Summary report of the 2020 Kattegat cod age reading exercise (SmartDots ID 269 & 270)

Coordination and analysis: Julie Coad Davies (DTU Aqua)

1 Executive summary

The 2020 Kattegat cod age reading exercise took place from January to March 2020 on the ICES SmartDots platform. The exercise consists of two events with samples from the same fish, one event with broken otoliths and one event with sectioned otoliths. 200 samples (stratified by quarter and age) were collected from ICES subdivision 21 in 2019, from harbour sampling, survey and discard trips. Sample preparation and digitisation were carried out at DTU Aqua, National Institute of Aquatic Resources, Denmark. The aim of the exercise was to firstly, identify and resolve any age interpretation issues and secondly, compare the ages estimated from each method.

The last age reading exchange for Kattegat cod took place in 2016 (in preparation for the ICES WKBALT 2017, Benchmark Workshop on Baltic Stocks). Physical samples were exchanged and only the two primary age readers from Denmark and Sweden took part, overall percentage agreement was 95%, with a coefficient of variation of 2.9% and no consistent patterns of bias detectable which would have an effect on the stock assessment of Kattegat cod.

Three age readers from DTU Aqua took part in this exercise. Routine age reading of cod at DTU Aqua is based on the broken otolith method. In recent years the readers have participated in age reading exercises based on the sectioned otolith method. By including otoliths from the same fish in this exercise, one broken and one sectioned, a comparison of the ages estimated from the two methods was possible. Based on the results an evaluation of the precision and quality of the age estimations from the two methods was possible.

Overall results show a high level of agreement between readers; for the broken otoliths the overall percentage agreement was 79%, with a coefficient of variation of 28% and an average percentage error of 16%; for the sectioned otoliths the overall percentage agreement was higher at 85%, with a lower coefficient of variation of 23% and a lower average percentage error of 10%. These results indicate that the sectioned method allows for a higher agreement and more precision between readings.

When the readings estimated for each sample were compared, there was agreement reached across methods on 70% of the samples and in the majority of cases where disagreement existed, a higher modal age was reached from the broken method. An examination of the annotated images revealed difficulties in correctly identifying the first winter ring which can often be confused with the settling ring, mostly in the broken otoliths. Another confounding issue is the apparent change in timing of the translucent zone formation seen in the samples in this exercise. This change has also been observed in young cod from the western Baltic Sea and linked to water temperatures in the juvenile shallow water habitats.

The age estimation process is dependent on knowing the catch date of the sample and the periodicity of the annual deposition of the growth (opaque) and non-growth (translucent) zones. A change in the later requires that readers are made aware of any changes occurring in the annual growth pattern and guidelines provided for them on how to interpret these changes when estimating the age of the fish. The results from the exercise identify the need for updated guidelines to be provided for the readers of Kattegat cod otoliths.

2 Overview of samples and readers

Table 1: Overview of samples (n=200) used for the 2020 Kattegat cod exercise.

Year	ICES area	Quarter	Number of samples	Modal age range	Length range
2019	27.3.a.21	1	52	1-8	140-1060 mm
2019	27.3.a.21	2	32	1-3	0-330 mm
2019	27.3.a.21	3	29	0-5	110-800 mm
2019	27.3.a.21	4	87	0-4	90-700 mm

Table 2: Reader overview for the 2020 Kattegat cod exercise.

Reader code	Reader initials	Expertise
R01 DK	HR	Advanced
R02 DK	MJ	Advanced
R03 DK	SEL	Advanced

3 Results

Table 3: Percentage agreement (PA) table represents the PA per modal age and reader, the PA of all readers combined per modal age and a weighted mean of the PA per reader, per method.

Broken						Sectioned				
Modal age	**R01 DK**	**R02 DK**	**R03 DK**	**all**		**Modal age**	**R01 DK**	**R02 DK**	**R03 DK**	**all**
0	100 %	92 %	77 %	**90 %**		0	98 %	89 %	81 %	**90 %**
1	61 %	86 %	100 %	**82 %**		1	78 %	86 %	96 %	**87 %**
2	95 %	78 %	35 %	**69 %**		2	96 %	61 %	68 %	**75 %**
3	88 %	56 %	83 %	**76 %**		3	96 %	85 %	87 %	**89 %**
4	80 %	100 %	30 %	**69 %**		4	88 %	100 %	38 %	**75 %**
5	100 %	80 %	100 %	**93 %**		5	88 %	38 %	100 %	**75 %**
6	100 %	100 %	100 %	**100 %**		6	-	-	-	**-**
7						7	-	-	-	**-**
8						**8**	100 %	100 %	100 %	**100 %**
Weighted Mean	**83 %**	**78 %**	**75 %**	**79 %**		**Weighted Mean**	**91 %**	**81 %**	**84 %**	**85 %**

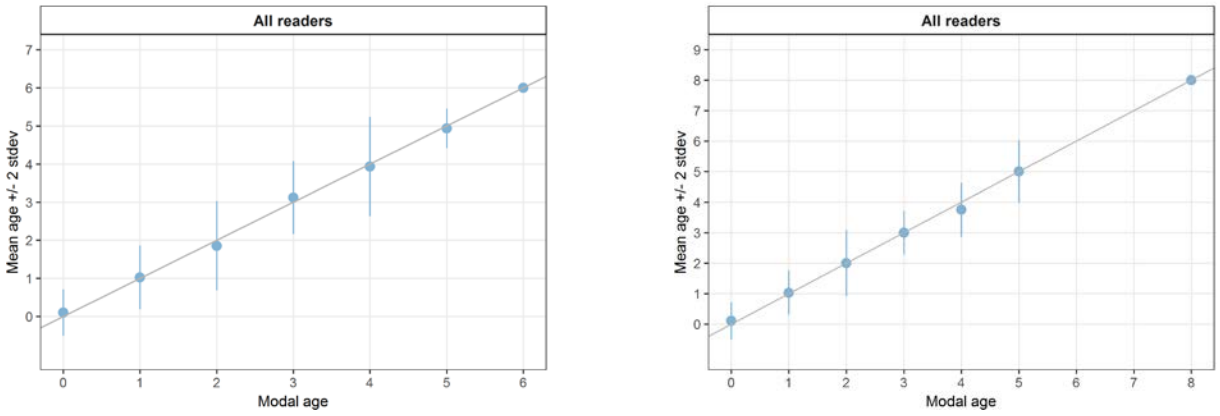
Table 4: Coefficient of Variation (CV) table presents the CV per modal age and reader, the CV of all readers combined per modal age and a weighted mean of the CV per reader, per method.

Broken						Sectioned				
Modal age	**R01 DK**	**R02 DK**	**R03 DK**	**All**		**Modal age**	**R01 DK**	**R02 DK**	**R03 DK**	**all**
0	-	-	-	**-**		0	-	-	-	**-**
1	64 %	33 %	0 %	**41 %**		1	47 %	36 %	18 %	**35 %**
2	11 %	28 %	36 %	**32 %**		2	9 %	31 %	30 %	**27 %**
3	11 %	16 %	13 %	**15 %**		3	10 %	13 %	12 %	**12 %**
4	16 %	0 %	20 %	**17 %**		4	9 %	0 %	15 %	**12 %**
5	0 %	9 %	0 %	**5 %**		5	7 %	17 %	0 %	**10 %**
6	-	-	-	**0 %**		6	-	-	-	**-**
7						7				
8						8	-	-	-	**0 %**
Weighted Mean	**29 %**	**23 %**	**14 %**	**28 %**		**Weighted Mean**	**23 %**	**23 %**	**17 %**	**23 %**

Table 5: Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader, per method.

Broken						Sectioned				
Modal age	**R01 DK**	**R02 DK**	**R03 DK**	**all**		**Modal age**	**R01 DK**	**R02 DK**	**R03 DK**	**all**

0	**0.00**	**0.08**	**0.23**	**0.10**		**0**	**0.02**	**0.11**	**0.19**	**0.10**
1	-0.02	0.10	0.00	**0.03**		1	0.00	0.06	0.04	**0.03**
2	0.05	0.16	**-0.65**	**-0.14**		2	0.04	0.21	-0.25	**0.00**
3	0.12	0.40	-0.17	**0.12**		3	0.02	0.08	-0.10	**0.00**
4	0.30	0.00	**-0.50**	**-0.07**		4	-0.12	0.00	**-0.62**	**-0.25**
5	0.00	-0.20	0.00	**-0.07**		5	0.12	-0.12	0.00	**0.00**
6	0.00	0.00	0.00	**0.00**		6	-	-	-	-
7						7	-	-	-	-
8						8	0.00	0.00	0.00	**0.00**
Weighted Mean	**0.05**	**0.18**	**-0.17**	**0.02**		**Weighted Mean**	**0.02**	**0.09**	**-0.03**	**0.02**



Broken **Sectioned**

Figure 1: Age bias plot for all for broken and sectioned otoliths. Mean age recorded +/- 2 stdev of all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

4 Conclusion

The results of this exercise were presented and discussed with the participants and it was agreed that the sectioned method provides a higher quality preparation for age determination and that the results obtained from reading the sectioned otoliths are more accurate. The ages estimated from the broken otoliths are higher compared to those estimated from the sectioned otoliths. The guidelines provided for cod in the western Baltic Sea should be followed when ageing cod from the Kattegat. For samples caught in Q3 and Q4 the TZ's at the outermost otolith edge should not be counted. The guideline of a mean diameter of the first TZ being 2.0 +/- 0.5 mm can be applied if there is any doubt in regards to the location of the first TZ. More experience in identifying the otolith edge type is required.

The events are now open on SmartDots for the readers to compare their readings. Taking measurements and correct identification of otolith edge type is more reliable on sectioned otoliths and in order to compile data on TZ diameters and otolith edge type for Kattegat cod the sectioned otoliths will be photographed and uploaded to SmartDots for further calibration events. A set of reader guidelines will be compiled based on these images.

Readers emphasised the need for more biological information on area specific spawning times, changes in growth, optimal temperature for growth and reproduction and observed changes in water temperature that are impacting the biological characteristics of this stock. It was discussed that following maturation and first spawning the growth patterns may revert to the traditional pattern and investigation should be carried out on fish age 3 and above and reader guidelines provided.