Report of the 2018 North Sea Norway Pout (*Trisopterus esmarkii*) age reading exchange

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Table of Contents

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1 Introduction

The executive summary can be found in the Norway Pout Summary Report 2018, available on http://ices.dk/marine- data/tools/Pages/smartdots.aspx

Norway pout (*Trisopterus esmarkii*) is a small gadoid species that lives at depths ranging from 50-250 meters in dense schooling aggregations, usually over muddy substrate. It is a short-lived species that rarely grow older than five years (Nielsen *et al*., 2012) and most likely a one-time spawner. It is distributed in the eastern Atlantic from west of Ireland to the Kattegat, surrounding the Faroe Islands and from the North Sea to the Barents Sea with highest densities of all age groups found in the northern North Sea. Nash *et al*., (2012) suggest one main spawning area and accordingly one stock component in the whole northern area on the shelf area (nop.27.3a4 - Norway pout, *Trisopterus esmarkii* in Subarea 4 and Division 3.a, North Sea, Skagerrak, and Kattegat). Spawning takes place from January to May, traditionally in the area between the Shetland Islands and Norway, after which the eggs and larvae are transported into the Skagerrak in the upper layers of the water column. 20% of fish at age 1 are estimated to be mature (Lambert *et al*., 2009) and prior to maturation individuals migrate back into northern parts of the North Sea. Recruitment is highly variable, SBB is rapidly influenced due to the short lifespan of the species and strong year classes exist. They feed primarily on crustaceans, especially copepods and krill and they are an important prey item for a number of larger fish such as cod, haddock, saithe, whiting and also marine mammals. Denmark and Norway are the only nations having a targeted Norway pout commercial fishery with small-meshed trawls for reduction purposes. The fishery is mainly conducted in quarters 3 and 4 in the Northern North Sea at Fladen Ground and in the Norwegian zone (EEZ) in the North Sea with only a limited fishery in Skagerrak. They are also landed as part of a mixed commercial fishery with blue whiting.

In 2015 a preliminary age reading exchange took place between the primary age readers of Norway pout from DTU Aqua (Denmark) and IMR (Norway) to identify if any age reading issues exist. The samples included in the exchange were from the commercial Norway pout fishery in the North Sea and Skagerrak-Kattegat areas (nop.27.3a4 stock) as age readings from this fishery are used directly in the Norway pout stock assessment to estimate catch, mean weight, maturity and mortality at age. 227 samples were selected from quarter 4, 2014 and quarter 3, 2015 covering the fish length range of Norway pout in the North Sea. Results showed an overall agreement of 72% with 100% agreement at age 0 and a decrease in agreement with an increase in age. There was a tendency for the Norwegian reader to estimate the ages of the fish to be one year older in comparison to the Danish reader. Norway pout grow very quickly in the first year, thus the centre of the otoliths are highly opaque, and this may cause problems when identifying the first winter ring. In addition, subsequent growth zones are much narrower in comparison and the interpretation of growth zones towards edge may also contribute to difficulties in age determination, especially for older fish. The exchange was carried out without the inclusion of otolith images and thus no record of which growth structures the readers identify when determining the age of the fish. These results indicated the need for a full scale exchange to be carried out based on otoliths images and including all age reading laboratories who routinely read Norway pout.

This exchange was initially planned for 2016 and a timetable proposed which would allow for the results to be considered in relation to the 2017 stock assessment and potential InterBenchmark Assessment if required. Due to difficulties with sample collection and the WebGR age reading platform delays were encountered. A revised timetable was proposed in line with the launch of the BETA version of the new age reading tool – SmartDots, making the results available for the Norway pout stock assessment in Spring 2018. This full scale otolith exchange took place from January to March 2018 and 14 readers from seven countries participated (Scotland, UK, France, Norway, Denmark, Netherlands and Germany).

2 Methods and Analysis

2.1 SmartDots Age Reading Tool

This was the first official SmartDots - WGBIOP (Working Group on Biological Parameters) age reading exchange to be conducted using this tool. Readers were given in-house training by their national age reader co-ordinators and instructions on how the images should be annotated and exercises completed using the SmartDots tool were provided by the exchange co-ordinator (Annex 1).

An integrated module of the SmartDots tool is the reporting module which runs the analysis via an R script to produce an R Markdown document which can be edited by the exchange co-ordinator. The analysis follows traditional methods where the level of accuracy compared to modal age was indicated by percentage agreement (PA) and bias tests and plots, and the level of precision i.e. the reproducibility of age estimates was indicated by the coefficient of variation (CV). The tables and plots presented are from the Guus Eltink Excel sheet 'Age Reading Comparisons' (Eltink, A.T.G.W. 2000). Additional analyses of age data were included; average percentage error (APE) and age error matrices (AEM's). As SmartDots provides a measure of distance between the annotations made by the readers this data was used as a measure of growth increment width and allowed for a comparison of growth curves for each fish and for each reader.

2.2 Methods

The 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.

Percentage Agreement

The table presents the percentage agreement (PA) per modal age and reader. The PA's are calculated as the ratio between the total number of age readings in agreement with modal age and the total number of age readings for that sample per reader and modal age:

$$PA = \frac{nmodalage}{ntotal} * 100$$

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

Co-efficient of Variation (CV)

The table presents the co-efficient of variation (CV) per modal age and reader. The CV's are calculated as the ratio between the standard deviation (σ) and mean value (μ) 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.

Average Percentage Error (APE)

APE was calculated based on the method outlined by Beamish & Fournier (1981). This method is not independent of fish age and thus provides a better estimate of precision. The average percentage error is calculated per image as:

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

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

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.

Age error matrix (AEM)

Age error matrices (AEM's) 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%. When the AEM is compiled for assessment purposes it uses only those "advanced" readers who provide age data for the stock assessment in that specific area.

Otolith Growth Analysis

SmartDots provides a measure of distance between the annotations made by the readers and thus provides a measure of growth increment width. This data is used to establish growth curves for each fish and for each reader.

2.3 Sample overview

The availability of samples for the exchange was problematic. As readers use different methods for age determination of this species having a pair otoliths from one fish prepared in 3 ways; whole, broken and sectioned is optimal. This was not possible as quite often there is only one of the pair available. The samples used are however considered adequately representative of the stock given that they were collected during the 2016 IBTS Q3 and commercial fishing trips 2014 Q4 in ICES area 27.4.a. and they cover the length range of the fish which are selected for age determination at national laboratories.

Table 2.1: Overview of samples used for SmartDots event ID 77 – sectioned otoliths.

Year	ICES area	Quarter	Number of samples	Modal age range	Length range
2016	27.4.a	3	94	0-3	100-190 mm
2016	27.4.b	3	2	0	100 mm

Table 2.2: Overview of samples used for the SmartDots event ID 74 – whole and broken otoliths.

Year	ICES area	Quarter	Number of samples	Modal age range	Length range
2014	27.4.a	4	58	0-2	90-185 mm

Samples and images of sectioned otoliths were provided by CEFAS UK (Table 2.1). The intention was to retake the images at DTU Aqua with scale bars marked on the images and with improved light quality to match those of the

whole and broken otoliths. Unfortunately the otoliths were delayed in the post and new images were not available to upload to SmartDots before the exchange was scheduled to begin.

Samples of whole and broken otoliths (from the same fish) were provided by DTU Aqua (Table 2.2). Otolith images were digitised at DTU Aqua using a standard set up. Images were taken of the whole and broken otoliths on a black background, soaked in water, under reflected light, at 20 x magnification for whole otoliths and 32 x magnifications for broken otoliths, using a Leica stereomicroscope MZ6, Leica camera DFC320 and Leica Imaging software (LAS V.4.2).

Otolith images and associated data were uploaded to SmartDots and two exercises (events) made available for annotation **2018 Norway Pout Exchange – Whole and Broken (SmartDots event ID 74)** and **2018 Norway Pout Exchange – Sectioned (SmartDots event ID 77).** Readers were provided with written instructions on how to complete the exercises (Annex 1). The exercises were run as blind tests where the readers could not see the annotations of the other readers.

2.4 Reader overview

Age readers of Norway Pout read by whole, broken or sectioned otoliths. In Tables 2.4.1 and 2.4.2 below provide a reader overview by method, readers expertise is defined as either *Advanced*, meaning that the reader provides age data to ICES for assessment purposes or *Basic*, meaning the opposite. Table 2.4.1 is the reader overview for event ID 77 where images of sectioned otoliths were provided to readers from Germany (DE), UK (GB), Netherlands (NL) and France (FR). Table 2.4.2 is the reader overview for event ID 74 where images of whole and broken otoliths were provided to readers from Norway (NO), Denmark (DK), Scotland (GB-SCT). The full list of participant details can be found in Annex 2.

For each event the analysis was run twice, first based on all readers and secondly on only those readers who provide age data for assessment purposes i.e. advanced. The amount of age reading experience of each reader is taken into consideration in the calculation of modal age, where more weight is given to the most experienced readers.

Table 2.4.1: Reader overview - SmartDots event ID 77 – sectioned otoliths.

Reader code	Expertise
R01 DE	Advanced
R02 DE	Advanced
R03 GB	Advanced
R04 NL	Basic
R05 FR	Basic

Table 2.4.2: Reader overview - SmartDots event ID 74 – whole and broken otoliths.

Reader code	Expertise
R01 NO	Advanced
R02 NO	Advanced
R03 DK	Advanced
R04 GB-SCT	Advanced
R05 NO	Advanced
R06 NO	Advanced
R07 DK	Advanced
R08 GB-SCT	Basic
R09 GB-SCT	Basic

3 Results

3.1 Sectioned otoliths (Event ID 77)

3.1.1 All readers

The results show that there is a very high level of agreement between readers who read sectioned otoliths. The overall average percentage agreement (PA) is 99% (Table 3.1.1), with an overall average CV of 8% (Table 3.1.2). The APE is 1%. The overall relative bias is 0 (Table 3.1.3) (age bias plot is not shown) with R01 estimating one fish at modal age 2 to be age 3 and R03 estimating two fish at modal age 1 to be age 0. Table 3.1.4 gives the number of age readings per modal age, it should be noted that there is just 1 fish at modal age 3. See Annex 3. Additional results, for statistics per sample, by clicking on the links in the Image ID column in Table 8.2 you can see each image and readers annotations.

Table 3.1.1: 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 DE	R02 DE	R03 GB	R04 NL	R05 FR	all
0	100 %	100 %	100 %	100 %	100 %	**100 %**
1	100 %	100 %	95 %	100 %	100 %	**99 %**
2	97 %	100 %	100 %	100 %	100 %	**99 %**
3	100 %	100 %	100 %	100 %	100 %	**100 %**
Weighted Mean	**99 %**	**100 %**	**97 %**	**100 %**	**100 %**	**99 %**

Table 3.1.2: 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 DE	R02 DE	R03 GB	R04 NL	R05 FR	all
0	-	-	-	-	-	**-**
1	0 %	0 %	24 %	0 %	0 %	**10 %**
2	9 %	0 %	0 %	0 %	0 %	**4 %**
3	-	-	-	-	-	**0 %**
Weighted Mean	**3 %**	**0 %**	**15 %**	**0 %**	**0 %**	**8 %**

Table 3.1.3: 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.

Modal age	R01 DE	R02 DE	R03 GB	R04 NL	R05 FR	All
0	0.00	0.00	0.00	0.00	0.00	**0.00**
1	0.00	0.00	-0.02	0.00	0.00	**-0.00**
2	0.03	0.00	0.00	0.00	0.00	**0.01**
3	0.00	0.00	0.00	0.00	0.00	**0.00**
Weighted Mean	**0.01**	**0.00**	**-0.01**	**0.00**	**0.00**	**0.00**

Table 3.1.4: Number of age readings per modal age

Modal age	27.4.a	Total
0	-	**-**
1	55	**55**
2	31	**31**
3	1	**1**
Total	**87**	**87**

The growth plot in Figure 3.1 shows no overlap between annuli 0, 1 and 2 indicating that the readers are in agreement as to which growth structures are the true annuli. R01 mistakenly annotated the centre of one otolith image which meant it was given an age of 3 and not 2, this can be seen from the outliers and the larger box plot for R01 in Figure 3.1.

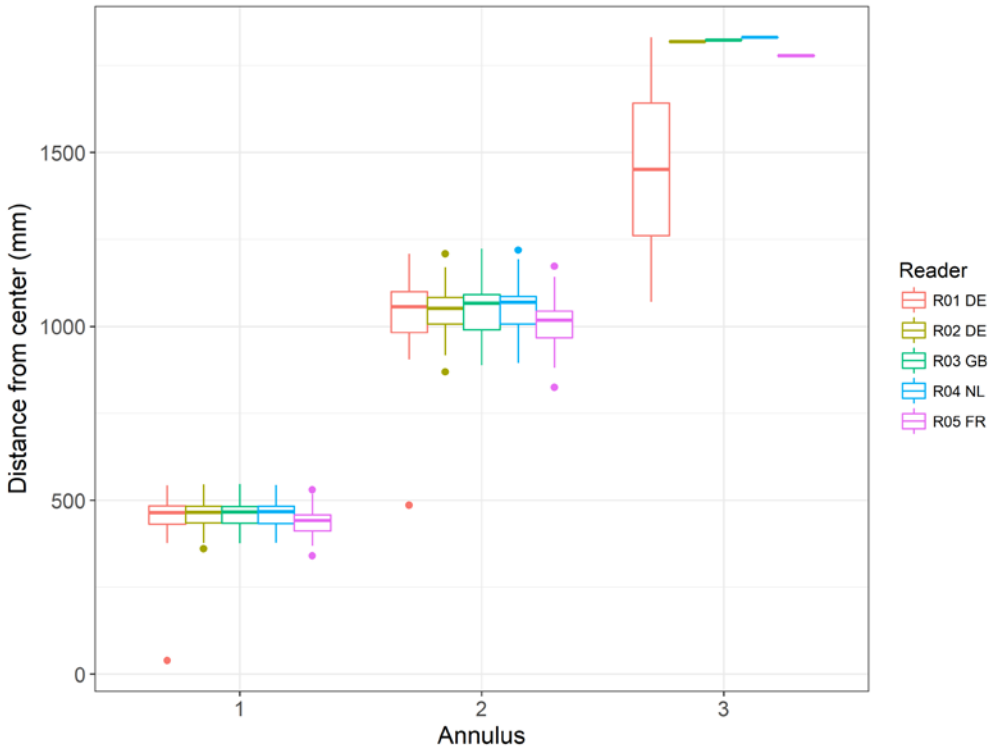

Figure 3.1: Plot of average distance from the centre to the annuli for all readers (where annotations are made at the end of each winter ring). The boxes represent the mean, upper and lower box boundaries of the interquartile range, whiskers represent the minimum and maximum values and the dots represent the outliers.

3.1.2 Advanced readers only

When only those readers who provide age data for stock assessment purposes are include in the analysis the overall PA is 99% (Table 3.1.5), overall CV is 10% (Table 3.1.6) and overall APE is 2%. See Annex 3. Additional results, for the full results based on advanced readers only, including statistics per sample. By clicking on the links in the Image ID column in Table 8.6 you can see each image and readers annotations.

Table 3.1.5: 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 DE	R02 DE	R03 GB	all
0	100 %	100 %	100 %	**100 %**
1	100 %	100 %	95 %	**98 %**
2	97 %	100 %	100 %	**99 %**
3	100 %	100 %	100 %	**100 %**
Weighted Mean	**99 %**	**100 %**	**97 %**	**99 %**

Table 3.1.6: 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 DE	R02 DE	R03 GB	all
0	-	-	-	**-**
1	0 %	0 %	24 %	**14 %**
2	9 %	0 %	0 %	**5 %**
3	-	-	-	**0 %**
Weighted Mean	**3 %**	**0 %**	**15 %**	**10 %**

The age error matrix (Table 3.1.7) is shown for each ices area which makes up the nop.27.3a4 stock, the matrix shows the proportion of each modal age mis-aged as other ages. Values in bold indicate the proportion of samples aged in agreement with modal age. The zero values indicate very minor proportions mis-aged as other ages and appear as zero's due to rounding of values. Only advanced readers are used for calculating the AEM as these are the readers who provide age data for stock assessment purposes. The AEM for 27.4.b is based on just 2 samples.

Table 3.1.7: Age error matrix (AEM) for 27.4.a and 27.4.b (stock nop.27.3a4). The AEM shows the proportional distribution of age readings for each modal age. Age column should sum to one but due to rounding there might be small deviations in some cases.

ices_area	stock	Modal age	0	1	2	3
27.4.a	nop.27.3a4	Age 0	**1**	0	-	-
27.4.a	nop.27.3a4	Age 1	-	**1**	-	-
27.4.a	nop.27.3a4	Age 2	-	0	**1**	-
27.4.a	nop.27.3a4	Age 3	-	-	0	**1**
ices_area	**stock**	**Modal age**	**0**	**1**	**2**	**3**
27.4.b	nop.27.3a4	Age 0	1	-	-	-

3.2 Whole and Broken otoliths (Event ID 74)

3.2.1 All readers

The results show that the overall level of agreement between readers of the whole and broken otoliths is good. The overall average percentage agreement (PA) is 82% (Table 3.2.1), with an overall average CV of 28% (Table 3.2.2). The overall CV is high but it should be taken into consideration that CV in this case is calculated based on a sample set of fish with a modal age range of 0-2 years. The APE is 18%. There is an overall tendency for readers to overestimate the age at modal age 0 and 1 and underestimate the age compared to modal age 2 (Table 3.2.3 and Figure 3.2.1), the amount and direction of bias varies across readers, see Figure 8.9 (Annex 3) for individual age reader bias plots. Those most in agreement with modal age are R02, R06, R01 and R09 with PA's above 90%, followed by R07, R03 and R04 (79%, 78% and 71% respectively) and then R05 and R08 with PA's below 70%. At modal age 0 the PA for readers R05, R07 and R08 is below 50%. The inter reader bias test (Table 3.2.4) shows that there is a certainty of bias between R03, R05, R07, R08 and modal age. See Annex 3. Additional results, for statistics per sample. By clicking on the links in the Image ID column in Table 8.11 you can see each image and readers annotations.

Table 3.2.1: 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 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT	all
0	100 %	100 %	100 %	88 %	44 %	100 %	47 %	44 %	100 %	**80 %**
1	90 %	100 %	100 %	100 %	76 %	90 %	80 %	62 %	100 %	**89 %**

2	86 %	95 %	38 %	29 %	62 %	95 %	100 %	95 %	76 %	**75 %**
Weighted Mean	**91 %**	**98 %**	**78 %**	**71 %**	**62 %**	**95 %**	**79 %**	**69 %**	**91 %**	**82 %**

Table 3.2.2: 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 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT	all
0	-	-	-	-	-	-	-	-	-	**-**
1	27 %	0 %	0 %	0 %	44 %	27 %	34 %	36 %	0 %	**30 %**
2	19 %	11 %	36 %	46 %	21 %	11 %	0 %	11 %	25 %	**26 %**
Weighted Mean	**23 %**	**6 %**	**18 %**	**23 %**	**32 %**	**19 %**	**17 %**	**23 %**	**12 %**	**28 %**

Table 3.2.3: 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.

Modal age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT	all
0	0.0	0	0.0	0.1	0.6	0.0	0.6	0.6	0.0	**0.2**
1	0.1	0	0.0	0.0	0.3	0.1	0.2	0.4	0.0	**0.1**
2	0.0	0	-0.6	-0.5	0.4	0.0	0.0	0.0	-0.2	**-0.1**
Weighted Mean	**0.0**	**0**	**-0.2**	**-0.2**	**0.4**	**0.0**	**0.2**	**0.3**	**-0.1**	**0.1**

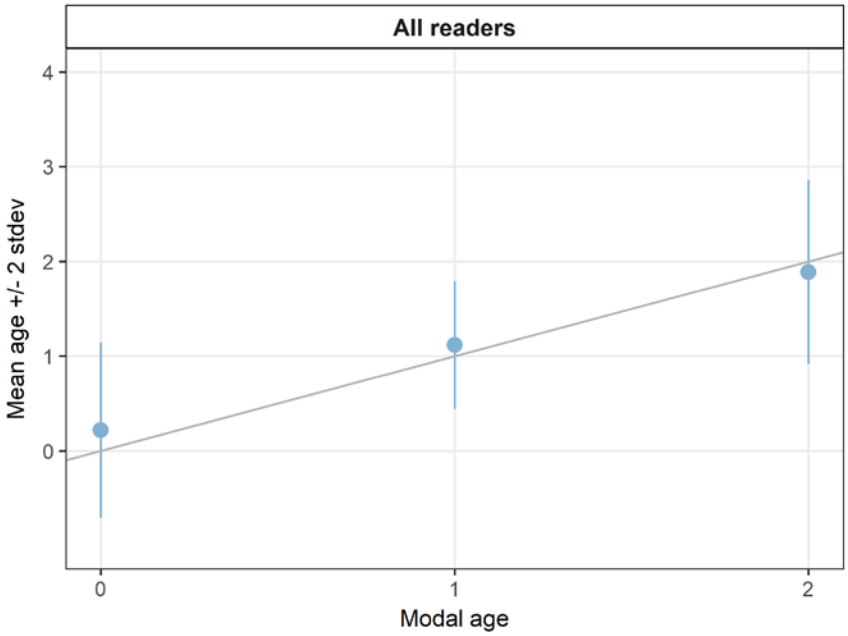

Figure 3.2.1: Age bias plot for all readers of whole and broken otoliths. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

Table 3.2.4: Inter reader bias test. The Inter-reader bias test gives probability of bias between readers and with modal age. - = no sign of bias (p>0.05), * = possibility of bias (0.01<p<0.05), * * = certainty of bias (p<0.01)

Comparison	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT
R01 NO	.	-	**	*	**	-	*	**	*
R02 NO	-	.	**	-	**	-	**	**	-
R03 DK	**	**	.	-	**	**	**	**	*
R04 GB-SCT	*	-	-	.	**	*	**	**	-
R05 NO	**	**	**	**	.	**	*	-	**
R06 NO	-	-	**	*	**	.	**	**	*
R07 DK	*	**	**	**	*	**	.	-	**
R08 GB-SCT	**	**	**	**	-	**	-	.	**

R09 GB-SCT	*	-	*	-	**	*	**	**	.
Modal age	-	-	**	-	**	-	**	**	*

The growth plot (per method) in Figure 3.2.2 show no overlap between the annotations at annuli 1 and 2 on the whole otoliths which means that readers are in agreement as to which structures are used to interpret the age of the fish. Once the annuli become more difficult to interpret at the edge (due to a narrowing of annulus width with an increase in age) readers will switch to reading the broken otolith rather than a whole otolith. The growth plot based on measurements of annuli on broken otoliths shows more variation but with little overlap between annulus 1 and 2. Few readers are identifying a third annnulus, with poor interreader consistency as to where the end of the third winter ring is. At modal age 2, R01 annotates 2 fish to be 3 years old, R05 annotates 9 fish to be 3 years old and R09 just 1 fish to be 3 years old, see Table 8.11 (Annex 3) .There are images where R04 is mistakingly annotating the centre of the otolith which is then being counted as a annulus and this could explain the outliers at each annulus, the overlap between the annotations at annulus 2 and 3 and the annotation at annulus 4 for R04.

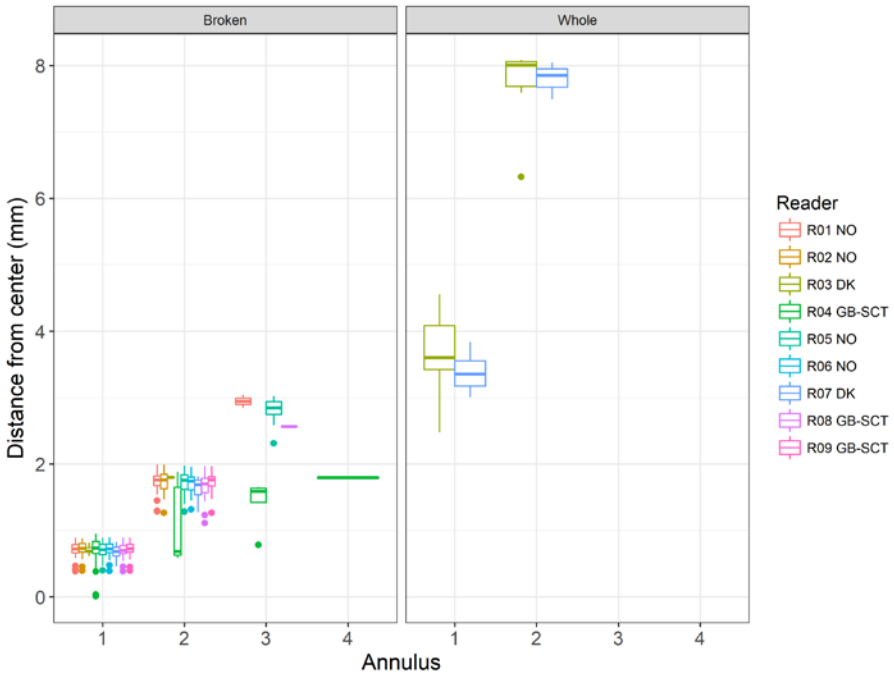

Figure 3.2.2: Plot of average distance from the centre to the annuli (where annotations are made at the end of each winter ring) for all readers and for each preparation separately. The boxes represent the mean, upper and lower box boundaries of the interquartile range, whiskers represent the minimum and maximum values and the dots represent the outliers.

3.2.2 Results by preparation method

The following tables give an overview of the results by preparation method based on all readers. In general readers of Norway pout otoliths read either broken or sectioned otoliths. Whole otoliths are usually only read when there is no doubt that the fish is either a 0 year old or possibly 1 year old. If in doubt the reader will break the otolith to confirm the age of the fish. Readers from Denmark apply this method. In this analysis the modal age in each table is calculated across whole and broken samples combined, subsequently the CV (Table 3.2.6), PA (Table 3.2.7) and relative bias (Table 3.2.8) for each preparation method are calculated against this modal age. Of the 520 age readings only 60 were estimated using whole otoliths in comparison to 460 made on broken otoliths. PA is higher at modal ages 0 and 1 when the whole otolith is read whereas at modal age 2 the PA is higher when the broken otolith is read. CV is lower at modal age 1 when whole otoliths are read in comparison to broken but at modal age 2 this is reversed and higher CV, meaning more variation is seen in the estimations made on broken otoliths at age 2. Relative bias is lower for whole otoliths at modal age 0 and lower for sectioned otolith at modal age 2. At modal age 1 the values are equal.

Table 3.2.5: Number of age readings per preparation method for all readers.

Modal age	Broken	Whole	total
0	121	22	**143**
1	171	17	**188**
2	168	21	**189**
Total	**460**	**60**	**520**

Table 3.2.6: CV per preparation method

Modal age	Broken	Whole	all
0	-	-	**-**
1	31 %	23 %	**30 %**
2	23 %	36 %	**26 %**
Weighted Mean	**27 %**	**30 %**	**28 %**

Table 3.2.7: Percentage Agreement per preparation method

Modal age	Broken	Whole	all
0	77 %	100 %	**80 %**
1	88 %	94 %	**89 %**
2	80 %	38 %	**75 %**
Weighted Mean	**82 %**	**77 %**	**82 %**

Table 3.2.8: Relative Bias per preparation method

Modal age	Broken	Whole	all
0	0.3	0.0	**0.1**
1	0.1	0.1	**0.1**
2	0.0	-0.6	**-0.3**
Weighted Mean	**0.1**	**-0.2**	**0.0**

3.2.3 Advanced readers only

When only advanced readers are included in the analysis the PA increases at modal ages 0 (83%) and 1 (94%) showing an improvement in the results, PA decreases at modal age 2 (71%) (Table 3.2.9). At modal age 0 the PA of R05 and R07 remain below 50% as there are a number of fish which these 2 readers estimate to be 1 year old. At modal age 1 the CV decreases when only the advanced readers are included but increases at modal age 2 (Table 3.2.10). Overall there is little change in both PA and CV values, as with the relative bias values (Table 3.2.11) and the bias plot (Figure

3.2.3) where slight positive bias is seen at the youngest ages (0 and 1) and negative bias at age 2. See Figure 8.14 (Annex 3) for individual readers age bias plots. Results of additional analyses can also be found in Annex 3. Additional results including CV, PA and APE per sample. By clicking on the links in the Image ID column in Table 8.15 you can see each image and readers annotations.

Table 3.2.9: 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 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	all
0	100 %	100 %	100 %	88 %	44 %	100 %	47 %	**83 %**
1	95 %	100 %	100 %	100 %	80 %	95 %	84 %	**94 %**
2	86 %	91 %	36 %	27 %	64 %	95 %	100 %	**71 %**
Weighted Mean	**93 %**	**97 %**	**76 %**	**69 %**	**64 %**	**97 %**	**80 %**	**82 %**

Table 3.2.10: 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 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	all
0	-	-	-	-	-	-	-	-
1	21 %	0 %	0 %	0 %	44 %	21 %	32 %	**27 %**
2	18 %	15 %	36 %	46 %	21 %	11 %	0 %	**28 %**
Weighted Mean	**20 %**	**8 %**	**19 %**	**24 %**	**32 %**	**16 %**	**15 %**	**27 %**

Table 3.2.11: Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	all
0	0	0.0	0.0	0.1	0.6	0	0.6	**0.2**
1	0	0.0	0.0	0.0	0.2	0	0.2	**0.1**
2	0	-0.1	-0.6	-0.6	0.4	0	0.0	**-0.1**
Weighted Mean	**0**	**0.0**	**-0.2**	**-0.2**	**0.4**	**0**	**0.2**	**0.0**

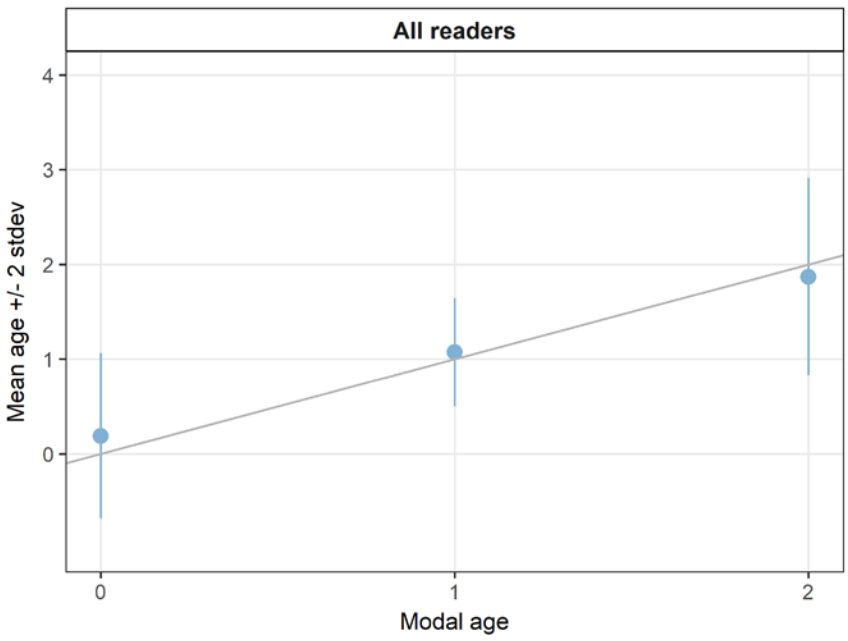

Figure 3.2.3: Age bias plot for advanced readers of whole and broken otoliths. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The age error matrix (Table 3.2.12) is shown for the nop.27.3a4 stock, the matrix shows the proportion of each modal age mis-aged as other ages. Only advanced readers are used for calculating the AEM as these are the readers who provide age data for stock assessment purposes. Values in bold indicate the proportion of samples aged in agreement with modal age. The zero values indicate very minor proportions mis-aged as other ages and appear as zero's due to rounding of values. At modal age 0 a small proportion is mis-aged as age 1 and even less as age 2. At modal age 1 the proportion mis-aged is even lower, again those mis-aged are overestimated. At modal age 2 the proportion mis-aged is highest with a higher proportion underestimated in age compared to the proportion overestimated.

Table 3.2.12: Age error matrix (AEM) for 27.4.a, nop.27.3a4. The AEM shows the proportional distribution of age readings for each modal age. Age column should sum to one but due to rounding there might be small deviations in some cases. Bold values indicate the proportion of age readings in agreement with modal age.

ices_area	stock	Modal age	0	1	2
27.4.a	nop.27.3a4	Age 0	**0.8**	-	-
27.4.a	nop.27.3a4	Age 1	0.2	**0.9**	0.2
27.4.a	nop.27.3a4	Age 2	0.0	0.1	**0.7**
27.4.a	nop.27.3a4	Age 3	-	0.0	0.1

4 Discussion and Conclusion

This was the first official WGBIOP age reading exchange to be run on the new age reading tool SmartDots. User feedback, both from age readers and co-ordinators was extremely positive. Following WGBIOP 2017 age reader co-ordinators were asked to return to their institutes, install SmartDots and train their readers. They were also asked to enter their age readers expertise details into the SmartDots database via the new ICES web interface which is available on login in and can be found at http://ices.dk/marine-data/tools/Pages/smartdots.aspx. Readers were provided with additional instructions on how to complete the Norway Pout exchange from the event co-ordinator. Events were created in SmartDots and images and data uploaded. Initial tests were run in January 2018 and soon after the events were made available to all age readers for annotation. Some problems with the speed of the system were solved during the course of the exchange and all 14 age readers completed the exchange before the March 18th deadline. A summary report was provided to the stock assessor of stock nop.27.3a4 in time for the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) at the beginning of May 2018. Both the summary report and this full report have been produced by the SmartDots age reading reporting module which is directly linked to the database and age reading tool and consists of a set of R scripts which produce editable R-markdown documents. All analyses and data output are standardised in line with the WGBIOP Guidelines for Otolith Exchanges (last updated at WGBIOP, 2-6 October 2017, Cagliari, Italy). The executive summary is given in the summary report.

The results of the 2018 Norway Pout age reading exchange show an overall higher PA and lower CV when analysing the readings of the sectioned otoliths (event ID 77) compared to readings of the whole and broken otoliths (event ID 74). For event ID 77 the overall PA is 99% and the overall relative bias 0. An examination of the images shows very clear annuli on the sectioned otoliths in comparison to the annuli on the broken otoliths.

Images of broken otoliths can be difficult to interpret because a) the surface is not flat resulting in parts of the image being out of focus and b) there can be a shadow effect where otolith material below the visible surface can be seen in the image giving the appearance that there is more material at the otolith edge than in reality. Both factors contribute to the difficulties in age reading images of broken otoliths which may induce a bias in the results. Software does exist which combines a number of images into 1 which could improve the quality of the images. It is recommended that such software is utilised in the next exchange in order to eliminate this bias. It is possible that reading sectioned Norway Pout otoliths provides more reliable age estimations in comparison to reading whole and/or broken otoliths and this could be tested in the future if the abovementioned imaging method was applied.

The lower overall PA (82%) and higher APE (18%) attained when analysing the readings of the whole and broken otoliths (event ID 74) is partly attributed to a poor level of agreement at modal age 0 where the PA values for readers R05, R07 (both of which provide age data for assessment purposes) and R08 are below 50% and CV values are above 30%. A closer examination of the annotated images shows these readers are estimating many of these fish to be 1 year old based on annotations of the broken otoliths. Some of these images are poor quality and it is possible that the readers are misinterpreting the structures edge due to a shadow effect. On the other hand there are images which are clear and differences in reader interpretation are resulting in lower PA and higher CV's for these otoliths. At modal ages 0 and 1 an overall slight positive bias is apparent and a negative bias at modal age 2 (Table 3.2.11 and Figure 3.2.3). This is a typical pattern seen in many age calibration exercises where there is a tendency for readers to underestimate in comparison to modal age at younger ages and overestimate in comparison to modal age at older ages. The growth plot based on measurements of annuli of broken otoliths shows fewer readers are identifying a third annnulus and apparently with less consistency between readers as to where the end of the winter ring is. This

could be due to image quality, however readers we asked to provide a readabilty score for their age readings based on those outlined by WKNARC, 2011. An AQ3 score identifies an otolith as unreadable and based on the scores provided by the readers this was not the case. In the future an analysis of the readability scores given by the readers will be implemented which will allow for an improved qualitative analysis in the reporting procedure.

It was not possible to include images of sectioned, broken and whole otoliths from the same fish in this exchange. Doing so would have allowed for the calculation of a single modal age per fish which all readers could then be compared against. This is recommended for any future calibration exercises. In addition, making the physical preparations available for readers to examine under the microscope when annotating images in SmartDots should be considered in the future.

When comparing the results of the two age readers who took part in the 2016 exchange (R01 and R03, Norway and Denmark respectively) a similar pattern still exists where R01 sometimes estimates the fish to be one year older in comparison to R03. At modal age 0 this disagreement is not apparent. At modal age 1, R01 has a higher level of agreement with modal age, R03 estimates a larger number of fish to be age 1, all of which are calculated to be modal age 2, implying that R01 is underestimating at modal age 2. A closer examination of the annotated images which can be accessed by following the interactive links in Table 8.11 (see NPout_018 as an example) shows that the disagreement between these 2 readers may be attributed to the method applied; R01 reads broken otoliths whereas R03 reads whole otoliths. This species is fast growing in their first year of life and thus the otoliths have a highly opaque centre meaning that it may not always be possible to identify the inner most winter ring when the otoliths are examined whole. As a consequence it is recommended that in the future reading whole otoliths of this species should be discontinued and that either the broken or sectioned method is applied to all otoliths.

This was the first exchange to be run on the new SmartDots software and readers had a short amount of time to familiarise themselves with the features of the new tool meaning that some mistakes were made where readers annotated the images multiple times or annotations were made without intention. In some of the more recent WebGR exercises readers were asked to annotate both the centre and edge of the otolith in addition to each winter ring. This is not the case with SmartDots as the age is given by the system based on the number of annotations made on an image. Some filtering was done to remove annotations which appeared to be errors but this was not possible in all examples as it was not always clear whether or not the mistake was intentional or not. In the future readers will be responsible for ensuring that only the annotations that they would like to have included in the analysis are marked as approved.

Recommendations:

- Any further exchanges should include images of whole, broken and sectioned otoliths from the same fish to allow for a more thorough comparison of age readers and methods. Images of broken otoliths should be taken with the appropriate software.
- In the future, reading whole otoliths should be discontinued.
- AQ scores are utilised in the analyses.
- Only reader “approved” annotations are included in the analyses.
- SmartDots is developed to facilitate agreed aged reference collections.

5 References

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6 Annex 1. Instruction for the 2018 Norway Pout exchange

Sample overview

	whole	broken	sectioned
4a Q3 2016			96
4a Q4 2014	58	58	

4a Q4 2014 samples are from the same fish

Event ID 77 – Norway Pout Exchange - Sectioned

Sectioned otoliths have been provided for readers from CEFAS, IFREMER and THEUNEN. Please annotate all sectioned otoliths in Event ID 77 – Norway Pout Exchange - Sectioned. Please use the **Adjustments** tool to adjust the brightness and contrast where needed. There is also a zoom function.

Event ID 74 – Norway Pout Exchange – Whole and Broken

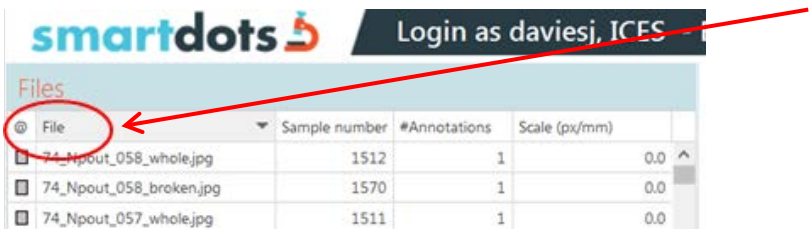
Whole and broken otoliths have been provided for readers from all other institutes (1 whole and 1 broken otolith for each fish). Please use both images to confirm the age but please annotate **EITHER** the whole **OR** the broken otolith in Event ID 74 – Norway Pout Exchange – Whole and Broken. It is OK to annotate the whole otolith from one fish and the broken otolith from another fish. Please use the **Adjustments** tool to adjust the brightness and contrast where needed. There is also a zoom function.

Instructions:

1. Make annotations on the line provided, at the **end of the winter ring** and only on the winter rings which are counted as a year when estimating the age. SmartDots will automatically give the age of the fish based on the number of annotations that you make.
   You do **NOT** need to mark the centre or the outermost edge of the otolith.
2. If you have any **comments** about the otoliths please write them in the comments field.
3. Please provide a **readability score** for each age that you give:
   AQ1: Easy to age with high precision
   AQ2: Difficult to age with acceptable precision.
   AQ3: Unreadable or very difficult to age with acceptable precision.
4. You must **approve** your final annotation for each otolith.

A useful tip:

In SmartDots it is possible to sort the samples so that for example, in Event ID 74 the whole and broken otoliths from 1 fish appear one after the other. Right click on the File header for sorting options.



7 Annex 2. List of participants

Table 7.1: Participant list for Event 77 – sectioned otoliths.

Reader code	SmartUser name	Institution	Country	Expertise
R01 DE	Beussel	Thünen Institute of Sea Fisheries / Thünen-Institut für Seefischerei	GERMANY	Advanced
R02 DE	Wilhelmsl	Thünen Institute of Sea Fisheries / Thünen-Institut für Seefischerei	GERMANY	Advanced
R03 GB	Brownd	CEFAS (Centre for Environment, Fisheries and Aquaculture Science)	UNITED KINGDOM	Advanced
R04 NL	Os	Wageningen Marine Research (WMR)	NETHERLANDS	Basic
R05 FR	Chantre	IFREMER (Institut français de recherche pour l'exploitation de la mer)	FRANCE	Basic

Table 7.2: Participants list for Event 74 – whole and broken otoliths

Reader code	SmartUser name	Institution	Country	Expertise
R01 NO	Solbakken	IMR (Institute of Marine Research)	NORWAY	Advanced
R02 NO	Mjanger	IMR (Institute of Marine Research)	NORWAY	Advanced
R03 DK	Sindahl	DTU-Aqua (Danish National Institute of Aquatic Resources)	DENMARK	Advanced
R04 GB-SCT	Peter	Marine Laboratory Scotland	Scotland	Advanced
R05 NO	Skadal	IMR (Institute of Marine Research)	NORWAY	Advanced
R06 NO	Huseboe	IMR (Institute of Marine Research)	NORWAY	Advanced
R07 DK	RasmussenH	DTU-Aqua (Danish National Institute of Aquatic Resources)	DENMARK	Advanced
R08 GB-SCT	Hendersong	Marine Laboratory Scotland	Scotland	Basic
R09 GB-SCT	GillespieMules	Marine Laboratory Scotland	Scotland	Basic

8 Annex 3. Additional results

Event ID 77 – Sectioned otoliths – all readers

Data Overview

Table 8.1: Summary of statistics; PA (%), CV (%) and APE (%).

CV	PA	APE
8 %	99 %	1 %

Table 8.2: Data overview including biological data, estimated ages, modal age and statistics per sample based on all readers. By clicking on the Image ID you can view the annotations.

Fish ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 DE	R02 DE	R03 GB	R04 NL	R05 FR	Modal age	PA %	CV %	APE %
Npout_059_sectioned	77	771	100	U	2016-08-24	27.4.b	0	0	0	0	0	0	100	-	-
Npout_060_sectioned	77	772	100	U	2016-08-24	27.4.b	0	0	0	0	0	0	100	-	-
Npout_061_sectioned	77	773	150	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_062_sectioned	77	774	150	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_063_sectioned	77	775	140	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_064_sectioned	77	776	140	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_065_sectioned	77	777	160	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_066_sectioned	77	778	160	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_067_sectioned	77	779	170	F	2016-08-25	27.4.a	2	2	2	2	2	2	100	0	0
Npout_068_sectioned	77	780	130	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_069_sectioned	77	781	180	F	2016-08-25	27.4.a	2	2	2	2	2	2	100	0	0
Npout_070_sectioned	77	782	150	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_071_sectioned	77	783	150	F	2016-08-25	27.4.a	1	1	0	1	1	1	80	56	40
Npout_072_sectioned	77	784	140	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_073_sectioned	77	785	130	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_074_sectioned	77	786	140	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_075_sectioned	77	787	130	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_076_sectioned	77	788	160	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_077_sectioned	77	789	140	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_078_sectioned	77	790	150	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_079_sectioned	77	791	170	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0

Npout_080_sectioned	77	792	140	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_081_sectioned	77	793	170	F	2016-08-25	27.4.a	2	2	2	2	2	2	100	0	0
Npout_082_sectioned	77	794	150	F	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_083_sectioned	77	795	160	M	2016-08-25	27.4.a	1	1	1	1	1	1	100	0	0
Npout_084_sectioned	77	796	160	M	2016-08-25	27.4.a	2	2	2	2	2	2	100	0	0
Npout_085_sectioned	77	797	190	F	2016-08-26	27.4.a	3	3	3	3	3	3	100	0	0
Npout_086_sectioned	77	798	180	F	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_087_sectioned	77	799	160	M	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_088_sectioned	77	800	180	F	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_089_sectioned	77	801	160	M	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_090_sectioned	77	802	170	M	2016-08-26	27.4.a	3	2	2	2	2	2	80	20	15
Npout_091_sectioned	77	803	170	M	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_092_sectioned	77	804	150	F	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_093_sectioned	77	805	150	M	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_094_sectioned	77	806	190	F	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_095_sectioned	77	807	140	M	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_096_sectioned	77	808	130	M	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_097_sectioned	77	809	140	F	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_098_sectioned	77	810	130	M	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_099_sectioned	77	811	170	F	2016-08-26	27.4.a	2	2	2	2	2	2	100	0	0
Npout_100_sectioned	77	812	150	F	2016-08-26	27.4.a	1	1	1	1	1	1	100	0	0
Npout_101_sectioned	77	813	100	U	2016-08-29	27.4.a	0	0	0	0	0	0	100	-	-
Npout_102_sectioned	77	814	100	U	2016-08-29	27.4.a	0	0	0	0	0	0	100	-	-
Npout_103_sectioned	77	815	170	F	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0
Npout_104_sectioned	77	816	150	M	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0
Npout_105_sectioned	77	817	130	M	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0
Npout_106_sectioned	77	818	160	F	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0
Npout_107_sectioned	77	819	160	F	2016-08-29	27.4.a	1	1	2	1	1	1	80	37	27
Npout_108_sectioned	77	820	150	F	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0

Npout_109_sectioned	77	821	180	F	2016-08-29	27.4.a	2	2	2	2	2	2	100	0	0
Npout_110_sectioned	77	822	140	M	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0
Npout_111_sectioned	77	823	170	F	2016-08-29	27.4.a	2	2	2	2	2	2	100	0	0
Npout_112_sectioned	77	824	140	M	2016-08-29	27.4.a	1	1	1	1	1	1	100	0	0
Npout_113_sectioned	77	825	130	M	2016-08-29	27.4.a	1	1	0	1	1	1	80	56	40
Npout_114_sectioned	77	826	100	M	2016-08-29	27.4.a	0	0	0	0	0	0	100	-	-
Npout_115_sectioned	77	827	100	U	2016-08-29	27.4.a	0	0	0	0	0	0	100	-	-
Npout_116_sectioned	77	828	140	M	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_117_sectioned	77	829	150	F	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_118_sectioned	77	830	150	M	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_119_sectioned	77	831	140	F	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_120_sectioned	77	832	160	F	2016-08-30	27.4.a	2	2	2	2	2	2	100	0	0
Npout_121_sectioned	77	833	130	F	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_122_sectioned	77	834	130	F	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_123_sectioned	77	835	160	F	2016-08-30	27.4.a	1	1	1	1	1	1	100	0	0
Npout_124_sectioned	77	836	140	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_125_sectioned	77	837	150	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_126_sectioned	77	838	150	F	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_127_sectioned	77	839	140	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_128_sectioned	77	840	170	M	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_129_sectioned	77	841	160	F	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_130_sectioned	77	842	170	F	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_131_sectioned	77	843	160	F	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_132_sectioned	77	844	180	F	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_133_sectioned	77	845	130	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_134_sectioned	77	846	180	F	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_135_sectioned	77	847	130	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_136_sectioned	77	848	100	M	2016-08-31	27.4.a	0	0	0	0	0	0	100	-	-
Npout_137_sectioned	77	849	100	F	2016-08-31	27.4.a	0	0	0	0	0	0	100	-	-

Npout_138_sectioned	77	850	140	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_139_sectioned	77	851	150	F	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_140_sectioned	77	852	140	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_141_sectioned	77	853	150	F	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_142_sectioned	77	854	170	F	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_143_sectioned	77	855	160	M	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_144_sectioned	77	856	130	M	2016-08-31	27.4.a	1	1	1	1	1	1	100	0	0
Npout_145_sectioned	77	857	170	F	2016-08-31	27.4.a	2	2	2	2	2	2	100	0	0
Npout_146_sectioned	77	858	100	U	2016-08-31	27.4.a	0	0	0	0	0	0	100	-	-
Npout_147_sectioned	77	763	180	F	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_148_sectioned	77	764	170	M	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_149_sectioned	77	765	160	F	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_150_sectioned	77	766	190	F	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_151_sectioned	77	767	150	M	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_152_sectioned	77	768	150	M	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_153_sectioned	77	769	160	F	2016-09-01	27.4.a	2	2	2	2	2	2	100	0	0
Npout_154_sectioned	77	770	180	M	2016-09-01	27.4.a	2	2	-	2	2	2	100	0	0

Table 8.3: Number of readings per reader and modal age (based on all readers). The total numbers of readings per reader and per modal age are summarized at the end of the table.

Modal age	R01 DE	R02 DE	R03 GB	R04 NL	R05 FR	total
0	9	9	9	9	9	**45**
1	55	55	55	55	55	**275**
2	31	31	30	31	31	**154**
3	1	1	1	1	1	**5**
Total	**96**	**96**	**95**	**96**	**96**	**479**

Table 8.4: Age composition by reader gives a summary of number of readings per reader (based on all readers).

Modal age	R01 DE	R02 DE	R03 GB	R04 NL	R05 FR
0	9	9	11	9	**9**
1	55	55	52	55	**55**
2	30	31	31	31	**31**
3	2	1	1	1	**1**
Total	**96**	**96**	**95**	**96**	**96**

Table 8.5: Mean length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age (based on all readers). A weighted mean is also given.

Age	R01 DE	R02 DE	R03 GB	R04 NL	R05 FR
0	100 mm	100 mm	107 mm	100 mm	**100 mm**
1	145 mm	145 mm	145 mm	145 mm	**145 mm**

2	170 mm	170 mm	169 mm	170 mm	**170 mm**
3	180 mm	190 mm	190 mm	190 mm	**190 mm**
Weighted Mean	**149 mm**	**149 mm**	**149 mm**	**149 mm**	**149 mm**

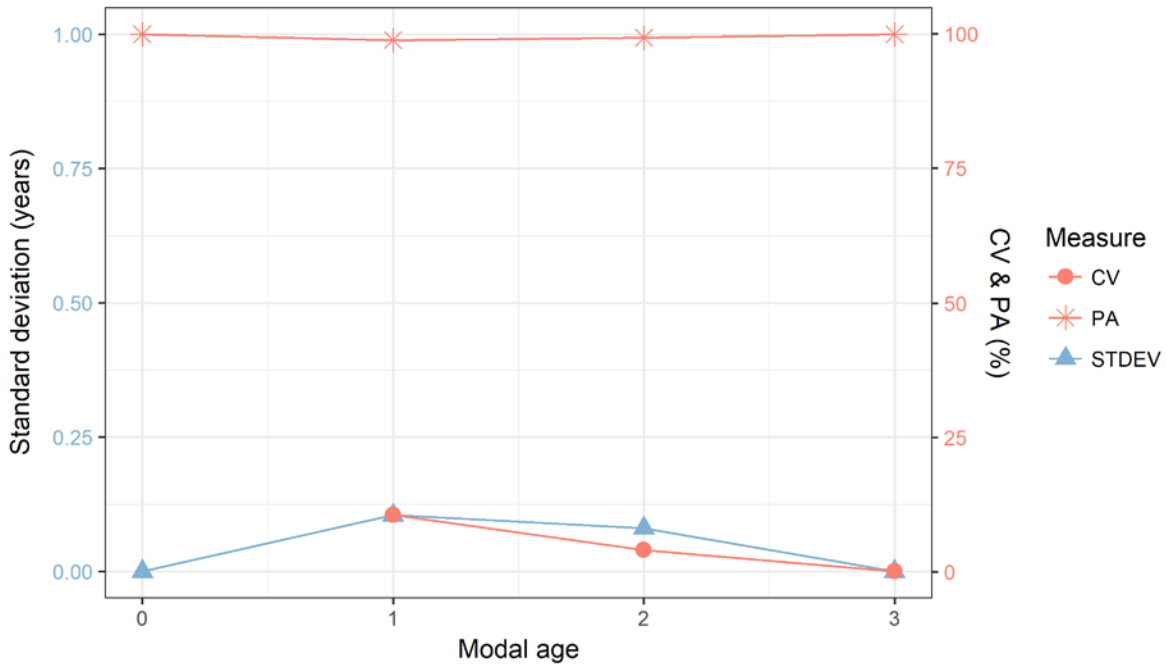


Figure 8.1: CV, PA and (STDEV (standard deviation) are plotted against modal age

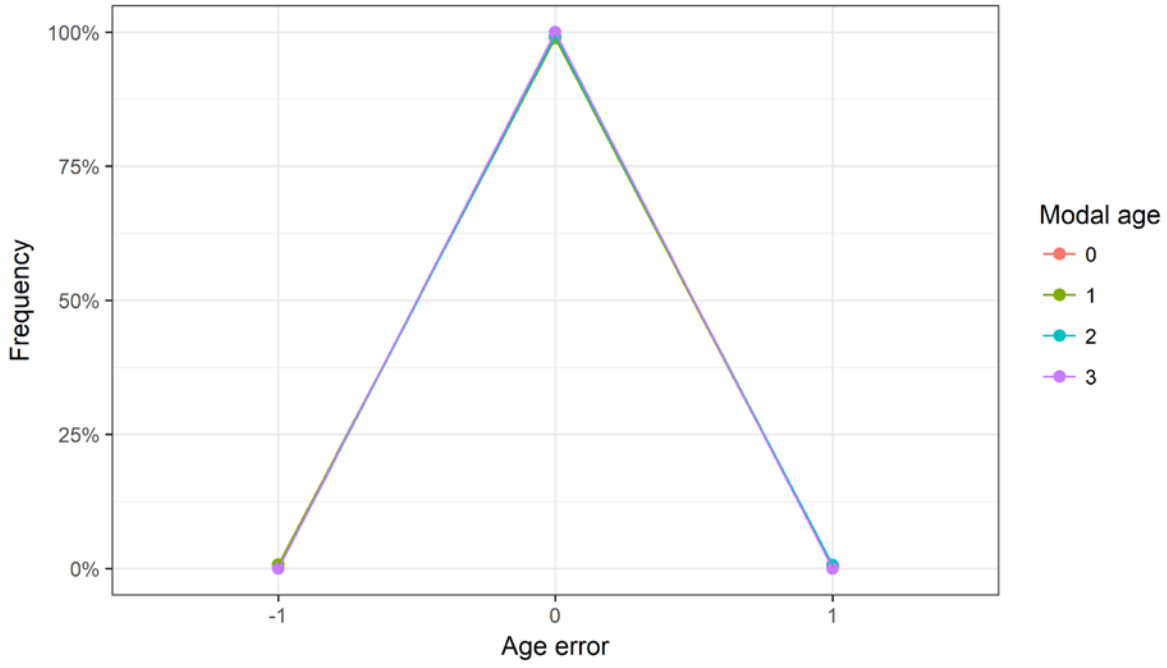


Figure 8.2: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed if relative bias occurs.

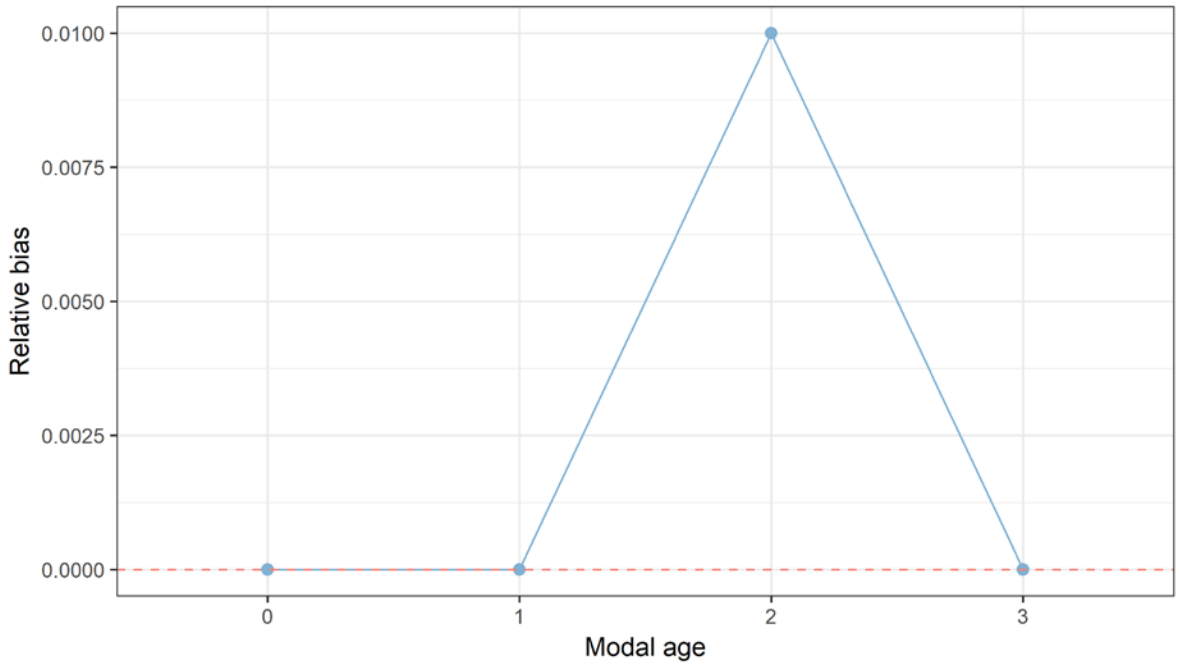


Figure 8.3: The relative bias by modal age as estimated by all age readers combined.

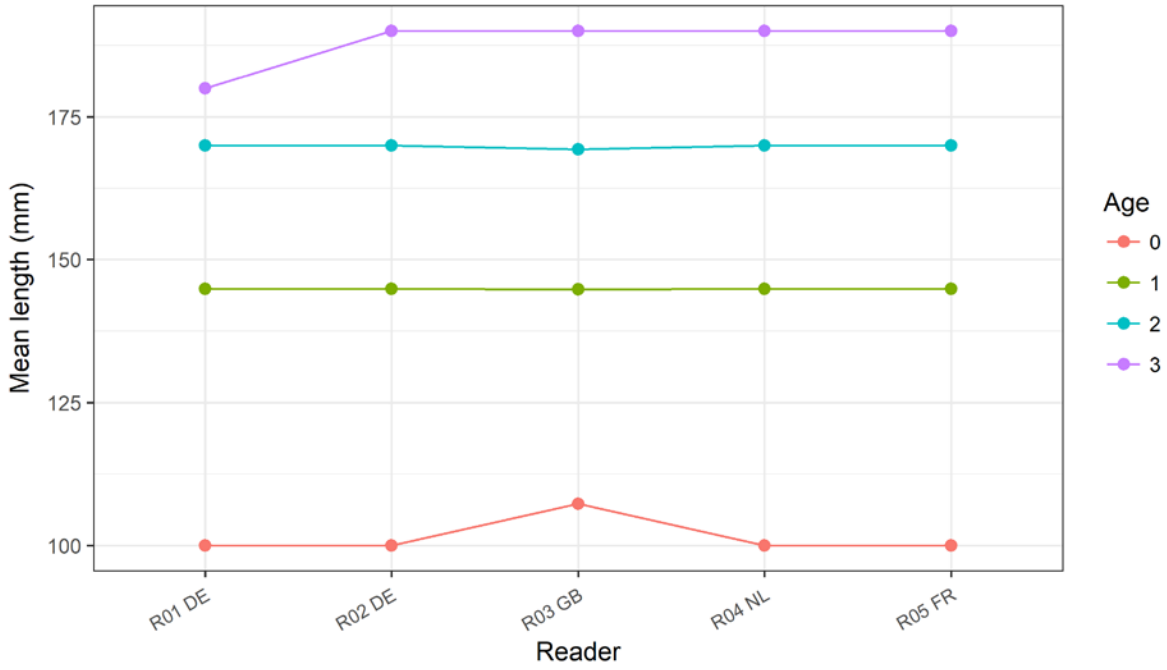


Figure 8.4: The mean length at age as estimated by each age reader.

Event ID 77 – Sectioned otoliths - advanced readers

Table 8.6: Data overview including biological data, estimated ages, modal age and statistics per sample based on advanced readers. By clicking on the Image ID you can view the annotations.

Fish ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 DE	R02 DE	R03 GB	Modal age	PA %	CV %	APE %
Npout_059_sectioned	77	771	100	U	2016-08-24	27.4.b	0	0	0	0	100	-	-
Npout_060_sectioned	77	772	100	U	2016-08-24	27.4.b	0	0	0	0	100	-	-
Npout_061_sectioned	77	773	150	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_062_sectioned	77	774	150	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_063_sectioned	77	775	140	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_064_sectioned	77	776	140	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_065_sectioned	77	777	160	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_066_sectioned	77	778	160	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_067_sectioned	77	779	170	F	2016-08-25	27.4.a	2	2	2	2	100	0	0
Npout_068_sectioned	77	780	130	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_069_sectioned	77	781	180	F	2016-08-25	27.4.a	2	2	2	2	100	0	0
Npout_070_sectioned	77	782	150	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_071_sectioned	77	783	150	F	2016-08-25	27.4.a	1	1	0	1	67	87	67
Npout_072_sectioned	77	784	140	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_073_sectioned	77	785	130	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_074_sectioned	77	786	140	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_075_sectioned	77	787	130	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_076_sectioned	77	788	160	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_077_sectioned	77	789	140	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_078_sectioned	77	790	150	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_079_sectioned	77	791	170	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_080_sectioned	77	792	140	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_081_sectioned	77	793	170	F	2016-08-25	27.4.a	2	2	2	2	100	0	0
Npout_082_sectioned	77	794	150	F	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_083_sectioned	77	795	160	M	2016-08-25	27.4.a	1	1	1	1	100	0	0
Npout_084_sectioned	77	796	160	M	2016-08-25	27.4.a	2	2	2	2	100	0	0

Npout_085_sectioned	77	797	190	F	2016-08-26	27.4.a	3	3	3	3	100	0	0
Npout_086_sectioned	77	798	180	F	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_087_sectioned	77	799	160	M	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_088_sectioned	77	800	180	F	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_089_sectioned	77	801	160	M	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_090_sectioned	77	802	170	M	2016-08-26	27.4.a	3	2	2	2	67	25	19
Npout_091_sectioned	77	803	170	M	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_092_sectioned	77	804	150	F	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_093_sectioned	77	805	150	M	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_094_sectioned	77	806	190	F	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_095_sectioned	77	807	140	M	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_096_sectioned	77	808	130	M	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_097_sectioned	77	809	140	F	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_098_sectioned	77	810	130	M	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_099_sectioned	77	811	170	F	2016-08-26	27.4.a	2	2	2	2	100	0	0
Npout_100_sectioned	77	812	150	F	2016-08-26	27.4.a	1	1	1	1	100	0	0
Npout_101_sectioned	77	813	100	U	2016-08-29	27.4.a	0	0	0	0	100	-	-
Npout_102_sectioned	77	814	100	U	2016-08-29	27.4.a	0	0	0	0	100	-	-
Npout_103_sectioned	77	815	170	F	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_104_sectioned	77	816	150	M	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_105_sectioned	77	817	130	M	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_106_sectioned	77	818	160	F	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_107_sectioned	77	819	160	F	2016-08-29	27.4.a	1	1	2	1	67	43	33
Npout_108_sectioned	77	820	150	F	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_109_sectioned	77	821	180	F	2016-08-29	27.4.a	2	2	2	2	100	0	0
Npout_110_sectioned	77	822	140	M	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_111_sectioned	77	823	170	F	2016-08-29	27.4.a	2	2	2	2	100	0	0
Npout_112_sectioned	77	824	140	M	2016-08-29	27.4.a	1	1	1	1	100	0	0
Npout_113_sectioned	77	825	130	M	2016-08-29	27.4.a	1	1	0	1	67	87	67

Npout_114_sectioned	77	826	100	M	2016-08-29	27.4.a	0	0	0	0	100	-	-
Npout_115_sectioned	77	827	100	U	2016-08-29	27.4.a	0	0	0	0	100	-	-
Npout_116_sectioned	77	828	140	M	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_117_sectioned	77	829	150	F	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_118_sectioned	77	830	150	M	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_119_sectioned	77	831	140	F	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_120_sectioned	77	832	160	F	2016-08-30	27.4.a	2	2	2	2	100	0	0
Npout_121_sectioned	77	833	130	F	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_122_sectioned	77	834	130	F	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_123_sectioned	77	835	160	F	2016-08-30	27.4.a	1	1	1	1	100	0	0
Npout_124_sectioned	77	836	140	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_125_sectioned	77	837	150	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_126_sectioned	77	838	150	F	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_127_sectioned	77	839	140	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_128_sectioned	77	840	170	M	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_129_sectioned	77	841	160	F	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_130_sectioned	77	842	170	F	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_131_sectioned	77	843	160	F	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_132_sectioned	77	844	180	F	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_133_sectioned	77	845	130	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_134_sectioned	77	846	180	F	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_135_sectioned	77	847	130	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_136_sectioned	77	848	100	M	2016-08-31	27.4.a	0	0	0	0	100	-	-
Npout_137_sectioned	77	849	100	F	2016-08-31	27.4.a	0	0	0	0	100	-	-
Npout_138_sectioned	77	850	140	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_139_sectioned	77	851	150	F	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_140_sectioned	77	852	140	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_141_sectioned	77	853	150	F	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_142_sectioned	77	854	170	F	2016-08-31	27.4.a	2	2	2	2	100	0	0

Npout_143_sectioned	77	855	160	M	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_144_sectioned	77	856	130	M	2016-08-31	27.4.a	1	1	1	1	100	0	0
Npout_145_sectioned	77	857	170	F	2016-08-31	27.4.a	2	2	2	2	100	0	0
Npout_146_sectioned	77	858	100	U	2016-08-31	27.4.a	0	0	0	0	100	-	-
Npout_147_sectioned	77	763	180	F	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_148_sectioned	77	764	170	M	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_149_sectioned	77	765	160	F	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_150_sectioned	77	766	190	F	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_151_sectioned	77	767	150	M	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_152_sectioned	77	768	150	M	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_153_sectioned	77	769	160	F	2016-09-01	27.4.a	2	2	2	2	100	0	0
Npout_154_sectioned	77	770	180	M	2016-09-01	27.4.a	2	2	-	2	100	0	0

Table 8.7: Number of age readings table gives an overview of number of readings per reader and modal age (based on advanced readers). The total numbers of readings per reader and per modal age are summarized at the end of the table.

Modal age	R01 DE	R02 DE	R03 GB	total
0	9	9	9	**27**
1	55	55	55	**165**
2	31	31	30	**92**
3	1	1	1	**3**
Total	**96**	**96**	**95**	**287**

Table 8.8: Age composition by reader gives a summary of number of readings per reader (based on advanced readers).

Modal age	R01 DE	R02 DE	R03 GB
0	9	9	**11**
1	55	55	**52**
2	30	31	**31**
3	2	1	**1**
Total	**96**	**96**	**95**

Table 8.9: Mean length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age (based on advanced readers). A weighted mean is also given.

Age	R01 DE	R02 DE	R03 GB
0	100 mm	100 mm	**107 mm**
1	145 mm	145 mm	**145 mm**
2	170 mm	170 mm	**169 mm**
3	180 mm	190 mm	**190 mm**
Weighted Mean	**149 mm**	**149 mm**	**149 mm**

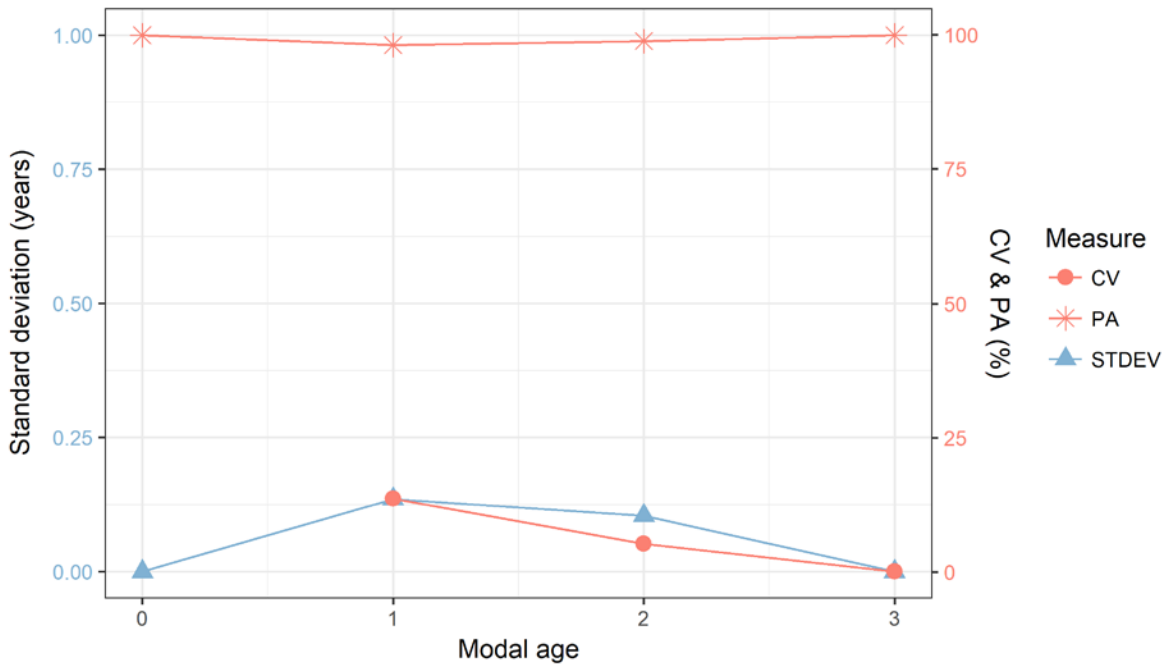


Figure 8.5: CV, PA and (STDEV (standard deviation) are plotted against modal age

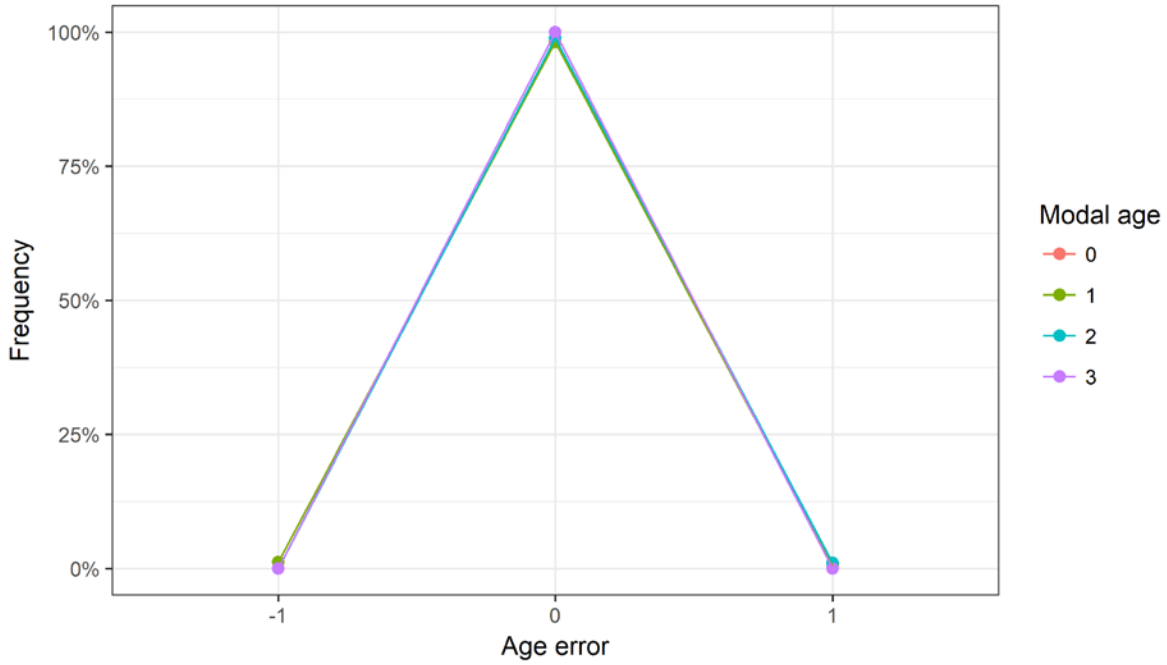


Figure 8.6: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

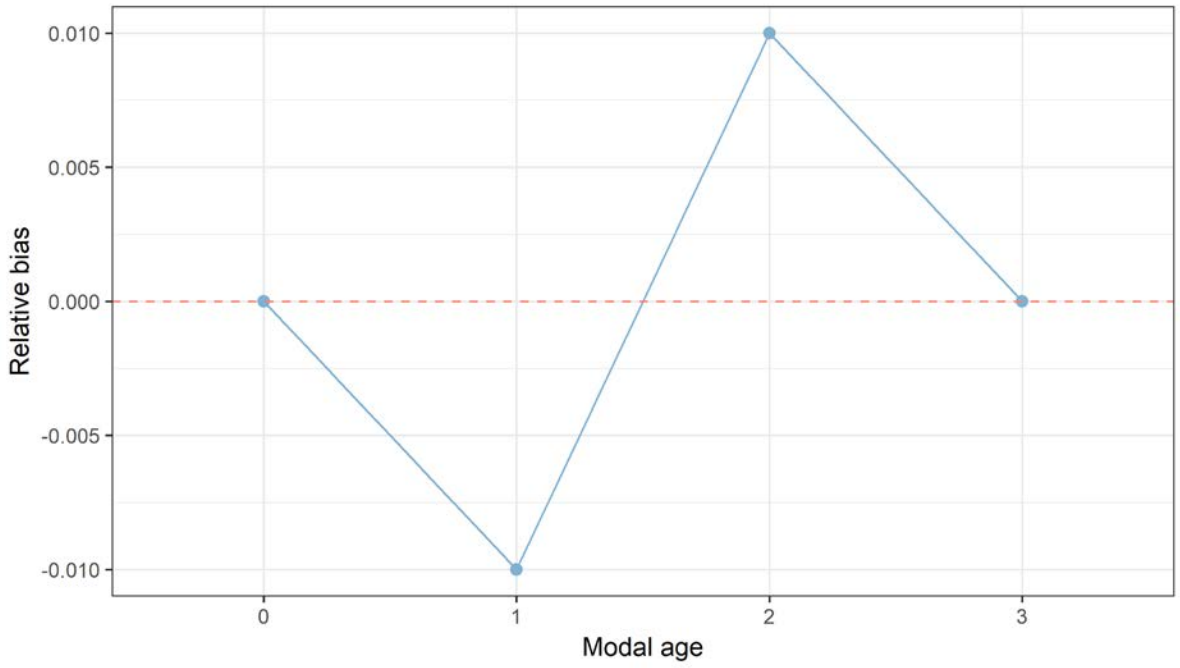


Figure 8.7: The relative bias by modal age as estimated by all age readers combined.

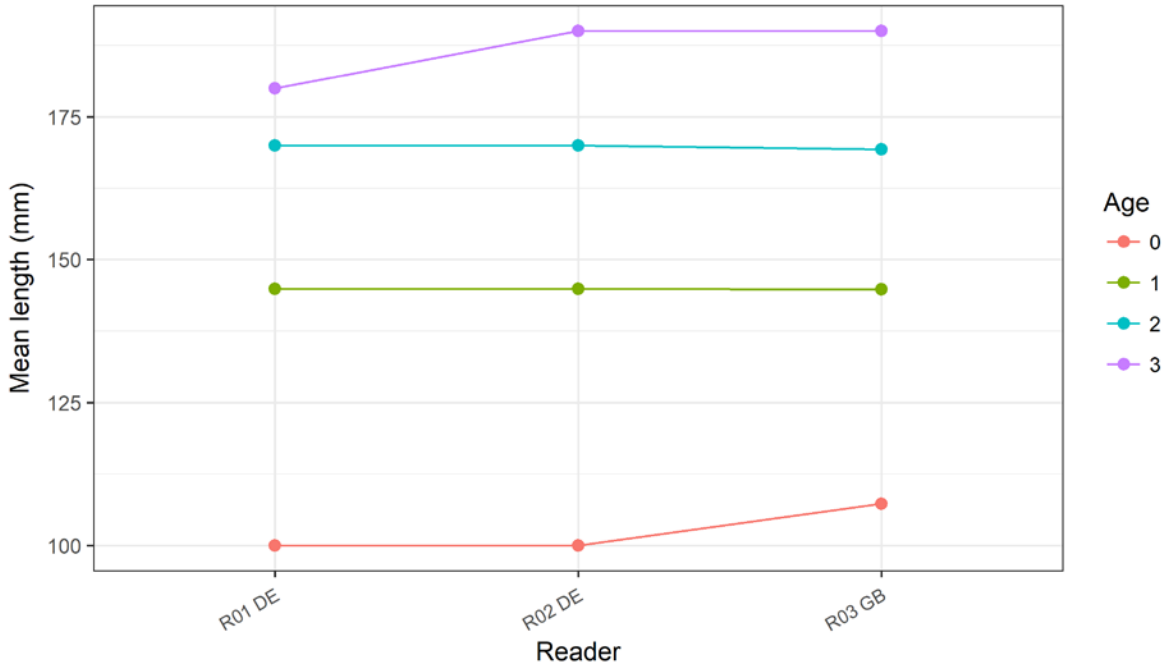


Figure 8.8: The mean length at age as estimated by each age reader.

Event ID 74 – Whole and Broken otoliths – all readers

Data Overview

Table 8.10: Summary of statistics; PA (%), CV (%) and APE (%).

CV	PA	APE
28 %	82 %	18 %

Table 8.11: Data overview including biological data, estimated ages, modal age and statistics per sample based on all readers. By clicking on the Image ID you can view the annotations.

Fish ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT	Modal age	PA %	CV %	APE %
Npout_001	74	598-540	105	U	2014-11-01	27.4.a	0	0	0	1	1	0	1	1	0	0	56	-	-
Npout_002	74	599-541	105	U	2014-11-01	27.4.a	0	0	0	0	1	0	1	2	0	0	67	-	-
Npout_003	74	600-542	105	U	2014-11-01	27.4.a	0	0	0	0	1	0	1	1	0	0	67	-	-
Npout_004	74	601-543	110	U	2014-11-01	27.4.a	0	0	0	0	1	0	-	1	0	0	75	-	-
Npout_005	74	602-544	120	U	2014-11-01	27.4.a	0	0	0	1	1	0	1	1	0	0	56	-	-
Npout_006	74	603	135	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_007	74	546-604	140	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_008	74	547-605	140	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_009	74	548-606	140	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	2	1	1	89	30	18
Npout_010	74	549-607	145	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	2	1	1	89	30	18
Npout_011	74	550-608	145	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	2	1	1	89	30	18
Npout_012	74	551-609	145	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_013	74	552-610	150	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	2	1	1	89	30	18
Npout_014	74	553-611	150	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	2	1	1	89	30	18
Npout_015	74	612-554	155	U	2014-11-01	27.4.a	2	2	1	2	3	2	2	3	1	2	56	35	22
Npout_016	74	613-555	155	U	2014-11-01	27.4.a	1	2	1	1	2	2	2	2	1	2	56	34	32
Npout_017	74	614	160	U	2014-11-01	27.4.a	1	1	1	1	2	2	-	2	1	1	62	38	34
Npout_018	74	615-557	160	U	2014-11-01	27.4.a	2	2	1	3	2	2	2	2	2	2	78	25	11
Npout_019	74	616-558	165	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	2	2	78	25	19
Npout_020	74	617-559	165	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	1	2	67	30	27
Npout_021	74	560-618	165	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	2	2	78	25	19

Npout_022	74	619-561	170	U	2014-11-01	27.4.a	2	2	1	1	3	2	2	2	2	2	67	32	21
Npout_023	74	620-562	170	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	2	2	78	25	19
Npout_024	74	563-621	175	U	2014-11-01	27.4.a	2	2	1	1	2	1	2	2	1	2	56	34	32
Npout_025	74	622-564	180	U	2014-11-01	27.4.a	2	2	2	1	2	2	2	2	2	2	89	18	10
Npout_026	74	623-565	180	U	2014-11-01	27.4.a	2	2	2	2	3	2	2	2	2	2	89	16	9
Npout_027	74	624-566	180	U	2014-11-01	27.4.a	3	2	2	1	3	2	2	2	2	2	67	28	19
Npout_028	74	625-567	185	U	2014-11-01	27.4.a	2	2	2	1	2	2	2	2	2	2	89	18	10
Npout_029	74	626-568	185	U	2014-11-01	27.4.a	3	2	2	1	3	2	2	2	2	2	67	28	19
Npout_030	74	627-569	90	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	1	0	0	89	-	-
Npout_031	74	570-628	95	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	0	0	100	-	-
Npout_032	74	571-629	95	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	0	0	100	-	-
Npout_033	74	572-630	95	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	0	0	100	-	-
Npout_034	74	631-573	100	U	2014-10-25	27.4.a	0	0	0	0	1	0	1	0	0	0	78	-	-
Npout_035	74	574-632	100	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	0	0	100	-	-
Npout_036	74	575-633	100	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	0	0	100	-	-
Npout_037	74	576-634	105	U	2014-10-25	27.4.a	0	0	0	0	1	0	0	0	0	0	89	-	-
Npout_038	74	635-577	105	U	2014-10-25	27.4.a	0	0	0	0	0	0	1	1	0	0	78	-	-
Npout_039	74	636-578	105	U	2014-10-25	27.4.a	0	0	0	0	1	0	1	1	0	0	67	-	-
Npout_040	74	637-579	110	U	2014-10-25	27.4.a	0	0	0	0	2	0	2	1	0	0	67	-	-
Npout_041	74	638	135	U	2014-10-25	27.4.a	1	1	1	1	1	1	2	2	1	1	78	36	28
Npout_042	74	639	135	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_043	74	640	140	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_044	74	641	140	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_045	74	642	145	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_046	74	643	150	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_047	74	644-586	150	U	2014-10-25	27.4.a	2	1	1	1	2	1	2	2	1	1	56	36	34
Npout_048	74	587-645	155	U	2014-10-25	27.4.a	1	1	1	1	3	1	2	1	1	1	78	53	39
Npout_049	74	646-588	155	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	1	1	100	0	0
Npout_050	74	647-589	155	U	2014-10-25	27.4.a	1	1	1	1	2	1	1	1	1	1	89	30	18

Npout_051	74	648-590	160	U	2014-10-25	27.4.a	2	1	1	1	2	2	2	1	1	1	56	36	34
Npout_052	74	649-591	160	U	2014-10-25	27.4.a	2	2	1	1	3	2	2	2	2	2	67	32	21
Npout_053	74	650-592	170	U	2014-10-25	27.4.a	2	2	1	1	2	2	2	2	2	2	78	25	19
Npout_054	74	593-535	170	U	2014-10-25	27.4.a	2	2	1	2	3	2	2	2	2	2	78	25	11
Npout_055	74	594-536	175	U	2014-10-25	27.4.a	2	1	1	2	2	2	2	2	1	2	67	30	27
Npout_056	74	595-537	175	U	2014-10-25	27.4.a	2	2	2	3	2	2	2	2	2	2	89	16	9
Npout_057	74	596	175	U	2014-10-25	27.4.a	2	2	2	2	3	2	2	2	2	2	89	16	9
Npout_058	74	597	180	U	2014-10-25	27.4.a	2	2	2	2	2	2	2	2	2	2	100	0	0

Table 8.12: Number of readings per reader and modal age (based on all readers). The total numbers of readings per reader and per modal age are summarized at the end of the table.

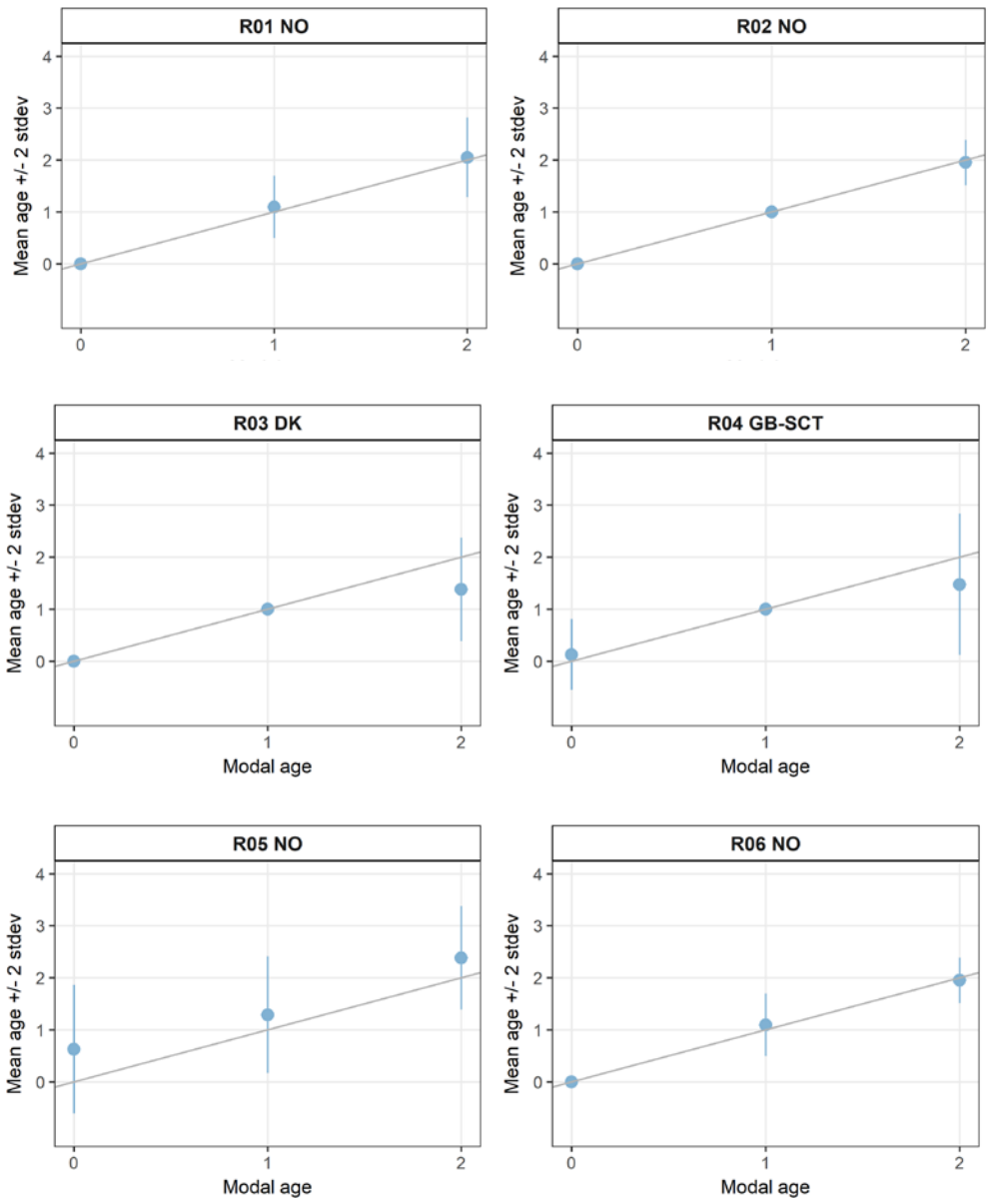
Modal age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT	total
0	16	16	16	16	16	16	15	16	16	**143**
1	21	21	21	21	21	21	20	21	21	**188**
2	21	21	21	21	21	21	21	21	21	**189**
Total	**58**	**58**	**58**	**58**	**58**	**58**	**56**	**58**	**58**	**520**

Table 8.13: Age composition by reader gives a summary of number of readings per reader (based on all readers).

Modal age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT
0	16	16	16	14	7	16	7	7	**16**
1	20	22	34	36	24	20	23	21	**26**
2	20	20	8	6	18	22	26	29	**16**
3	2	0	0	2	9	0	0	1	**0**
Total	**58**	**58**	**58**	**58**	**58**	**58**	**56**	**58**	**58**

Table 8.14: Mean length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age (based on all readers). A weighted mean is also given.

Age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	R08 GB-SCT	R09 GB-SCT
0	103 mm	103 mm	103 mm	101 mm	97 mm	103 mm	97 mm	99 mm	**103 mm**
1	146 mm	148 mm	154 mm	153 mm	131 mm	146 mm	133 mm	131 mm	**150 mm**
2	169 mm	171 mm	180 mm	172 mm	164 mm	170 mm	166 mm	163 mm	**173 mm**
3	182 mm	-	-	168 mm	170 mm	-	-	155 mm	-
Weighted Mean	**143 mm**	**143 mm**	**143 mm**	**143 mm**	**143 mm**	**143 mm**	**144 mm**	**143 mm**	**143 mm**


R01 NO
R02 NO
R03 DK
R04 GB-SCT
R05 NO
R06 NO
Mean age +/- 2 stdev
Modal age
0
1
2
3
4

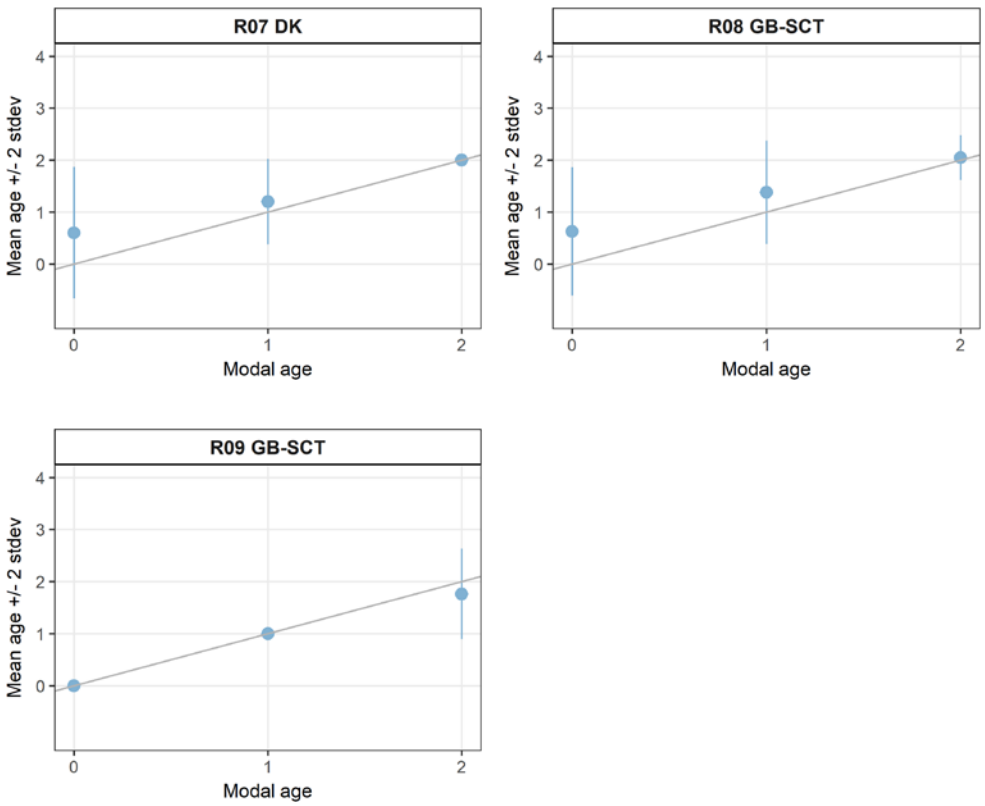


Figure 8.9: Age bias plot for each reader of whole and broken otoliths. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

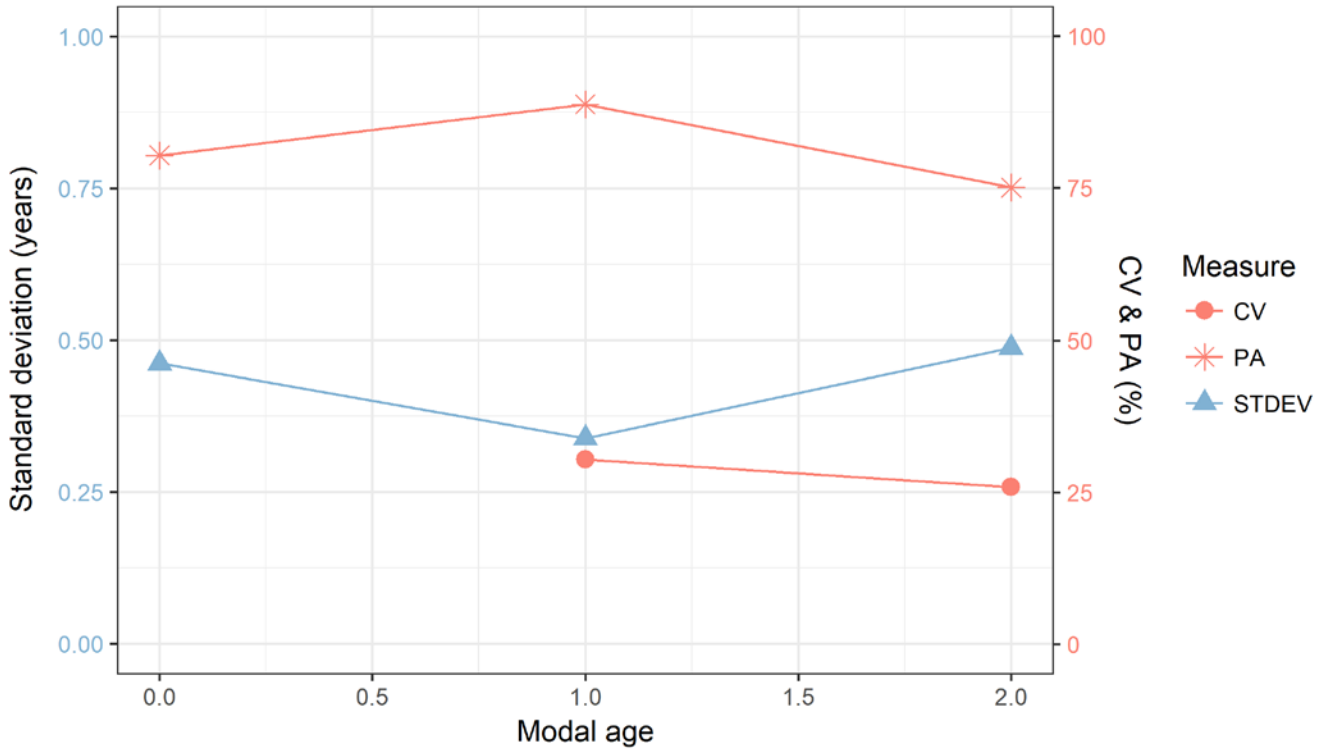


Figure 8.10: CV, PA and (STDEV (standard deviation) are plotted against modal age

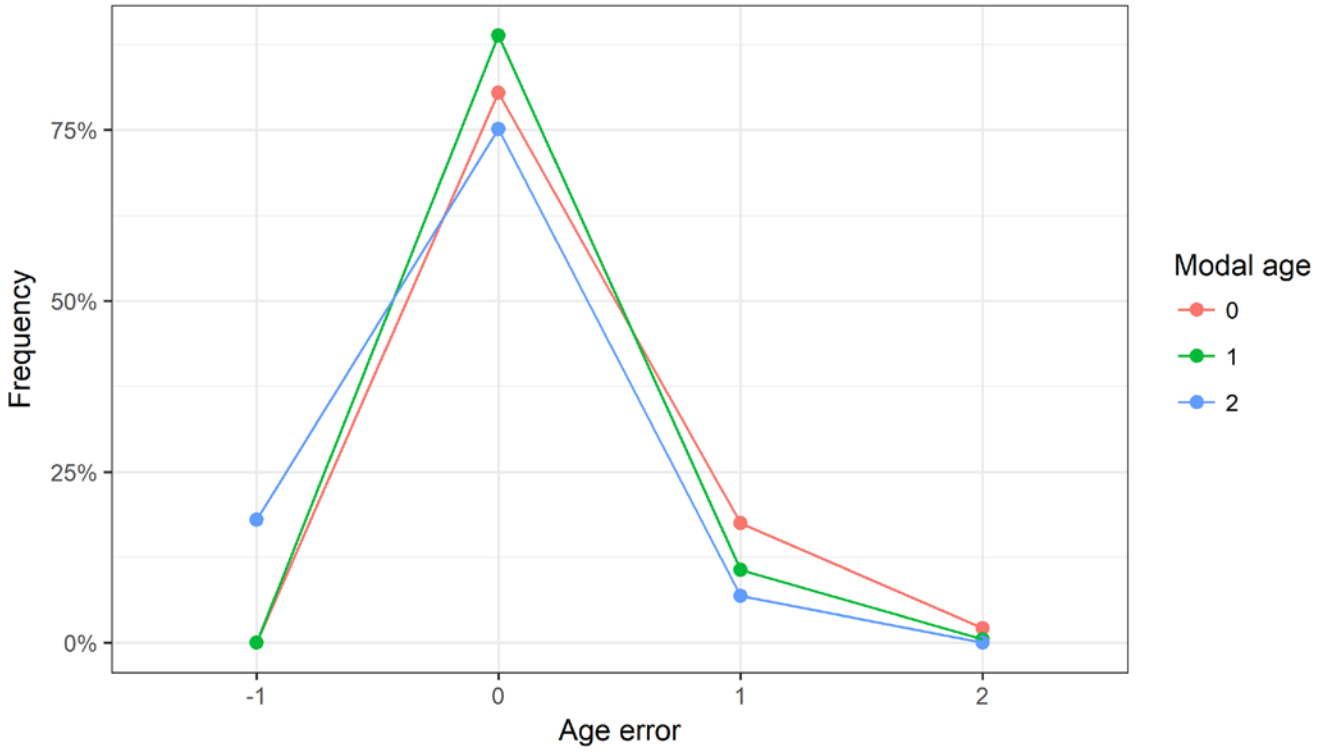


Figure 8.11: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

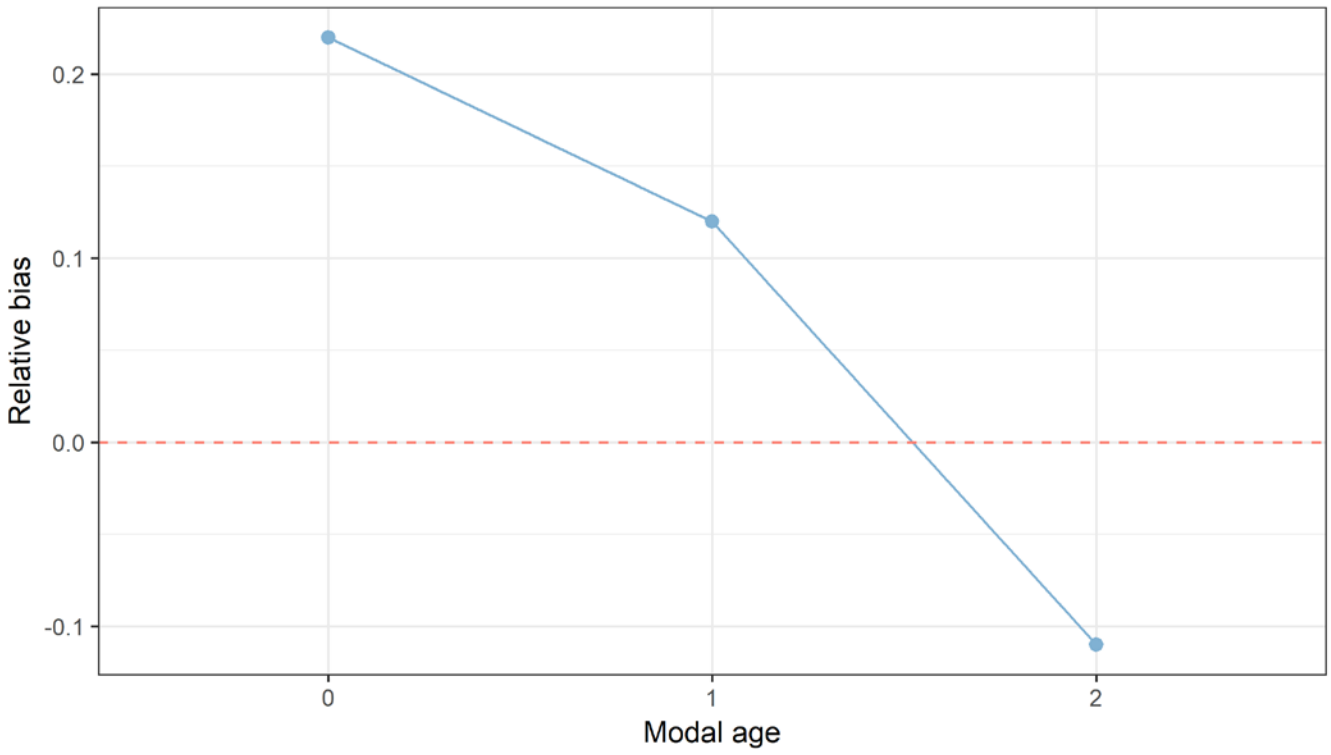


Figure 8.12: The relative bias by modal age as estimated by all age readers combined.

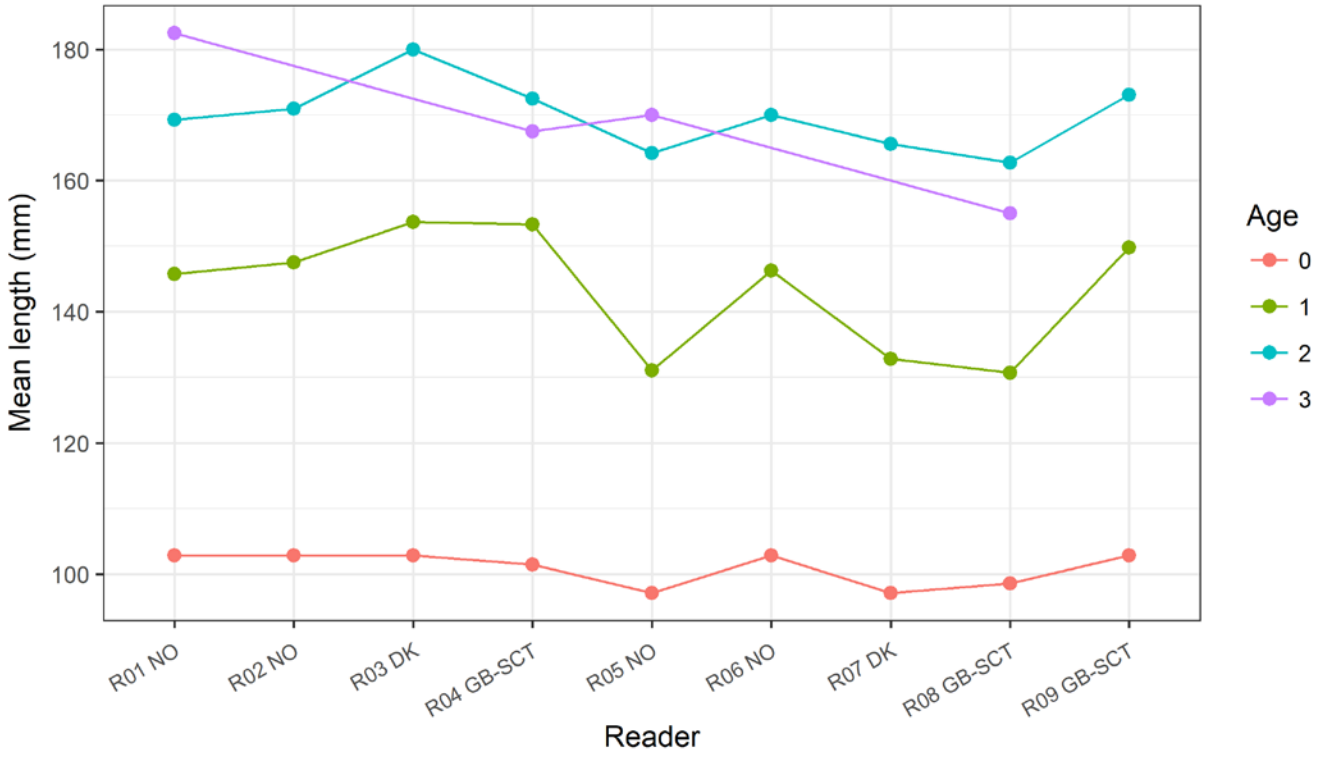


Figure 8.13: The mean length at age as estimated by each age reader.

Event ID 74 – Whole and Broken otoliths – advanced readers

Table 8.15: Data overview including biological data, estimated ages, modal age and statistics per sample based on advanced readers. By clicking on the Image ID you can view the annotations.

Fish ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	Modal age	PA %	CV %	APE %
Npout_001	74	598-540	105	U	2014-11-01	27.4.a	0	0	0	1	1	0	1	0	57	-	-
Npout_002	74	599-541	105	U	2014-11-01	27.4.a	0	0	0	0	1	0	1	0	71	-	-
Npout_003	74	600-542	105	U	2014-11-01	27.4.a	0	0	0	0	1	0	1	0	71	-	-
Npout_004	74	601-543	110	U	2014-11-01	27.4.a	0	0	0	0	1	0	-	0	83	-	-
Npout_005	74	602-544	120	U	2014-11-01	27.4.a	0	0	0	1	1	0	1	0	57	-	-
Npout_006	74	603	135	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_007	74	546-604	140	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_008	74	547-605	140	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_009	74	548-606	140	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0

Npout_010	74	549-607	145	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_011	74	550-608	145	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_012	74	551-609	145	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_013	74	552-610	150	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_014	74	553-611	150	U	2014-11-01	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_015	74	612-554	155	U	2014-11-01	27.4.a	2	2	1	2	3	2	2	2	71	29	14
Npout_016	74	613-555	155	U	2014-11-01	27.4.a	1	2	1	1	2	2	2	2	57	34	31
Npout_017	74	614	160	U	2014-11-01	27.4.a	1	1	1	1	2	2	-	1	67	39	33
Npout_018	74	615-557	160	U	2014-11-01	27.4.a	2	2	1	3	2	2	2	2	71	29	14
Npout_019	74	616-558	165	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	71	28	24
Npout_020	74	617-559	165	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	71	28	24
Npout_021	74	560-618	165	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	71	28	24
Npout_022	74	619-561	170	U	2014-11-01	27.4.a	2	2	1	1	3	2	2	2	57	37	26
Npout_023	74	620-562	170	U	2014-11-01	27.4.a	2	2	1	1	2	2	2	2	71	28	24
Npout_024	74	563-621	175	U	2014-11-01	27.4.a	2	2	1	1	2	1	2	2	57	34	31
Npout_025	74	622-564	180	U	2014-11-01	27.4.a	2	2	2	1	2	2	2	2	86	20	13
Npout_026	74	623-565	180	U	2014-11-01	27.4.a	2	2	2	2	3	2	2	2	86	18	11
Npout_027	74	624-566	180	U	2014-11-01	27.4.a	3	2	2	1	3	2	2	2	57	32	23
Npout_028	74	625-567	185	U	2014-11-01	27.4.a	2	2	2	1	2	2	2	2	86	20	13
Npout_029	74	626-568	185	U	2014-11-01	27.4.a	3	2	2	1	3	2	2	2	57	32	23
Npout_030	74	627-569	90	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	100	-	-
Npout_031	74	570-628	95	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	100	-	-
Npout_032	74	571-629	95	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	100	-	-
Npout_033	74	572-630	95	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	100	-	-
Npout_034	74	631-573	100	U	2014-10-25	27.4.a	0	0	0	0	1	0	1	0	71	-	-
Npout_035	74	574-632	100	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	100	-	-
Npout_036	74	575-633	100	U	2014-10-25	27.4.a	0	0	0	0	0	0	0	0	100	-	-
Npout_037	74	576-634	105	U	2014-10-25	27.4.a	0	0	0	0	1	0	0	0	86	-	-
Npout_038	74	635-577	105	U	2014-10-25	27.4.a	0	0	0	0	0	0	1	0	86	-	-

Npout_039	74	636-578	105	U	2014-10-25	27.4.a	0	0	0	0	1	0	1	0	71	-	-
Npout_040	74	637-579	110	U	2014-10-25	27.4.a	0	0	0	0	2	0	2	0	71	-	-
Npout_041	74	638	135	U	2014-10-25	27.4.a	1	1	1	1	1	1	2	1	86	33	21
Npout_042	74	639	135	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_043	74	640	140	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_044	74	641	140	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_045	74	642	145	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_046	74	643	150	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_047	74	644-586	150	U	2014-10-25	27.4.a	2	1	1	1	2	1	2	1	57	37	34
Npout_048	74	587-645	155	U	2014-10-25	27.4.a	1	1	1	1	3	1	2	1	71	55	43
Npout_049	74	646-588	155	U	2014-10-25	27.4.a	1	1	1	1	1	1	1	1	100	0	0
Npout_050	74	647-589	155	U	2014-10-25	27.4.a	1	1	1	1	2	1	1	1	86	33	21
Npout_051	74	648-590	160	U	2014-10-25	27.4.a	2	1	1	1	2	2	2	2	57	34	31
Npout_052	74	649-591	160	U	2014-10-25	27.4.a	2	2	1	1	3	2	2	2	57	37	26
Npout_053	74	650-592	170	U	2014-10-25	27.4.a	2	2	1	1	2	2	2	2	71	28	24
Npout_054	74	593-535	170	U	2014-10-25	27.4.a	2	2	1	2	3	2	2	2	71	29	14
Npout_055	74	594-536	175	U	2014-10-25	27.4.a	2	1	1	2	2	2	2	2	71	28	24
Npout_056	74	595-537	175	U	2014-10-25	27.4.a	2	2	2	3	2	2	2	2	86	18	11
Npout_057	74	596	175	U	2014-10-25	27.4.a	2	2	2	2	3	2	2	2	86	18	11
Npout_058	74	597	180	U	2014-10-25	27.4.a	2	2	2	2	2	2	2	2	100	0	0

Table 8.16: Number of age readings table gives an overview of number of readings per reader and modal age (based on advanced readers). The total numbers of readings per reader and per modal age are summarized at the end of the table.

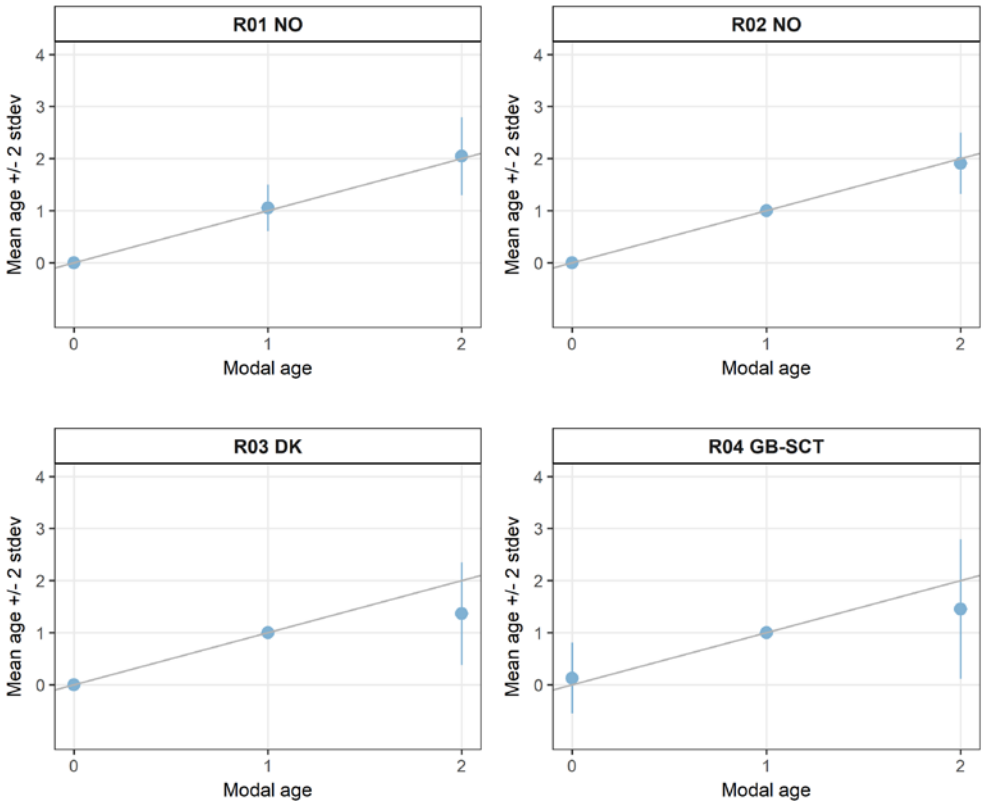
Modal age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK	total
0	16	16	16	16	16	16	15	**111**
1	20	20	20	20	20	20	19	**139**
2	22	22	22	22	22	22	22	**154**
Total	**58**	**58**	**58**	**58**	**58**	**58**	**56**	**404**

Table 8.17: Age composition by reader gives a summary of number of readings per reader (based on advanced readers).

Modal age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK
0	16	16	16	14	7	16	**7**
1	20	22	34	36	24	20	**23**
2	20	20	8	6	18	22	**26**
3	2	0	0	2	9	0	**0**
Total	**58**	**58**	**58**	**58**	**58**	**58**	**56**

Table 8.18: Mean length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age (based on advanced readers). A weighted mean is also given.

Age	R01 NO	R02 NO	R03 DK	R04 GB-SCT	R05 NO	R06 NO	R07 DK
0	103 mm	103 mm	103 mm	101 mm	97 mm	103 mm	**97 mm**
1	146 mm	148 mm	154 mm	153 mm	131 mm	146 mm	**133 mm**
2	169 mm	171 mm	180 mm	172 mm	164 mm	170 mm	**166 mm**
3	182 mm	-	-	168 mm	170 mm	-	-
Weighted Mean	**143 mm**	**143 mm**	**143 mm**	**143 mm**	**143 mm**	**143 mm**	**144 mm**



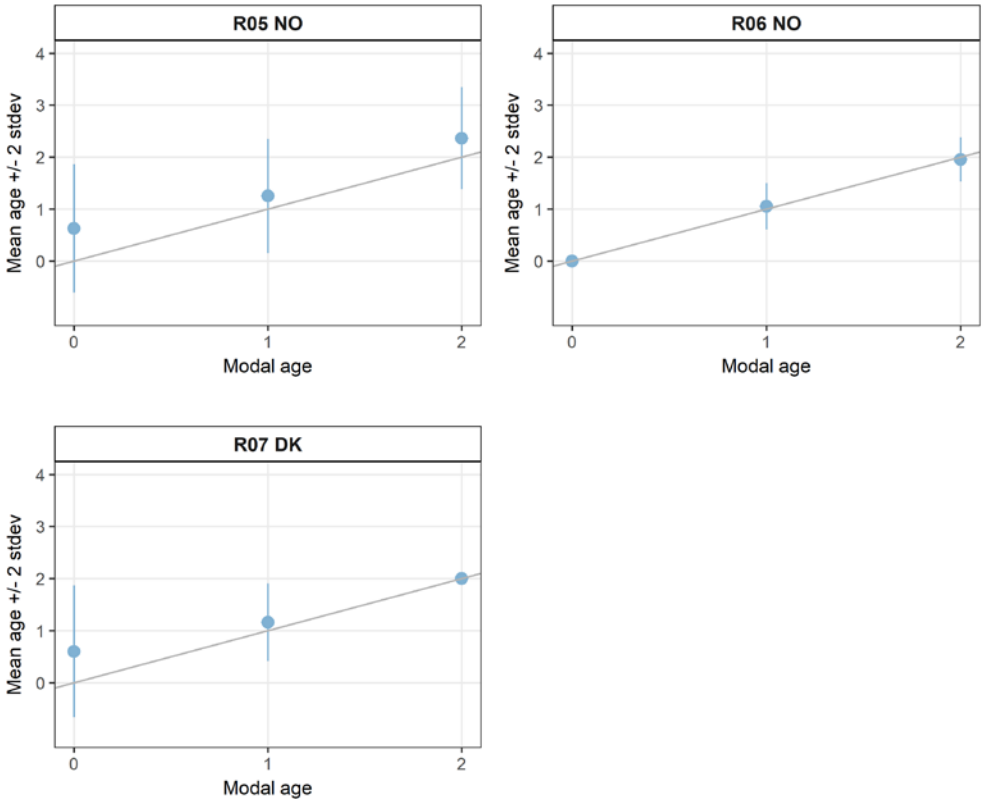


Figure 8.14: Age bias plot for each advanced reader of whole and broken otoliths. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

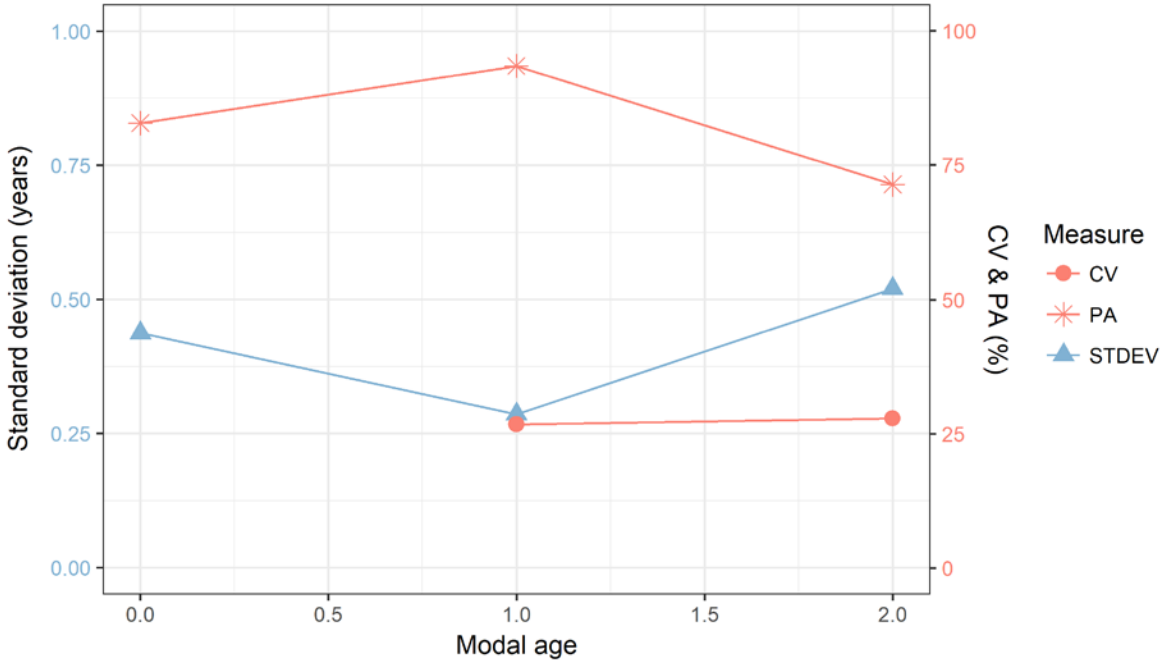


Figure 8.15: CV, PA and (STDEV (standard deviation) are plotted against modal age

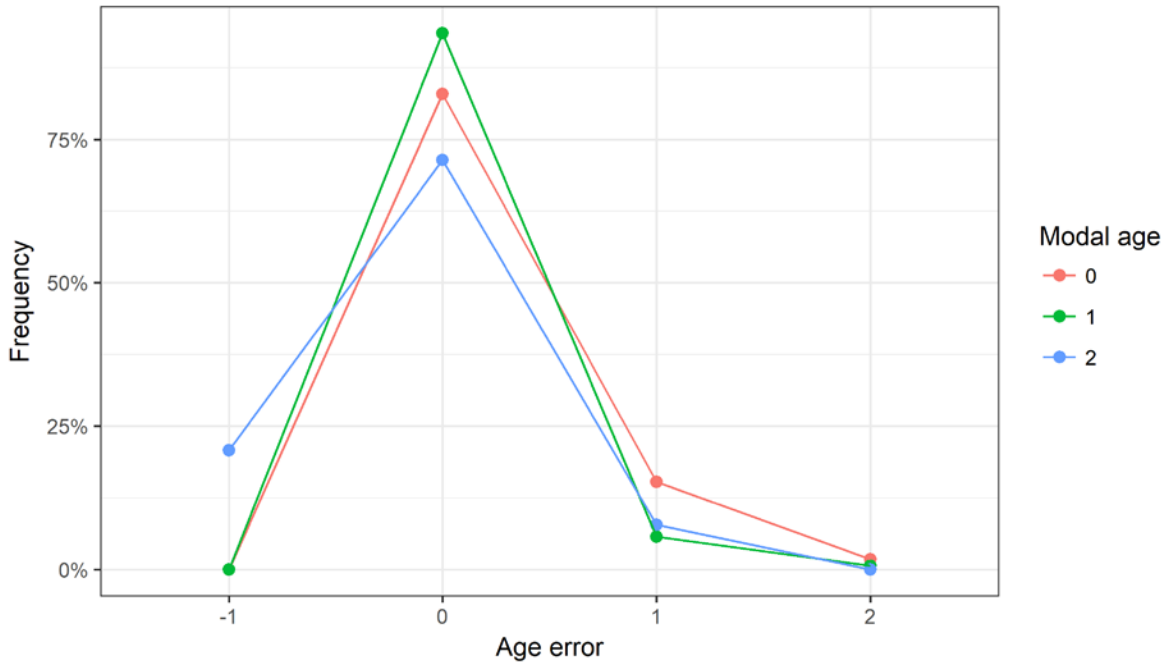


Figure 8.16: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

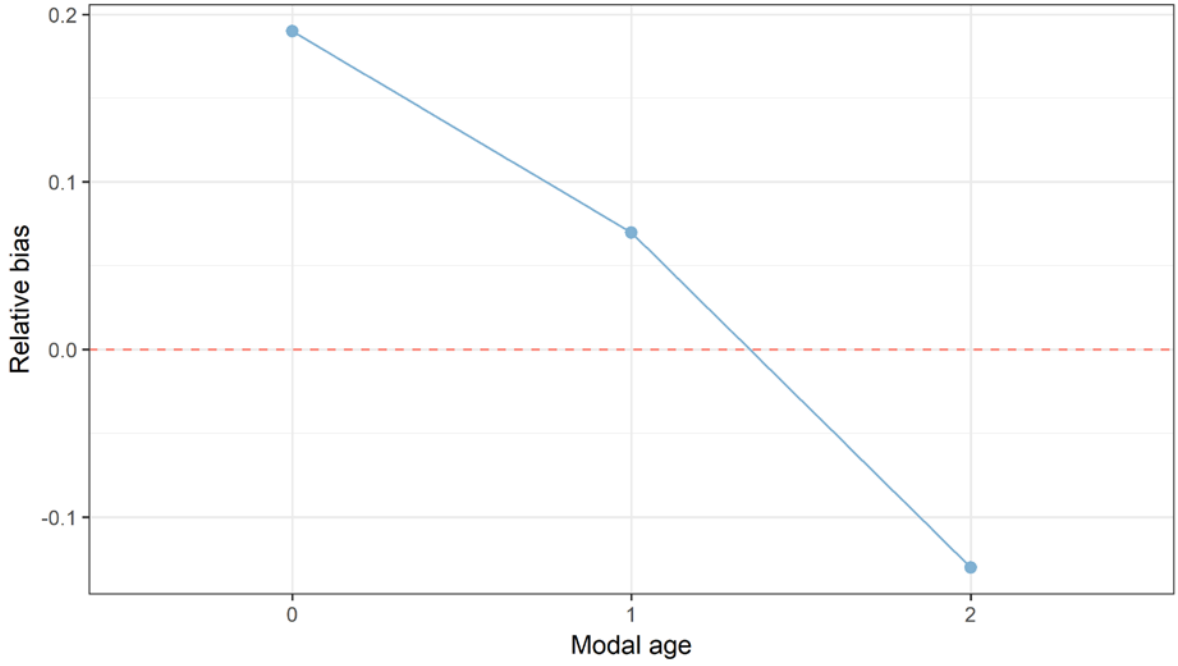


Figure 8.17: The relative bias by modal age as estimated by all age readers combined.

Figure 8.18: The mean length at age as estimated by each age reader.