Stock Annex: Flounder (*Platichthys flesus*) in subdivisions 24 and 25 (West of Bornholm and Southwestern central Baltic)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Flounder
Working Group:	Baltic Fisheries Assessment Working Group **(**WGBFAS)
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Authors:	
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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 separated 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 - 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 fertilisation occurs at an average of 10-13 psu, whereas an average salinity required to obtain neutral egg buoyancy is 13.9-26.1 psu (Nissling *et al*., 2002).

There are also differences within the pelagic spawners, which led to the designation of three stocks/assessment units at the DCWKBALFLAT: SD 22 and 23; SD 24 and 25; SD 26 and 28 (ICES 2014). There is evidence of a differentiation between SD 22 and 23 from SD 24 and 25 based on egg buoyancy (Nissling *et al*., 2002), length at maturity (Table 1), and to some extent genetics (Hemmer-Hansen *et al*., 2007b). Even though there is no physical connection between SD 22 and SD 23, 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 if these two units are merged. 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

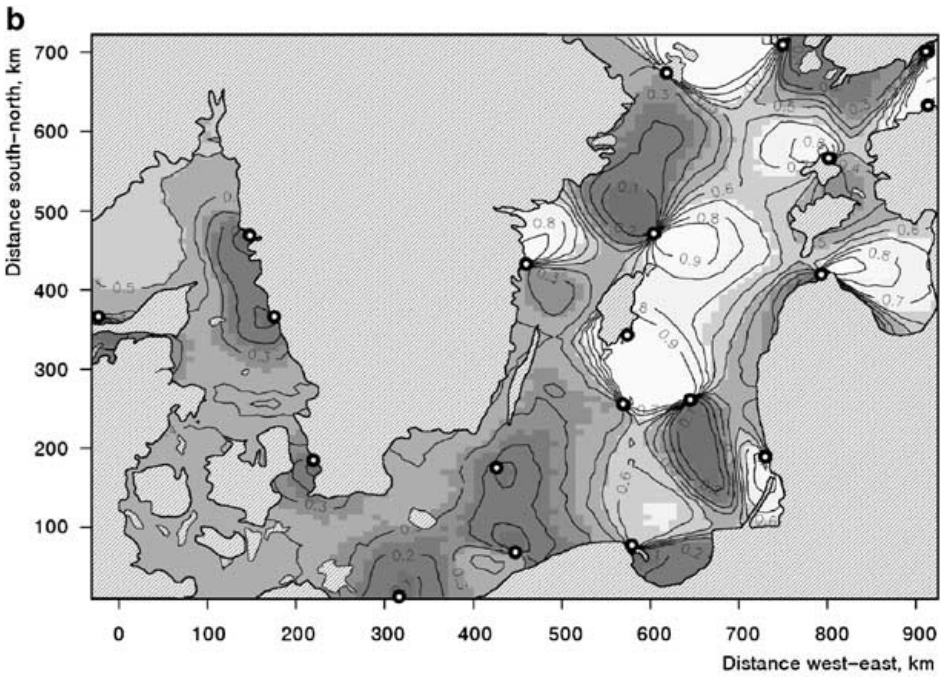

Figure 1. Map of posterior probabilities of population membership (number of populations = 2 and 50 000 iterations). Lighter areas correspond to higher probability to belong to the demersal population, sampling locations are indicated with white dots (Florin and Höglund, 2008).

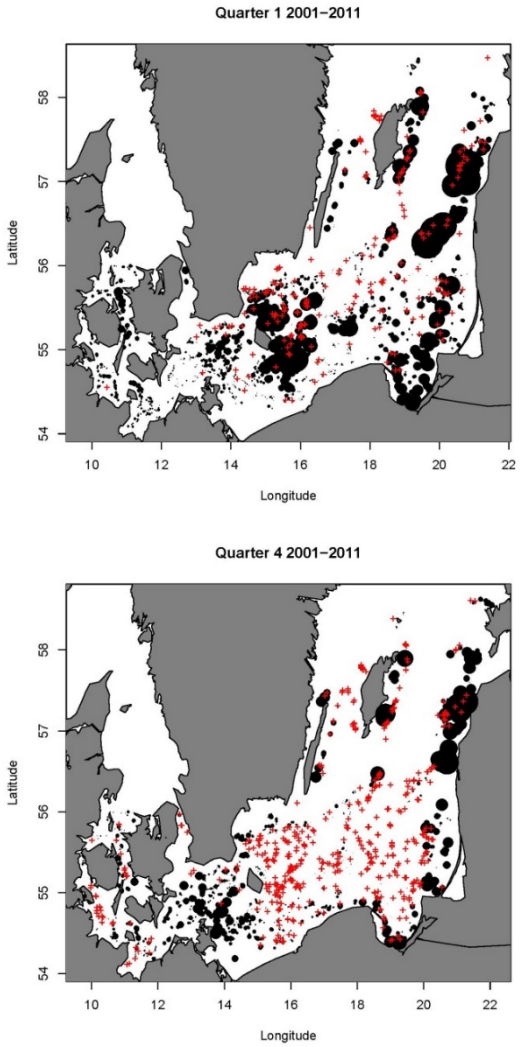

Figure 2. Average relative distribution of flounder biomass in the BITS survey in quarter 1 (spawning time) and quarter 4 from years 2001-2011. Bubble size is proportional to biomass, red crosses means zero catch.

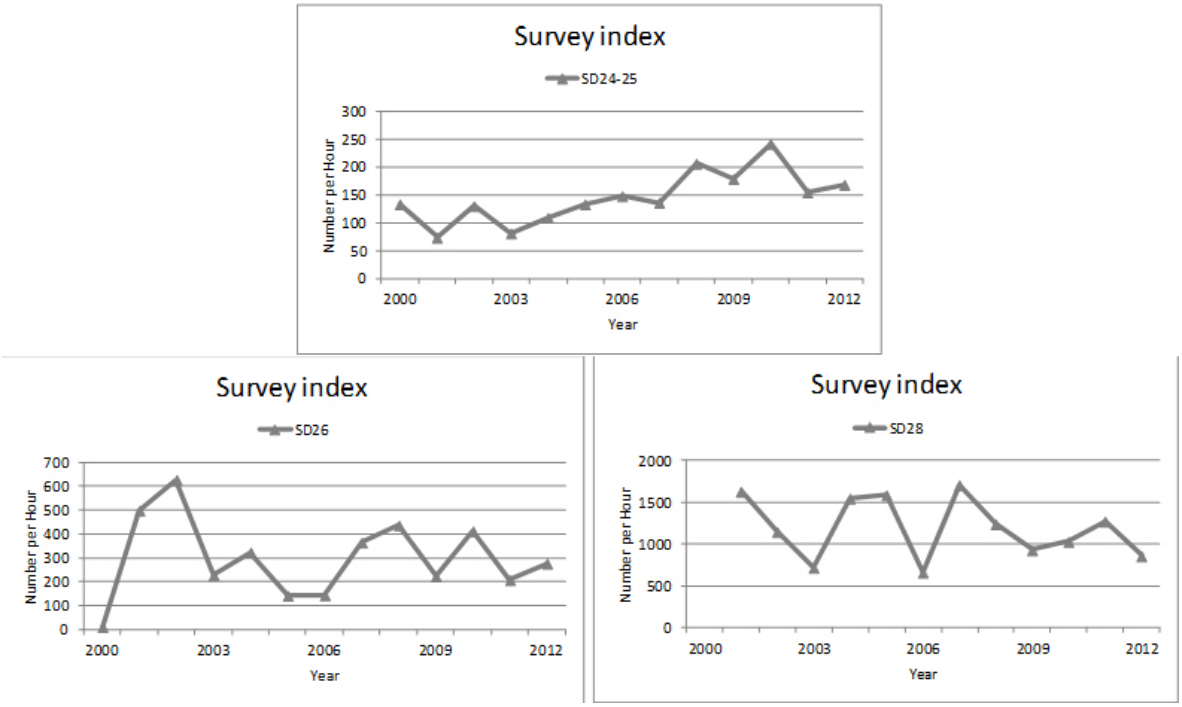

Figure 3. Survey indices from BITS survey quarter I for flounder in different SD.

A.2. Fishery

The fishing season spans mainly between months June to February. The total landings of this stock increased from 4000 -7000 t in 1973-1993, and to 8000 – 13000 t after 2000. Some high landings in the mid-1990s are due to misreporting (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 remained around 10000 t.

In Subdivisions 24 and 25, Poland, Denmark and Germany are the main fishing nations (Figure 4). Polish landings increased during the 2000's and are at least 60% of the total landings, while Danish landings show a decreasing trend in the 2000's.

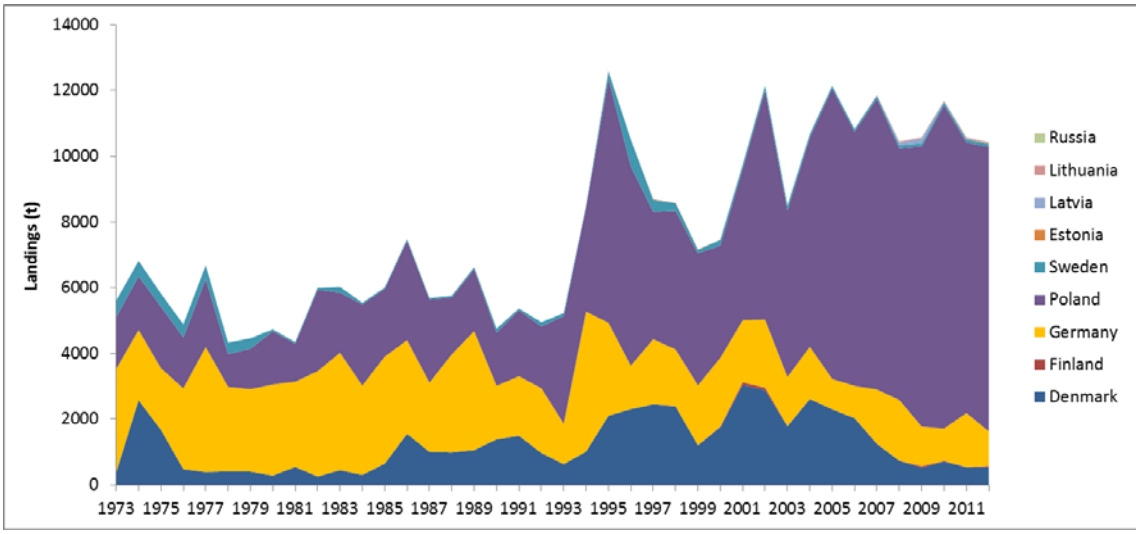

Figure 4. Flounder in SD 24 – 25. Landings in tonnes by country.

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 by-catch in the cod fishery. The major season for flounder by-catch 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 by-catch 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 O2 /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 (WKARFLO; ICES 2007, 2008) were available (since 2000).

Weight at age in the stock was estimated by applying weight-length relationship to length data from age-length key and averaging obtained weights within age groups.

Mature proportion 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:

$E(m(L)|A = a) = \sum_k m(k)P(L = k|A = a)$

(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 survival 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 inappropriate for 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 Subdivision 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, R/V "Eisbär" was replaced by R/V "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 presently 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 cod-end 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

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 fishes ≥ 20 cm from BITS-Q1 and BITS-Q4 survey and the data is 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 sub-divisions 24-25 were: a=0.0078 and b=3.10 for 1st quarter and a=0.0125 and b=2.98 for 4th quarter.

Both BITS-Q1 and BITS-Q4 surveys are aggregated into one annual index value for a given year (using geometric mean between quarters). The Biomass-Index is calculated for each year. 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.

H. Other Issues

During WKABALFLAT (ICES, 2014) 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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