SmartDots Report for event 277

Megrim (*Lepidorhombus whiffiagonis*) 8.c, 9.a otolith exchange 2020

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(coordination and analysis)

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1 Executive summary

Event 277 in SmartDots.

An otolith exchange from the Iberian Atlantic stock (Div. 8.c, 9.a) of megrim was performed for **the first time**.

A total of 120 whole otoliths and images were analyzed, representative of the whole range of specimens commercially captured.

The "multistage modal age approach" was used, and the percentage of multiple mode cases was reduced from 14% (traditional approach) to 0% (multistage approach).

For **all readers**, the overall agreement (PA) was 68%, CV was 14%, APE was 9% and relative bias (RB) was -0.07.

For the **readers involved in the assessment** of this stock, better results were obtained: overall PA of 82%, CV of 11%, APE of 6% and RB of -0.10.

Strata **semester** was analyzed showing better results for **all readers** in the first semester compared to the second one: PA (74% vs 62%), CV (12% vs 16%), RB (-0.02 vs -0.12)

As usual, the overall PA decreases with increasing **age** (from age 5) but the overall CV was stable with age (from age 3). RB increases from age 7 (ages with low samples and low landings). Three readers (basic-intermediate experience) showed higher RB and lower PA, mainly in ages ≥ 6.

No noticeable general concerns related to the age estimation in that stock were found, except the usual increasing difficulty of interpretation in older megrim due to increased otolith opacity.

Similar or better results in present EX than in previous megrim EXs & WKs (almost all based on stock 7.b-k, 8.abd).

A reference collection, training in older ages and continue calibration EXs for all readers are **recommended**. Considering the good results of the readers providing readings for stock assessment, no specific recommendation are suggested for them.

Coordinator: Jorge Landa (Spain)

The report is in preparation and will be uploaded to Smartdots when finished.

2 Introduction

The megrim (*Lepidorhombus whiffiagonis*) inhabits northeast Atlantic, from Iceland to Cape Bojador, and the Mediterranean Sea, at depths from 50 m to 700 m, associated with fine sand bottoms (Whitehead et al., 1986; Sánchez et al, 1998; Mytilineou et al., 2005; Fernández-Zapico et al., 2017).

It is a commercially exploited flatfish, being mainly caught by mixed bottom trawl fisheries in European waters. Megrim catches were estimated at around 16000 (3315+920+12026+320)t in Atlantic European waters in 2020 (ICES, 2021a; ICES 2021b).

The International Council for the Exploration of the Sea (ICES) has established four Atlantic stocks of megrim in: Div. 8.c, 9.a (Iberian Atlantic waters), Div. 7.b–k, 8.a,b,d (Celtic Seas and northern Bay of Biscay), Div. 4.a, 6.a (northern North Sea and West of Scotland), and Div. 6.b (Rockall) (ICES, 2021a; ICES, 2021b).

The megrim in stock 8.c, 9.a here studied is captured by the Spanish and Portuguese fleets, with annual catches between 250 to 400 t since 2011 (ICES, 2021a).

The ICES Working Group on Biological Parameters (WGBIOP) in 2019 (ICES, 2019b) established the need to perform an age calibration exchange of megrim (*Lepidorhombus whiffiagonis*) from ICES Div. 8.c, 9.a. in 2020, coordinated by Jorge Landa (IEO, Spain).

Several age calibration exchanges and workshops on megrim took place in 1997, 2004 and 2010, most analyzing samples from the 7.b-k, 8.a,b,d stock (Anon, 1997; Egan et al, 2004; Etherton, 2011) and one based on samples of the 4.a, 6.a stock in 2018-19 (Gault and Craig, 2019). The present exchange will therefore be the first based on the 8.c, 9.a stock of megrim. The sagitta otoliths are the common calcified structures used for the age estimation in megrim, and are the ones analyzed in this exchange.

The **objective**, as in other exchanges of calcified structures, is to estimate the agreement, precision and relative bias in the age estimations in megrim otoliths from age readers of the different age reading laboratories, to check that these parameters are within acceptable level (ICES, 2019b).

3 Agenda and participant list

The agenda can be found in **Annex 1** and the list of participating age readers are in **Annex 2**.

4 Material

The megrim length range (20-47 cm) of the collection represents the whole range of specimens commercially captured by the Spanish fleet in the ICES Div. 8.c, 9.a.

First, an overview of the samples is presented in **Table 1**. A total of 120 whole otoliths and images were analyzed, 60 from each semester. The whole fish length range commercially captured was also represented in each semester.

Therefore the collection was based on:

- The whole otolith set that was circulated among the participating readers of the various laboratories involved.
- The image set of those otoliths was available on Smartdots.

Information on sex was available in all the specimens for the exchange, but not their fish lengths.

Both whole saggital otoliths were available in most samples of the exchange collection, although for a few specimens, broken otoliths or only one otolith were included. The representation of these types of otoliths in the collection is proportional to that usually is read by the age readers in the age estimation monitoring for the stock assessment in the area.

The otoliths from each specimen were immersed in water and the pictures were taken by IEO. Those digitized images were uploaded to Smartdots.

5 Methods

This report contains statistical analyses and comparisons of age readings in the form of tables and graphical plots. The first part of the results section includes the tables and plots from the Guus Eltink Excel sheet 'Age Reading Comparisons (Eltink, 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. When summarizing the output and reporting the results of the exchange events developed within the SmarDots framework, the modal age (the most common age decided by the age readers for every fish sample) is the most relevant measurement. 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) (see below). However, the standard approach of calculating the mode (each reader has the same weight=1) the mode is taken as the lowest age of the multiple modal ages. This way renders multiple cases (fish samples) with multiple modal ages (i.e. different ages got the same highest number of readers). Accordingly, this implies a wrong perception of the age by fish individual and introduction of bias in the calculation of the PA and AEM. As a solution, in this report a multistage approach to select the modal age is used. This multistage approach is based in the different weight given to the age readers according to their experience. Two different weight scores scales were assigned, a weight score decreasing linearly with the experience and another decreasing with a negative exponential shape. The modal age by fish individual is decided following the next approach:

1.-If there is a single mode estimated with the standard approach (equal weight for all readers) this value is used as the modal age, if not

2.-Adding up, for each age category, the score assigned with the linear weighting for all the readers that decided that age for that fish. Next, the modal age is selected as the age category that obtains the highest score sum. If, despite this approach, there were still multiple ages with the same score (and hence multiple modes), the next step is applied:

3.-Adding up, for each age category, the score assigned with the negative exponential weighting for all the readers that decided that age for that fish. Select as the modal age the age with the highest score sum.

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.

Pecentage Agreement (PA)

The percentage agreement per reader per modal age tells how large the part of readings that are equal to the modal age is. 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.

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

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 (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.

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:

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

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 (ICES, 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.

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 otolith (fish) and for each reader.

6 Overview of samples and readers

Table 1: Overview of samples used for the exchange event number 277. Strata S1 and S2 correspond to the first and second semester respectively.

Year	ICES area	Strata	Quarter	Number of samples	Modal age range	Length range
2019	27.8.c	Strata_S1	1	14	3-7	200-440 mm
2019	27.8.c	Strata_S1	2	41	3-9	235-465 mm
2019	27.8.c	Strata_S2	3	25	2-8	205-465 mm
2019	27.8.c	Strata_S2	4	35	2-10	215-475 mm
2019	27.9.a	Strata_S1	2	5	3-4	210-250 mm

6.1 Results

6.1.1 All readers

All samples included

Multimodal cases

In this exchange event, 120 otolith fish individuals were aged and the 14 % of them showed multiple modes when the traditional approach (all readers equally weighted) was used to define the mode (**Table 2**). The use of the multistage approach favored the percentage of multiple mode cases is reduced to 0 %. The complete list of cases with multiple modes is presented in **Table A3.3** in the **Annex 3** section, where the ageing from each of the readers participating in the exchange event is presented.

Table 2: Total number of samples (NSample) and percentage of cases (fish samples) with multiple modes depending on the approach to weight the experience of the reader which will be considered when defining the fish age mode. PercMM_traditional shows the percentage of the total samples for which multiple modes are obtained when all the readers are equally weighted. PercMM_linear_weight shows the percentage of the total samples for which multiple modes are obtained when the weight assigned to the different readers decreases linearly with the experience, while in the PercMM_negexp the weight applied decreases with a negative exponential shape with the experience. The PercMM_multistage shows the percentage of multiple mode cases when a combination of the different methodologies is used, as explained in the material and methods section

NSample	PercMM_traditional	PercMM_linear_weight	PercMM_negexp_weight	PercMM_multistage
120	14 %	0 %	0 %	0 %

Summary statistics

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 68 % (between 55-86%), the weighted average CV is 14 % (between 7-15%) and APE is 9 % (between 4-13%) (**Table 3**). Good general results in relative accuracy for all readers have been obtained (-0.07), with values between -0.5 and +0.3 (**Table 7**).

Table 3: 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
120	14 %	68 %	9 %

The statistics by **age group** show that the overall relative bias of all readers is low, with values below $\pm$ 0.1 (between -0.08 and +0.06) up to age 6 (which accounts for approx. 93 samples, i.e. 77% of the otoliths read). The overall bias increases from age 7 onwards (which accounts for only 27 samples, i.e. approx. 23% of the total) with values between -0.2 and -0.5 (**Figure 1**). Considering that the samples analyzed are representative of commercial landings, the overall

impact of this relative bias of these older ages is small. Regarding the precision of all readers, CV and APE remain at low and similar values (10-16% and 7-9%, respectively) at almost all ages (3-9). PA remains at values between 69-78% until age 5 and decreases progressively with age thereafter (**Table 4, Table 5, Table 6**).

Comparing results between **age readers**, two of them (R01 and R02) show high percentage of agreement, precision and relative accuracy, with values of 82-86%, 7-8% and 0.08-0.1 in PA, CV and relative bias, respectively (Table **4, Table 5, Table 6, Table 7**). On the other hand, three age readers (R04, R08 and R06) stand out for a higher relative bias than the rest and a lower agreement. Of these, R04 and R08 had a negative relative bias (-0.5, -0.3 respectively), more evident from age 6 onwards (**Table 7**, **Figure A3.1**). Both readers counted fewer annuli than those considered truly annual, and had 61% and 55% agreement respectively. In contrast, R06 had a positive bias (0.3), also more evident from age 6 onwards (**Table 7, Figure A3.1**), counting more annuli than those considered true annual, and a percentage of agreement of 63%. In summary, R04 and R08 tended to estimate younger ages than the rest of readers, and R06, older (**Table A3.5)**. Examples of those age estimates are shown in **Figures A3.11, Figure A3.12, Figure A3.13**. The remaining readers, R03, R05 and R07, had intermediate statistics to the two aforementioned groups, with PA of 62-69%, and good relative accuracy, (-0.1)-(-0.2). Similar average distance from the centre to each winter annulus for all readers was found (**Figure 2**) showing a close location of most of the annuli by most readers except for R06 and R08 who show lower values from age 4 onwards and which is related to the negative bias they have at those ages. It should be noted that the values obtained by R05 are not correctly represented in this figure, as they are actually similar to the rest of the readers, and not extremely low, as **Figure 2** erroneously shows. Some mistake in the Smartdots algorithms prevents an adequate representation of the mean values of this reader R05. This anomaly has been reported several times to the Smartdots team, but no solution has been obtained before the writing of this report. Hopefully, this bug will be fixed to prevent the inconvenience in future exchanges.

Coefficient of Variation (CV)

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

Modal age	R01 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	16 %	0 %	47 %	34 %	20 %	38 %	25 %	21 %
3	7 %	7 %	19 %	17 %	14 %	17 %	22 %	14 %
4	9 %	12 %	11 %	10 %	16 %	11 %	13 %	9 %
5	6 %	9 %	12 %	11 %	16 %	18 %	9 %	19 %
6	8 %	11 %	11 %	18 %	13 %	13 %	13 %	11 %
7	5 %	7 %	11 %	12 %	12 %	11 %	9 %	9 %
8	5 %	8 %	5 %	11 %	11 %	8 %	11 %	9 %
9	0 %	6 %	7 %	15 %	0 %	6 %	6 %	8 %
10	0 %	-	0 %	-	-	0 %	-	9 %
Weighted Mean	**7 %**	**8 %**	**15 %**	**15 %**	**14 %**	**15 %**	**14 %**	**13 %**

Modal age	all
2	**29 %**
3	**16 %**
4	**12 %**
5	**14 %**
6	**13 %**
7	**11 %**

8	**10 %**
9	**11 %**
10	**18 %**
Weighted Mean	**14 %**

Percentage of Agreement (PA)

The percentage agreement per reader per modal age tells how large part of the readings that are equal to the modal age. The weighted mean including at the bottom of the table is weighted according to number of age readings.

Table 5: 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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	89 %	100 %	33 %	56 %	78 %	56 %	78 %	67 %
3	95 %	95 %	71 %	71 %	83 %	67 %	57 %	81 %
4	86 %	76 %	81 %	84 %	61 %	71 %	71 %	86 %
5	90 %	90 %	81 %	81 %	57 %	81 %	76 %	52 %
6	68 %	74 %	65 %	44 %	63 %	50 %	74 %	50 %
7	88 %	76 %	65 %	41 %	59 %	53 %	59 %	18 %
8	83 %	67 %	83 %	17 %	33 %	67 %	67 %	17 %
9	100 %	33 %	67 %	33 %	0 %	67 %	33 %	0 %
10	100 %	-	0 %	0 %	0 %	0 %	0 %	0 %
Weighted Mean	**86 %**	**82 %**	**69 %**	**61 %**	**62 %**	**63 %**	**67 %**	**55 %**

Modal age	total
2	**69 %**
3	**78 %**
4	**77 %**
5	**76 %**
6	**61 %**
7	**57 %**
8	**54 %**
9	**42 %**
10	**18 %**
Weighted Mean	**68 %**

Average Percentage Error (APE)

Table 6: 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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	9 %	0 %	40 %	32 %	16 %	29 %	19 %	**19 %**
3	3 %	3 %	12 %	15 %	7 %	13 %	19 %	**8 %**
4	6 %	8 %	5 %	7 %	11 %	10 %	8 %	**4 %**
5	4 %	5 %	5 %	8 %	11 %	10 %	8 %	**13 %**
6	7 %	6 %	8 %	15 %	8 %	10 %	7 %	**10 %**
7	2 %	3 %	6 %	10 %	10 %	9 %	6 %	**5 %**
8	4 %	4 %	4 %	8 %	8 %	4 %	9 %	**5 %**
9	0 %	5 %	5 %	12 %	0 %	5 %	5 %	**6 %**

10	0 %	-	0 %	0 %	0 %	0 %	0 %	**7 %**
Weighted Mean	**4 %**	**5 %**	**9 %**	**13 %**	**9 %**	**11 %**	**10 %**	**9 %**

Modal age	**all**
2	**19 %**
3	**9 %**
4	**7 %**
5	**7 %**
6	**8 %**
7	**8 %**
8	**9 %**
9	**9 %**
10	**14 %**
Weighted Mean	**9 %**

Relative bias

The relative bias is the difference between the mean age (per modal age per reader) and modal age. As for the previous tables, a combined bias for all readers and weighted means are calculated.

Table 7: 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 ES**	**R02 ES**	**R03 ES**	**R04 FR**	**R05 ES**	**R06 FR**	**R07 FR**	**R08 ES**
2	0.1	0.00	-0.4	-0.4	0.2	-0.2	-0.2	0.3
3	0.0	-0.05	-0.1	-0.3	0.1	0.2	-0.3	0.1
4	0.1	0.14	0.0	-0.2	-0.1	0.3	0.1	0.0
5	0.1	0.14	0.0	-0.2	-0.2	0.2	-0.2	-0.2
6	0.3	0.11	0.2	-0.6	-0.1	0.7	0.0	-0.4
7	0.0	0.00	-0.1	-0.6	-0.4	0.5	-0.1	-0.9
8	-0.2	0.00	-0.2	-1.2	-0.8	0.0	-0.5	-1.0
9	0.0	0.67	-0.3	-1.3	-1.0	0.3	0.7	-1.3
10	0.0	-	-2.0	-4.0	-3.0	-3.0	-4.0	-2.5
Weighted Mean	**0.1**	**0.08**	**-0.1**	**-0.5**	**-0.2**	**0.3**	**-0.1**	**-0.3**

Modal age	**all**
2	**-0.08**
3	**-0.05**
4	**0.06**
5	**-0.05**
6	**0.04**
7	**-0.20**
8	**-0.48**
9	**-0.29**
10	**-**
Weighted Mean	**-0.07**

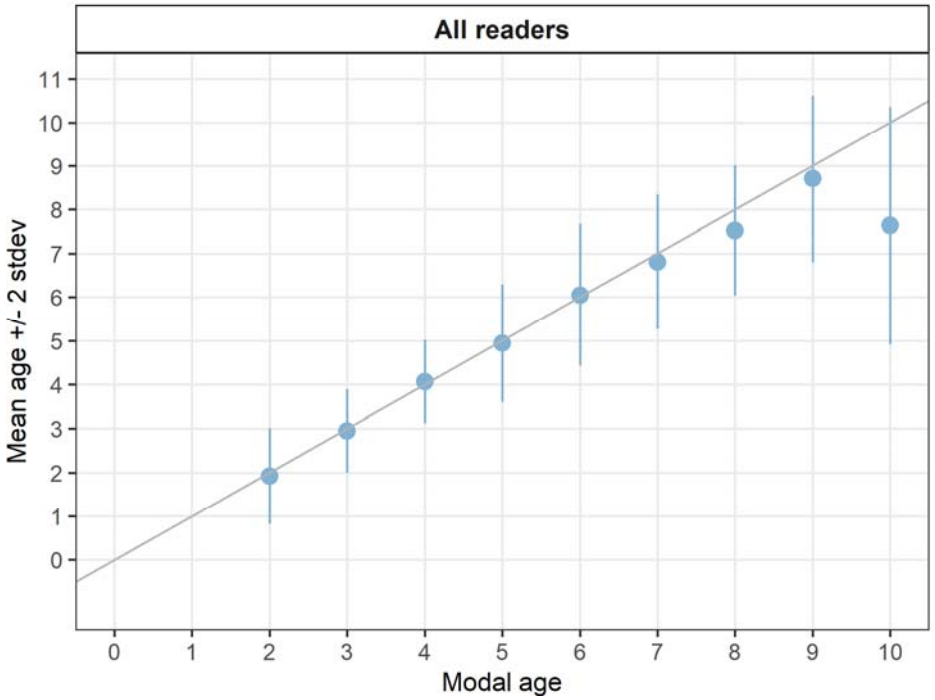

Figure 1: Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between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

Inter-reader bias test

Table 8: 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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
R01 ES	-	-	**	**	**	*	*	**
R02 ES	-	-	-	**	**	**	**	**
R03 ES	**	-	-	**	-	**	-	**
R04 FR	**	**	**	-	**	**	**	*
R05 ES	**	**	-	**	-	**	-	-
R06 FR	*	**	**	**	**	-	**	**
R07 FR	*	**	-	**	-	**	-	-
R08 ES	**	**	**	*	-	**	-	-
Modal age	*	-	-	**	*	**	-	**

Growth analysis

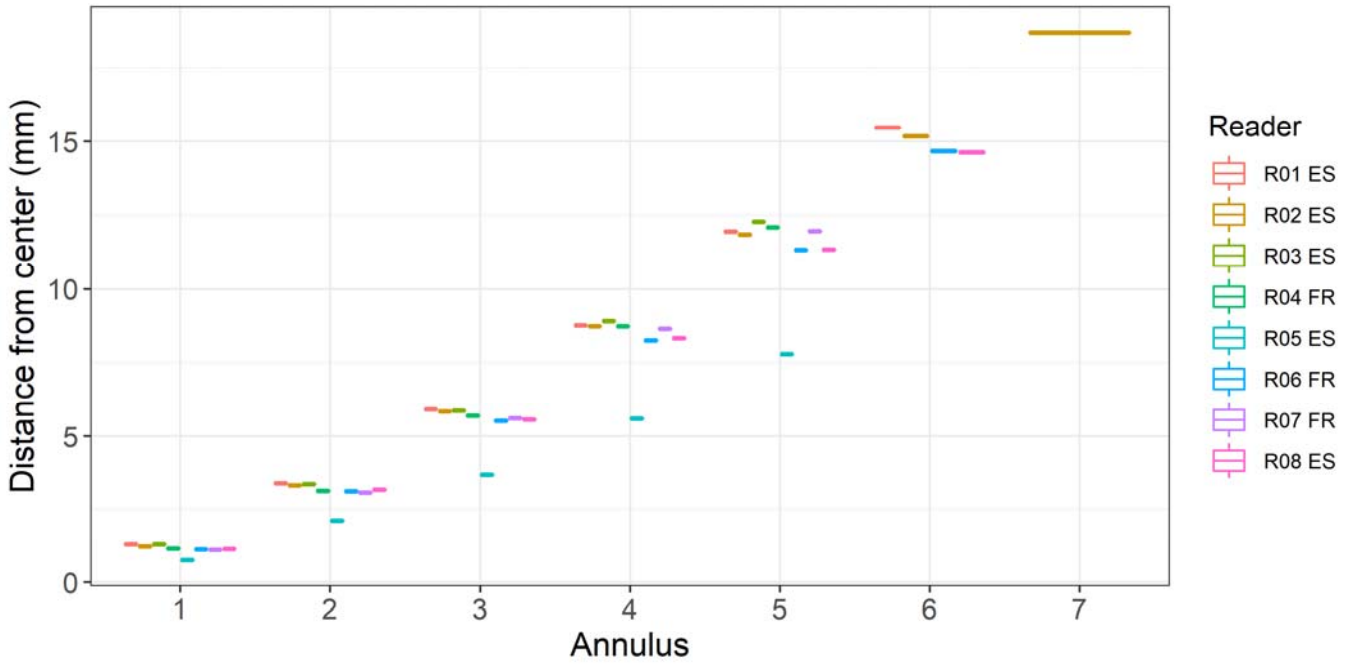

Figure 2: Plot of average distance from the centre to the winter rings for all readers. The values obtained by R05 are not correctly represented in this figure, as they are actually similar to the rest of the readers, and not extremely low, as erroneously is shown.

Samples split by strata (semester)

The analysis by time stratum (**semester**) shows better overall results in PA, CV, APE and relative bias in the first semester (74, 12, 7, -0.02) compared to those in the second one (62, 16, 11, -0.12).

Regarding the analysis of the results by age reader, there are no marked differences between the results per semester for each reader, except for R04 that shows markedly worse values than the rest in the second semester (39, 18, 15, -0.8), mainly in older ages (≥ 6 years). The interpretation of the edge type and the older annuli in otoliths from the second semester are the main challenges to be solved for R04.

Comparison results by reader on strata: Strata_S1

Multimodal cases

Table 9: Strata Strata_S1 .Total number of samples (NSample) and percentage of cases (fish samples) with multiple modes depending on the approach to weight the experience of the reader which will be considered when defining the fish age mode. PercMM_traditional shows the percentage of the total samples for which multiple modes are obtained when all the readers are equally weighted. PercMM_linear_weight shows the percentage of the total samples for which multiple modes are obtained when the weight assigned to the different readers decreases linearly with the experience, while in the PercMM_negexp the weight applied decreases with a negative exponential shape with the experience. The PercMM_multistage shows the percentage of multiple mode cases when a combination of the different methodologies is used, as explained in the material and methods section

NSample	PercMM_traditional	PercMM_linear_weight	PercMM_negexp_weight	PercMM_multistage
60	8 %	0 %	0 %	0 %

Summary statistics

Table 10: Strata Strata_S1 .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
60	12 %	74 %	7 %

Coefficient of Variation (CV)

Table 11: Strata Strata_S1 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	-	-	-	-	-	-	-	-
3	0 %	12 %	12 %	12 %	14 %	0 %	21 %	18 %
4	10 %	12 %	11 %	0 %	14 %	7 %	14 %	11 %
5	7 %	10 %	13 %	5 %	15 %	20 %	8 %	20 %
6	7 %	13 %	7 %	7 %	12 %	14 %	7 %	11 %
7	0 %	6 %	8 %	9 %	13 %	11 %	9 %	12 %
8	0 %	8 %	9 %	9 %	0 %	8 %	0 %	9 %

9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Weighted Mean	**5 %**	**10 %**	**11 %**	**6 %**	**13 %**	**12 %**	**11 %**	**15 %**

Modal age	**all**
2	**-**
3	**15 %**
4	**11 %**
5	**13 %**
6	**11 %**
7	**10 %**
8	**7 %**
9	**12 %**
10	**-**
Weighted Mean	**12 %**

Percentage of Agreement (PA)

Table 12: Strata Strata_S1 .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 ES**	**R02 ES**	**R03 ES**	**R04 FR**	**R05 ES**	**R06 FR**	**R07 FR**	**R08 ES**
2	-	-	-	-	-	-	-	**-**
3	100 %	88 %	88 %	88 %	83 %	100 %	25 %	75 %
4	82 %	64 %	82 %	100 %	67 %	91 %	64 %	82 %
5	88 %	88 %	76 %	94 %	65 %	76 %	82 %	59 %
6	82 %	70 %	82 %	78 %	73 %	55 %	82 %	55 %
7	100 %	80 %	60 %	60 %	50 %	60 %	60 %	30 %
8	100 %	50 %	50 %	50 %	100 %	50 %	100 %	50 %
9	100 %	0 %	0 %	100 %	0 %	0 %	100 %	0 %
10	-	-	-	-	-	-	-	-
Weighted Mean	**90 %**	**76 %**	**75 %**	**84 %**	**66 %**	**73 %**	**68 %**	**58 %**

Modal age	**total**
2	**-**
3	**81 %**
4	**79 %**
5	**79 %**
6	**72 %**
7	**62 %**
8	**69 %**
9	**38 %**
10	**-**
Weighted Mean	**74 %**

Average Percentage Error (APE)

Table 13: Strata Strata_S1 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	-	-	-	-	-	-	-	-
3	0 %	8 %	8 %	8 %	10 %	0 %	17 %	8 %
4	7 %	11 %	5 %	0 %	12 %	4 %	11 %	5 %
5	4 %	6 %	7 %	2 %	10 %	11 %	6 %	11 %
6	5 %	8 %	3 %	6 %	8 %	10 %	5 %	9 %
7	0 %	4 %	7 %	7 %	10 %	8 %	7 %	9 %
8	0 %	6 %	7 %	7 %	0 %	6 %	0 %	7 %
9	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
10	-	-	-	-	-	-	-	-
Weighted Mean	**3 %**	**7 %**	**6 %**	**4 %**	**9 %**	**7 %**	**8 %**	**9 %**

Modal age	all
2	**-**
3	**10 %**
4	**7 %**
5	**6 %**
6	**7 %**
7	**8 %**
8	**4 %**
9	**9 %**
10	**-**
Weighted Mean	**7 %**

Relative bias

Table 14: Strata Strata_S1. 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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	-	-	-	-	-	-	-	-
3	0.00	-0.12	-0.12	-0.12	-0.17	0.00	-0.75	0.00
4	0.18	0.36	0.00	0.00	-0.33	0.09	0.18	0.00
5	0.12	0.18	-0.06	-0.06	-0.18	0.29	-0.18	-0.06
6	0.18	0.20	0.00	0.22	0.18	0.64	0.18	-0.27
7	0.00	0.20	-0.40	-0.20	-0.40	0.30	-0.20	-0.90
8	0.00	0.50	-0.50	-0.50	0.00	0.50	0.00	-0.50
9	0.00	1.00	-1.00	0.00	-1.00	1.00	0.00	-2.00
10	-	-	-	-	-	-	-	-
Weighted Mean	**0.10**	**0.20**	**-0.13**	**-0.05**	**-0.18**	**0.30**	**-0.12**	**-0.27**

Modal age	all
2	**-**
3	**-0.16**
4	**0.06**
5	**0.01**
6	**0.17**
7	**-0.20**
8	**-0.06**
9	**-0.25**

10	-
Weighted Mean	**-0.02**

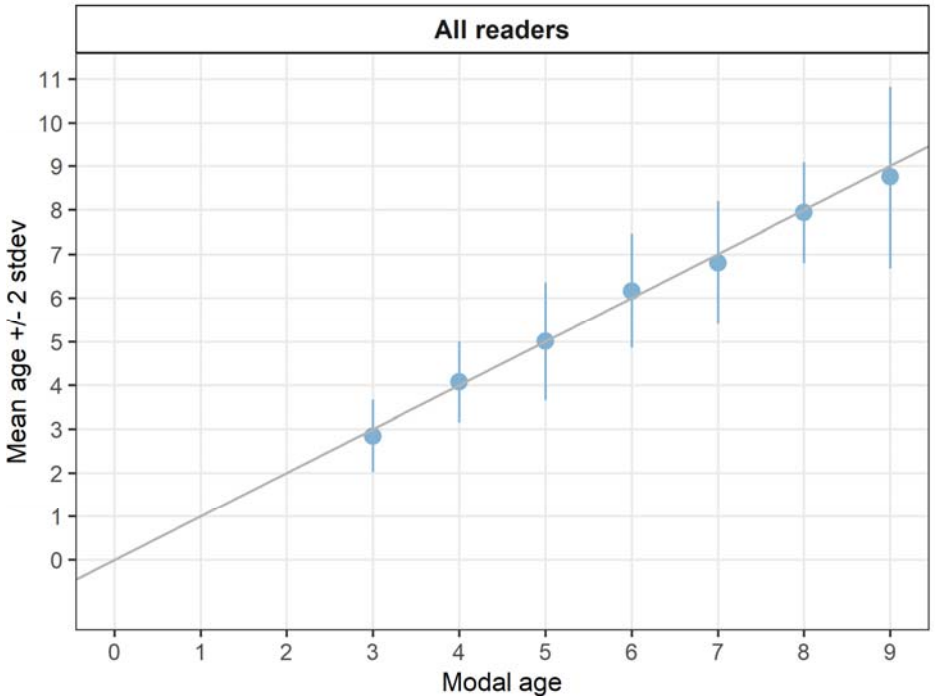

Figure 3: Strata Strata_S1 .Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age.

Inter-reader bias test

Table 15: Strata Strata_S1 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
R01 ES	-	-	**	**	**	*	*	**
R02 ES	-	-	-	**	**	**	**	**
R03 ES	**	-	-	**	-	**	-	**
R04 FR	**	**	**	-	**	**	**	*
R05 ES	**	**	-	**	-	**	-	-
R06 FR	*	**	**	**	**	-	**	**
R07 FR	*	**	-	**	-	**	-	-
R08 ES	**	**	**	*	-	**	-	-
Modal age	*	-	-	**	*	**	-	**

Growth Analysis

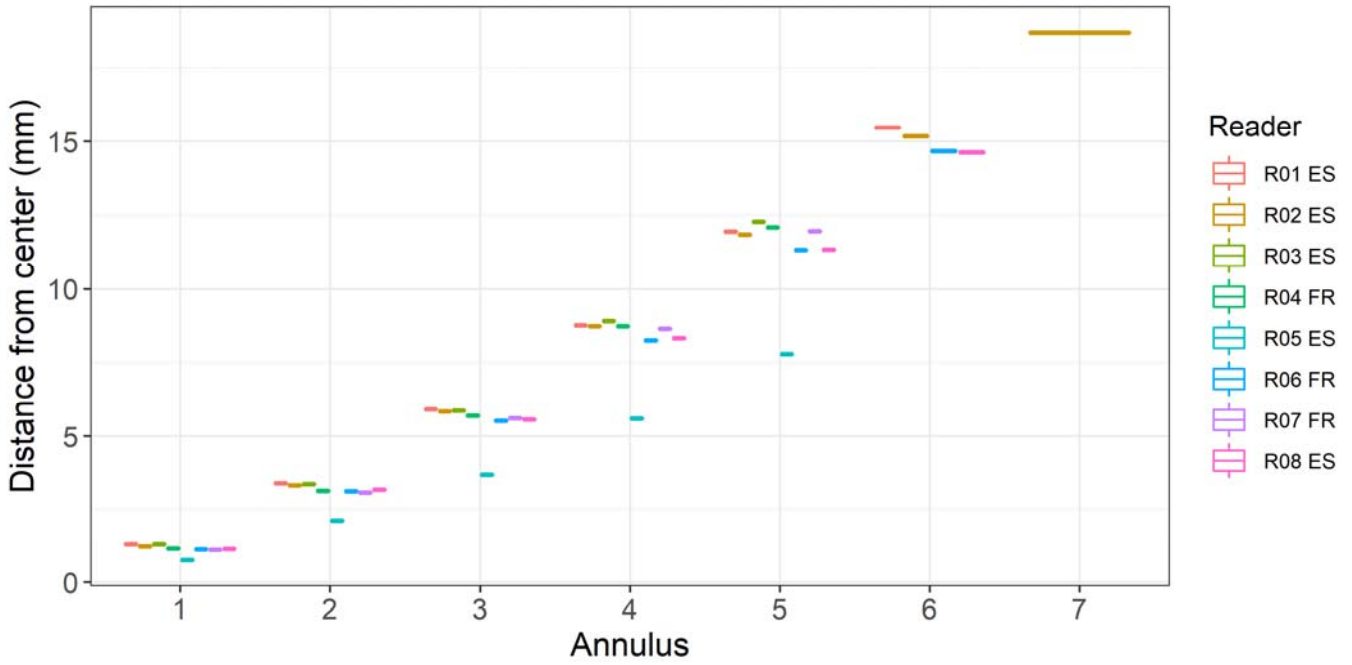

Figure 4: Strata Strata_S1 .Plot of average distance from the centre to the winter rings for all readers. The values obtained by R05 are not correctly represented in this figure, as they are actually similar to the rest of the readers, and not extremely low, as erroneously is shown.

Comparison results by reader on strata: Strata_S2

Multimodal cases

Table 16: Strata Strata_S2 .Total number of samples (NSample) and percentage of cases (fish samples) with multiple modes depending on the approach to weight the experience of the reader which will be considered when defining the fish age mode. PercMM_traditional shows the percentage of the total samples for which multiple modes are obtained when all the readers are equally weighted. PercMM_linear_weight shows the percentage of the total samples for which multiple modes are obtained when the weight assigned to the different readers decreases linearly with the experience, while in the PercMM_negexp the weight applied decreases with a negative exponential shape with the experience. The PercMM_multistage shows the percentage of multiple mode cases when a combination of the different methodologies is used, as explained in the material and methods section

NSample	PercMM_traditional	PercMM_linear_weight	PercMM_negexp_weight	PercMM_multistage
60	20 %	0 %	0 %	0 %

Summary statistics

Table 17: Strata Strata_S2 .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
60	16 %	62 %	11 %

Coefficient of Variation (CV)

Table 18: Strata Strata_S2 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	16 %	0 %	47 %	34 %	20 %	38 %	25 %	21 %
3	9 %	0 %	22 %	19 %	12 %	19 %	17 %	12 %
4	8 %	8 %	12 %	13 %	16 %	12 %	12 %	8 %
5	0 %	0 %	0 %	20 %	20 %	0 %	13 %	12 %
6	8 %	8 %	14 %	15 %	10 %	12 %	19 %	10 %
7	9 %	7 %	11 %	12 %	12 %	10 %	10 %	0 %
8	6 %	6 %	0 %	9 %	7 %	6 %	13 %	7 %
9	0 %	7 %	0 %	0 %	0 %	0 %	0 %	0 %
10	0 %	-	0 %	-	-	0 %	-	9 %
Weighted Mean	**8 %**	**4 %**	**17 %**	**18 %**	**13 %**	**15 %**	**16 %**	**10 %**

Modal age	all
2	**29 %**
3	**16 %**
4	**12 %**
5	**13 %**
6	**16 %**
7	**13 %**
8	**10 %**
9	**11 %**
10	**18 %**
Weighted Mean	**16 %**

Percentage of Agreement (PA)

Table 19: Strata Strata_S2 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	89 %	100 %	33 %	56 %	78 %	56 %	78 %	67 %
3	92 %	100 %	62 %	62 %	83 %	46 %	77 %	85 %
4	90 %	90 %	80 %	70 %	56 %	50 %	80 %	90 %
5	100 %	100 %	100 %	25 %	25 %	100 %	50 %	25 %
6	50 %	78 %	44 %	11 %	50 %	44 %	62 %	44 %
7	67 %	71 %	71 %	14 %	71 %	43 %	57 %	0 %
8	75 %	75 %	100 %	0 %	0 %	75 %	50 %	0 %
9	100 %	50 %	100 %	0 %	0 %	100 %	0 %	0 %
10	100 %	-	0 %	0 %	0 %	0 %	0 %	0 %
Weighted Mean	**83 %**	**88 %**	**63 %**	**39 %**	**57 %**	**53 %**	**66 %**	**52 %**

Modal age	total
2	**69 %**
3	**76 %**
4	**76 %**

5	**66 %**
6	**48 %**
7	**49 %**
8	**47 %**
9	**44 %**
10	**18 %**
Weighted Mean	**62 %**

Average Percentage Error (APE)

Table 20: Strata Strata_S2 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	9 %	0 %	40 %	32 %	16 %	29 %	19 %	19 %
3	5 %	0 %	15 %	18 %	9 %	17 %	10 %	8 %
4	4 %	5 %	5 %	11 %	12 %	11 %	5 %	4 %
5	0 %	0 %	0 %	12 %	16 %	0 %	11 %	9 %
6	8 %	4 %	11 %	13 %	9 %	10 %	12 %	9 %
7	5 %	6 %	8 %	8 %	9 %	8 %	7 %	0 %
8	5 %	5 %	0 %	8 %	6 %	5 %	10 %	6 %
9	0 %	5 %	0 %	0 %	0 %	0 %	0 %	0 %
10	0 %	-	0 %	0 %	0 %	0 %	0 %	7 %
Weighted Mean	**5 %**	**3 %**	**13 %**	**15 %**	**10 %**	**13 %**	**10 %**	**8 %**

Modal age	all
2	**19 %**
3	**8 %**
4	**7 %**
5	**10 %**
6	**12 %**
7	**10 %**
8	**9 %**
9	**9 %**
10	**14 %**
Weighted Mean	**11 %**

Relative bias

Table 21: Strata Strata_S2 . 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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
2	0.1	0.00	-0.4	-0.4	0.2	-0.2	-0.2	0.3
3	-0.1	0.00	-0.1	-0.4	0.2	0.4	-0.1	0.1
4	0.1	-0.10	0.0	-0.3	0.2	0.5	0.0	0.1
5	0.0	0.00	0.0	-1.0	-0.2	0.0	-0.5	-0.8
6	0.5	0.00	0.4	-1.3	-0.5	0.8	-0.1	-0.6
7	0.0	-0.29	0.4	-1.1	-0.4	0.7	0.1	-1.0
8	-0.2	-0.25	0.0	-1.5	-1.2	-0.2	-0.8	-1.2

9	0.0	0.50	0.0	-2.0	-1.0	0.0	1.0	-1.0
10	0.0	-	-2.0	-4.0	-3.0	-3.0	-4.0	-2.5
Weighted Mean	**0.1**	**-0.05**	**0.0**	**-0.8**	**-0.2**	**0.2**	**-0.2**	**-0.3**

Modal age	all
2	**-0.08**
3	**0.01**
4	**0.07**
5	**-0.31**
6	**-0.10**
7	**-0.20**
8	**-0.69**
9	**-0.31**
10	**-**
Weighted Mean	**-0.12**

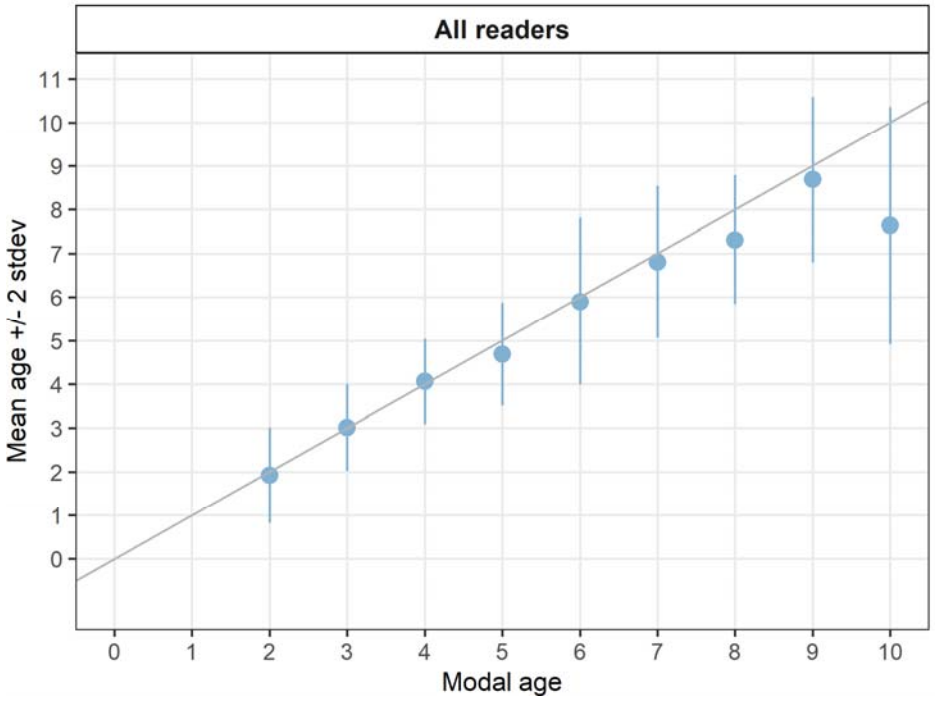

Figure 5: Strata Strata_S2 .Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age.

Inter-reader bias test

Table 22: Strata Strata_S2 .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 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
R01 ES	-	-	**	**	**	*	*	**
R02 ES	-	-	-	**	**	**	**	**

R03 ES	**	-	-	**	-	**	-	**
R04 FR	**	**	**	-	**	**	**	*
R05 ES	**	**	-	**	-	**	-	-
R06 FR	*	**	**	**	**	-	**	**
R07 FR	*	**	-	**	-	**	-	-
R08 ES	**	**	**	*	-	**	-	-
Modal age	*	-	-	**	*	**	-	**

Growth Analysis

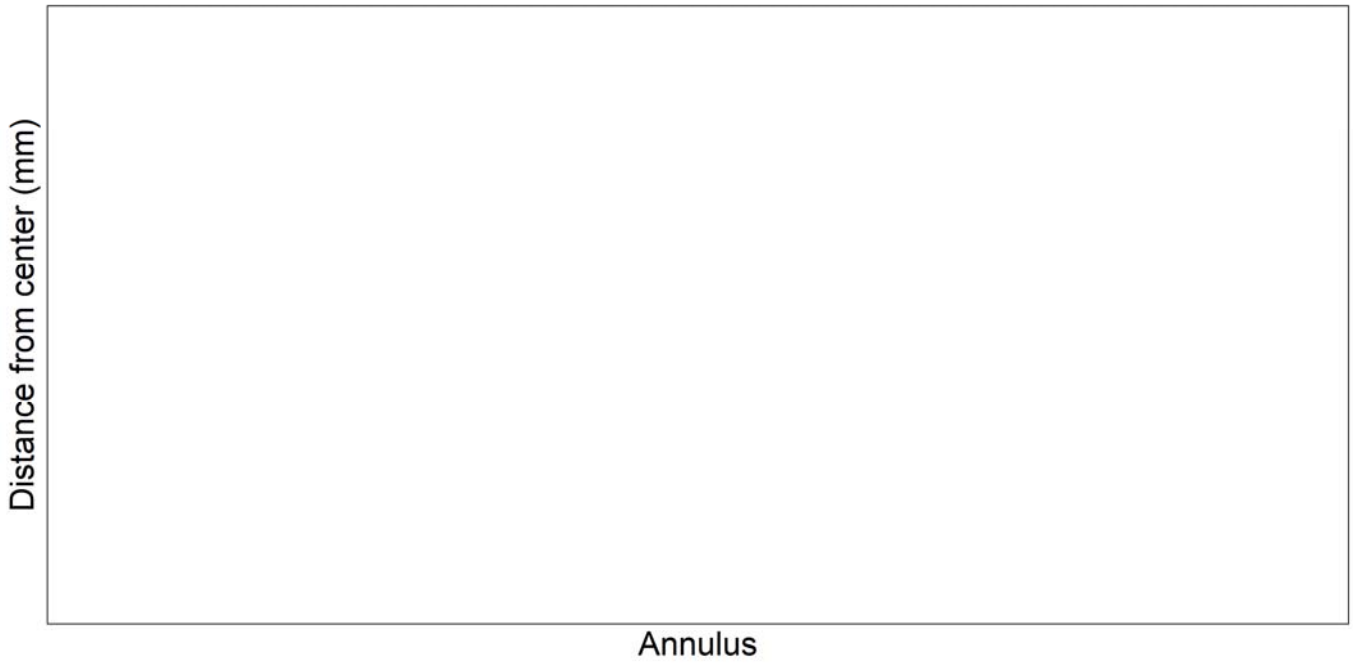

Figure 6: Strata Strata_S2 .Plot of average distance from the centre to the winter rings for all readers. The values obtained by R05 are not correctly represented in this figure, as they are actually similar to the rest of the readers, and not extremely low, as erroneously is shown.

Overall comparison of results by strata

Table 23: Number of age readings per strata and modal age for all advanced readers combined.

Modal age	Strata_S1	Strata_S2	total
2	0	72	**72**
3	62	103	**165**
4	84	79	**163**
5	135	32	**167**
6	85	69	**154**
7	80	55	**135**
8	16	32	**48**

9	8	16	**24**
10	0	11	**11**
Total	**470**	**469**	**939**

Coefficient of Variation (CV)

Table 24: CV per strata and modal age for all advanced readers combined.

Modal age	Strata_S1	Strata_S2	all
2	-	29 %	**29 %**
3	15 %	16 %	**16 %**
4	11 %	12 %	**12 %**
5	13 %	13 %	**14 %**
6	11 %	16 %	**13 %**
7	10 %	13 %	**11 %**
8	7 %	10 %	**10 %**
9	12 %	11 %	**11 %**
10	-	18 %	**18 %**
Weighted Mean	**12 %**	**16 %**	**14 %**

Percentage of Agreement (PA)

Table 25: Percentage Agreement per strata and modal age for all advanced readers combined.

Modal age	Strata_S1	Strata_S2	total
2	-	69 %	**69 %**
3	81 %	76 %	**78 %**
4	79 %	76 %	**77 %**
5	79 %	66 %	**76 %**
6	72 %	48 %	**61 %**
7	62 %	49 %	**57 %**
8	69 %	47 %	**54 %**
9	38 %	44 %	**42 %**
10	-	18 %	**18 %**
Weighted Mean	**74 %**	**62 %**	**68 %**

Average Percentage Error (APE)

Table 26: Average Percentage Error per strata and modal age for all advanced readers combined.

Modal age	Strata_S1	Strata_S2	all
2	-	19 %	**19 %**
3	10 %	8 %	**9 %**
4	7 %	7 %	**7 %**
5	6 %	10 %	**7 %**
6	7 %	12 %	**8 %**
7	8 %	10 %	**8 %**
8	4 %	9 %	**9 %**
9	9 %	9 %	**9 %**

10	-	14 %	**14 %**
Weighted Mean	**7 %**	**11 %**	**9 %**

Relative bias

Table 27: Relative Bias per strata and modal age for all advanced readers combined.

Modal age	Strata_S1	Strata_S2	all
2	-	-0.1	-
3	-0.16	0.0	**-0.08**
4	0.07	0.1	**0.07**
5	0.01	-0.3	**-0.15**
6	0.16	-0.1	**0.03**
7	-0.20	-0.2	**-0.20**
8	-0.06	-0.7	**-0.38**
9	-0.25	-0.3	**-0.28**
10	-	-2.4	-
Weighted Mean	**-0.02**	**-0.2**	**-0.09**

Growth analysis

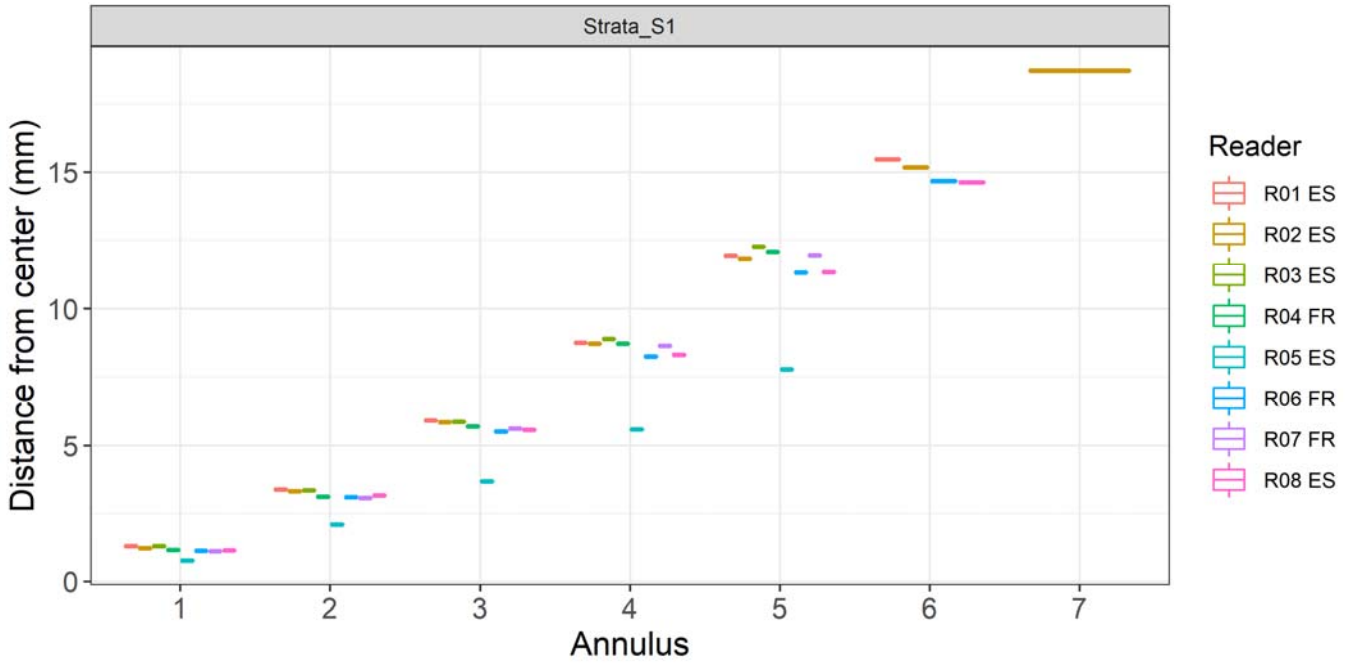

Figure 7: Plot of average distance from the centre to the winter rings for all readers by strata. The values obtained by R05 are not correctly represented in this figure, as they are actually similar to the rest of the readers, and not extremely low, as erroneously is shown.

6.1.2 Advanced readers

All samples included

The analysis of the statistics obtained by age shows that the overall relative bias from the stock assessment readers (R01, R03) is very low and lower than the aforementioned obtained with all readers, with values between 0 and -0.02 (**Figure 8**) at all ages except age 10. That age is only represented in the present exchange by 2 individuals and its proportion in the commercial landings is minimal. Considering that the plus group for stock assessment is age '7+', the impact of these differences between the two readers participating in the stock assessment process are minimal. Regarding the precision obtained by the stock assessment readers, CV and APE remain at low and similar values (5-14% and 3-8%) at almost all ages (3-9). PA remains at values above 79% until age 9 (**Table 30, Table 31, Table 32**).

Regarding the analysis by time stratum (semester), better results were observed in percentage of agreement, CV, APE and relative bias in the first semester (87, 7, 4, -0.13) compared to the second one (77, 14, 9, -0.1), as previously obtained for all readers.

Mean distances from the centre to each winter annulus were estimated to be nearly equal for both stock assessment readers (**Figure 9**).

The general Age Error Matrix (AEM) and the AEM for strata are shown in **Table 34, Table 35, Table 36**.

Multimodal cases

Table 28: Summary of statistics; Total number of samples (NSample), a percentage of cases (fish samples) with multiple modes depending on the approach to weight the experience of the reader which will be considered when defining the fish age mode. PercMM_traditional shows the percentage of the total samples for which multiple modes are obtained when all the readers are equally weighted. PercMM_linear_weight shows the percentage of the total samples for which multiple modes are obtained when the weight assigned to the different readers decreases linearly with the experience, while in the PercMM_negexp the weight applied decreases with a negative exponential shape with the experience. The PercMM_multistage shows the percentage of multiple mode cases when a combination of the different methodologies is used, as explained in the material and methods section

NSample	PercMM_traditional	PercMM_linear_weight	PercMM_negexp_weight	PercMM_multistage
120	36 %	0 %	0 %	0 %

Summary statistics

In this exchange event, 120 otolith fish individuals were aged. Of those, 36 %when the traditional approach (all readers equally weighted) is used to define the mode. The percentage of multiple mode cases is reduced to 0 %. 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 82 %, with the weighted average CV of 11 % and APE of 6 %.

Table 29: 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
120	11%	82 %	6 %

Coefficient of Variation (CV)

Table 30: 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 ES	R03 ES	all
2	0 %	52 %	**34 %**
3	0 %	20 %	**14 %**
4	0 %	11 %	**7 %**
5	0 %	9 %	**7 %**
6	0 %	13 %	**9 %**
7	0 %	11 %	**8 %**
8	0 %	6 %	**5 %**
9	0 %	7 %	**5 %**
10	0 %	0 %	**13 %**
Weighted Mean	**0 %**	**15 %**	**11 %**

Percentage of Agreement (PA)

Table 31: 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 ES	R03 ES	total
2	100 %	22 %	**61 %**
3	100 %	67 %	**83 %**
4	100 %	83 %	**92 %**
5	100 %	76 %	**88 %**
6	100 %	59 %	**79 %**
7	100 %	59 %	**79 %**
8	100 %	71 %	**85 %**
9	100 %	67 %	**83 %**
10	100 %	0 %	**50 %**
Weighted Mean	**100 %**	**64 %**	**82 %**

Average Percentage Error (APE)

Table 32: 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 ES	R03 ES	all
2	0 %	44 %	**25 %**
3	0 %	14 %	**8 %**
4	0 %	5 %	**3 %**
5	0 %	8 %	**4 %**
6	0 %	8 %	**4 %**
7	0 %	8 %	**4 %**
8	0 %	5 %	**3 %**
9	0 %	5 %	**3 %**
10	0 %	0 %	**11 %**
Weighted Mean	**0 %**	**11 %**	**6 %**

Relative Bias

Table 33: 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 ES	R03 ES	all
2	0	-0.3	**-0.2**
3	0	-0.1	**-0.1**
4	0	-0.1	**0.0**
5	0	-0.2	**-0.1**
6	0	0.0	**0.0**
7	0	-0.2	**-0.1**
8	0	-0.3	**-0.1**
9	0	-0.3	**-0.2**
10	0	-2.0	**-1.0**
Weighted Mean	**0**	**-0.2**	**-0.1**

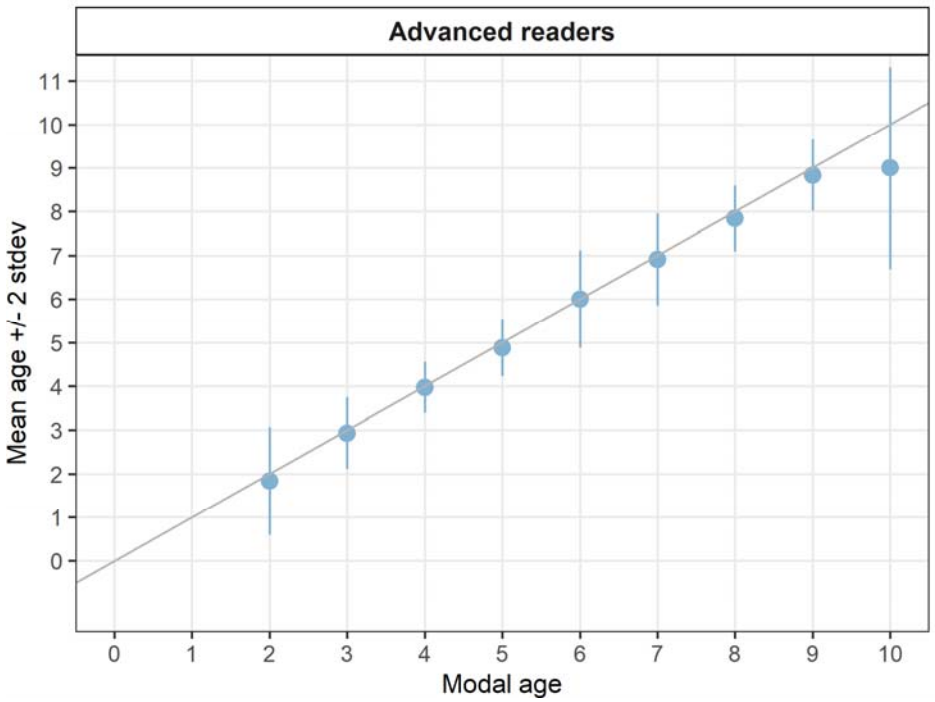

Figure 8: Age bias plot for advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age.

Growth analysis

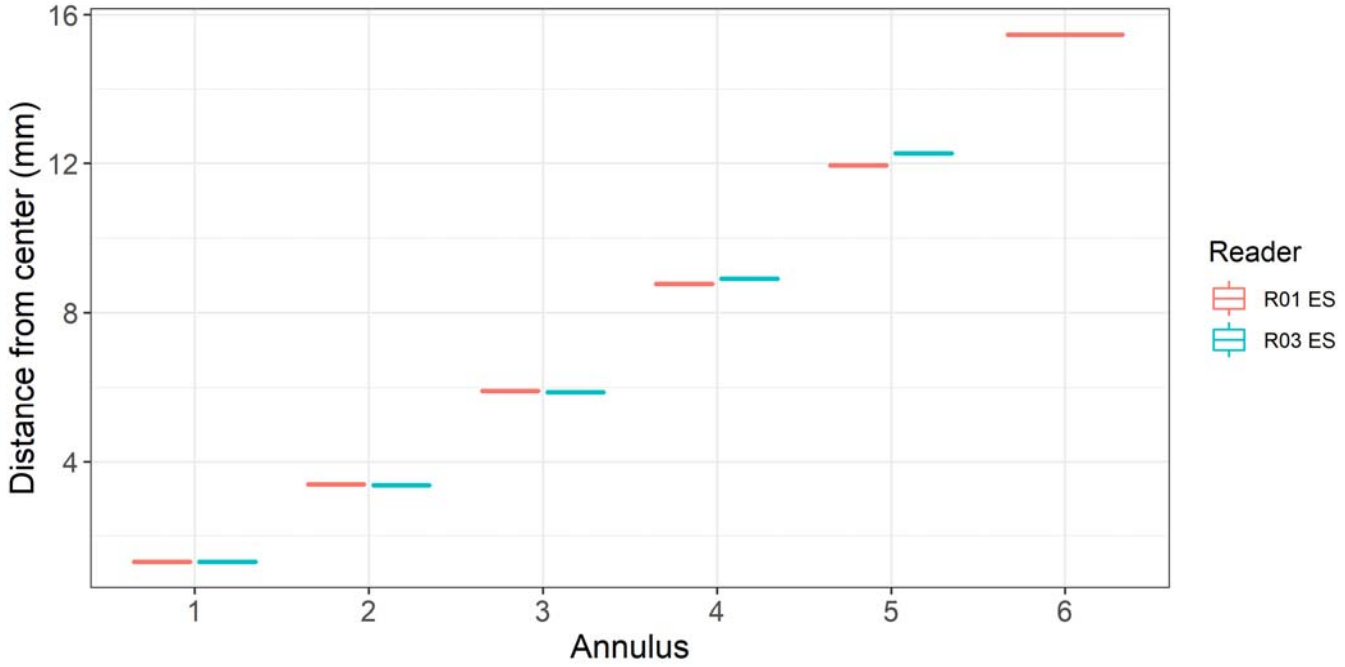

Figure 9: Plot of average distance from the centre to the winter rings for advanced readers.

General Age Error Matrix (AEM)

Table 34: General Age error matrix (AEM)

Modal age	2	3	4	5	6	7	8	9	10
Age 1	0.3	-	-	-	-	-	-	-	-
Age 2	0.6	0.1	-	-	-	-	-	-	-
Age 3	0.1	0.8	0.1	-	-	-	-	-	-
Age 4	-	0.0	0.9	0.1	-	-	-	-	-
Age 5	-	-	0.0	0.9	0.1	-	-	-	-
Age 6	-	-	-	-	0.8	0.2	-	-	-
Age 7	-	-	-	-	0.1	0.8	0.2	-	-
Age 8	-	-	-	-	0.0	0.0	0.8	0.2	0.5
Age 9	-	-	-	-	-	0.0	-	0.8	-
Age 10	-	-	-	-	-	-	-	-	0.5

AEM by strata

Table 35: Age error matrix (AEM) for Strata_Strata_S1.

strata	Modal age	2	3	4	5	6	7	8	9	10
Strata_S1	Age 2	-	0.1	-	-	-	-	-	-	-
Strata_S1	Age 3	-	0.9	0.1	-	-	-	-	-	-
Strata_S1	Age 4	-	-	0.9	0.1	-	-	-	-	-
Strata_S1	Age 5	-	-	-	0.9	0.1	-	-	-	-
Strata_S1	Age 6	-	-	-	-	0.9	0.2	-	-	-

Strata_S1	Age 7	-	-	-	-	-	0.8	0.2	-	-
Strata_S1	Age 8	-	-	-	-	-	-	0.8	0.5	-
Strata_S1	Age 9	-	-	-	-	-	-	-	0.5	-

Table 36: Age error matrix (AEM) for Strata_Strata_S2.

strata	Modal age	2	3	4	5	6	7	8	9	10
Strata_S2	Age 1	0.3	-	-	-	-	-	-	-	-
Strata_S2	Age 2	0.6	0.2	-	-	-	-	-	-	-
Strata_S2	Age 3	0.1	0.8	0.1	-	-	-	-	-	-
Strata_S2	Age 4	-	0.1	0.9	0.1	-	-	-	-	-
Strata_S2	Age 5	-	-	0.1	0.9	0.1	-	-	-	-
Strata_S2	Age 6	-	-	-	-	0.6	0.1	-	-	-
Strata_S2	Age 7	-	-	-	-	0.2	0.8	0.1	-	-
Strata_S2	Age 8	-	-	-	-	0.1	0.1	0.9	-	0.5
Strata_S2	Age 9	-	-	-	-	-	0.1	-	1	-
Strata_S2	Age 10	-	-	-	-	-	-	-	-	0.5

6.2 Discussion

The material analyzed here, including samples from both semesters, in which a different type of border is generally shown, and including samples of the fish size range used in the stock assessments, are important considerations in the otolith exchanges and recommended in the WGBIOP Guidelines for Otolith Exchanges and Workshops (ICES, 2019b).

The study of various types of otoliths (broken, damaged, only one available) in this exchange in similar proportions to those landed commercially, also allows us to obtain results more representative of what readers usually analyze when interpreting age for stock assessment.

Since the present exchange is the first one performed from the 8c, 9a stock of megrim, there are no precedent results from this stock to compare these results (**Figure 10**). However, when the present overall results are compared with those of other stocks (**Figure 11**), similar-better results in present exchange than in previous megrim age estimation exchanges and workshops (almost all based on stock 7.b-k, 8.abd) are observed (**Figure 10, Figure 11**). Thus, the weighted average percentage agreement (PA) is similar to those from events where better results were previously obtained (WK in 1997, EX in 2010). The very good low values in the relative bias, CV and APE obtained in the present exchange indicate comparatively good relative accuracy and precision.

1990-91	7.b-k, 8.abd
1997	7.b-k, 8.abd
2004	7.b-k, 8.abd
2010	7.b-k, 8.abd
2018-19	4.a, 6.a
2020-21	8.c, 9.a

Figure 10. International megrim age estimation exchanges and workshops held, and map with the megrim stock studied in each event.

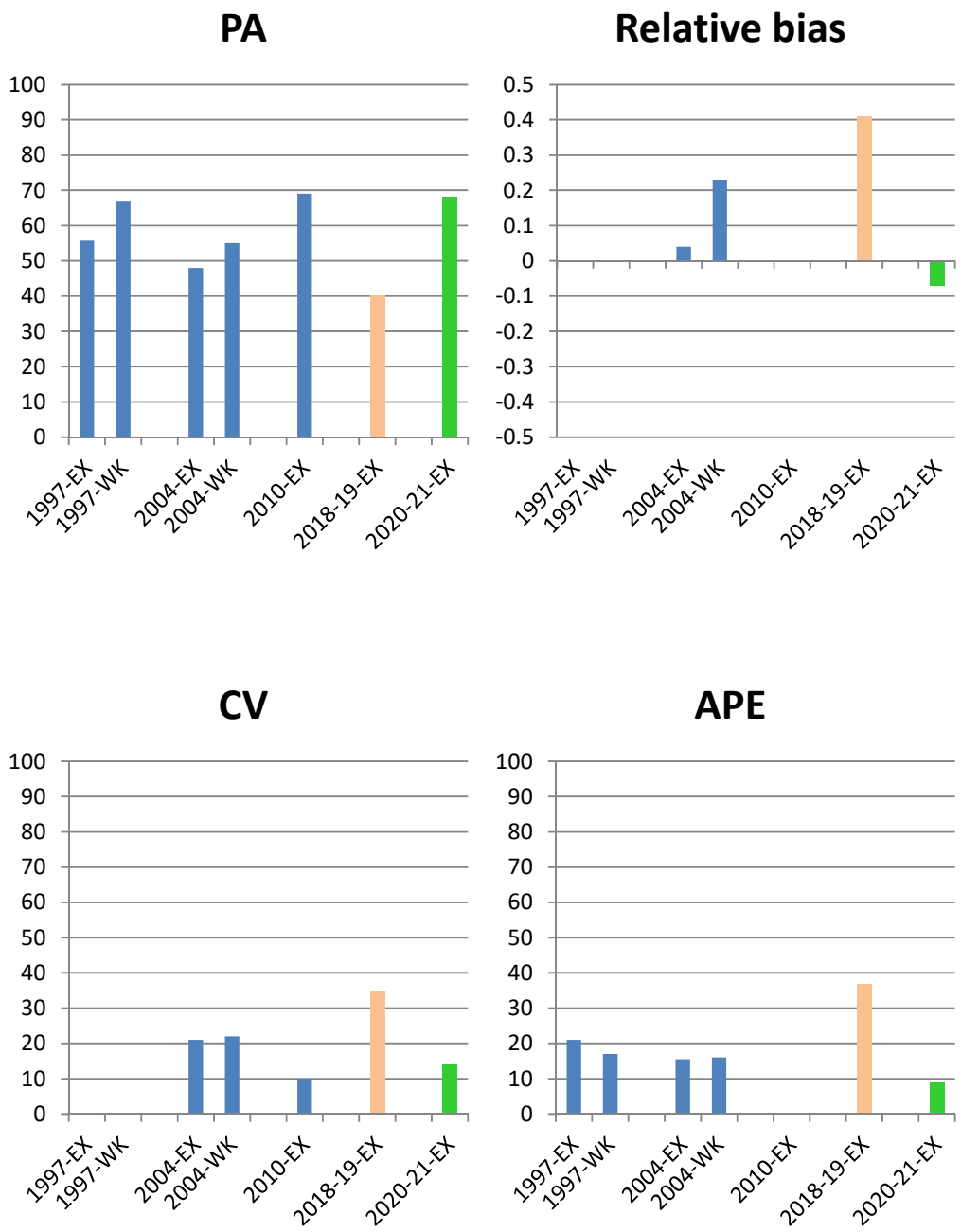

Figure 11. Results in the present exchange (2020-21 EX) and in previous megrim age estimation exchanges (EX) and workshops (WK). The color of each event indicates the studied stock described in Figure 10.

6.3 Conclusions

This is the **first otolith** exchange performed for the Iberian Atlantic stock (Div. 8.c, 9.a) of megrim and the whole range of specimens commercially captured is analyzed.

The "multistage modal age approach" was used for the first time in megrim otolith exchanges, reducing the multiple modes to 0%.

For **all readers**, the overall agreement (PA) was 68%, CV was 14%, APE was 9% and relative bias (RB) was -0.07.

For the **readers involved in the assessment** of this stock, better results than for all readers were obtained: overall PA of 82%, CV of 11%, APE of 6% and RB of -0.10.

Strata **semester** showed better results for **all readers** in the first semester compared to the second one.

PA decreased with increasing **age** (from age 5) but the overall CV was stable with age (from age 3). RB increased from age 7 (ages with low samples and low landings). Three readers (basic-intermediate experience) showed higher RB and lower PA, mainly in ages ≥ 6.

No noticeable general concerns related to the age estimation in that stock were found, except the usual increasing difficulty of interpretation in older megrim due to increased otolith opacity.

Similar-better results in present exchange than in previous megrim age estimation exchanges and workshops (almost all based on stock 7.b-k, 8.abd) are observed.

A reference collection, training in older ages and continue calibration exchanges for all readers are **recommended**.

Considering the good results of the readers providing age estimates for stock assessment, no specific recommendation are suggested for them.

7 Acknowledgements

Many thanks to Lorena Rodríguez for her help in preparing the material and images for this exchange.

Thanks to the participants in the otolith exchange, especially to those outside this stock, whose participation has helped to achieve the objectives of this exchange.

Thanks to the Smartdots team for the resolution of doubts raised.

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9 Annex 1. Protocol and agenda

The following protocol was sent to the participants of the exchange prior to its beginning. It contains the otolith circulation of the otolith set.

Protocol for the "Megrim (*Lepidorhombus whiffiagonis*) 8.c, 9.a otolith exchange 2020"

by Jorge Landa

1. Introduction

The last ICES Working Group on Biological Parameters (WGBIOP) in 2019 (ICES, 2019b) established the need to perform an age calibration exchange of megrim (*Lepidorhombus whiffiagonis*) from ICES Div. 8.c, 9.a. in 2020, coordinated by Jorge Landa (IEO, Spain).

Several age calibration exchanges and workshops on megrim have taken place in 1997, 2004 and 2010, most analyzing samples from the 7.b-k, 8.a,b,d stock (Anon, 1997; Egan et al, 2004; Etherton, 2011) and one based on samples of the 4.a, 6.a stock in 2018-19 (Gault and Craig, 2019). The present exchange will therefore be the first based on the 8.c, 9.a stock of megrim.

The **objective**, as in other exchanges of calcified structures, is to estimate the agreement, precision and relative bias in the age estimations from age readers of the different age reading laboratories, to check that these parameters are within acceptable level (ICES, 2019b).

2. Participants

Age readers from different European institutes involved in the age estimation of megrim were contacted and the following ones, involved in the fisheries in the 8.c, 9.a stock or in adjacent areas, agreed to participate in this exchange.

Name	Institute	Country	e-mail	experience
Lorena Rodríguez	IEO	Spain	lorena.rodriguez@ieo.es	intermediate
Jorge Landa (coordinator)	IEO	Spain	jorge.landa@ieo.es	advanced
Isabel Loureiro	IEO	Spain	isabel.loureiro@ieo.es	advanced
Arantza Maceira	AZTI	Spain	amaceira@azti.es	intermediate

Carmen Abaroa	AZTI	Spain	cabaroa@azti.es	basic
Romain Elleboode	IFREMER	France	Romain.elleboode@ifremer.fr	advanced
Antoine Dussuel	IFREMER	France	Antoine.Dussuel@ifremer.fr	basic
Solene Telliez	IFREMER	France	Solene.Telliez@ifremer.fr	basic

3. Otolith collection

A total of 120 otoliths, 60 of them from each semester, have been selected from the IEO otolith collection, from specimens collected in research surveys and commercial catches.

The fish length range (20-47 cm) of the collection represent the whole range of specimens commercially captured by the Spanish fleet in the ICES Div. 8.c, 9.a.

Including samples from both semesters, in which a different type of border is generally shown, and including samples of the fish size range used in the stock assessments, are considered important considerations in the otolith exchanges and recommended in the WGBIOP Guidelines for Otolith Exchanges and Workshops (ICES, 2019b).

Information on sex will be available in all the specimens for the exchange, but not the fish length.

Both whole saggital otoliths are available in most samples of the exchange collection, although for a few specimens, broken otoliths or only one otolith are included. The representation of this type of otoliths in the collection is proportional to that usually is read by the age readers in the age estimation monitoring for the stock assessment in the area.

The otoliths from each specimen were immersed in water and the pictures were taken by IEO. Those digitized images have been uploaded to Smartdots.

Therefore the collection consists of:
- The whole **otolith set**
- The **image set** of those otoliths, available on **Smartdots**

4. Age interpretation procedure

Although the images are available on Smartdots from the beginning of the exchange, the **participants will read the otoliths only when they receive the otolith set in their institutes**, following the institute circulation program (Figure A1.1).

The age estimation should be performed first in the hard otoliths (whole **otolith set)** of each specimen, and then annotate their estimated annuli in the **otolith image** set on Smartdots. It is recommended to be using the Smardots app (in the computer) located next to the stereo-miscroscope, to be able to record the ages in Smartdots immediately after having identified the annuli in the hard otoliths. If in some institute the computer and the stereo-miscroscope cannot be kept together, then they will be read first in the stereo-miscroscope and shortly afterwards (try to be the same day) the annuli will be recorded in smartdots.

4.1. Otolith set

The otoliths will be observed **soaked in water** on a **black background**, under a stereo microscope (around 15x magnification are recommended) and **reflected light**. Each age reader is free to leave the otoliths soaked in water for a time prior to reading, as usual in each institute. After reading, otoliths will be carefully dried and placed in each envelope. Every care should be taken **to prevent damage to the otolith set**, as this will reduce precision in age reading for subsequent readers.

The age will be estimated by interpreting and counting the **well-defined translucent growth bands/rings (winter rings)** considered as annual (annuli), observed in the three main areas of the otoliths (Figure A1.2, Figure A1.3).

The overall scheme of **otolith edge interpretation** (Table A1.1) agreed in the workshop on megrim otolith and fin rays age reading (Anon, 1997) will be followed. Birthday is assumed to be 1st January.

The final age will be noted in the attached **data sheet** (AGE ESTIMATES) and **returned to IEO Santander** after finishing the age readings. Please, provide **one age estimate** only per otolith sample.

4.2. Image set in Smartdots:

All images will be managed through SmartDots. A calibrated scale bar is visible on each image. The age can be estimated in one or more of the three recommended areas for ageing interpretation in the megrim otoliths (Figure A1.2, Figure A1.3). However the final location of each annual winter ring in the image can only be done in a fixed reading line, and all participants will have to annotate the dots (corresponding to the winter rings) on this line created in the right otolith. Do not annotate the centre of the otolith or the outermost edge of the otolith. Only **place a dot at the end of each winter ring in the fixed line**, as these are counted when estimating the age. If you think that a winter ring should be located on the otolith edge (eg in the first quarter), logically, you should place it there. **SmartDots will automatically give the age of the fish based on the number of annotations that you make**.

Please, use a width spot of 8 (Dot settings, width) in SmartDots for your spots.

A **Smartdots user manual** (April 2020) is available for all exchange participants here:

https://ices.dk/data/tools/Pages/smartdots.aspx. (RESOURCES; User handbooks (2020))

Smartdots can be **downloaded** in: https://ices.dk/data/tools/Pages/smartdots.aspx

(RESOURCES; Getting started, Download the app)

Login for Smartdots. Each participant need to connect to the ICES Web API using the Token authentication. A token can be obtained here http://ices.dk/marine-data/tools/Pages/smartdots. In case users don't have an ICES login they can request a guest token. Please find more information on it in the Smartdots user manual (ICES, 2019a). You can have a token for 5, 30 or 100 days (recommended).

5. Timetable

From 01/06/2020 the otolith set will begin to be read by the reader of the first institute and after that, to circulate between institutes **(**Figure A1.1**). From that day on, all readers should check that they can access Smartdots, even if they will not use it until the otolith set arrives.**

Considering the current circumstances of the pandemic affecting the development of work in institutes and the sending of packages between institutes, in addition to the availability of time for readers to read the samples, deadlines will not be established. As soon as each otolith set has been read in one institute, if circumstances allow, please send it to the next institute to the address below.

6. Participant contact details

Lorena Rodríguez
Instituto Español de Oceanografía, Centro Oceanografico de Vigo. Subida a Radio Faro, 50. 36390 Vigo. Spain.

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Table A1.1. Overall agreed scheme of otolith edge interpretation of *L. whiffiagonis* agreed in the Workshop on Megrim Otolith and Fin Rays Age Reading (from Anon, 1997).

	Quarter 1	**Quarter 2**	**Quarter 3**	**Quarter 4**
N annuli Hyaline Edge	Age = N	Age = N	Age = N-1 Early winter	Age = N-1 Early winter
N annuli Opaque edge	Age = N+ 1 late winter	Age = N	Age = N	Age = N

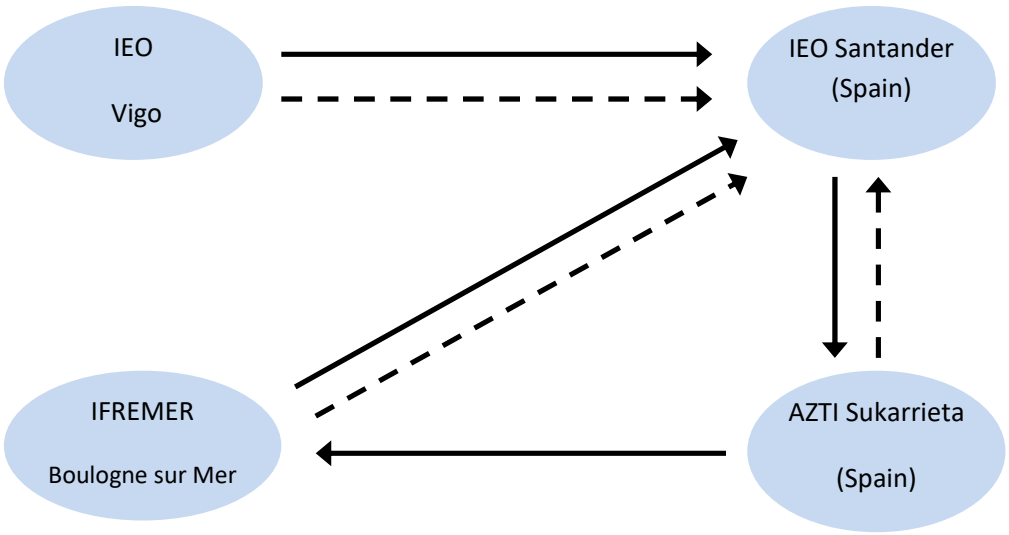


Figure A1.1. Otolith circulation of the otolith set (continued arrow) and the data sheet (discontinued arrow).

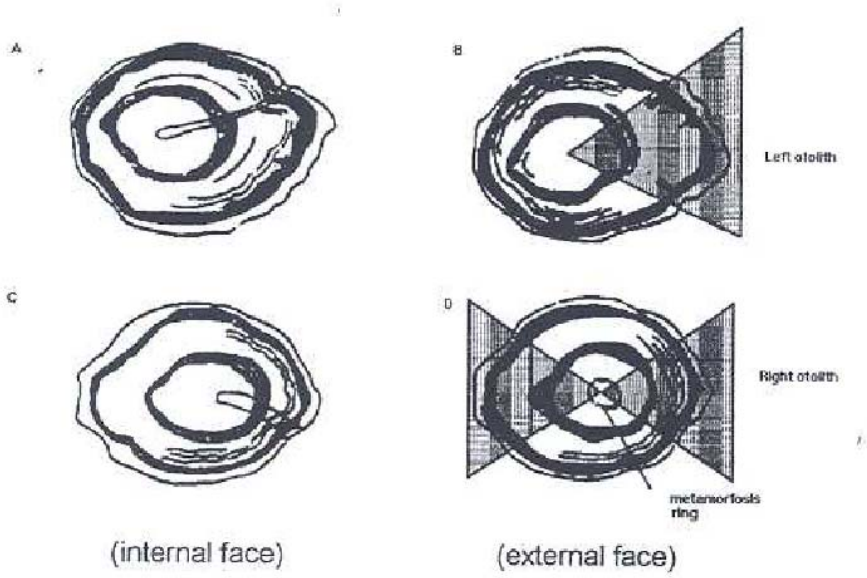


Figure A1.2. Recommended areas for age estimation in the left otolith (B) and rigth otolith (D) of *L. whiffiagonis* in the Workshop on Megrim Otolith and Fin Rays Age Reading (from Anon, 1997).

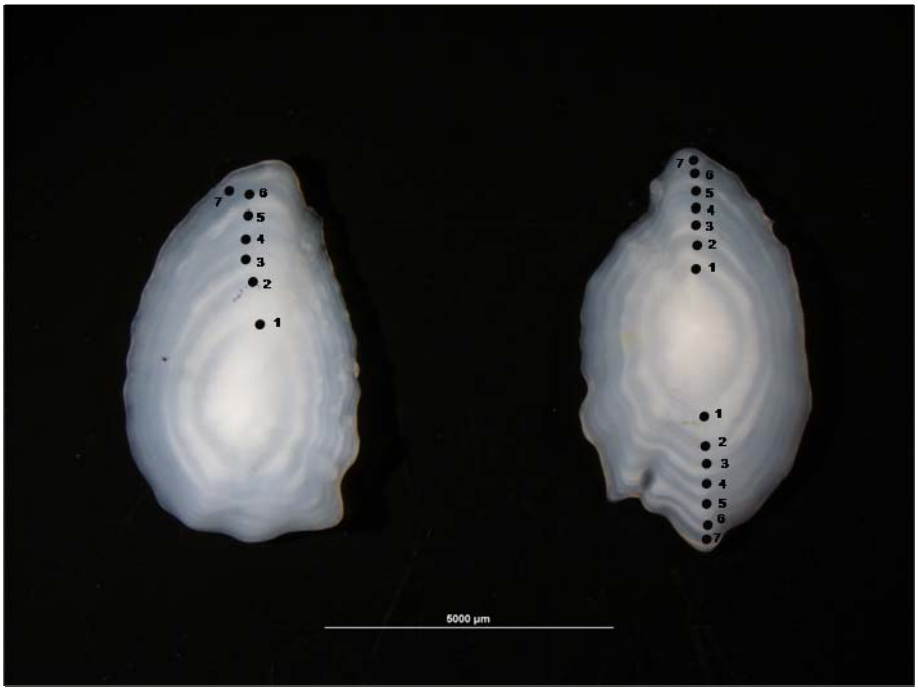


Figure A1.3. Left and right otoliths of *L. whiffiagonis* from the fourth quarter and with an estimated age of 7 years. The image shows the three main age estimation areas in both otoliths and the translucent annuli counted in each area (from Landa et al., 2019).

10 Annex 2. List of participants

Table A2.1: Participants list.

Name	Institute	Country	e-mail	experience	reader number
Lorena Rodríguez	IEO	Spain	lorena.rodriguez@ieo.es	intermediate	R03
Jorge Landa (coordinator)	IEO	Spain	jorge.landa@ieo.es	advanced	R01
Isabel Loureiro	IEO	Spain	isabel.loureiro@ieo.es	advanced	R02
Arantza Maceira	AZTI	Spain	amaceira@azti.es	intermediate	R05
Carmen Abaroa	AZTI	Spain	cabaroa@azti.es	basic	R08
Romain Elleboode	IFREMER	France	Romain.elleboode@ifremer.fr	intermediate	R04
Antoine Dussuel	IFREMER	France	Antoine.Dussuel@ifremer.fr	basic	R06
Solene Telliez	IFREMER	France	Solene.Telliez@ifremer.fr	basic	R07

Reader code	Expertise	Expertise_rank	strata
R01 ES	Advanced	1	Strata_S1
R01 ES	Advanced	1	Strata_S2
R02 ES	Basic	2	Strata_S1
R02 ES	Basic	2	Strata_S2
R03 ES	Advanced	3	Strata_S2
R03 ES	Advanced	3	Strata_S1
R04 FR	Basic	4	Strata_S2
R04 FR	Basic	4	Strata_S1
R05 ES	Basic	5	Strata_S2
R05 ES	Basic	5	Strata_S1
R06 FR	Basic	6	Strata_S1
R06 FR	Basic	6	Strata_S2
R07 FR	Basic	7	Strata_S1
R07 FR	Basic	7	Strata_S2
R08 ES	Basic	8	Strata_S2
R08 ES	Basic	8	Strata_S1

11 Annex 3. Additional results

11.1 Results all readers

Summary statistics

Table A3.1: Summary of statistics; PA (%), CV (%) and APE (%).

NSample	CV	PA	APE
60	16 %	62 %	11 %

Data Overview

Table A3.2: Data overview including modal age and statistics per sample.

Fish ID	Sample ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES	Modal age	PA %	CV %	APE %
2036_S2	2036_S2	277	29489	223	M	20/09/2019 00:00:00	27.8.c	2	2	2	1	2	1	2	2	2	75	26	21
2037_S2	2037_S2	277	29490	311	F	21/09/2019 00:00:00	27.8.c	3	3	4	3	3	4	4	4	3	50	15	14
2049_S2	2049_S2	277	29491	260	M	22/09/2019 00:00:00	27.8.c	2	3	3	2	3	2	3	3	3	62	20	18
2052_S2	2052_S2	277	29492	340	F	22/09/2019 00:00:00	27.8.c	3	3	3	3	3	3	3	3	3	100	0	0
2053_S2	2053_S2	277	29493	332	F	22/09/2019 00:00:00	27.8.c	3	3	3	2	3	3	3	3	3	88	12	8
2056_S2	2056_S2	277	29494	247	M	22/09/2019 00:00:00	27.8.c	2	2	3	2	3	2	2	3	2	62	22	20
2090_S2	2090_S2	277	29495	211	F	24/09/2019 00:00:00	27.8.c	2	2	1	1	2	2	2	2	2	75	26	21
2092_S2	2092_S2	277	29496	236	F	24/09/2019 00:00:00	27.8.c	2	2	1	1	2	1	1	2	2	50	36	33
2099_S2	2099_S2	277	29497	366	F	24/09/2019 00:00:00	27.8.c	3	3	4	3	4	4	3	3	3	62	15	14
2102_S2	2102_S2	277	29498	209	M	25/09/2019 00:00:00	27.8.c	2	2	2	2	2	2	2	3	2	88	17	10
2103_S2	2103_S2	277	29499	206	M	25/09/2019 00:00:00	27.8.c	2	2	1	1	2	1	1	2	2	50	36	33
2107_S2	2107_S2	277	29500	353	F	27/09/2019 00:00:00	27.8.c	4	3	4	3	-	4	3	4	4	57	15	14

2108_S2	2108_S2	277	29501	259	M	27/09/2019 00:00:00	27.8.c	3	3	3	3	4	4	3	4	3	62	15	14
2112_S2	2112_S2	277	29502	217	M	27/09/2019 00:00:00	27.8.c	2	2	1	2	2	2	2	2	2	88	19	12
2113_S2	2113_S2	277	29503	274	M	27/09/2019 00:00:00	27.8.c	6	6	5	5	6	6	5	5	6	50	10	9
2116_S2	2116_S2	277	29504	390	F	27/09/2019 00:00:00	27.8.c	5	5	5	5	6	5	5	5	5	88	7	4
2130_S2	2130_S2	277	29505	281	F	27/09/2019 00:00:00	27.8.c	3	3	2	2	3	3	2	3	3	62	20	18
2139_S2	2139_S2	277	29506	392	F	28/09/2019 00:00:00	27.8.c	6	7	8	5	6	7	8	6	6	38	16	13
2140_S2	2140_S2	277	29507	463	F	28/09/2019 00:00:00	27.8.c	7	8	8	6	6	7	8	7	8	38	12	9
2150_S2	2150_S2	277	29508	272	F	28/09/2019 00:00:00	27.8.c	3	3	2	2	3	3	2	3	3	62	20	18
2165_S2	2165_S2	277	29509	315	M	28/09/2019 00:00:00	27.8.c	4	4	4	4	5	5	4	4	4	75	11	9
2180_S2	2180_S2	277	29510	295	F	28/09/2019 00:00:00	27.8.c	3	2	2	2	3	3	2	3	2	50	21	20
2183_S2	2183_S2	277	29511	429	F	28/09/2019 00:00:00	27.8.c	6	5	7	4	-	7	6	5	6	29	19	16
2184_S2	2184_S2	277	29512	300	F	28/09/2019 00:00:00	27.8.c	3	3	2	2	3	3	3	3	3	75	17	14
2187_S2	2187_S2	277	29513	375	F	28/09/2019 00:00:00	27.8.c	4	4	5	4	5	5	4	4	4	62	12	11
2191_S2	2191_S2	277	29514	336	F	02/10/2019 00:00:00	27.8.c	5	4	4	3	4	5	4	4	4	62	16	11
2200_S2	2200_S2	277	29515	425	F	02/10/2019 00:00:00	27.8.c	8	8	8	7	7	8	7	7	8	50	7	7
2216_S2	2216_S2	277	29516	340	F	03/10/2019 00:00:00	27.8.c	5	5	5	4	4	5	5	4	5	62	11	10
2217_S2	2217_S2	277	29517	296	F	03/10/2019 00:00:00	27.8.c	4	4	4	4	4	5	5	4	4	75	11	9
2221_S2	2221_S2	277	29518	217	M	03/10/2019 00:00:00	27.8.c	3	3	3	3	3	4	3	3	3	88	11	7
2232_S2	2232_S2	277	29519	222	F	04/10/2019 00:00:00	27.8.c	2	2	1	2	2	2	2	2	2	88	19	12
2256_S2	2256_S2	277	29520	347	M	05/10/2019	27.8.c	8	7	7	5	7	8	6	6	7	38	15	12

2260_S2	2260_S2	277	29521	234	M	00:00:00 05/10/2019	27.8.c	3	3	3	3	3	4	3	3	3	88	11	7
2318_S2	2318_S2	277	29522	240	M	00:00:00 07/10/2019	27.8.c	4	4	4	4	4	4	4	4	4	100	0	0
2336_S2	2336_S2	277	29523	266	F	00:00:00 09/10/2019	27.8.c	4	4	4	4	4	4	4	4	4	100	0	0
2338_S2	2338_S2	277	29524	385	F	00:00:00 09/10/2019	27.8.c	-	6	6	4	5	8	4	5	6	29	26	20
2356_S2	2356_S2	277	29525	352	F	00:00:00 10/10/2019	27.8.c	5	5	5	4	5	5	4	4	5	62	11	10
2361_S2	2361_S2	277	29526	309	M	00:00:00 10/10/2019	27.8.c	7	7	7	7	5	8	8	6	7	50	14	10
2372_S2	2372_S2	277	29527	286	F	00:00:00 10/10/2019	27.8.c	3	3	3	3	3	4	3	3	3	88	11	7
2377_S2	2377_S2	277	29528	301	F	00:00:00 10/10/2019	27.8.c	3	3	3	3	-	3	3	3	3	100	0	0
2384_S2	2384_S2	277	29529	404	F	00:00:00 11/10/2019	27.8.c	7	6	7	5	6	6	6	6	6	62	10	7
2386_S2	2386_S2	277	29530	455	F	00:00:00 11/10/2019	27.8.c	8	8	8	6	7	8	6	6	8	50	14	12
2388_S2	2388_S2	277	29531	402	F	00:00:00 12/10/2019	27.8.c	7	6	7	6	7	8	7	6	7	50	10	8
2389_S2	2389_S2	277	29532	418	F	00:00:00 12/10/2019	27.8.c	7	6	7	6	6	7	6	6	6	62	8	7
2392_S2	2392_S2	277	29533	447	F	00:00:00 12/10/2019	27.8.c	7	7	9	6	7	9	7	6	7	50	16	12
2395_S2	2395_S2	277	29534	323	M	00:00:00 12/10/2019	27.8.c	7	6	6	4	5	8	-	6	6	43	22	14
2397_S2	2397_S2	277	29535	372	F	00:00:00 13/10/2019	27.8.c	4	4	3	4	4	4	4	4	4	88	9	6
2414_S2	2414_S2	277	29536	321	M	00:00:00 13/10/2019	27.8.c	4	4	4	3	3	4	4	4	4	75	12	10
2418_S2	2418_S2	277	29537	375	F	00:00:00 14/10/2019	27.8.c	6	6	6	5	5	6	6	5	6	62	9	8
2419_S2	2419_S2	277	29538	405	F	00:00:00 14/10/2019	27.8.c	5	5	5	3	4	5	4	4	5	50	17	14
2425_S2	2425_S2	277	29539	388	F	00:00:00 15/10/2019	27.8.c	7	6	6	4	5	6	6	5	6	50	16	13
2427_S2	2427_S2	277	2954	477	F	00:00:00 15/10/20	27.8.	7	6	7	6	7	7	7	6	7	62	8	7

			0			19 00:00:00	c												
2429_S2	2429_S2	277	29541	385	F	17/10/2019 00:00:00	27.8.c	4	4	4	4	5	5	4	5	4	62	12	11
2435_S2	2435_S2	277	29542	408	F	21/10/2019 00:00:00	27.8.c	6	7	7	6	7	7	8	6	7	50	10	8
2436_S2	2436_S2	277	29543	462	F	22/10/2019 00:00:00	27.8.c	10	-	8	-	7	7	-	8	10	20	15	10
2441_S2	2441_S2	277	29544	438	F	27/10/2019 00:00:00	27.8.c	9	10	9	7	8	9	10	8	9	38	12	9
2446_S2	2446_S2	277	29545	446	F	01/11/2019 00:00:00	27.8.c	10	-	8	6	-	7	6	7	10	17	21	15
2448_S2	2448_S2	277	29546	435	F	03/11/2019 00:00:00	27.8.c	8	7	8	7	7	8	8	7	8	50	7	7
2459_S2	2459_S2	277	29547	473	F	20/10/2019 00:00:00	27.8.c	-	7	8	5	6	7	7	6	7	43	15	12
2466_S2	2466_S2	277	29548	367	M	20/10/2019 00:00:00	27.8.c	9	9	9	7	8	9	10	8	9	50	11	8
4003_S1	4003_S1	277	29429	380	F	01/03/2019 00:00:00	27.8.c	7	7	6	7	5	7	7	5	7	62	14	12
4006_S1	4006_S1	277	29430	390	F	01/03/2019 00:00:00	27.8.c	6	6	6	6	5	6	6	5	6	75	8	7
4011_S1	4011_S1	277	29431	200	M	01/03/2019 00:00:00	27.8.c	3	3	2	3	2	3	2	4	3	50	26	20
4017_S1	4017_S1	277	29432	300	F	01/03/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	4	5	88	7	4
4018_S1	4018_S1	277	29433	270	M	01/03/2019 00:00:00	27.8.c	4	5	4	4	4	4	5	4	4	75	11	9
4019_S1	4019_S1	277	29434	290	F	01/03/2019 00:00:00	27.8.c	5	5	5	5	4	5	5	4	5	75	10	8
4022_S1	4022_S1	277	29435	280	F	01/03/2019 00:00:00	27.8.c	5	5	4	5	4	5	5	4	5	62	11	10
4030_S1	4030_S1	277	29436	290	M	01/03/2019 00:00:00	27.8.c	6	6	5	5	4	5	5	5	5	62	13	9
4038_S1	4038_S1	277	29437	270	M	01/03/2019 00:00:00	27.8.c	4	4	4	4	3	4	4	4	4	88	9	6
4048_S1	4048_S1	277	29438	440	F	01/03/2019 00:00:00	27.8.c	7	7	7	8	7	7	7	7	7	88	5	3
4080_S1	4080_S1	277	29439	260	M	01/03/2019 00:00:00	27.8.c	4	5	4	4	4	4	5	4	4	75	11	9

4086_S1	4086_S1	277	29440	260	F	01/03/2019 00:00:00	27.8.c	4	4	3	-	3	4	4	3	4	57	15	14
4099_S1	4099_S1	277	29441	250	M	01/03/2019 00:00:00	27.8.c	3	3	3	3	3	3	3	3	3	100	0	0
4119_S1	4119_S1	277	29442	360	M	14/06/2019 00:00:00	27.8.c	6	6	6	7	6	6	7	6	6	75	7	6
4120_S1	4120_S1	277	29443	410	F	14/06/2019 00:00:00	27.8.c	7	7	7	7	7	7	8	7	7	88	5	3
4121_S1	4121_S1	277	29444	420	F	14/06/2019 00:00:00	27.8.c	6	6	6	-	7	6	6	5	6	71	10	5
4122_S1	4122_S1	277	29445	380	F	14/06/2019 00:00:00	27.8.c	6	6	6	6	6	6	6	6	6	100	0	0
4124_S1	4124_S1	277	29446	370	F	14/06/2019 00:00:00	27.8.c	5	5	4	5	4	5	5	5	5	75	10	8
4125_S1	4125_S1	277	29447	390	F	14/06/2019 00:00:00	27.8.c	6	7	5	5	5	6	5	6	5	50	13	11
4138_S1	4138_S1	277	29448	390	F	14/06/2019 00:00:00	27.8.c	7	7	6	7	6	7	7	6	7	62	8	7
4139_S1	4139_S1	277	29449	410	F	14/06/2019 00:00:00	27.8.c	6	8	6	7	8	7	6	7	6	38	12	10
4140_S1	4140_S1	277	29450	410	F	14/06/2019 00:00:00	27.8.c	7	7	6	7	7	6	6	6	7	50	8	8
4141_S1	4141_S1	277	29451	400	F	14/06/2019 00:00:00	27.8.c	6	6	6	-	6	6	6	6	6	100	0	0
4144_S1	4144_S1	277	29452	350	F	14/06/2019 00:00:00	27.8.c	5	5	5	5	5	6	5	5	5	88	7	4
4146_S1	4146_S1	277	29453	370	F	14/06/2019 00:00:00	27.8.c	6	-	6	6	6	7	7	5	6	57	11	8
4147_S1	4147_S1	277	29454	320	F	14/06/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	5	5	100	0	0
4150_S1	4150_S1	277	29455	320	F	14/06/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	4	5	88	7	4
4152_S1	4152_S1	277	29456	330	F	14/06/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	5	5	100	0	0
4153_S1	4153_S1	277	29457	300	M	14/06/2019 00:00:00	27.8.c	5	5	4	5	5	4	4	5	5	62	11	10
9002_S1	9002_S1	277	29458	248	M	27/03/2019 00:00:00	27.8.c	3	2	3	2	3	3	2	3	3	62	20	18
9013_S1	9013_S1	277	29459	328	F	03/04/2019	27.8.c	5	5	5	5	5	5	5	5	5	100	0	0

9021_S1	9021_S1	277	29460	303	F	00:00:00 03/04/2019 00:00:00	27.8.c	5	5	5	4	4	5	4	4	5	50	12	11
9024_S1	9024_S1	277	29461	348	F	03/04/2019 00:00:00	27.8.c	4	4	4	4	4	4	4	4	4	100	0	0
9028_S1	9028_S1	277	29462	311	M	03/04/2019 00:00:00	27.8.c	5	4	4	4	4	4	5	5	4	62	12	11
9031_S1	9031_S1	277	29463	288	M	03/04/2019 00:00:00	27.8.c	4	4	4	4	3	4	4	4	4	88	9	6
9033_S1	9033_S1	277	29464	372	F	03/04/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	5	5	100	0	0
9034_S1	9034_S1	277	29465	316	F	03/04/2019 00:00:00	27.8.c	4	4	4	4	4	4	4	4	4	100	0	0
9043_S1	9043_S1	277	29466	424	F	09/05/2019 00:00:00	27.8.c	7	7	6	6	7	7	6	6	7	50	8	8
9051_S1	9051_S1	277	29467	394	F	09/05/2019 00:00:00	27.8.c	8	8	7	7	8	8	8	7	8	62	7	6
9052_S1	9052_S1	277	29468	335	F	09/05/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	5	5	100	0	0
9053_S1	9053_S1	277	29469	450	F	09/05/2019 00:00:00	27.8.c	8	9	8	8	8	9	8	8	8	75	6	5
9054_S1	9054_S1	277	29470	341	F	09/05/2019 00:00:00	27.8.c	5	5	5	4	4	4	4	4	4	62	12	11
9056_S1	9056_S1	277	29471	454	F	09/05/2019 00:00:00	27.8.c	7	8	7	6	8	9	7	6	7	38	14	11
9058_S1	9058_S1	277	29472	445	F	09/05/2019 00:00:00	27.8.c	9	10	8	9	8	10	9	7	9	38	12	9
9060_S1	9060_S1	277	29473	364	F	09/05/2019 00:00:00	27.8.c	6	6	5	6	6	6	6	5	6	75	8	7
9062_S1	9062_S1	277	29474	421	F	09/05/2019 00:00:00	27.8.c	7	8	7	6	6	8	7	5	7	38	15	12
9063_S1	9063_S1	277	29475	430	F	09/05/2019 00:00:00	27.8.c	7	7	7	7	6	8	6	6	7	50	10	8
9076_S1	9076_S1	277	29476	452	F	23/05/2019 00:00:00	27.8.c	-	5	7	5	7	9	4	8	5	29	28	23
9078_S1	9078_S1	277	29477	467	F	23/05/2019 00:00:00	27.8.c	7	7	7	6	6	9	6	6	6	50	15	11
9079_S1	9079_S1	277	29478	396	F	23/05/2019 00:00:00	27.8.c	7	7	7	7	7	7	7	7	7	100	0	0
9080_S1	9080_S1	277	2947	415	F	23/05/20	27.8.	7	6	6	6	6	7	6	6	6	75	7	6

			9			19 00:00:00	c												
9081_S1	9081_S1	277	29480	402	F	23/05/2019 00:00:00	27.8.c	6	5	6	6	6	7	6	6	6	75	9	4
9091_S1	9091_S1	277	29481	355	F	23/05/2019 00:00:00	27.8.c	4	5	4	4	-	5	4	4	4	71	11	10
9092_S1	9092_S1	277	29482	347	F	23/05/2019 00:00:00	27.8.c	5	5	5	5	5	5	5	5	5	100	0	0
GLW0031_S1	GLW0031_S1	277	29483	236	M	10/04/2019 00:00:00	27.8.c	3	3	3	3	3	3	2	3	3	88	12	8
GLW0081_S1	GLW0081_S1	277	29484	251	M	12/04/2019 00:00:00	27.9.a	4	4	4	-	-	4	3	4	4	83	11	7
GLW0086_S1	GLW0086_S1	277	29485	236	M	15/04/2019 00:00:00	27.9.a	3	3	3	3	-	3	2	3	3	86	13	9
GLW0097_S1	GLW0097_S1	277	29486	249	M	15/04/2019 00:00:00	27.9.a	3	3	3	3	-	3	3	2	3	86	13	9
GLW0104_S1	GLW0104_S1	277	29487	223	M	16/04/2019 00:00:00	27.9.a	3	3	3	3	3	3	2	3	3	88	12	8
GLW0106_S1	GLW0106_S1	277	29488	210	M	16/04/2019 00:00:00	27.9.a	3	3	3	3	3	3	2	3	3	88	12	8

List of multimodal cases

Table A3.3: List of cases for which multiple modes where obtained when all readers are considered. 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
2	**2037_S2**
2	**2092_S2**
2	**2103_S2**
2	**2113_S2**
2	**2140_S2**
2	**2180_S2**
3	**2183_S2**
2	**2200_S2**
3	**2338_S2**
2	**2436_S2**
2	**2446_S2**
2	**2448_S2**
2	**4139_S1**
2	**4140_S1**
2	**9021_S1**
2	**9043_S1**
2	**9076_S1**

Number of age readings by modal age

Table A3.4: Number of age readings table gives an overview of number of readings per reader and modal age. The total numbers of readings by modal age and by reader are also presented.

Modal age	R01 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES	total
2	9	9	9	9	9	9	9	9	**72**
3	21	21	21	21	18	21	21	21	**165**
4	21	21	21	19	18	21	21	21	**163**
5	20	21	21	21	21	21	21	21	**167**
6	19	19	20	18	19	20	19	20	**154**
7	16	17	17	17	17	17	17	17	**135**
8	6	6	6	6	6	6	6	6	**48**
9	3	3	3	3	3	3	3	3	**24**
10	2	0	2	1	1	2	1	2	**11**
Total	**117**	**117**	**120**	**115**	**112**	**120**	**118**	**120**	**939**

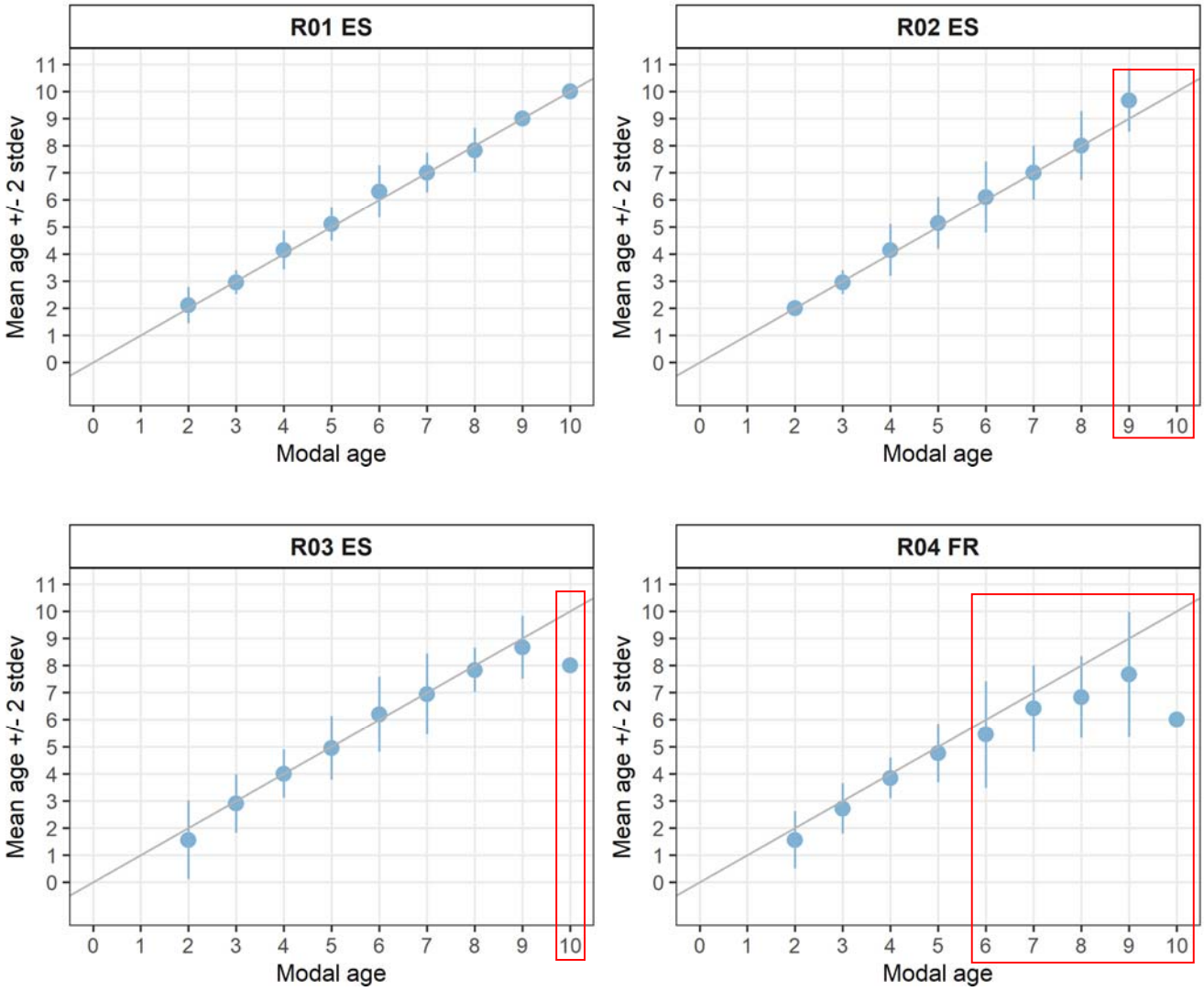
Number of age readings by age

Table A3.5: Age composition by reader gives a summary of number of readings per reader and age. The total numbers of readings by age and by reader are also presented.

Age	R01 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES	total
1	0	0	5	4	0	3	2	0	**14**
2	9	10	7	11	8	6	15	7	**73**
3	21	21	18	19	21	15	14	21	**150**
4	18	16	22	23	20	22	22	29	**172**
5	21	25	21	23	22	23	21	24	**180**
6	16	17	17	18	18	13	20	24	**143**
7	21	17	17	14	16	19	13	10	**127**
8	6	7	10	2	7	11	8	5	**56**
9	3	2	3	1	0	7	1	0	**17**
10	2	2	0	0	0	1	2	0	**7**
Total	**117**	**117**	**120**	**115**	**112**	**120**	**118**	**120**	**939**

Age	R01 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES	total
1	0	0	5	4	0	3	2	0	**14**
2	9	10	7	11	8	6	15	7	**73**
3	21	21	18	19	21	15	14	21	**150**
4	18	16	22	23	20	22	22	29	**172**
5	21	25	21	23	22	23	21	24	**180**
6	16	17	17	18	18	13	20	24	**143**
7	21	17	17	14	16	19	13	10	**127**
8	6	7	10	2	7	11	8	5	**56**
9	3	2	3	1	0	7	1	0	**17**
10	2	2	0	0	0	1	2	0	**7**
Total	**117**	**117**	**120**	**115**	**112**	**120**	**118**	**120**	**939**

Separate age bias plots by reader



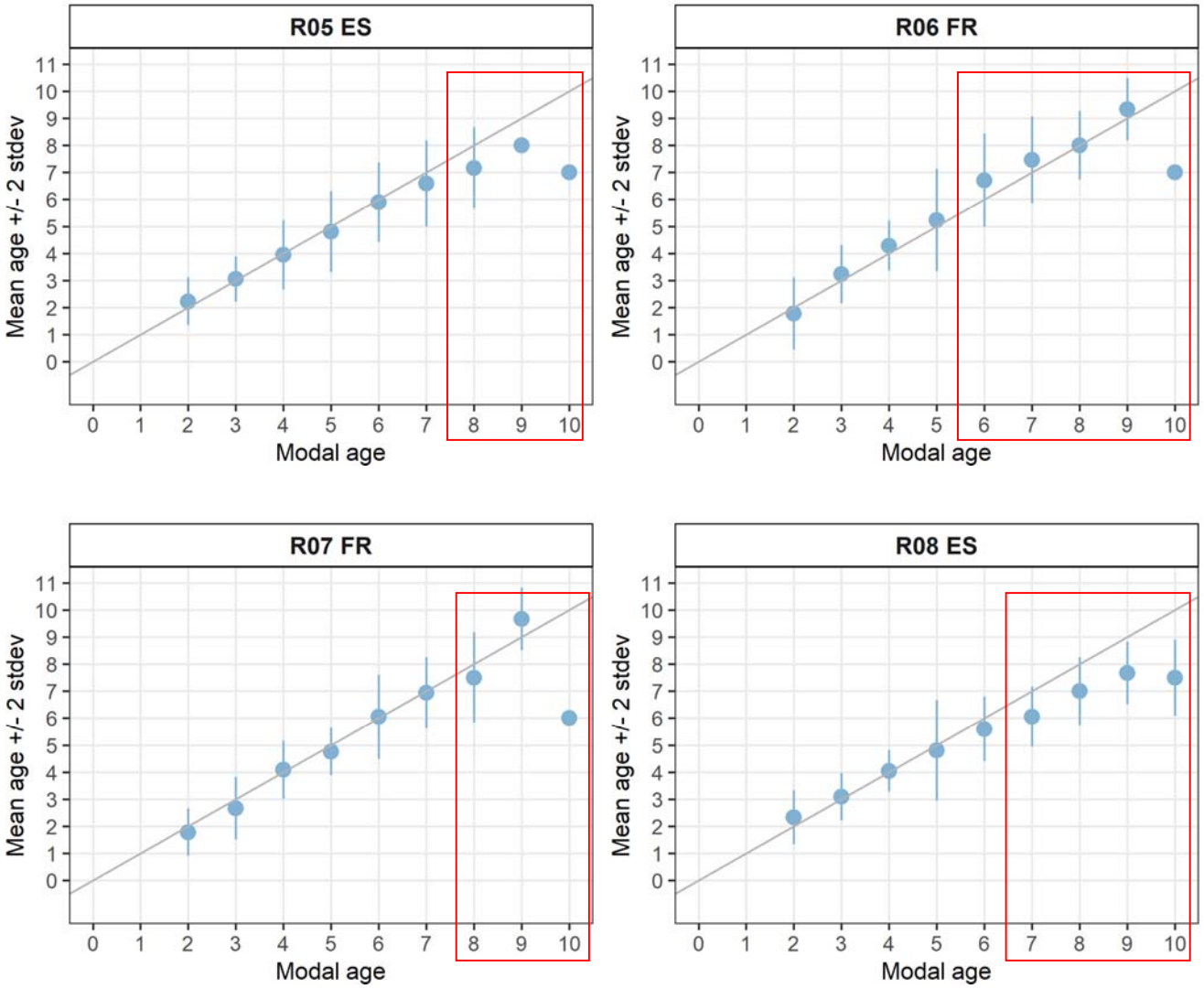


Figure A3.1: Age bias plot for each reader. Mean age recorded +/- 2 stdev of each reader is plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age. The most biased age groups for each reader are highlighted in red.

Statistics by modal age plot (STDEV, CV and PA)

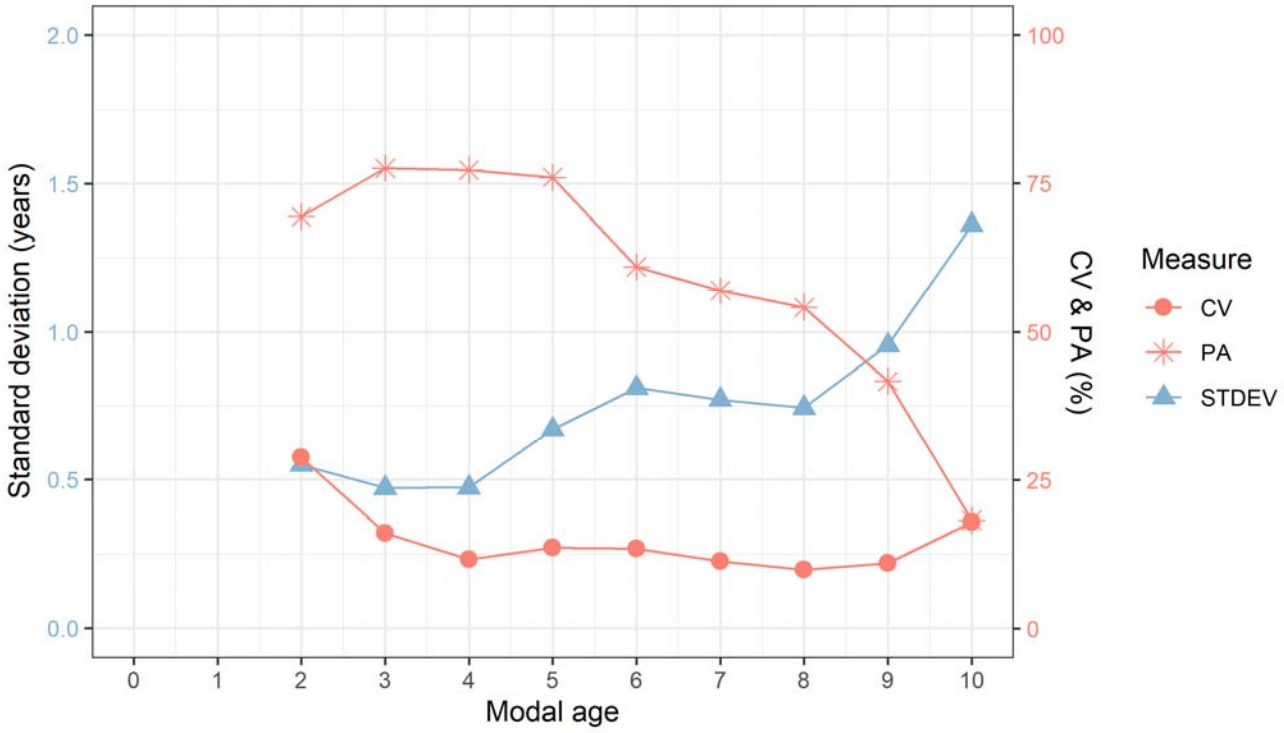


Figure A3.2: CV, PA and (STDEV (standard deviation) are plotted against modal age

Distribution of age reading errors

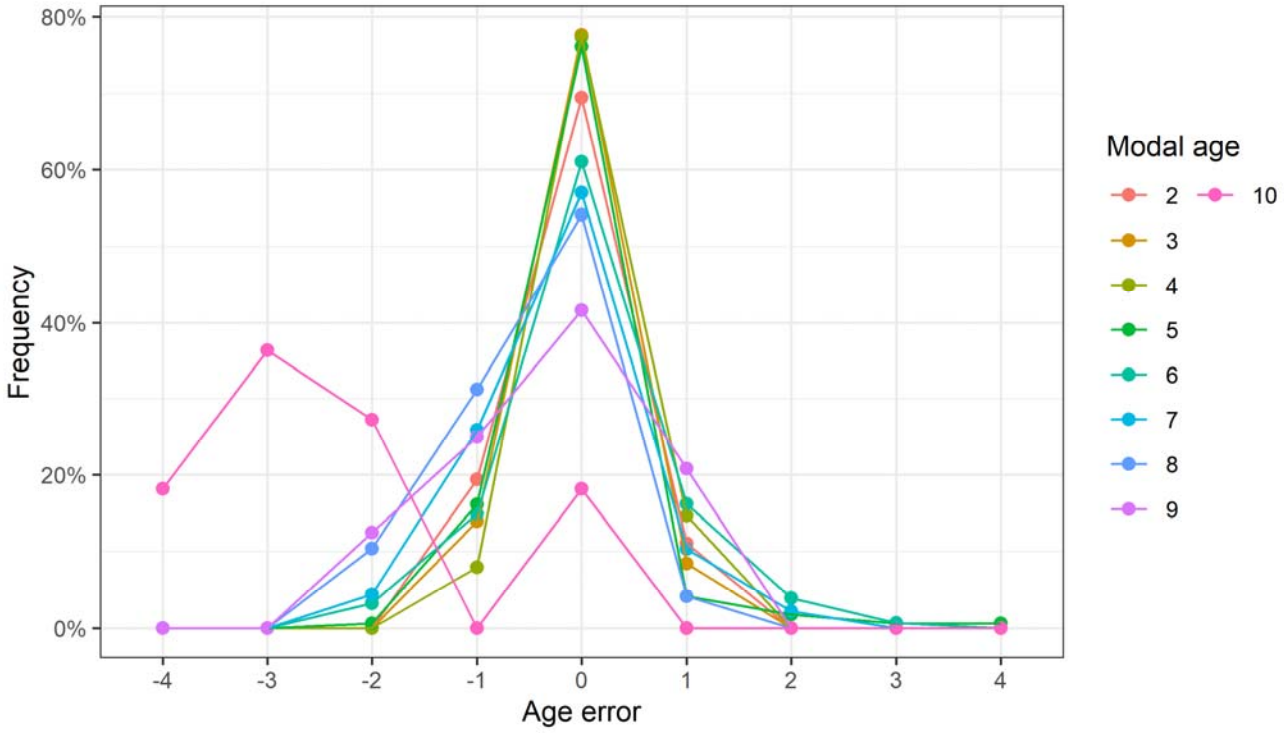


Figure A3.3: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

Relative bias for all readers

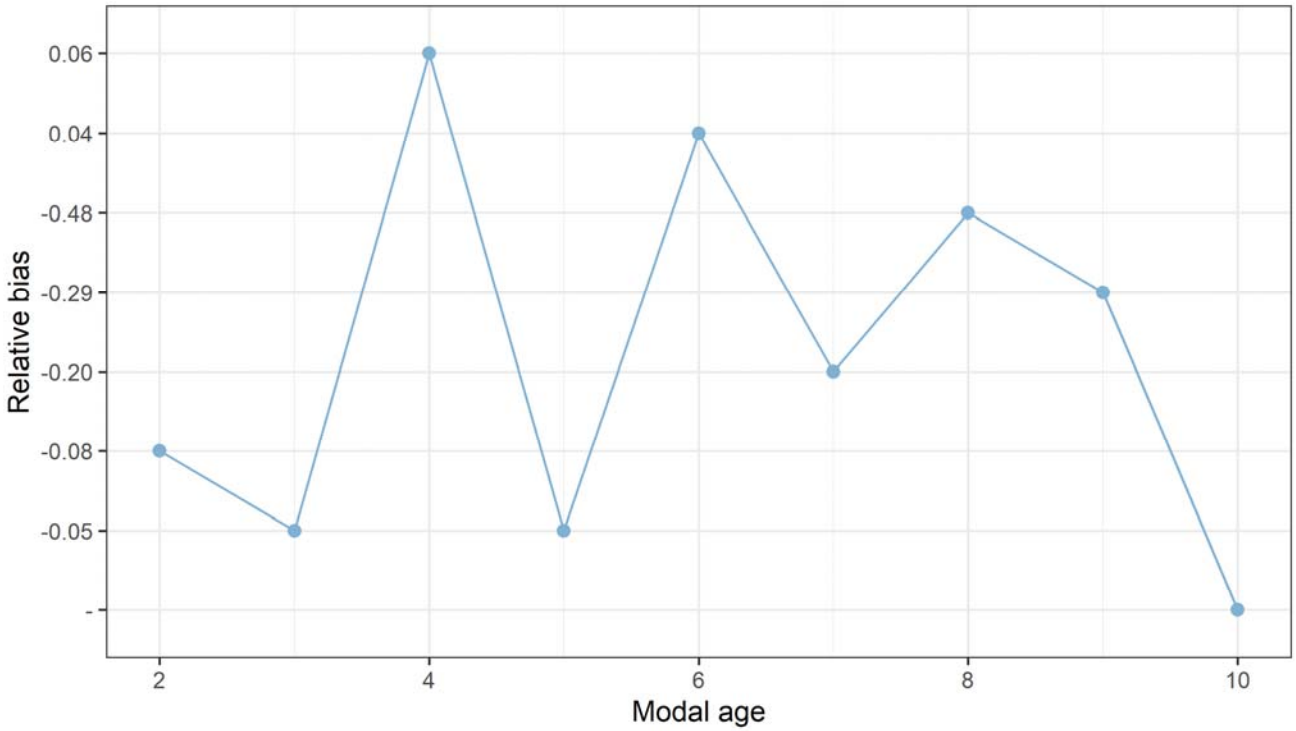


Figure A3.4: The relative bias by modal age as estimated by all age readers combined.

Mean length at age by reader

Table A3.6: Mean fish length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age. A weighted mean is also given.

Age	R01 ES	R02 ES	R03 ES	R04 FR	R05 ES	R06 FR	R07 FR	R08 ES
1	-	-	218 mm	219 mm	-	222 mm	221 mm	-
2	226 mm	231 mm	254 mm	262 mm	216 mm	228 mm	235 mm	223 mm
3	269 mm	272 mm	264 mm	281 mm	271 mm	265 mm	286 mm	267 mm
4	308 mm	309 mm	309 mm	327 mm	313 mm	293 mm	332 mm	308 mm
5	334 mm	342 mm	339 mm	349 mm	349 mm	336 mm	322 mm	359 mm
6	378 mm	380 mm	390 mm	422 mm	401 mm	377 mm	409 mm	407 mm
7	413 mm	409 mm	415 mm	397 mm	426 mm	421 mm	418 mm	426 mm
8	418 mm	432 mm	445 mm	445 mm	423 mm	393 mm	408 mm	434 mm
9	417 mm	408 mm	417 mm	445 mm	-	439 mm	445 mm	-
10	454 mm	442 mm	-	-	-	445 mm	402 mm	-
Weighted Mean	**339 mm**	**339 mm**	**341 mm**	**340 mm**	**342 mm**	**341 mm**	**340 mm**	**341 mm**

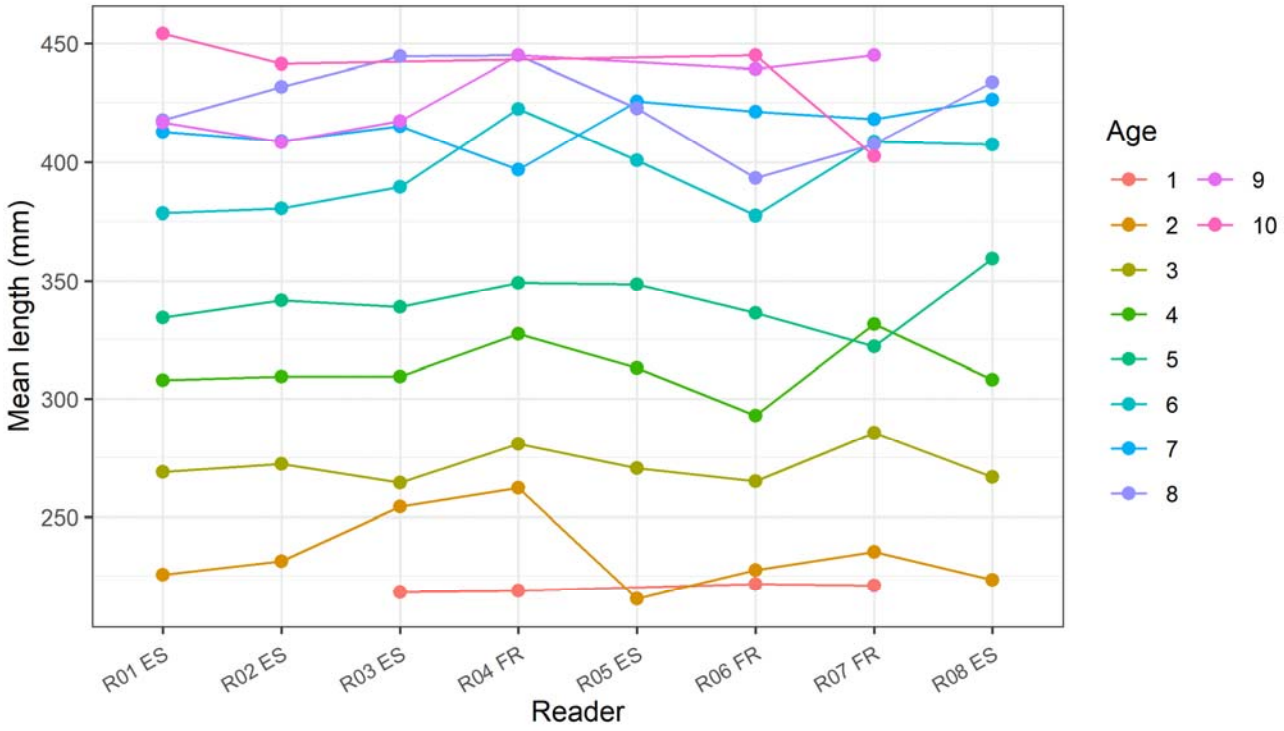


Figure A3.5: The mean fish length at age as estimated by each age reader.

11.2 Results Advanced readers

All samples included

Summary statistics

Table A3.7: Summary of statistics; PA (%), CV (%) and APE (%).

NSample	CV	PA	APE
60	14 %	77 %	9 %

Data overview

Table A3.8: Data overview including modal age and statistics per sample.

Fish ID	Sample ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 ES	R03 ES	Modal age	PA %	CV %	APE %
2036_S2	2036_S2	277	29489	223	M	20/09/2019 00:00:00	27.8.c	2	2	2	100	0	0
2037_S2	2037_S2	277	29490	311	F	21/09/2019 00:00:00	27.8.c	3	4	3	50	20	14
2049_S2	2049_S2	277	29491	260	M	22/09/2019 00:00:00	27.8.c	2	3	2	50	28	20
2052_S2	2052_S2	277	29492	340	F	22/09/2019 00:00:00	27.8.c	3	3	3	100	0	0
2053_S2	2053_S2	277	29493	332	F	22/09/2019 00:00:00	27.8.c	3	3	3	100	0	0
2056_S2	2056_S2	277	29494	247	M	22/09/2019 00:00:00	27.8.c	2	3	2	50	28	20
2090_S2	2090_S2	277	29495	211	F	24/09/2019 00:00:00	27.8.c	2	1	2	50	47	33
2092_S2	2092_S2	277	29496	236	F	24/09/2019 00:00:00	27.8.c	2	1	2	50	47	33
2099_S2	2099_S2	277	29497	366	F	24/09/2019 00:00:00	27.8.c	3	4	3	50	20	14
2102_S2	2102_S2	277	29498	209	M	25/09/2019 00:00:00	27.8.c	2	2	2	100	0	0
2103_S2	2103_S2	277	29499	206	M	25/09/2019 00:00:00	27.8.c	2	1	2	50	47	33
2107_S2	2107_S2	277	29500	353	F	27/09/2019 00:00:00	27.8.c	4	4	4	100	0	0
2108_S2	2108_S2	277	29501	259	M	27/09/2019 00:00:00	27.8.c	3	3	3	100	0	0
2112_S2	2112_S2	277	29502	217	M	27/09/2019 00:00:00	27.8.c	2	1	2	50	47	33
2113_S2	2113_S2	277	29503	274	M	27/09/2019 00:00:00	27.8.c	6	5	6	50	13	9
2116_S2	2116_S2	277	29504	390	F	27/09/2019 00:00:00	27.8.c	5	5	5	100	0	0
2130_S2	2130_S2	277	29505	281	F	27/09/2019 00:00:00	27.8.c	3	2	3	50	28	20
2139_S2	2139_S2	277	29506	392	F	28/09/2019	27.8.c	6	8	6	50	20	14

						00:00:00							
2140_S2	2140_S2	277	29507	463	F	28/09/2019 00:00:00	27.8.c	7	8	7	50	9	7
2150_S2	2150_S2	277	29508	272	F	28/09/2019 00:00:00	27.8.c	3	2	3	50	28	20
2165_S2	2165_S2	277	29509	315	M	28/09/2019 00:00:00	27.8.c	4	4	4	100	0	0
2180_S2	2180_S2	277	29510	295	F	28/09/2019 00:00:00	27.8.c	3	2	3	50	28	20
2183_S2	2183_S2	277	29511	429	F	28/09/2019 00:00:00	27.8.c	6	7	6	50	11	8
2184_S2	2184_S2	277	29512	300	F	28/09/2019 00:00:00	27.8.c	3	2	3	50	28	20
2187_S2	2187_S2	277	29513	375	F	28/09/2019 00:00:00	27.8.c	4	5	4	50	16	11
2191_S2	2191_S2	277	29514	336	F	02/10/2019 00:00:00	27.8.c	5	4	5	50	16	11
2200_S2	2200_S2	277	29515	425	F	02/10/2019 00:00:00	27.8.c	8	8	8	100	0	0
2216_S2	2216_S2	277	29516	340	F	03/10/2019 00:00:00	27.8.c	5	5	5	100	0	0
2217_S2	2217_S2	277	29517	296	F	03/10/2019 00:00:00	27.8.c	4	4	4	100	0	0
2221_S2	2221_S2	277	29518	217	M	03/10/2019 00:00:00	27.8.c	3	3	3	100	0	0
2232_S2	2232_S2	277	29519	222	F	04/10/2019 00:00:00	27.8.c	2	1	2	50	47	33
2256_S2	2256_S2	277	29520	347	M	05/10/2019 00:00:00	27.8.c	8	7	8	50	9	7
2260_S2	2260_S2	277	29521	234	M	05/10/2019 00:00:00	27.8.c	3	3	3	100	0	0
2318_S2	2318_S2	277	29522	240	M	07/10/2019 00:00:00	27.8.c	4	4	4	100	0	0
2336_S2	2336_S2	277	29523	266	F	09/10/2019 00:00:00	27.8.c	4	4	4	100	0	0
2338_S2	2338_S2	277	29524	385	F	09/10/2019 00:00:00	27.8.c	-	6	6	100	-	0
2356_S2	2356_S2	277	29525	352	F	10/10/2019 00:00:00	27.8.c	5	5	5	100	0	0
2361_S2	2361_S2	277	29526	309	M	10/10/2019 00:00:00	27.8.c	7	7	7	100	0	0
2372_S2	2372_S2	277	29527	286	F	10/10/2019 00:00:00	27.8.c	3	3	3	100	0	0
2377_S2	2377_S2	277	29528	301	F	10/10/2019 00:00:00	27.8.c	3	3	3	100	0	0
2384_S2	2384_S2	277	29529	404	F	11/10/2019 00:00:00	27.8.c	7	7	7	100	0	0
2386_S2	2386_S2	277	29530	455	F	11/10/2019 00:00:00	27.8.c	8	8	8	100	0	0
2388_S2	2388_S2	277	29531	402	F	12/10/2019 00:00:00	27.8.c	7	7	7	100	0	0
2389_S2	2389_S2	277	29532	418	F	12/10/2019 00:00:00	27.8.c	7	7	7	100	0	0
2392_S2	2392_S2	277	29533	447	F	12/10/2019 00:00:00	27.8.c	7	9	7	50	18	12
2395_S2	2395_S2	277	29534	323	M	12/10/2019 00:00:00	27.8.c	7	6	7	50	11	8
2397_S2	2397_S2	277	29535	372	F	13/10/2019 00:00:00	27.8.c	4	3	4	50	20	14

2414_S2	2414_S2	277	29536	321	M	13/10/2019 00:00:00	27.8.c	4	4	4	100	0	0
2418_S2	2418_S2	277	29537	375	F	14/10/2019 00:00:00	27.8.c	6	6	6	100	0	0
2419_S2	2419_S2	277	29538	405	F	14/10/2019 00:00:00	27.8.c	5	5	5	100	0	0
2425_S2	2425_S2	277	29539	388	F	15/10/2019 00:00:00	27.8.c	7	6	7	50	11	8
2427_S2	2427_S2	277	29540	477	F	15/10/2019 00:00:00	27.8.c	7	7	7	100	0	0
2429_S2	2429_S2	277	29541	385	F	17/10/2019 00:00:00	27.8.c	4	4	4	100	0	0
2435_S2	2435_S2	277	29542	408	F	21/10/2019 00:00:00	27.8.c	6	7	6	50	11	8
2436_S2	2436_S2	277	29543	462	F	22/10/2019 00:00:00	27.8.c	10	8	10	50	16	11
2441_S2	2441_S2	277	29544	438	F	27/10/2019 00:00:00	27.8.c	9	9	9	100	0	0
2446_S2	2446_S2	277	29545	446	F	01/11/2019 00:00:00	27.8.c	10	8	10	50	16	11
2448_S2	2448_S2	277	29546	435	F	03/11/2019 00:00:00	27.8.c	8	8	8	100	0	0
2459_S2	2459_S2	277	29547	473	F	20/10/2019 00:00:00	27.8.c	-	8	8	100	-	0
2466_S2	2466_S2	277	29548	367	M	20/10/2019 00:00:00	27.8.c	9	9	9	100	0	0
4003_S1	4003_S1	277	29429	380	F	01/03/2019 00:00:00	27.8.c	7	6	7	50	11	8
4006_S1	4006_S1	277	29430	390	F	01/03/2019 00:00:00	27.8.c	6	6	6	100	0	0
4011_S1	4011_S1	277	29431	200	M	01/03/2019 00:00:00	27.8.c	3	2	3	50	28	20
4017_S1	4017_S1	277	29432	300	F	01/03/2019 00:00:00	27.8.c	5	5	5	100	0	0
4018_S1	4018_S1	277	29433	270	M	01/03/2019 00:00:00	27.8.c	4	4	4	100	0	0
4019_S1	4019_S1	277	29434	290	F	01/03/2019 00:00:00	27.8.c	5	5	5	100	0	0
4022_S1	4022_S1	277	29435	280	F	01/03/2019 00:00:00	27.8.c	5	4	5	50	16	11
4030_S1	4030_S1	277	29436	290	M	01/03/2019 00:00:00	27.8.c	6	5	6	50	13	9
4038_S1	4038_S1	277	29437	270	M	01/03/2019 00:00:00	27.8.c	4	4	4	100	0	0
4048_S1	4048_S1	277	29438	440	F	01/03/2019 00:00:00	27.8.c	7	7	7	100	0	0
4080_S1	4080_S1	277	29439	260	M	01/03/2019 00:00:00	27.8.c	4	4	4	100	0	0
4086_S1	4086_S1	277	29440	260	F	01/03/2019 00:00:00	27.8.c	4	3	4	50	20	14
4099_S1	4099_S1	277	29441	250	M	01/03/2019 00:00:00	27.8.c	3	3	3	100	0	0
4119_S1	4119_S1	277	29442	360	M	14/06/2019 00:00:00	27.8.c	6	6	6	100	0	0
4120_S1	4120_S1	277	29443	410	F	14/06/2019 00:00:00	27.8.c	7	7	7	100	0	0
4121_S1	4121_S1	277	29444	420	F	14/06/2019 00:00:00	27.8.c	6	6	6	100	0	0
4122_S1	4122_S1	277	29445	380	F	14/06/2019	27.8.c	6	6	6	100	0	0

						00:00:00							
4124_S1	4124_S1	277	29446	370	F	14/06/2019 00:00:00	27.8.c	5	4	5	50	16	11
4125_S1	4125_S1	277	29447	390	F	14/06/2019 00:00:00	27.8.c	6	5	6	50	13	9
4138_S1	4138_S1	277	29448	390	F	14/06/2019 00:00:00	27.8.c	7	6	7	50	11	8
4139_S1	4139_S1	277	29449	410	F	14/06/2019 00:00:00	27.8.c	6	6	6	100	0	0
4140_S1	4140_S1	277	29450	410	F	14/06/2019 00:00:00	27.8.c	7	6	7	50	11	8
4141_S1	4141_S1	277	29451	400	F	14/06/2019 00:00:00	27.8.c	6	6	6	100	0	0
4144_S1	4144_S1	277	29452	350	F	14/06/2019 00:00:00	27.8.c	5	5	5	100	0	0
4146_S1	4146_S1	277	29453	370	F	14/06/2019 00:00:00	27.8.c	6	6	6	100	0	0
4147_S1	4147_S1	277	29454	320	F	14/06/2019 00:00:00	27.8.c	5	5	5	100	0	0
4150_S1	4150_S1	277	29455	320	F	14/06/2019 00:00:00	27.8.c	5	5	5	100	0	0
4152_S1	4152_S1	277	29456	330	F	14/06/2019 00:00:00	27.8.c	5	5	5	100	0	0
4153_S1	4153_S1	277	29457	300	M	14/06/2019 00:00:00	27.8.c	5	4	5	50	16	11
9002_S1	9002_S1	277	29458	248	M	27/03/2019 00:00:00	27.8.c	3	3	3	100	0	0
9013_S1	9013_S1	277	29459	328	F	03/04/2019 00:00:00	27.8.c	5	5	5	100	0	0
9021_S1	9021_S1	277	29460	303	F	03/04/2019 00:00:00	27.8.c	5	5	5	100	0	0
9024_S1	9024_S1	277	29461	348	F	03/04/2019 00:00:00	27.8.c	4	4	4	100	0	0
9028_S1	9028_S1	277	29462	311	M	03/04/2019 00:00:00	27.8.c	5	4	5	50	16	11
9031_S1	9031_S1	277	29463	288	M	03/04/2019 00:00:00	27.8.c	4	4	4	100	0	0
9033_S1	9033_S1	277	29464	372	F	03/04/2019 00:00:00	27.8.c	5	5	5	100	0	0
9034_S1	9034_S1	277	29465	316	F	03/04/2019 00:00:00	27.8.c	4	4	4	100	0	0
9043_S1	9043_S1	277	29466	424	F	09/05/2019 00:00:00	27.8.c	7	6	7	50	11	8
9051_S1	9051_S1	277	29467	394	F	09/05/2019 00:00:00	27.8.c	8	7	8	50	9	7
9052_S1	9052_S1	277	29468	335	F	09/05/2019 00:00:00	27.8.c	5	5	5	100	0	0
9053_S1	9053_S1	277	29469	450	F	09/05/2019 00:00:00	27.8.c	8	8	8	100	0	0
9054_S1	9054_S1	277	29470	341	F	09/05/2019 00:00:00	27.8.c	5	5	5	100	0	0
9056_S1	9056_S1	277	29471	454	F	09/05/2019 00:00:00	27.8.c	7	7	7	100	0	0
9058_S1	9058_S1	277	29472	445	F	09/05/2019 00:00:00	27.8.c	9	8	9	50	8	6
9060_S1	9060_S1	277	29473	364	F	09/05/2019 00:00:00	27.8.c	6	5	6	50	13	9
9062_S1	9062_S1	277	29474	421	F	09/05/2019 00:00:00	27.8.c	7	7	7	100	0	0

9063_S1	9063_S1	277	29475	430	F	09/05/2019 00:00:00	27.8.c	7	7	7	100	0	0
9076_S1	9076_S1	277	29476	452	F	23/05/2019 00:00:00	27.8.c	-	7	7	100	-	0
9078_S1	9078_S1	277	29477	467	F	23/05/2019 00:00:00	27.8.c	7	7	7	100	0	0
9079_S1	9079_S1	277	29478	396	F	23/05/2019 00:00:00	27.8.c	7	7	7	100	0	0
9080_S1	9080_S1	277	29479	415	F	23/05/2019 00:00:00	27.8.c	7	6	7	50	11	8
9081_S1	9081_S1	277	29480	402	F	23/05/2019 00:00:00	27.8.c	6	6	6	100	0	0
9091_S1	9091_S1	277	29481	355	F	23/05/2019 00:00:00	27.8.c	4	4	4	100	0	0
9092_S1	9092_S1	277	29482	347	F	23/05/2019 00:00:00	27.8.c	5	5	5	100	0	0
GLW0031_S1	GLW0031_S1	277	29483	236	M	10/04/2019 00:00:00	27.8.c	3	3	3	100	0	0
GLW0081_S1	GLW0081_S1	277	29484	251	M	12/04/2019 00:00:00	27.9.a	4	4	4	100	0	0
GLW0086_S1	GLW0086_S1	277	29485	236	M	15/04/2019 00:00:00	27.9.a	3	3	3	100	0	0
GLW0097_S1	GLW0097_S1	277	29486	249	M	15/04/2019 00:00:00	27.9.a	3	3	3	100	0	0
GLW0104_S1	GLW0104_S1	277	29487	223	M	16/04/2019 00:00:00	27.9.a	3	3	3	100	0	0
GLW0106_S1	GLW0106_S1	277	29488	210	M	16/04/2019 00:00:00	27.9.a	3	3	3	100	0	0

List of multimodal cases

Table A3.9: List of cases for which multiple modes where obtained when all readers are considered. 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
2	**2037_S2**
2	**2049_S2**
2	**2056_S2**
2	**2090_S2**
2	**2092_S2**
2	**2099_S2**
2	**2103_S2**
2	**2112_S2**
2	**2113_S2**
2	**2130_S2**
2	**2139_S2**
2	**2140_S2**
2	**2150_S2**
2	**2180_S2**
2	**2183_S2**
2	**2184_S2**
2	**2187_S2**
2	**2191_S2**
2	**2232_S2**
2	**2256_S2**

2	**2392_S2**
2	**2395_S2**
2	**2397_S2**
2	**2425_S2**
2	**2435_S2**
2	**2436_S2**
2	**2446_S2**
2	**4003_S1**
2	**4011_S1**
2	**4022_S1**
2	**4030_S1**
2	**4086_S1**
2	**4124_S1**
2	**4125_S1**
2	**4138_S1**
2	**4140_S1**
2	**4153_S1**
2	**9028_S1**
2	**9043_S1**
2	**9051_S1**
2	**9058_S1**
2	**9060_S1**
2	**9080_S1**

Number of age readings by modal age

Table A3.10: Number of age readings table gives an overview of number of readings per reader and modal age. The total numbers of readings by modal age and by reader are also presented.

Modal age	R01 ES	R03 ES	total
2	9	9	**18**
3	21	21	**42**
4	18	18	**36**
5	21	21	**42**
6	16	17	**33**
7	21	22	**43**
8	6	7	**13**
9	3	3	**6**
10	2	2	**4**
Total	**117**	**120**	**237**

Number of age readings by age

Table A3.11: Age composition by reader gives a summary of number of readings per reader and age. The total numbers of readings by age and by reader are also presented.

Age	R01 ES	R03 ES	total
1	0	5	**5**
2	9	7	**16**
3	21	18	**39**
4	18	22	**40**
5	21	21	**42**
6	16	17	**33**
7	21	17	**38**
8	6	10	**16**

9	3	3	**6**
10	2	0	**2**
Total	**117**	**120**	**237**

Separate age bias plots by reader

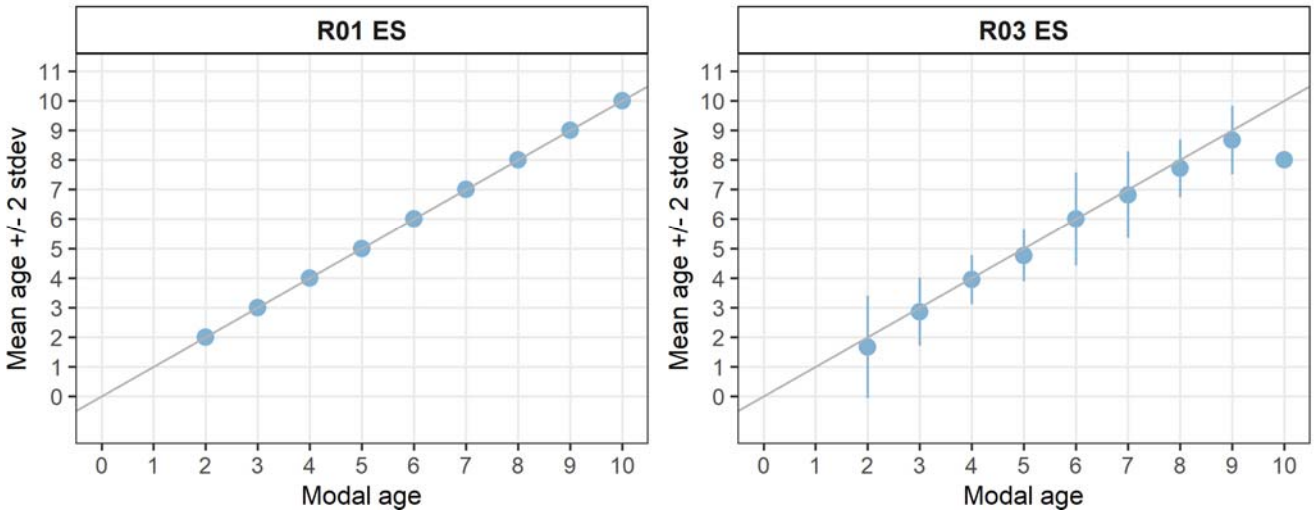


Figure A3.6: Age bias plot for each reader. Mean age recorded +/- 2 stdev of each reader is plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age.

Statistics by modal age plot (STDEV, CV and PA)

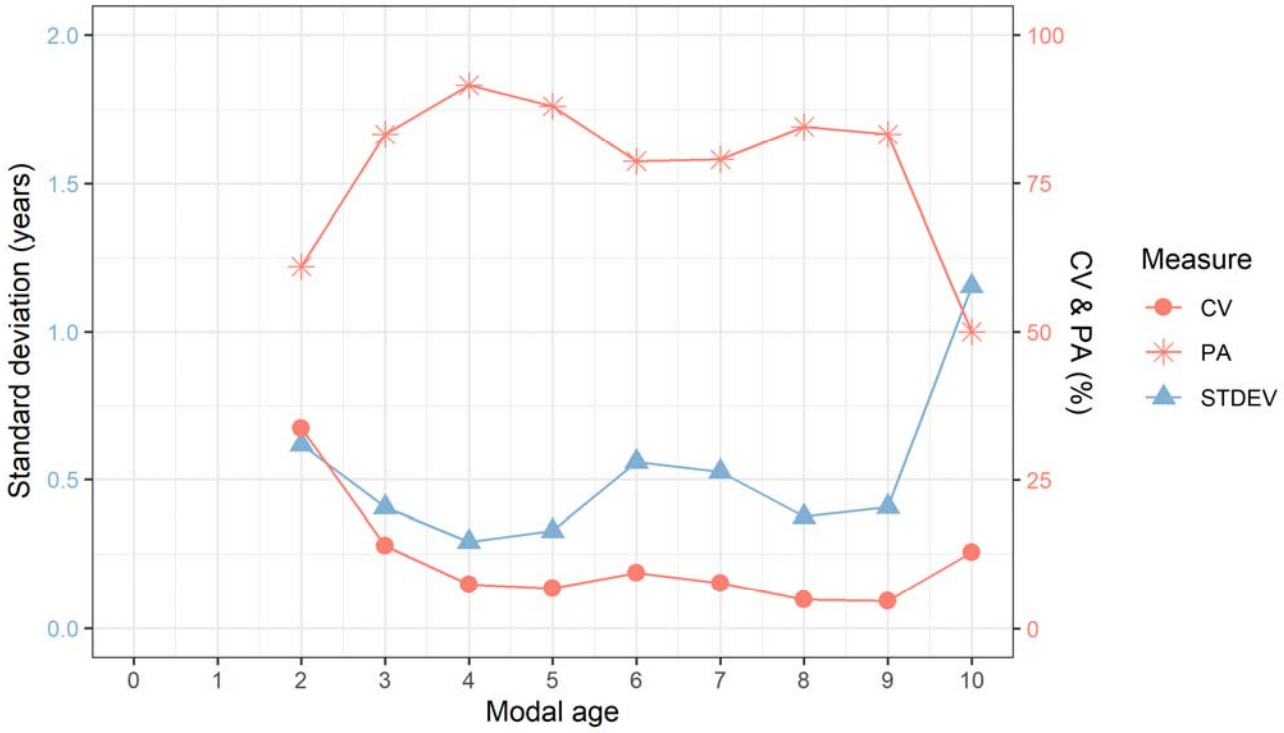


Figure A3.7: CV, PA and (STDEV (standard deviation) are plotted against modal age

Distribution of age reading errors

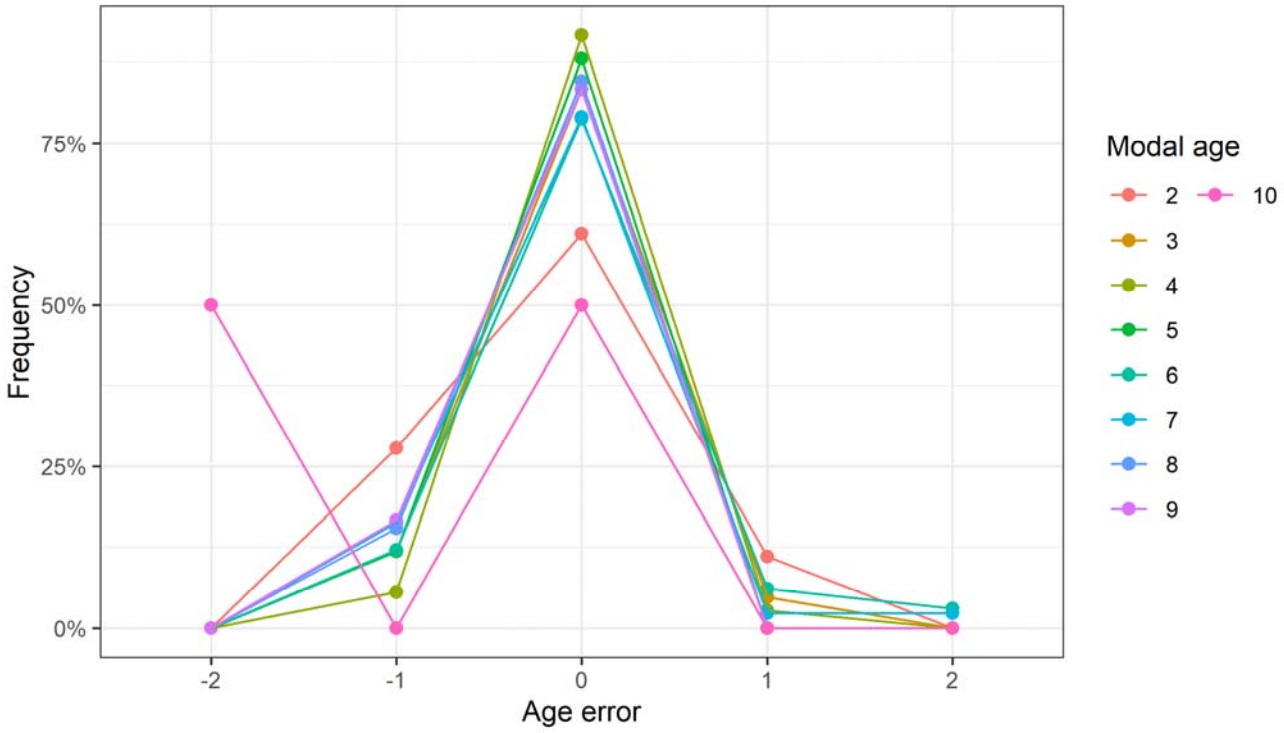


Figure A3.8: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

Relative bias for all readers

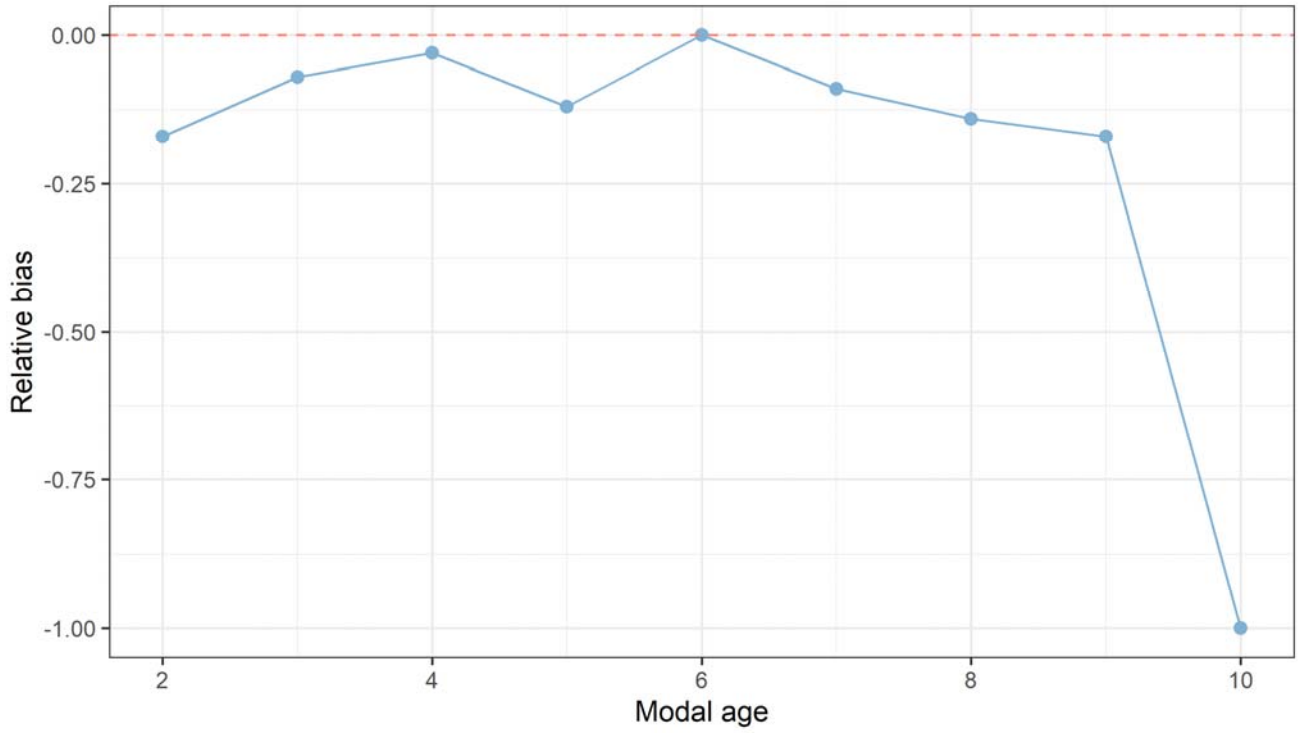


Figure A3.9: The relative bias by modal age as estimated by all age readers combined.

Mean length at age by reader

Table A3.12: Mean fish length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age. A weighted mean is also given.

Age	R01 ES	R03 ES
1	-	**218 mm**
2	226 mm	**254 mm**
3	269 mm	**264 mm**
4	308 mm	**309 mm**
5	334 mm	**339 mm**
6	378 mm	**390 mm**
7	413 mm	**415 mm**
8	418 mm	**445 mm**
9	417 mm	**417 mm**
10	454 mm	-
Weighted Mean	**339 mm**	**341 mm**

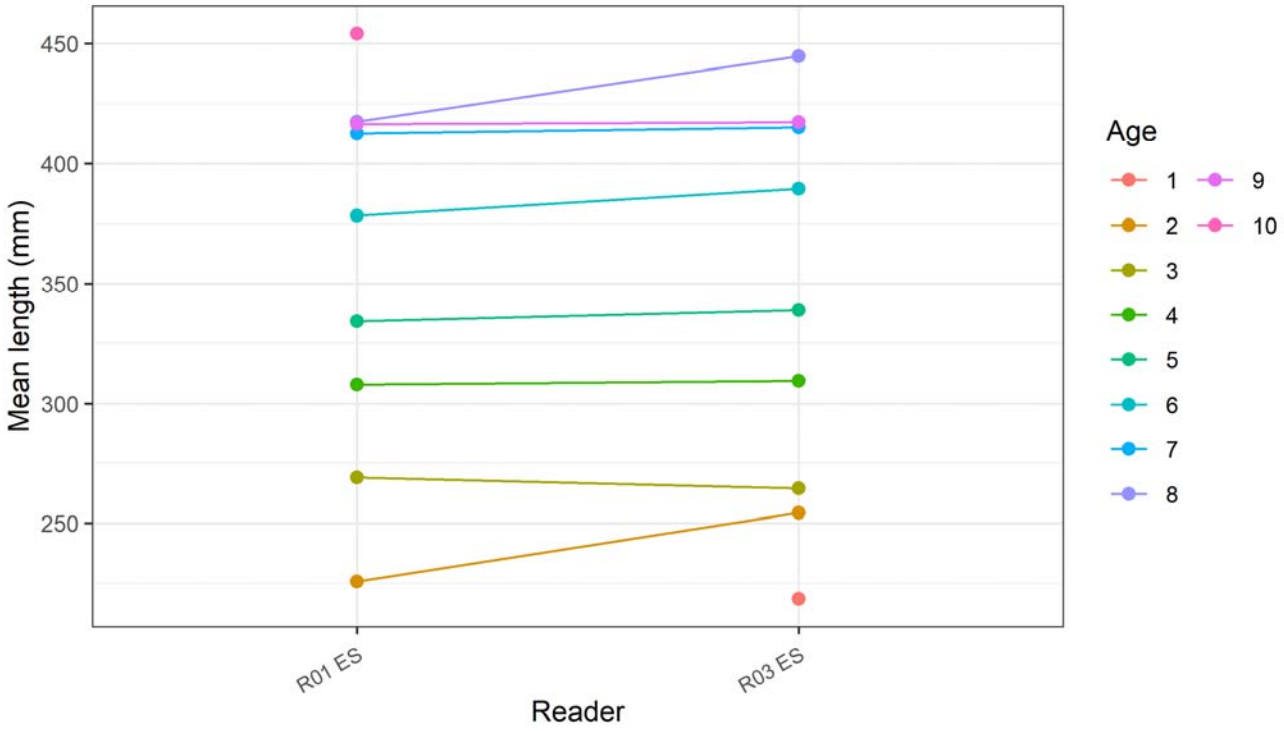


Figure A3.10: The mean fish length at age as estimated by each age reader.

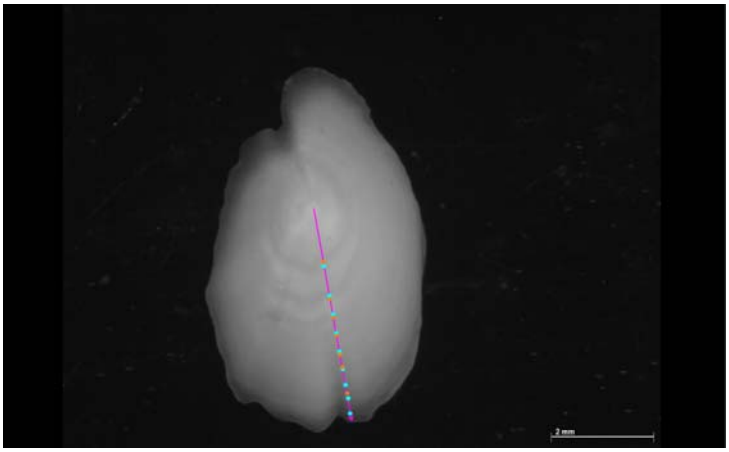


Figure A3.11. Example of age underestimation by a reader (R04) on an old otolith from the second half of the year. Location of the supposed annuli on otolith 2466_S2, considered to be of age 9 by most readers, including advanced readers. Note that of the last 3 hyaline increments considered as annual by the expert reader R01 (in blue), only one of them is taken into account by R04 (in orange) and therefore R04 underestimates the age (7 years old).

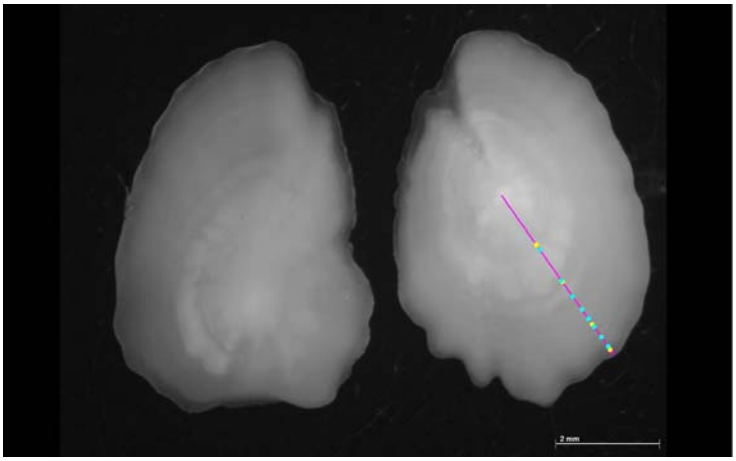


Figure A3.12. Example of age underestimation by a reader (R08) on an old otolith from the second half of the year. Location of the supposed annuli on otolith 2386_S2, considered to be of age 8 by most readers, including advanced readers. Note that the third hyaline increment and the penultimate one, considered as annual by the expert reader R01 (in blue), are not considered as annual by R08 (in yellow) and therefore underestimates the age (6 years).

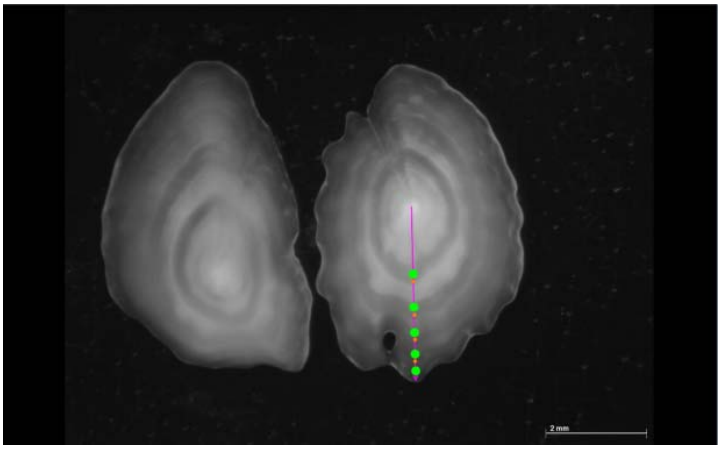


Figure A3.13. Example of age overestimation by a reader (R06) on an otolith from the second half of the year. Location of the supposed annual rings on otolith 2429_S2, considered to be of age 4 by most readers, including advanced readers. Note that R06 (in green) includes a supposed annulus close to the edge not considered as such by the expert reader R01 (in orange) and therefore overestimates the age (5 years).

12 Annex 5. Recommendations

All readers

On the one hand, it would be advisable for readers R04 and R08 to analyze in detail the results obtained regarding the underestimation of the age obtained, especially in otoliths older than 6 years. Similarly, reader R06 should analyse the overestimation of age observed, especially in otoliths older than 6 years.

R04, R06 and R08 are readers with not extensive experience in megrim age estimation (experience in megrim from 2017-2019). Reviewing the images in this Exchange, especially for ages older than 6, as well as the examples shown in Figure A3.11, Figure A3.12 and Figure A3.13, may help them improve their age interpretation criteria.

Considering the differential results between the two semesters obtained for some readers, such as R04, the interpretation of the edge type and the older annuli in otoliths mainly from the second semester are the main challenges to be solved for R04.

Stock assessment readers

Considering the good results of the readers providing age estimates for stock assessment, no specific recommendation are suggested for them.

General

It would be advisable to conduct a new exchange of this stock before 10 years or earlier if new readers join the interpretation of the age for its stock assessment.

A reference collection and training of the readers in older ages are **recommended**.