Stock Annex: Flounder (*Platichthys* spp.) in subdivisions 26 and 28 (east of Gotland and Gulf of Gdansk)

Stock specific documentation of standard assessment procedures used by ICES.

Stock Flounder (*Platichthys* spp.) in subdivisions 26 and 28

Working Group: Baltic Fisheries Assessment Working Group (WGBFAS)

Created:

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Last updated: 2020

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Main modifications: Updates in text; New paragraph on recently described flounder species; Information about historical surveys was removed; Standardized effort calculation method added; Information about LBI calculations method added.

A. General

A.1. Stock definition

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 (since 2018 considered as two separate species) 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).

Taking into account contrasting reproductive flounder behaviours in the Baltic Sea: offshore spawning of pelagic eggs and coastal spawning of demersal eggs, Momigliano *et al.* (2018) distinguished two flounder species in the Baltic Sea. Both of them are present in the management area (SD 26 and 28). According to survey data from 2014 and 2015, the share of offshore spawning European flounder *Platichthys flesus* and the coastal spawning - newly described species Baltic flounder *Platichthys solemdali*, was estimated to be approximately 45 and 55% respectively (Ojaveer *et al.*, 2017). Baltic flounder 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. European 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).

It is not possible at this stage to separate the proportion of this species in either stock assessment or fisheries, as external morphological characters cannot discriminate between European and Baltic flounders. The two taxa can be clearly distinguished based on gamete physiology and morphology (Momigliano *et al.*, 2018).

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Flounder in the Gulf of Riga, SD 28-1, most probably are Baltic flounder. However, since historical fisheries data for flounder currently provided by countries are not divided into sub units of SD 28 it was decided to allocate the Gulf of Riga (SD 28-1) into the SD 26-28(2) unit as well. The density of flounder in Gulf of Riga is low, therefore the impact of allocating this subunit, considered to be Baltic flounder, to the European flounder is believed to be minimal.

During favourable hydrological conditions, European flounder 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 of European flounder.

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.

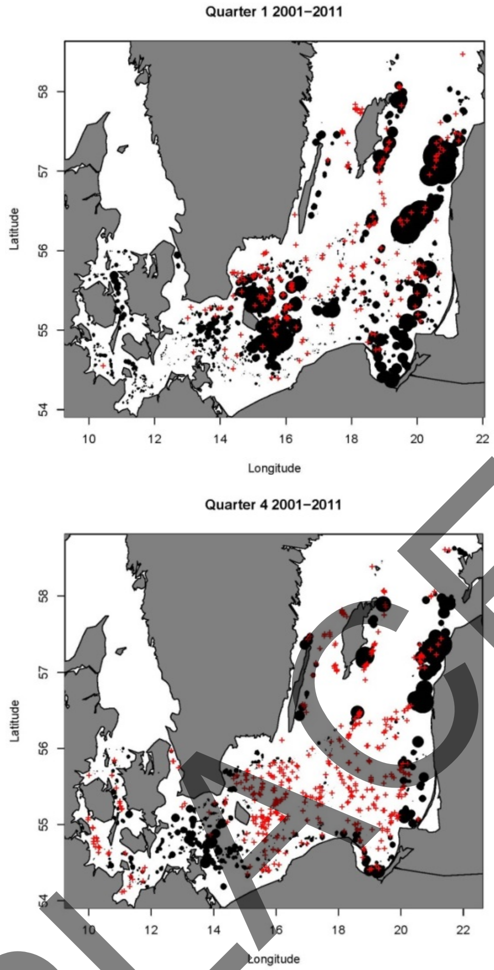

Figure 1. Average relative distribution of flounder biomass in BITS survey in Quarter 1 (spawning time) and quarter 4 from years 2001-2011. Bubble size is proportional to biomass, red crosses mean zero catch.

A.2. Fishery

Flounder landings in SD 26 and 28 up to 2019 fluctuated between 2000- to 5000 tonnes. The major part (81 % in 1996-2019) of the landings belonged to SD 26.

The main fishing countries in Subdivision 26 are Poland (39%% of landings from long term average from 1996-2019), Russia (38%) and Lithuania (17%). The landings in SD 26 started to increase in the 1990s and for the next 1520 years fluctuated between 3000 and 3500 tonnes. Decrease of landings to 2000 tonns was observed in last years. Polish fishery was mainly a gillnet fishery along the coast whereas the Russian and Lithuanian landings were by-catches mainly in a bottom trawl fishery for cod. The main fishing countries in Subdivision 28 are Latvia (83%) and Estonia (10 %). Increase of flounder landings were observed form 2014-2017 due to poor cod fishing possibilities The small scale fishery in the coastal zone is a significant part of the landings in Subdivision 28.

The highest landings recorded, 6455 tonnes, in SD28, were in 1975. Later, in beginning of 1980's after the strong decrease of flounder stock, a specific ban of the flounder fishery was introduced for couple of years.

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 and sometimes are even 100% of the catch.

Since 2015, discards have been estimated by a new method which raises discard rate by all demersal fish landings. In cases when there is no discard rate available for a stratum, it is borrowed from other strata according to allocation scheme, considering differences in discard patterns between subdivisions, countries, gear types and quarters. The highest discards ratio in subdivisions 26 and 28 can be assigned to Denmark and Sweden. Discarding of flounder in Estonia and Russia is forbidden.

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 (10-19m), 9 (20-39m), 10 (40-59m), 11 (60-79m), 12 (80-99m), 13 (90-119m), 14 (120-200m) and second by fished subdivision areas. Hauls with 0 fish per hour were included. All fish with length < 20cm 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

Effort data back to 2009 is available for all countries. As countries have not used the same approach, the effort was standardized within each country and weighted by the national demersal fish (cod and flounder) landings from SD 26–28.

Standardized (SE) effort by average effort by country (*se*) was calculated from equation:

$$se = \frac{f_c}{avg\ f_c}$$

where: f_c – effort by country c

Standardized effort by total demersal landings (SE) in year (y) by country (c) was calculated from equation:

$$\mathrm{SE} = \sum\left(L_{\mathrm{y,c}} \cdot se_{y,c}\right) \div \sum L_{y,\mathrm{c}}$$

$L_{y,c}$ – landings by country and year

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 and Lithuania and for SD 28 from Latvia and Estonia (the time-ranges 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, 2012b).

Model used: Data Limited Stock Category 3.2. Stock trend model based on scientific surveys

Model Options and input data types and characteristics:

Stock trends 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 is 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 sub-divisions 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 SDs 26+28 were: a=0.0154 and b=2.91 for 1st quarter and a=0.0158 and b=2.90 for 4th quarter.

The combined biomass index is calculated using the geometric mean of 1st and 4th quarter biomass indices. The Biomass-Index is calculated for each year.

The stock status was evaluated by calculating length based indicators applying the LBI method developed by WKLIFE V (ICES, 2015). Commercial landings from InterCatch from 2014–2019 were used to estimate CANUM and WECA(Figure 3.4.7, 3.4.8.). Whereas the biological parameters: L_{inf} and L_{mat} were calculated using survey data from DATRAS.

In WGBFAS 2017 potential reference points were calculated first however later it was rejected in ADG BS. Results of LBI were green for fishing pressure, which was in contradiction with the decline in the survey index used as stock size indicator. The ADG or WG did not really understand what creates this apparent inconsistency between the results of the LBI and the biomass indicator. It was noted also issues with age reading, that makes the estimate of L_{inf} very uncertain. The Linf value used in the analysis was 28 cm, but it was unclear if this value is appropriate. The results from the presented LBI analysis for this stock did not appear reliable and were rejected by the ADG.

For estimating L_{inf} data from 2014–2019 from Q4, and for both sexes were taken. Only age data determined by recommended ageing technique was included in the analyse, as a result for Subdivision 26 data from Poland, Lithuania, and Latvia while for Subdivision 28 – data from Latvia and Estonia were used. Age data with inadequate ageing technique (whole otoliths) were excluded from calculations. Preliminary analysis indicated different growth rate in subdivisions 26 and 28 therefore expert group decided to calculate separate L_{inf} for each subdivision and later calculate one weighted L_{inf} where landings of flounder by subdivisions were used as a weighting factor. For Subdvision 25 L_{inf} was 32.46 cm, while for Subdivision 28 – 28.38 cm (Figure 3.4.9.) Landing proportion between subdivisons in last five years is 65% (for Subdivision 26) and 35 % (for Subdivision 28). As a final weighted L_{inf} was calculated 31.04 cm. Data from BITS Q4 only were used. In Q1 flounder is close to spawning time and both flounder species are separated in this time of the year. In BITS Q1 surveys mainly European flounder (or pelagic flounder) are represented. In Q4 both species is mixing, therefore those data better represent all flounder in subdivisions 26 and 28.

In the case of L_{mat} data for females were derived from 2014–2019 (also Q4 – reason is described in previous paragraph). Like for Linf, the same approach was used to calculate weighted $L_{mat.}$ L_{mat} for Subdivision 26 was 18.8 cm, for Subdivision 28 – 15.3 cm, while weighted average for the stock – 17.6 cm Figure 3.4.10).

Accepted biological parameters mentioned above are as follows:

L_{inf} = 31.04 mm
L_{mat} = 17.6 mm

The results were compared to standard length-based reference values to estimate the status of the stock (Table 3.4.5).

The results of LBI (Table 3.2.5, Figure 3.4.11.) show that stock status of fle.27.2628 is above possible reference points (Table 3.4.6). $L_{max5\%}$ is well above the lower limit of 0.80 (*i.e.* 1.28 in 2019), some truncation in the length distribution in the catches might take place. Catch is close to the theoretical length of L_{opt} and L_{mean} is stable over time and close to 1, indicating fishing close to the optimal yield. Exploitation consistent with F_{MSY} proxy (LF=M).

Table 1. Description of the selected LBI

Indicator	Calculation	Reference point	Indicator ratio	Expected value	Property
$L_{max5\%}$	Mean length of largest 5%	L_{inf}	$L_{max5\%}$ / L_{inf}	>0.8	Conservation (large individuals)
$L_{95\%}$	95th percentile		$L_{95\%}$ / L_{inf}		
P_{mega}	Proportion of individuals above L_{opt} + 10%	0.3–0.4	P_{mega}	>0.3	
$L_{25\%}$	25th percentile of length distribution	L_{mat}	$L_{25\%}$ / L_{mat}	>1	Conservation (immatures)
L_c	Length at first catch (length at 50% of mode)	L_{mat}	L_c/L_{mat}	>1	
L_{mean}	Mean length of individuals >L_c	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{mean}/L_{opt}	≈1	Optimal yield
L_{maxy}	Length class with maximum biomass in catch	$L_{opt} = \frac{3}{3+M/k} \times L_{inf}$	L_{maxy} / L_{opt}	≈1	
L_{mean}	Mean length of individuals >L_c	$L_{F=M}$ = $(0.75L_c+0.25L_{inf})$	L_{mean} / $L_{F=M}$	≥1	MSY

D. Short-Term Projection

Since 2020 ICES has been requested to provide information on stock status but has not been requested to provide advice on fishing opportunities for this stock.

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 for flounder ageing to use only recommended methods (sliced or broken and burned). If it is possible countries should re-age their historical age data using recommended ageing methodology for this species in the Baltic Sea.

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