SmartDots Report for the 2026 North Sea Sprat age reading exchange (ID 4004)

Coordination and analysis: Julie Coad Davies, National Institute of Aquatic Resources, DTU Aqua, Denmark

Table of Contents

1 Summary

This calibration exercise was run as part of the WKARSPRAT2 2026. 90 samples were included which had previously been read as part of the WKARSPRAT 2016. Readers who completed the exercise were those providing age data for the spr.27.3a4 stock assessment purposes at the time, referred to “advanced” readers. Overall PA was 86%, with a CV of 30% and an APE of 17%, with a modal age range of 1-3 years.

2 Methods

The results section includes the tables and plots from the Guus Eltink Excel sheet 'Age Reading Comparisons (Eltink, A.T.G.W. 2000). The order and numbering of tables and plots are the same as in the excel sheet. Tables 6.1 - 6.4 from the 'Age Reading Comparisons' sheet are not outputted since these are merely used to do calculations for the other tables.

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.

2.1 Overview of samples and readers

Table 1: Overview of samples used for the exchange event number 4004

Year	ICES area	Strata	Quarter	Number of samples	Modal age range	Length range
2010	27.4.b	Strata_spr.27.3a4	1	23	1-3	80-130 mm
2010	27.4.b	Strata_spr.27.3a4	3	21	1-2	90-120 mm
2010	27.4.b	Strata_spr.27.3a4	4	39	1-3	90-140 mm
2010	27.4.c	Strata_spr.27.3a4	3	7	1	90-100 mm

Table 2: Reader overview.

Reader code	Expertise	Expertise_rank	strata
R01 DK	Advanced	1	Strata_spr.27.3a4
R03 NO	Advanced	3	Strata_spr.27.3a4
R04 GB-SCT	Advanced	4	Strata_spr.27.3a4
R05 SE	Advanced	5	Strata_spr.27.3a4
R06 DE	Advanced	6	Strata_spr.27.3a4
R07 NO	Advanced	7	Strata_spr.27.3a4
R08 GB	Advanced	8	Strata_spr.27.3a4
R09 GB	Advanced	9	Strata_spr.27.3a4
R10 NO	Advanced	10	Strata_spr.27.3a4

3 Results based on readers providing age data for stock assessment

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
90	30 %	86 %	17 %

Coefficient of Variation (CV)

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

Modal age	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	all
1	48 %	14 %	14 %	0 %	39 %	0 %	25 %	**29 %**	26 %	**37 %**
2	21 %	13 %	12 %	15 %	25 %	13 %	15 %	**17 %**	18 %	**19 %**
3	16 %	16 %	0 %	0 %	15 %	16 %	34 %	**14 %**	18 %	**18 %**
Weighted Mean	**36 %**	**13 %**	**13 %**	**6 %**	**33 %**	**5 %**	**22 %**	**24 %**	**23 %**	**30 %**

Percentage of Agreement (PA)

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

Modal age	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	total
1	46 %	98 %	98 %	100 %	73 %	100 %	92 %	**88 %**	92 %	**87 %**
2	64 %	94 %	94 %	91 %	67 %	93 %	91 %	**85 %**	86 %	**85 %**
3	60 %	80 %	100 %	100 %	40 %	80 %	80 %	**80 %**	75 %	**77 %**
Weighted Mean	**53 %**	**96 %**	**97 %**	**97 %**	**69 %**	**97 %**	**91 %**	**87 %**	**89 %**	**86 %**

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 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	all
1	38 %	4 %	4 %	0 %	33 %	0 %	13 %	**18 %**	14 %	**22 %**
2	20 %	6 %	3 %	6 %	22 %	7 %	6 %	**12 %**	9 %	**11 %**
3	14 %	11 %	0 %	0 %	13 %	11 %	25 %	**10 %**	14 %	**9 %**
Weighted Mean	**30 %**	**5 %**	**3 %**	**2 %**	**28 %**	**3 %**	**11 %**	**16 %**	**12 %**	**17 %**

Relative Bias

Table 7: The relative bias (as the difference between the mean and modal age) per modal age and advanced reader is presented, as well as the weighted mean relative bias per reader and the relative bias per modal age for all advanced readers combined.

Modal age	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	all
1	0.71	0.02	0.02	0.00	0.29	0.00	0.08	**0.12**	0.08	**0.15**
2	0.36	-0.06	0.00	-0.03	0.39	-0.07	-0.03	**0.15**	0.07	**0.09**
3	0.40	-0.20	0.00	0.00	0.60	-0.20	-0.40	**0.20**	-0.25	**0.02**
Weighted Mean	**0.57**	**-0.02**	**0.01**	**-0.01**	**0.34**	**-0.03**	**0.01**	**0.13**	**0.06**	**0.12**

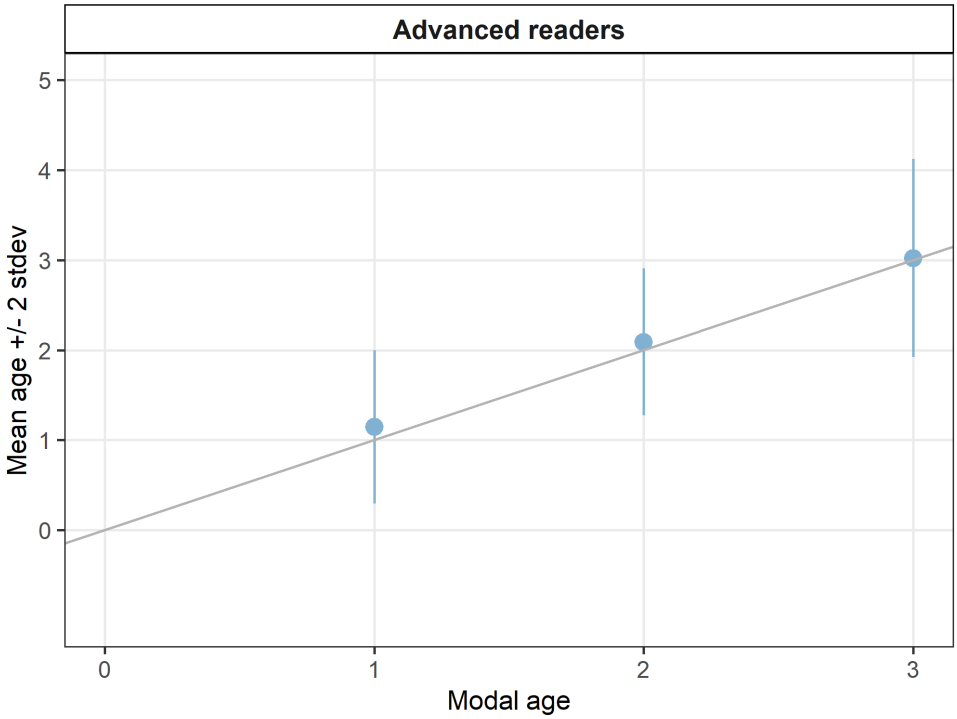


Figure 1: Age bias plot for advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference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

Table 8: Age error matrix (AEM) for spr.27.3a4.

modal_age	1	2	3	4	Total
1	**0.87**	0.11	0.01	0.01	1
2	0.03	**0.85**	0.11	0.01	1
3	0.02	0.07	**0.77**	0.14	1

4 References

Beamish R. J. and Fournier D. A. (1981) A method for comparing the precision of a set of age determination. Canadian Journal of Fisheries and Aquatic Sciences, 38, 982–983

GUIDELINES AND TOOLS FOR AGE READING. Eltink, A.T.G.W., Newton A.W., Morgado C., Santamaria M.T.G and Modin J. (2000) Guidelines and tools for age Reading. (PDF document version 1.0 October 2000) Internet: http://www.efan.no

Eltink, A.T.G.W. (2000) Age reading comparisons. (MS Excel workbook version 1.0 October 2000) Internet: http://www.efan.no

ICES (2014) Report of the Workshop on Statistical Analysis of Biological Calibration Studies (WKSABCAL). ICES CM 2014/ACOM: 35

5 Additional results

Table 9: Data overview including modal age and statistics per sample.

Fish ID	length	Catch date	ICES area	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	Modal age	PA %	CV %	APE %
Sprat003	130	01-01-2010 00:00:00	27.4.b	3	3	3	3	3	3	3	3	3	3	100	0	0
Sprat006	106	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat011	106	01-01-2010 00:00:00	27.4.b	3	2	2	2	3	2	2	3	2	2	67	21	19
Sprat013	111	01-01-2010 00:00:00	27.4.b	3	3	3	3	3	3	3	3	3	3	100	0	0
Sprat016	89	01-01-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat022	87	01-01-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat024	94	01-01-2010 00:00:00	27.4.b	2	2	2	2	3	2	2	2	2	2	89	16	9
Sprat025	95	01-01-2010 00:00:00	27.4.b	2	2	3	2	3	2	2	2	-	2	75	21	17
Sprat029	111	01-01-2010 00:00:00	27.4.b	4	3	3	3	4	3	3	3	3	3	78	14	11
Sprat030	122	01-01-2010 00:00:00	27.4.b	3	2	2	2	2	2	2	2	2	2	89	16	9
Sprat031	108	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat032	103	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	-	2	100	0	0
Sprat038	109	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat041	99	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat047	93	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	-	2	2	2	2	100	0	0
Sprat049	84	01-01-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	1	2	89	18	10
Sprat055	110	01-02-2010 00:00:00	27.4.b	3	2	2	2	3	2	2	2	2	2	78	20	16
Sprat057	110	01-02-2010 00:00:00	27.4.b	3	2	2	3	4	2	2	2	2	2	67	30	24
Sprat059	80	01-02-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	-	1	100	0	0
Sprat060	110	01-02-2010 00:00:00	27.4.b	3	3	3	3	4	3	3	4	-	3	75	14	12
Sprat065	115	01-02-2010 00:00:00	27.4.b	2	2	2	2	3	-	2	2	2	2	88	17	10
Sprat068	90	01-02-2010 00:00:00	27.4.b	2	-	2	2	2	2	2	2	2	2	100	0	0
Sprat072	120	01-02-2010 00:00:00	27.4.b	3	2	2	2	3	-	2	2	3	2	62	22	20
Sprat079	89	01-07-2010 00:00:00	27.4.b	1	2	1	1	1	1	1	1	1	1	89	30	18
Sprat087	94	01-07-2010	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0

Fish ID	length	Catch date	ICES area	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	Modal age	PA %	CV %	APE %
Sprat103b	95	00:00:00 01-07-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	-	1	100	0	0
Sprat105b	88	01-07-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat112	93	01-07-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat113	96	01-07-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat114	98	01-07-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat117	93	01-07-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat119	106	01-07-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	-	1	88	31	19
Sprat122	89	01-07-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat142	95	01-08-2010 00:00:00	27.4.c	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat143	94	01-08-2010 00:00:00	27.4.c	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat155	92	01-08-2010 00:00:00	27.4.c	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat159	100	01-08-2010 00:00:00	27.4.c	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat160	99	01-08-2010 00:00:00	27.4.c	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat162	92	01-08-2010 00:00:00	27.4.c	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat170	89	01-08-2010 00:00:00	27.4.c	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat174	109	01-09-2010 00:00:00	27.4.b	2	2	2	2	2	-	2	2	-	2	100	0	0
Sprat175	117	01-09-2010 00:00:00	27.4.b	3	2	2	1	2	2	1	2	2	2	67	32	21
Sprat176	120	01-09-2010 00:00:00	27.4.b	3	2	2	2	2	2	2	2	2	2	89	16	9
Sprat177	109	01-09-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat178	108	01-09-2010 00:00:00	27.4.b	3	1	1	1	1	1	1	1	1	1	89	55	32
Sprat190	115	01-09-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat194	110	01-09-2010 00:00:00	27.4.b	2	1	1	2	2	1	2	2	2	2	67	30	27
Sprat199	103	01-09-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat200	103	01-09-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat201	97	01-09-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat202	95	01-09-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat221	108	01-10-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat222	113	01-10-2010	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0

Fish ID	length	Catch date	ICES area	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	Modal age	PA %	CV %	APE %
Sprat226	122	01-10-2010 00:00:00	27.4.b	4	1	1	1	1	1	1	2	-	1	75	71	50
Sprat235	105	01-10-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat236	107	01-10-2010 00:00:00	27.4.b	2	1	2	1	2	1	1	2	2	2	56	34	32
Sprat238	120	01-10-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat242	106	01-10-2010 00:00:00	27.4.b	2	1	1	1	1	1	1	1	1	1	89	30	18
Sprat243	105	01-10-2010 00:00:00	27.4.b	1	1	1	1	2	1	1	1	1	1	89	30	18
Sprat247	112	01-10-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	1	1	1	78	36	28
Sprat248	111	01-10-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	2	2	1	56	36	34
Sprat250	112	01-10-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	2	1	1	67	38	33
Sprat253	120	01-10-2010 00:00:00	27.4.b	4	2	3	3	4	2	1	3	2	3	33	38	31
Sprat260	112	01-10-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	3	2	2	89	16	9
Sprat263	110	01-10-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	1	1	1	78	36	28
Sprat265	105	01-10-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat267	111	01-10-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	1	2	1	67	38	33
Sprat268	112	01-10-2010 00:00:00	27.4.b	2	1	1	1	1	1	2	1	1	1	78	36	28
Sprat272	139	01-11-2010 00:00:00	27.4.b	3	2	2	2	2	2	3	3	2	2	67	21	19
Sprat273	133	01-11-2010 00:00:00	27.4.b	2	2	2	2	3	2	2	2	2	2	89	16	9
Sprat274	133	01-11-2010 00:00:00	27.4.b	2	2	2	2	3	2	2	3	3	2	67	21	19
Sprat275	138	01-11-2010 00:00:00	27.4.b	3	2	2	2	4	2	2	3	3	2	56	28	24
Sprat276	121	01-11-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat278	122	01-11-2010 00:00:00	27.4.b	3	1	1	1	2	1	2	2	1	1	56	47	40
Sprat279	128	01-11-2010 00:00:00	27.4.b	3	2	2	2	3	2	2	2	-	2	75	21	17
Sprat281	135	01-11-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat285	130	01-11-2010 00:00:00	27.4.b	3	2	2	2	2	2	2	2	2	2	89	16	9
Sprat286	127	01-11-2010 00:00:00	27.4.b	3	2	2	2	2	2	2	2	2	2	89	16	9
Sprat292	104	01-11-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	1	1	1	78	36	28
Sprat296	116	01-11-2010 00:00:00	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0
Sprat299	117	01-11-2010	27.4.b	2	2	2	2	2	2	2	2	2	2	100	0	0

Fish ID	length	Catch date	ICES area	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	Modal age	PA %	CV %	APE %
		00:00:00														
Sprat301	120	01-11-2010 00:00:00	27.4.b	4	1	-	1	2	1	1	2	2	1	50	59	43
Sprat303	115	01-11-2010 00:00:00	27.4.b	3	1	1	1	2	1	2	2	2	1	44	42	36
Sprat305	112	01-11-2010 00:00:00	27.4.b	2	1	1	1	1	1	2	1	1	1	78	36	28
Sprat322	120	01-12-2010 00:00:00	27.4.b	4	1	2	1	3	1	1	1	1	1	67	67	53
Sprat323	105	01-12-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0
Sprat332	115	01-12-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	1	1	1	78	36	28
Sprat338	100	01-12-2010 00:00:00	27.4.b	2	1	1	1	2	1	1	1	1	1	78	36	28
Sprat343	95	01-12-2010 00:00:00	27.4.b	1	1	1	1	2	1	1	1	1	1	89	30	18
Sprat344	90	01-12-2010 00:00:00	27.4.b	1	1	1	1	1	1	1	1	1	1	100	0	0

Number of age readings by modal age

Table X: 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.

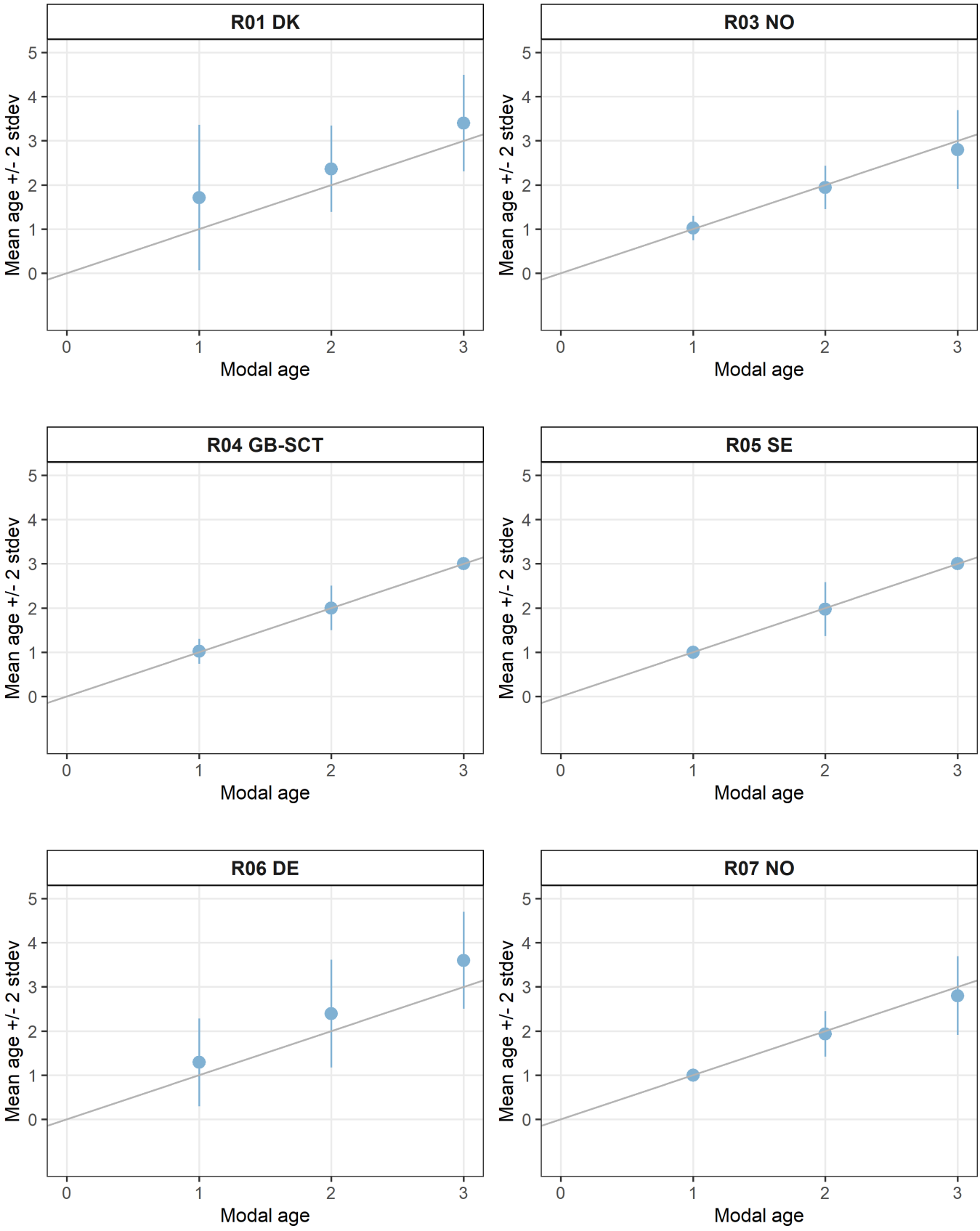
Modal age	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	total
1	52	52	51	52	52	52	52	52	48	463
2	33	32	33	33	33	29	33	33	29	288
3	5	5	5	5	5	5	5	5	4	44
Total	**90**	**89**	**89**	**90**	**90**	**86**	**90**	**90**	**81**	**795**

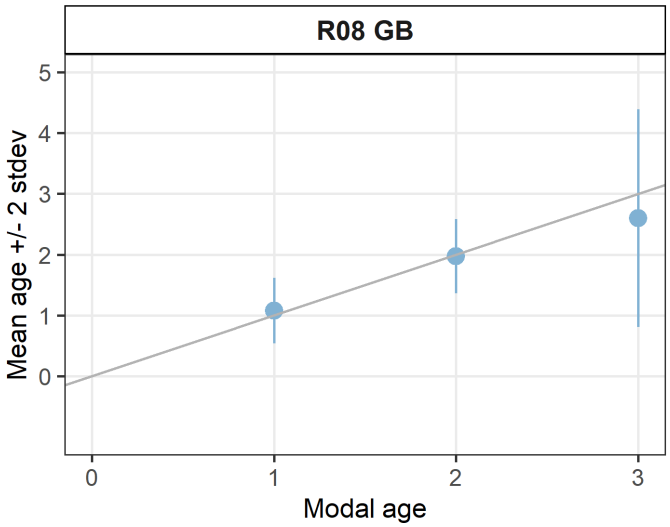
Number of age readings by age

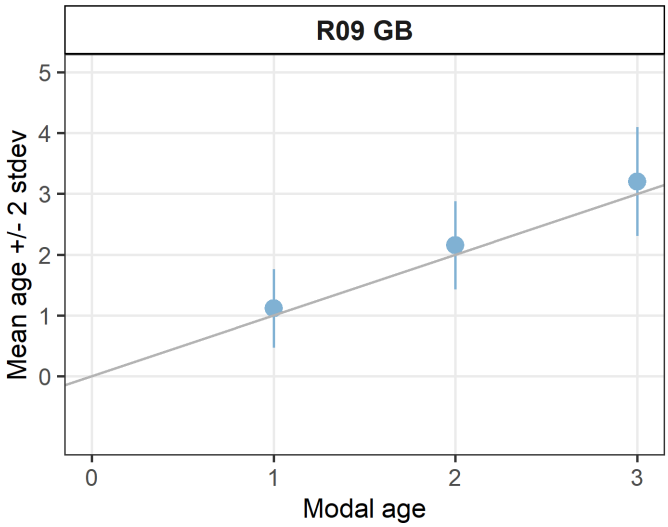
Table X: Age composition by reader gives a summary of number of readings per reader and age. The total numbers of readings by age and by reader are also presented.

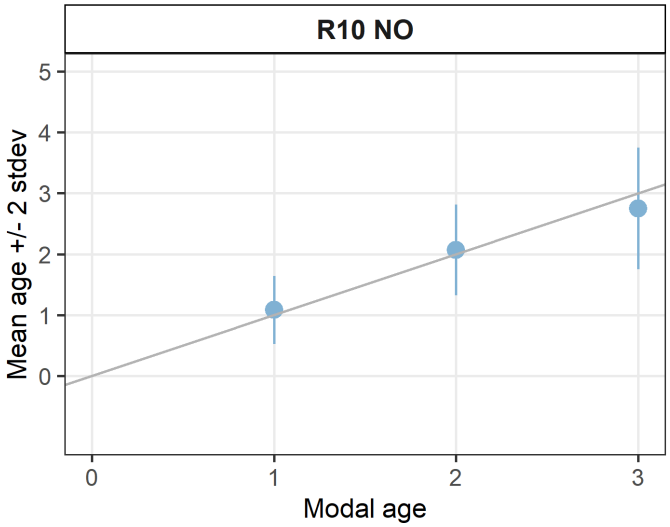
Age	R01 DK	R03 NO	R04 GB-SCT	R05 SE	R06 DE	R07 NO	R08 GB	R09 GB	R10 NO	total
1	24	53	51	54	38	54	51	46	45	416
2	43	32	32	30	35	28	34	34	30	298
3	18	4	6	6	12	4	5	9	6	70
4	5	0	0	0	5	0	0	1	0	11
Total	**90**	**89**	**89**	**90**	**90**	**86**	**90**	**90**	**81**	**795**

Separate age bias plots by reader


R01 DK
R03 NO
R04 GB-SCT
R05 SE
R06 DE
R07 NO
Mean age +/- 2 stdev
Modal age
0
1
2
3
4
5


R08 GB
Mean age +/- 2 stdev
Modal age
0
1
2
3
4
5


R09 GB
Mean age +/- 2 stdev
Modal age
0
1
2
3
4
5


R10 NO
Mean age +/- 2 stdev
Modal age
0
1
2
3
4
5