

WKSANDEEL 2022 Working Document on age reader calibration using SmartDots – 2022 North Sea Sandeel

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

Main conclusions

The results outlined in this document are based on age readers who provide age data for stock assessment purposes (advanced readers), 3 from Norway and 2 from Denmark. A set of 120 otolith images were age read by the readers in an exchange which took place using the SmartDots application (ID 424). The otolith images were previously read in 2019

(<https://smarddots.ices.dk/SampleImages/2019/219/2019%20North%20Sea%20Sandeel%20Age%20Reading%20Exchange%20Report.pdf>). The same 3 readers from Norway took part in both exchanges, whereas from Denmark only 1 reader took part in both exchanges.

In 2019, the weighted average percentage agreement (PA) was 81 % and the weighted average coefficient of variation (CV) was 24 % (based on advanced readers only). In 2022, results improved and the weighted average percentage agreement (PA) was 87 % and the weighted average coefficient of variation (CV) was 20%.

Included in both the 2019 and 2022 exchanges were a subset of 40 otoliths (from SA1) with 100% agreement in the 2016 exchange (WKSAND 2016 WD). Based on only these 40 otoliths, the weighted average percentage agreement (PA) in 2019 was 85 % and the weighted average coefficient of variation (CV) was 24%. An improvement was seen in 2022 when the weighted average percentage agreement (PA) was 92 % and the weighted average coefficient of variation (CV) was 17%.

In 2019 the following age reading issues were apparent; a) incorrect interpretation of the otolith edge in Q4 where some readers were counting an extra year and b) disagreement as to whether or not a faint innermost translucent zone (present in some otoliths) should be counted as a true winter ring or not. The former issue appears to be resolved as a result of repeated calibration of readers and feedback on age reading issues. The latter is a reoccurring issue (see Image Examples) which needs attention and requires otolith microstructure examination of problematic otoliths from different areas in order to validate whether or not this is a true winter ring.

2022 results do not show any indication that a single stock or month of capture (or age) is more difficult to read even though in 2019 concerns were raised over image quality of the otoliths from san.sa.3r and san.sa.5r which were mounted in eukit and which may have contributed to the lower PA for these areas/stocks. CV at modal age 1 is highest but it should be noted that the calculation of CV is dependent on age and CV at modal age 0 is not calculated for this reason. Even though PA at modal age 0 is high (84%) it is lower than PA at modal ages 1 (90%) and 2 (93%), indicating there are some difficulties in the correct interpretation of modal age 0 with a general pattern of positive bias in relation to modal age which is interpreted as an overestimation of age.

Sample overview

120 otolith images were provided by Denmark and Norway (Table 1), collected from SA1 Q4 2015, Q2 2016, Q4 2018; SA3 Q2 2016, Q2 2017 and Q4 2018 and SA5 Q2 2011 representing sandeel stocks; san.sa.1r, san.sa.3r and san.sa.5r respectively. The modal age range was from 0-9 years. A subset of 40 otoliths from san.sa.1r with 100% agreement across all readers in the 2016 exchange were included (modal age range 0-4). Those from Norway were pairs of otoliths mounted in eukit and those from Denmark were loose otoliths (some singles and some pairs), otoliths were photographed on a black background under reflected light. Readers were asked to annotate all 120 images and provide a readability score (<https://vocab.ices.dk/?ref=1395>) for each age estimation.

Table 1: Overview of samples used for the 2022 North Sea Sandeel exchange. The modal age range for all samples is 0-9 and fish length range from 70-250mm. Samples in bold were included in the 2016, 2019 and 2022 exchanges.

Year	ICES area	Strata	Quarter	Number of samples	Modal age range	Length range
2015	27.4.b	san.sa.1r	4	20	0-3	100-150 mm
2016	27.4.b	san.sa.1r	2	20	1-4	85-185 mm
2018	27.4.b	san.sa.1r	4	20	0-4	70-165 mm
2016	27.4.a	san.sa.3r	2	9	1-5	135-245 mm
2016	27.4.b	san.sa.3r	2	4	2	125-160 mm
2017	27.4.a	san.sa.3r	2	7	1-8	100-250 mm
2018	27.3.a.20	san.sa.3r	4	2	0	70-80 mm
2018	27.4.b	san.sa.3r	4	18	0-4	45-200 mm
2011	27.4.a	san.sa.5r	2	11	2-9	95-215 mm
2017	27.4.a	san.sa.5r	2	9	1-7	85-175 mm

Methods applied

Results presented here are based on output from SmartDots and a standardised r-script , there are a few examples of readers annotating some images incorrectly and placing a dot on the centre of the otolith, this will add an extra year to the age of the fish and will increase the CV and reduce the PA for those fish. In reality, the true results are slightly better.

The analysis follows traditional methods where the level of accuracy compared to modal age is indicated by percentage agreement (PA), bias tests and plots, and the level of precision, i.e. the reproducibility of age estimates is indicated by the coefficient of variation (CV). The tables and plots presented are from the Guus Eltink Excel sheet 'Age Reading Comparisons' (Eltink, A.T.G.W. 2000). Additional analyses of age data were included in the form of age error matrices (AEM's).

Percentage Agreement (PA)

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

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

Co-efficient of Variation (CV)

The table presents the 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:

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

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

Results

Tables 2 – 5 below show the results based on advanced readers (those providing age data for assessment) from the 2022 North Sea Sandeel age reading exchange. All age readings in Table 2 were included in the calculation of modal age, coefficient of variation (Table 3), percentage agreement (Table 4), and bias (Table 5 and Figure 1). CV at modal age 1 is highest at 35% and shows a decreasing trend with an increase in age. PA is highest at modal age 2 (93%), compared to modal age 0 (84%). Relative bias is 0.19 at modal age 0 with all readers showing positive bias, indicating an overestimation of age in comparison to modal age, this is also seen in Figure 1.

Table 2: Number of age readings made per advanced reader for each modal age.

Modal age	R01 NO	R02 NO	R03 DK	R04 NO	R05 DK	total
0	12	12	11	12	11	58
1	35	35	34	33	33	170
2	42	43	41	43	43	212
3	11	11	11	10	11	54
4	10	10	10	10	10	50
5	3	3	3	3	3	15
6	2	2	2	2	2	10
7	2	2	2	2	2	10
8	1	1	1	1	1	5
9	1	1	1	1	1	5
Total	119	120	116	117	117	589

Table 3: Coefficient of Variation (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 advanced reader.

Modal age	R01 NO	R02 NO	R03 DK	R04 NO	R05 DK	all
0	-	-	-	-	-	-
1	25 %	22 %	52 %	30 %	37 %	35 %
2	0 %	13 %	19 %	13 %	10 %	13 %
3	14 %	0 %	15 %	20 %	35 %	19 %
4	11 %	12 %	12 %	14 %	8 %	11 %
5	12 %	11 %	12 %	12 %	0 %	11 %
6	0 %	11 %	28 %	11 %	11 %	14 %
7	0 %	11 %	0 %	0 %	0 %	7 %
8	-	-	-	-	-	15 %
9	-	-	-	-	-	8 %
Weighted Mean	11 %	15 %	28 %	19 %	21 %	20 %

Table 4: Percentage agreement (PA) table represents the PA per modal age and advanced reader, the PA of all advanced readers combined per modal age and a weighted mean of the PA per advanced reader.

Modal age	R01 NO	R02 NO	R03 DK	R04 NO	R05 DK	all
0	83 %	92 %	91 %	92 %	64 %	84 %
1	94 %	94 %	79 %	91 %	91 %	90 %
2	100 %	93 %	85 %	93 %	95 %	93 %
3	82 %	100 %	82 %	70 %	82 %	83 %

4	80 %	80 %	80 %	70 %	90 %	80 %
5	67 %	67 %	67 %	67 %	100 %	73 %
6	100 %	50 %	50 %	50 %	50 %	60 %
7	100 %	50 %	0 %	100 %	100 %	70 %
8	100 %	0 %	0 %	0 %	100 %	40 %
9	100 %	100 %	0 %	0 %	100 %	60 %
Weighted Mean	92 %	90 %	79 %	85 %	89 %	87 %

Table 5: Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age and a weighted mean of the relative bias per advanced reader.

Modal age	R01 NO	R02 NO	R03 DK	R04 NO	R05 DK	all
0	0.17	0.25	0.09	0.08	0.36	0.19
1	-0.06	0.06	-0.21	0.03	0.12	-0.01
2	0.00	0.02	-0.15	0.02	0.05	-0.01
3	-0.18	0.00	0.00	-0.10	-0.18	-0.09
4	-0.20	0.00	0.00	0.10	0.10	0.00
5	-0.33	0.33	-0.33	-0.33	0.00	-0.13
6	0.00	0.50	-1.00	0.50	0.50	0.10
7	0.00	-0.50	-1.00	0.00	0.00	-0.30
8	0.00	-1.00	-2.00	1.00	0.00	-0.40
9	0.00	0.00	-1.00	1.00	0.00	0.00
Weighted Mean	-0.04	0.05	-0.17	0.04	0.09	-0.01

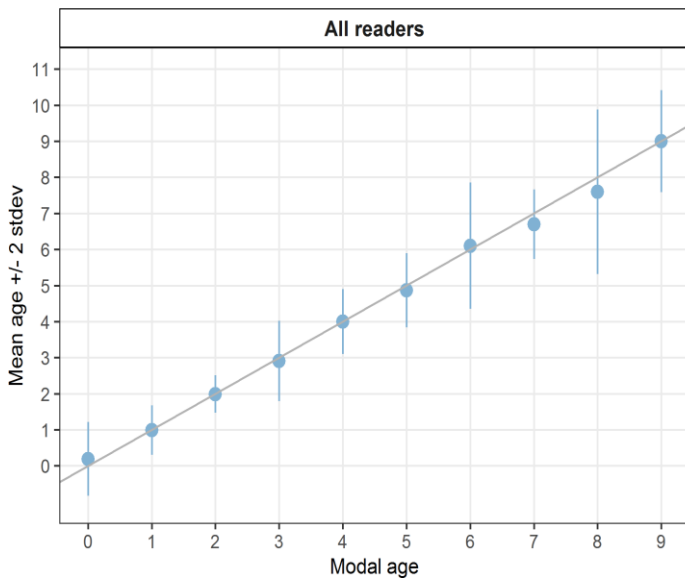


Figure 1: Age bias plot for all advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

Results by strata (stock)

A separate analysis of the age readings based on their strata (stock) shows the highest weighted mean PA (Table 8) for san.sa.1r. The age error matrices (AEM's) showing the proportions of age readings in agreement with modal age (Table 10, 11 and 12) are also highest for san.sa.1r. (Table 10). CV (Table 7) is highest for san.sa.1r but it should be noted that the modal age range is 0-4. For san.sa.3r the modal age range is 0-8 and there is much more variability around the modal age. For san.sa.5r the variability is even higher over a modal age range of 0-9. For all strata the

relative bias (Table 9) is positive at modal age 0, with an average of 0.28 across strata indicating an overestimation of age in comparison to modal age 0.

Table 6: Number of age readings per strata for all advanced readers.

Modal age	san.sa.1r	san.sa.3r	san.sa.5r	total
0	29	25	4	58
1	115	38	17	170
2	113	64	35	212
3	29	20	5	54
4	10	30	10	50
5	0	5	10	15
6	0	5	5	10
7	0	5	5	10
8	0	5	0	5
9	0	0	5	5
Total	296	197	96	589

Table 7: Coefficient of Variation (CV) per modal age per strata. “all” is an average CV per modal age across strata.

Modal age	san.sa.1r	san.sa.3r	san.sa.5r	all
0	-	-	-	-
1	27 %	49 %	35 %	35 %
2	13 %	0 %	19 %	13 %
3	16 %	24 %	24 %	19 %
4	12 %	12 %	8 %	11 %
5	-	12 %	9 %	11 %
6	-	19 %	9 %	14 %
7	-	8 %	7 %	7 %
8	-	15 %	-	15 %
9	-	-	8 %	8 %
Weighted Mean	20 %	17 %	18 %	20 %

Table 8: Percentage agreement (PA) per modal age per strata. “all” is an average PA per modal age across strata.

Modal age	san.sa.1r	san.sa.3r	san.sa.5r	all
0	86 %	88 %	50 %	84 %
1	93 %	82 %	88 %	90 %
2	93 %	100 %	83 %	93 %
3	79 %	95 %	60 %	83 %
4	80 %	77 %	90 %	80 %
5	-	60 %	80 %	73 %
6	-	60 %	60 %	60 %
7	-	60 %	80 %	70 %
8	-	40 %	-	40 %
9	-	-	60 %	60 %
Weighted Mean	91 %	86 %	79 %	87 %

Table 9: Relative Bias per modal age per strata. “all” is an average relative bias per modal age across strata.

Modal age	san.sa.1r	san.sa.3r	san.sa.5r	all
0	0.21	0.12	0.50	0.28
1	-0.03	0.05	0.00	0.01
2	-0.05	0.00	0.11	0.02
3	-0.07	-0.15	0.00	-0.07
4	0.00	0.03	-0.10	-0.02
5	-	-0.40	0.00	-
6	-	-0.20	0.40	-
7	-	-0.40	-0.20	-
8	-	-0.40	-	-

9	-	-	0.00	-
Weighted Mean	-0.02	-0.02	0.06	0.03

Table 10: Age error matrix (AEM) for san.sa.1r. The AEM shows the proportional distribution of age readings for each modal age. Age column should sum to one but due to rounding there might be small deviations in some cases.

strata	Modal age	0	1	2	3	4	5	6	7	8	9
san.sa.1r	Age 0	0.86207	0.05217	-	-	-	-	-	-	-	-
san.sa.1r	Age 1	0.10345	0.93043	0.06195	-	-	-	-	-	-	-
san.sa.1r	Age 2	-	0.01739	0.92920	0.13793	-	-	-	-	-	-
san.sa.1r	Age 3	0.03448	-	0.00885	0.79310	0.1	-	-	-	-	-
san.sa.1r	Age 4	-	-	-	0.06897	0.8	-	-	-	-	-
san.sa.1r	Age 5	-	-	-	-	0.1	-	-	-	-	-

Table 11: Age error matrix (AEM) for san.sa.3r. The AEM shows the proportional distribution of age readings for each modal age. Age column should sum to one but due to rounding there might be small deviations in some cases.

strata	Modal age	0	1	2	3	4	5	6	7	8	9
san.sa.3r	Age 0	0.88	0.07895	-	0.05	-	-	-	-	-	-
san.sa.3r	Age 1	0.12	0.81579	-	-	-	-	-	-	-	-
san.sa.3r	Age 2	-	0.07895	1	-	-	-	-	-	-	-
san.sa.3r	Age 3	-	0.02632	-	0.95	0.1000	-	-	-	-	-
san.sa.3r	Age 4	-	-	-	-	0.7667	0.4	0.2	-	-	-
san.sa.3r	Age 5	-	-	-	-	0.1333	0.6	-	-	-	-
san.sa.3r	Age 6	-	-	-	-	-	-	0.6	0.4	0.2	-
san.sa.3r	Age 7	-	-	-	-	-	-	0.2	0.6	0.2	-
san.sa.3r	Age 8	-	-	-	-	-	-	-	-	0.4	-
san.sa.3r	Age 9	-	-	-	-	-	-	-	-	-	0.2

Table 12: Age error matrix (AEM) for san.sa.5r. The AEM shows the proportional distribution of age readings for each modal age. Age column should sum to one but due to rounding there might be small deviations in some cases.

strata	Modal age	0	1	2	3	4	5	6	7	8	9
san.sa.5r	Age 0	0.5	0.05882	-	-	-	-	-	-	-	-
san.sa.5r	Age 1	0.5	0.88235	0.02857	-	-	-	-	-	-	-
san.sa.5r	Age 2	-	0.05882	0.82857	0.2	-	-	-	-	-	-
san.sa.5r	Age 3	-	-	0.14286	0.6	0.1	-	-	-	-	-
san.sa.5r	Age 4	-	-	-	0.2	0.9	0.1	-	-	-	-
san.sa.5r	Age 5	-	-	-	-	-	0.8	-	-	-	-
san.sa.5r	Age 6	-	-	-	-	-	0.1	0.6	0.2	-	-
san.sa.5r	Age 7	-	-	-	-	-	-	0.4	0.8	-	-
san.sa.5r	Age 8	-	-	-	-	-	-	-	-	-	0.2
san.sa.5r	Age 9	-	-	-	-	-	-	-	-	-	0.6
san.sa.5r	Age 10	-	-	-	-	-	-	-	-	-	0.2

Results of the re-reading of the 2016 agreed age set

Included in the 2019 and 2022 exchanges were 40 fish with 100% agreement in 2016. When comparing the results achieved in 2019 to those in 2022 an overall improvement is apparent with an increase in PA from 85.4% to 91.9% and a decrease in CV from 24.2% to 17.4% (Table 12).

Table 12: Comparison of 2019 and 2022 results (Percentage Agreement (PA) and Coefficient of Variation (CV)) from the re-reading of the 40 otoliths with 100% agreement in 2016

Modal age	2019		2022	
	CV	PA	CV	PA
0	-	67%	-	75%
1	29.2%	85%	15.1%	94%
2	9.5%	92%	12.2%	89%
3	25.1%	61%	0.0%	100%
4	5.3%	92%	11.2%	80%
Weighted Mean	24.4%	85.4%	17.4 %	91.9 %

Image examples

Figures 2, 3 and 4 illustrate the disagreement between readers on whether or not to include a faint inner translucent zone when estimating the age of the fish. Images show the variability the width of the translucent zone between otoliths and also between the rostrum and post-rostrum.

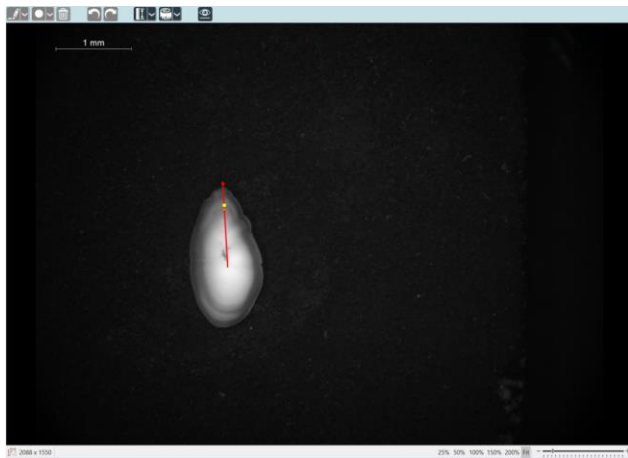


Figure 2: Sandeel_2022_013, modal age 1, catch date 27-11-2018, TL 105mm. Three readers are counting a faint inner translucent zone as a winter ring and estimating the age to be 1 year. R01 NO and R03 DK estimating age 0.

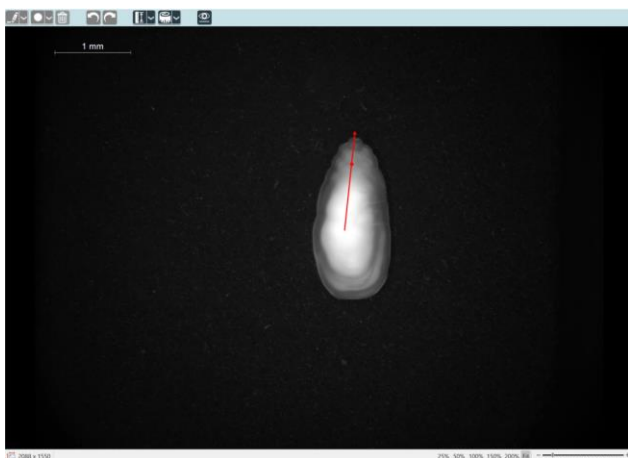


Figure 3: Sandeel_2022_012, modal age 0, catch date 27-11-2018, TL 115mm. One reader is counting a faint inner translucent zone as a winter ring and estimating the age to be 1 year. R01 NO, R02 NO, R04 NO and R03 DK estimating age 0.



Figure 4: Sandeel_2022_034, modal age 0, catch date 21-11-2018, TL 100mm. Disagreement between readers on whether the innermost translucent zone should be counted as a winter ring or not. R01 NO and R03 DK estimating age 0.

Data Overview

Table 13: Data overview including modal age and statistics per sample.

Fish ID	Event ID	Image ID	length	sex	Catch date	ICES area	R01 NO	R02 NO	R03 DK	R04 NO	R05 DK	Modal age	PA %	CV %	APE %
Sandeel_2022_001	424	-	200	F	25/11/2018 19:24:00	27.4.b	4	4	4	4	4	4	100	0	0
Sandeel_2022_002	424	-	190	M	25/11/2018 19:24:00	27.4.b	3	4	4	3	4	4	60	15	13
Sandeel_2022_003	424	-	185	M	25/11/2018 19:24:00	27.4.b	3	3	3	3	3	3	100	0	0
Sandeel_2022_004	424	-	175	F	05/12/2018 23:18:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_005	424	-	170	F	05/12/2018 23:18:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_006	424	-	165	M	05/12/2018 23:18:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_007	424	-	160	F	05/12/2018 23:18:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_008	424	-	155	F	25/11/2018 19:24:00	27.4.b	2	2	-	2	2	2	100	0	0
Sandeel_2022_009	424	-	150	F	25/11/2018 19:24:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_010	424	-	140	M	25/11/2018 19:24:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_011	424	-	140	F	25/11/2018 19:24:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_012	424	-	115		27/11/2018 20:47:00	27.4.b	0	0	0	0	1	0	80	-	-
Sandeel_2022_013	424	-	105		27/11/2018 20:47:00	27.4.b	0	1	0	1	1	1	60	91	80
Sandeel_2022_014	424	-	100		27/11/2018 20:47:00	27.4.b	1	1	0	1	1	1	80	56	40
Sandeel_2022_015	424	-	135	F	25/11/2018 19:24:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_016	424	-	125	F	25/11/2018 19:24:00	27.4.b	1	1	1	2	1	1	80	37	27

Sandeel_2022_017	424	-	95	F	05/12/2018 18:33:00	27.4.b	0	0	0	0	1	0	80	-	-
Sandeel_2022_018	424	-	80	U	03/12/2018 00:01:00	27.3.a.20	1	0	0	0	0	0	80	-	-
Sandeel_2022_019	424	-	70	U	03/12/2018 00:01:00	27.3.a.20	0	0	0	0	0	0	100	-	-
Sandeel_2022_020	424	-	45	U	05/12/2018 18:33:00	27.4.b	0	0	0	0	0	0	100	-	-
Sandeel_2022_021	424	-	165	M	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_022	424	-	160	M	21/11/2018 17:29:00	27.4.b	2	3	3	2	3	3	60	21	18
Sandeel_2022_023	424	-	155	F	21/11/2018 17:29:00	27.4.b	3	3	4	2	4	3	40	26	20
Sandeel_2022_024	424	-	155	M	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_025	424	-	150	M	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_026	424	-	145	F	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_027	424	-	140	M	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_028	424	-	140	M	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_029	424	-	135	M	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_030	424	-	125	M	21/11/2018 17:29:00	27.4.b	1	1	1	1	2	1	80	37	27
Sandeel_2022_031	424	-	125	F	21/11/2018 17:29:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_032	424	-	115	M	21/11/2018 17:29:00	27.4.b	2	2	-	2	2	2	100	0	0
Sandeel_2022_033	424	-	110	M	21/11/2018 17:29:00	27.4.b	1	1	0	1	1	1	80	56	40
Sandeel_2022_034	424	-	100	F	21/11/2018 17:29:00	27.4.b	0	3	0	1	1	0	40	-	-
Sandeel_2022_035	424	-	100		21/11/2018 17:29:00	27.4.b	0	0	0	0	0	0	100	-	-
Sandeel_2022_036	424	-	90		21/11/2018 17:29:00	27.4.b	0	0	0	0	0	0	100	-	-
Sandeel_2022_037	424	-	80		21/11/2018 17:29:00	27.4.b	0	0	0	0	0	0	100	-	-
Sandeel_2022_038	424	-	70		21/11/2018 17:29:00	27.4.b	0	0	0	0	0	0	100	-	-
Sandeel_2022_039	424	-	165	F	21/11/2018 04:29:00	27.4.b	2	3	3	3	3	3	80	16	11
Sandeel_2022_040	424	-	155	M	21/11/2018 04:29:00	27.4.b	2	2	2	2	3	2	80	20	15
Sandeel_2022_041	424	-	125	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_042	424	-	115	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_043	424	-	110	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_044	424	-	110	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_045	424	-	105	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0

Sandeel_2022_046	424	-	105	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_047	424	-	105	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_048	424	-	100	U	24/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_049	424	-	140	U	26/11/2015 00:00:00	27.4.b	2	2	2	1	2	2	80	25	18
Sandeel_2022_050	424	-	125	U	26/11/2015 00:00:00	27.4.b	1	1	1	2	1	1	80	37	27
Sandeel_2022_051	424	-	145	U	24/11/2015 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_052	424	-	150	U	24/11/2015 00:00:00	27.4.b	3	3	3	-	3	3	100	0	0
Sandeel_2022_053	424	-	140	U	24/11/2015 00:00:00	27.4.b	3	3	3	3	3	3	100	0	0
Sandeel_2022_054	424	-	160	U	16/04/2016 00:00:00	27.4.b	4	4	4	5	4	4	80	11	8
Sandeel_2022_055	424	-	185	U	17/04/2016 00:00:00	27.4.b	4	3	4	4	4	4	80	12	8
Sandeel_2022_056	424	-	180	U	17/04/2016 00:00:00	27.4.b	3	3	3	3	3	3	100	0	0
Sandeel_2022_057	424	-	150	U	17/04/2016 00:00:00	27.4.b	-	2	2	2	2	2	100	0	0
Sandeel_2022_058	424	-	145	U	17/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_059	424	-	140	U	17/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_060	424	-	135	U	17/04/2016 00:00:00	27.4.b	2	1	1	2	2	2	60	34	30
Sandeel_2022_061	424	-	170	U	17/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_062	424	-	160	U	17/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_063	424	-	150	U	17/04/2016 00:00:00	27.4.b	2	2	1	2	2	2	80	25	18
Sandeel_2022_064	424	-	140	U	17/04/2016 00:00:00	27.4.b	2	2	1	2	2	2	80	25	18
Sandeel_2022_065	424	-	130	U	17/04/2016 00:00:00	27.4.b	2	2	1	2	2	2	80	25	18
Sandeel_2022_066	424	-	120	U	16/04/2016 00:00:00	27.4.b	2	2	1	2	2	2	80	25	18
Sandeel_2022_067	424	-	110	U	16/04/2016 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_068	424	-	100	U	16/04/2016 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_069	424	-	90	U	16/04/2016 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_070	424	-	85	U	16/04/2016 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_071	424	-	115	U	17/04/2016 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_072	424	-	110	U	17/04/2016 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0
Sandeel_2022_073	424	-	135	U	28/11/2015 00:00:00	27.4.b	1	1	0	1	1	1	80	56	40
Sandeel_2022_074	424	-	130	U	28/11/2015 00:00:00	27.4.b	1	1	1	1	1	1	100	0	0

Sandeel_2022_075	424	-	130	U	28/11/2015 00:00:00	27.4.b	1	1	0	1	1	1	80	56	40
Sandeel_2022_076	424	-	120	U	28/11/2015 00:00:00	27.4.b	1	1	0	1	1	1	80	56	40
Sandeel_2022_077	424	-	115	U	28/11/2015 00:00:00	27.4.b	1	1	0	1	1	1	80	56	40
Sandeel_2022_078	424	-	140	U	24/11/2015 00:00:00	27.4.b	0	1	1	1	1	1	80	56	40
Sandeel_2022_079	424	-	135	U	24/11/2015 00:00:00	27.4.b	0	0	-	0	1	0	75	-	-
Sandeel_2022_080	424	-	165	U	16/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_081	424	-	250		26/04/2017 00:00:00	27.4.a	8	7	6	9	8	8	40	15	12
Sandeel_2022_082	424	-	225		09/05/2016 00:00:00	27.4.a	7	6	6	7	7	7	60	8	7
Sandeel_2022_083	424	-	245		09/05/2016 00:00:00	27.4.a	6	7	4	6	6	6	60	19	12
Sandeel_2022_084	424	-	175		13/05/2016 00:00:00	27.4.a	4	5	5	4	5	5	60	12	10
Sandeel_2022_085	424	-	175		13/05/2016 00:00:00	27.4.a	4	4	5	4	5	4	60	12	11
Sandeel_2022_086	424	-	165		13/05/2016 00:00:00	27.4.a	4	4	4	4	4	4	100	0	0
Sandeel_2022_087	424	-	180		13/05/2016 00:00:00	27.4.a	4	5	3	5	4	4	40	20	15
Sandeel_2022_088	424	-	200		09/05/2016 00:00:00	27.4.a	4	4	4	4	4	4	100	0	0
Sandeel_2022_089	424	-	200		26/04/2017 00:00:00	27.4.a	3	3	3	3	3	3	100	0	0
Sandeel_2022_090	424	-	195		26/04/2017 00:00:00	27.4.a	3	3	3	3	0	3	80	56	40
Sandeel_2022_091	424	-	210		26/04/2017 00:00:00	27.4.a	3	3	3	3	3	3	100	0	0
Sandeel_2022_092	424	-	185		09/05/2016 00:00:00	27.4.a	2	2	2	2	2	2	100	0	0
Sandeel_2022_093	424	-	160		28/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_094	424	-	140		28/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_095	424	-	130		28/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_096	424	-	125		28/04/2016 00:00:00	27.4.b	2	2	2	2	2	2	100	0	0
Sandeel_2022_097	424	-	120		26/04/2017 00:00:00	27.4.a	1	1	1	1	1	1	100	0	0
Sandeel_2022_098	424	-	150		26/04/2017 00:00:00	27.4.a	1	2	-	1	3	1	50	55	43
Sandeel_2022_099	424	-	100		26/04/2017 00:00:00	27.4.a	1	1	1	1	1	1	100	0	0
Sandeel_2022_100	424	-	135		13/05/2016 00:00:00	27.4.a	1	2	1	-	1	1	75	40	30
Sandeel_2022_101	424	-	215		08/05/2011 00:00:00	27.4.a	9	9	8	10	9	9	60	8	4
Sandeel_2022_102	424	-	205		08/05/2011 00:00:00	27.4.a	7	7	6	7	7	7	80	7	5
Sandeel_2022_103	424	-	200		08/05/2011 00:00:00	27.4.a	6	6	6	7	7	6	60	9	8

Sandeel_2022_104	424	-	185	08/05/2011 00:00:00	27.4.a	5	6	4	5	5	5	60	14	8
Sandeel_2022_105	424	-	175	14/05/2017 00:00:00	27.4.a	5	5	5	5	5	5	100	0	0
Sandeel_2022_106	424	-	195	08/05/2011 00:00:00	27.4.a	4	4	4	4	4	4	100	0	0
Sandeel_2022_107	424	-	215	08/05/2011 00:00:00	27.4.a	3	4	4	4	4	4	80	12	8
Sandeel_2022_108	424	-	170	08/05/2011 00:00:00	27.4.a	2	3	2	3	2	2	60	23	20
Sandeel_2022_109	424	-	160	08/05/2011 00:00:00	27.4.a	2	3	2	3	2	2	60	23	20
Sandeel_2022_110	424	-	150	14/05/2017 00:00:00	27.4.a	3	3	2	4	3	3	60	24	13
Sandeel_2022_111	424	-	135	08/05/2011 00:00:00	27.4.a	2	2	2	2	2	2	100	0	0
Sandeel_2022_112	424	-	95	08/05/2011 00:00:00	27.4.a	2	2	1	2	2	2	80	25	18
Sandeel_2022_113	424	-	145	08/05/2011 00:00:00	27.4.a	2	2	2	2	2	2	100	0	0
Sandeel_2022_114	424	-	120	14/05/2017 00:00:00	27.4.a	2	2	2	2	3	2	80	20	15
Sandeel_2022_115	424	-	105	14/05/2017 00:00:00	27.4.a	1	1	1	1	1	1	100	0	0
Sandeel_2022_116	424	-	135	14/05/2017 00:00:00	27.4.a	2	2	2	2	2	2	100	0	0
Sandeel_2022_117	424	-	95	14/05/2017 00:00:00	27.4.a	1	1	1	1	2	1	80	37	27
Sandeel_2022_118	424	-	140	14/05/2017 00:00:00	27.4.a	1	1	1	-	-	1	100	0	0
Sandeel_2022_119	424	-	110	14/05/2017 00:00:00	27.4.a	1	1	1	0	-	1	75	67	50
Sandeel_2022_120	424	-	85	14/05/2017 00:00:00	27.4.a	1	0	1	0	-	0	50	-	-

References

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

WKSAND (2016) Sandeel age reading exchange 2016 – Working Document for WKSAND 2016 Compiled by Julie Olivia
Davies, Technical University of Denmark, National Institute of Aquatic Resources, DTU Aqua.