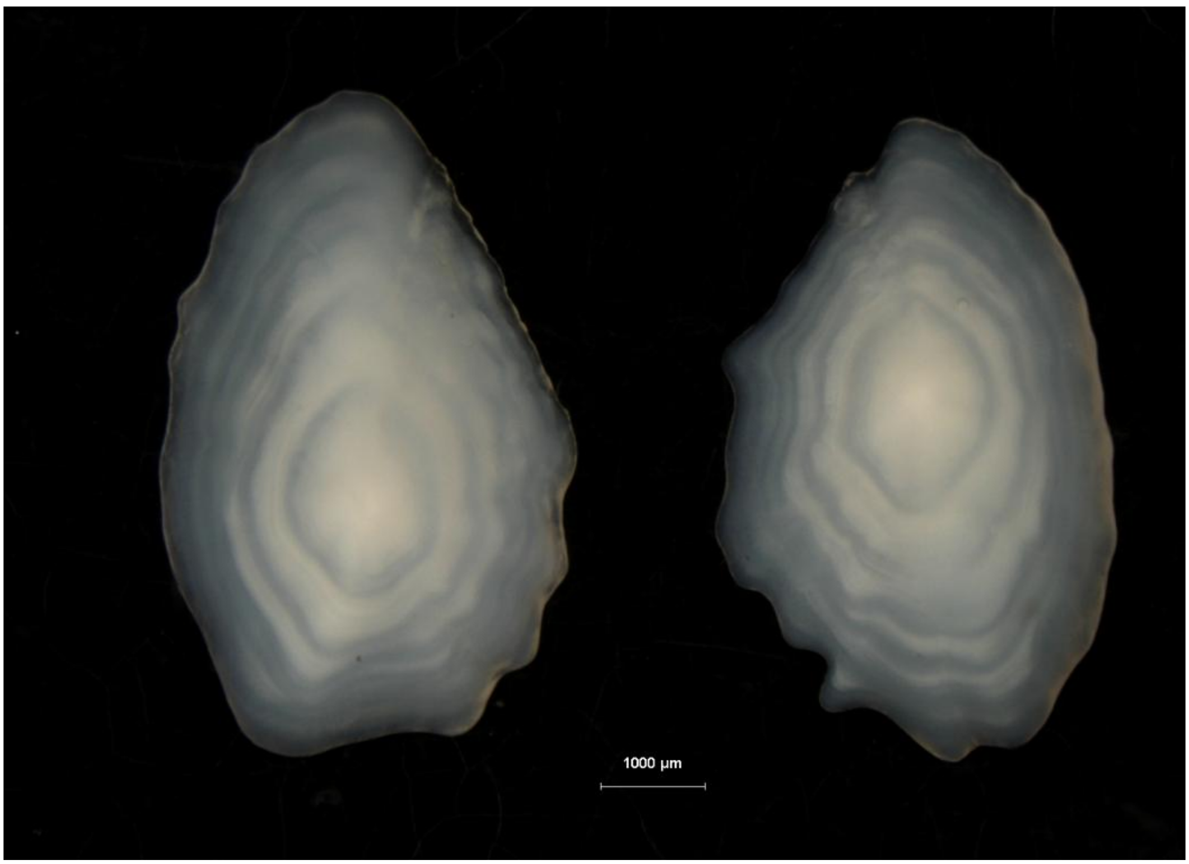
SmartDots Report for event 3985

Age Reading exchange of megrim

(*Lepidorhombus whiffiagonis*)



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May 2026

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1 Executive summary

This report presents the outcomes of SmartDots Event 3985, an international age-reading intercalibration exercise for megrim (*Lepidorhombus whiffiagonis*) within ICES areas 27.7b–k and 8abd. This exercise was conducted as a preliminary intercalibration ahead of the WKARMEG workshop to assess the consistency of age determination among participants. It also aimed to identify the main sources of disagreement and the most challenging aspects of age determination, thereby highlighting areas requiring further discussion during the workshop. The ultimate objective was to reduce uncertainty in the biological inputs used for stock assessments.

A total of 101 whole otoliths were analyzed by multiple readers with varying levels of expertise. Age estimates were evaluated using standard precision metrics, including percentage agreement (PA), coefficient of variation (CV), average percentage error (APE), and age bias analyses. In addition, a multistage modal age estimation approach, incorporating reader expertise, was applied alongside the traditional unweighted method.

Results indicate moderate overall agreement among all readers (PA 51%, CV 24%, APE 17%), with variability concentrated in younger and older age classes. The traditional modal age approach produced multiple modal ages in 17% of cases, whereas the multistage approach successfully resolved all ambiguities, demonstrating its effectiveness in improving consistency of assigned ages.

Performance improved substantially when analyses were restricted to advanced readers (PA 64%, CV 17%, APE 11%), with reduced bias and increased precision. Nevertheless, statistically significant differences persisted between some readers, indicating that full harmonization has not yet been achieved. The main issues identified were the recognition of the first annulus, the identification of split rings, and the interpretation of the otolith edge.

Overall, the exercise confirms that age estimation for this species remains subject to reader-dependent variability, particularly at the extremes of the age range. However, the application of the multistage modal age method and the restriction to validated readers increase the reliability of derived age data for stock assessment purposes.

It is recommended for WKARMEG to focus on standardizing interpretation criteria, addressing difficult age classes, and strengthening training to further reduce inter-reader variability and improve the robustness of age data used in ICES assessments. The follow-up workshop WKARMEG is foreseen in June 2026 in Boulogne to resolve the issues.

2 Terms of reference

- Resolve differences in age interpretation between readers of different countries which has catch in this stock.
- Analyze the results of SmartDots intercalibration event; ICES Science plan 3.3, 4.1
- Clarify the interpretation of annual growth rings using otolith (Science Plan codes: 3.1, 3.2 and 5.2).

3 Introduction

The ICES Working Group on Biological Parameters (WGBIOP) in 2025 established the need to perform an age calibration workshop of megrim (*Lepidorhombus whiffiagonis*) from ICES Div. **7.b–k and 8.a, 8.b, and 8.d** in 2026, coordinated by Karen Bekaert (ILVO, Belgium) and Larissa Modica (CSIC-IEO, Spain). This report presents the outcomes of SmartDots Event 3985, an international age-reading intercalibration exercise for megrim (*Lepidorhombus whiffiagonis*) within ICES areas 27.7b–k and 8abd. This exercise was conducted as a preliminary intercalibration ahead of the WKARMEG workshop to assess the consistency of age determination among participants. It also aimed to identify the main sources of disagreement and the most challenging aspects of age determination, thereby highlighting areas requiring further discussion during the workshop.

Biology of megrim

Megrim (*Lepidorhombus whiffiagonis*) is a bottom-living flatfish that is found on muddy and sandy bottoms along the continental shelf at depths from 20 m up to 700 m in northeast Atlantic and Mediterranean (Macdonald et al., 2013). In the northeast Atlantic its distribution covers a very wide area, from Iceland to Cape Bojador (Sánchez et al., 1998; Fernández-Zapico et al., 2017). Megrim is a relatively slow-growing fish with a north-south gradient of growth. Greater lengths and ages are found in northern areas of its distribution (Landa and Piñeiro, 2000). The first three age classes show the greatest variation in growth, with a higher growth rate in southern areas with females growing faster and attaining larger sizes than males (Landa et al., 1996). Females may live longer and reach greater ages and lengths than males, showing clear sexual dimorphism in growth (Landa et al., 1996). Megrim can grow up to 60 cm TL, but common length in landings is between 24 and 37 cm (ICES 2025).

Spawning mainly occurs from January to April in many parts of its range, although timing can vary geographically (Macdonald et al., 2013). Spawning in the 27.7b-k, 8abd occurs mainly in January to early march (Dominguez-Petit et al., 2022). Sexual maturity is reached around 3 years in females and 1.7 years in males, although this can be influenced by location and environmental conditions (ICES, 2023; Macdonald et al., 2013). It is long lived, reaching 17 years for females and 11 years for males. This species shows sexual dimorphism, i.e. growth is very different in males and females until reaching the sexual maturity (Table 1:).

Table 1: Values of the L50 (Length at first maturity) and A50 (Age at first maturity) for megrim belonging to stock meg.27.7b -k,8abd. L50 is expressed as Total length in centimetres; A50 is expressed in years.

Stock	Sex	L50 (cm)	A50 (Y)	Reference
meg.27.7b-k,8abd	Female	25.4	~3	ICES, 2023
meg.27.7b-k,8abd	Male	15.2	~1.7	ICES, 2023

Management of megrim

Megrim is a flatfish which is widely distributed across Europe from the Mediterranean area to the northern part of the Atlantic area.

ICES (the International Council for the Exploration of the Sea) has identified that the management of megrim fisheries should be based on four separate stocks because the species is distributed across distinct geographical areas with different population dynamics. This stock division allows for more accurate scientific assessments and sustainable management measures tailored to each population.

The four megrim stocks identified by ICES are:

- West and southwest of Ireland, Bay of Biscay meg.27.7b-k8abd for *Lepidorhombus whiffiagonis*
- Cantabrian Sea and Atlantic Iberian waters meg.27.8c9a for *Lepidorhombus whiffiagonis*
- Northern North Sea and West of Scotland lez.27.4a6a, mixed stock for *Lepidorhombus whiffiagonis* and *Lepidorhombus boscii*
- Rockall lez.27.6b, mixed stock for *Lepidorhombus whiffiagonis* and *Lepidorhombus boscii*

The megrim stock in ICES divisions 7.b–k and 8.a, 8.b, and 8.d is exploited by six countries, although more than 90% of the total landings are accounted for by four countries: France, Spain, Ireland, and the United Kingdom, in that order (ICES, 2024). The most recent stock assessment revealed several methodological concerns, resulting in advice recommending a 30% reduction in catches for 2026 compared with the previous year (ICES, 2025). To help mitigate these limitations and improve future assessments, the advice report identified several priority actions, including reducing inter-country variability in age determinations and incorporating an ageing error matrix into the next assessment process (ICES, 2025). These recommendations provided the rationale for undertaking the present exchange and the WKARMEG 2026 workshop.

Setup of the exchange

The exchange exercise included 101 images of whole megrim otoliths. Age ranged between 1-10 years and length between 96 – 530 mm. Eleven readers from five countries annotated the images in SmartDots. Form those readers, six were advanced (data used for stock assessments) and five were basic. The otolith images were selected based on stratification by age class, area and quarter.

4 Methods

This report contains statistical analyses and comparisons of age readings in the form of tables and graphical plots.

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 SmartDots 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 imply 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.

Percentage Agreement (PA)

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

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

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

Age error matrix (AEM)

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

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.

5 Overview of samples and readers

Table 2: Overview of samples used for the exchange event number 3985

Year	ICES area	Strata	Quarter	Number of samples	Modal age range	Length range
2021	27.7.e	Strata_WH	3	1	6	375 mm
2022	27.7.e	Strata_WH	4	1	6	405 mm
2022	27.8.a	Strata_WH	2	4	2-7	180-395 mm
2023	27.7.g	Strata_WH	2	3	4-10	295-490 mm
2023	27.8.a	Strata_WH	3	1	8	275 mm
2024	27.7.b	Strata_WH	3	2	1-3	95-160 mm
2024	27.7.c.2	Strata_WH	3	2	4-10	155-480 mm
2024	27.7.e	Strata_WH	2	3	2-8	175-455 mm
2024	27.7.e	Strata_WH	3	2	1-5	180-285 mm
2024	27.7.f	Strata_WH	2	4	3-7	230-410 mm
2024	27.7.f	Strata_WH	3	3	3-8	270-480 mm
2024	27.7.f	Strata_WH	4	2	6-7	300-400 mm
2024	27.7.g	Strata_WH	4	1	8	350 mm
2024	27.7.h	Strata_WH	2	1	5	270 mm
2024	27.7.h	Strata_WH	3	3	5-9	285-475 mm
2024	27.8.a	Strata_WH	1	5	2-8	155-410 mm
2025	27.7.b	Strata_WH	3	3	2-4	135-200 mm
2025	27.7.c.2	Strata_WH	3	2	2-9	130-555 mm
2025	27.7.c.2	Strata_WH	4	9	2-10	120-335 mm
2025	27.7.g	Strata_WH	1	1	4	280 mm
2025	27.7.h	Strata_WH	1	3	5-8	285-440 mm
2025	27.7.j	Strata_WH	1	3	7-10	415-530 mm
2025	27.7.j	Strata_WH	2	8	6-10	310-530 mm
2025	27.7.k.2	Strata_WH	2	19	3-10	260-420 mm
2025	27.7.k.2	Strata_WH	3	4	1	145-150 mm
2025	27.7.k.2	Strata_WH	4	1	9	270 mm
2025	27.8.b	Strata_WH	1	10	2-9	210-445 mm

Table 3: Reader overview.

Reader code	Expertise	Expertise_rank	strata
R02 ES	Advanced	2	Strata_WH
R04 GB	Advanced	4	Strata_WH
R06 BE	Advanced	6	Strata_WH
R08 ES	Advanced	8	Strata_WH
R10 BE	Advanced	10	Strata_WH
R12 FR	Advanced	12	Strata_WH
R16 FR	Basic	16	Strata_WH
R18 IE	Basic	18	Strata_WH
R20 IE	Basic	20	Strata_WH
R22 ES	Basic	22	Strata_WH
R26 ES	Basic	26	Strata_WH

6 Results

6.1 All readers

In this exchange event, 101 otolith fish individuals were aged (Table 4). Of those, 17 % showed multiple modes when the traditional approach (all readers equally weighted) is used to define the mode (Table 4). The percentage of multiple mode cases is reduced to 0 % when multistage approach is applied (Table 4). The complete list of cases with multiple modes is presented in Table 5, where the ageing from each of the readers participating in the exchange event is presented.

Multimodal cases

Table 4**:** 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
101	17 %	3 %	0 %	0 %

List of multimodal cases

Table 5**:** List of cases for which multiple modes were 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	BYDR07_MEG_D_M_8A_202207221049
2	BYDR08_MEG_D_7E_M_2024101710423
2	BYDR08_MEG_L_7E_M_2024101710346
2	C119_LW_T333_S2_VIGO2_SEM1
2	C12_LW_T97_S2_L37_PR24_SEM2
3	C265_LW_T415_S1_VIGO2_SEM1
2	C276_LW_T418_S2_VIGO2_SEM1
2	C3_LW_T150_S2_L12_PR25
2	C381_LW_T472_S2_VIGO2_SEM1
2	C382_LW_T532_S2_VIGO2_SEM1
2	C392_LW_T471_S2_VIGO2_SEM1
2	C86_LW_T486_S2_VIGO2_SEM1
2	CDDR04_MEG_L_7G_M_2025040920122
2	CDDR06_MEG_L_7H_M_2025060210098
2	CNVE02_MEG_L_7H_2025020410097
2	CNVE05_MEG_D_7F_M_2025040510251

NModes_trad	SampleID
2	NKSZ02_MEG_L_7F_M_2025022610103
2	**NKSZ08_MEG_D_7F_M_2024093010149**

Summary statistics

Table 6: 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
101	24 %	51 %	17 %

In this exchange event, 101 otolith fish individuals were aged. Of those, 17 %when the traditional approach (all readers equally weighted) is used to define the mode. The percentage of multiple mode cases is reduced to 0 %. The complete list of cases is presented in table 30 in the annex 1 where the ageing from each of the readers participating in the exchange event is presented. 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 51 %, with the weighted average CV of 24 % and APE of 17 %.

Coefficient of Variation (CV)

Table 7: 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	all
1	61 %	35 %	61 %	0 %	45 %	35 %	60 %	84 %	39 %	35 %	39 %	**62 %**
2	33 %	27 %	26 %	22 %	40 %	21 %	39 %	25 %	27 %	44 %	41 %	**37 %**
3	23 %	12 %	18 %	0 %	19 %	35 %	50 %	22 %	16 %	21 %	13 %	**24 %**
4	23 %	11 %	0 %	17 %	8 %	10 %	27 %	40 %	23 %	31 %	44 %	**26 %**
5	13 %	11 %	0 %	11 %	9 %	9 %	18 %	14 %	17 %	19 %	15 %	**14 %**
6	9 %	8 %	13 %	17 %	13 %	12 %	19 %	15 %	26 %	22 %	24 %	**19 %**
7	9 %	14 %	16 %	17 %	15 %	12 %	11 %	22 %	23 %	18 %	17 %	**18 %**
8	11 %	7 %	9 %	14 %	4 %	6 %	15 %	19 %	19 %	23 %	21 %	**18 %**
9	14 %	26 %	16 %	21 %	8 %	24 %	14 %	30 %	24 %	39 %	33 %	**26 %**
10	5 %	10 %	19 %	8 %	11 %	17 %	13 %	15 %	16 %	23 %	22 %	**19 %**
Weighted Mean	**18 %**	**14 %**	**15 %**	**14 %**	**16 %**	**16 %**	**24 %**	**25 %**	**23 %**	**27 %**	**27 %**	**24 %**

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 8**:** 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	**R02 ES**	**R04 GB**	**R06 BE**	**R08 ES**	**R10 BE**	**R12 FR**	**R16 FR**	**R18 IE**	**R20 IE**	**R22 ES**	**R26 ES**	**total**
1	83 %	0 %	33 %	100 %	33 %	17 %	17 %	80 %	0 %	83 %	67 %	**46 %**
2	73 %	55 %	73 %	82 %	55 %	73 %	0 %	78 %	55 %	36 %	45 %	**56 %**
3	71 %	86 %	71 %	100 %	71 %	14 %	0 %	57 %	57 %	57 %	86 %	**61 %**
4	64 %	82 %	100 %	55 %	91 %	82 %	45 %	9 %	36 %	27 %	27 %	**56 %**
5	64 %	73 %	100 %	73 %	82 %	82 %	55 %	73 %	82 %	27 %	36 %	**68 %**
6	71 %	77 %	69 %	54 %	54 %	71 %	14 %	58 %	50 %	36 %	29 %	**53 %**
7	45 %	36 %	55 %	36 %	64 %	55 %	55 %	36 %	36 %	45 %	55 %	**47 %**
8	50 %	71 %	50 %	36 %	86 %	79 %	43 %	31 %	29 %	29 %	36 %	**49 %**
9	14 %	29 %	86 %	50 %	43 %	29 %	43 %	17 %	14 %	14 %	14 %	**32 %**
10	78 %	44 %	11 %	56 %	56 %	33 %	22 %	22 %	44 %	22 %	22 %	**37 %**
Weighted Mean	**61 %**	**59 %**	**66 %**	**61 %**	**66 %**	**59 %**	**31 %**	**45 %**	**43 %**	**36 %**	**40 %**	**51 %**

Average Percentage Error (APE)

Table 9**:** 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	**R02 ES**	**R04 GB**	**R06 BE**	**R08 ES**	**R10 BE**	**R12 FR**	**R16 FR**	**R18 IE**	**R20 IE**	**R22 ES**	**R26 ES**	**all**
1	42 %	24 %	50 %	0 %	33 %	26 %	44 %	**60 %**	33 %	24 %	33 %	**47 %**
2	27 %	23 %	16 %	16 %	29 %	17 %	24 %	**11 %**	23 %	39 %	35 %	**27 %**
3	18 %	8 %	15 %	0 %	10 %	30 %	42 %	**16 %**	14 %	19 %	9 %	**14 %**
4	15 %	8 %	0 %	14 %	4 %	7 %	18 %	**33 %**	19 %	26 %	38 %	**19 %**
5	7 %	6 %	0 %	6 %	4 %	4 %	11 %	**9 %**	11 %	15 %	13 %	**8 %**
6	6 %	5 %	7 %	12 %	9 %	7 %	14 %	**12 %**	17 %	17 %	19 %	**11 %**
7	8 %	11 %	13 %	13 %	11 %	9 %	9 %	**17 %**	19 %	14 %	14 %	**13 %**
8	8 %	5 %	8 %	10 %	3 %	3 %	12 %	**17 %**	14 %	19 %	17 %	**11 %**
9	11 %	16 %	10 %	16 %	7 %	19 %	11 %	**24 %**	18 %	31 %	26 %	**17 %**
10	2 %	7 %	15 %	7 %	9 %	14 %	11 %	**13 %**	12 %	19 %	17 %	**14 %**
Weighted Mean	**13 %**	**10 %**	**11 %**	**10 %**	**11 %**	**12 %**	**18 %**	**19 %**	**18 %**	**22 %**	**22 %**	**17 %**

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 10**:** 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	all
1	0.33	1.33	1.67	0.00	1.00	1.17	2.00	0.60	2.50	0.17	0.33	**1.01**
2	0.45	0.55	0.09	-0.18	0.18	0.27	1.00	0.00	0.55	-0.45	-0.36	**0.19**
3	0.43	0.14	-0.29	0.00	0.00	-0.29	0.14	0.14	0.43	-0.43	-0.14	**0.01**
4	0.18	-0.18	0.00	-0.27	-0.09	0.18	0.00	-0.18	0.45	-1.18	-1.18	**-0.21**
5	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.18	0.36	-0.64	-0.45	**-0.03**
6	0.14	-0.08	-0.08	-0.15	0.23	0.07	-0.79	0.67	0.93	-0.71	-0.50	**-0.02**
7	0.64	0.18	0.64	0.18	0.45	0.18	-0.55	1.09	1.36	-0.64	-0.82	**0.25**
8	0.14	0.14	0.71	-0.07	0.14	0.07	-1.00	1.31	1.57	-0.93	-1.14	**0.09**
9	-0.14	-0.86	0.57	-0.50	0.29	-0.43	-0.29	2.83	2.00	-1.71	-1.29	**0.04**
10	0.00	-0.22	0.11	-0.56	-0.44	-0.56	-1.67	2.44	0.56	-1.78	-1.44	**-0.32**
Weighted Mean	**0.22**	**0.09**	**0.30**	**-0.13**	**0.15**	**0.06**	**-0.24**	**0.85**	**1.01**	**-0.84**	**-0.74**	**0.06**

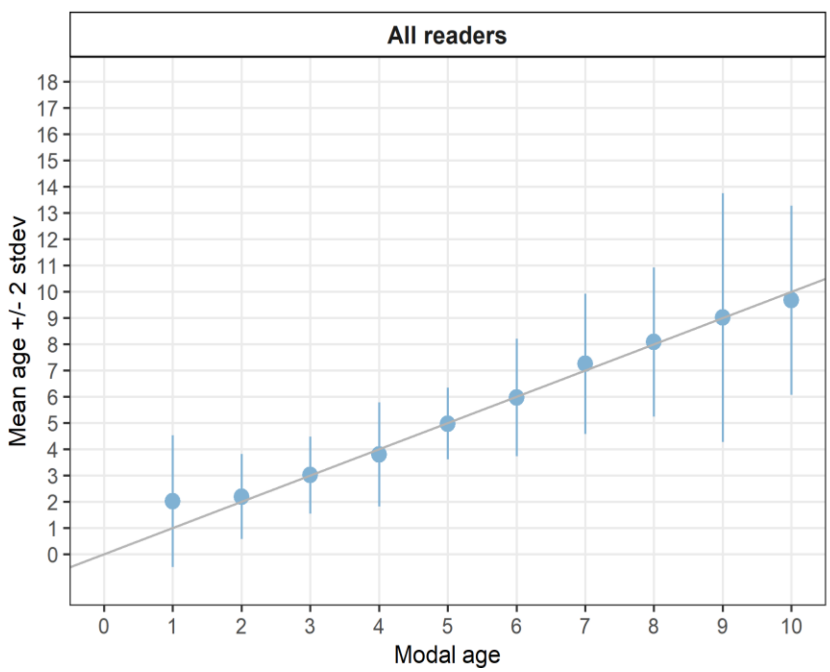

Figure 1: Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between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

Inter-reader bias test

Table 11**:** 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) , / = diagonal of the tab le (no bias)

Comparison	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES
R02 ES	/	**	**	-	**	**	-	-	-	**	**
R04 GB	**	/	**	**	**	**	*	-	**	**	**
R06 BE	**	**	/	-	**	**	-	-	-	**	**
R08 ES	-	**	-	/	-	**	*	**	**	**	-
R10 BE	**	**	**	-	/	**	-	-	-	**	**
R12 FR	**	**	**	**	**	/	-	-	*	**	**
R16 FR	-	*	-	*	-	-	/	*	**	-	**
R18 IE	-	-	-	**	-	-	*	/	**	**	**
R20 IE	-	**	-	**	-	*	**	**	/	**	**
R22 ES	**	**	**	**	**	**	-	**	**	/	**
R26 ES	**	**	**	-	**	**	**	**	**	**	/
Modal age	*	**	-	*	-	**	-	*	**	**	*

Growth analysis

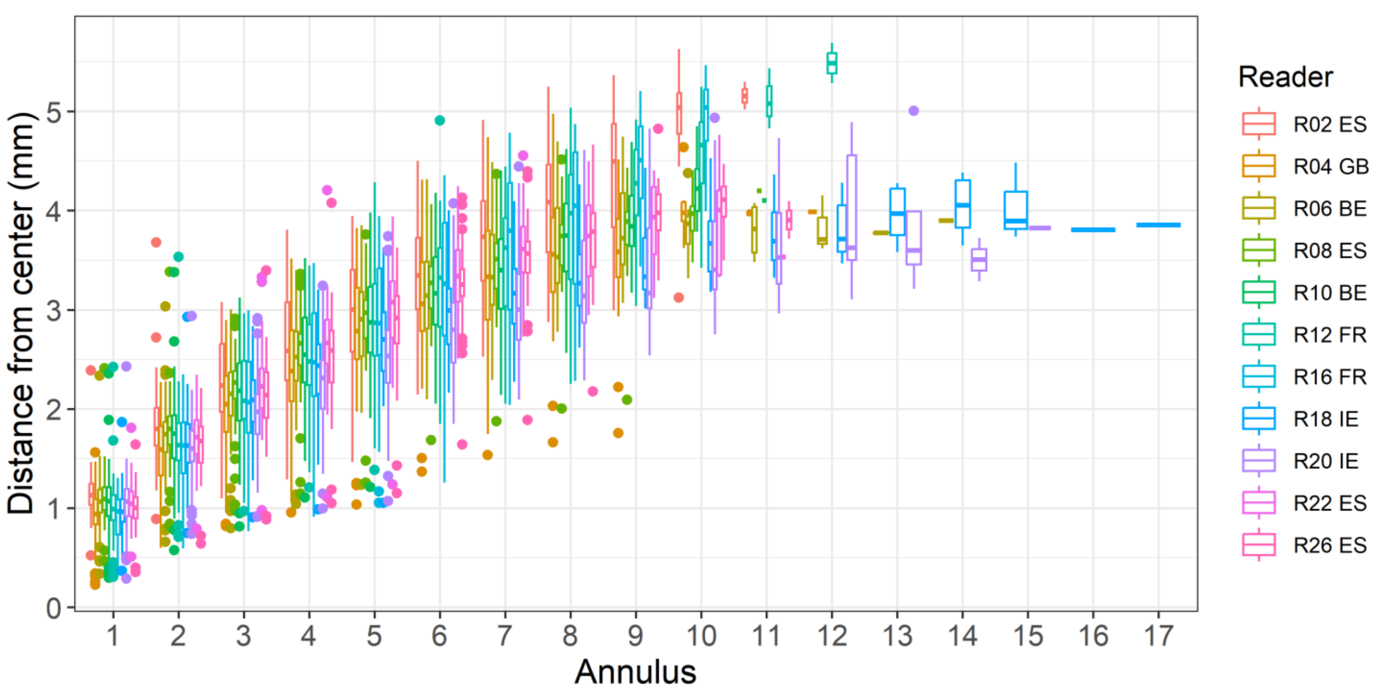

Figure 2: Plot of average distance from the centre to the winter rings for all readers. The boxes represent the median, upper and lower box boundaries of the interquartile range, whiskers represent the minimum and maximum values and the dots represent the outliers.

6.2 Advanced readers

Multimodal cases

Table 12: 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
101	18 %	2 %	0 %	0 %

Summary statistics

Table 13: 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
101	17 %	64 %	11 %

In this exchange event, 101 otolith fish individuals were aged. Of those, 18 %when the traditional approach (all readers equally weighted) is used to define the mode. The percentage of multiple mode cases is reduced to 0 %. The complete list of cases with multiple modes is presented in table 35 in the annex 1 section, where the ageing from each of the readers participating in the exchange event is presented. 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 64 %, with the weighted average CV of 17 % and APE of 11 %.

Coefficient of Variation (CV)

Table 14: 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	all
1	67 %	40 %	75 %	0 %	58 %	41 %	**61 %**
2	38 %	21 %	27 %	30 %	34 %	20 %	**29 %**
3	23 %	12 %	18 %	0 %	19 %	35 %	**21 %**
4	24 %	13 %	14 %	21 %	23 %	17 %	**20 %**
5	11 %	11 %	0 %	11 %	11 %	9 %	**9 %**
6	10 %	7 %	9 %	13 %	10 %	13 %	**11 %**
7	5 %	10 %	9 %	14 %	6 %	14 %	**10 %**
8	7 %	5 %	8 %	13 %	9 %	9 %	**9 %**
9	10 %	21 %	13 %	15 %	5 %	15 %	**15 %**
10	3 %	12 %	18 %	8 %	12 %	16 %	**12 %**
11	-	-	-	-	-	-	**15 %**
Weighted Mean	**17 %**	**13 %**	**15 %**	**14 %**	**16 %**	**17 %**	**17 %**

Percentage of Agreement (PA)

Table 15**:** 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	total
1	75 %	0 %	50 %	100 %	50 %	25 %	**50 %**
2	67 %	67 %	67 %	67 %	67 %	75 %	**68 %**
3	71 %	86 %	71 %	100 %	71 %	14 %	**69 %**
4	62 %	77 %	92 %	54 %	85 %	69 %	**73 %**
5	73 %	73 %	100 %	73 %	73 %	82 %	**79 %**
6	77 %	83 %	67 %	67 %	58 %	62 %	**69 %**
7	88 %	50 %	62 %	50 %	75 %	50 %	**62 %**
8	69 %	85 %	54 %	23 %	77 %	77 %	**64 %**
9	30 %	50 %	70 %	44 %	60 %	20 %	**46 %**
10	89 %	44 %	22 %	56 %	44 %	33 %	**48 %**
11	100 %	0 %	0 %	100 %	0 %	0 %	**33 %**
Weighted Mean	**69 %**	**66 %**	**67 %**	**60 %**	**67 %**	**55 %**	**64 %**

Average Percentage Error (APE)

Table 16**:** 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	all
1	50 %	30 %	64 %	0 %	50 %	25 %	**49 %**
2	23 %	19 %	19 %	27 %	24 %	17 %	**20 %**
3	18 %	8 %	15 %	0 %	10 %	30 %	**11 %**
4	17 %	7 %	7 %	17 %	14 %	12 %	**11 %**
5	7 %	6 %	0 %	6 %	6 %	4 %	**5 %**
6	8 %	3 %	7 %	8 %	8 %	9 %	**7 %**
7	3 %	8 %	6 %	10 %	5 %	10 %	**6 %**
8	5 %	2 %	7 %	11 %	4 %	5 %	**5 %**
9	8 %	13 %	9 %	12 %	5 %	12 %	**11 %**
10	2 %	8 %	14 %	7 %	10 %	12 %	**9 %**
11	0 %	0 %	0 %	0 %	0 %	0 %	**13 %**
Weighted Mean	**12 %**	**9 %**	**11 %**	**11 %**	**11 %**	**12 %**	**11 %**

Relative Bias

Most of the bias for the advanced readers is concentrated in the younger age classes 1 and 2) with high tendency to overestimate especially in age 1 (Table 17).

Table 17**:** 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	all
1	0.50	1.50	1.75	0.00	1.00	1.00	**0.96**
2	0.08	0.33	0.17	-0.33	0.25	0.25	**0.12**
3	0.43	0.14	-0.29	0.00	0.00	-0.29	**0.00**
4	0.31	-0.08	-0.15	-0.38	-0.31	0.23	**-0.06**
5	-0.09	0.09	0.00	0.09	0.09	0.00	**0.03**
6	0.31	0.00	0.17	-0.08	0.25	0.15	**0.13**
7	0.12	-0.25	-0.12	-0.12	0.25	0.12	**0.00**
8	0.15	0.00	0.54	-0.23	0.00	-0.15	**0.05**
9	-0.60	-0.60	0.60	-0.67	0.40	-1.10	**-0.33**
10	0.11	-0.33	0.22	-0.56	-0.67	-0.44	**-0.28**
11	0.00	-2.00	-2.00	0.00	-3.00	1.00	**-1.00**
Weighted Mean	**0.11**	**-0.02**	**0.19**	**-0.24**	**0.04**	**-0.05**	**0.00**

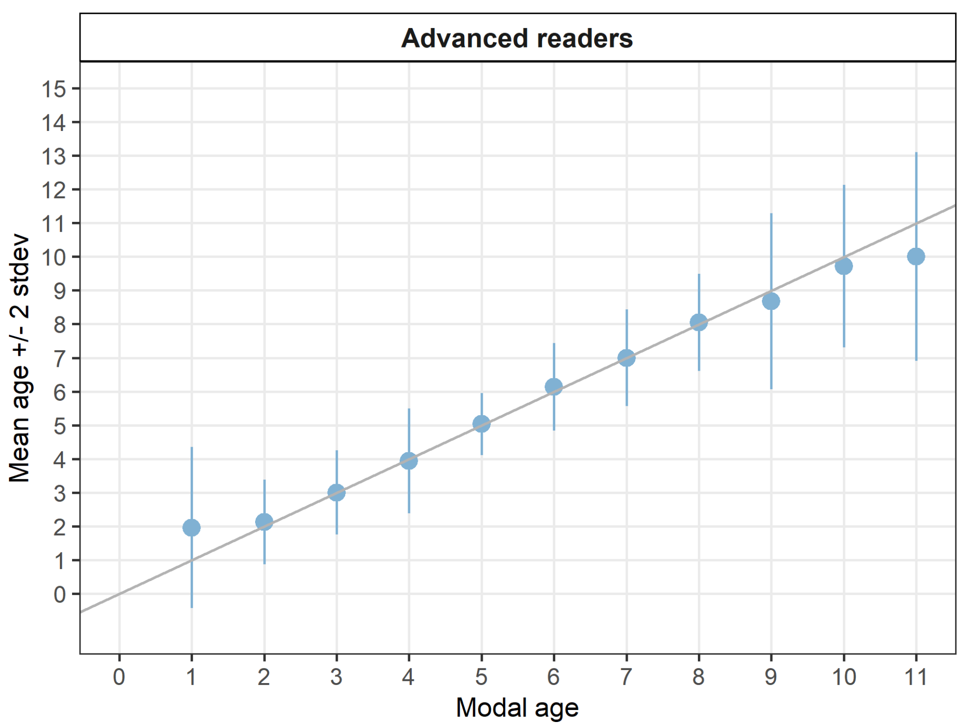

Figure 3: Age bias plot for advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference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

Growth analysis

The results from the growth analysis showed high variability in all the length classes both between readers and also in some case within each reader (large box plot whiskers and IQR) with some cases with very high variation especially in older age classes (Figure 4).

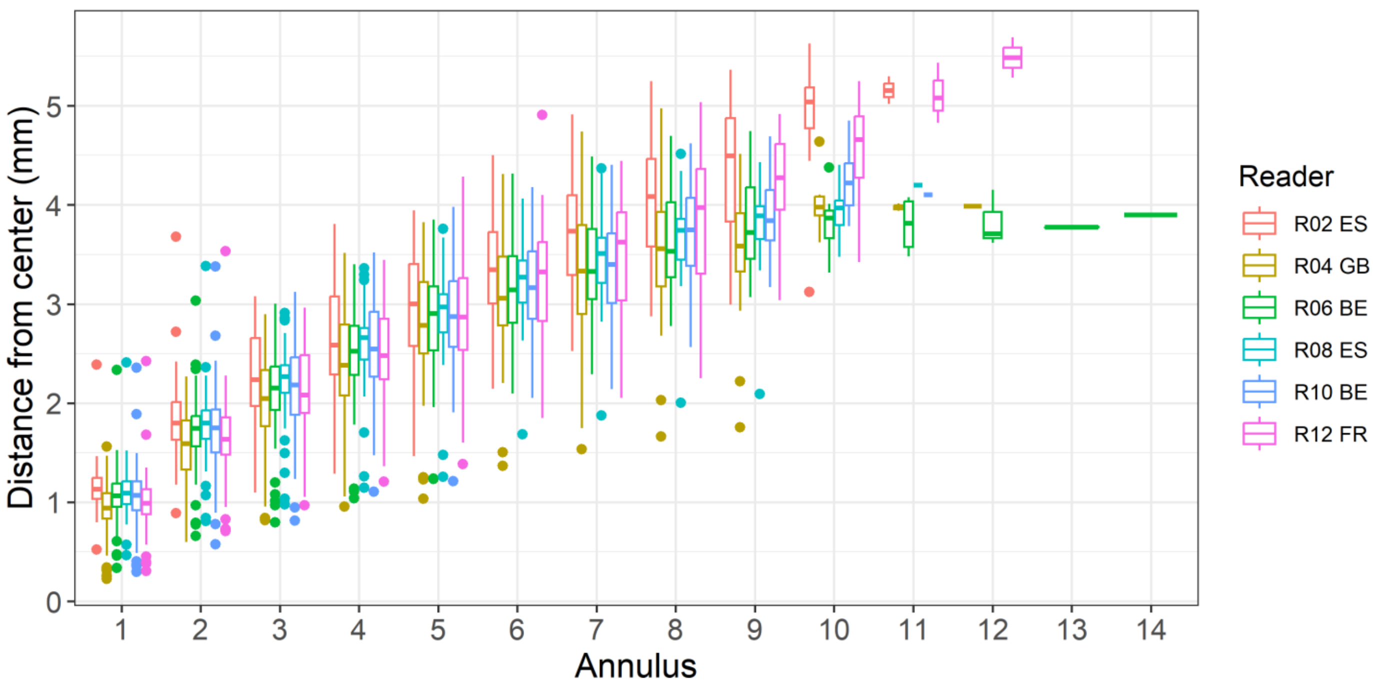

Figure 4: Plot of average distance from the centre to the winter rings for advanced readers. The boxes represent the mean, upper and lower box boundaries of the interquartile range, whiskers represent the minimum and maximum values and the dots represent the outliers.

General Age Error Matrix (AEM)

Age error matrix provides a useful benchmark. Diagonal agreement is highest for ages 4-6 (0.69-0.79) and gradually decreases for ages 7-10 (0.46-0.64). Errors are predominantly restricted to adjacent ages, indicating a generally consistent ageing process across the stock as a whole (Table 18).

Table 18: General Age error matrix (AEM). The modal age is in rows and the age classifications by the advanced readers in columns.

modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	0.50	0.21	0.17	0.08	0.04	-	-	-	-	-	-	-	-	-	1.00
2	0.11	0.68	0.18	0.03	-	-	-	-	-	-	-	-	-	-	1.00
3	-	0.17	0.69	0.12	0.02	-	-	-	-	-	-	-	-	-	1.00
4	0.01	0.04	0.10	0.73	0.08	0.04	-	-	-	-	-	-	-	-	1.00
5	-	-	-	0.09	0.79	0.12	-	-	-	-	-	-	-	-	1.00
6	-	-	-	-	0.11	0.69	0.16	0.04	-	-	-	-	-	-	1.00
7	-	-	-	-	0.02	0.17	0.62	0.17	0.02	-	-	-	-	-	1.00
8	-	-	-	-	-	0.03	0.13	0.64	0.18	0.03	-	-	-	-	1.01
9	-	-	-	0.02	-	0.03	0.08	0.22	0.46	0.15	0.02	-	0.02	-	1.00
10	-	-	-	-	-	-	0.02	0.13	0.22	0.48	0.07	0.06	-	0.02	1.00
11	-	-	-	-	-	-	-	0.17	0.33	-	0.33	0.17	-	-	1.00

AEM by ICES area

Although not all areas included all age classes, several patterns emerged from the analysed data. Overall, the matrices indicate that ageing precision varied among subdivisions, with 27.7.b showing the highest consistency whereas 27.7.e, 27.7.h, and the older age groups in 27.7.j and 27.7.k.2 exhibited the greatest uncertainty. Most ageing discrepancies involved confusion between adjacent age classes. While several areas showed the common pattern of decreasing agreement with increasing age, 27.8.a differed in that the strongest agreement was observed for the oldest represented age classes, whereas uncertainty was concentrated in younger and intermediate age classe. (Tables 19 to 28). This last result could be due to the fact that some of the readers discarded several otoliths from this divisions due to the judgement that they are extremely hard toread, meaning that only the most expert readers contributed to the ageing results for this subdivisión

Table 19: Age error matrix (AEM) for ICES area 27.7.b.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.b	1	0.33	0.17	0.33	-	0.17	-	-	-	-	-	-	-	-	-	1
27.7.b	2	-	0.92	0.08	-	-	-	-	-	-	-	-	-	-	-	1
27.7.b	3	-	-	0.83	0.17	-	-	-	-	-	-	-	-	-	-	1
27.7.b	4	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-	1

Table 20: Age error matrix (AEM) for ICES area 27.7.c.2.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.c.2	2	-	0.71	0.25	0.04	-	-	-	-	-	-	-	-	-	-	1.00
27.7.c.2	4	-	0.04	0.21	0.75	-	-	-	-	-	-	-	-	-	-	1.00
27.7.c.2	5	-	-	-	0.17	0.83	-	-	-	-	-	-	-	-	-	1.00
27.7.c.2	9	-	-	-	-	-	0.08	0.08	0.08	0.50	0.17	-	-	0.08	-	0.99
27.7.c.2	10	-	-	-	-	-	-	-	0.08	0.25	0.58	-	-	-	0.08	0.99

Table 21: Age error matrix (AEM) for ICES area 27.7.e.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.e	1	0.50	0.17	0.17	0.17	-	-	-	-	-	-	-	-	-	-	1.01
27.7.e	4	0.17	0.33	0.17	0.33	-	-	-	-	-	-	-	-	-	-	1.00
27.7.e	5	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	1.00
27.7.e	6	-	-	-	-	0.17	0.61	0.11	0.11	-	-	-	-	-	-	1.00
27.7.e	8	-	-	-	-	-	-	-	0.67	0.33	-	-	-	-	-	1.00

Table 22: Age error matrix (AEM) for ICES area 27.7.f.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.f	3	-	0.28	0.72	-	-	-	-	-	-	-	-	-	-	-	1
27.7.f	5	-	-	-	0.08	0.5	0.42	-	-	-	-	-	-	-	-	1
27.7.f	7	-	-	-	-	-	0.28	0.61	0.11	-	-	-	-	-	-	1
27.7.f	8	-	-	-	-	-	-	-	0.67	0.33	-	-	-	-	-	1

Table 23: Age error matrix (AEM) for ICES area 27.7.g.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.g	4	-	-	0.08	0.75	0.17	-	-	-	-	-	-	-	-	-	1
27.7.g	7	-	-	-	-	-	-	0.50	0.50	-	-	-	-	-	-	1
27.7.g	8	-	-	-	-	-	-	0.33	0.67	-	-	-	-	-	-	1
27.7.g	9	-	-	-	-	-	-	-	0.17	0.5	0.33	-	-	-	-	1

Table 24: Age error matrix (AEM) for ICES area 27.7.h.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.h	5	-	-	-	0.06	0.83	0.11	-	-	-	-	-	-	-	-	1
27.7.h	8	-	-	-	-	-	0.17	0.33	0.17	0.33	-	-	-	-	-	1
27.7.h	9	-	-	-	-	-	-	0.08	0.33	0.42	0.17	-	-	-	-	1
27.7.h	10	-	-	-	-	-	-	-	0.33	0.17	0.50	-	-	-	-	1

Table 25: Age error matrix (AEM) for ICES area 27.7.j.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.j	6	-	-	-	-	-	0.67	0.33	-	-	-	-	-	-	-	1.00
27.7.j	8	-	-	-	-	-	0.06	0.06	0.56	0.22	0.11	-	-	-	-	1.01
27.7.j	9	-	-	-	-	-	-	0.17	0.33	0.50	-	-	-	-	-	1.00
27.7.j	10	-	-	-	-	-	-	0.03	0.07	0.20	0.47	0.13	0.10	-	-	1.00
27.7.j	11	-	-	-	-	-	-	-	0.17	0.33	-	0.33	0.17	-	-	1.00

Table 26: Age error matrix (AEM) for ICES area 27.7.k.2.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.k.2	1	0.58	0.25	0.08	0.08	-	-	-	-	-	-	-	-	-	-	0.99
27.7.k.2	2	0.33	0.50	0.17	-	-	-	-	-	-	-	-	-	-	-	1.00
27.7.k.2	3	-	-	0.83	0.17	-	-	-	-	-	-	-	-	-	-	1.00
27.7.k.2	4	-	-	-	0.92	0.08	-	-	-	-	-	-	-	-	-	1.00
27.7.k.2	5	-	-	-	0.17	0.83	-	-	-	-	-	-	-	-	-	1.00
27.7.k.2	6	-	-	-	-	0.08	0.75	0.17	-	-	-	-	-	-	-	1.00
27.7.k.2	7	-	-	-	-	0.06	0.17	0.56	0.17	0.06	-	-	-	-	-	1.02
27.7.k.2	8	-	-	-	-	-	-	0.17	0.72	0.11	-	-	-	-	-	1.00
27.7.k.2	9	-	-	-	0.08	-	0.08	0.17	0.17	0.33	0.17	-	-	-	-	1.00

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.7.k.2	10	-	-	-	-	-	-	-	0.33	0.33	0.33	-	-	-	-	0.99

Table 27: Age error matrix (AEM) for ICES area 27.8.a.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.8.a	2	0.22	0.61	0.11	0.06	-	-	-	-	-	-	-	-	-	-	1.00
27.8.a	3	-	-	0.50	0.33	0.17	-	-	-	-	-	-	-	-	-	1.00
27.8.a	5	-	-	-	0.08	0.83	0.08	-	-	-	-	-	-	-	-	0.99
27.8.a	6	-	-	-	-	-	0.50	0.33	0.17	-	-	-	-	-	-	1.00
27.8.a	7	-	-	-	-	-	-	1.00	-	-	-	-	-	-	-	1.00
27.8.a	8	-	-	-	-	-	-	0.08	0.92	-	-	-	-	-	-	1.00

Table 28: Age error matrix (AEM) for ICES area 27.8.b.

ices_area	modal_age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
27.8.b	2	-	0.67	0.33	-	-	-	-	-	-	-	-	-	-	-	1.00
27.8.b	3	-	0.33	0.50	0.17	-	-	-	-	-	-	-	-	-	-	1.00
27.8.b	4	-	-	0.06	0.61	0.17	0.17	-	-	-	-	-	-	-	-	1.01
27.8.b	6	-	-	-	-	0.25	0.75	-	-	-	-	-	-	-	-	1.00
27.8.b	8	-	-	-	-	-	-	0.17	0.50	0.33	-	-	-	-	-	1.00
27.8.b	9	-	-	-	-	-	-	-	0.27	0.55	0.09	0.09	-	-	-	1.00

7 Discussion

The SmartDots intercalibration exercise demonstrated that age determination of megrim (*Lepidorhombus whiffiagonis*) from ICES divisions 7.b–k and 8.a, 8.b and 8.d remains subject to considerable inter-reader variability, despite the participation of experienced readers. Overall precision across all readers was moderate (PA = 51%, CV = 24%, APE = 17%), indicating that differences in age interpretation continue to exist, particularly in the youngest and oldest age classes.

While increased uncertainty in the oldest age groups is a recurring challenge and has also been observed in previous exchanges with otherwise satisfactory levels of agreement, the poor consistency observed for the youngest fish points to difficulties in identifying the first annulus. This issue was already highlighted in the previous exchange report (Modica & Landa, 2025) and appears to remain a significant source of ageing disagreement.

Substantial differences were observed between individual readers. Readers R18 and R20 consistently over-aged fish, whereas R22 and R26 tended to under-age them across most age classes. indicating a widespread tendency to overestimate the age of the youngest fish, likely due to difficulties in identifying the first annulus. In contrast, biases for intermediate ages were generally small, while the variability observed in older age classes reflected differing interpretations of closely spaced annuli among readers. These results suggest that identification of the first annulus and interpretation of annuli in older fish remain the principal sources of ageing disagreement when considering all the readers together.

The comparison between all readers and the subset of advanced readers clearly illustrates the importance of reader experience. Restricting the analysis to advanced readers increased percentage agreement from 51% to 64%, while reducing CV from 24% to 17% and APE from 17% to 11%. These improvements indicate that trained readers produce more consistent age estimates and reinforce the rationale for using validated readers when generating age data for stock assessments.

Nevertheless, even among advanced readers, complete agreement was not achieved. The inter-reader bias tests identified statistically significant differences between several reader pairs, suggesting that systematic differences in interpretation remain. Relative bias was generally small when averaged across all advanced readers, but individual readers displayed tendencies to consistently over- or underestimate ages in particular age classes. These differences were most pronounced for age-1 fish, where identification of the first annulus proved particularly challenging, and for the oldest fish (ages 9–11), where narrow increments, split rings and edge interpretation complicated age assignment.

The age error matrix further demonstrated that disagreements primarily occurred between adjacent age classes, indicating that most discrepancies were limited to differences of one year rather than gross misclassification. Such a pattern is commonly observed in age-reading exercises and suggests that readers generally interpret otolith structure similarly but differ in the placement or recognition of individual annual increments. Some subdivisions used as strata showed higher ageing errors than others. However, these differences should be interpreted with caution as the apparent better performance might be due to the decision of attributing AQ3 to some of the images, resulting in exclusion from the analyses. Consequently, it is not possible to draw robust conclusions about the errors in different areas although some of them seem to score better such as 27.7b at least for some age classes.

Growth analyses also showed broadly similar patterns among readers, although some variation in the position of winter-ring annotations was evident. A detailed examination of these otoliths during the WKARMEG workshop will therefore be valuable for identifying common interpretation rules.

Overall, the exercise successfully identified the principal sources of disagreement prior to the workshop. The results indicate that the workshop discussions should focus on standardizing the identification of the first annulus, distinguishing true annual rings from split or accessory rings, and establishing consistent criteria for interpreting edge type and marginal increment formation. Particular attention should also be given to the oldest age classes, where increasing compression of growth increments reduces precision.

8 Conclusion

The SmartDots Event 3985 intercalibration exercise successfully evaluated the consistency of megrim age determination among readers from countries contributing to the assessment of the ICES stock 27.7b–k and 8.a, 8.b and 8.d. The exercise demonstrated moderate agreement across all participants but substantially improved precision when only advanced readers were considered.

Although experienced readers showed good overall agreement, statistically significant differences between readers indicate that complete harmonization has not yet been achieved. Most discrepancies were associated with the interpretation of the first annulus, split rings, edge characteristics and compressed increments in older fish. These issues represent the primary topics that should be addressed during the WKARMEG workshop.

The most concerning outcome of this exercise relates to the youngest age classes. The strong positive bias observed for age-1 fish, together with the patterns identified in the age error matrix, indicates persistent difficulties in the recognition of the first annulus, resulting in the frequent over-ageing of young individuals. This issue has a direct impact on the estimation of recruitment and therefore represents a priority area for improvement. In contrast, the lower agreement observed for the oldest age classes is a well-known source of uncertainty in age determination and could be addressed operationally by introducing a 7+ age group in the stock assessment, thereby reducing the effects of ageing uncertainty at older ages. Consequently, efforts should focus primarily on improving consistency in the identification of the first annulus, as this currently appears to be the main source of ageing disagreement among readers.

The outcomes of this preliminary exercise provide a strong basis for the workshop by identifying problematic samples and highlighting specific aspects of age interpretation requiring harmonization. Continued calibration, targeted discussion of difficult otoliths, and regular training exercises are expected to further reduce reader bias and improve the consistency of age estimates used in ICES stock assessments.

Overall, the exercise confirms that the quality and consistency of megrim age data can be improved through structured intercalibration and expert consensus, thereby increasing confidence in the biological information underpinning stock assessment and fisheries management.

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10 Annex 1. Additional results

10.1 Results all readers

Summary statistics

Table 29: Summary of statistics; PA (%), CV (%) and APE (%).

NSample	CV	PA	APE
101	24 %	51 %	17 %

Data Overview

Table 19: Data overview including modal age and statistics per sample.

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	Modal age	PA %	CV %	APE %
C119_LW_T333_S2_VIGO2_SEM1	333	F	11-06-2025	27.7.k.2	6	6	7	6	7	7	5	6	6	5	5	6	45	13	9
C123_LW_T341_S2_VIGO2_SEM1	341	F	11-06-2025	27.7.k.2	8	8	8	7	7	8	7	7	7	6	6	7	45	10	8
C10_LW_T148_S2_L12_PR25	148	F	21-09-2025	27.7.k.2	1	2	1	1	1	1	2	1	2	1	1	1	73	37	31
C11_LW_T143_S2_L12_PR25	143	F	21-09-2025	27.7.k.2	1	2	3	1	2	2	3	1	3	1	1	1	45	48	41
C3_LW_T150_S2_L12_PR25	150	F	21-09-2025	27.7.k.2	1	2	4	1	3	2	4	-	5	1	2	1	30	57	48
C5_LW_T149_S2_L12_PR25	149	F	21-09-2025	27.7.k.2	1	2	2	1	2	3	2	1	4	1	1	1	45	54	41
C133_LW_T320_S2_VIGO2_SEM1	320	F	11-06-2025	27.7.k.2	7	6	7	5	7	6	5	7	6	5	5	7	36	15	12
C134_LW_T313_S2_VIGO2_SEM1	313	F	11-06-2025	27.7.k.2	7	6	6	6	7	6	5	6	6	5	5	6	55	12	8
C2_LW_T155_S1_L14_PR24	155	M	17-09-2024	27.7.c.2	4	4	4	3	4	4	3	3	3	2	2	4	45	24	20
C203_LW_T279_S2_VIGO2_SEM1	279	F	19-06-2025	27.7.k.2	4	4	4	4	4	4	3	5	4	4	4	4	82	11	5
C217_LW_T273_S1_VIGO2_SEM1	273	M	19-06-2025	27.7.k.2	6	6	6	5	6	6	4	6	5	4	4	6	55	17	15
C242_LW_T258_S2_VIGO2_SEM1	258	F	19-06-2025	27.7.k.2	3	3	3	3	4	3	2	3	3	3	3	3	82	15	6
C247_LW_T264_S1_VIGO2_SEM1	264	M	19-06-2025	27.7.k.2	7	8	7	6	7	7	6	5	7	4	4	7	45	21	17
C248_LW_T260_S1_VIGO2_SEM1	260	M	19-06-2025	27.7.k.2	6	6	6	5	6	6	4	6	6	4	4	6	64	17	15
C257_LW_T379_S2_VIGO2_SEM1	379	F	24-06-2025	27.7.k.2	8	7	7	7	8	9	7	7	7	6	6	7	55	12	9
C262_LW_T404_S2_VIGO2_SEM1	404	F	24-06-2025	27.7.k.2	8	9	9	7	8	8	5	7	8	7	7	8	36	15	11
C265_LW_T415_S1_VIGO2_SEM1	415	M	24-06-2025	27.7.k.2	10	9	10	8	8	9	8	12	7	7	7	10	18	18	14

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	Modal age	PA %	CV %	APE %
C269_LW_T393_S2_VIGO2_SEM1	393	F	24-06-2025	27.7.k.2	6	6	7	6	6	5	5	8	6	6	7	6	55	14	10
C14_LW_T143_S2_L26_PR25_SEM2	143	F	24-09-2025	27.7.b	2	2	3	2	2	2	3	2	2	1	1	2	64	32	18
C31_LW_T134_S1_L26_PR25_SEM2	134	M	24-09-2025	27.7.b	2	2	2	2	2	2	3	2	2	1	1	2	73	28	17
C5_LW_T201_S2_L26_PR25_SEM2	201	F	24-09-2025	27.7.b	4	4	4	4	4	4	4	3	4	2	2	4	73	23	19
C276_LW_T418_S2_VIGO2_SEM1	418	F	24-06-2025	27.7.k.2	9	8	10	9	10	7	7	10	9	7	7	7	36	15	13
C284_LW_T400_S2_VIGO2_SEM1	400	F	24-06-2025	27.7.k.2	8	8	8	8	8	8	6	9	9	7	7	8	55	11	8
C286_LW_T342_S2_VIGO2_SEM1	342	F	24-06-2025	27.7.k.2	5	5	5	5	5	5	4	5	5	5	5	5	91	6	3
C291_LW_T329_S2_VIGO2_SEM1	329	F	24-06-2025	27.7.k.2	4	5	5	4	5	5	4	5	5	4	5	5	64	11	10
C293_LW_T360_S2_VIGO2_SEM1	360	F	24-06-2025	27.7.k.2	6	6	6	6	6	6	5	6	7	6	6	6	82	7	3
C295_LW_T316_S2_VIGO2_SEM1	316	F	24-06-2025	27.7.k.2	5	4	4	4	4	4	3	5	5	4	5	4	55	15	12
C2_LW_T555_S2_L30_PR25_SEM2	555	F	29-09-2025	27.7.c.2	10	8	13	9	9	6	9	17	10	10	11	9	27	28	19
C324_LW_T313_S1_VIGO2_SEM1	313	M	27-06-2025	27.7.j	8	8	9	6	8	8	6	8	7	5	5	8	45	19	17
C334_LW_T310_S2_VIGO2_SEM1	310	F	27-06-2025	27.7.j	7	6	6	6	7	6	5	7	6	5	5	6	45	13	9
C8_LW_T481_S2_L33_PR24	481	F	21-09-2024	27.7.c.2	10	9	14	10	10	8	8	14	12	8	9	10	27	22	17
C4_LW_T162_S1_L35_PR24	162	M	25-09-2024	27.7.b	3	3	3	3	3	4	4	2	4	2	2	3	45	26	18
C7_LW_T130_S1_L36_PR25_SEM2	130	M	30-09-2025	27.7.c.2	2	2	2	2	3	2	3	2	3	2	1	2	64	28	20
C10_LW_T135_S2_L37_PR25_SEM2	135	F	01-10-2025	27.7.c.2	2	3	4	4	4	4	3	2	3	2	2	4	36	30	24
C12_LW_T97_S2_L37_PR24_SEM2	97	F	25-09-2024	27.7.b	1	2	5	1	3	3	6	1	5	1	1	1	45	73	61
C7_LW_T139_S1_L37_PR25_SEM2	139	M	01-10-2025	27.7.c.2	4	4	4	3	4	4	4	3	4	2	2	4	64	24	20
C381_LW_T472_S2_VIGO2_SEM1	472	F	27-06-2025	27.7.j	10	10	9	9	8	7	7	12	12	7	9	10	18	20	15
C382_LW_T532_S2_VIGO2_SEM1	532	F	27-06-2025	27.7.j	8	8	9	9	10	7	7	15	11	9	10	9	27	24	17
C383_LW_T443_S2_VIGO2_SEM1	443	F	27-06-2025	27.7.j	8	8	10	8	8	9	7	10	8	9	7	8	45	12	10
C385_LW_T502_S2_VIGO2_SEM1	502	F	27-06-2025	27.7.j	11	10	12	10	11	10	10	15	10	10	10	10	64	14	10
C2_LW_T335_S2_L38_PR25_SEM2	335	F	01-10-2025	27.7.c.2	10	9	9	10	10	10	9	10	10	5	5	10	55	22	16
C9_LW_T139_S1_L38_PR25_SEM2	139	M	01-10-2025	27.7.c.2	4	3	4	3	4	4	4	2	4	2	1	4	55	34	28
C392_LW_T471_S2_VIGO2_SEM1	471	F	27-06-2025	27.7.j	10	10	9	9	9	10	8	14	10	7	9	10	36	18	12
C3_LW_T283_S2_L39_PR25_SEM2	283	F	01-10-2025	27.7.c.2	9	9	9	7	9	10	9	8	9	4	5	9	55	24	18
C43_LW_T458_S2_VIGO2_SEM1	458	F	12-03-2025	27.7.j	10	10	8	9	10	11	7	10	10	9	7	10	45	14	12

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	Modal age	PA %	CV %	APE %
C44_LW_T529_S2_VIGO2_SEM1	529	F	12-03-2025	27.7.j	10	12	11	10	10	12	10	14	13	11	11	10	36	12	10
C46_LW_T415_S2_VIGO2_SEM1	415	F	12-03-2025	27.7.j	8	9	9	8	9	7	7	10	8	7	7	7	36	13	10
C14_LW_T129_S1_L63_PR25_SEM2	129	M	11-10-2025	27.7.c.2	2	3	3	2	4	2	5	1	3	1	1	2	27	53	42
C2_LW_T120_S1_L63_PR25_SEM2	120	M	11-10-2025	27.7.c.2	2	3	2	2	3	2	3	2	3	1	2	2	55	28	23
C7_LW_T129_S1_L63_PR25_SEM2	129	M	11-10-2025	27.7.c.2	2	2	2	2	2	3	3	2	2	1	1	2	64	32	18
C2_LW_T272_S1_L64_PR25_SEM2	272	M	11-10-2025	27.7.k.2	8	4	9	6	9	7	7	9	7	3	4	9	27	33	26
C4_LW_T233_S1_L71_PR25_SEM2	233	M	13-10-2025	27.7.c.2	5	4	5	5	5	5	5	5	5	3	4	5	73	15	11
C86_LW_T486_S2_VIGO2_SEM1	486	F	08-05-2025	27.7.j	11	9	9	11	8	12	10	12	13	10	9	9	27	15	13
BYDR03_MEG_L_7G_M_2024021110092	276		23-07-2023	27.8.a	8	8	8	7	8	8	6	8	10	4	4	8	55	26	20
BYDR07_MEG_D_M_8A_202207221049	180		21-04-2022	27.8.a	2	2	1	1	1	2	3	-	2	2	2	2	60	35	27
BYDR07_MEG_D_M_8A_202207221060	239		21-04-2022	27.8.a	4	3	2	2	2	3	4	2	4	2	3	2	45	31	26
BYDR07_MEG_L_M_8A_2022072210006	393		21-04-2022	27.8.a	8	6	7	6	6	7	6	7	11	7	7	7	45	20	12
BYDR07_MEG_L_M_8A_2022072210010	287		21-04-2022	27.8.a	5	5	5	5	4	6	7	6	5	4	4	5	45	19	13
BYDR08_MEG_D_7E_M_2024101710423	174		27-05-2024	27.7.e	4	4	2	2	1	3	1	3	2	2	2	2	45	43	35
BYDR08_MEG_L_7E_M_2024101710346	334		27-05-2024	27.7.e	6	6	5	6	5	5	6	5	5	5	5	5	64	9	9
BYDR08_MEG_L_7E_M_2024101710354	457		27-05-2024	27.7.e	9	8	8	9	8	8	8	12	11	9	8	8	55	15	11
BYDR09_MEG_D_7F_M_2024112010123	248		24-06-2024	27.7.f	3	3	3	3	3	2	2	3	3	3	3	3	82	14	11
BYDR09_MEG_L_7F_M_2024112010075	410		31-05-2024	27.7.f	7	7	6	7	7	7	6	8	7	7	7	7	73	8	5
CDDR03_MEG_L_7F_M_2025031310327	481		23-09-2024	27.7.f	9	8	8	9	8	8	8	12	10	9	9	8	45	14	9
CDDR04_MEG_L_7G_M_2025040920122	351		20-11-2024	27.7.g	7	7	8	8	8	7	6	8	10	5	5	8	36	20	15
CDDR04_MEG_L_M_7E_2021071010489	375		01-07-2021	27.7.e	6	7	6	6	6	6	6	7	7	6	6	6	73	7	6
CDDR06_MEG_L_7H_M_2025060210098	437		04-02-2025	27.7.h	7	9	10	8	9	8	8	11	14	8	8	8	45	22	15
CDDR07_MEG_D_8B_2025070210078	250		13-03-2025	27.8.b	4	4	4	4	4	5	6	7	5	3	3	4	45	27	21
CDDR07_MEG_D_8B_2025070210112	209		13-03-2025	27.8.b	4	3	2	3	3	2	4	3	4	2	3	3	45	26	18
CDDR07_MEG_L_8B_M_2025070210009	355		13-03-2025	27.8.b	6	5	-	5	6	6	5	-	8	5	6	6	44	17	12
CDDR07_MEG_L_8B_M_2025070210013	414		13-03-2025	27.8.b	8	9	9	9	9	8	8	-	10	8	8	8	50	8	7
CDDR07_MEG_L_8B_M_2025070210016	446		13-03-2025	27.8.b	6	-	6	-	-	6	7	-	12	8	8	6	43	28	20
CDDR07_MEG_L_8B_M_2025070210022	416		13-03-2025	27.8.b	8	11	9	-	10	9	10	-	15	7	7	9	22	26	18

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	Modal age	PA %	CV %	APE %
CNVE02_MEG_D_7H_2025020410147	284		23-07-2024	27.7.h	6	6	5	5	5	5	5	5	8	4	4	5	55	21	14
CNVE02_MEG_L_7H_2025020410062	472		17-07-2024	27.7.h	8	8	9	9	10	9	9	10	12	8	8	9	36	13	9
CNVE02_MEG_L_7H_2025020410097	474		17-07-2024	27.7.h	8	7	9	9	7	6	6	11	12	8	7	7	27	24	18
CNVE05_MEG_D_7F_M_2025040510251	298		17-10-2024	27.7.f	5	6	5	6	6	5	4	6	6	4	5	6	45	15	13
CNVE05_MEG_L_7F_2025040510139	401		17-10-2024	27.7.f	7	6	7	8	7	8	7	9	10	6	7	7	45	16	13
CNVE11_MEG_D_7H_M_2025101410085	287		15-03-2025	27.7.h	5	5	5	5	5	5	5	5	6	4	4	5	73	11	7
CNVE11_MEG_L_7H_M_2025101410020	440		13-03-2025	27.7.h	10	8	10	10	8	9	7	11	11	8	8	8	36	15	13
NKSZ02_MEG_D_7E_M_2025022610430	181		23-07-2024	27.7.e	3	4	1	1	1	2	1	4	2	2	2	1	36	54	41
NKSZ02_MEG_D_7E_M_2025022610459	285		29-07-2024	27.7.e	5	5	5	5	5	5	4	5	5	4	4	5	73	10	8
NKSZ02_MEG_D_7F_M_2025022610144	268		23-07-2024	27.7.f	3	3	3	3	3	2	2	4	3	3	3	3	73	19	11
NKSZ02_MEG_L_7F_M_2025022610103	360		23-07-2024	27.7.f	7	6	6	7	7	6	5	7	6	6	6	6	55	10	8
NKSZ05_MEG_D_8A_M_2024053110076	239		25-02-2024	27.8.a	5	4	3	3	3	4	6	3	4	2	3	3	45	31	24
NKSZ05_MEG_D_8A_M_2024053110111	155		25-02-2024	27.8.a	2	2	2	1	2	2	1	2	2	1	2	2	73	27	23
NKSZ05_MEG_L_8A_M_2024053110021	310		11-02-2024	27.8.a	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
NKSZ05_MEG_L_8A_M_2024053110027	410		11-02-2024	27.8.a	8	8	8	8	8	8	8	8	8	8	8	8	100	0	0
NKSZ05_MEG_L_8A_M_2024053110030	376		25-02-2024	27.8.a	7	7	7	7	7	7	7	8	8	7	5	7	73	11	5
NKSZ06_MEG_D_8B_M_2025061010052	284		26-02-2025	27.8.b	6	5	4	4	4	6	6	6	7	4	3	6	36	25	22
NKSZ06_MEG_D_8B_M_2025061010068	221		26-02-2025	27.8.b	6	4	4	4	3	5	6	3	6	3	2	4	27	34	27
NKSZ06_MEG_D_8B_M_2025061010069	223		26-02-2025	27.8.b	3	3	2	2	2	2	4	-	3	3	2	2	50	27	23
NKSZ06_MEG_L_7E_M_2023051210376	405		04-11-2022	27.7.e	6	6	6	8	7	8	7	9	9	6	7	6	36	16	13
NKSZ06_MEG_L_8B_2025061010007	372		26-02-2025	27.8.b	9	8	9	7	8	8	8	10	10	6	6	8	36	17	13
NKSZ07_MEG_D_7G_2025072810173	280		13-03-2025	27.7.g	4	4	4	3	4	4	4	4	5	3	4	4	73	14	8
NKSZ07_MEG_D_7H_M_2024092310148	268		17-05-2024	27.7.h	4	5	5	5	5	5	5	4	5	4	4	5	64	11	10
NKSZ08_MEG_D_7F_M_2024093010149	229		23-05-2024	27.7.f	3	3	2	3	2	2	2	4	3	3	3	3	55	24	19
NKSZ08_MEG_L_7F_M_2024093010096	404		23-05-2024	27.7.f	5	5	5	6	6	4	5	7	5	6	6	5	45	15	12
NKSZ09_MEG_D_7G_M_2023101810179	293		12-05-2023	27.7.g	5	4	4	5	4	4	4	5	6	4	4	4	64	15	13
NKSZ09_MEG_L_7G_M_2023101810115	398		12-05-2023	27.7.g	7	8	8	7	8	8	7	7	8	6	6	8	45	11	9
NKSZ10_MEG_L_7G_M_2023102810097	490		19-06-2023	27.7.g	9	9	9	10	10	8	8	11	11	10	10	10	36	11	9

Number of age readings by modal age

Table 20**:** 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.

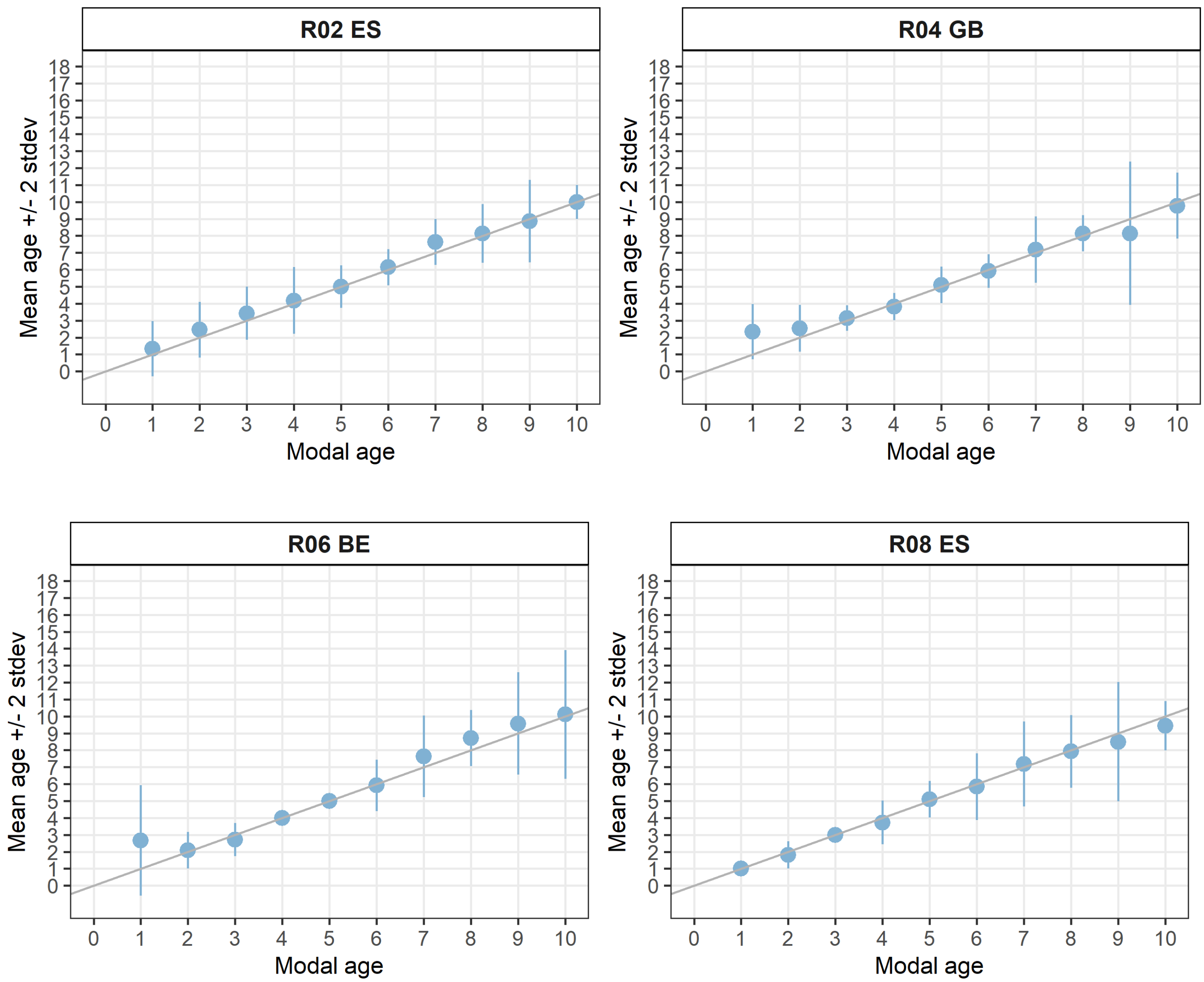
Modal age	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	total
1	6	6	6	6	6	6	6	5	6	6	6	65
2	11	11	11	11	11	11	11	9	11	11	11	119
3	7	7	7	7	7	7	7	7	7	7	7	77
4	11	11	11	11	11	11	11	11	11	11	11	121
5	11	11	11	11	11	11	11	11	11	11	11	121
6	14	13	13	13	13	14	14	12	14	14	14	148
7	11	11	11	11	11	11	11	11	11	11	11	121
8	14	14	14	14	14	14	14	13	14	14	14	153
9	7	7	7	6	7	7	7	6	7	7	7	75
10	9	9	9	9	9	9	9	9	9	9	9	99
Total	**101**	**100**	**100**	**99**	**100**	**101**	**101**	**94**	**101**	**101**	**101**	**1099**

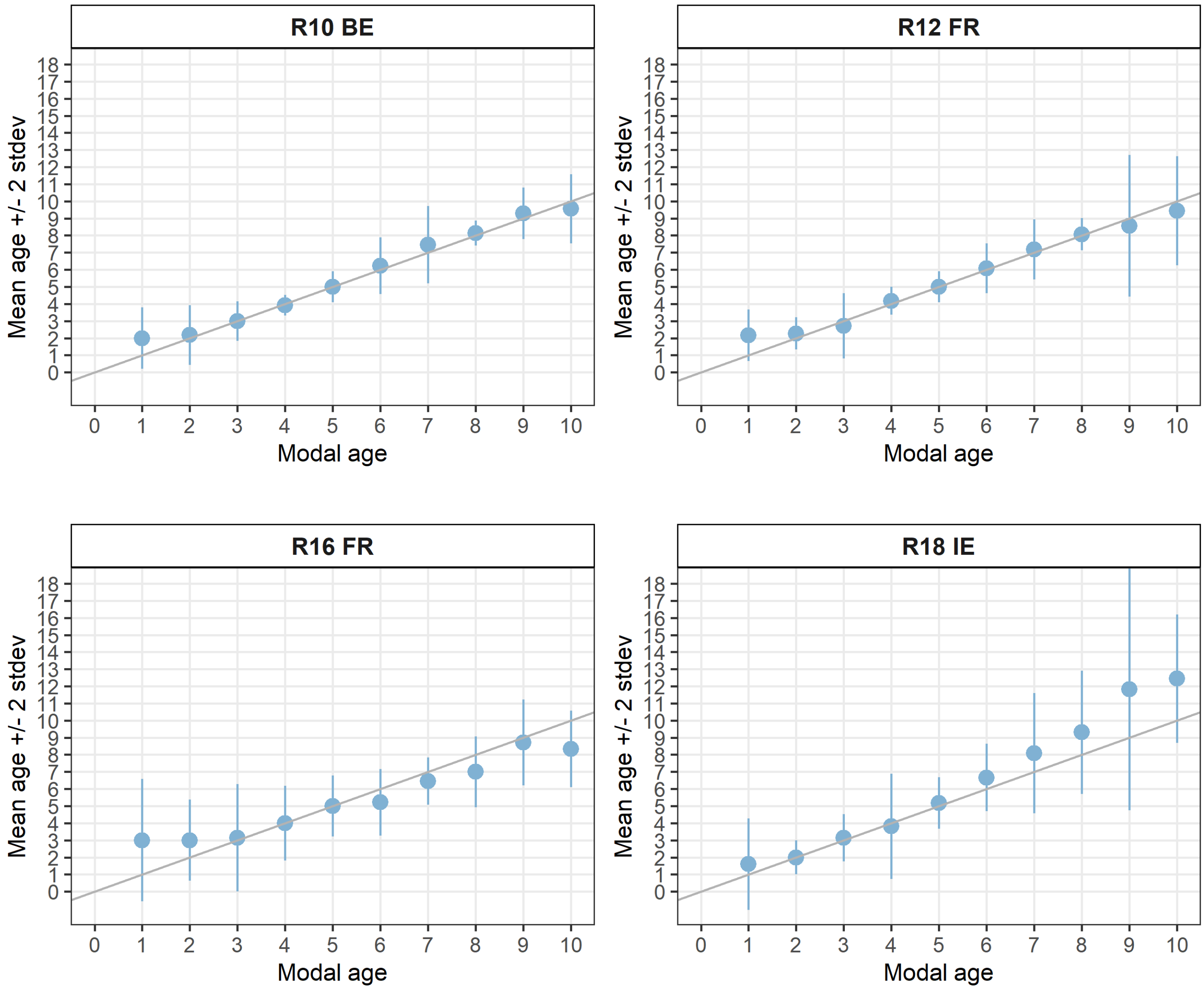
Number of age readings by age

Table 21**:** 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES	total
1	5	0	3	8	4	1	3	5	0	11	10	50
2	9	11	11	9	9	15	6	10	8	13	13	114
3	7	12	8	11	10	6	11	9	11	10	9	104
4	12	14	13	8	14	12	16	5	9	16	14	133
5	11	10	13	13	9	13	16	12	15	11	15	138
6	13	15	10	13	9	14	15	8	11	11	9	128
7	11	6	8	10	12	11	16	11	10	11	14	120
8	16	16	9	9	16	16	10	8	8	8	7	123
9	6	10	16	11	7	6	4	4	4	5	5	78
10	9	4	5	6	9	4	4	7	11	4	3	66
11	2	1	1	1	1	1	0	4	5	1	2	19
12	0	1	1	0	0	2	0	5	5	0	0	14
13	0	0	1	0	0	0	0	0	2	0	0	3
14	0	0	1	0	0	0	0	3	1	0	0	5
15	0	0	0	0	0	0	0	2	1	0	0	3
17	0	0	0	0	0	0	0	1	0	0	0	1
Total	**101**	**100**	**100**	**99**	**100**	**101**	**101**	**94**	**101**	**101**	**101**	**1099**

Separate age bias plots by reader




R10 BE
R12 FR
R16 FR
R18 IE
Mean age +/- 2 stdev
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Modal age
0 1 2 3 4 5 6 7 8 9 10

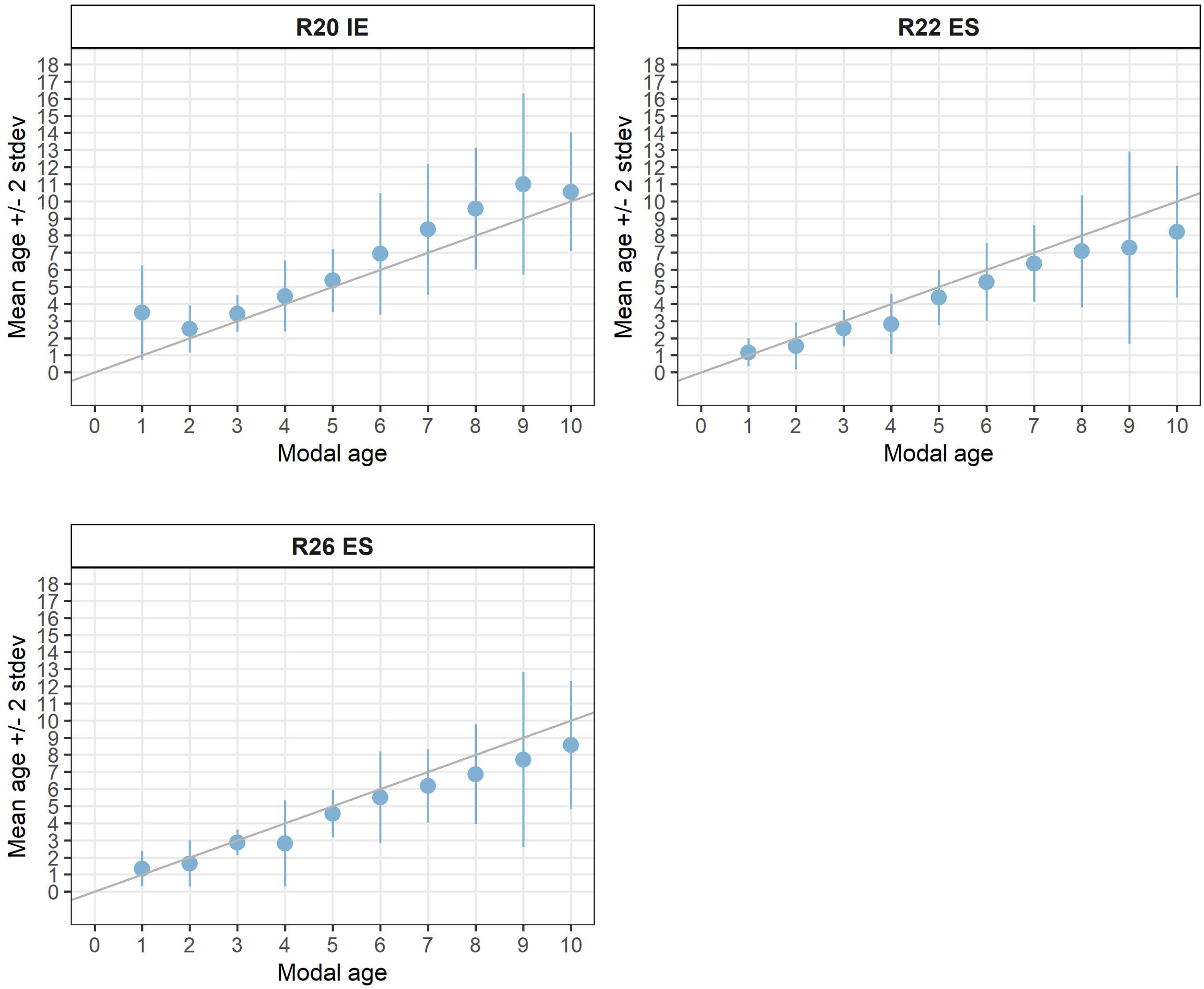


Figure 5: Age bias plot by each reader

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

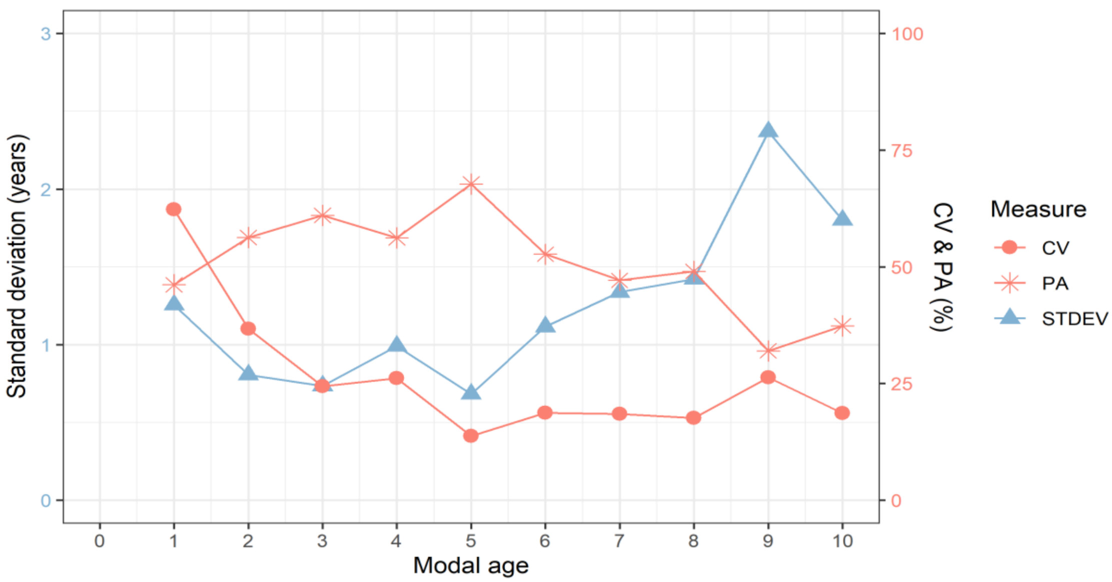


Figure 6: CV, PA and (STDEV (standard deviation) are plotted against modal age

Distribution of age reading errors

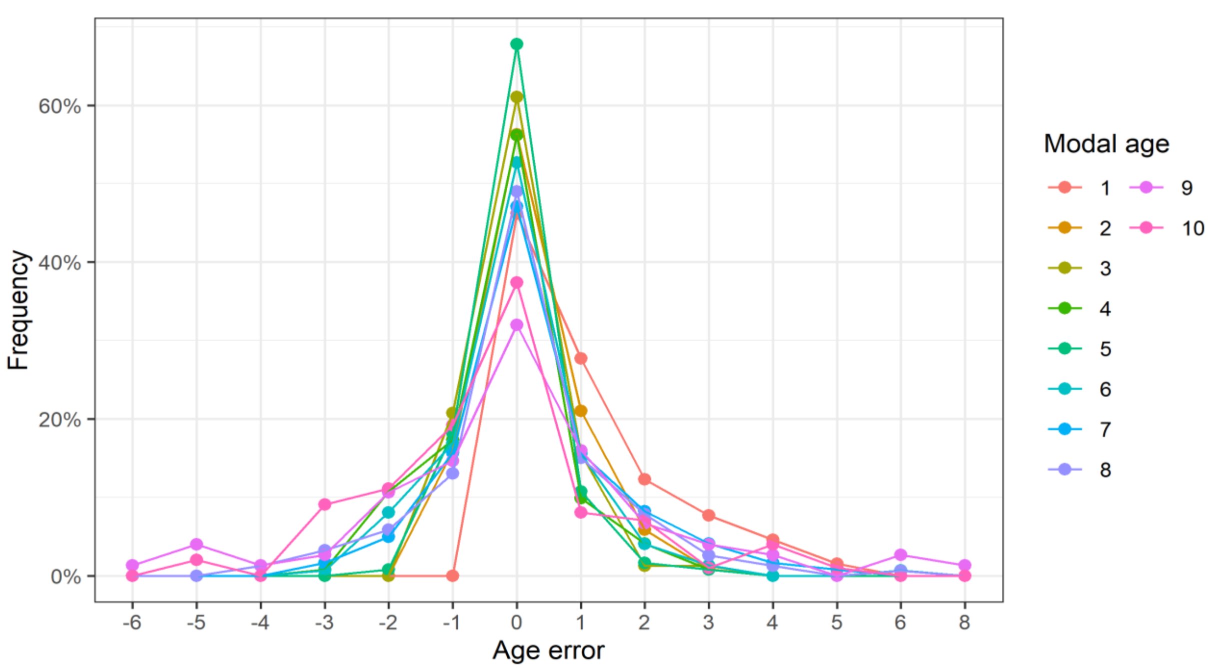


Figure 7: The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown

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

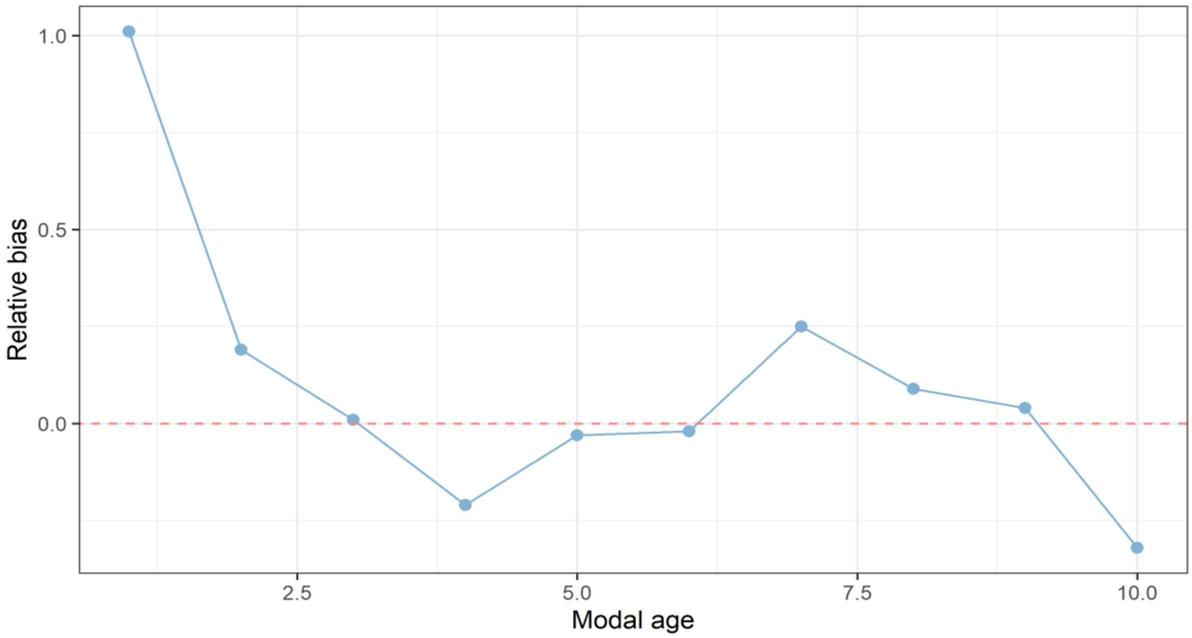


Figure 8: The relative bias by modal age as estimated by all age readers combined.

Mean length at age by reader

Table 33: 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	R16 FR	R18 IE	R20 IE	R22 ES	R26 ES
1	137 mm	-	170 mm	150 mm	171 mm	148 mm	170 mm	133 mm	-	136 mm	134 mm
2	139 mm	142 mm	172 mm	158 mm	172 mm	176 mm	217 mm	149 mm	156 mm	176 mm	169 mm
3	224 mm	197 mm	199 mm	211 mm	184 mm	174 mm	169 mm	205 mm	185 mm	248 mm	247 mm
4	222 mm	231 mm	219 mm	252 mm	225 mm	228 mm	239 mm	245 mm	195 mm	285 mm	274 mm
5	299 mm	315 mm	289 mm	292 mm	297 mm	295 mm	316 mm	296 mm	277 mm	329 mm	324 mm
6	333 mm	336 mm	351 mm	336 mm	346 mm	355 mm	312 mm	301 mm	308 mm	381 mm	372 mm
7	358 mm	394 mm	357 mm	360 mm	359 mm	385 mm	405 mm	358 mm	341 mm	417 mm	418 mm
8	397 mm	411 mm	397 mm	409 mm	406 mm	405 mm	443 mm	352 mm	386 mm	447 mm	439 mm
9	417 mm	416 mm	414 mm	473 mm	407 mm	428 mm	411 mm	370 mm	376 mm	474 mm	478 mm
10	462 mm	476 mm	431 mm	463 mm	459 mm	398 mm	483 mm	416 mm	420 mm	508 mm	508 mm
11	494 mm	416 mm	529 mm	486 mm	502 mm	458 mm	-	460 mm	462 mm	529 mm	542 mm
12	-	529 mm	502 mm	-	-	508 mm	-	462 mm	469 mm	-	-
13	-	-	555 mm	-	-	-	-	-	508 mm	-	-
14	-	-	481 mm	-	-	-	-	494 mm	437 mm	-	-
15	-	-	-	-	-	-	-	517 mm	416 mm	-	-
17	-	-	-	-	-	-	-	555 mm	-	-	-
Weighted Mean	**314 mm**	**313 mm**	**314 mm**	**312 mm**	**313 mm**	**314 mm**	**314 mm**	**314 mm**	**314 mm**	**314 mm**	**314 mm**

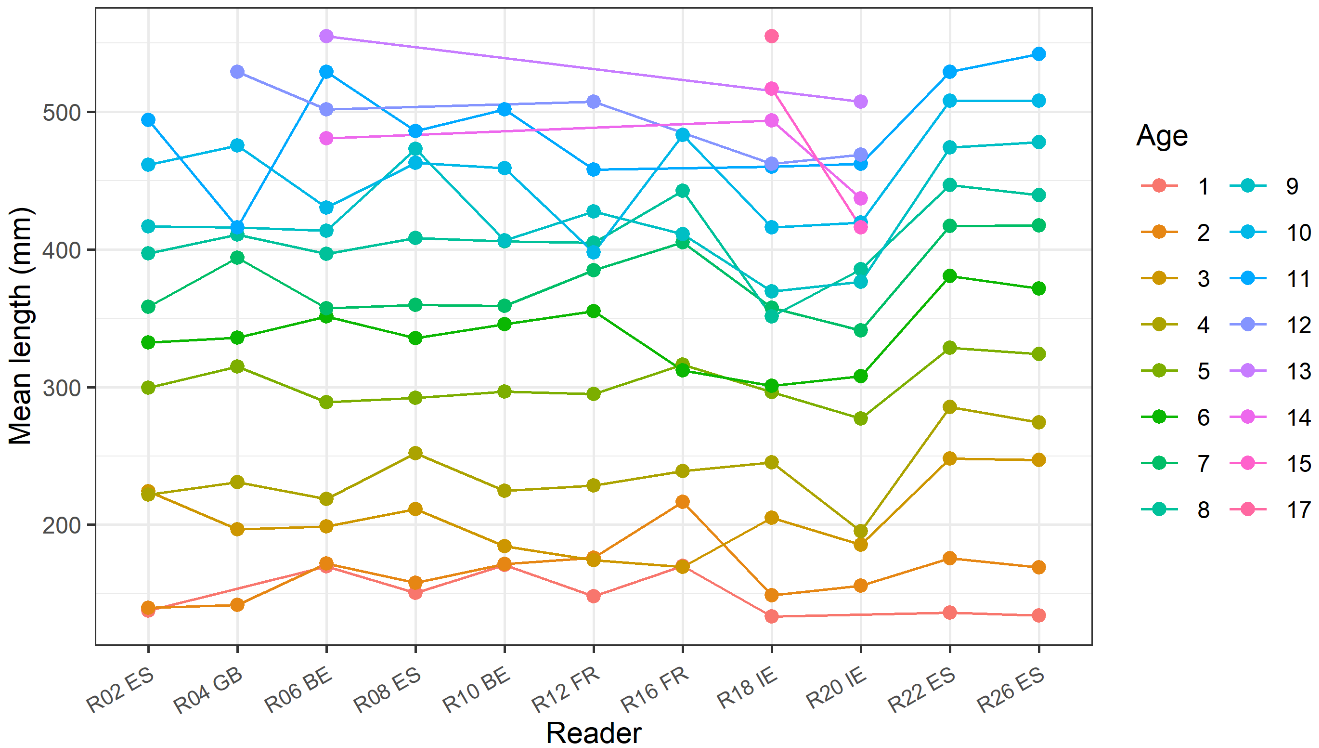


Figure 9: The mean fish length at age as estimated by each age reader.

10.2 Results Advanced readers

All samples included

Summary statistics

Table 43: Summary of statistics; PA (%), CV (%) and APE (%).

NSample	CV	PA	APE
101	17 %	64 %	11 %

Data overview

Table 35: Data overview including modal age and statistics per sample.

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	Modal age	PA %	CV %	APE %
C119_LW_T333_S2_VIGO2_SEM1	333	F	11-06-2025	27.7.k.2	6	6	7	6	7	7	6	50	8	8
C123_LW_T341_S2_VIGO2_SEM1	341	F	11-06-2025	27.7.k.2	8	8	8	7	7	8	8	67	7	6
C10_LW_T148_S2_L12_PR25	148	F	21-09-2025	27.7.k.2	1	2	1	1	1	1	1	83	35	24
C11_LW_T143_S2_L12_PR25	143	F	21-09-2025	27.7.k.2	1	2	3	1	2	2	2	50	41	30
C3_LW_T150_S2_L12_PR25	150	F	21-09-2025	27.7.k.2	1	2	4	1	3	2	1	33	54	41
C5_LW_T149_S2_L12_PR25	149	F	21-09-2025	27.7.k.2	1	2	2	1	2	3	2	50	41	30
C133_LW_T320_S2_VIGO2_SEM1	320	F	11-06-2025	27.7.k.2	7	6	7	5	7	6	7	50	13	11
C134_LW_T313_S2_VIGO2_SEM1	313	F	11-06-2025	27.7.k.2	7	6	6	6	7	6	6	67	8	7
C2_LW_T155_S1_L14_PR24	155	M	17-09-2024	27.7.c.2	4	4	4	3	4	4	4	83	11	7
C203_LW_T279_S2_VIGO2_SEM1	279	F	19-06-2025	27.7.k.2	4	4	4	4	4	4	4	100	0	0
C217_LW_T273_S1_VIGO2_SEM1	273	M	19-06-2025	27.7.k.2	6	6	6	5	6	6	6	83	7	5
C242_LW_T258_S2_VIGO2_SEM1	258	F	19-06-2025	27.7.k.2	3	3	3	3	4	3	3	83	13	9
C247_LW_T264_S1_VIGO2_SEM1	264	M	19-06-2025	27.7.k.2	7	8	7	6	7	7	7	67	9	5
C248_LW_T260_S1_VIGO2_SEM1	260	M	19-06-2025	27.7.k.2	6	6	6	5	6	6	6	83	7	5
C257_LW_T379_S2_VIGO2_SEM1	379	F	24-06-2025	27.7.k.2	8	7	7	7	8	9	7	50	11	9
C262_LW_T404_S2_VIGO2_SEM1	404	F	24-06-2025	27.7.k.2	8	9	9	7	8	8	8	50	9	7
C265_LW_T415_S1_VIGO2_SEM1	415	M	24-06-2025	27.7.k.2	10	9	10	8	8	9	10	33	10	7
C269_LW_T393_S2_VIGO2_SEM1	393	F	24-06-2025	27.7.k.2	6	6	7	6	6	5	6	67	11	6
C14_LW_T143_S2_L26_PR25_SEM2	143	F	24-09-2025	27.7.b	2	2	3	2	2	2	2	83	19	13
C31_LW_T134_S1_L26_PR25_SEM2	134	M	24-09-2025	27.7.b	2	2	2	2	2	2	2	100	0	0

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	Modal age	PA %	CV %	APE %
C5_LW_T201_S2_L26_PR25_SEM2	201	F	24-09-2025	27.7.b	4	4	4	4	4	4	4	100	0	0
C276_LW_T418_S2_VIGO2_SEM1	418	F	24-06-2025	27.7.k.2	9	8	10	9	10	7	9	33	13	10
C284_LW_T400_S2_VIGO2_SEM1	400	F	24-06-2025	27.7.k.2	8	8	8	8	8	8	8	100	0	0
C286_LW_T342_S2_VIGO2_SEM1	342	F	24-06-2025	27.7.k.2	5	5	5	5	5	5	5	100	0	0
C291_LW_T329_S2_VIGO2_SEM1	329	F	24-06-2025	27.7.k.2	4	5	5	4	5	5	5	67	11	10
C293_LW_T360_S2_VIGO2_SEM1	360	F	24-06-2025	27.7.k.2	6	6	6	6	6	6	6	100	0	0
C295_LW_T316_S2_VIGO2_SEM1	316	F	24-06-2025	27.7.k.2	5	4	4	4	4	4	4	83	10	7
C2_LW_T555_S2_L30_PR25_SEM2	555	F	29-09-2025	27.7.c.2	10	8	13	9	9	6	9	33	25	17
C324_LW_T313_S1_VIGO2_SEM1	313	M	27-06-2025	27.7.j	8	8	9	6	8	8	8	67	13	8
C334_LW_T310_S2_VIGO2_SEM1	310	F	27-06-2025	27.7.j	7	6	6	6	7	6	6	67	8	7
C8_LW_T481_S2_L33_PR24	481	F	21-09-2024	27.7.c.2	10	9	14	10	10	8	10	50	20	13
C4_LW_T162_S1_L35_PR24	162	M	25-09-2024	27.7.b	3	3	3	3	3	4	3	83	13	9
C7_LW_T130_S1_L36_PR25_SEM2	130	M	30-09-2025	27.7.c.2	2	2	2	2	3	2	2	83	19	13
C10_LW_T135_S2_L37_PR25_SEM2	135	F	01-10-2025	27.7.c.2	2	3	4	4	4	4	4	67	24	19
C12_LW_T97_S2_L37_PR24_SEM2	97	F	25-09-2024	27.7.b	1	2	5	1	3	3	1	33	61	47
C7_LW_T139_S1_L37_PR25_SEM2	139	M	01-10-2025	27.7.c.2	4	4	4	3	4	4	4	83	11	7
C381_LW_T472_S2_VIGO2_SEM1	472	F	27-06-2025	27.7.j	10	10	9	9	8	7	10	33	13	10
C382_LW_T532_S2_VIGO2_SEM1	532	F	27-06-2025	27.7.j	8	8	9	9	10	7	8	33	12	10
C383_LW_T443_S2_VIGO2_SEM1	443	F	27-06-2025	27.7.j	8	8	10	8	8	9	8	67	10	8
C385_LW_T502_S2_VIGO2_SEM1	502	F	27-06-2025	27.7.j	11	10	12	10	11	10	10	50	8	6
C2_LW_T335_S2_L38_PR25_SEM2	335	F	01-10-2025	27.7.c.2	10	9	9	10	10	10	10	67	5	5
C9_LW_T139_S1_L38_PR25_SEM2	139	M	01-10-2025	27.7.c.2	4	3	4	3	4	4	4	67	14	12
C392_LW_T471_S2_VIGO2_SEM1	471	F	27-06-2025	27.7.j	10	10	9	9	9	10	10	50	6	5
C3_LW_T283_S2_L39_PR25_SEM2	283	F	01-10-2025	27.7.c.2	9	9	9	7	9	10	9	67	11	7
C43_LW_T458_S2_VIGO2_SEM1	458	F	12-03-2025	27.7.j	10	10	8	9	10	11	10	50	11	8
C44_LW_T529_S2_VIGO2_SEM1	529	F	12-03-2025	27.7.j	10	12	11	10	10	12	10	50	9	8
C46_LW_T415_S2_VIGO2_SEM1	415	F	12-03-2025	27.7.j	8	9	9	8	9	7	9	50	10	8
C14_LW_T129_S1_L63_PR25_SEM2	129	M	11-10-2025	27.7.c.2	2	3	3	2	4	2	2	50	31	25

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	Modal age	PA %	CV %	APE %
C2_LW_T120_S1_L63_PR25_SEM2	120	M	11-10-2025	27.7.c.2	2	3	2	2	3	2	2	67	22	19
C7_LW_T129_S1_L63_PR25_SEM2	129	M	11-10-2025	27.7.c.2	2	2	2	2	2	3	2	83	19	13
C2_LW_T272_S1_L64_PR25_SEM2	272	M	11-10-2025	27.7.k.2	8	4	9	6	9	7	9	33	27	21
C4_LW_T233_S1_L71_PR25_SEM2	233	M	13-10-2025	27.7.c.2	5	4	5	5	5	5	5	83	8	6
C86_LW_T486_S2_VIGO2_SEM1	486	F	08-05-2025	27.7.j	11	9	9	11	8	12	11	33	15	13
BYDR03_MEG_L_7G_M_2024021110092	276		23-07-2023	27.8.a	8	8	8	7	8	8	8	83	5	4
BYDR07_MEG_D_M_8A_202207221049	180		21-04-2022	27.8.a	2	2	1	1	1	2	2	50	37	33
BYDR07_MEG_D_M_8A_202207221060	239		21-04-2022	27.8.a	4	3	2	2	2	3	2	50	31	25
BYDR07_MEG_L_M_8A_2022072210006	393		21-04-2022	27.8.a	8	6	7	6	6	7	6	50	12	10
BYDR07_MEG_L_M_8A_2022072210010	287		21-04-2022	27.8.a	5	5	5	5	4	6	5	67	13	7
BYDR08_MEG_D_7E_M_2024101710423	174		27-05-2024	27.7.e	4	4	2	2	1	3	4	33	45	38
BYDR08_MEG_L_7E_M_2024101710346	334		27-05-2024	27.7.e	6	6	5	6	5	5	6	50	10	9
BYDR08_MEG_L_7E_M_2024101710354	457		27-05-2024	27.7.e	9	8	8	9	8	8	8	67	6	5
BYDR09_MEG_D_7F_M_2024112010123	248		24-06-2024	27.7.f	3	3	3	3	3	2	3	83	14	10
BYDR09_MEG_L_7F_M_2024112010075	410		31-05-2024	27.7.f	7	7	6	7	7	7	7	83	6	4
CDDR03_MEG_L_7F_M_2025031310327	481		23-09-2024	27.7.f	9	8	8	9	8	8	8	67	6	5
CDDR04_MEG_L_7G_M_2025040920122	351		20-11-2024	27.7.g	7	7	8	8	8	7	7	50	7	7
CDDR04_MEG_L_M_7E_2021071010489	375		01-07-2021	27.7.e	6	7	6	6	6	6	6	83	7	5
CDDR06_MEG_L_7H_M_2025060210098	437		04-02-2025	27.7.h	7	9	10	8	9	8	9	33	12	10
CDDR07_MEG_D_8B_2025070210078	250		13-03-2025	27.8.b	4	4	4	4	4	5	4	83	10	7
CDDR07_MEG_D_8B_2025070210112	209		13-03-2025	27.8.b	4	3	2	3	3	2	3	50	27	20
CDDR07_MEG_L_8B_M_2025070210009	355		13-03-2025	27.8.b	6	5	-	5	6	6	6	60	10	9
CDDR07_MEG_L_8B_M_2025070210013	414		13-03-2025	27.8.b	8	9	9	9	9	8	9	67	6	5
CDDR07_MEG_L_8B_M_2025070210016	446		13-03-2025	27.8.b	6	-	6	-	-	6	6	100	0	0
CDDR07_MEG_L_8B_M_2025070210022	416		13-03-2025	27.8.b	8	11	9	-	10	9	9	40	12	9
CNVE02_MEG_D_7H_2025020410147	284		23-07-2024	27.7.h	6	6	5	5	5	5	5	67	10	8
CNVE02_MEG_L_7H_2025020410062	472		17-07-2024	27.7.h	8	8	9	9	10	9	9	50	9	6
CNVE02_MEG_L_7H_2025020410097	474		17-07-2024	27.7.h	8	7	9	9	7	6	8	17	16	13

Sample ID	length	sex	Catch date	ICES area	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	Modal age	PA %	CV %	APE %
CNVE05_MEG_D_7F_M_2025040510251	298		17-10-2024	27.7.f	5	6	5	6	6	5	5	50	10	9
CNVE05_MEG_L_7F_2025040510139	401		17-10-2024	27.7.f	7	6	7	8	7	8	7	50	11	8
CNVE11_MEG_D_7H_M_2025101410085	287		15-03-2025	27.7.h	5	5	5	5	5	5	5	100	0	0
CNVE11_MEG_L_7H_M_2025101410020	440		13-03-2025	27.7.h	10	8	10	10	8	9	10	50	11	9
NKSZ02_MEG_D_7E_M_2025022610430	181		23-07-2024	27.7.e	3	4	1	1	1	2	1	50	63	50
NKSZ02_MEG_D_7E_M_2025022610459	285		29-07-2024	27.7.e	5	5	5	5	5	5	5	100	0	0
NKSZ02_MEG_D_7F_M_2025022610144	268		23-07-2024	27.7.f	3	3	3	3	3	2	3	83	14	10
NKSZ02_MEG_L_7F_M_2025022610103	360		23-07-2024	27.7.f	7	6	6	7	7	6	7	50	8	8
NKSZ05_MEG_D_8A_M_2024053110076	239		25-02-2024	27.8.a	5	4	3	3	3	4	3	50	22	18
NKSZ05_MEG_D_8A_M_2024053110111	155		25-02-2024	27.8.a	2	2	2	1	2	2	2	83	22	15
NKSZ05_MEG_L_8A_M_2024053110021	310		11-02-2024	27.8.a	5	5	5	5	5	5	5	100	0	0
NKSZ05_MEG_L_8A_M_2024053110027	410		11-02-2024	27.8.a	8	8	8	8	8	8	8	100	0	0
NKSZ05_MEG_L_8A_M_2024053110030	376		25-02-2024	27.8.a	7	7	7	7	7	7	7	100	0	0
NKSZ06_MEG_D_8B_M_2025061010052	284		26-02-2025	27.8.b	6	5	4	4	4	6	4	50	20	17
NKSZ06_MEG_D_8B_M_2025061010068	221		26-02-2025	27.8.b	6	4	4	4	3	5	4	50	24	18
NKSZ06_MEG_D_8B_M_2025061010069	223		26-02-2025	27.8.b	3	3	2	2	2	2	2	67	22	19
NKSZ06_MEG_L_7E_M_2023051210376	405		04-11-2022	27.7.e	6	6	6	8	7	8	6	50	14	12
NKSZ06_MEG_L_8B_2025061010007	372		26-02-2025	27.8.b	9	8	9	7	8	8	8	50	9	7
NKSZ07_MEG_D_7G_2025072810173	280		13-03-2025	27.7.g	4	4	4	3	4	4	4	83	11	7
NKSZ07_MEG_D_7H_M_2024092310148	268		17-05-2024	27.7.h	4	5	5	5	5	5	5	83	8	6
NKSZ08_MEG_D_7F_M_2024093010149	229		23-05-2024	27.7.f	3	3	2	3	2	2	3	50	22	20
NKSZ08_MEG_L_7F_M_2024093010096	404		23-05-2024	27.7.f	5	5	5	6	6	4	5	50	15	11
NKSZ09_MEG_D_7G_M_2023101810179	293		12-05-2023	27.7.g	5	4	4	5	4	4	4	67	12	10
NKSZ09_MEG_L_7G_M_2023101810115	398		12-05-2023	27.7.g	7	8	8	7	8	8	8	67	7	6
NKSZ10_MEG_L_7G_M_2023102810097	490		19-06-2023	27.7.g	9	9	9	10	10	8	9	50	8	6

List of multimodal cases

Table 36: 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	BYDR07_MEG_D_M_8A_202207221049
2	BYDR08_MEG_D_7E_M_2024101710423
2	BYDR08_MEG_L_7E_M_2024101710346
2	C119_LW_T333_S2_VIGO2_SEM1
2	C12_LW_T97_S2_L37_PR24_SEM2
3	C265_LW_T415_S1_VIGO2_SEM1
2	C276_LW_T418_S2_VIGO2_SEM1
2	C3_LW_T150_S2_L12_PR25
2	C381_LW_T472_S2_VIGO2_SEM1
2	C382_LW_T532_S2_VIGO2_SEM1
2	C392_LW_T471_S2_VIGO2_SEM1
2	C86_LW_T486_S2_VIGO2_SEM1
2	CDDR04_MEG_L_7G_M_2025040920122
2	CDDR06_MEG_L_7H_M_2025060210098
2	CNVE02_MEG_L_7H_2025020410097
2	CNVE05_MEG_D_7F_M_2025040510251
2	NKSZ02_MEG_L_7F_M_2025022610103
2	**NKSZ08_MEG_D_7F_M_2024093010149**

Number of age readings by modal age

Table 37: 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR	total
1	4	4	4	4	4	4	24
2	12	12	12	12	12	12	72
3	7	7	7	7	7	7	42
4	13	13	13	13	13	13	78
5	11	11	11	11	11	11	66
6	13	12	12	12	12	13	74
7	8	8	8	8	8	8	48
8	13	13	13	13	13	13	78
9	10	10	10	9	10	10	59
10	9	9	9	9	9	9	54
11	1	1	1	1	1	1	6
Total	**101**	**100**	**100**	**99**	**100**	**101**	**601**

Number of age readings by age

Table 38**:** 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	**R02 ES**	**R04 GB**	**R06 BE**	**R08 ES**	**R10 BE**	**R12 FR**	**total**
1	5	0	3	8	4	1	21
2	9	11	11	9	9	15	64
3	7	12	8	11	10	6	54
4	12	14	13	8	14	12	73
5	11	10	13	13	9	13	69
6	13	15	10	13	9	14	74
7	11	6	8	10	12	11	58
8	16	16	9	9	16	16	82
9	6	10	16	11	7	6	56
10	9	4	5	6	9	4	37
11	2	1	1	1	1	1	7
12	0	1	1	0	0	2	4
13	0	0	1	0	0	0	1
14	0	0	1	0	0	0	1
Total	**101**	**100**	**100**	**99**	**100**	**101**	**601**

Separate age bias plots by reader

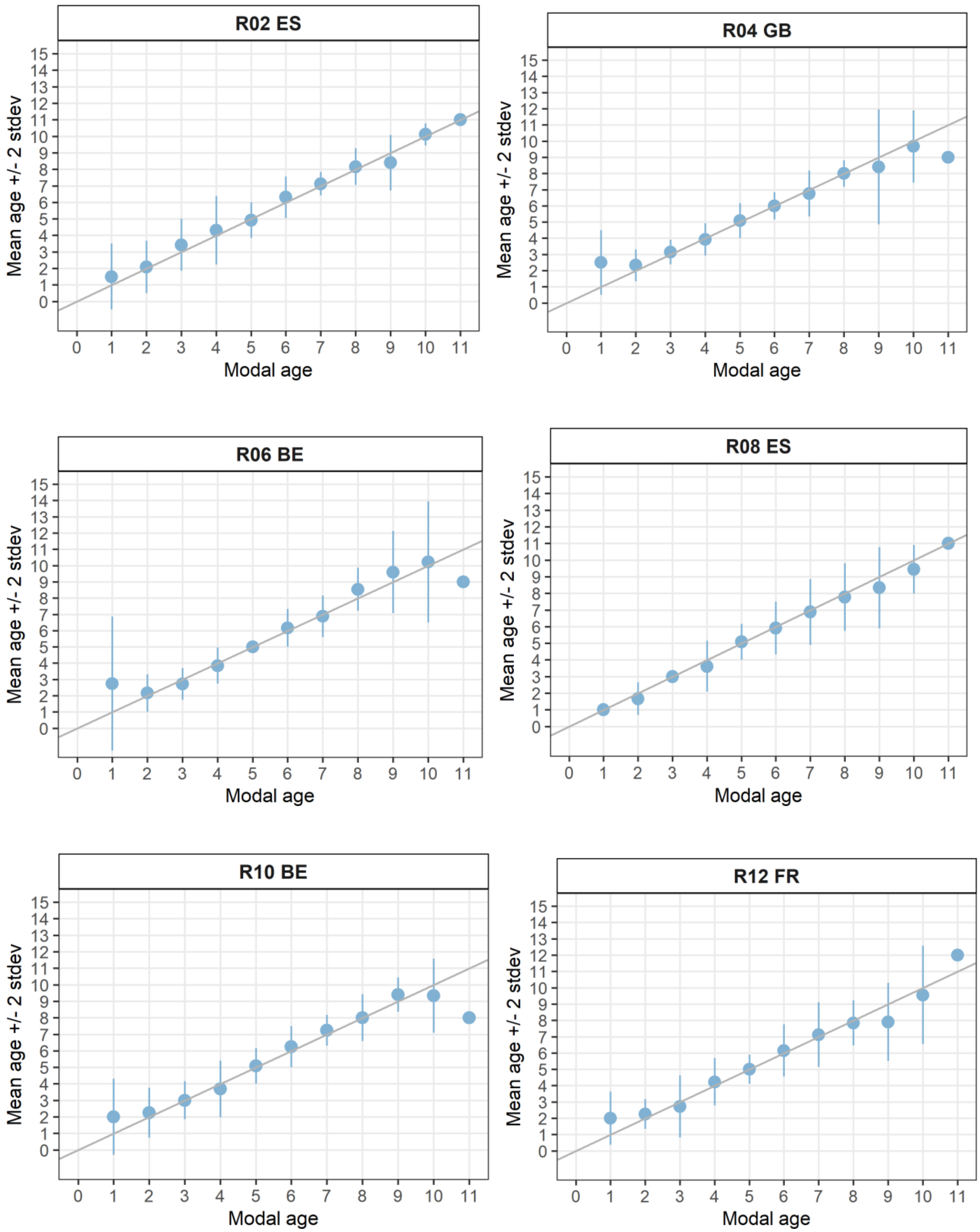


Figure 10: *Separate age bias plots by each reader*

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

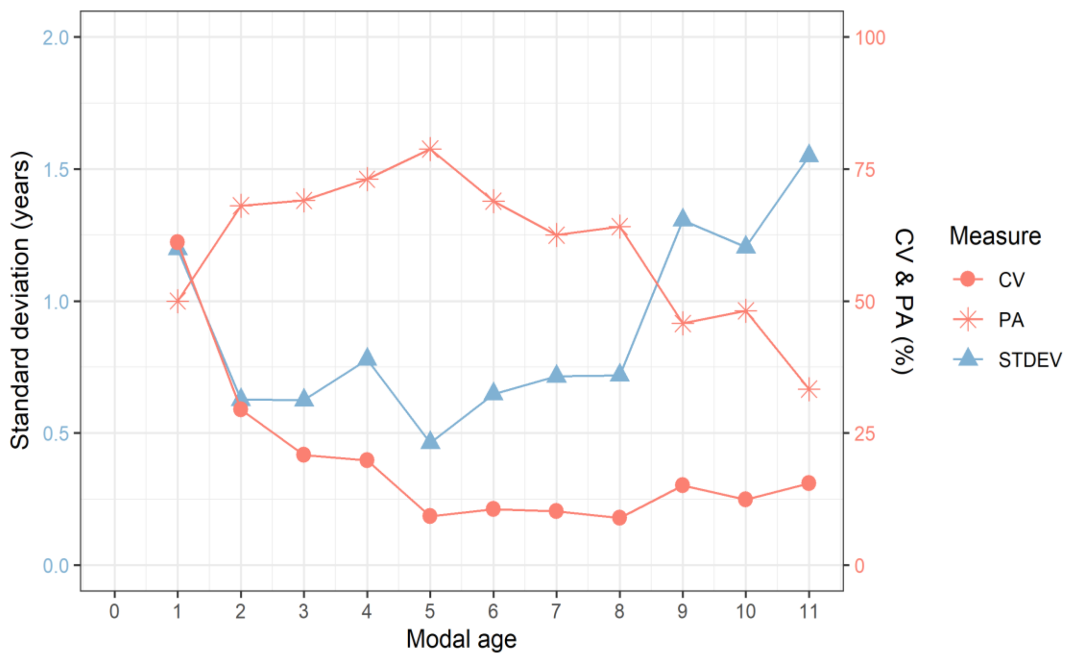


Figure 11: CV, PA and (STDEV (standard deviation) are plotted against modal age

Distribution of age reading errors

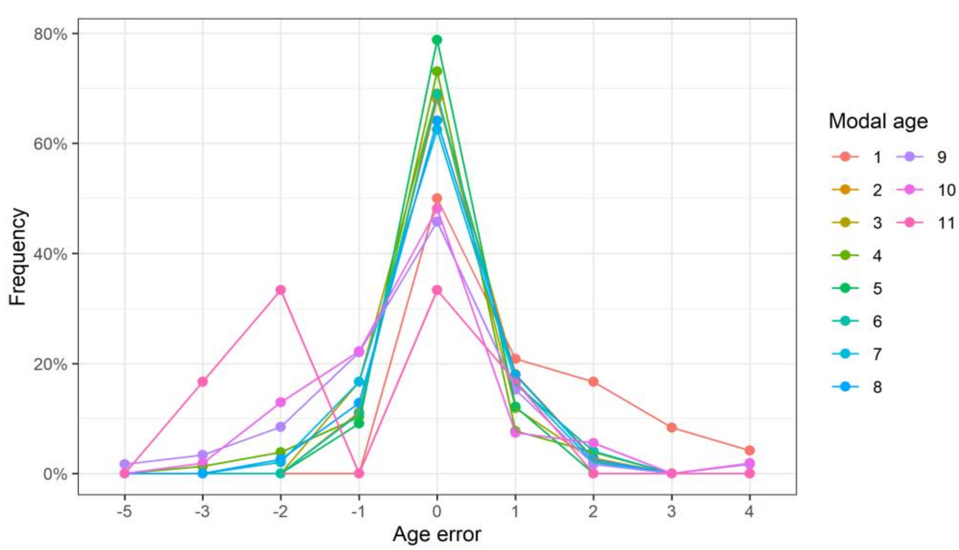


Figure 6**:** The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

Relative bias for all readers

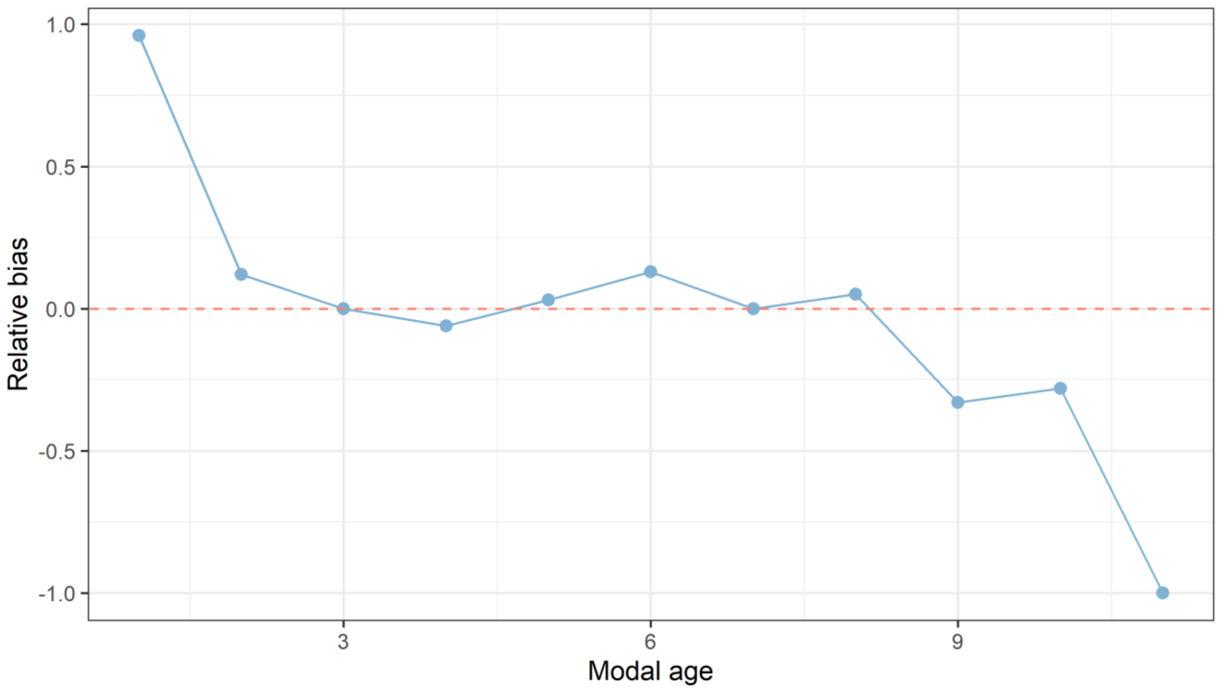


Figure 13**:** The relative bias by modal age as estimated by all age readers combined.

Mean length at age by reader

Table 39**:** 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	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR
1	137 mm	-	170 mm	150 mm	171 mm	148 mm
2	139 mm	142 mm	172 mm	158 mm	172 mm	176 mm
3	224 mm	197 mm	199 mm	211 mm	184 mm	174 mm
4	222 mm	231 mm	219 mm	252 mm	225 mm	228 mm
5	299 mm	315 mm	289 mm	292 mm	297 mm	295 mm
6	333 mm	336 mm	351 mm	336 mm	346 mm	355 mm
7	358 mm	394 mm	357 mm	360 mm	359 mm	385 mm
8	397 mm	411 mm	397 mm	409 mm	406 mm	405 mm
9	417 mm	416 mm	414 mm	473 mm	407 mm	428 mm
10	462 mm	476 mm	431 mm	463 mm	459 mm	398 mm
11	494 mm	416 mm	529 mm	486 mm	502 mm	458 mm

Age	R02 ES	R04 GB	R06 BE	R08 ES	R10 BE	R12 FR
12	-	529 mm	502 mm	-	-	508 mm
13	-	-	555 mm	-	-	-
14	-	-	481 mm	-	-	-
Weighted Mean	**314 mm**	**313 mm**	**314 mm**	**312 mm**	**313 mm**	**314 mm**

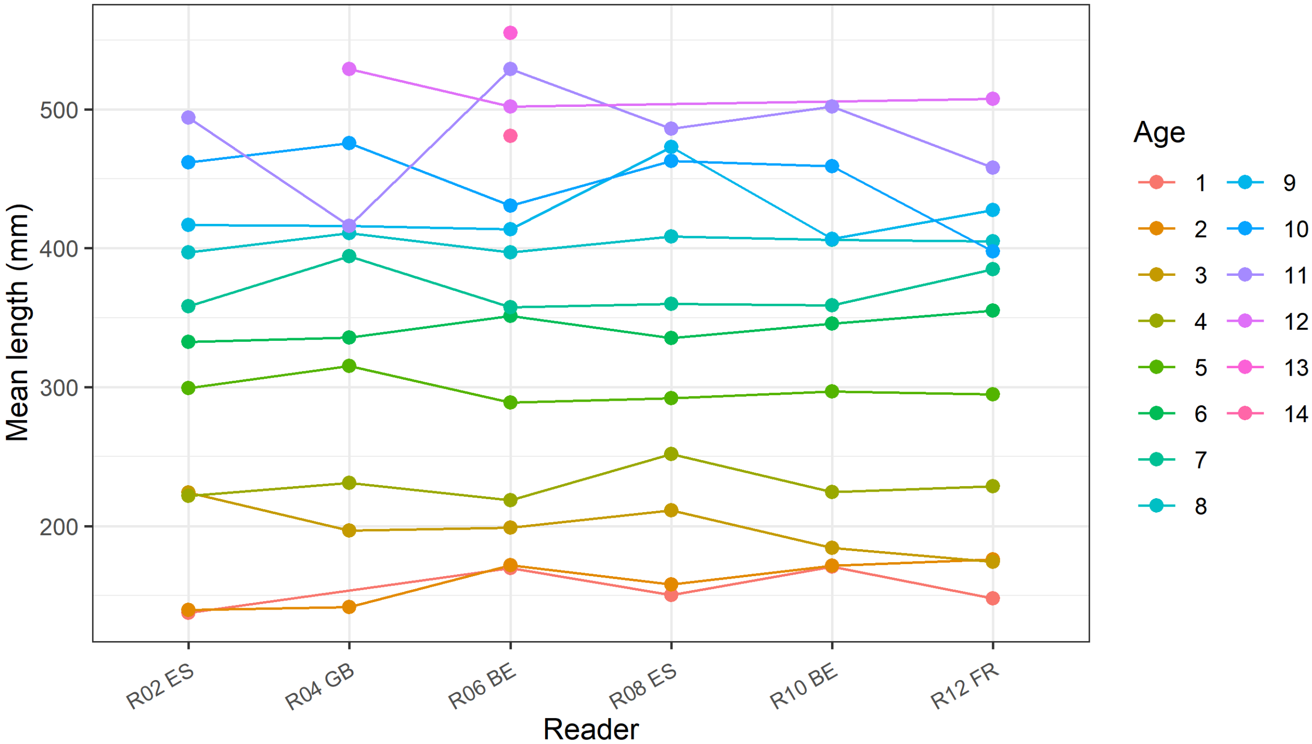


Figure 14: The mean fish length at age as estimated by each age reader.