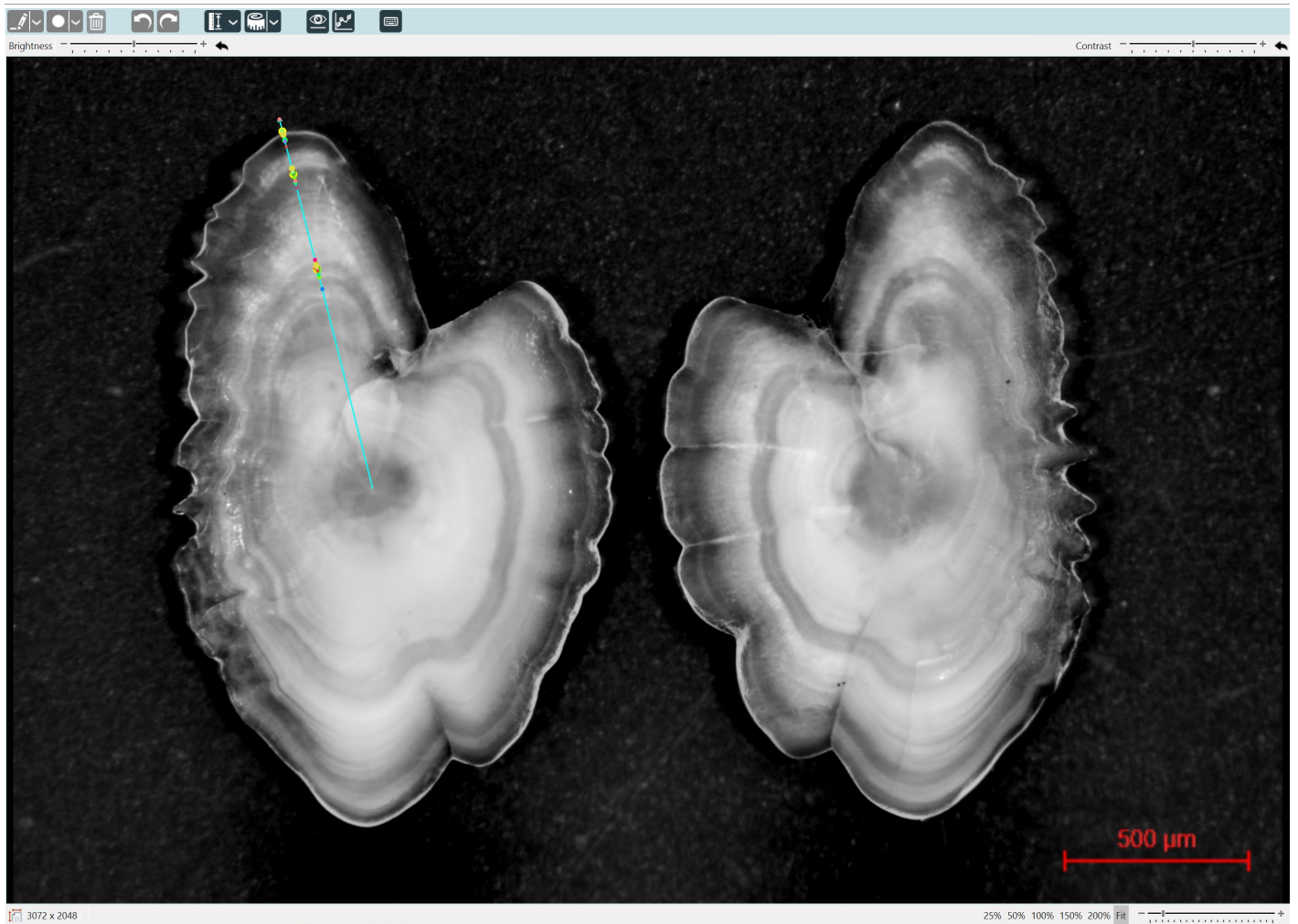


# 2025 North Sea Sprat (spr.27.3a4) age reading exchange (Event ID:1910) SmartDots Report

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# 1 Summary

The 2025 North Sea sprat exchange took place via the SmartDots platform from January to March 2025. A total of 17 age readers took part, 9 advanced readers who provide age data for stock assessment of **spr.27.3a4** and 8 basic readers who do not provide age data for stock assessment.

A total of 112 images were provided for annotation. The set comprised of 48 samples (fish) with 2 images per sample – 1 image taken with reflected light and 1 image taken with transmitted light. Readers routinely use different age reading methods with Sweden reading whole otoliths viewed on glass slides with transmitted light while all other countries read whole otoliths viewed on a black background under reflected light. For this reason, the same otoliths were photographed twice. Images taken under reflected light were provided by DTU Aqua while images taken using transmitted light were provided by SLU Aqua. In addition, 16 agreed age otolith images from the 2016 Workshop on age estimation of sprat (WKARSPRAT) were included, these are referred to as the Reference Collection (RC).

Based on only those readers providing data for stock assessment purposes (termed “advanced”), the overall percentage agreement (PA) was 77 % with a coefficient of variation (CV) of 28 % and an average percentage error (APE) of 18 % (Table 22). PA is lowest at modal age 0 and 2, at 73 % (Table 24) while CV and APE are highest at modal age 1 at 31% (Table 23) and 23% (Table 25) respectively. This shows there is disagreement and uncertainty between the readers as to how to interpret the growth structures laid down in the first years of the fishes life. There is an overall positive bias of 0.06 (Table 26), highest at modal age 0 at 0.38 indicating overestimation in comparison to modal age, also apparent at modal age 1, at 0.16. For modal ages 2-4 the bias is negative, indicating a tendency to underestimate in comparison to modal age (ranging from -0.24 to -0.11).

In comparison, the results from the age reading exercise carried out at WKARSPRAT are similar. Results in 2016 from ICES area 3a were PA = 67.8%; CV = 22.3% and APE = 16.9%. Results in 2016 from ICES area 4 were PA = 81%; CV = 21.7% and APE = 16.2%. A total of 16 agreed age fish (RC) from WKARSPRAT were read by all readers again in 2025 (not the exact same set of readers completed each exchange). For all but 1 fish the same modal age was reached in 2025. Figure 5 shows this otolith and the annotations of advanced readers in 2025, modal age = 2. In 2016, the modal age for the same otolith was 1. The image shows the often banded appearance of the growth structures laid down in the first years of the fishes life and the disagreement between readers on how to interpret them.

In general, ageing uncertainty is due to; the “banded” appearance of first translucent zone, whether or not to count a narrow translucent zone which is present in the opaque inner zone seen in some otoliths. whether or not to include a narrow translucent zone which is sometimes apparent at the otolith edge for fish caught in June/July and underestimation of older ages due to difficulties in the identification of the narrow growth zones at the otolith edge.

All annotations are now visible in the SmartDots software and multiple annotations can be seen on each image for comparison. A recently added feature to the software shows modal age and PA per image.

Preliminary results were provided to the stock assessor prior to HAWG 2025. The current SMS stock assessment model is not adapted to incorporate ageing error but ageing error data from this exchange is available. Results will be presented at the ICES Benchmark workshop on selected herring and sprat stocks (WKBHERSPR) 2025.

# 2 Methods applied

This report contains statistical analyses and comparisons of age readings in the form of tables and graphical plots from the Guus Eltink Excel sheet 'Age Reading Comparisons (Eltink, A.T.G.W. 2000).

## **Modal age: a multistage approach to define the modal age by sampled fish**

In this event, the multistage approach to calculate the modal age has been used. It is a key statistic by itself, but it is also fundamental for the estimation of some other relevant statistics to assess the performance of the techniques assessed in the exchange event, like the Percentage Agreement (PA), or input for stock assessments like the Age Error Matrix (AEM). However, when the standard approach of calculating the mode (each reader has the same weight=1) is applied, the mode is taken as the lowest age of the multiple modal ages. The multistage approach is based on the different weight given to the age readers according to their experience and an application of 3 methods/stages. During the WGBIOP 2019 meeting it was found that the combination of the modes decided using these three methods (so called 'multistage approach'), allows assigning a single modal age to each fish individual.

## **Percentage Agreement (PA)**

The percentage agreement is estimated by modal age and reader as the proportion (as percentage) of times that the lectures of that reader agreed with the resulting modal age. This percentage is estimated as the number of times that a reader agreed with the modal age divided by the total number of otoliths read by a reader for each modal age.

$$PA = \frac{\text{number of readings that agree with modal age}}{\text{total number of readings by modal age}} \cdot 100\%$$

## **Coefficient of Variation (CV)**

The table presents the Coefficient of Variation (CV) per modal age and reader. The CV's are calculated as the ratio between the standard deviation ( $\sigma$ ) and mean value ( $\mu$ ) per reader and modal age:

$$CV = \frac{\sigma}{\mu} \cdot 100\%$$

To the table is also added the CV of all readers combined per modal age and a weighted mean of the CV per reader.

## **Relative bias**

The relative bias is calculated as the difference between the mean and the modal age. This statistic is presented in first place by modal age and reader, but it is also calculated as an average value by modal age for all readers together (or only advanced readers).

## **Average Percentage Error (APE)**

The Average Percentage Error (APE) was calculated based on the method outlined by Beamish & Fournier (1981). This method is dependent of fish age and thus provides a better estimate of precision than percentage agreement. As the calculations of both CV and APE pose problems if the mean age is close to 0, all observations for which modal age was 0 were omitted from the CV and APE calculations.

The average percentage error is calculated per image as:

$$APE = \frac{100\%}{n} \sum_{i=1}^n \left| \frac{a_i - \bar{a}}{\bar{a}} \right|$$

where  $a_i$  is the age reading of reader  $i$  and  $\bar{a}$  is the mean of all readings from 1 to  $n$ .

### **Age error matrix (AEM)**

Age error matrices (AEM) were produced following procedures outlined by WKSABCAL (2014) where the matrix shows the proportion of each modal age mis-aged as other ages. The sum of each row is 1, which equals 100%. The age data was analysed twice, the first time all readers were included and the second time only the “advanced” readers were included. If a reader is “advanced” then they are considered well trained and they provide ages for stock assessment or similar purposes. When the AEM is compiled for assessment purposes it uses only those readers who provide age data for the stock assessment in that specific area.

### **Strata applied**

In this report the strata applied are:

RC = Reference collection

TL = Transmitted light

RL = Reflected light

# 3 Overview of samples and readers

**Table 3.1:** Overview of samples used for the exchange event number 1910 (n=64)

Year	ICES area	Quarter	Number of samples	Modal age range	Length range
2013	27.3.a	1	3	3-4	130-140 mm
2014	27.3.a	2	1	1	80 mm
2014	27.3.a	3	1	0	80 mm
2015	27.3.a	3	1	1	100 mm
2015	27.3.a	4	3	0-1	80-110 mm
2015	27.4.b	2	4	1-2	90-110 mm
2015	27.4.b	3	2	1	125 mm
2016	27.4.b	1	1	2	115 mm
2023	27.3.a.20	3	2	2-3	100-115 mm
2023	27.4.b	2	9	1-3	95-140 mm
2023	27.4.b	3	3	0	80-85 mm
2023	27.4.b	4	14	0-3	85-130 mm
2024	27.3.a.21	3	6	1-3	85-150 mm
2024	27.4.b	1	8	1-3	80-140 mm

**Table 3.2:** Reader overview showing expertise level, routine preparation method applied and expertise rank indicating the level of experience (1 being most experienced and 18 the least).

Reader code	Expertise	Routine age reading method	Expertise rank
R01 DK	Advanced	Whole/Reflected light	1
R02 NO	Advanced	Whole/Reflected light	2
R03 NO	Basic	Whole/Reflected light	3
R04 NO	Advanced	Whole/Reflected light	4
R05 SCT	Advanced	Whole/Reflected light	5
R06 SE	Advanced	Whole/Transmitted light	6
R07 DE	Advanced	Whole/Reflected light	7
R08 NO	Advanced	Whole/Reflected light	8
R09 NO	Advanced	Whole/Reflected light	9
R10 NL	Advanced	Whole/Reflected light	10
R11 DE	Basic	Whole/Reflected light	11
R13 DK	Basic	Whole/Reflected light	13
R14 FR	Basic	Whole/Reflected light	14
R15 SE	Basic	Whole/Transmitted light	15
R16 DK	Basic	Whole/Reflected light	16
R17 NO	Basic	Whole/Reflected light	17
R18 PL	Basic	Whole/Reflected light	18

# 3.1 Results

## 3.1.1 All readers (basic and advanced) and all samples included

**Table 1:** List of cases for which multiple modes were obtained. The column NModes\_trad shows the number of multiple modes for each FishID or SampleID when all readers are given the same expertise weight.

NModes_trad	SampleID
3	8710529_ALA_RLX_XX
3	8710529_ALA_TLX

**Table 2:** Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
112	35 %	71 %	25 %

### Coefficient of Variation (CV)

**Table 3:** 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

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	-	-	-	-	-	-	-	-
1	36 %	20 %	46 %	0 %	35 %	36 %	0 %	20 %
2	25 %	23 %	21 %	36 %	27 %	29 %	24 %	17 %
3	19 %	39 %	14 %	40 %	0 %	24 %	19 %	27 %
4	-	-	-	-	-	-	-	-
Weighted Mean	28 %	25 %	33 %	22 %	26 %	31 %	13 %	20 %

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	-	-	-	-	-	-	-	-	-	-
1	27 %	33 %	22 %	49 %	41 %	65 %	37 %	0 %	42 %	43 %
2	17 %	20 %	40 %	34 %	37 %	38 %	26 %	21 %	26 %	34 %
3	10 %	0 %	39 %	15 %	19 %	30 %	21 %	14 %	14 %	24 %
4	-	-	-	-	-	-	-	-	-	16 %
Weighted Mean	20 %	24 %	32 %	36 %	43 %	48 %	30 %	11 %	30 %	35 %

### Percentage of Agreement (PA)

**Table 4:** 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.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	60 %	100 %	9 %	91 %	0 %	100 %	100 %	73 %
1	75 %	95 %	50 %	100 %	77 %	64 %	100 %	95 %
2	78 %	79 %	67 %	37 %	68 %	68 %	79 %	89 %
3	64 %	64 %	82 %	36 %	100 %	82 %	73 %	73 %
4	100 %	0 %	0 %	100 %	100 %	100 %	100 %	100 %
Weighted Mean	72 %	84 %	52 %	69 %	71 %	75 %	89 %	86 %

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	100 %	0 %	100 %	45 %	36 %	73 %	0 %	100 %	82 %	66 %
1	91 %	45 %	95 %	60 %	57 %	55 %	32 %	100 %	73 %	75 %
2	89 %	74 %	47 %	53 %	68 %	42 %	59 %	83 %	74 %	68 %
3	91 %	100 %	64 %	64 %	64 %	55 %	45 %	82 %	73 %	71 %
4	100 %	100 %	100 %	100 %	0 %	100 %	0 %	100 %	100 %	76 %
Weighted Mean	92 %	56 %	77 %	56 %	57 %	55 %	38 %	92 %	75 %	71 %

### Average Percentage Error (APE)

**Table 5:** Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	-	-	-	-	-	-	-	-
1	30 %	8 %	41 %	0 %	29 %	34 %	0 %	8 %
2	19 %	19 %	19 %	34 %	18 %	22 %	11 %	10 %
3	18 %	34 %	11 %	32 %	0 %	12 %	11 %	17 %
4	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
Weighted Mean	23 %	17 %	25 %	19 %	19 %	24 %	6 %	11 %

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	-	-	-	-	-	-	-	-	-	-
1	15 %	32 %	9 %	43 %	37 %	51 %	29 %	0 %	31 %	34 %
2	5 %	17 %	34 %	31 %	25 %	28 %	22 %	11 %	15 %	21 %
3	5 %	0 %	34 %	14 %	18 %	18 %	20 %	11 %	12 %	17 %
4	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	12 %
Weighted Mean	9 %	22 %	23 %	31 %	36 %	35 %	24 %	6 %	21 %	25 %

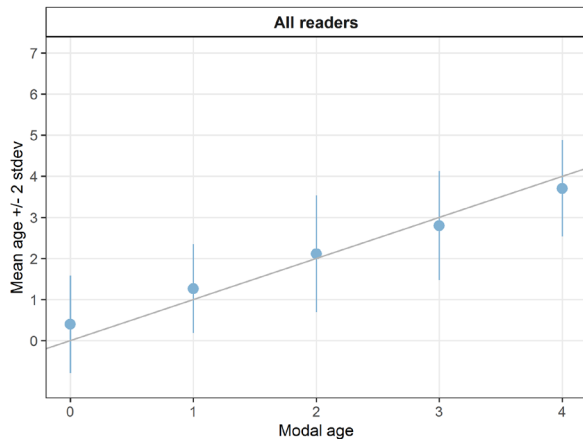
### Relative bias

**Table 6:** The relative bias (as the difference between the mean and modal age) per modal age and reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all readers combined.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	0.40	0.00	1.00	0.09	1.17	0.00	0.00	0.27
1	0.25	0.05	0.68	0.00	0.23	0.36	0.00	0.05
2	0.28	-0.21	0.33	-0.63	0.11	0.26	0.00	-0.11
3	-0.36	-0.64	-0.18	-0.91	0.00	-0.09	-0.09	-0.18
4	0.00	-1.00	-1.00	0.00	0.00	0.00	0.00	0.00
Weighted Mean	0.17	-0.17	0.46	-0.33	0.24	0.19	-0.02	0.00

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	0.00	1.45	0.00	0.73	0.64	0.27	1.14	0.00	0.18	0.43
1	0.09	0.55	-0.05	0.55	0.48	0.27	0.82	0.00	0.18	0.26
2	0.00	0.26	-0.32	0.84	-0.16	1.00	0.29	-0.06	0.05	0.11
3	0.09	0.00	-0.64	0.36	-0.36	0.00	-0.55	-0.18	0.27	-0.20
4	0.00	0.00	0.00	0.00	-1.00	0.00	-2.00	0.00	0.00	-0.29
Weighted Mean	0.05	0.52	-0.22	0.63	0.14	0.44	0.40	-0.05	0.16	0.16





**Figure 1:** Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and 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).

### 3.1.2 All readers (basic and advanced) and Strata = Reference Collection (RC)

**Table 7:** Strata RC .Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
16	31 %	79 %	22 %

#### Coefficient of Variation (CV)

**Table 8:** Strata RC .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

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	-	-	-	-	-	-	-	-
1	38 %	0 %	36 %	0 %	30 %	36 %	0 %	0 %
2	28 %	0 %	0 %	47 %	28 %	28 %	47 %	47 %
3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
4	-	-	-	-	-	-	-	-
Weighted Mean	30 %	0 %	25 %	7 %	25 %	30 %	7 %	7 %

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	-	-	-	-	-	-	-	-	-	-
1	0 %	36 %	0 %	53 %	38 %	53 %	32 %	0 %	0 %	37 %
2	47 %	0 %	0 %	47 %	47 %	0 %	0 %	47 %	47 %	36 %
3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	8 %
4	-	-	-	-	-	-	-	-	-	16 %
Weighted Mean	7 %	22 %	0 %	44 %	33 %	37 %	25 %	7 %	6 %	31 %

### Percentage of Agreement (PA)

**Table 9:** Strata RC .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.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	0 %	100 %	50 %	50 %	0 %	100 %	100 %	100 %		
1	62 %	100 %	78 %	100 %	89 %	56 %	100 %	100 %		
2	50 %	100 %	100 %	50 %	50 %	50 %	50 %	50 %		
3	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %		
4	100 %	0 %	0 %	100 %	100 %	100 %	100 %	100 %		
Weighted Mean	64 %	94 %	75 %	88 %	80 %	69 %	94 %	94 %		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	100 %	0 %	100 %	100 %	50 %	100 %	0 %	100 %	0 %	66 %
1	100 %	78 %	100 %	78 %	67 %	78 %	22 %	100 %	100 %	83 %
2	50 %	100 %	0 %	50 %	50 %	100 %	100 %	50 %	50 %	62 %
3	100 %	100 %	100 %	100 %	100 %	100 %	0 %	100 %	100 %	94 %
4	100 %	100 %	100 %	100 %	0 %	100 %	0 %	100 %	100 %	76 %
Weighted Mean	94 %	75 %	88 %	81 %	62 %	88 %	25 %	94 %	81 %	79 %

### Average Percentage Error (APE)

**Table 10:** Strata RC .Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	-	-	-	-	-	-	-	-		
1	34 %	0 %	28 %	0 %	18 %	34 %	0 %	0 %		
2	20 %	0 %	0 %	33 %	20 %	20 %	33 %	33 %		
3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %		
4	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %		
Weighted Mean	22 %	0 %	18 %	5 %	13 %	25 %	5 %	5 %		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	-	-	-	-	-	-	-	-	-	-
1	0 %	28 %	0 %	39 %	33 %	39 %	21 %	0 %	0 %	27 %
2	33 %	0 %	0 %	33 %	33 %	0 %	0 %	33 %	33 %	25 %
3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	4 %
4	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	12 %
Weighted Mean	5 %	16 %	0 %	30 %	26 %	25 %	16 %	5 %	4 %	22 %

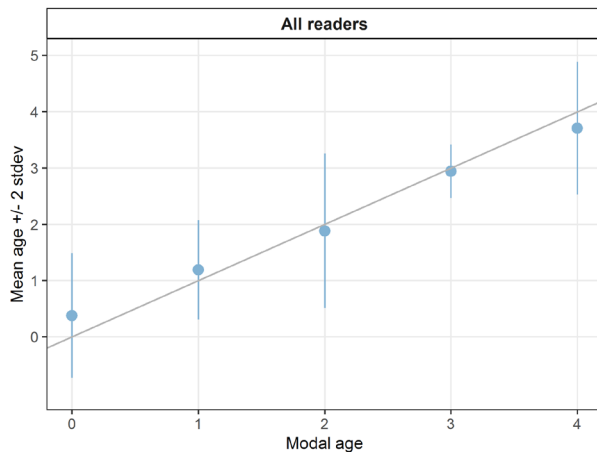
### Relative bias

**Table 11:** Strata RC . The relative bias (as the difference between the mean and modal age) per modal age and reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all readers combined.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	1.00	0.00	0.50	0.5	1.00	0.00	0.00	0.00		
1	0.38	0.00	0.22	0.0	0.11	0.44	0.00	0.00		

2	0.50	0.00	0.00	-0.5	0.50	0.50	-0.50	-0.50
3	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00
4	0.00	-1.00	-1.00	0.0	0.00	0.00	0.00	0.00
<b>Weighted Mean</b>	<b>0.36</b>	<b>-0.06</b>	<b>0.13</b>	<b>0.0</b>	<b>0.20</b>	<b>0.31</b>	<b>-0.06</b>	<b>-0.06</b>

	R09	R10	R11	R13	R14	R15	R16	R17	R18	ALL
Modal age	NO	NL	DE	DK	FR	SE	DK	NO	PL	
0	0.00	1.00	0.00	0.00	0.50	0.00	1.50	0.00	1.00	<b>0.41</b>
1	0.00	0.22	0.00	0.33	0.33	0.33	0.89	0.00	0.00	<b>0.19</b>
2	-0.50	0.00	-1.00	1.00	-0.50	0.00	0.00	-0.50	-0.50	<b>-0.12</b>
3	0.00	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	0.00	<b>-0.06</b>
4	0.00	0.00	0.00	0.00	-1.00	0.00	-2.00	0.00	0.00	<b>-0.29</b>
<b>Weighted Mean</b>	<b>-0.06</b>	<b>0.25</b>	<b>-0.12</b>	<b>0.31</b>	<b>0.12</b>	<b>0.19</b>	<b>0.44</b>	<b>-0.06</b>	<b>0.06</b>	<b>0.12</b>



**Figure 2:** Strata RC .Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and 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).

### 3.1.3 All readers (basic and advanced) and Strata = Reflected Light (RL)

**Table 12:** Strata Strata\_RL .Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
48	34 %	69 %	24 %

#### *Coefficient of Variation (CV)*

**Table 13:** Strata RL .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

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	-	-	-	-	-	-	-	-
1	33 %	26 %	41 %	0 %	37 %	-	0 %	26 %
2	26 %	25 %	21 %	36 %	27 %	-	21 %	12 %
3	21 %	44 %	16 %	41 %	0 %	-	21 %	30 %
4	-	-	-	-	-	-	-	-
<b>Weighted Mean</b>	<b>27 %</b>	<b>29 %</b>	<b>27 %</b>	<b>25 %</b>	<b>26 %</b>	<b>-</b>	<b>14 %</b>	<b>21 %</b>

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	-	-	-	-	-	-	-	-	-	-
1	33 %	25 %	30 %	46 %	42 %	-	41 %	0 %	48 %	44 %
2	12 %	20 %	38 %	34 %	37 %	-	26 %	18 %	23 %	30 %
3	11 %	0 %	44 %	15 %	21 %	-	21 %	16 %	15 %	26 %
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	18 %	20 %	37 %	44 %	42 %	-	27 %	11 %	30 %	34 %

### Percentage of Agreement (PA)

**Table 14:** Strata RL .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.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	67 %	100 %	0 %	100 %	0 %	-	100 %	67 %		
1	83 %	92 %	31 %	100 %	69 %	-	100 %	92 %		
2	81 %	76 %	62 %	35 %	71 %	-	82 %	94 %		
3	56 %	56 %	78 %	22 %	100 %	-	67 %	67 %		
4	-	-	-	-	-	-	-	-		
Weighted Mean	74 %	81 %	45 %	62 %	68 %	-	88 %	83 %		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	100 %	0 %	100 %	33 %	33 %	-	0 %	100 %	100 %	64 %
1	85 %	23 %	92 %	45 %	50 %	-	38 %	100 %	54 %	71 %
2	94 %	71 %	53 %	53 %	71 %	-	53 %	88 %	76 %	71 %
3	89 %	100 %	56 %	56 %	56 %	-	56 %	78 %	67 %	67 %
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	92 %	50 %	73 %	48 %	55 %	-	43 %	91 %	73 %	69 %

### Average Percentage Error (APE)

**Table 15:** Strata RL .Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	-	-	-	-	-	-	-	-		
1	24 %	13 %	31 %	0 %	33 %	-	0 %	13 %		
2	18 %	20 %	20 %	34 %	16 %	-	11 %	6 %		
3	19 %	39 %	12 %	31 %	0 %	-	14 %	20 %		
4	-	-	-	-	-	-	-	-		
Weighted Mean	20 %	22 %	21 %	22 %	19 %	-	8 %	12 %		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	-	-	-	-	-	-	-	-	-	-
1	23 %	20 %	15 %	38 %	37 %	-	33 %	0 %	41 %	36 %
2	5 %	18 %	31 %	31 %	23 %	-	23 %	6 %	15 %	18 %
3	6 %	0 %	39 %	14 %	19 %	-	19 %	12 %	13 %	19 %
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	11 %	18 %	27 %	36 %	34 %	-	23 %	6 %	23 %	24 %

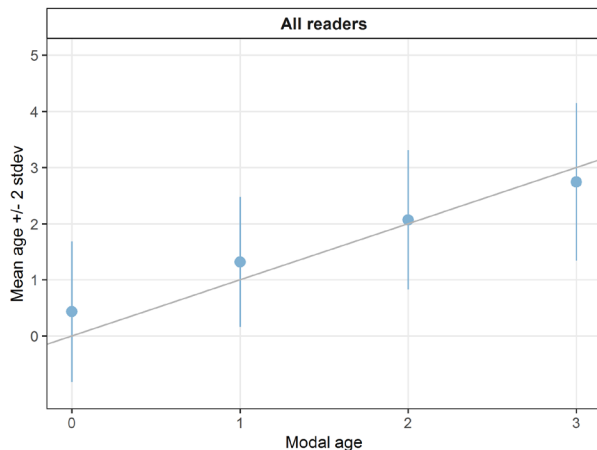
## Relative bias

**Table 16:** Strata RL . The relative bias (as the difference between the mean and modal age) per modal age and reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all readers combined.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO
0	0.33	0.00	1.11	0.00	1.20	-	0.00	0.33
1	0.17	0.08	1.00	0.00	0.31	-	0.00	0.08
2	0.25	-0.24	0.38	-0.65	0.06	-	0.06	-0.06
3	-0.44	-0.78	-0.22	-1.11	0.00	-	-0.11	-0.22
4	-	-	-	-	-	-	-	-
Weighted Mean	0.11	-0.21	0.57	-0.44	0.25	-	-0.00	0.02

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	ALL
0	0.00	1.56	0.00	0.89	0.67	-	1.00	0.00	0.00	-
1	0.15	0.77	-0.08	0.73	0.58	-	0.77	0.00	0.31	-
2	0.06	0.29	-0.24	0.82	-0.12	-	0.33	0.00	0.12	-
3	0.11	0.00	-0.78	0.44	-0.44	-	-0.44	-0.22	0.33	-
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	0.08	0.60	-0.25	0.74	0.15	-	0.38	-0.04	0.19	-



**Figure 3:** Strata RL .Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and 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).

### 3.1.4 All readers (basic and advanced) and Strata = Transmitted Light (TL)

**Table 17:** Strata Strata\_TL .Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
48	43 %	60 %	33 %

### ***Coefficient of Variation (CV)***

**Table 18:** Strata TL .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

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	-	-	-	-	-	-	-	-		
1	-	-	-	-	-	37 %	-	-		
2	-	-	-	-	-	30 %	-	-		
3	-	-	-	-	-	27 %	-	-		
4	-	-	-	-	-	-	-	-		
Weighted Mean	-	-	-	-	-	31 %	-	-		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	all
0	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	75 %	-	-	-	57 %
2	-	-	-	-	-	37 %	-	-	-	39 %
3	-	-	-	-	-	33 %	-	-	-	30 %
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	-	-	-	-	-	49 %	-	-	-	43 %

### ***Percentage of Agreement (PA)***

**Table 19:** Strata TL .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.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	-	-	-	-	-	100 %	-	-		
1	-	-	-	-	-	69 %	-	-		
2	-	-	-	-	-	71 %	-	-		
3	-	-	-	-	-	78 %	-	-		
4	-	-	-	-	-	-	-	-		
Weighted Mean	-	-	-	-	-	77 %	-	-		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	total
0	-	-	-	-	-	67 %	-	-	-	83 %
1	-	-	-	-	-	38 %	-	-	-	54 %
2	-	-	-	-	-	35 %	-	-	-	53 %
3	-	-	-	-	-	44 %	-	-	-	61 %
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	-	-	-	-	-	44 %	-	-	-	60 %

### ***Average Percentage Error (APE)***

**Table 20:** Strata TL .Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	-	-	-	-	-	-	-	-		
1	-	-	-	-	-	33 %	-	-		

2	-	-	-	-	-	21 %	-	-		
3	-	-	-	-	-	15 %	-	-		
4	-	-	-	-	-	-	-	-		
Weighted Mean	-	-	-	-	-	24 %	-	-		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	all
0	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	61 %	-	-	-	46 %
2	-	-	-	-	-	28 %	-	-	-	30 %
3	-	-	-	-	-	22 %	-	-	-	18 %
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	-	-	-	-	-	38 %	-	-	-	33%

### Relative bias

**Table 21:** Strata TL . The relative bias (as the difference between the mean and modal age) per modal age and reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all readers combined.

Modal age	R01 DK	R02 NO	R03 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO		
0	-	-	-	-	-	0.00	-	-		
1	-	-	-	-	-	0.31	-	-		
2	-	-	-	-	-	0.24	-	-		
3	-	-	-	-	-	-0.11	-	-		
4	-	-	-	-	-	-	-	-		
Weighted Mean	-	-	-	-	-	0.15	-	-		

Modal age	R09 NO	R10 NL	R11 DE	R13 DK	R14 FR	R15 SE	R16 DK	R17 NO	R18 PL	all
0	-	-	-	-	-	0.33	-	-	-	-
1	-	-	-	-	-	0.23	-	-	-	-
2	-	-	-	-	-	1.12	-	-	-	-
3	-	-	-	-	-	0.00	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	-	-	-	-	-	0.52	-	-	-	-

## 3.1.5 Advanced readers and all samples included

**Table 22:** Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
112	28 %	77 %	18 %

### Coefficient of Variation (CV)

**Table 23:** Coefficient of Variation (CV) table presents the CV per modal age and advanced reader, the CV of all advanced readers combined per modal age and a weighted mean of the CV per reader.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	-	-	-	-	-	-	-	-	-	-
1	36 %	0 %	0 %	34 %	36 %	0 %	0 %	21 %	34 %	31 %

2	29 %	23 %	36 %	26 %	32 %	26 %	16 %	16 %	20 %	28 %
3	19 %	39 %	40 %	0 %	24 %	19 %	27 %	10 %	0 %	24 %
4	-	-	-	-	-	-	-	-	-	9 %
Weighted Mean	29 %	17 %	22 %	25 %	32 %	14 %	12 %	17 %	24 %	28 %

### Percentage of Agreement (PA)

**Table 24:** Percentage agreement (PA) table represents the PA per modal age and reader, advanced the PA of all advanced readers combined per modal age and a weighted mean of the PA per reader.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	total
0	60 %	100 %	91 %	0 %	100 %	100 %	73 %	100 %	0 %	73 %
1	74 %	100 %	100 %	81 %	62 %	100 %	100 %	95 %	48 %	84 %
2	74 %	80 %	35 %	70 %	65 %	75 %	90 %	90 %	75 %	73 %
3	64 %	64 %	36 %	100 %	82 %	73 %	73 %	91 %	100 %	76 %
4	100 %	0 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	89 %
Weighted Mean	70 %	86 %	67 %	73 %	73 %	88 %	88 %	94 %	58 %	77 %

### Average Percentage Error (APE)

**Table 25:** Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

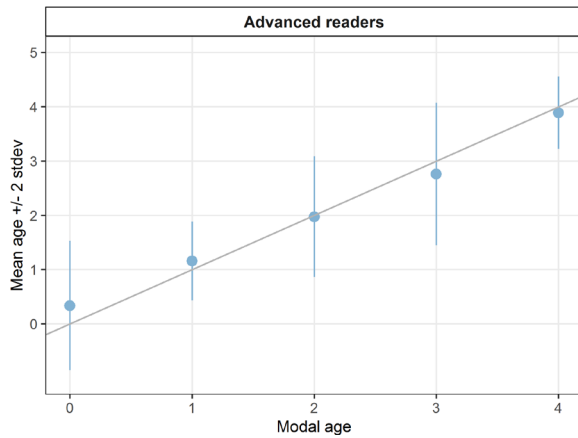
Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	-	-	-	-	-	-	-	-	-	-
1	31 %	0 %	0 %	26 %	34 %	0 %	0 %	9 %	33 %	23 %
2	20 %	18 %	34 %	17 %	23 %	15 %	9 %	5 %	17 %	15 %
3	18 %	34 %	32 %	0 %	12 %	11 %	17 %	5 %	0 %	17 %
4	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	5 %
Weighted Mean	23 %	14 %	19 %	17 %	25 %	8 %	7 %	6 %	22 %	18 %

### Relative Bias

**Table 26:** The relative bias (as the difference between the mean and modal age) per modal age and advanced reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all advanced readers combined.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	0.40	0.00	0.09	1.17	0.00	0.00	0.27	0.00	1.45	0.38
1	0.26	0.00	0.00	0.19	0.38	0.00	0.00	0.05	0.52	0.16
2	0.21	-0.20	-0.65	0.10	0.20	-0.05	-0.10	0.00	0.25	-0.03
3	-0.36	-0.64	-0.91	0.00	-0.09	-0.09	-0.18	0.09	0.00	-0.24
4	0.00	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.11
Weighted Mean	0.15	-0.19	-0.34	0.22	0.17	-0.03	-0.02	0.03	0.50	0.06





**Figure 4:** Age bias plot for advanced readers. Mean age recorded +/- 2 stdev of each reader and 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).

### General Age Error Matrix (AEM)

**Table 27:** General Age error matrix (AEM). The modal age is in rows and the age classifications by the advanced readers in columns. The matrix shows the proportion of each modal age mis-aged as other ages. The sum of each row is 1, which equals 100%.

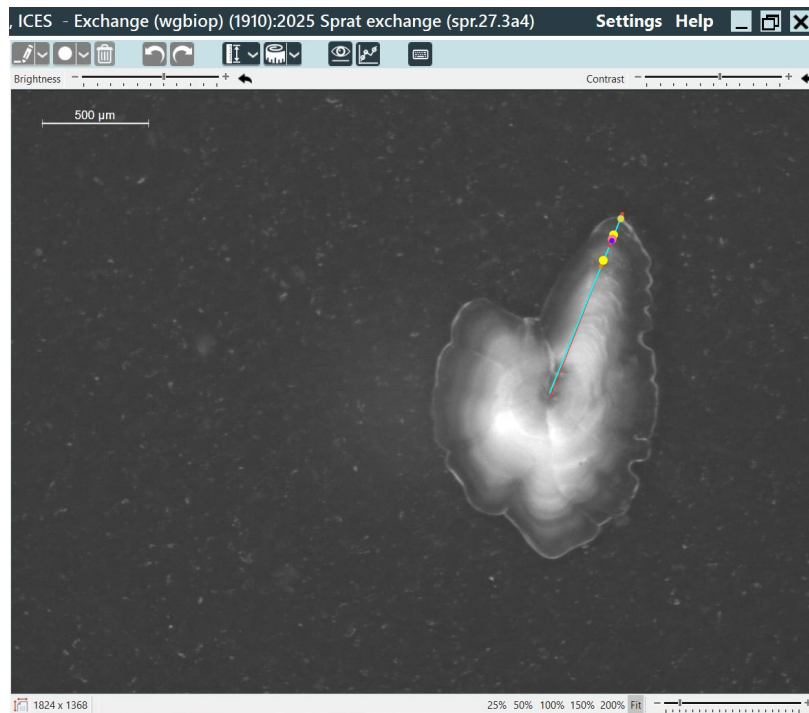
modal_age	0	1	2	3	4	Total
0	<b>0.73</b>	0.20	0.06	-	-	0.99
1	-	<b>0.84</b>	0.16	-	-	1.00
2	-	0.16	<b>0.73</b>	0.11	0.01	1.01
3	-	0.08	0.12	<b>0.76</b>	0.04	1.00
4	-	-	-	0.11	<b>0.89</b>	1.00

### 3.1.6 Advanced readers and Strata = Reference Collection (RC)

**Table 28:** Strata RC .Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
16	24 %	84 %	16 %

When all the otolith samples are considered (both single and multimodal cases) the weighted average percentage agreement based on modal ages for all readers is 84 %, with the weighted average CV of 24 % and APE of 16 %.



**Figure 5:** Image 1234576, catch date 23/06/2015, area 27.4.b, TL 105mm. Modal age in 2025 = 2 (PA = 56%). Modal age in 2016 = 1 (PA = 100%)

### ***Coefficient of Variation (CV)***

**Table 29:** Strata RC .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

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	-	-	-	-	-	-	-	-	-	-
1	38 %	0 %	0 %	30 %	36 %	0 %	0 %	0 %	36 %	30 %
2	28 %	0 %	47 %	28 %	28 %	47 %	47 %	47 %	0 %	33 %
3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
4	-	-	-	-	-	-	-	-	-	9 %
Weighted Mean	30 %	0 %	7 %	25 %	30 %	7 %	7 %	7 %	22 %	24 %

### ***Percentage of Agreement (PA)***

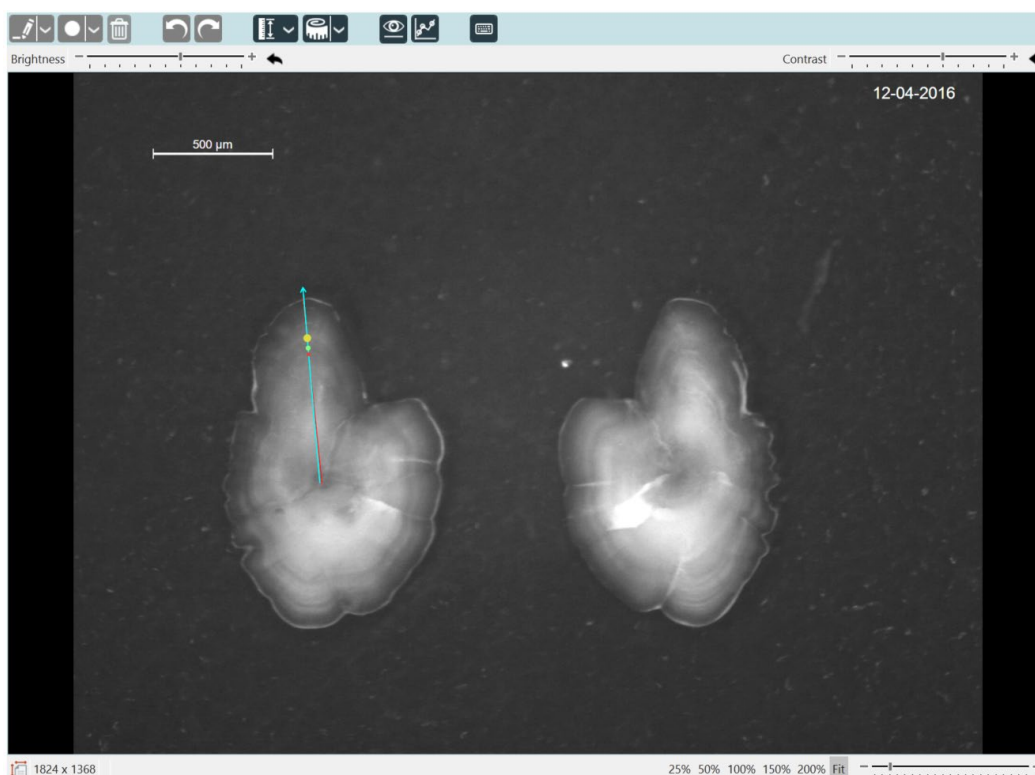
**Table 30:** Strata RC .Percentage agreement (PA) table represents the PA per modal age and reader, the PA of all readers combined per modal age and a weighted mean of the PA per reader.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	total
0	0 %	100 %	50 %	0 %	100 %	100 %	100 %	100 %	0 %	69 %
1	62 %	100 %	100 %	89 %	56 %	100 %	100 %	100 %	78 %	88 %
2	50 %	100 %	50 %	50 %	50 %	50 %	50 %	50 %	100 %	61 %
3	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
4	100 %	0 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	89 %
Weighted Mean	64 %	94 %	88 %	80 %	69 %	94 %	94 %	94 %	75 %	84 %

## Average Percentage Error (APE)

**Table 31:** Strata RC .Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	-	-	-	-	-	-	-	-	-	-
1	34 %	0 %	0 %	18 %	34 %	0 %	0 %	0 %	28 %	<b>19 %</b>
2	20 %	0 %	33 %	20 %	20 %	33 %	33 %	33 %	0 %	<b>22 %</b>
3	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	<b>0 %</b>
4	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	<b>5 %</b>
Weighted Mean	<b>22 %</b>	<b>0 %</b>	<b>5 %</b>	<b>13 %</b>	<b>25 %</b>	<b>5 %</b>	<b>5 %</b>	<b>5 %</b>	<b>16 %</b>	<b>16 %</b>

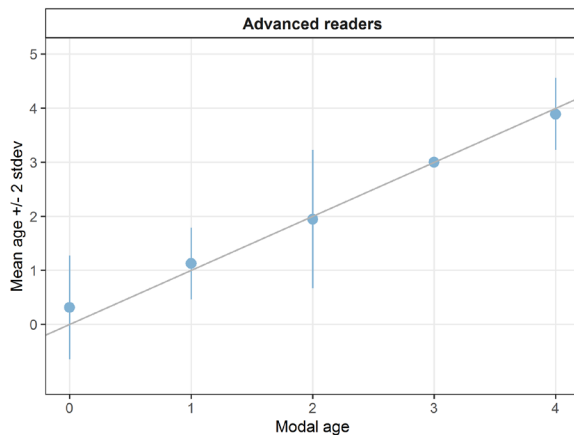


**Figure 6:** Image 1234581, catch date 14/12/2015, area 27.3.a, TL 78mm. Modal age 2016 = 0 (PA = 100%). Modal age 2025 = 0 (PA = 67%)

## Relative bias

**Table 32:** Strata RC . The relative bias (as the difference between the mean and modal age) per modal age and advanced reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all advanced readers combined.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	1.00	0.00	0.5	1.00	0.00	0.00	0.00	0.00	1.00	<b>0.39</b>
1	0.38	0.00	0.0	0.11	0.44	0.00	0.00	0.00	0.22	<b>0.13</b>
2	0.50	0.00	-0.5	0.50	0.50	-0.50	-0.50	-0.50	0.00	<b>-0.06</b>
3	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
4	0.00	-1.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	<b>-0.11</b>
Weighted Mean	<b>0.36</b>	<b>-0.06</b>	<b>0.0</b>	<b>0.20</b>	<b>0.31</b>	<b>-0.06</b>	<b>-0.06</b>	<b>-0.06</b>	<b>0.25</b>	<b>0.10</b>

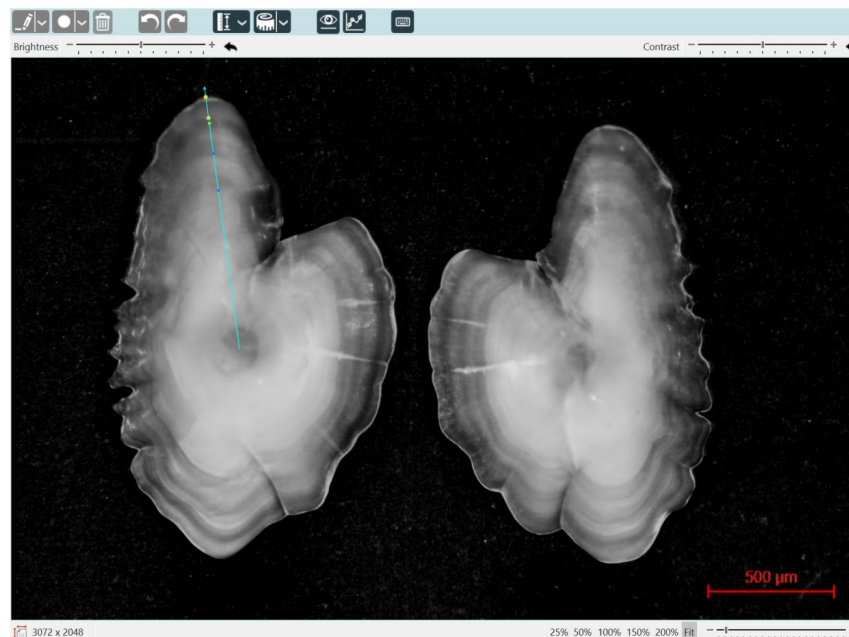


**Figure 7:** Strata\_RC .Age bias plot for advance readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age.

### 3.1.7 Advanced readers and Strata = Reflected Light (RL)

**Table 33:** Strata\_RL .Summary of statistics; Total number of samples (NSample), coefficient of variance (CV), percentage of agreement (PA) and average percentage error (APE) for all ages and readers

NSample	CV	PA	APE
48	28 %	75 %	19 %



**Figure 8:** Image 8710678\_ALA\_RLX\_XX, catch date 28/06/2023, area 27.4.b, TL 110mm. Modal age = 3. PA = 50% and CV = 39% and APE = 33%. Blue dots indicating 3 years, Yellow dots indicating 2 years and Green dots indicating 1 year.

### ***Coefficient of Variation (CV)***

**Table 34:** Strata\_RL .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

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	-	-	-	-	-	-	-	-	-	-
1	34 %	0 %	0 %	36 %	-	0 %	0 %	27 %	26 %	<b>32 %</b>
2	29 %	24 %	36 %	26 %	-	24 %	12 %	11 %	20 %	<b>27 %</b>
3	21 %	44 %	41 %	0 %	-	21 %	30 %	11 %	0 %	<b>26 %</b>
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	<b>29 %</b>	<b>21 %</b>	<b>26 %</b>	<b>25 %</b>	-	<b>16 %</b>	<b>13 %</b>	<b>16 %</b>	<b>20 %</b>	<b>28 %</b>

### ***Percentage of Agreement (PA)***

**Table 35:** Strata\_RL .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.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	total
0	67 %	100 %	100 %	0 %	-	100 %	67 %	100 %	0 %	<b>71 %</b>
1	82 %	100 %	100 %	75 %	-	100 %	100 %	92 %	25 %	<b>84 %</b>
2	76 %	78 %	33 %	72 %	-	78 %	94 %	94 %	72 %	<b>75 %</b>
3	56 %	56 %	22 %	100 %	-	67 %	67 %	89 %	100 %	<b>69 %</b>
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	<b>72 %</b>	<b>83 %</b>	<b>60 %</b>	<b>70 %</b>	-	<b>85 %</b>	<b>85 %</b>	<b>94 %</b>	<b>52 %</b>	<b>75 %</b>

### ***Average Percentage Error (APE)***

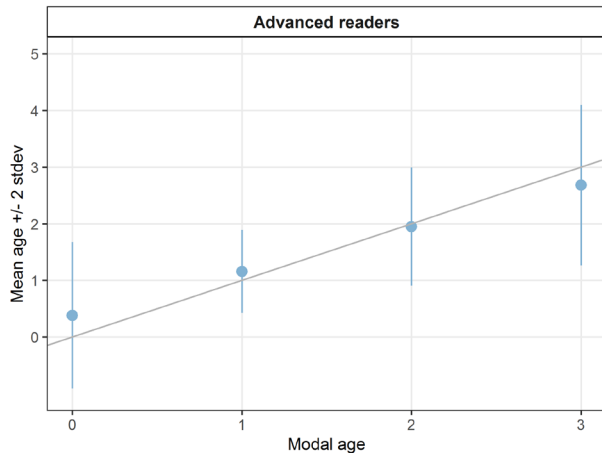
**Table 36:** Strata\_RL .Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all advanced readers combined per modal age and a weighted mean of the APE per reader.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	-	-	-	-	-	-	-	-	-	-
1	25 %	0 %	0 %	30 %	-	0 %	0 %	14 %	21 %	<b>23 %</b>
2	19 %	19 %	33 %	15 %	-	11 %	5 %	5 %	18 %	<b>15 %</b>
3	19 %	39 %	31 %	0 %	-	14 %	20 %	6 %	0 %	<b>21 %</b>
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	<b>21 %</b>	<b>18 %</b>	<b>23 %</b>	<b>17 %</b>	-	<b>8 %</b>	<b>7 %</b>	<b>8 %</b>	<b>18 %</b>	<b>19 %</b>

### ***Relative bias***

**Table 37:** Strata\_RL . The relative bias (as the difference between the mean and modal age) per modal age and advanced reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all advanced readers combined.

Modal age	R01 DK	R02 NO	R04 NO	R05 SCT	R06 SE	R07 DE	R08 NO	R09 NO	R10 NL	all
0	0.33	0.00	0.00	1.20	-	0.00	0.33	0.00	1.56	-
1	0.18	0.00	0.00	0.25	-	0.00	0.00	0.08	0.75	-
2	0.18	-0.22	-0.67	0.06	-	0.00	-0.06	0.06	0.28	-
3	-0.44	-0.78	-1.11	0.00	-	-0.11	-0.22	0.11	0.00	-
4	-	-	-	-	-	-	-	-	-	-
Weighted Mean	<b>0.09</b>	<b>-0.23</b>	<b>-0.46</b>	<b>0.23</b>	-	<b>-0.02</b>	<b>-0.00</b>	<b>0.06</b>	<b>0.58</b>	-



**Figure 9:** Strata\_RL .Age bias plot for advance readers. Mean age recorded +/- 2 stdev of each reader and 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). Relative bias is the age difference between estimated mean age and modal age.

### 3.1.8 Advanced readers and Strata = Transmitted Light (RL)

There is just 1 advanced reader using this method.

## 3.2 Conclusion

The results of the 2025 exchange are similar to those from the last age reading exchange which took place during WKARSPRAT in 2016. In 2025, samples from all areas were analysed together (no differentiation between North Sea, Skagerrak and Kattegat). When all age readers were included the overall percentage agreement was 71%, with a coefficient of variation of 35% and an average percentage error of 25%. An improvement in the results were seen when only the readers providing age data for stock assessment were included in the analysis. The overall percentage agreement increased to 77%, and the coefficient of variation decreased to 28% while the average percentage error of also decreases to 18%. This would be expected given the amount of additional experience the readers providing data for assessment have. It would however be expected that a higher level of agreement and lower level of uncertainty in comparison to the modal age would be reached for fish with a short life span. The results of the re-reading of the WKARSPRAT reference collection are overall good but at modal ages 0 and 1 there is clear positive bias. Readers should examine these otoliths and refer to the agreed age reading protocol compiled during the 2016 workshop.

It appears that what is causing most uncertainty between the readers is:

- 1) the first translucent zone can appear “banded” as opposed to distinct annual opaque and translucent zones. An example being fish ID 8710614 and to a lesser extent fish ID 8710613. This was an issue discussed at the WKARSPRAT 2016 where it was agreed that the *“first winter “band” can be split and fragmented into many different translucent rings which makes it wider and can also be wrongly interpreted as several winter rings.”*
- 2) whether or not to count a narrow translucent zone which is present in the opaque inner zone seen in some otoliths. This can be related to the issue above, but in some cases a very narrow and faint translucent ring is visible which some readers count as the first translucent zone. See Fish ID 1234581 (Figure 6) which in 2016 reached 100% PA at modal age = 0 but in 2025 reached just 67% PA at modal age = 0.
- 3) whether or not to include a narrow translucent zone which is sometimes apparent at the otolith edge for fish caught in June/July. This zone can vary from extremely narrow and only visible at the rostrum or post rostrum edge to a wider and clear zone which can be followed around the otolith edge. Here, the overall pattern of opaque and translucent zones seen in the otoliths should be considered so that an overall decrease in the width is followed.
- 4) Underestimation of older ages due to difficulties in the identification of the narrow opaque and translucent growth zones at the edge.

Individual reader PA, CV and APE are shown in each report section and a recently added feature to the software shows modal age and PA per image. All readers annotations are now visible in the SmartDots software for comparison purposes.

Preliminary results were provided to the stock assessor prior to HAWG 2025 and will be presented at the ICES Benchmark workshop on selected herring and sprat stocks (WKBHERSPR) 2025.

# 4 References

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