ICES WKBALFLAT REPORT 2014

ICES ADVISORY COMMITTEE

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Report of the Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT)

27–31 January 2014

Copenhagen, Denmark

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Executive Summary

The Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT) 2014 was convened between 26 November 2013 and 31 January 2014. It included an initial three days data compilation workshop (DCW) 26–28 November 2013 and a five day benchmark meeting 27–31 January 2014. The process started with a data call in October 2013 for which all member states were requested to upload data to relevant ICES databases and provide information to the stock coordinators. The group worked by correspondence between the two physical meetings.

The DCW was chaired by two ICES chairs: Margit Eero (Denmark) and Mikaela Bergenius (Sweden). The benchmark meeting in January was chaired by Liz Brooks (USA) with the assistance of the two ICES chairs. Two independent scientists from outside the ICES community reviewed the work conducted and provided comments and input during the discussions: Anne Hollowed (USA) and Mark Fowler (Canada).

This benchmark workshop considered the assessment units, data availability for assessment and the assessment methods for Dab and Flounder in Subdivisions 22–32 in the Baltic Sea.

Concerning stock units, the starting point was one assessment unit for Dab in Subdivisions (SD) 22–32 and one for Flounder in SDs 22–32 (based on Advice 2013). In 2013, both stocks were assessed according to the ICES data-limited approach for advice. As an outcome of WKBALFLAT, the Flounder stock was separated into four assessment units:

- Flounder SD 22–23
- Flounder SD 24–25
- Flounder SD 26 and 28
- Flounder SD 27, 29–32

These units were derived based on earlier work by ICES/HELCOM workshops, WKFLABA (ICES, 2010) and WKFLABA2 (ICES, 2012a) and recommendations by SIMWG (ICES, 2012). For dab, one stock unit in SD 22–32 was maintained. However, there are some indications that SD 21 could potentially be merged with dab in SD 22–32 and future work is recommended to solve the issue of dab stock ID in this region.

Both dab and flounder are mainly caught as bycatch species in cod or other flatfish fisheries in the Baltic Sea. Therefore one of the main data issues for these stocks is related to discards. The amount of discard of flatfish in the Baltic is significant and often of a similar magnitude as the flatfish landings. The discard behaviour for bycatch species is rather complex and unpredictable because it varies independent of factors directly connected to the abundance of flatfish stocks. Large efforts were made by the group to compile discard information from different countries for Flounder stocks in SD 22–23, SD 24–25 and SD 26&28 and for dab in SD 22–32. The discard compilation was carried out using the facilities of ICES database InterCatch. During this process several issues were identified related to incomplete sampling and limitations for discard extrapolation possibilities in the standard software. Thus, the present discard estimates were considered too uncertain to be used as a basis for catch advice. Therefore, providing only landings advice for both dab and all flounder stocks was recommended. Both short-term and long-term solutions were developed to allow improvement of discard estimates in future.

Another common issue for the stocks considered by WKBALFLAT is the lack of age information both for commercial catches and surveys. Age readings, carried out by approved methods, are currently available only for a few recent years. Length distributions are available and methods to convert these to ages were explored, with promising results. However, proper validation of the resulting age distributions, for example with real age readings, was not possible to conduct during WKBALFLAT. Therefore, more work on this aspect is needed before age based stock assessment methods could be used as a basis for advice for these stocks. Exploratory analyses with production models and the age-based stock assessment model SAM were carried out.

Due to the issues mainly with discards and age information described above, the conclusion of WKBALFLAT was to use survey based trend assessments as a basis for advice (ICES category 3.3.) for all flounder and dab stocks in the Baltic. However, significant progress was made by WKBALFLAT towards developing analytical assessments for most of these stocks. It was emphasized that this work should be taken further to WGBFAS where improving the input data and exploratory analyses with analytical assessment models should be continued, in parallel with survey based assessment to be used for advice. This could facilitate possible transition to analytical assessments for some of these stocks in future.

1 Terms of Reference and description of the benchmark process

1.1 Terms of Reference of the Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT)

2013/2/ACOM39 A **Benchmark Workshop on Baltic Flatfish Stocks** (WKBALFLAT), chaired by External Chair Elizabeth Brooks, USA and ICES Chairs Margit Eero, Denmark and Mikaela Bergenius, Sweden, and attended by two invited external experts, Anne Hollowed, USA, and Mark Fowler, Canada will be established and will meet at ICES HQ for a data compilation meeting 26–28 November 2013 and at ICES HQ for the Benchmark meeting, 27–31 January 2014:

a) Evaluate the appropriateness of data and methods to determine stock status and investigate methods for short-term outlook taking agreed or proposed management plans into account for the stocks listed in the text table below. The evaluation shall include consideration of:

   i) Stock identity and migration issues;

   ii) Life-history data;

   iii) Fishery-dependent and fishery-independent data;

   iv) Further inclusion of environmental drivers, multispecies information, and ecosystem impacts for stock dynamics in the assessments and outlook.

b) Agree and document the preferred method for evaluating stock status and (where applicable) short-term forecast and update the stock annex as appropriate. Knowledge of environmental drivers, including multispecies interactions, and ecosystem impacts should be integrated in the methodology;

If no analytical assessment method can be agreed, then an alternative method (the former method, or following the ICES data-limited stock approach) should be put forward;

c) Evaluate the possible implications for biological reference points, when new standard analyses methods are proposed. Propose new MSY reference points taking into account the WKFRAME results and the introduction to the ICES advice (Section 1.2).

d) Develop recommendations for future improving of the assessment methodology and data collection;

e) As part of the evaluation:

   i) Conduct a three day data compilation workshop (DCWK). Stakeholders are invited to contribute data (including data from non-traditional sources) and to contribute to data preparation and evaluation of data quality. As part of the data compilation workshop consider the quality of data including discard and estimates of misreporting of landings;

   ii) Following the DCWK, produce working documents to be reviewed during the Benchmark meeting at least seven days prior to the meeting.

	STOCK	ASSESSMENT LEADER	ICES EXPERT GROUP
dab-2232	Dab in Subdivisions 22–32	Rainer Oeberst	WGBFAS
fle-2232	Flounder in Subdivisions 22–32	Didzis Ustups	WGBFAS

The Benchmark Workshop will report by 15 March 2014 for the attention of ACOM.

1.2 The benchmark process

ACOM, under the advice of the Baltic Fisheries Assessment Working Group (WGBFAS) recommended flounder and dab in Subdivisions 22–32 to undergo a benchmark assessment in 2013–2014. The expert group compiled a provisional "issue list" of reasons why the assessment methods for each stock needed to undergo a benchmark examination. These issue lists formed the basis of the benchmark process. The benchmark process started with a data call in October 2013, followed by a data compilation workshop (DCW) in November 2013 and a workshop in January 2014.

The initial DCW in November 2013 used the issue list as a basis for planning the work during the benchmark. At the DCW the work thus focused on to 1) discuss and conclude on the biological support for which assessment units to proceed with, 2) overview the available data for each proposed assessment unit, 3) suggest assessment method for each proposed assessment unit to explore at benchmark 4), formulate a plan for the work to be undertaken in preparation for the benchmark.

The external reviewers joined the DCW via WebEx. The product of the DCW was a workplan and a prioritization of the issues to be dealt with. The group emphasized that the data availability, quality and properties would play a dominant role in determining the appropriate assessment models. The practicalities of the assessment models were also to be taken into account.

At the DCW, after the proposed assessment units were identified, responsible experts were assigned to these units to lead the investigations for each stock, and present the work at the benchmark in January. The stock leaders were also responsible for the completion of the report sections and the stock annex for their allocated stock.

The stock leaders were:

- Dab Subdivisions 22–32 Rainer Oeberst (Germany)
- Flounder Subdivisions SD 22–23 Sven Stötera (Germany)
- Flounder Subdivisions 24–25 Anna Luzenczyk (Poland)
- Flounder Subdivisions 26 and 28 Didzis Ustups (Latvia)
- Flounder Subdivisions 27, 29–32 Ann-Britt Florin (Sweden)

The stock teams worked by correspondence between the two meetings. One plenary WebEx was held the week before the benchmark meeting in January to discuss the progress concerning each stock and to address problems. All participants were encouraged to submit their work in working documents at least a week prior to the final benchmark workshop in January 2014 for viewing of the external experts.

The final benchmark meeting in January used the decisions made at DCW on stock units, presentations and working documents presented to benchmark, and plenary discussions including input from the reviewers to justify the choice of stock assessment approach for each stock. Plenary discussions were held continuously during the week to talk through new results and make decisions. On the last day of the meeting the format of the report was discussed in plenary and writers for the various sections identified.

After the final meeting, the report was edited by correspondence and reviewed by the external experts.

2 Data call and general issues with discards

2.1 Data call

All of countries involved in the ICES data call were asked to upload their landing and discard data of flounder and dab in InterCatch from 2000 to 2012. If it was possible data were divided by fleets (Active and Passive) and quarters. If detailed information was not available countries were asked to upload just landing information by years. For quality checking reported landings of flounder from WGBFAS were used. In the data compilation workshop the group agreed that a difference in 5% (or less) between landings reported in InterCatch and those reported in the WGBFAS report was acceptable. If the difference was more than 5%, countries were asked to clarify the reason and upload new data or confirm a difference.

Data in InterCatch were uploaded for the whole Baltic Sea as one flounder stock - Flounder SD 22–32. After 10th of December, based on a decision at the WKBALFLAT Data Compilation Workshop, flounder was divided into four stock units. The data uploaded to InterCatch compared to the data reported to WGBFAS are reported in Table 2.1 and 2.2.

Table 2.1. Uploaded flounder landing data (in %) in InterCatch compared to WGBFAS report by country.

Year	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
2000	107	104	73	0	99	100	100	100	100
2001	104	100	84	0	100	100	100	100	98
2002	105	100	81	100	100	100	100	100	100
2003	107	100	96	103	100	100	100	100	101
2004	113	100	65	100	100	100	106	100	100
2005	100	100	93	100	100	100	106	100	100
2006	100	100	422	101	101	100	100	100	100
2007	100	100	493	103	100	100	100	100	100
2008	100	100	570	99	100	96	100	100	101
2009	100	90	164	99	100	100	95	100	99
2010	99	105	160	99	100	100	97	100	100
2011	100	100	198	101	103	100	100	100	100
2012	100	100	175	100	100	100	100	100	100

Table 2.2. Uploaded flounder landing data (in %) in InterCatch compared to WGBFAS report by subdivision.

YEAR	BAL22	BAL23	BAL24	BAL25	BAL26	BAL27	BAL28	BAL29	BAL30	BAL31	BAL32	TOTAL
2000	74	691	38	135	74	101	100	91	99		73	82
2001	82	533	32	149	79	106	100	98	154	137	79	88
2002	101	546	85	122	80	100	100	95	93		102	101
2003	101	597	82	128	81	103	100	97	104		99	102
2004	103	698	86	120	101	99	100	96	33		96	105
2005	101	99	77	125	101	99	100	107	30		101	103
2006	102	98	100	100	100	100	100	126	155	0	119	101
2007	104	100	100	100	100	101	100	138	236	2	123	101
2008	100	100	99	100	100	104	100	121	779	100	108	100
2009	100	100	96	97	94	96	100	118	620	42	85	96
2010	100	100	90	100	100	100	100	110	26 289		102	98
2011	99	102	101	100	100	100	104	108	210	209	101	100
2012	100	100	100	100	100	100	100	120	340	1300	115	100

Data from Latvia, Lithuania, Poland, Russia and Sweden correspond to the reported landings in the WGBFAS report (Table 2.1). Denmark for 2000-2005 used a different (more appropriate) fishing allocation scheme that resulted in a landing redistribution by subdivisions. Thus, a part of the landings reported in SD 24 according to latest allocation scheme belongs to SD 23 (landings are 5–6 times higher than in previous reports) and 25. Due to limited data availability Germany and Estonia did not upload some of years in IC format before 10th of December (data were received from national authorities later and uploaded when flounder stock was divided in four stock units as decided at the WKBALFLAT data compilation workshop, DCW). Historically, Finland and Estonia have reported commercial and recreational fishery together. Finnish data for the entire time-series and Estonian data for 2009–2012 were corrected after the WKBALFLAT DCW. However, corrected Estonian data are currently not included in InterCatch.

Overall, only two countries had uploaded data from 2000 at the deadline of the ICES data call. In the Data Compilation Workshop it was found that the main reason for this is in the lack of expertise in working with InterCatch database. Some countries uploaded data from the last 3–4 years only and as a result the stock coordinator used reported landings from the WGBFAS report to fill the gaps. Information from WGBFAS was available in lower resolution than that was requested in the ICES Data Call.

2.2 Discard data

2.2.1 General issues

The amount of discard of flatfish in the Baltic is significant and often of a similar magnitude as the flatfish landings. The discard behaviour is rather complex and unpredictable because it varies independent of factors directly connected to the abundance of flatfish stocks. Most flatfish species in the Baltic (maybe except plaice and sole) are most often caught as bycatches in other fisheries - pre-dominantly in the cod fishery. Only Poland has a small flounder directed regular fishery. The discard pattern varies significantly from country to country. In some countries (Russia and Poland) most of the catches of flounder are landed either because of profitable market conditions or because of a discard ban (Russia), while the opposite is the case in other countries (Sweden and Denmark) where flounder only occasionally is landed depending of the market situation. In most countries the market situation changes from quarter to quarter and from year to year due to conditions not related to flatfish (e.g. the regulation of other species). Because of the relatively high amount of discards (at least the same magnitude as the landings) the discard is crucial to a realistic estimation of the fishing mortality (F).

The available investigations have shown that there is a relatively high percentage of mortality for discarded fish. During WKBALFLAT the survival rate for flounder was defined as: 50% survival during winter (i.e. 1st and 4th quarters) and 10% during summertime (i.e. 2nd and 3rd quarters). This represents conservative (i.e. the lowest survival rates) values among the ones derived from different studies (WD 2.1). For dab, the survival is believed to be 0% throughout the year. At the same time, the rather complex and unpredictable discard behaviour makes it very difficult to model the amount of the discard and makes the estimation of the discard very dependent on a proper sampling scheme. Unfortunately, the discard sampling is far from optimal because many strata are not sampled. Consequently, the discard from those strata have to be estimated based on data from other strata where sampling has taken place in order to get an estimate of the total discard of the stock.

The amount of discard applied to a given data gap stratum was estimated based on the discard rate from the extrapolation source raised with landings for the data gap stratum. Because the dynamics in the discard pattern in most countries is more or less independent of the landing pattern for bycatch species, the result of the extensive data extrapolation will create a discard dynamic which does not reflect the true pattern. Because the discard constitutes such a significant fraction of the catches, the result will be that the catch pattern is seriously biased by the unrealistic discard pattern. As data gaps often are present in the same stratum through many years, the consequence of the bias could be that important year-class dynamics are levelled out or even that false year-class dynamics are introduced as well. All this provides a poor basis for the assessment.

2.2.2 Issues connected to the data call

Working with the actual data submitted, it was realized that the format in which the data were submitted to the WG did not provide sufficient information to calculate the total discard per stock. For stocks which mostly are caught as bycatch in other fisheries, the discard cannot be raised from sample level to total discard based on the landings of the stock because the species is not landed at all. This means that the discard will be dramatically underestimated.

The sampling is stratified on Year, Country, Subdivision, gear type (Active, Passive) and quarter. This gives approximately 288 strata considering that no countries are fishing in all subdivisions. Unfortunately, it is not possible to cover that many strata within the economics of the sampling framework and with manpower available. This leaves many strata un-sampled. In order to calculate the total stock-discard, discard rates must be borrowed from other sampled strata. Figure 2.1 below gives an overview of the reported landings (weight) and discard (weight) by gear type in InterCatch for flounder in SD 22 and 23. Only Germany, Sweden and Denmark are fishing on that stock. A long time span of missing discard occurs for both active and passive gears. Due to the unpredictable nature of the discard behaviour, the extensive extrapolation of data might produce inaccurate total annual discards and may introduce unrepresentative discard dynamics in the time-series. If age-based data are required, the data situation is further aggravated because age readings following the new and currently acceptable procedures (broken and burned, otolith slicing and staining) generally are only available for a limited number of recent years. Only Poland has applied the slicing method in the whole time-series back to 2000, though for the first quarter only.

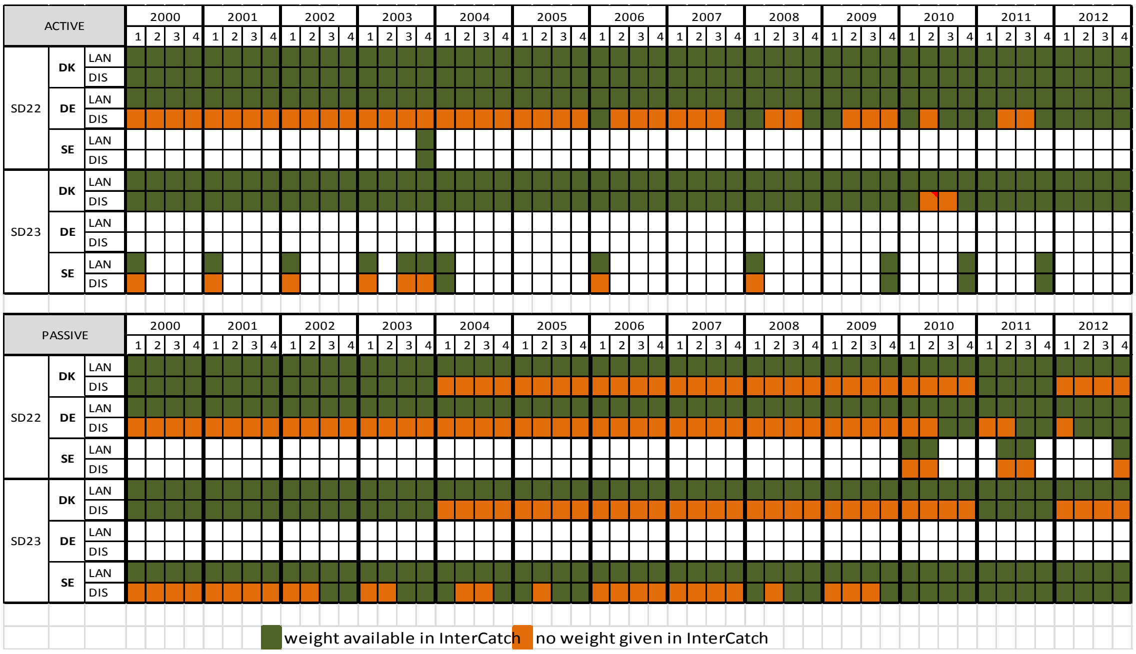


Figure 2.1. Example of coverage of Flounder catches. Logged weight of landings and calculated weight of discard based on sampling of discards rates. (From the presentation by Sven Stötera at the WG: Flounder in Subdivision 22 and 23 (FLE-2223).

2.2.3 Long-term solutions

Taking into account the importance of the discards, a proper sampling scheme including sufficient coverage and suitable stratification is a precondition for any type of assessment of flounder and dab in the Baltic. Furthermore, one has to look into which raising factor is able to produce realistic discard estimates. This factor could be based on landings of e.g. cod, an assemblage of species landed or all species landed in the fisheries where flatfish are caught or it could be based on effort considerations. Acknowledging that some extent of data extrapolation probably always will be needed, the selection of source data must be based on proper investigation of which strata actually exhibit a similar discard pattern as the extrapolation target strata. The sources might be one stratum or some kind of average of a number of strata. The data extrapolation has to be conducted in a way which is consistent from year to year and can be documented.

2.2.4 Short-term solutions

In order to move forward with the improvement of discard data, the catch (landing and discard) data should be uploaded to InterCatch without any form of national data extrapolating. This will enable the stock coordinators to get a realistic estimate of the coverage of the sampling.

Preliminary approach to improve the discard estimates was discussed in a subgroup. The strata where no discard can be estimated were suggested to be extrapolated using a general extrapolation scheme where the average discard rate (based on the data available for the specified stratum) is applied to the data gap. If no data are available for a given stratum, the following prioritized rules were suggested to be used until usable data are found:

1) Same gear type, same country, same subdivision, adjacent quarter;
2) Same gear type, same country, same quarter, adjacent subdivision;
3) Same gear type, same quarter, same subdivision, adjacent country;
4) Same gear type, same subdivision, adjacent quarter, adjacent country;
5) Same gear type, same quarter, adjacent subdivision, adjacent country.

The data extrapolation process will be programmed in SAS or R that these could be easy to apply to any stock. The procedures for discard extrapolations are expected to be refined via intersessional discussions.

This approach (possibly refined resulting from intersessional further discussions) is intended to be applied for processing of the 2013 data. If this turns out to be a significant improvement of the data compilation, the same procedure will be applied on the whole dataseries back to 2000. This will provide an improved basis for developing further analytical assessments for flatfish stocks until the long-term solutions can be implemented.

2.2.5 Conclusions on discards

The present discard estimates were considered too uncertain to be used as a basis for catch advice. Therefore, providing only landings advice for both dab and all flounder stocks was recommended.

To enable catch advice, the following improvements are needed:

- Documentation of discards is needed, where did the samples come from, and what the countries already have extrapolated themselves. In general, only data from sampled strata should be provided, with extra information/advice on how to fill the gaps of unsampled strata (e.g. if zero landings of flounder, should the discards be estimated based on cod landing, etc.);
- A common approach to calculating and raising discards for bycatch species, in particular when there are zero landings should be established;
- To be able to use InterCatch for discard compilation, discards ratios should be available to borrow across years or neighbouring flounder stocks;
- To be able to use InterCatch for discard compilation, it needs to be possible to use other discard raising factors than currently available, for example cod landings. Another option would be to add an additional column for total landings on a trip.

3 Knife edge and statistical slicing methods to convert length information to age

3.1 Knife edge slicing

Knife edge slicing method is used to convert the observed distribution of number at length to number-at-age when otolith age reading is lacking and it has been extensively used to construct age matrix for both catches and surveys (e.g. STECF 2012). Knife edge slicing method uses the von Bertalanffy growth curve to assign observed numbers at length to numbers-at-age. The observed length is used as an input to the growth equation and the associated age is returned. Only integer ages are allowed so the returned age is rounded down to the nearest integer. This integer cannot be less than the minimum age, or greater than the plus group. The knife edge slicing function was initially developed by Kell and Kell (2011), further developed by Scott *et al*., (2011). The knife edge slicing function assumes that recruitment happens at the start of the year and it returns a catch-at-age matrix for both the catches and the surveys.

3.2 Statistical slicing

The statistical slicing method assumes that the observed distribution of numbers at length is composed of a mixture of distributions representing the different cohorts (or age classes) in the population. The statistical slicing method estimates the parameters of each distribution. The fitting is performed using the mixdist package in (http://www.r-project.org, http://www.math.mcmaster.ca/peter/mix/mix.html) and the Fisheries Library in R (FLR) (Kell *et al*., 2007). A detailed description of the package and the fitting method can be found in Juan Du (2002).

Each age class is represented as a distribution and each distribution has three parameters: π, μ, σ; π is the proportion of the total numbers assigned to that age class, μ and σ are the mean and standard deviation of the distribution, i.e. the mean length of the age class and the spread of the lengths within that age class. For example, this means that for a stock with six age classes there are a total of 18 parameters to be estimated. However, it is also possible to fix some of these parameters. For example, it is possible to fix the means of the distributions of the older age groups. Additionally, instead of estimating a separate σ for each distribution, it is possible to estimate a common coefficient of variation for all distributions (i.e. $\sigma_1/\ \mu_1=\sigma_1/\ \mu_1$, etc.).

It is necessary to set some initial values for the parameters that are to be estimated, and also specify fixed values for those parameters that have to be fixed. The parameters are set using the mixparam() function of the mixdist package in R. The initial values of π are set as the mean proportions calculated using the knife edge method above. The initial values of μ are set using the von Bertalanffy parameters. The initial value of the constant coefficient of variation was assumed to be 0.05 and thus σ, the standard deviation of the distribution, was adjusted to reflect this value. As mentioned above, it is also needed to include the timing parameter to the ages because the catches are assumed to be taken in the middle of the year. For the surveys instead, the observed number at length are adjusted to the month the survey has been carried out.

Moreover, besides the observed length, initial constraints and assigned values, it is necessary to specify what type of distribution to use to fit the length data. Here we fitted three different types of distribution, normal, lognormal and gamma, and then we compared the results to select the most appropriate model based on the best fitting. The mix() function returns the value of Chi-squared (X^2) and the degrees-of-freedom. This means that is possible to compare the fits by calculating the reduced X^2, where reduced $X^2 = X^2/df$. A rough rule-of-thumb is that the larger the reduced X^2, the worse the fit, and a reduced X^2 less than one suggest that the model is over fitting the data. Additionally, it is important to notice that a low reduced X^2 means only that the fit is statistically better but it does not necessarily imply that the resulting estimates of fit are biologically sensible. This implies that the choice of the appropriate distribution is therefore left to the judgment of the scientist.

Moreover, several different model settings were tested and combinations of these (i.e. constant coefficient of variation, no constraint on standard deviations for all the age classes, mean size of the cohorts lying along a growth curve and specified means of the cohorts are fixed). The different number-at-age matrix (for both the catches and the surveys) obtained after statistical slicing with the different model settings were then tested for internal consistency, i.e. how well the estimated cohorts are tracked in the catch-at-age matrix. Here we shown an example of the work flow, which was used for all stocks, and an example of the main results of the modelling obtained for flounder in SD 22–23.

3.3 Work flow for slicing the length frequency (LFD) distribution into number-at-age

1) Define the VBF parameters.

2) Slicing the observed LFD into number-at-age using the knife edge method.

3) Using the parameters derived by the knife edge slicing as initial values, we fitted the statistical slicing with three different types of distribution (i.e. normal, lognormal and gamma) on the observed LFD and select the best model based on the reduced X^2. The best distribution was selected based on the highest number of years which gave the lowest reduced X^2 (Table 3.1).

4) Using the best distribution, we fitted the statistical slicing model with different settings (i.e. constant coefficient of variation for the different cohorts, no constraint on standard deviations for all the cohorts, mean size of the cohorts lying along a growth curve and specified means of the cohorts are fixed) and several combinations of these.

5) The different statistical slicing models obtained with the different settings were tested for internal consistency, i.e. how well the cohorts are tracked in the estimated catch age matrix. The model which gave the highest internal consistency was chosen as the final model.

6) The final model was used to derive the number-at-age matrix for both the catches and the surveys.

Table 3.1. Flounder in SD 22&23. Summary of the reduced X^2 for the different distributions (i.e. normal, lognormal and gamma) and years. In bold are the best fit according to the reduced X^2 statistics. In this case, the normal distribution was chosen as it resulted in the lowest reduced X^2 for most of the year.

year	Normal	Lognormal	Gamma
2000	**11794**	14000	13656
2001	19935	**15446**	19855
2002	**25060**	27110	26276
2003	**5360**	6615	5922
2004	**16748**	17249	16829
2005	**21277**	22809	22793
2006	**17410**	18599	17438
2007	**16233**	17654	17054
2008	**17512**	19107	18964
2009	**4973**	8586	6103
2010	10228	10355	**9623**
2011	10003	**8066**	8822
2012	**14131**	15161	14766

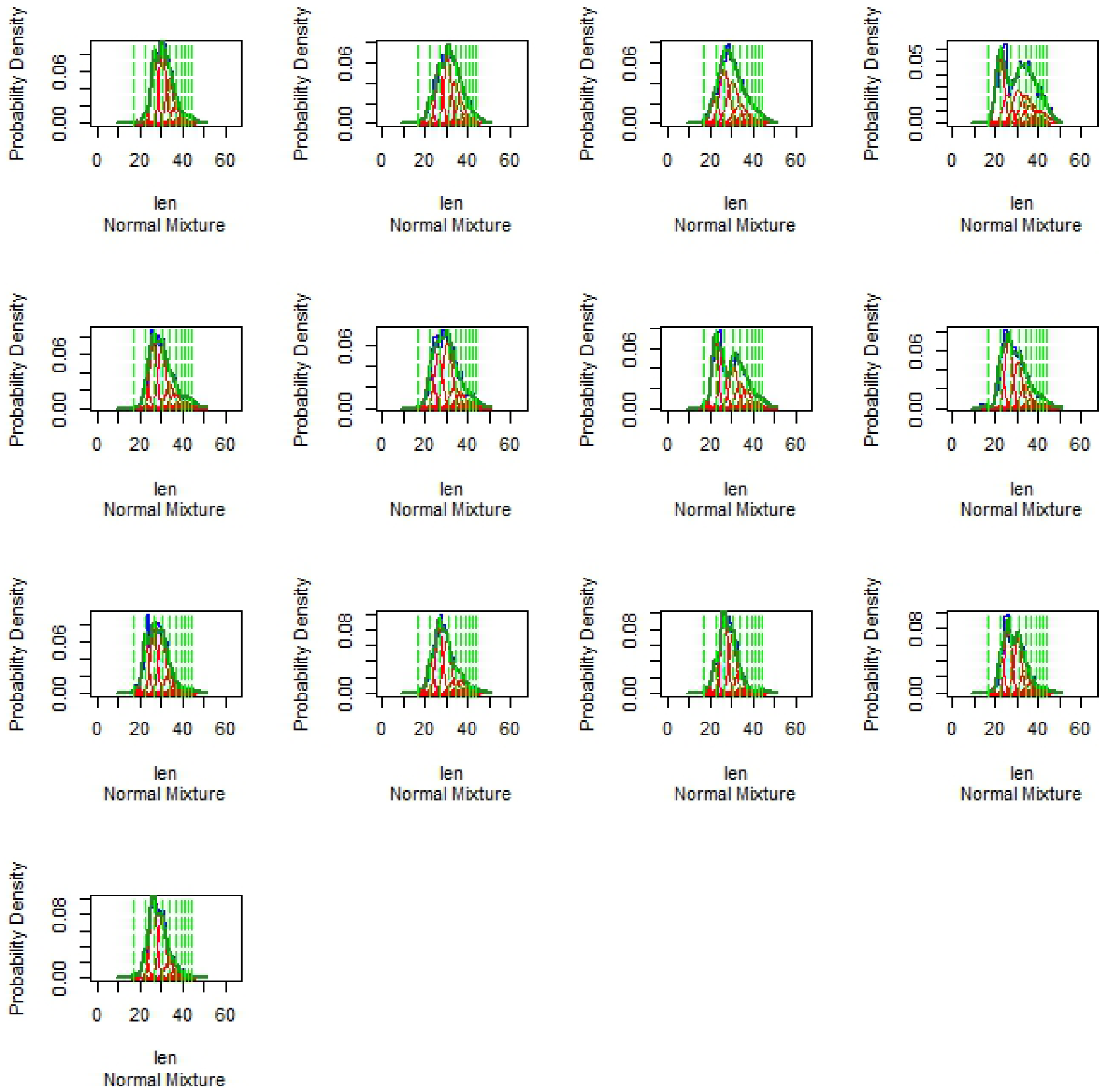


Figure 3.1. Flounder in SD 22–23. Final model: length–frequency distribution of the catches from 2000 to 2012 fitted with the statistical slicing method using the normal distribution, constant coefficient of variation for the different cohorts and fixed specified means of the cohorts. The red triangles on the x-axis indicate the position of the mean of each cohort. The green vertical lines indicate the mean length for each cohort estimated by the von Bertalanffy growth curve. The blue line indicates the accumulated distribution by length for all age classes. The tick green lines indicated the total length–frequency distribution as estimated the statistical slicing final model.

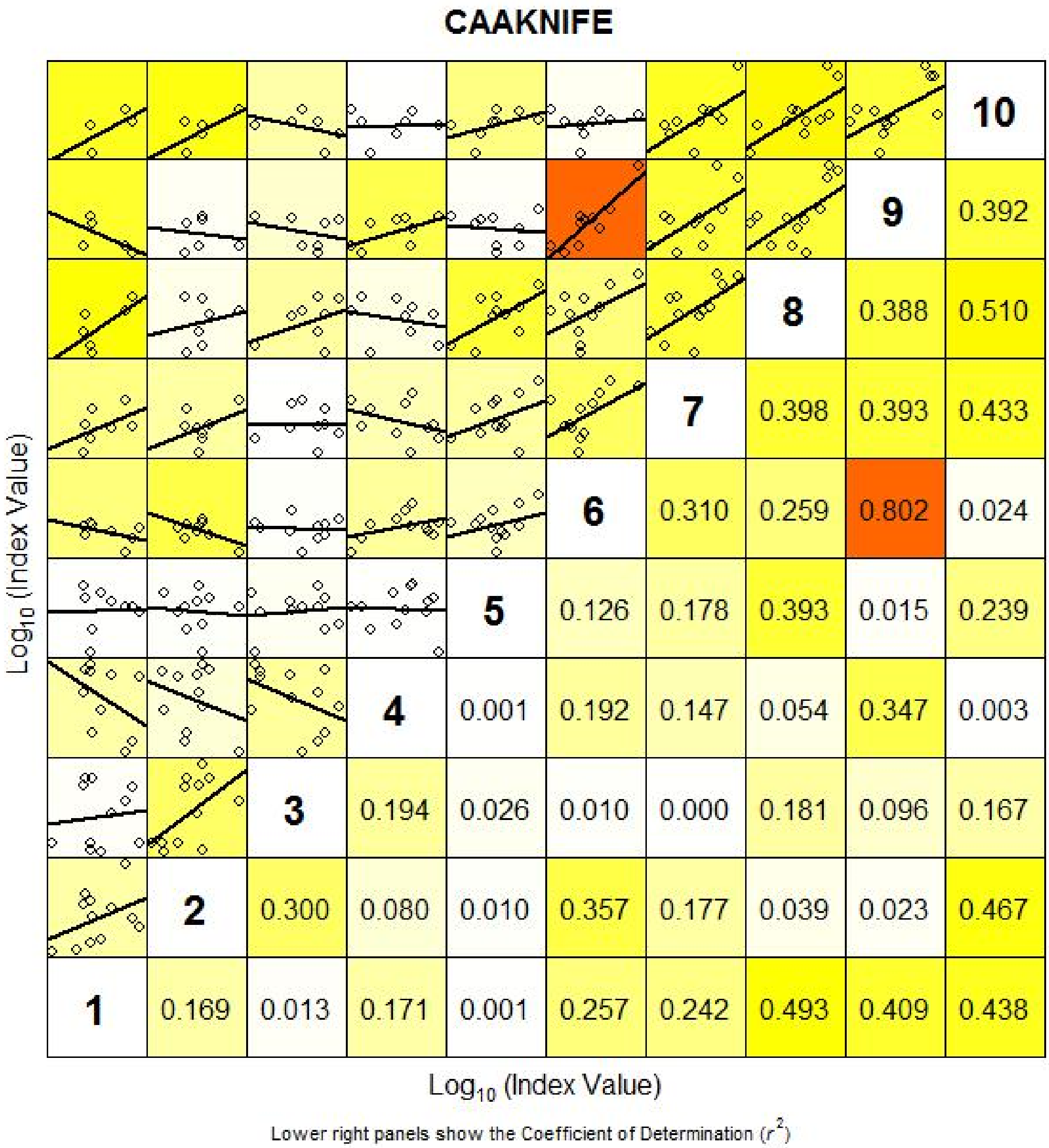


Figure 3.2a. Flounder in SD 22–23. Internal consistency plot of the final model for the catch-at-age estimated with the knife-edge model (i.e. CAAKNIFE).

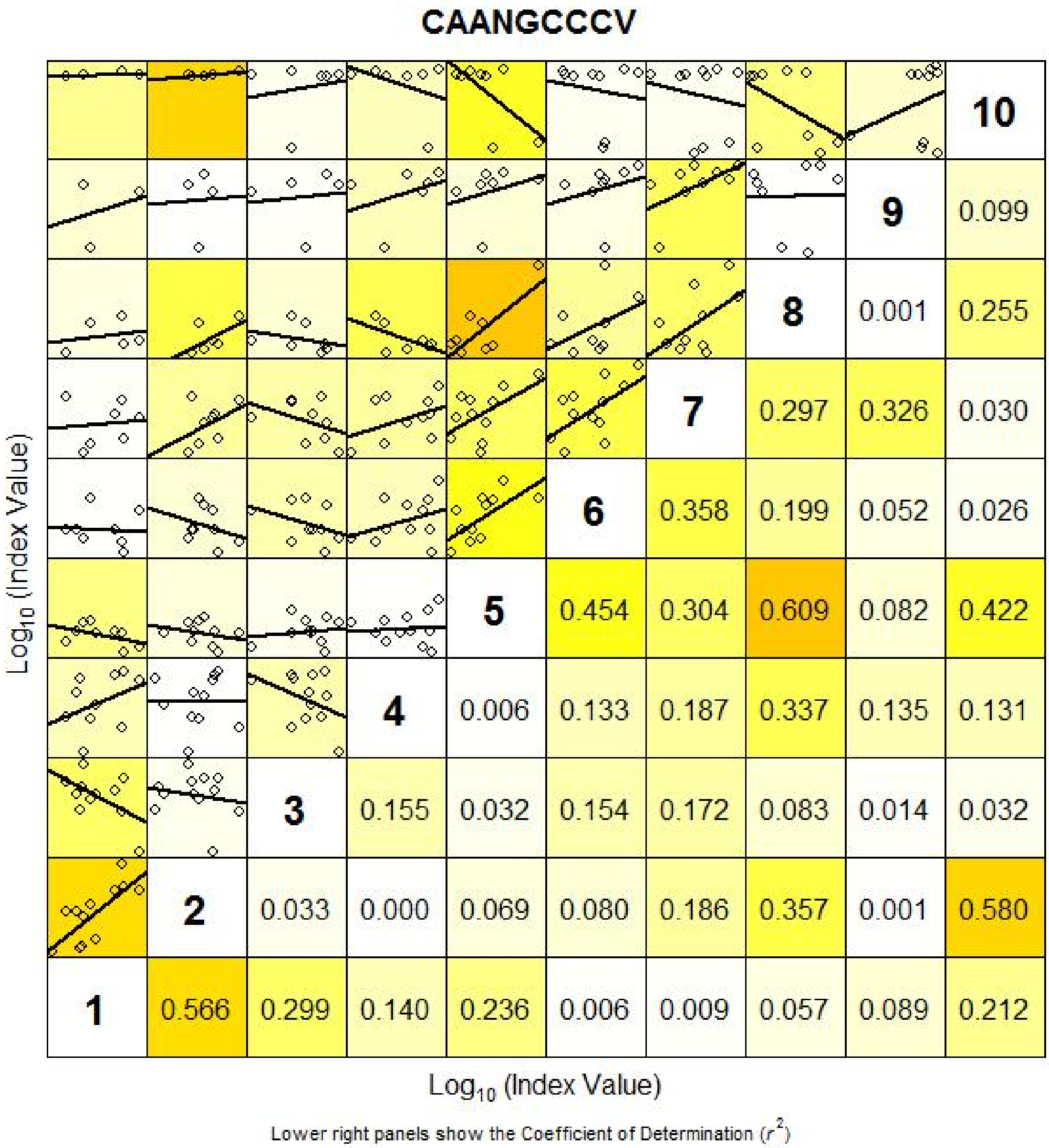


Figure 3.2b. Flounder in SD 22–23. Internal consistency plot of the final model for the catch-at-age estimated with the statistical slicing model fitted using the normal distribution, constant coefficient of variation for the different cohorts and fixed specified means of the cohorts (i.e. CAANGCCCV).

3.4 Conclusions

The fitting of the statistical slicing was generally statistically satisfactory and the results obtained (i.e. the number-at-age matrix from the catches and from the surveys) were used for exploratory analysis in the SAM models. Due to more general issues with input data, for example related to discards (see Chapter 2), the analyses were not put forward to be used in the final assessment.

Further, it is important to highlight that due to time constraints, only some of the statistical slicing model settings were tested for each of the analysed stocks (i.e. flounder in SD 22–23, 24–25 and 26 and 28, dab in SD 22–23). Thus, if the statistical slicing method should be used in the future to derive the historical part (i.e. when age–length keys from otoliths are not available) of the number-at-age for the catches and the surveys, it is important that more model settings are tested than done during WKBALTFLAT. Moreover, it is also crucial that the results obtained from any slicing methods (i.e. knife edge and/or statistical), in terms of number-at-age, are compared with the number-at-age structure derived from otolith readings for the same sample.

4 Dab in Subdivision 22–32

4.1 Stock ID and substock structure

Dab is mainly captured in SD 22. Only low landings were reported in SD 24 and more eastern located SDs. The eastern border of dab occurrence is not clearly described. Single specimens are caught only occasionally in the Polish EEZ (unpublished data, E. Gosz) as well as in SD 26–32 (Plikšs and Aleksejevs, 1998; Ojaveer *et al.*, 2003).

Temming (1989) separated dab in the Baltic Sea area (SD 22 and western part of SD 24, south of Mön) from dab in the Bornholm area (SD 25) mainly based on tags and meristic investigations by Jensen (1938). Nissling *et al.* (2002) proposed two stocks one in SD 23 and western part of SD 24, and the second in the eastern part of SD 24 and SD 25 based on salinity requirements for the mobility of spermatozoa and neutral egg buoyancy. They reported that dab eggs are neutral buoyant at salinity of 26.4 psu and 21.0 psu in SD 24 and SD 25, respectively. About 1% of eggs will obtain neutral buoyancy at 17.8 psu.

For dab there are no data on genetics and no direct comparisons has been made between SD 23 and 22. Nevertheless, based on the data above (Temming, 1989; Nissling *et al.*, 2002) WKFLABA suggested that there are three stocks in the Baltic Sea (Figure 1 in ICES, 2010). One stock in Baltic Sea SD 22 and 24W, one stock in Öresund SD 23 and one joint stock in Arkona and Bornholm basin (SD 24E and 25). It is unclear where the split of SD 24 would be located. WKFLABA (ICES, 2010, 2012a) considered that it is possible that the Öresund stock should be merged with the Baltic Sea stock but merging stocks that have independent dynamics can be considered as more severe error from a stock conserving point of view, than to erroneously divide a homogenous stock in two separate assessment units (c.f. Laikre *et al.*, 2005).

During WKBALFLAT, analyses were conducted on hydrographical data in SD 24 and 25, the spatial distribution of dab in the Baltic Sea during the Baltic International Trawl Survey (BITS) in quarter 1 (BITS-Q1) and 4 (BITS-Q4) as well as the spatial distribution of dab in the North Sea, Skagerrak and Kattegat during International Bottom Trawl Survey (IBTS) in quarter 1 (IBTS-Q1) and 3 (IBTS-Q3) to evaluate possible relations between dab in the Baltic Sea and in the Kattegat (Figures 4.1, 4.2).

Salinity (psu) at the standard stations TF 0113 in the Arkona Sea and TF 0213 in the Bornholm Sea of the Institute of Baltic Sea Research-Warnemünde in the near bottom layer were in some cases above 17.8 psu where ~ 1% of dab eggs will obtain neutral buoyancy. However the salinity was always lower than the required mean salinity of neutral buoyancy of 26.4 psu and 21.0 psu for SD 24 and SD 25, respectively (Nissling *et al.*, 2002) (Table 4.1). The required values of salinity were also not observed after the major inflow in 2003.

The density of small dab (<20 cm) and large dab (≥20 cm) were very low or zero in the Arkona Basin and Bornholm Basin during the BITS in quarter 1, also in the years where salinity was above 17.8 psu (Oeberst, 2014 a, WD 4.1). The hydrographical conditions and the density of dab during the prespawning period in the Arkona Basin and the Bornholm Basin do not support the hypothesis of WKFLABA (ICES, 2010) that a self-reproducing dab stock exists in SD 24E and 25.

Further, BITS in quarter 1 and 4 between 2001 and 2013 were used to describe the spatial distribution of dab smaller than 20 cm and larger or equal to 20 cm in SD 21–

28 (Oeberst, 2014a, WD 4.1). High cpue values of large dab were regularly observed in SD 21 to SD 23 in quarter 1 and 4. Significantly lower densities were found in western part of SD 24 (west of the Darßer Sill). Only single individuals were captured in SD 24 east of the Darßer Sill and in SD 25. Thus, based on hydrographical conditions and low densities of dab in SD 24–25, WKBAFLAT decided to treat the area of SD 22–32 as one stock.

The spatial distribution patterns of both length ranges of dab from 2001 to 2013 suggest connection of dab between SD 21 and the Baltic (SD 22–32). The spatial distribution patterns did not indicate areas of concentration of dab in SD 21 and SD 22, which would suggest that these areas are clearly spatially disconnected (e.g. quarter 4 in 2001, quarter 1 in 2004), although dab is relative patchy distributed in some cases during the BITS of both quarters.

Cpue values of dab in quarter 1 were highest in the deepest parts of the North Sea and in the southern part of the Kattegat, and the cpue values were low in the Skagerrak in the same period (Oeberst, 2014 b, WD 4.2). In contrast to this high cpue values were also registered close to the Danish coast in quarter 3 and higher cpue values were observed around of Skagen. The distribution patterns of quarter 3 suggest a possible exchange between dab in the North Sea and the Kattegat. However, the low densities of dab in the Skagerrak in quarter 1 suggests that dab in the Kattegat is more related to dab in SD 22–32 than with dab in the North Sea.

Conclusions

The decision on WKBALFLAT in terms of stock units of dab deviates from the proposed three stock units proposed by WGFLABA (ICES, 2010). The hydrographical conditions do not support the existence of a stock in SD 24 E and SD 25 (Table 4.1) and the spatial distribution during BITS of quarter 1 and quarter 4 did not support a separate stock in SD 23 (Figure 4.1 as example, Oeberst, 2014 a, WD 4.1). Thus, WKBALFLAT decided to treat the area of SD 22–32 as one stock. The spatial distribution of dab during IBTS in quarter 1 and 3 and BITS in quarter 1 and 4 support the hypothesis of close relations between dab in the Baltic Sea and dab in the Kattegat (Figure 4.2 as example, Oeberst, 2014 b, WD 4.2).

However, the group agreed that assessment of dab stock should be conducted for the unit SD 22–32 until additional analyses also support the connection between SD 21 and SD 22–32 are performed.

Table 4.1. Salinity (psu) and oxygen content (ml/l) in the near bottom layer at the standard stations of the Institute of Baltic Sea Research-Warnemünde in the Arkona Sea (TF 0113, 54° 55.5′N, 13° 30.0′E, depth of 44 m) and the Bornholm Sea (TF 0213, 55° 15.0′N, 15° 59.0′E, depth of 83 m) in spring between 2001 and 2012.

Year	Month	Arkona Sea		Bornholm Sea	
		Salinity	Oxygen content	Salinity	Oxygen content
2001	March	19.63	6.29	16.31	7.35
2001	May	18.35	4.15	16	0.55
2002	March	14.75	5.68	15.46	1.14
2002	May	14.32	6.3	16.66	0.12
2003	April	20.99	4.8	19.4	10.59
2003	May	19.02	3.86	19.28	5.27
2004	March	14.18	7.82	19.95	0.34
2004	April	11.98	3.81	16.51	1.65
2004	May	11.9	6.73	17.35	0.85
2005	April	11.98	8.12	16.52	0
2005	May	18.26	7.08	16.18	-0.47
2006	February	18.14	6.16	17.12	0.87
2006	May	16.56	6.12	16.23	0.06
2007	March	19.43	7.52	16.21	0.85
2007	May	17.83	3.73	16.4	0.08
2008	April	15.33	6.74	16.19	3.09
2008	May	17.21	3.76	15.76	1.56
2009	March	12.51	7.5	15.45	1.8
2009	May	13.89	5.71	15.87	0.31
2010	March	16.59	7.8	15.8	1.68
2010	May	18.64	7.19	16.55	0.39
2011	March	11.8	9.15	15.34	0.28
2011	May	8.43	7.07	14.62	1.57
2012	February	17.4	4.93	16.24	4.13
2012	March	16.31	7.23	15.8	2.97
2012	May	14.94	3.69	15.57	2.81

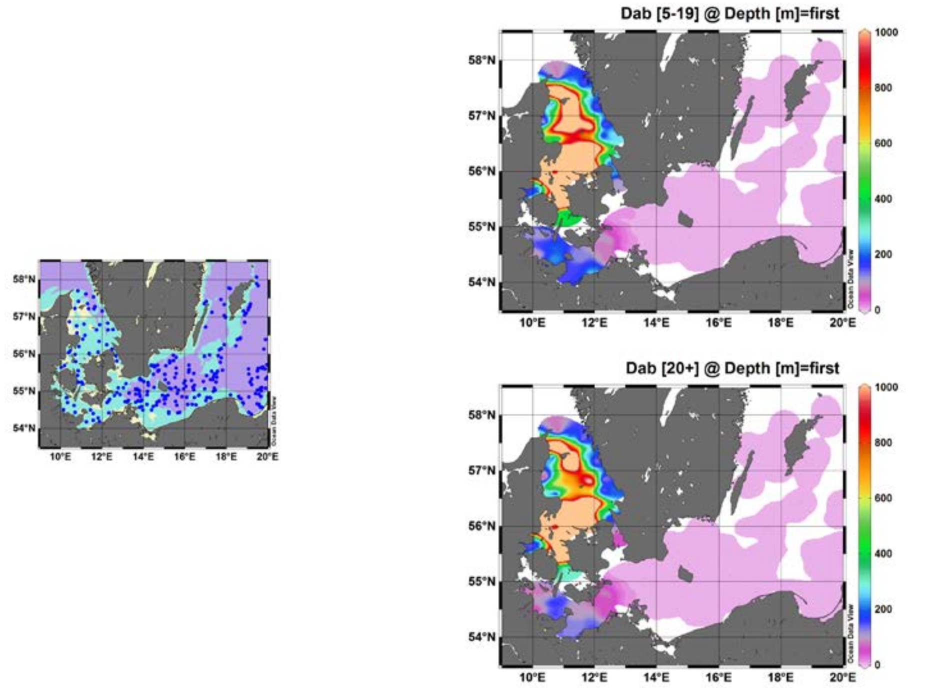


Figure 4.1. Position of fishing stations (left panel) and spatial distribution of dab <20 cm (right upper panel) and dab >19 cm (right lower panel) during BITS in quarter 1 in 2013.

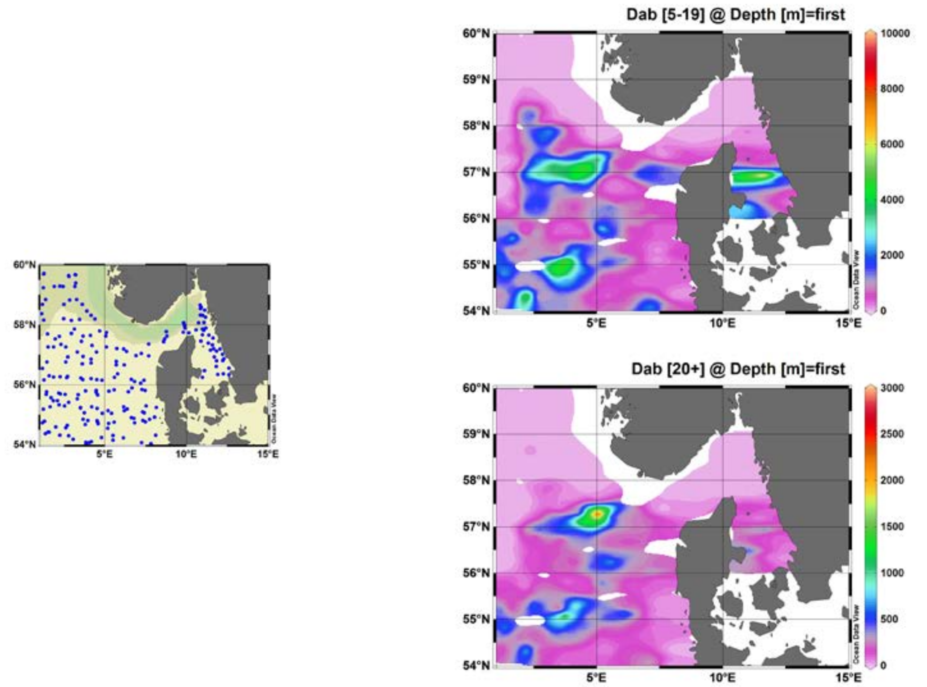


Figure 4.2. Position of fishing stations (left panel) and spatial distribution of dab <20 cm (right upper panel) and dab >19 cm (right lower panel) during IBTS in quarter 1 in 2013.

4.2 Issue list

The following issues were identified for dab during last year's WGBFAS in planning for WKBALFLAT:

STOCK	DAB 22-32 (21-32)	
Stock coordinator	Name: Rainer Oeberst	E-mail: rainer.oeberst@ti.bund.de
Stock assessor	Name: Rainer Oeberst	E-mail:
Data contact	Name: Rainer Oeberst	E-mail:

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			
	Prey relations	Look into literature New stomach data available?		Marie Storr-Paulsen Rainer Oeberst
	Ecosystem drivers			
	Other ecosystem parameters that may need to be explored?			
Tuning series	2 surveys (2 BITS)	Include < 20 cm Dab	Data is available	Exchange data based on DATRAS indices by SD (CF presently not in DATRAS!)
Discards	Discard is high (from Denmark and Sweden) but not used presently	Discard should be included Survival rate (Rainer translate the German work)	Data is available (2000– present) Denmark and Sweden	Request to be sent to Sweden, Germany and Denmark. (Inter catch) back to 2000
Biological Parameters	Sex ratio from survey Maturity ogive Stock weight by sex	Data should be in DATRAS	Rainer (Germany)	Request to Sweden, Denmark and Germany check DATRAS flatfish
Assessment method (Age / length)	Length / age based assessment	Length distribution from commercial landings Denmark (1987-2013) Germany (1995-2013) Germany (5 years of age readings) Denmark (2 years of age readings)	Denmark / Germany Apply length and age data to InterCatch (if possible by sex)	Assessment person familiar with length based assessment. (at the data preparation work shop)

4.3 Multispecies and mixed fisheries issues

Dab is captured as bycatch in cod, plaice and flounder fishery, thus the development of the dab catch is strongly influenced by these other fisheries.

4.4 Ecosystem drivers

Inflow of highly saline waters with high oxygen content from the Kattegat into the Baltic Sea, the Arkona Sea and more eastern located areas can slightly improve the probability of the neutral buoyancy of dab eggs in SD 22–25. However, the major inflow in January 2003 (Table 4.1) did not improve the hydrographical conditions in such a way that successful and stable reproduction of dab in SD 24 and SD 25 is probable (according to thresholds of mean salinity of neutral buoyancy of 26.4 psu and 21.0 psu for SD 24 and SD 25, respectively).

4.5 Exploratory Assessment analysis

4.5.1 Catch-quality, misreporting, discards

Dab is mainly landed in SD 22–24 where between (Figure 4.3) 86% and 100% of total landings were realized by Denmark and Germany. The landings of Sweden in SD 22–30 are of minor importance. After high level of about 2000 t between 1981 and 1997 landings decreased to 715 t in 2002 followed with fluctuating landings around 1250 t with increasing proportions of landings in SD 25. Estimates of the amount of discards in 2011 and 2012 showed that in some periods more or equal amount of dab was discarded as landed. It was agreed that discarded also landed dab should be taken into account for describing the removal of dab from the stock by fishery because the survival rate of discarded dab is very low (Mieske and Oeberst, 2014; WD 2.1). Therefore, landings and discards were required in the data call for WKBALFLAT, from 2000 onwards.

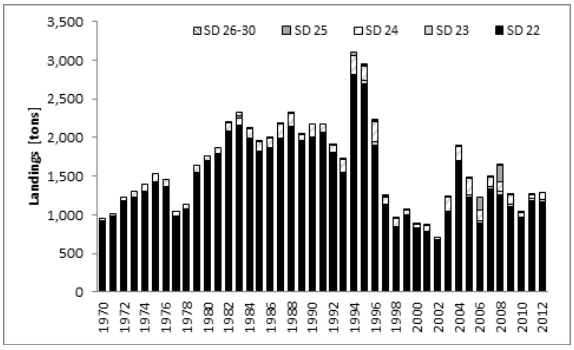


Figure 4.3. Landings of dab (tons) by ICES subdivisions from 1970–2012.

The preparation of the data showed large problems in the available data:

- Landings were reported in many cases, but the estimates of discards were not available;
- Length frequencies of the reported landings and discards were not available;
- Age-based estimates of catch in numbers (CANUM) were only reported by Denmark from 2010 to 2012 and by Germany from 2008 to 2012 in some cases.

Figure 4.4 presents an overview of the reported landings and discards by year, quarter and fishery for Danish and German dab fishery in SD 22. In many cases discards were not reported, but, landings were also not available in some cases. Detailed descriptions of the available data and resulting discard estimates are presented in Oeberst (2014 c, WD 4.3). The estimation of not reported discards based on the relation between landings and discards of other years produces uncertain estimates due to the high variability of the quotient discards / landings from year to year (see Section 2).

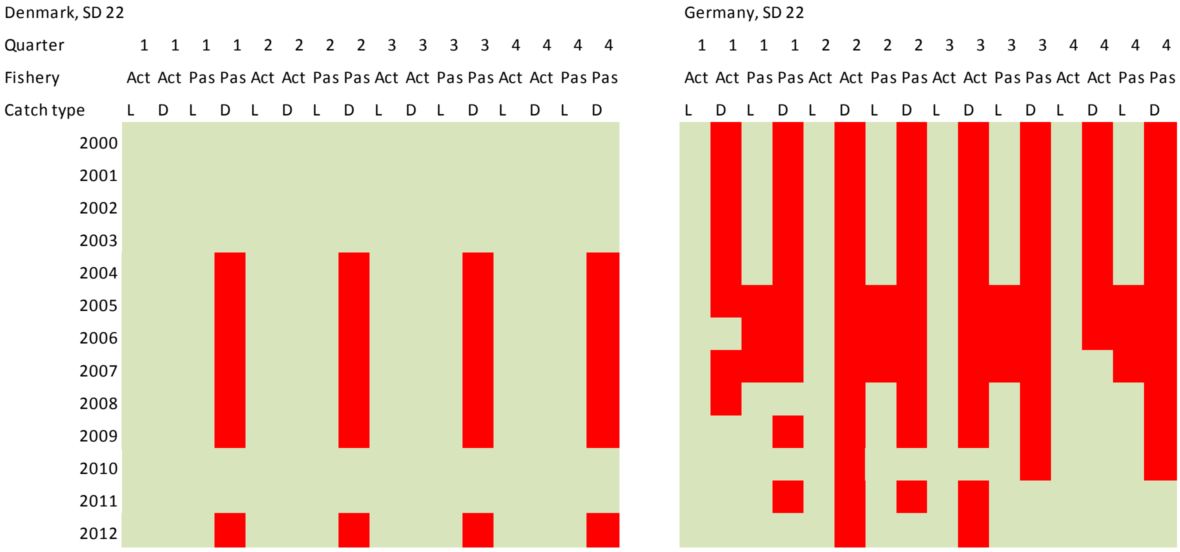


Figure 4.4. Overview of reported landings (L) and discards (D) by year, quarter and fishery (Active and Passive) for Danish and German data in SD 22 (- data are reported, - not data available).

4.5.2 Surveys

Trawl surveys were initiated in the Baltic Sea by Poland in 1976. Other countries established their own national surveys some years later. They used different national gears and different periods within the quarter 1 (Q1) and 4 (Q4). The coverage of the Baltic Sea was significantly higher during the surveys in quarter 1. Internationally coordinated Baltic International Trawl Surveys (BITS) were established in 2001 to coordinate the national surveys and one year later the surveys were coordinated by the ICES Working Group "Baltic International Fish Survey" (WGBIFS). Since 2001 all participating countries used standardized gear types, the haul positions and the periods of the surveys were coordinated. The main target species of the surveys was cod, but, flounder and all other flatfishes were also recorded according to the manual of the BITS (ICES 2013). The total number of planned stations is allocated to the ICES subdivisions and the depth layers according to agreed procedure (ICES 2013). The allocation is based on the area of the depth layers and the mean density distribution of cod in quarter 1 during the last five years. The distribution patterns of flounder were not taken into account during the planning of the surveys due to lower commercial importance. BITS-Q1 is carried out between middle of February and end of March. The survey is immediately carried out before dab starts spawning in April (Muus and Nielsen, 1999). The estimation of the mean catch per hour (cpue) by length and haul, depth strata and ICES SD is described in the BITS manual (ICES, 2013a). The estimates are provided by ICES at the DATRAS website.

4.5.3 Age-length information

Age of dab have been determined by Germany in SD 22 and SD 24 since 2008 by means of slices of the otolith centre and by Denmark in SD 22–23 since 2010 based on whole otolith. Estimates of the mean length-at-age showed strong differences between the estimated mean age of Denmark and Germany (Figure 4.5, Oeberst, 2014 d, WD 4.4). Inter-calibration experiments of ageing of dab based on both methods of ageing are planned for the future to improve the age based estimates. Repeated ageing of dab by German readers showed an agreement of ~70% between the first and the repeated readings. In addition, the agreement between both readers was ~80%.

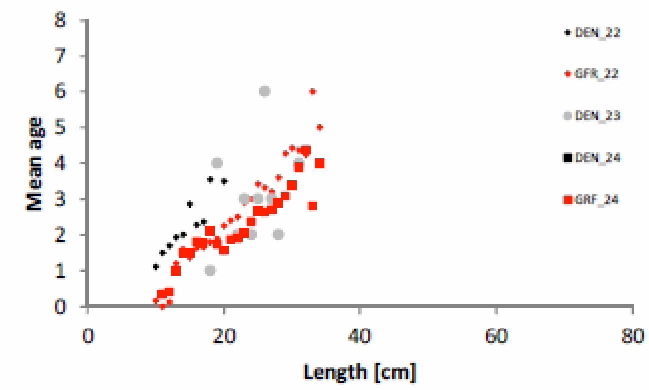


Figure 4.5..: Development of mean age-at-length of dab by year, quarter, SD and country for the western Baltic Sea in quarter 4 in 2011.

Length frequencies of dab landings and discards together as well of BITS abundance indices were used to estimate the number by age groups by slicing the length frequencies into age groups for years where age data were not available. Different approaches were applied. Method 1(described in detail in Section 2.2.3) assumes that the length frequencies of age groups are normally, lognormally or gamma distributed. In addition, different settings were used to get the most appropriate approximation of the observed length frequencies. In one case it was assumed that the relation between the standard deviation and the mean length of length frequencies is constant. That means that the standard deviation increases with increasing mean length. Alternatively, the mean length of each age group was estimated based on the parameters of von Bertalanffy growth function (BGF) and the standard deviation of the length of age groups were not restricted. Method 2 assumes that length frequencies of age groups are normally distributed. In addition, information from the BGF was used as start point of the approximation process. It was further required that the estimated mean length of the age group is located within the interval [mean length based on BGF ± 2.5] and the standard deviation of the age groups were restricted to [1.5, 4]. The estimated intervals were estimated based on the parameters of the BGF (Oeberst, 2014 e, WD 4.5).

Length and age-based data of dab were available from Germany BITS in SD 22 between 2008 and 2012. These data were used to estimate the number of age groups, N(a), the mean length of age groups, L(a), and the standard deviation of the length of age groups, S(a) based on the standard method given in the BITS manual. In addition, the length frequencies were used to estimate the same age based parameters N(a), L(a) and S(a) by means of the above describe methods of slicing to assess the quality of the results of the different slicing methods.

The relative length frequencies of the different years were similar (Figure 4.6) with maximum values between 12 cm and 16 cm followed by strong decrease of the cpue values per length class. The relative age frequencies based on age data (Figure 4.7–4.9, lines) varied from year to year, with two groups of similar age frequencies apparent (2009 and 2010–2008 and 2011 and 2012). In contrast to this the relative age frequencies based on Method 2 are stable over the total period. The relative age frequencies based in slicing Method 1 were dominated by age group 1. The effect of the different setting used for the approximation concerning the relative age distribution seems to be low. On the other hand the development of the S(a) values were different.

Due to large difference between results from the different slicing methods and from those based on age readings, the group concluded that the slicing methods will not be used for the final assessment. An exploratory assessment with the obtained age frequencies was conducted at benchmark. Resolving age reading inconsistencies between GER and DK would first be needed in order to obtain a solid basis for validation of the results from slicing methods in future.

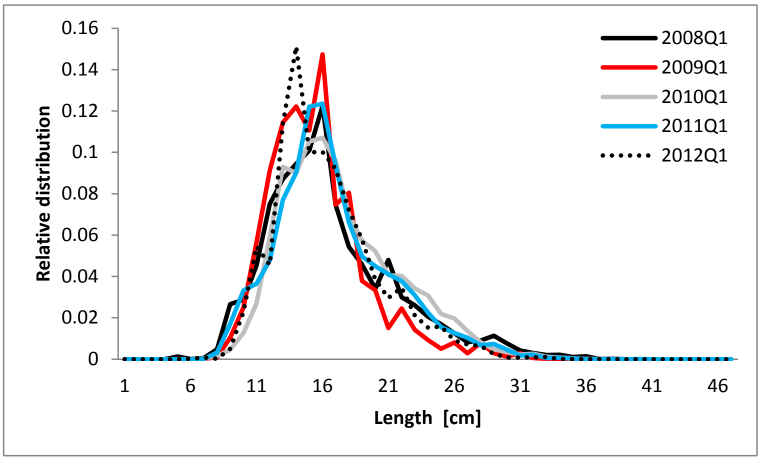


Figure 4.6. Relative length frequencies of dab in SD 22 of BITS in quarter 1 between 2008 and 2012.

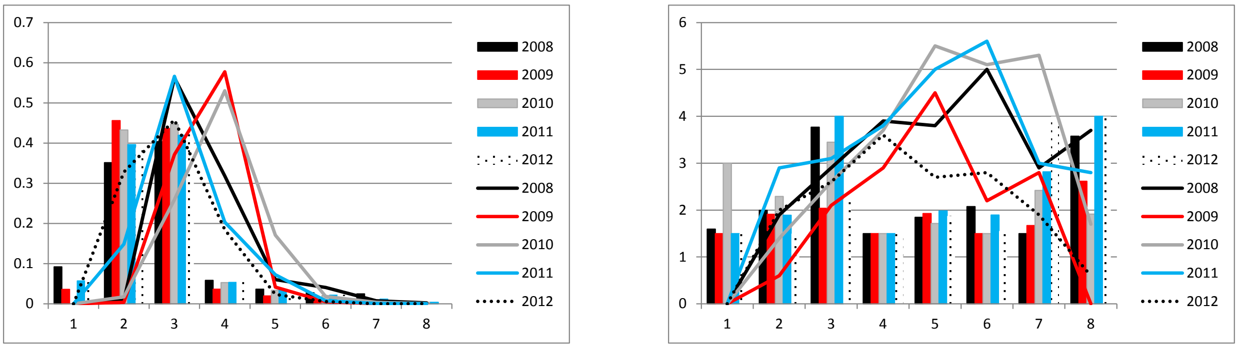


Figure 4.7. Relative age frequencies of dab in SD 22 in quarter 1 between 2008 and 2012 (left panel) and standard deviation of the length of age groups (right panel) based on the method given in the BITS manual (lines) and the Method 2 of slicing (bar).

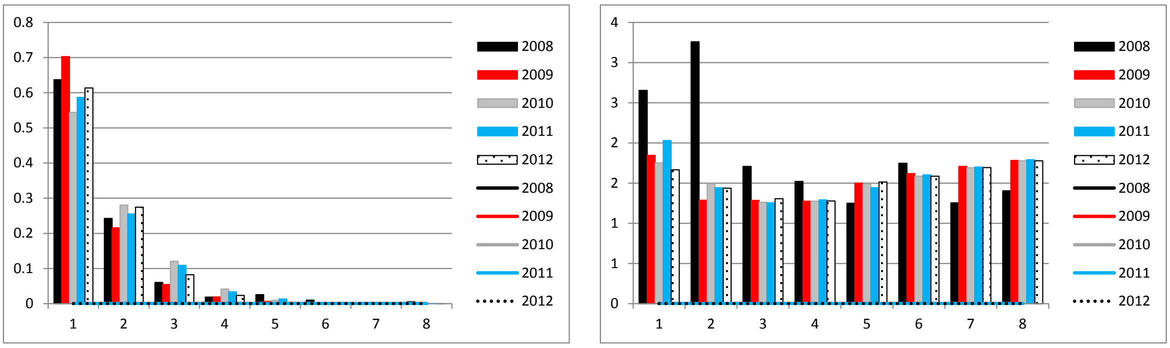


Figure 4.8. Relative age frequencies of dab in SD 22 in quarter 1 between 2008 and 2012 (left panel) and standard deviation of the length of age groups (right panel) based on the Method 1 of slicing with mean length of age groups based on BGF and no restrictions concerning the standard deviation of the length of age groups.

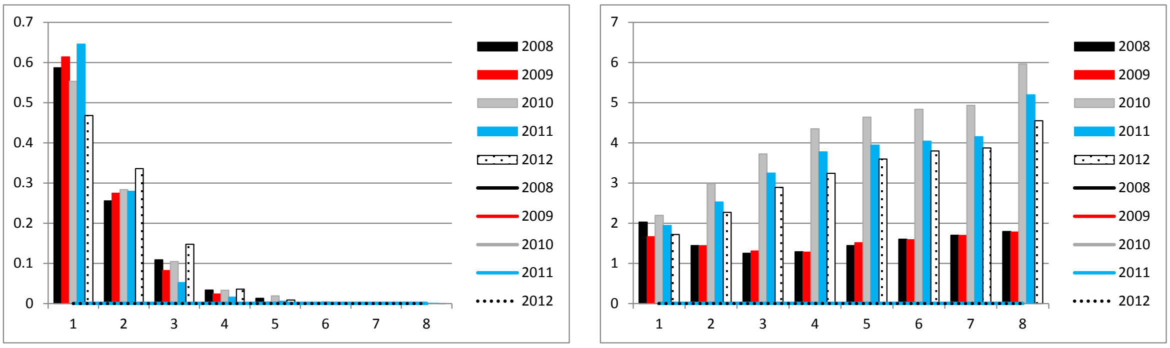


Figure 4.9. Relative age frequencies of dab in SD 22 in quarter 1 between 2008 and 2012 (left panel) and standard deviation of the length of age groups (right panel) based on the Method 1 of slicing with constant relation between mean length and standard deviation of length.

4.5.4 Weights, maturities, growth

Weight–length relation of dab was estimated based on data available from BITS. The weight–length relationship of both sexes was used to estimate biomass index of the dab stock based on results of the BITS in quarter 1 and quarter 4. The mean differences between mean weight of female and male dab were larger than 100 g for dab >37 cm (Figure 4.10). The regression models were estimated with:

$W = 0.0077L^{3.122}$	BOTH SEXES
$W = 0.0079L^{3.100}$	male dab
$W = 0.0053L^{3.253}$	female dab

The minimum length of maturation varied by sex and SD with decreasing trends for both male and female dab in SD 24.

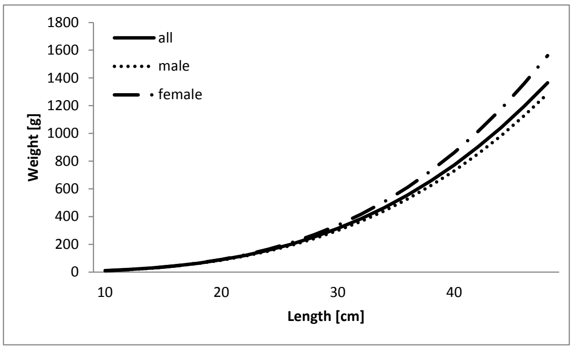


Figure 4.10. Weight–length relationship of dab by sex, based on data of BITS.

Table 2. Minimum length of maturation and L_{50} of the maturity ogive based on BITS in quarter 1 between 2008 and 2012.

SEX, AREA	MINIMUM LENGTH OF MATURATION	L_{50} OF MATURITY OGIVE
Male, SD 22:	~11 cm	19.5 cm–11 c,
Male, SD 24:	13 cm–9 cm, decreasing trend	18.5 cm–7.85 cm, decreasing trend
Female, SD 22:	14 cm–11 cm	19.4 cm–13.5 cm
Female, SD 24:	18 cm–13 cm, decreasing trend	22.5 cm–16.5 cm

Parameters of the different growth models were estimated based on all available length–age data (Figure 4.11, Oeberst, 2014, e). The variations between the regression functions in Figure 4.11 can be attributed to length ranges >30 cm and these are mirrored by the functions for age in month (Figure 4.12). The parameters of the BGF based on all data from both sexes are given below.

The BGF were used for slicing:

$$L = 43.30(1 - e^{-0.187(Age\_Month/12+0.631)})$$

However, it must be taken into account that the available age–length data do not present random sample due to the sampling strategy used in BITS. Therefore, the length frequencies of youngest dab is truncated by the selectivity of the used gear and the length frequencies of age groups are not normally distributed affecting the estimates of k and L_∞. In addition, small fluctuation of the parameters of BGF varied from year to year. Therefore, the estimated parameters of BGF present only a first approach of the BGF and variations of the estimated mean length-at-age and the standard deviation of the length frequencies of age groups must be further investigated.

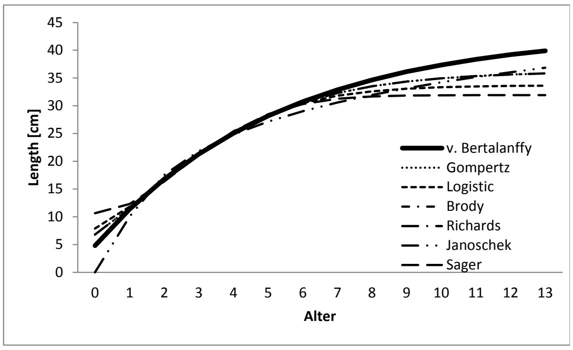


Figure 4.11. Growth function of different models based on 7776 age data from BITS in quarter 1 and 4 from 2008 onwards.

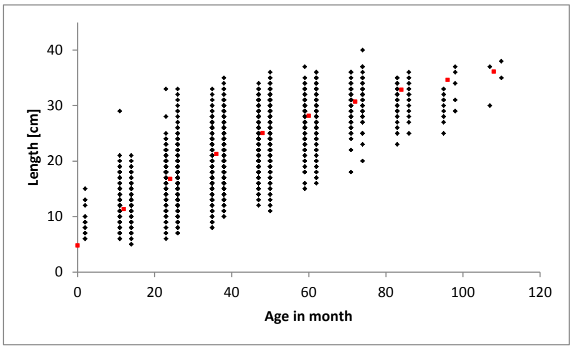


Figure 4.12. Relation between age in month and length based on BITS in SD 22–24 between 2008 and 2012 (black dots: observations, red dots: mean length of age groups at the beginning of the years based on Bertalanffy growth function).

4.5.5 Exploratory Assessment model (not for advice, but further development)

The aim of the benchmark workshop was to explore the possibilities to improve the available data-limited stock assessment to age-based analytical assessment. As a possible model SAM was taken into account, but, due to the uncertainty of estimated discards (missing data) and the uncertainty of the slicing method for transferring length frequencies into age frequencies it was agreed that the data-limited approach based on landings and stock indices will be used in the immediate future. However, exploratory assessment runs with SAM were conducted and further developments to improve the input data were strongly encouraged.

4.6 Proposed Assessment approach

Due to uncertainties in available discard estimates (see chapter 2), the WKBALFLAT concluded that these estimates should currently not be used for the purpose of advice. Thus, only landings advice can presently be provided.

The mean cpue per length per stock (SD 22–32) by quarter and year were combined with the mean weight–length relation based on data sampled between 2008 and 2012 to estimate relative the biomass of the stock. To get approximation of the spawning–stock biomass only dab larger than 14 cm were taken into account because more than 50% of dab >14 cm of both sexes were maturing during quarter 1 with high fluctuations from year to year. The estimated biomass were always significantly higher in quarter 4 (Figure 4.13), but, the indices of both quarters described the same temporal development. The geometric mean of the indices of quarter 1 and quarter 4 was used to provide a proxy to describe the development of the SSB.

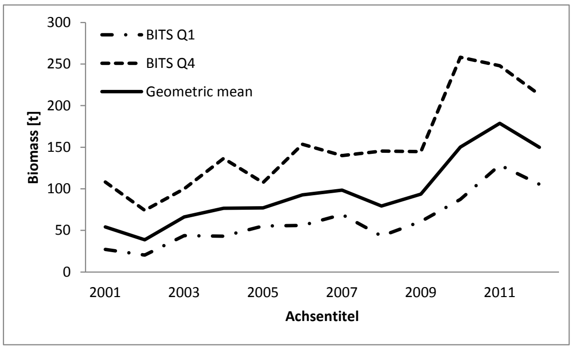


Figure 4.13. Development of the biomass (proxy for SSB) in tons of dab larger than 14 cm in quarter 1 and 4 between 2001 and 2012 as well as the geometric mean of both estimates.

4.6.1 Short-term projections

Not available.

4.6.2 Appropriate Reference Points (MSY)

Not available.

4.7 Future Research and data requirements

Three main points were identified as prerequisite of analytical assessments. i) Discards estimates need to be improved; ii) the ageing procedures of dab by Denmark and Germany must be verified and standard method for interpretation of the otolith structures must be agreed and regularly inter-calibration experiments must be established; iii) The application of the slicing of length frequencies is necessary because age data are not available for before 2008. Therefore, the most appropriate slicing approach needs to be identified, verified with age readings from the later years.

This is a prerequisite for future developments towards application of age-based assessment models (such as SAM) for this stock.

4.8 Recommendations

Although strong improvements were made concerning working up input data for an analytical assessment, the group recommends application of the data-limited approach (based on survey indices only) for advice. This is because of quality issues mainly with discards and age information. Further improvements in input data and conducting exploratory analytical assessment analyses, in parallel to survey based assessment, is recommended. This would facilitate possible transition to analytical assessment in future.

5 Flounder

5.1 Issue list

The following issues were identified for flounder during last year's WGBFAS in planning for WKBALFLAT:

Stock	**..........FLE 22-32....**	
Stock coordinator	Name: Didzis Ustups	Email: didzis.ustups@bior.gov.lv
Stock assessor	Name: Didzis Ustups	Email:
Data contact	Name: Didzis Ustups	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[3]	Additional M - predator relations			
	Prey relations	Look into literature New stomach data available ?		Marie Storr-Paulsen Rainer Oeberst
	Ecosystem drivers			
	Other ecosystem parameters that may need to be explored?			
Tuning series	2 surveys (2 BITS) National local surveys: Latvian- Juveniles Lithuania - Juveniles Estonia ? Germany – juveniles Russia (commercial CPUE SD 26) Latvia (commercial CPUE SD 28)	Include < 20 cm	Data is available from BITS **Formal request to :** Latvian- Juveniles Lithuania - Juveniles Estonia ? Germany – juveniles Russia (commercial CPUE SD 26) Latvia (commercial CPUE SD 28)	Exchange data based on DATRAS indices by SD (CF presently not in DATRAS !) Didzis
Discards	Discard is high (from Denmark and Sweden) but not used presently	Discard should be included Survival rate (Rainer translate the German work)	Data is available (2000 – present) Denmark and Sweden	

5.2 Stock ID of Flounder in the Baltic Sea

5.2.1 Background

Flounder is regularly distributed in all parts of the Baltic Sea, except in the northern Bothnian Bay, the eastern-most part of the Gulf of Finland and the deepest areas of the Gotland Deep. The stock structure of the flounder in the Baltic Sea is very complex. Stock identifications differ between studies relying on migration patterns (Aro, 1989), spawning behaviour (Nissling *et al.*, 2002) or genetic analyses (Florin and Höglund, 2008; Hemmer Hansen *et al.*, 2007).

In previous ICES/HELCOM workshops WKFLABA (ICES, 2010 and WKFLABA2 (ICES, 2012a) several assessment units were defined based on evidence from genetics, egg characteristics, fecundity, life-history characters and tagging (ICES 2010; ICES 2012a) (Table 5.1).

Table 5.1. Assessment units defined in WKFLABA (ICES, 2010) and WKFLAB2 (ICES 2012a).

Number of stocks	Stockname	ICES SD
five stocks with pelagic eggs	Belt Sea	22
	Öresund	23
	Southern Baltic	24+25
	Bay of Gdańsk	26
	Eastern Gotland	28 (26, 29)
six stocks with demersal eggs	Swedish east coast	27
	Latvian coast + Gulf of Riga + Hiumaa	28E+ 29SE
	Gotland Island	28 (27E)
	Åland	29,30
	Finnish coast of Gulf of Finland	32
	Estonian coast of Gulf of Finland	32

However, a review by SIMWG (ICES, 2012b) suggested that the evidence of separation between flounder with demersal eggs was only based on local tagging experiments and hence the exact differentiation into units could be questioned and therefore SIMWG suggested only one stock of flounder with demersal eggs. For the same reason, only evidence based on tagging, flounder in SD26 and SD 28 was merged, as was flounder in SD22 and SD23. Therefore the final suggested units by SIMWG were reduced to four stocks.

In the latest Advice from ICES all flounder in the Baltic Sea were considered as one stock (ICES 2013).

5.2.2 Stock definitions agreed at the WKBALFLAT Data Compilation Workshop 26–28 November 2013

In WKBALFLAT data compilation workshop we reviewed and re-evaluated the results from WKFLABA 2010, 2012 and SIMWG 2012 as well as the studies therein. We used the single assessment unit identified in ICES Advice 2013, i.e. one stock of Baltic Sea flounder in SD 22–32, as a starting point and all evidence of separation was compared to the default option of no separation. We also restricted the units to combinations of ICES Subdivisions (i.e. not allow splitting a given SD). This was a pragmatic decision since all fishery data are stored at SD level and more fine-scaled structures, although perhaps better reflecting true biological populations, would not be possible (and useful) for assessment purposes.

Results from the following stock identification methods were discussed:

- genetics;
- spawning time;
- tagging;
- growth;
- length-at-maturity;
- egg density;
- cpue survey;
- Sperm activity;

- fecundity.

Two ecotypes of flounder; pelagic and demersal spawners

From the literature, there are two sympatric flounder populations in the Baltic Sea, which differ in their spawning habitat and egg characteristics (Nissling *et al.*, 2002; 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 (the Baltic Proper includes the part of the Baltic Sea, from Åland Sea to the Danish sounds, with the Åland Sea, the Gulf of Finland and Gulf of Riga not included). Successful reproduction occurs down to salinity of 5–7 PSU. Pelagic spawners spawn at 70–130 m depth, and their eggs are neutrally buoyant at 10–20 PSU and require oxygen concentrations of 1–2ml/l for development (Vitins, 1980; Nissling *et al.*, 2002; Ustups *et al.*, 2013). Differences in egg and spermatozoa characteristics are summarized in Table 5.2.1.

Table 5.2.1. Reproductive characteristics from flounder sampled in different SDs. Data from Nissling *et al.* (2002).

VARIABLE	SD23	SD24	SD25	SD28
Salinity of Neutral Egg Buoyancy	26.1±0.8	15.2±1.9	13.9±1.5	20.3±1.1
Egg size	1.12±0.07	1.34±0.04	1.43±0.06	0.99±0.05
Lowest salinity of spermatozoa activation	11.6±1.0	11.8±0.6	10.3±1.3	3.4±0.3

In SD 28 both types exist, during spawning they are separated, with pelagic spawners in the deep-sea area and flounder with demersal eggs spawning in coastal areas. Size-specific fecundity differs between the two spawning types with higher fecundity in demersal spawners but no differences within ecotypes (Nissling and Dahlman, 2010, Figure 5.2.1.).

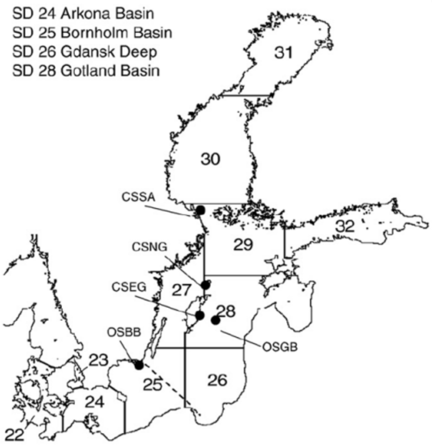


Fig. 1. The Baltic Sea with ICES subdivisions (SD) and positions of sampling locations; OSBB and OSGB (~53–90 m depth), and CSEG, CSNG and CSSA (~5–13 m depth). Dashed line indicates the distribution of coastal spawning flounder in the inner Baltic Sea according to Molander (1954).

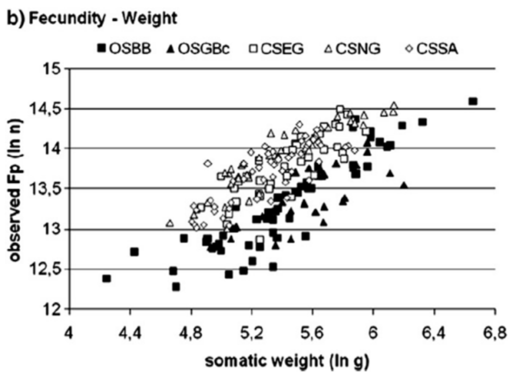


Fig. 4. Observed potential fecundity (Fp) in relation to a) total length and b) somatic weight of coastal- (CSEG, CSNG and CSSA) and offshore spawning (OSBB and OSGBc) flounder *Pleuronectes flesus*.

Figure 5.2.1. Map shows location of samples of flounders with pelagic eggs (Offshore Spawners, OS) and flounder with demersal eggs (Coastal Spawners, CS) and the diagram shows that the demersal spawners (white symbols) have higher size-specific fecundity than pelagic spawners (dark symbols). Figures from Nissling and Dahlman (2010).

There is also strong genetic evidence for separating these ecotypes into separate stocks (Florin and Höglund, 2008; Hemmer Hansen *et al.*, 2007a) with the pelagic spawners distributed in the southern and the deeper eastern part of the Baltic Sea and the demersal spawners in the northern area (Figures 5.2.2 and 5.2.3):

- Pelagic spawners in SD: 22,23, 24, 25, 26 & 28-2;
- Demersal spawners in SD: 27, 28-1 &29–32.

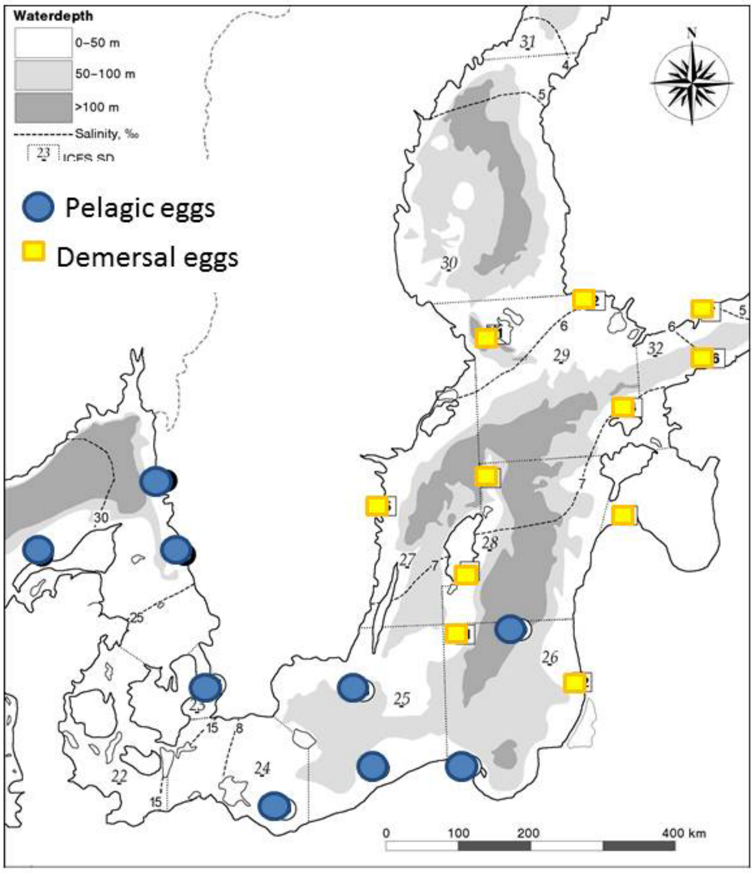


Figure 5.2.2. Map of sampling locations and identified populations according to microsatellite variation. The two distinct populations of flounder in the Baltic Sea correspond to distribution of flounder with demersal or pelagic eggs.

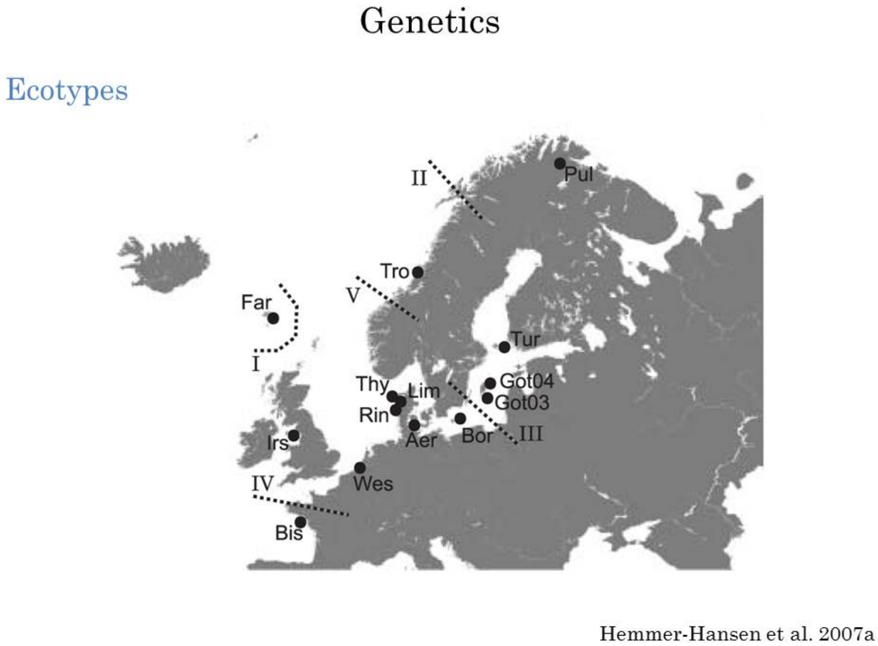


Figure 5.2.3. Map of sampling locations and major barriers to gene flow according to microsatellite variation, showing that the barrier in the Baltic Sea corresponds to distribution of flounder with demersal eggs or pelagic eggs.

There is a spatio-temporal overlap between the demersal and pelagic ecotypes, especially in SD 28 but the proportions of mixing are unknown. However, since landings in SD 28-2 are relatively large compared to these in the other SDs of the demersal stock it would overshadow the developments in “real” demersal component. Thus, to avoid the dynamics in the demersal unit to be very much driven by SD 28-2 (containing a mixture of the two ecotypes) it was decided that 28-2 was to be allocated to the pelagic unit. Flounder in the Gulf of Riga, SD 28-1, probably are of the demersal - coastal spawning type. However, since fisheries data for flounder currently are not divided into subunits of SD 28 it was later decided to allocate also the Gulf of Riga into the pelagic unit. The abundance of flounder in Gulf of Riga is low and therefore the impact of considering the SD 28 as a whole is assumed to be minimal.

During favourable hydrological conditions flounder with pelagic eggs may occur also in SD 29 and even spread into SD 32 during spawning season (ICES, 2010; Grauman, 1981). Furthermore during feeding migration flounder from the open Baltic Sea may enter the Gulf of Finland (Mikelsaar, 1958). The extent of this is unknown and therefore SD 29 and 32 are kept as belonging to the stock with demersal eggs.

Further splitting of ecotypes into management units

There is evidence of a differentiation between SD 22 and 23 from SD 24 and 25 based on egg buoyancy (Nissling *et al.*, 2002, Table 5.2.1), length at maturity (Table 5.2.2., Figure 5.2.4.) and to some extent genetics (Hemmer Hansen *et al.*, 2007b, Figure 5.2.5.). Although there is no physical connection between SD 22 and SD 23, flounders in these areas are considered to be connected through the western part of SD 24. The split of a given SD, in this case SD 24-west and SD 24-east, is not practical for assessment purposes as data are only available at the SD level. Therefore, although the western part of SD24 is recognized as being part of the flounder stock in SDs 22–23, the entire SD24 is assumed as representing the stock in SD 24–25, for assessment purposes.

Table 5.2.2. Range of length at 50% maturity for flounder in different ICES SD based on BITS Q1 2008–2011 (data from WKFLABA 2912, ICES 2012a). Flounder in SD 22 mature at a much greater size than flounders in other areas. No data from SD 23 & 27.

SD	22	23	24+25	26	27	28
LM50 (cm)	25–26		15–21	14–21		18–19

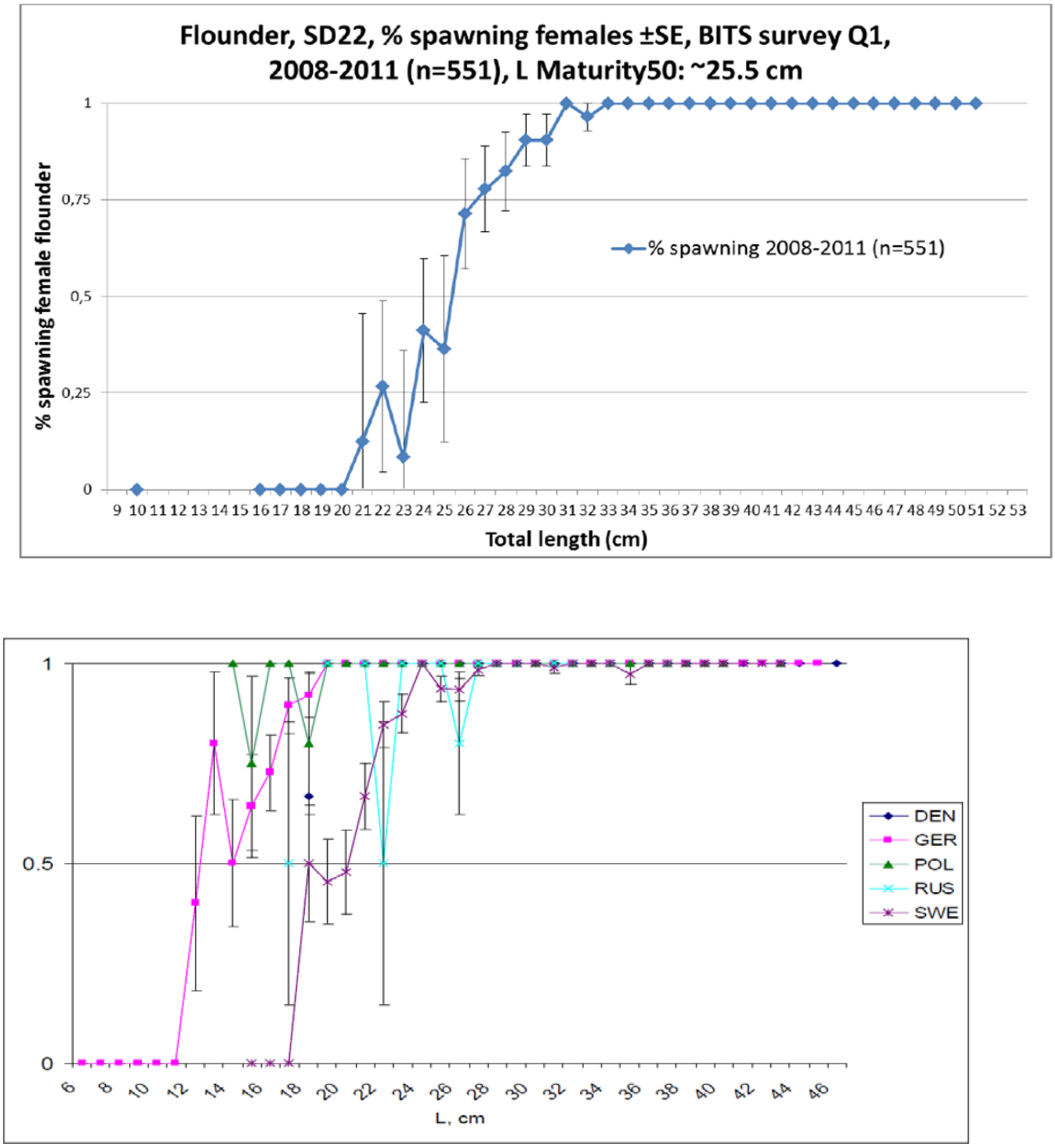


Figure 5.2.4. Length at 50% maturity from BITS Q1 2008–2011 in SD 22 (upper panel) and SD 24+25 (lower panel). Comparing German data from SD22 with SD 24 reveal large differences in size at maturity (25.5 cm in SD 22; 13.5 cm in SD 24+25).

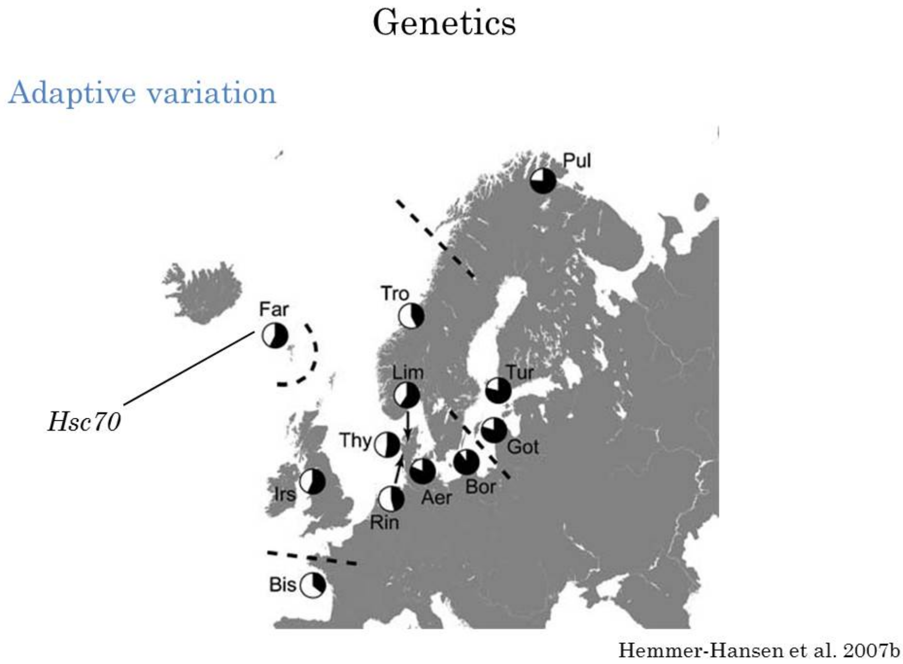
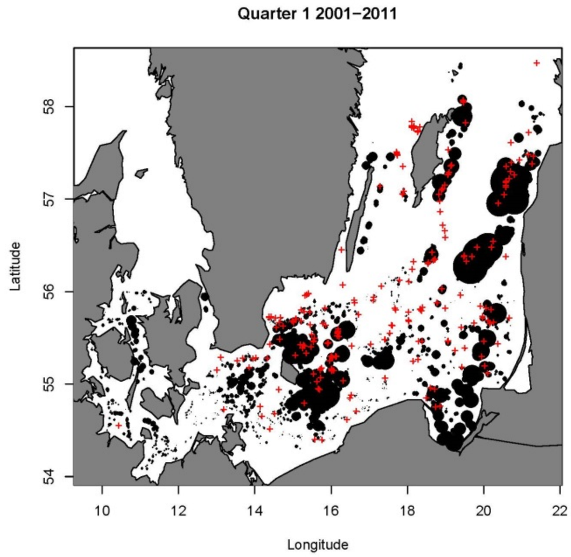


Figure 5.2.5. Variation in Heatshockprotein, which shows evidence of local adaptation within the pelagic flounder with a difference in genotype frequencies between the Bornholm and the Belt Sea sample.

The flounder in SD 24–25 is in turn differentiated from flounder in SD 26 and 28 based on separate spawning areas (Figure 5.2.6.), trends in survey cpue (Figure 5.2.7) and tagging data showing no dispersal between these areas (Cieglewicz, 1963; Otterlind, 1967; Vitins, 1976). At the data compilation workshop it was recommended to further examine these areas during the benchmark, to investigate whether a more consistent assessment and lower uncertainty in assessment is obtained when merging the two units.



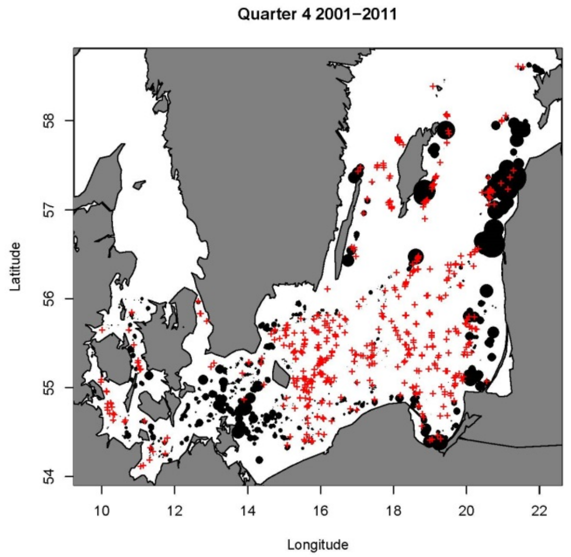


Figure 5.2.6. Average relative distribution of flounder biomass in BITS survey in Quarter 1 (spawning time) and quarter 4 from years 2001–2011. Bubble size is proportional to biomass, red crosses mean zero catch.

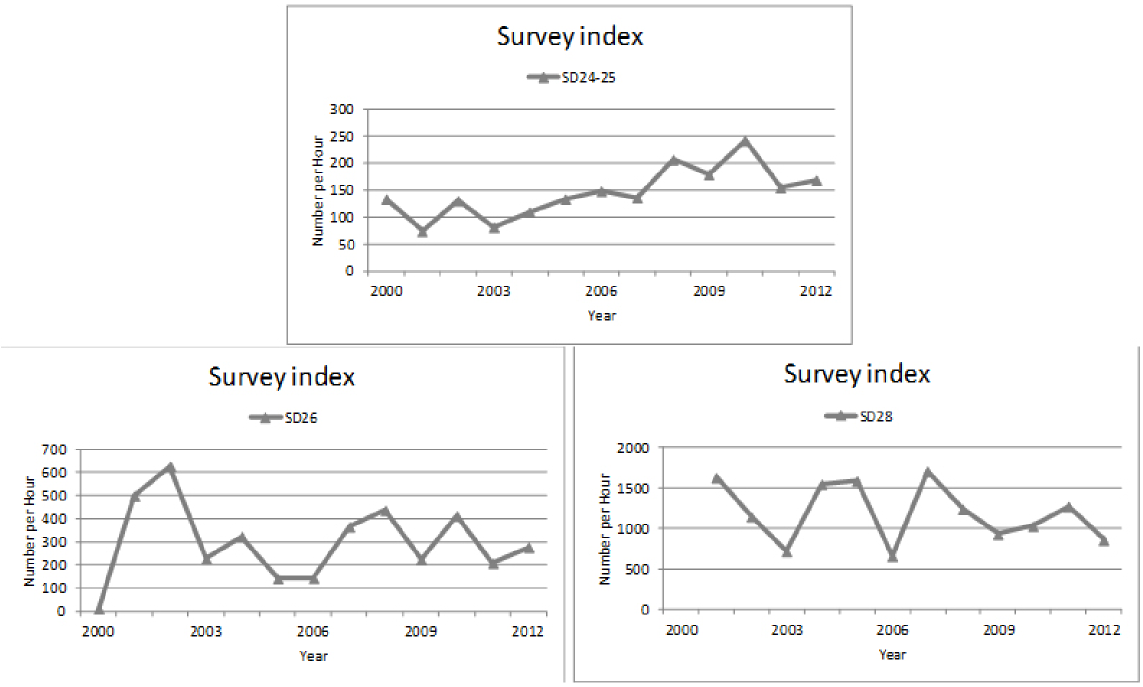


Figure 5.2.7. Survey indices from BITS survey q1 showing positive trend in SD 24+ 25 but no trend in SD 26 or 28. Data from ICES Advice (ICES, 2013).

For demersal type flounder, although tagging studies suggest limited dispersal between areas (see ICES (2010) for references), no other data are available supporting the identification of distinct stock units of demersal flounder. Furthermore due to very low landings in individual areas the split into several stocks is not practically feasible since it would result in data deficiency. Therefore demersal flounder was kept as a single stock.

5.2.3 Conclusion

Reviewing evidence of stock structure of flounder in the Baltic Sea the WKBALFLAT data compilations workshop came to the conclusion that there was evidence of three stocks with pelagic eggs and one stock with demersal eggs (Table 5.2.3.). The same as identified by SIMWG (ICES 2012b).

Table 5.2.3. Recommended stock units by WKBALFLAT.

Number of stocks	Stock distribution	ICES SD
three stocks with pelagic eggs	Belts and Sound	22+23
	Southern Baltic Sea	24+25
	Eastern Gotland and Gulf of Gdańsk	26+28
one stock with demersal eggs	Northern Baltic Sea	27, 29–32

5.2.4 Remaining issues

There is a need for future studies resolving remaining issues regarding flounder stocks in the Baltic Sea.

- Genetics:
    - Extent of spatial and temporal overlap between ecotypes in northern Baltic Sea Proper, especially the ecotype in SD 28;
    - Investigate adaptive variation for fine scale distribution of genomic patterns;
    - Large genetic difference between the Baltic and North Sea (Florin and Höglund, 2008), but uncertainty where the border is located;
- Moving borders of stock units due to spatially variable hydrological conditions;
- Extent of larval dispersal, resulting in exchange of recruits between the currently defined stock units (e.g. from SD 24–25 to other SDs);
- At the DCW, it was decided that the necessity to split between 24–25 and 26 and 28 should be further examined during the benchmark, whether a more consistent assessment and lower uncertainty in assessment is obtained when merging the two units. However, due to issues with input data for analytical assessments (described in further detail in respective stock sections), such analyses were not possible to conduct as part of the benchmark. Therefore, two different stocks were considered, one for SD24 and SD25 and another for SD26 and SD28.

6 Flounder in Subdivision 22–23

6.1 Multispecies and mixed fisheries issues

Flounder in SD22 and SD23 is caught as a bycatch-species in cod-targeting fisheries (trawls, active gears) and in a mixed-flatfish fishery (gillnetter, passive gears). 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. Due to the lack of a landing-obligation, the discarded fraction can cover all length-classes and rise up to 100% of a catch.

6.2 Ecosystem drivers

Not addressed at the benchmark.

6.3 Exploratory Assessment analysis

6.3.1 Catch– quality, misreporting, discards

The catch from commercial fisheries includes a landed and a discarded fraction. Misreporting of flounder landings may occur, where flounder and other flatfishes (plaice, dab) are mixed.

ICES Subdivision 22 is the main fishing area with Denmark and Germany being the main fishing countries. Subdivision 23 is only of minor importance as a fishing area, where Sweden is the main fishing country.

Annual landings in SD22 are available from 1974 onwards and typically vary between 3000 tons and 1000 tons (Figure 6.1). Landings in the period from 2000 to 2012 (i.e. the period where sampling-data are available and that was therefore used for exploratory assessment and BITS-Index calculation) show a declining trend (Figure 6.2). Landings in SD23 were usually lower than 350 ton/year and declined to 150 tons after 2008 (Figure 6.2). Since 2000, the highest total landings of flounder in SD22 was observed in 2000 (>3000 t) and the lowest in 2006 (<1000 t). Since 2007 the landings are around 1400 tons, of which 80% of total landings are from the Danish fleet.

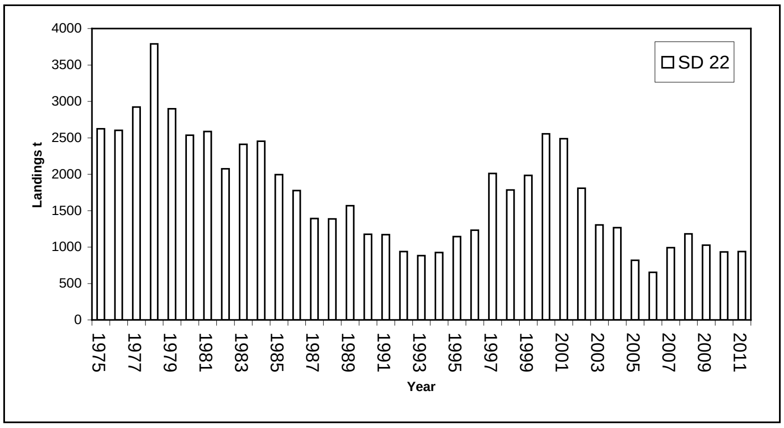


Figure 6.1. Landings of flounder in SD 22 in the period from 1974 to 2012, all countries and fishing gears combined (data from WGBFAS Report 2013).

Flounder are caught by trawlers (active gears) and gillnetters (passive gears) mostly. The minimum landing size is 25 cm. Active gears provide most of the catches in SD 22 (ca. 70%), whereas landings from passive gears are low. However, in SD 23, passive gears provide around 85% of total flounder catches (for Swedish fleet 98–100%). The majority of landings in both subdivisions are from the Danish fleet (Figure 6.3).

Landings and discards of flounder are highly variable, depending on e.g. fish quality, local and national markets (which is driven not only by flounder, but also by cod and plaice), vessel-capacity and quota-limitations (e.g. cod). Discards also differ between areas and gear.

Commercial catch was calculated for the time-series from 2000 to 2012 for all quarters, countries, and gears in Subdivisions 22 and 23.

The calculation of the given discard weights for the period back to the year 2000 was done by national data submitter, based on the national sampling-programmes. The quality of the national estimations cannot be assured or revised since calculation methods were not given to the stock coordinator.

Missing discard weights were estimated by the stock coordinator, using the landing/discard-ratio from similar strata. The discard-ratio was calculated as:

$$Catch\ (C) = Landing\ (L) + Discard\ (D)$$
$$Discard\ ratio\text{: } \frac{D}{C} \times 100 = \%D$$

Example: Catch: 100 kg, Landing: 95 kg, Discard: 5 kg

$$\frac{5kg}{100kg} = 0.05 \times 100 = \mathbf{5}\%\ Discard$$

In general, discards are higher in active (e.g. trawls) then in passive fishing gears (e.g. gillnets and traps). Both fishing gears show discard-ratios between 0 and 100% of the catch, with active gears having average discard-ratio of 30–50% of the catch, whereas passive gears have an average discard-ratio of 10–20%.

A general introduction about discard of flatfishes in the Baltic Sea is given in Section 2.2 of the report. The borrowing scheme of the discard-ratio for the flounder in SD22–23 is given in WD6.1. However, no discard was estimated for strata not having a landing of flounder assigned, either due to zero landings (and a 100% discard) or to no catches occurring in this quarter (for this gear-type). These "zero-landings"-strata are, however, of minor importance for the flounder stock in SD2223. In SD22, where almost 80–90% of flounder is caught, landings took place in every stratum (gear-type per quarter). Only in SD23, there are non-reported landings for the active-gear fraction which usually lands about 100–300 kg per quarter.

Due to a number of issues with discard estimation, outlined in Section 2 of this report, only a landing advice should be provided for flounder in SD22–23.

A survival-rate (i.e. 50% survival in Q1 and Q4 and 10% survival in Q2 and Q3) was applied on the discarded fraction of the catch. These numbers represent the lower limits among the relatively wide range of survival rates obtained from several studies conducted in the Baltic Sea (see e.g. Revill, 2012; Herrmann *et al.*, 2013; Broadhurst *et al.*, 2006; and the WKBALFLAT Working document, provided by R. Oeberst, WD 2.1).

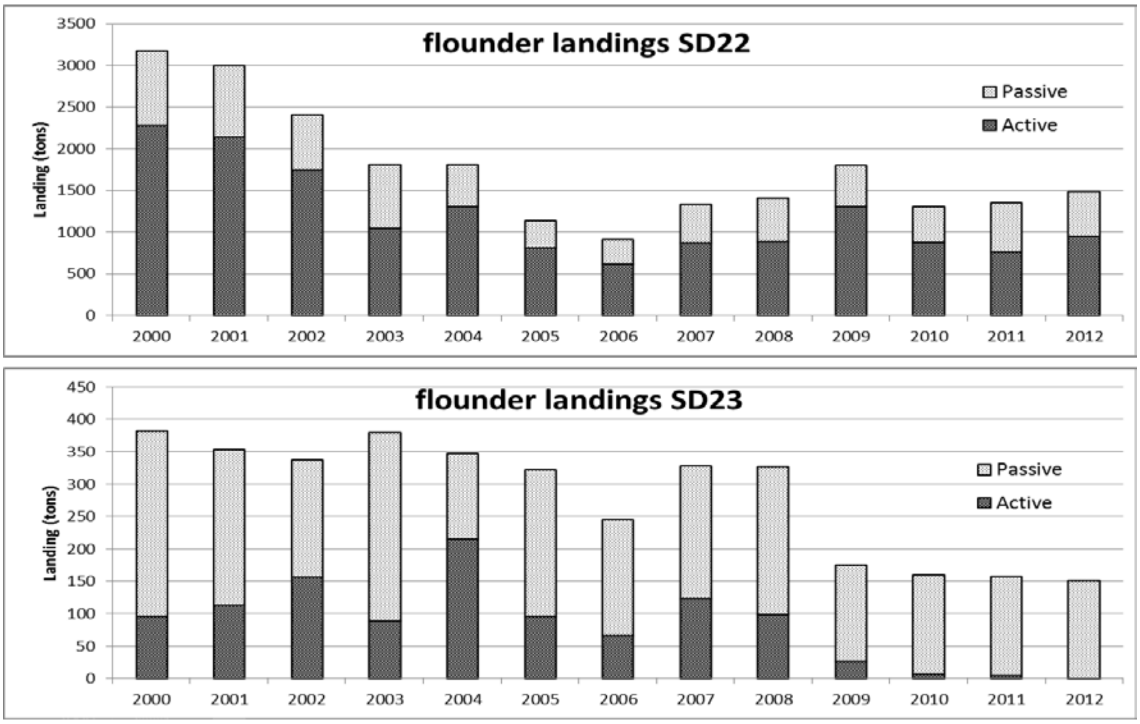


Figure 6.2. Landings of flounder in SD 22 (upper panel) and SD23 (lower panel) in the period from 2000 to 2012, divided by fishing method.

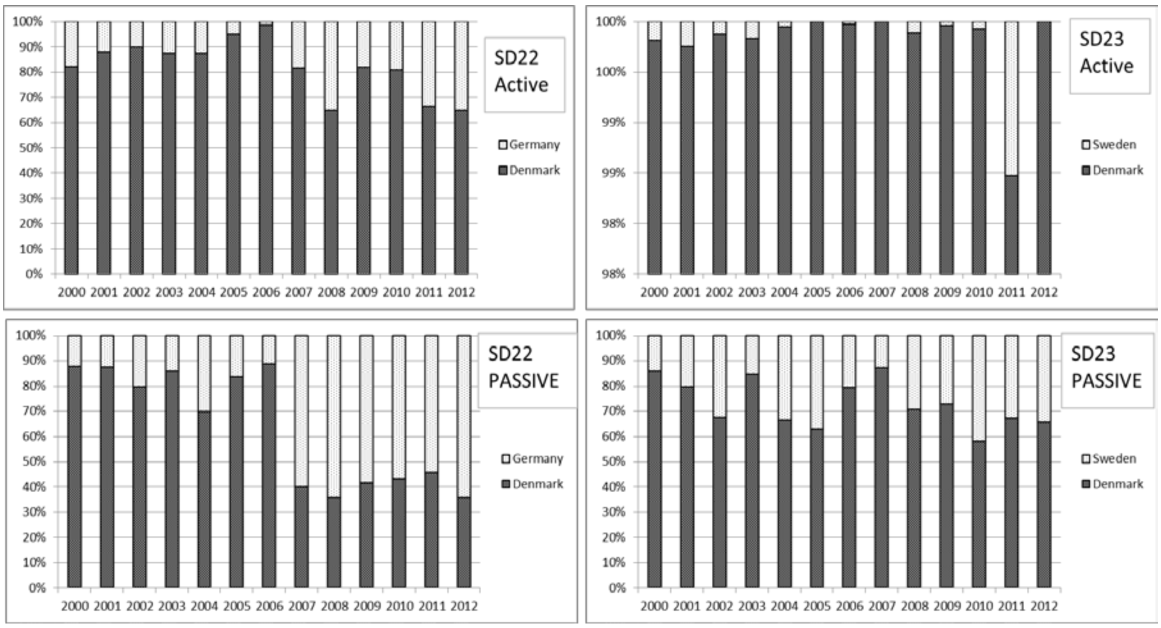


Figure 6.3. Relative share of fishing countries to total flounder-landings between 2000 and 2012.

6.3.2 Surveys

The "Baltic International Trawl Survey (BITS)" is covering the area of the flounder stock in SD2223. 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.

Table 6.1. Average number of BITS-stations in SD22 and SD23.

Area and quarter	Average no. of stations	Standard deviation
SD 22 Q1	24	4.62
Q4	26	5.28
SD 23 Q1	3	0.62
Q4	3	0.66

Fishing stations are assigned each year by a randomized list, the average number of stations covering Subdivisions 22 and 23 are given in Table 6.1. Effort and cpue 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.

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.

6.3.3 Age-length information

During the benchmark workshop, 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 does not cover all strata in the given period of 2000 to 2012.

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 (see also WD 6.2 for details). The resulting length distributions (Figure 6.4) were tested for their internal consistency (See also WD 6.2).

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-at-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.

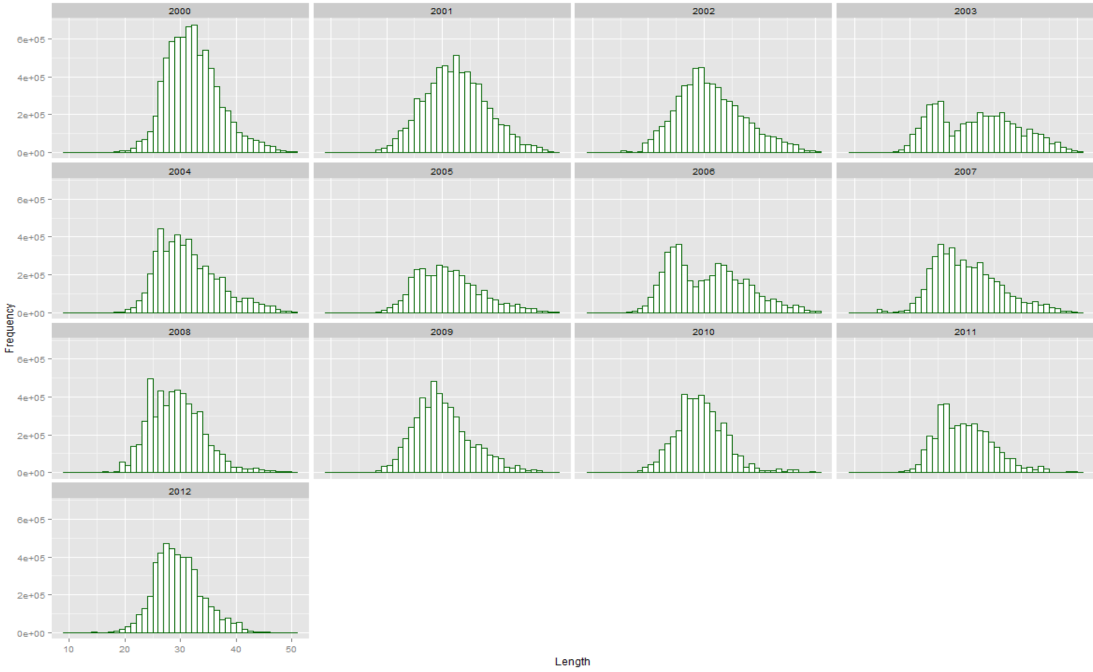


Figure 6.4. Length-distribution of FLE-2223 in the catch per year after final borrowing/extrapolation by stock-coordinator.

6.3.4 Weights, maturities, growth

Mean weight per age and length class were only available from German sampling-programme (commercial fisheries, Figure 6.5) 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.

The mean weight per age for the stock (Table 6.2) and the maturity ogive (Table 6.3) was calculated from BITS data from 2008 to 2012, where real age data were available. For the years 2000 to 2007, an average of the years 2009–2012 was used.

Table 6.2. Mean weight per age from BITS data (2000–2008: average from 2009 to 2012).

Year/Age	1	2	3	4	5	6	7	8	9	10
2000	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2001	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2002	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2003	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2004	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2005	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2006	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2007	0.090	0.155	0.255	0.361	0.49	0.549	0.639	0.723	0.871	1.004
2008	0.081	0.098	0.198	0.292	0.366	0.438	0.626	0.725	0.681	1.323
2009	0.119	0.136	0.233	0.332	0.423	0.508	0.593	0.705	0.929	0.984
2010	0.075	0.178	0.276	0.367	0.515	0.614	0.687	0.801	0.994	1.022
2011	0.092	0.195	0.289	0.415	0.582	0.657	0.702	0.793	0.775	0.766
2012	0.082	0.168	0.279	0.401	0.565	0.53	0.587	0.591	0.977	0.927

Table 6.3. Maturity ogive from BITS data (2000–2008: average from 2009 to 2012).

Year/Age	1	2	3	4	5	6	7	8	9	10
2000	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2001	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2002	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2003	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2004	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2005	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2006	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2007	0.12	0.56	0.81	0.95	0.94	0.94	0.88	0.88	0.9	0.87
2008	0	0.4	0.7	0.9	1	1	0.9	0.8	0.85	0.4
2009	0.05	0.6	0.75	0.95	1	0.95	0.65	0.95	0.8	0.5
2010	0.15	0.6	0.8	0.95	1	1	0.95	1	0.85	0.9
2011	0.3	0.55	0.9	0.95	0.9	1	1	0.7	1	1
2012	0.05	0.65	0.9	1	0.8	0.8	0.9	1	1	0.7

No differentiation between sexes was made, since only German data on sex ratios from the commercial catches were available. Especially in small and large length classes, the coverage is considered not representative. However, growth is observed to be different between sexes in flounder. 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.

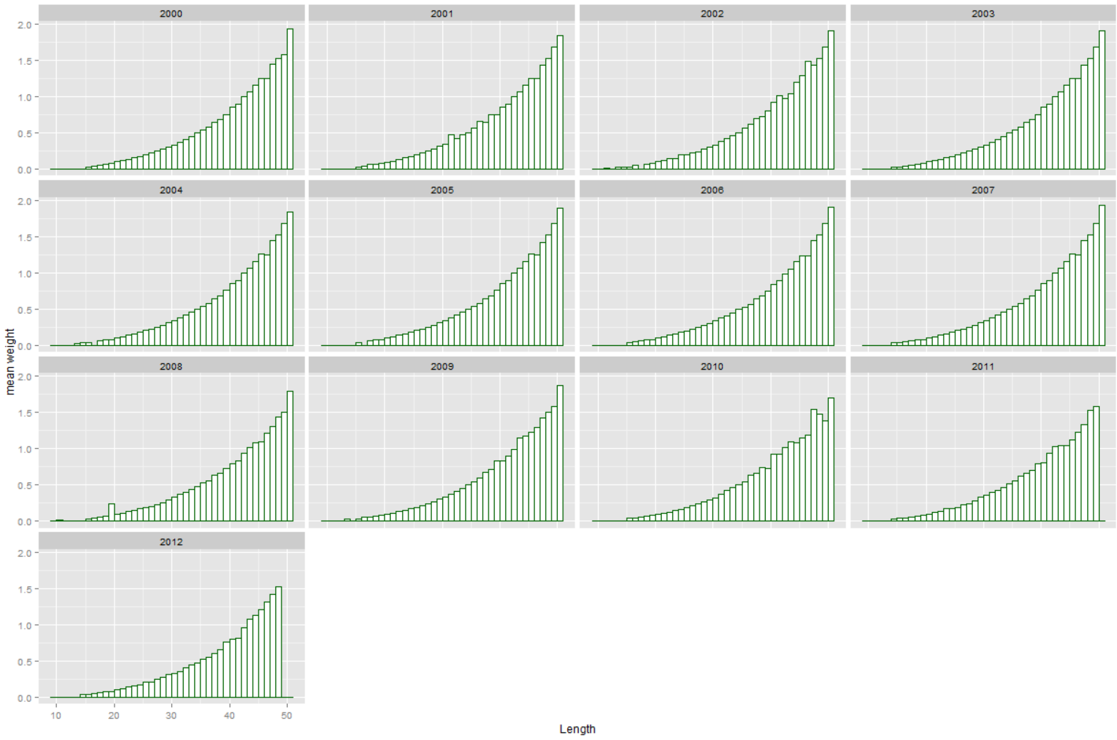


Figure 6.5. Mean weights per length class of FLE-2223 in the Catch per Year after final borrowing/extrapolation by stock-coordinator.

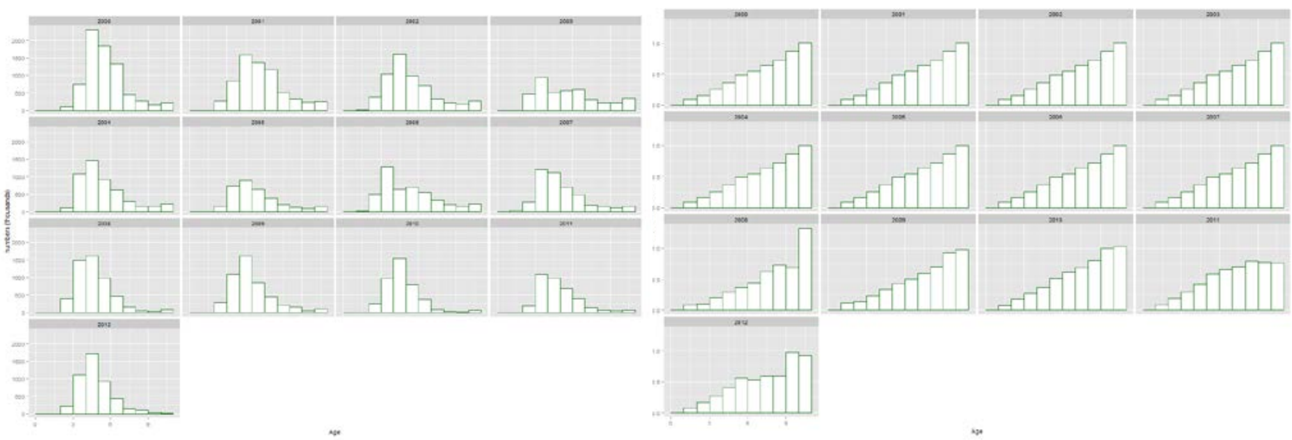


Figure 6.6. Numbers (left panel) and mean weights per age (right panel) of FLE-2223 in the Catch per Year after final borrowing/extrapolation by stock-coordinator.

6.3.5 Exploratory Assessment model

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 (Figure 6.6, left panel). However, both sexes were combined due to insufficient data on sex-ratio from all years and subdivisions.

WECA was calculated from commercial samples (only German data, gaps were filled by values of length–weight-relationship (Table 6.4) and BITS data, Figure 6.6, right panel). BITS data were used for survey cpue.

Table 6.4. Parameter for length–weight relationship (commercial sampling, Germany).

SPECIES	YEAR	SD	QUARTER	NUMBERS	LN_A	B	R
flounder	2008	22	1	237	-12,474	3,194	0,906
flounder	2008	22	4	248	-12,675	3,238	0,977
flounder	2009	22	1	659	-13,354	3,348	0,957
flounder	2011	22	1	72	-13,011	3,290	0,925
flounder	2011	22	3	59	-12,192	3,162	0,942
flounder	2011	22	4	107	-11,402	3,021	0,873
flounder	2012	22	1	960	-12,938	3,279	0,944
flounder	2012	22	2	153	-10,043	2,768	0,971
flounder	2012	22	3	105	-10,933	2,939	0,941
flounder	2012	22	4	156	-11,022	2,948	0,926
flounder	2013	22	1	873	-12,783	3,252	0,937
flounder	2013	22	2	141	-10,254	2,785	0,944
flounder	2013	22	4	409	-12,024	3,127	0,953
flounder	2013	22	average	4179	-11,931	3,104	0,938

Natural mortality was set as a fix value of 0.2 for all years and age classes (based on the knowledge from other flatfish in other areas); maturity ogive was taken from BITS data. No differentiation in sexes was made. Mean weights were calculated over the whole time period (2000 to 2012). The SAM model was run using the stock assessment.org Web-application. Several exploratory runs were conducted, starting with the general default-settings (see WD 6.3 for input data and settings. WD 4 provides an example of a data output, and an example is also presented in Figure 6.7.

The SAM model seems to be promising for future analytical assessments of this stock, however, further analysis of the input data and model settings are needed. The work done so far at the benchmark workshop should be seen as exploratory only and not used as basis for advice.

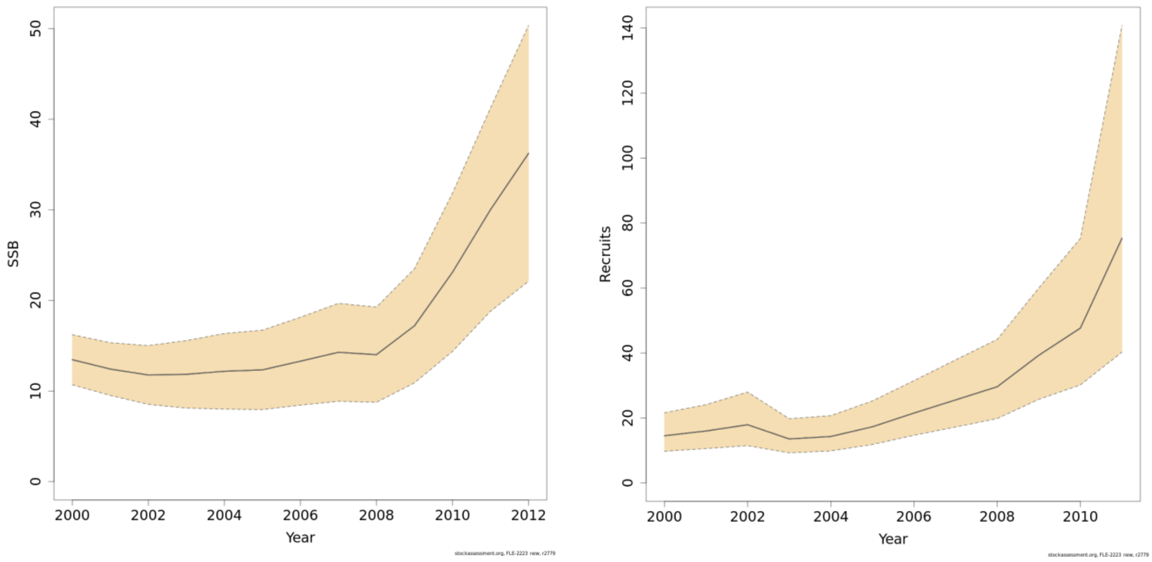


Figure 6.7. Results of SAM-assessment (exploratory), showing trends in SSB (left panel) and Recruitment (right panel). More results are given in WD 6.4.

6.4 Proposed Assessment approach

6.4.1 Describe the proposed assessment model

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. WD 6.2 shows an overview of available data (length classes from commercial sampling per area and quarter, divided by country and fishing gear). 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 use 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 Biomass Index from BITS-Survey (i.e. a relative index, calculated from standardized methods and gears). The index should be calculated by length classes, to avoid the problem of missing age information.

The Biomass Index is a product of the calculated BITS Index and average weight per length class. The average weight per length-class is calculated from a length–weight relationship based on BITS data to cover all length classes. The weight is calculated using the average weight–length relation from the period 2001 to 2012.

The catch per unit of effort (number/hour) only uses fish ≥20 cm from Q1 and Q4 BITS survey from the ICES DATRAS database. Fish 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 (including 0 catch) and weighted by depth stratum area (Figure 6.5, upper panel).

Both 1st and 4th quarter surveys are aggregated into one index value for a given year (using geometric mean between quarters). The Biomass Index is calculated for each year. For advice, the relative change in the average biomass index in the last two years is compared to the average of the three years before.

Biomass stock index was calculated by using the cpue numbers per length class and the average weight per length class obtained from length–weight relationship (Figure 6.5, lower panel).

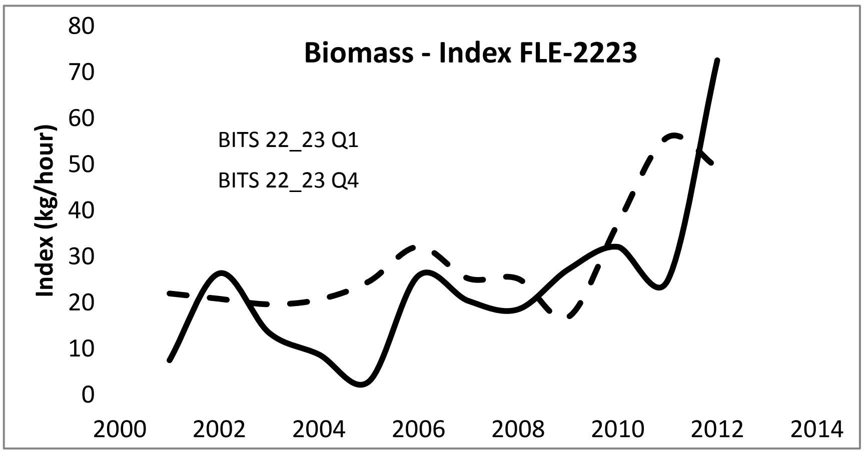


Figure 6.4. Survey trends in BITS. Upper panel shows cpue as numbers/hours, lower panel shows the Biomass Index where weight from length–weight relation is included.

Survey trends have increased steadily since the early 2000s. The average stock size indicator (number/hour) in the last two years (2011–2012) is 48% higher than the abundance indices in the three previous years (2008–2010).

To account for unknown discards in areas/quarters/gear-types where no landings was assigned, only a landings advice should be given for the flounder stock in SD 22–23.

6.4.2 Short-term projections

Not available.

6.4.3 Appropriate Reference Points (MSY)

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.

6.5 Future Research and data requirements

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 caught fish are required (only German data were available for WKBALFLAT).

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 fish (e.g. during harbour sampling) but also from this fraction.

For the exploratory SAM Assessment, sliced data were used (i.e. age 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.

6.6 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 (see also Section 2).

7 Flounder in Subdivision 24–25

7.1 Multispecies and mixed fisheries issues

Flounder is generally taken as bycatch in demersal fisheries and, to a minor extent, in a directed fishery.

In Poland trawl and gillnet fishing directed to flounder is common. Polish flounder catches generally increases when cod resources decreases. 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 Subdivision 24 there is a German trawl fishery directed to catch flounder, in particular in the 3rd and in the 4th quarter. This fishery contributes a maximum of about 35% to the total German flounder landings.

7.2 Ecosystem drivers

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 O^2/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).

7.3 Exploratory Assessment analysis

7.3.1 Catch- quality, misreporting, discards

Catch quality is poor due to the uncertainty of the discard estimates. 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.

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. When, for example, no discard data are available for particular stratum and there was no landing of flounder assigned, then the discard was also estimated as zero.

Due to this constraint the group recommendation was to recalculate discards, using better approach, which avoid the underestimation of discards.

In the Subdivisions 24 and 25, Poland, Denmark and Germany are the main fishing nations (Figure 7.4.1.1). The total landings of this stock increased from 4000–7000 t in 1973–1993 to 8000–13 000 t after 2000. Some high landings in the mid-1990s are misreported (cod was reported as flounder). In 2003 the landing dropped to 8500 t (Figure 7.4.1.2). 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 10 700 t.

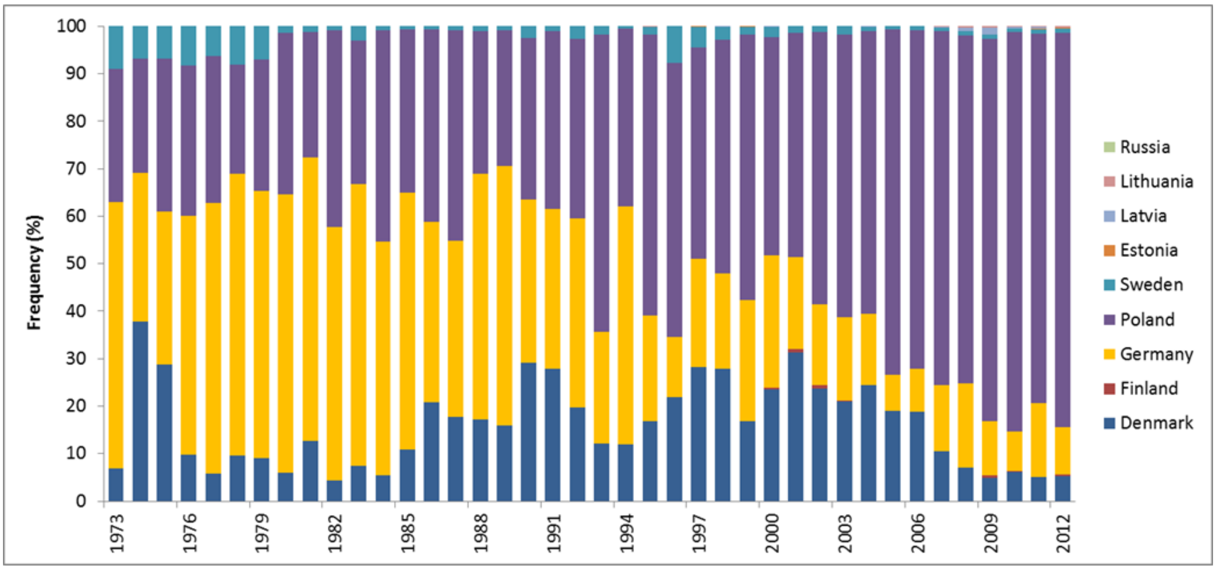


Figure 7.4.1.1. Flounder in SD 24–25. Proportion of the landings by country.

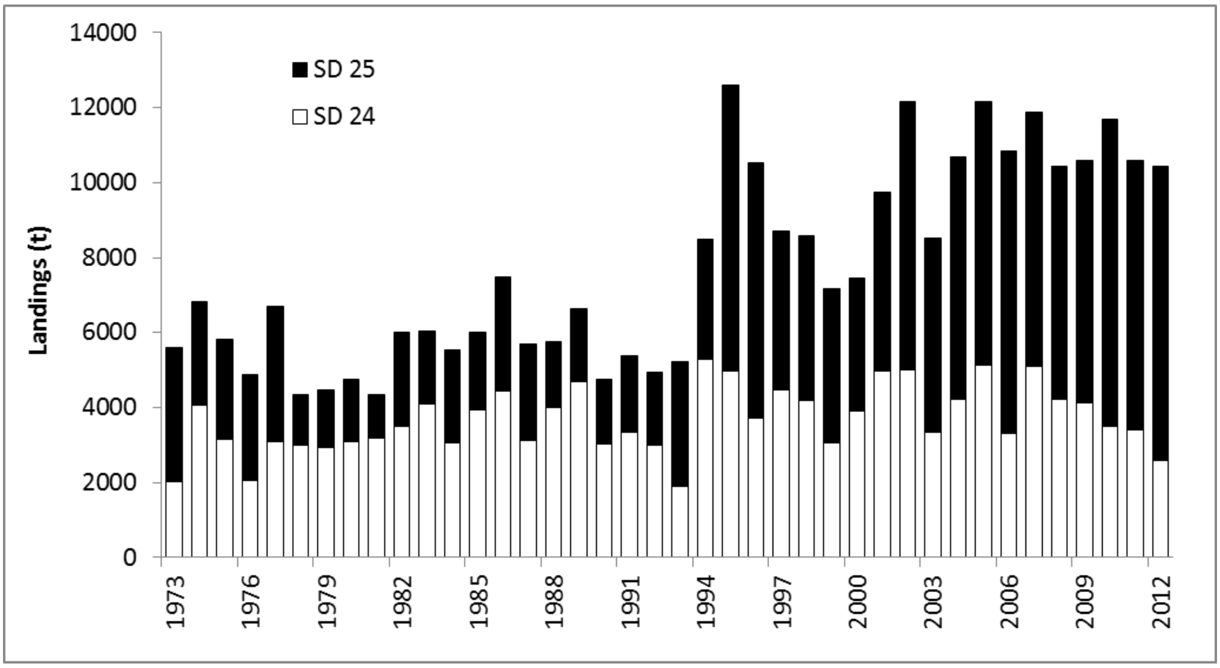


Figure 7.4.1.2. Flounder in SD 24–25. Landings in tonnes.

Flounder landings in both SDs are dominated by active gears, taking in average 70% of total landings in SD 24 and about 80% in SD25 (Figure 7.4.1.3).

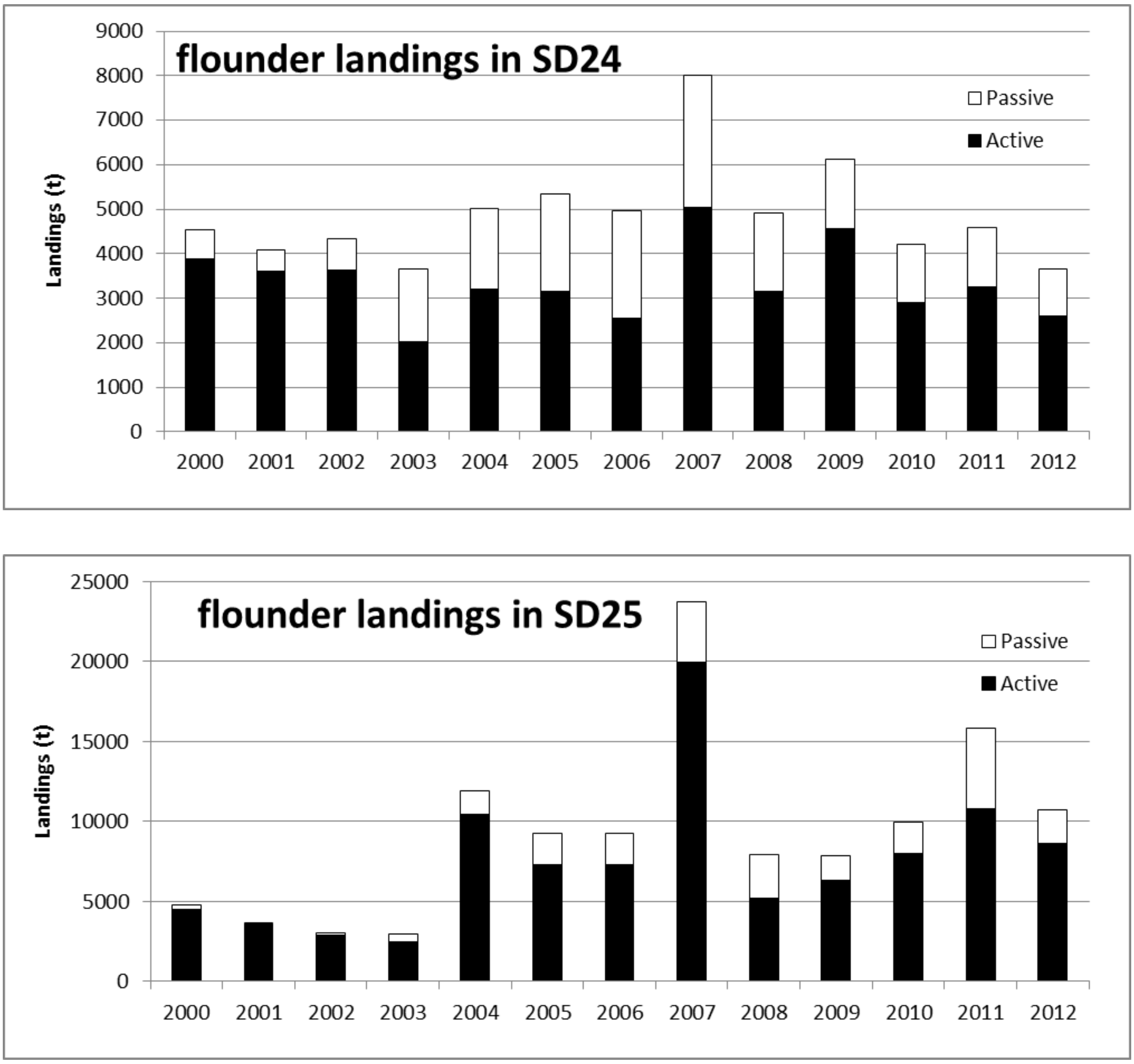


Figure 7.4.1.3. Landings of flounder in SD 24 (upper panel) and SD25 (lower panel) in the period from 2000 to 2012, divided by fishing method.

In the last 13 years flounder landings in SD 24 by passive gears were dominated by Poland and Germany, while in active fishery Poland and Germany together with Denmark was sharing the majority of total landings. In SD 25 German flounder landings came almost exclusively from active gears. Landings by the use of passive gears in SD 25 were performed mainly by Poland (Figure 7.4.1.4).

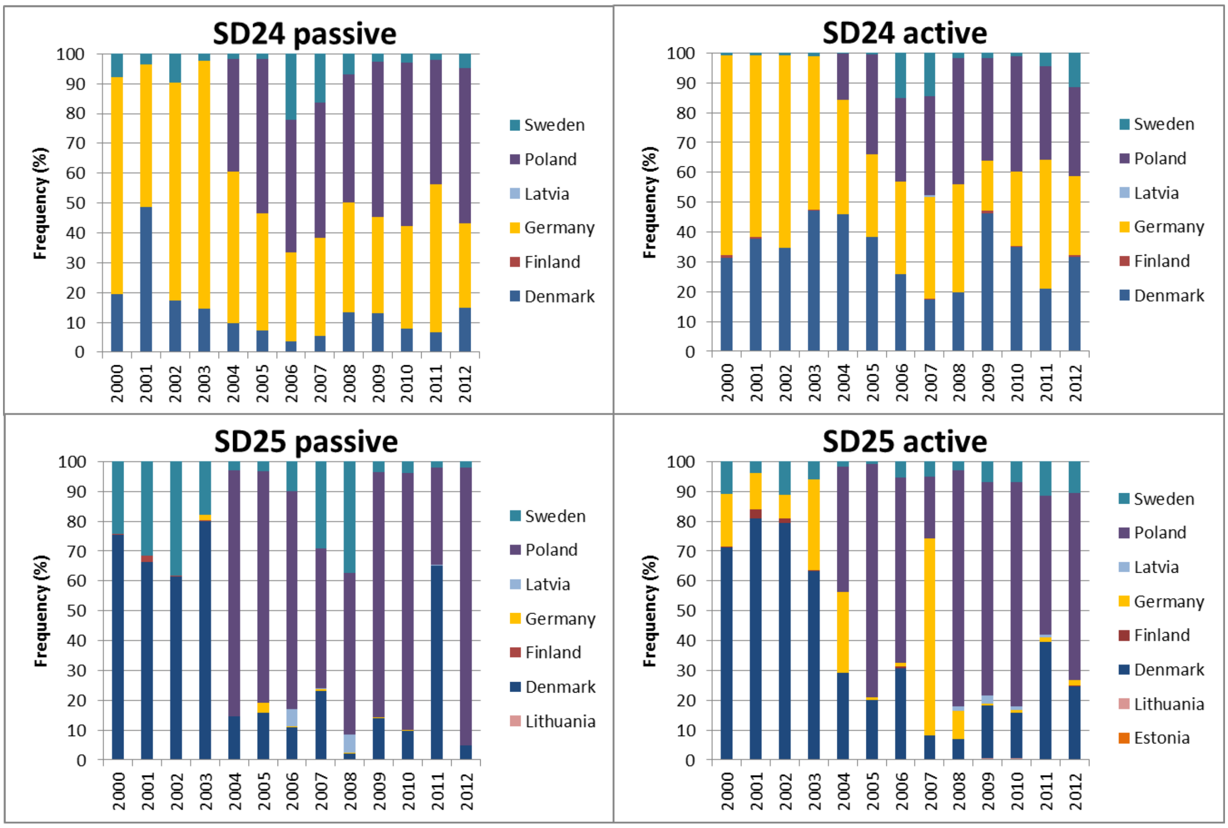


Figure 7.4.1.4. Relative share of fishing countries to total flounder landings between 2000 and 2012. Some countries in some years reported their landings without a distinction of fishing gear. These landings were excluded from the figure (Polish landings 2000–2003, Latvia 2004–2005, Lithuania 2007, Estonia 2009–2012).

7.3.2 Surveys

Before 2001

In the period 1978–2000 Germany carried out a stratified fixed station bottom-trawl survey in Subdivisions 24 and 25 in the 1st quarter as well as in 24 in the 4th quarter. These surveys were planned as recruitment investigations of cod. Flounder data were sampled regularly and stock indices could be estimated. The station grids and a description of the herring bottom trawl (HG20/25) used are presented by Schulz and Vaske (1988). In 1991, RV "Eisbär" was replaced by RV "Solea" and in 1993 the positions of the stations in SD 25 were changed.

A survey to estimate young flounder has been carried out in the Oderbank area (SD 24) since 1978. This survey proved not suitable to estimate the recruits for the total stock in SD 24 and 25 (Westernhagen, 1970).

From 2001 Germany terminated the survey in SD 25 and continued with the survey only in SD 22 and 24. The currently used TV3#520 trawl has about the same catchability for demersal species as the German HG20/25 and thus a conversion factor close to 1.

Polish demersal trawl surveys have been part of the international surveys conducted annually in the Baltic. Data from Polish bottom-trawl surveys performed twice a year, in 1st and 4th quarter, are available from SD 24 (1997–2000) and from SD 25 since 1992. Sampling strategy was based on a fixed stations grid, arranged as depth cross sections. Until 1993 surveys were conducted by chartered cutters. Since 1993 the surveys have been conducted from aboard the research vessel BALTICA. Fishing operations in 1981–2000 were carried out using the same standard trawl (the mesh in the codend was 6 mm from knot to knot). A new TV-3 trawl was introduced in 1999 and some comparative trawling with the P20/25 gear was conducted (Horbowy *et al.*, 2003). Polish gear P 20/25 and the German gear HG 20/25 have almost the same construction with only small variations (Oeberst and Grygiel, 2002).

After 2001

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. BITS surveys in SD 24 are performed by Germany and in SD 25 by Poland, Denmark and Sweden. Data from these surveys are available in DATRAS database. However, it should be noted, that the age data in DATRAS contain age information derived from different age determination methods (both, an old age reading methods as well as the recommended age reading methodology using slicing or the breaking and burning technique). It was agreed that for assessment purposes, only the recommended method should be used. Survey age data determined with a new method are available for Germany-SD24 and Denmark, Poland, Sweden-SD 25 (Table 7.3.2.1).

Table 7.3.2.1. 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

7.3.3 Age-length information

During WKBALFLAT 2014, possibilities for age/length based analytical assessment were explored.

Length distributions from commercial catches are available for SD 24 from Denmark, Germany, Latvia, Poland and for SD 25 from Germany, Latvia, Poland, Sweden; in the time period from 2000 onwards (different time ranges depending on country). The gaps in length distributions in given strata were filled by borrowing proportions in length classes from similar strata. Figure 7.4.3.1 presents length distribution after final borrowing/extrapolation by stock coordinator.

Length distributions from survey are available for SD 24 from Germany and from SD 25 from Denmark, Poland, Sweden in the time period from 2000 onwards.

Age data are considered to be applicable only when the ageing was conducted using recommended methods (slicing and staining or breaking and burning technique) established by WKARFLO (ICES, 2007, 2008) and WKFLABA (ICES, 2010). Age readings achieved by using the new methodology are available for survey (Table 7.3.2.1) and for commercial data (Table 7.3.3.1).

Table 7.3.3.1. 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

Due to time constraints, only some of the statistical slicing model settings were tested. Thus, if the statistical slicing method should be used in future to derive the historical part (i.e. when age–length keys from otoliths are not available) of the number-at-age for the catches and the surveys, it is important that more model settings are tested than done during WKBALFLAT. Moreover, it is also crucial that the results obtained from any slicing methods (i.e. knife edge and/or statistical), in terms of number-at-age, are compared with the number-at-age structure derived from otolith readings for the same sample (see Section 3).

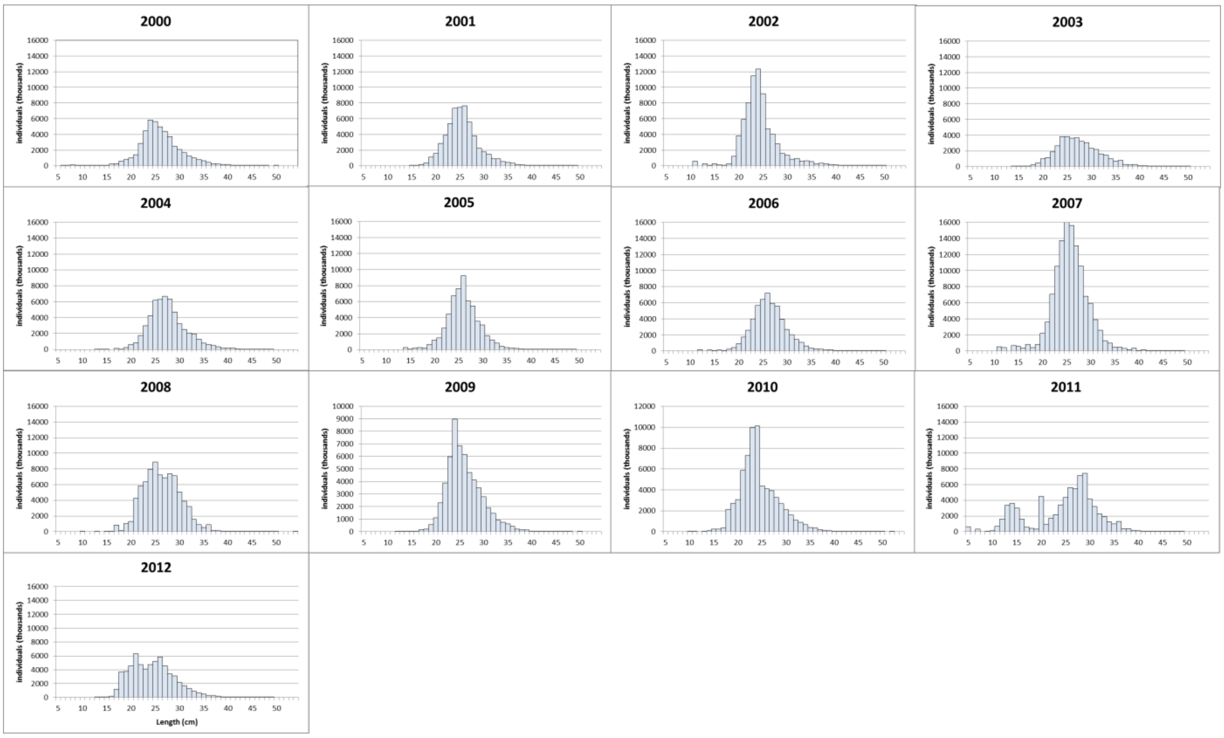


Figure 7.4.3.1. Length distribution of FLE-2425 in the catch per year.

7.3.4 Weights, maturities, growth

Weight-at-age in catch, weight-at-age in landings, weight-at-age in discards were estimated separately. They were assigned only for the years in which new aging procedure was available (since 2000).

Weight-at-age in stock was estimated by applying weight–length relationship with length data from age–length key and averaging obtained weights within age groups (Table 7.4.4.1).

Table 7.4.4.1. Mean weight in stock per age (2000–2008: average from 2009 to 2012).

AGE / YEARS	2	3	4	5	6	7	8
2000–2008	0.114	0.202	0.275	0.328	0.348	0.379	0.365
2009	0.092	0.174	0.253	0.321	0.343	0.345	0.354
2010	0.112	0.2	0.282	0.307	0.383	0.423	0.312
2011	0.118	0.205	0.286	0.353	0.309	0.4	0.407
2012	0.135	0.227	0.281	0.333	0.356	0.349	0.385

Mature proportion were calculated using BITS survey data (Table 7.4.4.2).

Table 7.4.4.2. Proportion of flounder mature at age from BITS data (2000–2008: average from 2009 to 2012).

AGE / YEARS	2	3	4	5	6	7	8
2000–2008	0.88	0.97	0.98	0.99	0.99	0.99	0.99
2009	0.9	0.97	0.99	0.99	1	0.99	0.99
2010	0.84	0.96	0.98	0.98	0.99	0.99	0.98
2011	0.91	0.97	0.98	0.99	0.98	0.99	0.99
2012	0.85	0.97	0.98	0.98	0.99	0.99	0.99

A logistic regression on length was used to estimate the maturity-at-length m(L):

$$logit\big(m(L)\big) = \alpha + \beta L$$

and finally the mean maturity-at-age was estimated in the same manner as the mean weights:

$$E(m(L)|A = a) = \sum_{k} m(k)P(L = k|A = a)$$

(see WD 5.1).

To avoid the problems with distinction of stage 2- fish, which are skipping spawning or resting before spawning from 2- fish, which have not spawned yet, expanding of maturity scale by adding the class 2j (juvenile), for those countries which use Meier scale should be applied.

7.3.5 Exploratory Assessment model (not for advice, but further development)

Due to time constraints and the need for further work on data to obtain reliable estimates of discards, only one assessment model was attempted. It was a difference version of the Schaefer stock-production model:

$$\mathbf{B_{y+1}} = \mathbf{B_y} + \mathbf{rB_y}(\mathbf{1} - \frac{\mathbf{B_y}}{\boldsymbol{B_{inf}}}) - \mathbf{C_y}$$

where *B*=biomass, *C*=catch, *r*=intrinsic rate of increase, B_{inf}=carrying capacity, *y*=year.

The model was fitted to BITS survey indices covering 1994–2013 using maximum likelihood method (minimizing negative log likelihood). Survey indices, *I*, were assumed lognormally distributed and proportional to the biomass

$$I_y=q^*B_y^*e^{N(0,sd)}$$

where *N* is a normally distributed random variable with zero mean and variance sd^2. Parameters estimated with the maximum likelihood method were *r*, B_{inf}, B_0 (biomass in first year, i.e. biomass in 1994), and *q*. For the survey indices the geometric mean of 1st and 4th quarter indices was taken (Figure 7.4.5.1). The model was fitted with two different catchability coefficients (one fitted to period 1994–2000 and one for period 2001–2013) as the survey gear and survey design were changed in BITS in 2001. Catches used in the model included discards (Section 7.4.1), however, it was stressed that discard estimates were preliminary and further work is needed to derive estimates which could be acceptable.

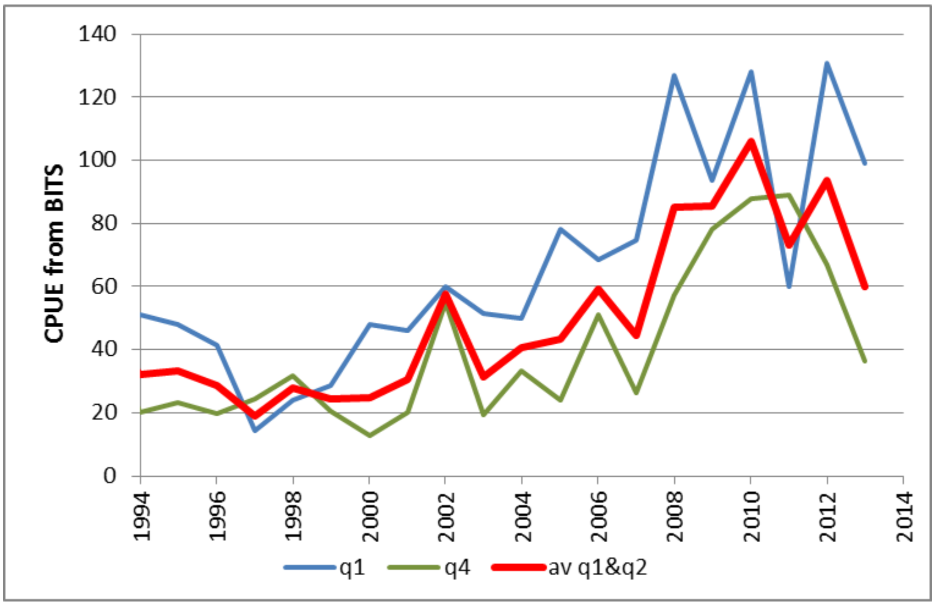


Figure 7.4.5.1. BITS survey indices for 1st and 4th quarter in Subdivision 24–25 (in terms of weight) and the geometric average of the indices.

An option which included additional information for model fitting was also attempted. That was based on derivation of the intrinsic rate of increase r from demographic methods (McAllister *et al.*, 2001). To derive *r* the growth (weight), maturity, and natural mortality data were used. In addition, the steepness of the stock–recruitment relationship is needed and that was taken from literature for flatfish stocks (Myers *et al.*, 1999; steepness of 0.8 was assumed). The estimate of *r* from demographic methods was 0.5. The deviation of *r* estimated within the model from *r* derived using demographic methods was included in minimized function with weight (penalty) varying from zero (additional information not used) to ten (very high weight on the additional information term).

The estimates of biomass and retrospective analysis of biomass estimates are presented in Figures 7.4.5.2–7.4.5.3. There was little difference between biomass estimates when deviation of model fitted *r* from *r* of 0.5 estimated using demographic methods was included (with weight=1) or excluded from the fitting procedure. Both of the estimated biomass trends reproduce trends in survey indices relatively well. The discard estimate for 2007 was considered unrealistically high and was replaced by an average value. The retrospective pattern was distorted mainly by the model fitted to 1994–2010; the fits to the other year spans were relatively consistent. The model results are preliminary as there is concern about quality of the discard estimates used in the assessment. When discard estimates are improved the model could be fitted again and its usefulness in assessment and advice could be further explored.

The age-structured model (e.g. SAM or XSA) should be also attempted for that stock and the quality of the model fit and behaviour inspected. However, first further work on discard estimates is needed. With acceptable discard estimates both age-structured and production models should be fitted and their performance in assessment process investigated. Analytical assessment of this stock is still in the developmental phase and should not be used alone for the provision of the advice.

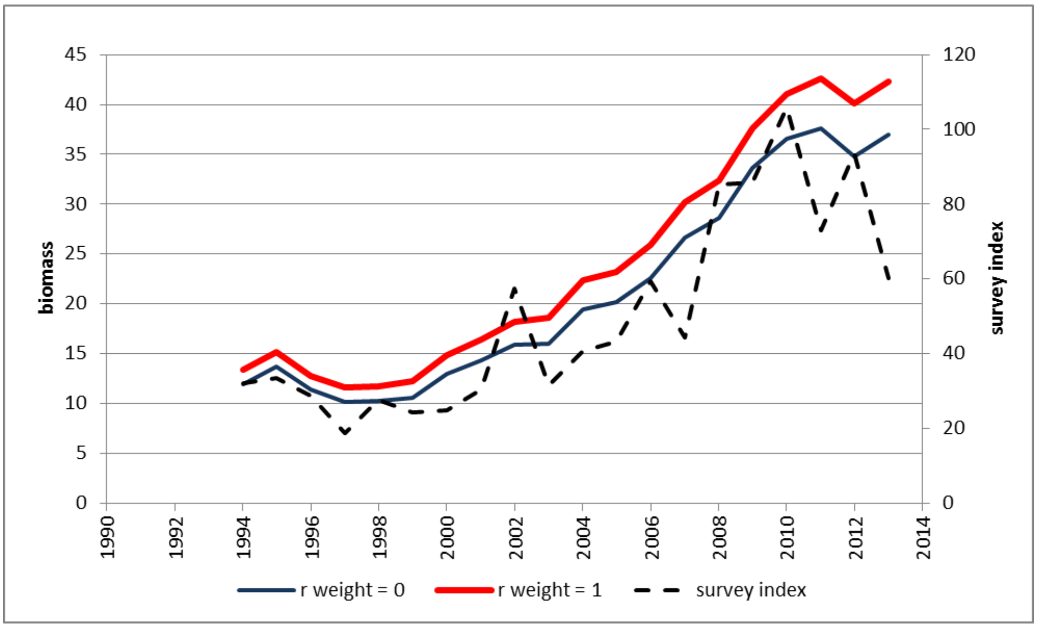


Figure 7.4.5.2. Estimates of flounder biomass (Subdivision 24–25, 10^3 tons) from the Schaefer stock-production model when external information on r is included (r weight =1) or not used (r weight =0) in the model. For comparison survey indices are presented.

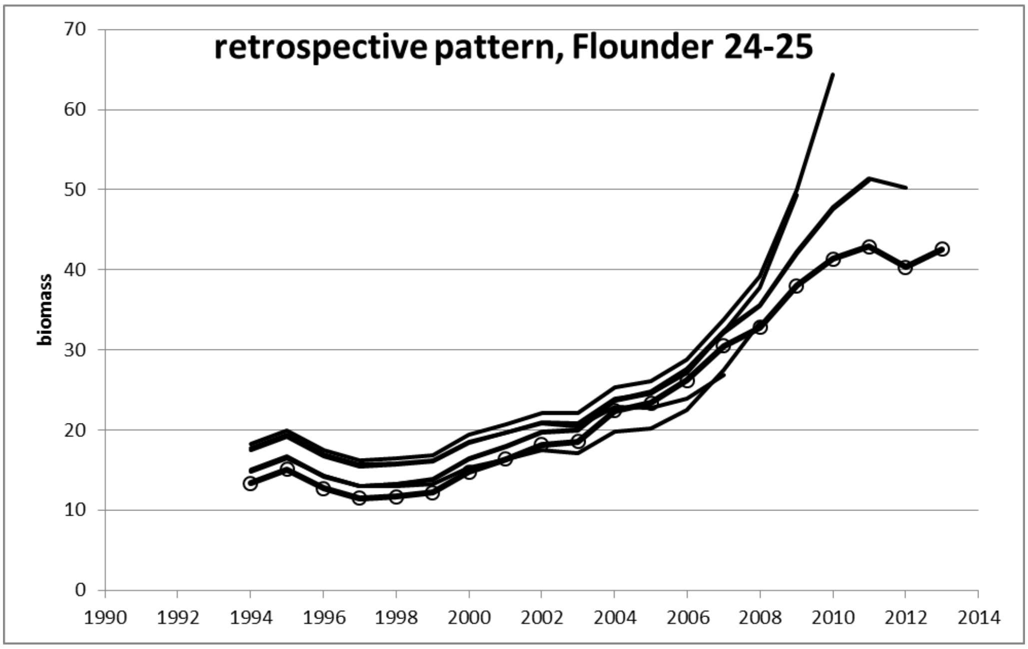


Figure 7.4.5.3. Retrospective pattern of estimates of flounder biomass (Subdivision 24–25) from the Schaefer stock production model.

7.4 Proposed Assessment approach

7.4.1 Describe the proposed assessment model

Before further work on analytical assessment is performed WKBALFLAT suggested to use DLS approach, Category 3, for evaluating the stock status of FL2425 (ICES 2012).

Work on discards estimates has to be further advanced to get reliable estimates. This is expected to happen within a year. WLBALFLAT recommends that for the time being the ICES advice will have to take the form of the landings advice.

7.4.2 Describe the accepted data configuration

[include common section describing how survey biomass was calculated (dropping length <xx cm; L-W eqn or mean weight, etc.) and that q1 and q4 were combined by taking the geometric mean]

Fle 24–25 is categorized as a data-limited-stock (DLS). Stock trend model based on scientific surveys is recommended for this stock and estimated using the Biomass Index from BITS 1st and 4th quarter 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. The catch per unit of effort (number/hour) uses only fish ≥20 cm from BITS-Q1 and BITS-Q4 survey and the data are extracted from the ICES DATRAS database, because the survey is not covering shallow waters, where juvenile flounder (mostly smaller than 20 cm) occur.

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 1991–2013, 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 Subdivisions 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. For advice, the relative change in the average biomass index in the last two years is compared to the average of the three years before.

7.4.3 Short-term projections

7.4.4 Appropriate Reference Points (MSY)

7.5 Future Research and data requirements

Given the high variability of the discard ratios, estimating discards is very uncertain without an extensive sampling programme.

The division between flounder in SDs 24–25 and SDs 26–28.2 should be further examined during a future benchmark, to check whether a more consistent assessment with lower uncertainty is obtained when merging these two units.

7.6 Recommendations

During WKABALFLAT it was decided that the survey index for this stock should be calculated using only data derived from the new aging method, thereby changing the decisions made at the previous meetings (WGBFAS 2005; WKFLABA 2010) where the survey data from the German BITS SD 24 quarter 1 and 4 and the survey data from the Polish BITS SD25 quarter 1 were used as tuning fleets in the tentative assessments for flounder in SD24–25. Validation of slicing methods to convert length to age in historical time-series, using real age readings, should be conducted.

The discards should be estimated using recommended method.

If a new agreed discard calculation method recommended to 2013 data processing give a significant improvement of the data compilation, then the same procedure should be applied on the whole dataseries back to 2000 (see Section 2.2).

Discard mortality was assumed as 50% in I and IV quarter and 90% in II and III quarter (ICES, 2014).

These numbers represent the lower survival values among the relatively wide range of survival rates obtained from several studies conducted in the Baltic Sea (see WKBALFLAT 2014, WD 2.1).

After the recommended improvement of discard data estimation (and quality), it is recommended to continue the developing an analytical assessment for the flounder stock in SDs 24–25 containing both production model and SAM.

8 Flounder in Subdivision 26 and 28

8.1 Issue list

1) The further work on discard estimates is recommended.

2) Calculation of catches including discards estimated based on recommended method. The estimated discards should be reduced by 50% in I and IV quarter of the year, and 10% in II and III (assumed survival rate).

3) Calculation of the new stock indices based on flounder biomass.

8.2 Multispecies and mixed fisheries issues

Flounder is generally taken as bycatch in cod fisheries and, to a minor extent, in a directed fishery. The directed flounder fishery is variable by country, fishing season and cod TAC.

8.3 Ecosystem drivers

Recruitment success can fluctuate depending on hydrological conditions on the spawning grounds (Nissling *et al.*, 2002). However some results suggest that recruitment may be regulated in a post-settlement stage, probably in the shallow coastal nursery areas (Ustups *et al*., 2013).

8.4 Exploratory Assessment analysis

8.4.1 Catch– quality, misreporting, discards

Landings

In the WKBALFLAT benchmark process all of 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. The deviation from reported data is described in Chapter 2.2.1. In the future stock assessment new data from InterCatch will be used.

The total landings in SD26 and 28 combined increased from 3127 tons in 2011 to 3620 tons in 2012 (Figure 8.4.1.).

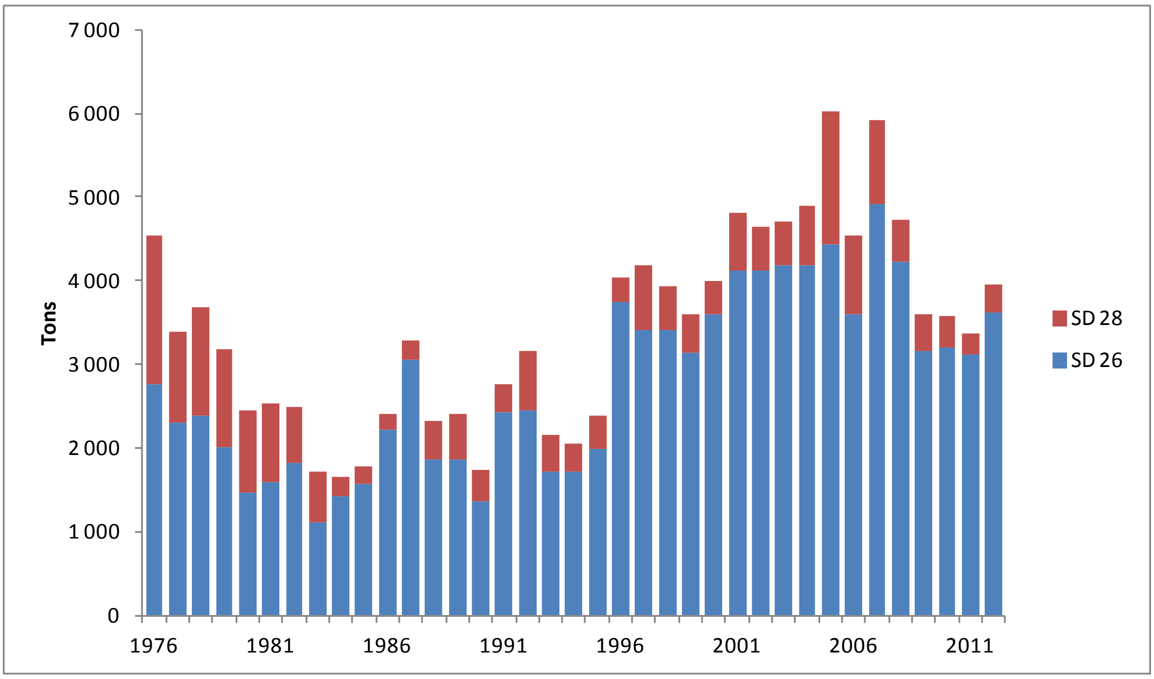


Figure 8.4.1. Flounder landings in Subdivisions 26 and 28 by years.

The main fishing countries in Subdivision 26 are Russia, Poland and Lithuania. In the previous years the Polish fishery was mainly a gillnet fishery along the coast whereas the Russian and Lithuanian landings were bycatches mainly in a bottom-trawl mixed fishery. Total landings in Subdivision 26 increased since 1996.

The total landings in Subdivision 28 amounted to about 339 tons in 2012, an increase compared to the 250 t in 2011. The Latvian landings were 244 tons, mainly taken by the gillnet fishery. Estonian landings were 70 tons. Landings in the last years have continued to decrease due to decreasing of fishing effort. The highest landings recorded were in the end of 1970s. Later in beginning of 1980s after the strong decrease of the flounder stock, a specific ban of flounder fishery was introduced.

Discards

Discard raising was attempted at the WKBALFLAT but due to the low sampling coverage and issues with discards raising it was not accepted by the benchmark workshop. It was decided that landings only (not catches) should be the basis for advice.

In this section below is a description of discard raising procedure that was attempted but not accepted later by the WKBALFLAT. Further investigations into the discard raising procedure were recommended.

Discard raising for time period 2000–2012 was performed using InterCatch database. Data availability by countries is available in Table 8.4.1.1.

Table 8.4.1.1. Available discard data (in yellow) by countries. All fleets (Active, Passive and All) included.

SD	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
26	Denmark													
	Finland													
	Germany													
	Poland													
	Sweden													
	Estonia													
	Latvia													
	Lithuania													
	Russia													
28	Denmark													
	Finland													
	Germany													
	Poland													
	Sweden													
	Estonia													
	Latvia													
	Lithuania													
	Russia													

Discard data from SD 26 were available from Poland, Latvia, Lithuania, Sweden, Denmark and Russia. Due to national legislation in Russia discard rate 0% for all years was applied. In SD 28 mainly Latvian data (and two years from Sweden) were available in InterCatch.

Raising procedure was performed for each of four flounder stock units separately. Prior to applying a common raising scheme, examples were built for years 2011 and 2012. Examples were sent to national experts to get agreement about discard raising from every country. It is important to understand that reason of flounder discard is driven mainly by price and market capacity in every country. As an example, in SD 26 Poland has the highest landings. Flounder in Poland has a high market value and therefore discard rate in the fishery is low (less than 5%). On the contrary, in Denmark, the flounder market price is low and Danish fishermen are discarding almost all of the flounder in SD 26. Probably, the second most important factor influencing discarding of flounder is the amount of cod landings.

Based on discussions in Data Compilation Workshop the following approach to discard raising was attempted:

0) *A priori* countries were divided in four groups;

- i) high discard ratio (Denmark and Sweden)
- ii) medium discard ratio (Estonia, Finland, Latvia, Lithuania)
- iii) low discard ratio (Poland)
- iv) zero discard (Russia)

1) discard data were borrowed from the same country, the same fleet, the same subdivision (from neighbour quarter);
2) discard data were borrowed from the same group, the same fleet, the same subdivision;
3) discard data were borrowed from the same group, the same fleet;
4) discard data were borrowed from the same group;
5) discard data were borrowed from any available data from the same year.

In Table 8.4.1.2 an examples for 2011 is presented. The discard raising schemes for 2011 and 2012 were sent by e-mail to national experts and after acceptance the same approach was used for years 2007–2012.

Table 8.4.1.2. An attempted discard raising scheme for Flounder in SD 26 and 28, 2011. Cells with coloured background indicate original data (source). For better visualization every country has different colour. Numbers in cells with coloured backgrounds are available discard samples. Information in cells with white background and coloured fonts shows source of data borrowing. LT_26_1_A means that data were borrowed from Lithuania, SD 26, 1st quarter, Active fishing gear.

SD	Fleet	Q	Denmark	Estonia	Finland	Latvia	Lithuania	Poland	Russia	Sweden	Num of Samples
BAL26	Active	1	1		LT_26_1_A	LV_26_2_A	1	PL_26_2_A			2
		2				1	1	1			3
		3				1	1	PL_26_2_A		1	3
		4	1			1	1	PL_26_2_A			3
	Passive	1				1	LV_26_1_P	PL_26_3_P			1
		2				1	LV_26_2_P	PL_26_3_P			1
		3				LV_26_4_P	PL_26_3_P	1		PL_26_3_P	1
		4				1	LV_26_4_P	PL_26_3_P			1
	All	1		LV_26_1_P LT_26_1_A							
		2		LV_26_2_P LV_26_2_A							
		3		LV_26_3_A							
		4		LV_28_4_A LV_26_4_P							
BAL26 Total			**2**			**6**	**4**	**2**		**1**	**15**
BAL28	Active	1									
		2				LV_26_2_A					
		3				LV_26_3_A					
		4				LV_26_4_A	LT_26_4_A				

SD	Fleet	Q	Denmark	Estonia	Finland	Latvia	Lithuania	Poland	Russia	Sweden	Num of Samples
	Passive	1				LV_26_1_P				LV_28_2_P	
		2				1				LV_28_2_P	1
		3				LV_26_4_P				PL_26_3_P	
		4				LV_26_4_P				LV_26_4_P	
BAL28	All	1		LV_26_2_A LV_28_2_P							
		2		LV_26_2_A LV_28_2_P							
		3		LV_26_3_A							
		4		LV_26_4_A LV_26_4_P							
BAL28 Total						**1**					**1**
Grand Total			**2**			**7**	**4**	**2**		**1**	**16**

Very limited information about discard rates was available from 2000–2006. Only an average (from whole time-series 2000–2012) was available. Poland has more than 50% of landings. As it was describe above, in Poland the discard rate is very low and it is not possible to borrow the discard ratio from Denmark or Latvia (only data were available) where discard rate is medium to high. Therefore for all countries (except Denmark and Latvia) the average discard rate (for each country individual) from 2007–2012 was applied to years 2000–2006. Due to limited discard information (discard ratio was available for a minor part of Latvian landings), the same approach was used to Latvian data in 2000–2002; an average was calculated from all available data 2003–2012. Data calculation was performed in InterCatch and MS Excel spreadsheets.

The average discard rate by countries and year are presented in Figure 8.4.1.1. Discard rate is calculated as the discard proportion from the catch.

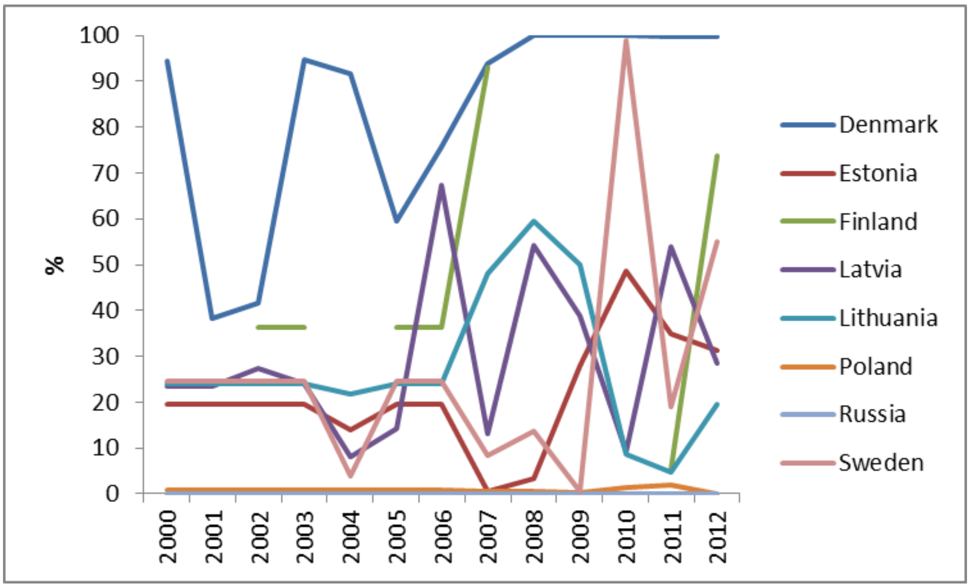


Figure 8.4.1.1. Estimated discard rate by countries for flounder in the Baltic Sea, Subdivisions 26 and 28.

The highest discard ratio (in %) was observed in Denmark where in some years almost all of flounder were discarded. The highest discard amount (in tons) were in Latvia and Lithuania and in some years in Sweden (Figure 8.4.1.2).

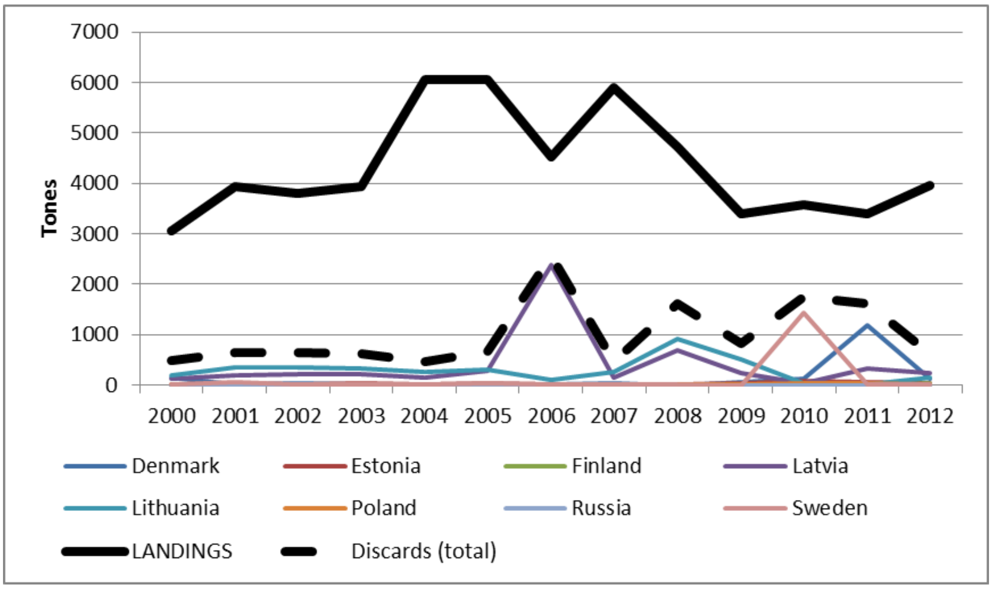


Figure 8.4.1.2. Estimated discards and landings of flounder in Subdivisions 26 and 28.

A long-term average of discard amount in SD 26 and 28 was 995 t.

To calculate total catch survival rate (Table 8.4.1.3) according to agreement at Data Compilation Workshop was applied to discards. Total catch was calculated using formula:

Catch= landings+ dead discards

Table 8.4.1.3. Survival rate of flounder in the Baltic Sea.

Quarter	Survival rate
1	50%
2	10%
3	10%
4	50%

Survival rate was not possible to incorporate in InterCatch database (using existing expertise of flounder experts).

However, no discards were estimated for strata not having a landings of flounder assigned, either due to zero landings (and a 100% discard) or to no catches occurring in this quarter (for this gear-type). This could result in a discard underestimation for countries with high discard ratio (for example Sweden, Denmark).

In conclusion, due to possible underestimation of discards the presented discard estimation was not accepted in Workshop and should be re-calculated. It was decided that only landings (not catches) should be used as a basis for advice.

8.4.2 Surveys

Catch per unit of effort (number per hour) from the BITS Survey in 1st and 4th quarters was used to calculate an index representing flounder abundance by numbers. Data were compiled from the ICES DATRAS output format "*cpue_per_length_per_haul*". Averages were weighted first by fished depth stratum areas 8 (10–19 m), 9 (20–39 m), 10 (40–59 m), 11 (60–79 m), 12 (80–99 m), 13 (90–119 m), 14 (120–200 m) and second by fished subdivision areas. Hauls with 0 fish per hour were included. All fish with length <20 cm were excluded from calculations due to sampling design, the smaller fish presumably not being covered representatively. Flounder nurseries are located in shallow coastal areas and are not covered in BITS surveys.

Stock trends of flounder in SD26 are presented in Figure 8.4.2.1. Stock index from the last two years decreased by 32% comparing to 2008–2010.

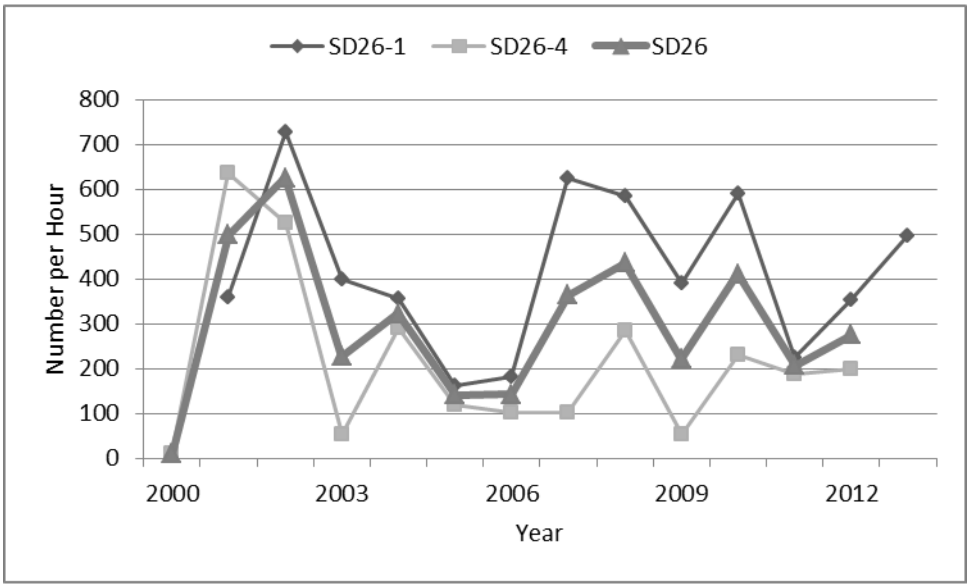


Figure 8.4.2.1. Catch per unit of effort (number per hour) from BIT Survey in 1st and 4th Quarters, Subdivision 26.

Stock trends from Baltic International Trawl Survey (BITS) are shown for flounder from SD28 in Figure 8.4.2.2. Stock index from the last two years decreased by 0.15% comparing to 2008–2010. It should be mentioned that index values in SD 28 are typically higher than in SD 26, while most of landings (up to 85%) come from SD 26.

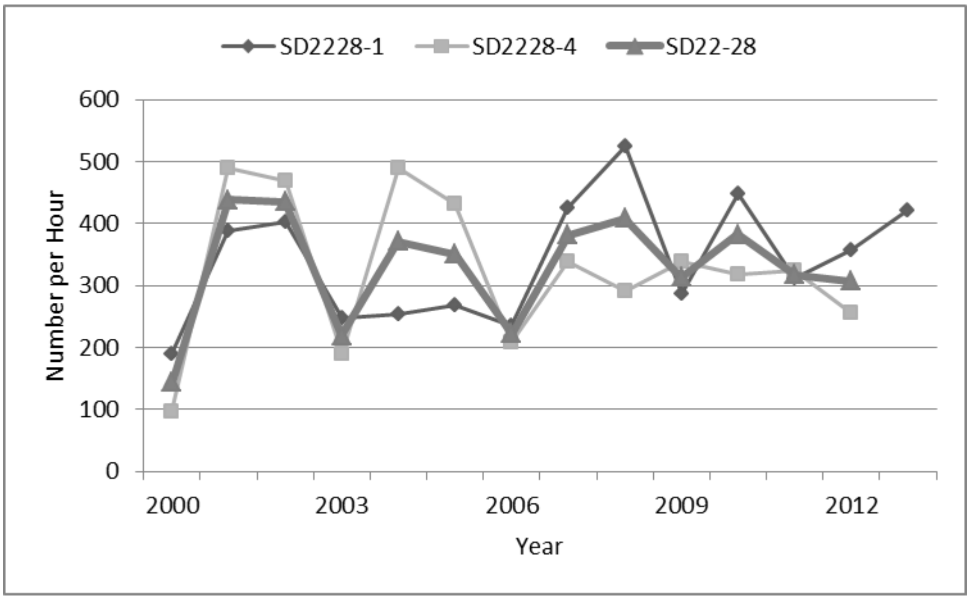


Figure 8.4.2.2. Catch per unit of effort (number per hour) from BIT Survey in 1st and 4th Quarters, Subdivision 28.

New biomass indices based on weight were calculated in the Workshop and they are presented in Chapter 8.5.4 (Figure 8.5.4.1).

8.4.3 Age-length information

Age data from the recommended ageing method was available from limited time period. Most of the countries started to use a new method only in last two–three years. Only Poland, so far, re-aged part of their otoliths back to 2000. Therefore, in ICES data call, countries were asked to upload length distribution and sex from commercial landings. The aim was to apply slicing method to obtain age distributions.

Work flow for slicing the length–frequency (LFD) distribution into number-at-age is provided in Section 3.3. A full description on the slicing method is available in Section 3.

8.4.4 Weights, maturities, growth

Weight in the stock

Information from the DATRAS database was used to calculate flounder weight in the stock in ICES Subdivisions 26 and 28 from the BITS survey, 1st quarter. According to recommendation from previous workshop on flounder age reading, the age data from the sliced or broken and burned methodology was used. Available data, according to information provided in WKBALFLAT Data compilation workshop, are presented in Table 8.4.4.1.

Table 8.4.4.1. Available age information (yellow cells) of flounder in DATRAS database by countries and years.

Country	Years												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Poland													
Latvia													
Lithuania													
Denmark													
Sweden													

Average weight for each age group by year was calculated. Missing information was replaced by the average value of two neighbour years (one before and one after) from the same age group. Weight data in years 2000 and 2001 were replaced with data from year 2002, in 2003 the average from 2002 of 2004 (Table 8.4.4.2).

Table 8.4.4.2. Average weight of flounder in the stock. BITS 1st quarter data, SD 26 and 28. Yellow cells indicate replaced values.

YEAR	AGE										
	1	2	3	4	5	6	7	8	9	10	11+
2000		41	65	235	202	312	758	830	868	905	776
2001		41	65	235	202	312	758	830	868	905	776
2002		41	65	235	202	312	758	830	868	905	776
2003		42	75	223	294	381	711	645	750	908	761
2004		44	86	211	386	449	664	459	632	908	746
2005	10	40	97	169	325	532	489	841	734	908	850
2006		22	66	245	437	461	685	671	716	910	570
2007		28	45	150	311	452	573	496	699	580	570
2008	52	42	76	127	205	202	248	254	283	250	290
2009		30	59	131	167	274	317	247	278	356	352
2010		48	84	118	173	200	279	206	311	276	310
2011		50	97	156	203	220	260	298	294	318	328
2012		55	134	180	169	224	248	266	343	256	249

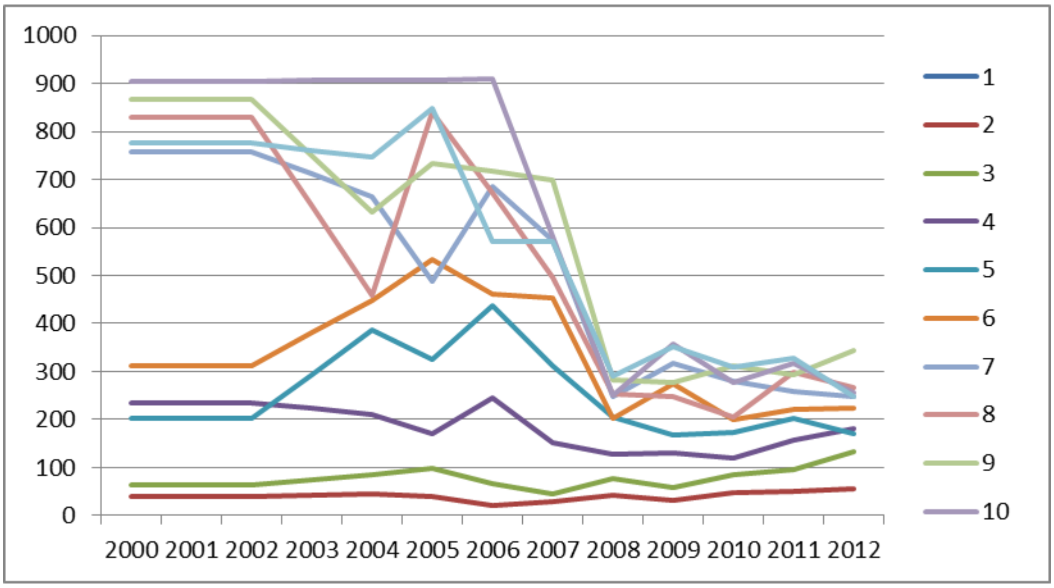


Figure 8.4.4.1. Average weight of flounder in the stock. BITS 1st quarter data, SD 26 and 28.

Average weight in the stock for older groups (six years and older) decreased drastically from 2008 (Figure 8.4.4.1.). For the time period 2000–2007 data from Poland only was used to calculate weight data, while for the time period 2008–2012 data from five different countries were available.

To investigate this further in the following calculation only Poland data were included (Table 8.4.4.3 and Figure 8.4.4.2). The results show that there was still a decrease in average weight after 2008, although the decrease was not as steep as when all of the available data were included.

Table 8.4.4.3. Average weight of flounder in the stock, Poland data only. BITS 1st quarter data, SD 26 and 28. Yellow cells indicate replaced values.

Year	Age									
	1	2	3	4	5	6	7	8	9	10	11
2000		42	75	223	294	381	711	645	657	906	761
2001		42	75	223	294	381	711	645	657	906	761
2002		41	65	235	202	312	758	830	683	905	776
2003		42	75	223	294	381	711	645	657	906	761
2004		44	86	211	386	449	664	459	632	908	746
2005	10	40	97	169	325	532	489	841	734	908	850
2006		22	66	245	437	461	685	671	716	910	628
2007		28	45	150	311	452	573	496	699	634	628
2008	52	30	80	143	230	296	398	429	676	358	406
2009		52	99	191	294	354	493	429	485	443	676
2010		47	115	200	265	281	342	362	949	499	387
2011		169	155	295	316	310	374	447	736	428	405
2012		59	171	289	302	344	428	295	346	522	423

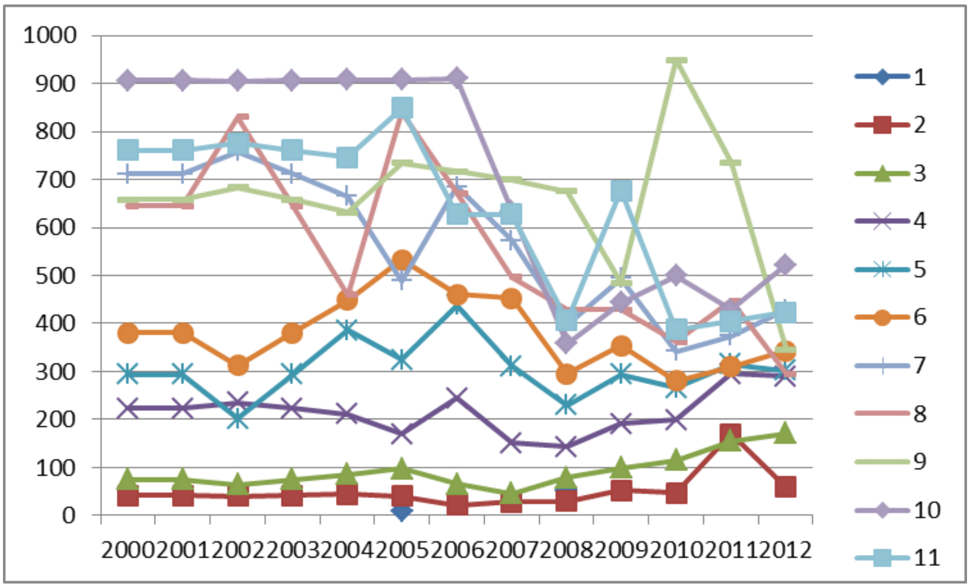


Figure 8.4.4.2. Average weight of flounder in the stock, Poland data only. BITS 1st quarter data, SD 26 and 28.

Weight in the catch

Flounder weight in catch was calculated using InterCatch database. All available data were used. Two time periods could be separated in data availability. From 2000 to 2007 weight data were available from Poland only. It should be mentioned that number of observations was low. From 2008 to 2012 most of countries uploaded data in InterCatch.

The InterCatch database does not allow the inclusion of survival rate of discards in the calculations. Therefore, all of discards were included what could result in overestimation of mean weight in the younger age groups. Probably, discarded fish have lower weight and including all of discard in catch may result in lowering of average weight.

It should be mentioned than in first time period when Poland age data were available, age range of flounder was narrower. The mean weight of older age groups at the beginning of time-series are often much higher than in latest years (Table 8.4.4.4 and Figure 8.4.4.3.)

The missing values were replaced as average from four closest neighbour values (years) from the same age group.

Table 8.4.4.4. Average weight of flounder in the catch.

YEAR	AGE										
	1	2	3	4	5	6	7	8	9	10	11+
2000	42	130	154	242	443	689	710	1017	372	590	315
2001	42	95	140	250	349	268	365	815	250	590	315
2002	42	130	126	243	455	594	882	294	372	590	315
2003	42	108	145	271	328	401	440	230	372	385	315
2004	42	108	271	279	358	371	289	845	372	951	315
2005	42	108	267	307	323	434	379	409	372	590	315
2006	42	108	172	231	307	424	319	409	372	590	315
2007	42	108	184	226	295	310	319	409	370	590	307
2008	42	129	139	203	156	213	279	304	441	551	297
2009	42	79	156	176	211	282	331	258	428	474	315
2010	29	134	198	252	267	274	302	312	357	443	315
2011	42	194	177	161	277	309	301	302	335	390	355
2012	55	154	221	213	287	262	278	293	360	339	299

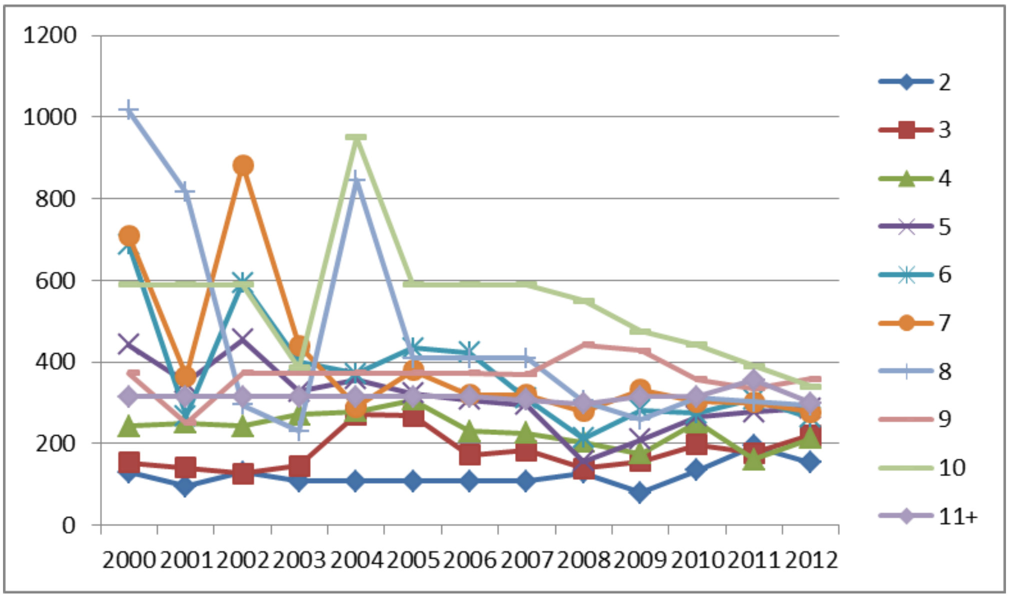


Figure 8.4.4.3. Average weight of flounder in the stock, Poland data only. BITS 1st quarter data, SD 26 and 28.

Maturity

Proportion of mature fish by years was calculated based on data from DATRAS database. Only BITS 1st quarter age data with the recommended ageing methodology were included in calculations (Table 8.4.4.5). No information from 2000, 2001 and 2003 was available. Missing information was filled with the average from entire time period.

Table 8.4.4.5. Available age and maturity data by countries and years in DATRAS.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
LAT									256	226	225	221	208	1136
LTU												252		252
POL			56		85	91	48	76	116	77	139	118	183	989
SWE									644		356	403	631	2034
Grand Total			**56**		**85**	**91**	**48**	**76**	**1016**	**303**	**720**	**994**	**1022**	**4411**

Data from Poland, Sweden, Latvia and Lithuania were converted to mature and immature flounder using scheme in Table 8.4.4.6.

Table 8.4.4.6. Conversion factors of maturity stage of flounder used in PROPMAT calculations.

Country	National Maturity scale	Mature/Immature
LAT	II	I
	III	M
	IV	M
	V	M
	VI	M
	VII	I
LTU	62	M
	63	M
	64	M
POL	I	I
	II	I
	III	M
	IV	M
	V	M
	VI	M
	VII	M
	VIII	M
SWE	I	I
	II	I
	III	M
	IV	M
	IX	M
	V	M
	VI	M
	VII	M
	VIII	M

Proportion of mature flounder by age groups is showed in Figure 8.4.4.45. Proportion of adult fish in 2008 is anomalously lower than in other years.

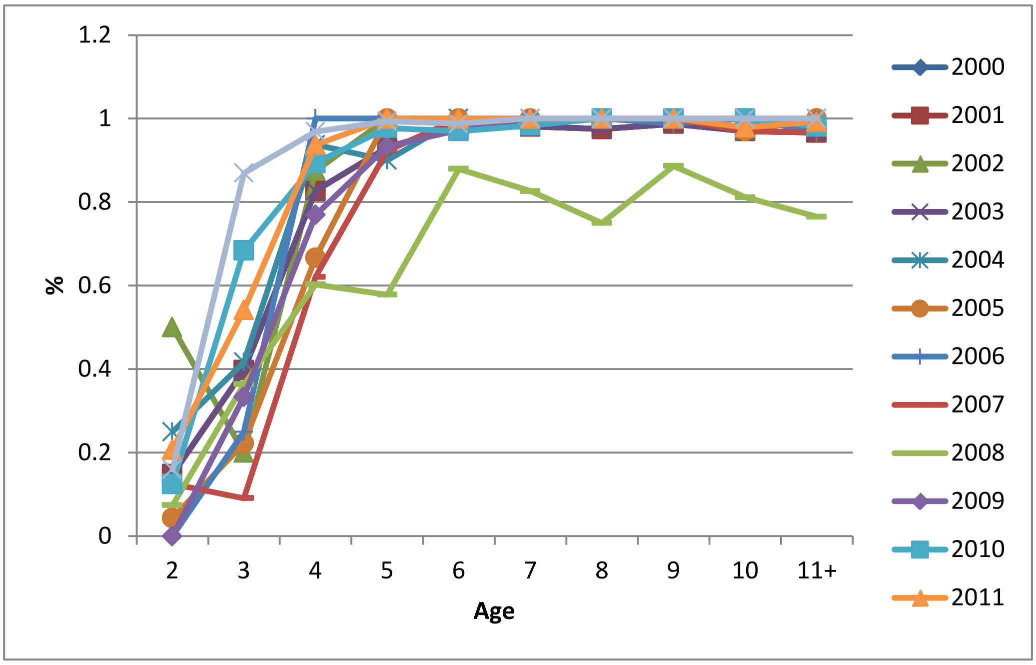


Figure 8.4.4.45. Proportion of adult fish by years and age groups in Subdivision 26 and 28.

8.4.5 Exploratory Assessment model

The difference version of the Schaefer stock-production model was applied as exploratory assessment for flounder in Subdivision 26 and 28. The used model was very similar to the stock-production model applied for flounder in Subdivision 24–25 (see Section 7.5.1). The main difference was that for fitting the model for the stock in SDs 26 and 28, two tuning indices were used: one from BITS survey applied in similar way as for the SDs 24–25 stock, and one from the Russian commercial cpue data. The year range of tuning data also differed somewhat from the Subdivision 24–25 stock; BITS survey used for fitting the SD 25+28 stock covered period 1991–2013 and Russian cpue covered years 1995–2013.

Russian cpue series refer to two types of bottom-trawling vessels: the MRTR and MRTK. MRTRs vessels specialize in bottom-trawl fishing, while the MRTK vessels fish both demersal and pelagic species. Both types of vessels cover 88–97% of total Russian flounder catch in Subdivision 26. Under the current fishing regulation in the Russian Federation, to monitor the catch, a ship owner should provide the information on: kind of activity (commercial fishing, transition into the operations area, anchorage), daily catch and catch range. The data obtained from all vessels are combined into an electronic database. Vessel day by vessel type is estimated by taking into account the kind of activity; it includes only those days when the vessel performed commercial fishing. Average flounder cpue for MRTR and MRTK vessels was calculated as a flounder catch in tones divided by the number of commercial fishing vessel days by vessel type.

The BITS survey indices for 1st and 4th quarter and their geometric mean are presented in Figure 8.4.5.1. The commercial cpue of both Russian series and their mean are included in Figure 8.4.5.2.

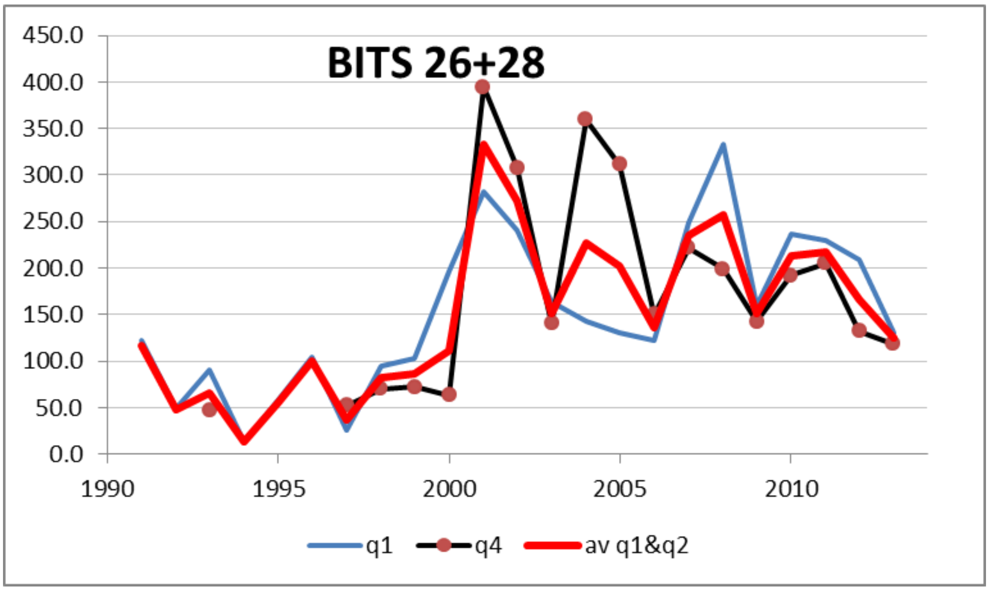


Figure 8.4.5.1. BITS survey indices for 1st and 4th quarter (in terms of weight) and the geometric average of both indices.

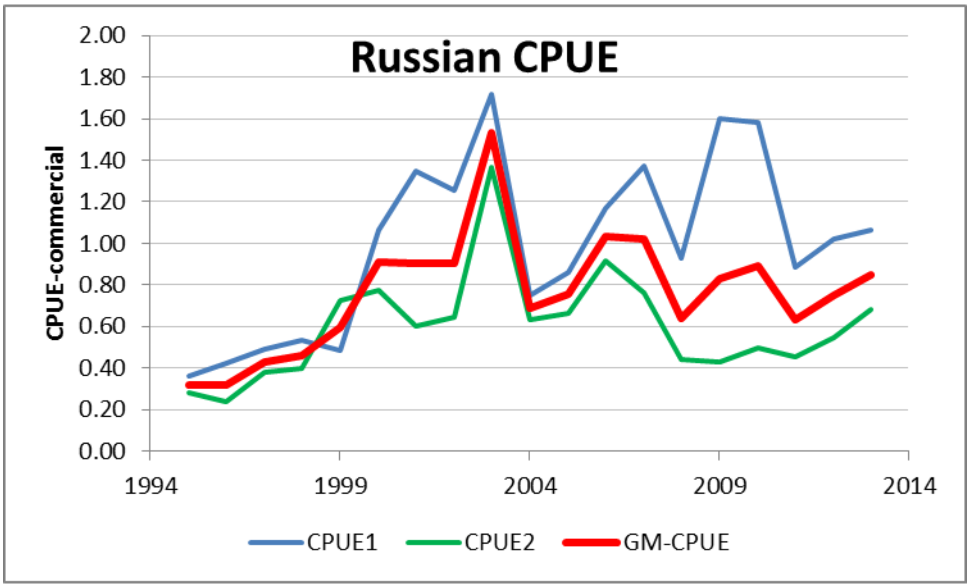


Figure 8.4.5.2. Cpue from two Russian commercial fleets (in terms of weight) and the geometric average of both indices.

Similar as for the Subdivision 24–25 stock (Section 7.4.5), the option which included information on intrinsic rate of increase *r* estimated using demographic methods (McAllister *et al.*, 2001) was included in minimized function with weight (penalty) varying from zero (additional information not used) to ten (very high weight of additional information term). The estimate of demographic *r* was 0.55.

The estimates of biomass and retrospective analysis of biomass estimates are presented in Figures 8.4.5.3–8.4.5.4. There is little difference between biomass estimates when deviation of model fitted *r* from r estimated using demographic methods is included (with weight 1) or excluded in the fitting procedure. The models fitted with each of the considered indices (survey and commercial cpue) separately show that the assessment is driven more by commercial cpue than by survey indices (Figure 8.4.5.3). Retrospective pattern shows underestimation of biomass in recent years.

It was concluded in the benchmark workshop that further reviewing of the Russian cpue should be done. In the model, catch data from 1995 was used. However, the estimated discard rate was not accepted. Therefore, presented assessment should be updated in the future with new discard estimates.

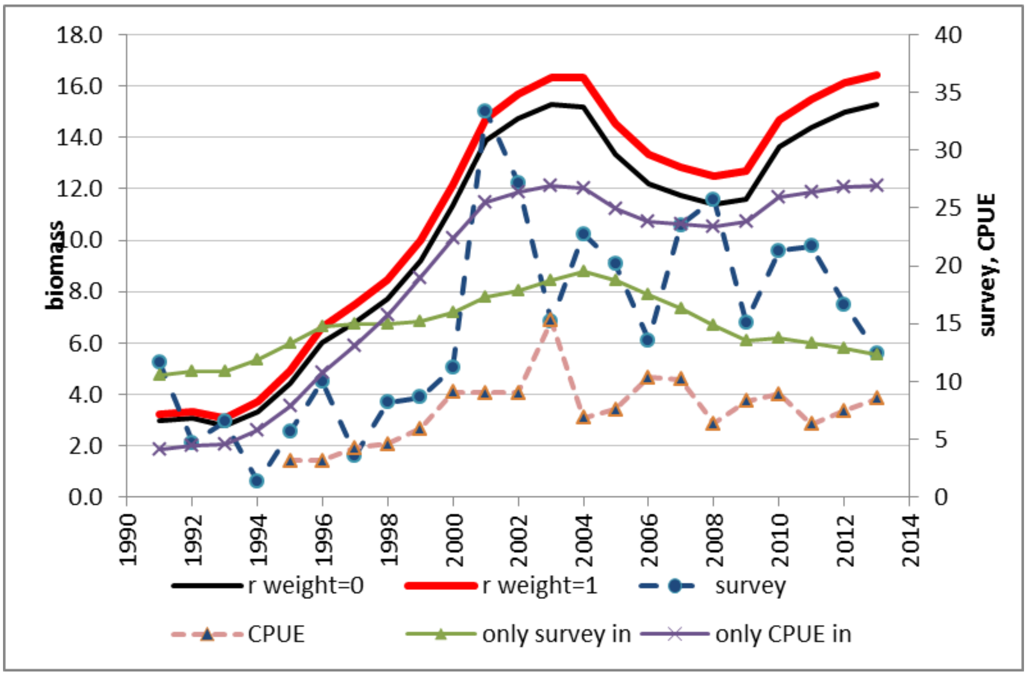


Figure 8.4.5.3. Estimates of flounder biomass (Subdivision 26+28) from production model when external information on r is included (r weight =1) or not used in the model (r weight =0). In addition, survey indices and biomasses for model fitted with each of the considered indices separately are shown.

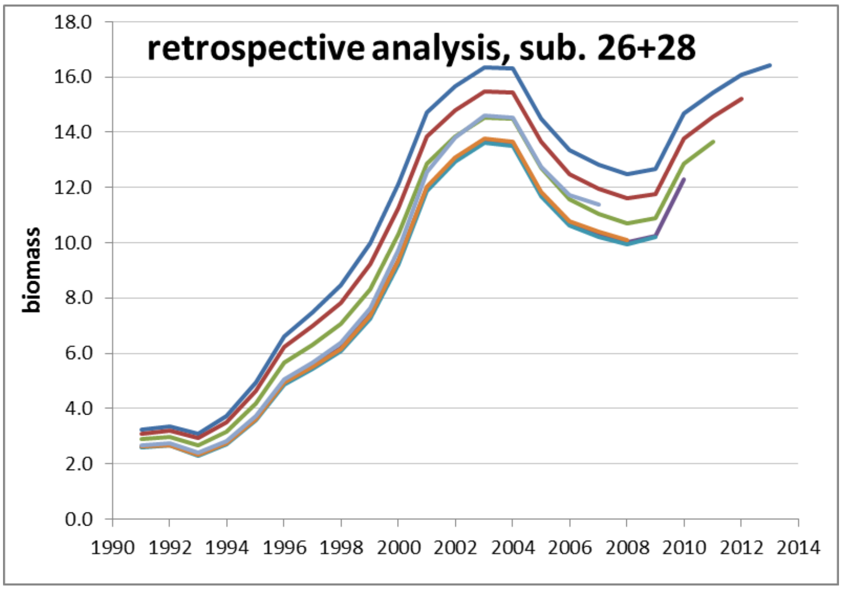


Figure 8.4.5.4. Retrospective pattern of estimates of flounder biomass (Subdivision 26+28) from production model.

8.5 Proposed Assessment approach

8.5.1 Describe the proposed assessment model

Due to problems of quality of the data commercial data (mainly discards estimation) the benchmark workshop decided that the flounder stocks in SD 26 and 28 is assessed following the method proposed for category 3 stock: stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES, 2012).

Therefore, the model used could be Data Limited Stock Category 3.2 Survey based index (but no MSY trigger). The average index from the last two years of survey information should be compared with the average index from the three preceding years.

8.5.2 Describe the accepted data configuration

DATRAS database provides cpue by length in numbers. Weight-at-length was estimated as an average weight-at-length for data from 1991–2013, separately for 1st and 4th quarter and Subdivisions 24–25 and 26+28. Next, to such data weight–length relationships of the form w=aL^b were fitted, where a and b are parameters. Parameters obtained for 26+28 were: a=0.0154 and b=2.91 for 1st quarter and a=0.0158 and b=2.90 for 4th quarter. Next, such biomasses for fish longer than 20 cm were summed to get total biomass index by quarters. For the final index the geometric mean of 1st and 4th quarter indices should be taken.

8.5.3 Short-term projections

Not applicable.

8.5.4 Appropriate Reference Points (MSY)

No reference points were defined at the benchmark workshop.

8.6 Future Research and data requirements

Given the high variability of the discard ratios, estimating discards is very uncertain without an extensive sampling programme. It was discussed in the benchmark workshop that discards estimations should be done outside InterCatch database to apply more flexible allocations possibilities.

The division between flounder in SDs 24–25 and SDs 26–28.2 should be further examined and whether a more consistent assessment with lower uncertainty is obtained when merging these two areas.

Slicing methods to convert length distributions to age (as no age information is available back in time) should be validated with real age readings from the same dataset, for time periods when this is possible.

The age-structured model (e.g. SAM) should be attempted for that stock and the quality of the model fit and behaviour inspected. However, first further work on discard estimates is needed. With acceptable discard estimates both age-structured and production models should be fitted and their performance in assessment process investigated. Analytical assessment of this stock is still in the developmental phase, and should not be used alone in the provision for the advice.

8.7 Recommendations

The discards should be estimated using recommended method that takes in account zero landings situations.

If a new agreed discard calculation method recommended to 2013 data processing give a significant improvement of the data compilation, the same procedure will be applied on the whole dataseries back to 2000 (see Section 2.2).

After the discard data quality is improved, it is recommended to continue developing an analytical assessment for FLE-26 and 28 considering both production model and age-based model such as SAM.

It is recommended for countries to re-age historical data back to 2000 with the recommended ageing method, which will increase the range of years with adequate age information.

9 Flounder in Subdivision 27 and 29–32

9.1 Issue list

9.2 Multispecies and mixed fisheries issues

Flounder in this area is caught in directed fishery mainly with gillnets in Finland, Estonia and Sweden and to a lesser extent by Danish seine in Estonia. However, it is also a bycatch in the cod fishery both using gillnets and trawls in Sweden and Estonia.

9.3 Ecosystem drivers

Reproductive success depends on hydrological conditions. It is successful down to 5–7 PSU (Nissling *et al*., 2002) and require oxygen concentrations of 1–2ml/l for development (Nissling *et al*., 2002; Vitins, 1980; Ustups *et al*., 2013).

9.4 Exploratory Assessment analysis

9.4.1 Catch– quality, misreporting, discards

Total yearly landings are available for all three countries fishing on the stock, Estonia, Sweden and Finland from 1980 and onwards in WGBFAS reports. However, it was revealed that the previously published ICES estimates of landings data in WGBFAS and in the ICES Advice also include landings from the recreational fishery for Estonia and Finland. Data uploaded to the ICES database InterCatch in the data call (quarterly data in active and passive fleet years 2000–2012) have for Finland been corrected to include commercial landings only. A new report of yearly commercial flounder landings in Finland 1980–1999 has, as well as a new report from Estonia on commercial landings only in 2009–2012, been used to construct a new flounder landings table by country and SD (Table 9.2). This recalculation resulted mainly in changes for the SD 29 and 32. In 2012, the yearly total landings in SD 29 and 32 (the SDs with higher landings) decreased from 120 and 86 tonnes previously reported to 86 and 74 tonnes, respectively. For earlier years the change was even more dramatic, resulting in more than 50% reduction in reported landings. For example, 464 and 416 tonnes were previously reported in SD 29 and 32 respectively in 1996, but removing recreational fishery from Finland results in a total of 146 and 154 tonnes reported. It must be stressed that this is probably also an overestimate since Estonian numbers still include recreational fishery for the years before 2009. It was decided at WKBALFLAT that for the assessment only commercial landings should be used, restricting the period of usable landings data to 2009–2012. The quality of the recreational catch values needs further analysis, both in terms of sampling design and raising procedures.

It was decided to allocate flounder in SDs 27 and 29–32 to a common stock representing flounder with demersal eggs (see Section 5). Flounder with this ecotype also occurs in SD 28 but it was deemed more appropriate to allocate flounder in SD28-2 to the pelagic egg type of flounder because landings in SD 28-2 are relatively large compared to these in the other SDs (1–3 times the combined landings of 27, 29-32), which would overshadow the developments in "real" demersal component. Thus, to avoid the dynamics in the demersal unit to be very much driven by SD 28-2 (containing a mixture of the two ecotypes) it was decided that 28-2 was to be allocated to the pelagic unit in SD 26+28 (see Section 5). Furthermore, since fisheries data for flounder currently is not divided into subunits of SD 28 it was not possible to include data from the Gulf of Riga (SD 28-1) in the analyses of this stock. This means that part of the population in this assessment unit is missing. Since the proportion of the different ecotypes in SD 28 is unknown and comparable estimate of relative population size in the different areas is lacking, it is impossible to provide reliable estimate of the proportion of the ecotype that is missing in the assessment. Nevertheless, assuming that landings reflect population size and assuming the proportion of demersal egg type to be 10%, it would mean that 10–30% of the population is missing (i.e. allocated to the flounder stock in SD 26 and 28) in the assessment, when using the landings from 2009–2012.

Landings of flounder in SD 27, 29–32 peaked at more than 2000 tonnes in the early 1980s but have since then declined to about 200 tonnes yearly (Figure 9.1). The fishery is dominated by Estonia who takes about 80% of the landings. Flounder is mainly fished in the Gulf of Finland (SD 32) and the Åland Sea (SD 29) by the Estonian and Finnish fishery and to a lesser extent by the Swedish fishery in SD 27 (Figure 9.2). In the Gulf of Bothnia (SD30+31) less than 1 ton is taken yearly in Finnish fishery. The fishery is almost exclusively using passive gears, dominated by gillnets, but also trapnets are used. Fishing occurs all year-round but is concentrated to the late summer and autumn (77% of the landings were made in Q3 and 17% in Q4 in 2012).

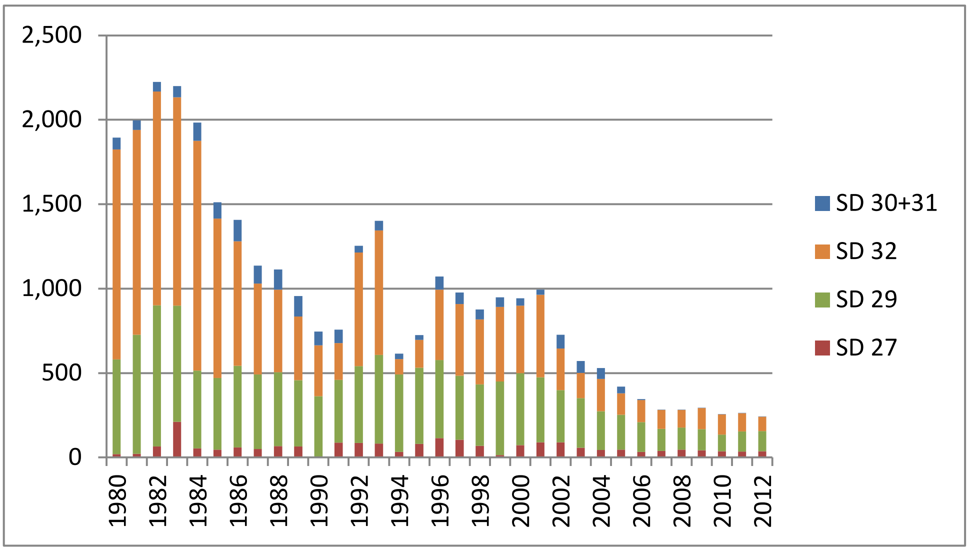


Figure 9.1. Landings in SD 27, 29–32 of flounder. For Estonia 1980–2008 also include recreational landings.

Discard in the fishery dominated by passive gears are presumably low. No estimates of discards are available from Sweden and Estonia. According to Estonian fishery regulations discarding is not allowed and a maximum of 10% bycatch is allowed. Interviews with fishers revealed that discarding do exist (T. Drevs, pers. comm). During spawning time and immediately after spawning all flounder, caught in traps, are discarded. For example, in northwestern Hiiumaa (SD 29) the discard of flounder during spawning time has been 2–3 t per trap. During summer small flounders are discarded in the traps with small mesh size. In Finland, however, reporting of all catch is mandatory. Since there have been no reprimands against discarding it's likely that the fishermen report it. The legislation and practice has been in place the entire time period included in the data call (2000–2012). Reported discard in Finland were

155 kg out of a total catch of 5 tonnes in 2012, corresponding to a discard rate of 3% for this stock. The available studies indicate a minimum estimate of 50% survival in winter and 10% in summer for flounder in trawl fishery (WD 2.1) that was applied in calculating discards for the other flounder stocks in the Baltic. Survival of discard in gillnet fishery, which is the dominating fishery in this stock, is however unknown and could be anything from 0 to 100% depending on if the discard takes place at sea or in the harbour, i.e. fish are dumped on land.

At WKBALFLAT it was decided that given the large uncertainty on discards it is impossible to use discard estimates for the assessment. Consequently, only commercial landings advice can be provided for the time being. However, in the future it is recommended that discard and recreational catch estimates should be improved to allow for inclusion in the assessment.

Recreational fishery

Flounder is also caught to a great extent in the recreational fishery. Statistics from Ministry of Environment in Estonia estimate that a yearly catch of more than 40 tonnes, representing 20% of the total catch, are made in the recreational fishery. Data are available from 2005–2012 (Table 9.1). (http://www.envir.ee/orb.aw/class=file/action=preview/id=1197601/Harrastuspyygi+saagi+koondandmed+2005–2012++17.04.2013.pdf). The catch is estimated by reports of fishers with fishing cards. With possession of a fishing card it is allowed to use entangling net, longline consisting of up to 100 hooks, hoopnet, dragnet, crayfish dipnet and trap. Mainly gillnets are used for flounder recreational fishing. The fishers, who use one simple handline; more than one simple handline; handline; spinning reel; troll; pulling device; fly hook; bottom line (“tonka” and “krunda”); trimmer and harpoon gun and up to five-prong harpoon for underwater fishing, have no responsibility to report their catch (http://www.envir.ee/1181039).

In Finland the recreational catches are estimated every second year by a mail survey (for 6000 households from the whole population) and assumed to be the same as the year before in the intermediate year. The catch is not reported separately by quarters, but only estimated as total for the year. The recreational fishery is further described in the (WD 9.1). The bulk of the Finnish recreational flounder catch is taken from SDs 29–32 by gillnets for household use. Other fishing techniques used for flounder (like angling) are of minor importance, comprising of about 1 tonne annually. Data are available from 2000–2012, showing a decrease over time from over 300 tonnes to less than 50 tonnes (Table 9.1).

In Sweden national surveys of the recreational fishery have been performed by Statistics Sweden and Swedish Board of Fisheries describing the situation in 2006 and 2010. The first study is described in Thörnqvist (2009). The study was performed in two steps, first a simple questionnaire were posted to a stratified sample of 10 000 Swedish citizens. The stratification was based on geography, age and sex to get a representative collection of samples from all parts of Sweden. A second more detailed questionnaire were send to those that had reported to had been fishing, which included questions of fishing area, species caught, species thrown back, number of fishing days per gear type (two types of gears: hand-held or bulk catching gears), etc. The fishing pattern among those that answered the questionnaires might be different from the fishing pattern among those not answering. Therefore, drop- out analyses were performed by telephone interviews for both enquires to avoid biased sampling. Using the Hansen–Hurwitz method (Hansen and Hurwitz, 1943) mean and variation of total catches per species, gear type and geographic area was estimated. In 2006 it is estimated that 60 tonnes of flounder (±42.5 tonnes) was caught in recreational fishery in the Baltic Proper, corresponding to SD 27, 28 and 29. This is of the same magnitude as the commercial fishery which landed 50 tonnes of flounder in 2006 in the same SDs. No recreational catches of flounder were reported from Gulf of Bothnia (SDs 30 and 31). Most recreational fishery for flounder is using bulk catching gear like gill-nets. It is possible that this is an underestimate of flounder catches since flounder might also have been reported as "other flatfishes" (140 ±-57 tonnes). The questionnaire asked specifically about plaice, flounder, turbot and "other flatfishes". However, the only "other flatfish" occurring regularly in the Baltic Proper is dab so "other flatfishes" probably includes all of the mentioned species. Figures from a survey in 2010 (data from Swedish Agency for Marine and Water Management) merge all flatfishes together and estimates the total catch of flatfish in Baltic Proper to be 75 tonnes (± 64 tonnes) compared to 50 tonnes of flounder landed in SDs 27,28 and 29 (Table 9.1). No recreational catches were reported from Gulf of Bothnia (SDs 30 and 31).

It is evident that recreational fishery stands for a large part of the total outtake in this assessment unit (Figure 9.2) and ideally this should be taken into account in the assessment. However, due to the large uncertainty about the estimates it was decided not to use data on recreational fishery in the assessment at WKBALFLAT. In the future we should strive to include better estimates of the impact of recreational fishery on this stock.

Table 9.1. Estimates of recreational landings of flounder (tonnes).

YEAR	ESTONIA	ESTONIA	FINLAND	FINLAND	FINLAND	FINLAND	SWEDEN
	SD 29	SD 32	SD29	SD30	SD31	SD32	SD27,28,29
2000			187	30	1	156	
2002			78	63		14	
2004			64	3		12	
2005	16	21					
2006	16	22	48	2			60(±42)
2007	19	19					
2008	19	17	27	7		6	
2009	14	15					
2010	22	22	9		1	1	75 (±64)
2011	20	21					
2012	22	21	24	1		13	

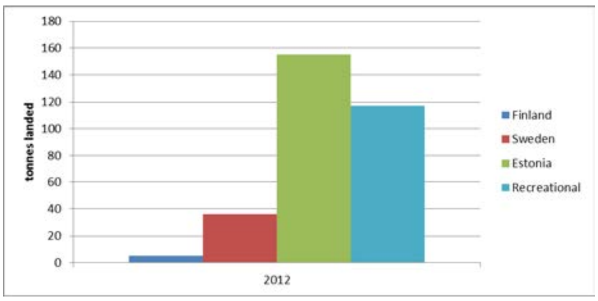


Figure 9.2. Landings of flounder in SD 27, 29–32 in 2012 by country and also total of estimated recreational landings are shown, assuming an equal amount of recreational and commercial landings for Sweden.

Table 9.2. Flounder landings by SD. Original tables (Tables 4.1a–f by WGBFAS 2013) corrected for Finland 1980–2012 and Estonia 2009–2013 to only include commercial landings. Rows with changes compare to original WGBFAS table are marked in yellow. Table is not updated for other countries and years and hence might differ from data in InterCatch and from what is currently used as the most updated information for other countries.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1973	Denmark	1 983		386									2 369
	Finland												0
	Gem. Dem. F	181		1 624	1 516								3 321
	Gem. Fed. R	349		4									353
	Poland				1 580	2 070							3 650
	Sweden				502								502
	USSR							2 610					2 610
	Total	2 513	0	2 014	3 598	2 070	0	2 610	0	0	0	0	12 805
1974	Denmark	2 097		2 578									4 675
	Finland												0
	Gem. Dem. F	165		1 482	654								2 301
	Gem. Fed. R	304		3									307
	Poland				1 635	2 473							4 108
	Sweden				470								470
	USSR							2 510					2 510
	Total	2 566	0	4 063	2 759	2 473	0	2 510	0	0	0	0	14 371
1975	Denmark	1 992		1 678									3 670
	Finland								113	22		47	182
	Gem. Dem. F	163		1 469	406								2 038
	Gem. Fed. R	469		1									470
	Poland				1 871	2 585							4 456
	Sweden				400								400
	USSR							6 455					6 455
	Total	2 624	0	3 148	2 677	2 585	0	6 455	113	22	0	47	17 671
1976	Denmark	2 038		482									2 520
	Finland								118	23		59	200
	Gem. Dem. F	174		1 556	901								2 631
	Gem. Fed. R	392		2									394
	Poland				1 549	2 289							3 838
	Sweden				400								400
	USSR					471		1 779	409			359	3 018
	Total	2 604	0	2 040	2 850	2 760	0	1 779	527	23	0	418	13 001
1977	Denmark	1 974		389									2 363
	Finland								115	32		56	203
	Gem. Dem. F	555		2 708	1 096								4 359
	Gem. Fed. R	393		4									397
	Poland				2 071	2 089							4 160
	Sweden				416								416
	USSR					210		1 081	321			414	2 026
	Total	2 922	0	3 101	3 583	2 299	0	1 081	436	32	0	470	13 924
1978	Denmark	2 965		415									3 380
	Finland								174	61		155	390
	Gem. Dem. F	348		2 572									2 920
	Gem. Fed. R	477		1									478
	Poland				996	2 106							3 102
	Sweden				346								346
	USSR					288		1 290	334			395	2 307
	Total	3 790	0	2 988	1 342	2 394	0	1 290	508	61	0	550	12 923
1979	Denmark	2 451		405									2 856
	Finland								192	54		153	399
	Gem. Dem. F	189		2 509									2 698
	Gem. Fed. R	259		3									262
	Poland				1 230	1 860							3 090
	Sweden				315								315
	USSR					158		1 170	330			1 012	2 670
	Total	2 899	0	2 917	1 545	2 018	0	1 170	522	54	0	1 165	12 290
1980	Denmark	2 185		286									2 471
	Finland								27	14	1	11	53
	Gem. Dem. F	138		2 775									2 913
	Gem. Fed. R	212		1									213
	Poland				1 613	1 380							2 993
	Sweden			16	46		20	181	32				295
	USSR					93		798	334			1 080	2 305
	Total	2 535	0	3 078	1 659	1 473	20	979	393	14	1	1 091	11 243

* Denmark: Catches of SD 23 are included in SD 22 & catches of SDs 28&29 are included in SD 27

Sweden: Catches of SDs 24-29 of the years 1973-1979 are included in SD 25

Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30; in the years 1973-1979 recreational catches are included.

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1981	Denmark	1 964		548									2 512
	Finland								67	4		7	78
	Gem. Dem. R	271		2 595									2 866
	Gem. Fed. R	351		1									352
	Poland				1 151	1 541							2 692
	Sweden			21	30		21	194	34				300
	USSR					58		742	445			1 078	2 323
	Total	2 586	0	3 165	1 181	1 599	21	936	546	4	0	1 085	11 123
1982	Denmark	1 563	104	257									1 924
	Finland								38	6		6	50
	Gem. Dem. R	263		3 202									3 465
	Gem. Fed. R	248		1									249
	Poland				2 484	1 623							4 107
	Sweden			22	33		65	16	3				139
	USSR					195		665	615			1 121	2 596
	Total	2 074	104	3 482	2 517	1 818	65	681	656	6	0	1 127	12 530
1983	Denmark	1 714	115	450									2 279
	Finland								28	7		3	38
	Gem. Dem. R	280		3 572									3 852
	Gem. Fed. R	418		1									419
	Poland				1 828	905							2 733
	Sweden			72	108		212	52	9				453
	USSR					209		551	497			1 114	2 371
	Total	2 412	115	4 095	1 936	1 114	212	603	534	7	0	1 117	12 145
1984	Denmark	1 733	85	306									2 124
	Finland								27	10		6	43
	Gem. Dem. R	349		2 719									3 068
	Gem. Fed. R	371		1									372
	Poland				2 471	1 288							3 759
	Sweden			18	27		53	13	2				113
	USSR					145		202	286			1 226	1 859
	Total	2 453	85	3 044	2 498	1 433	53	215	315	10	0	1 232	11 338
1985	Denmark	1 561	130	649									2 340
	Finland								21	9		7	37
	Gem. Dem. R	236		3 253									3 489
	Gem. Fed. R	199		4									203
	Poland				2 063	1 302							3 365
	Sweden			16	24		47	12	2				101
	USSR					268		189	265			806	1 528
	Total	1 996	130	3 922	2 087	1 570	47	201	288	9	0	813	11 063
1986	Denmark	1 525	65	1 558									3 148
	Finland								36	11		5	52
	Gem. Dem. R	127		2 838									2 965
	Gem. Fed. R	125		10									135
	Poland				3 030	1 784							4 814
	Sweden			20	31		60	15	3				129
	USSR					442		159	281			556	1 438
	Total	1 777	65	4 426	3 061	2 226	60	174	320	11	0	561	12 681
1987	Denmark	1 208	122	1 007									2 337
	Finland								37	18		3	58
	Gem. Dem. R	71		2 096									2 167
	Gem. Fed. R	114		11									125
	Poland				2 530	1 745							4 275
	Sweden			17	26		51	13	2				109
	USSR					1 315		203	279			397	2 194
	Total	1 393	122	3 131	2 556	3 060	51	216	318	18	0	400	11 265
1988	Denmark	1 162	125	990									2 277
	Finland								43	21		5	69
	Gem. Dem. R	92		2 981									3 073
	Gem. Fed. R	133		5									138
	Poland				1 728	1 292							3 020
	Sweden			23	35		68	17	3				146
	USSR					578		439	257			331	1 605
	Total	1 387	125	3 999	1 763	1 870	68	456	303	21	0	336	10 328

* Denmark: Catches 1981 of SD 23 are included in SD 22 & catches of SDs 28&29 are included in SD 27
Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Gem. Dem. R Catches of SD 26 are included in SD 25
Gem. Fed. R Catches of SD 25 are included in SD 24
Poland Catches of SD 24 are included in SD 25

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1989	Denmark	1 321	83	1 062									2 466
	Finland							1	39	24		6	70
	Gem. Dem. R	126		3 616									3 742
	Gem. Fed. R	122		2									124
	Poland				1 896	1 089							2 985
	Sweden			22	34		66	16	3				141
	USSR					783		512	214			214	1 723
	Total	1 569	83	4 702	1 930	1 872	66	528	256	24	0	220	11 251
1990	Denmark	941		1 389									2 330
	Finland								35	19		4	58
	Gem. Dem. R	52		1 622									1 674
	Gem. Fed. R	183		10									193
	Poland				1 617	599							2 216
	Sweden				120								120
	USSR					752		390	144			141	1 427
	Total	1 176	0	3 021	1 737	1 351	0	390	179	19	0	145	8 018
1991	Denmark	925		1 497									2 422
	Finland								53	17		5	75
	Germany	246		1 814									2 060
	Poland				2 008	1 905							3 913
	Sweden			24	31		88	20					163
	Estonia					49		1	135			51	236
	Latvia					123		323					446
	Lithuania					125							125
	Russia					216		10					226
	Total	1 171	0	3 335	2 039	2 418	88	354	188	17	0	56	9 666
1992	Denmark	713	185	975									1 873
	Finland								48	10		5	63
	Germany	227		1 972									2 199
	Poland				1 877	1 869							3 746
	Sweden			41	88	3	86	11	3				232
	Estonia							47	47			46	140
	Latvia					26		664					690
	Lithuania					399							399
	Russia					146							146
	Total	940	185	2 988	1 965	2 443	86	722	98	10	0	51	9 488
1993	Denmark	649	194	635									1 478
	Finland								52	26		5	83
	Germany	235		1 230									1 465
	Poland				3 276	1 229							4 505
	Sweden		26	27	63	1	83	10					210
	Estonia							52	86			55	193
	Latvia					99		389					488
	Lithuania					155							155
	Russia					225							225
	Total	884	220	1 892	3 339	1 709	83	451	138	26	0	60	8 802
1994	Denmark	882	181	1 016									2 079
	Finland								47	24		8	79
	Germany	44		4 262		2		3					4 311
	Poland				3 177	1 266							4 443
	Sweden		84	20	18	37	33	55	10				257
	Estonia								3			4	7
	Latvia					31		276					307
	Lithuania					218							218
	Russia					167							167
	Total	926	265	5 298	3 195	1 721	33	334	60	24	0	12	11 868
1995	Denmark	859	231	2 110									3 200
	Finland								54	29		6	89
	Germany	286		2 825		4		40					3 155
	Poland				7 437	1 482							8 919
	Sweden		58	28	186	7	81	18					378
	Estonia				8			16	52			35	111
	Latvia					39		322					361
	Lithuania				8	187							195
	Russia					271							271
	Total	1 145	289	4 963	7 639	1 990	81	396	106	29	0	41	16 679

* Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Denmark: Catches of SDs 28&29 are included in SD 27
Gem. Dem. R Catches of SD 26 are included in SD 25
Gem. Fed. R Catches of SD 25 are included in SD 24
Germany Catches of SD 25 are included in SD 24
Poland/Latvia Catches of SD 24 are included in SD 25

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
1996	Denmark	1 041	227	2 306									3 574
	Finland				1				47	36		9	93
	Germany	189		1 322		10		9					1 530
	Poland				6 069	2 556							8 625
	Sweden	2	58	101	718	48	114	31					1 072
	Estonia							44	99			145	288
	Latvia					74		215					289
	Lithuania					316							316
	Russia					740							740
	Total	1 232	285	3 729	6 788	3 744	114	299	146	36	0	154	16 527
1997	Denmark	1 356		2 421	31	10							3 818
	Finland				1				35	32		13	81
	Germany	655		1 982		12		4					2 653
	Poland				3 877	1 730							5 607
	Sweden		42	62	308	31	105	370					918
	Estonia				15			101	96			125	337
	Latvia					78		284					362
	Lithuania					554							554
	Russia					1 001							1 001
	Total	2 011	42	4 465	4 232	3 416	105	759	131	32	0	138	15 331
1998	Denmark	1 372		2 393									3 765
	Finland				2				36	21		14	73
	Germany	411		1 729		2							2 142
	Poland				4 215	1 370							5 585
	Sweden		61	49	187	18	70	117					502
	Estonia				10			146	79			87	322
	Latvia				2	88		274					364
	Lithuania					737							737
	Russia					1 188							1 188
	Total	1 783	61	4 171	4 418	3 403	70	537	115	21	0	101	14 678
1999	Denmark	1 473		1 206									2 679
	Finland								43	22	2	9	76
	Germany	510		1 825									2 335
	Poland				4 015	1 435							5 450
	Sweden		37	24	87	47	15						210
	Estonia				8			92	150			164	414
	Latvia					140		365					505
	Lithuania					547							547
	Russia					964							964
	Total	1 983	37	3 055	4 111	3 133	15	457	193	22	2	173	13 180
2000	Denmark	1 896		1 757									3 653
	Finland			14	4	0			34	13	0	9	74
	Germany	660		2 089									2 749
	Poland				3 423	1 668							5 091
	Sweden		41	49	122	0	73	28					313
	Estonia				2	1		65	150			126	344
	Latvia				3	113		302					418
	Lithuania					575							575
	Russia					1 236							1 236
	Total	2 556	41	3 910	3 556	3 593	73	395	184	13	0	135	14 453
2001	Denmark	2 030		3 048									5 078
	Finland			9	68				28	14	0	7	127
	Germany	458		1 886									2 344
	Poland				4 608	1 433							6 041
	Sweden		52	31	96	3	90	178			3		453
	Estonia							100	161			221	482
	Latvia					201		412					613
	Lithuania					1 127							1 127
	Russia					1 355							1 355
	Total	2 488	52	4 974	4 773	4 119	90	690	189	14	3	228	17 620

* Finland: Catches of SDs 27&28 are included in SD 29 & catches of SD 31 are included in SD 30
Poland/Latvia Catches of SD 24 are included in SD 25
Germany Catches of SD 25 are included in SD 24

Year	Country*	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
2002	Denmark	1 490		2 883	2								4 375
	Finland			5	34	0			16	77		21	153
	Germany	317		2 066									2 383
	Poland				6 979	1 512							8 491
	Sweden		42	30	111	4	90	48		5			330
	Estonia							91	199			226	516
	Latvia					221		375					596
	Lithuania					1 077							1 077
	Russia					1 314							1 314
	Total	1 807	42	4 984	7 126	4 128	90	514	215	82	0	247	19 235
2003	Denmark	1 063		1 786	1	1							2 851
	Finland			2	7	0	0		16	9	0	7	40
	Germany	241		1 490									1 731
	Poland				5 068	1 425							6 493
	Sweden		33	45	105		57	17					257
	Estonia							122	192			128	442
	Latvia					281		392					673
	Lithuania					1 066							1 066
	Russia					1 402							1 402
	Total	1 304	33	3 323	5 181	4 175	57	531	208	9	0	135	14 955
2004	Denmark	952		2 615									3 567
	Finland				0				13	18	0	4	35
	Germany	315		1 591									1 906
	Poland				6 364	1 900							8 264
	Sweden		31	19	86		45	18					199
	Estonia							89	144			167	400
	Latvia				7	169		600					776
	Lithuania					834							834
	Russia					1 277							1 277
	Total	1 267	31	4 225	6 457	4 180	45	707	157	18	0	171	17 258
2005	Denmark	725	184	2 159	144								3 212
	Finland			1	2	0			11	10	0	3	26
	Germany	94		883	43								1 020
	Poland			2 072	6 762	1 714							10 548
	Sweden	+	38	26	58	+	47	124	2	+			296
	Estonia							133	144			114	391
	Latvia			2		383		1 333					1 718
	Lithuania					949							949
	Russia					1 393							1 393
	Total	819	223	5 143	7 009	4 439	47	1 590	157	10	0	117	19 553
2006	Denmark	620	182	517	1 517	4							2 840
	Finland			2	3			0	11	4.166	0	2	22
	Germany	34		974	7								1 015
	Poland			1 779	5 950	1 681							9 410
	Sweden		30	23	61	1	33	20					168
	Estonia							83	165			129	377
	Latvia					317		838					1 155
	Lithuania					355							355
	Russia					1 231							1 231
	Total	654	212	3 295	7 538	3 589	33	941	176	4	0	131	16 573
2007	Denmark	585	233	623	622	2							2 065
	Finland			2	8	1		0	6	1	0	2	21
	Germany	406		1 432	217	0							2 055
	Poland			3 016	5 837	1 836							10 690
	Sweden		26	27	59	1	39	18	0	0	0		171
	Estonia							92	125			111	328
	Latvia			8	7	166		877					1 058
	Lithuania				11	268							279
	Russia					2 650							2 650
	Total	991	259	5 109	6 761	4 925	39	987	131	1	0	113	19 317

* Finland: Where not given separately,catches of SDs 27&28 are included in SD 29 and catches of SD 31 are included in SD 30

Poland/Latvia Where not given separately,catches of SD 24 are included in SD 25

Germany Where not given separately,catches of SD 25 are included in SD 24

Year	Country	SD 22	SD 23	SD 24	SD 25	SD 26	SD 27	SD 28	SD 29	SD 30	SD 31	SD 32	Total
2008	Denmark	554	199	427	313								1 492
	Finland				0				5	1	0	3	10
	Germany	627		1 608	238								2 473
	Poland*			2 094	5 569	1 456							9 119
	Sweden	0	47	29	66	0	49	18	0	0			209
	Estonia							91	125			103	319
	Latvia			44	29	203		374					651
	Lithuania				31	601		27					660
	Russia					1 960							1 960
	Total	1 180	246	4 202	6 248	4 221	49	512	130	1	0	106	16 894
2009	Denmark	505	113	326	199								1 142
	Finland			41	0				6	1	0	3	51
	Germany	521		1 181	29	1							1 731
	Poland			2 540	5 985	1 671							10 195
	Sweden		37	27	65	0	41	17	0	0			187
	Estonia****				0			77	59			97	233
	Latvia				154	52		312					518
	Lithuania				31	472	.	27					530
	Russia					969							969
	Total	1 026	149	4 114	6 464	3 164	41	433	65	1	0	100	15 558
2010	Denmark	557	91	332	385	0							1 364
	Finland			13	2		0		6	1	0	3	26
	Germany	376		957	31								1 364
	Poland			2 173	7 665	1 731							11 569
	Sweden	0	29	21	64	0	36	15	0	0			165
	Estonia****				15	0		80	84			97	276
	Latvia				31	25		225					281
	Lithuania				19	407		55					481
	Russia					1 030							1 030
	Total	933	120	3 497	8 212	3 193	36	375	90	1	0	100	16 556
2011	Denmark	441	78	311	224	1							1 055
	Finland			3	2	1	0	0	5	1	0	2	15
	Germany	497	0	1 504	147								2 147
	Poland			1 567	6 666	1 437							9 670
	Sweden	0	28	26	60	1	34	20	0	0	1		170
	Estonia****				20	15	0	67	94	0	0	83	280
	Latvia				39	114	0	156					309
	Lithuania				15	418	0	0					434
	Russia					1 139							1 139
	Total	938	106	3 410	7 174	3 127	34	244	99	1	1	85	15 220
2012**	Denmark	530	98	290	250	0							1169
	Finland			20	17	10			3	0	0	1	51
	Germany***	569		904	151								1624
	Poland			1331	7325	1501							10158
	Sweden	0	22	23	67	2	36	13	0		0		163
	Estonia*****				19	11		66	82			73	251
	Latvia				8	378		244					631
	Lithuania				24	640		12					675
	Russia					1079							1079
	Total	1 100	121	2 569	7 862	3 620	36	335	86	0	0	74	15 802

* Poland 2008 corrected

** provisional

*** Data were not uplouded in InterCatch

**** Data Corrected for Estonia 2009-2012, older data includes recreational fishery

9.4.2 Surveys

The BITS survey is not representative for flounder with demersal eggs since during the time of the quarter one (BITS-Q1) survey this type of flounder are most probably in more shallow, coastal areas. During the BITS-Q4 survey they are mixed with the flounder with pelagic eggs (ICES, 2010). Furthermore the BITS surveys do not cover the northern parts of the Baltic Sea (SDs 29–32) which is the main distribution area of flounder with demersal eggs.

Cpue are however available from national surveys for this assessment unit. National gillnet surveys are performed by Estonia in Muuga Bay near Tallinn (mesh size 40–60 mm bar length) in SD 32 from 1993 and 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 of 14–20 m. Gillnet surveys are also undertaken from 1999 onwards in different parts of the Gulf of Finland in Estonian waters (Pakri, Muuga, Ihasalu, Kaberneeme and Kolga bays) with mesh sizes 16, 22, 24, 30, 35, 40, 45, 50 and 60 mm (bar length). In SD 32 from Käsmu area (since 1997) survey takes place in August. In 1997–2000 gillnets 17, 22, 25, 30, 33, 38 mm were used and, since 2001 mesh sizes of 42, 45, 50, 55 and 60 mm have been added.

In SD 29 survey takes place on southeast coast of Hiiumaa island (Saarnaki) in July/August (since 1998). Gillnets are with mesh sizes 17, 22, 25, 30, 33 and 38 mm.

Gillnet surveys are also conducted by Sweden using the same gear as in Kudema and the same time of year September/October in two areas in southern and 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.

Data on effort were available for some countries and fleet segments (Table 9.3) and cpue from the commercial fishery in Finland are available for several gears (gillnets and trapnets) in SD 29–32 for the years 1998–2012. The effort in cpue is given as the number of gear days. For example, gillnet fishing with ten gillnets on five days equals 50 gillnet days. The unit catch is given as the size of the catch (kg) per gear and per fishing day. The unit catch is calculated from observations deviating from zero, i.e. only effort from trips resulting in flounder landings was used.

Estonia cpue from the Danish seine fishery in SD 29 are available from 2009–2012 (kg per hauls), in addition effort data from Danish seine and gillnet fishery in SD29 and 32 are available for the same time period.

Landings per unit of effort from the Swedish commercial flounder gillnet fishery (gillnets <=100 mm diagonal mesh) in SD 27 are also available for 2000–2012. Effort is calculated as the number of fishing hours from the daily logbooks for ships >10 m. The unit catch is calculated from observations deviating from zero.

Table 9.3. Total estimates of effort in flounder fishery in SDs 27, 29–32.

YEAR	SWE (H GILL-NET, SHIPS>10M)	SWE (KWH FOR COD TRAWLERS)	EE (NR OF HAULS WITH DANISH SEINE)	EE (NR OF NET HAULS WITH GILLNETS)	FIN (GEAR DAYS IN PASSIVE GEARS)
2000	4386				539157.5
2001	6370				568041.2
2002	7582				470030
2003	11084	414255.21			510690.3
2004	5268	304680.41			433066.8
2005	15021	217642.76			386629.5
2006	3515	217844.29			338995.5
2007	4202	235675.16			234093.5
2008	4540	217434.72			241773.6
2009	3436	193145.05	202.00	70903	345588.9
2010	3980	147761.11	76.00	99390	313221.8
2011	3450	145480.76	14.00	74499	295906
2012	4040	148454.14	50.00	52990	183214.5

9.4.3 Age-length information

Age information from commercial catches is very limited. Catch in numbers-at-age (CANUM) and mean weight-at-age (WECA) (using slicing or the breaking and burning technique for age reading as recommended by WKARFLO (ICES, 2007, 2008) and WKFLABA (ICES, 2010)) are available from Sweden from 2009 and 2010 in SD 27 and from Estonia from 2011–2012 in SD 29 and 32. No age data from Finland or from SD 30 and 31 were available.

Length distributions from the commercial fishery are available for Estonian gillnet fishery in SD32 and 29 from 2000–2012 and from the Estonian Danish Seine fishery in SD 29 from 2004–2012.

Age information from surveys are available from Estonia (using the broken and burning technique for age reading) in SD 29 (years 2000–2012) and SD 32 (years 2011–2012) and in Sweden (using the slicing and staining technique for age reading) from Muskö in SD 27 (years 2002–2012). Length frequencies are available for the whole time-series for all four surveys (Figure 9.3).

It was determined at WKBALFLAT that the age data from commercial catches covered too few years to be able to use for an analytical assessment. In addition, it was decided not to use age data from available surveys in a survey-based analytical assessment, like SURBA. Therefore it was decided to use the Data Limited Stock approach for assessment of flounder in SD 27, 29–32.

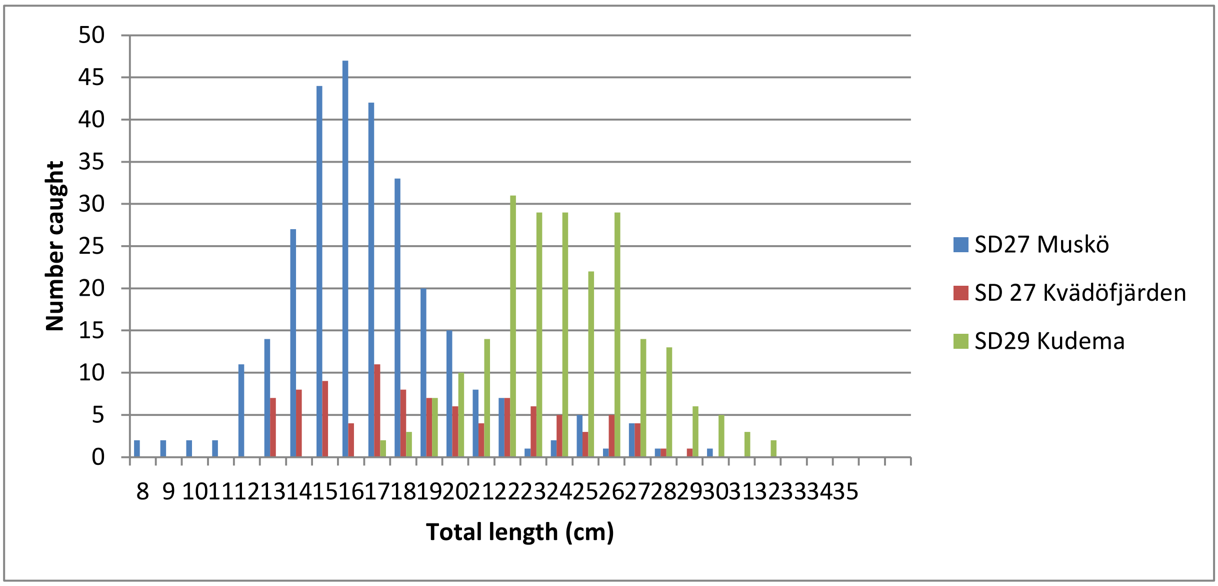


Figure 9.3. Length distribution in gillnet surveys performed in Q4 in 2012.

9.4.4 Weights, maturity, growth

Since it was decided to use a DLS assessment approach and time did not permit, data on weights, maturities and growths were not presented at WKBALFLAT. However, it is recommended to be compiled for the future for surveys and the part of the commercial fishery where CANUM is reported.

9.4.5 Exploratory Assessment model

9.4.5.1 Age distribution in surveys

Age sampling is stratified and hence the age distribution per year and survey are constructed by the use of age–length keys applied to the length distribution in the total catch. Age distributions of catch-at-age in the Küdema and Muskö surveys are presented in Figures 9.4 and 9.5 respectively. The age structure of the two surveys was somewhat different with younger fishes. This is not surprising considering the different length distribution of the two surveys, with larger fishes in the Küdema survey (Figure 9.3). In the Muskö survey the large cohorts of 2005 and 2007 can be clearly followed, while for Küdema only the 2007 year class can be tracked (Figures 9.4 and 9.5).

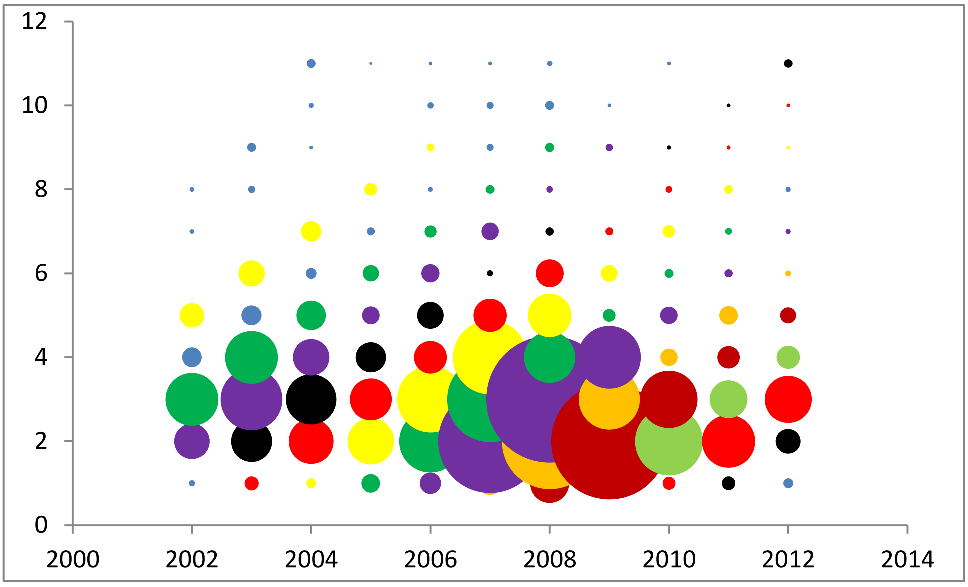


Figure 9.4. Catch-at-age from SD27 Muskö (only ages up to 11 are shown). Size of bubble is proportionate to the catch per unit of effort of different age groups (y-axis) at different sampling years (X-axis).

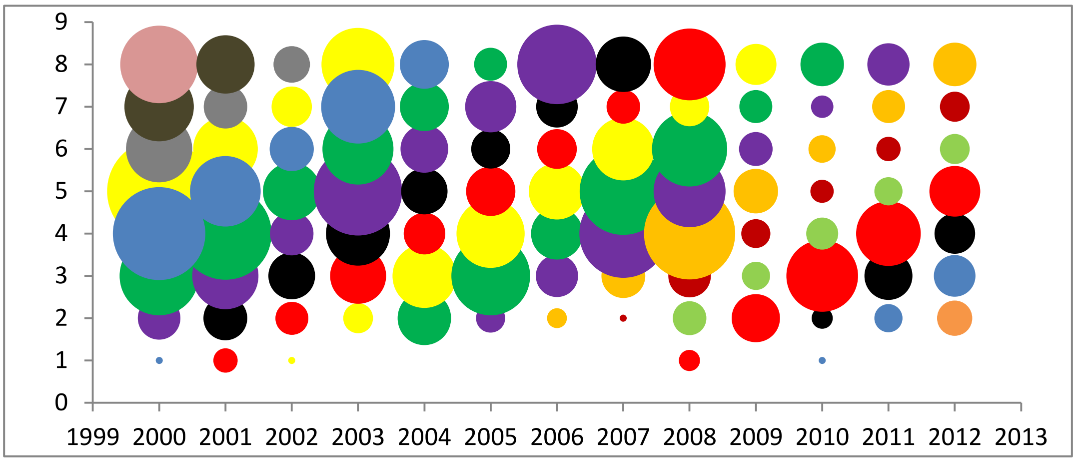


Figure 9.5. Catch-at-age from SD 29 Küdema (8 is a plusgroup). Size of bubble is proportionate to the catch per unit of effort of different age groups (y-axis) at different sampling years (X-axis).

Mortality rates were estimated using catch–curve analysis (Quinn and Deriso, 1999). This method was used to estimate total mortality (Z) by adapting a regression line for the Ln-transformed catch-at-age data in numbers (Figure 9.6a, b). The slope of the regression line specifies Z (Table 9.4).

The analyses suggest that average total mortality was quite low in SD 29 (0.26) which can be compared to the estimate of natural mortality for flounder of 0.20 (Florin *et al.*, 2013). In SD 27 however the estimates of average total mortality was significantly higher (1.02).

It was decided at WKBALFLAT not to use these estimates for advice since there were some caveats about the data. Such as the lack of older, and larger, individuals in SD 27, which suggest that this is an area mainly for juvenile flounder and that older individuals have migrated out of the area. Hence, suggesting that the disappearance of older age classes is not due to high mortality but migration. Concern was also raised about the unusually even distribution between age groups in the survey in SD29, and the consequently low correlation coefficients in the Catch–Curve analysis for some cohorts.

Table 9.4. Catch–curve analysis ages 3–7 from gillnet surveys Q4.

	SD27, Muskö, Sweden			SD29, Küdema, Estonia		
cohort	equation	z	R2	equation	z	R2
1999	y = -0.8204x + 4.2661	0.82	0.94	y = -0.1443x + 0.9285	0.14	0.36
2000	y = -0.6433x + 3.2831	0.64	0.80	y = -0.2105x + 1.1072	0.21	0.73
2001	y = -1.0388x + 4.532	1.03	0.83	y = -0.2119x + 1.6586	0.21	0.58
2002	y = -0.6844x + 3.4056	0.68	0.70	y = -0.2727x + 2.1151	0.27	0.29
2003	y = -0.965x + 5.3948	0.96	0.89	y = -0.4483x + 2.4022	0.45	0.40
2004	y = -1.3546x + 6.3185	1.35	0.92	y = -0.3567x + 1.8562	0.36	0.38
2005	y = -1.6874x + 8.1912	1.68	0.97	y = -0.1789x + 0.1546	0.18	0.35
	Mean (SD)	1.02 (0.38)		Mean (SD)	0.26 (0.11)	

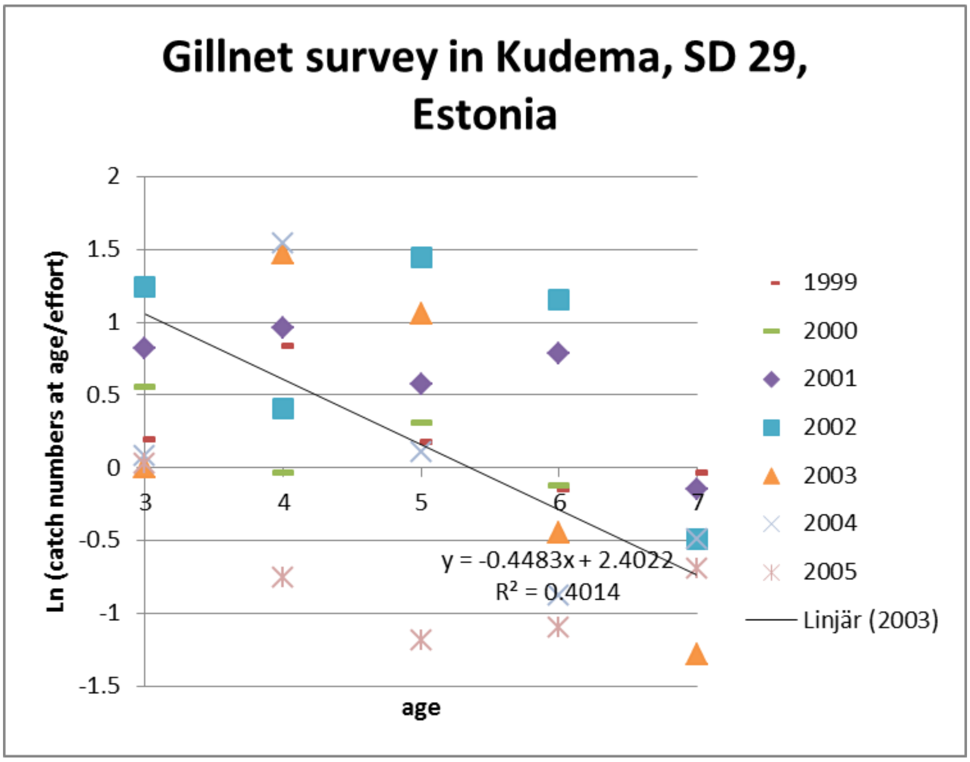


Figure 9.6a. Ln catch-at-age for different cohorts, linear regression of cohort 2003 is shown.

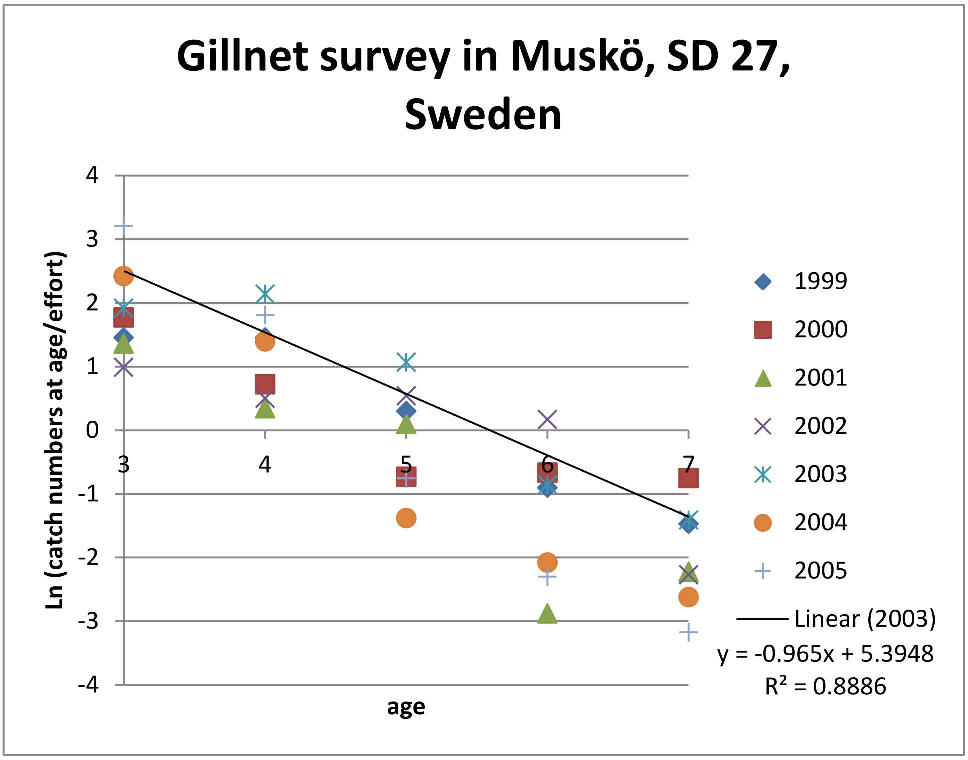


Figure 9.6b. Ln catch-at-age for different cohorts, linear regression of cohort 2003 is shown.

9.4.5.2 Trends in surveys

Trends in cpue were looked at in the four available national gillnet surveys. Using numbers caught per net and night (Figure 9.7a) and a linear regression, it was evident that there was a negative trend in SD 29 and the southernmost survey in SD 27 but no trend in the survey in SD 32 or the northern part of SD 27, when looking over the whole time-series. The same pattern was evident when using biomass (kg) instead and restricting the survey in SD 32 to only include data from October (Figure 9.7b). The restriction in time of SD 32 survey was made to make it comparable with the other surveys which were performed only in autumn while the SD 32 survey took place from May to October. It was evident that cpue fluctuated between years, probably due to recruitment of strong year classes and also that not all surveys show the same trend.

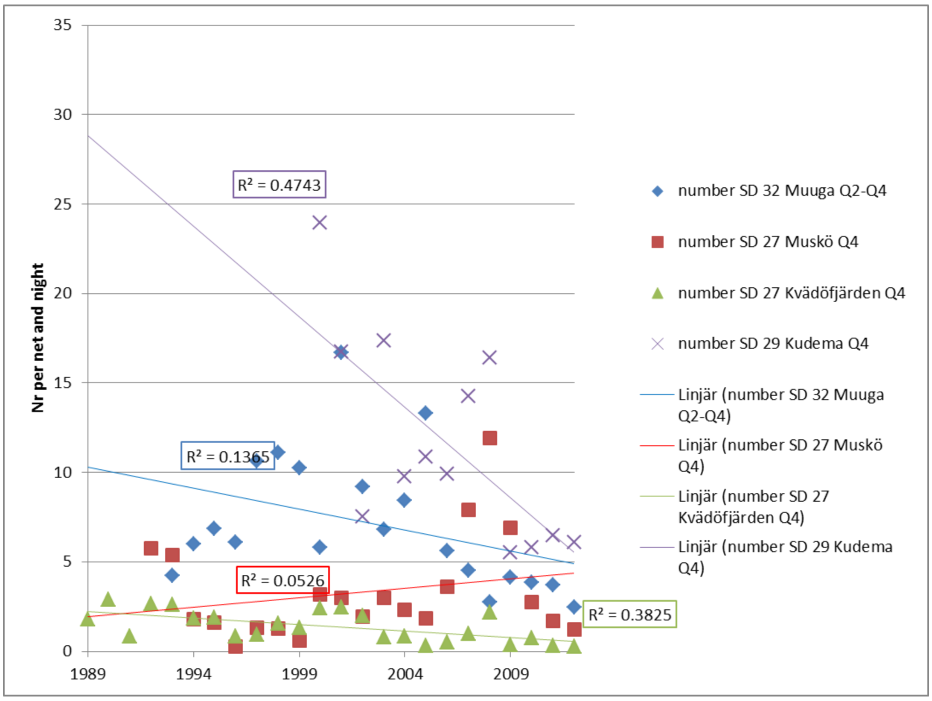


Figure 9.7a. Negative trend in numbers per unit of effort southern part of SD 27 and in SD 29 but no trend in 32 or northern part of SD 27.

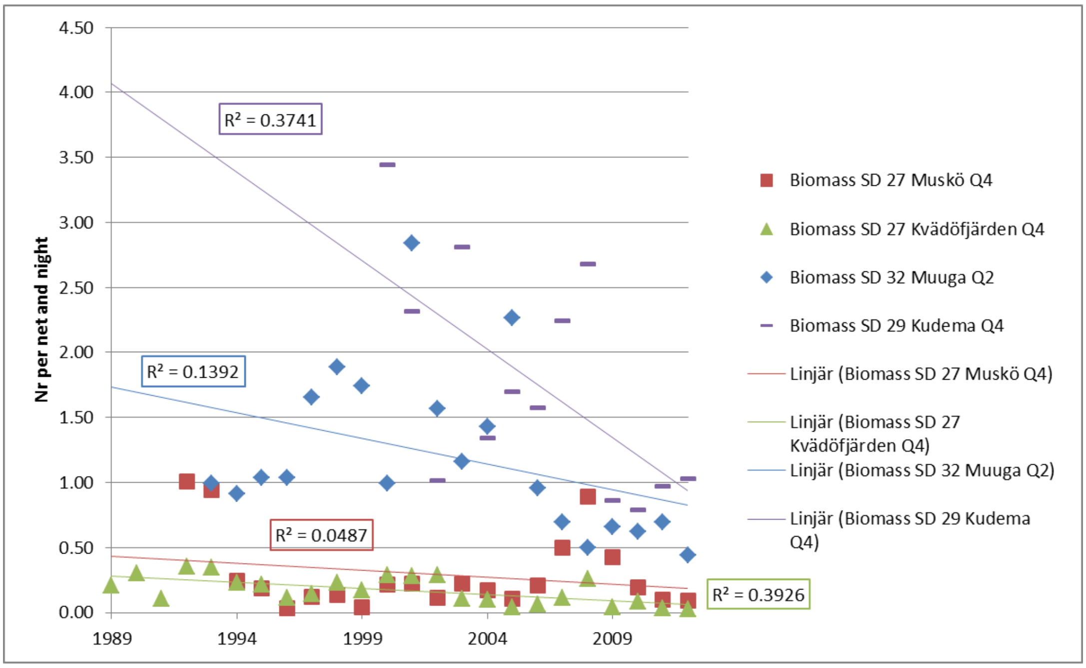


Figure 9.7b. Negative trend in biomass (kg) per unit of effort in southern part of SD 27 and in SD 29 but no trend in 32 or northern part of SD 27.

9.4.5.3 Trends in commercial cpue

18 datasets with different estimates of commercial cpue from different gears and SDs were available (Table 9. 5). Trends were first investigated by looking at a linear regression of the whole time-series in one SD at a time. In SD 29 in the larger sized gillnets (51–60 mm and >60 mm) there are no overall correlation while there is a negative correlation for the smaller sized gillnet (Figure 9.8). In SD 30 all gillnets show a nega-

tive correlation as do the trapnets (Figure 9.9 a, b). No trend was evident in flounder gillnet in SD 27 (Figure 9.10). In SD 31, there was a negative trend in small sized gillnets but an extreme outlier in the starting year may have been responsible for this (Figure 9.11). In SD 32 there was strong negative trend in all gillnet series except 51–60 mm, but no trend in the trapnets (Figure 9.12). Overall 13 showed a negative trend and five were without significant trends. In addition an exploratory assessment was made by comparing the average cpue for the last two years to the previous three years (adhering to the ICES DLS approach). According to this 12 series showed a decrease in mean cpue while six had an increase in mean cpue (data shown in Table 9.5).

Even though there in general were negative trends both looking at the longer time-series and using the DLS approach it was decided by WKBALFLAT not to use the trends in the commercial cpue in the final advice. This was because there was no information on which of these gears might best reflect the development of the flounder stock in the area, or how to pool information from several different gears showing opposite trends. Therefore it was decided not to use commercial cpue for stock assessment of flounder in SDs 27, 29–32.

Table 9.5. Commercial cpue per SD in Finnish (FI), Estonian (EE) and Swedish (SE) fishery using different gears. For details see section on surveys.

	SD29	SD29	SD29	SD29	SD29	SD27	SD31	SD32	SD32	SD32	SD32	SD32	SD30	SD30	SD30	SD30	SD30	SD30	SD30
Year	FI, Gillnet, >60 mm	FI, Gillnet, 36–45 mm	FI, Gillnet, 46–50 mm	FI, Gillnet, 51–60 mm	EE, Danish seine	SE, flounder gillnets	FI, Gillnet, 36–45 mm	FI, Gillnet, >60 mm	FI, Gillnet, 36–45 mm	FI, Gillnet, 46–50 mm	FI, Gillnet, 51–60 mm	FI, Trapnet	FI, Gillnet traps	FI, Gillnet, >60 mm	FI, Gillnet, 36–45 mm	FI, Gillnet, 46–50 mm	FI, Gillnet, 51–60 mm	FI, Trapnet	FI, Whitefish trapnet
1998	1.00	0.06	0.06	0.37			0.69	1.00	0.03	0.05	0.27	0.27	0.45	0.45	0.08	0.15	0.13	2.81	1.51
1999	0.57	0.05	0.11	0.51			0.10	0.81	0.03	0.06	0.15	0.18	0.33	0.55	0.05	0.12	0.06	1.25	1.06
2000	0.66	0.05	0.16	0.43		3.70	0.00	0.69	0.03	0.05	0.14	0.06	0.23	0.19	0.04	0.08	0.05	1.57	0.46
2001	0.41	0.04	0.07	0.49		4.20	0.04	0.68	0.04	0.04	0.07	0.03	0.19	0.13	0.03	0.06	0.06	1.56	0.72
2002	0.47	0.03	0.07	0.36		2.82	0.05	0.80	0.03	0.05	0.08	0.11	0.15	0.14	0.02	0.03	0.05	0.82	0.51
2003	0.45	0.03	0.08	0.27		1.67	0.00	0.66	0.03	0.03	0.05	0.07	0.14	0.18	0.02	0.06	0.07	1.00	0.80
2004	0.63	0.03	0.10	0.06		2.18	0.18	0.39	0.02	0.03	0.02	0.09	0.32	0.11	0.03	0.09	0.12	1.63	1.76
2005	0.57	0.04	0.10	0.60		1.80	0.00	0.38	0.01	0.05	0.01	0.42	0.33	0.07	0.02	0.05	0.05	0.64	0.58
2006	0.77	0.02	0.09	0.06		2.69	0.03	0.50	0.01	0.02	0.02		0.12	0.04	0.01	0.03	0.03	0.50	0.61
2007	1.02	0.02	0.04	0.63		2.72	0.11	0.55	0.02	0.02	0.97	0.12	0.10	0.30	0.01	0.01	0.00	0.07	0.12
2008	0.64	0.03	0.05	0.20		3.50	0.00	0.25	0.01	0.02	0.08	0.14	0.05	0.02	0.01	0.02	0.20	0.01	0.13
2009	0.20	0.02	0.04	0.42	48.06	3.57	0.00	0.38	0.02	0.03	0.10	0.12	0.07	0.06	0.01	0.00	0.10	0.04	0.10
2010	0.61	0.03	0.04	0.22	43.11	2.27	0.01	0.31	0.02	0.02	0.16	0.06	0.10	0.02	0.01	0.03	0.02	0.10	0.10
2011	0.58	0.03	0.04	0.36	36.43	3.31	0.01	0.31	0.01	0.02	0.02	0.05	0.08	0.09	0.01	0.14	0.05	0.03	0.09
2012	0.12	0.04	0.02	0.21	53.80	1.78	0.00	0.17	0.03	0.02	0.09	0.05	0.05	0.02	0.01	0.05		0.03	0.41
Average cpue																			
2012/2011	0.35	0.03	0.03	0.28	45.11	2.54	0.01	0.24	0.02	0.02	0.06	0.05	0.07	0.06	0.01	0.09	0.05	0.03	0.25
2008–2010	0.48	0.03	0.04	0.28	45.58	3.11	0.00	0.31	0.02	0.02	0.11	0.11	0.07	0.03	0.01	0.02	0.10	0.05	0.11
Trend	-28%	30%	-35%	2%	-1%	-18%	93%	-23%	18%	-25%	-49%	-55%	-12%	67%	-26%	462%	-48%	-47%	132%

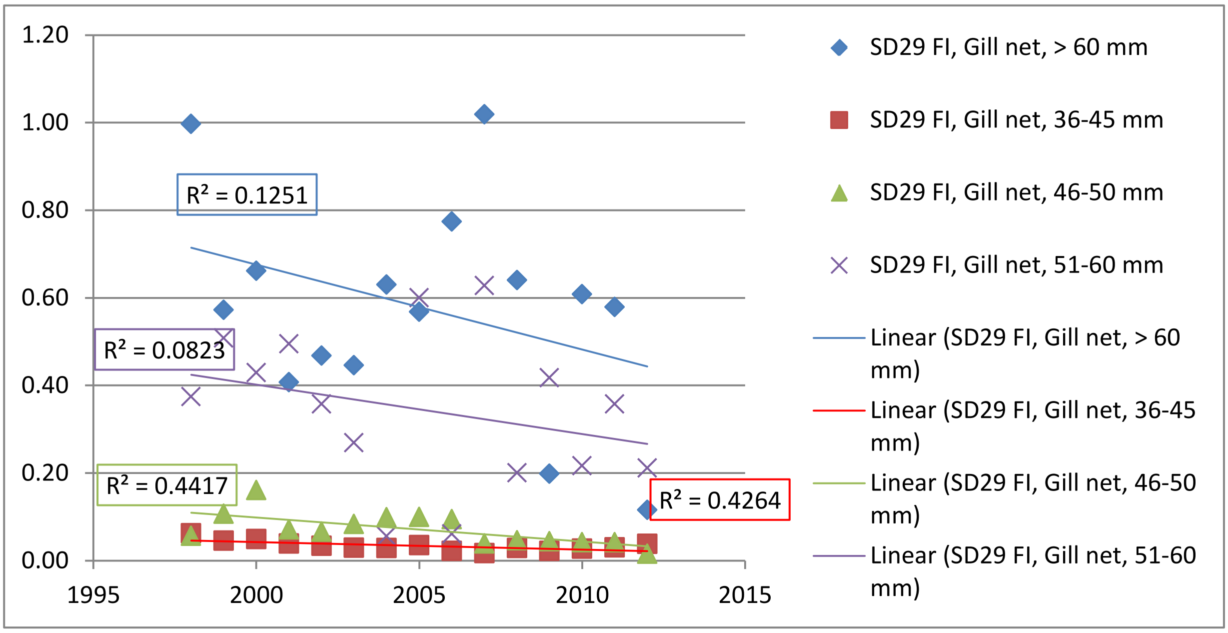


Figure 9.8. Catch in Kg per unit effort in Finnish commercial fishery with gillnets in SD 29.

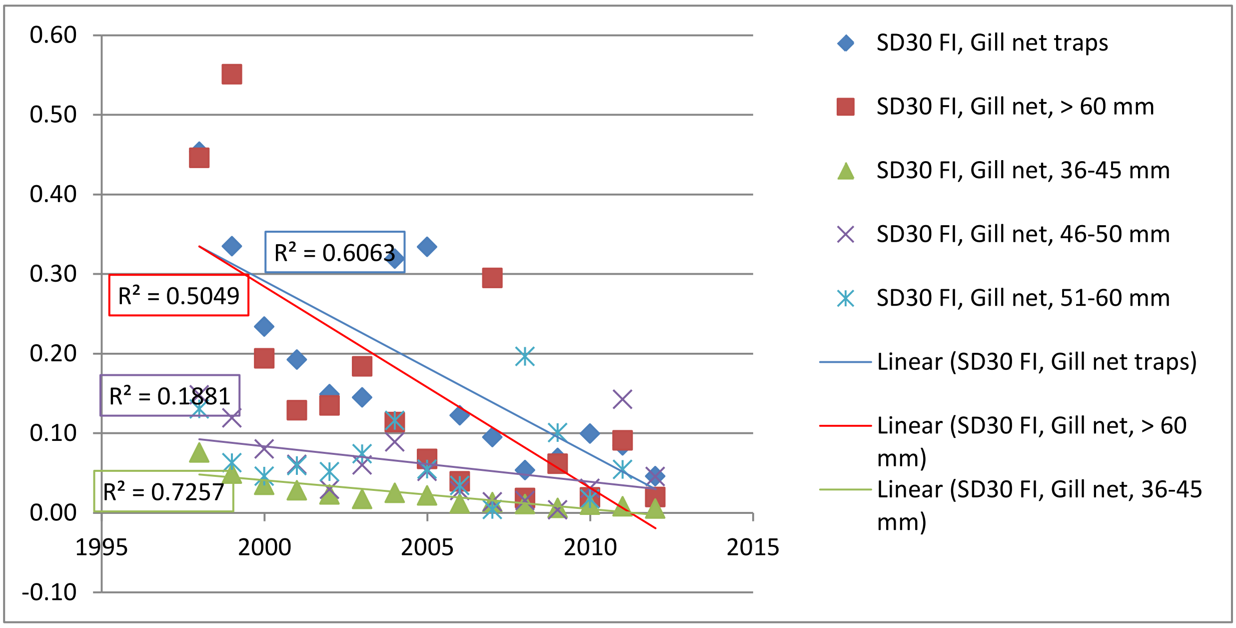


Figure 9.9a Catch in Kg per unit effort in Finnish commercial fishery with gillnets in SD 30.

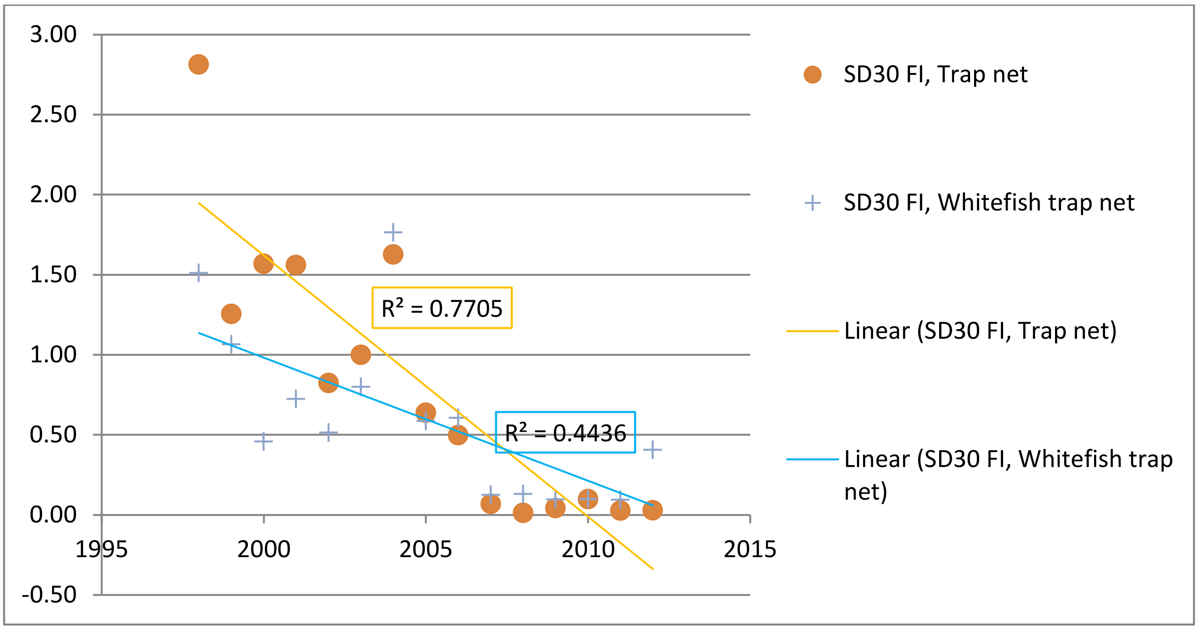


Figure 9.9b. Catch in Kg per unit effort in Finnish commercial fishery with trapnets in SD 29.

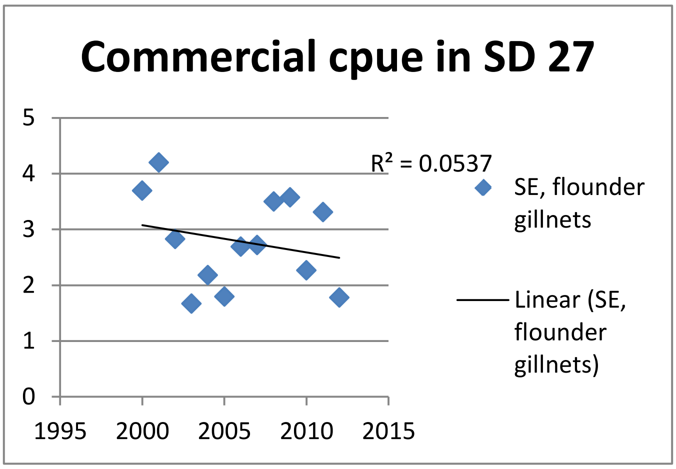


Figure 9.10. Catch in Kg per unit effort in Swedish commercial fishery with flounder gillnets (>60 mm meshes) in SD 27.

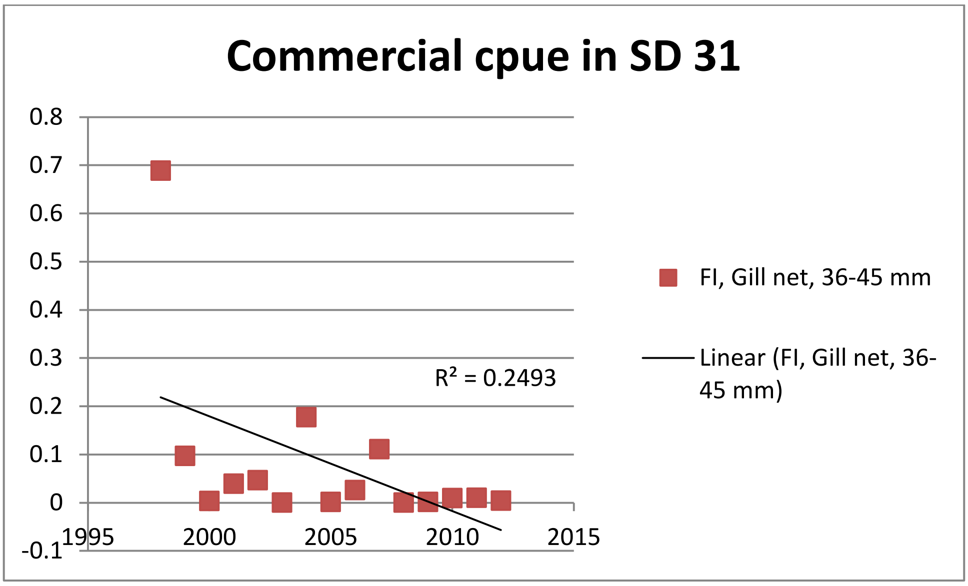


Figure 9.11. Catch in Kg per unit effort in Finnish commercial fishery with gillnets in SD 31.

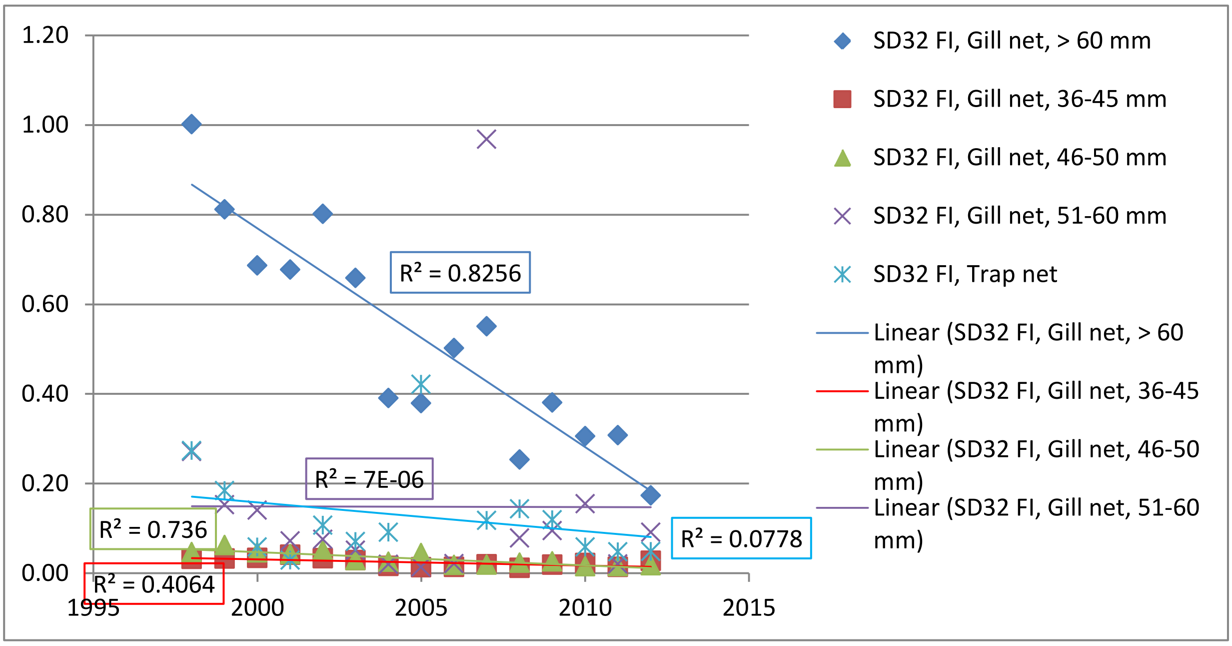


Figure 9.12 Catch in Kg per unit effort in Finnish commercial fishery with gillnets in SD 32.

9.5 Proposed Assessment approach

9.5.1 Describe the proposed assessment model

Category 3: Stocks for which survey-based assessments indicate trends (ICES DLS approach).

Model used: Data Limited Stock Category 3.2 Survey based index but no MSY trigger. The average index from the last two years was then compared with the average index from the three preceding years.

9.5.2 Describe the accepted data configuration

Landings were taken from InterCatch for Sweden and Finland. For Estonia IC data were mixed with commercial and recreational fishery and data were provided separately by the national data provider. For 2008 the commercial and recreational fishery landings were not possible to separate. Therefore the proportion of recreational fishery in the succeeding year, 2009, was used as a proxy to subtract the recreational landings from total landings reported in 2008.

Biomass index (kg/effort) from national gillnet surveys together with total commercial landings should be used a basis for advice. Characteristics of surveys used for biomass index are shown in Table 9.6. Effort in SD 32 was number of gears* night while in SD 27 and 29 it was number of netpanels (5) * nr of stations (six or eight)* number of fishing nights (usually six). Surveys were restricted to the same quarter (Q4) to make them as comparable to each other as possible. Surveys in SD27 and 29 already took place in the same quarter (Q4) but the survey in SD32 was extended between May and October and for this only data from October was used. The two surveys from SD 27 where combined using the arithmetic mean to get only one biomass index per SD. Survey index from different SDs were subsequently weighted by the yearly total landings in the respective subdivision to calculate an overall biomass index for flounder in the whole area SD 27, 29–32. This is in order to give more weight to surveys in these SDs where most of the fishery is taking place. It is recognized that landings may not be representing stock size in given subareas. However, using landings as weighting factor ensures that the advice for fisheries management would mostly be based on survey trends that are impacted by fisheries and to a lesser degree by trends in areas where for example no fishery for flounder is taking place.

Table 9.6. Characteristics of surveys used for biomass index.

TYPE	NAME	SD	YEAR RANGE	DESCRIPTION
Cpue (kg/effort) in survey	Muuga Bay	32	1993–2012	Gillnet survey (mesh size from 40 to 60 mm bar length), fished from May–October, performed by Estonian Marine Institute, University of Tartu
Cpue (kg/effort) in survey	Küdema Bay	29	2000–2012	Gillnet survey, six fixed stations fished during six nights in October/November in depths 14–20 m. (mesh size 21.5, 30, 38, 50 and 60 mm bar length), performed by Estonian Marine Institute, University of Tartu
Cpue (kg/effort) in survey	Muskö	27	1992–2012	Gillnet survey, eight fixed stations fished during six nights in September/October in depths 16–18 m. (mesh size 21, 30, 38, 50 and 60 mm bar length), performed by Institute of Coastal Research, Department of Aquatic Resources, Swedish University of Agricultural Sciences
Cpue (kg/effort) in survey	Kvädöfjärden	27	1989–2012	Gillnet survey, six fixed stations fished during six nights in October in depths 15–20 m. (mesh size 21, 30, 38, 50 and 60 mm bar length) performed by Institute of Coastal Research, Department of Aquatic Resources, Swedish University of Agricultural Sciences

The biomass indices and landings used for weighting are shown in Table 9.7. Looking at the SDs separately revealed a drastic decrease in average cpue for all three areas (ranging between 11 and 80% decrease). However looking over the whole time-series it might be suspected that 2008 was a year of unusual high catches not really suitable for use as a reference period (Table 9.7, Figure 9.7a, b). In order to investigate the sensitivity of the conclusions to single extreme years a separate estimate using just the years 2009 and 2010 as reference was also performed. In this case the decrease was reduced (28–67%) and the trend even turned positive for SD 29 (+22%).

Combining all surveys to a joint biomass index resulted in a decrease of 37% using the 2008–2010 as reference period and a 20% decrease using the 2009–2010 as reference period.

Based on the change in survey index the suggested landings should be changed proportionally. In addition there should be a precautionary cap (decrease in proposed landings) of 20% if there is no data available showing a decrease in effort or that fishing mortality is low. The previous calculations of mortality in SD 27 and SD29 give contradictory results with a low mortality in SD 29 and a high mortality in SD27. Looking at effort however, suggests that effort has been reduced.

National effort data were combined for all SDs (27, 29–32) for different gear types to investigate if there had been an overall reduction in fishing effort. In the period 2008–2012 there has been a reduction in Finnish and Estonian fishery as well as the active Swedish fishery. In gillnets there are no reduced effort for Swedish fishery the last five years. However comparing the last years to the first years in the 2000s the effort has been reduced here as well (Figure 9.10).

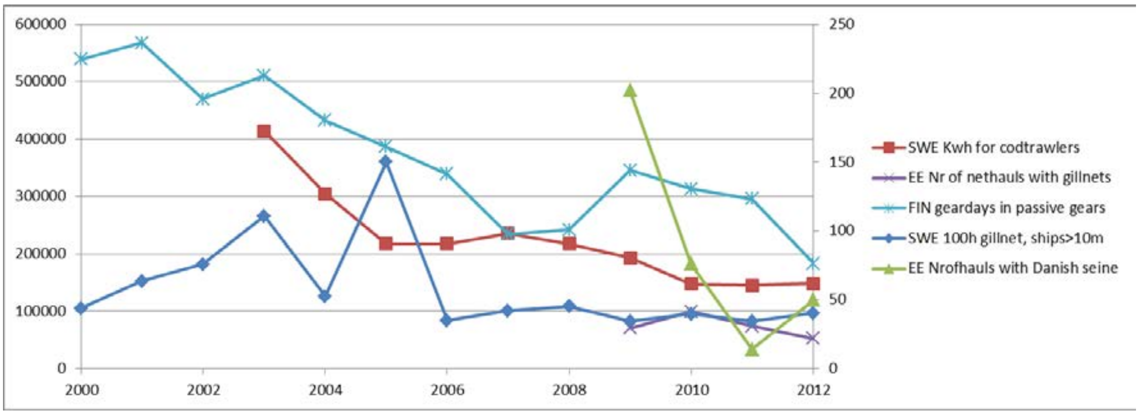


Figure 9.10. Changes in total efforts in flounder fishery in different fleet segments for the whole assessment area.

Table 9.7. Biomass index per SD (Kg per net and night in SD 32 and per netpanel and night in SD29 & 27) shown together with total commercial landings per SD used for weighting and the resulting weighted index for flounder in the assessment unit 27, 29–32.

YEARS	BIOMASS SD 32 MUUGA OCT	BIOMASS SD 29	BIOMASS AVERAGE SD 27	TOTAL LANDINGS SD 32	TOTAL LANDINGS SD 29	TOTAL LANDINGS SD 27	TOTAL LANDINGS FLE 27, 29–32	YEAR IN DLS ASSESSMENT	TOTAL WEIGHTED INDEX
1989									
1990									
1991									
1992			0.68						
1993	0.49		0.64						
1994	0.20		0.24						
1995	0.43		0.20						
1996	0.40		0.07						
1997	0.47		0.13						
1998	0.73		0.18						
1999	0.28		0.11						
2000	0.25	0.69	0.25						
2001	0.65	0.46	0.25						
2002	0.17	0.20	0.20						
2003	0.30	0.56	0.16						
2004	0.47	0.27	0.14						
2005	0.39	0.34	0.07						
2006	0.42	0.31	0.13						
2007	0.10	0.45	0.31						
2008	0.11	0.54	0.57	92	105	49	246	2008	0.38
2009	0.36	0.17	0.23	100	65	41	206	2009	0.28
2010	0.14	0.16	0.14	100	90	36	226	2010	0.15
2011	0.24	0.19	0.06	85	99	34	218	2011	0.19
2012	0.13	0.21	0.06	74	86	36	196	2012	0.15
Average cpue								Average cpue	
2012/2011	0.18	0.20	0.06					2012/2011	0.17
2008–2010	0.20	0.29	0.32					2008–2010	0.27
Trend	-11%	-31%	-80%					Trend	-37%
2012/2011	0.18	0.20	0.06					2012/2011	0.17
2009–2010	0.25	0.16	0.19					2009–2010	0.21
Trend	-28%	22%	-67%					Trend	-20%

9.5.3 Short-term projections

N/A.

9.5.4 Appropriate Reference Points (MSY)

N/A.

9.6 Future Research and data requirements

It should be further investigated on how different sources of data should best be combined to get an overall trend for the demersal flounder in the Baltic Sea. Could for example commercial lpue data be combined with survey data to increase the reliability of the assessment?

Results indicate that landings in the recreational fishery are large enough to effect the flounder populations in this assessment unit. However, better estimates of these data are needed, especially estimates of uncertainty, detailed description of methods for Sweden and Estonia and a description of recreational fishery in Sweden at the appropriate geographic scale.

The recreational catches should be separated from commercial landings in InterCatch and future WGBFAS reports. Also, information on discards in commercial fisheries would be needed.

9.7 Recommendations

The ICES WGRFS should include the flounder stock in SD the working groups dealing with recreational data to evaluate the methods how recreational catch is estimated.

Member countries separate recreational catch from commercial catch in historical data.

10 External reviewers recommendations and comments

Scientists participating in WKBFLAT were responsive to review comments and demonstrated a high level of scientific acumen and knowledge of the stocks. The collaborative sprit amongst scientists from member nations contributed to the success of the benchmark assessment. These characteristics of the group portend rapid advancements in seeking solutions to analytical issues raised during the meeting.

Recommendations:

1) Future benchmark assessments would benefit from an attempt to gather all of the pertinent information into a single document by stock (essentially a draft annex). While the information was available for reviewers, the reviewers had to know where to look to find information. This was time consuming and the relevance of key information could have been missed by reviewers in preparation for the meeting.

 1.1) A detailed description of the methods used in exploratory modelling as well as results and diagnostics should have been provided to the reviewers to facilitate a more complete evaluation of the models.

2) Data are available that could support the development of age-structured assessments. We encourage further development of these assessments, and further improvement of the data being used, as it would represent an advancement over current survey and catch based methods. Several issues must be resolved before the age based assessments should be used:

3) Input Data:

 3.1) As noted in the recommendations of the group, development of standard methods for estimation of discards is critical for dab and flounder in the Baltic. A subgroup should be tasked with developing estimation protocols that are robust to potential future developments of flounder or dab target fisheries as well as changes in target fisheries that have a high encounter rate with dab or flounder. The group should carefully consider whether to estimate discard rates based solely on observed hauls or whether to also consider reported discard rates. The answer to this question may lie in a review of the observer coverage by each nation for fisheries that encounter dab and flounder. The database where discards are estimated (InterCatch) is currently not flexible enough to allow borrowing schemes that are appropriate. Nations may need to estimate their discards outside InterCatch, and the analyst would need to have access to landings from the targeted stock (cod or plaice, for the stocks in WKBALFLAT). Further, it was noted that there may be some nonstandard reporting of fleet type in InterCatch, and this and other issues should be addressed at the same time.

 3.2) Sampling design and observed responses for the recreational catch estimates for demersal flounders should be carefully examined to determine their reliability. It is recommended that the recreational fishery working group investigate how to split out recreational catch for the Estonian data. They should also consider whether it is possible to improve on what is done for estimates of recreational catch in Finland, where the same value is assumed for two consecutive years; perhaps taking an average for the year where no estimate is available would be more appropriate.

3.3) Data presented at the meeting suggested that aging errors may be present for Dab. An otolith exchange between Germany and Denmark is recommended to resolve these issues.

3.4) For flounder stocks 26–28 and 24–25 estimates of historical age composition may be facilitated using age–length keys based on Polish age samples. A careful examination of the number of ages per length category by year will be needed to assess whether regional age–length keys can be developed or whether a single key should be used for the two stocks.

3.5) In cases of dab 22–32 and flounder stocks 22–23, it may be necessary to use slicing to reconstruct the historical age composition. One could try to determine which slicing method is better by calculating the age-consistency matrix and comparing it with the age-consistency matrix calculated from the period 2008–2012 (where the preferred age method has been used). Alternatively ages could be estimated within a SS3 model using a length–age transition matrix approach (See Methot and Wetzel, 2013, Can. J. Fish Aquat. Sci.). The latter approach tracks age groups through time and thus corrects for the potential influence of strong year classes on the perception of the probability of age at a given length.

3.6) Once standard aging issues have been resolved between Countries, use of an age–length-key is recommended over slicing. The sampling scheme for collection of the age data for the age–length-key should be evaluated retrospectively to assess whether the planned sample collection levels are being achieved. A brief description of the sampling protocol should be provided to reviewers in advance of the meeting.

3.7) The BITS survey data are the most reliable population estimates of the population age distribution. If possible it would be useful to collect age distributions by sex to assess the potential effects of sexual dimorphism on the age transition estimates.

3.8) A complete map of the survey locations for the Q1 and Q4 BITS survey would inform the user of the overall sampling density achieved by the surveys.

3.9) An effort to estimate the area swept by the BITS trawl survey should be attempted to facilitate estimation of biomass by quarter, depth and area. Although these estimates rely on assumptions of survey catchability and selectivity, they would provide a useful check on model results that rely on survey indices. In addition, future modelling approaches may elect to estimate survey catchability and selectivity within the model and tune to the area swept biomass estimates.

3.10) Survey indices should be presented with error bars to allow the reviewer to evaluate the variability of the regional cpue estimates.

3.11) Conducting regional surveys twice a year is an ambitious undertaking. In several regions the time-trend in cpue showed differences in scale but trends in abundance were highly correlated. It would be useful to understand the mechanisms underlying differences in quarterly abundance scaling especially if these differences could be attributed to survey q for a given quarter. If the survey is sampling a different fraction of the population in the spring and fall this should be incorporated in assessment models. Alternatively, if the changes in the abundance scale between quarters reflect movement between SD, then it would be important to recognize how this might inform appropriate stock units.

3.12) If it is possible to characterize the oxygen and or salinity level associated with the survey points for the BITS survey, this may help explain some of the noise and some of the trends that look strange (e.g. flounder stock in SD22–23). It could also help interpret fishery trends for the demersal flounder stock. For years where oxygen or salinity inhibit successful reproduction, this information could be a useful covariate to inform recruitment estimation in a statistical catch-at-age model.

3.13) If SD32 continues to be considered with SD27 and SD29, it would be good if the mesh size of the gillnet survey were standardized.

3.14) Where sexual dimorphism in growth is pronounced, explore sex-specific models (e.g. Stock Synthesis). If that cannot be achieved, investigate the possibility of constructing biological parameters as sex-weighted means where sex-compositions are discernible.

4) Modelling

4.1) The use of SAM models is appropriate to this stock as it would allow for time varying catchability (q) and selectivity (s) in the fishery.

4.2) Once the data issues described above are resolved, the input data should be sufficient to develop Statistical Age Structured models as an alternative to SAM. If this approach was considered, the analysts should recognize that estimates of fishery selectivity and catchability will be difficult for non-target fisheries. Careful analysis of fisheries regulations (closures) and market forces should be considered. Time varying q and s may be influencing the results. This could impact results of surplus production models since the time-trend in catch would not necessarily be proportional to biomass. If an SS3 type model was developed, analysts could consider treating s and q from catch time-series from different fleets (target and non-target).

4.3) Analysts should recognize that the model estimates of selectivity derived from non-target fisheries may not represent selectivity for target fisheries. Analysts should carefully consider whether past selectivities are appropriate proxies for future directed target fisheries.

4.4) Full descriptions of key diagnostics should be provided to reviewers to enable a thorough review of model performance.

4.5) (Production Model) A further refinement of the model might be to incorporate annual estimates of survey variability.

5) Research – Recognizing that the stocks reviewed in this benchmark are mainly bycatch species, and that managers will need to allocate limited resources (both personnel and research funding) among a wide array of species in a way that is efficient and cost-effective, we offer the following

suggestions as potential research items that could help address sources of uncertainty that were identified for dab and flounder.

5.1) Several discussions suggested that interannual variability of ocean conditions (salinity and oxygen) would influence the spatial distribution of flounders. These issues should be carefully considered when evaluating time-trends in survey cpue. Analysts may wish to consider time /seasonal varying q for surveys due to concentration or dispersion of fish in the survey area.

5.2) Analysts should examine retrospective circulation patterns derived from drifters and coupled biophysical models of the Baltic to evaluate potential dispersal pathways of dab and flounder. If possible, requests should be made to modify existing models for zooplankton and sprat to provide drift and survival trajectories for dab and flounder. These trajectories would be useful in evaluating the expected stability and reliability of current stock delineations derived by the benchmark assessment.

5.3) For dab, there is concern that there may be mixing with SD21; evaluate whether Subdivision 21 belongs with this stock.

5.4) Working groups for stock structure analysis should include scientists with expertise in the data (to advise whether or not proposed stock splits are consistent with the spatial resolution of the data) and should also include scientists familiar with stock assessment models (to advise on implications of proposed stock units on model application and model assumptions).

5.5) Tagging studies referenced in the stock ID presentation were conducted many years ago. It would be good to investigate whether those same patterns are observed now. To that end, new tagging studies could be conducted to obtain a picture of current movement.

5.6) It was suggested that an additional column should be added to DATRAS to identify which ageing method was used. However, we support the conclusion of an earlier WGBFLABA that each country re-age otoliths from years 2000–2007 for quarter 1. Comparing q1 vs. q4 ALK for a period where ages are available (2008–2012) would help assure that age trends are not being smoothed by using only ages and lengths from q1.

5.7) The time-series available for modelling are quite short (only from year 2000) while the exploitation history is much longer. Consider whether it is possible in SAM, or any other modelling framework, to incorporate earlier estimates of catch. If it is appropriate to estimate a separate survey for the years 1990–1999, that would also help to provide a slightly longer view of abundance trends.

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Annex 1: Participants lists

Data Compilation Workshop on Baltic Flatfish Stocks (DCWKBalFLAT)

26–28 November 2013

Name	Address	Phone/Fax	E-mail
Casper Willestofte Berg	DTU Aqua - National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark	Phone +45 33963433 Fax +45	cbe@aqua.dtu.dk
Mikaela Bergenius ICES Chair	Swedish University of Agricultural Sciences Institute of Coastal Research PO Box 109 742 22 Öregrund Sweden	Phone +46 Fax +46	mikaela.bergenius@slu.se
Liz Brooks External Chair By WebEx	National Marine Fisheries Services Northeast Fisheries Science Centre 166 Water Street Woods Hole MA 02543 United States	Phone +1 508 495 2238 Fax +1 508 495 2393	liz.brooks@noaa.gov
Henrik Degel	DTU Aqua - National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark	Phone +45 33963386 Fax +45 33 96 3333	hd@aqua.dtu.dk
Tenno Drevs By WebEx	Estonian Marine Institute University of Tartu 14 Mäealuse Street 12618 Tallinn Estonia	Phone +372 Fax +372	tenno.drevs@ut.ee
Margit Eero ICES Chair	DTU Aqua - National Institute of Aquatic Resources Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark	Phone +45 21314880 Fax +45 33963333	mee@aqua.dtu.dk

Name	Address	Phone/Fax	E-mail
Ann-Britt Florin	Swedish University of Agricultural Sciences Institute of Coastal Research PO Box 109 742 22 Öregrund Sweden	Phone +46 10-4784122 Fax +46	ann-britt.florin@slu.se
Mark Fowler Invited Expert By WebEx	Fisheries and Oceans Canada Bedford Institute of Oceanography PO Box 1006 Dartmouth NS B2Y 4A2 Canada	Phone +1 902 426 3529 Fax +1 902 426 1506	Mark.Fowler@dfo-mpo.gc.ca
Jakob Hemmer-Hansen By Webex	DTU Aqua - National Institute of Aquatic Resources Department of Inland Fisheries Vejlsøvej 39 DK-8600 Silkeborg Denmark	Phone 33963129	jhh@aqua.dtu.dk
Anne Hollowed Invited Expert By WebEx	National Marine Fisheries Services Alaska Fisheries Science Center 7600 Sand Point Way N.E. Seattle WA 98115 United States	Phone +1 206 526 4223 Fax +1 206 526 6723	Anne.Hollowed@noaa.gov
Anna Luzenczyk	National Marine Fisheries Research Institute ul. Kollataja 1 81-332 Gdynia Poland	Phone +48 58 735 62 74 Fax +48 58 735 6110	anna.luzenczyk@mir.gdynia.pl
Zuzanna Mirny	National Marine Fisheries Research Institute ul. Kollataja 1 81-332 Gdynia Poland	Phone +48 58735 6213 Fax +48	Zuzanna.mirny@mir.gdynia.pl
Cristina Morgado	ICES		Cristina.morgado@ices.dk
Rainer Oeberst	Johann-Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries Institute for Baltic Sea Fisheries Alter Hafen Süd 2 18069 Rostock Germany	Phone +49 381 811 6125 Fax +49 381 811 6199	rainer.oeberst@ti.bund.de

Name	Address	Phone/Fax	E-mail
Marie Storr-Paulsen	DTU Aqua - National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark	Phone +45 3388 3442 Fax +45 3396 3333	msp@aqua.dtu.dk
Sven Stötera	Johann-Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries Institute for Baltic Sea Fisheries Alter Hafen Süd 2 18069 Rostock Germany	Phone +49 381-8116-123 Fax +49	Sven.stoetera@ti.bund.de
Didzis Ustups	Institute of Food Safety, Animal Health and Environment (BIOR) 8 Daugavgrivas Str. Dept of Fish Resources Research 1048 Riga Latvia		Didzis.Ustups@bior.gov.lv

Benchmark Workshop on Baltic Flatfish Stocks (WKBalFLAT)

27–31 January 2014

Name	Address	Phone/Fax	E-mail
Pavel Afanasyev	Russian Federal Research Institute of Fisheries & Oceanography (VNIRO) 17 Verkhne Krasnoselskaya 107140 Moscow Russian Federation	Phone +7 Fax +7	afanasiev@vniro.ru
Michael Andersen	Danish Fishermen's Association Fredericia Nordensvej 3 Taulov 7000 Fredericia Denmark	Phone +45 70 10 9645 Cell: +45 4026 5040	ma@dkfisk.dk
Casper Willestofte Berg	DTU Aqua - National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark	Phone +45 33963433 Fax +45	cbe@aqua.dtu.dk
Mikaela Bergenius ICES Chair	Swedish University of Agricultural Sciences Institute of Coastal Research PO Box 109 742 22 Öregrund Sweden	Phone +46 Fax +46	mikaela.bergenius@slu.se
Elizabeth Brooks Invited Expert	National Marine Fisheries Services Northeast Fisheries Science Centre 166 Water Street Woods Hole MA 02543 United States	Phone +1 508 495 2238 Fax +1 508 495 2393	liz.brooks@noaa.gov
Max Cardinale	Swedish University of Agricultural Sciences Institute of Marine Research PO Box 4 453 21 Lysekil Sweden	Phone +46 523 18 750 / 700 Fax +46 523 13977	massimiliano.cardinale@slu.se

NAME	ADDRESS	PHONE/FAX	E-MAIL
Henrik Degel	DTU Aqua – National Institute of Aquatic Resources Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark		hd@aqua.dtu.dk
Tenno Drevs By WebEx	Estonian Marine Institute University of Tartu 14 Mäealuse Street 12618 Tallinn Estonia	Phone +372 Fax +372	tenno.drevs@ut.ee
Margit Eero ICES Chair	DTU Aqua – National Institute of Aquatic Resources Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark	Phone +45 33963318 Fax +45 33963333	mee@aqua.dtu.dk
Ann-Britt Florin WebEx Thurs/Friday	Swedish University of Agricultural Sciences Institute of Coastal Research PO Box 109 742 22 Öregrund Sweden	Phone +46 17 34 64 72 Fax +46 76 126 80 62	ann-britt.florin@slu.se
Mark Fowler Invited Expert	Fisheries and Oceans Canada Bedford Institute of Oceanography PO Box 1006 Dartmouth NS B2Y 4A2 Canada	Phone +1 902 426 3529 Fax +1 902 426 1506	Mark.Fowler@dfo-mpo.gc.ca
Kim Kær Hansen	Danish Fishermen's Association Fiskeriforening Øst Lendemarkhovedgade 32 DK-4780 Stege Denmark	Phone +45 40 891 381 Fax +45	kim@fisker.mail.dk khh@fisker.mail.dk
Jan Harbowy	National Marine Fisheries Research Institute ul. Kollataja 1 81-332 Gdynia Poland	Phone +48 609 421 687 Fax +48	horbowy@mir.gdynia.pl
Anne B. Hollowed Invited Expert	National Marine Fisheries Services Alaska Fisheries Science Center 7600 Sand Point Way N.E. Seattle WA 98115 United States	Phone +1 206 526 4223 Fax +1 206 526 6723	Anne.Hollowed@noaa.gov

NAME	ADDRESS	PHONE/FAX	E-MAIL
Igor Karpushevskiy	AtlantNIRO 5 Dmitry Donskogo Street RU-236000 Kaliningrad Russian Federation	Phone +7 4012 925 568 Fax +7 4012 219 997	karpushevskiy@atlant.baltnet.ru
Anna Luzeńczyk	National Marine Fisheries Research Institute ul. Kollataja 1 81-332 Gdynia Poland	Phone +48 58 735 62 74 Fax +48	aluzenczyk@mir.gdynia.pl
Cristina Morgado	ICES H.C. Andersens Blvd. 44–46 1553 Copenhagen Denmark		cristina@ices.dk
Rainer Oeberst	Thünen Institute Institute for Baltic Sea Fisheries Alter Hafen Süd 2 18069 Rostock Germany	Phone +49 381 811 6125 Fax +49 381 811 6199	rainer.oeberst@ti.bund.de
Marie Storr-Poulsen	DTU Aqua – National Institute of Aquatic Resources Charlottenlund Slot Jægersborg Alle 1 2920 Charlottenlund Denmark		msp@aqua.dtu.dk
Sven Stötera	Thünen Institute Institute for Baltic Sea Fisheries Alter Hafen Süd 2 18069 Rostock Germany	Phone +49 381 8116 123 Fax +49 381 8116 199	sven.stoetera@ti.bund.de
Didzis Ustups	Institute of Food Safety, Animal Health and Environment (BIOR) 8 Daugavgrivas Str. Fish Resources Research Department 1048 Riga Latvia		Didzis.Ustups@bior.gov.lv

Annex 2: Recommendations

General

- Documentation of discards needed, where did the samples actually come from, and what the countries already have extrapolated themselves. 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 landing, etc.) [specify by data call sent by ICES to Baltic Member states].
- Recommend to WGCatch a workshop to come up with common approach to calculating and raising discards for bycatch species, in particular when there are zero landings.

InterCatch

- Discards ratios should be available to borrow across years, but do not allocate length frequency or ages.
- Need to be able to use other discard raising factors than are currently available. For example, the ability to use cod landings for the discard raising factor for Baltic bycatch species. Another option would be to add an additional column for total landings on a trip.
- Recommend that data submitters can view the entire time-series of national data.
- Recommend that a new report is developed giving relevant information concerning landings, discards, length frequencies from a selected list of stocks.

DATRAS

- Need ability to identify the aging method used (similar to how maturity methods are identified).
- Recommend that nations can give permission to ICES to incorporate new variables, e.g. ageing method id or species code, without the need for countries to upload their entire data again.

Dab

- Exchange of otoliths between DK and GER to solve age reading issues.
- 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.

Flounder

- Re-aging of old otoliths with new method as recommended by WGFLABA 2012.
- We recommend that sex ratios are collected from commercial samples (landings and discards) for flatfish due to sexually dimorphic growth. Consider whether the length frequency should be sex-stratified before sampling for ages or whether the *status quo* approach is sufficient.

Flounder 27 and 29–32

- Recommend that WGRFS include this stock in the working groups dealing with recreational data to evaluate the methods how recreational catch is estimated.
- Recommend that member countries separate recreational catch from commercial catch in historical data.

Annex 3: Overviews on sampling quality

Table Annex 3.1. Dab sampling at sea in the Baltic Sea for Denmark, Germany and Sweden in 2012.

Dab in SD22–32 (2012)	Total landings 2012: 1285 t (source: Dab advice 2013)					
	Denmark		Germany		Sweden	
Importance: Contribution to stock landing	45%		45%		0.2%	
Sampling / design effect/diagnostic for randomness… (Description according to best practice)						
Sampling design	probability based discard sampling		probability based catch sampling		probability based discard sampling	
Primary sampling unit	Vessel* trips		Vessel		Vessel* trips	
Sampling frame	quarterly vessel list		annual vessel list		quarterly vessel list	
Periodicity	effort is following the fishery		1–2 samples/week during fishing seasons			
Contact protocol	yes		Yes		yes	
Sampling manual available	yes (Danish)		Yes (German); English version under preparation		no	
Landings by nation	572		574		2.6 t (Subdiv 22–32)	
Strata from the sampling frame	Fleet 1	Fleet 2	Fleet 1	Fleet 2	Fleet 1	Fleet 2
	active gear (Trawler)	passive gear	active gear (Trawler)	passive gear	active gear (Trawler)	passive gear
Importance: Contribution to national landing	67%	33%	89%	11%	12%	88%
Mean discard rate of the fleet in the year	96%	assumed low	33%	48%	98%	84%
Importance: Contribution to national discards in fleet	100%	0%	84%	16%	53%	47%
Catch-at-age						

	Denmark		Germany		Sweden	
	Fleet 1	Fleet 2	Fleet 1	Fleet 2	Fleet 1	Fleet 2
Quality indicator						
Total number of vessels in the fleet	151	199	58	887	47	263
Number of trips sampled on board of vessels	34	0	42	36	22	62
Number of unique vessels sampled	15	0	28	23	11	32
Total number of trips conducted by the fleet	4686	11 519	3891	22 156	2011	9883
Number of trips sampled where stock occurred in the discards	34		21	24	8	36
Number of trips sampled where stock occurred in the landings			22	28	1	3
Number of port samples						
Age key quality indicator (e.g. Mean number of age samples per trip sampled from this fleet)			35 otoliths/trip	8 otoliths/trip		
Non-response rate	68%		47%	53%	61%	66%
Industry decline (refusal rate)	27%		10%	3%	22%	Not recorded 2012
Goodness-of-fit						
Bias 1: Spatio-temporal coverage	tested and considered all right		tested and considered all right			
Bias 2: Vessel selection	6% are having a to small vessel for observers to participate		smaller passive gear vessels rejected observers			

Table Annex 3.2. Flounder sampling at sea in the Baltic Sea for Denmark, Germany, Sweden and Poland in 2012.

FLOUNDER IN SD 22–32 (2012)	TOTAL LANDINGS 2012: 15 851 T (SOURCE: FLOUNDER ADVICE 2013)							
	Denmark		Germany		Sweden		Poland	
Importance: Contribution to stock landing	7%		10%		1%		64%	
Sampling / design effect/diagnostic for randomness… (Description according to best practice)								
Sampling design	probability based discard sampling		probability based catch sampling		probability based discard sampling		probability based/ad-hoc sampling	
Primary sampling unit	Vessel* trips		Vessel		Vessel* trips		Vessel	
Sampling frame	quarterly vessel list		annual vessel list		quarterly vessel list		Vessel list	
Periodicity	effort is following the fishery		1-2 samples/week during fishing seasons					
Contact protocol	yes		Yes		yes		yes	
Sampling manual available	yes (Danish)		Yes (German); English version under preparation		no		under preparation	
Landings by nation (t)	1169		1625		163		10 089	
Strata from the sampling frame	Fleet 1	Fleet 2	Fleet 1	Fleet 2	Fleet 1	Fleet 2	Fleet 1	Fleet 2
	active gear (Trawler)	passive gear	active gear (Trawler)	passive gear	active gear (Trawler)	passive gear	active gear (Trawler)	passive gear
Importance: Contribution to national landing	67%	33%	65%	35%	35%	65%	64%	36%
Mean discard rate of the fleet in the year	96%	assumed low	30%	36%	95%	44%	3.40%	0.32%
Importance: Contribution to national discards in fleet	100%	0%	61%	39%	93%	7%	97.40%	2.60%

		Denmark		Germany		Sweden		Poland	
		Fleet 1	Fleet 2	Fleet 1	Fleet 2	Fleet 1	Fleet 2	Fleet 1	Fleet 2
	Quality indicator								
1	Total number of vessels in the fleet	151	199	58	887	47	263	145	394
	Number of trips sampled on board of vessels	34	0	42	36	22	62	19	24
	Number of unique vessels sampled	15	0	28	23	11	32	10	14
	Total number of trips conducted by the fleet	4686	11519	3891	22156	2011	9883	3740	12163
	Number of trips sampled where stock occurred in the discards	34		35	30	22	56	11	15
	Number of trips sampled where stock occurred in the landings			38	31	3	15	15	9
	Number of port samples	8				0	0	15	30
	Age key quality indicator (e.g. Mean number of age samples per trip sampled from this fleet)			84 otoliths/trip	23 otoliths/trip			46	42
2	Non-response rate	68%		47%	53%	61%	66%		
	Industry decline (refusal rate)	27%		10%	3%	22%	Not recorded 2012		
3	Goodness-of-fit								
	Bias 1: Spatio-temporal coverage	tested and considered all right		tested and considered all right					
	Bias 2: Vessel selection	6% are having a to small vessel for observers to participate		smaller passive gear vessels rejected observers					

Annex 4: Working Documents

List of Working Documents

WD 2.1: Survival rate cod and flatfish captured by different gear types;

WD 3.1: Test of similarity and differences between Sex-ratios for flounder as function of country, Subdivision, Quarter, Gear type and Year;

WD 4.1: Spatial distribution of dab (*Limanda limanda*) during quarter 1 and 4 BITS from 2001 to 2013;

WD 4.2: Spatial distribution of dab (*Limanda limanda*) during quarter 1 and 3 IBTS from 2001 to 2012;

WD 4.3: Data of commercial dab fishery in the Baltic Sea between 2000 and 2012;

WD 4.4: Quality of ageing of dab by German reader and comparison of the aging of German and Danish readers;

WD 4.5: Growth of dab (*Limanda limanda*) based age–length data of individuals;

WD 5.1: Calculation of weight and maturity-at-age for flounder;

WD 6.1: Flounder SD 22–23 data quality and weight-borrowing schemes Landing/Discard;

WD 6.2: Flounder SD 22–23 data quality and numbers-at-length borrowing scheme;

WD 6.3: Flounder SD 22–23 Slicing and Internal Consistency/Input data exploratory SAM;

WD 6.4: Flounder SD 22–23 Output from exploratory Sam-runs;

WD 9.1: Finnish recreational Flounder catches.

Survival rate cod and flatfish captured by different gear types

by

Bernd Mieske and Rainer Oeberst
Thünen Institute of Baltic Sea Fisheries (TI-OF), Rostock, Germany

Introduction

The individuals with a length smaller than the minimum landing size (discards) of a fishery is dependent on the defined minimum landing size (MLS) in relation to the regulations concerning the selectivity characteristics of the used gears. MLS increased from 33 cm to 35 cm in 1994 and was defined by 38 cm in 2003. It is well known that the current regulations for the fishery of cod and flatfish in the Baltic Sea produce discards because the L_{50} of the selection characteristics of the accepted cod-end mesh sizes are close to the MLS of 38 cm.
In the current BACOMA cod end with single twine meshes the L50 for cod is 46 cm with a selection range of 7 cm and the L50 for cod in the current T90 cod end made from single twine end is 43 cm with a selection range of 5 cm (Herrmann et al., 2013), but the authors also reported a L50 value of 38.9 cm and selection range of 6.3 cm for legal T90 cod-end with mesh size 120 mm (4 mm double twine and 50 open meshes in circumference).
L50 value of 21.5 cm and selection range of 2.4 cm for legal T90 cod-end with mesh size 120 mm (4 mm double twine and 50 open meshes in circumference) were estimated for plaice. The MLS of this species in the Baltic Sea is 25 cm.
The fraction of discards can be relative high if a new year-class is growing into the selection range of the used gear during the fishing season.
The survival rate of discarded individuals in the Baltic Sea is uncertain. The stock assessment does not handle the discards as catch in many cases. Therefore, the models assume that all discards will be part of the total stock in the future. High mortality rates of discarded individuals will result in an overestimation of the current stock and produce a higher level of uncertainty in the stock assessment.
First estimates of the survival rate of European plaice, dab and Atlantic cod were presented by Fulton (1890, in Broadhurst et al. 2006). Broudhurst et al. (2006) summarized the available experiments in the literature related to "Estimating collateral mortality from towed fishing gear". In addition, they systematized the different reasons of collateral mortality. Revill (2012) also summarized the literature concerning discarded fish. Low number of experiments was carried out in the Baltic Sea concerning the survival rate of escaped (F_E) and discarded (F_D) fish and in most cases large range of mortality was given (see Broadhurst et al. 2006). In addition, factors were given which influenced the mortality rates.
Experiments were carried out onboard of the side trawler RC "Clupea" and the stern trawler RC "Solea" to estimate the survival rate of escaped and discarded fish between 1996 and 2002. The numbers of realized experiments onboard of the RC "Clupea" were significantly influenced by the weather conditions. In addition, the total catch of the analyzed species cod, flounder, plaice, dab and turbot varied dependent on the area and the period of investigations as well as the duration of the hauls. The experiments onboard of RC "Solea" were only a part of the planned activities during the total cruise. The results of the different cruises were presented in reports.
This study summaries and systemize the results of German experiments. However, the data present only raw estimates because the number of analyses individuals is low, especially for flatfish.

Material and Methods

The survival experiments were carried out with the German research cutters "Clupea" and "Solea". RC "Clupea" is a side trawler which stops during the haul process of the gear. This stop results in a decompression of the cod-end directed to the captured fish. Solea is a stern trawler. The pressure in the cod-end directed to the captured fish is nearly constant during the hauling of the trawl.
Cruises of RC "Clupea" were realized between 1996 and 2002 to estimate the survival rate of discarded (F_D) cod and flatfish (Table 1). The number of hauls varied between 2 and 14 dependent on the weather conditions. The hauls were realized close to Rostock or close to Saßnitz with the bottom otter trawl "Warnemünder Dorschzeese". The duration of the hauls ranged from 1 hour to 3 hours. Duration of 3 hours is close to the period used by the commercial fishery. Since 1998 a cover cod end has been used to estimate the survival rate of escaping individuals (F_E) (see Table 1). The water temperature varied between 2.5 °C and 15 °C dependent on the period of the cruises.

In each case the cod-end was carefully depleted on the deck of the vessel. Within short periods (~ 5 minutes) the catch was sorted by species and the weight by species was determined. Then all captured individuals were

immediately transferred into a live fish transport tank. Cover cod-ends were kept in the water until all individuals of the main cod end were processed.
The volume of the live fish transport tank was 1 m³. During the keeping process on the deck of the vessel the tank was flow through with 5000 l seawater per hour. The catches of RC "Clupea" were transferred at the same day into a floating net cage (Figure 1). Dead individuals were taken away from the storage units to minimize the probability of infections of remaining specimens.
Survival experiments were also realized onboard of RC "Solea" between 1995 and 1997 (Table 2). For these studies, the herring bottom trawl HG 640/40 was used. Cod was captured in different areas (SD 21, 22, 24 and 25) to establish broodstocks in a marine hatchery (Bleil and Oeberst, 1998). Besides the hatching of cod from the place of capture to the marine hatchery survival experiments were carried out with flatfish. In case of large catch random subsample of the total catch were transferred into three live fish transport tanks with a total volume of 2.7 and 3.7 m³. In 2001 and 2002 additional survival experiments were realized as small part of the total cruises. The handling of specimens were similar to the procedures used onboard of RC "Clupea".
It must be pointed out that all individuals were very carefully handled onboard of the cutters which is not the case onboard of the commercial vessels during the routine processing of the catch in most cases. In addition, the retention time the specimens in air was shorter than 10 minutes in most cases and was very short in relation to the routine handling onboard of commercial vessels.

Results

The captured individuals were immediately after sorting and weighting transferred into the live fish transport tank and later transferred into the floating net cages. The hatching period varied between 43 hours (CL 92) and 10 days (SO 489, live fish transport tank). Analyses of the vitality of the individuals indicated that a caging period of more than 48 hours is necessary to avoid overestimations of the survival rate (SO 431). In most cases the detention period was more than 48 hours. Therefore, it can be concluded that the estimated survival rates are not significantly influenced by the caging process in the live fish transport tank and in the floating net cages.

Survival of cod and flatfish escaping the cod-end (F_E)

Escaped small cod, flounder, plaice and turbot were captured with a cover cod-end during the cruises of RC "Clupea" between 1998 and 2002. The estimated survival rates of escaped small individuals and of larger specimens in the main cod-end were similar (Table 3).
In many cases the survival rate of small individuals in the cover cod-end was slightly higher indicating that the escapement through the meshes of the cod-end did not significantly influence the survival rate. It can be concluded that the highest survival of discards can be reached by optimum construction of the trawl and the cod-end, inclusively all special equipment like exit-windows, sorting grids, etc.
The survival rate of discarded cod is negative correlated to the total catch (Figure 2), (experiments onboard of RC "Clupea" and onboard of a commercial cutter, 4 of 27 samples). Survival rate of more than 50 % were only observed in hauls with less than 200 kg in some cases. With increasing total catch the survival rate significantly decreased.
Survival rates of discarded cod and flatfish were in general lower compared to individuals larger than the landing size.

Survival rate of discarded fish (F_D)

The survival rate of discarded cod is influenced by the water temperature (Table 4). In winter the survival rate varied between 55 % (CL 86) and 100 % (CL 97) for haul durations of 3 hours. Smaller survival rate was observed with 21 % in March (So 489) for two hauls with duration of 30 minutes. The differences indicate that the handling of fish onboard of stern trawler results in higher mortality of cod. Lowest survival rate was observed in summer with 14 % (So 477). The water temperature of 13.4 °C close to the bottom and the effect of the stern trawler reduce the survival rate with high probability. In autumn the survival rate of discarded cod varied between 1.7 % (CL 54) and 100 % (CL 67). The survival rate was above 75 % in 6 of 15 experiments.
Results of the 92th Clupea cruise in October 1999 additionally showed that the survival rate of cod smaller 27 cm is very low also if the individuals were very careful and fast handled onboard of the cutter.
The survival rate of discarded flounder is about 100 % in winter and varied between 75 % and 100 % in autumn (27 % in one case, CL 54). Estimates for summer were not available. Lower survival was observed for plaice. In winter the survival rate varied between 78 % and 100 % and in autumn between 25 % and 100 %, but, in most cases the survival rate was above 75 %.
Discarded turbot is robust against the process of trawling. More than 80 % of the discarded turbot survived also if the period in air was larger than 20 minutes (CL 92). However, a survival rate of 8% was only observed for a haul duration of 4 hours (SO 413).

Survival rates of dab were low compared to the other flatfish, especially, if the hauls are realized in water with more than 13 °C (SO 477 and CL 119). Practical experience also suggested that the survival of dab is negatively influenced by pressure or lesions of the abdominal cavity.
The survival rate of individuals with legal landing size was always higher compared to the discards.
Furthermore, the survival rate seems also not to be correlated with the velocity of the vessel (CL 67).
The experiments have shown that the survival rate is determined by factors like the duration of the haul, the total catch, the length distribution of species, the water temperature etc. Therefore, the presented survival rates are only preliminary and raw estimates.

Conclusion

The estimated survival rates of cod and flatfish probably overestimate the survival rates of discards captured in of the commercial fishery. The duration of commercial hauls is significantly longer in most cases and the total catches are higher. In addition, the handling of the captured individuals is not so careful possible like onboard of the research cutters. The duration in air will be longer than 5 to 10 minutes as it was realized during the experiments in most cases. Therefore, it can be assumed that the survival rate will be significantly lower onboard of commercial stern trawlers with long haul duration, large catches and long retention periods of the individuals onboard of the vessels before the individuals are place back into the water.

Discussion

The experiments showed that the survival rate of cod and flatfish in the Baltic Sea is highly variable and dependent on different parameters. The estimates correspond with results of other experiments summarized in Broadhurst et al. (2006). Fulton (1890) estimated a mortality rate of 100 % for discarded cod. In contrast to this the escapement mortality of cod is high (Vinogradov, 1960, Surronen et al. 1996a). Berghahn et al. (1992) assess the mortality of discarded flounder between 0 % and 66 %. Slightly lower mortality rates were observed during German experiments. Estimates of the mortality rate of dab varied between 0 % and 99 % in the literature (Broadhurst et al. 2006) corresponding with the presented data. Plaice seems to be the flatfish with the lowest mortality rate of discarded individuals. German data varied between 0 % and 64 % (SO 391). In contrast to this mortality rates of 100 % were also observed by van Beck et al. (1990) and Berghahn et al. (1992).
The different authors pointed out that the tow duration, total catch, period of handling onboard of the vessels, the total catch and the water temperature influence the mortality rate. Similar factors were also detected based on the German experiments. Long haul duration, high water temperature, large total catch and long period onboard of the vessels results in a decreasing survival rate. But, the experiments also suggested that low temperatures like in winter positively affect the survival rate of discards.
The high variability and the complexity of the factors affecting the survival rate does not make it possible to quantify a mean survival rate by species, especially, because the handling and the duration of individuals outside of the water during the experiments did not represent the routine handling onboard of commercial fishing vessels. Furthermore, it must be taken into account that additional factors like higher vulnerability by predators and infection mortality due to lesions during the catch or escapement. Therefore, it can be assumed that only a small or negligible part of the discards survive.

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Tables

Table 1: Parameters of RC "Clupea" cruises to estimate the survival rate of cod and flatfish

Year	Notation	Period	Number of hauls	Haul duration [hours]	Water depth [m]	Water temperature [°C]	Main cod end mesh size i [mm]	Cover cod end mesh size i [mm]
1996	CL 54	23/09/ - 25/10/1996	5	3	20	11 - 13.3	105	
1997	CL 67	22/09/ - 04/10/1997	3	3	19 - 28	~ 15	105	
1998	CL81	12/10/ - 30/10/1998	5	3	20	10	105	12 & 40
1999	CL86	01/02/1999	2	3	25	3.1 - 3.9	33	
1999	CL92	11/10/ - 22/10/1999	5	3	< 20 m	12.5 -13	120	50
2000	CL 97	31/01/ - 11/02/2000	3	3 & 1		~ 2.5	120	43
2001	CL 119	01/10/ - 19/10/2001	14	1	16.6	13.5	105	43
2002	CL 133	30/09/ - 17/10/2002	9	1		15	105	43

Table 2: Table 1: Parameters of RC "Solea" cruises to estimate the survival rate of cod and flatfish

Year	Notation	Period	Haul duration	Water depth	Water temperature
1995	SO 385				-0.6 – 0.4
1996	SO 361	30/09/ - 17/10/1996	4		13.3 - 16.7
1997	SO 391	01/09/ - 10/09/1997	4	16 - 18	13.3 - 16.7
2001	SO 477	12/06/ - 22/06/2001	0.5	18 - 20	7.0 - 13.4
2002	SO 489	11/03/ - 24/03/2002	1		3.5 - 8.8.2

Table 3: Survival rate of cod, flounder, plaice and turbot in the main cod end and in the cover cod end by years

			Survival rate [%]	
Cruise	Year	Species	Main cod end	Discards in the cover cod end
CL 81	1998	Cod	78	85
CL 92	1999	Cod	86	79 - 91
CL 97	2000	Cod	85	84
CL 119	2001	Cod	78	85
CL 133	2002	Cod	94	98
CL 81	1998	Flounder	85	83
CL 97	2000	Flounder	100	
CL 119	2001	Flounder	57	89
CL 133	2002	Flounder	93	100
CL 97	2000	Plaice	100	
CL 133	2002	Plaice	77	95
CL 97	2000	Turbot	100	
CL 119	2001	Turbot	100	100
CL 133	2002	Turbot	98	

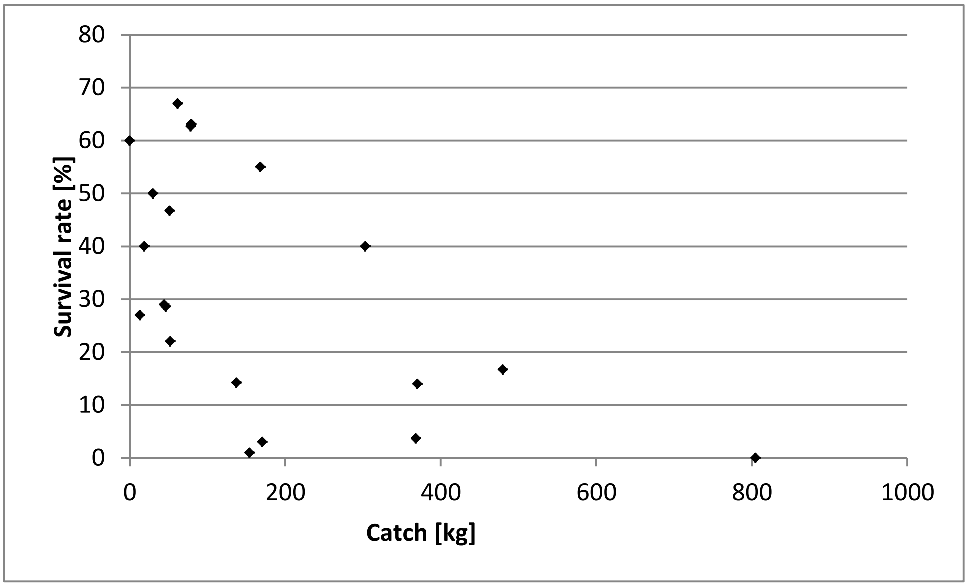
Table 4: Overview of the survival rate of cod and flatfish by experiments

Year	Cruise	Number of hauls	Range of total catch [k]	Water temperature [°C]	Cod (survival rate [%])	Flounder (survival rate [%])	Plaice (survival rate [%])	Turbot (survival rate [%])	Dab (survival rate [%])	Haul duration [h]
1995	SO 385	1	161	-0.6 - 0.4		97	95		69	4
1995	SO 385	1	1550	-0.57 - 1.2		95	95.8		44	4
1995	SO 385	1	336	-0.6 - -0.7		100	100	100	90.5	2
1999	CL86	2	115 - 213	~ 2	100	55 - 86	100	0	85 - 100	3
2000	CL 97	3	26 - 129	~ 3	84 - 100	100	100	100	not caged	3 & 1
2002	SO 489	2	34	~ 4	21 - 76	100	83 - 100		50	0.5 - 1
1998	CL 81	5	34 - 88	~ 10	35 - 100	92 - 100	90 - 100	75 - 100	10 - 100	
1996	SO 391	4		8 - 11		64	34	82		4
1996	CL54	5		11 - 13.3	40	50		30		3
1999	CL92	5		12.5 - 13	72 - 100	100	100			3
2001	SO 477	2		13.4	14.3 - 46				51	0.5
2001	CL119	14		13.5	78.4	85.2	56.5	100	5.2	1
2002	CL133	4	30 - 52	~ 15	94	93 - 100	77 - 100	100		1
1997	CL 67	2	18 - 75	> 15	0	10 - 15		25 - 33		3
1997	So 413	2	133 - 149	~ 15		18 - 64		11.5	0	

Figures

Figure 1: Floating net cage use during the survival experiments with RC “Clupea” in the harbor of Warnemünde

Figure 2: Survival rate of discarded cod in relation to the total catch



Test of similarity and differences between Sex-ratios for flounder as function of country, Sub-division, Quarter, Gear type and Year

The Sex ratio provided from the ICES Data Call in connection with the Benchmark Assessment of flounder January 2014 was analyzed. The data overlap by stratum is given in the appendix. Only Sweden has provided the sex-ratio data as actual numbers of individuals sexed of each sex. All other countries have provided the sex-ratio as the percentage of males or females. The actual numbers are essential for the analysis and therefore the numbers of individuals were estimated by the inverse of the fraction multiplied vith the smallest factor which transformed this into an integer. Some problems were experienced when rounding were used for indication of the percentage (e.g. when the observed fraction of males were 2/3~66.66666667%).

Initially, the following parameters were tested for order of importance: quarter, country, year, sub-division and Gear type. The following Generalized Additive Models were formulated (shown in R-syntax):

```
m1 = gam( cbind(n-nmale,nmale) ~ quarter + s(length,by=quarter),data=dl,family=binomial )

m2 = gam( cbind(n-nmale,nmale) ~ country + s(length,by=country),data=dl,family=binomial )

m3 = gam( cbind(n-nmale,nmale) ~ year + s(length,by=year),data=dl,family=binomial )

m4 = gam( cbind(n-nmale,nmale) ~ subdiv + s(length,by=subdiv),data=dl,family=binomial )

m5 = gam( cbind(n-nmale,nmale) ~ gear + s(length,by=gear),data=dl,family=binomial )
```

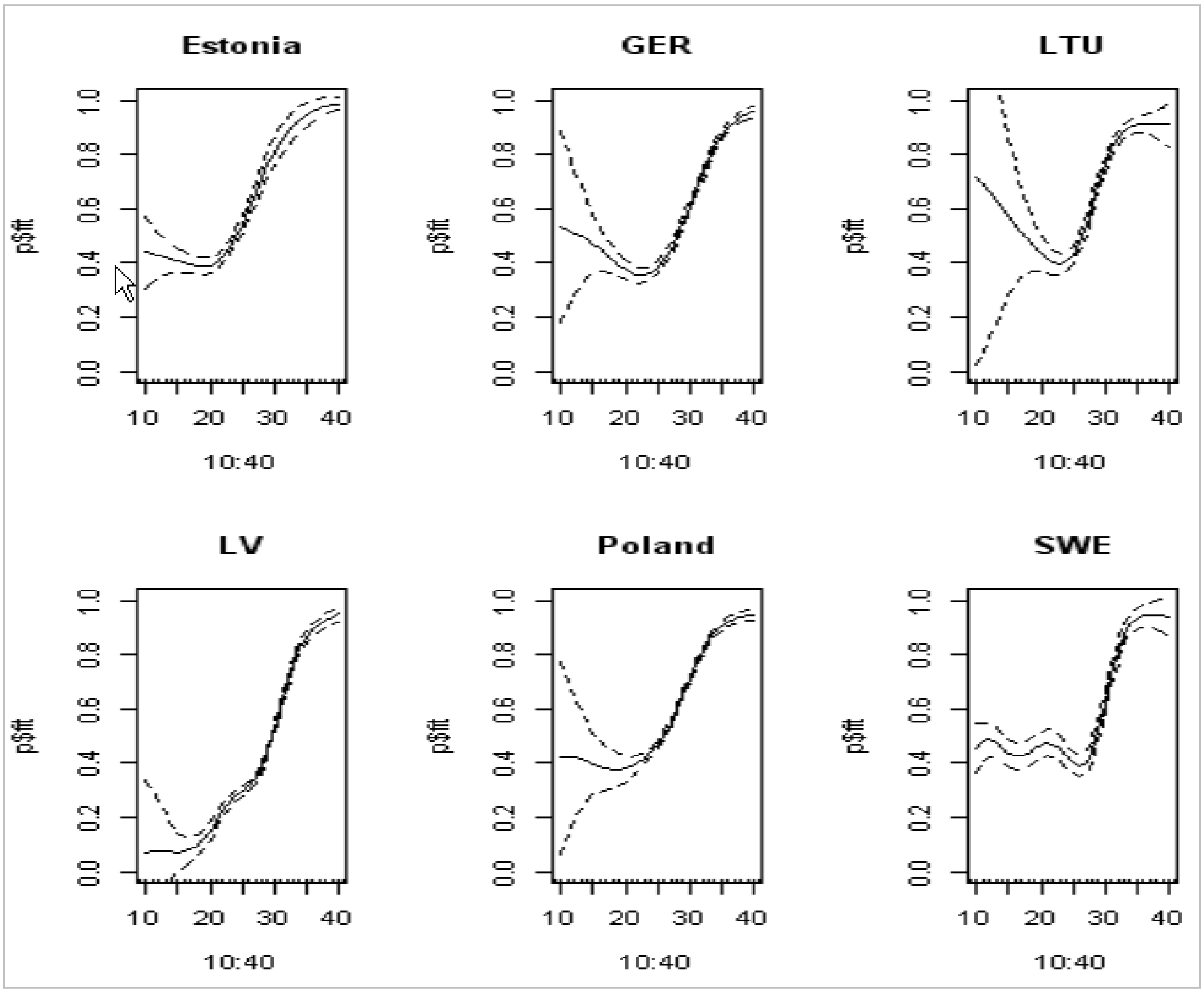
The Akaike information criterion (AIC) was applied and the resuls are given below. It reveals that the parameter which explains most of the observed differences in the sex ratios is the Country (m2) followed by Quarter (m1), Sub-division (m4) and Gear type (m5). Year (m3) is the least important parameter.

Model	df	AIC
m1	27.92350	15596.67
m2	34.86094	15399.72
m3	53.45421	16096.85
m4	45.28375	15676.32
m5	19.23837	16025.70

The Akaike information criterion by model

This indicates that in case of data gabs of sex ratio, it might be an advantage to source the sex ratio data from another year (same country) instead of the ratio from another country (same year). Subsequently, it indicates that another Sub-division should be chosen as source instead of another country or quarter. Generally, the least suitable solution is to source from data from another country (same Quarter, Sub-division and year). This is rather unfortunate as the data data situation is that some countries have not these data available. But, these are general considerations, which do not take into account the possible dependencies between the variables considered. E.g. the difference in sex-ratio by country might be due to difference in fishing areas (Sub-divisions).

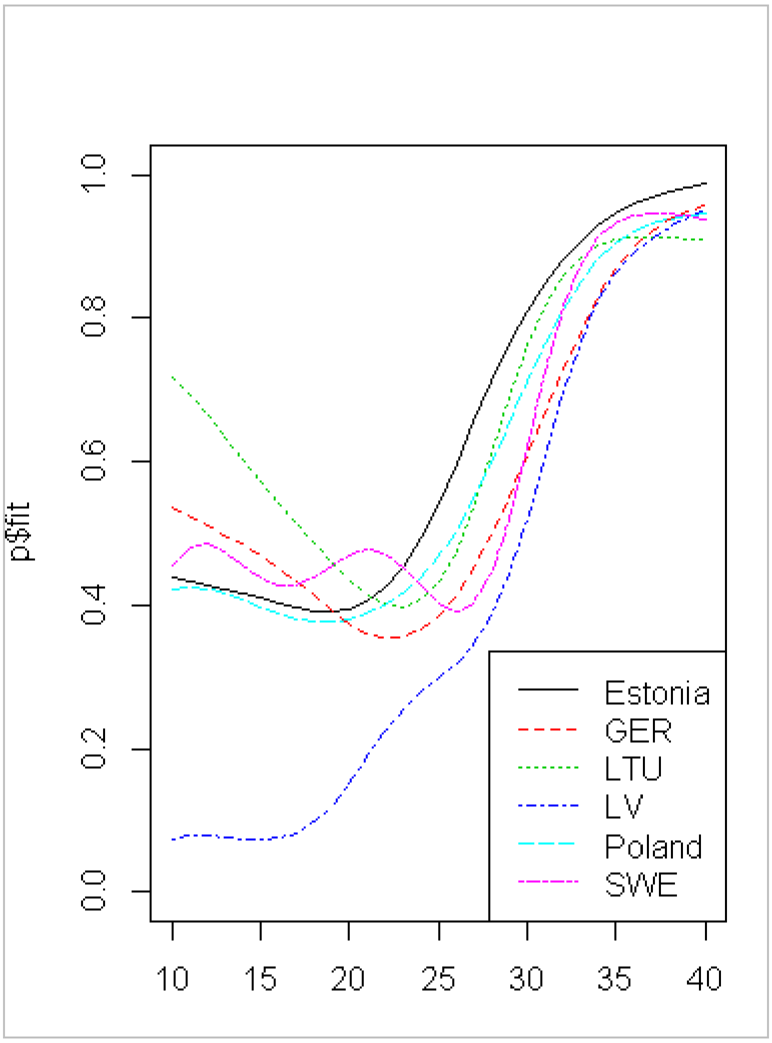
The purpose of the analyses is to give guidedencde which source data should be used in case where a given country has sex ratio data gabs. The probability (P) by length class (model= m2) for each country is given below. Only the length range from 10 to 40 cm is shown in order to be able to show sufficient detailes in this range. It can be seen that the probability curve from Estonia, Poland, Germany, Sweden and Lithuania are rather similar (considering the uncertainty in the lower end of the length range) while the curves from Latvia deviates significantly from the rest in the lower length range.



Probability of sex ratio (male/female) by length for each country.

Model: m2 = gam(cbind(n-nmale,nmale) ~ country + s(length,by=country),data=dl,family=binomial)

Only the length range between 10 to 40 cm is plotted in order to show this range in more details. The rug in the bottom indicates lengst where one or more observations exist.



Probability of sex ratio (male/female) by length for each country. Same data as above – just in one graph for comparement.

Model: m2 = gam(cbind(n-nmale,nmale) ~ country + s(length,by=country),data=dl,family=binomial)

Only the length range between 10 to 40 cm is plotted in order to show this range in more details.

quarter = 1

	subdiv							
country	22	24	25	26	27	28	29	32
Estonia	0	0	0	0	0	0	0	0
GER	540	270	270	0	0	0	0	0
LTU	0	0	0	270	0	0	0	0
LV	0	702	1404	1404	0	702	0	0
Poland	0	972	972	972	0	0	0	0
SWE	0	0	324	0	0	0	0	0

quarter = 2

country	subdiv 22	24	25	26	27	28	29	32
Estonia	0	0	0	0	0	270	270	270
GER	540	540	270	0	0	0	0	0
LTU	0	0	0	270	0	0	0	0
LV	0	0	1404	1404	0	702	0	0
Poland	0	972	972	972	0	0	0	0
SWE	0	0	0	0	0	0	0	0

quarter = 3

country	subdiv 22	24	25	26	27	28	29	32
Estonia	0	0	0	0	0	270	270	270
GER	540	540	0	0	0	0	0	0
LTU	0	0	0	270	0	0	0	0
LV	0	0	702	1404	0	1404	0	0
Poland	0	972	972	972	0	0	0	0
SWE	0	0	0	0	0	0	0	0

quarter = 4

country	subdiv 22	24	25	26	27	28	29	32
Estonia	0	0	0	0	0	270	270	270
GER	540	540	270	0	0	0	0	0
LTU	0	0	0	270	0	0	0	0
LV	0	0	1404	1404	0	1404	0	0
Poland	0	972	972	972	0	0	0	0
SWE	0	0	324	0	324	0	0	0

Tabulating of data overlap by country, Quarter and Sub-division.

Analysies of Deviance Tables

Based on the results of the AIC analysis where the the most important parameter (next to the country) was identified as being the quarter. ANOVA tests for difference in Sex-ratio based on comparement of the the two following models (expressed in R-syntax):

Model 1: cbind(n - nmale, nmale) ~ s(length)

Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)

The ANOVA test was made for each cases of of data overlap of strata defined by country, quarter, sub-division (as indentified in tables abowe). Only data from the two countries in question were included in the analysis. The P value given in an ANOVA test based on Generalized Additive Models (GAM) is not exact as it is in most other cases, but is here an approximation. Never the less, the approximation is in this case good enough to be used for evaluation of the similarity of the distributions.

Below is listed each ANOA result in connection with the relevant information about model and data framing. The results are summarized in the table in the end of the section.

Subsequently, the same type of analyses was carried out for the third most important parameter identified by the AIC analysis: the Sub-division. The ANOVA results in connection with the relevant information about model and data framing is given below.

Significants codes: 0 = ‘***’ 0.001 =‘**’ 0.01= ‘*’ 0.05 =‘.’ 0.1= ‘ ’ 1=

Individual tests for difference between two countries by quarters and Sub-division

Sub-division 22

No data overlap between countries.

Only sex-ratio data from Germany

Sub-division 24

dllim <- dl[(dl$country=='GER'|dl$country=='LV') & dl$quarter==qq & dl$subdiv==24,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    73.607     36.672
2    71.913     29.548 1.6938   7.1245  0.02024 *
```

dllim <- dl[(dl$country=='Poland'|dl$country=='LV') & dl$quarter==qq & dl$subdiv==24,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    158.03     126.62
2    156.42     124.84 1.6091   1.7794   0.3208
```

dllim <- dl[(dl$country=='Poland'|dl$country=='GER') & dl$quarter==qq & dl$subdiv==24,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    189.43     138.74
2    188.32     135.19 1.1136   3.5515  0.06959 .
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    312.96     370.18
2    307.40     288.91 5.5556   81.264 1.039e-15 ***
```

quarter 3

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev    Df Deviance Pr(>Chi)
1    343.60     254.93
2    338.54     247.80 5.064   7.1213   0.2176
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    337.90     265.44
2    334.67     252.66 3.2309   12.781 0.006404 **
```

Sub-division 25

dllim <- dl[(dl$country=='LV'|dl$country=='GER') & dl$quarter==qq & dl$subdiv==25,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    147.02     173.97
2    146.00     109.87 1.0166   64.099 1.238e-15 ***
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    185.34     149.92
2    186.64     147.88 -1.2988   2.0365
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    60.000     29.474
2    56.936     26.722 3.0642   2.7512    0.443
```

dllim <- dl[(dl$country=='Poland'|dl$country=='GER') & dl$quarter==qq & dl$subdiv==25,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    284.51     190.89
2    282.32     179.82 2.1817    11.07 0.004896 **
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev    Df Deviance  Pr(>Chi)
1    361.16     423.44
2    358.78     324.28 2.384   99.165 < 2.2e-16 ***
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    259.31     199.97
2    255.95     194.03 3.3593    5.932   0.1443
```

dllim <- dl[(dl$country=='SWE'|dl$country=='GER') & dl$quarter==qq & dl$subdiv==25,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    177.45     171.06
2    174.55     155.28 2.9034   15.773 0.001137 **
```

dllim <- dl[(dl$country=='SWE'|dl$country=='GER') & dl$quarter==qq & dl$subdiv==25,]

quarter 3

```
Not enough (non-NA) data to do anything meaningful
```

dllim <- dl[(dl$country=='SWE'|dl$country=='LV') & dl$quarter==qq & dl$subdiv==25,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    165.60     209.82
2    164.54     170.35 1.0624   39.474 3.876e-10 ***
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev   Df Deviance  Pr(>Chi)
1    129.73    106.389
2    128.11     90.552 1.62   15.837 0.0002085 ***
```

dllim <- dl[(dl$country=='SWE'|dl$country=='Poland') & dl$quarter==qq & dl$subdiv==25,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    306.19     259.53
2    300.87     240.12 5.3176   19.407 0.002094 **
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    331.91     273.73
2    327.77     259.44 4.1318    14.29 0.007168 **
```

dllim <- dl[(dl$country=='LV'|dl$country=='Poland') & dl$quarter==qq & dl$subdiv==25,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    273.68     246.24
2    272.32     194.67 1.3601   51.572 1.662e-12 ***
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    377.70     414.34
2    375.88     366.23 1.8222   48.107 2.536e-11 ***
```

quarter 3

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1     256.7     191.35
2     253.7     185.66 2.9937   5.6914   0.1271
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev    Df Deviance Pr(>Chi)
1    259.66     204.17
2    257.63     194.69 2.029   9.4808 0.009031 **
```

Sub-division 26

dllim <- dl[(dl$country=='LV'|dl$country=='Poland') & dl$quarter==qq & dl$subdiv==26,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    374.47     492.57
2    370.71     394.35 3.7562   98.215 < 2.2e-16 ***
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    502.60    1039.42
2    496.26     576.53 6.3452   462.89 < 2.2e-16 ***
```

quarter 3

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1     287.6     318.88
2     286.0     216.94 1.6035   101.95 < 2.2e-16 ***
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    407.77     447.22
2    405.04     403.88 2.7313   43.339 1.366e-09 ***
```

dllim <- dl[(dl$country=='LTU'|dl$country=='Poland') & dl$quarter==qq & dl$subdiv==26,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    285.12     334.80
2    281.49     323.56 3.6264   11.236  0.01803 *
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
```

```
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    273.13     400.83                         
2    267.81     385.53 5.3209   15.298  0.01153 *
```

quarter 3

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    226.46     252.78                          
2    222.15     197.38 4.3075   55.396 4.184e-11 ***
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    269.21     295.84                          
2    264.76     267.62 4.4551   28.216 1.871e-05 ***
```

dllim <- dl[(dl$country=='LTU'|dl$country=='LV') & dl$quarter==qq & dl$subdiv==26,]

quarter 1

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    280.49     337.61                          
2    276.77     199.72 3.7247    137.9 < 2.2e-16 ***
```

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    421.19     646.88                          
2    417.15     362.71 4.0399   284.17 < 2.2e-16 ***
```

quarter 3

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    183.58      166.3                          
2    180.03      131.0 3.5481   35.294 2.256e-07 ***
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    305.87     243.63                         
2    300.92     234.79 4.9557   8.8381   0.1131
```

Sub-division 27

No data overlap between countries.

Only sex ratio data from Sweden.

Sub-division 28

dllim <- dl[(dl$country=='Estonia'|dl$country=='LV') & dl$quarter==qq & dl$subdiv==28,]

quarter 2

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev       Df Deviance Pr(>Chi)
1    161.42     429.48
2    161.52     151.71 -0.10061   277.77
```

quarter 3

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    137.61     190.16
2    133.51     161.02 4.1033   29.137 8.26e-06 ***
```

quarter 4

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    163.17     159.37
2    160.82     146.53 2.3519   12.833 0.002511 **
```

Sub-division 29

No data overlap between countries.

Only sex ratio data from Estonia

Sub-division 32

No data overlap between countries.

Only sex ratio data from Estonia

Individual tests for difference between two countries by Sub-division

Sub-division 22

No data overlap between countries.

Only sex ratio data from Germany

Sub-division 24

dllim <- dl[which((dl$country=='GER'|dl$country=='Poland') & dl$subdiv==24),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    1196.6     1082.2
2    1193.0     1055.5 3.5658   26.737 1.359e-05 ***
```

dllim <- dl[which((dl$country=='LV'|dl$country=='Poland') & dl$subdiv==24),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    736.16     608.15
2    734.18     602.05 1.9788   6.0944  0.04651 *
```

Sub-division 25

dllim <- dl[which((dl$country=='LV'|dl$country=='Poland') & dl$subdiv==25),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    1178.0     1197.4
2    1174.4     1041.6 3.5508   155.81 < 2.2e-16 ***
```

llim <- dl[which((dl$country=='GER'|dl$country=='LV') & dl$subdiv==25),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev      Df Deviance  Pr(>Chi)
1    431.41     464.18
2    430.74     442.86 0.66547   21.319 1.705e-06 ***
```

dllim <- dl[which((dl$country=='GER'|dl$country=='Poland') & dl$subdiv==25),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    1145.2     1164.3
2    1141.6     1089.6 3.5716   74.674 1.153e-15 ***
```

dllim <- dl[which((dl$country=='GER'|dl$country=='SWE') & dl$subdiv==25),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    403.61     538.34
2    400.72     459.13 2.8972    79.21 < 2.2e-16 ***
```

dllim <- dl[which((dl$country=='Poland'|dl$country=='SWE') & dl$subdiv==25),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    1149.7     1070.3
2    1144.4     1058.0 5.3121   12.246  0.03833 *
```

dllim <- dl[which((dl$country=='LV'|dl$country=='SWE') & dl$subdiv==25),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    437.33     553.02
2    433.44     410.86 3.8871   142.16 < 2.2e-16 ***
```

<u>Sub-division 26</u>

dllim <- dl[which((dl$country=='LV'|dl$country=='Poland') & dl$subdiv==26),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    1583.4     3037.0
2    1580.6     2221.9 2.8321   815.05 < 2.2e-16 ***
```

dllim <- dl[which((dl$country=='LV'|dl$country=='LTU') & dl$subdiv==26),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    1206.3     1861.2
2    1202.1     1469.0 4.1761   392.17 < 2.2e-16 ***
```

dllim <- dl[which((dl$country=='Poland'|dl$country=='LTU') & dl$subdiv==26),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    1065.2     1396.0
2    1061.7     1358.9 3.4978    37.12 8.776e-08 ***
```

Sub-division 27

No data overlap between countries.

Only sex ratio data from Sweden.

Sub-division 28

dllim <- dl[which((dl$country=='Estonia'|dl$country=='LV') & dl$subdiv==28),]

```
Model 1: cbind(n - nmale, nmale) ~ s(length)
Model 2: cbind(n - nmale, nmale) ~ country + s(length, by = country)
  Resid. Df Resid. Dev     Df Deviance  Pr(>Chi)
1    513.51     873.97
2    509.56     660.57 3.9488   213.39 < 2.2e-16 ***
```

Sub-division 29

No data overlap between countries.

Only sex ratio data from Estonia

Sub-division 32

No data overlap between countries.

Only sex ratio data from Estonia

Overview of ANOVA results

Individual tests for difference between two countries by quarters and Sub-division

Sub-dividion	Quarter	Country 1	Country 2	P-value	Interpretation
24	1	GER	LV	0.02024 *	Maybe not equal
24	1	POL	LV	0.3208	Equal
24	1	POL	GER	0.06959 .	Equal
24	2	POL	GER	039e-15 ***	NOT equal
24	3	POL	GER	0.2176	Equal

24	4	POL	GER	0.006404 **	Prabably not equal
25	1	LV	GER	1.238e-15 ***	NOT equal
25	2	LV	GER	2.0365	Equal
25	4	LV	GER	0.443	Equal
25	1	POL	GER	0.004896 **	Prabably not equal
25	2	POL	GER	< 2.2e-16 ***	NOT equal
25	4	POL	GER	0.1443	Equal
25	1	SWE	GER	0.001137 **	Prabably not equal
25	1	SWE	LV	3.876e-10 ***	NOT equal
25	4	SWE	LV	0.0002085 ***	NOT equal
25	1	SWE	POL	0.002094 **	Prabably not equal
25	4	SWE	POL	0.007168 **	Prabably not equal
25	1	LV	POL	1.662e-12 ***	NOT equal
25	2	LV	POL	2.536e-11 ***	NOT equal
25	3	LV	POL	0.1271	Equal
25	4	LV	POL	0.009031 **	Prabably not equal
26	1	LV	POL	< 2.2e-16 ***	NOT equal
26	2	LV	POL	< 2.2e-16 ***	NOT equal
26	3	LV	POL	< 2.2e-16 ***	NOT equal
26	4	LV	POL	1.366e-09 ***	NOT equal
26	1	LTU	POL	0.01803 *	Maybe not equal
26	2	LTU	POL	0.01153 *	Maybe not equal
26	3	LTU	POL	4.184e-11 ***	NOT equal
26	4	LTU	POL	1.871e-05 ***	NOT equal
26	1	LTU	LV	< 2.2e-16 ***	NOT equal
26	2	LTU	LV	< 2.2e-16 ***	NOT equal
26	3	LTU	LV	2.256e-07 ***	NOT equal
26	4	LTU	LV	0.1131	Equal
28	2	EST	LV	277.77	Equal
28	3	EST	LV	8.26e-06 ***	NOT equal
28	4	EST	LV	0.002511 **	Prabably not equal

Individual tests for difference between two countries by sub-division

Sub-division	Country 1	Country 2	P-value	Interpretation
24	GER	POL	1.359e-05 ***	NOT equal
24	LV	POL	0.04651 *	Maybe not equal
25	LV	POL	< 2.2e-16 ***	NOT equal
25	GER	LV	1.705e-06 ***	NOT equal
25	GER	POL	1.153e-15 ***	NOT equal
25	GER	SWE	< 2.2e-16 ***	NOT equal
25	POL	SWE	0.03833 *	Maybe not equal
25	LV	SWE	< 2.2e-16 ***	NOT equal
26	LV	POL	< 2.2e-16 ***	NOT equal
26	LV	LTU	< 2.2e-16 ***	NOT equal

26	POL	LTU	0.776e-08 ***	NOT equal
26	EST	LV	< 2.2e-16 ***	NOT equal

What to do?

The general overall learning of the results is that country is the overall most important parameter followed by quarter, sub-division. Year and gear type has very little inpact on the sex-ratio distribution.

The more detailed analyses of the sex-ratio data show that the sex-ratios by length group in most cases (2 out of 12 cases of data data overlap) are different across countries if only country and sub-division are considered. If, in addition, the quarter is considered, then few more strata (but still only 5 out of 31 cases of data data overlap) can be regarded as having a similar sex-ratio and therefore formally allowing the exchange of the ratio between countries.

What we were hoping for was a general impression of the analysis results, which would indicate that only insignificant differencies were identified in the sex-ratio distribution between countries. In this case between Poland and the rest of the countries because the data set from Polans is more complet than other countries. This wouls mean that we probably without introducing any big error could extrapolate data from one country (Poland) to another. This is not the case and we have to realize that an error is introduced if we use data from other countries as source data for filling gabs in the sex-ratio for another country.

Never the less, we are forced to do such data extrapolation if we want to consider the sexes separate in the assessment of the flounders. This means that we accept that the result is biased by the unprober extrapolation procedure. The bias can be minimized by following the the guidelines below:

Depending of the type of data gab the following data extrapolation procedure is suggested:

Missing data in only a year range: extrapolate the closest year back in time.

One country has sex ratios for most years but miss data for one or more quarters in a given sub-division: borrow from data from the same country, same quarter but the closest sub-division

All years are missing for a country: extrapolate from a country, which have data for same quarter and sub-division

Appendixes

Appendix A: Tabulating of observations by country, Quarter, Sub-division, Gear type and Year (higest resolution equal to the data call resolution).

Sub-division 22

quarter = 1, gear = Active

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	54	0	0	0	0
2009	0	54	0	0	0	0
2010	0	54	0	0	0	0
2011	0	54	0	0	0	0
2012	0	54	0	0	0	0

quarter = 2, gear = Active

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	54	0	0	0	0
2009	0	54	0	0	0	0
2010	0	54	0	0	0	0
2011	0	54	0	0	0	0
2012	0	54	0	0	0	0

quarter = 3, gear = Active

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0

```
  2007        0   0   0  0       0   0
  2008        0  54   0  0       0   0
  2009        0  54   0  0       0   0
  2010        0  54   0  0       0   0
  2011        0  54   0  0       0   0
  2012        0  54   0  0       0   0
```

quarter = 4, gear = Active

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0       0   0
  2005        0   0   0  0       0   0
  2006        0   0   0  0       0   0
  2007        0   0   0  0       0   0
  2008        0  54   0  0       0   0
  2009        0  54   0  0       0   0
  2010        0  54   0  0       0   0
  2011        0  54   0  0       0   0
  2012        0  54   0  0       0   0
```

quarter = 1, gear = Passive

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0       0   0
  2005        0   0   0  0       0   0
  2006        0   0   0  0       0   0
  2007        0   0   0  0       0   0
  2008        0  54   0  0       0   0
  2009        0  54   0  0       0   0
  2010        0  54   0  0       0   0
  2011        0  54   0  0       0   0
  2012        0  54   0  0       0   0
```

quarter = 2, gear = Passive

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0       0   0
  2005        0   0   0  0       0   0
  2006        0   0   0  0       0   0
  2007        0   0   0  0       0   0
  2008        0  54   0  0       0   0
```

2009	0	54	0	0	0	0
2010	0	54	0	0	0	0
2011	0	54	0	0	0	0
2012	0	54	0	0	0	0

quarter = 3, gear = Passive

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	54	0	0	0	0
2009	0	54	0	0	0	0
2010	0	54	0	0	0	0
2011	0	54	0	0	0	0
2012	0	54	0	0	0	0

quarter = 4, gear = Passive

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	54	0	0	0	0
2009	0	54	0	0	0	0
2010	0	54	0	0	0	0
2011	0	54	0	0	0	0
2012	0	54	0	0	0	0

Sub-division 24

quarter = 1, gear = Active

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	54	0
2005	0	0	0	0	54	0
2006	0	0	0	0	54	0
2007	0	0	0	0	54	0

```
  2008        0  54   0  0      54   0
  2009        0  54   0  0      54   0
  2010        0  54   0  0      54   0
  2011        0  54   0  0      54   0
  2012        0  54   0  0      54   0
```

quarter = 2, gear = Active

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0      54   0
  2005        0   0   0  0      54   0
  2006        0   0   0  0      54   0
  2007        0   0   0  0      54   0
  2008        0  54   0  0      54   0
  2009        0  54   0  0      54   0
  2010        0  54   0  0      54   0
  2011        0  54   0  0      54   0
  2012        0  54   0  0      54   0
```

```
quarter = 3, gear = Active
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0      54   0
  2005        0   0   0  0      54   0
  2006        0   0   0  0      54   0
  2007        0   0   0  0      54   0
  2008        0  54   0  0      54   0
  2009        0  54   0  0      54   0
  2010        0  54   0  0      54   0
  2011        0  54   0  0      54   0
  2012        0  54   0  0      54   0
```

```
quarter = 4, gear = Active
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0      54   0
  2005        0   0   0  0      54   0
  2006        0   0   0  0      54   0
  2007        0   0   0  0      54   0
  2008        0  54   0  0      54   0
  2009        0  54   0  0      54   0
  2010        0  54   0  0      54   0
  2011        0  54   0  0      54   0
  2012        0  54   0  0      54   0
```

```
quarter = 1, gear = Passive
```

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0
2006	0	0	0	54	54	0
2007	0	0	0	54	54	0
2008	0	0	0	54	54	0
2009	0	0	0	54	54	0
2010	0	0	0	54	54	0
2011	0	0	0	54	54	0
2012	0	0	0	54	54	0

quarter = 2, gear = Passive

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	54	0
2005	0	0	0	0	54	0
2006	0	0	0	0	54	0
2007	0	0	0	0	54	0
2008	0	54	0	0	54	0
2009	0	54	0	0	54	0
2010	0	54	0	0	54	0
2011	0	54	0	0	54	0
2012	0	54	0	0	54	0

quarter = 3, gear = Passive

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	54	0
2005	0	0	0	0	54	0
2006	0	0	0	0	54	0
2007	0	0	0	0	54	0
2008	0	54	0	0	54	0
2009	0	54	0	0	54	0
2010	0	54	0	0	54	0
2011	0	54	0	0	54	0
2012	0	54	0	0	54	0

quarter = 4, gear = Passive

year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	54	0
2005	0	0	0	0	54	0
2006	0	0	0	0	54	0
2007	0	0	0	0	54	0

2008	0	54	0	0	54	0
2009	0	54	0	0	54	0
2010	0	54	0	0	54	0
2011	0	54	0	0	54	0
2012	0	54	0	0	54	0

Sub-division 25

quarter = 1, gear = Active

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0
2006	0	0	0	54	54	0
2007	0	0	0	54	54	54
2008	0	54	0	54	54	54
2009	0	54	0	54	54	54
2010	0	54	0	54	54	54
2011	0	54	0	54	54	54
2012	0	54	0	54	54	54

quarter = 2, gear = Active

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0
2006	0	0	0	54	54	0
2007	0	0	0	54	54	0
2008	0	54	0	54	54	0
2009	0	54	0	54	54	0
2010	0	54	0	54	54	0
2011	0	54	0	54	54	0
2012	0	54	0	54	54	0

quarter = 3, gear = Active

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	54	0
2005	0	0	0	0	54	0
2006	0	0	0	0	54	0
2007	0	0	0	0	54	0
2008	0	0	0	0	54	0
2009	0	0	0	0	54	0
2010	0	0	0	0	54	0

```
  2011        0   0   0  0      54   0
  2012        0   0   0  0      54   0
```

```
quarter = 4, gear = Active

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54      0   0
  2001        0   0   0 54      0   0
  2002        0   0   0 54      0   0
  2003        0   0   0 54      0   0
  2004        0   0   0 54     54   0
  2005        0   0   0 54     54   0
  2006        0   0   0 54     54  54
  2007        0   0   0 54     54   0
  2008        0  54   0 54     54  54
  2009        0  54   0 54     54  54
  2010        0  54   0 54     54  54
  2011        0  54   0 54     54  54
  2012        0  54   0 54     54  54
```

```
quarter = 1, gear = Passive

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54      0   0
  2001        0   0   0 54      0   0
  2002        0   0   0 54      0   0
  2003        0   0   0 54      0   0
  2004        0   0   0 54     54   0
  2005        0   0   0 54     54   0
  2006        0   0   0 54     54   0
  2007        0   0   0 54     54   0
  2008        0   0   0 54     54   0
  2009        0   0   0 54     54   0
  2010        0   0   0 54     54   0
  2011        0   0   0 54     54   0
  2012        0   0   0 54     54   0
```

```
quarter = 2, gear = Passive

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54      0   0
  2001        0   0   0 54      0   0
  2002        0   0   0 54      0   0
  2003        0   0   0 54      0   0
  2004        0   0   0 54     54   0
  2005        0   0   0 54     54   0
  2006        0   0   0 54     54   0
  2007        0   0   0 54     54   0
  2008        0   0   0 54     54   0
  2009        0   0   0 54     54   0
  2010        0   0   0 54     54   0
  2011        0   0   0 54     54   0
  2012        0   0   0 54     54   0
```

```
quarter = 3, gear = Passive

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54      0   0
```

year	Estonia	GER	LTU	LV	Poland	SWE
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0
2006	0	0	0	54	54	0
2007	0	0	0	54	54	0
2008	0	0	0	54	54	0
2009	0	0	0	54	54	0
2010	0	0	0	54	54	0
2011	0	0	0	54	54	0
2012	0	0	0	54	54	0

quarter = 4, gear = Passive

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0
2006	0	0	0	54	54	0
2007	0	0	0	54	54	0
2008	0	0	0	54	54	0
2009	0	0	0	54	54	0
2010	0	0	0	54	54	0
2011	0	0	0	54	54	0
2012	0	0	0	54	54	0

Sub-division 26

quarter = 1, gear = Active

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0
2006	0	0	0	54	54	0
2007	0	0	0	54	54	0
2008	0	0	0	54	54	0
2009	0	0	0	54	54	0
2010	0	0	0	54	54	0
2011	0	0	0	54	54	0
2012	0	0	0	54	54	0

quarter = 2, gear = Active

	country					
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0

```
  2005        0   0   0 54      54   0
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

```
quarter = 3, gear = Active
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54       0   0
  2001        0   0   0 54       0   0
  2002        0   0   0 54       0   0
  2003        0   0   0 54       0   0
  2004        0   0   0 54      54   0
  2005        0   0   0 54      54   0
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

```
quarter = 4, gear = Active
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54       0   0
  2001        0   0   0 54       0   0
  2002        0   0   0 54       0   0
  2003        0   0   0 54       0   0
  2004        0   0   0 54      54   0
  2005        0   0   0 54      54   0
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

```
quarter = 1, gear = combined
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0       0   0
  2001        0   0   0  0       0   0
  2002        0   0   0  0       0   0
  2003        0   0   0  0       0   0
  2004        0   0   0  0       0   0
  2005        0   0   0  0       0   0
  2006        0   0   0  0       0   0
  2007        0   0   0  0       0   0
  2008        0   0  54  0       0   0
  2009        0   0  54  0       0   0
  2010        0   0  54  0       0   0
  2011        0   0  54  0       0   0
  2012        0   0  54  0       0   0
```

quarter = 2, gear = combined

country year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	54	0	0	0
2009	0	0	54	0	0	0
2010	0	0	54	0	0	0
2011	0	0	54	0	0	0
2012	0	0	54	0	0	0

quarter = 3, gear = combined

country year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	54	0	0	0
2009	0	0	54	0	0	0
2010	0	0	54	0	0	0
2011	0	0	54	0	0	0
2012	0	0	54	0	0	0

quarter = 4, gear = combined

country year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	0	0	54	0	0	0
2009	0	0	54	0	0	0
2010	0	0	54	0	0	0
2011	0	0	54	0	0	0
2012	0	0	54	0	0	0

quarter = 1, gear = Passive

country year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	54	0
2005	0	0	0	54	54	0

```
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

```
quarter = 2, gear = Passive

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54       0   0
  2001        0   0   0 54       0   0
  2002        0   0   0 54       0   0
  2003        0   0   0 54       0   0
  2004        0   0   0 54      54   0
  2005        0   0   0 54      54   0
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

```
quarter = 3, gear = Passive

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54       0   0
  2001        0   0   0 54       0   0
  2002        0   0   0 54       0   0
  2003        0   0   0 54       0   0
  2004        0   0   0 54      54   0
  2005        0   0   0 54      54   0
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

```
quarter = 4, gear = Passive

      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0 54       0   0
  2001        0   0   0 54       0   0
  2002        0   0   0 54       0   0
  2003        0   0   0 54       0   0
  2004        0   0   0 54      54   0
  2005        0   0   0 54      54   0
  2006        0   0   0 54      54   0
  2007        0   0   0 54      54   0
  2008        0   0   0 54      54   0
  2009        0   0   0 54      54   0
  2010        0   0   0 54      54   0
  2011        0   0   0 54      54   0
  2012        0   0   0 54      54   0
```

Sub-division 27

quarter = 4, gear = Passive

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	54
2008	0	0	0	0	0	54
2009	0	0	0	0	0	54
2010	0	0	0	0	0	54
2011	0	0	0	0	0	54
2012	0	0	0	0	0	54

Sub-division 28

quarter = 1, gear = Active

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	0	0
2005	0	0	0	54	0	0
2006	0	0	0	54	0	0
2007	0	0	0	54	0	0
2008	0	0	0	54	0	0
2009	0	0	0	54	0	0
2010	0	0	0	54	0	0
2011	0	0	0	54	0	0
2012	0	0	0	54	0	0

quarter = 3, gear = Active

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	0	0
2005	0	0	0	54	0	0
2006	0	0	0	54	0	0
2007	0	0	0	54	0	0
2008	0	0	0	54	0	0
2009	0	0	0	54	0	0
2010	0	0	0	54	0	0
2011	0	0	0	54	0	0
2012	0	0	0	54	0	0

quarter = 4, gear = Active

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0
2003	0	0	0	54	0	0
2004	0	0	0	54	0	0
2005	0	0	0	54	0	0
2006	0	0	0	54	0	0
2007	0	0	0	54	0	0
2008	0	0	0	54	0	0
2009	0	0	0	54	0	0
2010	0	0	0	54	0	0
2011	0	0	0	54	0	0
2012	0	0	0	54	0	0

quarter = 2, gear = combined

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	54	0	0	0	0	0
2009	54	0	0	0	0	0
2010	54	0	0	0	0	0
2011	54	0	0	0	0	0
2012	54	0	0	0	0	0

quarter = 3, gear = combined

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	0	0
2008	54	0	0	0	0	0
2009	54	0	0	0	0	0
2010	54	0	0	0	0	0
2011	54	0	0	0	0	0
2012	54	0	0	0	0	0

quarter = 2, gear = Passive

country						
year	Estonia	GER	LTU	LV	Poland	SWE
2000	0	0	0	54	0	0
2001	0	0	0	54	0	0
2002	0	0	0	54	0	0

```
  2003       0   0   0 54      0   0
  2004       0   0   0 54      0   0
  2005       0   0   0 54      0   0
  2006       0   0   0 54      0   0
  2007       0   0   0 54      0   0
  2008       0   0   0 54      0   0
  2009       0   0   0 54      0   0
  2010       0   0   0 54      0   0
  2011       0   0   0 54      0   0
  2012       0   0   0 54      0   0
```

```
quarter = 3, gear = Passive
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000       0   0   0 54      0   0
  2001       0   0   0 54      0   0
  2002       0   0   0 54      0   0
  2003       0   0   0 54      0   0
  2004       0   0   0 54      0   0
  2005       0   0   0 54      0   0
  2006       0   0   0 54      0   0
  2007       0   0   0 54      0   0
  2008       0   0   0 54      0   0
  2009       0   0   0 54      0   0
  2010       0   0   0 54      0   0
  2011       0   0   0 54      0   0
  2012       0   0   0 54      0   0
```

```
quarter = 4, gear = Passive
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000       0   0   0 54      0   0
  2001       0   0   0 54      0   0
  2002       0   0   0 54      0   0
  2003       0   0   0 54      0   0
  2004       0   0   0 54      0   0
  2005       0   0   0 54      0   0
  2006       0   0   0 54      0   0
  2007       0   0   0 54      0   0
  2008      54   0   0 54      0   0
  2009      54   0   0 54      0   0
  2010      54   0   0 54      0   0
  2011      54   0   0 54      0   0
  2012      54   0   0 54      0   0
```

Sub-division 32

```
quarter = 2, gear = combined
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000       0   0   0  0      0   0
  2001       0   0   0  0      0   0
  2002       0   0   0  0      0   0
  2003       0   0   0  0      0   0
  2004       0   0   0  0      0   0
  2005       0   0   0  0      0   0
  2006       0   0   0  0      0   0
  2007       0   0   0  0      0   0
```

```
  2008       54   0   0  0       0   0
  2009       54   0   0  0       0   0
  2010       54   0   0  0       0   0
  2011       54   0   0  0       0   0
  2012       54   0   0  0       0   0
```

```
quarter = 3, gear = Passive
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0      0   0
  2001        0   0   0  0      0   0
  2002        0   0   0  0      0   0
  2003        0   0   0  0      0   0
  2004        0   0   0  0      0   0
  2005        0   0   0  0      0   0
  2006        0   0   0  0      0   0
  2007        0   0   0  0      0   0
  2008       54   0   0  0      0   0
  2009       54   0   0  0      0   0
  2010       54   0   0  0      0   0
  2011       54   0   0  0      0   0
  2012       54   0   0  0      0   0
```

```
quarter = 4, gear = Passive
```

```
      country
year   Estonia GER LTU LV Poland SWE
  2000        0   0   0  0      0   0
  2001        0   0   0  0      0   0
  2002        0   0   0  0      0   0
  2003        0   0   0  0      0   0
  2004        0   0   0  0      0   0
  2005        0   0   0  0      0   0
  2006        0   0   0  0      0   0
  2007        0   0   0  0      0   0
  2008       54   0   0  0      0   0
  2009       54   0   0  0      0   0
  2010       54   0   0  0      0   0
  2011       54   0   0  0      0   0
  2012       54   0   0  0      0   0
```

Appendix B: Tabulating of observations by country, Sub-division and Year.

```
, , subdiv = 22
```

```
      country
year   Estonia GER LTU  LV Poland SWE
  2000        0   0   0   0      0   0
  2001        0   0   0   0      0   0
  2002        0   0   0   0      0   0
  2003        0   0   0   0      0   0
  2004        0   0   0   0      0   0
  2005        0   0   0   0      0   0
  2006        0   0   0   0      0   0
  2007        0   0   0   0      0   0
```

```
  2008       0 432   0   0      0   0
  2009       0 432   0   0      0   0
  2010       0 432   0   0      0   0
  2011       0 432   0   0      0   0
  2012       0 432   0   0      0   0

, , subdiv = 24

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0  54      0   0
  2001       0   0   0  54      0   0
  2002       0   0   0  54      0   0
  2003       0   0   0  54      0   0
  2004       0   0   0  54    432   0
  2005       0   0   0  54    432   0
  2006       0   0   0  54    432   0
  2007       0   0   0  54    432   0
  2008       0 378   0  54    432   0
  2009       0 378   0  54    432   0
  2010       0 378   0  54    432   0
  2011       0 378   0  54    432   0
  2012       0 378   0  54    432   0

, , subdiv = 25

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0 378      0   0
  2001       0   0   0 378      0   0
  2002       0   0   0 378      0   0
  2003       0   0   0 378      0   0
  2004       0   0   0 378    432   0
  2005       0   0   0 378    432   0
  2006       0   0   0 378    432  54
  2007       0   0   0 378    432  54
  2008       0 162   0 378    432 108
  2009       0 162   0 378    432 108
  2010       0 162   0 378    432 108
  2011       0 162   0 378    432 108
  2012       0 162   0 378    432 108

, , subdiv = 26

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0 432      0   0
  2001       0   0   0 432      0   0
  2002       0   0   0 432      0   0
  2003       0   0   0 432      0   0
  2004       0   0   0 432    432   0
  2005       0   0   0 432    432   0
  2006       0   0   0 432    432   0
  2007       0   0   0 432    432   0
  2008       0   0 216 432    432   0
  2009       0   0 216 432    432   0
  2010       0   0 216 432    432   0
  2011       0   0 216 432    432   0
  2012       0   0 216 432    432   0

, , subdiv = 27

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0   0      0   0
  2001       0   0   0   0      0   0
  2002       0   0   0   0      0   0
```

```
  2003       0   0   0   0      0   0
  2004       0   0   0   0      0   0
  2005       0   0   0   0      0   0
  2006       0   0   0   0      0   0
  2007       0   0   0   0      0  54
  2008       0   0   0   0      0  54
  2009       0   0   0   0      0  54
  2010       0   0   0   0      0  54
  2011       0   0   0   0      0  54
  2012       0   0   0   0      0  54

, , subdiv = 28

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0 324      0   0
  2001       0   0   0 324      0   0
  2002       0   0   0 324      0   0
  2003       0   0   0 324      0   0
  2004       0   0   0 324      0   0
  2005       0   0   0 324      0   0
  2006       0   0   0 324      0   0
  2007       0   0   0 324      0   0
  2008     162   0   0 324      0   0
  2009     162   0   0 324      0   0
  2010     162   0   0 324      0   0
  2011     162   0   0 324      0   0
  2012     162   0   0 324      0   0

, , subdiv = 29

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0   0      0   0
  2001       0   0   0   0      0   0
  2002       0   0   0   0      0   0
  2003       0   0   0   0      0   0
  2004       0   0   0   0      0   0
  2005       0   0   0   0      0   0
  2006       0   0   0   0      0   0
  2007       0   0   0   0      0   0
  2008     162   0   0   0      0   0
  2009     162   0   0   0      0   0
  2010     162   0   0   0      0   0
  2011     162   0   0   0      0   0
  2012     162   0   0   0      0   0

, , subdiv = 32

      country
year   Estonia GER LTU  LV Poland SWE
  2000       0   0   0   0      0   0
  2001       0   0   0   0      0   0
  2002       0   0   0   0      0   0
  2003       0   0   0   0      0   0
  2004       0   0   0   0      0   0
  2005       0   0   0   0      0   0
  2006       0   0   0   0      0   0
  2007       0   0   0   0      0   0
  2008     162   0   0   0      0   0
  2009     162   0   0   0      0   0
  2010     162   0   0   0      0   0
  2011     162   0   0   0      0   0
  2012     162   0   0   0      0   0
```

Spatial distribution of dab (*Limanda limanda*) during quarter 1 and 4 BITS from 2001 to 2013

by

Rainer Oeberst
Johann Heinrich von Thünen Institute
Institute of Baltic Sea Fisheries

Introduction

Dab in the Baltic Sea is mainly captured as by-catch in SD 21 – 32. The minimum landings size is 25 cm. Data of landings are available from 1970 onwards, but, analyses of last years suggested that amount of unreported discards has nearly the same magnitude like landings. Dab is mainly captured in SD 21 and 22. Only low landings were reported in SD 24 and more eastern located SD's. The eastern border of its occurrence is not clearly described. Single specimens are caught only occasionally in the Polish EEZ (unpublished data, E. Gosz) as well as in SD 26-32 (Plikšs and Aleksejevs, 1998, Ojaveer et al., 2003).
First trawl surveys were carried out in the Baltic Sea by Poland in 1976. Other countries established their own national surveys some years later. They used different national gears and different periods within the quarter 1 (Q1) and 4 (Q4). The coverage of the Baltic Sea was significantly higher during the surveys in quarter 1. Internationally coordinated Baltic International Trawl Surveys (BITS) were established in 2001 to coordinate the national surveys and one year later the surveys were coordinated by the ICES working group "Baltic International Fish Survey" (WGBIFS). Since 2001 all participating countries used standardized gear types, the haul positions and the periods of the surveys were coordinated. The main target species of the surveys was cod, but, flounder and all other flatfishes were also recorded according to the manual of the BITS (ICES 2013). The total number of planned stations is allocated to the ICES subdivisions and the depth layers according to agreed procedure (ICES 2013). The allocation is based on the area of the depth layers and the mean density distribution of cod in quarter 1 during the last five years. The distribution patterns of flounder were not taken into account during the planning of the surveys due to lower commercial importance.
Q1 BITS is carried out between middle of February and end of March. The survey is immediately carried out before dab starts spawning in April (Muus and Nielsen, 1999). According to Nissling et al. (2002) eggs of dab require salinity ≥ 17.8 psu for buoyancy indicating that dab spawns in the basins. These areas are well covered by the BITS in both quarters.

Material and Methods

Since 2001 standardized gear types TV3 #930 (TVL) and TV3 #520 (TVS) have been used by all countries which participated in the Baltic International Trawl Survey (BITS). 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 the more important for the commercial use.
The procedures for analyzing the hauls are given in the BITS manual (ICES, 2013). Total weight of all species is determined. Length frequencies of cod, all flatfish, herring and sprat are measured and biological parameters (length, weight, age, sex, maturity stage) of cod and flatfish are sampled. The data are uploaded to the ICES database DATRAS where the sourced data and different catch per hour estimates by length and age are provided.
Data of quarter 1 and 4 from 2001 to 2013 were used for the study.
The number of total stations differed between quarter 1 and 4 surveys. The numbers of hauls were significantly lower during the surveys in quarter 4. Fishing stations were not carried out in water < 10 m in the western Baltic Sea (SD 21 – 24) and in water < 20 in the eastern Baltic Sea (SD 25 – 28). One to three fishing stations were only conducted in SD 23. Mean length distributions by SD were estimated according the procedures given in the BITS manual (ICES 2013).

For the presentation of the spatial distributions total length range was separated into two separate intervals from 5 cm to 19 cm and for dab ≥ 20 cm based on the probability of maturation (according to lm given in www.FishBase.org).
The spatial distribution patterns of the defined length groups were described using Ocean data View (www.awi-bremerhaven.de) where Iso-surface plots with colour shading and contouring of gridded fields were calculated based on VG gridding with a scales of 40 in both directions. This method analyzes the distribution of the data points and constructs a variable resolution, rectangular grid, where grid-spacing along X and Y directions vary according to data density. High resolution (small grid-spacing) is provided in regions with good data coverage, whereas in areas of sparse sampling the grid is coarse and resolution is limited.

Results

High CPUE values of dab were observed between 10 m and 60 m. Only low CPUE values were found east of 13 °E. On the other hand no trend of CPUE values was observed in relation to latitude. Data of the BITS in quarter 1 in 2013 illustrate the situation (Fig. 1).
Highest maximum CPUE value was observed in SD 21 with 11146 individuals per hour in quarter 4 of 2002 for both length groups (Table 1 – 4). Similar high densities of dab were also captured in quarter 4 in 2001. In the following years the maximum CPUE values decreased to values of less than 1000 from 2004 onwards (one exception in SD 22 in quarter 4 in 2011, Table 4). Estimates of SD 24 were significantly lower compared to data of SD 12 and SD 22. In addition, dab were noticed in SD 25 with single individuals. The strong decrease of the CPUE values from 2003 to 2004 was detected in SD 21 and in SD 22 and with lower intensity in SD 23 and 24.
The length frequencies by year, SD and quarter from 2008 to 2013 (Figure 2 and 3) support the statements based on Table 1 – 4. Highest densities were observed in SD 21. The CPUE values in SD 22 were significantly smaller, but, the length ranges in SD 22 were slightly larger, due to the higher CPUE values for dab > 21 cm. Significantly different length frequencies were estimated in SD 24. The CPUE values were more than ten times smaller in many cases and the length distributions were dominated by dab > 20 cm during many BITS (quarter 1 in 2009, 2010 and 2012; quarter 4 in 2008, 2009 – 2011). The decreasing density of small dab from SD 21 to SD 24 indicates that reproduction is concentrated in SD 21 and SD 22 and that intensive and successful reproduction in SD 24 did not occur.
The spatial distribution patterns of both length ranges of dab from 2001 to 2013 also support the hypnotised connection of dab in SD 21 and SD 22 - SD 24 (Fig. 4). High CPUE values of large dab were regularly observed in SD 21 to SD 23 in quarter 1 and 4. Significantly lower densities were found in western part of SD 24 (west of the Darßer Sill). Only single individuals were captured in SD 24 east of the Darßer Sill and in SD 25. The spatial distribution patterns also did not indicate areas of concentration of dab in SD 21 and SD 22 which are clearly spatially disconnected (eg. quarter 4 in 2001, quarter 1 in 2004) although dab is relative patchy distributed in some cases during the BITS of both quarters. Higher densities of large dab in the basin of SD 24 and in SD 25 during quarter 1 BITS, shortly before the main spawning season, were not detected in the total period.

Discussion

The findings based on BITS disagree with the currently used structure of plaice stocks in the Baltic Sea applied in stock assessment (SD 22 – 32) and disagree with conclusions of WKFLABA (ICES 2010, 2012) where three stocks of dab were proposed (SD 23, SD22 + SD 24 W, SD 24 E + SD 25). The existence of one stock with uniform dynamics of dab in SD 21 – 25 can be concluded based in BITS.

Similar strong decrease of the stock indices in SD 21 and SD 22 were observed from quarter 4 in 2003 to quarter 1 in 2004 and which also occurred in SD23 and SD 24. The low maximum CPUE values in the area east of the Darßer Sill do also not support the hypothesis of a stock in SD 24 E and SD 25. These areas have been well covered by the BITS in both quarters since 2001. Standard gears and standard survey design have been applied since 2001 indicating that the observed CPUE values are not significantly influenced by variations of the amount or spatial distribution of fishing stations. The standard gears use a mesh size if i=20 mm in the cod end. The applied mesh size corresponds with a L_{50} of ~ 5 cm (Richter at al., 2002, Oeberst, 2007). That means that age group 1 might be slightly underestimated because smallest dab were not representative captured if the parameter of Bertalanffy growth function taken for dab in the south eastern North Sea (Rijnsdorp et al., 1992). Similar conclusion follows based on the BGF estimated for dab in the Baltic Sea (Oeberst, 2013c- Growth).

Quarter 1 BITS is carried out between middle of February and end of March. The survey is immediately carried out before dab starts spawning in April (Muus and Nielsen, 1999) and therefore present the spatial distribution of prespawning dab. Nissling et al. (2002) reported that activation of spermatozoa occurred at 11 – 14 psu with increasing duration of mobility with increasing salinity. They also found that neutral buoyancy of eggs varied between ICES SD 23 and SD 25 with an observed minimum of 19 psu and estimated that ~1 % of eggs will obtain buoyancy at 17.8 psu. The required high salinity for the buoyancy of eggs in combination of required oxygen content ≥ 2ml/l for successful development of eggs suggest that probability of reproductive success in SD 24 and 25 has been very low since 2001.

Salinity of more than 15 psy was seldom observed in the basins of SD 25 in spring between 2001 and 2013 due to low frequency of inflow events. The mean salinity in the Bornholm Deep by year was around 15 psu between 2008 and 2012 combined with mean oxygen content lower than 1.7 ml/l (IOW Marine Science Reports No 91, 2013). The salinity in the Bornholm Deep was higher between 2001 and 2007 (16.2 psu – 17.1 psu), but the mean oxygen content was lower than 1 ml/l in the same period IOW Marine Science Reports No 66, 2006 & No 77, 2008). Only in 2003 the hydrographical conditions were close to the lowest boundary for successful reproduction of dab with mean salinity of 17.0 psu and mean oxygen content of 4.5 ml/l due to the inflow in January 2003. Oxygen content of more than 2 ml/l were always observed in the Basin of the Arkona Sea in spring, but, the salinity was lower than 15 psu in some years indicating low reproduction success in this area. Beside the unfavourable hydrographical conditions only small densities of large dab were observed in the basins of SD 24 and 25 during quarter 1 BITS, indicating a low potential spawning stock size.

Therefore, it is unlikely that a stable self-reproducing stock exist in SD 24 east together with SD 25 as proposed by WKFLABA (ICES, 2010). The occurrence of small dab in the area east of the Darßer Sill can be explained by the water driven transport of pelagic stages from SD 22 and SD 23 (Westerberg, 1994, Hinrichsen et al. 2001).

The results of the BITS clearly showed the connection of dab in SD 21 and SD 22. High CPUE values were noticed in the transition zone between SD 21 and SD 22 between 2001 and 2003. In the following years the spatial distribution of dab also did not indicated a clear separation into two stocks with clearly defined spatial boundaries. In addition, the spatial distribution of dab did not significantly change between subsequent BITS indicating low migration intensity.

Summing up the results of the BITS in relation to available studies in the literature it can be concluded that dab is main reproducing in SD 21 – 23. Reproduction is also possible in the southern part of SD 22 with success. The pelagic stages can be transported from the spawning grounds into SD 24 and SD 25, but, a successful reproduction of these individuals is unlikely. Therefore, dab in the Baltic Sea is to be managed as one unit.

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Westernberg (1994) analysed the occurrence and drift of cod eggs in the Öresund. He estimated that about 10^{11} cod eggs were transported from the Öresund region in the Arkona Sea 1993 and 1994.

Tables

Table 1: Maximum CPUE of dab ≥ 20 cm (catch in number per hour in units of TVS) in quarter 1 by SD and year

SD	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
21	2661	2702	3238	140	101	105	133	143	200	105	78	78	163
22	1804	822	3166	161	164	161	116	295	302	146	295	107	89
23	40	48	126	76	58	59	64	15	94	41	25	36	56
24	44	12	103	23	48	16	13	37	24	60	64	11	55
25	0	2	1	2	2	0	2	6	4	1	3	1	2

Table 2: Maximum CPUE of dab ≥ 20 cm (catch in number per hour in units of TVS) in quarter 4 by SD and year

SD	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
21	6432	11146	2857	88	131	126	112	112	160	92	123	92
22	10188	10502	6124	190	221	128	206	339	254	296	572	113
23	806	1252	94	54	100	79	81	39	72	44	109	62
24	18	554	327	236	36	64	34	201	42	440	62	121
25	0	2	0	0	0	0	0	0	0	0	2	0

Table 3: Maximum CPUE of dab between 5 cm and 19 cm (catch in number per hour in units of TVS) in quarter 1 by SD and year

SD	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
21	2694	2763	3365	146	111	106	141	163	215	131	99	102	180
22	1838	840	3345	285	220	260	254	346	413	475	386	424	379
23	341	137	234	124	105	113	71	48	142	95	70	71	120
24	58	18	140	37	89	47	38	56	63	131	109	33	173
25	1	2	4	12	7	2	2	6	18	6	6	8	4

Table 4: Maximum CPUE of dab between 5 cm and 19 cm (catch in number per hour in units of TVS) in quarter 4 by SD and year

SD	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
21	6432	11146	2873	89	146	156	122	115	160	101	124	106
22	10528	10634	6263	316	280	282	350	460	382	380	1059	355
23	1092	1510	117	89	111	111	266	91	146	57	122	72
24	26	836	477	295	149	141	58	351	157	516	359	524
25	0	2	2	2	10	0	0	4	2	8	14	1

Figures

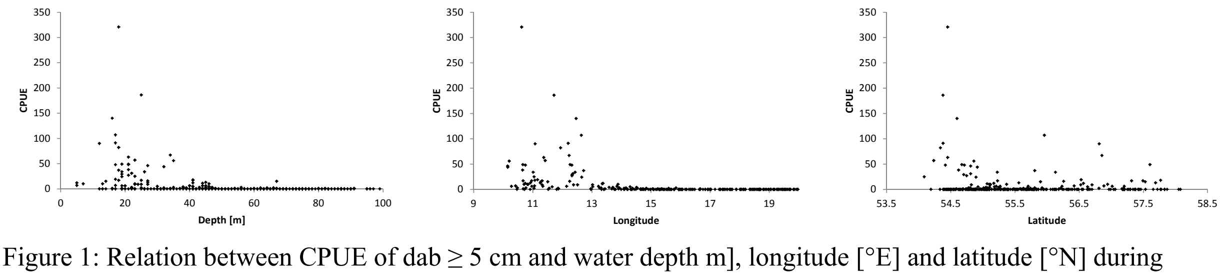


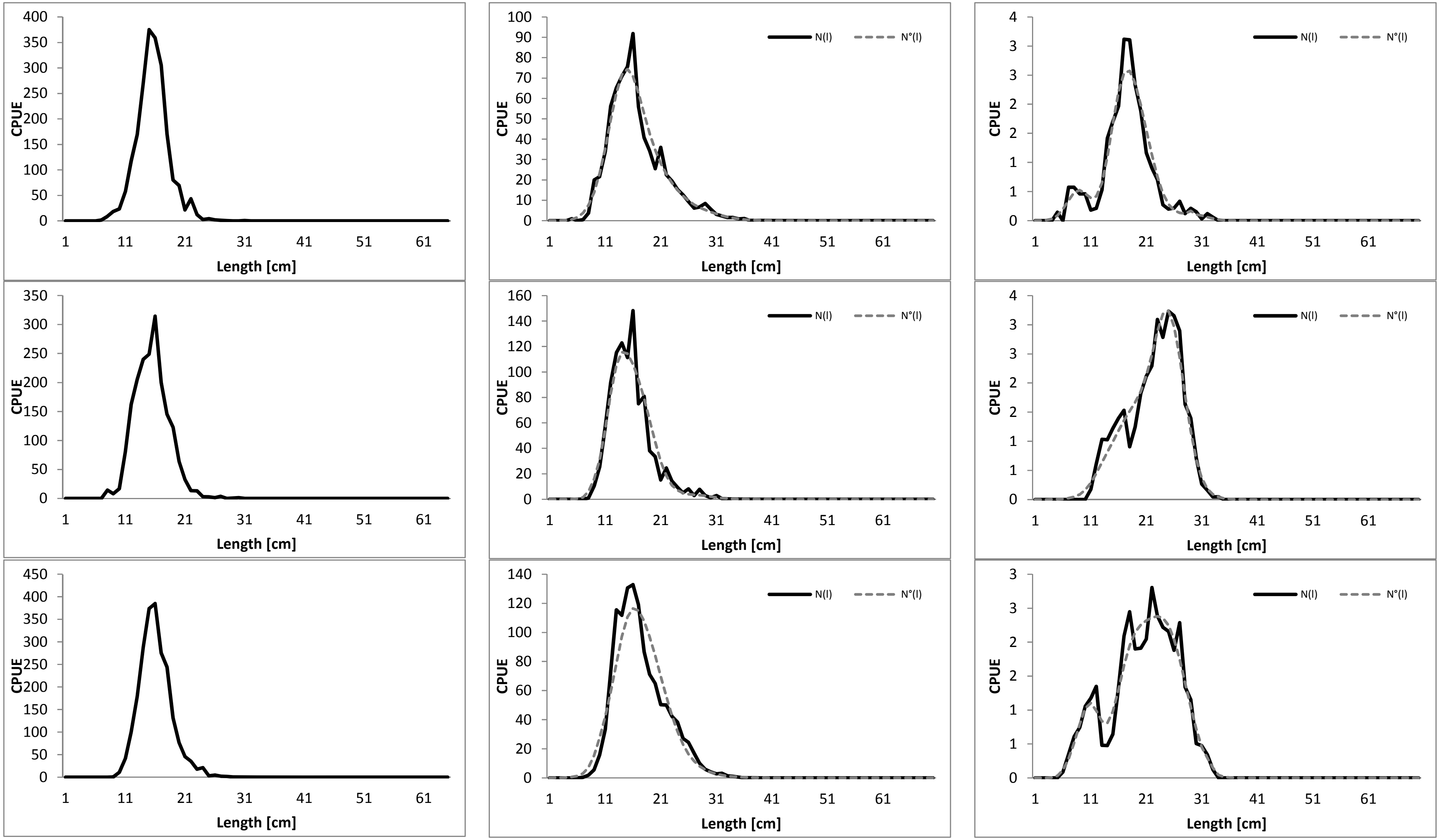
Figure 1: Relation between CPUE of dab ≥ 5 cm and water depth m], longitude [°E] and latitude [°N] during BITS in quarter 1 in 2013

Year **SD 21** **SD 22** **SD 24**

2008

2009

2010



2011

2012

2013

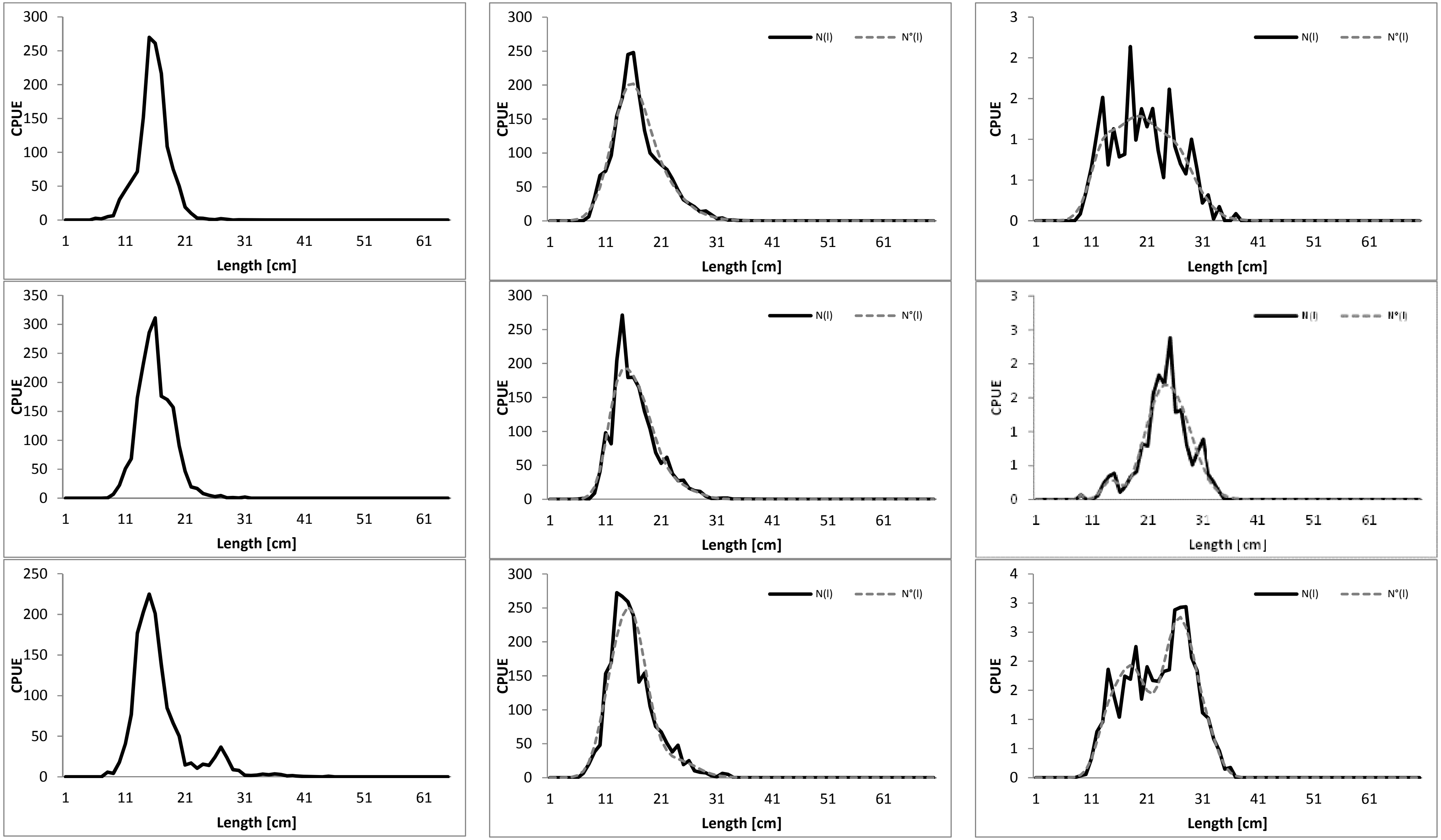


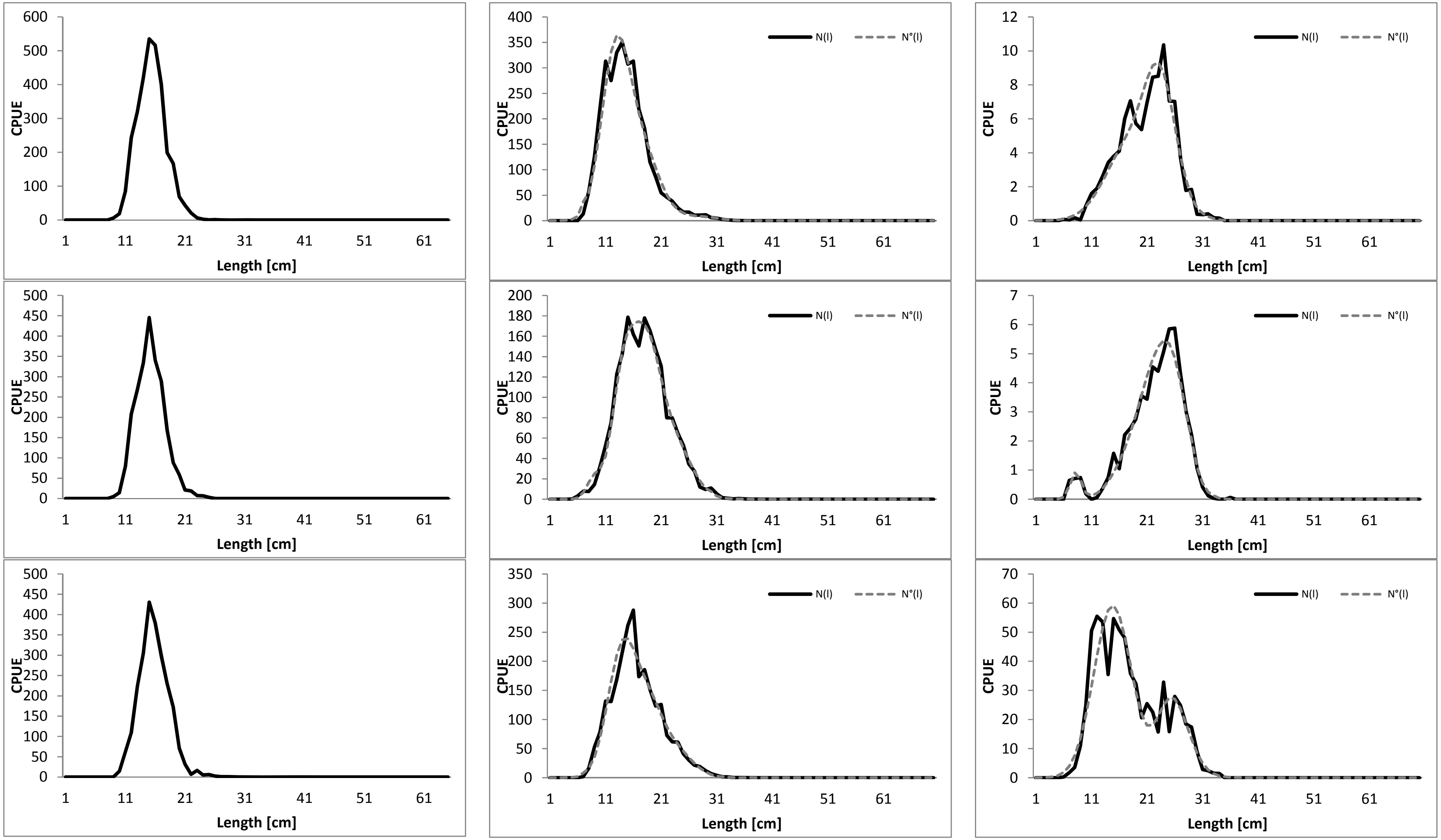
Figure 2: Mean length frequencies of dab by year and ICES SD of quarter 1 BITS from 2008 to 2013 (black line)

Year SD 21 SD 22 SD 24

2008

2009

2010



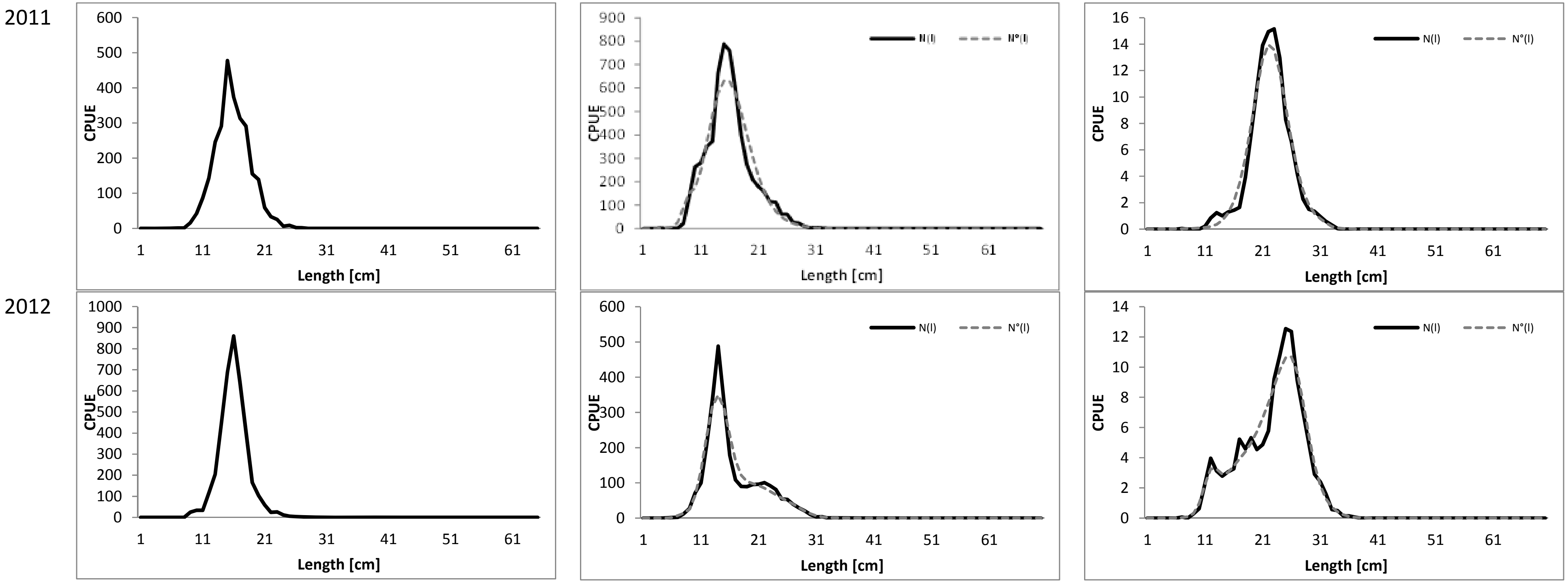
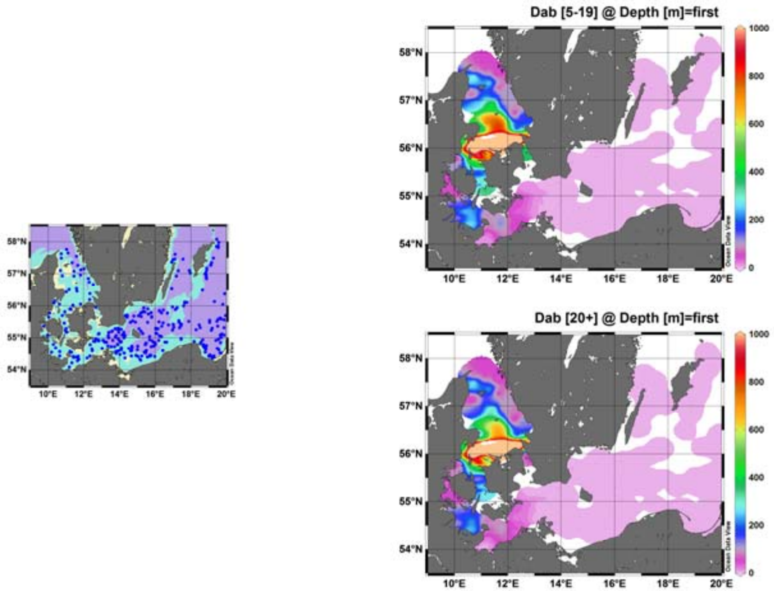
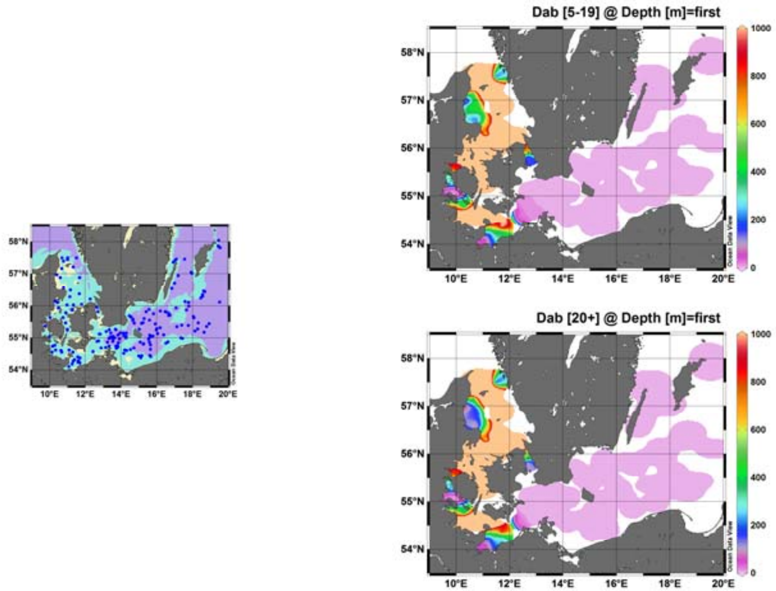


Figure 3: Mean length frequencies of dab by year and ICES SD of quarter 4 BITS from 2008 to 2013 (Black line)



2001, Q1



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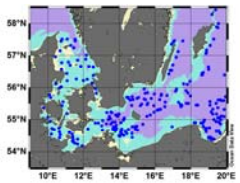

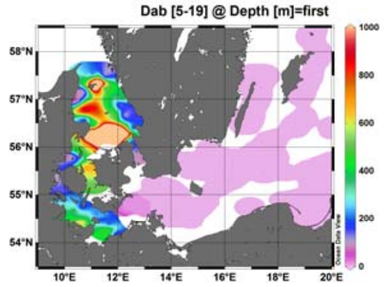

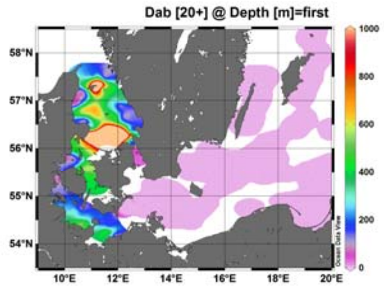

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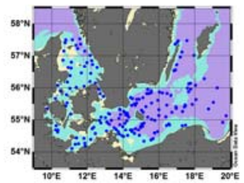

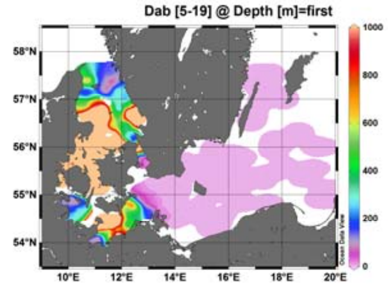

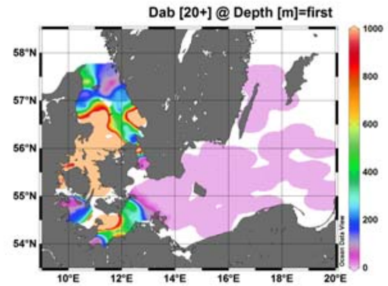

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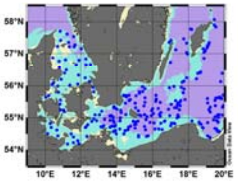

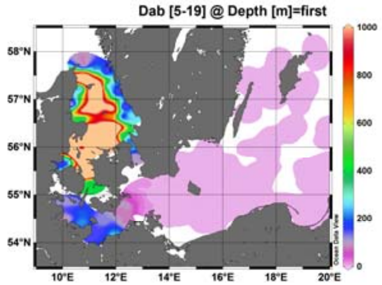

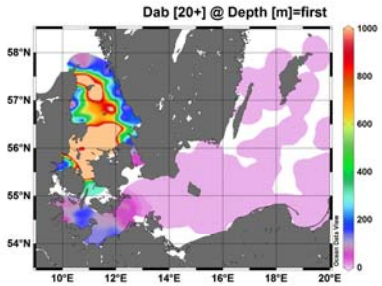

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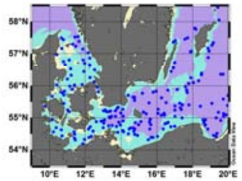

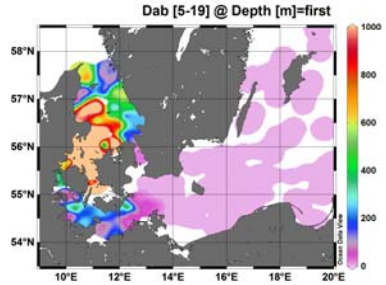

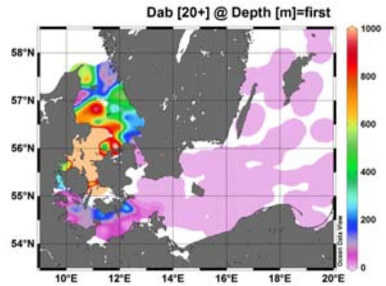

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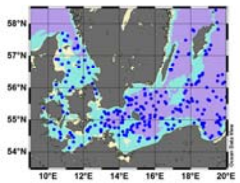

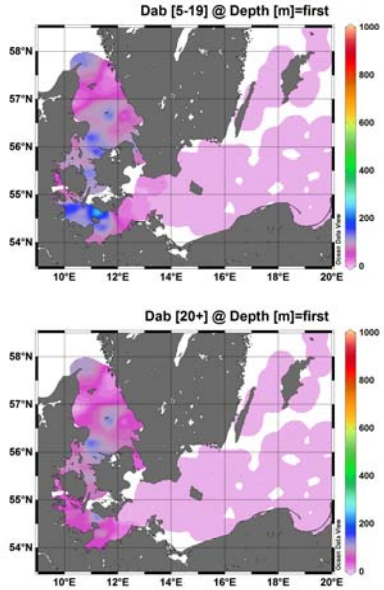

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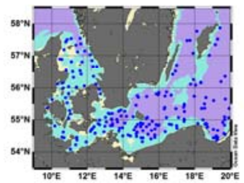

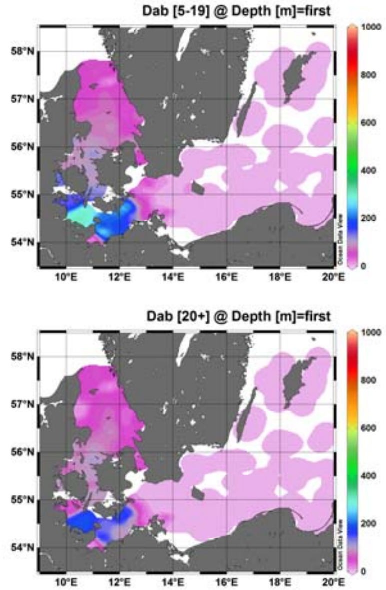

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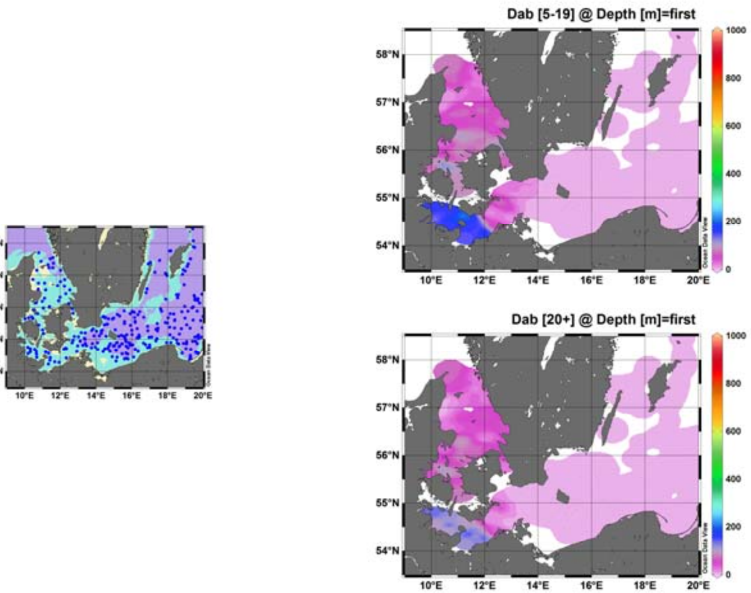

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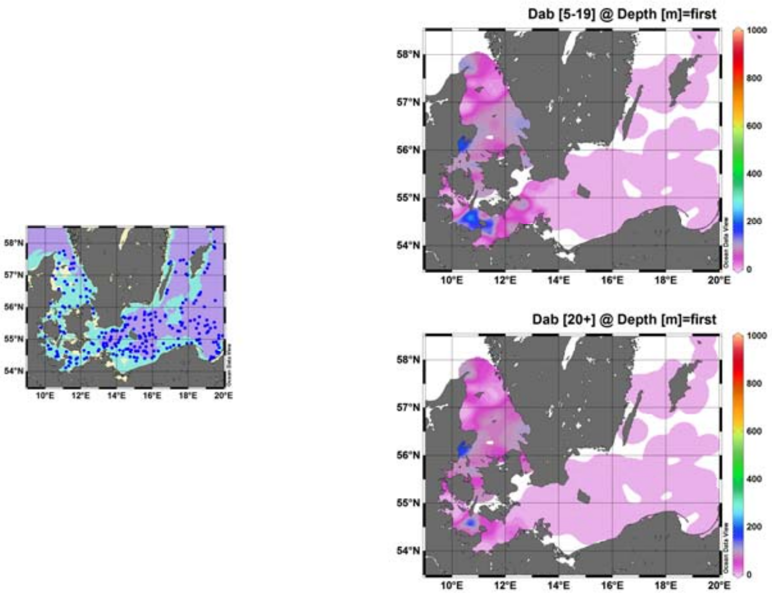

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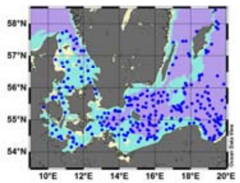

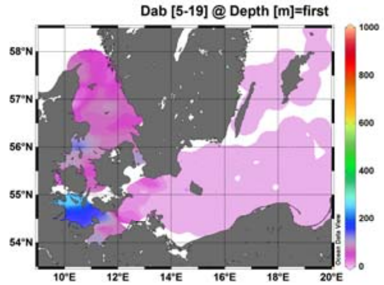

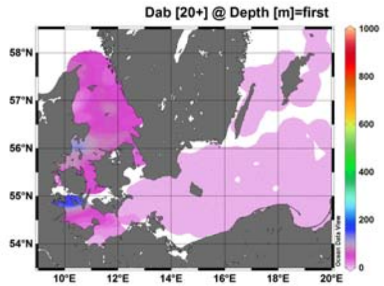

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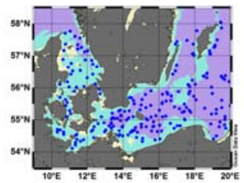

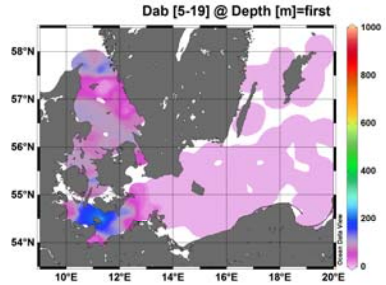

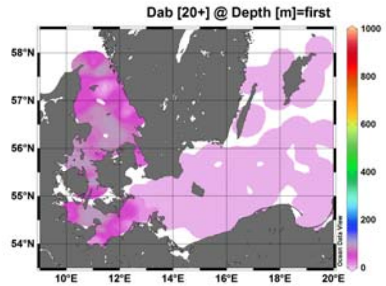

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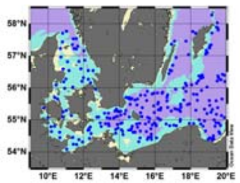

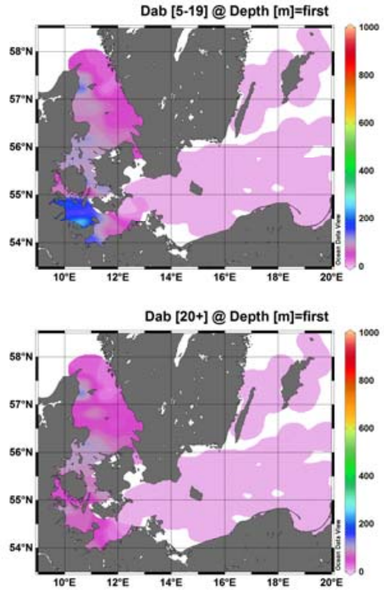

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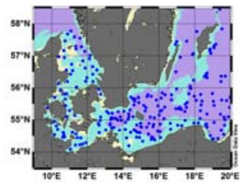

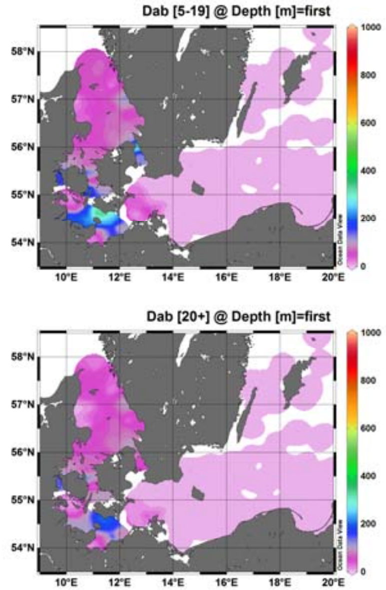

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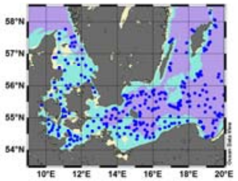

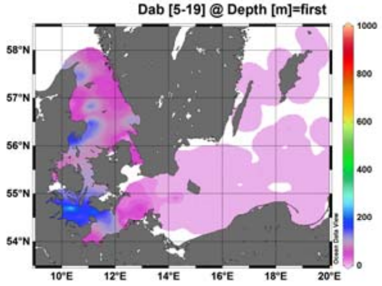

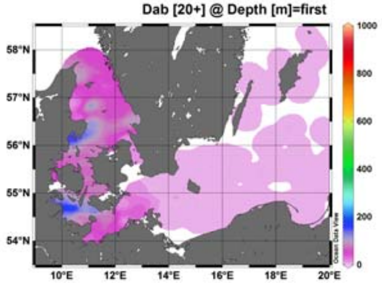

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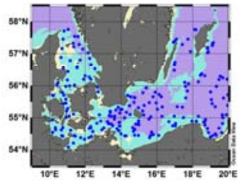

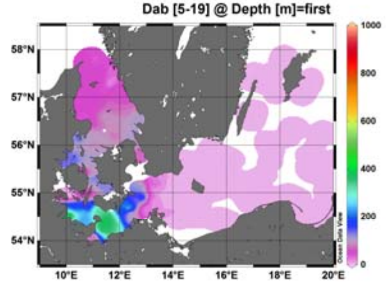

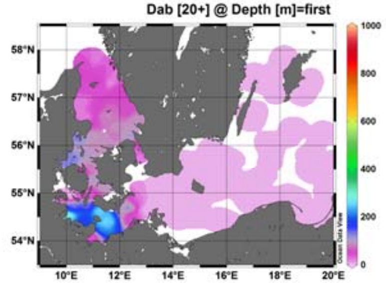

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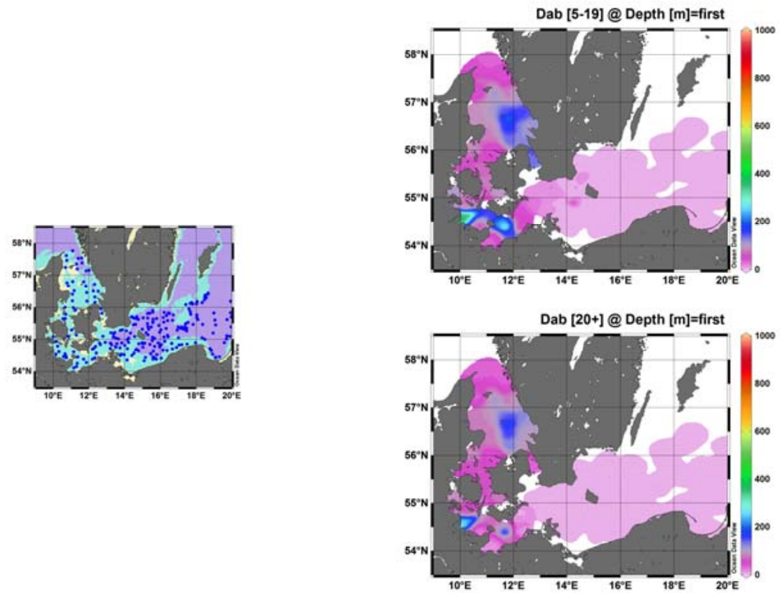

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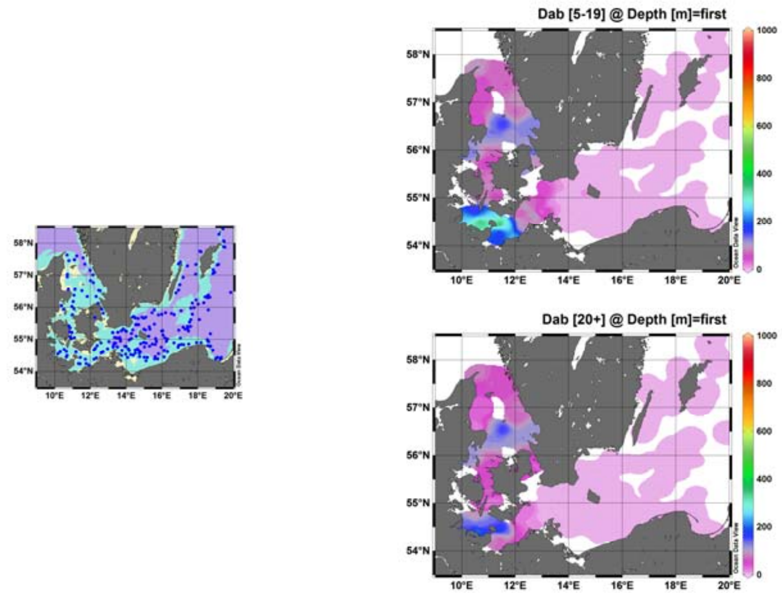

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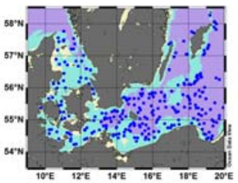

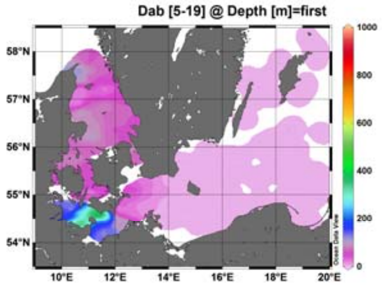

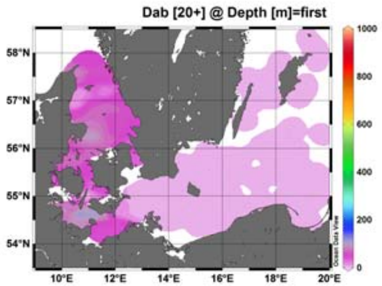

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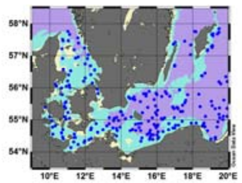

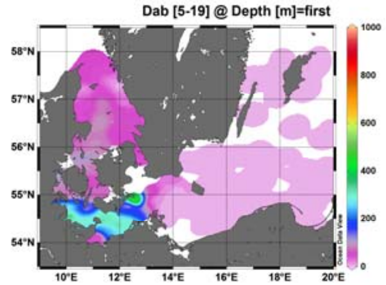

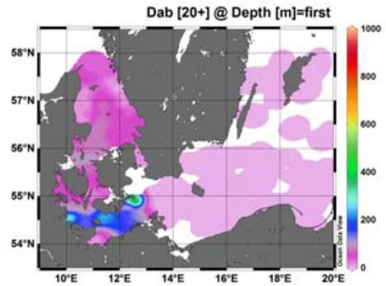

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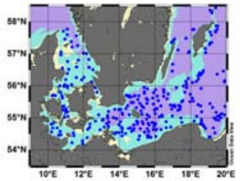

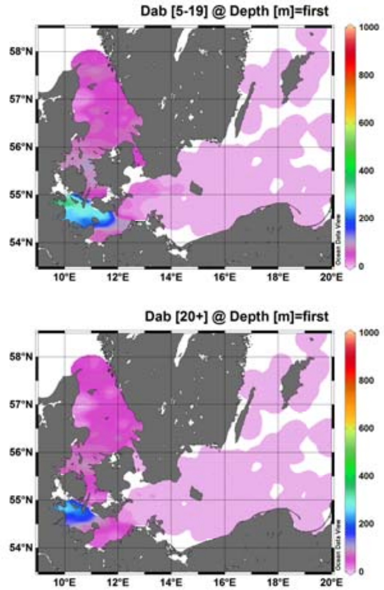

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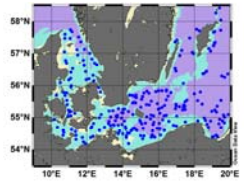

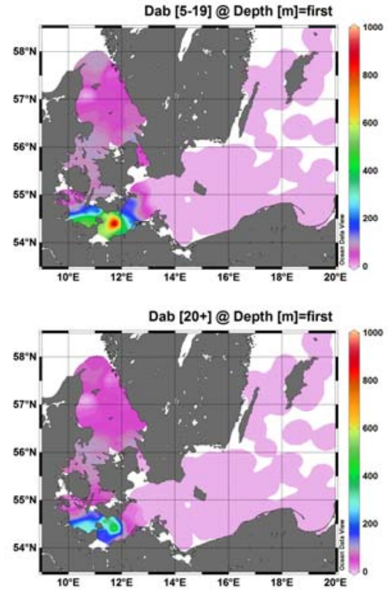

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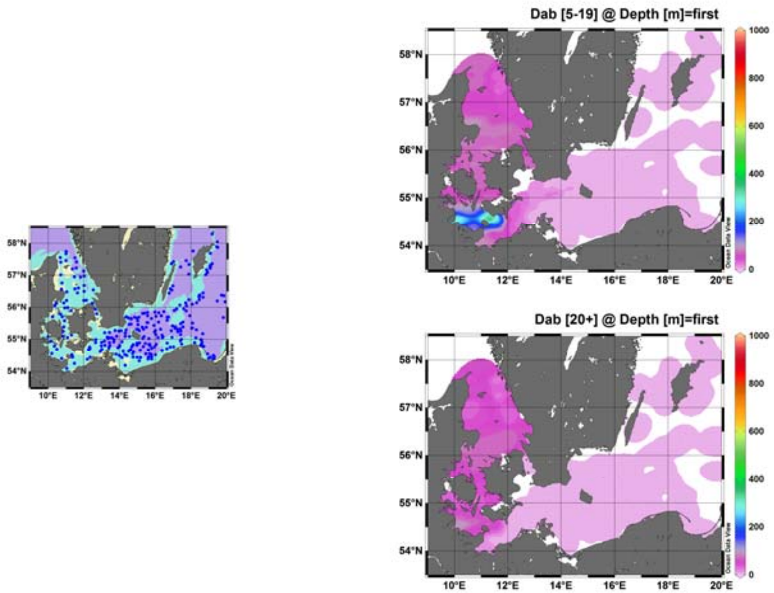

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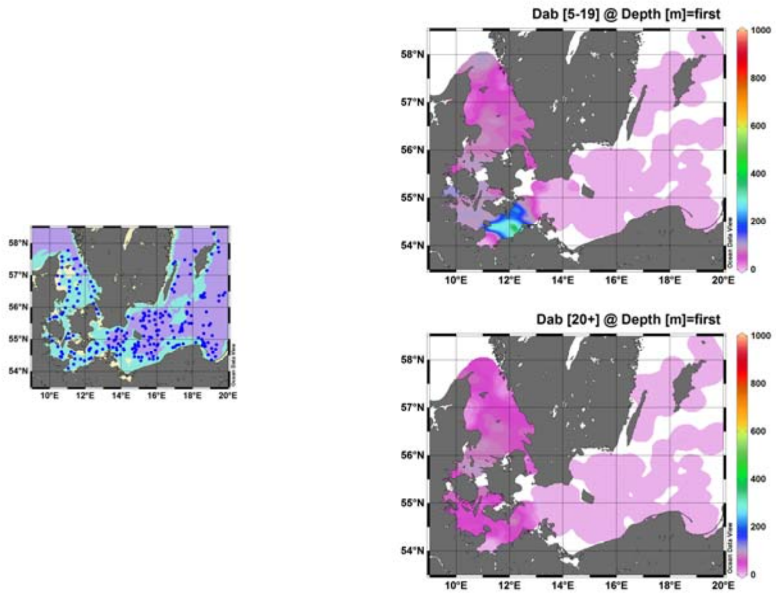

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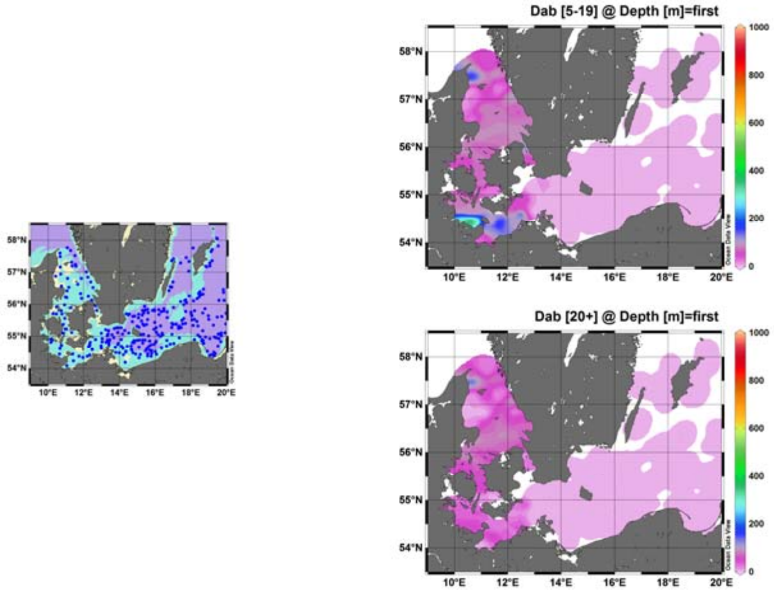


2013, Q1

Figure 4: Position of fishing stations (left panel) and spatial distribution of dab < 20 cm (right upper panel) and dab > 19 cm (right lower panel) by year and quarter of BITS between 2001 and 2013

Spatial distribution of dab (*Limanda limanda*) during quarter 1 and 3 IBTS from 2001 to 2012

by

Rainer Oeberst
Johann Heinrich von Thünen Institute
Institute of Baltic Sea Fisheries

Introduction

Dab is regularly captured during IBTS in quarter 1 and quarter 4. Both surveys cover the North Sea, the Skagerrak and the Kattegat. GOV was used as standard gear in both surveys during in total period. Standardized fishing stations were also conducted in the Kattegat during BITS in quarter 1 and 4 between 2001 and 2012. It was proposed based on the analyses of these data that the dab stock in SD 22 – SD 32 should also incorporate dab in SD 21 (Oeberst, 2014 a). This study describes (i) the spatial distribution of dab in the eastern part of the North Sea, the Skagerrak and the Kattegat based on IBTS data and (ii) the relation between water depth and the CPUE of dab < 10 cm and dab > 19 cm.

Material and Methods

CPUE per length per haul of IBTS from 2001 to 2012 of both surveys are downloaded from DATRAS database of ICES. The data contain the position of the haul, the water depth, the CPUE by length and data of the ship. Hauls within the area from 54 °N to 60 °N and 1 °E to 15 °E were taken into account.

The spatial distribution patterns of the defined length groups were described using Ocean data View (www.awi-bremerhaven.de) where Iso-surface plots with colour shading and contouring of gridded fields were calculated based on VG gridding with a scales of 50 in both directions. This method analyzes the distribution of the data points and constructs a variable resolution, rectangular grid, where grid-spacing along X and Y directions vary according to data density. High resolution (small grid-spacing) is provided in regions with good data coverage, whereas in areas of sparse sampling the grid is coarse and resolution is limited.

Results

Dab between 3 cm and 39 cm were captured during IBTS (all stations) and between 10 m and 130 m. But, CPUE were low in areas deeper than 100 m in most cases (see examples of 2001, 2003 and 2009 in Fig. 1 – 3). High CPUE values were observed at single stations and the distribution pattern of CPUE is probably log normally distributed.

The spatial distribution patterns of dab in quarter 1and quarter 3 in the area between 54 °N to 60 °N and 1 °E to 15 °E are given in Figure 4 by years and quarters. Dab is mainly captured in the deepest areas of the analyses part of the North Sea in in the southern parts of the Kattegat during quarter 1. In the shallow waters close to the Danish coast of the North Sea high CPUE values of dab were only registered in small area in some years. The CPUE values of the Skagerrak were low in all years indicating different spawning areas of dab in the North Sea and in the Kattegat and Baltic Sea. In quarter 3 dab of both length groups were observed in the deeper area of the North Sea as well as shallow waters close to the Danish coast. CPUE values were also higher in the area around of Skagen. The different distribution patter in the Skagerrak suggest intensive migration between the spawning grounds in spring and feeding grounds in quarter 3. It can not be decides based on the data whether the dab around Skagen in quarter 3 comes from the North Sea or from the Kattegat. The distribution patterns suggest a possible exchange between dab in the North Sea and the Kattegat. However, the low densities of dab in the Skagerrak in quarter 1 suggest that dab in the Kattegat is more related to dab in SD 22 – 32 than with dab in the North Sea.

References

Oeberst, R. 2014. Spatial distribution of dab (Limanda limanda) during quarter 1 and 4 BITS from 2001 to 2013. Working document WKFLABALT 27 – 31 January 2014, 22 pp

Figures

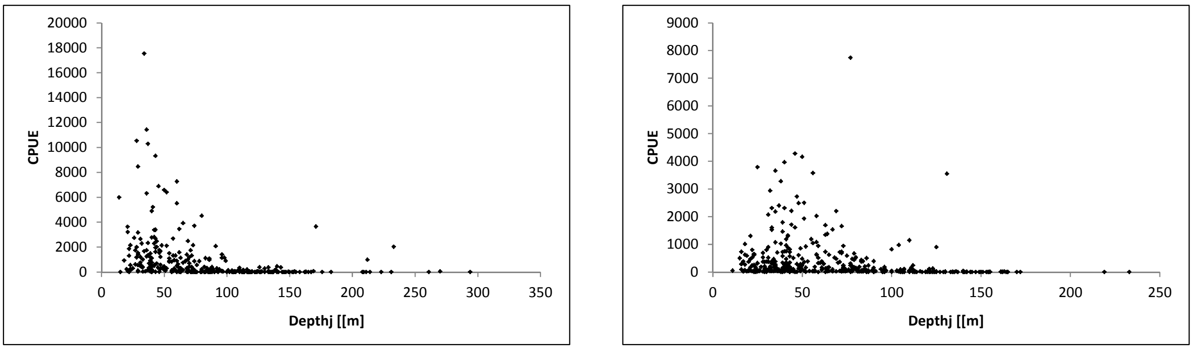


Figure 1: Relation between CPUE of dab < 20 cm as well as dab > 19 m and water depth [m] during IBTS in quarter 1 and quarter 3 in 2001

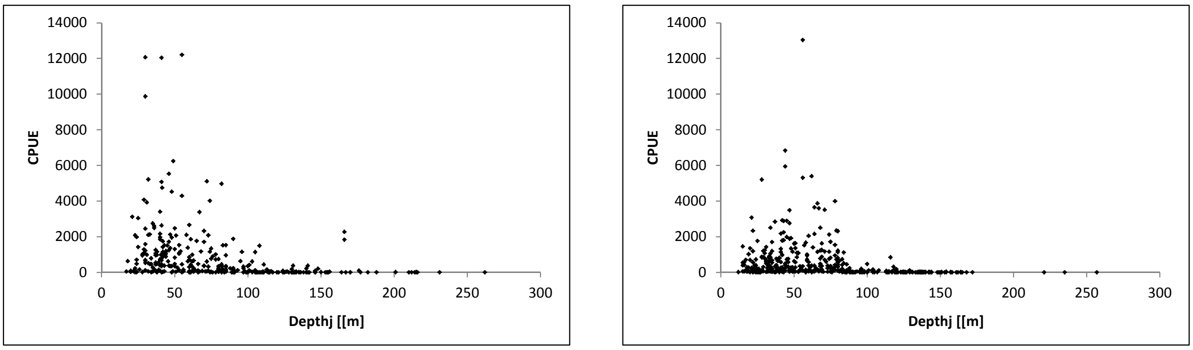


Figure 2: Relation between CPUE of dab < 20 cm as well as dab > 19 m and water depth [m] during IBTS in quarter 1 and quarter 3 in 2003

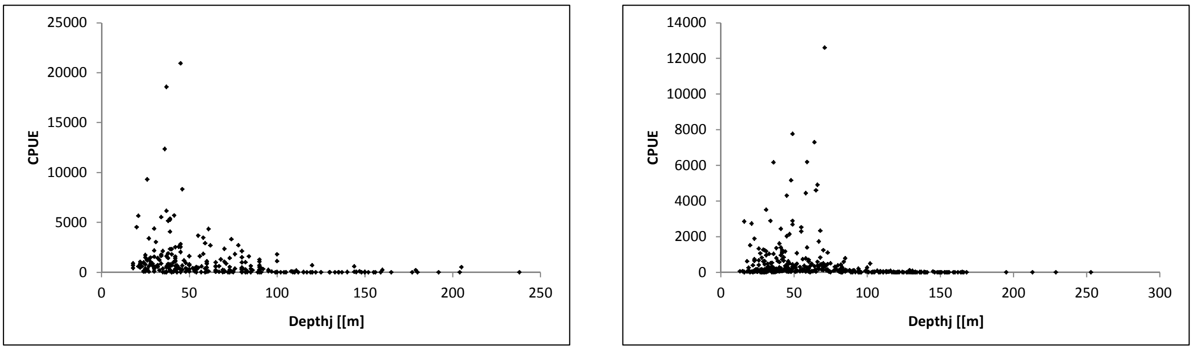
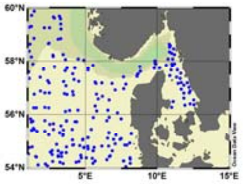
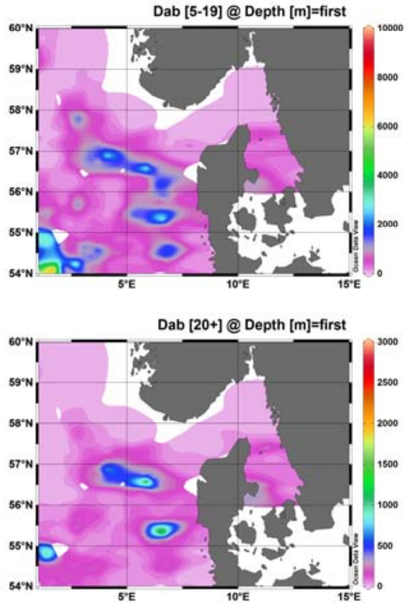
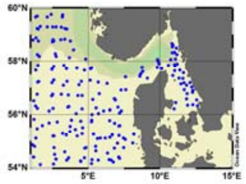


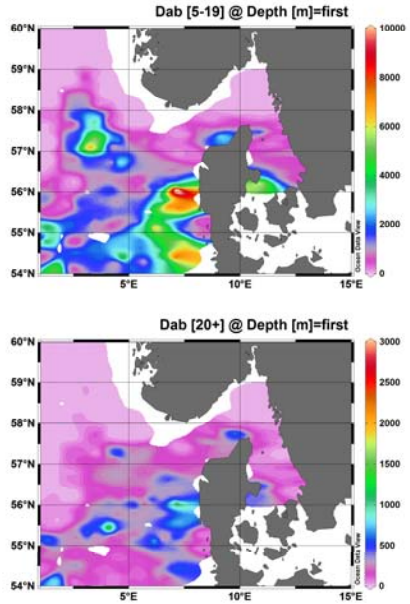
Figure 3: Relation between CPUE of dab < 20 cm as well as dab > 19 m and water depth [m] during IBTS in quarter 1 and quarter 3 in 2009



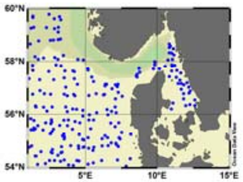


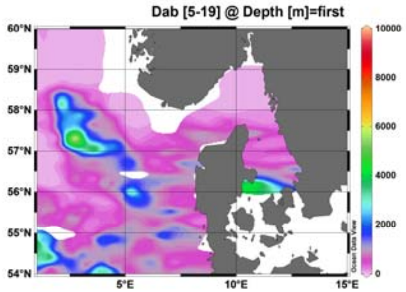
2001 Q1

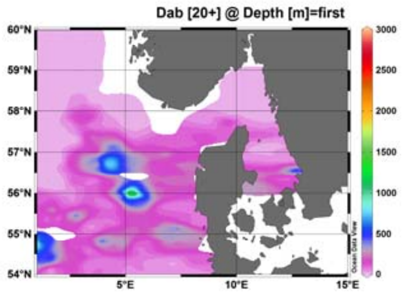




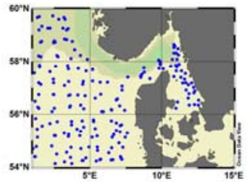
2001, Q3

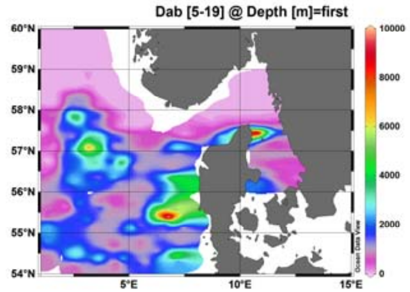


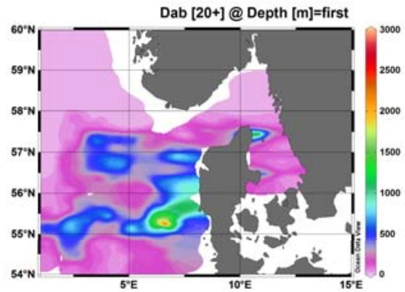




2002 Q1







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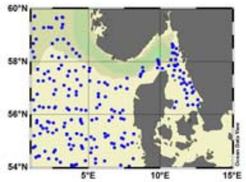
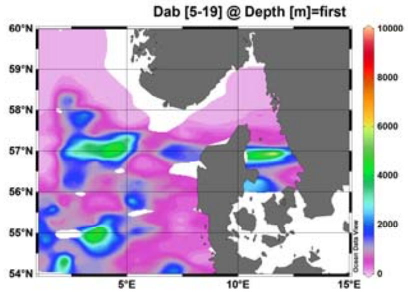
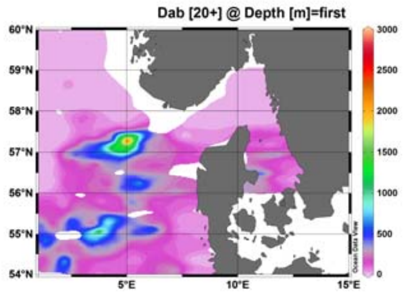
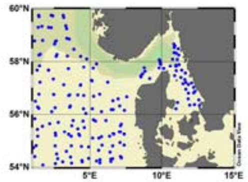
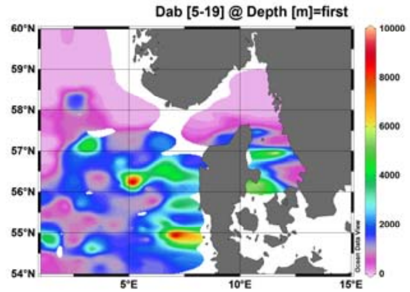


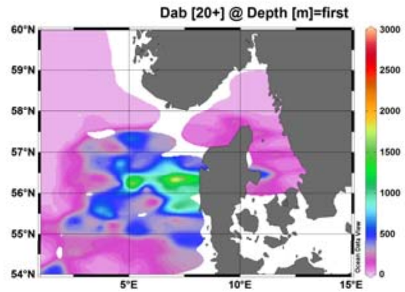




2003 Q1







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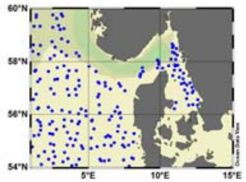

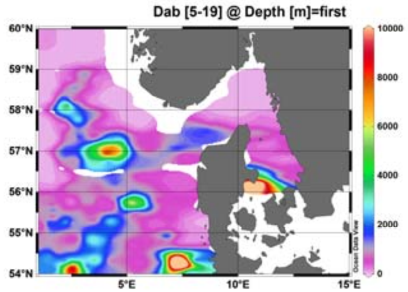

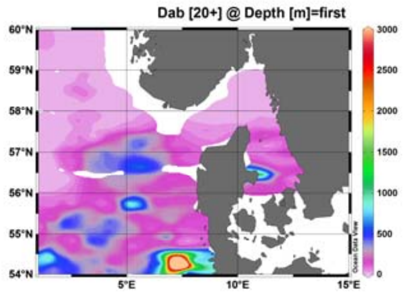

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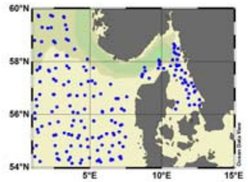

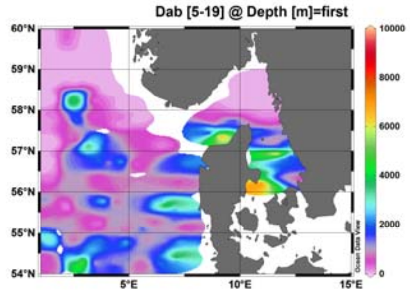

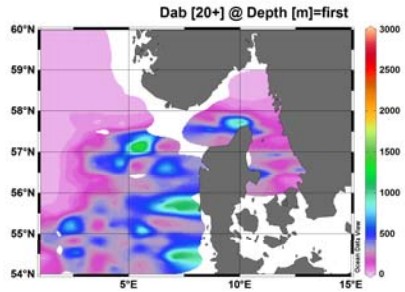

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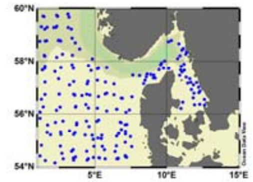
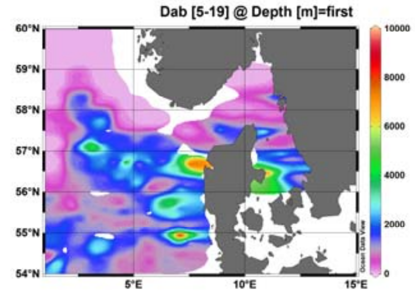
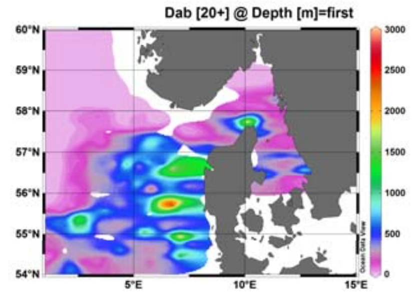
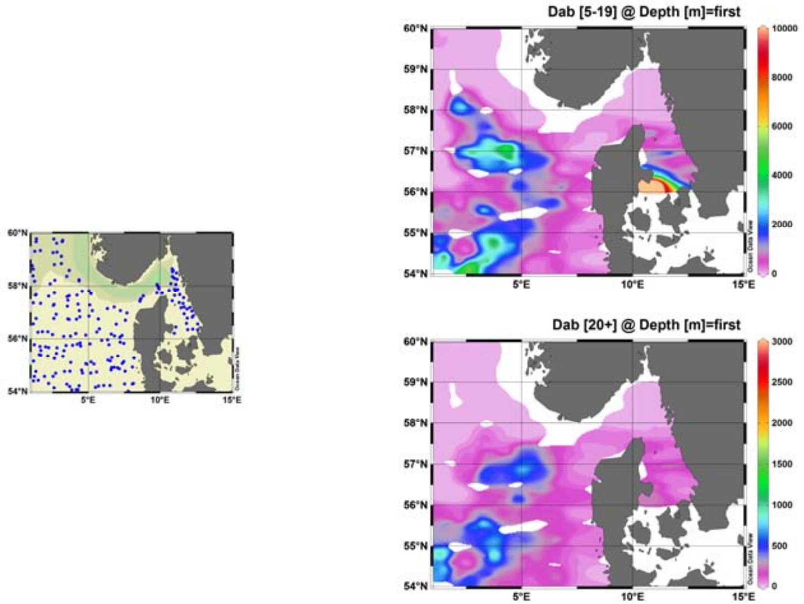


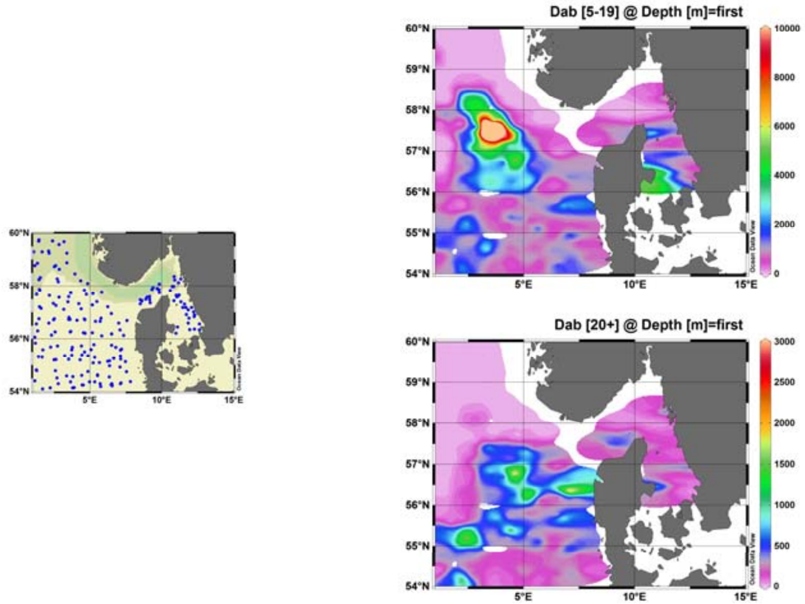




2005, Q3



2006 Q1



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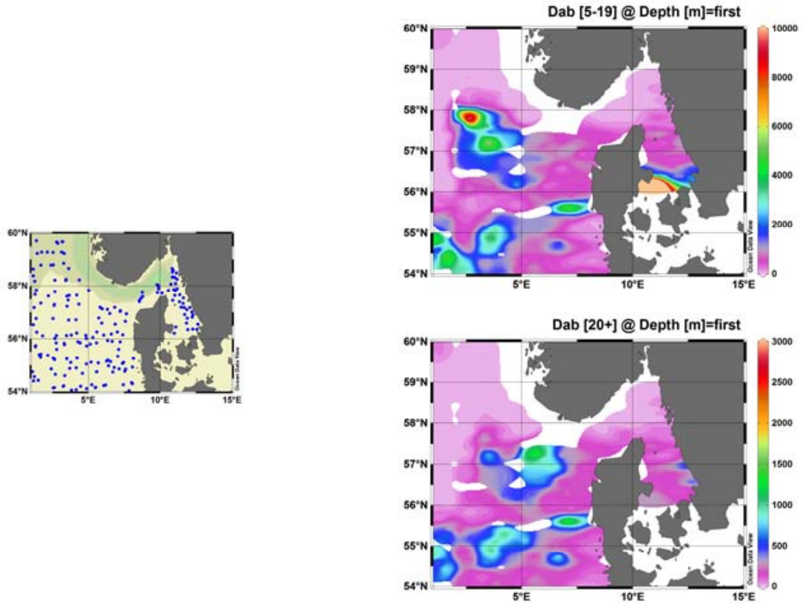
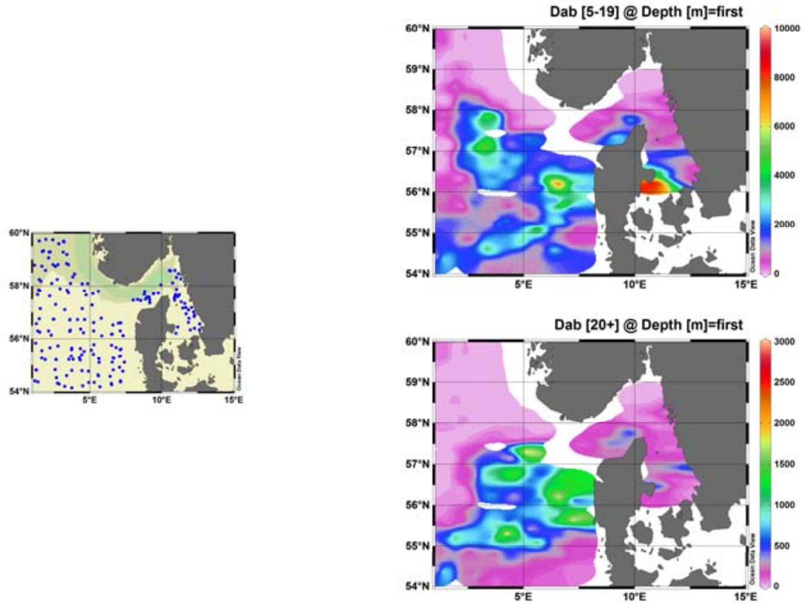


2007 Q1



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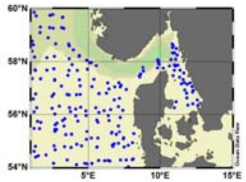

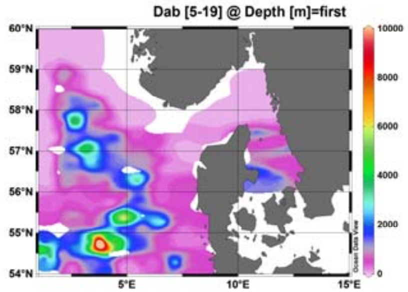

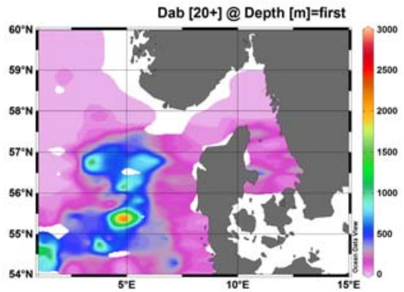

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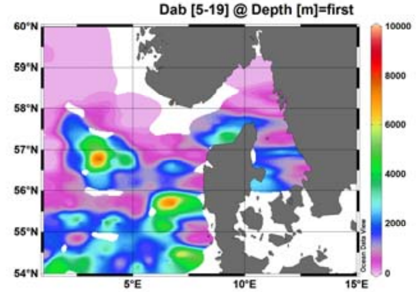

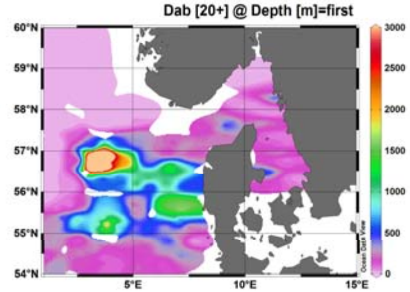

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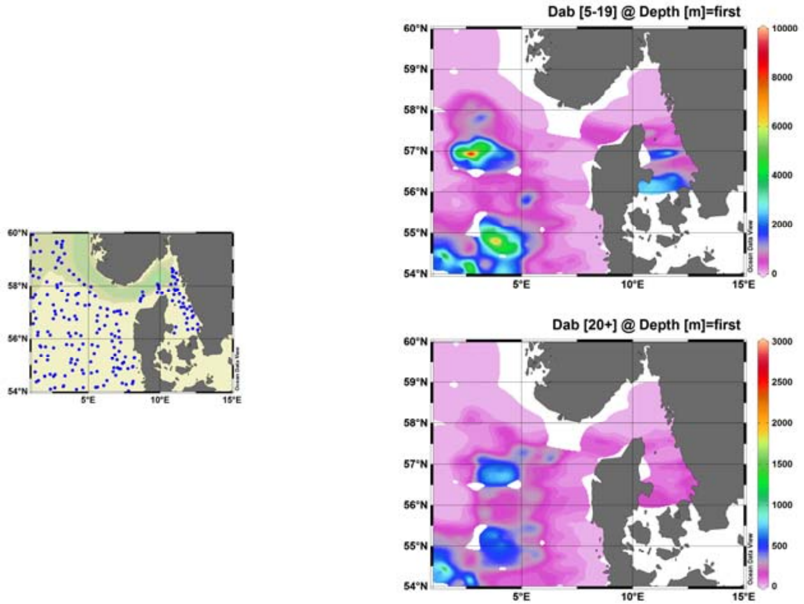

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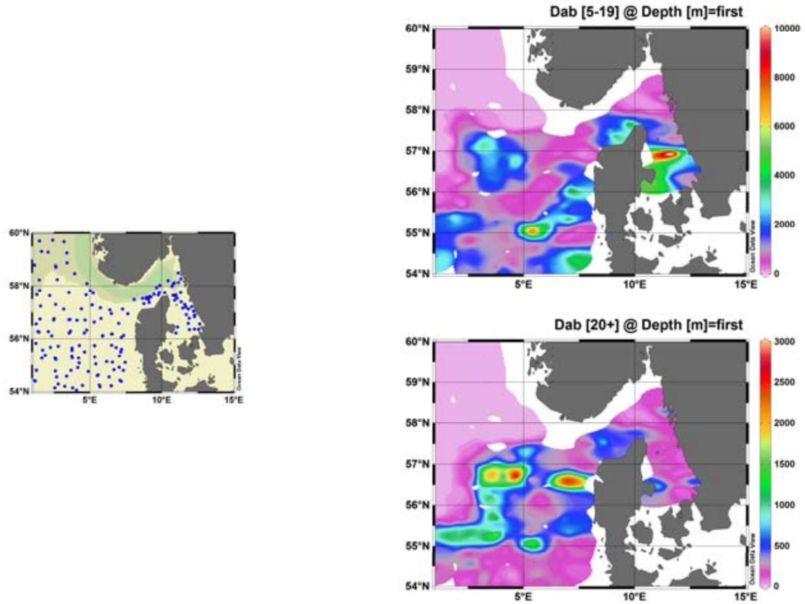
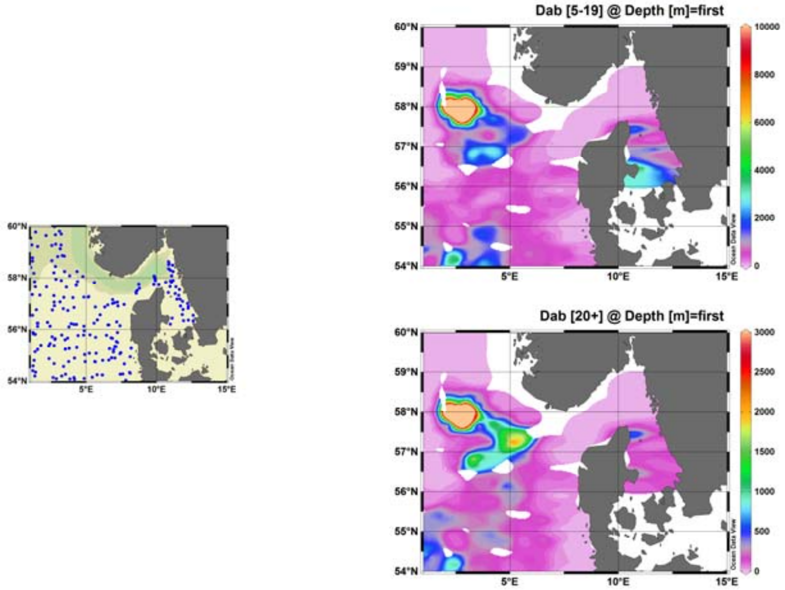


2009, Q3



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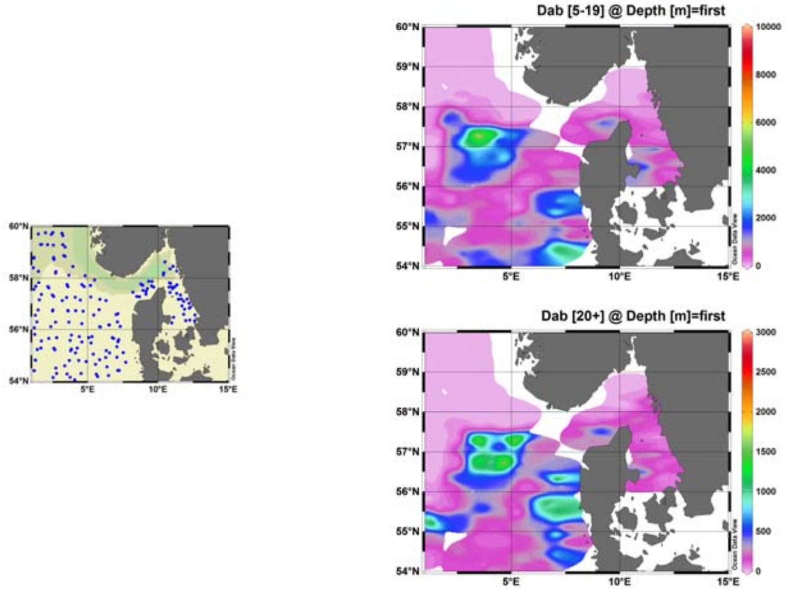

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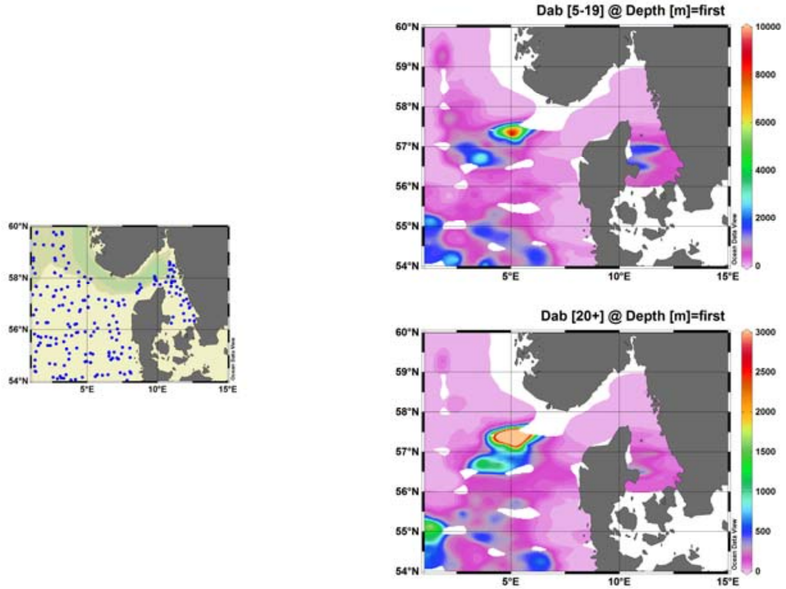
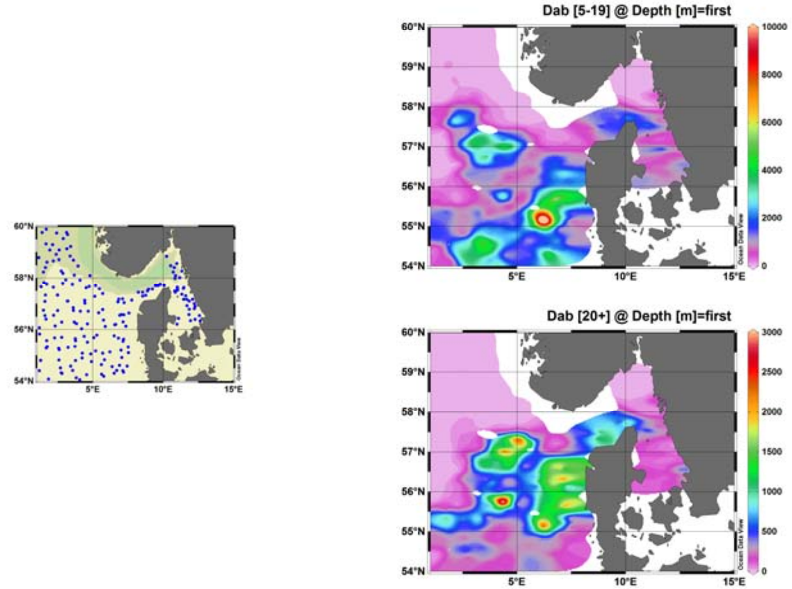
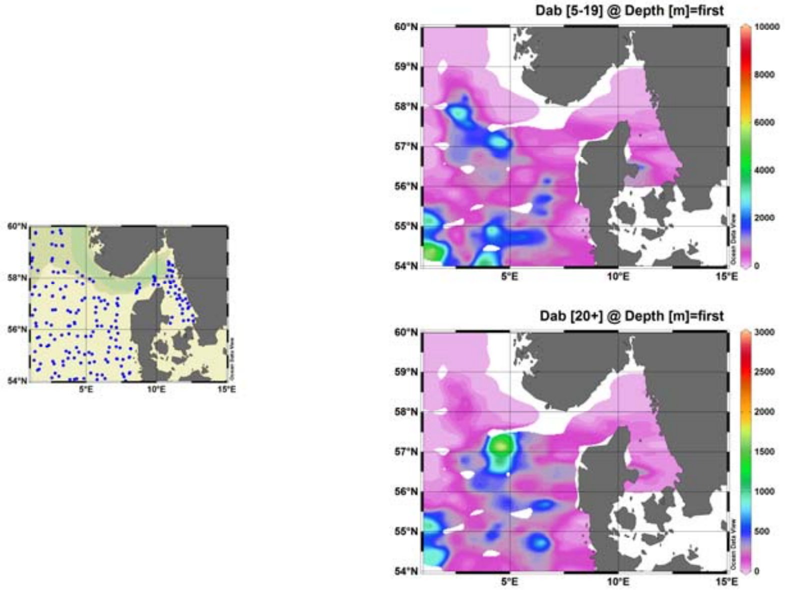


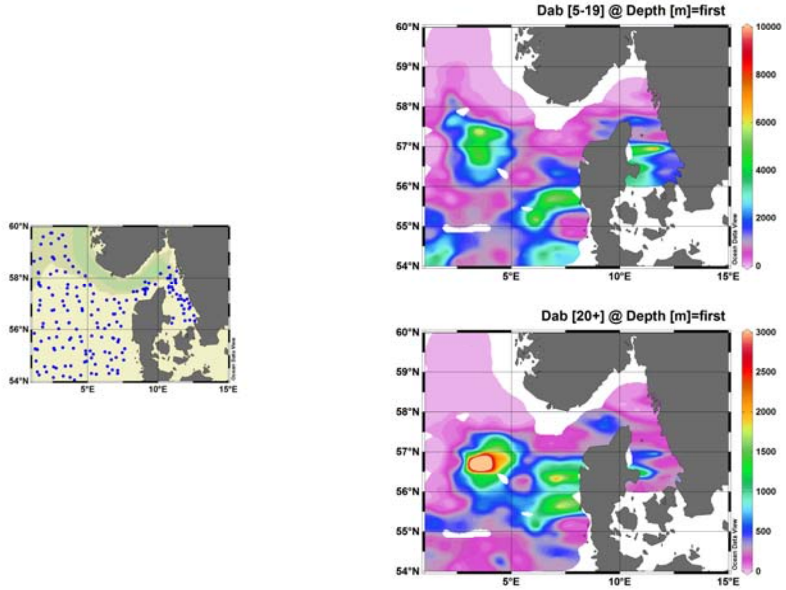
2011 Q1



2011, Q3



2012 Q1



2012, Q3

Figure 4: Position of fishing stations (left panel) and spatial distribution of dab < 20 cm (right upper panel) and dab > 19 cm (right lower panel) by year and quarter of IBTS between 2001 and 2013

Data of commercial dab fishery in the Baltic Sea between 2000 and 2012

by

Rainer Oeberst

Thünen Institute of
Baltic Sea Fisheries (TI-OF)
Germany

Introduction

WGBFAS agreed that the estimation of the Baltic stocks of flounder and dab should be improved from the level of data-limited stock to analytical assessment. This method requires detailed information concerning the commercial fishery. Landings were only reported until 2013, but first estimates of discards showed that the amount of discards had the same level of landings in some cases. Analyses have shown that the survival rate of discarded dab is close to zero (Mieske & Oeberst, 2014). Therefore, it was agreed that total catch (landings and discards) must be taken into account in the assessment (WKBALFLAT, November 2013). Therefore, data call concerning all available data were provided by the chairs of the data compilation workshop of WKBALFLAT at 11 October 2013.

The paper describes the (i) data which were provided by Denmark Germany and Sweden related to the commercial fishery of dab, (ii) the rules used to estimate missing data and (iii) the assignment allocation of catch without length and age based information to available age distributions.

Material and Methods

Landings and discards were reported by country, for units which are characterized by year, SD, fishery (active and passive) and catch type (discards and landings) between 2000 and 2012. However, data were not available for all units. In some cases landings were reported but discards were not available and vice versa although data of other years clear suggested that landings or discards occurred. In addition, age distribution and weight at age of discards and landings have been reported since 2008 for some units. In other cases length frequencies of landings and / or discards were reported, but catch without additional information also occurred. Landings and discards were seldom and only with very low amount reported for SD 25 to SD 28.

Following rules were used to solve the open problems:

Landings and discards of SD 25 to SD 28 were added to SD 24.
Not reported discards and landings were estimated based on the reported landings or discards and the relation between landings and discards of the different years in the same country, the same SD, and the same fishery if the data clearly suggested that the estimated data are probable.
Length frequencies of discards and landings significantly differed due to the landings size of 25 cm. Figure 1 illustrates the problem based on landings and discards by Denmark in SD 22 ion quarter 2 of 2000. Separate transfer of the length frequencies of landings and discards are uncertain due to the truncated length frequency close to the minimum landing size. Therefore, it was agreed during the Data Compilation workshop of WKBALFALT in November 2013 that only the combination of the length frequencies of landings and discards together of a unit are used for slicing. The length frequencies were sliced with two methods. Length frequencies of active and passive fishery were separately analyzed due to the different frequencies.

Total catch of a unit was transferred into catch in number by age group (CANUM) according following priority:

- Provided catch in number per age group was used if age based data were submitted
- Length frequencies of landings and discards of units were transferred into CANUM if the length frequencies of landings and discards were reported
- Length or age frequencies of other units were used if only catch data were available or only length frequencies of landings or discards.

Results

Denmark

Landings and discards in tons provided by Denmark are given Tables 1 – 7 by ICES subdivision. Catches are given by year, quarter, fishery and catch type. Table 1 as example illustrates the missing data of discards in the passive fishery between 2004 and 2009 and 2012. The data of the other years clearly show that discards probably occurred, but, data was not reported. The not reported discards in tons were estimates based on the mean relation between landings and discards of the years where both data were available in the same quarter. The same procedure was used in all SD and for all countries. Tables 4 to 7 show that discards and landings in SD 25 to SD 28 were low and occurred only in some years and quarters. Therefore, all landings and discards of SD 25 to SD 28 were added to the corresponding data of SD 24. The results of the applied procedures are presented in Tables 8 – 10. Tables 8 and 9 shows the landings and discards based in Table 1 and the estimates for empty units. Table 10 shows the landings and discards of SD 24 – 28. The data of Table 8 to 10 were used in the assessment.

Landings and discards of Germany are given in Table 11 to 15. Table 11 to 13 present the reported data in SD 22, 24 and 25 and Table 12 and 13 gives the data used in the assessment based on the same procedure as applied for Denmark.

Swedish landings and discards are given in Table 16 to 222. Table 16 – 20 document the reported data and Table 21 and 22 presents the data used in the assessment for SD 23 and SD 24 – 28.

The availability of age and length based data to transfer catch in tons into catch in number per age group are documented in Figure 2 – 8. Figure 2 described the availability of information for SD 22 provided by Denmark by year, quarter, fishery and catch type. Different notations are used to qualify the available data. Zero indicates that landings or discards were not reported. In many cases the corresponding data were estimates (see above). Nine marks units where catch in tons were reported, but, length or age based information were not available. One characterizes units were length distributions were reported. Two given for landings indicate that length frequencies of landings and discards were reported by year, quarter and fishery. Additionally 1 is added for discards. These length frequencies were transferred into age frequencies by slicing. Three informs that catch in number per age group was reported. The different tables show the availability of length and age based data by country and SD. The overview shoed that age based data were only available for some units from 2008 onwards. Sweden only provided length based information. In addition, length frequencies of landings and discards were not available in many cases. Therefore, available age frequencies of landings and discards based on age data or sliced length frequencies must be extrapolated to other years, countries of quarters.

This procedure is risky if the provided data were already extrapolated based on one sample. Equal mean weight per age group for different SD and quarter of the same year were observed for:

Denmark, Q1 to Q4 in SD 24 in 2010 of discards of active fishery

Denmark, Q1 to Q4 in SD 22, 23 and 24 in 2011 of discards of active fishery
Denmark, Q1 to Q4 in SD 22, 23 and 24 on 2012 of discards of active fishery
Denmark, Q1 to Q4 in SD 22, 23 and 24 on 2010 of discards of passive fishery
Denmark, Q1 to Q4 in SD 22, 23 and 24 on 2011 of discards of passive fishery

Reported catch and the catch calculated based on mean weight and age frequency by unit (country, SD, quarter and fishery in SD 22 – 24) were compared to assess the quality of the used procedures (Fig. 9). The R^2 values of the linear regressions were always 0.99, but, the slopes varied between 0.75 and 1.11 between 2000 and 2009 and between 0.99 and 1.01 between 2010 and 2012. The reasons for the partly large deviations from the expected value of 1 are the application of the length-weight relationships because weight data were not available and use of length frequencies from other units if age or length data were not available.

References

Mieske, B., Oeberst, R. 2014. Survival rate cod and flatfish captured by different gear types. Working document WKFLABALT 27 – 31 January 2014, 8 pp.

TABLES

Table 1: Landings and discards in tons of Denmark in SD 22 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	192.403	157.129	42.643	1.349	42.44	16.28	75.088	0.428	57.33	19.641	27.745	0.669	138.763	21.074	38.92	0.543
2001	236.052	193.816	47.572	0.589	41.694	25.882	62.898	0.197	44.961	27.437	25.821	0.253	101.714	67.723	29.615	0.304
2002	144.869	123.98	37.205	3.352	31.53	11.486	64.706	1.012	45.969	14.964	29.207	1.44	108.679	23.094	30.771	1.291
2003	197.984	227.653	45.901	12.766	19.989	12.35	40.532	3.209	39.665	32.86	32.547	5.732	148.515	56.781	34.992	4.964
2004	450.627	553.786	73.387		58.918	35.422	71.254		52.597	34.749	29.808		185.44	75.593	32.58	
2005	287.177	430.469	73.934		64.475	66.704	103.236		68.766	98.046	26.646		101.04	76.596	24.142	
2006	225.817	165.993	49.684		29.805	8.738	70.437		34.653	15.506	21.949		94.912	15.431	16.171	
2007	404.313	143.738	64.546		44.551	15.541	91.844		51.286	14.992	29.635		165.357	28.026	19.587	
2008	425.597	292.833	48.352		27.491	21.434	68.723		34.808	18.764	35.497		105.741	57.09	21.475	
2009	263.661	121.593	53.428		21.441	7.215	65.267		14.768	7.786	27.096		59.355	27.66	22.911	
2010	218.697	64.770	43.328	46.949	32.422	5.565	64.613	20.706	24.812	8.704	28.933	20.439	66.87	24.892	18.97	19.145
2011	277.777	297.07	40.769	39.087	71.53	22.644	69.925	18.882	30.397	19.063	21.241	15.966	38.519	36.154	15.768	20.664
2012	228.896	170.077	38.422		24.478	9.142	42.369		33.949	29.132	11.966		117.86	56.717	17.336	

Table 2: Landings and discards in tons of Denmark in SD 23 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	2.997	21.732	4.371	0.723	0.17	0.234	4.644	0.094	1.368	0.263	5.179	0.28	0.992	0.711	2.974	0.525
2001	11.601	42.782	10.54	0.295	0.634	1.639	9.991	0.084	0.462	0.899	4.32	0.153	0.704	2.811	3.552	0.31
2002	6.36	28.419	4.81	1.467	0.16	0.074	3.285	0.147	0.357	0.208	2.317	0.55	0.513	0.991	2.379	1.273
2003	5.358	46.069	3.627	4.217	0.227	1.711	2.627	0.874	0.164	0.714	3.468	3.169	0.247	2.012	3.596	6.567
2004	10.714	131.158	6.41		0.286	2.652	6.731		0.075	0.584	2.796		0.669	1.48	6.065	
2005	6.419	88.471	7.878		0.226	5.139	9.19		0.299	12.694	4.633		0.661	11.144	4.49	
2006	4.692	13.609	13.15		0.026	0.555	9.432		0.359	6.729	4.062		0.387	4.079	3.983	
2007	7.829	33.274	10.545		0.526	5.966	10.431		0.173	4.395	5.88		0.222	2.162	4.33	
2008	7.43	181.366	8.626		0.263	5.532	7.985		0.065	5.056	4.133		1.024	4.071	6.003	
2009	0.914	3.117	8.823		0.015	0.014	7.446				2.904		0.417	1.544	4.647	
2010	0.101	1.1	6.738	12.804	0.011		5.821	7.015		0.001	2.926	12.557	0.119	0.228	3.275	16.753
2011	0.208	1.585	4.01	11.641	0.018	1.613	10.541	4.804	0.035	0.066	2.765	11.317	0.098	0.726	3.225	14.91
2012	0.158	0.715	7.119		0.005	0.007	7.895		0.011	0.004	4.483		0.032	0.158	3.557	

Table 3: Landings and discards in tons of Denmark in SD 24 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	13.244	74.047	0.161	0.912	0.647	16.318	0.038	0.34	6.013	23.084	0.062	0.361	22.625	54.654	0.397	0.468
2001	11.568	195.226	0.942	0.58	0.704	39.121	0.129	0.158	10.125	25.733	1.781	0.105	47.483	164.971	3.044	0.207
2002	12.545	67.627	0.338	2.037	0.316	10.105	0.025	0.816	3.022	11.493	0.066	0.567	24.964	34.944	0.469	0.643
2003	14.32	214.101	0.664	8.187	1.126	25.507	0.05	3.427	13.023	54.545	0.115	1.917	135.92	224.286	2.794	2.533
2004	80.175	306.464	9.484		1.569	74.244	0.18		9.356	27.007	0.61		81.664	139.852	1.167	
2005	21.035	231.161	1.436		8.057	384.411	0.855		32.058	179.838	0.123		99.868	162.959	1.342	
2006	35.542	43.484	2.715		4	21.129	0.08		23.041	38.641	0.074		87.229	68.809	0.291	
2007	24.976	97.118	0.908		2.716	26.076	0.063		6.322	33.662	0.032		60.733	74.384	0.389	
2008	22.857	440.221	1.469		1.003	58.311	0.058		10.432	103.197	0.087		39.651	226.707	0.438	
2009	36.555	155.878	3.205		3.051	50.981	0.302		5.576	68.014	0.278		40.935	126.025	0.18	
2010	28.961	91.436	2.517	8.524	2.879	28.568	0.64	15.828	3.283	28.778	0.163	16.111	14.647	57.611	0.81	8.931
2011	16.858	375.577	2.434	6.442	2.883	38.409	0.325	9.141	4.406	46.752	0.079	9.545	12.75	125.959	0.616	7.724
2012	40.481	263.148	2.54		0.866	122.64	0.613		3.761	83.94	0.075		25.128	98.341	0.896	

Table 4: Landings and discards in tons of Denmark in SD 25 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.101		0.089				0.011		0.002		0.062		0.039		0.308	
2001	0.087	0.084	0.034		0.012	0.054	0.002		0.042	0.012			0.103	0.015	0.005	
2002	0.073	0.021	0.063			0.004			0.001	0.001	0.004		0.003	0.005	0.055	
2003	1.521	0.049	0.175		0.036	0.013	0.022		0.26	0.014	0.246		0.731	0.019	0.628	
2004	0.308		0.018		0.12		0.026		0.009				0.091		0.004	
2005	1.082	0.016			1.099	0.006				0.001	0.003		8.045	0.006	0.02	
2006	14.904				0.96				0.093				0.046		0.043	
2007	6.275	0.004			0.156	0.003			0.004				0.072	0.001	0.033	
2008	0.1				0.112				0.036		0.005		0.06			
2009	0.033	0.007	0.005		0.03	0.003			0.13	0.001				0.002		
2010	0.338				0.06		0.001		0.011							
2011	0.043				0.033				0.021				0.025			
2012	0.005		0.001													

Table 5: Landings and discards in tons of Denmark in SD 26 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.173															
2001														0.001		
2002	0.015	0.001			0.008											
2003									0.002				0.013	0.002		
2004													0.002			
2005	0.029															
2006	0.241		0.032		0.001											
2007																
2008																
2009														0.001		
2010																
2011																
2012									0.006							

Table 6: Landings and discards in tons of Denmark in SD 27 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000																
2001																
2002																
2003													0.011			
2004																
2005																
2006																
2007																
2008																
2009																
2010																
2011																
2012																

Table 7: Landings and discards in tons of Denmark in SD 28 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.147															
2001													0.095			
2002																
2003																
2004																
2005																
2006																
2007																
2008																
2009																
2010																
2011																
2012																

Table 8: Landings and discards in tons of Denmark in SD 22 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	192.403	157.129	42.643	1.349	42.44	16.28	75.088	0.428	57.33	19.641	27.745	0.669	138.763	21.074	38.92	0.543
2001	236.052	193.816	47.572	0.589	41.694	25.882	62.898	0.197	44.961	27.437	25.821	0.253	101.714	67.723	29.615	0.304
2002	144.869	123.98	37.205	3.352	31.53	11.486	64.706	1.012	45.969	14.964	29.207	1.44	108.679	23.094	30.771	1.291
2003	197.984	227.653	45.901	12.766	19.989	12.35	40.532	3.209	39.665	32.86	32.547	5.732	148.515	56.781	34.992	4.964
2004	450.627	553.786	73.387	30.022	58.918	35.422	71.254	8.243	52.597	34.749	29.808	8.532	185.44	75.593	32.58	13.726
2005	287.177	430.469	73.934	30.246	64.475	66.704	103.236	11.943	68.766	98.046	26.646	7.627	101.04	76.596	24.142	10.171
2006	225.817	165.993	49.684	20.325	29.805	8.738	70.437	8.149	34.653	15.506	21.949	6.283	94.912	15.431	16.171	6.813
2007	404.313	143.738	64.546	26.405	44.551	15.541	91.844	10.625	51.286	14.992	29.635	8.483	165.357	28.026	19.587	8.252
2008	425.597	292.833	48.352	19.78	27.491	21.434	68.723	7.951	34.808	18.764	35.497	10.161	105.741	57.09	21.475	9.047
2009	263.661	121.593	53.428	21.857	21.441	7.215	65.267	7.551	14.768	7.786	27.096	7.756	59.355	27.66	22.911	9.652
2010	218.697	64.77	43.328	46.949	32.422	5.565	64.613	20.706	24.812	8.704	28.933	20.439	66.87	24.892	18.97	19.145
2011	277.777	297.07	40.769	39.087	71.53	22.644	69.925	18.882	30.397	19.063	21.241	15.966	38.519	36.154	15.768	20.664
2012	228.896	170.077	38.422	15.718	24.478	9.142	42.369	4.902	33.949	29.132	11.966	3.425	117.86	56.717	17.336	7.304

Table 9: Landings and discards in tons of Denmark in SD 23 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	2.997	21.732	4.371	0.723	0.17	0.234	4.644	0.094	1.368	0.263	5.179	0.28	0.992	0.711	2.974	0.525
2001	11.601	42.782	10.54	0.295	0.634	1.639	9.991	0.084	0.462	0.899	4.32	0.153	0.704	2.811	3.552	0.31
2002	6.36	28.419	4.81	1.467	0.16	0.074	3.285	0.147	0.357	0.208	2.317	0.55	0.513	0.991	2.379	1.273
2003	5.358	46.069	3.627	4.217	0.227	1.711	2.627	0.874	0.164	0.714	3.468	3.169	0.247	2.012	3.596	6.567
2004	10.714	131.158	6.41	6.906	0.286	2.652	6.731	2.319	0.075	0.584	2.796	4.485	0.669	1.48	6.065	12.498
2005	6.419	88.471	7.878	8.488	0.226	5.139	9.19	3.166	0.299	12.694	4.633	7.432	0.661	11.144	4.49	9.252
2006	4.692	13.609	13.15	14.168	0.026	0.555	9.432	3.249	0.359	6.729	4.062	6.516	0.387	4.079	3.983	8.207
2007	7.829	33.274	10.545	11.361	0.526	5.966	10.431	3.593	0.173	4.395	5.88	9.433	0.222	2.162	4.33	8.923
2008	7.43	181.366	8.626	9.294	0.263	5.532	7.985	2.751	0.065	5.056	4.133	6.63	1.024	4.071	6.003	12.37
2009	0.914	3.117	8.823	9.506	0.015	0.014	7.446	2.565			2.904	4.659	0.417	1.544	4.647	9.576
2010	0.101	1.1	6.738	12.804	0.011	0.121	5.821	7.015		0.001	2.926	12.557	0.119	0.228	3.275	16.753
2011	0.208	1.585	4.01	11.641	0.018	1.613	10.541	4.804	0.035	0.066	2.765	11.317	0.098	0.726	3.225	14.91
2012	0.158	0.715	7.119	7.67	0.005	0.007	7.895	2.72	0.011	0.004	4.483	7.192	0.032	0.158	3.557	7.33

Table 10: Landings and discards in tons of Denmark in SD 24 - 28 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	13.665	74.047	0.25	0.912	0.647	16.318	0.049	0.34	6.015	23.084	0.124	0.361	22.664	54.654	0.705	0.468
2001	11.655	195.31	0.976	0.58	0.716	39.175	0.131	0.158	10.167	25.745	1.781	0.105	47.681	164.987	3.049	0.207
2002	12.633	67.649	0.401	2.037	0.324	10.109	0.025	0.816	3.023	11.494	0.07	0.567	24.967	34.949	0.524	0.643
2003	15.841	214.15	0.839	8.187	1.162	25.52	0.072	3.427	13.285	54.559	0.361	1.917	136.675	224.307	3.422	2.533
2004	80.483	306.464	9.502	48.479	1.689	74.244	0.206	4.926	9.365	27.007	0.61	25.499	81.757	139.852	1.171	5.269
2005	22.146	231.177	1.436	7.34	9.156	384.417	0.855	23.4	32.058	179.839	0.126	5.142	107.913	162.965	1.362	6.059
2006	50.687	43.484	2.747	13.878	4.961	21.129	0.08	2.189	23.134	38.641	0.074	3.093	87.275	68.809	0.334	1.314
2007	31.251	97.122	0.908	4.641	2.872	26.079	0.063	1.724	6.326	33.662	0.032	1.338	60.805	74.385	0.422	1.756
2008	22.957	440.221	1.469	7.509	1.115	58.311	0.058	1.587	10.468	103.197	0.092	3.637	39.711	226.707	0.438	1.978
2009	36.588	155.885	3.21	16.383	3.081	50.984	0.302	8.265	5.706	68.015	0.278	11.621	40.935	126.028	0.18	0.813
2010	29.299	91.436	2.517	8.524	2.939	28.568	0.641	15.828	3.294	28.778	0.163	16.111	14.647	57.611	0.81	8.931
2011	16.901	375.577	2.434	6.442	2.916	38.409	0.325	9.141	4.427	46.752	0.079	9.545	12.775	125.959	0.616	7.724
2012	40.486	263.148	2.541	12.984	0.866	122.64	0.613	16.777	3.767	83.94	0.075	3.135	25.128	98.341	0.896	4.045

Table 11: Landings and discards in tons of Germany in SD 22 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	66.924		4.657		20.736		9.56		4.506		2.412		82.412		2.764	
2001	172.187		18.507		8.406		19.567		8.583		39.954		65.433		29.876	
2002	41		10.7		11		14.3		5.4		3.1		82.1		5	
2003	41.097		13.661		4.928		11.275		25.226		2.661		343.756		7.639	
2004	293.19		30.764		34.771		19.486		15.665		4.978		252.84		27.19	
2005	173.279				38.288				6.257				89.93			
2006	134.739	108			163.385				18.184				166.024			
2007	184.407				149.407				9.789	1			189.183	15		
2008	160.105		39.477	11	13.697		34.688		2.522		7.019	4	184.576	191	17.974	5
2009	133.957	36	50.626		6.76		28.481		9.959		13.277		248.621		40.578	
2010	124.924	24	49.356	1.22	17.729		21.223	0.3	2.946	0.022	5.099	0.08	129.249	43	11.472	1.22
2011	267.531	176.2	41.856		10.016		19.898		3.608		4.908	1.1	226.901	133	13.008	13
2012	241.43	76	51.977	18	30.612		17.456	8	10.99		7.508	4	262.248	34	18.371	1

Table 12: Landings and discards in tons of Germany in SD 24 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.271		0.133		0.286				0.502				1.348			
2001	282.48		21.572		84.383		27.092		467.806		70.237		427.24		86.746	
2002	0.03		0.3		0.6		0.6		0.1		0.4		2.9		0.3	
2003	0.241		0.208		0.02		0.193		0.03		0.325		5.305		0.31	
2004	1.531		0.687		0.216		0.568		0.279		0.43		5.408		0.403	
2005	0.328				0.13				2.704	0.53			32.593	6.8		
2006	1.419	0.47							0.886	0.6			15.192	2.3		
2007	1.913				0.084				1.512				10.609	5		
2008	0.184	0.05	1.247		0.053		0.795		3.417	0.667	0.368		18.527	8	5.258	
2009	1.379		2.831		0.008		1.873		0.642	0.58	0.377		18.869	2.67	3.15	

2010	1.359		3.056		0.726	0.104	1.648		0.255	0.61	0.836		5.124	0.344	3.461	
2011	0.274		5.307		0.77	5.2	2.524		0.318	0.16	0.502		0.293	0.301	1.559	
2012	1.58		3.357		1.196		2.93		0.809		0.757		0.703		1.384	

Table 13: Landings and discards in tons of Germany in SD 25 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000					0.155				0.011							
2001	246.12				48.809				2.895				0.802			
2002																
2003	0.015												0.042			
2004																
2005																
2006																
2007																
2008																
2009																
2010	0.188												1.45			
2011																
2012					0.051											

Table 14: Landings and discards in tons of Germany in SD 22 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	66.924	29.926	4.657	1.009	20.736	9.272	9.56	2.258	4.506	0.247	2.412	0.81	82.412	35.645	2.764	0.994
2001	172.187	76.996	18.507	4.008	8.406	3.759	19.567	4.622	8.583	0.47	39.954	13.409	65.433	28.301	29.876	10.743
2002	41	18.334	10.7	2.317	11	4.919	14.3	3.378	5.4	0.296	3.1	1.04	82.1	35.51	5	1.798
2003	41.097	18.377	13.661	2.958	4.928	2.204	11.275	2.663	25.226	1.383	2.661	0.893	343.756	148.681	7.639	2.747
2004	293.19	131.104	30.764	6.662	34.771	15.548	19.486	4.603	15.665	0.859	4.978	1.671	252.84	109.358	27.19	9.777
2005	173.279	77.484			38.288	17.121			6.257	0.343			89.93	38.896		
2006	134.739	108			163.385	73.06			18.184	0.997			166.024	71.808		

2007	184.407	82.46			149.407	66.809			9.789	1			189.183	15		
2008	160.105	71.593	39.477	11	13.697	6.125	34.688	8.194	2.522	0.138	7.019	4	184.576	191	17.974	5
2009	133.957	36	50.626	10.963	6.76	3.023	28.481	6.728	9.959	0.546	13.277	4.456	248.621	107.533	40.578	14.591
2010	124.924	24	49.356	1.22	17.729	7.928	21.223	0.3	2.946	0.022	5.099	0.08	129.249	43	11.472	1.22
2011	267.531	176.2	41.856	9.064	10.016	4.479	19.898	4.7	3.608	0.198	4.908	1.1	226.901	133	13.008	13
2012	241.43	76	51.977	18	30.612	13.689	17.456	8	10.99	0.602	7.508	4	262.248	34	18.371	1

Table 15: Landings and discards in tons of Germany in SD 24 - 28 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.271	0.082	0.133	0.029	0.441	0.986	0	0	0.513	0.407	0	0	1.348	0.481	0	0
2001	528.6	85.162	21.572	4.672	133.192	290.974	27.092	6.4	470.701	379.479	70.237	23.573	428.042	152.529	86.746	31.193
2002	0.03	0.009	0.3	0.065	0.6	2.069	0.6	0.142	0.1	0.081	0.4	0.134	2.9	1.035	0.3	0.108
2003	0.256	0.073	0.208	0.045	0.02	0.069	0.193	0.046	0.03	0.024	0.325	0.109	5.347	1.894	0.31	0.111
2004	1.531	0.462	0.687	0.149	0.216	0.745	0.568	0.134	0.279	0.226	0.43	0.144	5.408	1.931	0.403	0.145
2005	0.328	0.099	0	0	0.13	0.448	0	0	2.704	0.53	0	0	32.593	6.8	0	0
2006	1.419	0.47	0	0	0	0	0	0	0.886	0.6	0	0	15.192	2.3	0	0
2007	1.913	0.577	0	0	0.084	0.29	0	0	1.512	1.227	0	0	10.609	5	0	0
2008	0.184	0.05	1.247	0.27	0.053	0.183	0.795	0.188	3.417	0.667	0.368	0.124	18.527	8	5.258	1.891
2009	1.379	0.416	2.831	0.613	0.008	0.028	1.873	0.442	0.642	0.58	0.377	0.127	18.869	2.67	3.15	1.133
2010	1.547	0.41	3.056	0.662	0.726	0.104	1.648	0.389	0.255	0.61	0.836	0.281	6.574	0.344	3.461	1.245
2011	0.274	0.083	5.307	1.149	0.77	5.2	2.524	0.596	0.318	0.16	0.502	0.168	0.293	0.301	1.559	0.561
2012	1.58	0.476	3.357	0.727	1.247	4.124	2.93	0.692	0.809	0.656	0.757	0.254	0.703	0.251	1.384	0.498

Table 16: Landings and discards in tons of Sweden in SD 23 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000			0.591				0.438				0.394		0.035		0.789	
2001	0.1		0.673				0.891				1.05				0.795	
2002			1.996				0.965				0.365	7.541			0.566	8.194
2003	0.035		0.32								0.066	0.43			0.23	0.202
2004	0.039		0.0	4.208			0.441				0.007					0.685
2005			0.621	14.55			0.617				0.006	0.598			0.014	6.059

2006	0.005		0.47				0.358				0.118	24.974			0.222	
2007	0.169		0.378				0.167				0.373				0.12	
2008	0.097		0.705	0.197			1.12				0.442	1.367			0.693	2.045
2009			1.481				0.238								0.161	1.369
2010			0.617	1.793			0.19	2.531			0.127	1.448			0.043	0.498
2011			0.018	0.958			0.131	3.546			0.408	5.389			0.137	2.101
2012			0.24	5.345			0.146	2.114			0.108	1.797			0.01	0.479

Table 17: Landings and discards in tons of Sweden in SD 24 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.008												0.13			
2001	1.37				0.15				0.034				0.075			
2002			0.03	0.224				2.133		0.348						
2003				0.145				0.788	0.097		0.0	0.691	0.046		0.007	
2004	0.118		0.068	0.714	0.037		0.029	1.103	0.154	0.22	0.0	0.39	0.176		0.009	
2005	0.142		0.033		0.137		0.082	0.02	0.126		0.0	0.06	0.559		0.014	0.37
2006	0.736		0.001		0.07	0.015			0.555	0.502	0.0		0.278			
2007	0.352		0.004		0.035				0.526				0.023			
2008	0.099				0.031				0.15	1.157			0.014		0.016	
2009	0.245		0.088	0.441	0.006			0.304	0.138	6.507	0.0	0.526	0.003			0.027
2010	0.004		0.012	0.213	0.005		0.026	0.395	0.126	2.25		0.019				0.007
2011	0.011	1.483		0.045	0.006		0.007	0.233	0.027	0.437		0.142	0.085		0.003	0.07
2012		5.114	0.007	0.454			0.008	0.125	0.316	7.696	0.0	0.295				0.041

Table 18: Landings and discards in tons of Sweden in SD 25 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000			0.003				0.004				0.023		0.685		0.01	
2001	1.3		0.019		0.83		0.017				0.005				0.004	
2002		0.057	0.002			0.007	0.003				0.002					
2003			0.024	0.099			0.003	0.026		0.037	0.001	0.068				
2004			0.141				0.029	0.344		0.155	0.009	0.114	0.005	1.021	0.006	
2005	0.025		0.013	0.597			0.002	0.058	0.013		0.002	0.069	0.012	0.936		
2006	0.007	0.015							0.027	0.033	0.021			0.179		

2007		0.549			0.002	0.057	0.008									
2008							0.005		0.002	0.039	0.36			0.326	0.07	
2009		0.04	0.004			0.017	0.01		0.003	0.195	0.053			0.457	0.125	0.083
2010		0.101	0.003				0.035	0.284			0.178			0.068	0.009	0.105
2011		0.1		0.167		0.081			0.06		0.804	0.043	0.06	0.074	0.153	0.041
2012				0.692		0.204	0.004	0.102		0.015	0.363	0.029		0.047	0.04	0.016

Table 19: Landings and discards in tons of Sweden in SD 27 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000																
2001																
2002							0.04									
2003																
2004																
2005																
2006																
2007																
2008							0.106				0.106				0.035	
2009							0.045				0.539				0.072	
2010							0.005				0.03					
2011											0.059					
2012											0.112				0.094	

Table 20: Landings and discards in tons of Sweden in SD 28 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000																
2001																
2002																
2003																
2004																
2005																
2006											0.005					
2007																

2008							0.42				1.439				0.05	
2009			0.04				0.62				1.958				0.08	
2010							0.46				1.162					
2011							0.02				0.377					
2012							0.347				0.766					

Table 21: Landings and discards in tons of Sweden in SD 23 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

uarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000			0.591				0.438				0.394		0.035		0.789	68.256
2001	0.1		0.673				0.891				1.05				0.795	68.775
2002			1.996				0.965				0.365	21.636			0.566	8.194
2003	0.035		0.32								0.066	3.912			0.23	0.202
2004	0.039		0.032	0.653			0.441				0.007					0.685
2005			0.621	12.682			0.617				0.006	0.356			0.014	6.059
2006	0.005		0.47				0.358				0.118	6.994			0.222	19.205
2007	0.169		0.378				0.167				0.373				0.12	10.381
2008	0.097		0.705	14.397			1.12				0.442	26.2			0.693	2.045
2009			1.481				0.238								0.161	1.369
2010			0.617	12.6			0.19	3.475			0.127	7.528			0.043	0.498
2011			0.018	0.368			0.131	2.396			0.408	24.184			0.137	2.101
2012			0.24	4.901			0.146	2.67			0.108	6.402			0.01	0.479

Table 22: Landings and discards in tons of Sweden in SD 24 - 28 by unit (year, quarter,fishery (**Act**ive, **Pas**sive) and catch type **L**andings and **D**iscards) with estimates of not reported landings or discards

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Cach type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0.008	0.196	0.003	0	0	0	0.004	0	0	0	0.023	0	0.815	0	0.01	0
2001	2.67	33.606	0.019	0	0.98	0	0.017	0	0.034	0.562	0.005	0	0.075	0	0.004	0
2002	0	0	0.032	0.224	0	0.007	0.043	2.133	0	0.348	0.002	0	0	0	0	0
2003	0	0	0.024	0.244	0	0	0.003	0.814	0.097	1.642	0.034	0.759	0.046	0	0.007	0
2004	0.118	2.894	0.209	0.714	0.037	0	0.058	1.447	0.154	0.375	0.027	0.504	0.181	1.021	0.015	0
2005	0.167	3.483	0.046	1.406	0.137	0	0.084	0.078	0.139	2.084	0.015	0.129	0.571	0.936	0.014	0.37

2006	0.743	18.069	0.001	0.025	0.07	0.015	0	0	0.582	0.535	0.029	0	0.278	0.179	0	0
2007	0.352	9.183	0.004	0.098	0.037	0.057	0.008	0	0.526	8.701	0	0	0.023	0	0	0
2008	0.099	2.428	0	0	0.031	0	0.531	0	0.152	1.196	1.905	0	0.014	0.326	0.171	0
2009	0.245	6.05	0.132	0.441	0.006	0.017	0.675	0.304	0.141	6.702	2.56	0.526	0.003	0.457	0.277	0.11
2010	0.004	0.199	0.015	0.213	0.005	0	0.526	0.679	0.126	2.25	1.37	0.019	0	0.068	0.009	0.112
2011	0.011	1.583	0	0.212	0.006	0.081	0.027	0.233	0.087	0.437	1.24	0.185	0.145	0.074	0.156	0.111
2012	0	5.114	0.007	1.146	0	0.204	0.359	0.227	0.316	7.711	1.255	0.324	0	0.047	0.134	0.057

FIGURES

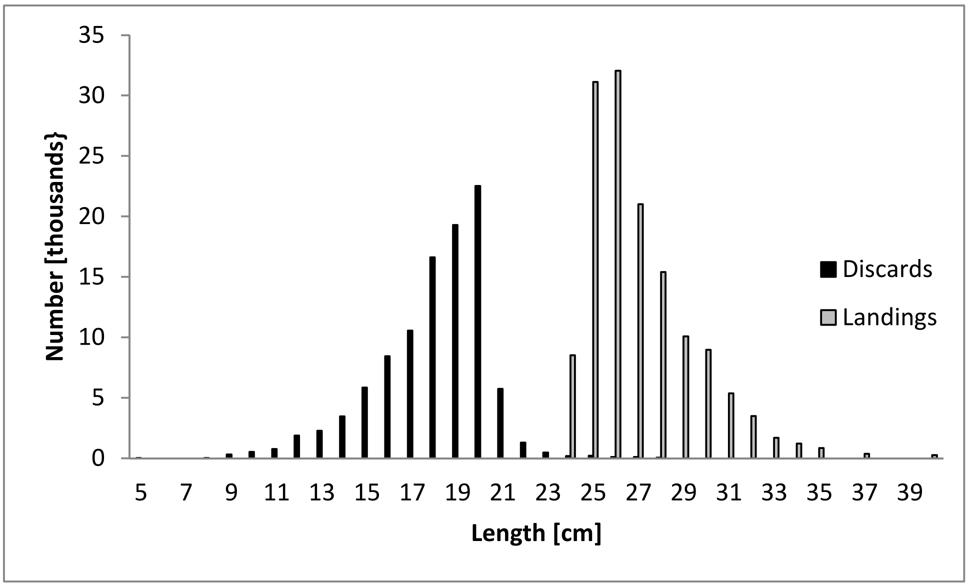


Figure 1: Discarded and landed dab in SD 22 in quarter 2 of 2000 in active fishery by Denmark

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	2	1	2	1	2	1	2	1	2	1	9	1	2	1	9	1
2001	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
2002	2	1	2	1	2	1	9	1	2	1	9	1	2	1	2	1
2003	2	1	2	1	2	1	9	1	2	1	9	1	2	1	9	1
2004	2	1	9	0	2	1	9	0	2	1	9	0	2	1	9	0
2005	2	1	9	0	9	1	9	0	2	1	9	0	2	1	9	0
2006	2	1	9	0	2	1	9	0	2	1	9	0	9	1	9	0
2007	2	1	9	0	2	1	9	0	2	1	9	0	9	1	9	0
2008	2	1	9	0	2	1	9	0	2	1	9	0	2	1	9	0
2009	2	1	1	0	2	1	1	0	2	1	1	0	2	1	1	0
2010	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2011	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2012	2	3	1	0	2	3	1	0	2	3	1	0	2	3	1	0

Figure 2: Overview of availability of age of length or length frequencies of Danish dab catch in SD 22 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	9	1	9	1	9	1	9	1	9	1	9	1	9	1	9	1
2001	2	1	9	1	9	1	9	1	9	1	9	1	9	1	9	1
2002	2	1	9	1	9	1	9	1	9	1	9	1	9	1	9	1
2003	2	1	9	1	9	1	9	1	9	1	9	1	9	1	9	1
2004	9	1	9	0	9	1	9	0	9	1	9	0	9	1	9	0
2005	9	1	9	0	2	1	9	0	9	1	9	0	9	1	9	0
2006	9	1	9	0	9	1	9	0	9	1	9	0	9	1	9	0
2007	9	1	9	0	9	1	9	0	9	1	9	0	9	1	9	0
2008	9	1	9	0	9	1	9	0	9	1	9	0	9	1	9	0
2009	9	1	9	0	9	1	9	0	0	0	9	0	9	1	9	0
2010	9	3	9	3	9	0	9	3	0	3	9	3	9	3	9	3
2011	9	3	9	3	9	3	9	3	9	3	9	3	9	3	9	3
2012	9	3	9	0	9	3	9	0	9	3	9	0	9	3	9	0

Figure 3: Overview of availability of age of length or length frequencies of Danish dab catch in SD 23 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	2	1	9	1	9	1	9	1	2	1	9	1	2	1	9	1
2001	2	1	9	1	2	1	9	1	2	1	9	1	2	1	9	1
2002	2	1	9	1	2	1	9	1	2	1	9	1	2	1	9	1
2003	2	1	9	1	2	1	9	1	9	1	9	1	2	1	9	1
2004	2	1	9	0	2	1	9	0	9	1	9	0	2	1	9	0
2005	2	1	9	0	2	1	9	0	9	1	9	0	2	1	9	0
2006	1	1	9	0	1	1	9	0	1	1	9	0	1	1	9	0
2007	1	1	9	0	1	1	9	0	9	1	9	0	9	1	9	0
2008	1	1	9	0	1	1	9	0	9	1	9	0	1	1	9	0
2009	9	1	9	0	9	1	9	0	9	1	9	0	9	1	9	0
2010	9	3	9	3	9	3	9	3	9	3	9	3	9	3	9	3
2011	9	3	9	3	9	3	9	3	9	3	9	3	9	3	2	3
2012	9	3	9	0	9	3	9	0	9	3	9	0	2	3	9	0

Figure 4: Overview of availability of age of length or length frequencies of Danish dab catch in SD 24 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2001	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2002	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2003	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2004	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2005	9	0	0	0	9	0	0	0	9	0	0	0	9	0	0	0
2006	2	1	0	0	9	0	0	0	9	0	0	0	9	0	0	0
2007	9	0	0	0	9	0	0	0	9	1	0	0	2	1	0	0
2008	3	0	3	3	9	0	9	0	9	0	9	3	3	3	9	3
2009	3	3	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2010	3	3	9	3	9	0	9	9	9	3	3	3	3	3	3	3
2011	3	3	9	0	3	0	9	0	9	0	9	3	3	3	3	3
2012	3	3	3	3	9	0	3	3	3	0	3	3	3	3	3	3

Figure 5: Overview of availability of age of length or length frequencies of German dab catch in SD 22 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	9	0	9	0	9	0	0	0	9	0	0	0	9	0	0	0
2001	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2002	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2003	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2004	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0
2005	9	0	0	0	9	0	0	0	2	1	0	0	2	1	0	0
2006	2	1	0	0	0	0	0	0	2	1	0	0	2	1	0	0
2007	9	0	0	0	9	0	0	0	9	0	0	0	2	1	0	0
2008	9	3	9	0	9	0	9	0	3	3	9	0	3	3	9	0
2009	9	0	9	0	9	0	9	0	3	3	9	0	3	3	9	0
2010	9	0	9	0	3	3	9	0	9	3	9	0	3	3	9	0
2011	9	0	9	0	3	3	9	0	9	3	9	0	3	3	9	0
2012	3	0	9	0	9	0	9	0	9	0	3	0	9	0	9	0

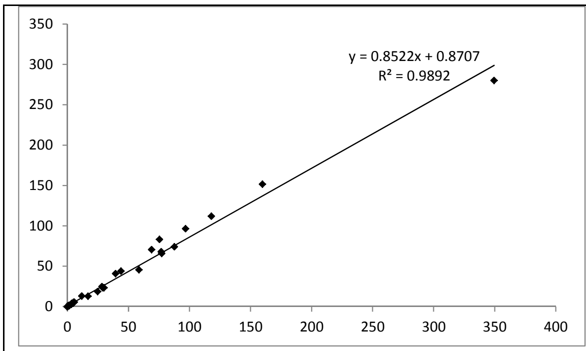
Figure 6: Overview of availability of age of length or length frequencies of German dab catch in SD 24 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)

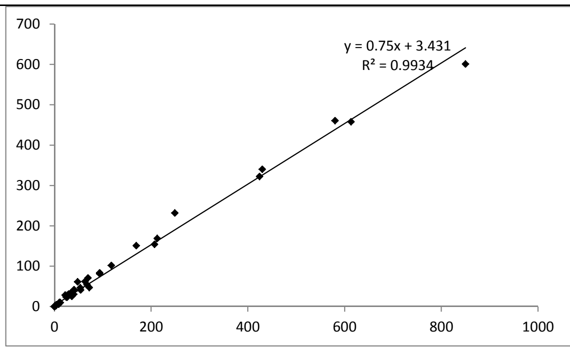
Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	0	0	9	0	0	0	9	0	0	0	9	0	9	0	9	0
2001	9	0	9	0	0	0	9	0	0	0	9	0	0	0	9	0
2002	0	0	9	0	0	0	9	0	0	0	9	1	0	0	9	1
2003	9	0	9	0	0	0	0	0	0	0	2	1	0	0	9	1
2004	9	0	9	1	0	0	9	0	0	0	9	0	0	0	0	1
2005	0	0	2	1	0	0	9	0	0	0	9	1	0	0	2	1
2006	9	0	9	0	0	0	9	0	0	0	9	1	0	0	9	0
2007	9	0	9	0	0	0	9	0	0	0	9	0	0	0	9	0
2008	9	0	2	1	0	0	9	0	0	0	2	1	0	0	2	1
2009	0	0	9	0	0	0	9	0	0	0	0	0	0	0	9	1
2010	0	0	2	1	0	0	9	1	0	0	9	1	0	0	9	1
2011	0	0	2	1	0	0	2	1	0	0	9	1	0	0	9	1
2012	0	0	9	1	0	0	9	1	0	0	9	1	0	0	9	1

Figure 7: Overview of availability of age of length or length frequencies of Swedish dab catch in SD 23 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)

Quarter	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Fishery	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas	Act	Act	Pas	Pas
Catch type	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D
2000	9	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0
2001	9	0	0	0	9	0	0	0	9	0	0	0	9	0	0	0
2002	0	0	2	1	0	0	0	1	0	1	0	0	0	0	0	0
2003	0	0	0	1	0	0	0	1	9	0	2	1	9	0	9	0
2004	9	0	9	1	9	0	2	1	9	1	9	1	9	0	9	0
2005	9	0	9	0	9	0	9	1	9	0	9	1	9	0	9	1
2006	9	0	9	0	9	9	0	0	9	1	9	0	9	0	0	0
2007	9	0	9	0	9	0	0	0	9	0	0	0	9	0	0	0
2008	9	0	0	0	9	0	0	0	9	1	0	0	9	0	9	0
2009	9	0	9	1	9	0	0	1	9	1	9	1	9	0	0	1
2010	9	0	9	1	9	0	9	1	9	1	0	1	0	0	0	1
2011	9	1	0	1	9	0	9	1	9	1	0	1	9	0	9	1
2012	0	1	9	1	0	0	9	1	9	1	2	1	0	0	0	1

Figure 8: Overview of availability of age of length or length frequencies of Swedish dab catch in SD 24 by year, quarter, fishery and catch type (0: catch not reported, 1: length frequency reported, 2: length frequencies of discards and landingsof the same fisherey reported, 3: age frequency reported, 9: catch only)





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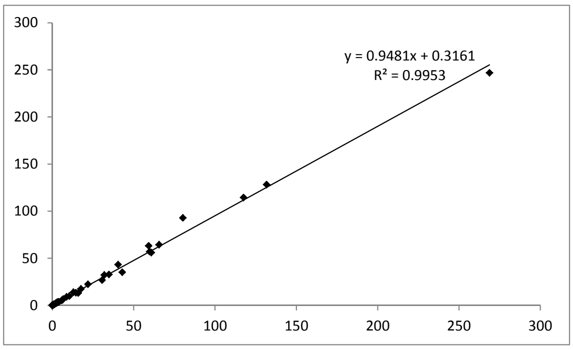

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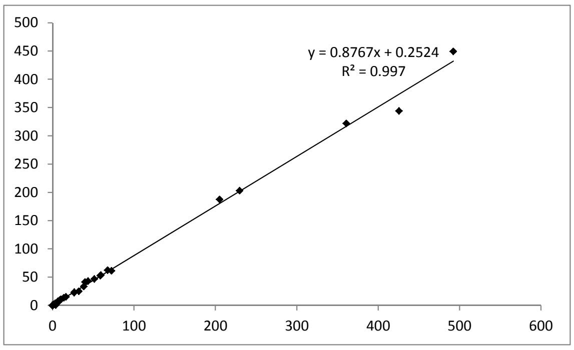
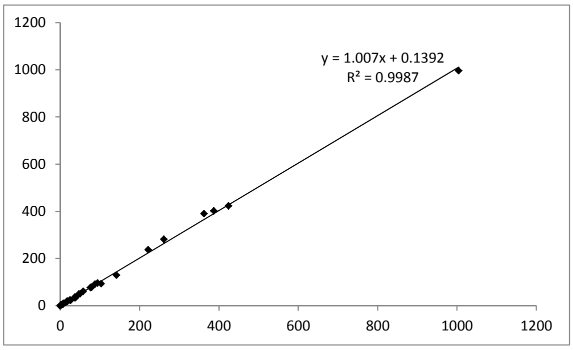


2002



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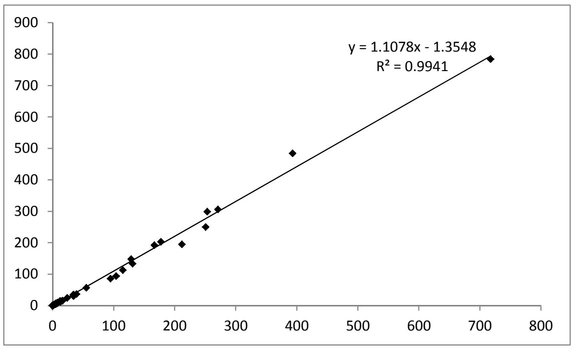

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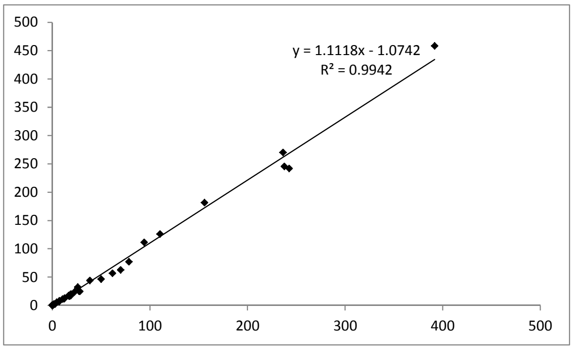

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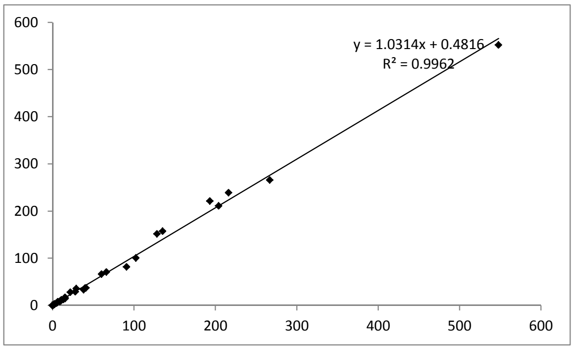
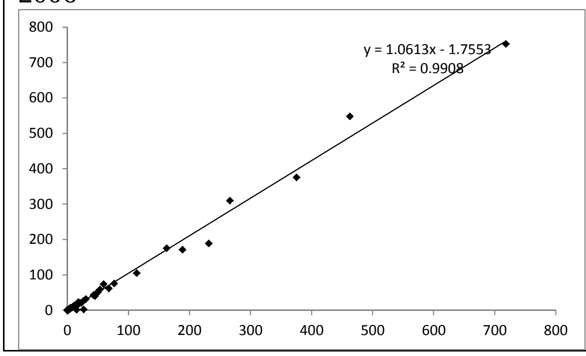
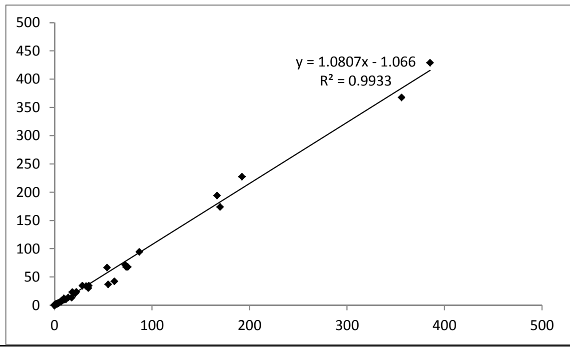


2006



2007



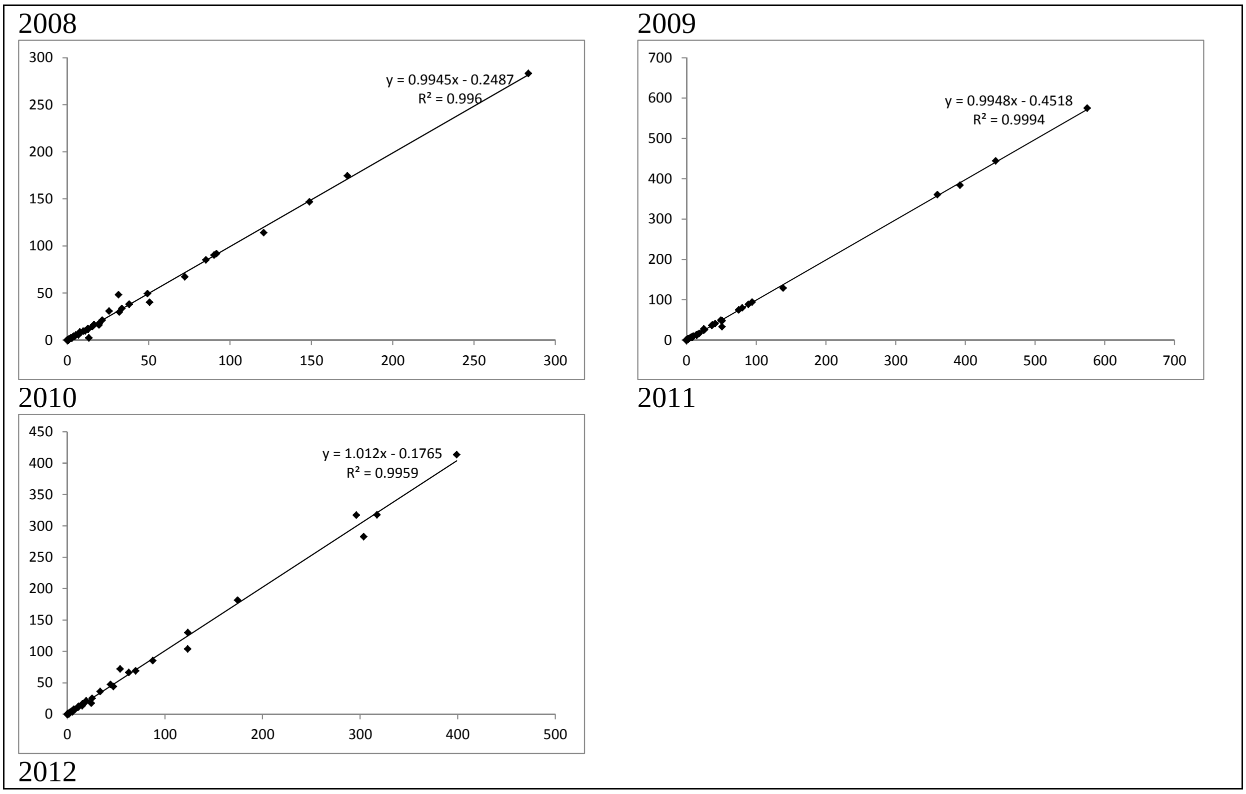


Figure 9: Relation between reported catch and the catch calculated based on mean weight and age frequency by unit (country, SD, quarter and fishery in SD 22 – 24)

Quality of ageing of dab by German reader and comparison of the aging of German and Danish readers

by

R. Oeberst
Johann Heinrich von Thünen Institute
Institute of Baltic Sea Fisheries

Introduction

The age of fish is a basic parameter in most stock assessment models. Errors within the ageing process directly influence the stock assessment results.

Inter-calibration experiments of the age readings of dab captured in the Baltic Sea were not conducted within the different working groups of ICES related to age readings. To assess the quality of age readings within the Institute of Baltic Sea Fishery in Rostock the otolith of dab captured during the Baltic International Trawl Survey (BITS) in quarter 1 in 2011 were aged again. Beside the comparison of the age data of first reading in 2011 and the repeated reading in 2013 the data were also used to compare the estimates of both readers of the institute.

In addition, the age data of Danish and German readers were compared. Age data of dab have been stored in the DATRAS database of ICES since 2008. In most cases German data are available, but, Danish data are also stored in some cases. The mean age by length (MAL) was used to compare the assessed age by country and ICES SD (Oeberst, 2012).

The aim of this study is (i) to assess the quality of one reader by repeated ageing of the same otoliths and (ii) to compare the age readings by country and SD by means of the development of MLA.

Material and Methods

Otoliths of dab captured in ICES subdivision 22 and 24 during the BITS in quarter 1 in 2011 were aged in spring 2011 and in summer 2013 by the same age reader at the Institute of Baltic Sea Fishery (OF). This age reader (Reader 1) is in general responsible for the ageing of all dab otoliths. In addition, the age of otolith were determined by a second reader (Reader 2) who is reading dab otoliths if necessary. Same information as in 2011 was available for the repeated ageing (length, date of capture, etc.). In total 298 otoliths were aged twice by Reader A and 221 otoliths by Reader B. The length of dab varied between 8.5 cm and 40.5 cm and the age reading results from 2009 varied between 1 and 18 years.

Data of BITS from quarter1 in 2008 to quarter 4 in 2012 were used to compare the development of MAL.

Results

The differences between Reader 1 and Reader 2 in 2013 varied between -1 and +1 as illustrated in Figure 1 (left panel) based on the relative distribution of differences in Table 1. The slope of the regression between estimates of Reader 1 and Reader 2 is very close to 1 (Fig. 1, right panel) and the high R^2 value of 0.87 indicate a high agreement of the ageing procedures of both readers.

Reader 1 estimated in 68 of 298 cases one year more and in 20 cases one year less indicating a slightly positive shift of the interpretation of the otolith structure (Fig. 2, left panel, Table 2). In one case the differences was 3. The slope of the regression between data of 2013 (Reader 1) and 2011 (Reader o) of 0.93 suggested that the younger dab are slightly higher aged in 2013 (Fig. 2, right panel). The dataset with the difference of 3 did not influence the estimates, significantly. The R^2 value of 0.77 indicates a high variability between the estimates of both years.

Reader 2 estimated in 52 of 221 cases one year more and in 15 cases one year less indicating a slightly positive shift of the interpretation of the otolith structure (Fig. 3, left panel, Table 3). The same tendency was observed for Reader 1. The slope of the regression between data of 2013 (Reader 2) and 2011 (Reader o) of 0.84 indicates similar but slightly more pronounced tendency like Reader 1 that the younger dab are slightly higher aged in 2013 (Fig. 3, right panel).

Comparison of mean age at length

Overview of the available age data in DATRAS is given in Table 4 by country, ICES SD, year and quarter. Main amount of data is available in SD 22 and 24 based on German data. Small numbers of age data are also available from Denmark for some BITS. Therefore, the analyses of MAL of dab mainly present information concerning the German ageing of dab in relation to different BITS. Age data from Sweden were not available.

The estimates of MAL of quarter 1 and 4 in 2008 and 2009 showed different MAL of small dab (~ 10 cm) (Fig. 4). In quarter 4 in 2008 and quarter 1 in 2009 the mean MAL were ~ 2 years. In quarter 1 in 2008 and in quarter 4 in 2009 the mean MAL of small dab were ~ 1.5 and ~ 0.5, respectively. In addition, the slope of the MAL varied from BITS to BITS and large differences of the development of MAL in SD 22 and SD 24 were found in quarter 4 in 2008 and in quarter 1 in 2009. The estimated MAL of German data varied in a wide range in the subsequent BITS (MAL of small dab, slope of MAL). The MAL of Danish and German data significantly differed in all BITS were data of both countries were available. The partly strong fluctuations of Danish MAL (decrease in quarter 1 in 2010) are partly influenced by low number of age readings.

Conclusion

The analyses clearly showed that stable structure of the interpretation of the structure of dab otolith does not exist and that the interpretation of the otolith by Danish and German readers significantly differed. The uncertainty of ageing will significantly influence the results of age based stock assessment. Therefore, it is suggested that the present type of inter-calibration of a reader should be regularly carried out by the reader of Denmark and Germany. In addition, a bilateral workshop of Denmark and Germany related to the ageing of dab is required to harmonize the interpretation of the interpretation of otoliths.

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Oeberst, R. 2012. DATRAS data used for evaluating the quality of ageing of western Baltic. Working doc WKBALT, Copenhagen, Denmark, 20. – 22.11.2012. 19 pp. In: ICES. 2013. Report of the Benchmark Workshop on Baltic Multispecies Assessment (WKBALT).401 p. (p. 206 – 225)

Tables

Table 1: Absolute and relative frequency of the difference between age data of Reader 1 – Reader 2 based on 221 otolith

Reader 1 – Reader 2	-4	-3	-2	-1	0	1	2	3	4
Absolute number	0	0	0	16	178	27	0	0	0
Proportion [%]	0	0	0	7.2	80.5	12.2	0	0	0

Table 2: Absolute and relative frequency of the difference between age data of 2011 - 2013 based on 289 otolith

Age_{2011} – Age $_{2013}$	-4	-3	-2	-1	0	1	2	3	4
Absolute number	0	0	0	20	209	68	0	1	0
Proportion [%]	0	0	0	6.7	70.1	22.8	0	0.3	0

Table 3: Absolute and relative frequency of the difference between age data of 2011 - 2013 based on 221 otolith

Age_{2011} – Age $_{2013}$	-4	-3	-2	-1	0	1	2	3	4
Absolute number	0	0	0	15	154	52	0	0	0
Proportion [%]	0	0	0	6.8	69.7	23.5	0	0	0

Table 4: Number of age readings of dab stored in DATRAS by country, ICES subdivision (SD), year and quarter

		Denmark			Germany	
Year	Quarter	21	22	23	22	24
2004	1				275	
2008	1				396	242
2009	1				379	384
2010	1	91	95	77	418	
2011	1	19	19		412	309
2012	1					
2008	4				362	327
2009	4				333	283
2010	4	14			285	357
2011	4	14	93	10	366	299
2012	4	9			248	381

Figures

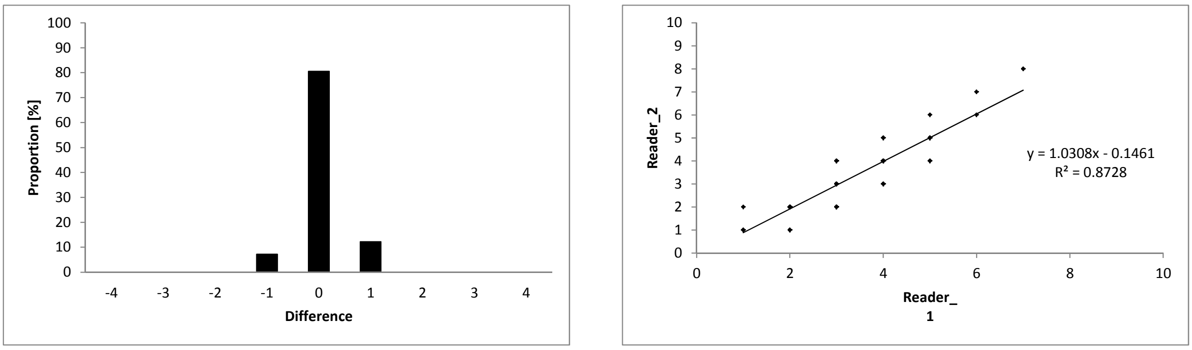

Figure 1: Differences between the age of Reader 1 and Reader 2 in 2013 (left panel) and the relation between the age data of both readers.

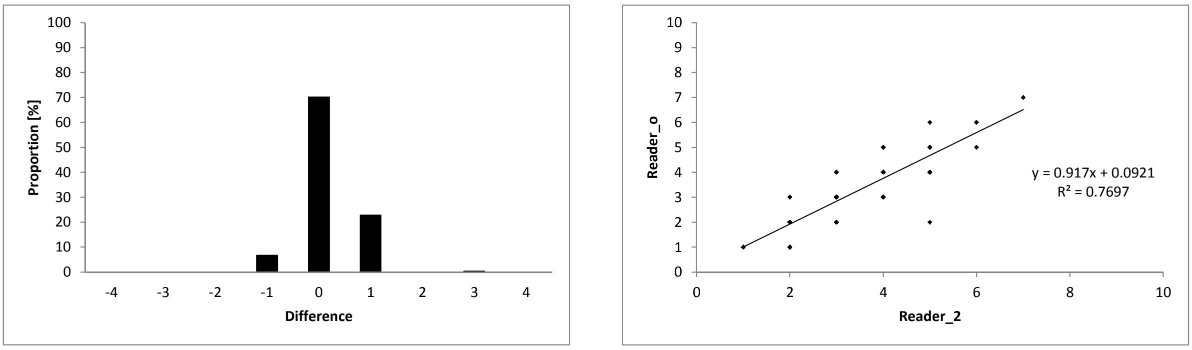

Figure 2: Differences between the age data of 2011 and 2013 of Reader 1 (left panel) and the relation between the age data of 2011 (Reader_o) and 2013 (Reader_1).

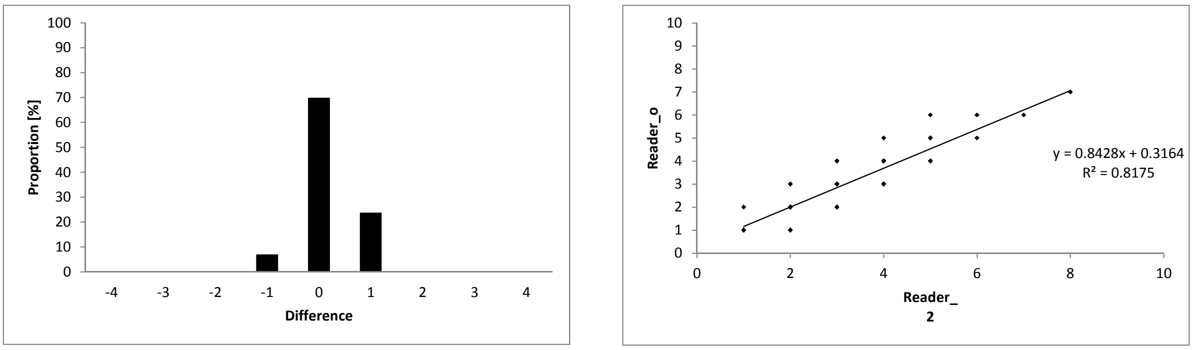

Figure 3: Differences between the age data of 2011 and 2013 of Reader 2 (left panel) and the relation between the age data of 2011 (Reader_o) and 2013 (Reader_2).

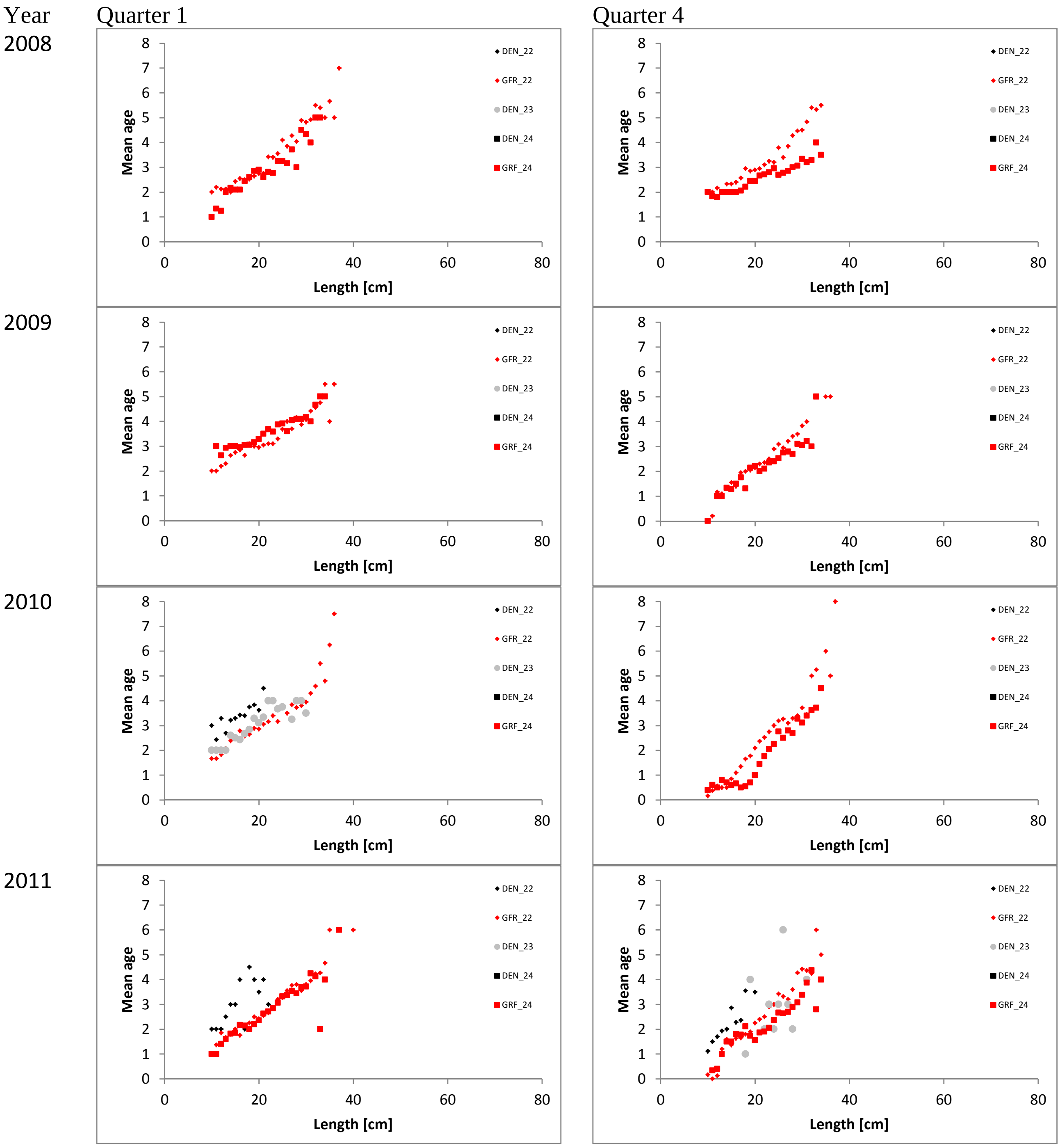

Figure 4: Development of mean age at length of dab by year, quarter, SD and country for the western Baltic Sea during quarter 1 between 2008 and quarter 4 in 2011

Growth of dab (*Limanda limanda*) based age-length data of individuals

by

R. Oeberst
Johann Heinrich von Thünen Federal Research Institute
for Rural Areas, Forests and Fisheries
Institute of Baltic Sea Fisheries
Alter Hafen Süd 2
D - 18069 Rostock, Germany

Introduction

Dab occurs in the Baltic Sea in SD 21 to SD 24 and is mainly captured as by-catch. Currently dab in SD 22 – SD 32 is used as assessment unit and landings (partly discards) and length based stock indices based on BITS are used to advice the future fishery.

Age of dab has been regularly determined by Germany for individuals captured in SD 22 and 24 during BITS in quarter 1 and quarter 4 since 2008 (Table 1). In addition, age data have also been sampled by Denmark in SD 21 to SD 23 since 2010.

The available German age data were used to estimate growth of dab. Age in month was used to take into account the different periods of quarter 1 and quarter 4 BITS. Different growth models were applied to evaluate whether the Bertalanffy growth function is the most appropriated function.
The comparison of the observed length frequency by SD and the back-calculated length frequency based on the number, mean length and standard deviation of length of age groups was used to assess the quality of ageing. In addition, the new estimates of the number, the mean length and the standard deviation of length by age groups were provided by minimizing the observed and back-calculated length frequency to evaluate whether this method provide realistic estimates and whether the method can be applied for the period 2001 to 2007 to provide age based stock indices.

Materials and Methods

Growth functions

In total 4191 and 3355 age values were determined based on otolith in SD 22 and SD 24 in quarter 1 and 4, respectively, from 2008 onwards. The availability of age data of smallest dab is influenced by two factors. The catch of smallest dab was limited due to the selection characteristics of the used gear with a mesh-size of the cod-end of i = 35 mm (Oeberst et al., 2012). L_{50} of 10.3 cm was estimated based on the mesh size and a selection factor of 3.1. The selection range of 4.6 cm was estimated by Richter et al. (2002). The selection characteristic is presented in Equation 1 and is presented in Figure 2 indicating clear effects of the catchability of age group 0 and 1 in quarter 4 and of age group 1 and 2 in quarter 1 with overestimation of the mean length of these age groups based on the data of individuals.

$$f(l) = \frac{1}{(1+e^{-(-4.92+0.48l)})} \quad (1)$$

Maximum of 20 dab per length interval was randomly sampled within each ICES SD for ageing according to the BITS manual (ICES, 2013). The maximum number of age determinations can be smaller in length classes where only one age group occurs with high probability according to previous studies.

Age in month was used for the growth functions to combine the data of quarter 1 and 4 in one analyses. Age in month was determined by
Age_month = age * 12 + T (2)
where T was 2 or 11 for quarter 1 and 4, respectively.

Parameters of growth functions based on the data of individuals were estimated by means of Statgraphics Centurino and Solver of EXCEL.
Following growth models were taken into account:

$L = L_\infty(1-e^{-k(t-t_0)})$	Bertalanffy
$L = Ae^{-e^{b-ct}}$	Gompertz
$L = A/(1+be^{-ct})$	Logistic
$L = A-be^{-kt}$	Brody
$L = A(1-be^{-kt})^M$	Richards
$L = L_0 + a(1-e^{-bt^c})$	Janoschek
$L = A-(A-L_0)e^{-kt^p}$	Sager

Observed and back-calculated length frequencies

Mean CPUE per length, N(l), was estimated for SD 21 – 24 according the procedures given in the BITS manual (ICES 2013). Conversion factor was not applied because only a very low number of hauls were realized with the large TV by Denmark in the north eastern part of SD 24. The stock indices by age groups, N(a), the mean length of age groups, L(a) and the standard deviation of the length of age groups, S(a), were estimated by combining the N(l) and the Age-Length Keys, ALK, of the SD according to the procedures given in the BITS manual. The estimated L(a) by year, SSD and age group were used to estimate parameters of BGF. Missing age data by length classes (CPUE of length class > 0 but no age data in the same length class) were corrected by defined procedure, but, not in all cases. Therefore, sum of N(a) over could by slightly smaller than the sum of N(l) of the same SD.
The theoretical length frequency, N°(l), was estimated based on N(a), L(a) and S(a) according Oeberst (2000) assuming normally distributed length frequencies of age groups. The comparison of N(L) and N°(L) are used to assess the quality of ageing.

Results

In total age of 7776 dab were determined ranging from age group 0 to age group 9. The xy-plot of all data and the mean length at age at the beginning of the year estimated based on the Bertalanffy growth functions are presented in Figure 2. Length of age groups 2 to 4 covered ~ 30 cm. The length range of age groups decreased with increasing age and maximum length did not significantly increased for dab older 3 years.
The parameters of the different growth functions were given in Table 2 and the mean length at age were presented in Figure 3. Similar mean length of age groups were estimated for age groups 2 to 7 by the different models, but, large differences of the mean length were estimated for age group 0 and dab older than 7 years. The standard deviations of the residuals of all models ranged from 3.96 to 3.99.
The Bertalanffy growth function was used in the further analyses because the alternative models did not explained the relation between age and length with significant higher quality.
The studentized residuals of the Bertalanffy model (Fig. 4) showed that all residuals of age group 0 and a large part of the residual of age group 1 were positive, indicating that length distributions of both age groups are truncated due to the selectivity characteristics of the cod-end mesh-size.
In contrast to this the residuals of the oldest age groups were negative in most cases. The length frequencies of these age groups are very small and are influenced by fishery. Therefore, the growth function based on the age and length data of individuals presents only preliminary estimates.
The parameters of the Bertalanffy growth function for quarters (both sexes) and sexes (both quarters) were given in Table 3 and the functions were presented in Figure 5.
The growth functions of quarter 1 and 4 are close together and relative similar to the graph based on all data. Different growth functions were estimated for male and female dab. Female dab growing faster and the estimated L_∞ were larger. Estimate based on all data is significantly influenced by the ~ 62 % of females in the total sample.

N°(L) – quality of ageing

The estimated stock indices, N(a), the mean length, L(a) and the standard deviation of length, S(a) by age group, BITS, year and SD are given in Table 4 – 7. The stock was dominated by age groups 1 to 4 in quarter 1 and by age groups 0 to 4 in quarter 4 with significantly lower N(a) in SD 24. The L(a) values of the same age group varied in wide ranges and the L(a) values of SD 24 were larger compared to SD 22.
The back-calculated N°(l) slightly differed from N(l) (Figure 6 and 7, examples for 2009 and 2010). The general agreement indicated that N(L) can be approximated by N°(L) based on N(a), L(a) and S(a) with high accuracy and that the estimated age is suitable to reconstruct the N(l). However, the minima and the maxima of N(L) were not accurately described by N°(L). The differences indicated slightly overestimation of the standard deviations of the length of age groups. N(L) also showed that the proportion of small dab (< 20 cm) was significantly smaller in SD 24.

The L(a) by SD and age in month is presented in Figure 8 clearly showed that L(a) was smaller in SD 22 in mean resulting in different parameters of BGF for both SDS's (Table 8). In addition, the parameters of BGF are given based on all available data. The differences of L(a) by SD are mainly determined by the different k values. However, the growth functions based on L(a) and based on individuals (Figure 9) were close together taking into account that the standard deviation of the residuals was ~ 2.8.

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Tables

Table 1: Number of age readings of dab stored in DATRAS by country, ICES subdivision (SD), year and quarter

		Denmark			Germany	
Year	Quarter	SD 21	SD 22	SD 23	SD 22	SD24
2004	1				275	
2008	1				396	242
2009	1				379	384
2010	1	91	95	77	418	
2011	1	19	19		412	309
2012	1					
2008	4				362	327
2009	4				333	283
2010	4	14			285	357
2011	4	14	93	10	366	299
2012	4	9			248	381

Table 2: Parameters of the different growth functions

$L = 43.30(1 - e^{-0.187(Age\_Month/12+0.631)})$	Bertalanffy
$L = 36.25e^{e^{-0.5166-0.3824 Age\_Month/12}}$	Gompertz
$L = 33.69/(1+3.28e^{-0.574 Age\_Month/12})$	Logistic
$L = 43.28 - 38.47e^{-0.187 Age\_Month/12}$	Brody
$L = 36.25(1-0.0030e^{-0.382 Age\_Month/12})^{600}$	Richards
$L = 346 + 1394.5(1 - e^{0.216(Age\_Month/12)^{-0.030}})$	Janoschek
$L = 31.92 - (31.92 - 10.64)e^{-0.082(Age\_Month/12)^{1.925}}$	Sager

Table 3: Parameters of the Bertalanffy growth functions based on different selection criteria (all data, data of males and female by quarter and data of both quarters by sex)

	All data	Quarter 1 & both sexes	Quarter 4 & both sexes	Male & both quarters	Female & both quarters
Number	7776	4417	3359	2954	4822
L_∞	43.30	45.97	41.57	37.59	41.32
K	0.1868	0.176	0.1905	0.183	0.230
t_0	-0.631	0.100	0.139	0.204	0.082

Table 4: Stock index, N(a), mean length, L(a) and standard deviation of length, S(a) by year and age group of BITS in SD 22 in quarter 1

Year	Age	1	2	3	4	5	6	7	8
2008	N(a)	6.4	421.1	238.3	45.2	30.4	5.6	1.7	1
	L(a)	9.3	14.8	18.7	23.4	27.5	29.6	29.6	30.3
	S(a)	1.85	2.9	3.94	3.84	4.98	2.85	3.67	2.57
2009	N(a)	3.9	373.6	580.6	41.7	5.3	0.7	0	0
	L(a)	9.3	13.6	17.2	23.8	29.1	30.5		
	S(a)	0.58	2.11	2.87	4.54	2.19	2.81		
2010	N(a)	21.5	321.7	658.2	212.1	22.6	4.8	0.5	0.2
	L(a)	10.8	15	18.4	20.6	20.9	25.3	33.8	33.7
	S(a)	1.36	2.65	3.67	5.51	5.07	5.3	1.71	2.72
2011	N(a)	298.5	1137	408.5	145.5	14.9	2	1.4	0
	L(a)	13.9	16.2	20.8	23	24.5	32	28.7	
	S(a)	2.86	3.06	3.85	5.01	5.56	3.05	2.83	
2012	N(a)	588.2	821.2	330.6	42	9.9	0.5	0.7	0.1
	L(a)	13.5	17	20.4	26.1	27.8	33.8	28.7	34.5
	S(a)	2	2.62	3.59	2.65	2.84	1.93	0.61	0
2013	N(a)	423	1454.9	241.8	79.9	26.5	7.9	2.6	0
	L(a)	12.3	16.1	19.8	25.3	26.2	30.7	29.8	
	S(a)	2.25	2.68	4.14	3.04	2.41	2.88	3.42	

Table 5: Stock index, N(a), mean length, L(a) and standard deviation of length, S(a) by year and age group of BITS in SD 24 in quarter 1

Year	Age	1	2	3	4	5	6	7	8
2008	N(a)	0	9.2	10.5	0.4	0.4	0.1	0	0
	L(a)	9.3	17	20.1	28	30.7	29.5		
	S(a)	1.99	2.29	2.82	2.48	2.25	0		
2009	N(a)	0	0.4	14.9	18.6	0.9	0	0	0
	L(a)		13.4	19.3	25.6	29			
	S(a)		1.53	4.09	2.71	3.25			
2010	N(a)	5.2	9.3	15	6.1	0.3	0.1	0	0
	L(a)	11.2	18.4	23.5	27.4	31	32.9		
	S(a)	1.97	2.71	3.26	2.73	1.41	0.49		
2011	N(a)	3.3	8.5	5.8	3.8	0.2	0.1	0	0
	L(a)	13.3	18.6	23.2	27.5	32.6	35.9		
	S(a)	2.18	3.68	4.34	3.03	1.6	2.32		
2012	N(a)	1	4.3	7.8	2.7	1.6	0.1	0	0
	L(a)	14.8	22.4	24.9	28.3	29.9	32.5		
	S(a)	1.38	2.73	2.88	2.39	3.35	1.4		
2013	N(a)	2.8	13.8	11	8.1	1.4	1.1	0.4	0
	L(a)	14.1	18.6	26.3	28.6	31.9	31.7	33.2	
	S(a)	1.84	2.93	2.56	2.63	2.32	2.46	1.38	

Table 6: Stock index, N(a), mean length, L(a) and standard deviation of length, S(a) by year and age group of BITS in SD 22 in quarter 4

Year	Age	0	1	2	3	4	5	6	7
2008	N(a)	0	13.9	2048	1003.3	67	21.8	3.4	0
	L(a)		7.5	13.3	18.1	25.1	29.4	32	
	S(a)		0	2.52	3.02	3.65	2.36	1.89	
2009	N(a)	65.7	510.6	1024	309.6	31.6	9	0	1.8
	L(a)	9.5	14.6	18.7	24	27.3	29.5		30.5
	S(a)	1.27	2.02	2.7	2.75	2.28	3.59		0
2010	N(a)	2.1	1520	546	321.2	40	8.2	3.2	1
	L(a)	7.5	14.6	19.5	23.5	27	27	29.3	33
	S(a)	0	2.65	2.34	2.83	2.43	3.05	3.26	0.6
2011	N(a)	159.3	1455	3066	869.5	281.7	41.9	6.7	2.6
	L(a)	9.2	14.4	16.6	18.7	21.5	22	27.9	29.9
	S(a)	0.79	2.69	3.18	4.06	4.22	4.63	2.58	1.78
2012	N(a)	16.2	1735	420.2	300.7	163.6	56.4	22.8	9.1
	L(a)	8.1	14.3	19.5	22.5	23.8	27.3	27.6	27.6
	S(a)	0.81	2.06	2.96	3.52	3.84	2.2	2.99	2.09

Table 7: Stock index, N(a), mean length, L(a) and standard deviation of length, S(a) by year and age group of BITS in SD 24 in quarter 4

Year	Age	0	1	2	3	4	5	6	7
2008	N(a)	0	2.6	43.6	52.5	1.1	0.1	0	0
	L(a)		17.2	18.3	23.9	30.7	28.5		
	S(a)		5.39	4.19	2.82	2.22	0		
2009	N(a)	2.3	5.2	29.2	19	1.6	0	0.1	0
	L(a)	8.7	17.1	22.6	26.4	26.9		29.5	
	S(a)	0.94	2.77	3.13	2.66	1.96		0	
2010	N(a)	190.3	317.1	83.2	88.9	15.8	2	0	0
	L(a)	14.5	15.9	24.8	27.1	29.5	30.1		
	S(a)	3.18	3.41	2.24	2.41	2.78	3.87		
2011	N(a)	1.2	19.4	65.2	20.2	5.8	0.8	0.1	0.1
	L(a)	14.7	19.8	22.7	25.8	24.6	30.9	32.5	31.5
	S(a)	5.07	2.79	2.49	2.73	4.69	1.53	0	0
2012	N(a)	7	24.7	40.8	40.4	7	2.4	1.8	0
	L(a)	12.5	17.1	23.1	26.8	29	31.5	29.9	
	S(a)	1.24	3.15	2.81	2.26	2.5	2.61	3.64	

Table 8: Parameter of the Bertalanffy growth functions of BITS in quarter 1 and quarter 4 by SD.

	SD 22 & 24	SD 22	SD 24
L_∞	39.89	41.69	42.21
k	0.20	0.17	0.20
t_0	-0.613	-0.528	-0.758

Figures

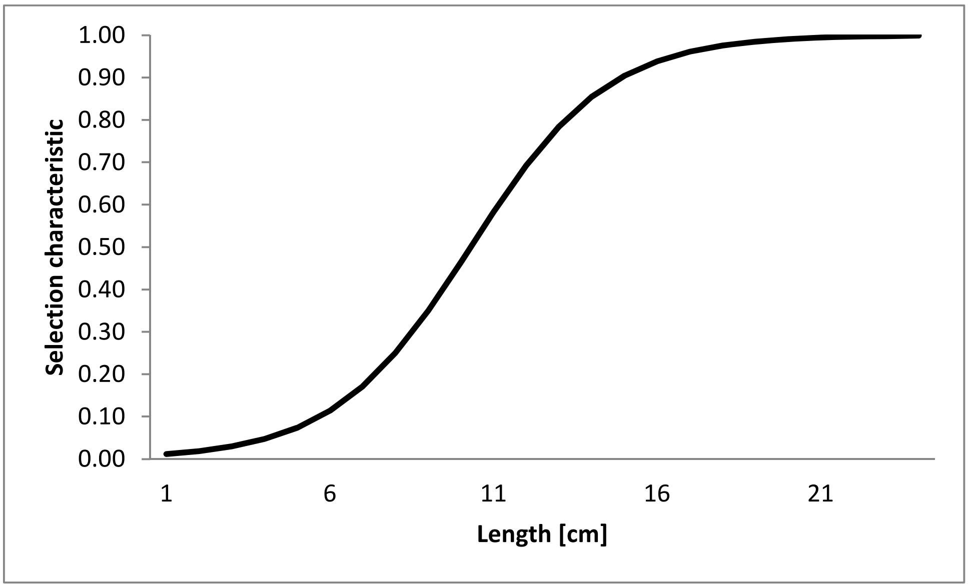


Figure1: Selection characteristics of the small standard gear TVS of BITS for dab

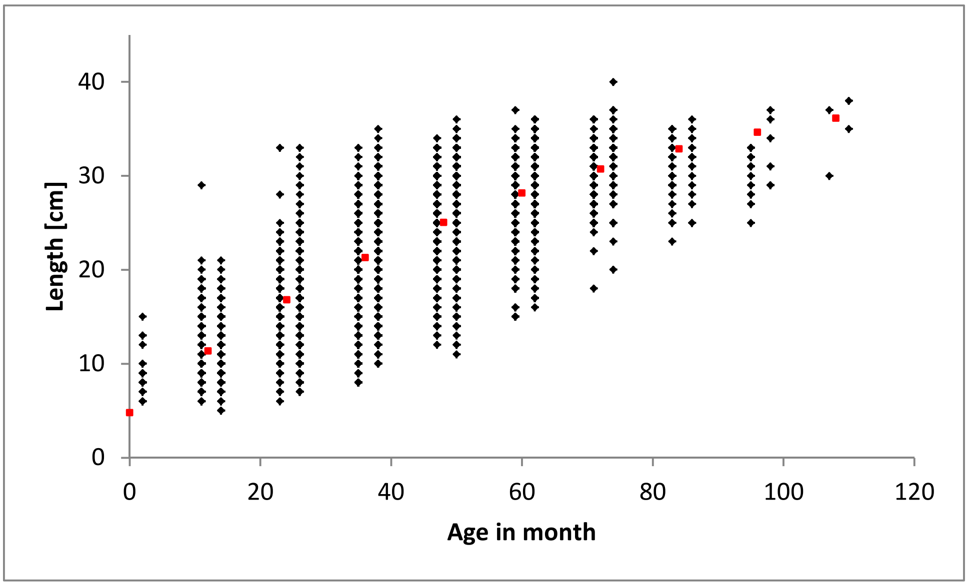


Figure 2: Relation between age in month and length based on BITS in SD 22 – 24 between 2008 and 2012 (black dots: observations, red dots: mean length of age groups at the beginning of the years based on Bertalanffy growth function)

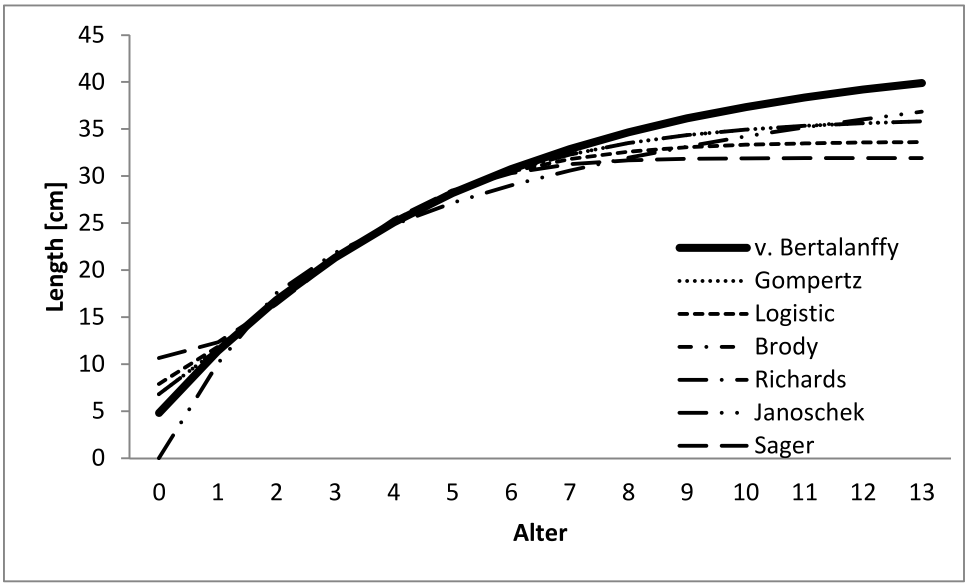


Figure 3: Growth function of different models based on 7776 age data from BITS in quarter 1 and 4 from 2008 onwards (see Table 1 for models)

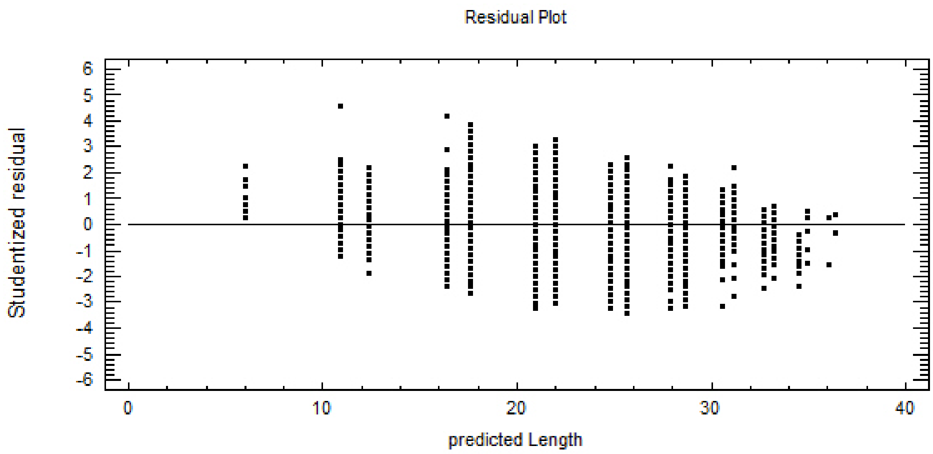


Figure 4: Studentized residuals of Bertalanffy growth function based on all data

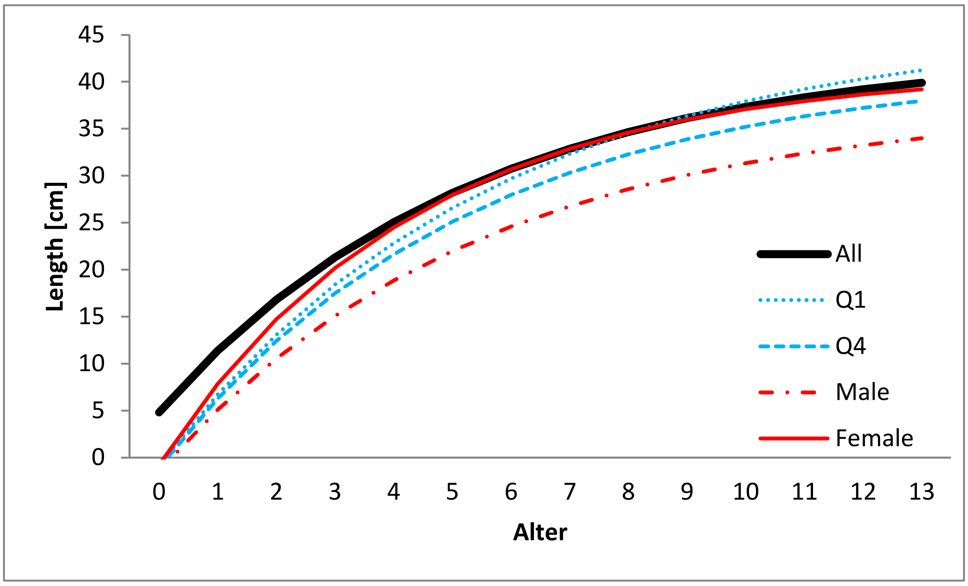


Figure 5: Bertalanffy growth functions based on different selection criteria (All: all data, Q1: data of males and female in quarter 1, Q4: data of males and female in quarter 4, Male: data male dab of both quarters, Female: data female dab of both quarters)

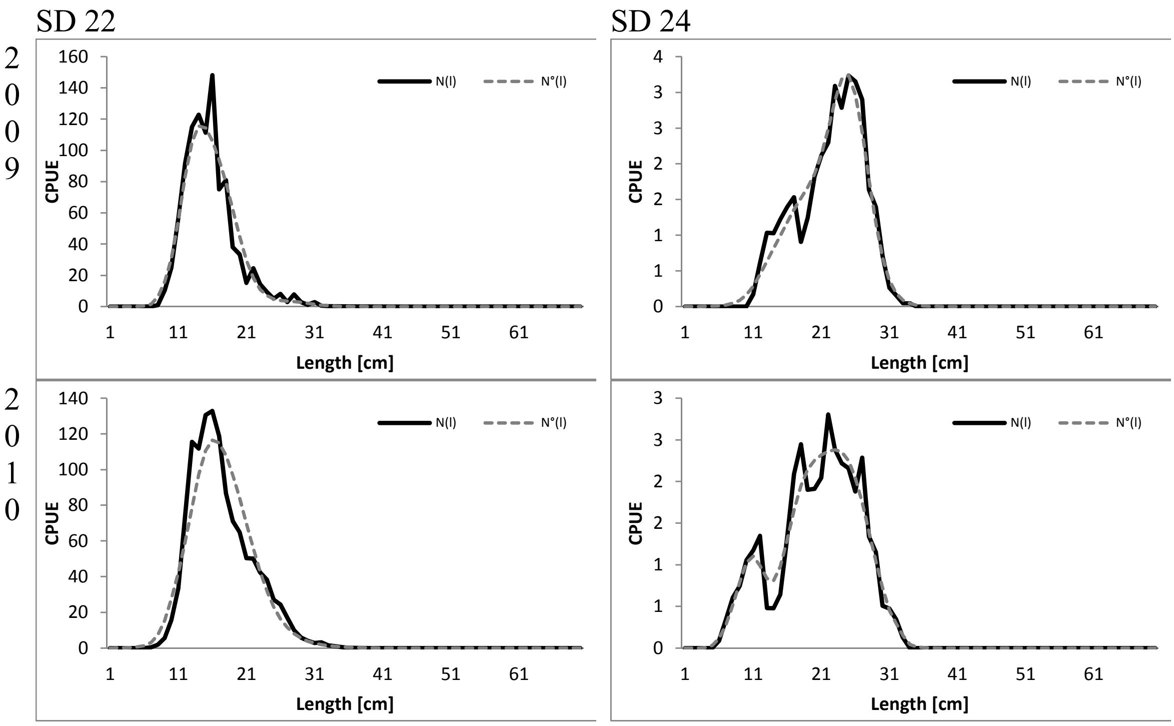


Figure 6: observed, N(l) and back-calculated, N°(l) length frequencies by year and SD of BITS in quarter 1

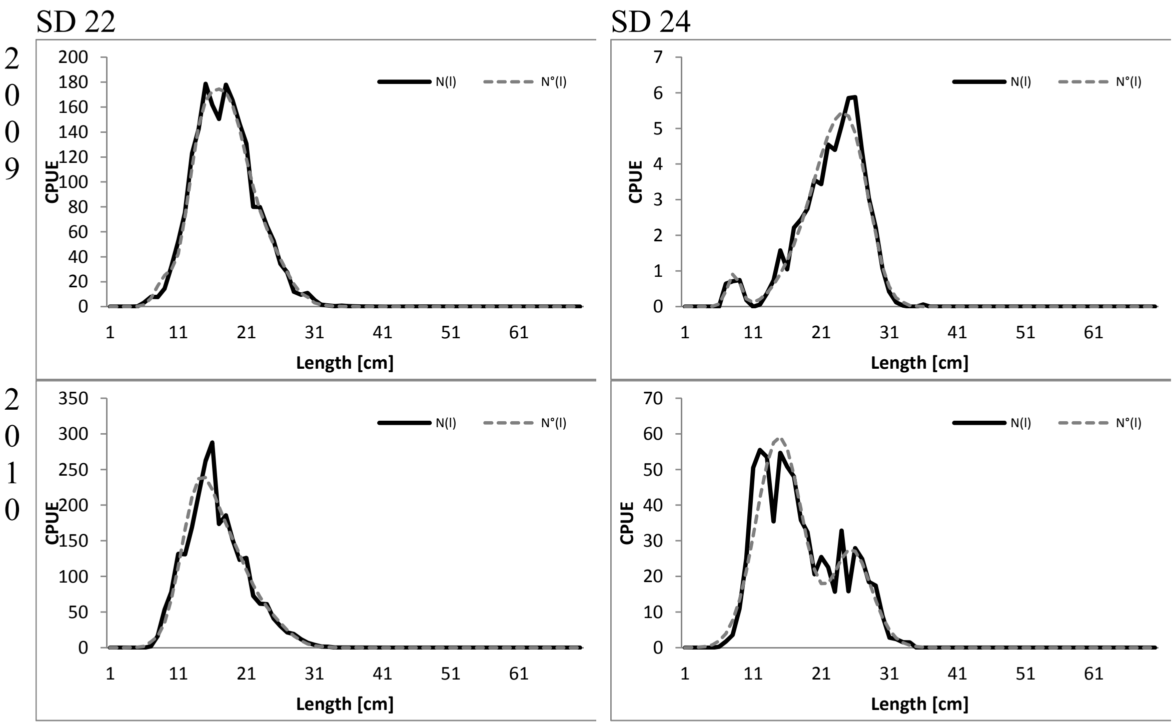


Figure 7: observed, N(l) and back-calculated, N°(l) length frequencies by year and SD of BITS in quarter 4

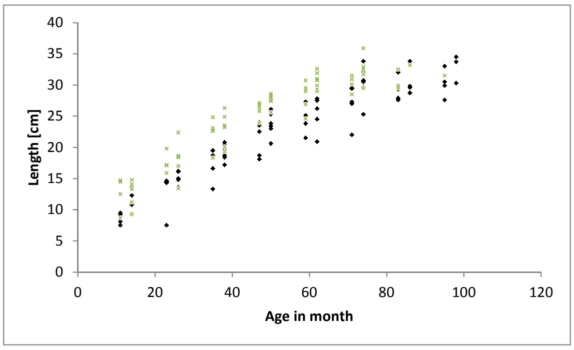


Figure 8: Relation between age in month and mean length at age, L(a), for SD 22 (black rectangle) and SD 24 4 (green cross) of both quarters between 2008 and 2013.

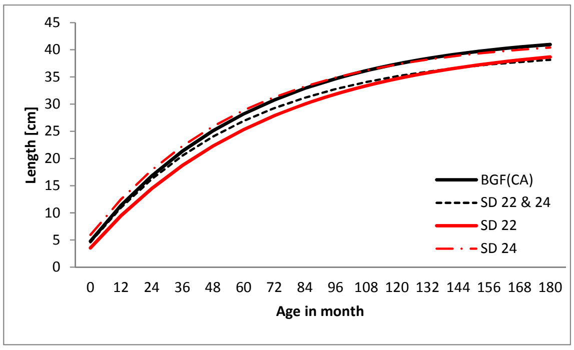


Figure 9: Bertalanffy growth functions based on data of individuals, BGF(CA), and mean length, L(a), of BITS in quarter 1 and quarter 4 by SD.

Weight and maturity calculations for flounder in the Baltic Sea using BITS survey data

Casper W. Berg

December 17, 2013

1 Methods

1.1 Weight at age

For each year a length-weight relationship $W(L) = aL^b$ is estimated by fitting the log-transformed model as a linear model. Then the distribution of length given age $P(l_i|a)$ is calculated from an age-length key $P(a|l)$ (just the raw proportions of age per length group) and the length distribution $P(l)$ using Bayes rule:

$$P(L = l_i|A = a) = \frac{P(A = a|L = l_i)P(L = l_i)}{\sum_k P(A = a|L = k)P(L = k)}$$

and the mean weight at age is found by applying the non-linear function $W(L)$ is to length distribution and integrating out

$$\mathbb{E}(W(L)|A = a) = \sum_k W(k)P(L = k|A = a)$$

1.2 Maturity at age

We define to types of maturities: "Mature proportion" (all mature indivduals including those skipping spawning) and "Spawning proportion" with individuals skipping spawning not included. The transform from national maturity scales to mature/immature and spawning/not spawning is done using the following table: `https://datras.ices.dk/Data_products/FieldDescription.aspx?Fields=Maturity&SurveyID=2826` which is given as a conversion table at the end of this document. Note, that for Polish data the information on the homepage is wrong, since category "II" should correspond to "immature" in quarter 1.

A logistic regression on length is used to estimate the maturity at length $m(L)$:

$$\text{logit}(m(L)) = \alpha + \beta L$$

and finally the mean maturity at age is estimated in the same manner as the mean weights:

$$\mathbb{E}(m(L)|A = a) = \sum_k m(k)P(L = k|A = a)$$

2 Results

	1	2	3	4	5	6	7	8
2009	29.88	91.75	174.46	252.52	320.92	343.26	345.23	354.49
2010	43.29	111.56	199.61	282.16	307.10	382.56	422.64	312.45
2011	50.63	118.07	205.39	285.91	353.26	309.32	400.30	407.17
2012	53.72	135.17	226.75	280.74	332.56	355.63	348.97	385.48

Table 1: Weight at age for flounder in area 24 and 25

	1	2	3	4	5	6	7	8
2009	0.22	0.64	0.85	0.93	0.96	0.97	0.96	0.97
2010	0.25	0.69	0.93	0.97	0.97	0.99	0.99	0.97
2011	0.29	0.61	0.83	0.90	0.93	0.89	0.94	0.95
2012	0.33	0.68	0.91	0.94	0.96	0.97	0.96	0.97

Table 2: Spawning proportion at age for flounder in area 24 and 25

	1	2	3	4	5	6	7	8
2009	0.58	0.90	0.97	0.99	0.99	1.00	0.99	0.99
2010	0.56	0.84	0.96	0.98	0.98	0.99	0.99	0.98
2011	0.65	0.91	0.97	0.98	0.99	0.98	0.99	0.99
2012	0.58	0.85	0.97	0.98	0.98	0.99	0.99	0.99

Table 3: Mature proportion at age for flounder in area 24 and 25

	1	2	3	4	5	6	7	8	9	10
2009	0.00	61.06	134.42	192.08	226.34	231.65	204.70	221.22	168.35	271.09
2010	21.98	76.64	133.93	197.75	214.59	197.37	219.45	194.35	243.95	238.97
2011	3.08	62.75	121.31	162.71	229.86	192.25	195.44	214.16	172.25	254.51
2012	0.00	74.34	125.25	136.73	141.16	169.13	175.00	199.87	236.98	203.90

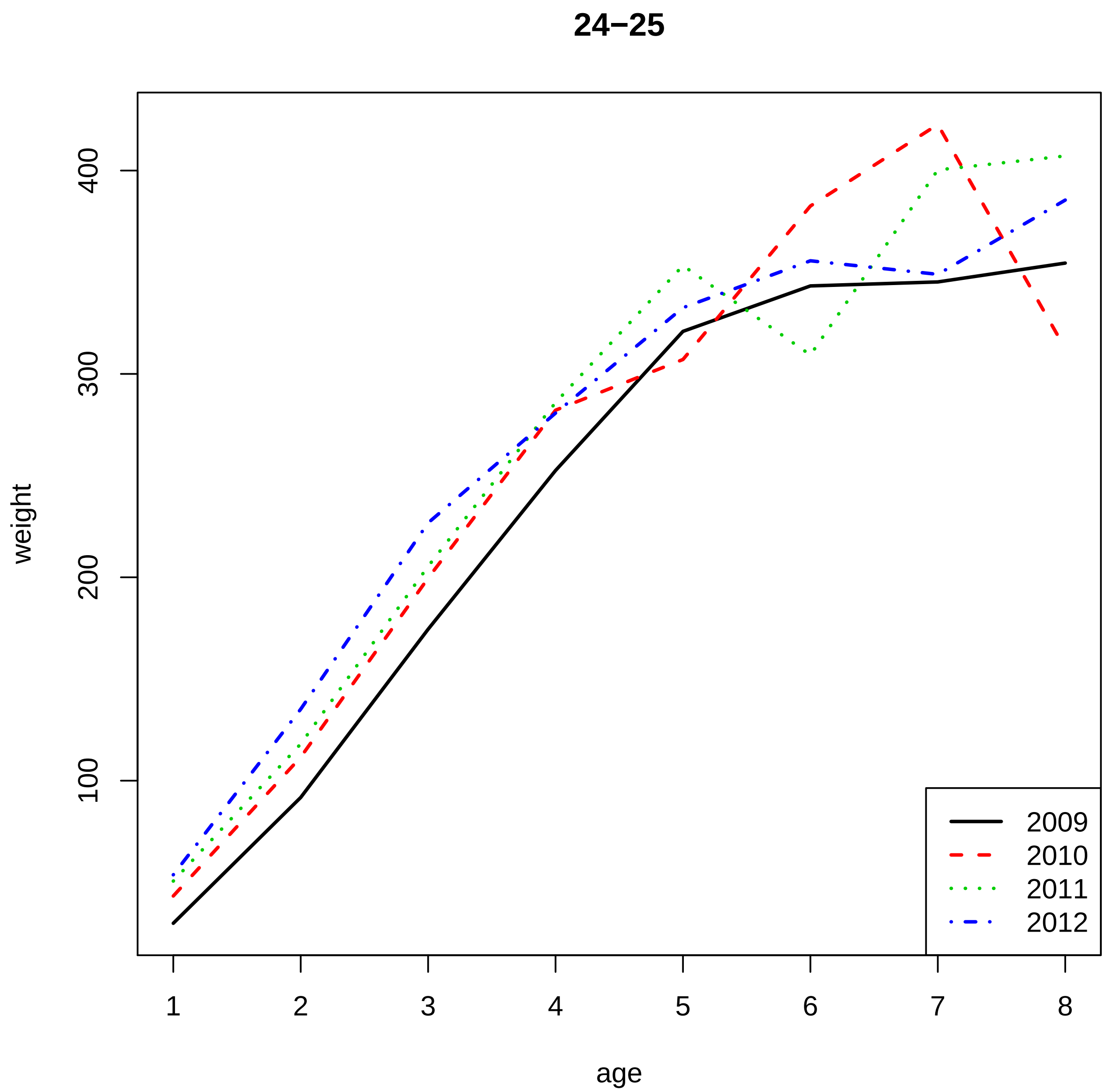
Table 4: Weight at age for flounder in area 26 and 28

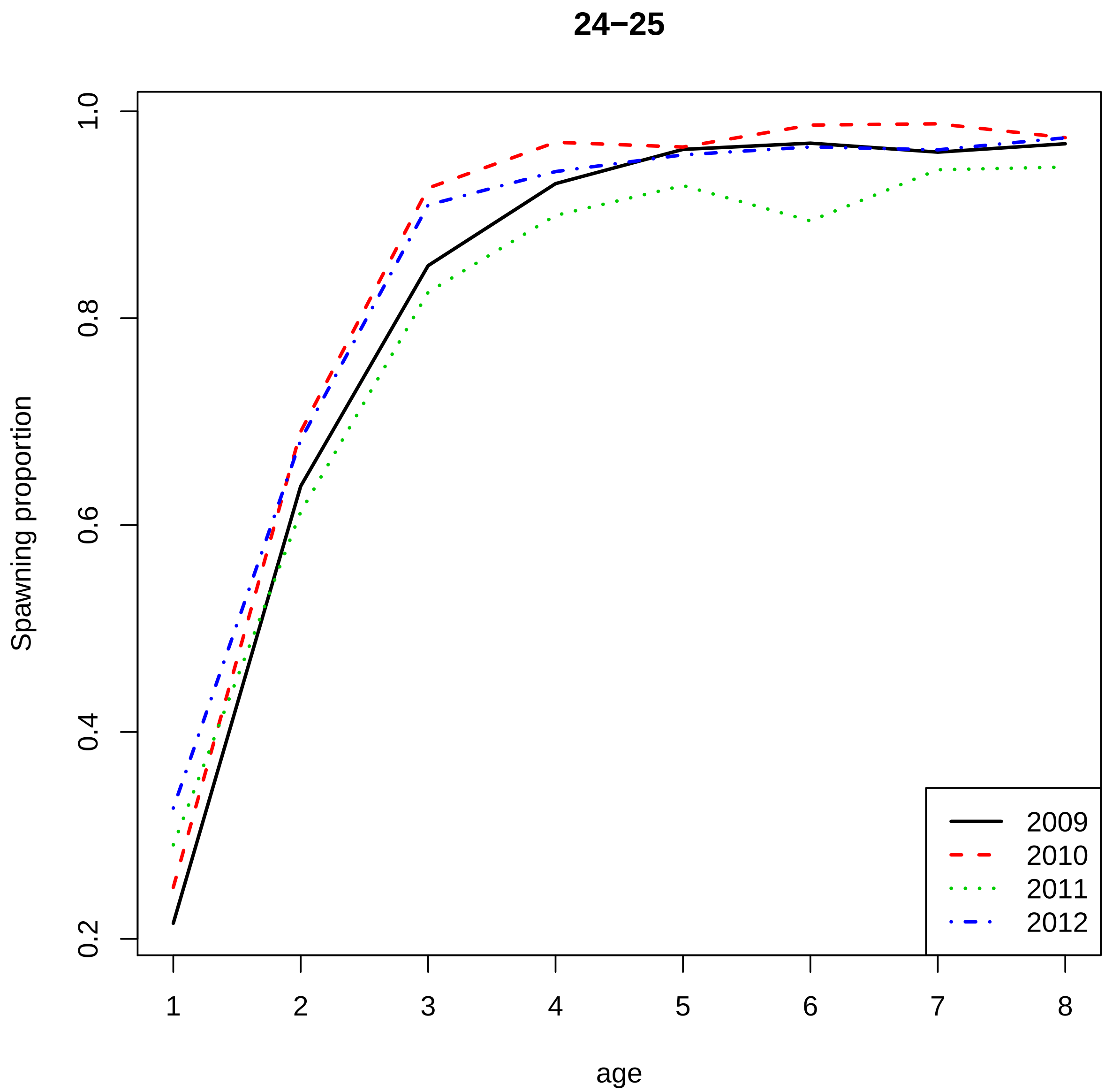
	1	2	3	4	5	6	7	8	9	10
2009	0.00	0.61	0.89	0.94	0.93	0.96	0.92	0.93	0.90	0.97
2010	0.34	0.80	0.92	0.97	0.95	0.95	0.97	0.95	0.96	0.97
2011	0.04	0.60	0.86	0.90	0.94	0.92	0.93	0.94	0.92	0.97
2012	0.00	0.72	0.91	0.92	0.94	0.96	0.96	0.98	0.99	0.98

Table 5: Spawning proportion at age for flounder in area 26 and 28

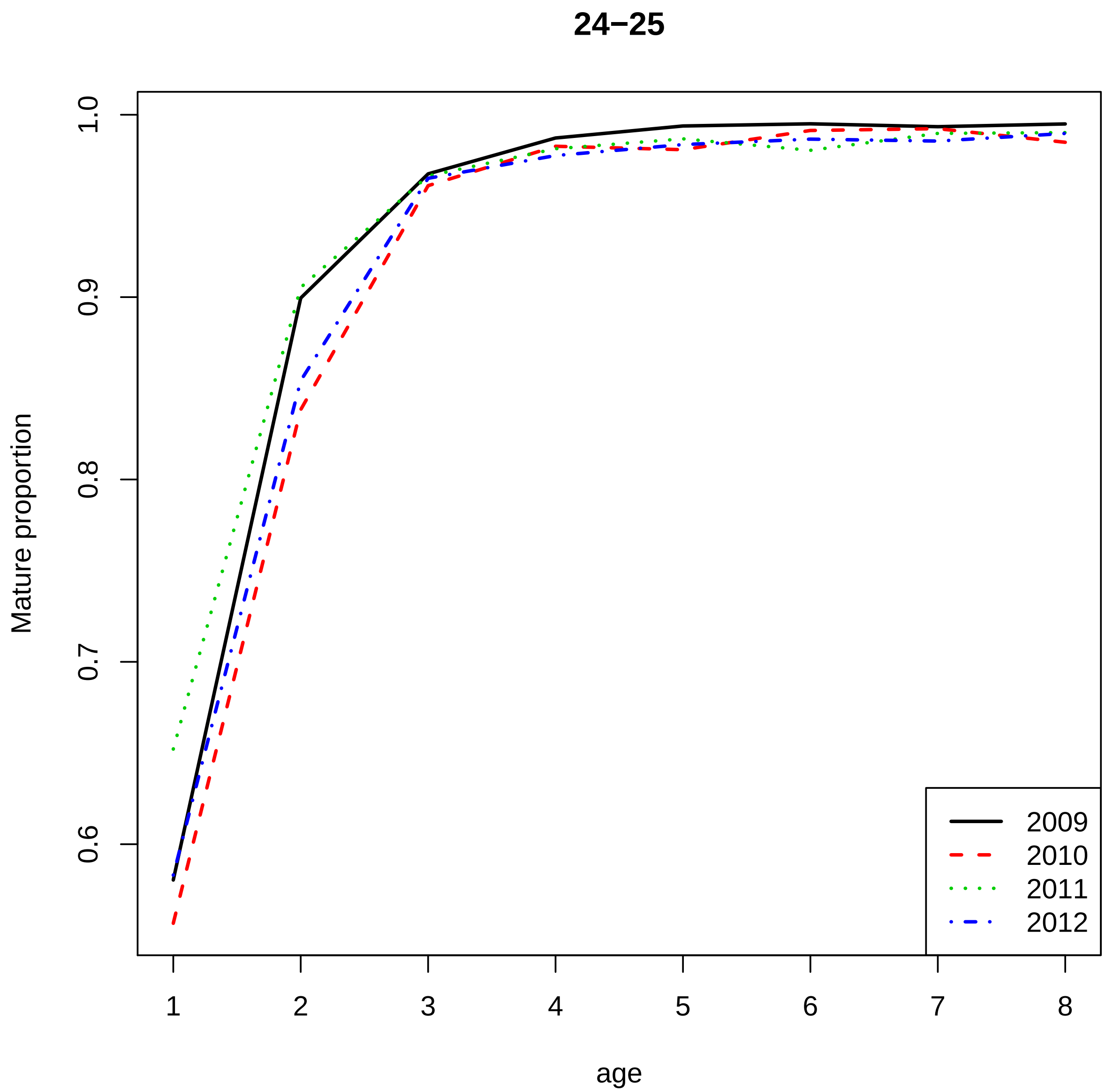
	1	2	3	4	5	6	7	8	9	10
2009	0.00	0.91	0.97	0.98	0.98	0.99	0.98	0.98	0.98	0.99
2010	0.43	0.86	0.95	0.98	0.97	0.97	0.98	0.97	0.97	0.98
2011	0.20	0.79	0.93	0.95	0.97	0.96	0.96	0.97	0.96	0.98
2012	0.00	0.79	0.93	0.93	0.94	0.96	0.96	0.98	0.98	0.98

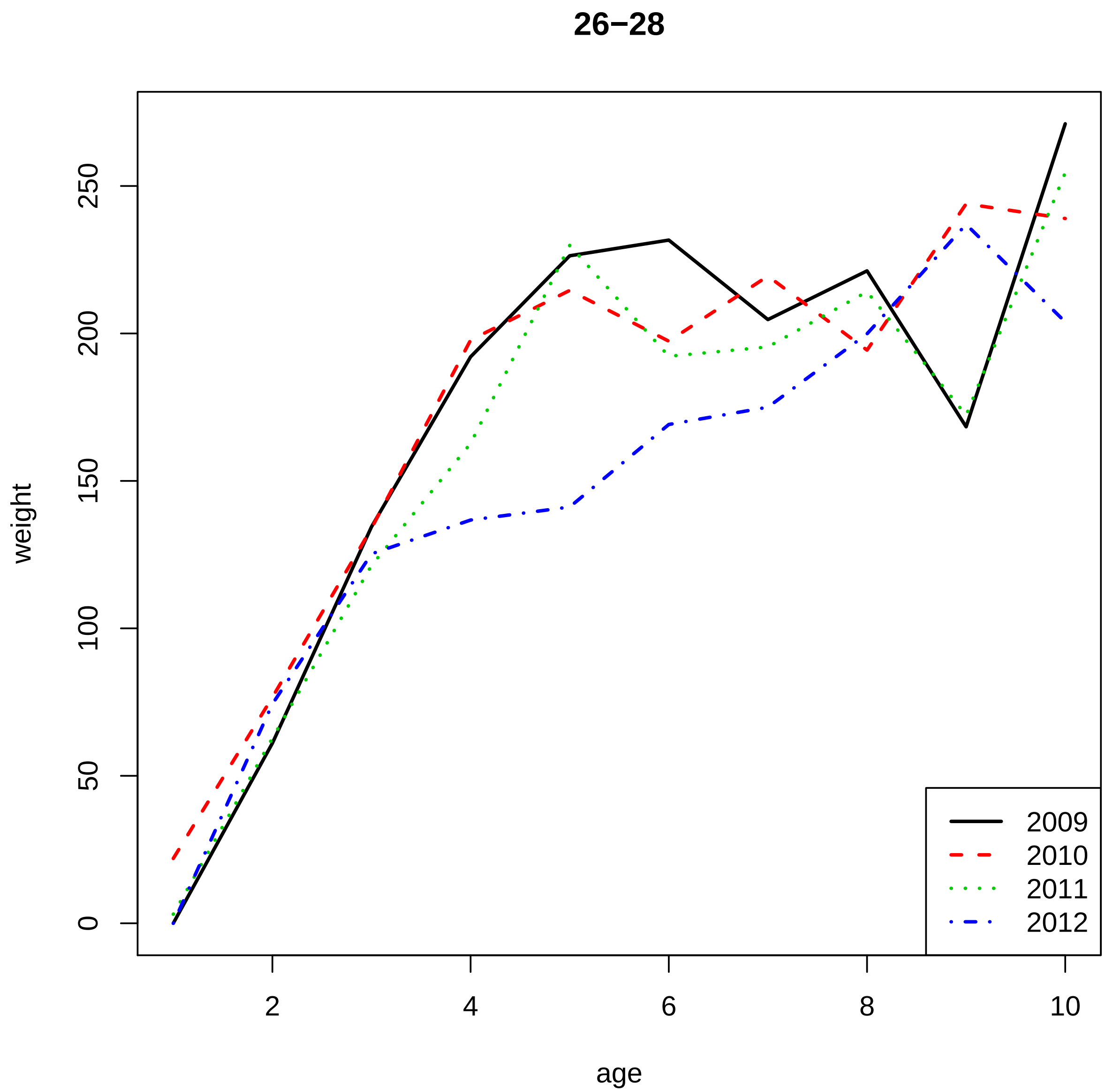
Table 6: Mature proportion at age for flounder in area 26 and 28

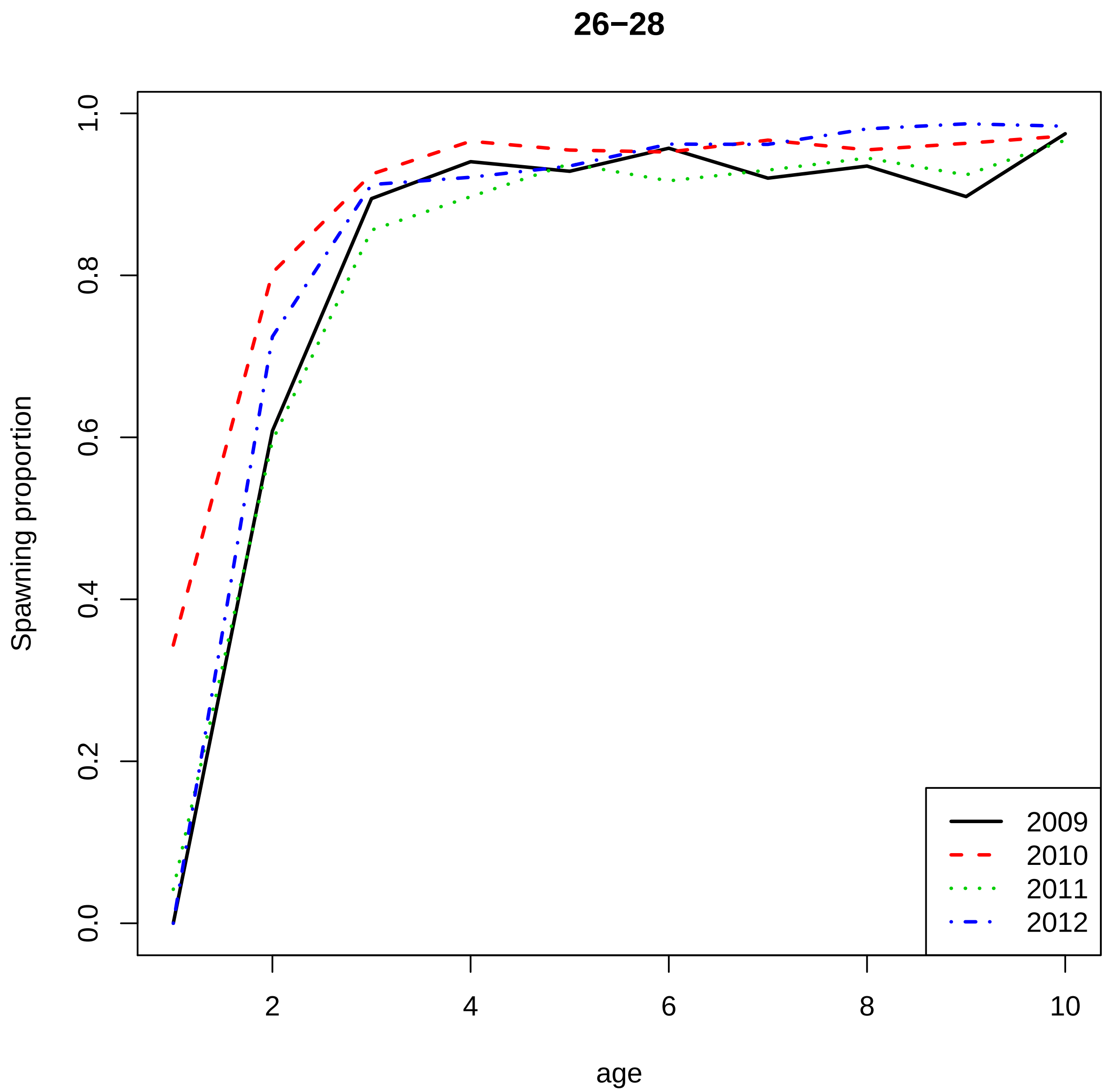

24−25
weight
400
300
200
100
1
2
3
4
5
6
7
8
age
2009
2010
2011
2012

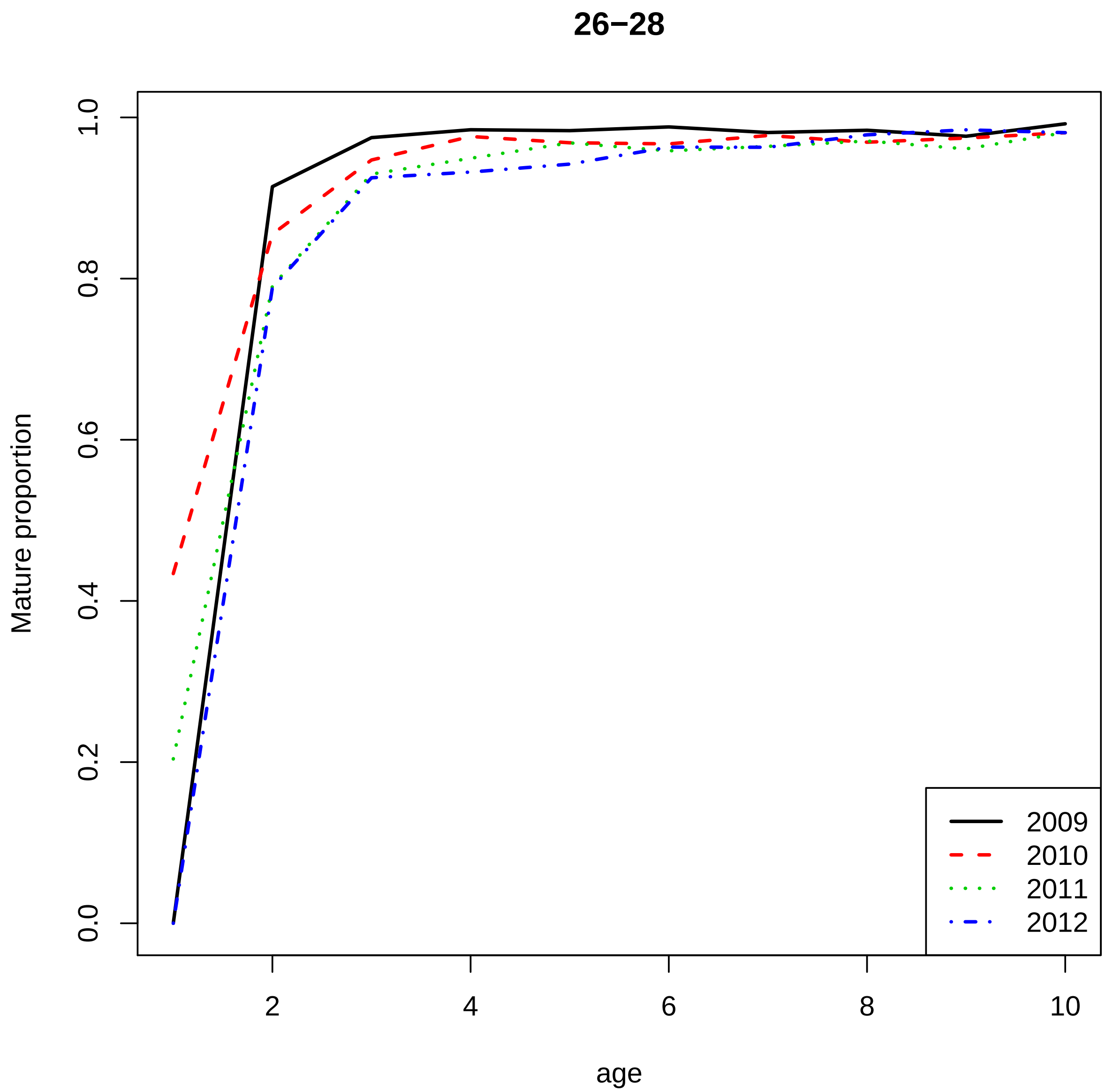


24–25
Spawning proportion
1.0
0.8
0.6
0.4
0.2
1
2
3
4
5
6
7
8
age
2009
2010
2011
2012


24−25
Mature proportion
1.0
0.9
0.8
0.7
0.6
1
2
3
4
5
6
7
8
age
2009
2010
2011
2012


26−28
weight
age
0
50
100
150
200
250
2
4
6
8
10
2009
2010
2011
2012


26−28
Spawning proportion
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
age
2009
2010
2011
2012


26−28
Mature proportion
0.0
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
age
2009
2010
2011
2012

3 R source code

```
## AgeFuns.R
##
## Author: Casper W. Berg, DTU Aqua

weight.at.age<-function(d,minAge,maxAge){
  checkSpectrum(d);
  if(any(xtabs(Age==1~Year,d[[1]])==0)) stop(paste("Some years have no observations of age",minAge));


  d[[1]] = subset(d[[1]],Age>=minAge);
  d[[1]]$Age[ d[[1]]$Age > maxAge ] = maxAge;
  cm.b=attr(d,"cm.breaks")
  ## fit W = a*L^b
  WAAmodel=lm(log(IndWgt)~I(log(LngtCm)),data=d[[1]])
  WL = exp(predict(WAAmodel,newdata=data.frame(LngtCm=cm.b[-length(cm.b)],IndWgt=NA)))

  ## find length distr. given age p( l | a)
  ## p( l_i | a ) = p( a | l_i ) * p(l_i) / sum( p( a | l) p(l) )
  pl = colSums(d$N)/sum(d$N)
  d[[1]]$sizeGroup <- cut(d[[1]]$LngtCm, breaks = cm.b,
                          right = FALSE)
  tab = xtabs(NoAtALK ~ sizeGroup + Age, data = d[[1]])
  pal = tab/rowSums(tab)
  pla = pal;
  for(i in 1:ncol(pla)){
    pa = sum(pal[,i]*pl,na.rm=TRUE)
    pla[,i] = pal[,i]*pl / pa;
  }

  ## find E(w(l) | a ) = sum( w(l)*p(l|a) )
  Ewa = numeric(ncol(pla))
  for(a in 1:ncol(pla)){
    Ewa[a] = sum( WL*pla[,a],na.rm=TRUE)
  }

  Ewa
}

## OBS: only works for BITS flatfish
maturity.at.age<-function(d,minAge,maxAge,plot=FALSE,type="Mature" ){
  checkSpectrum(d);
  if(any(xtabs(Age==1~Year,d[[1]])==0)) stop(paste("Some years have no observations of age",minAge));
  d[[1]] = subset(d[[1]],Age>=minAge);
  d[[1]]$Age[ d[[1]]$Age > maxAge ] = maxAge;
  cm.b=attr(d,"cm.breaks")

  ## transform DATRAS maturity to Mature/Immature
  mk=read.table("matkey.txt",header=TRUE,sep=",")
  kk=paste(mk$code,mk$country);
  if(type=="Mature")
    matcode2mature = structure(mk$mature,names=kk) else if(type=="Spawning")
    matcode2mature = structure(mk$spawning,names=kk) else
      stop("Unknown type");

  lookup <- function(x,table){
    x <- factor(x)
    levels(x) <- table[levels(x)]
    if(is.numeric(table)) as.numeric(as.character(x)) else x
  }

  d[[1]] = transform(d[[1]],Matur=lookup(paste(d[[1]]$Maturity,d[[1]]$Country),matcode2mature))

  ## fit maturity as a function of length
  MAAmodel=glm(Matur~LngtCm,data=d[[1]],family=binomial,weights=NoAtALK)
  ML = predict(MAAmodel,newdata=data.frame(LngtCm=cm.b[-length(cm.b)]),type="response")

  pl = colSums(d$N)/sum(d$N)
  d[[1]]$sizeGroup <- cut(d[[1]]$LngtCm, breaks = cm.b,
                          right = FALSE)
  tab = xtabs(NoAtALK ~ sizeGroup + Age, data = d[[1]])
  pal = tab/rowSums(tab)
  pla = pal;
  for(i in 1:ncol(pla)){
    pa = sum(pal[,i]*pl,na.rm=TRUE)
    pla[,i] = pal[,i]*pl / pa;
  }

  Ema = numeric(ncol(pla))
  for(a in 1:ncol(pla)){
    Ema[a] = sum( ML*pla[,a],na.rm=TRUE)
  }

  Ema
}
```

```
## Function to add one sample of age 0 with minimum observed length to years with no 0-age observations.
fixAge0<-function(x,age0=0){
  d=split(x,x$Year)
  minLength=min(x[[3]]$LngtCm,na.rm=TRUE)
  for(y in 1:length(d)){
        if(!any(d[[y]][[1]]$Age==age0,na.rm=TRUE)) {
          d[[y]][[1]]=rbind(d[[y]][[1]][1,],d[[y]][[1]]);
          d[[y]][[1]][1,"Age"]=age0;
          d[[y]][[1]][1,"LngtCm"]=minLength;
          d[[y]][[1]][1,"NoAtALK"]=1;
        }
      }
  dd <- do.call("c",d)
  dd
}

#######################################################################
##
## Calculate weight-at-age and maturity-at-age for Baltic flounder
##
##
## Author: Casper W. Berg, DTU Aqua
#######################################################################
library(DATRAS)
library(maps); library(mapdata);
library(maptools);
library(xtable)
source("AgeFuns.R");

tabFile="tables.tex";
pdf(onefile=FALSE)
years=2009:2012

##24-25 (8+ ), 26+28 (-27)  (10+)

## Country
## Poland   Q1: 2000-2002 and 2004-2012; Q4: 2011-2012
## Latvia  2007-2012
## Estonia 2010-2012
## Finland 2007-2012
## Lithuania     Q1: 2012; Q4: 2011-2012
## Denmark 2012
## Germany 2009-2012
## Sweden   2007-2012

##exclude list
cc=list("POL","POL","LAT","EST","FIN","LTU","LTU","DEN","GFR","SWE")

y1=list(2003,2000:2010,2000:2006,2000:2009,2000:2006,2000:2011,2000:2010,2000:2011,2000:2008,2000:2006)
qq=list(1,4,1:4,1:4,1:4,1,4,1:4,1:4,1:4);

if(!file.exists("BITS.RData")){
  BITS=readExchangeDir("../DATRAS/exchange/BITS/",strict=FALSE)
  BITS=subset(BITS,Year %in% as.character(2000:2012))
  save(BITS,file="BITS.RData")
} else load("BITS.RData");

d=BITS
d=subset(d,Species=="Platichthys flesus")
d=addSpectrum(d,by=1)

## Exclude age data using old methodology
d[[1]]$include=TRUE;
for(i in 1:length(cc)){
  d[[1]]$include[ d[[1]]$Country==cc[[i]] & d[[1]]$Year %in% as.character(y1[[i]]) & d[[1]]$Quarter %in% qq[[i]] ]=FALSE;
}
d[[1]]=subset(d[[1]],include==TRUE)

## more subsetting
d=subset(d,Gear %in% c("TVS","TVL") );
d=subset(d,Year %in% as.character(years))
d=subset(d,Quarter==1)
d[[1]]=subset(d[[1]],Age>0) ## Remove zero year olds for Q1


##xtabs(NoAtALK~Year+Country+Quarter,d[[1]])

d[[1]]=subset(d[[1]],Age<30); ## OBS 99 means unknown!!!

d=addSpatialData(d,"ICES_areas.shp")

dOld=d

#######################
## 24-25
#######################
##par(mfrow=c(3,2))
```

```
areas=c("24","25")
d=subset(dOld,ICES_SUB %in% areas)
maxAge=8
d=fixAge0(d,1)
d=addSpectrum(d,by=1)

ysplit= split(d,d$Year)

WAA=lapply(ysplit,weight.at.age,minAge=1,maxAge=maxAge)
MAA=lapply(ysplit,maturity.at.age,minAge=1,maxAge=maxAge,type="Spawning")
MAA.2=lapply(ysplit,maturity.at.age,minAge=1,maxAge=maxAge,type="Mature")

matplot(1:maxAge,t(do.call(rbind,WAA)),type="l",lwd=2,ylab="weight",xlab="age",main=paste(areas,collapse="-"))
legend("bottomright",col=1:length(years),lty=1:length(years),legend=years,lwd=2)

matplot(1:maxAge,t(do.call(rbind,MAA)),type="l",lwd=2,ylab="Spawning proportion",xlab="age",main=paste(areas,collapse="-"))
legend("bottomright",col=1:length(years),lty=1:length(years),legend=years,lwd=2)

matplot(1:maxAge,t(do.call(rbind,MAA.2)),type="l",lwd=2,ylab="Mature proportion",xlab="age",main=paste(areas,collapse="-"))
legend("bottomright",col=1:length(years),lty=1:length(years),legend=years,lwd=2)

tabalign=rep("c",maxAge+1)
cat(print(xtable( do.call(rbind,WAA),align=tabalign,
  caption=paste("Weight at age for flounder in area", paste(areas,collapse=" and ")))),file=tabFile);
cat(print(xtable( do.call(rbind,MAA),align=tabalign,
  caption=paste("Spawning proportion at age for flounder in area", paste(areas,collapse=" and ")))),file=tabFile,append=TRUE);
cat(print(xtable( do.call(rbind,MAA.2),align=tabalign,
  caption=paste("Mature proportion at age for flounder in area", paste(areas,collapse=" and ")))),file=tabFile,append=TRUE);

#######################
## 26 + 28
#######################

areas=c("26","28")
d=subset(dOld,ICES_SUB %in% areas)
d=fixAge0(d,age0=1)
d=addSpectrum(d,by=1)
maxAge=10
ysplit= split(d,d$Year)

WAA=lapply(ysplit,weight.at.age,minAge=1,maxAge=maxAge)
MAA=lapply(ysplit,maturity.at.age,minAge=1,maxAge=maxAge,type="Spawning")
MAA.2=lapply(ysplit,maturity.at.age,minAge=1,maxAge=maxAge,type="Mature")

matplot(1:maxAge,t(do.call(rbind,WAA)),type="l",lwd=2,ylab="weight",xlab="age",main=paste(areas,collapse="-"))
legend("bottomright",col=1:length(years),lty=1:length(years),legend=years,lwd=2)

matplot(1:maxAge,t(do.call(rbind,MAA)),type="l",lwd=2,ylab="Spawning proportion",xlab="age",main=paste(areas,collapse="-"))
legend("bottomright",col=1:length(years),lty=1:length(years),legend=years,lwd=2)

matplot(1:maxAge,t(do.call(rbind,MAA.2)),type="l",lwd=2,ylab="Mature proportion",xlab="age",main=paste(areas,collapse="-"))
legend("bottomright",col=1:length(years),lty=1:length(years),legend=years,lwd=2)

tabalign=rep("c",maxAge+1)
cat(print(xtable( do.call(rbind,WAA),align=tabalign,
  caption=paste("Weight at age for flounder in area", paste(areas,collapse=" and ")))),file=tabFile,append=TRUE);
cat(print(xtable( do.call(rbind,MAA),align=tabalign,
  caption=paste("Spawning proportion at age for flounder in area", paste(areas,collapse=" and ")))),file=tabFile,append=TRUE);
cat(print(xtable( do.call(rbind,MAA.2),align=tabalign,
  caption=paste("Mature proportion at age for flounder in area", paste(areas,collapse=" and ")))),file=tabFile,append=TRUE);

dev.off()
```

3.1 matkey.txt

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Working document 1: data quality and weight-borrowing schemes Landing / Discard

General Issues

Submitting countries were asked to upload the official Landings and calculated/estimated Discards of flounder into the ICES-database InterCatch.

For FLE-2223, three countries were asked to upload data. If no other information is available, only landings were submitted. Figure 1 shows an overview of submitted weights for landings and discards per area, country, quarter and fishing gear.

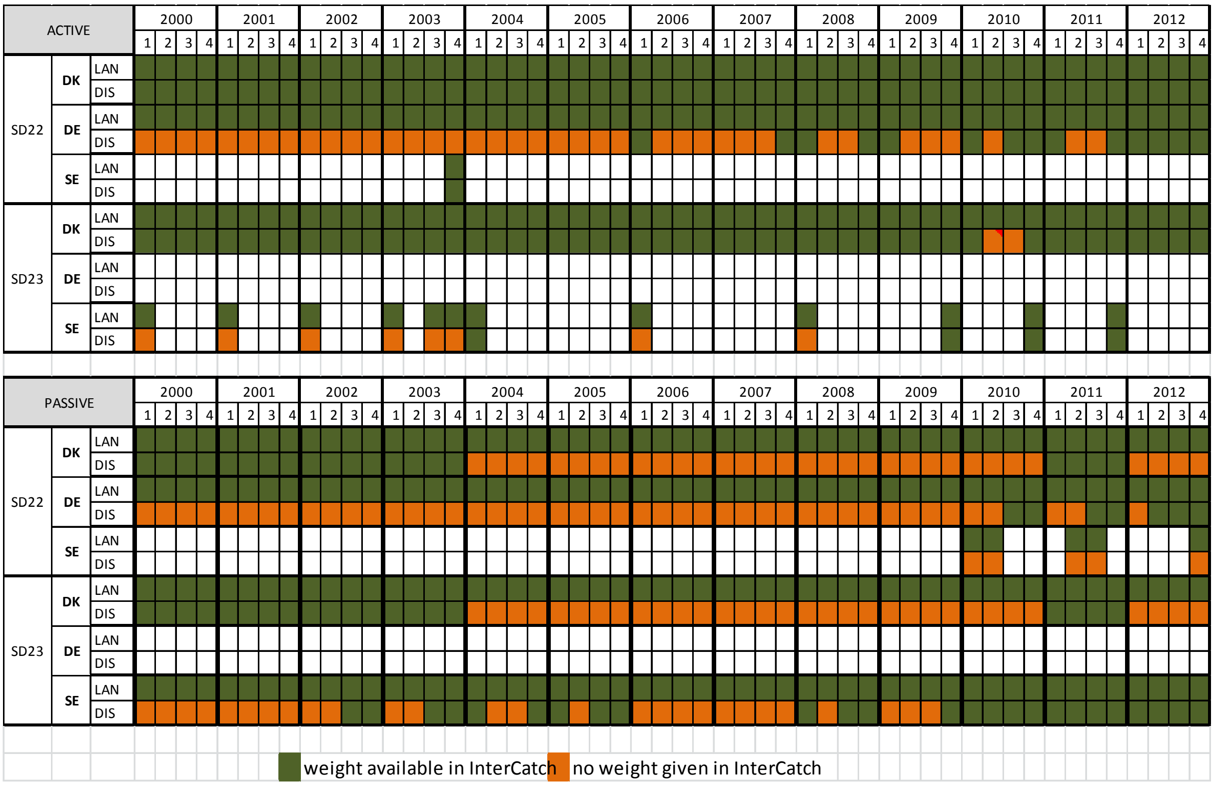


Figure 1: overview of weights for landings and discards as submitted by countries to the ICES-database InterCatch

In strata where no weight-information were available, the value was estimated using similar strata. However, no estimation was made for strata not have a landing or discard assigned, since it was not possible to dertermine wether it is due to "no catch" or "no landing" (100% discards).

Missing values were assigned using a general pattern. As far as possible, the estimation was done directly in InterCatch. Remaining estimation (due to missing borrowing-functions in the database) were done manually.

Discard data from SD22 were available from Denmark, Germany and Sweden, but did not cover the whole time period or fleet. Germany provided only landings for the period of 2000 to 2005 (Passive fleet: 2000 to 2008), Sweden almost has no landings in SD22. Denmark is the main fishing country in this area and provided landing and discard-data for the Active fleet. For the Passive fleet, Denmark stopped its sampling-program in 2004, so Discards are only available for the period 2000 to 2003 (and in a small extent in 2011).

Germany has no fishing activities in SD23, so no sampling took place there. Landing and Discard-weights were available from the Danish fishing fleet (2000 to 2012). Like in SD22, Discard sampling in the Passive fleet segment stopped in 2004, so no information on discards where available in this period.

Sweden only has a marginal Active fishery in SD23, whereas the Passive segment is fishing throughout the whole year. Discard-weights were provided for the main fishing seasons (i.e. first, fourth quarter and some third quarter, see table 1). No discard-estimations were made for 2000- 2001 and 2006-2007.

Raising procedure was performed for each of 4 flounder stock units separately. The Discard of flounder is very variable; it is driven by area and local/national markets and capacity. The amount of Discards is not only driven by flounder-market, but influenced by market-prices of cod and plaice as well.

Based on discussions in Data Compilation Workshop, following approach was used in discard raising procedure. When filling the gaps, where no discard information was available, the process was done stepwise:

a.) same country, same fleet, same Subdivision (+/- one quarter)

b.) same fleet, same Subdivision, same quarter (country with similar discard pattern)

c.) same fleet, same subdivision, similar country (+/- one quarter)

d.) same country, same fleet, same quarter, different subdivision

e.) apply Discard-weight manually (e.g. average weights)

After applying the borrowing schemes in InterCatch, there were still gaps in data, where the database was not able to find fitting discard-strata to borrow from; those were filled manually after downloading (This was done by e.g. using average discard-rates of the same country or discard-rates from following years; Figure 2 states all used Discard-schemes).

To calculate total catch, a survival rate (agreed during DCW 2013, Table 2) was applied to discards. Total catch was calculated using formula

Catch = Landing + (Discard * (1-Survival-rate))

Table 1: Survival rate of flounder in the Baltic Sea

Quarter	Survival rate
1	50%
2	10%
3	10%
4	50%

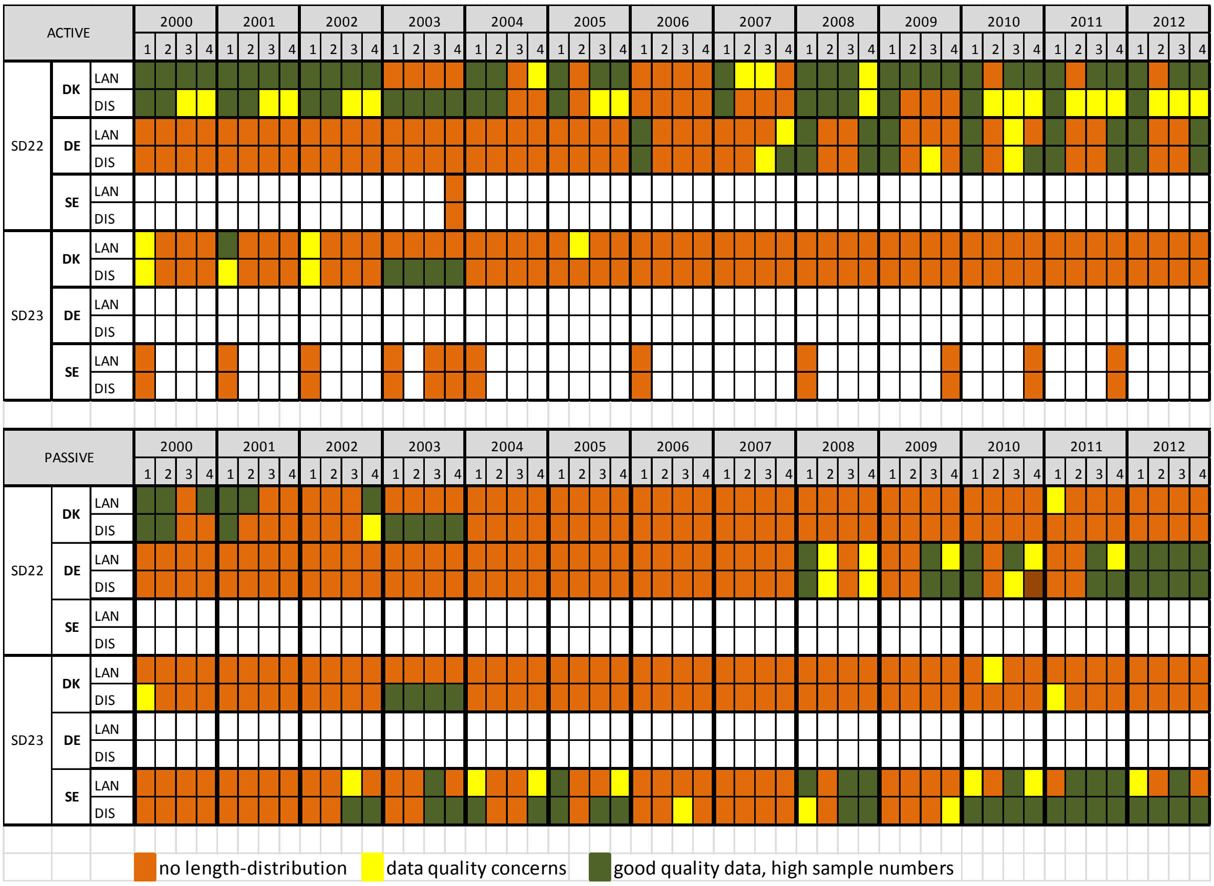
The Survival rate was calculated in MS Excel due to a lack of a corresponding function in InterCatch.

Working document 2: data quality and numbers at Length borrowing scheme

Sufficient data for catch length-distributions for FLE-2223 in the strata were often only available from 2008 onwards. The time period from 2000 to 2007 is mostly driven by Danish data (Discard-data from Active fleet segment).

While compiling the length-data and preparing them for raising, some data issues occurred that have an influence on the data quality.

Data were therefore classified into three categories (no data, data with quality issues and data of a good quality) and listed by country and per fleet, subdivision and quarter (Figure 1). Data quality concerns were e.g. low numbers measured, unrealistic numbers or unknown raising procedures .



Datasets (i.e. numbers at length) which are classified as "data quality concerns) were not used for extrapolation or borrowing.

The sampling-coverage of the passive fleet segment in general is very poor. Denmark stopped its sampling program for this segment in 2003, Germany only started to sample this segment in 2008. Sampling intensity is increasing since 2009, with increasing numbers of measured and aged fishes in all countries.

The length-distribution from the sampling-programs was used for raising the number per length-class up to the catch. Raising was first done per country and later, if needed, for the whole catch per area and quarter. No differentiation in sex was made.

Mean weights-per-length classes were only available from Germany and DATRAS (BITS). Gaps were filled using a multiple step-approach reducing the quality of the weight-data with each step

a.) sampling data (taking from similar strata, e.g. neighbouring quarter or country with similar fishing patterns for the fleet-segment b.) mean value from length-weight-relationship (sample data, same quarter)

c.) mean value from length-weight-relationship (sample data, all quarter)

d.) DATRAS data, same year (Q1 for 1st and 2nd quarter, Q 4 for 3rd and 4th quarter)

e.) DATRAS data, mean value from all years (Q1 for 1st and 2nd quarter, Q4 for 3rd and 4th quarter)

f.) other source (each field commented)

DATRAS data from BITS-survey were only used to fill gaps, where no mean weights from commercial sampling were available, which is only the case in very small fishes (<10 cm TL).

Length-distributions and were assigned to more then two thirds of the catches by borrowing from a sampled stratum. It is not recommended to use these matrices to perform anything more then exploratory analytical assessments.

Additionally, no individual weights from commercial-sampling or Survveys were available for SD 23, all values were extrapolated from SD 22. However, the fishing pattern in SD 23 is different from the fisheries in SD 22, where more active fishery takes place, so that this extrapolation might not picture the real length-distribution in commercial catches/landings in SD 23.

The national length-distributions were combined to a single length-distribution per area and quarter in a given year and afterwards combined to a single length-distribution per area and year.

For slicing, data were prepared as a single length-distribution for the whole commercial catch (with an applied survival-rate) for a given year, combining quarter and fishing-gears.

Data were not separated by Sexes, since only German data were available and not representative for larger length-classes (where often just one or two individuals per stratum were caught).

Working Document 3: Sclicing and Internal Consistency / Input data exploratory SAM

Length-data were sliced using van-Bertalanffy Grwoth equation (Using the slicing function in R, Copyright Laurence Kell, Alexander Kell, Finlay Scott, Chato Osio, Max Cardinale, 2011), using the following parameters

$$L(t) = L_{\infty}(1 - e^{-K(t-t_0)})$$

- Linf = 50.52, K = 0.179, t0 = -0.744
- Age+ group was set to 10

The slicing was conducted for length-distribution from commercial catches, as well as CPUE from 1st and 4 th quarter BITS. The resulting numbers-at-Age matrix was tested for internal consistency

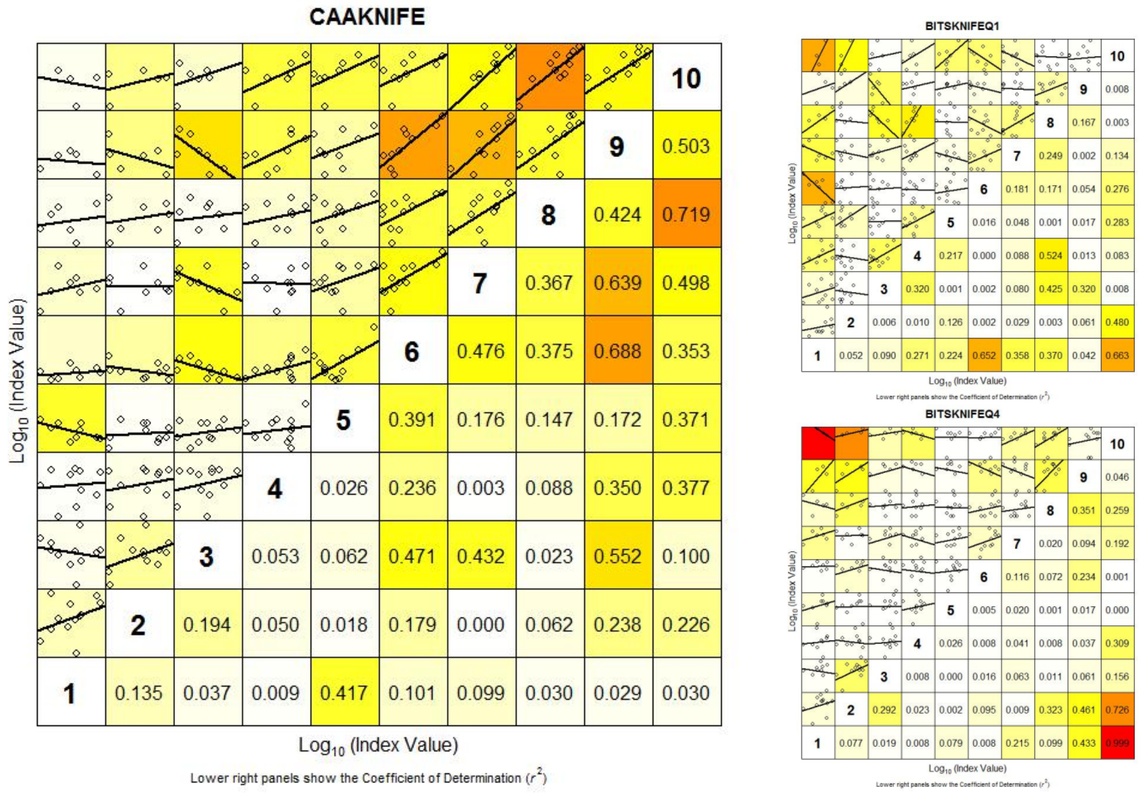


Figure 3.1 Internaal consistency plots from knife-edge slicing of numbers-at-length-matrices (left panel: sampling data, right panels: Survey CPUE)

For the exploratory analytical assessment, data from sampling and BITS were used as input to perform a State-space fish stock assessment model (SAM).

1. Catch at Age (CAA)

- Resulting from numbers-at-length-Slicing (knife-edge)
- Numbers were raised from national length-sampling data to Catch per quarter
- Plusgroup at Age 10, numbers in thousands

```
catch in numbers (thousands)
1	2
2000	2012
1	10
1
22.647	828.718 1707.747	1298.908	1392.964	1456.528	616.120 359.506 180.283 195.997
3.266	2482.653	3349.843	1167.759	1050.156	830.982 368.782 270.337 192.051 234.224
35.122	772.984 1851.44 1011.535	703.347 715.345 456.671 283.971 153.992 245.789
3.728	501.87	990.797 515.807 572.594 606.198 318.096 222.364 222.132 323.636
2.338	545.337 2458.865	1870.726	734.252 513.146 248.28	121.701 65.159	85.578
2.775	798.559 2766.997	526.783 369.694 276.666 125.867 97.276	38.506	76.452
10.429	1046.705	2496.344	677.557 724.761 481.443 273.626 148.851 51.692	94.486
48.573	712.945 2714.851	1250.222	538.004 345.792 109.832 105.767 47.662	67.868
6.615	412.595 1675.176	1734.532	1015.946	470.465 146.805 41.396	24.598	48.527
3.269	284.208 1105.204	1612.552	852.015 450.371 220.753 156.109 53.209	97.689
0.527	336.727 1163.688	1473.817	783.267 375.972 77.096	34.013	17.045	61.723
1.711	238.324 1281.721	944.243 658.558 386.228 144.185 58.574	43.246	68.815
5.076	232.764 1170.715	1678.86 882.618 430.538 139.157 104.588 26.394	29.072
```

2. Weight at Age (WAA) and mean stock weight (SW)

- Resulting from average weights-per-age from commercial samples
- Sample-weights from 2008 to 2012 were averaged and extrapolated back to 2000
- Average 2008-2012 is also mean stock-weight
- German data only

```
weight in catch (kg)
1	3
2000	2012
1	10
1
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.090	0.155	0.255	0.361	0.490	0.549	0.639	0.723	0.871	1.004
0.081	0.098	0.198	0.292	0.366	0.438	0.626	0.725	0.681	1.323
0.119	0.136	0.233	0.332	0.423	0.508	0.593	0.705	0.929	0.984
0.075	0.178	0.276	0.367	0.515	0.614	0.687	0.801	0.994	1.022
0.092	0.195	0.289	0.415	0.582	0.657	0.702	0.793	0.775	0.766
0.082	0.168	0.279	0.401	0.565	0.530	0.587	0.591	0.977	0.927
```

3. CPUE from BIT-Survey (survey)

- Taken from DATRAS, CPUE-values from SD22 only
- Separated by quarter

```
flounder CPUE from BITS
102
BITS Q1. SD22
2001    2012
1   1   0.0 0.25
1   9
1   0.51    7.10    10.70   13.59   10.62   8.12    2.93    1.75    0.74
1   2.31    4.79    16.07   22.05   11.01   5.12    1.76    0.98    0.62
1   0.75    13.68   19.70   15.84   6.95    6.57    1.80    1.33    0.54
1   7.46    4.67    14.43   18.54   10.45   5.72    1.80    1.32    1.21
1   0.15    4.15    9.71    20.22   12.59   8.41    2.97    1.14    1.55
1   0.06    2.76    11.65   25.07   19.60   11.01   3.46    3.28    1.67
1   1.44    15.92   26.68   23.09   10.22   4.75    2.50    1.89    0.90
1   1.18    5.15    9.50    22.52   15.69   9.05    2.75    1.02    1.66
1   5.85    4.50    11.57   14.74   6.07    4.82    2.96    2.25    0.54
1   6.11    19.52   37.52   33.59   15.41   9.73    3.28    2.63    1.85
1   3.00    8.03    25.86   53.00   28.84   15.38   5.29    3.94    2.96
1   3.86    81.11   50.71   41.12   23.54   11.78   4.29    2.06    1.32
BITS Q4. SD22
2001    2012
1   1   0.75    1.0
1   9
1   0.751   4.295   7.275   9.324   3.446   1.549   0.798   0.020   0.279
1   2.220   51.823  48.088  27.536  5.749   3.836   0.452   0.106   0.020
1   4.122   37.152  20.201  15.479  6.340   2.104   0.625   0.106   0.020
1   0.332   2.047   9.199   11.186  4.177   1.326   0.625   0.193   0.279
1   0.060   0.838   0.990   3.618   0.980   0.462   0.193   0.106   0.366
1   1.529   9.049   10.293  31.124  16.852  9.192   2.094   0.539   1.057
1   4.727   30.075  18.883  15.351  9.918   6.253   1.922   0.625   0.798
1   1.961   19.932  20.690  15.727  7.646   4.091   2.007   1.921   0.798
1   0.665   29.177  44.377  24.645  9.275   6.177   1.316   0.798   0.366
1   1.442   15.107  34.267  38.570  16.286  4.807   2.833   1.070   0.538
1   12.070  82.650  28.402  21.589  12.485  3.540   0.711   0.106   0.193
1   11.551  30.905  77.560  96.181  36.678  8.647   3.885   6.973   0.020
```

4. Maturity ogive (MO) and Natural mortality (NM)

- Taken from DATRAS (MO),
- values from 2008 to 2012 were averaged for 2000 to 2007
- NM was set as constant 0.2

```
maturity ogive (from BITS, both quarter combined)
1   6
2000    2012
1   10
1
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.12    0.56    0.81    0.95    0.94    0.94    0.88    0.88    0.90    0.87
0.00    0.40    0.70    0.90    1.00    1.00    0.90    0.80    0.85    0.40
0.05    0.60    0.75    0.95    1.00    0.95    0.65    0.95    0.80    0.50
0.15    0.60    0.80    0.95    1.00    1.00    0.95    1.00    0.85    0.90
0.30    0.55    0.90    0.95    0.90    1.00    1.00    0.70    1.00    1.00
0.05    0.65    0.90    1.00    0.80    0.80    0.90    1.00    1.00    0.70
```

```
natural mortality
1   5
2000    2012
1   10
1
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2
```

Working Document 4: Output from exploratory Sam-runs

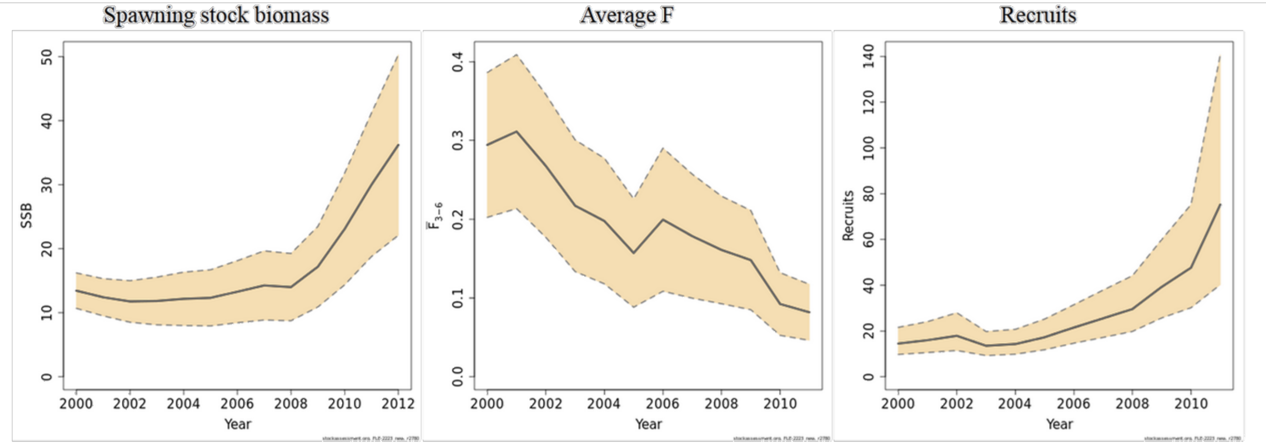
Different runs with different setting were conducted, using the SAM-Web application (stockassessment.org). From the first runs (random wlk with no changes in basic settings), parameter were refined with each runs, minimizing variance and residuals from the results.

For the latest run in the exploratory assessment, the F_{bar} was set to cover the ages 3-6, which seem to be completely assessed by the fishery. Different Parameter in older age-classes (Ages >7, not fully covered by commercial fisheries) were coupled to minimize the influence (Figure 4.1)

```
# Min Age (should not be modified unless data is modified accordingly)
1
# Max Age (should not be modified unless data is modified accordingly)
10
# 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   8   8
0  0   0   0   0   0   0   0   0   0
0  0   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   0   0
1  2   3   4   5   6   7   7   7   0
8  9   10  11  12  13  14  14  14  0
# Coupling of power law model EXPONENTS (if used)
0  0   0   0   0   0   0   0   0   0
0  0   0   0   0   0   0   0   0   0
0  0   0   0   0   0   0   0   0   0
# Coupling of fishing mortality RW VARIANCES
1  1   1   1   1   1   1   1   1   1
0  0   0   0   0   0   0   0   0   0
0  0   0   0   0   0   0   0   0   0
# Coupling of log N RW VARIANCES
1  2   2   2   2   2   2   2   2   2
# Coupling of OBSERVATION VARIANCES
5  1   1   1   1   1   1   1   1   1
3  2   2   2   2   2   2   2   2   0
4  4   4   4   4   4   4   4   4   0
# 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
```

Figure 4.1 Setting for exploratory SAM-assessment conducted on FLE-2223, covering the period of 2000 to 2012.

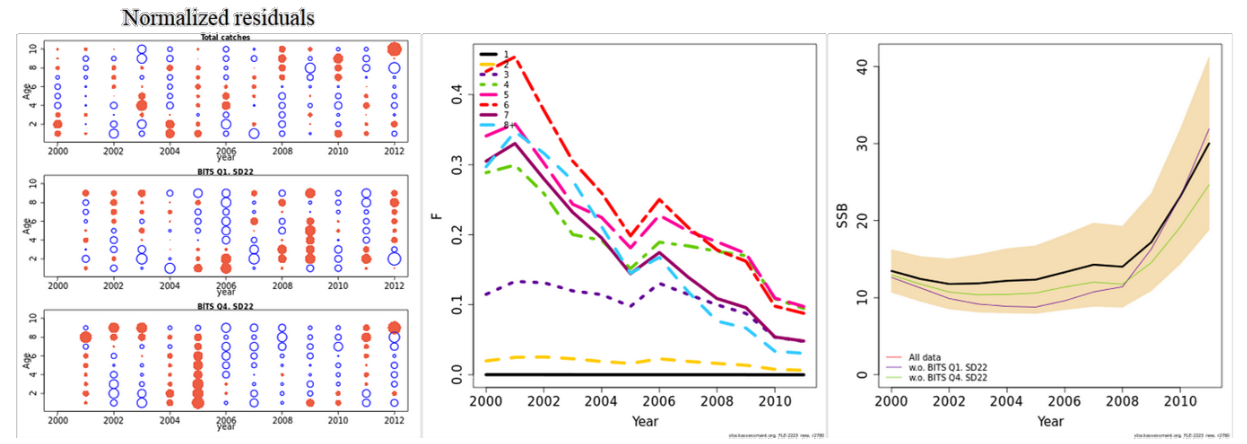
Results from latest run (using setting from Figure 4.1)



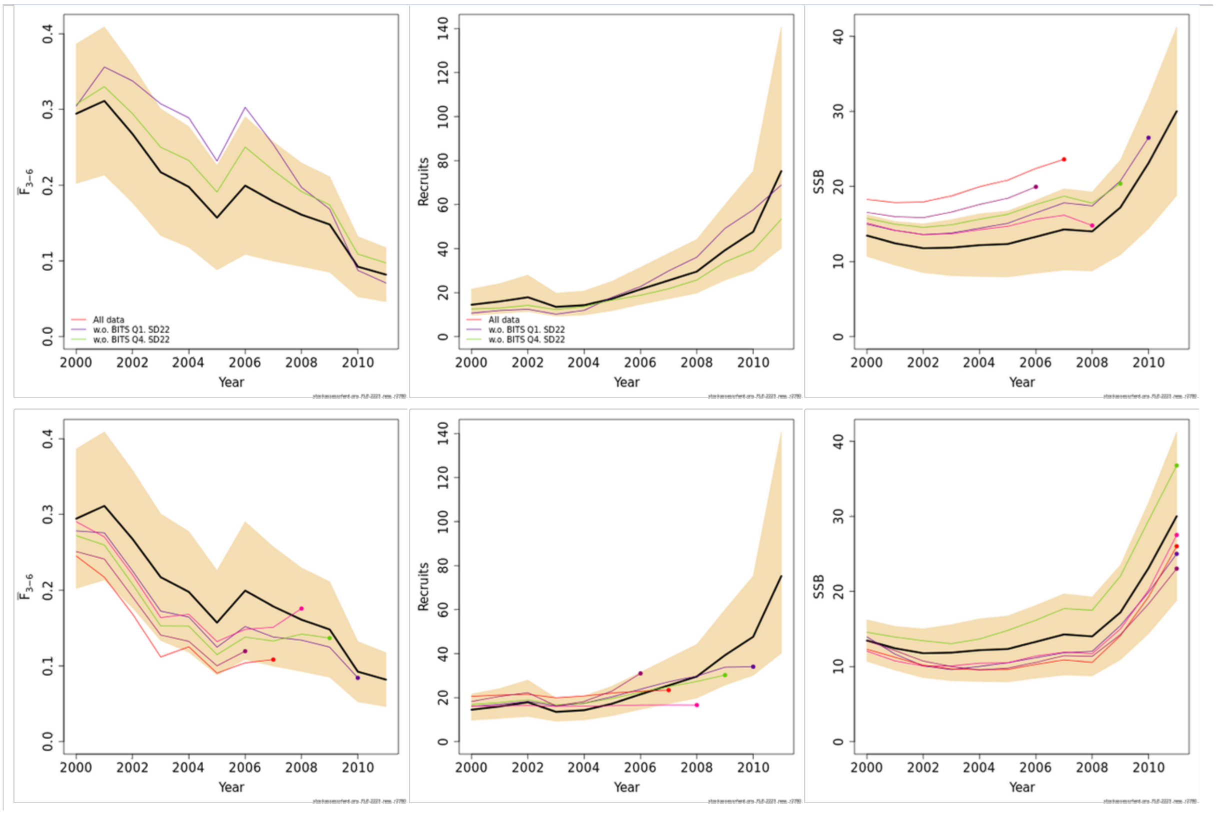
Spawning stock biomass. Estimates from the current run and point wise 95% confidence intervals are shown by black line and shaded area. The perviously saved 'baserun' is the overlying gray lines.

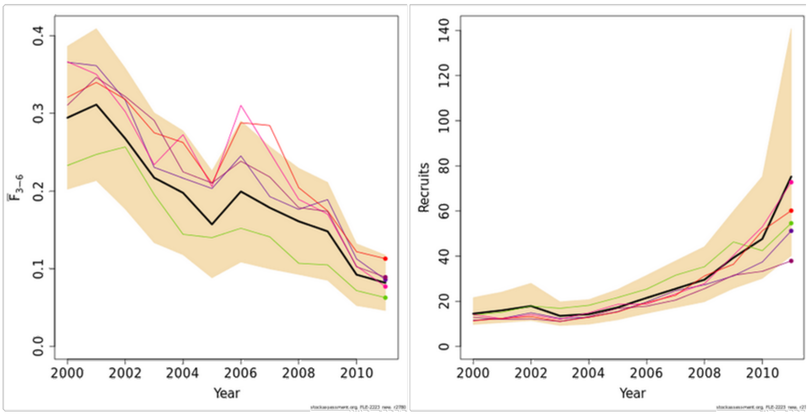
Average fishing mortalities. Estimates from the current run and point wise 95% confidence intervals are shown by black line and shaded area. The perviously saved 'baserun' is the overlying gray lines.

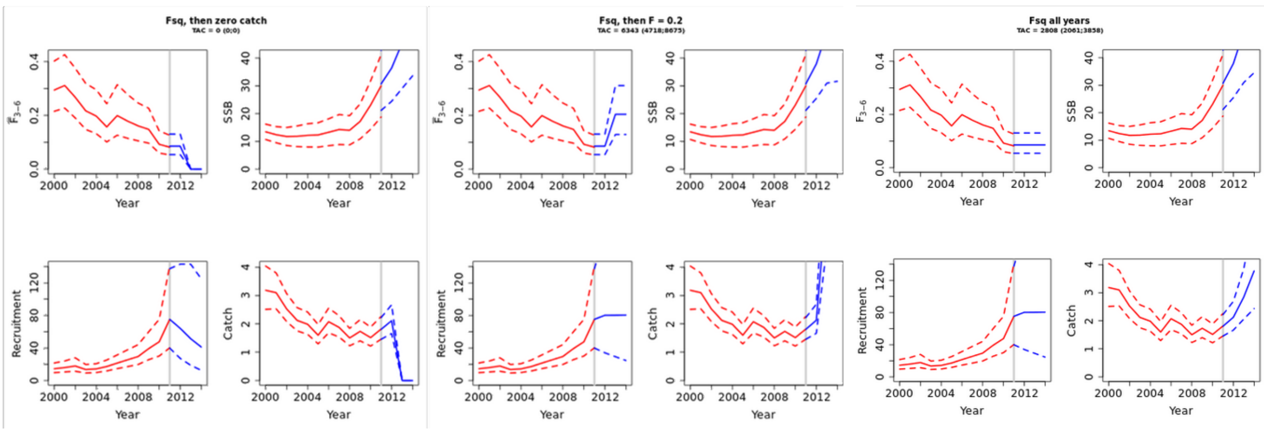
Number of recruits entering the population. Estimates from the current run and point wise 95% confidence intervals are shown by black line and shaded area. The perviously saved 'baserun' is the overlying gray lines.



Normalized residuals for the current run. Blue circles indicate positive residuals (obs larger than predicted) and filled green circles indicate negative residuals.


All data
w.o. BITS Q1. SD22
w.o. BITS Q4. SD22
Year
Recruits
SSB


Year
Recruits


Fsq, then zero catch
TAC = 0 (0;0)
Fsq, then F = 0.2
TAC = 6343 (4718;8675)
Fsq all years
TAC = 2808 (2061;3858)
Year
SSB
Recruitment
Catch

Working document for the 2014 benchmark WG of WKBALFLAT/relevant stock annex in relation to the estimates of Finnish recreational Flounder catches by Jukka Pönni.

Estimation of Finnish recreational catches: Quality description

Introduction

The statistics on recreational fishing presents the number of fishing households and persons, the number of those using different gear types, the number of fishing days and the catch by all species, by gear type and by fishing area.

These statistics have been produced by the Finnish Game and Fisheries Research Institute. Producing statistics is one of the continuous basic duties laid down by law for the research institute and it is funded from the central government Budget. The statistics on the recreational fishing were drawn up by Pentti Moilanen, researcher at the Finnish Game and Fisheries Research Institute.

The Advisory Board of the Official Statistics of Finland determines criteria for the statistics. The quality description presented here includes items recommended by the Advisory Board. Further information on the statistics is available at www.stat.fi/meta/svt/laatuseloste_en.html

Relevance of statistical information

Recreational fishing statistics are used to monitor the state of fish stocks and trends in recreational fishing. The data are also needed to evaluate the social significance of recreational fishing. One part of the presented catch estimates includes to the obligations of fishery data collection program of EU (EC Regulation No. 1639/2001). The catch estimates of recreational fishing are also included to the statistical program of FAO.

The data is collected by postal questionnaire using a sample drawn from the population register maintained by the Population Register Centre. The statistical unit in the recreational fishing statistics is the household. The term recreational fishing includes all the fishing practised by Finnish households with the exception of that carried out by professional fishermen and their households. The statistics do not include fishing by foreign visitors to Finland or by Finns abroad.

Fishing was considered as such when a person has used gear of some kind at least once in the year. With respect to the fishing law the person is considered to have fished even if he or she had only rowed or steered the boat while someone else was fishing.

The definition of a fishing day depends on the type of gear used. In the case of rod and line, a fishing day means that one person has used a certain type of rod on one day. In the case of gill nets, fish traps, crayfish traps and trap nets, a fishing day means that the person has inspected the gear in question on one day.

The division of fishing areas follows the Fishing Industry Units of the Employment and Economic Development Centres (Fig. 1). Another division follows the provincial division (Fig. 2) in the inland water area. In the sea area the subareas were divided also by the boundaries of Uusimaa – Varsinais-Suomi, Varsinais-Suomi – Satakunta and Ostrobothnia – Central Ostrobothnia regions. The division is slightly different from the International Council for Exploration of the Sea (ICES) division in the sea area. The fishing days were allocated to the statistical areas by gear type. Catches were reported as ungutted weight and were allocated by species to the statistical areas according to the most important fishing area for the species.

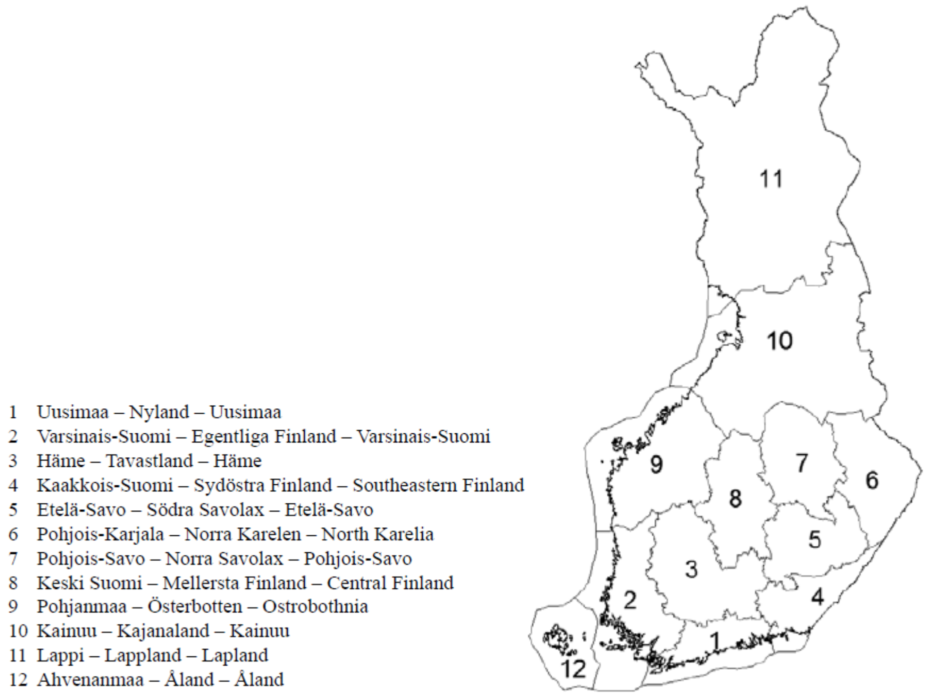


Figure 1. Centres of Economic Development, Transport and Environment (fishery units) and Åland

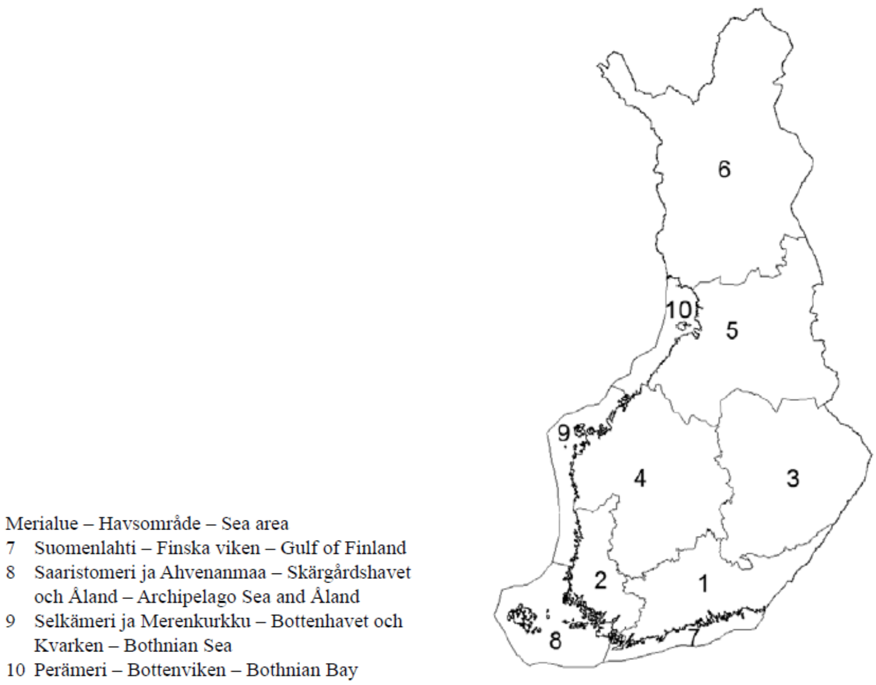


Figure 2. The area division by Regional State Administrative Agencies and by sea areas

Correctness and accuracy of data

The annual sample comprises 6000 household-dwelling units. One household-dwelling unit consists of the persons living permanently in the same dwelling and comprises one or more households. The sampling is targeted at persons aged 18-74 years.

The sample design is stratified sampling. The strata are formed taking into account the location of the person’s municipality of residence (Helsinki metropolitan area, other Southern Finland, Western Finland, Eastern Finland, Province of Oulu, Lapland and Åland), the type of municipality (urban, densely populated or rural) and the location of the municipality in relation to the sea (archipelago, coast, inland). There are six strata in all.

The questionnaire has four pages, and the focus of the questions is on the age and gender of the persons in the households and the persons participating in fishing, the importance of fishing as a hobby, fishing activity by fishing area, and catch sizes. The survey has been conducted at the beginning of every odd year. Contact is made three times. The number of returned questionnaires has usually been about 50 per cent of those posted.

All the forms are checked before data is recorded. The recorded data are also submitted to various logic and limit value editing procedures. Discrepancies and any errors found are checked against the original forms and, if necessary, the data record is amended.

The responses are rejected if it is not clear whether the household had been fishing or not. The responses are checked against the registers of professional fishermen at the disposal of the Finnish Game and Fisheries Research Institute, and rejected if the respondent is found in the register. The computation data includes the responses of fishing households and non-fishing households.

For a sample of those who do not respond to the postal questionnaire, post-sampling is conducted as a telephone interview.

For the computation, a weighting factor is formed for each statistical unit, or household. The survey data (e.g. catch size) for the household are then multiplied by that factor. The weighting factor is formed from the inverses of the inclusion probability and response probability of the sampling unit, that is, household-dwelling unit, and from the calibration weight. The bias caused by non-response is corrected using the homogeneous response group model. The sample is divided by stratum into two homogeneous response group sets within which the probability of responding is considered to be constant. The first group comprises of those responding to the questionnaire at first and second contacts, and the second group of those responding at the third contact.

In the calibration, the distributions to be calculated from the sample can be made to correspond to the marginal distributions. Such marginal distributions are the number of households in six household groups and the number of households by the Fishing Industry Unit obtained from the income distribution statistics of Statistics Finland, the age distribution of men and women and the number of men and women by the Fishing Industry Unit obtained from population statistics, and the number of fishing households by strata estimated using both postal questionnaire and telephone interview data. The household groups are formed according to the size and age distribution of the household. The calibration corrects the bias in the estimates arising from non response, as the size, structure and place of residence of the household all have an effect on response activity.

The partial loss due to missing data items is taken into account using hierarchical imputation, in which the missing item is replaced with a value obtained from the data record. In practice, the estimation is carried out with SAS software and the SAS macro CLAN97 developed by Statistics Sweden. Imputation of the partial loss is done with SOLAS software.

Unreliability due to sampling is depicted by the 95 per cent confidence interval presented in the tables. The reliability of the results is also indicated by the coefficient of variation in the tables. Its interpretation is simple. The smaller the coefficient of variation, the more reliable is the estimate. If the coefficient of variation is, for instance, 12.5 per cent, the lower and upper limits of the confidence interval differ from the estimate by about 25 per cent, that is, the total length of the confidence interval is about half of the estimate. In terms of the sampling error these estimates can be considered relatively reliable in fishing surveys. If, however, the coefficient of variation is 50 per cent, the lower and upper limits of the confidence interval differ from the estimate by 100 per cent, that is, the total length of the confidence interval is twice the estimate. The reliability of a certain catch estimate depends on how many households engaging in fishing have caught the species in question and on how great the differences are between the catches of various households. Thus, the most unreliable estimates refer to catches of species taken by only a few households or to catches with great variation.

Household-dwelling units in which all persons are aged 75 or older are not included in the sampling. Nor are persons permanently resident in institutions, e.g., old persons' homes. For recreational fishing, however, this under coverage is small. The effect of the measuring error has not be established in this context.

Timeliness and promptness of published data

The recreational fishing statistics are issued every other year (even years). The results are published by the end of September in the following year. Information on the issue schedule is available on the Finnish Game and Fisheries Research Institute's website at www.rktl.fi/english/statistics

Coherence and comparability of data

The numbers of fishing households and of persons engaging in fishing are measured by the same method.

When comparing the numbers of fishing days using stationary gears (gill net, fish trap, crayfish trap and trap net) the figures refer to the number of times the gears were inspected and notto the soaking time.

The estimates presented for recreational catches in 2002-2012 are somewhat lower than those given in statistics in the 2000 statistics. The difference is attributed largely to the method used in the 2002-2012 statistics, which has sought to take selective non-response into account more accurately than before. The changes in methods are described more closely in Finnish in the Internet pages of the Finnish Game and Fisheries Research Institute

www.rktl.fi/tilastot/kalastustilastot/vapaa_ajankalastustilasto

Table 1. Estimated Finnish recreational flounder landings 2000-2012. Recreational catches are estimated every second year by a mail survey(for a large sample of the households from the whole population) and assumed to be the same as the year before in the intermediate year. The catch is not divided into year quarters, it is only one figure for the whole year. The entire recreational flounder catch is taken by passive gear from SD's 29-32. The annual recreational catches are separated into year-quarters according to the annual landings distribution of the professional fishery.

Sum of RECREATIONAL		Quarter				
Year	SubDiv	1	2	3	4	Grand Total
2000	BAL29	2314	24285	139989	20413	187000
2000	BAL30	4405	11205	11179	3212	30000
2000	BAL31		833	167		1000
2000	BAL32	10218	16512	117209	12062	156000
2000 Total		16936	52835	268543	35686	374000
2001	BAL29	3818	34879	133782	14520	187000
2001	BAL30	3741	10324	10791	5144	30000
2001	BAL31		868	132		1000
2001	BAL32	10628	21606	113291	10475	156000
2001 Total		18187	67677	257995	30140	374000
2002	BAL29	1752	17288	54831	4129	78000
2002	BAL30	8253	22243	22804	9699	63000
2002	BAL31					
2002	BAL32	371	1597	11647	385	14000
2002 Total		10376	41128	89283	14214	155000
2003	BAL29	1397	14896	57037	4669	78000
2003	BAL30	10015	24860	24623	3503	63000
2003	BAL31					
2003	BAL32	275	2060	11093	571	14000

2003 Total		11688	41816	92753	8743	155000
2004	BAL29	1751	11298	48225	2726	64000
2004	BAL30	752	1016	771	461	3000
2004	BAL31					
2004	BAL32	535	1099	9745	621	12000
2004 Total		3038	13413	58742	3808	79000
2005	BAL29	855	13744	45533	3868	64000
2005	BAL30	282	847	1259		2389
2005	BAL31					
2005	BAL32	367	2169	8425	1040	12000
2005 Total		1503	16761	55216	4908	78389
2006	BAL29	1399	7902	35713	2986	48000
2006	BAL30	299	817	766	118	2000
2006	BAL31					
2006	BAL32	768	3538	19017	1678	25000
2006 Total		2465	12258	55496	4781	75000
2007	BAL29	747	9034	36492	1727	48000
2007	BAL30	191	785	718	306	2000
2007	BAL31					
2007	BAL32	811	3787	19609	793	25000
2007 Total		1748	13606	56820	2827	75000
2008	BAL29	510	4964	20426	1099	27000
2008	BAL30	465	3358	2220	958	7000
2008	BAL31					
2008	BAL32	134	956	4443	468	6000
2008 Total		1109	9278	27088	2525	40000
2009	BAL29	818	4330	19959	1893	27000
2009	BAL30	512	3914	1838	736	7000

2009	BAL31					
2009	BAL32	533	1170	3836	461	6000
2009 Total		1863	9414	25633	3090	40000
2010	BAL29	270	1790	6490	450	9000
2010	BAL30					
2010	BAL31		327	337	337	1000
2010	BAL32	92	170	689	49	1000
2010 Total		362	2287	7516	836	11000
2011	BAL29	129	1329	7055	487	9000
2011	BAL30					
2011	BAL31		531	469		1000
2011	BAL32	56	306	497	141	1000
2011 Total		185	2165	8022	628	11000
2012	BAL29	1177	5484	15737	1602	24000
2012	BAL30	156	500	275	69	1000
2012	BAL31					
2012	BAL32	794	2001	9640	565	13000
2012 Total		2127	7985	25652	2236	38000
Grand Total		71587	290622	1028760	114420	1505389

??

Annex 5: Stock Annexes

Stock Annex: Dab in the Baltic Sea (Subdivisions 22–32)

Stock-specific documentation of standard assessment procedures used by ICES.

Stock	Dab SD 22–32
Working Group	WGBFAS
Date	January 2014
Revised by	WKBALFLAT 2014/ Rainer Oeberst

A. General

A.1. Stock definition

Dab is distributed mainly in the western part of the Baltic Sea. Landings are mainly taken in SD 22, with smaller proportions in SD 24 and some commercial landings of dab are reported also in SD 25, 27 and 28 (Florin, 2005; ICES, 2010). The eastern border of its occurrence is not clearly described. Single specimens are caught only occasionally in the Polish EEZ (unpublished data, E. Gosz) as well as in SD 26–32 (Plikšs and Aleksejevs, 1998; Ojaveer *et al.*, 2003).

Temming (1989) mainly based on tags and meristic investigations by Jensen (1938), separated dab in the Belt Sea area (SD 22 and western part of SD 24, south of Mön) from dab in the Bornholm area (SD 25). Nissling *et al.* (2002) suggest two stocks of dab, one in SD 23 and western part of SD 24, and the second in the eastern part of SD 24 and SD 25 based on salinity requirements for egg development and neutral buoyancy of eggs.

Genetic analyses related to dab and direct comparisons between SD 23 and 22 are not available. Nevertheless, based on the data above (Temming, 1989; Nissling *et al.*, 2002) WKFLABA (ICES, 2010) suggested that there are three stocks in the Baltic Sea (Figure 1, ICES, 2010): one stock in Belt Sea SD 22 + 24W, one stock in Öresund SD 23 and one joint stock in Arkona and Bornholm basin (SD 24E + 25). It is unclear where the split of SD 24 would be located. WKFLABA concluded that it is possible that the Öresund stock should be merged with the Belt Sea stock, but, merging stocks that have independent dynamics can be considered a more severe error from a stock conserving point of view, than to erroneously divide a homogenous stock in two separate assessment units (c.f. Laikre *et al.*, 2005) (ICES, 2010). Hence WKFLABA proposed the separation of dab into three stocks in the Baltic (ICES, 2010).

Descriptions of the spatial distribution patterns of dab are available from the international coordinated **B**altic **I**nternational **T**rawl **S**urvey (BITS) in SD 21–28 in quarter 1 and 4 and the **I**nternational **B**ottom **T**rawl **S**urvey (IBTS) which covers the North Sea, the Skagerrak and the Kattegat in quarter 1 and quarter 4. Hydrographical data, especially salinity and oxygen content in SD 24 and SD 25 are available from BITS and from standard stations of the Institute of Baltic Sea Research-Warnemünde in the near bottom layer in spring. Salinity was only in some years (2003, 2005 and 2007) above 17.8 psu where ~1% of dab eggs will obtain neutral buoyancy, but it was always lower than the required mean salinity of neutral buoyancy (Nissling *et al.*, 2002). The required values of salinity were also not observed after the major inflow in 2003 (Oeberst, 2014c). Thus, poor hydrographical conditions in the prespawning and spawning period in combination with the very low cpue values in SD 24 and SD 25 in quarter 1 between 2001 and 2013 do not support the hypothesis of WKFLABA (2010) that there is currently a self-reproducing dab stock in SD 24W and 25. Based on these observations, WKBALFLAT decided to treat the area SD 22–32 as combined.

Further, the spatial distributions of dab based on BITS in quarter 1 and quarter 4 suggest the hypothesis that dab in SD 21 is connected to SD 22–32 (Oeberst, 2014a). Figure 2 shows the spatial distribution of dab during BITS in quarter 1 in 2003. The density of dab in the Arkona Sea and Bornholm Sea is very low also after the major inflow in January 2003. The stock separation between Skagerrak and SD 21 is supported by the spatial distribution of dab during IBTS in quarter 1 and 3. Cpue values of dab are very low in the Skagerrak during quarter 1 (Oeberst, 2014b). High cpue values were observed in the deeper area of the North Sea and in the southern part of the Kattegat as illustrated in Figure 3 for IBTS in quarter 1 in 2013. In quarter 4 dab was also observed in the shallow waters of the Danish coast of the North Sea and with low densities around Skagen (southern part of Skagerrak).

Therefore, it is possible that the dab in SD 21–32 should be considered as one stock. Further work is needed to validate this hypothesis, however, that was not possible to conduct as part of WKBALFLAT (ICES, 2014). Thus, dab in SD 22–32 is currently treated as a separate stock.

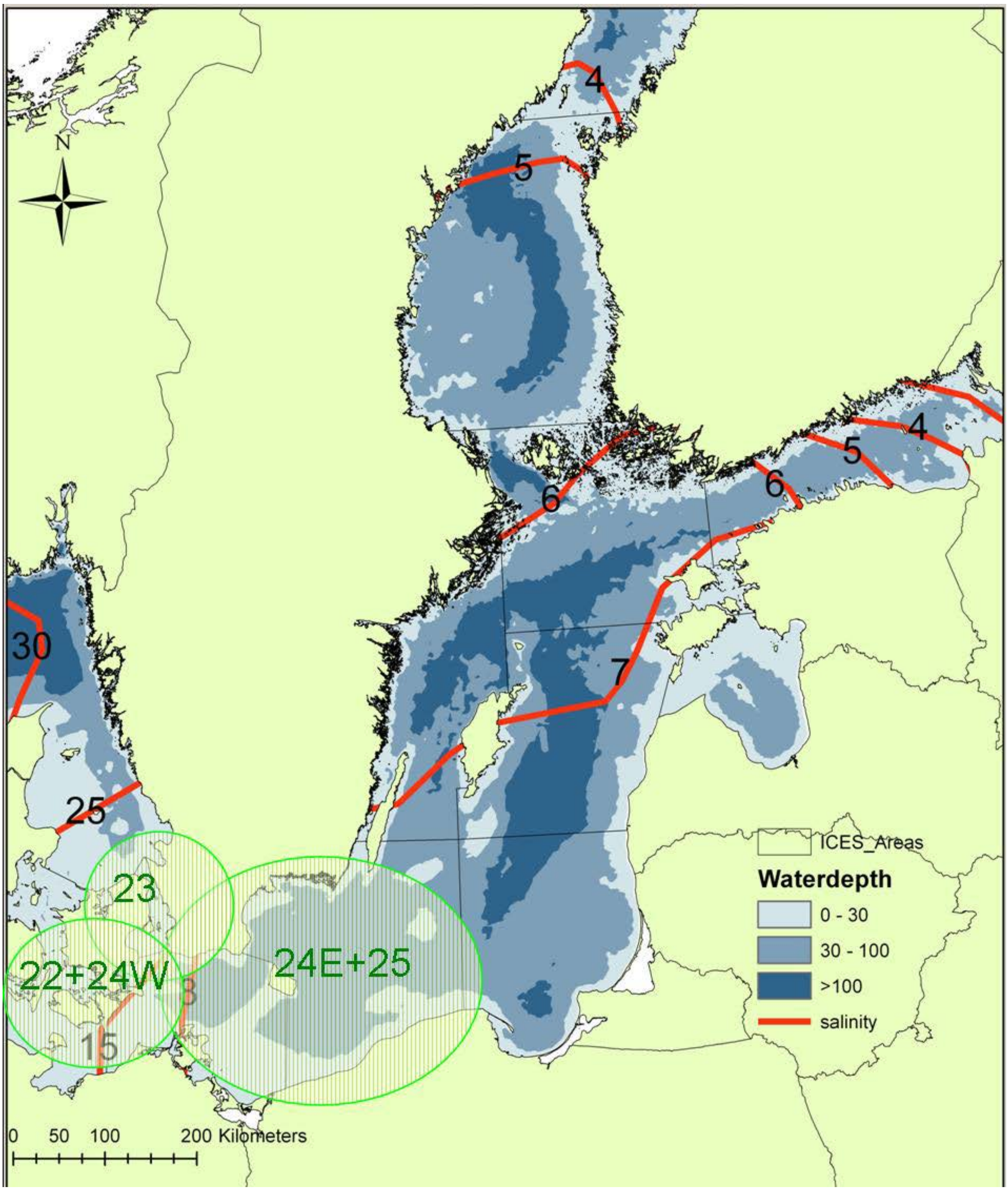


Figure 1. Approximate location of three identified stocks of dab in the Baltic Sea by WKFLABA (2010). Numbers within circles refers to ICES SD.

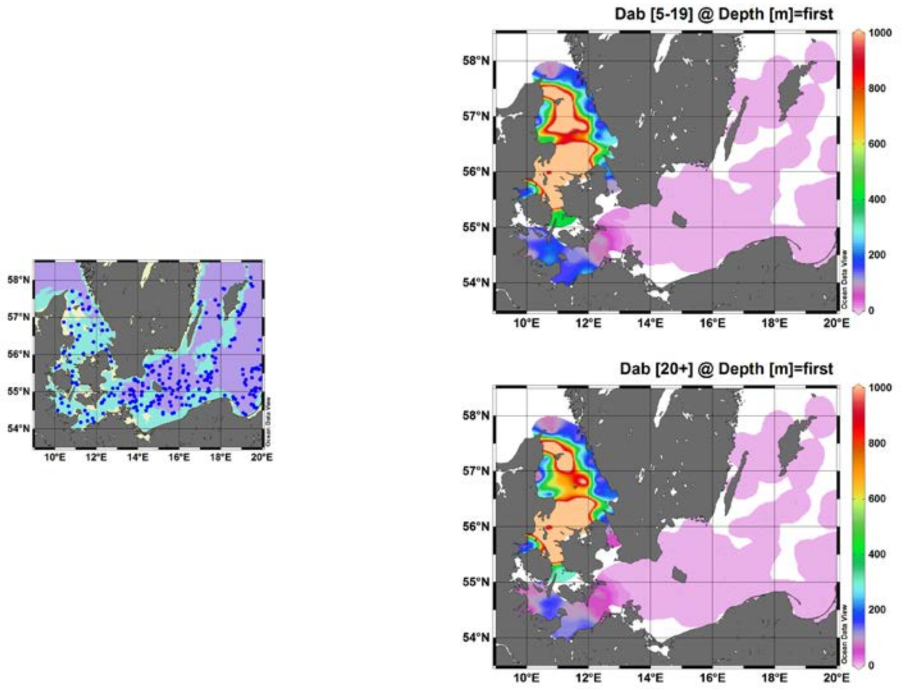


Figure 2. Position of fishing stations (left panel) and spatial distribution of dab <20 cm (right upper panel) and dab >19 cm (right lower panel) during BITS in quarter 1 in 2003.

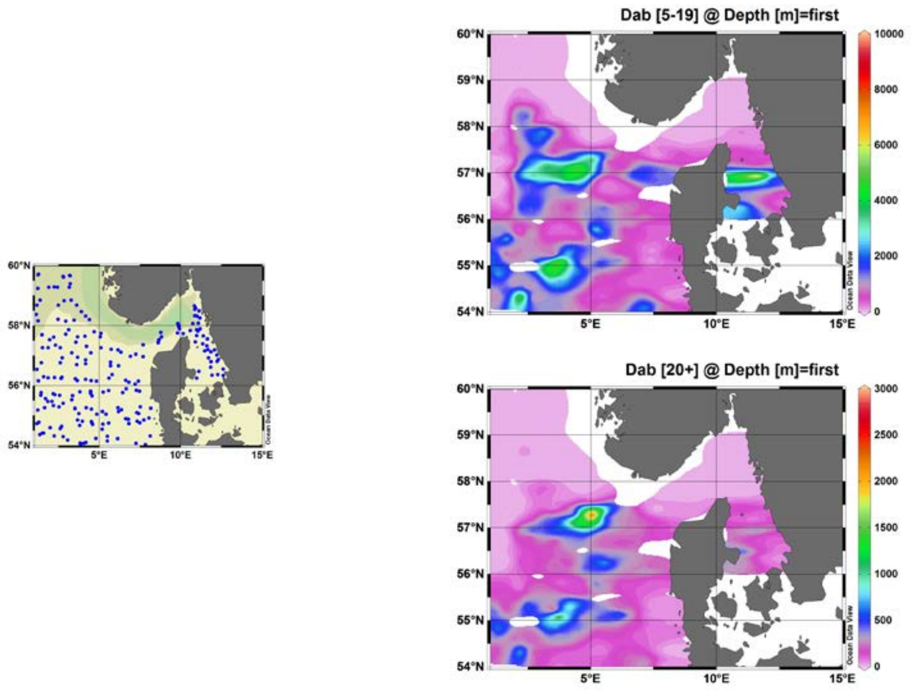


Figure 3. Position of fishing stations (left panel) and spatial distribution of dab <20 cm (right upper panel) and dab >19 cm (right lower panel) during IBTS in quarter 1 in 2013.

A.2. Fishery

Dab is captured as bycatch of cod, plaice and flounder fishery and is mainly landed in SD 22–24 (Figure 4), where between 86% and 100% of total landings were realized by Denmark and Germany. The landings of Sweden in SD 22–30 are of minor importance. Danish and German landings in SD 22 amount to more than 1000 tonnes yearly and represent 47% and 36% respectively of total landings in the Baltic Sea during the last three years (data from ICES, 2010). A significant yearly amount of landings from SD 24, around 100 tonnes, is removed by the same dominant countries, and commercial dab landings are reported to a lesser extent by Sweden in SD 25, 27 and 28 (Florin, 2005; ICES, 2010).

After the level of landings at about 2000–3000 t between 1981 and 1997 landings decreased to 715 t in 2002 followed by fluctuating landings around 1 250 t with increasing proportions of landings in SD 25. Estimates of the amount of discards in 2011 and 2012 showed that in some periods similar (or even higher) amounts of dab were discarded than landed. It was agreed that both discarded and landed dab should be taken into account for describing the total removal of dab from the stock by the fishery because the survival rate of discarded dab is very low (Mieske and Oeberst, 2014).

Minimum mesh opening size for dab is 120 mm and minimum landing size of dab is 25 cm. There is no seasonal protection of dab.

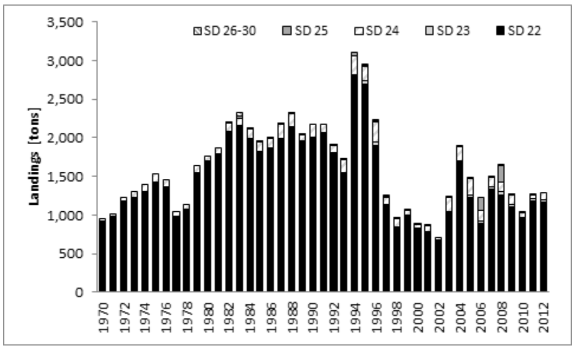


Figure 4. Landings of dab (tons) by ICES subdivisions from 1970–2012.

A.3. Ecosystem aspects

Analyses related to ecosystem aspects of dab in the Baltic Sea are not available.

B. Data

B.1. Commercial catch

Landings by countries and ICES Subdivisions are available from 1970 onwards. Estimates of discards were reported by countries from 2000 onwards. However, estimates were not available for all years, quarters and fisheries. The complex and unpredictable discard behaviour makes it very difficult to model the amount of the discard and makes the estimation of the discards very dependent on a proper sampling scheme. Unfortunately, the discard sampling is far from optimal because many strata are not sampled (Oeberst, 2014c). Consequently, the discard from those strata have to be estimated based on data from other strata where sampling has taken place in order to get an estimate of the total discard of the stock.

The amount of discard applied to a given data gap stratum was estimated based on the discard rate from the extrapolation source raised with landings for the data gap stratum. Because the dynamic in the discard pattern in most countries is more or less independent of the landing pattern for bycatch species, the result of the extensive data extrapolation will create a discard dynamic which does not reflect the true pattern. Because the discard constitutes such a significant fraction of the catches, the result will be, that the catch pattern is serious biased by the unrealistic discard pattern. As data gaps often are present in the same stratum through many years, the consequence of the bias could be that important year-class dynamics are levelled out or even that false year-class dynamics are introduced as well. All this provides a poor basis for the assessment.

Due to these issues, discard estimates are currently considered too uncertain to be used for advice purposes. Both long-term and short-term solutions were developed by WKBALFLAT (ICES, 2014) to improve the discard estimates in the future. Until then, only landings advice can be provided.

B.2. Biological

Length frequencies of landings and discards are available but have not been reported for all years, quarters and fisheries by all countries (Oeberst, 2014c). Age samples are available by Germany from 2008 onwards and by Denmark from 2010 onwards. Age samples were not available from Sweden. Exploratory analyses to derive catch in number by age group based on length frequencies have been carried out using different slicing methods. However, the estimates were considered uncertain due to large differences between results from the different slicing methods and from those based on age readings. Resolving age reading inconsistencies between Germany and Denmark would first be needed in order to obtain a solid basis for validation of the results from slicing methods in the future.

Mean weight-at-age and the proportions of spawner by age group are available for 2008 to 2012 based on BITS. Age samples were not available before 2008.

B.3. Surveys (BITS in quarter 1 and 4)

National bottom-trawl surveys were conducted in the Baltic Sea between 1978 and 2000 in quarter 1 and quarter 4. However, large parts of ICES SD 22 were not covered by the surveys. Baltic International Trawl Survey (BITS) was established in 2001 and was coordinated by WGBIFS. A new survey design was applied with randomly selected stations taken from the Tow Database. Small and larger versions of standard gear (TVS and TVL), which were adapted to the different sizes of research vessels, were used and conversion factors were estimated based in inter-calibration experiments to transfer the catch per unit of effort data of TVS into units of TVL. A constant conversion factor of 1.4 was used to transfer the cpue values of dab captured by TVS into units of TVL.

The mesh size in the codend of the standard gears is 10 mm suggesting that the catchability of dab larger than 11 cm is not influenced by the codend mesh size if it is assumed that the selectivity characteristics of dab and flounder are comparable (Oeberst, 2007). Around 300 fishing stations are planned for quarter 1 BITS and about 240 fishing stations for quarter 4 BITS, in the entire Baltic Sea each year. Hauls which were realized between 10 m and 19 m (BITS stratum 8) in SD 22–24 were taken into account. The mean cpue values were estimated according the procedures given in the BITS manual. The minimum observed length of dab during BITS was 4 cm and the maximum length was 40 cm. Truncation of length range for the stock assessment is not supported by the length distributions observed during BITS. Dab was mainly observed west of 12°E, but, dab was also captured east of 15°E in quarter 1 of many years (maximum 18°33’ E in 2008). Highest cpue values were observed between 10 m and 30 m. Collection of otoliths for age determination has intensified since 2011.

B.4. Commercial cpue

Data are not available.

B.5. Other relevant data

Data are not available.

C. Assessment: data and method

This stock is assessed using the method 3.2.0 of the ICES DLS methods (ICES, 2012). To apply the method the cpue per length of BITS-Q1 and BITS-Q4 in Subdivisions 22 and 32 are used.

To obtain a biomass index, the weight–length relationship: $W = 0.0077\ L^{3.122}$ is applied to the cpue by length data. The length–weight relationship was estimated based on samples collected from 2008 to 2012.

To obtain a proxy for the spawning–stock biomass indices, only dab larger than 14 cm are taken into account. More than 50% of dab >14 cm of both sexes were maturing during quarter 1 with high fluctuations from year to year. To obtain an annual spawning biomass index, the geometric mean of the biomass index of each quarter is calculated.

Applying the method 3.2.0 to dab in SD22–32 corresponds to comparing the average of the biomass index of the two last years with the average of the three preceding years. The ration should be used to provide landings advice, within the range of [-20%; 20%] (uncertainty cap).

D. Short-term projection

Not available.

E. Medium-term projections

Not available.

F. Long-term projections

Not available.

G. Biological reference points

	TYPE	VALUE	TECHNICAL BASIS
MSY	**MSY $B_{trigger}$**	**not defined**	
Approach	**F_{MSY}**	**not defined**	
	B_{lim}	**not defined**	
Precautionary	**B_{pa}**	**not defined**	
Approach	**F_{lim}**	**not defined**	
	F_{pa}	**not defined**	

H. Other issues

H.1. Historical overview of previous assessment methods

To provide landings advice, the dab in SD 22–32 should be assessed with a Survey-based trend model (as suggested for data-limited stock following the DLS Guidance Report, 2012). However, continued developments towards an analytical assessment (e.g. SAM) should be ensured. The data quality currently doesn't allow the results of the analytical assessment to be used for advice, and different issues, such as discards and deriving age structure based on length measurements need to be improved (as described above). Further development in these calculation procedures and analyses is strongly encouraged to be carried out in parallel with survey based trend analyses, to allow for a possible transition to analytical methods in the future.

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Stock Annex: Flounder in the Belts and Sound (SD 22–23)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	FLE 22–23, Flounder in the Belts and Sound
Working Group	WGBFAS
Date	30/01/14 (No previous Stock Annex).
Revised by	Sven Stötera (WKBALFLAT 2014)

A. General

A.1. Stock definition

There are two sympatric flounder populations in the Baltic Sea, which differ in their spawning habitat and egg characteristics (Nissling *et al*., 2002; 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. Pelagic spawners spawn at 70–130 m depth, and their eggs are neutrally buoyant at 10.6–12.0 PSU salinity and require oxygen concentrations of 1–2 ml/l for development (Nissling *et al*., 2002). There is also strong genetic evidence for separating these ecotypes into separate stocks (Florin and Höglund, 2008; Hemmer Hansen *et al*., 2007) with the pelagic spawners distributed in the southern and the deeper eastern part of the Baltic Sea and the demersal spawners in the northern area. The pelagic spawners are considered to inhabit SDs 22,23,24,25,26,28, with a spatio-temporal overlap between the demersal and pelagic ecotypes, especially in SD 28 but the proportions of mixing are unknown. The pelagic spawners were further separated into three stocks: SD 22–23; 24–25 and SD 26 and 28 (ICES, 2012a; ICES, 2014).

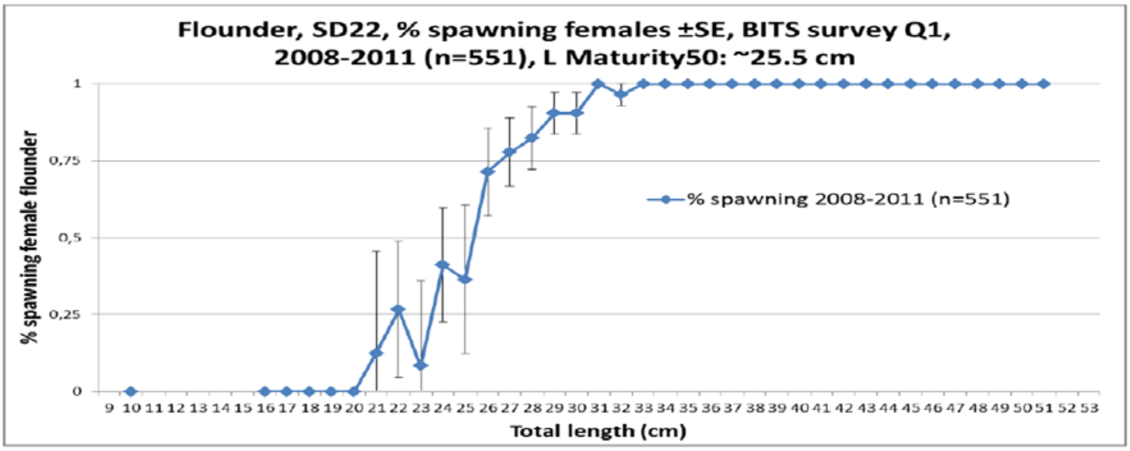
There is evidence of a differentiation between SD 22 and 23 from SD 24 and 25 based on egg buoyancy (Nissling *et al*., 2002, Table 1), length-at-maturity (Nissling *et al*., 2002, Table 2, Figure 1) and to some extent genetics (Hemmer Hansen *et al*., 2007). Even though there is no physical connection between SD 22 and SD 23, flounder populations in these areas are assumed to be connected through the western part of SD 24. Dividing the SD 24 for setting stock boundaries was not considered practical due to most of the data being recorded at SD level. Therefore, the entire SD 24 was merged with the SD 24–25 stock, even though the western part of SD 24 is considered to belong together with SD 22–23 stock.

Table 1. Reproductive characteristics from flounder sampled in different SD:s. Data from Nissling *et al*., 2002.

Variable	SD23	SD24	SD25	SD28
Salinity of Neutral Egg Buoyancy	26.1±0.8	15.2±1.9	13.9±1.5	20.3±1.1
Egg size	1.12±0.07	1.34±0.04	1.43±0.06	0.99±0.05
Lowest salinity of spermatozoa activation	11.6±1.0	11.8±0.6	10.3±1.3	3.4±0.3

Table 2. Range of length at 50% maturity for flounder in different ICES SD based on BITS Q1 2008–2011 (data from WKFLABA 2012, ICES 2012a). Flounder in SD 22 mature at a much greater size than flounders in other areas. No data from SD 23 & 27.

SD	22	23	24+25	26	27	28
LM50 (cm)	25–26		15–21	14–21		18–19



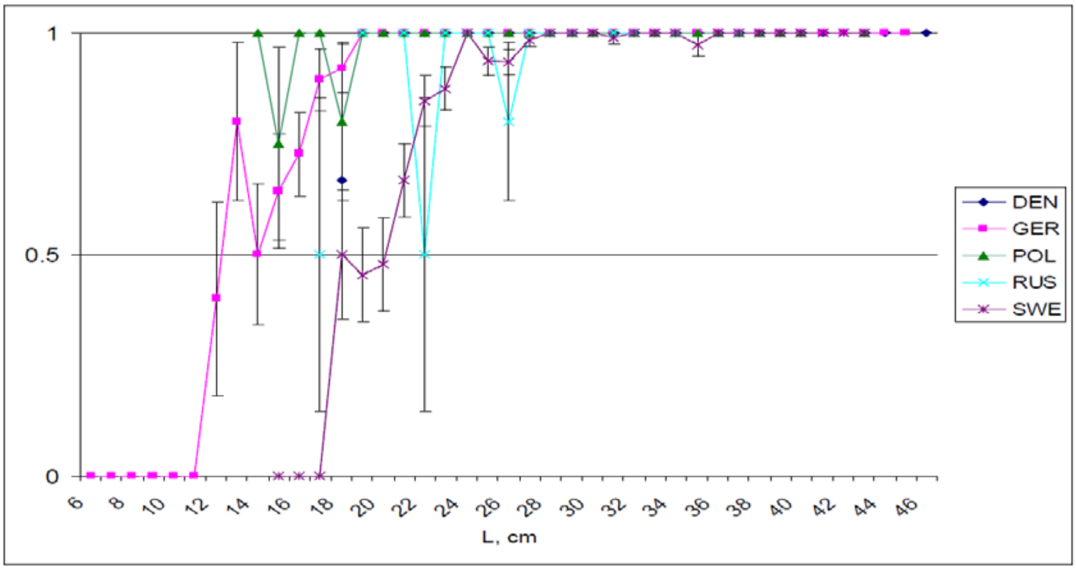


Figure 1. Length at 50% maturity from BITS Q1 2008–2011 in SD 22 (upper panel) and SD 24+25 (lower panel). Comparing German data from SD22 with SD 24 reveal large differences in size at maturity (25.5 cm in SD 22; 13.5 cm in SD 24+25).

A.2. Fishery

ICES Subdivision 22 is the main fishing area for this stock with Denmark and Germany being the main fishing countries. Subdivision 23, where the main part of the landings is taken by Sweden, is only of minor importance as a fishing area.

Annual landings in SD22 in the period since 2000 vary between 3000 tons and 1500 tons. Landings in SD23 were below 350 tonne/year in the entire time-series since 2000 and declined to 150 tonnes after 2008. The highest total landings of flounder in SD22 were observed in 2000 (>3000 t) and the lowest in 2006 (<1000 t). Since 2007 the landings are around 1400 t. 80% of total landings are from the Danish fleet.

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).

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

The Catch from commercial fisheries includes a landed and a discarded fraction.

Landing weights back to 2000 are available from Germany, Denmark and Sweden. Landings were provided using ICES database InterCatch. Landings are provided by subdivision, quarter and fishing gear.

In WKBALFLAT (ICES, 2014), an attempt was made to set up a time-series of flounder discards in SD 22–23. The calculation of discard weights for the period back to 2000 was done by national data submitter, based on the national sampling programmes. The quality of the national estimations cannot be assured or revised since calculation methods were not available for the stock coordinator. Missing discard weights were estimated by the stock coordinator, using the Landing/Discard ratio from similar strata. The discard ratio was calculated as:

$$\text{Catch (C)} = \text{Landing (L)} + \text{Discard (D)} \quad \rightarrow \quad \text{Discard ratio: } D/C \times 100 = \%D$$

However, no discard was estimated for strata not having a landing of flounder assigned, either due to zero landings (and a 100% discard) or no catches occurring in this quarter (for a given gear type). These “zero landings” strata are, however, of minor importance for the stock in SDs 22–23. In SD22, which corresponds to 80–90% of flounder landings, landings took place in every stratum (gear type per quarter). In SD23, there are non-reported landings for the active gear fraction which usually lands about 100–300 kg per quarter.

Given that the flounder is a bycatch species, it could be more appropriate to raise flounder discards with for example cod, instead of flounder landings, but this option is not available in InterCatch and was not possible to do it during the benchmark (ICES, 2014) due to time constraints and data availability.

Discards of flounder are highly variable, depending on e.g. local and national markets (which is driven not only by flounder, but also by cod and plaice), vessel capacity and quota limitations (e.g. cod). Discards also differ between areas and gear.

In general, discards are higher in active (e.g. trawls) than in passive fishing gears (e.g. set-nets and traps). Both fishing gears show discard ratios between 0 and 100% of the catch, with active gears having average discard ratio of 30–50% of the catch, whereas passive gears have an average discard ratio of 10–20%.

A survival-rate (i.e. 50% survival in Q1 and Q4 and 10% survival in Q2 and Q3) was applied to the discarded fraction of the catch. These numbers represent the lower limits among the relatively wide range of survival rates obtained from several studies conducted in the Baltic Sea (see e.g. Revil, 2012; Herrmann *et al.*, 2013; Broadhurst *et al.*, 2006; and the WKBALFLAT Working document 2.1).

Given the uncertainties with the current estimates of discards, it was decided at WKBALFLAT that only a landing advice should be provided for the flounder stock in SD 22–23, until further work is done on a more appropriate calculation of the discards raising procedure (see below) (ICES, 2014).

To enable a catch advice, the following improvements are needed;

- More detailed documentation of discards is needed, such as where did the samples come from, and what the countries already have extrapolated themselves. In general, only data from sampled strata should be provided, with extra information/advice on how to fill the gaps of unsampled strata (e.g. if zero landings of flounder, should the discards be estimated based on cod landing, etc.).
- A common approach to calculating and raising discards for bycatch species, in particular when there are zero landings, should be established.
- To be able to use InterCatch for discard compilation, discards ratios should be available to borrow across years.
- To be able to use InterCatch for discard compilation, it needs to be possible to use other discard raising factors than presently available, for example cod landings. Another option would be to add an additional column for total landings on a trip.

B.2. Biological

B.3. Surveys

The Baltic International Trawl Survey (BITS) is covering the area of the flounder stock in SDs 22–23. The survey is conducted twice a year (1st and 4th quarter) by the member-states having a fishery in this area. Survey design and gear is standardized. Due to a change in survey gear in 2000, first and fourth quarter BITS indices during the period 2001 to the present are used.

Fishing Stations are assigned each year by a randomized list, the average number of stations covering Subdivisions 22 and 23 is given in Table 1. Effort and cpue 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.

Table 1. Average number of BITS-stations in SD22 and SD23.

Area and quarter	Average no. of stations	Standard deviation
SD 22 Q1	24	4,62
Q4	26	5,28
SD 23 Q1	3	0,62
Q4	3	0,66

B.4. Commercial cpue

n/a.

B.5. Other relevant data

During WKBALFLAT 2014, possibilities for age/length based analytical assessment were explored.

Length distributions are available from Germany, Denmark and Sweden in the time-period from 2000 onwards.

Age data are considered to be applicable only when the ageing was conducted using new methods (breaking and burning of otoliths technique) as recommended by WKARFLO (ICES 2007, 2008) and WKFLABA (ICES 2010).

From commercial fisheries samples, age information for CANUM and 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 (ICES, 2014). 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.

C. Assessment: data and method

Model used: Stock trend model based on scientific surveys

Model Options chosen:

Input data types and characteristics:

Stock trend are 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. The catch per unit of effort (number/hour) uses only fish ≥20 cm from both surveys and data are 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. The weight is calculated using the average weight–length relation from the period 2001 to 2012.

Weight–length relation was calculated using $W = a \times L^b$

where a and b are growth parameters, calculated from BITS data (pooled data from 2001 to 2012, both quarter combined).

$$a = 0.0168$$
$$b = 3.104$$

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. For advice, the relative change in the average biomass index in the last two years is compared to the average of the three years before.

D. Short-term projection

Not conducted.

E. Medium-term projections

Not conducted.

F. Long-term projections

Not conducted.

G. Biological reference points

	Type	Value	Technical basis
MSY	**MSY $B_{trigger}$**	**not defined**	
Approach	**F_{MSY}**	**not defined**	
	B_{lim}	**not defined**	
Precautionary	**B_{pa}**	**not defined**	
Approach	**F_{lim}**	**not defined**	
	F_{pa}	**not defined**	

H. Other issues

To provide landings advice, the flounder stock in the SD 22–23 should be assessed with a Survey based trend model (as suggested for data-limited stock following the DLS Guidance Report, 2012). However, an additional exploratory analytical assessment (e.g. SAM) should be carried out. The data quality currently doesn't allow the results of the analytical assessment to be used for advice, and different issues, such as discards and deriving age structure based on length measurements need to be improved (as described above). Further development in these calculation procedures and analyses is strongly encouraged to be carried out in parallel with survey based trend analyses, to allow for a possible transition to analytical methods in future.

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Stock Annex: Flounder in the Southern Baltic Sea (SD 24 and 25)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Flounder in the Southern Baltic Sea (SD 24–25)
Working Group	WKBALFLAT/WGBFAS
Date	15/03/14 (No previous Stock Annex).
Revised by	Anna Luzeńczyk, Zuzanna Mirny (WKBALFLAT, ICES 2014)

A. General

A.1. Stock definition

ICES SD 24 and 25 were defined as a new assessment unit for flounder at the Data Compilation for Benchmark Workshop on Baltic Flatfish Stocks (DCWKBALFLAT, ICES 2014) in 2013, thereby changing the decisions made at the previous ICES/HELCOM workshops WKFLABA (ICES, 2010) and WKFLABA2 (ICES, 2012).

The stock is considered separate from the other flounder populations occurring in the Baltic Sea.

First of all, there are significant disparities between two sympatric flounder populations in the Baltic Sea, which 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; Figure 1), although they utilize the same feeding grounds in summer and 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, 28.1 and 29–32, but they can also inhabit e.g. SD 25 (Nissling and Dahlman, 2010).

Pelagic spawners (the group to which flounder in SDs 24–25 belong) 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 fertilization 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 (Table 1), 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 28.2 based on separate spawning areas (Figure 2), 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 (Figure 3) 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.

Table 1. Length range at 50% maturity for flounder in different ICES SD based on individual countries data from the WKBALFLAT data call. Flounder in SD 22 mature at a much greater size than flounder in other areas. There are no data available from SD 23 & 27.

SD	22	23	24+25	26	27	28
LM50 (cm)	25–26		15–21	14–21		18–19

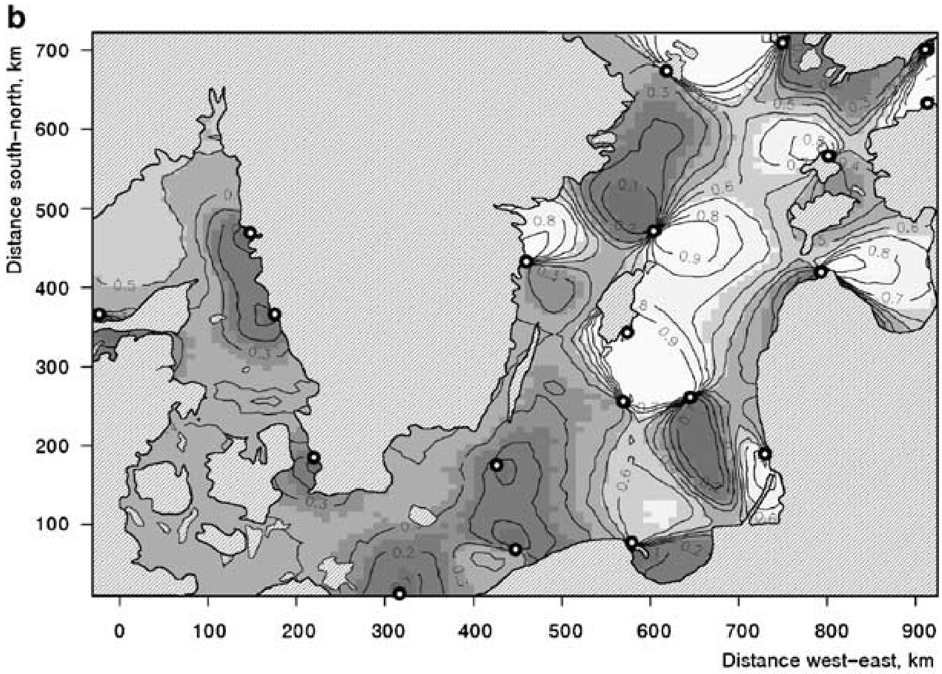
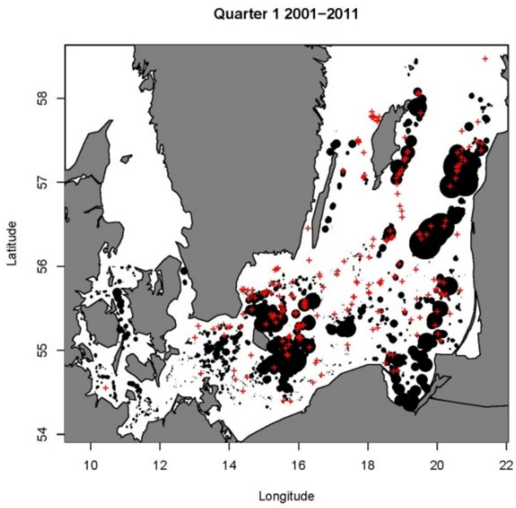


Figure 1. Map of posterior probabilities of population membership (number of populations =2 and 50 000 iterations). Lighter areas correspond to higher probability to belong to the demersal population; sampling locations are indicated with white dots (Florin and Höglund, 2008).



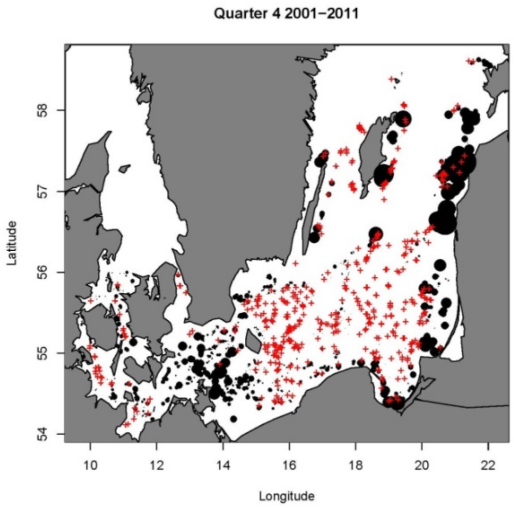


Figure 2. Average relative distribution of flounder biomass in the BITS survey in quarter I (spawning time) and quarter IV from years 2001–2011. Bubble size is proportional to biomass, red crosses means zero catch.

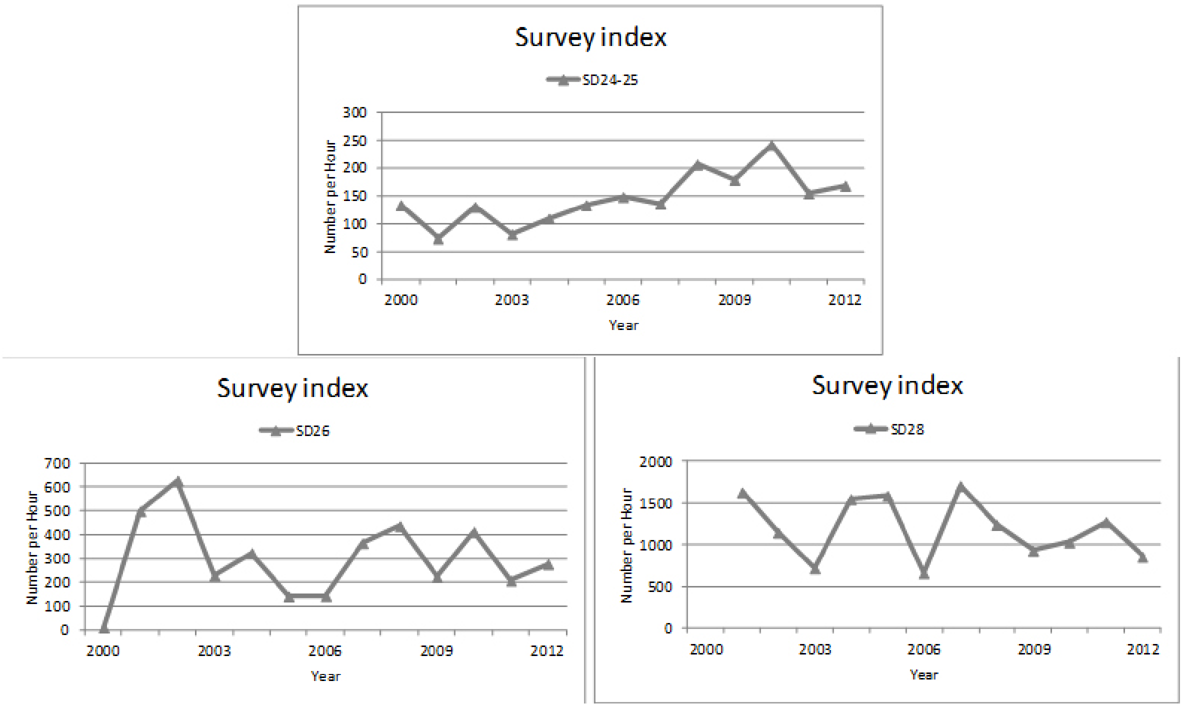


Figure 3. Survey indices from BITS survey quarter I for flounder in different SD.

A.2. Fishery

The fishing season spans mainly the months June to February. The total landings of this stock increased from 4000–7000 t in 1973–1993, and to 8000–13 000 t after 2000. Some high landings in the mid-1990s are misreported (cod was reported as flounder). In 2003 the landings decrease compared to 2002, which was 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 remain around 10 000 t.

In Subdivisions 24 and 25, Poland, Denmark and Germany are the main fishing nations (Figure 4). Polish landings increased during the 2000s and are at least 60% of the total landings, while Danish landings show a decreasing trend in the 2000s.

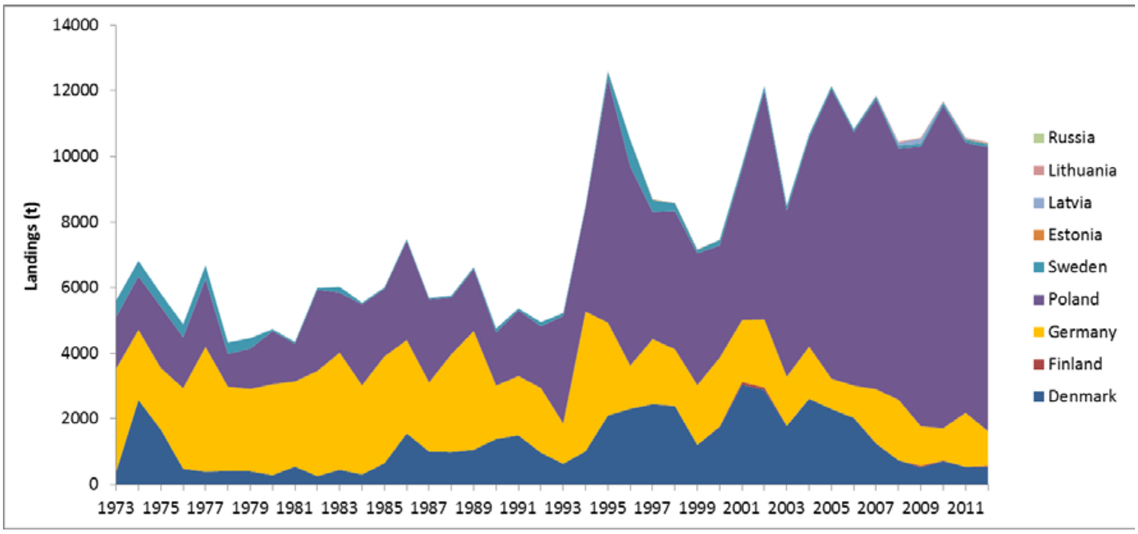


Figure 4. Flounder in SD 24–25. Landings in tonnes by country.

In Poland, trawl and gillnet fishing directed to flounder is common. Polish flounder catches increase when cod resources decrease. About 60% of the Polish landings are from 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, where 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 ICES SD24 there is a German trawl fishery directed to flounder, in particular in the 3rd and in the 4th quarters. This fishery contributes a maximum of about 35% to the total German flounder landings. In SD 24 about 85% of the landings are taken in the trawl fishery. In SD 25 nearly all German flounder landings are taken by trawl. The German flounder landings depend largely on the market situation (price and demand for flounder). In 2007, some periods of good prices for flounder were reported by the fishermen. Therefore the variation in the landing cannot be considered as an indicator for the stock size.

Council Regulation (EC) No 2187/2005 of 21 December 2005 concerning the flounder stock in ICES Subdivisions 24 and 25:

Under Article 14, 1. *The flounder shall be regarded as undersized if it is smaller than the minimum size of 23 cm.*

Under Article 15, 1. *Undersized fish shall not be retained on board or be transshipped, landed, transported, stored, sold, displayed or offered for sale, but shall be returned immediately to the sea.*

Additional national rules concerning flounder:

Until 2007, it was not allowed to land female flounders, caught in the German 12 Nm zone from 1st February to 30th April.

A.3. Ecosystem aspects

Flounder from SD 24–25 spawns in the Arkona Deep, the Slupsk Furrow, and the Bornholm Deep. Spawning takes place from March to May. After spawning, flounders migrate to feeding grounds in shallow coastal waters (Bagge, 1981; ICES, 1978).

For the flounder stock in SD 24 and 25 the reproductive volume is defined by >=12.0 psu and >= 2 ml O^2/l. Therefore, the recruitment success can fluctuate depending on the hydrological condition on the spawning grounds.

B. Data

B.1. Commercial catch

Landings in tonnes are available from Denmark, Germany, Poland and Sweden from 1973 onwards. For other countries data are available for the following years: Finland 1996–onwards, Estonia 1995, 1997–2000 and 2009– onwards, Lithuania 1995 and 2007–onwards, Latvia 1998, 2000 and 2004–onwards (Table 2).

Table 2. Overview of available landings data per country.

	Denmark	Germany	Poland	Sweden	Finland	Estonia	Lithuania	Latvia
Years with total landings data	1973–present	1973–present	1973–present	1973–present	1996–present	1995	1995	1998
						1997–2000	2007–present	2000
						2009–present		2004–present

Available age samples from landings based on recommended age determination methods using slicing or breaking and burning technique for age reading, recommended by WKARFLO (ICES 2007; 2008) and WKFLABA (ICES, 2010), are presented in Table 3.

Table 3. An overview of available age samples from landings based on the recommended age determination methods (available samples for different countries are marked yellow; DE-Germany, DK-Denmark, LV-Latvia, PL-Poland, SE-Sweden).

	SD24				SD25			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2000					PL			
2001					PL			
2002					PL			
2003	PL							
2004	PL				PL			
2005	PL				PL			
2006	PL				PL			SE
2007	PL				PL, SE			
2008	PL	DE	DE	DE	PL	DE		DE, SE
2009	DE	DE	DE	DE	PL, DE, SE	DE		DE, SE
2010	PL	DE	DE	DE	PL, DE, SE, LV	DE		DE, SE
2011	PL	PL, DE	PL, DE	PL, DE	PL, DE,SE	PL,DE	PL	PL, SE
2012	PL, DE, DK	PL, DE, DK	PL, DE, DK	PL, DE, DK	PL, SE	PL, DE	PL	PL, DE, SE

The discard ratios in both subdivisions are significantly different between countries, fleets, vessels and even individual hauls of the same vessel and trip. Therefore, a common discard ratio cannot be applied. As there are the difficulties with reporting discards, poor data coverage within *strata* (defined by year, SD, country and fleet type: active or passive) exists.

During WKBALFLAT (ICES, 2014) the quality of the estimations of discards was questioned. The main problem was very high flounder discards, which exceed the landings or sometimes are even 100% of the catch. When no discard data are available for particular stratum and there was no landing of flounder assigned, then the discard was also estimated as non-existent, which is not necessarily true. This leads to an underestimation of discards, and therefore the current discard estimates should not be used in the provision of advice.

Due to this constraint the WKBALFLABA recommended to recalculate discards, and to consider an alternative approach to deriving discard ratios that would be less prone to underestimation of discards.

Age samples from discards based on the recommended age determination methods have been available from Sweden from 2006 and 2008–2012, Poland from 2007 and 2009–2012, Germany since 2008, and Denmark from 2012 (Table 4).

Table 4. An overview of age samples available from discards based on the recommended age determination methods (available samples for different countries are marked red; DE-Germany, DK-Denmark, PL-Poland, SE-Sweden).

	SD24				SD25			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
2000								
2001								
2002								
2003								
2004								
2005								
2006								SE
2007					PL			
2008	DE	DE	DE	DE		DE		DE, SE
2009	DE	DE	DE	DE	PL, DE	DE		DE, SE
2010	DE	DE	DE	DE	PL, DE, SE	DE		DE, SE
2011		PL, DE	PL, DE	PL, DE	DE, SE	PL, DE		SE
2012	DE, DK	PL, DE, DK	PL, DE, DK	PL, DE, DK	PL, DE, SE	PL, DE		DE, SE

B.2. Biological data

Weight-at-age in catch, weight-at-age in landings, and weight-at-age in discards were estimated separately. Weights were assigned only for the years where ages from the new aging procedure were available (since 2000).

Weight-at-age in stock was estimated by applying weight–length relationship with length data from age–length key and averaging obtained weights within age groups.

Mature proportions were calculated using BITS survey data. A logistic regression on length was used to estimate the maturity-at-length m(L):

$$logit\big(m(L)\big) = \alpha + \beta L$$

and finally the mean maturity-at-age is estimated in the same manner as the mean weights:

$$E(m(L)|A = a) = \textstyle\sum_k m(k)P(L = k|A = a)$$

(see WKBALFLAT 2014, WD 5.1).

Discard mortality was assumed to be 50% in I and IV quarter and 90% in II and III quarter (ICES, 2014).

These numbers represent the lower limits among the relatively wide range of surviv-al rates obtained from several studies conducted in the Baltic Sea (see WKBALFLAT 2014, WD 2.1).

The previously used age reading method (from whole otoliths) was considered inap-propriate to flounder, because it resulted in high inconsistencies in age reading. The most problematic was ageing the old fish, for which the otoliths tend to grow in thickness rather than in length (ICES, 2008). In these cases, the rings on the edge of the whole otoliths are not visible because they overlapped, and consequently the age is underestimated.

B.3. Surveys (BITS-Q1, BITS-Q4)

In the period 1978–2000 Germany carried out a stratified fixed station bottom-trawl survey in Subdivisions 24 and 25 in the 1st quarter as well as in 24 in the 4th quarter. These surveys were planned for recruitment investigations of cod. Flounder data were sampled regularly and stock indices could be estimated. The station grids and a description of the herring bottom trawl (HG20/25) used are presented by Schulz and Vaske (1988). In 1991, RV "Eisbär" was replaced by RV "Solea" and in 1993 the positions of the stations in SD 25 were changed.

A special young fish survey on flounder has been carried out in the Oderbank area (SD 24) since 1978. This survey was not suitable to estimate the recruits for the total stock in SD 24 and 25 (Westernhagen, 1970).

From 2001 Germany terminated the survey in SD 25 and continued with the survey only in SD 22 and 24. The currently used TV3#520 has about the same catchability for demersal species as German HG20/25 and thus a conversion factor close to 1.

Polish demersal trawl surveys were part of an international survey conducted annually in the Baltic. Data from Polish bottom-trawl surveys conducted in the 1st and 4th quarter are available from SD 24 (1997–2000) and from SD 25 since 1992. Sampling strategy was based on a fixed stations grid, arranged as depth cross sections. Until 1993 surveys were conducted by chartered cutters. Since 1993 the surveys have been conducted from aboard the research vessel BALTICA. Fishing operations in 1981–2000 were carried out using the same standard trawl (the mesh in the codend was 6 mm from knot to knot). A new TV-3 trawl was introduced in 1999 and some comparative trawling with the P20/25 gear was conducted (Horbowy *et al.*, 2003). Polish gear P 20/25 and the German gear HG 20/25 have almost the same construction with only small variations (Oeberst and Grygiel, 2002).

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. BITS surveys in SD 24 are performed by Germany and in SD 25 are performed by Poland, Denmark and Sweden. Data from that survey are available in DATRAS database. However, it should be noted, that age data in DATRAS contains age information derived by different age-determination methods (both the old age reading method as well as the recommended method of slicing or the breaking and burning technique). It was agreed that for assessment purposes, only the recommended aging method should be used. Survey age data determined with the recommended method have been available for SD 24 since 2009 (Germany) and for SD 25 from Poland for 1st quarters of 2000–2002, 2004–2010, since 2011 for both 1st and 4th quarters; from Denmark since 2012 and from Sweden since 2007.

B.4. Commercial cpue

N/a.

B.5. Other relevant data

During WKBALFLAT 2014, possibilities for undertaking an age/length-based analytical assessment were explored.

Length distributions from commercial catches are available for SD 24 from Denmark, Germany, Latvia, Poland and for SD 25 from Germany, Latvia, Poland, Sweden in the time period from 2000 onwards (different time range depending on country).

Length distributions from survey are available for SD 24 from Germany and from SD 25 from Denmark, Poland, and Sweden for the time period from 2000 onwards.

Age data are considered to be applicable only when the ageing was conducted using recommended methods (slicing and staining or breaking and burning technique) as recommended by WKARFLO (ICES, 2007, 2008) and WKFLABA (ICES, 2010).

Due to time constraints, only some of the statistical slicing model settings were tested. Thus, if the statistical slicing method should be used in the future to derive the historical part (i.e. when age–length keys from otoliths are not available) of the number-at-age for the catches and the surveys, it is important that more model settings are tested than done during WKBALTFLAT. Moreover, it is also crucial that the results obtained from any slicing methods (i.e. knife edge and/or statistical), in terms of number-at-age, are compared with the number-at-age structure derived from otolith reading for the same sample (ICES, 2014).

C. Assessment: data and method

The flounder stock in SD 24–25 belongs to category 3: Stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES 2012).

Model used: Data-Limited Stock Category 3.2. Stock trend model based on scientific surveys.

Model Options and input data types and characteristics:

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. The catch per unit of effort (number/hour) uses only fish ≥20 cm from BITS-Q1 and BITS-Q4 survey and the data are extracted from the ICES DATRAS database, because the survey is not covering shallow waters, where juvenile flounder (mostly smaller than 20 cm) occur.

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 1991–2013, 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 Subdivisions 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. For advice, the relative change in the average biomass index in the last two years is compared to the average of the three previous years.

D. Short-term projection

N/a.

E. Medium-term projections

N/a.

F. Long-term projections

N/a.

G. Biological reference points

N/a.

H. Other issues

During WKABALFLAT it was decided that the new tuning fleet for this stock should be calculated using only data derived from the new ageing method, thereby changed the decisions made at the previous meetings (ICES, 2005; 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 SD2425.

Due to time constraints and the need for further work on data to obtain reliable estimates of discards, only one assessment model was attempted. It was a difference version of the Schaefer stock production model. After improving discard estimates, the second recommended model - SAM should be applied.

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Stock Annex: Flounder in SDs 26 and 28

Stock specific documentation of standard assessment procedures used by ICES.

Stock	FLE 26, 28 (Flounder in Eastern Gotland and Gulf of Gdańsk).
Revised by	Didzis Ustups, Ann-Britt Florin (WKBALFLAT, 2014).

A. General

A.1. Stock definition

There are two sympatric flounder populations in the Baltic Sea, which differ in their spawning habitat and egg characteristics (Nissling *et al*., 2002; 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. Successful reproduction occurs down to 5–7 PSU. Pelagic spawners spawn at 70–130 m depth, and their eggs are neutrally buoyant at 10–20 PSU and require oxygen concentrations of 1–2 ml/l for development (Vitins, 1980; Nissling *et al*., 2002; Ustups *et al*., 2013).

In SD 28 both spawner types exist; however, during spawning they are separated, with pelagic spawners in the deeper areas and flounder with demersal eggs spawning in coastal areas.

There is a spatio-temporal overlap between the demersal and pelagic ecotypes, especially in SD 28 but the proportions of mixing are unknown. However, since landings in SD 28-2 are relatively large compared to the other SDs of the demersal stock, it would overshadow the developments in "real" demersal component. Thus, to avoid the dynamics in the demersal unit being driven by the flounders in SD 28-2 (containing a mixture of the two ecotypes) it was decided that flounders in SD 28-2 would be allocated to the pelagic ecotype. Flounder in the Gulf of Riga, SD 28-1, most probably are of the demersal ecotype (coastal spawning). However, since historical fisheries data for flounder currently provided by countries are not divided into subunits of SD 28 it was decided to allocate the Gulf of Riga (SD 28-1) into the pelagic unit as well. The density of flounder in Gulf of Riga is low, therefore the impact of allocating this subunit, considered to be of the demersal ecotype, to the pelagic ecotype is believed to be minimal.

During favourable hydrological conditions, flounder with pelagic eggs may occur also in SD 29 and even spread into SD 32 during spawning season (ICES, 2010; Grauman, 1981). Furthermore, during feeding migration flounder from the open Baltic Sea may enter the Gulf of Finland (Mikelsaar, 1958). The extent of this is unknown and therefore SD 29 and 32 are assumed to belong to the stock with demersal eggs.

The flounder in SD 24 and 25 are differentiated from flounder in SD 26 and 28 based on separate spawning areas (Figure 1), trends in survey cpue, and tagging data that indicate no dispersal between these areas (Cieglewicz, 1963; Otterlind, 1967; Vitins, 1976). This needs further examination to determine whether a more consistent assessment with lower uncertainty is obtained when merging the two units.

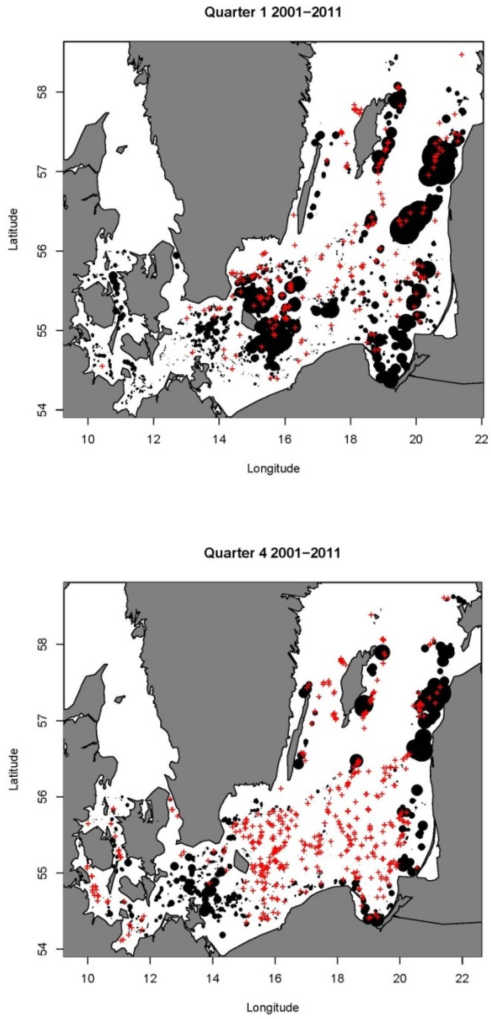

Figure 1. Average relative distribution of flounder biomass in BITS survey in Quarter 1 (spawning time) and quarter 4 from years 2001–2011. Bubble size is proportional to biomass, red crosses mean zero catch.

A.2. Fishery

Flounder landings in SD 26 and 28 fluctuated between 2000 to 5000 tonnes. The major part of the landings belongs to SD 26.

The main fishing countries in Subdivision 26 are Russia (56% of landings from long-term average), Poland (24%) and Lithuania (16%). The landings started to increase in the 1990s and for the last 15–20 years have been between 3000 and 3500 tonnes. In the previous years the Polish fishery was mainly a gillnet fishery along the coast whereas the Russian and Lithuanian landings were bycatches mainly in a bottom-trawl fishery for cod. The main fishing countries in Subdivision 28 are Latvia (71%) and Estonia (12%). Landings in the last years have continued to decrease due to decreasing of fishing effort. Fishing activity is mainly determined by the cod fishery (quota availability, area of fishing) and a decrease of fleet size. The small-scale fishery in the coastal zone is a significant part of the landings in Subdivision 28.

The highest landings recorded were at the end of 1970s. Later, in beginning of 1980s after the strong decrease of flounder stock, a specific ban of the flounder fishery was introduced.

A.3. Ecosystem aspects

Recruitment success can fluctuate depending on hydrological conditions on the spawning grounds (Nissling *et al.*, 2002). However some results suggest that recruitment may be regulated in a post-settlement stage, probably in the shallow coastal nursery areas (Ustups *et al.*, 2013).

B. Data

B.1. Commercial catch

The catch from commercial fisheries includes a landed and a discarded fraction.

Landings data are available from Poland, Latvia, Lithuania, Estonia, Finland, Russia, Germany, Denmark and Sweden from 2000 onwards in the ICES database InterCatch. Landings are provided by subdivision, quarter and fishing gear (i.e. active and passive). Landings from 1973 to 1999 are reported in previous WGBFAS reports (ICES, 2012a, 2013) and available in Excel sheets by countries and subdivisions as part of the data call in preparation for the WKBALFLAT 2014 (ICES, 2014).

The discard ratios in both subdivisions differ between countries, fleets, vessels and even individual hauls of the same vessel and trip. Therefore, a common discard ratio cannot be applied across all countries. As the discards are not readily reported, there is poor data coverage within *strata* (defined by year, SD, country and fleet type: active or passive).

The quality of the estimations of discards is highly uncertain (ICES, 2014). The main problem is the very high records of flounder discards, which exceed the landings or sometimes are even 100% of the catch. When no discard data are available for a particular stratum and there were no landings of flounder assigned, the discard was set as non-existent, which is not necessary true. This leads to an underestimation of discards, and therefore the current discards estimates should not be used in the provision of advice.

A survival rate (i.e. 50% survival in Q1 and Q4 and 10% survival in Q2 and Q3) was applied to the discarded fraction of the catch. These numbers represent the lower limits among the relatively wide range of survival rates obtained from several studies conducted in the Baltic Sea (see e.g. Revil, 2012; Herrmann *et al.*, 2013; Broadhurst *et al.*, 2006 and the WKBALFLAT Working document 2.1).

Given the uncertainties with the current estimates of discards, it was decided at WKBALFLAT that only landings advice should be provided for the flounder stock in SD 26, 28, until further work is done on a more appropriate calculation of the discards raising procedure (see below) (ICES, 2014).

To enable catch advice, the following improvements are needed:

- Documentation of discards is needed, where did the samples come from, and what the countries already have extrapolated themselves. In general, only data from sampled strata should be provided, with extra information/advice on how to fill the gaps of unsampled strata (e.g. if zero landings of flounder, should the discards be estimated based on cod landing, etc.);
- A common approach to calculating and raising discards for bycatch species, in particular when there are zero landings should be established;

- To be able to use InterCatch for discard compilation, discards ratios should be available to borrow across years or neighbouring flounder stocks;
- To be able to use InterCatch for discard compilation, it needs to be possible to use other discard raising factors than presently available, for example cod landings. Another option would be to add an additional column for total landings on a trip.

B.2. Biological

B.3. Surveys

The Baltic International Trawl Survey (BITS) covers the area of the flounder stock in 26 and 28. 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 are standardized. International Baltic International Trawl Survey (BITS) was established in 2001 and is coordinated by the ICES WGBIFS.

Around 300 fishing stations are planned for BITS-Q1 and about 240 fishing stations for BITS-Q4, in the entire Baltic Sea each year. The mean cpue values were estimated according to the procedures given in the BITS manual. Catch per unit of effort (number per hour) from BITS-Q1 and BITS-Q4 were used to calculate an index representing flounder abundance by numbers. Data were compiled from ICES DATRAS output format "cpue_per_length_per_haul". Averages were weighted first by fished depth stratum areas 8 (10–19 m, 9 (20–39 m), 10 (40–59 m), 11 (60–79 m), 12 (80–99 m), 13 (90–119 m), 14 (120–200 m) and second by fished subdivision areas. Hauls with 0 fish per hour were included. All fish with length <20 cm were excluded from the calculations due to sampling design, because flounder nurseries areas are located in shallow coastal areas which are not covered in the BITS surveys.

B.4. Commercial cpue

Commercial cpue is available from Russia. The Russian cpue series refer to two types of bottom-trawling vessels: the MRTR and MRTK. MRTRs vessels specialize in bottom-trawl fishing, while the MRTK vessels, except bottom-trawl fishing, can fish pelagic species. Both types of vessels cover 88–97% of total Russian flounder catch in Subdivision 26. Under the current fishing regulation in the Russian Federation, to monitor the catch, a ship owner should provide the SSD. The information includes: kind of activity (commercial fishing, transition into the operations area, anchorage), daily catch and catch range. The data obtained from all vessels are combined into an electronic database. Vessel day by vessel type is estimated by taking into account the kind of activity; it includes only those days when the vessel performed commercial fishing. Average flounder cpue for MRTR and MRTK vessels was calculated as flounder catch in tones divided by the number of commercial fishing vessel-days by vessel type.

B.5. Other relevant data

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

Length distributions from commercial catches in the time period from 2000 onwards are available for SD 26 from Latvia, Poland, Russia, Lithuania and for SD 28 from Latvia and Estonia. The time range available depends on the country.

Age data are considered to be applicable only when the ageing was conducted using recommended methods (slicing and staining or breaking and burning techniques) as recommended by WKARFLO (ICES, 2007, 2008) and WKFLABA (ICES, 2010). Von-Bertalanffy parameters were estimated based on age data from the survey.

Because the estimated parameters didn't fit to the slicing method (L_{inf} in Bertalanfy growth equation was significantly lower than observed in the commercial samples), other von-Bertalanffy parameters from the literature were used (Froese and Sampang, 2013). Detailed description of the slicing method is available in the WKBALFLAT, 2014 report (ICES, 2014).

It is important to highlight that due to time constraints, only some of the statistical slicing model settings were tested. If the statistical slicing method should be used in the future, then development and validation of this approach 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.

C. Assessment: data and method

Category 3: Stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES, 2012).

Model used: Data-Limited Stock Category 3.2. Stock trend model based on scientific surveys.

Model Options and input data types and characteristics:

Stock trend are 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. The catch per unit of effort (number/hour) uses only fish ≥20 cm from both surveys and data are extracted from the ICES DATRAS database. The values are averaged from all (incl. 0 catch) daytime hauls weighted by depth stratum area. Weight-at-length was estimated as an average weight-at-length for data from 1991–2013, separately for 1st and 4th quarter for Subdivisions 26+28. Next, to these data, a weight–length relationships of the form $w=aL^b$ was fitted, where a and b are parameters. Parameters obtained for 26+28 were: a=0.0154 and b=2.91 for 1st quarter and a=0.0158 and b=2.90 for 4th quarter.

For the final index the geometric mean of 1st and 4th quarter indices should be taken. The Biomass Index is calculated for each year. For advice, the relative change in the average biomass index in the last two years is compared to the average of the three years before.

D. Short-term projection

N/a.

E. Medium-term projections

N/a.

F. Long-term projections

N/a.

G. Biological reference points

N/a.

H. Other issues

Further developments of additional exploratory analytical assessments presented at WKBALFLAT (ICES, 2014) (production model and age based SAM) are recommended. However, before transitioning to a new stock assessment model, the discard estimates should be re-calculated.

It is recommended that also other countries (not only Poland) should re-age their historical age data using recommended ageing methodology for this species in the Baltic Sea.

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Stock Annex: Flounder in the Northern Baltic Sea (SD 27, 29–32)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	FLE 27, 29–32, Flounder in the Northern Baltic Sea
Working Group	WGBFAS
Date	15/03/14 (No previous Stock Annex).
Revised by	Ann-Britt Florin (at WKBALFLAT)

A. General

A.1. Stock definition

There are two sympatric flounder populations in the Baltic Sea, which differ in their spawning habitat and egg characteristics (Nissling I., 2002; Nissling and Dahlman, 2010). Flounder with demersal eggs produce small and heavy eggs which develop at the bottom of shallow banks and coastal areas in the northern part of the Baltic Proper. Reproduction is successful down to 5–7 PSU (Nissling *et al*., 2002). Flounder with pelagic eggs spawn at 70–130 m depth, and their eggs are neutrally buoyant at 10–20 PSU salinity and require oxygen concentrations of 1–2 ml/l for development (Nissling *et al*., 2002; Vitins, 1980; Ustups *et al.,* 2013). There is strong genetic evidence for separating these ecotypes into separate stocks (Florin and Höglund, 2008; Hemmer Hansen *et al*., 2007a) with flounder with pelagic eggs distributed in the southern and the deeper eastern part of the Baltic Sea and flounder with the demersal egg-type in the northern area.

In previous ICES/HELCOM workshops (WKFLABA and WKFLABA2) several stocks were defined within each ecotype of flounder based on evidence from life-history characters and tagging (ICES, 2010; ICES, 2012a). However, in the review by SIMWG (ICES, 2012) it was suggested to have one single assessment unit of flounder with demersal eggs in the Baltic Sea and at the WKBALFLAT (ICES, 2014) Data compilation workshop (26–28 November 2013) the same conclusion was made.

Flounder in ICES SD 27, 29–32 are considered to consist of the demersal ecotype. There is a spatio-temporal overlap between the demersal and pelagic ecotypes, especially in SD 28 but the proportions of mixing are unknown. However since landings in SD 28-2 are relatively large compared to the other SDs it would overshadow the developments in other demersal component. Thus, to avoid the dynamics in the demersal assessment unit to be very much driven by SD 28-2 (containing a mixture of the two ecotypes) it was decided that 28-2 was to be allocated to the pelagic assessment unit. Furthermore since fisheries data for flounder currently are not divided into subunits of SD 28 it was not possible to include data from the Gulf of Riga SD 28-1 in the analyses of the demersal stock. During favourable hydrological conditions flounder with pelagic eggs may occur also in SD 29 and even spread into SD 32 during spawning season (ICES, 2010; Grauman, 1981). Furthermore during feeding, migrating flounder from the open Baltic Sea may enter the Gulf of Finland (Mikelsaar, 1958). The extent of this is unknown and therefore SD 29 and 32 are assumed to belong to the one assessment unit with demersal eggs.

A.2. Fishery

Commercial landings

Landings of flounder in SD 27, 29–32 peaked at over 2000 tonnes in the early 1980s but have since then declined to around 200 tonnes yearly. The fishery is dominated by Estonia who takes about 80% of the landings. Flounder is mainly fished in the Gulf of Finland (SD 32) and the Åland Sea (SD 29) by the Estonian and Finnish fishery and to a lesser extent by the Swedish fishery in SD 27. In the Gulf of Bothnia (SD30 and 31) less than 1 ton is taken yearly in the Finnish fishery. The fishery is almost exclusively using passive gears, primarily gillnets but trapnets are also used. Fishing occurs all year-round but is concentrated to the late summer and autumn.

The minimum legal landing size in SD 27 is 21 cm and 18 cm in SD 29S and 32 (south of the 59°30'N latitude). There are no length restrictions in SD 29N and in SDs 30 and 31. There is a seasonal fishing ban between the 15th February and 15th of May in SD 27, and 29S and between 15th February and 31st of May in SD 32. Minimum legal diagonal mesh size is 110 mm.

Discard

Discards in the fishery dominated by passive gears are presumably low. No estimates of discards are available from Sweden and Estonia. According to Estonian fishery law discarding is not allowed and a maximum of 10% bycatch is allowed. Interviews with fishers revealed that discards do exist (T. Drevs, personal comm.). During spawning time and immediately after spawning, all flounder caught in traps, are discarded. For example, in Northwestern Hiiumaa SD 29 the discard of flounder during spawning time has been 2–3 t per trap. From summer small flounders are discarded in the traps with a small mesh size. In Finland, however, reporting of all catch is mandatory. Since there have not been any consequences of discarding, it’s likely that the fishermen report it. The legislation and practice has been in place the entire time period included in the data call in preparation for the WKBALFLAT (2000–2012). Reported discards in Finland for this stock were 155 kg out of a total catch of 5 tonnes in 2012, corresponding to a discard rate of 3%. Survival of discarded flounder is unknown and could be anything from 0 to 100% depending on if the discard takes place at sea or in the harbour. In conclusion, no reliable estimates of discards are available and therefore only landings could be used for weighting of survey trends and only landings advice can be provided. Further work on discard estimation is needed.

Recreational fishery

Flounder is also caught to a great extent in the recreational fishery. Statistics from Ministry of Environment in Estonia estimate that a yearly catch of more than 40 tonnes, representing 20% of the total catch, are made in the recreational fishery. Data are available from 2005–2012. (http://www.envir.ee/orb.aw/class=file/action=preview/id=1197601/Harrastuspyygi+saagi+koondandmed+2005-2012++17.04.2013.pdf). The catch is estimated from individual reporting cards. The possession of a fishing card entitles the card holder to fish with gillnets, entangling nets, longlines consisting of up to 100 hooks, hoopnets, dragnets, crayfish dipnets and traps. Mainly gillnets are used for flounder fishing. Fishers who use one simple handline; more than one simple handline; handline; spinning reel; troll; pulling device; fly hook; bottom line (“tonka”, “krunda”); trimmer and harpoon gun and up to five-prong harpoon for underwater fishing, have no responsibility to report their catch (http://www.envir.ee/1181039).

In Finland recreational catches are estimated every second year by a mail survey (for a large sample of the households from the whole population) and assumed to be the same as the year before in the intermediate year. A total catch for the year is estimated (ICES, 2014). The bulk of the Finnish recreational flounder catch is taken from SDs 29–32 by gillnets for household use. Other fishing techniques used for flounder (like angling) are of minor importance, comprising about 1 tonne annually. Data are available from 2000 onwards.

In Sweden the recreational catches are estimated by mail surveys (to a large number of households from the whole population) performed by Statistics Sweden and Swedish Agency for Marine and Water Management (former Swedish Board of Fisheries). Data are available for the Baltic Proper 2006 and 2010 suggesting that the recreational fishery could be of the same magnitude as the commercial fishery (ICES, 2014). Most of the recreational fishers for flounder use bulk catching gear like gillnets. In conclusion, the impact of the recreational fishery probably is large for this stock but the information is not detailed enough to be used in the assessment.

A.3. Ecosystem aspects

Flounder with demersal eggs produce small and heavy eggs which develop at the bottom of shallow banks and coastal areas in the northern part of the Baltic Proper. Reproduction is successful down to 5–7 PSU (Nissling *et al.*, 2002). Flounder with pelagic eggs spawn at 70–130 m depth, and their eggs are neutrally buoyant at 10–20 PSU salinity and require oxygen concentrations of 1–2 ml/l for development (Nissling *et al.*, 2002; Vitins 1980; Ustups *et al.*, 2013).

B. Data

B.1. Commercial catch

Total landings (CATON) are available for all three countries fishing on the stock, Estonia, Sweden and Finland, from 1980 and onwards. The total landings also include landings from the recreational fishery from 1980–2008 for Estonia and from 1980–1999 for Finland. CANUM and WECA (using slicing or breaking and burning technique for age reading as recommended by WKARFLO, ICES 2007 and 2008 and WKFLABA, ICES 2010) are available from Sweden for 2009 and 2010 in SD 27 and from Estonia for 2011 and 2012 in SD 29 and 32.

B.2. Biological

N/a.

B.3. Surveys

The Baltic International Trawl Survey (BITS) survey is not representative for flounder with demersal eggs since during the time of the quarter one survey (BITS-Q1) this type of flounder is most probably in more shallow, coastal areas and during the BITS-Q4 survey they are mixed with the flounder with pelagic eggs (WKFLABA, ICES, 2010). Furthermore the BITS survey do not cover the northern parts of the Baltic Sea (SD 29–32) which is the main distribution area of flounder with demersal eggs.

Fisheries-independent cpue are available from national surveys for this stock. National gillnet surveys are performed by Estonia in Muuga bay near Tallinn (mesh size 40–60 mm bar length) in SD 32 since 1993 and 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. Gillnet surveys are also undertaken from 1999 onwards in different parts of the Gulf of Finland in Estonian waters (Pakri, Muuga, Ihasalu, Kaberneeme and Kolga Bays) with mesh sizes 16, 22, 24, 30, 35, 40, 45, 50 and 60 mm (bar length). Gillnet surveys are also conducted by Sweden 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.

B.4. Commercial cpue

Data on effort and cpue from commercial fisheries in Finland are available for several gears (gillnets and trapnets) in SD 29–32 from 1998 and onwards. The effort in cpue is given as the number of gear days. For example, gillnet fishing with ten gillnets on five days equals 50 gillnet days. The unit catch is given as the size of the catch (kg) per gear and per fishing day. The unit catch is calculated from observations deviating from zero (i.e. zero catches are not included).

From Estonia, effort and cpue from the Danish seine fishery in SD 29 are available since 2009 (kg per hauls), in addition effort data from the gillnet fishery in SD29 and 32 are available for the same time period.

Landings per unit of effort from the Swedish commercial flounder gillnet fishery (gillnets > =100 mm diagonal mesh) in SD 27 is also available for 2000–2012. Effort is calculated as number of fishing hours from the daily logbooks for ships >10 m. The unit catch is calculated from observations deviating from zero (i.e. zero catches are not included).

C. Assessment: data and method

Category 3: Stocks for which survey-based assessments indicate trends (ICES DLS approach, ICES 2012c).

Model used: Data-Limited Stock Category 3.2 Survey based index but no MSY trigger

Model Options chosen: Biomass index (kg/effort) from national gillnet surveys (see surveys described below). Surveys used are restricted to the same quarter (October). The arithmetic mean is used to obtain the biomass index per SD, for SDs with multiple surveys. Survey indices from different SDs are subsequently weighted by the total landings in the respective subdivision to calculate an overall biomass index for flounder in the whole area SD 27, 29–32 (ICES, 2014). This is in order to give more weight to surveys in these SDs where most of the fishery is taking place. It is recognized that landings may not be representing stock size in given subareas. However, using landings as weighting factor ensures that the advice for fisheries management would mostly be based on survey trends that are impacted by fisheries and to a lesser degree by trends in areas where for example no fishery for flounder is taking place.

For providing advice, the average index from the last two years is then compared with the average index from the three preceding years, according to ICES DLS guidelines. Based on the change in survey index the suggested landings should be changed proportionally, within the limits of [-20%; 20%] (uncertainty cap). In addition, unless there are data available showing a decrease in effort, or that fishing mortality is low, or a substantial increase in biomass (more than 50%), a precautionary buffer of 20% reduction should be applied (according to ICES DLS guidelines, ICES, 2012).

Input data types and characteristics:

Landings were taken from InterCatch for Sweden and Finland. For Estonia IC landings were a mixture from the commercial and recreational fishery, and data were provided separately by the national data provider. Characteristics of surveys used for biomass indices are shown below.

TYPE	NAME	SD	FROM YEAR AND ONWARDS	DESCRIPTION
cpue (kg/effort) in survey	Muuga Bay	32	1993	Gillnet survey (mesh size 40 & 60 mm bar length), fished from May–October, performed by Estonian Marine Institute, University of Tartu
cpue (kg/effort) in survey	Küdema Bay	29	2000	Gillnet survey, six fixed stations fished during six nights in October/November in depths 14–20 m. (mesh size 21.5, 30, 38, 50 and 60 mm bar length), performed by Estonian Marine Institute, University of Tartu
cpue (kg/effort) in survey	Muskö	27	1992–	Gillnet survey, eight fixed stations fished during six nights in September/October in depths 16–18 m. (mesh size 21, 30, 38, 50 and 60 mm bar length), performed by Institute of Coastal Research, Department of Aquatic Resources, Swedish University of Agricultural Sciences
cpue (kg/effort) in survey	Kvädöfjärden	27	1989–	Gillnet survey, six fixed stations fished during six nights in October in depths 15–20 m. (mesh size 21, 30, 38, 50 and 60 mm bar length) performed by Institute of Coastal Research, Department of Aquatic Resources, Swedish University of Agricultural Sciences

Data preparation

SURVEY	DATA	SD INDEX	STOCK INDEX
Muuga Bay	October, since 1993	32	SD index weighted by the landings of the respective SD
Küdema Bay	October/November, since 2000	29	
Muskö	September/October, since 1992	27, based on the arithmetic mean of Muskö and Kvädöfjärden biomass indices	
Kvädöfjärden	October, since 1989		

D. Short-term projection

N/a.

E. Medium-term projections

N/a.

F. Long-term projections

N/a.

G. Biological reference points

N/a.

H. Other issues

As no reliable estimates of discards are available only landings could be used for weighting of survey trends and only landings advice can be provided. The possibility of estimating discards and giving total catch advice should be evaluated in the future.

There is also a need to further examine if this assessment unit should be divided into several units due to limited migration between SDs. Furthermore, the influence of flounder with demersal eggs in SD 28 on this assessment unit should also be investigated.

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