploited in the past. In 2009 Sweden and Denmark implemented protected areas on the historically important spawning grounds in order to protect the cod. Within these areas fishing is either prohibited or restricted to certain seasons and/or species selective gear types.

The *Nephrops* fishery takes place the whole year around in the deeper parts of the Kattegat. The by-catch of cod, in particular, in the *Nephrops* fishery has declined profoundly in the last 25 years. Effort regulations enforced in the 1st cod recovery plan (EC No. 423/2004) and the present management plan (EC No. 1342/2008), national allocations of the *Nephrops* quota and the gear restrictions in the protected areas have caused an increase in the usage of the species selective sorting grid in the *Nephrops* fisheries. In 2010 sorting grids were used in approximately half of the deployed effort in demersal Kattegat fisheries. By-catches and discards of cod have thereby decreased in the *Nephrops* fishery.

The flatfish fishery is limited, due to low Swedish quotas on cod and place, and is located to various fishing grounds in the Kattegat area. There also exists an artisanal fishery on eel and crab in shallow waters. The pelagic fishery is the dominating fishery in terms of biomass. This fishery targets herring and sprat. The major part (>80%) of these quotas are however caught in Skagerrak.

Baltic herring and sprat fishery

The Swedish fishery for herring and sprat in the Baltic is carried out by four fleet categories:

Trawlers catching herring and sprat with a minimum mesh size of 32 mm. This fishery is for human consumption and for meal/oil.

Trawlers catching sprat (with a bycatch of herring) with a minimum mesh size of 16 mm. A part of the landings is used for human consumption. Most of the landings are used for industrial purposes. Herring is caught as by-catches in this fishery.

Coastal fishery for herring with gillnets. This fishery is for human consumption.

Purse seine fishery near the coast for spawning herring in the second quarter of the year. This fishery is also for human consumption.

Most of the Swedish landings of herring and sprat from the Baltic are from pelagic trawls and also with bottom trawls for herring. Fishing with gillnets for herring is of local importance in the coastal fisheries, especially in the northern Baltic.

Baltic cod and flatfish fishery

In the 1980s the Swedish landings from the western cod stock increased to about 10 to 20% of the total landings from the area. The Swedish landings have since then remained at that level. The Swedish share of the total landings from the eastern cod stock has increased steadily since the early 1980s to about 20—25% in recent years. The Swedish fishery for cod and flatfishes in the Baltic is carried out by four fleet categories, all fisheries are for human consumption:

- Trawlers catching cod using Bacoma panel or T90 codend. Flatfishes are caught as bycatches in this fishery. A large part of the caught flounders are however discarded. Sweden has allocated proportions of the national quota to trawlers and fisheries using passive gears. Trawlers are allowed to catch 60% of the quota for eastern Baltic cod and 40% of the quota for western Balic cod. Fisheries have at a national level been regulated by 2 week rations based on the sizes (GT) of the vessels. In 2010 this system was changed into a system of quarterly rations for the trawlers.
- Baltic gillnetters/longliners fishing for cod with a minimum mesh size in the gillnets of 105 mm. Flatfishes are caught as bycatches in this fishery. Longlines are starting to increase on the behalf of gillnetters in this category.
- Gillnetters fishing for flatfishes. Cod may be caught as bycatch in this fishery.
- Coastal fishery with trap nets for eel and other species. Cod and flatfishes may be caught in this fishery.

1.5 Reviews of groups or work important for WGBFAS

1.5.1 Baltic International fish survey Working Group (WGBIFS)

The outcome of the WGBIFS which were relevant for the WGBFAS was presented by the chair. The results of the Baltic International Trawl Survey (BITS) from 4th quarter 2014 and 1st quarter 2015 were presented together with the results of the spring (BASS) and autumn acoustic survey (BIAS). All indices were recommended to be used in the assessments if certain years (1993, 1995 and 1997 for sprat and herring in Central Baltic, and 1999 for Bothnian Sea herring) were excluded from the acoustic time series due to poor coverage.

Furthermore last year WGBFAS was asking for information on the BIAS survey for herring in the central Baltic compared to in the Bothnian Sea. The outcome was also presented at WGBFAS.

Although the BITS survey was recommended to provide standardized time-series of flounder, plaice and dab, it should be considered that the shallow areas with water depth less than 20 m are not covered by the survey. If significant components of a given flatfish stock are staying in this zone during the survey and particularly if the size of this component it variable from year to year, this will introduce a bias in the results as the component is not included in the results.

1.6 Methods used by the Working Group

1.6.1 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:

1) Cod in the Kattegat (upgraded to a Cat. 1 stock)
2) Cod in the Subdivisions 22—24
3) Sole in Division IIIa + SDs 22—24
4) Plaice in 21—23
5) Herring in the Subdivisions 25—29 and 32, excluding Gulf of Riga
6) Herring in the Gulf of Riga

Herring in the Bothnian Sea (Subdivision 30) (down scaled to trend based)

7) Herring in the Bothnian Bay (Subdivision 31) (trend based)
8) Sprat in the Subdivisions 22—32.
9) Plaice 24—25 (trend based)
10) Cod in Subdivisions 25—32 As in last years WG the analytic assessment was not accepted by the working group (trend based)

No analytical assessment of Flounder 2223, 2425, 26 and 28, and 27-32, brill 22—32, dab2232 and turbot 2232 was performed, but an assessment based trend was carried out.

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 2224, plaice in 2123, plaice in 2432, herring in SD 30 and sole in IIIa+SDs 22—23. 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.kcod.stockassessment.org.

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

1.6.2 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 exploatory assessment	

1.6.3 Biological reference points

1.6.3.1 New Reference points

Presently defined reference points for Baltic stocks were taken from the Joint ICES-MyFISH workshop, November 2014 and summarized in table below.

STOCK	LIMIT REFERENCE POINTS	PA REFERENCE POINTS	MSY REFERENCE POINTS	MANAGEMENT PLAN
Cod in Katttegat	Blim is 6 400 t Technical basis: lowest observed SSB Flim not defined	Bpa 10 500 t Technical basis: Blim*exp(1.645*0.3) Fpa not defined	MSY Btrigger not defined FMSY not defined	FMGT= 0.4 EU management plan EC 1342/08
Cod in SD 22-24	Blim 27 400 Technical basis: Break point of stock recruitment relationship Flim not defined	Bpa = MSY Btrigger 38 400 t Technical basis: Blim * 1.4 Fpa not defined	MSY Btrigger 38 400 t FMSY = 0.26	FMGT= 0.6 EU management plan based on stochastic simulations(reference F age range 3-6).
Cod in SD 25-32	Not defined			

STOCK	LIMIT REFERENCE POINTS	PA REFERENCE POINTS	MSY REFERENCE POINTS	MANAGEMENT PLAN
Herring in SD 25-29&32 excluding Gulf of Riga	Blim 430 000 t Technical basis: Bloss Flim 0.52 Consistent with Blim	Bpa 600 000 t Technical basis: Blim * 1.4 Fpa 0.41 Technical basis: Consistent with Bpa	MSY Btrigger 600 000 t Technical basis: Bpa FMSY = 0.22 Stochastic simulations, including S–R relationship. FMSY (SMS) (multispecies)= ~0.30	
Herring in the Gulf of Riga	Blim not defined Flim not defined	Btrigger 60 000 t Technical basis: WKMAMPEL 2009 Fpa 0.4 Technical basis: from medium-term projections	MSY Btrigger 60 000 t FMSY = 0.32	
Herring in SD 30	Blim not defined Flim not defined	Bpa not defined Fpa not defined	FMSY= 0.15 MSY Btrigger 316 000 t Technical basis: EQsim	
Herring in SD 31	Not defined	Not defined	Not defined	
Sprat in SD 22-32	Blim 410 000 Technical basis: S-R relationship (biomass which produces half of maximal recruitment). Flim 0.39 Technical basis: Consistent with Bpa	Bpa 570 000 Technical basis: Blim * 1.4 Fpa 0.32 Technical basis: Consistent with Bpa	FMSY= 0.26 MSY Btrigger 570 000 t Technical basis: Stochastic simulations, including S–R relationship. FMSY (SMS) (multispecies)= 0.25-0.32	
Flounder SD 22-23	Not defined	Not defined	Not defined	
Flounder SD 24-25	Not defined	Not defined	Not defined	
Flounder SD 26 and 28	Not defined	Not defined	Not defined	
Flounder SD 27 and 29-32	Not defined	Not defined	Not defined	
Plaice SD 24-32	Not defined	Not defined	Not defined	

STOCK	LIMIT REFERENCE POINTS	PA REFERENCE POINTS	MSY REFERENCE POINTS	MANAGEMENT PLAN
Bril SD 22-32	Not defined	Not defined	Not defined	
Turbot SD 22-32	Not defined	Not defined	Not defined	
Plaice SD 21-23	Blim 4 480 t Technical basis: Bloss Flim not defined	Bpa 600 000 t Technical basis: Blim * 1.4 Fpa 0.67 Technical basis: Consistent with Bpa	Fmsy = 0.37 MSY Btrigger 5 550 t Technical basis: = Bpa Technical basis: EQsim.	
Sole in Division IIIA	Blim 1200 Flim is 0.92 Technical basis: Flim replacement line; Consistent with Blim (WKMSYREF2 2014)	Bpa 2000 Technical basis: Blim*e1.645σ , σ=0.30 (WKMSYREF2 2014) Fpa 0.49 Technical basis: consistent with Bpa and Flim	MSY Btrigger 2000 t Technical basis: lowest observed SSB excluding 1984-85 low SSB's (WKFLAT 2010) FMSY = 0.22 Technical basis: Candidate; based on equilibrium scenarios constrained by prob(SSB<Blim)<5% w. stochastic recruitment (WKMSYREF2 2014)	

1.7 Quality handbook

1.7.1 Stock annex

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

1.7.2 Methods to be applied in subsequent assessments

Assessment classifications:

Stock	Classification in 2014	Assessment in 2015
Cod in Kattegat	SALY	Update
Cod in SD 22-24	Update	Benchmarked
Cod in SD 25-32	Update	Benchmarked
Sole in Division IIIa + SDs 22-23	Update	Update
Flounder in SD 22-23	Exploratory	Trend based
Flounder in SD 24-25	Exploratory	Trend based
Flounder in SD 26-28	Exploratory	Trend based
Flounder in SD 27-32	Exploratory	Trend based
Plaice SD 21-23	Update	Benchmarked
Plaice SD 24-32	No analytical assessment	Benchmarked
Dab SD 22-32	No analytical assessment	Trend based
Brill SD 22-32	No analytical assessment	Trend based
Turbot SD 22-32	No analytical assessment	Trend based
Herring in SD 25-27, 28.2, 29 &32	Update	Update
Herring in GOR (SD 28.1)	Update	Update
Herring in SD 30 (Bothnian Sea)	Update	Update
Herring in SD 31 (Bothnian Bay)	Trend based	Trend based
Sprat in SD 22-32	Update	Update

1.8 Ecosystem considerations

1.8.1 Introduction

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 Working group for regional ecosystem descriptions (WGRED), the Study group on Baltic Sea fish and fisheries issues (SGBFFI), the Workshop on integrated assessments in the Baltic Sea (WKIAB), the Working group on introductions and transfers of marine organisms (WGITMO), the Workshop on the impact of zooplankton on cod abundance and production (WKIZC), and peer-reviewed publications as input to the sections below. The descriptions of the Kattegat and Baltic Sea ecosystems (Section 1.8.2) and their changes (section 1.8.3) are to a large extent based on the WGRED report, but have been revised to include information on all of the basins hosting stocks assessed by the WGBFAS, as suggested by the SGBFFI (ICES, 2006a). In Section 1.8.4 we list the details of how ecosystem variability has been accounted for and in which stock assessments. Finally, in

Section 1.8.5, we propose measures and further development of methods to account for ecosystem variability and fisheries-induced ecosystem effects in stock assessments.

1.8.2 Ecosystem description

1.8.2.1 Kattegat

1.8.2.1.1 Topography and oceanographic conditions

The Kattegat forms part of the transitional area between the North Sea and the Baltic Sea. Its surface area is 22 000 km^2 and the mean depth is 23 m (Håkansson, 2002). Hydrographic conditions are strongly influenced by the run-off of freshwater from the Baltic Sea and input of Atlantic water from the west/northwest. As a result the Kattegat has a strong latitudinal salinity gradient from 15 to 25 PSU. The Kattegat is also stratified vertically due to the run-off of Baltic water, and a sharp pycnocline separates surface water from inflowing saline water from the Skagerrak and North Sea.

Thermal conditions in the Kattegat are typical for temperate-boreal ecosystems, and show strong seasonality. Winter surface temperatures can fall below freezing, resulting in ice coverage in some years in some areas. Summer surface temperatures rise to 15–20^{o} C and a warm surface layer develops in spring. Thermal stratification is eroded in autumn and the water column becomes vertically homogeneous down to the permanent halocline. Oxygen deficiency may periodically occur after thermal stratification in late summer and in combination with long periods of low wind stress. The problem is exacerbated by large scale eutrophication of the coastal waters. Demersal fish will migrate out of low oxygen areas, and benthic organisms may experience mortality and reduced growth.

Circulation in the Kattegat is influenced by exchanges with neighbouring seas (Skagerrak, Belt Sea, Øresund and the Baltic Sea) and depends on meteorological forcing; tides are much weaker than in the southern North Sea. The horizontal exchanges can transport fish eggs and larvae among areas. For example 0-group plaice abundance along both the Danish and Swedish coasts of the Kattegat depends partly on wind-induced advection of water masses containing eggs and larvae to coastal nursery areas (Pihl, 1990; Nielsen *et al.*, 1998; Pihl *et al.*, 2000). The role of these processes on population abundance of this and other species is however unclear, partly due to large uncertainties in stock assessment – derived estimates of recruitment (ICES, 2005d).

1.8.2.1.2 The fish community

The Kattegat fish community includes many of the same species found in the North Sea and can be characterized as temperature-boreal (Muus and Nielsen, 1999). The community biomass is dominated by a relatively small number of species which include flatfishes (e. g., plaice, flounder, dab, turbot, sole), gadoids (primarily cod but historically also haddock, whiting and pollock), and pelagic fishes (e.g., herring, sprat; ICES, 2005d). The community is supplemented on a seasonal basis by migrant species, including mackerel, garfish, and occasionally horse mackerel (Muus and Nielsen, 1999).

The Skagerrak-Kattegat area is commonly described as a transition area between the North Sea and the Baltic also in terms of fish stock identity. Spawning aggregations that may supply recruits to the Skagerrak-Kattegat area have been located in the adjacent eastern North Sea, based on evidence of a major transport of eggs and larvae of cod, whiting, haddock, Norway pout and saithe in this direction (Munk *et al.*, 1995; 1999). Considering the population structure of cod in the North Sea region, comprising the eastern English channel, the proper North Sea, the Skagerrak and Kattegat, genetic surveys suggest spatially, separated sub-populations units (Hutchinson *et al.*, 2001; Knutsen *et al.*, 2003; 2004). The observed level of differentiation is, however, on the whole, very small and the stability over time of putative sub-units remains to be shown (e.g. Nielsen *et al.*, 2005). Notwithstanding the uncertainty of the genetic integrity of population sub-units, cod spawning aggregations are well known in the southern part of the Kattegat (Hagström *et al.*, 1990; Svedäng and Bardon, 2003; Svedäng *et al.*, 2004).

1.8.2.2 Baltic Sea

1.8.2.2.1 Topography and oceanographic conditions

The Baltic Sea receives freshwater input from rivers and saltwater inflow from the North Sea in the narrow straits between Denmark and Sweden. This results in a salinity gradient from southwest to northeast that is one of the primary determinants and drivers of this brackish water ecosystem.

The topography is highly varied with large areas (ca 30%) that are less than 25 m deep interspersed by a number of deeper basins in the Baltic Proper, Bothnian Sea, and the Gulf of Finland that are separated by sills (the Gulf of Riga and the Bothnian Bay are internal fjords). Inflows of saline and oxygen rich water from the North Sea therefore needs to be strong to reach into all the main basins. As the water column in the open Baltic is permanently stratified, oxygen depletion in the deeper saline layers can occur due to the limited oxygen transport, with detrimental effects on benthos as well as cod and flounder recruitment. Inflows are necessary to renew oxygen depleted bottom water in the basins and thus influence fish recruitment. Major inflows occurred 1976, 1983, and 1993, and a medium-sized inflow occurred in 2003 (ICES, 2005a).

The anoxic conditions also influence the nutrient levels in the Baltic Sea. The Baltic Sea became eutrophicated during the 20th century and nutrient levels in the Baltic Sea have remained persistently high since the mid-1990s (Helcom, 2003). Anoxic conditions cause phosphorus leakage from sediments and prevent denitrification resulting in nutrient surplus in the deep water, which may increase primary production also in surface water layers (Helcom, 2003). Eutrophication causes seasonal hypoxia also in shallow coastal waters with serious consequences for recruitment of coastal spawning species, as well as coastal biodiversity see also Section 2.1.

1.8.2.2.2 The plankton community

The composition of both the phytoplankton and zooplankton communities is determined mainly by the salinity gradient. In the southwest marine species such as diatoms and the zooplankton *Pseudocalanus spp*. dominates, whereas brackish water species such as dinoflagellates, and the zooplankton *Eurytemora affinis* and *Bosmina longispina maritima* are more common in the northeast. The marine species, e.g. *Pseudocalanus sp*., eggs and nauplii are sensitive to low salinity and oxygen levels (Schmidt *et al.*, 2003, Renz and Hirche, 2005). Other species are favoured by increasing temperature, such as *Acartia spp*. in which activation of resting eggs increases with temperature (Alheit *et al.*, 2005). Zooplankton community is also affected by clupeid fish predation (Möllmann *et al.*, 2008; Casini *et al.*, 2008, 2009).

Primary production decreases northwards, from about 170 g C m^{-2} year^{-1} in the Baltic Proper (Johansson *et al.*, 2004) to 20–30 g C m^{-2} year^{-1} in the Bothnian Bay (Sandberg *et al.*, 2004). There is no corresponding decrease in heterotrophic production (Samuelsson *et al.*, 2006), which results in an increased relative importance of bacterioplankton in the ecosystems further north. In the Bothnian Bay the phytoplankton community is phosphorous limited, whereas it is nitrogen limited in the Bothnian Sea and Baltic Proper (Granéli *et al*., 1990, Andersson *et al*., 1996). Terrestrial derived dissolved organic carbon via run-off decreases from north to south, and supports bacterial and mesozooplanktonic secondary production in the Bothnian Bay (Zweifel *et al*., 1995, Rolff and Elmgren, 2000).

1.8.2.2.3 The benthic community

The benthic community on hard bottom substrates is dominated by mussels while deposit feeders and burrowing forms dominate on soft bottoms. Community composition changes and species richness declines with decreasing salinity. Throughout the Baltic Sea, seaweed and seagrass habitats in shallow coastal areas form important nursery grounds for coastal spawning species, as well as important feeding habitats. The *Fucus vesiculosus* communities also have the most species rich fauna in the Baltic Sea, hosting mussels, snails, crustaceans, bryozoans and even insect larvae (Kautsky and Kautsky. 2000).

Baltic Proper

The soft bottom communities are characterised by the bivalve *Macoma balthica*, with *Abra alba* and *Arctica islandica* being more common in deeper soft bottoms in the southwestern Baltic Sea and polychaetes in deeper soft bottoms in the eastern parts. Hard bottom communities are dominated by *Fucus vesiculosus* and *Mytilus edulis* (Voipio, 1981). The isopod *Idotea baltica* is one of the major grazers on *Fucus* (Kautsky and Kautsky, 2000). Eelgrass (*Zostera marina*) occurs in sandy bottoms in the southern Baltic Proper. Much of the production in coastal soft bottom communities goes to larval food for fish (Nellbring, 1988).

Bothnian Sea and Bothnian Bay

The Bothnian benthic communities are instead dominated by glacial relicts: the isopod *Saduria entomon* and the amphipod *Monoporeia affinis,* and by the mussel *Macoma baltica* (Kautsky and Kautsky, 2000; Laine, 2003). Decomposition is taken over by a variety of sediment-living meiofauna and insect larvae, mainly *Chironomidae*.

1.8.2.2.4 The fish community

The Baltic Sea fish community with about 100 species is unique in its combination of marine and limnic fish species. Its composition is predominantly determined by salinity, resulting in a transition from dominance by marine species (ca 70 sp.) to limnic species (ca 30 sp.) from south to north and in the gradient from the open sea to coastal waters.

The commercially most important species overall are cod (*Gadus morhua*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*), flounder (*Platichthys flesus*), turbot (*Psetta maxima*), and salmon (*Salmo salar*). Locally, high-valued species such as eel (*Anguilla anguilla*), vendace (*Coregonus albula*), whitefish (*Coregonus lavaretus*), and pikeperch (*Sander lucioperca)* are also commercially important.

Baltic Proper

The open sea fish community is dominated by cod, herring and sprat. Recently, large amounts of three-spined sticklebacks (*Gasterosteus aculeatus*) have also occurred in the northern areas of the Baltic Proper. Cod feeds as young on large copepods and mysids (Hüssy *et al*., 1997, Köster and Möllman, 2000a), and when older on benthic organisms and fish such as herring, sprat, and small cod (Köster and Möllman, 2000a, Köster *et* *al*., 2003a). Small herring feeds on zooplankton (Möllmann and Köster, 2002, Casini *et al*., 2004), whereas larger herring eats also mysids and amphipods (Möllman and Köster, 1999, Casini *et al*., 2004). Herring may also predate on cod eggs (Köster and Möllmann, 2000a). Sprat feeds strictly on zooplankton (Möllmann and Köster, 1999, 2002, Viitasalo *et al*., 2001, Casini *et al*., 2004), but also on cod eggs (Köster and Möllman, 2000).

The coastal fish community is dominated by limnic species such as perch (*Perca fluviatus*), roach (*Rutilus rutilus*), pike (*Esox lucius*), bream (*Abramis brama*), silver bream (*Blicca bjoerkna*), rudd (*Scardinius erythrophthalmus*), and tench (*Tinca tinca*) (Kautsky and Kautsky, 2000). Due to the coastal spawning of some marine species, such as herring, they can also be subject to interactions with limnic species; for example, predation by pikeperch on young herring (Hansson *et al*., 1997). In most coastal areas small benthic fish species, both marine and limnic, from families such as Gobiidae, Cottidae, or Gasterosteidae are abundant.

Gulf of Riga

The Gulf of Riga is a separate semi-enclosed ecosystem of the Baltic Sea characterised by low salinity of about 5 PSU, which thus limits the residence of marine species like cod. Cod is only found in the Gulf of Riga when the Eastern Baltic cod stock is on a very high level (last time in early 1980s). The dominant species in the Gulf of Riga is herring, but the fish fauna include several freshwater species like perch, pikeperch, diadromous species such as smelt, vimba and whitefish. Cod is present in the Gulf of Riga only when at high abundances in the Baltic Proper (Casini *et al*., 2012).

The year class strength of Gulf of Riga herring strongly depends on the severity of winter, with rich year classes appearing after mild winters (Rannak, 1971). After mild winters the spawning starts earlier and the spawning activity is more evenly distributed over the spawning season. This results in a more even distribution and lower mortality of egg on the spawning grounds. Additionally, after mild winters the zooplankton is more abundant providing better feeding conditions for feeding of herring larvae.

Bothnian Sea and Bothnian Bay

Many marine species, such as cod and flounder, have their northernmost distribution limit in the Bothnian Sea, whereas other marine species such as herring and fourhorned sculpin (*Triglopsis quadricornis*) are common also in the northernmost Bothnian Bay. In southern Bothnian Sea herring and sprat are the most important species in the open sea, whereas vendace (*Coregonus albula*) and herring are the most important in the Bothnian Bay pelagic habitat. Recently, large amounts of three-spined sticklebacks (*Gasterosteus aculeatus*) have also occurred in the Bothnian Sea. Common coastal-dwelling species are sticklebacks (*Gasterosteus aculaetus* and *Pungitius pungitius*), perch, pike, roach (*Rutilus rutilus*), bleak (*Alburnus alburnus*), but pikeperch (*Sander lucioperca*) and burbot (*Lota lota*) are also important. Salmon (*Salmo salar*) and the benthic feeding whitefish (*Coregonus lavaretus*) are together with herring and vendace the most important species for coastal fisheries.

1.8.2.2.5 Birds and mammals

The marine mammals in the Baltic consist of grey (*Halichoerus grypus*), ringed (*Phoca hispida*), and harbour seals (*Phoca vitulina*), and a small population of harbour porpoise (*Phocaena phocaena*). Seals have been recorded caught in fyke nets, set nets and salmon driftnets, but although the recorded data almost certainly underestimate the total number of by-caught seals, the added mortality did not appear to restrain the seal populations from increasing before 2004 (Karlsson and Helander, 2004). In the central Baltic the grey seals population has been increasing, except a small drop in 2009. In 2012 there was estimated to be 28 000 grey seals in the Baltic (Figure 1.8.1).

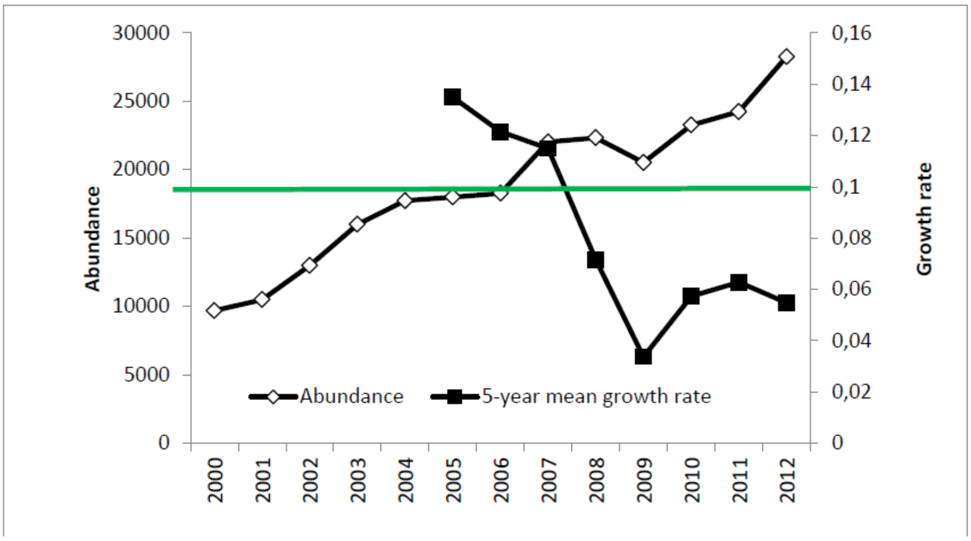


Figure 1.8.1. Abundance of greyseals in the Baltic and a 5 year mean growth rate for the seals (Tero *et al.*, 2013).

The seabirds in the Baltic Sea comprise pelagic species like cormorants, divers, gulls and auks, as well as benthic feeding species like dabbling ducks, sea ducks, mergansers and coots (ICES, 2003). Common eider, for example, predates on mussels. The Baltic Sea is more important for wintering (c.10 million) than for breeding (c.0.5 million) seabirds and sea ducks.

1.8.2.2.6 Parasites

The prevalence of cod infected with anisakid nematodes (*Anisakis simplex*, *Contracaecum osculatum* and *Pseudoterranova* sp.) increased in later years compared to the results of studies conducted in the past three decades. Myjak *et al*. (1994) investigated > 3000 individuals of cod, sampled in the southern Baltic (1987–1993). Average prevalence of infection was low: 4% for anisakids in total; 0.9 *for A. simplex* and 2.5 for *C. osculatum*. Only 1 cod was infected with *Pseudoterranova decipiens* . Average intensity of infection was low 10.2 for C. osculatum (14.4 for anisakids in total).

In 2011, average prevalence of infection of Baltic cod increased to 11.2%, with average intensity of 50 (Nadolna and Podolska, 2013).

A further increasing trend was recorded in subsequent years (2012–2013) (Podolska and Nadolna, personal communication). In last two years the presence of nematodes (particularly *C. osculatum*) was noted in small, young cod (in length classes of 26–30 cm), which may be the result of greater availability of infected food. The grey seal serve as a final host for *C. osculatum*; therefore, an increasing seal population size may impact the dispersion of these nematode species in the Baltic.

The population size of the grey seal in the entire Baltic Sea has continued to increase over the past few years to almost 30 000 ind., therefore, an increasing seal population size may impact the dispersion of these nematode species in the Baltic. The presence of

Psedoterranova was reported in 2011–2013 two areas (Bornholm and middle Baltic). The presence of *P. decipiens* in cod has not been previously considered to be a problem for Baltic cod because this nematode has not been frequently reported during the past few decades. The occurrence of *P. decipiens* in cod may be an effect of the re-colonization of the Baltic with seals.

1.8.3 Ecosystem changes

1.8.3.1 Kattegat

1.8.3.1.1 Trends in abiotic factors

- Sea surface summer temperatures in the Kattegat-Great Belt-Øresund region have increased by 2°C during 1984—2001 (MacKenzie and Schiedek, 2006). This increase is much faster than that expected as a result of global warming (ca. 3°C over the next 70–100 years; Kerr, 2004), and is likely contributing to some of the ecological changes seen in the Kattegat. Temperature is now as high as or higher than at any time since the start of measurements by ICES in 1921 (Figure 1.8.2).
- Phosphate concentration exhibits a significant negative trend in the inshore Kattegat, whereas there is an increasing trend in the DIN:DIP ratio (Axe *et al.*, 2004). Significant decrease in silicate was observed. Indirect indicators of eutrophication (autumn bottom oxygen concentration; growing-season chlorophyll-a concentration) exhibited significant positive trends (Håkansson, 2002; Ærtebjerg *et al.*, 2003). A significant negative trend in near-bottom oxygen concentrations exists in all areas except the inshore Kattegat (Axe *et al.*, 2004). These situations reduce the size of habitat for benthic fish species and kill benthic prey for fish species (Pihl, 1994).

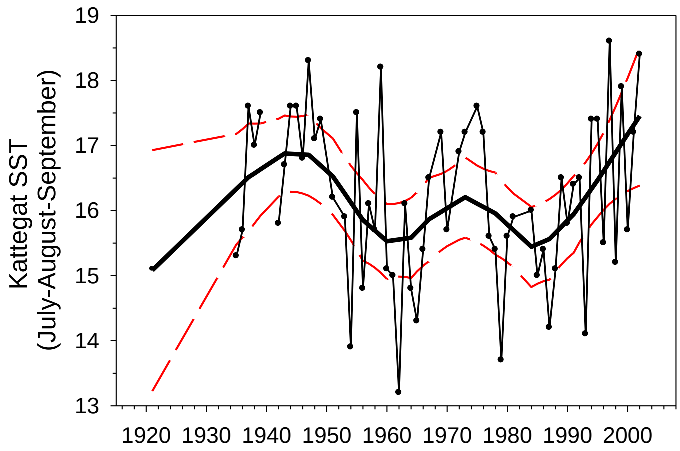


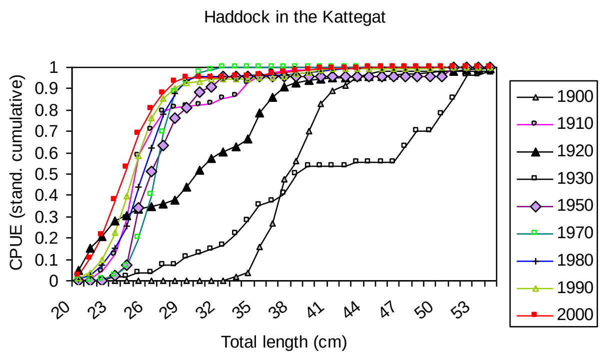
Figure 1.8.2 Interannual variability in sea surface temperature in the Kattegat-Great Belt-Øresund during summer (July-August-September) based on data from the ICES Hydrographic Database (MacKenzie and Schiedek, 2006). Line with dots: raw data; thick solid line: statistical fit based on General Additive Modelling; red dashed line: 95% confidence limits of statistical fit as estimated from General Additive Model (GAM).

1.8.3.1.2 Trends in vegetation

- ***Fucus* spp., red algae, and eelgrass (Z. marina)** have diminished in the Kattegat due to eutrophication (Wallentinus, 1996; Schramm, 1996), whereas opportunistic filamentous algae have increased. Thus, important spawning and feeding grounds for coastal spawning species such as herring, flatfish and many limnic species are decreasing. However, while the variation of eelgrass in shallow-water populations seem more stochastic, deep-water eelgrass populations have declined markedly over the last century in response to eutrophication, long-term changes (Fredriksen *et al.,* 2004).
- The **non-native seaweed** *Sargassum muticum* has expanded rapidly in Kattegat since late 1980s (Wallentinus, 1996), and *Graciliaria vermiculophylla*, first observed in eastern Skagerrak in 2003, was in 2005 found also in Kattegat (SBF 2006). *G. vermiculophylla* can have negative effects on eelgrass (and hence important fish habitats) through its competitive dominance for light.

1.8.3.1.3 Trends in comb jellies

- The warty comb jelly, *Mnemiopsis leidyi*, was found for the first time in 2006 in the western Baltic and the North Sea region. In the summer 2007, the species became abundant in the Skagerrak – Kattegat area. In the genetic studies on the samples of 2008 from the comb jellies of the Baltic Sea, it was found that the comb jellies supposed to be *Mnemiopsis leidyi* belonged to the genus *Mertensia*, which is common in arctic seas. *Mnemiopsis* is also found in the Western Baltic as a reproducing population. It has also been found in the central Baltic Sea, where it, however, does not seem to live as a self-sustaining population (Schaber *et al*., 2011).



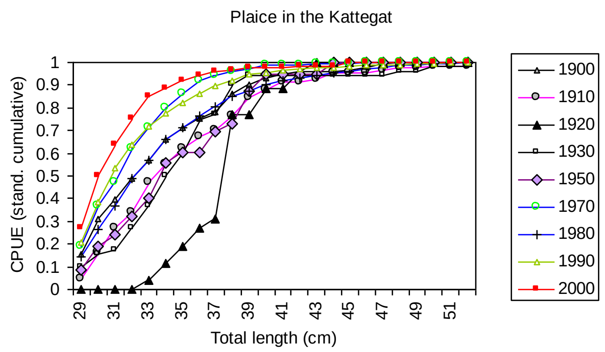


Figure 1.8.3. Cumulative length distribution for haddock and plaice in the Kattegat observed in Swedish trawl surveys, estimated per decade between 1901 and 2004 (Hagberg, 2005). The catch per unit effort (CPUE) values have been standardised within decade.

Trends in fish community

- The fish community in the Kattegat has changed over time. Some species, e.g. haddock and pollock, are no longer present or are now extremely rare, and the size composition of species such as cod, haddock and plaice have all decreased during the 20th century (Figure 1.8.3).
- The period of warm temperatures since the late 1980s-early 1990s (Figure 1.8.2) has caused the presence of some warm-adapted species (e.g., sole) to increase (ICES, 2005d), as observed also in the North Sea and other areas of the northeast Atlantic (Brander *et al.*, 2003; Genner *et al.*, 2004; Perry *et al.*, 2005).
- There is some evidence that the productivity of the benthic fish community has increased since the late 1950s due to eutrophication (Nielsen and Richardson, 1996).
- Regarding some of the ecologically and commercially most important species at the present time, the following trends have been documented:

  i) cod biomass has fallen nearly continuously for 20-30 years and the recruitment of the Kattegad cod stock is still historic low. The decline of the cod stock in the Kattegat has shown associations with the disappearance of separate spawning aggregations/subpopulations in the Kattegat area (Svedäng and Bardon, 2003; Cardinale and Svedäng, 2004; Hagberg, 2005).

  ii) the biomass of plaice is increasing and continues to support important commercial fisheries

  iii) sole biomass has increased in the late 1990s and early 2000s but has in later years decreased

  iv) herring biomass has decreased in the 2000s

1.8.3.2 Baltic Sea

The ecosystem changes in the Baltic Sea are synthesized by the Working Group on Integrated Assessments of the Baltic Sea (ICES, 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 IEA are multivariate analyses of time series of the physical, chemical and biological environment – including all trophic levels and biological diversity – as well as socio-economic factors and treats fish and fisheries as an integral part of the environment.

All seven sub-regions displayed pronounced structural changes (i.e. regime shifts, RS) in the last two to three decades, related to climate, fisheries and eutrophication. Regime shifts were identified in all multivariate datasets (Table 1.8.3.1). The major period of reorganisation in the Baltic sub-regions is at the end of the 1980 (mainly between 1987 and 1988). Several sub-regions (CBS, GoR, GoF, BoB) underwent structural change also during the middle of 1990s, probably related to the major inflow in 1993. Further, indications exist that a recent shift in ecosystem organization occurred in some sub-regions (CBS, GoF, Coast) in the early years of the present century.

The main drivers of the observed ecosystem changes vary somewhat between sub-regions, but they all include the increasing temperature and decreasing salinity (Figure 1.8.4). 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 1.8.4). 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 1.8.4).

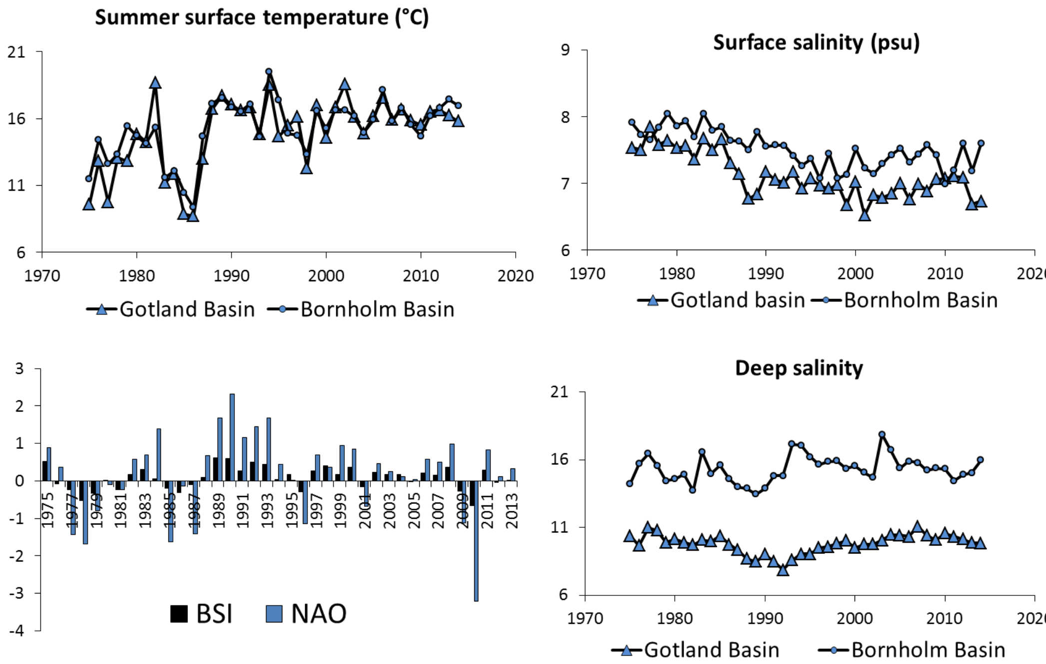


Figure 1.8.4. Time-series in summer surface temperature and surface salinity (top panels), BSI (Baltic Sea Index) and NAO (North Atlantic Oscillation index) and deep salinity (lower panel) in the Gotland Basin and Bornholm Basin.

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 areas, likely due to lack of strong water inflows from the North Sea and potentially increased biological oxygen consumption on seafloor.

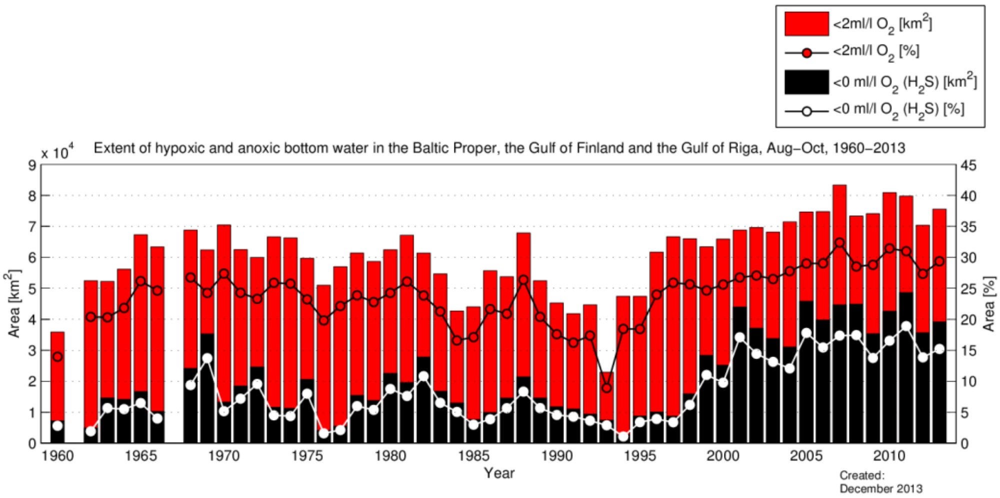


Figure 1.8.5. Time-series of anoxic and hypoxic seabed in the entire Baltic Proper.

Spatial considerations

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 1.8.6), 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 1.8.7), 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.

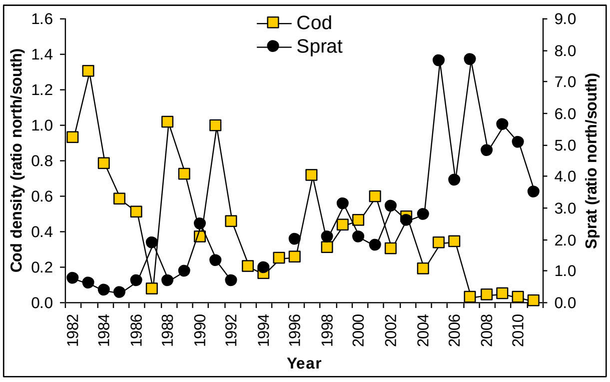


Figure 1.8.6. Ratio between sprat stock in northern Baltic Proper (SDs 27–29) and southern areas (SDs 25–26) as calculated by acoustic surveys, and ratio between cod stock in the northern Baltic Proper (SDs 27–28) and southern areas (SDs 25–26) from bottom trawl surveys. Modified from Casini *et al.* (2011).

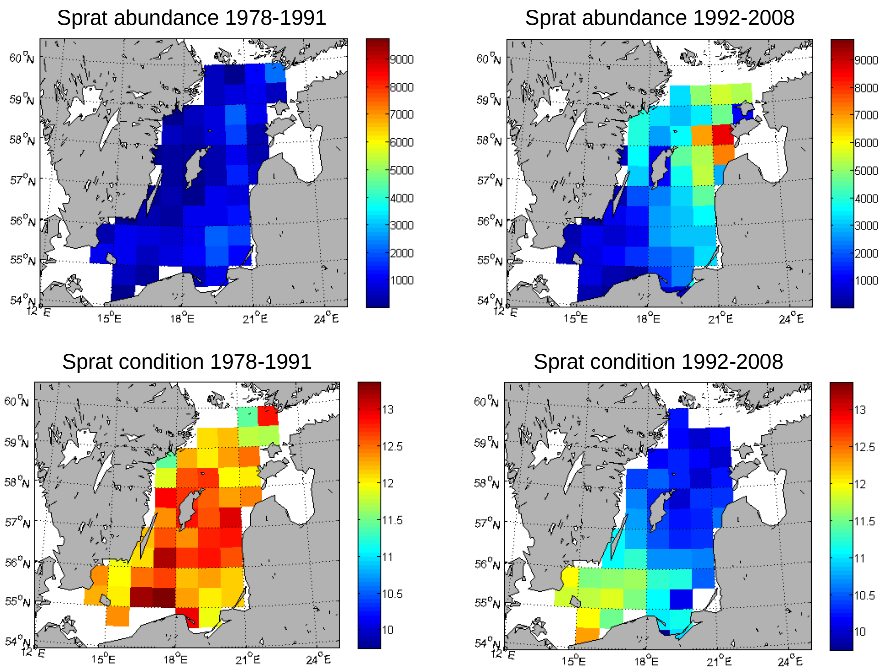


Figure 1.8.7. Spatial patterns in mean sprat abundance and clupeid condition in 1984–1991 and 1992–2008, from autumn acoustic survey. Only years with at least 10 individuals per rectangle were used in the condition calculation. From Casini *et al.* (2011).

The combination of an increasing cod stock and low abundance of sprat and herring in SD 25 (in the main distribution area of cod) has resulted in the lowest biomass of clupeids per cod currently available in this area since the 1970s. In line with low biomass of clupeids in the area, the mean weight of older cod (age-groups 4-7) in SD 25 has sharply declined since 2007 (Figure 1.8.8).

The importance of spatial consideration should therefore be increased in both stock assessment and advice. Accordingly, a new ICES Study Group on Spatial Analyses for the Baltic Sea (SGSPATIAL) has been formed and will meet in Lysekil (Sweden) for the first time in November 2012. For more information on spatial patterns and their importance for stock assessment and management can be found in Section 8 of this report.

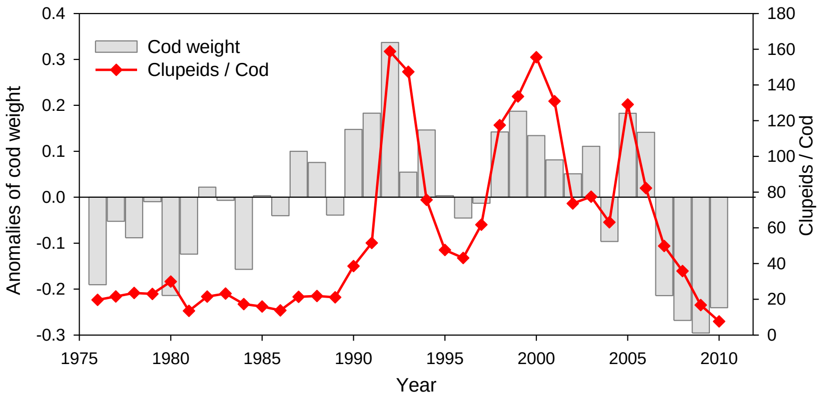


Figure 1.8.8. Anomalies in mean weight of cod (average of age-groups 4–7) in SD 25 (bars) compared to changes in the biomass of clupeids (sprat and herring) relative to the number of adult cod (at age 4 and older) in the same area (line) (Eero *et al.*, 2013).

1.8.4 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. Ecosystem changes have been considered in the following 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 (Section 6.2) and sprat stocks (Section 7) by using SMS estimates of natural mortality up to 2012 (WKBALT 2013).
- In previous assessments the influence of climatic factors on sprat recruitment has been considered in the sprat predictions. However, because the NAO index for February was not available to the working group, this was not possible in the short-term predictions made in 2008—2012.
- Sea surface temperatures and zooplankton abundance have been previously accounted for in the assessment of the Gulf of Riga herring, when estimating herring recruitment for the short term predictions. Other ecosystem aspects (as condition factor of the spawners) have been tested in 2012 to improve the predictive power, but need more analyses before being fully implemented in recruitment forecasts. Therefore, in 2013 a geometric from 1989 onwards was used in forecasts.

1.8.5 Ecosystem considerations in stock assessment and management

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 1.8.9.

Another important field of collaboration is to develop and update environmentally-sensitive stock-recruitment models of the Baltic Sea stocks to be potentially applied for example in the short-term predictions.

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 (WGIAB; ICES 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; ICES, 2013, Kroll *et al.* in prep.). The reference value of reproductive volume distinguishing positive from negative environmental influence on cod recruitment (Figure 1.8.9) was derived using the quantitative relationship between recruitment residuals and reproductive volume (ICES 2013).

The reproductive volume integrated across all three basins (Bornholm, Gdansk and Gotland) indicates poor abiotic conditions for cod recruitment of year-classes 2010–2011, in terms availability of oxygenated saline water allowing for cod egg survival (Figure 1.8.10). This suggest that the abundance of 2-year olds recruiting to the fishable stock in 2012 and 2013 will be less than expected from SSB alone.

WGBFAS and WGIAB will continue a close collaboration in the future. Specifically, WGIAB will provide updated ecosystem information that WGBFAS could use in the single stock assessment work, in the description of the stock status, and ultimately in management advices (see also Sections 1.8.5.1 and 1.8.6).

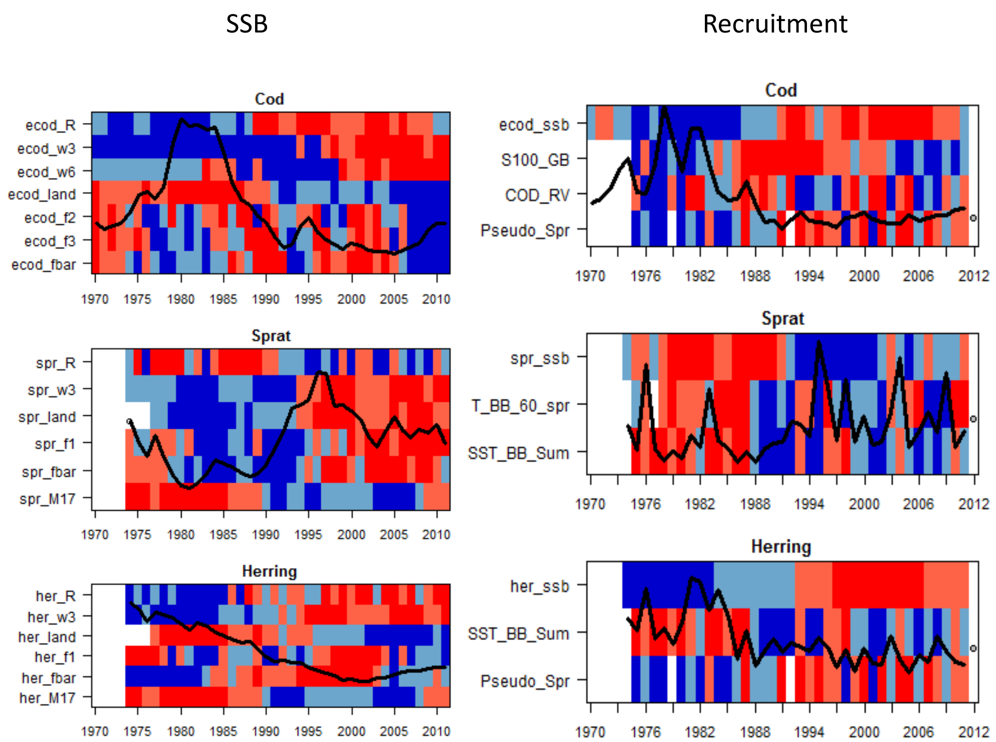


Figure 1.8.9. Temporal changes in indicators influencing the SSB and recruitment of the eastern Baltic cod, sprat and central Baltic herring. The colors refer to quartiles of the values observed in the time series, high values are marked with blue and low values with red colors, except for mortality where the colors 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).

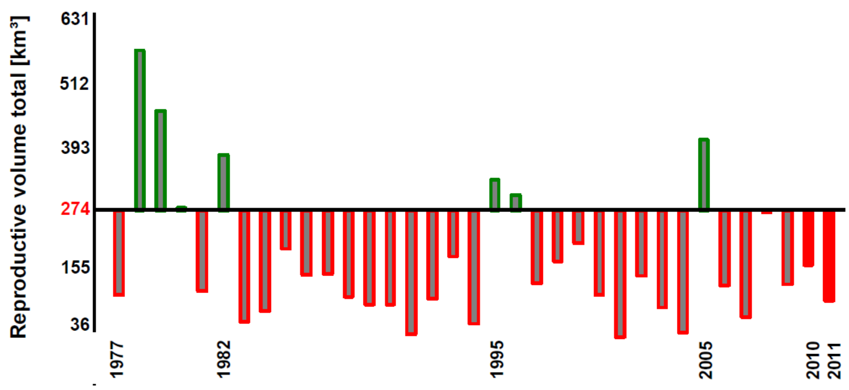


Figure 1.8.10. Time series of reproductive volume for Eastern Baltic cod (summed across the three deep basins in the Baltic Sea), assembled by WGIAB 2013 (ICES, 2013). Relationships between each variable and residuals from cod recruitment (backshifted) vs. cod SSB were derived during WGIAB (ICES, 2013, Kroll *et al.*, in preparation), 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).

1.8.6 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) **SGSPATIAL**: due to the large changes in the distribution of several Baltic Sea stocks, SGSPATIAL is suggested to continue carrying out analyses elucidating the reasons and the effects of these changes SGSPATIAL is also suggested to quantify the spatial overlaps between predator and prey and between competing species, for multispecies purposes.

1.9 Stock Overviews

In WGBFAS, a total of 3 cod stocks, 1 sole stock, 4 herring stocks, 1 sprat stock and 10 flatfish species, are considered. In 2014 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, sole in IIIa and sprat in SD 22—32, plaice in 21—23. Spawning stock trends are given for herring in SD 31, 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 2014, reported landings were below 100 t. The SSB has been at the historically lowest level since the late 1990s, an increase is however seen the last three years. The present level of fishing mortality is uncertain due to significant unallocated removals, which are considered to be both due to fisheries and biological issues. The recruitment in the last decade is well below the long-term historical 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. Recruitment is rather variable and the stock is highly dependent upon the strength of incoming year-classes, the last two year classes is estimated to be moderate good. The 2015 spawning stock biomass was estimated around 23 700 t (which is below Blim, 27 400 t). 2015 year class is estimated to average.

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 some migration of fish between areas and especially in SD 24 overlap between the two stocks are considered. Spawning is confined to the deep basins where egg survival depends on oxygen concentration in the deep saline water layer where fertilized eggs are neutrally buoyant. The total and spawning stock biomass increased by the end of the 1970s due to the extremely abundant year classes in 1976, 1977 and 1980 and favourable reproduction conditions in the southern and central Baltic Sea. The spawning stock declined from the historically highest level during 1982—1983 to the lowest level on record in 2004 and 2005. The decline of the stock was a result of an increase of the effort in the traditional bottom trawl fishery, introduction of gillnet fishery, and decreased egg and larval survival due to unfavourable oceanographic conditions (i. e., low oxygen concentrations for eggs and low food supply for larvae). Since the mid-1980s cod reproduction has only been successful in the southern spawning areas - Bornholm Basin and Slupsk Furrow. Recruitment has in later years been increasing as well as the spawning biomass. However, the condition of the cod has been decreasing since 2007 and is present at a historic low level. The decrease in growth for larger cod is likely caused by many factors such as a general decrease in food availability (benthos, pelagic fish and other food items) influenced by density dependence of cod, increased parasites induced by seals and increased anoxic areas. This resent change in growth has influenced the assumption of a stable catchability by age in the survey and has led to a rejection of the analytic assessment this year.

Sole in Division IIIa

The landings of Sole in Division IIIa and SD 22—24 fluctuated between 200 and 500 t annually prior to the mid-1980s. Landings increased to a maximum of 1400 t in 1993 and since then have decreased to less than 310 t in 2014 the lowest level since 1983. 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 behaviour 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 increased from ca. 920 t in 1984 to ca. 4800 t in 1992–1994. Since 1994 the SSB have decreased to be around $B_{trigger}$ (2000 t) and decreasing since 2005 and presently just above Blim. Fishing mortality stabilizing above F_{msy} (0.22) and below Fpa (0.47). Recruitment has been decreasing since 2008 with a historic low in 2014. The sole survey has been re-introduced in 2014 after not having being carried out in 2011 and 2013.

Plaice in 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 in 2014 indicates that discard in weight was close to 50% of the total catch. The SSB in the plaice stock has increased since 2009 and is in 2015 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 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. The average stock size indicator in the last two years (2013—2014) is close to 30% higher than the abundance indices in the three previous years (2010—2012). 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 50% in 2014.

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 2014). Flounder (*Platichthys flesus*) is the most widely distributed among all flatfish species in the Baltic Sea.

Flounder in 22–23

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 (2013—2014) is 86% higher than the biomass-indices in the three previous years (2010—2012).

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 24–25

This stock is the largest flounder stock in the Baltic. Flounder is taken as by-catch in demersal fisheries for cod and, to a minor extent, in a directed fishery. The quality of the catch data is poor due to the uncertainty of the discard estimates. The discard ratio in both subdivisions is different between countries, gear types and quarters. Discarding practices are controlled by factors such as market price and cod catches. Despite of high variability in the discard ratios, discard estimates for 2014 were used in this year's advice as sampling coverage increased compared to the previous years.

In the Subdivisions 24 and 25, Poland, Denmark and Germany are the main fishing nations. Polish contribution increased from the 90's together with increase of total landings, and was in recent years about 80%. Flounder landings in both Subdivisions are dominated by active gears, taking in average 70% of total landings.

Discards are considered to be substantial. SSB has been increasing (x3) over the recent period. As no reliable discard data is available the advice is given for landings only.

Flounder in 26 and 28

Flounder is taken as by-catch in demersal fisheries and, to a minor extent, in a directed fishery. The main countries landing flounder from Subdivisions 26 and 28 are Russia, Poland, Latvia and Lithuania. Denmark and Sweden discard most of their flounder catches. Discards are considered to be substantial, but can presently not be quantified.

The stock size indicator from surveys has been decreasing. The average stock size indicator in the last two years (2013—2014) is nearly 50% lower than the abundance indices in the three previous years (2010—2012).

Flounder in 27, 29–32

Flounder is taken both as bycatch in demersal fisheries and in a directed fishery. Landings mainly originate from passive gears such as gillnets. 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 (2014b) 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 clear trend is evident.

Dab in 22–32

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 3 fold. The survey index for 2014 is showing an increase compared to 2013.

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 growing to a relatively larger size has declined and during the last years the more northerly components - reaching a maximum size of only about 18—20 cm - are dominating in the landings. The latest stronger year-classes were the 2002, 2007 and 2011year-class, respectively. These year-classes are, however, just about the long-term average. The 2014 year class is estimated to be the second highest of the whole time series. The spawning stock size has shown an increasing trend, with minor fluctuations, since the beginning of the 1990´s. The present SSB estimate for 2014 is above the long-term average (1974—2014). 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 2013 estimatet to 0.16 and thereby well 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 66 000—118 000 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 Subdivision 30

The spawning stock of Bothnian Sea herring was at relatively low level of 100 000—150 000 t until the middle 1980s and has since the end of the 1990s showed an increase and has been above $MSYB_{trigger}$ since 1986. Although recruitment has been on average much higher during the high biomass period, favourable environmental conditions (i.e. warm summers in late 1980s, 1997, 2001, 2002, and 2006) have contributed to the production of abundant year classes. The 2006 year class is estimated to be almost as large as the 2002 year class that exceeded the earlier largest year classes by more than double, and at least consecutive year classes of 2008, 2009, and 2010 appear to be abundant, as well. In the biomasses from the acoustic surveys in 2007—2014, there is no trend in SSB, Z at age or change in the age diversity of the stock from the acoustic survey. This suggests that current exploitation does not impact the state of the stock. SSB is in 2014 estimated to be at similar high levels in the mid 80ies.

Herring in Subdivision 31

Herring in Subdivision 31 is the smallest herring stocks assessed by the WG. Only exploratory XSA run was conducted due to the unavailability of reliable data. The dynamics of the stock appear to be largely influenced by the environmental factors. The CPUE has had an increasing or stable trend in all fleets since 1980. In the same time, the trawling hours and trapnet effort have had a continuously decreasing trend. The weight at age has had a very similar development with herring in Subdivision 30. According to catch data, year classes 2007 and 2008 were particularly poor, but they are followed by abundant year classes of 2010, 2011 and 2012. The two latest year classes is estimated to be average

Sprat in Subdivisions 22–32

Sprat in Subdivisions 22–32 has been the largest stock assessed by this WG with a sable SSB around 1 mil. tonnes since 2004, however, in later years the herring stock has been estimated to be larger as the SSB has been declining from a historical high in the late 1990s. 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 1.7 million t. The stock size increased due to the combination of strong recruitments and declining natural mortality (effect of low cod biomass). In 2011 and 2012 F was below Fmsy, however in 2014 F has increased again to be above Fmsy and is now estimated to be 0.36. In 2016 the stock is predicted to increase to nearly 877 000 t if it is exploited at F_{sq}. The marked part of the sprat catches is taken in mixed sprat-herring fishery, and species composition of these catches is imprecise in some fishing areas /periods.

1.10 Recommendations

See Annex 2.

2 Cod

2.1 Cod in Subdivisions 25–32

2.1.1 The fishery

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

2.1.2 Landnings trends

National landings of cod from the eastern Baltic stock (Subdivisions 25–32) are given in Table 2.4.1 as provided by the Working Group members. The total landings in 2014 sum up to 28 908 t, the lowest value in the time series. Since 2009 the available TAC for Eastern Baltic cod is not taken. In 2012 69% of the TAC was taken, in 2013 46% was taken and in 2014 only 44% was taken. The reason for this could be low cod market price, decrease of fishing fleet in some countries due to vessel scraping, low abundance of fish above the minimum landing size (see below), and increased discards/high grading due to low fish quality i.e. low fish weight and condition.

The biomass of fishable cod in the stock, i.e. above the minimum landing size (MLS=38 cm), rule in force until 2014, has decreased and the biomass of fish below the minimum landing size has increased since 2010 (Figure 2.4.1a). The proportion of cod above MLS has largely decreased during the past 25 years, from ~80% in the early 1990 to ~25% in the last few years. In the last three years (2013—2015), this proportion has stabilized (Figure 2.4.1b). The decrease in the proportion of fish above MLS has likely been a consequence of decreased individual growth rate and relatively high recruitment the last 5 years. The reduced individual growth rate has also resulted in that age groups that were previously above the minimum landing size are now below it and not catchable by the industry. Based on the BITS survey, the biomass of cod above MLS is in 2015 approximately 27% in weight (12% in numbers). The low fishable biomass can partially explain the low quota uptake and the high abundance of cod just below the MLS can have contributed to the observed increased discarding.

From 2015, there is a discard ban for cod in the Baltic Sea, and thus no minimum landing size exists any longer, but a minimum conservation reference size (MCRS) became in force. The proportion of cod above MCRS (size under which cod cannot be sold for human consumption, MCRS = 35 cm), has also decreased during the past 25 years, although the trend was not as strong as for the MLS.

2.1.2.1 Unallocated landings

For 2014, similar to 2010—2013, information on unreported landings was not available and the Working Group was not in position to quantify them. Unallocated landings have been a significant problem during 1993—1996 and 2000—2007 when the reported catches have increased by 35—40%. Although, only some countries provided information on unreported landings, the EU fishery inspection evaluation report of catch registration in the Baltic Sea member states for 2005—2007 indicates that misreporting was applicable for all Baltic countries. 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.

The total landing by countries, sub-divisions and gears is shown in Table 2.4.2.

2.1.2.2 Discards

Discard estimates were included in the catch-at-age data for the assessment in order to give a better estimate of the true exploitation pattern of the fishery. Discard data for 2014 were available from all countries (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden). As no adjustments for misreporting in landings were made, no adjustments of the discards were made.

The total estimate of discards in 2014 in numbers is nearly 28 mill. (Table 2.4.3.a), which is double the amount for 2013 (14 mill) and the average 1996—2013 (12 mill). The doubling in discards in 2014 compared to 2013 might be explained by an increase in the number of undersized cod. But also nearly a million of marketable cod (however still below 5% of the total discard), most of them just above the legal landing size, were discarded (see table 2.4.4), possibly because they were very thin. Almost 93 % of discards in numbers is from active gears, the rest is from passive gears (i.e. gillnets). In 2014 the discard rate from active gears is significant higher than the long run trend (1996–2014), where the active gears constituted approximately 78% of the total discard. Table 2.4.3b gives the estimated discarded numbers by length class, quarter, Subdivision and gear. The most abundant length class discarded in 2014 was length class 30-37 cm (85%) followed by length classes 25—29 cm and 38-44 cm 4 (11% and 3%, respectively) (Table 2.4.4). Tables 2.4.4 and 2.4.5 give a comparison between landings and discards numbers by length class for the year 2014. Tables 2.4.6a and 2.4.6b give the estimated mean weight per length class in the discards and the discarded biomass by length class for the year 2014. The total discarded weight of cod in 2014 is over 9 600 t, representing 25% of total catches in tonnes or 41% in numbers, respectively.

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 general low sampling intensity, of particularly passive gears, and thus large uncertainties in the estimates.

All data for landings and discards were uploaded and processed in InterCatch. When biological information were not available for a given fleet segment, area and quarter adjacent information were borrowed. An overview of from what segments data were borrowed for a segment with missing information can be found in Tables 2.4.7a and 2.4.7b.

2.1.2.3 Effort and CPUE data

Stock assessment in the WG 2015, as on the WG 2014, was based on trends from BITS surveys (see section 2.1.4 below) and therefore no data on effort and commercial CPUEs were available.

2.1.3 Biological composition of catch

2.1.3.1 Length composition

Estimated length distributions in the landings by Subdivision, Quarter and gear (trawl and gillnet) were provided by all countries. The length composition extrapolation procedure for strata that has no biological information is given in Stock Annex. The length composition data were applied to the national landings. Table 2.4.8a shows the catch in numbers by length class, quarter, sub-division and gear, while Table 2.4.8b gives the mean weight in the catches by length class, quarter and sub-division.

There are long-standing problems with ageing inconsistencies in this stock. These were illustrated by analysis of survey age-length keys in Section 2.4.6.1 in the 2004 WG Report (ICES CM 2004/ACFM:22) concluding that there are substantial differences in age-determination for fish from the same Sub-division and year. The analysis indicated that there is variation between nations within year, and they differ between years. It was concluded that the age-reading inconsistencies are highly complex, and that their classification into two 'schools' of age-reading approaches (e.g. Reeves, 2003) represents a substantial oversimplification of the actual situation.

Further analyses during the Benchmark WKBALTCOD 2015 indicated high incongruence between and within readers. Therefore, length-based models or age-based models including ageing errors have been tested at the WKBALTCOD 2015 and WGBFAS 2015. The group however judged these attempts still preliminary and decided also this year to provide advice based on BITS survey trends (see section 2.1.4 below).

2.1.3.2 Quality of catch and biological information

There have previously been problems with catch misreporting for this stock. At present, it is believed that the misreporting is very little due to the quota situation. In previous years, before 2009, the WG has attempted to correct for the misreporting by applying raising factors to national catches based on the available information on misreporting by each national fleet. See previous WG reports for further explanations and details. Like for the previous two years, no correction for misreporting was done this year.

As in WGBFAS 2013 and 2014, also in 2015 the input data were prepared solely using InterCatch, whereas previously the different countries have reported national biological information by using InterCatch, "Yellow sheets", or FishFrame. 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—2015 and the data compiled in previous years.

In 2014 and 2015 the analytic assessment of the eastern Baltic cod stock was not accepted by the WG. The reason for the rejection was due to a very large inconsistency in data, a pattern that has become more and more evident in last years. The challenges are likely not related to the lack of data or wrong model, but the biology and ecosystem changes occurred in the central Baltic with large effects on the Eastern Baltic cod stock.

One of the aspects that have been evident in later years is the decreased individual growth and condition of older cod. The reason for the decreased growth is still not clear, but increased extent of anoxic areas, change in the bottom fauna, larger interspecific competition in the main cod distribution area and increased level of seal parasites could be some of the explanations. These changes may also have affected cod natural mortality, even though this aspect has not been studied so far.

A decrease in growth could further imply that selectivity has changed in the tuning fleets were selectivity could have decreased for the younger age classes in the commercial fleet (cod is so slim they are getting through the cod end) and at the same time an increase in selectivity for the older fish in the scientific surveys (the larger cod are now caught better, with the fine mesh size in the BITS).

Furthermore, there are indications that the decrease in growth have led to that otoliths have become more difficult to read and there is now more discrepancy between countries age readings.

2.1.4 Stock trends from BITS survey

An index of SSB was produced using the combined time-series of BITS Q1 and Q4 surveys. CPUE (No./h) per length-class from the DATRAS database was used to estimate the total CPUE (No./h) of fish >= 30 cm, which corresponds to L_{50} (length at which 50% of the individuals are mature), separately for each Quarter and SD (SDs 25 to 28). Thereafter, CPUE in weight (Kg/h) of the fish >= 30 was estimated by Quarter and SD using the quarter-specific length-weight relationships from the DATRAS database. Mean CPUE (Kg/h) for Q1 and Q4 for the whole stock were thereafter obtained by using SD-specific area as weighting. The CPUEs (Kg/h) from Q1 and Q4 were then averaged (Q1 raw and Q4 shifted 1 year ahead) to produce an index of SSB from 2003 to 2015 (Figure 2.4.2).

After a steep increase between 2005 and 2010, the SSB index abruptly decreased between 2011 and 2013, and remained nearly constant since then, with an average of 138 Kg/h. In 2015, SSB proxy increased by 11%, from 126 to 140 Kg/h. The average CPUE of the last two years (2014-2015) was 38 % lower than the average CPUE of the previous three years (2011-2013).

Time-series of harvest rates between 2003 and 2014 were created as ratio between catches and SSB index (Figure 2.4.3). The harvest rate was the highest in 2004, followed by a drop. Between 2009—2011 the harvest rate was nearly constant, while thereafter an increase has occurred, although keeping at relatively low levels. Between 2013 and 2014 the increase was of 22%. The average harvest rate of the last two years (2013—2014) was 33 % higher than the average harvest rate of the previous three years (2010—2012).

Due to problems in the analytical stock assessment that were neither solved at the Benchmark 2015 WKBALTCOD nor at the WGBFAS 2015, the SSB index from BITS surveys and the harvest rate were used to provide advice also this year, following the ICES approach for data limited stocks.

The Eastern Baltic cod stock is still concentrated in the southern part of the stock area (mainly SD 25 and at a less extent SD 26) and (Figure 2.4.4), and mixing with the Western Baltic cod stock also occurs in SD 24 (Benchmark WKBALTCOD 2015).

2.1.5 Exploratory analytical assessment runs

A number of analytical assessments methods were tested for this stock, both during the Benchmark WKBALTCOD 2015 and the WGBFAS 2015. Here a short summary of the results is presented. For longer explanations see the WKBALTCOD 2015 report.

Stock Synthesis (SS3)

Stock Synthesis (SS3) provides a statistical framework for calibration of a population dynamics model using a diversity of fishery and survey data. It is designed to accommodate both age and size structure in the population and with multiple stock sub-areas. Selectivity can be cast as age specific only, size-specific in the observations only, or size-specific with the ability to capture the major effect of size-specific survivorship. The overall model contains subcomponents which simulate the population dynamics of the stock and fisheries, derive the expected values for the various observed data, and quantify the magnitude of difference between observed and expected data. Some SS features include growth estimation, spawner-recruitment relationship, movement between areas. SS is most flexible in its ability to utilize a wide diversity of age, size, and aggregate data from fisheries and surveys.

Four different model runs were performed with SS3. One base run was made where natural mortality was related to cod condition (see WKBALTCOD 2015 for details on other assumed model settings). A second run with the same settings except that the natural mortality was higher compared to the base run as it was assumed that mortality was dependent on rate of parasite infection. A third run was with the traditional natural mortality of 0.2 except for ages 0 and 1 where it was assumed that natural mortality was the same as in the rest of the models. The forth run was with a new assumed growth (with mortality as in run 2) decline based on periods compared to the previous assumed growth that was calculated on cohort.

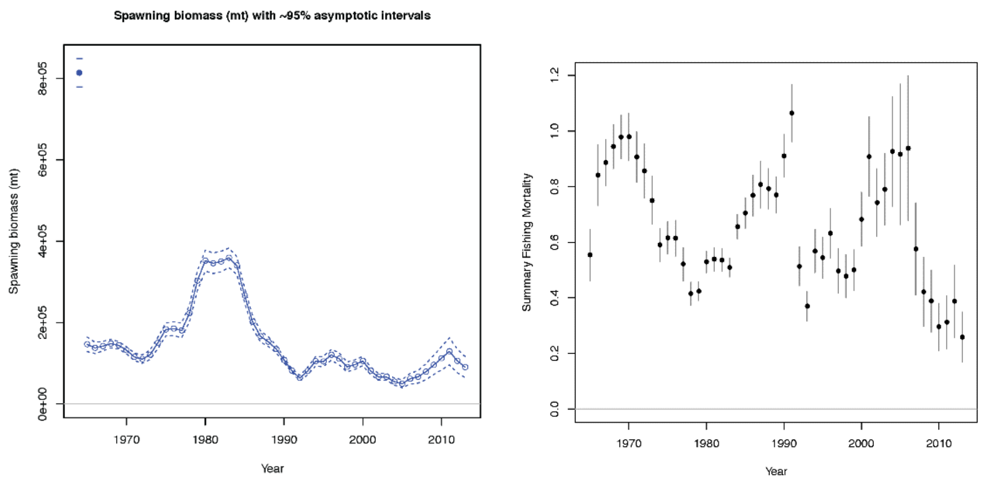


Figure 2.4.5. Cod in SD 25–32. The development of Eastern Baltic cod SSB and fishing mortality based on the settings in base model.

All but the third models resulted in a god fit. The third model where natural mortality was assumed to be 0.2 gave unrealistic high SSB and an extremely high F. The third model was therefore not considered valid and not discussed further. The rest of the models showed a similar pattern in SSB and F. SSB ranged between 140 to 190 thousand tonnes whereas F ranged from 0.19—0.30 (Figure 2.4.5). The retrospective pattern was also very good for all of these models.

CSA model (Collie & Sissenwine, 1983)

In the CSA the stock numbers are modelled as

$$\boldsymbol{N_{t+1} = (N_t - C_t + R_t)\, exp(-M)}$$

where

N – abundance,

C – catch in numbers,

R – recruitment,

M – natural mortality.

The Collie-Sissenwine Analysis (CSA) (Collie and Sissenwine, 1983) was implemented from NOAA toolbox (http://nft.nefsc.noaa.gov/Download.html). This is two-stage stock assessment model, which allows dividing the population into recruits and post-recruits. The model was fitted to 2001-2014 data on total catches in numbers and BITS estimates of stock size. In the CSA to convert numbers into biomasses, time series of mean weight in the recruit and post-recruit part of the stock as well as in the catches were used. CV of catch numbers and survey indices were taken as 0.1, and 0.3, respectively. The analyses including Markov Chain Monte Carlo were performed with 2000 iterations.

Three approaches of the CSA model based on length distribution were implemented. In the age-based assessment performed by WGBFAS in the previous years, age 2 was assumed as recruits. To distinguish between recruits and post-recruits in the CSA the age-length relationship from SS3 model was applied. The two values for each age were provided: the beginning and the middle of length range. For the age 2 the beginning size was 26 and middle 29, whereas for age 3 – 33 and 36 cm, respectively. In addition, based on the knowledge about growth rate of the cod, the 10 cm length range for recruits was assumed, while post-recruits were presume as equal and longer than 38 cm.

Thus, three options for length range of recruits and post-recruits were used;

n	recruits [cm]	Post-recruits [cm]
1	26-32	33+
2	29-35	36+
3	28-37	38+

For all three options, the effects of different natural mortalities were investigated; first included corrections of M due to low cod condition, and in the second M corrections for both fish condition and mortality caused by parasites infection (in the last 4 years) were implemented. In CSA M for both recruits and post-recruits must be the same, so to obtain one value per year mean M was estimated as weighted by CPUE for each length range.

The method is very sensitive to the assumption of length range for recruits and post-recruits. We could get biomass from 60 to 400 thousand tons, depending on these assumptions. The runs including M due to parasite infection in 2011-2014 were always slightly better fitted to the data (lower negative log likelihood and smaller residuals) than the runs without this correction. The best fitted run (26-32 cm recruits, 33cm + post-recruits with M condition + M parasites) gave the broadest confidence ranges, which was not expected. Even if some of the assumed length ranges differed only by a few cm, the respective BITS stock numbers and catches were quite different as most cod are now in smaller length classes.

SAM with ageing errors

During the benchmark WKBALTCOD 2015 a modified SAM integrating ageing error was developed and investigated. The model applies an error matrix on the predicted NAA vector, after which the prediction is compared to the CANUM and survey data. The parameters of the error matrix are estimated by SAM and their value is part of the model output. During the benchmark, the fit of five different models against 2014 years data (i.e. data until 2013) were compared. The data included a Danish commercial fleet, the BITS surveys in quarter 4, and BITS in quarter 1. The latter survey index was split between 2000/2001 due to a change in gear and the need to have independent estimation of catchabilities. The models fitted were a single probability model (SP), a double probability model (DP) and a binomial model (BM). The error matrix was applied to the entire assessment period, and with the DP and the DB model also from 2007 an onwards. The reason was increasing differences in the ALKs of Sweden, Denmark and Poland (Eero et al. in prep).

The best fit was gained with the DP model applied to the entire data set. The error function of this model is described by two probabilities, p is the probability of correctly identifying an annulus, and q is the probability of identifying a false band as an annulus. This model was inspired by studies on the reading of otoliths of the EBC, which reveals that cod lay down more bands than those created by seasonal changes. The estimated values of the reading errors were p=0.71 and q=0.16, which means that on average is 29% of the annuli not identified, and partly compensated by on average 16% of false bands being recognised as annuli. This indicates that the fish are on average under-aged by the readers.

For the actual assessment with the updated data 2015, it was decided to go forward with the DP model but without the commercial Danish fleet. It was also decided that survey and catch data should be recalculated with the Swedish age-length key in order to minimize the ageing error. Two runs with ageing errors were run, one from 2007 and one from 1966 and compared with the model without ageing errors. The estimated ageing errors are smaller for this data than for the data used at the benchmark when the all countries' ALKs were applied: p=0.95, q=0.07 for AE from 2007, and p=0.92 and q=0.10 for AE from 1966. This suggests that the AE is on average smaller during 2007-2014, than during 1966—2014. In contrast, the difference between the Swedish, Danish and Polish ALKs was larger after 2007 (Eero et al. in prep.). The contrasting results could possibly be explained by the fact that the differences in growth rates have increased between different areas and therefore landed by different countries. The changes in SSB due to AE are within the confidence interval of the run without AE (Figure 2.4.6). Note that the WAA matrix has not been corrected for AE in the calculation of SSB. The models with AE exhibit larger inter-annual variation in $F_{4\text{-}6}$ and number of recruits, and more so in the model with AE applied from 1966 (Figure 2.4.6). It is known that assessment models with AE are able to accentuate the cohorts (Punt *et al*., 2008). The number of recruits is higher for those periods the AE is applied, and hence differ between the two AE-models. The AE models do also exhibit a somewhat higher F (Figure 2.4.6). This must be interpreted as a changed tuning effect by the survey data in favor of higher F, at the same time the AE model has found a higher number of fish (not presented here).

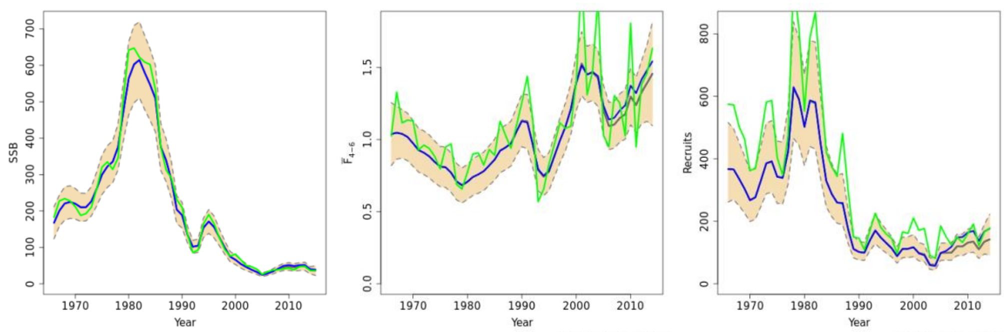


Figure 2.4.6. Cod in SD 25–32. Sam output, from left to right: SSB, $F_{4\text{-}6}$, and R, for models without ageing error (AE; black line), with AE from 2007 (blue line), with AE from 1966 (green line).

The Fs estimated by SAM with AE are for ages 4 and 5 in-between the Fs calculated from the survey indexes (Table 2.4.9). For the model with AE from 1966 this is true also for age 3. A problem for the assessment is the totally different profiles of the F-at-age between the two survey indexes. BITS Q1 is more even, whereas BITS Q4 exhibits a steep increase with age. The age intervals for the BITS are 2-6 for Q1 and 2-5 for Q4. The assessment of *F* has a marked threshold effect for ages 4-7 because it is based on changes between ages and that we lose tuning data with increasing age. For this reason we linked F for ages 5+ to the same parameter in the model with AE from 1966. Given the Fs shown in the tuning fleets, the Fs estimated by SAM are very understandable.

One reason for not accepting the SAM assessment in 2014 was the retrospective pattern. For the model with AE from 1966, the retrospective pattern for SSB shows a small overestimation. Fbar shows large stochastic pattern, whereas the recruitment is very reasonable (EBC_2015_SALK_DPAEfrom1900 in www.stockassessment.org). The model with AE from 2007 exhibits SSB, Fbar and recruits outside the confidence interval when the data is truncated 3 years or more (EBC_2015_SALK_DPAEfrom2007).

Table 2.4.9 Fishing mortalities (*F*) 2014 estimated from SAM without ageing errors (AE), with AE applied from 2007 and onwards, and with AE applied on the entire assessment period (from 1966). The last two rows in each subsection depict the calculated *F* from the surveys used in the assessment, *F=Z-M*, where *M* is the natural mortality used as model input. The Z value has been calculated taking into account the estimated catchabilities of SAM: Z=-ln(($s_{y+1,a+1}/q_{a+1}$)/($s_{y,a}/q_a$)), where $s_{y,a}$ is the survey index for year *y* and age *a*, and q_a is the catchability of age *a*. The values of BITS Q4 have been shifted to an older age since it represents the largest part of the mortality period.

Model/Survey	F2	F3	F4	F5	F6
SAM No AE	0.08	0.71	1.55	1.70	1.12
BITS Q1 2014	0.11	1.21	1.51	0.72	
BITS Q4 2013		1.05	2.07	3.16	
SAM AE from 2007	0.14	0.80	1.64	1.86	1.14
BITS Q1 2014	-0.05	1.24	1.46	0.72	
BITS Q4 2013		0.86	1.94	3.16	
SAM AE from 1966	0.16	0.86	1.52	1.69*	
BITS Q1 2014	-0.26	1.30	1.18	0.72	
BITS Q4 2013		0.50	1.62	3.16	

*F5+, i.e. F is the same parameter for ages 5 and older

Comparison of the outputs of the different assessment models

At the WKBALTCOD (2015), four model types were assumed to be most relevant for exploring the exploitation of Eastern Baltic cod. They included the traditional SAM model but based on a catch matrix based on a Swedish age-length key. The second model was a SAM model, based on a catch matrix based on a Swedish age-length-key but with an ageing error (double probability). The third model was stock synthesis (SS3) with different natural mortalities and growth parameters of and lastly the fourth model a production model (CSA).

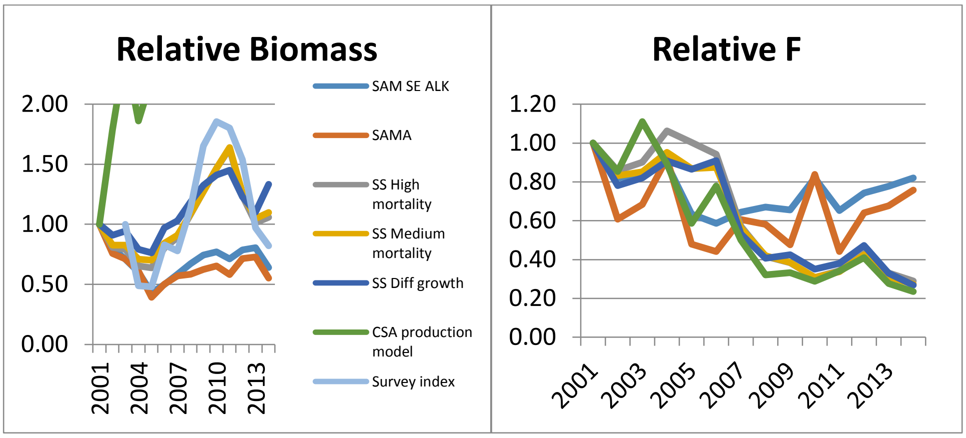


Figure 2.4.7. Cod in SD 25–32. Left panel: The relative SSB for different assessment models and with the SSB index. Right panel: the relative fishing mortalities for the different assessment models. SS denotes stock synthesis model; SAM denotes the SAM model and CSA is the production model. Note that the production model describes adult biomass and the other models describe SSB.

All these models, which relay on different model assumptions, produce different exploitation rates and stock biomasses. The relative development of SSB and F is not that different between the model types (see Figure 2.4.7), including the survey index, but the absolute values are very different. The SAM models suggest that SSB is around 40 thousand tonnes and with an F over 1.5. The SS models suggest that SSB is 140 to 190 thousand tones whereas F ranged from 0.19—0.30. This makes it hard to decide what model to trust even though the diagnostics is generally better for the SS models compared to the SAM models.

2.1.6 Reference points and Management Plans

Limit reference points

As there is no accepted analytical assessment for this stock and because part of stock is distributed in the western Baltic area, the earlier estimated reference points are no longer considered relevant for this stock. There are presently no reference points estimated for eastern Baltic cod.

Evaluation of a Multi-annual plan for the Baltic cod stocks

Based on the fact that there is no analytical assessment and because the western Baltic stock has been split into a western and eastern part in SD 24, the stock cannot be evaluated against the multi-annual management plan.

2.1.7 Quality of the analytical assessment

The WG has previously noted the following problems in relation to the input data for the analytical assessment of this stock. These have prevented the WG to provide analytical assessment in 2014 and 2015.

Large inconsistencies exist in age determinations for the eastern Baltic cod stock owing to the lack of clear growth rings in the otoliths.

Mixing of the eastern and western Baltic cod stocks is considered to have increased in recent years. This mixing has been quantified at the Benchmark (WKBALTCOD 2015), and is now applied to split the catches in SD 24 into Western and Eastern Baltic cod stocks.

The strong decrease of the growth has likely affected the catchability of the BITS surveys.

There have been changes in management regions, closed seasons and areas and gear regulations in recent years, which may have led to changes in exploitation pattern including discard practice.

The following investigations could be proposed:

1) Tagging studies could help with both the migration and ageing issues.

2) Survey indices: if there is a trend in catchability, there is a need to revise both the survey indices and the indices derived from the commercial tuning fleet.

3) Analysis of the rapid decrease in the abundance of larger and older cod in recent years and to determine if these individuals are dying of natural causes (low condition, anoxia, parasites) or if they are dying by fishing.

4) Determine what factors affects cod growth/condition and their effect on maturity and fecundity.

5) Model adjustments: How can the above problems be incorporated into the model.

2.1.8 Management considerations

The present distribution pattern of cod, sprat and herring (cod mainly concentrated in Subdivision 25 and 26, and clupeids in the more northern Subdivisions) (Figure 2.4.8), 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. However, under this scenario, cod cannibalism would likely be higher, and limited growth of cod due to food deprivation a bigger problem. On the other hand, a reduction of clupeid F in Subdivision 25 will likely improve growth and condition of cod as well as reduce cannibalism. An increase in clupeid F in northern areas (SDs 27—32) will not have a negative effect on cod, since this will not affect the main stock component, which is distributed in southern areas (SDs 25—26). Further, a higher F on clupeids in northern areas would likely reduce density dependence among clupeids and improve the growth and condition of both sprat and herring individuals.

Consistent with an increasing cod stock and a declining availability of sprat and herring in the current main distribution area of cod (Subdivision 25, and Subdivision 26), the mean weight of larger cod has sharply declined in recent years. However, there are also other possibilities for the decline in growth including overall density dependent growth, reduced availability of benthic invertebrates and large extent of anoxic areas (Benchmark WKBALTCOD 2015). There is also evidence that cod is cannibalistic but this is also dependent on cod stock size and size distribution and less likely now when there are few larger cod present in the stock.

2.1.9 References

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Table 2.4.1 Cod in SD 25-32. Total landings (tons) by country.

Year	Denmark	Estonia	Finland	German Dem.Rep.[2]	Germany Fed. Rep.	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands[4]	Norway	Unallocated[3]	Total
1965	35 313		23	10 680	15 713			41 498		21 705	22 420				147 352
1966	37 070		26	10 589	12 831			56 007		22 525	38 270				177 318
1967	39 105		27	21 027	12 941			56 003		23 363	42 980				195 446
1968	44 109		70	24 478	16 833			63 245		24 008	43 610				216 353
1969	44 061		58	25 979	17 432			60 749		22 301	41 580				212 160
1970	42 392		70	18 099	19 444			68 440		17 756	32 250				198 451
1971	46 831		53	10 977	16 248			54 151		15 670	20 910				164 840
1972	34 072		76	4 055	3 203			57 093		15 194	30 140				143 833
1973	35 455		95	6 034	14 973			49 790		16 734	20 083				143 164
1974	32 028		160	2 517	11 831			48 650		14 498	38 131				147 815
1975	39 043		298	8 700	11 968			69 318		16 033	49 289				194 649
1976	47 412		287	3 970	13 733			70 466		18 388	49 047				203 303
1977	44 400		310	7 519	19 120			47 702		16 061	29 680				164 792
1978	30 266		1 437	2 260	4 270			64 113		14 463	37 200				154 009
1979	34 350		2 938	1 403	9 777			79 754		20 593	75 034	3 850			227 699
1980	49 704		5 962	1 826	11 750			123 486		29 291	124 350	1 250			347 619
1981	68 521		5 681	1 277	7 021			120 901		37 730	87 746	2 765			331 642
1982	71 151		8 126	753	13 800			92 541		38 475	86 906	4 300			316 052
1983	84 406		8 927	1 424	15 894			76 474		46 710	92 248	6 065			332 148
1984	90 089		9 358	1 793	30 483			93 429		59 685	100 761	6 354			391 952
1985	83 527		7 224	1 215	26 275			63 260		49 565	78 127	5 890			315 083
1986	81 521		5 633	181	19 520			43 236		45 723	52 148	4 596			252 558
1987	68 881		3 007	218	14 560			32 667		42 978	39 203	5 567			207 081
1988	60 436		2 904	2	14 078			33 351		48 964	28 137	6 915			194 787
1989	57 240		2 254	3	12 844			36 855		50 740	14 722	4 520			179 178
1990	47 394		1 731		4 691			32 028		50 683	13 461	3 558			153 546
1991	39 792	1 810	1 711		6 564	2 627	1 865	25 748	3 299	36 490		2 611			122 517

Year	Denmark	Estonia	Finland	German	Germany	Latvia	Lithuania	Poland	Russia	Sweden	USSR	Faroe Islands[4]	Norway	Unallocated[3]	Total
				Dem.Rep.[2]	Fed. Rep.										
1992	18 025	1 368	485		2 793	1 250	1 266	13 314	1 793	13 995		593			54 882
1993	8 000	70	225		1 042	1 333	605	8 909	892	10 099		558		18 978	50 711
1994	9 901	952	594		3 056	2 831	1 887	14 335	1 257	21 264		779		44 000	100 856
1995	16 895	1 049	1 729		5 496	6 638	4 513	25 000	1 612	24 723		777	293	18 993	107 718
1996	17 549	1 338	3 089		7 340	8 709	5 524	34 855	3 306	30 669		706	289	10 815	124 189
1997	9 776	1 414	1 536		5 215	6 187	4 601	31 396	2 803	25 072		600			88 600
1998	7 818	1 188	1 026		1 270	7 765	4 176	25 155	4 599	14 431					67 428
1999	12 170	1 052	1 456		2 215	6 889	4 371	25 920	5 202	13 720					72 995
2000	9 715	604	1 648		1 508	6 196	5 165	21 194	4 231	15 910				23 118	89 289
2001	9 580	765	1 526		2 159	6 252	3 137	21 346	5 032	17 854				23 677	91 328
2002	7 831	37	1 526		1 445	4 796	3 137	15 106	3 793	12 507				17 562	67 740
2003	7 655	591	1 092		1 354	3 493	2 767	15 374	3 707	11 297				22 147	69 476
2004	7 394	1 192	859		2 659	4 835	2 041	14 582	3 410	12 043				19 563	68 578
2005	7 270	833	278		2 339	3 513	2 988	11 669	3 411	7 740				14 991	55 032
2006	9 766	616	427		2 025	3 980	3 200	14 290	3 719	9 672				17 836	65 532
2007	7 280	877	615		1 529	3 996	2 486	8 599	3 383	9 660				12 418	50 843
2008	7 374	841	670		2 341	3 990	2 835	8 721	3 888	8 901				2 673	42 235
2009	8 295	623			3 665	4 588	2 789	10 625	4 482	10 182				3 189	48 439
2010	10 739	796	826		3 908	5 001	3 140	11 433	4 264	10 169					50 277
2011	10 842	1 180	958		3 054	4 916	3 017	11 348	5 022	10 031					50 368
2012	12 102	686	1 405		2 432	4 269	2 261	14 007	3 954	10 109					51 225
2013	6 052	249	399		541	2 441	1 744	11 760	2 870	5 299					31 355
2014[1]	6 035	166	350		676	1 999	1 088	11 026	3 444	4 125					28 908

1) Provisional data.

2) Includes landings from Oct.-Dec. 1990 of Fed.Rep.Germany.

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

4) For 1997 landings not officially reported estimated by the WG.

Table 2.4.2 Cod in SD 25-32. Total landings (t) by Subdivision, fleet and country in 2014.

Year:	2014		Fleet:	Active and passive gears combined					
Sub-div.	25	26	27	28	29	30	31	32	25-32
Country:									
Denmark	5 631	404	-	-	-	-	-	-	6 035
Estonia	94	64	-	2	2	-	-	3	166
Finland	66	276	-	-	7	0	0	0	350
Germany	676	-	-	-	-	-	-	-	676
Latvia	317	1 505	-	178	-	-	-	-	1 999
Lithuania	52	1 036	-	-	-	-	-	-	1 088
Poland	7 197	3 829	-	-	0	-	-	-	11 026
Russia	-	3 444	-	-	-	-	-	-	3 444
Sweden	3 274	749	26	2	73	1	-	-	4 125
Total	17 307	11 306	26	182	82	1	0	3	28 908

Year:	2014		Fleet:	Active gears					
Sub-div.	25	26	27	28	29	30	31	32	25-32
Country:									
Denmark	5 425	385	-	-	-			-	5 810
Estonia	94	64	-	0	0			0	158
Finland	66	276	-	-	-			-	342
Germany	676	-	-	-	-	0		-	676
Latvia	301	909	-	84	-			-	1 295
Lithuania	52	774	-	-	-			-	826
Poland	4 517	3 113	-	-	-			-	7 630
Russia	-	3 077	-	-	-			-	3 077
Sweden	2 644	749	0	0	-			-	3 394
Total	13 776	9 347	0	84	0	0		0	23 208

Year:	2014		Fleet:	Passive gears					
Sub-div.	25	26	27	28	29	30	31	32	25-32
Country:									
Denmark	205	20	-	-	-	-	-	-	225
Estonia	-	-	-	2	2	-	-	3	8
Finland	-	-	-	-	7	0	0	0	7
Germany	-	-	-	-	-	-	-	-	-
Latvia	15	595	-	94	-	-	-	-	704
Lithuania	-	261	-	-	-	-	-	-	261
Poland	2 680	715	-	-	0	-	-	-	3 396
Russia	-	367	-	-	-	-	-	-	367
Sweden	630	0	26	2	73	1	-	-	731
Total	3 531	1 959	26	98	82	1	0	3	5 700

Table 2.4.3a Cod in SD 25-32. Discard (in numbers ('000)) by gear type and year.

Stock	25-32																		
Gear	Year																		
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Passive gear	2037	2255	12772	865	14471	1920	1283	3933	1349	799	2786	496	2452	1244	1595	584	268	1132	1836
Active gear	5318	15325	9565	21314	8822	9008	5841	4315	2324	4396	9937	10562	6275	7538	7482	9367	18367	12688	26027
Grand Total	7355	17580	22337	22179	23293	10929	7125	8248	3673	5195	12722	11058	8728	8782	9078	9950	18635	13820	27864

Table 2.4.3b Cod 25-32. Estimated numbers (10*3) discard by length class, quarter and subdivision

Stock	COD-2532																							
Year	2014																							
CatchCategory	Discards																							
		BAL25		BAL25 Total	BAL26		BAL26 Total	BAL27		BAL27 Total	BAL28		BAL28 Total	BAL29		BAL29 Total	BAL30	BAL30 Total	BAL31	BAL31 Total	BAL32		BAL32 Total	Total
Quarter	LengthClass	Active	Passive		Active	Passive		Active	Passive		Active	Passive		Active	Passive		Passive		Passive		Active	Passive		
1	10-14	0		0																				0
	15-19							0		0	0		0											0
	20-24	47	14	61	10	7	17	0	0	0	0	0	0	0	1	1						0	0	79
	25-29	508	30	538	75	19	93	0	0	0	0	0	0	0	3	3						0	0	634
	30-37	4,613	65	4,678	556	43	599	0	0	0	0	0	1	0	3	3						0	0	5,281
	38-44	132	2	133	30	3	33	0	0	0	0	0	0	0	2	2						0	0	168
	45-49	0	0	0	0	1	2		0	0		0	0		0	0						0	0	2
	50-54		0	0		0	0					0	0		0	0								0
	55-59					0	0					0	0		0	0								0
	60-64								0	0		0	0		0	0								0
2	10-14	0		0																				0
	15-19							0		0	0		0											0
	20-24	63	35	98	86	7	94	0	0	0	1	0	1		5	5	0	0	0	0		0	0	198
	25-29	784	69	853	484	21	505	0	0	0	6	0	6		17	17	0	0	0	0	0	0	0	1,382
	30-37	5,947	154	6,101	3,272	47	3,319	0	1	1	26	1	27		21	21	0	0	0	0	0	0	0	9,469
	38-44	250	1	250	251	4	254	0	0	0	3	0	3		10	10	0	0	0	0	0	0	0	518
	45-49	5	0	5	4	2	5		0	0		0	0		2	2	0	0	0	0		0	0	13
	50-54		0	0		0	0		0	0		0	0		0	0	0	0				0	0	0
	55-59					0	0		0	0		0	0		0	0	0	0				0	0	0
	60-64								0	0		0	0		0	0	0	0				0	0	0
3	15-19	0	1	1	5	0	6				0		0											7
	20-24	10	7	17	10	12	22		0	0	3	1	3		3	3	0	0				0	0	45
	25-29	298	50	348	42	28	70		0	0	14	3	17		10	10	0	0				0	0	444

	30-37	4,437	184	4,621	232	52	284		0	0	64	3	67		11	11	0	0				0	0	4,984
	38-44	13	1	14	6	2	8		0	0	8	1	9		6	6	0	0				0	0	37
	45-49	0		0	0	1	1		0	0		0	0		1	1	0	0				0	0	3
	50-54					1	1		0	0		0	0		0	0								1
	55-59				0	0	0		0	0		0	0		0	0								0
	60-64								0	0		0	0		0	0						0	0	0
	70-79					0	0																	0
4	15-19	0	0	0	10	0	10				0		0											11
	20-24	13	15	27	22	14	37		0	0	2	1	3		0	0	0	0				0	0	68
	25-29	262	117	379	116	39	155	0	0	0	12	4	16	0	1	1	0	0				0	0	552
	30-37	2,255	524	2,779	856	126	982	0	0	0	54	5	59	0	1	1	0	0				0	0	3,822
	38-44	74	4	77	47	5	52		0	0	6	2	9	0	1	1	0	0				0	0	139
	45-49				0	2	3		0	0		1	1		0	0	0	0				0	0	3
	50-54					2	2		0	0		0	0		0	0								2
	55-59				0	0	1		0	0		0	0		0	0								1
	60-64								0	0		0	0		0	0								0
	70-79					0	0																	0
	10-14	0		0																				0
Total	15-19	0	1	1	16	0	16	0		0	1		1											17
All Quarters	20-24	132	70	202	128	40	169	0	0	0	6	2	8	0	9	9	0	0	0	0		0	0	389
	25-29	1,852	266	2,118	716	107	823	0	1	1	32	7	39	0	31	31	0	0	0	0	0	0	0	3,013
	30-37	17,252	928	18,179	4,916	268	5,184	1	1	2	145	8	154	0	36	36	0	0	0	0	0	0	0	23,556
	38-44	468	7	475	334	13	347	0	1	1	17	4	21	0	18	18	0	0	0	0	0	0	0	862
	45-49	5	0	6	5	6	11		0	0		1	1		4	4	0	0	0	0		0	0	22
	50-54		0	0		3	3		0	0		0	0		0	0	0	0				0	0	3
	55-59				0	0	1		0	0		0	0		0	0	0	0				0	0	1
	60-64								0	0		0	0		0	0	0	0				0	0	1
	70-79					0	0																	0
Total	All Length Classes	19,710	1,272	20,981	6,116	437	6,553	1	3	4	201	23	224	0	100	100	0	0	0	0	0	1	1	27,864

*** Zeroes indicate small numbers (< 500 individuals) becoming zeroes due to rounding.**

Table 2.4.4 Cod in SD 25-32. Landing and discard in numbers ('000) and percentages by length class in the year 2014.

Year	2014			
	Landings		Discards	
Length Class	Number (thousands)	Percentage (%)	Number (thousands)	Percentage (%)
10-14			176	0.00
15-19	35 152	0.09	17 464	0.06
20-24	12 796	0.03	388 829	1.40
25-29	12 796	0.03	3 012 711	10.81
30-37	2 764 071	6.84	23 555 964	84.54
38-44	28 035 075	69.37	861 884	3.09
45-49	6 917 845	17.12	21 523	0.08
50-54	1 846 527	4.57	3 288	0.01
55-59	530 940	1.31	1 108	0.00
60-64	142 096	0.35	626	0.00
65-69	54 980	0.14		
70-79	36 728	0.09	97	0.00
80-89	20 948	0.05		
90-99	2 556	0.01		
>=100	221	100		100

Table 2.4.5 Cod in SD 25-32. Discard percentage (of landings + discards in numbers) by length class in the year 2014.

Year	2014
Length Class	Discards
10-14	100.00%
15-19	33.19% *
20-24	96.81%
25-29	99.58%
30-37	89.50%
38-44	2.98%
45-49	0.31%
50-54	0.18%
55-59	0.21%
60-64	0.44%
65-69	0.00%
70-79	0.26%
80-89	0.00%
90-99	0.00%
>=100	0.00%

***based on Polish landings of fish 16-19 cm in SD26 in Q4, active fleet.**

Table 2.4.6a. Cod in SD 25–32. 2014. Mean weight (grams) of discard by length class.

Species	Cod
Year	2014
Stock	25-32
Catch category	Discard
Quarter	(All)
Average of weight (g)	
Length class	Grand Total
10-14	52
15-19	57
20-24	91
25-29	180
30-37	364
38-44	657
45-49	962
50-54	1,171
55-59	1,586
60-64	1,950
70-79	2,000

Table 2.4.6b Cod in SD 25-32. Discard in weight (tons) by length class in the year 2014.

Species	Cod
Year	2014
Stock	25-32
Catch category	Discard
Quarter	(All)
wgt (tons)	
Length class	2014
10-14	0
15-19	1
20-24	43
25-29	587
30-37	8 531
38-44	433
45-49	21
50-54	4
55-59	2
60-64	1
70-79	0
Total	9 623

Table 2.4.7a Cod in SD 25-32. Allocation scheme for landings in 2014.

Unsampled Landings strata	Allocated sampled strata	Unsampled Landings strata	Allocated sampled strata
DE_BAL25_Active_1_L	PL_BAL25_Active_1_L	FI_BAL29_Passive_4_L	LV_BAL28_Passive_2_L
	PL_BAL25_Active_2_L	FI_BAL30_Passive_1_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_1_L	FI_BAL30_Passive_2_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_2_L	FI_BAL30_Passive_3_L	LV_BAL28_Passive_2_L
DE_BAL25_Active_3_L	PL_BAL25_Active_4_L	FI_BAL30_Passive_4_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_3_L	FI_BAL31_Passive_2_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_4_L	FI_BAL31_Passive_3_L	LV_BAL28_Passive_2_L
DK_BAL25_Active_3_L	PL_BAL25_Active_4_L	FI_BAL32_Passive_1_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_3_L	FI_BAL32_Passive_2_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_4_L	FI_BAL32_Passive_3_L	LV_BAL28_Passive_2_L
DK_BAL25_Passive_3_L	LV_BAL25_Passive_1_L	FI_BAL32_Passive_4_L	LV_BAL28_Passive_2_L
	PL_BAL25_Passive_1_L	LT_BAL25_Active_1_L	PL_BAL25_Active_1_L
	PL_BAL25_Passive_2_L		PL_BAL25_Active_2_L
	PL_BAL25_Passive_3_L		SE_BAL25_Active_1_L
	PL_BAL25_Passive_4_L		SE_BAL25_Active_2_L
	SE_BAL25_Passive_3_L	LT_BAL25_Active_2_L	PL_BAL25_Active_1_L
	SE_BAL25_Passive_4_L		PL_BAL25_Active_2_L
DK_BAL26_Active_1_L	LT_BAL26_Active_1_L		SE_BAL25_Active_1_L
	LV_BAL26_Active_1_L		SE_BAL25_Active_2_L
	LV_BAL26_Active_2_L	LV_BAL25_Active_1_L	PL_BAL25_Active_1_L
	PL_BAL26_Active_2_L		PL_BAL25_Active_2_L
	RU_BAL26_Active_2_L		SE_BAL25_Active_1_L
	SE_BAL26_Active_2_L		SE_BAL25_Active_2_L
DK_BAL26_Active_3_L	LT_BAL26_Active_4_L	LV_BAL25_Active_4_L	PL_BAL25_Active_4_L
	LV_BAL26_Active_4_L		SE_BAL25_Active_3_L
	RU_BAL26_Active_3_L		SE_BAL25_Active_4_L
	RU_BAL26_Active_4_L	LV_BAL25_Passive_2_L	LV_BAL25_Passive_1_L
	SE_BAL26_Active_4_L		PL_BAL25_Passive_1_L
DK_BAL26_Active_4_L	LT_BAL26_Active_4_L		PL_BAL25_Passive_2_L
	LV_BAL26_Active_4_L		PL_BAL25_Passive_3_L
	RU_BAL26_Active_3_L		PL_BAL25_Passive_4_L
	RU_BAL26_Active_4_L		SE_BAL25_Passive_3_L
	SE_BAL26_Active_4_L		SE_BAL25_Passive_4_L
DK_BAL26_Passive_4_L	LT_BAL26_Passive_3_L	LV_BAL25_Passive_4_L	LV_BAL25_Passive_1_L
	LT_BAL26_Passive_4_L		PL_BAL25_Passive_1_L
	LV_BAL26_Passive_3_L		PL_BAL25_Passive_2_L
	LV_BAL26_Passive_4_L		PL_BAL25_Passive_3_L
	PL_BAL26_Passive_4_L		PL_BAL25_Passive_4_L
	RU_BAL26_Passive_3_L		SE_BAL25_Passive_3_L
	RU_BAL26_Passive_4_L		SE_BAL25_Passive_4_L
EE_BAL25_Active_1_L	PL_BAL25_Active_1_L	LV_BAL26_Active_3_L	LT_BAL26_Active_4_L
	PL_BAL25_Active_2_L		LV_BAL26_Active_4_L
	SE_BAL25_Active_1_L		RU_BAL26_Active_3_L
	SE_BAL25_Active_2_L		RU_BAL26_Active_4_L
EE_BAL25_Active_2_L	PL_BAL25_Active_1_L		SE_BAL26_Active_4_L
	PL_BAL25_Active_2_L	LV_BAL26_Passive_1_L	LV_BAL26_Passive_2_L
	SE_BAL25_Active_1_L		RU_BAL26_Passive_1_L
	SE_BAL25_Active_2_L		RU_BAL26_Passive_2_L
EE_BAL25_Active_3_L	PL_BAL25_Active_4_L	LV_BAL28_Active_2_L	LV_BAL28_Active_3_L
	SE_BAL25_Active_3_L	LV_BAL28_Active_4_L	LV_BAL28_Active_3_L

Unsampled Landings strata	Allocated sampled strata	Unsampled Landings strata	Allocated sampled strata
	SE_BAL25_Active_4_L	LV_BAL28_Passive_1_L	LV_BAL28_Passive_2_L
EE_BAL25_Active_4_L	PL_BAL25_Active_4_L	LV_BAL28_Passive_3_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_3_L	LV_BAL28_Passive_4_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_4_L	PL_BAL26_Active_3_L	LT_BAL26_Active_4_L
EE_BAL26_Active_1_L	LT_BAL26_Active_1_L		LV_BAL26_Active_4_L
	LV_BAL26_Active_1_L		RU_BAL26_Active_3_L
	LV_BAL26_Active_2_L		RU_BAL26_Active_4_L
	PL_BAL26_Active_2_L		SE_BAL26_Active_4_L
	RU_BAL26_Active_2_L	PL_BAL26_Passive_1_L	LV_BAL26_Passive_2_L
	SE_BAL26_Active_2_L		RU_BAL26_Passive_1_L
EE_BAL26_Active_2_L	LT_BAL26_Active_1_L		RU_BAL26_Passive_2_L
	LV_BAL26_Active_1_L	PL_BAL26_Passive_3_L	LT_BAL26_Passive_3_L
	LV_BAL26_Active_2_L		LT_BAL26_Passive_4_L
	PL_BAL26_Active_2_L		LV_BAL26_Passive_3_L
	RU_BAL26_Active_2_L		LV_BAL26_Passive_4_L
	SE_BAL26_Active_2_L		PL_BAL26_Passive_4_L
EE_BAL26_Active_3_L	LT_BAL26_Active_4_L		RU_BAL26_Passive_3_L
	LV_BAL26_Active_4_L	PL_BAL26_Passive_3_L	RU_BAL26_Passive_4_L
	RU_BAL26_Active_3_L	PL_BAL27_Active_1_L	LV_BAL28_Active_3_L
	RU_BAL26_Active_4_L	PL_BAL27_Active_3_L	LV_BAL28_Active_3_L
	SE_BAL26_Active_4_L	PL_BAL28_Active_1_L	LV_BAL28_Active_3_L
EE_BAL26_Active_4_L	LT_BAL26_Active_4_L	PL_BAL28_Active_2_L	LV_BAL28_Active_3_L
	LV_BAL26_Active_4_L	PL_BAL29_Active_1_L	LV_BAL28_Active_3_L
	RU_BAL26_Active_3_L	PL_BAL29_Passive_2_L	LV_BAL28_Passive_2_L
	RU_BAL26_Active_4_L	PL_BAL29_Passive_4_L	LV_BAL28_Passive_2_L
	SE_BAL26_Active_4_L	RU_BAL26_Active_1_L	LT_BAL26_Active_1_L
EE_BAL28_Active_1_L	LV_BAL28_Active_3_L		LV_BAL26_Active_1_L
EE_BAL28_Active_2_L	LV_BAL28_Active_3_L		LV_BAL26_Active_2_L
EE_BAL28_Active_3_L	LV_BAL28_Active_3_L		PL_BAL26_Active_2_L
EE_BAL28_Active_4_L	LV_BAL28_Active_3_L		RU_BAL26_Active_2_L
EE_BAL28_Passive_1_L	LV_BAL28_Passive_2_L		SE_BAL26_Active_2_L
EE_BAL28_Passive_2_L	LV_BAL28_Passive_2_L	SE_BAL26_Passive_3_L	LT_BAL26_Passive_3_L
EE_BAL28_Passive_3_L	LV_BAL28_Passive_2_L		LT_BAL26_Passive_4_L
EE_BAL28_Passive_4_L	LV_BAL28_Passive_2_L		LV_BAL26_Passive_3_L
EE_BAL29_Active_1_L	LV_BAL28_Active_3_L		LV_BAL26_Passive_4_L
EE_BAL29_Active_2_L	LV_BAL28_Active_3_L		PL_BAL26_Passive_4_L
EE_BAL29_Active_3_L	LV_BAL28_Active_3_L		RU_BAL26_Passive_3_L
EE_BAL29_Active_4_L	LV_BAL28_Active_3_L		RU_BAL26_Passive_4_L
EE_BAL29_Passive_1_L	LV_BAL28_Passive_2_L	SE_BAL27_Active_1_L	LV_BAL28_Active_3_L
EE_BAL29_Passive_2_L	LV_BAL28_Passive_2_L	SE_BAL27_Active_2_L	LV_BAL28_Active_3_L
EE_BAL29_Passive_3_L	LV_BAL28_Passive_2_L	SE_BAL27_Active_4_L	LV_BAL28_Active_3_L
EE_BAL29_Passive_4_L	LV_BAL28_Passive_2_L	SE_BAL27_Passive_1_L	LV_BAL28_Passive_2_L
EE_BAL32_Active_1_L	LV_BAL28_Active_3_L	SE_BAL27_Passive_2_L	LV_BAL28_Passive_2_L
EE_BAL32_Active_2_L	LV_BAL28_Active_3_L	SE_BAL27_Passive_3_L	LV_BAL28_Passive_2_L
EE_BAL32_Active_3_L	LV_BAL28_Active_3_L	SE_BAL27_Passive_4_L	LV_BAL28_Passive_2_L
EE_BAL32_Active_4_L	LV_BAL28_Active_3_L	SE_BAL28_Active_2_L	LV_BAL28_Active_3_L
EE_BAL32_Passive_1_L	LV_BAL28_Passive_2_L	SE_BAL28_Active_3_L	LV_BAL28_Active_3_L
EE_BAL32_Passive_2_L	LV_BAL28_Passive_2_L	SE_BAL28_Active_4_L	LV_BAL28_Active_3_L
EE_BAL32_Passive_3_L	LV_BAL28_Passive_2_L	SE_BAL28_Passive_1_L	LV_BAL28_Passive_2_L
EE_BAL32_Passive_4_L	LV_BAL28_Passive_2_L	SE_BAL28_Passive_2_L	LV_BAL28_Passive_2_L
FI_BAL25_Active_4_L	PL_BAL25_Active_4_L	SE_BAL28_Passive_3_L	LV_BAL28_Passive_2_L
	SE_BAL25_Active_3_L	SE_BAL28_Passive_4_L	LV_BAL28_Passive_2_L

Unsampled Landings strata	Allocated sampled strata	Unsampled Landings strata	Allocated sampled strata
	SE_BAL25_Active_4_L	SE_BAL29_Passive_1_L	LV_BAL28_Passive_2_L
FI_BAL26_Active_4_L	LT_BAL26_Active_4_L	SE_BAL29_Passive_2_L	LV_BAL28_Passive_2_L
	LV_BAL26_Active_4_L	SE_BAL29_Passive_3_L	LV_BAL28_Passive_2_L
	RU_BAL26_Active_3_L	SE_BAL29_Passive_4_L	LV_BAL28_Passive_2_L
	RU_BAL26_Active_4_L	SE_BAL30_Passive_2_L	LV_BAL28_Passive_2_L
	SE_BAL26_Active_4_L	SE_BAL30_Passive_3_L	LV_BAL28_Passive_2_L
FI_BAL29_Passive_1_L	LV_BAL28_Passive_2_L	SE_BAL30_Passive_4_L	LV_BAL28_Passive_2_L
FI_BAL29_Passive_2_L	LV_BAL28_Passive_2_L	SE_BAL31_Passive_2_L	LV_BAL28_Passive_2_L
FI_BAL29_Passive_3_L	LV_BAL28_Passive_2_L		

Table 2.4.7b Cod in SD 25-32. Allocation scheme for discards in 2014.

Unsampled Discards strata	Allocated sampled strata	Unsampled Discards strata	Allocated sampled strata
DE_BAL25_Active_1_D	DE_BAL25_Active_2_D	FI_BAL31_Passive_2_D	LV_BAL28_Passive_2_D
	PL_BAL25_Active_1_D	FI_BAL31_Passive_3_D	LV_BAL28_Passive_2_D
	PL_BAL25_Active_2_D	FI_BAL31_Passive_4_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_1_D	FI_BAL32_Passive_1_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_2_D	FI_BAL32_Passive_2_D	LV_BAL28_Passive_2_D
DE_BAL25_Active_3_D	PL_BAL25_Active_3_D	FI_BAL32_Passive_3_D	LV_BAL28_Passive_2_D
	PL_BAL25_Active_4_D	FI_BAL32_Passive_4_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_3_D	LT_BAL25_Active_1_D	DE_BAL25_Active_2_D
	SE_BAL25_Active_4_D		PL_BAL25_Active_1_D
	PL_BAL25_Active_3_D		PL_BAL25_Active_2_D
	PL_BAL25_Active_4_D		SE_BAL25_Active_1_D
	SE_BAL25_Active_3_D		SE_BAL25_Active_2_D
	SE_BAL25_Active_4_D	LT_BAL25_Active_2_D	DE_BAL25_Active_2_D
DK_BAL25_Passive_1_D	LV_BAL25_Passive_1_D		PL_BAL25_Active_1_D
	PL_BAL25_Passive_2_D		PL_BAL25_Active_2_D
	SE_BAL25_Passive_1_D		SE_BAL25_Active_1_D
	SE_BAL25_Passive_2_D		SE_BAL25_Active_2_D
DK_BAL25_Passive_2_D	LV_BAL25_Passive_1_D	LT_BAL26_Active_2_D	LV_BAL26_Active_1_D
	PL_BAL25_Passive_2_D		LV_BAL26_Active_2_D
	SE_BAL25_Passive_1_D		PL_BAL26_Active_1_D
	SE_BAL25_Passive_2_D		RU_BAL26_Active_2_D
DK_BAL25_Passive_3_D	PL_BAL25_Passive_3_D		SE_BAL26_Active_2_D
	PL_BAL25_Passive_4_D	LV_BAL25_Active_1_D	DE_BAL25_Active_2_D
	SE_BAL25_Passive_3_D		PL_BAL25_Active_1_D
	SE_BAL25_Passive_4_D		PL_BAL25_Active_2_D
DK_BAL25_Passive_4_D	PL_BAL25_Passive_3_D		SE_BAL25_Active_1_D
	PL_BAL25_Passive_4_D		SE_BAL25_Active_2_D
	SE_BAL25_Passive_3_D	LV_BAL25_Active_4_D	PL_BAL25_Active_3_D
	SE_BAL25_Passive_4_D		PL_BAL25_Active_4_D
DK_BAL26_Active_1_D	LV_BAL26_Active_1_D		SE_BAL25_Active_3_D
	LV_BAL26_Active_2_D		SE_BAL25_Active_4_D
	PL_BAL26_Active_1_D	LV_BAL25_Passive_2_D	LV_BAL25_Passive_1_D
	RU_BAL26_Active_2_D		PL_BAL25_Passive_2_D
	SE_BAL26_Active_2_D		SE_BAL25_Passive_1_D
DK_BAL26_Active_3_D	LT_BAL26_Active_4_D		SE_BAL25_Passive_2_D
	LV_BAL26_Active_4_D	LV_BAL25_Passive_4_D	PL_BAL25_Passive_3_D
	RU_BAL26_Active_3_D		PL_BAL25_Passive_4_D
	RU_BAL26_Active_4_D		SE_BAL25_Passive_3_D

Unsampled Discards strata	Allocated sampled strata	Unsampled Discards strata	Allocated sampled strata
	SE_BAL26_Active_4_D		SE_BAL25_Passive_4_D
DK_BAL26_Active_4_D	LT_BAL26_Active_4_D	LV_BAL26_Active_3_D	LT_BAL26_Active_4_D
	LV_BAL26_Active_4_D		LV_BAL26_Active_4_D
	RU_BAL26_Active_3_D		RU_BAL26_Active_3_D
	RU_BAL26_Active_4_D		RU_BAL26_Active_4_D
	SE_BAL26_Active_4_D		SE_BAL26_Active_4_D
DK_BAL26_Passive_4_D	LV_BAL26_Passive_3_D	LV_BAL26_Passive_1_D	LT_BAL26_Passive_2_D
	LV_BAL26_Passive_4_D		LV_BAL26_Passive_2_D
	RU_BAL26_Passive_3_D		RU_BAL26_Passive_1_D
	RU_BAL26_Passive_4_D		RU_BAL26_Passive_2_D
EE_BAL25_Active_1_D	DE_BAL25_Active_2_D	LV_BAL28_Active_2_D	LV_BAL28_Active_3_D
	PL_BAL25_Active_1_D	LV_BAL28_Active_4_D	LV_BAL28_Active_3_D
	PL_BAL25_Active_2_D	LV_BAL28_Passive_1_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_1_D	LV_BAL28_Passive_3_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_2_D	LV_BAL28_Passive_4_D	LV_BAL28_Passive_2_D
EE_BAL25_Active_2_D	DE_BAL25_Active_2_D	PL_BAL25_Passive_1_D	LV_BAL25_Passive_1_D
	PL_BAL25_Active_1_D		PL_BAL25_Passive_2_D
	PL_BAL25_Active_2_D		SE_BAL25_Passive_1_D
	SE_BAL25_Active_1_D		SE_BAL25_Passive_2_D
	SE_BAL25_Active_2_D	PL_BAL26_Active_2_D	LV_BAL26_Active_1_D
EE_BAL25_Active_3_D	PL_BAL25_Active_3_D		LV_BAL26_Active_2_D
	PL_BAL25_Active_4_D		PL_BAL26_Active_1_D
	SE_BAL25_Active_3_D		RU_BAL26_Active_2_D
	SE_BAL25_Active_4_D		SE_BAL26_Active_2_D
EE_BAL25_Active_4_D	PL_BAL25_Active_3_D	PL_BAL26_Active_3_D	LT_BAL26_Active_4_D
	PL_BAL25_Active_4_D		LV_BAL26_Active_4_D
	SE_BAL25_Active_3_D		RU_BAL26_Active_3_D
	SE_BAL25_Active_4_D		RU_BAL26_Active_4_D
EE_BAL26_Active_1_D	LV_BAL26_Active_1_D		SE_BAL26_Active_4_D
	LV_BAL26_Active_2_D	PL_BAL26_Passive_1_D	LT_BAL26_Passive_2_D
	PL_BAL26_Active_1_D		LV_BAL26_Passive_2_D
	RU_BAL26_Active_2_D		RU_BAL26_Passive_1_D
	SE_BAL26_Active_2_D		RU_BAL26_Passive_2_D
EE_BAL26_Active_2_D	LV_BAL26_Active_1_D	PL_BAL26_Passive_2_D	LT_BAL26_Passive_2_D
	LV_BAL26_Active_2_D		LV_BAL26_Passive_2_D
	PL_BAL26_Active_1_D		RU_BAL26_Passive_1_D
	RU_BAL26_Active_2_D		RU_BAL26_Passive_2_D
	SE_BAL26_Active_2_D	PL_BAL26_Passive_3_D	LV_BAL26_Passive_3_D
EE_BAL26_Active_3_D	LT_BAL26_Active_4_D		LV_BAL26_Passive_4_D
	LV_BAL26_Active_4_D		RU_BAL26_Passive_3_D
	RU_BAL26_Active_3_D		RU_BAL26_Passive_4_D
	RU_BAL26_Active_4_D	PL_BAL28_Active_1_D	LV_BAL28_Active_3_D
	SE_BAL26_Active_4_D	PL_BAL29_Passive_2_D	LV_BAL28_Passive_2_D
EE_BAL26_Active_4_D	LT_BAL26_Active_4_D	RU_BAL26_Active_1_D	LV_BAL26_Active_1_D
	LV_BAL26_Active_4_D		LV_BAL26_Active_2_D
	RU_BAL26_Active_3_D		PL_BAL26_Active_1_D
	RU_BAL26_Active_4_D		RU_BAL26_Active_2_D
	SE_BAL26_Active_4_D		SE_BAL26_Active_2_D
EE_BAL28_Active_1_D	LV_BAL28_Active_3_D	SE_BAL26_Active_1_D	LV_BAL26_Active_1_D
EE_BAL28_Active_2_D	LV_BAL28_Active_3_D		LV_BAL26_Active_2_D
EE_BAL28_Passive_1_D	LV_BAL28_Passive_2_D		PL_BAL26_Active_1_D
EE_BAL28_Passive_2_D	LV_BAL28_Passive_2_D		RU_BAL26_Active_2_D

Unsampled Discards strata	Allocated sampled strata	Unsampled Discards strata	Allocated sampled strata
EE_BAL28_Passive_3_D	LV_BAL28_Passive_2_D		SE_BAL26_Active_2_D
EE_BAL28_Passive_4_D	LV_BAL28_Passive_2_D	SE_BAL26_Active_3_D	LT_BAL26_Active_4_D
EE_BAL29_Active_1_D	LV_BAL28_Active_3_D		LV_BAL26_Active_4_D
EE_BAL29_Active_4_D	LV_BAL28_Active_3_D		RU_BAL26_Active_3_D
EE_BAL29_Passive_1_D	LV_BAL28_Passive_2_D		RU_BAL26_Active_4_D
EE_BAL29_Passive_2_D	LV_BAL28_Passive_2_D		SE_BAL26_Active_4_D
EE_BAL29_Passive_3_D	LV_BAL28_Passive_2_D	SE_BAL26_Passive_3_D	LV_BAL26_Passive_3_D
EE_BAL29_Passive_4_D	LV_BAL28_Passive_2_D		LV_BAL26_Passive_4_D
EE_BAL32_Active_2_D	LV_BAL28_Active_3_D		RU_BAL26_Passive_3_D
EE_BAL32_Passive_1_D	LV_BAL28_Passive_2_D		RU_BAL26_Passive_4_D
EE_BAL32_Passive_2_D	LV_BAL28_Passive_2_D	SE_BAL27_Active_1_D	LV_BAL28_Active_3_D
EE_BAL32_Passive_3_D	LV_BAL28_Passive_2_D	SE_BAL27_Active_2_D	LV_BAL28_Active_3_D
EE_BAL32_Passive_4_D	LV_BAL28_Passive_2_D	SE_BAL27_Active_4_D	LV_BAL28_Active_3_D
FI_BAL25_Active_4_D	PL_BAL25_Active_3_D	SE_BAL27_Passive_1_D	LV_BAL28_Passive_2_D
	PL_BAL25_Active_4_D	SE_BAL27_Passive_2_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_3_D	SE_BAL27_Passive_3_D	LV_BAL28_Passive_2_D
	SE_BAL25_Active_4_D	SE_BAL27_Passive_4_D	LV_BAL28_Passive_2_D
FI_BAL26_Active_4_D	LT_BAL26_Active_4_D	SE_BAL28_Active_2_D	LV_BAL28_Active_3_D
	LV_BAL26_Active_4_D	SE_BAL28_Active_3_D	LV_BAL28_Active_3_D
	RU_BAL26_Active_3_D	SE_BAL28_Active_4_D	LV_BAL28_Active_3_D
	RU_BAL26_Active_4_D	SE_BAL28_Passive_1_D	LV_BAL28_Passive_2_D
	SE_BAL26_Active_4_D	SE_BAL28_Passive_2_D	LV_BAL28_Passive_2_D
FI_BAL29_Passive_1_D	LV_BAL28_Passive_2_D	SE_BAL28_Passive_3_D	LV_BAL28_Passive_2_D
FI_BAL29_Passive_2_D	LV_BAL28_Passive_2_D	SE_BAL28_Passive_4_D	LV_BAL28_Passive_2_D
FI_BAL29_Passive_3_D	LV_BAL28_Passive_2_D	SE_BAL29_Passive_1_D	LV_BAL28_Passive_2_D
FI_BAL29_Passive_4_D	LV_BAL28_Passive_2_D	SE_BAL29_Passive_2_D	LV_BAL28_Passive_2_D
FI_BAL30_Passive_1_D	LV_BAL28_Passive_2_D	SE_BAL29_Passive_3_D	LV_BAL28_Passive_2_D
FI_BAL30_Passive_2_D	LV_BAL28_Passive_2_D	SE_BAL29_Passive_4_D	LV_BAL28_Passive_2_D
FI_BAL30_Passive_3_D	LV_BAL28_Passive_2_D	SE_BAL30_Passive_2_D	LV_BAL28_Passive_2_D
FI_BAL30_Passive_4_D	LV_BAL28_Passive_2_D	SE_BAL30_Passive_3_D	LV_BAL28_Passive_2_D
		SE_BAL30_Passive_4_D	LV_BAL28_Passive_2_D

Table 2.4.8a Cod in SD 25-32. Numbers (10*3) per length class in commercial catches by subdivision, quarter and gear in 2014.

Stock	COD-2532
Year	2014
Catch Category	Catch

Quarter	Length Class	BAL25 Active	BAL25 Passive	BAL25 Total	BAL26 Active	BAL26 Passive	BAL26 Total	BAL27 Active	BAL27 Passive	BAL27 Total	BAL28 Active	BAL28 Passive	BAL28 Total	BAL29 Active	BAL29 Passive	BAL29 Total	BAL30 Passive	BAL30 Total	BAL31 Passive	BAL31 Total	BAL32 Active	BAL32 Passive	BAL32 Total	Total
1	10-14	0		0																				0
	15-19							0		0	0		0	0		0								0
	20-24	47	14	61	10	7	17	0	0	0	0	0	0	0	1	1						0	0	79
	25-29	508	30	538	75	19	93	0	0	0	0	0	0	0	3	3						0	0	634
	30-37	5,640	111	5,750	592	43	634	0	0	0	0	0	1	0	3	4	0	0				0	0	6,389
	38-44	5,546	542	6,087	1,934	200	2,134	0	1	2	0	2	2	0	6	6	0	0				0	0	8,232
	45-49	776	181	957	533	145	678	0	1	1	0	1	1	0	3	3	0	0				0	0	1,640
	50-54	167	43	211	156	31	187	0	0	0	0	0	0	0	1	1	0	0				0	0	399
	55-59	56	9	64	39	7	45	0	0	0	0	0	0	0	0	0	0	0				0	0	110
	60-64	18	1	19	13	2	15	0	0	0	0	0	0	0	0	0	0	0				0	0	34
	65-69	8	1	9	8	0	8		0	0		0	0		0	0						0	0	17
	70-79	5	0	5	4	0	4																	9
	80-89	2	0	2	3	0	3																	5
	90-99	0		0	0		0																	1
	>=100	0		0	0		0																	0
2	10-14	0		0																				0
	15-19							0		0	0		0								0		0	0
	20-24	63	36	99	86	7	94	0	0	0	1	0	1		5	5	0	0	0	0	0	0	0	199
	25-29	784	70	854	484	21	505	0	0	0	6	0	6		17	17	0	0	0	0	0	0	0	1,383

	30-37	6,734	239	6,974	3,300	47	3,347	0	1	1	27	1	27		21	21	0	0	0	0	0	0	0	10,370
	38-44	6,882	1,090	7,972	2,472	308	2,780	0	10	10	14	10	24		38	38	1	1	0	0	0	1	1	10,826
	45-49	1,063	346	1,409	594	185	779	0	6	6	3	6	9		19	19	0	0	0	0	0	1	1	2,224
	50-54	217	67	284	183	32	215	0	1	1	1	1	2		3	3	0	0	0	0	0	0	0	507
	55-59	67	14	81	50	8	58	0	0	0	0	0	0		1	1	0	0	0	0	0	0	0	140
	60-64	23	6	29	18	4	22	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	51
	65-69	10	2	12	5	2	7		0	0		0	0		0	0	0	0	0	0		0	0	19
	70-79	10	6	15	5	0	5																	21
	80-89	1	0	1	2	0	2																	3
	90-99	0		0	1		1																	2
	>=100	0		0	0		0																	0
3	15-19	0	1	1	5	0	6				0		0											7
	20-24	10	7	17	10	12	22		0	0	3	1	3		3	3	0	0				0	0	45
	25-29	298	50	348	42	28	70		0	0	14	3	17		10	10	0	0				0	0	444
	30-37	4,510	187	4,697	233	56	288		0	0	65	3	68		12	12	0	0	0	0		0	0	5,066
	38-44	799	84	883	825	131	956		2	2	59	20	79		21	21	0	0	0	0		0	0	1,941
	45-49	171	126	297	174	108	281		1	1	16	11	27		10	10	0	0	0	0		0	0	617
	50-54	41	55	97	39	47	86		0	0	5	2	7		2	2	0	0	0	0		0	0	192
	55-59	13	18	31	13	14	27		0	0	1	0	2		0	0	0	0				0	0	60
	60-64	3	5	8	3	4	7		0	0	0	0	0		0	0	0	0				0	0	16
	65-69	1	1	2	1	2	3		0	0		0	0		0	0	0	0				0	0	5
	70-79	1	1	2	1	1	1																	3
	80-89	0	0	0	0		0																	0
	90-99	0		0	0		0																	0
	>=100	0		0																				0
4	15-19	0	0	0	45	0	45	0		0	0		0	0		0								46
	20-24	13	15	27	34	14	48	0	0	0	2	1	3	0	0	0	0	0				0	0	79
	25-29	262	117	379	128	39	167	0	0	0	12	4	16	0	1	1	0	0				0	0	563
	30-37	2,572	557	3,129	1,165	139	1,304	0	0	0	55	5	60	0	1	1	0	0				0	0	4,494
	38-44	2,397	555	2,952	4,379	501	4,880	0	3	3	29	31	60	0	2	2	0	0				0	0	7,898
	45-49	565	524	1,089	1,078	264	1,342	0	1	1	7	18	25	0	1	1	0	0				0	0	2,458
	50-54	179	215	394	255	97	352	0	0	0	2	3	6	0	0	0	0	0				0	0	752

	55-59	42	69	111	76	35	110	0	0	0	1	0	1	0	0	0	0	0				0	0	222
	60-64	4	18	22	8	12	20		0	0	0	0	0	0	0	0	0	0				0	0	42
	65-69	4	1	5	5	4	9		0	0		0	0		0	0	0	0				0	0	14
	70-79	2	0	2	2	1	2																	4
	80-89	0	0	0	12		12																	13
	90-99	0	0	0	0		0																	0
	>=100	0		0																				0
Total	10-14	0		0																				0
All Quarters	**15-19**	**0**	**1**	**1**	**51**	**0**	**51**	**0**		**0**	**1**		**1**	**0**		**0**					**0**		**0**	**53**
	20-24	132	72	203	140	40	181	0	0	0	6	2	8	0	9	9	0	0	0	0	0	0	0	402
	25-29	1,852	267	2,119	728	107	835	0	1	1	32	7	39	0	31	31	0	0	0	0	0	0	0	3,026
	30-37	19,455	1,094	20,550	5,290	285	5,574	1	2	2	146	10	156	0	37	37	0	0	0	0	0	0	0	26,320
	38-44	15,624	2,271	17,894	9,610	1,140	10,750	0	16	16	103	63	166	0	67	67	1	1	0	0	0	2	2	28,897
	45-49	2,575	1,176	3,752	2,379	702	3,080	0	9	9	27	36	63	0	34	34	0	0	0	0	0	1	1	6,939
	50-54	605	381	986	633	207	841	0	2	2	8	7	15	0	6	6	0	0	0	0	0	0	0	1,850
	55-59	177	110	287	178	63	241	0	0	0	2	1	3	0	1	1	0	0	0	0	0	0	0	532
	60-64	47	31	78	42	22	64	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	143
	65-69	22	5	27	19	8	27		0	0		0	0		0	0	0	0	0	0		0	0	55
	70-79	17	7	24	11	2	13																	37
	80-89	3	0	3	18	0	18																	21
	90-99	1	0	1	2		2																	3
	>=100	0		0	0		0																	0
Total	All Length Classes	40,511	5,414	45,925	19,100	2,576	21,676	1	31	32	324	127	451	0	186	186	1	1	0	0	0	4	4	68,276

Table 2.4.8b Cod in SD 25-32. Mean weight (grams) per length class in the catches by subdivision and quarter in 2014.

Quarter	Length class	BAL25	BAL26	BAL27	BAL28	BAL29	BAL30	BAL31	BAL32	Total
1	10-14	52								52
	15-19			35	35	35				35
	20-24	97	93	85	84	83	82		82	91
	25-29	183	182	172	173	175	179		179	179
	30-37	380	369	388	397	413	439		436	389
	38-44	592	634	651	705	721	800		751	658
	45-49	930	926	970	1,004	1,004	1,039		1,011	961
	50-54	1,239	1,251	1,221	1,285	1,285	1,370		1,300	1,261
	55-59	1,629	1,568	1,643	1,748	1,748	1,887		1,772	1,666
	60-64	2,156	2,137	1,872	1,996	1,996	2,119		2,020	2,088
	65-69	2,813	2,643	3,530	3,530	3,530	3,530		3,530	2,823
	70-79	3,935	3,746							3,850
	80-89	5,585	4,988							5,356
	90-99	7,478	7,579							7,511
	>=100	9,645	9,438							9,541
2	10-14	52								52
	15-19			35	35				35	35
	20-24	99	91	85	85	82	82	82	84	90
	25-29	184	184	172	172	179	179	179	174	180
	30-37	397	374	386	387	438	439	463	405	399
	38-44	620	667	678	668	773	800	797	722	688
	45-49	962	962	992	983	1,023	1,039	1,041	1,011	987
	50-54	1,284	1,298	1,261	1,244	1,329	1,370	1,387	1,300	1,296
	55-59	1,669	1,638	1,710	1,682	1,820	1,887	1,912	1,772	1,719
	60-64	2,214	2,145	1,955	1,922	2,064	2,119	2,176	2,020	2,108
	65-69	2,808	2,617	3,530	3,530	3,530	3,530	3,530	3,530	2,874
	70-79	3,893	3,694							3,821
	80-89	5,487	4,791							5,214
	90-99	7,525	7,762							7,588
	>=100	9,645	9,430							9,559
3	15-19	60	64		35					62
	20-24	98	101	82	84	82	82	82	82	92
	25-29	174	187	179	173	179	179	179	179	179
	30-37	362	379	433	397	437	439	439	436	394
	38-44	570	632	719	690	765	800	800	751	672
	45-49	901	922	992	992	1,019	1,039	1,039	1,011	964
	50-54	1,307	1,247	1,261	1,261	1,318	1,370	1,370	1,300	1,283
	55-59	1,691	1,602	1,710	1,710	1,802	1,887	1,887	1,772	1,703
	60-64	2,272	2,158	1,955	1,955	2,049	2,119	2,119	2,020	2,128
	65-69	2,897	2,754	3,530	3,530	3,530	3,530	3,530	3,530	2,902
	70-79	4,052	3,692							3,846

	80-89	5,830	5,648							5,735
	90-99	7,933	7,664							7,878
	>=100	9,505								9,505
4	15-19	60	59	35	35	35				57
	20-24	98	103	85	84	83	82	82	82	92
	25-29	179	187	172	173	175	179	179	179	180
	30-37	364	376	386	397	422	439	398	436	388
	38-44	565	621	678	690	748	800	807	751	660
	45-49	918	934	992	992	1,022	1,039	1,031	1,011	969
	50-54	1,297	1,252	1,261	1,261	1,334	1,370	1,180	1,300	1,284
	55-59	1,639	1,607	1,710	1,710	1,827	1,887	1,610	1,772	1,693
	60-64	2,277	2,193	1,955	1,955	2,079	2,119	1,950	2,020	2,148
	65-69	2,828	2,668	3,530	3,530	3,530	3,530		3,530	2,847
	70-79	3,935	3,740							3,834
	80-89	5,779	5,661							5,721
	90-99	7,758	7,455							7,718
	>=100	9,505								9,505
All Quarters	10-14	52								52
	15-19	60	62	35	35	35			35	57
	20-24	98	98	84	84	83	82	82	83	91
	25-29	180	185	173	173	177	179	179	177	180
	30-37	376	375	395	394	427	439	439	426	393
	38-44	588	637	678	687	751	800	800	743	670
	45-49	931	935	985	992	1,017	1,039	1,039	1,011	971
	50-54	1,279	1,260	1,248	1,261	1,316	1,370	1,370	1,300	1,281
	55-59	1,654	1,602	1,688	1,710	1,799	1,887	1,887	1,772	1,696
	60-64	2,226	2,160	1,929	1,955	2,047	2,119	2,119	2,020	2,118
	65-69	2,833	2,681	3,530	3,530	3,530	3,530	3,530	3,530	2,861
	70-79	3,951	3,719							3,839
	80-89	5,674	5,367							5,535
	90-99	7,672	7,625							7,661
	>=100	9,575	9,436							9,533

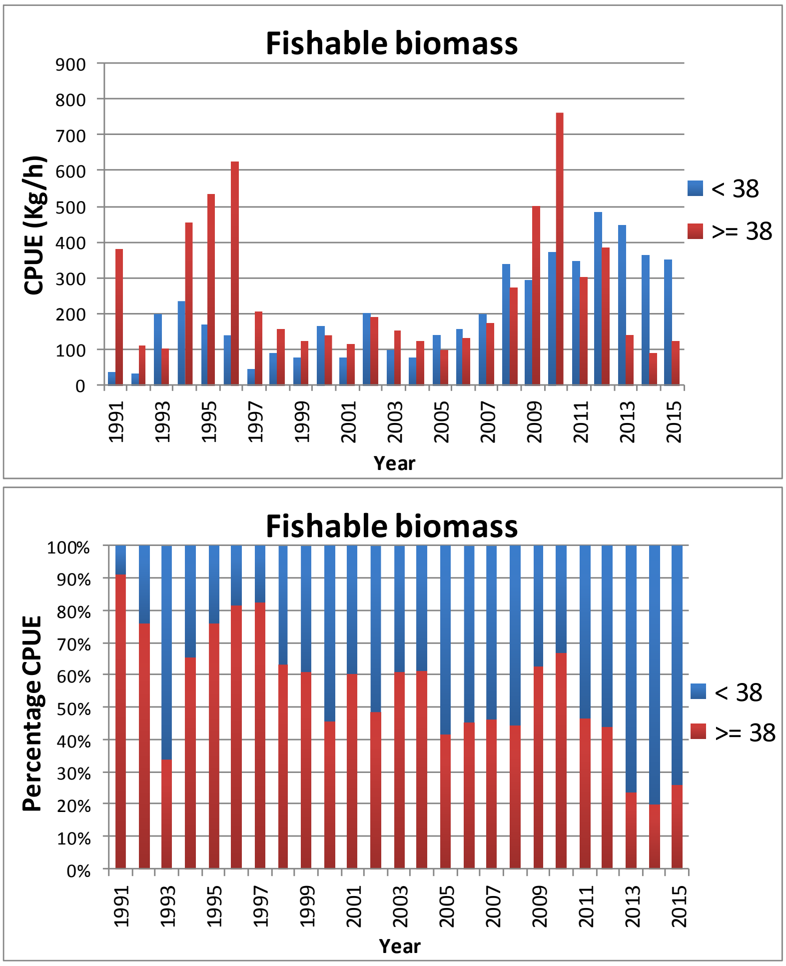


Figure 2.4.1 Cod in SD 25-32. Comparison of fishable biomass above minimum landing size (MLS), 38 cm, based on Quarter 1 survey catches (BITS) over time. Top panel: total weight above and below 38 cm. Bottom panel: proportion in weight above 38 cm, which suggests that only 27% (12% in numbers) of the fish was actually avalible for catch in 2014.

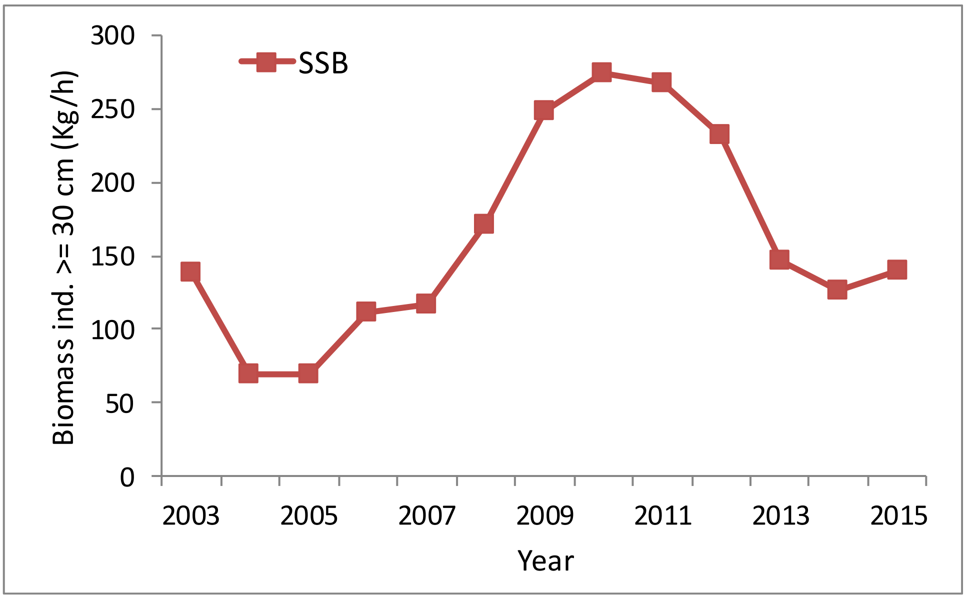


Figure 2.4.2 Cod in SD 25-32. Stock size indicator, calculated as cpue of fish ≥ 30 cm from the 1st and 4th quarters, from the BITS in SDs 25–28 (from ICES DATRAS database).

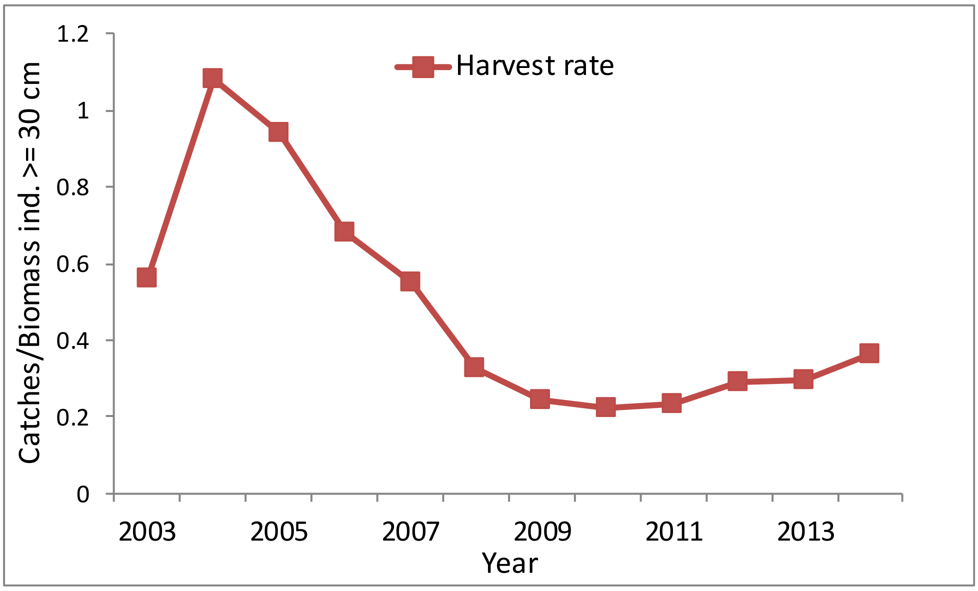


Figure 2.4.3 Cod in SD 25-32. Harvest rate, estimated as catches/SSB index.

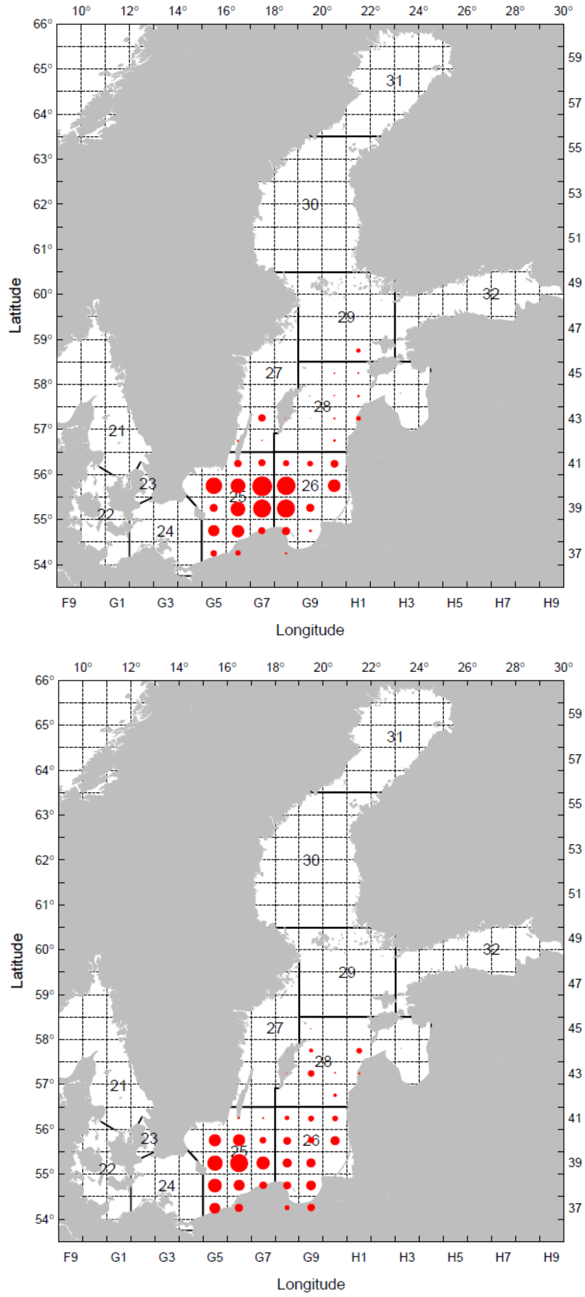


Figure 2.4.4 Cod in SD 25–32. Distribution of Eastern Baltic Sea cod (fish >= 30 cm, proxy for SSB) from bottom trawl survey (BITS) in the 4th Quarter 2014 (left panel) and 1st Quarter 2015 (right panel).

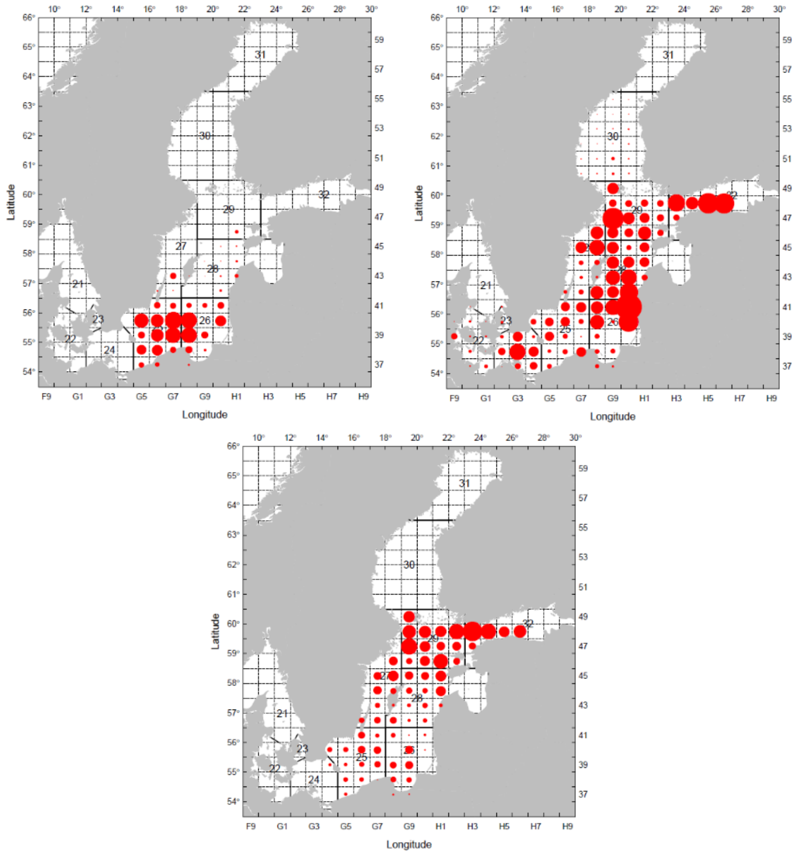


Figure 2.4.7 Cod in SD 25–32. Distribution of eastern Baltic Sea cod from bottom trawl survey (BITS) in the 4th quarter 2014 (left panel); Baltic sprat from the acoustic survey (BIAS) in the 4th quarter 2014 (middle panel); and herring in Subdivisions 25 to 29 and 32, excluding the Gulf of Riga, from the BIAS survey (BIAS) in the 4th quarter 2014 (right panel). Figure with cod include fish >= 30 cm, while figures with herring and sprat include ages from 0 to 8.

2.2 Cod in the Kattegat

2.2.1 The fishery

2.2.1.1 Recent changes in fisheries regulations

Besides TAC regulation, fishing in Kattegat are restricted by effort limitations. The 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 management plan (EC No. 1342/2008) for North Sea (incl. Kattegat) cod a new effort system was introduced. In this system each Member State is given amounts of kWdays for different gear groups. It is then the MS responsibility to distribute the kWdays among the fishing vessels. The amount of kWdays for gear groups catching cod will be subject to yearly cuts as long as the cod stock is below reference points in the management plan. MS can however apply for derogation from the kWdays system if the catches in a certain part of the fleet can be 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). Using this possibility, Sweden has applied for 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 180 mm panel during the first three quarters of a year. In 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. 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.

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 2014 were 108 tons, similar levels as last year (Table 2.2.1), and the TAC was 100 tons. Since 2000, ICES has considered the stock to be outside safe biological limits and since 2002 it has been advised that there should be no fishing on this stock and that a rebuilding plan should be implemented in order to raise SSB above the agreed Bpa (10 500 t).

2.2.1.3 Unallocated removals

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), that could potentially have biased landings statistics for some years.

Discard estimates were available from Sweden for 1997—2014 and from Denmark for 2000—2014 (Table 2.2.2). The background and calculation procedures are explained in the Stock Annex. The discards have formally not been used in the assessment mainly due to uncertainty in the estimation of Danish discards, which is related to a low sampling level in some years, high variability in discard rates and the calculation procedures that have for previous years averaged discard rates over four years. This implied that any changes in discarding practice due to e.g. changes in technical measures may not be reflected in the estimates. In recent years, the sampling effort of discards has increased and the calculation procedures have become more consistent. There are hence, two runs including the discards estimates presented in the report.

The estimated discard numbers by age and total discards in tons are presented in Table 2.2.2. The sampling levels are shown in Table 2.2.3.

In 2014, the estimated discards formed about 76 percent of the catch weight and the proportion of discards in catch has increased in recent years (Figure 2.2.1). In numbers, the available data indicates that close to 96 percent of the cod caught in the Kattegat is discarded. Discarding mostly affects cod at ages 1-2 with a major increase in discard at age 2 in 2014 (Table 2.2.2; Figure 2.2.2).

Cod landings in the Kattegat by Danish recreational fishery in 2009 and 2010 have been estimated at 35 and 65 t, respectively (Sparrevohn and Storr-Paulsen 2010; Sparrevohn et al. 2011). In 2012 the amount was amounted to 57 t. There is presently no estimate of the cod landings of the recreational fisheries in 2014.

Commercial fishing

The fishery in the Kattegat is dominated by trawling, at present primarily with mesh sizes at 90—99 mm. A major shift in fishing gears occurred between 2003 and 2004 when the use of 70—89 mm trawls without sorting grids was banned. This caused an increase in the 90—99 mm trawl fishery in 2004. The effort of 90—99 mm trawls was stable in 2006–2010. Developments in total fishing effort in the Kattegat in recent years were evaluated in 2011 by STECF Sub-group EWG 11-11. The national data provided for these analyses indicate that the total nominal effort (kWdays) of Danish fleet in the Kattegat has decreased by about a half in the period from 2000 to 2009. In 2010 the effort slightly increased. Swedish nominal effort in the Kattegat was stable in 2006—2008. During 2009 and 2010 the effort decreased. In recent years, the use of trawls equipped with a sorting grid in the Nephrops fishery has increased in the Swedish fishery and is now more common than the usage of conventional trawls. Since 2011 Danish fishermen are obligated to use the Seltra trawl the first 9 month of the year, in accordance with the derogation under article 13.

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 Quality of the biological data

Both Danish and Swedish sampling data were available from the commercial fishery in 2014. Danish and Swedish commercial sample sizes are shown in Table 2.2.4.a and b. Landings were allocated to age groups using the Danish and Swedish age information as shown in Table 2.2.5. The total landings from Germany was under 10 kg and not considered in this assessment. 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 2014, presented in Table 2.2.7, 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.

2.2.2.3 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.

2.2.2.4 Natural mortality

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

2.2.3 Assessment

2.2.3.1 Survey data

In one of the Sam runs in the 2015 years assessment a new survey was introduced, the cod survey (CodS).

The goal of the CodS is to provide fisheries independent data for estimating the abundance, biomass, recruitment index and distribution of cod. The cod survey is directly targeting cod with a high spatial coverage (80 stations, compared to 15-25 in the other surveys, Fig 2.2.6). The design of the cod survey also allows for an independent estimate of Spawning stock biomass(Figure 2.2.7)The CPUE-values were available from IBTS 1st and 3rd quarter surveys and from the BITS surveys in the 1st and 4th quarter (Danish R/V Havfisken). 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–e, highlighting the consistency of the most recent data in each series with information from earlier years.

The survey indices available for the Working Group are presented in Table 2.2.10, highlighting the age-groups and years that were used in the assessment. In two runs there was no changes in selection of tuning indices compared to last year were made. In the other two runs the Cod survey was included. The survey time series used in the assessment are plotted in Figure 2.2.4. The indices from **all** surveys indicate high cod abundance in 2014 especiallay for ages 2-+the values are in the level of indices from late 1990 and early 2000.

The tuning series available for assessment:

Fleet	Details
BITS -4Q	Danish survey, 4th quarter, R/V Havfisken (age 1-5) (1997-2014)
BITS -1Q	Danish survey, 1st quarter, R/V Havfisken (age 1-5) (1997-2015)
IBTS -3Q	International Bottom Trawl Survey, 3rd quarter, Kattegat (age 1-6) (1997-2014)
IBTS-1Q	International Bottom Trawl Survey, 1st quarter, Kattegat; (Ages 1-6) (1997-2015)
CODS 4Q	Cod survey, 4th Quarter, Kattegat, (ages 1-6). (2008-2014)

2.2.3.2 Assessment using 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. However the inclusion of the cod survey is not included in the stock annex but presented in the report. As the time-series of discard data starts from 1997 and reliable extrapolations back in time cannot be made, the run including the discards included all input data from 1997 only. The final two assessment runs the SPALY run including the Cod survey , with and without estimating total removals from 2003—2014. (run 3 and 4 below). In addition as comparison the SPALY run was also included in this report as comparison.

Catch (landings and discards) from 1997—2014 with estimating total removals from 2003—2014 within the model based on survey information. (SPALY 1 from last year)

Catch (landings and discards) from 1997—2014 without estimating total removals (SPALY2)

Catch Landings and discards from 1997—2014 +including the cod survey with estimating total removals from 2003–2014 within the model based on survey information. (SPALY 1+CODS)

Catch (landings and discards) from 1997—2014 +including the cod survey without estimating total removals (SPALY2+CODS)

Unallocated removals were estimated separately for the years 2003—2014, but common for all age-groups within a year. The scaling factors estimated for 2003—2014 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 were significant. The total removals were estimated several fold higher than reported landings, and are not explainable by the estimated discard data only (Figure 2.2.14).

Estimates of recruitment, SSB and mortality (Z-0.2) with confidence intervals from the two runs with total removals estimated are presented in Figure 2.2.12—2.2.14 and Tables 2.2.6—2.2.8All information about the residuals and results from the different SAM runs are found in the appendix 1-4 in this report and in Figures 2.2.12—2.2.16.

Conclusions on recruitment trends

The absolute values of recruitment estimated from the assessment analyses are considered uncertain, mainly due to uncertainties in discards and possibly also due to uncertain natural mortality estimates.

The year class of 2012 was a relative strong yearclass, that showed up in BITS Q1 2013 and in the IBTS Q1 2013. Also it showed up in Cods 4Q 2014 and in the catch both 2013 and 2014

The best indication of the relative strength of recent year-classes is likely to be obtained from survey indices (Figure 2.2.10). All recruitments in the surveys are below the average levels from 2004 -2014

2.2.4 Conclusions on trends in SSB and fishing mortality

SSB of cod in Kattegat steadily declined from around 35 000 tons in the late 1970s to a level of 5000—6000 tons in the end of the 1990s. Since about 2000, the SSB is estimated at the historically lowest level. However all four runs both with and without the Cod survey this year showed an large increased SSB levels (5455-6561compared to last years , equal to the SSB levels in early 2000 (The independent estimate of SSB from the Cod survey estimate a similar high SSB around 7200 tonnes (Figure 2.2.7)

However, the exact level of fishing mortality can still not be reliably estimated. The runs that estimated total removals shows estimated mortality (Z-0.2) in the interval of 0,40 to 0,648. In contrast the run without estimating total removals in the intervall of 0,039 to 0,047. However the overall perception is that the total mortality has gone down since 2008 (Table 2.2.11—2.2.15, appendix 1—4))

The overall harvest rate (catch/SSB) based on available catch information is estimated to have declined considerable as well since 2010 and are now at the level of 13 % 2014 (Figure 2.2.9)

2.2.5 Short term forecast and management options

Since one of the Sam runs (SPALY+ CodS with estimating total removals from 2003–2014) showed a mortality of 0.40 and a SSB estmate of 6561 tonnes. This is of the level of the mortality and SSB in the management plan.

The short term forecast is based on the SAM short term forecast module. The short term prediction carried out by the SAM model is simulation based, and accounts for uncertainty in the final year estimates. From the assessment model it takes the final estimates of fishing mortality and stock numbers, and their estimation variances and covariances. These quantities are then simulated forward in time for a number of specified scenarios (e.g. scaling of fishing mortality levels). The uncertainties are propagated forward in time, and the process variation (as estimated from the historic period) is added. The simulation is carried out at logarithmic scale, and medians are used as main summary statistic on the untransformed scale. It is important to note that taking uncertainty into account does not merely supply confidence intervals on the final future catch estimates, but can also affect the estimates themselves as the errors accumulate in the non-linear projections.

The settings for the short term forecast were as follows:

The mean weights at age were assumed to be equal to the average of the mean weights at age across the years 2012—2014. Natural mortality was set to 0.20 and we used the average fishing mortality rate in 2012—2014 scaled to the last year. Recruitment in 2014 and 2015 were estimated based on resampling from the sampled distribution in 1997—2013.

The short term forecast showed that at status quo fishing mortality (F=0.40), the cod catches (landings and discards) in the Kategatt would be 634 tonnes (371 tonnes-1083 tonnes) in 2016 This would increase the SSB to 9135 tonnes 2016.(Figure 2.2.11)

2.2.6 Medium-term predictions

No medium-term predictions were performed.

2.2.7 Reference points

Target fishing mortality according to EU management plan EC 1342/08 is 0.4. Potential F targets based on yield-per-recruit analyses were suggested by benchmark in 2009 (see Stock Annex). Fmax was estimated at 0.43. These analyses were based on both selection pattern and weight at age data from 2005—2007. The precautionary approach reference points for biomass defined in 1999 were: Blim=6400 tons, Bpa=10500 tons.

2.2.8 Quality of the assessment

Indices from four 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—2014, the survey data indicates significantly higher total removals from the stock than can be explained by the reported catch data.

The SAM run with the cod survey produced a better retrospective pattern in the analyses than did the the SPALY run (Figure 2.2.17—2.2.19). Appendix (1—4 for comparison).At present, the relative proportion of unallocated removals due to fishing and biology driven factors cannot be specified (WKROUND 2009). Therefore, current level of fishing mortality cannot be reliably estimated. (0,68-0,04) in the SPALY runs and between (0.40-0.04) in the Spaly +CodS runs. The highest estimate of the amount of unnalocated removals has decreased considerably since 2010.

The exact estimates of SSB are considered uncertain, however all available information consistently indicates that SSB is has increased from low levels and to 2014 are in the vicinity of 5445 to 6561.

2.2.9 Comparison with previous assessment

The input data were updated from the time series used in last year's assessment. The assessment was performed using state-space assessment model (SAM) as in last year. The results from this years assessment can be found in table 1.The results from the final SAM run (SPALY+Cod survey) and SPALY is found in table 2.2.14and 2.2.15.and Figure 2.2.19—2.2.22

2.2.10 Technical minutes

There was no major comments on last year's assessment.

2.2.11 Management considerations

It should be taken into consideration that:

Discarding of young ages and also high-grading of marketable cod takes place. Discards currently form about 96% of the numbers and more than 76% of the weight of cod caught in the Kattegat.

Table 2.2.1 Cod in the Kattegat. Landings (in tonnes) 1971-2014.

Year	Kattegat			Total	
	Denmark	Sweden	Germany1		
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	
2013	75	32	0.0	108	

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 in tonnes. The estimation of total discards is not entirely consistent between the years

Denmark

Year	a1	a2	a3	a4	a5	a6
1997						
1998						
1999						
2000	1378	921	121	4	1	0
2001	1155	831	109	3	1	0
2002	911	566	65	2	0	0
2003	1066	684	81	2	0	0
2004	1811	647	55	2	0	0
2005	1085	601	67	2	0	0
2006	1100	547	58	2	0	0
2007	1098	537	55	2	0	0
2008	21	169	99	0	0	0
2009	260	103	6	0	0	0
2010	305	406	14	0	0	0
2011	581	395	24	0	0	0
2012	661	134	8	0	0	0
2013	556	261	21	1	0	0
2014	355	684	21	4	0	0

Sweden

Year	a1	a2	a3	a4	a5	a6
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

DK and SWE discard numbers combined — **Total discard in tons**

Year	a1	a2	a3	a4	a5	a6	Total discard in tons
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	2300	1797	274	23	2.5	0.0	992
2001	1901	1551	251	21	2.2	0.0	823
2002	1578	985	158	14	1.6	0.0	577
2003	1580	1399	130	6	1.3	0.2	750

2004	2793	1230	588	3	2.4	0.3	1063
2005	1322	1065	73	7	0.4	0.0	575
2006	1884	994	240	9	2.9	0.3	849
2007	1631	816	87	14	0.5	0.1	577
2008	724	384	62	7	1	0	165
2009	473	168	28	4	0	0	77
2010	345	406	11	0	0	0	167
2011	652	446	33	0	0	0	216
2012	841	188	13	0	0	0	142
2013	1105	451	41	2	0	0	351
2014	435	857	40	5	2	0	339

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	2008	2009	2010	2011	2012	2013	2014
Denmark				52	68	43	30	47	33	22	10	24	38	34	43	48	58	55
Sweden	45	50	55	63	40	63	38	26	48	66	72	50	49	58	48	41	44	39
Total	45	50	55	115	108	106	68	73	81	88	82	74	87	92	91	89	102	94

Table 2.2.4 a Cod in the Kattegat. Sampling level of Danish landings, 2014

Quarter	Landings in tons	n. of size distributions sampled	n. of cod aged	n. of cod weighed	n. of cod measured
1	22.5	6	150	153	153
2	3.7	2	35	35	35
3	11.3	3	80	80	80
4	30.4	6	78	78	78
Total	67.9	17	343	346	346

Table 2.2.4 b Cod in the Kattegat. Sampling level of Swedish landings, 2014

Quarter	Landings in tons	n. of size distributions sampled	n. of cod aged	n. of cod weighed	n. of cod measured
1	6.0	4	82	82	82
2	4.0	5	183	183	183
3	5.0	3	271	271	271
4	11.0	4	386	386	386
Total	26	16	922	922	922

Table 2.2.5. Cod in the Kattegat. Landings numbers and mean weight at age by quarter and country for 2014

Sub-div	21					
Year	2014	Quarter	1			
Country	Denmark		Sweden		Grand Total	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*1000	weight (g)	*1000	weight (g)	*1000	weight (g)
1						
2			1.33	719.00	1.33	719.00
3	5.28	1748.13	4.05	1712.15	9.33	1732.52
4	4.28	2744.38	1.23	2203.35	5.50	2623.82
5	0.31	5318.30	0.31	3436.37	0.62	4385.31
6	0.03	8365.50	0.07	4457.67	0.10	5517.12
7			0.07	6072.17	0.07	6072.17
9						
10+						
SOP (t)	22.85			12.38	35.23	
Landings (t)	22.50			12.25	34.75	
Year	2014	Quarter	2			
Country	Denmark		Sweden		Grand Total	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*1000	weight (g)	*1000	weight (g)	*1000	weight (g)
1						
2			0.355573	725.1709	0.36	725.17
3	1.769309	1993.7	1.174821	1781.93	2.94	1909.20
4	3.703654	2379.123	0.441068	2407.729	4.14	2382.17
5	0.135032	4783.293	0.152136	3631.224	0.29	4172.95
6	0.004496	8365.5	0.040797	4457.667	0.05	4845.60
7			0.040797	6072.167	0.04	6072.17
9						
10+						
SOP (t)	13.02			4.40	17.42	
Landings (t)	11.15			4.37	15.52	
Year	2014	Quarter	3			
Country	Denmark		Sweden		Grand Total	
Age	Numbers	Mean	Numbers	Mean	Numbers	Mean
	*1000	weight (g)	*1000	weight (g)	*1000	weight (g)
1						
2	0.948426	858.5844	1.321078	788.5007	2.27	817.79
3	4.626244	2151.751	1.371503	1883.016	6.00	2090.30
4	0.058456	5992	0.321318	2214.212	0.38	2795.71
5	0.029228	6357	0.12634	2621.563	0.16	3323.38
6	0.003038	8365.5	0.027405	1523.301	0.03	2206.11
7						
9						
10+						
SOP (t)	11.30			4.71	16.04	
Landings (t)	11.38			4.66	16.04	

Year	2014	Quarter	4			
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	2.535643	1414.673	2.864394	1013.359	5.40	1201.80
3	3.833748	2501.629	2.426037	2071.435	6.26	2334.90
4	4.650072	2701.496	0.658077	2915.756	5.31	2728.06
5	1.186654	3971.465	0.399853	3761.364	1.59	3918.51
6	0.028071	8365.5	0.076233	5800.25	0.10	6490.63
7			0.057175	4303.833	0.06	4303.83
9						
10+						
SOP (t)	30.45			12.04	42.73	
Landings (t)	30.56			11.48	42.04	

Year	2014	Quarter	ALL			
Country	Denmark		Sweden		Grand Total	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	3.484069	1414.673	5.867751	1013.359	9.35	1162.87
3	15.51198	2501.629	9.022173	2071.435	24.53	2343.43
4	12.68779	5992	2.64634	2915.756	15.33	5461.11
5	1.664011	6357	0.986163	3761.364	2.65	5391.13
6	0.061611	8365.5	0.214351	5800.25	0.28	6372.96
7			0.167888	6072.167	0.17	6072.17
9						
10+						
SOP (t)	130.85		38.32		169.18	
Landings (t)	75.62		32.15		107.77	

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	1472	2686	6335	1094	291	127
1998	1499	3587	1595	1908	283	76
1999	1201	3859	3972	455	409	77
2000	2317	3229	2445	1028	126	103
2001	1957	2457	2140	706	188	45
2002	1592	1501	836	393	85	40
2003	1580	2249	691	186	65	16
2004	2796	1373	1192	207	65	39
2005	1323	1485	188	169	21	12
2006	1892	1099	651	38	33	9
2007	1631	885	180	172	16	26
2008	176	261	178	36	32	7
2009	449	154	34	22	9	4
2010	371	544	33	8	4	2
2011	653	486	85	6	2	1
2012	843	204	28	13	2	0
2013	1107	472	62	10	3	1
2014	434	867	65	20	4	0

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+

	Age							
Year	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

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+

	Age							
Year	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	5.1	NA
2014	0.049	0.285	1.050	2.541	3.869	5.431	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+

	Age							
Year	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

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

Havfisken – 4Q						
1997	2014					
1	1	0.83	0.92			
1	4					
1	11.16	1.96				
1	35.43	19.13	2.04			
1	5.22	1.41	0.19			
1	50.71	3.88	0.29			
1	103.28	5.69	0.32			
1	33.92	2.89	1.22			
1	8.16	7.86	0.14			
1	54.67	11.42	3.25			
1	6.60	2.94	0.99			
1	5.71	1.14	0.00			
1	29.65	0.36	0.00			
1	12.55	12.30	0.00			
1	16.15	0.75	0.52			
1	75.79	1.19	0.52			
1	41.36	3.96	0.66			
1	9.96	4.75	5.90			
Havfisken –1Q						
1997	2015					
1	1	0	0.25			
1	3					
1	104.55	24.11	16.37			
1	-9.00	-9.00	-9.00			
1	464.86	25.74	8.85			
1	97.62	44.33	5.52			
1	25.79	30.10	11.12			
1	98.27	16.65	3.15			
1	8.34	47.24	5.78			
1	175.06	11.18	5.33			
1	83.15	86.68	2.55			
1	122.18	39.54	10.58			
1	28.87	46.53	8.61			
1	13.10	6.65	1.01			
1	16.21	0.91	0.00			
1	38.50	21.42	1.39			
1	46.25	15.00	14.26			
1	86.62	10.83	1.84			
1	212.34	51.34	10.26			
1	98.78	781.88	12.41			
1	37.35	17.53	15.17			
IBTS – 1Q						
1997	2015					
1	1.00	0.00	0.25			
1	6.00					
1	174.47	54.18	108.87	6.34	1.38	1.05
1	199.37	470.65	47.07	24.62	2.67	1.32
1	237.68	167.80	62.98	2.26	3.11	0.58
1	74.85	233.69	47.39	14.03	1.31	1.16

1	47.05	46.06	24.37	5.28	1.69	0.75
1	93.05	20.84	15.72	14.69	3.27	1.07
1	2.34	52.55	3.58	2.63	1.71	0.38
1	91.02	14.12	32.85	6.01	2.05	2.65
1	19.99	86.95	5.06	10.70	1.20	0.39
1	67.31	21.88	27.47	2.66	2.25	0.99
1	41.61	41.94	7.40	7.52	0.77	0.83
1	8.39	2.41	2.22	0.86	0.58	0.42
1	25.38	0.93	0.44	2.04	0.00	0.33
1	14.64	22.46	0.24	0.33	0.53	0.54
1	43.73	24.43	17.36	0.60	0.18	0.13
1	46.96	9.53	2.02	4.06	0.00	0.08
1	31.39	14.16	3.62	0.88	1.41	0.27
1	3.45	30.82	9.95	3.22	0.48	0.21
1	18.34	10.18	27.36	9.50	4.20	2.20

IBTS – 3Q				
1991	2013			
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	0.00	0.08
1	2.50	1.28	0.00	0.08
1	8.35	1.59	0.45	0
1	8.34	1.25	0.05	0.583
1	9.96	6.79	1.09	0.05
1	3.64	9.83	7.43	0.812

CODS_Q4						
2008	2014					
1	1	0.83	0.92			
1	6					
1	55.5	21.3	12.6	7.8	5.1	1.8
1	162.5	7.6	2.2	2.3	2.8	1.24
1	114.2	69.4	3	0.45	0.44	0.15
1	97	62.1	28.6	6.1	0.97	0.27
1	-9	-9	-9	-9	-9	-9
1	211	216.2	67.6	33.2	5.8	0.85
1	142.4	308.9	270.1	111.9	49.5	21.2

Table 2.2.11.SPALY scaling . Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	15850	9428	26644	14528	12731	16578	12204	10632	14008	1.290	1.082	1.539
1998	13780	8265	22977	10352	9111	11761	7880	6916	8979	1.299	1.103	1.530
1999	14320	8659	23682	9421	8340	10642	7491	6652	8435	1.340	1.146	1.567
2000	8828	5530	14093	7108	6375	7926	5734	5138	6399	1.413	1.210	1.650
2001	4983	3128	7939	6240	5510	7067	5016	4424	5686	1.485	1.249	1.765
2002	10084	6375	15950	5127	4514	5823	4144	3633	4726	1.280	1.079	1.518
2003	4351	2601	7278	4576	4067	5149	3706	3293	4170	1.137	0.948	1.364
2004	13709	8621	21800	5208	4565	5941	3909	3445	4436	1.100	0.918	1.317
2005	8583	5422	13586	6506	5736	7380	4458	3954	5027	1.116	0.935	1.332
2006	10733	6725	17129	7145	6256	8159	5222	4584	5949	1.061	0.884	1.274
2007	3960	2326	6744	4500	4003	5058	3607	3197	4070	1.230	1.016	1.489
2008	2019	1240	3288	2497	2217	2811	2159	1898	2455	1.252	1.024	1.532
2009	6353	3963	10183	1492	1290	1725	1004	883	1141	1.149	0.934	1.413
2010	5620	3535	8933	1919	1669	2207	1096	965	1243	1.005	0.810	1.247
2011	6623	4178	10498	2246	1930	2613	1481	1278	1715	0.857	0.672	1.093
2012	12874	8054	20580	2435	2060	2877	1524	1307	1776	0.829	0.641	1.072
2013	21429	13145	34934	4169	3495	4973	2364	1989	2811	0.746	0.551	1.010
2014	6113	3299	11326	7754	6324	9508	3949	3160	4934	0.648	0.439	0.956
2015							5445	3434	8635			

Table 2.2.12.SPALY No scaling. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

YEAR	RECRUITS	LOW	HIGH	TSB	LOW	HIGH	SSB	LOW	HIGH	F35	LOW	HIGH
1997	14063	7246	27293	14668	11537	18648	12375	9631	15900	1.312	0.962	1.789
1998	12533	6510	24129	10535	8502	13055	7956	6383	9917	1.321	0.973	1.795
1999	10446	5614	19437	8638	7106	10499	7011	5746	8555	1.449	1.097	1.913
2000	6926	3943	12166	6686	5613	7964	5473	4556	6573	1.517	1.142	2.014
2001	3668	2034	6614	5434	4479	6592	4494	3683	5483	1.724	1.283	2.318
2002	6321	3638	10985	4496	3748	5393	3788	3114	4609	1.382	0.989	1.930
2003	2536	1221	5267	3413	2788	4177	2827	2278	3508	1.124	0.779	1.622
2004	7719	4598	12959	4455	3510	5654	3557	2758	4589	0.984	0.613	1.579
2005	3462	2096	5719	3533	2544	4906	2544	1769	3659	0.602	0.368	0.982
2006	5246	3139	8768	4135	2948	5800	3157	2176	4582	0.401	0.239	0.675
2007	2500	1424	4387	2960	2063	4246	2449	1651	3632	0.441	0.262	0.744
2008	740	423	1294	1602	1087	2360	1468	969	2223	0.449	0.273	0.740
2009	2186	1272	3758	930	616	1404	754	469	1213	0.309	0.188	0.508
2010	1454	847	2495	999	720	1386	711	487	1039	0.220	0.136	0.357
2011	2112	1230	3624	1217	862	1719	948	646	1390	0.132	0.081	0.213
2012	3404	1956	5921	1337	906	1974	1059	679	1651	0.093	0.058	0.151
2013	4296	2459	7503	2093	1457	3007	1559	1044	2327	0.076	0.049	0.118
2014	1583	871	2876	4261	2849	6374	2686	1738	4151	0.047	0.028	0.078
2015							5788	3406	9836			

Table 2.2.13 Summary table of spawning stock biomass (SSB) and Mortality (z-0.2) for the four SAM runs in the assessment. SSB estimates compares 2014 to 2015 , Z compares 2014-2013

SAM RUN	2014/2013	2015
SPALY without scaling SSB	2682	5788
Z	0,076	0.047
SPALy with scaling SSB	3949	5445
Z	0,746	0.648
SPALY+CODs without scaling SSB	3177	6032
Z	0,073	0.039
SPALY+COds with scaling SSB	4347	6561
Z	0,541	0.40

Table 2.2.14. SPALY +Cod survey No scaling. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

YEAR	RECRUITS	LOW	HIGH	TSB	LOW	HIGH	SSB	LOW	HIGH	F35	LOW	HIGH
1997	13754	7144	26481	14568	11693	18150	12301	9788	15458	1.329	0.988	1.788
1998	11719	6243	21999	10293	8507	12454	7824	6457	9481	1.337	0.997	1.793
1999	9804	5447	17646	8602	7199	10277	7010	5854	8394	1.470	1.128	1.916
2000	6836	3987	11721	6600	5663	7693	5417	4619	6352	1.542	1.179	2.017
2001	3776	2166	6583	5450	4583	6481	4499	3766	5374	1.788	1.363	2.347
2002	6169	3651	10423	4402	3765	5147	3700	3133	4370	1.450	1.068	1.969
2003	2771	1459	5260	3373	2819	4038	2779	2295	3364	1.189	0.851	1.661
2004	7403	4507	12158	4306	3460	5359	3431	2720	4327	1.096	0.703	1.710
2005	3505	2158	5691	3301	2419	4504	2350	1666	3317	0.662	0.406	1.080
2006	5062	3093	8285	3852	2757	5383	2916	2016	4218	0.442	0.259	0.754
2007	2529	1461	4378	2688	1879	3844	2200	1486	3258	0.507	0.292	0.880
2008	869	610	1237	1434	988	2082	1297	867	1941	0.538	0.325	0.890
2009	2347	1665	3309	778	525	1153	599	372	963	0.395	0.234	0.667
2010	1679	1198	2353	854	623	1172	564	387	821	0.291	0.174	0.487
2011	1606	1142	2258	1089	772	1537	849	579	1246	0.154	0.094	0.254
2012	3252	1901	5560	1247	846	1839	980	628	1530	0.097	0.060	0.158
2013	3320	2369	4654	2154	1500	3094	1650	1108	2458	0.073	0.047	0.113
2014	2069	1466	2918	4822	3150	7381	3177	1979	5098	0.039	0.023	0.065
2015							6032	3529	10310			

Table 2.2.15. Spaly +Cod survey scaled. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	16262	9829	26905	14654	12712	16893	12299	10595	14278	1.276	1.061	1.536
1998	13468	8247	21995	10536	9201	12066	7988	6938	9196	1.283	1.077	1.530
1999	13594	8366	22090	9428	8315	10689	7525	6652	8513	1.328	1.123	1.572
2000	8718	5540	13721	7133	6348	8015	5753	5108	6478	1.416	1.201	1.670
2001	5173	3279	8163	6173	5464	6973	4956	4380	5608	1.524	1.279	1.816
2002	9760	6274	15181	5130	4500	5848	4158	3628	4767	1.274	1.059	1.533
2003	4544	2770	7456	4549	4009	5161	3668	3229	4165	1.092	0.894	1.333
2004	13456	8590	21078	5288	4610	6066	3992	3482	4576	1.061	0.872	1.291
2005	8741	5657	13507	6686	5845	7647	4579	4020	5215	1.090	0.898	1.323
2006	11361	7294	17695	7412	6461	8501	5422	4721	6228	1.020	0.838	1.241
2007	4605	2716	7805	4847	4299	5465	3868	3417	4379	1.282	1.061	1.549
2008	2395	1491	3848	2682	2385	3016	2306	2035	2613	1.400	1.160	1.689
2009	6816	4462	10411	1489	1282	1730	977	861	1108	1.305	1.065	1.599
2010	5313	3490	8089	1776	1520	2075	994	866	1142	1.100	0.870	1.390
2011	5731	3724	8820	2003	1706	2351	1333	1131	1570	0.805	0.614	1.057
2012	12113	7669	19132	2282	1893	2751	1432	1187	1727	0.697	0.514	0.945
2013	15423	8898	26731	3940	3197	4856	2422	1938	3025	0.541	0.379	0.772
2014	6931	4206	11421	8023	6187	10404	4347	3223	5862	0.403	0.259	0.627
2015							6561	4097	10506			

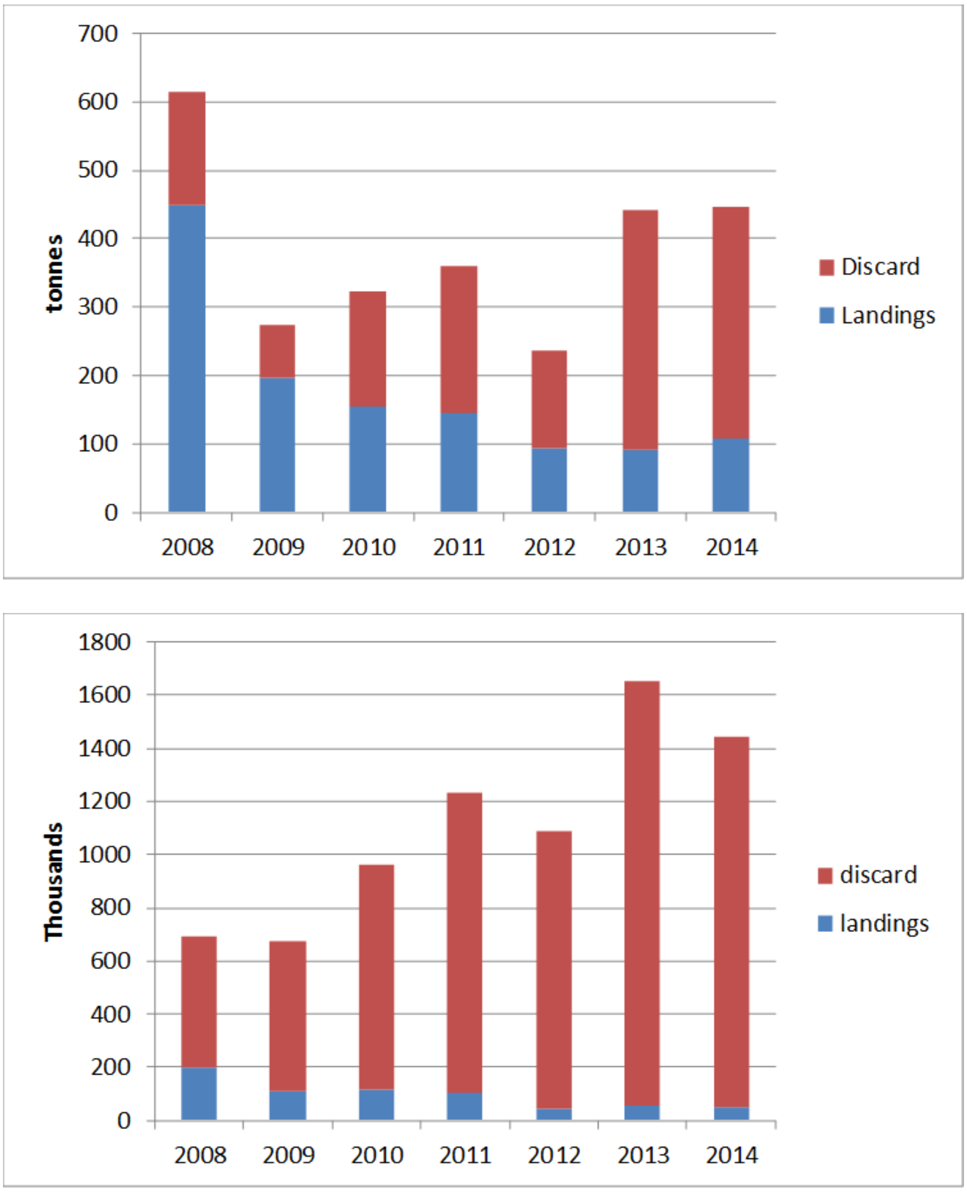


Figure. 2.2.1. Cod in the Kattegat. Estimates of discards (Denmark and Sweden combined) compared to reported landings, both in tons (upper panel) and in numbers (lower panel)

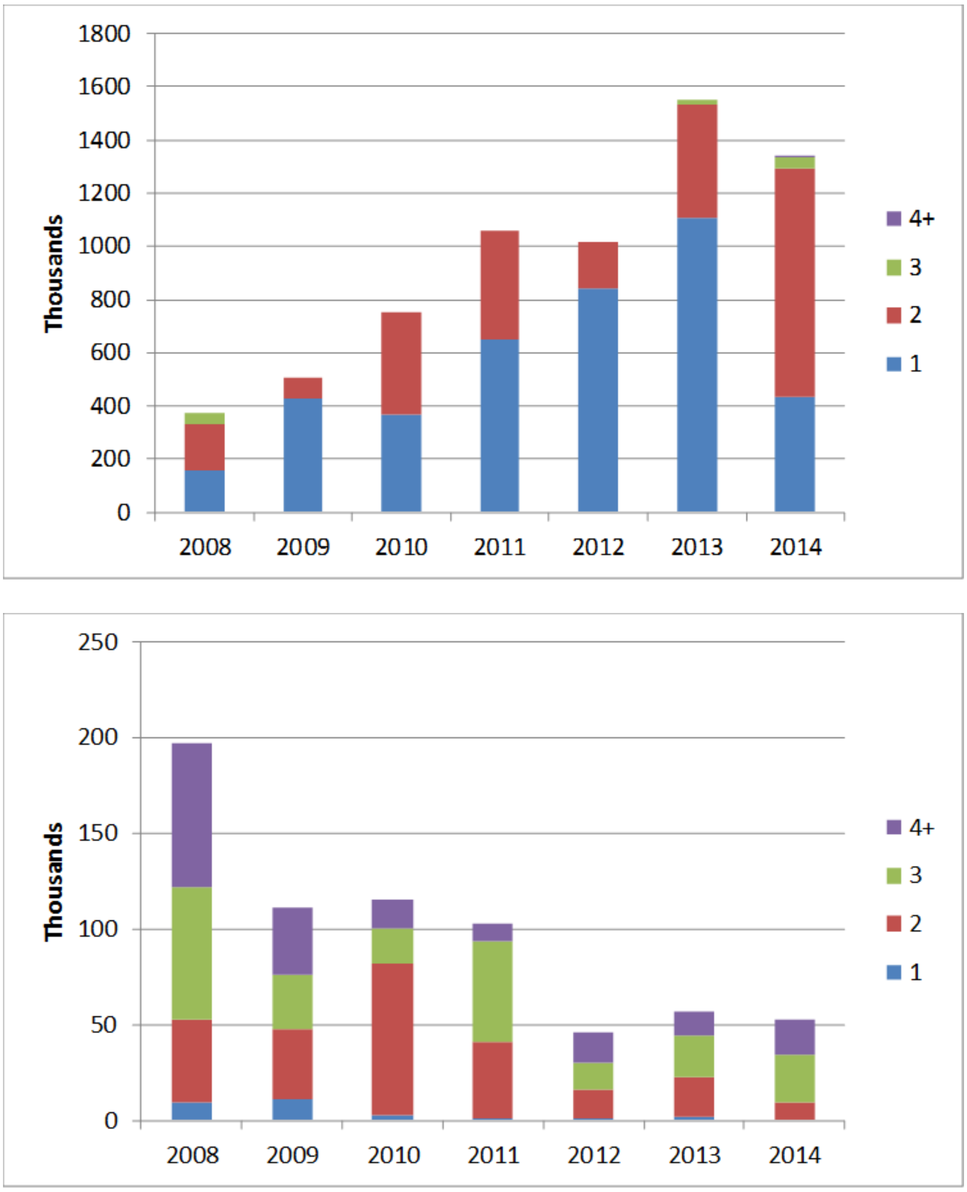


Figure. 2.2.2. Cod in the Kattegat . Estimates of discards age in numbers by upper panel. Landings in numbers by age lower panel (Sweden and Denmark combined)

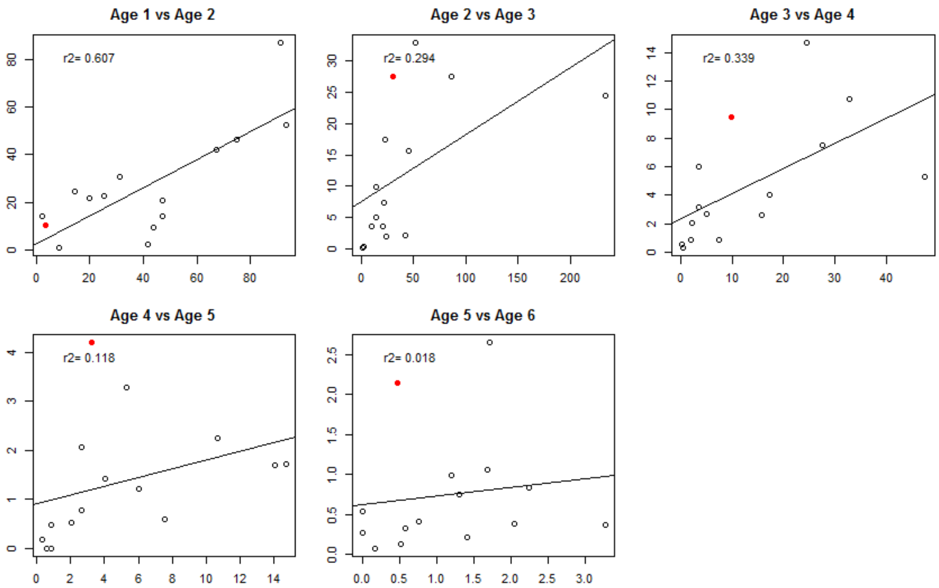


Figure 2.2.3a. Cod in Kattegat. IBTS 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2014. Individual points are given by year-class. Red dots highlight the information from the latest year.

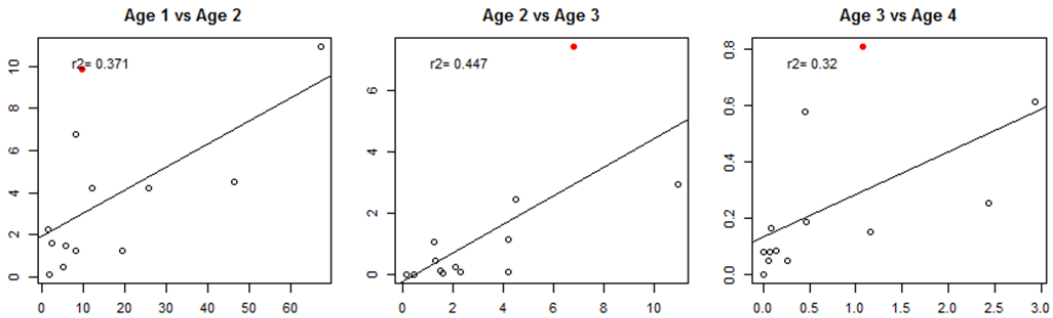


Figure 2.2.3 b. Cod in Kattegat. IBTS 3rd quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2013. Individual points are given by year-class. Red dots highlight the information from the latest year.

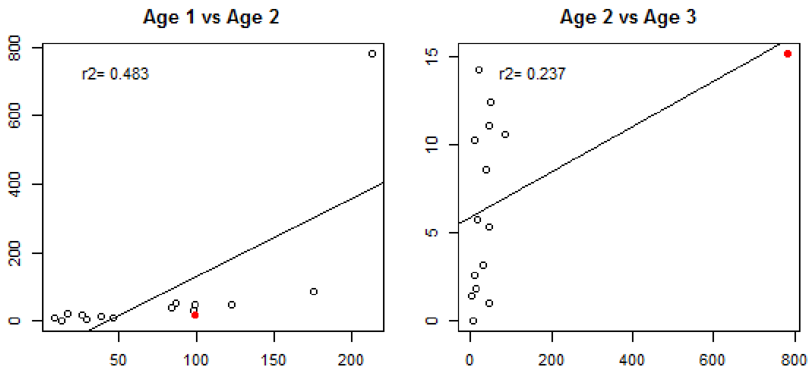


Figure 2.2.3c. Cod in Kattegat. Havfisken 1st quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2015. Individual points are given by year-class. Red dots highlight the information from the latest year.

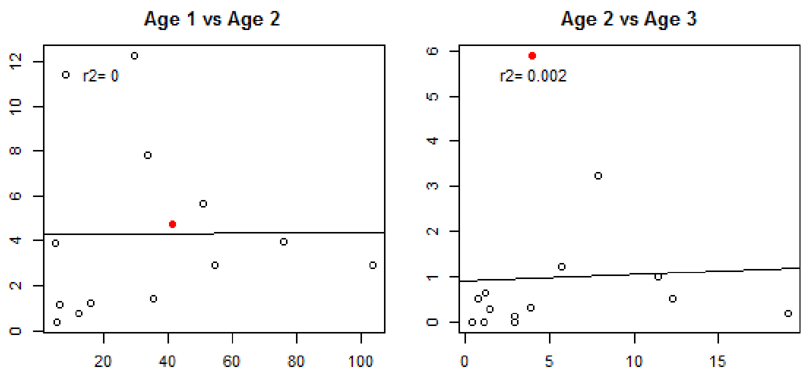


Figure 2.2.3 d. Cod in Kattegat. Havfisken 4th quarter survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2000-2014. Individual points are given by year-class. Red dots highlight the information from the latest year.

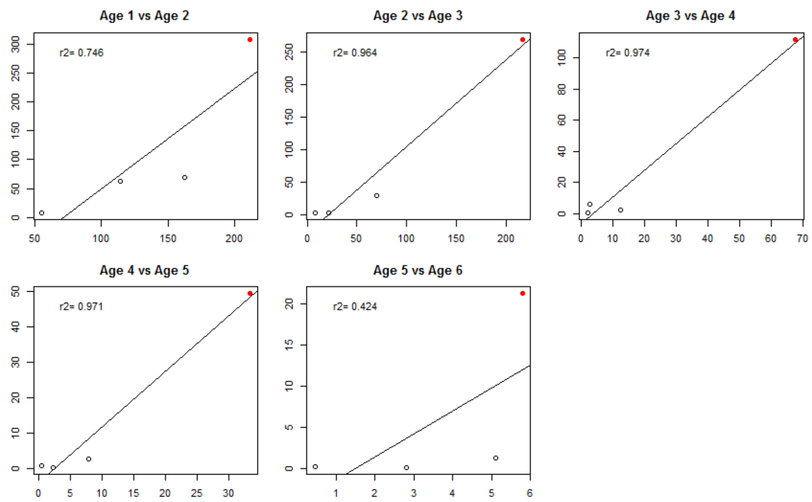


Figure 2.2.3e .Cod in Kattegat. Cod survey quarter 4 survey numbers at age vs numbers at age +1 of the same cohort in the following year in the period 2008-2014. Individual points are given by year-class. Red dots highlight the information from the latest year.

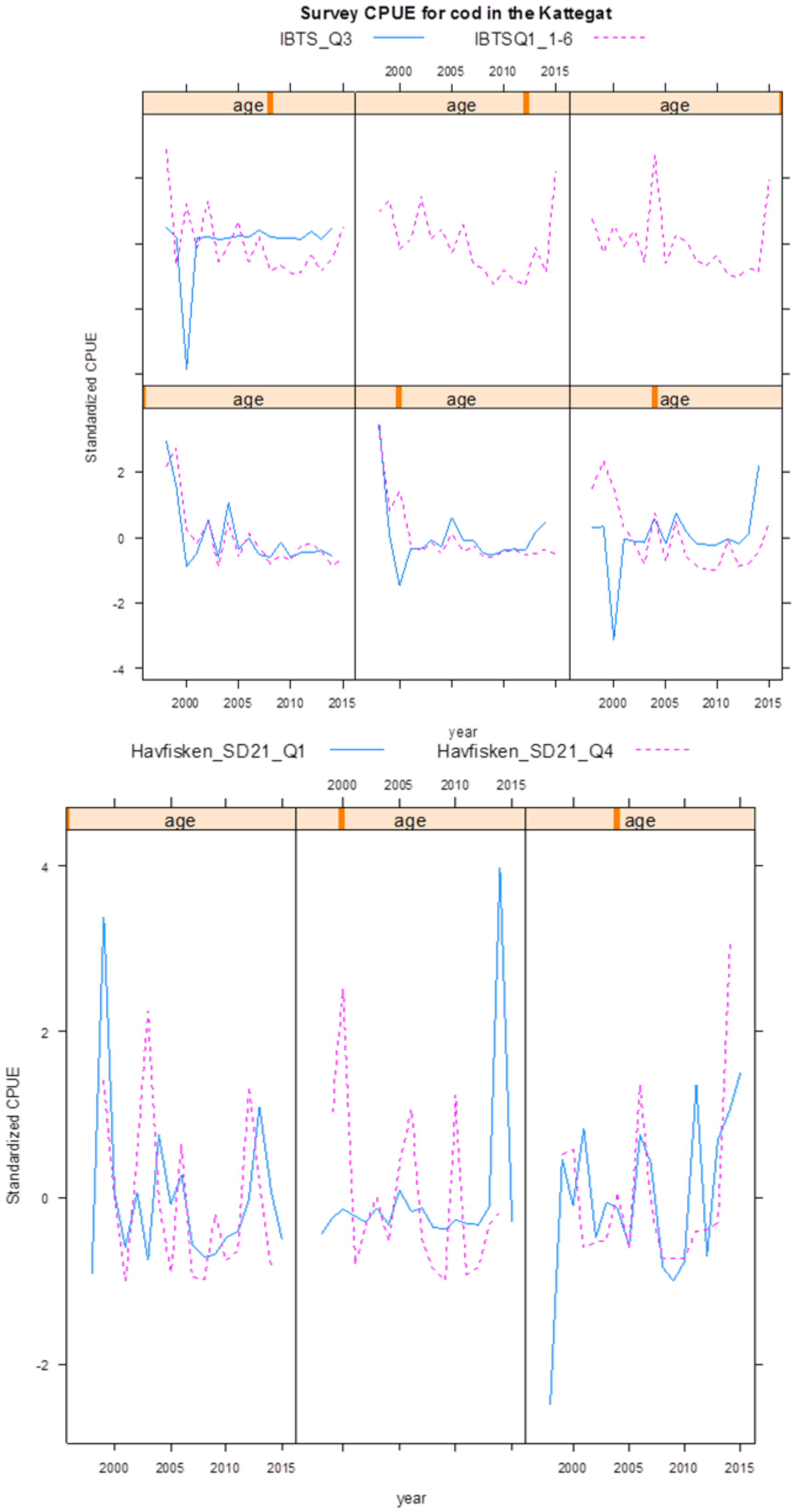


Figure 2.2.4.Cod in the Kattegatt. CPUE from IBTS and Havfisken surveys by age groups.

Figure 2.2.5. Cod in the Kattegat. Landings numbers and mean weight at age by quarter and country for 2014

Sub-div	21					
Year	2014	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			1,33	719,00	1,33	719,00
3	5,28	1748,13	4,05	1712,15	9,33	1732,52
4	4,28	2744,38	1,23	2203,35	5,50	2623,82
5	0,31	5318,30	0,31	3436,37	0,62	4385,31
6	0,03	8365,50	0,07	4457,67	0,10	5517,12
7			0,07	6072,17	0,07	6072,17
9						
10+						
SOP (t)	22,85			12,38	35,23	
Landings (t)	22,50			12,25	34,75	

Sub-div	21					
Year	2014	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			0,355573	725,1708847	0,36	725,17
3	1,769309	1993,70036	1,174821	1781,930438	2,94	1909,20
4	3,703654	2379,12285	0,441068	2407,728735	4,14	2382,17
5	0,135032	4783,29329	0,152136	3631,223964	0,29	4172,95
6	0,004496	8365,5	0,040797	4457,666667	0,05	4845,60
7			0,040797	6072,166667	0,04	6072,17
9						
10+						
SOP (t)	13,02			4,40	17,42	
Landings (t)	11,15			4,37	15,52	

Sub-div **21**

Year	**2014**	**Quarter**	**3**			
Country	**Denmark**		**Sweden**		**Grand Total**	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	0,948426	858,584404	1,321078	788,5006903	2,27	817,79
3	4,626244	2151,75147	1,371503	1883,015907	6,00	2090,30
4	0,058456	5992	0,321318	2214,211746	0,38	2795,71
5	0,029228	6357	0,12634	2621,562975	0,16	3323,38
6	0,003038	8365,5	0,027405	1523,301104	0,03	2206,11
7						
9						
10+						
SOP (t)	11,30			4,71	16,04	
Landings (t)	11,38			4,66	16,04	

Sub-div **21**

Year	**2014**	**Quarter**	**4**			
Country	**Denmark**		**Sweden**		**Grand Total**	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	2,535643	1414,6734	2,864394	1013,358813	5,40	1201,80
3	3,833748	2501,62905	2,426037	2071,435399	6,26	2334,90
4	4,650072	2701,49563	0,658077	2915,756445	5,31	2728,06
5	1,186654	3971,46521	0,399853	3761,364408	1,59	3918,51
6	0,028071	8365,5	0,076233	5800,25	0,10	6490,63
7			0,057175	4303,833333	0,06	4303,83
9						
10+						
SOP (t)	30,45			12,04	42,73	
Landings (t)	30,56			11,48	42,04	

Sub-div 21

Year	2014 Quarter		ALL			
Country	**Denmark**		**Sweden**		**Grand Total**	
Age	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)	Numbers *1000	Mean weight (g)
1						
2	3,484069	1414,6734	5,867751	1013,358813	9,35	1162,87
3	15,51198	2501,62905	9,022173	2071,435399	24,53	2343,43
4	12,68779	5992	2,64634	2915,756445	15,33	5461,11
5	1,664011	6357	0,986163	3761,364408	2,65	5391,13
6	0,061611	8365,5	0,214351	5800,25	0,28	6372,96
7			0,167888	6072,166667	0,17	6072,17
9						
10+						
SOP (t)	130,85		38,32		169,18	
Landings (t)	75,62		32,15		107,77	

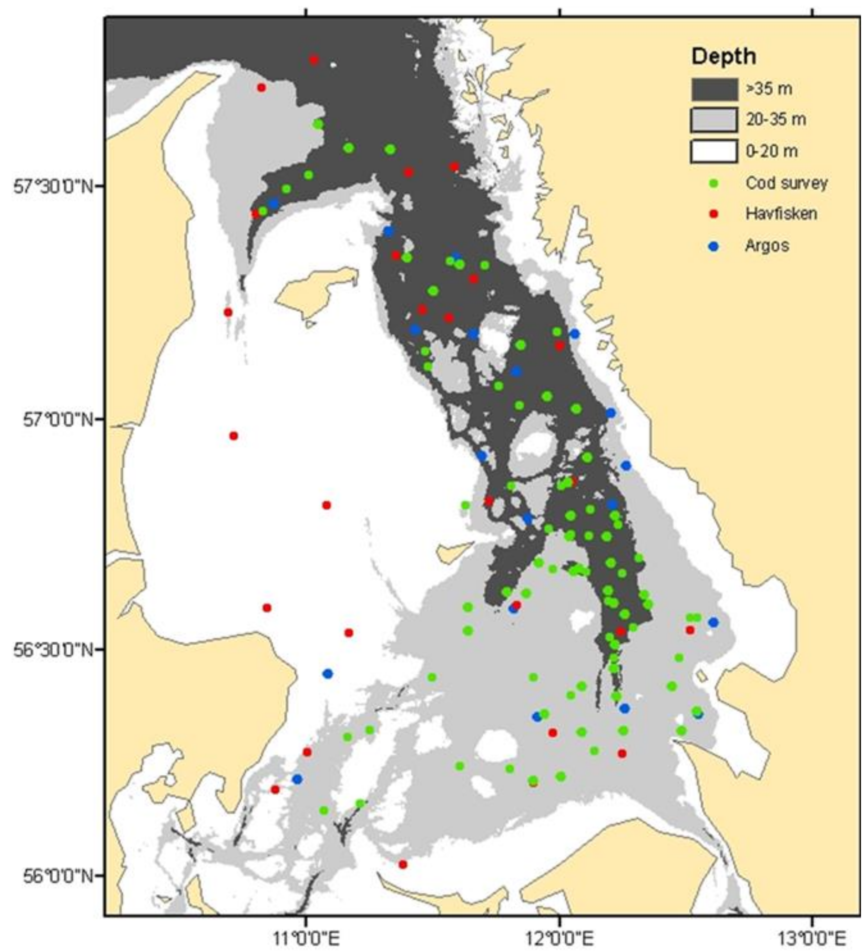


Figure 2.2.6. Spatial distribution of the stations in the cod survey in Kategatt. The cod survey contains 80 hauls in relation to the BITS and IBTS surveys in the areas that contains 15-25 hauls per expedition.

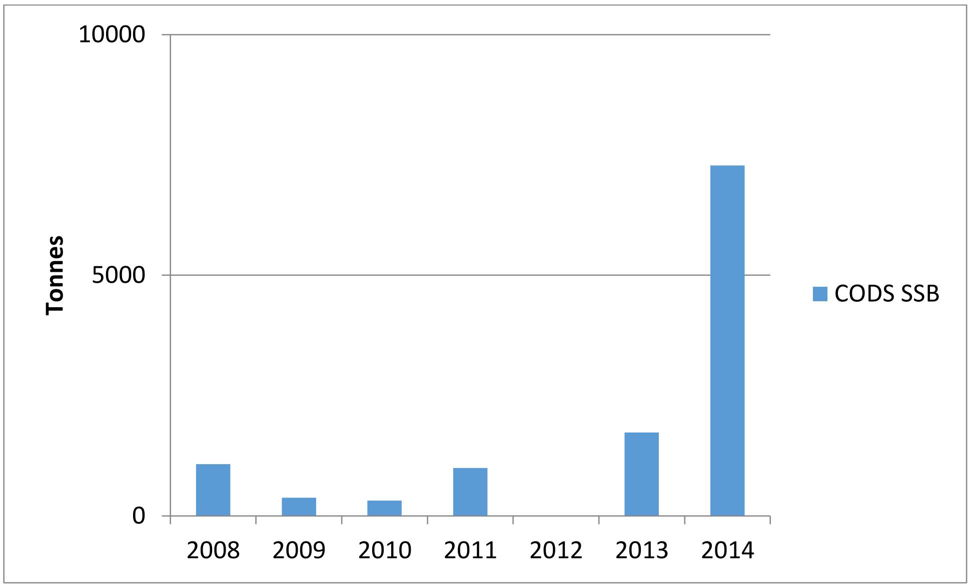
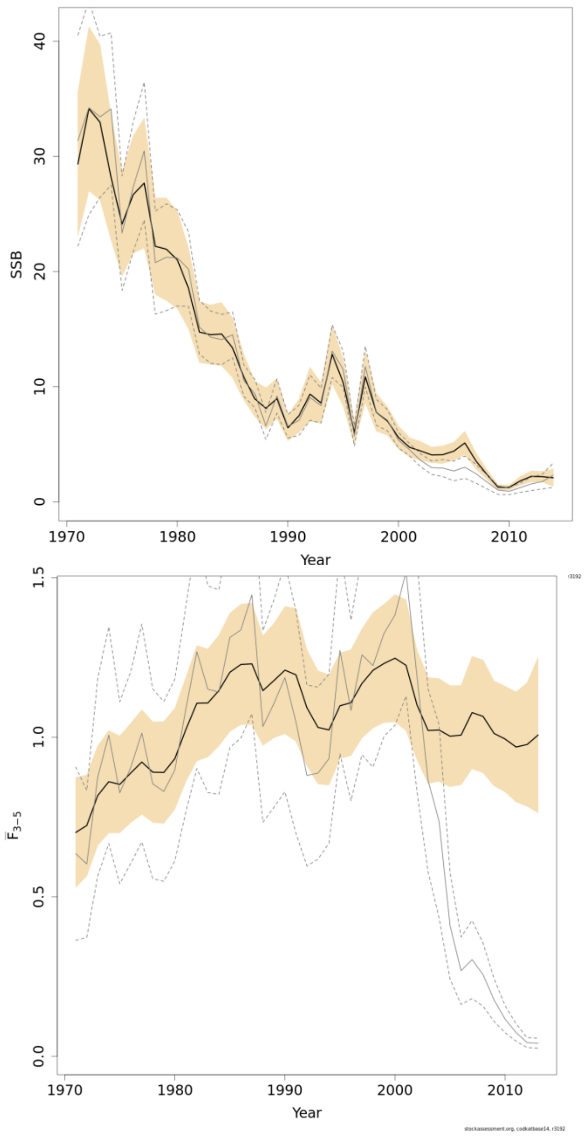


Figure 2.2.7 Estimates of SSB from the Cod survey 2008 to 2014 . The estimate of SSB 2014 is at the level of 7200 tonnes



SSB
0
10
20
30
40
1970
1980
1990
2000
2010
Year
r3192
$\overline{F}_{3-5}$
0.0
0.5
1.0
1.5
1970
1980
1990
2000
2010
Year
stockassessment.org, codkatbase14, r3192

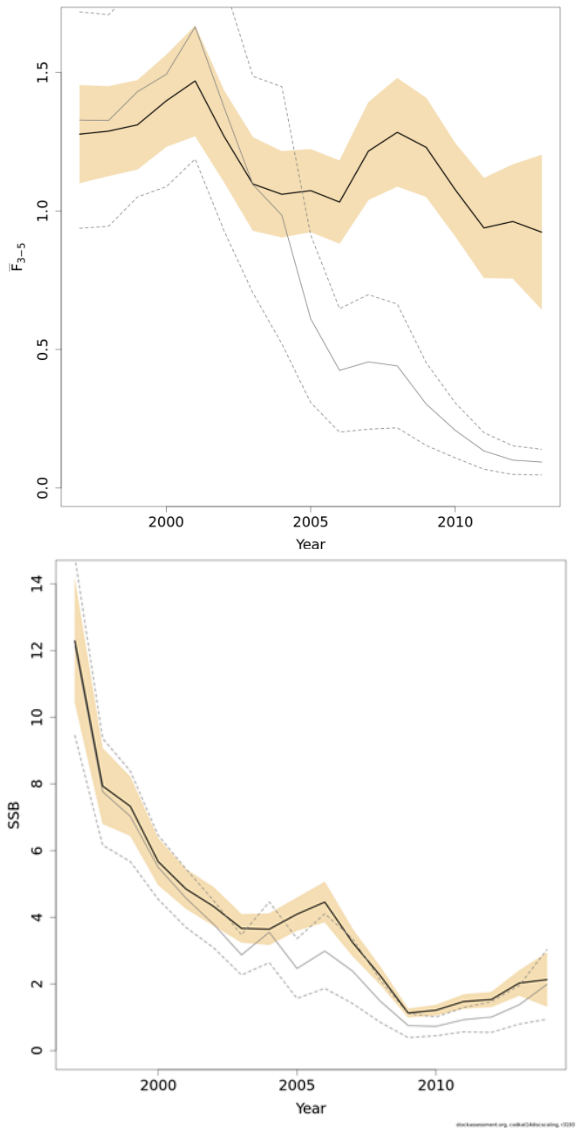


Figure 2.2.8. Cod in the Kattegatt. Mortality (z-0.2) and SSB estimates. SSB (upper panel left) and Z (upper panel right) for the run with landings without (grey lines) and with estimating total removals within the model. SSB (lower panel left) and Z (lower panel right) for the run with discards without (grey lines) and with estimating total removals within the model.. The dashed lines and the brown area surrounding the lines shows 95 % confidence intervals.

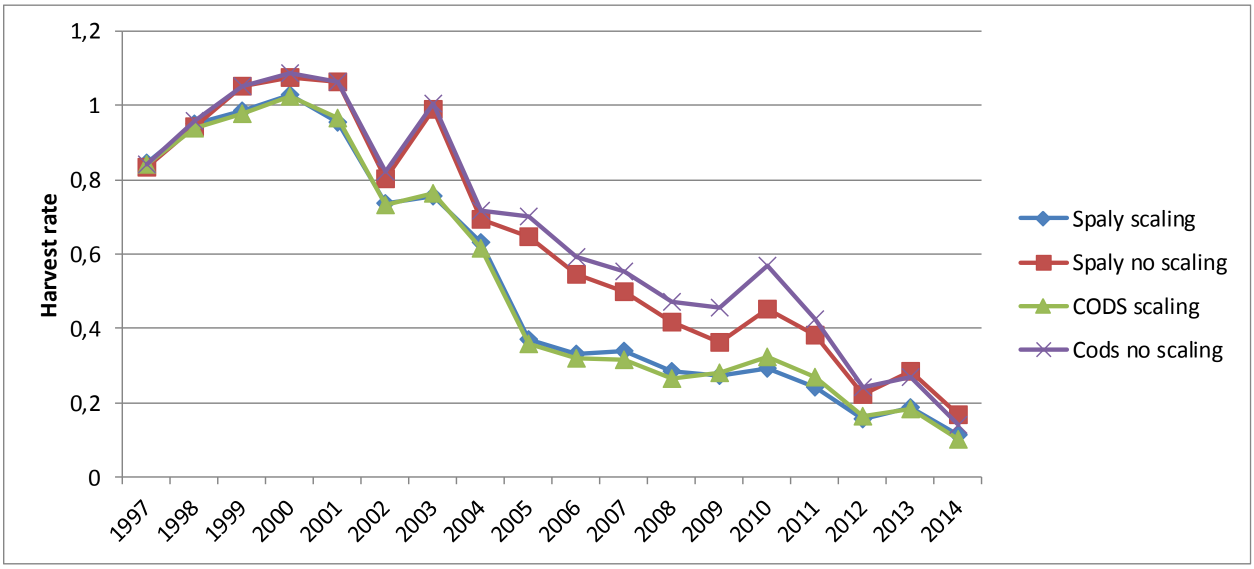


Figure 2.2.9. Cod in the Kategatt. Estimated harvest rate i.e catch (landings plus discards) divided by the SSB. From all the SAM runs.

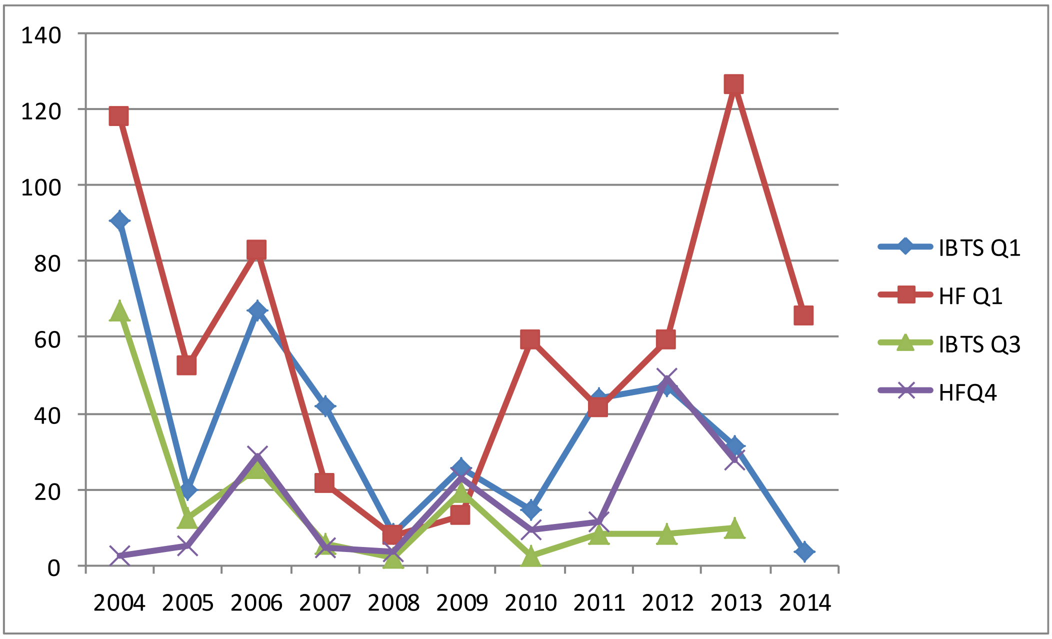


Figure 2.2.10 Cod in the Kattegat. Trends in recruitment index (Age 1) from different surveys.

a)

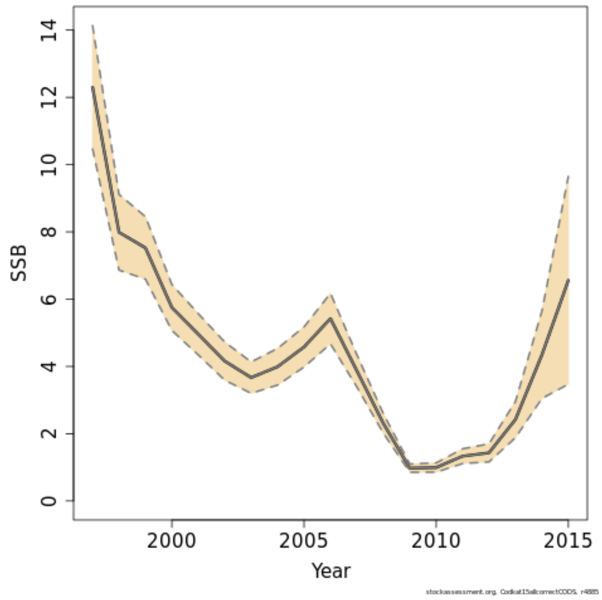
Description\Variable	Fbar 15	Fbar 16	Fbar17	SSB15	SSB16	SSB17	SSB % change	C15	C16	C17
F= Fsq , F at 0.4	0.41	0.40	0.41	7328	9135	8937	-2	6033	6484	6694

b)

Scaling factor 2014	C15	C16	C17
Mean= 10,22	590	634	654
Max=17,45	345	371	383
Min=5,99	1007	1082	1117

Figure 2.2.11 Result from exploratory short term forecast for the SAM run with SPALY +Cod survey scaled A) the catch result including scaling, the scaling factors from the year 201 is found in the left table in table b). The mean, max and min catch advice 2016 is fouand in the mid column of table b9

a)



b)

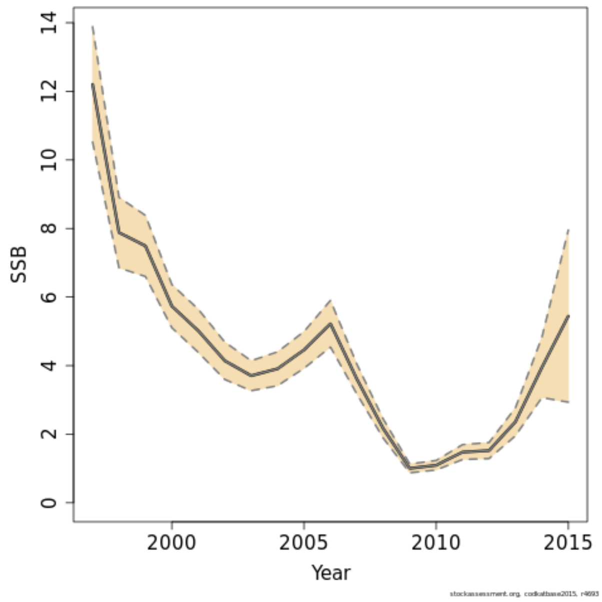
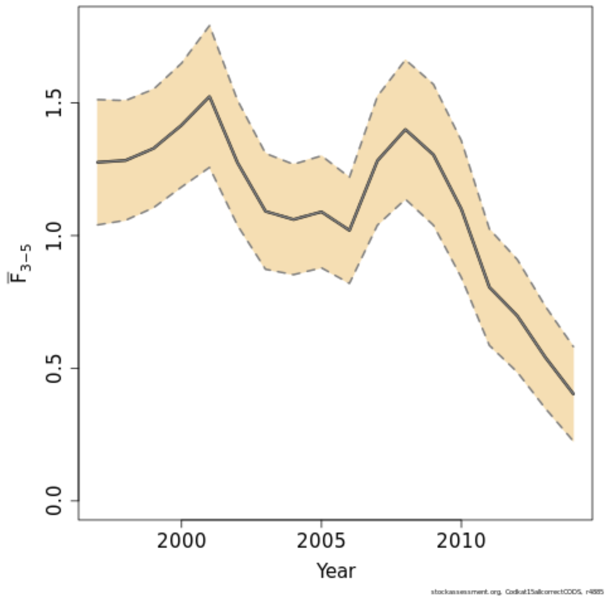


Figure 2.2.12 SSB .a) SPALY+CODS scaling b) SPALY scaling

a)



b)

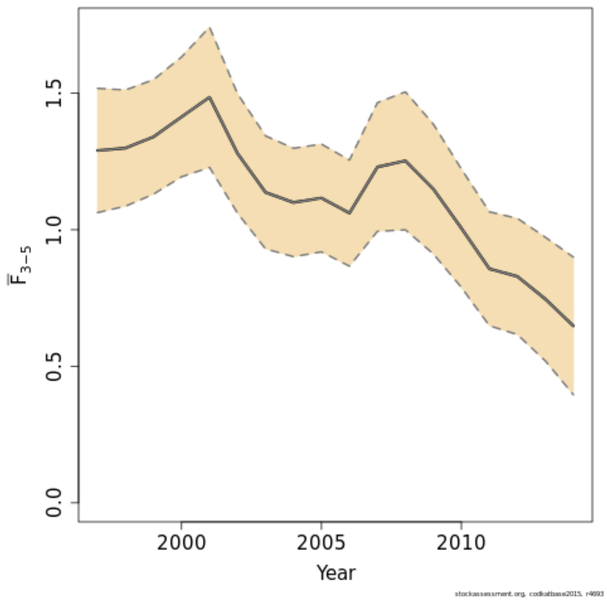
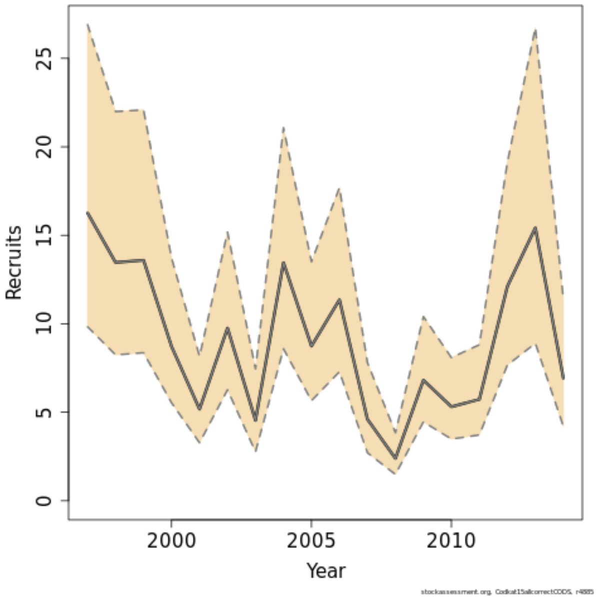


Figure 2.2.13 Unallocated mortality (Z-0.2) .a) SPALY+CODS scaling b) SPALY scaling

a)



b)

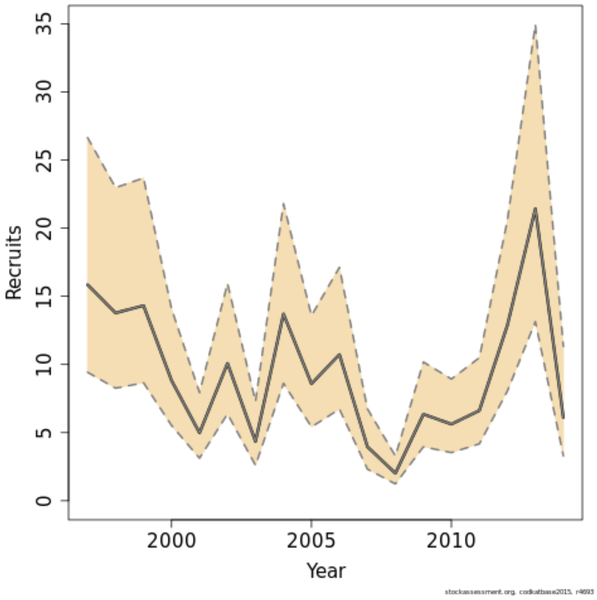
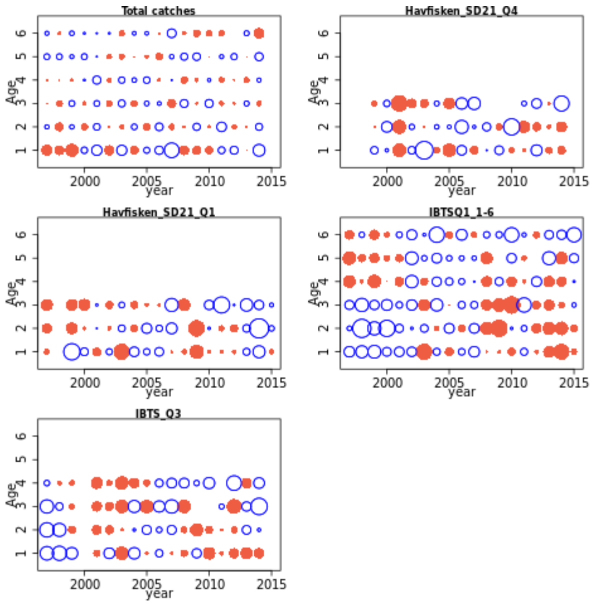


Figure 2.2.14 Unallocated mortality (Z-0.2) .a) SPALY+CODS scaling b) SPALY scaling

a)



b)

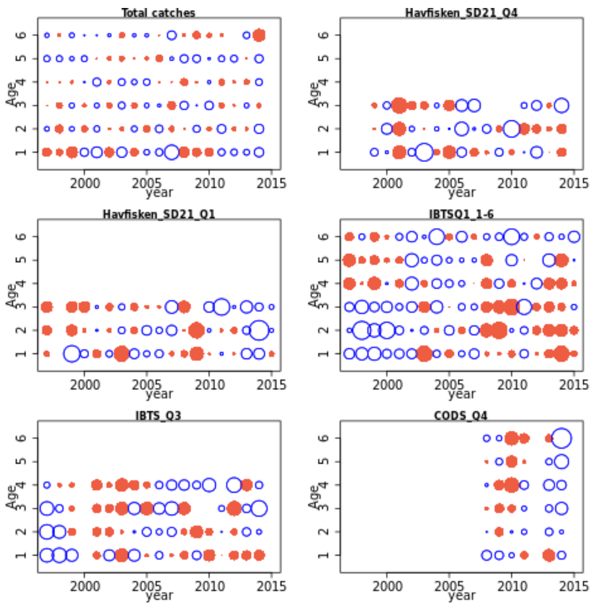


Figure 2.2.15 residuals .a) SPALY+CODS scaling b) SPALY scaling

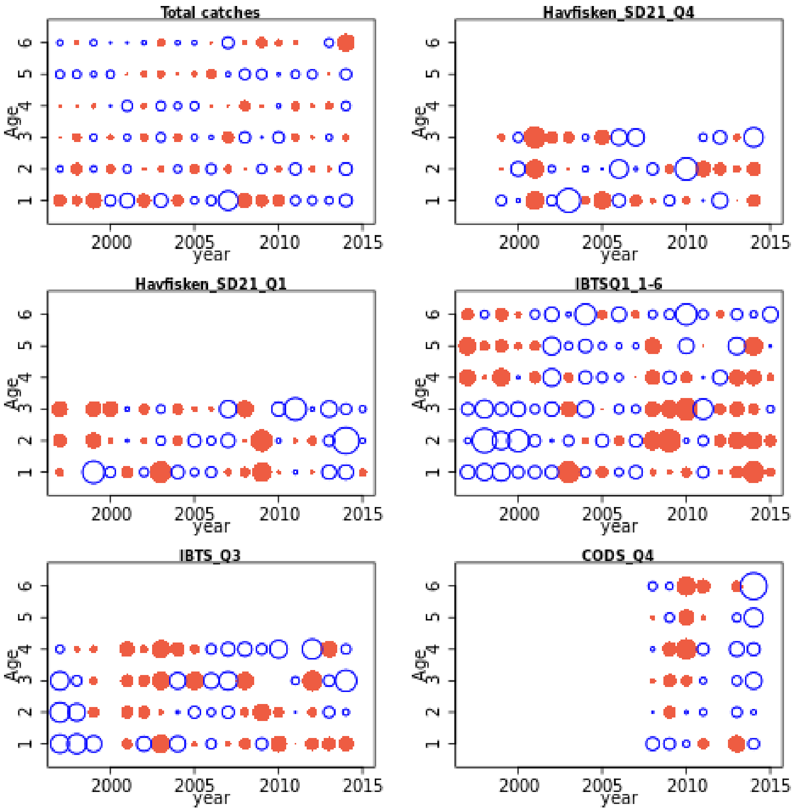
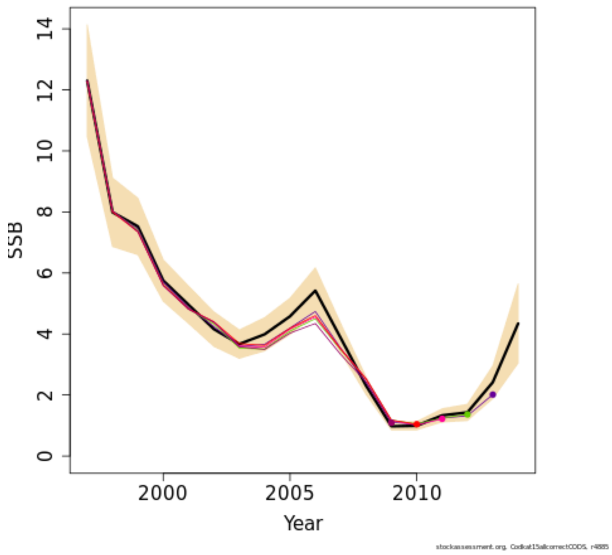


Figure 2.2.16 Cod in the Kattegatt. Residuals for the SPALY+ Cods run. The figures show normalized residuals for the current run. Blue circles indicate positive residuals (larger than predicted) and filled red circles indicate negative residuals (lower than predicted).

a)



b)

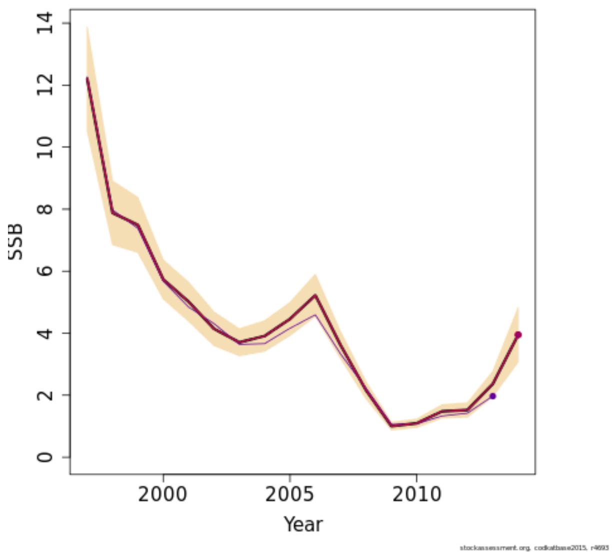
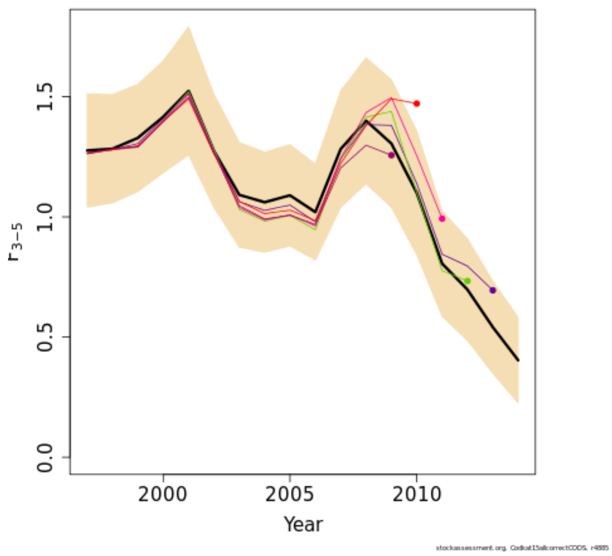


Figure 2.2.17 Retrospective_SSB .a) SPALY+CODS scaling b) SPALY scaling

a)



b)

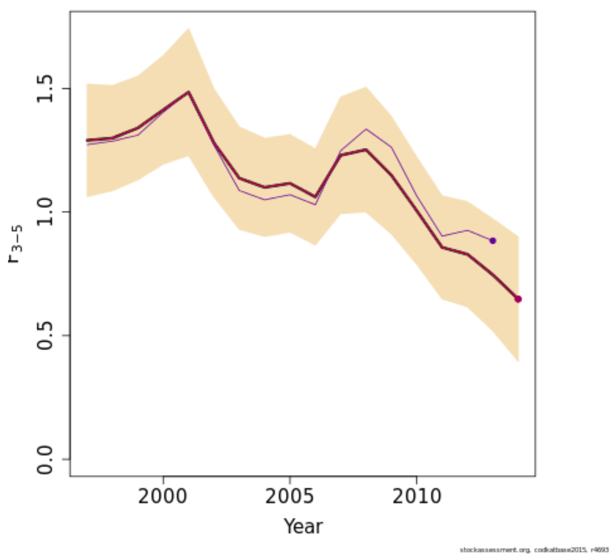
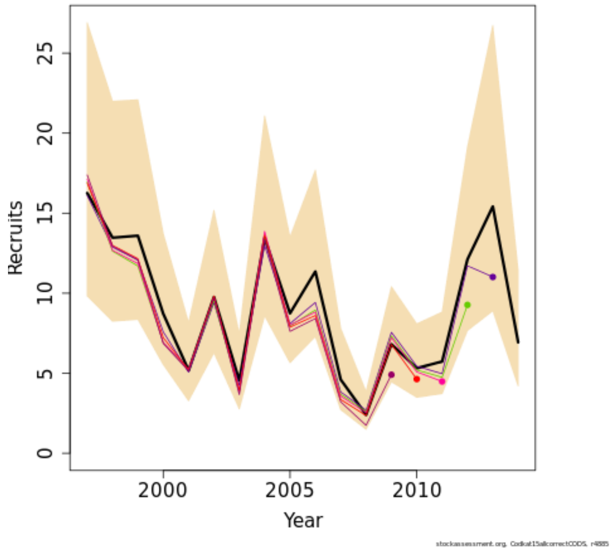


Figure 2.2.18 Retrospective_Z .a) SPALY+CODS scaling b) SPALY scaling

a)



b)

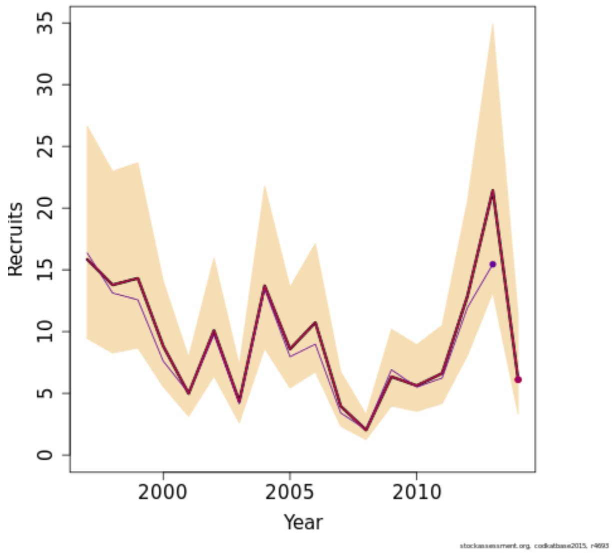


Figure 2.2.19 Retrospective_Recuitment .a) SPALY+CODS scaling b) SPALY scaling

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 < B_{pa} in 2014. F (3-5) is in 2014 estimated at 0.84.
6) Management plan. The management plan has been developed and evaluated considering the assessment for a geographical area of SD 22-24. Presently, the assessment is done for the western Baltic cod stock, and the previous management plan is thus considered no longer relevant.

2.3.1 The Fishery

Catches are mainly taken by trawlers and gillnetters; and to a small degree by Danish Seines in subdivisions 22-24. There is a trawling ban in place in subdivision (SD) 23 (the Sound), but a small area in the north of SD23 is open for trawlers. This implies that at present gillnetters are taking the major part of the commercial cod catches in SD23. In SD 22 and 24 the main part of the catches are taken by trawlers. Major part of western Baltic cod stock landings is taken in SD 22 (Figure 2.3.1). Overall catches are predominantly Danish, German and Swedish, with smaller amounts occasionally reported by other Baltic coastal states, mainly from SD24. Time series of total cod landings by SD in the management area of SD 22-24 are given in Table 2.3.1; and landings by passive and active gear in 2014 are given in Table 2.3.2 (both include eastern Baltic cod landings in SD 24).

2.3.1.1 Fisheries regulations

Since 2015, a discard ban is in place, obliging the fisheries to land the entire catch of cod, with a "conservation reference size" of ≥35 cm (for commercial use) and a "Below minimum landing size" (BMS) of <35 cm. This regulation replaced the minimum landings size of 38 cm valid until end of 2014. For information on historical regulations, see Stock Annex.

2.3.1.2 Commercial landings

In 2014, the reported commercial landings of the Western Baltic cod stock were estimated at 8.0 thousand tonnes, 4.3 thousand tonnes of which were taken in SD 22 (Table 2.3.1, Figure 2.3.1). The landings in SD 22 by EU sorting categories are shown in Figure 2.3.2.

Commercial cod landings in SD 24 were adjusted for the assessment purpose, to include only those representing the WB cod population. To do this, weighted average of the proportions of WB cod in SD 24 in the 2 sub-areas (Area 1 and Area 2 in Figure 2.3.5, see section 2.3.2.1 for separation between the stocks) was applied. The weightings for each year represented relative proportions of Danish and German (main part of fisheries in SD 24) commercial cod landings taken in Areas 1 and 2, in each year.

2.3.1.3 Discards

All countries uploaded their data to InterCatch. Discard data from at-sea observer programs for 2014 were available from Germany, Sweden, Denmark and Poland for SD 22-24. Denmark does not sample discards of passive gears and assumes zero discards. Discards of the passive gear of Denmark were raised using mainly discard ratios from Germany and Sweden (Table 2.3.8b).

The discards are not entirely comparable to previous assessments for the management area of SD 22-24 because after the benchmark 2015, only discard data from 22-23 are considered (Table 2.3.3). For the western Baltic cod stock in SD 24, a similar proportion of discards compared to landings as in SD 22-23 is assumed. Cod discards in SD 22-23 are remarkably lower than those previously estimated for cod 22-24 because of the higher discard level of trawlers in SD24 as well as the high discards originating from long-liners in SD24. In SD 22-23, the active and passive gear displayed discard rates of about 10 and 2%, respectively (Table 2.3.4). In SD24, discards rates were higher (22% for active, 9% for passive gear, the latter mainly due to the contribution of high discard rates from long-liners). The discard data from SD 24 are not included in the discard estimates for western Baltic cod stock.

The total discard of Western Baltic cod (SD 22-23 data up-scaled to include the discards associated with western Baltic cod landings in SD 24) in 2014 were estimated at 1.266 mill individuals or 452 t (5 % of the total commercial catch in weight).

The discard weights at age for 2014 were included in the catch-at-age weights (see section 2.3.2.3).

2.3.1.4 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 1800-3000 t in the years 2005-2014. The earlier years are extrapolated based on the estimates for the recent period (WKBALT 2013).Recreational catches are mainly taken by private and charter boats and to a small degree by land-based fishing methods. Since 2008 the majority of cod harvested were taken in SD 24, while the majority of released cod were from SD 22.

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 as well should be made in the future. The amount of recreational catch included in the assessment compared to commercial landings and discards is shown in Figure 2.3.3 and Table 2.3.5.

All German recreational cod catch in SD 22-24 is assumed to be WB cod (WKBALTCOD 2015).

2.3.1.5 Total catch

Total catches in the management area of western Baltic (SD 22-24), including commercial landings, discards and recreational catch of western Baltic cod stock, and landings and discards of eastern Baltic cod in SD 24 are shown in Table 2.3.5.

2.3.1.6 Data quality

Denmark, Germany, Sweden, and Poland provided quarterly landings, LANUM and WELA by gear type and Subdivisions (Table 2.3.6). Finland and Latvia provided landings only.

Denmark and Sweden sample landings via harbour-sampling and sample discard via at-sea sampling. Germany samples catches (i.e. both landings and discards) via at-sea observers and purchased samples from commercial vessels. 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 2014 are given in Table 2.3.7.

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 2014 (i.e. the allocation overview) applied in InterCatch is given in Table 2.3.8a for landings and in Table 2.3.8b for discards.

The age distribution of the discards shows that major discards of cod-2223 originated from German trawlers in quarter 1 (Figure 2.3.4). Many cod age 3 were discarded in 2014 in certain strata.

The age distribution of the landings shows that the Danish landings of cod-2223 from quarter 1 in SD22 contained significantly older fish than those most other strata. Most landed cod were age 3, followed by age 4 and 5.

Unlike the previous years, differences in age distribution between countries were not apparent. The greater ages of Danish landings from quarter 1 in SD22 (Figure 2.3.4) apparently reflect real differences in the size composition of the landings between Denmark and Germany (WKBALTCOD 2015).

Sampling levels in German recreational fisheries are shown in Tables 2.3.9 and 2.3.10.

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 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) in Figure 2.3.5.

In 2014, 51 % of cod in SD 24 was found to be WB cod in Area 1 and 25 % in Area 2 (Table 2.3.11).

2.3.2.2 Age compositions of catch

Time series of commercial landings, discards, recreational catch and total catch at age are shown in Tables 2.3.12, 2.3.13, 2.3.14 and 2.3.15, respectively. Age composition information is only used from SD 22-23. Commercial catch at age for the entire western cod population (i.e. including western Baltic cod in SD 24) were obtained by upscaling the catch at age in SD 22 by the ratio of landings 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 2014 was age-group 2, a relatively large year class. The share of cod older than age 4 is less than 10 % (Figure 2.3.6). The main part of estimated discards for the western Baltic cod stock is age-groups 1 and 2 in numbers (Figure 2.3.6 and 2.3.7).

Preliminary data from a few observer trips in the 1st quarter of 2015 indicates that the cod between 35 and 38 cm in length are still present in Danish discard data from SD 22, despite the minimum conservation reference size at 35 cm.

2.3.2.3 Mean weight at age

Mean weight at age in commercial landings, discards and in total catch is shown in Tables 2.3.16, 2.3.17 and 2.3.18, respectively, 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 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 catch (Table 2.3.19).

2.3.2.4 Maturity Ogives

The maturity ogive estimations are based on data from BITS 1st quarter surveys in SD 22-23 (Table 2.3.20) and represents spawning probability (see Stock Annex and WKBALT 2013 for details). 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 2.3.21).

2.3.3 Catch-at-age Analysis

2.3.3.1 Tuning fleets

The tuning series used in the assessment are BITS 1st and 4th quarter 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 2.3.22. 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 (until 13 degrees longitude).

FLEET	Year range	Age range
BITS, Q4, SD22-24W (13 degrees)	2001- 2014	age 0-4
BITS, Q1, SD22-24W (13 degrees)	2001- 2015	age 1-4

Internal consistency of all tuning series is presented in Figure 2.3.9.

2.3.3.2 Stock assessment runs

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 assessment results.

The summaries for SSB, Recruitment and F from the final run are shown in Figure 2.3.11 and Table 2.3.23. Stock number and fishing mortalities are presented in Tables 2.3.24, 2.3.25, respectively. The residuals of the final run are presented in Figure 2.3.12. Estimated catchabilities by age are presented in Figure 2.3.13.

The retrospective analysis (Figure 2.3.14) does not indicate systematic bias and the estimates are generally within the confidence intervals of the final estimates.

The input data and setting are visible in www.stockassessment.org, the stock is "WBcod_2015".

2.3.4 Historical stock trends

The SSB of the western Baltic cod stock has been estimated at around 35 kt in the mid-1990s. Thereafter it decreased to around 15 kt in late 2000s. Since 2014, the SSB has increased and was estimated at 24 kt in the beginning of 2015, which is, however, still below Blim (27.4 kt) and Bpa (38.4 kt).

F (3-5) of the Western Baltic cod has been at around 1.0 until mid-2000s when it decline to around 0.8 where it has remained until 2014.

2.3.5 Recruitment estimation

Recruitment in the 1990s and early 2000s was generally higher than estimated for the last 10 years. The 2012 and 2013 year-classes were above the average observed in the last 10 years, and the estimate for 2014 is on an average level of this period.

2.3.6 Short-term forecast and management options

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

From the assessment model it takes the final estimates of fishing mortality and stock numbers, 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 2.3.26 and the different management options are shown in Table 2.3.27.

2.3.7 Reference points

The cod in SD 22-24 is subject to an EU long-term management plan. ICES evaluated the EC management plan in March 2009 and concluded that the plan is in accordance with the precautionary approach. The management plan has an F target = 0.6 (based on ages 3-6) with a 10% in- or decrease of F until F target is reached, with a maximum of ± 15% in the TAC between years.

WKBALTCOD (2015) estimated Fmsy at 0.26 (F3-5)

Biomass reference points Blim= 27.4kt and Bpa at 38.4kt (WKBALT COD 2015). Bpa is considered to correspond to Bmsy trigger.

2.3.8 Quality of assessment

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 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 2223 + 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). Therefore, despite the uncertainties mentioned above, this years´ assessment is considered to provide a more reliable perspective of stock status of the western Baltic cod stock.

2.3.9 ADG notes

The ADG noted that, while the retrospective bias in F did not occur this year, SSB was estimated 32% lower than last year. The EG is encouraged to provide an explanation for the reasons of such a difference when they occur.

The basis for the assessment was revised compared to last year, and is now for the western Baltic cod stock only.

2.3.10 Comparison with previous assessment

In previous years the assessment was conducted for an area of SD 22-24 that includes a fraction of the eastern Baltic cod stock. This year's assessment is for the western Baltic cod stock only. Therefore the estimates from this year's assessment are not directly comparable with the estimates from earlier assessments.

2.3.11 Management considerations

The management area of SD 22-24 contains a mixture of eastern and western Baltic cod populations particularly in SD 24. Thus, part of the catches taken in the management area of SD 22-24 originates from the eastern Baltic cod stock. The eastern Baltic cod landings and discards in SD 24 in 2014 were 5439 tons and 1682 tons, respectively.

The current stock assessment refers to the Western Baltic cod stock only.

Table 2.3.1 Cod in management area of SD 22-24. Total landings (tons) of cod in the ICES Sub-divisions 22, 23, 24. (includes eastern cod landings in SD 24)

	Denmark			Finland	German Dem.Rep.[1]	Germany, FRG		Estonia		Lithuania	Latvia	Poland	Sweden			Total				
	22	23	22+24	24	22+24	22	22+24	22	24	24	24	24	22	23	22+24	22	23	24	Unalloc.	
1965			19457		9705		13350								2182	27867		17007		44874
1966			20500		8393		11448								2110	27864		14587		42451
1967			19181		10007		12884								1996	28875		15193		44068
1968			22593		12360		14815								2113	32911		18970		51881
1969			20602		7519		12717								1413	29082		13169		42251
1970			20085		7996		14589								1289	31363		12596		43959
1971			23715		8007		13482								1419	32119		14504		46623
1972			25645		9665		12313								1277	32808		16092		48900
1973			30595		8374		13733								1655	38237		16120		54357
1974			25782		8459		10393								1937	31326		15245		46571
1975			23481		6042		12912								1932	31867		12500		44367
1976		712	29446		4582		12893								1800	33368	712	15353		49433
1977		1166	27939		3448		11686							550	1516	29510	1716	15079		46305
1978		1177	19168		7085		10852							600	1730	24232	1777	14603		40612
1979		2029	23325		7594		9598							700	1800	26027	2729	16290		45046
1980		2425	23400		5580		6657							1300	2610	22881	3725	15366		41972
1981		1473	22654		11659		11260							900	5700	26340	2373	24933		53646
1982		1638	19138		10615		8060							140	7933	20971	1778	24775		47524
1983		1257	21961		9097		9260							120	6910	24478	1377	22750		48605
1984		1703	21909		8093		11548							228	6014	27058	1931	20506		49495
1985		1076	23024		5378		5523							263	4895	22063	1339	16757		40159
1986		748	16195		2998		2902							227	3622	11975	975	13742		26692
1987		1503	13460		4896		4256							137	4314	12105	1640	14821		28566
1988		1121	13185		4632		4217							155	5849	9680	1276	18203		29159
1989		636	8059		2144		2498							192	4987	5738	828	11950		18516
1990		722	8584		1629		3054							120	3671	5361	842	11577		17780
1991		1431	9383				2879							232	2768	7184	1663	7846		16693

	Denmark			Finland	German Dem.Rep.[1]	Germany, FRG		Estonia		Lithuania	Latvia	Poland	Sweden			Total				
	22	23	22+24	24	22+24	22	22+24	22	24	24	24	24	22	23	22+24	22	23	24	Unalloc.	
1992		2449	9946				3656							290	1655	9887	2739	5370		17996
1993		1001	8666				4084							274	1675	7296	1275	7129	5528	21228
1994		1073	13831				4023							555	3711	8229	1628	13336	7502	30695
1995		2547	18762	132			9196				15			611	2632	16936	3158	13801		33895
1996		2999	27946	50			12018		50		32			1032	4418	21417	4031	23097	2300	50845
1997		1886	28887	11			9269		6			263		777	2525	21966	2663	18995		43624
1998		2467	19192	13			9722		8		13	623		607	1571	15093	3074	16049		34216
1999		2839	23074	116			13224		10		25	660		682	1525	20409	3521	18225		42155
2000		2451	19876	171			11572		5		84	926		698	2564	18934	3149	16264		38347
2001		2124	17446	191			10579		40		46	646		693	2479	14976	2817	16451		34244
2002		2055	11657	191			7322				71	782		354	1727	11968	2409	9781		24158
2003		1373	13275	59			6775				124	568		551	1899	9573	1925	13127		24624
2004		1927	11386				4651				221	538		393	1727	9091	2320	9430	13	20854
2005		1902	9867	2			7002	72	67		476	1093		720	835	8729	2621	10686	9	22045
2006		1899	9761	242			7516		91		586	801			1855	9979	1914	10858		22751
2007		2169	8975	220			6802		69		273	2371		534	2322	7840	2713	13183		23736
2008		1612	8582	159			5489		134		30	1361		525	2189	5687	2139	12256		20082
2009		567	7871	259			4020		194		23	529		269	1817	3451	839	11259		15549
2010		689	6849	203			4250			9	159	319		490	1151	3925	1179	9016		14120
2011		783	7799	149			4521				24	487		414	2153	5493	1198	9641		16332
2012		733	8381	260			4522		3		11	818		390	1955	4896	1123	11053		17072
2013		580	6566	50			3237				128	708		380	1317	4675	960	7333		12968
2014	2206	795	6804	7		2109	3243				39	854	1	565	1231	4316	1361	7862		13538

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

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

Year:	2014	Gear:	Active and passive gear combined	
Sub-div.	22	23	24	22-24
Country:				
Denmark	2206	795	4597	7599
Germany	2109	0	1134	3243
Sweden	1	565	1231	1796
Poland	0	0	854	854
Finland	0	0	7	7
Latvia	0	0	39	39
Estonia	0	0	0	0
Lithuania	0	0	0	0
Russia	0	0	0	0
Total	4316	1361	7862	13538

Year:	2014		Gear:	Active gear
Sub-div.	22	23	24	22-24
Country:				
Denmark	1116	40	3893	5048
Germany	1306	0	821	2128
Sweden	0	0	791	792
Poland	0	0	448	448
Finland	0	0	7	7
Estonia	0	0	0	0
Lithuania	0	0	0	0
Russia	0	0	0	0
Latvia	0	0	0	0
Total	2423	40	5960	8422

Year:	2014		Gear:	Passive gear
Sub-div.	22	23	24	22-24
Country:				
Denmark	1090	756	705	2550
Germany	803	0	313	1115
Sweden	1	565	439	1005
Poland	0	0	406	406
Latvia	0	0	39	39
Estonia	0	0	0	0
Finland	0	0	0	0
Lithuania	0	0	0	0
Russia	0	0	0	0
Total	1893	1321	1901	5116

Table 2.3.3 Western Baltic cod. Discards (Number *1000) in SD 22-23 in 2014. by quarter and gear type.

Sum of DISCARD	Quarter				
Gear type	1	2	3	4	Grand Total
Passive gears	40	25	66	51	182
Active gears	395	163	41	95	694
Grand Total	435	188	107	146	876

Table 2.3.4 Cod in SD 22-24. Discard rates (in weight) by active and passive gear and by SD in the management area of SD 22-24 in 2014.

Area	Fleet	% discard
SD22	Active	9
	Passive	2
SD23	Active	11
	Passive	2
SD24	Active	22
	Passive	8

Table 2.3.5. Western Baltic cod. Catches in the WB management area (SD 22-24) for WB and EB stocks (in tonnes)

Year	WB cod			EB cod		Total			Total catch in SD 22-24	TAC in SD 22-24
	Landings	Discards	Recreational catch	Landings	Discards[1]	Landings	Discards	Recreational catch		
1994	21409	2386	1991	1784	NA	23193	NA	1991		
1995	29854	2896	2163	4041	NA	33895	NA	2163		
1996	38335	8851	2192	10210	NA	48545	NA	2192		
1997	37009	4405	2337	6615	NA	43624	NA	2337		
1998	29628	7044	2205	4588	NA	34216	NA	2205		
1999	35817	5202	2278	6338	NA	42155	NA	2278		
2000	31653	3231	2244	6694	NA	38347	NA	2244		
2001	26983	3181	2335	7261	NA	34244	NA	2335		
2002	19592	1077	2218	4566	NA	24158	NA	2218		
2003	18055	4318	2187	6569	NA	24624	NA	2187		
2004	15916	3010	2474	4925	NA	20841	NA	2474		29600
2005	16845	2013	2967	5191	NA	22036	NA	2967		24700
2006	16472	1878	1959	6279	NA	22751	NA	1959		28400
2007	15859	1014	1781	7876	1186	23736	2200	1781	27716	26700
2008	11148	103	1765	8934	1020	20082	1123	1765	22970	19200
2009	7093	247	2888	8456	568	15549	815	2888	19252	16300
2010	7641	942	2607	6479	429	14120	1371	2607	18098	17700
2011	8845	230	2032	7487	551	16332	781	2032	19145	18800
2012	8654	307	2354	8419	598	17072	905	2354	20331	21300
2013	7742	274	2428	5226	1976	12968	2250	2428	17646	20000
2014	8099	452	2891	5439	1682	13538	2134	2891	18563	17037

[1] calculated by substracting the discards estimated for WB cod populations from the previously used discards for the area of SD 22-24

Table 2.3.6. 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 2014

Year:		Gear:	Trawl and gillnet combined			
Year:	2014	Quarter:	1			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1						
2	272	808	30	965	302	824
3	311	1405	117	1384	427	1399
4	326	2765	53	1912	379	2646
5	65	4034	12	2592	77	3809
6	72	5714	9	3499	81	5468
7	6	5051	2	4250	8	4851
8	1	8298	2	1805	3	4749
9	1	9588	1	5846	2	8141
10	3	13039	0	13696	3	13129
11	1	16082	0	16082	1	16082
SOP [t]	2329		372		2705	
Landings (t)	2329		376		2705	

Year:	2014	Quarter:	2			
Sub-div,	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1						
2	280	813	46	944	326	831
3	88	1208	29	1387	117	1252
4	36	2989	18	2304	55	2759
5	5	4224	2	3858	6	4122
6	6	6998	3	4932	9	6295
7	1	5051	0	7120	1	5325
8			0	8304	0	8304
9			0	9590	0	9590
10			0	13039	0	13039
11			0	16082	0	16082
SOP [t]	508		150		658	
Landings (t)	508		150		658	

Year:	2014	Quarter:	3			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	2	557			2	557
2	315	962	126	1023	441	979
3	79	1729	48	1587	127	1676
4	63	3666	22	2121	85	3262
5	5	4543	2	2157	7	3810
6	2	6644	3	3643	5	4996
7			0	7400	0	7400
8						
9						

10+						
SOP [t]	708		266		967	
Landings (t)	708		269		977	

Year:	2014	Quarter:	4			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	19	834	8	983	28	879
2	447	1108	407	1111	854	1110
3	60	1989	46	1380	107	1725
4	34	3397	11	2529	44	3189
5	3	4694	2	3867	4	4388
6	3	7860	1	4798	4	6903
7	0	7280	0	7280	0	7280
8						
9						
10+						
SOP [t]	778		566		1336	
Landings (t)	770		566		1336	

Year:	2014	Quarter:	All			
Sub-div.	Sub-div. 22		Sub-div. 23		Sub-div. 22-23	
Age	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weight [g]	Numbers *10-3	Mean weights [g]
1	21	810	8	983	30	859
2	1315	948	609	1073	1924	988
3	538	1486	239	1424	777	1467
4	459	2953	104	2088	563	2793
5	78	4100	18	2784	95	3857
6	83	5902	16	3896	99	5577
7	7	5051	3	5142	10	5077
8	1	8298	2	1905	3	4779
9	1	9588	1	5955	2	8157
10	3	13039	0	13626	3	13128
11	1	16082	0	16082	1	16082
SOP [t]	4316		1347		5676	
Landings (t)	4316		1361		5676	

Table.2.3.7. Western Baltic cod. Number of samples by quarter for 2014 available to the Working Group (SD22-23 samples only).

			Harbour and market sampling (landings)			Sea sampling (discards)		
Country	Quarter	Total landings in tonnes	Number of samples	Number of fish measured	Number of fish aged	Number of samples	Number of fish measured	Number of fish aged
Denmark	1	1574	13	513	513	15	121	94
	2	264	7	152	152	0	0	0
	3	506	19	320	320	0	0	0
	4	657	17	257	229	8	27	17
	Total	3001	56	1242	1214	23	148	111
Germany[1]	1	944	25	3044	674	23	968	317
	2	318	14	1521	306	12	245	88
	3	356	11	1693	347	12	781	69
	4	491	6	895	247	7	225	20
	Total	2109	56	7153	1574	54	2219	494
Sweden	1	187	6	288	288	4	56	48
	2	76	9	319	319	1	9	9
	3	115	6	238	238	1	9	9
	4	188	286	9	9	3	15	14
	Total	566	307	854	854	9	89	80
Total	1	2705	44	3845	1475	42	1145	459
	2	658	30	1992	777	13	254	97
	3	977	36	2251	905	13	790	78
	4	1336	309	1161	485	18	267	51
	Total	5676	419	9249	3642	86	2456	685

[1] Germany has a catch sampling program via (1) at-sea observer, and (2) purchase of catch samples from commercial vessels. The number of samples, fish measured and aged of the landings part is given under the "Harbor and market sampling" columns, the discard part is given under the "Sea sampling" columns. Landings and discards in the catch are separated by a knife-edge approach.

Table 2.3.8a. Cod in Sub-divisions 22-23. Unsampled landings strata and allocated sampled strata in 2014.

DE_BAL22_4_Active_L,DE_BAL22_3_Active_L

DE_BAL22_4_Active_L,DK_BAL22_4_Active_L

DK_BAL23_1_Active_L,DE_BAL22_1_Active_L

DK_BAL23_1_Active_L,DE_BAL22_2_Active_L

DK_BAL23_1_Passive_L,DE_BAL22_1_Passive_L

DK_BAL23_1_Passive_L,SE_BAL23_1_Passive_L

DK_BAL23_2_Active_L,DE_BAL22_1_Active_L

DK_BAL23_2_Active_L,DE_BAL22_2_Active_L

DK_BAL23_2_Passive_L,DE_BAL22_2_Passive_L

DK_BAL23_2_Passive_L,SE_BAL23_2_Passive_L

DK_BAL23_4_Active_L,DE_BAL22_3_Active_L

DK_BAL23_4_Active_L,DK_BAL22_4_Active_L

DK_BAL23_4_Passive_L,DE_BAL22_4_Passive_L

DK_BAL23_4_Passive_L,SE_BAL23_4_Passive_L

SE_BAL22_1_Passive_L,DE_BAL22_1_Passive_L

SE_BAL22_1_Passive_L,SE_BAL23_1_Passive_L

SE_BAL22_4_Passive_L,DE_BAL22_4_Passive_L

SE_BAL22_4_Passive_L,SE_BAL23_4_Passive_L

SE_BAL23_4_Active_L,DE_BAL22_3_Active_L

SE_BAL23_4_Active_L,DK_BAL22_4_Active_L

Table 2.3.8b. Unsampled discard strata and allocated sampled strata for Western Baltic cod in 2014 (SD22-23).

DK_BAL22_1_Passive_D,DE_BAL22_1_Passive_D

DK_BAL22_1_Passive_D,SE_BAL23_1_Passive_D

DK_BAL22_2_Active_D,DE_BAL22_1_Active_D

DK_BAL22_2_Active_D,DE_BAL22_2_Active_D

DK_BAL22_2_Passive_D,DE_BAL22_2_Passive_D

DK_BAL22_2_Passive_D,SE_BAL23_2_Passive_D

DK_BAL22_3_Active_D,DE_BAL22_3_Active_D

DK_BAL22_3_Passive_D,DE_BAL22_3_Passive_D

DK_BAL22_3_Passive_D,SE_BAL23_3_Passive_D

DK_BAL22_4_Passive_D,DE_BAL22_4_Passive_D

DK_BAL22_4_Passive_D,SE_BAL23_4_Passive_D

DK_BAL23_1_Active_D,DE_BAL22_1_Active_D

DK_BAL23_1_Passive_D,DE_BAL22_1_Passive_D

DK_BAL23_1_Passive_D,SE_BAL23_1_Passive_D

DK_BAL23_2_Active_D,DE_BAL22_1_Active_D

DK_BAL23_2_Active_D,DE_BAL22_2_Active_D

DK_BAL23_2_Passive_D,DE_BAL22_2_Passive_D

DK_BAL23_2_Passive_D,SE_BAL23_2_Passive_D

DK_BAL23_3_Active_D,DE_BAL22_3_Active_D

DK_BAL23_3_Passive_D,DE_BAL22_3_Passive_D

DK_BAL23_3_Passive_D,SE_BAL23_3_Passive_D

DK_BAL23_4_Passive_D,DE_BAL22_4_Passive_D

DK_BAL23_4_Passive_D,SE_BAL23_4_Passive_D

SE_BAL22_1_Passive_D,DE_BAL22_1_Passive_D

SE_BAL22_1_Passive_D,SE_BAL23_1_Passive_D

SE_BAL22_4_Passive_D,DE_BAL22_4_Passive_D

SE_BAL22_4_Passive_D,SE_BAL23_4_Passive_D

SE_BAL23_4_Active_D,DE_BAL22_4_Active_D

Table 2.3.9 Western Baltic Cod. Overview of the numbers of on-site surveys and interviewed anglers, 2005 – 2014.

YEAR	ANGLING METHOD	NUMBER OF ON-SITE SURVEYS	NUMBERS OF INTERVIEWS
2005	Charter boat angling	93	1114
	Boat angling		213
	Trolling		8
	Shore angling	90	121
	Wading		37
	Total	183	1493
2006	Charter boat angling	89	1905
	Boat angling		313
	Trolling		2
	Shore angling	79	137
	Wading		40
	Total	168	2397
2007	Charter boat angling	80	1256
	Boat angling		196
	Trolling		4
	Shore angling	82	371
	Wading		71
	Total	162	1898
2008	Charter boat angling	81	789
	Boat angling		128
	Trolling		3
	Shore angling	48	90
	Wading		43
	Total	129	1050
2009	Charter boat angling	204	1694
	Boat angling		346
	Trolling		18
	Shore angling	49	172
	Wading		51
	Total	253	2281
2010	Charter boat angling	233	1783
	Boat angling		366
	Trolling		40
	Shore angling	57	178
	Wading		50
	Total	290	2417
2011	Charter boat angling	283	2165
	Boat angling		411
	Trolling		7
	Shore angling	58	175
	Wading		51
	Total	341	2809
2012	Charter boat angling	258	1437
	Boat angling		359
	Trolling		24
	Shore angling	58	113
	Wading		25
	Total	316	1958

Year	Angling method	Number of on-site surveys	Numbers of interviews
2013	Charter boat angling	240	2391
	Boat angling, Trolling		617
	Shore angling, Wading	84	411
	Total	324	3419
2014	Charter boat angling	231	2078
	Boat angling, Trolling		493
	Shore angling, Wading	84	278
	Total	315	2849

Table 2.3.10. 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 - 2014.

Year	Sample Type	Number of Samples	Harvest n	Release n
2005	Charter boat angling	13	2862	
	Shore angling	4	1026	
	Total	17	3888	
2006	Charter boat angling	8	352	
	Shore angling	1	10	
	Total	9	362	
2007	Charter boat angling	3	26	
	Shore angling	4	506	
	Total	7	532	
2008	Boat, charter boat angling, trolling	22	266	16
	Shore angling	4	346	
	Total	26	612	16
2009	Boat, charter boat angling, trolling	77	1384	884
	Shore angling	3	3	10
	Total	80	1384	894
2010	Charter vessel sampling – survey agent	89	3734	2665
	Shore fishing – self-measurement	12	1065	31
	Total	101	4799	2666
2011	Boat, charter boat angling, trolling	61	4078	1073
	Shore angling	14	456	13
	Total	75	4534	1086
2012	Boat, charter boat angling, trolling	32	1549	530
	Shore angling			
	Total	32	1549	530
2013	Boat, charter boat angling, trolling	44	2236	1366
	Shore angling			
	Total	44	2236	1366
2014	Boat, charter boat angling, trolling	39	3333	1366
	Boat angling – self-measurement	3	403	1089
	Total	42	3736	2455

Table 2.3.11. Western Baltic cod. Percentage of western cod in Area 1 (western part of SD 24 until 13 degee longitude) and Area 2 (eastern part of SD 24, from 13 degrees east); and weighted average of those applied to extract the WB cod landings in SD 24.

Year	Area_1 (W)	Area_2 (_E)	Pct of WB cod in cod landings from 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

2.3.12 Western Baltic cod.Landings (in numbers (000)) by year and age.

Year	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

2.3.13 Western Baltic cod. Discard (in numbers (000)) by year and age.

YEAR	A1	A2	A3	A4	A5
1994	4244	2061	874	11	0
1995	3400	4704	288	28	0
1996	29146	3103	13	0	0
1997	16824	0	0	0	0
1998	21485	3422	153	0	0
1999	3163	10696	359	0	0
2000	2315	3794	2148	0	0
2001	2574	5796	397	63	0
2002	1093	1777	169	13	0
2003	939	9677	527	17	0
2004	3072	1192	3277	0	0
2005	569	4740	20	0	0
2006	889	2912	911	50	3
2007	202	1966	339	26	3
2008	0	176	63	1	0
2009	153	344	127	10	0
2010	234	1076	546	363	5
2011	143	108	134	169	3
2012	303	253	144	111	1
2013	503	82	140	78	7
2014	362	876	24	4	0

2.3.14 Western Baltic cod.German recreational catch (in numbers (000)) by year and age.

Year	A1	A2	A3	A4	A5	A6	A7
1994	503	800	651	106	40	20	14
1995	399	1091	592	217	40	26	14
1996	173	1515	450	118	76	33	11
1997	735	753	643	128	59	38	19
1998	576	1267	309	153	26	29	17
1999	250	1382	482	134	60	37	19
2000	691	925	577	107	33	26	17
2001	571	1123	437	160	48	19	12
2002	544	1080	540	123	50	21	16
2003	375	1442	371	134	20	12	10
2004	589	948	558	162	64	37	20
2005	157	2351	338	269	28	12	4
2006	116	713	1020	51	21	13	13
2007	53	682	692	244	50	22	14
2008	80	814	589	109	90	7	5
2009	331	1265	581	442	181	66	19
2010	144	2093	247	146	45	8	16
2011	160	573	1347	23	5	3	3
2012	289	862	362	504	20	9	9
2013	907	895	847	67	37	1	1
2014	379	1217	1002	277	65	18	6

Table 2.3.15 Western Baltic cod. Catch in numbers ('000) at age (incl. Landing, discards, recreational catch)

YEAR	1	2	3	4	5	6	7+
1994	5608	7674	15878	2284	118	38	28
1995	4512	17148	5771	5852	1243	157	17
1996	29414	28110	17776	836	2135	140	13
1997	19387	2750	29433	2687	381	362	96
1998	24473	23283	2591	5873	681	134	92
1999	4072	35554	13360	1731	1274	282	111
2000	3815	11172	23158	3172	159	270	64
2001	4553	17382	7464	5035	840	65	101
2002	2074	11046	9005	1717	928	279	33
2003	1963	21275	5450	1461	251	203	76
2004	3726	3651	12615	2070	401	159	103
2005	993	15473	2024	3250	371	103	53
2006	1264	5173	12810	613	594	90	27
2007	313	5958	3647	3908	465	241	47
2008	100	1591	3251	1057	961	265	133
2009	661	2052	2205	1433	687	250	99
2010	563	6489	1814	1118	478	141	70
2011	375	1546	4919	1478	296	85	43
2012	705	2422	1776	2544	546	69	23
2013	1697	1577	2716	950	782	314	69
2014	782	4755	2106	1102	204	163	30

Table. 2.3.16 Western Baltic cod. Mean weight at age in commercial landings.

AGE	1	2	3	4	5	6	7+
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	4.986
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

Table. 2.3.17 Western Baltic cod. Mean weight at age in discards

AGE	1	2	3	4
1994-2013[1]	0.262	0.391	0.531	0.469
2014	0.262	0.391	0.531	0.469

[1] the value from 2014 is applied

Table 2.3.18. Western Baltic cod. Mean weight at age in catch (combined for commercial landings, discards, recreational catch)

YEAR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7+
1994	0.300	0.701	1.309	2.368	4.112	5.261	5.290
1995	0.288	0.676	1.164	2.088	3.616	5.694	5.738
1996	0.263	0.653	1.087	2.046	2.861	5.155	5.398
1997	0.295	0.762	0.995	1.696	2.266	4.023	6.068
1998	0.292	0.690	1.144	1.906	2.951	3.921	6.141
1999	0.311	0.585	1.119	1.444	3.101	3.903	4.935
2000	0.352	0.607	0.923	1.668	3.314	5.050	6.601
2001	0.358	0.595	1.071	1.751	3.181	4.838	6.793
2002	0.358	0.665	1.116	1.708	3.350	4.112	6.114
2003	0.413	0.617	1.051	1.978	3.652	5.117	6.909
2004	0.295	0.655	0.892	1.516	3.374	4.361	5.916
2005	0.387	0.636	1.263	2.171	3.410	4.867	6.738
2006	0.276	0.504	1.046	2.280	3.627	4.351	5.481
2007	0.348	0.698	1.068	2.037	3.047	4.668	5.989
2008	0.956	0.766	1.273	2.127	3.161	4.378	6.928
2009	0.392	0.423	1.145	1.844	2.994	4.505	4.940
2010	0.431	0.793	0.991	1.462	2.871	3.443	4.609
2011	0.396	0.982	1.220	1.283	1.893	2.588	2.265
2012	0.427	0.832	1.156	1.932	2.597	2.652	3.793
2013	0.562	0.834	1.209	1.720	2.476	3.298	3.545
2014	0.374	0.807	1.315	2.511	3.307	5.288	5.177

Table 2.3.19 Western Baltic cod. Mean weight (kg) at age in stock.

YEAR	1	2	3	4	5	6	7+
1994	0.063	0.301	0.874	2.368	4.112	5.261	5.290
1995	0.063	0.301	0.874	2.088	3.616	5.694	5.738
1996	0.057	0.259	0.990	2.046	2.861	5.155	5.398
1997	0.050	0.327	0.896	1.696	2.266	4.023	6.068
1998	0.081	0.316	0.735	1.906	2.951	3.921	6.141
1999	0.042	0.285	0.801	1.444	3.101	3.903	4.935
2000	0.059	0.234	0.801	1.668	3.314	5.050	6.601
2001	0.043	0.388	0.895	1.751	3.181	4.838	6.793
2002	0.043	0.433	1.117	1.708	3.350	4.112	6.114
2003	0.054	0.321	1.032	1.978	3.652	5.117	6.909
2004	0.067	0.536	0.870	1.516	3.374	4.361	5.916
2005	0.051	0.350	1.038	2.171	3.410	4.867	6.738
2006	0.043	0.310	0.795	2.280	3.627	4.351	5.481
2007	0.073	0.411	0.908	2.037	3.047	4.668	5.989
2008	0.043	0.465	1.019	2.127	3.161	4.378	6.928
2009	0.051	0.559	1.327	1.844	2.994	4.505	4.940
2010	0.066	0.369	1.082	1.462	2.871	3.443	4.609
2011	0.045	0.360	0.767	1.283	1.893	2.588	2.265
2012	0.050	0.301	0.882	1.932	2.597	2.652	3.793
2013	0.049	0.391	0.866	1.720	2.476	3.298	3.545
2014	0.039	0.345	0.965	2.511	3.307	5.288	5.177

Table 2.3.20 Western Baltic cod. Proportion mature at age (spawning probability).

YEAR	1	2	3	4	5	6	7
1994	0.03	0.35	0.74	0.78	1	1	1
1995	0.03	0.35	0.74	0.78	1	1	1
1996	0.03	0.35	0.74	0.78	1	1	1
1997	0.03	0.35	0.74	0.78	1	1	1
1998	0.03	0.35	0.74	0.78	1	1	1
1999	0.03	0.35	0.74	0.78	1	1	1
2000	0.04	0.52	0.83	0.81	1	1	1
2001	0.01	0.49	0.82	0.92	1	1	1
2002	0.01	0.40	0.79	0.82	1	1	1
2003	0.02	0.39	0.72	0.77	1	1	1
2004	0.02	0.46	0.77	0.79	1	1	1
2005	0.02	0.53	0.79	0.92	1	1	1
2006	0.01	0.70	0.88	0.98	1	1	1
2007	0.02	0.79	0.91	0.98	1	1	1
2008	0.03	0.81	0.87	0.95	1	1	1
2009	0.03	0.70	0.85	0.88	1	1	1
2010	0.17	0.69	0.80	0.84	1	1	1
2011	0.14	0.67	0.86	0.88	1	1	1
2012	0.19	0.67	0.81	0.89	1	1	1
2013	0.10	0.67	0.86	0.88	1	1	1
2014	0.08	0.67	0.81	0.89	1	1	1

Table 2.3.21 Western Baltic cod. Natural mortality at age.

Year	0	1	2	3	4	5	6	7+
1994	0.8	0.27	0.2	0.2	0.2	0.2	0.2	0.2
1995	0.8	0.29	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.8	0.29	0.2	0.2	0.2	0.2	0.2	0.2
1997-2014	0.8	0.24	0.2	0.2	0.2	0.2	0.2	0.2

Table 2.3.22. Western Baltic cod. Tuning fleets.

BITS Q4					
Year	a0	a1	a2	a3	a4
2001	13728.8	940.7	472.4	42.1	78.4
2002	1659.8	2272.8	390.7	86.5	13.1
2003	16877.8	1415.4	923.6	33.4	40.2
2004	5960.9	12549.6	942.2	98.4	17.8
2005	4981.4	2845.2	1694.1	40.6	70.2
2006	2695.2	4077.6	354.4	258.5	73.2
2007	555.2	421.9	196.0	67.4	277.5
2008	23354.2	60.4	61.7	31.9	68.6
2009	3155.5	2695.3	66.5	42.1	21.8
2010	11324.6	952.0	578.6	11.7	11.5
2011	4094.6	1948.9	125.8	69.8	5.5
2012	18383.6	1838.2	363.6	25.3	55.9
2013	8410.4	4482.2	208.7	34.6	21.9
2014	6858.8	1869.2	814.5	67.4	56.2
BITS Q1					
Year	a1	a2	a3	a4	
2001	5024.7	4006.9	620.5	439.4	
2002	11012.6	2295.6	945.2	95.9	
2003	939.5	3461.9	268.6	129.1	
2004	9719.3	1229.9	1201.9	49.2	
2005	7613.2	25494.0	660.0	491.1	
2006	11324.8	4754.4	3914.7	100.9	
2007	2190.1	7583.3	1170.1	1010.0	
2008	102.6	813.4	611.5	227.2	
2009	7384.9	621.5	467.1	205.6	
2010	2944.2	8253.3	181.5	108.8	
2011	10289.9	5761.6	7017.7	34.9	
2012	2020.5	2760.3	876.1	755.0	
2013	7258.1	2371.9	1302.9	165.9	
2014	4329.9	3814.8	364.2	146.8	
2015	2848.4	4247.4	1070.0	107.8	

Table 2.3.23. Western Baltic cod. Estimated recruitment (millions), total stock biomass (TBS), spawning stock biomass (SSB) (tonnes), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits (Age 1)	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1994	65186	35813	118648	49415	37428	65239	31666	23156	43304	1.021	0.825	1.263
1995	90672	50396	163136	51948	41822	64526	31257	24674	39596	1.144	0.952	1.373
1996	25387	13267	48580	54339	43235	68296	34269	27231	43126	1.109	0.937	1.313
1997	80098	45413	141272	53051	40920	68777	35561	26808	47172	1.117	0.946	1.32
1998	111302	63157	196147	52418	41961	65480	27529	22023	34411	1.131	0.957	1.336
1999	38910	22326	67812	53584	42174	68080	31761	25311	39856	1.249	1.055	1.478
2000	41481	24276	70880	48243	37810	61555	36534	28163	47393	1.216	1.038	1.425
2001	27502	16736	45191	40905	33646	49730	30730	25139	37565	1.256	1.068	1.476
2002	44623	27801	71622	35066	28843	42633	24416	19924	29921	1.22	1.036	1.437
2003	14704	8748	24715	31195	25620	37983	19176	15942	23065	1.116	0.95	1.311
2004	64344	39931	103682	32958	26796	40538	21068	16801	26417	1.089	0.919	1.289
2005	23766	14922	37852	38754	31250	48062	27065	22038	33239	0.977	0.819	1.165
2006	22584	13784	37001	36207	28923	45325	31195	24807	39226	0.868	0.701	1.075
2007	7606	4749	12181	35277	28582	43541	32370	26053	40220	0.9	0.747	1.084
2008	3911	2041	7494	24884	20609	30047	22697	18724	27513	0.949	0.798	1.129
2009	29319	17712	48534	18972	15936	22585	15386	12823	18461	1.008	0.842	1.205
2010	11107	6943	17768	18195	14778	22402	13747	11259	16785	0.988	0.825	1.184
2011	17654	10725	29058	16923	13364	21429	13586	10635	17355	0.92	0.765	1.106
2012	12555	7761	20311	19766	15938	24513	16012	12795	20038	0.878	0.709	1.087
2013	33996	20078	57563	18064	14675	22237	14118	11382	17511	0.936	0.713	1.23
2014	23695	12489	44954	23671	17961	31196	18363	13877	24299	0.842	0.58	1.222
2015	19750	7626	51149	29822	19503	45602	23742	15399	36604			

Table 2.3.24. Western Baltic cod. Estimated stock numbers (SAM).

Year\Age	0	1	2	3	4	5	6	7+
1994	189283	65186	18555	30122	4467	315	60	45
1995	63831	90672	44936	8461	9039	1468	118	29
1996	171099	25387	68050	21178	1971	2604	348	32
1997	230499	80098	12267	34441	4853	629	650	120
1998	91400	111302	54122	5480	8398	1291	198	199
1999	90490	38910	78276	23017	1584	2065	370	126
2000	63895	41481	25540	32958	5273	336	477	115
2001	92319	27502	29673	10305	7218	1390	91	152
2002	32241	44623	19401	12136	2230	1575	385	58
2003	124991	14704	36717	7892	2553	553	387	118
2004	53263	64344	11029	17603	2191	650	180	147
2005	46028	23766	50262	5128	5030	609	164	86
2006	17499	22584	16363	24760	1824	1408	174	64
2007	8954	7606	15409	8145	7795	797	466	79
2008	64087	3911	5602	6972	2752	1978	299	183
2009	26187	29319	4234	3858	2376	919	455	137
2010	41648	11107	22857	3049	1528	677	216	130
2011	30001	17654	7539	12730	1561	493	150	78
2012	76420	12555	11663	4188	4711	720	140	55
2013	54176	33996	8198	6488	1612	1393	255	68
2014	45071	23695	23506	4724	2477	456	331	71
2015		19750	17824	14200	1881	887	134	118

Table 2.3.25 Western Baltic cod. Estimated fishing mortalities by age from SAM.

YEAR\AGE	1	2	3	4	5+
1994	0.113	0.554	1.078	0.97	1.014
1995	0.121	0.601	1.197	1.09	1.144
1996	0.122	0.601	1.184	1.062	1.082
1997	0.12	0.599	1.184	1.086	1.081
1998	0.119	0.611	1.192	1.114	1.086
1999	0.124	0.663	1.308	1.24	1.199
2000	0.12	0.659	1.293	1.204	1.152
2001	0.119	0.678	1.337	1.245	1.186
2002	0.111	0.647	1.285	1.21	1.165
2003	0.099	0.578	1.153	1.104	1.09
2004	0.089	0.527	1.076	1.075	1.114
2005	0.078	0.462	0.939	0.957	1.034
2006	0.069	0.414	0.833	0.841	0.931
2007	0.067	0.409	0.838	0.875	0.988
2008	0.064	0.395	0.837	0.919	1.091
2009	0.063	0.39	0.85	0.981	1.192
2010	0.059	0.364	0.81	0.966	1.188
2011	0.054	0.331	0.75	0.904	1.106
2012	0.052	0.312	0.716	0.867	1.051
2013	0.052	0.316	0.744	0.921	1.144
2014	0.049	0.29	0.677	0.826	1.022

Table 2.3.26 Western Baltic Cod. Input to short-term forecast.

2015

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	LWt
1	20405	0.242	0.12	0	0	0.05	0.05	0.45	0.864
2		0.2	0.67	0	0	0.35	0.31	0.82	0.999
3		0.2	0.83	0	0	0.90	0.71	1.23	1.314
4		0.2	0.89	0	0	2.05	0.87	2.05	2.212
5		0.2	1.00	0	0	2.79	1.07	2.79	2.994
6		0.2	1.00	0	0	3.75	1.07	3.75	3.795
7		0.2	1.00	0	0	4.17	1.07	4.17	4.164

2016

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	LWt
1	17916	0.242	0.12	0	0	0.05	0.05	0.45	0.864
2		0.2	0.67	0	0	0.35	0.31	0.82	0.999
3		0.2	0.83	0	0	0.90	0.71	1.23	1.314
4		0.2	0.89	0	0	2.05	0.87	2.05	2.212
5		0.2	1.00	0	0	2.79	1.07	2.79	2.994
6		0.2	1.00	0	0	3.75	1.07	3.75	3.795
7		0.2	1.00	0	0	4.17	1.07	4.17	4.164

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt	LWt
1	18660	0.242	0.12	0	0	0.05	0.05	0.45	0.864
2		0.2	0.67	0	0	0.35	0.31	0.82	0.999
3		0.2	0.83	0	0	0.90	0.71	1.23	1.314
4		0.2	0.89	0	0	2.05	0.87	2.05	2.212
5		0.2	1.00	0	0	2.79	1.07	2.79	2.994
6		0.2	1.00	0	0	3.75	1.07	3.75	3.795
7		0.2	1.00	0	0	4.17	1.07	4.17	4.164

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)**
LWt	**Weight in commercial landings (kg)**

Natural mortality (M): **Constant**

Weight in the landing, catch (LWt, CWt): average of 2012-2014

Weight in the stock (SWt): average of 2012-2014

Exploitation pattern (Sel.): Average for 2012-2014

Table 2.3.27. Western Baltic cod stock. Management options.

Rational	Total catch[1] 2016	Commercial plus recreational catch 2016*		Basis	F_{total} 2016	F_{total}2016*		SSB 2017	%SSB change[6]	% TAC change[7]
		Wanted catch[2]	Unwanted catch[3]			Wanted catch[2]	Unwanted catch[3]			
MSY AR (MSY Ref)	5385	5295	90	F = 0.26 * (SSB/ MSY Bt_{rigger})	0.19	0.19	0.00	43505	58	NA
MSY (MSY Ref)	7163	7045	118	F = 0.26	0.26	0.25	0.01	41348	51	NA
MSY low (MSY Ref)	4321	4249	72	F = 0.15	0.15	0.15	0.00	44817	63	NA
MSY low AR (MSY Ref)	3221	3166	54	F = 0.15 * (SSB/ MSY Bt_{rigger})	0.11	0.1	0.01	46172	68	NA
MSY high (MSY Ref)	11543	11327	216	F = 0.45	0.45	0.44	0.01	36129	32	NA
MSY high AR (MSY Ref)	8618	8473	145	F = 0.45 * (SSB/ MSY Bt_{rigger})	0.32	0.31	0.01	39732	45	NA
Zero catch	0	0	0	F = 0	0	0	0	49947	82	NA
Management plan[4]	17317	16978	339	90% F_{2014} ($F_{3–6}$)	0.8[5]	0.78	0.02	29184	7	NA
Management plan long-term target[4]	13907	13671	236	F_{total} = 0.6 ($F_{3–6}$)	0.6[5]	0.59	0.01	33226	21	NA
Other options	12715	12472	243	F_{2014} × 0.6	0.51	0.49	0.02	34667	26	NA
				−15% TAC change****						
				0% TAC change****						
	15883	15573	310	F_{2014} × 0.8	0.68	0.66	0.02	30976	13	NA
	17346	16976	370	F_{2014} × 0.9	0.76	0.74	0.02	29330	7	NA
				+15% TAC change****						
	18703	18312	392	F_{2014} × 1.0	0.84	0.82	0.02	27717	1	NA
	19964	19562	402	F_{2014} × 1.1	0.93	0.91	0.02	26323	-4	NA
	23365	22885	480	F_{2014} × 1.4	1.18	1.15	0.03	22483	-18	NA
	2613	25685	447	F_{2014} × 1.7	1.43	1.4	0.0	19396	-29	NA

Weights in thousand tonnes.

[1] Includes commercial and recreational catch

[2]"Wanted catch" is used to describe fish that would be landed in the absence of the EU landing obligation, plus the recreational catch.

[3] The "unwanted catch" refers to the component of commercial catch that was previously discarded.

[4]The basis for management plan (cod in the area of SD 22-24) is not comparable to the basis for current stock assessment (western Baltic cod stock)

[5]The fishing mortality provided for a reference F age range of 3–6.

[6]SSB 2017 relative to SSB 2016.

[7] The calculated catches are for the western Baltic cod stock and are not comparable with the TACs or advice provided for the area of SD 22-24 in earlier years.

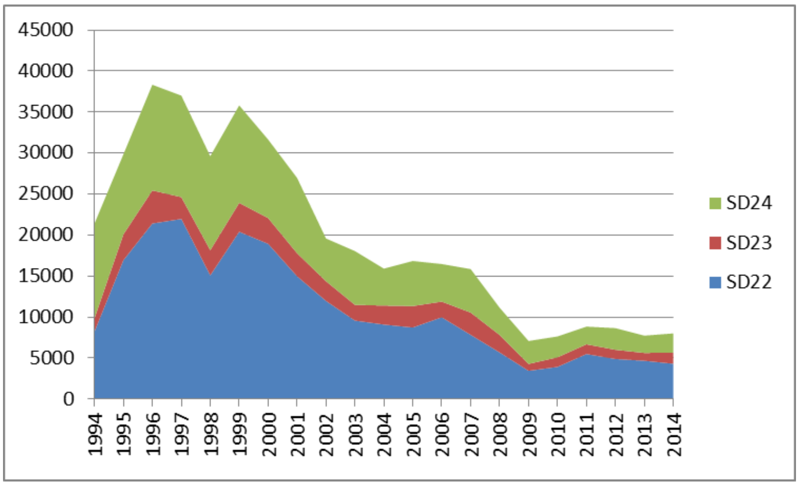


Figure 2.3.1. Western Baltic cod. Landings by SD (tonnes).

Figure 2.3.2. Western Baltic cod. Proportion of cod landings of Denmark (upper) and Germany (lower) in SD22 (by quarter 1-4 for the years 2002-2014) by EU size sorting categories 1 (7+kg) to 5 (0,3-1kg). Absolute (left) and relative (right) contributions.

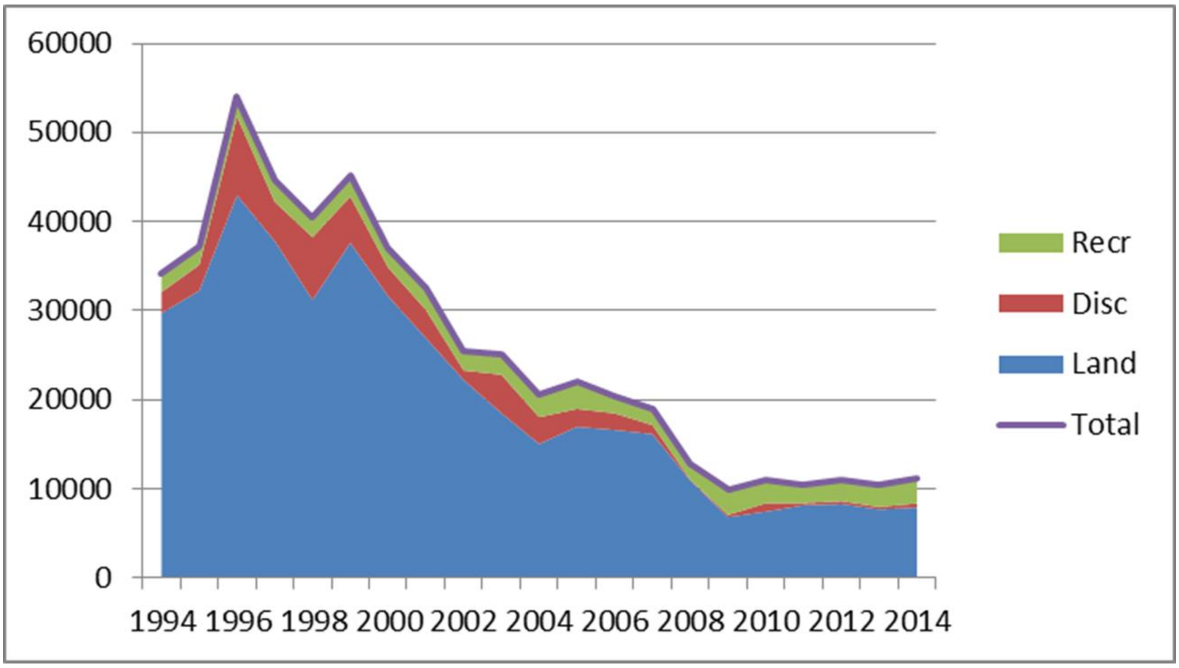


Figure 2.3.3. Western Baltic cod. Commercial landings, discard and recreational catch.

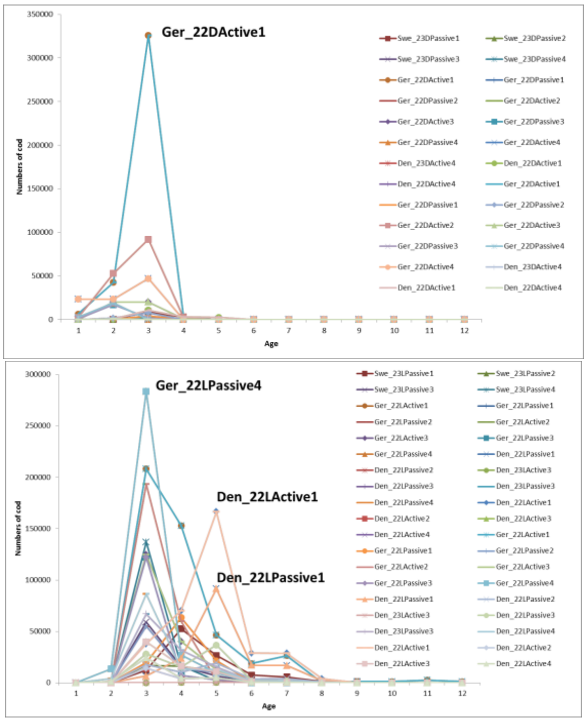


Figure 2.3.4. Western Baltic cod. Numbers-at-age of cod in SD 2223 for discards (left) and landings (right) by strata. Major strata are indicated.

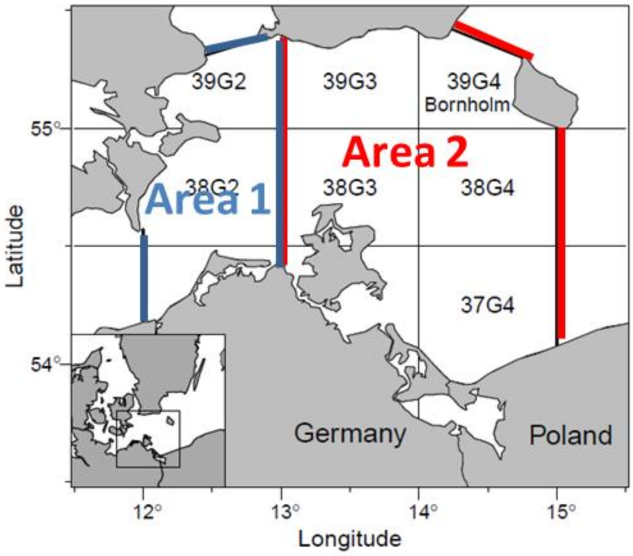


Figure 2.3.5. Western Baltic cod. Subareas (Area 1 and Area 2 within SD 24) for which different keys for splitting between eastern and western Baltic cod catches in SD 24 were applied.

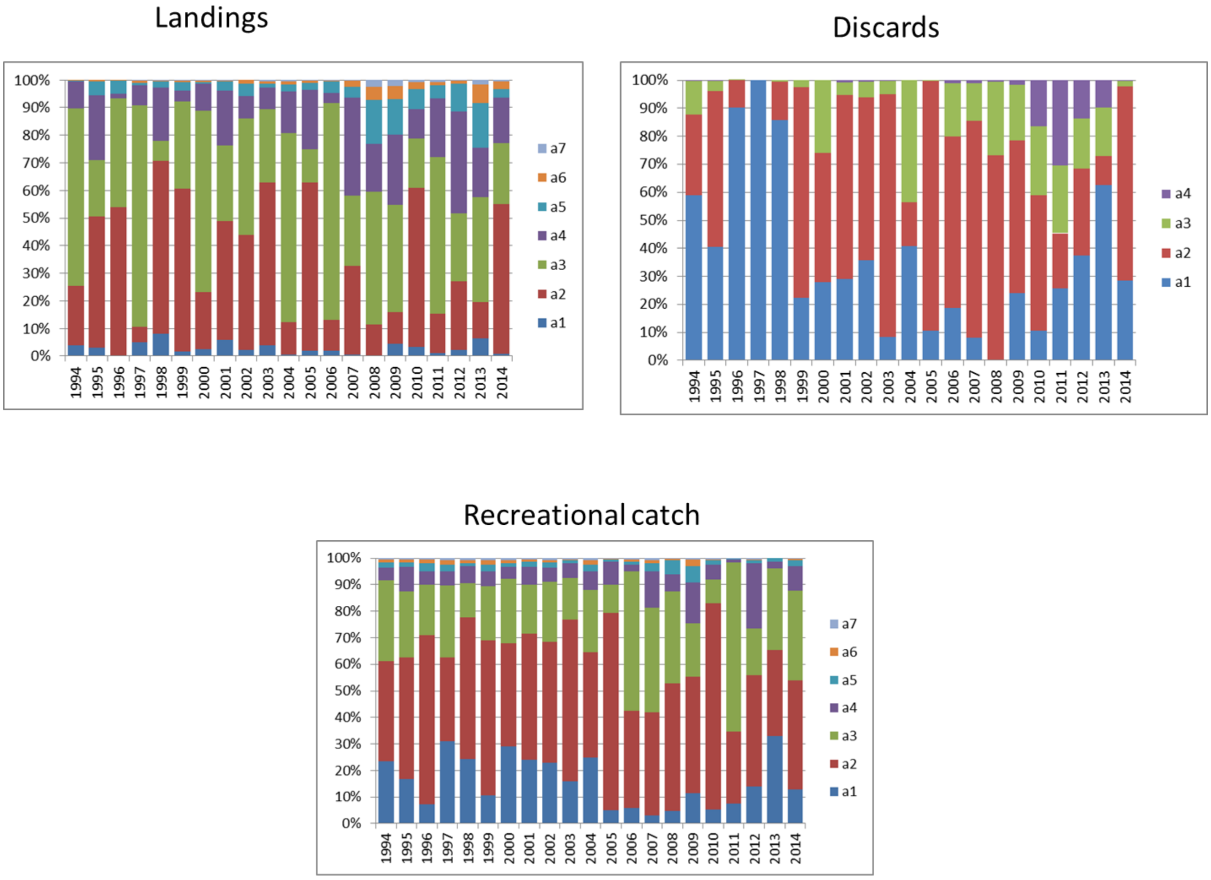


Figure 2.3.6. Western Baltic cod. Age distribution of cod in commercial landings, discards and recreational catch.

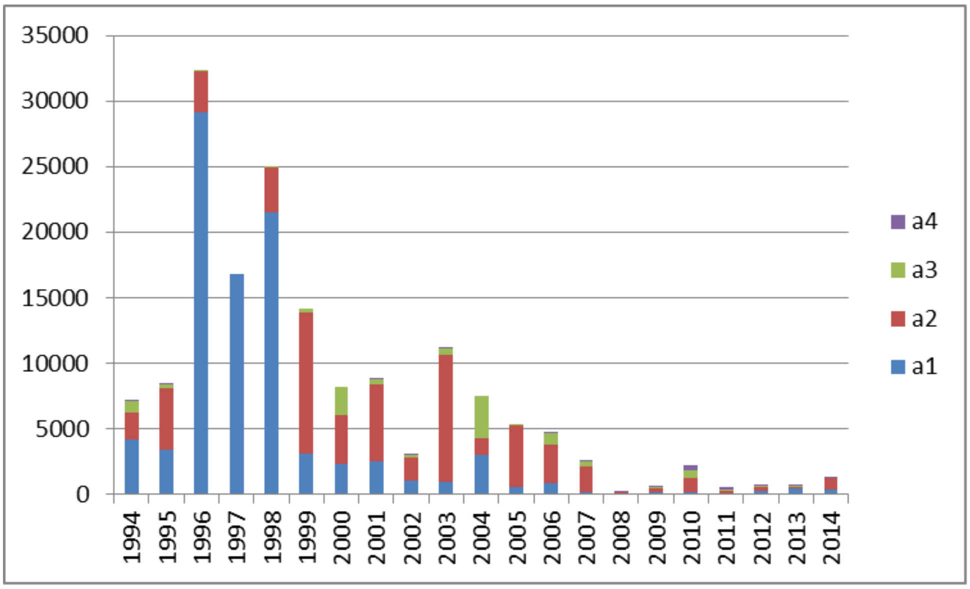


Figure 2.3.7. Western Baltic cod. Discards in numbers by age.

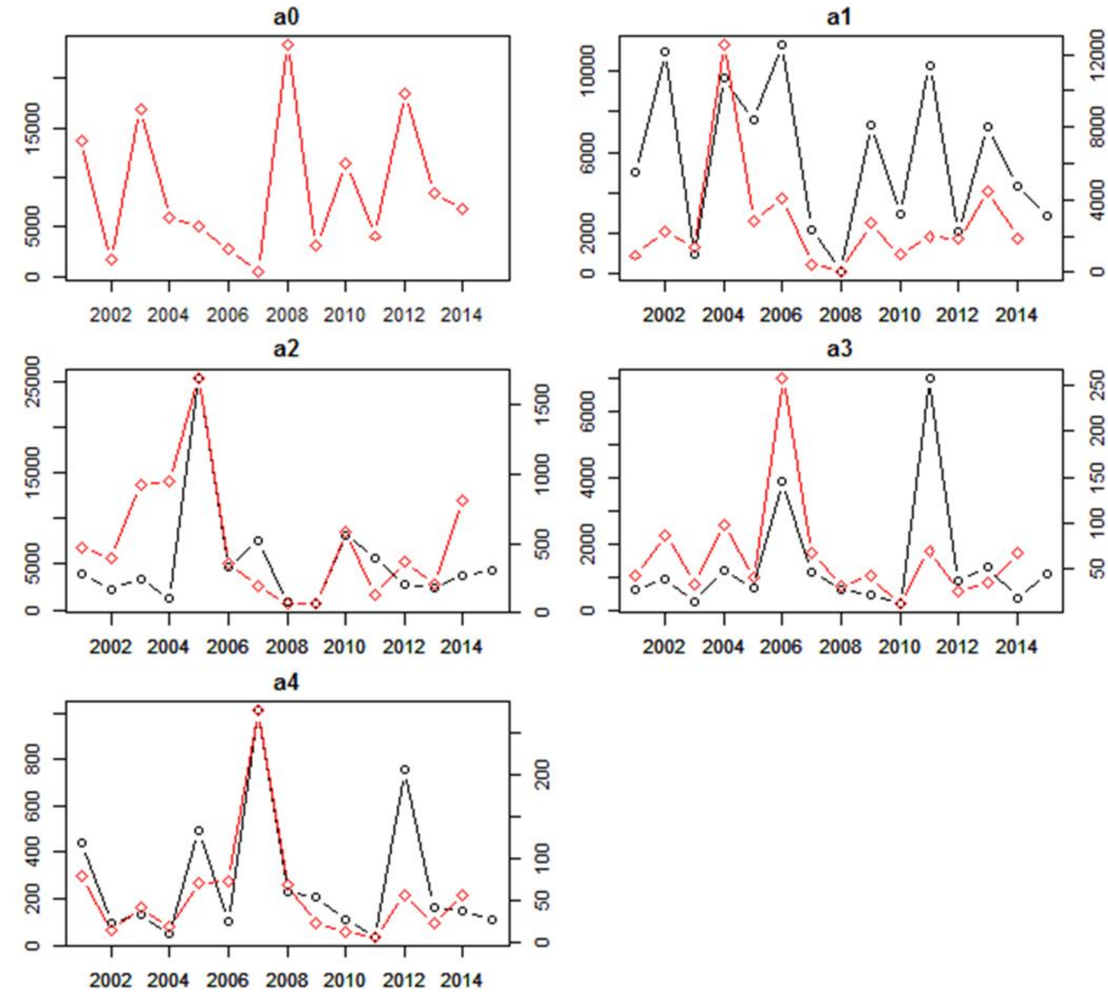


Figure 2.3.8. Western Baltic cod. BITS survey indices by age for Q1 (black circles) and Q4 (red diamonds).

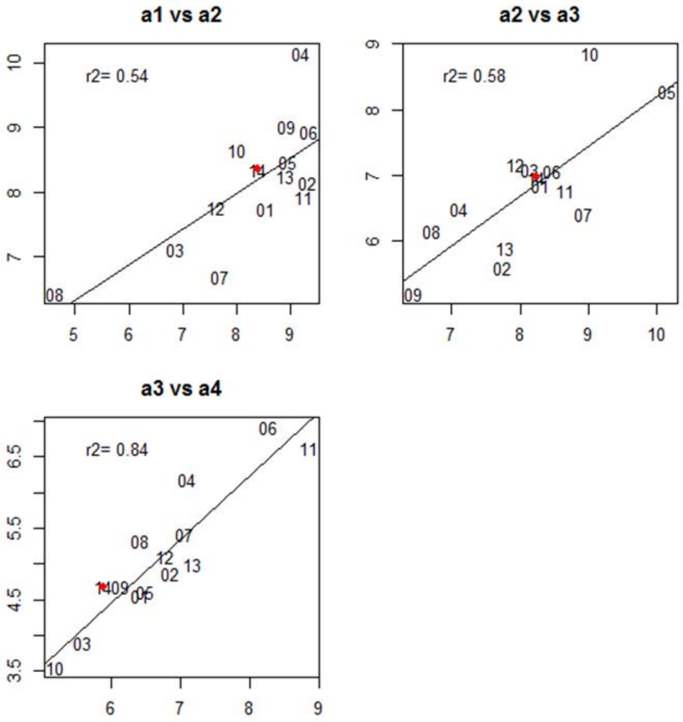


Figure 2.3.9a. Western Baltic cod. CPUE at age *i* vs numbers at age *i* +1 in the following year, in BITS Q1 survey. Year annotation of individual points refers to the year of age *i*. Red dots highlight the information from the latest year.

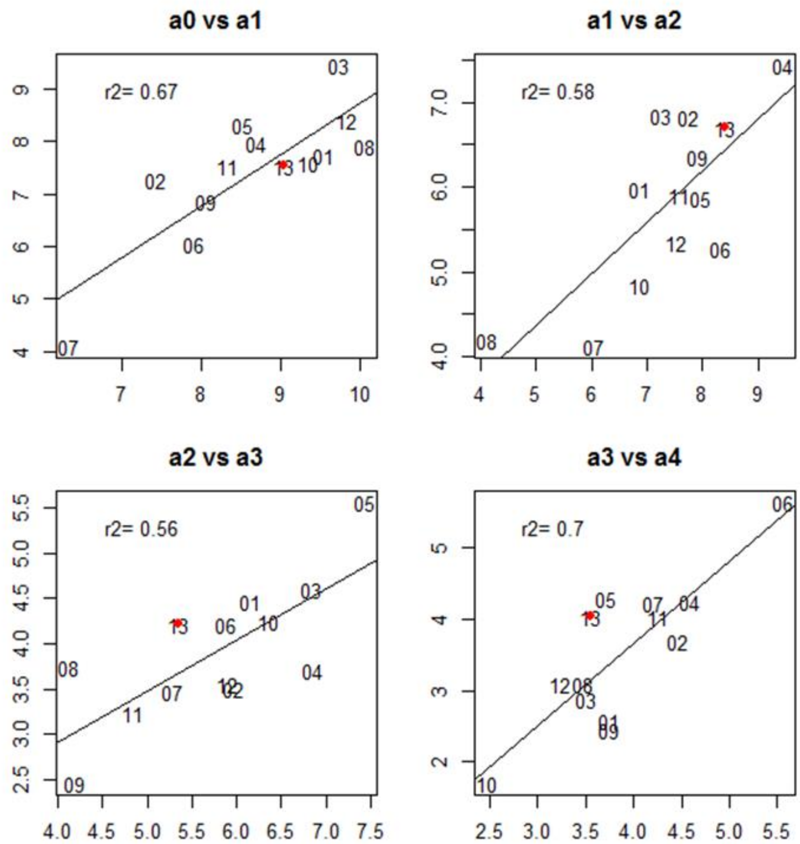


Figure 2.3.9b. Western Baltic cod. CPUE at age *i* vs numbers at age *i* +1 in the following year, in BITS Q4 survey. Year annotation of individual points refers to the year of age *i*. Red dots highlight the information from the latest year.

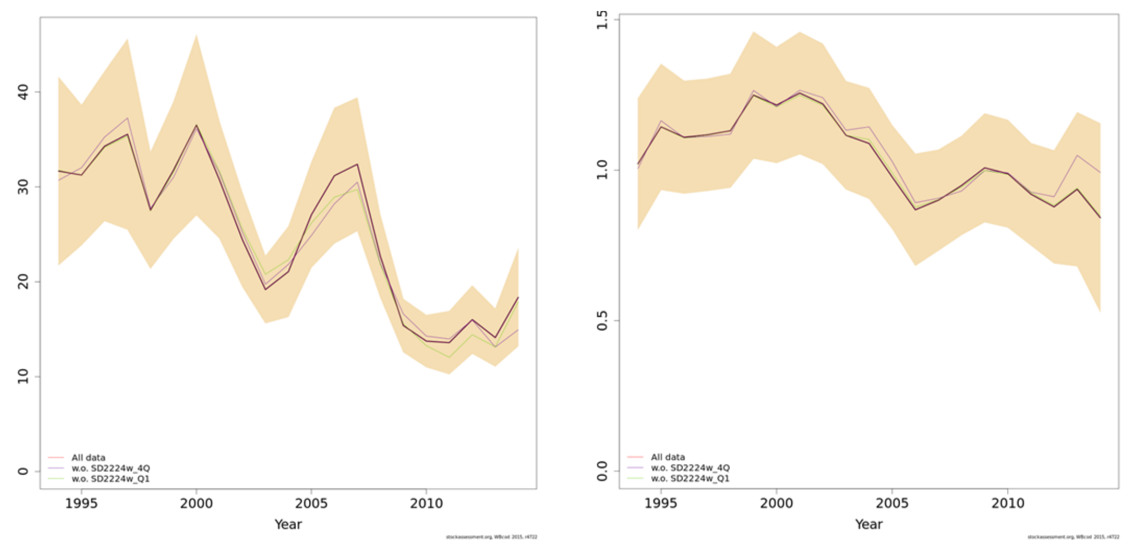


Figure 2.3.10. Western Baltic cod. The SSB and F from exploratory runs leaving out one tuning series at a time.

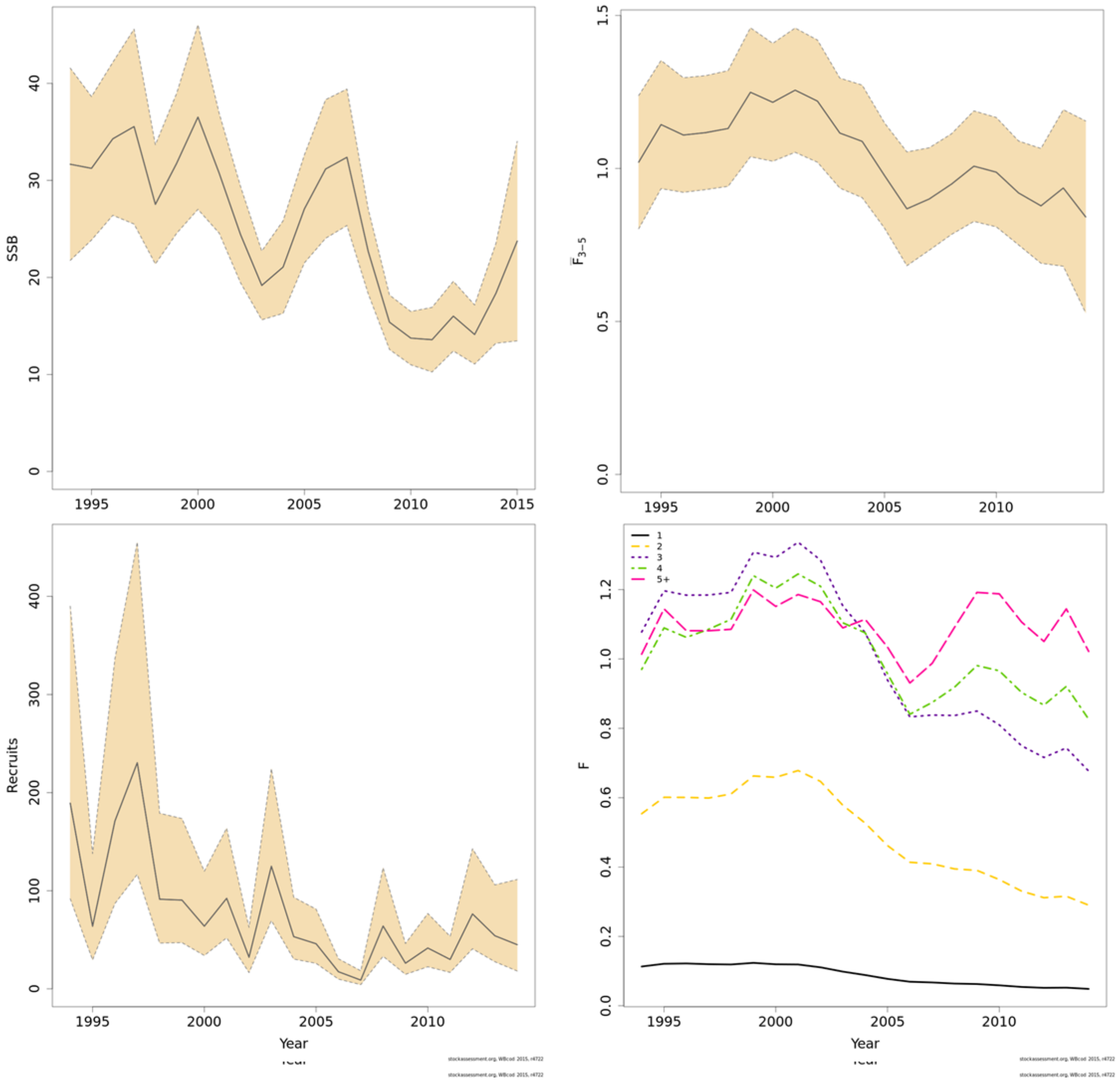


Figure 2.3.11. Western Baltic cod. SSB (upper left), F (3-5) (upper right) and stock numbers at age 0 (lower left) and F by age groups (lower right) from the final assessment.

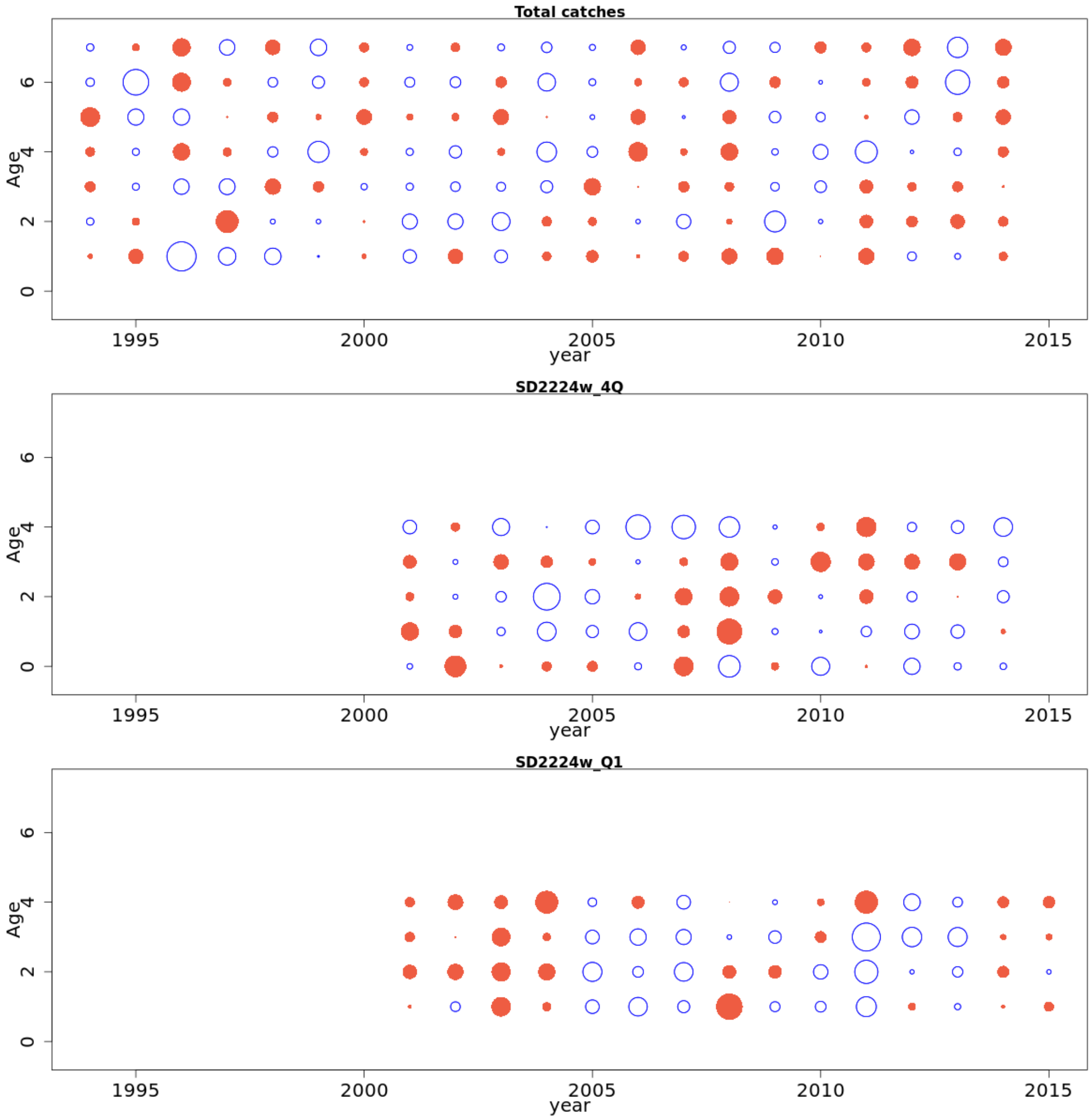


Figure 2.3.12. Western Baltic cod. Standardized residuals from the final SAM run. Open circles are positive and filled circles negative residuals.

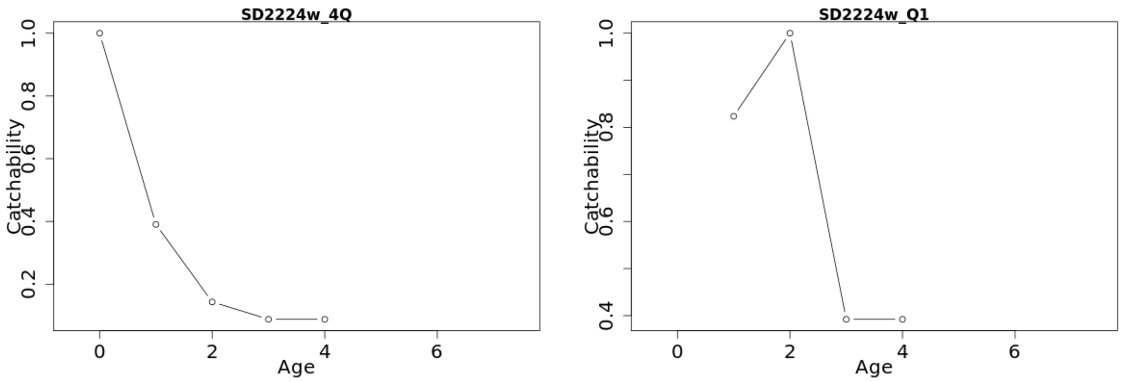


Figure 2.3.13. Western Baltic cod. Estimated catchabilities in Q4 and Q1 surveys from final SAM assessment.

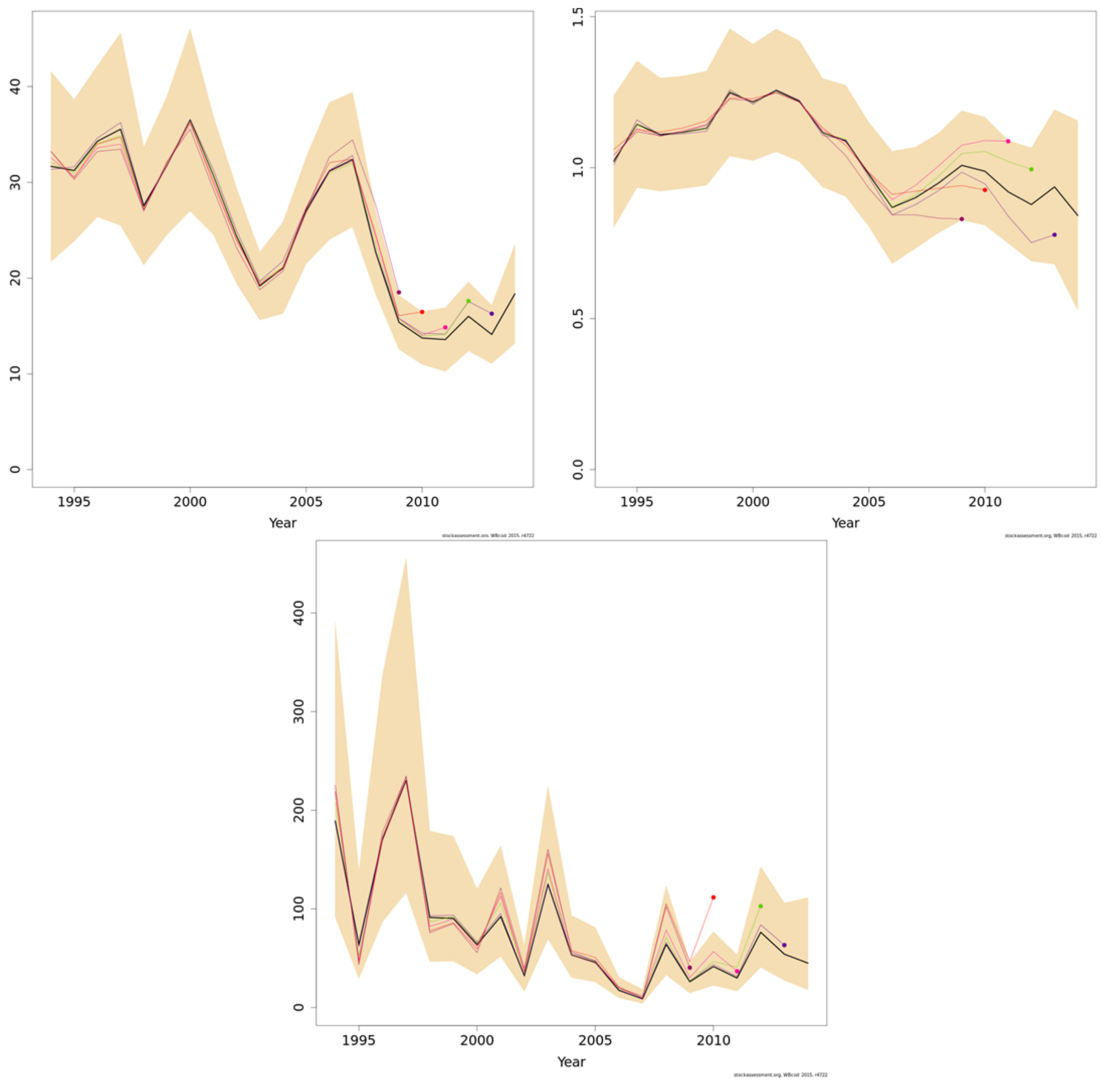


Figure 2.3.14. Western Baltic cod. Retrospective analyses of SSB, F(3-5) and recruitment (age 0).

3 Sole in Division IIIa and Subdivisions 22-24 (Skagerrak, Kattegat, the Belts and western Baltic)

The present sole assessment is an update assessment. Reference points for this stock were benchmarked at WKMSYREF3 in November 2014, which resulted in redefined MSY reference points (see section 3.9).

3.1 The Fishery and regulations

Sole has economically been one of the most important species in recent years in the Danish Kattegat fisheries. The importance of sole is more limited in Skagerrak compared to Kattegat. 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 3.1). In average more than 75% of the annual sole catches with trawl are caught outside the summer season. 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.

In 2000-2005, the fishery became increasingly limited by quota restrictions and weekly or semi-monthly catch rations, increasing the incentive for misreporting and discarding (ICES 2004; Hovgård 2005). Since 2005 a number of regulations changed and the incentive for misreporting was no longer there.

Several changes in trawl selectivity have been made since 2007 to protect cod in the Kattegat, gear changes which might also influence CPUE of sole. The usage of an exit window with square meshes at a minimum of 120 mm became mandatory in 2008 in the Danish fisheries. Further, new trawls with sorting windows with various designs and mesh sizes (named SELTRA) have been introduced since then (Madsen and Valentinsson, 2010; Madsen et al., 2010). In 2009, as part of the attempts to rebuild the cod stock in the Kattegat, Sweden and Denmark introduced protected areas on historically important spawning grounds. The protected zone consists of four different areas in which the fisheries are either not allowed or limited to certain selective gears (e.g. Danish SELTRA with 300-mm mesh size in exit window (SELTRA300)) throughout part, or all of the year. Since 2011, the use of various types of SELTRA trawls has become mandatory in the Danish fisheries in the Kattegat. To conduct a profitable sole fishery in the fourth quarter it is allowed to use less selective trawls in that period, however that period of the year is not included in the CPUE time series.

Catch trends

The officially reported landings by area, gear and country for 2014 are given in Table 3.1. Denmark takes 87% of the total catch. Kattegat is traditionally the most important area accounting for approximately 60% of the annual catches. The proportion of Danish landings from the Skagerrak in 2014 (45%) is the highest proportion since 2001.

Historical catches, including the working group corrections, are given in Table 3.2 and Figure 3.2. The fishery fluctuated between 200 and 500 t annually prior to the mid-1980s and increased to 1400 t in 1993. Since then, landings have decreased with a low in recent years of about 330 t. Figure 3.1 provides the Danish catches cumulated by month since 1998, indicating the two main periods of fishery.

3.1.1 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 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 2014 amounts to 10% of the catches by weight based on sampling.

Discards by age are tabulated in Table 3.3 since 1999. Discards from 1999 have not yet been raised to total discarded numbers. Since the discards are 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.

3.1.2 Effort and CPUE Data

The calibration indices for estimating fishing mortality is based on official logbook data from trawlers outside the main sole season and the Fisherman-DTU Aqua sole survey conducted in 4th quarter. This survey ceased in 2012-13 but has resumed in 2014. In addition to these two indices, private logbook information from selected Danish trawlers and gillnetters are still kept as tuning series although they have ceased years ago.

Official logbooks from trawlers, 12–20 m, 90–104 mm mesh, April–August 1994–2014
Private logbooks ,6 trawlers, October-January 1987-2008
Private logbooks, 3 gillnetters, April-oktober 1994-2007
Fisherman- DTU Aqua survey, November-December 2004-2011, 2014

Official logbook data

The official logbook data was compiled in accordance with the procedure provided in the Stock Annex. The trawler fleet used as tuning fleet in the assessment is based on all logbooks from the fleet in the period April-August (trawlers 12-20 m length, mesh size 90-104 mm). The fleet comprises nearly all trawl fisheries for sole and Danish trawl catches are about 40-45% of the entire fishery. The tuning fleet therefore, represents a main segment in the sole fishery.

The aggregated CPUE of the trawlers is provided in Figure 3.3. Catch rates from official logbooks show a decreasing trend over the past decade, while effort has been increasing.

It is recognized that the recent regulations in the fishery (SELTRA trawl and grid) likely have caused a change in the selectivity of smaller sole that may have affected the CPUE index used as tuning input to the assessment (see section 3.1). Presently it was not possible to quantify this and therefore accommodate for the likely change but a potential way forward could be to select data from the fleet in the period where no restrictions are in place (4th quarter). However, historically (2002-2005), 4th quarter was deliberately avoided in the analyses due to an incentive to misreport sole. A split into two time series might solve this at the next benchmark opportunity.

Scientific survey data

Danish Fisherman/scientific survey targeting sole

A survey conducted cooperatively by DTU Aqua and with Danish fishermen starting in 2004 (Jørgensen, 2015, WD#1 WGBFAS 2015) was designed with fixed haul positions chosen by both scientific and fishermen. The survey ceased in 2011 but resumed in 2014. Based on 77 successful hauls out of 80 planned hauls (Fig 3.4), age disaggregated indices are from the survey are used for the analytical assessment (Table 3.5). The aggregated index continues the decreasing trend 2007-11 and the 2014 value is record low (Fig. 3.3 and Table 3.5).

3.2 Biological composition of the catch

3.2.1 Age composition

As usual age structure of the catch was available only for the Danish fishery (Table 3.4) and the age structure of the Danish catch was assumed to apply to the total international catch (Table 3.6).

The age composition of the catch has mainly been composed of 3-5-year-olds since the beginning of the 1990s (Figure 3.6). However in the recent years the age groups 2 -4 have increased in proportion and fishery is more dependent on recruitment. Recruits (i. e. age 2) enter the fishery in the 4th quarter. Abundant year classes of particular age-groups generally appear as abundant in the following year. The noise for the older age groups in the log cohorts is presumably due to ageing problems.

A separable VPA was conducted in order to explore potential changes in selectivity in the fishery. The residuals from the analysis assuming a fixed selection pattern did not show any particular trends indicating consistency and that no shift in catchability has taken place in the fishery (Figure 3.7).

3.2.2 Quality of catch and biological data

Denmark provided statistics on catch sampling for the Kattegat, Skagerrak and the Belts (Table 3.4). Overall sampling intensity decreased somewhat in 2014, and sampling remained inadequate especially for Skagerrak and the Belts. The small and scattered catches mainly taken as by-catch prevent proper port sampling with the present sampling intensity. Initiatives to improve sampling under the present fishery with small catches could amongst others be cooperation with fishermen (reference fleet).

3.3 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 3.5 and Figure 3.8. 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. In 2013 weights for most age groups declined after a period of increase since the early 2000s. Data from the Fisherman-DTU Aqua survey is now available for an appropriate time series and is intended to be used for compilation of mean weight at age in the stock (Figure 3.9). The inclusion of these data awaits the next benchmark assessment.

3.4 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). This maturity ogive is similar to that used for the North Sea sole stock (ICES CM 2006/ACFM: 35).

3.5 Natural mortality

The natural mortality was assumed to be 0.1 per year for all ages..

3.6 Catch-at-age analysis

3.6.1 Tuning fleets

The tuning fleets are described with effort and CPUE data in section 3.1.2 and provided in Table 3.6.

3.6.2 Examination of input data and final settings

Since the benchmark in 2010 (WKFLAT) SAM is used as assessment model.

Model residuals

Model residuals from SAM for all fleets inclusive catches are provided in Figure 3.10. Estimated sd of log observations are provided by age group and fleet in Table 3.8.

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 3.11). From the plots it is obvious that the, commercial fleet (OL trawlers), contributes to increase F considerably in recent years and consequently, but to a lesser degree, decrease SSB. The influence of this tuning series is remarkably strong on estimation of fishing mortality since without this series the recent estimates of F falls outside the confidence intervals. Further examination of the trawler tuning fleet is required, also in the light of the recently implemented use of SELTRA devices that apparently changed the catch efficiency of these trawlers.

Model assumptions on recruitment estimation

In the SAM model an option on estimation of recruitment (youngest age group) can be either random walk (dependence on previous years recruitment) or dependent on a stock-recruitment relationship, i.e. Ricker or Beverton-Holt. The benchmark 2010 revealed that the Ricker function improves the model significantly based on AIC and Ricker model is therefore the assumption in the estimation of recruitment in the SAM model.

Final stock and fishery estimation

Stock summary (SSB, fishing mortality and recruitment) as estimated from the SAM model is provided in Figure 3.12. The estimates are medians from the model with 95% confidence limits of the estimates.

The SSB in 2014 is estimated to increase slightly to 1252 tons. However, this increase is likely due to increasing mean weights in the landings (Fig. 3.8). Fishing mortality increases in 2014 by 11% to 0.46 and recruitment in 2014 is at a historic low (Figure 3.12, Table 3.11).

Retrospective analysis

A retrospective analysis (Figure 3.13) of the SAM estimates shows some bias for the F estimation in 4 of the 5 years with an under-estimation in the order of 5-10% and a similar over-estimation of SSB. Examination of commercial fleets and exploratory assessments.

Gear regulations have taken place in the trawl fisheries since 2010 in order to protect the cod stock in especially Kattegat. A sorting window device, SELTRA, with mesh sizes up to 300 mm have been implemented in 90 mm mesh sizes trawl for an area in Kattegat. Information provided by the fishery suggests that catch efficiency of sole have decreased markedly with the use of SELTRA devices. This change is assumed to affect all sizes of sole. EU requested ICES to evaluate the likely consequences of the implementation of SELTRA windows for the sole assessment and catch advice. ICES responded that it was not able to quantify the loss in catch efficiency and therefore neither able to re-assess the stock (ICES 2015, special request 6.2.3.1). However, there are reasons to evaluate whether the trawler tuning series is an appropriate tuning index and not hampers the assessment due to the assumed gear changes.

The trawler series have since the cease of the DTU Aqua-Fisherman survey in 2012 been the only tuning series extending to the last year and therefore essential for the assessment to run. However, with the resuming of the survey in 2014 and onwards, critical examination of the trawler tuning series is now an option. The SAM fleet sensitivity analyses (Fig.3.11) clearly demonstrated that the trawler fleet has a major influence on the recent development of fishing mortality and SSB history, contributing to increasing F and decreasing SSB. Fig 3.14 illustrates the difference in stock perception when leaving out the trawler tuning fleet. SSB in recent years is estimates to be around 1500 t compared to around 1000 t in the SPALY (**S**ame **P**rocedure **A**s **L**ast **Y**ear, i.e. default) assessment. Fishing mortality in 2014 is revised from 0.46 to 0.28. From Fig. 3.15 it is obvious that the lowering of F is due to older age groups only, i.e. ages 6+. From Fig. 3.10, model residuals from the SPALY assessment suggests that the trawlers catches less older fish than predicted (high negative residuals in latest years) which is interpreted as high F on those age groups. If the gear changes (SELTRA window) mainly affect the older ages, this decrease in catch efficiency could be a plausible cause and will thus be a bias in the assessment.

In order to evaluate whether exclusion of the trawler fleet would improve the assessment, retrospective analyses were conducted with and without this fleet. Since the survey had a time gap of two years (2012-13), an appropriate comparison of the retro analyses will only include the years up to 2011, when the survey time series is still complete. The two retros perform quite different (Fig. 3.16); without the trawlers included in the assessment the retrospective pattern that has been observed in the past with consistent underestimation of F is now no longer evident and the retro pattern is weak. A matter of concern is the shift in Fbar not only for the recent years but for the entire time range in the SPALY retro plot. Fbar changes approx. 10% over the entire time series between the first and last year of the retrospective analyses. Another issue of excluding the trawler fleet is that uncertainty on the F estimates reduces in recent years. Thus in summary, removal of the trawler therefore improves the assessment quality.

WGBFAS recommends to exclude the commercial trawler series as a tuning index in the sole assessment, but since the removal implies a change in perception of SSB (approx. 10% higher since 2007) and F, reference points are likely required to be recalculated prior to advice based on such a corrected assessment. Further work is therefore suggested before a decision is taken. The issue will be a candidate for a benchmark work.

3.6.3 Recruitment estimates

Recruitment of the 2012 year-class (age 2) was estimated by SAM to be record low 739 thousand soles whereas the estimated geometric mean for the period 1994-2014 as used for catch forecast is approx. 2.4 million (Table 3.10 and Table 3.11). The main contributor to the measurements of recruiting year classes, the DTU Aqua-Fisherman survey ceased in 2011, but have been resumed in 2014 and will continue annually.

3.7 Historical stock trends

Estimated fishing mortalities and stock numbers at age are provided in Tables 3.9 and 3.10, and the stock summary is given in Table 3.11 and Figure 3.12. SSB in 2014 was estimated around a historic low at 1252 t and the corresponding F(4-8) has increased to 0.46. The input data and setting are visible in www.stockassessment.org, the stock is "Sole3a2013"

In recent period the spawning stock biomass peaked at approx. 3,500 t in 2005 and has since decreased more or less continuously to the present low (Figures 3.12 and Table 3.11). In the same period fishing mortality has been relatively stable around 0.35-0.4 but with a recent increase. Retrospective performance of the assessment is provided in Fig 3.13 and historic performance is given in Figure 3.17. Due to retrospective behaviour of the assessment, the historic perception of fishing mortality has changed continuously.

3.8 Short-term forecast and management options

The input to the standard short term forecast (MFDP) is given in Table 3.13. Weight-at-age , natural mortality ,and exploitation pattern were estimated according to Stock Annex. Exploitation pattern was unscaled due to lack of trend. Applying F_{sq} (0.42) in 2015 will provide landings of 290 t.

Age 2 (recruits) input to short was changed from the procedure described in Stock Annex. The recent consistent low recruitment since 2008 is only partly reflected in the standard estimation procedure (gm(94-12). Therefore the abundance in 2014–2016 is assumed constant at the geometric mean for 1994–2014 (2.4 million), eg. including the most recent estimate. However, this estimate for the short term forecast is still very optimistic considering the estimates of the recent year classes.

Discards are not included in the assessment but comprise 11% in weight in 2014. This is a marked increase from the 2013 discard estimate of 3%. The catch options in the advice tables for 2016 therefore contain additional catches of discards amounting 11% (topping up procedure).

The forecast predicts that a fishing mortality at F_{sq} ($F_{4\text{–}8}$ = 0.42) will lead to yields of 290 t in 2015 and 312 t in 2016 (Table 3.14). At this level of exploitation, spawning stock biomass is estimated at 1210 t in 2016 and 1470 t in 2017 (for trends see Figure 3.18). Fishing at the F_{msy} rule in 2016 will lead to yields at 110 t and a spawning stock in 2017 at 1670 t. Catch in 2016 and stock composition in 2016 and 2017, is estimated to be dominated by age 3 as indicated in Figure 3.19 under the assumed average recruitment and Fsq exerted in 2015.

A yield-per-recruit analysis was made with long term averages (15 years) with unscaled exploitation pattern. The results are presented in Table 3.15. The yield-per-recruit curve (Figure 3.20) indicates that maximal yield per recruit is poorly estimated at $F_{4\text{–}8}$ about 0.74 and that $F_{0.1}$ is estimated to 0.21

3.9 Reference points

Reference points have been redefined by WKMSYREF3 in January 2015 and are as follows:

	Type	Value	Technical basis
MSY	MSY Btrigger	2000 t	lowest observed SSB excluding 1984-85 low SSB's
Approach	FMSY (lower,median, upper)	0.0.17, 0.22, 0.26	based on Stochastic simulations. F associated with highest yield and low prob. of SSB<Btrigger; uses short time series regime 1992-2013.(WKMSYREF3 2015).
	Blim	1200 t	Candidate; based on Bloss and segmented regression (WKMSYREF2 2014)
Precautionary	Bpa	2000 t	Blim*e1.645σ , σ=0.30 (WKMSYREF2 2014)
Approach	Flim	0.47	Fmed98 excluding the abnormal years around 1990
	Fpa	0.30	consistent with Flim

3.10 Quality of assessment

The commercial trawler tuning series affect the estimates of especially fishing mortality in recent years (Fig 3.11) leaving out this series will result in significant lower Fs in recent years and somewhat higher SSB. A number of gear changes have taken place in recent years in this fleet in order to protect cod in the mixed fishery (see sec. 3.6.3). These changes have most likely influenced the selective properties in the fleet which might bias the assessment and contribute to the the uncertainty of the estimates and the retropattern as observed.

The retrospective pattern continues to constitute a major problem for the consistency of the assessment, with underestimation of F and corresponding overestimation of SSB.

Sampling from this relatively small and spatially dispersed fishery is always a challenge and often results in few measured fish per sample. More intense sampling will likely increase the coverage insignificant in relation to the associated costs and therefore no improvement is foreseen for this stock. Sole, as other flatfishes, are known to have sex differentiated growth, females growing larger and older than the males. The present situation, with relatively low stock size (around B_{lim}), the changes proportion between the sexes in the stock and the catch might influence the overall mean weight-at-age, and may have caused the low weight for the older ages due to a dominance of (smaller) males in these ages.

3.11 Comparison with previous assessment

This year's assessment is unchanged from last year with regard to methods and principal input data; however, the survey that ceased in 2011 is now resumed in 2014 and used as tuning series; it uses a stochastic state-space based model (SAM) that estimate uncertainties on the estimates. A new Fmsy was proposed at WKMSYREF3 in 2014 and the catch forecasts are based on this.

3.12 Management considerations

Management of the sole fishery should take into account that in particular the trawl fishery is a mixed fishery with cod by catch ratios about 10% of total catches. If the mixed fishery for sole and cod could be un-coupled, management in the Kattegat would be more straightforward and sustainable. 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 considerably. This again will have an impact on the estimates of biomass reference points. Similarly will establishment of a weight-at-age in the stock from the survey have implications on perception of present stock biomass.

3.13 Issues for forthcoming benchmark

A number of issues that potentially could improve the assessment were identified this year. Even though exploratory assessments were performed to illustrate the effect of these issues it was evaluated that changes in stock and fishery perception were so significant that these changes should be dealt with at a forthcoming benchmark assessment.

Since significant gear changes likely have taken place for the principal commercial fleet, the trawlers based on logbook information, the changes should either be quantified and thus taken account for in the assessment or if not possible, the tuning index should be removed. Since the survey has been resumed and is expected to continue annually this biomass index is considered sufficient and appropriate as the single tuning fleet in case the trawlers will be removed.

VMS data from the fishery could add to the information on the spatial distribution. More specific discard data from other nations than Denmark (Sweden) is available and presently not utilized.

The resuming of the survey in 2014 opens for inclusion of biological parameters into the assessment; stock mean weights and maturity will be examined for use.

The sampling level for sole (both length and age sampling from the fishery) is critical low. Even though this is due to few and scattered samplings, an evaluation of the consequences and possible improvements should be conducted.

Depending on the change in perception of stock and fishery after benchmark adjustments, recalculation of biomass and fishery reference points could be an option.

Table 3.1. Sole IIIa. Landings (t) of sole in 2014 by area, nation, quarter and gear.

Skagerrak (SD20)	Quarter				Gear		Total
Nation	1	2	3	4	Trawl	Gillnet	
Denmark	26	46	4	29	53	51	104
Sweden	2	1	1	1	4	0	4
Total	28	46	5	30	58	51	109

Kattegat (SD21)	Quarter				Gear		Total
Nation	1	2	3	4	Trawl	Gillnet	
DK	37	26	24	74	104	57	161
Sweden	6	12	11	9	9	28	37
Total	42	37	35	83	113	85	198

Belts (SD22-24)	Quarter				Gear		Total
Nation	1	2	3	4	Trawl	Gillnet	
DK	7	14	9	17	14	34	48
Sweden	0	1	0	0	0	1	1
Total	7	16	9	17	14	35	49

Table 3.2 Sole in Division IIIa. Catches (tons) in the Skagerrak, Kattegat and the Belts 1952–2014. 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	152.5	78	33	54	9	6	0		332
2014	161	104	48	41	2	3	0.3		360

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 3.3 Sole in IIIa. Discard from active gear as obtained from observers.

	Number (thousands)												
Age	Year												
	1999	2000	2001	2002	2003	2004	2005	2006-2009	2010	2011	2012	2013	2014
1		148							7	2	2	7	46
2		293		44	254				28	19	13	26	28
3		1114			64		53		27	13	18	18	131
4		56		43	71				15	9	28	9	7
5				18	6				21	8	8	6	15
6					6				2	5	8	11	9
7					1				10	7	5	10	15
8					1				3	5	2	4	10
9									9	3	4	6	2
10					1				1	5	3	2	
11											3		1
Total		1611		105	404		53		123	77	94	99	264

	Mean weight (gram)												
Age	Year												
	1999	2000	2001	2002	2003	2004	2005	2006-2009	2010	2011	2012	2013	2014
1		54							88	70	64	70	68
2	82	126		98	96				112	93	102	92	89
3	88	107			110				98	85	99	104	146
4		82		97	146				145	108	144	106	188
5	116			109					119	111	85	85	119
6	124				98				83	96	116	112	108
7					158				108	102	114	103	120
8	183				123				97	109	124	104	122
9									133	102	143	118	116
10					158				117	121	131	112	
11											115	71	115

Table 3.4 Sole in IIIa. Number of samples, length measurements and ageings in 2014 from Danish fishery.

	Belts			Skagerrak			Kattegat			Total		
Quarter	Samples	Length measured	Aged	Samples	Length measured	Aged	Samples	Length measured	Aged	Samples	Length measured	Aged
1	12	2	2	7	121	121	6	85	77	25	208	200
2	10	0	0	7	7	0	6	25	15	23	32	15
3	11	0	0	7	0	0	6	96	44	24	96	44
4	15	3	3	7	0	0	6	299	64	28	302	67
Total	48	5	5	28	128	121	24	505	200	100	638	326

Table 3.5 Sole IIIa. Weight at age (kg) in the catch and in the stock.

Table 2 Catch weights at age (kg)

YEAR,	1984,
AGE	
2,	.1830,
3,	.2130,
4,	.2570,
5,	.2940,
6,	.2970,
7,	.2800,
8,	.3210,
+gp,	.3680,
0 SOPCOFAC,	.9930,

Table 2 Catch weights at age (kg)

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	.1740,	.1650,	.1600,	.1590,	.1760,	.1800,	.1740,	.2130,	.1780,	.1740,
3,	.2340,	.2310,	.1940,	.1970,	.2210,	.2280,	.2290,	.2520,	.2240,	.2290,
4,	.2830,	.2870,	.2450,	.2350,	.2550,	.2510,	.2750,	.3360,	.2740,	.2800,
5,	.2910,	.2970,	.2740,	.2510,	.2660,	.3080,	.2920,	.4120,	.3280,	.3420,
6,	.3350,	.4090,	.3190,	.3350,	.2710,	.3330,	.3460,	.4300,	.3740,	.3880,
7,	.2920,	.2670,	.3600,	.3480,	.3520,	.4000,	.3090,	.4910,	.4030,	.4450,
8,	.2790,	.2620,	.4170,	.3630,	.3000,	.5470,	.3860,	.5660,	.3880,	.4480,
+gp,	.3640,	.3830,	.3610,	.3520,	.3550,	.5550,	.5030,	.6220,	.4740,	.3940,
0 SOPCOFAC,	.9984,	.9995,	1.0027,	1.0032,	.9964,	.9970,	.9508,	.9304,	.9980,	.9931,

Table 2 Catch weights at age (kg)

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
2,	.1870,	.1760,	.1980,	.1610,	.1620,	.1690,	.1840,	.1720,	.1740,	.2030,
3,	.2000,	.2180,	.2720,	.2190,	.2320,	.2360,	.2420,	.2050,	.2100,	.2370,
4,	.2480,	.2670,	.2960,	.3160,	.3040,	.3040,	.2900,	.2940,	.2460,	.2910,
5,	.2910,	.3070,	.3080,	.3220,	.3680,	.3440,	.3780,	.3730,	.3600,	.3280,
6,	.3510,	.3390,	.3450,	.3500,	.3600,	.3190,	.3460,	.3860,	.3820,	.3710,
7,	.3820,	.4040,	.3590,	.3580,	.3780,	.3640,	.3080,	.2140,	.4310,	.4010,
8,	.4320,	.4570,	.3640,	.3770,	.3970,	.3520,	.3620,	.2920,	.2610,	.3700,
+gp,	.3830,	.6640,	.3610,	.3270,	.3500,	.3280,	.2810,	.2760,	.3820,	.3150,
0 SOPCOFAC,	.9767,	.9826,	.9983,	1.0006,	1.0041,	1.0004,	.9941,	.9967,	.9971,	.9916,

Table 2 Catch weights at age (kg)

YEAR,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	2014,
AGE										
2,	.1920,	.2010,	.2110,	.2150,	.2110,	.2580,	.2610,	.2850,	.2390,	.2270,
3,	.2230,	.2150,	.2280,	.2460,	.2590,	.2700,	.2710,	.2790,	.2250,	.2830,
4,	.3000,	.2630,	.2950,	.2670,	.3010,	.2830,	.2920,	.3170,	.2760,	.3720,
5,	.3240,	.3170,	.3020,	.2800,	.3190,	.3240,	.2770,	.3750,	.3040,	.4210,
6,	.3670,	.3390,	.3540,	.2900,	.4030,	.3110,	.3580,	.4060,	.3730,	.4420,
7,	.3710,	.3210,	.3390,	.2960,	.4390,	.3690,	.4760,	.4060,	.3050,	.4860,
8,	.4210,	.2930,	.3800,	.3010,	.4390,	.3100,	.2850,	.3500,	.3060,	.4540,
+gp,	.3720,	.3440,	.2440,	.2460,	.2630,	.2630,	.3010,	.4060,	.2870,	.4060,
0 SOPCOFAC,	.9841,	.9794,	.9654,	1.0209,	.9832,	1.0103,	1.0003,	1.0006,	1.0891,	1.0006,

1

Table 3.6. Sole IIIa. Tuning fleets.

Tuning Data; Sole in ICES Div IIIa									
104									
Fisherman-DTU Aqua survey									
2004	2014								
1	1	0.8	1						
1	9								
1	12.3	57.5	45	29.9	22.2	12.1	9.4	6	1.7
1	13.7	36.5	65.6	35.2	22	8.2	4	1.9	0.3
1	29.9	32.2	30.1	60.8	24	13.8	4.8	1.9	2
1	29.5	25.6	17.3	29.4	28.7	28	13.5	11.5	3.1
1	8.1	27.6	20.3	16.2	20.4	19.9	13.8	14.2	4.9
1	12.3	13.5	34.7	13.1	13.3	15.9	19.5	8.1	4.5
1	10.9	12.4	18.5	15	6	13.9	10.2	17.4	6.2
1	6.4	35.3	18.3	12.2	13.8	7.4	7.9	5.7	12.5
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	21.2	11.4	16.8	10.6	13.3	6.5	5	14.9	0.7
Official logbooks TR All combined									
1994	2014								
1	1	0.25	0.66						
3	9								
3599	11208	14943	7856	3762	914	750	218		
3605	6392	20034	15748	5874	2974	828	531		
4414	7584	4370	6933	4502	2429	1211	761		
3510	1235	3449	3557	4579	2426	1389	619		
4185	2465	3649	4914	3154	3157	3401	2171		
5192	14720	2639	5082	3415	2728	1875	1524		
6994	10637	19579	2081	3314	3959	2964	3130		
6269	8419	9986	6209	1952	2956	1005	1520		
6444	11200	5295	4445	8895	2291	2456	3186		
6091	15602	17717	6983	8115	3535	1299	1457		
5267	12361	16276	7507	6008	3721	1743	1250		
3732	5946	14773	8052	1594	447	886	146		
4162	3968	12025	11457	7179	1172	753	139		
4042	4355	5020	6246	4843	2629	1212	696		
4930	2546	2959	1870	7031	3033	2633	1382		
5145	10533	7512	6512	2401	1910	691	749		
5947	8763	6663	2874	2128	749	1307	637		
4980	6160	8880	2795	762	608	87	617		
7855	10012	18858	8547	5276	728	2426	728		
8064	6839	7225	4871	2957	641	212	1208		
6608	7771	8325	5767	3662	778	202	1426		
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 3.7. Sole IIIa. Catch in numbers (thousands) by year and age.

Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1984,
	AGE	
	2,	64,
	3,	638,
	4,	240,
	5,	117,
	6,	31,
	7,	33,
	8,	40,
	+gp,	175,
0	TOTALNUM,	1338,
	TONSLAND,	337,
	SOPCOF %,	99,

Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
	AGE										
	2,	786,	258,	391,	516,	863,	1209,	530,	506,	523,	127,
	3,	594,	1255,	857,	1035,	613,	1300,	1301,	1178,	1804,	1037,
	4,	190,	671,	1018,	897,	847,	651,	928,	939,	1251,	1451,
	5,	55,	210,	434,	484,	592,	564,	334,	493,	826,	752,
	6,	60,	33,	174,	129,	404,	310,	345,	320,	418,	444,
	7,	16,	36,	64,	37,	83,	167,	302,	178,	117,	152,
	8,	8,	33,	31,	23,	30,	27,	180,	166,	137,	45,
	+gp,	69,	63,	87,	60,	52,	31,	76,	239,	157,	59,
0	TOTALNUM,	1778,	2559,	3056,	3181,	3484,	4259,	3996,	4019,	5233,	4067,
	TONSLAND,	397,	643,	722,	706,	824,	1050,	1011,	1294,	1439,	1198,
	SOPCOF %,	100,	100,	100,	100,	100,	100,	95,	93,	100,	99,

Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
	AGE										
	2,	272,	316,	54,	303,	249,	142,	170,	655,	48,	195,
	3,	622,	1015,	251,	146,	826,	483,	369,	758,	431,	602,
	4,	1359,	537,	440,	212,	150,	771,	360,	285,	480,	814,
	5,	1226,	691,	365,	299,	228,	114,	354,	423,	280,	475,
	6,	600,	440,	505,	267,	177,	130,	68,	472,	344,	257,
	7,	385,	232,	360,	250,	165,	123,	84,	94,	197,	187,
	8,	142,	148,	262,	218,	167,	135,	36,	85,	25,	86,
	+gp,	104,	203,	263,	292,	233,	306,	205,	464,	210,	171,
0	TOTALNUM,	4710,	3582,	2500,	1987,	2195,	2204,	1646,	3236,	2015,	2787,
	TONSLAND,	1297,	1059,	814,	605,	638,	646,	476,	862,	619,	824,
	SOPCOF %,	98,	98,	100,	100,	100,	100,	99,	100,	100,	99,

Table 1 Catch numbers at age Numbers*10**-3

	YEAR,	2005,	2006,	2007,	2008,	2009,	2010,	2011,	2012,	2013,	2014,
	AGE										
	2,	231,	122,	293,	313,	554,	230,	138,	26,	48,	13,
	3,	1015,	400,	420,	330,	683,	591,	558,	157,	226,	66,
	4,	1083,	857,	384,	354,	445,	458,	613,	284,	286,	178,
	5,	583,	734,	583,	297,	285,	211,	246,	160,	194,	109,
	6,	276,	505,	299,	489,	139,	132,	65,	111,	137,	199,
	7,	117,	169,	135,	240,	92,	67,	28,	36,	62,	105,
	8,	102,	67,	81,	179,	29,	83,	14,	54,	23,	68,
	+gp,	91,	116,	108,	202,	88,	103,	106,	192,	96,	67,
0	TOTALNUM,	3498,	2970,	2303,	2404,	2315,	1875,	1768,	1020,	1072,	805,
	TONSLAND,	990,	836,	633,	656,	640,	541,	507,	358,	332,	331,
	SOPCOF %,	98,	98,	97,	102,	98,	101,	100,	100,	109,	100,

1

Table 3.8. Sole IIIa. SAM diagnostics. Standard deviation estimates of log observations. (Fleet1: Canum, fleet2: Survey, fleet3: OL trawlers, fleet4: PL gillnetters, fleet5: PL trawlers)

	Fleet	Age	sd(logObs)	low	high
1	1	2	0.63	0.44	0.91
2	1	3	0.19	0.12	0.28
3	1	4	0.19	0.12	0.28
4	1	5	0.19	0.12	0.28
5	1	6	0.19	0.12	0.28
6	1	7	0.19	0.12	0.28
7	1	8	0.19	0.12	0.28
8	1	9	0.19	0.12	0.28
9	2	2	0.59	0.48	0.73
10	2	3	0.59	0.48	0.73
11	2	4	0.59	0.48	0.73
12	2	5	0.59	0.48	0.73
13	2	6	0.59	0.48	0.73
14	2	7	0.59	0.48	0.73
15	2	8	0.59	0.48	0.73
16	3	3	0.38	0.32	0.45
17	3	4	0.38	0.32	0.45
18	3	5	0.38	0.32	0.45
19	3	6	0.38	0.32	0.45
20	3	7	0.38	0.32	0.45
21	3	8	0.38	0.32	0.45
22	4	2	0.54	0.35	0.84
23	4	3	0.27	0.21	0.34
24	4	4	0.27	0.21	0.34
25	4	5	0.27	0.21	0.34
26	4	6	0.27	0.21	0.34
27	4	7	0.27	0.21	0.34
28	4	8	0.27	0.21	0.34
29	5	2	0.47	0.32	0.70
30	5	3	0.47	0.40	0.55
31	5	4	0.47	0.40	0.55
32	5	5	0.47	0.40	0.55
33	5	6	0.47	0.40	0.55

Table 3.9. Sole IIIa. Fishing mortality at age (age 6-9 assumed constant).

Year\Age	2	3	4	5	6+
1984	0.082	0.414	0.479	0.369	0.384
1985	0.091	0.358	0.403	0.362	0.301
1986	0.095	0.346	0.427	0.400	0.348
1987	0.101	0.330	0.431	0.427	0.455
1988	0.107	0.335	0.435	0.409	0.395
1989	0.109	0.333	0.446	0.435	0.438
1990	0.107	0.330	0.459	0.445	0.394
1991	0.100	0.306	0.435	0.444	0.525
1992	0.094	0.296	0.421	0.464	0.654
1993	0.091	0.305	0.433	0.498	0.673
1994	0.087	0.290	0.412	0.485	0.555
1995	0.087	0.307	0.410	0.469	0.597
1996	0.087	0.324	0.399	0.427	0.497
1997	0.081	0.284	0.374	0.407	0.466
1998	0.079	0.252	0.357	0.410	0.441
1999	0.075	0.239	0.340	0.388	0.393
2000	0.072	0.235	0.339	0.374	0.365
2001	0.069	0.219	0.292	0.356	0.288
2002	0.068	0.208	0.274	0.357	0.369
2003	0.063	0.179	0.256	0.336	0.345
2004	0.067	0.205	0.291	0.357	0.399
2005	0.071	0.241	0.314	0.358	0.450
2006	0.075	0.252	0.335	0.388	0.423
2007	0.080	0.277	0.371	0.419	0.396
2008	0.082	0.283	0.405	0.451	0.486
2009	0.081	0.289	0.436	0.456	0.328
2010	0.073	0.274	0.425	0.460	0.365
2011	0.064	0.243	0.405	0.400	0.310
2012	0.055	0.177	0.326	0.318	0.414
2013	0.051	0.158	0.315	0.292	0.488
2014	0.047	0.121	0.275	0.255	0.588

Table 3.10. Sole IIIa. Stock number at age from SAM.

Year\Age	2	3	4	5	6	7	8	9+
1984	2672	1761	579	392	107	94	129	533
1985	4522	2257	748	218	234	76	37	306
1986	3995	4373	1888	625	139	136	97	231
1987	3912	3351	3020	1197	430	149	88	239
1988	3910	3697	2637	1654	464	142	76	189
1989	5366	2321	2460	1687	1121	235	86	150
1990	7178	4570	1704	1591	989	597	101	113
1991	6585	5387	2832	1010	899	716	458	180
1992	7539	5104	3050	1438	604	433	360	458
1993	5440	6712	3492	2021	853	261	256	328
1994	2688	4691	4604	2011	1095	324	127	179
1995	3169	2445	4122	3291	1388	789	257	235
1996	2142	3228	1614	2150	1359	664	363	469
1997	1222	1095	1530	1181	1495	1031	670	663
1998	3121	746	739	907	712	754	678	823
1999	3387	4168	563	730	603	515	475	808
2000	2485	2317	2500	372	457	403	414	990
2001	3598	2028	1616	1281	289	408	173	960
2002	5704	3810	1236	1339	1321	306	325	1260
2003	3162	3645	2684	1114	1232	677	119	786
2004	3495	3393	3192	1606	816	607	317	513
2005	2831	4355	4046	2180	802	298	265	311
2006	2365	1994	3271	2476	1540	474	223	349
2007	2494	1711	1290	1800	930	569	274	355
2008	2852	1425	1084	798	1155	555	463	481
2009	2755	2682	1205	810	471	423	149	373
2010	2306	2431	1395	551	409	202	294	354
2011	1795	2249	1688	730	236	155	61	448
2012	1297	1247	1298	724	383	113	165	486
2013	955	1396	1013	773	399	173	56	280
2014	739	787	892	582	493	225	128	164
2015*		638	631	614	409	248	113	147

***Estimated by simple forward projection of 2013 stock**

Table 3.11. Sole IIIa. 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	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F48	Low	High
1984	2672	1441	4957	1424	1072	1890	934	724	1206	0.400	0.291	0.550
1985	4522	2648	7721	1812	1339	2453	1026	785	1340	0.333	0.243	0.457
1986	3995	2425	6583	2604	2035	3333	1945	1511	2502	0.374	0.286	0.489
1987	3912	2491	6144	2658	2172	3253	2032	1657	2492	0.444	0.344	0.574
1988	3910	2492	6133	2684	2204	3269	2062	1693	2512	0.406	0.317	0.521
1989	5366	3426	8404	2999	2446	3678	2055	1705	2476	0.439	0.346	0.557
1990	7178	4518	11405	3938	3177	4881	2645	2186	3202	0.417	0.331	0.526
1991	6585	4214	10289	4253	3481	5196	3107	2565	3764	0.491	0.395	0.611
1992	7539	4707	12074	5470	4461	6709	3865	3221	4637	0.569	0.454	0.714
1993	5440	3477	8512	4770	3935	5782	3802	3135	4611	0.590	0.471	0.740
1994	2688	1701	4248	4215	3583	4959	3747	3178	4418	0.512	0.418	0.628
1995	3169	2053	4893	4051	3463	4740	3459	2955	4048	0.534	0.435	0.656
1996	2142	1387	3309	3378	2896	3940	3001	2570	3504	0.464	0.379	0.568
1997	1222	738	2025	2726	2331	3187	2484	2120	2910	0.436	0.355	0.536
1998	3121	2018	4827	2235	1884	2651	1732	1470	2042	0.418	0.338	0.516
1999	3387	2186	5250	2838	2368	3402	2290	1918	2733	0.382	0.309	0.471
2000	2485	1595	3871	2618	2198	3117	2198	1844	2619	0.362	0.293	0.447
2001	3598	2343	5525	2664	2218	3198	2001	1686	2375	0.302	0.240	0.380
2002	5704	3484	9340	3643	2968	4472	2662	2217	3195	0.347	0.279	0.432
2003	3162	2018	4956	3471	2922	4123	2920	2455	3475	0.326	0.256	0.414
2004	3495	2311	5288	3794	3203	4496	3085	2608	3649	0.369	0.294	0.463
2005	2831	1886	4249	4067	3427	4827	3523	2958	4197	0.404	0.324	0.505
2006	2365	1576	3549	3409	2884	4030	2934	2471	3482	0.399	0.319	0.498
2007	2494	1652	3765	2553	2165	3012	2027	1727	2379	0.396	0.316	0.495
2008	2852	1849	4398	2233	1851	2695	1620	1362	1928	0.463	0.361	0.593
2009	2755	1688	4496	2436	1981	2995	1854	1526	2253	0.376	0.295	0.478
2010	2306	1418	3751	2211	1774	2754	1616	1319	1979	0.396	0.309	0.507
2011	1795	1097	2937	2084	1670	2601	1615	1304	2001	0.347	0.270	0.446
2012	1297	749	2243	1857	1494	2308	1487	1212	1825	0.377	0.290	0.490
2013	955	527	1730	1356	1072	1715	1128	903	1409	0.414	0.314	0.547
2014	739	331	1647	1420	1110	1815	1252	991	1582	0.459	0.332	0.635

Table 3.12. Sole IIIa. Input to Yield per recruit.

MFYPR version 2a							
Run: ypr1							
Sole in IIIa Prediction							
Time and date: 23:11 13-04-2015							
Fbar age range: 4-8							
Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.1	0	0	0	0.250	0.056	0.250
3	0.1	1	0	0	0.262	0.167	0.262
4	0.1	1	0	0	0.322	0.336	0.322
5	0.1	1	0	0	0.367	0.317	0.367
6	0.1	1	0	0	0.407	0.547	0.407
7	0.1	1	0	0	0.399	0.547	0.399
8	0.1	1	0	0	0.370	0.547	0.370
9	0.1	1	0	0	0.366	0.547	0.366
Weights in kilograms							

Table 3.13. Sole IIIa. Input to short term prediction.

MFDP version 1a								
Run: run1								
Time and date: 15:49 12-04-2015								
Fbar age range: 4-8								
2015								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2357	0.1	0	0	0	0.250	0.051	0.250
3	638	0.1	1	0	0	0.262	0.152	0.262
4	631	0.1	1	0	0	0.322	0.305	0.322
5	614	0.1	1	0	0	0.367	0.288	0.367
6	409	0.1	1	0	0	0.407	0.497	0.407
7	248	0.1	1	0	0	0.399	0.497	0.399
8	113	0.1	1	0	0	0.370	0.497	0.370
9	147	0.1	1	0	0	0.366	0.497	0.366
2016								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2357	0.1	0	0	0	0.250	0.051	0.250
3	.	0.1	1	0	0	0.262	0.152	0.262
4	.	0.1	1	0	0	0.322	0.305	0.322
5	.	0.1	1	0	0	0.367	0.288	0.367
6	.	0.1	1	0	0	0.407	0.497	0.407
7	.	0.1	1	0	0	0.399	0.497	0.399
8	.	0.1	1	0	0	0.370	0.497	0.370
9	.	0.1	1	0	0	0.366	0.497	0.366
2017								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	2357	0.1	0	0	0	0.250	0.051	0.250
3	.	0.1	1	0	0	0.262	0.152	0.262
4	.	0.1	1	0	0	0.322	0.305	0.322
5	.	0.1	1	0	0	0.367	0.288	0.367
6	.	0.1	1	0	0	0.407	0.497	0.407
7	.	0.1	1	0	0	0.399	0.497	0.399
8	.	0.1	1	0	0	0.370	0.497	0.370
9	.	0.1	1	0	0	0.366	0.497	0.366
Input units are thousands and kg - output in tonnes								

Table 3.14. Sole IIIa. Management options table for short term prediction.

Basis: F(2015) = Fsq = mean F(12-14) = 0.4167; R94-14= GM = 2.4 million; SSB(2015) = 0.96kt; SSB(2016) = 1.21kt; landings (2015) = 0.29kt,

Rationale	Catches (2016) 3)	Landings (2016)	Basis	F(2016)	SSB(2017)	%SSB change 1)	%TAC change 2)
MSY framework	0.115	0.110	F_{MSY} *SSB_{2016}/MSY $B_{trigger}$	0.13	1.67	39%	-46%
	0.135	0.129	F_{MSY} upper *SSB_{2016}/MSY $B_{trigger}$	0.16	1.66	37%	-37%
	0.090	0.086	F_{MSY} lower *SSB_{2016}/MSY $B_{trigger}$	0.10	1.70	41%	-58%
Precautionary approach	0.371	0.357	Fpa = Fsq *1.18	0.49	1.42	18%	74%
Zero catch	0.000	0.000	F=0	0.00	1.79	48%	-100%
Status quo	0.175	0.168	50% Fsq (F_{2015}*0.5)	0.21	1.62	34%	-18%
	0.246	0.237	-15% TAC(F_{2015}*0.52	0.22	1.61	33%	-15%
	0.184	0.177	F_{MSY} (F_{2015}*0.53)	0.22	1.61	33%	-15%
	0.213	0.205	No change TAC (F_{2015}*0.62)	0.26	1.58	31%	0%
	0.324	0.312	Fsq ($F_{2015)}$	0.42	1.47	22%	52%
	0.362	0.348	+15% TAC(F_{2015}*1.14)	0.30	1.55	28%	15%

Weights in '000 tonnes.

1) SSB 2014 relative to SSB 2013.

2) Catches 2015 relative to TAC 2014.

3) A discard estimate of 4% by weight for 2014 has been added to the landingsestimates to derive catches

Table 3.15. Sole IIIa. Yield per recruit output.

MFYPR version 2a									
Run: ypr1									
Time and date: 23:11 13-04-2015									
Yield per results									
FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0	0.000	0.000	0.000	10.508	3.652	9.508	3.402	9.508	3.402
0.1	0.046	0.283	0.103	7.686	2.614	6.686	2.364	6.686	2.364
0.2	0.092	0.420	0.151	6.318	2.110	5.318	1.859	5.318	1.859
0.3	0.138	0.502	0.180	5.502	1.808	4.502	1.558	4.502	1.558
0.4	0.184	0.557	0.198	4.955	1.605	3.955	1.355	3.955	1.355
0.5	0.229	0.596	0.210	4.559	1.458	3.559	1.208	3.559	1.208
0.6	0.275	0.627	0.219	4.258	1.346	3.258	1.096	3.258	1.096
0.7	0.321	0.651	0.225	4.018	1.257	3.018	1.007	3.018	1.007
0.8	0.367	0.671	0.230	3.823	1.184	2.823	0.934	2.823	0.934
0.9	0.413	0.687	0.234	3.659	1.123	2.659	0.873	2.659	0.873
1.0	0.459	0.702	0.237	3.519	1.071	2.519	0.821	2.519	0.821
1.1	0.505	0.714	0.239	3.398	1.027	2.398	0.776	2.398	0.776
1.2	0.551	0.725	0.240	3.292	0.987	2.292	0.737	2.292	0.737
1.3	0.596	0.734	0.242	3.197	0.953	2.197	0.702	2.197	0.702
1.4	0.642	0.743	0.243	3.113	0.921	2.113	0.671	2.113	0.671
1.5	0.688	0.751	0.243	3.036	0.894	2.036	0.643	2.036	0.643
1.6	0.734	0.758	0.244	2.967	0.868	1.967	0.618	1.967	0.618
1.7	0.780	0.764	0.244	2.903	0.845	1.903	0.595	1.903	0.595
1.8	0.826	0.770	0.244	2.845	0.824	1.845	0.574	1.845	0.574
1.9	0.872	0.776	0.244	2.791	0.805	1.791	0.554	1.791	0.554
2.0	0.918	0.781	0.244	2.741	0.787	1.741	0.536	1.741	0.536

Reference point	F multiplier	Absolute F
Fbar(4-8)	1	0.4588
FMax	2.0296	0.9312
F0.1	0.3814	0.175
F35%SPR	0.5139	0.2358

Weights in kilograms

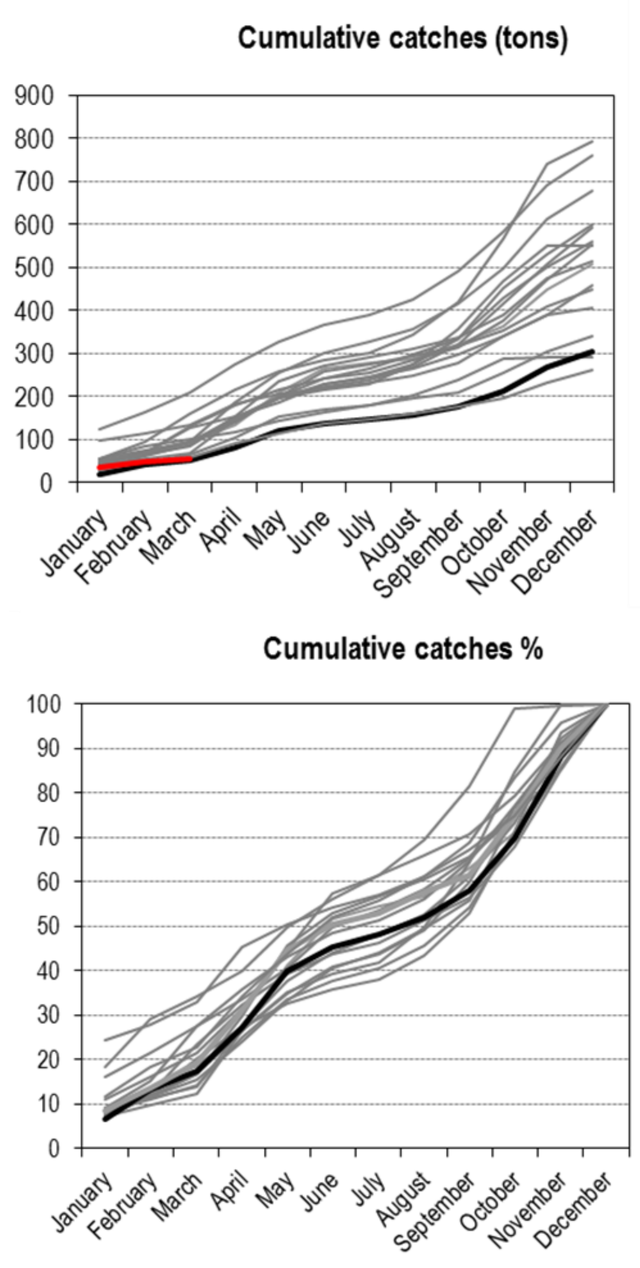


Fig. 3.1. Sole IIIa. Landings of sole in Skagerrak and Kattegat (IIIa) by nation since 1952. Bold red line indicate estimated total landings including misreportings as estimated by the WG.

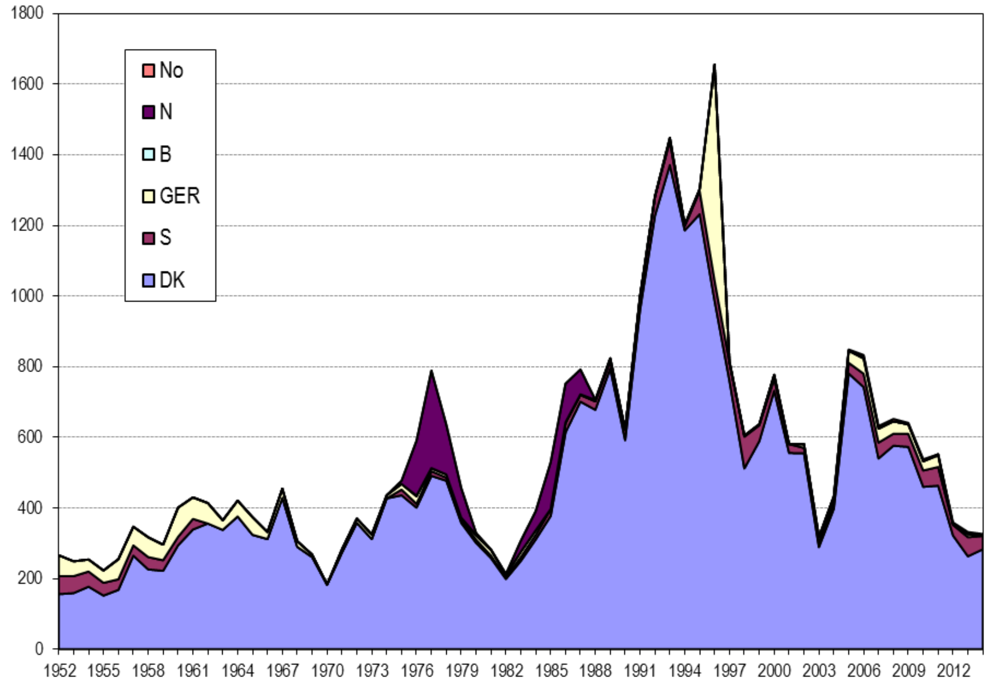


Fig. 3.2. Sole IIIa. Landings of sole in Skagerrak and Kattegat (IIIa) by nation since 1952. Bold red line indicate estimated total landings including misreportings as estimated by the WG

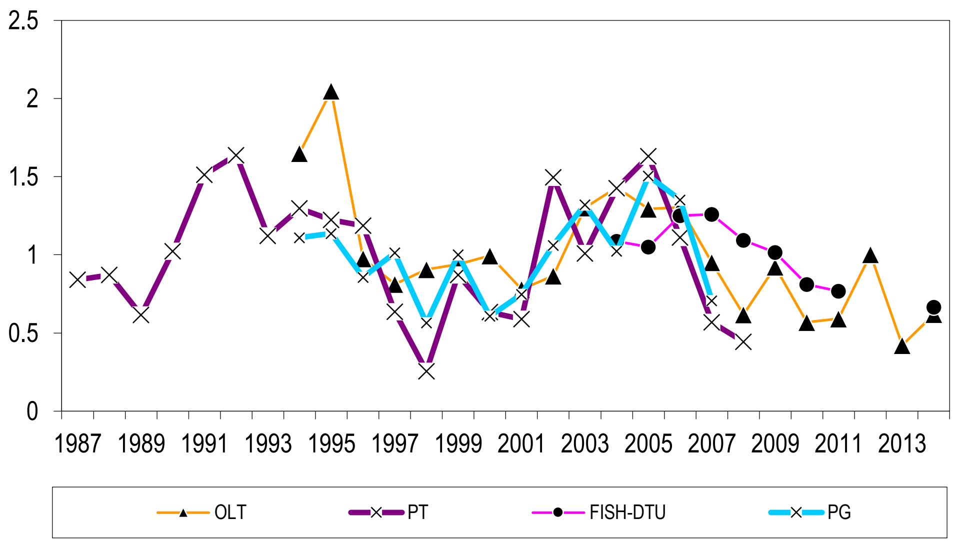


Figure 3.3 . Sole IIIa and SD22-23. Standardised CPUE of sole from Official logbooks from trawlers (OLT), private logbooks from trawlers (PT), Fisherman/DTU Aqua survey (FISH/DTU), and private logbooks gillnetters (PG).

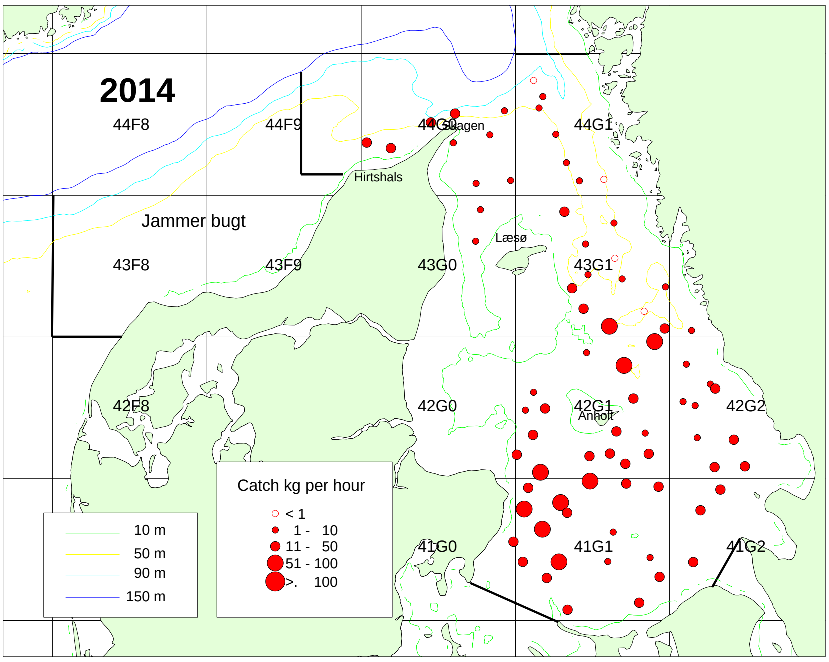


Fig. 3.4. Sole IIIa. Fisherman-DTU Aqua survey. Distribution of stations in 2014.

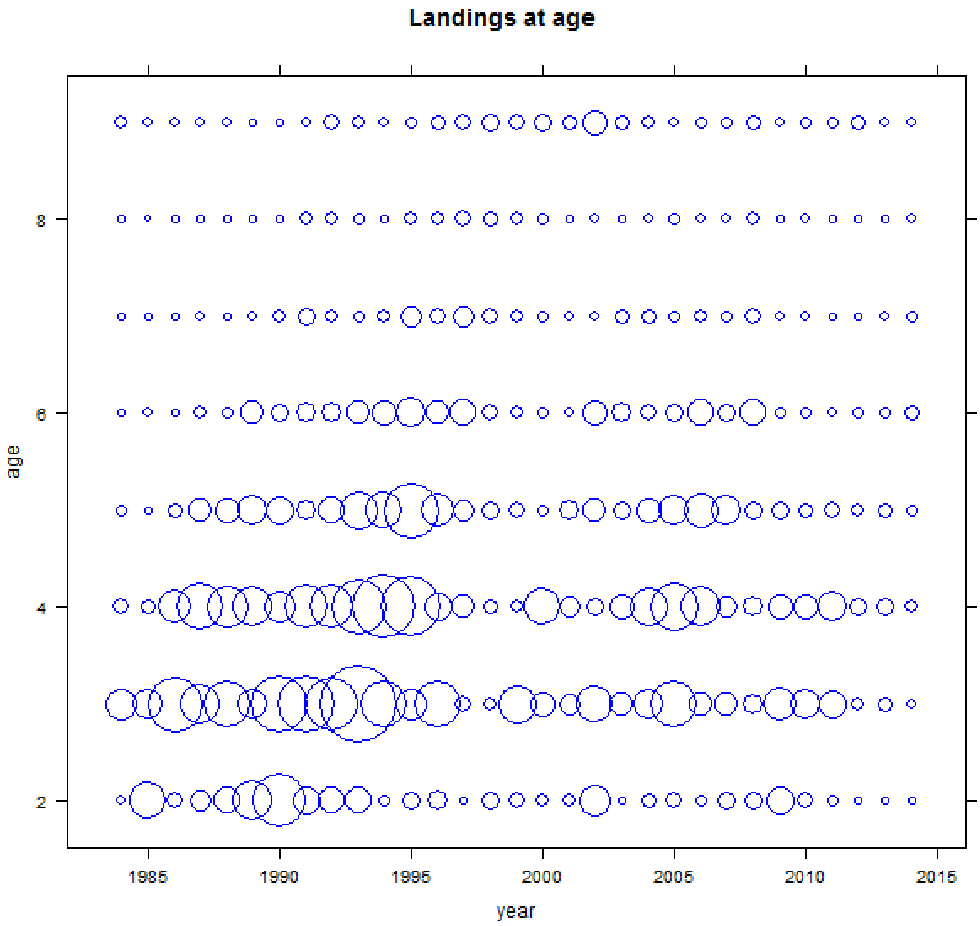


Figure 3.6. Sole IIIa. Landing numbers at age.

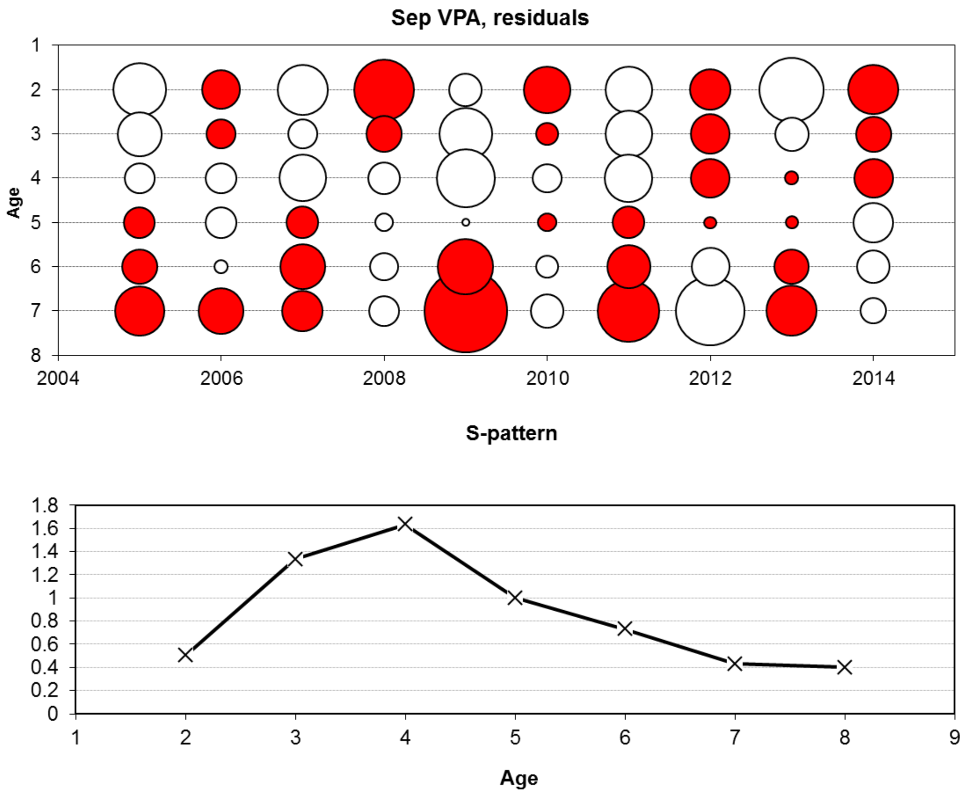


Fig. 3.7. Sole IIIa. Residuals and selection pattern from a separable VPA on ages 2 to 10 with terminal F of 0.1 at age 5 (ref. age) and terminal S of 0.5.

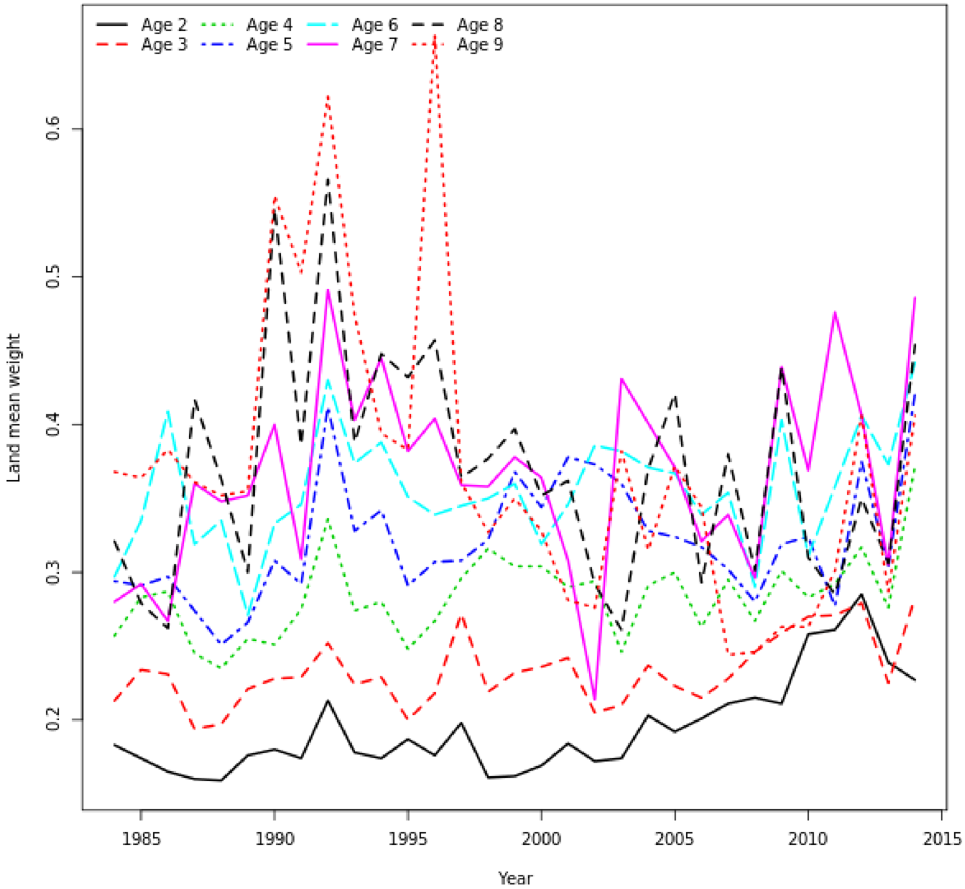


Fig. 3.8. Sole IIIa. Landings weight-at-age.

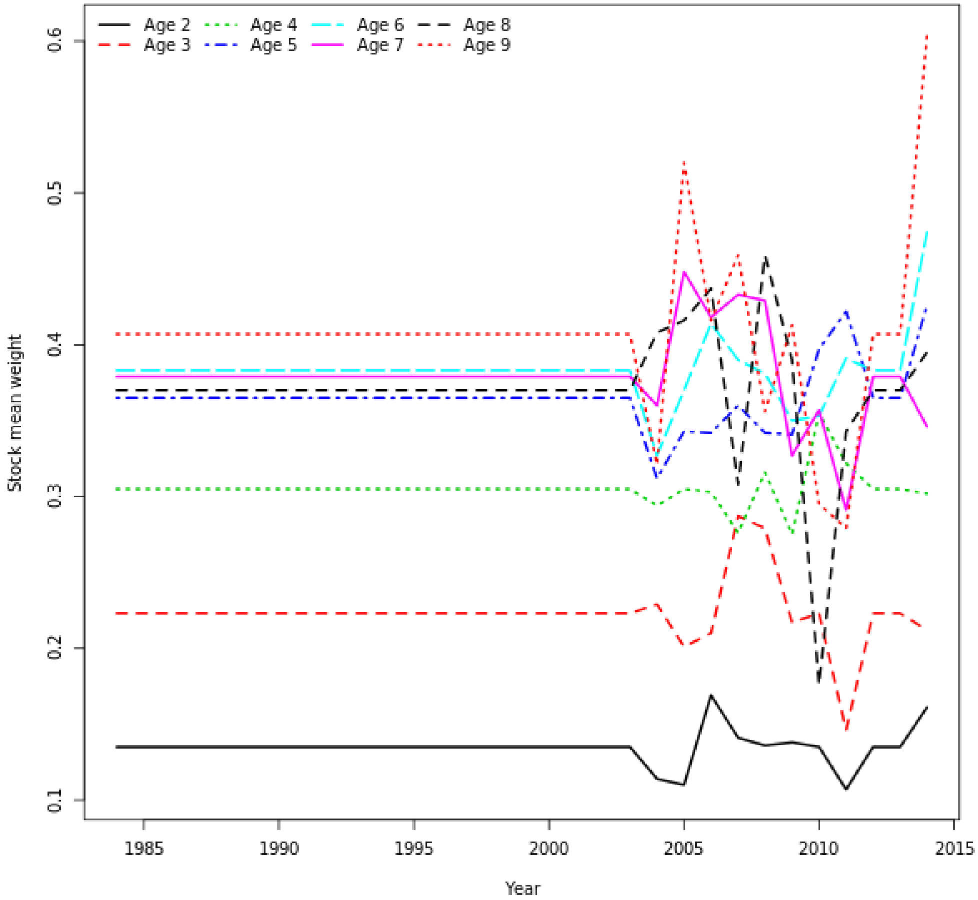


Fig. 3.9. Sole IIIa. Mean weight-at-age from DTU Aqua-Fisherman survey. Weights in 1984-2002 and 2012-13 are assumed equal to the average of the surveyed period 2003-2011 and 2014.

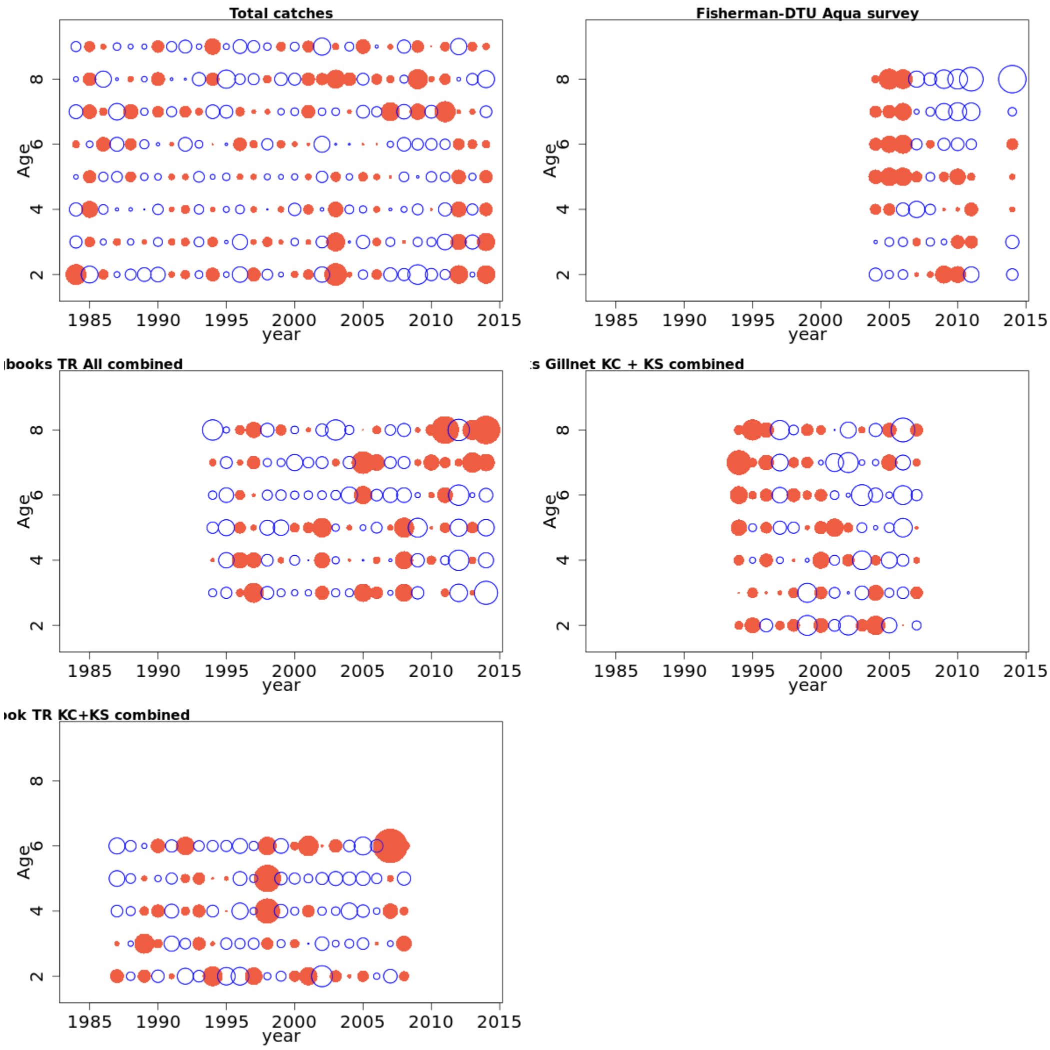


Fig. 3.10. Sole IIIa. Model residuals from SAM for each fleet and landings.

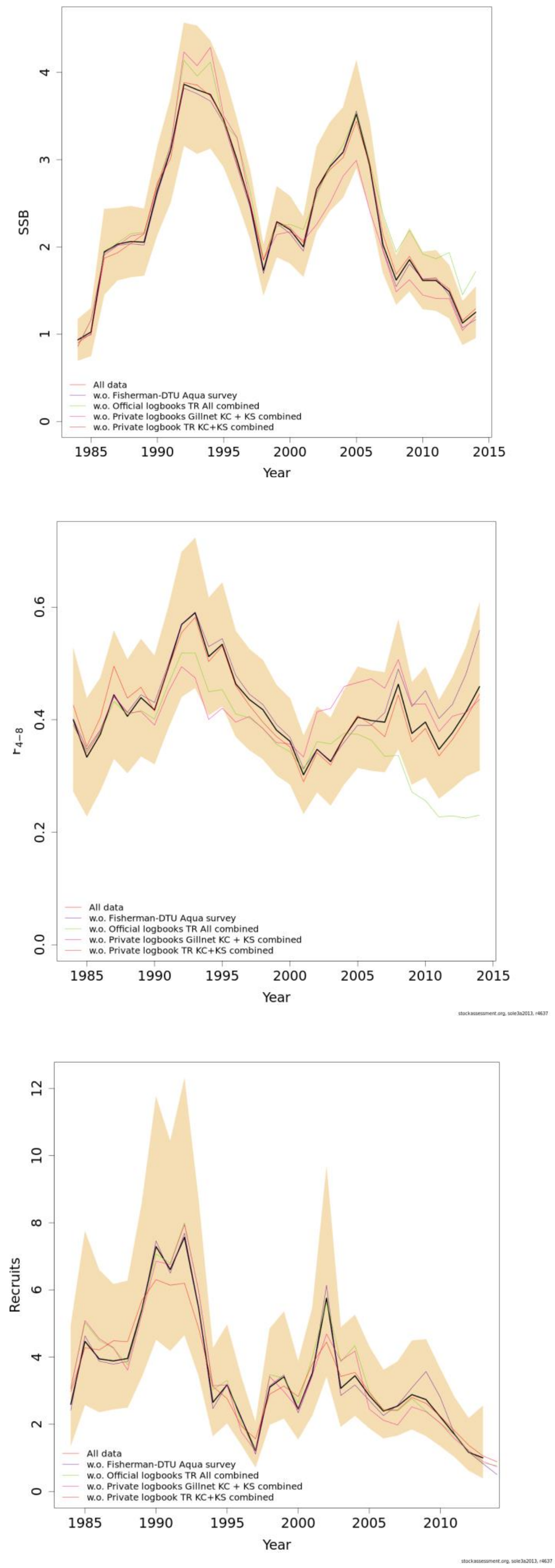


Fig. 3.11. Sole IIIa. Fleet sensitivity. Estimated SSB, fishing mortality and recruitment from runs leaving single fleets out.

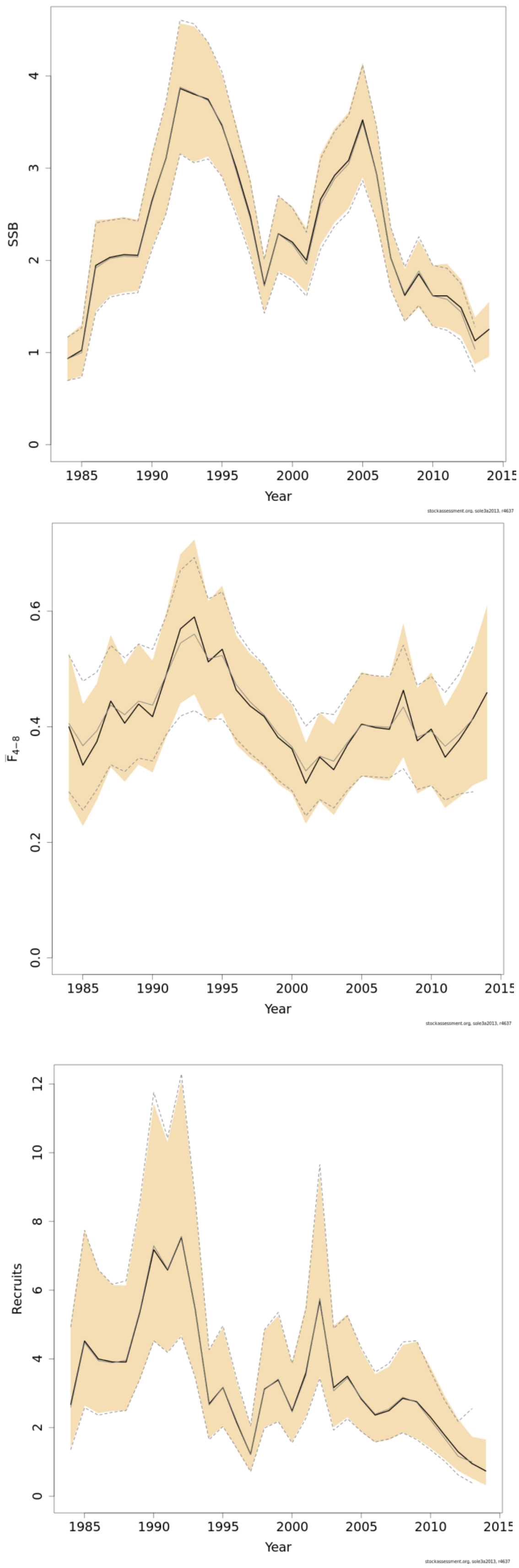


Fig. 3.12. Sole in IIIa. Stock summary from final SAM run compared to last year's assessment (grey curves and dashed lines, confidence intervals).

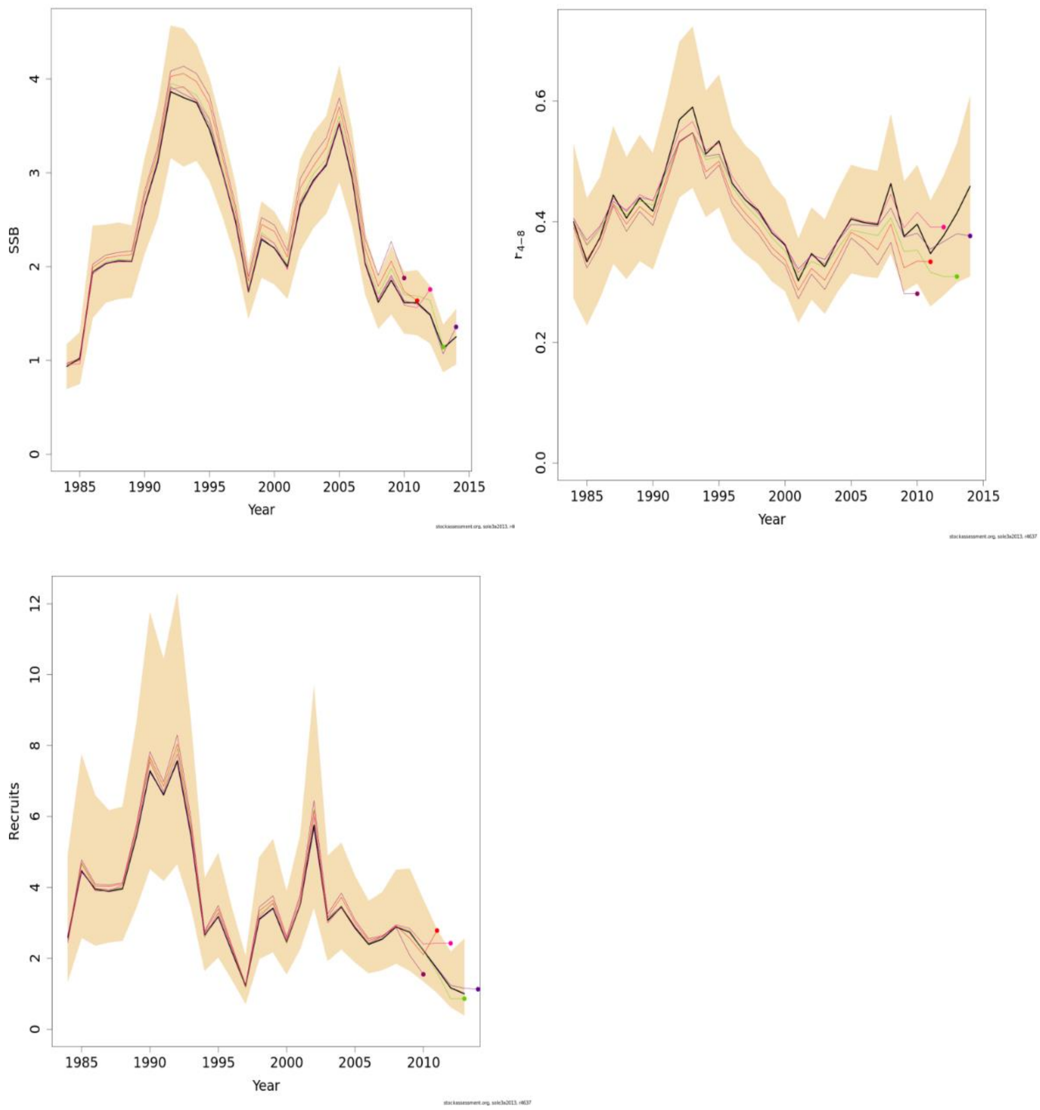


Fig. 3.13. Sole IIIa. Retrospective analyses of SSB, F and R by the SAM model. Confidence limits are provided for the 2012 scenario.

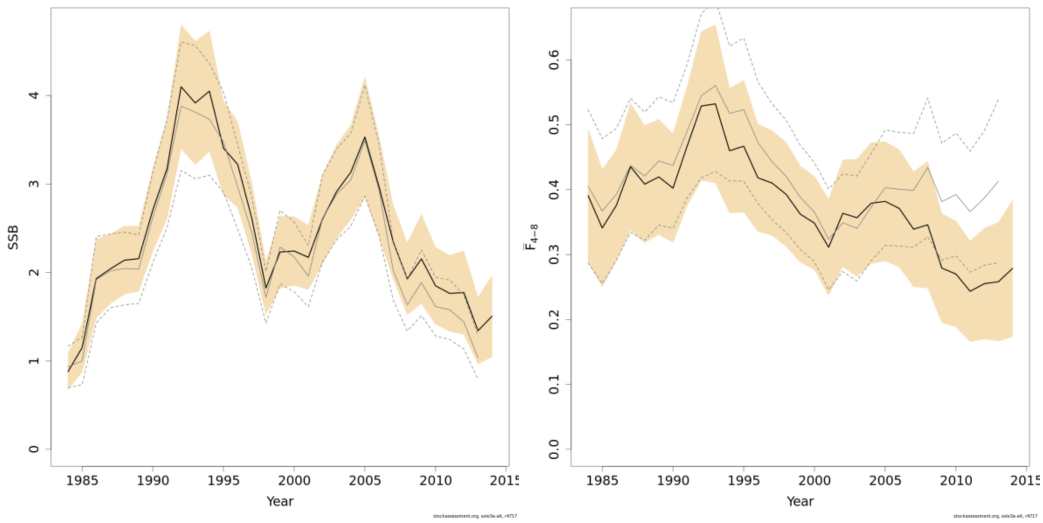


Fig 3.14 SSB and F from a SAM run without trawler fleet compared to last years accepted assessment.

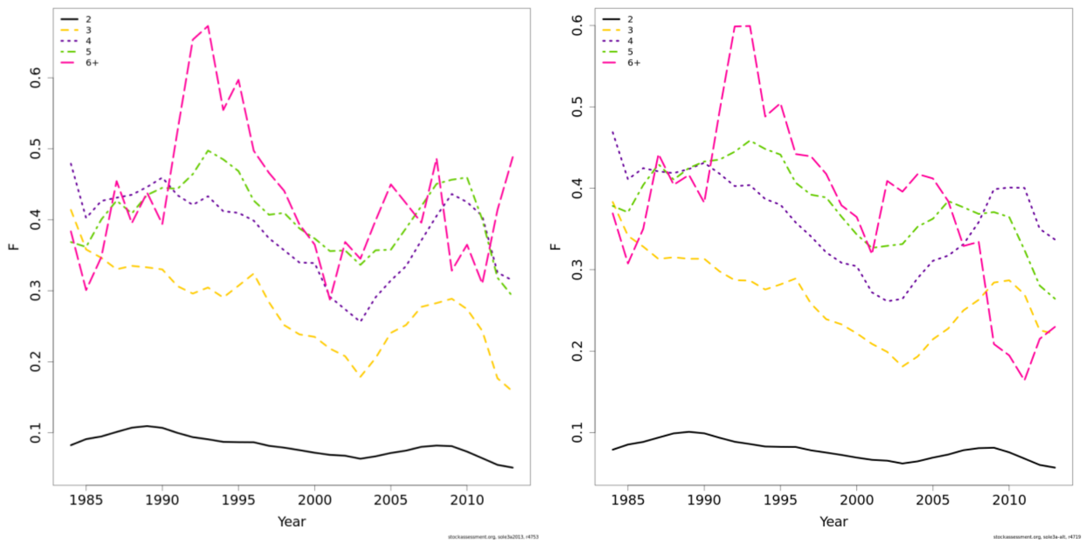


Fig. 3.15. F at age. Left: for SPALY SAM run (i.e. with survey and comm. fleets), right: from SAM run without trawler tuning series.

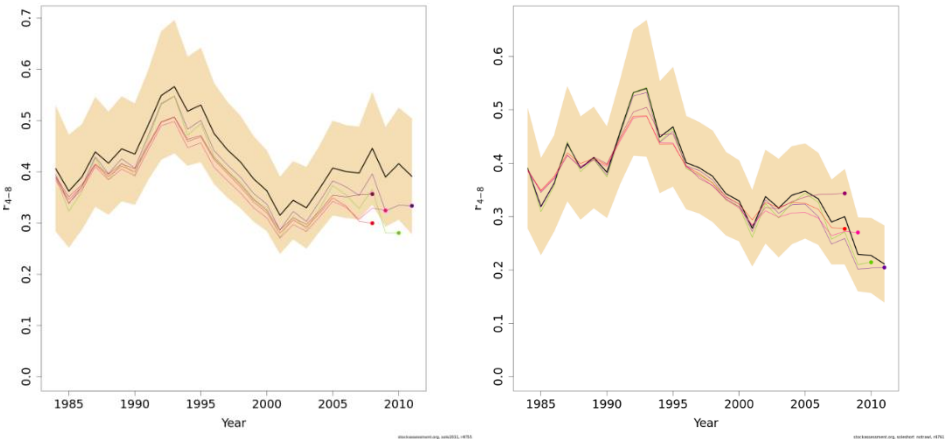


Fig. 3.16. Retrospective analyses of fishing mortality 1984-2011. Left: SPALY assessment , Right: without the comm. trawler fleet.

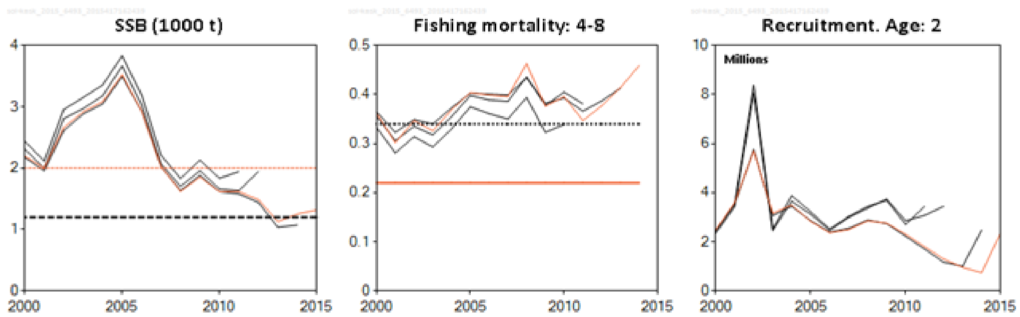


Fig. 3.17. Sole IIIa. Historical performance of F, SSB and recruitment. .

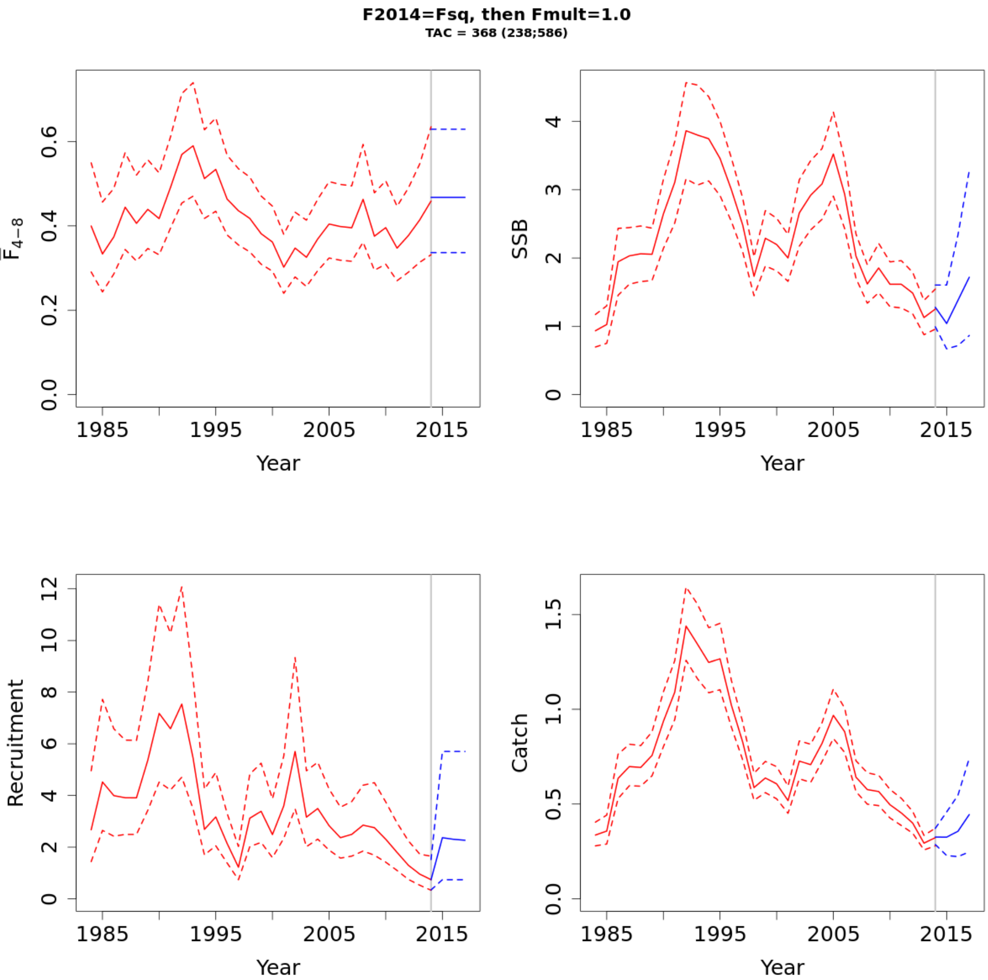


Fig. 3.18. Sole IIIa. Illustrative forecasts of SSB and recruitment assuming status quo F and R as gm(1994-2014).

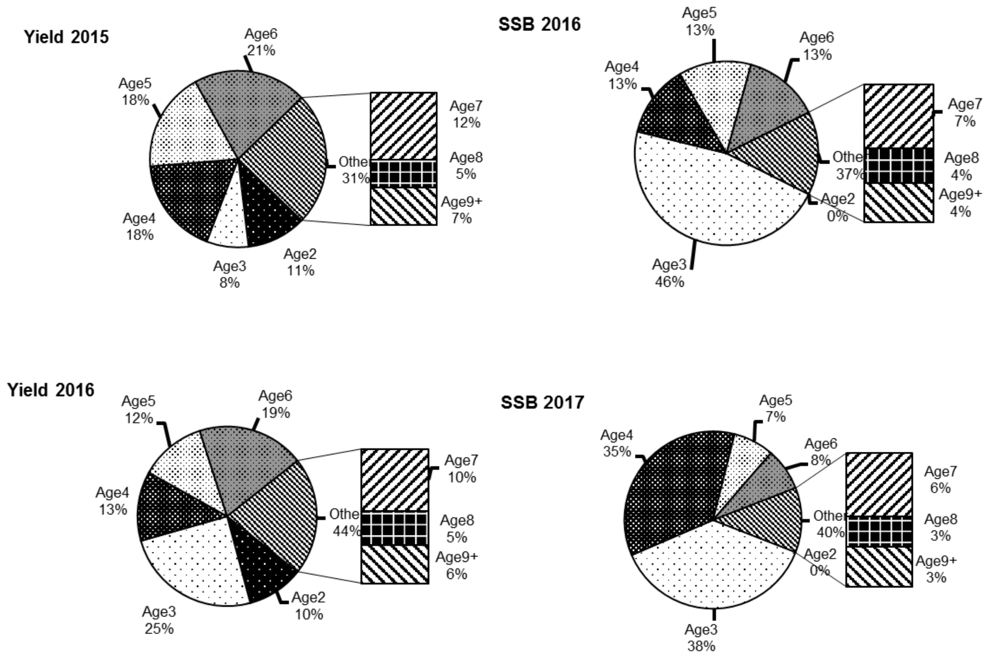


Figure 3.19. Sole IIIa. Short-term forecast for 2015-2017. Yield and SBB at age 2-9+ for status quo fishing mortality and gm(1994-2014) recruitment

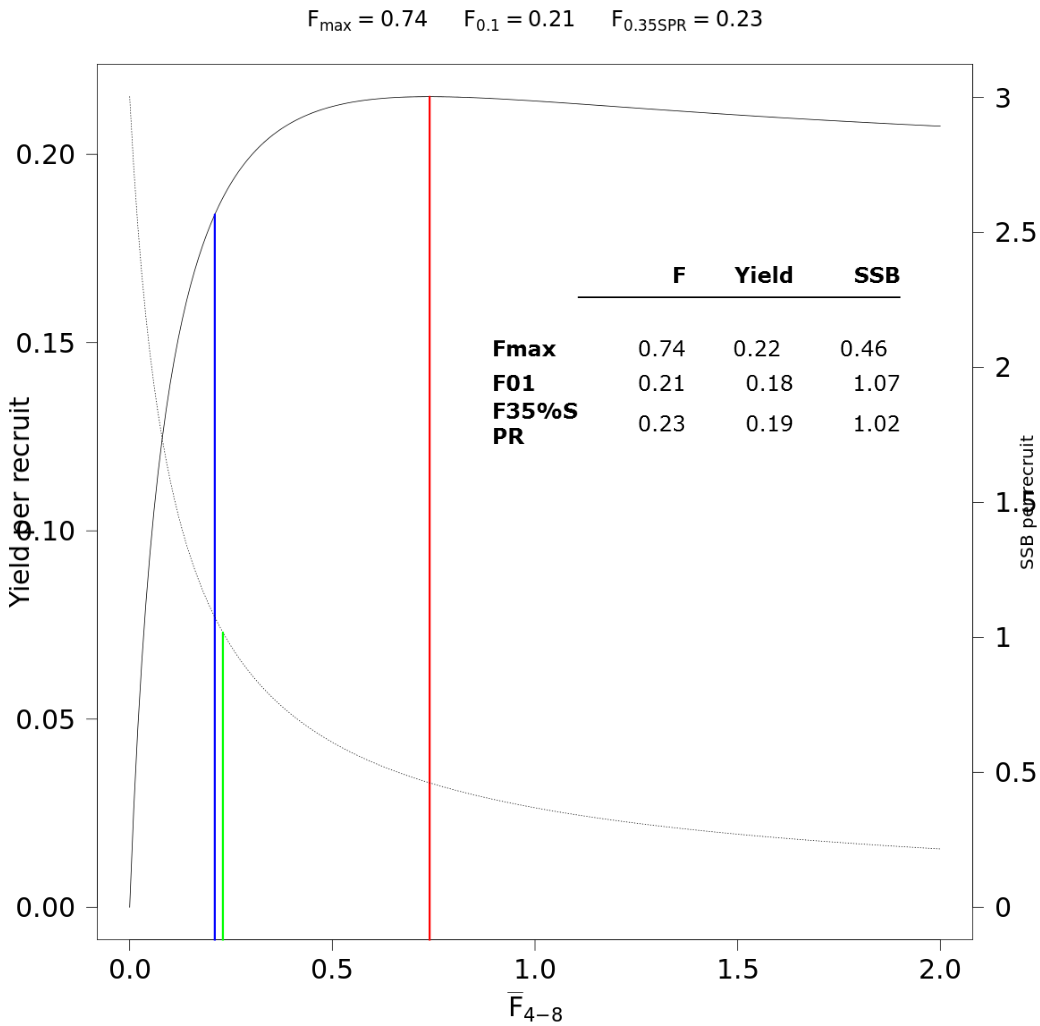


Fig. 3.20. Sole IIIa. Yield per recruit curve and reference point estimates (red=Fmax, green=F35%SPR and blue=F0.1)

4 Flounder in the Baltic

4.1 Introduction

4.1.1 WKBALFLAT – Benchmark

In January 2014 the flounder stocks in the Baltic were benchmarked. As a result four different stocks of flounder were identified (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 in 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 Appendix 7.

4.1.2 Discard

During WKBALFLAT the quality of the estimations of discards were questioned. The main problem was very high flounder discards, 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.

4.1.3 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 2 surveys were available as well.

4.1.4 Effort

Two time series were available for the flounder stocks. The first time series from 2009/2014 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 fishing days. 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 cod landings for every country and year and final effort for whole population was calculated summing all countries efforts.

The second time series was taken from STECF-Report 2014 and shows trends in nominal effort by gear types for the period 2004—2013 (calculated as kW × days-at-sea).

4.1.5 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).

4.1.6 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).

4.2 Flounder in Subdivisions 22 and 23 (Belts and Sound) update assessment

4.2.1 The fishery

The landing data of flounder in the Western Baltic (fle-2223) according to ICES Subdivisions and countries are presented in Table 4.2.1. The trend and the amount of the landings of this flatfish are shown in Figure 4.2.2.

Flounder is mainly caught in the area of Belt Sea (SD 22). ICES Subdivision 22 is the main fishing area with Denmark and Germany being the main fishing countries. Subdivision 23 is of minor importance for the contribution to the total landings. Denmark and Sweden are the main fishing countries there. The highest total landings of flounder in SD's 22 and 23 were observed at the end of the seventies (3790 t in 1978) and the lowest around the period between 2003 and 2007 (886 t in 2006). 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 varied between 1400 and 1000 tons. Landings in 2014 decreased to 1193 tons.

Flounder are caught mostly by trawlers and gillnetters. The minimum landing size is 25 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).

Discards of flounder are known to be high with ratios around 30—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 quarter 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 2014, 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 were given by the national data submitters In strata not having landings assigned, no discard-information was given.

Sampling coverage in the passive-gear segment is low, especially on discard in SD 22 and SD23, where only German data were available.

Given the increasing quality of the discard-data, the stock-trend analysis contained landings as well as discards and CPUE-indices from Trawl-Surveys (BITS in quarter 1 and 4) to qualify the stock-status and give advice for 2016.

In SD 22–23, the flounder stock shows a positive trend according to indices from the Baltic International Trawl Survey (BITS) which are shown for flounder in Figure 4.2.3.

Table 4.2.1. Fle-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	1'983		181	349		
1974	2'097		165	304		
1975	1'992		163	469		
1976	2'038		174	392		
1977	1'974		555	393		
1978	2'965		348	477		
1979	2'451		189	259		
1980	2'185		138	212		
1981	1'964		271	351		
1982	1'563	104	263	248		
1983	1'714	115	280	418		
1984	1'733	85	349	371		
1985	1'561	130	236	199		
1986	1'525	65	127	125		
1987	1'208	122	71	114		
1988	1'162	125	92	133		
1989	1'321	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	1'041	227		189	2	58
1997	1'356			655		42
1998	1'372			411		61
1999	1'473			510		37
2000	1896			660		41
2001	2030			458		52
2002	1'490			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		23

continued

Table 4.2.2. Fle-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	2'513		2'513
1974	2'566		2'566
1975	2'624		2'624
1976	2'604		2'604
1977	2'922		2'922
1978	3'790		3'790
1979	2'899		2'899
1980	2'535		2'535
1981	2'586		2'586
1982	2'074	104	2'178
1983	2'412	115	2'527
1984	2'453	85	2'538
1985	1'996	130	2'126
1986	1'777	65	1'842
1987	1'393	122	1'515
1988	1'387	125	1'512
1989	1'569	83	1'652
1990	1'176		1'176
1991	1'171		1'171
1992	940	185	1'125
1993	884	220	1'104
1994	926	265	1'191
1995	1'145	289	1'434
1996	1'232	285	1'517
1997	2'011	42	2'053
1998	1'783	61	1'844
1999	1'983	37	2'020
2000	2'556	41	2'597
2001	2'488	52	2'540
2002	1'807	42	1'849
2003	1'304	33	1'337
2004	1'267	31	1'298
2005	819	222	1'041
2006	654	212	866
2007	991	259	1'250
2008	1'181	246	1'427
2009	1'026	150	1'176
2010	933	120	1'053
2011	938	106	1'044
2012	1099	120	1'219
2013	1352	102	1'454
2014	1102	91	1'193

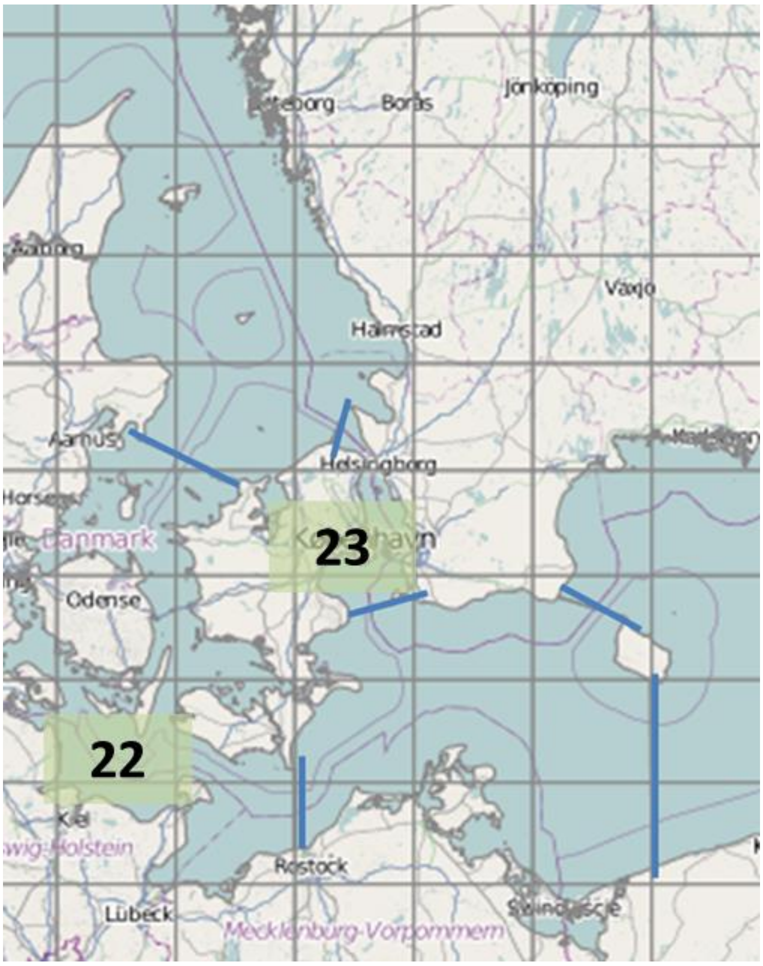


Figure 4.2.1. Fle-2223. Approximate location of the identified stock of flounder in the Western Baltic Sea. Numbers refer to ICES SD.

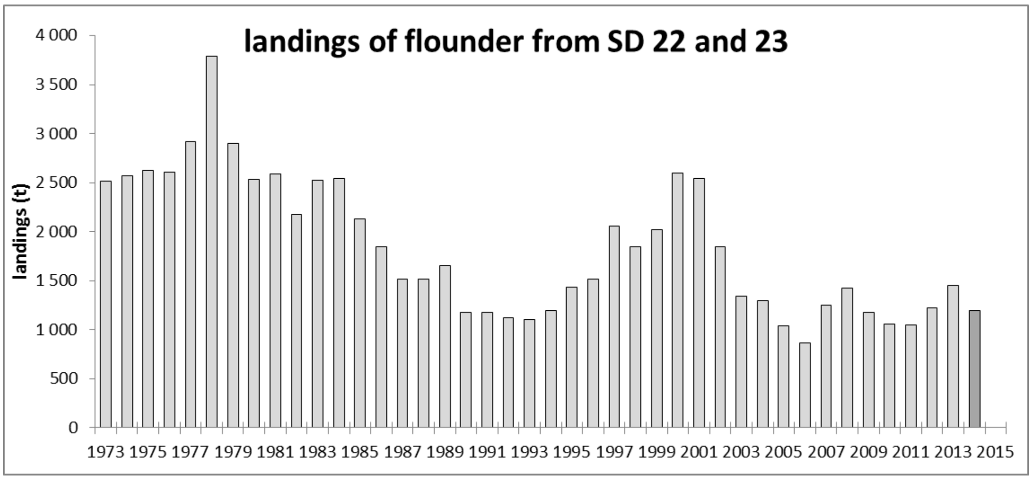


Figure 4.2.2. Fle-2223. Total landings of flounder in tons for Subdivisions SD22–23 (Western Baltic Sea)

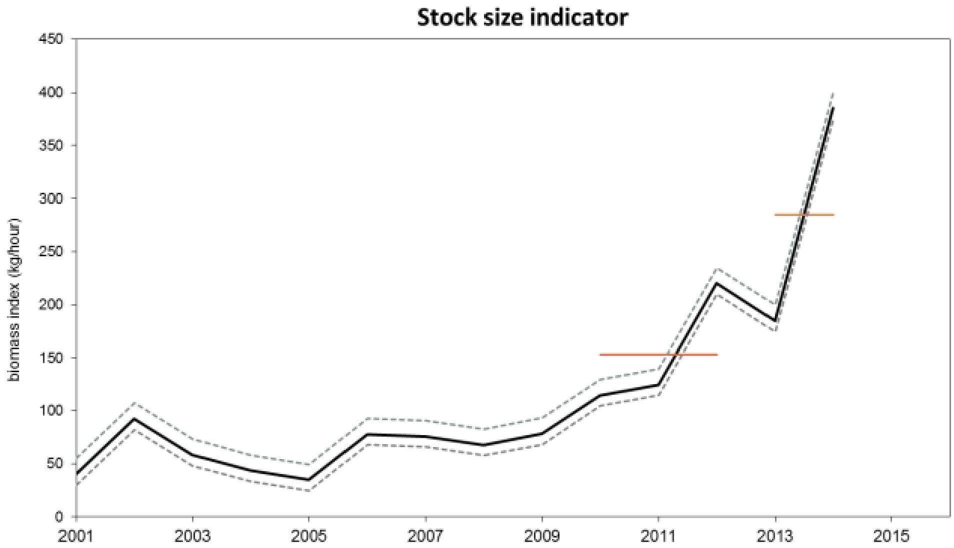


Figure 4.2.3. Fle-2223. Survey-biomass-index (BITS). Dashed lines indicate the average values used for advice (i.e. avg of the last two years and the avg of the three years before)

4.2.2 Discards

During WKBALFLAT (2014) the quality of the estimations of discards were questioned. The main problem was very high flounder discards, which exceed the landings or sometimes are even 100% of the catch. Within InterCatch, the recommended program used to store catch data and providing the input files to assessment, when no discard data are available for a particular stratum and there was no landing of flounder assigned, then the discard was also estimated as zero.

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, a new method for estimating the discards was recommended and should be applied to all flounder stocks

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 less sampled; only a few biological samples are available. However, discard estimation by national data submitter are given in many strata.

Sampling intensity has increased steadily in the last years; therefore less discard-ratios were borrowed. Table 4.2.3 gives an overview of total landings and the estimated discard weights. Before 2006, sampling intensity was too low to give a reasonable estimation, especially in the passive segment, where almost no data are available.

Table 4.2.3. Fle-2223. overview of sampling-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

About half of the strata (gear-type per subdivision per quarter per country) are covered by sampling and national discard-estimations. These strata cover about 70-80% of total landings. In 2011, Denmark conducted a discard-sampling-study for the passive gear segment.

Discards increased in 2014 (while landings decreased), which might be caused by higher plaice and cod catches. In previous years, discards were around one third of the catch. 2009 discards were high; around 47% of the catch was discarded.

4.2.3 Effort

Fishing effort in Subdivisions 22 and 23 decreased from 2004 to 2010 with 50% (see Figure 4.2.4 from STECF-report 2013) and remains stable since then. No significant de-/increase were found in the time-period 2009 to 2013 (see Figure 4.2.5, data from WGBFAS data 2014 call for historic effort-data)

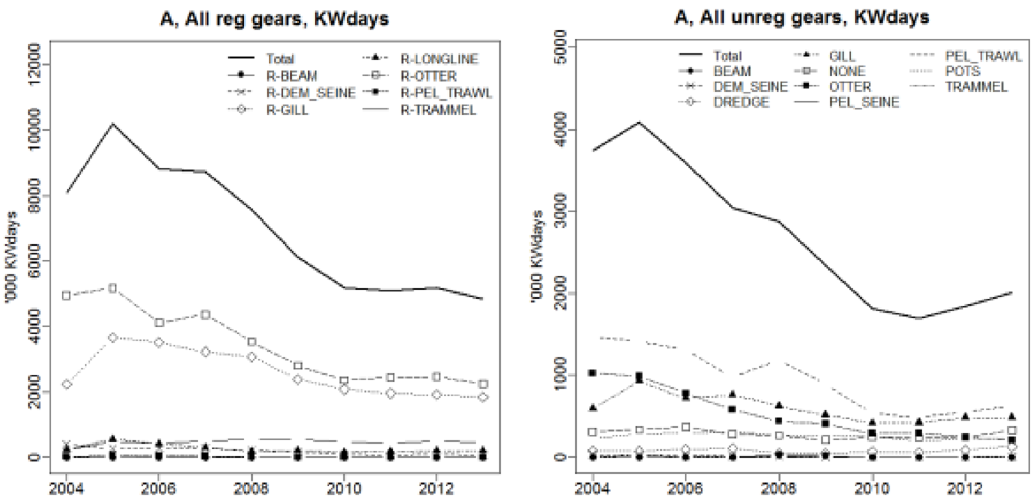
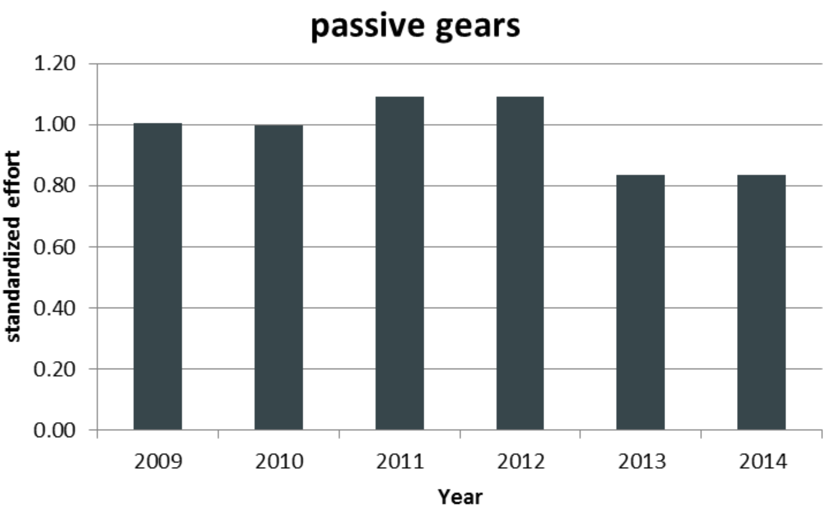


Figure 4.2.4. Fle-2223. Flounder in Subdivisions 22–23 (Belts and Sound). Area A Baltic: Trend in nominal effort by gear types 2004–2012 (kW × days-at-sea). Left panel: Regulated gears. Right panel: Unregulated gears. Note that data from Poland, Latvia, and Lithuania are only available from 2004, and Estonian data from 2005 onwards. Therefore, effort trends are shown from 2004 to 2013. No data were available from Finland (from STECF, 2014).



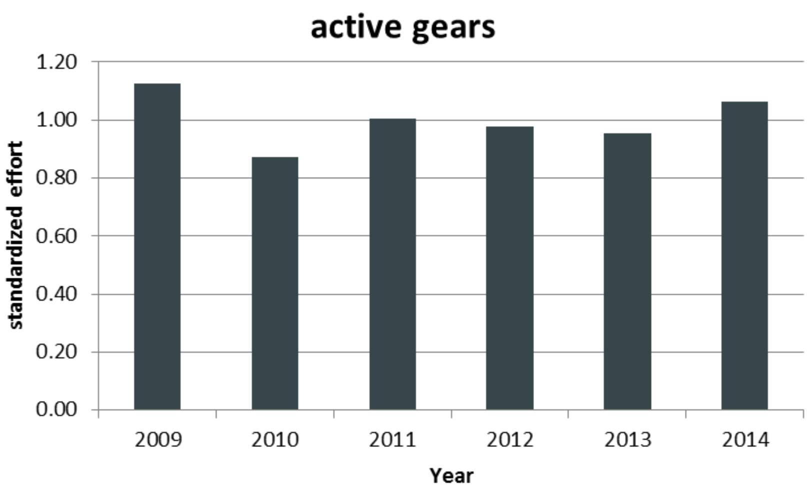


Figure 4.2.5. Fle-2223. standardized effort for active and passive fleet in Subdivision 22 and 23 (Belts and Sound). Standard catches (effort per strata and country divided by average effort per country) were weighed by national cod-landings. The calculates st. effort for active gears only includes German data, no Danish data were available during WGBFAS 2015

4.2.4 Tuning fleet

The "Baltic International Trawl Survey (BITS)" is covering the area of the flounder stock in SD2223 (Table 4.2.4). 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 to present are considered.

Fishing stations are assigned each year by a randomized list, the average number of stations covering Subdivision 22 and 23 is given in Table 4.2.4. 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.

Table 4.2.4. Fle-2223. average number of BITS-stations in SD22 and SD23

Area and quarter	average no. of stations	Standard deviation
SD22 Q1	24	4.62
Q4	26	5.28
SD23 Q1	3	0.62
Q4	3	0.66

Biological data (e.g. length, weight and age) from the first and fourth quarter BITS during the period 2001 to present are available. Biological information (e.g. mean-weights) and CPUE-index was used.

4.2.5 Age-length information

During the benchmark workshop (WKBALFLAT 2014), possibilities for age/length based analytical assessment were explored.

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 2014.

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 technique) as recommended by WKARFLO (ICES, 2007; 2008) and WKFLABA (ICES, 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).

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 (see Section 3). Further development and validation of this approach, for example comparison with real age reading data for later years, is encouraged. Further, 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.

The calculated CANUM for the period 2000 onwards were only used for exploratory analyses, 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. Such analyses were not conducted at the benchmark workshop, but are recommended to be carried out in future.

Weights, maturities, growth

Mean weight per age and length-class were only available from German sampling-programme (commercial fisheries, Figure 4.2.5) and BITS. Gaps were filled by using a length-weight relationship, calculated from commercial-fishery sampling data. Germany has no fishery in SD 23, therefore, no weight-information were available from commercial fisheries. Calculated weights from SD 22 were assumed to be the same as

SD 23. It is however unlikely, that mean-weight are similar, since the fishing pattern and timing is different between the Subdivisions. SD 23 shows almost no active fisheries, 90% of the catches come from passive gears. Passive gears often catch larger fishes and have a lower discard-rate.

4.2.6 Stock Assessment

For exploratory purposes, data were compiled to run a State-space fish stock assessment model (SAM).

CANUM were generated via a knife-edge slicing approach of length-distributions (explained above, see also section 3 for description of the method and WD 6.3 for an overview of input-data). The catch-length-distribution was sliced for all subdivisions, quarter, countries and gears combined (). However, both sexes were combined due to insufficient data on sex-ratio from all years and subdivisions. This exploratory stock assessment is however not used for advice and therefore was excluded from report. Result are however available, e.g. in WKBALFLAT Report and WGBFAS 2014 Report.

Proposed Assessment approach

The flounder stock in SD 22—23 is categorized as a data-limited-stock (DLS). Especially the beginning of the time-period (2000 to 2006) is very data poor with a low sampling-coverage in time and space.. Especially in the years 2000—2006 more than half of the strata (landings and discards) 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-dependant 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).

The BITS-index uses only fishes ≥ 20 cm from Q1 and Q4 BITS survey from the ICES DATRAS database. Fishes with a total length < 20 cm were excluded, since the used standard-gear is not catching theses length-classes representatively due to limitation in mesh-size and fishing area (not covering the shallow areas where small flounder would occur). The values for the effort were averaged from all daytime hauls (incl. 0 catch) and weighted by depth stratum area (Figure 4.2.3, upper panel).

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.

The stock-index was calculated by using the cpue-numbers per age and the average-weight per length-class obtained from length-weight relationship (Table 4.2.7).

Survey trends have increased steadily since the early 2000s. The average stock size indicator (number/hour) in the last two years (2013—2014) is 81% higher than the abundance indices in the three previous years (2010—2012).

Table 4.2.9 Fle-2223 Biomass-index values 2001 to 2013 (data-source: DATRAS)

Year	Survey	Index-value
2002	avg Q1/Q4	92
2003	avg Q1/Q4	58
2004	avg Q1/Q4	43
2005	avg Q1/Q4	34
2006	avg Q1/Q4	78
2007	avg Q1/Q4	76
2008	avg Q1/Q4	68
2009	avg Q1/Q4	78
2010	avg Q1/Q4	114
2011	avg Q1/Q4	125
2012	avg Q1/Q4	220
2013	avg Q1/Q4	184
2014	avg Q1/Q4	385

Discard estimations are sufficient enough to enable a catch advice for 2016, including both landings and discards.

Reference Points

The flounder stock in SD 22–23 is assessed as Data Limited Stock Category 3.2 by a survey based index. No reference points have been defined.

Future Research and data requirements

Presently it is not possible to raise data probably in InterCatch as only strata with landings can be used to raise with and if you have a stock with high discard levels without landings from the same species this cannot be raised.

To improve data-quality, a better coverage of sampling from the commercial fisheries is needed. Further, both the data collection and the procedure for estimation of discards need to be improved. Especially concerning the non-sampled strata and strata not having landings of flounder (see Section 2.2 of the report). Raw national discard data need to be available to the stock coordinator to enable data-quality checks.

Better data on sex-ratio and individual weights from commercially catched fishes are required (only German data were available).

Biological data from discarded fishes should also be collected in the context of the sampling-program. Discards are considered to be an important factor in the flatfish-fishery and often exceed the amount of landed fish. For better estimation on length- and age-structure, biological samples should be taken not only from the retained fishes (e.g. during harbour-sampling) but also from this fraction.

For the exploratory SAM-Assessment, sliced data were used (i.e. ages-distribution estimated by length-distribution). These methods should be validated by comparing the outcomes with real-age-distributions.

Age readings using the new methods should be applied to historical otoliths. This will enable comparisons with the resulting age-matrix from the slicing and enable better quality of CANUM.

4.2.7 Recommendations

It is recommended to continue developing an analytical assessment for flounder in SD 22-23. To do so, data quality must be improved to allow for reasonable slicing of length-distributions and extrapolation.

Furthermore, information on the magnitude of discard is required from both Subdivisions SD22 and SD23. Especially in SD 23, strata without attached landings need to be defined as "zero landings" or "zero-catches".

For analytical assessments, weights from length-classes or from age-classes should be collected also from SD 23.

Future ICES-data calls concerning historical data need to be more specific in terms of the data format. From three submitting countries, only one country submitted all available data in time and in the required format.

Literature

[1] Scientific, Technical and Economic Committee for Fisheries (STECF) – Evaluation of Fishing Effort Regimes in European Waters - Part 2 (STECF-13-21). 2013. Publications Office of the European Union, Luxembourg, EUR 26327 EN, JRC86088, 863 pp.

4.3 Flounder in Subdivision 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) 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: SD 22 and 23; SD 24 and 25; SD 26 and 28.

Flounder in SD 24 and 25 are different from flounder in SD 26 and 28 based on separate spawning areas, but 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.

For the flounder stock in SD 24 and 25, the volume of water suitable for reproduction is defined by salinity >=12.0 psu and oxygen content >= 2 ml O2 /l. Therefore the recruitment success can fluctuate dependent on hydrological condition on the spawning grounds (the spawning areas for this stock are the Arkona Deep, the Slupsk Furrow, and the Bornholm Deep) (ICES, 2014 a-b).

4.3.1 The Fishery

Flounder by most of the countries is generally taken as bycatch in demersal fisheries.. However, in Poland, trawl and gillnet fishing directed to flounder is common. Polish flounder catches generally increase when cod resources decrease. A share of about 60% of the Polish landings is caught by the directed flounder fishery in the Polish EEZ (SD 26 included).

The Danish landings are mainly bycatch in the cod fishery. The major season for flounder bycatch is winter, when some fishing boats may catch up to two tons per day, depending on depth and area. Most flounder are caught in the area east and southeast of Bornholm (SD 25). There is a high variability between years. The amount of the flounder catch discarded depends on price and size of the flounder. In the most recent years the price declined and therefore the amount of flounder discarded increased.

German flounder landings are also mainly bycatch in the cod-directed fishery, but in the ICES SD 24 there is a German trawl fishery directed to catch flounder, in particular in the 3rd and in the 4th quarter. This fishery contributes to a maximum of about 35 % to the total German flounder landings.

The total landings of this stock increased from 4000—7000 t in 1973—1993 to 8000—13000 t after 2000 and reached the highest value 14610t, in 2014. Before 2000, some of the country reported merged flounder landings from SD 24-25. After 2000 landings from SD 25 were about two times higher than from SD 24. Some high landings in the mid-1990s are misreported (cod was reported as flounder). In 2003 the landing dropped to almost 9 thousands t. This decrease compared to 2002 is partly due to the longer summer ban for the cod trawl fishery and partly due to German trawlers that did not target flounder in 2003. In 2004 the flounder landings increased again and reached about 11 thousands t (Figure 4.3.1).

In the Subdivisions 24 and 25, Poland, Denmark and Germany are the main fishing nations. Polish contribution increased from 90's, together with total landings and in the recent years was about 80% (Figure 4.3.2, Table 4.3.1).

Flounder landings in both SD's are dominated by active gears, taking 85% of total landings in 2014 (Figure 4.3.3).

For 2014 the discard was estimated for the first time according to new methodology suggested during WKBALFLAT. The whole catch for flounder in Subdivisions 24—25 reached 20 484 tonnes in 2014.

4.3.1.1 Discards

During WKBALFLAT the quality of the estimated discards were questioned. Very high flounder discard, which exceed the landings or sometimes are even 100% of the catch cannot be properly raised within InterCatch, the recommended program used for storing catch data and providing the input files to assessment. In InterCatch, when no discard data are available for particular stratum and there was no landing of flounder assigned, then the discard is also erroneously estimated as zero.

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 to the call for data submission for ICES WGBFAS, new method for discards estimation was recommended and should be applied to all flounder stocks:

$$\text{Discard Rate}_{\text{Time,SD,fleet segment,Species}} = \frac{\sum \text{Weight of discard}_{\text{Trip,Haul,Time,SD,Fleet segment,Species}}}{\sum \text{Weight of landing}_{\text{Trip,Haul,Time,SD,Fleet segment}}}$$

$$\text{Discard (ton)}_{\text{Time,SD,Fleet segment,Species}} = \text{Landings (ton)}_{\text{Time,SD,fleet segment}} \times \text{Discard Rate}_{\text{Time,SD,fleet segment,Species}}$$

Despite the presence of high variability in the discard ratios, discard estimates for 2014 were prepared by using allocation scheme considering differences between subdivisions, countries, gear types and quarters (Table 4.3.2). Discard for 2014 was raised based on all demersal fish landings and implemented in this year's advice.

The discard ratio for 2014 is 40% of the flounder landings and was estimated on the level of 5 874t, which together with landings 14 610 t give catch equal to 20 484t.

4.3.1.2 Effort and CPUE data

According to the data call, all countries had to provide their effort data back to 2009 in fishing days. As countries used not the same approach (for instance: effort for flounder, effort for cod, effort for all demersal fish), data within country were standardized and then combined by using mean weighted by demersal fish landings from SD 24—25. The effort estimated for this stock does not show any trend (Figure 4.3.4).

For the different fleet segment effort data, for SD 22—24 (Figure 4.3.5) and SD 25—28 (Figure 4.3.6), there is no clear trends in the most fisheries effort since 2009(STECF, 2013).

4.3.2 Biological composition

4.3.2.0 Age composition

Because of the major age determination problems in case of flounder, WGBFAS decided in 2006 that age data from whole otoliths shall not be used for the stocks assessment (ICES 2006; see also Gardmark, *et al*. 2007, ICES 2007a). 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, 2007b, 2008) and WKFLABA (ICES, 2010). Age readings achieved by using the new methodology are available for survey (Table 4.3.3) and for commercial data (Table 4.3.4).

4.3.2.1 Quality of catch and biological data

The number of sampled fish in SD 24 is higher than in SD 25, even though the landings in SD 25 are much higher, most of the samples are analyzed by Germany and Poland (Figure 4.3.7—4.3.8).

Sampling coverage of discard increased comparing to the previous years, but the extensive sampling programme is still needed (Figure 4.3.9).

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). After the recommended improvement of the backwards discard data estimation, it is advised to continue developing an analytical assessment for the flounder stock in SDs 24—25 containing both production model and SAM.

To provide aged-based assessment, during WKBALFLAT, it was decided that the new tuning fleet for this stock should be calculated using only data derived from the advised ageing method, thereby changed the decisions made at the previous meetings (ICES, 2008; ICES, 2010) where the survey data from the German BITS SD 24 quarter 1 and 4 and the survey data from the Polish BITS quarter 1 SD25 were used as tuning fleets in the tentative assessments for flounder in SD's 24—25.

WKFLABA 2 found indications that maturity staging could be a potential problem in further stock assessment. Due to different maturity staging results, there are problems with the determination of spawning stock size. This topic was analysed by the 2nd ICES/HELCOM Workshop on Flatfish in the Baltic Sea where differences form varies Baltic Sea areas based on BITS surveys were demonstrated (ICES, 2012a).

4.3.3 Tuning fleets

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 in SD 25 by Poland, Denmark and Sweden. Number of stations is higher in SD 25 comparing to SD 24 (Table 7.3.5).

4.3.4 Biomass-Index

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 2012b).

Stock trend is estimated using the Biomass Index from BITS-Q1 and BITS-Q4 surveys. The index is calculated by length-classes, and covers the period from 2001 onwards.

The Biomass-Index is a product of the calculated cpue by length and average-weight per length-class. Because the survey is not covering shallow waters, where juvenile flounder (mostly smaller than 20 cm) occur, the catch per unit effort (number/hour) include only fishes ≥ 20 cm from BITS-Q1 and BITS-Q4 survey and the data is extracted from the ICES DATRAS database.

The values are averaged from all (incl. 0 catch) daytime hauls weighted by depth stratum area. The average weight per length-class is calculated from a length-weight relationship based on BITS-data to cover all length-classes. Weight at length was estimated as an average weight at length for data from 1991—2014?, separately for 1st and 4th quarter. Next, to such data weight-length relationships of the form $w=aL^b$ were fitted, where a and b are parameters. Parameters obtained for the sub-divisions 24-25 were: a=0.0078 and b=3.10 for 1st quarter and a=0.0125 and b=2.98 for 4th quarter.

Both BITS-Q1 and BITS-Q4 surveys 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. The advice index for this year is 1.42.

4.3.5 Historical stock trends

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 4.3.10). Advice factor for this year is 1.42, so the biomass index increase by 42% in the last two years comparing to averaged biomass index from 2010-2012.

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Table 4.3.1 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Total landings (tons) 1973-2013 by Subdivision and country.

	Denmark			Estonia			Finland			Germany			Latvia			Lithuania			Poland			Sweden			Total
Year	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

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
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
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

Table 4.3.2 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Discard information and allocation scheme for 2014.

24		2014	Discard						
fleet	**quarter**	**Denmark**	**Germany**	**Sweden**	**Poland**	**Finland**	**Estonia**	**Latvia**	**Lithuania**
Active	1				PL_A_1_25				
	2	SE_A_3_24		SE_A_3_24	PL_A_2_25				
	3								
	4			SE_A_1_24	PL_A_4_25				
Passive	1	SE_P_1_24			PL_P_4_25				
	2	SE_P_2_24			PL_P_2_25				
	3	SE_P_3_24							
	4	SE_P_4_24			PL_P_4_25				

25		2014							
fleet	quarter	Denmark	Germany	Sweden	Poland	Finland	Estonia	Latvia	Lithuania
Active	1		DE_A_1_24				DE_A_1_24		LV_A_1_25
	2						DE_A_2_24		LV_A_2_25
	3	SE_A_3_25					DE_A_3_24		
	4					PL_A_4_25	DE_A_4_24		
Passive	1	SE_P_1_25			PL_P_4_25				
	2	SE_P_2_25							
	3	SE_P_3_25							
	4	SE_P_4_25							

Legend:

- no landings
- landings
- discard with biological samples
- estimated discard

Table 4.3.3 Flounder in Subdivisions 24–25 (Southern Baltic Sea). 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 4.3.4 Flounder in Subdivisions 24–25 (Southern Baltic Sea). 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 4.3.5 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Number of BITS-stations in SD24 and SD25

	SD24		SD25	
	Q1	Q4	Q1	Q4
2000		62		47
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
average	49	46	96	70

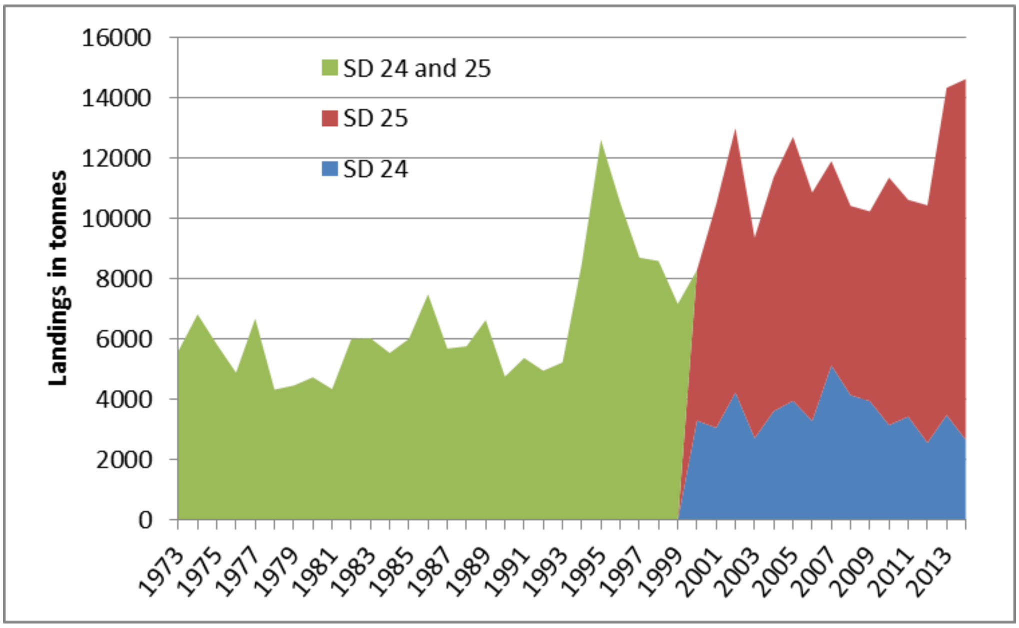
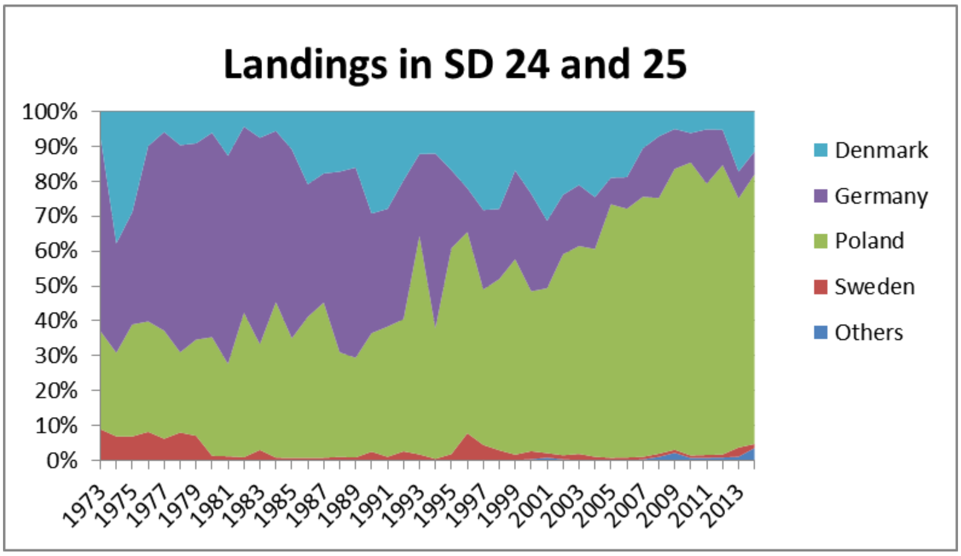
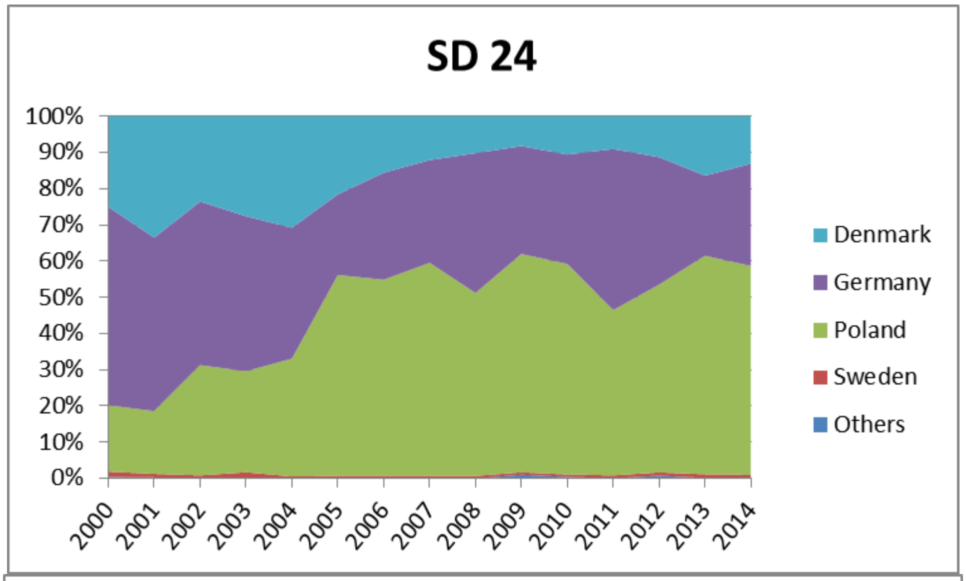


Fig 4.3.1 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Landings in tonnes.





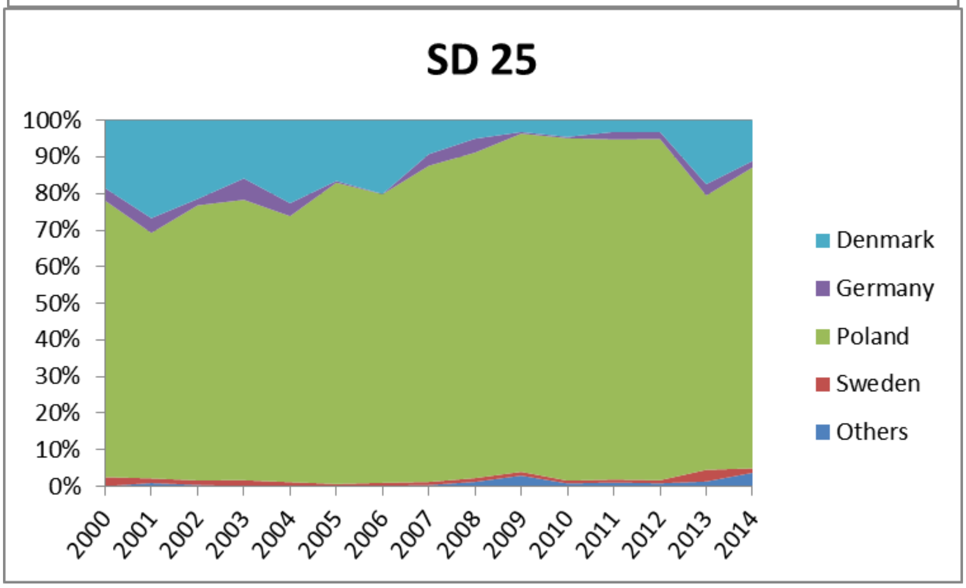


Fig. 4.3.2 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Proportion of the landings by country (for merged SD 24–25 – upper plot and separately for SD24 and SD 25 – lower plots).

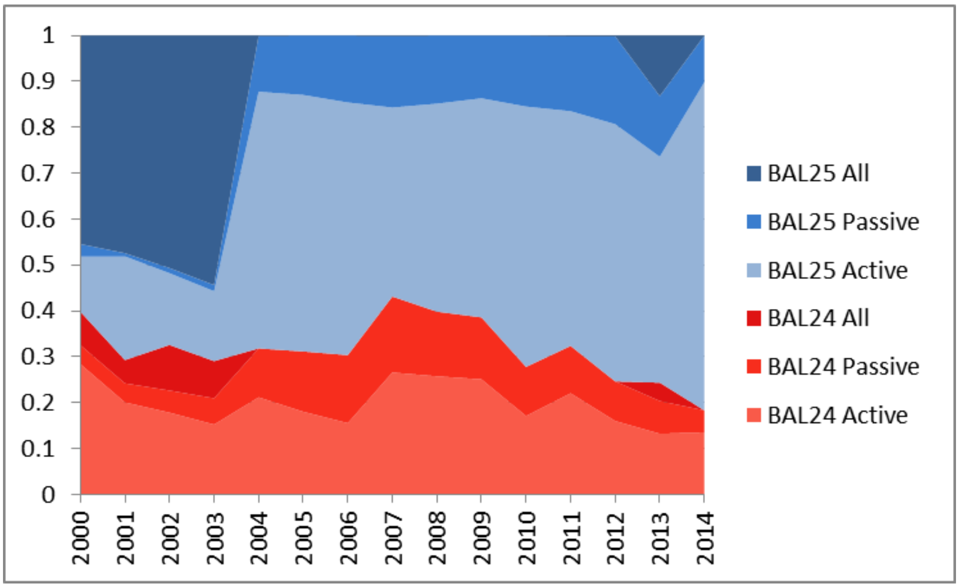


Figure 4.3.3 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Proportion of the landings by fleet type (SD 24 - reddish colours, SD 25 – bluish).

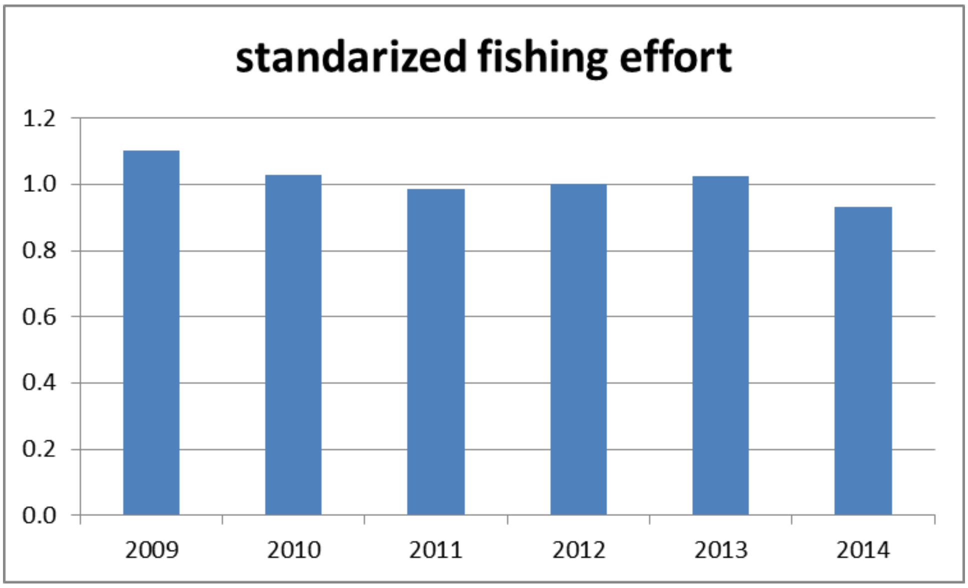


Figure 4.3.4 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Fishing effort data standardized between country combined by using mean weighted by cod landings.

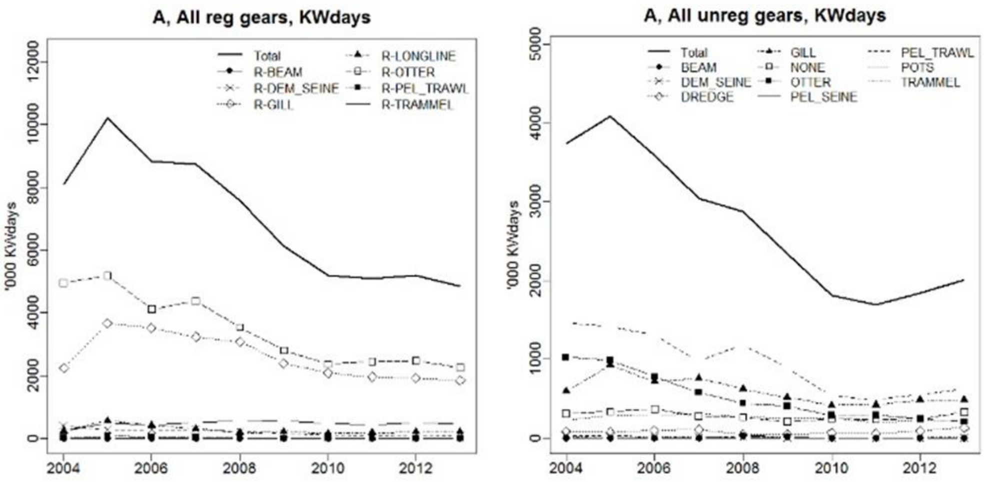


Figure 4.3.5 Area A Baltic: Trend in nominal effort by gear types 2004–2012 (kW × days-at-sea). Left panel: Regulated gears. Right panel: Unregulated gears. Note that data from Poland, Latvia, and Lithuania are only available from 2004, and Estonian data from 2005 onwards. Therefore, effort trends are shown from 2004 to 2013. No data were available from Finland (from STECF, 2014).

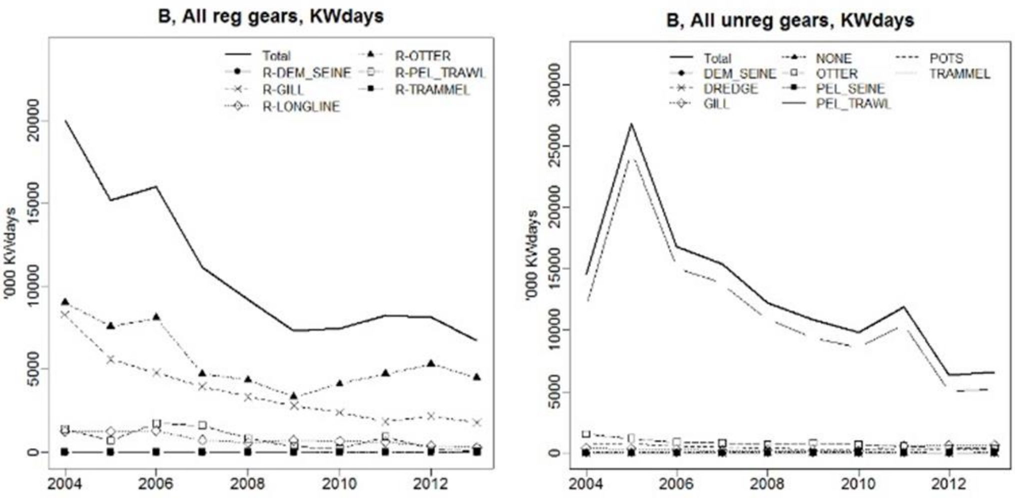


Figure 4.3.6 Area B Baltic: Trend in nominal effort by gear types 2004–2012 (kW × days-at-sea). Left panel: Regulated gears. Right panel: Unregulated gears. Note that data from Poland, Latvia, and Lithuania are only available from 2004, and Estonian data from 2005 onwards. Therefore, effort trends are shown from 2004 to 2013. No data were available from Finland (from STECF, 2014).

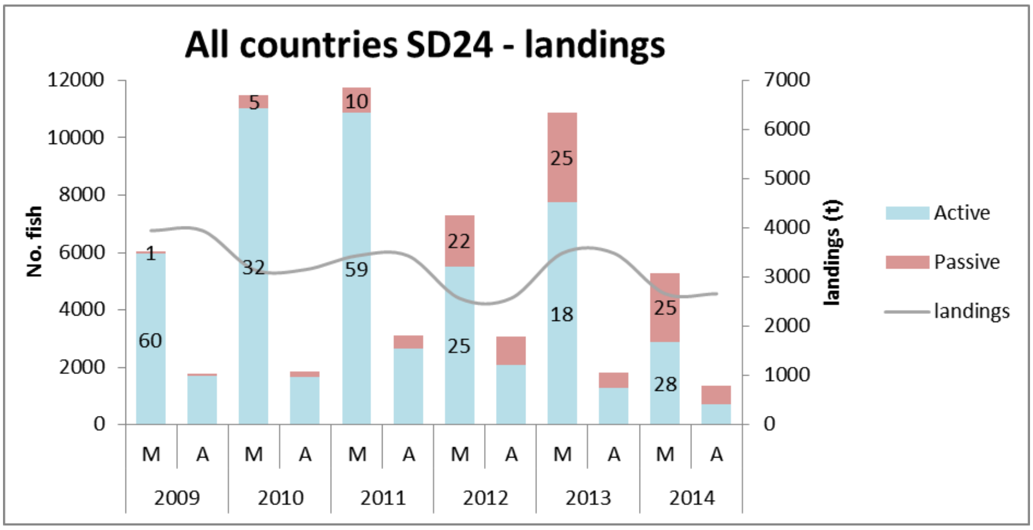


Figure 4.3.7 Flounder in Subdivisions 24–25 (Southern Baltic Sea). The coverage of sampled data in Subdivision 24 (first column of each year presents number of measured fish, second – number of aged fish; numbers on the columns are number of samples of: passive fleet - upper value and active fleet – lower value).

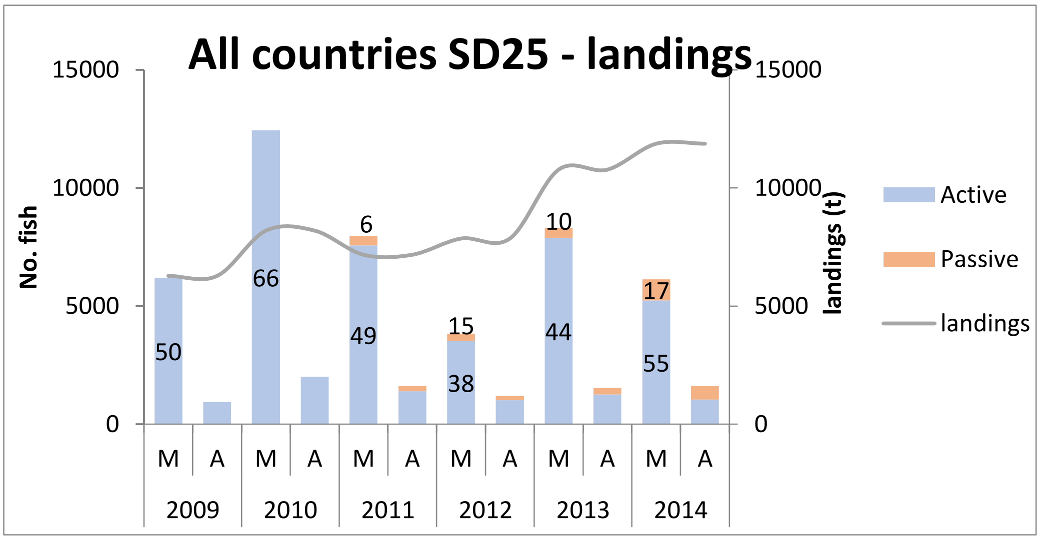
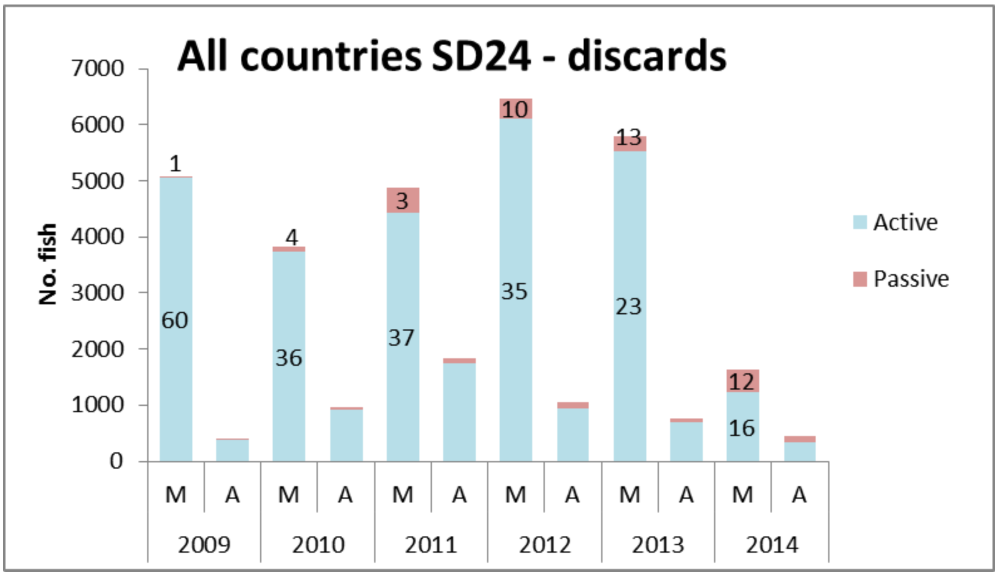


Figure 4.3.8 Flounder in Subdivisions 24–25 (Southern Baltic Sea). The coverage of sampled data in Subdivision 25 (first column of each year presents number of measured fish, second – number of aged fish; numbers on the columns are number of samples of: passive fleet - upper value and active fleet – lower value).



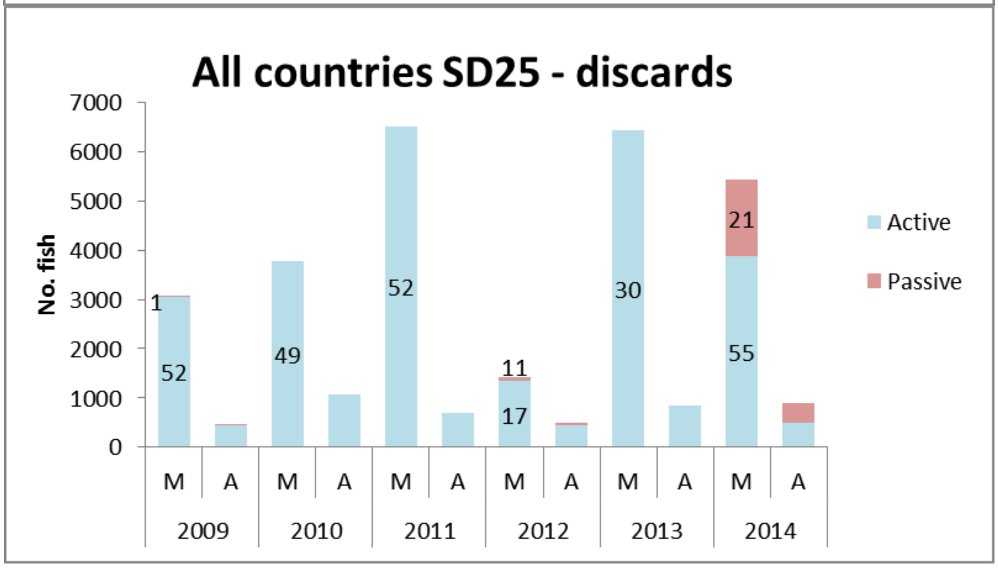


Figure 4.3.9 Flounder in Subdivisions 24–25 (Southern Baltic Sea). The coverage of discard sampled data (first column of each year presents number of measured fish, second – number of aged fish; numbers on the columns are number of samples of: passive fleet - upper value and active fleet – lower value) in Subdivision 24 (left) and 25 (right).

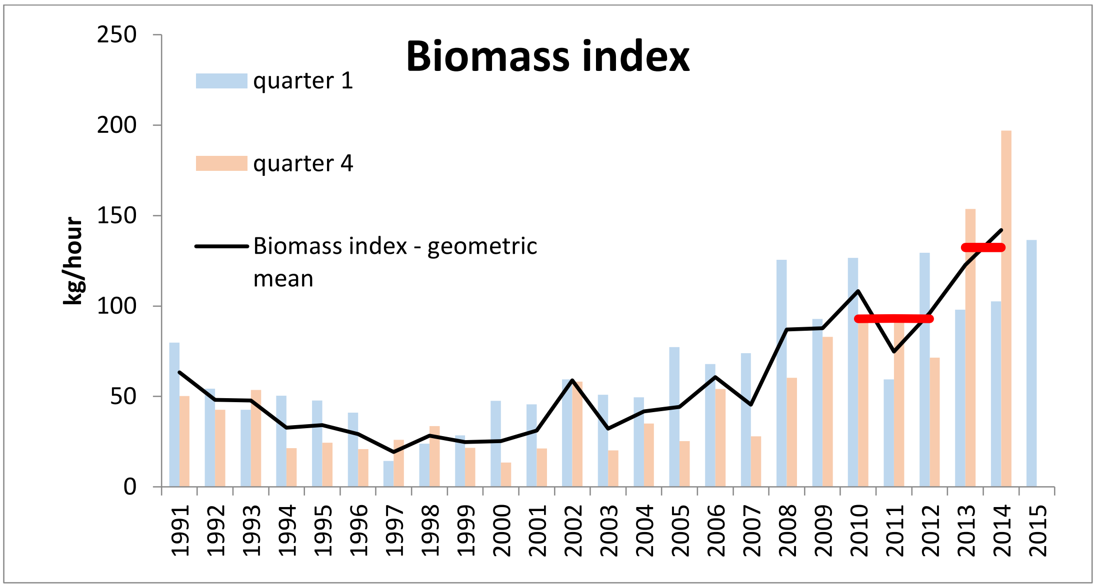


Figure 4.3.10 Flounder in Subdivisions 24–25 (Southern Baltic Sea). Biomass index, read lines indicate mean of the biomass index from the last two and from the previous three years.

4.4 Flounder in Eastern Gotland and Gulf of Gdansk (26–28)

4.4.1 Fishery

Landings by countries and subdivisions are presented in Table 4.4.1. In the WKBALFLAT benchmark process all landings from 2000 were uploaded in InterCatch. Every country uploaded their data according to the Ices Data call. The uploaded data were not exactly the same as it was reported in previous years in WGBFAS report and was revised in 2014. In the future stock assessment the new data from InterCatch will be used.

The total landings in SD26 and 28 combined decreased from 5089 tons in 2013 to 4613 tons in 2014 (Figure 4.4.1., 4.4.2.). The highest landings were recorded in Latvia (1578 tons), Poland (1210 tons) and Russia (1047 tons). The major part of the landings was realised with active fishing gears (3581 tons).

The main fishing countries in Subdivision 26 are Poland, Russia, Latvia and Lithuania (Table 4.4.1). In the previous years the Polish fishery was mainly a gillnet fishery targeting flounder along the coast whereas the Russian and Lithuanian landings were by-catches mainly in a bottom trawl mix-fishery.

The total landings in Subdivision 28 amounted to about 1333 tons in 2014 a remarkable increase compared to the 698 t in 2013. The landings in Subdivision 28 from 2011 increased from 260 tons to 1333 tons. The Latvian landings were 1279 tons (almost doubled comparing one year before), mainly taken by the trawl and gillnet fishery. Estonian landings were 54 tons.

Landings in the last year (2014) was higher than last five years average. Due to unfavourable cod fishing conditions, in some countries specialized flounder fishery was performed in last two years.

It should be mentioned that Sweden updated flounder landing information the 20th of April and the updated information was not included in the report.

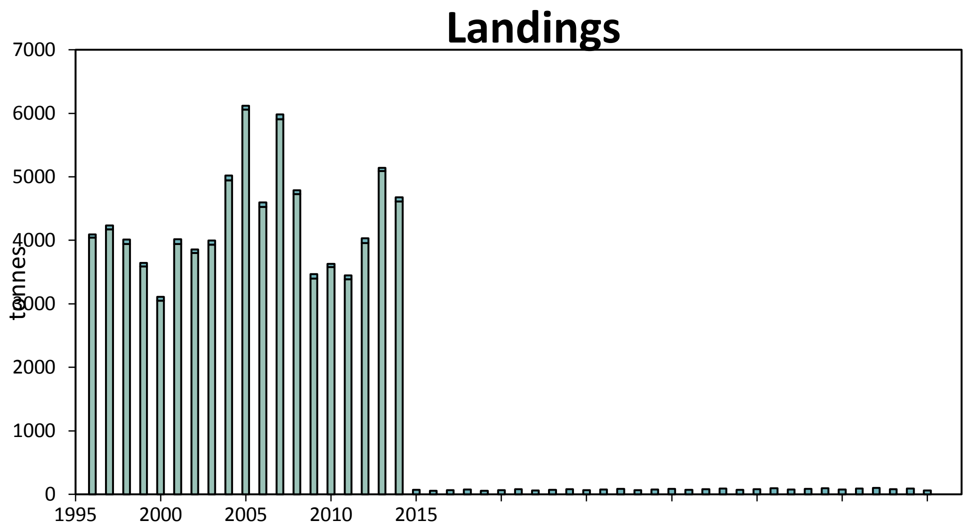


Figure 4.4.1. Landings of flounder in Subdivisions 26 and 28

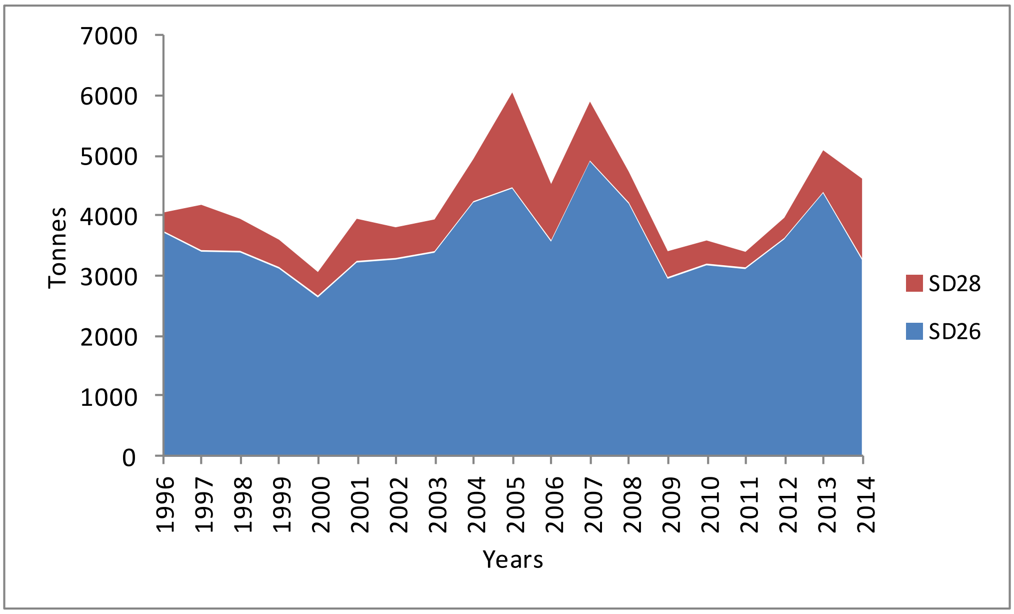


Figure 4.4.2. Landings of flounder in by subdivisions.

Table 4.4.1. Flounder in Subdivisions 26 and 28 (Eastern Gotland and Gulf of Gdansk). Total 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		
	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
Finland	1		1	10		10	8		8	0.46	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
Sweden*	1	20	20	2	13	14	21	24	45	0.27	0	0
Estonia	15	74	89	11	70	81	24	52	76	25.5	53.8	79
Latvia	114	166	280	378	244	622	780	619	1 399	299	1279	1 578
Lithuania	418	0	418	640	12	651	947	1	949	698	0	698
Russia	1 139		1 139	1 079		1 079	1 010		1 010	1047	0	1 047
Total	3 127	260	3 387	3 620	339	3 959	4 391	698	5 089	3 281	1 333	4 614

*** Sweden landings updated landings from 2014 were uploaded in InterCatch in 20 April and therefore are not included in the report**

4.4.2 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 2014 according to ICES Data Call were submitted on MS Excel sheets. Landings of all demersal fished were used as a raising factor to calculate flounder discards in Subdivisions 26 and 28. Discards rates from Latvia, Lithuania, Poland, Russia and Sweden were available for the working group. Discard data in Denmark and Finland were not collected in in this area in 2014. Discard data from Estonia was not presented for the working group. Discard data from Lithuania was raised on national level and raised discards were uploaded in InterCatch after the deadline of data call. Discard data from Russia were received on the time of working group.

Estimated discard ratio varied significantly by countries from 0 to 99.6% of the catch (Table 4.4.2). Weighted average of flounder discard in Subdivisions 26 and 28 in 2014 was estimated 17,5%, where landings of demersal fish species were used as raising factor.

The highest discard ratio (in %) was observed in Sweden where almost all of flounder were discarded. The highest discard amount (in tons) were in Latvia and Poland (Table 4.4.2).

The discard ratio in both subdivisions is different between countries, fleets, vessels, and even individual hauls of the same vessel and trip. Therefore, a common discard ratio cannot be applied. Discarding practices are, in fact, controlled by factors such as market price and cod catches. Given the high variability in the discard ratios, estimating discards is very uncertain without an extensive sampling programme. **It was decided that only landings (not catches) should be used as a basis for advice.**

Table 4.4.2.Estimated discard rate by countries for flounder in the Baltic Sea, Subdivisions 26 and 28 in 2014

Country	Landings (tons)	Discards (tons)	% from Catch	Comments
Denmark	0.872	NA		Discards were not collected
Estonia	79.228	NA		Discards were not presented
Finland	0.459	NA		Discards were not collected
Latvia	1577.8	601.3	27.6	
Lithuania	698.075	97.7	12.3	Discards were repertod to IC
Poland	1209.738	195.9	13.9	
Russia	1047.097	0	0	Discards were reported in WG
Sweden	0.271	67.7	99.6	
Grand Total	4613.5	962.5	17.5	

4.4.3 Catch at age in number and mean weight at age

Poland, Russia, Latvia, Lithuania and Estonia supplied sampling efforts and number at age and weight at age data in the landings. Totally 5266 otoliths were collected from landings and it covers 71.98 % of landings (Table 4.4.3, 4.4.4., 4.4.6.). Sample coverage in subdivision 26 was remarkable higher than in Subdivision 28 (Table 4.4.5).

Latvia and Lithuania supplied sampling efforts and number at age and weight at age data in the discards (Table 4.4.3).

It should be mentioned that number of otoliths from Lithuania reported in InterCatch should be checked while it is the same for catch categories and fishing fleet inside of one quarter (Table 4.4.3). Data in Table 4.4.6. indicate that Lithuania covered 100% from active and passive landings. Actual number probably is lower due to wrong reporting in InterCatch.

According to the manual national data submitter should upload only original data in InterCatch and borrowing and whole filling should be done by stock coordinator only.

Russia is still using whole otoliths for age reading of flounder. WKFLABA and WGBFAS recommended that this method is not recommended for age reading of flounder and sliced or broken and burned method should be used.

Table 4.4.3. Number of collected otoliths (reported in InterCacth) from flounder catch in SubDivisions 26 and 28.

			Country					
Season	Fleets	Catch Cat.	Estonia	Latvia	Lithuania*	Poland	Russia	Grand Total
1	Active	D			168			168
		L			168	46		214
	Passive	L				45	160	205
1 Total					336	91	160	587
2	Active	D		75				75
		L	50	400	499			949
	Passive	D		160	499			659
		L		306	499	58	200	1063
2 Total			50	941	1497	58	200	2746
3	Active	D			470			470
		L	151	100	470		170	891
	Passive	D			470			470
		L		100	470	50	172	792
3 Total			151	200	1880	50	342	2623
4	Active	L		100	416		170	686
	Passive	L	50		416			466
4 Total			50	100	832		170	1152
Grand Total			251	1241	4545	199	872	7108

Table 4.4.4. Number of collected otoliths (reported in InterCacth) from flounder landings in Sub-Divisions 26 and 28 by fishing gears.

		Country					
Quarter	Fleets	Estonia	Latvia	Lithuania*	Poland	Russia	Grand Total
1	Active			168	46		214
	Passive				45	160	205
1 Total				168	91	160	419
2	Active	50	400	499			949
	Passive		306	499	58	200	1063
2 Total		50	706	998	58	200	2012
3	Active	151	100	470		170	891
	Passive		100	470	50	172	792
3 Total		151	200	940	50	342	1683
4	Active		100	416		170	686
	Passive	50		416			466
4 Total		50	100	832		170	1152
Grand Total		251	1006	2938	199	872	5266

Table 4.4.5. Number of collected otoliths (reported in InterCacth) from flounder landings in Sub-Divisions 26 and 28 by SubDivisions.

		Country					
Area	Season	Estonia	Latvia	Lithuania	Poland	Russia	Grand Total
BAL26	1			168	91	160	419
	2		600	998	58	200	1856
	3		100	940	50	342	1432
	4			832		170	1002
BAL26 Total			700	2938	199	872	4709
BAL28	2	50	106				156
	3	151	100				251
	4	50	100				150
BAL28 Total		251	306				557
Grand Total		251	1006	2938	199	872	5266

Table 4.4.6. Proportion of covered flounder landings (%) with age data in Subdivision 26 and 28 by fishing fleets.

	Active	Passive
Denmark	0	0
Estonia	36	26
Finland	0	0
Latvia	75	42
Lithuania	100	100
Poland	40	78
Russia	62	82
Sweden	0	0

Distribution of age groups in active and passive gears (CANUM) by quarters in Subdivision 26 is presented in Figures 4.4.3., 4.4.4. It should be mentioned that some countries (for example Latvia and Lithuania) used plus group when age data were reported.

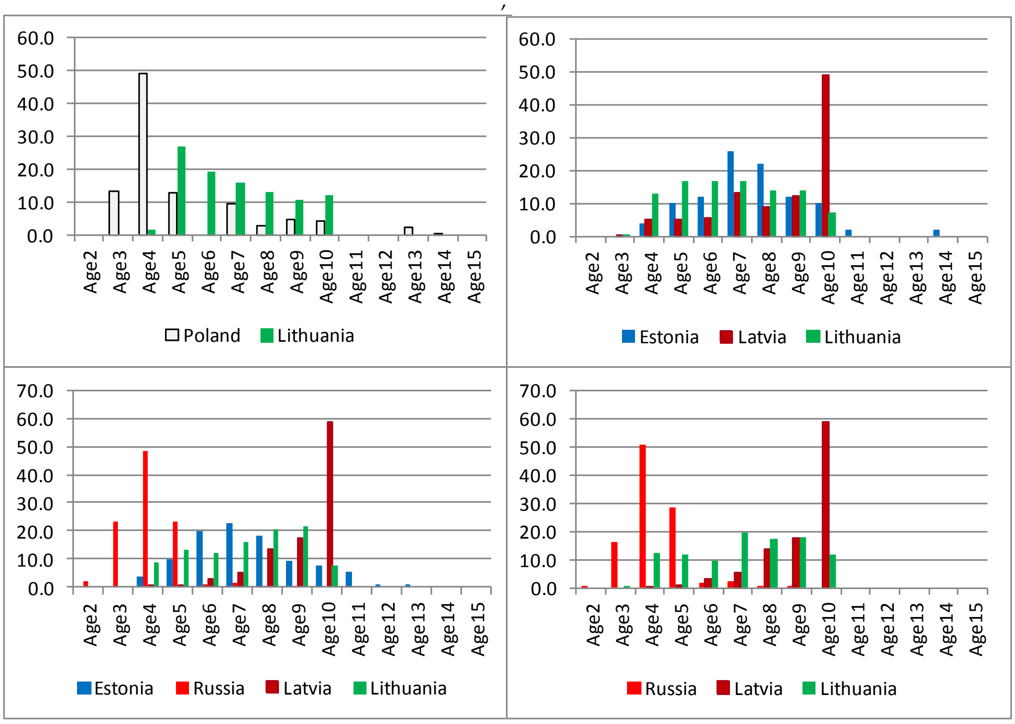


Figure 4.4.3. Distribution of age groups in active gear (CANUM) by quarters in Subdivision 26 and 28.

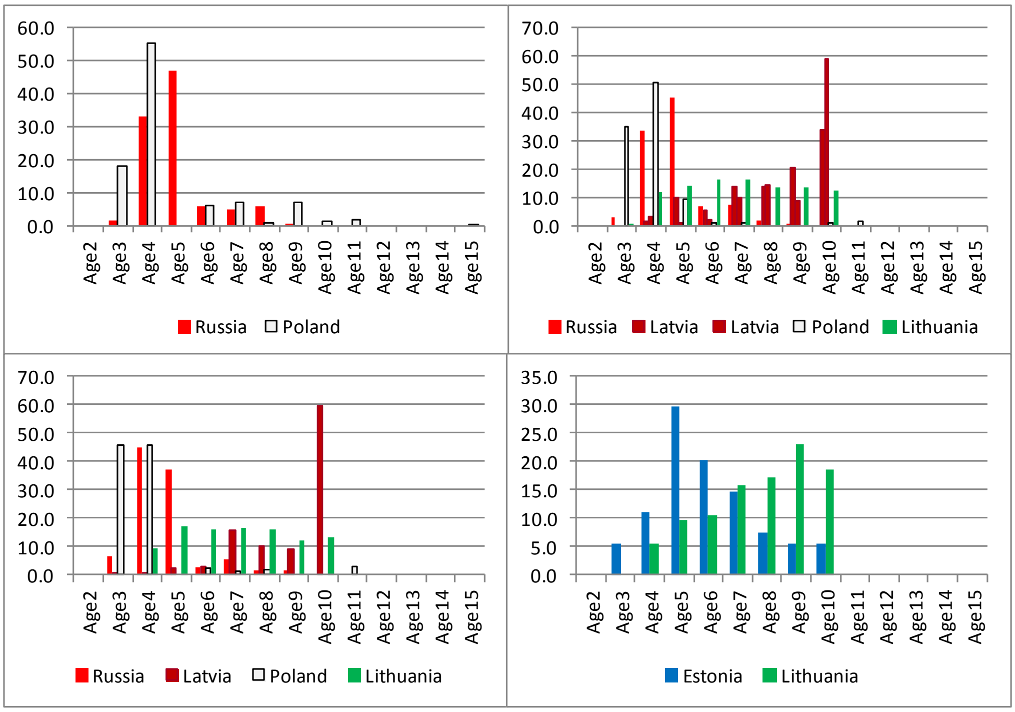


Figure 4.4.4. Distribution of age groups in passive gear (CANUM) by quarters in Subdivision 26. and 28.

4.4.4 Stock 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.

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 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 sub-divisions 26+28. Next, to such data weight-length relationships of the form w=aL^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 < 20cm were excluded from calculations due to sampling design. 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 is taken.

4.4.5 Historical stock trends

The stock decreased the last four years and abundance is estimated to have decreased by 26% between 2010—2012 (average of the three years) and 2013-2014 (average of the two years). This implies a decrease in landings by at least 20 % in relation to landings in 2014. After updated information from DATRAS database index for 2013 Quarter 4 was changed.

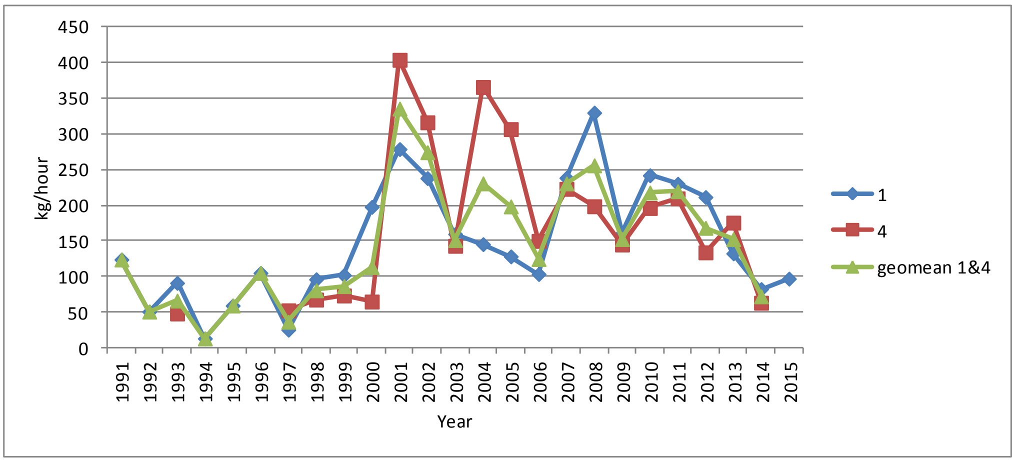


Figure 4.4.5. Catch per unit of effort (kg per hour) from BIT Survey in 1st and 4th Quarters, Subdivision 26 and 28.

Table 4.4.4. Catch per unit of effort (kg per hour) from BIT 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	13.5		13.5
1995	59.6		59.6
1996	105.3		105.3
1997	25.7	52.8	36.8
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	145.1	152.8
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		

4.4.6 Effort data

Two time series of effort data were available for the Working group.

First time series from 2009—2014 was available from ICES WGBFAS data call where countries were asked to submit flatfish effort data by fishing fleet and subdivision. Effort data was asked to report as fishing days. 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 countries 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 whole population was calculated summing all countries efforts.

Results of effort calculations are presented in Figure 4.4.6. The reported efforts were on stable level from 2009 to 2012. Significant increase of efforts was observed in last two years. Cod fishing condition was unfavourable in the last years therefore some fishermen switched their effort from cod fishery to specialized flounder fishery. As a result increase of effort and landings were observed in area. In last two years switch of area was observed. Some fishermen did not perform cod fishing in Subdivision 25 and started to fish flounder in Subdivisions 26 and 28.

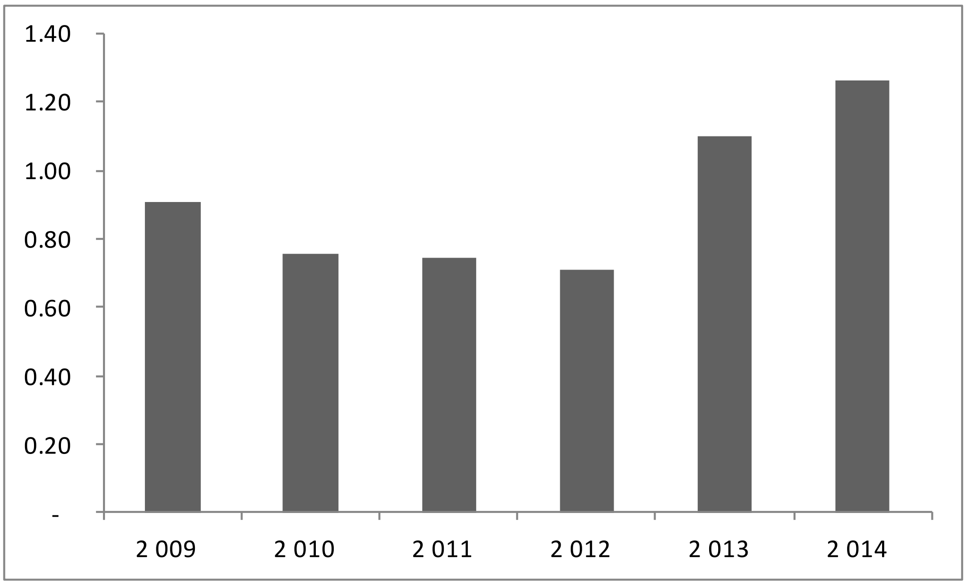


Figure 4.4.6. Effort datta of flounder in Subdiviion 26 and 28.

The second time series from STECF report was available for the working group (Figure 4.4.7). Reported results are not including results from 2014 (and is covering a larger area including Subdivisions 24, 25 and 27) therefore described changes in effort form first time series could not be observed and are on stable level. The plenary of the working group decided to use for Advice first time series only.

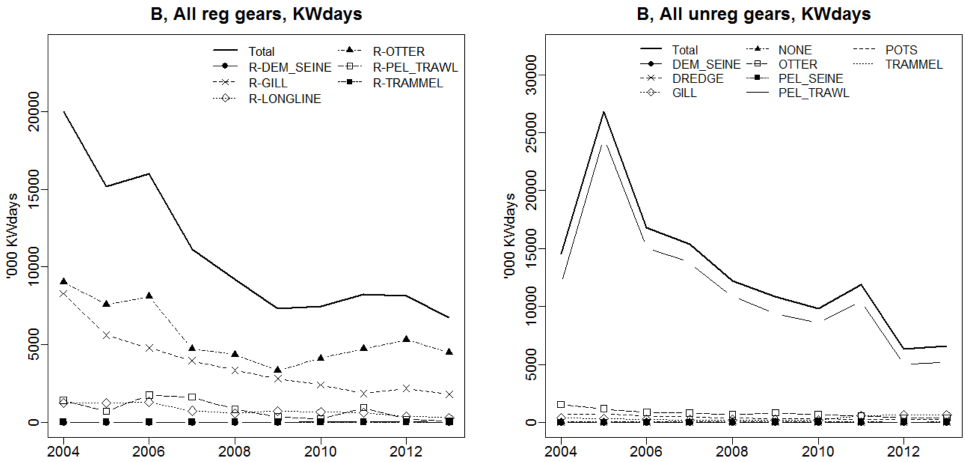


Figure 4.4.7. Flounder in Subdivisions 24-28 . Area B Baltic: Trend in nominal effort by gear types 2004–2013 (kW × days-at-sea). Left panel: Regulated gears. Right panel: Unregulated gears. Note that data from Poland, Latvia, and Lithuania are only available from 2004, and Estonian data from 2005 onwards. Therefore, effort trends are shown from 2004 to 2013. No data were available from Finland (from STECF, 2014).

4.5 Northern flounder (SD 27, 29–32)

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.

4.5.1 Biology

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.

4.5.2 Fishery

In subdivisions 27 and 29—32 flounder is caught mainly in the SDs 29 and 32. The majority (>90% in 2014) 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 4.5.1). 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 recent years also Poland (Table 4.5.1).

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, using estimates from SD 25 and scaling up to total landings of demersal fish species in the fished strata (passive gear per quarter and SD) gives an estimate of 27 tonnes discarded in 2014. 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 less than half a tonnes in 2014.

In the northern Baltic Sea the importance of recreational fishery is substantial. In Sweden and Finland the flatfish landings from the recreational fishery equals or even exceeds the commercial catch. In Estonia the reported recreational catch is on average equivalent to 1/5th of the commercial catch. Using the estimates from WKBALFLAT (ICES 2014) total recreational landings in this area are up to 40% of the commercial landings, however the quality of the estimates are not well known and the data is therefore not included in the advice.

Table 4.5.1. 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

Year	Country	SD 27	SD 29	SD 30	SD 31	SD 32	Total
	Sweden	86	3				89
	Estonia		47			46	93
	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

Year	Country	SD 27	SD 29	SD 30	SD 31	SD 32	Total
	Total	57	172	9	0	135	374
2004	Finland*		13	18	0	4	34
	Sweden	45					45
	Estonia**		127			167	294
	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

*** Finland 1980-2007: Catches of SDs 27&28 are included in SD 29 & 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**

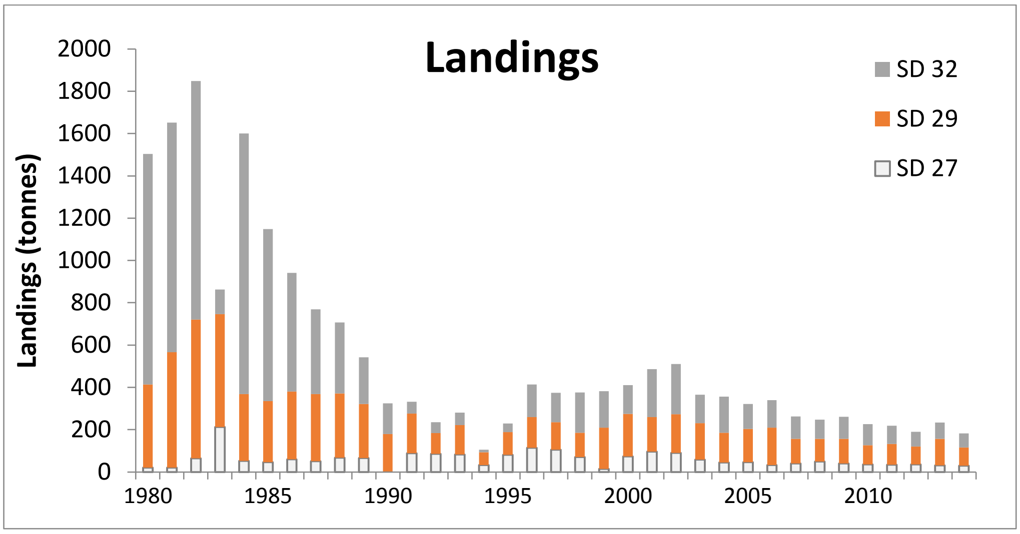


Figure 4.5.1. Official landings of flounder in Subdivisions (SD) 27 and 29-32.

4.5.3 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 4.5.2).

Table 4.5.3 Fishing effort (number of fishing days) per country and gear type (passive/active). Data for 2009- 2013 from WGBFAS Datacall in 2014, and data for 2014 in Intercatch database. Different countries have used different definition of effort for flounder fishery therefore figures are not directly comparable between countries.

	SWE Active	SWE Passive	EE Active	FI Active	FI Passive	PL Passive
2009	4	3249	46	11	12562,91	
2010	11	2654	22	4	13883,35	
2011	4	2427	3	0	10970,33	
2012	3	2683	14	6	8009,381	
2013	2	2344	77	0	8707	4
2014	3	2415	56	0	5341	1

4.5.4 Stock assessment

Assessment method of category 3 for stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES, 2012c) was used. The model Data Limited Stock Category 3.2.0. (Survey based index but no MSY trigger) was applied. For providing advice, the average index based on the last two years was compared with the average index from the three preceding years, according to ICES DLS guidelines. Last year's advice is used as starting point for the current advice.

Table 4.5.2 Flounder in Subdivisions 27 and 29–32 (Northern Baltic Sea). Biomass index for the surveys Muuga Bay (SD 32), Küdema Bay (SD 29), Muskö (SD 27), and Kvädöfjärden (SD 27) and combined index. Effort is number of gillnet stations times number of fishing days.

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			1.05			
1990			1.52			
1991			0.53			
1992			1.75	5.04	3.40	
1993	0.49		1.72	4.98	3.35	
1994	0.20		1.15	1.23	1.19	
1995	0.43		1.08	0.94	1.01	
1996	0.4		0.56	0.17	0.36	
1997	0.47		0.72	0.62	0.67	
1998	0.73		1.14	0.69	0.91	
1999	0.28		0.87	0.2	0.53	
2000	0.25	3.45	1.45	1.09	1.27	2.03
2001	0.65	2.32	1.4	1.11	1.25	1.38
2002	0.17	1.01	1.43	0.56	0.99	0.64
2003	0.3	2.81	0.52	1.1	0.81	1.67
2004	0.47	1.35	0.5	0.87	0.68	0.86
2005	0.39	1.70	0.2	0.53	0.36	1.03
2006	0.42	1.57	0.31	1.02	0.66	1.04
2007	0.1	2.24	0.58	2.51	1.54	1.29
2008	0.11	2.68	1.29	4.44	2.87	1.77
2009	0.36	0.86	0.2	2.2	1.20	0.71
2010	0.14	0.79	0.45	1.04	0.75	0.49
2011	0.24	0.97	0.16	0.5	0.33	0.58
2012	0.13	1.03	0.14	0.48	0.31	0.56
2013	0.13	2.03	0.32	0.95	0.63	1.21
2014	0.71	2.35	0.43	0.98	0.70	1.49

1) Biomass prior to 2009 is estimated from numbers and length distribution

2) Arithmetic mean

3) Weighted mean with the respective SDs landings.

4.5.5 Tuning fleet

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, 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 used to get three biomass indices, one for each of the SD 27, 29 and 32. The indices from these SD:s were then combined using the total commercial landings of flounder per SD as a weighting factor (Table 4.5.2).

4.5.6 Assessment

Stock trends are calculated based on national gillnet surveys: two in SD 27, one in SD 29 and one in SD 32 (Figure 4.5.3). Stock size indicator based on the 2013–2014 increased by 147 % comparing to 2010—2012. It is evident that stock size indicator has fluctuated over time (2000—2014) but still the index in 2014 is 21% above the long-time average (Fig 4.5.4).

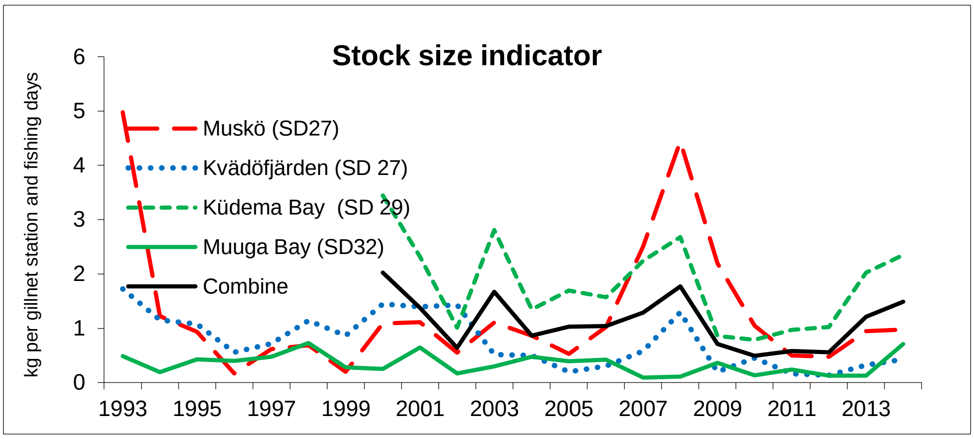


Fig 4.5.3 Flounder in Subdivisions 27 and 29-32 (Northern Baltic Sea). Combined biomass index of Muuga Bay (SD 32) (solid green line), Küdema Bay (SD 29) (dashed green line), Muskö (SD 27) (red dash line), Kvädöfjärden (SD 27) (dotted blue line) surveys and combined index (kg per gillnet station and fishing days).

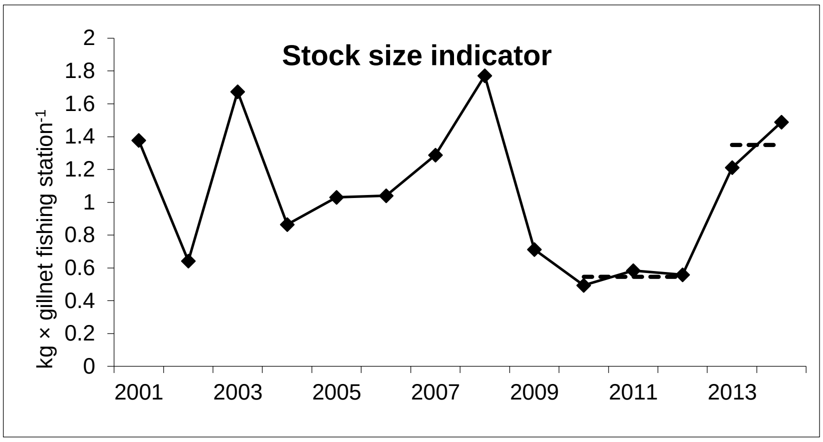


Fig 4.5.4 Flounder in Subdivisions 27 and 29-32 (Northern Baltic Sea) Combined biomass index of four surveys (Muuga Bay (SD 32), Küdema Bay (SD 29), Muskö (SD 27), and Kvädöfjärden (SD 27)) (kg × gillnet fishing station−1). The dashed lines denote the average of the biomass index of the respective year range.

5 Turbot, dab, and brill in the Baltic

5.1 The fishery

The landings of turbot, dab, and brill by ICES Subdivisions and countries are presented in Tables 5.1–5.3. Landings of turbot decreased from 316 t in 2011 to 232 t in 2012, increased to the level of 2011 with 316 t in 2013 and were 253 t in 2014. Landings of dab were similar in 2011 and 2012 with 1268 t and 1285 t, respectively and increased to 1384 t in 2013 and were 1269 t in 2014. Nearly the same landings of brill were reported in 2013 with 31 t compare to 2012 (30 t). Landings were 27 t in 2014. The temporal development and the amount of the landings of these flatfishes are shown in Figure 5.1.

5.1.1 Turbot

5.1.1.1 Fishery

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 1.210 t from 1965 to 1996 followed by a decreased to 525 t in 2000 and a slower decrease until the minimum of 232 t in 2012, increased again to 313 t in 2013 and were 253 t in 2014 (Table 5.1, Figure 5.2). 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 360t 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 landed turbot from Subdivisions 22 and 24. Since 2000 these landings have decreased notably. The German landings in the last year were about 60 t and remained at the same level as 2007 (57 t).

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.

5.1.1.2 Discard

Estimates of discards have been available from Denmark and Germany since 2012. In total 17 t (30 % of landings) of turbot was discarded in SD 22. The discards were lower in SD 24 to SD 26 with 11 t (17 % of landings), 15 t (3 % of landings) and 0.3 t (1 % of landings), respectively. Sweden reported also discards in 2013 beside Denmark and Germany. Highest discards were reported in SD 24 with 15.4 t presenting 15 % of landings. Discards were similar in SD 22 and 25 with 5.7 t, respectively presenting ~ 7 % of landings in both SD. Discards also increase slightly to 1.2 t (2 % of landings) in SD 26

The variability of discards in amount and in relation to landings in 2012 to 2014 showed that the estimation of not reported discards before 2012 based on the extrapolation of available data is uncertain. Therefore, only landings were used for the advice.

5.1.1.3 Biological data

Available age data were compared during WKFLABA 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.

5.1.1.4 Tuning fleet

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 5.3). Assessment

The advice is base based on the data-limited approach of ICES. The approach was already use last year and the precautionary buffer were applied. Although the mean abundance index of 2013 and 2014 were 10 % smaller than the mean of the abundance index from 2010–2012 the same advice as last year was used because the nominal effort of regulated and unregulated fishery have not increased since 2010 (STECF, 2014).

5.1.2 Dab

5.1.2.1 Stock structure

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.

5.1.2.2 Fishery

Total landings of **dab** were around 1.000 t between 1970 and 1978 and fluctuated around 2000 t between 1979 and 1996 (Table 5.1). 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 in 2013 (1384 t) were slightly higher than landings of 2011 and 2012 with ~ 1270 t. In 2014 1269 t was landed. Around 90% of dab landings were realized in SD 22 and less than 1 % of landings have been realized in SD 25 to SD 29 since 2009.

The main dab landings are reported by Denmark (Subdivision 22 and 24) and Germany (mainly in Subdivision 22, Figure 5.4). The German and Danish landings of dab are mostly bycatches of the directed cod fishery. Estimates of discards were available from Denmark and Germany in 2012 to 2014.

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.

	Landings in tons			Discards in tons		
Year	SD 22	SD 23	SD 24	SD 22	SD 23	SD 24
2012	1173.0	22.5	89.3	523.0	0.8	664.7
2013	1280.0	17.9	86.4	1283.0	7.5	164.8
2014	117.4	11.4	82.1	646.1	22.47	86.6

5.1.2.3 Discard

5.1.2.4 Biological information

Age samples were realized from 2008 onwards by Germany and Denmark during Baltic International Trawl Survey (BITS) and commercial fishery. This indicate 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.

5.1.2.5 Tuning fleet

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 5.7). 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. The stock indices used in the last (CPUE in number) and recent year are highly correlated (R = 0.96).

5.1.2.6 Stock assessment

The advice is base based on the data-limited approach of ICES. The mean biomass index of 2013 and 2014 were 12 % higher than the mean of the biomass index from 2010–2012 (Fig. 5.5). It was further agreed that the advice based on landings for 2015 change in advice based on catch for 2016. The estimates of discards between 2012 and 2014 were used to estimate catch of dab in these years. Therefore, the advice for 2016 was estimated based on the mean catch between 2012 and 2014 multiplied by the index factor of 1.12. The precautionary buffer of 20 % was not applied because nominal effort of regulated and unregulated fishery have not been increased since 2010 (STECF, 2014).

5.1.3 Brill

5.1.3.1 The fishery

Total landings of **brill** varied from 1 t to 160 t between 1975 and 2004 (Table 5.3, Figure 5.6). 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 27 t in 2014 Less than 100 kg of brill was discarded in 2012. The amount of discards increased to 299 kg in 2013 and further increased to 5200 kg in 2014.

5.1.3.2 Tuning fleet

Stock indices (CPUE) were estimated as arithmetic mean of mean catch in number per hour for brill with a length of ≥ 20 cm of quarter 1 and quarter 4. The CPUE values of the small TV were multiplied with a conversion factor of 1.4. The CPUE values of brill highly fluctuated from 2004 onwards (Figure 5.7).

The low CPUE values between 2001 and 2003 correspond with low landings in the same years and the increase of the CPUE values in the following years also correspond with increasing landings.

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. Therefore, effort data of brill fishery were not available. Analyses of STECF in 2012 for the western Baltic Sea indicated a stable effort of regulated and unregulated fisheries between 2010 and 2012 (Figure 5.11).

5.1.3.3 Stock assessment

The basis for the advice is the ICES data-limited approach. This approach was already used last year and the precautionary buffer was applied. The mean abundance index of 2013 and 2014 were 57 % smaller than the mean of the abundance index from 2010–2012. This significantly decrease truncated to a decrease of 80 % according to the ICES rule taking into accounts that nominal effort of regulated and unregulated fishery have not been increased since 2010 (STECF, 2014).

5.1.4 References

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Oeberst, R. 2014b. Spatial distribution of dab (Limanda limanda) during quarter 1 and 3 IBTS from 2001 to 2012. Working doc. of Benchmark Workshop on Baltic Flatfish stocks (WKBALFLAT), 27 – 31 January 2014. 14pp.

Table 5.1. Turbot in the Baltic Sea: total landings (tons) by ICES Sub-division and country.

Year/SD	Denmark					Germ. Dem. Rep.		Germany, FRG				Poland		Sweden[2]							Latvia		Lithuania	Russia	Finland						Estonia	
	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		6	11	0	0	8	23	0	2	4	3	6	15	5	0	0	0	0	0	0	0	0
2012	43	3	16	1	0			16	27	0	0	55	11	0	0	3	14	0	2	2	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	

continued

Table 5.1 continued

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	63	32	34	2	10	0	254
2012	59	3	46	70	45	2	7	0	232
2013	88	5	83	77	50	1	7	0	313
2014	119	5	60	39	19	2	9	0	253

[1] From October-December 1990 landings of Germany, Fed. Rep. are included

[2] For the years 1970-1981 and 1990 the catches of Sub-divisions 25-28 are included in Sub-division 24

[3] For the years 1970-1981 and 1990 the Swedish catches of Sub-divisions 25-28 are included in Sub-division 24

[4] Preliminary data

Danish catches in 2002-2004 in SW Baltic were separated according to Sub-divisions 24 and 25

In 2005 Lithuanian landings are reported for 1995 onwards

Table 5.2. Dab in the Baltic Sea: total landings (tons) of by Sub-division 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	1,011
1972	1,110		30		9		63						23						1,182	0	53	0	0	0	0	0	0	1,235
1973	1,087		58		18		118						30						1,223	0	88	0	0	0	0	0	0	1,311
1974	1,178		51		18		118						34						1,314	0	85	0	0	0	0	0	0	1,399
1975	1,273		74		20		131						32						1,424	0	106	0	0	0	0	0	0	1,530
1976	1,238		60		17		114						27						1,369	0	87	0	0	0	0	0	0	1,456
1977	889		32		13		89						25						991	0	57	0	0	0	0	0	0	1,048
1978	928		51		19	14	128	4											1,075	0	69	0	0	0	0	0	0	1,144
1979	1,413		50		18	25	123	1					9						1,554	0	85	0	0	0	0	0	0	1,639
1980	1,593		21		15	25	101						3						1,709	0	49	0	0	0	0	0	0	1,758
1981	1,601		32		24	39	164						5						1,789	0	76	0	0	0	0	0	0	1,865
1982	1,863		50		46	38	182	4					6	5	8	6		1	2,091	0	98	5	0	8	6	0	1	2,209
1983	1,920		42		46	28	198						24	20	32	22		2	2,164	0	94	20	0	32	22	0	2	2,334
1984	1,796		65		30	47	175	2					4	3	5	4		1	2,001	0	118	3	0	5	4	0	1	2,132
1985	1,593		58		52	51	187	2					3	3	5	3		1	1,832	0	114	3	0	5	3	0	1	1,958
1986	1,655		85		36	35	185	1					1	1	1	1			1,876	0	122	1	0	1	1	0	0	2,001
1987	1,706		93		14	87	276	4					1	1	1	1			1,996	0	185	1	0	1	1	0	0	2,184
1988	1,846		75		22	91	281	1					1	1	1	1			2,149	0	168	1	0	1	1	0	0	2,320
1989	1,722		48		26	19	218	1					1	1	2	1			1,966	0	69	1	0	2	1	0	0	2,039
1990	1,743		146		14	11	252	1					8						2,009	0	166	0	0	0	0	0	0	2,175
1991	1,731		95				340	5					1						2,071	0	101	0	0	0	0	0	0	2,172
1992	1,406		81				409	6						1	1		4		1,815	0	87	1	0	1	0	4	0	1,908
1993	996		155				556	10				7	1	1			1		1,552	7	166	1	0	0	0	1	0	1,727
1994	1,621		163				1,190	80	45			5	1	1					2,811	5	244	46	0	0	0	0	0	3,106
1995	1,510	47	127	10			1,185	49	3			5	1	5		1			2,695	52	177	18	0	0	1	0	0	2,943
1996	913	37	128				991	134	13	2	3		3	4	1				1,907	37	265	17	2	1	0	0	0	2,229
1997	728		60				413	21	2			5	5	10	3	1			1,141	5	86	12	0	3	1	0	0	1,248
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					1,003	3	64	1	0	0	0	0	0	1,071
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						1,053	1	179	0						1,233
2004	953		185				745	10	0			1	1	0					1,698	1	196	0						1,894
2005	752	34	163	16			474	45	9			1	1	0					1,226	35	209	25	0	0	0	0	0	1,495
2006	400	23	112	161			494	24	11			1	2	0		0			894	24	138	172						1,228
2007	860	40	108	7			472	18	0			0	0	0	0	0			1,332	40	126	7						1,504
2008	757	36	86	222			507	33	0			3	0	1	1	2			1,264	39	119	223		1	2			1,648
2009	521	25	97	0			587	32	0			2	0	0	1	3			1,108	27	129	1		1	3			1,268
2010	552	18	51	0			398	17	2			1	0	0					950	19	69	2						1,041
2011	544	20	39	0			647	15	0			1	0	1	0	0			1,192	21	53	1						1,268
2012	481	22	69	0			692	20	0	0	0	1	0	0	0	1	0	0	1,173	23	89	0						1,285
2013	445	18	69	0			834	17	0	0		0	0	1	0	0	1		1,279	18	86	1						1,384
2014	373	11	57	0			801	25	2	0		0	0	0	0	0			1,174	11	82	2						1,269

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.

[2] For the years 1970-1981 and 1990 the catches of Sub-divisions 25-28 are included in Sub-division 24.

[3] For the years 1970-1981 and 1990 the Swedish catches of Sub-divisions 25-28 are included in Sub-division 24.

[5] In 1995 Danish landings of Sub-divisions 25-28 are included.

Table 5.3. Brill in the Baltic Sea: total landings (tons) 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	30
2013	24	6	0	1	0	1	0	25	7	0	32
2014	19	5	0	2	0	1	0	21	6	0	27

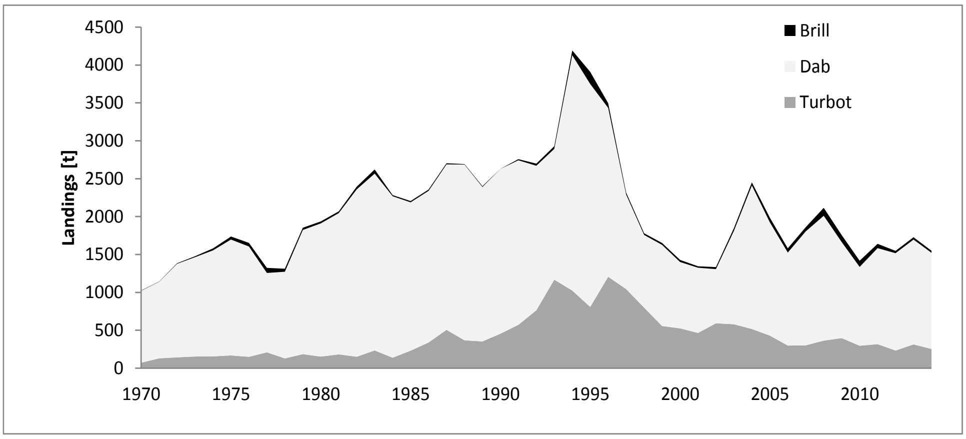

Figure 5.1 Landings of turbot, dab and brill in ICES Subdivisions 22 – 32

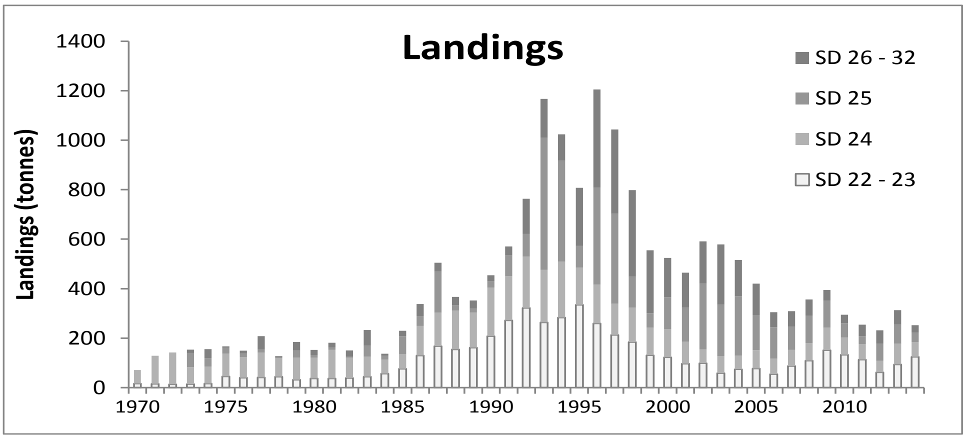

Figure 5.2 Development of turbot landings [t] from 1970 onwards by ICES subdivision (SD)

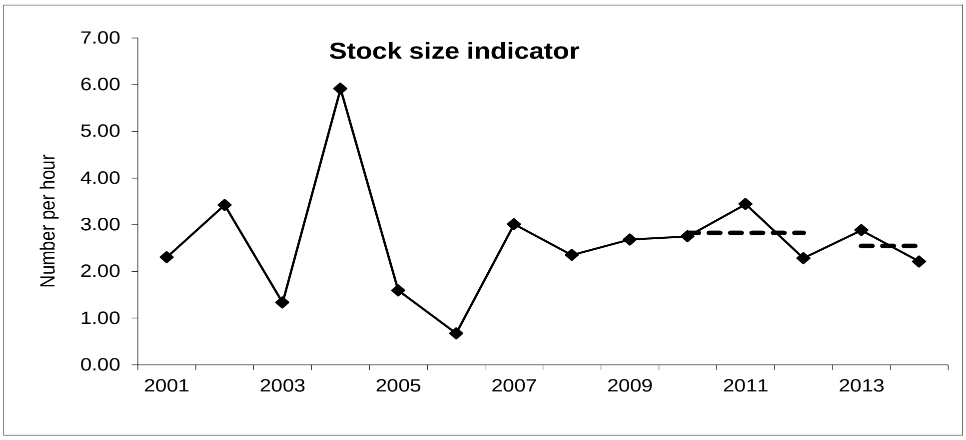

Figure 5.3 Mean CPUE (no. hr^{-1}) of turbot with L ≥ 20 cm based on arithmetic mean of the Baltic International Trawl Survey (BITS-Q1+Q4) in Subdivisions (SD) 22–28.

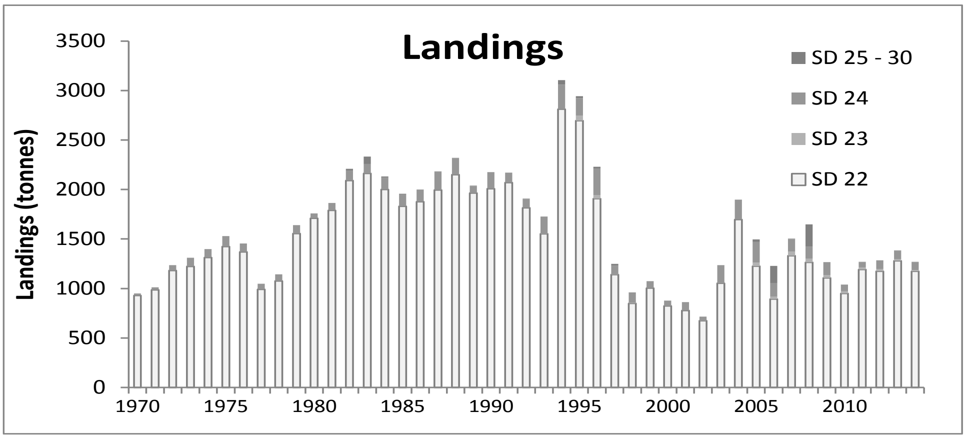

Figure 5.4 Development of dab landings [t] from 1970 onwards by ICES subdivision (SD)

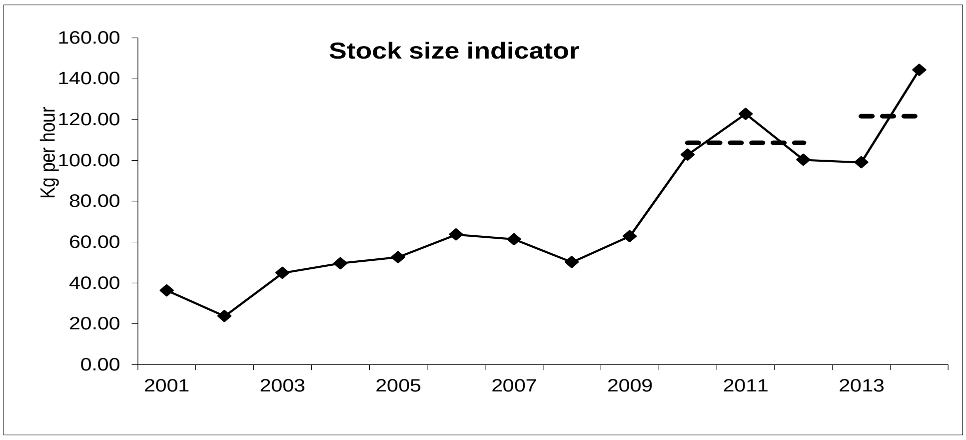

Figure 5.5 Mean biomass (kg hr^{-1}) of dab with L ≥ 15 cm based on geometric mean of the Baltic International Trawl Survey (BITS-Q1+Q4) in Subdivisions (SD) 22–24.

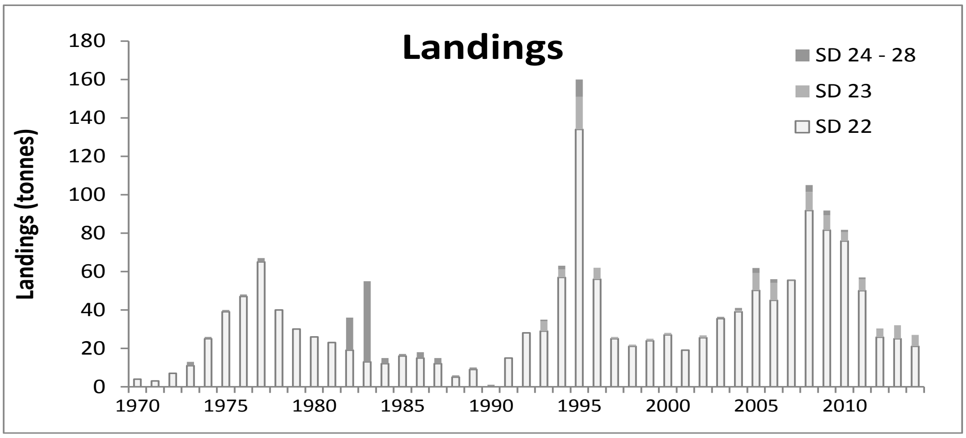

Figure 5.6 Development of brill landings [t] from 1970 onwards by ICES subdivision (SD)

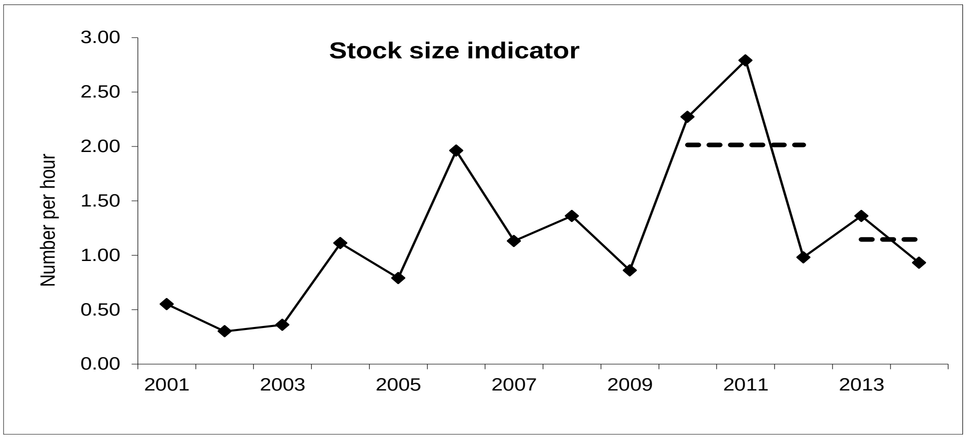

Figure 5.7 Mean CPUE (no. hr^{-1}) of brill with L ≥ 20 cm based on arithmetic mean of the Baltic International Trawl Survey (BITS-Q1+Q4) in Subdivisions (SD) 22–24.

6 Herring

6.1 Introduction

6.1.1 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 2014 is given in Table 6.1.1.

In Table 6.1.2 the proportion of herring in landings is given by country, Subdivision and quarter for 2014 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 6.1.3 shows the total reported landings of herring by quarter for 2014, along with the number of samples, the number of fish measured and the number of fish aged.

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 majority take herring and sprat simultaneously. According to the national data submitters the mixing of pelagic species in the landings are adequately taking care of before submitting input data.

Sprat and herring fishery in Denmark

Denmark is having two sampling system in the pelagic fishery. The first is conducted by the Danish control were the species composition is measured. The second sampling system is conducted by DTU Aqua as part of the DCF regulations and here species composition, length, weight and age are measured. At present Denmark is only using the samples from the control to calculate the species composition in the landings, however there is a possibility to also include the samples from DTU Aqua and thereby increase the total number of samples. There will be some overlap between the vessels from where the samples have been taken and therefore it is not possible to just add the number of samples from the two sources.

Species compositions have been calculated since 1989 for the Skagerrak, Kattegat and North Sea, data are available also for the Baltic area in this time frame.

Slipping events are known to take place in the sprat fishery duo to, to high herring composition in the catch. Denmark had including 2014 a stricter rule than the common EU regulation and only 20% herring is allowed in the sprat landings from the Baltic. However, as no information on slipping has been reported in the logbooks, it is presently not possible to quantify the events. Do to the discard ban there is from 2015 no by-catch rule anymore and all catches has to be landed in depended of species composition.

Data on species composition are sampled and can be reported by square and month.

We do not consider species identification by the control or by DTU Aqua staff to be a very large problem.

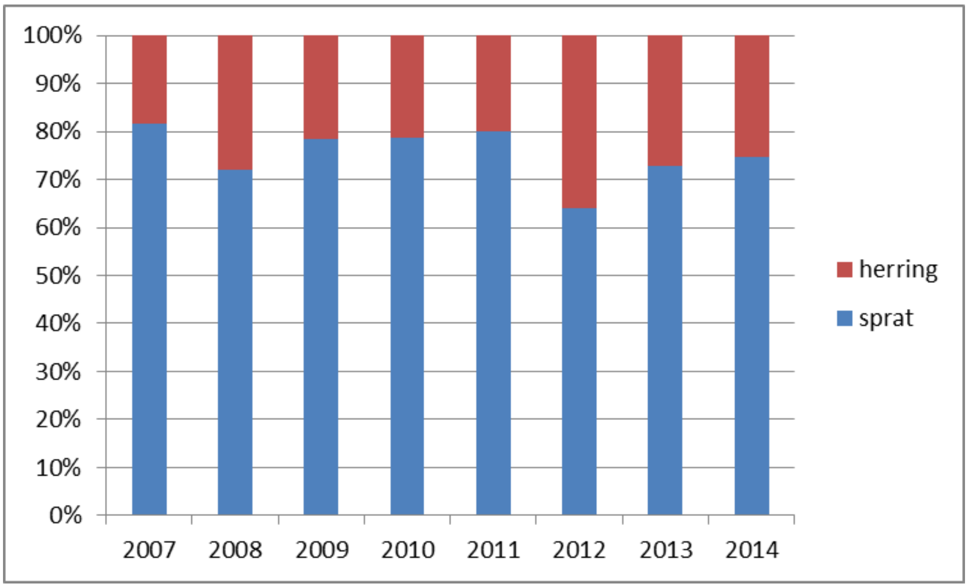

Figure 6.1.1. Relative value of herring and sprat in the Danish Baltic pelagic fishery from 2007-2014

Sprat and herring fishery in Estonia

Herring fishery

Estonian Baltic sea fishery is, in general, a trawl fishery and is directed mainly on herring and sprat. Pelagic trawls took, depending on region, from 40 to 99 % of total landings in 2014. The rest were taken as trap net catch of herring at the spawning grounds of herring. The Estonian fishing fleet has been decreasing in 2004-2012 as a result of the EU scrapping program, and stabilised since then. At present most of the Baltic trawl fleet consists stern trawlers >=300 HP, the coastal fishery is supported by the small boats <12m. The overview of Estonian fishing fleet is available in the Registry of Estonian Fishing Vessels, which can be found at the website of Estonian Ministry of Agriculture (http://www.agri.ee/fisheries/).

The total Estonian herring landings from the main fishing areas in the Baltic were slightly above 23,000 t in 2014. 419 t were taken from the Sub-division 28-2, 10,600 t in the Gulf of Riga (Sd. 28-1), 3,400t in Sub-division 29 and 8,800 t in the Sub-division 32. There have been no big changes in the proportion of catches between the Sub-divisions during the recent decade.

Altogether, 15,600 t were taken by pelagic trawl fishery and 7,500 t by the pound-net fishery on spawning grounds. The Gulf of Riga traditionally was the most important area of pound-net fishery (6,100t).

The discarding does not occur in the Estonian pelagic fishery.

Sprat fishery

All sprat landings are coming from the pelagic trawl fishery. Total catch of sprat was almost 28,500 t. in 2014. Most of the catch was taken in the Sub-divisions 29 and 32- 9,900 and 17,500 t, respectively. Only 1,100 t were taken in Sub-division 28-2. . The information on species composition of mixed sprat/herring catches is obtained from the logbooks, and from the observations of environmental inspectors, regularly visiting the landing sites.

No discarding and sorting take place in herring and sprat fishery.

The protection measures enforced in pelagic fisheries: closed season for trawl fishery for 1 month in the Gulf of Riga (in April-May, (dates are depending on the ice conditions), and ban for use of trawls in coastal areas (below 20 m).

Sprat and herring fishery in Finland (no update)

Herring and sprat fishery in Germany

In 2014, the total German **herring landings** in the Baltic Sea **(Subdivisions 22-29)** reached 11 279 t (2013: 16 006 t).

In 2014 the total German **herring landings** from the Western Baltic **Sea in Subdivisions (SDs) 22 and 24** amounted to 10 241 t, which represents a decrease of 30 % compared to the landings in 2013 (14,591 t). This decrease was caused by a decrease of the TAC/quota and some minor quota transfer with other Baltic countries. The fishing activities in one of the main spawning areas, the Greifswald Bay (SD 24) could not start earlier than in March due to cold winter in January/February. The German fishery was forced to stop their activities in the Western Baltic areas already at the end of April due to quota restrictions.

Only a small part of the total German **herring landings** was taken **in Subdivisions 25-29** (2014: 1,731; 2013: 1,415 t; 2012: 896 t; 2011: 2,730 t; 2010: 2,235 t; 2009: 1,252 t). For the first time 441.7 t of the total landings were taken as by-catch in the sprat fishery (EU regulation: 8 % (1,200 t) of the total German sprat quota in 2014 (14,977 t) can be taken as herring by-catch).The landings taken in the directed herring fisheries (1,290 t) exceeded the existing TAC/quota (2014: 658 t) by means of quota transfer (+ 632 t) with other countries around the Baltic Sea. All landings in this area were

- taken by the trawl fishery and
- landed in foreign ports.

As in the past, it was no possible to sample herring in these areas since all catches were landed in foreign ports.

The German **herring fishing fleet** in the Baltic Sea consists of two fleets where all catches are taken in a directed fishery:

1) coastal fleet with undecked vessels boats (rowing/motor boats <=10 m & engine power <=100 HP)

2) cutter fleet with decked vessels and total lengths between 12 m and 34 m.

The German **sprat landings** in **Subdivisions 22-29** in 2014 reached according to the

a) share of the EU quota (2014: 14,997 t) and

b) further transfer of quota (overall 3,925 t were transferred to other Baltic countries)

10,166 t, which represents a final utilization of the overall quota of 11,072 t of 92 % (2013: 10,315 t = 99 %).

As in previous years most sprat was

- landed in foreign ports (2014: 94 %; 2013: 93 %; 2012: 91 %, 2010-2011: 92 %),
- caught in the first quarter (2014: 75 %; 2013: 78 %; 2012: 62 %, 2011: 64 %, 2010: 60 %),

- caught in Subdivisions 25-29 (2014: 94 %; 2013: 93 %; 2012: 91 %, 2011: 89 %, 2010: 90 %). These catches were exclusively landed in foreign ports (2010-2014: 100%).

The German **sprat fishing fleet** in the Baltic Sea consists of only one fleet where all catches are taken in a directed trawl fishery (cutter fleet of total length <=12 m and >12-30 m).

Even so most of the sprat was landed in foreign port in 2014 (94 %), it was possible to sample 87 % (8 836 t) of the total landings. It was possible to get samples to compile assessment input data for:

- Quarter 1 in SDs 22, 24, 25, 26, 28 and 29,
- Quarter 2 in SDs 24, 25 and 28.

The officially reported trawl landings (t) and the referring assessment input data were not corrected for the differences in species composition in the samples.

Further details on the German herring and sprat fishery in 2014 are given in Annex 8 (WD Gröhsler).

Sprat and herring fishery in Latvia (no update)

Sprat and herring fishery in Lithuania

Herring

Herring mainly was caught in SD 26, SD 28 and SD 29 (see below). Almost 62% of herring was caught by pelagic pair trawl and 38% by pelagic otter trawl. In general this is a mixed pelagic fishery when herring and sprat are caught together in different proportions dependently on season, gear and fishing ground. 83% of Lithuanian herring catches are landed in foreign ports. Share of herring landings by gear is presented in the text Table below.

Distribution of herring landings (tons) in 2014 by subdivisions and quarter

	Quarter				
Subdivision	I	II	III	IV	Total
25	9	22	0	0	31
26	645	171	0	240	1057
27	0	1	0	0	1
28	458	27	0	272	758
29	145	8	0	112	265

Distribution of landed herring (in tons and percentage) by gear in 2014

	Gear			
Landings	PTM	OTM	Other	Total, t
Tonnes	1298	797	1	2096
%	61,2	38,0	0,1	

Sprat

Sprat mainly in 2013 was caught in SD 26 (3524 t - 37%) and SD 28 (4519 t - 47%) .The landings are used for both industrial (PTM) and human consumption (OTM) purposes. Almost 76% of sprat was caught by pelagic pair trawl and 24% by pelagic otter trawl. In general this is a mixed pelagic fishery when herring and sprat are caught together in different proportions dependently on season, gear and fishing ground. In sprat fishery the by-catch oh herring makes up to 20% of total catch volume. 96% of Lithuanian sprat catches were landed in foreign ports.

Distribution of sprat landings (tons) in 2014 by subdivisions and quarter

	Quarter				
Subdivision	I	II	III	IV	Total
25	299	356	0	0	655
26	2740	517	0	267	3524
27	0	10	0	0	10
28	1878	1268	0	1374	4519
29	409	43	0	488	939

Distribution of landed sprat (in tons and percentage) by gear

	Gear		
Landings	PTM	OTM	Total, t
Tones	7354	2292	9646
%	76,2	23,8	

Sprat and herring fishery in Poland

Polish catch-statistics of Baltic Clupeids submitted to WGBFAS are the official landings of herring and sprat based on the data from logbooks, distributed into species by national experts in herring and sprat. There exist two types of herring-like catches in the Polish commercial fishery:

a) catches for human consumption,

b) industrial catches.

In 2013 and 2014 adequately, 57 and 76% of Polish sprat annual landings were designated to human consumption, and respectively, 43 and 24% were selected to fishmeal production (industrial catches). In 2013 and 2014 adequately, 94 and 99% of Polish herring annual landings were designated to human consumption, and respectively, 6 and 1% were selected to industrial purposes. In catches for the human consumption, species shares are well separated by using different mesh size of codend in the catches of herring and sprat and use of mechanical sorting machines. Statistics of these landings and their sampling are of good precision. However, there exists the problem of bycatch of juvenile herring in sprat landings, which is solved by sorting and biological sampling both in harbour landings and at sea. As the result, the official quantity of herring landings received from logbooks is raised by its bycatch in sprat landings and official sprat landings are decreased by this quantity. In the several recent years an average annual by-catch of young herring in Polish sprat catches designated to human consumption was low and in 2013 and 2014 amounted respectively, 1.0 and 2.5%.

Landings of Clupeids for industrial purposes concern mixed catches, done using trawl with sprat small-meshed codend, and principally aren't sorted for species however, in some cases cod and herring with large size are manually sorted out from sprat. These landings are done as industrial sprat and noted in logbook under the sprat species. Only in few logbooks shares of herring, sprat and in to some cases cod too are estimated. Majority of these types of landings, done by Polish commercial fleet, take place mostly in the Danish and to some extent in the Swedish harbours. The statistics, concerning this type of fishery, is created basing on landings documents. The Polish observers sample these catches directly at sea, for species composition and collection of biological materials. Results of sampling are extrapolated for landings of the whole fleet. Sampling is insufficient in case of far areas (ICES Sub-divisions 27, 28, 29) and for cutters not entering the Polish ports for the longer time. In this case, only the landings are reported to WGBFAS, based on logbook, however in March-April additional limited Polish sampling effort is dedicated to sprat fished in north-eastern Baltic.

Fishing grounds placed in the ICES Sub-divisions 26 and 25 due to closely location versus the main Polish fishery ports, from many years played the major role in Baltic sprat and herring catches. In 2013 and 2014 adequately, 67 and 55% of Polish sprat annual landings originated from ICES SD 26 and respectively, 24 and 38% of landings were taken from ICES SD 25. Relatively small amount of the Polish annual sprat landings originated from the ICES Sub-divisions 24, 27, 28 and 29, and e.g. in 2014 it was totally 7%. In 2013 and 2014 adequately, 62 and 58% of Polish herring annual landings originated from ICES SD 25 and respectively, 21 and 33% of landings were taken from ICES SD 26. The Pomeranian Bay and Arkona Basin is played the third role in herring fishing, e.g. in 2013 and 2014 respectively, 13 and 8% of annual landings were connected with the above-mentioned areas. Relatively small amount of the Polish annual herring landings originated from the ICES Sub-divisions 27, 28.2 and 29, and e.g. in 2013 it was totally 4%.

February-May from many years is the main fishing season in Polish sprat fishery and in 2013 and 2014 in this time of year was landed 92 and 77%, respectively. The main fishing season in the Polish herring fishery varied in some years, and e.g. in 2013 was from July to August, and in 2014 was in March and September-October. The midwater otter trawls (OTM) and far next, the pelagic pair trawls (PTM) plays the most important role in Polish catches of Baltic sprat and e.g. in 2014 the annual landings obtained with the above-mentioned fishing gears was 92 and 6%. The bottom trawls have a minor role in both, sprat and herring fishery. The midwater otter trawls (OTM) and the pelagic pair trawls (PTM) plays the most important role in Polish catches of Baltic herring and e.g. in 2013 the annual landings obtained with the above-mentioned fishing gears was 86%, and the trap-nets and gill-nets played the next role, with the average share of 9 and 5%, respectively.

In 2011, herring Total Allowable Catch determined for the ICES Sub-divisions 25-27, 28.2, 29 and 32 of Baltic Sea was used by ship-owners without dividing it for each fishery vessel. In case of herring from the ICES Sub-divisions 22-24 distribution of allowable catch was done for vessels, which owners had the quota of “western herring” in years 2007, 2008 or 2009 and caught it in at least one of these years. In the next years, the system of distribution of herring catch quota in Poland was similar like in a case of sprat. Intensive exploitation of Central Baltic herring stock within the year, by the Polish fishing fleet, in some cases lead to temporary ban of landings, e.g. in 2012 it was in the period of 30 October till end of year and in 2013.

Sprat and herring fishery in Russia

This fleet, targeting sprat for the human consumption, during I-IV quarters, has average by-catches of herring between 15,6–36,5%. As usually, during summer and fall this fleet targets sprat for the animal food and by-catches of small herring is increased. The species composition of the mixed catches is defined from logbooks and, partly, by observers of AtlantNIRO (Kaliningrad), on board of larger commercial vessels. The small vessels fleet MRTK operates mainly within 12-NM limit over the year. Mesh size in the trawl bag is 20 mm opening. The catches of sprat in quarter I can reach 71,7%, in quarter II – 84,4%, in quarter III – 80,3%, in quarter IV – 63,5%. The species composition of this mixed fishery defined from logbooks and sporadically checked by fishery inspection in harbors. Russian fishermen utilized their sprat and herring quotas in 26 SD on 82,0% and 81,3% respectively. Basic parameters of work of a pelagic trawl fleet represent in table 1.

Table 1. Parameters of pelagic trawl fleet in 2013

Parameters of pelagic trawl fleet	Quarter				For
	I	II	III	IV	year
The number of fishing days (the sum for all vessels)	745	459	430	485	2119
Landing of one vessel for 1 day, t (average)	17,6	11,6	12,2	18,7	15,0
Sprat in catches, %	64,1	66,5	54,4	85,8	68,9
Herring in catches, %	35,9	33,5	45,6	14,2	31,1

Demersal trawl fleet

This fishery targets for cod and flounder. Cod and flounder are fished mainly by vessels type MRTK and MRTR with engine power up to 300 h.p. up to 27 m length. These commercial vessels are fishing with bottom trawls using the BACOMA windows (120 mm mesh opening) in the cod-ends. Russian fishermen utilized their cod and flounder quotas in 26 SD on 45,9% and 85,8% respectively. Basic parameters of work of a demersal trawl fleet represent in table 2.

Table 2. Parameters of demersal trawl fleet in 2013

Parameters of demersal trawl fleet	Quarter				For
	I	II	III	IV	year
The number of fishing days (the sum for all vessels)	267	306	217	571	1361
Landing of one vessel for 1 day, t (average)	3,2	2,2	2,6	3,4	2,9
Cod in catches, %	67,8	84,5	59,8	79,3	72,9
Flounder in catches, %	32,2	15,5	40,2	20,7	27,1

Gillnet fleet

This fishery targets for cod with by catch of flounder. Cod and flounder are fished mainly by vessels type TB, SCHS, PTS with engine power up to 225 h.p. These vessels are using the anchored gillnets with mesh opening of 110-115 mm. Basic parameters of work of gillnet fleet represent in table 3.

Table 3. Parameters of work of gillnet fleet in 2013

Parameters of gillnet fleet	Quarter				For
	I	II	III	IV	year
The number of fishing days (the sum for all vessels)	95	151	88	261	595
Landing of one vessel for 1 day, t (average)	0,46	0,81	0,75	0,62	0,66
Cod in catches, %	90,7	93,2	84,9	97,2	93,1
Flounder in catches, %	9,3	6,8	15,1	2,8	6,9

Pound net fleet

This type of fishery exists in the Vistula Lagoon and Eastern part of Gulf of Finland. This fishery is targeting herring.

Methods used to determine species compositions for officially reported landings

Species composition defines based on logbooks, landing declarations and sporadically checked by fishery inspectors in harbours and on ships.

Herring and sprat fishery in Sweden

The Swedish fishery for herring and sprat in the Baltic is carried out by four different fleet categories:

- Trawlers catching herring and sprat with a minimum mesh size of 32 mm. This fishery is for human consumption and for meal/oil.
- Trawlers catching sprat (with a bycatch of herring) with a minimum mesh size of 16 mm. Most of the landings are used for industrial purposes, but a small part of the landings is used for human consumption. This is the main fishery in effort and landings.
- Coastal fishery for herring with gillnets. This fishery is for human consumption.
- A small fleet of purse seiners near the coast for spawning herring in the second quarter of the year for human consumption.

Since 2009 the main part of the Swedish pelagic fleet is set up with individual transferable fishing rights (TFC, previously ITQ). This has resulted in a sharp decrease in the number of pelagic vessels. The decrease in the number of vessels has continued and 2014 there were about 35 boats holding individual transferable fishing rights in the pelagic fisheries. Large scaled pelagic trawls catch the main Swedish catch of herring and sprat from the Baltic. Small scaled coastal fisheries, fishing with gillnets for herring is of local importance in the, especially in the northern Baltic.

Sweden regularly collects samples of approximately 5 kg from the pelagic fisheries catch for biological parameter. These samples are used also for species composition when they are large enough.

Sweden receives information about the pelagic landings from logbooks and sale slips and attempts to evaluate the species composition by including information from additional sampling. The total landing of herring and sprat is then accordingly adjusted to give more plausible figures for assessment.

The strategy has prior to 2005 been to use available samples collected by the Swedish Coast Guard. Currently this sampling had been taken over by the Fisheries control which takes 2-4 samples from pelagic fisheries and has not been used for adjustments.

There may be a possibility to cooperate and try to evaluate the statistical accuracy of this sampling.

In the last few years the acoustics from BIAS quarter 4 has been used for adjustment in species composition in SDs 25, 27, 28 and 29. The acoustic values are compared to log-books in quarter 4. Adjustments in quarter 4 can be up to 30–40% but on average for the whole year less than 10%.

In a recent paper by Hentati-Sundberg *et al.* (2014), it was estimated that there has been a high degree of misreporting in the Swedish pelagic fishery (1996–2009). Their analysis suggests that total catches have been underestimated during part of this study period and that systematic misreporting of species composition has taken place over the whole study period. However, applying their method on the recent years suggests that the species composition misreporting has decreased because of that the TAC for sprat and herring are closer to the densities per species found in the sea (stock assessment). There is no data on slipping in the Swedish fleet and recent development of the fishing effort suggests that the incentives for slipping have been reduced the last years.

6.1.2 Fisheries Management

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 TAC:s and reported landings for these management units are illustrated in Figure 6.1.1.

Management 2014 and 2015 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 2014 in relation to SSB	in relation to F	ICES Advice for 2015(Basis) (t)	TAC 2015 (t)
SPRAT				
SD 22-32	Above trigger & Full reproductivity	Appropriate & Harvested sustainably	222 000 (MSY approach)	*213 581
HERRING				
SD 25-29&32 (excl. GOR)	Above trigger & Full reproductivity	Below target & Harvested sustainably	193 000 (MSY approach)	*163 452
SD 28.1 (Gulf of Riga)	Above trigger & Undefined	Above target & Harvested sustainably	34 300 (MSY approach)	38 780
SD 30 (Bothnian Sea)	Above trigger & Undefined	appropriate & Undefined	181 000 (MSY approach)	158 470
SD 31 (Bothnian Bay)	Increasing	Increasing	5 534 (Data limited stocks)	

***EC share**

6.1.3 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 (SD 22–24, Div. IIIa and Iva) caught in SD 22–24.

Year	WBSSH caught in SD 22-24 (1000 tons)*	Total catches of the WBSSH stock (1000 tons)*	% 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%
Mean	36,7	70,0	52,6%

***Finnish data not included**

Proportion of Central Baltic herring (CBH) stock (SD 25–27, 28.2,29 and 32) caught in the Gulf of Riga (SD 28.1).

Year	CBH caught in Gulf of Riga (SD 28.1) (1000 tons)	Total catches of the CBH stock (SD 25-27, 28.2,29 &32) (1000 tons)	% 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%
Mean	3.9	121,0	3.3%

Proportion of the Gulf of Riga herring (GORH) stock (SD 28.1) 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 tons)	Total stock GORH catches (1000 tons)	% 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	30,4	1.0%
2014	0,2	26,2	0,8%
Mean	0,4	33,2	1,3%

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).

6.1.4 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 and

Gulf of Riga herring (SD 28.1).

The herring in the Gulf of Bothnia are assessed as two stocks:

Herring in SD 30,

Herring in SD 31.

The herring in SW Baltic (SD 22–24) is assessed together with the spring spawners in Kattegatt and Skagerrak (Division IIIa) within HAWG.

Table 6.1.1 Pelagic landings ('000 t) and species composition (%) in 2014 by Subdivision and quarter.

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
SD 25	Landings ('000 t)	26.6	25.8	6.6	8.0	**67.1**
	Herring (%)	26.9	27.2	90.6	83.6	**40.1**
	Sprat (%)	73.1	72.8	9.4	16.4	**59.9**
SD 26	Landings ('000 t)	57.8	16.5	7.6	21.5	**103.4**
	Herring (%)	24.4	31.3	51.6	26.8	**28.0**
	Sprat (%)	75.6	68.7	48.4	73.2	**72.0**
SD 27	Landings ('000 t)	6.8	4.2	0.1	3.0	**14.1**
	Herring (%)	46.8	43.2	81.5	50.5	**46.8**
	Sprat (%)	53.2	56.8	18.5	49.5	**53.2**
SD 28*	Landings ('000 t)	49.9	21.4	7.2	18.8	**97.3**
	Herring (%)	38.5	66.4	47.0	36.3	**44.9**
	Sprat (%)	61.5	33.6	53.0	63.7	**55.1**
SD 29	Landings ('000 t)	48.0	8.9	0.6	15.0	**72.5**
	Herring (%)	42.4	91.6	83.4	50.6	**50.4**
	Sprat (%)	57.6	8.4	16.6	49.4	**49.6**
SD 30	Landings ('000 t)	37.5	53.9	5.3	17.0	**113.8**
	Herring (%)	96.6	98.1	99.6	95.9	**97.3**
	Sprat (%)	3.4	1.9	0.4	4.1	**2.7**
SD 31	Landings ('000 t)	0.1	3.1	1.3	0.1	**4.6**
	Herring (%)	100.0	100.0	100.0	100.0	**100.0**
	Sprat (%)	0.0	0.0	0.0	0.0	**0.0**
SD 32	Landings ('000 t)	21.1	3.9	0.2	15.5	**40.7**
	Herring (%)	39.7	68.4	35.2	33.8	**40.2**
	Sprat (%)	60.3	31.6	64.8	66.2	**59.8**
Total	Landings ('000 t)	**248.0**	**137.6**	**28.9**	**98.9**	513.3
	Herring (%)	**43.9**	**69.0**	**71.1**	**50.6**	53.4
	Sprat (%)	**56.1**	**31.0**	**28.9**	**49.4**	46.6

*** Gulf of Riga included**

Table 6.1.2 Proportion of herring in landings 2014.

COUNTRY	QUARTER	SUB-DIVISION							
		25	26	27	28*	29	30	31	32
DEN	1	0.05	0.01	0.00	0.00	0.12	0.00	0.00	1.00
	2	0.01	0.00		0.00		0.00	0.00	
	3	1.00	1.00				0.00	0.00	
	4	0.78	0.07	0.00	1.00	0.10	0.00	0.00	0.00
EST*	1				0.21	0.21	0.00	0.00	0.29
	2				0.00	0.41	0.00	0.00	0.62
	3				0.00	0.25	0.00	0.00	0.32
	4	0.00	0.00		0.00	0.28	0.00	0.00	0.30
FIN	1			0.00	0.82	0.82	0.00	0.00	0.49
	2				1.00	1.00	0.00	0.00	0.99
	3				0.99	0.99	0.00	0.00	0.56
	4				0.89	0.89	0.00	0.00	0.27
GER	1	0.16	0.09	0.00	0.04	0.17	0.00	0.00	
	2	0.14	0.18	0.00	0.32		0.00	0.00	0.00
	3						0.00	0.00	0.00
	4	0.09			0.00	0.08	0.00	0.00	0.00
LAT*	1	0.02	0.04		0.00		0.00	0.00	
	2		0.06		0.00		0.00	0.00	
	3		0.12		0.00		0.00	0.00	
	4		0.12		0.00		0.00	0.00	
LIT	1	0.03	0.19		0.00	0.26	0.00	0.00	
	2	0.06	0.25	0.00	0.00	0.15	0.00	0.00	
	3						0.00	0.00	
	4		0.47		0.00	0.19	0.00	0.00	
POL	1	0.34	0.15	0.00	0.01	0.00	0.00	0.00	
	2	0.26	0.21	0.00	0.01		0.00	0.00	
	3	0.93	0.69				0.00	0.00	
	4	0.85	0.38		0.00		0.00	0.00	
RUS	1	0.00	0.43	0.00			0.00	0.00	1.00
	2	0.00	0.49	0.00			0.00	0.00	1.00
	3	0.00	0.45	0.00			0.00	0.00	
	4	0.00	0.14	0.00			0.00	0.00	1.00
SWE	1	0.39	0.41	0.00	0.25	0.39	0.00	0.00	
	2	0.46	0.23	0.00	0.70	1.00	0.00	0.00	
	3	0.65		0.00	0.22	1.00	0.00	0.00	
	4	0.81	0.41	0.00	0.63	0.44	0.00	0.00	0.23
Total	1	0.27	0.24	0.00	0.09	0.42	0.97	1.00	0.40
	2	0.27	0.31	0.00	0.20	0.92	0.98	1.00	0.68
	3	0.91	0.52	0.00	0.02	0.83	1.00	1.00	0.35
	4	0.84	0.27	0.00	0.11	0.51	0.96	1.00	0.34
Acoust. Stock**	4	0.71	0.66	0.85	0.58	0.85	0.99		0.58

* Gulf of Riga included

** SD 32 was covered by the acoustic survey only very partially (only the westermost part)

Table 6.1.3 Herring in Subdivisions 25-32. Samples of commercial catches by quarter and Subdivision for 2014 available to the Working Group.

	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
Subdivision 25	1	7,163	25	1,782	999
	2	7,032	28	3,129	1,244
	3	5,991	3	699	145
	4	6,721	13	1,521	712
	Total	26907	69	7,131	3,100
Subdivision 26	1	14,080	48	10,480	2,667
	2	5,168	23	3,797	1,303
	3	3,937	53	14,985	1,244
	4	5,761	50	12,293	1,858
	Total	28,945	174	41,555	7,072
Subdivision 27	1	3,197	8	602	598
	2	1,799	1	216	215
	3	87	0	0	0
	4	1,490	7	562	560
	Total	6,573	16	1,380	1,373
Subdivision 28*	1	19570	35	5783	3661
	2	18361	91	10163	9196
	3	3385	24	4768	2299
	4	6720	27	4991	2569
	Total	48036	177	25705	17725
Subdivision 29	1	20,348	15	1,725	707
	2	8,127	18	3,573	1,042
	3	466	0	0	0
	4	7,585	6	1,301	284
	Total	36,527	39	6,599	2,033
Subdivision 30	1	36,259	17	4,432	292
	2	52,832	26	5,748	525
	3	5,286	8	10,788	1,073
	4	16,350	23	6,472	2,039
	Total	110,727	74	27,440	3,929
Subdivision 31	1	112	0	0	0
	2	3,123	3117	3394	287
	3	1,314	1297	1474	181
	4	105	1284	1466	186
	Total	4,635	18	5,680	654
Subdivision 32	1	8,403	15	2,011	1,036
	2	2,640	26	3,672	2,293
	3	57	8	1,173	446
	4	5,237	28	7,800	1,482
	Total	16,337	77	14,656	5,257
Subdivisions 25-32	**1**	**109,132**	**163**	**26,815**	**9,960**
	2	**99,083**	**3,330**	**33,692**	**16,105**
	3	**20,523**	**1,393**	**33,887**	**5,388**
	4	**49,968**	**1,438**	**36,406**	**9,690**
	Total	**278,705**	**6,324**	**130,800**	**41,143**

* Gulf of Riga included

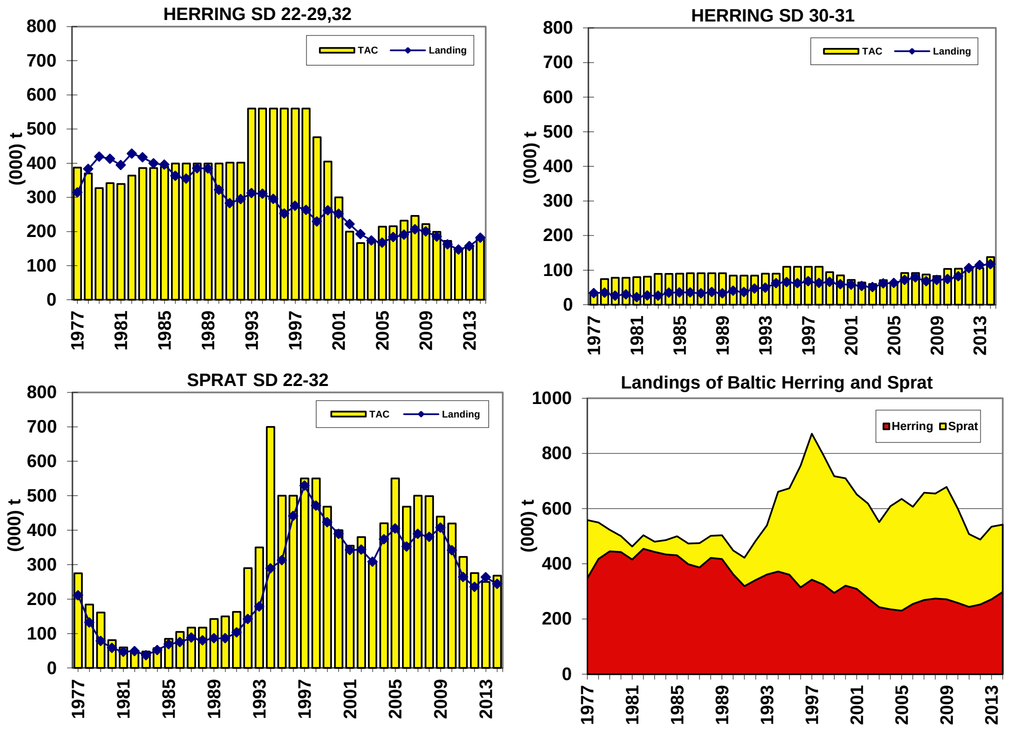

Figure 6.1.2 Reported landings of herring and sprat and agreed TACs in the Baltic Sea. (since 2007 TACs for herring and sprat: EC quota + Russian TAC)

6.2 Herring in Subdivisions 25–27, 28.2, 29 and 32 (update assessment)

6.2.1 The Fishery

6.2.1.1 Catch trends

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 6.1.3), are given in Table 6.2.1. Catches in 2014 amounted to 132 700 t, which is 31% higher than last year. Catches increased for Germany (22%), Estonia (22%), Finland (54%), Latvia (37%), Lithuania (22%), Poland (33%), Russia (58%) and Sweden (18%), but decreased for Denmark (-20%). The largest part of the catches was taken in 2014 by Sweden (26%), followed by Poland (21%) and Finland (21%).

Catches by country and Subdivision are presented in Tables 6.2.2–6.2.3 (incl. central Baltic herring caught in SD 28.1, see Section 6.1.3). The spatial distribution of catches shows that in the last few years most catches were taken in 25, 26 and 29. In 2014 the distribution of catches was as follows: 28% in SD 29, 20% in SD 25 and 22% in SD 26.

6.2.1.2 Unallocated catches

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. 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 countries that seemingly have problems estimating the proportion of herrings in the catches are dealing with this on national level with additional sampling and correct the input figures for assessment to assure as high accuracy as possible. Misreporting is regarded to be a minor problem.

6.2.1.3 Discards

Discarding at sea is regarded to be negligible.

6.2.1.4 Effot and CPUE data

Data on commercial effort and CPUE were not used in the assessment.

6.2.2 Biological composition of the catch

6.2.2.1 Age composition

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 8% of the total catches in 2014. All German catches, which are however only representing a minor part of the total catches, were landed in foreign ports and therefore no age composition of catches could be provided from Germany.

The compilation of 2014 national data was done by Subdivision and quarter, but not by fishery (Table 6.2.4). 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 2014 66% of the catches in numbers (Figure 6.2.1) which is 7% more than in 2013. The year class 2007 is now 7 years and contributing with 7% of the catches in numbers. The year class of 2011 as strong yearclass contributes to the fisheries by 24% of the catches. 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 6.2.2). Table 6.2.3 gives catches, catch numbers at age and mean weight at age by Subdivision, whereas Table 6.2.4 shows it by Subdivision and by quarter.

6.2.2.2 Quality of catch and biological data

The level and frequency of herring sampling in Subdivisions 25–29 and 32 (excl. GOR) in the Baltic for 2014 is compiled in Table 6.2.2. The overall frequency was 4 samples, 644 fishes measured and 216 fishes aged per 1000 tonnes landed. In 2014 sampling was most frequent in SD 26 followed by SD 28.2 and 32. The sampling for age composition is adequate. But it 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 2014). 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 still 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 is 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. The official catch figures of both sprat and herring are modified by Sweden, Poland and Denmark to account for possible mixing of sprat and herring in catches. It finally concluded that that the countries handle the problem adequately on a national level before providing the catch data.

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 was showing 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 to keep the old maturity ogive.

6.2.3 Mean weight-at-age

The mean weights-at-age were compiled by Subdivision and quarter for 2014 (Table 6.2.4) 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 1980's ceased around the mid 1990ies and remains at a low level with some slight increase in the last years. When a particular strong year class occurs, like the 2002 and 2007, there may be density dependent effects (Figure 6.2.3). The increased sprat stock size has most likely also contributed to the low herring weight-at-age during the past 20 years. The marked geographical differences in growth patterns are shown in Table 6.2.4. The mean weight is higher in Subdivisions 25 and 26 and decreases in the more northern Subdivisions. As consequence, the observed variation in average weight (total catches in ton/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 6.2.4). 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 unchanged in SD 25 and decreasing in SD 26. In 2014 the catches in 25 and 26 increased again. Catches are steadily increasing in SD 29 since 2010. There is no discernable change in mean weight at age but this may occur if the catches in future move further north 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).

6.2.4 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 6.2.2.2 and ICES CM 2013/ACOM:43). The new maturity ogive was not used due to inconsistencies in some parts of the data, very high maturity at age 1 with a noteable year and country effect. The new Maturity ogive was apart from inconsistencies mentioned, similar to the old so it was decided to keep the old maturity ogive static between 1974–2013 (Table 6.2.8).

6.2.5 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 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). As in last year’s assessment (WGBFAS 2014) final estimates of M in 2014 were chosen as 2011. The values of M are given in Table 6.2.7.

6.2.6 Catch at age analysis

6.2.6.1 Tuning fleets

As in 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. The final BIAS index for ages 1–8+ is given in Table 6.2.11.

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 6.2.5). Including the 2014 data resulted in some overall decline of the internal consistency compared to last year for most ages. Only ages 6-7 show some improvement.

XSA run

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 decided to use for M in 2014 (as last year for the value in 2012) the M value equal to 2011 (M2014=M2013=M2012= M2011).

The input data for catch at age analysis are found in Tables 6.2.5–6.2.11, 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 78 iterations, are shown in Table 6.2.12.Including the latest acoustic estimates for 2014 led similar regression statistics compared to last year's results. Fishing mortalities and stock number are given in Table 6.2.13 and Table 6.2.14, respectively. The summary is presented in Table 6.2.15.

The development of herring biomass as estimated by the acoustic surveys and by XSA is illustrated in Figure 6.2.6. The 2014 SSB acoustic and XSA estimates both show an increase, whereas the total biomass corresponding to the acoustic shows an increase an XSA total biomass gives a stable value the last three years. . Historically the acoustic biomass has shown that a high acoustic estimate is followed by a rather low one in the following year as shown in 2000/2001, 2003/2004 and 2006/2007, however these fluctuation in acoustic estimates has not been seen in later years.

A retrospective analysis for the whole time series is given in Figure 6.2.7. Presently, there is tendency to overestimate fishing mortality and underestimate spawning stock biomass.

As in previous assessments the residual catchability standard errors were, with a few exceptions, acceptable (<0.5) and showed no significant time trends (Figure 6.2.8). However, there are some year effects showing consistent positive residuals (2000, 2006 and 2014) and consistent negative residuals (2007, 2008 and 2009).

The abundance by age group of the tuning fleet, adjusted to the start of the year was plotted against the estimated stock numbers (Figure 6.2.9). The regression analyses gave R (squared) values in the range 0.5-0.8. which is slightly higher than last year's estimates.

6.2.6.2 Exploration of SAM

During the recent benchmark assessment (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 6.2.16. The assessment run and the software internal code are available at https:/www.stockassessment.org., CBH_WGBFAS2014. Results of SAM compared to XSA are presented in Figures 6.2.10. 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 recent years is similar to the XSA output showing a tendency to overestimate fishing mortality and underestimate spawning stock biomass (Figure 6.2.11).

6.2.7 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 1991-2014 was used in a RCT3 analysis to estimate the year class 2014 at age 1 for 2015. The RCT3 input and result are presented in Tables 6.2.17 and 6.2.18. The estimate of the year class 2014 (Age 1 in 2015: 29 548 mill.) is the second highest yearclass on record in the timeseries since 1974 .

6.2.8 Historical stock trend

A slow but steady increase of SSB was observed since 2001 (Figure 6.2.12). The SSB in 2014 is estimated to be 7% above the long-term mean. Since the assessment in 2011 the SSB has been revised upwardseach year probably caused by underestimation of incoming strong yearclasses. The general trend in the stock development is not changed however. The historical decrease 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, but a decrease starts in 1997 to reach a value of 17 billion fish. In 2003 an increasing trends starts but after 2010 the stock starts declining again and in 2014 the SSB in numbers is estimated to be 29 billion fish (Figure 6.2.13).

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 6.2.3). 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.

Fishing mortality 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) it has slightly increased to 0.16 in 201412 (Figure 6.2.12). The large proportion of slow-growing herring may have contributed to the increase in fishing mortality in the 1990ies 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 afterwards (Figure 6.2.12). The 2011 year class is still estimated to be the best since the last strong 2007 year class and 2014 is predicted to be the second strongest (29 548 mill) in the whole timeseries since 1974. In the long term recruitment has fluctuated in the range of 10–20 billion with no clear trend since the mid 80ies.

6.2.9 Short-term forecast and management options

The input data of the short-term prediction are presented in Table 6.2.19. The mean weights at age in the prediction, for both catch and stock, were the average of 2012–2014. Density dependent effects of strong year classes have shown decreasing mean weights. This was the case for the year class 2002 and it was considered to apply for this effect for the 8+ group. However an investigation of growth of strong year's classes showed that this is not necessarily an effect that is consistent for the oldest year classes. Therefore it was decided not include any decreasing of the mean weight in the 8+ group when calculating the average of 2012–2014.

The estimate of recruitment of age 1 for 2015 was taken from the RCT3 analysis (Tables 6.2.17–6.2.18), whereas recruits in 2016 and 2017 were the GM for 1988–2013 (period of lower recruitment, 15 110 mill.). The natural mortalities were assumed at 2012–2014 level. Since the recent development of F shows no clear trend, the exploitation pattern was taken as the average over 2012–2014. The TAC constraint of 190 831 t (EU quota of 163 451 t + EU/Russian quota of 22 900 t + CBH caught in GOR 4 700 t (mean 2009–2013) – GOR herring caught in the Central Baltic area 220 t) was used in the predictions in the intermediate year 2015 since the total TAC in 2015 was almost fully exploited. This resulted in a fishing mortality of 0.20 (Table 6.2.20), which lies above the present estimated F in 2014 of 0.16. The SSB is expected to decrease to 1 000 071t t in 2015.

The share of the different age groups to the yield in 2015 and 2016 and to the SSB in 2016 and 2017 is presented in Figure 6.2.14. The sensitivity of the projection to the assumed strength (GM for 1988–2013) of the 2015 year class (age 1 in 2016) is small to the predicted yield in 2016 (3%). This year class constitutes 16% of the SSB predicted for 2017 (as age 2). The year class 2014 from the RCT3 model constitutes 6% of yield in 2015 (as age 1), 19% of the yield in 2016 (as age 2) and 33% of SSB in 2016 (as age 3). The strongyear-class 2011 contributes to the yield in 2015 by 24% (as age 4), in 2016 by 20% (age-group5). The strong yearclass 2014 is shown in the yield 2016 by 19% (age group 2) and SSB 2016 by 28% (age group 2). Yield and Spawning Stock per Recruit

The input used for the calculation of the yield and spawning stock per recruit is presented in (Table 6.2.19). The output is in Table 6.2.21 and yield and SSB for long- and short-term is shown in Figure 6.2.12.

6.2.10 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. Further ranges of F_{MSY} are provided in the text table below.

Stock	MSY Flower	FMSY	MSY Fupper with AR	MSY Btrigger (1000 t)	MSY Fupper 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

6.2.11 Quality of assessment

The assessment has been benchmarked in 2013 (ICES CM 2013/ACOM:43).

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 natural mortality was provided from multi-species models for the years 1974-2011, taking the last two year’s M (2012/2013) equal to 2011.

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). 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 Sweden, Poland and Denmark. 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 is concluded that species misreporting can be regarded of minor importance.

Different growth rates within the distribution area of herring may influences the actual level of SSB estimates. However the rather stable distributions of the catches within the different SDs during the last year’s and the possibility to track the last strong year classes such as 2002, 2007 and 2011 in the catch at age data, suggest presently no major changes in the distribution of the different stock components.

6.2.12 Comparison with previous assessment

Compared to last year, the present assessment resulted in 12% higher SSB estimates for 2013. $F_{(3-6)}$ in 2013 was estimated to be 12% lower compared to last year’s assessment and recruitment-at-age 1 in 2012(year class 2011) was estimated to be 14% higher than in this year's assessment.

Parameter	WGBFAS 2014	WGBFAS 2015	Difference 2015/2014 (+/-)%
SSB 2013 (1000 t)	852	956	+12%
F(3-6) 2013	0,12	0,11	-12%
Recruitment Age 1 2012 (billions)	24,1	27,6	+14%

6.2.13 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. Fishing mortality (F3–6) is presently historically low (0.16). Since 2004 F is much below the adopted FMSY of 0.22 (ICES CM 2015/ACOM:64). It can be noted that several yearclasses above the longterm mean has contributed to the stock (2007, 2008, 2011, 2012) and the 2014 yearclass is predicted as being strong as well. . The fluctuations of the eastern cod stock and sprat stock (see also WKREFBAS 2008/ICES CM 2008/ACOM:28) should be taken in account in herring management. Currently the cod stock is concentrated 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 and the catches of herring are also noted to be decreasing in SD 25 and 26. WGBFAS is performing short-terms forecasts using the latest cod predation mortality estimates (SMS, ICES CM 2012/SSGSUE:10), in this way taking in account the predation by the cod stock.

Table 6.2.1 Herring in SD 25-29, 32 (excl. GOR). Catches by country (1000 t).

(incl. central Baltic herring caught in GOR, see Section 6.1.3)

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia**	Sweden	Total
1977	11.9		33.7	0.0			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	0.0			70.4	101.0	71.3	302.5
1980	10.6		44.0	0.0			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	0.0			65.8	89.8	56.9	273.1
1985	7.6		54.2	0.0			72.8	95.2	42.5	272.3
1986	3.9		49.4	0.0			67.8	98.8	29.7	249.6
1987	4.2		50.4	0.0			55.5	100.9	25.4	236.4
1988	10.8		58.1	0.0			57.2	106.0	33.4	265.5
1989	7.3		50.0	0.0			51.8	105.0	55.4	269.5
1990	4.6		26.9	0.0			52.3	101.3	44.2	229.3
1991	6.8	27.0	18.1	0.0	20.7	6.5	47.1	31.9	36.5	194.6
1992	8.1	22.3	30.0	0.0	12.5	4.6	39.2	29.5	43.0	189.2
1993	8.9	25.4	32.3	0.0	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

* **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 6.2.2 Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches of the central Baltic herring stock by quarter and Sub-division for 2014 available to the Working Group. 1/6

	Country	Quarter	Catches in tons	Number of samples	Number of fish meas.	Number of fish aged
Sub-division 25	Denmark	1	283	12	73	72
		2	5	1	6	6
		3	1010			
		4	251			
		Total	1,549	13	79	78
	Estonia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Finland	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Germany	1	335			
		2	148			
		3	0			
		4	2			
		Total	485	0	0	0
	Latvia	1	4.3			
		2				
		3				
		4				
		Total	4	0	0	0
	Lithuania	1	9			
		2	22			
		3	0			
		4	0			
		Total	31	0	0	0
	Poland	1	2,714	8	1,143	368
		2	5,453	19	2,523	641
		3	4,465	3	699	145
		4	4,733	6	971	164
		Total	17,365	36	5,336	1,318
	Sweden	1	3,817	5	566	559
		2	1,404	8	600	597
		3	517			
		4	1,735	7	550	548
		Total	7,473	20	1,716	1,704
	Total	1	7,163	25	1,782	999
		2	7,032	28	3,129	1,244
		3	5,991	3	699	145
		4	6,721	13	1,521	712
		Total	26,907	69	7,131	3,100

continued

Table 6.2.2 continued **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches of the central Baltic herring stock by quarter and Sub-division for 2014 available to the Working Group.** **2/6**

	Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Sub-division 26	Denmark	1	26	1	1	1
		2	0			
		3	52			
		4	11	1	4	4
		Total	88	2	5	5
	Finland	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Germany	1	181			
		2	83			
		3				
		4				
		Total	265	0	0	0
	Latvia	1	96	2	268	177
		2	45	1	232	106
		3	13	0	0	0
		4	15	0	0	0
		Total	168	3	500	283
	Lithuania	1	631	5	1111	707
		2	171	1	167	165
		3	0	0	0	0
		4	240	5	995	632
		Total	1,042	11	2,273	1,504
	Poland	1	3,548	8	1,341	341
		2	1,316	7	1,172	327
		3	1,480	6	1,034	312
		4	3,343	8	1,272	156
		Total	9,687	29	4,819	1,136
	Russia	1	6248	32	7,759	1,441
		2	3373	14	2,226	705
		3	2392	47	13,951	932
		4	1404	35	9,959	1,004
		Total	13,417	128	33,895	4,082
	Sweden	1	3350			
		2	180			
		3	0			
		4	748	1	63	62
		Total	4,278	1	63	62
	Total	1	14,080	48	10,480	2,667
		2	5,168	23	3,797	1,303
		3	3,937	53	14,985	1,244
		4	5,761	50	12,293	1,858
		Total	28,945	174	41,555	7,072

continued

Table 6.2.2 continued **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches of the central Baltic herring stock by quarter and Sub-division for 2014 available to the Working Group.** 3/6

	Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Sub-division 27	Denmark	1	13			
		2	0			
		3	0			
		4	4			
		Total	16	0	0	0
	Finland	1	64			
		2				
		3				
		4				
		Total	64	0	0	0
	Germany	1	45			
		2	188			
		3				
		4				
		Total	233	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Lithuania	1				
		2	1			
		3				
		4				
		Total	1	0	0	0
	Poland	1	10			
		2	5			
		3				
		4				
		Total	15	0	0	0
	Sweden	1	3,065	8	602	598
		2	1,606	1	216	215
		3	87			
		4	1,487	7	562	560
		Total	6,244	16	1,380	1,373
	Total	1	3,197	8	602	598
		2	1,799	1	216	215
		3	87	0	0	0
		4	1,490	7	562	560
		Total	6,573	16	1,380	1,373

continued

Table 6.2.2 continued **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches of the central Baltic herring stock by quarter and Sub-division for 2014 available to the Working Group.** **4/6**

Sub-division 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	141	1	53	53
	2	12			
	3	0			
	4	0			
	Total	153	1	53	53
Estonia	1	204	4	248	245
	2	2773	0	0	0
	3	0	4	404	399
	4	211	3	159	155
	Total	3,188	11	811	799
Finland	1	97			
	2	109			
	3				
	4				
	Total	206	0	0	0
Germany	1	169			
	2	54			
	3				
	4	2			
	Total	225	0	0	0
Latvia	1	1,048	10	2,248	1,132
	2	1,795	39	4,528	3,900
	3	216	8	1,977	776
	4	1,622	11	2,484	1,115
	Total	4,681	68	11,237	6,923
Lithuania	1	458			
	2	27			
	3	0			
	4	272			
	Total	757	0	0	0
Poland	1	95			
	2	145			
	3				
	4	10			
	Total	249	0	0	0
Russia	1				
	2				
	3				
	4				
	Total	0	0	0	0
Sweden	1	5,664	4	534	532
	2	272	2	415	409
	3	526	4	550	541
	4	1,489	6	601	596
	Total	7,951	16	2,100	2,078
Total	1	7,875	19	3,083	1,962
	2	5,187	41	4,943	4,309
	3	742	16	2,931	1,716
	4	3,606	20	3,244	1,866
	Total	17,410	96	14,201	9,853

continued

Table 6.2.2 continued **Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches of the central Baltic herring stock by quarter and Sub-division for 2014 available to the Working Group.** **5/6**

	Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Sub-division 29	Denmark	1	816	4	130	116
		2	0			
		3	0			
		4	86			
		Total	902	4	130	116
	Estonia	1	1,552	4	163	162
		2	477	9	765	681
		3	30	0	0	0
		4	1,331	2	78	77
		Total	3,390	15	1,006	920
	Finland	1	10,310	4	1,225	224
		2	7,606	9	2,808	361
		3	414			
		4	4,435	4	1,223	207
		Total	22,765	17	5,256	792
	Germany	1	518			
		2				
		3				
		4	6			
		Total	523	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	0.00	0	0	0
	Lithuania	1	144.7			
		2	7.7			
		3	0			
		4	112.2			
		Total	265	0	0	0
	Poland	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Sweden	1	7,008	3	207	205
		2	37			
		3	22			
		4	1,615			
		Total	8,682	3	207	205
	Total	1	20,348	15	1,725	707
		2	8,127	18	3,573	1,042
		3	466	0	0	0
		4	7,585	6	1,301	284
		Total	36,527	39	6,599	2,033

continued

Table 6.2.2 continued Herring in Sub-divisions 25-29, 32 (excl. GOR). Samples of commercial catches of the central Baltic herring stock by quarter and Sub-division for 2014 available to the Working Group. 6/6

	Country	Quarter	Catches in tons	Number of samples	Number of fish meas,	Number of fish aged
Sub-division 32	Denmark	1	14			
		2	0			
		3	0			
		4	0			
		Total	14	0	0	0
	Estonia	1	3,343	11	783	783
		2	1,964	20	1,847	1,847
		3	44	5	264	264
		4	3,405	13	1,178	1,178
		Total	8,756	49	4,072	4,072
	Finland	1	4,384	4	1,228	195
		2	13	6	1,825	151
		3	13	3	909	182
		4	460	3	906	129
		Total	4,870	16	4,868	657
	Latvia	1				
		2				
		3				
		4				
		Total	0	0	0	0
	Russia	1	662	2	922	58
		2	663	17	5,870	295
		3				
		4	1,112	12	5,716	175
		Total	2,437	31	12,508	528
	Sweden	1	0			
		2	0			
		3	0			
		4	260			
		Total	260	0	0	0
	Total	1	8,403	15	2,011	1,036
		2	2,640	26	3,672	2,293
		3	57	8	1,173	446
		4	5,237	28	7,800	1,482
		Total	16,337	77	14,656	5,257
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	**61,065**	**130**	**19,683**	**7,969**
		2	**29,953**	**137**	**19,330**	**10,406**
		3	**11,280**	**80**	**19,788**	**3,551**
		4	**30,400**	**124**	**26,721**	**6,762**
		Total	**132,698**	**471**	**85,522**	**28,688**

Table 6.2.3 Herring in SD 25-29, 32 (excl. GOR). Catch by country and SD and mean weight by SD in 2014.

Catches (1000 t) by country and SD

Country	Total	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
Denmark	2.723	1.549	0.088	0.016	0.153	0.902	0.014
Estonia	15.334	0.000	0.000	0.000	3.188	3.390	8.756
Finland	27.905	0.000	0.000	0.064	0.206	22.765	4.870
Germany	1.731	0.485	0.265	0.233	0.225	0.523	0.000
Latvia*	4.853	0.004	0.168	0.000	4.681	0.000	0.000
Lithuania	2.096	0.031	1.042	0.001	0.758	0.265	0.000
Poland	27.316	17.365	9.687	0.015	0.249	0.000	0.000
Russia	15.854	0.000	13.418	0.000	0.000	0.000	2.436
Sweden	34.888	7.473	4.278	6.244	7.951	8.682	0.260
Total	132.700	26.907	28.945	6.574	17.410	36.526	16.337

*Catches in SD 28.2 include 1 765.3 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	223580	14795	6238	36082	430	104231	61805
1	470062	31815	98981	23633	19475	225710	70446
2	902642	51069	83031	51385	33394	422462	261301
3	1003705	89091	153099	93998	99134	301201	267181
4	385671	56103	71489	10696	40024	128042	79317
5	488077	40966	41068	21737	81597	211263	91445
6	409753	74489	54811	22494	78172	136656	43131
7	285297	57026	49130	11661	73284	72778	21418
8	152679	30682	22542	3313	17450	58125	20567
9	51721	13989	17345	508	13972	5155	752
10+	46359	11627	17686	846	11411	4637	153
Total N	4419546	471653	615421	276352	468343	1670261	917516
CATON	132.700	26.907	28.945	6.574	17.410	36.526	16.337

Mean weight (g)

AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
0	5.5	13.3	11.0	4.6	3.8	4.9	4.5
1	11.8	24.9	13.1	10.3	11.4	10.9	7.7
2	20.1	48.4	36.5	20.0	24.2	16.4	14.9
3	29.4	52.1	47.6	26.5	30.2	23.2	19.1
4	39.0	71.7	61.1	29.8	35.9	24.7	21.6
5	35.0	66.1	57.1	33.2	38.3	28.5	23.6
6	44.6	62.6	59.9	39.7	43.2	35.5	28.1
7	49.2	64.5	63.0	42.4	45.5	37.1	34.3
8	50.9	64.2	69.1	46.1	51.2	44.0	31.5
9	59.5	64.5	74.2	43.7	45.9	38.5	37.3
10+	65.0	74.1	75.2	50.4	51.7	38.9	43.0

CATON is given in 1000 tons

Table 6.2.4 Herring in SD 25-29, 32 (excl. GOR). **1/2**

Catch in number at age per SD and quarter in 2014.

Catch in numbers (millions)

Quarter: 1							
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	159.767	17.926	13.263	1.353	13.477	69.901	43.846
2	463.891	21.950	35.944	10.490	6.906	255.326	133.275
3	529.740	24.470	86.789	48.895	29.360	212.778	127.449
4	207.068	15.638	49.664	4.568	12.959	89.127	35.111
5	256.867	9.967	15.837	10.997	33.822	127.599	58.645
6	212.061	25.184	23.489	13.027	42.962	78.175	29.223
7	142.521	17.183	18.090	8.459	35.431	45.762	17.596
8	79.731	11.670	9.265	2.030	11.772	25.321	19.674
9	20.506	5.657	6.188	0.508	5.202	2.646	0.306
10+	19.368	4.185	8.708	0.846	3.178	2.299	0.153
Total N	2091.520	153.829	267.236	101.174	195.070	908.932	465.278
CATON	**61.8**	**7.9**	**14.1**	**3.2**	**7.9**	**20.3**	**8.4**

Quarter: 2							
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	129.340	0.794	65.752	18.699	4.054	29.976	10.064
2	178.672	11.486	31.834	29.189	15.704	57.284	33.174
3	233.556	24.631	31.883	31.469	39.911	52.634	53.028
4	84.903	17.654	9.353	3.649	13.460	22.344	18.444
5	130.833	11.758	3.592	7.297	27.617	62.667	17.901
6	104.139	15.760	4.809	5.473	18.784	50.090	9.222
7	67.699	12.647	5.252	1.824	26.169	18.761	3.046
8	44.564	9.407	3.452	0.456	2.632	28.204	0.413
9	16.323	5.726	2.336	0.000	6.988	0.825	0.447
10+	11.625	2.895	1.894	0.000	6.067	0.768	0.000
Total N	1001.653	112.759	160.159	98.057	161.386	323.554	145.738
CATON	**30.1**	**7.3**	**5.2**	**1.8**	**5.1**	**8.1**	**2.6**

Quarter: 3							
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	23.608	0.000	2.473	1.992	0.000	18.604	0.540
1	31.950	2.005	14.218	0.198	0.144	14.907	0.479
2	19.640	4.245	8.403	0.646	2.091	3.177	1.078
3	41.524	20.517	11.910	0.753	5.993	1.592	0.759
4	20.470	10.848	4.438	0.137	3.980	0.830	0.238
5	21.857	11.084	6.371	0.190	3.692	0.311	0.208
6	28.859	16.744	8.585	0.220	2.653	0.559	0.097
7	27.893	15.329	10.946	0.076	1.040	0.474	0.028
8	11.160	4.952	5.385	0.046	0.287	0.477	0.013
9	5.771	1.887	3.772	0.000	0.072	0.040	0.000
10+	6.725	3.101	3.517	0.000	0.108	0.000	0.000
Total N	239.456	90.711	80.018	4.258	20.059	40.971	3.440
CATON	**10.5**	**5.3**	**3.9**	**0.1**	**0.7**	**0.5**	**0.1**

Quarter: 4							
AGE	**Sum**	**SD 25**	**SD 26**	**SD 27**	**SD 28.2**	**SD 29**	**SD 32**
O	199.972	14.795	3.765	34.090	0.430	85.628	61.265
1	149.006	11.090	5.749	3.383	1.801	110.926	16.057
2	240.440	13.388	6.849	11.060	8.693	106.675	93.774
3	198.885	19.473	22.517	12.881	23.870	34.197	85.946
4	73.229	11.963	8.034	2.342	9.625	15.741	25.525
5	78.520	8.157	15.268	3.253	16.465	20.687	14.691
6	64.694	16.801	17.928	3.773	13.773	7.832	4.588
7	47.184	11.868	14.842	1.301	10.644	7.781	0.748
8	17.223	4.654	4.440	0.781	2.759	4.123	0.466
9	9.121	0.719	5.049	0.000	1.710	1.644	0.000
10+	8.641	1.446	3.568	0.000	2.058	1.570	0.000
Total N	1086.916	99.559	104.243	38.774	91.397	311.177	241.795
CATON	**30.3**	**6.5**	**5.8**	**1.5**	**3.7**	**7.6**	**5.3**

CATON in 1000 tons

Table 6.2.4 continued **Herring in SD 25-29, 32 (excl. GOR).** **2/2**

Mean weight at age per SD and quarter in 2014.

Mean weight (g)

Quarter: 1							
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	7.2	12.8	10.6	10.5	9.9	5.4	5.7
2	17.1	39.4	36.0	20.1	29.5	14.3	12.7
3	28.3	47.3	48.9	28.4	32.5	23.1	18.2
4	37.2	67.0	63.0	30.8	38.5	24.2	20.6
5	32.7	60.9	65.8	34.7	40.8	28.6	22.9
6	42.7	59.0	62.4	40.5	44.9	36.1	28.1
7	45.8	61.1	61.8	43.6	49.1	36.1	34.1
8	46.3	65.9	68.7	48.8	52.3	37.5	31.5
9	58.4	66.6	69.6	43.7	48.8	38.9	34.8
10+	62.8	70.8	70.9	50.4	54.8	34.3	43.0

Quarter: 2							
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	7.9	31.5	9.7	7.7	6.1	4.6	4.9
2	20.4	47.3	35.1	16.6	17.5	13.9	12.9
3	27.4	52.5	45.2	20.4	24.8	20.4	18.0
4	39.7	79.1	61.9	23.9	30.6	22.9	20.9
5	33.2	78.3	58.8	27.3	33.1	26.5	24.1
6	40.3	66.0	62.7	32.1	37.4	34.3	28.2
7	46.4	65.9	65.9	32.5	40.3	39.8	32.6
8	54.5	68.0	67.0	20.0	47.0	50.0	32.6
9	53.6	62.2	74.2	0.0	42.3	38.7	39.1
10+	61.5	80.2	78.4	0.0	49.2	46.0	0.0

Quarter: 3							
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	3.7	0.0	7.8	4.6	0.0	3.0	4.7
1	21.9	48.0	24.2	23.7	33.0	16.2	15.7
2	37.6	63.7	36.1	28.5	29.9	20.4	17.7
3	43.2	48.6	43.5	33.9	33.4	22.6	20.2
4	55.1	65.6	55.7	36.6	36.0	19.3	21.5
5	50.5	53.8	54.4	41.0	38.2	26.1	23.3
6	56.9	58.8	59.6	47.6	44.7	24.9	22.3
7	62.5	64.5	62.8	47.9	47.3	28.1	23.1
8	59.9	55.6	66.8	53.8	51.1	32.8	26.9
9	67.8	57.9	73.4	0.0	51.9	30.6	0.0
10+	75.9	75.8	76.8	0.0	50.7	0.0	0.0

Quarter: 4							
AGE	Mean	SD 25	SD 26	SD 27	SD 28.2	SD 29	SD 32
O	3.7	0.0	7.8	4.6	0.0	3.0	4.7
1	21.9	48.0	24.2	23.7	33.0	16.2	15.7
2	37.6	63.7	36.1	28.5	29.9	20.4	17.7
3	43.2	48.6	43.5	33.9	33.4	22.6	20.2
4	55.1	65.6	55.7	36.6	36.0	19.3	21.5
5	50.5	53.8	54.4	41.0	38.2	26.1	23.3
6	56.9	58.8	59.6	47.6	44.7	24.9	22.3
7	62.5	64.5	62.8	47.9	47.3	28.1	23.1
8	59.9	55.6	66.8	53.8	51.1	32.8	26.9
9	67.8	57.9	73.4	0.0	51.9	30.6	0.0
10+	75.9	75.8	76.8	0.0	50.7	0.0	0.0

Table 6.2.5 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

Table 6.2.6 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

Table 6.2.7 Herring in SD 25-29, 32 (excl. GOR).

XSA input: Natural Mortality

NATMOR: Natural Mortality (Total International Catch) (Total)

(1971-2011 based on latest MSVPA/SMS-data provided by WGSAM 2012)

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	0.3346	0.3306	0.3279	0.3279	0.3249	0.3202	0.3036	0.3120
*2013	0.3346	0.3306	0.3279	0.3279	0.3249	0.3202	0.3036	0.3120
*2014	0.3346	0.3306	0.3279	0.3279	0.3249	0.3202	0.3036	0.312

Table 6.2.8 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+
1974-2014	0.0	0.7	0.9	1.0	1.0	1.0	1.0	1.0

Table 6.2.9 Herring in SD 25-29, 32 (excl. GOR).

SA 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+
1974-2014	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Table 6.2.10 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+
1974-2014	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35

Table 6.2.11 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	2342	5669	11000	12685	5533	3263	1452	2246
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

*not used due to incomplete coverage

**Data for 2008, 2010 and 2011 include small revisions (WGBFAS 2014)

Table 6.2.12 Herring in SD 25-29, 32 (excl. GOR). Output from XSA Final Run: Diagnostics 1/3

Lowestoft VPA Version 3.1
19/04/2015 13:53
Extended Survivors Analysis
Herring in Sub-div. 25 to 29 and 32 (excl. Gulf of Riga)
CPUE data from file BIAS_SD 25-27-28.2-29s-n_91-14.tun

Catch data for 41 years. 1974 to 2014. Ages 1 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BIAS SD25-27&28.2&29S&N	1991	2014	1	7	0.8	0.9

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 >= 6

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 = 1.500
Minimum standard error for population
estimates derived from each fleet = .300
Prior weighting not applied

Tuning converged after 78 iterations

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.042	0.059	0.037	0.032	0.036	0.042	0.037	0.014	0.026	0.035
2	0.088	0.089	0.094	0.082	0.079	0.05	0.064	0.059	0.041	0.074
3	0.126	0.126	0.162	0.144	0.122	0.114	0.088	0.069	0.072	0.092
4	0.198	0.174	0.175	0.182	0.198	0.168	0.149	0.089	0.103	0.166
5	0.215	0.23	0.201	0.187	0.188	0.243	0.171	0.136	0.124	0.198
6	0.175	0.239	0.244	0.285	0.208	0.3	0.206	0.157	0.135	0.175
7	0.187	0.186	0.192	0.246	0.349	0.293	0.242	0.175	0.188	0.15

XSA population numbers (Thousands)

YEAR	1	2	3	4	5	6	7
2005	9.00E+06	1.02E+07	1.14E+07	3.50E+06	2.20E+06	1.53E+06	5.41E+05
2006	1.61E+07	6.72E+06	7.24E+06	7.83E+06	2.25E+06	1.40E+06	1.03E+06
2007	1.44E+07	1.17E+07	4.79E+06	4.97E+06	5.12E+06	1.39E+06	8.74E+05
2008	2.86E+07	1.07E+07	8.25E+06	3.16E+06	3.24E+06	3.26E+06	8.62E+05
2009	2.16E+07	2.11E+07	7.52E+06	5.50E+06	2.02E+06	2.07E+06	1.90E+06
2010	1.56E+07	1.55E+07	1.46E+07	4.99E+06	3.39E+06	1.27E+06	1.29E+06
2011	9.50E+06	1.09E+07	1.08E+07	9.60E+06	3.10E+06	1.97E+06	6.98E+05
2012	2.76E+07	6.55E+06	7.32E+06	7.14E+06	5.95E+06	1.89E+06	1.16E+06
2013	2.15E+07	1.94E+07	4.44E+06	4.92E+06	4.71E+06	3.76E+06	1.17E+06
2014	1.62E+07	1.50E+07	1.34E+07	2.98E+06	3.20E+06	3.00E+06	2.38E+06

Estimated population abundance at 1st Jan 2015

0.00E+00	1.12E+07	1.00E+07	8.81E+06	1.82E+06	1.90E+06	1.83E+06

Taper weighted geometric mean of the VPA populations:

1.63E+07	1.15E+07	7.57E+06	4.66E+06	2.97E+06	1.75E+06	9.64E+05

Standard error of the weighted Log(VPA populations) :

0.3777	0.3994	0.4179	0.4048	0.4246	0.4751	0.4898

Table 6.2.12 continued Herring in SD 25-29, 32 (excl. GOR). Output from XSA Final Run: Diagnostics 2/3

Log catchability residuals.

Fleet : Baltic International Acoustic Survey (BIAS)

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	99.99	99.99	99.99	99.99	99.99	-0.25	99.99	-0.07	-0.13	0.53
2	99.99	99.99	99.99	99.99	99.99	0.37	99.99	-0.70	-0.24	-0.31
3	99.99	99.99	99.99	99.99	99.99	0.14	99.99	-0.15	-0.32	0.56
4	99.99	99.99	99.99	99.99	99.99	0.17	99.99	-0.15	-0.28	0.44
5	99.99	99.99	99.99	99.99	99.99	0.22	99.99	-0.57	-0.20	0.53
6	99.99	99.99	99.99	99.99	99.99	0.10	99.99	-0.10	-0.64	0.38
7	99.99	99.99	99.99	99.99	99.99	-0.16	99.99	-0.07	-0.03	0.58

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.17	-0.08	0.51	0.09	-0.17	0.22	0.10	-0.41	-0.16	-0.18
2	0.30	-0.13	0.63	0.23	0.21	0.60	-0.15	-0.02	-0.11	-0.20
3	-0.12	0.07	0.67	0.20	0.21	0.48	-0.52	-0.14	-0.15	-0.24
4	0.15	-0.08	0.25	-0.03	0.37	0.63	-0.53	-0.21	-0.30	-0.31
5	-0.20	-0.02	0.06	-0.43	0.21	0.73	-0.15	-0.06	-0.44	-0.35
6	-0.17	-0.21	0.29	-0.19	-0.01	0.33	-0.25	-0.31	-0.09	-0.07
7	-0.18	-0.01	0.17	-0.26	0.20	0.01	-0.48	-0.42	-0.23	0.02

Age	2011	2012	2013	2014
1	-0.03	0.21	-0.09	-0.02
2	-0.19	-0.13	-0.31	0.08
3	-0.03	-0.03	-0.20	0.09
4	-0.03	-0.10	-0.01	0.39
5	0.14	-0.03	-0.06	0.42
6	0.10	-0.10	0.19	0.36
7	0.34	0.22	0.17	0.26

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	-7.0346	-6.5056	-6.1888	-6.0515	-6.0507	-6.0507
S.E(Log q)	0.2946	0.3041	0.3263	0.3401	0.2440	0.2812

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	0.72	1.462	10.25	0.73	18	0.24	-7.73

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 Log q
2	1.35	-1.179	3.85	0.54	18	0.39	-7.03
3	0.96	0.172	6.86	0.67	18	0.31	-6.51
4	1.10	-0.350	5.3	0.57	18	0.37	-6.19
5	1.06	-0.238	5.49	0.58	18	0.38	-6.05
6	0.91	0.648	6.83	0.83	18	0.23	-6.05
7	0.96	0.241	6.36	0.77	18	0.28	-6.04

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BIAS	11038170	0.3	0	0	1	0.615	0.035
P shrinkage mean	11457380	0.4				0.359	0.034
F shrinkage mean	12533140	1.5				0.025	0.031

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
11223290	0.24	0.02	3	0.09	0.035

Table 6.2.12 continued Herring in SD 25-29, 32 (excl. GOR). Output from XSA Final Run: Diagnostics 3/3

Age 2 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
BIAS	9959757	0.214	0.081	0.380	2	0.978	0.074
F shrinkage mean	12634610	1.5				0.022	0.059

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10011580	0.21	0.06	3	0.291	0.074

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BIAS	8813738	0.178	0.159	0.890	3	0.984	0.092
F shrinkage mean	8685217	1.5				0.016	0.094

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8811711	0.18	0.13	4	0.730	0.092

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2010

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BIAS	1812651	0.158	0.130	0.820	4	0.986	0.166
F shrinkage mean	2134851	1.5				0.014	0.143

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1816848	0.16	0.11	5	0.715	0.166

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BIAS	1892697	0.145	0.111	0.770	5	0.987	0.198
F shrinkage mean	2182423	1.5				0.013	0.174

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1896244	0.14	0.1	6	0.685	0.198

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BIAS	1834645	0.132	0.092	0.700	6	0.989	0.174
F shrinkage mean	1549994	1.5				0.011	0.203

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1831207	0.13	0.08	7	0.640	0.175

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6
Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
BIAS	1517934	0.124	0.090	0.730	7	0.99	0.15
F shrinkage mean	1237374	1.5				0.01	0.181

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1514708	0.12	0.08	8	0.674	0.15

Table 6.2.13 **Herring in SD 25-29, 32 (excl. GOR).**

Fishing Mortality (F) at age.

Run title : Herring SD 25-29, 32 (excl. GOR)
Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Age 1	0.1715	0.1810	0.0973	0.1176	0.0856	0.0407	0.0737	0.0551	0.0391	0.0436	0.0347
Age 2	0.1270	0.1386	0.1772	0.1289	0.1933	0.1565	0.1550	0.1938	0.1635	0.1330	0.1138
Age 3	0.1708	0.1783	0.1824	0.1954	0.1737	0.2067	0.2072	0.2016	0.1813	0.2435	0.1724
Age 4	0.2264	0.2010	0.1786	0.1645	0.1719	0.2016	0.1923	0.2213	0.1658	0.2437	0.2656
Age 5	0.1685	0.2311	0.1770	0.1867	0.1435	0.2066	0.1799	0.1970	0.1827	0.1839	0.2554
Age 6	0.1724	0.1911	0.2361	0.2085	0.1688	0.1669	0.1699	0.1920	0.1665	0.2264	0.2023
Age 7	0.1900	0.2089	0.1983	0.1876	0.1621	0.1927	0.1815	0.2044	0.1726	0.2192	0.2424
Age 8+	0.1900	0.2089	0.1983	0.1876	0.1621	0.1927	0.1815	0.2044	0.1726	0.2192	0.2424
FBAR 3-6	**0.1845**	**0.2004**	**0.1935**	**0.1888**	**0.1645**	**0.1955**	**0.1873**	**0.2030**	**0.1741**	**0.2244**	**0.2239**

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age 1	0.0672	0.0585	0.0529	0.0610	0.0672	0.0399	0.0293	0.0738	0.0595	0.0362	0.0483
Age 2	0.1414	0.1469	0.1140	0.1839	0.1011	0.1481	0.1365	0.1230	0.1781	0.1146	0.0981
Age 3	0.1688	0.1716	0.1952	0.1789	0.2957	0.1624	0.2473	0.2225	0.2478	0.2358	0.2723
Age 4	0.1912	0.2127	0.2141	0.2196	0.2220	0.3298	0.2176	0.2140	0.3197	0.2943	0.4137
Age 5	0.2819	0.2175	0.2509	0.2416	0.3075	0.2629	0.3887	0.2123	0.3045	0.4211	0.3061
Age 6	0.2782	0.2086	0.2641	0.2377	0.3388	0.3506	0.2887	0.3723	0.2861	0.4483	0.3256
Age 7	0.2520	0.2141	0.2444	0.2343	0.2913	0.3167	0.3003	0.2677	0.3054	0.3910	0.3512
Age 8+	0.2520	0.2141	0.2444	0.2343	0.2913	0.3167	0.3003	0.2677	0.3054	0.3910	0.3512
FBAR 3-6	**0.2300**	**0.2026**	**0.2311**	**0.2194**	**0.2910**	**0.2764**	**0.2856**	**0.2553**	**0.2895**	**0.3499**	**0.3294**

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age 1	0.0695	0.0657	0.1481	0.0891	0.1423	0.1107	0.1138	0.0724	0.0557	0.0419	0.0590
Age 2	0.1181	0.1354	0.1645	0.2042	0.2014	0.2341	0.1592	0.1252	0.0924	0.0878	0.0891
Age 3	0.1634	0.2159	0.2898	0.2658	0.3562	0.2068	0.2720	0.1639	0.1577	0.1257	0.1255
Age 4	0.3277	0.2795	0.3839	0.3790	0.4198	0.4060	0.2547	0.2298	0.2066	0.1979	0.1742
Age 5	0.4088	0.4607	0.3393	0.3914	0.5035	0.3705	0.4087	0.2388	0.2016	0.2151	0.2303
Age 6	0.4274	0.5087	0.5108	0.2464	0.4643	0.4807	0.3225	0.3290	0.2373	0.1751	0.2387
Age 7	0.4081	0.4127	0.4544	0.4030	0.2267	0.5216	0.4216	0.2769	0.2987	0.1873	0.1857
Age 8+	0.4081	0.4127	0.4544	0.4030	0.2267	0.5216	0.4216	0.2769	0.2987	0.1873	0.1857
FBAR 3-6	**0.3318**	**0.3662**	**0.3809**	**0.3207**	**0.4360**	**0.3660**	**0.3145**	**0.2404**	**0.2008**	**0.1785**	**0.1922**

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	FBAR 12-14
Age 1	0.0369	0.0321	0.0356	0.0420	0.0372	0.0144	0.0262	0.0348	0.0251
Age 2	0.0937	0.0820	0.0793	0.0498	0.0638	0.0588	0.0406	0.0736	0.0577
Age 3	0.1619	0.1436	0.1217	0.1145	0.0876	0.0694	0.0715	0.0923	0.0777
Age 4	0.1750	0.1822	0.1976	0.1680	0.1494	0.0893	0.1035	0.1657	0.1195
Age 5	0.2012	0.1871	0.1885	0.2432	0.1714	0.1356	0.1243	0.1979	0.1526
Age 6	0.2445	0.2849	0.2080	0.3004	0.2063	0.1574	0.1348	0.1745	0.1556
Age 7	0.1925	0.2460	0.3494	0.2926	0.2418	0.1753	0.1885	0.1500	0.1713
Age 8+	0.1925	0.2460	0.3494	0.2926	0.2418	0.1753	0.1885	0.1500	
FBAR 3-6	**0.1956**	**0.1995**	**0.1790**	**0.2065**	**0.1537**	**0.1129**	**0.1085**	**0.1576**	

Table 6.2.14 Herring in SD 25-29, 32 (excl. GOR). Stock number at age (Number*10-4)**

Table 10 Stock number at age (start of year) Numbers*10-4**

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Age 1	1811034	1332616	2635049	1339485	1569424	1284673	1870095	3116438	2905897	2209173	2939265
Age 2	1508649	1111477	792139	1754150	854281	946263	772063	1056905	1859745	1690850	1318522
Age 3	789275	990117	706895	498370	1142227	526712	615297	442734	582891	1040990	962906
Age 4	745607	515449	626186	453558	313514	718202	337783	360241	256071	341661	567275
Age 5	347487	473328	329546	411021	300792	205325	458894	219570	213459	158242	191800
Age 6	242867	235973	298599	219503	268861	203314	130537	287986	138160	136259	101198
Age 7	398020	162970	153238	186468	139301	178967	136831	88216	178735	92198	86031
Age 8+	181574	319928	303284	352801	354908	302364	365999	314646	293002	243871	215914
TOTAL	**6024514**	**5141859**	**5844935**	**5215357**	**4943309**	**4365819**	**4687499**	**5886737**	**6427960**	**5913245**	**6382911**

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age 1	2282463	1148369	2093105	934337	1412105	1877346	1457292	1765474	1621256	1553062	1974654
Age 2	1910322	1485799	776553	1445067	645757	986303	1387923	1109551	1285813	1191187	1165372
Age 3	811131	1179873	935211	521685	892495	442125	659053	953712	772818	839650	827308
Age 4	573421	500135	736676	584100	332709	503033	293231	408256	607114	473426	518778
Age 5	326041	357666	309816	451497	360300	204293	281207	188567	263365	346977	276699
Age 6	111369	191711	222425	187910	272456	205802	123832	151658	123077	154080	179068
Age 7	65924	66571	122418	136195	117707	153021	114535	74560	83867	74019	77962
Age 8+	171448	119541	98855	111240	147199	125416	101628	102646	58775	97060	79537
TOTAL	**6252118**	**5049664**	**5295059**	**4372031**	**4180727**	**4497338**	**4418701**	**4754424**	**4816085**	**4729461**	**5099379**

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Age 1	1661644	980785	1550294	844589	1588880	1144812	1101874	2178862	1369269	899914	1605160
Age 2	1463052	1211603	711239	1029640	589000	1053665	788121	749955	1590818	1015101	672404
Age 3	822164	1016868	819498	465418	640014	368647	642006	512573	519914	1136844	724445
Age 4	492049	546140	635430	473090	272381	344767	231374	375671	342640	350410	783202
Age 5	268612	277662	320917	334741	248685	137689	177309	138334	236660	219907	225426
Age 6	159542	139968	136465	177280	173785	116066	73875	90874	86114	153224	140234
Age 7	101255	81812	65570	63797	106997	84353	55941	41679	51842	54121	102504
Age 8+	74232	61657	56715	40633	102566	54813	74738	92980	55824	103397	96896
TOTAL	**5042550**	**4316495**	**4296128**	**3429189**	**3722307**	**3304812**	**3145239**	**4180927**	**4253082**	**3932919**	**4350271**

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	GMST 74-12	AMST 74-12
Age 1	1441984	2861691	2164567	1559047	949910	2756405	2151493	1623851	0	1636597	1738264
Age 2	1168482	1068393	2114512	1553341	1086542	654983	1944350	1499873	1122329	1107495	1168604
Age 3	478800	825329	752346	1462752	1082143	732451	443729	1341423	1001158	734660	772710
Age 4	497391	315892	549852	498853	959760	714190	492319	297606	881171	464188	491013
Age 5	512164	323890	202488	339310	310258	595487	470582	319824	181685	279038	296037
Age 6	139384	326355	207444	126838	196899	188872	375725	300307	189624	164703	174868
Age 7	87394	86197	189556	128680	69835	116300	117148	238389	183120	100769	112195
Age 8+	70830	110859	91632	163292	126715	150181	151165	208748	282986		
TOTAL	**4396428**	**5918606**	**6272396**	**5832114**	**4782061**	**5908867**	**6146511**	**5830023**	**3842074**		

Table 6.2.15 Herring in SD 25-29, 32 (excl. GOR). Output from XSA:

Stock Summary.

Run title : Herring in Sub-div. 25 to 29 and 32 (excl. Gulf of Riga)

At 19/04/2015 13:56

Table 16 Summary (without SOP correction)

Year	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 6
1974	18110344	2658823	1682419	368652	0.2191	0.1845
1975	13326159	2382457	1575258	354851	0.2253	0.2004
1976	26350490	2295132	1366761	305420	0.2235	0.1935
1977	13394848	2317294	1518769	301952	0.1988	0.1888
1978	15694237	2238279	1441083	278966	0.1936	0.1645
1979	12846729	2076897	1408854	278182	0.1975	0.1955
1980	18700946	2139560	1357466	270282	0.1991	0.1873
1981	31164382	2452730	1286459	293615	0.2282	0.2030
1982	29058970	2555045	1428073	273134	0.1913	0.1741
1983	22091726	2281829	1405746	307601	0.2188	0.2244
1984	29392650	2183633	1318511	277926	0.2108	0.2239
1985	22824632	2010713	1265959	275760	0.2178	0.2300
1986	11483686	1751130	1201430	240516	0.2002	0.2026
1987	20931046	1760119	1146207	248653	0.2169	0.2311
1988	9343368	1663918	1149349	255734	0.2225	0.2194
1989	14121048	1626175	1011683	275501	0.2723	0.2910
1990	18773456	1470228	868697	228572	0.2631	0.2764
1991	14572920	1366488	779047	197676	0.2537	0.2856
1992	17654740	1257973	798752	189781	0.2376	0.2553
1993	16212562	1199951	749694	209094	0.2789	0.2895
1994	15530618	1246765	756137	218260	0.2887	0.3499
1995	19746536	1096310	661870	188181	0.2843	0.3294
1996	16616435	992626	607154	162578	0.2678	0.3318
1997	9807850	871708	571598	160002	0.2799	0.3662
1998	15502938	842435	520056	185780	0.3572	0.3809
1999	8445892	702922	442120	145922	0.3301	0.3207
2000	15888799	815398	451656	175646	0.3889	0.4360
2001	11448120	723444	405680	148404	0.3658	0.3660
2002	11018742	719408	422897	129222	0.3056	0.3145
2003	21788620	838543	489399	113584	0.2321	0.2404
2004	13692690	769959	499874	93006	0.1861	0.2008
2005	8999142	814640	561197	91592	0.1632	0.1785
2006	16051599	968459	624152	110372	0.1768	0.1922
2007	14419835	1014096	655926	116030	0.1769	0.1956
2008	28616912	1247514	674088	126155	0.1871	0.1995
2009	21645668	1295635	786991	134127	0.1704	0.1790
2010	15590471	1302239	857453	136706	0.1594	0.2065
2011	9499102	1209225	859512	116785	0.1359	0.1537
2012	27564046	1497183	898035	100893	0.1123	0.1129
2013	21514928	1488465	956055	100954	0.1056	0.1085
2014	16238513	1482135	1007528	132700	0.1317	0.1576
Arith. Mean	17455522	1503109	938283	202897	0.2262	0.2376
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 6.2.16 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	8
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	1	1	1	1	1	1	1
2	2	2	2	2 2	2	2	

Stock recruitment model code (**0=RW**, 1=Ricker, 2=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 6.2.17 Herring in SD 25-29, 32 (excl. GOR). Input for RCT3 analysis.

Yearclass	VPA Age 1 (millions)	Acoustic (SD 25-29S+N) Age 0 (millions)
1991	17,655	13,733
1992	16,213	1,608
1993	15,531	-11
1994	19,747	6,122
1995	16,616	-11
1996	9,808	336
1997	15,503	-11
1998	8,446	508
1999	15,889	2,591
2000	11,448	1,319
2001	11,019	2,123
2002	21,789	16,046
2003	13,693	9,067
2004	8,999	1,587
2005	16,052	5,568
2006	14,420	1,990
2007	28,617	12,197
2008	21,646	8,673
2009	15,590	3,366
2010	9,499	1,178
2011	27,564	10,100
2012	21,515	11,141
2013	-11	3,068
2014	-11	35,061

Table 6.2.18 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 24 years: 1991 - 2014
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 2008

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.38	6.49	0.26	0.691	14	9.07	9.96	0.318	0.548
					VPA	Mean =	9.57	0.35	0.452

Yearclass 2009

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.39	6.41	0.25	0.714	15	8.12	9.59	0.293	0.602
					VPA	Mean =	9.61	0.36	0.398

Yearclass = 2010

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.40	6.33	0.24	0.713	16	7.07	9.17	0.293	0.588
					VPA	Mean =	9.62	0.349	0.412

Yearclass = 2011

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.41	6.25	0.23	0.743	17	9.22	10.04	0.278	0.631
					VPA	Mean =	9.59	0.363	0.369

Yearclass = 2012

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.45	5.95	0.24	0.758	18	9.32	10.13	0.286	0.656
					VPA	Mean =	9.65	0.395	0.344

Yearclass = 2013

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.45	5.94	0.22	0.776	19	8.03	9.53	0.257	0.7
					VPA	Mean =	9.68	0.393	0.3

Yearclass = 2014

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index value	Predicted value	Std Error	WAP Weights
BIAS	0.46	5.84	0.22	0.783	19	10.46	10.64	0.303	0.630
					VPA	Mean =	9.70	0.396	0.370

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2008	17767	9.79	0.24	0.19	0.66	21646	9.98
2009	14754	9.60	0.23	0.01	0	15591	9.65
2010	11555	9.35	0.22	0.22	0.97	9500	9.16
2011	19353	9.87	0.22	0.22	0.96	27565	10.22
2012	21201	9.96	0.23	0.23	0.97	21515	9.98
2013	14449	9.58	0.22	0.07	0.10		
2014	29548	10.29	0.24	0.46	3.57		

Table 6.2.19 Herring in SD 25-29, 32 (excl. GOR). Input data for short-term predictions.

MFDP version 1a
Run: WGBFAS 2015_TAC
Time and date: 10:37 20/04/2015
Fbar age range: 3-6

2015

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	29548000	0.3346	0	0.35	0.3	0.0127	0.0251	0.0127
2	11223290	0.3306	0.7	0.35	0.3	0.0234	0.0577	0.0234
3	10011580	0.3279	0.9	0.35	0.3	0.0304	0.0777	0.0304
4	8811710	0.3279	1	0.35	0.3	0.0348	0.1195	0.0348
5	1816850	0.3249	1	0.35	0.3	0.0384	0.1526	0.0384
6	1896240	0.3202	1	0.35	0.3	0.0461	0.1556	0.0461
7	1831200	0.3036	1	0.35	0.3	0.0503	0.1713	0.0503
8	2829860	0.3120	1	0.35	0.3	0.0572	0.1713	0.0572

2016

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	15110164	0.3346	0	0.35	0.3	0.0127	0.0251	0.0127
2		0.3306	0.7	0.35	0.3	0.0234	0.0577	0.0234
3		0.3279	0.9	0.35	0.3	0.0304	0.0777	0.0304
4		0.3279	1	0.35	0.3	0.0348	0.1195	0.0348
5		0.3249	1	0.35	0.3	0.0384	0.1526	0.0384
6		0.3202	1	0.35	0.3	0.0461	0.1556	0.0461
7		0.3036	1	0.35	0.3	0.0503	0.1713	0.0503
8		0.3120	1	0.35	0.3	0.0572	0.1713	0.0572

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	15110164	0.3346	0	0.35	0.3	0.0127	0.0251	0.0127
2		0.3306	0.7	0.35	0.3	0.0234	0.0577	0.0234
3		0.3279	0.9	0.35	0.3	0.0304	0.0777	0.0304
4		0.3279	1	0.35	0.3	0.0348	0.1195	0.0348
5		0.3249	1	0.35	0.3	0.0384	0.1526	0.0384
6		0.3202	1	0.35	0.3	0.0461	0.1556	0.0461
7		0.3036	1	0.35	0.3	0.0503	0.1713	0.0503
8		0.3120	1	0.35	0.3	0.0572	0.1713	0.0572

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_{2015} Age 1:	Output form RCT3 Analysis (Table 6.2.17)
N_{2015} Age 2-8+:	Output from VPA (Table 6.2.14)
$N_{2016/2017}$ Age 1:	Geometric Mean from VPA-Output of age 1 (Table 6.2.15) for the years 1988-2013
Natural Mortality (M):	2015, 2016, 2017 = 2011 (last updated value from SMS (WGSAM 2012))
Weight in the Catch/Stock (CWt/SWt)	Average for 2012-2014
Expoitation pattern (Sel):	Average for 2012-2014

Table 6.2.20 **Herring in SD 25-29, 32 (excl. GOR).**

Output from short-term predictions with

management option table for *'TAC constraint' in 2015.

MFDP version 1a
Run: WGBFAS 2015_TAC
Herring in Sd 25-32 (excl. GOR).
Time and date: 10:37 20/04/2015
Fbar age range: 3-6

2015

Biomass	SSB	FMult	FBar	Landings
1659163	1000071	1.6001	0.2022	190831

2016					2017	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1563688	1095239	0	0	0	1615701	1183115
	1088442	0.1	0.0202	20178	1595680	1158103
	1081694	0.2	0.0404	39990	1576029	1133737
	1074995	0.3	0.0607	59445	1556740	1109999
	1068343	0.4	0.0809	78550	1537805	1086870
	1061740	0.5	0.1011	97312	1519217	1064333
	1055183	0.6	0.1213	115739	1500968	1042371
	1048674	0.7	0.1415	133838	1483052	1020967
	1042211	0.8	0.1617	151616	1465460	1000104
	1035794	0.9	0.1820	169078	1448187	979768
	1029423	1.0	0.2022	186233	1431224	959942
	1023098	1.1	0.2224	203086	1414567	940613
	1016818	1.2	0.2426	219644	1398207	921766
	1010582	1.3	0.2628	235913	1382140	903388
	1004391	1.4	0.2830	251899	1366358	885464
	998244	1.5	0.3033	267608	1350857	867982
	992140	1.6	0.3235	283045	1335629	850930
	986080	1.7	0.3437	298217	1320669	834296
	980063	1.8	0.3639	313128	1305972	818067
	974089	1.9	0.3841	327784	1291532	802232
	968157	2.0	0.4043	342190	1277344	786780

Input units are thousands and kg - output in tonnes

*'TAC constraint' in 2015:		
EU	163,451	t
+ EU/Russia	22,900	t
+ CBH in GOR	4,700	t (= mean catches 09-13)
- GORH	220	t (= mean catches 09-13)
Total	190,831	t

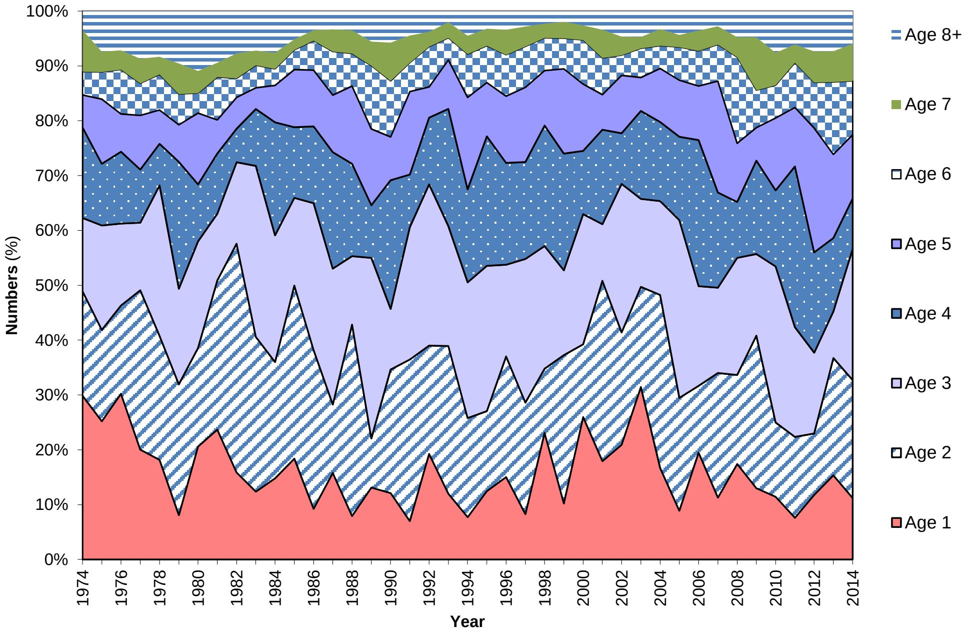

Figure 6.2.1 **Herring in SD 25-29, 32 (excl. GOR).**

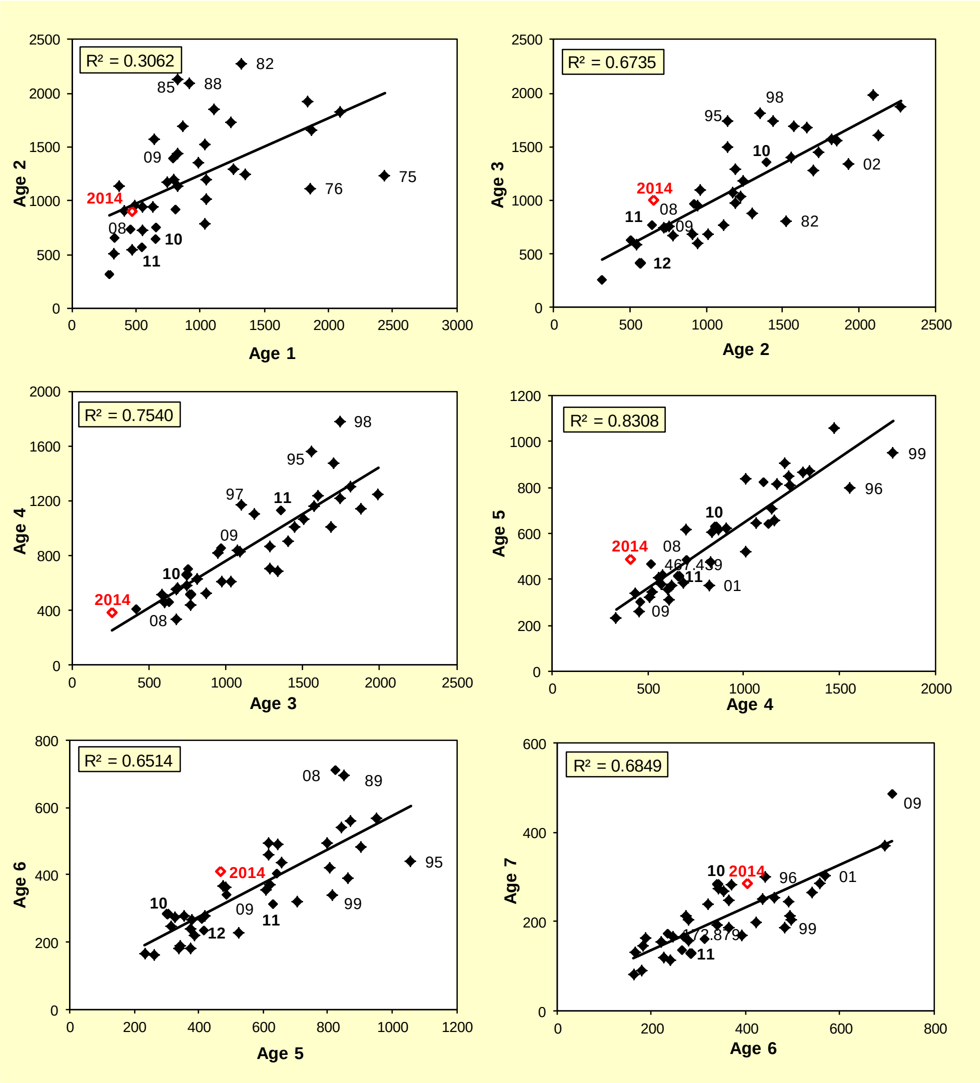

Figure 6.2.2 Herring in SD 25-29, 32 (excl. GOR). Catch in numbers (thousands) at age vs numbers at age +1 of the same cohort in the following year in the period 1974-2014.

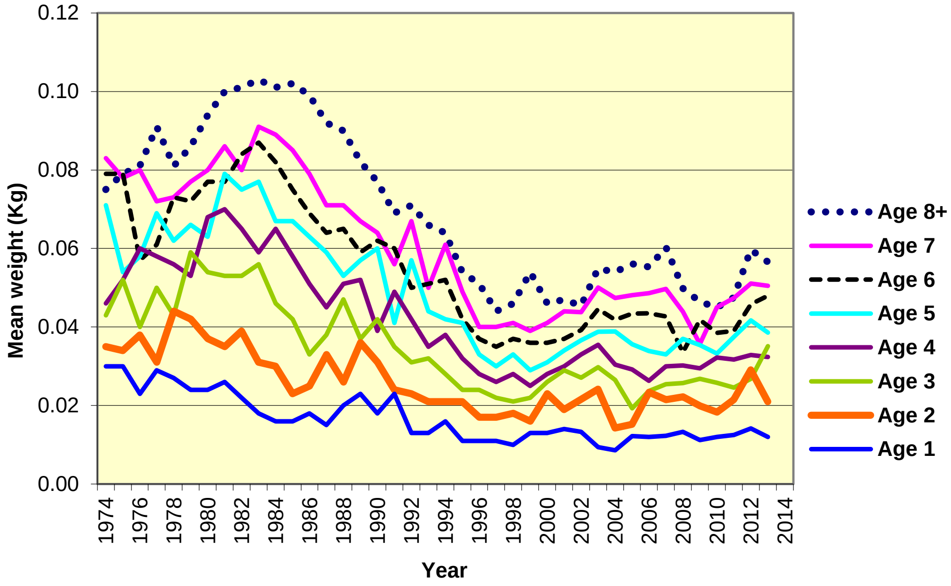

Figure 6.2.3 Herring in SD 25-29, 32 (excl. GOR). Trends in the mean weights at age (kg) in the catch (WECA).

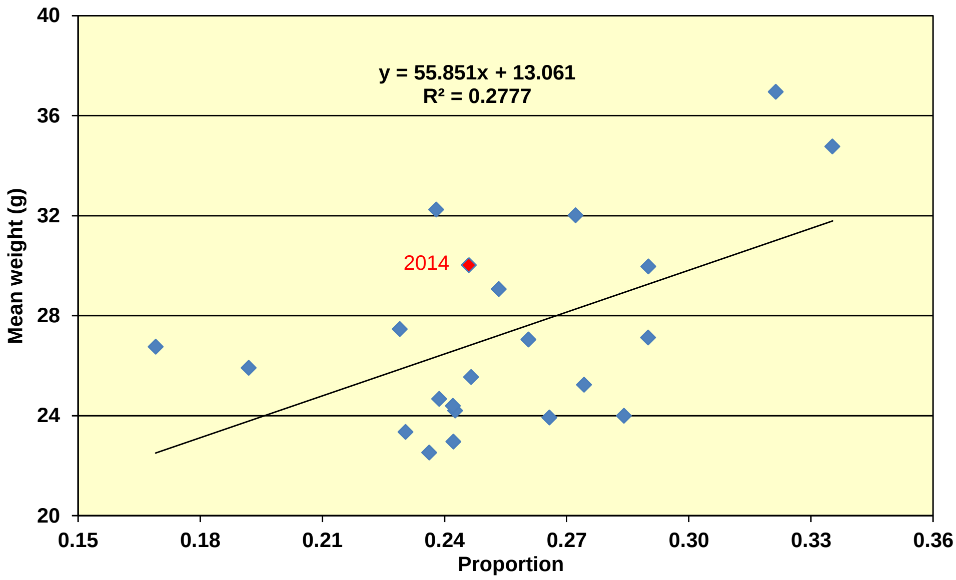

Figure 6.2.4 Herring in SD 25-29, 32 (excl. GOR). Average individual weight in catches versus the proportion of catches taken in SD 25 plus SD 26 (1993-2014).

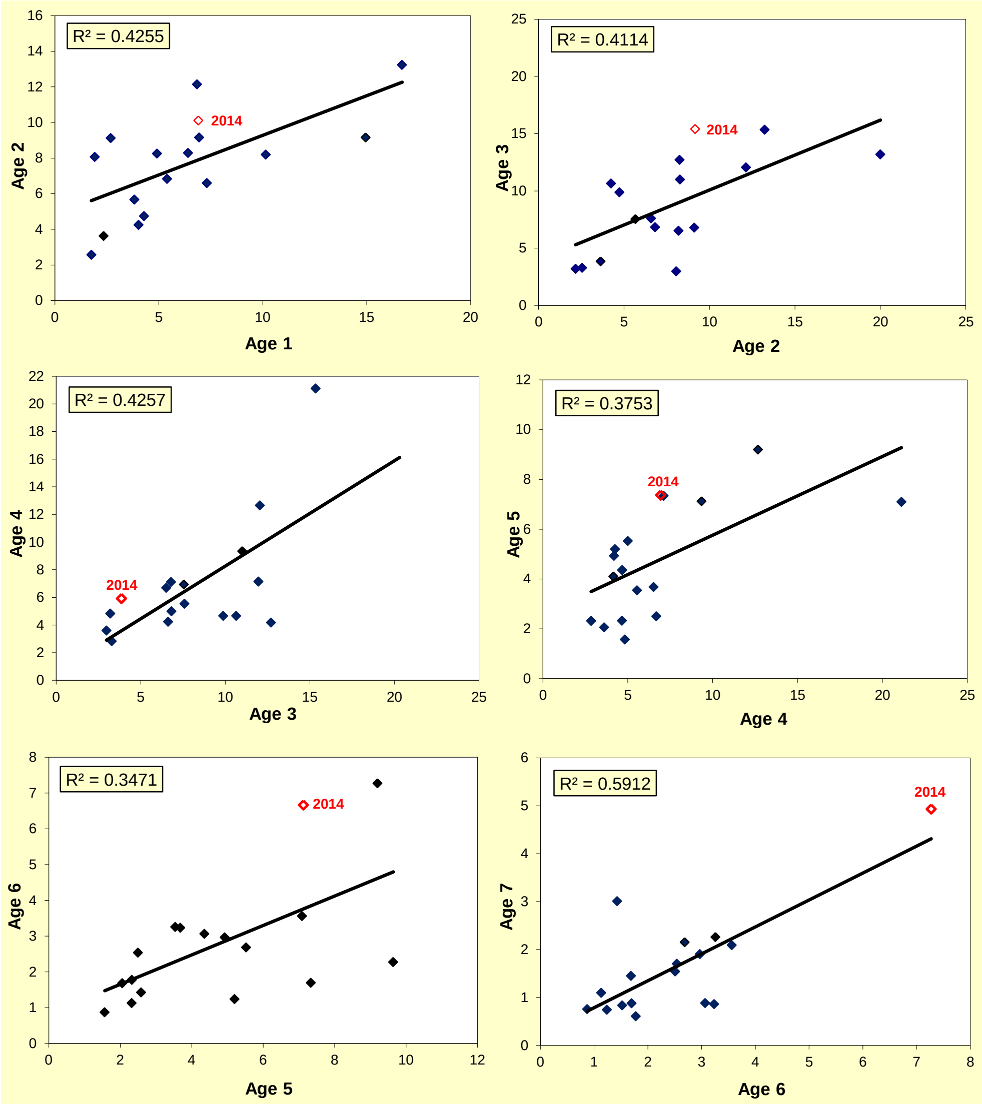

Figure 6.2.5 Herring in SD 25-29, 32 (excl. GOR). Acoustic survey numbers at age vs numbers at age +1of the same cohort in the following year in the period 1991-2014 (STANDARD INDEX). Years 1993, 1995 and 1997 were excluded.

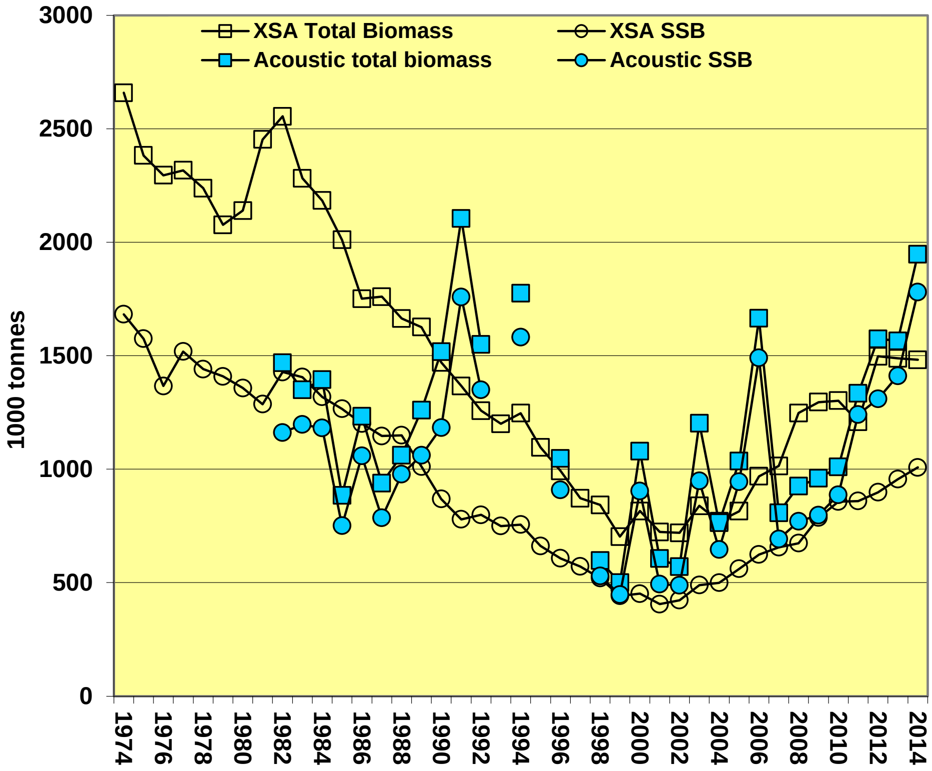

Figure 6.2.6 **Herring in SD 25-29, 32 (excl. GOR). Estimates of biomass and SSB from acoustic surveys (BIAS) and from XSA.**

Acoustic biomasses = Acoustic abundances x WECA

Acoustic SSB = Acoustic abundances x WECA x MATPROP

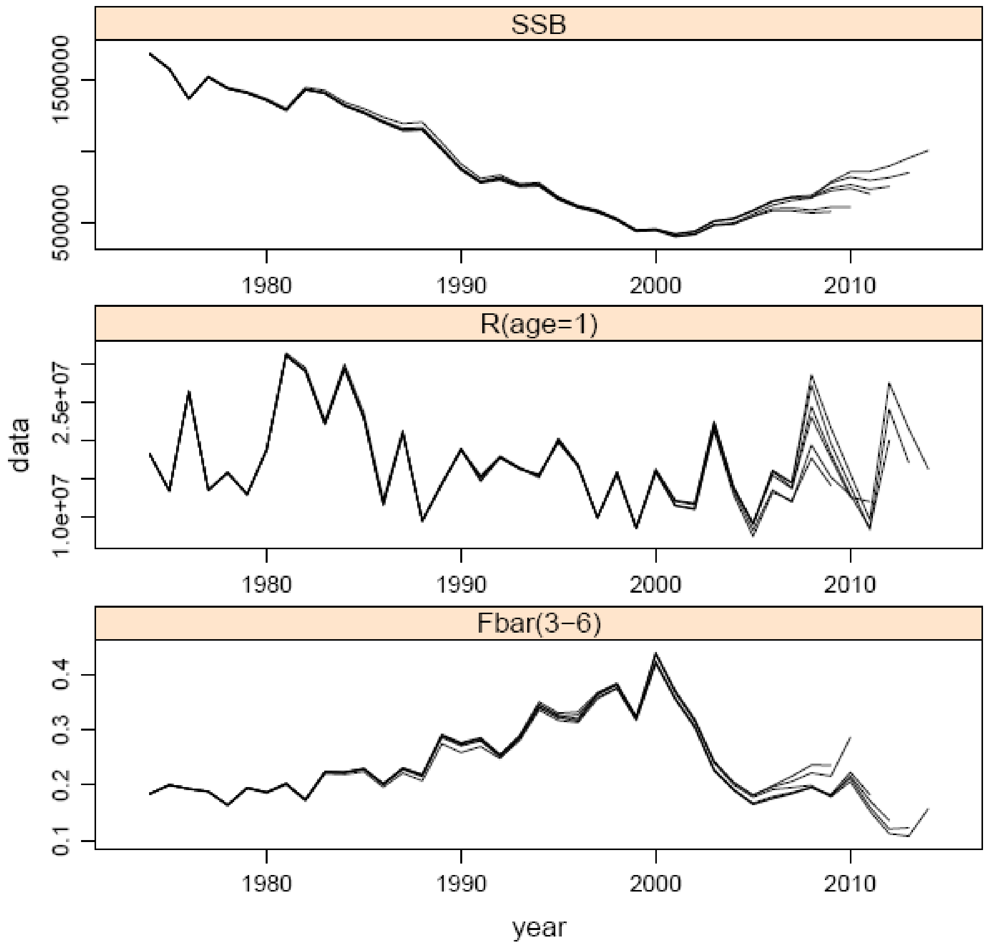

Figure 6.2.7 Herring in SD 25-29, 32 (excl. GOR). Retrospective Analysis.

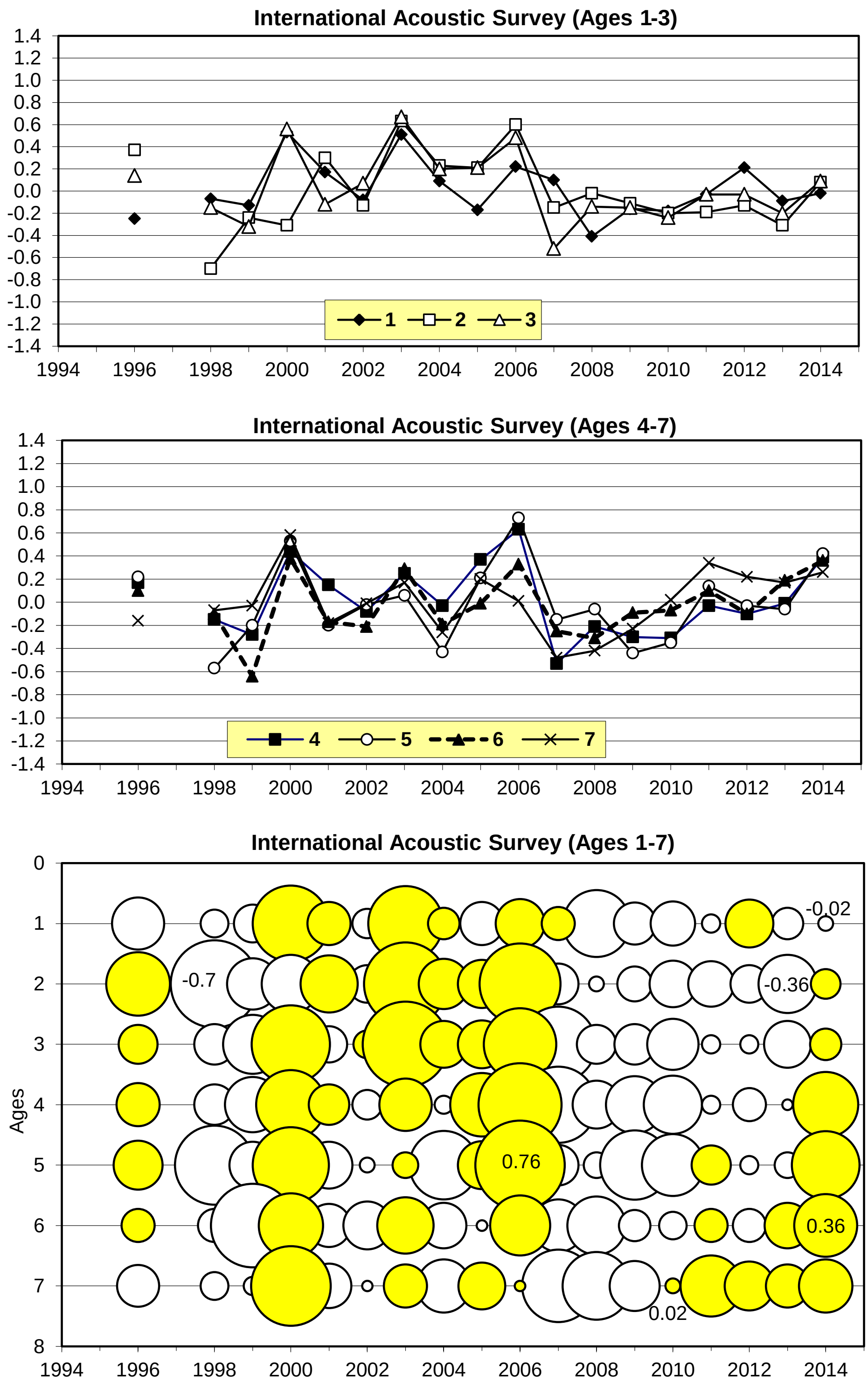

Figure 6.2.8 **Herring in SD 25-29, 32 (excl. GOR).**

International Acoustic Survey (Ages 1-7): Log Catchability residuals.

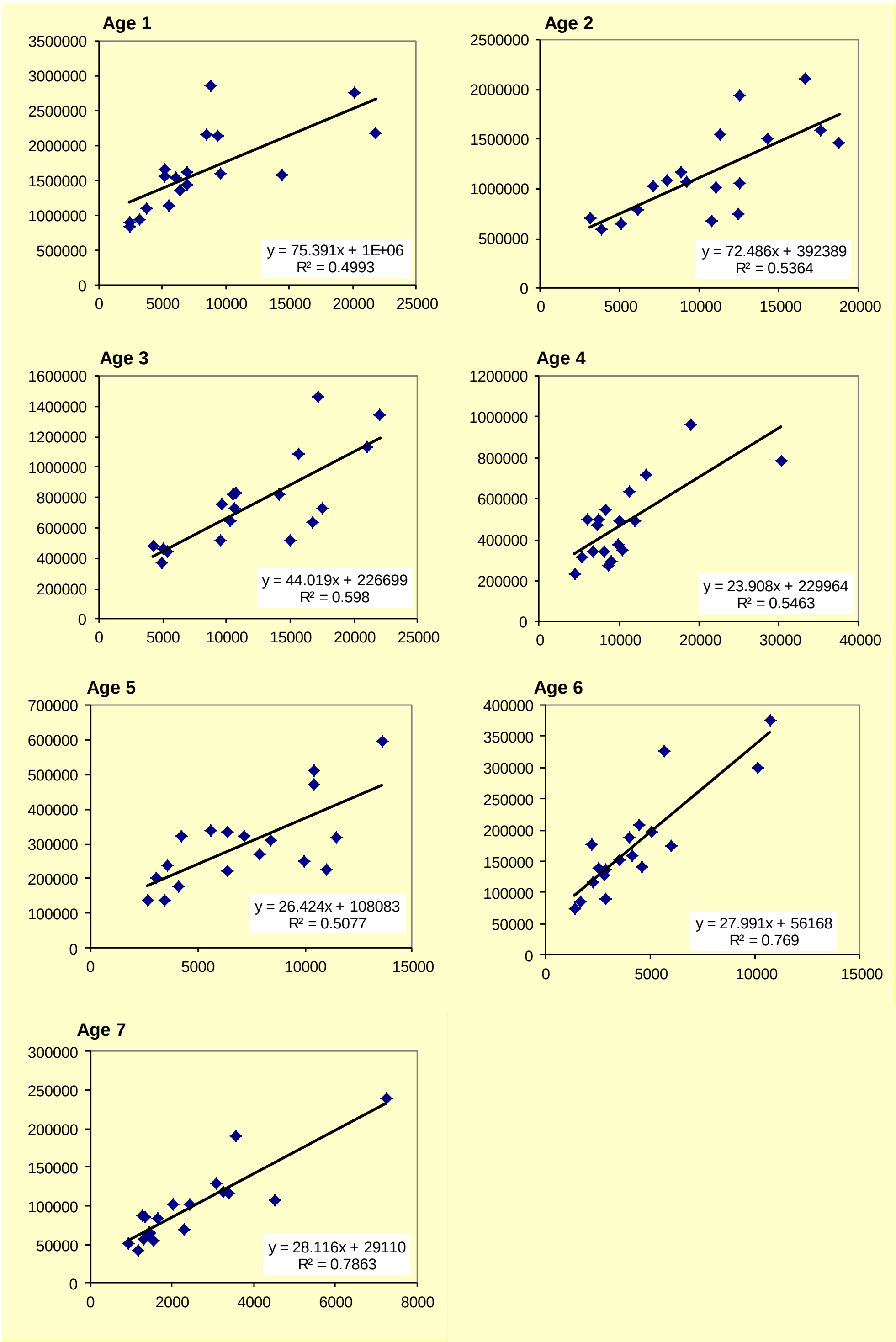

Figure 6.2.9 Herring in SD 25-29, 32 (excl. GOR). Regression of XSA population Vs acoustic survey population numbers, adjusted to start of year.

x-axis: Acoustic estimates

y-axis: XSA

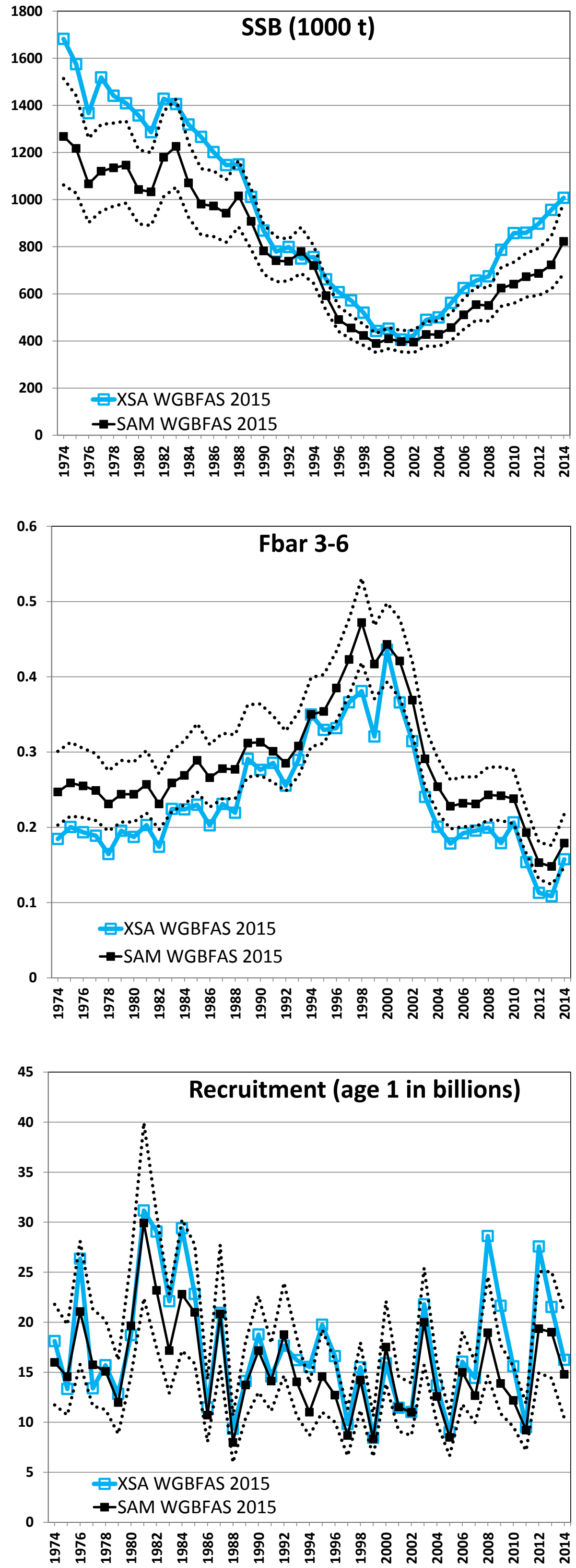

Figure 6.2.10 Herring in SD 25-29, 32 (excl. GOR). Comparison of fishing mortality (F3-6), spawning stock biomass (SSB) and recruitment (age 1) from XSA and SAM (dotted line represents the 95 % confidence intervals of the SAM results).

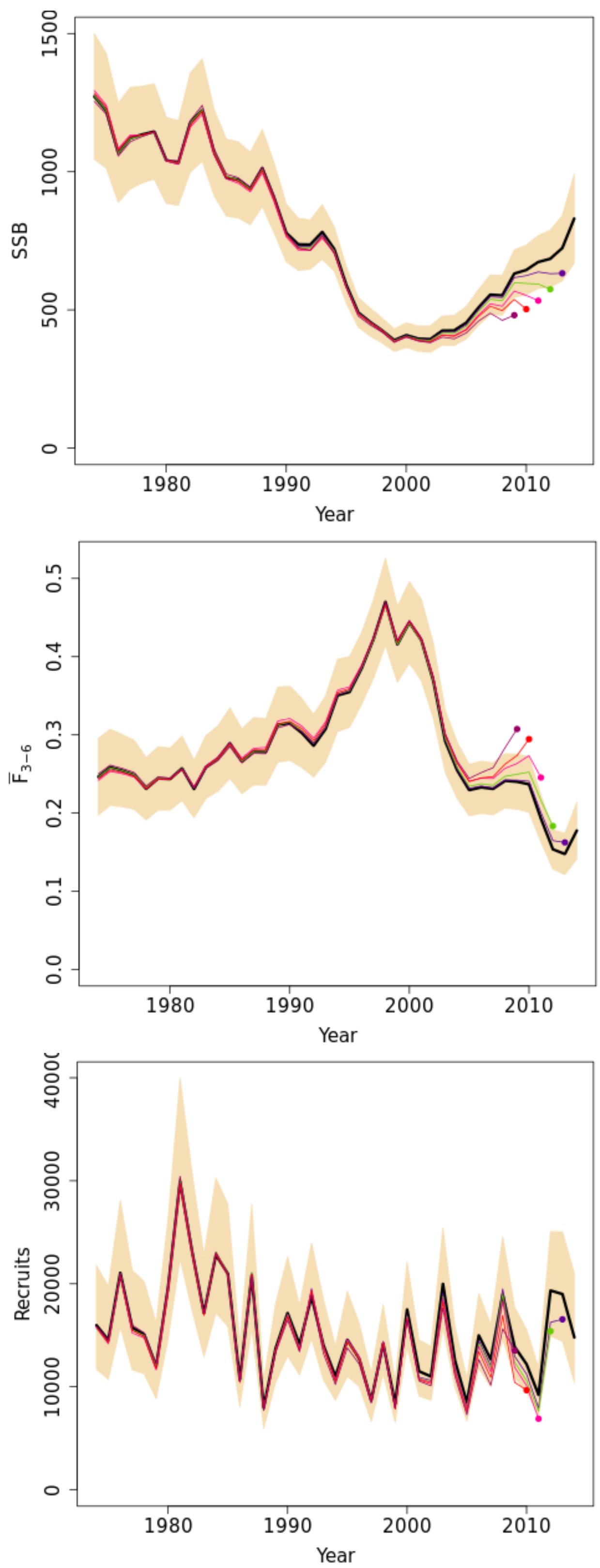

Figure 6.2.11 **Herring in SD 25-29, 32 (excl. GOR). Retrospective of SAM.**

(not including coupling of power law model exponents for age 1, which lead to no retrospective figures!).

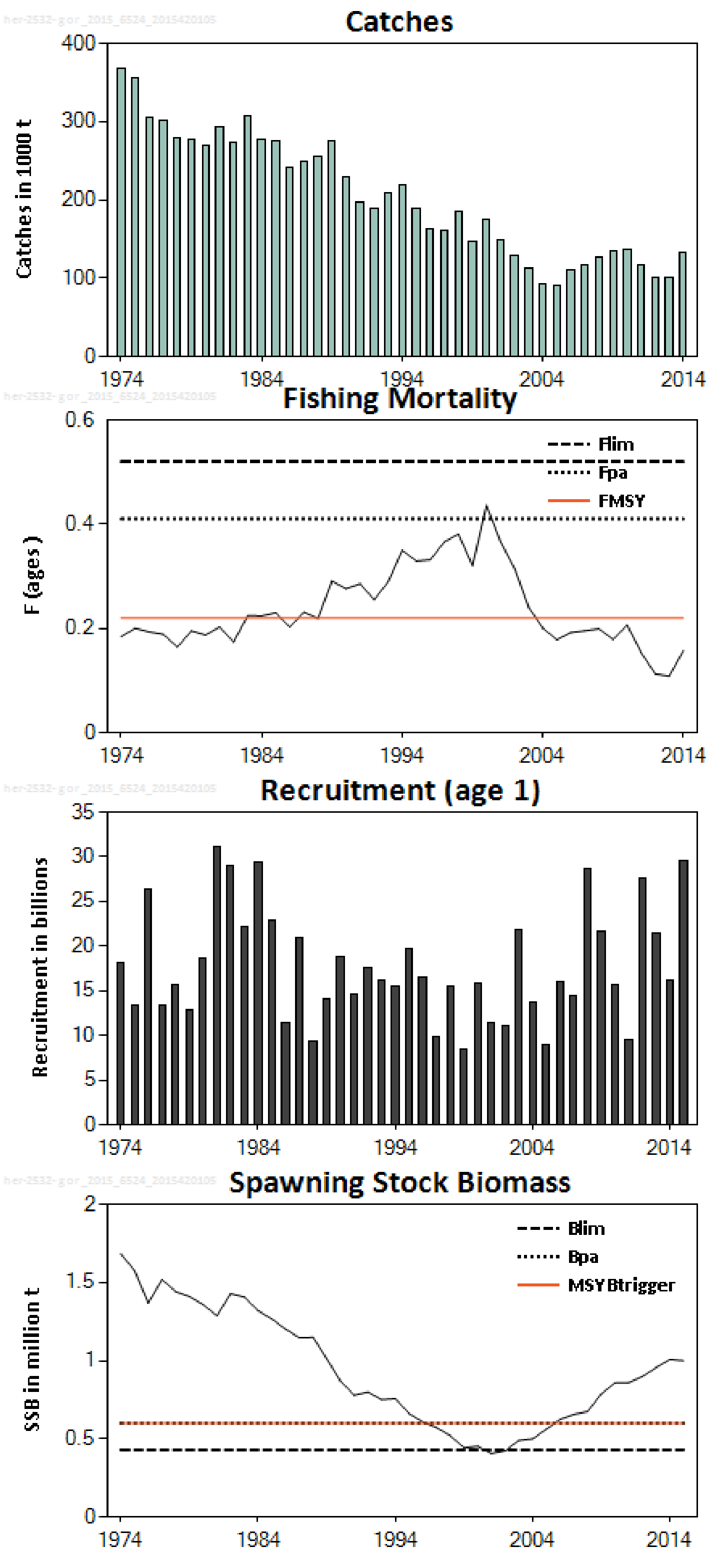

Figure 6.2.12 Herring in SD 25-29, 32 (excl. GOR). Summary sheet plots: Catches, fishing mortality, recruitment (age 1) and SSB (Recruitment in 2015 from RCT3 & SSB in 2015 predicted) 1/2

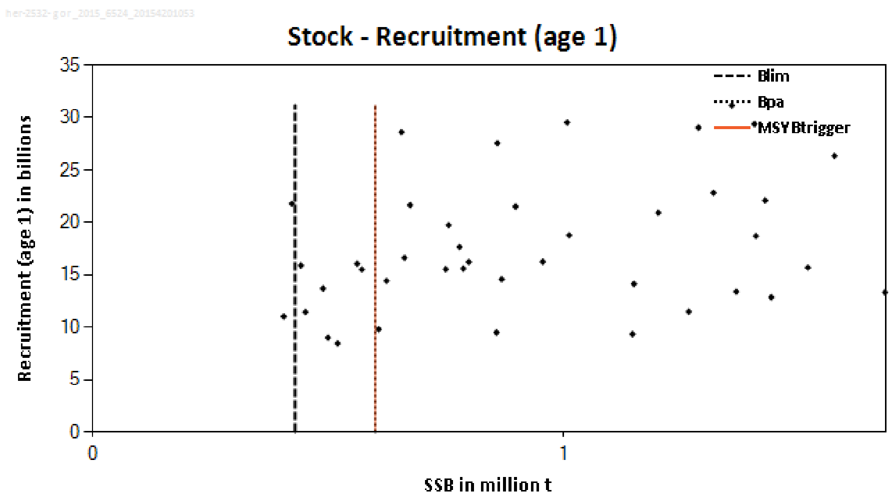

Figure 6.2.12 continued Herring in SD 25-29, 32 (excl. GOR). Summary sheet plots: 2/2

Stock-recruitment-plot.

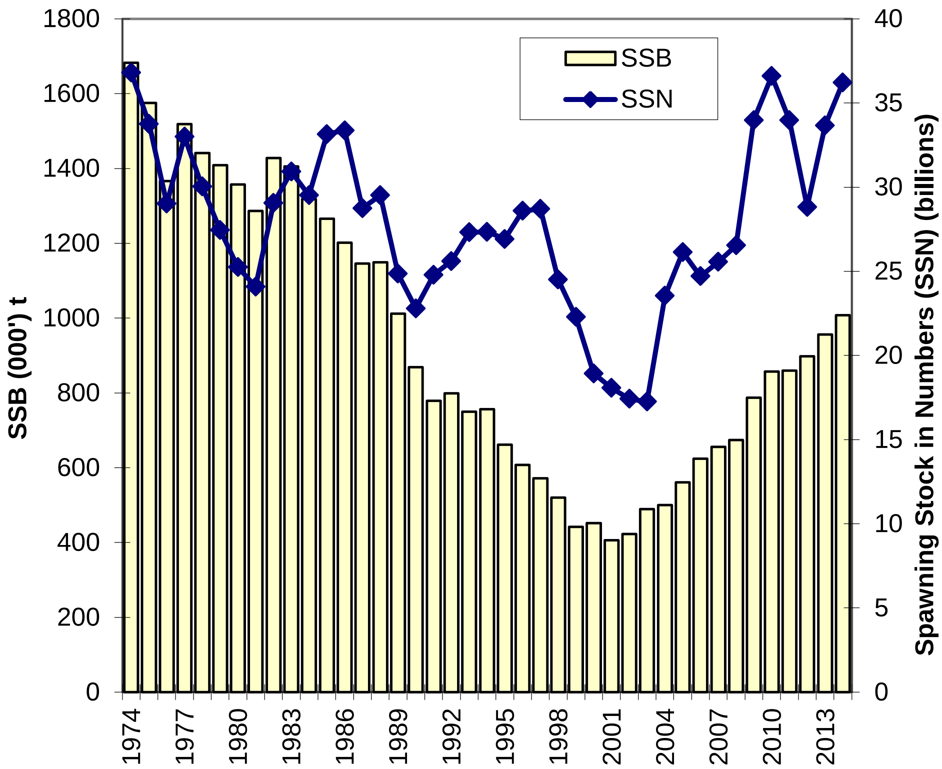

Figure 6.2.13 Herring in SD 25-29, 32 (excl. GOR).

SSB (000' t) and Spawning Stock in Numbers (SSN) (billions).

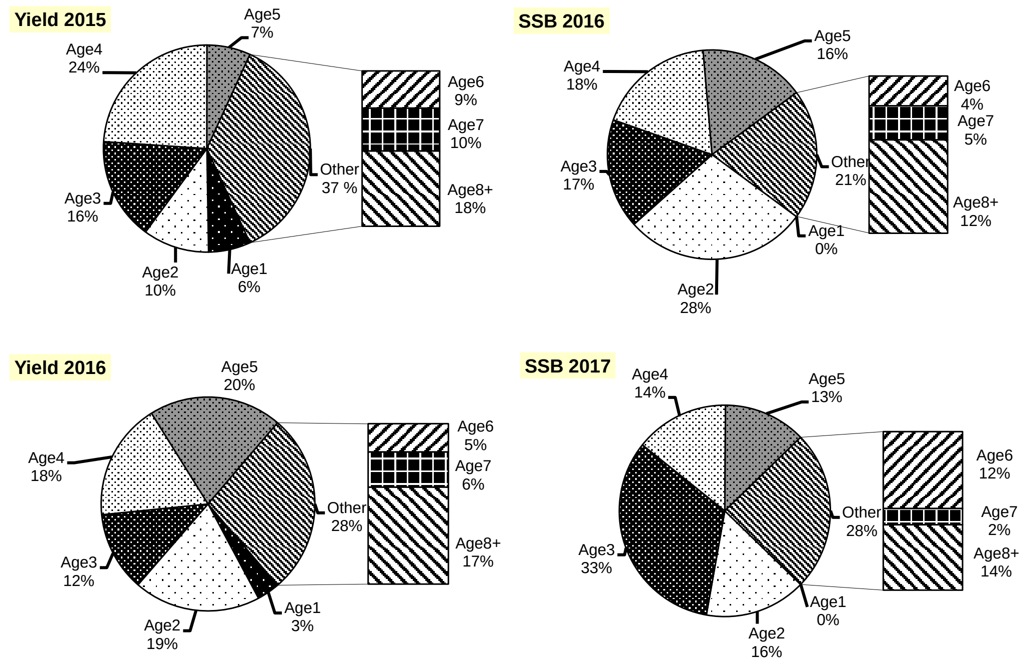

Figure 6.2.14 **Herring in SD 25-29, 32 (excl. GOR). Short-term forecast for 2015-2017. Yield and SBB at age 1-8+ for 'TAC constraint' fishing mortality in 2015.**

6.3 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). The differences in otolith structure serve as a basis for discrimination of Baltic herring populations (ICES, 2005). 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.

6.3.1 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 2014 these catches were 162 t, while the average catches in the last five years were 220 t. These catches are included in the total Gulf herring landings (Table 6.3.1b) and CATON (Table 6.3.4).

6.3.1.1 Catch trends in the area and in the stock

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. In 2009–2012 the average landings were respectively 34 757 t, however due to reduced TAC the catches in 2013-2014 decreased and were respectively 30 360 t and 30626 t (Table 6.3.1a).

The catches have shown a sharp increase in the 1990s after being at a record low level during the 1980s. In 1997 and in 2001−2004 they were the highest in the 1970−2014 period.

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 2014 the catches of the Gulf of Riga herring stock were 26 253 t.

The landings of open-sea herring in the Gulf of Riga were 4 535 t in 2014 (Table 6.3.1b). The average catch of open-sea herring in the last five years was 4620 t.

The trap-net catches of Gulf herring were 10 049 t in 2014 being 1 173 t higher than in 2013. The fishing effort remained at the same level as in 2013. The trap-net catches comprised 32.8% of the total catches of herring in 2014.

6.3.1.2 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 since in Latvia the trawl fishing fleet has decreased almost two times, it is considered that the fishing capacities now are more or less balanced with the fishing possibilities and no unallocated landings were assumed in 2011–2014. The level of misreporting in Estonian herring fishery has been low in 1995–2014 and therefore the official catch figures were used in the assessment.

6.3.1.3 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.

6.3.1.4 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 2014 the number of trap-nets was the same as in previous year (Table 6.3.8). 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 2005–2014. In Latvian the number of trawl fleet vessels is gradually decreasing due to scrapping and there were 24 active vessels in 2014. 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.

6.3.2 Biological composition of the catch

6.3.2.1 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 6.3.3, Figure 6.3.1). 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.

6.3.2.2 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 6.3.2. The check of consistency of catch-at-age data is shown in Figure 6.3.2. In 2014 the sample number per 1000 t was as follows: in Estonia 2.2 samples and in Latvia 2.9 samples.

6.3.3 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 6.3.6, Figure 6.3.3.). 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 2014 the mean weight-at age was slightly lower than in the previous 2 years (Figure 6.3.3.)

6.3.4 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 6.3.5).

6.3.5 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 6.3.7). 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.

6.3.6 Catch-at-age analysis

6.3.6.1 Tuning fleets

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 6.3.8-6.3.9. The check of internal consistency of tuning data is shown in Figures 6.3.4 and 6.3.5.

In trap-net fleet (Figure 6.3.4) the correlation was high and in 2014 was similar as in the previous year. In acoustic fleet the correlation did not changed much in comparison with the previous year. In some age groups it slightly improved while in other it became slightly worse (Figure 6.3.5.).

6.3.6.2 XSA run (update assessment)

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 is trap-net survey in the Estonian and Latvian trap-net fishery and the hydro-acoustic survey (Tables 6.3.8 and 6.3.9). 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 6.3.10 and the XSA results are shown in Tables 6.3.11-6.3.13. In general the diagnostics were similar to the last year, but they slightly improved for the trap-net fleet, while in the acoustics it slightly improved in some ages and became slightly worse in others. Log catcability residuals for both fleets are shown in Figure 6.3.6. For acoustic fleet some year effect is seen in 2010–2011. The retrospective analysis is shown in Figure 6.3.7. In comparison with assessment of the previous year this year assessment produced almost the same SSB estimate (-2.4%) and slightly higher fishing mortality estimate (+4.2%). The recruitment estimate of 2012 year class was 12.1% higher than obtained in 2013 (Table 6.3.11).

6.3.7 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 6.3.13). In 2000s three record high year classes appeared reaching values over 6000 millions 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 geometrical 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 3119.442 millions of age group 1 in the beginning of 2015, that is the geometric mean value for 1989–2012 year-classes. The same value for recruitment was used also for year-classes 2015 and 2016.

6.3.8 Historical stock trends

The resulting estimates of the main stock parameters (Table 6.3.13, Figure 6.3.8) 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 122 244 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 and the estimate for 2014 is 103 405 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 is regarded as F_{pa}. The fishing mortality has decreased in the last four years and in 2013 and 2014 was estimated respectively 0.31 and 0.34. The decrease of the fishing mortality is connected with the transition to F_{MSY}=0.32 (0.35 until 2014).

6.3.9 Short-term forecast and management options

The input data and summary of short-time forecast with management options are presented in the Tables 6.3.14 and 6.3.15. For prediction the mean weights-at-age were taken to be equal to the average of the last three years 2012–2014. The exploitation pattern has been taken equal to the average of 2012–2014 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 2015–2017 (year-classes of 2014, 2015, 2016) were taken to be equal to the geometrical mean of year classes over the period 1989–2012. The status quo fishing mortality was used for intermediate year because it was considered the TAC will not be utilised due to significant increase of TAC by 26% and due to worsened market conditions. The SSB in 2015 would be approximately 90.3 thousand t (according to the 2014 prediction 112.1 thousand t). In 2016 SSB will remain at the same level and in 2017 it will increase to 95 thousand t. The substantial decrease of SSB is due to poor year-class of 2013. The catch corresponding to FMSY (0.32) would be 26.2 thousand t in 2016. In 2015 the catches will be dominated by year-classes of 2011 and 2012, respectively 37% and 25%, and in 2016 the year classes of 2011 and 2012 will remain the most abundant, respectively 32% and 19% as well as the year-class of 2014 with 22%. The SSB in 2016 will be dominated by year classes of 2014, 2012 and 2013, respectively 32%, 34% and 19%, and in 2017 will be dominated by the younger age groups of 2 and 3 year-old herring as well as 5 year-old (Figure 6.3.9). The share of younger age groups (1-3) in the yield of 2015-2016 will decrease, 52% and 39% respectively. The yield-per-recruit summary is presented in Table 6.3.16.

6.3.10 Medium-term predictions

The medium term prediction for Gulf of Riga herring was performed at the Workshop on Multi-annual Management of Pelagic Fish Stocks in the Baltic (ICES, 2009) and was not performed in 2015.

6.3.11 Reference points

The biological reference points were estimated using the PA software (CEFAS, Lowestoft, UK). The results are presented in the Figures 6.3.10. The following values of reference points were obtained, being close to those found in the 2014 analysis – the values in brackets:

$\mathbf{F}_{0.1}$=0.25 (0.26)

$\mathbf{F}_{low}$=0.06 (0.09)

$\mathbf{F}_{med}$=0.33 (0.34)

$\mathbf{F}_{high}$=0.75 (0.75)

$\mathbf{F}_{loss}$ =0.32 (0.32)

The F_{PA} =0.4 has been obtained earlier from the medium-term simulations.

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. Based on stochastic simulations Fmsy=0.35 was obtained.

At WKMSYREF3 (ICES, 2014) the Fmsy was reviewed. For the analysis the assessment results of 1977-2013 were used. For the analysis of stock recruitment relationship full data series was used. The mean weight at age, proportion mature and exploitation pattern was taken from years 2004-2013. The stock recruitment fit using three models (Rickers, Beverton&Holt and segmented regression) weighted by the default "Buckland" method available in Equisim, estimated a 'straight line' for all models. Thus, a segmented regression model was used as the only stock recruitment model in the simulations with a breakpoint set arbitrarily at Btrigger. Blim was set at Btrigger divided by 1.4. The calculated Fmsy (without Btrigger)=0.32.

6.3.12 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 6.3.2.). 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. There are indications that hydro-acoustic survey underestimates the older age groups especially in the years when stock is dominated by an abundant age group 1. This was especially evident in 2006, and probably in 2008. Some year effect could be also seen in the acoustic data series.

6.3.13 Comparison with the previous assessment

The comparison between main input parameters for assessment and the results of XSA and predictions from 2014 and 2015 are presented in the text table below.

Comparison of XSA settings from assessments performed in 2012 and 2013

Category	Parameter	Assessment 2014	Assessment 2015	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	1996-2013	1996-2014	No
	Acoustic survey	1999-2013	1999-2014	No

Comparison of SSB and F estimates from assessments performed in 2014 and 2015

Assessment year	Tuning fleet	SSB (2013) (t)	FBAR3-7 (2013)	Diff.(+/-)%
2014 (update)	Trap-nets+acoustics	90,465	0.2951	
2015 (update)	Trap-nets+acoustics	87,909	0.3075	-2.4; +4.2

Comparison of prediction results performed in 2014 and 2015 Parameter	Prediction 2014	Prediction 2015	Actual yield 2014 (t)	Diff. (+/-)%
Yield 2014 (t)	27,000		26,253	-2.8
SSB 2015 (t)	109,500	90,347		-17.5
Yield 2015 (t)	34,300	28,445		-17.1

6.3.14 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 Sub-divisions 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.

Putnis, I., Müller-Karulis, B., and Kornilovs, G. 2011. Changes in the reproductive success of the Gulf of Riga herring. ICES C.M./H:13.

6.3.1a. 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

Table 6.3.1b 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
1976	27.4	4.5	31.9	-	27.4
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	26.2	4.5	30.6	0.2	26.3

Table 6.3.2. Sampling of herring landings in the Gulf of Riga in 2014

Country	Quarter	Landings	Samples	Measured	Aged
Estonia	I	3915	7	672	667
	II	6628	14	1347	1334
	III	15	2	220	0
	IV	3	0	0	0
	Total	10561	23	2239	2001
Latvia	I	7780	9	2028	1032
	II	6546	36	3873	3553
	III	2628	6	1617	583
	IV	3111	7	1747	703
	Total	20065	58	9265	5871
Total	I	11695	16	2700	1699
	II	13174	50	5220	4887
	III	2643	8	1837	583
	IV	3114	7	1747	703
Grand total	Total	30626	81	11504	7872

Table 6.3.3 Gulf of Riga herring. Catch in numbers 1977-2014 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

Table 6.3.4 Gulf of Riga herring. Catch in tons. (CATON)

Year	Catch
1970	33,196
1971	32,178
1972	27,145
1973	27,895
1974	30,850
1975	28,523
1976	27,422
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

Table 6.3.5 Gulf of Riga herring. Proportion of mature at year start in 1977-2014

Period	1	2	3	4	5	6	7	8	9+
1977-2013	0	0.93	0.98	0.98	1	1	1	1	1

Table 6.3.6 Gulf of Riga herring. Weights in catch and stock in 1970-2014, 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	0.0360
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	0.0684
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	0.0750
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	0.0300
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	0.0280
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	0.0240
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	0.0260
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

Table 6.3.7 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
1984-2014	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 6.3.8 Gulf of Riga herring. Tuning fleet: trap-nets (effort number of trap-nets)

Year	Effort	Age2	Age3	Age4	Age5	Age6	Age7	Age8*
1990	41.0	8.10	0.70	25.60	7.20	6.70	8.20	1.90
1991	87.0	42.90	22.80	10.00	54.00	10.00	9.10	10.50
1992	102.0	99.00	95.10	21.80	7.90	56.60	4.20	5.90
1993	78.0	67.80	74.60	70.40	24.80	7.70	32.10	2.10
1994	54.0	17.70	43.60	62.70	40.70	13.10	2.00	17.80
1995	64.0	37.30	53.40	68.70	59.20	33.60	11.40	0.80
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

Table 6.3.9 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	260
2013	1	9435	5552	592	1240	479	827	187	318
2014	1	1109	3832	2237	276	570	443	466	46

* Age 8 is true age group

Table 6.3.10

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

Herring Gulf of Riga

CPUE data from file c:\dati\vpa\herg\fleet1.txt

Catch data for 38 years. 1977 to 2014. Ages 1 to 8.

Fleet	First Year	Last year	First age	Last age	Alpha	Beta
Trap-nets	1996	2014	2	7	0.330	0.580
Acoustics	1999	2014	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	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.146	0.138	0.190	0.135	0.124	0.217	0.117	0.124	0.105	0.147
2	0.389	0.359	0.304	0.336	0.255	0.273	0.247	0.221	0.235	0.189
3	0.391	0.406	0.490	0.311	0.339	0.273	0.366	0.319	0.265	0.275
4	0.495	0.375	0.601	0.343	0.374	0.316	0.351	0.393	0.273	0.309

5	0.592	0.616	0.449	0.304	0.391	0.369	0.438	0.380	0.301	0.369
6	0.582	0.467	0.956	0.296	0.522	0.360	0.404	0.367	0.351	0.366
7	0.562	0.374	0.428	0.479	0.468	0.382	0.406	0.398	0.348	0.389

XSA population numbers (Thousands)

	AGE						
YEAR	1	2	3	4	5	6	7
2005	3.11E+06	6.78E+05	2.98E+06	4.85E+05	4.60E+05	1.28E+05	7.17E+04
2006	6.78E+06	2.20E+06	3.76E+05	1.65E+06	2.42E+05	2.09E+05	5.84E+04
2007	1.95E+06	4.83E+06	1.26E+06	2.05E+05	9.29E+05	1.07E+05	1.07E+05
2008	5.26E+06	1.32E+06	2.92E+06	6.32E+05	9.21E+04	4.85E+05	3.37E+04
2009	2.61E+06	3.76E+06	7.70E+05	1.75E+06	3.67E+05	5.56E+04	2.96E+05
2010	2.65E+06	1.89E+06	2.39E+06	4.49E+05	9.87E+05	2.03E+05	2.70E+04
2011	9.48E+05	1.75E+06	1.18E+06	1.49E+06	2.68E+05	5.58E+05	1.16E+05
2012	4.36E+06	6.91E+05	1.12E+06	6.67E+05	8.57E+05	1.42E+05	3.05E+05
2013	4.82E+06	3.15E+06	4.54E+05	6.65E+05	3.69E+05	4.80E+05	8.04E+04
2014	6.21E+05	3.56E+06	2.04E+06	2.85E+05	4.14E+05	2.24E+05	2.77E+05

Estimated population abundance at 1st Jan 2015

0.00E+00, 4.38E+05, 2.41E+06, 1.27E+06, 1.71E+05, 2.35E+05, 1.27E+05,

Taper weighted geometric mean of the VPA populations:

2.65E+06, 2.15E+06, 1.25E+06, 6.78E+05, 3.92E+05, 2.03E+05, 1.00E+05,

Standard error of the weighted Log(VPA populations) :

0.7643, 0.6511, 0.6551, 0.6533, 0.6554, 0.6868, 0.8116,

Log catchability residuals.

Fleet : Trap-nets

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	No data for this fleet at this age								
2	-0.63	-0.58	0.33	-1.06	-0.12	0.05	-0.04	-0.06	-0.66
3	-0.63	-0.52	-0.25	-1.02	-0.31	0.15	-0.02	0.20	0.13
4	-0.54	-0.36	-0.30	-0.21	-0.47	0.23	-0.13	0.04	0.20
5	-0.39	-0.42	-0.22	-0.17	0.37	0.22	-0.14	-0.58	0.02
6	-0.03	-0.51	-0.55	0.12	-0.11	0.34	-0.27	0.12	0.00
7	-0.42	-0.64	-0.26	-0.09	-0.63	0.30	-0.31	-0.48	-0.02

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	No data for this fleet at this age									
2	0.11	0.23	-0.30	0.48	0.11	-0.19	-0.20	0.02	0.17	0.36
3	-0.06	0.27	0.33	0.04	-0.18	-0.27	0.02	-0.14	0.07	0.08
4	-0.06	-0.12	0.50	0.06	0.11	-0.32	0.01	0.18	-0.17	-0.09
5	0.40	0.70	0.10	-0.07	0.13	-0.06	-0.23	-0.08	-0.07	-0.30
6	0.35	0.38	0.80	-0.08	0.34	0.05	0.11	-0.24	0.01	-0.64
7	0.10	0.38	0.03	-0.30	0.26	0.07	-0.08	0.03	-0.23	-0.27

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	-14.0683	-13.4185	-13.2081	-13.0727	-13.0727	-13.0727
S.E(Log q)	0.3210	0.2316	0.2260	0.3000	0.3705	0.2649

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	1.14	-0.843	13.99	0.77	19	0.37	-14.07
3	1.05	-0.435	13.39	0.88	19	0.25	-13.42
4	1.04	-0.352	13.20	0.89	19	0.24	-13.21
5	1.01	-0.085	13.08	0.82	19	0.32	-13.07
6	1.19	-1.013	13.16	0.73	19	0.43	-13.01
7	0.96	0.373	13.07	0.92	19	0.26	-13.13

Fleet : Acoustics

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	99.99	99.99	99.99	-0.02	-0.12	-0.40	-0.05	-0.07	0.54
2	99.99	99.99	99.99	0.41	0.38	-0.29	0.05	-0.29	0.42
3	99.99	99.99	99.99	0.58	0.23	0.14	-0.17	-0.08	-0.40
4	99.99	99.99	99.99	0.00	0.47	0.14	-0.11	-0.34	0.35
5	99.99	99.99	99.99	-0.12	0.11	0.06	-0.46	-0.19	-0.23
6	99.99	99.99	99.99	0.52	0.21	0.08	-0.03	0.48	0.26
7	99.99	99.99	99.99	0.20	0.56	-0.82	0.27	0.19	0.23

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.34	-0.06	-0.88	-0.08	0.26	0.11	0.55	-0.33	0.01	-0.05
2	0.55	-0.40	-0.61	0.16	-0.14	-0.10	0.74	-0.29	0.19	-0.32
3	0.30	-0.67	-0.05	0.25	-0.02	-0.46	0.63	0.16	0.08	-0.09
4	-0.32	-0.59	-0.25	0.22	-0.05	-0.62	0.65	0.14	0.54	-0.09
5	0.46	-0.71	0.01	0.26	-0.32	-0.54	0.76	0.12	0.15	0.24
6	-0.28	0.05	0.34	-0.44	-0.67	-0.69	0.38	0.89	0.46	0.61
7	0.08	-0.56	-0.08	-0.76	-0.30	-0.80	0.28	-0.05	0.76	0.46

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,	-6.0764	-6.2849	-6.4540	-6.5548	-6.5051	-6.5051	-6.5051
S.E(Log q),	0.3756	0.4055	0.3523	0.4064	0.4128	0.5248	0.5083

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	1.18	-1.028	4.52	0.77	16	0.44	-6.08
2	1.16	-0.728	4.93	0.67	16	0.48	-6.28
3	0.89	0.736	7.28	0.82	16	0.32	-6.45
4	0.86	0.837	7.50	0.79	16	0.36	-6.55
5	1.14	-0.626	5.62	0.67	16	0.48	-6.51
6	0.85	0.739	7.24	0.72	16	0.45	-6.39
7	0.80	1.368	7.54	0.83	16	0.39	-6.55

Fleet disaggregated estimates of survivors :

Age 1 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	1	0.000	0.000	0.00	0	0.000	0.000
Acoustics	416620	0.391	0.000	0.00	1	0.585	0.155
F shrinkage mean	471155	0.50				0.415	0.138

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
438432	0.31	0.08	2	0.257	0.147

Age 2 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	3438719	0.334	0.000	0.00	1	0.354	0.136
Acoustics	2072914	0.287	0.170	0.59	2	0.455	0.216
F shrinkage mean	1784843	0.50				0.191	0.247

Weighted prediction :

Survivors,	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
2410243	0.20	0.17	4	0.866	0.189

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	1427990	0.225	0.041	0.18	2	0.456	0.248
Acoustics	1171618	0.229	0.138	0.60	3	0.412	0.295
F shrinkage mean	1086648	0.50				0.132	0.314

Weighted prediction :

Survivors,	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
1269639	0.15	0.08	6	0.495	0.275

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2010

Fleet,	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	169496	0.183	0.049	0.27	3	0.514	0.312
Acoustics	180014	0.205	0.161	0.78	4	0.374	0.296
F shrinkage mean	151322	0.50				0.112	0.343

Weighted prediction :

Survivors, at end of year	Int s.e	Ext s.e	N	Var Ratio	F
171175	0.13	0.07	8	0.525	0.309

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	189308	0.163	0.038	0.23	4	0.543	0.440
Acoustics	330762	0.194	0.108	0.56	5	0.348	0.275
F shrinkage mean	227730	0.50				0.110	0.378

Weighted prediction :

Survivors, at end of year	Int s.e	Ext s.e	N	Var Ratio	F
234556	0.12	0.10	10	0.783	0.369

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2008

Fleet,	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	108144	0.159	0.150	0.95	5	0.549	0.418
Acoustics	172977	0.196	0.113	0.57	6	0.329	0.281
F shrinkage mean	112929	0.50				0.122	0.404

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
126899	0.12	0.10	12	0.832	0.366

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Trap-nets	134285	0.151	0.062	0.41	6	0.588	0.434
Acoustics	191142	0.196	0.144	0.73	7	0.292	0.323
F shrinkage mean	173900	0.50				0.120	0.350

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
153542	0.12	0.08	14	0.623	0.389

Table 6.3.11. Gulf of Riga Herring. XSA output: Fishing mortality at age (start of year) (104)

Run title: Herring Gulf of Riga

At 27/03/2015 10:34

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
2	0.4228	0.1644	0.2963	0.2305	0.2904	0.1825	0.2296	0.1989	0.2155	0.1122
3	0.6604	0.3472	0.2728	0.2875	0.351	0.347	0.4624	0.4558	0.4466	0.295
4	0.618	0.381	0.5812	0.2419	0.4407	0.403	0.4371	0.7189	0.4101	0.4668
5	0.6456	0.4184	0.3966	0.4997	0.3946	0.4595	0.4468	0.695	0.5522	0.4131
6	0.8246	0.3452	0.4304	0.3523	0.595	0.4485	0.5206	0.8902	0.7183	0.8095
7	0.7027	0.384	0.474	0.3678	0.4815	0.4411	0.4728	0.7757	0.5649	0.5679
+gp	0.7027	0.384	0.474	0.3678	0.4815	0.4411	0.4728	0.7757	0.5649	0.5679
FBAR 3-7	0.6903	0.3751	0.431	0.3498	0.4526	0.4198	0.4679	0.7071	0.5384	0.5105

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.02	0.012	0.0542	0.0275	0.0371	0.0399	0.0686	0.0685	0.0776	0.1081
2	0.0616	0.0723	0.1235	0.0972	0.0948	0.1402	0.1349	0.1395	0.1828	0.2118
3	0.1619	0.1968	0.259	0.2579	0.1529	0.2127	0.1763	0.1871	0.2615	0.2453
4	0.4277	0.2477	0.411	0.2146	0.2466	0.2168	0.1935	0.2334	0.3436	0.2863
5	0.6788	0.6159	0.2653	0.3426	0.2235	0.3256	0.2438	0.2535	0.4121	0.4177
6	0.3576	0.9475	0.4903	0.1442	0.3603	0.3102	0.3134	0.2647	0.3748	0.5328
7	0.4918	0.609	0.3915	0.2349	0.2783	0.2858	0.2515	0.2518	0.3794	0.4203
+gp	0.4918	0.609	0.3915	0.2349	0.2783	0.2858	0.2515	0.2518	0.3794	0.4203
FBAR 3-7	0.4236	0.5234	0.3634	0.2388	0.2523	0.2702	0.2357	0.2381	0.3543	0.3805

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
1	0.1556	0.1009	0.15	0.1151	0.1617	0.161	0.1002	0.201	0.1463	0.1375
2	0.3604	0.3341	0.2771	0.359	0.3084	0.3701	0.3256	0.3416	0.3888	0.3585
3	0.4436	0.3393	0.3144	0.3767	0.4481	0.4226	0.5566	0.4515	0.3913	0.4061
4	0.5393	0.4078	0.3696	0.4392	0.5206	0.4605	0.5309	0.6901	0.4947	0.3753
5	0.506	0.5726	0.4334	0.5895	0.5833	0.4783	0.4777	0.6502	0.5917	0.6163
6	0.5213	0.4745	0.6121	0.4369	0.6158	0.5668	0.5872	0.5946	0.5821	0.4669
7	0.5511	0.5173	0.5019	0.5674	0.5916	0.5327	0.719	0.6151	0.5619	0.3737
+gp	0.5511	0.5173	0.5019	0.5674	0.5916	0.5327	0.719	0.6151	0.5619	0.3737
FBAR 3-7	0.5123	0.4623	0.4463	0.4819	0.5519	0.4922	0.5743	0.6003	0.5243	0.4477

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	FBAR	
AGE										
1	0.1904	0.1347	0.1236	0.2175	0.1168	0.1238	0.105	0.1474	0.1254	
2	0.3037	0.3363	0.2547	0.2731	0.2473	0.221	0.2347	0.1889	0.2149	
3	0.4898	0.3115	0.3394	0.2727	0.3659	0.3189	0.2652	0.2746	0.2862	
4	0.6011	0.3432	0.3741	0.3157	0.3513	0.3926	0.2728	0.3091	0.3248	
5	0.449	0.3044	0.3905	0.3694	0.438	0.3803	0.3012	0.3692	0.3502	
6	0.9564	0.296	0.5225	0.3601	0.4044	0.3666	0.3508	0.3664	0.3613	
7	0.4276	0.4785	0.4684	0.3821	0.4055	0.3982	0.3475	0.3889	0.3782	
+gp	0.4276	0.4785	0.4684	0.3821	0.4055	0.3982	0.3475	0.3889		
FBAR 3-7	0.5848	0.3467	0.419	0.34	0.393	0.3713	0.3075	0.3417		

Table 6.3.12. Gulf of Riga Herring. XSA output: Stock numbers at age (start of year) (104)

Run title: Herring Gulf of Riga

At 27/03/2015 10:34

Terminal Fs derived using XSA (With F shrinkage)

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	94320	107646	97690	111027	90834	168832	125325	202519	138265	111653
2	283692	70934	77999	69312	77555	65226	124426	93217	161827	111103
3	32331	152180	49272	45169	42870	45177	42326	77021	62557	106805
4	26299	13676	88048	29213	26388	23503	24867	20759	39977	32768
5	8202	11605	7650	38347	17862	13226	12233	12510	8282	21718
6	3090	3521	6253	4007	18118	9375	6506	6094	5112	3904
7	3503	1109	2041	3167	2194	7783	4662	3011	2049	2041
+gp	130	1960	1631	911	1025	1036	2852	2402	1545	1463
TOTAL	451565	362630	330584	301154	276846	334158	343198	417532	419614	391454

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	390424	55724	127887	359047	363053	424515	320271	274191	344015	462603
2	90582	313318	45080	99177	285991	286430	333964	244824	209628	260627
3	81309	69728	238634	32619	73680	212976	203826	238916	174346	142955
4	65104	56617	46891	150796	20635	51773	140955	139905	162231	109897
5	16821	34753	36183	25452	99619	13203	34127	95099	90702	94196
6	11764	6985	15370	22721	14794	65229	7805	21897	60425	49179
7	1422	6736	2217	7707	16105	8448	39163	4671	13758	34008
+gp	563	1413	1827	2152	18445	21029	13291	27711	17886	18199
TOTAL	657988	545274	514090	699670	892321	1083601	1093401	1047215	1072991	1171663

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
AGE										
1	156628	275506	287184	263386	606677	226042	691927	101218	311237	677595
2	339948	109759	203907	202381	192204	422556	157546	512507	67781	220136
3	172657	194112	64342	126544	115721	115599	238946	93140	298175	37620
4	91579	90716	113194	38468	71083	60527	62021	112130	48549	165079
5	67572	43726	49399	64039	20299	34578	31267	29861	46041	24237
6	50790	33354	20194	26220	29080	9275	17547	15878	12761	20860
7	23633	24690	16991	8964	13868	12862	4308	7986	7173	5838
+gp	15767	18323	22473	13473	17300	11902	12469	17454	7332	7037
TOTAL	918575	790187	777684	743476	1066233	893340	1216031	890174	799049	1158402

YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	GMST
AGE										
1	194503	525706	260730	265281	94847	435705	482410	62055	0	221586
2	483478	131642	376173	188648	174739	69093	315200	355584	43843	163026
3	125931	292147	77001	238723	117544	111715	45352	204079	241024	103231
4	20521	63176	175176	44899	148808	66748	66490	28481	126964	58148
5	92865	9210	36699	98657	26807	85744	36905	41440	17117	30121
6	10714	48530	5562	20332	55825	14164	47994	22357	23456	14338
7	10707	3371	29552	2700	11613	30502	8038	27667	12690	6834
+gp	7610	7558	8486	26144	14511	11336	21644	20016	26462	
TOTAL	946329	1081339	969378	885384	644695	825007	1024033	761678	491556	

Table 6.3.13. Gulf of Riga Herring. XSA output: Summary.

Run title: Herring Gulf of Riga

At 27/03/2015 10:34

Terminal Fs derived using XSA (With shrinkage)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3-7
	Age 1					
1977	943198	76734	54522	24186	0.4436	0.6903
1978	1076457	66255	49355	16728	0.3389	0.3751
1979	976901	66129	46737	17142	0.3668	0.431
1980	1110273	69527	46710	14998	0.3211	0.3498
1981	908342	65528	47219	16769	0.3551	0.4526
1982	1688316	72892	42753	12777	0.2989	0.4198
1983	1253252	76264	50845	15541	0.3057	0.4679
1984	2025191	66122	39899	15843	0.3971	0.7071
1985	1382652	77366	51895	15575	0.3001	0.5384
1986	1116533	86573	64155	16927	0.2638	0.5105
1987	3904236	97201	51373	12884	0.2508	0.4236
1988	557235	115724	96200	16791	0.1745	0.5234
1989	1278873	85498	62881	16783	0.2669	0.3634
1990	3590466	137621	76630	14931	0.1948	0.2388
1991	3630526	139644	86130	14791	0.1717	0.2523
1992	4245148	164531	104434	20000	0.1915	0.2702
1993	3202706	172531	118460	22200	0.1874	0.2357
1994	2741908	166966	122244	24300	0.1988	0.2381
1995	3440148	163536	113805	32656	0.2869	0.3543
1996	4626028	164511	102933	32584	0.3166	0.3805
1997	1566281	131060	100901	39843	0.3949	0.5123
1998	2755064	117673	79436	29443	0.3706	0.4623
1999	2871835	133759	81516	31403	0.3852	0.4463
2000	2633858	130265	81505	34069	0.418	0.4819
2001	6066772	154970	77540	38785	0.5002	0.5519
2002	2260420	142080	99111	39701	0.4006	0.4922
2003	6919267	154345	84773	40803	0.4813	0.5743
2004	1012183	118806	90379	39115	0.4328	0.6003
2005	3112373	122224	71574	32225	0.4502	0.5243
2006	6775945	140321	68967	31232	0.4529	0.4477
2007	1945031	123174	88226	33742	0.3824	0.5848
2008	5257057	151491	85910	31137	0.3624	0.3467
2009	2607299	142485	100413	32554	0.3242	0.419
2010	2652806	132088	93128	30174	0.324	0.34
2011	948469	119099	92260	29639	0.3213	0.393
2012	4357052	129057	76022	28115	0.3698	0.3713
2013	4824102	149135	87909	26511	0.3016	0.3075
2014	620549	126200	103405	26253	0.2539	0.3417
2015	3119442*		90347**			
Arith.						
Mean	2707493	119721	78741	25504	0.3305	0.4321
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

*** geometric mean 1989-2012**

**** from short-term forecast**

Table 6.3.14. Short-term forecast input, Gulf of Riga herring

MFDP version 1a

Run: GoR2014_07

Time and date: 11:15 16/04/2014

Fbar age range: 3-7

2015								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	3119442	0.2	0	0.2	0.3	0.0096	0.1254	0.0096
2	438430	0.2	0.93	0.2	0.3	0.0148	0.2149	0.0148
3	2410240	0.2	0.98	0.2	0.3	0.0192	0.2862	0.0192
4	1269640	0.2	0.98	0.2	0.3	0.0225	0.3248	0.0225
5	171170	0.2	1	0.2	0.3	0.0250	0.3502	0.0250
6	234560	0.2	1	0.2	0.3	0.0271	0.3613	0.0271
7	126900	0.2	1	0.2	0.3	0.0288	0.3782	0.0288
8	264620	0.2	1	0.2	0.3	0.0318	0.3782	0.0318

2016								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	3119442	0.2	0	0.2	0.3	0.0096	0.1254	0.0096
2	.	0.2	0.93	0.2	0.3	0.0148	0.2149	0.0148
3	.	0.2	0.98	0.2	0.3	0.0192	0.2862	0.0192
4	.	0.2	0.98	0.2	0.3	0.0225	0.3248	0.0225
5	.	0.2	1	0.2	0.3	0.0250	0.3502	0.0250
6	.	0.2	1	0.2	0.3	0.0271	0.3613	0.0271
7	.	0.2	1	0.2	0.3	0.0288	0.3782	0.0288
8	.	0.2	1	0.2	0.3	0.0318	0.3782	0.0318

2016								
Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	3119442	0.2	0	0.2	0.3	0.0096	0.1254	0.0096
2	.	0.2	0.93	0.2	0.3	0.0148	0.2149	0.0148
3	.	0.2	0.98	0.2	0.3	0.0192	0.2862	0.0192
4	.	0.2	0.98	0.2	0.3	0.0225	0.3248	0.0225
5	.	0.2	1	0.2	0.3	0.0250	0.3502	0.0250
6	.	0.2	1	0.2	0.3	0.0271	0.3613	0.0271
7	.	0.2	1	0.2	0.3	0.0288	0.3782	0.0288
8	.	0.2	1	0.2	0.3	0.0318	0.3782	0.0318

Input units are thousands and kg - output in tonnes

Table 6.3.15. Short-term prediction results

MFDP version 1a

Run: GoR2014_07

"Herring Gulf of Riga

Time and date: 11:15 16/04/2014

Fbar age range: 3-7

2015				
Biomass	SSB	FMult	FBar	Landings
134085	90347	1	0.3402	28445

2016					2016	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
134554	95491	0	0	0	167080	125796
.	94919	0.1	0.034	3128	163739	121962
.	94350	0.2	0.068	6169	160489	118258
.	93785	0.3	0.102	9126	157330	114678
.	93223	0.4	0.1361	12001	154257	111219
.	92665	0.5	0.1701	14798	151269	107875
.	92111	0.6	0.2041	17518	148363	104644
.	91559	0.7	0.2381	20163	145536	101519
.	91012	0.8	0.2721	22737	142786	98499
.	90467	0.9	0.3061	25241	140111	95579
.	89926	1	0.3402	27676	137509	92756
.	89389	1.1	0.3742	30046	134977	90025
.	88854	1.2	0.4082	32352	132513	87384
.	88323	1.3	0.4422	34596	130116	84830
.	87796	1.4	0.4762	36780	127783	82360
.	87271	1.5	0.5102	38906	125512	79969
.	86750	1.6	0.5442	40975	123302	77657
.	86232	1.7	0.5783	42989	121151	75420
.	85718	1.8	0.6123	44949	119057	73254
.	85206	1.9	0.6463	46858	117018	71159
.	84698	2	0.6803	48716	115034	69131

Input units are thousands and kg - output in tonnes

Table 6.3.17. Yield-pr-recruit input.

MFYPR version 2a

Run: GoR_2015_01YPR

Herring Gulf of Riga

Time and date: 12:08 16.04.2015

Fbar age range: 3-7

6

Age	M	Mat	PF	PM	SWt	Sel	CWt
1	0.2	0	0.2	0.3	0.0096	0.1254	0.0096
2	0.2	0.93	0.2	0.3	0.0148	0.2149	0.0148
3	0.2	0.98	0.2	0.3	0.0192	0.2862	0.0192
4	0.2	0.98	0.2	0.3	0.0225	0.3248	0.0225
5	0.2	1	0.2	0.3	0.0250	0.3502	0.0250
6	0.2	1	0.2	0.3	0.0271	0.3613	0.0271
7	0.2	1	0.2	0.3	0.0288	0.3782	0.0288
8	0.2	1	0.2	0.3	0.0318	0.3782	0.0318

Weights in kilograms

Table 6.3.17. Yield-pr-recruit results.

MFYPR version 2a

Run: GoR_2015_01YPR

Herring Gulf of Riga

Time and date: 12:08 16.04.2015

Fbar age range: 3-7

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	0.1201	4.435	0.1092	4.1767	0.1028
0.1	0.034	0.1221	0.0029	4.9085	0.1022	3.8286	0.0912	3.5827	0.0853
0.2	0.068	0.2122	0.0048	4.4604	0.0892	3.3823	0.0783	3.1456	0.0728
0.3	0.102	0.2817	0.0062	4.115	0.0794	3.0386	0.0685	2.8091	0.0633
0.4	0.1361	0.3372	0.0072	3.8394	0.0718	2.7646	0.0609	2.5412	0.0559
0.5	0.1701	0.3828	0.0079	3.6137	0.0656	2.5405	0.0548	2.322	0.05
0.6	0.2041	0.4209	0.0085	3.4248	0.0606	2.3531	0.0498	2.1389	0.0452
0.7	0.2381	0.4535	0.0089	3.2639	0.0564	2.1938	0.0456	1.9833	0.0411
0.8	0.2721	0.4816	0.0092	3.125	0.0528	2.0563	0.0421	1.8492	0.0377
0.9	0.3061	0.5063	0.0095	3.0035	0.0497	1.9362	0.039	1.7322	0.0348
1	0.3402	0.5281	0.0097	2.8962	0.0471	1.8303	0.0364	1.629	0.0323
1.1	0.3742	0.5476	0.0099	2.8006	0.0447	1.7359	0.0341	1.5373	0.0301
1.2	0.4082	0.5651	0.01	2.7147	0.0427	1.6513	0.032	1.455	0.0281
1.3	0.4422	0.5809	0.0101	2.637	0.0408	1.5748	0.0302	1.3808	0.0264
1.4	0.4762	0.5954	0.0102	2.5663	0.0392	1.5053	0.0286	1.3134	0.0249
1.5	0.5102	0.6086	0.0103	2.5016	0.0377	1.4418	0.0271	1.2519	0.0235
1.6	0.5442	0.6208	0.0103	2.4422	0.0364	1.3835	0.0258	1.1956	0.0222
1.7	0.5783	0.6321	0.0104	2.3873	0.0351	1.3297	0.0246	1.1437	0.0211
1.8	0.6123	0.6425	0.0104	2.3365	0.034	1.28	0.0235	1.0957	0.02
1.9	0.6463	0.6523	0.0104	2.2892	0.033	1.2337	0.0225	1.0512	0.0191
2	0.6803	0.6614	0.0105	2.2451	0.032	1.1906	0.0215	1.0098	0.0182

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.3402
FMax	2.4327	0.8275
F0.1	0.7346	0.2499
F35%SPR	0.8583	0.292

Weights in kilograms

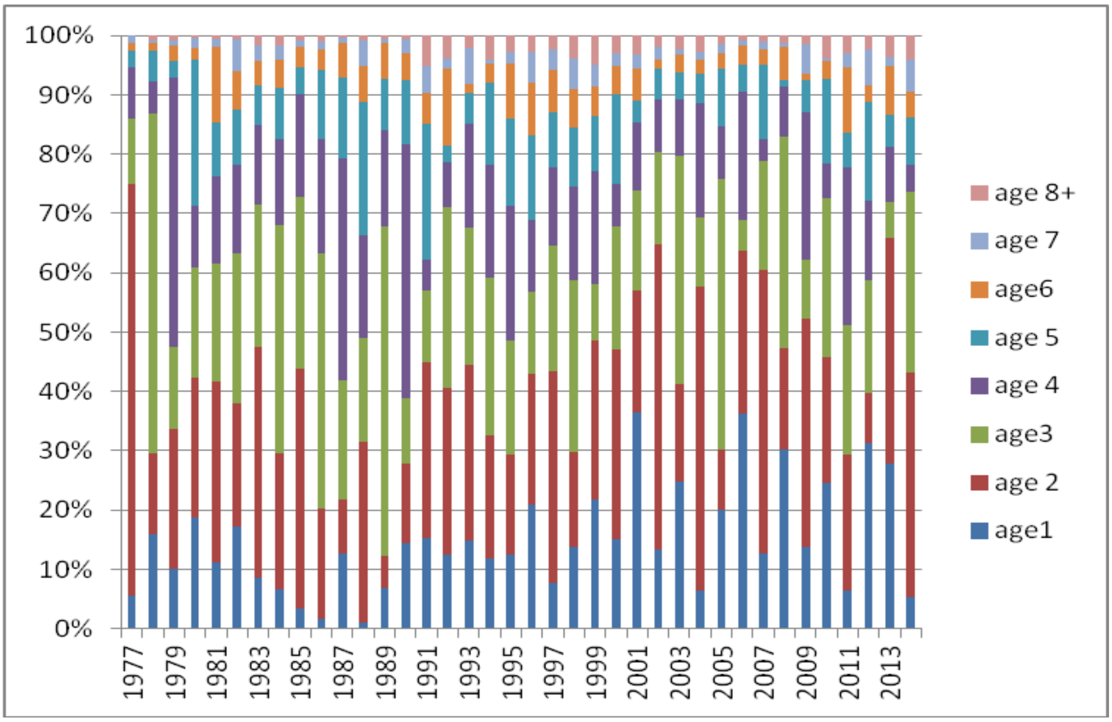


Figure 6.3.1. Gulf of Riga herring. Relative catch at age in numbers in 1977-2014

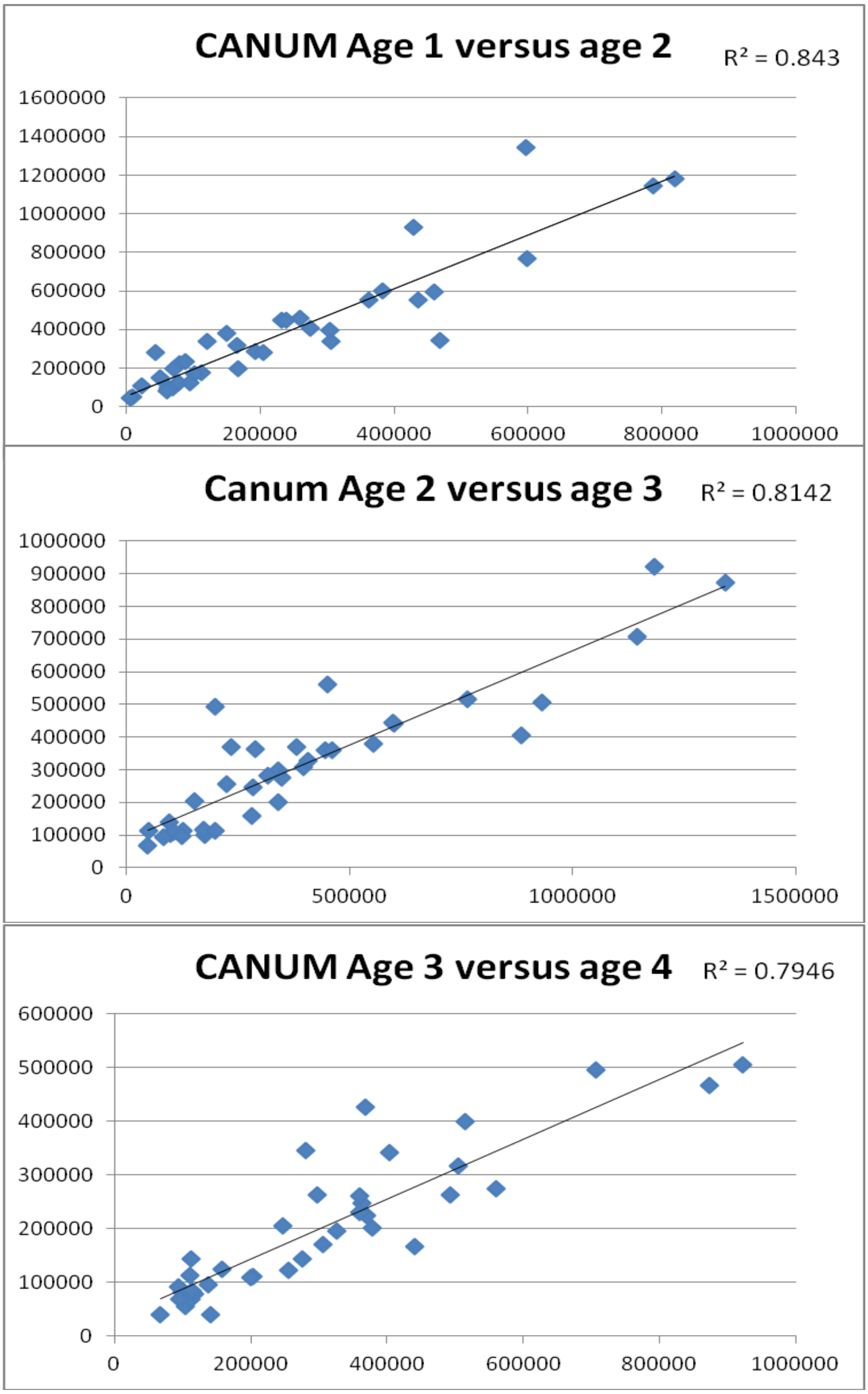


Figure 6.3.2. Gulf of Riga herring. Check for consistency in catch-at-age data

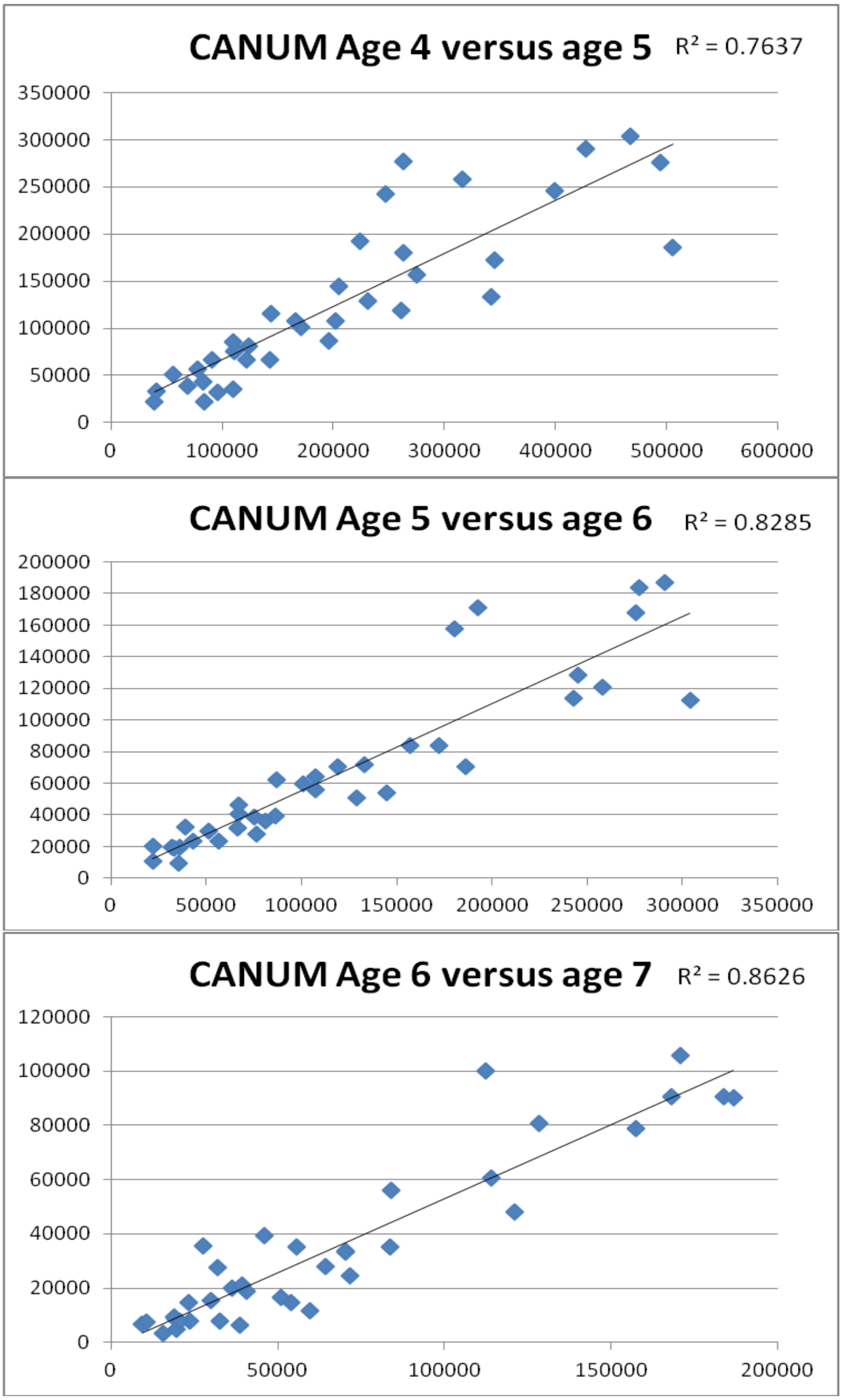


Figure 6.3.2 (cont). Gulf of Riga herring. Check for consistency in catch-at-age data

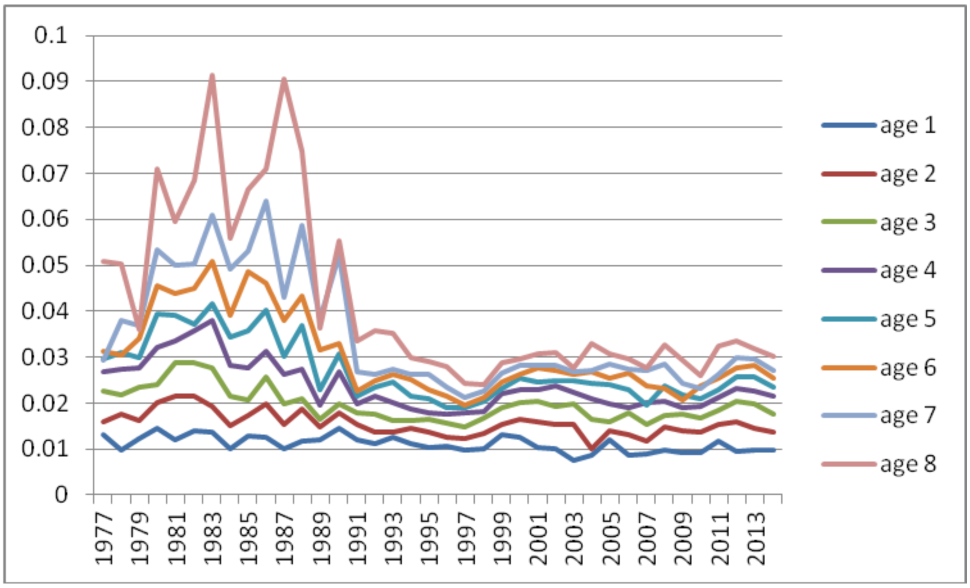


Figure 6.3.3. Gulf of Riga herring. Mean weight at age in the catches.

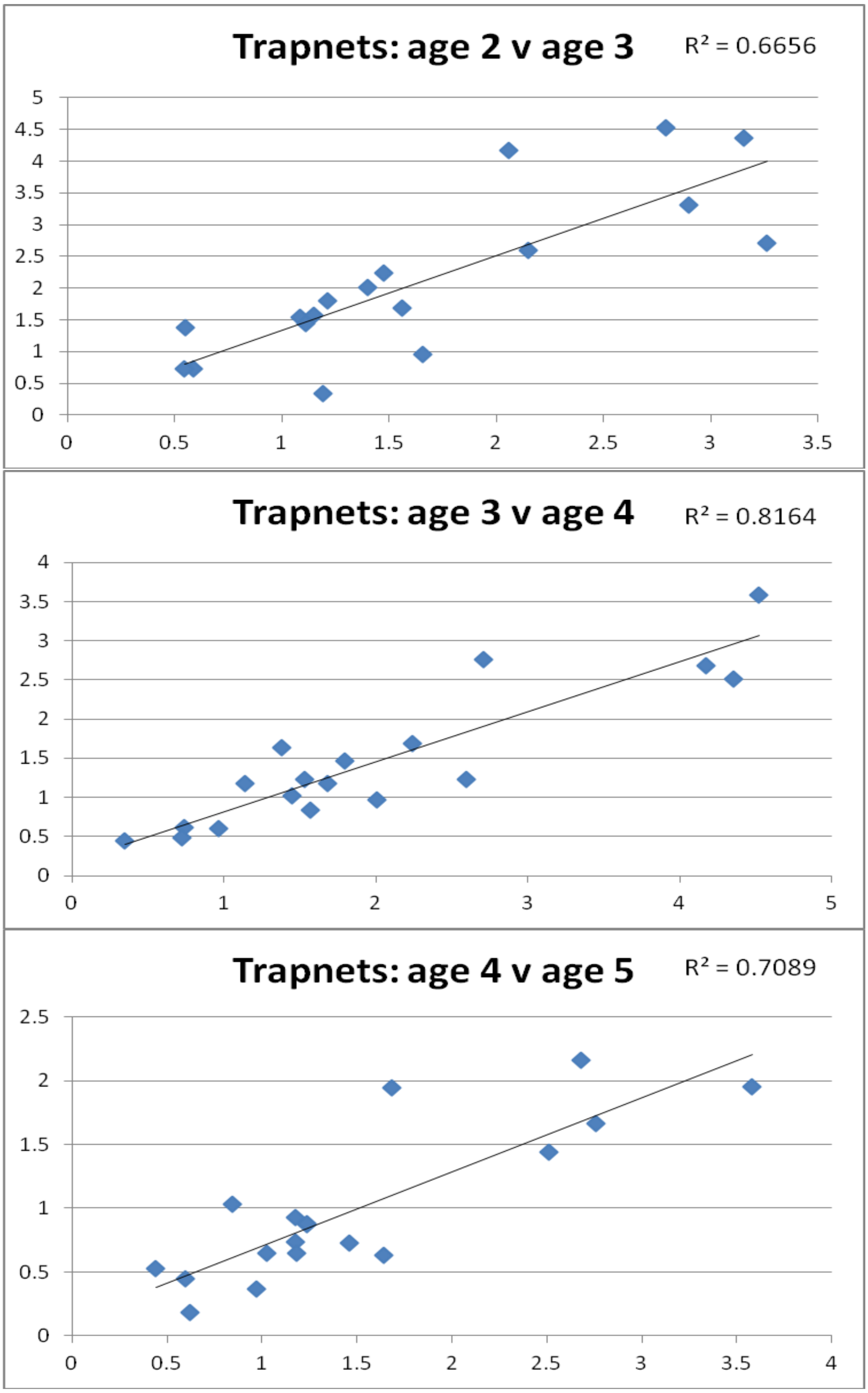


Figure 6.3.4. Gulf of Riga herring. Check for consistency of trap-net fleet (log indices) data

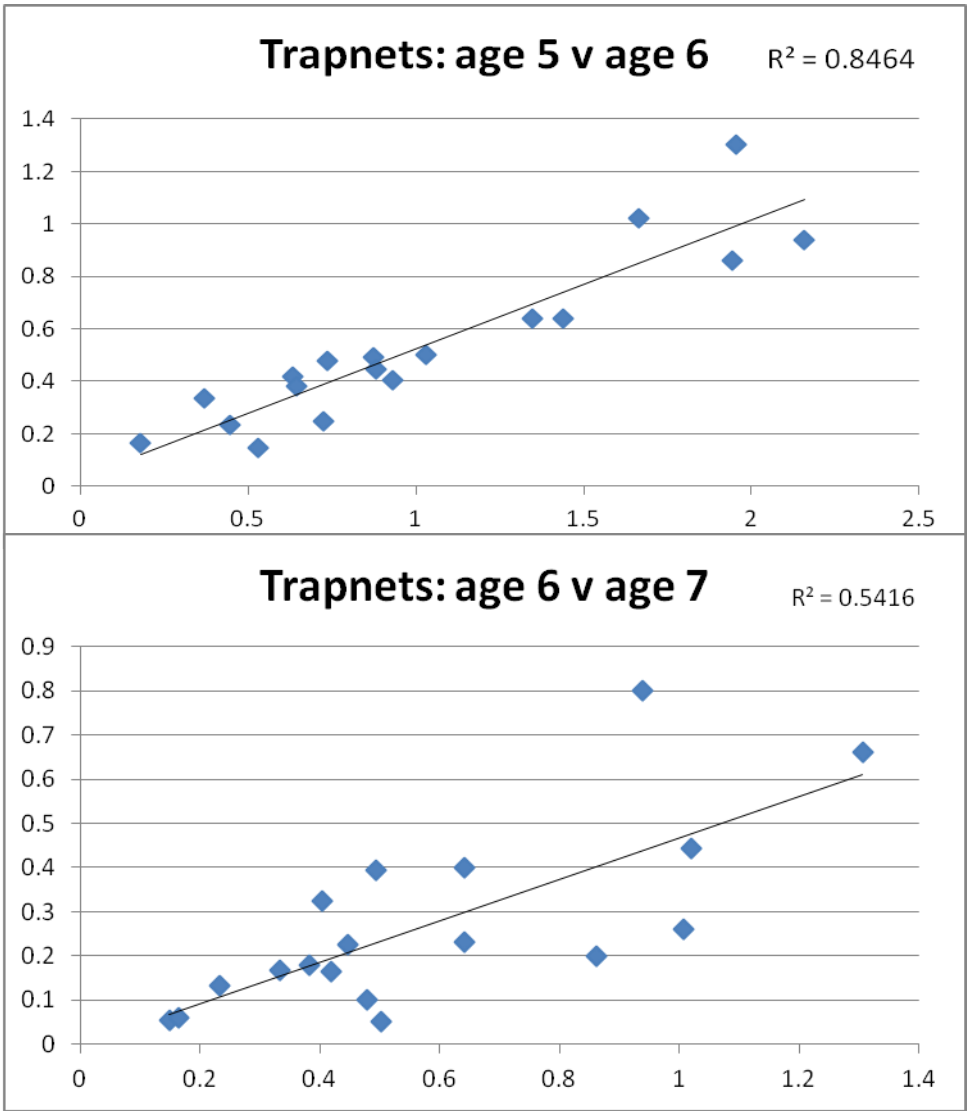


Figure 6.3.4 (cont). Gulf of Riga herring. Check for consistency of trap-net fleet (log indices) data

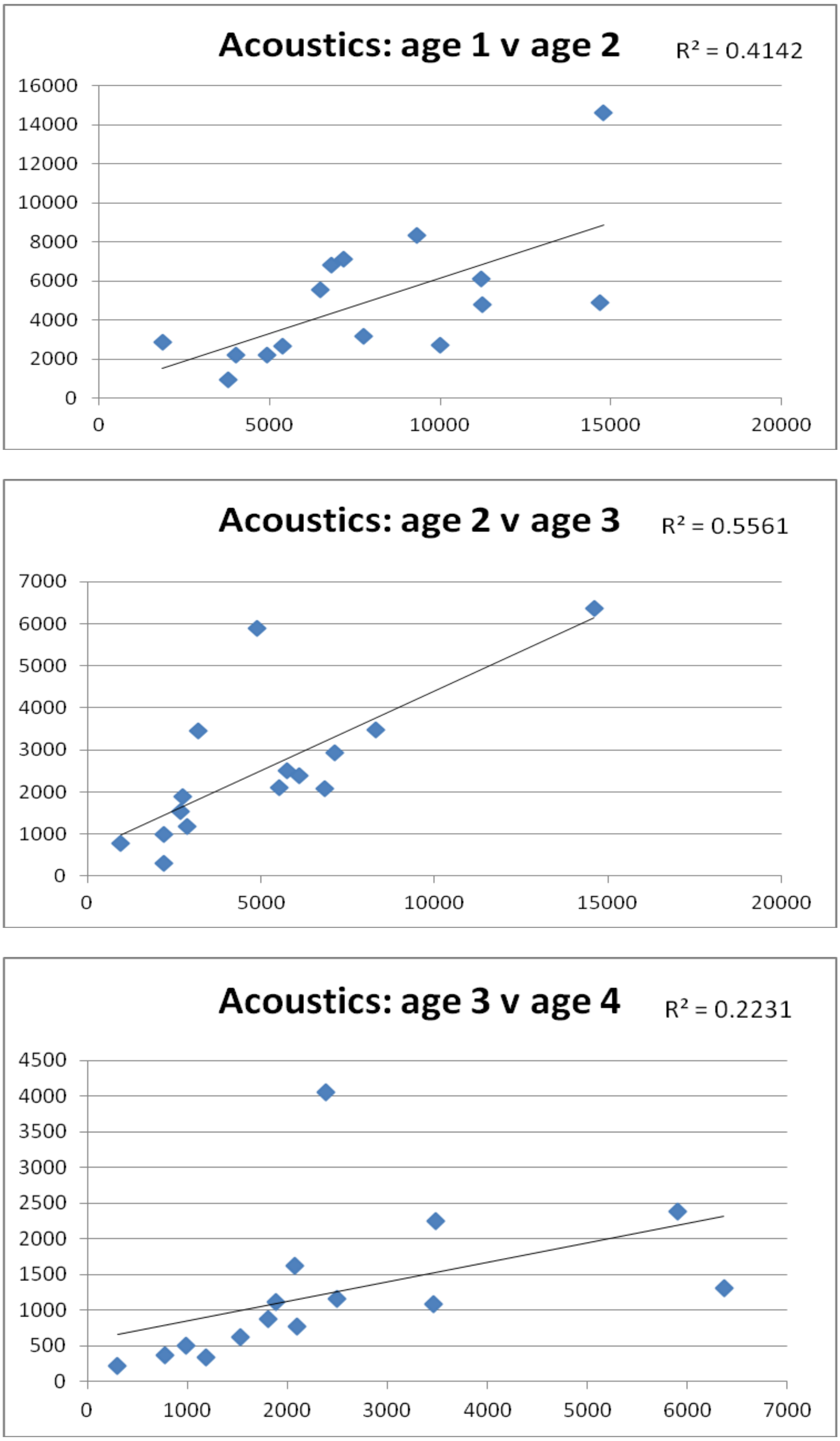
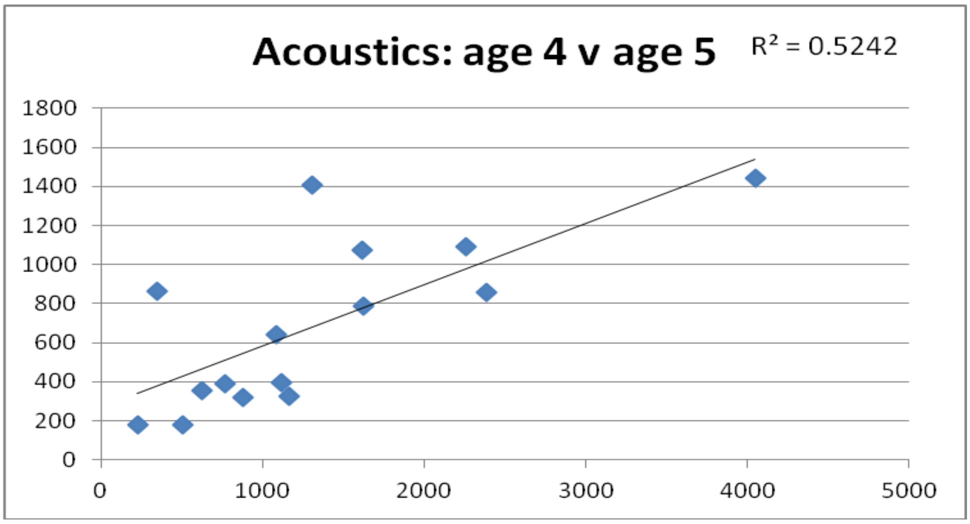
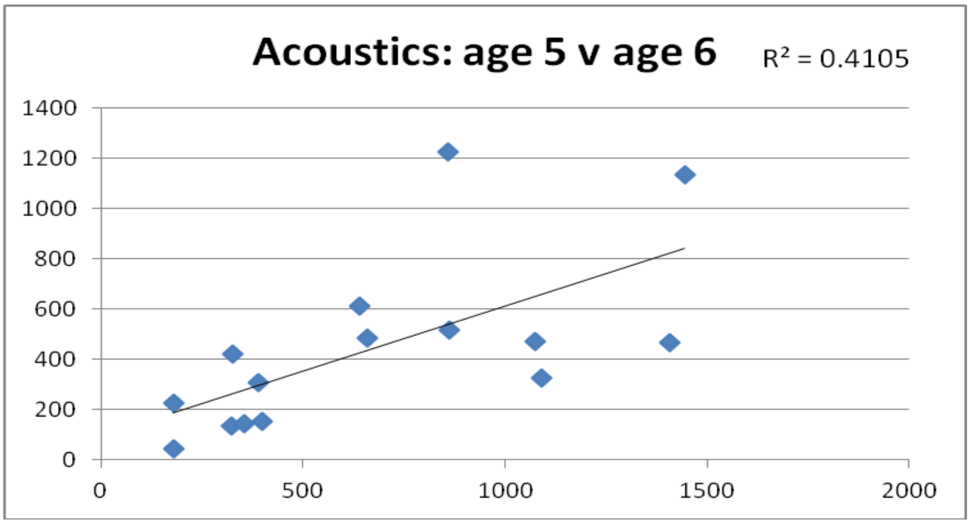


Figure 6.3.5. Gulf of Riga herring. Check for consistency of acoustic fleet data





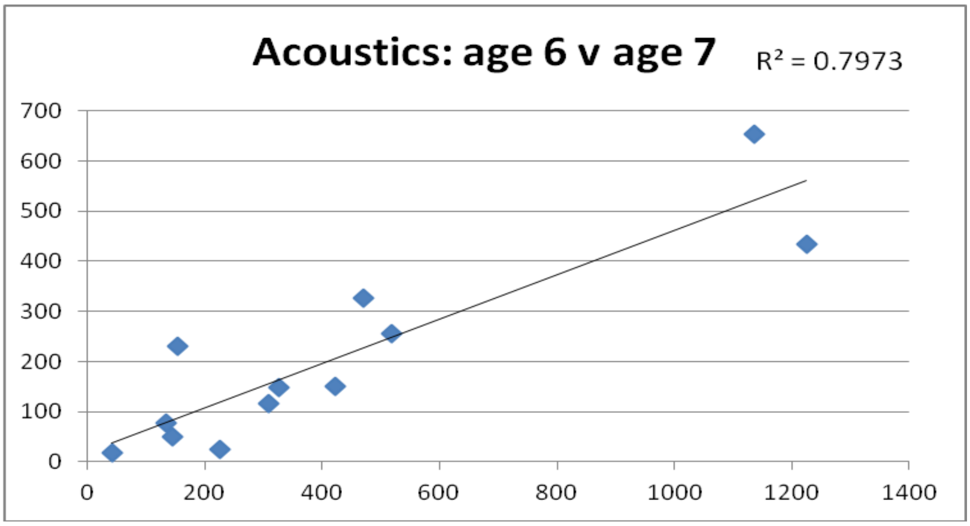


Figure 6.3.5 (cont). Gulf of Riga herring. Check for consistency of acoustic fleet data

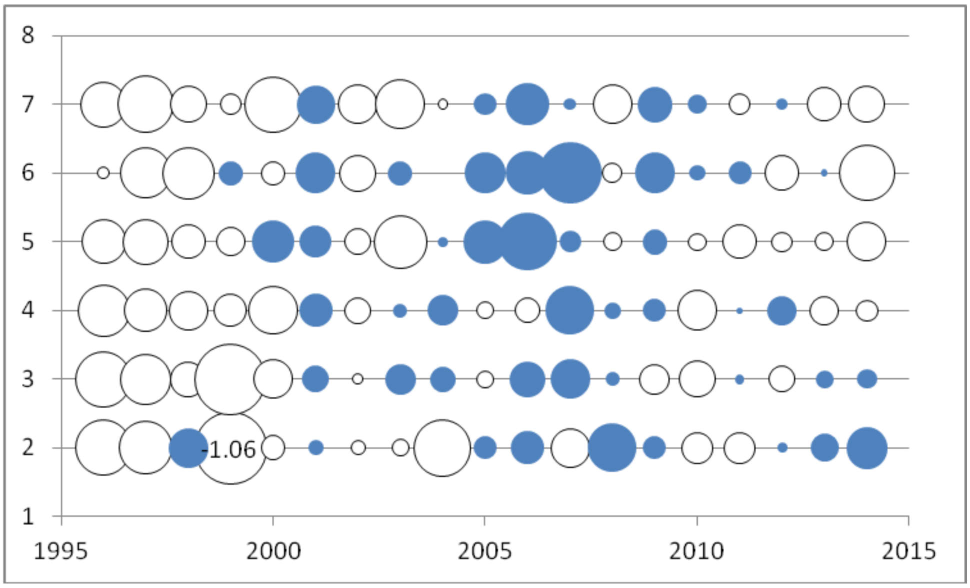


Figure 6.3.6a. Gulf of Riga herring. Log catchability residuals of trap-net fleet.

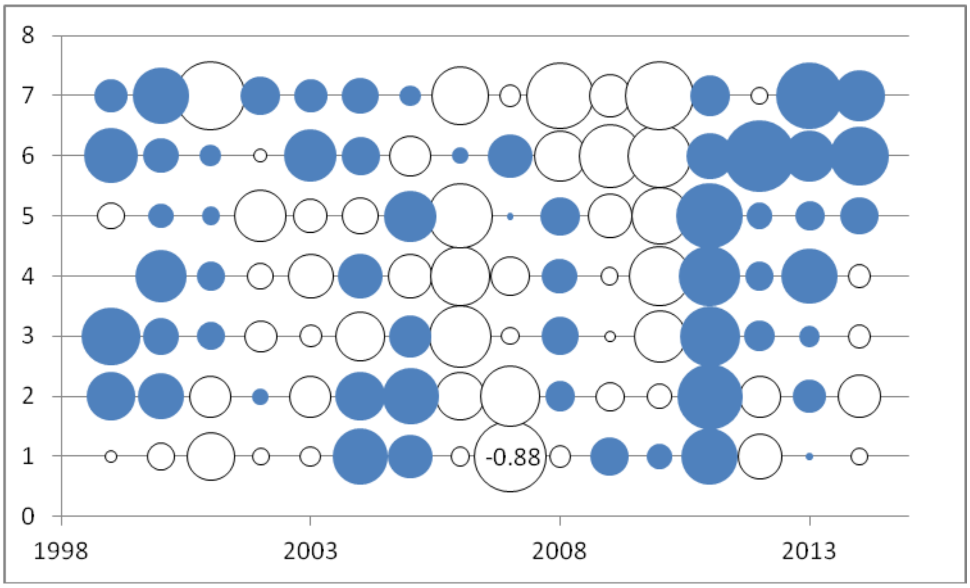
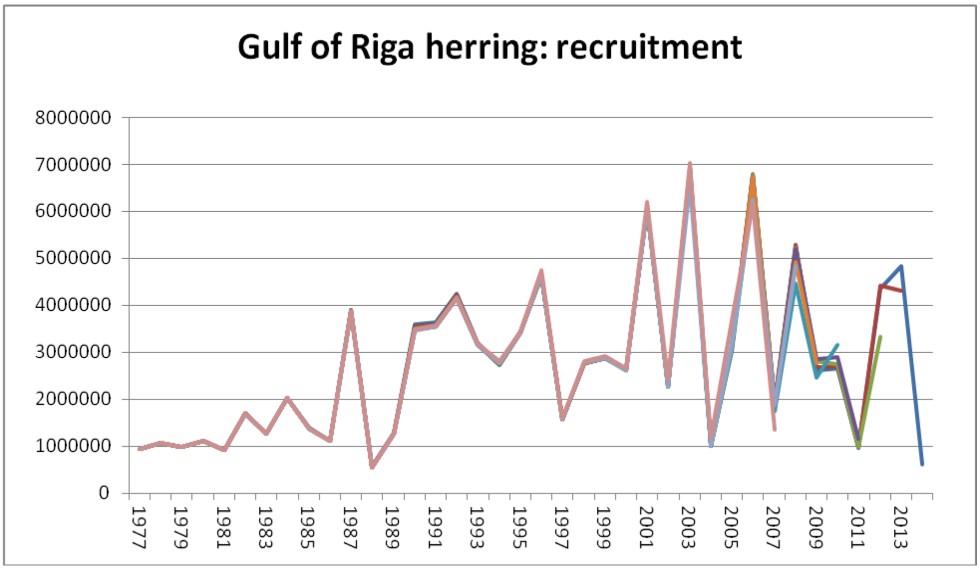
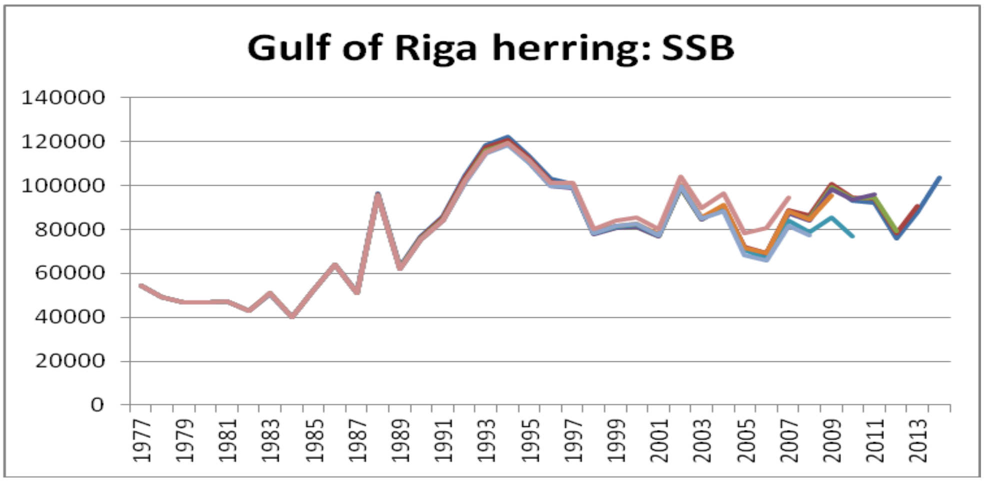


Figure 6.3.6b. Gulf of Riga herring. Log catchability residuals of acoustic fleet.





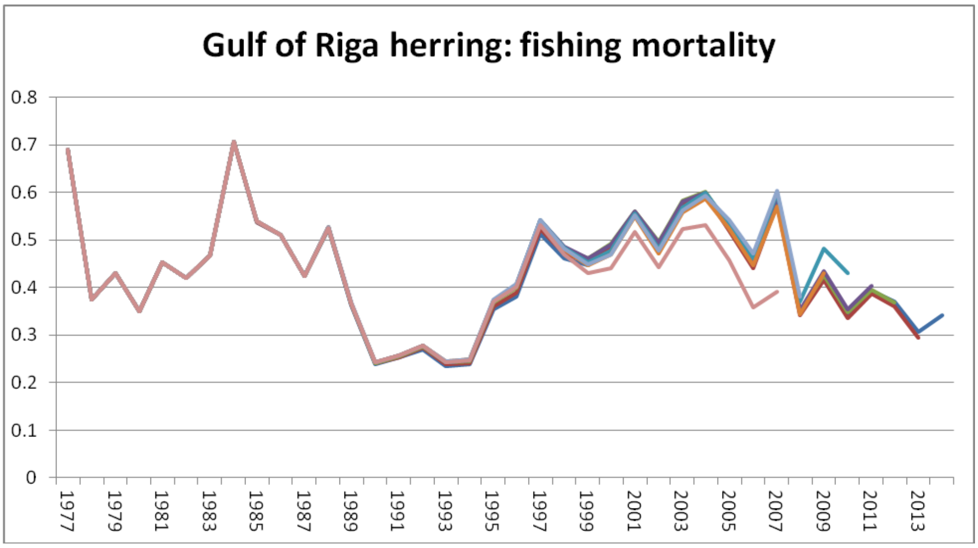


Figure 6.3.7. Gulf of Riga herring. Retrospective analysis.

Figure 6.3.8. Standard graphs.

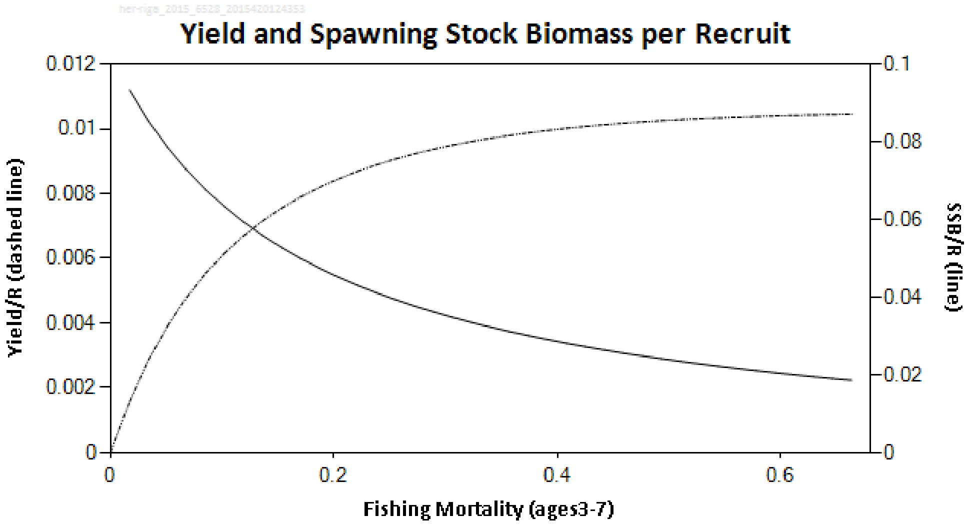
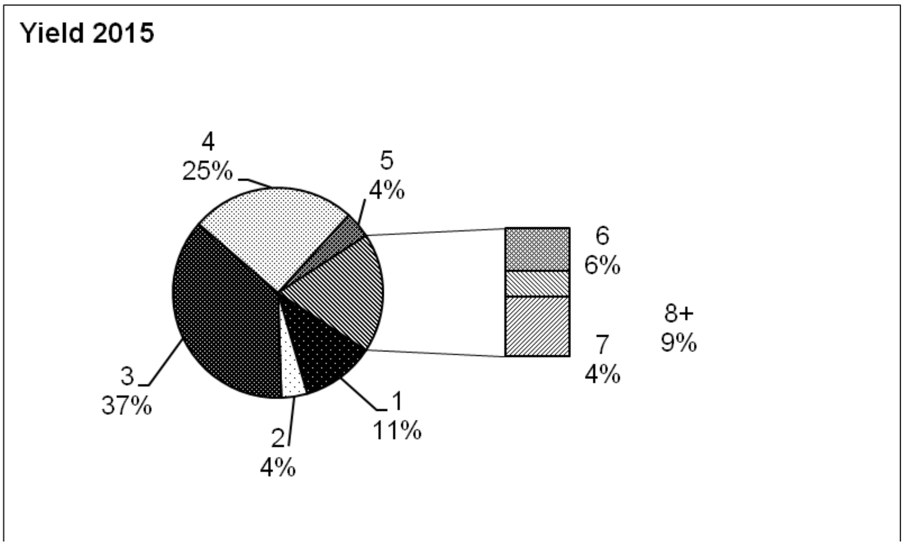


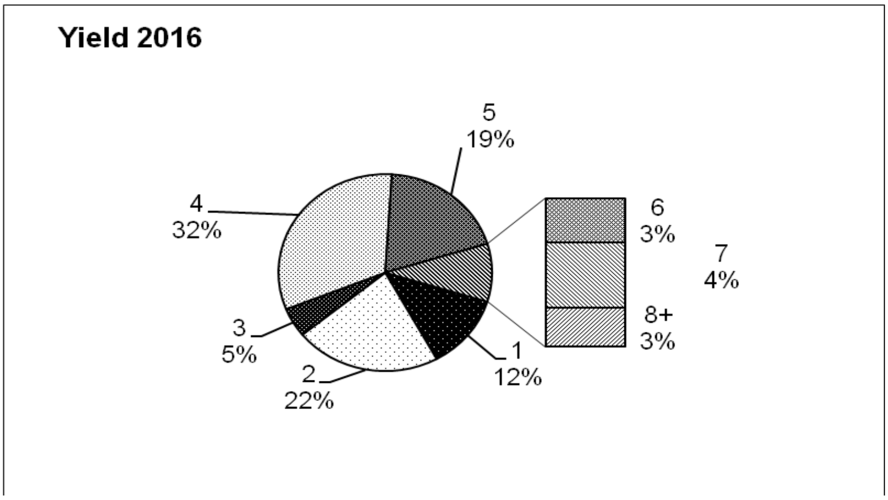
Figure 6.3.8. Standard graphs.

Herring in Subdivision 28.1 (Gulf of Riga)

Species: Clupea harengus

Stock code: her-riga





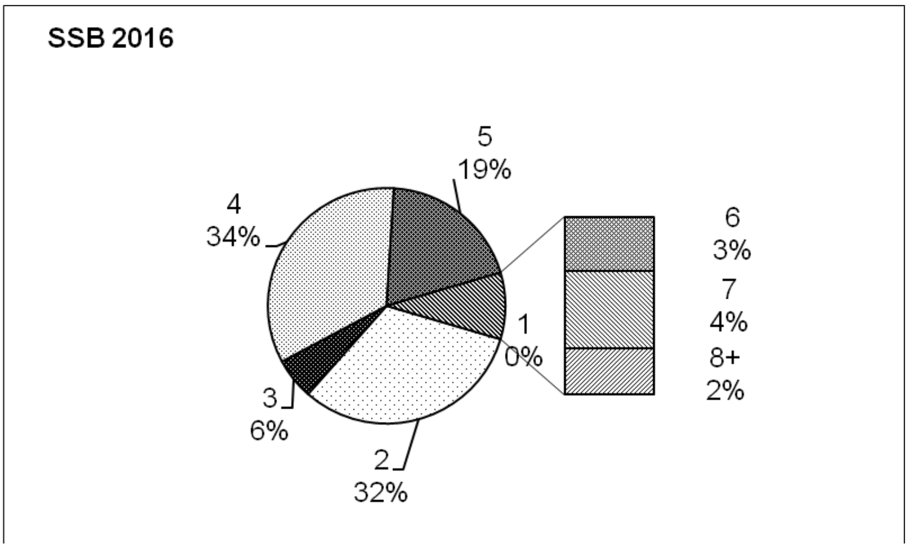


Figure 6.3.9. Gulf of Riga herring. Short-term forecast for 2014–2016. Yield and SSB at age 1–8+under the *status quo* fishing mortality.

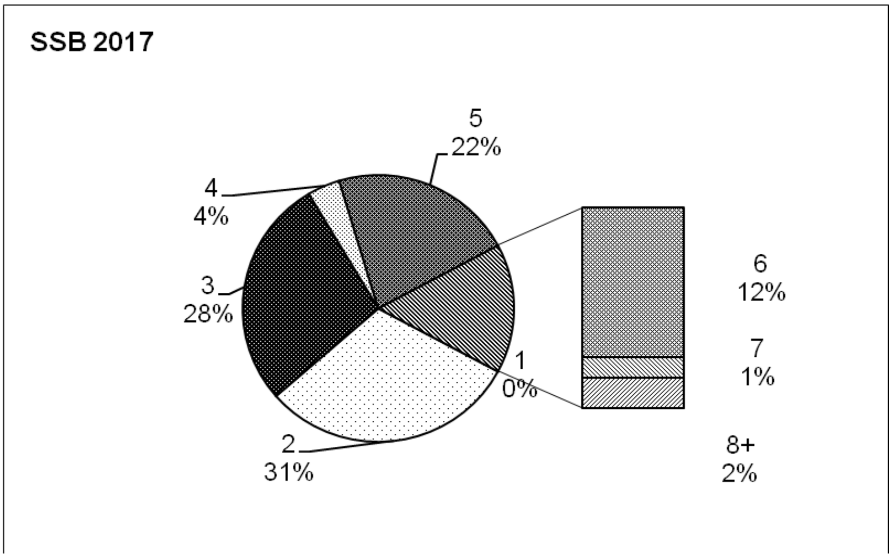


Figure 6.3.9. (cont) Gulf of Riga herring. Short-term forecast for 2014–2016. Yield and SSB at age 1–8+under the *status quo* fishing mortality.

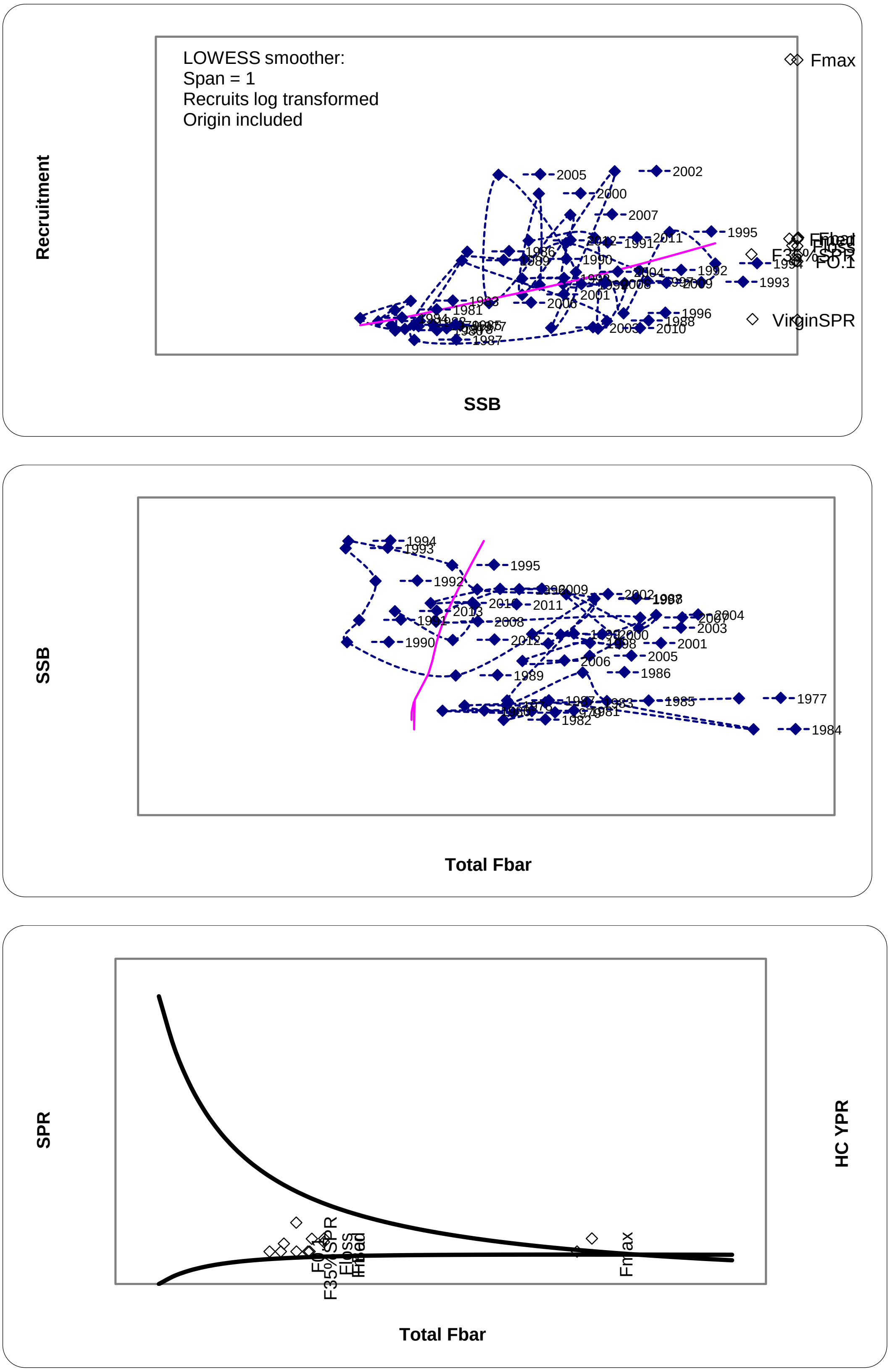
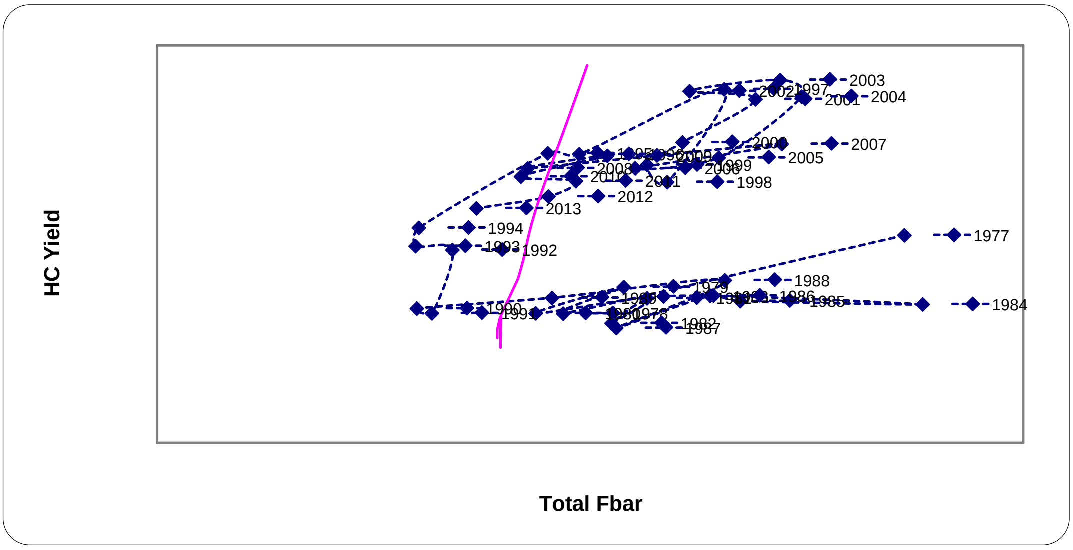
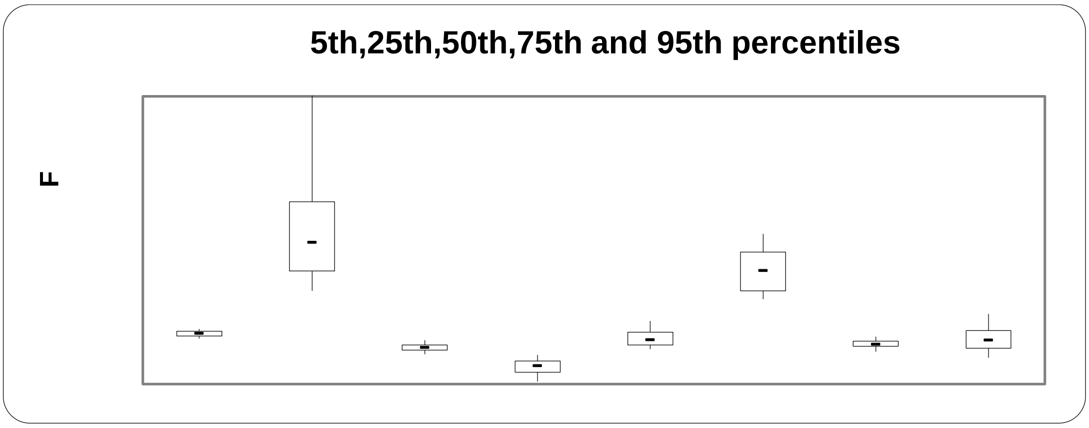


Figure 6.3.10. Gulf of Riga herring. PA plots and reference points.





Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	2671027	2671027	2741518	3185001	
MBAL	60000				27.03
Bloss	37783				
SSB90%R90%Surv	80798	81594	87441	98559	54.05
SPR%ofVirgin	30.02	29.49	31.18	34.36	
VirginSPR	0.11	0.11	0.12	0.13	
SPRloss	0.03	0.04	0.04	0.05	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.35	0.35	0.33	0.32	78.38
Fmax	0.96	0.98	0.79	0.65	0.00
F0.1	0.26	0.25	0.24	0.21	89.19
Flow	0.09	0.13	0.08	0.02	100.00
Fmed	0.34	0.31	0.27	0.24	78.38
Fhigh	0.75	0.79	0.65	0.59	0.00
F35%SPR	0.28	0.28	0.26	0.22	86.49
Floss	0.32	0.31	0.25	0.18	83.78

Figure 6.3.10. (cont.) Gulf of Riga herring. PA plots and reference points.

6.4 Herring in Subdivision 30

6.4.1 The Fishery

The three main fleets operating in Baltic herring fisheries in the Bothnian Sea 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 and demersal trawling, and the trawl is classified as pelagic or demersal depending only on its vertical position in the water column. In 2014, 53 % of the Finnish landings came from pelagic trawls, 41 % from demersal trawls, 6 % with trapnets, and 0.2 % with gill-nets. In 2014, 81 % of the Swedish catch came from pelagic trawls, 15 % from demersal trawls 4 % from gill-nets and 0.01 % from other passive gears.

6.4.1.1 Catch trends

The total catch in SD 30 (Bothnian Sea) increased by 751 tonnes (<1%) from 2013 to a new record, 110,534 tonnes in 2014 (Figure 6.4.1), of which 88 % (97779 tonnes) was Finnish catch and 12 % (12755 tonnes) was Swedish catch (Table 6.4.1). The Finnish catch decreased by 1 % (1156 tonnes) and the Swedish catch increased by 18 % (1906 tonnes) compared to 2013.

6.4.1.2 Unallocated landings

No unallocated landings were reported. In the year 2014, the unreported fraction of fishing activities in Finnish fisheries was 0 % in the group with an EU fishing logbook and about 17% among those completing coastal fishery forms (= fisheries with trapnets, coastal gill-nets and vessels less than 10 meters). Of the total catch, 96% was reported with the EU fishing logbook. In the final Finnish catch estimates, the landings data is corrected accordingly.

6.4.1.3 Discards

Discarding rates in the Finnish fisheries are 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 therefore 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 interest (order of buyers). In gillnet fisheries, all the fish damaged by seal (grey or ringed) predation is 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 (mainly specialized) fishery with nets. The reporting of discards has been voluntary in Sweden until 2010. Since 2011, there is a requirement for fishermen to report the entire catch (including drafts) over 50 kg in the logbook. However, not the entire fishery has been in compliance with this requirement, and many unreported discardings have occurred. Only a few records of herring discards are available each year, although the amount reported has increased in recent years. 17-18 tonnes discard is annually reported in SD 30. Fishers themselves regard the discard level of herring in net fishing as marginal in the Bothnian Sea, but the official statistics show that already reported herring discard is around 13% of the total herring catch of gillnets. In the SD 30, 1-2 tonnes of discarded herring are additionally reported from the trawl fisheries every year, which make up less than 1% of the total landings of that fishery. However, interviews of fishermen indicated that they estimated the discard rate to be about 10% for the entire year.

Disagreement with the official statistics can be explained by the low reporting level of discards in trawl fisheries. Based on the Swedish official statistics (in 2008-2010) and an informal interview of fishermen (carried out in 2012 by Swedish University of Agricultural Sciences), it can be assumed that 6-12% of Swedish herring catches, taken from SD 30 have been discarded in recent years. It will form up to 1% of the total herring catches in SD 30 and discards are therefore regarded as negligible in the assessment.

6.4.1.4 Effort and CPUE data

The total fishing effort for the trawl fisheries is reported as total trawling hours. The trawl fishing effort almost quadrupled during the 1990s but has thereafter halved. In 2014 the number of trawling hours in the pelagic fleet increased by 4 % (33749hours in 2013 and 35273 in 2014) while in demersal fleet the hours were in the same level as in previous year (19105 hours in 2013 and 19089 hours in 2014). The trawl fleets are not used in tuning due to problems in quantifying changes in fishing effort (eg. engine power and gear size). The cpue from all trapnet fishery in SD 30 was also used in tuning assessment models earlier. In the trapnet fisheries the number of trap-nets set is used as effort. Throughout the 1980s the number of trap nets decreased dramatically, in 1991 the number of trap-nets was only a fifth of the number in 1980, but it has since then remained more or less stable. In 2014 the number of all trapnets increased by 4 % from 2013.

The stock was downscaled to a category 3.1.0 (data limited stock) during the working group this year due to reasons outlined below. A spaly (same procedure as last year) update assessment run was performed and the catch advice for this stock was based on trends in the SSB and F. The input data and setting of the spaly assessment run are provided below.

Two tuning indices are used in the update assessment; a trapnet cpue time series and time series of the hydroacoustic survey:

The trapnet-tuning fleet was renewed in 2013 according to recommendations from WKPELA 2012 (see also IBP her-30 report). It comprised of unbroken timeseries of catch and effort combined from three areas in Finnish coast of Bothnian Sea (rectangles 23, 42 and 47) (Figure 6.4.2). In 2014, however, the area 23 did not a have qualified trapnet fishery anymore, i.e. catch and effort were 0 (Figure 6.4.3).

A joint Swedish – Finnish hydroacoustic survey has been annually conducted in late September – early October in the Bothnian Sea from 2007 until 2010 with Swedish RV Argos. In 2011 and 2012 the surveys were performed with Danish RV Dana and since 2013 with Finnish RV Aranda. 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 Finnish coast. The survey generally tracks all the age groups well, with the exception of the 2012 survey (Figure 6.4.8). The survey is providing yearly estimates of total abundances and biomasses of all age groups (Figure 6.4.6.). The age-groups 0 and 1 are not included in the survey-index due to the annual variation in its occurrence in the catches at the survey time. As there is only 8 years of time series so far no statistical analyses was conducted to determine a potential significance of the trend of the time series.

In 2012 the survey was not performed according to standard coverage (60nmi 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. It is recommended by WGBIFS that the data from the year 2012 should be treated with caution. Acoustic surveys have shown to be essential for the assessment of this stock, and therefore they should be continued with the required effort-level.

6.4.2 Biological composition of the catch

6.4.2.1 Age composition

The data of Finnish catches at age are available for years 1973–2014 and these age compositions have been used to apply to the Swedish catches as well except in 1987, 1989–1991, 1993 and 2000–2014 when the Swedish catches were mostly allocated according to Swedish age sampling. In 2014 Swedish unsampled catches were allocated in InterCatch according to Finnish sampling from respective fisheries (Table 6.4.2). Finnish and Swedish sampling of the catches are shown in Table 6.4.5.

The most common age class in numbers in the 2014 catches was the age-group 3 and biggest in biomass was the age-group 9+. The total catch in numbers is shown in Table 6.4.6.

6.4.2.2 Mean weight at age and condition

Mean weight at age in the catches (Table 6.4.3) was assumed similar to the mean weight in the stock. The average weight at age decreased for all ages since about 1990 (Figure 6.4.4), but stabilised in the beginning of the 2000 and has increased in all age-groups except in ages 1 and 2 in 2014.

6.4.2.3 Maturity at age

Constant maturity ogives have been used for period 1973 – 1982. Since 1983 the proportions mature at age have been annually updated from the samples taken before spawning time. Updated maturity ogives for 1973–2014 are shown in Table 6.4.4. There is generally high variability in maturity ogives among years, which causes some noise in assessments. In 2014 the estimated proportion of mature individuals in two-year-olds was on a little lower level than in 2013 (70 % in 2014 compared to 77 % in 2013). The annual variation in this age-group 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 discontinue to update the maturity ogives annually (WKPELA 2012).

6.4.2.4 Natural mortality

Natural mortality rate 0.20 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.

WGBFAS 2011 (Bergenius *et al*, Working Document 5. ICES 2011a), recommended that the potential effects of the rapid increase in the grey seal (Halichoerus grypus) population in the Bothnian Sea since the middle of the 1980s to the middle of 2000, after which the population growth has levelled out, should be investigated. Gårdmark *et al*.

(2012 b) analysed the effects of ignoring seal predation on herring stock estimates. Using a XSA and a state –space assessment model (SAM) they concluded that the uncertainty of standard estimates (due to measurement errors in fisheries catch-at-age data) was much greater than the bias caused by ignoring grey seal consumption (Gårdmark *et al*., 2012, ICES, 2012a, 2012). Due to the inherent uncertainty in estimates of M and due to the small effect of grey seal consumption on herring stock estimates, grey seal predation has not been included in the current stock assessment. Considering the gradual increase of the seals, the status of the seal population should be followed in the light of Gårdmark *et al*. (2012), and the effect on herring assessment re-investigated when regarded necessary.

The predation by cormorant (Phalacrocorax carbo) has been studied in Finland and Sweden. The number of cormorants increased rapidly in both countries in the 1990s and the 2000s. At both western and eastern coasts of the Bothnian Sea, cormorant numbers have varied during the recent five years. It can be roughly estimated that in recent years in the Bothnian Sea, cormorants have eaten on the average 500–600 tons of herring per year, which is around or less than one tenth of the proportion eaten by seals. Thus cormorants have not been included in the stock assessment.

The number of cod (*Gadus morhua*) in the northern parts of the Baltic main Basin and especially in Gulf of Bothnia (SD 30) is currently small and the predation is therefore also negligible. The Finnish total annual cod catch in 2014 was only 50 kg from the Bothnian Sea. For further information on the effects of seals on the herring population, other species interactions and ecosystem drivers see section about ecosystem aspects in the annex.

In conclusion, although previous analyses and simple calculations point to that the predation of seals, cormorants and cod on herring do not seem to have had a major impact on the total stock estimates, 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.

Quality of catch and biological data

An acoustic survey was initiated in 2007 in the Bothnian Sea. The biological samples for ages from the surveys in 2007-2014 have been annually used for 3rd and/or 4th quarter ALK's for length distributions from commercial sampling and mean weights at age in the input data.

From Finnish commercial catches, 59 length-samples and 71 age-samples were taken in 2014, and 15 length-samples and 6 age-samples from the Swedish fisheries. In total in 2014, 34328 herring were length-measured from commercial catches and 3929 aged from both commercial catches and surveys (Table 6.4.5).

6.4.3 2014 Assessment

The Inter-Benchmark-Process for the assessment of herring in SD 30 was performed in February-April 2013 and consequently a state-space assessment model (SAM) (ICES WGMG report 2009) was accepted to be the model used for the assessment of herring in SD 30.

This year's assessment is an update assessment (based on the spaly settings). Two tuning indices, a trapnet index and a hydroacoustic survey index were included. The trapnet index was however, not considered sufficiently reliable by the working group, as it is introducing increasing uncertainties to the assessment. Consequently, the working group decided that absolute stock estimates and fishing mortalities are no longer considered reliable and the stock was downgraded to a category 3.1.0. The working group agreed that the general trends of stock numbers and fishing mortalities are not questionable and the catch advice was therefore produced based on the trends in spawning stock biomass and fishing mortality. A benchmark is suggested for this stock in 2017, to mainly investigate the quality of the tuning indices. The acoustic survey index is still short but most likely sufficient as a single tuning index, but this needs to be investigated. The input data, specific settings of the spaly assessment (which was undertaken to produce stock trends) and issues that came up during the working group concerning the trapnet index are explained below.

The input data and model specification were the following:

- The assessment uses one data series of total catch-at-age for the years 1973-2014 and ages 1, 2,..., 9+. In addition, two tuning series were used; one short acoustic survey series for the years 2007-2014 and ages 2,3...,8+, and one longer trap-net series for the years 1990-2014 including ages 3,4,...,9+. The trapnet tuning index was introduced to the assessment during the last benchmark of this stock in 2013 (IBPHer-30; ICES, 2013). Commercial tuning fleets are generally not preferred compared to survey based indices (as the catch in the tuning fleet is also included in the catch matrix and the argument becomes somewhat circular), but at the time of the benchmark the BIAS survey index was considered too short to be the only tuning index included in the assessment. The trapnet tuning index was calculated according to the decisions made at the benchmark (IBPHer-30; ICES, 2013). There were several concerns raised regarding the trapnet index this year. First, the effort in two of the tree areas (the two northernmost) has been reduced to one in the last few years (Figure 6.4.3). In one of the three areas there was no effort last year (2014). The southernmost area, neighbouring the increasing CBH stock, therefore has an increased weight on the tuning index, and it is questionable how representative this tuning index now is of the stock. When calculating this index the lack of effort in one of the areas was handled this year as a missing value. A sensitivity run including an index calculated based on only the two areas including catch and effort was undertaken and compared to the run including all three areas. The SSB in the final year differed by about 10% between the two runs and it was decided to keep data from all three areas in calculating the index. Second, in accordance to the last benchmark (IBPHer-30; ICES, 2013) the model sensitivity to the settings regarding the site effect was investigated at the meeting. The data suggests that the catchability per trap increases with the number of traps, i.e. the CPUE index is proportional to the catch divided by an effort raised to the power 1.4. This index has been used in the assessment since the benchmark 2013. The alternative that was investigated assumed constant catchability per trap, i.e. no traps was declared as an offset in the GLM analysis (see benchmark report: ICES 2013). Introducing this offset to the model produced SSB levels that differed from the spaly settings by minus 500 thousand tonnes, revealing to the working group unacceptable uncertainties regarding the sensitivity of the model and absolute biomass levels of this stock. In addition, the conflicting stock levels produced when including or excluding the survey based index and the trapnet index respectively, further highlighted the uncertainty of this assessment and reliability of the trapnet index. The spaly setting was selected by the meeting as the basis for the assessment as it is and up-date assessment, but the the group was united in that only the trends of SSB, recruitment and fishing mortality should be used.. Third, the trapnet and acoustic indices show different trends. The trapnet abundance index show a large increase of the stock since the middle of 2000 while the survey index show a more stable trend (Table 6.4.8; Figure 6.4.13). This introduces uncertainties to the assessment, evident in the residuals presented below. It should be noted that compared to the 2012 assessment, in 2013 and 2014 assessments the age group 1 in the acoustic series was excluded from the analyses after discussions in the WGBFAS expert group due to not being representatively sampled in the acoustic survey.

- The input data are based on age determination from whole otoliths for 1973-2001 and from sliced and stained otoliths for 2002-2014.
- For the total catches it is assumed that the logarithm of the fishing mortalities for each group follow a random walk. The random walk is uncorrelated for ages 1, 2 and 9+ and correlated for all other ages. The variances of these random walks are assumed to be the same. A correlation parameter for the individual random walks are estimated within the model. All age groups have separate fishing mortalities.
- The model assumes no stock recruitment relationship, instead the number of one-year-old is assumed to follow a random walk on logarithmic scale.
- Each of the two tunings series have separate catchability parameters for ages below 5 years, and shared catchability parameters for ages 5 and above, all catchability parameters are assumed constant over time. The variance of the random walk for the logarithm of the numbers at age, process error along cohorts is assumed common for ages two and above, but age one has an independent variance parameter.
- For the short acoustic series the logarithm of the indices for all ages are assumed to have the same observation variance. For the long trap-net series all ages 4 and above, are assumed to have the same variance on logarithmic scale, but age 3 has an independent variance parameter.
- Details on model configuration and input data can also be viewed at http://www.stockassessment.org (username:guest, password:guest), choose stock BothSeaHerring_2015.

Normalized residuals of the model run are provided in Figure 6.4.7. The residuals are relatively small and do not show any clear year and cohort effects for the catch data. A clear bias is apparent in the last three years in the residuals of both the trapnet and the hydroacoustic survey indices. The trapnet observed values are larger than, and the hydroacoustic observed valued smaller than the predicted for all ages (Figure 6.4.7.). The reason for the increase in the catchability of the trapnets in the last three years is likely mainly explained by the issues raised above, that the trapnet index no longer is representative of the SD 30 area. (Figure 6.4.8). The comparatively low numbers observed in the hydroacoustic in 2012 may be due to the decreased area coverage and decreased number of trawl samples, compared to the other years and the information from the survey in 2012 should be treated with caution (WGBIFS 2014). In addition, in the last BIAS survey a very large year class 0 was observed and due to the technicalities of sampling (i.e. the younger individuals which occupy the surface are filling up the trawl and deeper areas are not well sampled) the older age classes may be underestimated this year (Kaljuste per com 2015, member of the WGBIFS group). In the hydroacoustic survey index the 0 and 1 year-olds are not included (IBPHer-30; ICES, 2013). Due to the conflicting trends in the two indices these are not given much weight in estimating the stock compared to the catch matrix (Figure 6.4.14 of relative observation weights). Estimates of recruitment, SSB and Fbar with confidence intervals from the SAM run are presented in Table 6.4.7 and Figure 6.4.9. The stock numbers and fishing mortalities by age can be found at http://www.stockassessment.org (username:guest, password:guest), choose stock BothSeaHerring_2015.

Consistencies of the different ages within catch data, hydroacoustic abundances and trapnet cpue and between tuning series are presented in Figure 6.4.10. In order to test the sensitivity of the model results to different tuning indices, model runs excluding one tuning series at a time were conducted (Figure 6.4.11 a-c). When excluding the trapnet tuning series and only keeping in the acoustic survey the patterns of estimated SSB and Fbar looks somewhat different, especially during the period between 1995 and 2010 , but are close to or within the model uncertainty estimates. When excluding the hydroacoustics there is a difference especially in the last two years. The differences are most likely because the model sees somewhat conflicting trends from the tuning series (Trapnet) and the total catches in the last years. The acoustic survey is still relatively short and samples a younger part of the population compared to the trap net fishery which could add to the differences in the patterns. Retrospective runs reveal that SSB are mostly underestimated and F overestimated, however the under- and overestimation are within the confidence intervals (Figure 6.4.12 a-c).

6.4.4 Recruitment estimates

Since this stock has been downscaled to a category 3.1.0 stock, the most likely recruitment and SSB levels should only be considered in relative terms. Recruitment of herring in the Bothnian Sea in 2002 was about two thirds as high as any other year class previously observed (Figure 6.4.9). This was an exceptionally abundant year class in the Baltic Sea area also for other fish species. The recruitment estimates since 2004 have been over the average recruitment estimated over the period after the Baltic Sea regime shift in the late 1980s, having new record high year classes in 2007, 2009, and 2012. The recruitment in 2014 was on a similarly high level as 2012 and 2013 (Figure 6.4.9). It should be noted however, that the confidence intervals, particularly around the more recent years, are very large. The 2014 hydroacoustic survey shows a record high recruitment (Figure 6.4.15) which can also be seen in some areas in Central Baltic Herring and Sprat stocks.

6.4.5 Historical stock trends

The herring spawning stock biomass remained relatively stable from the beginning of the assessment period (1973) until the mid 1980s after which it increased rapidly (Table 6.4.7). It peaked in 1994, decreased until 1998, remained rather stable until 2004 but thereafter increased again to a record high level in 2013. The large uncertainty around the SSB estimate, especially during the last years, should be considered. The likely reason for these large uncertainties is that the model sees conflicting trends from the tuning series (Trap net) and the total catches in the more recent years, which can be seen from the residuals (Figure 6.4.7). Note also that the uncertainty in the SSB appear lower in the first part of the time series when the coefficient of variation is in fact higher than the most recent part of the series (Figure 6.4.9). During the current period of high recruitment, the spawning stock biomass is between four to five times higher than it was in the low recruitment period before the late 1980s.

6.4.6 Short-term forecast and management options

No short term forecast was performed.

6.4.7 Reference points

New reference points were calculated by the WKREF3 working group (ICES, 2015c). Since there are large uncertainties in the estimated absolute numbers of the stock it was downgraded by the WGBFAS working group to a Category 3.1.0. The new reference points are therefore no longer valid. The effect of the recruitment function on F_{MSY} was examined in the pelagic benchmark 2012 using the output from the XSA assessment (WD2, Herring in SD30, ICES 2012). With this assessment there was a negative density-dependence in the recruits-SSB function. There was an indication that temperature affected recruitment for this stock. The choice of recruitment function could both increase and decrease the current estimate of F_{MSY}. Environmental factors and their impact on recruitment should be addressed in future studies.

6.4.8 Comparison with previous assessment

The stock was downgraded to a category 3.1.0 as there are large uncertainties concerning the absolute estimated stock levels. A comparison with last year's assessment based on the spaly settings is presented in the table below, but should for the mentioned reasons be treated with caution. The present estimate of the 2013 i spawning stock biomass is slightly high compared to the estimated spawning stock biomass for 2013 in the last year's assessment, whereas the estimate for fishing mortality in 2013 remained the same. . The data, assumptions and estimates from the 2013 year's assessment and the new assessment in 2014 are shown in the text table below.

Category	Parameter	Assessment 2014	Assessment 2015	Diff.(+/-) %
DATA INPUT	Age composition	From whole (1973-2001) and cut otoliths (2002-2013)	From whole (1973-2001) and cut otoliths (2002-2014)	
	Maturity ogives	1973-2001 age determination from whole otoliths; 2002-2013 from cut otoliths	1973-2001 age determination from whole otoliths; 2002-2014 from cut otoliths	
	Natural mortality	0.2 for all ages	0.2 for all ages	
SAM INPUT	Catchability independent on age	Age >=5	Age >=5	
	SE of the F shrinkage mean	No	No	
	Time weighting	No	No	
	Tuning data	Revised commercial trapnet cpue (1990-2013) ages 3,4…9+, acoustic survey indices (2007 – 2013) ages 2,3….8+.	Revised commercial trapnet cpue (1990-2014) ages 3,4…9+, acoustic survey indices (2007 – 2014) ages 2,3….8+.	
SAM RESULTS	SSB in 2013 (in '000 t)	1233048	1270600	3%
	TB in 2013 (in '000 t)	1584849	1602379	1%
	F(3-7) in 2013	0.09	0.09	0%
	Recruitment (age 1) in 2013 (billions)	20.08	17.49	- 13%

6.4.9 Quality of the assessment

In former years the assessment of this stock has been criticized of having only commercial fleets for tuning, but in 2012 new acoustic tuning series was introduced (WKPELA 2012). At the same time the pelagic trawl fleet was rejected from the tuning because the recent effort estimates were considered unreliable. The remaining commercial survey index (trap net tuning fleet) was slightly revised in 2012 and revised again in 2013 according to the recommendations of the reviewers of WKPELA (WD1 in IBP her-30 report).

Several concerns regarding the trapned tuning index were raised by the working group this year. In short, it is uncertain whether the trapnet index is still representative of the stock in SD 30; the stock levels estimated by the model is very sensitive to small changes in the model used to produce the tuning index; the acoustic tuning index, albeit still short, is showing conflicting trends to the trapnet index in recent years. The SAM model results show rather large residuals with a bias for both survey indices, the retrospective patterns of SSB and F show a continued overestimation of SSB and underestimation of F in recent years and there are wide confidence intervals, pointing to large uncertainty in the results (Figure 6.4.11). The working group agreed that the perceived stock trends are not questionable, but the absolute level of the stock is. The stock was therefore downgraded to a category 3.1.0 and the advice based on trends in SSB and F only.

The survey time series is short. It is anticipated that extending the acoustic survey time-series will improve the quality of the assessment.

The 2014 WGBIFS re-iterated its statement from 2013, that the 2012 acoustic survey results from Bothnian Sea should be treated with caution. This is due to a combination of bad area-coverage and reduced amount of control hauls producing suspicious results.

6.4.10 Management considerations

This stock is the dominating part of the resource basis for the herring TAC set for Management Unit III including Subdivisions 30 and 31. However, at present herring in Subdivisions 30 and 31 are assessed separately. Mixing of the Bothnian Sea stock and Bothnian Bay stock occur, but the magnitude of this migration in unknown.

The observations on similar growth rate but the differences in otoliths structure between herring in the Bothnian Sea and in the Bothnian Bay suggest a close relationship between the stocks or even that the Bothnian Bay stock may be a part of the Bothnian Sea stock, but support the conclusion that some isolation still exists between herring in the Bothnian Bay and the Bothnian Sea. The stock structure in Subdivisions 31 and 30 needs to be further explored. A benchmark is suggested for both stocks in 2017.

6.4.11 References

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Table 6.4.1. Herring in SD 30. Landings (t) by country.

Year	Finland	Sweden	Total
1971	24284	5100	29384
1972	24027	5700	29727
1973	20027	6944	26971
1974	17597	6321	23918
1975	13567	6000	19567
1976	19315	4455	23770
1977	22694	3610	26304
1978	22215	2890	25105
1979	17459	1590	19049
1980	18758	1392	20150
1981	12410	1290	13700
1982	16117	1730	17847
1983	16104	2397	18501
1984	23228	2401	25629
1985	24235	1885	26120
1986	23988	2501	26489
1987	22615	1905	24520
1988	24478	3172	27650
1989	25453	3205	28658
1990	28815	2467	31282
1991	23219	3000	26219
1992	35610	3700	39310
1993	36600	3579	40179
1994	53860	2520	56380
1995	58806	2280	61086
1996	54372	1737	56109
1997	63532	1995	65527
1998	54115	2777	56892
1999	60483	1862	62345
2000	54886	1374	56261
2001	52987	1997	54984
2002	46315	3903	50218
2003	45932	3707	49638
2004	50236	5214	55450
2005	55422	2 520	57 942
2006	66962	1 403	68 365
2007	72116	3 317	75 432
2008	61756	3 674	65 430
2009	64881	3992	68873
2010	68760	2967	71726
2011	75130	3370	78500
2012	94248	6 392	100 640
2013	98935	10 849	109 784
2014	97779(*	12 755	110 534

***) preliminary**

Table 6.4.2. Herring in SD 30. Allocation of Swedish unsampled landings

Swedish non-sampled landings and discards				Allocated according to Finnish sampling		
Q	Gear	Category	Tonnes	Q	Gear	Tonnes
1	Gillnet	Landing	3.7	1	Gillnet	2.6
1	Pelagic trawl	Landing	2151	1	Pelagic trawl	15998
2	Passive Gears	Landing	0.6	2	Trapnet	5278
3	Passive Gears	Landing	0.04	3	Trapnet	370
3	Pelagic trawl	Landing	187	3	Pelagic trawl	3719
4	Gillnet	Landing	28	4	Gillnet	8.6
4	Gillnet	Discard	0.2	4	Gillnet	8.6
4	Passive Gears	Landing	0.3	4	Gillnet	8.6
4	Pelagic trawl	Landing	1032	4	Pelagic trawl	7068

Table 6.4.4 Herring in SD 30. Proportion of mature at age.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1973	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1974	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1975	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1976	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1977	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1978	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1979	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1980	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.29	0.92	0.97	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.21	0.92	0.98	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.17	0.93	0.98	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.20	0.91	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.28	0.90	0.98	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.32	0.88	0.97	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.04	0.79	0.96	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.22	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.00	0.63	0.99	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.53	0.92	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.00	0.45	0.81	0.97	1.00	1.00	1.00	1.00	1.00
1994	0.00	0.65	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.37	0.92	0.95	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.32	0.82	0.97	1.00	1.00	1.00	1.00	1.00
1998	0.03	0.31	0.65	0.95	1.00	1.00	1.00	1.00	1.00
1999	0.01	0.38	0.87	0.99	1.00	1.00	1.00	1.00	1.00
2000	0.13	0.65	0.93	0.98	1.00	1.00	1.00	1.00	1.00
2001	0.01	0.61	0.97	0.97	1.00	1.00	1.00	1.00	1.00
2002	0.03	0.59	0.96	0.97	0.99	0.96	1.00	1.00	1.00
2003	0.00	0.55	0.94	0.97	0.96	1.00	1.00	0.88	0.89
2004	0.00	0.34	0.90	0.96	1.00	1.00	1.00	1.00	0.96
2005	0.02	0.25	0.86	0.95	0.94	0.97	1.00	1.00	0.96
2006	0.02	0.35	0.93	0.91	1.00	0.94	1.00	1.00	1.00
2007	0.02	0.55	0.86	1.00	0.96	1.00	1.00	0.90	0.97
2008	0.00	0.50	0.91	1.00	0.93	1.00	1.00	1.00	0.94
2009	0.00	0.50	0.91	0.95	0.95	0.91	0.97	0.97	1.00
2010	0.05	0.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2011	0.00	0.45	1.00	1.00	1.00	1.00	1.00	1.00	0.97
2012	0.01	0.75	0.97	0.98	1.00	1.00	0.94	1.00	0.99
2013	0.11	0.77	0.98	1.00	1.00	1.00	1.00	1.00	0.98
2014	0.16	0.70	1.00	1.00	1.00	1.00	0.94	0.95	0.93

Table. 6.4.5 Herring in SD 30. Sampling by country in 2014

FINLAND

Quarter	Landings in tons	Number of length samples	Number of fish meas.	Number of age samples	Number of fish aged
1	33295	14	4432	14	292
2	44686	21	5745	15	329
3	4972	2	10785	9	865
4	14826	22	6472	33	2039
Total	97 779	59	27 434	71	3 525

SWEDEN

Quarter	Landings in tons	Number of length samples	Number of fish meas.	Number of age samples	Number of fish aged
1	2964	3	1695		
2	8146	5	2031	3	196
3	314	6	2543	3	208
4	1524	1	625		
Total	12 947	15	6 894	6	404

Table 6.4.6. Herring in SD 30. Catch in Numbers (thousands)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1973	15070	45210	232100	140670	181860	78370	25120	7030	4020
1974	6680	71540	115410	174550	76310	59140	57230	23850	32430
1975	33680	111320	124410	61740	69220	38350	33680	29930	36480
1976	87880	98750	180710	126400	57270	80970	33570	35550	58260
1977	18650	173700	130520	192340	99120	58880	84400	48090	59860
1978	27850	69120	235210	128950	136180	69120	45390	53650	54680
1979	3980	25890	60750	220100	62740	81660	51790	17930	48800
1980	63030	55020	56020	53020	174070	77030	74030	39020	44020
1981	13970	48900	33930	42910	44910	86820	36920	23950	34930
1982	23110	92440	150720	38180	44210	57280	86410	26130	45220
1983	94020	185040	90020	109020	16000	20000	34010	60010	35010
1984	101710	146580	189460	98720	77780	17950	18950	33900	84760
1985	87350	282140	195790	129520	39160	57230	13050	13050	70280
1986	13900	388080	302720	146890	88340	32750	26800	4960	37720
1987	38970	42960	203830	212820	94920	58950	30970	11990	32970
1988	9980	184690	56910	177700	174710	81860	44930	17970	33940
1989	88180	69140	156320	59120	116240	116240	56110	25050	34070
1990	182990	363080	54900	104980	34670	85710	93420	38520	40450
1991	42090	190770	242710	43890	73440	50150	62690	37620	41200
1992	73340	210970	412890	268230	61280	70320	63290	45210	49230
1993	203310	333510	186290	291450	220340	44070	53080	33050	42070
1994	77500	366360	327110	208340	318050	270750	46300	68440	66430
1995	62360	230330	478760	305760	219260	267540	188080	39230	108630
1996	86390	412090	236330	311800	241300	154910	190660	116180	60570
1997	114510	366900	426700	264940	296890	222180	180440	146040	138390
1998	286340	216730	270210	297000	221900	171710	154060	63820	235510
1999	146210	678470	282410	326560	244240	153980	211850	77980	195730
2000	239010	201460	425100	310440	187870	193500	115700	76220	310190
2001	208120	392140	196730	440550	159320	129760	135840	90320	283240
2002	275862	258589	312651	149840	210191	95402	53337	85338	278442
2003	241202	369505	256915	195934	161628	180499	62910	52476	257680
2004	87669	921471	407703	210834	166427	134821	131383	63028	222886
2005	148723	206674	1134904	293866	167029	140499	81473	92785	235926
2006	157060	268432	120334	1024498	368522	154222	84624	126683	317097
2007	511212	618126	341113	154968	994014	266382	88943	119783	265191
2008	253591	826958	309179	308193	213115	393131	181107	124166	264066
2009	267566	445816	538329	395147	126558	128821	343300	174103	234577
2010	276116	798215	464788	378529	271358	101969	79992	227567	250903
2011	215290	578126	564038	368440	344526	168623	87156	79590	550325
2012	482525	381020	635022	566911	356444	321768	171013	143446	583950
2013	457703	843609	489543	365745	560202	293539	277875	176789	484928
2014	417566	668604	702897	233447	404151	279503	219666	201403	499982

Table 6.4.7 Herring in SD 30. SAM output summary table

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F37	Low	High
1973	2576648	1337510	4963789	269952	162121	449504	198194	115368	340483	0.116	0.065	0.207
1974	2755198	1465167	5181059	257816	154048	431482	178796	102950	310519	0.109	0.061	0.195
1975	2931427	1567355	5482655	265402	158730	443760	175606	101168	304815	0.081	0.046	0.144
1976	4089773	2174610	7691605	297747	178449	496799	200787	115802	348140	0.099	0.056	0.173
1977	1803068	960568	3384511	305590	182127	512748	208147	119284	363211	0.123	0.070	0.216
1978	1076257	570666	2029784	270763	158074	463787	216425	122978	380880	0.122	0.069	0.215
1979	1171740	622849	2204343	240386	138618	416866	197205	110791	351021	0.101	0.057	0.178
1980	1972870	1061486	3666764	222793	126483	392440	184057	101572	333527	0.116	0.066	0.204
1981	2369051	1277148	4394481	215346	123320	376043	166209	91477	301993	0.088	0.050	0.155
1982	3917640	2121046	7236006	222126	128517	383916	173685	97079	310743	0.113	0.065	0.196
1983	4930742	2665867	9119814	288370	169892	489471	204843	115751	362507	0.088	0.050	0.152
1984	7610200	4130711	14020625	392778	235164	656029	262761	149729	461123	0.103	0.059	0.178
1985	7648346	4147018	14105848	441971	268831	726621	289237	168613	496153	0.090	0.052	0.155
1986	2094866	1117651	3926504	474492	292062	770874	339083	204283	562834	0.073	0.042	0.125
1987	4483883	2466375	8151724	509406	314444	825249	407176	246584	672354	0.062	0.037	0.106
1988	2730513	1482292	5029846	560172	348781	899685	409217	247459	676711	0.062	0.038	0.104
1989	9323046	5125712	16957487	674684	427299	1065293	506358	313094	818919	0.056	0.035	0.092
1990	8877229	4899286	16085037	763753	491089	1187808	590662	374940	930502	0.049	0.031	0.079
1991	6569840	3665517	11775363	753135	489128	1159640	597196	383847	929126	0.046	0.029	0.072
1992	7834127	4411477	13912246	898966	588116	1374114	682829	440550	1058348	0.058	0.036	0.092
1993	8335216	4703700	14770463	873270	574755	1326826	615999	398379	952495	0.057	0.036	0.091
1994	5126840	2906325	9043890	852561	561822	1293756	698716	454485	1074193	0.085	0.054	0.134
1995	5879604	3354053	10306857	697320	461751	1053070	551833	358886	848512	0.115	0.073	0.181
1996	5449312	3114627	9534048	636666	422566	959243	517622	338027	792636	0.117	0.074	0.183
1997	4723214	2688462	8297958	570918	379998	857760	426770	277218	657000	0.158	0.101	0.248
1998	8903901	5038304	15735345	542531	358112	821921	387317	248689	603222	0.139	0.088	0.219
1999	4985279	2814120	8831540	553491	367802	832926	411679	267496	633579	0.146	0.093	0.230
2000	7504399	4251320	13246713	539285	355941	817070	426770	276681	658276	0.129	0.081	0.204
2001	6629235	3751401	11714758	584201	383901	889007	452707	292021	701811	0.115	0.072	0.183
2002	9038466	5123560	15944747	605615	398132	921225	457257	295133	708440	0.090	0.056	0.143
2003	14132674	7802697	25597878	620946	409774	940945	429768	278959	662105	0.099	0.063	0.156
2004	4818629	2695893	8612800	648229	430594	975865	446413	291327	684059	0.105	0.067	0.166
2005	6287034	3564378	11089397	703624	467690	1058581	543074	355969	828523	0.096	0.061	0.151
2006	10522222	6000420	18451570	753135	497853	1139318	564107	365697	870167	0.108	0.069	0.170
2007	15587814	8825713	27530912	878525	579801	1331158	648229	420122	1000189	0.103	0.066	0.161
2008	12372663	6992719	21891741	927270	609747	1410141	666636	430637	1031970	0.088	0.056	0.139
2009	16387018	9235636	29075894	1150837	754055	1756406	824886	531331	1280627	0.077	0.049	0.122
2010	14519455	8156780	25845317	1178791	775544	1791708	947896	617615	1454801	0.076	0.048	0.120
2011	11605620	6452641	20873688	1241710	814183	1893732	952647	616307	1472541	0.074	0.047	0.117
2012	18811896	10376560	34104503	1407042	909727	2176220	1133703	723300	1776970	0.086	0.054	0.137
2013	17487554	9244506	33080681	1602379	1031743	2488623	1270600	809280	1994891	0.085	0.053	0.137
2014	17876544	6499657	49167333	1774448	1116758	2819471	1405635	880724	2243393	0.072	0.044	0.119

Table 6.4.8. Herring in SD 30.

a) Trapned abundance index modeled based on catch and effort from three areas in the Bothnian Sea.

Year	age 3	age 4	age 5	age 6	age 7	age 8	age 9 +
1990	0.019	0.05	0.011	0.026	0.033	0.011	0.015
1991	0.105	0.02	0.033	0.013	0.021	0.019	0.019
1992	0.125	0.092	0.033	0.031	0.019	0.02	0.016
1993	0.048	0.071	0.06	0.018	0.018	0.012	0.009
1994	0.057	0.041	0.08	0.068	0.014	0.021	0.016
1995	0.051	0.031	0.03	0.039	0.028	0.004	0.016
1996	0.031	0.048	0.027	0.03	0.037	0.018	0.015
1997	0.028	0.025	0.034	0.018	0.02	0.016	0.013
1998	0.033	0.034	0.027	0.018	0.016	0.004	0.025
1999	0.033	0.047	0.029	0.016	0.02	0.008	0.013
2000	0.044	0.04	0.021	0.024	0.013	0.01	0.036
2001	0.04	0.078	0.024	0.014	0.024	0.011	0.044
2002	0.054	0.029	0.038	0.025	0.015	0.019	0.037
2003	0.053	0.03	0.025	0.026	0.01	0.005	0.026
2004	0.071	0.042	0.027	0.008	0.014	0.01	0.015
2005	0.2	0.066	0.04	0.017	0.015	0.012	0.023
2006	0.012	0.109	0.037	0.02	0.009	0.014	0.028
2007	0.049	0.023	0.154	0.048	0.005	0.019	0.039
2008	0.068	0.057	0.028	0.073	0.043	0.016	0.052
2009	0.127	0.068	0.03	0.028	0.075	0.026	0.058
2010	0.094	0.065	0.052	0.012	0.012	0.034	0.036
2011	0.097	0.084	0.059	0.026	0.017	0.013	0.115
2012	0.166	0.179	0.075	0.093	0.043	0.039	0.131
2013	0.112	0.067	0.141	0.066	0.065	0.028	0.101
2014	0.156	0.094	0.197	0.092	0.091	0.039	0.141

b) Hydroacoustic survey index based on area corrected numbers (millions) of herring in the Bothnian Sea.

Year	age 2	age 3	age 4	age 5	age 6	age 7	age 8 +
2007	4916	1846	1508	5254	1441	826	2348
2008	4846	3386	1649	1825	3344	1266	3049
2009	5090	5559	2438	1283	1518	3616	3757
2010	6535	3501	3536	1577	982	891	4479
2011	6101	7384	3086	3134	1442	642	3871
2012	3842	3109	2734	1868	1693	987	2495
2013	6646	2843	3486	3386	1435	1771	3947
2014	6186	4538	2068	1968	1565	1435	3370

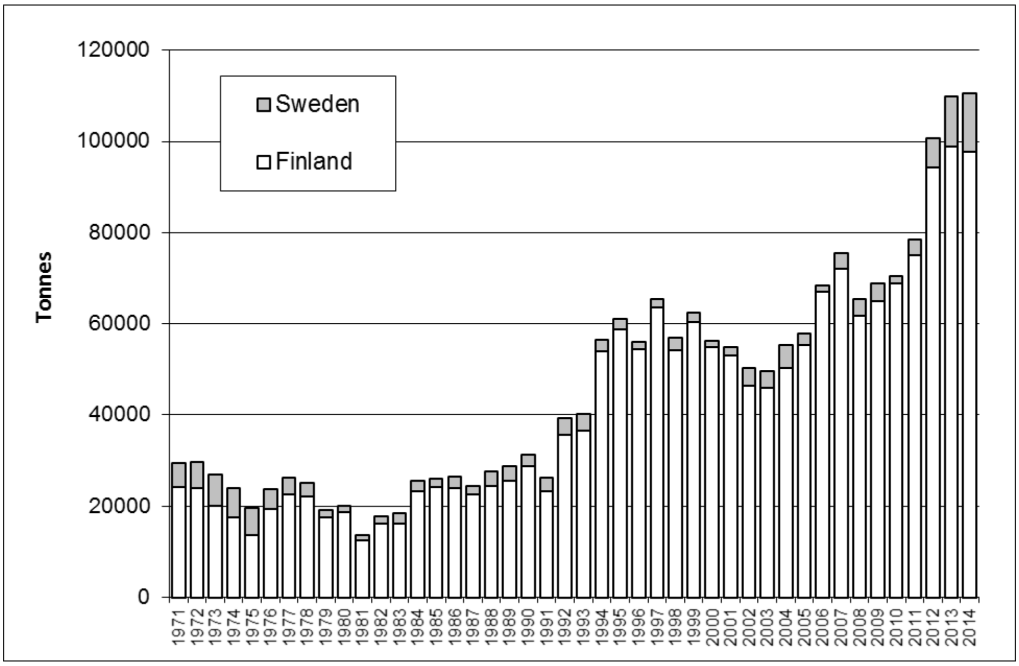


Figure 6.4.1. Herring in SD 30. Landings by country.

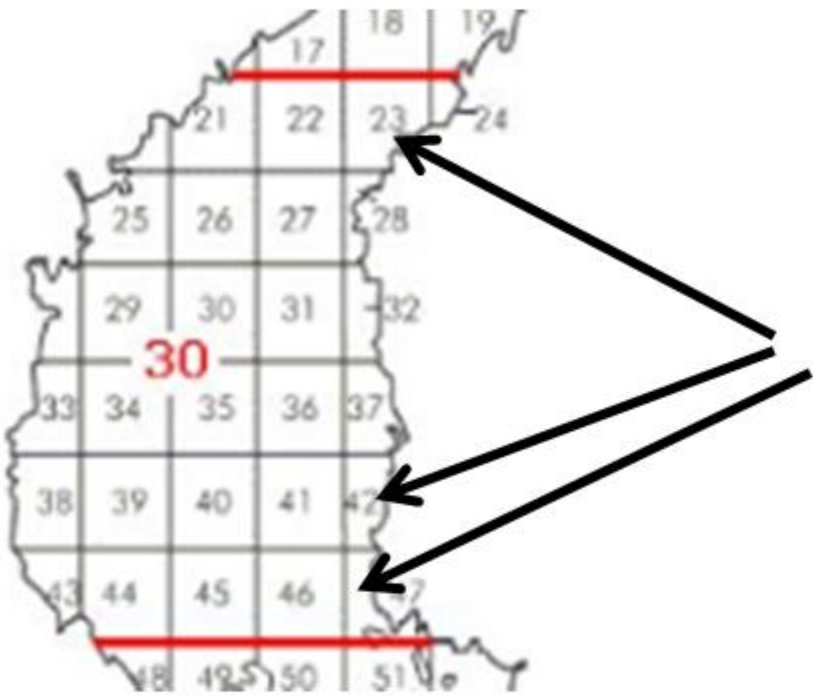


Figure 6.4.2 Herring in SD 30. The areas of unbroken timeseries of catch and effort data for trapnet tuning-series.

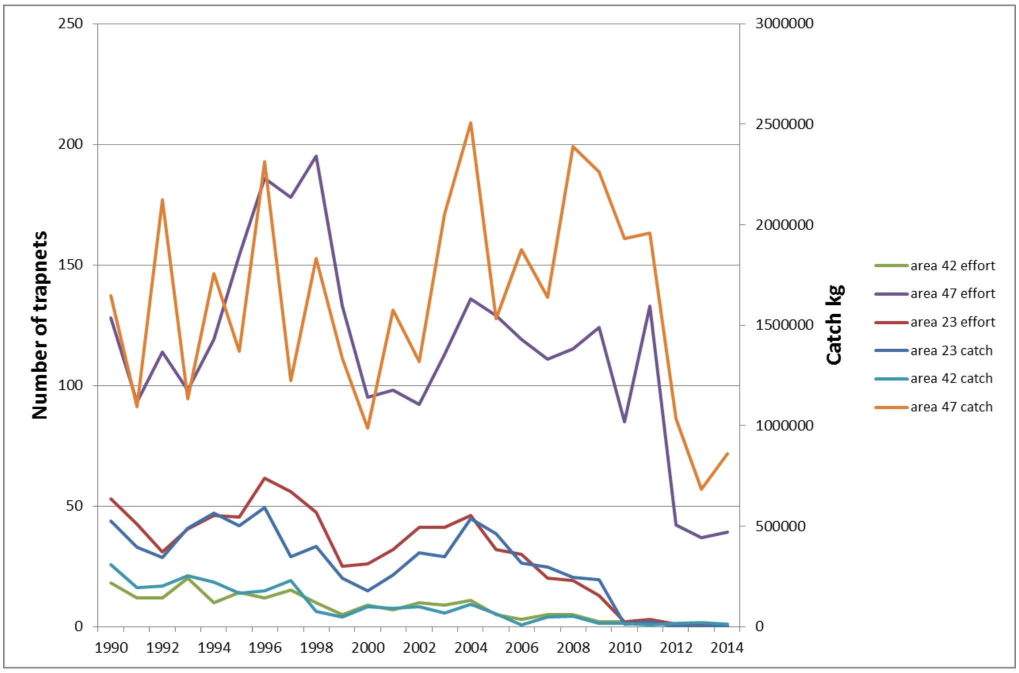


Figure 6.4.3. Herring in SD 30. Trapnets catch (kg) and effort (number of traps) in three different areas (see map Fig 6.4.2) used to calculate the trap net tuning indet for the spaly assessment.

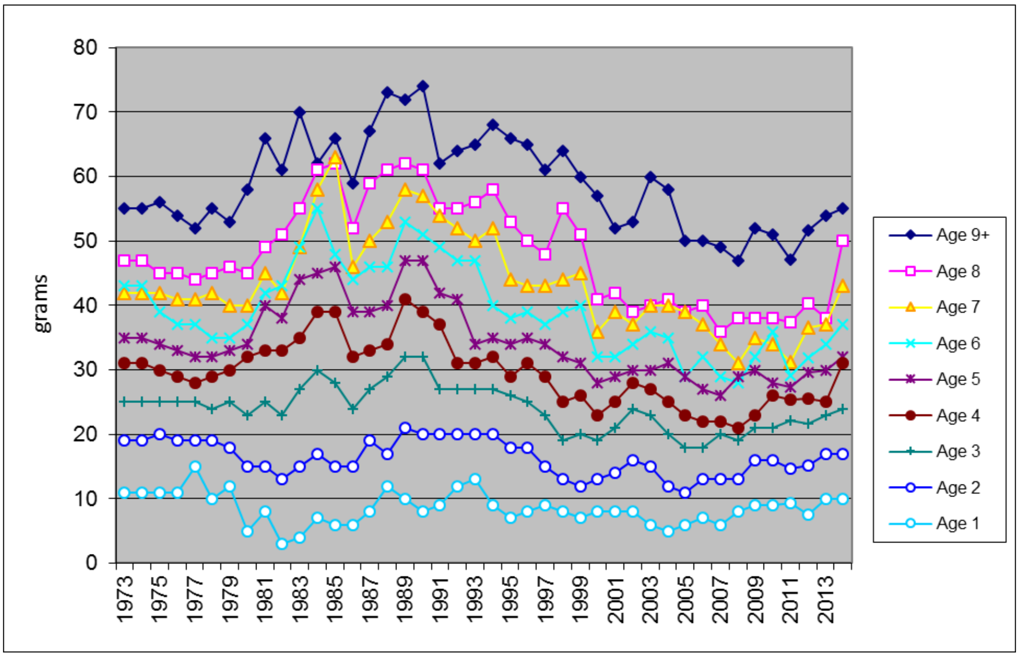


Figure 6.4.4 Herring in SD 30. Weights at age in catches

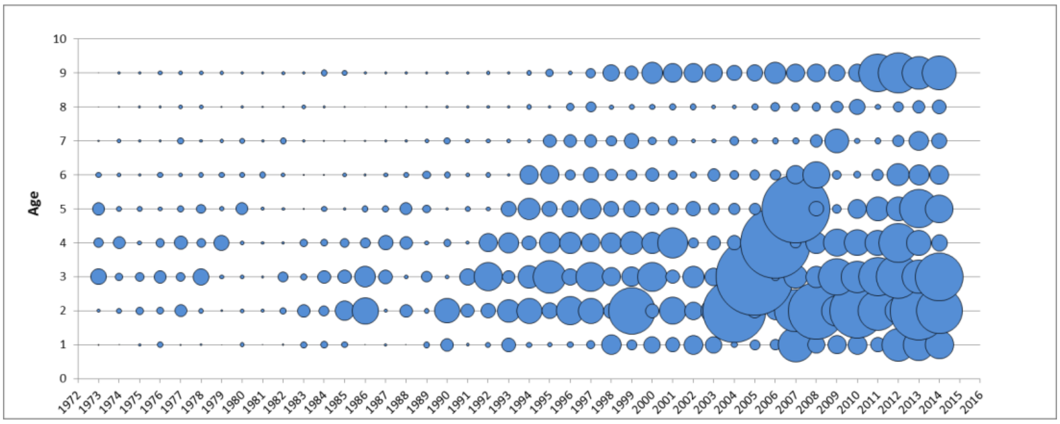


Figure 6.4.5. Herring in SD 30. Age composition from commercial catches 1073-2014.

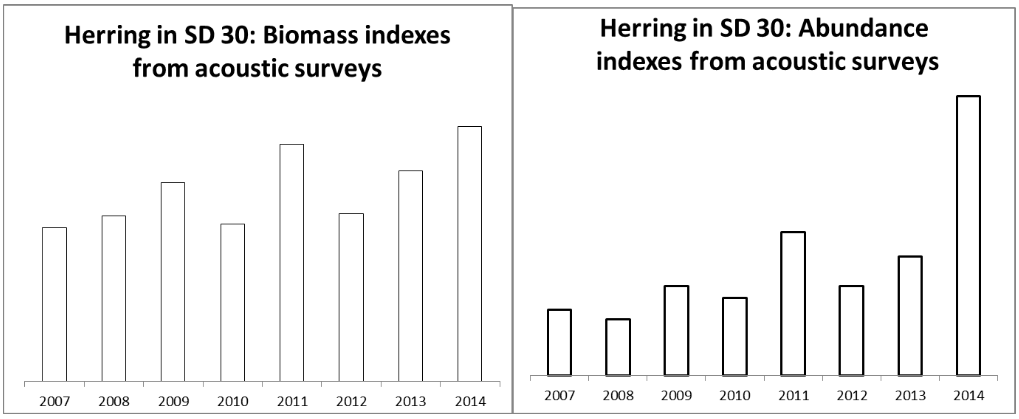


Figure 6.4.6 Herring in SD 30. Abundance and biomass indexes from 2007-2014 acoustic surveys.

Figure 6.4.7. Herring in SD 30. Normalized residuals for the catch data (top), acoustic index and CPUE from trapnet data. Red filled circles indicate negative residuals and blue open circles positive residuals.

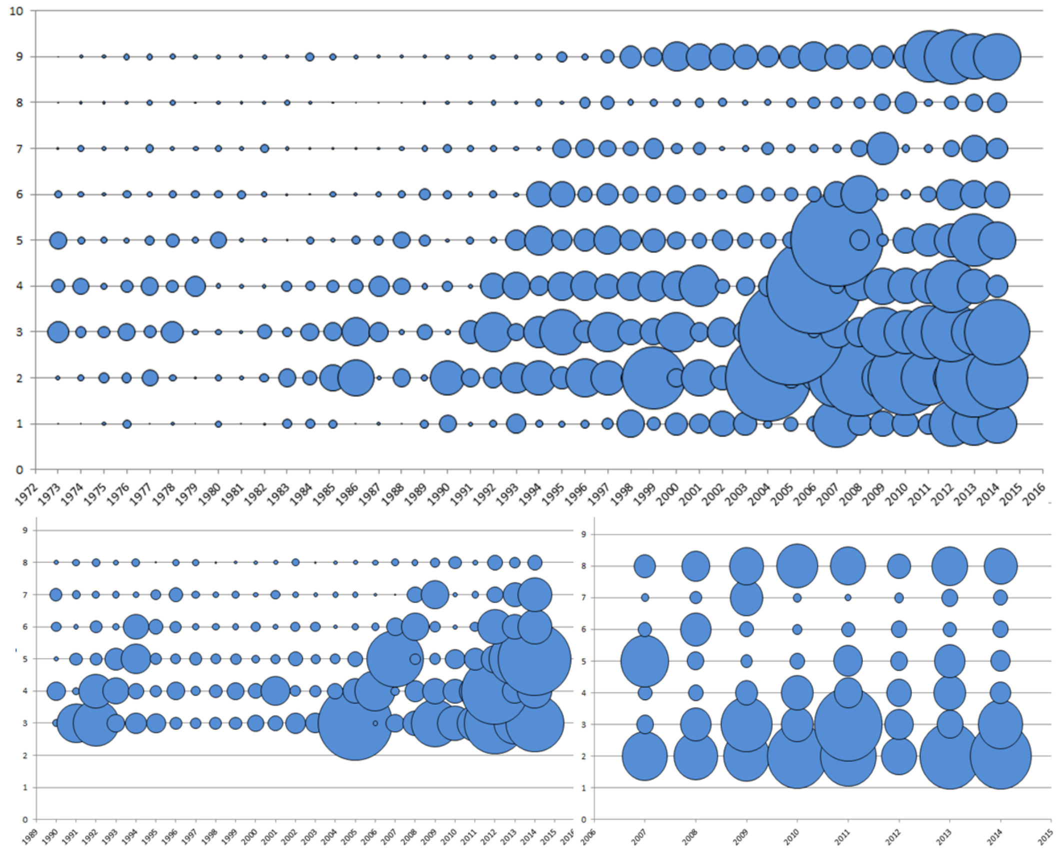


Figure 6.4.8. Herring in SD 30. Age composition in total catches, Trapnet fleet and Acoustic survey.

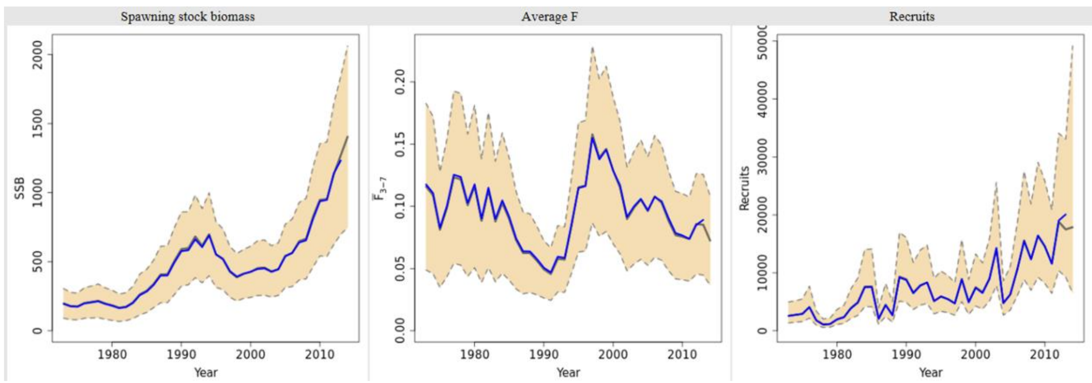
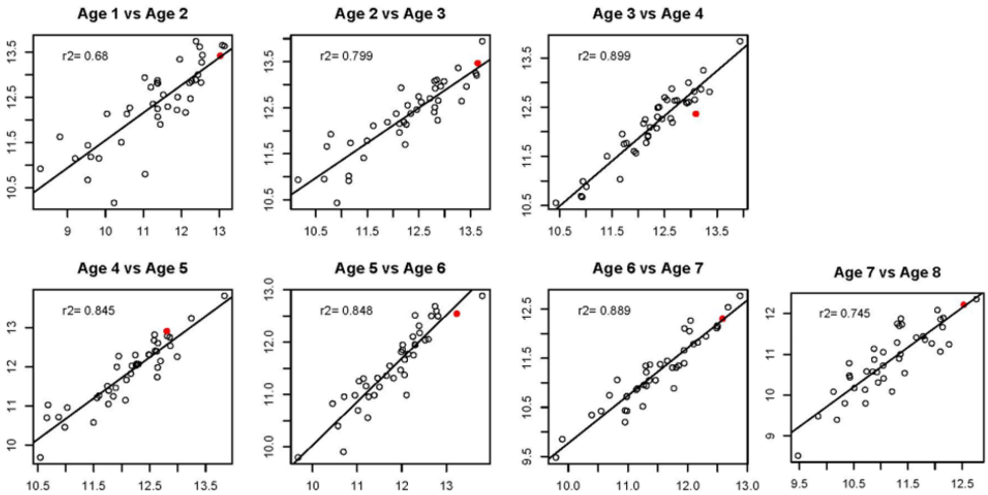
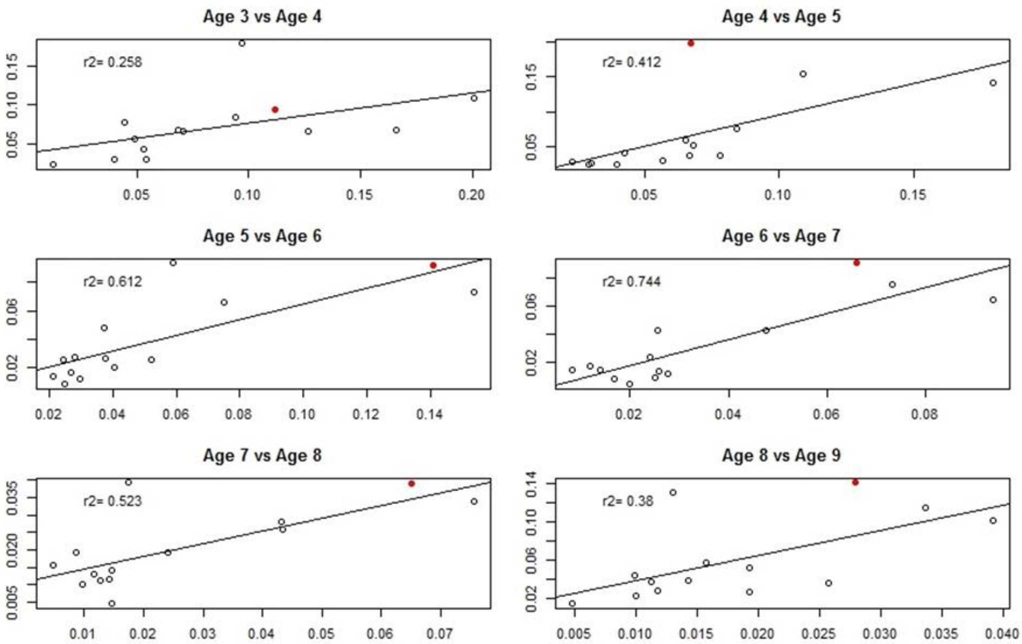


Figure 6.4.9 Herring in SD 30 Assessment Estimates of SSB, F3-7 and age 1 Recruitment. The grey line shows the assessment run in 2014.

Total Catches



Trapnet CPUE



Acoustic indices

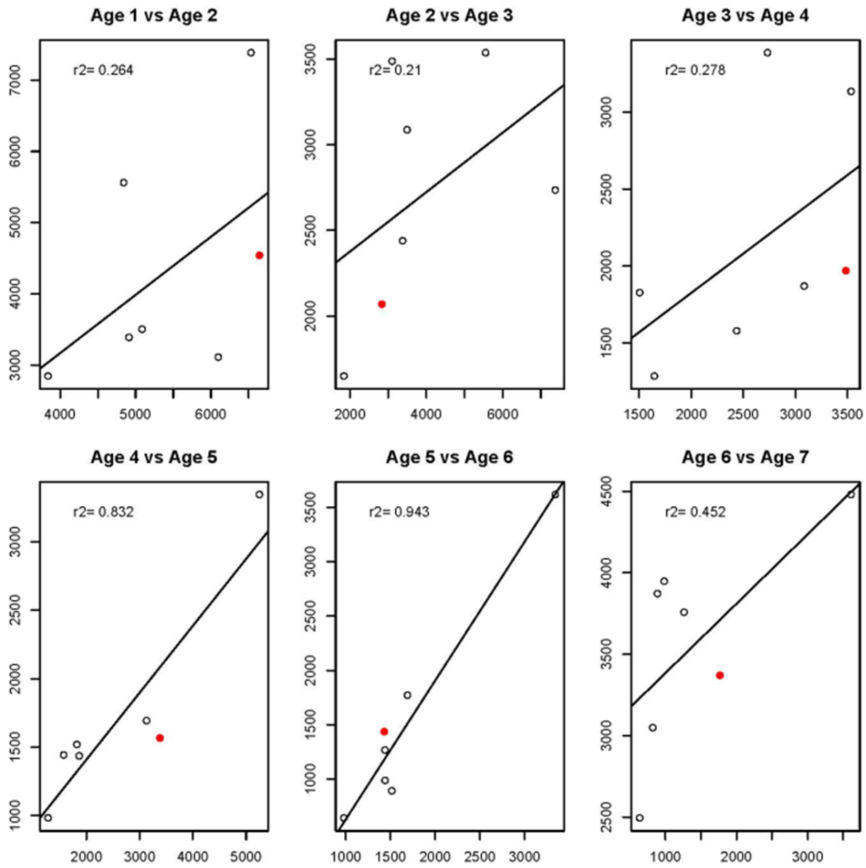


Figure 6.4.10. Herring in SD 30. Internal consistencies in Total catches, Trapnet CPUE anmd Acoustic indices

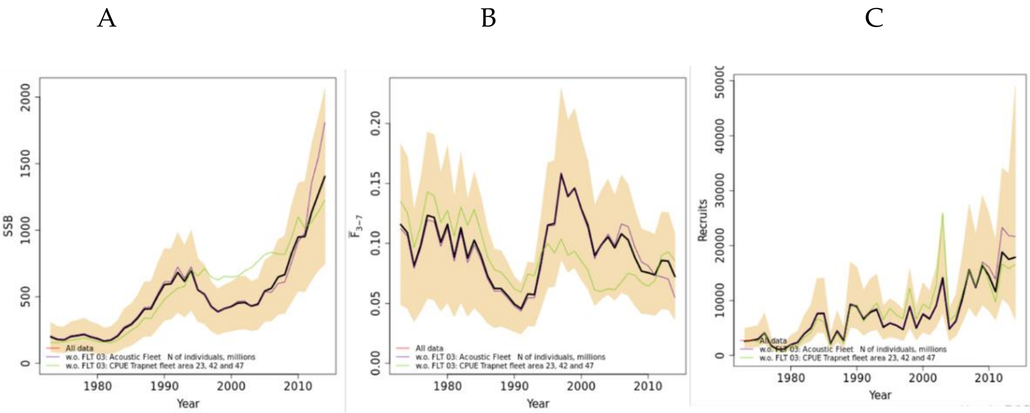


Figure 6.4.11 a-c. Herring in SD 30. Model runs excluding one survey at a time. a) SSB, b)F 3-7 and c) Recruitment. The shaded areas represent 95 % confidence intervals.

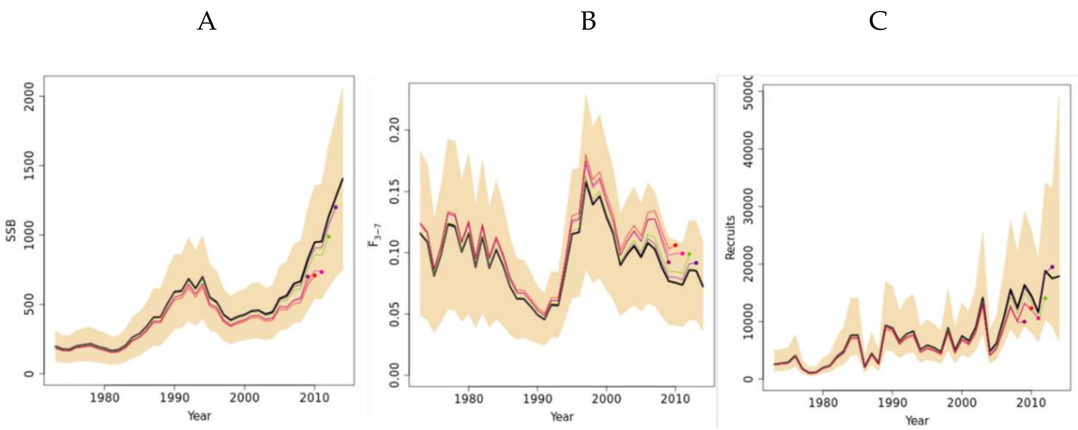


Figure 6.4.12 a-c. Herring in SD 30. Retrospective runs. A) SSB, b) F 3-7 and c) recruitment. The shaded areas represent 95 % confidence intervals.

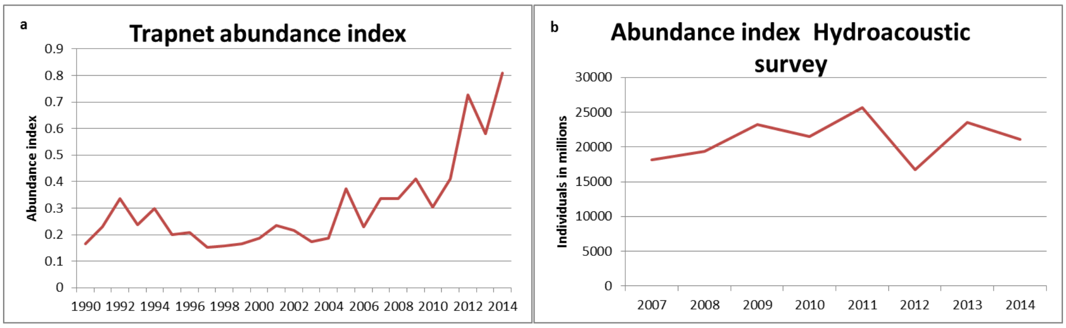


Figure 6.4.13 a and b. Herring in SD 30. a) Trapnet abundance index (based on ages 3 to 9+) and b) abundance index from hydroacoustic survey (based on ages 2 to 8+).

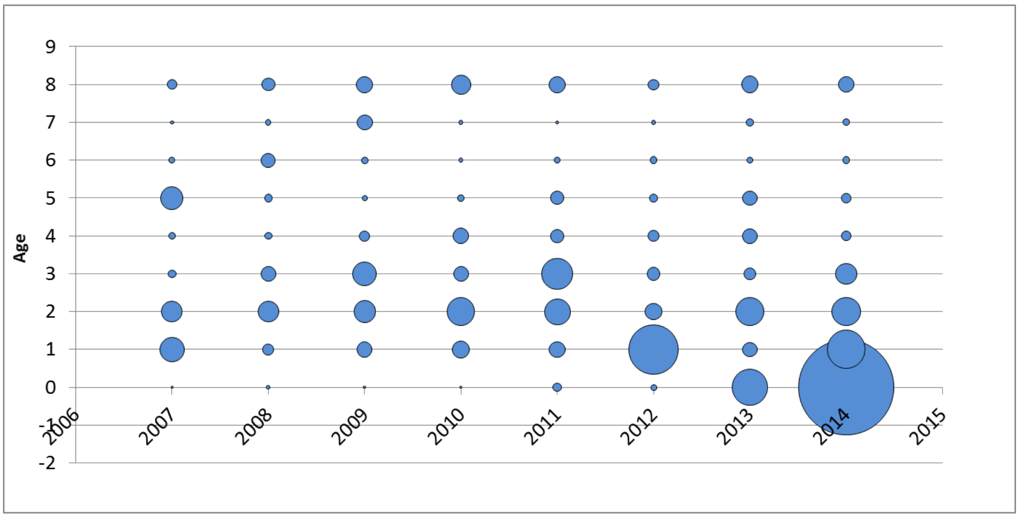


Figure 6.4.15. Herring in SD 30. Age composition from acoustic surveys in 2007-2014.

6.5 Herring in Subdivision 31 (update assessment)

6.5.1 The fishery

The two main fleets operating in Baltic herring fisheries in the Bothnian Bay are trawlers (single and pair trawlers) and trap net fisheries (targeting the spawning fish).

In the Finnish trawl fishery, the same trawl nets are often used in the pelagic and demersal (or semi-pelagic) trawling, of which trawling near bottom is the most common way. The trawling vessels in SD 31 are smaller than in SD 30, and this has not changed with time, probably because of the shallow and stony waters, where it is difficult or even impossible for large trawlers to operate. Trawls take 92% and trap net fisheries 8% of the Finnish catches, whereas trawls take 59% and gillnets and other small scale gears take 41% of the Swedish catch.

6.5.1.1 Catch Trends

The total catch (landings and discards) of herring in the Bothnian Bay in 2014 (4,832 t) is comprised of Finnish (4,636 t) and Swedish (196 t) catches (96% and 4%, respectively). The catches increased in 2014 by 5% from 2013 (Table 6.5.1). Generally, catches were decreasing from the beginning of the 1990s to the turn of the millennium, after which they varied at a lower level. The highest catches, mostly above 7,000 tons, were recorded during 1976–1993. Despite the long time trend of catch decrease in tons, the decrease in catch in numbers has not been as unambiguous. A probable reason for the decreasing trend is the decline in the number of fishermen, which has occurred in Finnish coastal areas due to decreased profitability of fishing. The fishing conditions in the Bothnian Bay are also harsh and demand local knowledge of the stony bottoms in the few southeastern areas that are regarded the best for trawling (Figure 6.5.1). The decline of fishery, independently of herring stock abundance, is supported by the stable CPUE levels since the 1980s. The CPUEs in 2010 and 2011 however, were affected by poor year classes in 2007 and 2008 (section 6.5.1.4). Since then, year classes have been more abundant, and also the price of herring has increased. Trawling hours and catches have been somewhat higher in 2012–2014 than in previous years.

6.5.1.2 Unallocated Landings

No unallocated landings were reported in the Finnish fishery. In the year 2014, the non-response fraction of fishing activities in Finnish fisheries was 0 % in the group with an EU fishing logbook and about 10% among those completing the coastal fishery forms (= fisheries with trap-nets, coastal gill-nets and vessels less than 10 meters). Of the total catch, 93% was reported in EU fishing logbooks. The data are corrected for unallocated landings in the final catch estimates.

6.5.1.3 Discards

The discarding rates in the Finnish fisheries in SD 31 are negligible and have therefore not been taken into account in the assessment. In the Swedish catches, however, which are primarily used for human consumption, the preferred fish size is 16 cm, and smaller fish are presumably mainly discarded. There is a requirement for fishermen to report the entire catch (including drafts) over 50 kg in the logbook. However, not the entire fisheries have been in compliance with this requirement, and many unreported discardings have occurred. Only a few records of herring discards are available each year. Discards are only reported voluntarily from gillnet fisheries, and no discard information is available from the year 2014. Based on the landing reports which include discard information, the discarding rate for the total catches were estimated to vary between 19 and 83% throughout the fishing season. Further analyses on discarding rates in the Swedish herring fisheries in SD 31 are planned for the future.

6.5.1.4 Effort and CPUE Data

According to the updated 2014 Finnish data, the number of total trawling hours increased in 2014 by 28% from 2013 and CPUE increased by 19%. The number of trap nets decreased from 56 in 2013 to 49 in 2014 (Figures 6.5.2 & 6.5.3, Table 6.5.2). The trap net CPUE in 2014 increased by 64% since 2013 (Figure 6.5.3).

The fishing effort in both fleets show a declining trend since the 1980s (Figure 6.5.2). In trap nets, the CPUE has been fluctuating without clear trends. For trawlers the CPUE has shown an increasing trend since the beginning of the time series in the 80s, however very fluctuating since the year 2000. (Figure 6.5.3). One explanation for the increase in CPUE could be that the trawlers that are still active are bigger than those that have stopped fishing. As opposed to this the trap net fishery is regarded as a tradition that has not undergone technological changes that would essentially improve the effectiveness of the fishery. The trap net material has however, largely been changed to the seal-proof ‘Dyneema’ to reduce catch losses caused by ringed seals and grey seals. In some of the recent years, trap net CPUEs may have been affected negatively by a change in the market. As a large part of the trap net fishers sell herring only for human consumption, they do not empty their trap nets completely very often. Instead, they keep the trap nets as storage for live fish, which are sold when there is a demand.

The large variation in the CPUE in trawl fisheries in the 2000s may be related to the small number of trawlers and varying conditions in the sea.

6.5.2 Biological composition of the catch

6.5.2.1 Age composition

Abundant year classes of herring appear irregularly over time. In the samples from the catches since 2000, four year classes have comprised more than 30% of the catch (in numbers) at age two: 1999, 2002, 2006, and 2009, which were all warm summers probably resulting in good conditions for food production. The age composition in the assessment of Bothnian Bay herring is mainly based on Finnish sampling, with the addition of Swedish sampling in the II–IV year-quarter. The combined landings and the summary of numbers sampled in 2014 are given in Table 6.5.3 and the catch-at-age input in Table 6.5.4. The catch in numbers and weight at age are shown in figures 6.5.4, 6.5.5 and 6.5.6, and the regression plots showing the numbers at age versus number at age +1 of CANUM and cpue in the fleets are shown in figures 6.5.7, 6.5.8 and 6.5.9.

6.5.2.2 Quality of catch and biological data

The Finnish and Swedish catch statistics are assumed to be reliable. In the Finnish sampling, 18 samples were taken and 5690 fish were measured and 1855 specimens aged. In the Swedish sampling, six length samples were taken and 1847 fish were measured, and 504 fish were aged. Age determination was conducted from stained otolith slices, which has been found to be the most reliable age determination method with the northern, slowly grown Baltic herring.

6.5.3 Mean weight at age

Mean weight-at-age in catches (Table 6.5.5, Figure 6.5.10) was also used as mean weight at age in the stock. The growth rate of young herring decreased in the first half of the 1990s, and since then, it has remained lower. In older age groups, mean weight-at-age decreased gradually during the 1990s and the 2000s, until a slight increase has taken place since 2008. During the monitoring period since 1980, mean weight at age in the Bothnian Bay has been very similar to weight at age in the Bothnian Sea (Figure 6.5.11).

6.5.4 Maturity at age

The maturity data are derived from the Finnish sampling. Constant maturity ogives have been used for the period 1980–1982. Since 1983 maturities at age have been determined annually, and since 1998 these have been determined from specimens that are sub-sampled for age determinations. Before spawning time, the number of sampled specimens from those length classes that are not expected to be fully mature, is increased in order to assure adequate age representation for age groups 2–5. Updated maturity ogive for 1980–2014 is shown in Table 6.5.6.

6.5.5 Natural mortality

The natural mortality value of 0.15 is assumed for all years and ages. There is no significant fish predation on herring. There are, however, ringed seals in the Bothnian Bay, and about 7000 seals have been estimated to live there. The ringed-seal population has been estimated to increase about 4.5% per year. In addition, some hundreds of grey seals have been estimated to be on the move in the Bothnian Bay, although their reproduction areas are further south, mainly in SD 29 and southern parts of SD 30. Supposing that ringed seals eat on the average 3–3.5 kg of fish per day, and that 80% of the fish they eat is herring, and that grey seals eat 5 kg of fish per day with varying proportions of herring in their food, it can be roughly estimated that seals eat 6–7 thousand tons of herring annually.

6.5.6 Catch-at-age analysis

6.5.6.1 Tuning fleets

Two fleets were used for tuning the exploratory XSA: the effort (trawling hours) and CPUE data from the Finnish trawl fleet since the year 2000, and effort and CPUE information from Finnish trap net fishery since 1994 (number of trap nets) (Table 6.5.2). Since 2000, the trawl data has consisted mainly of two trawls that are of equal size.

6.5.6.2 XSA runs

The assessment in SD 31 is an update assessment for a data limited stock (text table in section 6.5.13, Table 6.5.8). Age group one was included in the assessment, although it was not represented in the tuning series. This was because on average, age group one represents 5% of the catches in biomass, and the share of the age group in catch biomass can be above 10% in strong year classes.

6.5.6.3 Recruitment Estimates

There are no fishery independent recruitment data from this stock. The recruitment estimates obtained from the XSA show relatively few strong year classes appearing every 3–6 years (Figure 6.5.12). However, there have been relatively strong year classes appearing more often since the year 2000. In this area, which is extreme for herring distribution due to low salinity, low temperatures, and long ice-coverage, environmental conditions seem to determine the recruitment each year. For example, the abundant year classes of 1988, 1999, 2002, and 2006 hatched during very warm summers. Year classes 2007 and 2008 were small. Year classes 2009–2011 seem also abundant.

6.5.7 Historical stock trends

According to the XSA estimates (Table 6.5.7), the spawning stock biomass fluctuated between 28 000 t and 40 000 t in the 1980s, and in the first half of the 1990s, the SSB declined to a level of about 9 000–15 000 t, where it remained until an increase in 2011, and in 2014 the spawning biomass is estimated to be 26 000 t. However, these XSA estimates have not been accepted, and they are not consistent with the fairly stable long time trends in the CPUE, despite large year-to-year variation in the CPUEs (Figure 6.5.3).

The very similar growth rates of herring in the Bothnian Bay and the Bothnian Sea (Figure 6.5.11), where herring growth seems to be density dependent and the population is abundant, suggest some kind of close connection between the herring in those areas. Colder conditions and on average 2‰ lower but more varying salinity in the Bothnian Bay (1-4‰, on average 3‰) than in the Bothnian Sea (5‰) may make the herring in the Bothnian Bay more heterogeneous than in the Bothnian Sea, and more difficult to assess. The salinity of both areas decreased gradually from the 1980s, while especially in the Bothnian Sea herring, a steep drop in the annual increase of mean weight at age can be seen after 1989, which followed the quick increase of herring SSB documented in the Bothnian Sea. In the Bothnian Bay, it is also probable that the decreased salinity has benefitted a potential competitor of herring, vendace (*Coregonus albula*, a pelagic freshwater species). This potentially increased interspecific competition may consequently have resulted in decreased herring growth in the Bothnian Bay correspondingly as intraspecific competition may have decreased growth in the Bothnian Sea.

The low price of small herring and increased fuel costs have essentially decreased the profitability of the herring fishery in the Bothnian Bay, which is likely the most important reason for the reduced fishery along with difficult natural conditions. New fishers (and new methods) have not replaced the retired fishers.

6.5.8 Short-term forecast and management options

No short-term forecast was produced.

6.5.9 Medium-term projections

No medium-term projections were conducted.

6.5.10 Reference points

Among data limited stocks, the Bothnian Bay herring is classified in category 3.2. This category (3) 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.

Generally the CPUE:s in trap net and trawl fleets have been fluctuating a lot from year to year. In both exploratory XSA results (SSB) and CPUE:s, first in trawl fleet in 2011 and trap net in 2012, there was an increase due to recent large year classes. The SSB of the exploratory assessment in the last two years (2013-2014) is 54% higher than the average of the three previous years (2010-2012). The fishing mortality decreased in the 2000's to its lowest at 0.13 in 2010, but has been stable at 0.23–0.25 in 2012–2014. The increase of SSB implies an increase of at most 20% in catches in relation to last three years' average catches, corresponding to catches of no more than 6 641 t in 2016.

6.5.11 Quality of assessment

In the XSA results, the period of a continuously reducing fishery independently of stock size may have caused problems to the reliability of the XSA. However, it was regarded that the XSA shows recent trends in the stock and can be used as an indicator. Despite fluctuation in trap net and trawl CPUE:s (the latter only since 2000), they are regarded informative as indicators of the development in the stock.

6.5.12 Comparison with previous assessment

A comparison between the basic runs of 2014 and 2015 is presented in the text table below. Similar fleets as those in 2014 were used. Trawl fleet includes years from 2000 to 2014. Trap net fleet was set to include the years 1994-2014.

Comparisons of assessment in 2014 and 2015: Herring SD 31				
Category	Parameter	Assessment 2014	Assesment 2015	Difference 2014/2015
XSA-input	Catchability dependent on stock size	<2	<2	No
	Catchability independent of age	>=7	>=7	No
	Tapered time weighting	20 years	20 years	No
	Shrinkage	0.8	0.8	No
	Use of plus group	No	No	No
	Tuning data and Tuning period	Two fleets: Trap net from 1994 on Trawl from 2000 on	Two fleets: Trap net from 1994 on Trawl from 2000 on	No
	CPUE:			
	Trawl	Hours	Hours	No
	Trap net	No. nets	No. nets	No
	Fbar	3-7	3-7	No
XSA-results	SSB 2013 (‘000 t)	26.3	25.9	-2%
	F3-7 in 2013	0.26	0.23	-13%
	Recruitment Age 1 in 2013 (billions)	0.39	0.34	-15%

6.5.13 Management considerations

This stock is a minor part of the resource basis for the herring TAC set for Management Unit III. From the beginning of the year 2005 on, this management unit has included Subdivisions 30 and 31 (to the end of 2004, SD 29N was also included). The actual level of the stock size in SD 31 is unknown.

The observations on similar growth rate but the differences in otoliths structure between herring in the Bothnian Sea and in the Bothnian Bay suggest a close relationship between the stocks or even that the Bothnian Bay stock may be a part of the Bothnian Sea stock, but support the conclusion that some isolation still exists between herring in the Bothnian Bay and the Bothnian Sea. The stock structure in SD 31 and SD 30 needs to be further explored. However at present they are assessed separately.

Table 6.5.1 Herring in subdivision 31. Catches (tonnes) by country and the % change in total catch from the previous year.

Year	Finland	Sweden	Total	% change
1971	6 143	820	6 963	
1972	3 550	770	4 320	-38
1973	3 152	727	3 976	-8
1974	5 737	665	6 482	63
1975	4 802	800	5 547	-14
1976	7 763	750	8 508	53
1977	6 580	750	7 330	-14
1978	9 068	700	9 768	33
1979	6 275	785	7 060	-28
1980	8 899	760	9 659	37
1981	7 206	620	7 826	-19
1982	7 982	670	8 652	11
1983	7 011	696	7 707	-11
1984	8 322	594	8 916	16
1985	8 595	717	9 312	4
1986	8 754	336	9 090	-2
1987	7 788	320	8 108	-11
1988	8 501	267	8 768	8
1989	4 005	423	4 428	-49
1990	7 603	295	7 898	78
1991	6 800	400	7 200	-9
1992	6 900	400	7 300	1
1993	8 752	383	9 135	25
1994	5 195	411	5 606	-39
1995	3 898	563	4 461	-20
1996	5 080	114	5 194	16
1997	4 195	86	4 281	-18
1998	5 358	224	5 582	30
1999	3 909	248	4 157	-26
2000	2 479	113	2 592	-38
2001	2 755	67	2 822	9
2002	3 532	219	3 750	33
2003	3 855	150	4 004	7
2004	5 831	142	5 973	49
2005	4 800	169	4 970	-17
2006	2 684	269	2 954	-41
2007	2 992	253	3 245	10
2008	2 309	175	2 484	-23
2009	2 166	209	2 375	-4
2010	1 898	177	2 075	-13
2011	3 218	132	3 350	61
2012	5 206	161	5 367	60
2013	4 486	126	4 612	-14
2014	4 636	196	4 832	5
Average	5 489	411	5 903	

Table 6.5.2 Herring in SD 31. TUNING FLEETS.

TRAPNET. Effort: number of trapnets; Catch: millions.

Year	effort	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1994	120	3	1.25	2.6	1.92	0	0.26
1995	150	3.43	1.47	1.01	1.15	0.94	0.17
1996	149	0.84	2.9	1.44	0.89	1.26	0.45
1997	174	12.54	2.19	4.51	1.5	0.9	0.74
1998	197	6.5	6.79	1.71	0.91	0.69	0.35
1999	158	2.46	3.82	3.01	0.78	0.41	0.09
2000	138	1.31	2.61	2.1	2.95	0.46	0.07
2001	129	1.07	3.57	1.53	1.86	0.63	0.41
2002	120	10.9	1.15	0.64	0.95	0.62	0.12
2003	111	1.91	9.93	2.97	0.97	0.8	0.99
2004	106	6.21	2.39	2.64	0.7	0.39	0.23
2005	98	5.07	4.22	1.66	2.59	0.73	0.23
2006	81	0.74	2.91	0.81	0.37	0.84	0.11
2007	95	2.37	2.08	3.39	1.46	0.48	1.2
2008	88	2.41	1.25	0.59	1.38	0.7	0.25
2009	85	5.36	2.86	0.33	0.52	0.47	0.28
2010	92	0.34	1.9	0.68	0.12	0.08	0.27
2011	76	0.3	0.27	1.76	0.39	0.28	0.13
2012	69	3.5	0.42	0.54	1.81	0.72	0.31
2013	56	1.84	1.62	0.37	0.34	0.75	0.26
2014	49	2.74	1.87	1.29	0.26	0.30	0.86

FINNISH TRAWL FLEET. Effort:total annual trawling hours; Catch: millions

Year	effort	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
2000	3 272	8.14	7.18	12.59	9.93	12.15	2.26	0.42
2001	2 034	47.44	5.91	16.22	6.87	8.27	2.81	1.74
2002	4 100	9.89	75.99	7.65	5.26	5.26	4.28	5.05
2003	4 519	43.94	8.60	39.32	11.63	3.79	3.22	3.94
2004	4 636	90.68	73.97	29.79	30.80	8.29	4.46	2.54
2005	4 054	28.60	48.40	38.30	12.50	17.60	5.30	2.10
2006	3 172	21.70	9.20	32.30	9.00	6.40	8.70	1.40
2007	2 476	32.50	12.70	10.80	18.10	7.50	2.50	6.20
2008	1 887	37.80	15.00	8.80	4.90	9.71	4.80	2.20
2009	1 456	4.91	38.51	20.61	2.65	3.84	3.84	2.12
2010	3 585	4.50	5.67	29.77	8.54	1.73	1.31	3.22
2011	3 033	52.96	4.62	5.60	22.80	4.62	4.89	1.83
2012	2 499	43.94	56.97	6.08	7.74	23.70	10.58	4.67
2013	2 126	47.22	37.30	27.05	6.11	5.14	14.77	4.94
2014	2 727	29.56	44.94	30.56	21.17	4.23	4.89	10.12

Table 6.5.3 Herring in SD 31. Samples of commercial catches by quarter for 2013 available to the Working Group.

Herring

Sub-division	Country	Quarter	Landings in tons	Number of samples	Number of fish meas.	Number of fish aged
31	Finland	1	112	0	0	0
		2	3114	10	3107	1019
		3	1310	4	1293	429
		4	101	4	1280	407
		Total	4637	18	5680	1855
	Sweden	1	0	0	0	0
		2	78	3	917	233
		3	40	3	930	271
		4	77	0	0	0
		Total	195	6	1847	504
	Total	1	112	0	0	0
		2	3192	13	4024	1252
		3	1350	7	2223	700
		4	178	4	1280	407
		Total	4832	24	7527	2359

Table 6.5.4 Herring in SD 31. Catch in Numbers (thousands).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1980	61 900	57 900	5 900	13 600	88 200	13 200	22 800	18 100	18 700
1981	13 600	75 100	25 200	5 100	12 200	50 100	17 300	16 700	18 200
1982	3 700	15 400	119 300	22 200	5 200	15 800	28 500	6 600	16 100
1983	8 100	6 300	14 300	69 500	7 900	12 000	14 600	26 800	21 000
1984	40 500	144 600	20 100	10 800	54 800	7 500	6 400	1 100	19 500
1985	7 800	91 500	124 000	15 100	11 000	31 200	4 700	2 800	13 400
1986	5 200	18 300	52 200	70 900	12 400	14 600	29 700	4 200	24 700
1987	10 200	34 300	28 300	42 100	48 600	10 300	12 400	9 600	12 800
1988	6 500	41 800	29 400	25 300	39 200	40 900	8 000	8 300	14 500
1989	11 200	10 600	24 800	11 400	11 600	17 100	15 800	3 900	4 600
1990	16 900	148 500	8 800	26 400	12 600	13 500	20 900	9 300	10 700
1991	2 100	34 100	99 200	5 100	19 100	8 700	9 200	9 300	15 600
1992	16 200	21 500	50 500	89 800	6 500	11 500	11 500	10 500	13 000
1993	19 500	58 200	25 100	57 100	97 600	9 900	9 000	7 300	11 100
1994	7 000	37 700	34 600	12 800	29 200	40 300	2 100	9 700	4 200
1995	47 300	19 400	37 200	19 700	10 900	19 700	17 800	2 000	1 800
1996	23 100	107 700	11 600	26 100	17 200	10 300	12 700	13 000	1 100
1997	26 800	40 700	63 500	9 600	20 400	8 500	7 100	4 100	2 500
1998	10 200	42 500	66 900	66 200	16 700	8 500	6 400	3 300	3 000
1999	1 500	15 800	30 300	47 100	33 900	9 200	4 500	1 100	1 800
2000	50 766	10 213	8 868	15 987	12 685	16 071	2 862	508	1 839
2001	58 123	58 162	7 164	20 261	8 603	10 374	3 521	2 198	862
2002	32 620	11 985	91 421	9 460	6 330	6 515	5 146	5 287	859
2003	64 194	55 794	10 973	50 333	15 517	5 274	4 236	5 001	3 089
2004	16 724	100 494	82 613	33 062	34 092	9 150	4 940	2 820	2 617
2005	23 442	32 224	54 707	43 693	15 087	21 037	6 265	2 570	3 584
2006	19 532	24 477	11 771	36 809	11 182	7 384	10 350	2 059	4 039
2007	41 635	41 992	16 429	13 686	23 269	9 424	3 495	7 948	2 111
2008	12 843	46 426	18 578	10 452	5 674	11 533	5 642	2 641	7 102
2009	1 979	6 416	46 476	25 009	3 282	4 743	4 978	2 759	3 645
2010	17 339	5 983	6 907	33 450	9 896	2 207	1 508	3 807	3 846
2011	36 024	55 945	4 918	5 902	24 451	5 347	5 262	1 997	4 994
2012	30 418	48 082	61 191	6 642	8 425	26 452	12 156	5 356	9 969
2013	28 534	51 186	41 091	30 278	7 138	6 084	16 713	5 523	5 469
2014	16 892	33 287	50 609	34 413	23 846	4 764	5 504	11 392	4 472

Table 6.5.5 Herring in SD 31. 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+
1980	11.3	22.8	30.4	37.8	40.0	41.6	43.3	46.6	50.4
1981	14.4	20.7	28.8	33.6	39.2	42.0	44.6	46.6	52.0
1982	16.9	25.8	30.7	37.5	42.9	47.2	49.4	52.9	55.1
1983	15.5	27.2	34.4	38.3	39.5	47.6	47.9	53.0	55.9
1984	15.9	20.9	33.5	39.1	42.1	44.8	51.8	54.1	55.4
1985	12.3	19.8	29.7	37.3	43.7	45.3	53.0	53.4	58.3
1986	13.4	20.2	29.3	36.6	41.6	46.3	49.6	48.8	65.5
1987	14.2	22.6	31.5	38.2	43.6	48.6	54.1	57.2	63.3
1988	8.3	22.1	34.7	40.8	45.3	50.2	54.9	60.1	64.8
1989	11.4	21.7	32.6	41.7	46.4	49.8	53.2	58.1	64.6
1990	13.5	18.4	33.4	37.7	44.6	50.1	54.1	55.9	67.2
1991	14.9	20.3	27.3	35.4	41.5	46.5	48.9	53.8	66.3
1992	12.6	19.4	26.5	29.9	40.8	42.1	48.2	51.2	62.2
1993	14.2	20.3	27.6	31.5	33.4	43.2	48.5	52.6	60.1
1994	15.4	20.1	28.5	33.2	35.0	36.5	43.8	50.3	60.7
1995	6.6	17.5	28.7	33.1	35.8	38.7	41.0	48.1	60.8
1996	10.9	14.9	25.8	31.3	34.7	39.8	41.3	48.4	51.9
1997	9.5	16.5	22.7	30.1	35.0	37.3	41.3	43.0	43.2
1998	9.6	13.5	21.4	28.4	36.8	41.1	44.6	52.7	56.4
1999	9.2	14.0	20.7	27.5	35.4	44.1	49.3	54.1	55.7
2000	9.3	16.5	22.8	28.6	32.4	38.5	43.5	44.7	58.3
2001	7.0	15.8	24.4	24.4	25.9	32.3	35.8	35.8	41.2
2002	9.2	17.5	22.5	28.3	32.5	34.5	37.9	41.7	43.9
2003	7.4	14.9	22.2	26.5	28.8	34.6	38.0	37.5	44.4
2004	7.3	13.6	20.9	27.1	30.8	38.0	40.2	42.1	48.5
2005	10.9	16.2	21.2	27.2	33.0	35.3	39.7	45.5	51.4
2006	10.5	16.7	21.4	24.2	27.3	31.5	36	38.2	46.7
2007	8.0	16.0	22.0	25.0	28.0	33.0	35.0	41.0	49.0
2008	11.0	11.0	15.0	22.0	23.0	27.0	31.0	37.0	40.0
2009	13.0	16.0	21.0	24.0	29.0	31.0	34.0	36.0	43.0
2010	11.0	19.0	23.0	25.0	30.0	34.0	36.0	39.0	47.0
2011	12.0	20.0	26.0	32.0	30.0	35.0	37.0	39.0	38.0
2012	9.0	17.0	25.0	30.0	32.0	38.0	41.0	43.0	48.0
2013	10.0	18.0	25.0	27.0	32.0	35.0	38.0	38.0	45.0
2014	9.4	18.3	24.7	26.5	33.2	36.6	37.0	42.6	49.3

Table 6.5.6 Herring in SD 31. Proportion Mature at Year Start.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9+
1980	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.32	0.95	0.98	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.30	0.92	0.92	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.19	0.94	0.95	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.29	0.95	0.96	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.33	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1988	0.00	0.39	0.97	0.99	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.32	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.00	0.37	0.82	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.20	0.71	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.00	0.41	0.93	1.00	1.00	1.00	1.00	1.00	1.00
1994	0.00	0.42	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.15	0.85	1.00	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.63	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.29	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1998	0.00	0.43	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1999	0.00	0.50	0.96	1.00	1.00	1.00	1.00	1.00	1.00
2000	0.00	0.56	0.90	0.97	0.97	1.00	1.00	1.00	1.00
2001	0.00	0.64	0.94	1.00	1.00	1.00	1.00	1.00	1.00
2002	0.00	0.43	0.97	0.96	1.00	1.00	1.00	1.00	1.00
2003	0.02	0.62	1.00	0.96	1.00	1.00	1.00	1.00	1.00
2004	0.13	0.35	0.97	1.00	0.98	1.00	1.00	1.00	1.00
2005	0.00	0.49	0.96	1.00	0.95	1.00	1.00	1.00	1.00
2006	0.04	0.61	0.87	1.00	1.00	1.00	1.00	1.00	1.00
2007	0.02	0.77	0.97	1.00	1.00	1.00	1.00	0.97	1.00
2008	0.00	0.42	0.97	1.00	1.00	1.00	1.00	1.00	0.96
2009	0.00	0.98	0.95	0.98	0.89	1.00	0.96	1.00	1.00
2010	0.04	0.51	0.85	0.99	1.00	1.00	1.00	1.00	1.00
2011	0.04	0.51	0.85	0.99	1.00	1.00	1.00	1.00	1.00
2012	0.00	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2013	0.07	0.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2014	0.04	0.81	0.98	1.00	1.00	1.00	1.00	1.00	1.00

Table 6.5.7 **Herring in SD 31. XSA Summary table.**

YEAR	RECRUITS	TSB	SSB	CATCH	LANDINGS	FBAR 3- 7	Y/SSB	
1980	859928	52217	35315	9659	9 659	0.2092	0.27	
1981	271998	45674	28922	7826	7 826	0.2608	0.27	
1982	217727	44786	32813	8652	8 652	0.2933	0.26	
1983	873085	51164	30335	7707	7 707	0.4079	0.25	
1984	645172	55333	30298	8916	8 916	0.2158	0.29	
1985	328774	51682	34630	9312	9 312	0.2083	0.27	
1986	249361	52166	39724	9090	9 090	0.2493	0.23	
1987	333721	49311	37308	8108	8 108	0.218	0.22	
1988	102216	43323	34689	8768	8 768	0.2603	0.25	
1989	931344	43067	28511	4428	4 428	0.158	0.15	
1990	402142	47900	29341	7898	7 898	0.2077	0.27	
1991	173350	45796	32853	7200	7 200	0.1859	0.22	
1992	252234	36636	26078	7300	7 300	0.2716	0.28	
1993	244388	31000	21544	9135	9 135	0.4335	0.42	
1994	160110	23244	15948	5606	5 606	0.3449	0.34	
1995	550223	19556	11505	4461	4 461	0.3755	0.38	
1996	370777	21821	13094	5194	5 194	0.4556	0.38	
1997	225516	19804	11975	4281	4 281	0.4716	0.34	
1998	142224	17916	12687	5582	5 582	0.6404	0.42	
1999	132871	14548	10133	4157	4 157	0.5744	0.38	
2000	603087	17656	8640	2592	2 592	0.2757	0.27	
2001	247338	17861	11149	2822	2 822	0.2517	0.24	
2002	418345	21803	13274	3750	3 750	0.2469	0.26	
2003	481462	23174	14204	4004	4 004	0.275	0.26	
2004	149721	22601	14286	5973	5 973	0.41	0.38	
2005	177916	21055	13522	4970	4 970	0.3967	0.32	
2006	288340	19048	10760	2954	2 954	0.2534	0.22	
2007	547086	21256	11424	3245	3 245	0.2841	0.23	
2008	119864	18045	9708	2484	2 484	0.2217	0.20	
2009	82040	21111	14193	2375	2 375	0.2042	0.13	
2010	493977	25040	12937	2075	2 075	0.1265	0.12	
2011	487822	30958	15518	3350	3 350	0.143	0.18	*14*
2012	606181	35611	22128	5367	5 367	0.2519	0.21	*16*
2013	343566	37007	25862	4612	4 612	0.2271	0.16	2
2014	264506	36565	26162	4832	4 832	0.2458	0.16	2

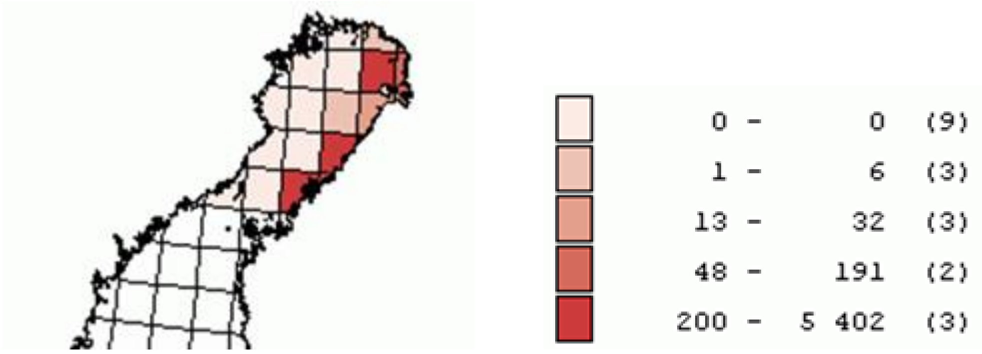


Figure 6.5.1 Herring in SD 31. The distribution of the fishing areas and catches (tons) of herring in the Bothnian Bay in 2011. The fishing areas have remained more or less the same since (the newest figure not available).

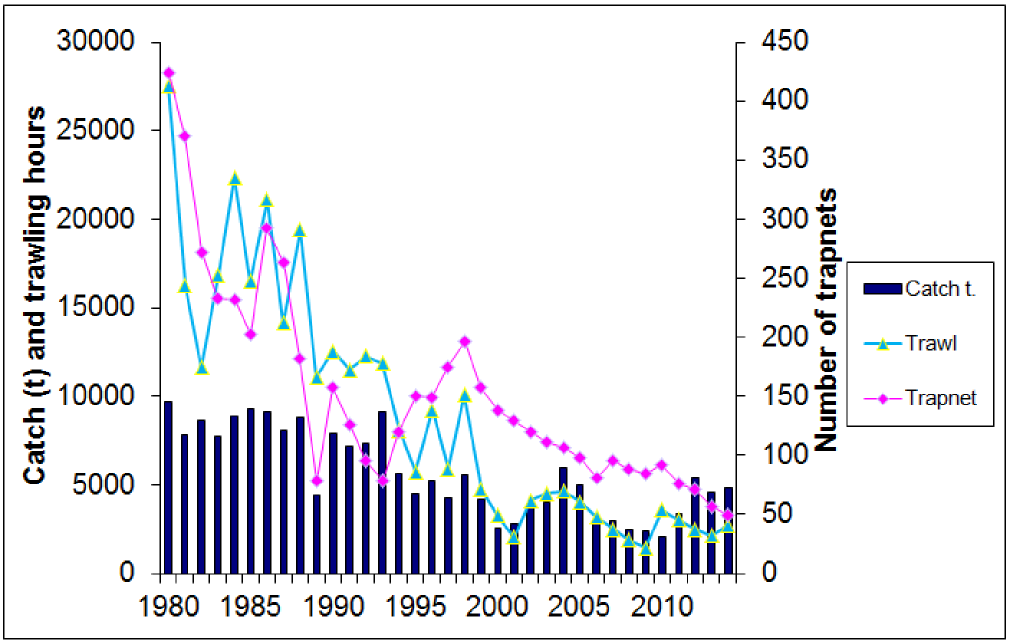


Figure 6.5.2 Herring in SD 31. The development of trawling hours, trapnet effort and total catch.

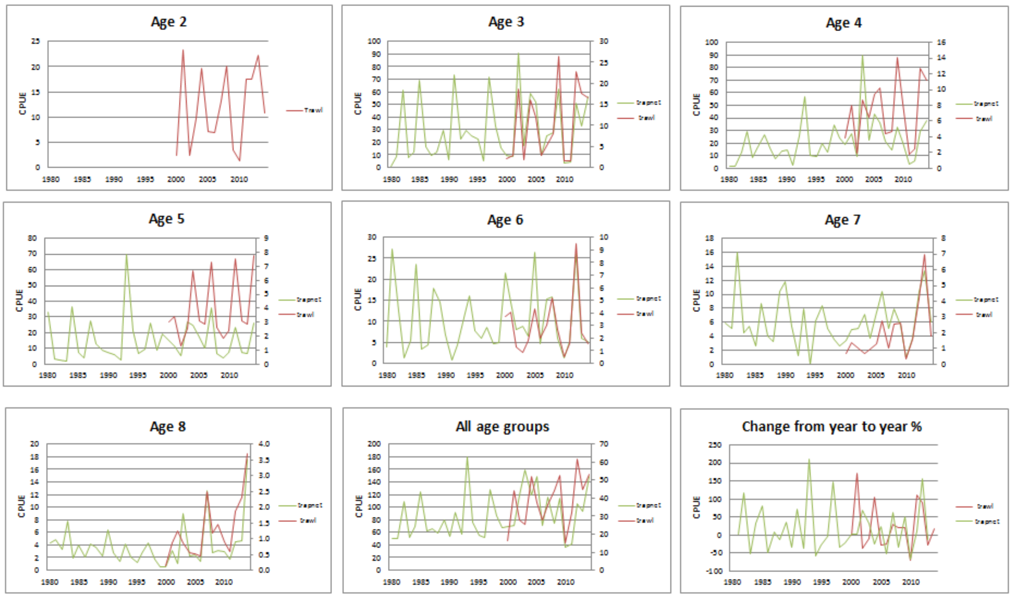


Figure 6.5.3 Herring in SD 31. CPUE in commercial trawl and trapnet data.

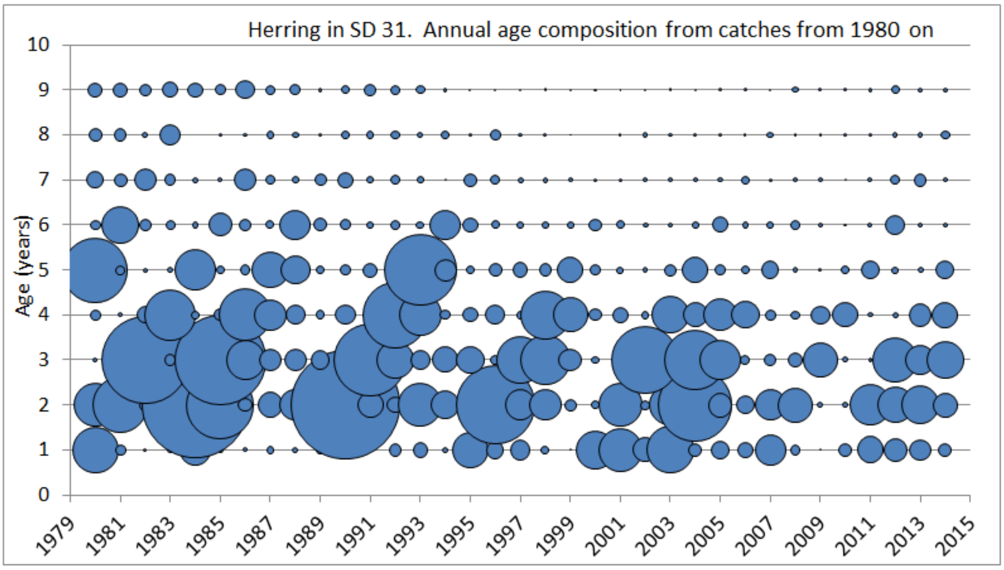


Figure 6.5.4. Herring in SD 31. Catch in numbers.

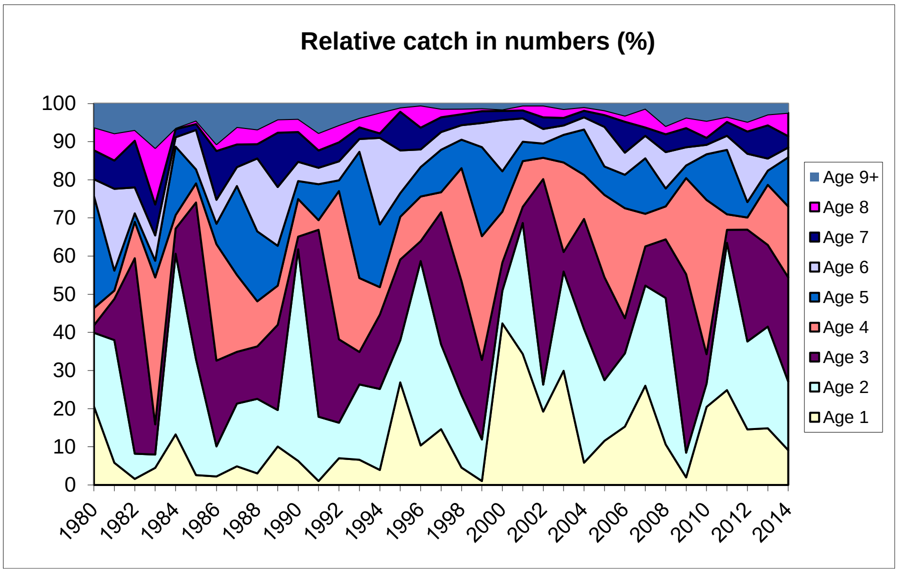


Figure 6.5.5 Herring in SD 31. Relative catch in numbers (%).

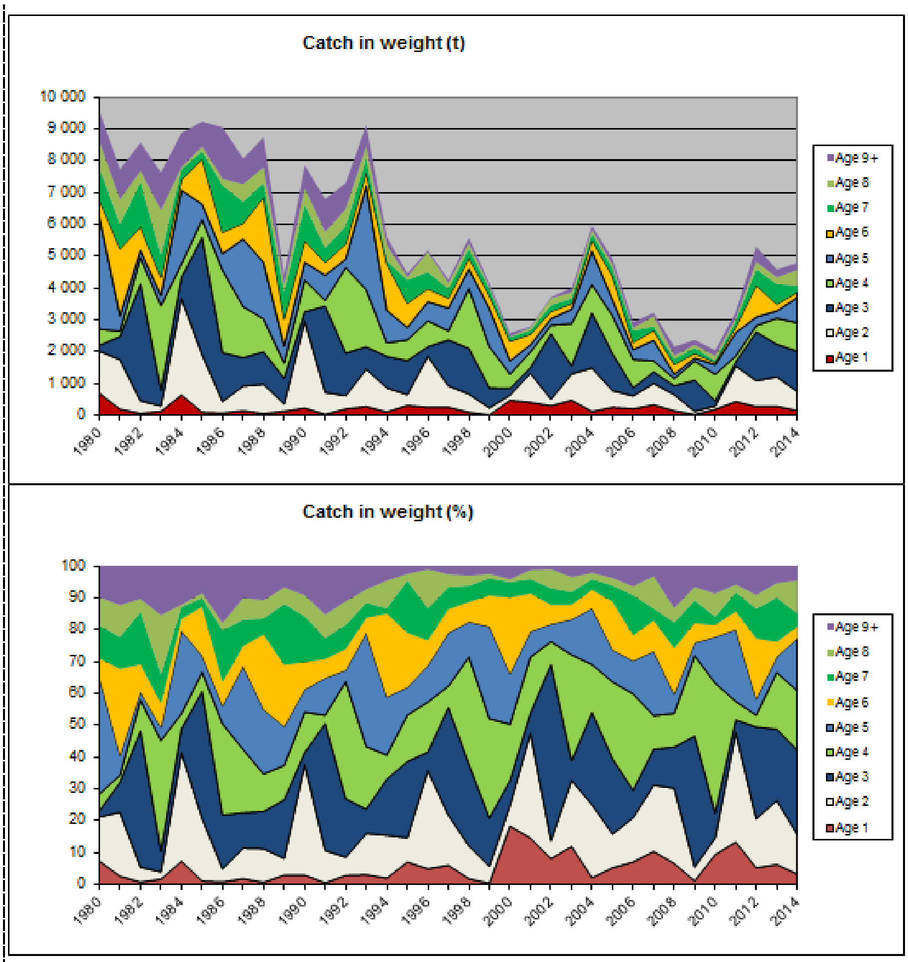


Figure 6.5.6 Herring in SD 31. Catch in weight by age.

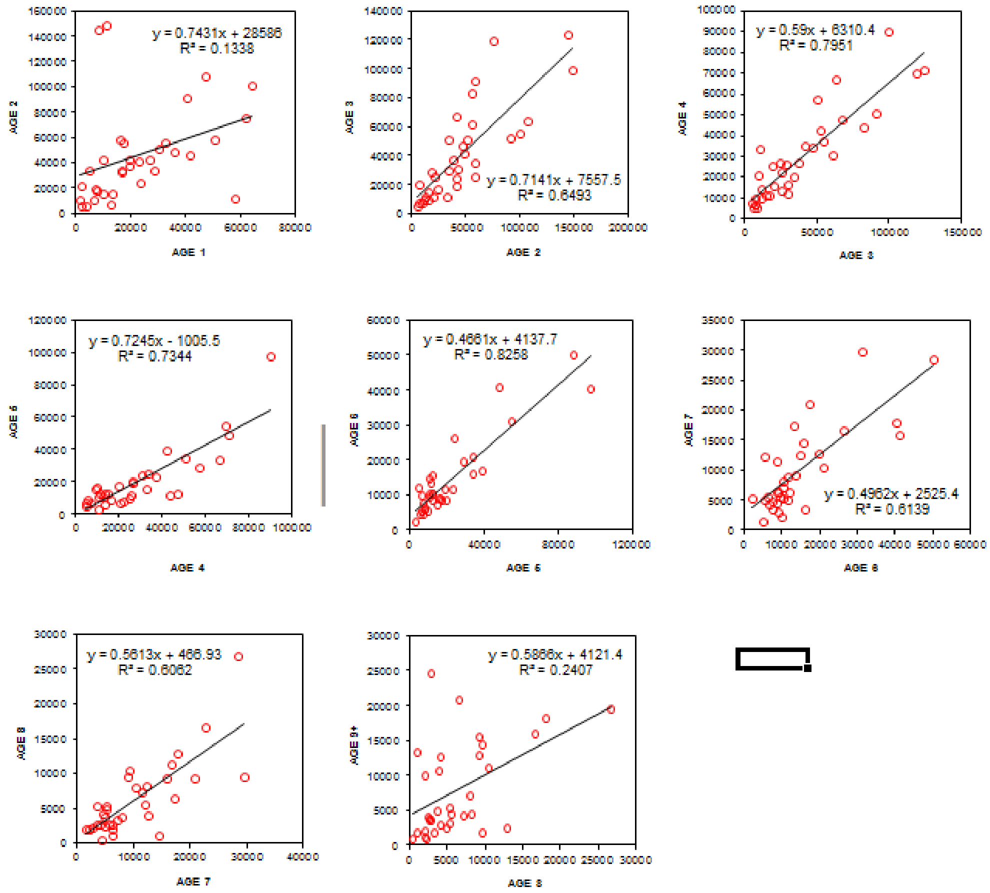


Figure 6.5.7 Herring in SD 31. Numbers at age versus number at age +1 in the catch (all fleets combined).

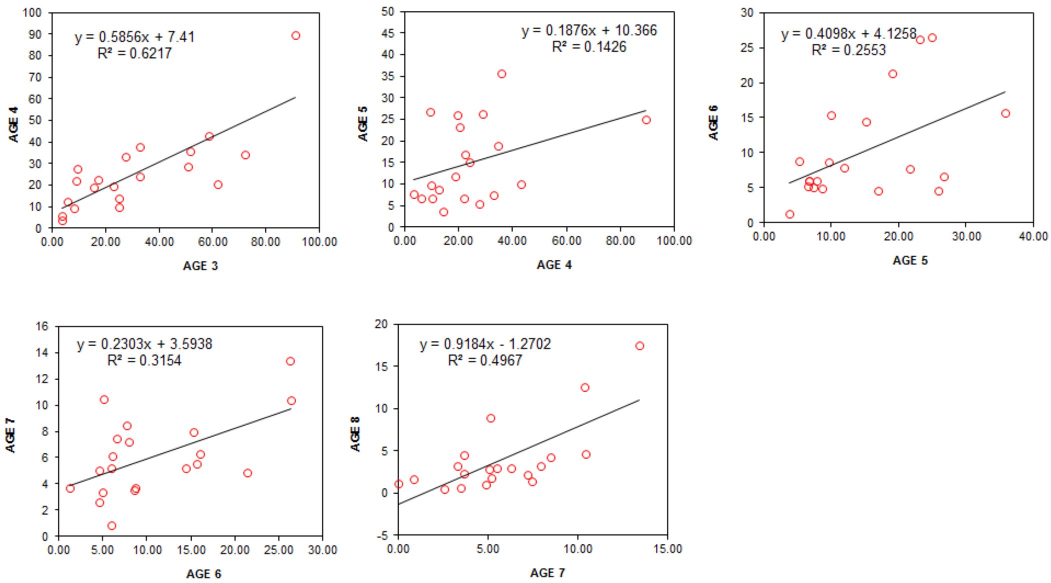


Figure 6.5.8 Herring in SD 31. Age versus age+1 in trapnet CPUE.

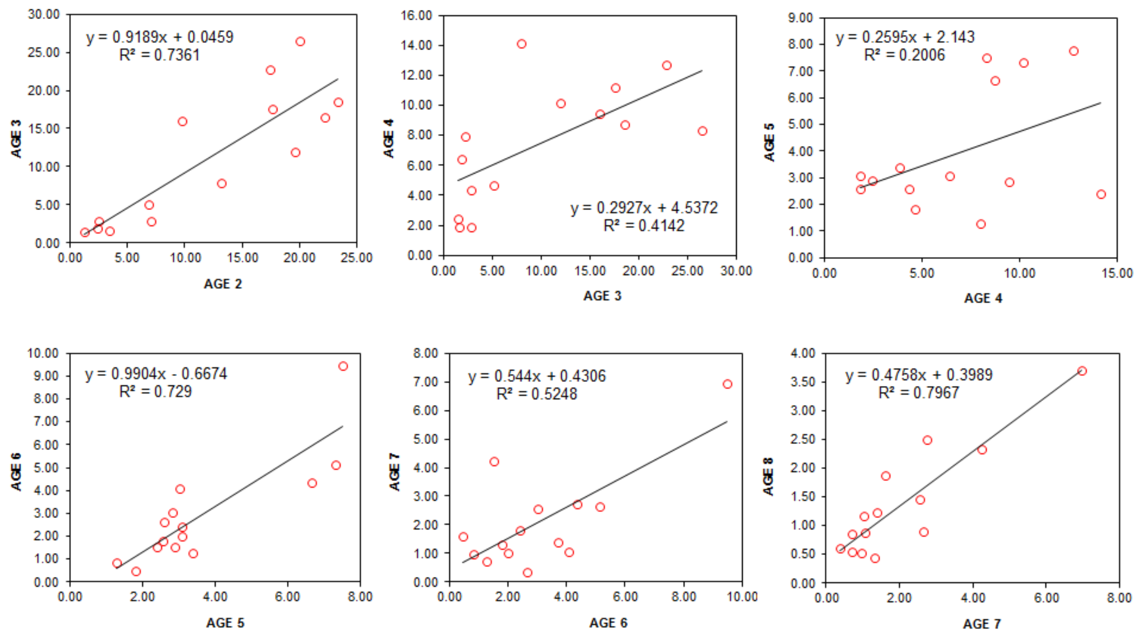


Figure 6.5.9 Herring in SD 31. Age versus age+1 CPUE in the trawl tunning fleet.

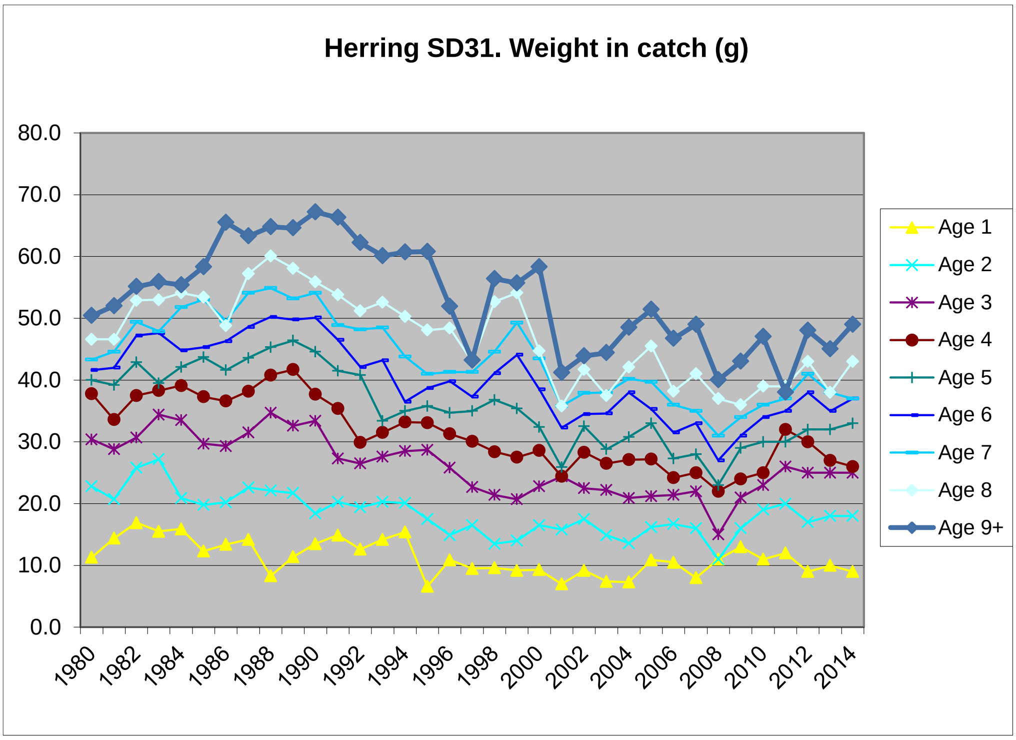
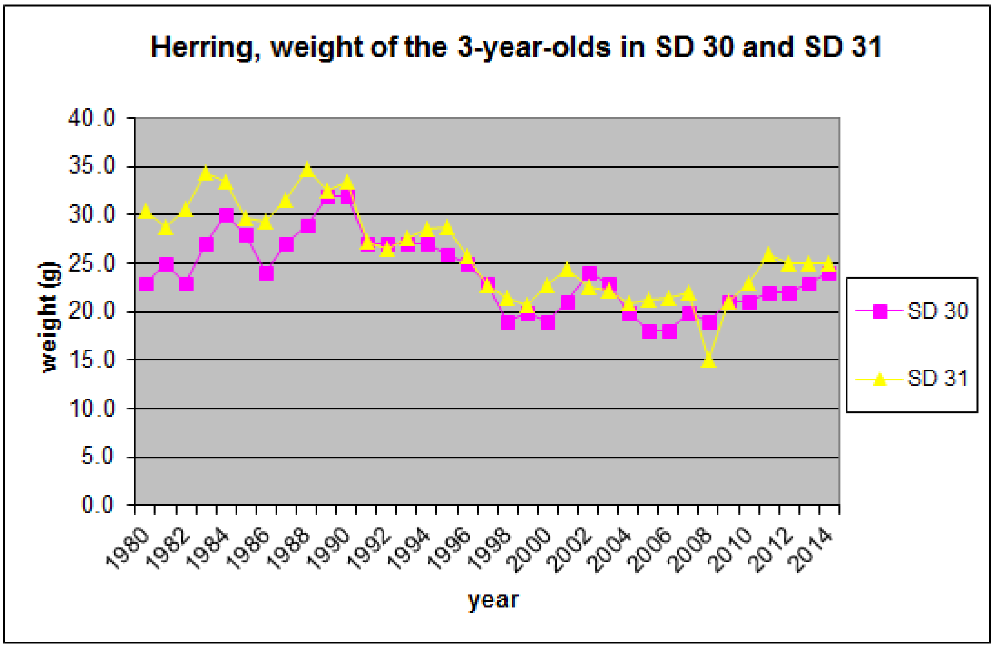


Figure 6.5.10 Herring in SD 31. Weight in Catch and in the Stock (g).



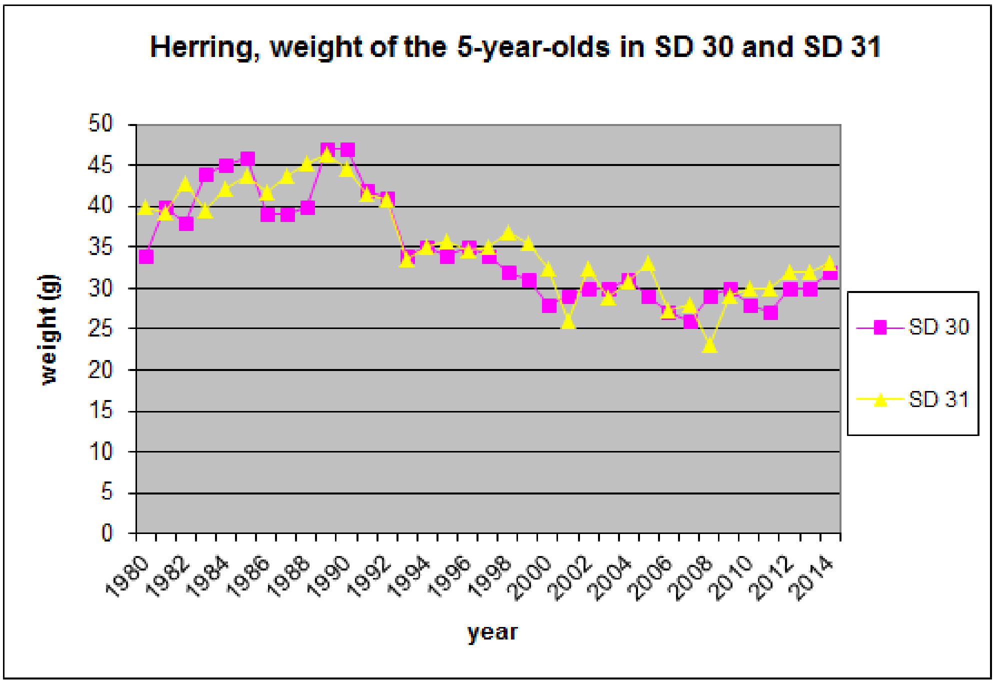


Figure 6.5.11 Herring in SD 31. The weight at ages 3 and 5 compared with the herring in SD 30. In older age groups errors in age determination could affect the result before the year 2003.

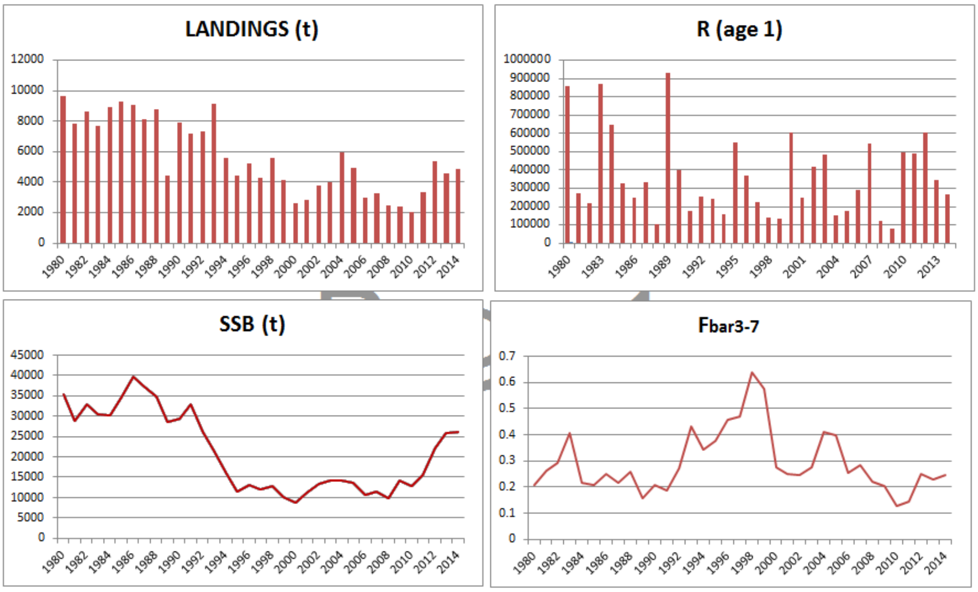


Figure 6.5.12 Herring in SD 31. Summary from the exploratory XSA assessment.

7 Sprat in Subdivisions 22–32 (update assessment)

As in previous years sprat in the Baltic Subdivisions 22–32 was assessed as a single unit.

In 2013 the sprat assessment was benchmarked at WKBALT (ICES, 2013a) 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 recent years for most ages (except age 1) new mortality estimates are higher than the previous ones by about 20%.

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.

Preliminary assessments by „assessment units" used up to early 1990s (Subdivisions 22–25, subdivisions 26+28, and subdivisions 27, 29–32) were conducted. The results showed that biomasses in former assessment units sum up to values close to values obtained in the assessment for the whole Baltic. However, effects of former assessment units on catch and biomass projection and stock management were not analysed as such task would require much more time and scientific effort.

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

Sprat catches in 2014 were 243769 t, which is 11% less than in 2013 and 54% less than the record high value of 529 400 t in 1997. In 2014 the TAC of 239979 t set for EU was utilized in 92%. The largest decrease in catches was observed for Poland (28%). For the Latvia, Sweden and Lithuania the catches decreased by 7-8%. At the same time the Danish, Finnish and Russian catches increased slightly compared to 2013.

The spatial distribution (by subdivision) of sprat catches was similar to previous years. Subdivision 26 dominated the catches with a 31% share in the sprat catch. Other important areas are Subdivisions 28, 25 and 29 (22, 16 and 15%, 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 2001–2014. Table 7.3 contains landings, catch numbers, and weight at age by subdivision and quarter.

7.1.1 Unallocated landings

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.

7.1.2 Discards

In most countries discards are probably small because 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) are 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 is unknown. However, the collection of sprat discards data is in progress (EU Regulation) and the data should be available for future WG meetings. In the latest 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 2 countries reported zero discards from the recent three years.

7.1.3 Effort and CPUE data

Only Denmark and Lithuania uploaded the fishing effort data for 2014 into the InterCatch in this year. Russia previously provided the data on fishing effort and cpue for Subdivision 26 in 1995-2010 (Table 7.4). These data indicate increase in cpue in 1995–2006 and stable cpue in 2007–2010. 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 composition of the catch

7.2.1 Age composition

All countries provided age distributions of their major catches (landed in their waters) by quarter and Subdivision. Catches for which the age composition was missing represented only about 7% of the total. Almost all German catches (94%) were taken outside the German waters but also these were very well sampled (87%). 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 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 2014 by quarter, ICES subdivision, and country is presented in Table 7.5. These data show that generally in 2014 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 4.4 times higher than indicated in the directive, and 843 length measurement and 195 age readings were recorded per 2000 t catch.

7.3 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 have increased somewhat. 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 in 2005 and it was considered satisfactory.

7.4 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 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 - 2014 were assumed the same as in 2011 (updated M estimates from SMS were not available due to problems with cod assessment) . Final estimates of M are given in Table 7.8.

7.5 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.

7.6 Catch-at-age analysis

7.6.1 Tuning fleets

Three tuning data sets covering Subdivisions 22–29 were available: from International Acoustic Surveys in autumn in 1991–2014, from International Acoustic Surveys in May in 2001–2014, and Acoustic Surveys covering age 0 sprat in Subdivisions 22–29 in 1991–2014 (Tables 7.12–7.14). The survey data were corrected for area coverage (WGBIFS, ICES, 2013c).

The internal consistency of survey at age estimates and consistency between surveys was checked on graphs (Figures 7.4–7.6). 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.

7.6.2 XSA runs

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 benchmark assessment (and no change from previous benchmark settings) :

tricubic time weighting,

catchability dependent on year class strength at age 1 (only for this age group the slopes of regressions were significantly different from 1),

catchability independent of age for ages 5 and older,

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 Figures 7.7a. The data are moderately noisy for October fleet (SE of log q = 0.4-0.5, exept age 7). The log q residuals from the May survey are lower with a SE's range of 0.3–0.4. The residuals from acoustic survey on age 0 (shifted to represent age 1) are low from 2000 onwards (regression SE < 0.3). The correlations between XSA estimates and survey indices are high (R^2 mostly at level of 0.7–0.8).

The May survey had the highest influence on survivor estimates (ca. 40–55% weight except of age 1). The weight of estimates resulting from shrinkage is low (up to 6%) (Figure 7.7b). The survey estimates of survivors are quite consistent at most ages – consistency is somewhat lower at age 2 where estimates based on October survey diverge from estimates using May survey and age 0 acoustic (Figure 7.7c).

Retrospective analysis (Figure 7.8) shows quite scattered estimates for F, with a tendency to overestimate F and underestimate SSB. 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 fishing mortalities, stock numbers and summary tables are presented in Tables 7.16–7.18. Fish stock summary plots are presented in Figures 7.9 and 7.10.

7.6.3 The assessment with SAM

The SAM model was attempted at benchmark workshop as the second assessment model for sprat. Results of SAM parameterised in similar way as XSA are compared with XSA estimates in Figure 7.11a. For 2014 the SAM estimates of SSB and recruitment are lower than the XSA estimates by ca. 30% while the F is higher by 20%. 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 BalSpr2015).

7.7 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 is high, generally at range of 0.70–0.80. Estimates are mainly determined by survey (weight of 60–70%). The 2014 year class was estimated very strong at almost 150 billion. The RCT3 program uses shrinkage option, which constraints the estimate (last 5 year classes were at average or below); without that option 2014 year class would be estimates at ca. 200 billion.

7.8 Historical stock trends

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 decreased, and after 2000 it has fluctuated mostly in range of 0.9–1.2 million tons. In recent years SSB has declined due to rather low recruitment. The estimate of SSB for 2014 is 780 thousand tons. 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).

7.9 Short-term forecast and management options

The RCT3 program estimate of the 2014 year class at age 1 was used in the predictions. The 2015 and 2016 year classes were assumed as geometric mean of the recruitment at age 1 in 1991-2014 (period of recruitment fluctuations without clear trend, the 2014 value is well estimated in the assessment). The natural mortalities were assumed at 2011 level (last vales of M available from SMS), while mean weights-at-age were taken as averages of the 2012–2014 values. The fishing pattern was smoothed as the average F at age in 2012–2014 scaled to the final year value (increase in F in 2013-2014). Input data for catch prediction are presented in Table 7.21.

The catch projection with status quo F produces catch of 264 Kt in 2015, which is higher than TAC of 240 Kt. Thus, two options for catch projection are presented: the F_{sq} and TAC constrain (Table 7.22a-b). However, TAC constrain is considered to be more realistic and is recommended to be used for advice, although differences between projection in two options are very small (1-2%) .

In Figure 7.13 the sensitivity of the projection to the assumed strength (GM) of the 2015 and 2016 year classes and the estimate of 2014 year class is presented. The assumed level of the 2015–2016 year classes contributes by 13% to the predicted catch in 2016 and by 44% to SSB in 2017.

7.10 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 (Figure 7.15). They all show 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)) 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) a)	0.19	0.26	0.27	570	0.21

7.11 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 constitute usually 40–55% of the predicted SSB.

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. It showed that sum of biomass of separately assessed components is not very different from biomass estimated for the whole stock. However, the effects of merging component on prediction and sprat management were not investigated and are not known.

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.

7.12 Comparison with previous assessment

The comparison between the results of 2014 and 2015 assessments is presented in the text table below. The XSA settings were the same in both years.

Category	Parameter	Assessment 2014	Assessment 2015	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 assumed as in 2011	M in 1974-2011 estimated in SMS, M2012- M2014 assumed as in 2011	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	No
		Acoustic on age 0 (subdiv. 22-29)	Acoustic on age 0 (subdiv. 22-29)	Yes
XSA results	SSB 2013 (million t)	1.00	0.90	12%
	TSB 2013 (million t)	1.7	1.6	11%
	F(3-5) 2013	0.35	0.38	-8%
	Recruitment (age 1) in 2013 (billions)	90	81	11%

7.13 Management considerations

There are no explicit management objectives for this stock. 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 stock declined, since 2002 the spawning biomass has been fluctuating at range of 0.9–1.2 million t., and declined again below the average in recent years. After 2000 fishing mortality increased and in recent years was fluctuated between F_{pa} and F_{lim}. The five year classes in row (2009–2013) were at or below the average , which contributed to stock decline, but the 2014 year class is predicted to be strong.

In 2016-2017 the stock is predicted to increase by ca 35% (from the 2015 value) 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.

7.14 References

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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

*** Sum of landings by Estonia, Latvia, Lithuania, and Russia**

Table 7.2 Sprat landings in the Baltic Sea by country and Subdivision (thousand tonnes).

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	-	-	-
Total	308.3	8.3	3.5	44.6	115.1	35.6	69.6	21.5	1.5	0.001	8.5

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

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

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	0.00	0.00	0.1
Estonia	28.5	0.00		0.00	0.00	0.0	0.0	1.1	9.9	0.00	0.00	17.5
Finland	11.7	0.00		0.00	0.00	0.0	0.2	0.1	2.8	2.80	0.00	5.8
Germany	10.2	0.60		0.04	2.62	2.2	0.6	1.5	2.6	0.00	0.00	0.0
Latvia	30.8	0.00		0.00	0.27	2.9	0.0	27.6	0.0	0.00	0.00	0.0
Lithuania	9.6	0.00		0.00	0.65	3.5	0.0	4.5	0.9	0.00	0.00	0.0
Poland	56.9	0.00		1.49	21.83	31.2	0.2	2.1	0.1	0.00	0.00	0.0
Russia	23.4	0.00		0.00	0.00	23.4	0.0	0.0	0.0	0.00	0.00	0.0
Sweden	46.0	0.00		0.04	8.27	6.4	6.3	11.0	12.8	0.25	0.00	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

Table 7.3 SPRAT in SD 22-32. Catch in numbers and weight at age by quarter and Sub-division in 2014

Sub-division 22									
	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	1.1	7.1	8.2			3.7	3.7
1	17.9	6.3	0.5	3.1	27.6	6.3	7.7	13.4	13.4
2	13.2	4.6	2.3	14.4	34.5	14.4	14.3	15.8	15.8
3	4.3	1.5	0.5	3.2	9.5	15.6	15.5	16.8	16.8
4	20.2	7.1	1.8	11.4	40.5	17.0	17.1	18.2	18.2
5	0.3	0.1	0.3	1.6	2.2	20.8	20.8	17.8	17.8
6	0.1	0.0	0.0	0.2	0.4	26.0	26.0	19.1	19.1
7	0.3	0.1	0.0	0.2	0.6	20.8	20.8	19.1	19.1
8	0.0	0.1	0.0	0.0	0.1				
9	0.0	0.0	0.0	0.0	0.0				
10	0.0	0.0	0.0	0.0	0.0				
Sum	56.1	19.8	6.5	41.4	123.8				
SOP	725.8	263.4	93.5	596.2	1678.9				
Catch	725.4	254.3	93.6	597.0	1670.3				

Sub-division 23									
	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	0.0	0.0				
1	0.0	0.0	0.0	0.0	0.0				
2	0.0	0.0	0.0	0.0	0.0				
3	0.0	0.0	0.0	0.0	0.0				
4	0.0	0.0	0.0	0.0	0.0				
5	0.0	0.0	0.0	0.0	0.0				
6	0.0	0.0	0.0	0.0	0.0				
7	0.0	0.0	0.0	0.0	0.0				
8	0.0	0.0	0.0	0.0	0.0				
9	0.0	0.0	0.0	0.0	0.0				
10	0.0	0.0	0.0	0.0	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	11.0	98.1	109.1			4.5	4.3
1	13.4	54.8	2.0	17.8	88.0	5.6	6.1	12.6	12.6
2	4.3	3.1	3.9	35.1	46.5	12.4	13.7	14.9	14.9
3	12.2	9.2	1.1	9.5	31.9	13.9	15.9	18.2	17.3
4	8.9	5.8	1.6	14.0	30.3	15.5	17.8	17.1	17.2
5	2.9	1.3	0.3	2.6	7.2	15.9	18.3	18.6	18.6
6	3.8	1.0	0.1	1.2	6.2	15.9	20.5	19.4	19.4
7	0.2	0.1	0.0	0.1	0.4	18.4	21.9	20.5	20.5
8	0.0	0.3	0.0	0.4	0.8		24.4	17.5	17.5
9	0.0	0.0	0.0	0.0	0.0				
10	0.0	0.0	0.0	0.0	0.0				

Sum	45.8	75.7	20.1	178.9	320.4				
SOP	546.9	681.3	188.8	1657.0	3074.1				
Catch	546.0	680.2	185.3	1651.8	3063.3				

Sub-division 25

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	19.7	34.8	54.4			4.2	5.5
1	304.5	100.7	6.1	14.6	425.8	4.6	6.2	12.4	12.3
2	379.3	318.8	9.8	21.0	728.8	10.0	10.6	14.2	14.1
3	491.3	566.5	9.3	19.1	1086.2	12.0	12.0	16.3	15.4
4	248.7	242.8	3.7	11.7	506.9	13.6	13.3	16.9	16.0
5	182.5	197.8	3.1	4.5	387.9	14.3	14.7	17.7	16.7
6	125.0	95.2	2.2	4.8	227.2	14.5	15.4	17.5	15.9
7	25.0	11.5	0.5	0.2	37.2	14.8	15.4	19.2	17.2
8	6.6	9.9	0.4	0.4	17.2	14.8	13.6	16.6	15.5
9	3.7	3.5	0.0	0.1	7.3	15.6	17.3		20.0
10	1.1	1.3	0.0	0.1	2.5	14.0	14.7		17.8
Sum	1767.5	1548.0	54.7	111.3	3481.5				
SOP	19432.9	18795.5	620.6	1313.1	40162.2				
Catch	19460.6	18773.2	619.8	1315.4	40169.0				

Sub-division 26

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	78.1	1029.3	1107.4			2.3	3.3
1	1450.4	733.5	123.5	211.6	2519.0	3.6	4.4	7.1	9.2
2	1402.3	348.0	139.6	369.4	2259.4	8.8	8.8	9.4	11.2
3	1284.1	300.5	71.3	268.2	1924.1	10.4	10.3	11.2	13.0
4	447.0	67.5	23.7	98.3	636.6	11.6	11.5	12.6	14.0
5	274.6	45.5	3.6	44.9	368.7	13.0	12.3	14.4	15.0
6	236.3	40.2	9.0	40.1	325.5	12.8	12.0	13.7	14.5
7	37.9	4.1	0.8	5.8	48.6	13.1	11.9	13.8	15.9
8	27.3	9.5	2.7	3.9	43.4	12.2	11.1	12.8	13.3
9	5.6	0.8	0.1	0.4	6.9	11.0	11.7	16.7	13.0
10	9.0	0.4	0.0	0.1	9.5	13.5	12.1	16.7	10.8
Sum	5174.6	1550.0	452.5	2072.0	9249.1				
SOP	43709.0	11372.0	3689.6	15749.4	74520.0				
Catch	43678.7	11354.8	3692.0	15745.6	74471.1				

Sub-division 27

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.9	70.0	70.9			3.1	3.1
1	65.3	102.4	0.4	32.0	200.2	4.2	3.9	10.7	10.7
2	162.4	112.1	0.3	18.6	293.4	8.9	7.3	11.8	11.8
3	83.1	56.8	0.3	25.0	165.1	10.1	9.3	12.2	12.2
4	24.3	15.2	0.2	11.2	50.9	11.3	9.5	13.4	13.4
5	21.5	12.5	0.0	2.5	36.4	10.7	11.4	13.9	13.9
6	37.3	20.8	0.1	9.8	68.1	12.3	11.3	13.5	13.5
7	4.7	4.2	0.0	2.1	11.0	14.2	10.3	14.3	14.3
8	1.9	1.4	0.0	0.7	4.0	13.5	8.0	15.5	15.5
9	0.0	0.0	0.0	1.1	1.1			14.3	14.3

10	1.9	4.2	0.0	0.7	6.7	12.5	10.7	12.0	12.0
Sum	402.2	329.5	2.3	173.7	907.7				
SOP	3636.4	2365.5	19.7	1466.0	7487.6				
Catch	3637.9	2364.4	19.7	1463.1	7485.1				

Sub-division 28

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	11.9	94.0	106.0			2.2	2.7
1	239.5	151.6	44.7	197.7	633.5	4.3	4.5	9.5	9.6
2	1176.7	263.3	86.2	227.4	1753.6	9.0	8.8	11.5	11.1
3	936.1	245.1	91.3	277.2	1549.8	10.5	9.9	11.9	12.1
4	327.6	55.9	40.2	114.5	538.2	11.5	10.9	12.4	12.6
5	111.3	37.2	10.6	30.1	189.3	12.1	11.1	12.5	12.8
6	233.7	41.2	37.5	92.6	404.9	12.9	11.9	13.1	13.5
7	41.1	8.5	6.7	31.2	87.5	11.5	11.9	13.0	13.5
8	42.5	13.7	5.0	28.2	89.4	12.5	11.8	13.0	14.0
9	4.2	0.0	0.0	0.5	4.7	14.5			13.0
10	2.1	0.0	0.0	0.5	2.6	13.0			13.0
Sum	3114.8	816.6	334.1	1093.9	5359.4				
SOP	30670.5	7201.5	3803.1	11936.1	53611.1				
Catch	30661.6	7203.2	3800.8	11950.3	53615.9				

Sub-division 29

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.1	96.0	96.1			2.8	2.2
1	485.9	7.4	3.1	160.2	656.5	3.7	3.6	8.7	8.9
2	1274.7	33.5	3.0	179.0	1490.3	8.2	7.6	10.3	10.2
3	915.7	20.5	1.6	166.1	1103.9	9.5	9.1	11.5	10.9
4	250.2	5.0	0.7	70.6	326.5	10.0	9.7	11.8	11.5
5	170.2	7.6	0.4	42.1	220.3	11.2	10.1	11.7	11.9
6	129.8	7.8	0.1	42.3	180.0	10.8	10.3	11.9	12.0
7	46.9	2.8	0.1	14.9	64.8	11.2	10.7	11.4	12.3
8	26.5	3.9	0.1	9.2	39.6	10.5	10.0	10.3	12.0
9	3.0	0.0	0.0	0.0	3.0	11.0			
10	10.6	0.0	0.0	0.0	10.6	11.7			
Sum	3313.5	88.5	9.2	780.4	4191.7				
SOP	27720.3	742.4	93.4	7387.4	35943.5				
Catch	27694.6	742.9	93.0	7393.4	35923.9				

Sub-division 30

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	10.9	10.9				3.4
1	0.6	1.0	0.0	0.0	1.6	3.6	3.6		8.0
2	4.2	2.3	0.2	1.2	7.9	7.9	7.6	12.9	12.4
3	15.1	9.7	0.0	2.3	27.1	9.3	9.1	13.3	13.5
4	10.0	5.6	0.3	2.5	18.4	9.7	9.7	13.6	13.6
5	35.9	21.7	0.2	5.1	62.9	10.9	10.1	14.9	14.5
6	29.9	29.7	0.0	4.1	63.8	10.4	10.3	14.4	15.5
7	18.6	20.9	0.3	5.2	45.0	10.8	10.7	14.9	14.8
8	10.6	13.0	0.5	23.0	47.2	10.3	10.0	14.7	15.8

9	0.0	0.0	0.0	0.0	0.0				
10	0.0	0.0	0.0	0.0	0.0				
Sum	124.9	104.0	1.5	54.3	284.7				
SOP	1285.1	1043.8	21.6	695.2	3045.6				
Catch	1285.8	1043.1	21.6	695.5	3046.0				

Sub-division 31

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.0	0.0	0.0				
1	0.0	0.0	0.0	0.0	0.0		3.6		
2	0.0	0.0	0.0	0.0	0.0		7.6		
3	0.0	0.0	0.0	0.0	0.0		9.1		
4	0.0	0.0	0.0	0.0	0.0		9.7		
5	0.0	0.0	0.0	0.0	0.0		10.1		
6	0.0	0.0	0.0	0.0	0.0		10.3		
7	0.0	0.0	0.0	0.0	0.0		10.7		
8	0.0	0.0	0.0	0.0	0.0		10.0		
9	0.0	0.0	0.0	0.0	0.0				
10	0.0	0.0	0.0	0.0	0.0				
Sum	0.0	0.0	0.0	0.0	0.0				
SOP	0.0	0.5	0.0	0.0	0.5				
Catch	0.0	0.5	0.0	0.0	0.5				

Sub-division 32

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	0.4	33.7	34.0			1.9	2.5
1	136.9	2.2	1.7	218.2	359.0	3.6	3.9	8.7	9.2
2	613.1	53.4	3.3	334.8	1004.6	7.7	7.4	10.2	10.3
3	355.1	29.4	2.4	214.1	600.9	9.2	8.9	10.8	10.9
4	124.5	12.6	0.9	87.3	225.3	9.6	9.4	11.3	11.7
5	110.4	18.1	0.6	54.6	183.8	10.5	9.8	11.2	11.6
6	80.2	12.0	0.4	33.5	126.0	10.5	9.8	11.8	12.0
7	40.4	4.3	0.3	12.2	57.2	11.0	9.6	11.8	11.8
8	52.2	9.7	0.4	13.1	75.3	10.9	10.0	11.2	12.8
9	0.0	0.0	0.0	0.0	0.0				
10	0.0	0.0	0.0	0.0	0.0				
Sum	1512.7	141.5	10.4	1001.5	2666.2				
SOP	12690.0	1215.8	105.3	10242.3	24253.4				
Catch	12744.6	1216.9	105.1	10257.4	24324.1				

Sub-divisions 22–32

	Numbers (milions)					Weight (g)			
Age	Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4
0	0.0	0.0	123.2	1473.9	1597.1	NA	NA	2.8	3.3
1	2714.4	1159.8	181.9	855.1	4911.2	3.8	4.6	8.0	9.4
2	5030.2	1139.2	248.5	1201.1	7619.0	8.7	9.1	10.5	11.0
3	4096.9	1239.2	177.9	984.7	6498.6	10.3	10.9	11.9	12.0
4	1461.3	417.5	73.1	421.7	2373.6	11.6	12.5	12.9	13.0
5	909.6	341.8	19.2	188.1	1458.6	12.4	13.2	13.8	13.1
6	876.0	247.9	49.6	228.6	1402.2	12.5	12.9	13.4	13.3
7	215.1	56.5	8.7	72.1	352.4	12.0	11.8	13.5	13.3

8	167.6	61.4	9.2	78.8	316.9	11.6	11.2	13.1	14.1
9	16.6	4.2	0.1	2.0	22.9	12.9	16.3	16.4	14.0
10	24.6	5.9	0.0	1.4	31.9	12.6	11.7	15.7	12.8
Sum	15512.2	4673.5	891.4	5507.4	26584.4				
SOP	140416.9	43681.7	8635.6	51042.7	243776.8				
Catch	140435.2	43633.5	8630.9	51069.6	243769.2				

Table 7.4 SPRAT in SD 22-32. Fishing effort and CPUE data

	Russia – Sub-division 26			
	Type of vessels			
Year	*)SRTM (51 m length, 1100 hp)		MRTK (27 m length, 300 hp)	
	Effort	CPUE,	Effort	CPUE,
	[h]	[kg/h]	[h]	[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

***) - vessels withdrawn from exploitation in 2007**

Table 7.5 Sprat in Sub-divisions 22-32. Samples of commercial catches by quarter, country and Sub-division for 2014 available to the Working Group.

Sub-division	Country	Quarter	Landings	Number of	Number of fish	
22			in tons	samples	measured	aged
	Denmark	1	308.0	1	117	59
		2	215.6			
		3	93.6			
		4	453.7	3	446	151
		Total	1 070.8	4	563	210
	Germany	1	417.4	1	258	56
		2	38.7			
		3	0.0			
		4	143.3			
		Total	599.4	1	258	56
	Total	1	725.4	2	375	115
		2	254.3	0	0	0
		3	93.6	0	0	0
		4	597.0	3	446	151
		Total	1 670.3	5	821	266
Sub-division	Country	Quarter	Landings	Number of	Number of fish	
23+24			in tons	samples	measured	aged
	Denmark	1	135.3			
		2	36.6			
		3	55.9			
		4	1 274.7	1	135	57
		Total	1 502.5	1	135	57
	Finland	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Germany	1	26.4	2	94	69
		2	5.4	1	223	49
		3				
		4	6.2			
		Total	38.0	3	317	118
	Latvia	1				
		2				
		3				
		4				
		Total	-	0	0	0
	Lithuania	1				
		2				
		3				
		4				
		Total	-	0	0	0
	Poland	1	368.4	2	498	83
		2	638.2	8	1926	481
		3	129.4			
		4	349.0	1	185	91
		Total	1 485.0	11	2609	655
	Sweden	1	15.9			

		2				
		3				
		4	21.9			
		Total	37.8	0	0	0
	Total	1	546.0	4	592	152
		2	680.2	9	2149	530
		3	185.3	0	0	0
		4	1 651.8	2	320	148
		Total	3 063.3	15	3061	830
Sub-division	**Country**	**Quarter**	**Landings**	**Number of**	**Number of fish**	
25			**in tons**	**samples**	**measured**	**aged**
	Denmark	1	5 960.1	10	1112	474
		2	491.4			
		3				
		4	72.1			
		Total	6 523.6	10	1112	474
	Estonia	1				
		2				
		3				
		4	1.0			
		Total	1.0	0	0	0
	Finland	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Germany	1	1 716.7	4	982	240
		2	886.8	1	270	49
		3				
		4	20.2			
		Total	2 623.7	5	1252	289
	Latvia	1	270.0			
		2				
		3				
		4				
		Total	270.0	0	0	0
	Lithuania	1	299.0			
		2	355.6			
		3				
		4				
		Total	654.6	0	0	0
	Poland	1	5 275.7	24	3952	584
		2	15 394.3	17	3342	631
		3	343.4	10	1614	288
		4	815.9	19	3385	301
		Total	21 829.3	70	12293	1804
	Sweden	1	5 939.1	5	516	513
		2	1 645.1	3	500	495
		3	276.4			
		4	406.3	2	365	362
		Total	8 266.8	10	1381	1370
	Total	1	19 460.6	43	6562	1811
		2	18 773.2	21	4112	1175

		3	619.8	10	1614	288
		4	1 315.4	21	3750	663
		Total	40 169.0	95	16038	3937
Sub-division 26	**Country**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**aged**
	Denmark	1	3 940.2	3	362	152
		2	684.8			
		3				
		4	143.3			
		Total	4 768.3	3	362	152
	Estonia	1				
		2				
		3				
		4	16.0			
		Total	16.0	0	0	0
	Finland	1				
		2				
		3				
		4				
		Total	-	0	0	0
	Germany	1	1 817.1	3	945	183
		2	384.2			
		3				
		4				
		Total	2 201.3	3	945	183
	Latvia	1	2 067.0	4	802	395
		2	665.0	1	207	80
		3	95.0	1	205	111
		4	108.0	1	183	97
		Total	2 935.0	7	1397	683
	Lithuania	1	2 740.4	3	803	299
		2	516.8	1	274	113
		3				
		4	266.5	4	927	378
		Total	3 523.8	8	2004	790
	Poland	1	19 982.3	29	5714	1007
		2	5 003.3	15	3456	573
		3	665.6	13	2370	297
		4	5 499.7	12	2297	476
		Total	31 150.9	69	13837	2353
	Russia	1	8 361.7	38	7341	367
		2	3 500.7	9	1810	272
		3	2 931.4	49	10281	523
		4	8 655.0	35	7455	548
		Total	23 448.8	131	26887	1710
	Sweden	1	4 770.0	1	199	197
		2	600.0			
		3				
		4	1 057.0	1	198	197
		Total	6 427.0	2	397	394
	Total	1	43 678.7	81	16166	2600
		2	11 354.8	26	5747	1038
		3	3 692.0	63	12856	931

		4	15 745.6	53	11060	1696
		Total	74 471.1	223	45829	6265
Sub-division 27	**Country**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**aged**
	Denmark	1	125.9			
		2				
		3				
		4	49.3			
		Total	175.2	0	0	0
	Estonia	1				
		2				
		3				
		4				
		Total	-	0	0	0
	Finland	1	157.3			
		2				
		3				
		4				
		Total	157.3	0	0	0
	Germany	1	106			
		2	543			
		3				
		4				
		Total	648.5	0	0	0
	Latvia	1				
		2				
		3				
		4				
		Total	-	0	0	0
	Lithuania	1				
		2	10.0			
		3				
		4				
		Total	10.0	0	0	0
	Poland	1	50.0			
		2	184.0			
		3				
		4				
		Total	234.0	0	0	0
	Sweden	1	3 198.8	5	433	431
		2	1 627.9	1	240	238
		3	19.7			
		4	1 413.8	5	497	494
		Total	6 260.2	11	1170	1163
	Total	1	3 637.9	5	433	431
		2	2 364.4	1	240	238
		3	19.7	0	0	0
		4	1 463.1	5	497	494
		Total	7 485.1	11	1170	1163
Sub-division 28	**Country**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**aged**
	Denmark	1	5 444.5	2	270	105
		2	251.6			

		3				
		4				
		Total	5 696.1	2	270	105
	Estonia	1	640.7	4	1044	400
		2	49.7	1	297	100
		3	0.1			
		4	391.8	1	214	100
		Total	1 082.4	6	1555	600
	Finland	1	110.8			
		2				
		3				
		4	25.6			
		Total	136.4	0	0	0
	Germany	1	1 066.4	3	1012	175
		2	397.8	1	297	57
		3				
		4	24.6			
		Total	1488.8	4	1309	232
	Latvia	1	11 143.0	6	1232	533
		2	3 718.0	6	1207	513
		3	3 497.0	5	945	462
		4	9 195.0	15	2942	1367
		Total	27 553.0	32	6326	2875
	Lithuania	1	1 877.9			
		2	1 267.8			
		3				
		4	1 373.5			
		Total	4 519.2	0	0	0
	Poland	1	1 180.4	2	450	92
		2	832.8			
		3				
		4	80.0			
		Total	2 093.2	2	450	92
	Russia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Sweden	1	9 197.8	4	506	497
		2	685.4			
		3	303.7			
		4	859.8	2	191	190
		Total	11 046.8	6	697	687
	Total	1	30 661.6	21	4514	1802
		2	7 203.2	8	1801	670
		3	3 800.8	5	945	462
		4	11 950.3	18	3347	1657
		Total	53 615.9	52	10607	4591

Sub-division 29	Country	Quarter	Landings in tons	Number of samples	Number of fish measured	aged
	Denmark	1	5991.2	4	402	201
		2				
		3				

		4	779.5			
		Total	6770.8	4	402	201
	Estonia	1	5671.2	11	2208	1100
		2	682.0	4	879	400
		3	90.0	2	448	200
		4	3443.9	15	3542	1500
		Total	9887.0	32	7077	3200
	Finland	1	2242.2	5	335	
		2	18.4	3	23	
		3	3.0			
		4	527.4	4	953	
		Total	2791.0	12	1311	0
	Germany	1	2502.0	5	1659	265
		2				
		3				
		4	64.1			
		Total	2566.1	5	1659	265
	Latvia	1				
		2				
		3				
		4				
		Total	0.0	0	0	0
	Lithuania	1	408.9			
		2	42.5			
		3				
		4	487.5			
		Total	938.9	0	0	0
	Poland	1	140.0			
		2				
		3				
		4				
		Total	140.0	0	0	0
	Sweden	1	10739.0	3	500	498
		2				
		3				
		4	2091.0			
		Total	12830.0	3	500	498
	Total	1	27694.6	28	5104	2064
		2	742.9	7	902	400
		3	93.0	2	448	200
		4	7393.4	19	4495	1500
		Total	35923.9	56	10949	4164
Sub-division	**Country**	**Quarter**	**Landings**	**Number of**	**Number of fish**	
30			**in tons**	**samples**	**measured**	**aged**
	Finland	1	1206.4	14	1215	
		2	891.8	11	711	
		3	21.4	1	2	
		4	677.3	18	2923	
		Total	2796.9	44	4851	0
	Sweden	1	79.4			
		2	151.3			
		3	0.2			
		4	18.2			

		Total	249.1	0	0	0
	Total	1	1285.8	14	1215	0
		2	1043.1	11	711	0
		3	21.6	1	2	0
		4	695.5	18	2923	0
		Total	3046.0	44	4851	0
Sub-division 31	**Country**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**aged**
	Finland	1				
		2	0.5			
		3				
		4				
		Total	0.5	0	0	0
Sub-division 32	**Country**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**aged**
	Denmark	1				
		2				
		3				
		4	110.9			
		Total	110.9	0	0	0
	Estonia	1	8 152.9	8	2006	800
		2	1 216.7	4	898	400
		3	94.5	6	1475	600
		4	8 047.7	8	2006	800
		Total	17 511.8	26	6385	2600
	Finland	1	4 591.7	4	1225	
		2	0.1	3	14	
		3	10.6	3	910	
		4	1 243.9	4	931	
		Total	5 846.4	14	3080	0
	Sweden	1				
		2				
		3				
		4	855.0			
		Total	855.0	0	0	0
	Total	1	12 744.6	12	3231	800
		2	1 216.9	7	912	400
		3	105.1	9	2385	600
		4	10 257.4	12	2937	800
		Total	24 324.1	40	9465	2600
Sub-divisions 22–32	**Total**	**Quarter**	**Landings in tons**	**Number of samples**	**Number of fish measured**	**aged**
		1	**140 435.2**	**210**	**38192**	**9775**
		2	**43 633.5**	**90**	**16574**	**4451**
		3	**8 630.9**	**90**	**18250**	**2481**
		4	**51 069.6**	**151**	**29775**	**7109**
		Total	**243 769.2**	**541**	**102791**	**23816**

Table 7.6 SPRAT in SD 22-32. Catch in Numbers (Thousands)

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

Table 7.7 SPRAT in SD 22-32.

Mean weight in the Catch and in the Stock (Kilograms)

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	0.011	0.0134	0.014	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	0.013	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	0.016
1981	0.0063	0.0141	0.0161	0.018	0.0165	0.0159	0.0168	0.0161
1982	0.0088	0.0117	0.016	0.0162	0.0167	0.0164	0.0163	0.0173
1983	0.0092	0.0145	0.0162	0.0171	0.0169	0.017	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	0.014	0.016	0.0171	0.0171	0.0158
1986	0.0079	0.0121	0.0129	0.014	0.0148	0.0161	0.017	0.0167
1987	0.0085	0.0117	0.0133	0.0145	0.0152	0.0164	0.017	0.0176
1988	0.0056	0.0103	0.0122	0.0142	0.0152	0.0153	0.0166	0.017
1989	0.0097	0.0136	0.0145	0.0158	0.0169	0.0173	0.0175	0.0181
1990	0.0104	0.0126	0.0149	0.016	0.0175	0.0177	0.0184	0.0181
1991	0.009	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	0.015	0.0162	0.0166	0.0166
1994	0.0080	0.0098	0.0121	0.014	0.0145	0.0152	0.0155	0.0159
1995	0.0065	0.0106	0.011	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	0.004	0.0078	0.0092	0.0091	0.0092	0.0106	0.0112	0.011
2000	0.0062	0.0102	0.01	0.0108	0.0113	0.0117	0.0128	0.0134
2001	0.0063	0.0093	0.0114	0.0108	0.0116	0.0113	0.011	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	0.011	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	0.011
2008	0.0068	0.0092	0.0098	0.0105	0.0103	0.0102	0.0112	0.0122
2009	0.0050	0.0092	0.01052	0.0109	0.0114	0.0108	0.011	0.012
2010	0.0052	0.008	0.0099	0.0107	0.011	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	0.012	0.0123	0.0123	0.0121
2013	0.0051	0.0096	0.0115	0.0125	0.0126	0.0129	0.013	0.0125
2014	0.0052	0.0092	0.0107	0.0120	0.0127	0.0127	0.0123	0.0123

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	0.5	0.5	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	0.8	0.8	0.8	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	0.7	0.7
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	0.5	0.5	0.5
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	0.4	0.4	0.4
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	0.3	0.3	0.3	0.29	0.29	0.29	0.29	0.29
1994	0.3	0.3	0.3	0.29	0.29	0.29	0.29	0.29
1995	0.3	0.3	0.3	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	0.3	0.3	0.3	0.3	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	0.3	0.3	0.3	0.3	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	0.4	0.4	0.4	0.4
2011	0.45	0.45	0.45	0.44	0.43	0.43	0.42	0.42
2012	0.45	0.45	0.45	0.44	0.43	0.43	0.42	0.42
2013	0.45	0.45	0.45	0.44	0.43	0.43	0.42	0.42
2014	0.45	0.45	0.45	0.44	0.43	0.43	0.42	0.42

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+
1974-2014	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+
1974-2014	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+
1974-2014	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

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

Table 7.13 SPRAT in SD 22-32. Tuning Fleet/InternationalAcoustic 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

Table 7.14 SPRAT in SD 22-32. Tuning Fleet/InternationalAcoustic Survey in SD 24-28 excl. 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	8 225	35 735	12 971	37 328	5 384	4 635	4 526	600
2002	1	27 412	18 982	36 814	19 045	14 759	2 517	3 670	2 585
2003	1	26 469	16 471	8 423	15 533	5 653	7 170	1 660	3 607
2004	1	136 162	65 566	15 784	11 042	12 655	3 271	7 806	6 321
2005	1	4 359	88 830	23 557	7 258	3 517	2 781	1 830	2 243
2006	1	13 417	7 980	76 703	21 046	5 702	1 970	1 526	1 943
2007	1	51 569	28 713	6 377	36 006	7 481	1 261	533	698
2008	1	9 029	40 270	20 164	5 627	21 188	4 210	757	1 477
2009	1	39 412	26 701	36 255	10 549	6 312	14 106	5 341	964
2010	1	9 387	58 680	15 199	15 963	5 062	1 654	5 566	1 273
2011	1	18 092	6 791	66 160	16 689	10 565	4 077	2 399	3 382
2012	1	22 700	22 080	11 274	35 541	7 515	5 025	1 367	2 158
2013	1	24 877	35 333	18 393	11 358	14 959	3 385	2 164	950
2014	1	10145	26907	19857	7458	6098	3810	1217	1058

Table 7.15 SPRAT in SD 22-32. Output from XSA.

Lowestoft VPA Version 3.1 10/04/2015 11:30

Extended Survivors Analysis

Sprat 22 32

CPUE data from file d:\SprDat14\Fleet3xsa.txt

Catch data for 41 years. 1974 to 2014. Ages 1 to 8.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: International	1991	2014	1	7	0.75	0.85
FLT02: International	2001	2014	1	7	0.35	0.42
FLT03: Latvian/Russi	1992	2014	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 70 iterations

Total absolute residual between iterations

69 and 70 = .00080

Final year F values

Age	1	2	3	4	5	6	7
Iteration 69	0.0992	0.2285	0.3228	0.3495	0.5484	0.383	0.4182
Iteration 70	0.0992	0.2285	0.3227	0.3493	0.5482	0.3831	0.4181

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014

1	0.07	0.17	0.16	0.11	0.14	0.10	0.16	0.07	0.10	0.10
2	0.27	0.12	0.33	0.31	0.25	0.25	0.17	0.19	0.23	0.23
3	0.30	0.33	0.23	0.37	0.42	0.30	0.30	0.20	0.31	0.32
4	0.45	0.34	0.44	0.33	0.47	0.38	0.32	0.36	0.37	0.35
5	0.61	0.45	0.38	0.39	0.42	0.33	0.28	0.31	0.45	0.55
6	0.35	0.46	0.43	0.46	0.41	0.47	0.31	0.29	0.36	0.38
7	0.59	0.31	0.50	0.44	0.47	0.30	0.49	0.35	0.25	0.42

XSA population numbers (Thousands)

AGE							
YEAR	1	2	3	4	5	6	7
2005	48700	154000	50800	9460	4760	3330	1720
2006	81300	33600	87500	27900	4480	1940	1760
2007	113000	49800	21600	45500	14500	2100	899
2008	75500	69400	25700	12400	21100	7210	997
2009	200000	47800	35900	12500	6270	10200	3230
2010	58200	121000	25600	16300	5370	2880	4740
2011	74800	34500	61800	12500	7390	2590	1210
2012	97900	40600	18500	29200	5850	3620	1240
2013	81100	58300	21400	9640	13200	2800	1760
2014	65100	46700	29500	10000	4290	5460	1270

Estimated population abundance at 1st Jan 2015

	0	37600	23700	13600	4560	1610	2420

Taper weighted geometric mean of the VPA populations:

	87500	55700	31400	16300	8200	4150	1980

Standard error of the weighted Log(VPA populations) :

	0.459	0.4859	0.5046	0.5353	0.5547	0.5681	0.6132

Log catchability residuals.

Fleet : FLT01: International

Age	1991	1992	1993	1994
1	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99
5	99.99	99.99	99.99	99.99
6	99.99	99.99	99.99	99.99
7	99.99	99.99	99.99	99.99

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	99.99	-0.19	99.99	0.03	-0.64	0.27	0.03	0.53	0.37	-0.15
2	99.99	0.38	99.99	0.05	0.55	-1.28	0.22	-0.03	0.77	0.17
3	99.99	-0.15	99.99	0.29	-0.06	0.19	-0.94	0.6	0.72	0.03

4	99.99	0.34	99.99	-0.14	0.46	-0.61	0.27	-0.6	0.75	0.21
5	99.99	-0.01	99.99	-0.03	0.49	0.04	-0.48	0.29	0.26	-0.13
6	99.99	0.49	99.99	0.07	0.19	0.33	0.44	-0.23	0.53	-0.14
7	99.99	0.54	99.99	-0.79	0.4	-0.35	0.19	0.47	1.23	-0.59

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	-0.29	0.23	0.11	0.15	-0.22	-0.1	0.03	0.12	-0.11	-0.26
2	0.59	-0.35	0.05	0.45	0.21	0.03	-0.24	-0.04	-0.16	-0.8
3	0.4	0.65	-0.57	0.29	0.05	-0.34	0.21	-0.36	-0.06	-0.53
4	0.5	0.52	-0.1	-0.45	-0.13	-0.42	0.23	0.02	-0.04	-0.28
5	0.45	0.84	-0.17	0.13	-0.01	-0.91	0.14	-0.26	0.21	-0.3
6	0.07	1.14	-0.42	0.07	-0.1	-0.03	0.26	-0.5	-0.16	-0.06
7	0.68	0.34	-0.33	0.5	-0.16	-0.39	0.79	-0.44	-0.65	-0.29

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	-0.349	0.0396	0.1549	0.3377	0.3377	0.3377
S.E(Log q)	0.4487	0.4501	0.385	0.43	0.4147	0.5751

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	0.59	2.485	5.06	0.79	18	0.25	-0.74

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	0.72	1.447	3.29	0.73	18	0.31	-0.35
3	0.68	1.868	3.24	0.78	18	0.28	0.04
4	0.92	0.407	0.67	0.7	18	0.37	0.15
5	0.89	0.5	0.67	0.68	18	0.4	0.34
6	1.01	-0.037	-0.46	0.65	18	0.44	0.38
7	1.22	-0.631	-2.14	0.44	18	0.72	0.37

Fleet : FLT02: International

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	99.99	99.99	99.99	99.99	99.99	99.99	0.02	0.69	-0.15	0.25
2	99.99	99.99	99.99	99.99	99.99	99.99	0.11	0.14	-0.01	0.43
3	99.99	99.99	99.99	99.99	99.99	99.99	-0.36	0.42	-0.45	0.19
4	99.99	99.99	99.99	99.99	99.99	99.99	0.14	0.27	0.01	0.19
5	99.99	99.99	99.99	99.99	99.99	99.99	-0.46	-0.22	-0.37	0.46
6	99.99	99.99	99.99	99.99	99.99	99.99	-0.61	-0.55	-0.31	-0.17
7	99.99	99.99	99.99	99.99	99.99	99.99	-0.47	-0.11	-0.2	0.35

Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	-0.38	-0.15	0.38	-0.33	-0.36	-0.03	0.15	0.01	0.26	-0.09
2	0.15	-0.79	0.18	0.19	0.14	0.02	-0.91	0.12	0.24	0.19

3	-0.43	0.23	-0.9	0.14	0.42	-0.14	0.47	-0.14	0.25	0.01
4	-0.18	-0.23	-0.14	-0.73	-0.04	0.08	0.38	0.3	0.28	-0.19
5	-0.29	0.2	-0.72	-0.04	-0.02	-0.11	0.3	0.21	0.14	0.4
6	-0.26	-0.02	-0.55	-0.56	0.29	-0.55	0.41	0.28	0.16	-0.38
7	0.07	-0.23	-0.54	-0.3	0.49	0.1	0.71	0.06	0.13	-0.05
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	-0.4805	-0.1086	0.2005	0.3291	0.3291	0.3291				
S.E(Log q)	0.4005	0.4005	0.3095	0.3397	0.4106	0.3589				
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	1.792	5	0.72	14	0.3	-1.34			
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	0.72	1.574	3.36	0.78	14	0.27	-0.48			
3	0.76	1.316	2.61	0.76	14	0.29	-0.11			
4	0.99	0.069	-0.07	0.74	14	0.32	0.2			
5	1.31	-1.224	-3.25	0.62	14	0.44	0.33			
6	1.07	-0.294	-0.77	0.65	14	0.42	0.17			
7	0.89	0.657	0.49	0.8	14	0.33	0.37			
Fleet : FLT03: Latvian/Russi										
Age	1991	1992	1993	1994						
1	99.99	99.99	99.99	99.99						
2	No data for this fleet at this age									
Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.72	99.99	-0.57	99.99	-1.06	-0.11	-0.32	0.02	0.13	-0.22
2	No data for this fleet at this age									
Age	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	-0.43	0.23	0.12	-0.1	-0.18	0	0.32	0.08	0.13	0.2
2	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	0.48	2.926	6.47	0.76	18	0.27	-1.08

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2013

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: International	28885	0.3	0	0	1	0.289	0.127
FLT02: International	34393	0.323	0	0	1	0.249	0.108
FLT03: Latvian/Russi	46127	0.3	0	0	1	0.289	0.082
P shrinkage mean	55656	0.49				0.122	0.068
F shrinkage mean	32148	0.75				0.051	0.115

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
37612	0.16	0.12	5	0.73	0.099

Age 2 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: International	17067	0.253	0.317	1.26	2	0.352	0.305
FLT02: International	29937	0.253	0.035	0.14	2	0.353	0.185
FLT03: Latvian/Russi	27049	0.3	0	0	1	0.241	0.203
F shrinkage mean	24372	0.75				0.054	0.223

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23710	0.15	0.14	6	0.925	0.228

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: International	12056	0.224	0.195	0.87	3	0.367	0.358
FLT02: International	14593	0.218	0.072	0.33	3	0.395	0.304
FLT03: Latvian/Russi	14819	0.3	0	0	1	0.184	0.3
F shrinkage mean	14288	0.75				0.055	0.31

Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
13628	0.14	0.08	8	0.555	0.323		
Age 4 Catchability constant w.r.t. time and dependent on age							
Year class = 2010							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
FLT01: International	4105	0.202	0.077	0.38	4	0.371	0.381
FLT02: International	4640	0.186	0.108	0.58	4	0.46	0.344
FLT03: Latvian/Russi	6264	0.302	0	0	1	0.117	0.266
F shrinkage mean	4026	0.75				0.052	0.387
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
4559	0.13	0.07	10	0.529	0.349		
Age 5 Catchability constant w.r.t. time and dependent on age							
Year class = 2009							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
FLT01: International	1331	0.189	0.062	0.33	5	0.367	0.633
FLT02: International	1750	0.17	0.199	1.17	5	0.481	0.514
FLT03: Latvian/Russi	1618	0.304	0	0	1	0.091	0.546
F shrinkage mean	2678	0.75				0.061	0.364
Weighted prediction :							
Survivors	Int	Ext	N	Var	F		
at end of year	s.e	s.e		Ratio			
1612	0.12	0.1	12	0.855	0.548		
Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5							
Year class = 2008							
Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
FLT01: International	2458	0.193	0.063	0.33	6	0.394	0.378
FLT02: International	2435	0.172	0.138	0.8	6	0.485	0.381
FLT03: Latvian/Russi	2018	0.307	0	0	1	0.058	0.445

F shrinkage mean	2508	0.75				0.063	0.372

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
2422	0.12	0.07	14	0.532	0.383

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2007

Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
FLT01: International	499	0.188	0.088	0.47	7	0.36	0.452
FLT02: International	596	0.164	0.081	0.49	7	0.532	0.391
FLT03: Latvian/Russi	498	0.313	0	0	1	0.046	0.453
F shrinkage mean	524	0.75				0.063	0.435

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
550	0.12	0.05	16	0.453	0.418

Table 7.16. SPRAT IN SD 22-32. Output from XSA. Fishing mortality (F) at age

Run title : Sprat 22 32

At 10/04/2015 11:40

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	0.07	0.04	0.03	0.08	0.05	0.07	0.03	0.05	0.02	0.02
2	0.10	0.10	0.10	0.10	0.23	0.13	0.19	0.18	0.14	0.03
3	0.30	0.17	0.19	0.24	0.12	0.18	0.21	0.14	0.23	0.07
4	0.40	0.48	0.22	0.37	0.28	0.13	0.23	0.14	0.20	0.15
5	0.29	0.39	0.56	0.22	0.43	0.28	0.19	0.11	0.25	0.10
6	0.57	0.29	0.41	0.56	0.18	0.21	0.31	0.19	0.17	0.12
7	0.43	0.39	0.40	0.39	0.30	0.21	0.25	0.15	0.21	0.13
+gp	0.43	0.39	0.40	0.39	0.30	0.21	0.25	0.15	0.21	0.13
FBAR 3- 5	0.33	0.35	0.32	0.28	0.27	0.20	0.21	0.13	0.23	0.11

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	0.03	0.02	0.04	0.03	0.01	0.07	0.03	0.02	0.02	0.02
2	0.06	0.09	0.06	0.06	0.17	0.04	0.16	0.09	0.09	0.10
3	0.08	0.11	0.14	0.13	0.18	0.20	0.07	0.20	0.16	0.14
4	0.13	0.19	0.18	0.36	0.20	0.17	0.19	0.13	0.22	0.15
5	0.26	0.17	0.29	0.30	0.31	0.24	0.13	0.18	0.23	0.19
6	0.19	0.22	0.23	0.43	0.25	0.32	0.18	0.12	0.15	0.22
7	0.20	0.19	0.24	0.37	0.26	0.25	0.17	0.14	0.20	0.19
+gp	0.20	0.19	0.24	0.37	0.26	0.25	0.17	0.14	0.20	0.19
FBAR 3- 5	0.16	0.16	0.20	0.26	0.23	0.21	0.13	0.17	0.20	0.16

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	0.02	0.03	0.06	0.03	0.08	0.05	0.13	0.07	0.15	0.09
2	0.16	0.06	0.19	0.25	0.11	0.23	0.10	0.24	0.22	0.28
3	0.23	0.21	0.18	0.27	0.36	0.29	0.31	0.14	0.44	0.35
4	0.25	0.33	0.37	0.43	0.43	0.41	0.27	0.38	0.35	0.43
5	0.29	0.46	0.30	0.48	0.36	0.41	0.36	0.35	0.35	0.44
6	0.28	0.49	0.43	0.27	0.45	0.31	0.40	0.47	0.34	0.29
7	0.28	0.43	0.37	0.39	0.45	0.35	0.36	0.47	0.32	0.62
+gp	0.28	0.43	0.37	0.39	0.45	0.35	0.36	0.47	0.32	0.62
FBAR 3- 5	0.26	0.34	0.28	0.39	0.39	0.37	0.31	0.29	0.38	0.41

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	FBAR **-**
AGE												

1	0.12	0.07	0.17	0.16	0.11	0.14	0.10	0.16	0.07	0.10	0.10	0.09
2	0.20	0.27	0.12	0.33	0.31	0.25	0.25	0.17	0.19	0.23	0.23	0.22
3	0.40	0.30	0.33	0.23	0.37	0.42	0.30	0.30	0.20	0.31	0.32	0.28
4	0.45	0.45	0.34	0.44	0.33	0.47	0.38	0.32	0.36	0.37	0.35	0.36
5	0.61	0.61	0.45	0.38	0.39	0.42	0.33	0.28	0.31	0.45	0.55	0.44
6	0.52	0.35	0.46	0.43	0.46	0.41	0.47	0.31	0.29	0.36	0.38	0.34
7	0.31	0.59	0.31	0.50	0.44	0.46	0.30	0.49	0.35	0.24	0.42	0.34
+gp	0.31	0.59	0.31	0.50	0.44	0.46	0.30	0.49	0.35	0.24	0.42	
FBAR 3- 5	0.49	0.45	0.37	0.35	0.36	0.44	0.34	0.30	0.29	0.38	0.41	

Table 7.17. SPRAT IN SD 22-32. Output from XSA. Stock number at age (Numbers*10^-6)

Run title : Sprat 22 32

At 10/04/2015 11:40

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	50439	18933	194490	42725	15221	30534	20034	67760	35164	133279
2	83207	28853	10662	117855	22850	7431	13090	8406	28903	15246
3	17887	46144	15424	6017	61617	9314	3002	4681	3161	11097
4	7517	8126	22804	7975	2745	28298	3607	1060	1832	1110
5	9600	3164	3030	11607	3231	1099	11793	1271	427	680
6	2718	4528	1304	1101	5560	1125	399	4438	540	154
7	4401	975	2062	559	379	2490	443	136	1753	214
+gp	984	2099	1553	1550	953	899	1491	1002	373	1708
TOTAL	176753	112822	251330	189391	112556	81189	53858	88754	72152	163487

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	50387	40542	15175	33943	13472	39974	49654	54557	92594	87975
2	61064	26102	23193	9093	21452	8701	25335	34808	40326	69127
3	6927	30776	13911	13593	5597	11780	5652	15525	24004	28216
4	4827	3406	16181	7568	7778	3052	6518	3770	9613	15668
5	456	2293	1680	8547	3487	4179	1753	3922	2496	5903
6	298	195	1167	800	4202	1693	2247	1113	2469	1534
7	67	138	95	594	350	2169	845	1362	757	1631
+gp	606	465	292	286	748	737	1496	1286	1013	1704
TOTAL	124632	103918	71695	74423	57086	72286	93501	116344	173272	211759

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	66157	258638	169748	58533	173160	56119	102743	49411	55495	121739
2	63597	48082	186118	119760	41884	116351	38187	64241	33169	33526
3	46318	40082	33605	115326	68767	27173	66025	24694	36385	18816
4	18111	27276	23976	21076	65299	34863	14421	34580	15489	16590
5	10082	10503	14669	12455	10154	30700	16608	7934	17226	7789

6	3652	5640	4947	8198	5766	5170	14579	8308	4058	8731				
7	917	2059	2575	2436	4706	2706	2717	7024	3774	2071				
+gp	978	1325	1486	982	1543	2001	2884	1597	5670	3379				
TOTAL	209812	393604	437125	338766	371280	275084	258163	197788	171265	212642				

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	GM(1974-2012)	AM(1974-2012)
AGE														
1	232751	48660	81345	112782	75490	199908	58188	74761	97903	81114	65130	0	62523	81548
2	82991	154036	33601	49822	69384	47832	120510	34517	40643	58259	46717	37612	38019	52153
3	18937	50773	87458	21616	25671	35900	25650	61759	18526	21354	29507	23710	20797	29687
4	9923	9457	27927	45530	12398	12479	16336	12506	29222	9635	10034	13628	10595	15664
5	8134	4756	4481	14457	21097	6271	5374	7392	5848	13169	4287	4559	5065	7604
6	3804	3325	1943	2104	7213	10191	2876	2588	3622	2799	5462	1612	2398	3700
7	4945	1715	1759	899	997	3232	4740	1207	1241	1763	1271	2422	1167	1875
+gp	5839	1573	2274	1582	1187	1111	2397	1765	1784	1774	1314	1118		
TOTAL	367324	274294	240787	248793	213437	316924	236072	196494	198790	189869	163722	84662		

Table 7.17. SPRAT IN SD 22-32. Output from XSA. Stock number at age (Numbers*10^-6)

Run title : Sprat 22 32

At 10/04/2015 11:40

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year)

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
1	50439	18933	194490	42725	15221	30534	20034	67760	35164	133279
2	83207	28853	10662	117855	22850	7431	13090	8406	28903	15246
3	17887	46144	15424	6017	61617	9314	3002	4681	3161	11097
4	7517	8126	22804	7975	2745	28298	3607	1060	1832	1110
5	9600	3164	3030	11607	3231	1099	11793	1271	427	680
6	2718	4528	1304	1101	5560	1125	399	4438	540	154
7	4401	975	2062	559	379	2490	443	136	1753	214
+gp	984	2099	1553	1550	953	899	1491	1002	373	1708
TOTAL	176753	112822	251330	189391	112556	81189	53858	88754	72152	163487

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
1	50387	40542	15175	33943	13472	39974	49654	54557	92594	87975
2	61064	26102	23193	9093	21452	8701	25335	34808	40326	69127
3	6927	30776	13911	13593	5597	11780	5652	15525	24004	28216
4	4827	3406	16181	7568	7778	3052	6518	3770	9613	15668
5	456	2293	1680	8547	3487	4179	1753	3922	2496	5903
6	298	195	1167	800	4202	1693	2247	1113	2469	1534
7	67	138	95	594	350	2169	845	1362	757	1631
+gp	606	465	292	286	748	737	1496	1286	1013	1704
TOTAL	124632	103918	71695	74423	57086	72286	93501	116344	173272	211759

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
1	66157	258638	169748	58533	173160	56119	102743	49411	55495	121739
2	63597	48082	186118	119760	41884	116351	38187	64241	33169	33526
3	46318	40082	33605	115326	68767	27173	66025	24694	36385	18816
4	18111	27276	23976	21076	65299	34863	14421	34580	15489	16590
5	10082	10503	14669	12455	10154	30700	16608	7934	17226	7789
6	3652	5640	4947	8198	5766	5170	14579	8308	4058	8731
7	917	2059	2575	2436	4706	2706	2717	7024	3774	2071
+gp	978	1325	1486	982	1543	2001	2884	1597	5670	3379
TOTAL	209812	393604	437125	338766	371280	275084	258163	197788	171265	212642

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	GM(1974-2012)	AM(1974-2012)
AGE														
1	232751	48660	81345	112782	75490	199908	58188	74761	97903	81114	65130	0	62523	81548

2	82991	154036	33601	49822	69384	47832	120510	34517	40643	58259	46717	37612	38019	52153
3	18937	50773	87458	21616	25671	35900	25650	61759	18526	21354	29507	23710	20797	29687
4	9923	9457	27927	45530	12398	12479	16336	12506	29222	9635	10034	13628	10595	15664
5	8134	4756	4481	14457	21097	6271	5374	7392	5848	13169	4287	4559	5065	7604
6	3804	3325	1943	2104	7213	10191	2876	2588	3622	2799	5462	1612	2398	3700
7	4945	1715	1759	899	997	3232	4740	1207	1241	1763	1271	2422	1167	1875
+gp	5839	1573	2274	1582	1187	1111	2397	1765	1784	1774	1314	1118		
TOTAL	367324	274294	240787	248793	213437	316924	236072	196494	198790	189869	163722	84662		

Table 7.18 Sprat in SD 22-32. Output from XSA. Stock summary.

Table 16 Summary (without SOP correction) Run title : Sprat 22-32

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS	OTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3-5
	Age 1					
1974	50439	1777	1097	242	0.22	0.33
1975	18933	1288	867	201	0.23	0.35
1976	194490	2077	738	195	0.26	0.32
1977	42725	1937	1257	181	0.14	0.28
1978	15221	1283	866	132	0.15	0.27
1979	30534	859	498	77	0.15	0.20
1980	20034	604	311	58	0.19	0.21
1981	67760	750	268	49	0.18	0.13
1982	35164	779	340	49	0.14	0.23
1983	133279	1692	478	37	0.08	0.11
1984	50387	1365	691	53	0.08	0.16
1985	40542	1152	639	70	0.11	0.16
1986	15175	857	581	76	0.13	0.20
1987	33943	844	466	88	0.19	0.26
1988	13472	611	415	80	0.19	0.23
1989	39974	876	438	86	0.20	0.21
1990	49654	1137	570	86	0.15	0.13
1991	54557	1351	776	103	0.13	0.17
1992	92594	1912	1033	142	0.14	0.20
1993	87975	2135	1352	178	0.13	0.16
1994	66157	2198	1402	289	0.21	0.26
1995	258638	3247	1489	313	0.21	0.34
1996	169748	3035	1904	441	0.23	0.28
1997	58533	2762	1879	529	0.28	0.39
1998	173160	2503	1406	471	0.33	0.39
1999	56119	2089	1427	421	0.30	0.37
2000	102743	2274	1352	389	0.29	0.31
2001	49411	1846	1213	342	0.28	0.29
2002	55495	1591	956	343	0.36	0.38
2003	121739	1569	812	308	0.38	0.41
2004	232751	2219	1053	374	0.35	0.49
2005	48660	1932	1313	405	0.31	0.45
2006	81345	1742	1091	352	0.32	0.37
2007	112782	1817	967	388	0.40	0.35
2008	75490	1850	1051	381	0.36	0.36
2009	199908	2184	999	407	0.41	0.44
2010	58188	1865	1172	342	0.29	0.34
2011	74761	1489	916	268	0.29	0.30
2012	97903	1644	863	231	0.27	0.29
2013	81114	1586	899	272	0.30	0.38
2014	65130	1360	780	244	0.31	0.41
Arith. Mean	81137	1661	942	236	0.24	0.29
Units	(Millions)	(Thousand tonnes)	(Thousand tonnes)	(Thousand tonnes)		

Table 7.19. Sprat in SD 22-32. Input data for RCT3 analysis.

Sprat 22-32:	Acoustic on age 0 in subdiv. 22-29	
Year	VPA, age 1	Acoustic Age 0, shifted
1992	92594	59473
1993	87975	48035
1994	66157	-11
1995	258638	64092
1996	169748	-11
1997	58533	3842
1998	173160	-11
1999	56119	1279
2000	102743	33320
2001	49411	4601
2002	55495	12001
2003	121739	79551
2004	232751	146335
2005	48660	3562
2006	81345	41863
2007	112782	66125
2008	75490	17821
2009	199908	115698
2010	58188	12798
2011	74761	41158
2012	97903	45186
2013	81114	33653
2014	65130	24694
2015	-11	162715

Table 7.20. Sprat in SD 22-32. Output from RCT3 analysis.

Analysis by RCT3 ver3.1 of data from file sprRec.txt
Sprat 22-32: YFS data from international acoustic survey on age 0

Data for 1 surveys over 24 years: 1991-2014
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	=	2008							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.41	7.27	0.33	0.736	14	11.66	12.1	0.414	0.629
				VPA	Mean	=	11.42	0.538	0.371
Yearclass	=	2009							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.42	7.19	0.32	0.778	15	9.46	11.18	0.368	0.699
				VPA	Mean	=	11.48	0.56	0.301
Yearclass	=	2010							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.43	7.06	0.3	0.784	16	10.63	11.65	0.353	0.712
				VPA	Mean	=	11.44	0.554	0.288
Yearclass	=	2011							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.44	6.91	0.31	0.755	17	10.72	11.65	0.364	0.681
				VPA	Mean	=	11.41	0.531	0.319
Yearclass	=	2012							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.44	6.87	0.29	0.764	18	10.42	11.5	0.333	0.696
				VPA	Mean	=	11.42	0.504	0.304

Yearclass	=	2013							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.45	6.75	0.27	0.766	19	10.11	11.33	0.314	0.699
				VPA	Mean	=	11.41	0.478	0.301

Yearclass	=	2014							
			I-----------Regression----------I			I-----------Prediction---------I			
Survey/	Slope	Inter-	Std	Rsquare	No.	Index	Predicted	Std	WAP
Series		cept	Error		Pts	Value	Value	Error	Weights
Acoust	0.48	6.48	0.27	0.76	20	12	12.19	0.336	0.651
				VPA	Mean	=	11.38	0.459	0.349

	Year	Average	WAP	Std	Std	Ratio		VPA	
		Prediction		Error	Error				
		age 1							
	2000	111385	11.62	0.5	0.11	0.05	102744	11.54	
	2001	84398	11.34	0.45	0.31	0.48	49411	10.81	
	2002	89515	11.4	0.43	0.08	0.04	55496	10.92	
	2003	121399	11.71	0.44	0.37	0.71	121740	11.71	
	2004	134876	11.81	0.42	0.44	1.14	232752	12.36	
	2005	64087	11.07	0.4	0.42	1.07	48660	10.79	
	2006	115807	11.66	0.37	0.16	0.19	81346	11.31	
	2007	124611	11.73	0.37	0.25	0.45	112782	11.63	
	2008	87122	11.38	0.34	0.05	0.02	75490	11.23	
	2009	139438	11.85	0.33	0.33	0.99	199909	12.21	
	2010	78534	11.27	0.31	0.14	0.2	58189	10.97	
	2011	108146	11.59	0.3	0.1	0.11	74761	11.22	
	2012	106586	11.58	0.3	0.11	0.14	97904	11.49	
	2013	95932	11.47	0.28	0.04	0.02	81115	11.3	
	2014	85035	11.35	0.26	0.04	0.02	65131	11.08	
	2015	147864	11.9	0.27	0.38	2.01			

Table 7.21 Sprat in SD 22-32. Input data for short-term prediction.

MFDP version 1a
Run: spr2015sq
Time and date: 20:54 14/04/2015
Fbar age range: 3-5

2015

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	147864	0.45	0.17	0.4	0.4	0.0054	0.1025	0.0054
2	37612	0.45	0.93	0.4	0.4	0.0094	0.2478	0.0094
3	23710	0.45	1	0.4	0.4	0.0111	0.3159	0.0111
4	13628	0.44	1	0.4	0.4	0.0119	0.4087	0.0119
5	4559	0.43	1	0.4	0.4	0.0124	0.4956	0.0124
6	1612	0.43	1	0.4	0.4	0.0126	0.3923	0.0126
7	2422	0.42	1	0.4	0.4	0.0125	0.3851	0.0125
8	1118	0.42	1	0.4	0.4	0.0123	0.3851	0.0123

2016

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	90405	0.45	0.17	0.4	0.4	0.0054	0.1025	0.0054
2	.	0.45	0.93	0.4	0.4	0.0094	0.2478	0.0094
3	.	0.45	1	0.4	0.4	0.0111	0.3159	0.0111
4	.	0.44	1	0.4	0.4	0.0119	0.4087	0.0119
5	.	0.43	1	0.4	0.4	0.0124	0.4956	0.0124
6	.	0.43	1	0.4	0.4	0.0126	0.3923	0.0126
7	.	0.42	1	0.4	0.4	0.0125	0.3851	0.0125
8	.	0.42	1	0.4	0.4	0.0123	0.3851	0.0123

2017

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	90405	0.45	0.17	0.4	0.4	0.0054	0.1025	0.0054
2	.	0.45	0.93	0.4	0.4	0.0094	0.2478	0.0094
3	.	0.45	1	0.4	0.4	0.0111	0.3159	0.0111
4	.	0.44	1	0.4	0.4	0.0119	0.4087	0.0119
5	.	0.43	1	0.4	0.4	0.0124	0.4956	0.0124
6	.	0.43	1	0.4	0.4	0.0126	0.3923	0.0126
7	.	0.42	1	0.4	0.4	0.0125	0.3851	0.0125
8	.	0.42	1	0.4	0.4	0.0123	0.3851	0.0123

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)

N2014 Age 1:	RCT3 estimate (Table 7.20)
N2014 Age 2-8+:	Survivors estimates from XSA (Table 7.16)
N2015-2016 Age 1:	Geometric mean from XSA-estimates at age 1 for the years 1991-2013
Natural Mortality (M):	2011
Weight in the Catch/Stock (CWt/SWt):	Average for 2012-2014
Expoitation pattern (Sel):	Average for2012-2014 scaled to 2014

Table 7.22a prat in SD 22-32. Output from short-term prediction with management option table for status quo fishery in 2014

MFDP version 1a
Run: spr2015sq
Sprat
Time and date: 20:54 14/04/2015
Fbar age range: 3-5

2015				
Biomass	SSB	FMult	FBar	Landings
1699	753	1.0000	0.4067	264

2016					2017	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1751	1078	0.0	0.000	0	1944	1255
.	1066	0.1	0.041	34	1912	1214
.	1054	0.2	0.081	67	1881	1175
.	1042	0.3	0.122	98	1851	1136
.	1030	0.4	0.163	130	1822	1100
.	1019	0.5	0.203	160	1793	1065
.	1007	0.6	0.244	189	1765	1031
.	996	0.7	0.285	218	1738	999
.	985	0.8	0.325	246	1712	967
.	974	0.9	0.366	274	1686	937
.	963	1.0	0.407	300	1661	908
.	952	1.1	0.447	326	1637	880
.	941	1.2	0.488	351	1613	854
.	931	1.3	0.529	376	1590	828
.	920	1.4	0.569	400	1568	803
.	910	1.5	0.610	424	1546	779
.	900	1.6	0.651	446	1524	756
.	890	1.7	0.691	469	1504	733
.	880	1.8	0.732	491	1483	712
.	870	1.9	0.773	512	1463	691
.	860	2.0	0.814	533	1444	671

Input units are millions and grams - output in tonnes

Table 7.22b Sprat in SD 22-32. Output from short-term prediction with management option table for TAC constrained fishery in 2014

MFDP version 1a
Run: spr2015TAC bis
Sprat
Time and date: 12:27 16/04/2015
Fbar age range: 3-5

2015				
Biomass	SSB	FMult	FBar	Landings
1699	762	0.8971	0.3649	240

2016					2017	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
1774	1098	0.0	0.000	0	1960	1269
.	1087	0.1	0.036	30	1932	1232
.	1076	0.2	0.072	60	1904	1196
.	1065	0.3	0.108	89	1876	1162
.	1054	0.4	0.144	118	1850	1128
.	1044	0.5	0.180	145	1824	1096
.	1033	0.6	0.216	172	1798	1065
.	1023	0.7	0.252	199	1773	1035
.	1012	0.8	0.288	225	1749	1006
.	1002	0.9	0.324	250	1726	978
.	992	1.0	0.360	275	1702	951
.	982	1.1	0.396	299	1680	924
.	972	1.2	0.432	322	1658	899
.	963	1.3	0.468	345	1636	875
.	953	1.4	0.504	368	1615	851
.	944	1.5	0.540	390	1595	828
.	934	1.6	0.576	411	1575	806
.	925	1.7	0.612	432	1555	784
.	916	1.8	0.648	453	1536	764
.	907	1.9	0.684	473	1517	744
.	898	2.0	0.720	493	1499	724

Input units are millions and grams - output in tonnes

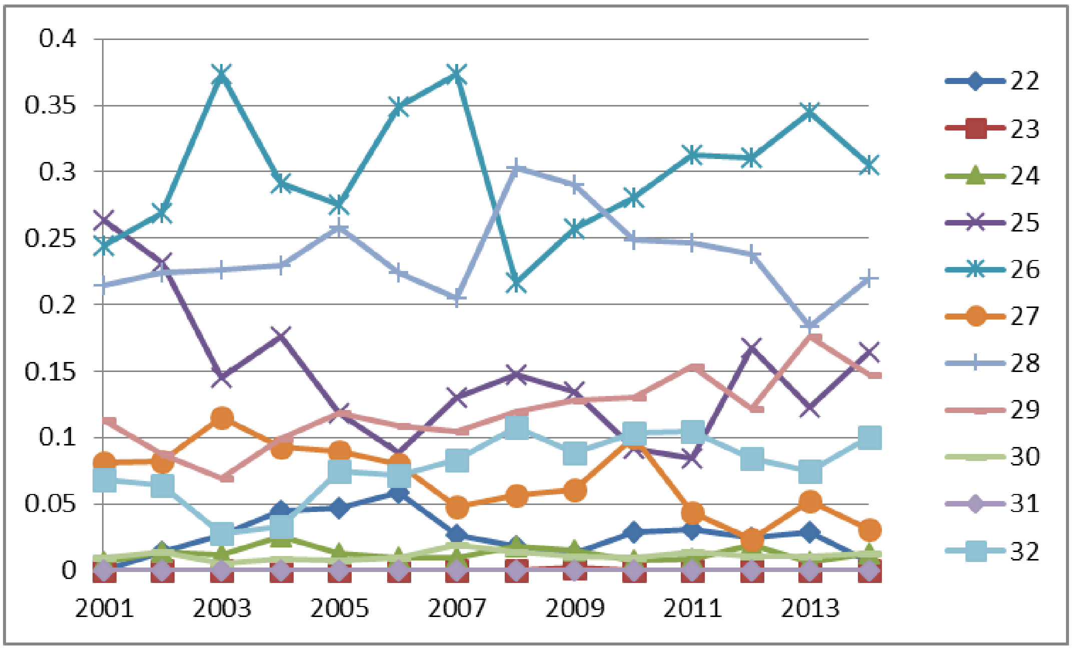

Fig. 7.0 Sprat in Subdivisions 22-32. Share of catches by Sub-division in 2001-2014

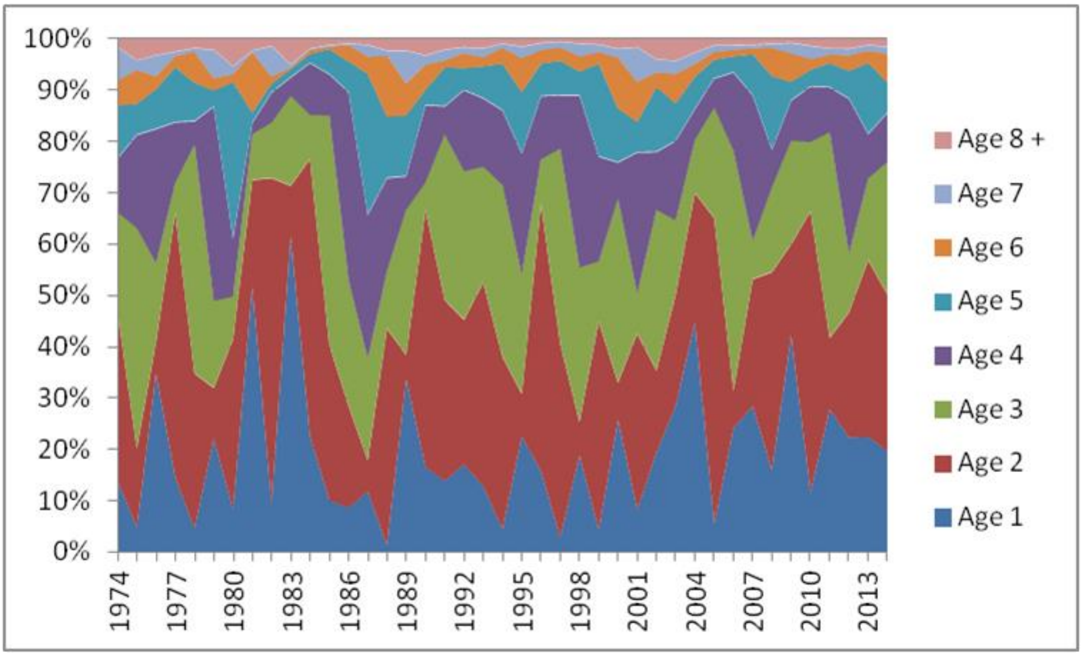

Figure 7.1 Sprat in SD 22-32. Relative catch-at-age in numbers.

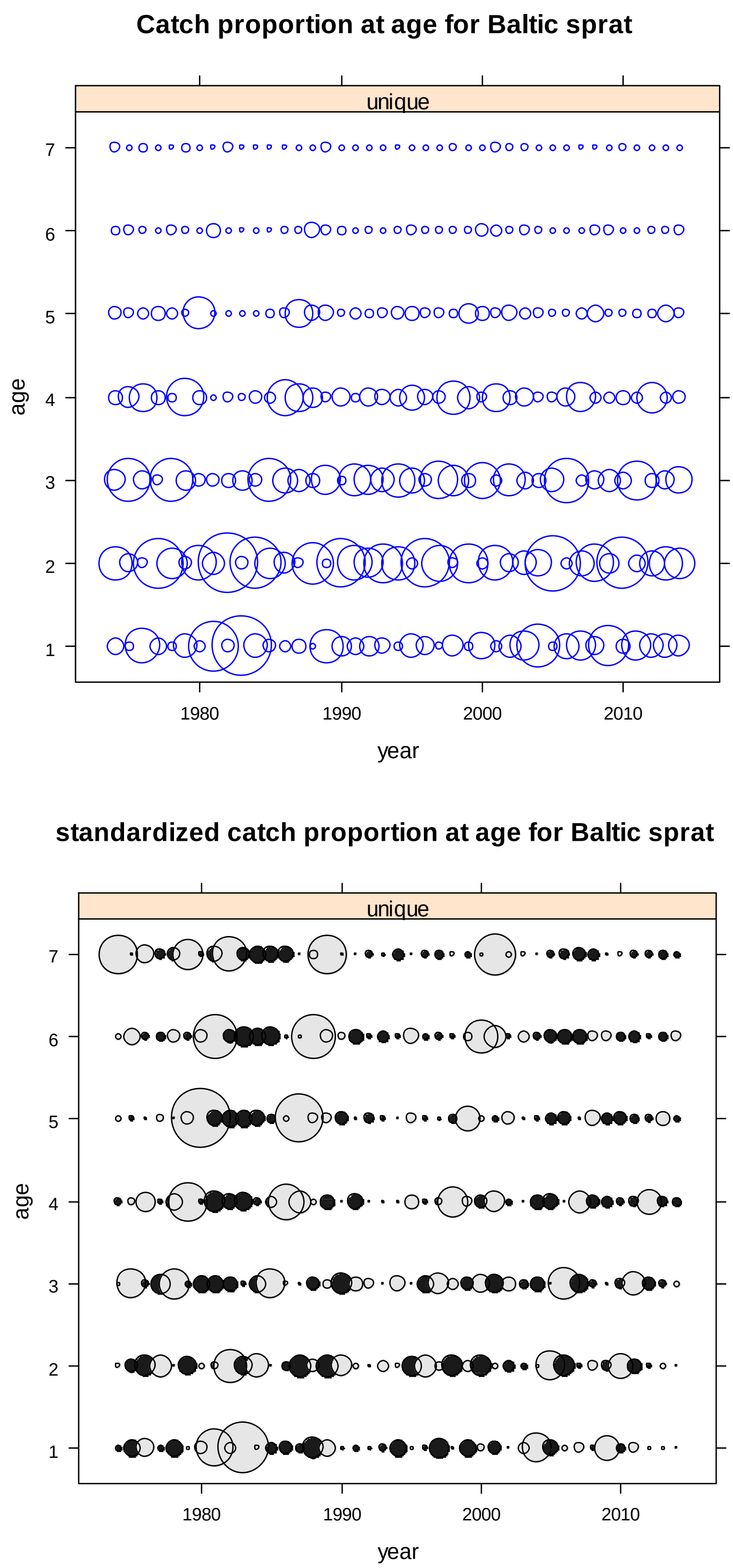

Figure 7.2. Sprat in SD 22-32. CANUM consistency check.

Fig. 7.3. Sprat in SD 22-32, mean weight-at-age in the catches (weight in the stock assumed as in the catches).

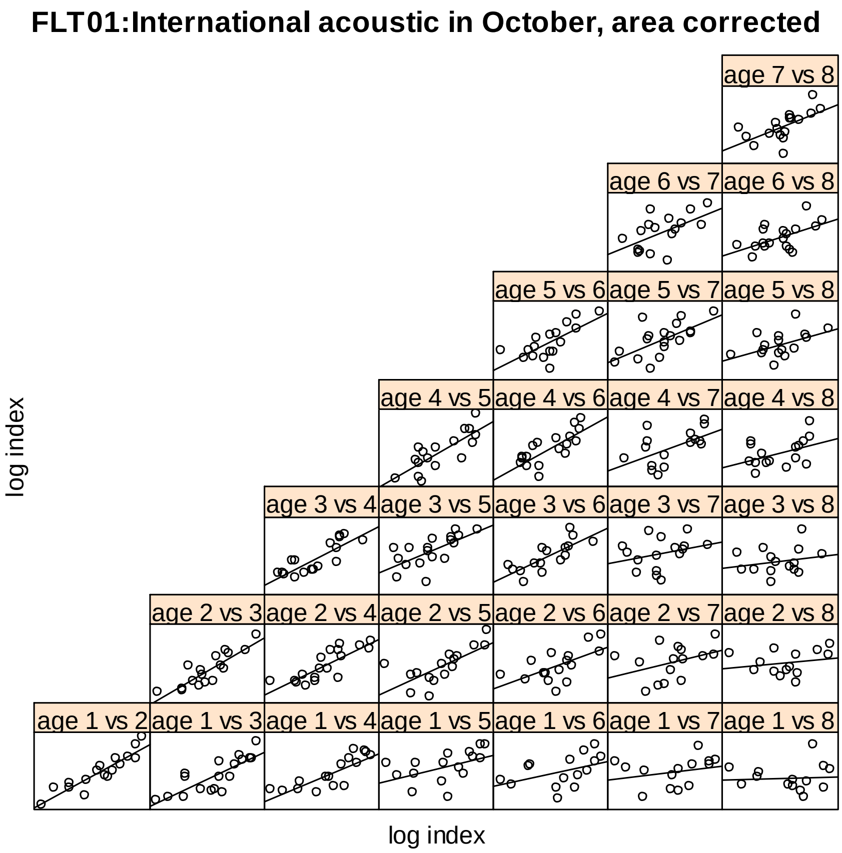

Figure 7.4. Sprat in SD 22-32. Check for consistency in October acoustic survey estimates.

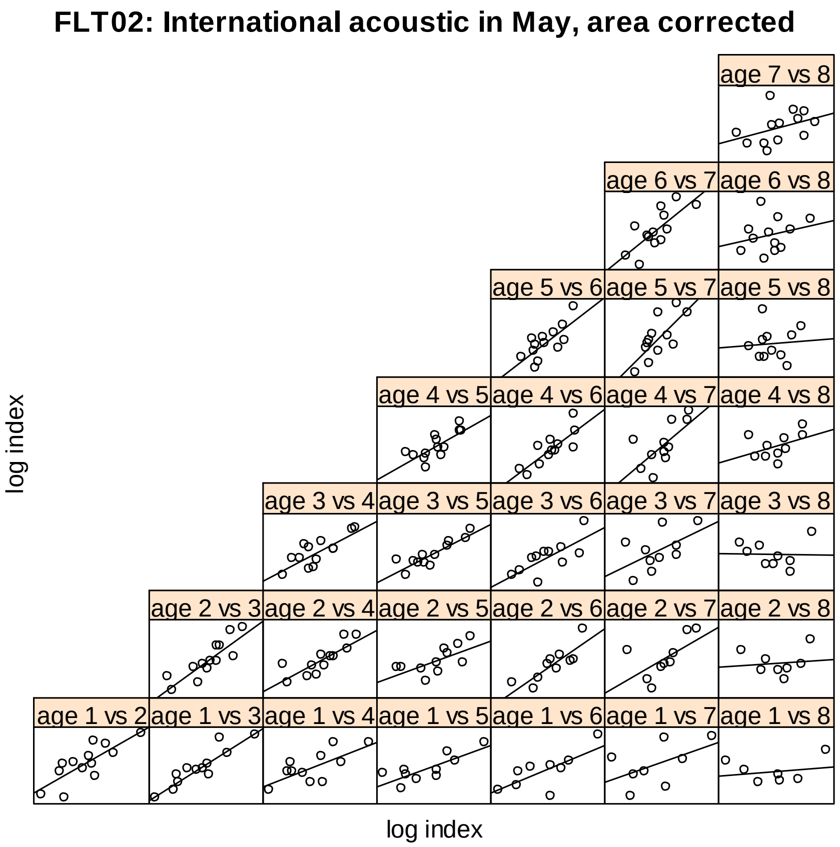

Figure 7.5. Sprat in SD 22-32. Check for consistency in May acoustic survey estimates.

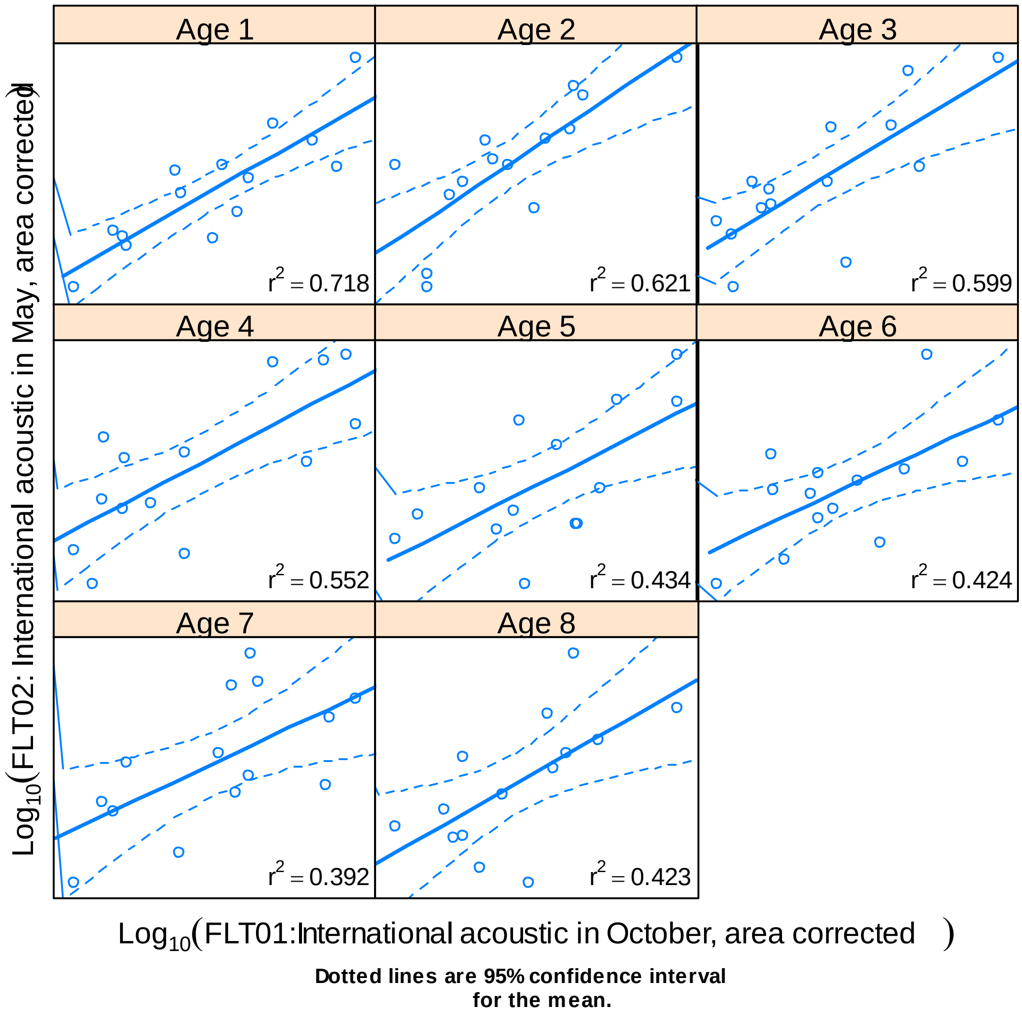

Figure 7.6 Sprat in SD 22-32. Check for consistency between May and October surveys.

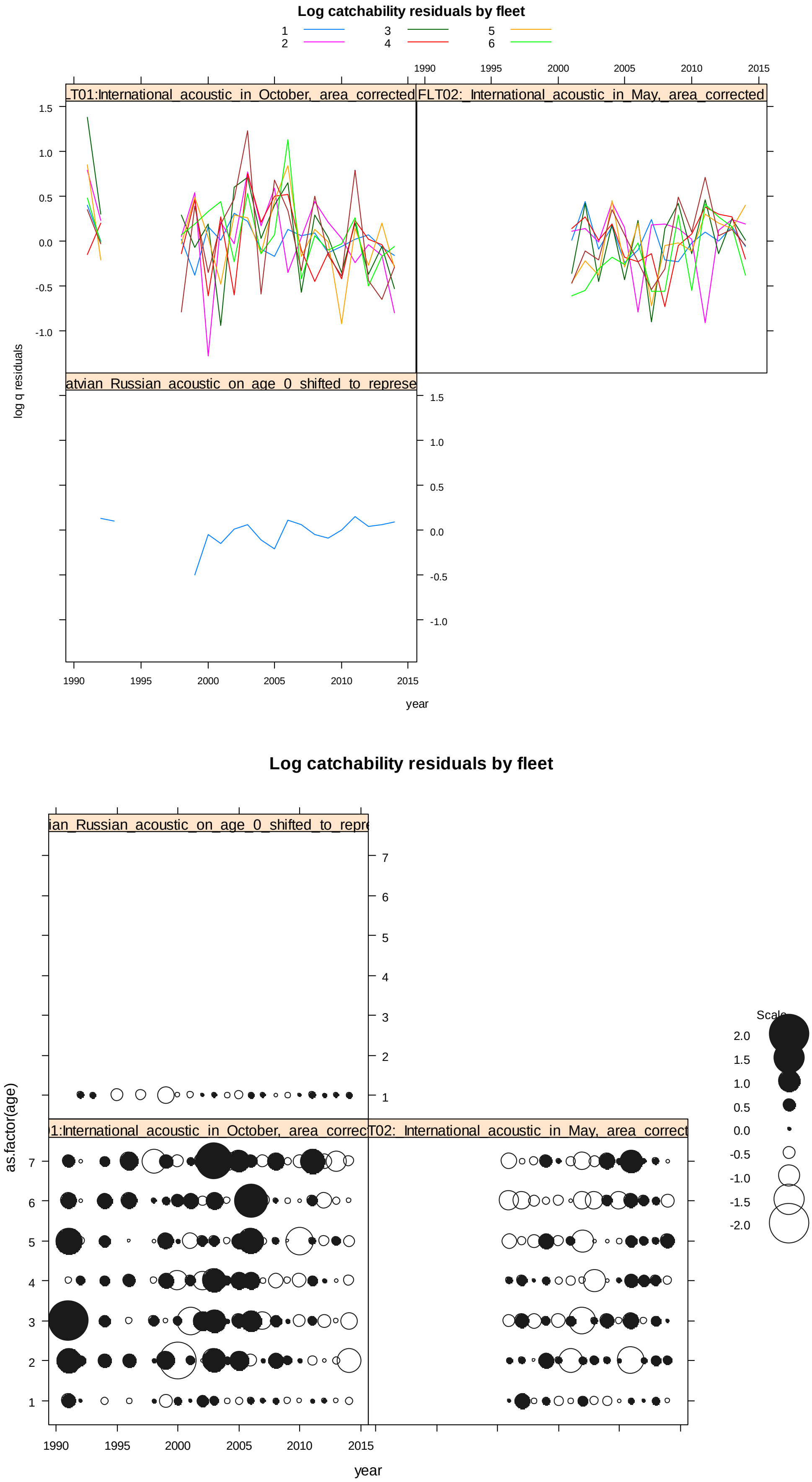

Figure 7.7a Sprat in SD 22-32. Log catchability residuals by fleet visualised in two ways.

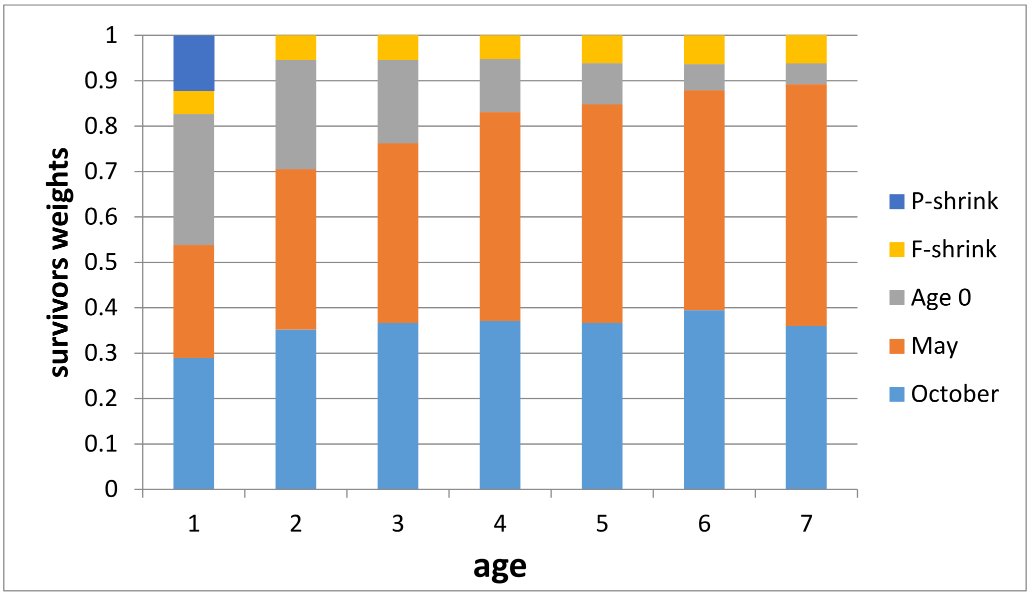

Figure 7.7b. Sprat In SD 22-32. Weights of survivors estimates by fleet used to provide final survivors estimates.

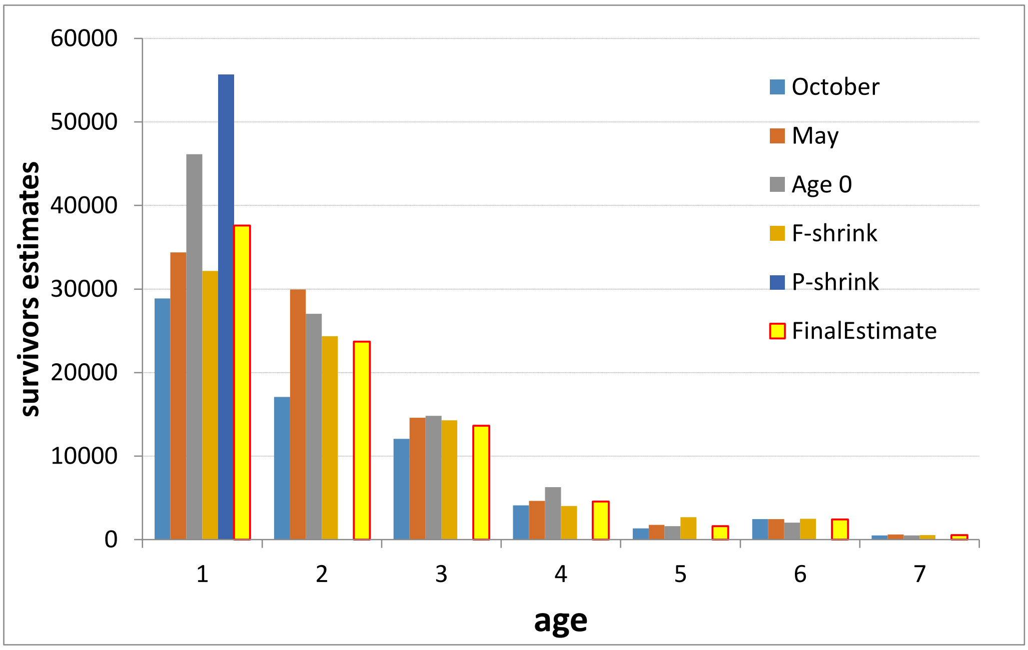

Figure 7.7c. Sprat in SD 22-32. Survivors estimates by fleet and age.

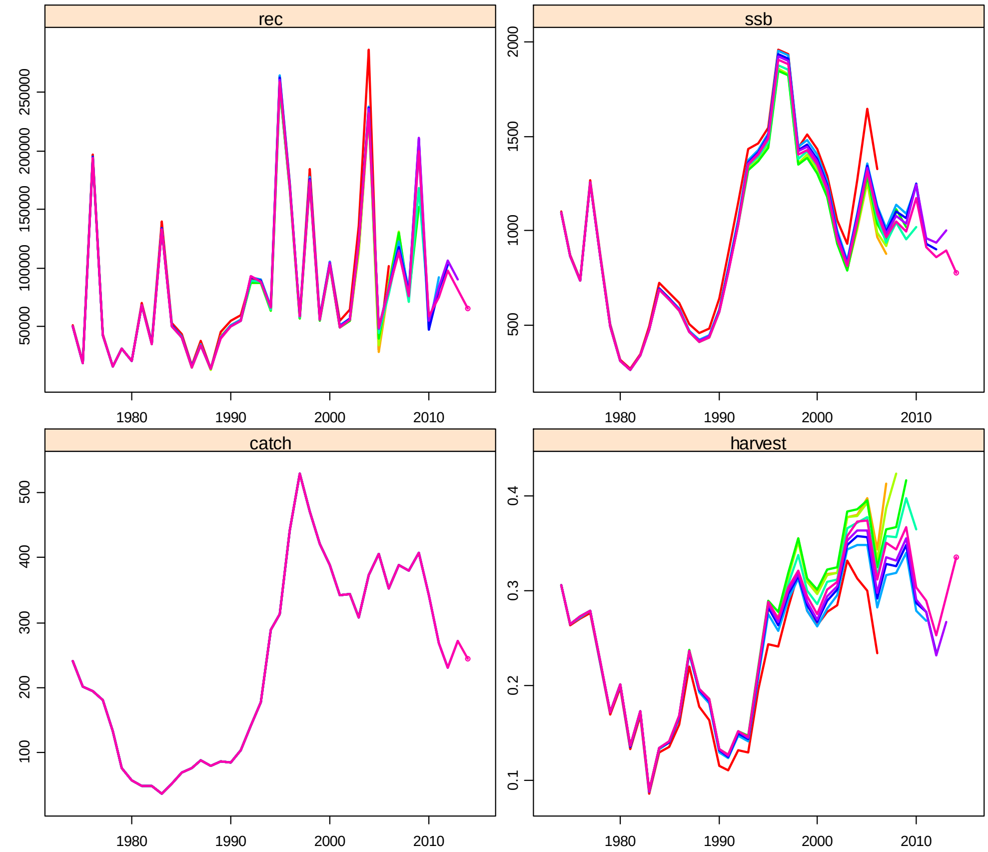

Figure 7.8 Sprat in SD 22-32. Retrospective analysis from XSA.

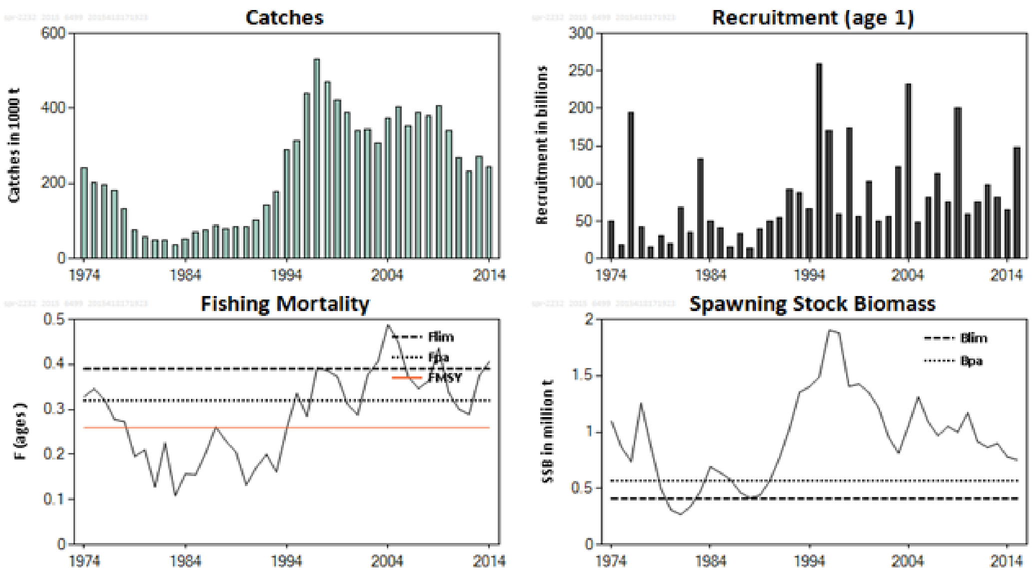

Figure 7.9 Sprat in SD 22-32. Summary sheet plots: landings, fishing mortality, recruitment (age 1) and spawning stock biomass.

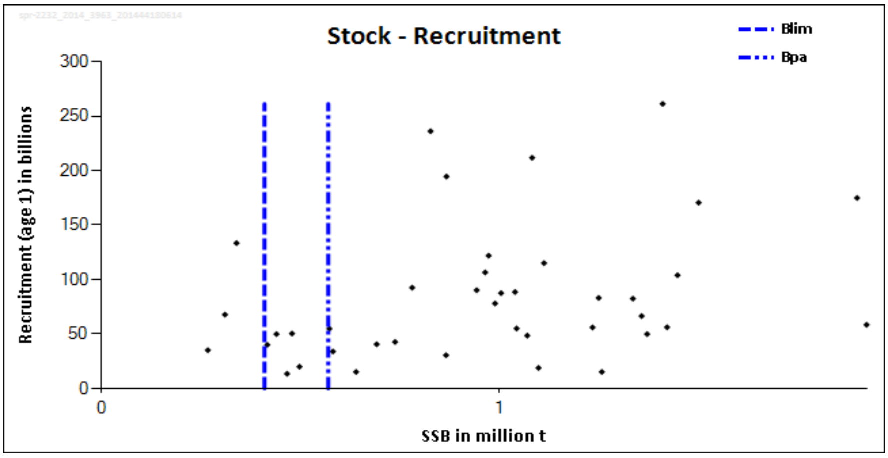

Figure 7.10 Sprat in SD 22-32. Stock recruitment plot (biomass reference lines indicated) .

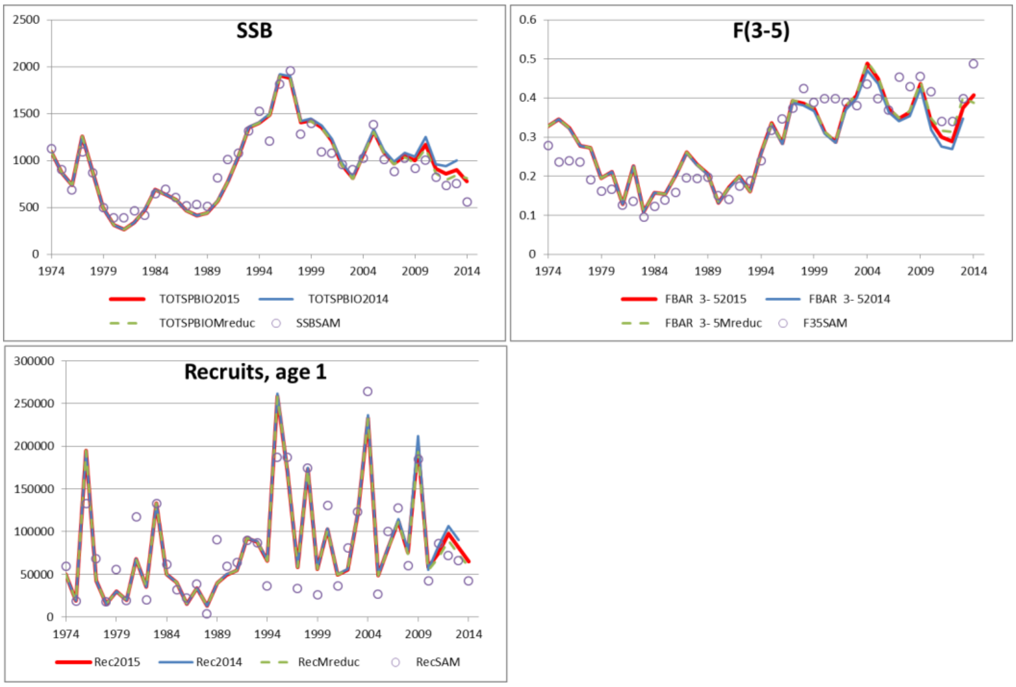

Figure 7.11a. Sprat In SD 22-32. Comparison of spawning stock biomass, fishing mortality, and recruitment (age 1) from XSA (present and 2014) with SAM. In addition, XSA results with M2 reduced (Mreduc) in 2013-2014 proportionally to survey index of cod biomass are shown.

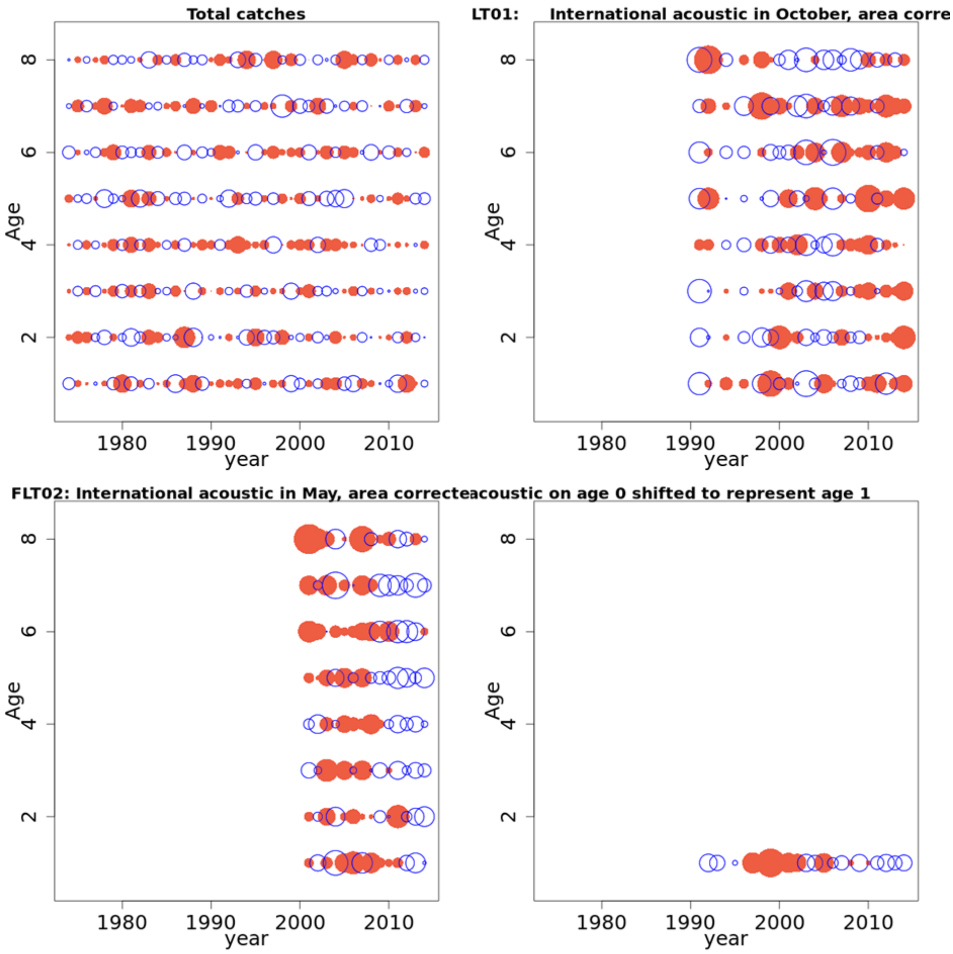

Figure 7.11b. Sprat In SD 22-32. Log catchability residuals by fleet from SAM.

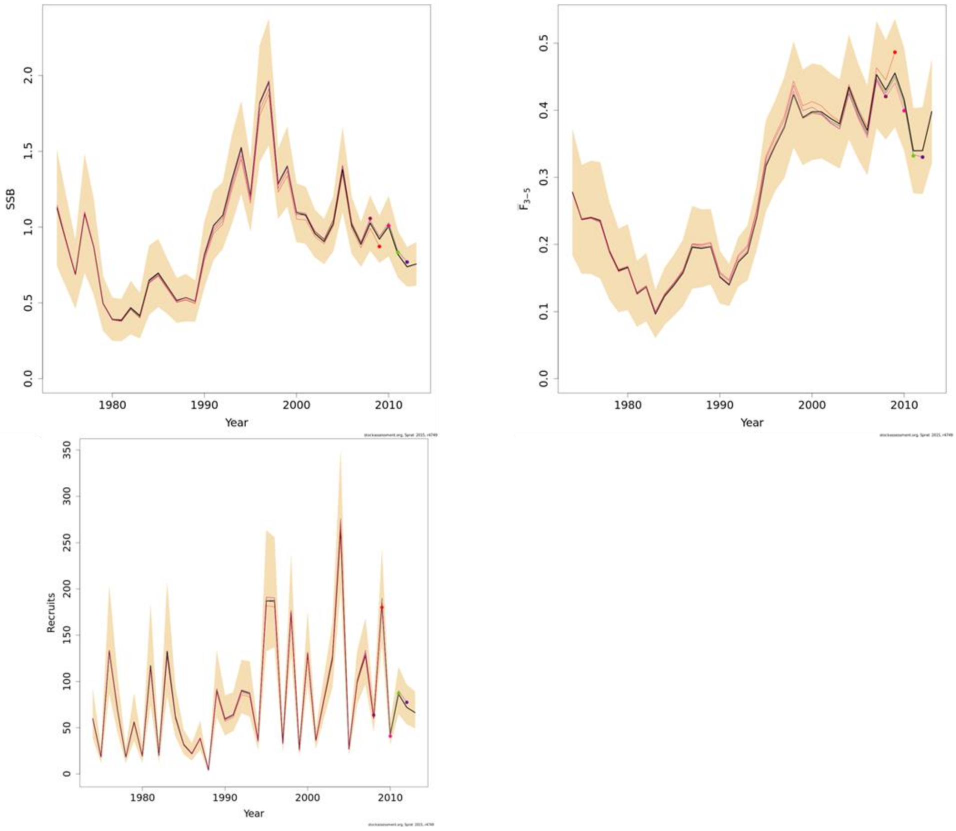

Figure 7.11c. Sprat in SD 22-32. Retrospective analysis from SAM.

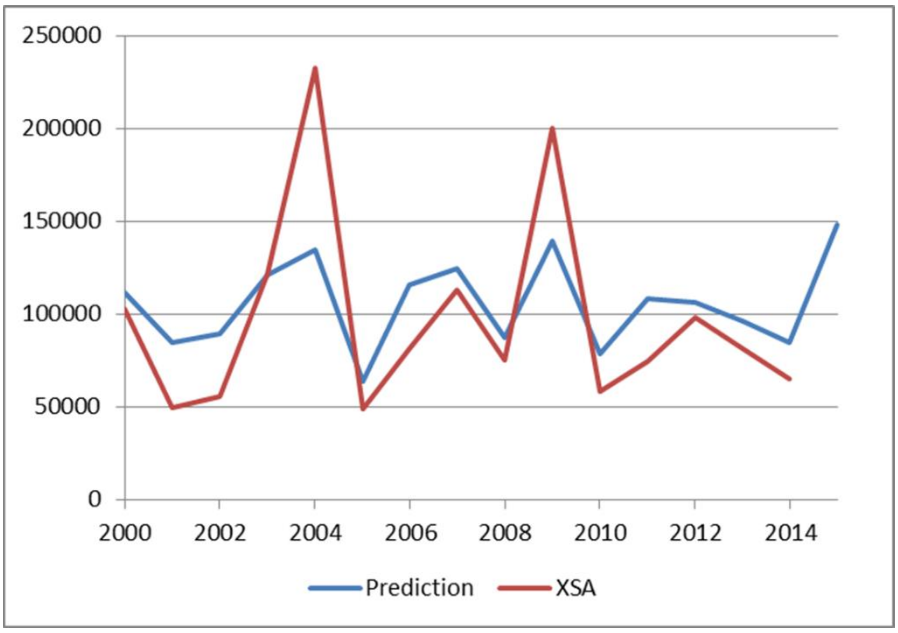

Figure 7.12 Sprat in SD 22-32. Comparison of recruitment estimates from RCT3 and XSA.

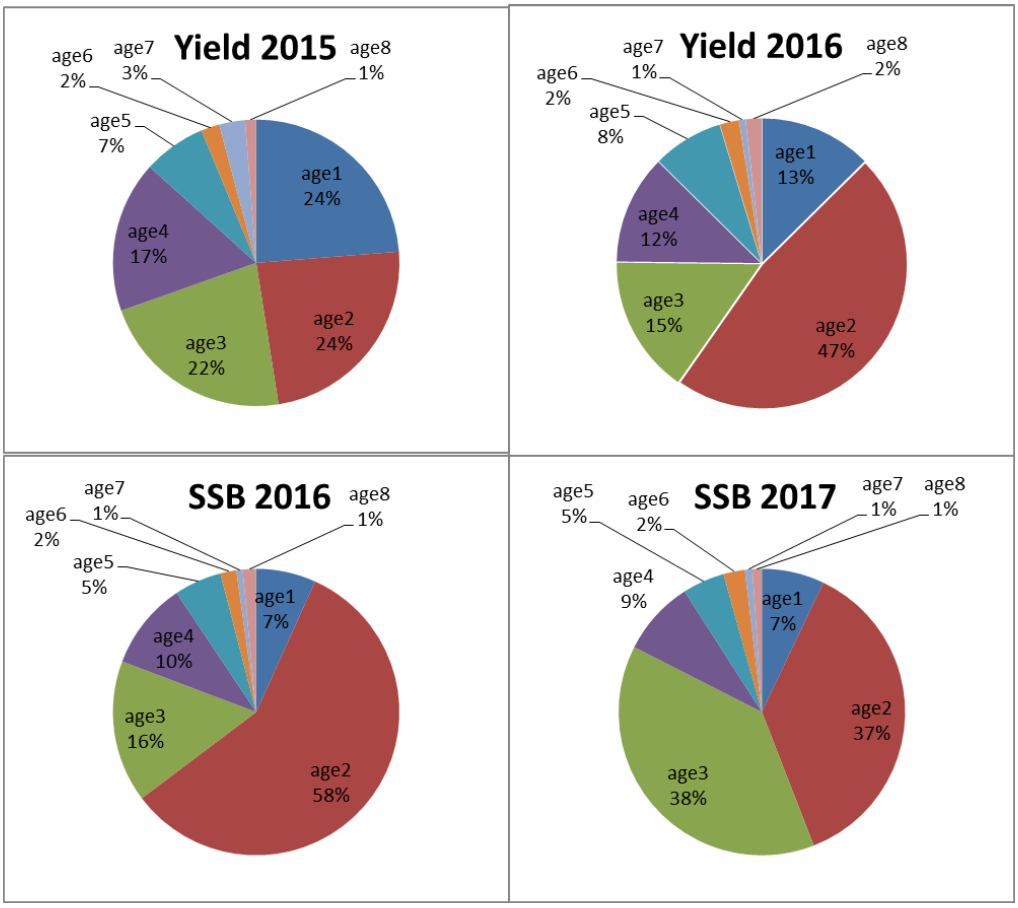

Figure 7.13 Sprat in SD 22-32. Short-term forecast for 2015-2017. Yield and SSB at age 1-8+under the TAC constrain in 2015.

8 Plaice in Subdivisions 21–23 and 24–32

8.1 Plaice in Kattegat, The Sound and Western Baltic (ple-2123)

This stock id is a result of the recommendation made by the benchmark work shop WKPLE in February 2015 (ICES 2015) , which confirmed the revised stock structure for the plaice stocks in the North Sea, Skagerrak, Kattegat and the Baltic Sea recommendation made by WKPESTO in in 2012 (ICES 2012). Plaice in Skagerrak is now included in the North Sea stock. Kattegat and Subdivision 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 benchmarke in February 2015 upgraded to category 1 (full analytical age based assessment).

The SAM model was used for the assessment.

8.1.1 Ecosystem aspects

No description of the ecosystem is available at present.

8.1.1.1 Fisheries

8.1.1.1.1 Technical Conservation Measures

Minimum Landing Size in SD 21 is 27 cm.

Minimum Landing Size in SD 22 and SD 23 is 25 cm.

Closed season for spawning females in SD 22 and 23 from 15/1 to 30/4.

In the Sund (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.

8.1.1.2 Description of the fishery

The catches are divided between Denmark (84% in weight, 2014) Germany (11%) and Sweden (5%).

The fishery is for particularly Kattegat a by-catch fishery due to the generally very low prices for plaice combined with the restrictive regulation in Kattegat for cod. In SD 22 some plaice directed fishery are taken place. The landings decreased dramatically in the end-seventies in SD 21 from 11 000 t to 3000 t and in SD 22 (from 3500 t to around 1000 and further down in late nineties to almost zero). Implementation of a number of changes in the regulatory systems in the Kattegat between 2007 and 2008 as well as continuous reductions in the allowed days at sea to protect Kattegat cod have significantly changed the fishing patterns of the Danish and Swedish fleets. After the mid-nineties the landings in SD 22 again increased to present levels around 1500 t while the landings in SD 21 again have decreased in the latest years. In SD 23 the catches have been low in the whole period (Figure 8.1.1 and Table 8.1.1).

The peak season for the fishery is the 1st quarter. During 2nd and 3rd quarter the landings are smaller and increase again in the 4th quarter (Table 8.1.3). There is a directed fishery for plaice (>25% of plaice in total monthly landings of a vessel) by Germany in SD22 in quarter 1 and quarter 4.

Approximately 64% of the landings are registered as caught by active gears. 36% is registered as caught by passive gears. Discard for 2014 is shown in table 8.1.3. In SD22 the discards of plaice by Germany are high because of quota restrictions, partly compromising the cod fishery. In contrast, Denmark usually is not fishing the national quota but have significant discard in both trawl and gillnet fishery due to low prices for plaice < 30 cm. The discarded individuals are by the fishermen assumed to survive the handling.

8.1.1.3 ICES Advice

The advice is based on the precautionary approach and the assessment is made using State based Assessment Model (SAM).

8.1.1.4 Management

There are no management objectives for the stock.

The management areas do not match the assessment areas.

TAC in 2013 is for Kattegat 1800 t and increased by 20% in 2014 to 2160 t. The TAC was 3409 t for SD 22—32.

From 2009, a new European scheme for effort management was implemented (Council Regulations (EC) N°43/2009, N°43/2009, N° 53/2010 and N° 57/2011) allocating different amounts of Kw*days by Member State and area to different effort groups of vessels depending on gear and mesh size. There is a specific amount of KW-days allocated to the Kattegat fisheries. The grouping of fishing gear concerned are: Bottom trawls, Danish seines and similar gear, excluding beam trawls of mesh size: TR1 (≤ 100 mm) – TR2 (≤ 70 and < 100 mm) – TR3 (≤ 16 and < 32 mm); Beam trawl of mesh size: BT1 (≤ 120 mm) – BT2 (≤80 and < 120 mm); Gill nets excluding trammel nets: GN1; Trammel nets: GT1 and Longlines: LL1.

In addition to these common European rules, national management actions have been implemented (cf. 7.1.1), with the specific aim of protecting spawning cod in the Kattegat.

Finally, in 2007, a rights-based regulation system was introduced in Denmark for the allocation of national quotas. Before that year the quotas were split into 14-days rations which were continuously adjusted to the amount of quota left. In 2007 this system was changed to a complex system were individual rights are attached to the vessels and not to the owners (FKA - Vessel Quota Share), with specific provisions for coastal and recreational fisheries. It is acknowledged that this complex system may have dramatically affected the structure of Danish fisheries, as can be seen from effort trends (Bailey and Rätz, 2011).

8.1.2 Data available

8.1.2.1 Sampling coverage

The sampling coverage is given in Table 8.1.2 and shows a generally good coverage of all areas except in the Sound, which is only sampled by Denmark and not sampled for landings at all. The Kattegat is over sampled if scaled to the catches because plaice is often caught as bycatch in cod fishery, which is intensively sampled because of the cod recovery plan.

8.1.2.2 Catch

The annual landings are available since 1970 (SD 22) and 1972 (SD 21) and are given by Sub-Division and country separately in Table 8.1.1. The landings by subdivision are plotted in figure 8.1.3.

Discard data are only available back to 2002 but the discard amount is extrapolated three years backwards to 1999 by the average discards from 2002—2004. SAM can handle if minor gabs 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 in order to provide a time series sufficiently long for the assessment.

No significant misreporting is believed to take place.

Relative age distributions in the catch at year are presented on Figure 8.1.5.

Discard and landings (2014) by gear type and quarter is given in table 8.1.3.

Landings and discard (2014) by subdivision, country and quarter is given in table 8.1.4. Landing and discard for the whole time series are given in Figure 8.1.4.

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. Improvement in the consistency has been reached, although significant inconsistency remains.

It is therefore acknowledged that the variability of growth as well as inconsistency in age reading are important source of uncertainty in the catch matrix. It is expected that with the current sampling levels, which are consistent with the Data Collection Framework requirements, significant precision improvements can be gained if the age reading inconsistency is resolved.

Catch at age were raised using ICES InterCatch database.

8.1.2.3 Weight at age

Weight at age in landings is presented in Table 8.1.5 and the mean weight at age is given in figure 8.1.6. Mean weight in stock is obtained from Combined 1 quarter surveys but is used as an average from 2002-2015. Weight in stock is shown in figure 8.1.11.

8.1.2.4 Maturity and 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.

The annual maturity ogives was revised for the WKPLE in 2015 and is based on the average from 1999-2014 from information from the Combined 1q survey Figure 8.1.13.

8.1.2.5 Catch, effort and research vessel data

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 total spatial distribution of each survey is given in Figure. 8.1.7 and Figure 8.1.8.

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 8.1.12.

8.1.3 Data analyses

8.1.3.1 Catch-at-age matrix

The discards in 1999—2001 are the average of the information from 2002—2004. The catch 1999—2001 is the sum of the backwards extended discards and the official landings.

8.1.3.2 Internal consistency in catch matrix

The internal consistency plots (Figure 8.1.14) indicate some problems. Particularly, the younger fish show low consistency following the cohorts because the trend some cases is defined by one outlying measuring point. The medium aged fish show better consistency, while the older fish have less consistency in general.

8.1.3.3 Tuning series

The internal consistency for both 1st quarter Combined and Combined 3rd and 4th quarter surveys (Figure 8.1.9 and Figure 8.1.10) shows acceptable internal consistency except for age 3 to 4 in the combined 3 and 4th quarter. Both surveys (but particularly the 1st quarter series) show increased abundance of all age. The indices by age classes for both combined series surveys are shown in Figure 8.1.12.

8.1.3.4 Final assessment

The stock was as a result of the WKPLE in February 20015 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 setting is according to the stock annex (PLE-2123).

The final run in SAM is named: PLE21_23_WGBFAS_2015_baserun

The stock is in a very good condition. The result shows (Figure 8.1.16 and tab. 8.1.6) an increase in SSB from 12000 tons in 2013 to 14000 tons in 2014 and estimated to 16000 tons in 2015. The F in 2014 is approximately the same as last year (0.2) and has been constantly decreasing in the whole period. This is the case for all age groups except age 1, which is constantly low (Figure. 8.1.19). The recruitment is regarded as constant but with significant variation. The recruitment in 2014 is estimated to 22 mill.

The “Leave one-out analysis” shows that 1st quarter Combined survey are given most weight particularly in the latest years (Figure. 8.1.17). The retrospective analysis is quite robust considering the short time series. Only in 2011 the F has been estimated to be outside the confident intervals (Figure. 8.1.18).

8.1.4 Historic Stock Trends

The survey indices are shown in Figure 8.1.12. See section 8.1.3 under "Description of the fishery" for historical trend details.

8.1.5 Recruitment estimates

The recruitment in 2014 is estimated to around 22 mill. This is a decrease since 2013 but still within what can be considered as a stable recruitment in the whole time series (1999-2014). The historic trend is given in Figure 8.1.16 and Table 8.1.6.

8.1.6 Short-term forecasts

The short term forecast was made according to the stock annex using the MFDP1a software. The recruitment is regarded as stable in the whole time series (Figure 8.1.16) and the recruitment for 2015 is estimated as the geometric mean for the whole time series. There are no trend in mean weight at for ages included in F(bar)(=3-5, Figure 8.1.11). There is no trend in F(bar) in the last three years (Figure 8.1.19) and therefore no scaling was used.

8.1.7 Medium-term forecasts

None

8.1.8 Biological reference point

Precautionary Approach reference points	Fpa=0.67 Bpa=5553
Target reference points	Blim= 4077 (=Bloss) Btrigger=5553
Fmsy	Fmsy=0.37

References

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Berg et al. 2013. Casper W. Berg, Anders Nielsen, Kasper Kristensen, Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models, Postprint of publication DOI 10.1016/j.fishres.2013.10.005

Table 10.1 1. Plaice in SD 21–23. Official landings by sub-Division and country. 1970–2013.

Year/SD	21-Denmark	21-Germany	21-Sweden	22-Denmark	22-Germany	22-Sweden	23-Sweden	23-Denmark
	21	21	21	22	22	22	23	23
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

Table 10.1.2 Sampling coverage and catches in 2014 by country Sub-division and quarter

Year	2014				
Row Labels	CATON (KG)	No. Of Length Samples	No. Of Length Measured	No. Of age samples	No. Of age readings
Discards	1945870	145	9899	145	2083
Denmark	1750341	85	7861	85	1148
BAL22	1220287	29	3489	29	474
Active	1220287	29	3489	29	474
Passive	0	0	0	0	0
BAL23	4681	1	53	1	9
Active	4681	1	53	1	9
Passive	0	0	0	0	0
IIIaS	525373	55	4319	55	665
Active	525373	55	4319	55	665
Passive	0	0	0	0	0
Germany	99541	21	823	21	291
BAL22	98751	21	823	21	291
Active	82521	12	774	12	285
Passive	16230	9	49	9	6
IIIaS	790	0	0	0	0
MIS_MIS_0_0_0_HC	790	0	0	0	0
Sweden	95987	39	1215	39	644
BAL23	1590	0	0	0	0
Passive	1590	0	0	0	0
IIIaS	94397	39	1215	39	644
Active	94397	39	1215	39	644
Passive	0	0	0	0	0
Landings	1931017	124	7120	124	3278
Denmark	1496846	90	5474	90	2628
BAL22	1097120	70	4156	70	1720
Active	659622	35	2078	35	860
Passive	437498	35	2078	35	860
BAL23	57158	0	0	0	0
Active	680	0	0	0	0
Passive	56478	0	0	0	0
IIIaS	342568	20	1318	20	908
Active	276678	10	659	10	454
Passive	65890	10	659	10	454
Germany	320766	34	1646	34	650
BAL22	319591	34	1646	34	650
Active	250146	15	1217	15	509
Passive	69445	19	429	19	141
IIIaS	1175	0	0	0	0

Year	2014				
Row Labels	CATON (KG)	No. Of Length Samples	No. Of Length Measured	No. Of age samples	No. Of age readings
MIS_MIS_0_0_0_HC	1175	0	0	0	0
Sweden	113405	0	0	0	0
BAL22	0	0	0	0	0
Passive	0	0	0	0	0
BAL23	45043	0	0	0	0
Active	0	0	0	0	0
Passive	45043	0	0	0	0
IIIaS	68363	0	0	0	0
Active	40028	0	0	0	0
Passive	28335	0	0	0	0
Grand Total	3876887	269	17019	269	5361

Table 10.1.3 Discard (kg) and landings (kg) in 2014 by gear type and quarter.

Sum of CATON (KG)	Column Labels				
Row Labels	1	2	3	4	Grand Total
CATON	Quarter				
	1	2	3	4	Total
Discards	1363856	126419	270200	185395	1945870
Active	1362322	126310	254795	183832	1927259
MIS_MIS_0_0_0_HC			105	685	790
Passive	1534	109	15300	877	17820
Landings	569593	274371	340693	746360	1931017
Active	482087	66852	129267	548948	1227154
MIS_MIS_0_0_0_HC			124	1051	1175
Passive	87506	207519	211303	196360	702688
Grand Total	1933449	400790	610894	931754	3876887

Table 10.1.4. Landings (kg) and discard (kg) in 2014 by Subdivision, catch category, country and quarter.

CATON	Quarter				
	1	2	3	4	Total
BAL21					
Discards	189244	111029	243331	76958	620561
Active	189244	111029	243225	76272	619770
MIS_MIS_0_0_0_HC			105	685	790
Passive	0	0	0	0	0
Landings	46257	50723	118137	196989	412106
Active	37084	26993	83374	169255	316706
MIS_MIS_0_0_0_HC			124	1051	1175
Passive	9173	23730	34639	26683	94225
BAL22					
Discards	1173927	10880	26687	107544	1319038
Active	1172997	10880	11387	107544	1302808
Passive	930	0	15300	0	16230
Landings	514485	174398	189391	538437	1416711
Active	444982	39581	45758	379447	909768
Passive	69503	134817	143633	158990	506943
BAL23					
Discards	685	4510	183	893	6271
Active	81	4401	183	16	4681
Passive	604	109	0	877	1590
Landings	8852	49250	33166	10933	102201
Active	21	278	135	246	680
Passive	8831	48972	33031	10687	101521
Grand Total	1933449	400790	610894	931754	3876887

Table 10.1.5. Mean weight (kg) in catch by age.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 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

Table 10.1.6. SAM Final run. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35)

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1999	53316	40347	70454	6461	5173	8070	4077	3184	5220	0.912	0.703	1.182
2000	47810	36711	62267	8218	6725	10043	5045	4086	6229	0.969	0.786	1.196
2001	29349	21558	39954	9579	7810	11749	6326	5121	7815	0.923	0.752	1.133
2002	36279	27506	47851	9591	7789	11810	6693	5370	8342	0.850	0.684	1.056
2003	25978	19512	34586	8683	7111	10602	6217	5038	7673	0.757	0.605	0.949
2004	31634	24174	41398	8099	6704	9784	5786	4732	7076	0.712	0.558	0.908
2005	25668	19578	33652	7868	6504	9517	5634	4609	6887	0.690	0.528	0.901
2006	22561	16904	30112	7677	6257	9419	5561	4478	6907	0.718	0.544	0.948
2007	24053	18650	31020	7227	5865	8905	5277	4205	6621	0.678	0.489	0.941
2008	25745	18825	35209	6980	5544	8787	5072	3945	6519	0.601	0.415	0.868
2009	32273	24696	42176	7205	5590	9286	5139	3849	6861	0.490	0.323	0.742
2010	41982	32382	54428	8426	6411	11075	5941	4323	8166	0.401	0.248	0.649
2011	44802	33852	59294	10381	7795	13824	7347	5291	10201	0.336	0.203	0.556
2012	39066	29177	52307	12882	9505	17460	9477	6715	13375	0.230	0.138	0.382
2013	31039	22451	42913	15687	11514	21373	12182	8652	17152	0.198	0.119	0.327
2014	22181	14436	34082	17611	12791	24249	14402	10198	20339	0.186	0.110	0.314
2015							16133	11172	23296			

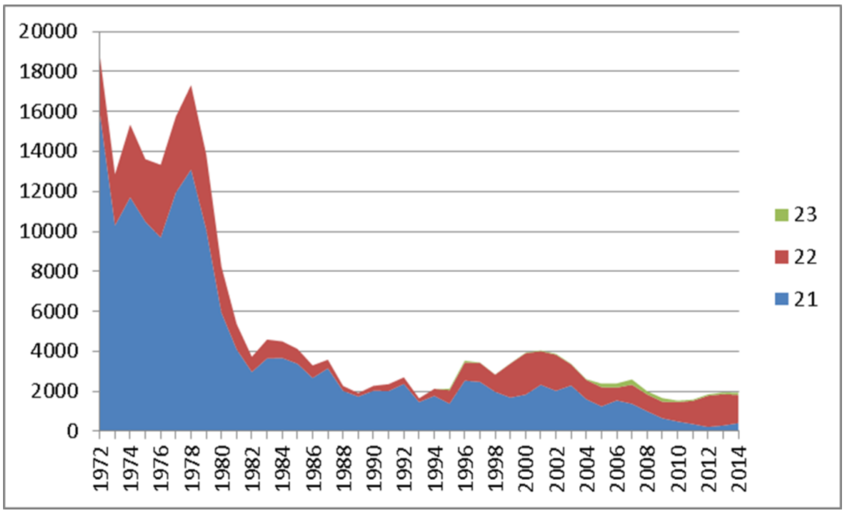


Figure 10.1.1. Landings by sub-division by year.

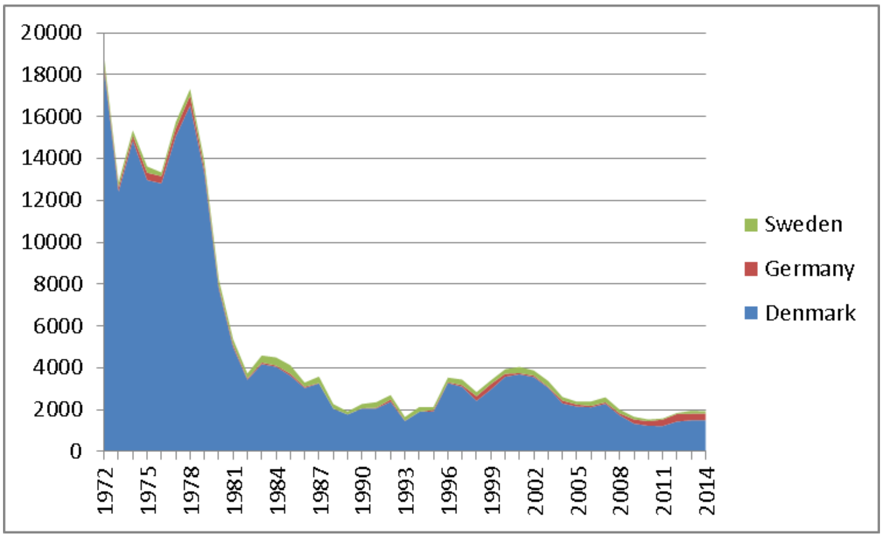


Figure 10.2.2. Landings by country by year.

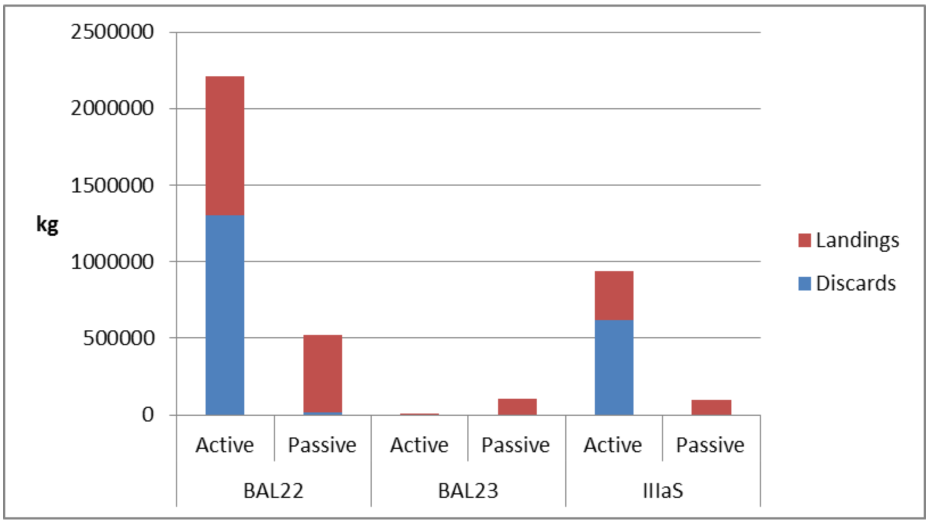


Figure 10.1.3. Catches by gear type, area and catch category

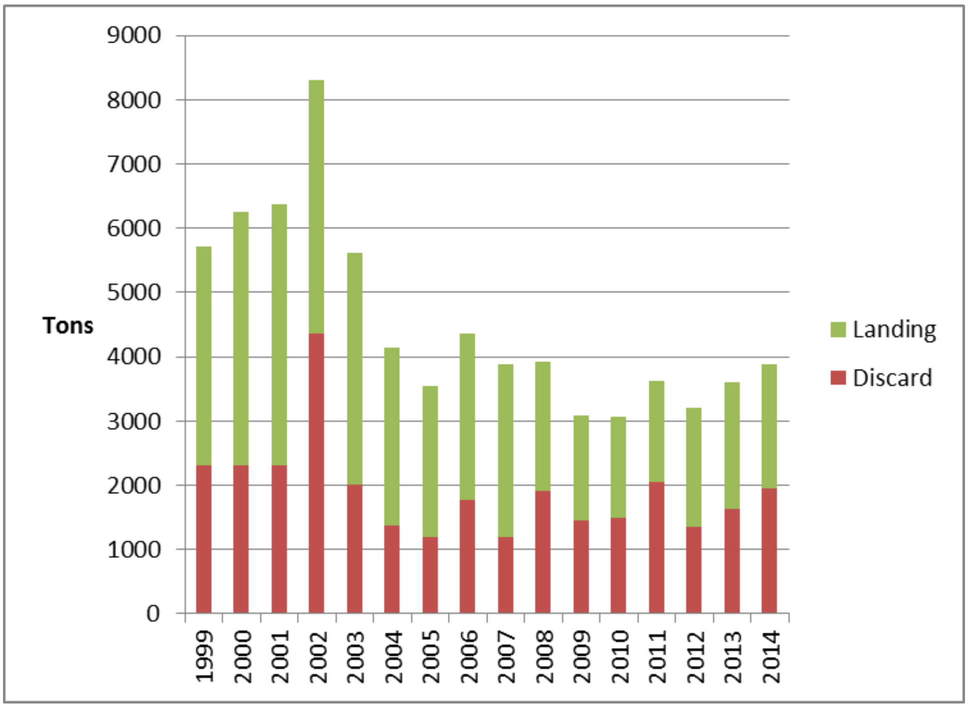


Figure 10.1.4. catches by year.

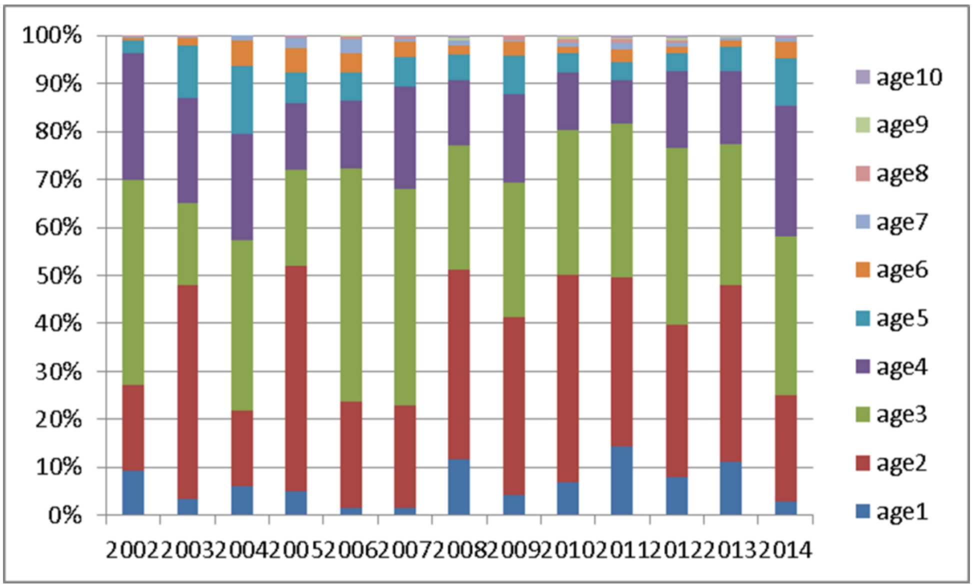


Figure 10.1.5. Relative age distribution in catches by year.

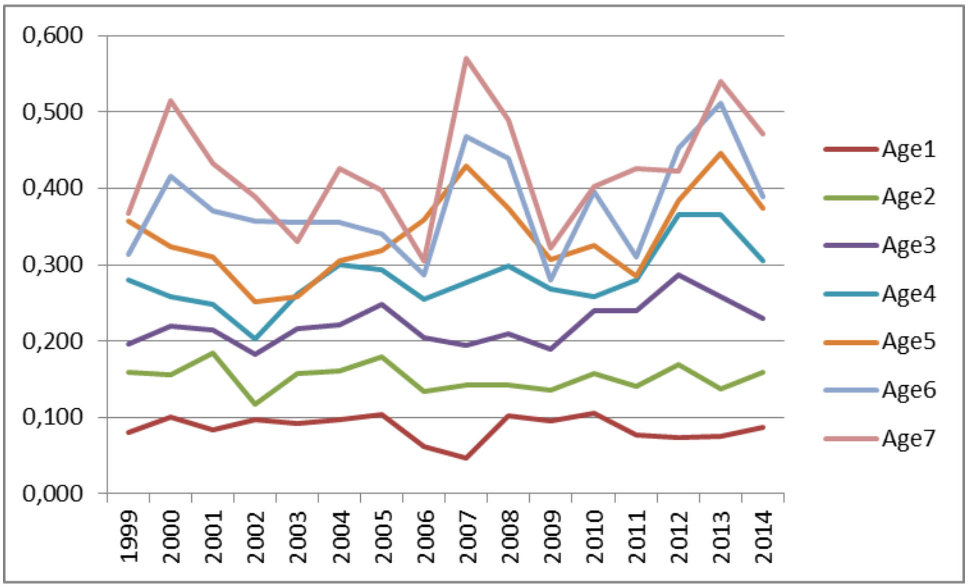


Figure 10.1.6. Mean weight at age by year.

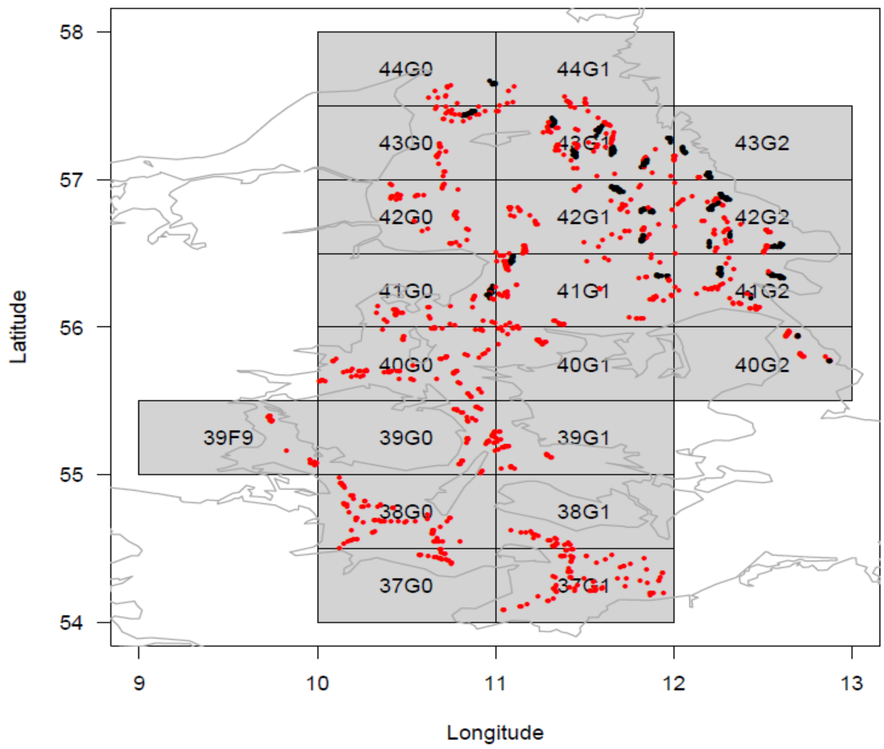


Figure. 10.1.7. Spatial distribution (all years) of BITS (red dots) and NS-IBTS (black dots).

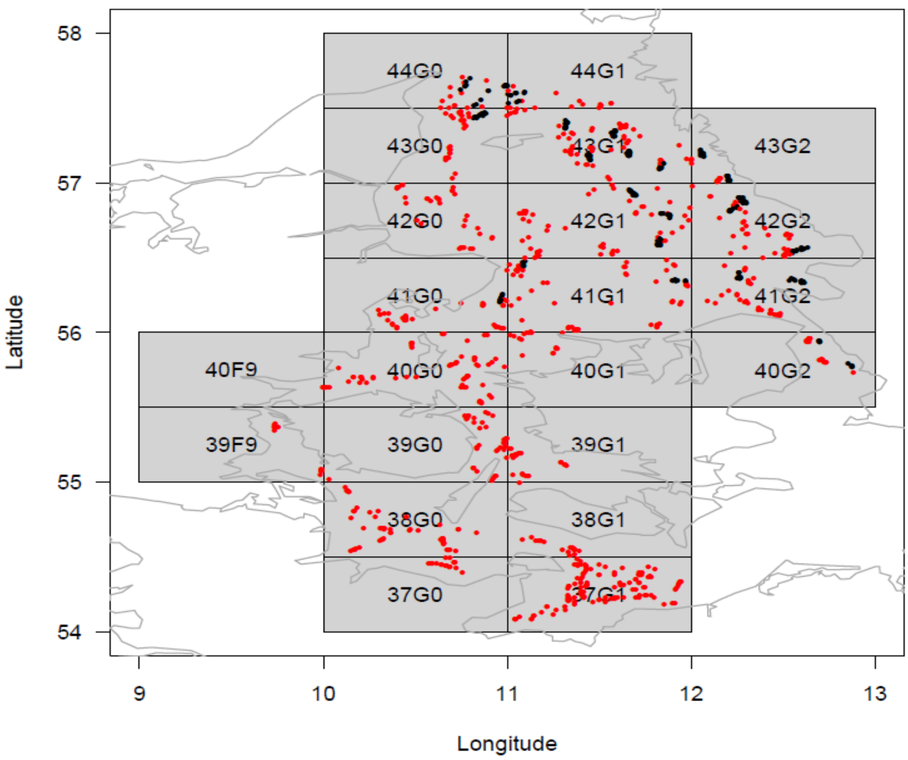


Figure. 10.1.8. Spatial distribution (all years) of BITS 4th q (red dots) and NS-IBTS 3rd q (black dots).

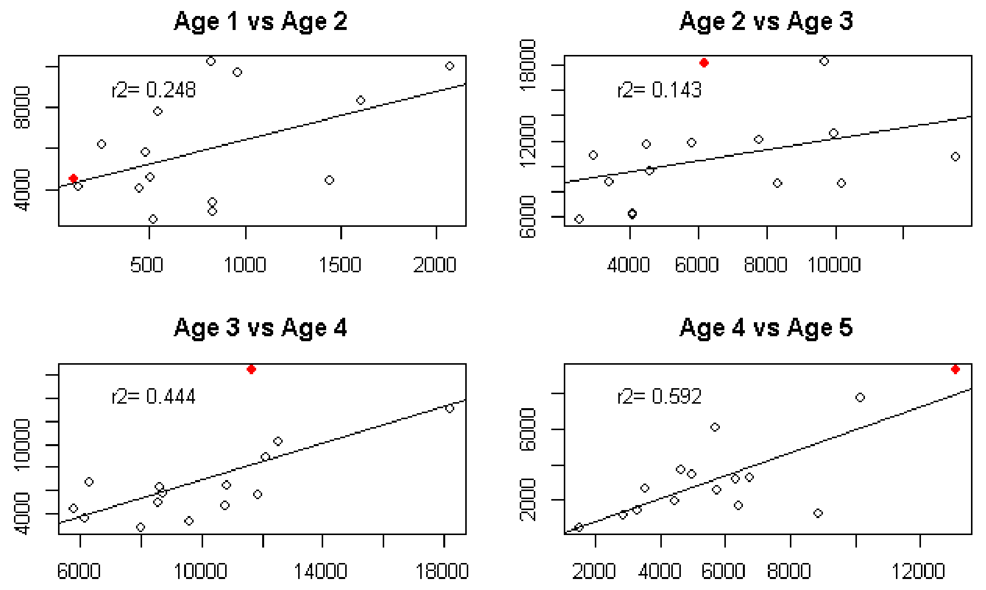


Figure 10.1.9. Internal consistency of Combined 1st quarter.

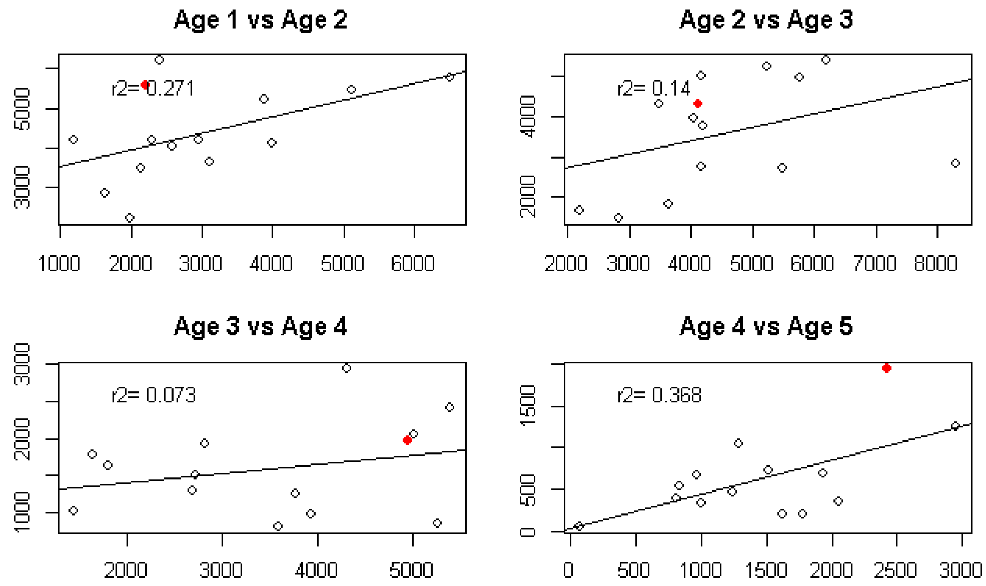


Figure 10.1.10. Internal consistency of Combined 3-4th quarter.

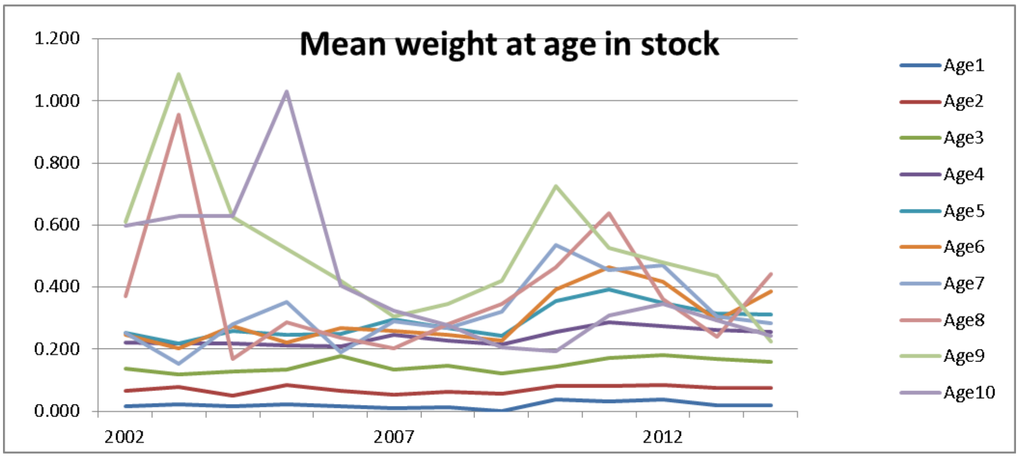


Figure 10.1.11. Mean weight in stock (1 q combined survey)

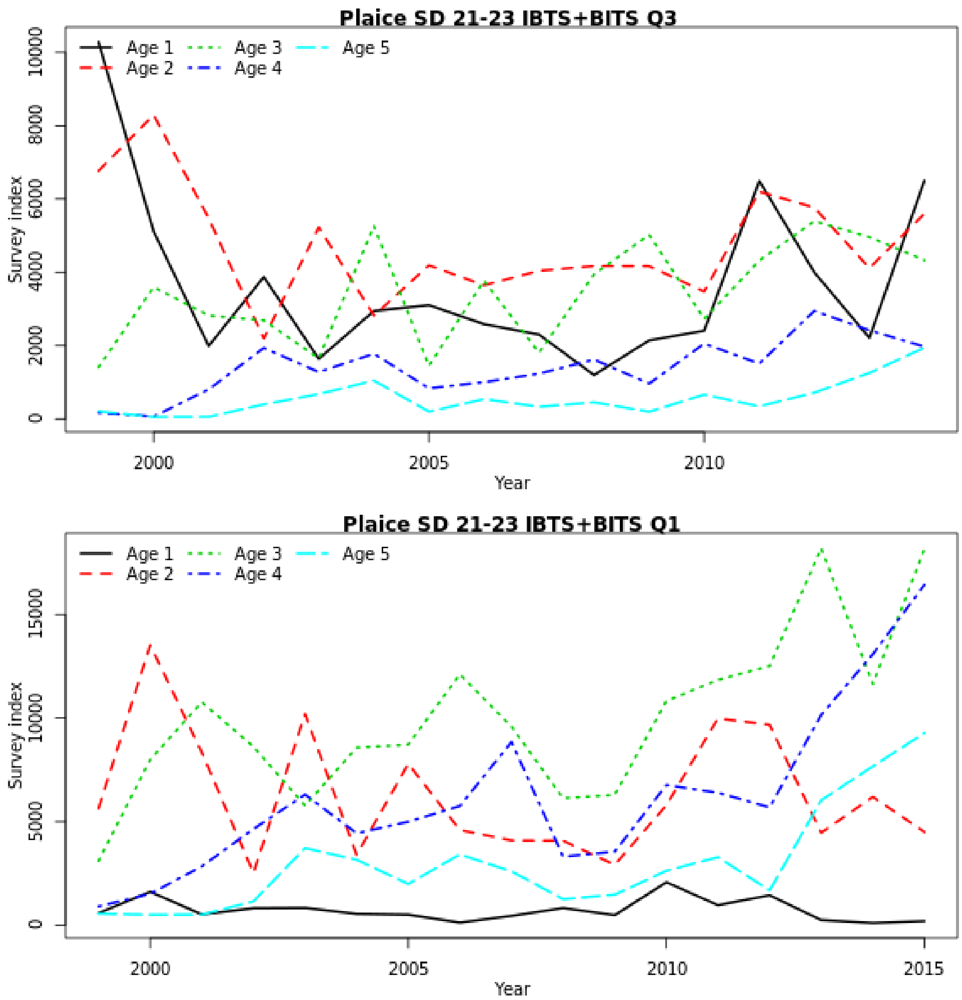


Figure 10.1.12. Survey indices. Top: Combined quarter 3+4. Bottom: Combined quarter 1.

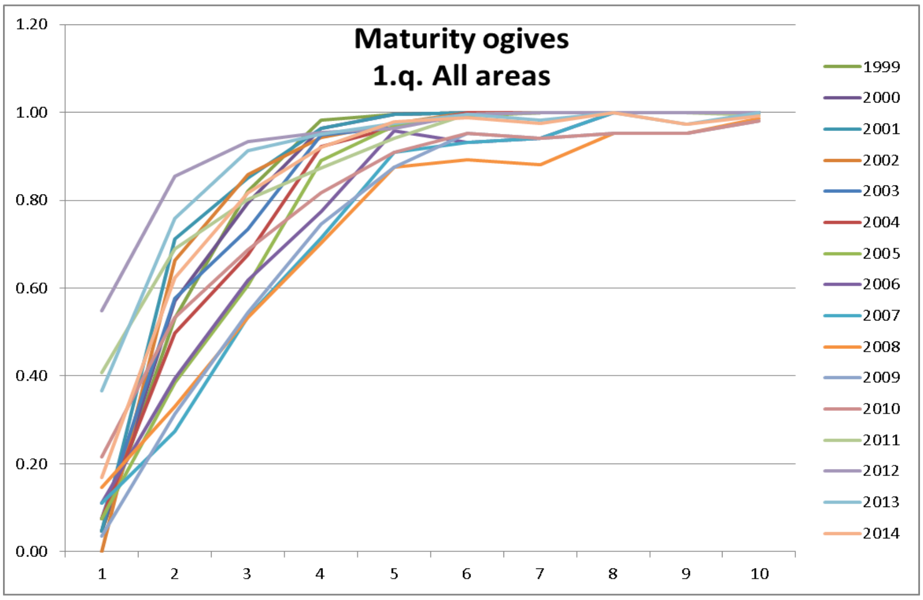


Figure 10.1.13. Maturity ogives by year

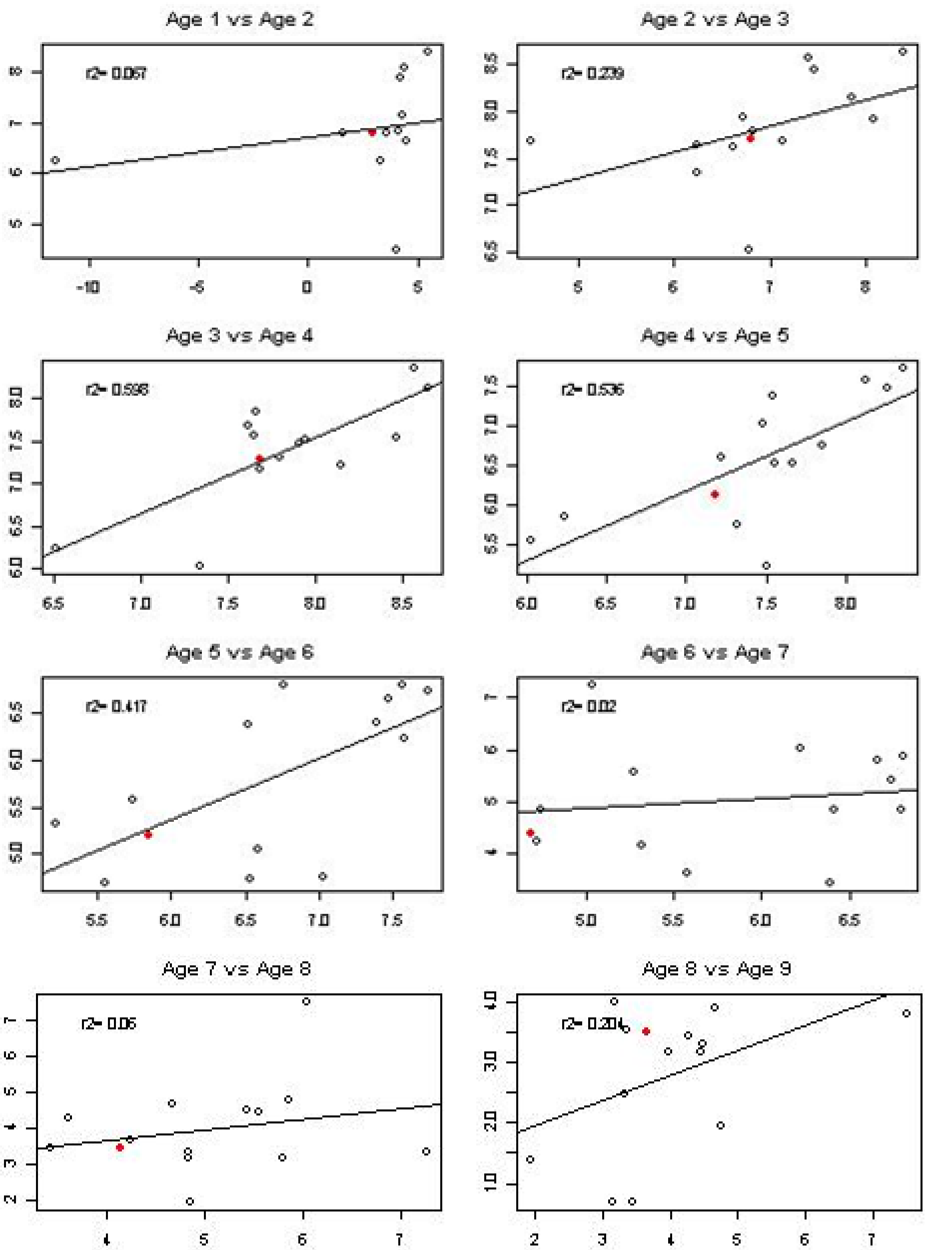


Figure 10.1.14. Internal consistency plot for catch matrix.

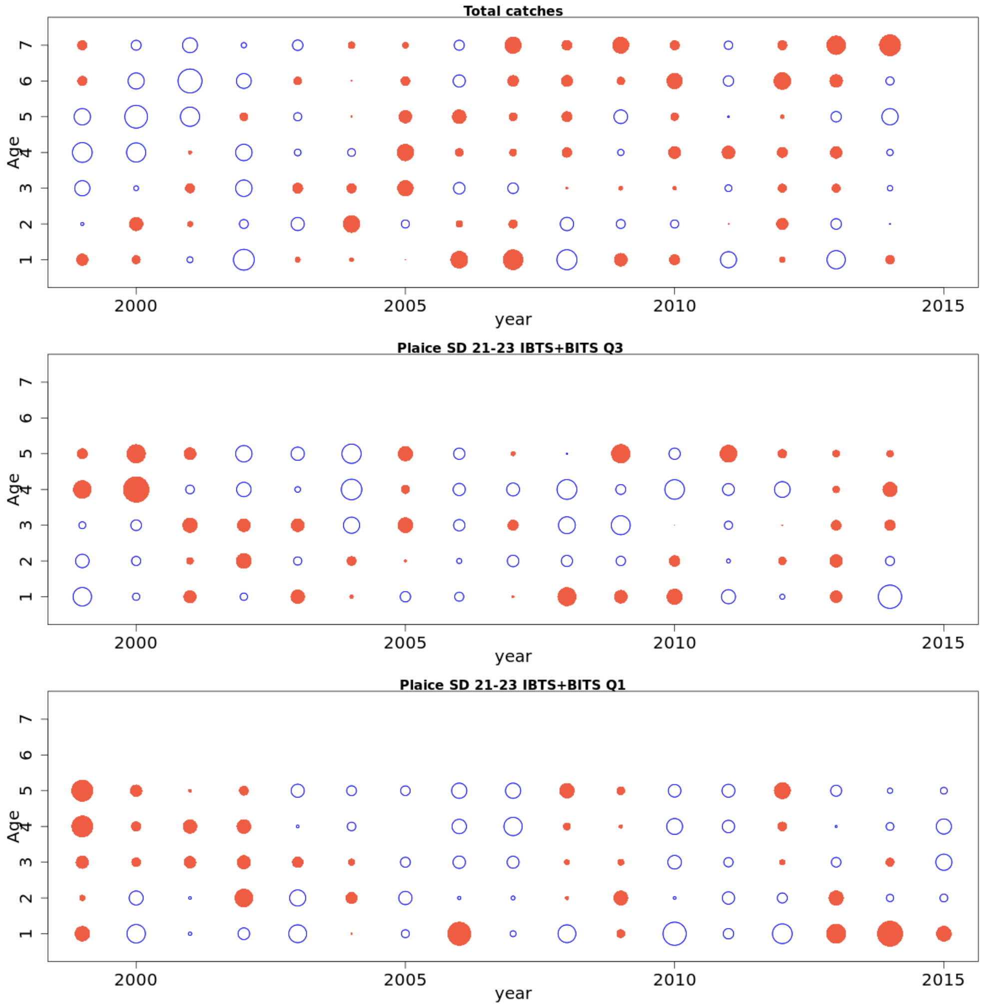


Figure 10.1.15. Residual pattern in total catches and surveys for the SAM run.

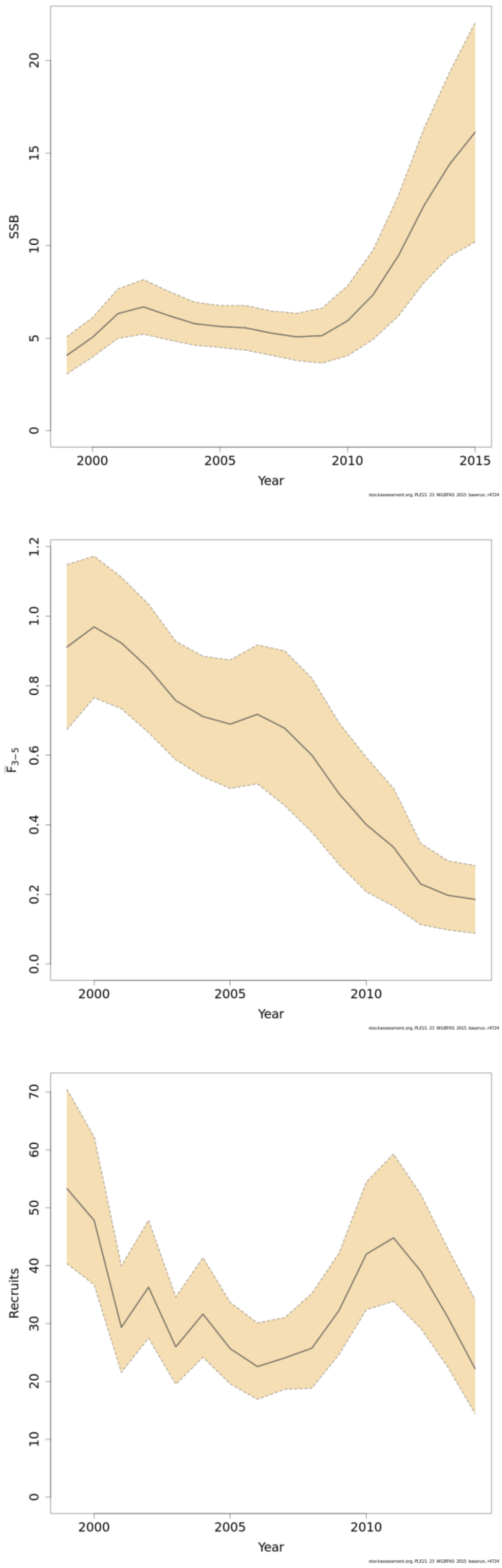


Figure 10.1.16. Final SAM summary plots (Spawning Stock Biomass (SSB), F_{bar}, and recruitment).

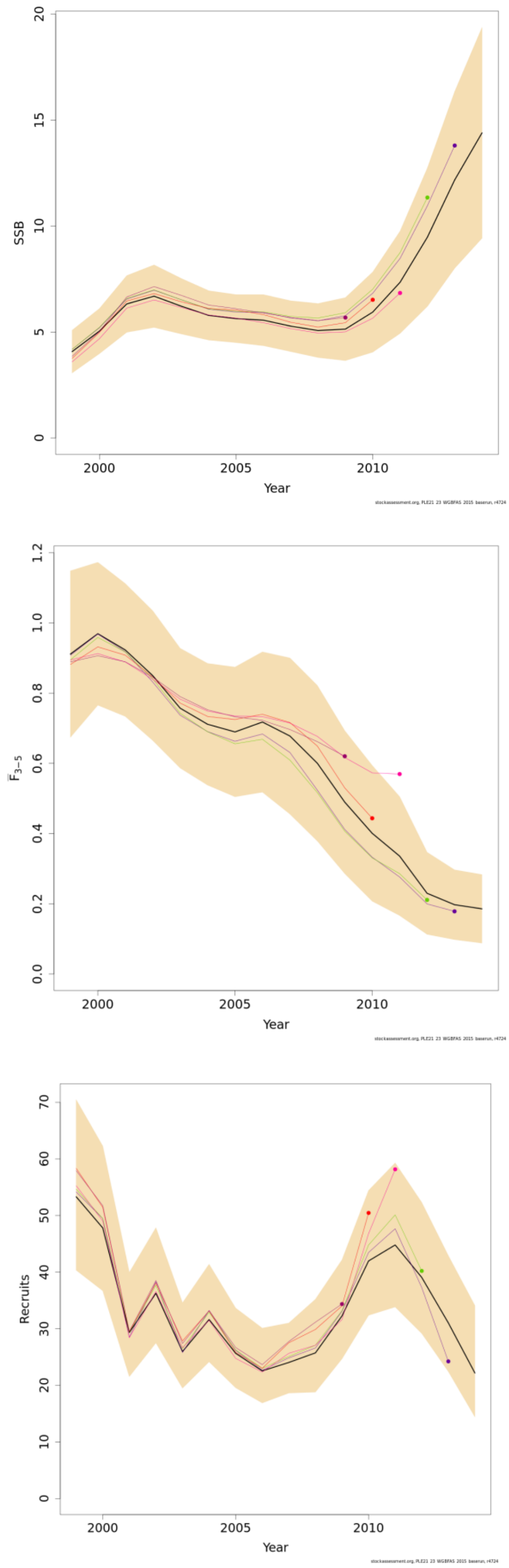


Figure 10.1.17. The results of the retrospective analysis showing the SSB, the F(3–5) and the recruitment.

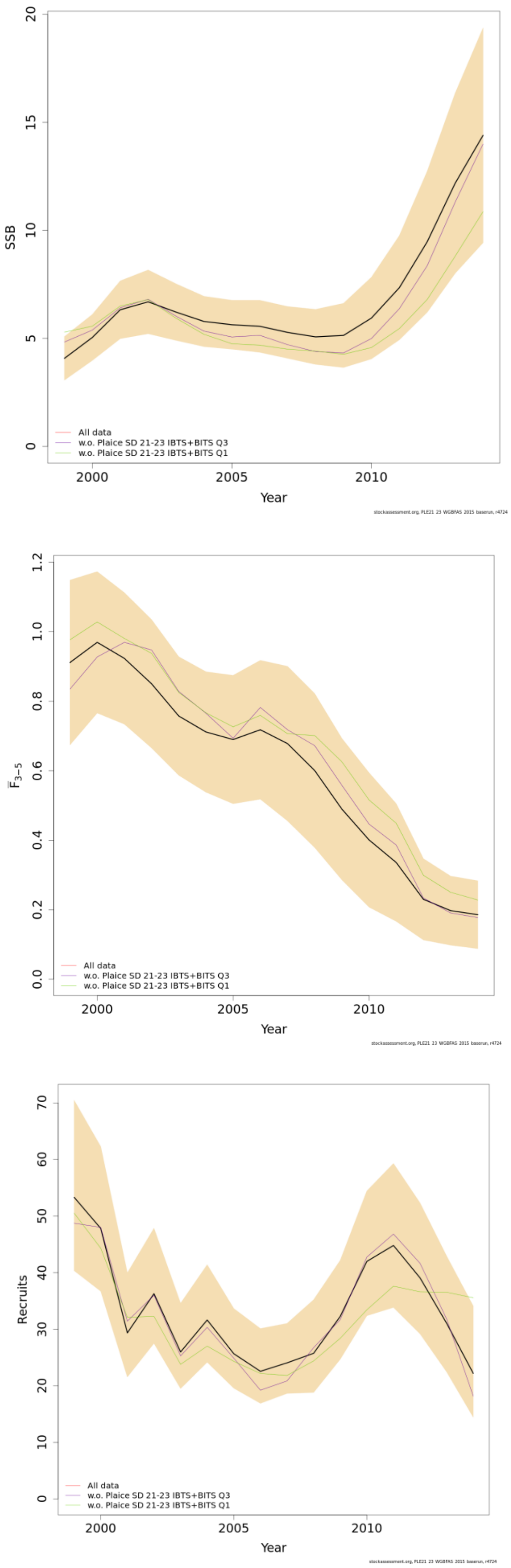


Figure 10.1.18. The results of the "Leave one out analysis.

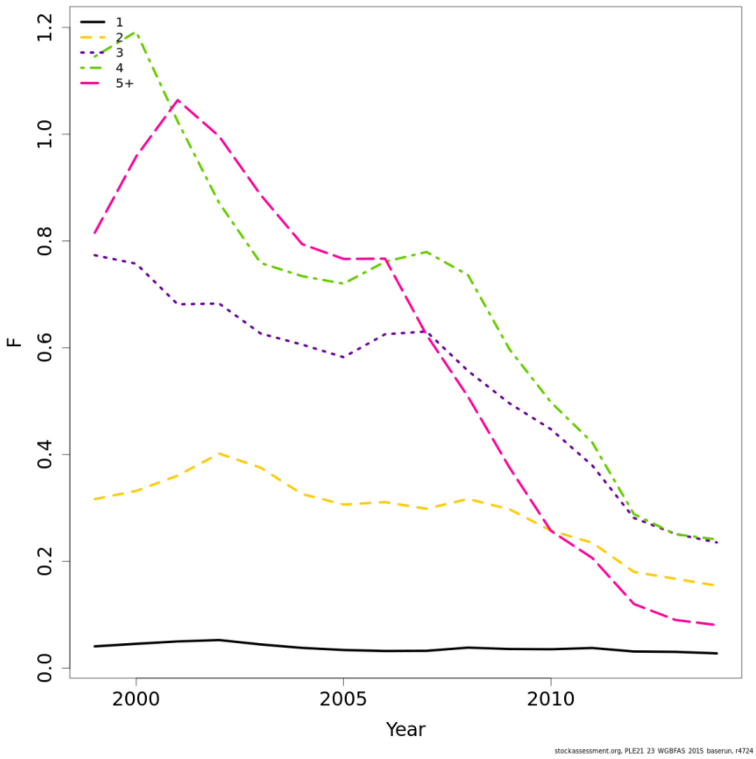


Figure 10.1.19. F by age for the SAM run.

8.2 Plaice in Subdivisions 24–32 (PLE-2432)

8.2.1 General stock information

8.2.1.1 Biology

Distribution of plaice in the Baltic Sea extends eastwards to the Gulf of Gdansk and northwards to the Gotland area, but it is also found sporadically farther north (Figure 8.2.10). The distribution of this species is dependent on salinity.

Based on information on biology and fishery of plaice ICES decided that the plaice from Subdivisions 22 (the Belts) and 23 (the Sound), which were previously assumed to be part of the Baltic Sea stock, should be considered a separate stock unit together with Subdivision 21 (Kattegat) (ICES, 2012a).

With respect to salinity requirements, opportunities for successful spawning of plaice exist regularly in the Arkona basin (SD 24) and the Bornholm basin (SD 25) but occasionally also in the Gdansk and Gotland basins (SD 26 and SD 28; Nissling *et al.*, 2002). Nursery areas are located in shallow waters down to 10 m depth.

Plaice spawn in February–March in the basins.

8.2.1.2 Benchmark 2015 (WKPLE)

The plaice stocks of the Baltic Sea were benchmarked in the beginning of 2015. The stock entity of plaice in Subdivisions 21—23 and in Subdivisions 24—32 is less well defined and available studies are inconclusive. WKPLE reviewed arguments to include 21—23 and 24—32 in one stock and had not sufficient arguments to suggest a deviation from the present perception of two stocks, the Kattegat-Belt stock (SD21—23) and the Baltic stock (SD24-32). Examination of a combined 21—23 and 24—32 assessment was initiated but further work is required.

8.2.1.3 The fishery

The landing data of plaice in the Eastern Baltic (PLE-2432) according to ICES Subdivisions and countries are presented in Tables 8.2.1a (overview) and 8.2.1b 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 are shown in Figure 8.2.11 and Figure 8.2.12 Plaice and dab have the greatest proportions of the total landings of flatfish when excluding flounder.

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. 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 decreased to 748t in 2011, slightly increased in 2012 to around 848 tons and decreased to 543 tons in 2014.

Plaice are caught by trawlers and gillnetters mostly. The minimum landing size is 27 cm in 2014, active gears provide most of the landings in SD 24 (ca. 65%) and SD 25 (ca.

77%), whereas landings from passive gears are low. However, in SD 26, passive gears provided 76% of total plaice landings in 2014.

8.2.1.4 Discard

Discard in the commercial fisheries can 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. In 2014, no discard-data from the commercial fisheries of Finland, and Russia were uploaded to InterCatch (although those 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.

8.2.2 Data available

The sampling for the Eastern plaice stock (PLE-2432) concentrates on SD24 and SD25 where >99% of catches (Landings and Discards) are taken. Beside length measurements, the individual weight, maturity, age and length of plaice is recorded both in commercial fishery samples and scientific surveys. The main countries involved in the biological sampling are Denmark, Poland and Germany. All three countries sample biological information; Sweden only samples length distributions (No Swedish sampling data were used during the analyses and assessment, since no usable data format was submitted or uploaded to InterCatch).

Plaice was benchmarked in 2015; WKPLE decided that both discard estimations and biological data are not sufficient to classify PLE-2432 as a category 1 stock (i.e. analytical assessment with a forecast). Different exploratory assessments (SAM, SURBA) suggest however that a category 3 assessment, using trends in SSB is acceptable for this stock.

8.2.2.1 Catch

The annual landings used by the Working Group, available since 1972, are given by Sub-Division and country separately in Table 8.2.5. Detailed landings and discards for 2014 are given in table 8.1.1.a and b. 65% of the landings were taken by Denmark in 2014 table 8.2.1b.

Plaice is mainly caught in SD24 and SD25. Both subdivisions account for more than 99% of the landings. However, discards also appear where no landings took place, esp. in SD25 many strata in active and passive fisheries have no landings attached. However, fisheries took place suggesting that 100% discard appeared. Recent years show a better covering in reported discards (Figure 8.2.1). Misreporting happened in all landing countries in the past. Before 2004, Polish landings were reported as "flatfish", in a mix with flounder and dab. Also in other countries misreporting was observed in the past, where flounder and dab were landed as plaice and even cod was landed as flatfish (due to quota limitations in the 70's). No reliable data on the quantity of those misreporting are available. The landings by subdivision are plotted in figure 8.2.1 and by SD and country in Figure. 8.2.2a-c. Landings at age are presented on Figure 8.2.3.

The sampling coverage is given in table 8.2.4. Discard and landings (2014) by gear type and quarter is given in table 8.2.1a.

Landings and discard (2014) by subdivision, country and quarter is given in table 8.2.1b.

No discard time series were available for the WG. Discard information for 2002 to 2014 were available from the benchmark (WKPLE 2015) but this was inconsistent with the discard information existing for 2012 and 2013 as they were calculated differently. After the benchmark, discard data is included in the assessment, however, given the poor coverage of discards estimations, only to give advice based on SSB trends.

Landings and discards at age were raised using ICES InterCatch database. The limited extrapolation options in IC do not allow a borrowing of discard ratios to strata with zero landings. This results in an underestimation of discards, since only strata with either a landings attached or strata with provided discard estimations (this includes zero-landings) can be used in the processing.

8.2.2.2 Catch, effort and research vessel data

Only scientific tuning fleets are used. Data from two surveys are available.

The data of the Baltic International Trawl Survey (BITS) from 2001 onwards were used to evaluate the current stock structure of Baltic plaice. Since 2001 standardized gear types TV3 #930 (TVL) and TV3 #520 (TVS) have been used by all countries which participate in the BITS. Survey-CPUE from 2000 and backwards can’t be compared directly, although the difference in catchability between the gear types is quite small. The positions of the hauls have been allocated based on a standard method since 2002. The allocation of the stations by ICES subdivision and depth layer is dependent on the area of the depth layers and the 5-years running mean of the density of cod age group 1+ in quarter 1 (ICES 2008 / WGBIFS) because cod is more important for the commercial use.

The procedures for analyzing the hauls are given in the BITS manual (ICES, 2014: WGBIFS). The data are uploaded to the ICES database DATRAS where the source data and different catch per hour estimates by length and age are provided.

8.2.2.3 Weight at age

Weight at age in landings is presented in Table 8.1.3.Mean weight in stock is obtained from BITS surveys.

8.2.2.4 Maturity and natural mortality

Natural mortality is assumed constant for all years and is set at 0.2 for age 1 and 0.1 for all remaining ages.

The maturity ogive was calculated from BITS data and uses a fixed value per age based on a 2008—2014 average. This is different from the benchmark in 2015 (WKPLE), where these values were yet not available. During WKPLE, the average maturity ogive of PLE-2123 was used.

8.2.2.5 Catch, effort and research vessel data

Catch per unit of effort (number/hour, see Figure 8.2.15.) of fish ≥ 20 cm from Q1 and Q4 BITS survey was calculated, using ICES DATRAS database. Averages from all (incl. 0 catch) daytime hauls were weighted by depth stratum area. Both 1st and 4th quarter surveys are aggregated into one index value for a given year (Figure 8.2.1). Only values from SD25 to SD26 were used for the index calculation. SD27+ does not provide enough hauls to give representative values.

8.2.2.6 Tuning fleet

No commercial tuning fleet is at present used for plaice in SD 24—32. A survey-based index is used as a fishery-independent tuning fleet for the assessment. Catch per unit of effort (number/hour, see Figure 8.2.15.) of fish ≥ 20 cm from Q1 and Q4 BITS survey was calculated, using ICES DATRAS database. Averages from all (incl. 0 catch) day-time hauls were weighted by depth stratum area. Both 1st and 4th quarter surveys are aggregated into one index value for a given year (Figure 8.2.15). Age-based CPUE-values are only given in strata where a respective age sampling took place. To evaluate the influence of these missing strata, the index was calculated based on lengths and ages. Although the index varies slightly, the difference is negligible for the latest years (on which the trend-based advice is given), WGBFAS decided to keep the age-based index values, but recommends WGBIFS to develop standardized routines to transform the length values into ages (uses e.g. an age-length-key). For SAM, the Q1 survey in 2005 has been excluded, since no age-based data were available.

8.2.2.7 Effort

Two time series for commercial effort were available for the plaice stock in SD24-32. The first time series from 2009 to 2014 was available from ICES WGBFAS data call where countries submitted flatfish effort data. Effort from 2014 back to 2009 was calculated as Days-at- Sea (provided by national data-submitter either by fleet or by stock). Due to different calculations-methods and aggregations, the effort data were not comparable directly. It was discussed that in the future more specific description about methodology should be given.

To compare effort data, a standardisation and weighting factor was applied for submitted effort data to calculate a common effort index for whole stock. In a first step, national data were standardised using the proportion for a given year from the national average of the whole time-period. Standardised effort data were weighted by cod landings for every country and year. A Final effort for the stock was calculated by summing all standardized national effort-data (Figure 8.2.14).

The second time series was taken from STECF-Report 2014 and shows trends in nominal effort by gear types for the period 2004—2013 (calculated as kW × days-at-sea). Data from Poland, Latvia (discard only), and Lithuania (discard only) are only available from 2004 onwards. Therefore, effort trends are shown from 2004 to 2014 Additionally, Estonian data from 2005 to 2012 (including substantial pelagic effort) was included (Figure 8.2.13).

Both datasets show no major increase or decrease in effort for the last years

8.2.3 Data analyses

Sampling intensity increased in recent years. However, the coverage is still scattered and not all samples show a data quality that allows direct use or reasonable borrowing (for “hole-filling” of unsampled strata). Data borrowing among strata took place in 2011 and 2012 for Danish data, the original stratum is not known.

The estimation of discard was often done based on just one trip in the respective stratum (e.g. I Swedish data, which was given by the data submitter in the comment section of IC), leading to a high grade of unreliability, since discards differ even between hauls.

Overall, the sampling coverage is poor, esp. in the years 2002 to 2005. The following years show an increasing coverage in age-samples and length-distribution in both landed and discarded fractions. But still, 50—70% of the strata is not sampled or lack reliable/usable data. PLE-2432 is still categorized as a data limited stock (DLS).

8.2.3.1 Catch-at-age matrix

A catch-at-age matrix is available for the years 2002 to 2014, based on commercial catches (Table 8.2.2).

8.2.3.2 Catch curve cohort trends

The internal consistency plots (Figure 8.2.6) indicate a more or less good consistency between age group both in surveys and commercial catches.

8.2.3.3 Tuning series

The internal consistency for the 1st quarter BITS (Figure 8.2.2a) shows good internal consistency, although it is lower between age groups 1 and 2. The 4th quarter (Figure 8.2.2b) snows also a good internal consistency. Both surveys show increased abundance of all age classes.

8.2.3.4 Exploratory SAM

No exploratory SAM run was made

8.2.3.5 Final assessment

The stock is categorized as a Category 3.1 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 2016. 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 quite good (Figure 8.2.7a–c), although the SSB shows a consistent overestimation. The F looks good, while the recruitment is poorly estimated. The "leave one out" analysis (Figure 8.2.8a–c) shows that the BITS Q1 has no significance for the assessment. The F by age group is shown in Figure 8.2.9. The final summary plots (F_{bar}, Spawning Stock Biomass (SSB) and recruitment) for the SAM run are shown in Figure 8.2.6a-c. The summary output from the SAM is shown in table 8.2.4

8.2.3.6 Historic Stock Trends

Before the benchmark in 2015, trends in the stock were evaluated by survey-indices only. The survey indices are shown in Figure 8.2.15. See table 8.2.5 under "Description of the fishery" for historical trend details.

8.2.3.7 Recruitment estimates

The recruitment was estimated as a result of the SAM run. The recruitment in 2014 has increased from little under 18 670 in 2013 to around 22 720 in 2014 (Figure 8.1.9.?).

8.2.3.8 Short-term forecasts

Not performed

8.2.3.9 Medium-term forecasts

None

8.2.3.10 Biological reference point

	ICES considers that:	ICES proposed that:
Precautionary Approach reference points	N/A.	N/A..
	N/A.	N/A.
Target reference points		N/A.
Fmsy		

8.2.3.11 ICES Advice

This stock was benchmarked in 2015 (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 catch for the adviceeis calculated as average SSB of 2 most resent years (2013—2014) divided with SSB average of the preceding three years (2010—2012) - this estimate gives an increase of 31.3%. Uncertainty cap is applied as the calculated trend exceeds the limit of 20% changes.

F_{SQ} is estimated to 0.56 over the period of 2010 to 2014. No F_{MSY} is available for the stock

However, a decreasing trend in total landings (and catch) appeared in the last three years. Advice will be then given based on the catch of the last year (2014). Advised catches for 2016 is 1218 tons based on the total catch and average discard ratio of the last year (2014).

8.2.4 Executive summary WKPLE (2015)

Small and dispersed landings of plaice in the Baltic (Subdivision 24—32) prevent proper sampling and result in a noisy catch-at-age matrix. In addition high and variable discard rates from fisheries targeting other species in the Baltic, i.e. discards without any landings, impeded accurate discard estimates in the Baltic. Basis for stock status continues therefore to be surveys conducted in 1st and 4th quarter. SAM modeling with the surveys provides SSB estimates with high uncertainty but acceptable for a trend based assessment. The computed SSB is considered for use in an indicative assessment with DLS approach to base advice upon. Future research should consider methods to improve discard estimates to deal with discards with zero landings. Also landings estimates should be refined to ensure plaice and no other species are included. Given the relative lack of stock id studies for this area continued work should explore stock structure and potential for a combined 21—23 and 24—31 assessment. Considering the large proportion of discards and small landings more flexible modeling platforms should be evaluated to deal with size-based discards and variable observations errors over time.

8.2.5 Future Research and data requirements

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.

Table 8.2.1.a Discard (kg) and landings (kg) in 2014 by gear type and quarter.

CATON	Fleet	Season				Total
		1	2	3	4	
Landings	Active	163.1	20.6	36.0	194.4	414.2
	Passive	7.9	23.2	63.7	25.0	119.8
Discards	Active	213.6	15.4	57.7	96.4	383.0
	Passive	45.5	30.6	14.0	7.5	97.7
Total		430.1	89.8	171.4	323.3	1014.7

Table 8.2.1.b Landings (kg) and discard (kg) in 2014 by Subdivision, catch category, country and quarter. Only countries having a TAC are shown in the overview

			Quarter				
Area	Country	Category	1	2	3	4	sum
BAL24	Denmark	Landings	76.6	21.0	48.4	85.0	231.1
		Discards	24.2	19.3	14.5	39.6	97.6
	Finland	Landings			0.0		0.0
		Discards			0.0		0.0
	Germany	Landings	20.2	7.1	6.7	23.0	57.1
		Discards	1.4	0.6	27.9	16.1	45.9
	Poland	Landings	3.1	1.1	13.2	4.7	22.1
		Discards	2.8	1.0	0.6	3.7	8.1
	Sweden	Landings	4.4	3.0	11.8	1.4	20.6
		Discards	72.9	4.3	21.0	1.4	99.6
BAL25	Denmark	Landings	53.9	1.6	0.9	61.5	117.9
		Discards	17.4	10.0	0.4	15.8	43.7
	Germany	Landings	0.2	0.1			0.4
		Discards	0.9	0.1			1.0
	Poland	Landings	9.6	7.7	11.1	29.9	58.3
		Discards	56.9	0.0	0.4	13.3	70.6
	Sweden	Landings	2.9	1.6	4.1	10.8	19.4
		Discards	81.9	9.6	2.8	8.3	102.7
BAL26	Poland	Landings	0.0	0.5	3.1	3.0	6.6
		Discards	0.7	0.6	3.7	3.0	8.0
	Sweden	Landings	0.1	0.0	0.0	0.0	0.1
		Discards	0.0	0.4		2.5	3.0
total			430.1	89.8	171.4	323.3	1014.7

Table 8.2.2. catch-at-age matrix (thousands) 2002 to 2014.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
2002	152.771	2025.684	740.724	113.751	28.151	9.526	0	0	0	0
2003	48.060	497.099	1634.208	390.094	64.082	8.057	2.578	0.204	0	0
2004	85.824	825.636	1347.470	520.537	68.882	4.347	25.921	0.471	0.825	0.825
2005	117.304	2395.448	535.113	120.710	30.068	18.362	4.392	1.177	0.219	0.847
2006	12.901	1030.440	3226.075	1379.674	343.499	116.384	11.560	5.332	0	0
2007	21.244	761.251	2291.605	1855.480	739.236	250.973	37.743	39.790	13.169	2.802
2008	40.041	931.405	1123.775	886.188	813.630	381.224	352.206	49.848	3.835	0
2009	60.793	558.623	2386.402	2005.055	547.639	184.972	71.650	30.816	7.568	1.173
2010	167.065	1537.441	2235.921	1655.109	443.950	187.069	65.022	12.733	9.647	1.325
2011	242.138	4201.886	3413.112	791.570	279.725	112.602	55.088	13.701	7.138	1.172
2012	312.313	3588.937	2927.913	447.810	180.998	88.087	64.995	33.322	2.649	3.248
2013	19.424	1044.114	3243.325	1148.306	341.830	116.569	65.697	29.779	29.182	16.934
2014	23.286	922.849	461.913	391.247	148.414	30.844	17.704	9.080	6.460	8.350

Table 8.2.3. Mean weight (kg) in landings by age 2002 to 2014.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+
2002	0.201	0.247	0.268	0.372	0.614	0.994	0	0	0	0
2003	0.242	0.275	0.309	0.36	0.618	0.709	0.789	1.04	0	0
2004	0.118	0.206	0.267	0.448	0.571	0.604	0.375	0.574	1.084	1.558
2005	0.116	0.229	0.325	0.387	0.529	0.505	0.619	0.886	1.3	1.229
2006	0.079	0.187	0.245	0.331	0.493	0.849	0.88	1.223	0	0
2007	0.059	0.142	0.229	0.338	0.492	0.67	0.899	0.927	0.906	0.97
2008	0.075	0.164	0.194	0.255	0.354	0.497	0.45	0.457	0.819	0
2009	0.113	0.139	0.198	0.272	0.394	0.569	0.659	0.677	0.898	0.992
2010	0.117	0.158	0.249	0.312	0.401	0.574	0.597	0.835	1.027	0.745
2011	0.118	0.175	0.241	0.338	0.457	0.534	0.555	0.789	0.732	0.887
2012	0.133	0.179	0.26	0.344	0.45	0.542	0.686	0.653	0.67	0.92
2013	0.124	0.229	0.271	0.356	0.437	0.547	0.685	0.598	0.766	0.906
2014	0.098	0.134	0.236	0.271	0.367	0.488	0.700	0.762	0.949	1.076

Table 8.2.4. SAM. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35)

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
2002	4387	2255	8536	2248	1415	3572	709	410	1226	0.847	0.587	1.222
2003	6689	3761	11897	2555	1720	3795	692	467	1027	0.854	0.592	1.231
2004	9513	5129	17643	3562	2381	5329	891	593	1339	0.759	0.590	0.976
2005	6616	3725	11752	4140	2848	6019	1408	971	2041	0.667	0.517	0.861
2006	3478	1611	7511	3882	2734	5510	1725	1223	2434	0.641	0.493	0.833
2007	2623	995	6913	3338	2340	4762	1677	1220	2305	0.625	0.482	0.812
2008	3508	1655	7434	3257	2327	4560	1591	1181	2145	0.607	0.465	0.793
2009	8676	4732	15908	4287	3073	5981	1684	1233	2301	0.611	0.474	0.789
2010	19807	9976	39325	6793	4393	10503	1847	1356	2516	0.627	0.489	0.804
2011	22675	11450	44904	9686	6052	15500	2743	1860	4046	0.639	0.490	0.835
2012	16450	8691	31138	9969	6660	14921	3450	2364	5034	0.632	0.470	0.849
2013	18672	9761	35721	9406	6318	14003	3287	2277	4745	0.619	0.444	0.863
2014	22720	10520	49067	11432	7171	18226	3748	2536	5538	0.592	0.403	0.870
2015							4834	2906	8043			

Table 8.2.5 Plaice in the Baltic Sea: total landings (tons) by ICES Sub-division and country.

Year/SD	Denmark			Germ. Dem. Rep.[1]	Germany, FRG		Poland		Sweden[2]						Finland		
	24(+25)	25	26+27	24	24(+25)	28	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			1'198	3		633	290	32								
1979	2'027			1'604	7		555	224	113								
1980	1'652			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	1'019			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	1	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[3]	153	159	0		146		429	3	10	15							
2003	326	299	2		96		480	10	16	51		0	0				
2004	167	239			65		292	8	6	37							
2005	164	241			108		511	11	16	28		0	0				
2006	82	632			185		52	3	17	41			0				
2007	408	490	0		157				41	61		0	0				
2008	450	339			159		29	0	45	69			0				
2009	581	359	0		120		42	0	43	79		0					
2010	345	295	1		78		93	8	22	61	1	0					
2011	291	233			115		37	1	33	36	0	0			1	0	0
2012	477	148	0		89	0	62	2	23	43	1	0			2	1	0
2013	382	196	0		47	0	45	5	29	33	0	0			1		
2014	231	118	0		57		80	7	21	19	0	0	0	0	0		

[1] From October-December 1990 landings of Germany, Fed. Rep. are included.

[2] For the years 1970-1981 and 1990 the Swedish catches of Sub-divisions 25-28 are included in Sub-division 24.

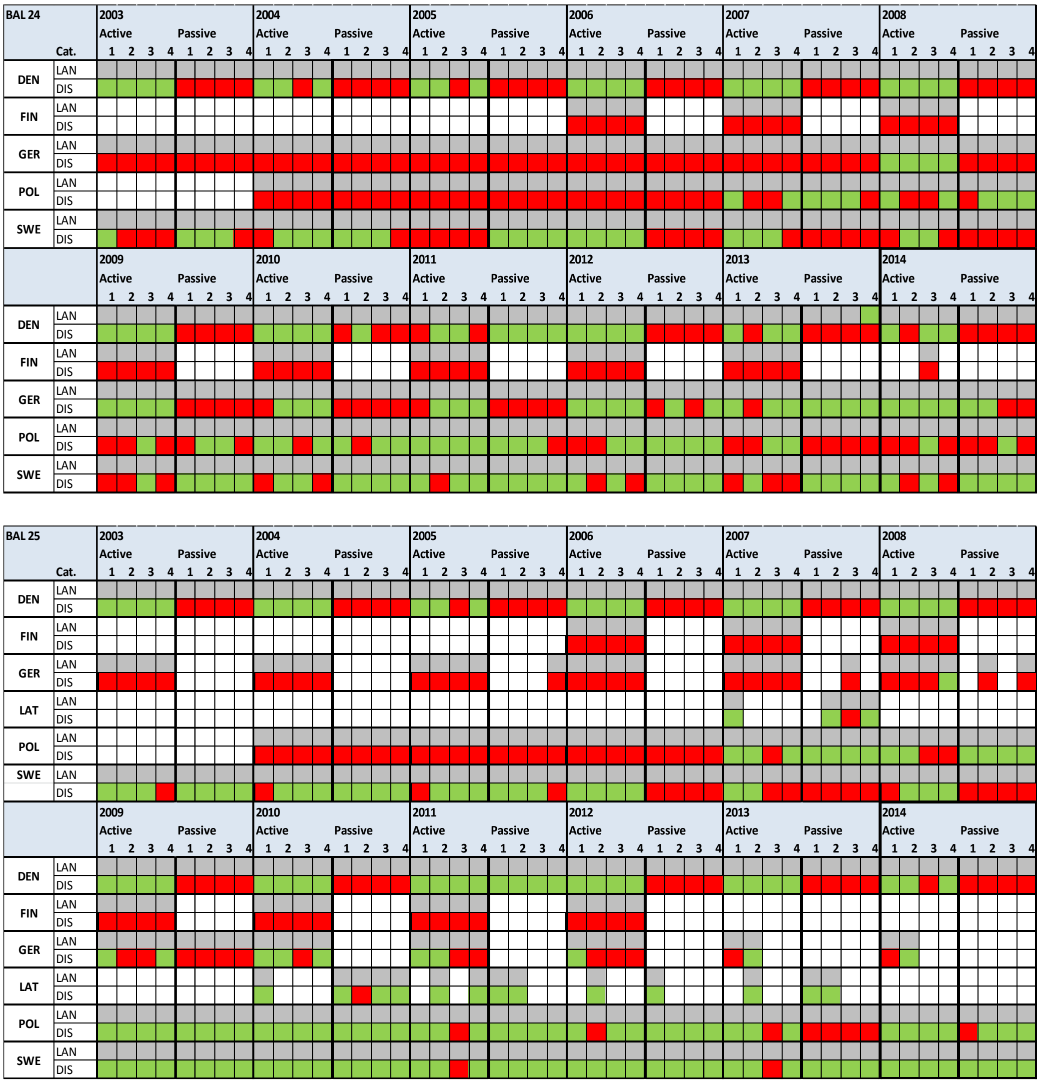
[3] Danish catches in 2002 in SW Baltic were separated according to Sub-divisions 24 and 25

Table 8.2.5, continued

Year	Total by SD						Total
	24[1]	25	26	27	28	29	SD 24-29
1970	659						659
1971	423						423
1972	370						370
1973	323	174	30				527
1974	198	114	86				398
1975	297	158	142				597
1976	307	164	76				547
1977	300	265	26				591
1978	1'914	633	290				2'837
1979	3'751	555	224				4'530
1980	2'073	383	53				2'509
1981	1'138	239	27				1'404
1982	464	49	64	7	1		585
1983	456	84	12	24	2		578
1984	199	109		4	1		313
1985	1'429	123	49	5	1		1'607
1986	1'446	178	59	9	1		1'693
1987	1'020	198	5	12	1		1'236
1988	389	16	1	9	1		416
1989	188	15		6	1		210
1990	152	6					158
1991	126	4	1	2			133
1992	81	7		1			89
1993	76	4					80
1994	163	50	4				217
1995	447	243	3		1		694
1996	368	206	15	1			590
1997	264	316	3	1			584
1998	325	118	14	1			458
1999	234	155	1				390
2000	207	420	3				630
2001	225	562	3				790
2002	309	603	3				915
2003	438	830	13	0	0		1'281
2004	289	781	11	0	0		1'081
2005	289	781	11	0	0		1'081
2006	284	725	3				1'012
2007	617	550	0	0	0		1'167
2008	665	437	0		0		1'102
2009	744	481	0	0			1'226
2010	473	420	9	0			903
2011	437	309	1	0			748
2012	609	236	3	0			848
2013	459	274	5	0			738
2014	309	217	7	0			534

[1] For the years 1970-1981 and 1990 catches of Sub-divisions 25-28 are included in Sub-division 24.

[2] Danish catches in 2002 in SW Baltic were separated according to Sub-divisions 24 and 25



no fishing effort, hence no plaice catches

commercial landings (incl. "zero landings" as reported by data submitter)

discard weight provided by Data submitter

no discard weight provided (strata to be filled)

Figure 8.2.1: Overview of discards estimations per SD, country, fleet and year

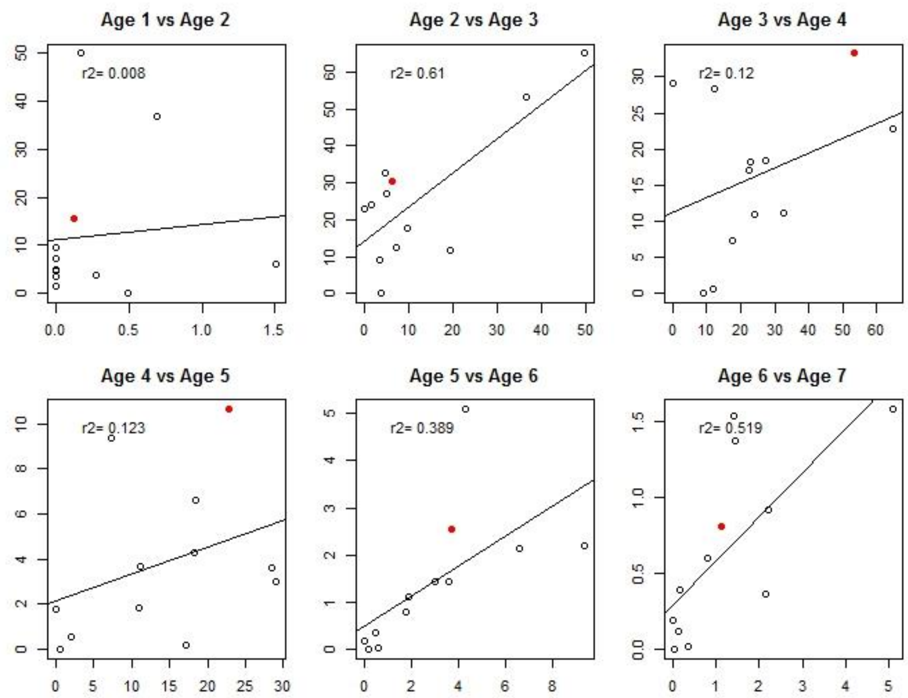


Figure 8.2.2a. Internal consistency of BITS 1st quarter.

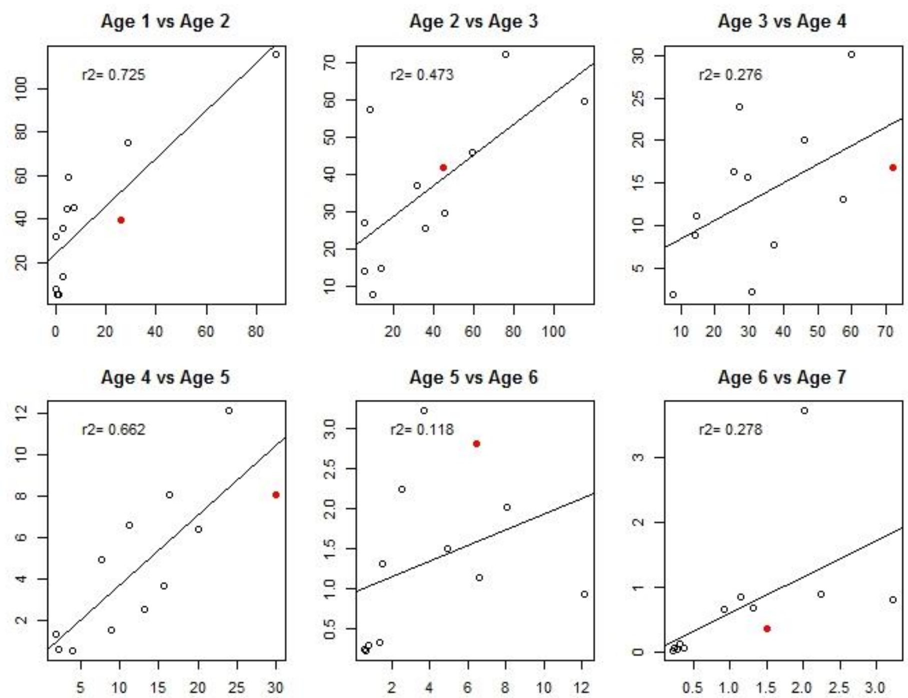


Figure 8.2.2b. Internal consistency of BITS 4th quarter.

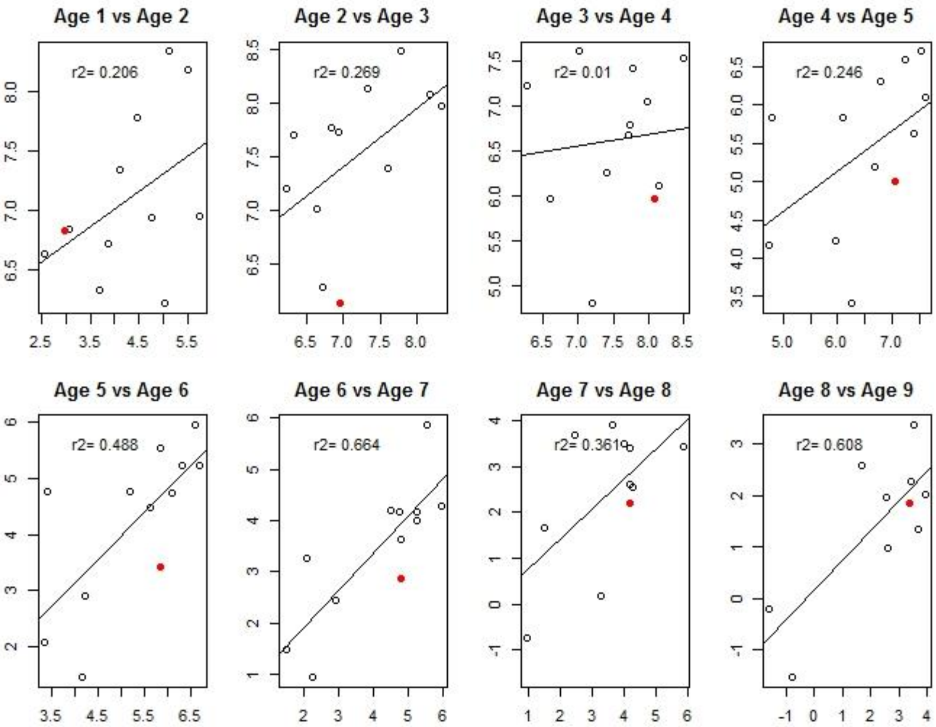
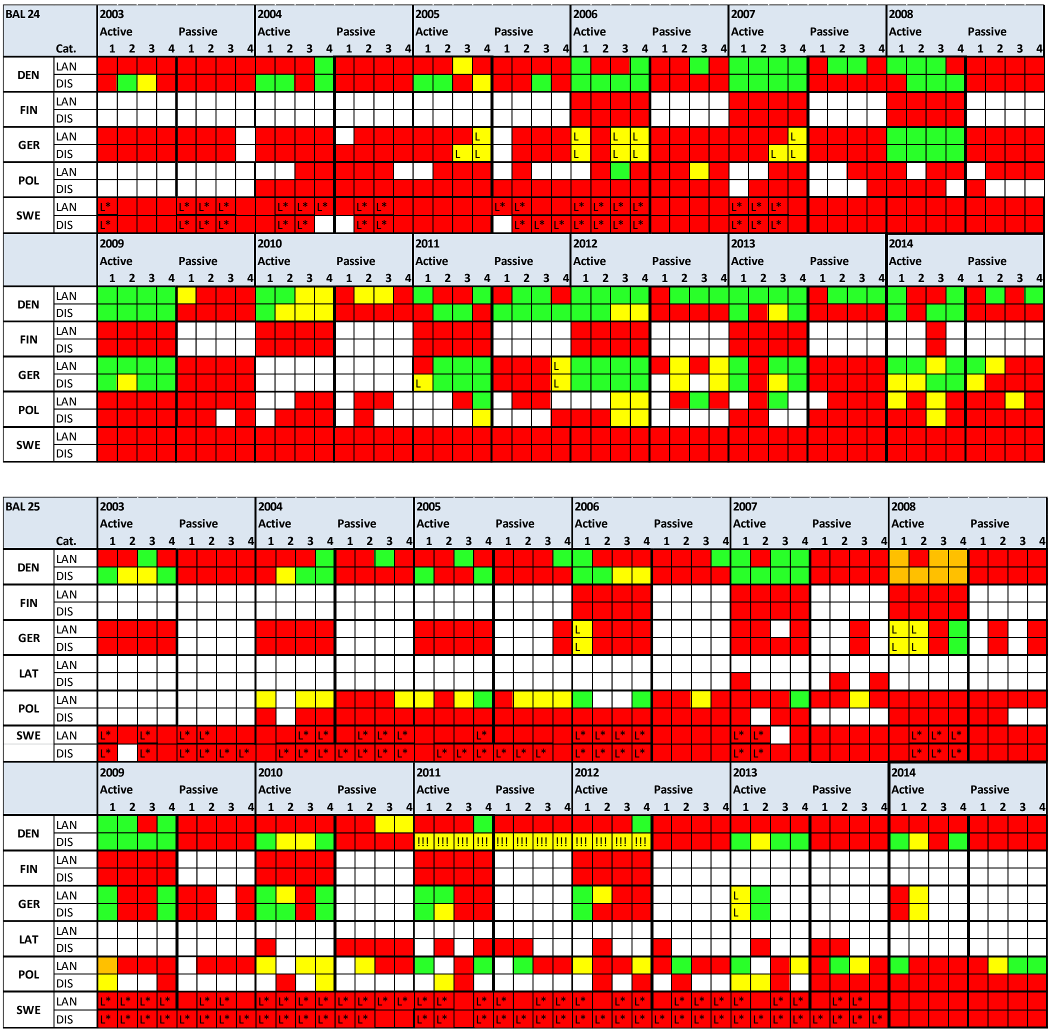


Figure 8.2.3. Internal consistency plot for catch matrix.



sufficient age data (min 20 ages)

unsufficient age data (<20) or only length data (marked by "L" in the cell)

unsampled landings/discards

L* accounts for Swedish data, where a low number of fish was measured per stratum. Additionally, raising took place but on an unknown data basis

L only Length data were taken

!!! = Copy/paste of datasets across SD and gears

Figure 8.2.4 Sampling intensity for biological sampling (Age readings and single fish data) per country, SD, geartype and years for all strata, where a fishery took place

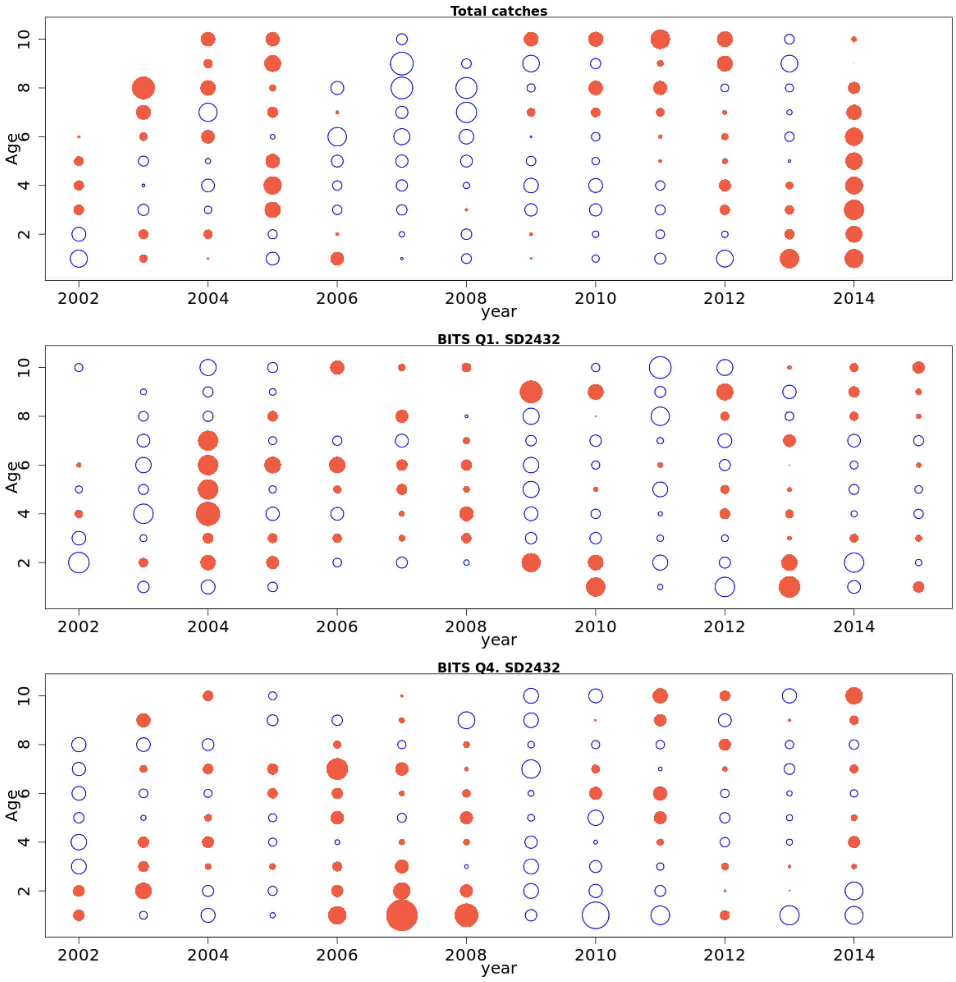


Figure 8.2.5. Residual pattern in total catches and surveys for the final SAM run.

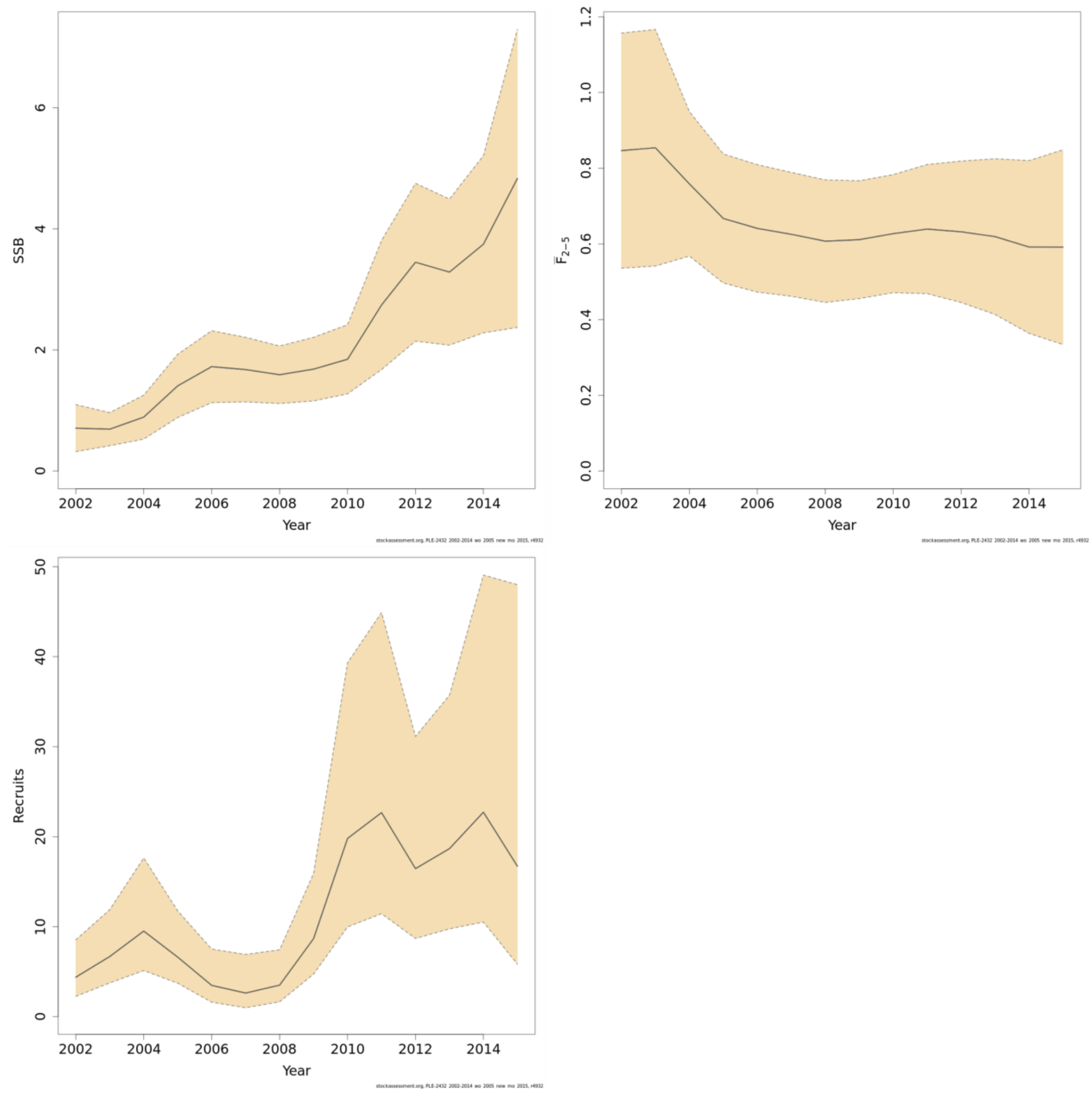


Figure 8.2.6a–c. The results of the final SAM run showing the SSB (a), the F(3–5) (b) and the recruitment (c).

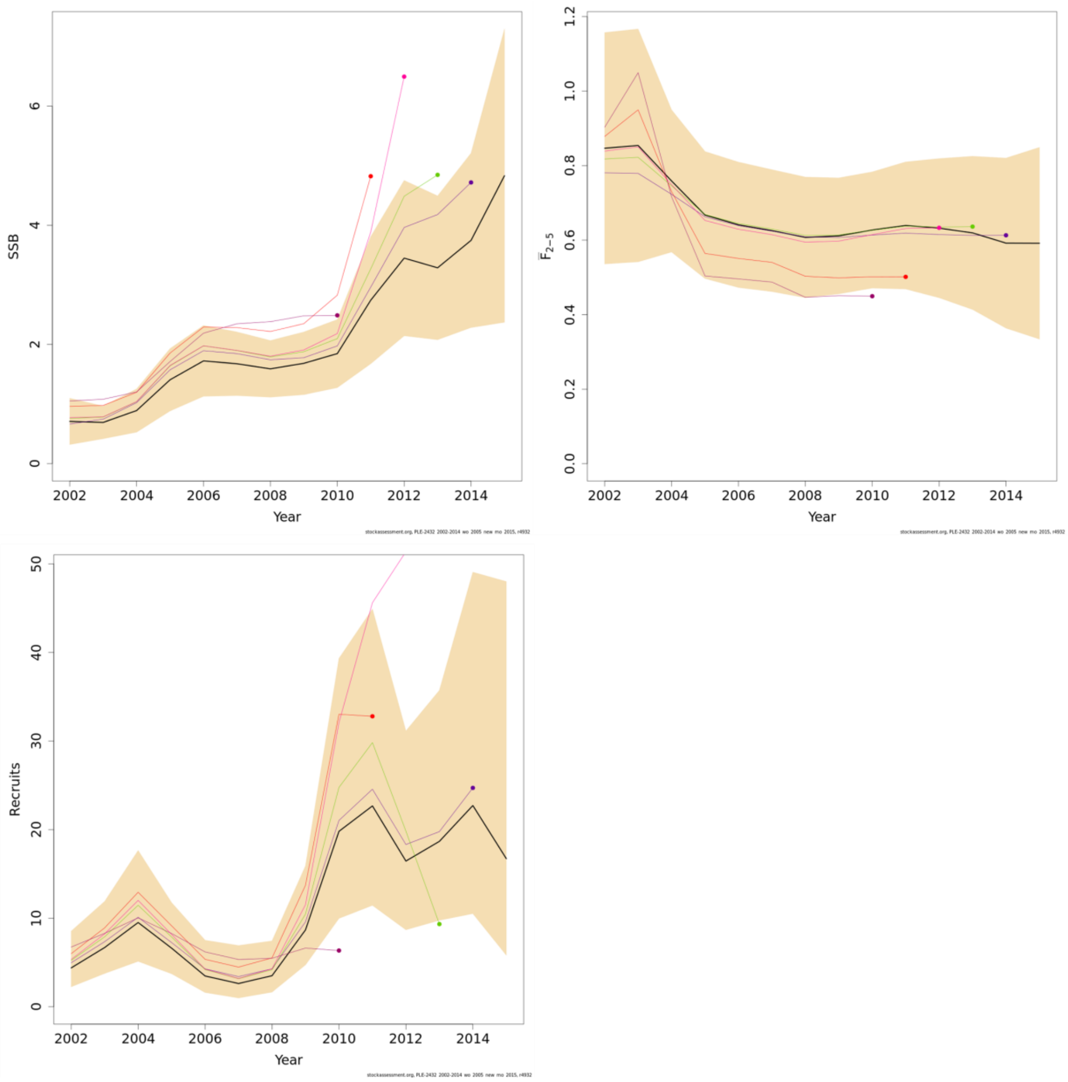


Figure 8.2.7a–c. The results of the retrospective analysis for the SAM run showing the SSB (a), the F(3–5) (b) and the recruitment (c)

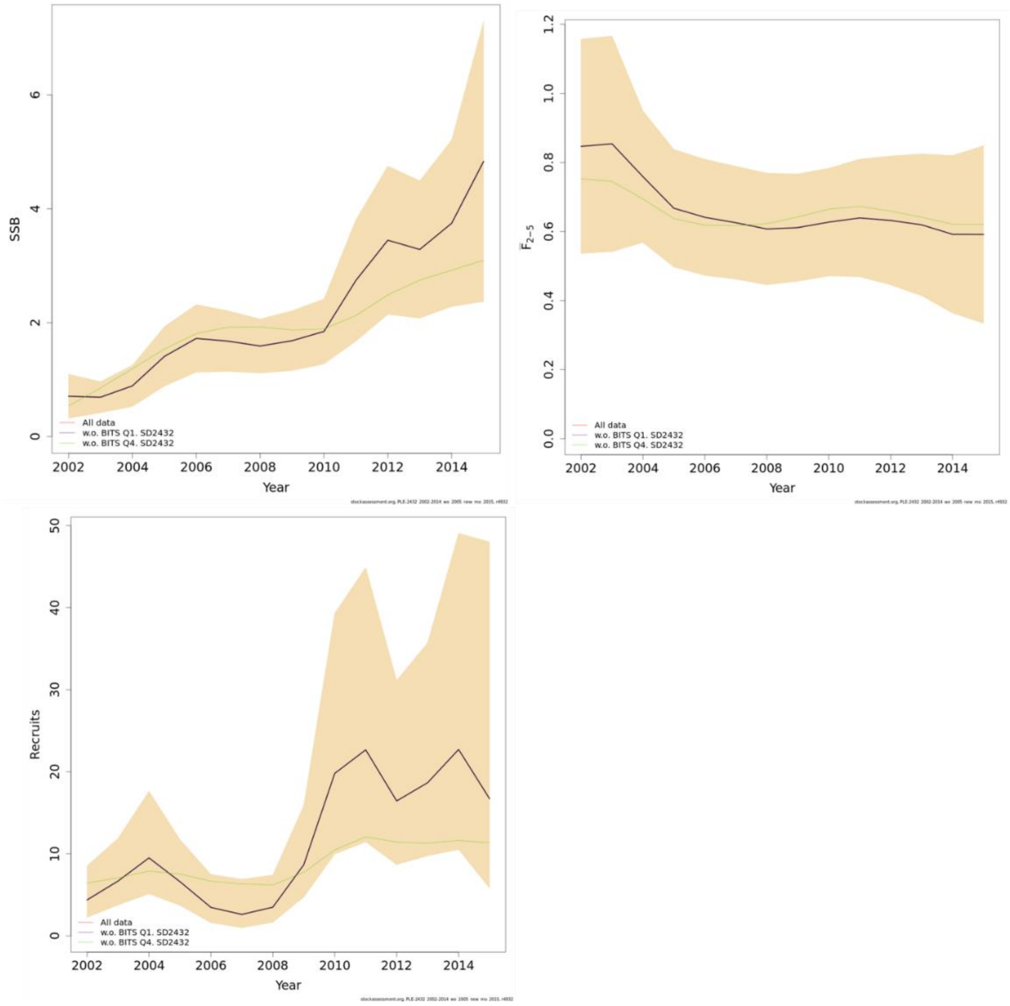


Figure 8.2.8.a–c. The results of the "Add one leave one out" analysis showing the SSB (a), the F(3–5) (b) and the recruitment (c)

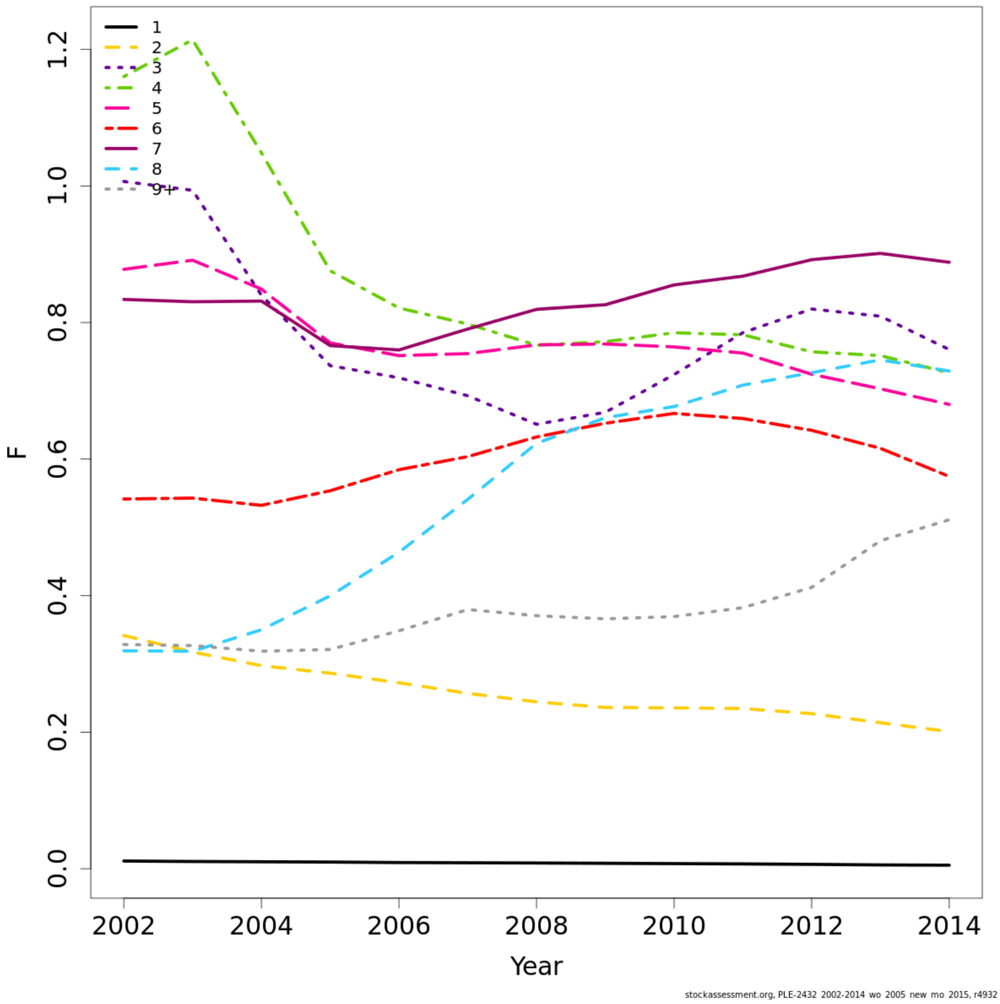


Figure 8.2.9. F by age for the SAM run.

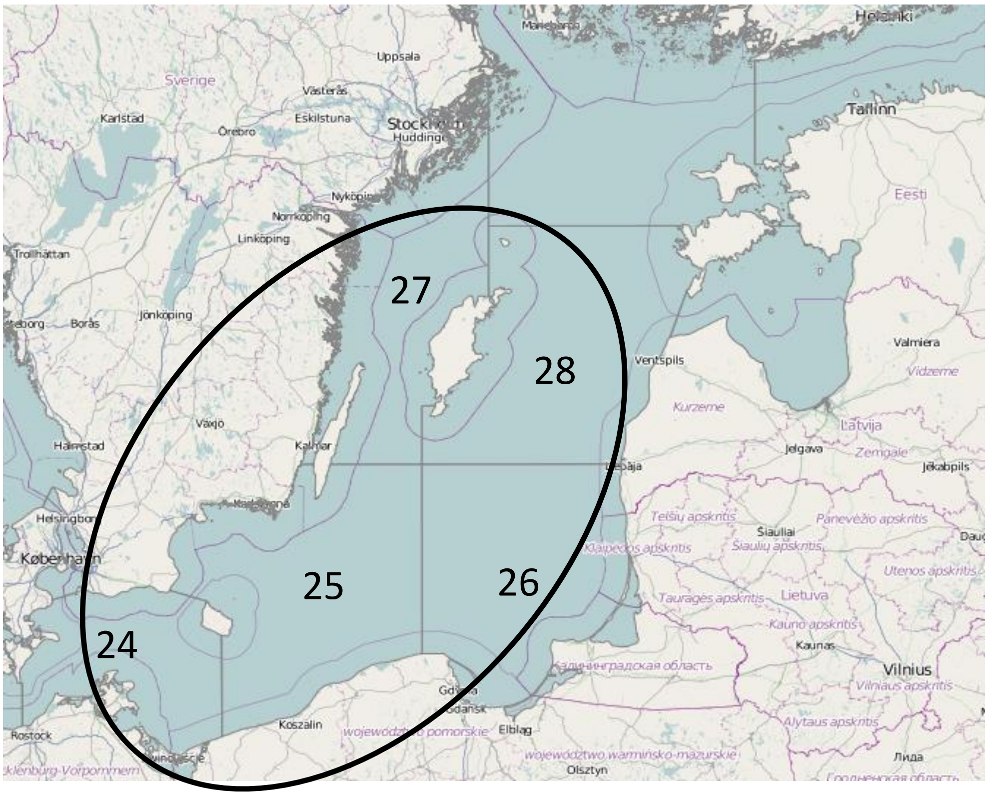


Figure.8.2.10. Approximate location of the identified stock of plaice in the Eastern Baltic Sea. Numbers refer to ICES SD.

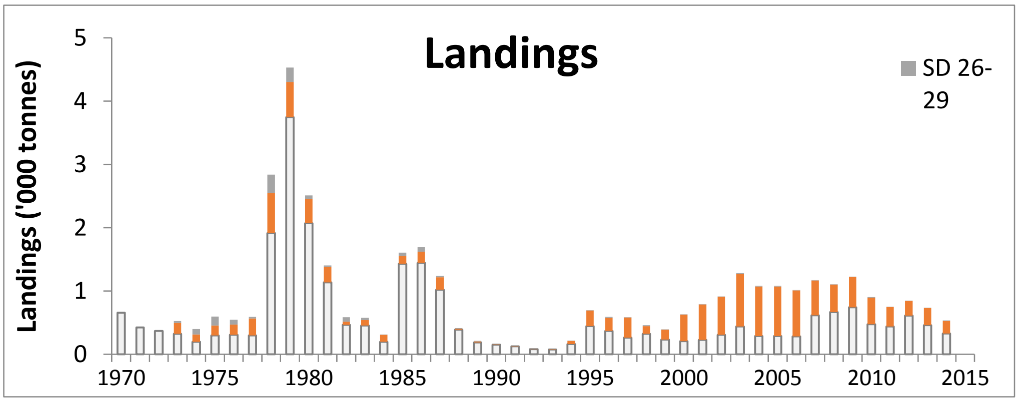


Figure 8.2.11. Total landings of Plaice in kilotons per Subdivisions SD24–29 (Eastern Baltic Sea)

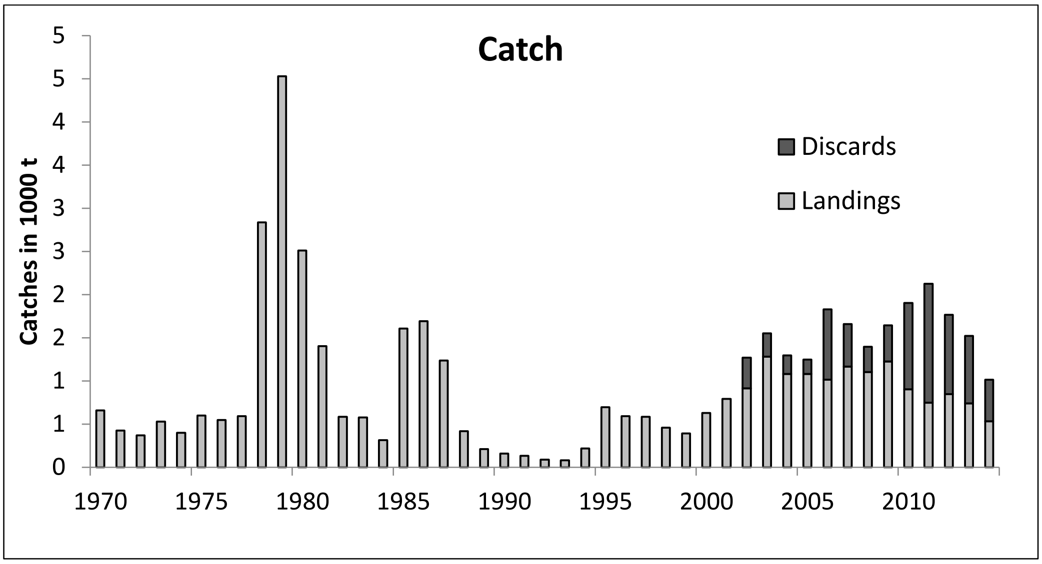


Figure 8.2.12. Total Catch of plaice in Subdivisions SD24-32 (Eastern Baltic Sea) including estimated discards for the time period of 2002 to 2014

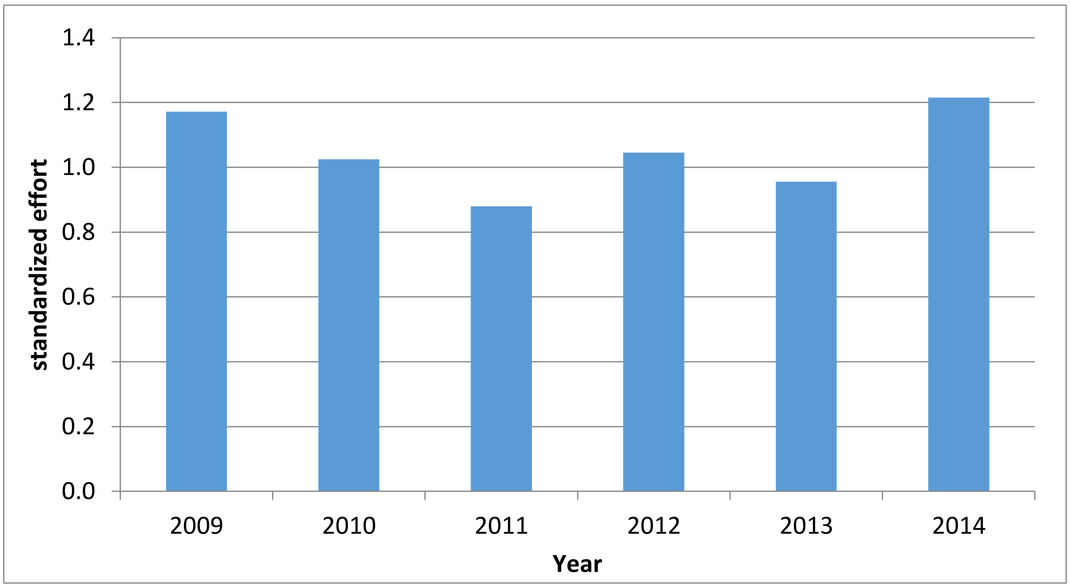


Figure 8.2.13. Plaice in Subdivisions 24–32 (Baltic Sea). Standardized fishing effort weighted by national cod landings per country. Includes only countries having plaice landings (i.e. Denmark, Poland, Sweden and Germany) No effort for the Danish active fleet were available.

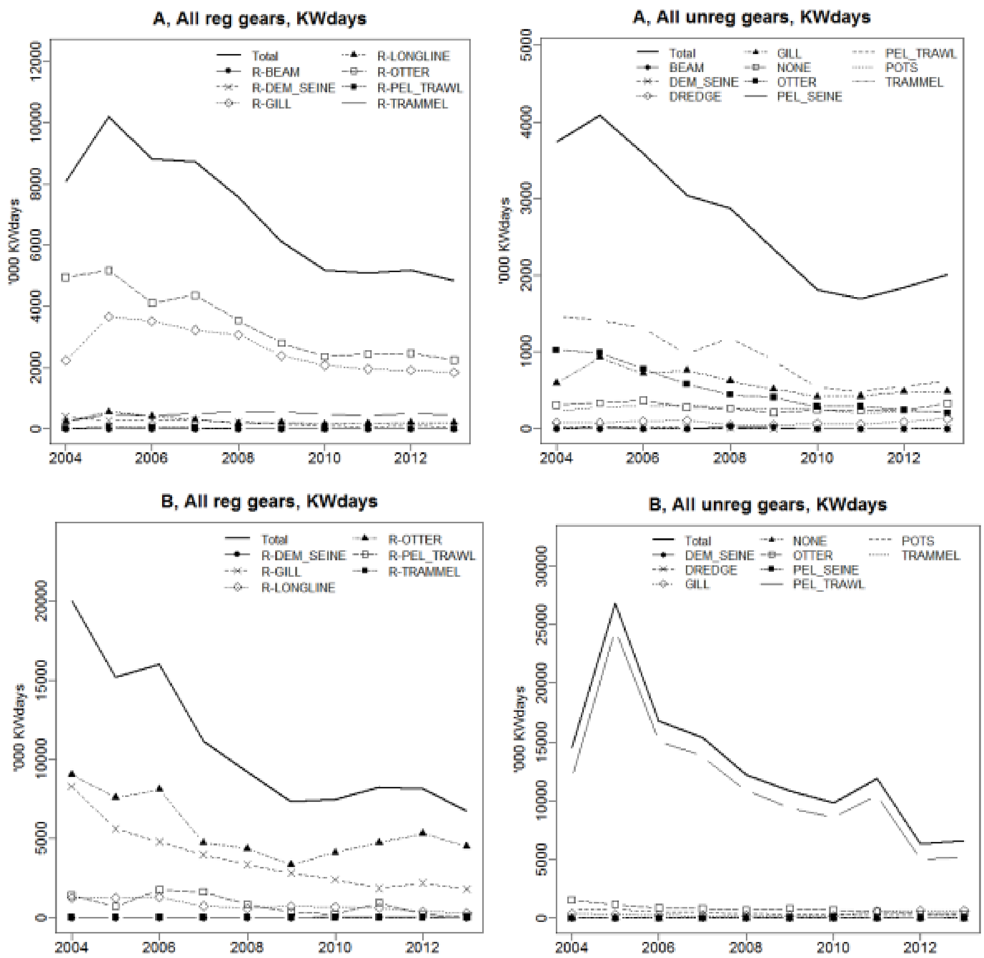


Figure 8.2.14. Plaice in Subdivisions 24–32 (Baltic Sea). Trend in nominal effort by gear types 2004–2013 (kW × days-at-sea). Left: Regulated gears. Right: Unregulated gears. Note that data from Poland, Latvia, and Lithuania are only available from 2004 onwards. Therefore, effort trends are shown from 2004 to 2013. Additionally, Estonian data from 2005 to 2013 (including substantial pelagic effort) was included. No data were available from Finland. Upper panels: area A (Subdivisions 22–24); lower panels: area B (Subdivisions 25, 26, 27 and 28.2) (from STECF, 2014).

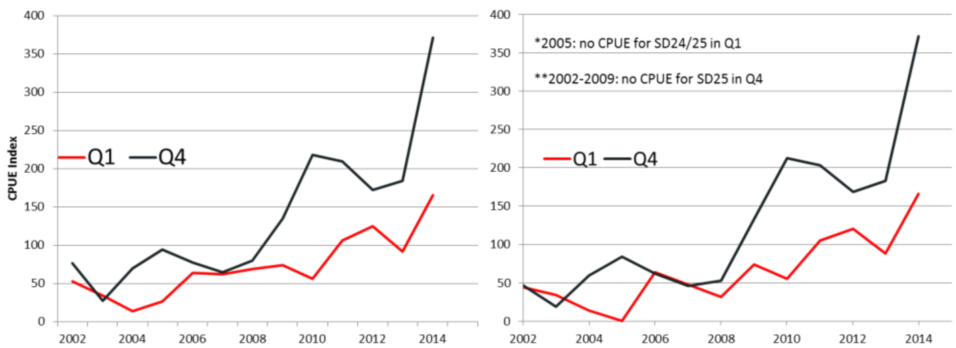


Figure 8.2.15. Plaice in Subdivisions 24-32 (Baltic Sea). Survey Index from BITS quarter 1 (Q1) and quarter 4 (Q4) surveys. Index was calculated by numbers per length-class (left figure) and numbers by age (right figure)

9 Benchmark information by stock

9.1 Kattegat Cod

Stock	**Kattegat cod**	
Stock coordinator	Name: Johan Lövgren	Email:johan.lovgren@slu.se
Stock assessor	Name: Johan Lövgren	Email: ohan.lovgren@slu.se
Data contact	Name: Johan Lvgen	Email:johan LÖvgren

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** **type of expertise / proposed names**
(New) data to be Considered	Additional M - predator relations	Seal diet and seal abundance data	sweden	Researcher slu aqua
	Prey relations			
	Ecosystem drivers			

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 type of expertise / proposed names**
and/or quantified[1]	*Other ecosystem parameters that may need to be explored?*			
Stock identity	Relative proportion between kategatt/north sea cod.	Genetical analyses during the year, old tagging experiments	swe	
Tuning series	Revising all tuning series in the assesemnt Look at the new tuning serie from CODS			
Discards	Discard data	Coverage, represenativety		
Biological Parameters	Catch weight Stock weight maturity			

[1] Include all issues that you think may be relevant, even if you do not have the specific expertise at hand.If need be, the Secretariat will facilitate finding the necessary expertise to fill in the topic. There may be items in this list that result in 'action points for future work' rather than being implemented in the assessment in one benchmark.

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 type of expertise / proposed names**
Assessment method	**Look at the settings in the SAM model in use** **New model, exploring SS3. setttings** **Looking at the**			
Biological Reference Points	defining Fmsy, etc Looking at Fbar settings			

9.2 Herring in SD 31

Stock	**Herring in SD 31**	
Stock coordinator	Name: Jari Raitaniemi	Email: jari.raitaniemi@luke.fi
Stock assessor	Name: Someone from SLU, Sweden?	Email: ______@slu.se
Data contact	Name: Jari Raitaniemi	Email: jari.raitaniemi@luke.fi

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 type of expertise / proposed names**
(New) data to be Considered and/or quantified[2]	Additional M - predator relations Gradual increase of the ringed seal population			SAM expertice
	Prey relations			
	Ecosystem drivers			

[2] Include all issues that you think may be relevant, even if you do not have the specific expertise at hand.If need be, the Secretariat will facilitate finding the necessary expertise to fill in the topic. There may be items in this list that result in 'action points for future work' rather than being implemented in the assessment in one benchmark.

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 type of expertise / proposed names**
	Other ecosystem parameters that may need to be explored? The status of her in SD 31 as an independent stock from her in SD 30			
Tuning series	Does adding gillnet data improve the assessment?	Testing the Swedish gillnet data as one of the tuning series	Gillnet sampling data, Sweden (SLU)	
Discards				
Biological Parameters				
Assessment method	SAM? XSA used so far.	Tests with SAM along with XSA		SAM expertice
Biological Reference Points	Is it possible to get an assessment that would be reliable enough to set ref points?			

9.3 Herring in SD 30

Stock	**Herring in SD 30**	
Stock coordinator	Name: Jukka Pönni	Email: jukka.ponni@luke.fi
Stock assessor	Name: Jukka Pönni	Email: jukka.ponni@luke.fi
Data contact	Name: Jukka Pönni	Email: jukka.ponni@luke.fi

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 type of expertise / proposed names**
(New) data to be Considered and/or quantified[3]	Additional M - predator relations			
	Prey relations			
	Ecosystem drivers			
	Other ecosystem parameters that may need to be explored?			

[3] Include all issues that you think may be relevant, even if you do not have the specific expertise at hand.If need be, the Secretariat will facilitate finding the necessary expertise to fill in the topic. There may be items in this list that result in 'action points for future work' rather than being implemented in the assessment in one benchmark.

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** **type of expertise / proposed names**
Tuning series	1) The CPUE from commercial trapnet-fisheries from 1990 is getting less datapoints every year and the geographical coverage has diminished from 2013 to 2014. It was introduced in last Benchmark, because acoustic survey time series was too short to be used alone in tuning. 2) Acoustic survey index from 2007-	1) Possibly checking and recalculating the trapnet time series. Since acoustic timeseries will have 2 years more in 2017, discarding the commercial series for good could be a solution. It was tried in 2015 WGBFAS to have only acoustic tuning for SAM model, and the resulting SSB and F estimates were promisingly similar to the run with both series (same trends)	2) Joint Finnish-Swedish acoustic survey performed with Finnish R/V Aranda.	Noél Holmgren and Niclas Norrström from University of Skövde, Sweden.
Discards				
Biological Parameters				

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 type of expertise / proposed names**
Assessment method				
Biological Reference Points		Re-calculation of FMSY		Noél Holmgren and Niclas Norrström from University of Skövde, Sweden.

9.4 Sole in IIIa and subdivision 22–24

Stock	**Sole in IIIa and subdivs 22-24.......................**	
Stock coordinator	Name: jesper Boje	Email: jbo@aqua.dtu.dk
Stock assessor	Name:	Email:
Data contact	Name:	Email:

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 type of expertise / proposed names**
(New) data to be Considered and/or quantified[4]	Additional M - predator relations			
	Prey relations			
	Ecosystem drivers			
	Other ecosystem parameters that may need to be explored?			

[4] Include all issues that you think may be relevant, even if you do not have the specific expertise at hand.If need be, the Secretariat will facilitate finding the necessary expertise to fill in the topic. There may be items in this list that result in 'action points for future work' rather than being implemented in the assessment in one benchmark.

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 type of expertise / proposed names**
Sampling	The sampling level for sole (both length and age sampling from the fishery) is critical low. Even though this is due to few and scattered samplings, an evaluation of the consequences and possible improvements should be conducted.			
Tuning series	Since significant gear changes likely have taken place for the principal commercial fleet, the trawlers based on logbook information, the changes should either be quantified and thus taken account for in the assessment or if not possible, the tuning index should be removed. Since the survey has been resumed and is expected to continue annually this biomass index is considered sufficient and appropriate as the single tuning fleet in case the trawlers will be removed.	Detailed exploration of trawler logbooks; spatial distribution and comparison with vms data Detailed information on gear use by area Information from experiments with SELTRA trawl and sole catches	Available at dtu aqua Likely available Not available yet	Jesper Boje
Discards	More specific discard data from other nations than Denmark (Sweden) is available and presently not utilized.			

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 type of expertise / proposed names**
Biological Parameters	The resuming of the survey in 2014 opens for inclusion of biological parameters into the assessment; stock mean weights and maturity will be examined for use.		Available at dtu aqua	
Assessment method				
Biological Reference Points	Change ref pts in accordance with changed stock perception; ie when changing tuning series			

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Annex 02 – Recommendations

Recommendation for ICES/ DATRAS

1) WGBFAS recommends to change the stock units in DATRAS and adjust them to current stocks used by for example WGBFAS and RCM Baltic. This accounts especially for the Baltic flatfish stocks (e.g. PLE-2123, PLE-2432, FLE-2223, FLE-2425, etc.). The current survey Indices, downloadable at DATRAS can't be used by the stock assessors and have therefore to be calculated by hand using the cpue per subarea.
2) Some areas/quarter are missing age-data submissions (especially for flatfish, where age sampling generally started in 2009), which results in a reduced age-based index. The situation also occurs for NS IBTS and Beam Trawl Survey; A solution is for example to borrow ALK from neighboring Areas. DATRAS already includes a borrowing procedure for NSIBTS and BTS, but for the Baltic stocks an agreement has not been reached on adopting this functionalities so there is no facility in DATRAS for rising/upscaling. Borrowing ALK for missing areas can have a significant influence in the calculation of Indices. WGBFAS recommends to the Survey working group to put this issue on the agenda for WGBIFS in 2016
3) To produce an annual survey index for Kattegat cod SD21 (1^{st} and 4^{th} quarter)

Recommendation for WGBIFS

4) To produce a list of all stocks WGBIFS recommends that data are reliable to be used by the WGBFAS from the BITS survey (ex. brill, turbot ect.)
5) To produce maps showing the cod distribution from BITS (maybe also plaice and flounder)

Recommendation to Latvia, Lithuania and Russia

6) Alternative survey index for turbot from Latvia, Lithuania and Russia. A clear description on the survey has to be provided to the WGBIFS six weeks before the meeting.

Recommendation for WGBIFS

7) To produce an updated text for the WGBFAS on ecosystem

Recomandation to WGBIOP

8) Age-reading workshop on herring

Annex 03 – Terms of Reference for the next meeting

WGBFAS – Baltic Fisheries Assessment Working Group

2015/2/ACOMXX The **Baltic Fisheries Assessment Working Group** (WGBFAS), chaired by Tomas Groehsler, Germany and Michele Casini, Sweden will meet at ICES Headquarters, 12-19 April 2016 to:

a) Address generic ToRs for Regional and Species Working Groups

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

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting.

An ICES data call will be sent out with a detailed description of the data needed and the deadline of data delivery. A first draft of the assessment should be available at the start of the meeting.

WGBFAS will report by 30 April 2016 for the attention of ACOM.

Annex 4 – List of stock annexes

A list of stock annexes (including direct hyperlinks) will be supplied here as soon as the work on the stock annexes has been finalized.

Annex 05 – Appendix of Audit Reports

Audit on the WGBFAS assessment of Sole in Division IIIa and Subdivisions 22-24 (Skagerrak, Kattegat,the Belts and western Baltic)

21.04.2015

Olavi Kaljuste

For single stock summary sheet advice:

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: SAM – tuned by 3 comm. fleets + 1 survey
5) **Data issues:** the data are available in the SharePoint as described in stock annex. The survey index series which was interrupted in 2011 has been resumed in 2014 and is used.
6) **Consistency**: Last year assessment was accepted, this year assessment was accepted. In general, the results are consistent with the last year's assessment. Only SSB was somewhat underestimated. SSB has increased somewhat, but F has increased remarkable.
7) **Stock status**: Bpa>SSB>Blim, Flim>F<Fpa, R is low in recent years.
8) **Man. Plan.**: NA

General comments

The assessment is clear and well documented.

Technical comments

The assessment is done according to the stock annex. This section is well documented and ordered. However, some figures and tables would need improvement to be easier understandable. The explaining labels in the figure 3.1 are not used in consistent way. It is hard to understand how many years are included in figure 3.2. There are no weight units given in the figure 3.8 and 3.9 and age 9 should be marked as a plus-group. In figure 3.10 half of the headers have been cut off. In figure 3.11 is the text so small that it is almost impossible to read it. There are no information about the units for figures 3.11-3.14, 3.16, 3.18 and tables 3.10-3.11. In figure 3.20 the axis labels overlap with the axis values.

Conclusions

The assessment has been performed correctly. There are no major reasons to deviate from the standard procedure for this stock. The update assessment gives a valid basis for the advice.

Audit report WBcod

Jesper Boje

The assessment has been conducted in line with description in stock annex.

In stock annex section c is provided contents of configuration file from SAM. Good idea to table this information in annex.

In the forecast Fsq is 0.65. However recent Fs are all higher? In the catch option table 2015 is assumed Fsq and 2016 the option F. 2017 are for all options again considered Fsq (0.65)? why this return to Fsq in 2017 ? it seem unlikely. 2017 should be continued Fsq or whatever is in 2016.

Recruitment used in STF as shown in table 2.3.26 does not correspond til n1(2015-17) in sam output.

Catch option table 2.3.27 is missing

Audit of Dab in Subdivisions 22–32 (DAB-2232)

Date: 30.04.2015

Auditor: Romas Statkus

General

Assessment

Stock assessment was not carried out because the required data were not available.

Model used for advice

Not used

For single stock summary sheet advice:

1) **Assessment type:** None
2) **Assessment**: Survey trends-based assessment
3) **Forecast**: not presented
4) **Assessment model**: none
5) **Data issues:** Data available as described in stock annex
6) **Consistency**: Same as last year
7) **Stock status**: Biological reference points not available
8) **Man. Plan.**: No management plan for this stock

General comments

In general this was a well documented, well ordered and considered section. In some sections more clarification and description as well as editing was necessary.

Technical comments

No comments.

Conclusions

The assessment has been performed correctly.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?

Yes

- Is the assessment according to the stock annex description?

Yes

- Is general ecosystem information provided and is it used in the individual stock sections.

Yes

- If a management plan has been agreed, has the plan been evaluated?

No management plan for this stock

For update assessments

- 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?

Update assessment gives a valid basis for advice

-

Audit of Plaice in Subdivisions 24–32 (PLE-2432)

Date: 27.04.2015

Auditor: Georgs Kornilovs

General

Assessment

The first analytical assessment SAM was performed during benchmark metting (WKPLE) in 2015. In WGBFAS update of this assessment was made.

Model used for advice

The model used is a trend analysis, using general trends in SSB of an exploratory SAM.

For single stock summary sheet advice:

1) **Assessment type: update/SALY**
2) **Assessment**: exploratory SAM for SSB trend analysis
3) **Forecast**: not presented
4) **Assessment model**: SAM - tuning by 2 surveys
5) **Data issues:** Data available as described in stock annex
6) **Consistency**: Both last year's and this year's assessment accepted
7) **Stock status**: Biological reference points not available
8) **Man. Plan.**: No management plan for this stock

General comments

In general this was a well documented, well ordered and considered section. In some sections more clarification and description was necessary. The author of the report for Plaice in Sd 24-32 has received the comments of the audit.

Technical comments

The CANUM table was missing. The title of Figure 8.1.11.a-c. needed clarification. The comparison of the update assessment and previous assessment would be advisable.

Conclusions

The assessment has been performed correctly.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? **-Yes**
- Is the assessment according to the stock annex description? **-Yes**
- Is general ecosystem information provided and is it used in the individual stock sections. **-Yes**
- If a management plan has been agreed, has the plan been evaluated? **- NA**

For update assessments

- 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? **- NA**
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? **-Yes**

Audit of Turbot in Subdivisions 22–32 (TUR-2232)

Date: 29.04.2015

Auditor: Romas Statkus

General

Assessment

Stock assessment was not carried out because the required data were not available.

Model used for advice

Not used

For single stock summary sheet advice:

1) **Assessment type:** None
2) **Assessment**: Survey trends-based assessment
3) **Forecast**: not presented
4) **Assessment model**: none
5) **Data issues:** Data available as described in stock annex
6) **Consistency**: Same as last year
7) **Stock status**: Biological reference points not available
8) **Man. Plan.**: No management plan for this stock

General comments

In general this was a well documented, well ordered and considered section. In some sections more clarification and description as well as editing was necessary.

Technical comments

No comments.

Conclusions

The assessment has been performed correctly.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?

Yes

- Is the assessment according to the stock annex description?

Yes

- Is general ecosystem information provided and is it used in the individual stock sections.

Yes

- If a management plan has been agreed, has the plan been evaluated?

No management plan for this stock

For update assessments

- 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?

Update assessment gives a valid basis for advice

-

Audit of Herring in Subdivisions 25–27, 28.2, 29 and 32

Date 2015-04-22

Auditor: Noél Holmgren

General

- The EG answered the TORs relevant to providing advice.
- The assessment is according to the stock annex description.
- General ecosystem information is provided.

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:** Data are available as described in the stock annex. B.
6) **Consistency**: The stock has been underestimated the last five years as estimaterd from the retrospective pattern, e.g. for the year 2013, SSB increased 12% and Fbar decreased 12% from 2014 to 2015 years' assessment.
7) **Stock status**: SSB close to Blim in 1999-2001 but has since then increased to well above Bpa. F<Fmsy since 2004.
8) **Man. Plan.**: Plan is **not** evaluated by ICES

General comments

The assessment is well documented. However, it could be very confusing for outsiders that three different names are used for that stock in the report. Titel of the chapter 6.2 is "Herring in Subdivisions 25-27, 28.2, 29 and 32". In the titel of the Annex 14 and in the captions of the tables and figures in the chapter 6.2 "Herring in SD 25-29, 32 (Excl. GoR)" is used instead. In the text, there is even the name "Central Baltic Herring" used and there is explanation that also the fraction that is caught in the Gulf of Riga (SD 28.1) is included. In the InterCatch, there is that stock defined as "Herring in Subdivisions 25 - 29 (excluding Gulf of Riga) and 32 (her-2532-gor)". There exists even an alternative herring stock defined as "Herring in Baltic Fishing Areas 25 to 29 and 32 (her-cent)". I can not understand what is the difference of these two stock definisions. There is are remark in few tables and figures that also the herring fraction that was caught in the Gulf of Riga (SD 28.1) is incorporated, but not in all cases. This should done consistently throughout the report. Similar way the name of the tuning fleet should be hanled. Now it is called to "Acoustic", "Acoustics", "Acoustic survey", "International Acoustic Survey" and to "Baltic International Acoustic October Survey (BIAS)" in different places. The correct name of that survey is "Baltic International Acoustic Survey (BIAS)".

Technical comments

The report is describing the assessment in a clear way. Although, some of the tables and figures coul be improved. In Table 6.2.1 the old information about earlier updates could be removed. In table 6.2.11 the fleet name should be corrected and the old information about earlier updates could be removed. Additionally, there should be “Estimates: Millions” instead of the “Catch: Millions”. In Table 6.2.14 an explanation what the abbreviations “GMST” and “AMST” mean is missing in the caption. In figure 6.2.6 the old BIAS estimates (before the year 1991) should be removed, because these were not area corrected and WGBIFS has recommended not to use them as the quality of those historic estimates is uncertain. Additionally, it should be mentioned that the XSA figures are reflecting the situation at the beginning of the year, but BIAS figures estimate the fish abundance in October. I think that it is not correct to combine the BIAS abundance estimates with WECA. Herring weight from BIAS should be used instead. In figure 6.2.7 the units are not defined. In figure 6.2.9 the fleet name should be corrected. I do not understand how the tuning fleet (BIAS) figures have been adjusted to get the values at the start of the year. Also the units are unspecified. It seems that BIAS estimates are given in *10^6, but XSA numbers in *10^4. The units are unspecified in figure 6.2.11. In table 6.2.17 the fleet name should be corrected. There should be written “Table 6.2.18” instead of “Table 6.2.187” in chapter 6.2.6. In table 6.2.21 units are not specified. An explanation for used abbreviations is missing in the caption.

Conclusions

The assessment has been performed correctly.

No suggestions for future benchmark.

There are no **major** reason to deviate from the standard procedure for this stock.

The update assessment gives a valid basis for the advice.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?

Audit of Eastern Baltic Cod (SD 25–32)

Date 2015-05-15

Auditor: Yvonne Walther

General

The stock was benchmarked in March 2015 (WKBALTCOD, 2015).

1) **Assessment type: update** with exploratory assessment runs
2) **Assessment**: t**rends** based on survey, no accepted analytical assessment for this stock following the ICES approach for data limited stocks (category 3.2.0 stock)
3) **Forecast**: no forecast
4) **Assessment model**: A combined length-based biomass index from the Baltic International Trawl Survey (Q1 and Q4) was used as the index of stock development
   1) *Exploratory models:*
   2) Stock Synthesis (SS3)
   3) CSA model (Collie & Sissenwine, 1983)
   4) SAM with ageing errors
5) **Data issues:** Data are available as described in the stock annex. Discard data for 2014 were available. Concerns about quality of data expressed; ageing problems, mixing of stocks, changes in catchability, change in growth and condition.
6) **Consistency**: Consistency cannot be evaluated, analytical assessment has not been performed in 2014 and 2015
7) **Stock status**: Unknown, index shows decrease in trend by 20%, exploitation rate is considered increasing since 2009.
8) **Man. Plan.**: Management plan is in place but currently not used as basis for advice, due to problems experienced in the analytical assessment. There is a new management plan under development. The stock has no biological reference points.

Technical comments

The report is well structured and the complex problem with the stock is well described.

Audit of Herring in Subdivision 31

Date 28.04.2015

Auditor: Jukka Pönni

For single stock summary sheet advice:

1) **Assessment type: update assessment for a data limited stock**
2) **Assessment**: exploratory XSA
3) **Forecast**: not presented
4) **Assessment model**: XSA – tuning by 2 commercial fleets
5) **Data issues:** The data for assessment is available as described in stock annex. However, on the contrary what is stated in stock annex, the data is uploaded by national laboratories of Finland and Sweden to, and aggregated to international data in ICES InterCatch database.
6) **Consistency**: The exploratory assessment was consistent to last year's exploratory assessment.
7) **Stock status**: Stock is classified in category 3.2, which should provide reliable indications of trends in SSB, F and recruitment. The fishing pressure is considered to be stable and stock size increasing.
8) **Man. Plan.**: No management plan for herring in this area.

General comments

This was a well documented, well ordered and considered section. It was easy to follow and interpret

Technical comments

In section 6.5.11 there is a mistake in figure for catch option for 2016; it should be 6641 t instead of 5924 t.

In section 6.5.13 there is a typo, calling the trawl fleet as "trawl net fleet".

Conclusions

The assessment has been performed correctly. This stock could benefit from a benchmark for exploration of tuning fleets and/or combination the with Subdivision 30 herring stock.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? YES
- Is the assessment according to the stock annex description?YES
- Is general ecosystem information provided and is it used in the individual stock sections.YES
- If a management plan has been agreed, has the plan been evaluated?NO PLAN.

For update assessments

- 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, the exploratory assessment has.
- 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? It does.

Audit of Gulf of Riga herring (Subdivision 28.1)

Date 24/4 - 2015

Auditor: Niclas Norrström

For single stock summary sheet advice:

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**:short term forecast presented
4) **Assessment model**: XSA, tuning by using effort from Estonian and Latvian comm. trap nets + 1 acoustic survey
5) **Data issues:** No data issues.
6) **Consistency**: Consistent assessments. Only minor changes from last year.
7) **Stock status**: SSB > Btrigger for a long time, FMSY<F<Fpa
8) **Man. Plan.**: No explicit management objectives. Some amount of herring from subdivisions 25–27, 28.2, 29, 32 is taken in the Gulf of Riga 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 subdivisions 25–27, 28.2, 29, 32.

General comments

This is a well documented, well ordered and considered section.

Technical comments

Conclusions

The assessment has been performed correctly

Audit of Herring in Subdivision 30

Date 2015-04-29

Auditor: Tomas Gröhsler & Michele Casini

General

- The analytical update assessment was changed to a trend based assessment, which was then used as the basis for the advice
- No forecast was presented as the stock was downscaled to category 3.1.0.

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: trends, based on the results of an update analytical assessment
3) **Forecast**: not presented
4) **Assessment model**: SAM + tuning by 1 commercial trapnet + 1 acoustic survey + annual maturity data from Finnish commercial trawl catches before spawning + constant natural mortalities (0.2 for all ages).
5) **Data issues:** From 2014 onwards the time series of the commercial trapnet index will only be based on catch and effort data combined from two areas in Finnish cost of Bothnian Sea (1990-2013 based on three areas). Including and excluding the commercial trapnet tuning index within the update assessmenr lead to conflicting signals. The commercial tuning index alone shows a far higher increase in stock development compared to the results of the acoustic index. The 2012 acoustic survey coverage was only 50% of what was required and therefore 2012 survey results are highly uncertain.
6) **Consistency**: The model and methods used were the same as in the last benchmark in 2013. However, the stock was now downscaled to category 3.1.0. The results of the update analytical assessment were used as the basis to describe the trend of stock development.
7) **Stock status**: The SSB remained stable from the late 1990s until 2003; since then it increased to a record-high level. The precise level of SSB is unknown, since there is a great uncertainty about the SSB estimates. Although there also no precise estimates of the fishing mortality, they seem to be on low level and below FMSY since the beginning of the time-series, probably exceeding F_{MSY} only in the years 1997-2000. Recruitment at age 1 is seen to be variable but the long term mean seems to have risen over the time series.
8) **Man. Plan.**: None

General comments

The assessment is well documented.

Technical comments

- Section 6.4.3/input data: the acoustic survey covers ages 2,3,….8+, whereas in the Stock Annex age 1 is included. The report states that age 1 was excluded by previous WGBFAS (after the benchmark) because it was considered that age 1 was not sampled representatively. This should be changed in the Stock Annex.
- Section 6.4.3/model specification: It is stated that model sensitivity to the settings can (or should be) investigated, but this is not specified in the Stock Annex.
- Figures and Tables are not in numeric order in the text.
- All Figures and Tables should give the stock name (Table X: Herring in SD 30. …..; Figure Y: Herring in SD 30….)
- Missing units should be added to all Figures and Tables (i.a. Table 6.4.1, Table 6.4.7, Figure 6.4.1, Table 6.4.9)
- Larger parts of the present report text could be moved to the stock annex (i.a. discards, natural mortality, reference points)
- The present sub-section on medium-term projections within 6.4.6 should/could be deleted.
- The text Table in section 6.4.8, which shows the settings of WGBFAS 2014 compared to WGBFAS 2015, should not give any differences. Just updating/adding one year to the existing data series makes no difference of the basic setting!
- Wordings/Section 6.4.5. What is the meaning of following sentence: …. In addition, since the stock is experiencing a relatively low fishing mortality, and as a result a smaller part of the population being sampled, the uncertainty will be larger than if fishing mortality was higher…..
- Wordings/section 6.4.4: … The recruitment level in 2014 has been fairly stable since 2012. ??
- 'Section 6.4.4.1 SAM' within section 6.4.4 should/could be deleted?
- Section 6.4.4 Recruitment estimates: This section should summarise any information on recruitment development independent of the ones produced by the assessment (i.a. acoustic estimates of the 0-group?)
- A Table showing the input data of the commercial trapnet and acoustic indices should be included in the report.

Conclusions

There were major reason to deviate from the standard procedure for this stock. The trend-based assessment now used has been performed correctly. The next benchmark is scheduled for 2017. The trend-based assessment gives a valid basis for advice.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?

Audit of Cod in Kattegat

Date 2015-04-22

Auditor: Margit Eero

General

- The EG answered the TORs relevant to providing advice.
- The assessment is according to the stock annex description, besides an additional survey that was added this year.

For single stock summary sheet advice:

1) **Assessment type: update with some modifications**
2) **Assessment**: analytical
3) **Forecast**: differently from previous years, exploratory short term forecast was provided
4) **Assessment model**: SAM
5) **Data issues:** Data are available as described in the stock annex. New survey index available that has not been used in earlier assessments.
6) **Consistency**: Discrepancy between the survey information and catch data, with large implications for estimated mortalities.
7) **Stock status**: In some runs, SSB close to Blim
8) **Man. Plan.**: Management plan is in place

Technical comments

i) Concerning the 4 tables with the assessment results, please say in the table headings (instead of the file name) which table corresponds to which run.

ii) Please say in the report which run(s) is/are final assessment(s). The report presents 4 runs and this should be explained in the report which one is considered as the final run.

iii) The annexes with all SAM outputs but without figure captions or specific headings of the tables will likely be difficult to include in the report. Please select the figures/tables from these annexes to be included in the report and make a proper caption/heading for those and give the figures/tables a number. For the additional material that may not be that important to be included in the report, it is possible to refer to online SAM pages where these results can be found.

iv) The report requires some technical polishing of the language etc.

Audit of Plaice 21-23

Date 27.04.2015

Auditor: Anna Luzeńczyk

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: **SAM**

Only scientific tuning fleets are used:

- combined NS-IBTS 1st quarter and BITS 1st quarter
- combined NS-IBTS 3rd quarter and BITS 4th quarter

5) **Data issues:** Landings data available from 1970, and discards from 2002.

Discards were extrapolated three years backwards to 1999, so catch data used in SAM are from 1999.

6) **Consistency**: Last yr was just exploratory age-based analytical assessment.
7) **Stock status**: B<Blim for a while, Flim<F<Fpa, R uncertain, seem to be high recent years

B>MSY$B_{trigger}$ and F<F_{MSY}

8) **Man. Plan.**: Agreed 2006: SSB above 35 000 t within 10 years and to reduce fishing mortality to 0.27. The main elements in the plan are a 10% annual reduction in F and a 15% constrain on TAC change between years. Plan is **not** evaluated by ICES

No management plan for this stock

General comments

Technical comments

Assessment done according to the stock annex

Conclusions

The assessment has been performed correctly

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice? Yes
- Is the assessment according to the stock annex description? Yes
- Is general ecosystem information provided and is it used in the individual stock sections. Yes
- If a management plan has been agreed, has the plan been evaluated? NA

For update assessments

- 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? NA
- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice? Yes

Audit of Brill in Sub-divisions 22-32

Date 20.04.2015

Reviewer: T.Raid

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: Survey trends-based assessment
3) **Forecast**: not presented
4) **Assessment model**: n/a
5) **Consistency**: n/a
6) **Stock status**: unknown
7) **Man. Plan**: No management plan

General comments

Total catch figures are unknown**.** Reported landings show sharp decreasing trend from during the recent years from 105 t in 2008 to 30 t in 2012. The official landings were 31t in 2013 and 27 t in 2014 (Catch estimate 32 t, mainly from Sub-division 22). However, cpue indices from BITS are on average higher than early 2000s.

Technical comments

Survey data available from 1 and 4 quarter BITS. The quality of the survey index is not discussed in the Report. Discard data not reported. The Table 8.3.1.7 is missing the 2014 landing figure.

Conclusions

The survey index trend has been increasing in 2009-2011. However the index strongly decreased in 2012 and even more in 2014. Thus the trends of cpue indices and landings have been contradictory during the most recent period. The proposed according to ICES rules for data limited stocks catch advice of 23t seems to be reasonable on the background of decreasing and uncertain catches and drop in the survey index.

The possibility of running a production model for assessment using landings and survey data should be considered in future.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- If a management plan has been agreed, has the plan been evaluated?

For update assessments

- 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?

Audit of Flounder in Sub-divisions 24-25

Date 23.04.2015

Reviewer: D.Ustups

For single stock summary sheet advice:

Short description of the assessment: extremely useful for reference of ACOM!

1) **Assessment type: update**
2) **Assessment**: Survey trends-based assessment
3) **Forecast**:not presented
4) **Assessment model**: n/a
5) **Consistency**: n/a
6) **Stock status**: unknown
7) **Man. Plan**: No management plan

General comments

Total catch of flounder in ICES subdivisions 24 and 25 were presented in the report. Discard estimates were calculated and accepted in the plenary of the working group. Data from ICES Data Call 2015 are not presented.

Technical comments

In Fishery description paragraph importance of direct fishery should me more described. If it is common in Poland it should be necessary for whole stock.

The reason of wrong discard calculation in benchmark assessment WKFLABA should be described more precise.

From my point of view we could observe decreasing trend in fishing effort.

In historical trend analyze standard figure form advise should be added to illustrate difference in two periods - the basis for advise to increase a landing.

Conclusions

The survey index trend have been increasing during the last 10 years, even though the landings are also increasing. The last year estimate is the highest in the time series.

The possibility of running a full analytical assessment is limited due to limited biological information.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?

Yes

- Is the assessment according to the stock annex description?

Yes

- Is general ecosystem information provided and is it used in the individual stock sections.

Yes

- If a management plan has been agreed, has the plan been evaluated?

No management plan for this stock

For update assessments

- 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?

Update assessment gives a valid basis for advice

Audit of Flounder in Sub-divisions 27-32

Date 21.04.2015

Reviewer: D.Ustups

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: Survey trends-based assessment
3) **Forecast**: not presented
4) **Assessment model**: n/a
5) **Consistency**: n/a
6) **Stock status**: unknown
7) **Man. Plan**: No management plan

General comments

Total landings by countries were included in the report. Data from ICES Data Call 2015 are not presented. Fishery description includes estimates from recreational fishery what is import part for this stock. However it should be clarify is it landing or catch estimates.

Effort data from ICES Data call 2015 what could uploaded in InterCatch was not presented.

Technical comments

Numbering of figures and tables should be corrected.

Average from survey index should be add in the plot, standartgraph figures should be used to visualise incraese of 147%

Conclusions

The survey index trend has been increasing in last years. The last year estimate is higher that long term average. However the stock is on low level comparing to beginning of time series when signififficant amount of flounde were landed in ICES Subdiviion 32.

The possibility of running a full analytical assessment is limited due to limited biological information.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?

Yes

- Is the assessment according to the stock annex description?

Yes

- Is general ecosystem information provided and is it used in the individual stock sections.

Yes

- If a management plan has been agreed, has the plan been evaluated?

No management plan for this stock

For update assessments

- 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?

Update assessment gives a valid basis for advice

Audit of Sprat in Subdivisions 22–32

Date 21.04.2015

Auditor: Jari Raitaniemi & Jukka Pönni

For single stock summary sheet advice:

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: short-term forecast presented
4) **Assessment model**: XSA, SAM
5) **Data issues:** Data available
6) **Consistency:** Assessment has been perfomed consistently and accepted last year and also this year in the WG. There were 8-12% differences in 2013 estimates for F, SSB,R and TSB between 2014 and 2015.
7) **Stock status**: B>Blim about 25 years, Flim<F<Fpa, F>Fmsy, R stable in recent years.
8) **Man. Plan**: No management plan

General comments

This was a well documented, ordered and considered section, and easy to follow and interpret.

Technical comments

Minor comments on the text version on 21.4. given to the text coordinator.

Conclusions

The assesment has been performed correctly.

Checklist for review process

General aspects

- Has the EG answered those TORs relevant to providing advice?

Yes

- Is the assessment according to the stock annex description?

Yes

- Is general ecosystem information provided and is it used in the individual stock sections.

Yes

- If a management plan has been agreed, has the plan been evaluated?

No management plan for this stock

For update assessments

- 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

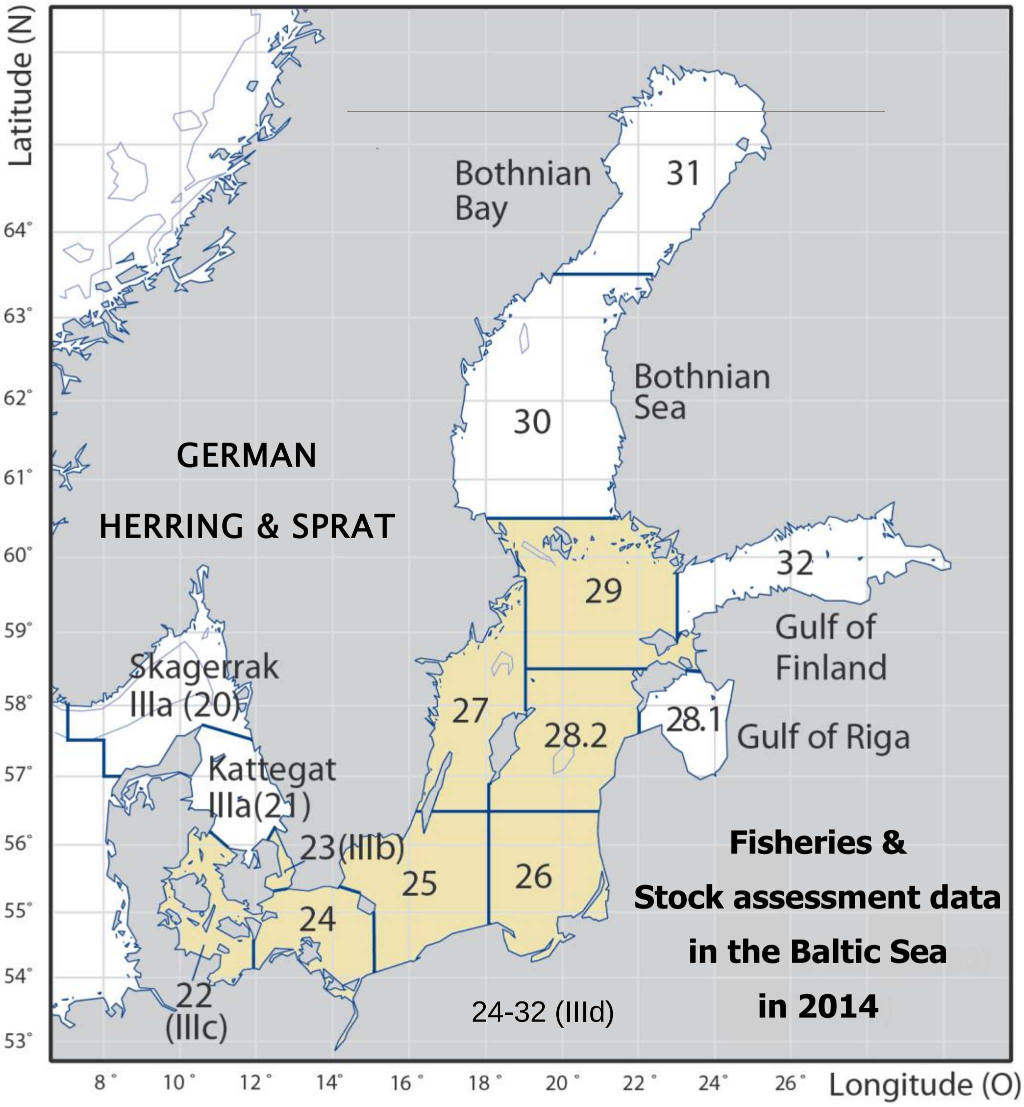
- Is there any **major** reason to deviate from the standard procedure for this stock?

No

- Does the update assessment give a valid basis for advice? If not, suggested what other basis should be sought for the advice?

Update assessment gives a valid basis for advice

Annex 06 – Working Documents



compiled by

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1 HERRING

1.1 Fisheries

In 2014 the total German herring landings from the Western Baltic Sea in **Subdivisions (SD) 22 and 24** amounted to 10,241 t, which represents a decrease of 30 % compared to the landings in 2013 (14,591 t). This decrease was caused by a decrease of the TAC/quota and some further quota transfer to other countries around the Baltic Sea (German quota for SDs 22 and 24 in 2014: 10,900 t - quota-transfer of 100 t). The fishing activities in one of the main fishing areas, the Greifswald Bay (SD 24) could only start not earlier than in March due to cold winter conditions in January/February. The German fishery was forced to stop their activities at the end of April due to quota restrictions.

Only a small part of the total German landings was taken **in Subdivisions 25-29** (2014: 1,731; 2013: 1,415 t; 2012: 896 t; 2011: 2,730 t; 2010: 2,235 t; 2009: 1,252 t). For the first time 441.7 t of the total landings were taken as by-catch in the sprat fishery (EU regulation: 8 % (1,200 t) of the total German sprat quota in 2014 (14,977 t) can be taken as herring by-catch).The landings taken in the directed herring fisheries (1,290 t) exceeded the existing TAC/quota (2014: 658 t) by means of quota transfer (+ 632 t) with other countries around the Baltic Sea. All landings in this area were

- taken by the trawl fishery and
- landed in foreign ports.

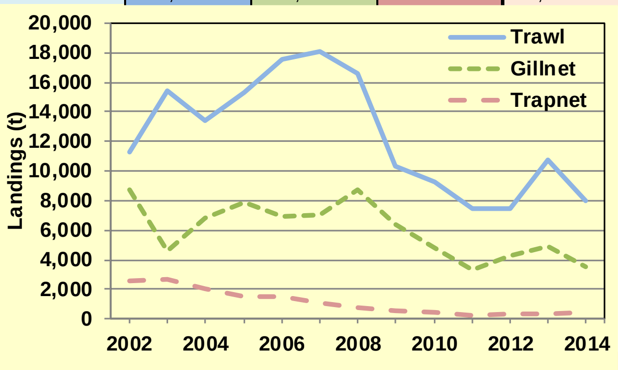
The landings (t) by quarter and Subdivision (SD) including information about the landings in foreign ports are shown in the table below:

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	397.052	6,912.927	335.400	181.420	45.049	168.607	517.757	1,248.233	14.6%	**8,558.212**	71.5%
	0.000	116.550	335.400	181.420	45.049	168.607	517.757	1,248.233	91.5%	1,364.783	73.9%
II	102.937	1,383.373	148.433	83.333	188.000	54.333	-	474.099	24.2%	**1,960.409**	16.4%
	0.000	0.000	148.433	83.333	188.000	54.333	-	474.099	100.0%	474.099	25.7%
III	1.861	1.138	-	-	-	-	-	0.000		**2.999**	0.0%
	0.000	0.000	-	-	-	-	-	0.000		0.000	0.0%
IV	153.306	1,288.498	1.636	-	-	1.636	5.727	8.999	0.6%	**1,450.803**	12.1%
	0.000	0.000	1.636	-	-	1.636	5.727	8.999	100.0%	8.999	0.5%
Total	**655.156**	**9,585.936**	**485.469**	**264.753**	**233.049**	**224.576**	**523.484**	**1,731.331**	**14.5%**	**11,972.423**	**100.0%**
	0.000	116.550	485.469	264.753	233.049	224.576	523.484	1,731.331	93.7%	1,847.881	100.0%
								2014/2013:		**2014/2013:**	
								122.3%		74.8%	
	= Fraction of total landings (t) in foreign ports							122.3%		110.2%	
						Proportion landed in foreign ports:				**15.4%**	

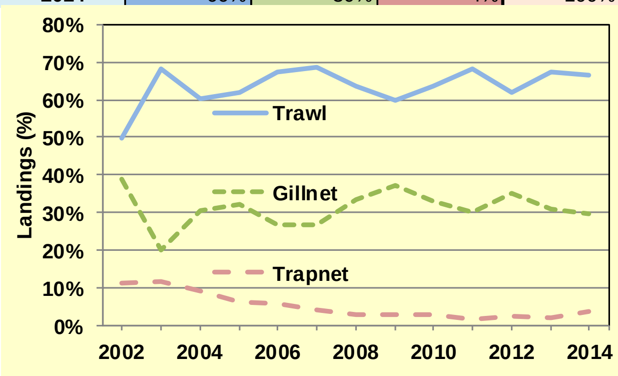
The main fishing season was during spring time as in former years. About 88 % of all herring (SDs 22-29) was caught between January and April (2013: 95 %; 2012: 92 %; 2011: 90 %, 2010: 89 %; 2009: 91 %). The majority of the German herring landings were taken in Subdivision 24 (2014: 80 %; 2013: 87 %; 2012: 86 %, 2011: 64 %; 2010: 73 %). 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 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 66 % in 2014 (2013: 67 %; 2012: 62 %; 2011: 68 %, 2010: 64 %). This 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



Landings in Subdivisions 22-29 (%)				
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%



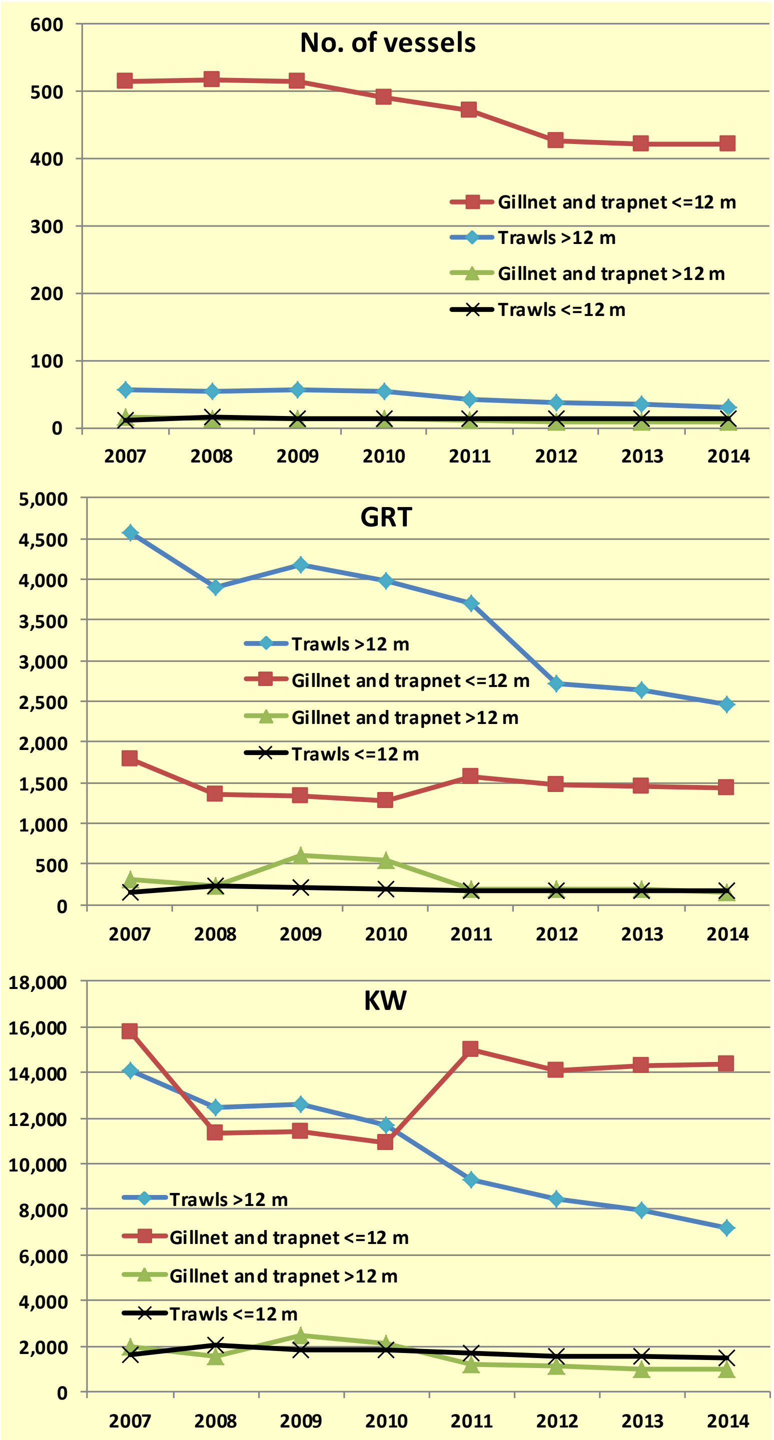
1.2 Fishing fleet

The German fishing fleet in the Baltic consists of two fleets where all catches for herring are taken in a directed fishery:

- 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 2006 until 2014 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 %):

	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2006	Fixed gears	<=12	517	1,782	15,673
	(gillnet and trapnet)	>12	16	545	2,482
	Trawls	<=12	13	220	2,055
		>12	62	4,404	14,227
	TOTAL		608	6,947	34,437
2007	Fixed gears	<=12	514	1,785	15,799
	(gillnet and trapnet)	>12	15	314	1992
	Trawls	<=12	10	161	1606
		>12	57	4,582	14,106
	TOTAL		596	6,842	33,503
2008	Fixed gears	<=12	518	1,350	11,319
	(gillnet and trapnet)	>12	14	234	1,560
	Trawls	<=12	16	232	2,041
		>12	54	3,912	12,465
	TOTAL		602	5,728	27,385
2009	Fixed gears	<=12	515	1,344	11,382
	(gillnet and trapnet)	>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	<=12	491	1,280	10,884
	(gillnet and trapnet)	>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	<=12	473	1,566	15,020
	(gillnet and trapnet)	>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	<=12	426	1,485	14,105
	(gillnet and trapnet)	>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


No. of vessels
600
500
400
300
200
100
0
2007
2008
2009
2010
2011
2012
2013
2014
Gillnet and trapnet <=12 m
Trawls >12 m
Gillnet and trapnet >12 m
Trawls <=12 m
GRT
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Trawls >12 m
Gillnet and trapnet <=12 m
Gillnet and trapnet >12 m
Trawls <=12 m
KW
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Trawls >12 m
Gillnet and trapnet <=12 m
Gillnet and trapnet >12 m
Trawls <=12 m

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 2014, are given below:

SD 22/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
January										
	Mean									
February	1	51.5	7.1	0.1	0.0	58.7	87.7	12.1	0.2	0.0
	Mean	51.5	7.1	0.1	0.0	58.7	87.7	12.1	0.2	0.0
March										
	Mean									
Q I	Mean	51.5	7.1	0.1	0.0	58.7	87.7	12.1	0.2	0.0

The results from the species composition of German trawl catches, which were sampled in Subdivision 24 of quarter 1 and 4 in 2014, are given below:

SD 24/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
January										
	Mean									
February	1	44.1	0.0	0.0	0.0	44.1	100.0	0.0	0.0	0.0
	Mean	44.1	0.0	0.0	0.0	44.1	100.0	0.0	0.0	0.0
March	2	63.3	0.0	0.0	0.0	63.3	100.0	0.0	0.0	0.0
	3	60.0	0.4	0.0	0.0	60.3	99.4	0.6	0.0	0.0
	4	55.4	1.0	0.0	0.0	56.3	98.3	1.7	0.0	0.0
	Mean	59.5	0.4	0.0	0.0	60.0	99.2	0.8	0.0	0.0
Q I	Mean	51.8	0.2	0.0	0.0	52.1	99.6	0.4	0.0	0.0

SD 24/Quarter IV		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
Octob.										
	Mean									
Novemb.	1	57.2	0.0	0.0	0.0	57.2	100.0	0.0	0.0	0.0
	Mean	57.2	0.0	0.0	0.0	57.2	100.0	0.0	0.0	0.0
Decemb.	2	29.1	0.0	0.0	0.0	29.1	100.0	0.0	0.0	0.0
	Mean	29.1	0.0	0.0	0.0	29.1	100.0	0.0	0.0	0.0
Q IV	Mean	43.1	0.0	0.0	0.0	43.1	100.0	0.0	0.0	0.0

The officially reported total trawl landings of herring in Subdivision 22 and 24 (see 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	1	**359**	87.7	315	-44
24	I	**4,028**	99.6	4,012	-16
	IV	**1,236**	100.0	1,236	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, which indicate a higher contribution of herring in Subdivision 22 (one sample!), would only result in overall small changes of the official statistics (total trawl landings in Subdivision 22 and 24 of

6,955 t – 110 t -> 2 % difference).

1.4 Discards

As in the years before no discards of herring have been reported in 2014.

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). The estimates of the growth parameters based on baseline samples of WBSSH and CBH support the applicability of SF in 2011-2014 (Oeberst et al., 2013, WD Oeberst et al., 2014; WD Oeberst et al., 2015). 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. The application of the present SF to commercial catch data in 2014, lead to similar results compared to 2005-2011. German gillnet catches in SD 22 and 24, mostly sampled at the spawning ground, consist of 100 % WBSSH. The highest amount of CBH was found in trawl landings (12 % in numbers and 6 % in biomass). As in the years before it was decided not to exclude CBH when compiling the assessment input data.

1.6 References

ICES 2013. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2013). ICES Document CM 2013/ACOM:46.

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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	358.662	1	439	89	4,028.329	4	1,686	496	**4,386.991**	**5**	**2,125**	**585**
	Q 2	71.222	0	0	0	391.972	0	0	0	**463.194**	**0**	**0**	**0**
	Q 3	0.123	0	0	0	no landings	-	-	-	**0.123**	**0**	**0**	**0**
	Q 4	142.067	0	0	0	1,236.013	2	1,134	308	**1,378.080**	**2**	**1,134**	**308**
	Total	572.074	1	439	89	5,656.314	6	2,820	804	**6,228.388**	**7**	**3,259**	**893**
GILLNET	Q 1	38.302	1	324	73	2,582.788	10	3,271	580	**2,621.090**	**11**	**3,595**	**653**
	Q 2	30.710	1	381	57	846.147	3	1,073	157	**876.857**	**4**	**1,454**	**214**
	Q 3	1.388	0	0	0	1.138	0	0	0	**2.526**	**0**	**0**	**0**
	Q 4	10.022	0	0	0	52.485	1	345	70	**62.507**	**1**	**345**	**70**
	Total	80.422	2	705	130	3,482.558	14	4,689	807	**3,562.980**	**16**	**5,394**	**937**
TRAPNET	Q 1	0.088	0	0	0	301.810	0	0	0	**301.898**	**0**	**0**	**0**
	Q 2	1.005	0	0	0	145.254	1	448	104	**146.259**	**1**	**448**	**104**
	Q 3	0.350	0	0	0	no landings	-	-	-	**0.350**	**0**	**0**	**0**
	Q 4	1.217	0	0	0	no landings	-	-	-	**1.217**	**0**	**0**	**0**
	Total	2.660	0	0	0	447.064	1	448	104	**449.724**	**1**	**448**	**104**
TOTAL	Q 1	**397.052**	**2**	**763**	**162**	**6,912.927**	**14**	**4,957**	**1,076**	**7,309.979**	**16**	**5,720**	**1,238**
	Q 2	**102.937**	**1**	**381**	**57**	**1,383.373**	**4**	**1,521**	**261**	**1,486.310**	**5**	**1,902**	**318**
	Q 3	**1.861**	**0**	**0**	**0**	**1.138**	**0**	**0**	**0**	**2.999**	**0**	**0**	**0**
	Q 4	**153.306**	**0**	**0**	**0**	**1,288.498**	**3**	**1,479**	**378**	**1,441.804**	**3**	**1,479**	**378**
	Total	**655.156**	**3**	**1,144**	**219**	**9,585.936**	**21**	**7,957**	**1,715**	**10,241.092**	**24**	**9,101**	**1,934**

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	335.400	0	0	0	181.420	0	0	0	45.049	0	0	0
	Q 2	148.433	0	0	0	83.333	0	0	0	188.000	0	0	0
	Q 3	0.000				0.000				0.000			
	Q 4	1.636	0	0	0	0.000				0.000			
	Total	485.469	0	0	0	264.753	0	0	0	233.049	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	168.607	0	0	0	517.757	0	0	0	1,248.233	0	0	0
	Q 2	54.333	0	0	0	0.000				474.099	0	0	0
	Q 3	0.000				0.000				0.000	0	0	0
	Q 4	1.636	0	0	0	5.727	0	0	0	8.999	0	0	0
	Total	224.576	0	0	0	523.484	0	0	0	1,731.331	0	0	0

1.8 Catch in numbers (millions)

1.8.1 Subdivisions 22 and 24

		SUBDIVISION 22				SUBDIVISION 24				SUBDIVISIONS 22+24			
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0			0.000	0.082				0.717			0.000	0.799
	1	0.085	0.017	0.001	0.695	0.613	0.060		6.048	0.698	0.077	0.001	6.743
	2	2.067	0.410	0.000	0.502	2.991	0.291		4.368	5.058	0.702	0.000	4.870
	3	2.649	0.526	0.000	0.395	9.031	0.879		3.439	11.681	1.405	0.000	3.834
	4	0.621	0.123	0.000	0.103	11.955	1.163		0.900	12.576	1.287	0.000	1.003
	5	0.121	0.024	0.000	0.025	5.794	0.564		0.216	5.915	0.588	0.000	0.241
	6	0.057	0.011	0.000	0.039	1.864	0.181		0.338	1.921	0.193	0.000	0.377
	7	0.044	0.009	0.000	0.007	1.432	0.139		0.065	1.476	0.148	0.000	0.072
	8+	0.013	0.003	0.000	0.019	1.094	0.106		0.167	1.106	0.109	0.000	0.186
	Sum	5.657	1.123	0.002	1.869	34.773	3.384		16.257	40.431	4.507	0.002	18.125
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GILLNET	0												
	1												
	2												
	3	0.003			0.023	0.048	0.022	0.000	0.119	0.051	0.022	0.000	0.141
	4	0.034	0.019	0.001	0.017	2.956	1.001	0.001	0.091	2.990	1.021	0.002	0.109
	5	0.035	0.069	0.003	0.012	5.279	1.091	0.001	0.065	5.314	1.160	0.005	0.078
	6	0.024	0.042	0.002	0.003	2.254	1.408	0.002	0.015	2.279	1.450	0.004	0.018
	7	0.042	0.030	0.001	0.002	1.411	0.645	0.001	0.009	1.453	0.675	0.002	0.010
	8+	0.065	0.016	0.001	0.000	1.594	0.552	0.001	0.002	1.659	0.568	0.001	0.002
	Sum	0.203	0.176	0.008	0.057	13.542	4.720	0.006	0.301	13.745	4.896	0.014	0.358
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAPNET	0												
	1												
	2	0.000	0.000	0.000	0.0004	0.108	0.052			0.108	0.052	0.000	0.0004
	3	0.000	0.004	0.001	0.0046	1.148	0.552			1.148	0.556	0.001	0.0046
	4	0.000	0.005	0.002	0.0057	1.416	0.682			1.417	0.686	0.002	0.0057
	5	0.000	0.002	0.001	0.0025	0.629	0.303			0.630	0.305	0.001	0.0025
	6	0.000	0.000	0.000	0.0005	0.113	0.054			0.113	0.055	0.000	0.0005
	7	0.000	0.000	0.000	0.0000	0.011	0.005			0.011	0.005	0.000	0.0000
	8+	0.000	0.000	0.000	0.0001	0.031	0.015			0.031	0.015	0.000	0.0001
	Sum	0.001	0.012	0.004	0.0139	3.455	1.663			3.456	1.674	0.004	0.0139
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TOTAL	0			0.000	0.082				0.717			0.000	0.799
	1	0.085	0.017	0.001	0.695	0.613	0.060		6.048	0.698	0.077	0.001	6.743
	2	2.0670	0.411	0.001	0.503	3.099	0.343		4.368	5.166	0.754	0.001	4.871
	3	2.653	0.530	0.002	0.423	10.227	1.453	0.000	3.557	12.880	1.983	0.002	3.980
	4	0.656	0.147	0.003	0.127	16.327	2.846	0.001	0.991	16.982	2.994	0.004	1.118
	5	0.157	0.095	0.004	0.040	11.702	1.957	0.001	0.281	11.859	2.053	0.005	0.321
	6	0.081	0.054	0.002	0.042	4.231	1.644	0.002	0.353	4.312	1.698	0.004	0.395
	7	0.085	0.039	0.001	0.009	2.854	0.790	0.001	0.073	2.939	0.828	0.002	0.082
	8+	0.078	0.018	0.001	0.020	2.718	0.674	0.001	0.168	2.796	0.692	0.002	0.188
	Sum	5.861	1.311	0.014	1.940	51.770	9.766	0.006	16.557	57.632	11.078	0.020	18.497

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	22	Trawl	1	Trawl	2	24	Trawl	1
Trawl	3,4	24	Trawl	4	Gillnet	3	24	Gillnet	2
Gillnet	3	22	Gillnet	2	Trapnet	1	24	Trapnet	2
Gillnet	4	24	Gillnet	4					
Trapnet	1,2,3, 4	24	Trapnet	2					

1.8.2 Subdivisions 25–29

No sampling

1.9 Mean weight in the catch (grams)

1.9.1 Subdivisions 22 and 24

		SUBDIVISION 22				SUBDIVISION 24				SUBDIVISIONS 22+24			
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0			16.4	16.4				16.4			16.4	16.4
	1	32.6	32.6	39.8	39.8	18.2	18.2		39.8	20.0	21.4	39.8	39.8
	2	49.2	49.2	77.5	77.5	44.0	44.0		77.5	46.1	47.0	77.5	77.5
	3	65.2	65.2	111.9	111.9	76.9	76.9		111.9	74.3	72.5	111.9	111.9
	4	86.7	86.7	142.5	142.5	122.9	122.9		142.5	121.1	119.5	142.5	142.5
	5	106.8	106.8	177.8	177.8	156.4	156.4		177.8	155.4	154.4	177.8	177.8
	6	114.6	114.6	146.5	146.5	169.2	169.2		146.5	167.6	166.0	146.5	146.5
	7	139.4	139.4	198.9	198.9	191.4	191.4		198.9	189.8	188.3	198.9	198.9
	8+	160.0	160.0	188.1	188.1	206.2	206.2		188.1	205.6	205.1	188.1	188.1
	Sum	63.4	63.4	76.0	76.0	115.8	115.8		75.3	108.5	102.8	76.0	75.4
GILLNET	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	0												
	1												
	2												
	3	126.5			155.0	154.0	121.4	121.4	155.0	152.5	121.4	121.4	155.0
	4	159.5	168.0	168.0	180.5	176.4	171.0	171.0	180.5	176.2	171.0	169.8	180.5
	5	177.9	172.6	172.6	193.6	186.3	175.5	175.5	193.6	186.2	175.3	173.5	193.6
	6	184.0	167.2	167.2	189.1	192.9	182.4	182.4	189.1	192.8	182.0	174.8	189.1
	7	191.4	180.2	180.2	200.4	207.8	182.1	182.1	200.4	207.3	182.0	181.0	200.4
	8+	212.4	195.3	195.3	236.5	214.9	192.6	192.6	236.5	214.8	192.7	193.9	236.5
	Sum	188.6	174.1	174.1	174.6	190.7	179.3	179.3	174.6	190.7	179.1	176.4	174.6
TRAPNET	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	0												
	1												
	2	49.2	49.2	49.2	49.2	49.2	49.2			49.2	49.2	49.2	49.2
	3	65.5	65.5	65.5	65.5	65.5	65.5			65.5	65.5	65.5	65.5
	4	90.7	90.7	90.7	90.7	90.7	90.7			90.7	90.7	90.7	90.7
	5	114.5	114.5	114.5	114.5	114.5	114.5			114.5	114.5	114.5	114.5
	6	119.5	119.5	119.5	119.5	119.5	119.5			119.5	119.5	119.5	119.5
	7	160.5	160.5	160.5	160.5	160.5	160.5			160.5	160.5	160.5	160.5
	8+	181.2	181.2	181.2	181.2	181.2	181.2			181.2	181.2	181.2	181.2
	Sum	87.3	87.3	87.3	87.3	87.3	87.3			87.3	87.3	87.3	87.3
TOTAL	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	0			16.4	16.4				16.4			16.4	16.4
	1	32.6	32.6	39.8	39.8	18.2	18.2		39.8	20.0	21.4	39.8	39.8
	2	49.2	49.2	71.1	77.4	44.1	44.8		77.5	46.2	47.2	71.1	77.5
	3	65.3	65.2	75.0	113.7	76.0	73.3	121.4	113.3	73.8	71.1	75.8	113.4
	4	90.5	97.5	118.4	145.4	129.8	132.1	171.0	146.0	128.3	130.4	136.4	146.0
	5	122.9	154.7	161.7	178.7	167.7	160.6	175.5	181.5	167.1	160.3	165.5	181.1
	6	135.4	155.9	163.9	149.0	180.5	178.9	182.4	148.3	179.7	178.2	172.8	148.3
	7	164.8	171.1	180.1	199.0	199.4	183.6	182.1	199.1	198.3	183.0	180.9	199.1
	8+	203.7	190.3	194.5	188.9	211.0	194.5	192.6	188.6	210.8	194.4	193.5	188.6
	Sum	67.7	78.5	136.9	79.0	133.5	141.6	179.3	77.8	126.8	134.2	150.4	77.9

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	22	Trawl	1	Trawl	2	24	Trawl	1
Trawl	3,4	24	Trawl	4	Gillnet	3	24	Gillnet	2
Gillnet	3	22	Gillnet	2	Trapnet	1	24	Trapnet	2
Gillnet	4	24	Gillnet	4					
Trapnet	1,2,3, 4	24	Trapnet	2					

1.9.2 Subdivisions 25 and 29

No sampling

1.10 Mean length in the catch (cm)

1.10.1 Subdivisions 22 and 24

		SUBDIVISION 22				SUBDIVISION 24				SUBDIVISIONS 22+24			
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0			14.1	14.1				14.1			14.1	14.1
	1	17.6	17.6	18.4	18.4	14.8	14.8		18.4	15.1	15.4	18.4	18.4
	2	19.8	19.8	22.2	22.2	19.3	19.3		22.2	19.5	19.6	22.2	22.2
	3	21.5	21.5	24.6	24.6	22.5	22.5		24.6	22.3	22.2	24.6	24.6
	4	23.2	23.2	26.5	26.5	25.5	25.5		26.5	25.3	25.2	26.5	26.5
	5	24.6	24.6	28.3	28.3	27.3	27.3		28.3	27.2	27.2	28.3	28.3
	6	25.0	25.0	26.6	26.6	28.0	28.0		26.6	27.9	27.8	26.6	26.6
	7	26.3	26.3	29.1	29.1	29.2	29.2		29.1	29.1	29.0	29.1	29.1
	8+	27.8	27.8	28.9	28.9	30.0	30.0		28.9	30.0	30.0	28.9	28.9
	Sum	21.2	21.2	21.5	21.5	24.7	24.7		21.5	24.2	23.8	21.5	21.5
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GILLNET	0												
	1												
	2												
	3	25.2		25.3	26.6	26.7	25.3	25.3	26.6	26.6	25.3	25.3	26.6
	4	27.1	27.8	27.9	28.2	28.0	27.9	27.9	28.2	28.0	27.9	27.9	28.2
	5	28.2	28.2	28.2	28.8	28.6	28.2	28.2	28.8	28.6	28.2	28.2	28.8
	6	28.5	27.9	28.7	28.6	29.0	28.7	28.7	28.6	29.0	28.7	28.7	28.6
	7	29.0	28.7	28.7	29.0	29.9	28.7	28.7	29.0	29.9	28.7	28.7	29.0
	8+	30.6	30.0	29.4	31.0	30.4	29.4	29.4	31.0	30.4	29.4	29.4	31.0
	Sum	29.0	28.3	28.5	27.7	28.9	28.5	28.5	27.7	28.9	28.5	28.5	27.7
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAPNET	0												
	1												
	2	20.1	20.1	20.1	20.1	20.1	20.1			20.1	20.1	20.1	20.1
	3	22.0	22.0	22.0	22.0	22.0	22.0			22.0	22.0	22.0	22.0
	4	24.2	24.2	24.2	24.2	24.2	24.2			24.2	24.2	24.2	24.2
	5	26.0	26.0	26.0	26.0	26.0	26.0			26.0	26.0	26.0	26.0
	6	26.3	26.3	26.3	26.3	26.3	26.3			26.3	26.3	26.3	26.3
	7	28.8	28.8	28.8	28.8	28.8	28.8			28.8	28.8	28.8	28.8
	8+	30.9	30.9	30.9	30.9	30.9	30.9			30.9	30.9	30.9	30.9
	Sum	23.8	23.8	23.8	23.8	23.8	23.8			23.8	23.8	23.8	23.8
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TOTAL	0			14.1	14.1				14.1			14.1	14.1
	1	17.6	17.6	18.4	18.4	14.8	14.8		18.4	15.1	15.4	18.4	18.4
	2	19.8	19.8	21.8	22.2	19.4	19.4		22.2	19.5	19.6	21.8	22.2
	3	21.5	21.5	22.5	24.7	22.5	22.4	25.3	24.7	22.3	22.1	22.6	24.7
	4	23.4	23.9	25.5	26.6	25.8	26.0	27.9	26.6	25.7	25.9	26.3	26.6
	5	25.4	27.2	27.8	28.3	27.8	27.6	28.2	28.4	27.8	27.6	27.9	28.4
	6	26.1	27.3	28.5	26.7	28.5	28.5	28.7	26.7	28.4	28.5	28.6	26.7
	7	27.6	28.2	28.7	29.1	29.5	28.7	28.7	29.1	29.5	28.7	28.7	29.1
	8+	30.1	29.7	29.5	28.9	30.2	29.5	29.4	28.9	30.2	29.6	29.4	28.9
	Sum	21.5	22.2	26.3	21.7	25.7	26.4	28.5	21.6	25.3	25.9	27.0	21.6

REPLACEMENT OF MISSING SAMPLES:

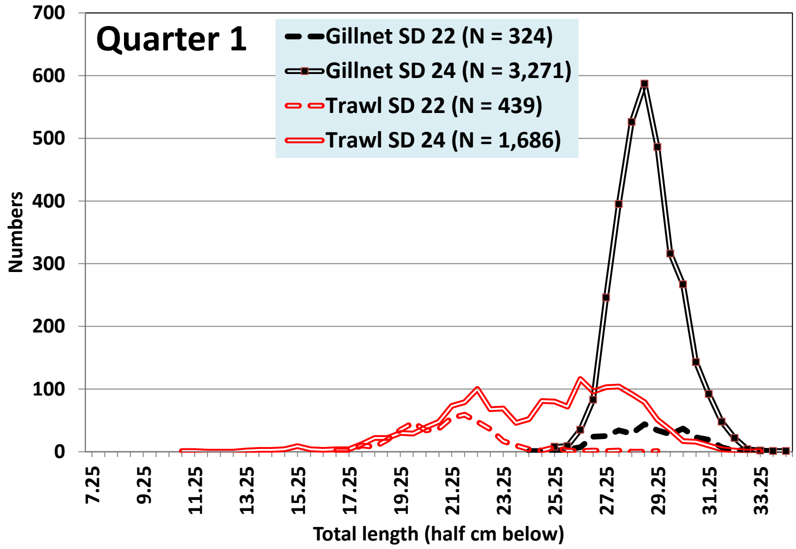
SUBDIVISION 22					SUBDIVISION 24				
Missing		Replacement by			Missing		Replacement by		
Gear	Quart.	Area	Gear	Quart.	Gear	Quart.	Area	Gear	Quart.
Trawl	2	22	Trawl	1	Trawl	2	24	Trawl	1
Trawl	3,4	24	Trawl	4	Gillnet	3	24	Gillnet	2
Gillnet	3	22	Gillnet	2	Trapnet	1	24	Trapnet	2
Gillnet	4	24	Gillnet	4					
Trapnet	1,2,3, 4	24	Trapnet	2					

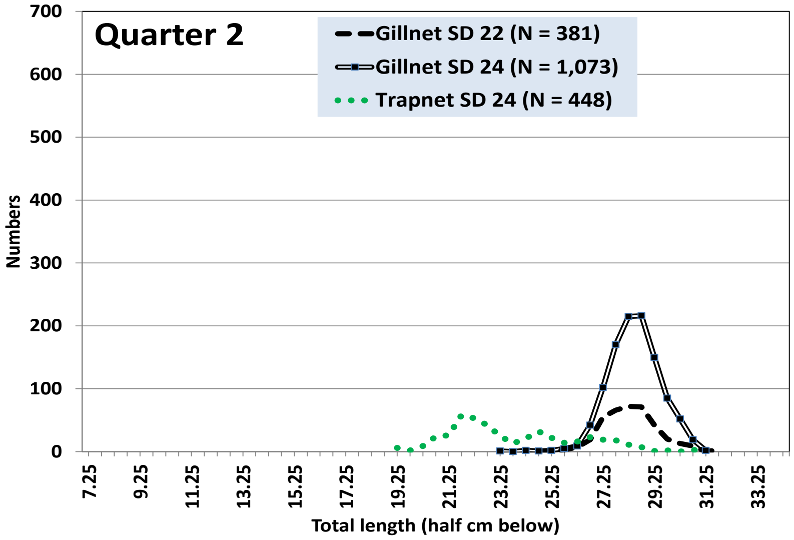
1.10.2 Subdivisions 25 and 29

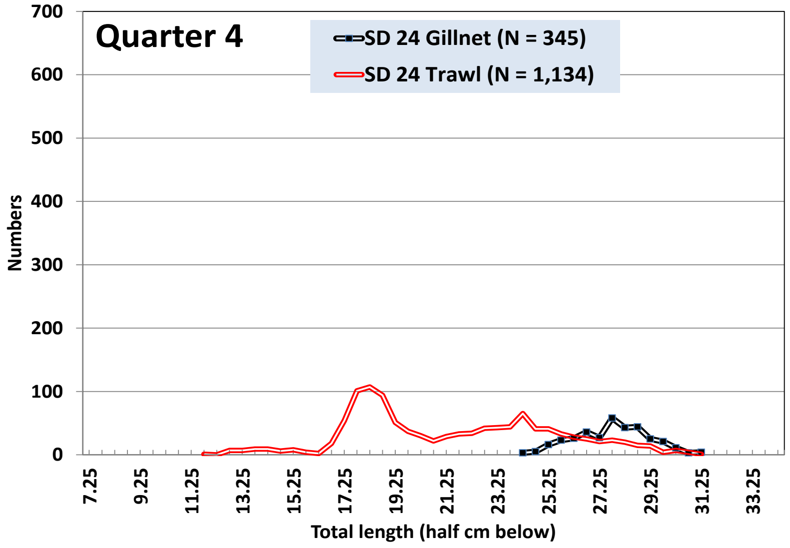
No sampling

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 sprat landings in Subdivisions 22-29 in 2014 according to the

(a) share of the EU quota (2014: 14,997 t) and

(b) further transfer of quota (overall 3,925 t were transferred to other Baltic countries)

reached 10,166 t, which represents a final utilization of the overall quota of 11,072 t of 92 % (2013: 10,315 t = 99 %).

As in previous years most sprat was

- landed in foreign ports (2014: 94 %; 2013: 93 %; 2012: 91 %, 2010-2011: 92 %),
- caught in the first quarter (2014: 75 %; 2013: 78 %; 2012: 62 %, 2011: 64 %, 2010: 60 %),
- caught in Subdivisions 25-29 (2014: 94 %; 2013: 93 %; 2012: 91 %, 2011: 89 %, 2010: 90 %). These catches were exclusively landed in foreign ports (2010-2014: 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	417.379	26.427	1,716.665	1,817.129	105.966	1,066.437	2,502.033	7,208.230	94.2%	**7,652.036**	75.3%
	0.000	0.000	1,716.665	1,817.129	105.966	1,066.437	2,502.033	7,208.230	100.0%	7,208.230	75.6%
II	38.740	5.375	886.832	384.187	542.529	397.823	-	2,211.371	98.0%	**2,255.486**	22.2%
	0.000	0.000	886.832	384.187	542.529	397.823	-	2,211.371	100.0%	2,211.371	23.2%
III	0.010	-	-	-	-	-	-	0.000	-	**0.010**	0.00%
	0.000	-	-	-	-	-	-	-	-	0.000	0.0%
IV	143.295	6.182	20.187	-	-	24.575	64.071	108.833	42.1%	**258.310**	2.5%
	0.000	0.000	20.187	-	-	24.575	64.071	108.833	100.0%	108.833	1.1%
Total	**599.424**	**37.984**	**2,623.684**	**2,201.316**	**648.495**	**1,488.835**	**2,566.104**	**9,528.434**	**93.7%**	**10,165.842**	100.0%
	0.000	0.000	2,623.684	2,201.316	648.495	1,488.835	2,566.104	9,528.434	100.0%	9,528.434	93.7%

	(1)	(2)
	2014/2013:	**2014/2013:**
Fraction of total landings (t) in foreign ports	99.7%	98.6%
	99.7%	99.7%
Proportion landed in foreign ports in 2014:		**93.7%**

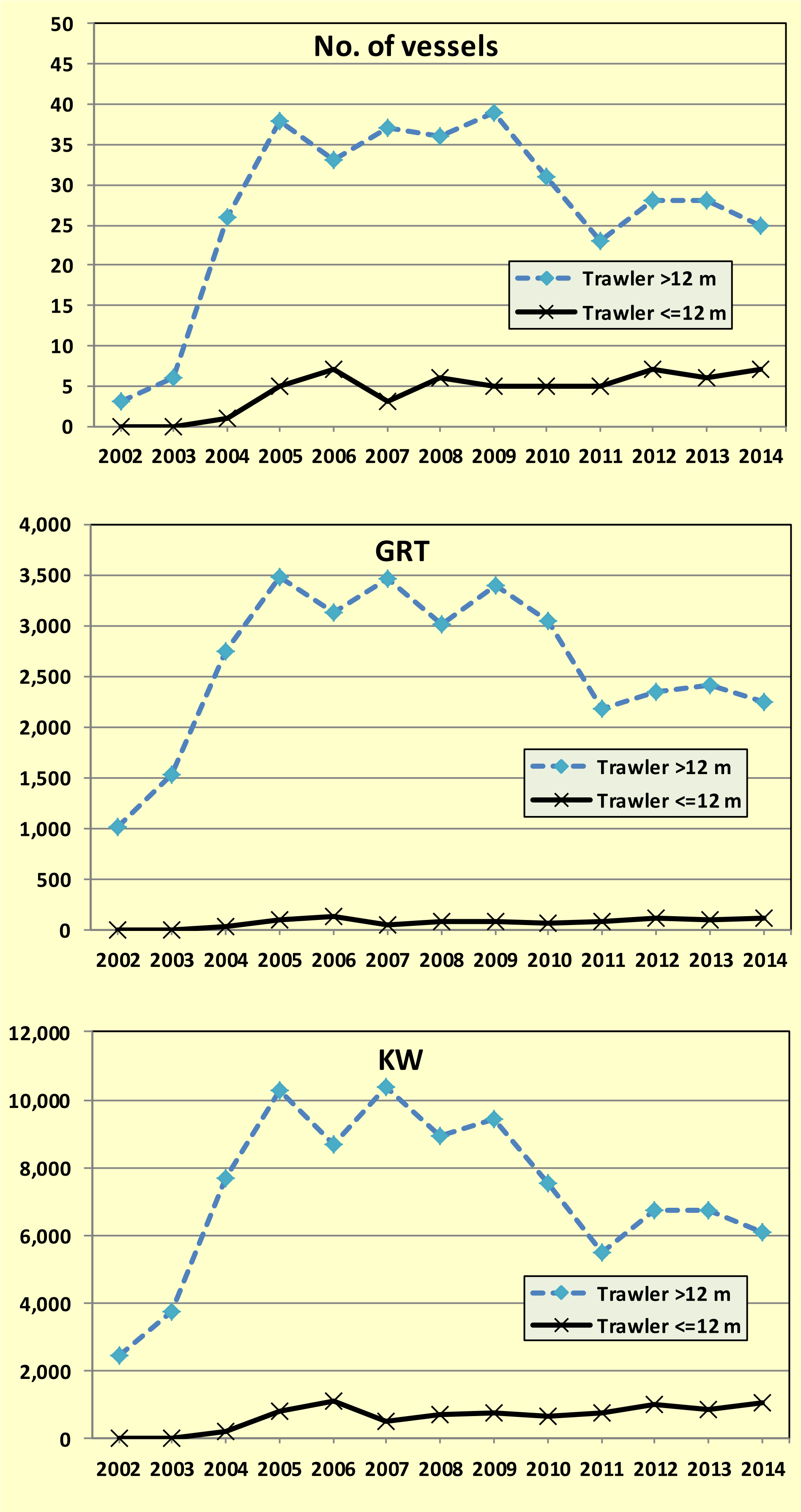
2.2 Fishing fleet

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 2007 – 2014 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
2007	<=12	3	43	492
	>12	37	3,454	10,396
2008	<=12	6	72	679
	>12	36	3,014	8,913
2009	<=12	5	79	761
	>12	39	3,389	9,438
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


No. of vessels
50
45
40
35
30
25
20
15
10
5
0
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Trawler >12 m
Trawler <=12 m
GRT
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Trawler >12 m
Trawler <=12 m
KW
12,000
10,000
8,000
6,000
4,000
2,000
0
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
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 22 of quarter 1** in 2014, are given below:

SD 22/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January										
	Mean									
February	1	13.1	1.7	0.1	0.2	15.2	86.5	11.4	0.9	1.2
	Mean	13.1	1.7	0.1	0.2	15.2	86.5	11.4	0.9	1.2
March										
	Mean									
Q I	Mean	13.1	1.7	0.1	0.2	15.2	86.5	11.4	0.9	1.2

The results from the species composition of German trawl catches, which were sampled in **Subdivision 24 of quarter 2** in 2014, are given below:

SD 24/Quarter II		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
April										
	Mean									
May										
	Mean									
June	1	2.2	0.0	0.0	0.0	2.2	100.0	0.0	0.0	0.0
	Mean	2.2	0.0	0.0	0.0	2.2	100.0	0.0	0.0	0.0
Q II	Mean	2.2	0.0	0.0	0.0	2.2	100.0	0.0	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 25 of quarter1 and quarter 2** in 2014, 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	5.5	0.7	0.0	0.0	6.3	88.8	11.2	0.0	0.0
	Mean	5.5	0.7	0.0	0.0	6.3	88.8	11.2	0.0	0.0
March	2	6.6	0.5	0.0	0.0	7.1	93.6	6.4	0.0	0.0
	3	5.5	1.9	0.0	0.0	7.4	74.3	25.7	0.0	0.0
	4	3.8	0.1	0.0	0.0	3.9	97.9	2.1	0.0	0.0
	Mean	5.3	0.8	0.0	0.0	6.1	88.6	11.4	0.0	0.0
Q I	Mean	5.4	0.8	0.0	0.0	6.2	88.7	11.3	0.0	0.0

SD 25/Quarter II		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
April	1	8.0	0.1	0.0	0.0	8.0	99.1	0.9	0.0	0.0
	Mean	8.0	0.1	0.0	0.0	8.0	99.1	0.9	0.0	0.0
May										
	Mean									
June										
	Mean									
Q II	Mean	7.953	0.069	0.000	0.000	8.022	99.1	0.9	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 26 of quarter1 and 1** in 2014, are given below:

SD 26/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January										
	Mean									
February	1	2.3	0.0	0.0	0.0	2.3	100.0	0.0	0.0	0.0
	2	8.4	0.0	0.0	0.0	8.4	100.0	0.0	0.0	0.0
	3	6.7	0.8	0.0	0.0	7.5	89.1	10.9	0.0	0.0
	Mean	5.8	0.3	0.0	0.0	6.1	96.4	3.6	0.0	0.0
March										
	Mean									
Q I	Mean	5.8	0.3	0.0	0.0	6.1	96.4	3.6	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 28 of quarter1 and 1** in 2014, are given below:

SD 28/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January	1	7.6	0.5	0.0	0.0	8.1	94.0	6.0	0.0	0.0
	Mean	7.6	0.5	0.0	0.0	8.1	94.0	6.0	0.0	0.0
February										
	Mean									
March	2	7.9	0.0	0.0	0.1	8.0	98.3	0.5	0.0	1.2
	3	7.2	0.3	0.0	0.0	7.5	95.6	4.4	0.0	0.0
	Mean	7.5	0.2	0.0	0.0	7.8	97.0	2.4	0.0	0.6
Q I	Mean	7.6	0.3	0.0	0.0	7.9	95.5	4.2	0.0	0.3

SD 28/Quarter II		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
April	1	8.3	0.0	0.0	0.0	8.3	100.0	0.0	0.0	0.0
	Mean	8.3	0.0	0.0	0.0	8.3	100.0	0.0	0.0	0.0
May										
	Mean									
June										
	Mean									
Q II	Mean	8.3	0.0	0.0	0.0	8.3	100.0	0.0	0.0	0.0

The results from the species composition of German trawl catches, which were sampled in **Subdivision 29 of quarter1** in 2014, are given below:

SD 29/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Sprat	Herring	Cod	Other	Total	Sprat	Herring	Cod	Other
January	1	8.3	0.0	0.0	0.0	8.3	100.0	0.0	0.0	0.0
	2	7.6	1.0	0.0	0.0	8.5	88.7	11.2	0.0	0.1
	3	7.3	0.5	0.0	0.0	7.9	93.1	6.9	0.0	0.0
	4	6.1	0.5	0.0	0.0	6.6	92.5	7.5	0.0	0.0
	Mean	7.3	0.5	0.0	0.0	7.8	93.6	6.4	0.0	0.0
February	5	8.0	0.9	0.0	0.0	8.9	89.4	10.6	0.0	0.0
	Mean	8.0	0.9	0.0	0.0	8.9	89.4	10.6	0.0	0.0
March										
	Mean									
Q I	Mean	7.6	0.7	0.0	0.0	8.4	91.5	8.5	0.0	0.0

The officially reported total trawl landings of Sprat in Subdivisions 22, 24-26, 28-29 (see 2.1) in combination with the detected 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)
22	I	417	86.5	361	-56
24	II	5	100.0	5	0
25	I	1,717	88.7	1,523	-194
	II	887	99.1	879	-8
26	I	1,817	96.4	1,752	-65
28	I	1,066	95.5	1,018	-48
	II	398	100.0	398	0
29	I	2,502	91.5	2,289	-213

The overall difference amounted to -584 t, which would represent a change of the total landing value for Germany in 2014 of -6 % (total landings in SD 22-29 in 2013 of 10,166 t – 584 t ->9, 581 t); differences in 2013: -7 %). 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 significant differences in 2014. However, an implementation error of about at least 6-7 % regarding the total landing figure for should be explored during the next benchmark process.

2.4 Discards

As in the years before no discards of herring have been reported in 2014.

2.5 Landings (tons) and sampling effort

Even so most of the sprat was landed in foreign port in 2014 (94 %), it was possible to sample 87 % (8,836 t) of the total landings:

Gear	Quarter	SUBDIVISION 22[1]				SUBDIVISION 24[2]				SUBDIVISION 25[3]			
		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	417.379	1	258	56	26.427	* 2	94	69	1,716.665	4	982	240
	Q 2	38.740	0	0	0	5.375	1	223	49	886.832	1	270	49
	Q 3	0.010	0	0	0	0.000	-	-	-	0.000	-	-	-
	Q 4	143.295	0	0	0	6.182	-	-	-	20.187	-	-	-
	Total	599.424	1	258	56	37.984	3	317	118	2,623.684	5	1,252	289

Gear	Quarter	SUBDIVISION 26[3]				SUBDIVISION 27[3]				SUBDIVISION 28[3]			
		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	1,817.129	3	945	183	105.966	0	0	0	1,066.437	3	1,012	175
	Q 2	384.187	0	0	0	542.529	0	0	0	397.823	1	297	57
	Q 3	0.000	-	-	-	0.000	-	-	-	0.000	-	-	-
	Q 4	0.000	-	-	-	0.000	-	-	-	24.575	-	-	-
	Total	2,201.316	3	945	183	648.495	0	0	0	1,488.835	4	1,309	232

*samples taken as by-catch in the herring trawl fishery

Gear	Quarter	SUBDIVISION 29[3]				SUBDIVISIONS 22-29[4]			
		Landings (tons)	No. samples	No. measured	No. aged	Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	2,502.033	5	1,659	265	7,652.036	18	4,950	988
	Q 2	0.000	-	-	-	2,255.486	3	790	155
	Q 3	0.000	-	-	-	0.010	0	0	0
	Q 4	64.071	0	0	0	258.310	0	0	0
	Total	2,566.104	5	1,659	265	10,165.842	21	5,740	1,143

Fraction of landings in foreign ports:

[1]SD 22: 0 %
[2]SD 24: 0 %
[3]SD 25, 26, 27, 28, 29: 100 %
[4]SD 22-29: 9,528 t (94 %)

2.6 Catch in numbers (millions)

		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	3.354				0.237	0.418			36.525	3.020			24.491			
	2	9.604				0.613	0.052			51.825	35.496			77.824			
	3	2.687				0.564	0.041			31.670	26.684			53.725			
	4	10.583				0.271	0.044			19.150	1.479			14.919			
	5	0.271				0.153				17.396	11.585			8.581			
	6	0.104				0.020				10.444	4.930			11.142			
	7	0.271								2.545				0.477			
	8+									2.545							
	Sum	26.875				1.858	0.554			172.098	83.193			191.158			

		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					21.09	5.45			36.69				122.38	8.89		
	2					42.52	16.18			112.09				294.48	51.73		
	3					31.18	16.50			80.26				200.09	43.23		
	4					7.60	2.53			18.84				71.37	4.06		
	5					10.03	2.65			24.77				61.20	14.24		
	6					3.09	0.44			2.83				27.63	5.37		
	7					0.65				1.98				5.93			
	8+					0.79				2.81				6.15			
	Sum					116.95	43.76			280.27				789.22	127.51		

*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	9.2				5.0	7.9			4.7	4.5			3.8			
	2	14.6				13.2	13.1			9.1	9.9			8.8			
	3	16.2				16.2	16.0			11.4	10.8			11.1			
	4	17.8				17.5	17.0			13.3	15.0			12.0			
	5	20.8				18.4				13.8	12.5			13.2			
	6	26.0				21.0				14.5	13.4			12.8			
	7	20.8								13.3				14.4			
	8+									12.8							
	Sum	14.4				14.2	9.7			10.0	10.7			9.0			

		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					4.1	3.8			4.0				4.3	4.2		
	2					8.8	8.5			8.5				8.9	9.5		
	3					10.8	10.4			10.0				10.7	10.7		
	4					11.2	11.5			11.3				13.0	12.8		
	5					12.2	12.3			11.8				12.7	12.5		
	6					13.2	14.7			12.9				13.6	13.5		
	7					12.6				13.4				13.7			
	8+					14.4				13.4				13.3			
	Sum					9.1	9.1			8.9				9.6	10.1		

*samples taken as by-catch in the herring trawl fishery

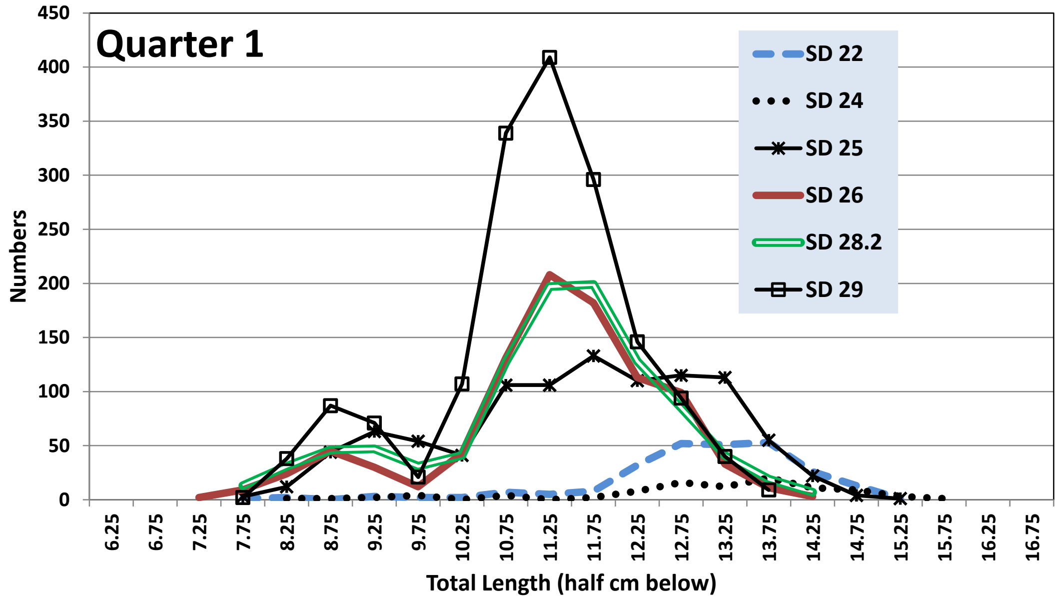
2.8 Mean length in the catch (cm)

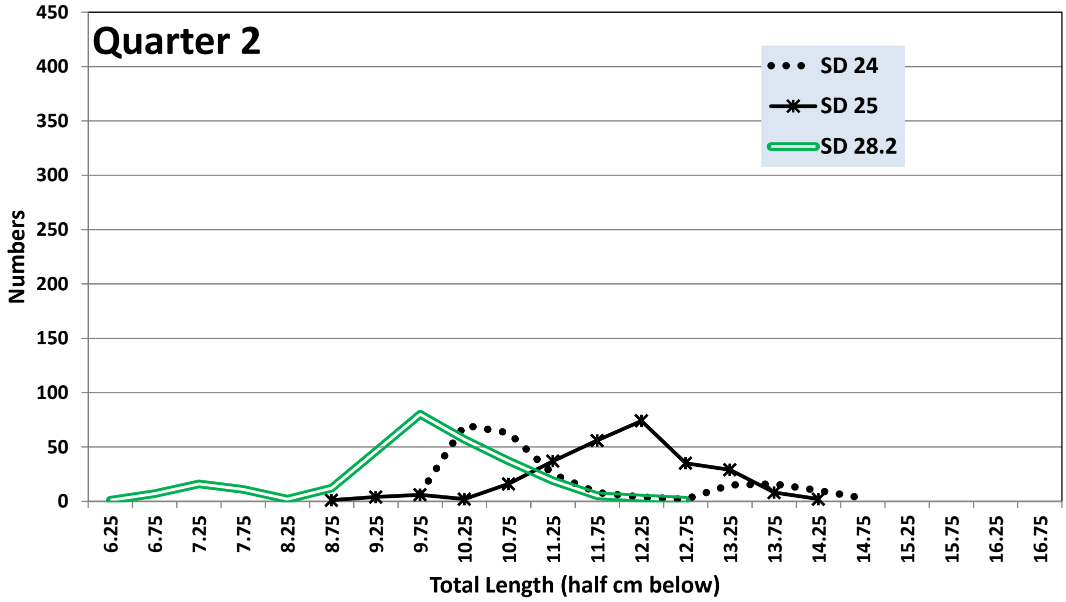
		SUBDIVISION 22				SUBDIVISION 24				SUBDIVISION 25				SUBDIVISION26			
	Age	Q1	Q2	Q3	Q4	*Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0																
	1	10.8				9.8	10.6			9.4	9.4			8.8			
	2	12.7				12.8	12.7			11.2	11.7			11.1			
	3	13.3				13.8	13.7			12.0	12.1			12.0			
	4	13.8				14.2	14.0			12.7	13.8			12.3			
	5	14.8				14.5				13.0	12.8			12.8			
	6	15.3				15.3				13.3	13.1			12.6			
	7	14.8								13.0				13.3			
	8+									12.8							
	Sum	13.0				13.1	11.3			11.5	12.0			11.3			

		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					9.0	8.8			8.9				9.1	9.1		
	2					11.2	11.0			10.9				11.1	11.5		
	3					12.0	11.8			11.6				11.8	12.0		
	4					12.2	12.2			12.1				12.6	12.8		
	5					12.6	12.7			12.3				12.6	12.7		
	6					13.0	13.6			12.8				12.9	13.2		
	7					12.8				12.9				13.0	0.0		
	8+					13.4				13.0				12.9	0.0		
	Sum					11.3	11.2			11.1				11.3	11.7		

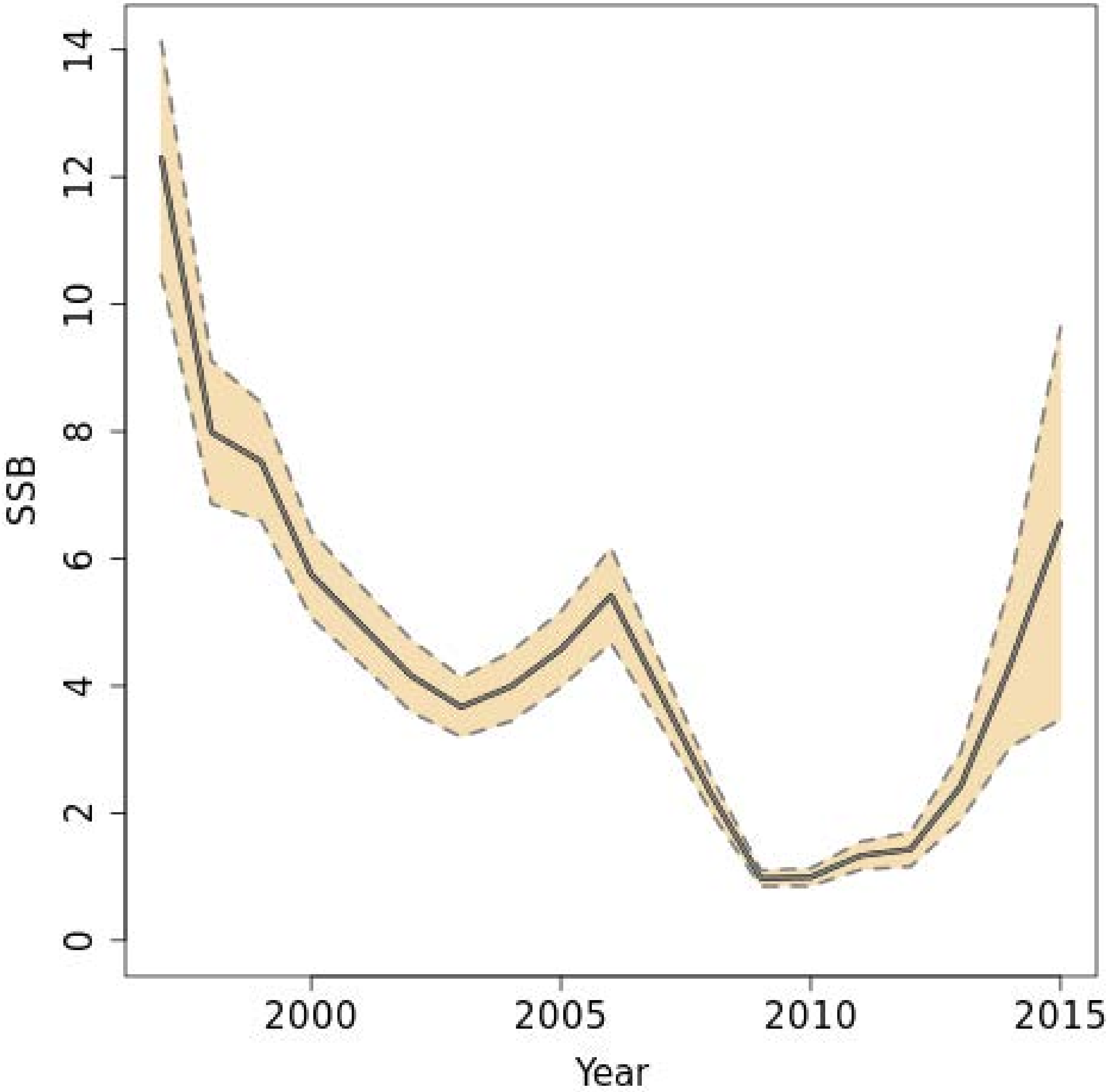
*samples taken as by-catch in the herring trawl fishery

2.9 Sampled length distributions of sprat by Subdivision and quarter

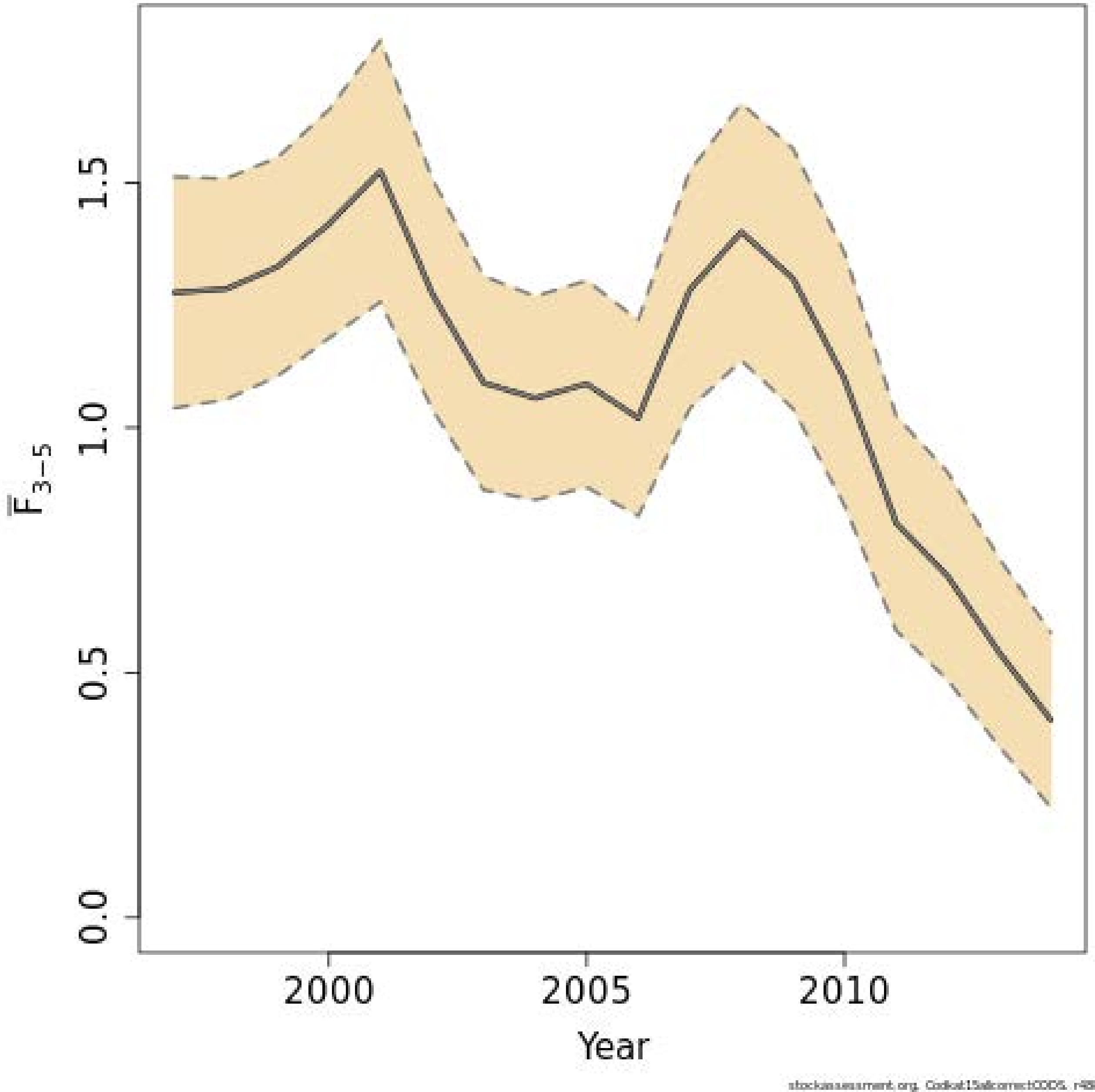




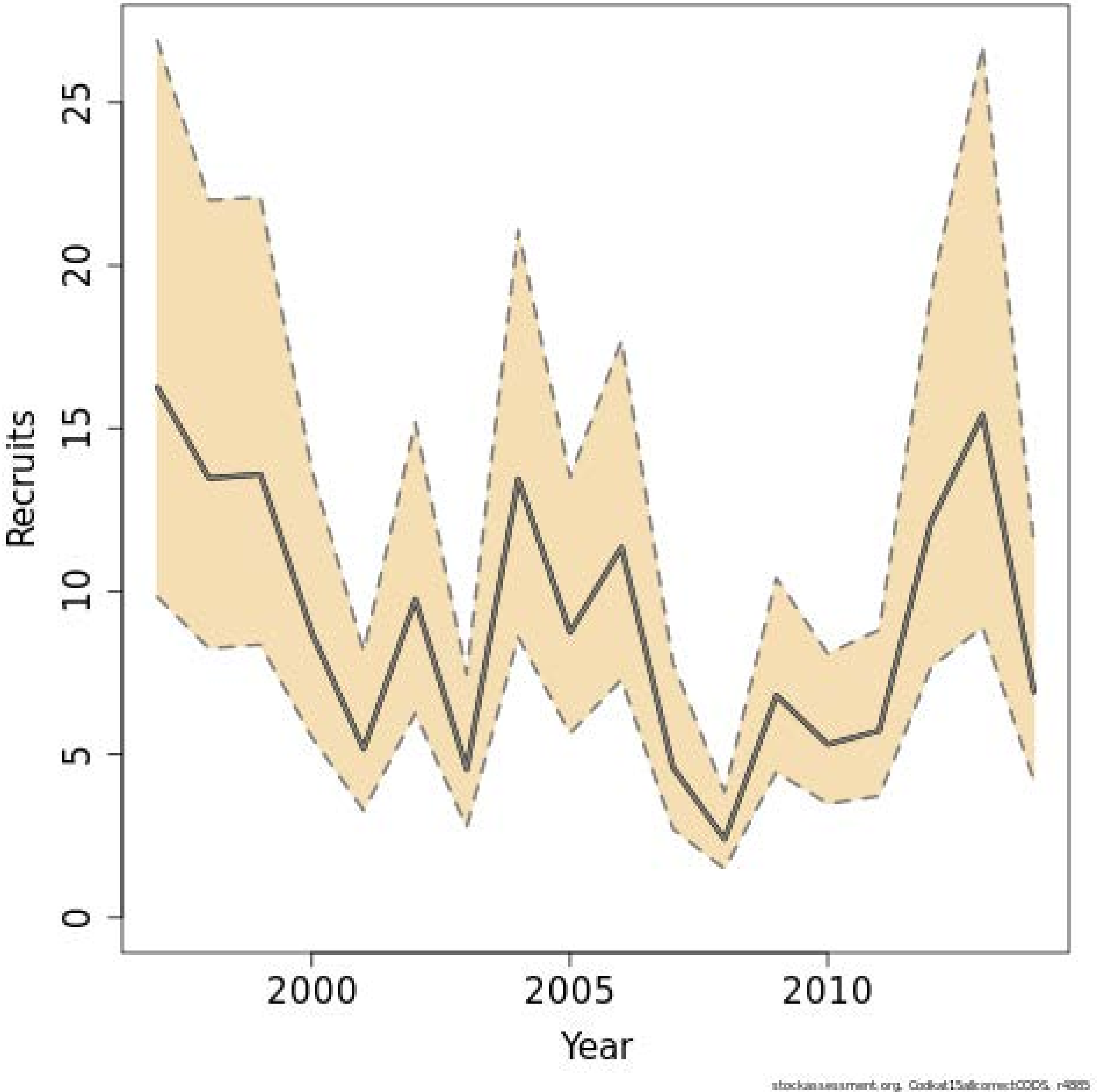
WD Kattegat cod



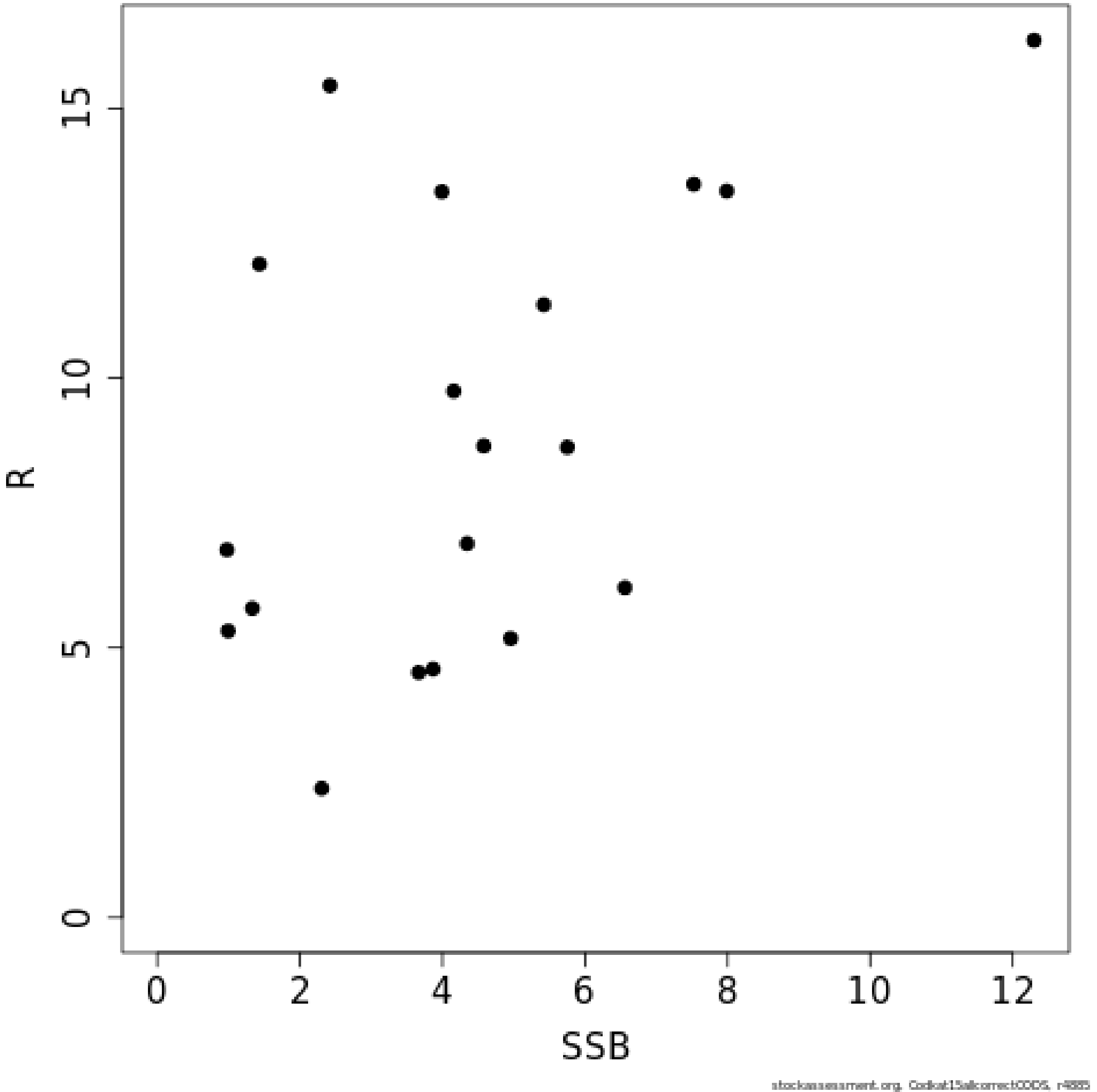
stockassessment.org, Collcat15allcorrectCODS, r4985

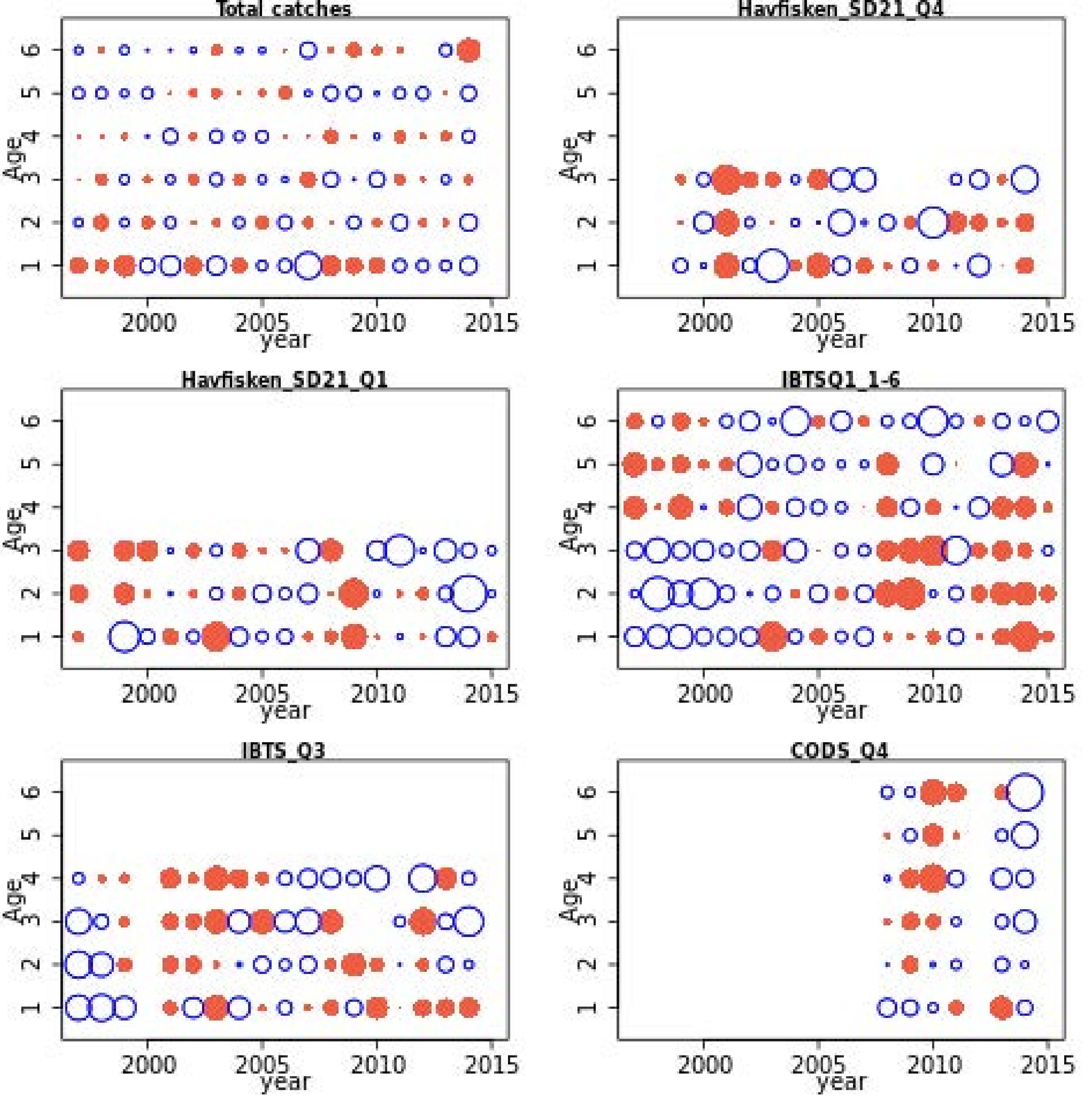


$\overline{F}_{3-5}$
0.0
0.5
1.0
1.5
2000
2005
2010
Year

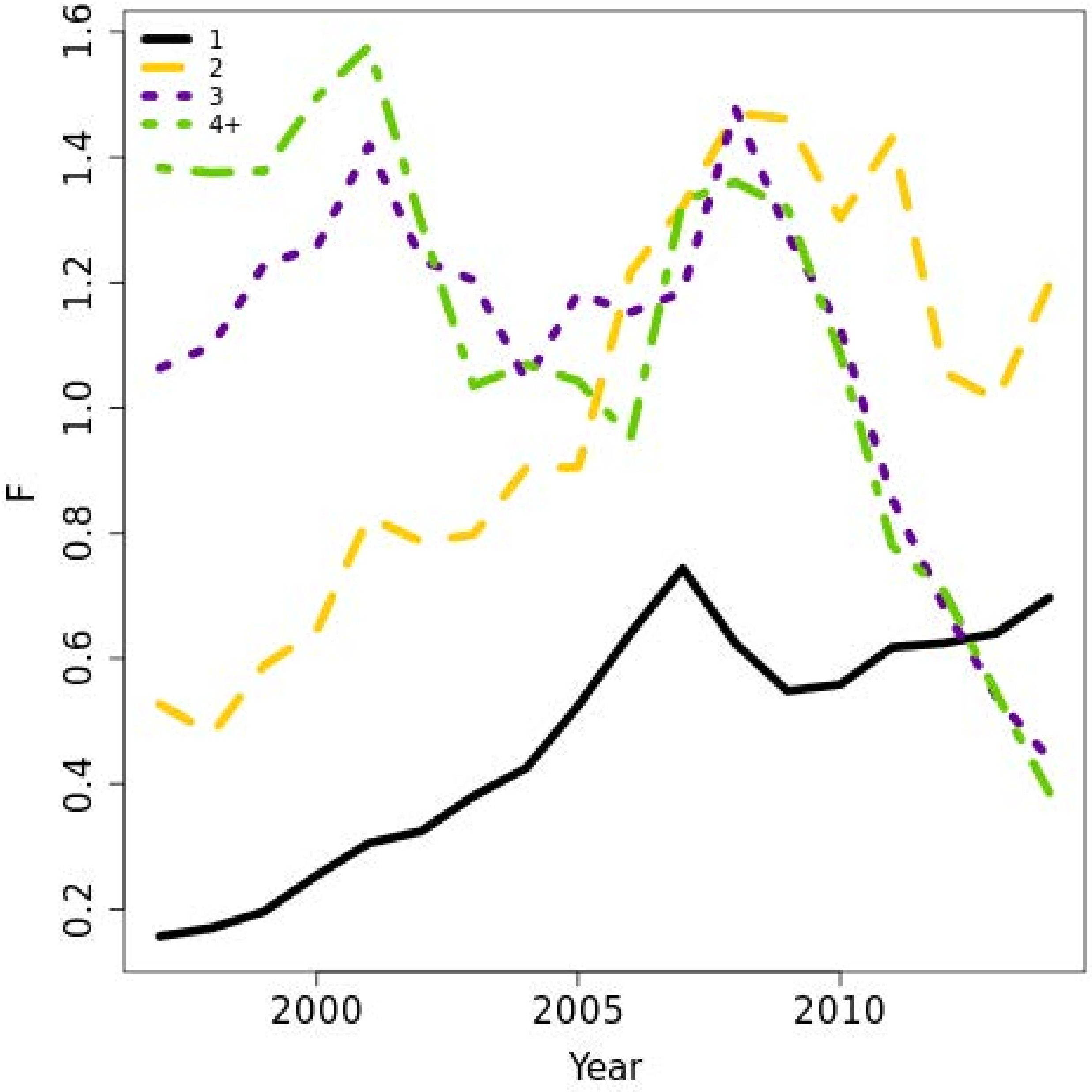


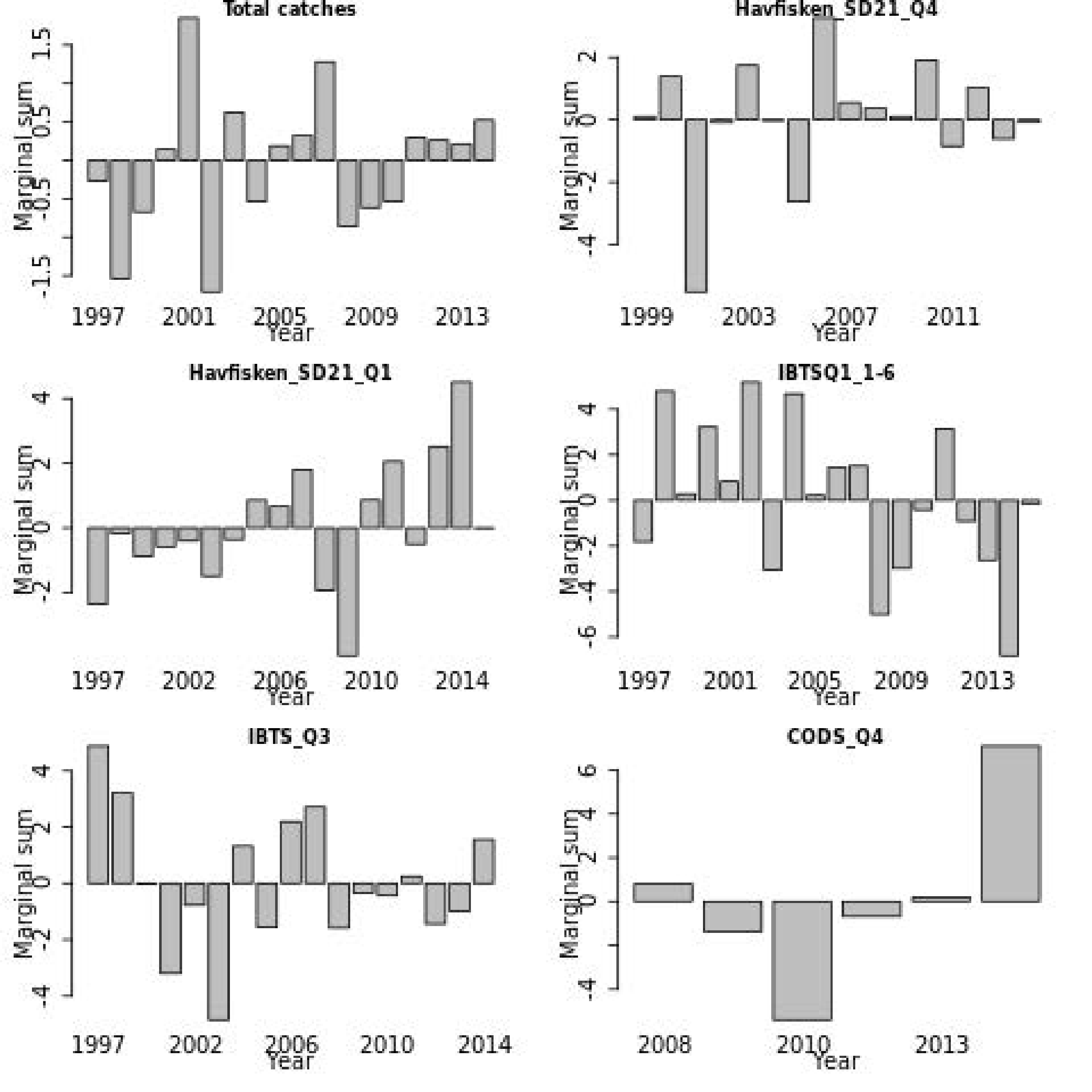
Recruits
0
5
10
15
20
25
2000
2005
2010
Year
stockassessment.org

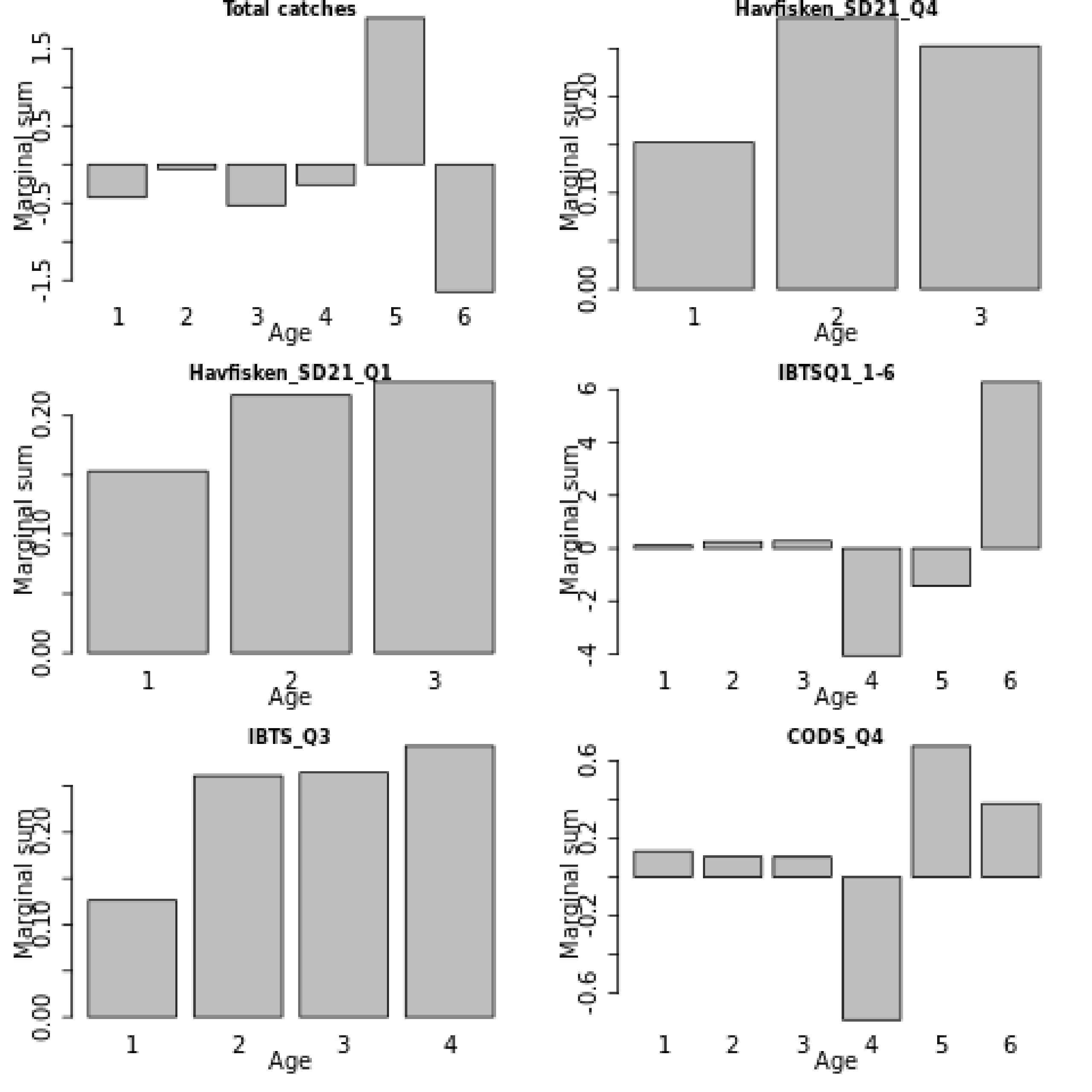

R
SSB
0
5
10
15
0
2
4
6
8
10
12
stockassessment.org, Codkat15alcorrectODS, r4885



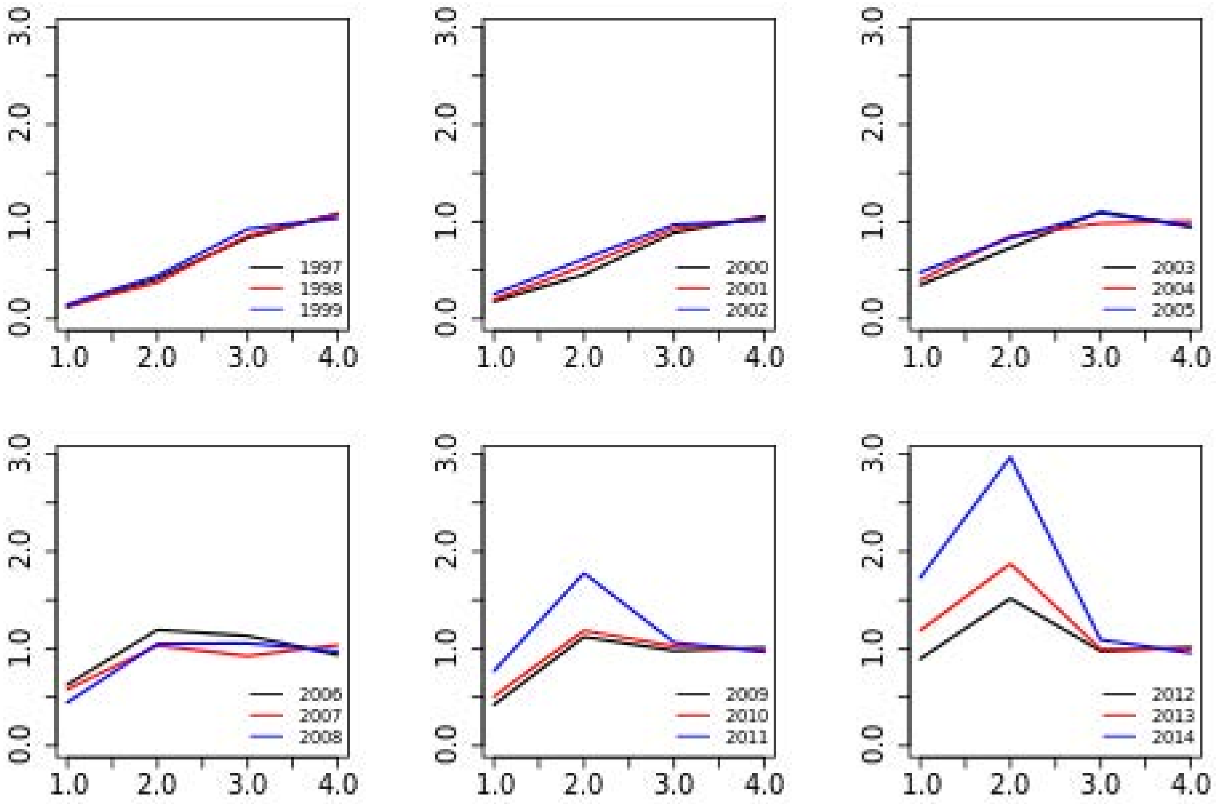
Total_catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Age
1
2
3
4
5
6
year
2000
2005
2010
2015


1
2
3
4+
F
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2000
2005
2010
Year

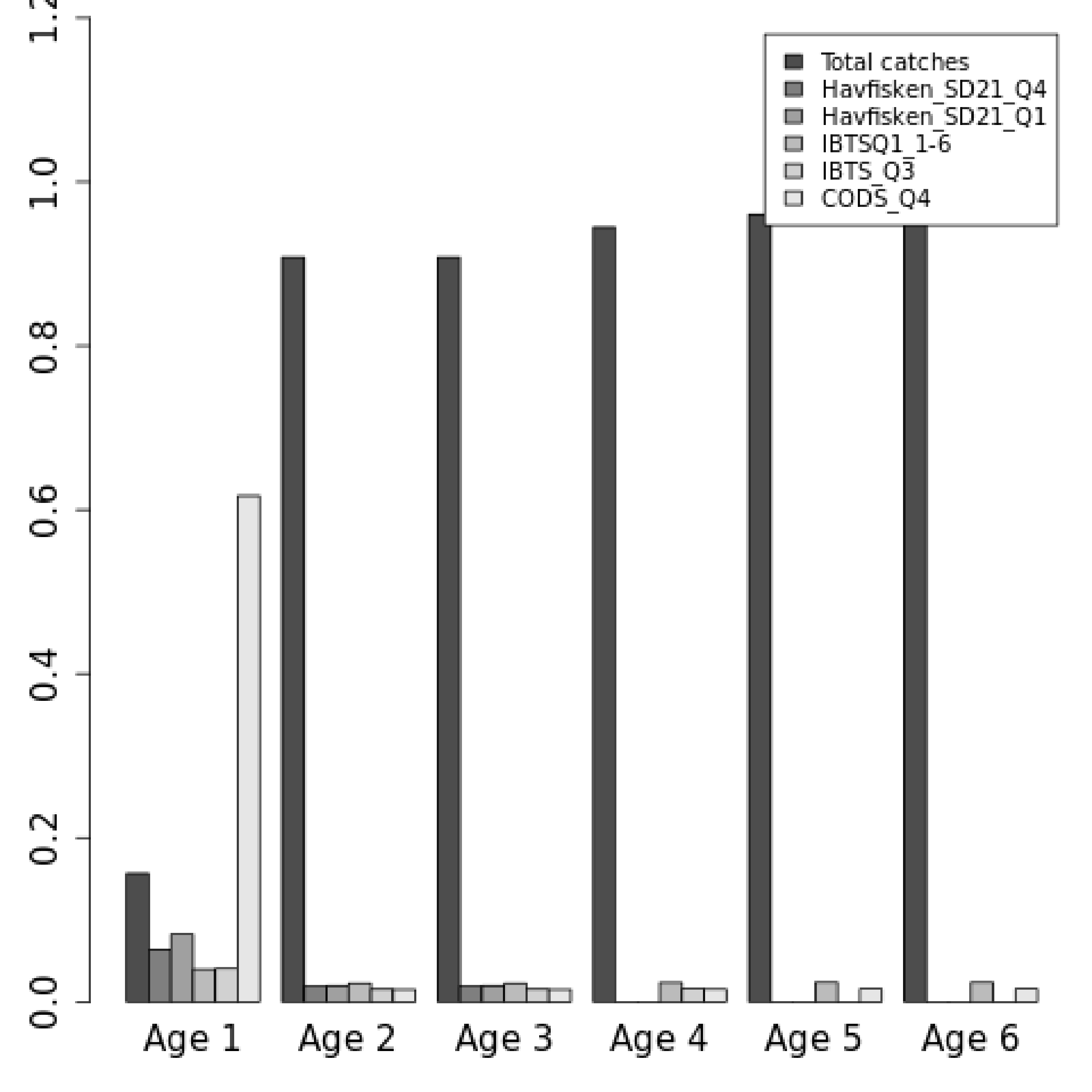

Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Marginal sum
Year
1997
2001
2005
2009
2013
1999
2003
2007
2011
2002
2006
2010
2014
2008
-1.5
-0.5
0.5
1.5
-6
-4
-2
0
2
4
6



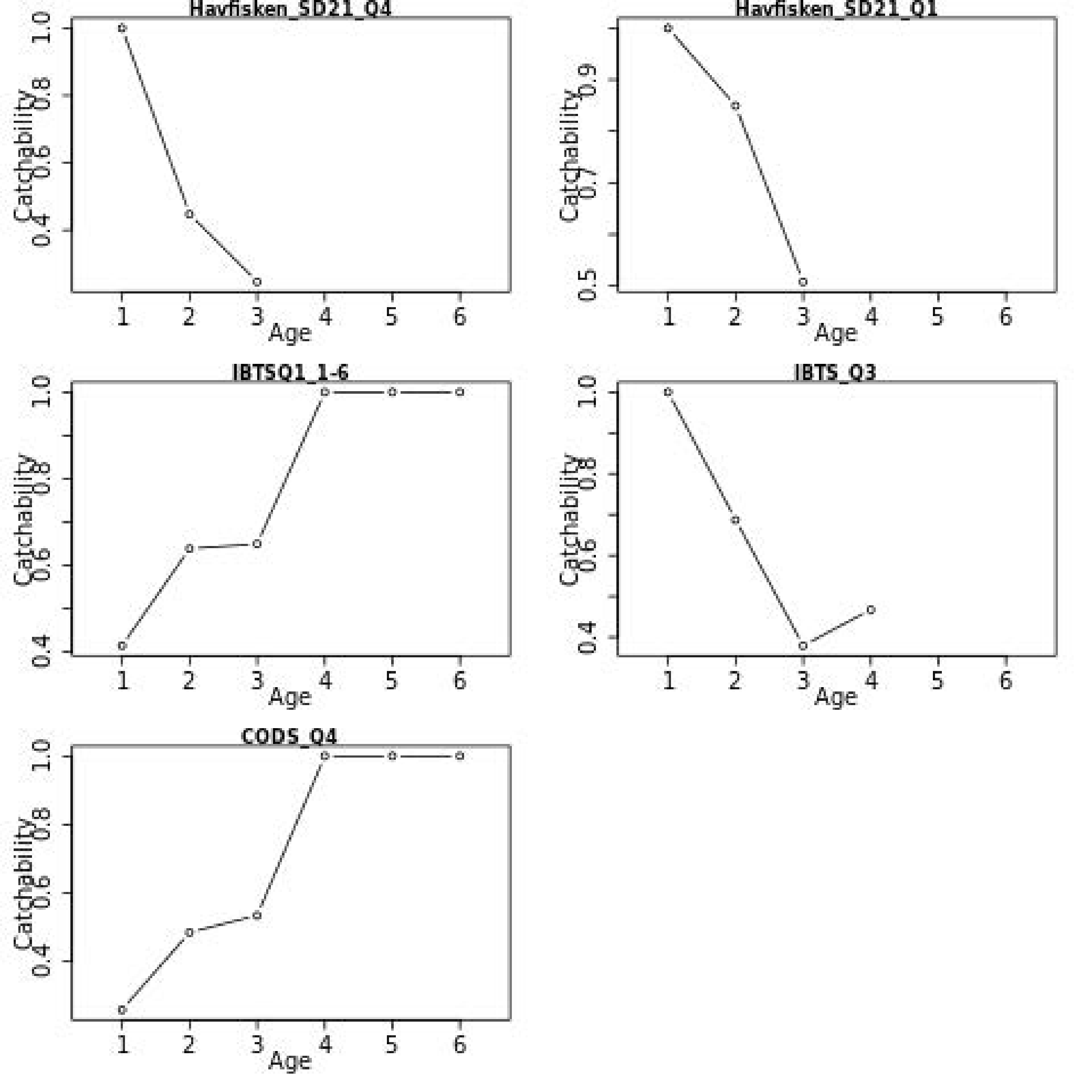
Total catches
Marginal sum
-1.5
-0.5
0.5
1.5
1
2
3
4
5
6
Age
Havfisken_SD21_Q4
Marginal sum
0.00
0.10
0.20
1
2
3
Age
Havfisken_SD21_Q1
Marginal sum
0.00
0.10
0.20
1
2
3
Age
IBTSQ1_1-6
Marginal sum
-4
-2
0
2
4
6
1
2
3
4
5
6
Age
IBTS_Q3
Marginal sum
0.00
0.10
0.20
1
2
3
4
Age
CODS_Q4
Marginal sum
-0.6
-0.2
0.2
0.6
1
2
3
4
5
6
Age



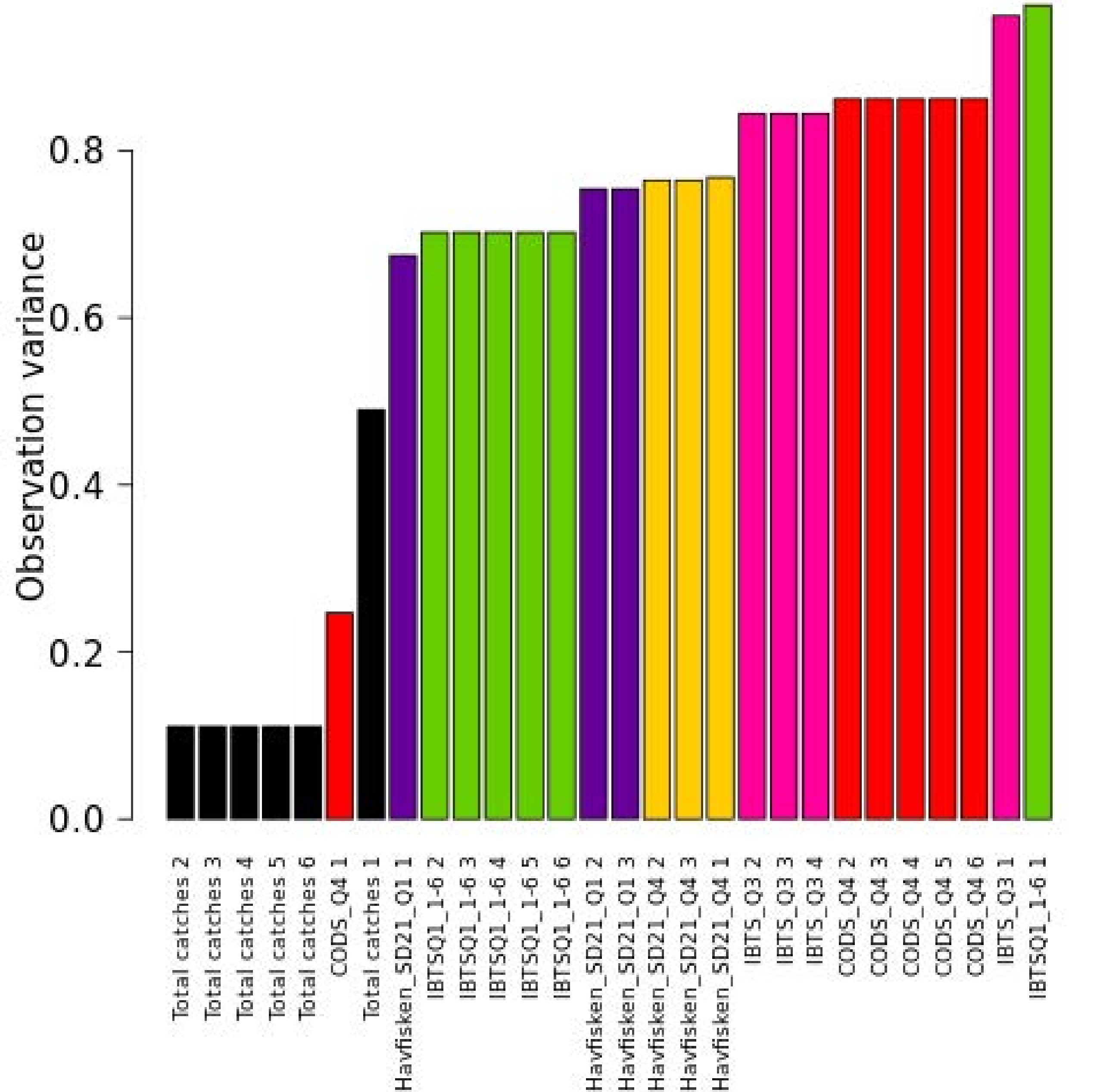
3.0
2.0
1.0
0.0
1.0
2.0
3.0
4.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014



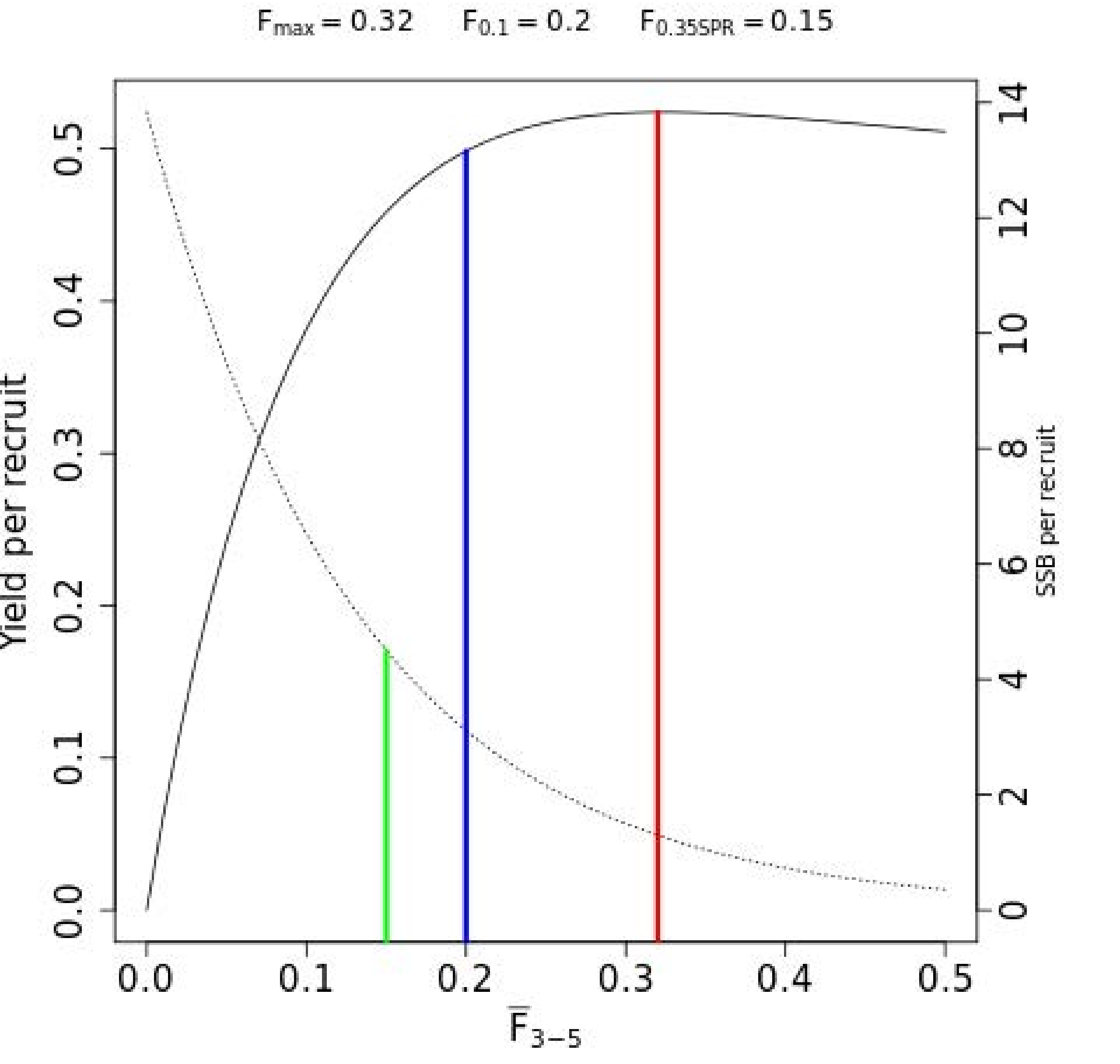
Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Age 1
Age 2
Age 3
Age 4
Age 5
Age 6

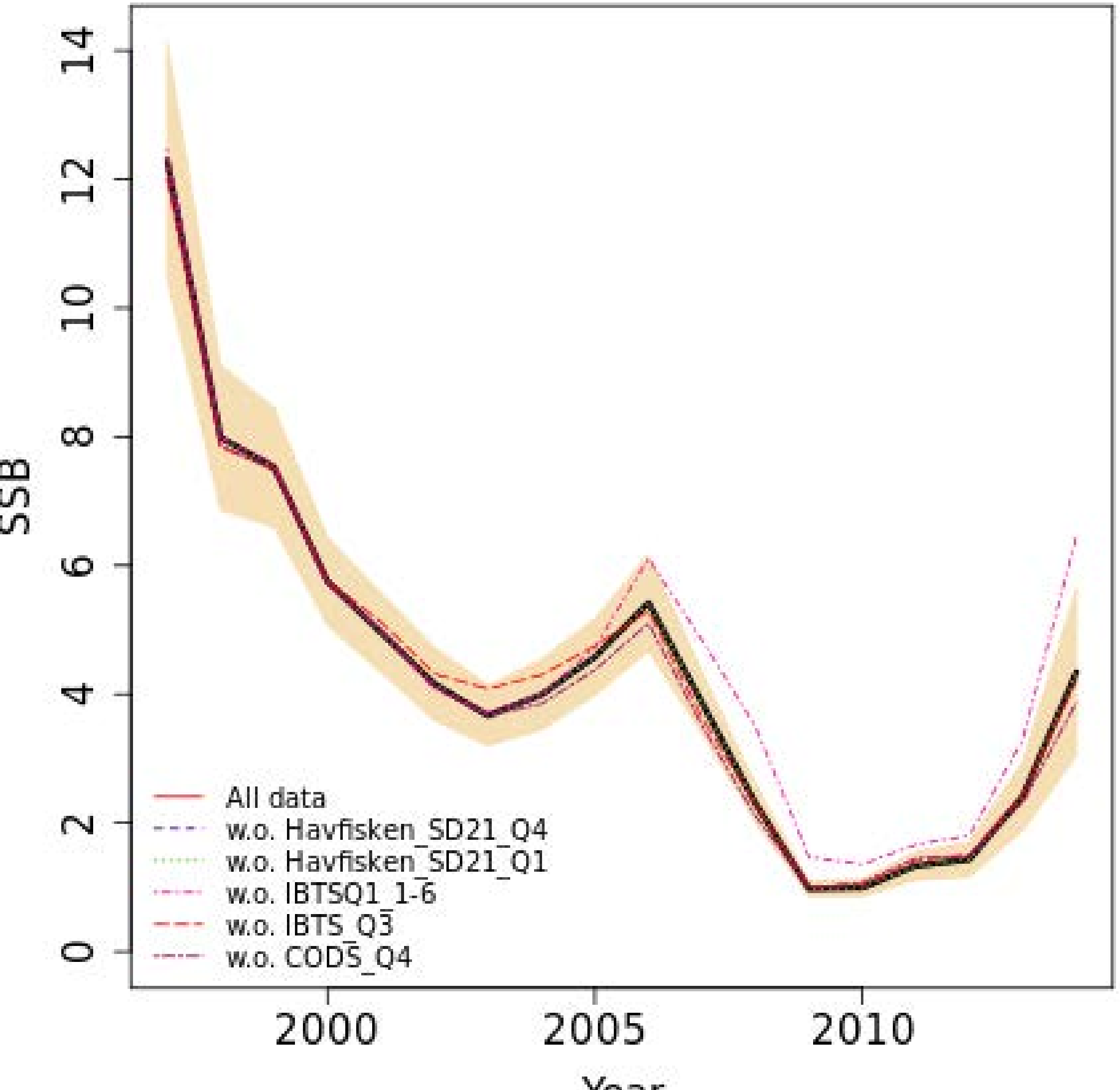


Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Catchability
Age
1.0
0.8
0.6
0.4
0.9
0.7
0.5
1
2
3
4
5
6

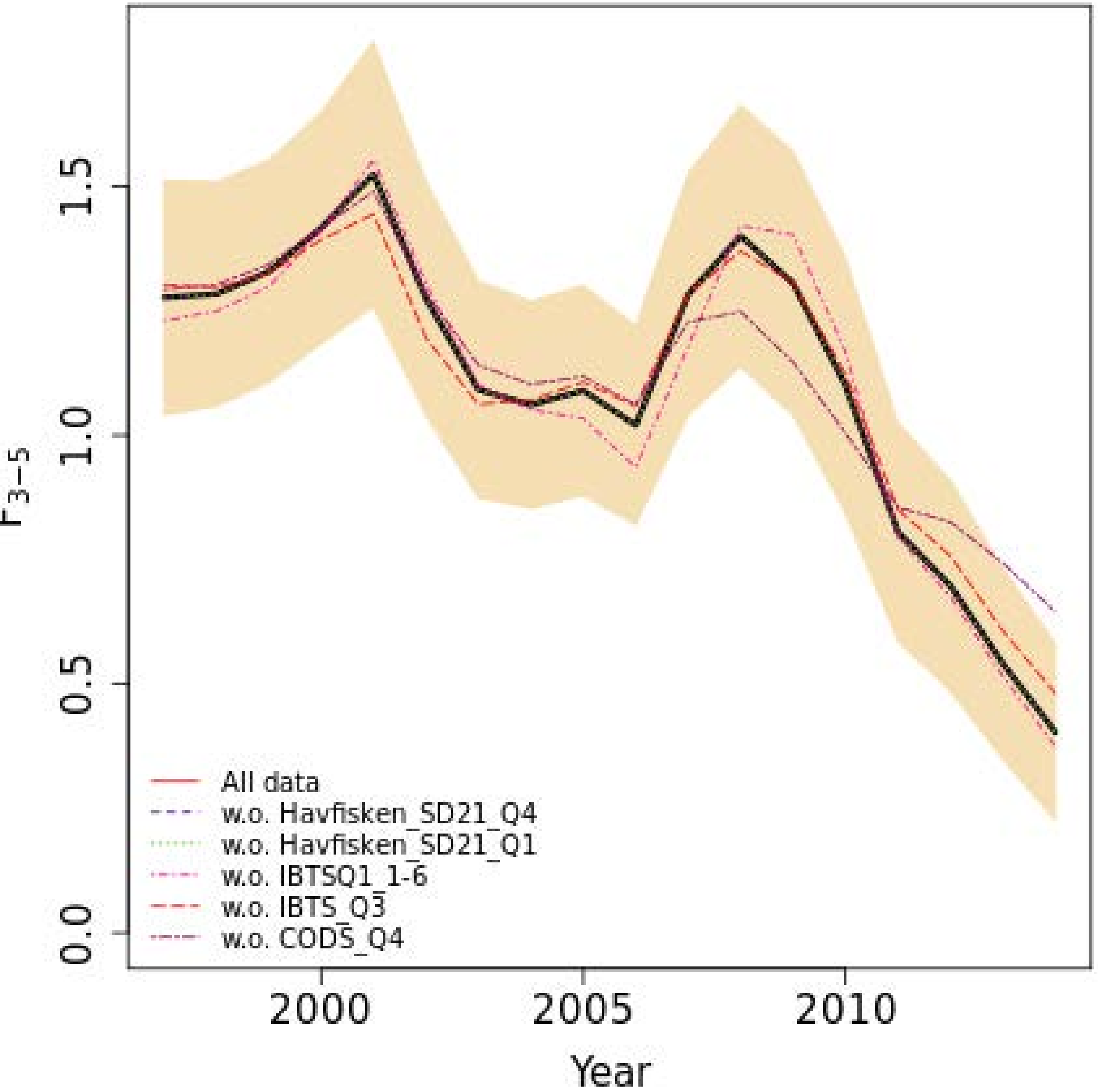


Observation variance
0.0
0.2
0.4
0.6
0.8
Total catches 2
Total catches 3
Total catches 4
Total catches 5
Total catches 6
CODS_Q4 1
Total catches 1
Havfisken_SD21_Q1 1
IBTSQ1_1-6 2
IBTSQ1_1-6 3
IBTSQ1_1-6 4
IBTSQ1_1-6 5
IBTSQ1_1-6 6
Havfisken_SD21_Q1 2
Havfisken_SD21_Q1 3
Havfisken_SD21_Q4 2
Havfisken_SD21_Q4 3
Havfisken_SD21_Q4 1
IBTS_Q3 2
IBTS_Q3 3
IBTS_Q3 4
CODS_Q4 2
CODS_Q4 3
CODS_Q4 4
CODS_Q4 5
CODS_Q4 6
IBTS_Q3 1
IBTSQ1_1-6 1

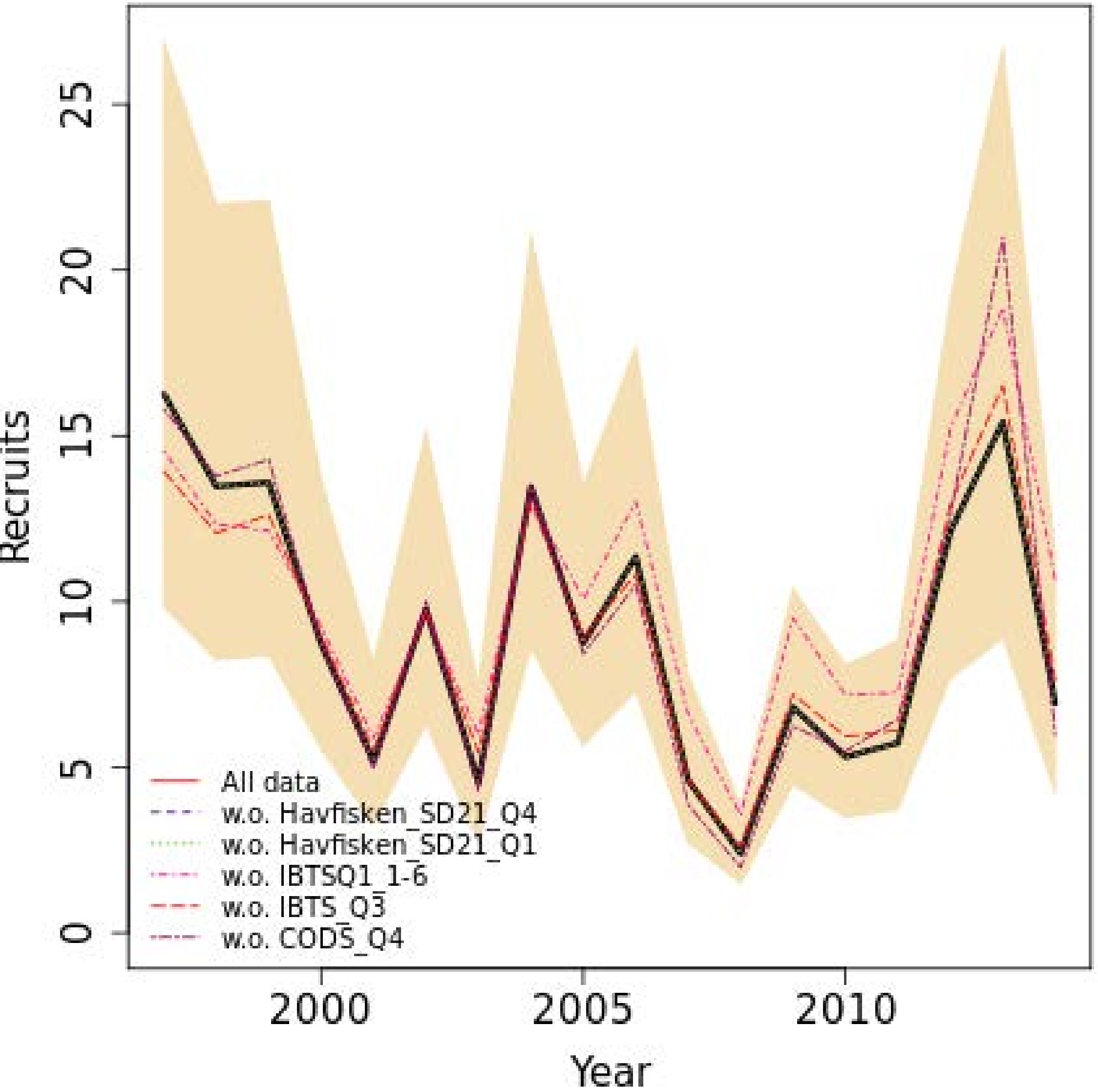

F max = 0.32 F 0.1 = 0.2 F 0.35SPR = 0.15
Yield per recruit
SSB per recruit
F 3−5
0.0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
12
14



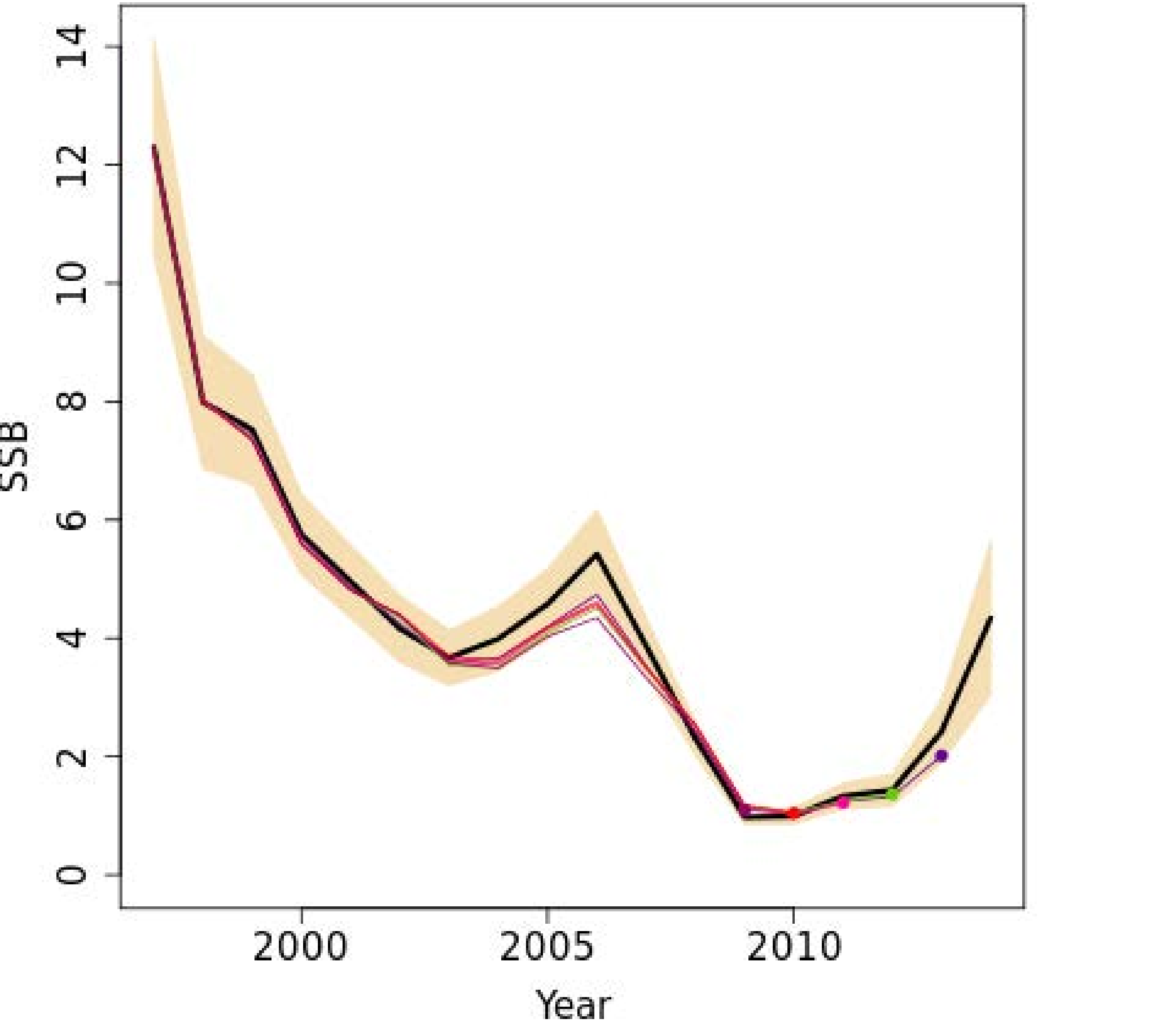
SSB
Year
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3
w.o. CODS_Q4



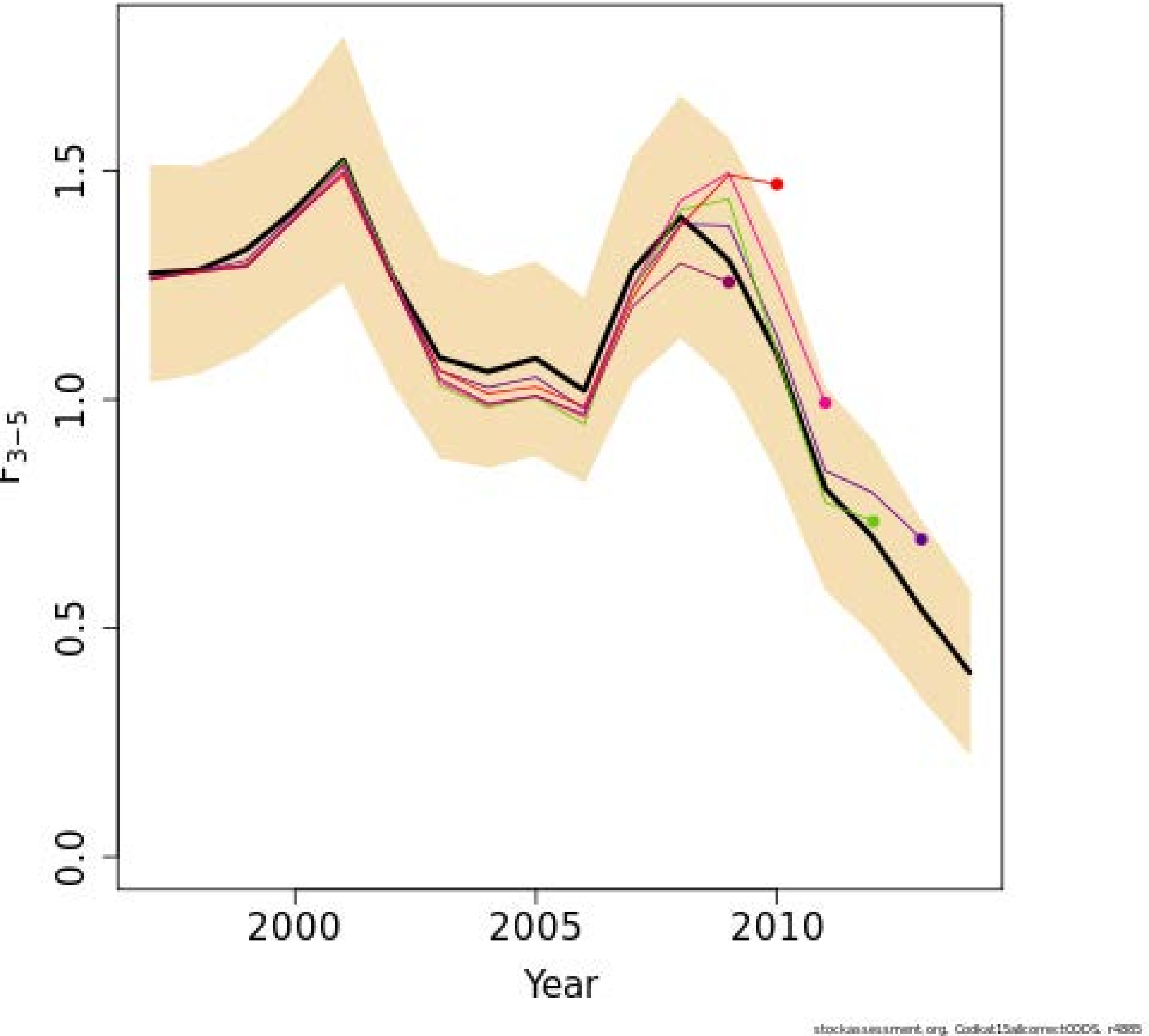
stockassessment.org, Coikat15allcorrectCODS, r4883



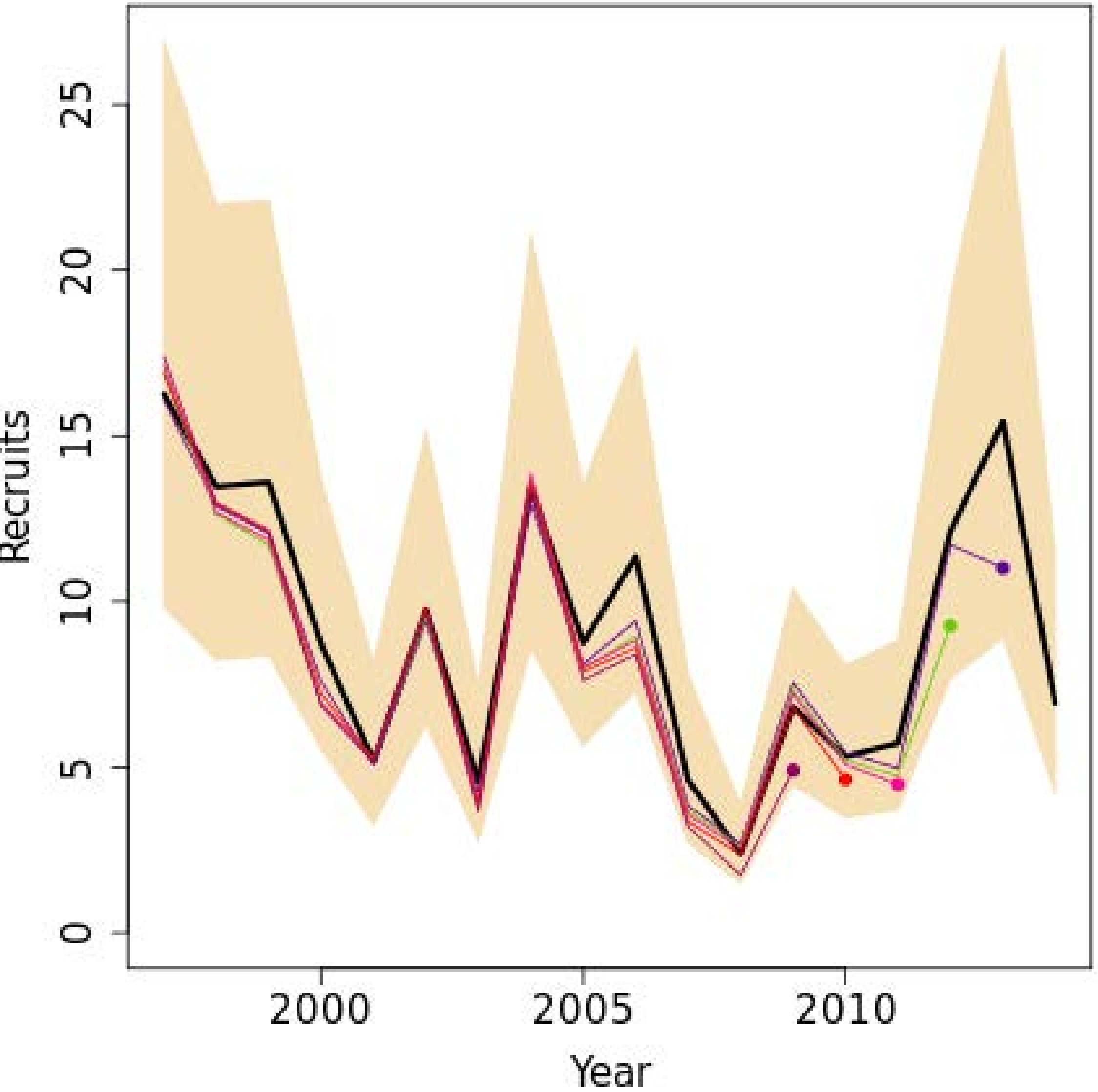
stockassessment.org



SSB
0
2
4
6
8
10
12
14
2000
2005
2010
Year



0.0
0.5
1.0
1.5
F_{3-5}
2000
2005
2010
Year



stockassessment.org, CodKat15allcorrectCODS, r4889

Table 1. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	16262	9829	26905	14654	12712	16893	12299	10595	14278	1.276	1.061	1.536
1998	13468	8247	21995	10536	9201	12066	7988	6938	9196	1.283	1.077	1.530
1999	13594	8366	22090	9428	8315	10689	7525	6652	8513	1.328	1.123	1.572
2000	8718	5540	13721	7133	6348	8015	5753	5108	6478	1.416	1.201	1.670
2001	5173	3279	8163	6173	5464	6973	4956	4380	5608	1.524	1.279	1.816
2002	9760	6274	15181	5130	4500	5848	4158	3628	4767	1.274	1.059	1.533
2003	4544	2770	7456	4549	4009	5161	3668	3229	4165	1.092	0.894	1.333
2004	13456	8590	21078	5288	4610	6066	3992	3482	4576	1.061	0.872	1.291
2005	8741	5657	13507	6686	5845	7647	4579	4020	5215	1.090	0.898	1.323
2006	11361	7294	17695	7412	6461	8501	5422	4721	6228	1.020	0.838	1.241
2007	4605	2716	7805	4847	4299	5465	3868	3417	4379	1.282	1.061	1.549
2008	2395	1491	3848	2682	2385	3016	2306	2035	2613	1.400	1.160	1.689
2009	6816	4462	10411	1489	1282	1730	977	861	1108	1.305	1.065	1.599
2010	5313	3490	8089	1776	1520	2075	994	866	1142	1.100	0.870	1.390
2011	5731	3724	8820	2003	1706	2351	1333	1131	1570	0.805	0.614	1.057
2012	12113	7669	19132	2282	1893	2751	1432	1187	1727	0.697	0.514	0.945
2013	15423	8898	26731	3940	3197	4856	2422	1938	3025	0.541	0.379	0.772
2014	6931	4206	11421	8023	6187	10404	4347	3223	5862	0.403	0.259	0.627
2015							6561	4097	10506			

Table 2. Estimated stock numbers.

Year\Age	1	2	3	4	5	6+
1997	16262	7030	10532	1592	405	180
1998	13468	11112	2720	2776	395	112
1999	13594	9286	5937	667	581	109
2000	8718	7828	3784	1424	170	143
2001	5173	4607	2985	905	256	61
2002	9760	3035	1326	598	130	59
2003	4544	5638	1263	370	140	35
2004	13456	2638	2252	361	117	69
2005	8741	7931	800	758	100	55
2006	11361	5139	3267	216	197	51
2007	4605	4149	928	776	71	109
2008	2395	1232	783	186	147	35
2009	6816	820	202	130	50	25
2010	5313	3321	199	52	26	13
2011	5731	2886	748	57	17	9
2012	12113	2512	451	205	30	10
2013	15423	5659	1104	188	54	17
2014	6931	12763	2114	670	139	16
2015	6116	2636	3306	1075	375	97

Table 3. Estimated fishing mortalities.

Year\Age	1	2	3	4+
1997	0.157	0.527	1.063	1.383
1998	0.170	0.480	1.099	1.376
1999	0.196	0.589	1.229	1.378
2000	0.254	0.645	1.257	1.496
2001	0.306	0.827	1.419	1.577
2002	0.325	0.786	1.236	1.294
2003	0.380	0.798	1.204	1.035
2004	0.425	0.904	1.043	1.070
2005	0.524	0.905	1.183	1.043
2006	0.641	1.217	1.153	0.953
2007	0.744	1.322	1.186	1.331
2008	0.624	1.470	1.478	1.361
2009	0.548	1.462	1.278	1.318
2010	0.558	1.302	1.126	1.086
2011	0.618	1.431	0.856	0.780
2012	0.625	1.057	0.680	0.706
2013	0.641	1.013	0.538	0.543
2014	0.697	1.197	0.440	0.385

Table 4. Estimated catch scaling factors (same for all ages within each year)

Year	Catch multiplier	Low	High
2003	1.23	0.87	1.74
2004	1.08	0.74	1.59
2005	2.78	1.87	4.12
2006	3.20	2.14	4.78
2007	3.06	2.02	4.65
2008	3.35	2.16	5.20
2009	3.96	2.56	6.14
2010	4.00	2.62	6.10
2011	4.47	2.90	6.88
2012	7.22	4.57	11.40
2013	6.91	4.27	11.19
2014	10.22	5.99	17.45

Table 5. Estimated catchabilities multiplied by 1000.

Index	Fleet number	Age	Catchability	Low	High
1	2	1	5.72278	3.58822	9.12717
2	2	2	2.56064	1.61878	4.05048
3	2	3	1.41207	0.86329	2.30969
4	3	1	8.49906	5.68536	12.70525
5	3	2	7.21856	4.76385	10.93813
6	3	3	4.31827	2.84481	6.55492
7	4	1	4.89618	2.95097	8.12362
8	4	2	7.54251	5.14258	11.06244
9	4	3	7.66953	5.26592	11.17026
10	4	4	11.80774	9.02335	15.45133
11	4	5	11.80774	9.02335	15.45133
12	4	6	11.80774	9.02335	15.45133
13	5	1	2.88682	1.69994	4.90235
14	5	2	1.98388	1.23523	3.18628
15	5	3	1.09423	0.66839	1.79140
16	5	4	1.34885	0.83435	2.18063
17	6	1	39.72796	26.35387	59.88915
18	6	2	74.51163	34.19896	162.34363
19	6	3	82.16712	37.74358	178.87644
20	6	4	153.93882	89.89796	263.60065
21	6	5	153.93882	89.89796	263.60065
22	6	6	153.93882	89.89796	263.60065

Table 6. Likelihood values.

Model	Negative log likelihood	Number of parameters
Base	452.25	47
Current	452.25	47

Table X. Forecasts (Fs and Catches are including estimated unallocated removals)

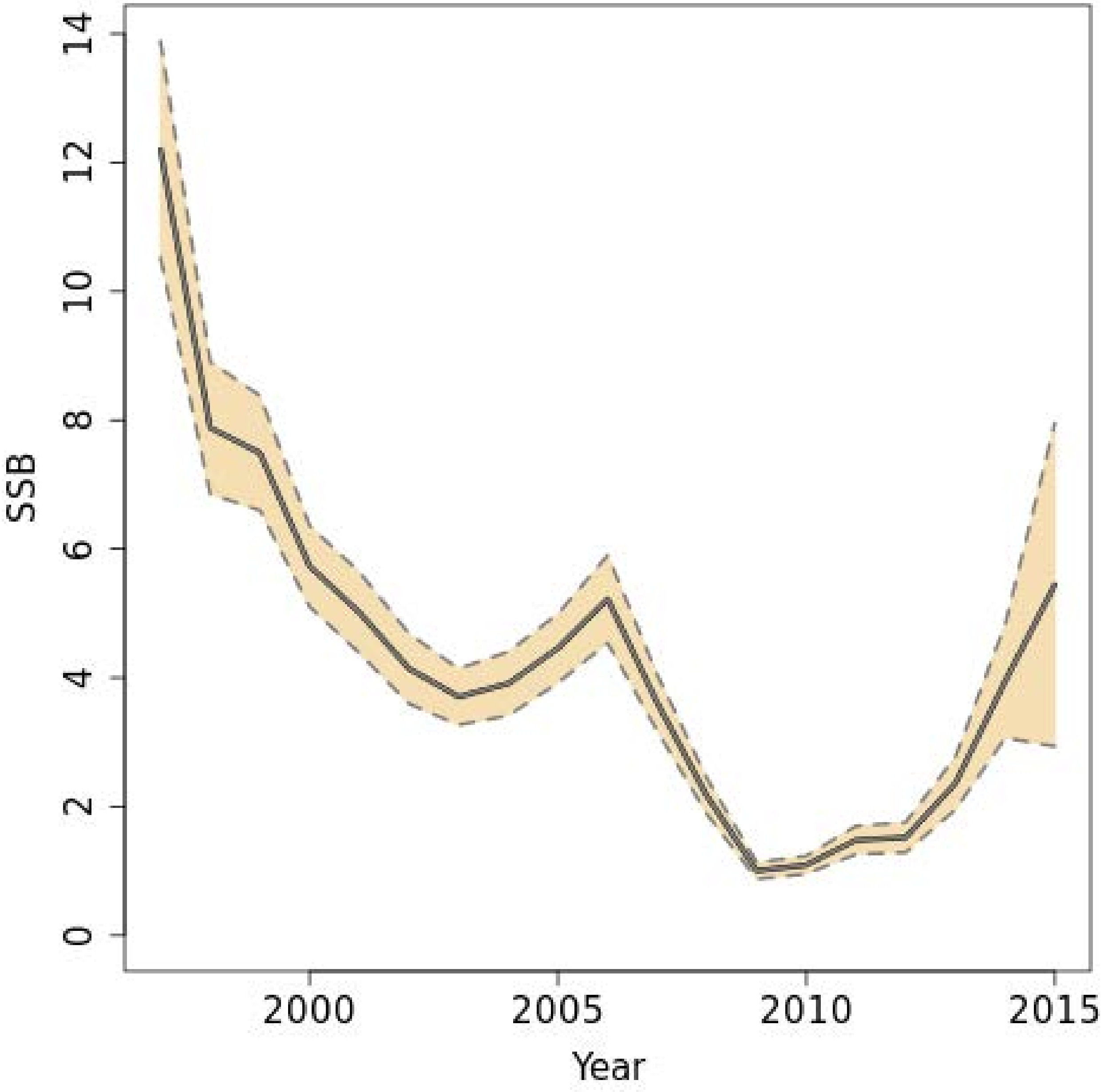
Description\Variable	Fbar14	Fbar15	Fbar16	SSB14	SSB15	SSB16	SSB % change	C14	C15	C16
F= Fsq , F at 0.4	0.41	0.40	0.41	7328	9135	8937	-2	6033	6484	6694
F= Fsq	0.41	0.41	0.41	7328	9135	8867	-3	6033	6580	6644

Table Xb. Forecasts (split in landings and discards)

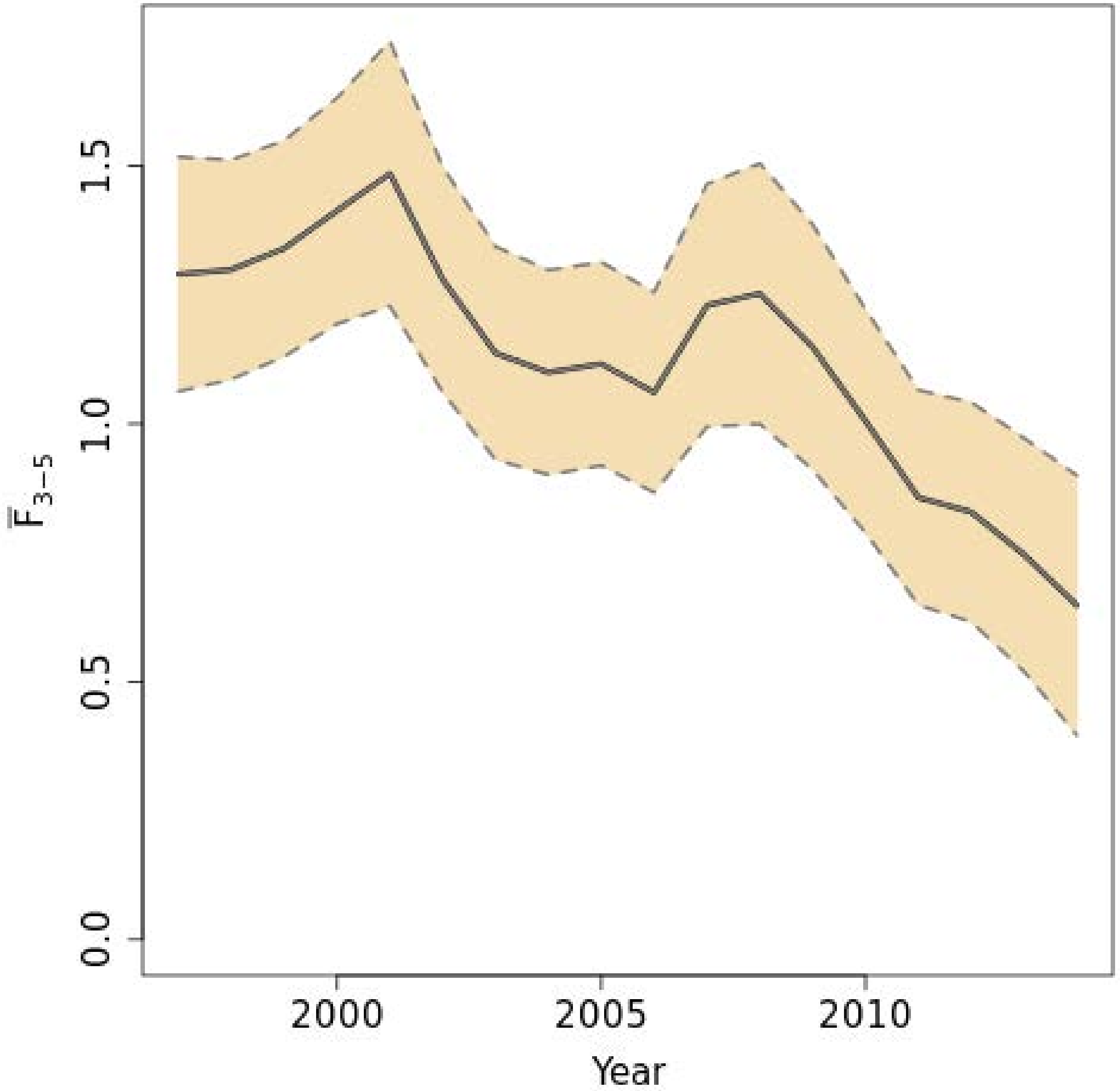
Description\Variable	L14	L15	L16	D14	D15	D16	Fbar14(L)	Fbar15(L)	Fbar16(L)
F= Fsq , F at 0.4	6033	6484	6694	0	0	0	0.41	0.40	0.41
F= Fsq	6033	6580	6644	0	0	0	0.41	0.41	0.41

Table Xc. Forecasts (L and D without catch multiplier, and R)

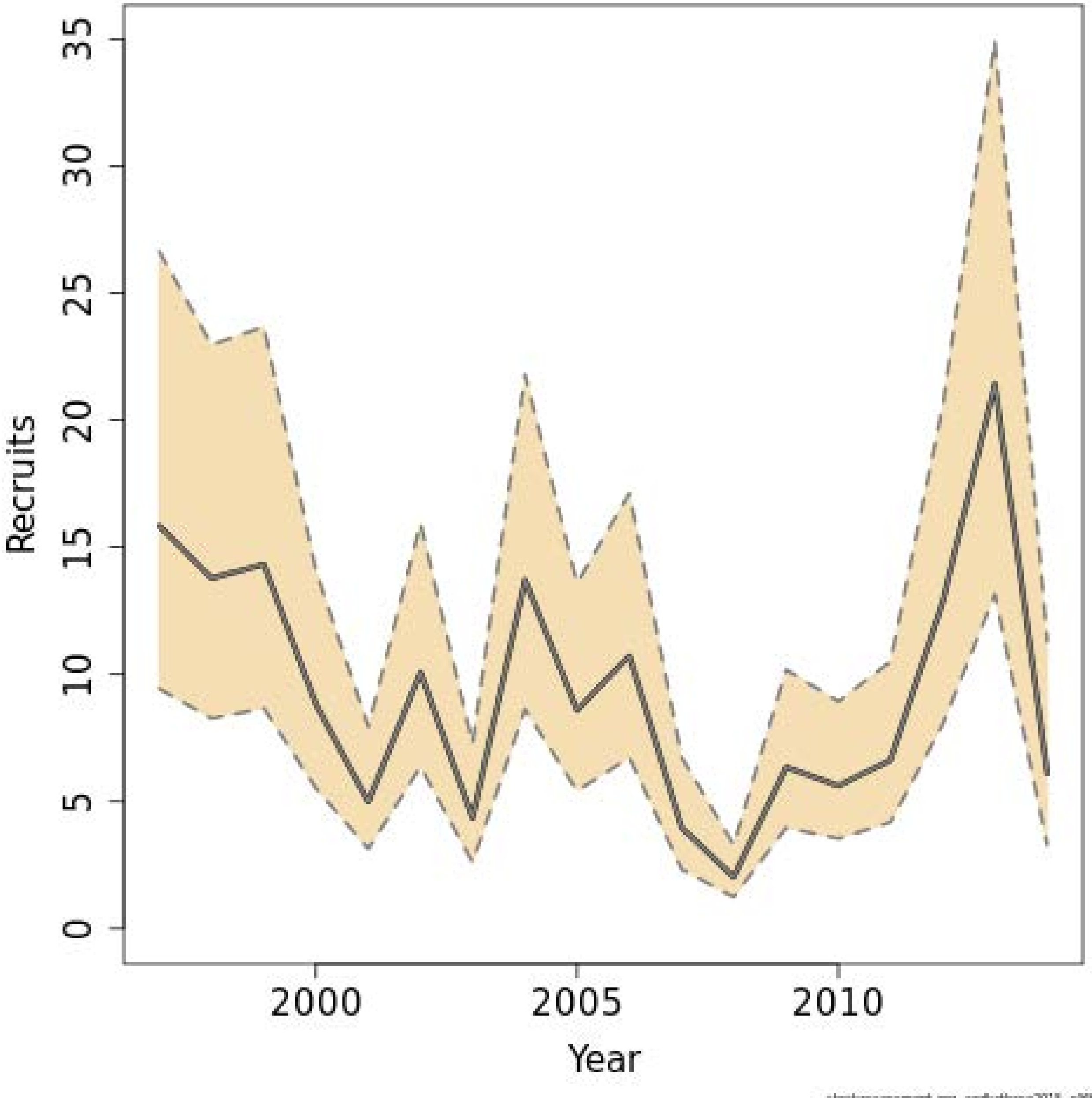
Description\Variable	L14	L15	L16	TAC % change	D14	D15	D16	R14	R15	R16
F= Fsq , F at 0.4	6033	6484	6694		0	0	0	6931	6931	6931
F= Fsq	6033	6580	6644		0	0	0	6931	6931	6931

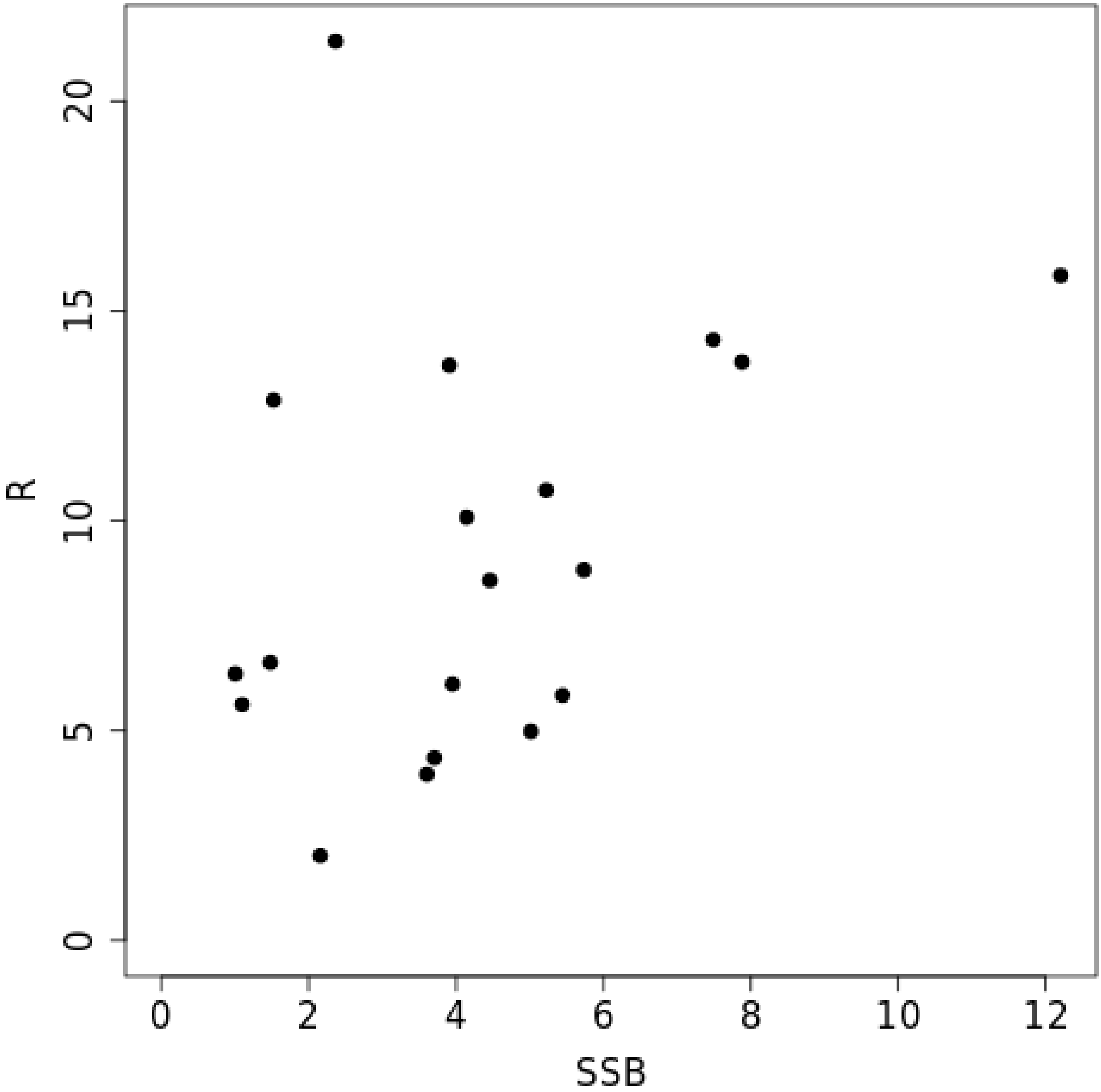


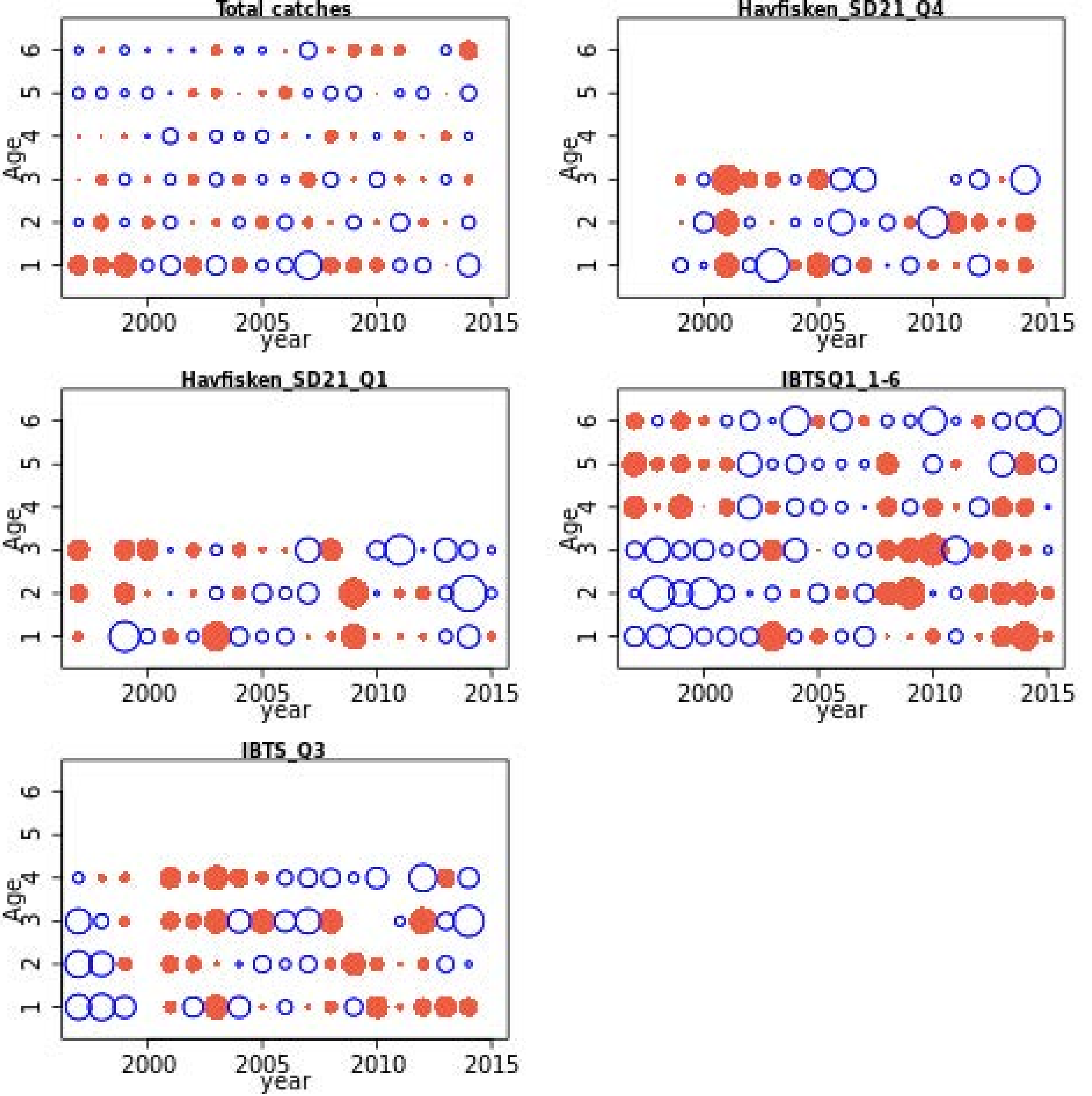
14
12
10
8
6
4
2
0
SSB
2000
2005
2010
2015
Year

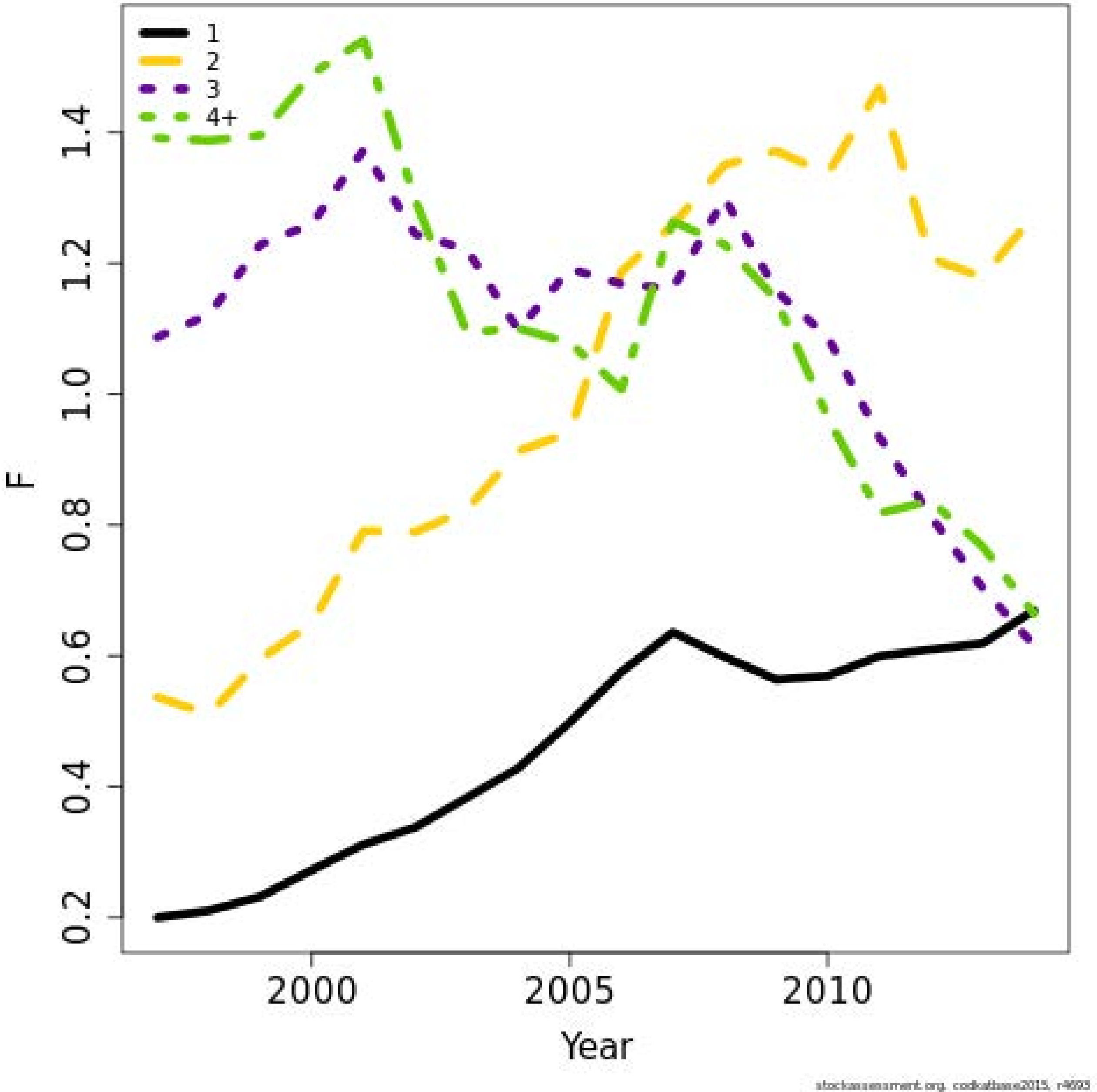


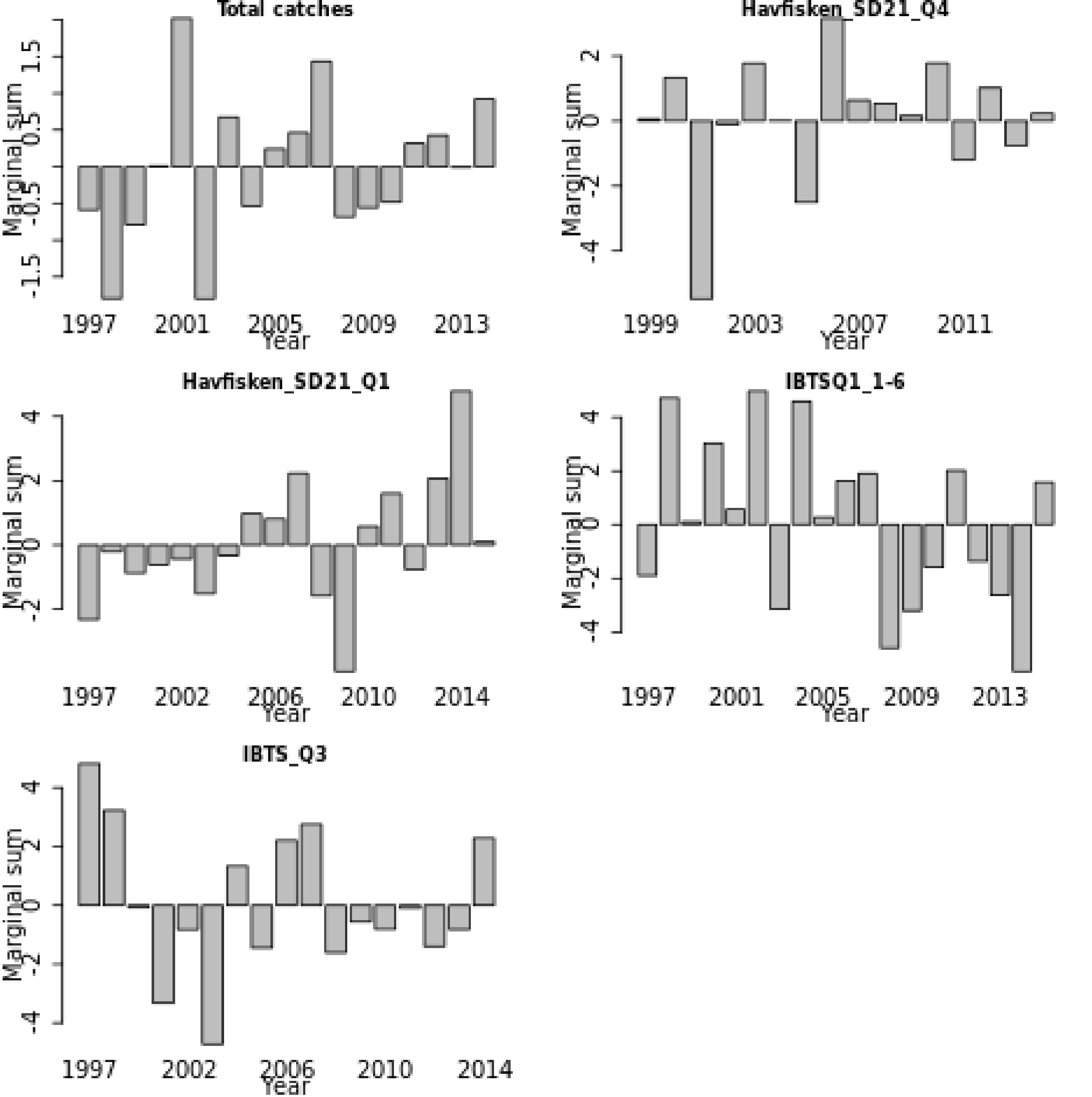
1.5
1.0
0.5
0.0
$\bar{F}_{3-5}$
2000
2005
2010
Year

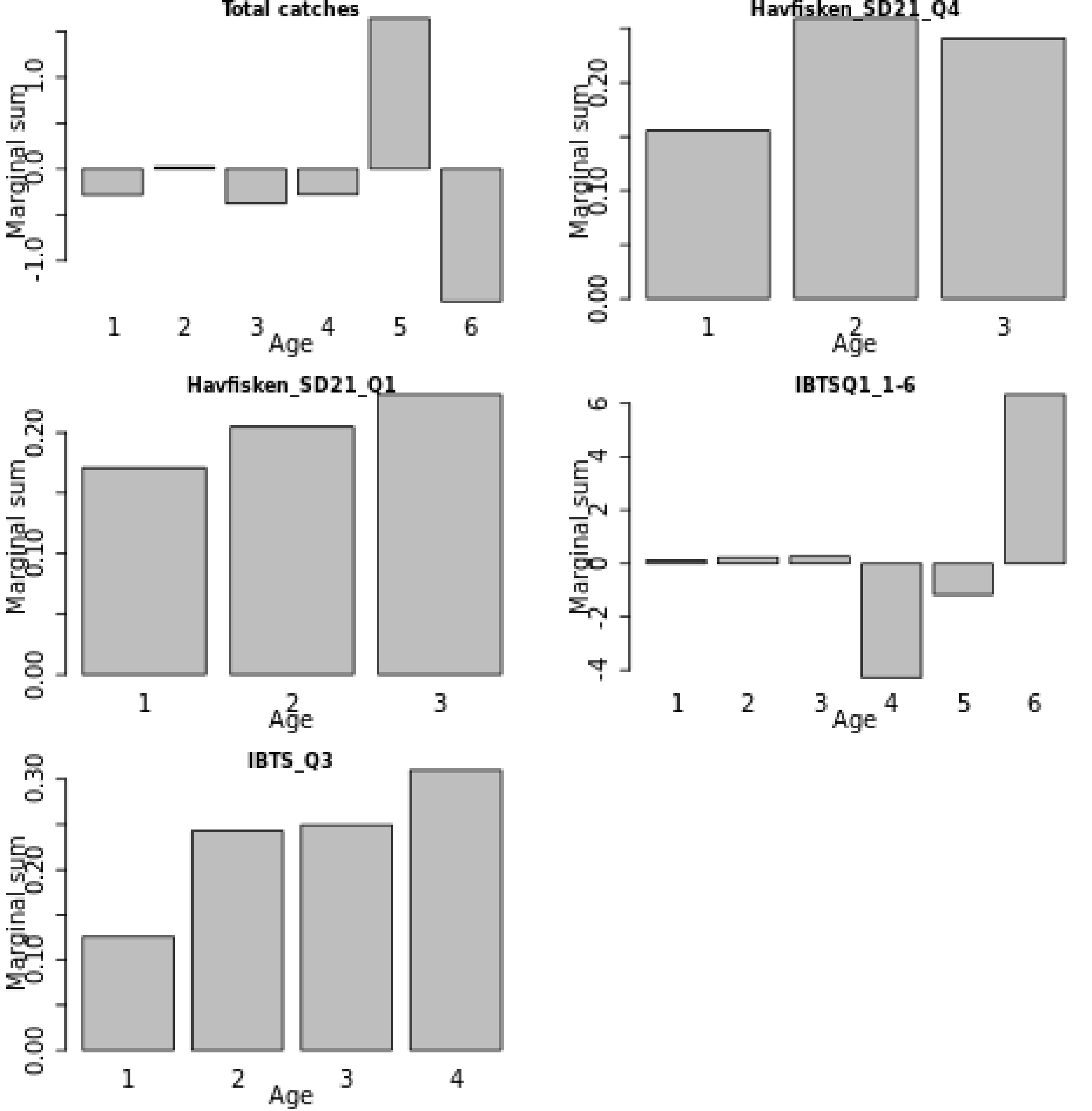

Recruits
0
5
10
15
20
25
30
35
2000
2005
2010
Year

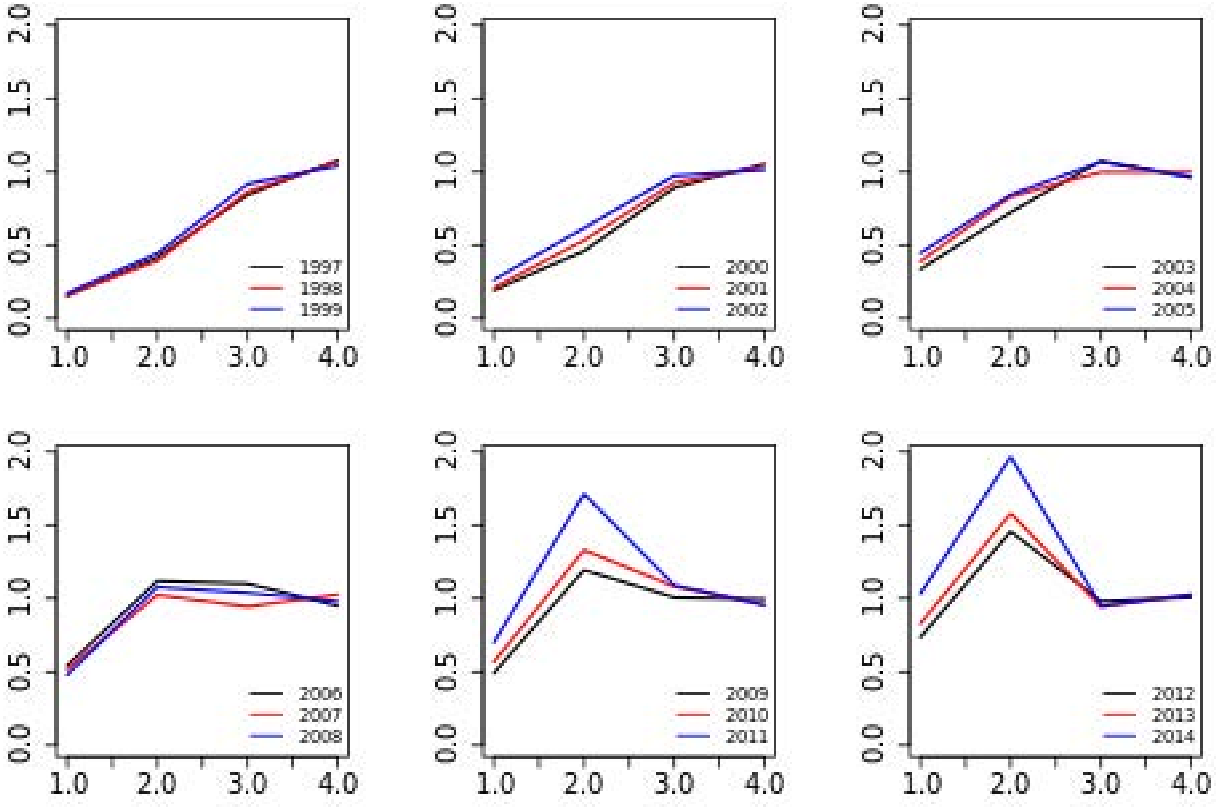

R
0
5
10
15
20
0
2
4
6
8
10
12
SSB


Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
Age
year
1
2
3
4
5
6
2000
2005
2010
2015

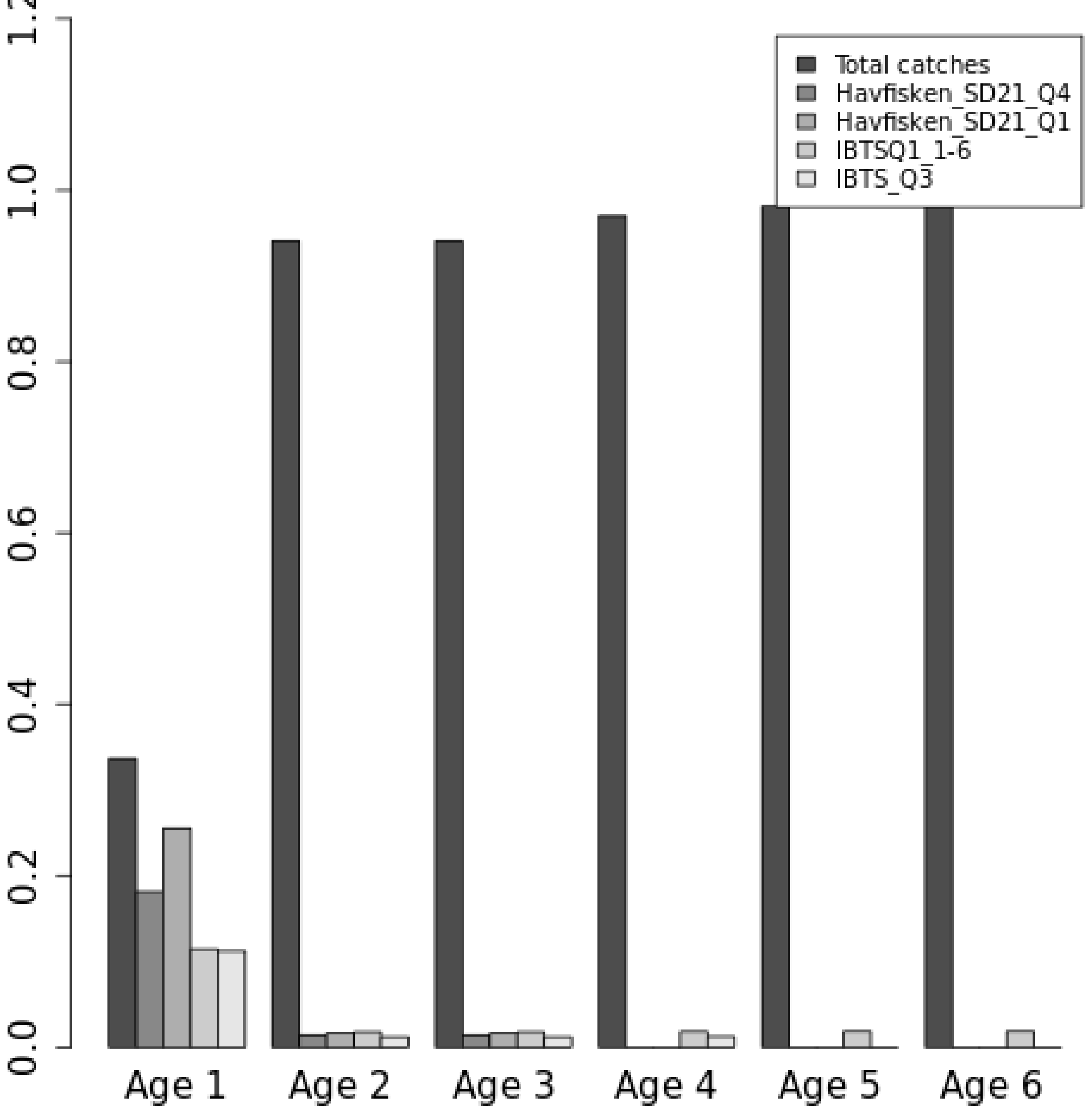

1
2
3
4+
F
0.2
0.4
0.6
0.8
1.0
1.2
1.4
2000
2005
2010
Year


Total catches
Marginal sum
Year
1997
2001
2005
2009
2013
1.5
0.5
-0.5
-1.5
Havfisken_SD21_Q4
1999
2003
2007
2011
2
0
-2
-4
Havfisken_SD21_Q1
2002
2006
2010
2014
4
IBTSQ1_1-6
IBTS_Q3

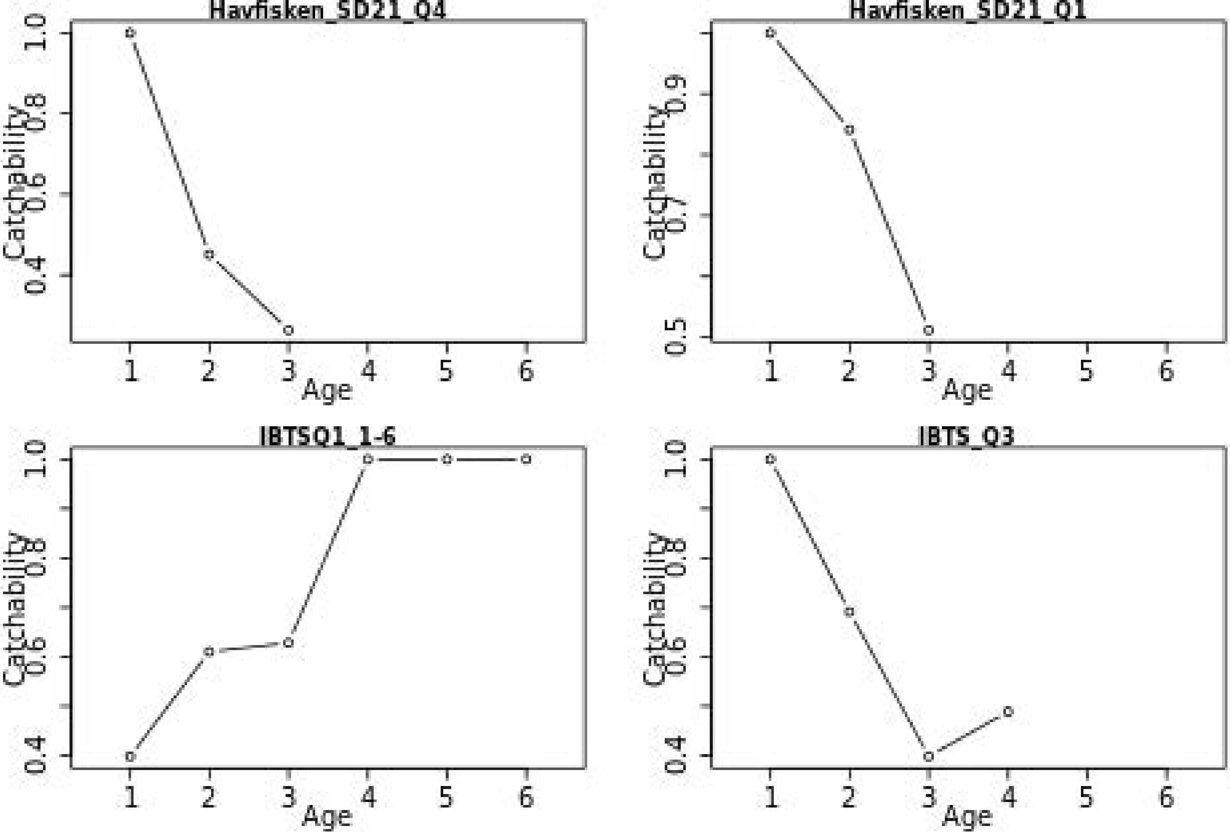

Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
Marginal sum
Age
1.0
0.0
-1.0
0.00
0.10
0.20
0.30
6
4
2
0
-2
-4
1
2
3
4
5
6

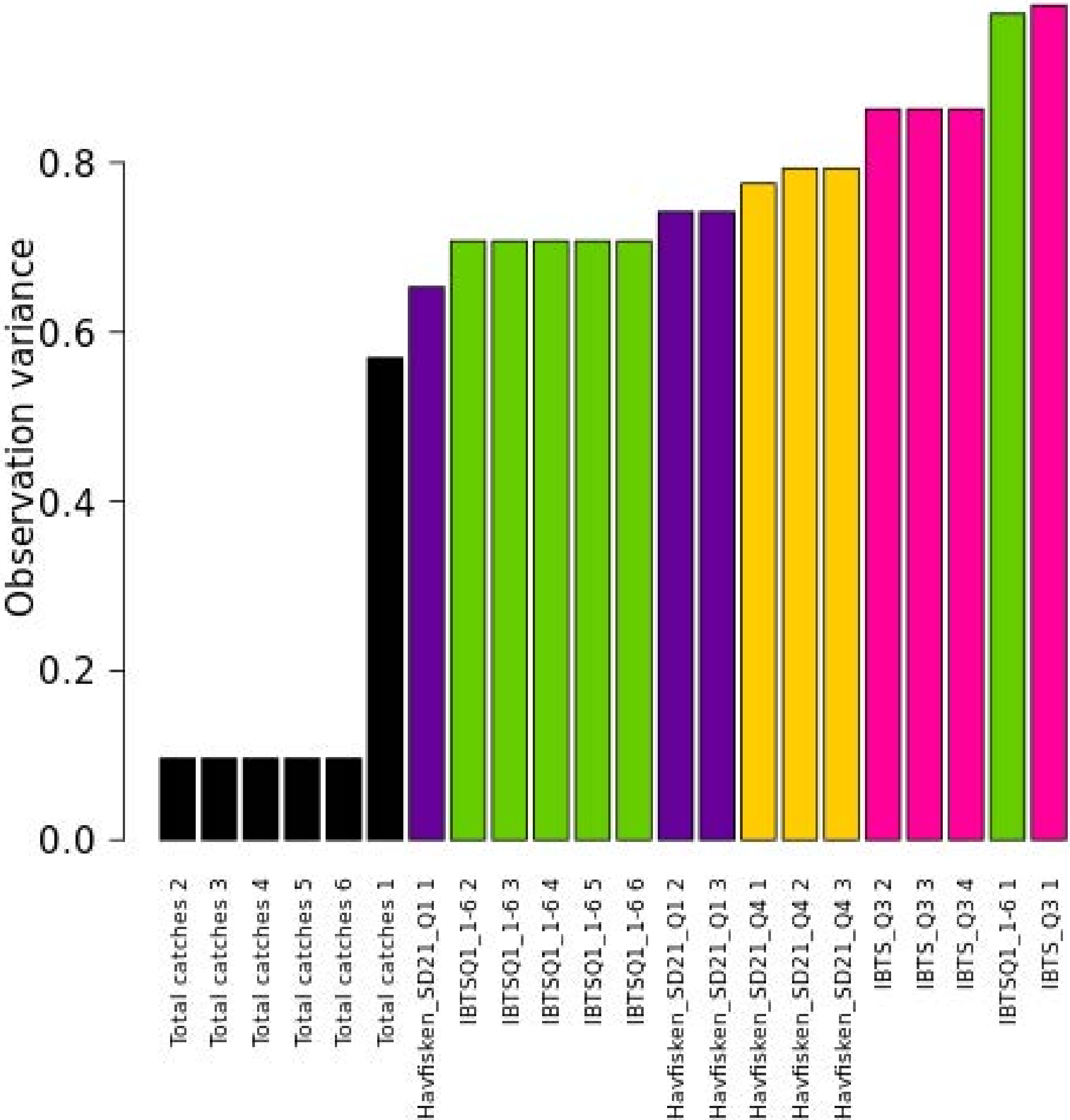


2.0
1.5
1.0
0.5
0.0
1.0
2.0
3.0
4.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

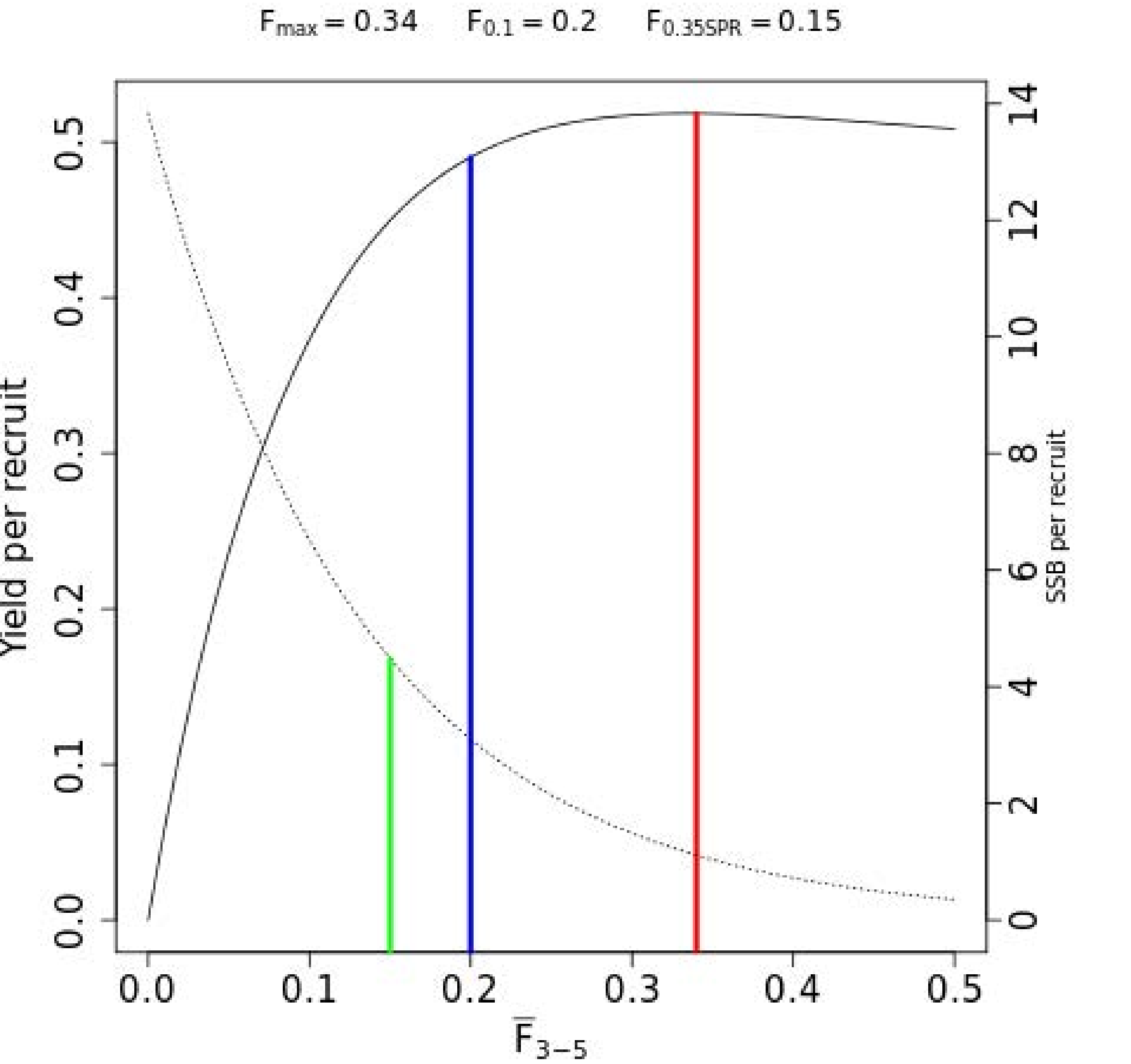


Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Age 1
Age 2
Age 3
Age 4
Age 5
Age 6

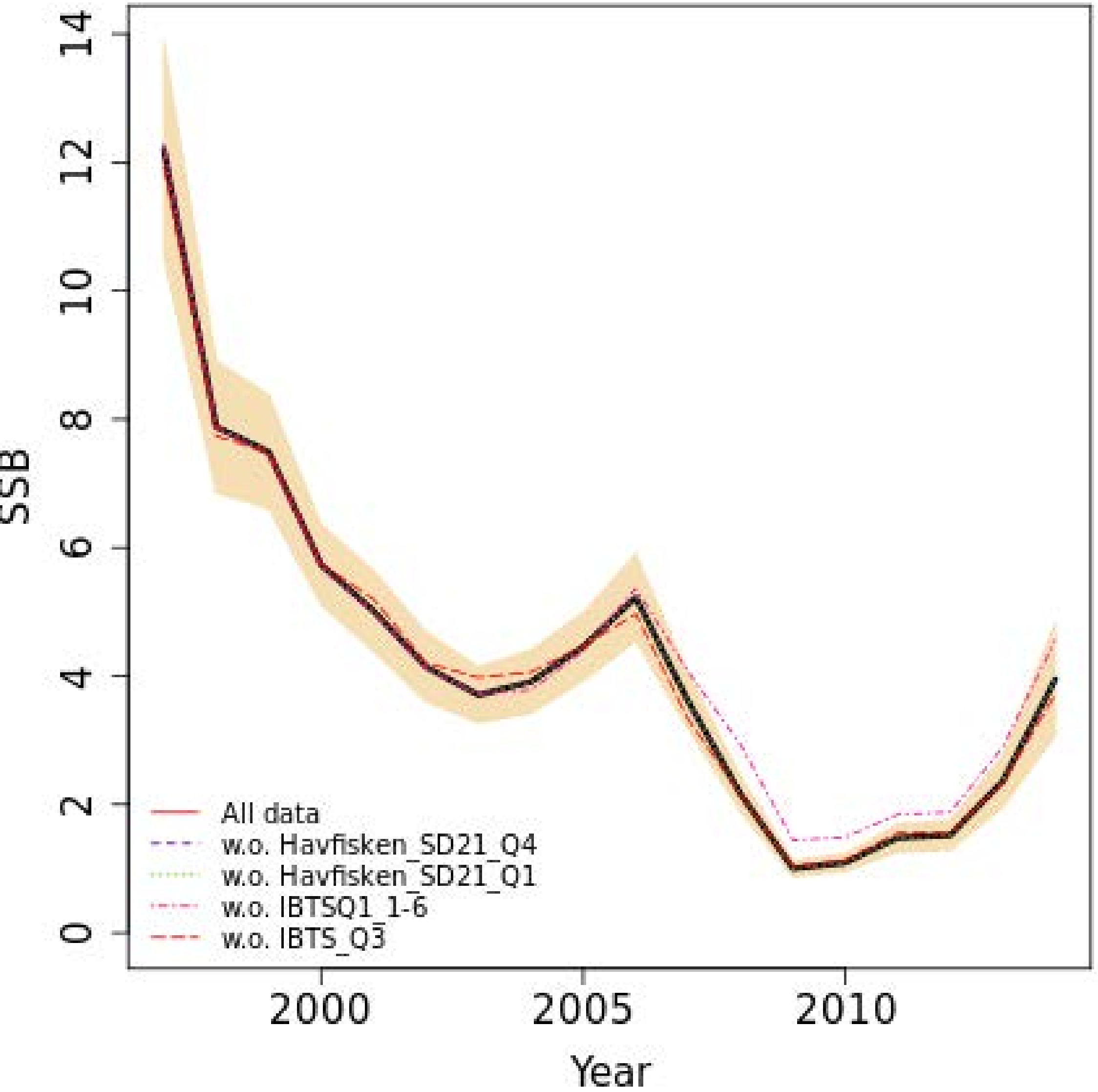

Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
Catchability
Age



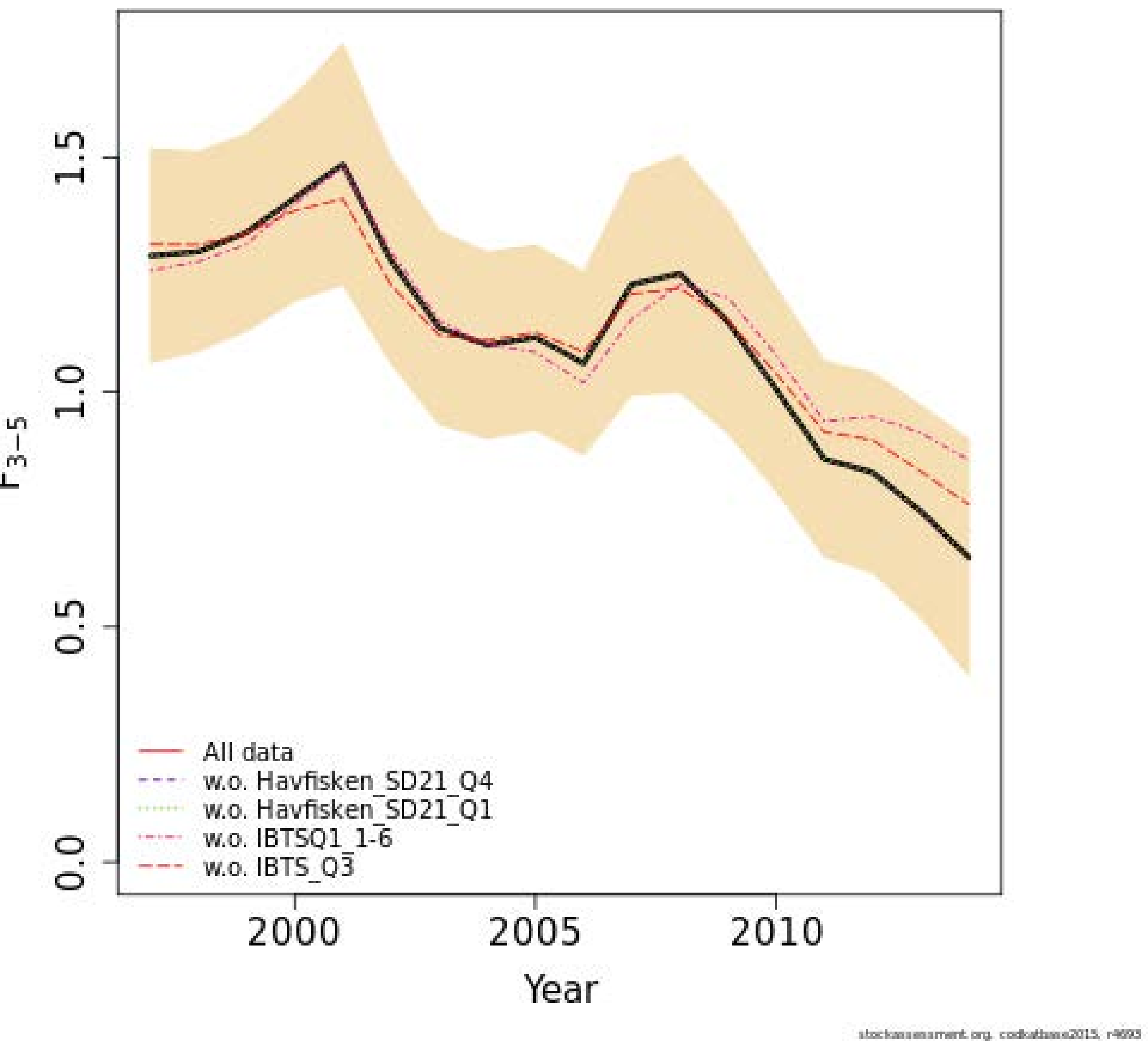
Observation variance
0.0
0.2
0.4
0.6
0.8
Total catches 2
Total catches 3
Total catches 4
Total catches 5
Total catches 6
Total catches 1
Havfisken_SD21_Q1 1
IBTSQ1_1-6 2
IBTSQ1_1-6 3
IBTSQ1_1-6 4
IBTSQ1_1-6 5
IBTSQ1_1-6 6
Havfisken_SD21_Q1 2
Havfisken_SD21_Q1 3
Havfisken_SD21_Q4 1
Havfisken_SD21_Q4 2
Havfisken_SD21_Q4 3
IBTS_Q3 2
IBTS_Q3 3
IBTS_Q3 4
IBTSQ1_1-6 1
IBTS_Q3 1



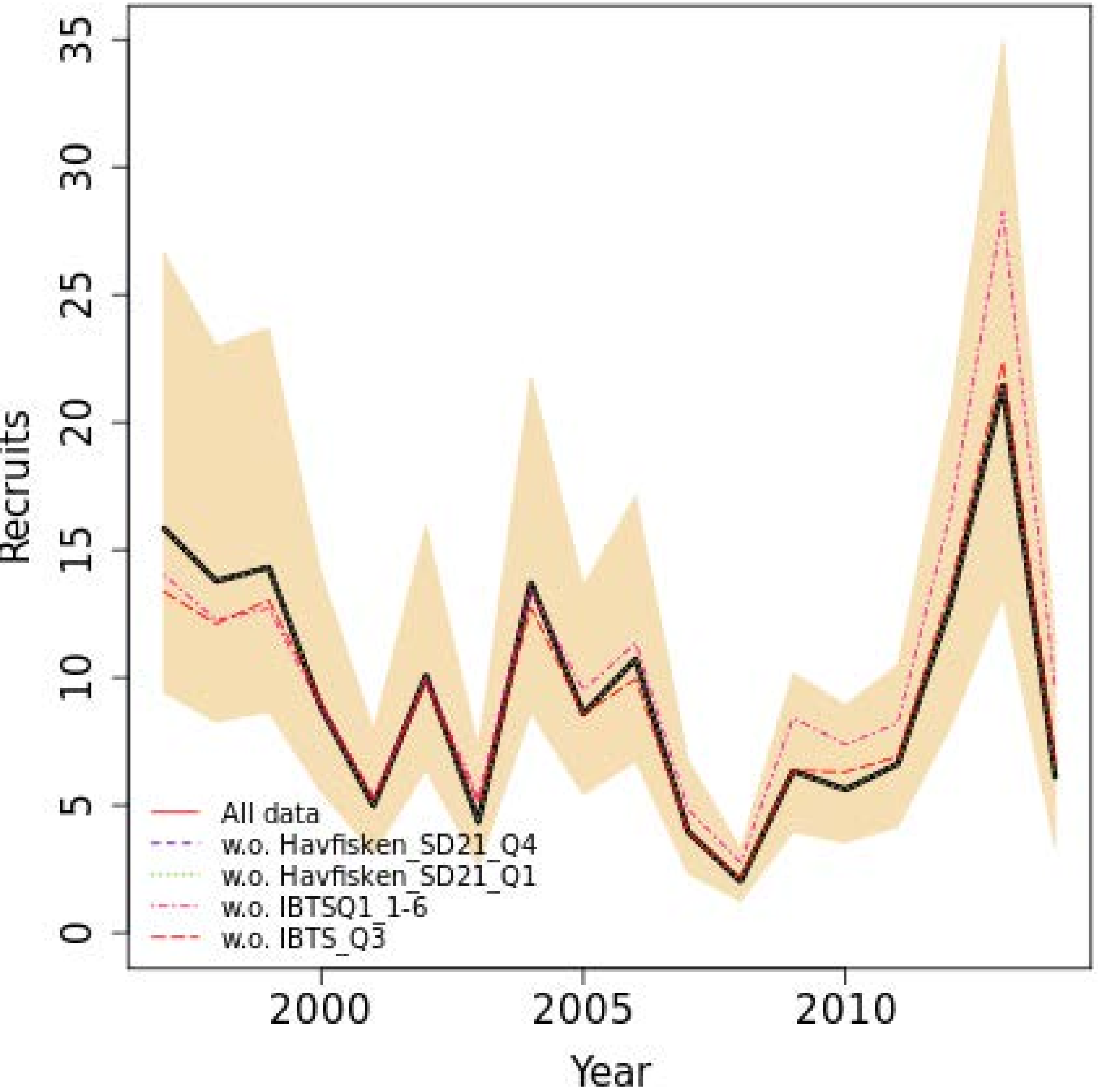
Fmax = 0.34 F0.1 = 0.2 F0.35SPR = 0.15
Yield per recruit
SSB per recruit
0.0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
12
14
F3−5

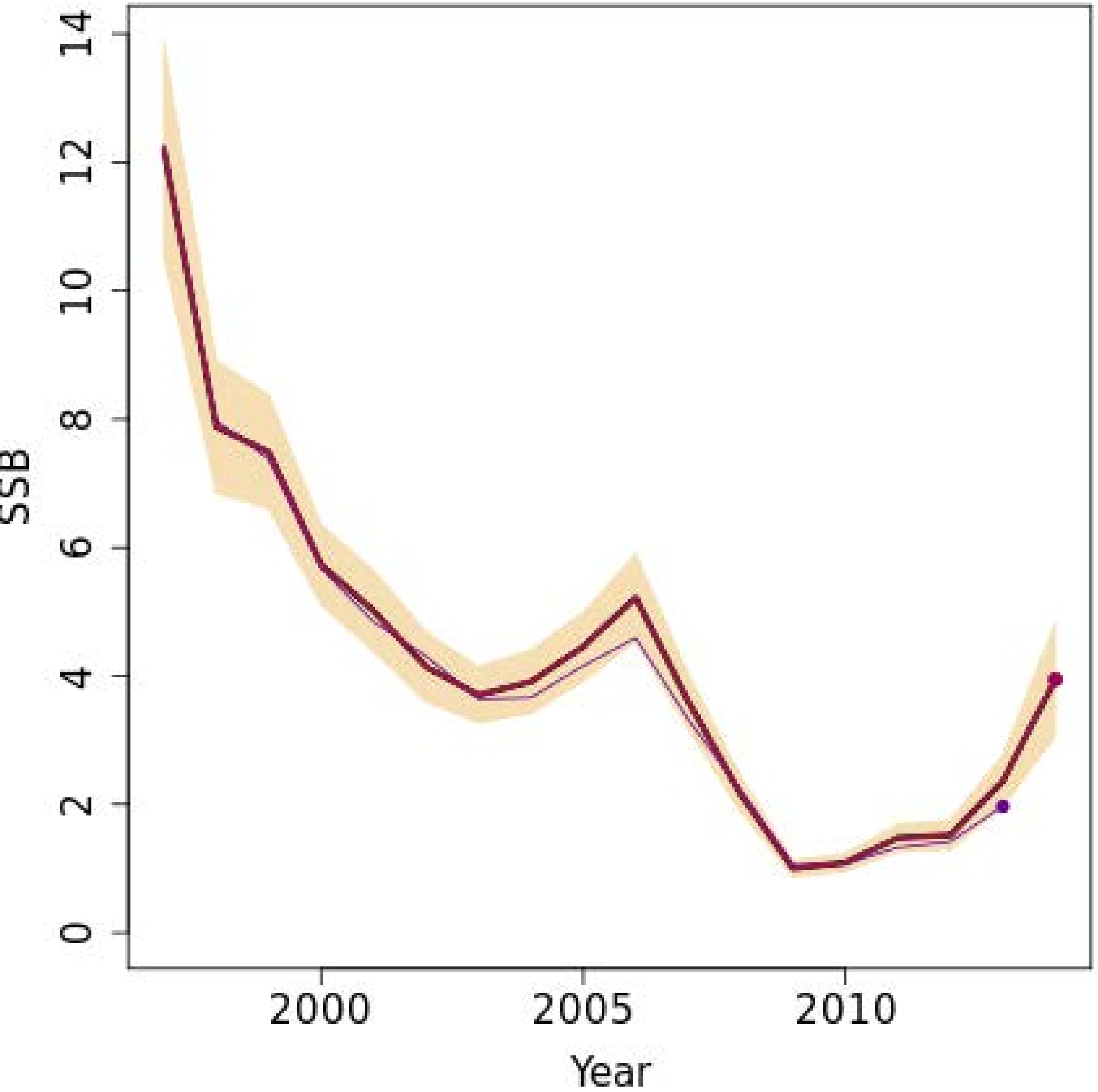


SSB
14
12
10
8
6
4
2
0
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3
2000
2005
2010
Year

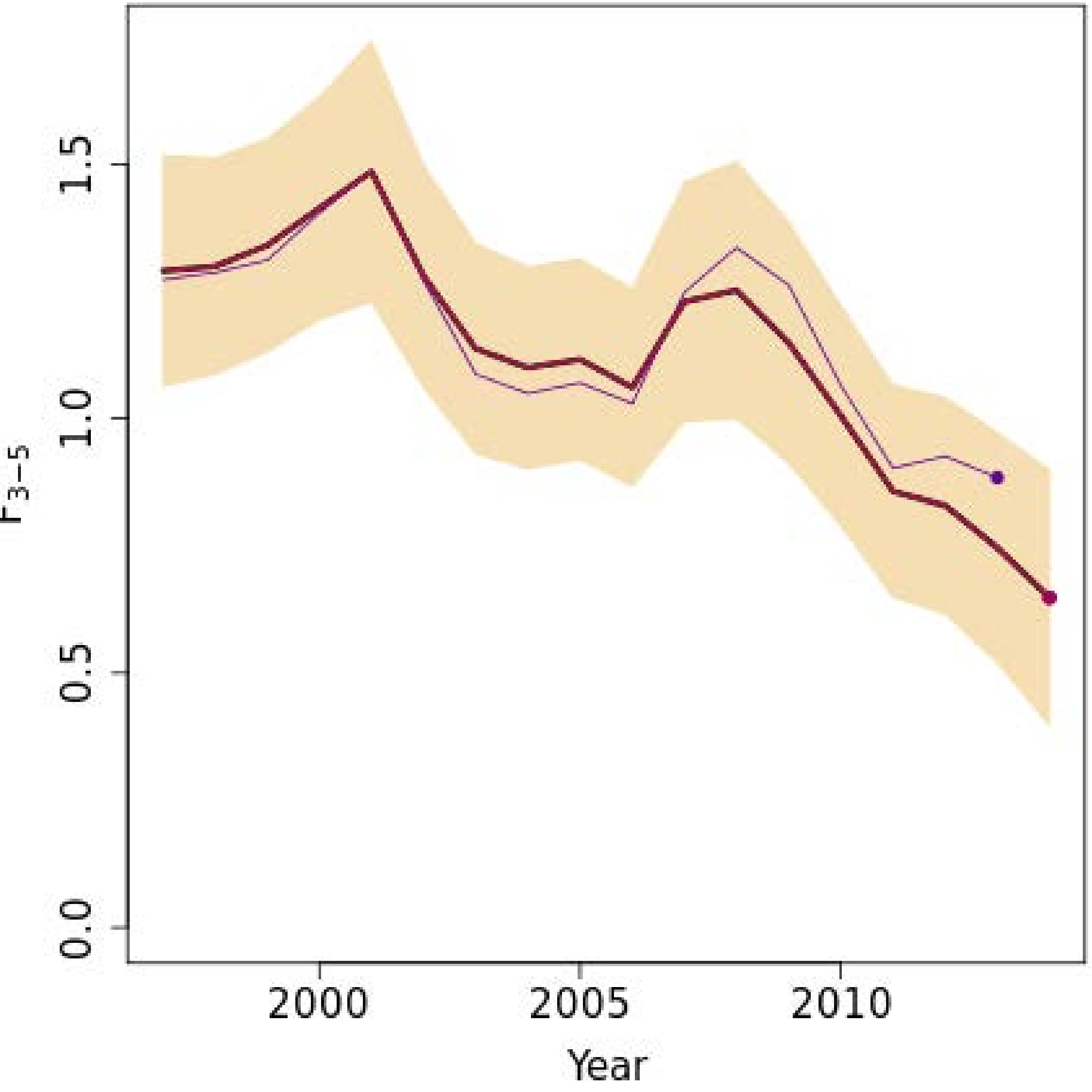


1.5
1.0
0.5
0.0
F_{3-5}
2000
2005
2010
Year
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3

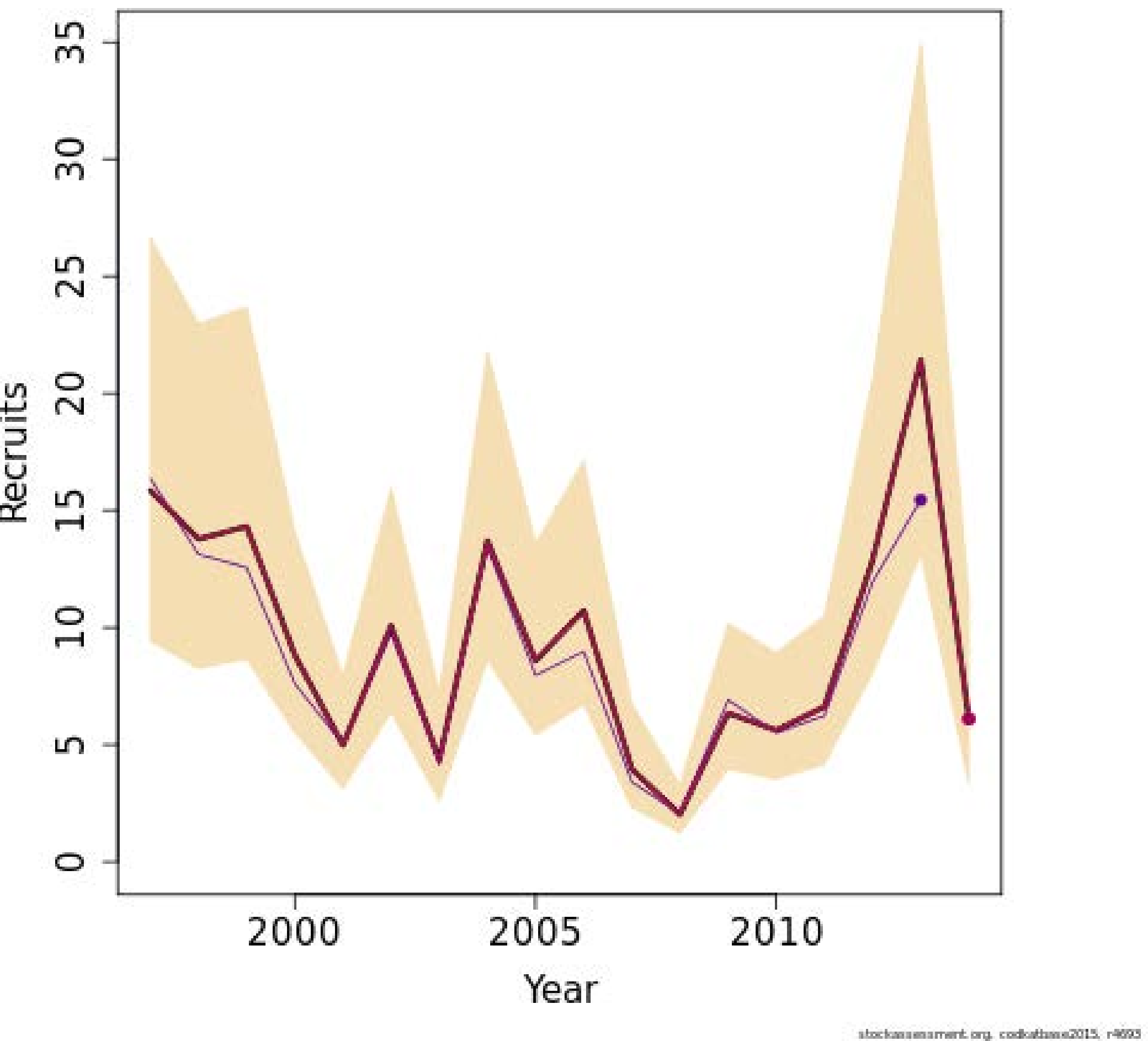

Recruits
Year
0
5
10
15
20
25
30
35
2000
2005
2010
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3



SSB
0
2
4
6
8
10
12
14
2000
2005
2010
Year



stockassessment.org, codkattbase2015, r4693



Recruits
Year
0
5
10
15
20
25
30
35
2000
2005
2010
stockassessment.org, codkattbase2015, r4693

Table 1. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	15850	9428	26644	14528	12731	16578	12204	10632	14008	1.290	1.082	1.539
1998	13780	8265	22977	10352	9111	11761	7880	6916	8979	1.299	1.103	1.530
1999	14320	8659	23682	9421	8340	10642	7491	6652	8435	1.340	1.146	1.567
2000	8828	5530	14093	7108	6375	7926	5734	5138	6399	1.413	1.210	1.650
2001	4983	3128	7939	6240	5510	7067	5016	4424	5686	1.485	1.249	1.765
2002	10084	6375	15950	5127	4514	5823	4144	3633	4726	1.280	1.079	1.518
2003	4351	2601	7278	4576	4067	5149	3706	3293	4170	1.137	0.948	1.364
2004	13709	8621	21800	5208	4565	5941	3909	3445	4436	1.100	0.918	1.317
2005	8583	5422	13586	6506	5736	7380	4458	3954	5027	1.116	0.935	1.332
2006	10733	6725	17129	7145	6256	8159	5222	4584	5949	1.061	0.884	1.274
2007	3960	2326	6744	4500	4003	5058	3607	3197	4070	1.230	1.016	1.489
2008	2019	1240	3288	2497	2217	2811	2159	1898	2455	1.252	1.024	1.532
2009	6353	3963	10183	1492	1290	1725	1004	883	1141	1.149	0.934	1.413
2010	5620	3535	8933	1919	1669	2207	1096	965	1243	1.005	0.810	1.247
2011	6623	4178	10498	2246	1930	2613	1481	1278	1715	0.857	0.672	1.093
2012	12874	8054	20580	2435	2060	2877	1524	1307	1776	0.829	0.641	1.072
2013	21429	13145	34934	4169	3495	4973	2364	1989	2811	0.746	0.551	1.010
2014	6113	3299	11326	7754	6324	9508	3949	3160	4934	0.648	0.439	0.956
2015							5445	3434	8635			

Table 2. Estimated stock numbers.

Year\Age	1	2	3	4	5	6+
1997	15850	6969	10410	1583	407	180
1998	13780	10482	2665	2753	397	111
1999	14320	9259	5911	659	579	109
2000	8828	7726	3758	1425	171	143
2001	4983	4727	3013	919	257	62
2002	10084	3018	1318	597	130	59
2003	4351	5658	1296	373	139	34
2004	13709	2629	2180	358	115	68
2005	8583	7664	790	739	96	54
2006	10733	5102	3158	205	185	48
2007	3960	3880	852	726	67	103
2008	2019	1134	744	170	139	32
2009	6353	813	206	135	52	25
2010	5620	3485	222	60	30	16
2011	6623	3297	809	63	20	10
2012	12874	2763	473	214	32	11
2013	21429	6049	1067	170	50	16
2014	6113	14812	1881	523	106	12
2015	5842	2457	3513	836	239	61

Table 3. Estimated fishing mortalities.

Year\Age	1	2	3	4+
1997	0.200	0.537	1.087	1.392
1998	0.211	0.511	1.122	1.388
1999	0.232	0.595	1.229	1.396
2000	0.272	0.650	1.260	1.490
2001	0.312	0.791	1.374	1.541
2002	0.337	0.790	1.244	1.297
2003	0.383	0.824	1.222	1.095
2004	0.428	0.913	1.098	1.101
2005	0.499	0.941	1.192	1.079
2006	0.576	1.187	1.168	1.007
2007	0.636	1.259	1.162	1.264
2008	0.598	1.351	1.300	1.229
2009	0.564	1.372	1.157	1.145
2010	0.569	1.337	1.088	0.964
2011	0.599	1.468	0.935	0.818
2012	0.610	1.207	0.813	0.837
2013	0.619	1.179	0.704	0.767
2014	0.669	1.273	0.616	0.664

Table 4. Estimated catch scaling factors (same for all ages within each year)

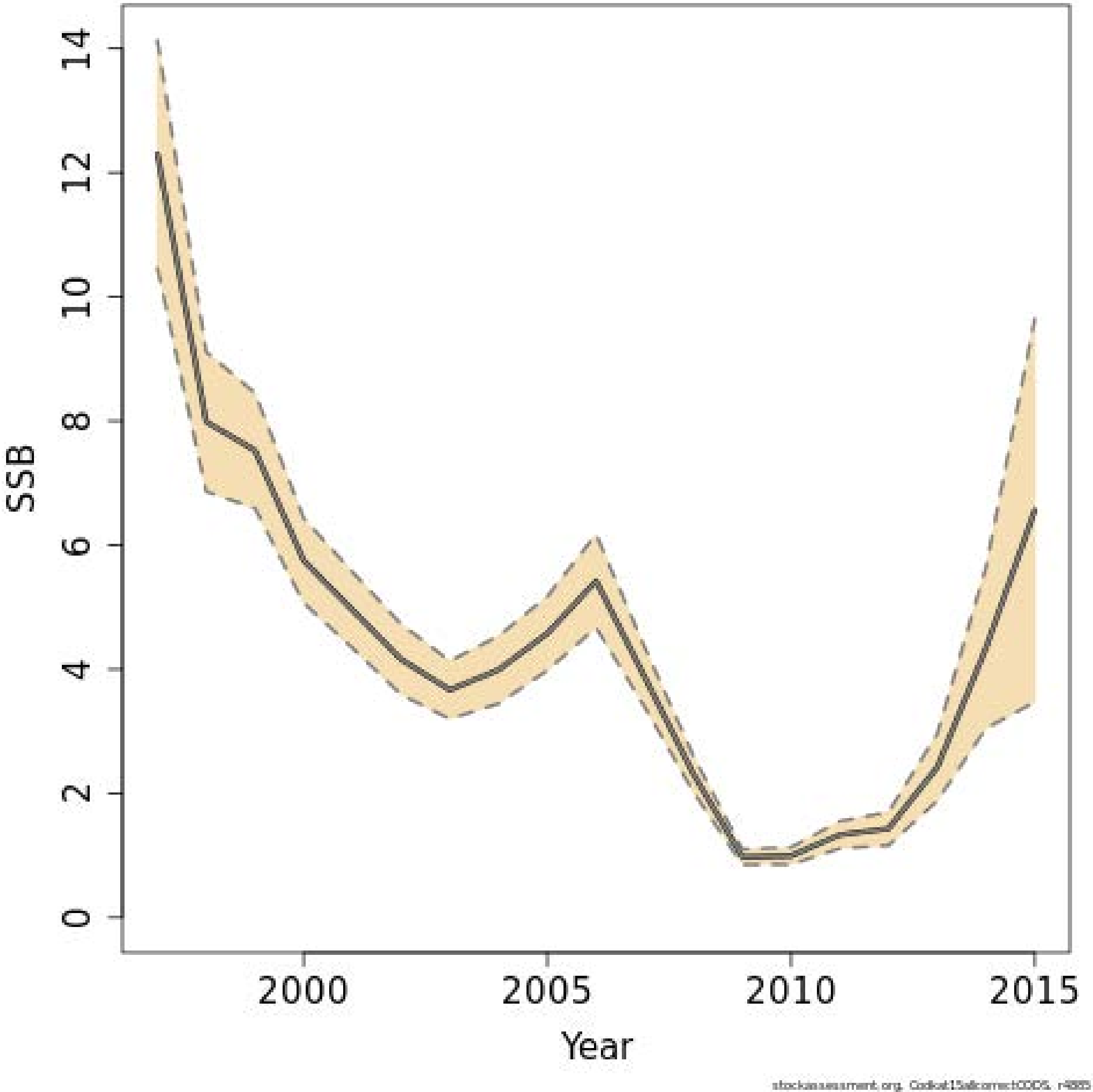
Year	Catch multiplier	Low	High
2003	1.27	0.93	1.74
2004	1.08	0.76	1.55
2005	2.75	1.90	3.99
2006	3.12	2.12	4.59
2007	2.80	1.87	4.21
2008	2.95	1.95	4.47
2009	3.80	2.52	5.75
2010	4.33	2.92	6.42
2011	5.20	3.49	7.74
2012	8.55	5.62	13.03
2013	8.13	5.37	12.32
2014	11.82	7.61	18.37

Table 5. Estimated catchabilities multiplied by 1000.

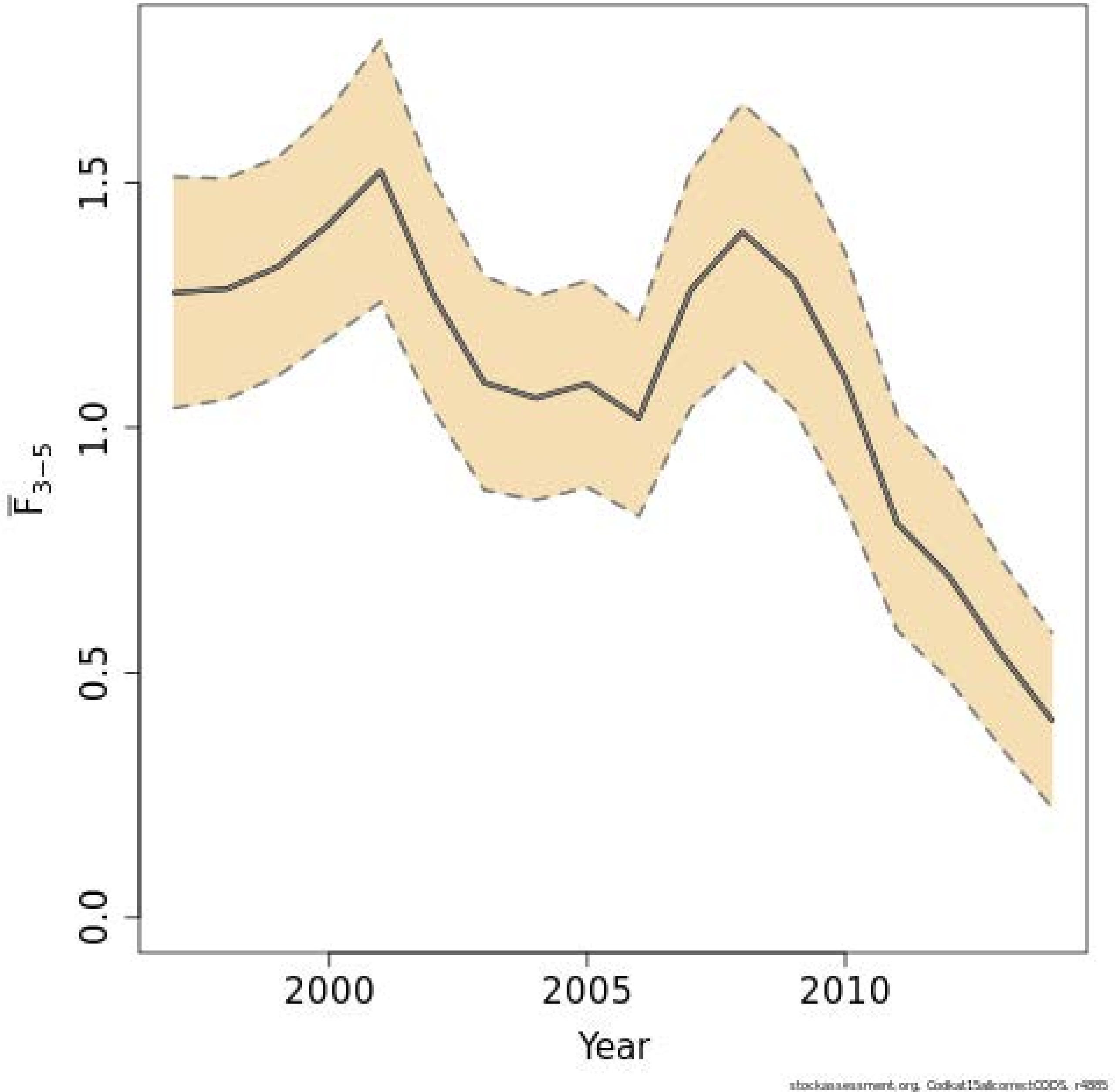
Index	Fleet number	Age	Catchability	Low	High
1	2	1	5.64717	3.54215	9.00316
2	2	2	2.54455	1.59283	4.06492
3	2	3	1.48937	0.89935	2.46649
4	3	1	8.50246	5.73963	12.59519
5	3	2	7.15102	4.76004	10.74301
6	3	3	4.35339	2.88994	6.55793
7	4	1	4.89324	2.94950	8.11793
8	4	2	7.49964	5.12041	10.98439
9	4	3	7.72109	5.30386	11.23996
10	4	4	12.28471	9.40551	16.04529
11	4	5	12.28471	9.40551	16.04529
12	4	6	12.28471	9.40551	16.04529
13	5	1	2.86496	1.67343	4.90490
14	5	2	1.97952	1.22502	3.19873
15	5	3	1.14026	0.69123	1.88098
16	5	4	1.39984	0.85969	2.27936

Table 6. Likelihood values.

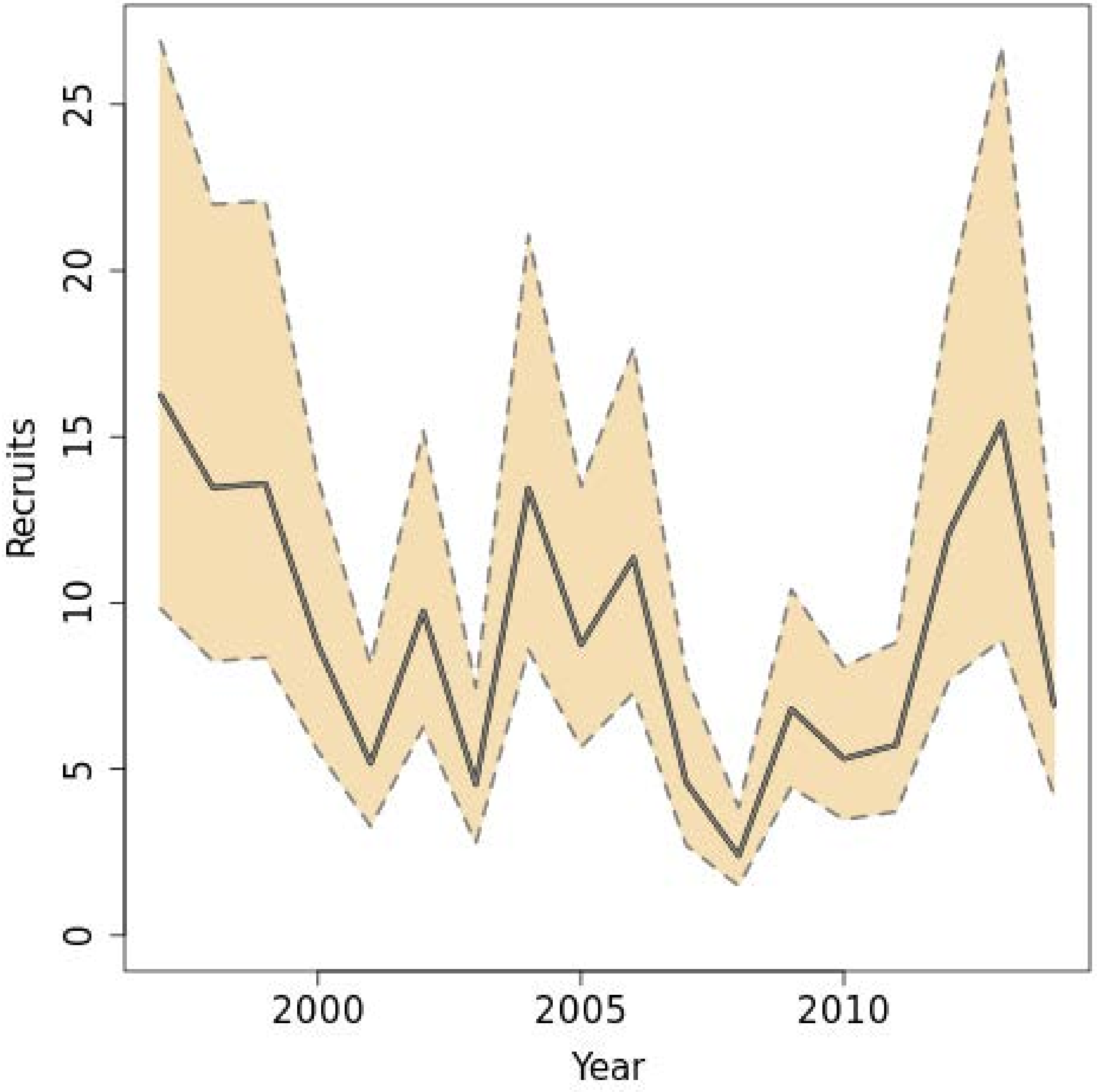
Model	Negative log likelihood	Number of parameters
Base	408.88	41
Current	408.88	41



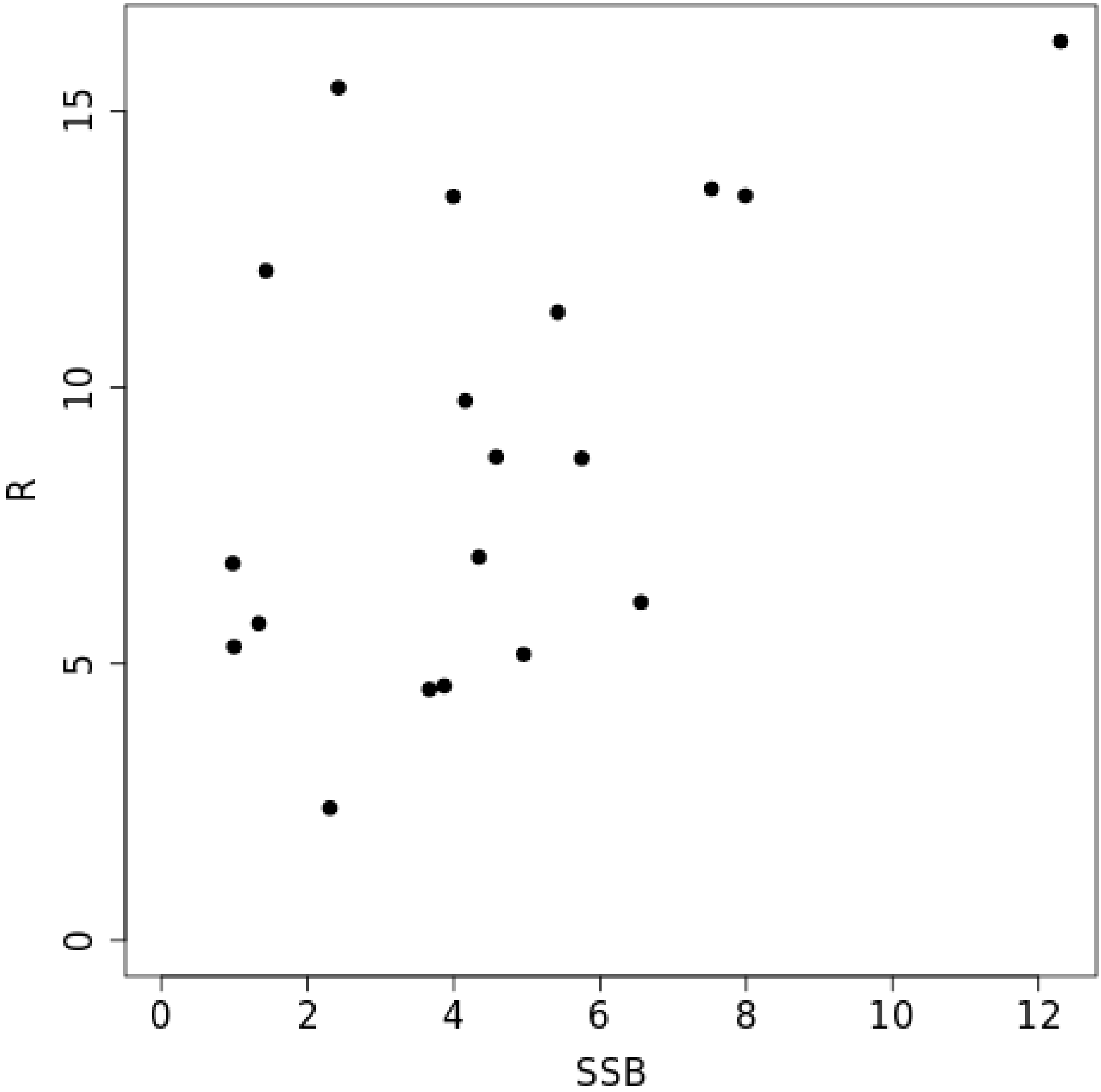
SSB
Year
0
2
4
6
8
10
12
14
2000
2005
2010
2015
stockassessment.org



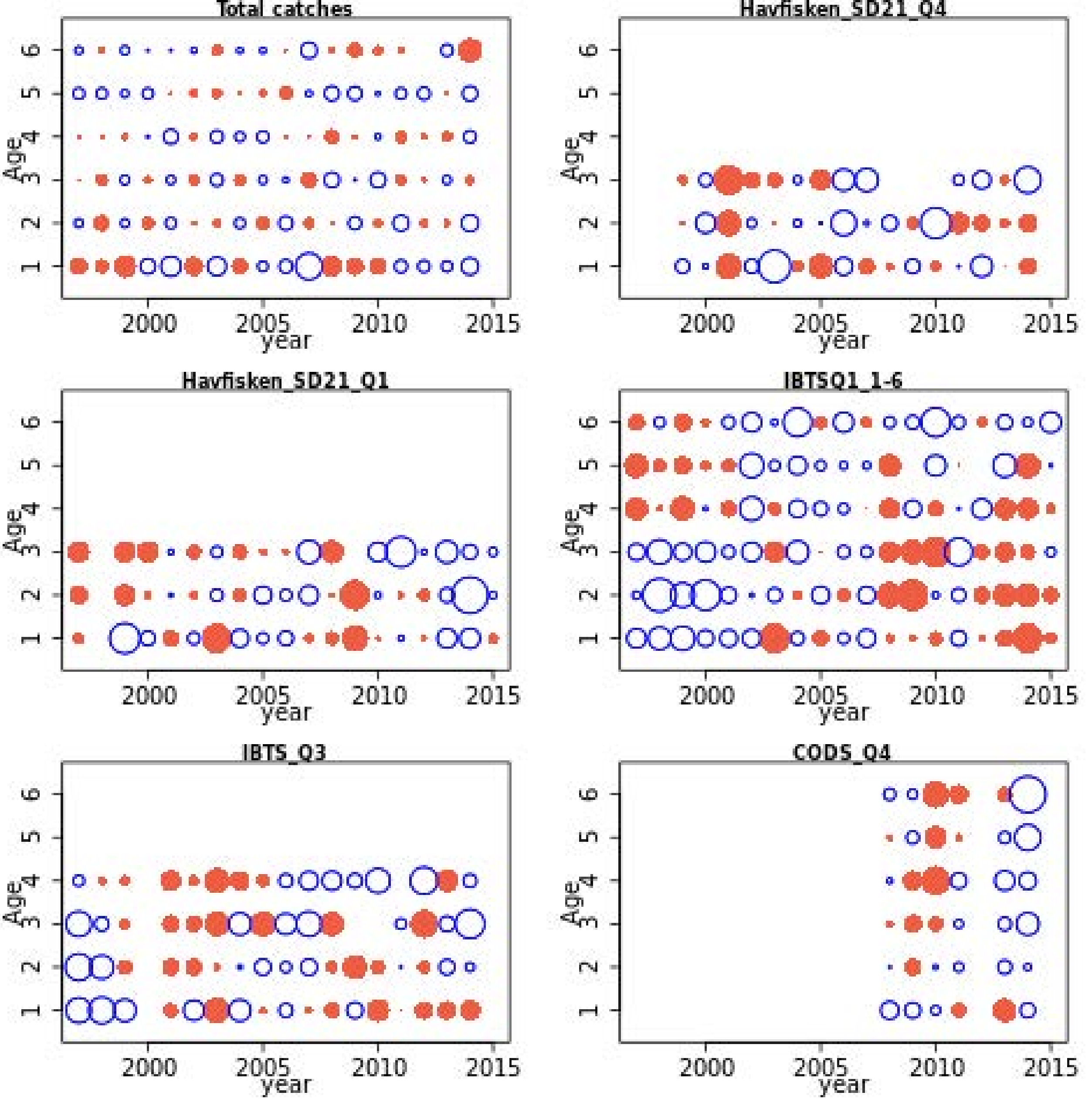
1.5
1.0
0.5
0.0
$\overline{F}_{3-5}$
2000
2005
2010
Year
stockassessment.org

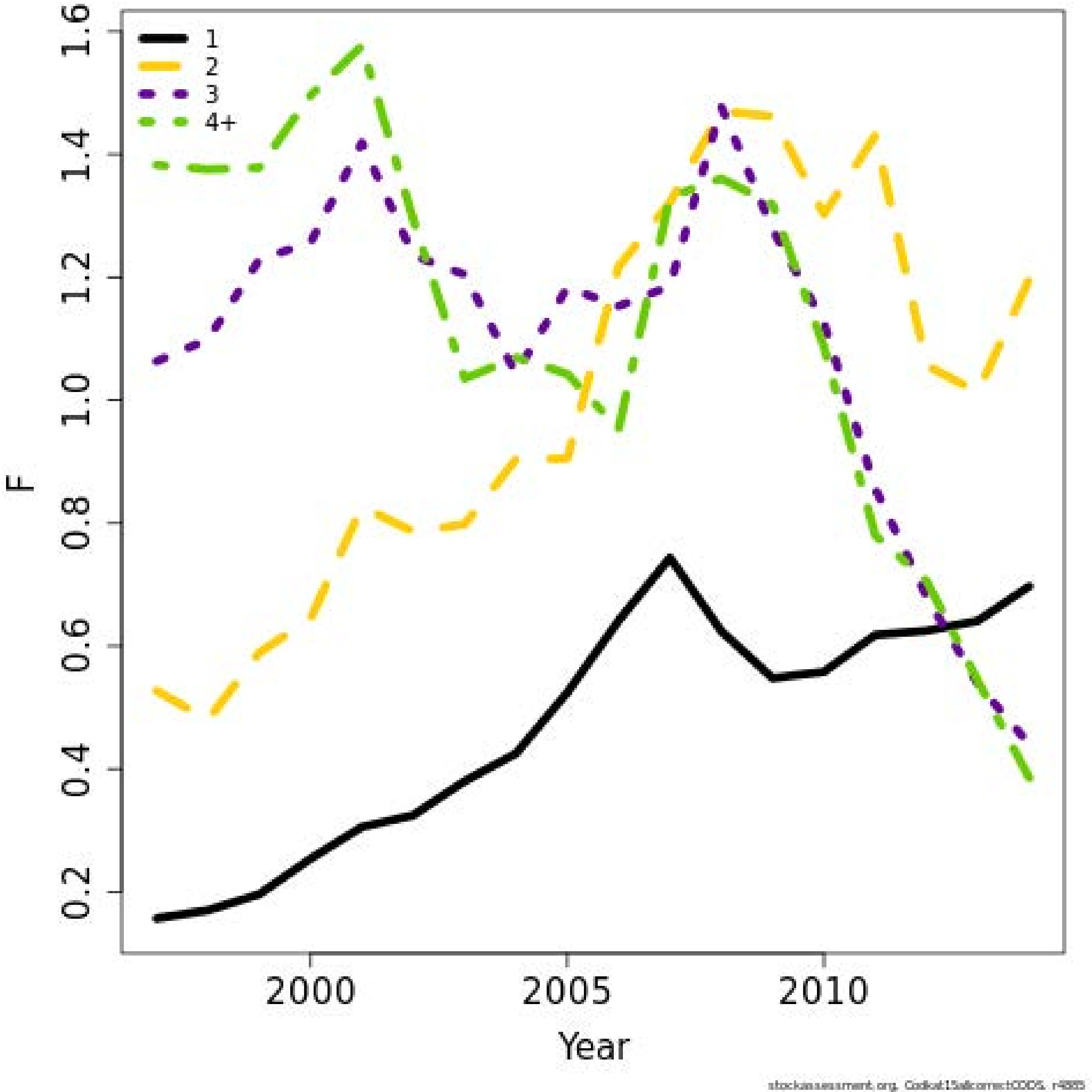


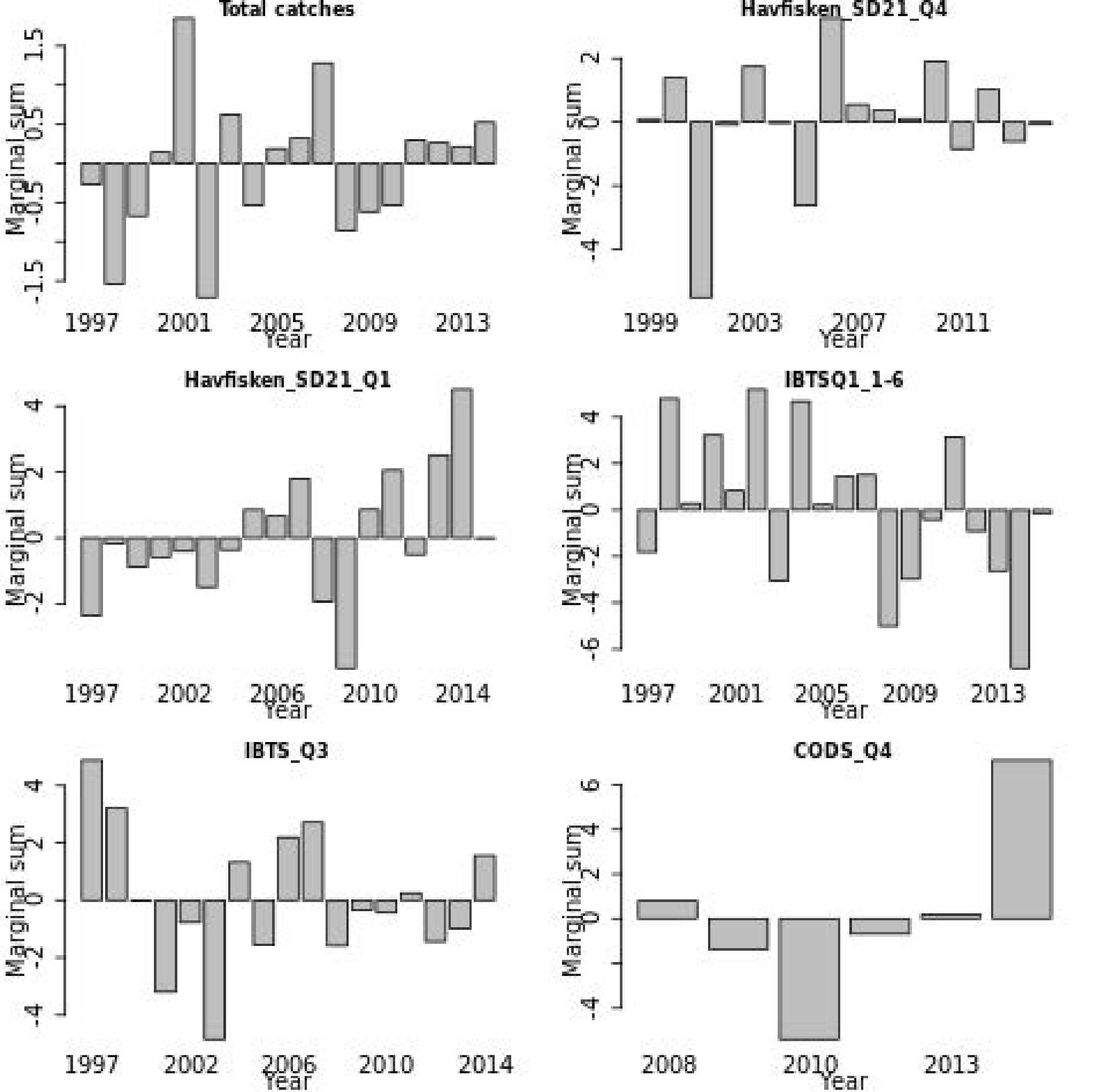
Recruits
0
5
10
15
20
25
2000
2005
2010
Year



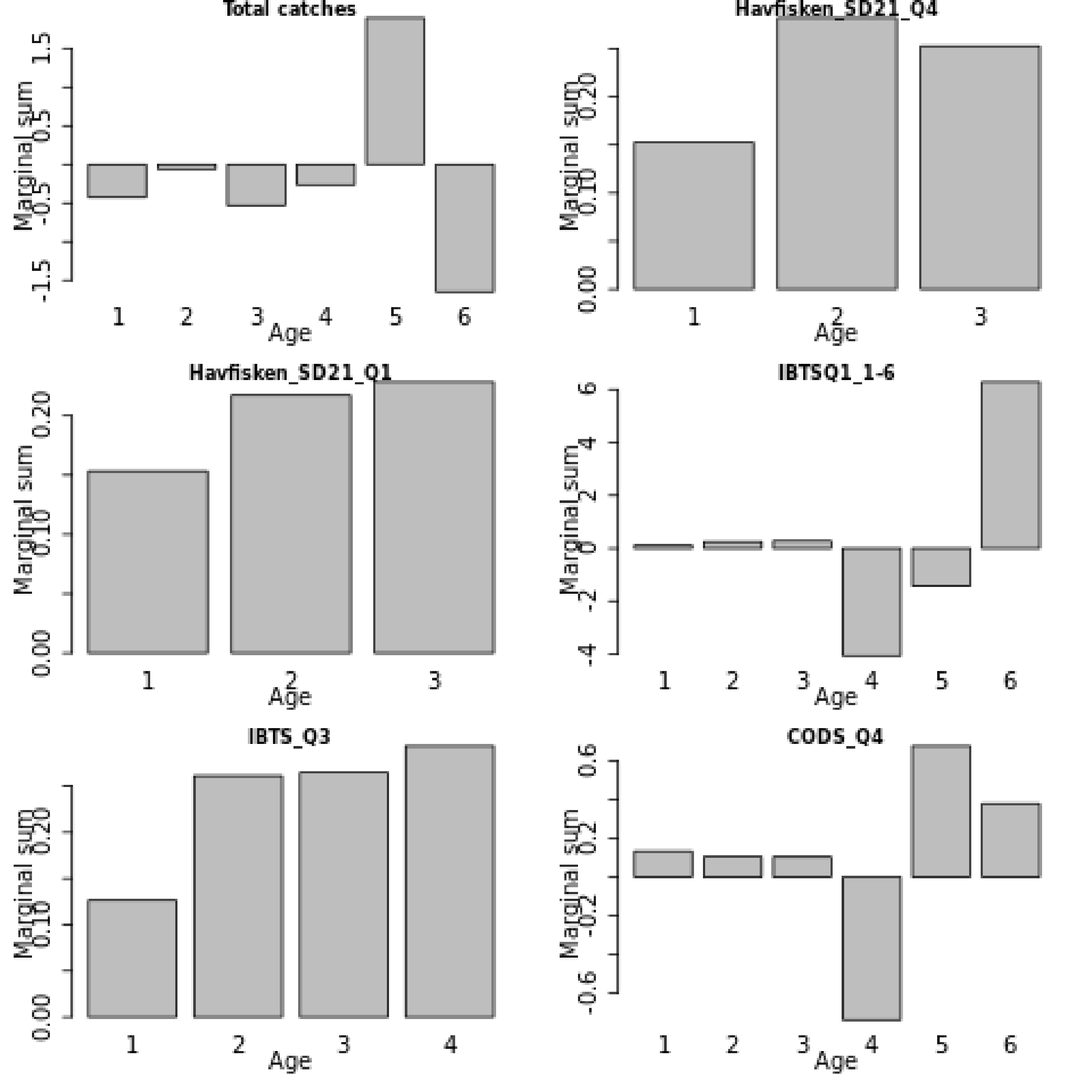
15
10
5
0
R
0
2
4
6
8
10
12
SSB

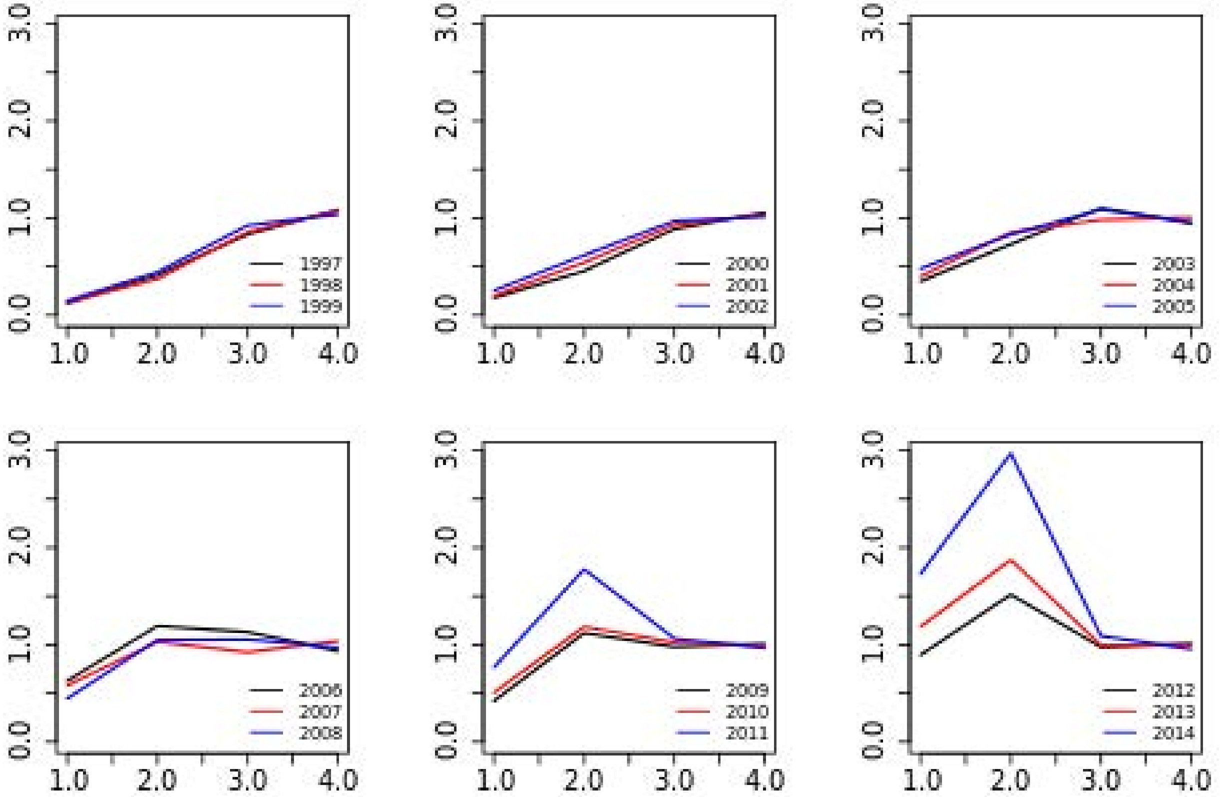

Total_catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Age
year
1
2
3
4
5
6
2000
2005
2010
2015

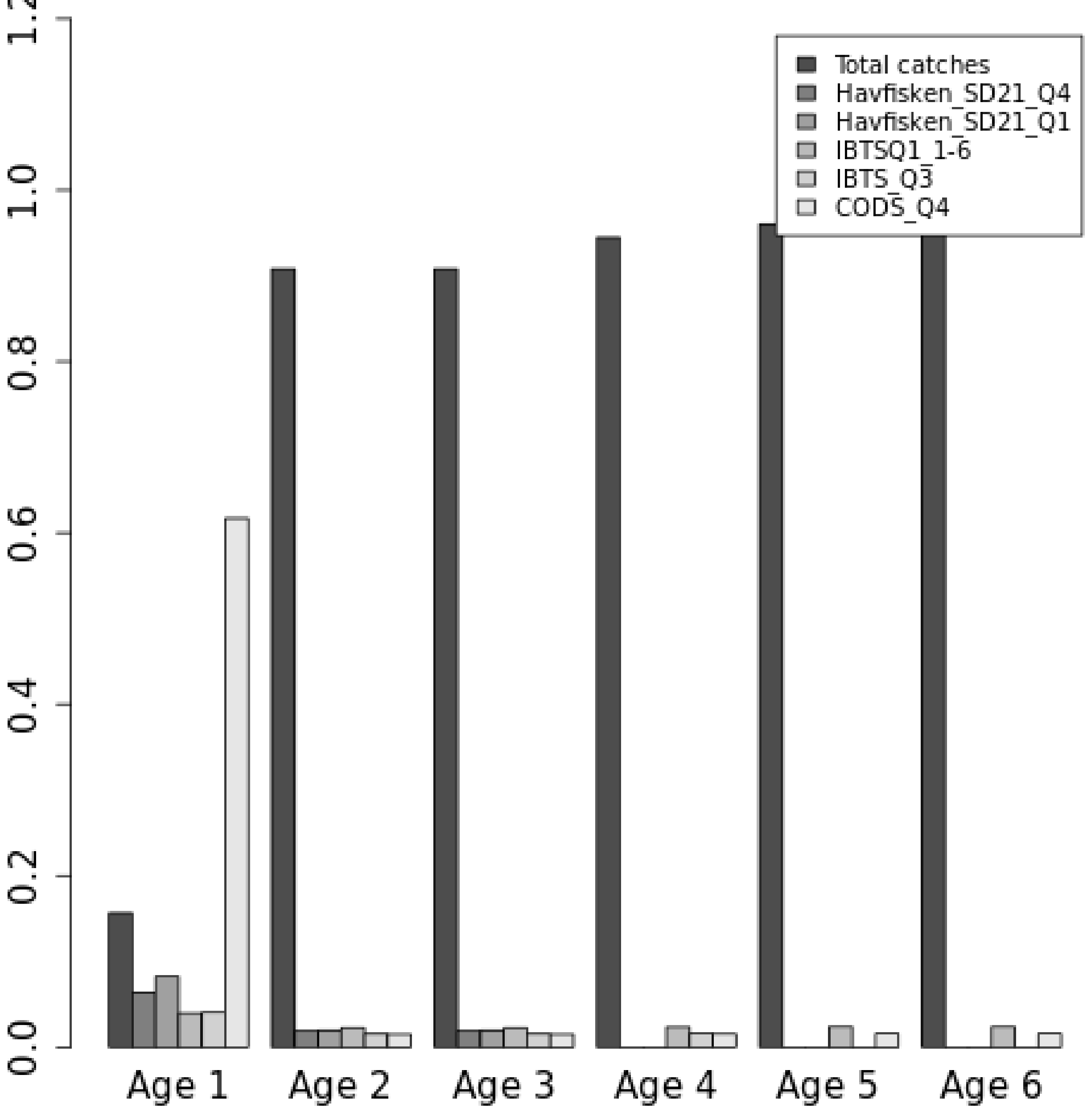

1
2
3
4+
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
F
2000
2005
2010
Year
stockassessment.org, Coilkat15alkorrectCODS, r4885



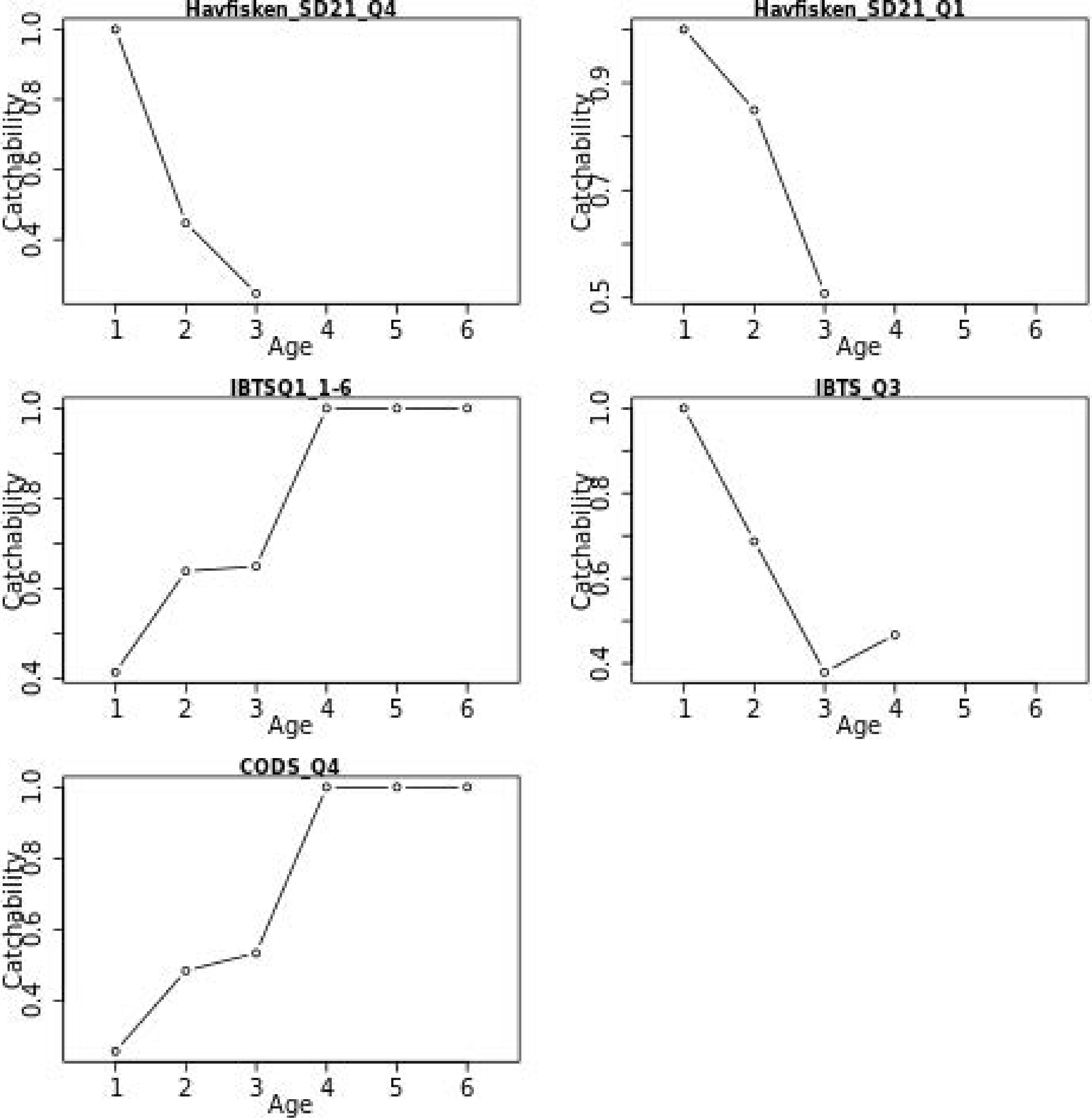
Total catches
Marginal sum
1.5
0.5
-0.5
-1.5
1997
2001
2005
2009
2013
Year
Havfisken_SD21_Q4
Marginal sum
2
0
-2
-4
1999
2003
2007
2011
Year
Havfisken_SD21_Q1
Marginal sum
4
2
0
-2
1997
2002
2006
2010
2014
Year
IBTSQ1_1-6
Marginal sum
4
2
0
-2
-4
-6
1997
2001
2005
2009
2013
Year
IBTS_Q3
Marginal sum
4
2
0
-2
-4
1997
2002
2006
2010
2014
Year
CODS_Q4
Marginal sum
6
4
2
0
-4
2008
2010
2013
Year

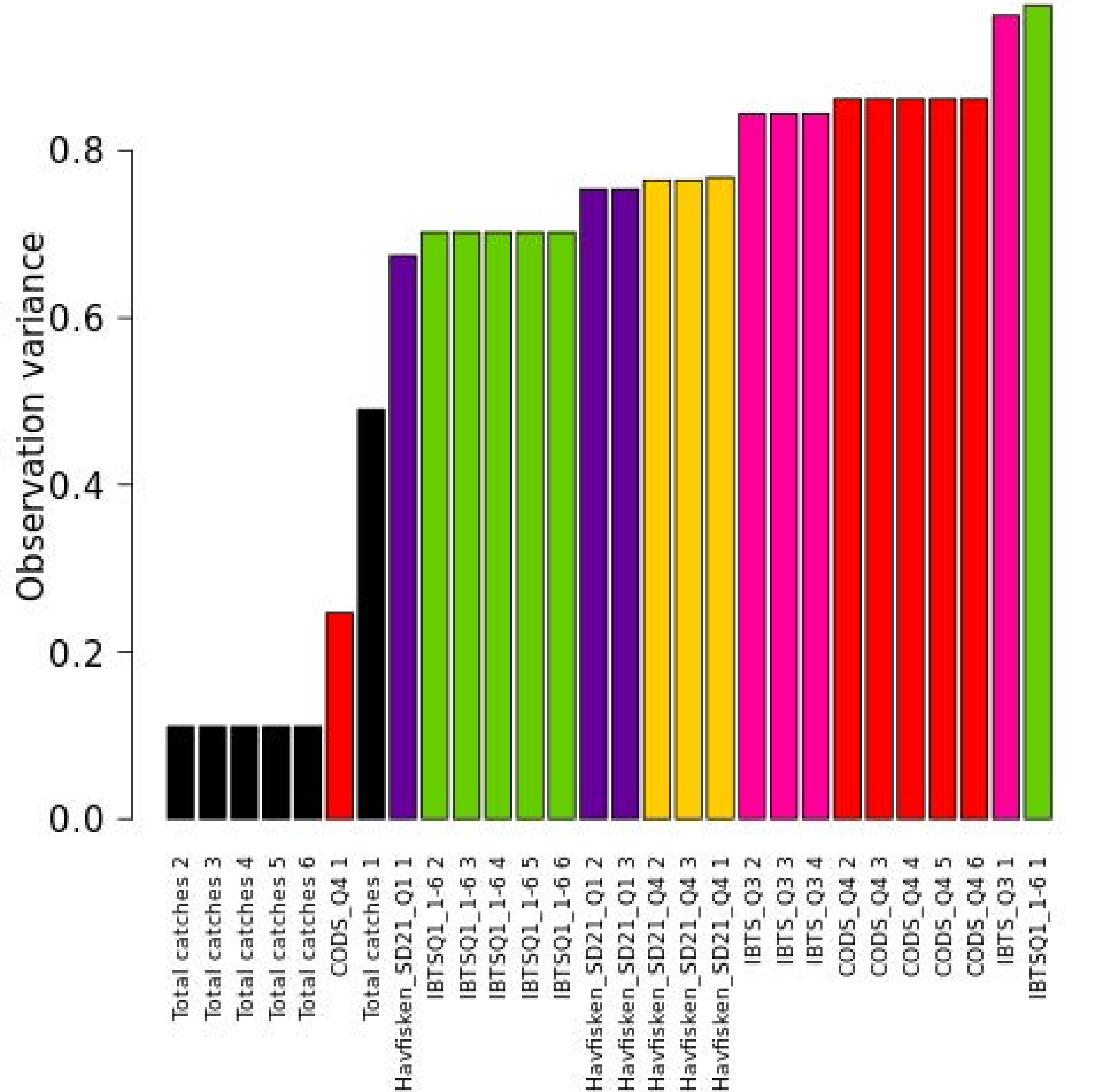

Total catches
Marginal sum
1.5
0.5
-0.5
-1.5
1 2 3 4 5 6
Age
Havfisken_SD21_Q4
Marginal sum
0.20
0.10
0.00
1 2 3
Age
Havfisken_SD21_Q1
Marginal sum
0.20
0.10
0.00
1 2 3
Age
IBTSQ1_1-6
Marginal sum
6
4
2
0
-2
-4
1 2 3 4 5 6
Age
IBTS_Q3
Marginal sum
0.20
0.10
0.00
1 2 3 4
Age
CODS_Q4
Marginal sum
0.6
0.2
-0.2
-0.6
1 2 3 4 5 6
Age


1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
0.0
1.0
2.0
3.0
4.0



Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Age 1
Age 2
Age 3
Age 4
Age 5
Age 6


Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Catchability
Age
1.0
0.8
0.6
0.4
0.9
0.7
0.5
1
2
3
4
5
6



Observation variance
0.0
0.2
0.4
0.6
0.8
Total catches 2
Total catches 3
Total catches 4
Total catches 5
Total catches 6
CODS_Q4 1
Total catches 1
Havfisken_SD21_Q1 1
IBTSQ1_1-6 2
IBTSQ1_1-6 3
IBTSQ1_1-6 4
IBTSQ1_1-6 5
IBTSQ1_1-6 6
Havfisken_SD21_Q1 2
Havfisken_SD21_Q1 3
Havfisken_SD21_Q4 2
Havfisken_SD21_Q4 3
Havfisken_SD21_Q4 1
IBTS_Q3 2
IBTS_Q3 3
IBTS_Q3 4
CODS_Q4 2
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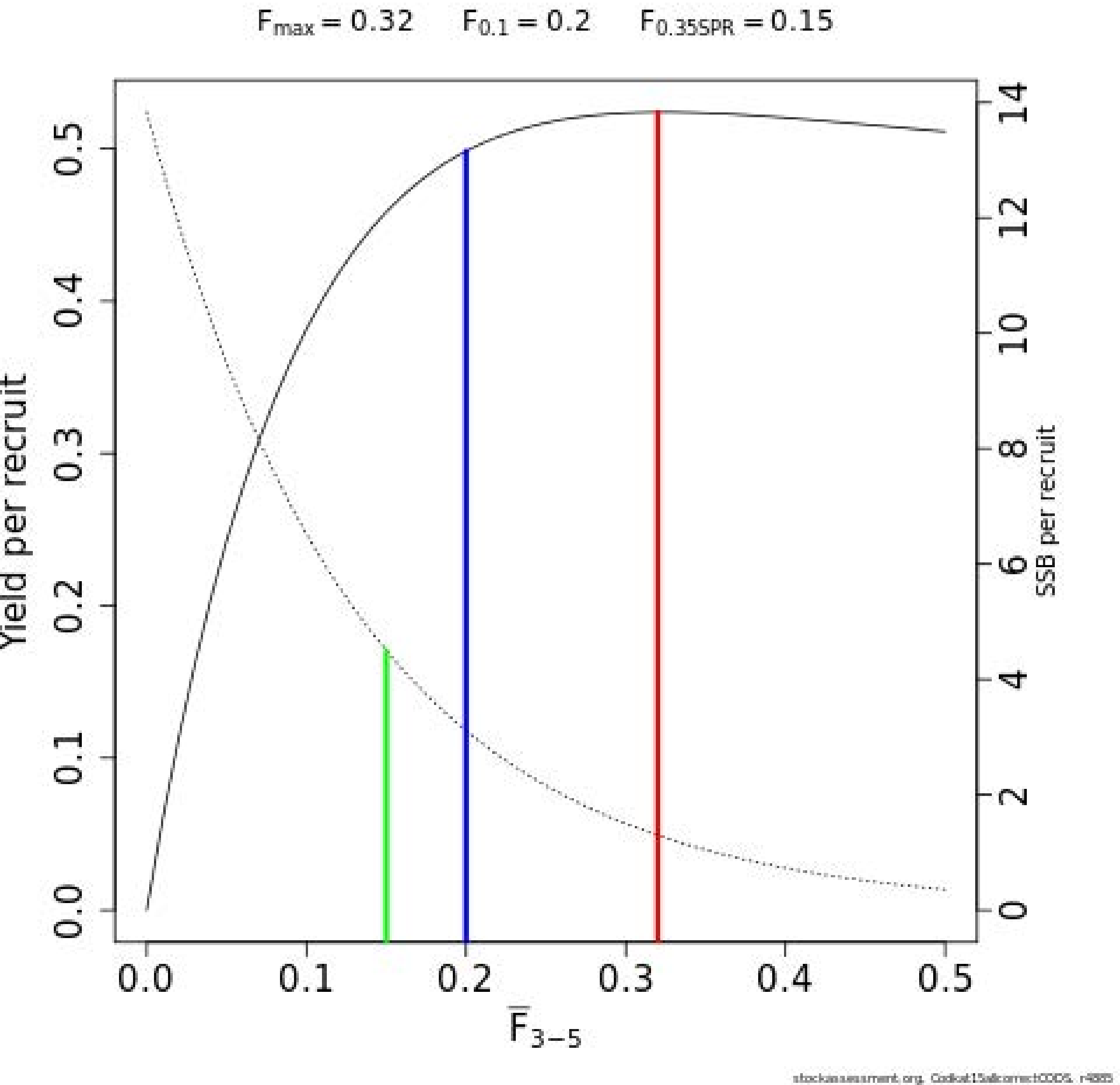
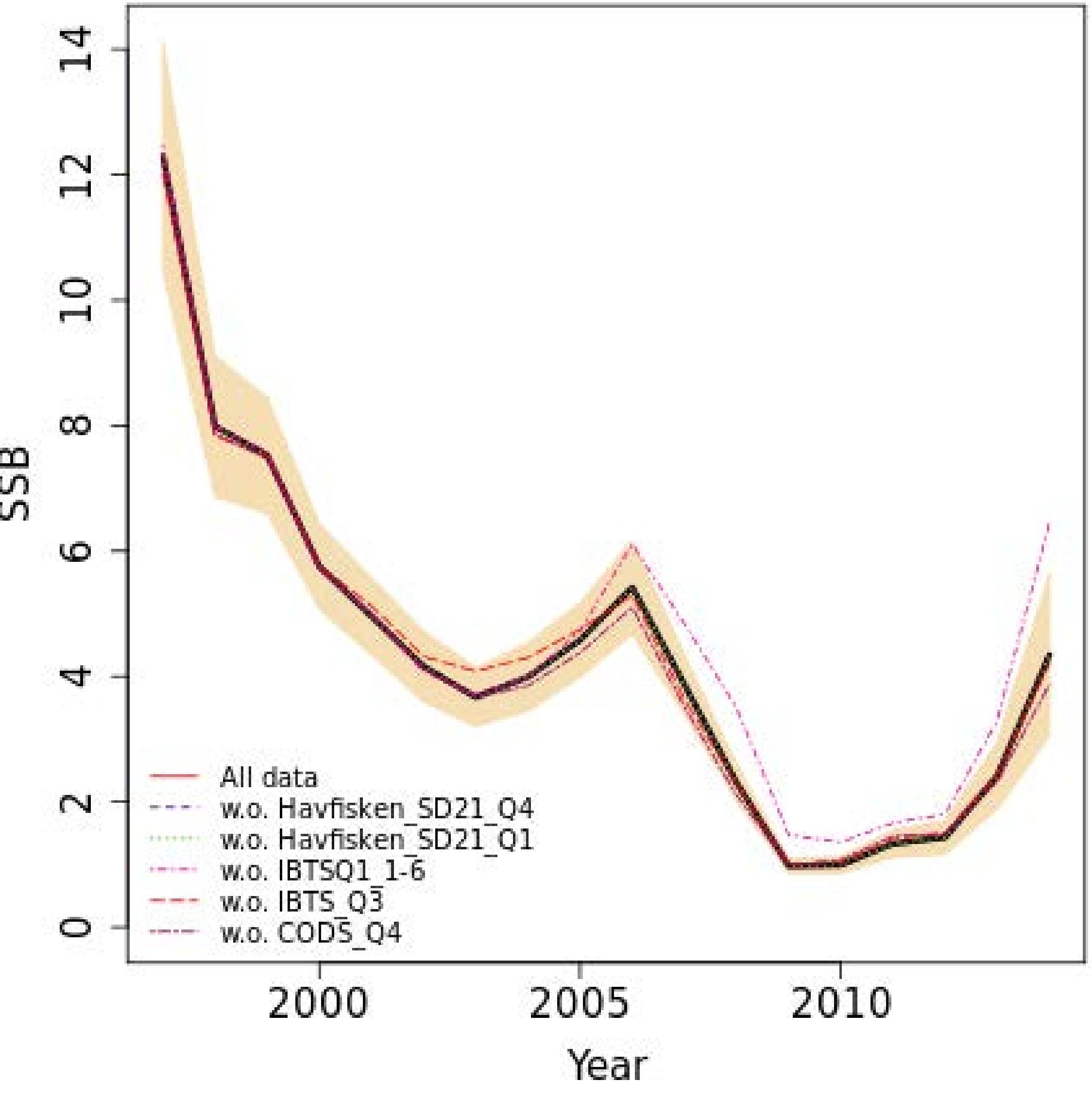
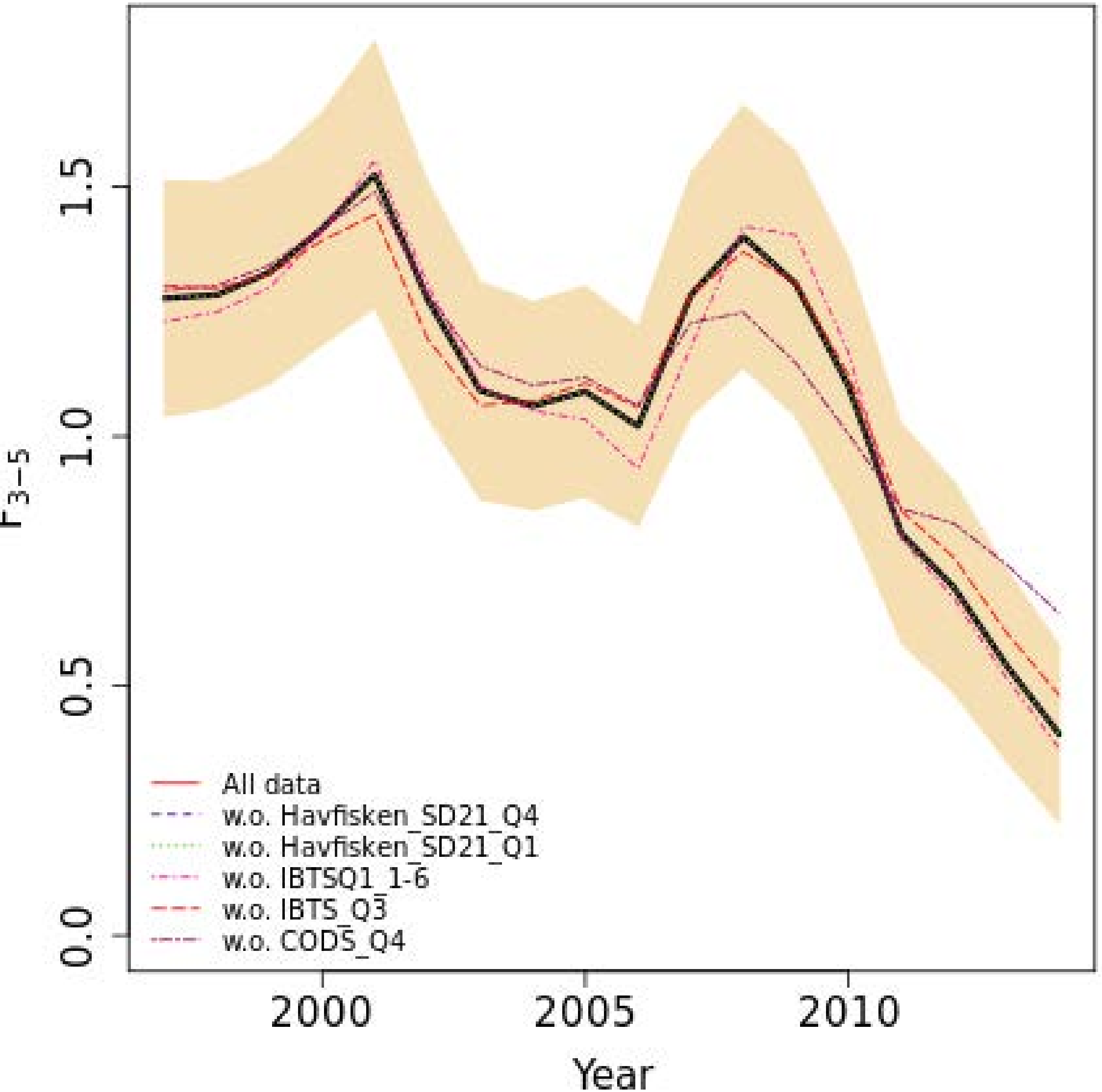
CODS_Q4 6
IBTS_Q3 1
IBTSQ1_1-6 1



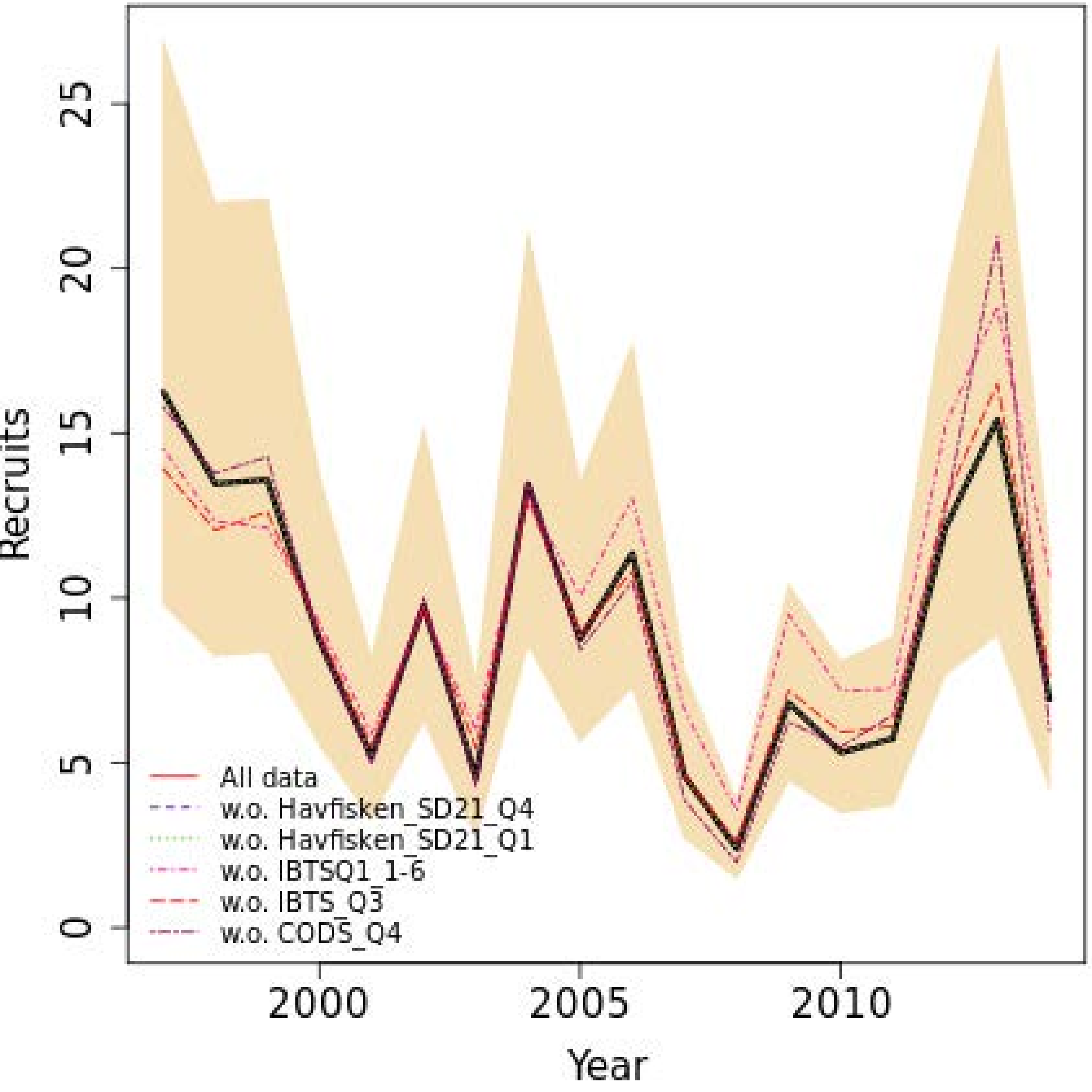
$F_{max} = 0.32$ $F_{0.1} = 0.2$ $F_{0.35SPR} = 0.15$
Yield per recruit
SSB per recruit
0.0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
12
14
$\overline{F}_{3-5}$
stockassessment.org



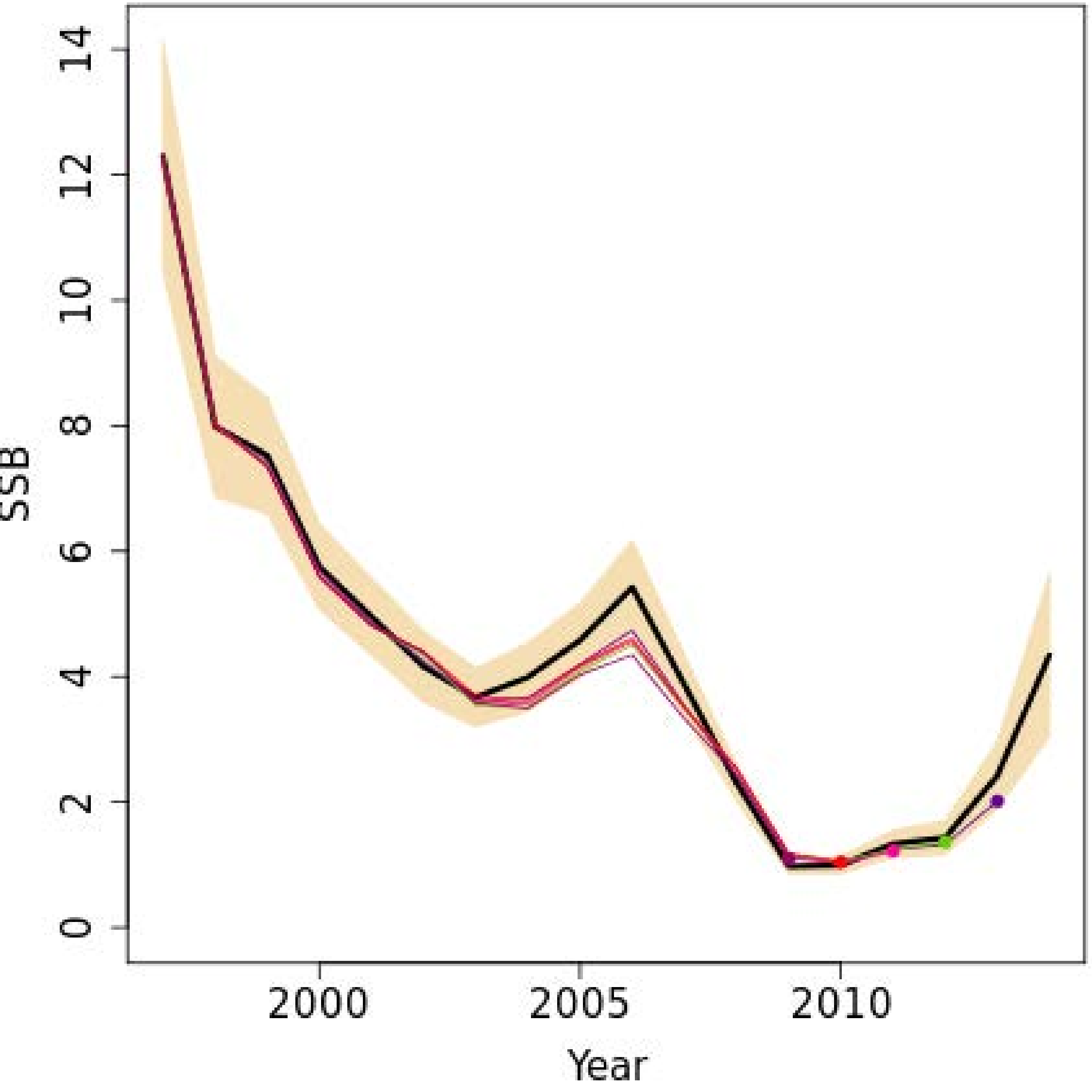
SSB
14
12
10
8
6
4
2
0
2000
2005
2010
Year
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3
w.o. CODS_Q4



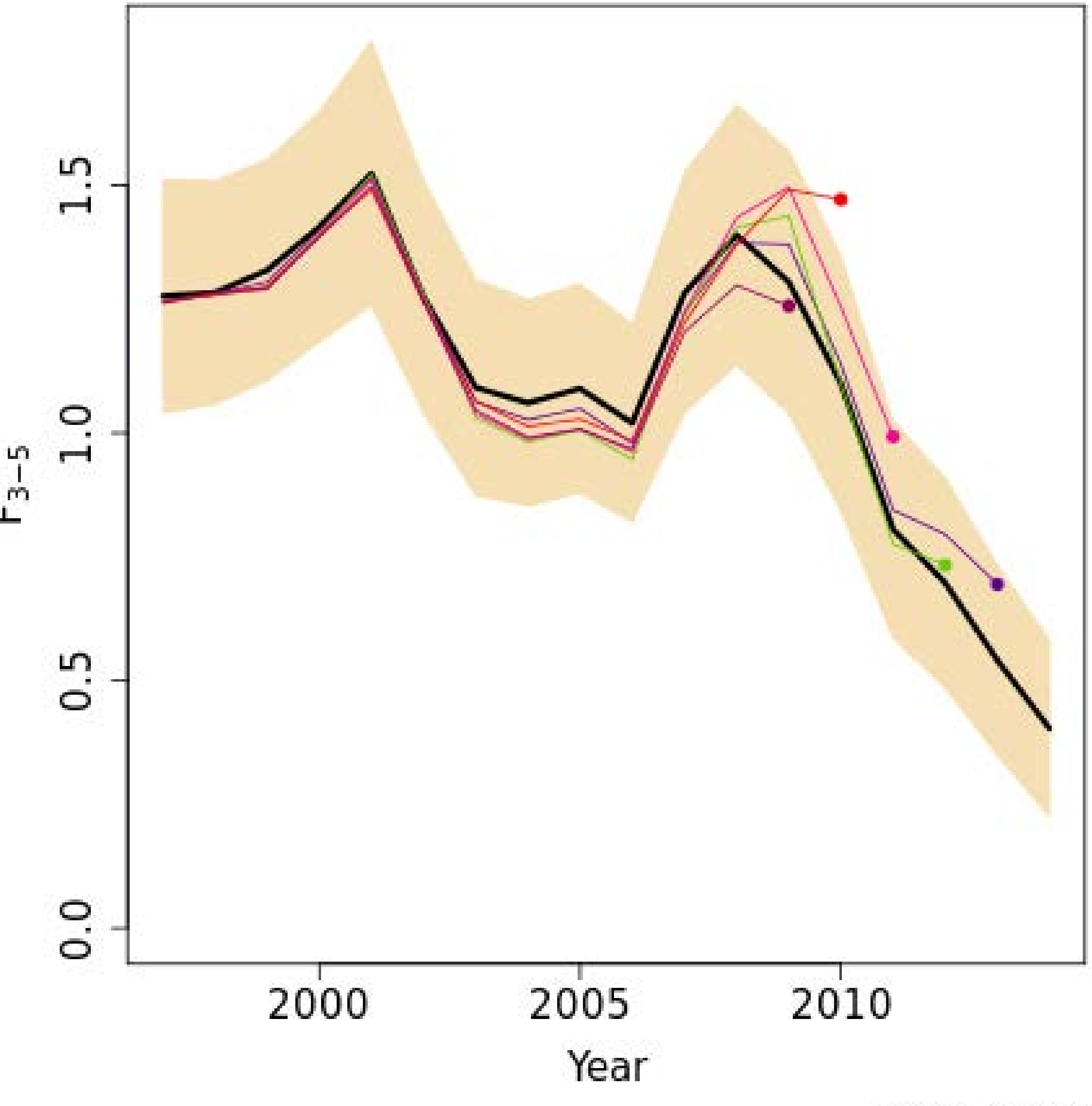
stockassessment.org, Codkat15allcorrectCODS, r4885



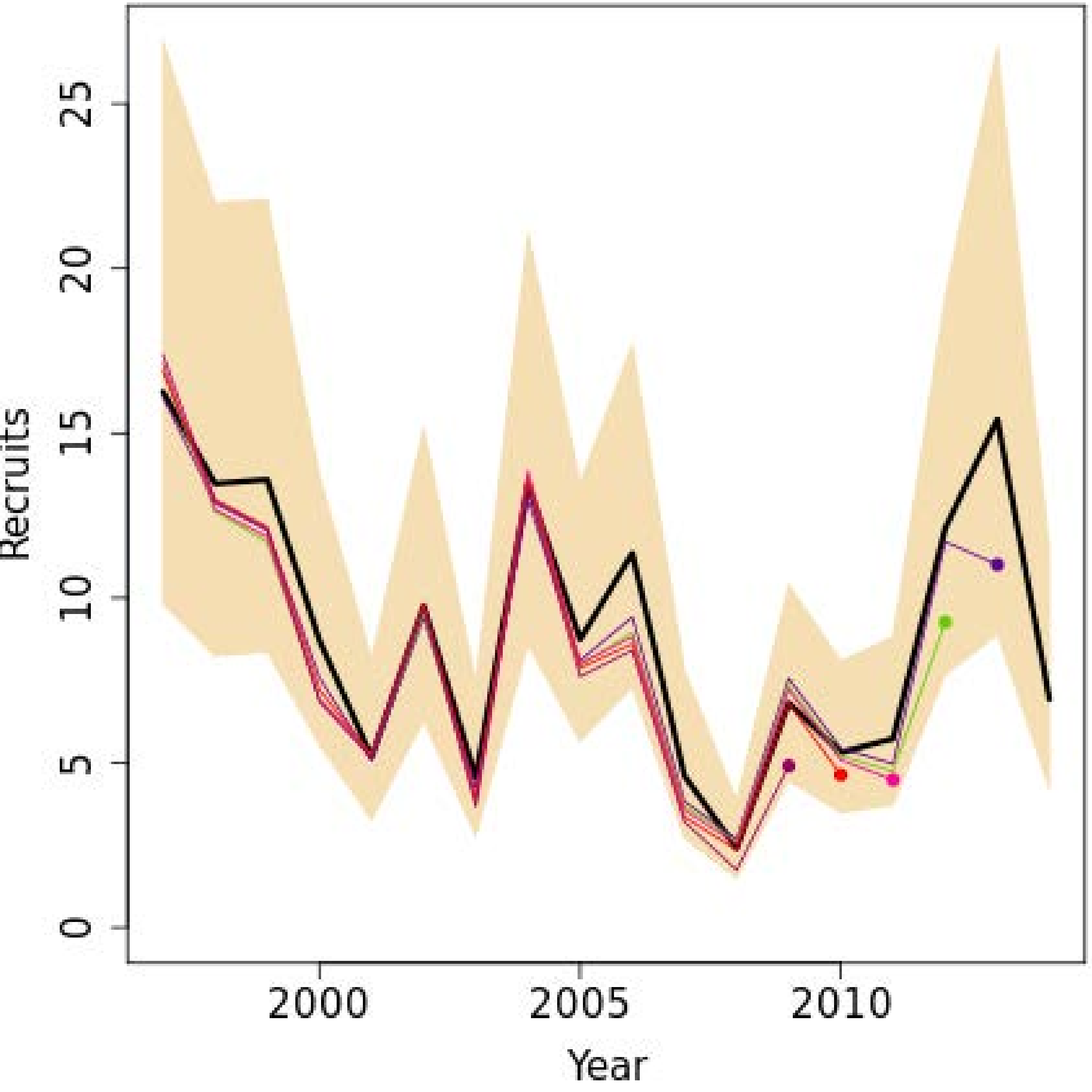
stockassessment.org



SSB
0
2
4
6
8
10
12
14
2000
2005
2010
Year



1.5
1.0
0.5
0.0
F_{3-5}
2000
2005
2010
Year



Recruits
0
5
10
15
20
25
2000
2005
2010
Year

Table 1. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	16262	9829	26905	14654	12712	16893	12299	10595	14278	1.276	1.061	1.536
1998	13468	8247	21995	10536	9201	12066	7988	6938	9196	1.283	1.077	1.530
1999	13594	8366	22090	9428	8315	10689	7525	6652	8513	1.328	1.123	1.572
2000	8718	5540	13721	7133	6348	8015	5753	5108	6478	1.416	1.201	1.670
2001	5173	3279	8163	6173	5464	6973	4956	4380	5608	1.524	1.279	1.816
2002	9760	6274	15181	5130	4500	5848	4158	3628	4767	1.274	1.059	1.533
2003	4544	2770	7456	4549	4009	5161	3668	3229	4165	1.092	0.894	1.333
2004	13456	8590	21078	5288	4610	6066	3992	3482	4576	1.061	0.872	1.291
2005	8741	5657	13507	6686	5845	7647	4579	4020	5215	1.090	0.898	1.323
2006	11361	7294	17695	7412	6461	8501	5422	4721	6228	1.020	0.838	1.241
2007	4605	2716	7805	4847	4299	5465	3868	3417	4379	1.282	1.061	1.549
2008	2395	1491	3848	2682	2385	3016	2306	2035	2613	1.400	1.160	1.689
2009	6816	4462	10411	1489	1282	1730	977	861	1108	1.305	1.065	1.599
2010	5313	3490	8089	1776	1520	2075	994	866	1142	1.100	0.870	1.390
2011	5731	3724	8820	2003	1706	2351	1333	1131	1570	0.805	0.614	1.057
2012	12113	7669	19132	2282	1893	2751	1432	1187	1727	0.697	0.514	0.945
2013	15423	8898	26731	3940	3197	4856	2422	1938	3025	0.541	0.379	0.772
2014	6931	4206	11421	8023	6187	10404	4347	3223	5862	0.403	0.259	0.627
2015							6561	4097	10506			

Table 2. Estimated stock numbers.

Year\Age	1	2	3	4	5	6+
1997	16262	7030	10532	1592	405	180
1998	13468	11112	2720	2776	395	112
1999	13594	9286	5937	667	581	109
2000	8718	7828	3784	1424	170	143
2001	5173	4607	2985	905	256	61
2002	9760	3035	1326	598	130	59
2003	4544	5638	1263	370	140	35
2004	13456	2638	2252	361	117	69
2005	8741	7931	800	758	100	55
2006	11361	5139	3267	216	197	51
2007	4605	4149	928	776	71	109
2008	2395	1232	783	186	147	35
2009	6816	820	202	130	50	25
2010	5313	3321	199	52	26	13
2011	5731	2886	748	57	17	9
2012	12113	2512	451	205	30	10
2013	15423	5659	1104	188	54	17
2014	6931	12763	2114	670	139	16
2015	6116	2636	3306	1075	375	97

Table 3. Estimated fishing mortalities.

Year\Age	**1**	**2**	**3**	**4+**
1997	0.157	0.527	1.063	1.383
1998	0.170	0.480	1.099	1.376
1999	0.196	0.589	1.229	1.378
2000	0.254	0.645	1.257	1.496
2001	0.306	0.827	1.419	1.577
2002	0.325	0.786	1.236	1.294
2003	0.380	0.798	1.204	1.035
2004	0.425	0.904	1.043	1.070
2005	0.524	0.905	1.183	1.043
2006	0.641	1.217	1.153	0.953
2007	0.744	1.322	1.186	1.331
2008	0.624	1.470	1.478	1.361
2009	0.548	1.462	1.278	1.318
2010	0.558	1.302	1.126	1.086
2011	0.618	1.431	0.856	0.780
2012	0.625	1.057	0.680	0.706
2013	0.641	1.013	0.538	0.543
2014	0.697	1.197	0.440	0.385

Table 4. Estimated catch scaling factors (same for all ages within each year)

Year	Catch multiplier	Low	High
2003	1.23	0.87	1.74
2004	1.08	0.74	1.59
2005	2.78	1.87	4.12
2006	3.20	2.14	4.78
2007	3.06	2.02	4.65
2008	3.35	2.16	5.20
2009	3.96	2.56	6.14
2010	4.00	2.62	6.10
2011	4.47	2.90	6.88
2012	7.22	4.57	11.40
2013	6.91	4.27	11.19
2014	10.22	5.99	17.45

Table 5. Estimated catchabilities multiplied by 1000.

Index	Fleet number	Age	Catchability	Low	High
1	2	1	5.72278	3.58822	9.12717
2	2	2	2.56064	1.61878	4.05048
3	2	3	1.41207	0.86329	2.30969
4	3	1	8.49906	5.68536	12.70525
5	3	2	7.21856	4.76385	10.93813
6	3	3	4.31827	2.84481	6.55492
7	4	1	4.89618	2.95097	8.12362
8	4	2	7.54251	5.14258	11.06244
9	4	3	7.66953	5.26592	11.17026
10	4	4	11.80774	9.02335	15.45133
11	4	5	11.80774	9.02335	15.45133
12	4	6	11.80774	9.02335	15.45133
13	5	1	2.88682	1.69994	4.90235
14	5	2	1.98388	1.23523	3.18628
15	5	3	1.09423	0.66839	1.79140
16	5	4	1.34885	0.83435	2.18063
17	6	1	39.72796	26.35387	59.88915
18	6	2	74.51163	34.19896	162.34363
19	6	3	82.16712	37.74358	178.87644
20	6	4	153.93882	89.89796	263.60065
21	6	5	153.93882	89.89796	263.60065
22	6	6	153.93882	89.89796	263.60065

Table 6. Likelihood values.

Model	Negative log likelihood	Number of parameters
Base	452.25	47
Current	452.25	47

Table X. Forecasts (Fs and Catches are including estimated unallocated removals)

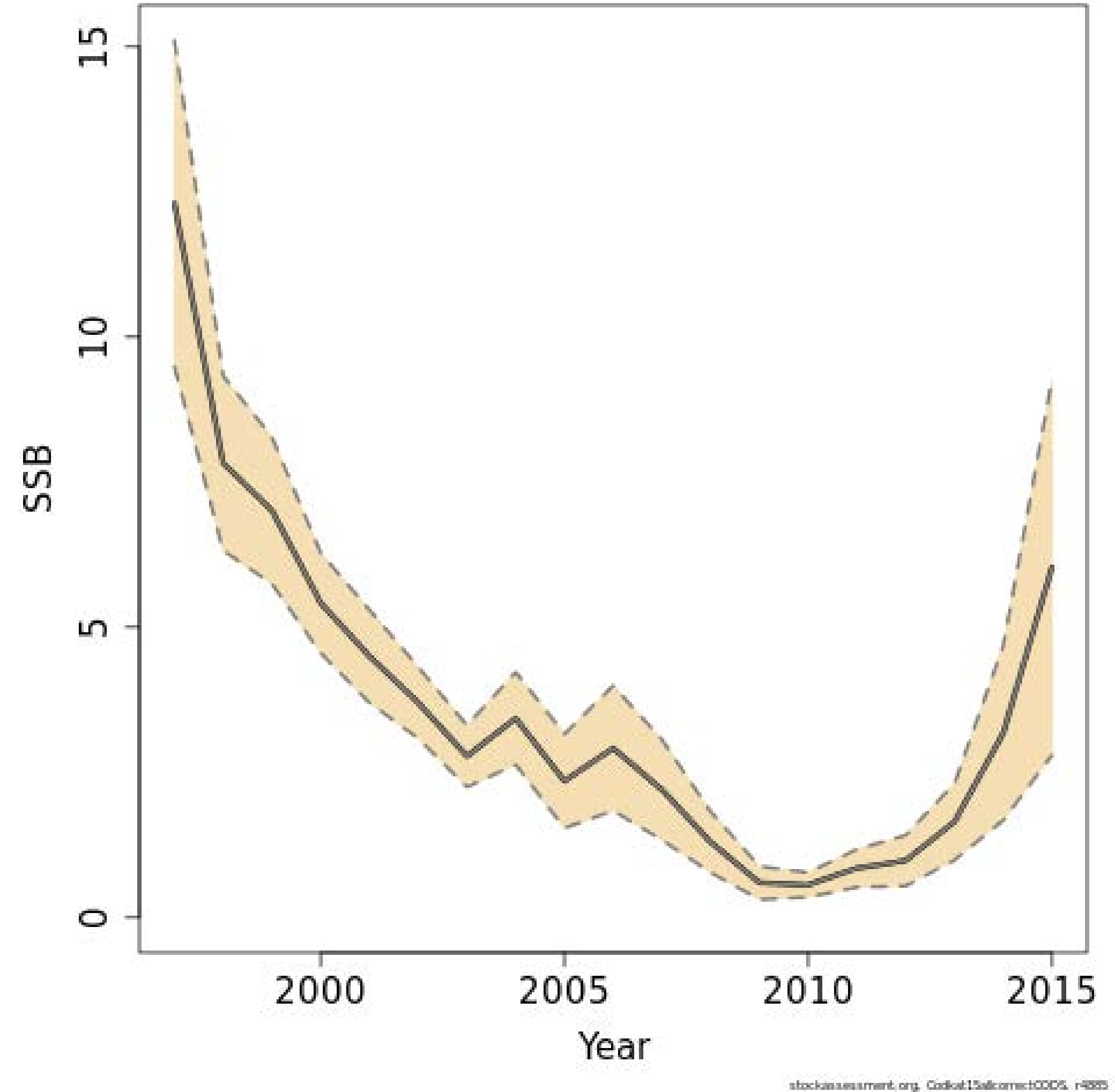
Description\Variable	Fbar14	Fbar15	Fbar16	SSB14	SSB15	SSB16	SSB % change	C14	C15	C16
F= Fsq , F at 0.4	0.41	0.40	0.41	7328	9135	8937	-2	6033	6484	6694
F= Fsq	0.41	0.41	0.41	7328	9135	8867	-3	6033	6580	6644

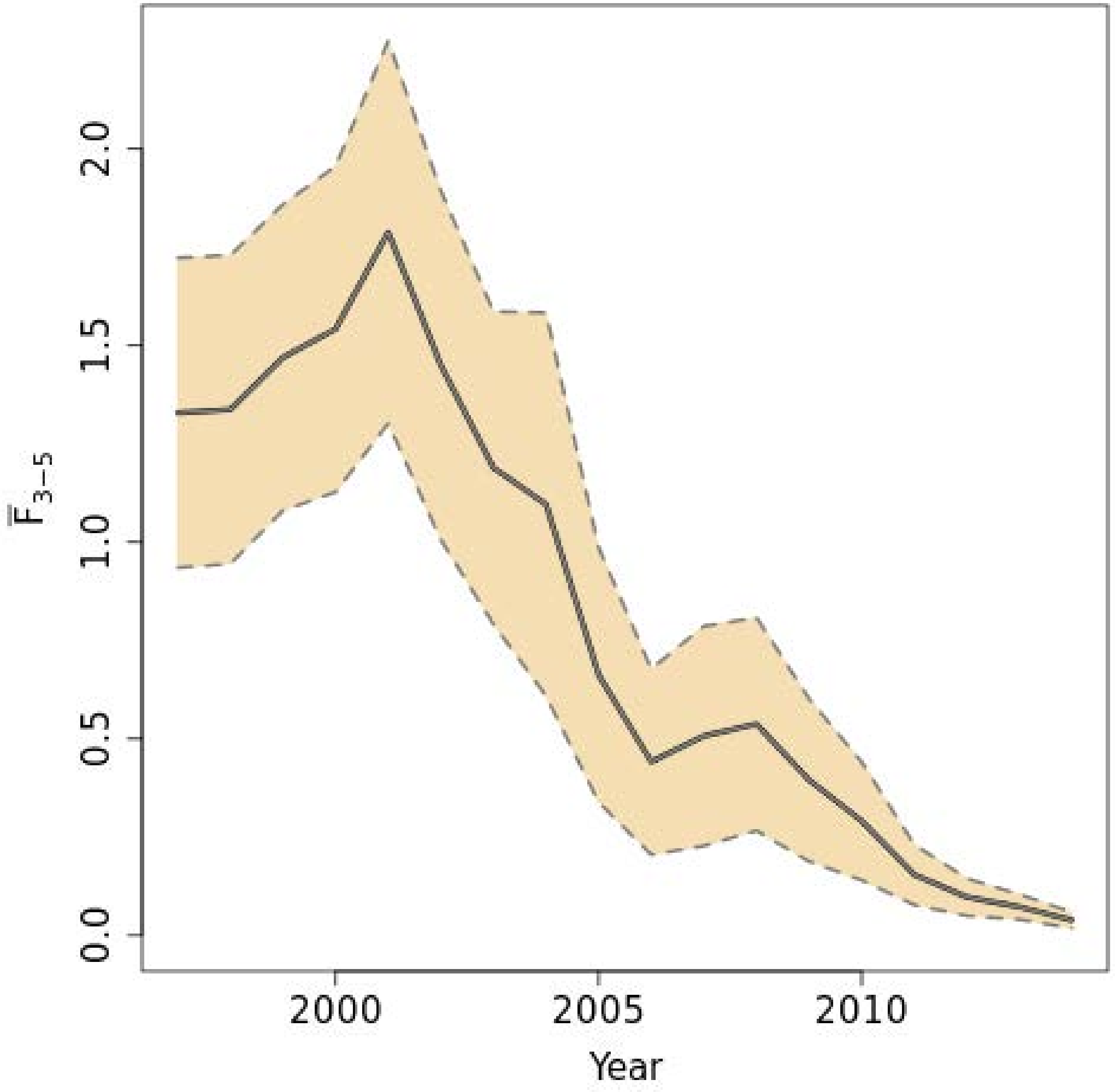
Table Xb. Forecasts (split in landings and discards)

Description\Variable	L14	L15	L16	D14	D15	D16	Fbar14(L)	Fbar15(L)	Fbar16(L)
F= Fsq , F at 0.4	6033	6484	6694	0	0	0	0.41	0.40	0.41
F= Fsq	6033	6580	6644	0	0	0	0.41	0.41	0.41

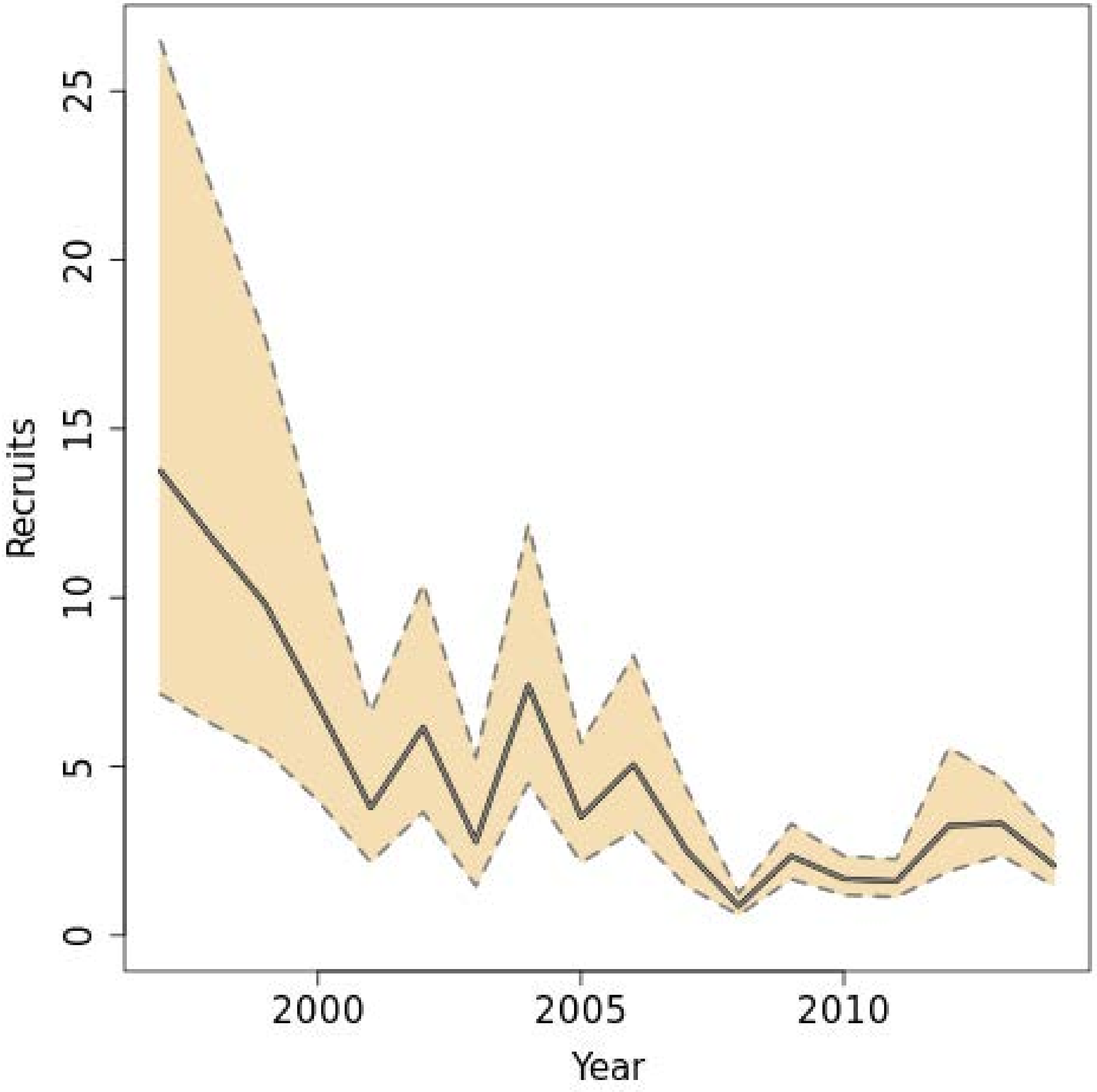
Table Xc. Forecasts (L and D without catch multiplier, and R)

Description\Variable	L14	L15	L16	TAC % change	D14	D15	D16	R14	R15	R16
F= Fsq , F at 0.4	6033	6484	6694		0	0	0	6931	6931	6931
F= Fsq	6033	6580	6644		0	0	0	6931	6931	6931

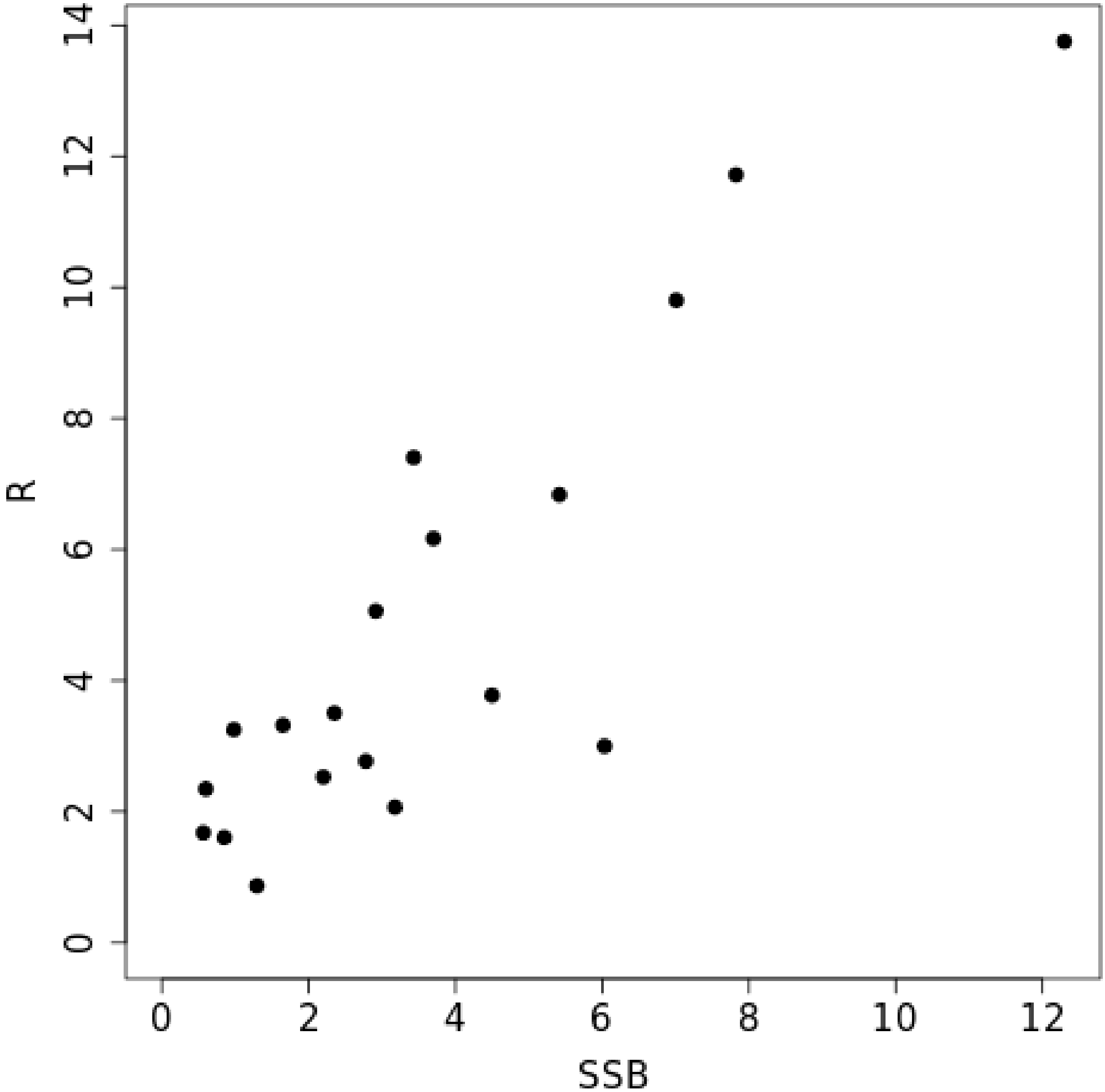

SSB
Year
0
5
10
15
2000
2005
2010
2015

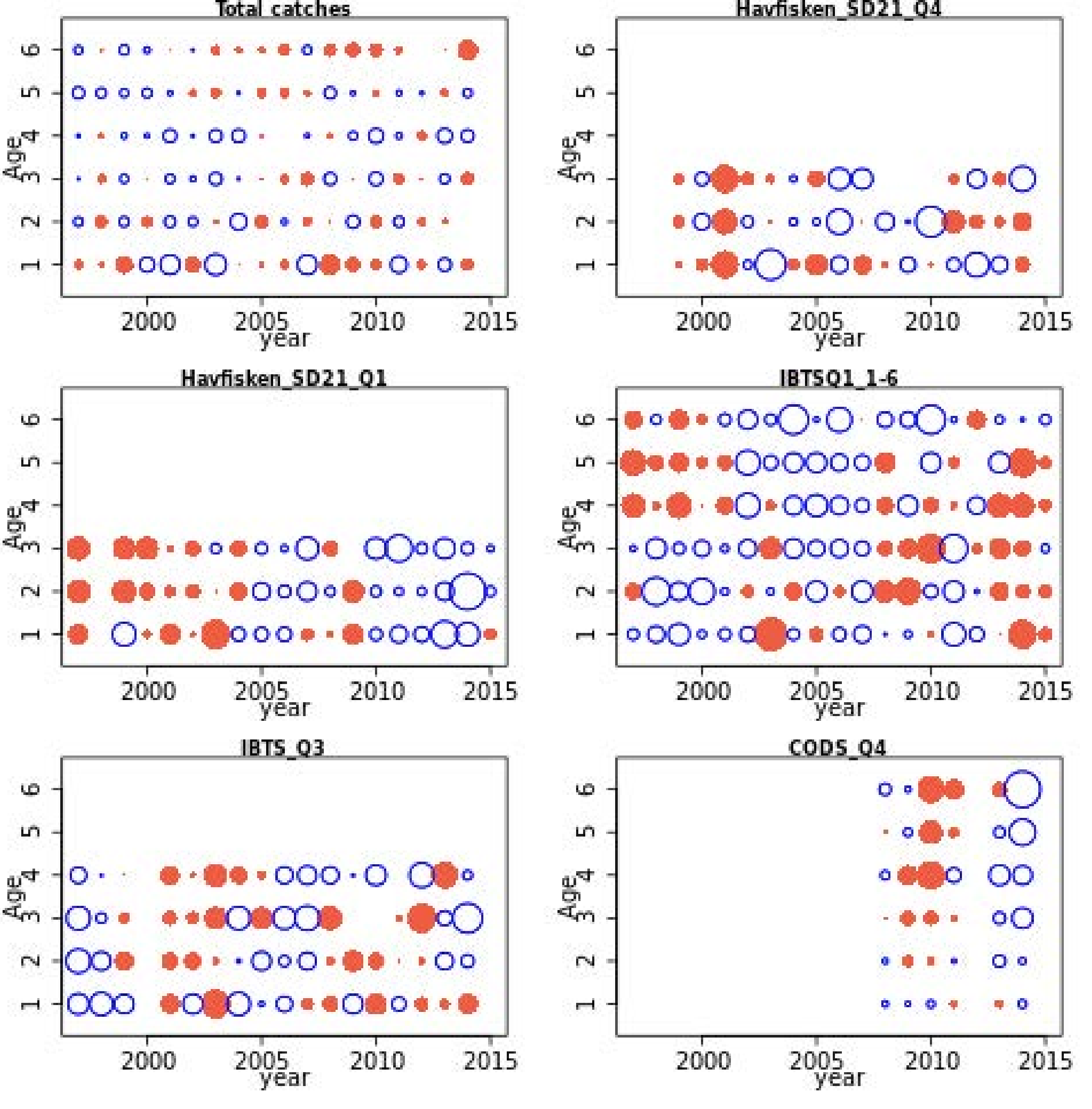


0.0
0.5
1.0
1.5
2.0
$\overline{F}_{3-5}$
2000
2005
2010
Year

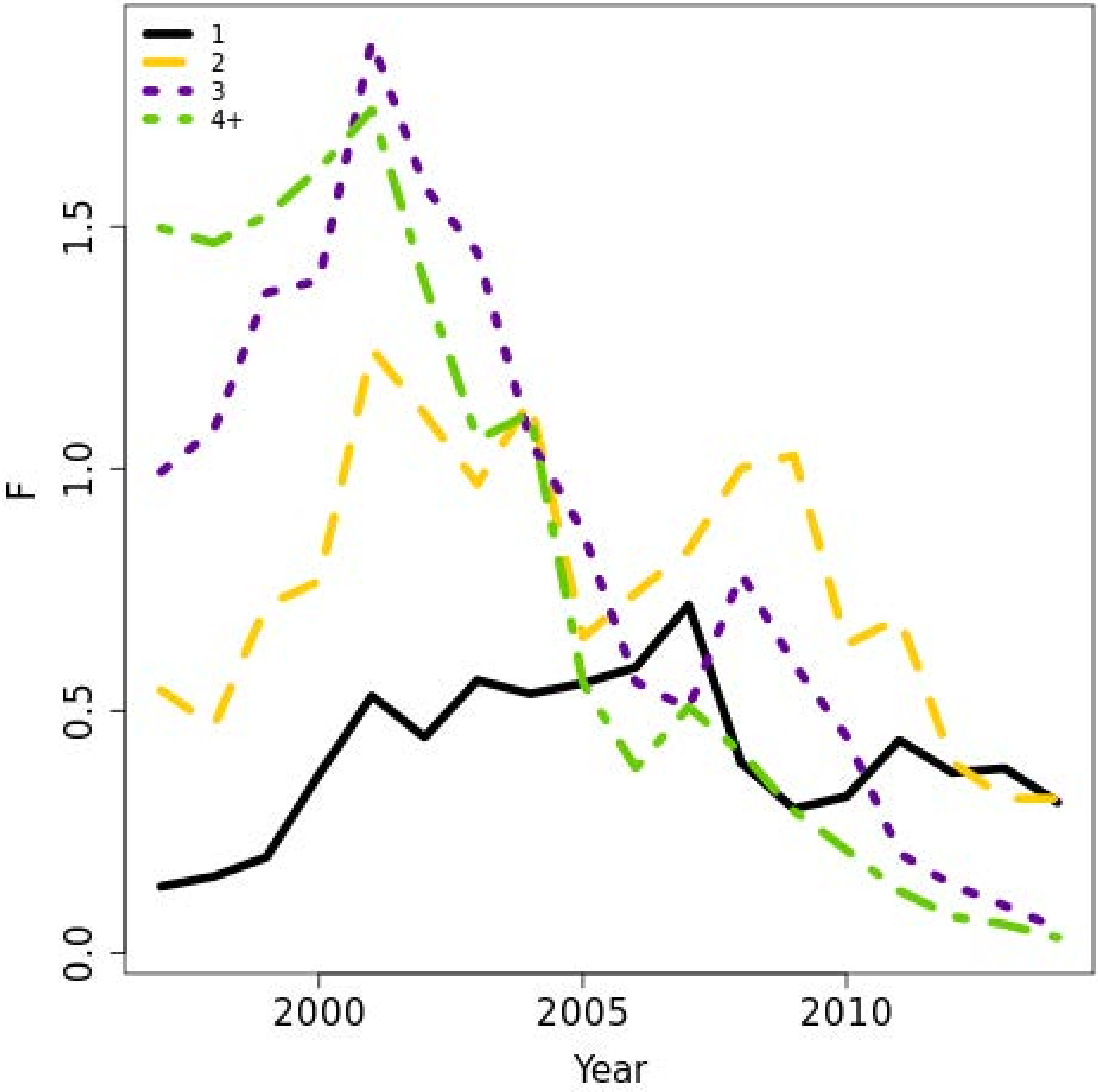


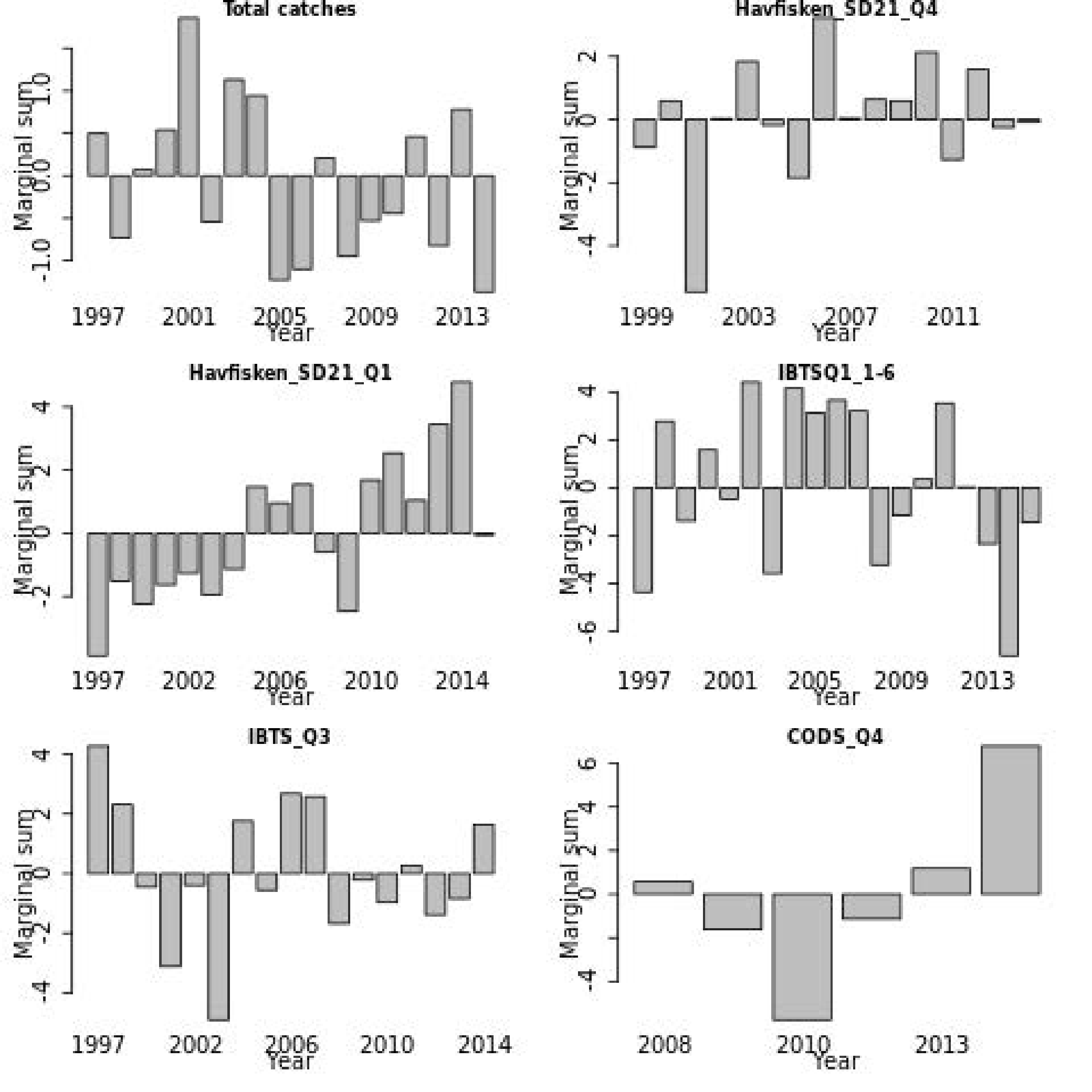
Recruits
0
5
10
15
20
25
2000
2005
2010
Year


R
SSB
0
2
4
6
8
10
12
14

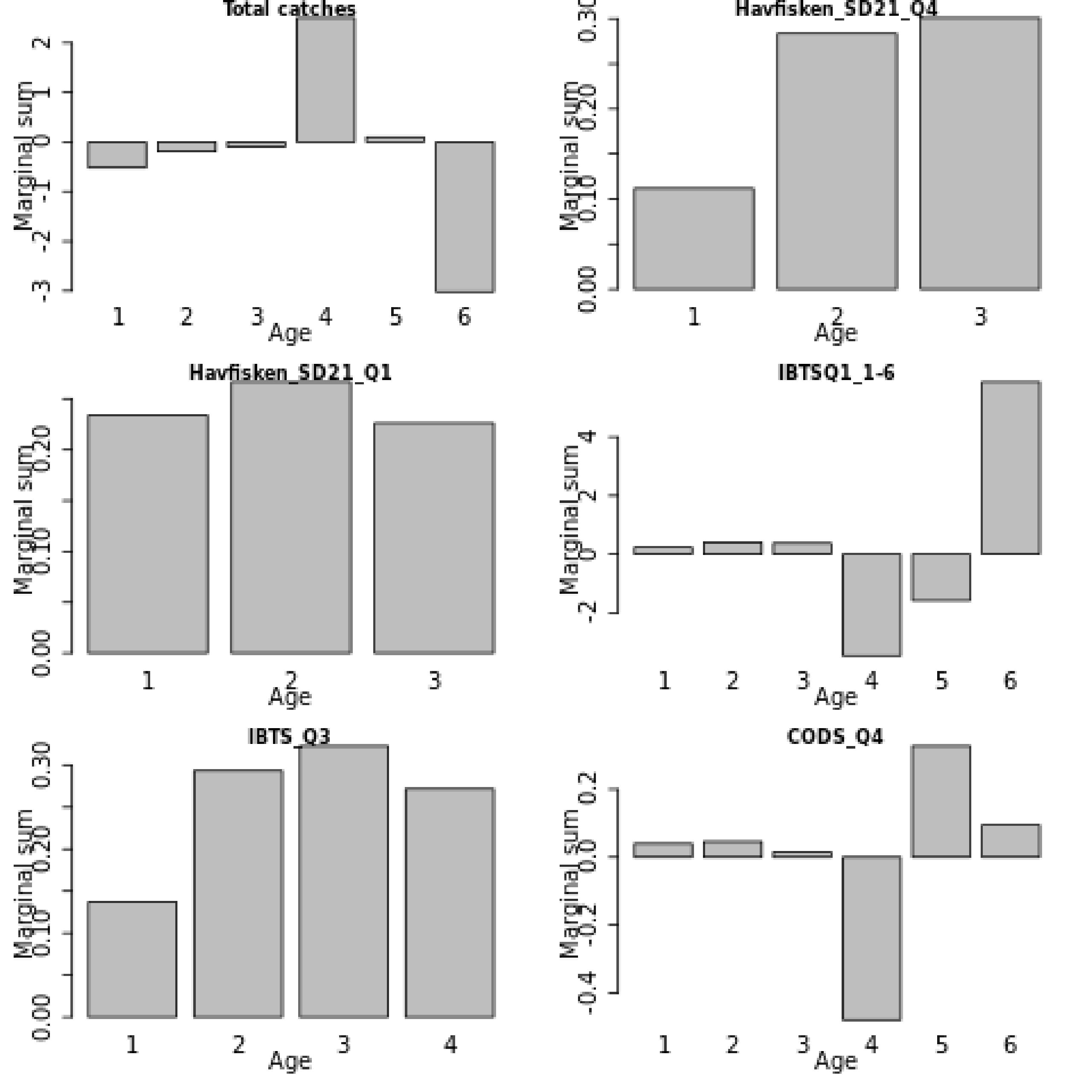


Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Age
year
1
2
3
4
5
6
2000
2005
2010
2015

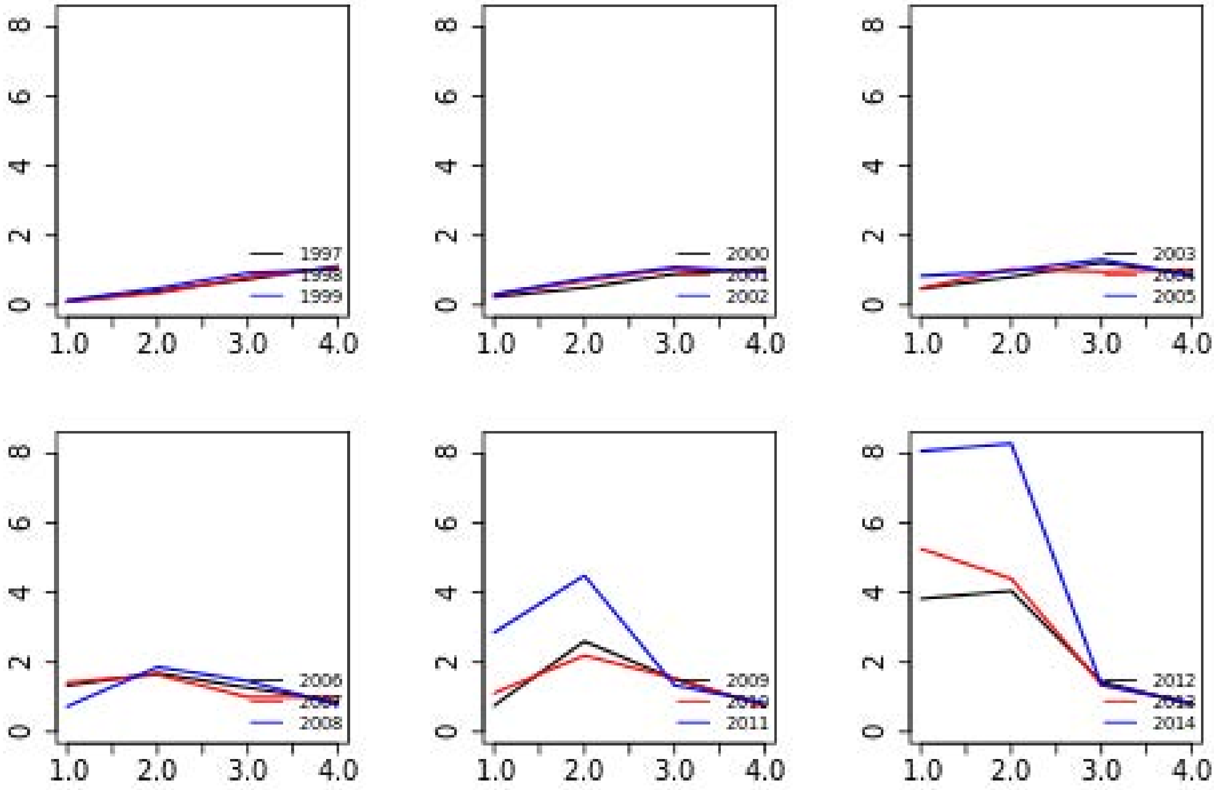

1
2
3
4+
F
0.0
0.5
1.0
1.5
2000
2005
2010
Year

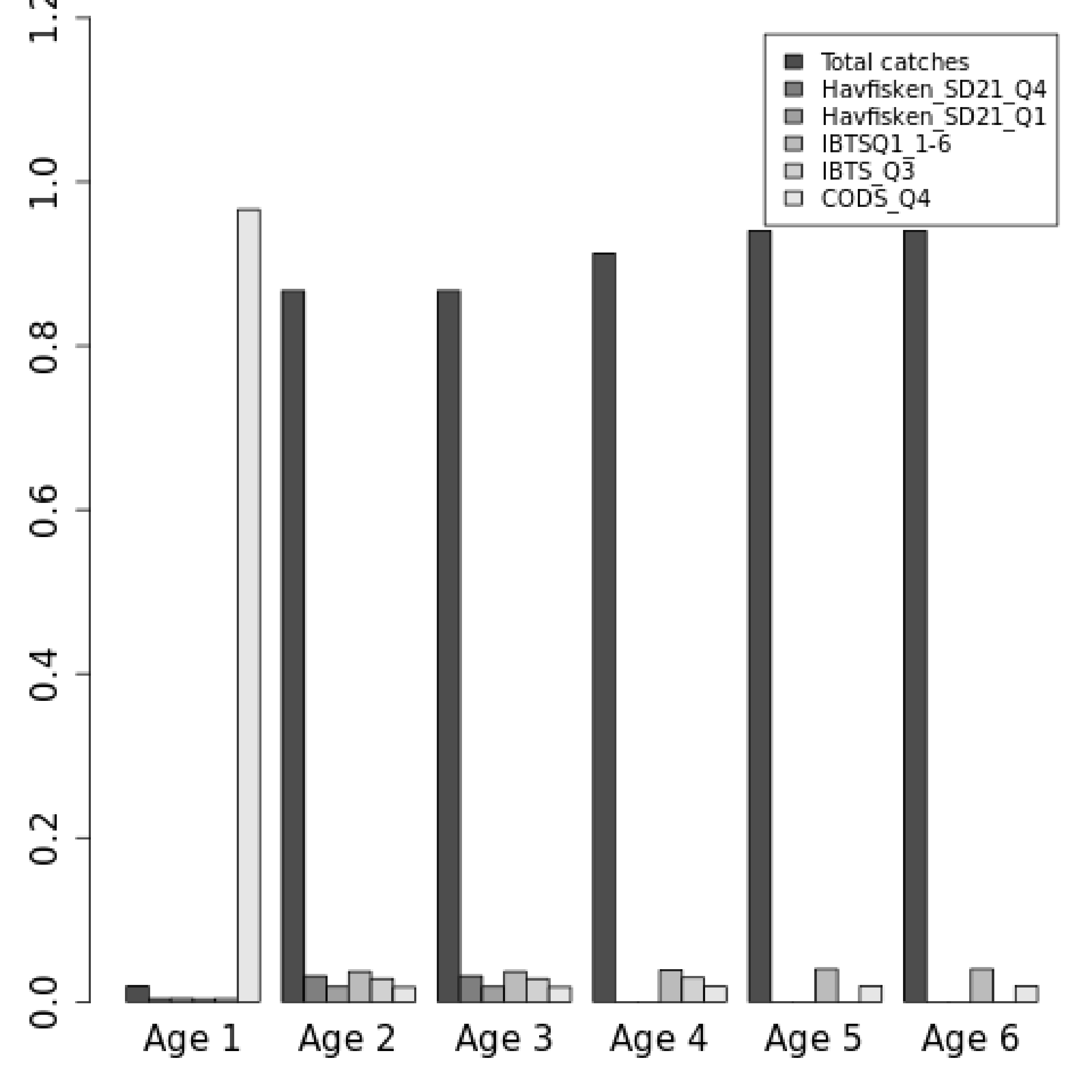


Total catches
Marginal sum
Year
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4

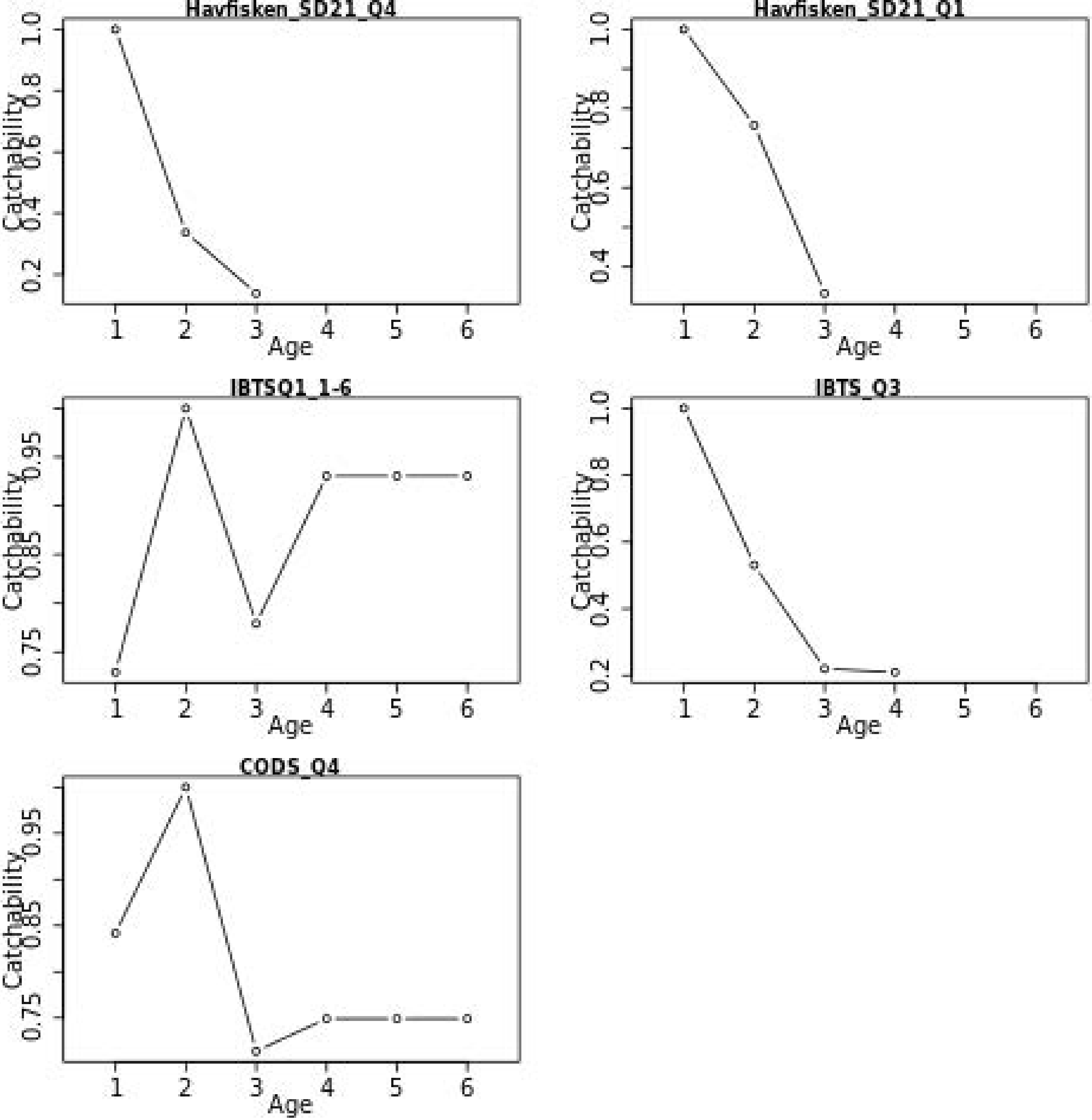


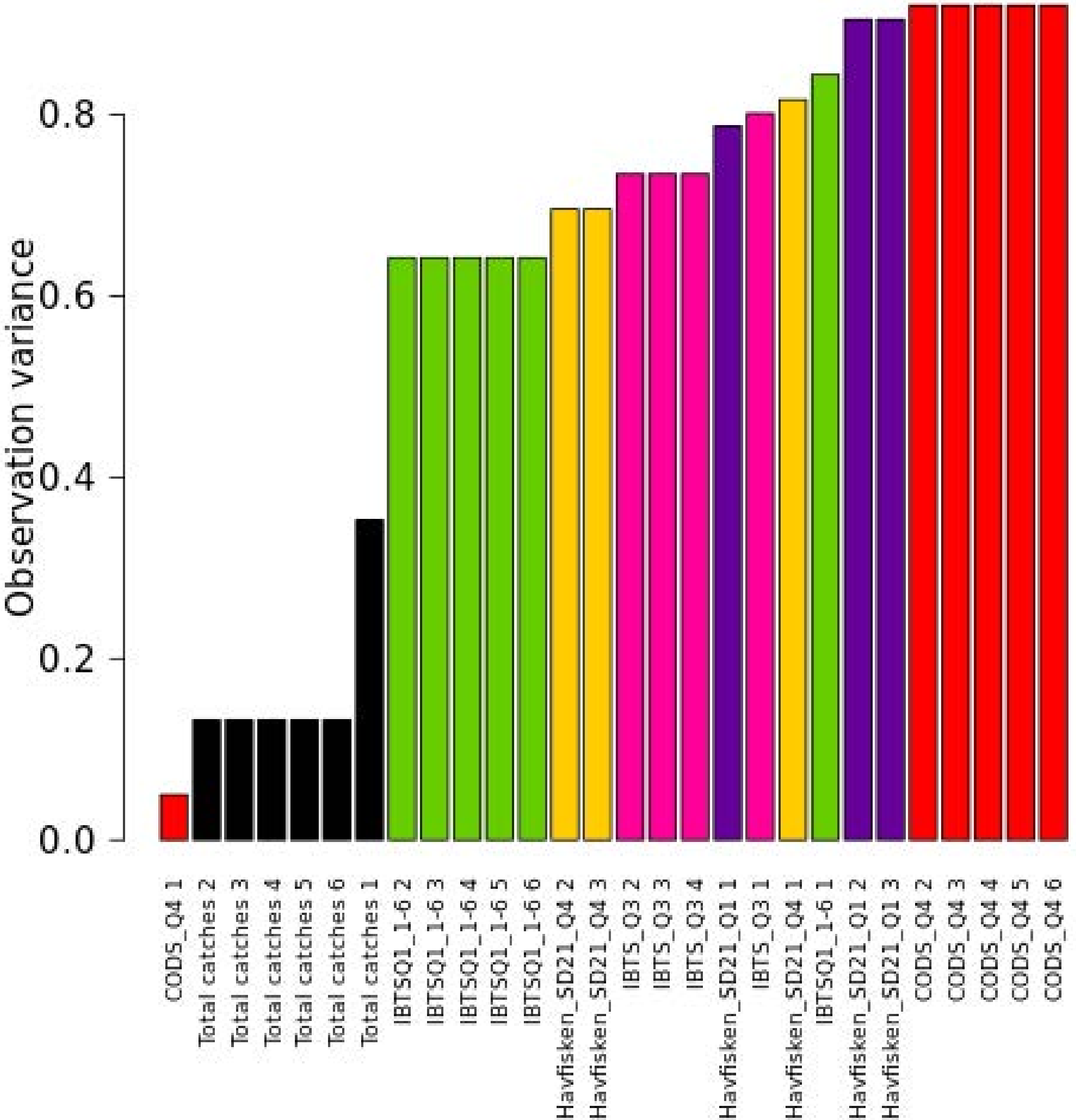
Total catches
Marginal sum
Age
Havfisken_SD21_Q4
Marginal sum
Age
Havfisken_SD21_Q1
Marginal sum
Age
IBTSQ1_1-6
Marginal sum
Age
IBTS_Q3
Marginal sum
Age
CODS_Q4
Marginal sum
Age


1997
1998
1999
2000
2001
2002
2003
2005
2006
2008
2009
2011
2012
2014
0
2
4
6
8
1.0
2.0
3.0
4.0

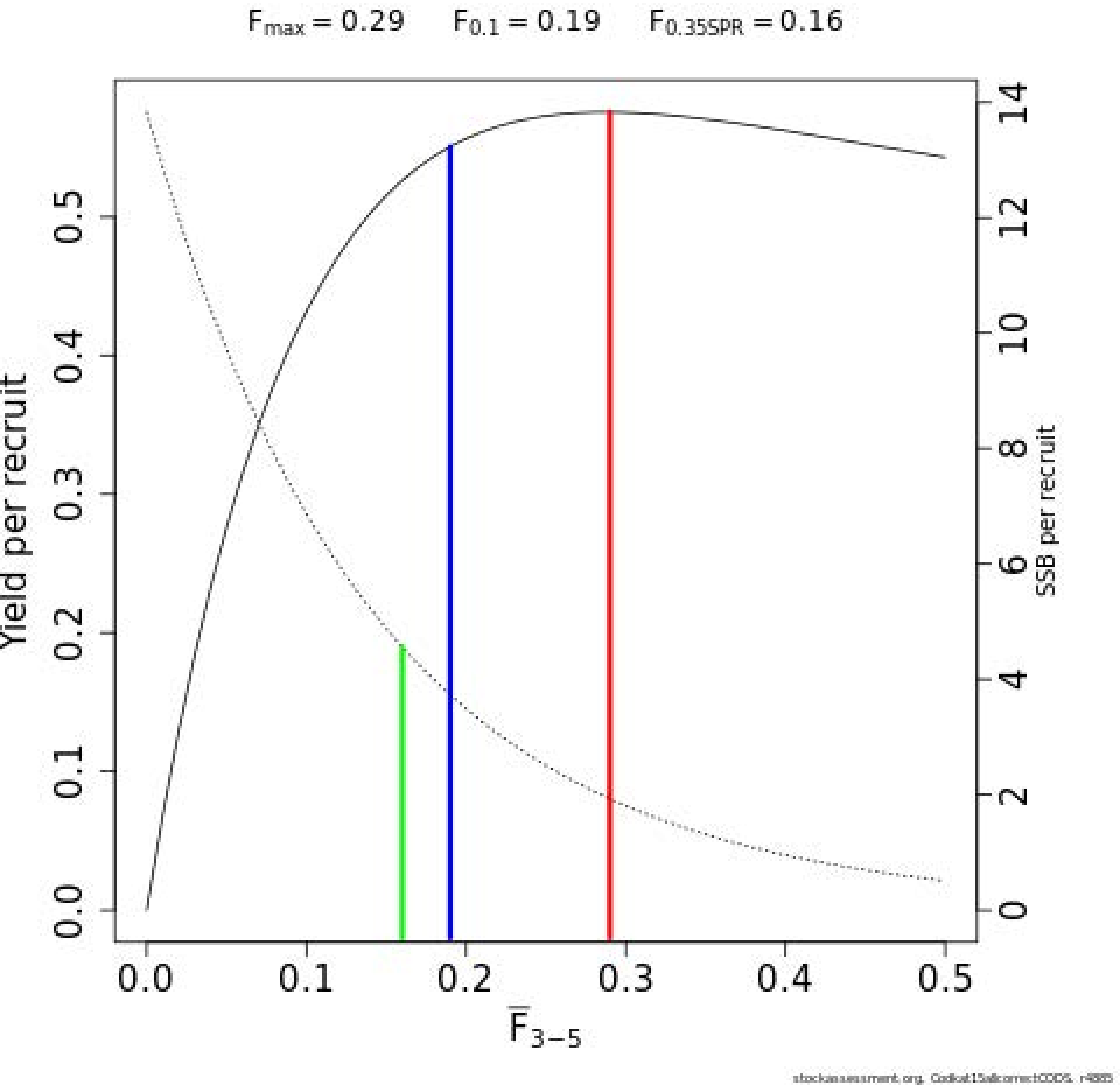


Total catches
Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
0.0
0.2
0.4
0.6
0.8
1.0
Age 1
Age 2
Age 3
Age 4
Age 5
Age 6


Havfisken_SD21_Q4
Havfisken_SD21_Q1
IBTSQ1_1-6
IBTS_Q3
CODS_Q4
Catchability
Age
1.0
0.8
0.6
0.4
0.2
0.95
0.85
0.75
1
2
3
4
5
6



Observation variance
0.0
0.2
0.4
0.6
0.8
CODS_Q4 1
Total catches 2
Total catches 3
Total catches 4
Total catches 5
Total catches 6
Total catches 1
IBTSQ1_1-6 2
IBTSQ1_1-6 3
IBTSQ1_1-6 4
IBTSQ1_1-6 5
IBTSQ1_1-6 6
Havfisken_SD21_Q4 2
Havfisken_SD21_Q4 3
IBTS_Q3 2
IBTS_Q3 3
IBTS_Q3 4
Havfisken_SD21_Q1 1
IBTS_Q3 1
Havfisken_SD21_Q4 1
IBTSQ1_1-6 1
Havfisken_SD21_Q1 2
Havfisken_SD21_Q1 3
CODS_Q4 2
CODS_Q4 3
CODS_Q4 4
CODS_Q4 5
CODS_Q4 6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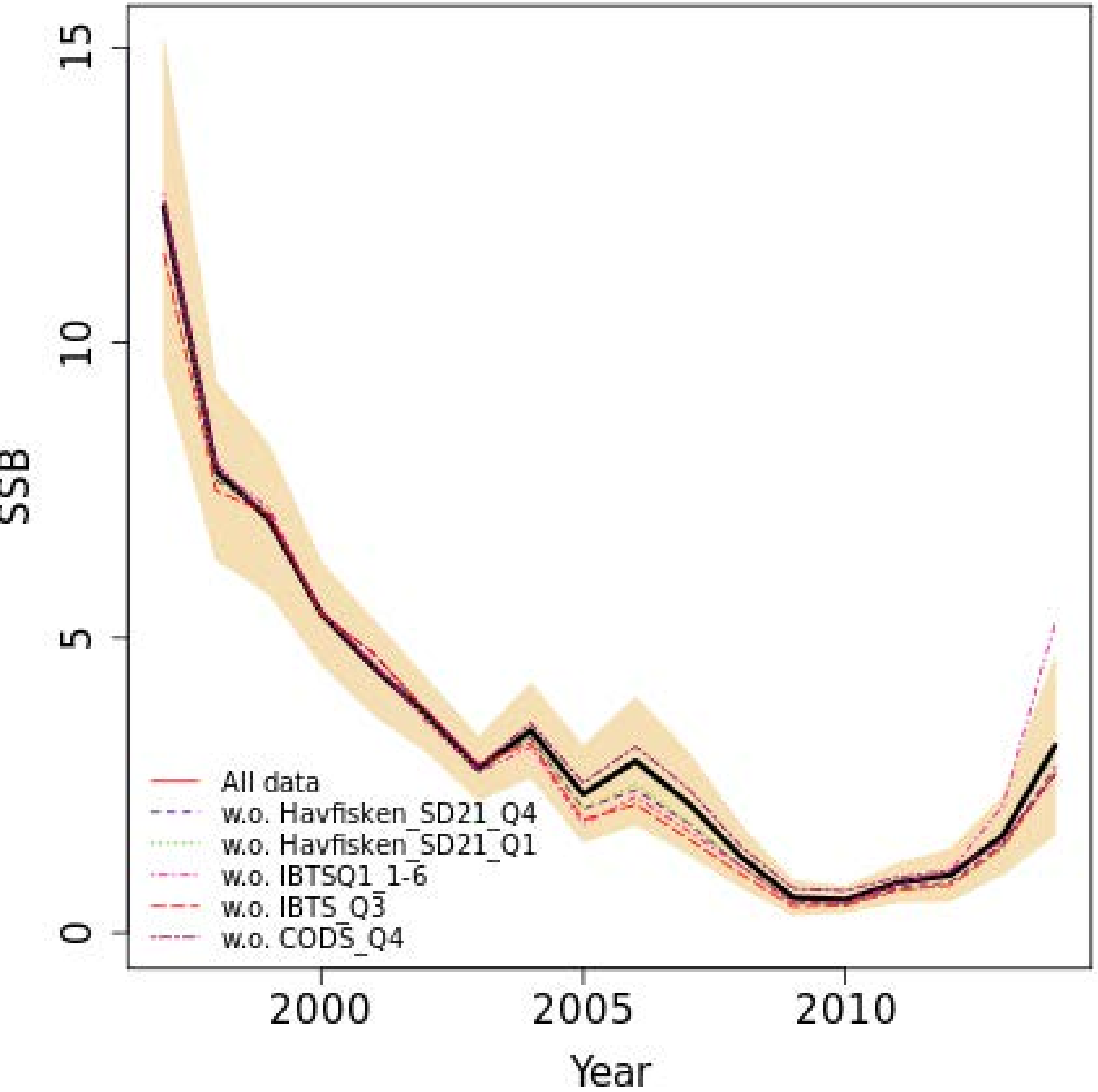
F0.1 = 0.19
F0.35SPR = 0.16
Yield per recruit
SSB per recruit
0.0
0.1
0.2
0.3
0.4
0.5
0
2
4
6
8
10
12
14
F3−5
stockassessment.org


15
10
5
0
SSB
2000
2005
2010
Year
All data
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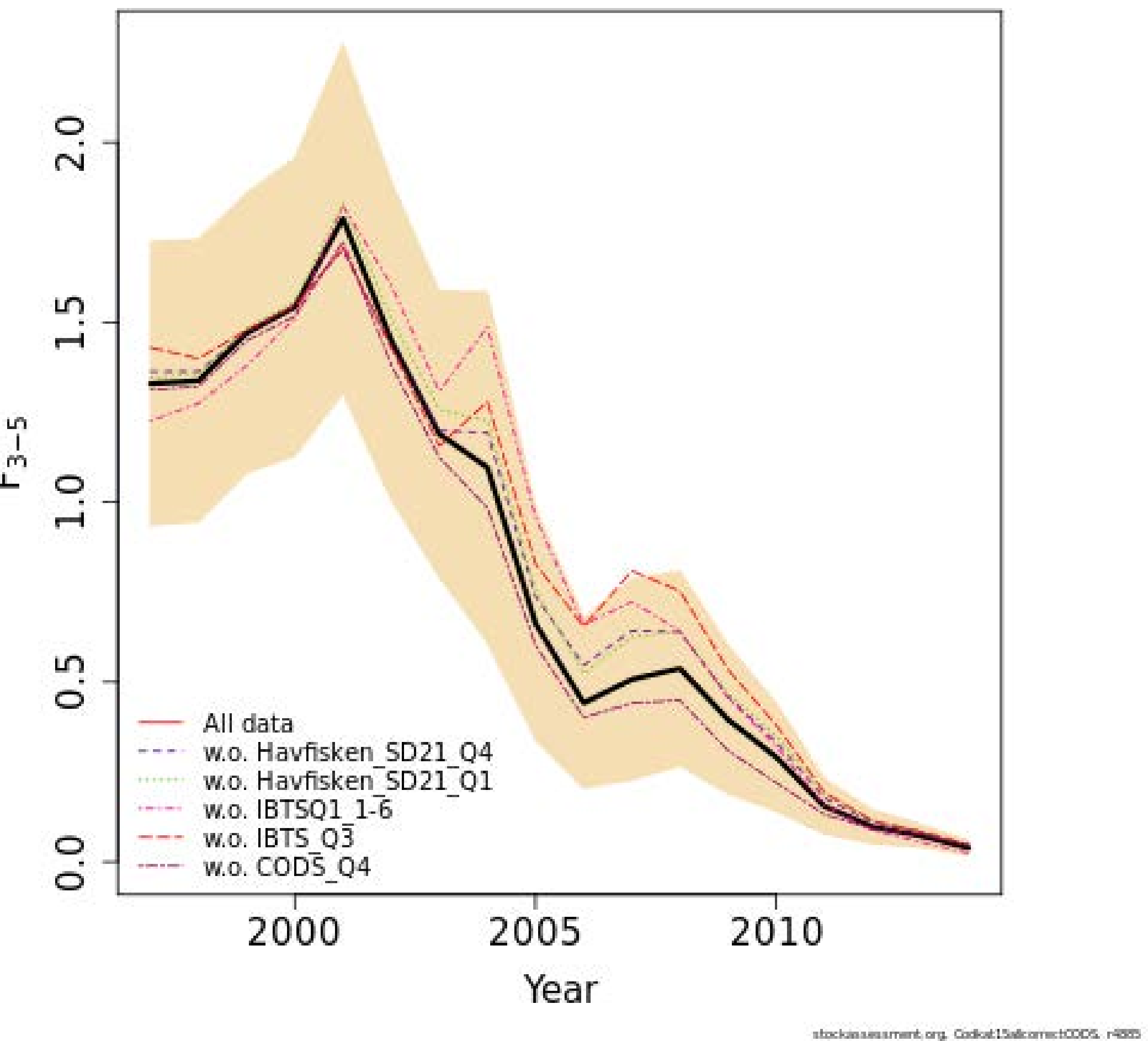
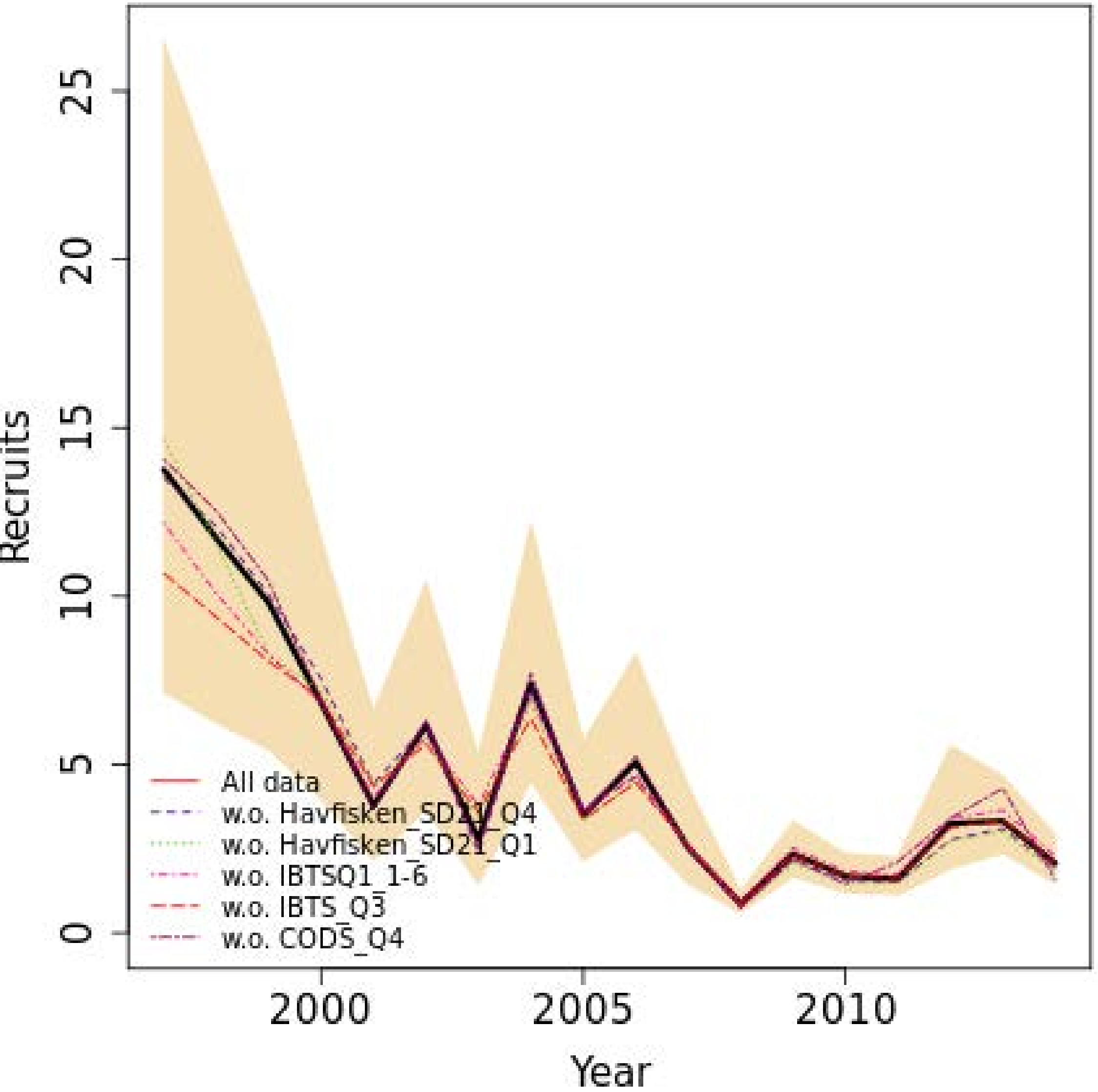
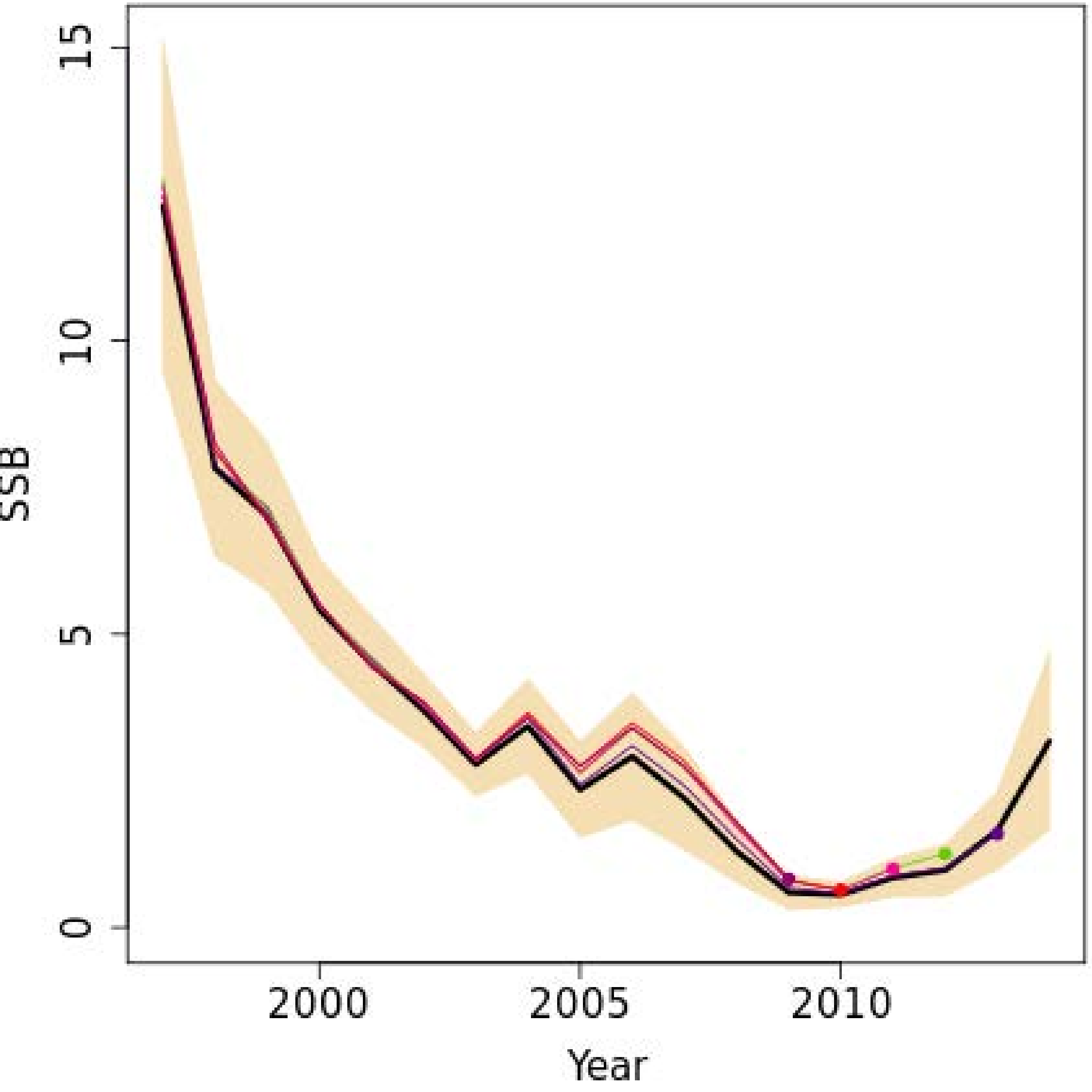
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3
w.o. CODS_Q4



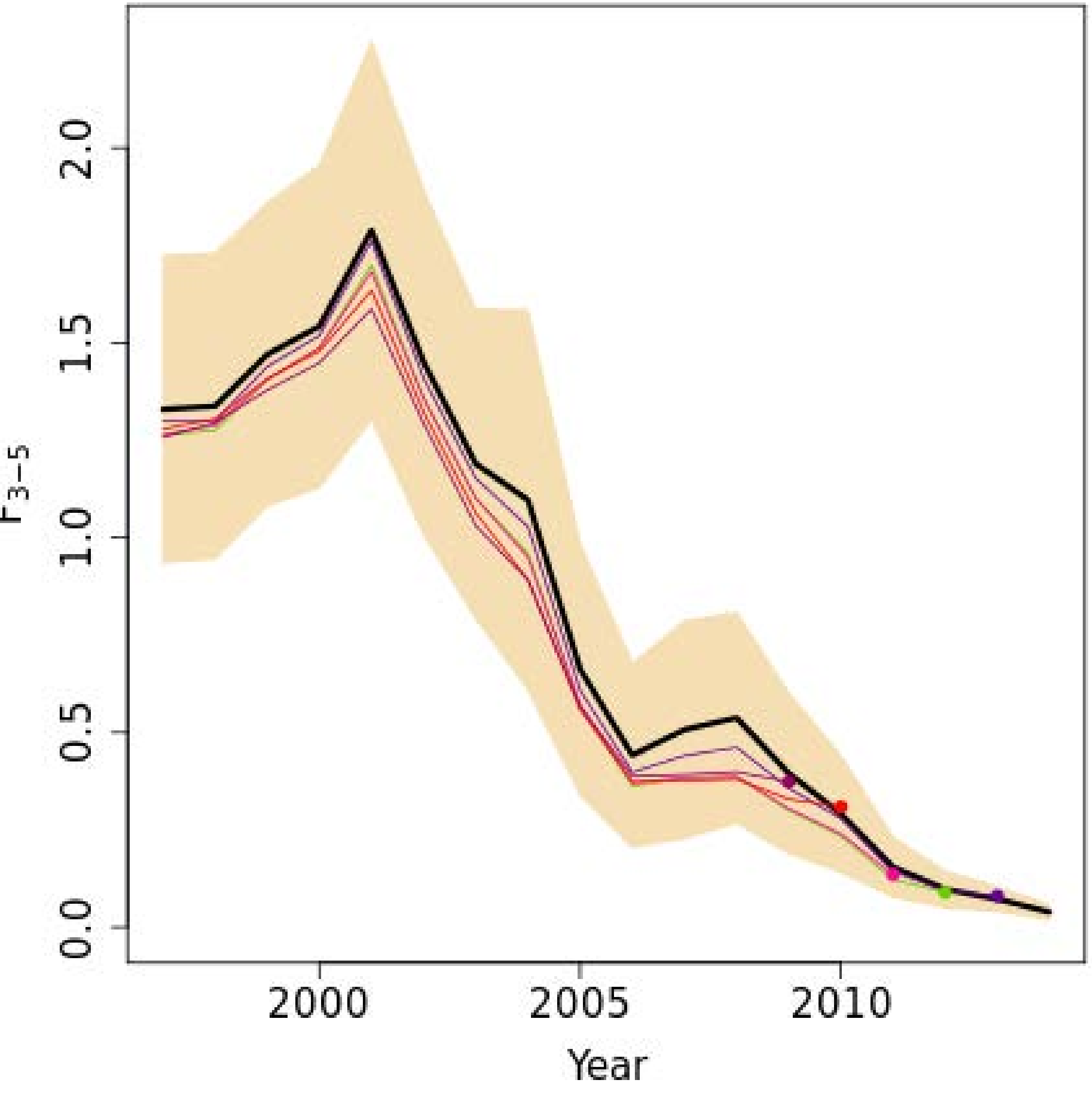
2.0
1.5
1.0
0.5
0.0
F_{3-5}
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3
w.o. CODS_Q4
2000
2005
2010
Year



Recruits
Year
25
20
15
10
5
0
2000
2005
2010
All data
w.o. Havfisken_SD21_Q4
w.o. Havfisken_SD21_Q1
w.o. IBTSQ1_1-6
w.o. IBTS_Q3
w.o. CODS_Q4



15
10
5
0
SSB
2000
2005
2010
Year



2.0
1.5
1.0
0.5
0.0
F_{3-5}
2000
2005
2010
Year

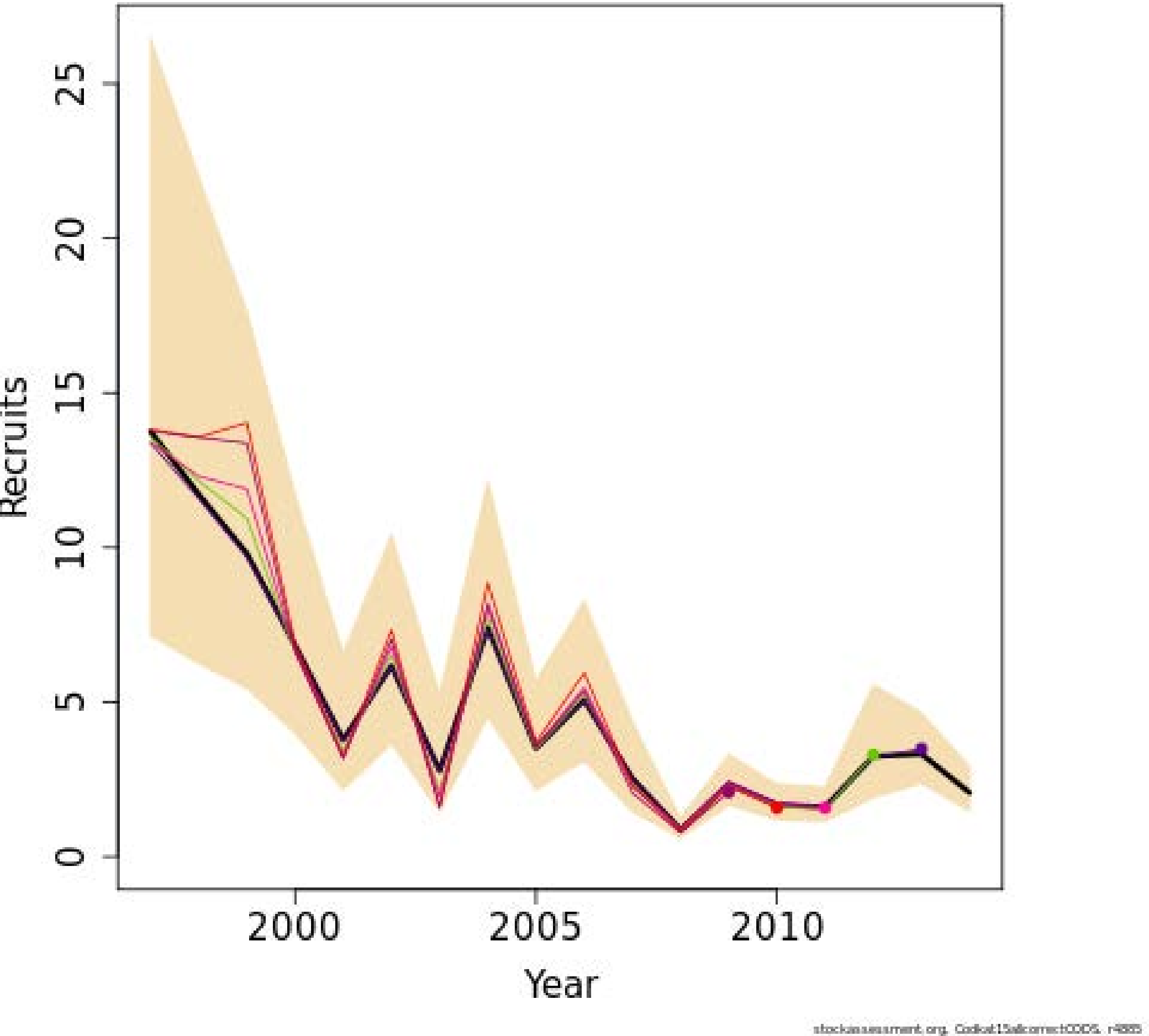

Recruits
Year
0
5
10
15
20
25
2000
2005
2010
stockassessment.org, Coilkat15allcorrectODDS, r4885

Table 1. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 3 to 5 (F35).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F35	Low	High
1997	13754	7144	26481	14568	11693	18150	12301	9788	15458	1.329	0.988	1.788
1998	11719	6243	21999	10293	8507	12454	7824	6457	9481	1.337	0.997	1.793
1999	9804	5447	17646	8602	7199	10277	7010	5854	8394	1.470	1.128	1.916
2000	6836	3987	11721	6600	5663	7693	5417	4619	6352	1.542	1.179	2.017
2001	3776	2166	6583	5450	4583	6481	4499	3766	5374	1.788	1.363	2.347
2002	6169	3651	10423	4402	3765	5147	3700	3133	4370	1.450	1.068	1.969
2003	2771	1459	5260	3373	2819	4038	2779	2295	3364	1.189	0.851	1.661
2004	7403	4507	12158	4306	3460	5359	3431	2720	4327	1.096	0.703	1.710
2005	3505	2158	5691	3301	2419	4504	2350	1666	3317	0.662	0.406	1.080
2006	5062	3093	8285	3852	2757	5383	2916	2016	4218	0.442	0.259	0.754
2007	2529	1461	4378	2688	1879	3844	2200	1486	3258	0.507	0.292	0.880
2008	869	610	1237	1434	988	2082	1297	867	1941	0.538	0.325	0.890
2009	2347	1665	3309	778	525	1153	599	372	963	0.395	0.234	0.667
2010	1679	1198	2353	854	623	1172	564	387	821	0.291	0.174	0.487
2011	1606	1142	2258	1089	772	1537	849	579	1246	0.154	0.094	0.254
2012	3252	1901	5560	1247	846	1839	980	628	1530	0.097	0.060	0.158
2013	3320	2369	4654	2154	1500	3094	1650	1108	2458	0.073	0.047	0.113
2014	2069	1466	2918	4822	3150	7381	3177	1979	5098	0.039	0.023	0.065
2015							6032	3529	10310			

Table 2. Estimated stock numbers.

Year\Age	1	2	3	4	5	6+
1997	13754	6825	10904	1512	387	172
1998	11719	11170	2705	2711	384	107
1999	9804	7958	5633	620	551	103
2000	6836	6849	3532	1370	164	136
2001	3776	3586	2632	871	243	59
2002	6169	2354	1121	565	125	58
2003	2771	3997	927	293	112	27
2004	7403	2008	1974	316	104	64
2005	3505	3633	354	437	56	31
2006	5062	2260	1714	131	119	33
2007	2529	1763	531	469	45	70
2008	869	450	340	118	99	24
2009	2347	247	83	93	39	19
2010	1679	1330	95	43	23	12
2011	1606	1024	528	54	18	9
2012	3252	709	237	203	30	12
2013	3320	1926	708	178	59	19
2014	2069	3476	1507	664	144	16
2015	3000	1067	2312	970	433	143

Table 3. Estimated fishing mortalities.

Year\Age	1	2	3	4+
1997	0.137	0.543	0.993	1.497
1998	0.158	0.469	1.080	1.466
1999	0.198	0.719	1.363	1.523
2000	0.369	0.768	1.388	1.619
2001	0.531	1.246	1.883	1.741
2002	0.446	1.113	1.582	1.384
2003	0.564	0.968	1.447	1.060
2004	0.536	1.142	1.059	1.115
2005	0.557	0.652	0.870	0.558
2006	0.590	0.744	0.560	0.382
2007	0.719	0.832	0.505	0.508
2008	0.393	1.001	0.783	0.415
2009	0.299	1.028	0.597	0.294
2010	0.324	0.637	0.447	0.213
2011	0.440	0.693	0.206	0.128
2012	0.373	0.395	0.140	0.076
2013	0.381	0.319	0.098	0.060
2014	0.312	0.320	0.052	0.032

Table 5. Estimated catchabilities multiplied by 1000.

Index	Fleet number	Age	Catchability	Low	High
1	2	1	12.42804	7.44986	20.73276
2	2	2	4.19149	2.60537	6.74320
3	2	3	1.73144	1.02699	2.91910
4	3	1	18.43323	11.88427	28.59109
5	3	2	13.96222	8.72101	22.35333
6	3	3	6.14817	3.73817	10.11192
7	4	1	10.26824	6.53424	16.13604
8	4	2	14.08000	9.88675	20.05173
9	4	3	10.97100	7.56260	15.91553
10	4	4	13.10318	9.47252	18.12542
11	4	5	13.10318	9.47252	18.12542
12	4	6	13.10318	9.47252	18.12542
13	5	1	5.99818	3.68539	9.76237
14	5	2	3.18342	1.99359	5.08337
15	5	3	1.32400	0.79885	2.19437
16	5	4	1.26005	0.73193	2.16924
17	6	1	106.82108	71.50843	159.57201
18	6	2	126.88172	53.86039	298.90186
19	6	3	90.58198	37.61772	218.11780
20	6	4	95.06447	48.59863	185.95697
21	6	5	95.06447	48.59863	185.95697
22	6	6	95.06447	48.59863	185.95697

Table 6. Likelihood values.

Model	Negative log likelihood	Number of parameters
Base	492.31	35
Current	492.31	35

Genetic analyses of cod in the Baltic Sea with microsatellite markers

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Introduction

The assessments of cod stocks and systems of their management use ICES recommendations, according to which two main cod groups are distinguished, including eastern (SD 25–32) and western (SD 22–24) groups (Bleil, Oeberst, 2004) - *Gadus morhua callarias* and *Gadus morhua* L., consequently. It is assumed that these two stocks occur on either side of longitude 14°30E (Bagge et al., 1994).

Material and methods

In this study, 7 samples of spawning cod with running sex products from the Baltic Sea were analysed. These samples were collected in the years 2006; 2010 and 2013 in the spawning areas of the Arkona Sea (ICES SD 24), Bornholm Sea (ICES SD 25) and Belt Sea (ICES SD 22) (Fig. 1, Table 1).Cruises took place in March, end of May and June covering the main spawning areas during the main spawning periods of cod.

In addition, three samples from the Norwegian Sea and from the Barents Sea (North-East Atlantic) were used for the comparative analyses.

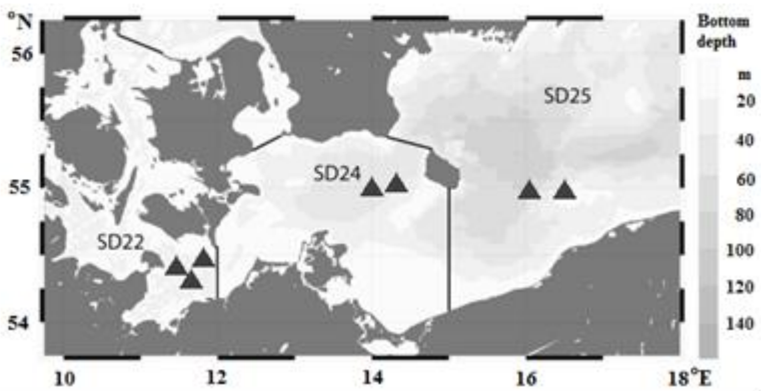

Fig.. 1:Sampling areas of cod in the Baltic Sea (map with the Baltic ICES subdivisions from Paul et al., 2013)

Table 1: Area, period, number of analysed cod

Area, location	**Sampling date**	**Latitude (N)**	**Longitude (E)**	**n**	**Code**
Eastern Baltic, Bornholm Sea/ SD25	March 2010	54°56,03'N	15°08,19' E	96	B10
Eastern Baltic, Bornholm Sea/ SD25	June 2013	54°44,61'N	14°59,97' E	60	B13
Western Baltic, Arkona Sea/ SD24	March 2010	54°59,81'N	13°32,27' E	96	A10
Western Baltic, Arkona Sea/ SD24	May 2013	54°41,62'N	13°34,25' E	39	A13
Western Baltic, Belt Sea/ SD22	March 2006	54°30'N	11°30' E	47	Belt06
Western Baltic, Belt Sea/ SD22	March 2010	54°12,61'N	11°19,84' E	48	Belt10
Western Baltic, Belt Sea/ SD22	March 2013	54°12,35'N	11°23,25' E	48	Belt13
Barents Sea, West Kildin	May 2002	69°20'N	34°04' E	45	BSWK
Barents Sea, East Kildin	March 2012	69°19'N	34°20' E	34	BSEK
Norwegian Sea, Lofoten	March 2003	69°18'N	15°24' E	85	NSL

The sequenced DNA microsatellite loci *Gmo3*, *Gmo8*, *Gmo_G12*, *Gmo_G18*, *Gmo19*, *Gmo34*, *Gmo35*, and *Pgmo32* of Atlantic cod (Table 2) (Miller et al., 2000; Jacobsdottirer al., 2006; Wesmajervi et al., 2007) were used as the markers to describe genetic differentiation at a population level. These loci demonstrate a fairly high level of polymorphism for cod, along with stability and reproducibility of the results (Skarstein et al., 2007; Westgaard and Fevolden, 2007; Wennevik et al., 2008).

DNA was extracted from fins using the Diatom DNA Prep kits (IsoGene, Russia). PCR amplification was performed using the GenePak PCR Core kits (Afanas’ev et al., 2011).

Table 2: Characteristic of investigated microsatellite loci

Locus	Sequence	Annealing temperature, °C	Sequence of primers
Gmo3	(GACA)n	50	f-AGGCACGCAGGTGGACAGGAAC r-GCAGCACGAGAGAGCTATTCCTC
Gmo34	(GACA)n	45	f-TCCACAGAAGGTCTCCTAA r-GGTTGGACCTCATGGTGAA
Gmo35	(ACC)n	45	f-GGAGGTGCTTTGAAGATG r-CCTTATCATGTACGTTGTTAAC
Gmo8	(GACA)n	54	f-GCAAAACGAGATGCACAGACACC r-TGGGGGAGGCATCTGTCATTCA
Gmo19	(GACA)n	54	f-CACAGTGAAGTGAACCCACTG r-GTCTTGCCTGTAAGTCAGCTTG
PGmo32	(TTG)n	45	f-CAATCGCCGTCCAACCAAC r-GGCGGCAGCAACGATTCTC
Gmo-G12	(CTTC)n	45	f-ATAACACTATTGCATTCCCTGTGT r-TCAGCGGAATTAGCAACTTAAAGA
Gmo-G18	(GACA)n	58	f-ACAGCAGGTAATGAGACAAGCAGA r-CTTAGTCTCGTTTGACCACACCTG

The GDA 1.0 (Lewis, Zaykin 2001) was used for calculating allele frequencies, the expected and observed heterozygosities (H_E, H_O), the allelic diversity (A), genetic identity (I) and genetic distance (D). Deviations from Hardy-Weinberg (HW) equilibrium were tested using the inbreeding coefficient F_{IS} (Weir and Cockerham, 1984) implemented in GENEPOP 3.4 (Raymond and Rousset 1995) and significance was assessed with exact tests. The allelic richness (A_R), corrected for the minimum sample size, was calculated using FSTAT 2.9.3 (Goudet 2001).

Population differentiation was estimated per sample pair and overall using F_{ST} or θ (Weir and Cockerham 1984) in GENEPOP or GDA, respectively. Significant differences in allele frequencies between populations were determined by Fisher's exact test in GENEPOP. All probability tests were based on the Markov chain method (Guo and Thompson 1992; Raymond and Rousset 1995) by using 1,000 steps, 100 batches and 1,000 iterations per batch. The sequential Bonferroni adjustments (Rice 1989) were applied to correct for the effect of multiple tests.

The Bayesian clustering method implemented in STRUCTURE 2.3.4 (Pritchard et al. 2000) was used to assign individuals to clusters using no prior information on what sites the individuals belong to. Considering previous findings of high levels of gene flow in cod we used the admixture model with correlated allele frequencies to reflect the most likely pattern of population connectivity. STRUCTURE was run using MCMC simulations of 800,000 iterations, with a burn-in period of 400,000. Runs were conducted for the number of putative populations (i.e. *K*), set at 1-10, with each having three iterations. The result files were then used in Structure Harvester (Earl and von Holdt 2012) in order to estimate the uppermost optimal number of clusters using Evanno's ΔK method (Evanno et al. 2005).

Evanno et al. (2005) suggests that STRUCTURE only captured the major structure in the data, although a subsequent analysis performed on each identified cluster can potentially demonstrate a more intricate population structure within these clusters. This study used the "hierarchical STRUCTURE analysis" as outlined by Vähä et al. (2007), Warnock et al. (2010) and Olafsson et al. (2014). Calculation were made with 500,000 burn-in period and 10^6 MCMC with *K* ranging from one to five, with three iterations per each *K*. STRUCTURE was run independently both with and without sampling location information. The estimated number of group (*K*) was based on ΔK and changes in the pattern of LnP(D) values.

The BARRIER 2.2 (Manni et al. 2004) was used to highlight the geographical areas with pronounced genetic discontinuity between the samples, i.e. barriers. Geographical coordinates were supplied for each sample and connected by Delauney triangulation, such that each connection had an associated distance (in this case the genetic distance F_{ST} described above). Using Monmonier's maximum distance algorithm, barriers were then identified.

Results

All microsatellite loci were polymorphic in cod samples. The allele numbers ranged from four alleles for locus *Gmo18* to 43 alleles for locus *Gmo8*. A some variation in allele numbers among samples was observed as indicated by the average allele richness per sample from 5.97 for A13 to 8.99 for BSWK. The value of H_E per sample ranged from 0.491 (A13) to 0.631 (Belt13).

Of the 80 single-locus tests for conformation to HWE, three had significance values of $P <$ 0.05, and it did not remain significant after applying the Bonferroni corrections. MICROCHECKER suggested that no loci showed signs of possible null alleles. There was no evidence for scoring error due to shuttering or large allele drop-out for any microsatellite loci.

A pairwise population analysis of cod detected a significant difference in allele frequencies for 37 of the 45 possible tests (Exact tests, P = 0.000-0.036), with multilocus F_{ST} ranging from 0.000 to 0.092. Five of 37 values were non-significant after correcting for multiple testing. The genetic homogeneities were observed between all north Atlantic cod (BSWK, BSEK, NSL), and between Baltic cod from the Arkona and Bornholm seas (A10, A13, B10, B13).

The overall values of θ = 0.032 with confidence interval CI = 0.015–0.059 were significant among all samples. Individual locus estimates of θ varied considerably from 0.0008 for *Gmo3* to 0.029 for *Gmo34*, and up to 0.099 for *Gmo8*, seven associated exact tests of global differentiation were significant (P < 0.001). There was no significant differentiation at only *Gmo3* locus.

The overall θ within the Baltic Sea samples also was significant θ = 0.016, CI = 0.007–0.027. Whereas θ withinthe north-east Atlantic was non-significant θ = 0.004, CI = -0.0008–0.014.

The Bayesian clustering analyses using STRUCTURE suggested that the largest ΔK appeared under the assumption of two groups (Fig. 2, 3). The two identified clusters corresponded with 1) the North-East Atlantic cod (NSL, BSWK, BSEK) and two samples of cod from the Belt Sea (Belt13, Belt06); and 2) the Baltic Sea cod from the Arkona and Bornholm seas (A10, A13, B10, B13) and one sample from the Belt Sea (Belt10). The classification of spawning cod captured in the Belt Sea in March 2010 to eastern Baltic cod was not expected. Second hierarchical STRUCTURE analysis (Fig. 4) was subsequently carried out for both previously identified clusters, separately. The first initial cluster was further separated into two groups of cod (*K*=2): 1) North-East Atlantic (NSL, BSWK, BSEK) and 2) the Belt Sea (Belt13, Belt06), while no subdivision was indicated within the second initial cluster (both with and without location information). The next step the application of of STRUCTURE analysis did not identified any clusters as within the North-East Atlantic and within the Belt Sea (2006, 2013) cod.

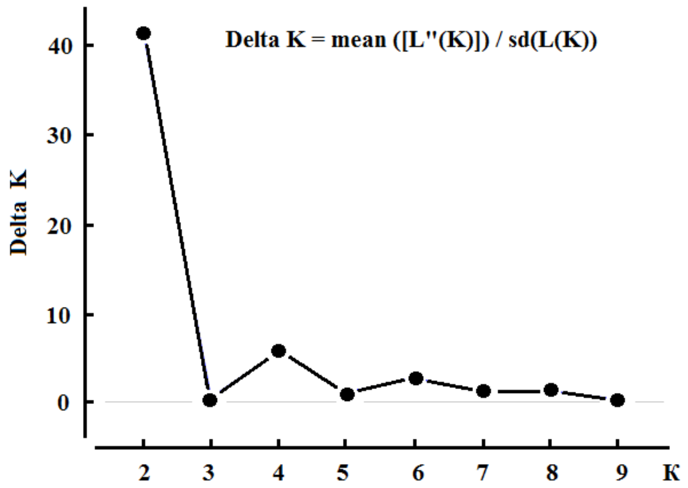

Figure 2: Assessment of the most likely number of clusters on the basis of the delta *K*. x-axis describes the hypothetical number of populations, y-axis presents delta *K*, estimated in accordance with the Evanno et al. 2005 based on the variability of eight microsatellite loci

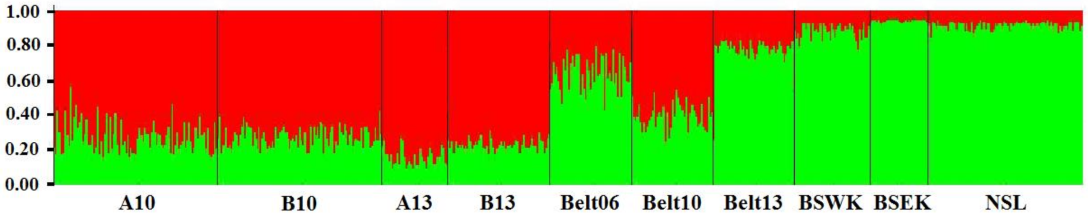

Figure 3: Probability of classification all samples to identify clusters based on of allelic composition of eight microsatellite loci with the program STRUCTURE.

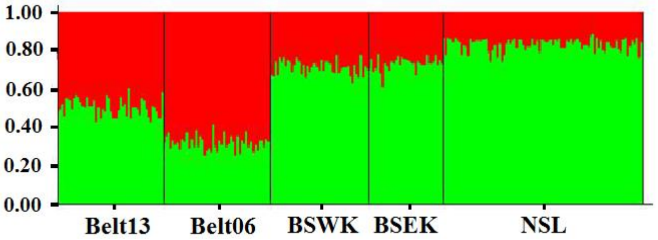

Figure 4: Probability of classification of subsamples to identified sub cluster in NSL, BSWK, BSEK, Belt13, Belt06 based on of allelic composition of eight microsatellite loci with the program STRUCTURE.

An UPGMA overall dendrogram of genetic distance (Nei 1972) based on allele frequencies at all loci is presented in Figure 5. There are two main branches in the dendrogram, corresponding to the two major clusters identified by STRUCTURE. The first main clusters separated into the three samples of cod from north-east Atlantic (NSL, BSWK, BSEK) which clustering together versus the two samples from the Belt Sea (2006, 2013). The genetic homogeneity were observed within north-east Atlantic cod, based on the overall θ, pairwise F_{ST} and genetic identity (I > 0.99) estimates, whereas the genetic differentiation between Atlantic cod and samples from the Belt sea (Belt06, Belt13) was significant as demonstrated in pairwise tests for genetic differentiation. The second main clusters represented by the samples from different years of Arkona and Bornholm seas (A10, A13, B10, B13) versus the sample from the Belt Sea (2010). The genetic differentiation between Arkona and Bornholm seas was significant (θ =0.0028 CI = 0.0007-0.005) but very low. Also we detected the significant estimates of differentiation with pairwise F_{ST} between samples from the Arkona and Bornholm seas on one hand, and sample from the Belt Sea (2010) on other hand. At the same time, the level of genetic differentiation between two main clusters was highly significant θ = 0.039 CI = 0.015-0.083.

Based on pairwise F_{ST} the barrier analyses (Fig. 6) identified two areas of relatively sharp changes in genetic composition. The first barrier (I) separated the north-east Atlantic cod of NEA from the cod of the Baltic Sea. The second barrier (II) was located within the Baltic Sea and separated the Arkona Sea and the Bornholm Sea from the Belt Sea cod. It should be noted the higher "strength" of the first reproductive barrier supported 7 of 8 microsatellite loci in comparison with a second barrier which supported only five loci.

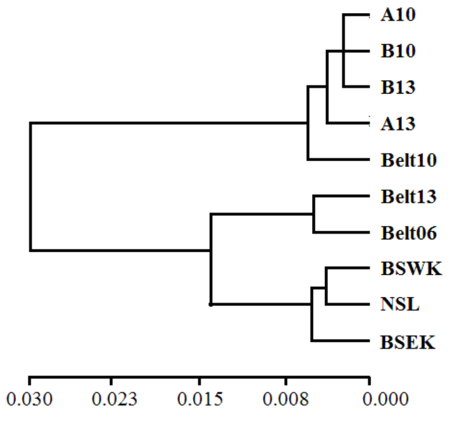

Fig. 5. UPGMA dendrogram based on genetic distance (Nei 1972) for eight microsatellite loci for the cod samples

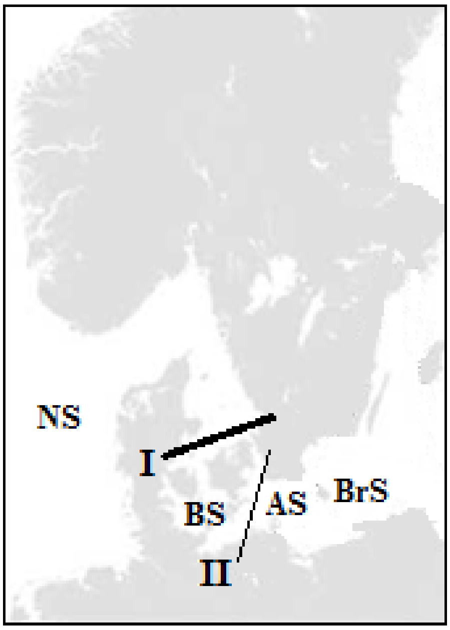

Fig. 6. The main areas of change of intensity of gene flow in the studied groups of cod in accordance with the results on BARRIER marked with Roman numerals according to their importance (explanation in the text). Designations: NS - North Sea; BS – Belt Sea; AS - Arkona Sea; BrS - Bornholm Sea.

We found genetic similarity in spawning cod captured in the Arkona Sea in March 2010 and May 2013 and in the Bornholm Sea in March 2010 and June 2013. It can be assumed that results are influenced by the increased of the abundance of cod < 38 cm in the Bornholm Sea in 2009 and 2010. The situation in the Belt Sea apparently unstable because spawning cod captured in the Belt Sea in March 2010 were assigned to eastern Baltic cod based on genetic methods. These results suggest highly variable mixing of western and eastern Baltic cod in SD 22 and SD 24. The results correspond with assumptions of Nielsen et al. (2004) concerning temporal variation of fish population structure in the transit area between the Baltic Sea and the North Sea.

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Joint fisheries research/fishing industry survey for sole in Skagerrak and Kattegat, November 2014

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 length distribution had a mode around 23 cm as in previous years but with slightly more large sole than previous. The biomass and abundance of sole has increased slightly during 2005 – 2007 but decreased about 25% between 2007 and 2008 and remained at the 2008 level in 2009 but decreased further in 2010. The Biomass increased slightly between 2010 and 2014 while the abundance was at the lowest level in the time series in 2014. 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 surveys were resumed in 2014.

The survey was originally designed in order to establish fisheries independent CPUE indices by means of annual fishing at 120 fixed stations where 60 of the positions of the hauls were selected by the skippers on the two 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 mainly placed 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 form NaturErhvervstyrelsen and the number of planned stations was reduced from 116 to 80 stations (Fig. 1).

Two commercial trawlers conduct the survey without any restrictions in the vessels quota and with dispensation from all by-catch regulations. There is staff from DTU Aqua on board the vessels during the surveys.

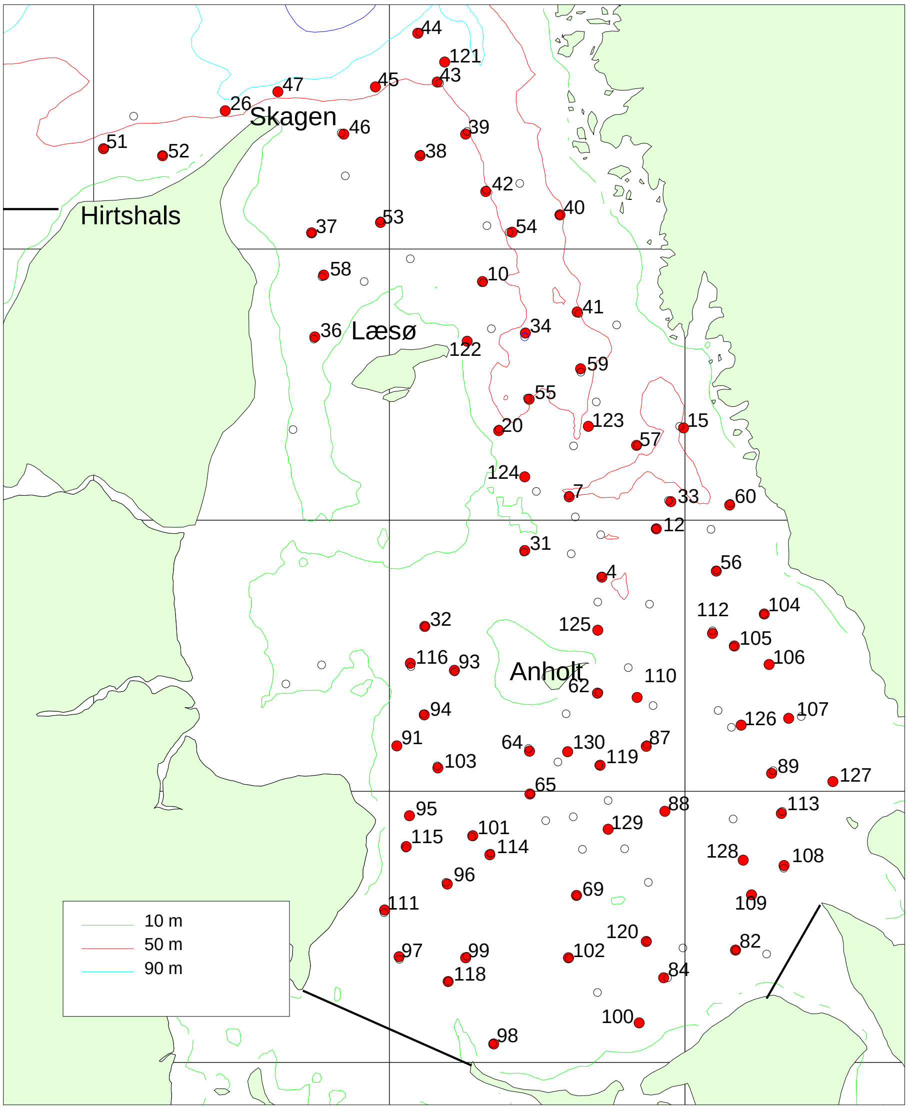


Fig 1. Distribution of stations in 2011 with excluded stations ○.

Materials and Methods

The survey has been conducted by a number of different trawlers thought the time series but they have all been in the same size class. In 2014 the surveys were conducted by:

Vessel	1	2
Engine (hp):	375	220
Tonnage:	49.7 BRT	51.10 BRT
Length (m):	17.05	17.00

Time
The survey in 2014 was conducted during 9/11 - 28/11, the same time as in previous years.

Survey area
The 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.

Jammer Bay is a part of the assessment area IIIa for sole, but there were not placed stations in the area due to high frequency of bad weather during the survey period.

Distribution of hauls
There survey was planned with 12 working days and 40 hauls by each vessel.

The survey was originally designed in order to establish fisheries independent CPUE indices by means of annual fishing at 120 fixed stations, 60 statins 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 2011the survey was reduced further to 80 fixed stations, all included in the originally set up (Fig. 1).

The reduction in stations has 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 numbers that is used in the assessment of sole).

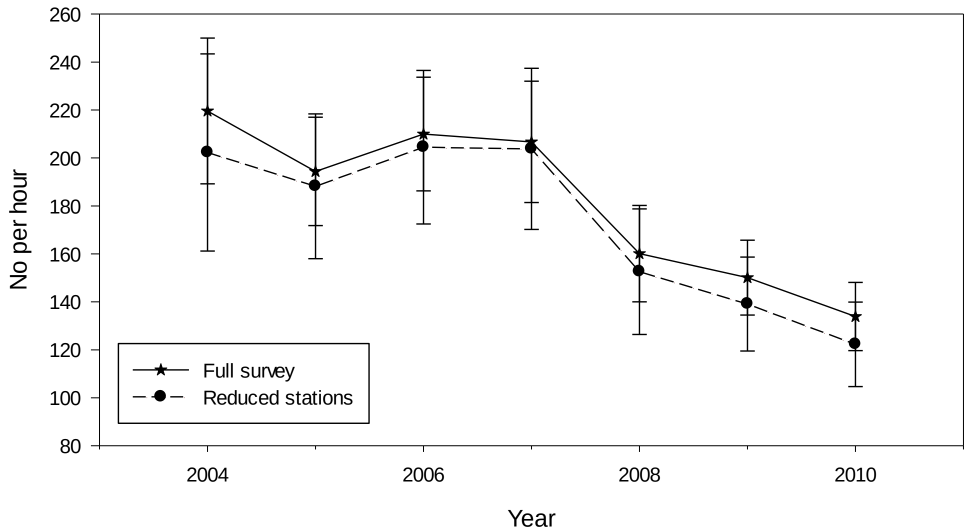


Fig. 2. Catch of Sole in numbers per hour in the “full survey” (116 stations) and the “reduced” survey (80 stations), respectively, with S.E.

The estimated trawlable biomass and abundance for the entire survey area is based on the 80 stations. Previously the estimate was based on 70 stations random selected by Aqua. 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 each year 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: 60 min (towing time down to 20 min is accepted).
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.

Biomass and abundance
The 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).

CPUE
CPUE is estimated as mean catch (kg or numbers) per hour with Standard Error.

Results

Sole

77 of the 80 planned stations were successfully covered in 2014 and sole were caught at all 77 stations. The catches ranged from 0.1 kg to 86.0 kg per hour. The greatest catches were generally taken southeast of Læsø and southwest of Anholt as in the previous years (Fig. 3). The CPUE, biomass and abundance 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 relatively stable since then.

CPUE.
The CPUE based on the 77 stations changed slightly but statistically insignificant (95% level) between 2011 and 2014 from 140.2 to 121.6 specimens and 19.0 to 19.2 kg per hour, respectively. The CPUE in number is however the lowest observed in the time series (Table 1, Fig. 4 and 5). The catches were dominated by fish age 1-5 (Table 2, Fig. 7).

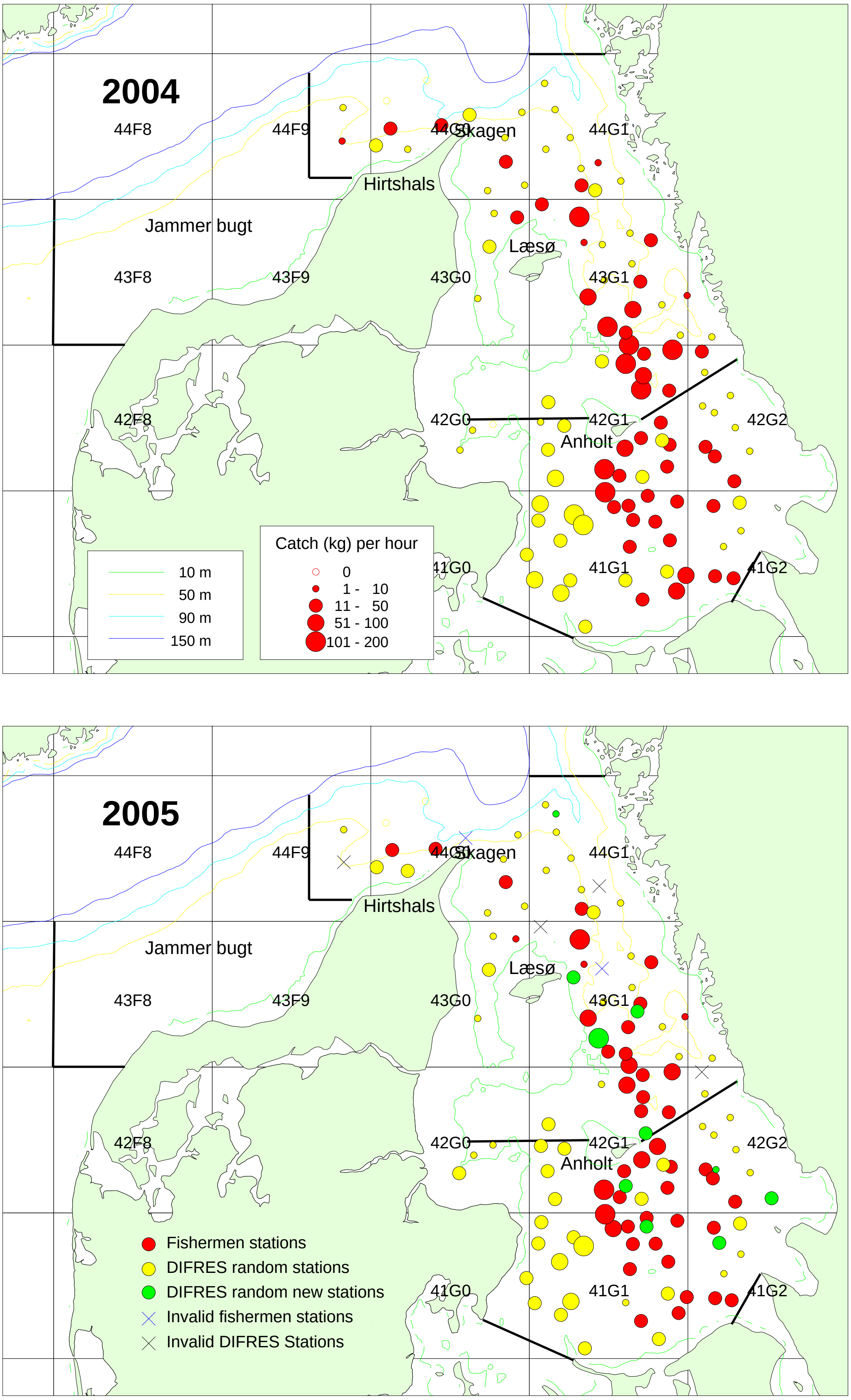
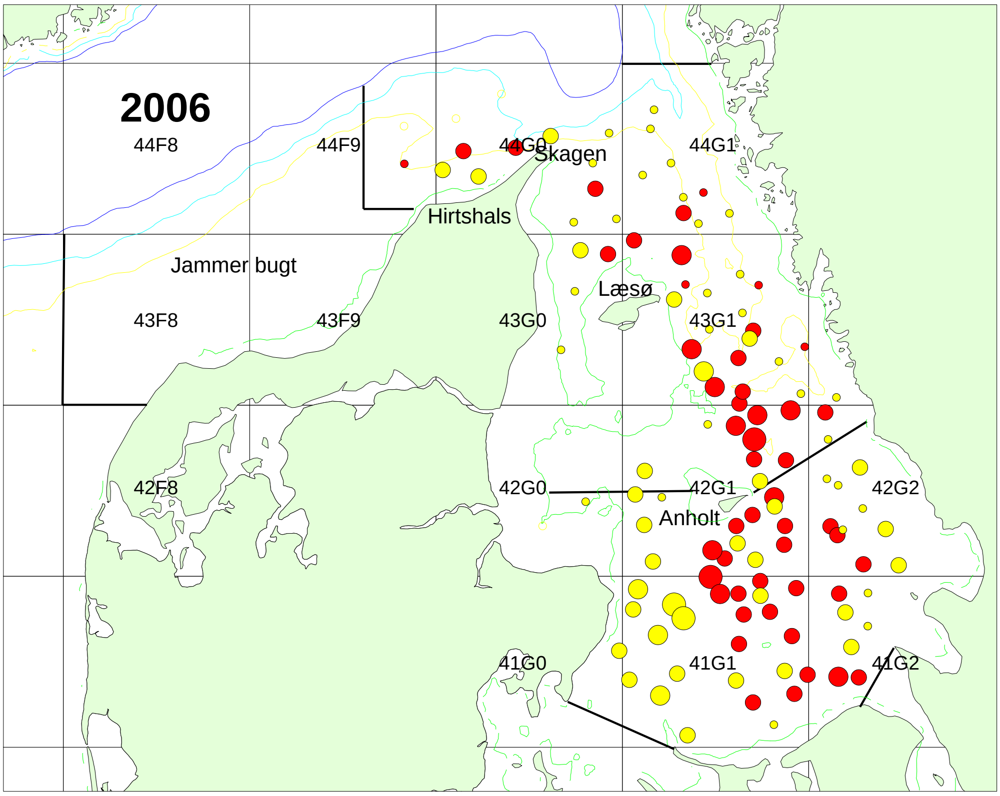


Fig. 3. Catch of sole (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.



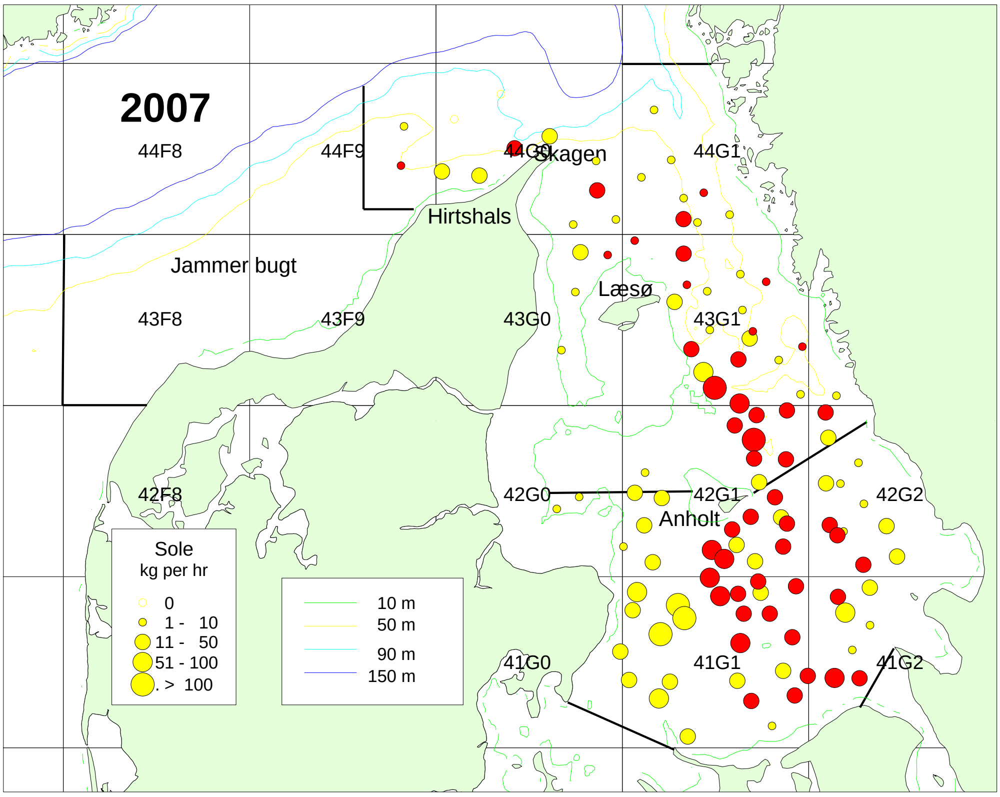
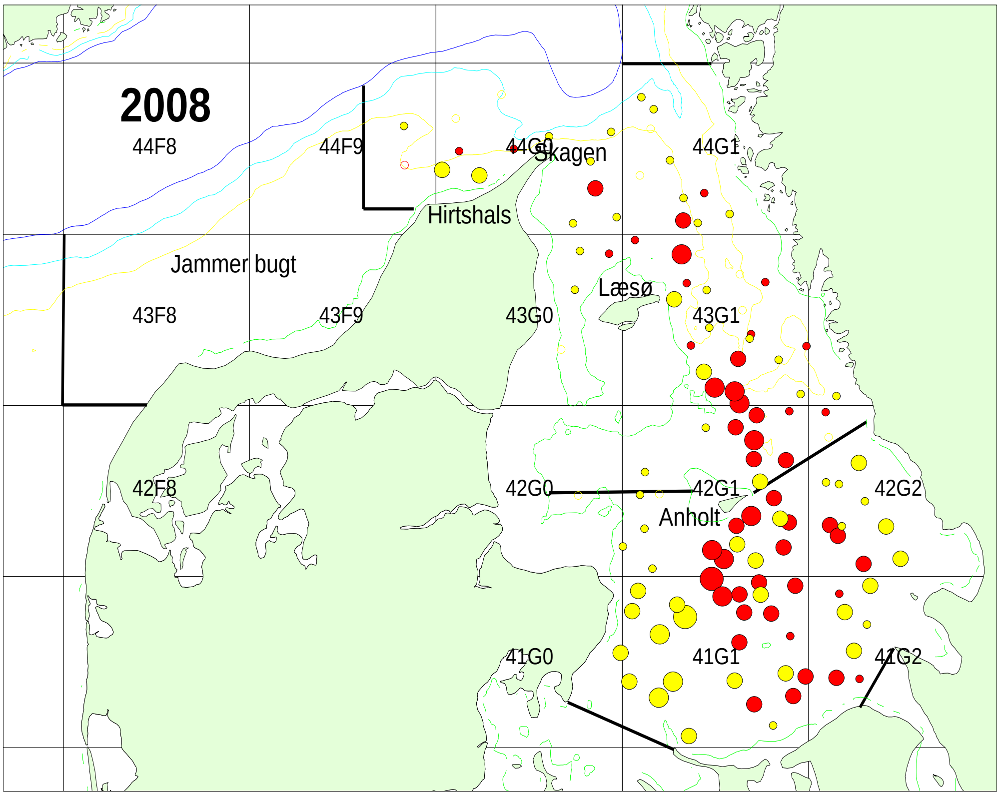


Fig. 3 cont. Catch of sole (kg per hour) 2006 - 2007. ● DTU AQUA stations ● Fishermen's stations.



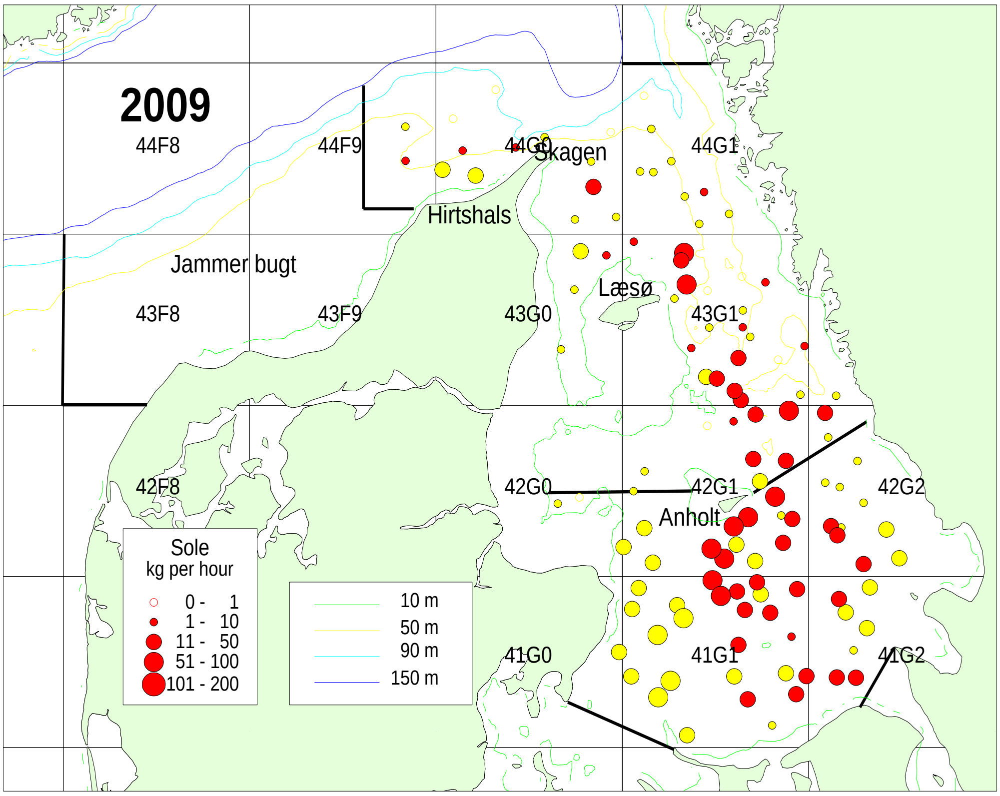
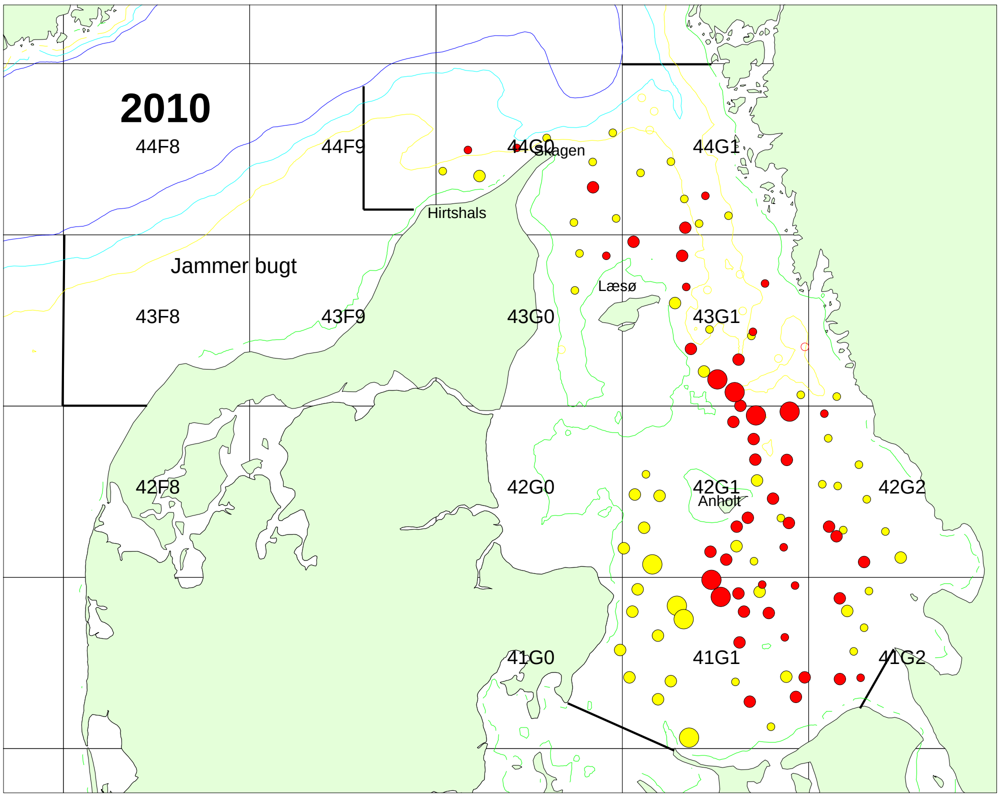


Fig. 3 cont. Catch of sole (kg per hour) 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.



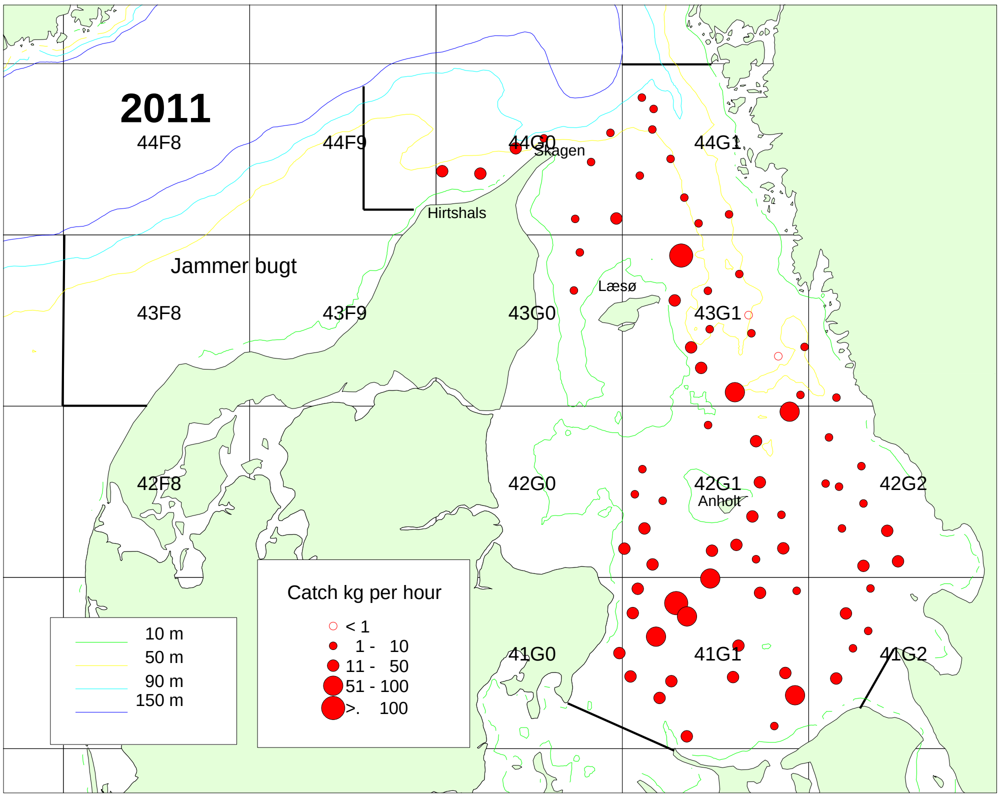


Fig.3 cont. Catch of sole (kg per hour) in 2010 and 2011. 2010 ● DTU AQUA stations ● Fishermen's stations.

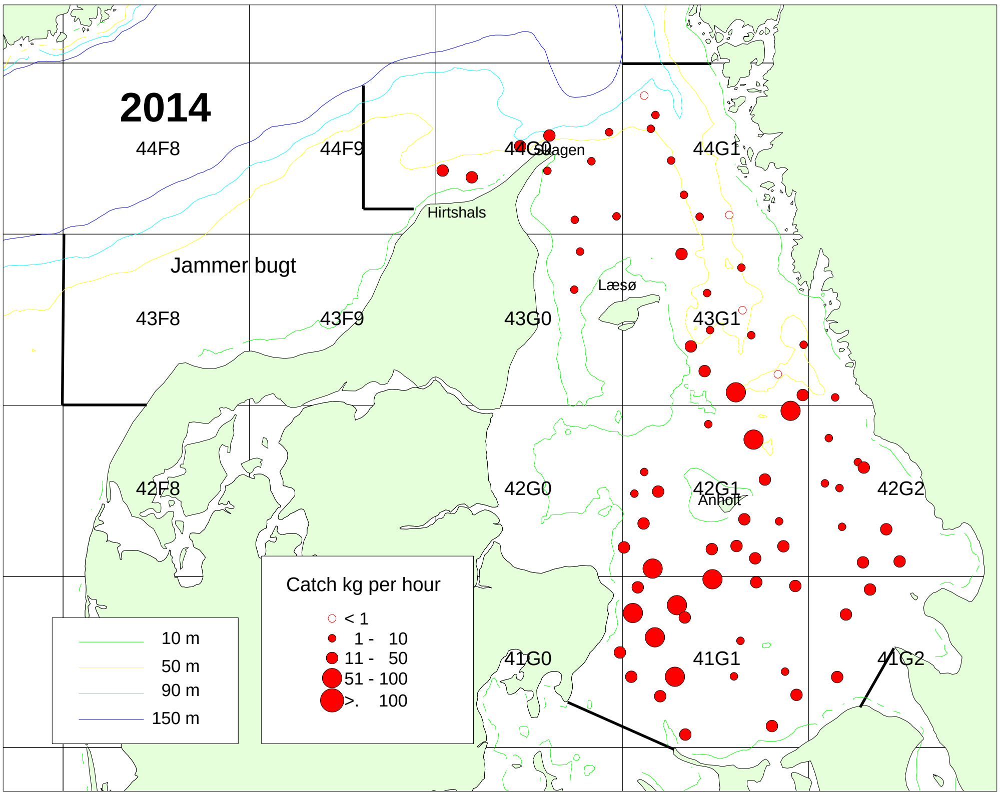


Fig. 3 cont. Catch of sole (kg per hour) in 2014.

Table 1. CPUE of sole in number and kg per hour with S.E. and number of hauls (n).

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

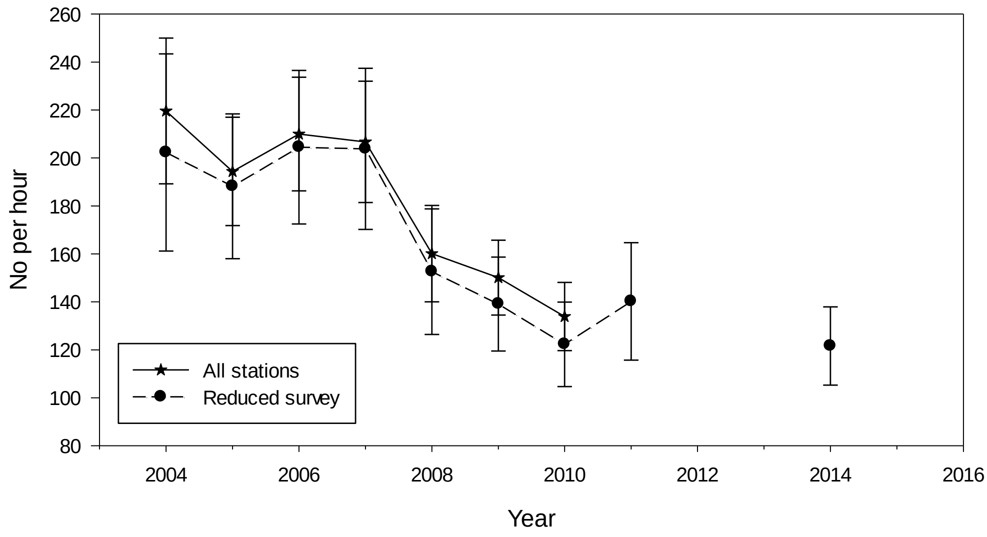


Fig. 4. Catch of sole in number per hour based on “full survey” and “reduced survey”, respectively, with 1* S.E. (See “Distribution of hauls”).

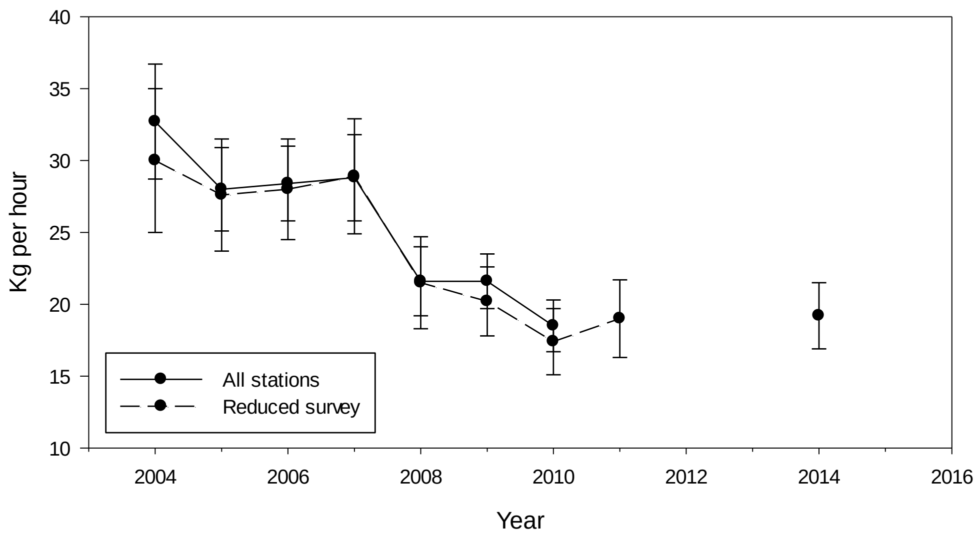


Fig. 5. Catch of sole in kg per hour based on “full survey” and “reduced survey”, respectively, with 1* S.E. (See “Distribution of hauls”).

Length distribution

In 2014 the length ranged from 9 to 44 cm with a mode at 23 cm as in 2008-2011 (Fig. 6). In 2014 there were somewhat more fish > 26 cm than seen in 2008-2011. Prior to 22008 the mode was at 22 cm. The length distribution has not changed despite the reduction in stations.

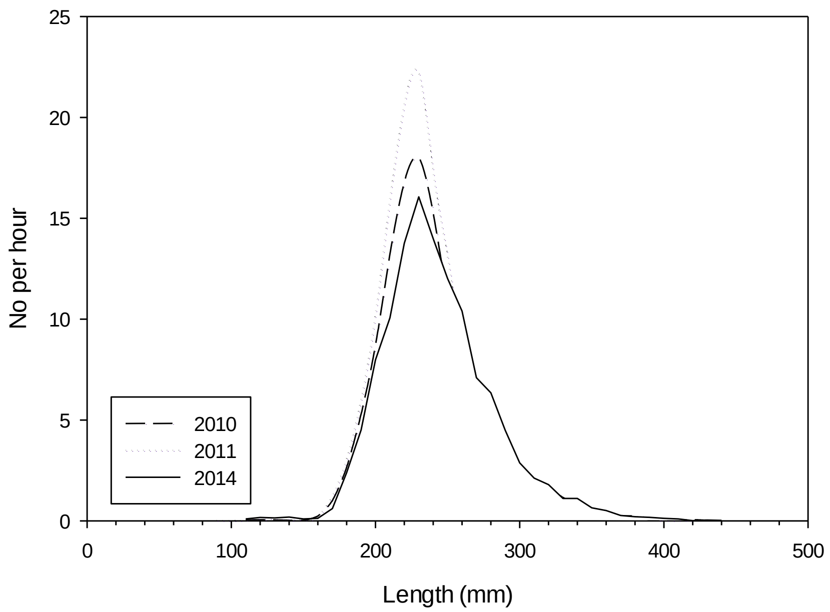


Fig. 6. Length distribution (mm) of sole standardized to number caught per hour in 2010, 2011 and 2014.

Table 2. Mean number of sole caught per hour distributed on age at 80 comparable stations 2004-2011 and 2014.

Age	2004	2005	2006	2007	2008	2009	2010	2011	2014
0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.7
1	12.3	13.7	29.9	29.5	8.1	12.3	10.9	6.4	21.2
2	57.5	36.5	32.2	25.6	27.6	13.5	12.4	35.3	11.4
3	45.0	65.6	30.1	17.3	20.3	34.7	18.5	18.3	16.8
4	29.9	35.2	60.8	29.4	16.2	13.1	15.0	12.2	10.6
5	22.2	22.0	24.0	28.7	20.4	13.3	6.0	13.8	13.3
6	12.1	8.2	13.8	28.0	19.9	15.9	13.9	7.4	6.5
7	9.4	4.0	4.8	13.5	13.8	19.5	10.2	7.9	5.0
8	6.0	1.9	1.9	11.5	14.2	8.1	17.4	5.7	14.9
9	1.7	0.3	2.0	3.1	4.9	4.5	6.2	12.5	0.7
10	0.7	0.2	1.5	4.7	5.3	2.1	3.4	10.2	4.5
11+	5.6	0.6	3.4	12.2	1.8	2.1	8.3	10.5	16.1
Total	202.3	188.1	204.5	203.6	152.6	139.1	122.3	140.2	121.6

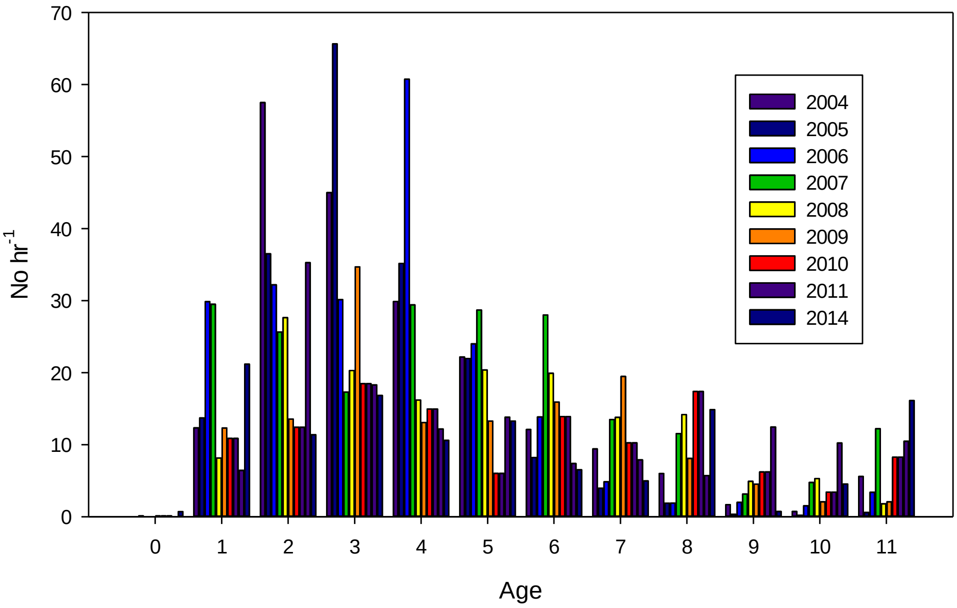


Fig. 7. Mean number of sole caught per hour distributed on age 2004-2011 and 2014. Age 11 is a plus group.

Biomass and abundance

The biomass of sole was estimated at 1499.7 tons in 2014, which is below the level in 2008 and 2009 but slightly above the 2010 and 2011 estimate and approximately 25% below the level during 2005-2007 (Table 3). The decrease between the 2004-2007 and 2008-2014 is, however, not statistically significant.

Table 3. Swept area biomass and abundance of sole with 1* S.E. and number of hauls.

Year	BIOMASS	SE_BM	ABUNDAN	SE_AB	Haul
2004	2391.48	363.42	15935791.28	2969937.05	68
2005	2201.79	284.38	14910144.89	2191447.53	77
2006	2300.84	245.39	16561209.19	2243489.75	78
2007	2254.15	263.26	15653952.90	2196027.43	75
2008	1717.51	215.03	12082628.29	1782711.12	80
2009	1675.95	175.78	11487877.69	1428147.20	78
2010	1379.77	145.05	9660045.47	1138982.87	79
2011	1471.56	193.60	10746623.19	1695182.32	80
2014	1499.71	170.56	9452928.68	1136106.23	77

The abundance decreased from 10.7 mill. in 2011 to 9.5 mill. in 2014 and the 2014 estimate is the lowest in the time series although it is at the level seen since 2008. The 2008-2014 estimates are however below the 2004-2007 level, although the difference is not statistically significant (95% level) (Table 3).

The largest total biomass and total abundance was found in ICES area 41G1 as in 2006 - 2011 (Fig. 3, Table 4), while the largest densities were found in Division 41G0. This estimate is however based on one haul only.

Table 4. Sole biomass 2014. 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
41G0	329	1	0.2087	68.7	
41G1	3357.6	17	0.1488	499.5	80.4
41G2	1421.2	3	0.0692	98.4	17.3
42G1	3039.6	16	0.1336	406.1	101.9
42G2	2003.8	9	0.0378	75.7	9.6
43G0	721.5	2	0.0142	10.2	0.5
43G1	2460.9	12	0.0746	183.7	68.6
43G2	331.3	1	0.0134	4.5	
44G0	1881.5	9	0.0626	117.8	48.1
44G1	1914.9	7	0.0184	35.2	9.0
All			0.0859	1499.7	170.5

Table 5. Sole abundance, 2014. Area, number of hauls, mean abundance per km^2, abundance and Standard Error distributed on ICES squares.

Div.	Area	Hauls	Mean sq km	Abundance	SE
41G0	329	1	1225.4	403167.7	
41G1	3357.6	17	1103.8	3706150.3	708699.9
41G2	1421.2	3	451.9	642210.1	153133.4
42G1	3039.6	16	851.4	2587898.4	664204.6
42G2	2003.8	9	193.7	388111.2	62863.1
43G0	721.5	2	85.5	61683.3	7575.1
43G1	2460.9	12	403.9	993919.0	351364.2
43G2	331.3	1	43.2	14311.0	
44G0	1881.5	9	251.1	472427.8	176205.9
44G1	1914.9	7	95.6	183049.8	50997.0
All			541.4	9452928.7	1136106.2

Cod.

In 2014 cod was caught at 76 of the 77 valid stations. The catches ranged between 0.2 and 251.1 kg (Fig. 8).

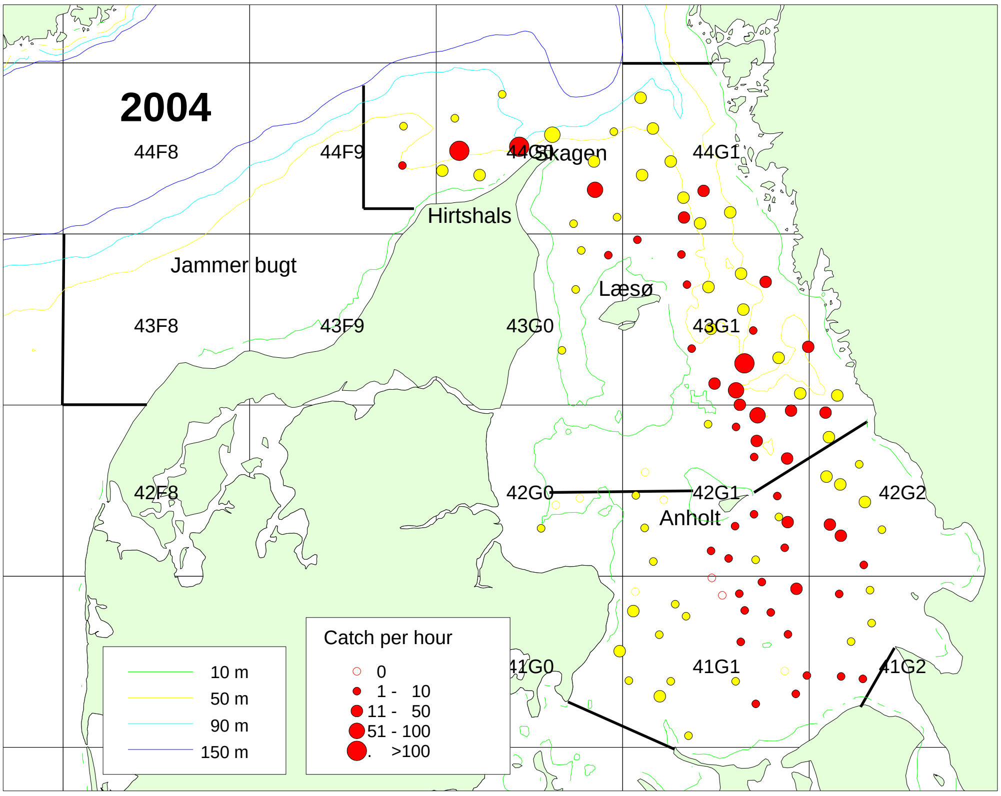
CPUE

The CPUE of cod increase between 2010 and 2011 from 26.0 to 190.9 specimens and 4.5 to 27.0 kg per, 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} while the CPUE in weight increased to 31.0 kg hr^{-1}, which is respectively the second largest and largest estimates in the time series. The CPUE was not changed by the reduction in stations (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

* Excluding one large haul on 1368 kg.



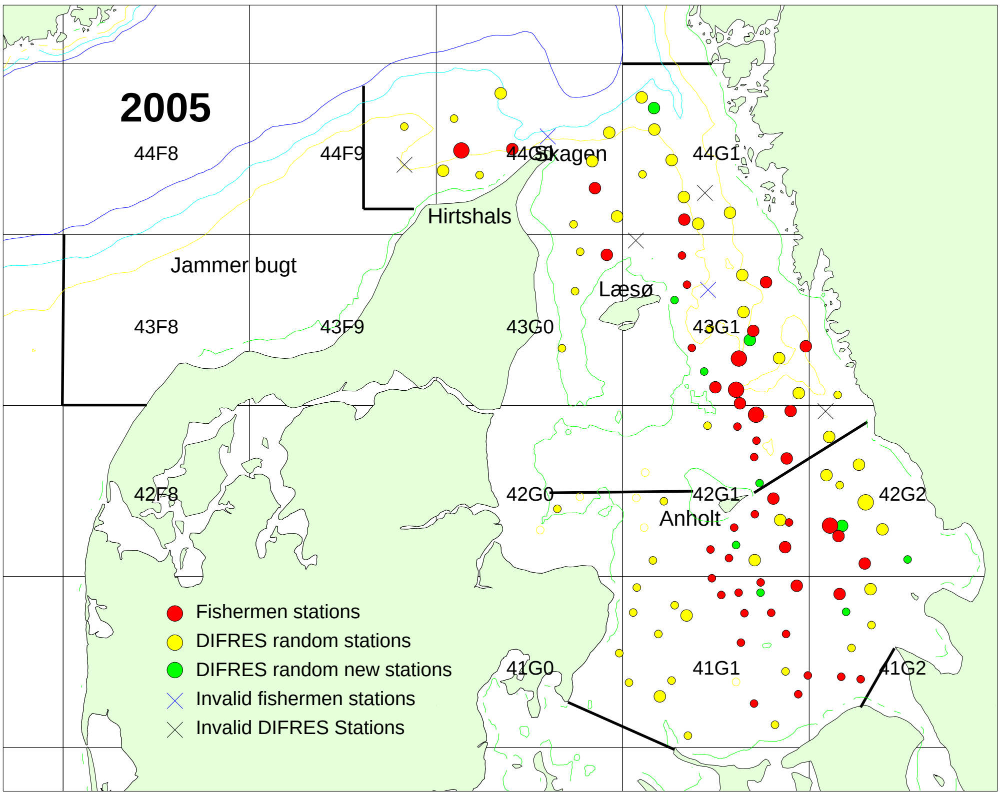


Fig. 8. Catch of cod (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.

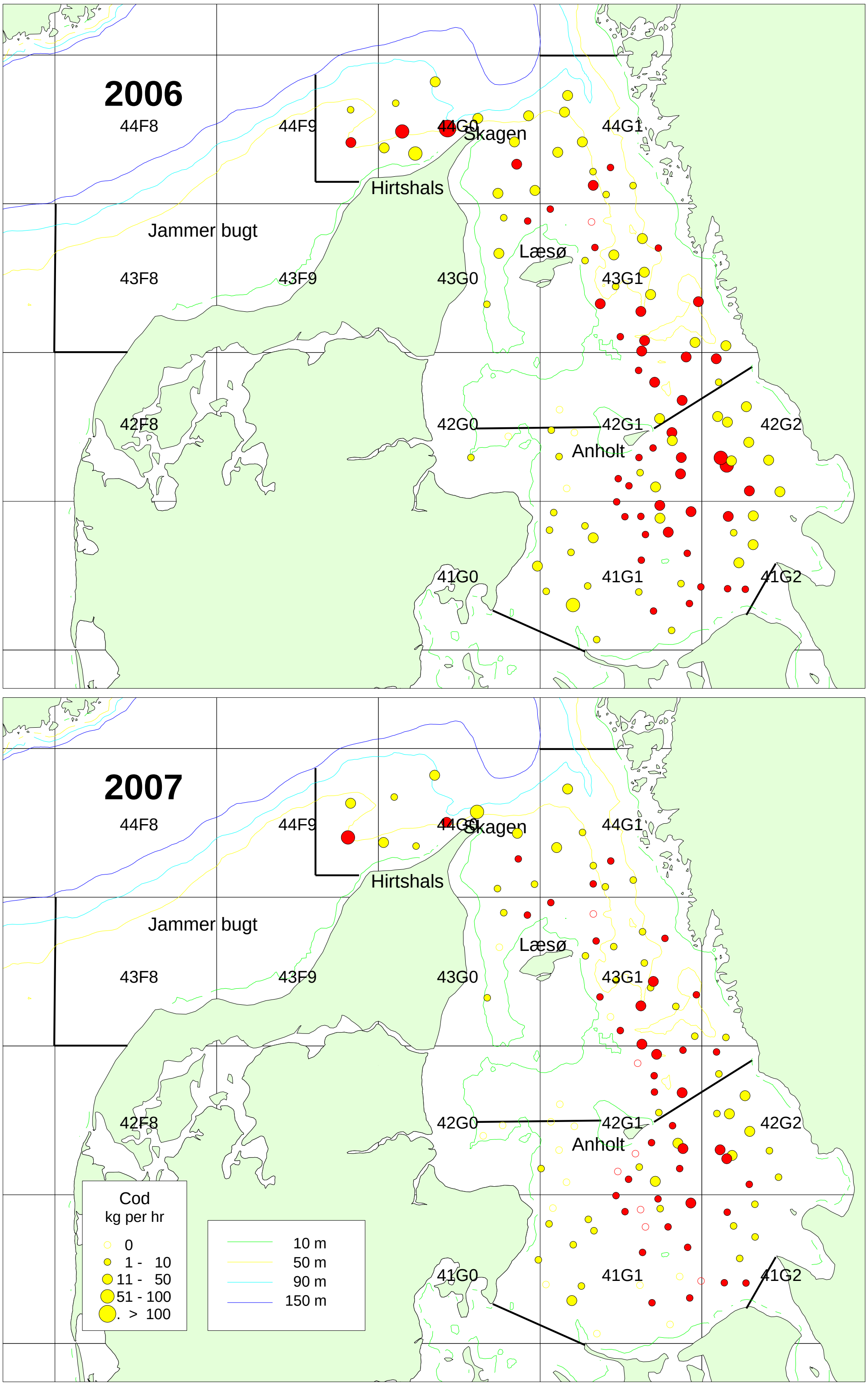


Fig. 8 cont. Catch of cod (kg per hour) in 2006 - 2007. ● DTU AQUA stations ● Fishermen's stations.

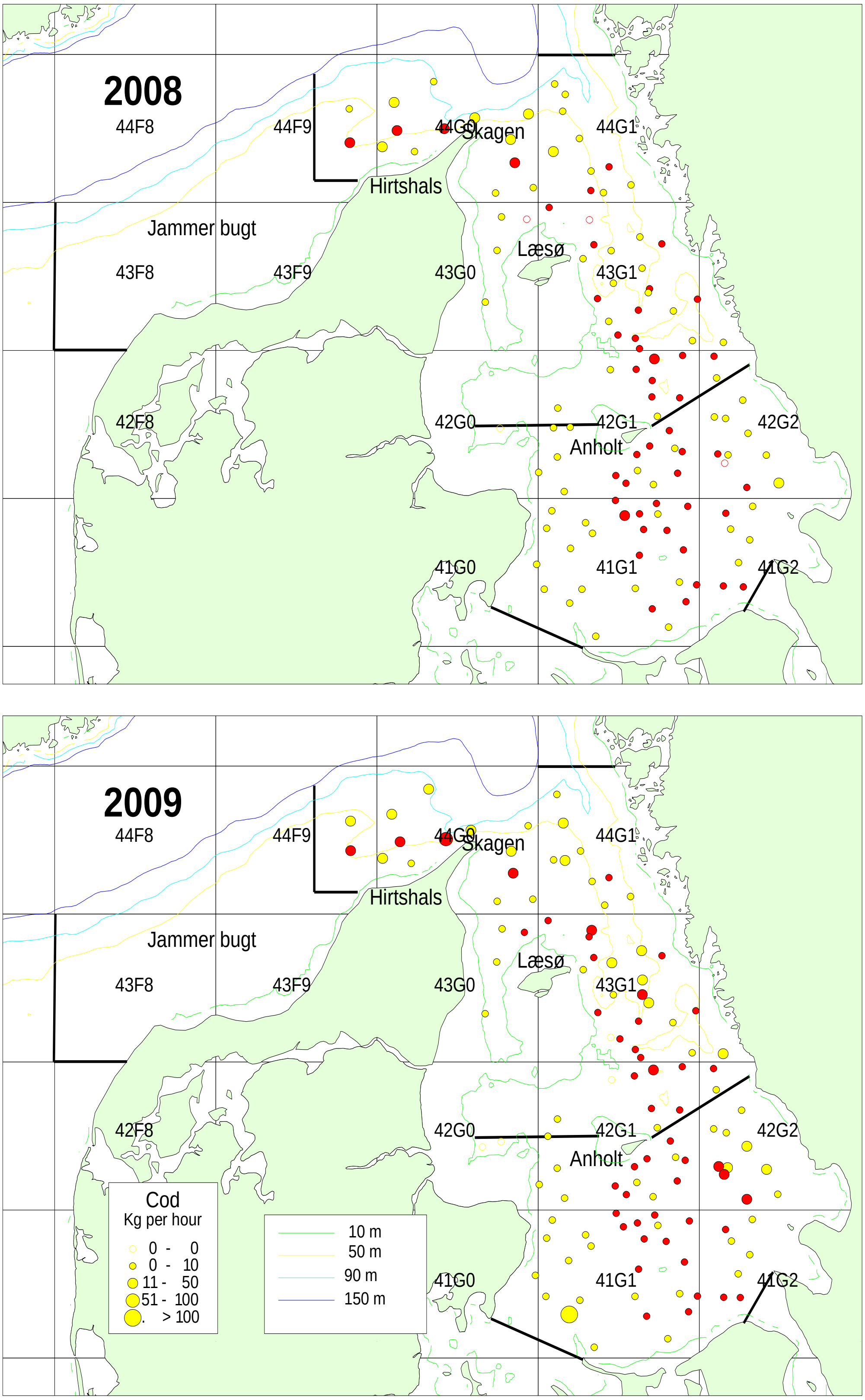
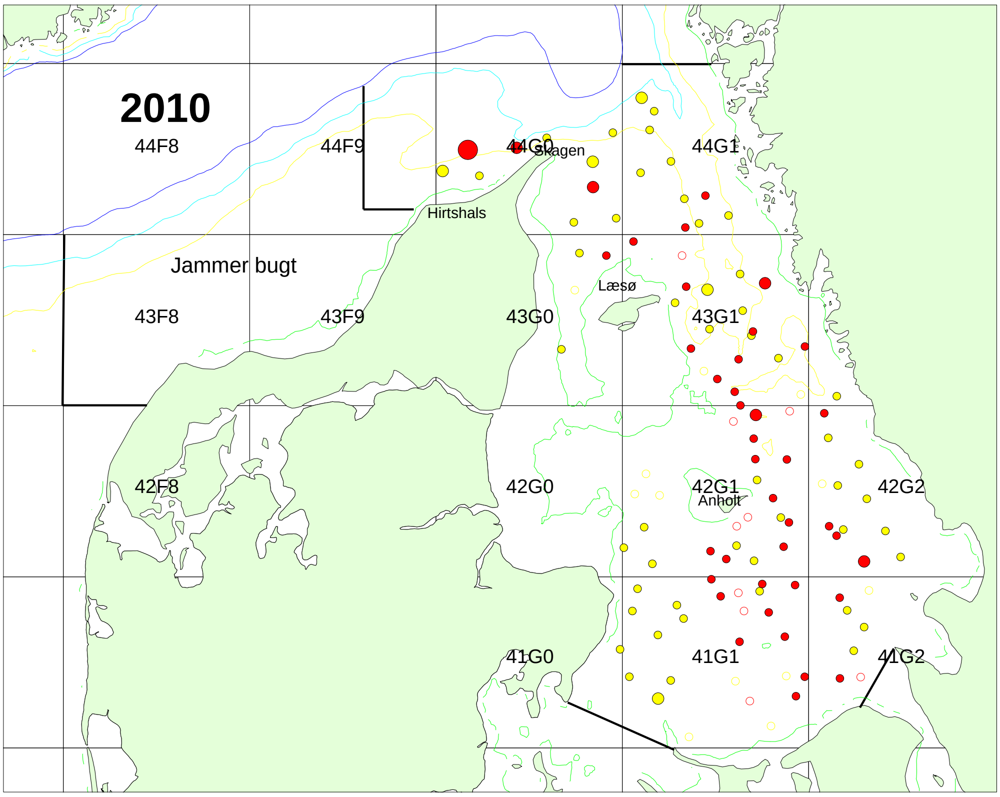


Fig. 8 cont.. Catch of cod (kg per hour) in 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.



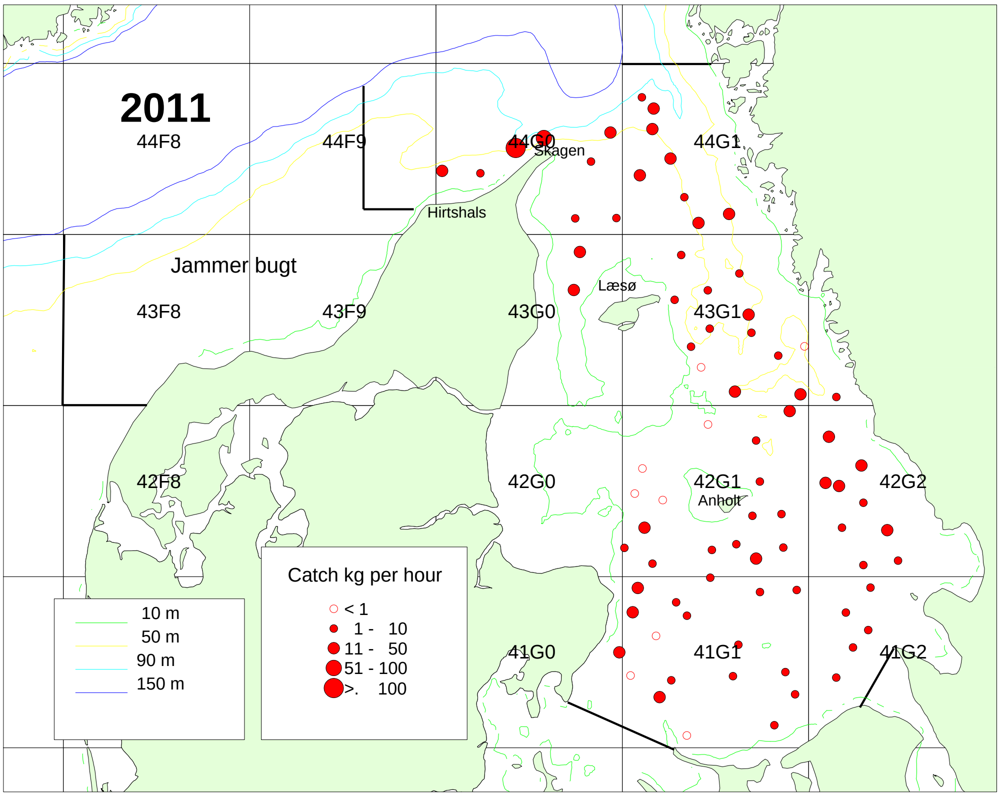


Fig. 8 cont.. Catch of cod (kg per hour) in 2010 and 2011. ● DTU AQUA stations ● Fishermen's stations.

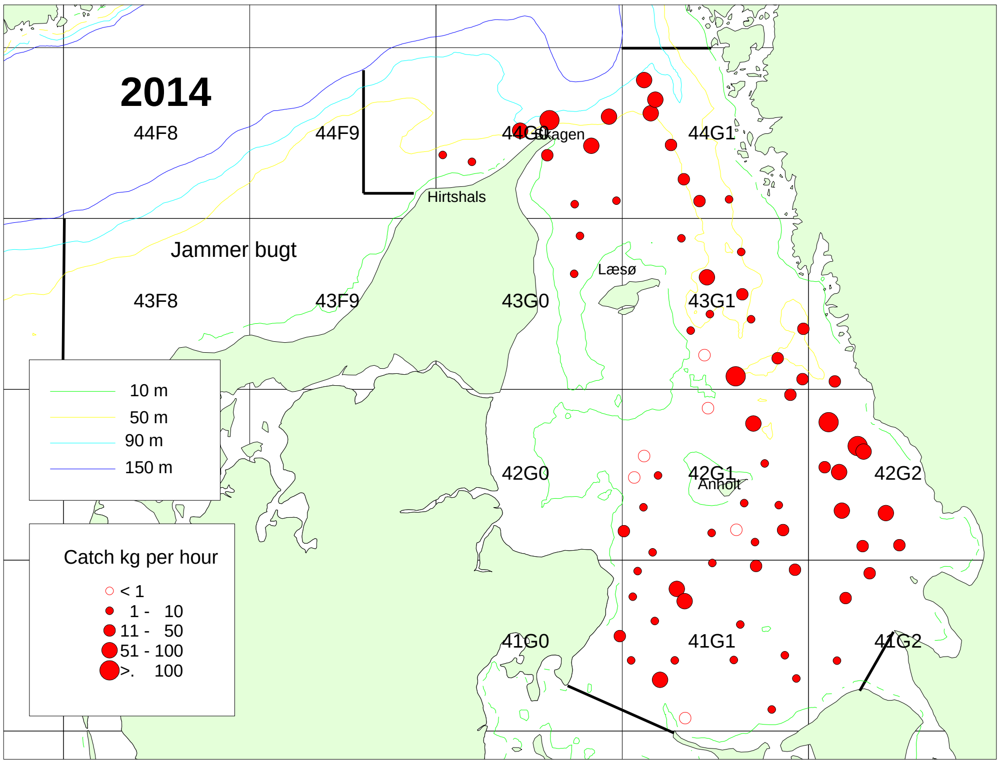


Fig. 8 cont. Catch of cod (kg per hour) in 2014.

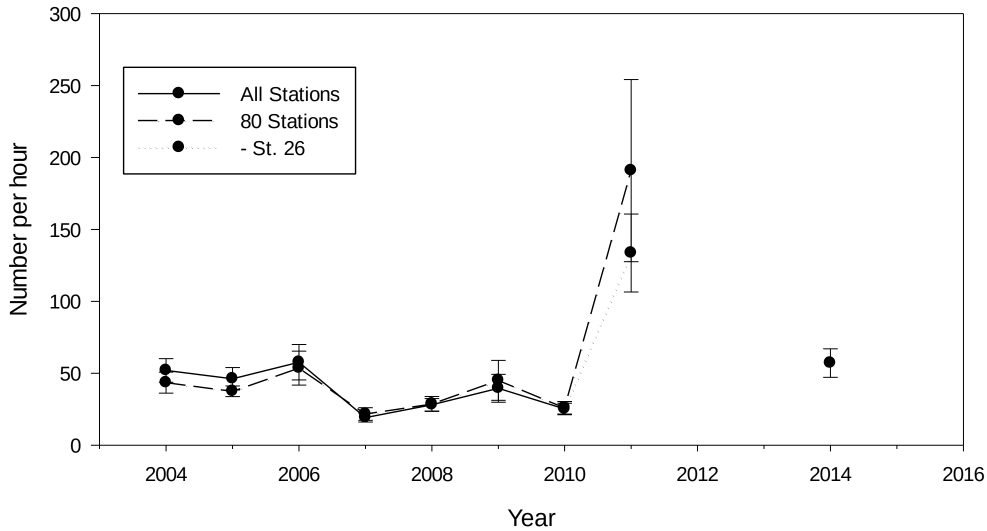


Fig. 9 Catch of cod in number per hour based on 116 and 80 stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

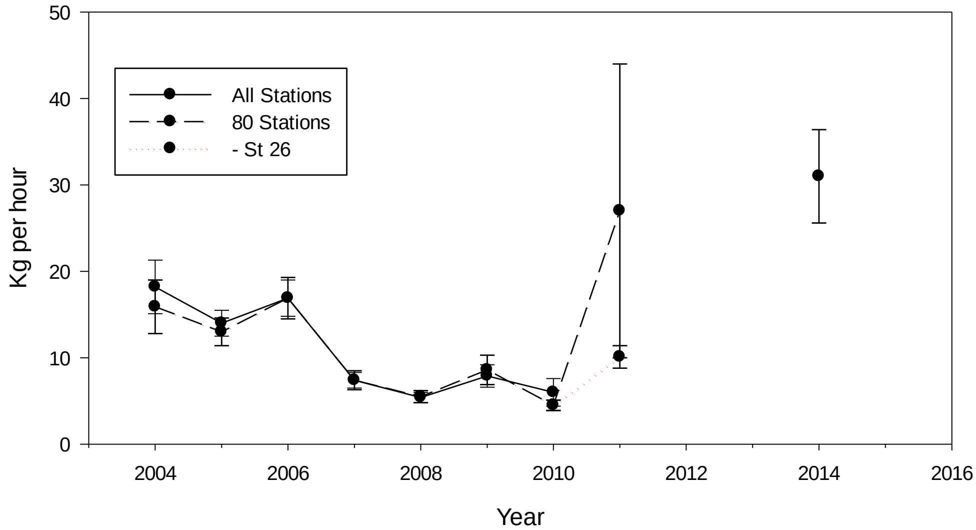


Fig. 10. Catch of cod in kg per hour based on 116 and 80 stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

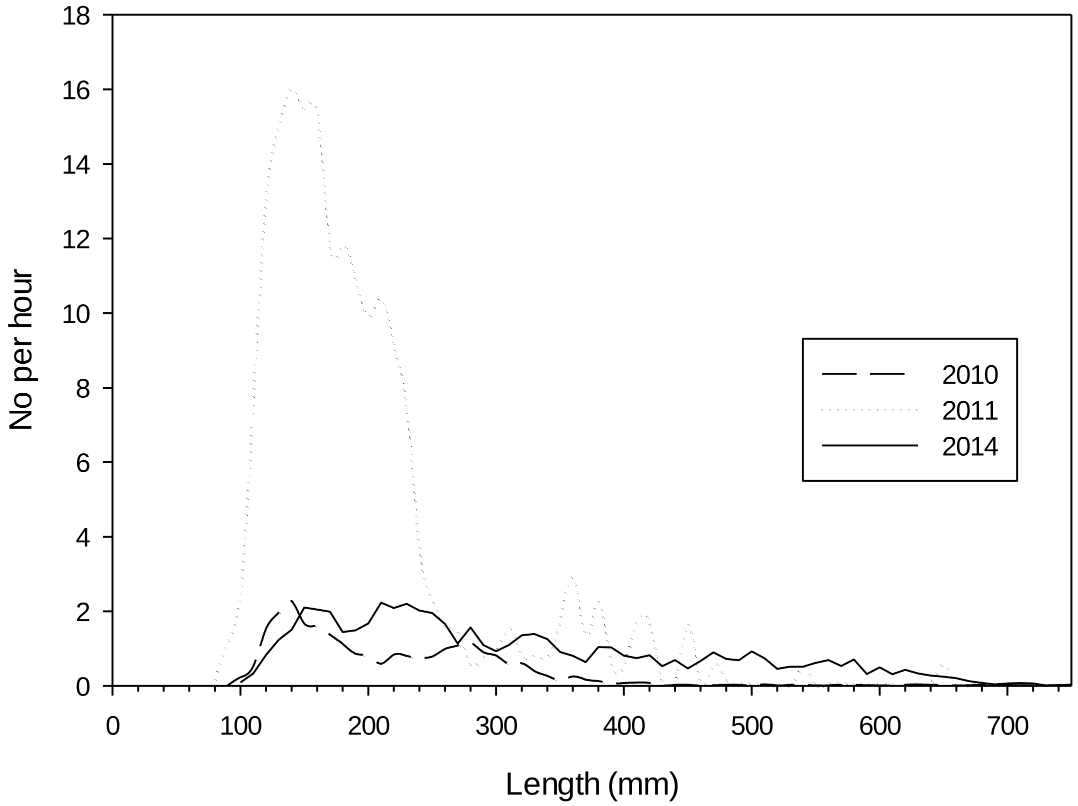


Fig 11. Length distribution of cod standardized to number caught hour^{-1}.

Length distribution

The length ranged from 10 to 81 cm without any clear modes, but with more fish > 40 cm than in previous years (Fig. 11).

Age distribution in Kattegat

The age distribution (standardized to catch by age hour^{-1}) in Kattegat only (i.e. 13 stations in Skagerrak is excluded) for 2004-2010 is based on a combined Danish/Swedish age length key sampled primo December 2010 in the Danish/Swedish survey for cod. In 2011and 2014 the CPUE is based on and a combined Danish/Swedish key sampled in December 2011 and 2014, respectively. (Table 7).

Table 7. Age distribution by year standardized to catch in no/hour. Age 0-2 only. n=number of valid stations. Data from Kattegat only.

Age	2004	2005	2006	2007	2008	2009	2010	2011	2014
n	57	66	64	65	67	65	66	67	67
0	3.87	9.19	7.23	2.94	18.79	8.84	6.39	56.93	7.64
1	21.95	15.13	24.11	5.89	6.13	24.15	8.72	20.29	19.08
2	3.93	8.52	6.14	2.39	0.85	2.48	1.07	1.68	16.61

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) but the abundance was reduced to less than a third (4.71 mill.). The biomass and abundance estimates have changed slightly without trends by the change in the way the biomass is estimated, but the overall trend sin the estimates have not changed.

Table 8. Swept area biomass and abundance of cod with 1* S.E. and number of hauls.

Year	BIOMASS	SE BM	ABUNDAN	SE AB	Haul
2004	1479.93	284.21	4021655.89	688225.40	68
2005	1106.69	111.01	3279389.41	294383.77	77
2006	1418.56	161.42	4527585.46	864192.62	78
2007	677.24	91.97	2144422.91	311316.01	75
2008	469.61	50.70	2483771.13	410041.47	80
2009	723.00	133.79	3874034.16	1051067.55	78
2010	373.79	50.10	2096501.53	296055.91	79
2011	2308.06	1465.67	16417225.31	5076904.63	80
2014	2538.63	397.38	4711426.05	755373.01	77

Table 9. Cod 2014. 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
41G0	329	1	0.0737	24.3	
41G1	3357.6	17	0.0743	249.6	91.0
41G2	1421.2	3	0.0555	78.8	9.9
42G1	3039.6	16	0.0506	154.0	61.2
42G2	2003.8	9	0.3954	792.4	249.6
43G0	721.5	2	0.0107	7.8	0.9
43G1	2460.9	12	0.1849	455.0	239.7
43G2	331.3	1	0.1555	51.5	
44G0	1881.5	9	0.1891	355.7	115.9
44G1	1914.9	7	0.1931	369.7	96.8
All			0.1454	2538.6	397.4

Table 10. Cod 2014. 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
41G0	329	1	124.5	40946.7	
41G1	3357.6	17	306.8	1029960.8	548356.1
41G2	1421.2	3	214.5	304777.7	80636.6
42G1	3039.6	16	149.4	454024.7	113177.5
42G2	2003.8	9	433.2	868101.2	255246.3
43G0	721.5	2	123.0	88737.4	19478.9
43G1	2460.9	12	211.6	520717.9	239924.2
43G2	331.3	1	177.6	58834.2	
44G0	1881.5	9	320.6	603202.5	222733.6
44G1	1914.9	7	387.6	742123.0	269704.4
All			269.8	4711426.1	755373.0

Plaice

In 2014 plaice was caught at all 77 valid stations. The catches ranged between 0.3 and 384.7 kg (Fig. 12). The largest catches were generally taken east of Djursland and around Skagen.

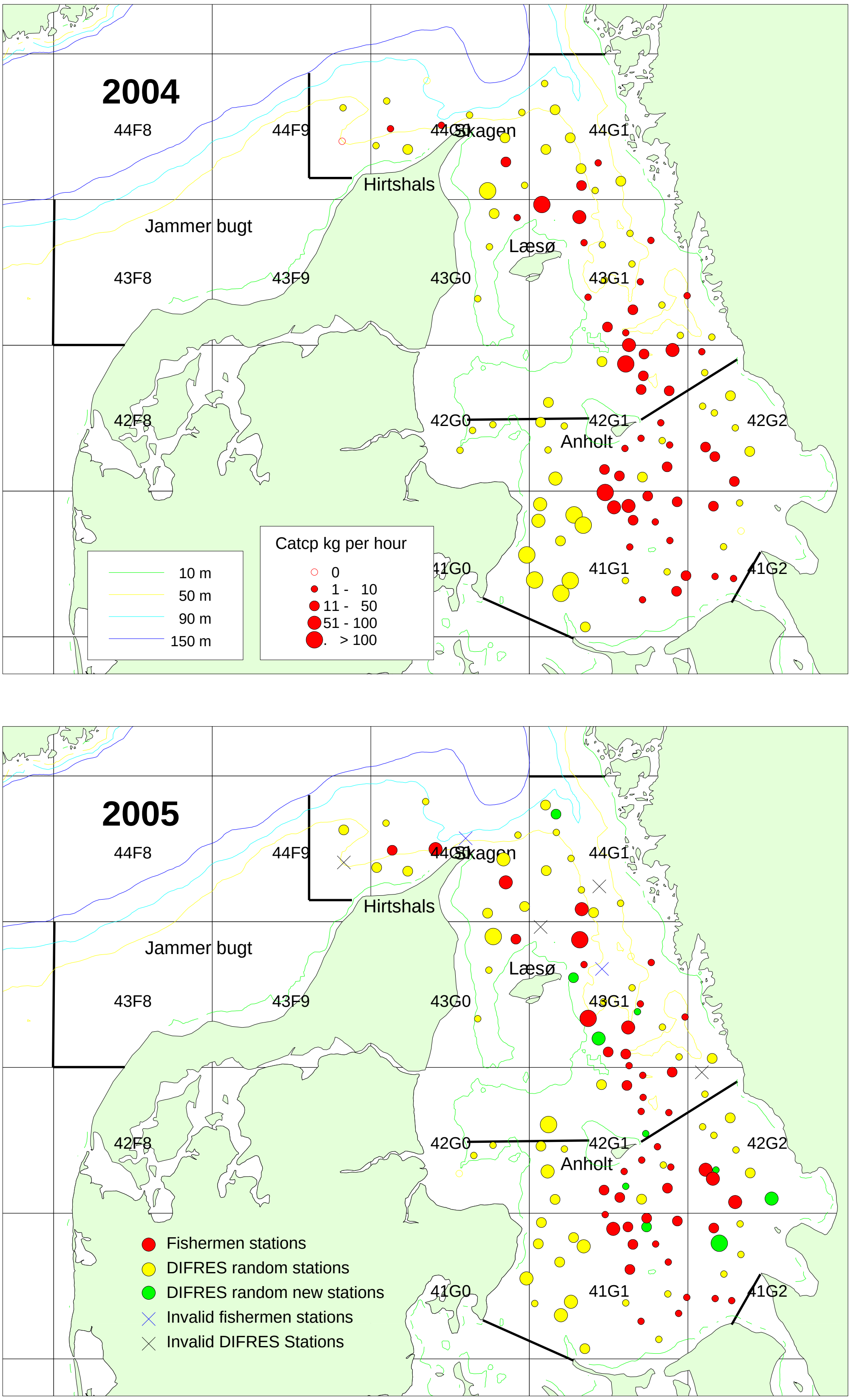


Fig. 12. Catch of plaice (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.

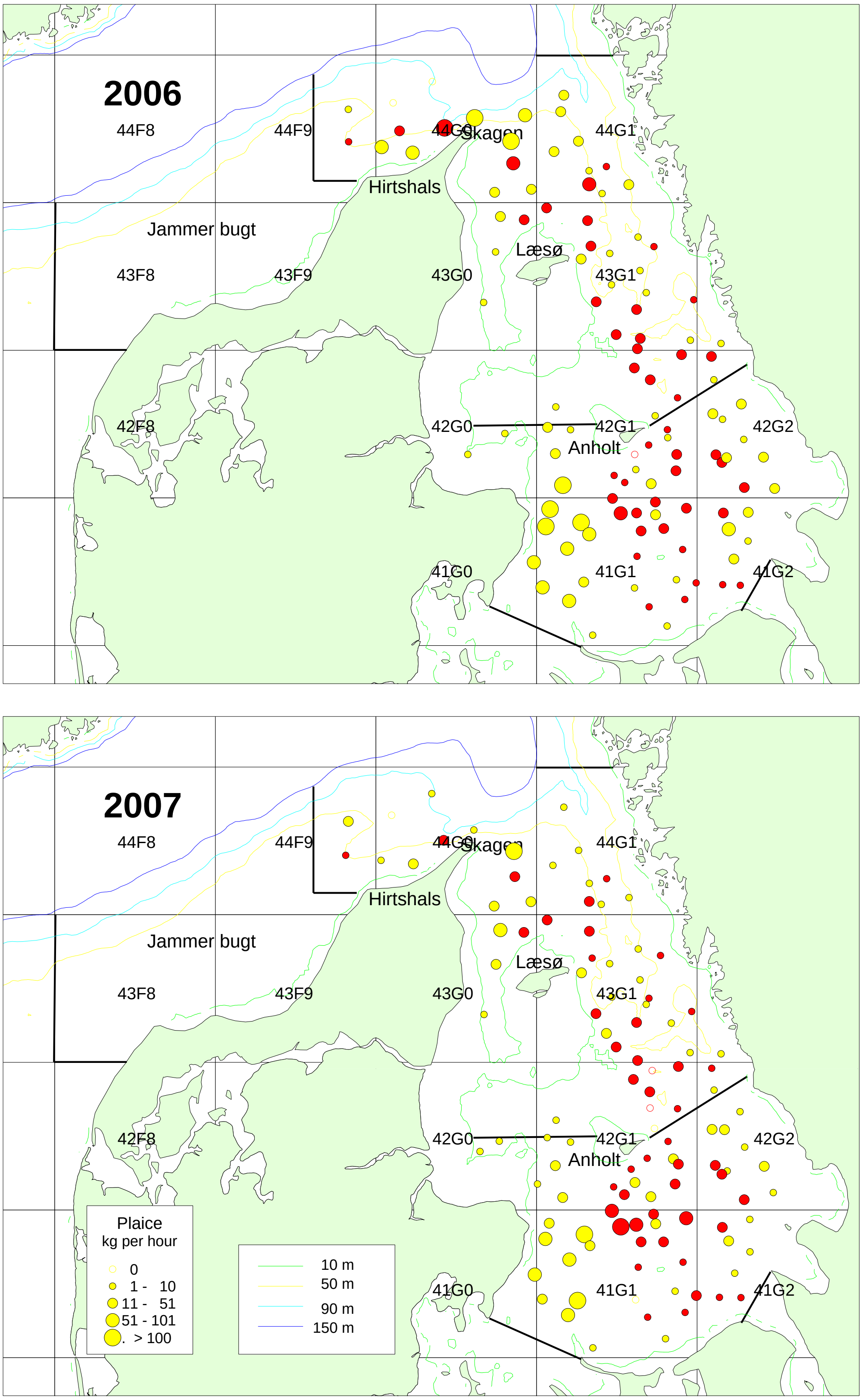
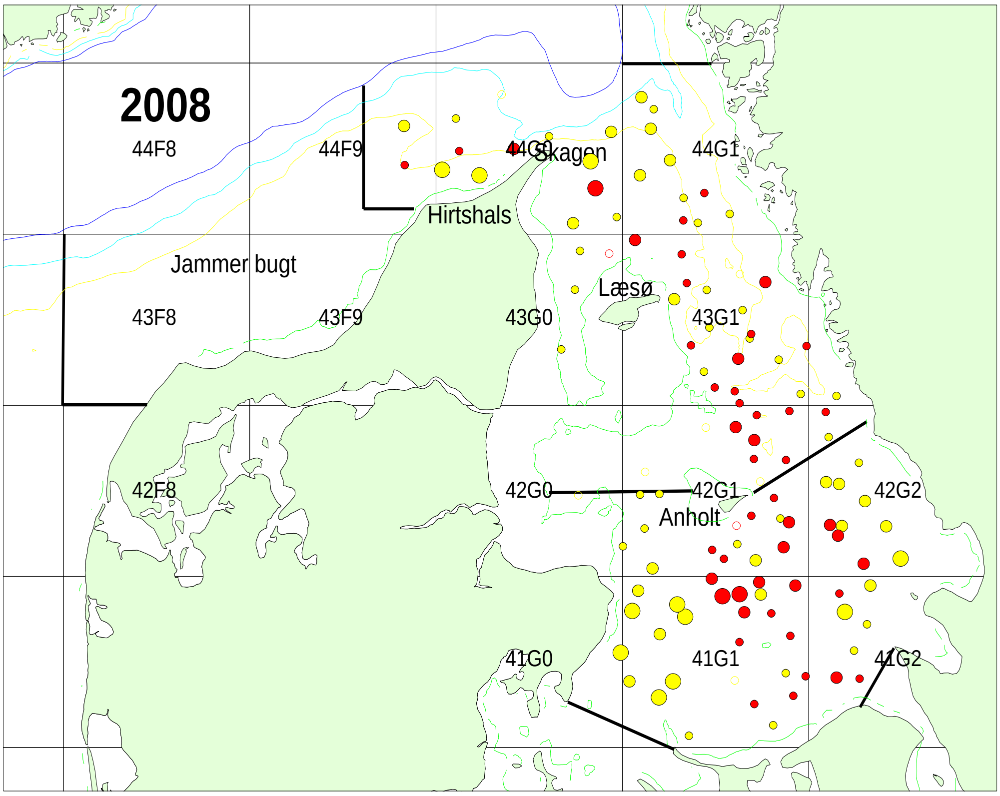


Fig. 12 cont.. Catch of plaice (kg per hour) in 2006 - 2007. ● DTU AQUA stations ● Fishermen's stations.



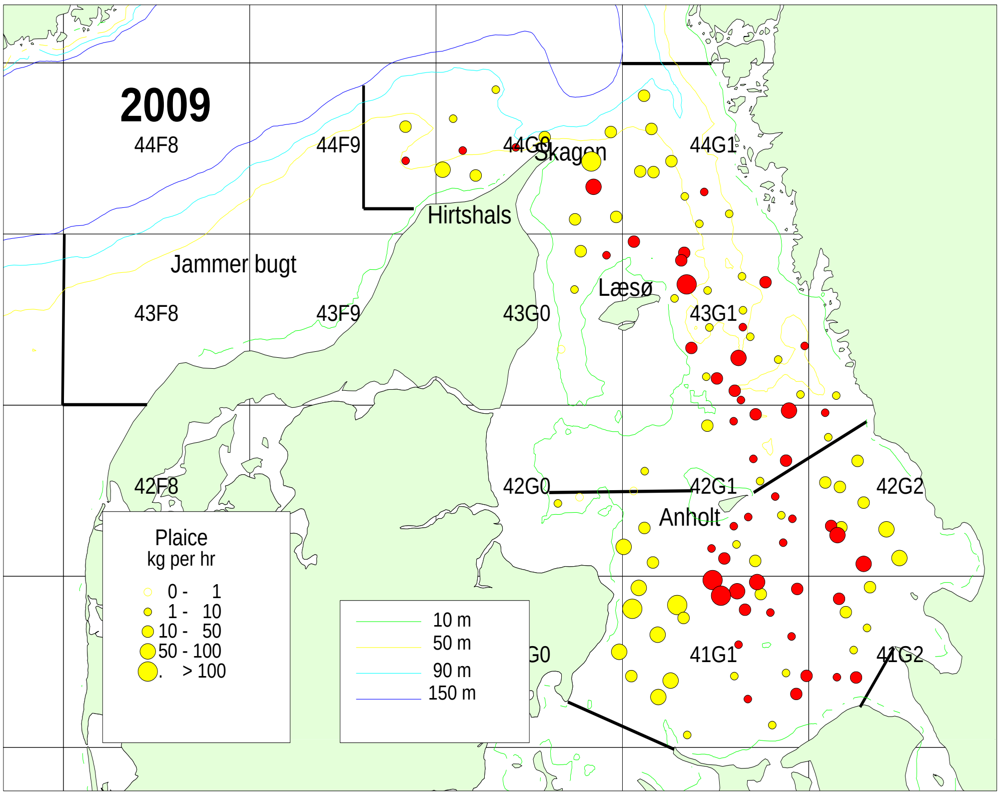
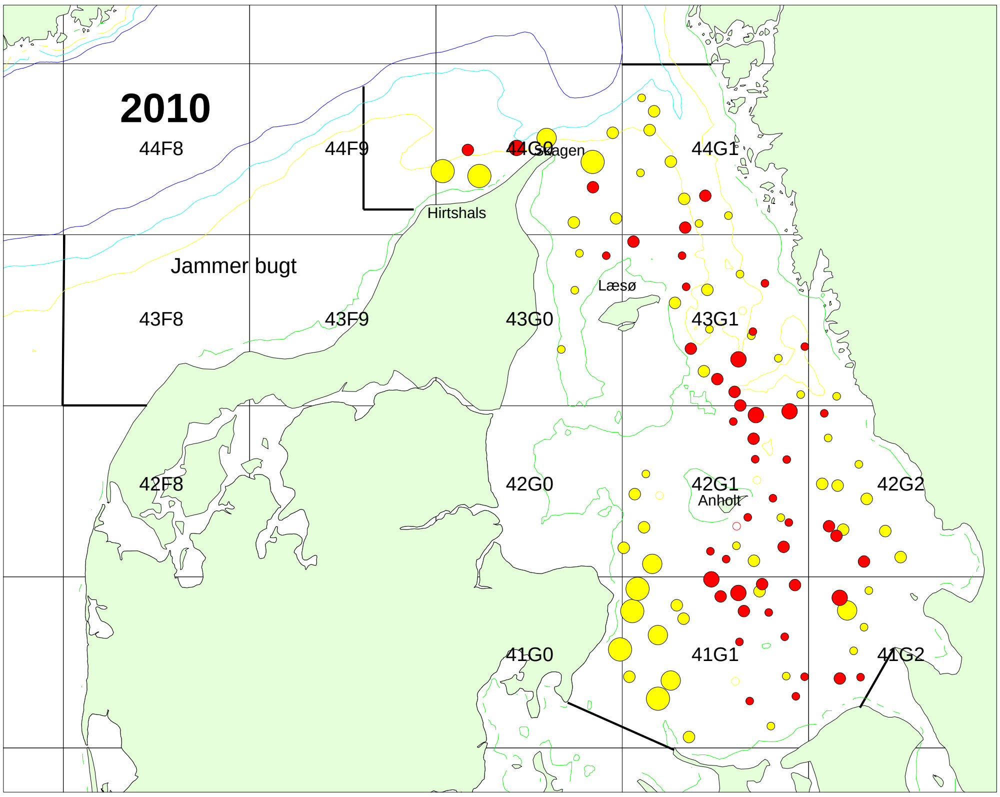


Fig. 12 cont.. Catch of plaice (kg per hour) in 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.



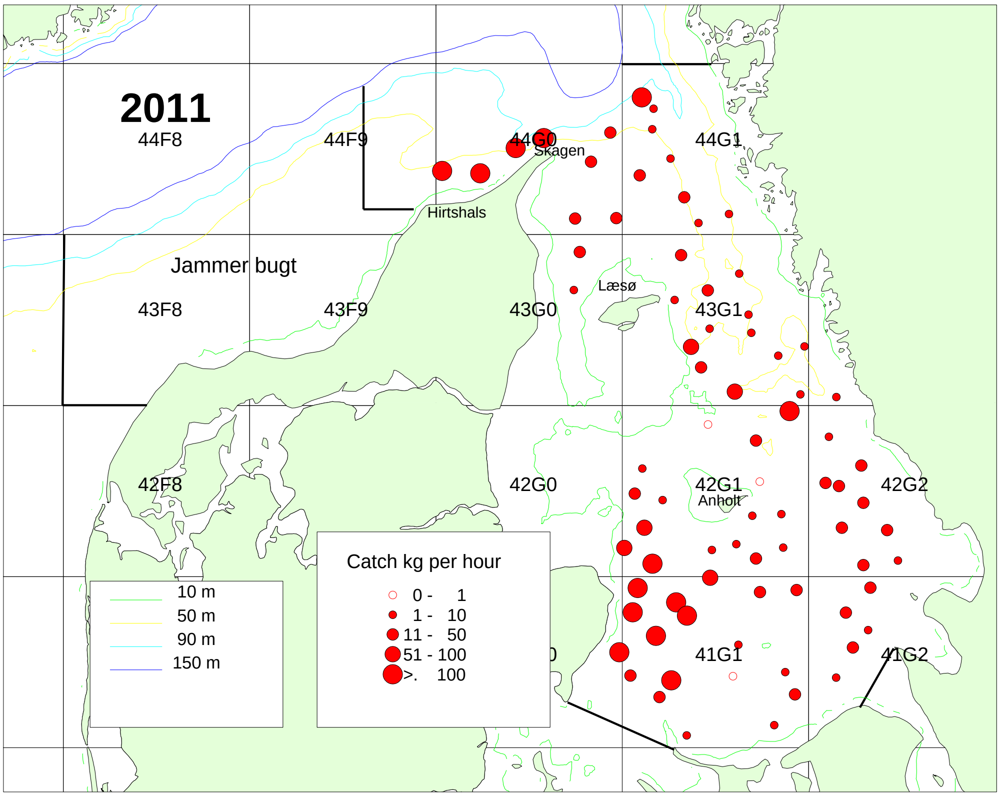


Fig. 12 cont.. Catch of plaice (kg per hour) in 2010 and 2011. 2010 ● DTU AQUA stations ● Fishermen's stations.

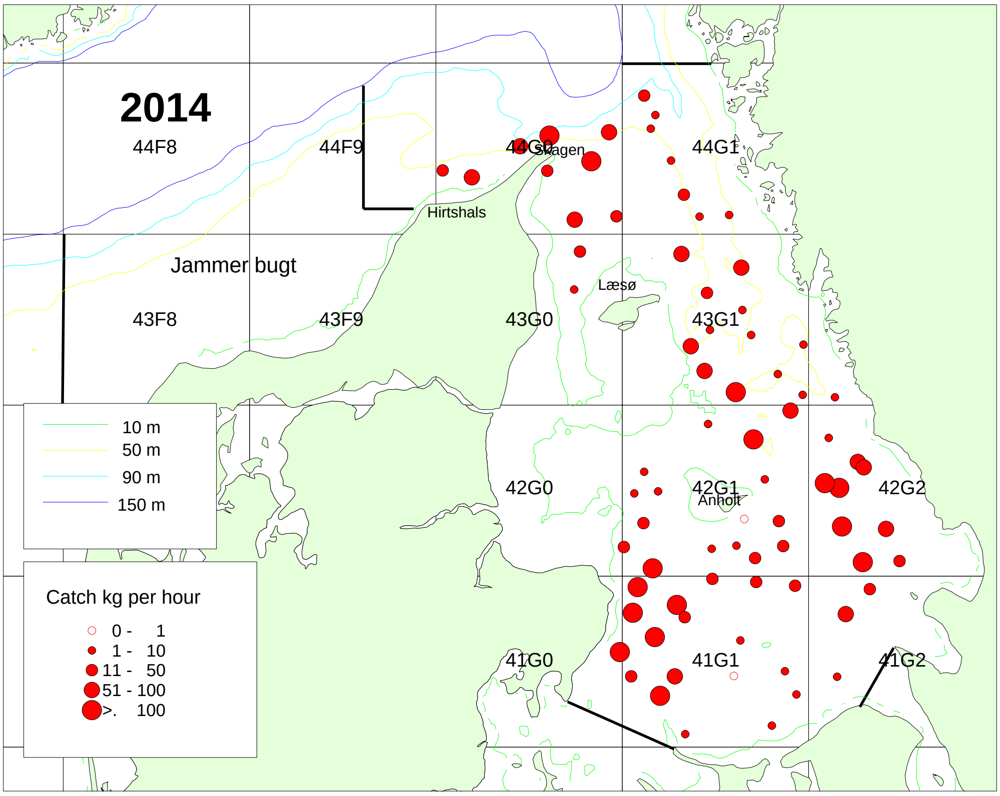


Fig. 12 cont.. Catch of plaice (kg per hour) in 2014.

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 still the highest in the time series. In 2014 the CPUE in numbers decreased compared to 2011 while the CPUE in weight increased. The reduction in stations has increased the CPUE both in numbers and kg slightly, but the over-all trends have not changed (Fig. 13 and 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

*Excluding one large haul.

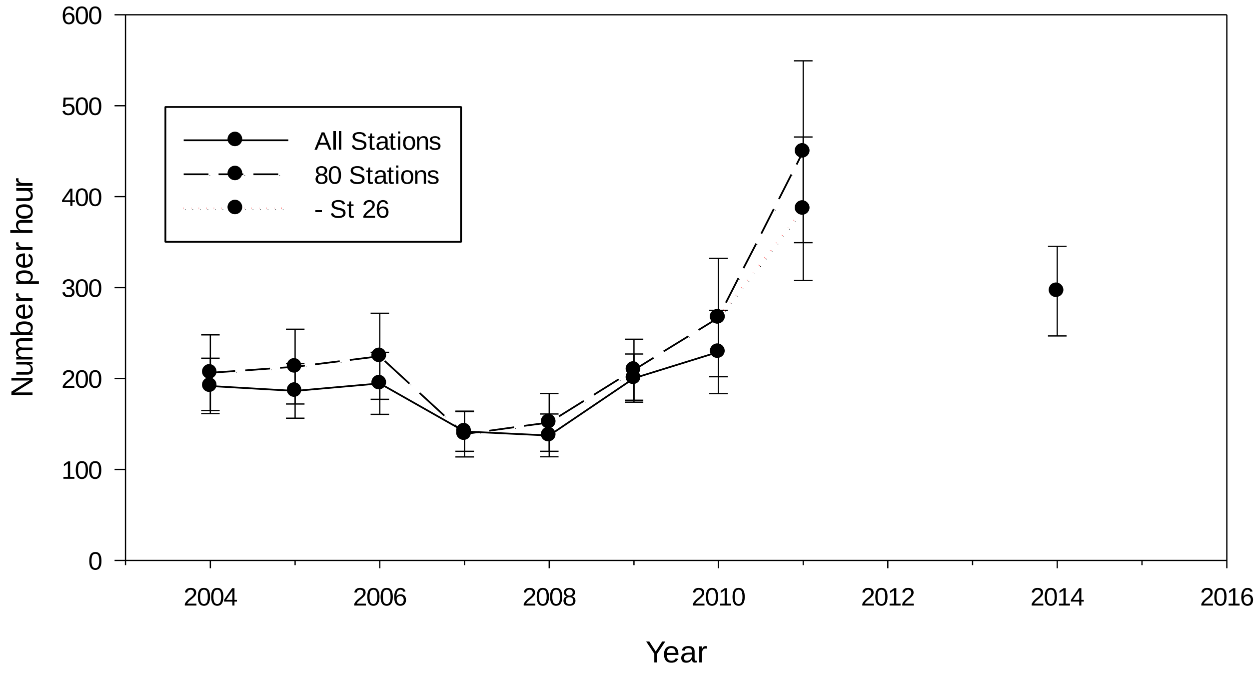


Fig. 13. Catch of plaice in number per hour based on 116 and 80 stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

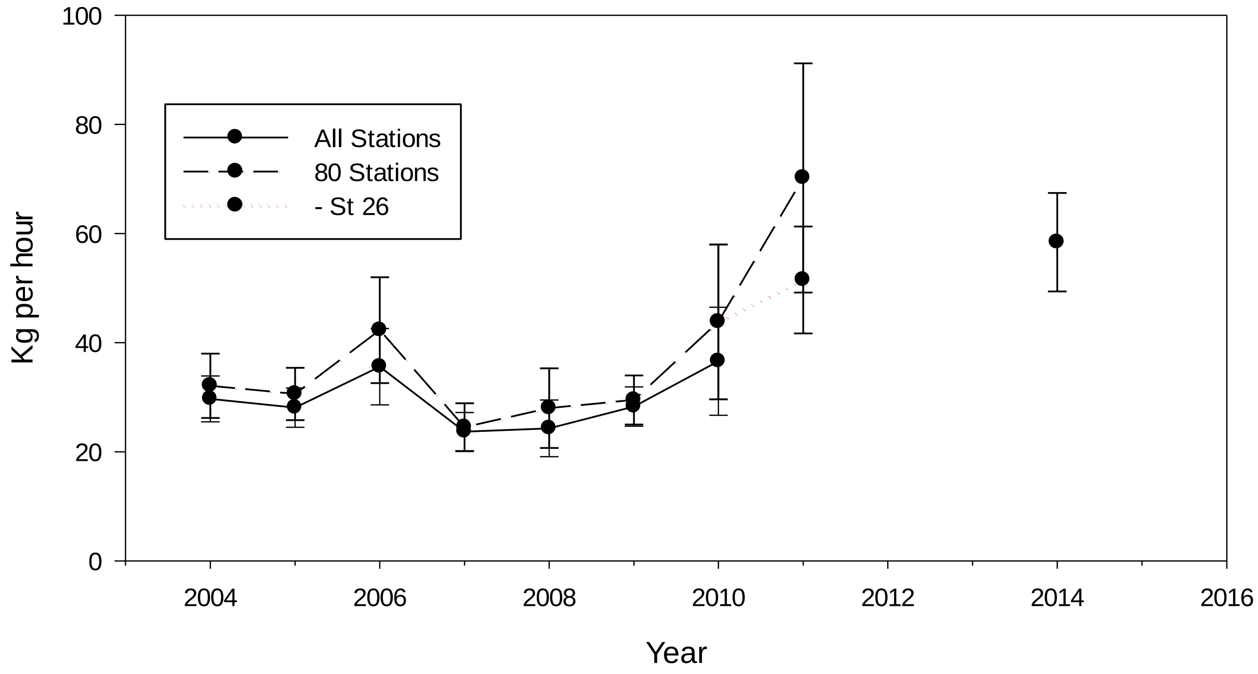


Fig. 14 Catch of plaice in kg per hour based on 116 and 80 stations, respectively, with 1* S.E. – St 26 excludes one large catch in 2011.

Length distribution
The length ranged from 12 to 51 cm. Most of the plaice were between 20 and 30 cm and there were generally few fish > 30 cm as in previous years (Fig. 15).

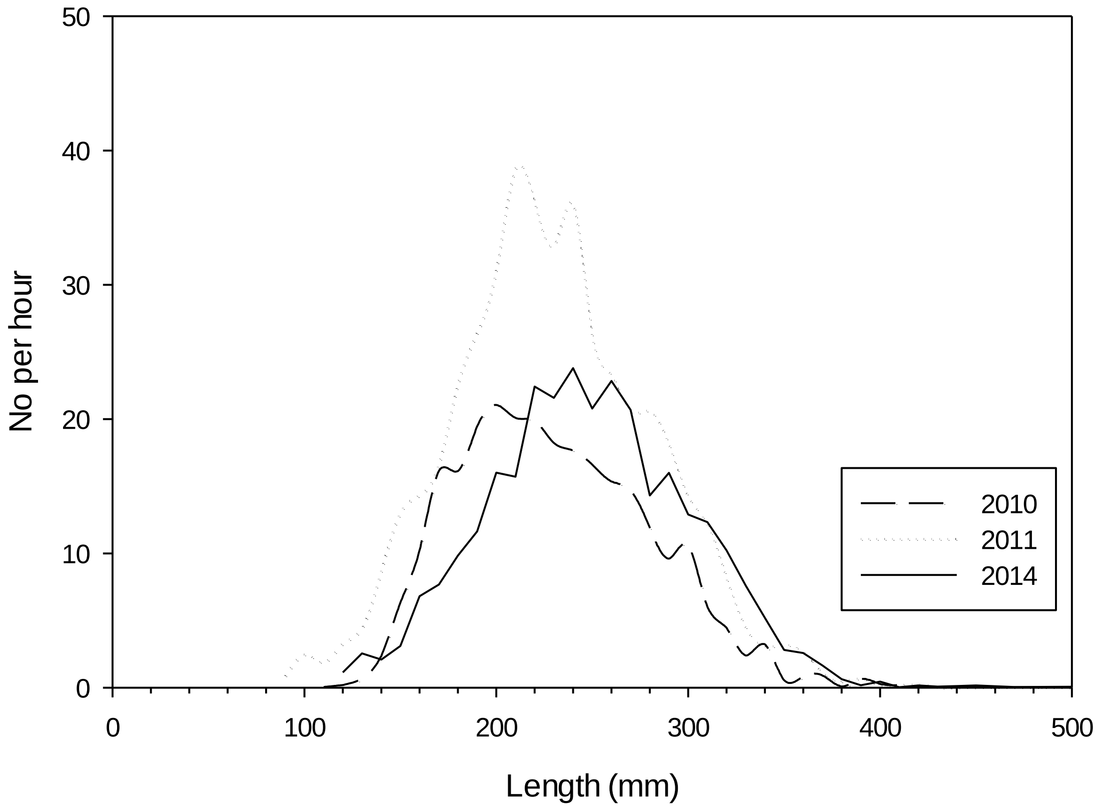


Fig. 15. Length distribution (mm) of plaice standardized to number caught per hour.

Biomass and abundance
The biomass of plaice was in 2011 estimated at 5813.8 tons which was an increase from 3766.7 tons in 2010 and the highest level observed (Table 12). The biomass decreased to 4689.7 tons in 2014 which was the second largest estimate in the time series. The largest biomass and highest density was found in 41G but the biomass was more even distributed than in the previous years (Table 13).

Table 12. Swept area biomass and abundance of plaice with 1* S.E. and number of hauls.

Year	BIOMASS	SE BM	ABUNDAN	SE AB	Haul
2004	2532.66	408.67	16162955.19	2826347.08	68
2005	2751.50	477.31	19585025.60	3976342.12	77
2006	3533.28	702.46	18873722.76	3621595.33	78
2007	2008.01	329.92	11296519.16	1819460.11	75
2008	2356.28	571.55	13296773.27	2744645.78	80
2009	2494.13	359.28	17794393.51	2653356.07	78
2010	3766.68	1172.47	22864506.72	5303737.87	79
2011	5813.78	1696.35	37275267.20	7769397.60	80
2014	4689.74	719.64	23654483.78	3832580.08	77

The abundance was estimated at 23.7 mill. which is a decrease from 32.3 mill. in 2011 but still the second highest level observed. The highest densities were found in 41G0 and 44G1 while the highest abundance was found in 44G1 (Table 14).

The biomass and abundance estimates estimated by the 80 stations are slightly lower compared to previous years estimates but the trends are the same and the difference is far from being statistically significant.

Table 13. Plaice 2014. 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
41G0	329	1	0.5502	181.0	
41G1	3357.6	17	0.3786	1271.3	456.7
41G2	1421.2	3	0.1974	280.5	174.3
42G1	3039.6	16	0.1899	577.1	252.5
42G2	2003.8	9	0.4125	826.6	233.3
43G0	721.5	2	0.0445	32.1	19.8
43G1	2460.9	12	0.2507	616.8	261.8
43G2	331.3	1	0.0499	16.5	
44G0	1881.5	9	0.4053	762.6	239.2
44G1	1914.9	7	0.0653	125.1	39.7
All			0.2686	4689.7	719.6

Table 14. Plaice 2014. 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
41G0	329	1	2396.2	788350.4	
41G1	3357.6	17	2342.3	7864571.3	2998661.4
41G2	1421.2	3	946.3	1344818.4	794876.6
42G1	3039.6	16	1012.4	3077250.9	1287671.3
42G2	2003.8	9	1307.0	2618891.0	615882.3
43G0	721.5	2	375.2	270675.9	140816.3
43G1	2460.9	12	1430.6	3520495.8	1246278.0
43G2	331.3	1	307.2	101767.2	
44G0	1881.5	9	1827.4	3438165.2	883960.6
44G1	1914.9	7	328.7	629497.6	202941.7
All			219.5	23654483.8	3832580.1

Norway lobster (Nephrops)

In 2011 Norway lobster was caught at 59 of the 77 valid stations. The catches ranged between 0.05 and 70.9 kg. Fishing takes place at night where the catchability of Norway lobster is expected to be low. The largest catches were taken east and south of Anholt, while the catches in the remaining part of the area were low (Fig. 18).

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

CPUE

CPUE in kg of Norway lobster peaked in 2011 where the CPUE was estimated as 33.2.1 kg hr^{-1} and in numbers as 1037.0 specimens hour^{-1}, respectively (Table 15). The CPUE was in 2014 reduced to 121.3 specimen and 6.0 kg hr^{-1}, respectively, which is back at the level seen in 2004-2007. The reduction in stations has decreased the CPUE both in numbers and kg slightly, but the over-all trends have not changed (Fig. 16 and 17)

Length distribution

The length of Norway lobster at all stations combined ranged from 20 to 70 mm (carapac length), without any clear 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 (Table 17). The biomass decreased to 501.6 tons in 2014, which is above the level seen in 2004-2007 but below the level in 2008-2011. The decrease in biomass was seen in all Divisions but was most pronounced in Divs. 43G and 44 G.

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	278.09	48.64	5366356.77	1065200.63	68
2005	438.76	84.90	12791042.74	3092800.00	77
2006	404.72	98.64	11013886.29	2913561.20	78
2007	279.43	54.49	7267886.63	1854763.60	75
2008	627.22	148.55	16889547.24	4367587.18	80
2009	636.02	122.82	13380444.51	2810844.74	78
2010	1407.82	242.50	34238366.52	6813403.99	79
2011	2761.36	613.32	87259234.37	22841241.50	80
2014	501.59	114.23	9570857.61	2242593.53	77

The abundance was estimated at 87.3 mill. in 2011 which is an almost trebling 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 decreased to about 1/10 of the estimate in 2011 (9.571 mill) and the estimate is the third lowest in the time series. The reduction in abundance was seen in all Divisions but was most pronounced in the northern area (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 2014, but it is probably caused by a change in catchability and poor recruitment.

The biomass and abundance estimates have changed slightly from year to year without trends by the change in the way the biomass has been estimated but the over-all trend in the estimates have not changed.

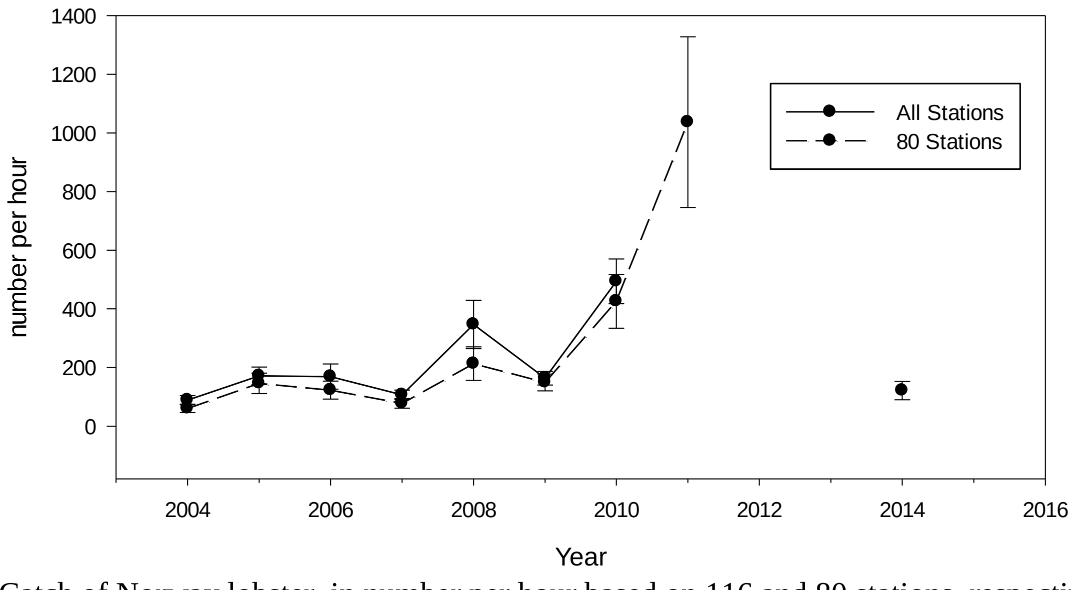


Fig. 16 Catch of Norway lobster in number per hour based on 116 and 80 stations, respectively, with 1* S.E.

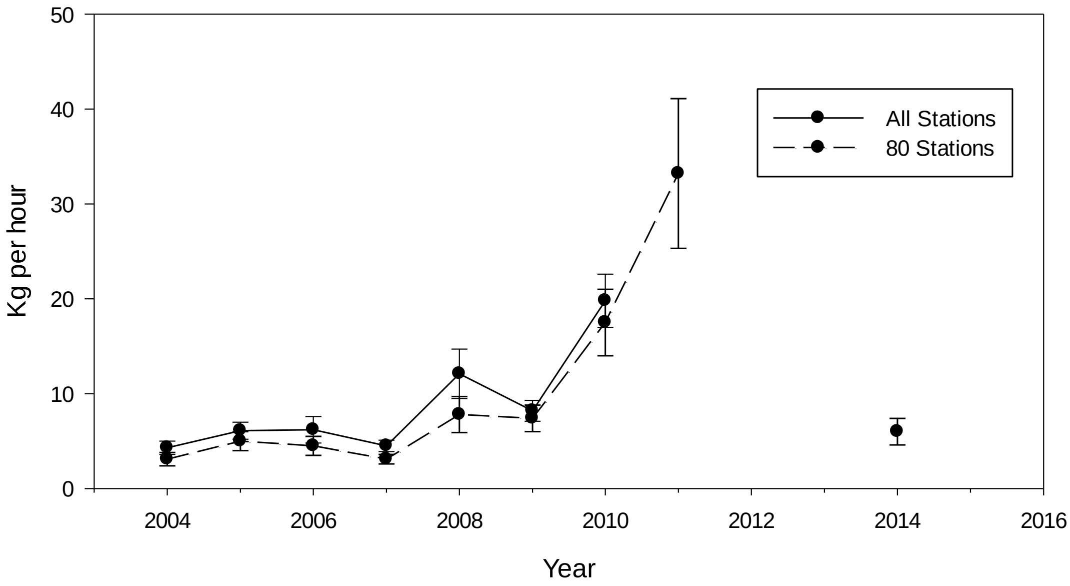


Fig. 17. Catch of Norway lobster kg per hour based on 116 and 80 stations, respectively, with 1* S.E.

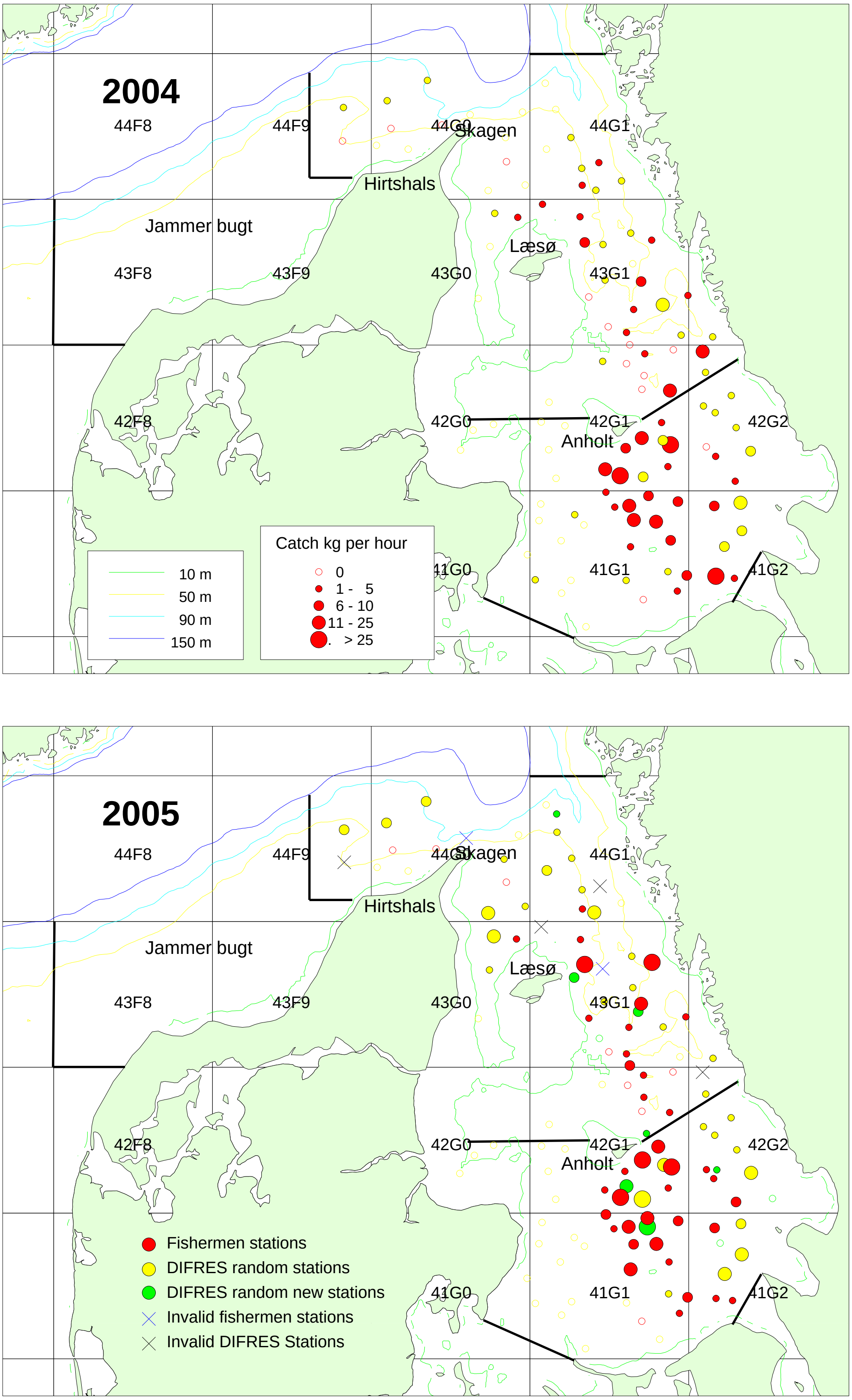


Fig. 18. Catch of Norway lobster (kg per hour) in 2004 and 2005. ● DTU AQUA stations ● Fishermen's stations.

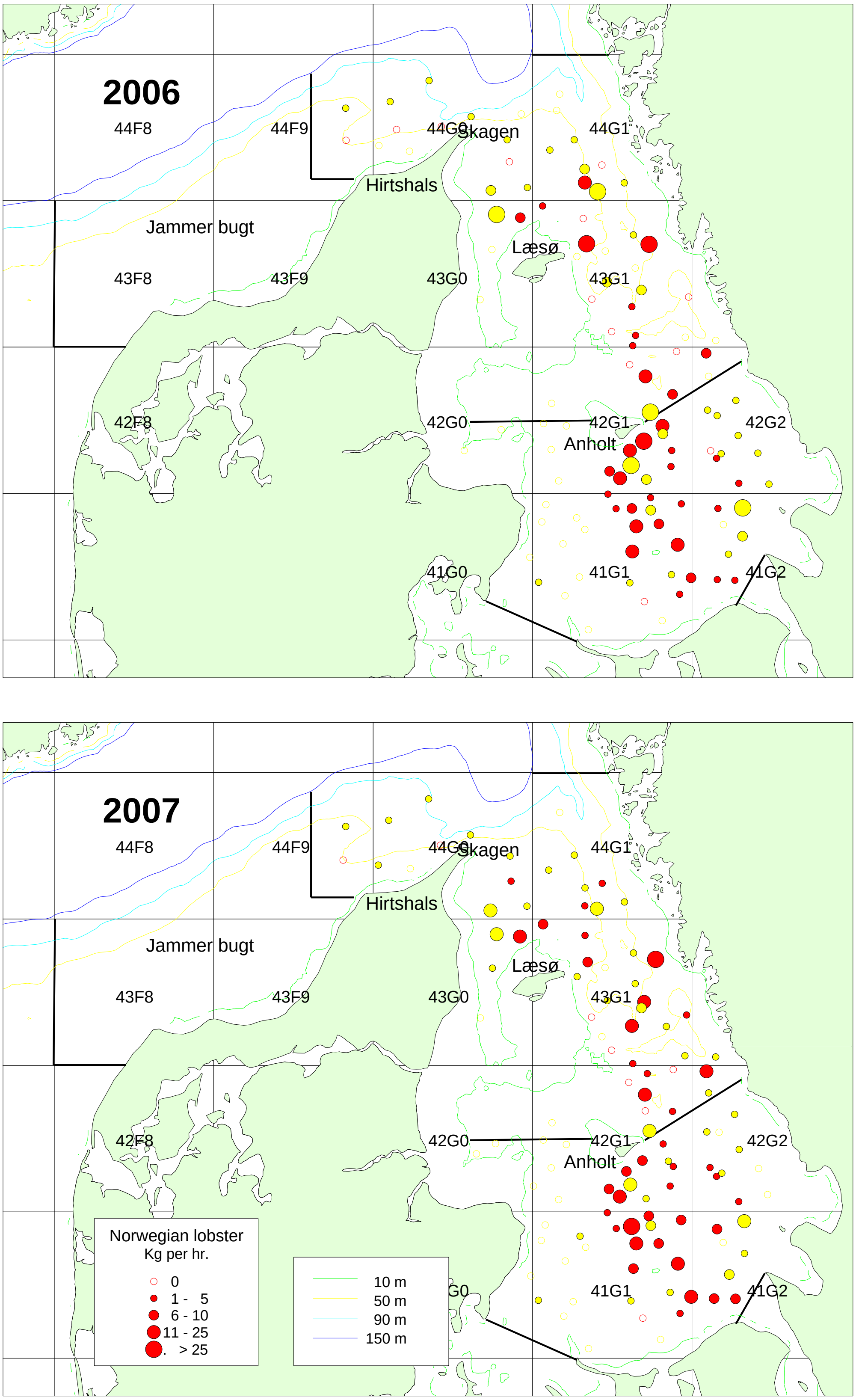
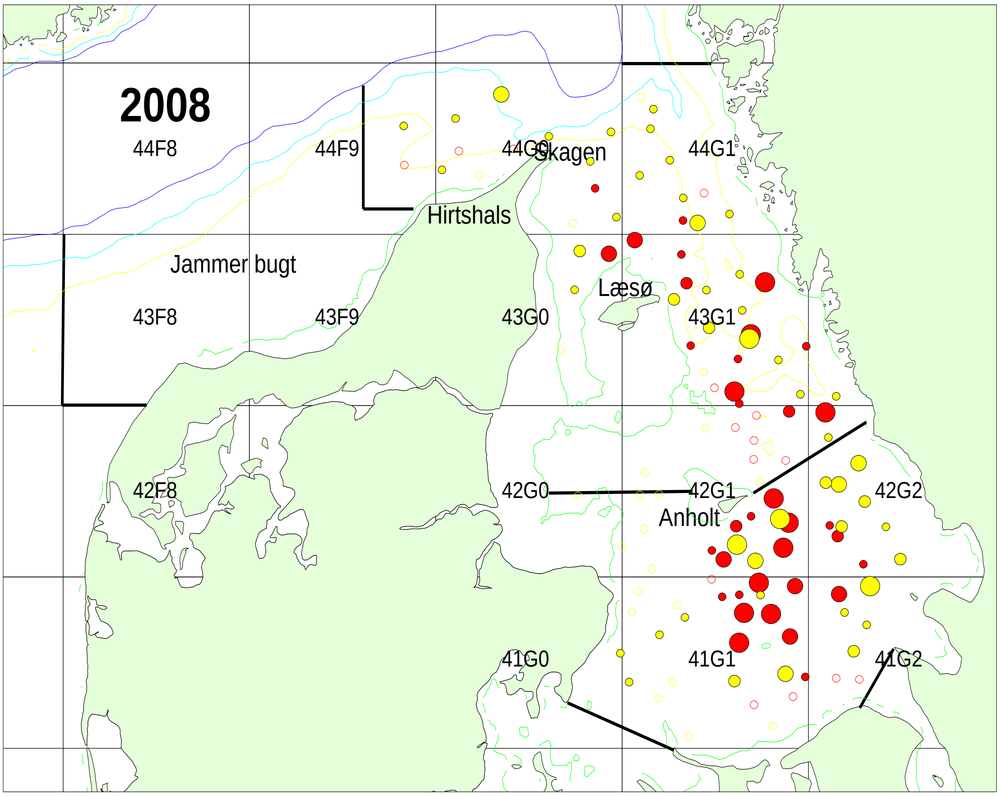


Fig. 18 cont. Catch of Norway lobster (kg per hour) in 2006 2007. ● DTU AQUA stations ● Fishermen's stations.



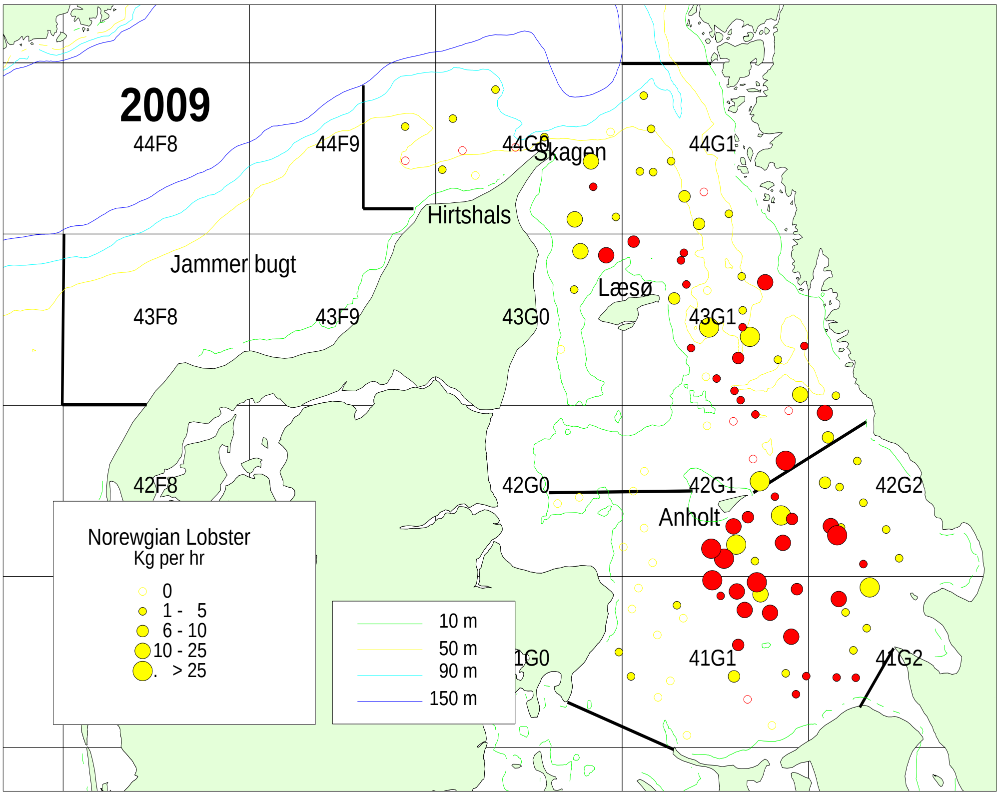


Fig. 18 cont. Catch of Norway lobster (kg per hour) in 2008 and 2009. ● DTU AQUA stations ● Fishermen's stations.

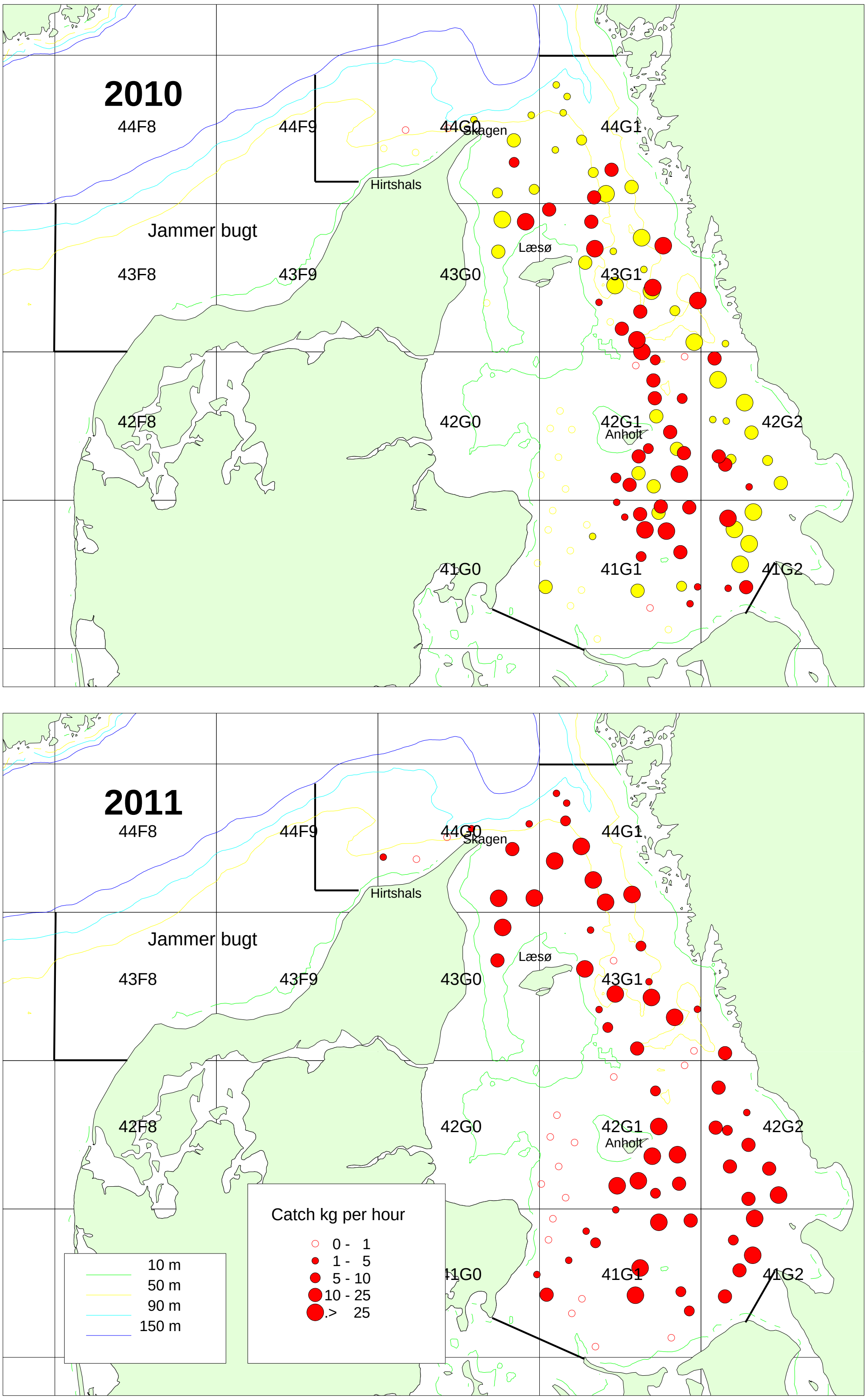


Fig. 18 cont. Catch of Norway lobster (kg per hour) in 2010 and 2011. 2010● DTU AQUA stations ● Fishermen's stations.

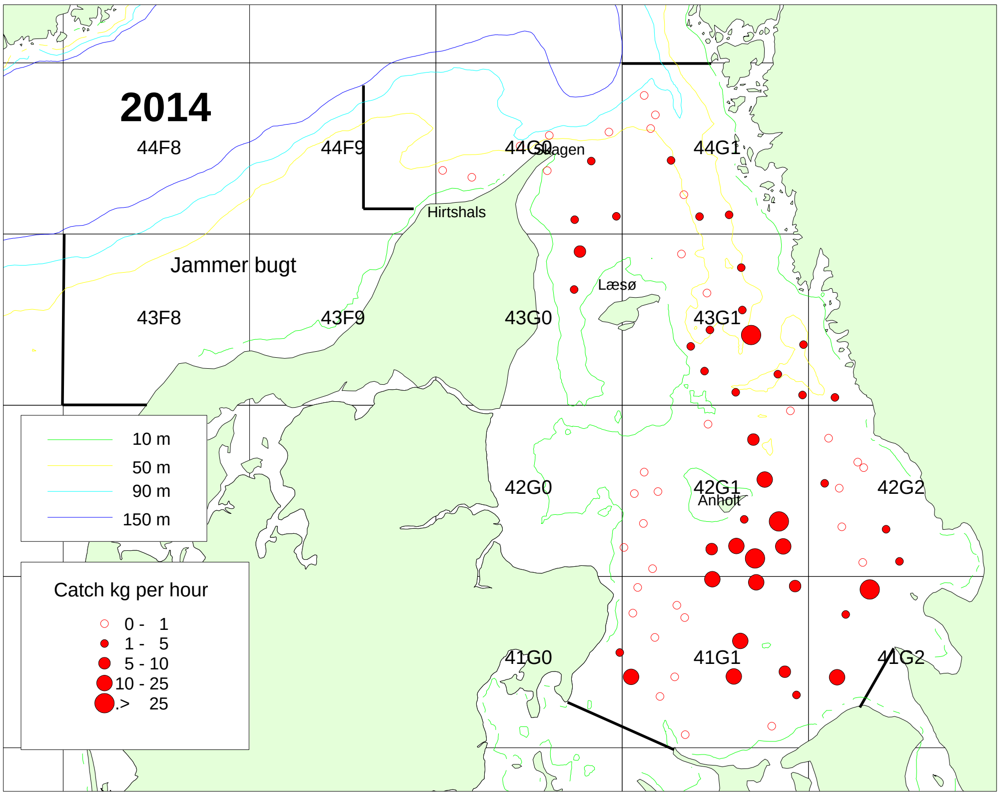


Fig. 18 cont. Catch of Norway lobster (kg per hour) in 2014.

Table 17. Norway lobster 2014. 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
41G0	329	1	0.0049	1.6	
41G1	3357.6	17	0.0291	97.6	29.3
41G2	1421.2	3	0.0771	109.5	67.3
42G1	3039.6	16	0.0474	144.2	53.8
42G2	2003.8	9	0.0042	8.4	1.6
43G0	721.5	2	0.0333	24.0	8.9
43G1	2460.9	12	0.0374	91.9	68.0
43G2	331.3	1	0.0048	1.6	
44G0	1881.5	9	0.0078	14.7	6.9
44G1	1914.9	7	0.0042	8.0	3.1
All			0.0287	501.6	114.2

Table 18. Norway lobster 2014. 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
41G0	329	1	57.4	18898.5	
41G1	3357.6	17	479.6	1610379.0	501326.9
41G2	1421.2	3	1129.9	1605819.1	881625.5
42G1	3039.6	16	1280.1	3891142.1	1653543.7
42G2	2003.8	9	57.9	115969.7	13339.2
43G0	721.5	2	426.4	307623.0	120048.0
43G1	2460.9	12	614.6	1512419.3	1106833.8
43G2	331.3	1	81.6	27031.9	
44G0	1881.5	9	159.9	300932.3	145963.3
44G1	1914.9	7	94.3	180642.7	66054.6
All			548.1	9570857.6	2242593.5

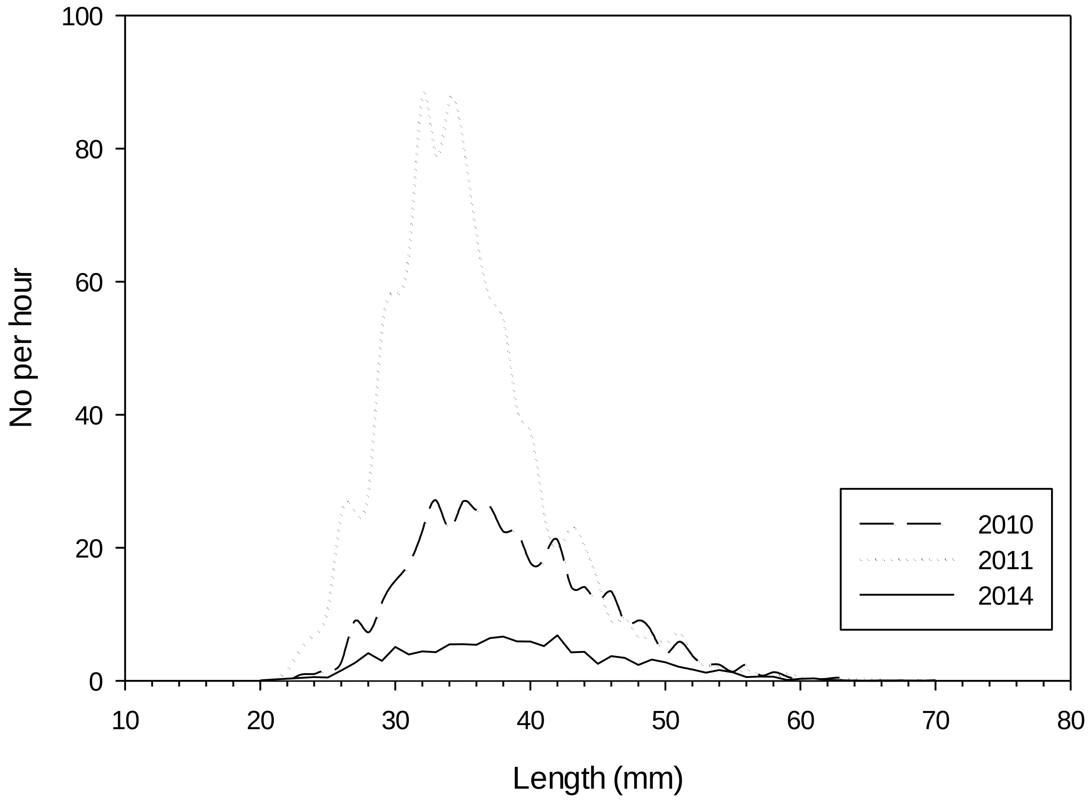


Fig.19. Length distribution (carapac length, mm) of Norway lobster standardized to number caught per hour 2010-2011 and 2014.

Annex 07 – Herring 30 new assessment (conducted during ADG)

During the advice working group (ADG) for the Baltic Sea an extra assessment run was requested by the ADG group were the latest years of the commercial tuning fleet were deleted due to the very low effort. Looking at the effort data it was decided to use the period were the effort was relative stable in all three trapnet fishing sites. Therefore the last eight years from the commercial trapnet tuning fleet were truncated (Fig. 6.4.3). All other settings were kept as agreed during the working group. However, as a consequence of the truncation of the last eight years in the commercial tuning fleet, the historic development of SSB changed and new F_{MSY} ranges were calculated with EqSim. The new F_{MSY} result (F_{MSY} =0.15) was very similar to the previous value (0.12). A summary of the final assessment run can be seen in figure 6.4.16 and table 6.4.9.

Calculation of new MSY values.

Basis for precautionary considerations

The criteria used in the Fmsy calculations follow the same basis as in FMSYREF3 (Blim =316000/1.4) (ICES, 2015). As the truncations is only done on the last eights years there is no revision to the historic part of the time series so the values used are comparable to those used during FMSYREF3. When fitting S-R, the function gives a relatively well established breakpoint, but this is also the result of changes in recruitment over time. Recruitment has been increasing over time and it is not possible to determine whether the higher recruitment values are the result of increased biomass or environmental change. If the latter is the case, setting a Blim would be more complex.

Methods

The approach follows FMSYREF3 (ICES, 2015) and uses the same version of EqSim modified only by improved fit to the SegReg funtion

The Stock recruitment relationship was tested with 2 different option 1. A combinations of Ricker, SegREg and Beverton Holt, 2. The second option was with just SegReg fitted (point of inflection) both combinations were done in EqSim. The choice of the S-R function (between two options above) made very little difference to the results and SegReg was chosen as there seemed little basis for Ricker (figure 6.4.17) while Beverton Holt fitted poorly (table 6.4.10).

Conclusions

With the ICES Advice Rule (AR) in place (ICES, 2015) the F_{MSY} estimated to be 0.15 gives the highest yield.

Fupper without AR is estimated as to 0.15 and with the AR to be 0.18. Flower with and without AR was set to 0.11

References

ICES 2015. EU request to ICES to provide FMSY ranges for selected North Sea and Baltic Sea stocks. ICES Special Request Advice.

Table 6.4.9 Herring in SD 30. SAM output summary table conducted during the ADG

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F37	Low	High
1973	2581807	1459756	4566328	253470	164809	389828	183322	115830	290140	0.121	0.074	0.199
1974	2799636	1616154	4849761	251199	162813	387565	172646	108192	275499	0.113	0.069	0.186
1975	2819302	1639661	4847628	260667	169028	401989	173512	108708	276947	0.084	0.051	0.137
1976	4089773	2368530	7061867	290106	189087	445094	194269	122166	308927	0.102	0.063	0.164
1977	1692979	985003	2909815	296262	192609	455695	201793	126637	321554	0.128	0.08	0.206
1978	1040280	604272	1790884	264078	168596	413635	211504	131752	339531	0.125	0.078	0.202
1979	1081652	627840	1863487	236097	149071	373929	193881	119518	314513	0.104	0.064	0.167
1980	1996687	1170498	3406037	215993	134826	346023	178975	108865	294237	0.117	0.073	0.188
1981	2260282	1328871	3844523	218163	137138	347062	168721	102205	278524	0.091	0.057	0.145
1982	3790468	2238329	6418917	216425	137577	340462	170246	104833	276476	0.115	0.073	0.182
1983	4799393	2833264	8129907	279288	180824	431369	200186	124609	321599	0.092	0.059	0.145
1984	7610200	4509604	12842621	381170	252296	575872	251450	159169	397234	0.107	0.068	0.167
1985	7519423	4460538	12675987	435391	292377	648359	284361	184042	439362	0.092	0.059	0.144
1986	2049282	1205349	3484099	457257	310693	672959	330380	220330	495400	0.074	0.048	0.114
1987	4601993	2763476	7663658	508897	348231	743690	404335	271995	601066	0.064	0.042	0.097
1988	2665761	1592634	4461966	549630	380362	794223	403124	271903	597674	0.063	0.042	0.094
1989	9752166	5872553	16194788	674010	474501	957403	501822	346230	727333	0.057	0.039	0.084
1990	9463946	5712801	15678172	760704	543476	1064760	584785	414165	825694	0.05	0.035	0.071
1991	6452641	3937199	10575177	777625	559937	1079944	615999	440365	861681	0.045	0.032	0.065
1992	7610200	4682019	12369694	889131	644493	1226629	678744	486718	946532	0.057	0.04	0.082
1993	8088873	4983983	13128027	865446	631062	1186882	615999	443184	856201	0.058	0.04	0.082
1994	4901246	3034266	7916977	840708	614436	1150308	691764	500539	956045	0.085	0.06	0.121
1995	5722979	3550788	9224006	691764	506581	944641	548532	395988	759838	0.115	0.081	0.163
1996	5368183	3340864	8625729	637303	467119	869488	520216	376487	718816	0.118	0.083	0.167
1997	4765915	2958698	7677005	568638	416733	775916	425917	305969	592888	0.156	0.11	0.222
1998	8850637	5472029	14315308	549630	400344	754583	391601	278764	550114	0.138	0.097	0.196
1999	4833107	2985566	7823949	557936	409094	760933	419996	302441	583243	0.141	0.099	0.2
2000	7195742	4455278	11621879	547436	399960	749289	435391	313684	604321	0.124	0.087	0.177
2001	6293324	3896698	10163973	585370	426505	803410	458630	329299	638757	0.113	0.079	0.161
2002	8589061	5329990	13840920	605010	441256	829535	460469	330850	640869	0.089	0.062	0.128
2003	13964096	8438541	23107782	621568	454385	850262	431922	311633	598643	0.099	0.069	0.14
2004	3843908	2373936	6224104	624683	459089	850007	438450	318004	604514	0.106	0.075	0.15
2005	4789804	2980018	7698684	651479	480528	883247	510426	372056	700255	0.101	0.071	0.142
2006	7489406	4718682	11887048	648229	477835	879387	497325	360692	685717	0.119	0.085	0.168
2007	10170480	6379498	16214233	638579	466736	873689	477347	343286	663763	0.136	0.095	0.194
2008	8293644	5191639	13249098	646288	468438	891660	469301	334309	658803	0.128	0.089	0.184
2009	10734785	6710607	17172160	782305	563330	1086400	560733	396757	792478	0.114	0.079	0.165
2010	9029432	5651548	14426250	788589	569435	1092086	637303	454867	892909	0.112	0.077	0.162
2011	6844801	4268700	10975543	778403	563758	1074773	598391	426864	838844	0.117	0.081	0.17
2012	11106044	6903092	17867965	762990	554310	1050230	600189	429587	838542	0.163	0.113	0.237
2013	10649250	6406348	17702209	873270	631163	1208246	674684	481393	945586	0.164	0.113	0.238
2014	11006538	4242826	28552641	912552	639793	1301594	695927	488083	992279	0.154	0.104	0.228

Reference	point	estimates	without	AR:					
	F05	F10	F50	medianMSY	meanMSY	Medlower	Meanlower	Medupper	Meanupper
catF	0.15	0.16	0.20	NA	0.14	NA	NA	NA	NA
lanF	NA	NA	NA	0.15	0.14	0.12	0.12	0.17	0.17
catch	61389	61015	43741	NA	61405	NA	NA	NA	NA
landings	NA	NA	NA	61894	61405	58348	60845	58346	60908
catB	396029	364685	222250	NA	415079	NA	NA	NA	NA
lanB	NA	NA	NA	389439	415079	466509	NA	326644	NA

Reference	point	estimates	with	AR:					
	F05	F10	F50	medianMSY	meanMSY	Medlower	Meanlower	Medupper	Meanupper
catF	0.179	0.196	0.273	NA	0.16	NA	NA	NA	NA
lanF	NA	NA	NA	0.155	0.16	0.121	0.12	0.198	0.203
catch	60814	58994	46617	NA	61744	NA	NA	NA	NA
landings	NA	NA	NA	61397	61744	58804	61058	58703	61039
catB	335228	308318	225745	NA	368669	NA	NA	NA	NA
lanB	NA	NA	NA	376855	368669	444683	NA	305451	NA

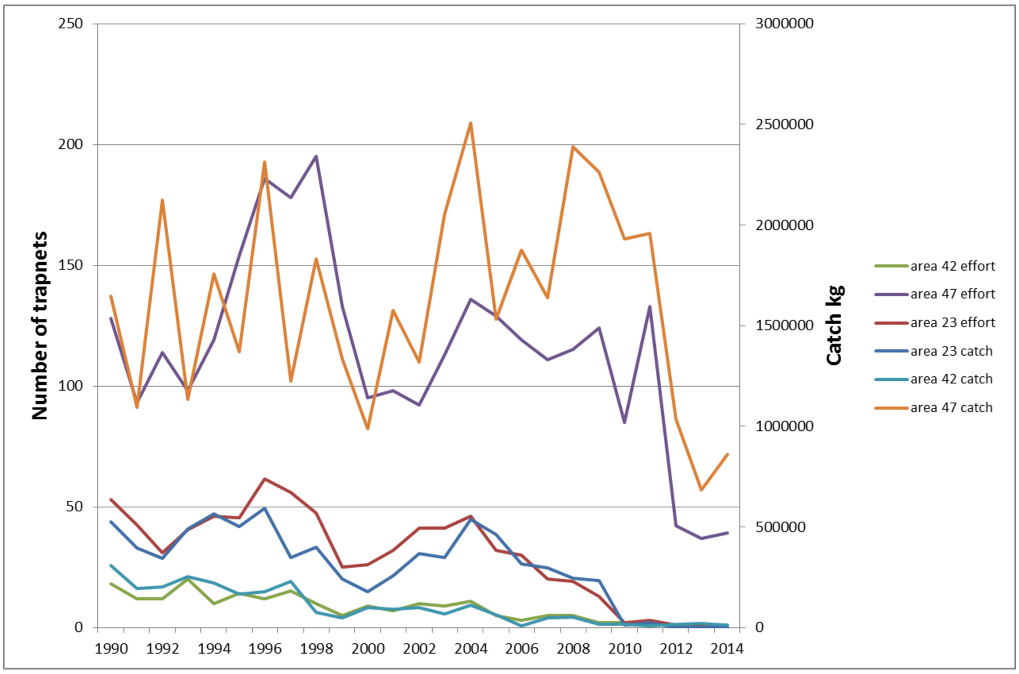


Figure 6.4.3. Herring in SD 30. Trapnets catch (kg) and effort (number of traps) in three different areas (see map Fig 6.4.2) used to calculate the trap net tuning indet for the spaly assessment.

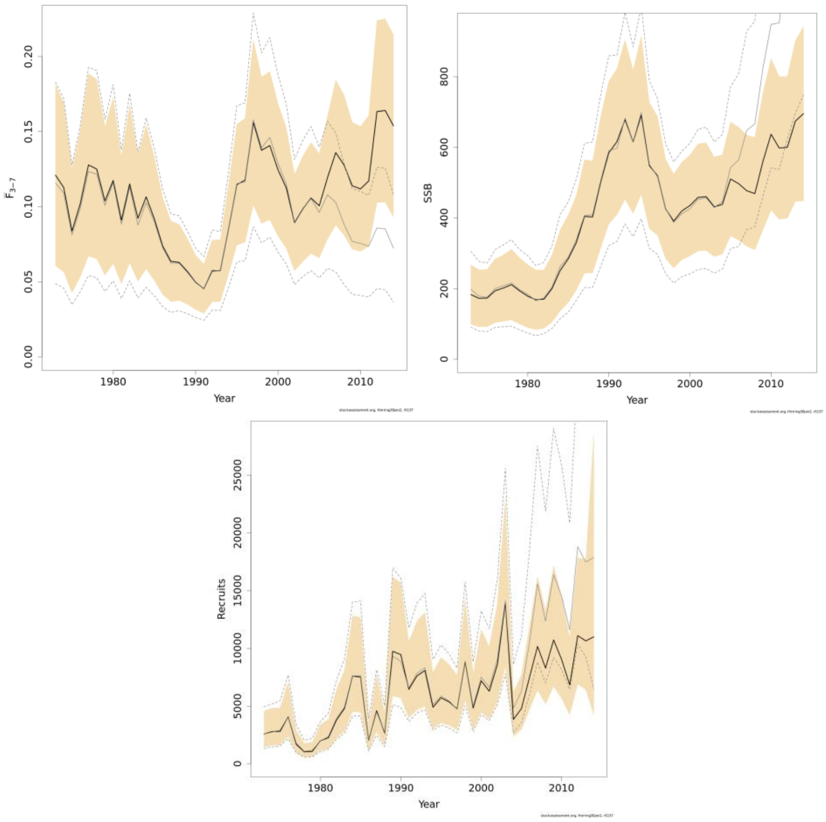


Figure 6.4.16 Herring in SD 30 Assessment Estimates of SSB, F (age 3-7) and Recruitment (age 1). The grey line shows the assessment run at the working (2015) group and the black line at the run conducted at the ADG.

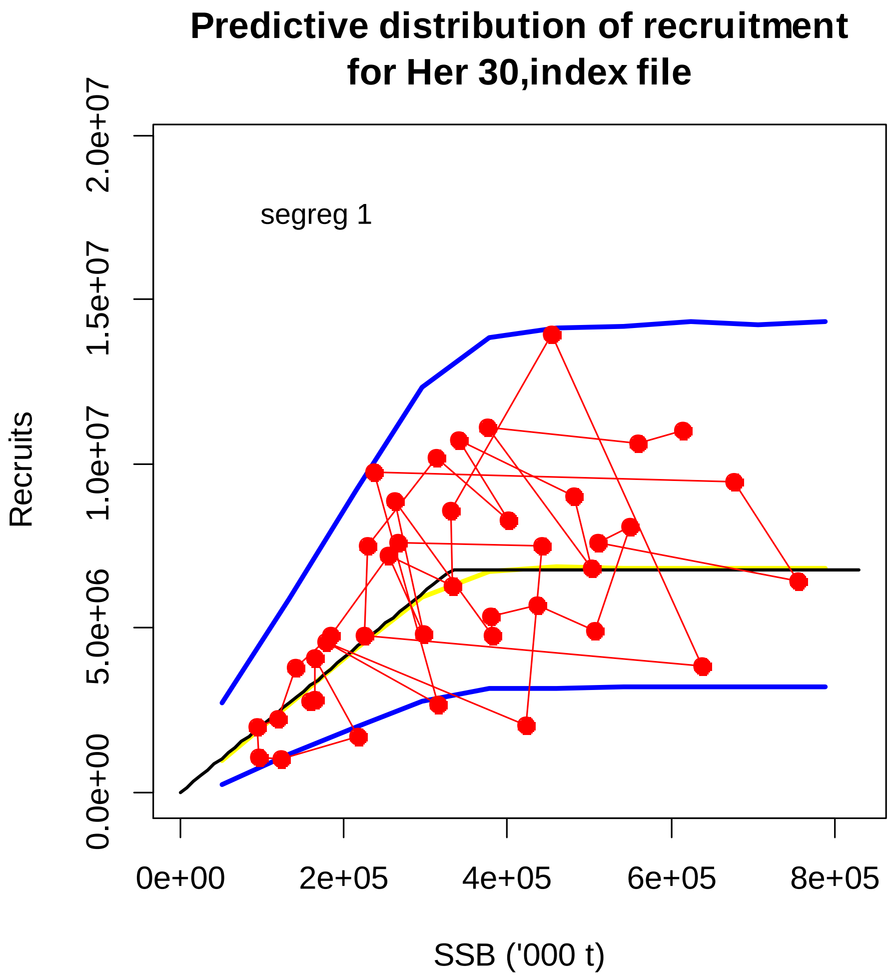


Figure 6.4.17. Herring in SD 30. Stock – recruitment relationship with SegReg function fitted values.

Annex 08 – Review Group Technical Minutes Kattegat cod assessment 2015

Review of ICES Kattegat cod assessment 2015

May 20, 2015

Reviewers: Michael Palmer, Northeast Fisheries Science Center, National Marine Fisheries Service, 166 Water St., Woods Hole, MA 02543

Stock (Cod in the Kattegat section 2))

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: presented (short-term)
4) **Assessment model**: SAM – tuning by comm + 5 surveys
5) **Consistency**: The base $SPALY_{scaling}$ model appears to have been conducted consistent with the accepted stock annex. There are no major diagnostic issues with this update to warrant the rejection of the base model. The major issue with this update is whether or not a new survey, the CodS survey should be included in the model.
6) **Stock status**: Stock status is contingent on the assessment model. Using the $SPALY_{scaling}$ model, terminal SSB< Blim and F>Fmax; however under the $SPALY+CodS_{scaling}$ model terminal SSB>Blim and F<Fmax.
7) **Man. Plan.**:

General comments

Overall the report was somewhat difficult to follow due to missing tables and figures and only having received portions of the report (e.g., appendices were not initially provided). The missing information was provided on request which proved to be extremely helpful. The report did have the appearances of being hastily assembled (misspellings, figure axis missing labels, out of order figure numbering, incomplete tables, etc.) and I suspect both future reviewers and managers would benefit from a more carefully assembled and full report.

It appears that the data and models and forecast have been used as specified in the stock annex. The major change in this assessment update is the introduction of a new survey series, the CodS survey, that was not previously included in the benchmark formulation. The CodS survey was designed to provide fisheries independent data for estimating the abundance, biomass, recruitment index and distribution of cod in the Kattegat region. The sampling protocol employs a random stratified sampling scheme with the stratification designed to target regions of varying cod density.

Four forms of the SPALY model (conducted using the state-space, SAM model) were evaluated in the assessment update: (1) the base SPALY with scaling model, (2) the SPALY model without scaling, (3) the SPALY model with scaling and incorporating the CodS survey, and (4) the SPALY model without scaling and incorporating the CodS survey. The stock assessors selected models 1 and 3 as the best candidate models and so this review has focused on a compare and contrast of these two models to simplify the review. Given the concerns expressed in both the stock annex and this update report about unreported catch, use of model variants which allow for rescaling of the catch seem warranted.

Given the departure from the model formulation specified in the stock annex, and the implications for stock status, it would have been helpful if projections could have been provided for both the $\text{SPALY}_{\text{scaling}}$ and $\text{SPALY+CodS}_{\text{scaling}}$ models rather than only the stock assessors preferred $\text{SPALY+CodS}_{\text{scaling}}$. Evaluating the impacts of model choice on catch advice in a consequence analysis would have been a useful addition to this update and assisted with the choice of the most appropriate assessment model, or at least provided information on possible impacts to catch advice.

Technical comments

The following figure numbers were skipped over in the text (i.e., figure numbering was not sequential): 2.2.5, 2.2.8-10, 2.2.13, 2.2.15-16

The description for Figure 2.2.22 requires additional detail to assist with the interpretation; i.e., which residuals are positive/negative, how are they measured (observed-predicted), what's the scale?

Figure 2.2.4. Age labels were not readable.

Section 2.1.3.1. There are too few observations from the CodS survey to make strong inferences about the internal consistency in terms of cohort tracking – the 2014 value has a high degree of leverage on the relationship.

Section 2.1.3.1. I disagree with the statement that the "indices from all surveys indicate high cod abundance in 2014". See Figure 1 in this review comparing the age-specific survey indices from the various surveys – Only two of the five surveys suggest high abundance in 2014 (BITS 1Q and CodS 4Q).

Section 2.1.3.2. The application of the rescaling factor equally to all ages assumes that un-reported landings affect all age classes equally. The stock annex make reference to the possibility of high-grading – combined with high uncertainty in the discard data would lead to an assumption that the unreported catch would be skewed towards the younger ages.

Section 2.1.3.2. Recruitment trends. I found it curious that no statement was made about the strength of the 2012 year class and the fact that it showed up in the BITS 1Q in 2013, the BITS 1Q and CodS 4Q survey in 2014 and the catch in both 2013 and 2014.

Section 2.1.8. The first sentence states: "Indices from four different surveys that provide information on cod in the Kattegat were used in the assessment" – given that the stock assessors selected the $\text{SPALY+CodS}_{\text{scaling}}$ model as the preferred model, should this not state **five** different surveys?

Section 2.1.8. The only stated support for the $\text{SPALY+CodS}_{\text{scaling}}$ model is that it has a better retrospective pattern. Typically there needs to be more than just a single diagnostic to support moving from an accepted model formulation to a new formulation. If there are additional diagnostics that provide support for the $\text{SPALY+CodS}_{\text{scaling}}$ model they should be clearly outlined in this section.

Appendix plots

The differences in the catchability patterns between surveys is striking – why the differences in the IBTS Q1 vs. Q4 (appendix plot 11)? There is no reasoning for this provided in the text.

IBTS Q1 appears to have the most influence on the model – removing this survey the in sensitivity tests (plot 14 in appendices) is the only one where results fell outside of the base model's CI (SSB and terminal F).

Why is there only one peel shown for the for the $SPALY_{scaling}$ model and five shown for the $SPALY+CodS_{scaling}$ model (appendix plots 17-19)? The lack of consistency makes it difficult to utilize retrospective error as a model selection diagnostic. Additionally, it would have been nice to have had the retrospective error quantified in some way (e.g., rho value, see Mohn, 1999).

Conclusions

The base model $SPALY_{scaling}$ model appears to have been conducted consistent with the accepted stock annex. There are no major diagnostic issues with this update to warrant the rejection of the base model. The major issue with this update is whether or not a new survey, the CodS survey should be included in the model.

The CodS survey appears to be sufficiently designed and given the higher sampling density, should provide more precise estimates of cod abundance in the stock area and be less susceptible to sampling error. Despite this, the support for its inclusion in the assessment model is at present equivocal (at least given the information provided). This is not to imply that there is not valid in continuation of the survey and continual evaluation in future models – it certainly does not degrade the performance of the assessment model and it's unlikely that there would be a valid reason provided in future benchmarks for excluding the index from the model. Specifically, there did appear to be support for the CodS model based on the likelihood ratios, but it was difficult to quantify other model diagnostics as there were only graphical representations of many of the key diagnostics (e.g., retrospective Mohn's rho, tabled values of fits to the various data inputs). Looking at the ratio of model results to their uncertainty (spread of the upper and lower CI) provided a rough index whether one model provided more previse estimates of various outputs and parameters, though these metrics were inconclusive (Table 1; e.g., the catch multiplier was marginally more precise in the $SPALY_{scaling}$ and vice versa for the terminal SSB estimate).

The impacts of including the CodS survey in the model are minimal in terms of SSB and age 1 recruitment with the $SPALY+CodS_{scaling}$ results falling within the confidence intervals of the $SPALY_{scaling}$ model (Figure 2). The terminal (2014) estimate of average age 3-5 fishing mortality in the $SPALY+CodS_{scaling}$ model falls just outside of the $SPALY_{scaling}$ model. That's not to say that the differences are inconsequential with there being a 20.5% difference in SSB and a 27.5% difference in estimated Z between models (see Table 2.2.15 in the report).

Much of the differences between models appear to be caused by the higher population estimates of age 4^+ fish in recent years in the $SPALY+CodS_{scaling}$ model (Figure 3) in turn leading to lower estimates of fishing mortality at age (Figure 4). Curiously, the $SPALY_{scaling}$ model estimated higher age 1 recruitment of the 2012 year class, though by age 2 model results were quite similar due to a higher fishing mortality in the $SPALY_{scaling}$ model. The initially high estimate of the 2012 year class was probably due to the influence of the BITS 1Q survey (Figure 5) which was somewhat mitigated by the inclusion of the CodS 4Q survey. Since only the CodS 4Q and IBTS 1Q survey contain information on the age 4^+ fish, the inclusion of this survey has considerable influence on the estimate of the older age classes and inferences about the rate of removals (Z).

The F reference points are only marginally affected by the model choice with F_{max}=0.32 in the SPALY+CodS$_{scaling}$ model, 0.34 in the the SPALY$_{scaling}$ model. $F_{0.1}$ and $F_{35\%}$ are identical under both models at 0.2 and 0.15 respectively.

Stock status is contingent on the assessment model. Using the SPALY$_{scaling}$ model, terminal SSB< Blim and F>Fmax; however under the SPALY+CodS$_{scaling}$ model terminal SSB>Blim and F<Fmax. While the support for conclusion of the CodS survey in the model is not strong, given the departure from the model formulation specified in the stock annex, and the implications for stock status it would have been helpful if projections could have been provided for both the SPALY$_{scaling}$ and SPALY+CodS$_{scaling}$ models rather than only the assessors preferred SPALY+CodS$_{scaling}$. Without this its impossible to fully evaluate the consequences of switching to the SPALY+CodS$_{scaling}$ model within this update. While this reviewer can find no reason not to include the survey in the model, its inclusion or exclusion is more a matter of internal ICES process rather than scientific merit.

Future assessments (both updates and benchmarks) would benefit from careful assembly of the reports, better characterization of the data uncertainty (CVs on catch and survey estimates) and a more quantitative (vs. graphical) description of model diagnostics.

References

Mohn R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES J. Mar. Sci. 56:473-488

Tables

Table 1. Comparison of the signal to error ratios for a subset of the Kattegat Atlantic cod model parameters estimates from the SPALY+CodS$_{scaling}$ model and the base SPALY$_{scaling}$ model. Ratio cells highlighted in grey indicate that signal:error ratio was higher for that particular model.

Parameter	SPALY$_{scaling}$				SPALY+CodS$_{scaling}$			
	Point estimate	Lower CI	Upper CI	Ratio point estimate:(Upper-Lower)	Point estimate	Lower CI	Upper CI	Ratio point estimate:(Upper-Lower)
2014 Catch multiplier	11.8	7.6	18.4	1.10	10.2	6.0	17.5	0.89
2015 SSB	5445	3434	8635	1.05	6561	4097	10506	1.02
2014 F_{3-5}	0.65	0.44	0.96	1.25	0.40	0.26	0.63	1.10
Catchability - Index1	5.6	3.5	9.0	1.03	5.7	3.6	9.1	1.03
Catchability - Index2	2.5	1.6	4.1	1.03	2.6	1.6	4.1	1.05
Catchability - Index3	1.5	0.9	2.5	0.95	1.4	0.9	2.3	0.98
Catchability - Index4	8.5	5.7	12.6	1.24	8.5	5.7	12.7	1.21
Catchability - Index5	7.2	4.8	10.7	1.20	7.2	4.8	10.9	1.17
Catchability - Index6	4.4	2.9	6.6	1.19	4.3	2.8	6.6	1.16
Catchability - Index7	4.9	2.9	8.1	0.95	4.9	3.0	8.1	0.95
Catchability - Index8	7.5	5.1	11.0	1.28	7.5	5.1	11.1	1.27
Catchability - Index9	7.7	5.3	11.2	1.30	7.7	5.3	11.2	1.30
Catchability - Index10	12.3	9.4	16.0	1.85	11.8	9.0	15.5	1.84
Catchability - Index11	12.3	9.4	16.0	1.85	11.8	9.0	15.5	1.84
Catchability - Index12	12.3	9.4	16.0	1.85	11.8	9.0	15.5	1.84
Catchability - Index13	2.9	1.7	4.9	0.89	2.9	1.7	4.9	0.90
Catchability - Index14	2.0	1.2	3.2	1.00	2.0	1.2	3.2	1.02
Catchability - Index15	1.1	0.7	1.9	0.96	1.1	0.7	1.8	0.97
Catchability - Index16	1.4	0.9	2.3	0.99	1.3	0.8	2.2	1.00
Catchability - Index17					39.7	26.4	59.9	1.18
Catchability - Index18					74.5	34.2	162.3	0.58
Catchability - Index19					82.2	37.7	178.9	0.58
Catchability - Index20					153.9	89.9	263.6	0.89
Catchability - Index21					153.9	89.9	263.6	0.89
Catchability - Index22					153.9	89.9	263.6	0.89

Figures

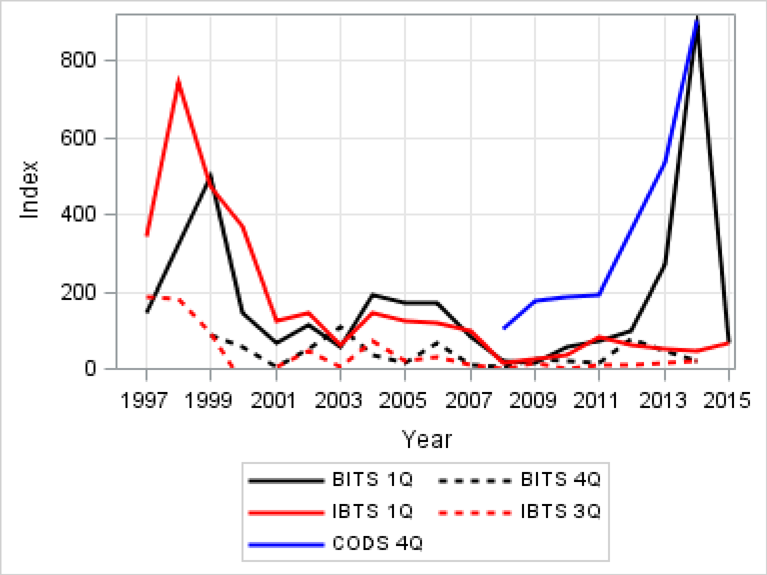


Figure 1. Comparison of the Kattegat Atlantic cod fisheries-independent indices (aggregated across all ages) for the five available survey time series.

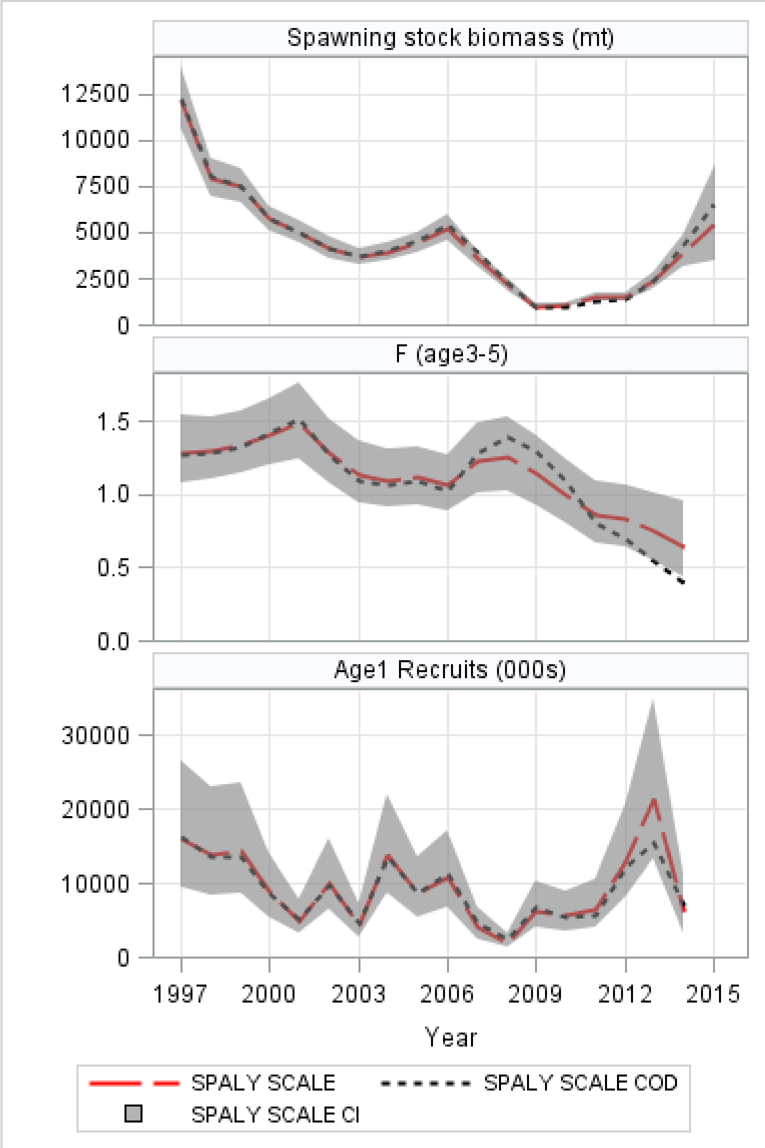


Figure 2. Comparison of Kattegat Atlantic cod SPALY+CodS$_{\text{scaling}}$ model results (spawning stock biomass, average age3-5 fishing mortality and age1 recruitment) to the base SPALY$_{\text{scaling}}$ model results.

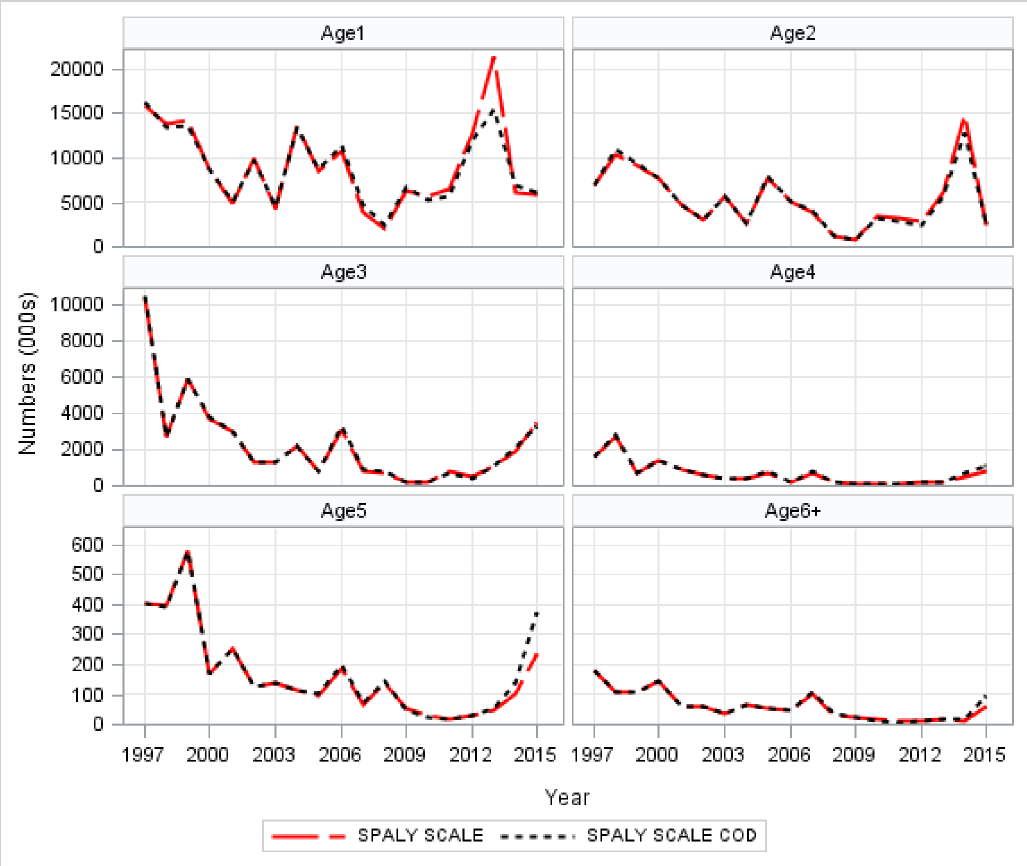


Figure 3. Comparison of Kattegat Atlantic cod SPALY+CodS$_{\text{scaling}}$ model results (population numbers at age) to the base SPALY$_{\text{scaling}}$ model results.

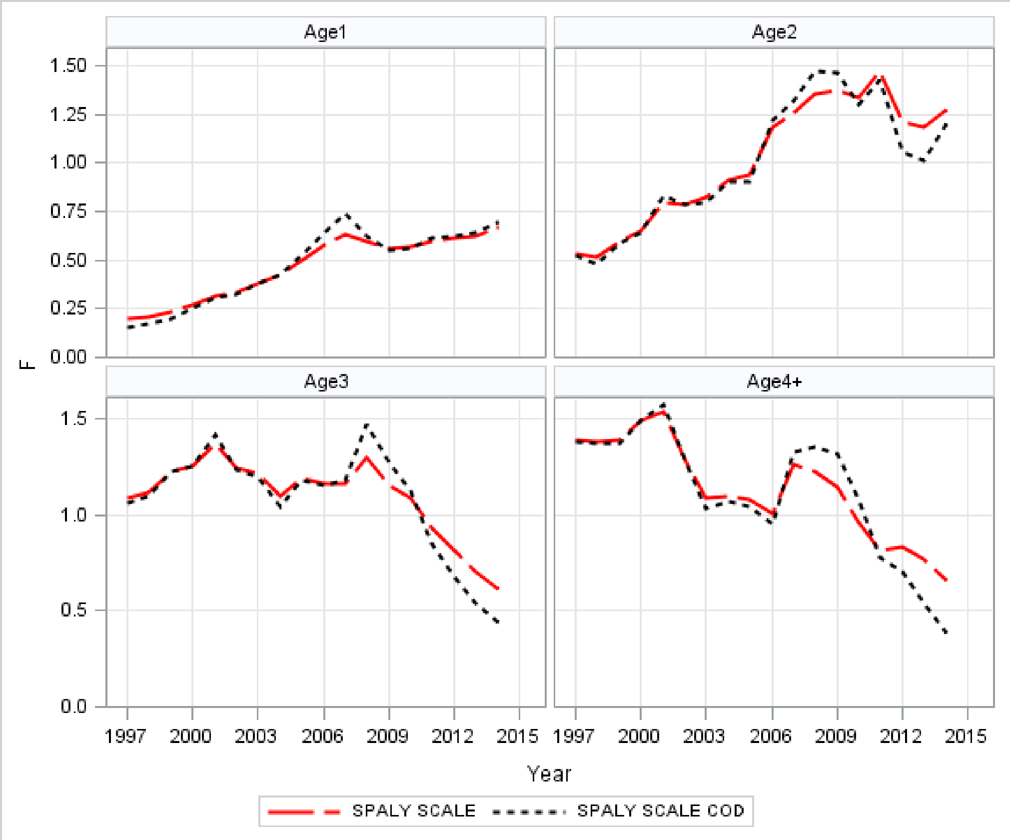


Figure 4. Comparison of Kattegat Atlantic cod SPALY+CodS$_{scaling}$ model results (fishing mortality at age) to the base SPALY$_{scaling}$ model results.

Figure 5. Comparison of the Kattegat Atlantic cod fisheries-independent indices-at-age for the five available survey time series.

Annex 09 – Review Group Technical Minutes Herring 30

Reviewers: **Massimiliano Cardinale**

General

The reviewer has been asked to review 3 different SAM model runs of the SD 30 (Baltic Sea) herring stock assessment. In particular, the following runs were examined: a SPALY run (base run, same model configuration as in 2014), a run where the commercial tuning fleet of the trapnet has been shortened down eliminating the last 8 years (2007-2014; -8 years run) of the time series, and a run where the commercial tuning fleet of the trapnet has been shortened down eliminating the last 5 years (2010-2014; -5 years run) of the time series. The elimination of the last 5 or 8 years was based on the rationale that the effort level in the trapnet fisheries has radically changed during the same time period and thus the recent values are not directly comparable against the historical part of the time series. The -8 years run shows the best residual pattern and the lowest log-likelihood when compared against the base run and the -5 years run. Also, the SPALY run shows larger confidence limits when compared to the -8 year run. Therefore, the reviewer considers that the -8 years run represents the best model configuration and should be used as basis for the advice. Finally, the MSY estimations made using MSY package and the -8 years run followed the guidelines defined by WKMSYREF3 and should be used to define the reference points for herring in SD 30.

The Review Group considered the following stocks:

- Herring SD 30

For single stock summary sheet advice:

1) **Assessment type:** SPALY run update with 2 alternative runs
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: SAM – tuned by 1 commercial fleet and 1 acoustic survey
5) **Consistency**: The last year (2014) assessment was accepted and used as basis for the advice. However, in the view of the reviewer, the SPALY assessment conducted in 2014 showed a rather large retrospective pattern and a poor residuals pattern. On the other hand, the 2015 -8 years run shows a much improved retrospective and residuals pattern and also the lowest log-likelihood when compared to the -5 years and the base run. The exclusions of the last -8 years of the trapnet tuning time series is justified by the radical change in effort during the last decade, which makes the last years of the trapnet tuning fleet not comparable with the rest of the time series. Thus, the reviewer considers that the -8 years run should be used for advice.
6) **Stock status**: B>MSY $B_{trigger}$, F<F_{MSY}, SSB and R are rather high in the latest years and have increased. However, it is important to notice that, although the trend

is very silar, the stock size is now estimated at a much lower level when compared against the 2014 assessment, which is due essentially to the different model configuration.

7) **Man. Plan.**: There is no Management Plan in place for this stock.

General comments

This review was based on the SAM runs and the trapnet time series historical development and not on the report of the WGBFAS.

Technical comments

The trapnet tuning fleet has been shortened down and the latest 8 years have been eliminated based on the rationale that the effort level has radically changed as shown in the figure included in the report.

Conclusions

The assessment configuration has been changed compared to the 2014 SPALY run as the latest 8 years of the trapnet tuning fleet has been eliminated. The reviewer considers that the new assessment model configuration is a clear improvement compared to the 2014 SPALY run and it should be used as basis for the advice. MSY estimations followed the guidelines defined by WKMSYREF3 and should be used to define the reference points for herring in SD 30.

Checklist for review process

General aspects

- Has the WG answered those TORs relevant to providing advice?
- Is the assessment according to the stock annex description?
- Is general ecosystem information provided and is it used in the individual stock sections.
- Has the group carried out evaluations of management plans?
- Has the group collected and analyzed mixed fisheries data?

For stocks where management plans or recovery plans have been agreed

- Has the management plan been evaluated in earlier reports?
- If the management plans has been evaluated during this WG:
    - o Is the evaluation credible and understandable
    - o Are the basic assumptions, the data and the methods (software) appropriate and available?

For update assessments

- 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?

For overview sections

- Are the main conclusions in accordance with the WG report?
- Verify that tables and figures been updated and are correct (except for the advice table)

Annex 10: Addendum to the forecast of the Western Baltic cod

An issue was raised regarding the assumption for intermediate year (2015) applied in the forecast for western Baltic cod and subsequent advice for 2016.

The original forecast presented in the report assumed Fsq (0.84) in 2015 that resulted in total commercial catch of WB stock at 14 084 t in 2015, which is close to the TAC (15 900 t) for the entire area of SD 22–24. This implies that almost entire quota for SD 22–24 was assumed to be taken as WB cod. In contrast, in last years the share of WB cod in commercial catches in SD 22–24 has only been around 50–55% (the rest is Eastern Baltic cod). Thus, the assumption for 2015 in the forecast presented in the report was found inconsistent with observations from previous years regarding the proportions of EB and WB cod caught in SD 22–24.

Therefore the forecast was revised with a more realistic assumption of catches of WB cod in 2015, assuming that 55% (based on estimates for 2014) of commercial catches taken in SD 22–24 would belong to the western Baltic stock (and the 45% to the eastern Baltic stock) and the total commercial catches in SD 22–24 would be restricted by TAC (15 900 t).

Main implications of this change are that in the former forecast the commercial catch of WB cod was assumed to increase from 8551 t in 2014 to 14 084 t in 2015, to maintain Fsq. Under the revised assumption the commercial catch in 2015 (8745 t) is similar to the level observed in 2014, which results in lower F in 2015 (0.52) compared to 2014 (0.84) and thereby a larger SSB in 2016. The advice for 2016 would then be (F_{MSY} approach) F= 0.23 (0.19 in former advice) and a catch in 2016 of 7797 t. The revised management option table is presented below (Table 2.3.27).

Table 2.3.27a. Western Baltic cod stock in Subdivisions 22–24. The basis for the forecast. Weights in tonnes. Recruitment in thousands.

Variable	Value	Source	Notes
F ages 3–5 (2015)	0.52	ICES (2015a)	Based on TAC constraint, the proportion of WB cod in commercial catches in SD 22–24 in 2014, and mean recreational catch (2012–2014)*
SSB (2016)	33373	ICES (2015a)	
R_{age0} (2016)	45 071	ICES (2015a)	Sampled from the last 10 years
R_{age1} (2016)	17 916	ICES (2015a)	Based on age 0 in 2015 sampled from the last 10 years
R_{age1} (2017)	18 660	ICES (2015a)	Based on age 0 in 2016 sampled from the last 10 years
Total catch (2015)	11303	ICES (2015a)	Based on TAC constraint, the proportion of WB cod in commercial catches in SD 22–24 in 2014, and mean recreational catch (2012–2014)*
Commercial wanted catch (2015)	8391	ICES (2015a)	Based on TAC constraint and the proportion of WB cod in commercial catches in SD 22–24 in 2014and the average fraction (in tons) of discards from commercial catch of WB cod in 2012–2014
Commercial unwanted catch (2015)	354	ICES (2015a)	Based on TAC constraint and the proportion of WB cod in commercial catches in SD 22–24 in 2014 and the average fraction (in tons) of discards from commercial catch of WB cod in 2012–2014
Recreational catches (2015)	2 558		Mean recreational catch (2012–2014)

***Total commercial catch in SD 22–24 in 2015 was assumed to be equal to TAC (15 900 t). In 2014, 55% of cod commercial catches in SD 22–24 were estimated to be western Baltic cod. Assuming the same proportion in 2015, under TAC constraint, results in commercial catches of western Baltic cod at 8745 t in SD 22–24. Recreational catch in 2015 is assumed to be an average of the estimates for 2012–2014.**

Table 2.3.27b. Western Baltic cod stock in Subdivisions 22–24. The forecast and catch options. Weights in thousand tonnes.

Rational	Total catch 2016*	Basis	F_{total} 2016	SSB 2017	%SSB change^
MSY approach	7797	F = F_{MSY} x (SSB_{2016}/ MSY $B_{trigger}$)	0.23	48907	47
F_{MSY}	8709	F_{MSY}	0.26	47841	43
F_{MSY} ranges without Advice Rule^^	5258	MSY F_{lower}	0.15	51953	56
	13937	MSY F_{upper}	0.45	41762	25
F_{MSY} ranges with Advice Rule included^^	4594	F = MSY $F_{lower(AR)}$ × (SSB_{2016}/ MSY $B_{trigger}$)	0.13	52840	58
	12366	F = MSY $F_{upper(AR)}$ × (SSB_{2016}/ MSY $B_{trigger}$)	0.39	43557	31
Zero catch	0	F_{2015} × 0	0	58226	74
Management plan**	20880	90% F_{2014} (F_{3-6})	0.8***	33370	0
Management plan long-term target**	16912	F_{total} = 0.6 (F_{3-6})	0.6***	38247	14
Other options	15322	F_{2014} × 0.6	0.51	39993	20
	16646	F_{2014} × 0.66	0.56	38 400	15
	19140	F_{2014} × 0.8	0.68	35471	6
	20871	F_{2014} × 0.9	0.76	33445	0
	22466	F_{2014} × 1.0	0.84	31472	−6
	23990	F_{2014} × 1.1	0.93	29820	−11
	28045	F_{2014} × 1.4	1.18	25234	−24
	31318	F_{2014} × 1.7	1.43	21569	−35

*** Includes commercial (wanted and unwanted) and recreational catch.**

**** The current management plan and the basis for the stock assessment no longer match.**

***** The fishing mortality provided for a reference F age range of 3–6.**

^ SSB 2017 relative to SSB 2016.

^^ According to ICES (2015b), F_{MSY} ranges are specified with and without the ICES Advice Rule (AR). For ranges without the AR F_{lower} and F_{upper} are not modified by SSB in the catch advice year. For the ranges with the AR, SSB_{2016} < MSY $B_{trigger}$; therefore, $F_{lower(AR)}$ and $F_{upper(AR)}$ are reduced by the factor SSB / MSY $B_{trigger}$.

Annex 11: Plaice in Kattegat, the Belt area and the Sound (PLE-2123)

Estimation of reference points

The stock was benchmarked in February 1015 and the final assessment used for the 2016 advice is an update of the Benchmark Base Run (ICES 2015a).

Input data

Assessment data include available discard estimates from 1999 to 2014 (direct estimates from 1999–2001 were unavailable so they were assumed equal to the mean of the observations from 2002–2004). Information on population age structure arises from a GAM procedure (Berg *et al.*, 2014) applied to the first quarter BITS and to the NS-IBTS surveys. The results of this procedure provide a single set of age-specific abundance indices used to tune the assessment model.

Assessment

The age-based assessment employed the state–space fish stock assessment model (SAM) developed by Anders Nielsen and Casper Berg (ICES 2015c; https://www.stockassessment.org). This statistical model provides estimates of spawning–stock biomass (SSB) and recruits (Figure 1).

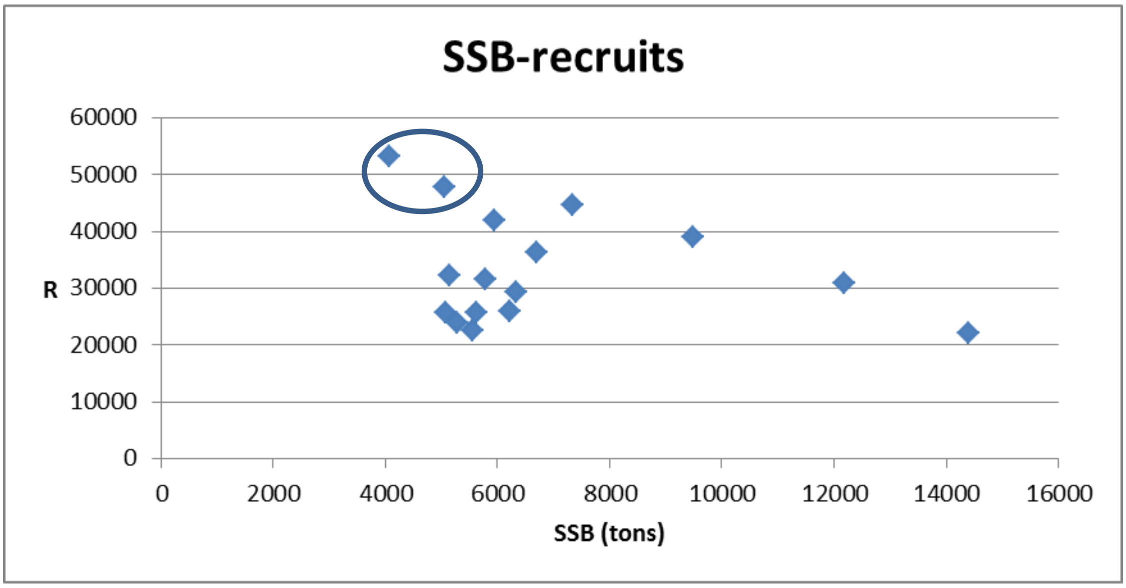


Figure 1. Recruitment (R) and spawning biomass (SSB) estimates from the SAM model. The first two observations in the time-series are circled and were omitted for reference point determinations since they are more uncertain.

The software EQSIM (https://github.com/wgmg/msy) was used to analyze the stock–recruit relationship. Bootstrap estimations (with replacement) of the stock–recruit relationship were run 1000 times (nsamp=1000) with the options to include a mix of models including: the Ricker, a segmented regression (so-called hockey stick), and the Beverton and Holt (Figure 2).

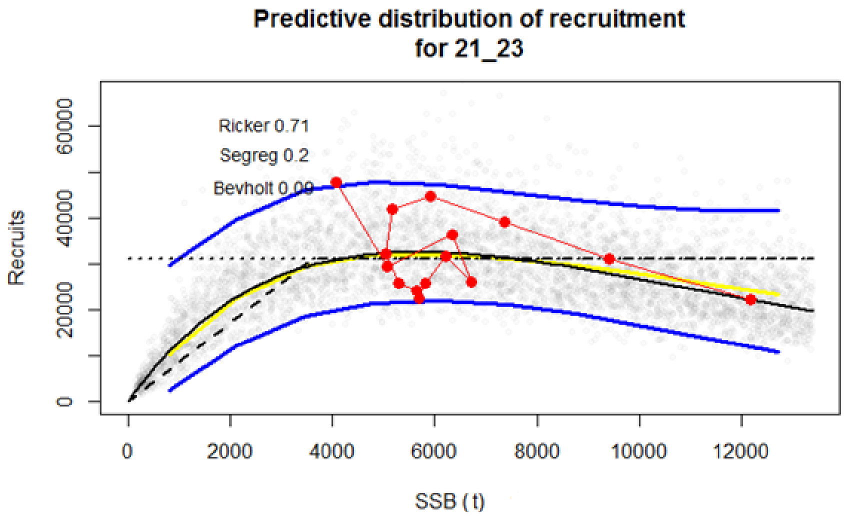


Figure 2. Predicted distribution of a mixed model putting most weight to the Ricker model.

Even though the estimation procedure resulted in an AIC weighting scheme that favoured the Ricker model, for most flatfish stocks it is uncommon to assume a decrease in recruitment at higher SSB sizes. Consequently, the segmented regression model was used which fit the observations reasonably well (the EQSIM model "Segreg"; Figure 3). In addition, B_{lim} was set to the historical lowest SSB value (B_{loss}), In this case this is the SSB in 1999 equal to 4077 tons (ICES 2003).

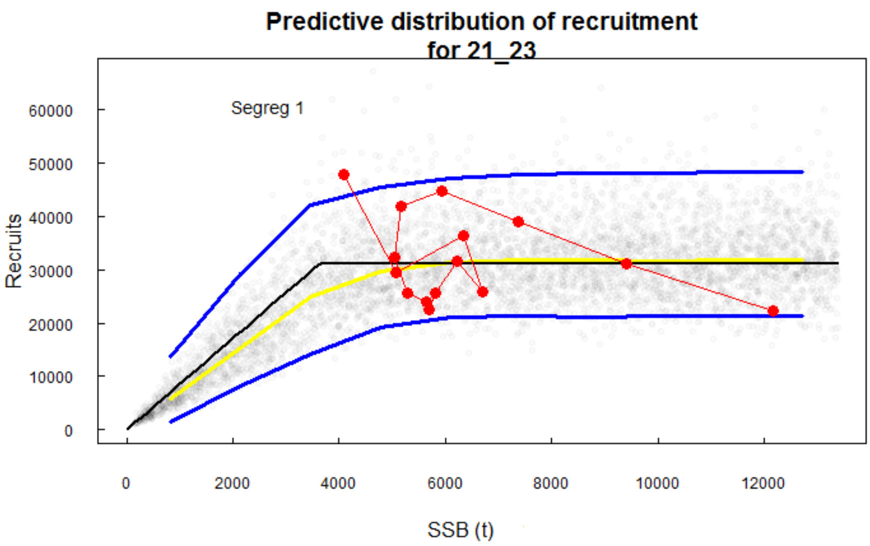


Figure 3. Predicted distribution of recruitment using a segmented regression model.

The B_{PA} is estimated to be 5553 tons (B_{PA}=B_{lim}*exp(sigma*1.645). Sigma= SSB $_{2015,high}$-SSB $_{2015low}$/4/SSB $_{2015}$. Results from EQSIM also provides the basis for developing a $B_{trigger}$ (=B_{PA}) based on a profile of total fishing mortality (Figure 4). The estimated F_{MSY} from this is 0.37.

The present SSB for the stock is well above estimated B_{PA} while the estimated F is well below F_{MSY} (Figure 5).

Although the F_{MSY} value estimated for PLE-2123 is higher than those estimated for other plaice stocks of neighbouring areas, F_{MSY} values are comparable between stocks (Table 2). The lower value estimated for PLE-2123 might be caused by the relative short data time-series available combined with the constant trend of increasing SSB in the same period. At no time during the study period (1999–2014) has the SSB been suficiently low to result in situation where the recuitment is dramatically reduced.

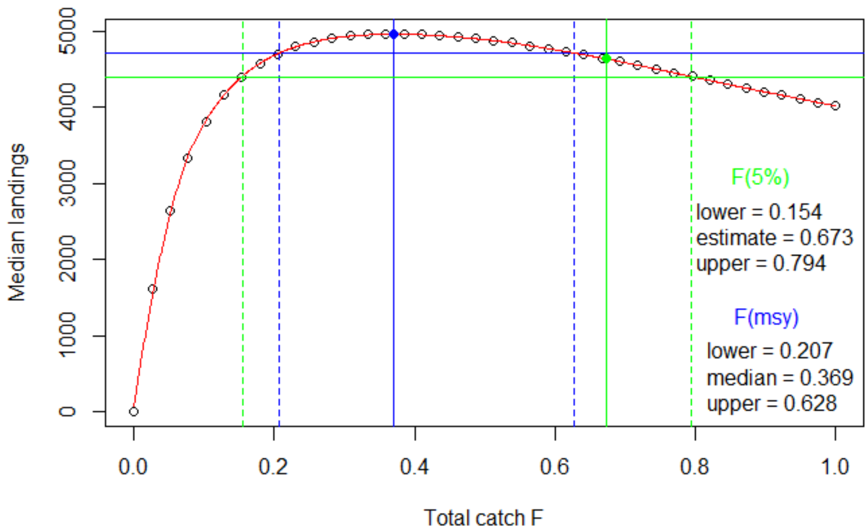


Figure 4. Simulation for estimation of F_{MSY} B_{lim}= 4077 t (=B_{loss}), B_{PA}=5553 t, $B_{trigger}$=5553 t. Year range: 1999–2014.

Table 1. Estimated Reference points.

Stock	B_{loss}	B_{lim}	B_{PA}	$B_{trigger}$	F_{MSY}
PLE-2123	4477	4477	5553	5553	0.37

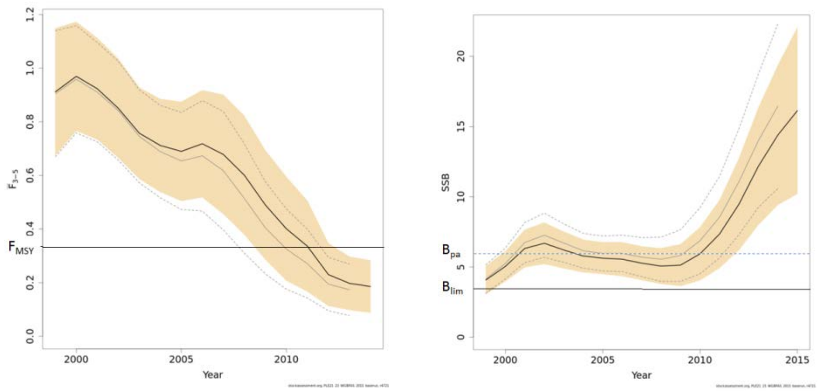


Figure 5. Results of SAM assessment with indication of estimated F_{MSY}, B_{PA} and B_{lim}.

Table 2. Comparable F_{MSY} values for ple-2123 and two other plaice stocks within European waters.

Stock	F_{MSY}	F_{PA}
PLE-2123 (1999–2014)	0.37	0.67
PLE-NSEA (2014)	0.25	0.6
PLE-ECHE(2015)	0.31	?

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Annex 12 Updated short-term forecast for sole (*Solea solea*) in Division IIIa and Subdivisions 22–24 (Skagerrak and Kattegat, Western Baltic Sea)

This annex was added to the report in November 2015.

The assessment of sole in Division IIIa and Subdivisions 22–24 had been considered uncertain for several years. Poor sampling coverage, a short fishery-independent tuning series, retrospective behaviour of estimated fishing mortality (F), and the knowledge of spatial changes in selectivity due to management measures implemented, were some of the main contributors to the uncertainty. An inter-benchmark process was conducted by correspondence between 1 July and 31 October 2015 to address these uncertainties (IBPSolKat; ICES, 2015a).

During the inter-benchmark new reference points were defined and adopted for the stock (ICES, 2015a). The changes in reference points in combination with a revised assessment and a new perception of the stock has changed the stock status and the catch advice for the stock (ICES, 2015b).

A recruitment index of age 1 is now obtained from the Fishermen–DTU Aqua sole survey and used in the assessment. This has improved the quality in assumptions on recruitment and younger age groups used in the catch forecast (ICES, 2015a, ICES, 2015b). Discards are not included in the assessment but comprise 11% in weight in 2014. This is a marked increase from the 2013 discard estimate of 3%. The catch options in the advice tables for 2016 therefore contain additional catches of discards amounting 4% (average discard rate 2010–2014). The input to the standard short term forecast is given in Table 1.

Due to the many changes in the regulation over the last years (selective devices, closed areas etc.) and thereby changes in the catchability it was decided to terminate the commercial tuning fleet used in the assessment.

The forecast procedure used prior to the inter-benchmark was to apply a stochastic assessment model and use the outcome of this (medians) as an input to a deterministic forecast. During the inter-benchmark this practice was considered inappropriate and it was suggested to utilize the uncertainty calculated by SAM into the forecast scenario. An example of a forecast scenario by SAM is provided in Figure 1. Although it is recognized that the use of uncertainty boundaries in the forecast is not yet a routine procedure in ICES, it is considered important to carry the uncertainty from the assessment into the forecast. Compared to the deterministic approach (MFDP3a software) the stochastic forecast (medians) is conservative and generally leads to lower catch advice. This is likely due to the incorporated uncertainty in the forecast estimation.

Assuming that catch in 2015 equals the TAC (205 t) the forecast predicts that a fishing mortality at F_{sq} ($F_{4\text{–}8} = 0.13$) in 2016 will lead to yields of 238 t in 2016 and spawning stock biomass of at 2755 t in 2017 (Table 2). Fishing at F_{MSY} will lead to yields of 394 t in 2016 and spawning stock biomass of 2599 t in 2017.

Table 1. The basis for the catch options.

Variable	Value	Source	Notes
F ages 4-8 (2015)	0.13	ICES 2015a	F corresponding to TAC constraint of landings of 205 t in 2015. F corresponds only to landings.
SSB (2016)	2461 t	ICES 2015a	F (TAC constraint)=0.13
R_{age1} (2015-2016)	1.991 mill.	ICES 2015a	Sampling from recent low recruitment (2010–2014).
Total catch (2015)	213 t	ICES 2015b	Assumed landings (quota in 2015) plus discards.
Landings (2015)	205 t*	ICES 2015b	Assessment not including discards, topping up in advice.
Discards (2015)	4%	ICES 2015b	Mean (2010–2014). Discard rate in weight.

*** TAC constraint of 205 t in 2015**

Table 2. The catch options. Weights in tonnes.

Rationale	Total catch (2016) *	Wanted catch (2016)**	Basis	F Wanted catch (2016)	SSB (2017)	%SSB change***	%TAC change wanted catch^
MSY approach	394	379	F_{MSY} x (SSB_{2016}/MSY $B_{trigger}$)	0.22	2599	6%	85%
Precautionary approach	394	379	$SSB_{2017}=B_{pa}$	0.22	2599	6%	85%
Zero catch	0	0	F=0	0.00	3000	22%	-100%
Other options	123	119	$F_{2015}\times 0.5$	0.07	2875	17%	-42%
	238	229	Fsq (F_{2015})	0.13	2755	12%	12%
	406	390	F_{MSY}	0.23	2588	5%	90%
	181	174	-15% TAC(F_{2015}*0.7)	0.09	2816	14%	-15%
	213	205	No change TAC (F_{2015}*0.9)	0.11	2784	13%	0%
	245	236	+15% TAC(F_{2015}*1.0)	0.13	2749	12%	15%

***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).**

**** The "wanted catch" is used to describe fish that would be landed in the absence of the EU landing obligation.**

***** SSB 2017 relative to SSB 2016.**

^ Wanted catch 2016 relative to TAC 2015.

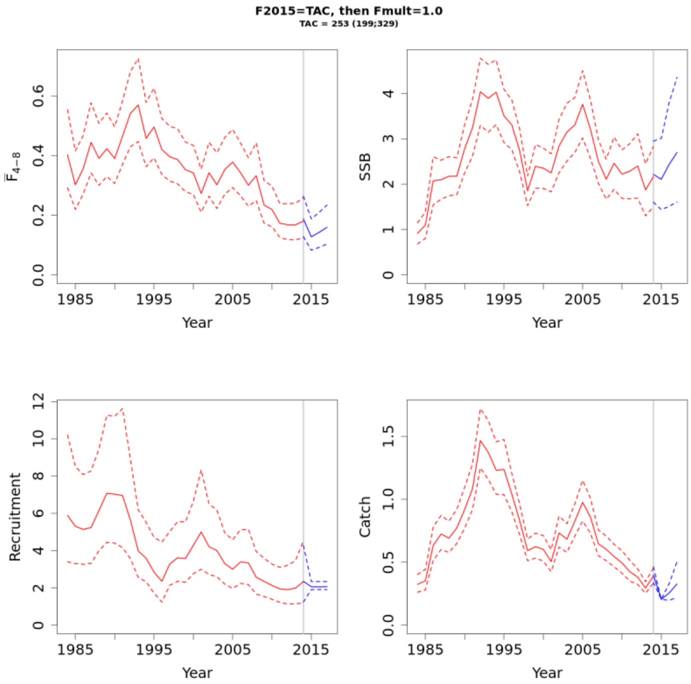

Figure 1. A forecast scenario from the SAM model assuming TAC constraint in 2015 and *status quo* F in 2016. Weights in thousand tonnes. Recruitment in millions.

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