WORKSHOP 2 ON AGE READING OF NORTH SEA PLAICE (*PLEURONECTES PLATESSA*) (WKARP2; outputs from 2021 meeting)

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i Executive summary

Workshop 2 on age reading of North Sea plaice (*Pleuronectes platessa*), (WKARP2) was the first age reading workshop focusing specifically on age reading of the North Sea plaice stock (ple.27.420) in the North Sea and Skagerrak. The objectives of the workshop were: to evaluate the level of agreement between age readers for the stock by reviewing results of the 2020 North Sea Skagerrak plaice exchange in consideration of previous calibration and validation work; to standardize laboratory procedures and age reading methods applied; to provide guidelines for reliable age interpretation; to provide age error data to the stock assessment working group; to create an agreed age reference collection of otoliths. Two age reading exercises, one exchange before the workshop (SmartDots ID 281), and one workshop exercise (ID 402) were completed using SmartDots[1]. Age readers' annotations of growth structures and ageing results from both exercises were examined using standardized quality analyses based on an R script , presented in this report. Age reading error data has been provided to the ICES WGNSSK[2] (Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak) which can be tested in the ple.27.420 stock assessment model. Disagreement between readers is mostly attributable to differences in the identification of the first winter ring as this can vary in width across samples collected from different areas. Results showed that estimated ages in older fish can be unreliable due to a narrowing of the annuli close to the otolith edge. Further work is required to provide guidelines for age readers about which structures should be identified as annuli. Different preparation methods are applied in national laboratories. The group concluded that reading whole and sectioned otoliths viewed under reflected light is optimal; no obvious benefit was identified from sectioning plaice otoliths from fish under the age of 6. Using images of otoliths, the reliability of the age reading results is depending on image quality. To help standardize image format, lighting and calibration a workshop is recommended to establish a set of guidelines for image quality used in age determination.

[1] https://www.ices.dk/data/tools/Pages/smartdots.aspx.

[2] https://www.ices.dk/community/groups/Pages/WGnssk.aspx.

ii Expert group information

Expert group name	Workshop 2 on age reading of North Sea plaice (*Pleuronectes platessa*) (WKARP2)
Expert group cycle	Annual
Year cycle started	2020
Reporting year in cycle	1/1
Chairs	Ulrika Beier, Netherlands
	Julie Coad Davies, Denmark
Meeting venue and dates	6–10 December 2021, online meeting (25 participants)

1 Introduction

Workshop 2 on age reading of North Sea plaice (*Pleuronectes platessa*)

European plaice (*Pleuronectes platessa L.*) is an important flatfish species in Northern European fisheries (Rijnsdorp and Millner, 1996). It is widely distributed in the North Sea, from the western Mediterranean to Iceland, also occurring in the Baltic Sea and along the coasts of the White Sea (Hoareau *et al*., 2004). Plaice mainly occur in shallow marine and brackish waters down to 100 m, usually at 10–50 m. Following reproduction in offshore areas during winter, the eggs and larvae are pelagic for 3–4 months before they settle in shallow coastal waters at a length of 12–14 mm. The regional population structure of plaice appears to be mainly shaped by deep water barriers and suitable nursery grounds (Hoareau *et al*., 2004). In autumn, plaice at a length of 7–12 cm migrate to deeper water (20–40 meters) to overwinter. In recent years, survey data indicate that nursery areas of plaice (ages 0 and 1) are shifting in the North Sea, from areas close to the coast towards offshore areas (Dutz *et al*., 2016; van Keeken *et al*., 2007). Older ages also show an expansion towards more northern areas (ICES, 2020).

Over a certain age (~4/5 years), most plaice caught are females, i.e. females generally grow bigger and older. This is most prominent in the North Sea but less so in Skagerrak. Plaice normally mature at 2–5 years of age, males usually at 18–26 cm, and females usually at approximately 30–35 cm in length (Rijnsdorp, 1989). In the North Sea and Skagerrak plaice spawn from January to March, sometimes a little later. Spawning occurs at depths between 20–40 meters at a temperature of approximately 6°C. Plaice caught in the southern part of the southern North Sea (ICES Area 27.4.c) between 51° N and 52° N mature earlier compared to the plaice caught in the central part of the North Sea (ICES Area 27.4.b), between 54° N and 56° N, and further to the north. Plaice caught in the most southern parts start and finish their spawning earlier compared to in the central and northern parts of the North Sea. After spawning, plaice start feeding again and yearly summer growth reoccurs, indicated by an opaque zone appearing on the outer part of the otolith. As plaice will finish spawning later in more northern areas, the opaque zone will in general show up later in the year there compared to further south. Additionally, spawning usually finishes later for larger and older fish having larger gonads (Rijnsdorp, 1989). Subsequently, the opaque ring may appear later in the year in older, larger fish compared to younger, smaller fish. Other factors such as catch area, temperatures during spring, and individual variation may cause exceptions to the above observed general patterns. After sexual maturation, growth decreases for both sexes.

Adult plaice conduct seasonal migrations, e.g. from spawning grounds to feeding grounds (Hunter *et al*., 2003). For example, adult plaice migrate in winter from the eastern English Channel (Subarea 7, Division 7.d) into the North Sea. Therefore, 50% of the adult plaice in Division 7.d in quarter 1 are also included in the assessment of the North Sea plaice stock ple.27.420 (ICES, 2020; 2021a; 2021b). In Skagerrak, plaice is mainly caught in summer, as feeding aggregations partly consisting of plaice coming in from the North Sea occur in Western Skagerrak (Ulrich *et al*., 2013). Plaice in the Skagerrak is assessed together with the North Sea stock (ple.27.420). since 2015 (ICES, 2020). Exploitation levels have decreased since the early 2000s, and since 2010 age 3–5 plaice are dominating in the landings. The TAC for plaice has not been fully used during the last years, and the proportion of discarded plaice in the total catch is increasing (ICES, 2021a; 2021b).

2 Review results and outcomes of the 2020 North Sea and Skagerrak plaice exchange (SmartDots ID 281)

ToR a

The 2020 North Sea and Skagerrak Plaice Age Exchange focused on plaice in subareas 4.b and 4.c (North Sea) and Subdivision 20 (Skagerrak) which are now considered a single-stock unit ple.27.420. The exchange was held via the SmartDots platform[3] between June and September 2020, where photos of plaice otoliths were used for age determination. Sixteen age readers from nine institutes took part. The main aim of the exchanges was to resolve interpretation differences across readers and preparation methods, and based on these outcomes plan for a follow-up workshop. The event was also used as a test to incorporate a reader ranking scheme into a new and improved calculation of modal age and the associated statistical analysis applied in the SmartDots standardized reporting module. The samples and images included in the exchange were provided by DTU Aqua (Denmark), ILVO (Belgium), and WMR (The Netherlands). Samples were chosen to represent the spatial and temporal scales of those routinely read by the participating readers. Given restrictions regarding the COVID-19 pandemic in early 2020, sample availability and preparation were more difficult than expected and continued restrictions have affected the reading time, analysis and report writing. Preparation methods for plaice otoliths vary across institutes, some institutes read whole otoliths under reflected light and others read sectioned otoliths under transmitted or reflected light. To cover methods used by the different institutes, the otoliths from the North Sea (ICES subareas 4.b and 4.c) were photographed both sectioned and whole (from the same fish) and the otoliths from the Skagerrak (ICES Subdivision 20) were photographed whole.

In this section of the report the analysis methods applied (section 2.1), an overview of samples and readers and age reading methods applied (section 2.2) and exchange results (section 2.3) are found. The final paragraph (section 2.4) summarizes the results and main conclusions.

2.1 Methods applied for the 2020 North Sea plaice exchange

2.1.1 Modal age: a multistage approach to define the modal age by sampled fish

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, as it indicates the most likely age of each sampled fish. It is also fundamental for the estimation of 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 traditional way of calculating modal age is that each reader has the same weight = 1, and in case there are multiple modal ages, i.e. the same number of readers have estimated different ages, the mode is taken as the lowest age among those. This practice implies a bias in the calculation of the PA and AEM. As a solution, in this report, a

[3] http://ices.dk/data/tools/Pages/smartdots.aspx

multistage approach to selecting the modal age is used. This multistage approach was based on the different weights given to the age readers based on their experience (weighting procedure described below). The experience was graded mostly based on the experience of reading the stock (years of experience and average number of samples per year), and to a less extent by general age reading experience including all species (years). The procedure used for weighting readers and calculating reader rank, based on their experience is described below. Two different weight scales were assigned, one where weight scores decreased linearly with experience and another decreasing with a negative exponential shape. The modal age for each fish individual is decided following the next approach:

1. If there is a single-mode estimated with the "traditional" approach (equal weight for all readers) this value is used as the mode; if not,
2. Adding up, by age, the linear weighting scores for all the readers that decided each age for that fish. Select as the modal age the age with the highest added score; if there are still multiple ages with the same score,
3. Adding up, by age, the negative exponential weighting scores for all the readers that decided each age for that fish. Select as the modal age the age with the highest added score.

During the WGBIOP 2019 meeting, it was found that stepwise using these three methods (so-called "multistage approach"), allows assigning a single modal age to each fish individual while avoiding a bias towards choosing the lower age as in the traditional method.

The procedure used for weighting readers and calculating reader rank:

To weight the readers' expertise accordingly the following information was collected for each reader (SmartUser) and preparation method, based on their experience in reading ple.27.420; first-year age reading, number of years reading this stock, mean number of otoliths read per year for this stock (based on the last three years). The following information was collected for each reader, based on their experience in age reading in general; first-year age reading, the number of years reading otoliths. A weight of 1 was given to the score calculated based on experience in reading ple.27.420 and a weight of 0.25 was given to the score calculated based on experience in age reading in general, an overall score was then used to rank the readers based on their experience. This procedure was agreed upon by members of WGBIOP whose age readers participated in the exchange.

Percentage Agreement (PA)

The percentage agreement per reader per modal age tells how large the part of readings is equal to the modal age. The percentage agreement is estimated by modal age and reader as the proportion (percentage) of times that the results 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.

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

Co-efficient of Variation (CV)

The table presents the CV per modal age and reader. The CVs are calculated as the ratio between the standard deviation (σ) and mean value (μ) per reader and modal age:

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

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

Average Percentage Error (APE)

APE was calculated based on the method outlined by Beamish and Fournier (1981). This method depends on 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 the modal age was 0 were omitted from the CV and APE calculations (this only applies to the traditional approach).

The average percentage error is calculated per image as:

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

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

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 which was aged equal to the modal age and the proportions aged as other ages. The sum of each row is 1 (100%). The age data were 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 "advanced" readers who provide age data for the stock assessment in that specific area.

Otolith Growth Analysis

SmartDots provides a measure of distance between the annotations made by the readers and thus provides a measure of growth increment width. These data are used to establish growth curves based on each otolith (fish) and for each reader.

Age Reading method comparison

For each of the samples collected in the North Sea, two images were provided for the readers, a sectioned otolith and a whole otolith and the readers were asked to annotate the image of the otolith prepared using the method they routinely age read. Currently, in SmartDots there is no standardized analysis to compare two or more age readings from the same fish. For this reason, the method comparison analysis was conducted outside SmartDots using the ATAQCS (Age Training And Quality Control System) workbook developed by Mark Etherton[4] at Cefas for comparisons of two readers' results on the same otoliths. A total of 106 samples were included. The first step was to calculate the modal age for each sample for each method. For the sectioned otoliths modal age was calculated for each sample using the Guus Eltink Excel sheet *Age Reading Comparisons* (Eltink, 2000), only readings from age readers who are experienced with this method were used and the reader rank calculated for the multistage approach was applied. The same approach was followed for readers of the whole otoliths. The sectioned modal age was given "trainee" status and the whole modal age given "expert" status because there is a larger number of age readers who routinely read whole otoliths compared to sectioned otoliths and the overall weighted scores are higher. The ATAQCS workbook then carries out a two-reader comparison and calculates percentage agreement, average percentage error (APE), bias and coefficient of variation values per modal age and overall.

[4] Contact details: mark.etherton@cefas.co.uk.

2.2 Overview of samples, readers, and age reading methods applied in the 2020 North Sea plaice exchange

In the 2020 North Sea plaice exchange, 90 samples of whole otoliths from Skagerrak Area 27.3.a.20 were provided, and 106 samples from the North Sea 27.4.b and c (Table 2.1). The North Sea otoliths were provided as both whole and sectioned, taken from the same fish but not the same otolith. The comparisons of the North Sea samples will be done for whole and sectioned separately, but using otoliths from both areas 27.4.b and c together.

Table 2.1. Overview of the samples, number of readers and modal age range by strata used for the 2020 North Sea Plaice age reading exchange.

Strata	N samples	N readers	Modal age range	Comparison
Skagerrak, 27.3.a.20, whole otoliths	90	14 (7 advanced)	0–14	All readers (section 2.3.2)
				Advanced readers (section 2.4.5)
North Sea, 27.4.b and c, whole otoliths	106	14 (7 advanced)	0–11	All readers (section 2.3.3)
				Advanced readers (section 2.4.6)
North Sea, 27.4.b and c, sectioned otoliths	106	7 (6 advanced)	0–16	All readers (section 2.3.4)
				Advanced readers (section 2.4.7)

Table 2.2. Reader overview showing reader code, level of expertise (based on whether or not the reader delivers data for stock assessment purposes), rank, and strata applied in the analysis.

Reader code	Expertise	Expertise_rank	strata
R02 SE	Advanced	3	Whole_27.4
R02 SE	Advanced	3	Whole_27.3.a.20
R02 SE	Advanced	5	Sectioned_27.4
R04 NL	Advanced	1	Sectioned_27.4
R04 NL	Advanced	5	Whole_27.3.a.20
R04 NL	Advanced	5	Whole_27.4
R06 DK	Advanced	9	Whole_27.4
R06 DK	Advanced	9	Whole_27.3.a.20
R08 SE	Advanced	6	Whole_27.4
R10 NL	Advanced	2	Sectioned_27.4
R10 NL	Advanced	8	Whole_27.3.a.20
R12 BE	Advanced	2	Whole_27.3.a.20

Reader code	Expertise	Expertise_rank	strata
R12 BE	Advanced	2	Whole_27.4
R14 BE	Advanced	4	Whole_27.4
R14 BE	Advanced	4	Whole_27.3.a.20
R14 BE	Advanced	5	Sectioned_27.4
R16 GB	Advanced	3	Sectioned_27.4
R18 DK	Advanced	1	Whole_27.3.a.20
R18 DK	Advanced	1	Whole_27.4
R20 NO	Basic	10	Whole_27.3.a.20
R20 NO	Basic	10	Whole_27.4
R26 FR	Basic	5	Sectioned_27.4
R26 FR	Basic	8	Whole_27.4
R26 FR	Basic	8	Whole_27.3.a.20
R28 GB-SCT	Basic	10	Whole_27.4
R28 GB-SCT	Basic	10	Whole_27.3.a.20
R30 DE	Basic	6	Whole_27.4
R30 DE	Basic	6	Whole_27.3.a.20
R32 DK	Basic	11	Whole_27.3.a.20
R32 DK	Basic	11	Whole_27.4
R34 NO	Basic	4	Sectioned_27.4
R34 NO	Basic	10	Whole_27.4
R34 NO	Basic	10	Whole_27.3.a.20
R36 FR	Basic	7	Whole_27.3.a.20
R36 FR	Basic	7	Whole_27.4

Table 2.3. Overview of age reading methods applied when reading ple.27.420.

Stock	Country	ICES Area	Preparation method	Light
ple.27.420, North Sea and Skagerrak	Belgium	27.4	Whole	Reflected
	Denmark	27.3a and 27.4	Whole	Reflected
	France	27.4	Whole	Reflected
	Germany	27.4	Whole	Reflected and transmitted

Stock	Country	ICES Area	Preparation method	Light
	Netherlands	27.4	Sectioned	Reflected
	Netherlands	27.4	Whole (young fish, until ~2018)	Reflected
	Sweden	27.3a	Whole	Reflected
	UK	27.4	Sectioned	Mostly reflected, sometimes transmitted
	Norway	27.4	Sectioned	Transmitted
	Scotland	27.4 and 27.6	Whole	Reflected

2.3 2020 North Sea and Skagerrak plaice exchange results (SmartDots ID 281)

An evaluation of the results based on the multistage modal age approach was carried out (Table 2.4). Of the 302 otoliths aged multiple modes were obtained for just 2% (equivalent to 7 samples listed in Table 2.5 when the traditional approach, i.e. all readers equally weighted, was used to define the mode. The results of the exchange when either the modal age obtained by the traditional approach, or by the multistage modal approach (Table 2.6), were compared. As there were few samples where multiple modes were obtained, the results comparing PA and CV of the different approaches were relatively similar (Table 2.6). For Skagerrak, the result from all readers in PA was slightly lower (67% compared to 69%) using the multistage modal age approach, but the CV was also lower (43% compared to 56%). For the North Sea, whole otoliths, the result from all readers in PA was slightly higher (80% compared to 79%) using the multistage modal age approach, but the CV was also higher (51% compared to 47%). For the North Sea, sectioned otoliths, the result from all readers in PA was slightly lower (78% compared to 79%) using the multistage modal age approach, and the CV was here also slightly higher (40% compared to 39%). In conclusion, applying the multistage modal age approach as a trial succeeded, including new scripts for the SmartDots report output, but as there were few samples which had multiple modes, conclusions could not be drawn regarding a clear effect of applying the multistage modal age approach instead of the traditional approach. Furthermore, as a main reason for introducing the new approach was to avoid a bias to "too young" fish (in the traditional approach the youngest age is chosen if there are multiple modes for a sample), it can be concluded that it would be relevant to compare error matrices and age bias plots to cases where there are higher frequencies of multiple modes in the sample collections. Results from the 2020 North Sea and Skagerrak plaice exchange presented below (sections 2.3.1 to 2.4.8) are based on the multistage modal age approach.

Table 2.4. 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. 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
302	2%	0%	0%	0%

Table 2.5. List of sampleID's for which multiple modes where obtained when all readers are considered. The column NModes_trad shows the number of multiple modes for each sampleID when all readers are given the same experience weight.

NModes_trad	SampleID
2	7058561_ALA_RLX_X0
3	7535731
2	7566949
2	7591898_ALA_RLX_BX
2	7641019
2	IBTS_2016_50
2	IBTS_2020_349

Table 2.6. Overview of results from all readers in the 2020 North Sea and Skagerrak plaice exchange (SmartDots ID 281) using the traditional approach of obtaining modal age vs. the multistage modal age approach.

Strata	N samples	N readers	Modal age range	Comparison	PA	CV
Skagerrak 27.3.a.20 whole	90	14	0–14	All readers (traditional approach)	69%	56%
				All readers multistage modal age approach	67%	43%
North Sea 27.4.b and c whole	106	14	0–11	All readers (traditional approach)	79%	47%
				All readers multistage modal age approach	80%	51%
North Sea 27.4.b and c sectioned	106	7	0–16	All readers (traditional approach)	79%	39%
				All readers multistage modal age approach	78%	40%

2.3.1 All readers and all samples

This first section is where all age readings of all readers reading all samples are included in the analysis and is followed by individual sections for Skagerrak (27.3.a.20) Whole, North Sea (27.4.b and c) Whole, and North Sea (27.4.b and c) Sectioned.

Table 2.7. 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
302	47%	72%	27%

Table 2.8. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
0	178 %	0%	447%	129%	436%	168%	381%	132%	0%	447%	188%	0%	0%	447%	161%	132%	**277%**
1	43%	13%	18%	35%	0%	58%	34%	50%	31%	43%	27%	40%	19%	0%	30%	24%	**37%**
2	35%	14%	22%	35%	32%	30%	34%	30%	0%	45%	31%	32%	57%	25%	24%	25%	**33%**
3	12%	18%	13%	11%	23%	12%	14%	25%	15%	25%	0%	9%	32%	18%	19%	23%	**18%**
4	6%	10%	17%	0%	9%	6%	7%	11%	16%	21%	7%	9%	39%	17%	0%	15%	**15%**
5	8%	12%	12%	11%	10%	22%	15%	18%	11%	20%	15%	14%	36%	20%	9%	19%	**17%**
6	15%	19%	16%	8%	14%	27%	27%	13%	7%	15%	10%	27%	21%	25%	9%	11%	**20%**
7	4%	17%	18%	6%	16%	13%	21%	15%	11%	11%	12%	18%	41%	16%	12%	14%	**18%**
8	7%	9%	40%	10%	14%	17%	16%	11%	17%	17%	17%	12%	29%	16%	13%	16%	**19%**
9	13%	14%	14%	7%	7%	13%	20%	21%	17%	12%	11%	12%	8%	8%	9%	11%	**15%**
10	14%	7%	12%	19%	5%	6%	10%	7%	20%	15%	13%	9%	8%	22%	27%	8%	**13%**
11	5%	5%	9%	–	5%	5%	14%	–	0%	5%	5%	10%	0%	5%	–	5%	**7%**
12	18%	27%	28%	–	0%	6%	8%	–	20%	33%	13%	6%	7%	6%	–	16%	**22%**
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**10%**
14	5%	5%	0%	–	5%	0%	12%	–	0%	5%	5%	0%	5%	8%	–	0%	**10%**
15	6%	5%	11%	–	5%	5%	0%	–	28%	14%	6%	0%	0%	5%	–	11%	**12%**
16	–	74%	–	–	–	–	9%	–	–	–	18%	–	–	–	–	–	**41%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
Weighted mean	**38%**	**12%**	**63%**	**29%**	**54%**	**39%**	**57%**	**35%**	**14%**	**68%**	**30%**	**17%**	**27%**	**59%**	**32%**	**29%**	**47%**

Table 2.9. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	Total
0	75%	100%	95%	60%	95%	70%	93%	44%	100%	95%	71%	100%	100%	95%	70%	50%	**85%**
1	82%	98%	97%	78%	100%	66%	93%	81%	86%	79%	91%	86%	97%	100%	92%	93%	**90%**
2	53%	93%	82%	80%	59%	53%	63%	67%	100%	53%	67%	79%	56%	76%	80%	76%	**71%**
3	86%	86%	86%	88%	79%	86%	73%	50%	79%	64%	100%	93%	79%	71%	71%	79%	**81%**
4	94%	83%	69%	100%	88%	94%	92%	71%	76%	53%	92%	88%	71%	65%	100%	82%	**82%**
5	81%	87%	80%	73%	90%	78%	61%	45%	85%	70%	77%	70%	74%	75%	80%	75%	**76%**
6	62%	46%	89%	75%	67%	44%	46%	25%	78%	56%	69%	56%	75%	67%	75%	89%	**63%**
7	91%	68%	69%	78%	62%	75%	56%	56%	69%	60%	56%	50%	62%	62%	67%	50%	**63%**
8	73%	67%	45%	70%	70%	62%	40%	40%	70%	45%	43%	47%	50%	50%	60%	50%	**54%**
9	50%	65%	55%	67%	64%	45%	24%	83%	45%	45%	56%	50%	50%	45%	43%	64%	**52%**
10	43%	73%	70%	60%	73%	70%	31%	60%	70%	45%	56%	55%	78%	45%	25%	70%	**58%**
11	67%	67%	33%	–	67%	33%	67%	–	100%	67%	67%	67%	100%	67%	–	67%	**67%**
12	0%	33%	0%	0%	100%	50%	33%	100%	0%	0%	33%	50%	0%	50%	0%	0%	**28%**
13	0%	100%	0%	–	100%	100%	0%	–	0%	100%	0%	100%	0%	0%	–	100%	**46%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	Total
14	50%	50%	0%	–	50%	100%	0%	–	0%	50%	50%	100%	50%	0%	–	100%	**46%**
15	0%	0%	0%	–	50%	50%	100%	–	50%	0%	0%	0%	0%	50%	–	0%	**23%**
16	–	50%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	**11%**
Weighted mean	**72%**	**81%**	**74%**	**74%**	**79%**	**68%**	**66%**	**60%**	**78%**	**62%**	**71%**	**72%**	**71%**	**70%**	**73%**	**70%**	**72%**

Table 2.10. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
0	150 %	0%	190%	120%	189%	140%	187%	89%	0%	190%	142%	0%	0%	190%	140%	100%	**169%**
1	30%	4%	6%	28%	0%	50%	13%	30%	21%	24%	15%	25%	7%	0%	16%	12%	**19%**
2	27%	7%	16%	18%	22%	26%	26%	24%	0%	38%	23%	24%	41%	20%	10%	12%	**18%**
3	8%	9%	9%	7%	14%	8%	12%	17%	9%	21%	0%	4%	18%	10%	10%	17%	**8%**
4	3%	7%	14%	0%	5%	3%	4%	10%	12%	18%	4%	3%	25%	15%	0%	10%	**9%**
5	6%	4%	6%	6%	4%	12%	12%	14%	7%	15%	7%	8%	22%	13%	4%	11%	**8%**
6	8%	14%	9%	6%	10%	20%	13%	10%	6%	12%	5%	19%	14%	15%	7%	6%	**13%**
7	2%	10%	14%	5%	10%	9%	15%	13%	9%	10%	8%	13%	29%	9%	8%	10%	**10%**
8	4%	8%	30%	6%	8%	12%	9%	9%	13%	13%	13%	8%	17%	11%	12%	10%	**11%**
9	10%	9%	11%	4%	6%	10%	13%	14%	13%	10%	9%	8%	6%	7%	7%	7%	**9%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
10	10%	5%	11%	13%	3%	4%	8%	4%	16%	12%	11%	5%	4%	13%	19%	5%	**9%**
11	4%	4%	6%	–	4%	4%	11%	–	0%	4%	4%	8%	0%	4%	–	4%	**4%**
12	13%	19%	20%	0%	0%	4%	6%	0%	14%	23%	10%	4%	5%	4%	0%	11%	**18%**
13	0%	0%	0%	–	0%	0%	0%	–	0%	0%	0%	0%	0%	0%	–	0%	**7%**
14	4%	4%	0%	–	3%	0%	9%	–	0%	4%	4%	0%	3%	6%	–	0%	**7%**
15	4%	4%	8%	–	3%	3%	0%	–	20%	10%	4%	0%	0%	3%	–	8%	**9%**
16	–	52%	0%	0%	0%	0%	6%	0%	0%	0%	12%	0%	0%	0%	0%	0%	**37%**
Weighted mean	**29%**	**6%**	**31%**	**23%**	**25%**	**31%**	**30%**	**23%**	**10%**	**36%**	**21%**	**11%**	**17%**	**28%**	**22%**	**19%**	**27%**

Table 2.11. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader. Red or black values (column "all") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
0	0.25	0.00	0.05	0.40	0.05	0.35	0.07	1.00	0.00	0.05	0.54	0.00	0.00	0.05	0.30	0.80	**0.24**
1	0.23	0.02	0.03	0.22	0.00	0.62	0.06	0.14	0.14	0.07	0.09	0.17	−0.03	0.00	−0.08	0.07	**0.11**
2	0.27	−0.07	−0.18	0.10	0.06	0.65	0.33	0.44	0.00	−0.41	−0.19	0.36	−0.25	−0.24	0.00	0.00	**0.05**
3	0.14	−0.09	−0.14	0.12	−0.14	0.14	0.27	0.00	0.07	−0.43	0.00	0.07	−0.21	0.00	0.00	−0.29	**−0.03**
4	0.06	−0.17	−0.38	0.00	−0.12	−0.06	0.08	0.29	−0.29	−0.59	−0.08	0.00	−0.41	−0.41	0.00	−0.24	**−0.14**
5	−0.19	0.00	−0.05	0.09	−0.05	0.17	0.45	0.91	−0.20	−0.40	0.06	−0.05	−0.47	−0.25	0.00	−0.20	**−0.01**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
6	0.00	0.31	0.33	0.25	−0.22	1.44	1.00	1.25	0.22	−0.33	0.00	0.33	0.62	0.33	−0.25	0.22	**0.34**
7	−0.09	−0.24	−0.44	0.22	0.12	0.31	0.64	0.89	−0.44	−0.53	−0.12	0.19	−1.12	0.00	−0.22	−0.12	**−0.06**
8	0.09	−0.37	−1.40	0.20	0.15	0.69	1.03	0.60	−0.70	−1.00	−0.50	0.11	−0.44	0.50	−0.70	0.35	**−0.09**
9	−0.50	−0.29	−0.82	0.00	0.45	0.45	1.18	0.83	−0.82	−0.64	−0.38	0.10	−0.30	−0.36	−0.71	−0.18	**−0.12**
10	−0.29	−0.20	−0.70	−1.00	−0.09	0.10	0.75	0.00	−1.00	−1.09	−0.69	0.00	0.11	−0.09	−2.00	−0.20	**−0.40**
11	−0.33	−0.33	0.00	–	−0.33	0.67	1.00	–	0.00	−0.33	−0.33	0.67	0.00	0.33	–	−0.33	**–**
12	−0.50	−2.67	−4.50	−1.00	0.00	−0.50	0.00	0.00	−5.00	−5.50	−0.33	−0.50	−1.50	−0.50	−4.00	−3.00	**−1.84**
13	−1.00	0.00	−2.00	–	0.00	0.00	3.00	–	−2.00	0.00	−1.00	0.00	−1.00	−1.00	–	0.00	**–**
14	−0.50	−0.50	−1.00	–	0.50	0.00	3.50	–	1.00	−0.50	−0.50	0.00	0.50	3.00	–	0.00	**–**
15	−2.50	−1.50	−2.00	–	−0.50	−0.50	0.00	–	−2.50	−5.00	−2.50	−1.00	−1.00	−0.50	–	−2.00	**–**
16	–	−5.50	−9.00	−2.00	1.00	−8.00	0.00	0.00	−9.00	−10.00	−8.00	−9.00	−4.00	−9.00	−6.00	−9.00	**–**
Wghtd. mean	**−0.01**	**−0.17**	**−0.43**	**0.09**	**0.02**	**0.36**	**0.47**	**0.51**	**−0.34**	**−0.57**	**−0.16**	**0.05**	**−0.32**	**−0.06**	**−0.30**	**−0.06**	**−0.01**

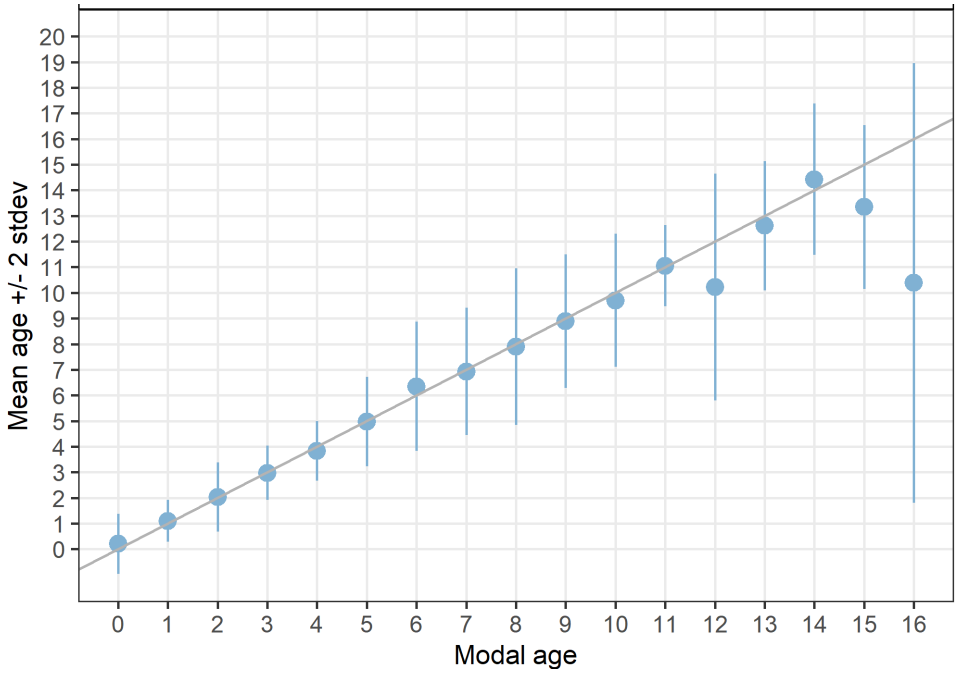


Figure 2.1. Age bias plot for all readers. Mean age recorded +/− 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between the estimated mean age and modal age.

2.3.2 All readers: Skagerrak (27.3.a.20) whole otoliths

Table 2.12. Whole_27.3.a.20 .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	43%	66%	28%

Table 2.13. Whole_27.3.a.20. 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 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB	R30 DE	R32 DK	R36 FR	All
0	0%	0%	316%	0%	117%	0%	0%	316%	40%	0%	–	316%	60%	**238%**
1	56%	35%	35%	0%	37%	77%	0%	35%	0%	56%	56%	0%	39%	**45%**
2	38%	0%	28%	37%	31%	38%	0%	44%	37%	34%	98%	28%	29%	**40%**
3	13%	0%	0%	13%	13%	16%	13%	14%	0%	13%	51%	15%	0%	**17%**
4	8%	11%	21%	8%	8%	10%	19%	20%	11%	12%	55%	20%	19%	**20%**
5	7%	0%	13%	16%	31%	12%	14%	25%	23%	19%	62%	30%	22%	**24%**
6	18%	23%	20%	16%	29%	38%	9%	19%	13%	34%	26%	33%	14%	**25%**
7	6%	12%	21%	23%	16%	20%	8%	13%	13%	19%	69%	15%	15%	**22%**
8	7%	5%	37%	14%	18%	20%	0%	11%	10%	6%	43%	21%	17%	**20%**
9	12%	5%	5%	6%	11%	5%	10%	16%	0%	9%	9%	8%	6%	**10%**
10	7%	4%	8%	4%	5%	7%	13%	9%	10%	5%	9%	11%	4%	**9%**
11	5%	5%	9%	5%	5%	14%	0%	5%	5%	10%	0%	5%	5%	**7%**
12	–	–	–	–	–	–	–	–	–	–	–	–	–	**18%**
13	–	–	–	–	–	–	–	–	–	–	–	–	–	**10%**
14	5%	5%	0%	5%	0%	12%	0%	5%	5%	0%	5%	8%	0%	**10%**
15	6%	5%	11%	5%	5%	0%	28%	14%	6%	0%	0%	5%	11%	**12%**
16	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB	R30 DE	R32 DK	R36 FR	All
Weighted mean	**13%**	**7%**	**53%**	**12%**	**30%**	**19%**	**8%**	**54%**	**13%**	**16%**	**46%**	**52%**	**21%**	**43%**

Table 2.14. Whole_27.3.a.20 .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 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB	R30 DE	R32 DK	R36 FR	Total
0	100%	100%	90%	100%	50%	100%	100%	90%	0%	100%	–	90%	0%	**80%**
1	67%	83%	83%	100%	80%	50%	100%	83%	100%	67%	80%	100%	67%	**82%**
2	29%	100%	71%	57%	43%	29%	100%	86%	57%	60%	17%	71%	71%	**61%**
3	83%	100%	100%	83%	83%	50%	83%	83%	100%	83%	67%	67%	100%	**83%**
4	90%	80%	56%	90%	90%	80%	70%	40%	80%	78%	50%	60%	70%	**72%**
5	88%	100%	89%	78%	56%	44%	89%	78%	78%	56%	62%	67%	78%	**74%**
6	60%	20%	80%	80%	20%	40%	60%	60%	40%	40%	50%	40%	80%	**52%**
7	86%	71%	71%	43%	71%	71%	57%	50%	29%	43%	43%	71%	43%	**58%**
8	70%	80%	60%	70%	44%	10%	100%	60%	50%	56%	38%	70%	50%	**59%**
9	60%	80%	80%	60%	20%	0%	80%	40%	100%	60%	50%	60%	60%	**56%**
10	50%	83%	83%	83%	67%	0%	83%	67%	67%	67%	80%	50%	83%	**66%**
11	67%	67%	33%	67%	33%	67%	100%	67%	67%	67%	100%	67%	67%	**67%**
12	0%	0%	0%	100%	100%	0%	0%	0%	100%	100%	0%	100%	0%	**38%**
13	0%	100%	0%	100%	100%	0%	0%	100%	0%	100%	0%	0%	100%	**46%**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB	R30 DE	R32 DK	R36 FR	Total
14	50%	50%	0%	50%	100%	0%	0%	50%	50%	100%	50%	0%	100%	**46%**
15	0%	0%	0%	50%	50%	100%	50%	0%	0%	0%	0%	50%	0%	**23%**
16	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
Weighted mean	**70%**	**80%**	**71%**	**76%**	**59%**	**47%**	**81%**	**65%**	**63%**	**65%**	**51%**	**67%**	**60%**	**66%**

Table 2.15. Whole_27.3.a.20. Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all readers combined per modal age, and a weighted mean of the APE per reader.

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R36 FR	All
0	0%	0%	180%	0%	100%	0%	0%	180%	30%	0%	–	180%	52%	**160%**
1	44%	24%	24%	0%	27%	58%	0%	24%	0%	44%	40%	0%	33%	**29%**
2	30%	0%	24%	26%	26%	30%	0%	29%	26%	28%	80%	24%	14%	**26%**
3	9%	0%	0%	9%	9%	14%	9%	10%	0%	9%	33%	13%	0%	**8%**
4	4%	8%	18%	5%	5%	8%	16%	17%	8%	6%	42%	17%	16%	**14%**
5	4%	0%	8%	9%	21%	10%	8%	19%	13%	13%	50%	21%	15%	**13%**
6	12%	17%	15%	11%	22%	27%	8%	12%	10%	26%	19%	23%	10%	**18%**
7	4%	9%	12%	15%	13%	16%	7%	11%	10%	16%	57%	11%	11%	**12%**
8	4%	4%	21%	11%	14%	15%	0%	10%	8%	6%	27%	15%	10%	**12%**
9	8%	4%	4%	5%	8%	5%	7%	13%	0%	8%	6%	4%	5%	**7%**
10	5%	3%	6%	3%	4%	6%	9%	7%	6%	4%	6%	8%	3%	**6%**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R36 FR	All
11	4%	4%	6%	4%	4%	11%	0%	4%	4%	8%	0%	4%	4%	**4%**
12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**16%**
13	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**7%**
14	4%	4%	0%	3%	0%	9%	0%	4%	4%	0%	3%	6%	0%	**7%**
15	4%	4%	8%	3%	3%	0%	20%	10%	4%	0%	0%	3%	8%	**9%**
16	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
Weighted mean	**9%**	**5%**	**31%**	**8%**	**23%**	**15%**	**6%**	**33%**	**9%**	**12%**	**34%**	**32%**	**16%**	**28%**

Table 2.16. Whole_27.3.a.20 .Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age, and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R36 FR	All
0	0.00	0.00	0.10	0.00	0.60	0.00	0.00	0.10	2.50	0.00	–	0.10	1.60	**0.32**
1	0.50	0.17	0.17	0.00	0.20	0.33	0.00	0.17	0.00	0.50	−0.20	0.00	0.33	**0.17**
2	0.57	0.00	−0.29	−0.14	0.86	0.57	0.00	−0.29	−0.14	0.60	−0.33	−0.29	0.00	**0.08**
3	0.17	0.00	0.00	0.17	0.17	0.50	0.17	−0.17	0.00	0.17	−0.33	0.33	0.00	**0.09**
4	0.10	−0.20	−0.56	−0.10	−0.10	0.20	−0.40	−0.70	−0.20	0.00	−0.70	−0.50	−0.40	**−0.27**
5	−0.12	0.00	0.22	−0.11	0.33	0.67	−0.22	−0.56	−0.22	−0.11	−1.12	−0.33	−0.44	**−0.15**
6	0.20	1.00	0.60	−0.40	2.20	1.80	0.40	−0.20	0.20	0.80	1.25	0.60	0.40	**0.67**

7	−0.14	−0.43	−0.14	−0.14	0.71	0.86	−0.43	−0.67	0.14	0.86	−2.00	0.57	0.14	**−0.04**
8	0.10	−0.20	−0.60	0.70	1.33	2.20	0.00	−0.60	0.40	0.44	−0.50	0.70	0.90	**0.38**
9	−0.20	−0.20	−0.20	0.40	1.40	1.40	−0.40	−0.60	0.00	0.60	0.00	0.00	0.40	**0.19**
10	0.17	0.17	−0.33	0.17	0.33	1.67	−0.50	−0.50	−0.17	0.33	0.40	0.83	0.17	**0.21**
11	−0.33	−0.33	0.00	−0.33	0.67	1.00	0.00	−0.33	−0.33	0.67	0.00	0.33	−0.33	**0.05**
12	−2.00	−3.00	−3.00	0.00	0.00	1.00	−4.00	−4.00	0.00	0.00	−2.00	0.00	−4.00	**−1.62**
13	−1.00	0.00	−2.00	0.00	0.00	3.00	−2.00	0.00	−1.00	0.00	−1.00	−1.00	0.00	**−0.38**
14	−0.50	−0.50	−1.00	0.50	0.00	3.50	1.00	−0.50	−0.50	0.00	0.50	3.00	0.00	**0.42**
15	−2.50	−1.50	−2.00	−0.50	−0.50	0.00	−2.50	−5.00	−2.50	−1.00	−1.00	−0.50	−2.00	**−1.65**
16	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
Weighted mean	**−0.01**	**−0.10**	**−0.24**	**0.04**	**0.61**	**0.94**	**−0.22**	**−0.52**	**0.02**	**0.30**	**−0.50**	**0.19**	**0.18**	**0.06**

2.3.3 All readers: North Sea (27.4.b and c) whole otoliths

Table 2.17. Whole_27.4. 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 reader.

NSample	CV	PA	APE
106	50%	75%	29%

Table 2.18. Whole_27.4. Coefficient of Variation (CV) table presents the CV per modal age and reader, the CV of all readers combined per modal age, and a weighted mean of the CV per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
0	105%	0%	0%	129%	316%	0%	0%	0%	0%	0%	0%	0%	161%	0%	**314%**
1	30%	0%	0%	35%	58%	20%	33%	45%	26%	27%	0%	0%	0%	0%	**37%**
2	27%	17%	17%	35%	28%	29%	0%	47%	30%	30%	23%	23%	24%	24%	**28%**
3	11%	28%	17%	11%	11%	11%	18%	31%	0%	0%	12%	17%	19%	30%	**18%**
4	0%	10%	10%	0%	0%	0%	10%	22%	0%	0%	0%	13%	0%	0%	**8%**
5	10%	14%	10%	11%	0%	19%	8%	17%	11%	9%	9%	8%	9%	15%	**12%**
6	0%	9%	0%	8%	15%	8%	0%	10%	0%	9%	0%	0%	9%	0%	**8%**
7	0%	14%	16%	6%	7%	28%	13%	11%	15%	13%	13%	15%	12%	13%	**15%**
8	–	13%	43%	10%	5%	6%	23%	20%	21%	16%	13%	10%	13%	12%	**19%**
9	9%	15%	18%	7%	6%	28%	22%	10%	12%	13%	6%	6%	10%	12%	**15%**
10	–	10%	17%	19%	5%	11%	29%	18%	15%	12%	5%	32%	27%	10%	**17%**
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**26%**
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**37%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
Weighted mean	**31%**	**10%**	**12%**	**29%**	**53%**	**16%**	**16%**	**25%**	**15%**	**14%**	**7%**	**9%**	**25%**	**10%**	**50%**

Table 2.19. Whole_27.4. 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 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	Total
0	50%	100%	100%	60%	90%	100%	100%	100%	100%	100%	100%	100%	70%	100%	**91%**
1	88%	100%	100%	78%	62%	96%	83%	78%	92%	91%	100%	100%	100%	100%	**91%**
2	75%	90%	90%	80%	60%	80%	100%	30%	70%	89%	80%	80%	80%	80%	**77%**
3	88%	75%	75%	88%	88%	88%	75%	50%	100%	100%	88%	75%	71%	62%	**80%**
4	100%	86%	86%	100%	100%	100%	86%	71%	100%	100%	100%	71%	100%	100%	**93%**
5	75%	82%	73%	73%	100%	73%	82%	64%	73%	82%	82%	82%	80%	73%	**78%**
6	100%	75%	100%	75%	75%	75%	100%	50%	100%	75%	100%	100%	75%	100%	**85%**
7	100%	67%	67%	78%	78%	44%	78%	67%	56%	56%	78%	56%	67%	56%	**66%**
8	100%	50%	30%	70%	86%	40%	40%	30%	40%	40%	60%	30%	60%	50%	**48%**
9	0%	33%	33%	67%	67%	17%	17%	50%	50%	40%	50%	33%	50%	67%	**43%**
10	0%	50%	50%	60%	75%	60%	50%	20%	40%	40%	75%	40%	25%	50%	**47%**
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
12	–	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	Total
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
16	–	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**
Weighted mean	**77%**	**78%**	**76%**	**74%**	**76%**	**74%**	**75%**	**59%**	**75%**	**77%**	**84%**	**74%**	**75%**	**78%**	**75%**

Table 2.20. Whole_27.4. Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all readers combined per modal age, and a weighted mean of the APE per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
0	100%	0%	0%	120%	180%	0%	0%	0%	0%	0%	0%	0%	140%	0%	**181%**
1	19%	0%	0%	28%	52%	8%	24%	24%	14%	15%	0%	0%	0%	0%	**19%**
2	12%	9%	9%	18%	24%	21%	0%	40%	19%	18%	18%	18%	10%	10%	**13%**
3	7%	21%	14%	7%	7%	7%	8%	26%	0%	0%	8%	14%	10%	25%	**11%**
4	0%	6%	6%	0%	0%	0%	6%	17%	0%	0%	0%	11%	0%	0%	**4%**
5	8%	9%	8%	6%	0%	12%	6%	12%	6%	4%	4%	6%	4%	7%	**6%**
6	0%	7%	0%	6%	12%	6%	0%	9%	0%	7%	0%	0%	7%	0%	**3%**
7	0%	11%	14%	5%	3%	18%	11%	9%	12%	10%	11%	12%	8%	10%	**10%**
8	0%	11%	32%	6%	3%	6%	19%	16%	15%	11%	10%	8%	12%	9%	**14%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
9	7%	11%	14%	4%	5%	19%	16%	8%	10%	10%	6%	5%	8%	11%	**11%**
10	0%	8%	14%	13%	4%	7%	21%	13%	12%	9%	4%	22%	19%	8%	**13%**
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
12	–	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**23%**
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
16	–	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**30%**
Weighted mean	**24%**	**7%**	**9%**	**23%**	**35%**	**9%**	**12%**	**17%**	**9%**	**8%**	**5%**	**7%**	**19%**	**6%**	**29%**

Table 2.21. Whole_27.4. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
0	0.50	0.00	0.00	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	**0.09**
1	0.12	0.00	0.00	0.22	0.71	0.04	0.17	0.04	0.08	0.09	0.00	0.00	0.00	0.00	**0.11**
2	0.00	−0.10	−0.10	0.10	0.50	0.30	0.00	−0.50	−0.10	0.22	−0.20	−0.20	0.00	0.00	**−0.01**
3	0.12	−0.38	−0.25	0.12	0.12	0.12	0.00	−0.62	0.00	0.00	−0.12	−0.25	0.00	−0.50	**−0.12**
4	0.00	−0.14	−0.14	0.00	0.00	0.00	−0.14	−0.43	0.00	0.00	0.00	−0.29	0.00	0.00	**−0.08**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	R20 NO	R26 FR	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	All
5	−0.25	−0.27	−0.27	0.09	0.00	0.27	−0.18	−0.27	0.09	0.00	0.00	−0.18	0.00	0.00	**−0.07**
6	0.00	−0.25	0.00	0.25	0.50	0.25	0.00	−0.50	0.00	−0.25	0.00	0.00	−0.25	0.00	**−0.02**
7	0.00	−0.56	−0.67	0.22	0.00	0.33	−0.44	−0.44	−0.44	−0.33	−0.44	−0.44	−0.22	−0.33	**−0.29**
8	0.00	−0.80	−2.20	0.20	−0.14	0.60	−1.40	−1.40	−0.90	−0.20	−0.40	0.30	−0.70	−0.20	**−0.56**
9	−1.50	−1.17	−1.33	0.00	−0.33	0.83	−1.17	−0.67	−0.83	−0.40	−0.50	−0.67	−0.67	−0.67	**−0.61**
10	−3.00	−0.75	−1.25	−1.00	−0.25	−0.20	−1.75	−1.80	−1.20	−0.40	−0.25	−1.20	−2.00	−0.75	**−1.02**
11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
12	–	−5.00	−6.00	−1.00	−1.00	−1.00	−6.00	−7.00	−2.00	−1.00	−1.00	−1.00	−4.00	−2.00	**−2.92**
13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
16	–	−11.00	−9.00	−2.00	−8.00	−1.00	−9.00	−10.00	−9.00	−9.00	−4.00	−9.00	−6.00	−9.00	**−7.38**
Weighted mean	**0.00**	**−0.46**	**−0.60**	**0.09**	**0.13**	**0.19**	**−0.44**	**−0.62**	**−0.31**	**−0.16**	**−0.19**	**−0.27**	**−0.28**	**−0.26**	**−0.23**

2.3.4 All readers: North Sea (27.4.b and c) sectioned otoliths

Table 2.22. Sectioned_27.4. 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
106	38%	75%	23%

Table 2.23. Sectioned_27.4. Coefficient of Variation (CV) table presents the CV per modal age and reader, the CV of all readers combined per modal age, and a weighted mean of the CV per reader.

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	All
0	–	0%	316%	211%	132%	161%	**230%**
1	–	0%	0%	0%	50%	30%	**31%**
2	–	17%	29%	36%	30%	28%	**31%**
3	–	11%	28%	14%	25%	0%	**18%**
4	–	10%	10%	0%	11%	0%	**9%**
5	–	12%	0%	13%	18%	12%	**14%**
6	–	14%	14%	7%	13%	9%	**14%**
7	0%	21%	10%	14%	15%	7%	**14%**
8	–	7%	9%	6%	11%	15%	**12%**
9	–	13%	9%	23%	21%	13%	**16%**
10	–	5%	6%	5%	7%	14%	**9%**

11	–	–	–	–	–	–	**–**
12	–	–	–	–	–	–	**4%**
13	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	**–**
16	–	–	–	–	–	–	**23%**
Weighted mean	**0%**	**8%**	**39%**	**30%**	**35%**	**30%**	**38%**

Table 2.24. Sectioned_27.4. 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 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	Total
0	–	100%	90%	80%	44%	70%	**77%**
1	–	100%	100%	100%	81%	88%	**92%**
2	–	90%	60%	70%	67%	70%	**71%**
3	–	88%	75%	75%	50%	100%	**78%**
4	–	86%	86%	100%	71%	100%	**89%**
5	–	82%	100%	64%	45%	82%	**75%**
6	0%	50%	50%	25%	25%	75%	**43%**
7	100%	67%	78%	56%	56%	78%	**68%**
8	–	70%	70%	70%	40%	40%	**58%**
9	100%	83%	67%	50%	83%	33%	**65%**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	Total
10	–	80%	60%	40%	60%	60%	**60%**
11	–	–	–	–	–	–	**–**
12	0%	100%	100%	100%	100%	0%	**67%**
13	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	**–**
16	–	100%	0%	0%	100%	0%	**40%**
Weighted mean	**60%**	**86%**	**81%**	**74%**	**60%**	**74%**	**75%**

Table 2.25. Sectioned_27.4. Average Percentage Error (APE) table represents the APE per modal age and reader, the APE of all readers combined per modal age, and a weighted mean of the APE per reader.

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	All
0	–	0%	180%	160%	89%	140%	**154%**
1	–	0%	0%	0%	30%	19%	**11%**
2	–	9%	22%	24%	24%	25%	**18%**
3	–	7%	21%	12%	17%	0%	**8%**
4	–	6%	6%	0%	10%	0%	**3%**
5	–	8%	0%	11%	14%	8%	**11%**
6	0%	8%	8%	6%	10%	7%	**12%**
7	0%	12%	7%	11%	13%	3%	**10%**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	All
8	–	5%	7%	5%	9%	11%	**8%**
9	0%	9%	7%	15%	14%	10%	**11%**
10	–	3%	5%	5%	4%	10%	**6%**
11	–	–	–	–	–	–	**–**
12	0%	0%	0%	0%	0%	0%	**4%**
13	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	**–**
16	–	0%	0%	0%	0%	0%	**16%**
Weighted mean	**0%**	**5%**	**23%**	**22%**	**23%**	**23%**	**23%**

Table 2.26. Sectioned_27.4. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age, and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	All
0	–	0.00	0.10	0.20	1.00	0.30	**0.31**
1	–	0.00	0.00	0.00	0.14	0.12	**0.03**
2	–	−0.10	0.20	0.20	0.44	−0.30	**0.08**
3	–	0.12	−0.38	0.25	0.00	0.00	**0.00**
4	–	−0.14	−0.14	0.00	0.29	0.00	**0.00**
5	–	0.27	0.00	0.45	0.91	0.27	**0.38**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	R26 FR	All
6	−1.00	0.00	0.00	0.75	1.25	−0.25	**0.29**
7	0.00	0.22	0.33	0.78	0.89	0.00	**0.43**
8	–	−0.10	−0.40	0.30	0.60	−1.00	**−0.12**
9	0.00	0.50	0.50	1.33	0.83	−0.17	**0.58**
10	–	−0.20	−0.40	0.60	0.00	−0.80	**−0.16**
11	–	–	–	–	–	–	**–**
12	1.00	0.00	0.00	0.00	0.00	1.00	**0.33**
13	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	**–**
16	–	0.00	1.00	1.00	0.00	−7.00	**−1.00**
Weighted mean	**0.00**	**0.05**	**−0.00**	**0.34**	**0.51**	**−0.15**	**0.14**

2.3.5 Advanced readers and all samples

This first section is where all age readings of advanced readers reading all samples are included in the analysis, followed by individual sections for Skagerrak (27.3.a.20) whole, North Sea (27.4.b and c) whole, and North Sea (27.4.b and c) sectioned.

Table 2.27. 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 advanced readers.

NSample	CV	PA	APE
302	47%	72%	27%

Table 2.28. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	All
0	178%	0%	447%	129%	436%	168%	381%	132%	0%	**292%**
1	43%	13%	18%	35%	0%	58%	34%	50%	31%	**41%**
2	35%	14%	22%	35%	32%	30%	34%	30%	0%	**30%**
3	12%	18%	13%	11%	23%	12%	14%	25%	15%	**16%**
4	6%	10%	17%	0%	9%	6%	7%	11%	16%	**11%**
5	8%	12%	12%	11%	10%	22%	15%	18%	11%	**15%**
6	15%	19%	16%	8%	14%	27%	27%	13%	7%	**21%**
7	4%	17%	18%	6%	16%	13%	21%	15%	11%	**16%**
8	7%	9%	40%	10%	14%	17%	16%	11%	17%	**20%**
9	13%	14%	14%	7%	7%	13%	20%	21%	17%	**17%**
10	14%	7%	12%	19%	5%	6%	10%	7%	20%	**12%**
11	5%	5%	9%	–	5%	5%	14%	–	0%	**8%**
12	18%	27%	28%	–	0%	6%	8%	–	20%	**22%**
13	–	–	–	–	–	–	–	–	–	**13%**
14	5%	5%	0%	–	5%	0%	12%	–	0%	**11%**
15	6%	5%	11%	–	5%	5%	0%	–	28%	**11%**
16	–	74%	–	–	–	–	9%	–	–	**40%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	All
Weighted mean	**38%**	**12%**	**63%**	**29%**	**54%**	**39%**	**57%**	**35%**	**14%**	**49%**

Table 2.29. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	Total
0	75%	100%	95%	60%	95%	70%	93%	44%	100%	**86%**
1	82%	98%	97%	78%	100%	66%	93%	81%	86%	**89%**
2	53%	93%	82%	80%	59%	53%	63%	67%	100%	**73%**
3	86%	86%	86%	88%	79%	86%	73%	50%	79%	**80%**
4	94%	83%	69%	100%	88%	94%	92%	71%	76%	**86%**
5	81%	87%	80%	73%	90%	78%	61%	45%	85%	**77%**
6	62%	46%	89%	75%	67%	44%	46%	25%	78%	**59%**
7	91%	68%	69%	78%	62%	75%	56%	56%	69%	**68%**
8	73%	67%	45%	70%	70%	62%	40%	40%	70%	**59%**
9	50%	65%	55%	67%	64%	45%	24%	83%	45%	**52%**
10	43%	73%	70%	60%	73%	70%	31%	60%	70%	**61%**
11	67%	67%	33%	–	67%	33%	67%	–	100%	**62%**
12	0%	33%	0%	0%	100%	50%	33%	100%	0%	**33%**
13	0%	100%	0%	–	100%	100%	0%	–	0%	**43%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	Total
14	50%	50%	0%	–	50%	100%	0%	–	0%	**36%**
15	0%	0%	0%	–	50%	50%	100%	–	50%	**36%**
16	–	50%	0%	0%	0%	0%	0%	100%	0%	**20%**
Weighted mean	**72%**	**81%**	**74%**	**74%**	**79%**	**68%**	**66%**	**60%**	**78%**	**73%**

Table 2.30. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	All
0	150%	0%	190%	120%	189%	140%	187%	89%	0%	**173%**
1	30%	4%	6%	28%	0%	50%	13%	30%	21%	**23%**
2	27%	7%	16%	18%	22%	26%	26%	24%	0%	**20%**
3	8%	9%	9%	7%	14%	8%	12%	17%	9%	**8%**
4	3%	7%	14%	0%	5%	3%	4%	10%	12%	**6%**
5	6%	4%	6%	6%	4%	12%	12%	14%	7%	**8%**
6	8%	14%	9%	6%	10%	20%	13%	10%	6%	**14%**
7	2%	10%	14%	5%	10%	9%	15%	13%	9%	**9%**
8	4%	8%	30%	6%	8%	12%	9%	9%	13%	**10%**
9	10%	9%	11%	4%	6%	10%	13%	14%	13%	**10%**
10	10%	5%	11%	13%	3%	4%	8%	4%	16%	**8%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	All
11	4%	4%	6%	–	4%	4%	11%	–	0%	**5%**
12	13%	19%	20%	0%	0%	4%	6%	0%	14%	**19%**
13	0%	0%	0%	–	0%	0%	0%	–	0%	**9%**
14	4%	4%	0%	–	3%	0%	9%	–	0%	**8%**
15	4%	4%	8%	–	3%	3%	0%	–	20%	**9%**
16	–	52%	0%	0%	0%	0%	6%	0%	0%	**36%**
Weighted mean	**29%**	**6%**	**31%**	**23%**	**25%**	**31%**	**30%**	**23%**	**10%**	**29%**

Table 2.31. Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age, and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	All
0	0.25	0.00	0.05	0.40	0.05	0.35	0.07	1.00	0.00	**0.24**
1	0.23	0.02	0.03	0.22	0.00	0.62	0.06	0.14	0.14	**0.16**
2	0.27	−0.07	−0.18	0.10	0.06	0.65	0.33	0.44	0.00	**0.18**
3	0.14	−0.09	−0.14	0.12	−0.14	0.14	0.27	0.00	0.07	**0.04**
4	0.06	−0.17	−0.38	0.00	−0.12	−0.06	0.08	0.29	−0.29	**−0.06**
5	−0.19	0.00	−0.05	0.09	−0.05	0.17	0.45	0.91	−0.20	**0.13**
6	0.00	0.31	0.33	0.25	−0.22	1.44	1.00	1.25	0.22	**0.51**
7	−0.09	−0.24	−0.44	0.22	0.12	0.31	0.64	0.89	−0.44	**0.11**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R16 GB	R18 DK	All
8	0.09	−0.37	−1.40	0.20	0.15	0.69	1.03	0.60	−0.70	**0.03**
9	−0.50	−0.29	−0.82	0.00	0.45	0.45	1.18	0.83	−0.82	**0.05**
10	−0.29	−0.20	−0.70	−1.00	−0.09	0.10	0.75	0.00	−1.00	**−0.27**
11	−0.33	−0.33	0.00	–	−0.33	0.67	1.00	–	0.00	**–**
12	−0.50	−2.67	−4.50	−1.00	0.00	−0.50	0.00	0.00	−5.00	**−1.57**
13	−1.00	0.00	−2.00	–	0.00	0.00	3.00	–	−2.00	**–**
14	−0.50	−0.50	−1.00	–	0.50	0.00	3.50	–	1.00	**–**
15	−2.50	−1.50	−2.00	–	−0.50	−0.50	0.00	–	−2.50	**–**
16	–	−5.50	−9.00	−2.00	1.00	−8.00	0.00	0.00	−9.00	**–**
Weighted mean	**−0.01**	**−0.17**	**−0.43**	**0.09**	**0.02**	**0.36**	**0.47**	**0.51**	**−0.34**	**0.09**

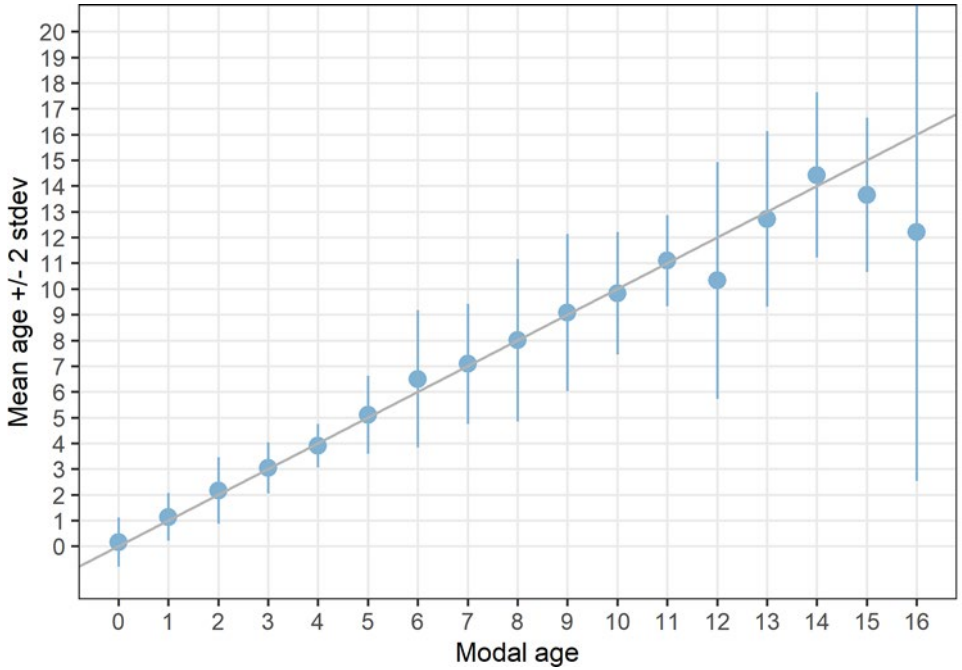


Figure 2.2. Age bias plot for advanced readers. Mean age recorded +/− 2 stdev of each reader and advanced readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between the estimated mean age and modal age. Advanced readers: Skagerrak (27.3.a.20) whole otoliths.

Table 2.32. Whole_27.3.a.20. 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 advanced readers.

NSample	CV	PA	APE
90	55%	69%	31%

Table 2.33. Whole_27.3.a.20. Coefficient of Variation (CV) table presents the CV per modal age and reader, the CV of all advanced readers combined per modal age and a weighted mean of the CV per reader.

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	All
0	0%	0%	316%	0%	117%	0%	0%	**344%**
1	56%	35%	35%	0%	37%	77%	0%	**47%**
2	38%	0%	28%	37%	31%	38%	0%	**35%**
3	13%	0%	0%	13%	13%	16%	13%	**12%**
4	8%	11%	21%	8%	8%	10%	19%	**14%**
5	7%	0%	13%	16%	31%	12%	14%	**17%**
6	18%	23%	20%	16%	29%	38%	9%	**26%**
7	6%	12%	21%	23%	16%	20%	8%	**17%**
8	7%	5%	37%	14%	18%	20%	0%	**20%**
9	12%	5%	5%	6%	11%	5%	10%	**11%**
10	7%	4%	8%	4%	5%	7%	13%	**9%**
11	5%	5%	9%	5%	5%	14%	0%	**8%**
12	–	–	–	–	–	–	–	**18%**
13	–	–	–	–	–	–	–	**13%**
14	5%	5%	0%	5%	0%	12%	0%	**11%**
15	6%	5%	11%	5%	5%	0%	28%	**11%**
16	–	–	–	–	–	–	–	**–**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	All
Weighted mean	**13%**	**7%**	**53%**	**12%**	**30%**	**19%**	**8%**	**55%**

Table 2.34. Whole_27.3.a.20. Percentage agreement (PA) table represents the PA per modal age and reader, the PA of all advanced readers combined per modal age, and a weighted mean of the PA per reader.

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	Total
0	100%	100%	90%	100%	50%	100%	100%	**91%**
1	67%	83%	83%	100%	80%	50%	100%	**80%**
2	29%	100%	71%	57%	43%	29%	100%	**61%**
3	83%	100%	100%	83%	83%	50%	83%	**83%**
4	90%	80%	56%	90%	90%	80%	70%	**80%**
5	88%	100%	89%	78%	56%	44%	89%	**77%**
6	60%	20%	80%	80%	20%	40%	60%	**51%**
7	86%	71%	71%	43%	71%	71%	57%	**67%**
8	70%	80%	60%	70%	44%	10%	100%	**62%**
9	60%	80%	80%	60%	20%	0%	80%	**54%**
10	50%	83%	83%	83%	67%	0%	83%	**64%**
11	67%	67%	33%	67%	33%	67%	100%	**62%**
12	0%	0%	0%	100%	100%	0%	0%	**29%**
13	0%	100%	0%	100%	100%	0%	0%	**43%**
14	50%	50%	0%	50%	100%	0%	0%	**36%**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	Total
15	0%	0%	0%	50%	50%	100%	50%	**36%**
16	–	–	–	–	–	–	–	**–**
Weighted mean	**70%**	**80%**	**71%**	**76%**	**59%**	**47%**	**81%**	**69%**

Table 2.35. Whole_27.3.a.20. Average Percentage Error (APE) table represents the APE per modal age and advanced reader, the APE of all advanced readers combined per modal age, and a weighted mean of the APE per reader.

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	all
0	0%	0%	180%	0%	100%	0%	0%	**183%**
1	44%	24%	24%	0%	27%	58%	0%	**31%**
2	30%	0%	24%	26%	26%	30%	0%	**26%**
3	9%	0%	0%	9%	9%	14%	9%	**9%**
4	4%	8%	18%	5%	5%	8%	16%	**9%**
5	4%	0%	8%	9%	21%	10%	8%	**9%**
6	12%	17%	15%	11%	22%	27%	8%	**18%**
7	4%	9%	12%	15%	13%	16%	7%	**9%**
8	4%	4%	21%	11%	14%	15%	0%	**12%**
9	8%	4%	4%	5%	8%	5%	7%	**8%**
10	5%	3%	6%	3%	4%	6%	9%	**6%**
11	4%	4%	6%	4%	4%	11%	0%	**5%**
12	0%	0%	0%	0%	0%	0%	0%	**16%**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	all
13	0%	0%	0%	0%	0%	0%	0%	**9%**
14	4%	4%	0%	3%	0%	9%	0%	**8%**
15	4%	4%	8%	3%	3%	0%	20%	**9%**
16	–	–	–	–	–	–	–	**–**
Weighted mean	**9%**	**5%**	**31%**	**8%**	**23%**	**15%**	**6%**	**31%**

Table 2.36. Whole_27.3.a.20. Relative bias table represents the relative bias per modal age per advanced reader, the relative bias of all advanced readers combined per modal age, and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate positive or negative overall bias, respectively.

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	All
0	0.00	0.00	0.10	0.00	0.60	0.00	0.00	**0.10**
1	0.50	0.17	0.17	0.00	0.20	0.33	0.00	**0.20**
2	0.57	0.00	−0.29	−0.14	0.86	0.57	0.00	**0.22**
3	0.17	0.00	0.00	0.17	0.17	0.50	0.17	**0.17**
4	0.10	−0.20	−0.56	−0.10	−0.10	0.20	−0.40	**−0.14**
5	−0.12	0.00	0.22	−0.11	0.33	0.67	−0.22	**0.11**
6	0.20	1.00	0.60	−0.40	2.20	1.80	0.40	**0.83**
7	−0.14	−0.43	−0.14	−0.14	0.71	0.86	−0.43	**0.04**
8	0.10	−0.20	−0.60	0.70	1.33	2.20	0.00	**0.49**
9	−0.20	−0.20	−0.20	0.40	1.40	1.40	−0.40	**0.31**
10	0.17	0.17	−0.33	0.17	0.33	1.67	−0.50	**0.24**

Modal age	R02 SE	R04 NL	R06 DK	R10 NL	R12 BE	R14 BE	R18 DK	All
11	−0.33	−0.33	0.00	−0.33	0.67	1.00	0.00	**0.10**
12	−2.00	−3.00	−3.00	0.00	0.00	1.00	−4.00	**−1.57**
13	−1.00	0.00	−2.00	0.00	0.00	3.00	−2.00	**−0.29**
14	−0.50	−0.50	−1.00	0.50	0.00	3.50	1.00	**0.43**
15	−2.50	−1.50	−2.00	−0.50	−0.50	0.00	−2.50	**−1.36**
16	–	–	–	–	–	–	–	**–**
Weighted mean	**−0.01**	**−0.10**	**−0.24**	**0.04**	**0.61**	**0.94**	**−0.22**	**0.15**

2.3.6 Advanced readers: North Sea (27.4.b and c), whole otoliths

Table 2.37. Whole_27.4. 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 advanced readers,

NSample	CV	PA	APE
106	46%	76%	30%

Table 2.38. Whole_27.4. Coefficient of Variation (CV) table presents the CV per modal age and reader, the CV of all advanced readers combined per modal age, and a weighted mean of the CV per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	All
0	105%	0%	0%	129%	316%	0%	0%	**247%**
1	30%	0%	0%	35%	58%	20%	33%	**44%**
2	27%	17%	17%	35%	28%	29%	0%	**26%**
3	11%	28%	17%	11%	11%	11%	18%	**16%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	All
4	0%	10%	10%	0%	0%	0%	10%	**6%**
5	10%	14%	10%	11%	0%	19%	8%	**12%**
6	0%	9%	0%	8%	15%	8%	0%	**8%**
7	0%	14%	16%	6%	7%	28%	13%	**16%**
8	–	13%	43%	10%	5%	6%	23%	**22%**
9	9%	15%	18%	7%	6%	28%	22%	**19%**
10	–	10%	17%	19%	5%	11%	29%	**16%**
11	–	–	–	–	–	–	–	**–**
12	–	–	–	–	–	–	–	**30%**
13	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	**–**
16	–	–	–	–	–	–	–	**44%**
Weighted mean	**31%**	**10%**	**12%**	**29%**	**53%**	**16%**	**16%**	**46%**

Table 2.39. Whole_27.4. Percentage agreement (PA) table represents the PA per modal age and reader, the PA of all advanced readers combined per modal age, and a weighted mean of the PA per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	Total
0	50%	100%	100%	60%	90%	100%	100%	**86%**
1	88%	100%	100%	78%	62%	96%	83%	**87%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	Total
2	75%	90%	90%	80%	60%	80%	100%	**82%**
3	88%	75%	75%	88%	88%	88%	75%	**82%**
4	100%	86%	86%	100%	100%	100%	86%	**94%**
5	75%	82%	73%	73%	100%	73%	82%	**79%**
6	100%	75%	100%	75%	75%	75%	100%	**85%**
7	100%	67%	67%	78%	78%	44%	78%	**70%**
8	100%	50%	30%	70%	86%	40%	40%	**52%**
9	0%	33%	33%	67%	67%	17%	17%	**37%**
10	0%	50%	50%	60%	75%	60%	50%	**56%**
11	–	–	–	–	–	–	–	**–**
12	–	0%	0%	0%	0%	0%	0%	**0%**
13	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	**–**
16	–	0%	0%	0%	0%	0%	0%	**0%**
Weighted mean	**77%**	**78%**	**76%**	**74%**	**76%**	**74%**	**75%**	**76%**

Table 2.40. Whole_27.4. 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 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	All
0	100%	0%	0%	120%	180%	0%	0%	**171%**
1	19%	0%	0%	28%	52%	8%	24%	**27%**
2	12%	9%	9%	18%	24%	21%	0%	**14%**
3	7%	21%	14%	7%	7%	7%	8%	**7%**
4	0%	6%	6%	0%	0%	0%	6%	**3%**
5	8%	9%	8%	6%	0%	12%	6%	**6%**
6	0%	7%	0%	6%	12%	6%	0%	**5%**
7	0%	11%	14%	5%	3%	18%	11%	**9%**
8	0%	11%	32%	6%	3%	6%	19%	**16%**
9	7%	11%	14%	4%	5%	19%	16%	**13%**
10	0%	8%	14%	13%	4%	7%	21%	**13%**
11	–	–	–	–	–	–	–	**–**
12	–	0%	0%	0%	0%	0%	0%	**27%**
13	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	**–**
15	–	–	–	–	–	–	–	**–**
16	–	0%	0%	0%	0%	0%	0%	**37%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	All
Weighted mean	**24%**	**7%**	**9%**	**23%**	**35%**	**9%**	**12%**	**30%**

Table 2.41. Whole_27.4. Relative bias table represents the relative bias per modal age per reader, the relative bias of all advanced readers combined per modal age, and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	All
0	0.50	0.00	0.00	0.40	0.10	0.00	0.00	**0.14**
1	0.12	0.00	0.00	0.22	0.71	0.04	0.17	**0.18**
2	0.00	−0.10	−0.10	0.10	0.50	0.30	0.00	**0.10**
3	0.12	−0.38	−0.25	0.12	0.12	0.12	0.00	**−0.02**
4	0.00	−0.14	−0.14	0.00	0.00	0.00	−0.14	**−0.06**
5	−0.25	−0.27	−0.27	0.09	0.00	0.27	−0.18	**−0.08**
6	0.00	−0.25	0.00	0.25	0.50	0.25	0.00	**0.12**
7	0.00	−0.56	−0.67	0.22	0.00	0.33	−0.44	**−0.18**
8	0.00	−0.80	−2.20	0.20	−0.14	0.60	−1.40	**−0.64**
9	−1.50	−1.17	−1.33	0.00	−0.33	0.83	−1.17	**−0.58**
10	−3.00	−0.75	−1.25	−1.00	−0.25	−0.20	−1.75	**−0.93**
11	–	–	–	–	–	–	–	**–**
12	–	−5.00	−6.00	−1.00	−1.00	−1.00	−6.00	**−3.33**
13	–	–	–	–	–	–	–	**–**
14	–	–	–	–	–	–	–	**–**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R12 BE	R14 BE	R18 DK	All
15	–	–	–	–	–	–	–	–
16	–	−11.00	−9.00	−2.00	−8.00	−1.00	−9.00	**−6.67**
Weighted mean	**0.00**	**−0.46**	**−0.60**	**0.09**	**0.13**	**0.19**	**−0.44**	**−0.17**

2.3.7 Advanced readers: North Sea (27.4.b and c) sectioned otoliths

Table 2.42. Sectioned_27.4. 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 advanced readers.

NSample	CV	PA	APE
106	38%	75%	23%

Table 2.43. Sectioned_27.4. 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	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	All
0	–	0%	316%	211%	132%	**245%**
1	–	0%	0%	0%	50%	**27%**
2	–	17%	29%	36%	30%	**30%**
3	–	11%	28%	14%	25%	**21%**
4	–	10%	10%	0%	11%	**10%**
5	–	12%	0%	13%	18%	**14%**
6	–	14%	14%	7%	13%	**15%**
7	0%	21%	10%	14%	15%	**15%**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	All
8	–	7%	9%	6%	11%	**10%**
9	–	13%	9%	23%	21%	**17%**
10	–	5%	6%	5%	7%	**6%**
11	–	–	–	–	–	**–**
12	–	–	–	–	–	**4%**
13	–	–	–	–	–	**–**
14	–	–	–	–	–	**–**
15	–	–	–	–	–	**–**
16	–	–	–	–	–	**3%**
Weighted mean	**0%**	**8%**	**39%**	**30%**	**35%**	**38%**

Table 2.44. Sectioned_27.4. 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 reader.

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	Total
0	–	100%	90%	80%	44%	**79%**
1	–	100%	100%	100%	81%	**96%**
2	–	90%	60%	70%	67%	**72%**
3	–	88%	75%	75%	50%	**72%**
4	–	86%	86%	100%	71%	**86%**
5	–	82%	100%	64%	45%	**73%**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	Total
6	0%	50%	50%	25%	25%	**35%**
7	100%	67%	78%	56%	56%	**66%**
8	–	70%	70%	70%	40%	**62%**
9	100%	83%	67%	50%	83%	**72%**
10	–	80%	60%	40%	60%	**60%**
11	–	–	–	–	–	**–**
12	0%	100%	100%	100%	100%	**80%**
13	–	–	–	–	–	**–**
14	–	–	–	–	–	**–**
15	–	–	–	–	–	**–**
16	–	100%	0%	0%	100%	**50%**
Weighted mean	**60%**	**86%**	**81%**	**74%**	**60%**	**75%**

Table 2.45. Sectioned_27.4. 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 SE	R04 NL	R10 NL	R14 BE	R16 GB	All
0	–	0%	180%	160%	89%	**158%**
1	–	0%	0%	0%	30%	**8%**
2	–	9%	22%	24%	24%	**20%**
3	–	7%	21%	12%	17%	**10%**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	All
4	–	6%	6%	0%	10%	**4%**
5	–	8%	0%	11%	14%	**11%**
6	0%	8%	8%	6%	10%	**12%**
7	0%	12%	7%	11%	13%	**11%**
8	–	5%	7%	5%	9%	**6%**
9	0%	9%	7%	15%	14%	**11%**
10	–	3%	5%	5%	4%	**4%**
11	–	–	–	–	–	**–**
12	0%	0%	0%	0%	0%	**3%**
13	–	–	–	–	–	**–**
14	–	–	–	–	–	**–**
15	–	–	–	–	–	**–**
16	–	0%	0%	0%	0%	**3%**
Weighted mean	**0%**	**5%**	**23%**	**22%**	**23%**	**23%**

Table 2.46. Sectioned_27.4. Relative bias table represents the relative bias per modal age per reader, the relative bias of all advanced readers combined per modal age, and a weighted mean of the relative bias per reader. Red or black values (column "All") indicate negative or positive overall bias, respectively.

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	All
0	–	0.00	0.10	0.20	1.00	**0.32**
1	–	0.00	0.00	0.00	0.14	**0.03**

Modal age	R02 SE	R04 NL	R10 NL	R14 BE	R16 GB	All
2	–	−0.10	0.20	0.20	0.44	**0.18**
3	–	0.12	−0.38	0.25	0.00	**0.00**
4	–	−0.14	−0.14	0.00	0.29	**0.00**
5	–	0.27	0.00	0.45	0.91	**0.41**
6	−1.00	0.00	0.00	0.75	1.25	**0.41**
7	0.00	0.22	0.33	0.78	0.89	**0.53**
8	–	−0.10	−0.40	0.30	0.60	**0.10**
9	0.00	0.50	0.50	1.33	0.83	**0.76**
10	–	−0.20	−0.40	0.60	0.00	**0.00**
11	–	–	–	–	–	**–**
12	1.00	0.00	0.00	0.00	0.00	**0.20**
13	–	–	–	–	–	**–**
14	–	–	–	–	–	**–**
15	–	–	–	–	–	**–**
16	–	0.00	1.00	1.00	0.00	**0.50**
Weighted mean	**0.00**	**0.05**	**−0.00**	**0.34**	**0.51**	**0.22**

2.3.8 Advanced readers: stock level (ple.27.420)

A stock-level analysis of age-reading agreements was carried out for the first time in 2020. Since 2015 (ICES, 2020; ICES, 2021b) the ple.27.420 stock is defined as a combination of plaice caught in ICES areas 27.4 and 27.20. Only age readings of those readers who provide age data for stock assessment purposes (advanced readers) based on images of otoliths prepared following their routine age reading methods were used in this analysis. The Guus Eltink Excel Workbook *Age Reading Comparisons* (Eltink, 2000) was used.

Table 2.47. 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 (except age 0). Reader number, country, and method (S = sectioned and W = whole) is given for each advanced reader for ple.27.420.

Modal age	R04 NL S	R18 DK W	R10 NL S	R12 BEL W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	All readers
0	0%	0%	316%	168%	178%	132%	0%	0%	129%	0%	447%	172.3%
1	0%	31%	0%	57%	43%	49%	44%	18%	34%	0%	18%	29.0%
2	17%	0%	29%	30%	35%	30%	33%	12%	35%	37%	22%	25.1%
3	11%	15%	27%	13%	13%	25%	15%	20%	14%	13%	22%	13.3%
4	0%	15%	0%	6%	6%	12%	8%	9%	0%	8%	22%	7.4%
5	12%	11%	11%	21%	8%	17%	16%	10%	14%	16%	28%	12.2%
6	14%	6%	14%	16%	10%	13%	8%	16%	8%	18%	17%	11.7%
7	20%	9%	10%	12%	5%	15%	23%	11%	6%	23%	18%	10.8%
8	6%	18%	10%	17%	6%	12%	15%	11%	10%	15%	36%	14.9%
9	16%	16%	10%	12%	13%	19%	20%	12%	6%	6%	14%	11.0%
10	5%	19%	6%	10%	14%	7%	16%	12%	19%	5%	12%	10.6%
11	–	0%	–	5%	5%	–	14%	5%	–	5%	9%	–
12	–	20%	–	6%	16%	–	12%	18%	–	–	28%	–

Modal age	R04 NL S	R18 DK W	R10 NL S	R12 BEL W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	All readers
13	–	–	–	–	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–	–	–	–	–
15	–	22%	–	4%	5%	–	4%	4%	–	4%	8%	–
0–15	7.8%	13.5%	39.1%	36.9%	38.2%	34.3%	19.1%	11.4%	29.0%	11.6%	65.0%	**32.0%**

Table 2.48. 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. Reader number, country, and method (S = sectioned and W = whole) is given for each advanced reader for ple.27.420.

Modal age	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	All readers
0	100%	100%	90%	70%	75%	44%	100%	100%	60%	100%	95%	87%
1	100%	86%	100%	63%	82%	82%	87%	97%	79%	100%	97%	87%
2	90%	100%	60%	53%	53%	67%	59%	94%	80%	57%	82%	73%
3	89%	80%	78%	80%	80%	44%	67%	87%	78%	83%	80%	77%
4	100%	81%	100%	94%	94%	67%	88%	88%	100%	90%	69%	87%
5	75%	86%	92%	71%	81%	42%	62%	90%	67%	78%	76%	75%
6	50%	88%	50%	50%	71%	25%	63%	50%	75%	75%	88%	64%
7	75%	73%	75%	80%	88%	50%	60%	73%	75%	43%	73%	70%
8	78%	63%	67%	53%	80%	44%	26%	63%	78%	70%	50%	58%
9	71%	42%	57%	50%	43%	86%	17%	50%	71%	60%	50%	51%
10	80%	64%	60%	58%	38%	60%	25%	64%	60%	71%	73%	58%
11	–	100%	–	33%	67%	–	67%	67%	–	67%	33%	–

Modal age	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	All readers
12	100%	0%	100%	50%	0%	100%	0%	0%	0%	100%	0%	29%
13	–	0%	–	100%	0%	–	0%	100%	–	100%	–	–
14	–	0%	–	100%	100%	–	0%	0%	–	100%	0%	–
15	–	67%	–	33%	0%	–	67%	0%	–	67%	0%	–
0–15	85.7%	78.4%	80.2%	65.3%	71.4%	58.8%	61.7%	79.0%	73.6%	76.4%	74.1%	**72.7%**

Table 2.49. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age, and a weighted mean of the relative bias per reader. Reader number, country, and method (S = sectioned and W = whole) is given for each advanced reader for ple.27.420. Red or black values (column "All readers") indicate negative or positive overall bias, respectively.

Modal age	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	All readers
0	0.00	0.00	0.10	0.35	0.25	1.00	0.00	0.00	0.40	0.00	0.05	0.16
1	0.00	0.14	0.00	0.63	0.23	0.14	0.10	0.03	0.21	0.00	0.03	0.15
2	−0.10	0.00	0.20	0.65	0.27	0.44	0.41	−0.06	0.10	−0.14	−0.18	0.16
3	0.11	0.07	−0.33	0.20	0.20	0.11	0.33	−0.20	0.22	0.17	0.00	0.08
4	0.00	−0.25	0.00	−0.06	0.06	0.33	0.13	−0.13	0.00	−0.10	−0.19	−0.05
5	0.33	−0.19	0.17	0.24	−0.19	1.00	0.43	−0.14	0.25	−0.11	0.24	0.16
6	0.00	0.13	0.00	0.88	0.00	1.25	0.38	0.13	0.25	−0.50	0.38	0.28
7	0.38	−0.33	0.38	0.40	−0.13	1.00	0.73	−0.40	0.25	−0.14	−0.33	0.12
8	0.00	−0.79	−0.44	0.74	0.00	0.56	1.32	−0.42	0.11	0.20	−1.44	−0.04
9	0.14	−0.83	0.29	0.42	−0.57	0.71	1.00	−0.75	0.00	0.40	−0.92	−0.07

Modal age	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	All readers
10	−0.20	−1.09	−0.40	0.08	−0.38	0.00	1.17	−0.45	−1.00	0.29	−0.64	−0.20
11	–	0.00	–	0.67	−0.33	–	1.00	−0.33	–	−0.33	0.00	–
12	0.00	−5.00	0.00	−0.50	−3.00	0.00	0.00	−4.00	−1.00	0.00	−4.50	−2.06
13	–	−2.00	–	0.00	−1.00	–	3.00	0.00	–	0.00	–	–
14	–	1.00	–	0.00	0.00	–	5.00	−1.00	–	0.00	−1.00	–
15	–	−1.67	–	−0.67	−2.33	–	0.33	−1.33	–	−0.33	−2.00	–
0–15	0.07	−0.31	0.01	0.39	−0.05	0.53	0.53	−0.25	0.12	−0.01	−0.32	**0.06**

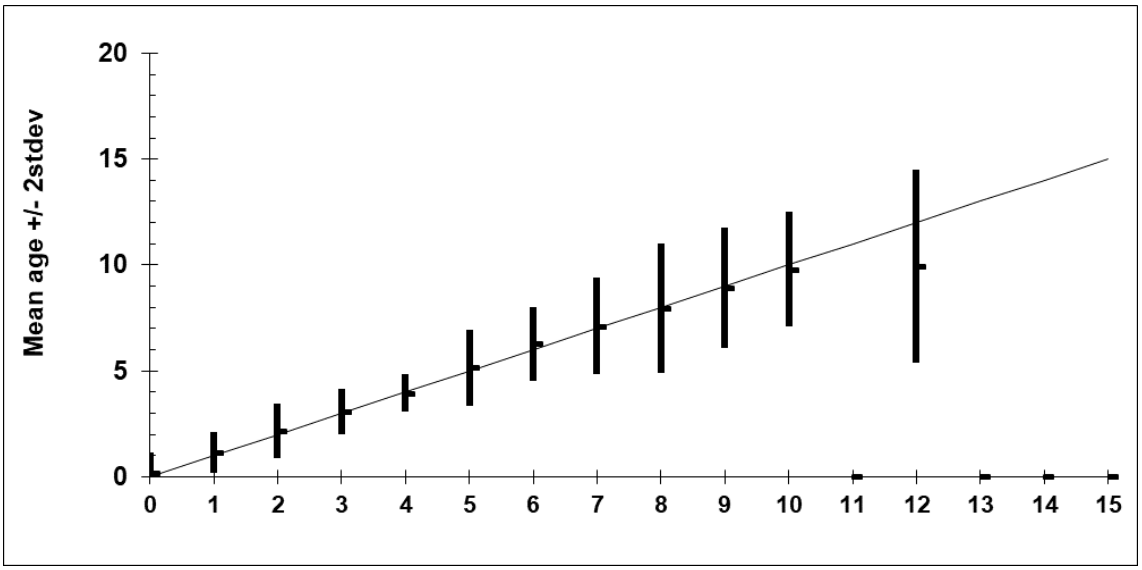


Figure 2.3. Age bias plot for all advanced readers for ple.27.420. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between the estimated mean age and modal age.

2.4 2020 North Sea plaice exchange results summary and conclusions

The results outlined are based on the multistage modal age approach (ICES, 2019). The preliminary results of this exchange, including a comparison of the results from the traditional and the multistage modal age analysis, were presented at WGBIOP 2020 (ICES, 2020) and plans to integrate this approach into the R script , which produces the standardized report template produced by SmartDots agreed. Given that only 7 samples resulted in multiple modal ages in this exchange the difference in the resulting statistics between the two approaches is not described.

Based on all readers and all samples combined the overall CV is 47%, PA is 72% and APE is 27%. The tables in section 2.3.1 show results for each age reader. The CV values at modal ages 0, 1 and 2 are most concerning due to the high overall values (partly attributable to the inclusion of the CVs at modal age 0). Readers' overall CVs are above 20% for all except 3 readers. The PA values for modal ages 0 and 1 are 85% and 90% respectively, falling to 71% at modal age 2, increasing to 81% and 82% at modal ages 3 and 4 before decreasing with an increase in age.

Based on only the advanced readers (those providing age data for stock assessment purposes) and all samples combined, the overall CV of 49% is high (Table 2.28). Modal ages 0, 1 and 2 are most concerning due to the high overall values here. When looking at the individual readers weighted means only 2 of the 9 readers have a CV below 20%. These results can be partly attributable to the inclusion of the CVs at modal age 0 by the script which is resulting in CVs which are higher than 100% for modal age 0. Overall PA is 73% (Table 2.29) and for modal ages 0–4 is above 80% except for modal age 2. Individual reader weighted means are below 70% for 3 of the 9 readers. Overall, individual reader bias (Table 2.13) shows an overall tendency for readers to overestimate the age of the fish compared with modal age at all modal ages from 0–9 except for modal age 4. The age bias plot (Figure 2.2) reflects these values.

The results by area and method (2.4.5, 2.4.6, 2.4.7) show a similar pattern, Skagerrak (27.3.a.20) Whole having a PA of 69% (Table 2.34) and North Sea (27.4) Sectioned and North Sea (27.4) Whole having higher overall PA of 75% (Table 2.44) and 76% (Table 2.39) respectively. Again the calculation of CVs includes modal age 0, leading to high values. The same overall pattern is seen

with modal ages 1 and 2 having the highest CV after modal age 0. Overall relative bias for North Sea (27.4) Sectioned and Skagerrak (27.3.a.20) Whole is positive and ranges from 0.15 to 0.22 thus reflecting the general tendency for readers to overestimate the age compared with modal age. It is the opposite for the North Sea (27.4) Whole otoliths where negative values dominate. Individual reader bias indicates over and/or underestimation compared with modal age so it is important for readers to look at their individual reader weighted means; Sectioned North Sea in Table 2.46 (R14 BE and R16 GB with positive relative bias), Whole North Sea in Table 2.41 (R12 BE and R14 BE with positive relative bias and R04 NL, R06 DK and R18 DK with negative relative bias) and for Whole Skagerrak in Table 2.36 (R12 BE and R14 BE with positive relative bias and R06 DK and R18 DK with negative relative bias).

The results do not necessarily reflect the true levels of agreement and bias. Readers were asked to read all samples independent of the routine ageing method. Readers' expertise (basic or advanced) is based on whether or not their data are used for assessment purposes and in the results in sections 2.3.1 to 2.3.7 their level of expertise by method is not considered. This is, however, considered in the stock level analysis in section 2.4.8.

Stock-level results for ple.27.420 are similar to those above with an overall PA of 73% (Table 2.48) and CV of 32% (Table 2.47). Reader bias is positive overall at 0.06, ranging from 0.08 to 0.28 to modal ages 0 to 7 (except for modal age 4 which is negative) indicating an overestimation of age compared with modal ages (Table 2.49). Individual reader bias ranges from −0.52 to 0.89 with the highest bias values being positive and again indicating an overestimation compared with modal age. In conclusion, also in agreement with WKARP (ICES, 2010), reading sectioned otoliths results in a higher frequency of overestimating age compared with modal age, especially for older fish. An explanation might be that winter rings may not be visible using whole otoliths from older fish, as otoliths later tend to grow vertically instead of horizontally, and also because rings are usually closer to each other in later ages. The overestimation of age from reading sectioned otoliths may then be explained that more rings, especially towards the outer part, are seen in sectioned otoliths compared to whole otoliths, thus arriving at an overestimation (positive bias) compared to modal age. Especially if readers are not normally reading sectioned otoliths, they may also be counting ‘false’ rings as age rings in sectioned otoliths. Conversely, an underestimation (negative bias) using whole otoliths can be explained by that age readers are not seeing or counting all age rings in whole otoliths, especially the outer rings of older fish, thus arriving at an underestimation (negative bias) compared to modal age. A positive or negative overall bias is thus here depending on the composition of whole and/or sectioned otoliths in the samples used, as well as the respective experiences of participating age readers interpreting age from either whole or sectioned otoliths.

3 Review and compare existing methods for age reading of North Sea plaice

ToR b

3.1 Method comparison from the 2020 North Sea and Skagerrak exchange (ID281)

For each sample in the exchange that was collected from the North Sea (27.4.b and c), the readers were provided with an otolith image of a whole otolith and a sectioned otolith. The samples were taken from the same fish although in most cases, not the same otolith. Readers were asked to annotate the image of the otolith prepared using the preparation method which they routinely read. To avoid bias and thus to make a fair comparison of the reading methods only readers who are experienced in a particular method are compared.

Table 3.1. Method comparison age reading results overview

No. Aged	106
No. Agreed	76
No. Disagreed	30
Bias	0.31
CV	0.06
APE	7.91
% Agreed	71.70

From the North Sea Area (27.4), 106 samples were used to test the agreement between the 2 age reading methods which are routinely applied by readers reading for stock assessment purposes (advanced readers). An agreement was reached on 76 of those samples meaning there was disagreement regarding the age of 30 of the samples. The percentage agreement was 71.7%, the APE was 7.91% and the CV was 0.06% (Table 3.1). There was 100% agreement at ages 0 and 1 and 90% at age 2. From ages 3 to 9 the agreement ranged from 75% to 33.3%. The overall bias was positive at 0.31 (Table 3.2) meaning that when there is disagreement in the age of a sample the sectioned method will estimate a higher age compared to the whole method. The error matrix overview (Table 3.3) clearly shows that reading using the sectioned method will result in higher ages, of the 30 fish where there is disagreement there are 22 samples where a higher age is obtained from the sectioned method and 8 samples where a lower age is obtained from the sectioned method. The discrepancy increases with an increase in the age of the fish and age the lower ages (2 and 3) the age obtained from the sectioned method is lower than the whole method whereas from ages 5 and up the age obtained from the sectioned method is higher.

Table 3.2. Method comparison of age reading results by modal age group, using only the ages from readers who are experienced with each method. Red or black values (column "all") indicate negative or positive overall bias, respectively.

Modal age	No. whole	No. sectioned	No. agreed	% agreed	APE (%)	STDEV	CV (%)	Bias
0	10	10	10	100.0	0.0	0.0	0.0	0.0
1	24	25	24	100.0	0.0	0.0	0.0	0.0
2	10	11	9	90.0	5.0	0.3	0.1	-0.1
3	8	6	5	62.5	12.5	0.6	0.1	−0.1
4	8	7	6	75.0	6.3	0.5	0.1	0.0
5	13	10	8	61.5	15.4	1.1	0.1	0.8
6	4	3	2	50.0	8.3	0.8	0.1	0.0
7	12	11	6	50.0	19.0	2.5	0.2	1.3
8	10	8	3	30.0	11.3	0.9	0.1	0.7
9	3	8	1	33.3	14.8	2.1	0.1	0.7
10	3	4	2	66.7	3.3	0.6	0.0	−0.3
11	1	0	0	#N/A	9.1	0.0	0.0	1.0
12	0	2	0	#N/A	#N/A	0.0	#N/A	#N/A
13	0	0	0	#N/A	#N/A	0.0	#N/A	#N/A
14	0	0	0	#N/A	#N/A	0.0	#N/A	#N/A
15	0	0	0	#N/A	#N/A	0.0	#N/A	#N/A
16	0	1	0	#N/A	#N/A	0.0	#N/A	#N/A

Table 3.3. Sectioned vs. whole method comparison matrix. Red shaded area is agreement, blue represents under-ageing by the sectioned method and yellow represents over-ageing by the sectioned method. Only ages from readers who are experienced with each method are used.

	Age sectioned																	
Age Whole	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
0	10																	**10**
1		24																**24**
2		1	9															**10**
3			2	5	1													**8**
4				1	6	1												**8**

Age Whole	Age sectioned 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
5						8	1	3	1									**13**
6						1	2	1										**4**
7								6	3	2							1	**12**
8								1	3	4	2							**10**
9									1	1			1					**3**
10										1	2							**3**
11												0	1					**1**
Total	**10**	**25**	**11**	**6**	**7**	**10**	**3**	**11**	**8**	**8**	**4**		**2**				**1**	**106**

3.2 Method comparison from the 2021 North Sea and Skagerrak workshop exercise (ID 402)

As a follow-up to the previous preparation method comparison (see section 3.1), an exercise was set up using a subset of North Sea samples from the 2020 North Sea and Skagerrak exchange (ID281) plus additional samples from Skagerrak, to make straightforward comparisons of results where different preparation methods had been used. All samples (photos) were taken using reflected light. From each of Skagerrak (27.3.a.20) and the North Sea (27.4.b and c), 50 samples were used. From the North Sea, the samples of whole and sectioned otoliths came from the same fish, but in most cases, not using the same otolith. In total, 17 readers were asked to read all 150 samples. Readers had varying experience in reading different methods. In the results shown below (Table 3.4), experience depending on method used has not been taken into account. Results for 9 advanced readers showed a relatively high agreement (74–76%), similar between areas, where it was highest for the North Sea sectioned otoliths, where the CV was also lowest (14%). Compared with the results from the 2020 plaice age reading exchange (see sections 2.3.2–2.3.4, 2.4.5–2.4.7), the PA was higher and the CV was lower for Skagerrak in the WKARP2 exercise (advanced readers). For the North Sea, PA's of both methods were similar when comparing the 2020 exchange with the WKARP2 2021 exercise, although the CVs were comparatively lower in the WKARP2 2021 exercise. For more detailed results from the WKARP2 exercise, see sections 4.3.2.1–4.3.2.8 and Annex 4.

Table 3.4. Overview of results of the method comparison within WKARP2 2021 where different preparation methods were used.

WKARP2 2021				All readers		Advanced (9)	
Strata	**N samples**	**N readers**	**Modal age range**	**PA (%)**	**CV (%)**	**PA (%)**	**CV (%)**
Skagerrak 27.3.a.20, whole	50	17	0–15	72	19	74	18

WKARP2 2021				All readers		Advanced (9)	
Strata	N samples	N readers	Modal age range	PA (%)	CV (%)	PA (%)	CV (%)
North Sea 27.4, whole	50	17	0–11	73	20	74	20
North Sea 27.4, sectioned	50	17	0–12	70	16	76	14

3.2.1 Comparison of whole, sectioned, and sectioned and stained otoliths

The otoliths included in the event from Skagerrak were prepared using three different preparation methods for each individual; whole with reflected light; sectioned with transmitted light; sectioned and stained with transmitted light (see example in Figure 3.1). Both types of sectioned otoliths from Skagerrak were photographed with transmitted light, as this is how sectioned otoliths from other flatfish are photographed in Denmark. The difference between transmitted light and reflected light, is that the non-growth/translucent rings will appear bright when photographed with transmitted light and the growth/opaque rings will appear dark, and vice versa in the situations of reflected light. The group concluded that plaice otoliths from the North Sea and Skagerrak, both whole and sectioned, should always be photographed with reflected light because most of the group are more familiar with this method, and consistency in the appearance of the growth zones will help to avoid mistakes when age reading plaice. Very few of the 50 otoliths that were stained (by means of soaking in neutral red for 15 minutes) ended up being easy to read and none were easier when compared to the sectioned otoliths. The group concluded that staining sectioned plaice otoliths in neutral red is not worth the effort as this does not improve the interpretation of the age.

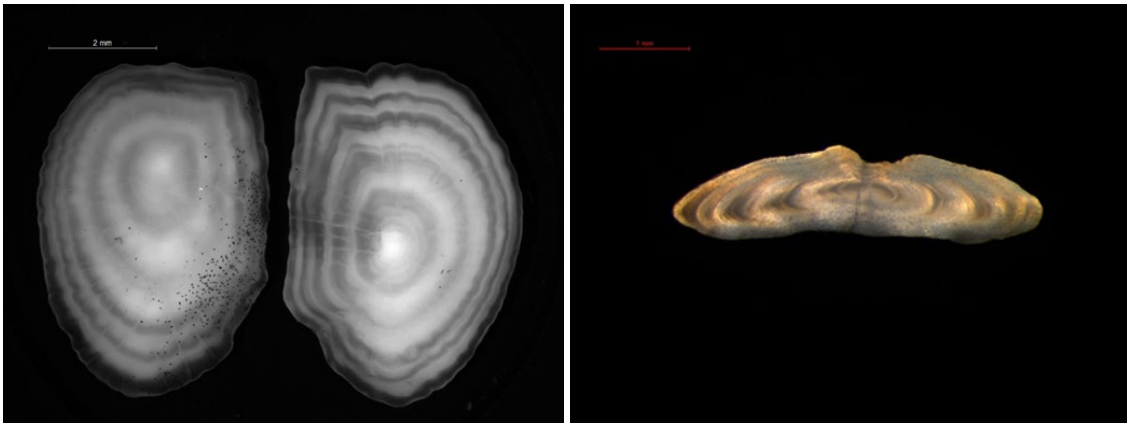


Figure 3.1. Three images of otolith 7517370. The fish was caught 21-03-2017, 28 cm and female. The top left image is of a pair of whole otolith with reflected light. The top right image is the same otolith sectioned and with transmitted light. The bottom left image is the sectioned and stained otolith with transmitted light. The agreed modal age for the whole otolith is 5 years.

In 2018, DTU Aqua performed a test on soaking time of whole plaice otoliths. The aim was to clarify if soaking whole otoliths in water affects the clarity of the rings. 46 otoliths were soaked in water for 0, 2 and 24 hours and then photographed with reflected light (Figure 3.2).

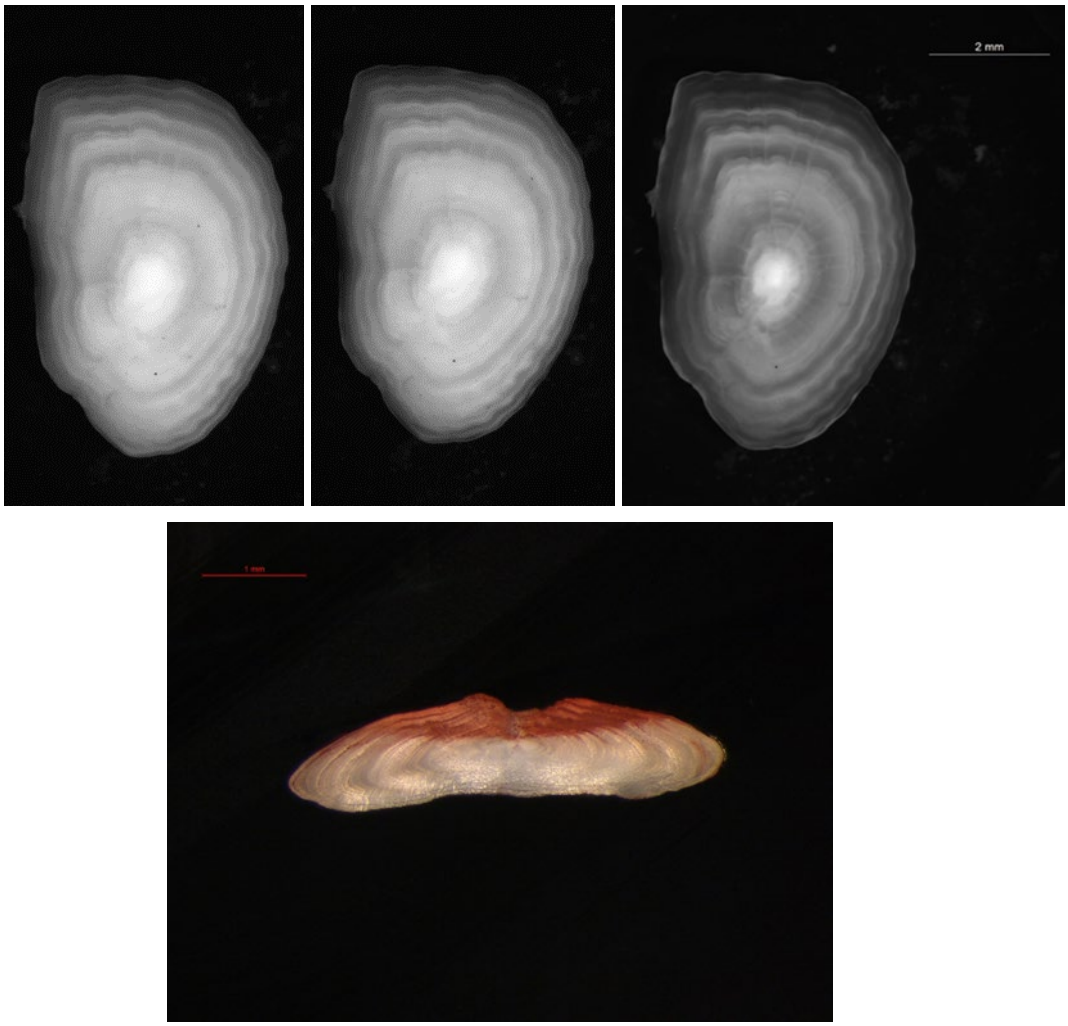


Figure 3.2. Images of the same otoliths, from left to right, after 0 hours, 2 hours and 24 hours in water.

From a purely visual point of view, it was concluded that soaking in water for 2 hours gives a clearer ring structure. There was not very much difference between 0 and 2 hours, but in some cases, the contrast of the outermost rings became a little clearer after 2 hours, and this is desirable. After 24 hours, the otoliths tend to become a lot more transparent, thus contrast is lost and the ring structure becomes fainter making it more difficult to identify the annuli, this is not desirable.

Only larger otoliths were used in this test, therefore further tests on small otoliths from young fish and other soaking periods are desirable. Consideration of the daily routines in the different labs need to be considered when deciding on this.

3.3 Investigations carried out at IMR-Norway on preparation methods for determining the age of North Sea plaice (*Pleuronectes platessa*)

The Institution of Marine Research (IMR) in Norway are sampling plaice from the International Bottom Trawl Surveys (IBTS) in ICES Area 4a. In 2018 all Member Countries of the IBTS Working Group (IBTSWG) were asked to include age readings in the sampling of the plaice. Norway has not previously aged plaice and therefore did an investigation of the methods applied in other laboratories, to determine which method gave the highest precision (PA) and lowest APE and CV.

Seven methods were tested on 144 otoliths from IBTS and the coast of Norway, the latter including larger specimens. The otoliths were divided into length groups of 5 cm to evenly distribute the length range within the methods. The first 4 methods applied sectioned otoliths; untreated, burnt, and stained with Neutral Red (N. Red) and Toluidine Blue (T. Blue). The other three methods applied the whole otolith immersed in milli Q-water, 10% glycerol and T. Blue. All otoliths were read three times by readers that were inexperienced in reading both flatfish and sectioned otoliths. The PA, APE, and CV were calculated and analysed for each method.

Whole otoliths stained in T. Blue were considered unreadable and excluded from further analyses. When examining the results for all ages within the methods, the sectioned otoliths had the highest PA, though below the ICES standards. However, when looking at the individual ages the reading of the whole otoliths had the highest PA when the individuals were 6 years (approximately ~< 40 cm) or younger. Since most of the catch of plaice from IBTS is smaller than 40 cm we decided to from now on read the whole otoliths in milli Q-water as the main method, and read the older ones sectioned. The results of the staining varied; it seems to make some easy-to-read otoliths clearer, but others got much more difficult to read. Thus, we decided to not continue with the staining procedures.

4 Review information on age estimations, otolith exchanges, workshops, and validation work so far

ToR c

4.1 2010 Workshop on age reading of North Sea (IV) and Skagerrak–Kattegat (IIIa) plaice (WKARP)

The workshop on age reading of North Sea (IV) and Skagerrak–Kattegat (IIIa) plaice (WKARP) took place in 2010 to; review information on age estimations, otolith exchanges, workshops and validation work done; use WebGR for image annotations and data analyses and to address the generic ToRs adopted for workshops on age calibration. Nine countries and 20 readers participated in the exchange with 14 readers participating in the workshop. The exchange and workshop otolith sets consisted of samples from IIIa and IV (Table 4.1) with readers representing a broader geographical range (III, IV, VI and VII stocks). As participating laboratories were routinely reading using whole otoliths and transverse sections for plaice ageing both preparation methods were included in the exchange and workshop sets.

Concerning reader agreement, Table 4.2 gives the results of the exchange sets. The agreement reached was higher and variance (APE and CV) lower for experienced readers compared to all readers, for each area and method. Agreement was higher and variance lower for otoliths from IV compared to from IIIa, this indicated that the otoliths from IV are easier to age than those from IIIa. In all cases, the statistics were better for whole otoliths than for sectioned otoliths, except for experienced readers reading IV otoliths.

In 2010 there were no formal definitions for age readers' expertise and no criteria needed to be met to be “experienced”. With the development of SmartDots and in line with producing results from calibration exercises that can be directly used for stock assessment purposes, two definitions for readers' expertise have been defined; basic = readers who do not provide age data for stock assessment purposes and advanced = readers who do provide age data for stock assessment purposes.

Table 4.1. Otolith included in the 2010 exchange (taken from WKARP report, ICES 2010).

ICES area	age range	Sections	Whole
IV	0-10	112	112
IIIa	0-10	92	96
IIIa + IV	11+	14	14

Table 4.2. Results of WKARP 2010 exchange sets (taken from WKARP report, ICES 2010).

	ICES area IV		ICES area IIIa	
	sections	whole	sections	whole
Number of readers	14	16	14	16
Agreement (%)	77%	81%	64%	70%
CV (%)	12%	10%	15%	12%
APE (%)	8%	7%	10%	9%
Number of experienced readers	5	8	5	8
Agreement experienced readers (%)	88%	84%	73%	76%
CV experienced readers (%)	5%	8%	12%	7%
APE experienced readers (%)	4%	6%	9%	6%

Discussions at the workshop revealed differences between laboratories in reading techniques applied and the interpretation methods being followed; some readers were counting opaque zones while others counted translucent zones; different light sources (transmitted vs. reflected) were being used which leads to differences in the colour of the growth and non-growth zones.

When determining age, the number of rings counted deviates from the number of rings visible in certain periods of the year. This depends on whether opaque or translucent rings are counted. It furthermore depends on regional differences in the timing of opaque/translucent deposition at the edge of the otolith. How to interpret age depending on quarter and area was discussed, e.g. in the light of previous studies of edge formation (Bolle and Rijnsdorp, 2000; Bolle *et al*., 2004). General patterns regarding opaque or translucent edges in different areas and quarters were then included in the ageing manual (ICES 2010; see also section 4.3 in this report).

Discussions during the 2010 workshop revealed that differences in agreement were often due to whether or not a regular growth pattern can be expected (where annulus width decreases with age), this being closely linked to the interpretation of the 1st winter ring, and whether or not a narrow and faint winter ring close to the nucleus should be counted. It was concluded that a validation study was required to answer questions related to the latter.

Regarding methods applied, the workshop from 2003 recommended using sectioned otoliths, especially for older fish. As several laboratories were not using sectioned otoliths, the method issue was readdressed at the 2010 workshop and preceding exchange. For the North Sea (Area 4), whole otoliths showed a higher agreement (82%) compared to sectioned (75%) for experienced readers. An explanation for this may be that whole otoliths were considered easier to read by participants having little to no experience with sectioned otoliths. For Kattegat-Skagerrak (Area 3.a) the agreement of experienced readers was the same (76%) for both methods. A small sample of 10+ otoliths used for comparing whole and sectioned otoliths showed no significant bias related to preparation method below the age of 10 years but indicated an underestimation of age in whole otoliths compared to sectioned otoliths. It was concluded that a larger sample set would be required for a more thorough evaluation.

Several relevant follow-up actions and recommendations came for WKARP (ICES, 2010). First, the maintenance, dissemination and further development of the age reading manual. WKARP2 updated both the general age reading guidelines and the age reading manual (specific to ple.27.420.) in plenary, see sections 5.1 and 5.2 respectively. Important to note in the guidelines are the updates related to quality control and in line with the use of SmartDots; definitions of age readers' expertise, opaque and translucent zones, the use of the standardized AQ codes and image capture techniques. SmartDots facilitates the publication of reports from age reading exchanges and workshops, meaning the reports (including guidelines and manuals) are publicly accessible for dissemination. WKARP emphasized the need for validation studies, especially concerning the formation of the first annulus. A coordinated effort to investigate the possibilities for validation was proposed but given the difficulties in funding these studies, this did not result in any thorough work being finalized. It was subsequently recommended by PGCCDBS 2012 that no further workshops be carried out before validation studies had been conducted. The efforts to carry out validation studies continues and the acknowledgement that resource availability still prevails. WGBIOP outlines and annually updates Generic ToRs and outcomes for ageing workshops[5], specifically ToR e) Validation studies on age estimations, asks for a review of studies and for follow-up actions to be formulated. WKARP2 ToR c reviews recent validation studies carried out for North Sea plaice. WKARP also recommended the compilation of agreed age reference collections to be initiated at a 2013 workshop, this workshop did not happen. WKARP2

[5] https://www.ices.dk/community/Pages/PGCCDBS-doc-repository.aspx#gui

will work together with WGSMART[6] (The ICES Working Group on SmartDots Governance) and WGBIOP[7] (ICES Working Group on Biological Parameters) to progress with the reference collection). Also proposed for the 2013 workshop was a comparison of age readings from whole and sectioned otoliths containing 50 fish from both the North Sea (4) and Kattegat-Skagerrak (3.a) as concerns were raised at the workshop about possible overestimation of age in older fish when reading whole otoliths due to an increase of the 'cliff edge' effect. This issue has been addressed by WKARP2. Finally, the need for age reading workshops to be held at regular (3–5 year) intervals with active participation from all laboratories contributing to age estimates for stock assessments was recommended. These workshops and exchanges should combine different stocks. No workshops have been held since WKARP in 2010, unfortunately. With the initiation of WGBIOP and the development of SmartDots planning and organising calibration events has been made easier. The realization that the incorporation of the results from these exercises can facilitate the quality assurance of data provided for stock assessment purposes requires that SmartDots events are carried out by stock. WGBIOP thus initiated a plan for a 2020 North Sea plaice exchange to be followed by a 2021 workshop. This is the first time that otoliths collected from the North Sea (27.4) and Skagerrak (27.3.a) are considered to belong to a single-stock unit, ple.27.420. The WKPLE benchmark (ICES, 2015) decided that plaice in the Skagerrak would be assessed together with the North Sea stock.

4.2 2020 North Sea and Skagerrak plaice exchange (SmartDots ID 281)

Table 4.3. Overview of results from the 2020 North Sea and Skagerrak Plaice exchange (SmartDots ID 281).

Strata	N samples	N readers	Modal age range	Comparison	PA%	CV%
Skagerrak 27.3.a.20	90	14 (7 advanced)	0–14	All readers	66%	43%
				Advanced readers	69%	55%
North Sea 27.4.b and c	106	14 (7 advanced)	0–11	All readers	75%	50%
				Advanced readers	76%	46%
North Sea 27.4.b and c	106	7 (6 advanced)	0–16	All readers	75%	38%
				Advanced readers	75%	38%
Stock level ple.27.420	196	11 (9 advanced)	0–16	Advanced readers	72%	32%

Definitions for readers' expertise are defined as: advanced = readers who do provide age data for stock assessment purposes; basic = readers who do not provide age data for stock assessment purposes.

See section 2.4 for a summary of the main results and conclusions from the 2020 North Sea and Skagerrak Plaice exchange (SmartDots ID 281).

[6] https://www.ices.dk/community/groups/Pages/WGSMART.aspx.

[7] https://www.ices.dk/community/groups/Pages/WGBIOP.aspx.

4.3 2021 North Sea and Skagerrak plaice workshop WKARP2

4.3.1 Preparations for the 2021 WKARP2

WKARP 2010 recommended that, in order to solve the issues related to the identification of the first winter ring, a validation study should be carried out. The studies which have been carried out to date were presented at the workshop and summaries can be found in section 4.3.1. Most relevant to the North Sea plaice stock is the study carried out on Eastern North Sea plaice which identified a check, visible in a collection of otoliths from a local population which was often misinterpreted as the first winter ring and leading to subsequent overestimation of age. As part of the work of WKARP2 investigations into the first winter ring formation in otoliths of fish resident in the greater North Sea and Skagerrak area were undertaken. The aim being to attempt to resolve issues with the identification of the first winter ring by providing measurement guidelines for application when age reading. Participating laboratories were asked to provide images of whole otoliths from the 2020 year class (age 0 fish in 2020 or age 1 in 2021). The initial aim was to have 10–15 otoliths per month per ICES Area. Images were provided by the UK, SCOT, FRA, GER, BEL, SWE and DK but as collections of these young fish are mostly only available from surveys or discard sampling the number of available images was limited. A total of 384 images of whole otoliths (Table 4.4), taken with reflected light were collected.

Table 4.4. Overview of samples collected for the first winter ring formation study.

		3a		4a		4b		4c		Total
Year	Month	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1	
2020										
	1						8		19	**27**
	5						10			**10**
	6					13				**13**
	7					32				**32**
	8	2			1	3	2	6	39	**53**
	9	4				15	8	36		**63**
	10					8				**8**
	11					5				**5**
	12					22	2			**24**
2021										
	1		5				1		16	**22**
	2						1		3	**4**
	5						10			**10**

		3a		4a		4b		4c		Total
Year	Month	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1	Age 0	Age 1	
	7						1	5	23	**29**
	8		14			19	33			**66**
	9		14			1	3			**18**
Total		**6**	**33**		**1**	**118**	**79**	**47**	**100**	**384**

For each image (example shown in Figure 4.2) it was noted whether it was the symmetrical or asymmetrical otolith, the edge type (opaque or translucent) and a measurement taken of the diameter at the widest part of the otolith. This was carried out by one of the workshop coordinators so a comparison of edge-type definitions between readers is not possible. When screening the images and data it became apparent that for quite a larger part of the samples the image quality was poor and that scale bars on the images had not been calibrated correctly. Both of these issues meant that it was not possible to take reliable measurements from these otoliths and poor image quality means correct identification of otolith edge type is unreliable. Some general observations could however be made, namely, otolith size at age 0 did not appear to differ between 2019 and 2020, nor did otolith size at age 1 and the end of the year the otolith diameter for the age 0 fish was between 2.5 and 3.5 mm. The examination of the otolith edge type showed little consistency between years for the age 1 fish, and for the age 0 fish, it appeared that almost all had a translucent edge for samples caught between June and December (Figure 4.1). Discussions during the workshop revealed that some of these samples had most likely been soaked in water overnight and that this could have altered the true appearance of the otolith, making them appear more translucent than in reality.

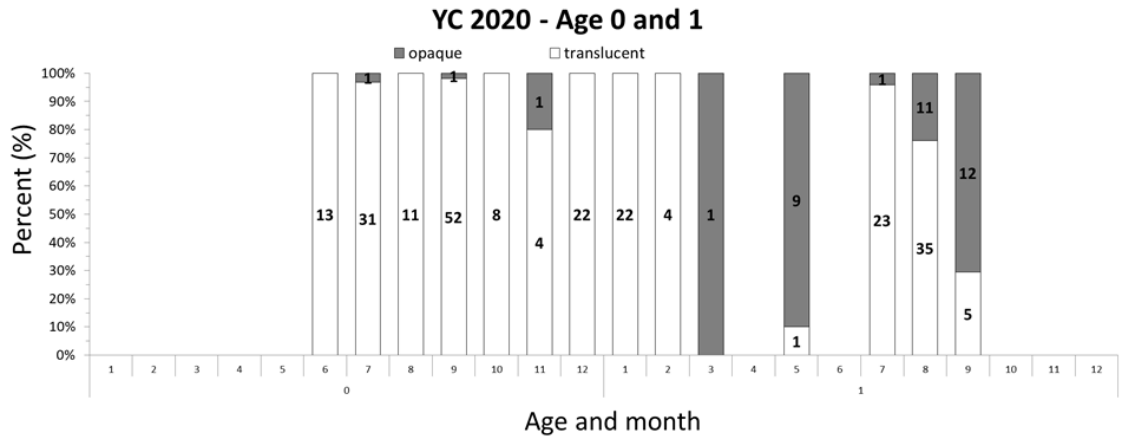


Figure 4.1. Percentage of edge type (opaque or translucent) per month for the 2020 year class (n = 268). Number of otolith images examined are shown in the bars on the plot.

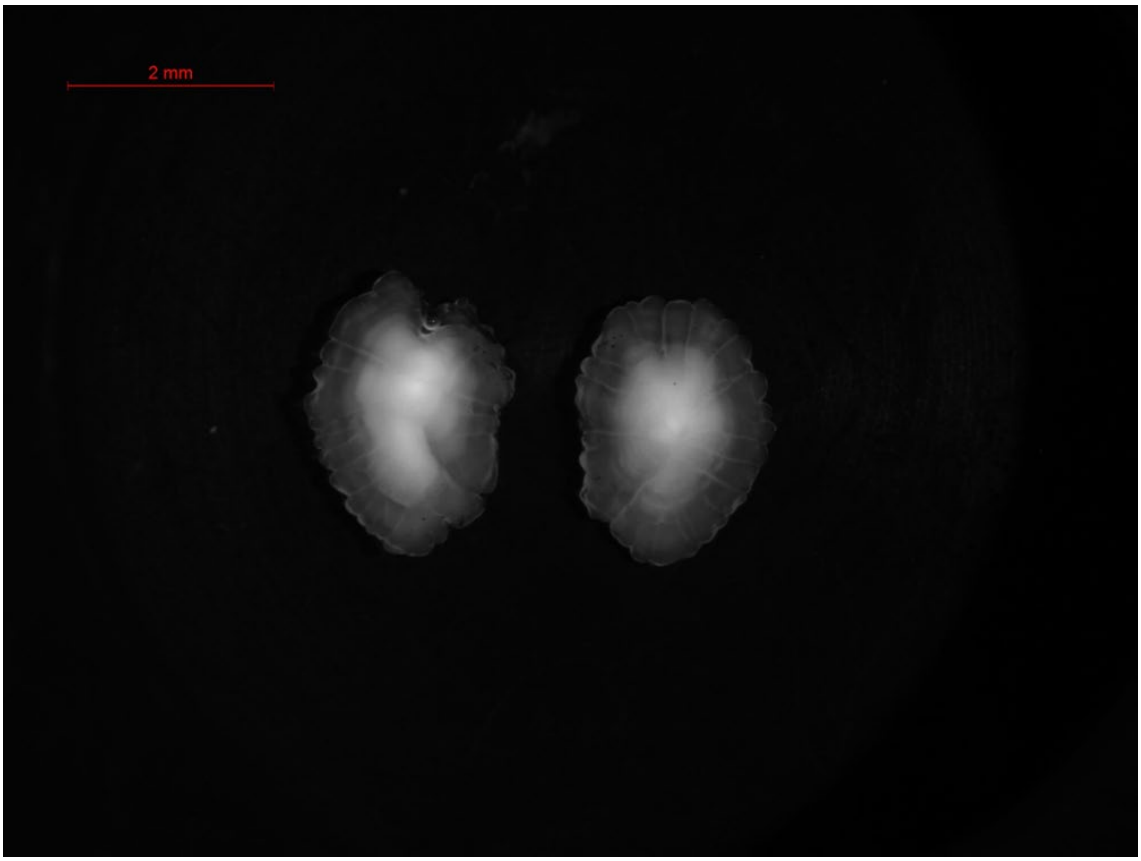


Figure 4.2. Sample 8176569, fish length 11 cm, age 0, catch month August 2020 from Area 4.b, edge type is translucent.

The results were presented and discussed in plenary and the group concluded that given the issues with the image quality and calibration, in addition to the poor temporal and spatial distribution of the available samples that no solid guidelines on otolith diameter at the end of the first year of growth could be added to the age reading manual. The sample set could however be expanded upon but the images would need to be retaken. WKARP2 will make a recommendation to WGBIOP to organize a tutorial/workshop on otolith image capture techniques which should include, as a minimum, sessions on measurement calibration, correct light techniques and image standardization.

One previous example investigated the timing of appearing opaque zones in plaice otoliths from the eastern English Channel (Area 7.d) and the North Sea (Area 4.b) (Bolle and Rijnsdorp, 2000; Bolle *et al*., 2004). The seasonality in the formation of translucent and opaque edge zones in the North Sea and eastern English Channel plaice was compared, where an opaque zone occurred earlier in the eastern English Channel compared to further north, i.e. the North Sea (Figure 6.6.1; Bolle and Rijnsdorp, 2000).

During the 2020 North Sea and Skagerrak Plaice exchange (SmartDots ID 281), the edge of the otolith was noted by age readers, and the results are shown in Figure 4.3. Results from the exchange were discussed during WKARP2, where it was apparent that the differences between areas in which the opaque ring appeared were not as clear as in the example from the previous WKARP (ICES, 2010). Explanations for this are that the number of samples was far less in the exchange compared to the study by Bolle and Rijnsdorp (2000), where > 4500 sectioned otoliths were analysed by one experienced reader compared with a number of readers with different experience participating in the exchange in 2020. Furthermore, the differences may be larger comparing the eastern English Channel (Area 7.d) and the North Sea (Area 4.b) (ICES, 2010), as opposed to comparing Skagerrak, North Sea Area 4.b, and North Sea 4.c (Figure 4.3).

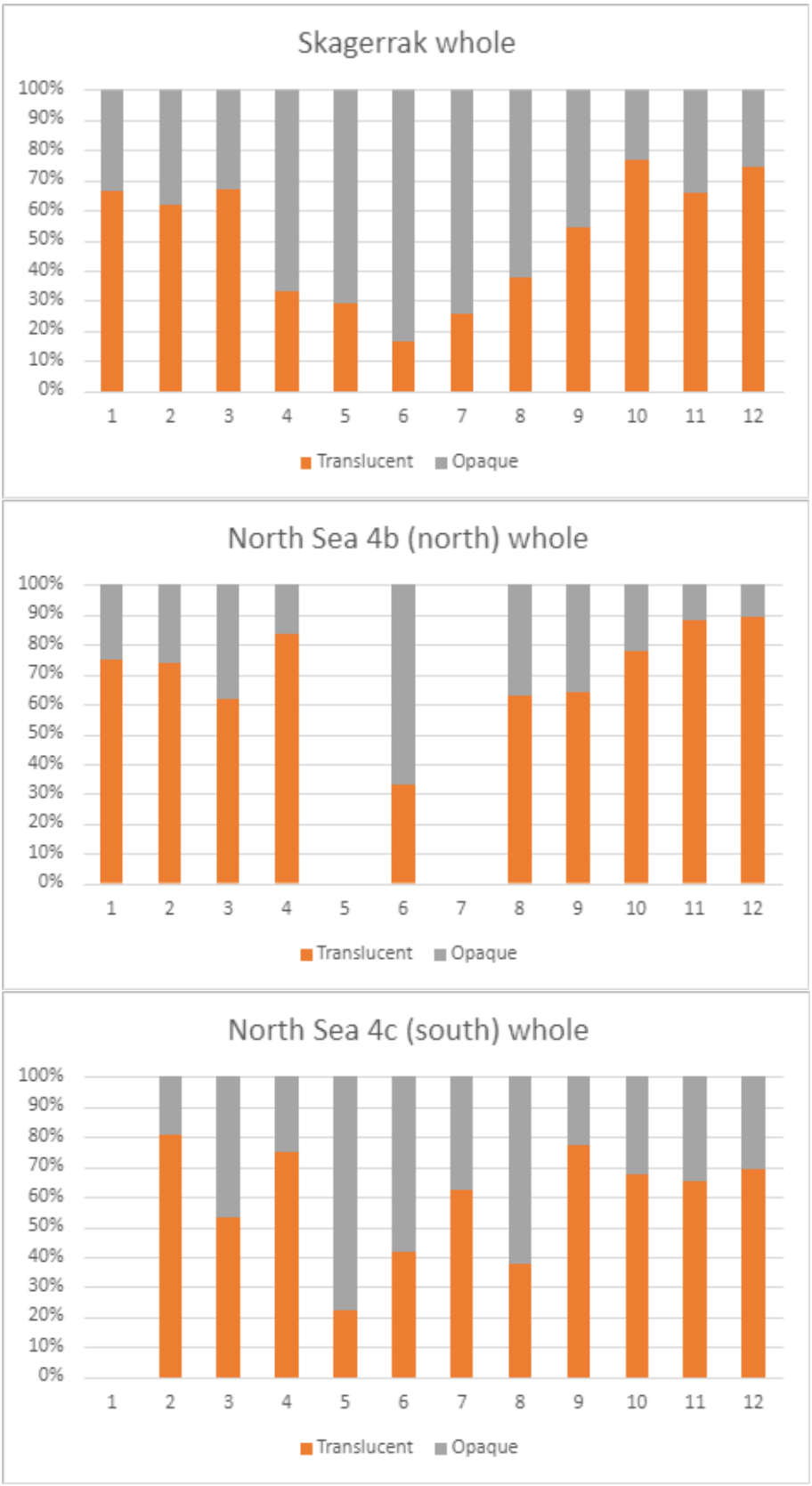


Figure 4.3. Proportion translucent/opaque otolith edges by month for plaice otoliths from Skagerrak Area 27.3.a.20 (top panel), North Sea Area 27.4.b (middle panel), and North Sea Area 27.4.c (bottom panel). Results from age readers noting translucent/opaque edge in the North Sea and Skagerrak otolith exchange 2020 (SmartDots ID 281).

4.3.2 North Sea and Skagerrak plaice workshop exercise (ID 402)

During the WKARP2 an exercise was made available on SmartDots (ID 402 – 2021 North Sea and Skagerrak Plaice) for the readers complete. The total image set comprised 250 images (Table 4.5): 50 samples from the Skagerrak (27.3.a.20) with 3 preparation methods for each sample (whole/reflected light, sectioned/transmitted light and sectioned and stained/transmitted light), and 50 samples from the North Sea (27.4.b and 27.4.c) with two preparation methods for each sample (whole/reflected light and sectioned/reflected light).

Readers were instructed to begin with the area and method routinely read by them but to try to annotate all 250 images. A short SmartDots tutorial was given instructing readers on how to filter the samples by area, preparation method and light, using the following abbreviations in the image names:

- ALA = whole
- SEX = sectioned
- SSX = sectioned, stained
- RLX = reflected light
- TRL = transmitted light

The analysis applied is the same as described in section 2.1 and the results produced are generated by the SmartDots R script which provides a standardized report template as an output. These results are based on the traditional modal age approach as the SmartDots R script has yet to be updated with the multistage modal age approach The results of the exercise are provided in the following sections.

See section 3.2. for a comparison of results between age reading methods from the 2021 workshop exercise and the 2020 exchange.

Table 4.5. Overview of samples used for the 2021 North Sea and Skagerrak plaice workshop exercise (ID 402).

Year	ICES Area	Quarter	Number of samples	Modal age range	Length range
2015	27.3.a.20	1	1	8	350 mm
2016	27.3.a.20	2	1	1	170 mm
2016	27.4.b	4	2	0	160–170 mm
2017	27.3.a.20	1	6	4–7	200–340 mm
2017	27.3.a.20	3	17	3–15	280–450 mm
2017	27.3.a.20	4	2	3–5	280–340 mm
2017	27.4.c	2	1	1	95 mm
2018	27.3.a.20	1	10	2–8	150–340 mm
2018	27.3.a.20	2	4	2–4	160–240 mm
2018	27.3.a.20	3	3	1–4	140–260 mm
2018	27.3.a.20	4	4	1–3	220–250 mm
2018	27.4.c	2	3	1–5	190–260 mm

Year	ICES Area	Quarter	Number of samples	Modal age range	Length range
2019	27.3.a.20	1	1	11	390 mm
2019	27.3.a.20	2	1	9	400 mm
2019	27.4.b	1	2	10–12	315–435 mm
2019	27.4.b	2	4	7–11	305–460 mm
2019	27.4.b	3	8	1–9	135–375 mm
2019	27.4.b	4	9	1–5	150–390 mm
2019	27.4.c	1	2	8–9	285–410 mm
2019	27.4.c	2	4	6–7	285–390 mm
2019	27.4.c	3	8	0–10	85–445 mm
2019	27.4.c	4	7	6–9	300–450 mm

Table 4.6. Reader overview for the 2021 North Sea and Skagerrak plaice workshop exercise (ID 402).

Reader code	Expertise
R02 SE	Advanced
R04 NL	Advanced
R06 DK	Advanced
R08 SE	Advanced
R10 NL	Advanced
R12 BE	Advanced
R14 BE	Advanced
R18 DK	Advanced
R20 NO	Basic
R28 GB-SCT	Advanced
R30 DE	Basic
R32 DK	Basic
R34 NO	Basic
R36 FR	Basic
R38 SE	Basic
R42 NO	Basic

4.3.2.1 Results: all readers – North Sea and Skagerrak – whole otoliths

The weighted average percentage agreement based on modal ages for all readers is 73%, with the weighted average CV of 20% and APE of 12%.

Table 4.7. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
1	28%	33%	68%	34%	0%	0%	28%	0%	0%	33%	29%	29%	30%	28%	34%	62%	37%	**37%**
2	29%	45%	16%	28%	16%	35%	32%	22%	41%	25%	36%	16%	29%	14%	33%	20%	26%	**30%**
3	19%	45%	32%	53%	0%	11%	43%	21%	16%	0%	35%	0%	35%	0%	12%	16%	26%	**32%**
4	9%	20%	13%	9%	27%	11%	19%	17%	15%	13%	18%	17%	50%	9%	23%	20%	9%	**19%**
5	9%	32%	15%	5%	15%	0%	7%	5%	17%	7%	0%	17%	13%	12%	12%	15%	11%	**13%**
6	8%	0%	8%	12%	8%	7%	7%	10%	0%	10%	8%	16%	14%	0%	0%	0%	8%	**9%**
7	0%	12%	8%	10%	0%	7%	9%	5%	10%	6%	7%	0%	12%	5%	12%	0%	11%	**8%**
8	14%	12%	16%	12%	10%	7%	9%	36%	17%	15%	12%	18%	34%	4%	17%	12%	21%	**18%**
9	9%	14%	8%	15%	23%	7%	26%	18%	4%	21%	8%	18%	12%	7%	24%	6%	17%	**17%**
10	5%	5%	8%	5%	5%	0%	9%	5%	0%	5%	5%	5%	5%	5%	0%	7%	16%	**7%**
11	7%	0%	53%	6%	0%	6%	12%	22%	-	-	0%	7%	16%	14%	0%	-	35%	**17%**
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**6%**
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**31%**
Weighted mean	**14%**	**24%**	**22%**	**19%**	**11%**	**9%**	**19%**	**15%**	**14%**	**14%**	**16%**	**14%**	**24%**	**10%**	**18%**	**21%**	**19%**	**20%**

Table 4.8. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
0	75%	100%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%	75%	100%	100%	100%	50%	**92%**
1	91%	91%	82%	82%	100%	100%	91%	100%	100%	86%	90%	90%	89%	91%	82%	64%	73%	**88%**
2	60%	82%	91%	82%	91%	64%	64%	82%	73%	67%	60%	91%	80%	91%	73%	78%	73%	**77%**
3	67%	78%	56%	67%	100%	89%	67%	89%	78%	100%	56%	100%	62%	100%	89%	80%	78%	**79%**
4	88%	75%	75%	88%	75%	75%	50%	50%	38%	75%	71%	62%	67%	88%	62%	50%	88%	**69%**
5	77%	79%	71%	93%	86%	100%	86%	93%	77%	89%	100%	79%	57%	86%	86%	73%	71%	**82%**
6	80%	100%	80%	60%	80%	80%	80%	60%	0%	40%	80%	40%	50%	100%	100%	100%	80%	**71%**
7	100%	62%	62%	57%	100%	75%	62%	88%	25%	83%	71%	100%	62%	88%	38%	100%	75%	**73%**
8	46%	77%	33%	54%	62%	62%	67%	15%	54%	58%	67%	54%	64%	92%	46%	67%	42%	**56%**
9	75%	56%	44%	56%	44%	67%	33%	67%	86%	62%	50%	33%	78%	67%	44%	60%	56%	**57%**
10	75%	75%	50%	75%	75%	100%	50%	75%	100%	75%	50%	50%	75%	75%	100%	50%	75%	**73%**
11	0%	100%	50%	50%	0%	50%	50%	50%	100%	0%	100%	50%	0%	50%	100%	0%	0%	**45%**
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
13	100%	0%	100%	0%	0%	100%	0%	100%	100%	100%	0%	0%	100%	0%	0%	-	0%	**44%**
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
15	0%	100%	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	100%	100%	100%	-	0%	**44%**
Wghtd. mean	**72%**	**78%**	**66%**	**72%**	**80%**	**81%**	**67%**	**72%**	**67%**	**71%**	**72%**	**72%**	**68%**	**87%**	**71%**	**71%**	**66%**	**73%**

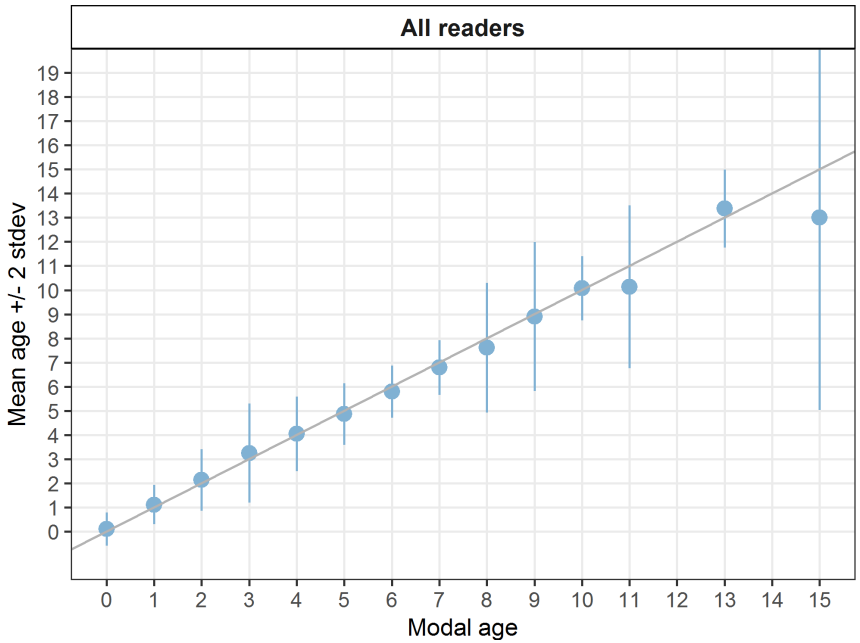


Figure 4.4. Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4.

4.3.2.2 Results: all readers – Skagerrak – whole otoliths

The weighted average percentage agreement based on modal ages for all readers is 72%, with the weighted average CV of 19% and APE of 12%.

Table 4.9. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
1	40%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	0%	0%	40%	0%	40%	40%	**23%**
2	22%	33%	20%	18%	20%	32%	31%	20%	20%	-	31%	20%	32%	18%	35%	22%	0%	**28%**
3	15%	48%	33%	53%	0%	12%	46%	23%	0%	0%	31%	0%	33%	0%	0%	0%	27%	**33%**
4	0%	19%	10%	10%	22%	10%	17%	12%	16%	20%	19%	11%	12%	10%	24%	12%	10%	**15%**
5	9%	14%	16%	6%	18%	0%	8%	0%	19%	8%	0%	20%	14%	14%	14%	17%	12%	**13%**
6	0%	0%	0%	0%	0%	0%	11%	13%	0%	13%	13%	16%	-	0%	0%	-	13%	**10%**
7	0%	17%	9%	9%	0%	9%	8%	9%	17%	-	9%	0%	17%	9%	14%	0%	18%	**11%**
8	18%	0%	28%	8%	8%	9%	8%	0%	20%	-	28%	0%	0%	0%	0%	20%	33%	**15%**
9	6%	15%	7%	16%	30%	9%	28%	12%	7%	22%	9%	28%	6%	6%	26%	-	21%	**21%**
10	7%	7%	7%	7%	7%	0%	6%	7%	0%	7%	7%	7%	0%	7%	0%	-	25%	**8%**
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**6%**
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**6%**
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**31%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
Weighted mean	**12%**	**20%**	**15%**	**16%**	**13%**	**10%**	**19%**	**10%**	**12%**	**11%**	**15%**	**12%**	**17%**	**12%**	**14%**	**17%**	**17%**	**19%**

Table 4.10. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
1	75%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	75%	100%	75%	75%	**94%**
2	67%	86%	86%	86%	86%	71%	57%	86%	86%	-	50%	86%	71%	86%	57%	67%	100%	**77%**
3	71%	71%	57%	57%	100%	86%	57%	86%	100%	100%	57%	100%	67%	100%	100%	100%	71%	**80%**
4	100%	83%	83%	83%	83%	83%	50%	67%	50%	50%	67%	83%	75%	83%	67%	75%	83%	**76%**
5	78%	80%	70%	90%	80%	100%	80%	100%	70%	86%	100%	70%	50%	80%	80%	71%	70%	**80%**
6	100%	100%	100%	100%	100%	100%	50%	50%	0%	50%	50%	0%	100%	100%	100%	-	50%	**71%**
7	100%	33%	67%	33%	100%	67%	67%	67%	33%	100%	67%	100%	33%	67%	33%	100%	67%	**65%**
8	0%	100%	0%	50%	50%	50%	50%	0%	50%	100%	0%	100%	0%	100%	100%	50%	50%	**48%**
9	75%	75%	50%	50%	50%	50%	0%	50%	67%	67%	50%	25%	75%	75%	50%	0%	25%	**51%**
10	50%	50%	50%	50%	50%	100%	0%	50%	100%	50%	50%	50%	100%	50%	100%	-	50%	**59%**
11	0%	100%	100%	0%	0%	0%	100%	100%	100%	-	100%	100%	0%	100%	100%	0%	0%	**56%**
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
13	100%	0%	100%	0%	0%	100%	0%	100%	100%	100%	0%	0%	100%	0%	0%	-	0%	**44%**
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
15	0%	100%	0%	0%	100%	100%	0%	0%	0%	100%	0%	0%	100%	100%	100%	-	0%	**44%**
Weighted mean	**73%**	**78%**	**70%**	**70%**	**80%**	**82%**	**56%**	**76%**	**71%**	**78%**	**65%**	**74%**	**64%**	**82%**	**76%**	**71%**	**66%**	**72%**

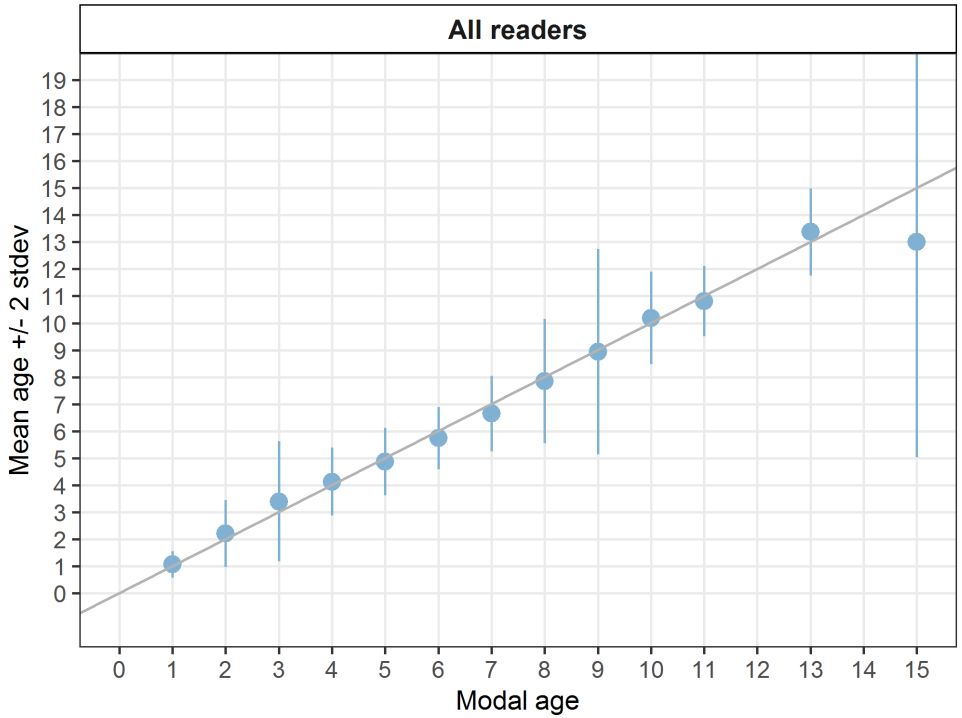


Figure 4.5. Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4.

4.3.2.3 Results: all readers – North Sea – whole otoliths

The weighted average percentage agreement based on modal ages for all readers is 73%, with the weighted average CV of 20% and APE of 12%.

Table 4.11. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	0%	44%	72%	38%	0%	0%	33%	0%	0%	35%	33%	35%	35%	0%	38%	74%	38%	**42%**
2	41%	67%	0%	40%	0%	41%	40%	22%	77%	25%	29%	0%	0%	0%	0%	0%	43%	**32%**
3	28%	0%	28%	0%	0%	0%	0%	0%	0%	0%	28%	0%	28%	0%	28%	-	0%	**16%**
4	20%	20%	20%	0%	28%	16%	28%	35%	0%	0%	-	35%	-	0%	20%	0%	0%	**28%**
5	11%	67%	11%	0%	0%	0%	0%	11%	0%	0%	0%	0%	11%	0%	0%	11%	10%	**14%**
6	10%	0%	10%	17%	10%	9%	0%	10%	0%	11%	0%	10%	17%	0%	0%	0%	0%	**9%**
7	10%	7%	8%	7%	0%	7%	10%	0%	7%	7%	7%	0%	7%	0%	12%	0%	7%	**7%**
8	14%	13%	15%	13%	10%	6%	10%	37%	17%	15%	9%	19%	38%	4%	18%	10%	20%	**18%**
9	12%	14%	10%	8%	20%	5%	9%	18%	0%	23%	9%	10%	16%	8%	25%	5%	10%	**14%**
10	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	7%	7%	7%	0%	0%	7%	0%	**4%**
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**23%**
Weighted mean	**12%**	**25%**	**21%**	**16%**	**7%**	**8%**	**15%**	**16%**	**12%**	**15%**	**14%**	**13%**	**21%**	**2%**	**17%**	**19%**	**17%**	**20%**

Table 4.12. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	All
0	75%	100%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%	75%	100%	100%	100%	50%	**92%**
1	100%	86%	71%	71%	100%	100%	86%	100%	100%	83%	86%	83%	83%	100%	71%	57%	71%	**85%**
2	50%	75%	100%	75%	100%	50%	75%	75%	50%	67%	75%	100%	100%	100%	100%	100%	25%	**77%**
3	50%	100%	50%	100%	100%	100%	100%	100%	0%	100%	50%	100%	50%	100%	50%	0%	100%	**76%**
4	50%	50%	50%	100%	50%	50%	50%	0%	0%	100%	100%	0%	50%	100%	50%	0%	100%	**52%**
5	75%	75%	75%	100%	100%	100%	100%	75%	100%	100%	100%	100%	75%	100%	100%	75%	75%	**89%**
6	67%	100%	67%	33%	67%	67%	100%	67%	0%	33%	100%	67%	33%	100%	100%	100%	100%	**71%**
7	100%	80%	60%	75%	100%	80%	60%	100%	20%	80%	75%	100%	80%	100%	40%	100%	80%	**78%**
8	55%	73%	40%	55%	64%	64%	70%	18%	55%	55%	80%	45%	78%	91%	36%	71%	40%	**58%**
9	75%	40%	40%	60%	40%	80%	60%	80%	100%	60%	50%	40%	80%	60%	40%	75%	80%	**62%**
10	100%	100%	50%	100%	100%	100%	100%	100%	100%	100%	50%	50%	50%	100%	100%	50%	100%	**85%**
11	0%	100%	0%	100%	0%	100%	0%	0%	-	0%	100%	0%	0%	0%	100%	-	0%	**33%**
Weighted mean	**71%**	**78%**	**61%**	**73%**	**80%**	**80%**	**78%**	**68%**	**62%**	**67%**	**80%**	**69%**	**72%**	**92%**	**66%**	**72%**	**65%**	**73%**

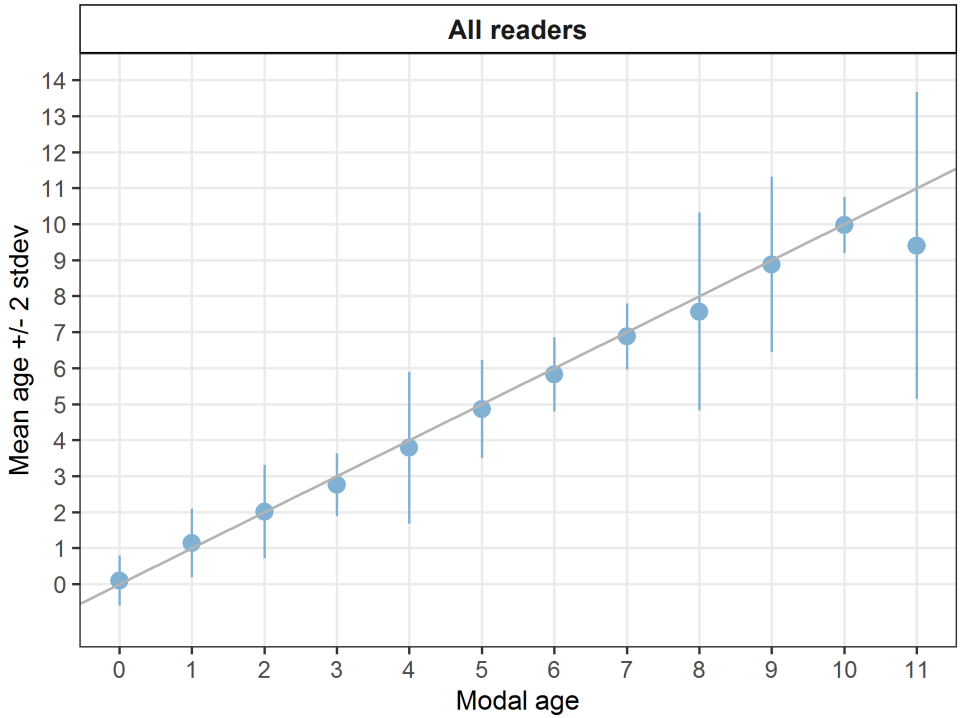


Figure 4.6. Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4.

4.3.2.4 Results: all readers – North Sea – sectioned otoliths

The weighted average percentage agreement based on modal ages for all readers is 70%, with the weighted average CV of 16% and APE of 10%.

Table 4.13. 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 SE	R04 NL	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	All
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
1	60%	0%	33%	0%	0%	33%	60%	44%	0%	33%	33%	58%	41%	49%	**42%**
2	29%	67%	41%	0%	29%	40%	22%	29%	29%	43%	22%	23%	-	22%	**32%**
3	0%	0%	0%	0%	20%	0%	20%	0%	0%	20%	0%	28%	-	0%	**13%**
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**13%**
5	0%	0%	18%	0%	0%	0%	10%	0%	0%	0%	0%	10%	-	10%	**8%**
6	18%	0%	0%	0%	0%	0%	9%	10%	17%	17%	17%	10%	13%	11%	**10%**
7	10%	5%	5%	14%	0%	12%	0%	8%	12%	11%	8%	6%	11%	10%	**10%**
8	7%	11%	13%	11%	9%	8%	6%	9%	7%	10%	19%	10%	20%	11%	**12%**
9	12%	5%	8%	12%	0%	8%	8%	0%	11%	11%	9%	9%	8%	6%	**9%**
10	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	-	0%	**2%**
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**14%**
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**6%**
Weighted mean	**19%**	**10%**	**15%**	**6%**	**5%**	**14%**	**17%**	**13%**	**9%**	**17%**	**14%**	**19%**	**22%**	**16%**	**16%**

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 4.14. 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 SE	R04 NL	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	All
0	75%	100%	25%	100%	100%	100%	25%	100%	75%	75%	25%	100%	-	50%	**73%**
1	57%	100%	86%	100%	100%	86%	57%	86%	100%	86%	86%	71%	25%	83%	**82%**
2	75%	75%	50%	100%	75%	75%	75%	75%	75%	25%	75%	50%	-	75%	**69%**
3	100%	100%	100%	100%	50%	100%	50%	100%	100%	50%	100%	50%	-	100%	**85%**
4	100%	0%	0%	100%	100%	100%	100%	0%	100%	100%	100%	0%	-	100%	**69%**
5	100%	100%	75%	100%	100%	100%	50%	100%	100%	100%	100%	50%	-	75%	**88%**
6	0%	100%	100%	100%	100%	100%	67%	67%	33%	33%	33%	67%	50%	33%	**63%**
7	57%	86%	86%	57%	100%	43%	100%	71%	43%	43%	71%	86%	50%	43%	**68%**
8	71%	71%	29%	71%	71%	57%	71%	50%	67%	71%	71%	29%	50%	50%	**59%**
9	33%	71%	57%	43%	100%	57%	57%	100%	57%	29%	43%	43%	50%	71%	**59%**
10	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	**96%**
11	0%	0%	100%	0%	100%	100%	0%	0%	0%	0%	0%	0%	-	0%	**23%**
12	0%	100%	100%	100%	100%	0%	100%	0%	0%	100%	100%	100%	0%	0%	**57%**
Weighted mean	**59%**	**84%**	**66%**	**80%**	**92%**	**74%**	**66%**	**77%**	**69%**	**60%**	**68%**	**60%**	**44%**	**63%**	**70%**

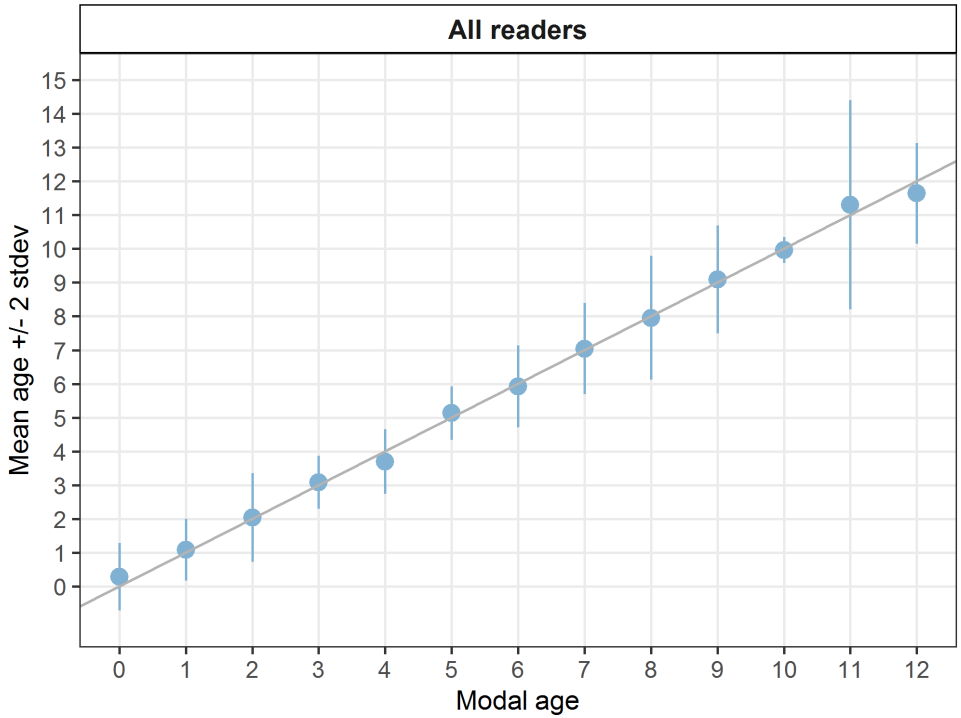


Figure 4.7. Age bias plot for all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4.

4.3.2.5 Results: advanced readers – North Sea and Skagerrak – whole otoliths

Table 4.15. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
0	-	-	-	-	-	-	-	-	-	**-**
1	28%	33%	68%	34%	0%	0%	28%	0%	33%	**37%**
2	28%	47%	17%	15%	17%	36%	29%	17%	0%	**28%**
3	18%	47%	33%	50%	11%	10%	41%	20%	0%	**36%**
4	10%	10%	10%	9%	18%	9%	17%	17%	13%	**14%**
5	10%	31%	14%	8%	22%	0%	8%	5%	7%	**15%**
6	10%	12%	6%	16%	11%	12%	12%	12%	10%	**12%**
7	0%	12%	7%	13%	5%	10%	10%	5%	5%	**9%**
8	14%	13%	17%	15%	8%	8%	11%	42%	16%	**19%**
9	9%	10%	8%	12%	16%	7%	27%	17%	18%	**17%**
10	5%	5%	8%	5%	5%	0%	9%	5%	5%	**6%**
11	7%	0%	53%	6%	0%	6%	12%	22%	-	**18%**
12	-	-	-	-	-	-	-	-	-	**29%**
13	-	-	-	-	-	-	-	-	-	**5%**
14	-	-	-	-	-	-	-	-	-	**-**
15	-	-	-	-	-	-	-	-	-	**16%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
Weighted mean	**14%**	**24%**	**22%**	**18%**	**12%**	**9%**	**20%**	**14%**	**12%**	**20%**

Table 4.16. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
0	75%	100%	100%	100%	100%	100%	100%	100%	0%	**94%**
1	91%	91%	82%	82%	100%	100%	91%	100%	86%	**92%**
2	67%	80%	90%	90%	90%	70%	70%	90%	100%	**81%**
3	70%	70%	50%	60%	90%	90%	60%	90%	100%	**74%**
4	86%	86%	86%	86%	86%	86%	57%	57%	75%	**78%**
5	71%	73%	73%	87%	80%	100%	80%	93%	89%	**83%**
6	71%	86%	86%	50%	57%	57%	71%	57%	57%	**66%**
7	100%	67%	78%	44%	89%	56%	56%	89%	86%	**73%**
8	67%	78%	50%	56%	78%	44%	75%	22%	62%	**59%**
9	75%	56%	44%	67%	56%	67%	44%	67%	62%	**59%**
10	75%	75%	50%	75%	75%	100%	50%	75%	75%	**72%**
11	0%	100%	50%	50%	0%	50%	50%	50%	0%	**41%**
12	0%	100%	0%	100%	0%	0%	100%	0%	0%	**33%**
13	100%	0%	100%	0%	0%	100%	0%	100%	100%	**56%**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
14	-	-	-	-	-	-	-	-	-	-
15	0%	100%	0%	0%	100%	100%	0%	0%	100%	**44%**
Weighted mean	**74%**	**77%**	**70%**	**71%**	**79%**	**78%**	**68%**	**76%**	**74%**	**74%**

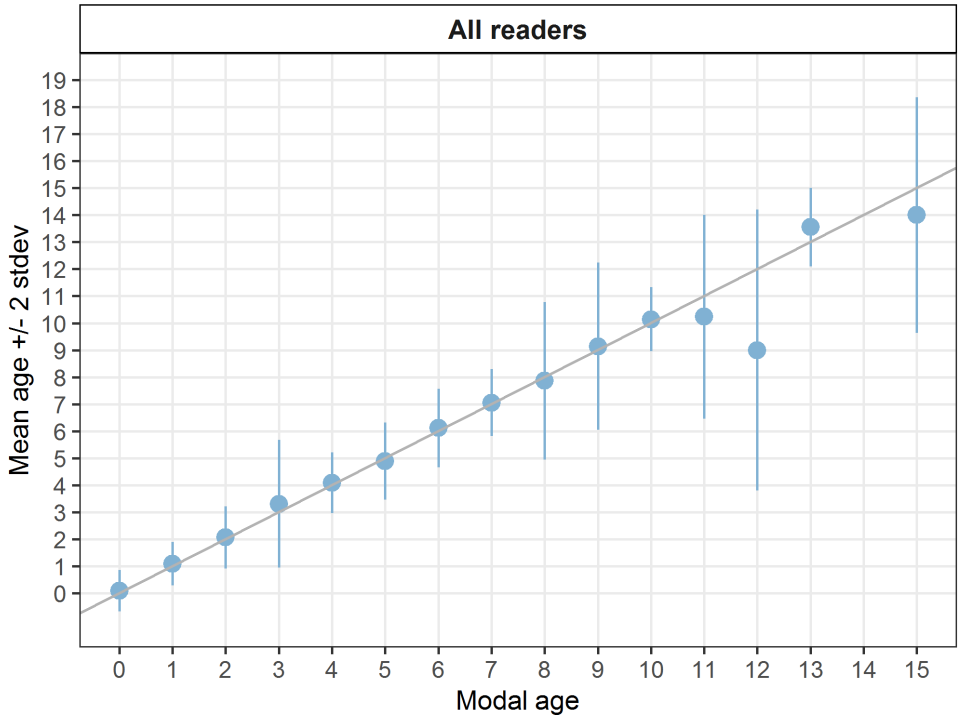


Figure 4.8. Age bias plot for advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plot-ted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4. The data overview for advanced readers only is not included in Annex 4 but the data overview based on all readers can be found in Annex 3.

4.3.2.6 Results: advanced readers – Skagerrak – whole otoliths

Table 4.17. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
1	40%	0%	0%	0%	0%	0%	0%	0%	-	**17%**
2	22%	33%	20%	18%	20%	32%	31%	20%	-	**28%**
3	15%	48%	33%	53%	0%	12%	46%	23%	0%	**39%**
4	0%	0%	0%	11%	0%	0%	12%	11%	20%	**8%**
5	10%	14%	15%	9%	26%	0%	9%	0%	8%	**13%**
6	0%	0%	0%	0%	0%	0%	11%	13%	13%	**7%**
7	0%	17%	9%	9%	0%	9%	8%	9%	-	**9%**
8	-	-	-	-	-	-	-	-	-	**15%**
9	6%	6%	7%	15%	11%	9%	34%	14%	7%	**19%**
10	7%	7%	7%	7%	7%	0%	6%	7%	7%	**7%**
11	-	-	-	-	-	-	-	-	-	**7%**
12	-	-	-	-	-	-	-	-	-	**29%**
13	-	-	-	-	-	-	-	-	-	**5%**
14	-	-	-	-	-	-	-	-	-	**-**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
15	-	-	-	-	-	-	-	-	-	**16%**
Weighted mean	**12%**	**18%**	**14%**	**17%**	**11%**	**8%**	**20%**	**11%**	**9%**	**18%**

Table 4.18. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
1	75%	100%	100%	100%	100%	100%	100%	100%	100%	**97%**
2	67%	86%	86%	86%	86%	71%	57%	86%	-	**78%**
3	71%	71%	57%	57%	100%	86%	57%	86%	100%	**74%**
4	100%	100%	100%	80%	100%	100%	60%	80%	50%	**88%**
5	70%	73%	73%	82%	73%	100%	73%	100%	86%	**81%**
6	100%	100%	100%	100%	100%	100%	50%	50%	50%	**83%**
7	100%	33%	67%	33%	100%	67%	67%	67%	100%	**68%**
8	0%	100%	0%	100%	100%	0%	100%	0%	-	**50%**
9	75%	75%	50%	75%	75%	50%	25%	50%	67%	**60%**
10	50%	50%	50%	50%	50%	100%	0%	50%	50%	**50%**
11	0%	100%	100%	0%	0%	0%	100%	100%	-	**50%**
12	0%	100%	0%	100%	0%	0%	100%	0%	0%	**33%**
13	100%	0%	100%	0%	0%	100%	0%	100%	100%	**56%**
14	-	-	-	-	-	-	-	-	-	**-**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
15	0%	100%	0%	0%	100%	100%	0%	0%	100%	**44%**
Weighted mean	**71%**	**78%**	**72%**	**72%**	**82%**	**82%**	**60%**	**78%**	**74%**	**74%**

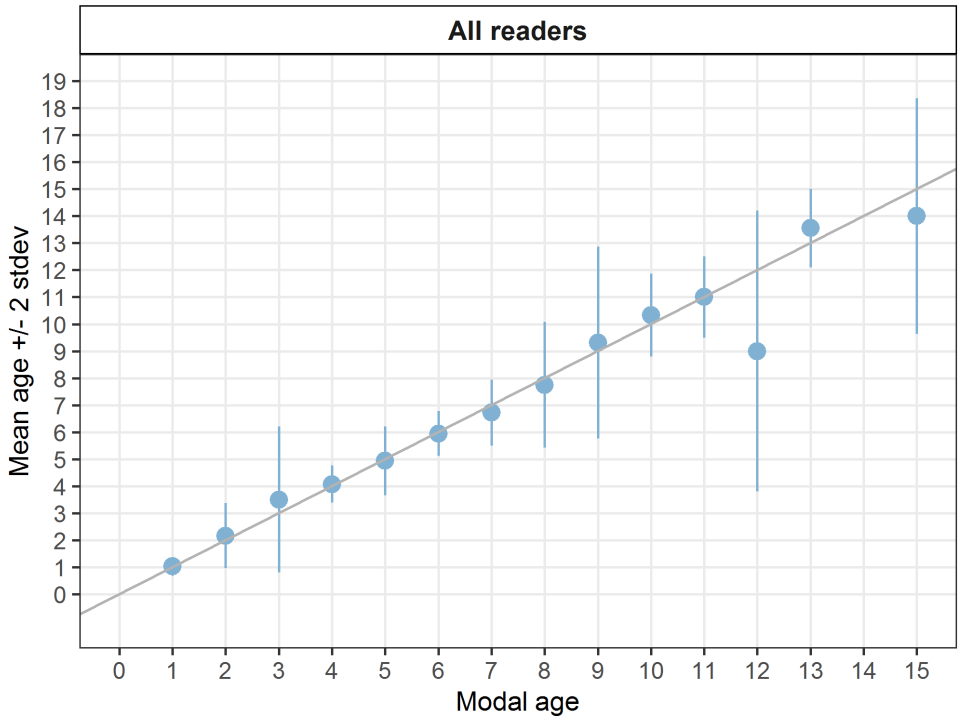


Figure 4.9. Age bias plot for advanced readers. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4. The data overview for advanced readers only is not included in Annex 4 but the data overview based on all readers can be found in Annex 3.

4.3.2.7 Results: advanced readers – North Sea – whole otoliths

The weighted average percentage agreement based on modal ages for advanced readers is 74%, with the weighted average CV of 20% and APE of xx%.

Table 4.19. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
0	-	-	-	-	-	-	-	-	-	**-**
1	0%	44%	72%	38%	0%	0%	33%	0%	35%	**43%**
2	35%	87%	0%	0%	0%	35%	0%	0%	0%	**25%**
3	22%	22%	25%	17%	22%	0%	17%	0%	0%	**18%**
4	20%	20%	20%	0%	28%	16%	28%	35%	0%	**22%**
5	11%	67%	11%	0%	0%	0%	0%	11%	0%	**19%**
6	12%	14%	8%	20%	13%	12%	14%	12%	10%	**13%**
7	0%	6%	6%	11%	6%	11%	11%	0%	6%	**8%**
8	14%	14%	17%	16%	9%	6%	11%	44%	16%	**19%**
9	12%	14%	10%	8%	20%	5%	9%	18%	23%	**15%**
10	0%	0%	7%	0%	0%	0%	0%	0%	0%	**2%**
11	-	-	-	-	-	-	-	-	-	**25%**
Weighted mean	**11%**	**27%**	**21%**	**14%**	**9%**	**7%**	**14%**	**14%**	**13%**	**20%**

Table 4.20. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	All
0	75%	100%	100%	100%	100%	100%	100%	100%	0%	**94%**
1	100%	86%	71%	71%	100%	100%	86%	100%	83%	**89%**
2	67%	67%	100%	100%	100%	67%	100%	100%	100%	**88%**
3	67%	67%	33%	67%	67%	100%	67%	100%	100%	**74%**
4	50%	50%	50%	100%	50%	50%	50%	0%	100%	**56%**
5	75%	75%	75%	100%	100%	100%	100%	75%	100%	**88%**
6	60%	80%	80%	25%	40%	40%	80%	60%	60%	**59%**
7	100%	83%	83%	50%	83%	50%	50%	100%	83%	**76%**
8	75%	75%	57%	50%	75%	50%	71%	25%	62%	**60%**
9	75%	40%	40%	60%	40%	80%	60%	80%	60%	**59%**
10	100%	100%	50%	100%	100%	100%	100%	100%	100%	**94%**
11	0%	100%	0%	100%	0%	100%	0%	0%	0%	**33%**
Weighted mean	**78%**	**76%**	**67%**	**69%**	**76%**	**74%**	**76%**	**74%**	**74%**	**74%**

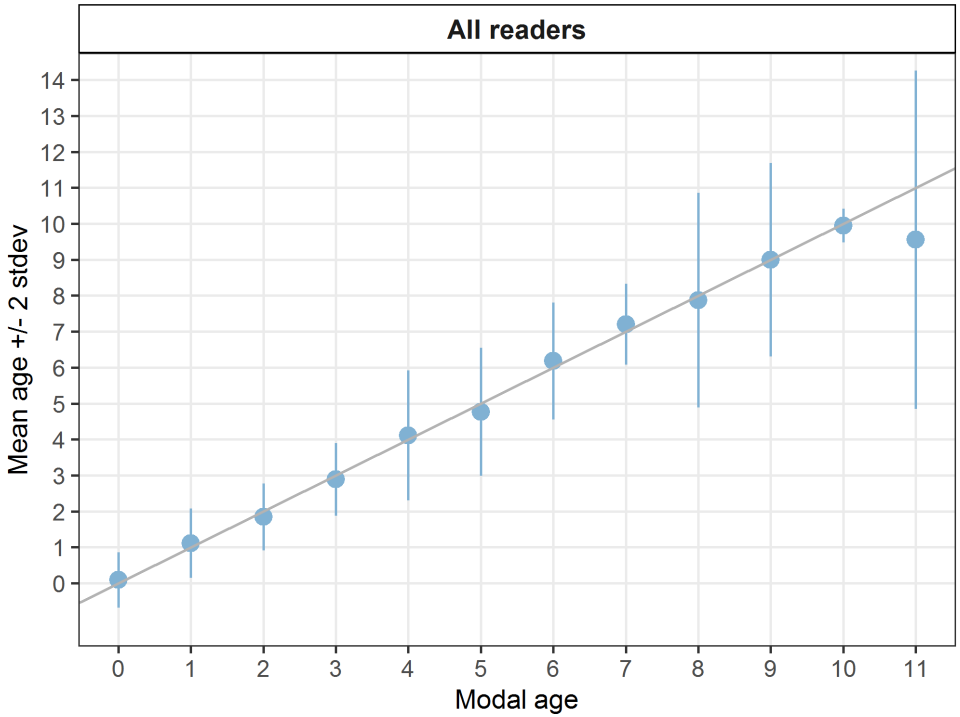


Figure 4.10. Age bias plot for all advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4. The data overview for advanced readers only is not included in Annex 4 but the data overview based on all readers can be found in Annex 3.

4.3.2.8 Results: advanced readers – North Sea – sectioned otoliths

The weighted average percentage agreement based on modal ages for advanced readers is 76%, with the weighted average CV of 14% and APE of xx%.

Table 4.21. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	All
0	-	-	-	-	-	-	-	-	**-**
1	58%	44%	-	0%	33%	0%	33%	60%	**39%**
2	0%	29%	-	22%	29%	29%	40%	22%	**28%**
3	0%	0%	-	0%	0%	20%	0%	20%	**12%**
4	-	-	-	-	-	-	-	-	**13%**
5	0%	0%	-	18%	0%	0%	0%	10%	**9%**
6	18%	0%	-	0%	0%	0%	0%	9%	**7%**
7	10%	5%	-	5%	14%	0%	12%	0%	**8%**
8	5%	10%	-	14%	5%	5%	8%	5%	**8%**
9	10%	4%	-	4%	11%	4%	7%	7%	**8%**
10	6%	0%	-	5%	5%	6%	5%	5%	**5%**
11	-	-	-	-	-	-	-	-	**12%**
12	-	-	-	-	-	-	-	-	**5%**
Weighted mean	**15%**	**13%**	**-**	**8%**	**13%**	**5%**	**14%**	**17%**	**14%**

Table 4.22. 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 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	All
0	75%	100%	-	25%	100%	100%	100%	25%	**75%**
1	71%	86%	-	100%	86%	100%	86%	57%	**84%**
2	100%	75%	-	75%	75%	75%	75%	75%	**79%**
3	100%	100%	-	100%	100%	50%	100%	50%	**86%**
4	100%	0%	-	0%	100%	100%	100%	100%	**71%**
5	100%	100%	-	75%	100%	100%	100%	50%	**89%**
6	0%	100%	-	100%	100%	100%	100%	67%	**81%**
7	57%	86%	-	86%	57%	100%	43%	100%	**76%**
8	83%	83%	0%	33%	83%	83%	67%	83%	**72%**
9	40%	83%	-	83%	50%	83%	67%	67%	**68%**
10	50%	100%	-	75%	75%	50%	75%	75%	**71%**
11	0%	0%	-	100%	0%	100%	100%	0%	**43%**
12	0%	100%	-	100%	100%	100%	0%	100%	**71%**
Weighted mean	**65%**	**86%**	**0%**	**74%**	**78%**	**88%**	**76%**	**68%**	**76%**

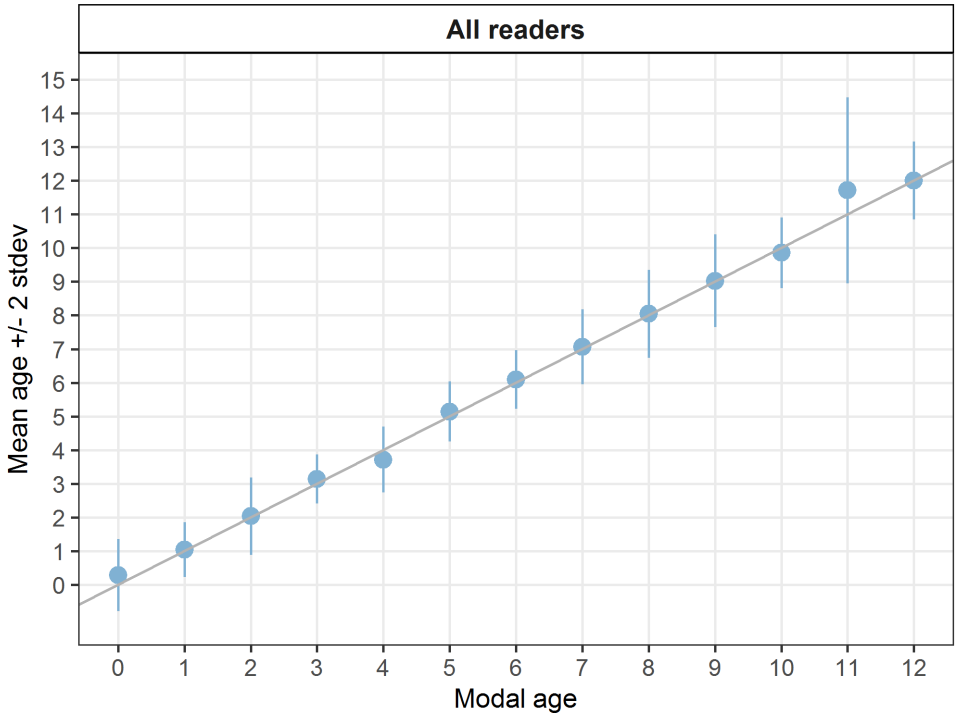


Figure 4.11. Age bias plot for all advanced readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age. The estimated mean age corresponds to modal age, if the estimated mean age is on the 1:1 equilibrium line (solid line).

The corresponding relative bias table representing the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader can be found in Annex 4. The data overview for advanced readers only is not included in Annex 4 but the data overview based on all readers can be found in Annex 3.

4.4 Closer examination of annotated images

The following are image examples which depict some of the main reasons for disagreement between the age readers.

- ID 138_BTS01_PLE_4C_2019082620601 (Figure 4.12), modal age 2 is read to be age 1, 2 and 3. The reader giving age 1 is not counting the innermost ring. The reader giving age 3 is counting the outermost ring (this should not be counted when a fish is caught in August).
- ID 146_CDDR09_PLE_4B_D_S_226278 (Figure 4.13), modal age 0 is read to be age 1 on the whole otolith by 1 reader, this is an example of a very wide first winter ring which the reader is having difficulty in interpreting correctly. On the sectioned otolith the reader is counting 4 rings which when viewed compared with the whole otolith are not visible. This depicts the issue of possible overestimation of fish age when otoliths are sectioned.
- ID PLE_2019_1400052_928 (Figure 4.14) Modal age 8 is read to be age 8 on the sectioned otolith but on the whole otolith, the annotated images show the reader is only estimating the age of the fish to be 5 years. This is an example of where the otolith there is a "cliff edge" effect and the otolith does not continue to grow on the horizontal plane but instead increases in thickness, making it difficult to see the winter rings laid down in the later years at the edge of the whole otolith.
- ID 7704738_ALA_RLX_XX (Figure 4.15) is an example of where the innermost ring is confusing some readers. This is a common problem as the first winter ring can often appear as a wide area of banded opaque and translucent zones.
- ID 7526461 (Figure 4.16) is an example of where the readers can sometimes count an additional winter ring at the edge which should not be included in the count of age. The overall appearance of the otolith edge is opaque and any translucent growth which is beginning at the otolith edge is the coming winter ring growth and should not be included in the count of age.

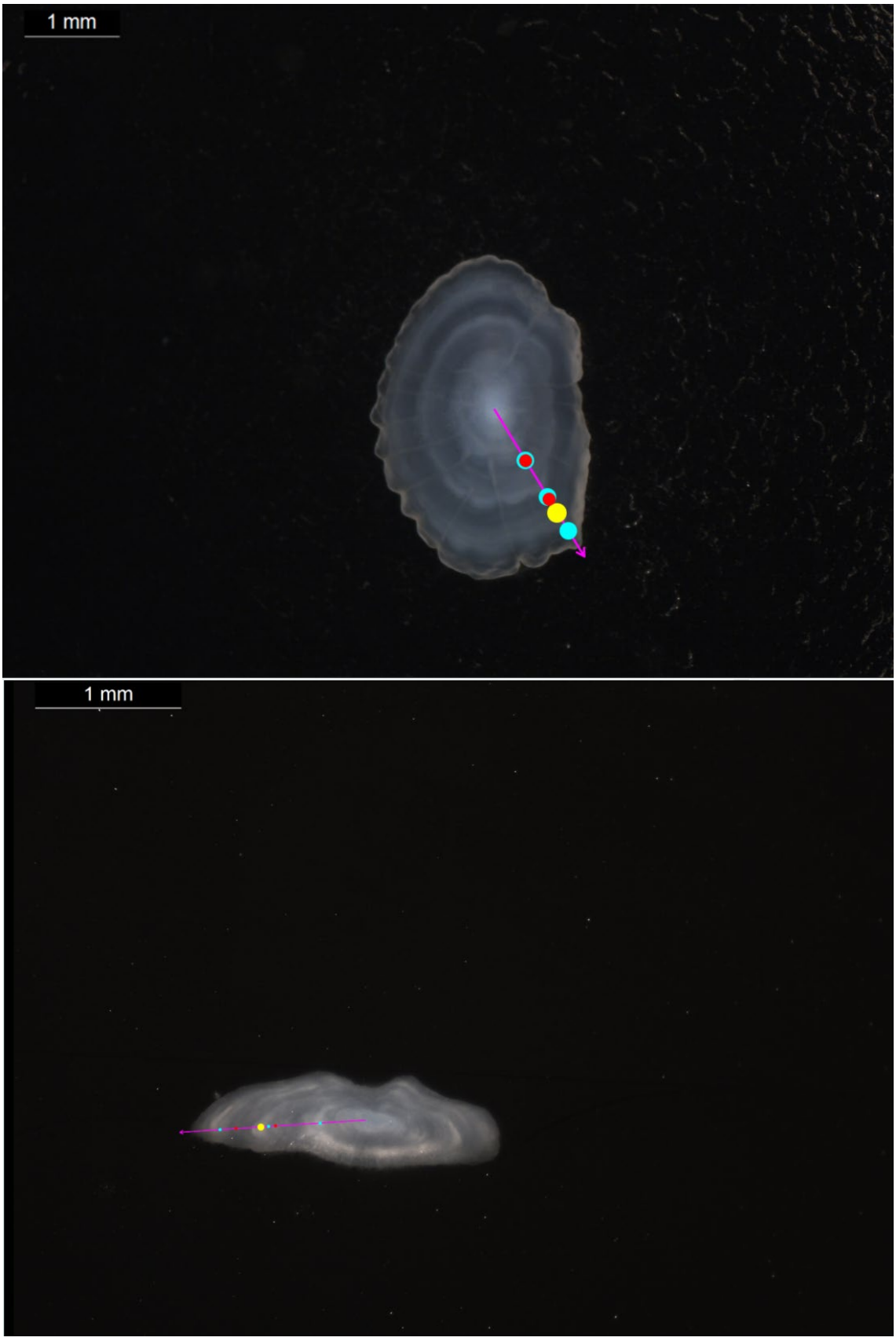


Figure 4.12. ID 138_BTS01_PLE_4C_2019082620601, length 131mm, capture date 26/08/2019 from Area 4.c. Event ID 281. Modal age 2. Top image (whole otolith) blue dots = age 3, red dots = age 2, yellow dot = age 1. Bottom image (sectioned otolith) blue dots = age 3, red dots = age 2, yellow dot = age 1.

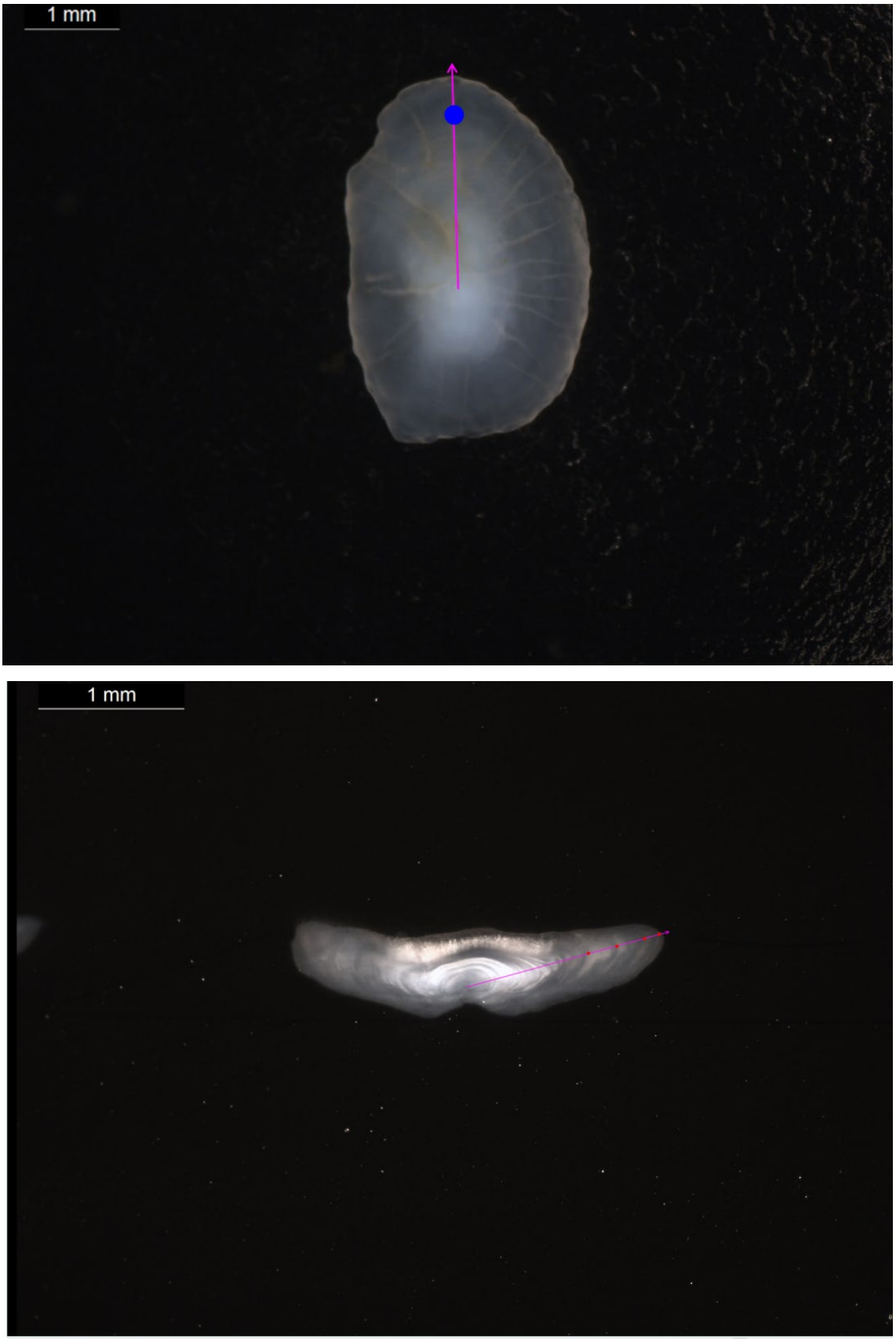


Figure 4.13. ID 146_CDDR09_PLE_4B_D_S_226278, length 170mm, capture date 14/12/2016 from Area 4.b. Event ID 402. Modal age 0. Top image (whole otolith) blue dot = age 0. Bottom image (sectioned otolith) red dots = age 4.

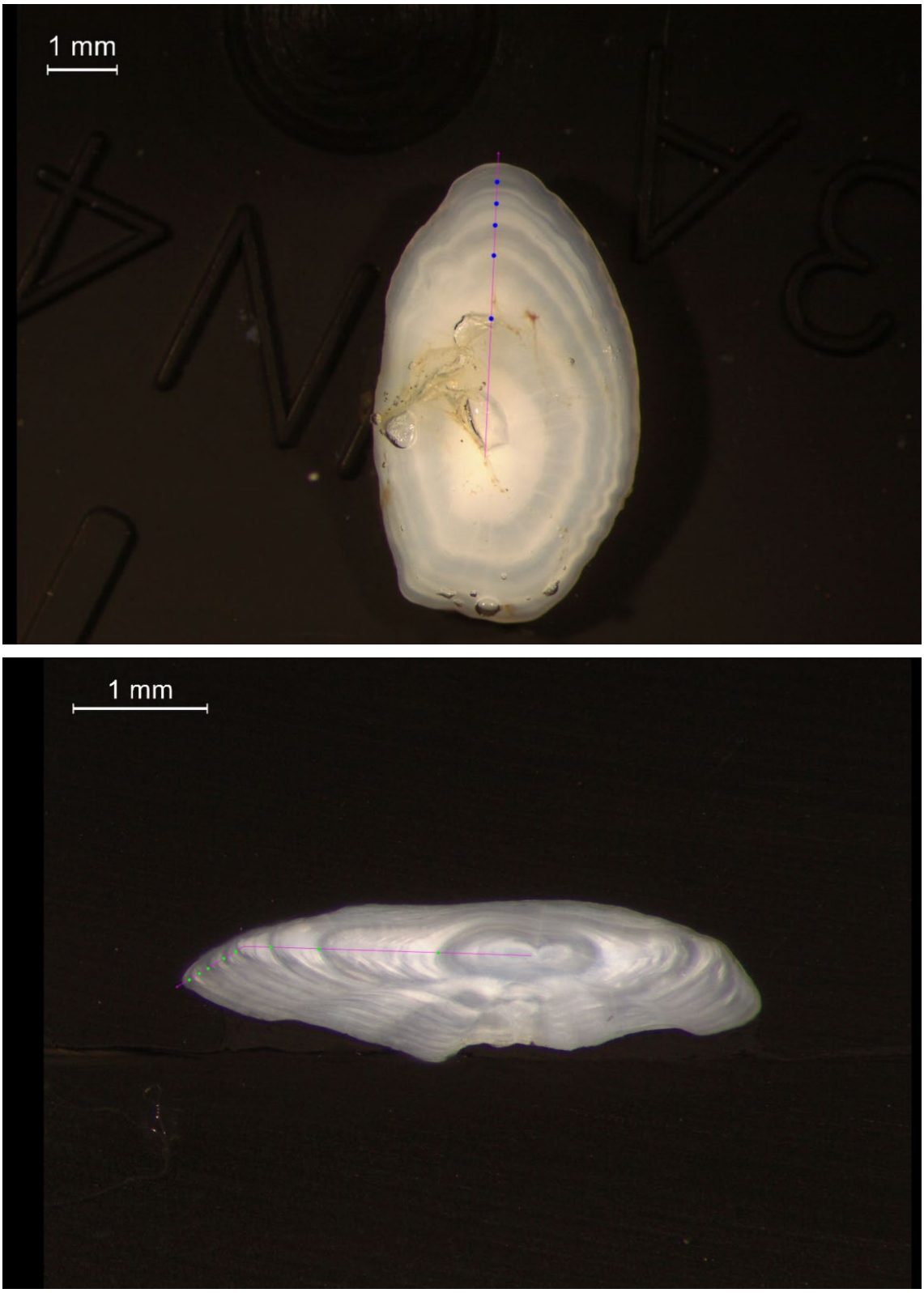


Figure 4.14. ID PLE_2019_1400052_928, length 286mm, capture date 05/09/2019 from Area 4.b. Modal age 8. Top image (whole otolith) green dots = age 8. Bottom image (sectioned otolith) blue dots = age 5.

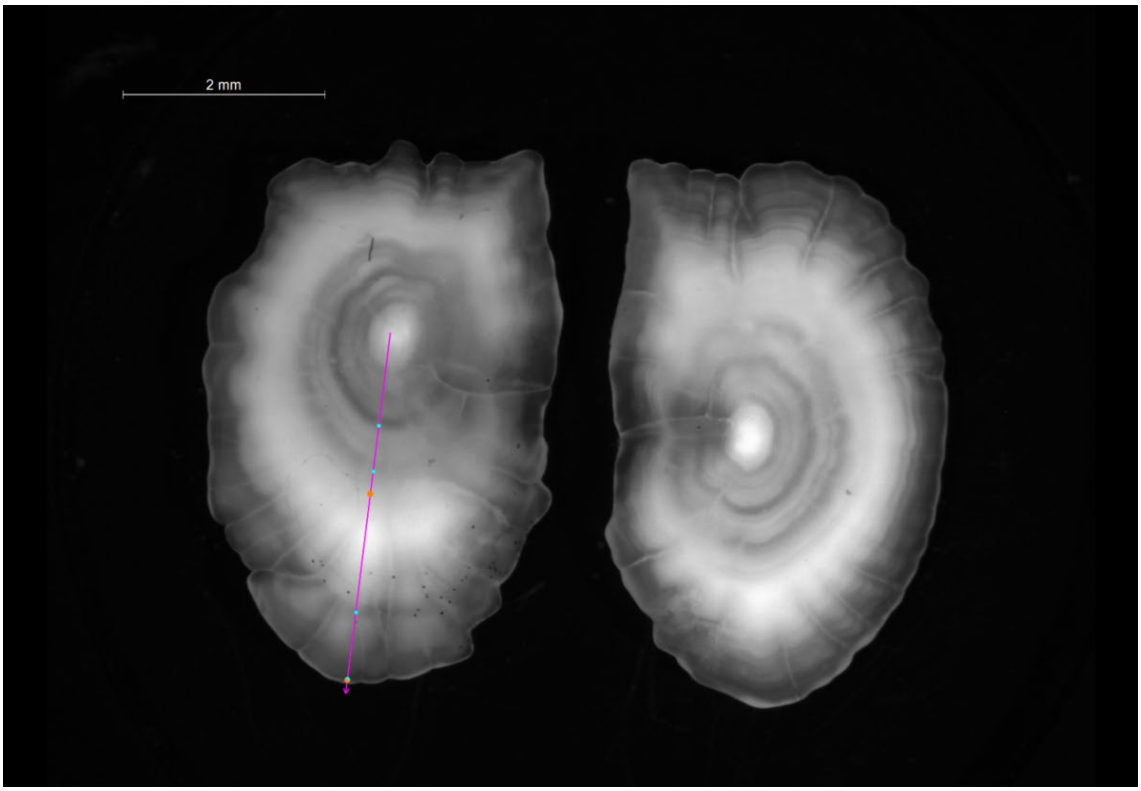


Figure.15. ID 7704738_ALA_RLX_XX, length 230 mm, capture date 07/04/2018 from Area 3.a. Event ID 281. Modal age 2 but blue dots = age 4, this reader is counting too many rings close to the centre and at the otolith edge.

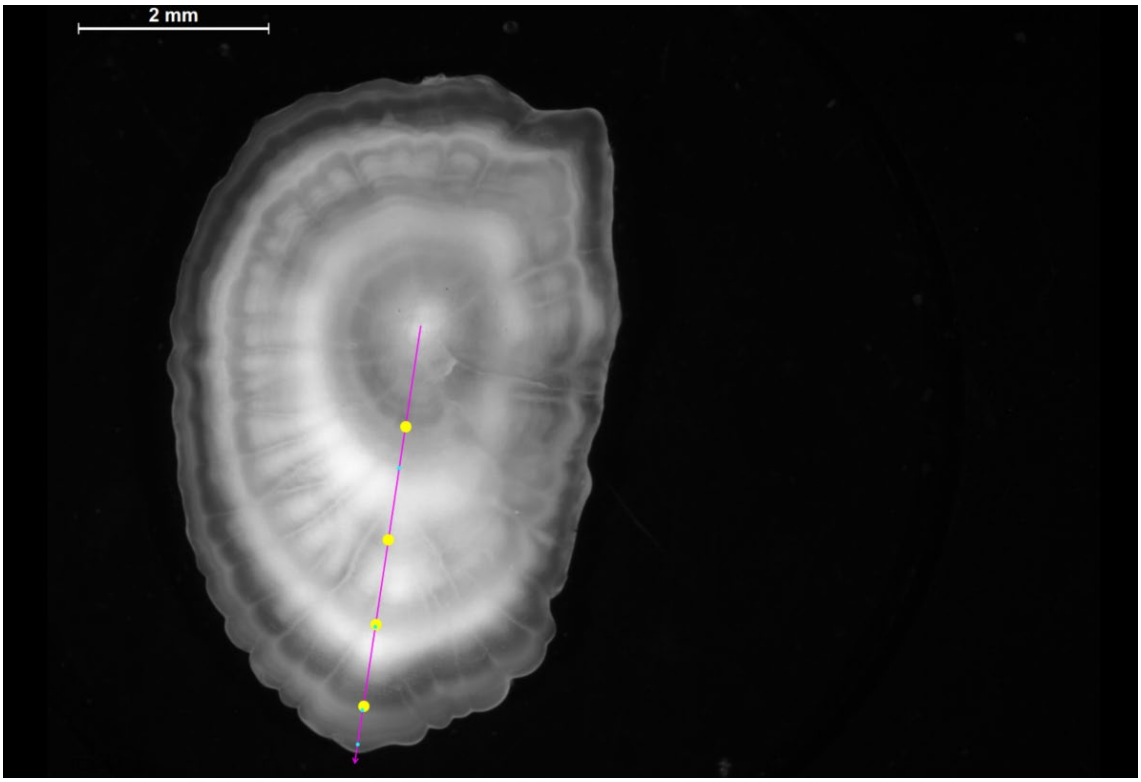


Figure 4.16. ID 7526461, length 360 mm, capture date 12/06/2017 from are 3.a. Event ID 281. Modal age 3 but yellow dots = age 4 as counting the second winter ring twice and blue dots = 4 as counting an additional winter ring at the otolith edge. Both events are now closed in SmartDots (IDs 281 and 402), meaning readers can view and compare multiple annotations per image

4.5 Validation work carried out to date

The following are summaries of presentations given at the 2021 WKARP2.

Patterns in ring formation of juvenile Baltic plaice

Uwe Krumme and Richard Timm[1]

[1]*Thünen Institute of Baltic Sea Fisheries, Rostock, Germany*

Determination of the age and timing of first increment formation is an ongoing issue in plaice (*Pleuronectes platessa*) from the North Sea and Baltic Sea. To better understand patterns in ring formation of juvenile Baltic plaice, length-frequencies of juvenile plaice were collected monthly with a scoop net in 2020 in shallow waters near Rostock, Germany. The length-frequency information was combined with visual categorization (eight types) and ring diameter measurements of whole otoliths to observe the development of the translucent zone (TZ) and opaque zone in age−0 and age−1 plaice otoliths. Age−0 plaice settled with 2−3 cm from May−July and attained a length range of 4−11 cm in December. Unlike previous assumptions, age−0 plaice formed 3 zones until the end of their first year: an opaque core (prior to settlement), a TZ (during warmer water temperatures and faster growth until late summer), and an opaque zone from autumn/winter into spring of the following year (reduced growth). Age−1 plaice formed two zone changes: the opaque zone of the previous year until late spring, a TZ during the second summer and another opaque zone was again formed from autumn/winter until spring of the following year (age−2). Hence, the TZ is formed during summer when juvenile Baltic plaice experience the best conditions for growth. A mean horizontal core diameter of about 630 μm suggests that both age reading methods (whole and sliced otoliths) may miss the first TZ: given a common thickness of otolith slices of 500−600 μm, inappropriate slicing may lead to underestimation of the true age, reading whole otoliths may also miss the first TZ when the core region is overgrown by opaque material. An age validation experiment with tetracycline-marked juvenile Baltic plaice is ongoing; results from this experiment will it is to be hoped provide evidence to clarify issues on age determination and the appropriateness of the age reading methods.

Multicriteria approach for validating first winter ring deposition in Eastern North Sea plaice (*Pleuronectes platessa)* otolith.

Francesca Vitale[1], Jan-Erik Johansson[1], Barbara Bland[1] and Pierluigi Carbonara[2]

[1]*Swedish University of Agricultural Sciences (SLU), Department of Aquatic Resources, Institute of Marine Research, Sweden*

[2]*COISPA Tecnologia e Ricerca, Stazione Sperimentale per lo Studio delle Risorse del Mare, Italy*

A major difficulty in accurate age determination of plaice (Pleuronectes platessa) consists in how to interpret the first hyaline ring, sometimes read as a "settling ring" and sometimes read as a true annual ring. As the misinterpretation of this first ring leads to a bias in age-based stock assessment, validating this first ring is crucial. The sampling was carried out between May and December 2011 in shallow water (2−5 m) in the Swedish fjord "Gullmaren", is a good settling ground. Adult specimens were also collected from the same areas in May 2011.

Here we applied a multicriteria approach based on edge analysis and morphometric measurements, useful in ring deposition validation studies when classic methods (e.g. mark and recapture, captivity rearing, radiochemical dating, bomb radiocarbon etc.) are difficult to implement.

The marginal analysis of the otolith from adults (age>0) and juveniles (age 0) show the same pattern with a prevalence of the opaque edge in summer/ early autumn and transparent (hyaline) edge in late autumn. However, a peak of juvenile specimens with hyaline edge, at a distance from the nucleus of about 400 μm, was observed in June. Moreover, morphometric

measurements of the radius in otolith with hyaline edge observed in specimens caught in October / November did not show significant differences (Wilcoxon – Mann–Whitney test; $p>0.05$) from the first ring displayed by adult specimens. Nonetheless, in the adults in which narrow and indistinct checks could be seen, the measurements showed distances (around 400 μm) corresponding to juveniles observed in June of a length of around 30 mm. These results suggest that a false ring deposition before the first winter ring does occur in juveniles.

Taken together both approaches present preliminary evidence indicating that the first ring displayed on the otolith of this plaice stock is unlikely to be the first winter ring, hence, not counted as annual rings. These checks could be laid down in response to environmental stress; the young fish are subjected to greater fluctuations in food supply, temperature and predation pressure than adults in deeper water. This study represents the first step toward age validation of this stock and may contribute to the disclosure of local populations.

5 Review existing guidelines and ageing criteria and compile an updated age reading manual with reference image sets

ToR d

5.1 Age reading guidelines

The following is an updated version of the age reading guidelines first outlined by WKARP 2010 and updated in plenary by WKARP2.

5.1.1 General

Relevant biological data such as catch data, area, length, weight and sex (if available) for each fish should be available and used in case of doubt when assigning fish age.

Use microscopes with good quality optics. Stick to one microscope that the reader is familiar with. Use generally low magnification, but zoom where necessary.

Ensure that the otoliths are cleaned of any residual tissue (preferably done when sampling).

Two otoliths are preferable.

WKARP2 advises all laboratories to count translucent rings (non-growth rings) for consistency, however, some laboratories choose to count opaque rings (growth rings). When annotating otolith images the point between the end of the translucent and the beginning of the opaque should be marked.

5.1.2 Reading techniques

Plaice otoliths can be read using 2 different preparation methods.

1. Whole otolith method: Both otoliths are put in a container (black or transparent) filled with a clear fluid (water, oil, alcohol). Adding a drop of washing up liquid to the water will help to reduce surface tension. Soaking the otoliths in water for a short period can improve the readability but extended soaking (over 2 hours) is not recommended, especially for the smaller otoliths.
2. Sectioned otolith method: Otoliths are embedded in resin (with or without added black stain) and then sectioned through the nucleus (it is preferable to take the symmetrical otolith and cut transversely). The thickness of the slides range between 0.45 and 0.6 mm, with some using a glass coverslip as well. If sectioned otoliths are not covered with a glass coverslip, the surface of sectioned otoliths is covered with a thin layer of oil before reading.

Preference of source of light, transmitted or reflected, varies between laboratories. Some use both transmitted and reflected light, others only transmitted or only reflected. Features of the otoliths, especially at the edge, might look different using alternative light settings. WKARP2 agreed that reflected light should be used for both whole and sectioned otoliths

WKARP 2010 also considered the break and burn method (WKARP, 2010) but this is not a method that is routinely applied for North Sea and Skagerrak plaice.

The different preparation methods and light sources are illustrated in Figure 5.1

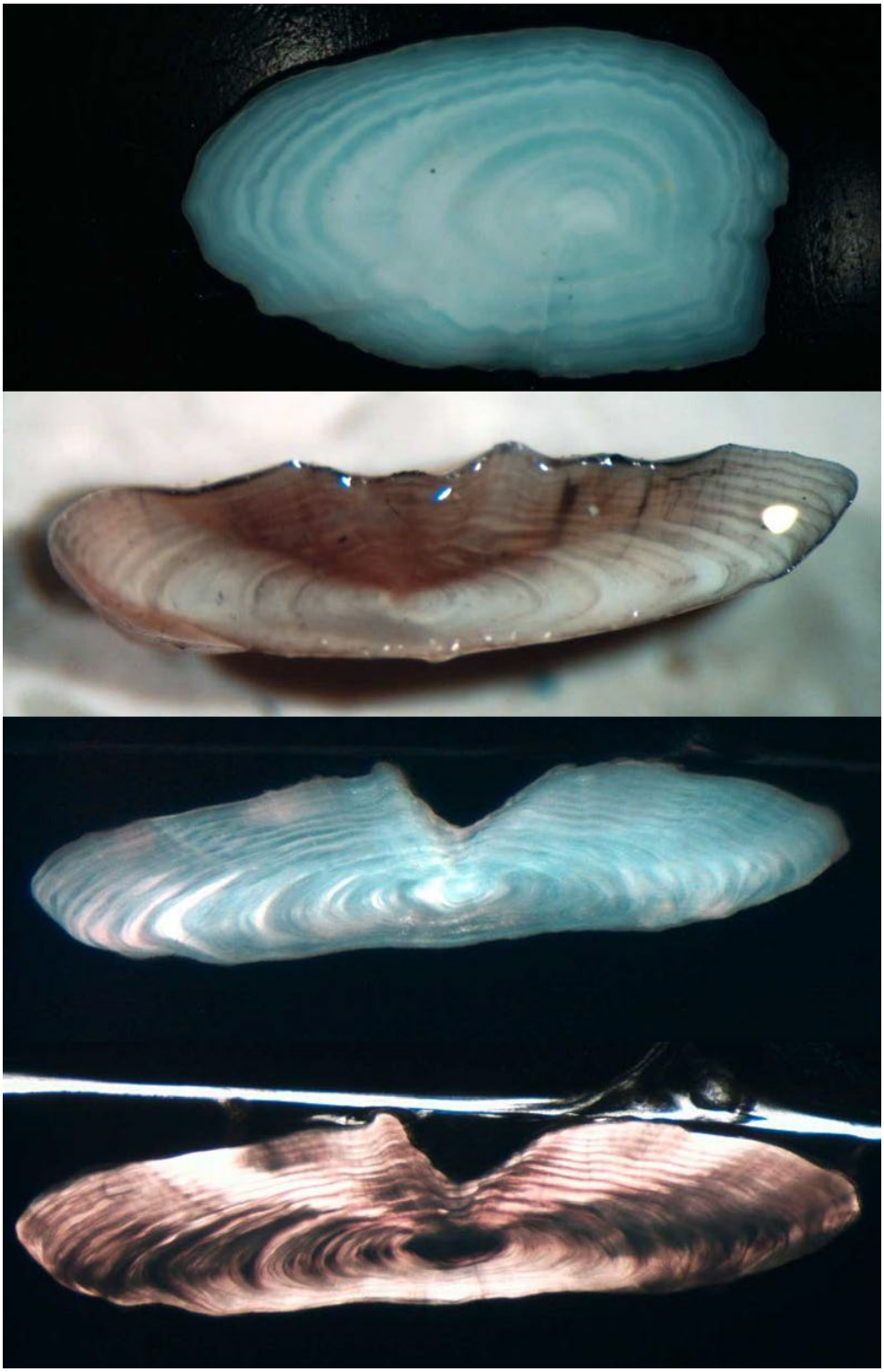


Figure 5.1. Otoliths of a plaice (female, 55cm, IVb, July) using different preparation methods and light sources. From top to bottom: (1) whole otolith, reflected light (2) broken–burnt method (this is not a routine preparation method for the North Sea plaice) (3) trans– verse section, reflected light (4) transverse section, transmitted light. The age interpretation is 11 years based on the broken–burnt and sectioned otolith. The age was estimated younger based on the whole otolith (9/10 years). Source: Mick Easey, Cefas, UK (presented at plaice workshop 2003), Figure 6.2.1. in WKARP 2010 report.

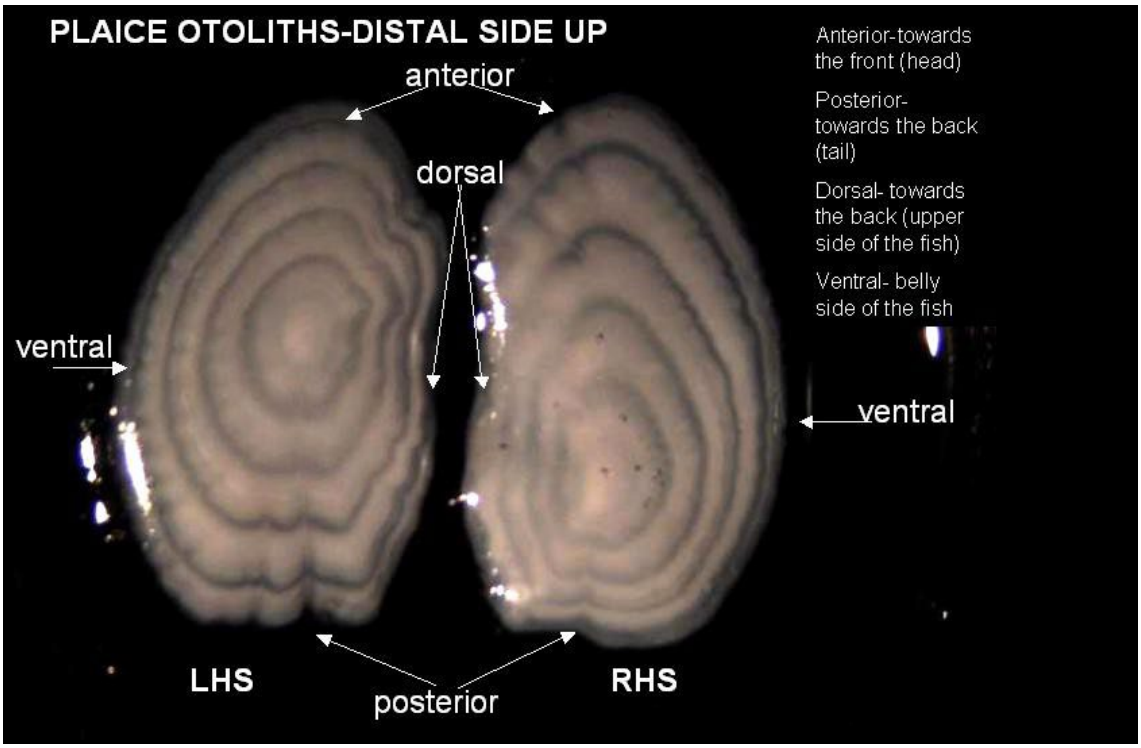


Figure 5.2. Description of morphological features of whole plaice otoliths mounted in microscopy medium (Q1, 5 years old). Source: Marcin Blaszkowski, The Marine Institute, Ireland. Figure 6.3.1. in WKARP 2010 report.

5.1.3 Considerations

Consider otoliths from other individual fish caught at the same time and area when interpreting the growth structures.

The clearest axis, generally of major growth, should be used for the age interpretation.

For whole otoliths, usually, the distal side is examined but sometimes the observation of the proximal side (where the sulcus is) might be helpful (Figure 5.2).

5.1.4 Quality control

Definition of advanced and basic readers: these definitions allow for a separate analysis of age readers who provide age data for stock assessment purposes. The results from the analysis of advanced readers ONLY are made available to the stock assessors who can then consider age reading error and bias in the stock assessment model runs.

Basic readers should go through an extensive training program led by an experienced (advanced) plaice reader(s).

Fish ages estimated by basic readers should be checked by experienced readers during the first years of training.

Experienced readers should always take part in international age reading exchanges and workshops. This ensures they are in agreement with other experienced readers in other laboratories age reading the same stock and ensures the sharing of knowledge and experience.

A standard ICES vocabulary[8] should be used for grading the quality of each age reading (ICES, 2011):

- AQ1: Rings can be counted with certainty;
- AQ2: Rings can be counted with difficulty and some doubt;
- AQ3: Rings cannot be counted, the calcified structure is considered unreadable, no age assigned;
- AQ3_QA: Rings cannot be counted, the calcified structure is considered unreadable, and age assigned for QA purposes only (This category is used for exchanges and workshops when readers identify otoliths which they are very much in doubt about).

Readers should record the edge type that they see when they are age-reading (not what they expect to see). If a reader sees that an opaque zone is beginning to form then they note the edge type to be opaque (the zone does not need to be fully completed).

- Opaque refers to the growth zones.
- Translucent refers to the non-growth zones.

It is very important that the light source is considered. When viewed on a black surface and under reflected light the opaque zones will appear light and translucent zones will appear dark. In contrast, when using transmitted light the opaque zones will appear dark and the translucent zones will appear light.

Placement of annotation lines should be along the clearest axis, no matter if it is symmetrical or asymmetrical otolith.

5.1.5 Image capturing

Photographing and annotating images is important for documenting how readers interpret the otolith structures and for quality assurance purposes. High photo quality is a necessity for accurate readings. Please follow the checklist below for image capturing and annotation.

- Otoliths must be thoroughly cleaned before photographing.
- If using whole otoliths, both otoliths (if available) are put in a container (black or transparent depending on whether transmitted or reflected light is used) filled with a clear fluid (water, oil or alcohol). Sectioned otoliths are to be covered with a thin layer of oil.
- Make sure to properly calibrate the image capture software with the current microscope settings. There may be microscope-specific calibration variance so for this reason, it is advised to use the same microscope for each stock. Avoid using different magnifications for a set of images for the same stock/species as this will require a new calibration for a new magnification. Save the calibration setting in your image capture software. Recalibrate the microscope setup regularly.
- Correctly calibrated scale bars should be added/included on all images and an image of a measuring stick with a scale bar saved with each set of images (see Figure 5.3). This will ensure that correct measurement can be made.
- Having the scale bar placed close to the ototlith will help when zooming in on the images. Using a scale bar without end bars and in a white font will permit automatic scale bar detection in SmartDots.
- Avoid over-exposed images as optimum contrast and brightness between growth and non-growth zones is essential. Care should be taken to avoid reflection from overhead lighting, a darkened room is preferable.

[8] https://vocab.ices.dk/?ref=1395.

- Remember to record the image information (e.g. camera and microscope settings, magnification, resolution and type of light) with each set of images. Save the configuration settings in your image capture software. The type of light (transmitted or reflected) used for imaging should be recorded on the image or in the image name.
- Pictures should be saved in jpeg or png format (tiff images are very large and can be slow to work with).
- When annotating otolith images the point between the end of the translucent and beginning of the opaque zone should be marked. No annotation should be made in the nucleus (see section 5.2 'When translucent rings are counted').
- Information on zone interpretation can be found in the following section.

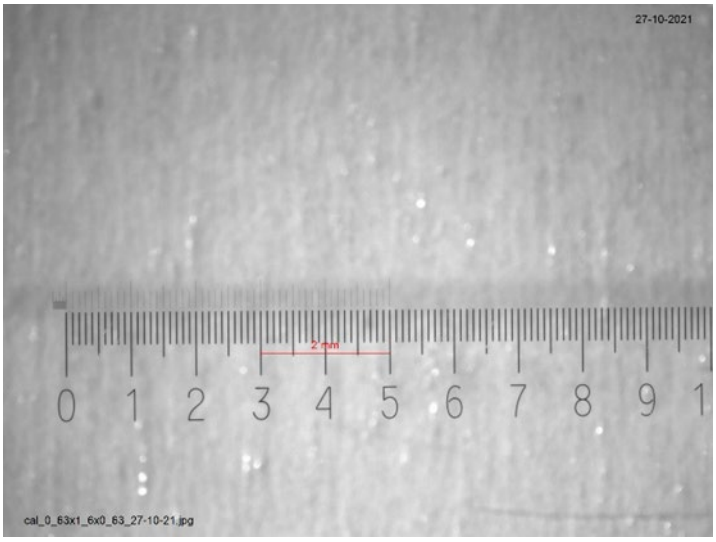


Figure 5.3. Calibration image showing a measuring stick, calibrated scale bar and with microscope settings shown on the image.

5.2 Age reading manual

The following is an updated version of the age reading manual first outlined by WKARP 2010 and updated in plenary by WKARP2.

5.2.1 Interpretation

5.2.1.1 Date of birth

The birthday of all plaice is considered to be 1 January.

5.2.1.2 Reading from images

One should be aware of the type of light source (transmitted or reflected light) used for image capturing when determining age from an image. When viewed on a black surface and under reflected light the opaque zones will appear light and translucent zones will appear dark. In contrast, when using transmitted light the opaque zones will appear dark and the translucent zones will appear light. The scale bar on the image can help the reader to get an idea of the size of the otolith when using the measuring tool in the SmartDots software.

5.2.1.3 First annulus

If there is a small and narrow translucent ring close to the nucleus and the increment width is smaller than the next translucent ring then the small ring is not counted (Figure 5.4). In that case, the second more prominent ring is considered to be the first true annulus. The first winter ring

can vary in width between years and also areas. It can often appear as a wide banded area with varying levels of opacity.

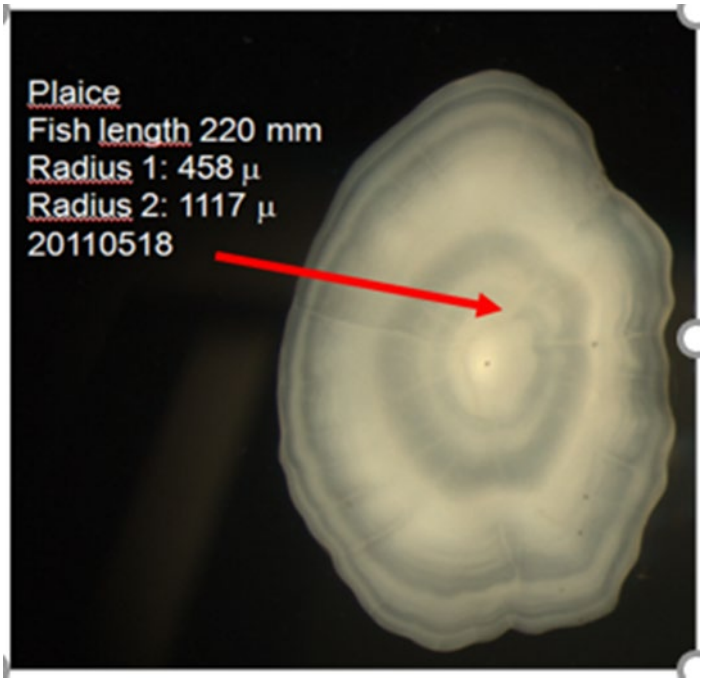


Figure 5.4. Plaice otolith from a fish captured in Skagerrak clearly shows the small, narrow translucent zone close to the nucleus which should not be included in the count of age. Taken from a presentation given at WGBIOP 2019.

5.2.1.4 Otolith edge

As age is determined relative to 1 January, the number of rings counted deviates from the number of rings visible in certain periods of the year. These periods depend on whether opaque or translucent rings are counted. It furthermore depends on temporal, spatial and age-related differences in the timing of opaque/translucent ring deposition. The translucent zone begins deposition from July and is usually not completed before New Year and can continue to be deposited through winter, there can be exceptions, especially with younger fish. It is important to note that regional differences in timing of otolith zone formation occur (see Introduction). Furthermore, fish age and annual temperature variations may also affect the timing of opaque/translucent growth.

Recording the edge type will allow for further investigations on the progression of edge type throughout the year and allow for comparison between areas and years.

5.2.1.5 When translucent rings are counted

For Q1 fish, there should be a translucent zone at the edge of the otolith. This translucent zone is counted when assigning an age. Therefore the age attributed is *n* where '*n*' is the number of translucent rings (Figure 5.5 a).

For Q2 fish, there should be a fully formed translucent zone at the edge of the otolith and there may also be evidence of opaque growth. This translucent zone is counted when assigning an age, therefore the age attributed is *n* where '*n*' is the number of translucent rings.

For Q3 fish one can expect to see either a translucent zone (possibly incomplete) or an opaque zone at the edge of the otolith.

- Generally, a translucent zone at the edge indicates the current year's growth and therefore is not counted; the age attributed is *n*-1.

- However, there can be some exceptions in older otoliths where there is a complete translucent zone at the edge with little or no opaque growth. In this case, the translucent zone is considered to be last year's growth and is therefore counted, the age attributed is *n*.
- If there is an opaque zone at the edge of the otolith then all translucent zones are counted and the age attributed is *n*.

Q3 causes the most confusion, as the age attributed is *n* or *n*-1. When assigning an age, one should consider certain factors such as whether the fish is young or old, whether it is early or late in the quarter, the area where the fish has been caught and consideration given to the regional, seasonal, and annual variations in temperature.

For Q4 fish, the edge of the otolith should have a translucent zone. This translucent zone is for the present winter and as the birth date is considered to be 1 January it is not counted. Therefore, the age assigned is *n*-1 (Figure 5.5 b).

5.2.1.6 When opaque rings are counted

For Q1 fish, the edge of the otolith should have a translucent zone. The opaque zone has not been deposited yet. Therefore, the age attributed is *m*+1 where '*m*' is the number of opaque rings (Figure 5.5 a).

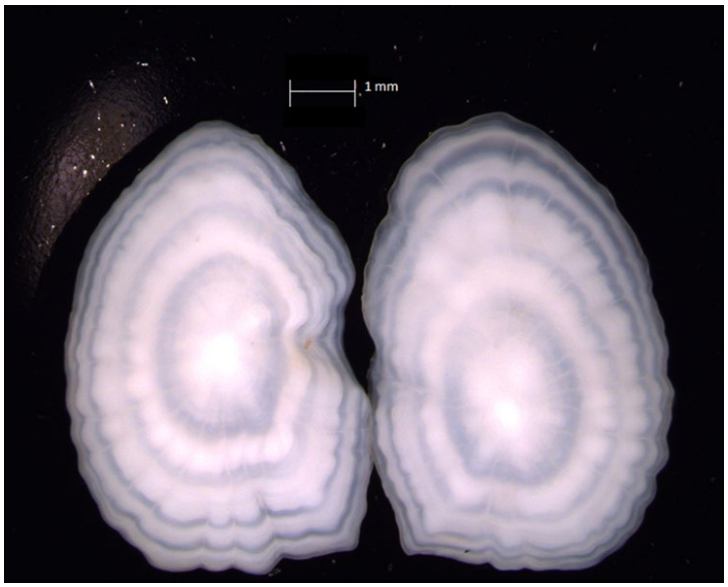
For Q2 fish, the edge of the otolith can be opaque or translucent. In young fish and fish from the southern part of the North Sea, the edge is usually already opaque. Translucent edges are observed in older fish originating in the northern part of the North Sea.

- If there is a translucent zone at the edge of the otolith then the otoliths are interpreted as Q1 otoliths, i.e. the age assigned is *m*+1.
- If there is an opaque zone at the edge of the otolith the age assigned is *m*.

For Q3 fish, the edge of the otolith can be opaque or translucent. In young fish and fish from the southern part of the North Sea, the edge is usually already translucent. Opaque edges are observed in older fish and fish originating in the northern part of the North Sea. In both cases the age assigned is *m*.

For Q4 fish, the edge of the otolith usually has a translucent zone, although in older fish and fish originating in the northern part of the North Sea the translucent zone formation may not have started yet. In both cases, the age assigned is *m* (Figure 5.5 b).

(a)



(b)

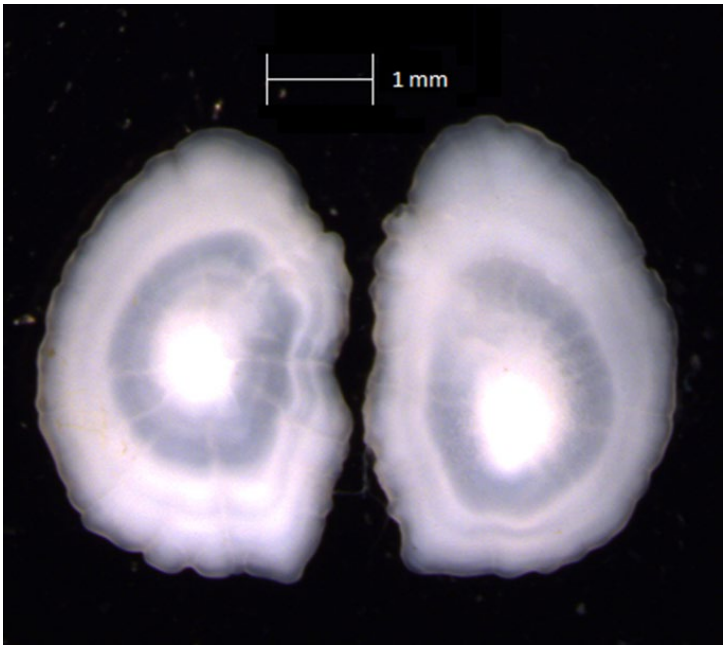


Figure 5.5. a) Whole otolith from plaice caught in Q1 (IBTS Q1 2022), 5 years of age, Skagerrak. Annotations are made between the end of the translucent and beginning of the opaque zone. The outer edge translucent zone is to be counted as a year, ergo the fish pictured was 5 years of age. b) Sectioned otolith from plaice caught in Q4 (BITS Q4 2020), 1 year of age, The Sound. Annotations are made between the end of the translucent and beginning of the opaque zone. The outer edge translucent zone is not to be counted as a year, ergo the fish pictured was 1 years of age.

5.2.1.7 Split rings

Split rings can be confused with true annuli which leads to age overestimation. Observation of the width of the rings from the nucleus to the edge gives a good indication as to whether it is a true ring or not. From nucleus to the edge, rings should get progressively narrower and more tightly packed, with the exception of the second annulus which may be larger in fish caught in the Skagerrak. However, due to environmental factors (i.e. starvation, water temperature fluctuation), this is not always true. Split rings can also be detected if the ring is not as prominent as the other rings. The final interpretation of age will depend on the experience of the age reader for a given stock.

5.3 Reference sets

It was agreed that a reference collection of plaice otoliths should be created, beginning with the images from this workshop that had an agreement of 100% from the advanced readers. This resulted in 16 images of whole otoliths from Skagerrak and the North Sea 13 whole otoliths and 17 sectioned otoliths with a 100% agreement, with an overlap of 10 otoliths with 100% agreement of both methods (the samples from both whole and sectioned were taken from the same fish). To increase the number of otoliths, the otoliths with 80–99% will be added to the reference set as well, and the advanced readers will be asked to re-read them, in hope that the agreement can increase to 100%. This raises the collection from 46 otoliths to 76 otoliths (Table 5.1).

Table 5.1. Overview of proposed samples to be included in the plaice reference set.

% agreement	Skagerrak whole # samples	North Sea whole # samples	North Sea sectioned # samples	North Sea overlapping # samples
100%	16	13	17	10
80–99%	7	13	10	

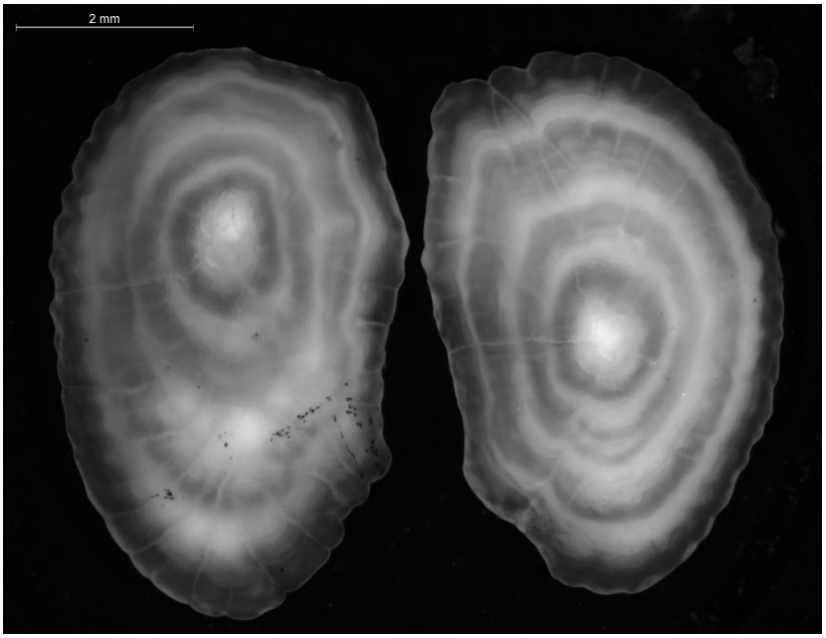


Figure 5.6. Whole otolith from Skagerrak caught in February. Agreed age 4 years.

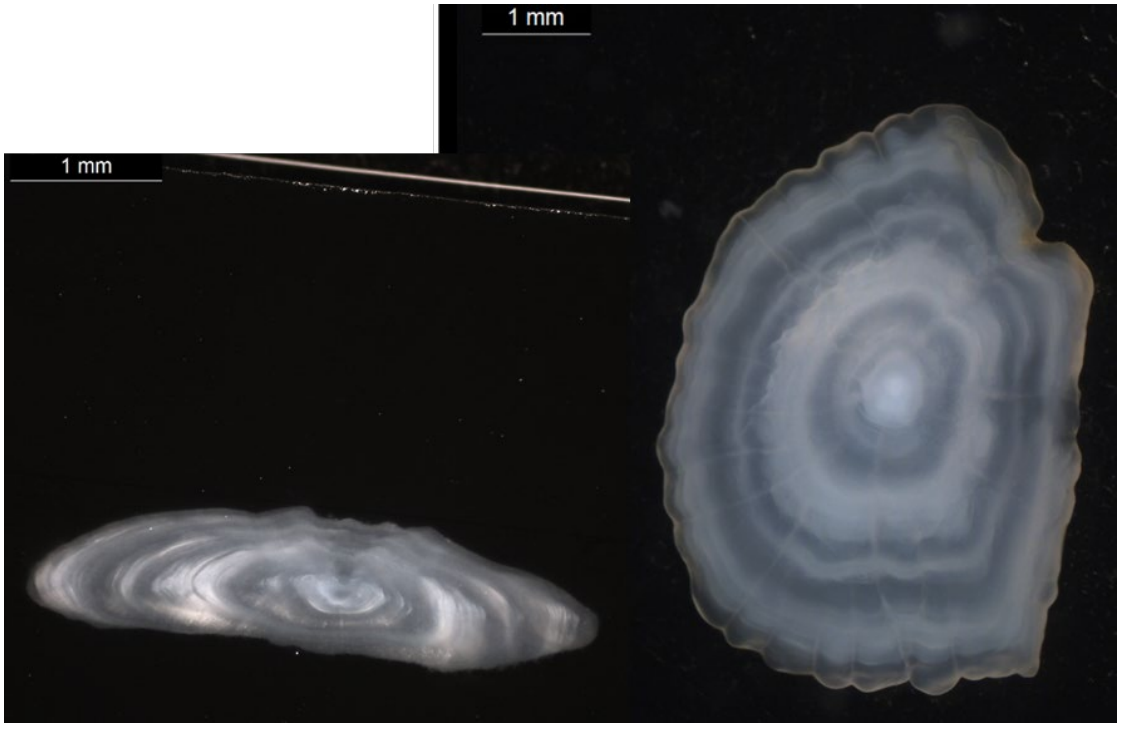


Figure 5.7. Sectioned (left) and whole (right) images of the same otolith from the North Sea caught in November. Agreed age 3.

To increase the number of otoliths with a 100% agreement between the advanced readers, more images need to be added to the collection in the following years. A subgroup has been created to keep an overview of how all quarters in Skagerrak and the North Sea are covered, and the goal is that samples from additional areas of the ple.27.420 stock shall be added to the reference collection. In future, the reference collection might be divided into smaller collections if possible, covering different areas/ICES squares, so there will be fewer crossovers and confusion for the readers. For this to become possible all laboratories that work routinely with plaice are asked to send good images (Figures 5.6 and 5.7 for example), of preferably both whole and sectioned images of the same otoliths, from all areas (suggested ~ 20 images per area per year, per institute) to the subgroup.

Only images photographed with reflected light will be included in the reference collection, as this is the method most laboratories are familiar with reading to avoid more confusion.

The reasons to create a reference set of plaice otoliths is that readers can make quality controls of their own work, but also so that new readers can have a set of otoliths to practise on, and to test new readers against more experienced readers.

It was discussed how large a set of reference images we aim for, and the conclusion being a little vague, ended with: big enough so that a random set can be read annually without having to re-read the same otolith many years in a row.

WGSMART are currently outlining a plan for including a reference collection module in the SmartDots software. This will require adaptation to the software. Input is required from WGBIOP on what samples a reference set should be comprised of, in terms of numbers per age, per area, what level of agreement between expert readers is required before an otolith can be included in the set and how to deal with otoliths which are problematic for the readers to interpret. The WKARP2 subgroup will cooperate with WGSMART and WGBIOP on this, to present the developments at WGBIOP 2022.

6 Address the generic ToRs adopted for workshops on age calibration

ToR e

WGBIOP outlines and annually updates Generic ToRs and outcomes for ageing workshops[9]each of which has been addressed by WKARP2.

a) Collect and review information on previous workshops

This has been addressed under ToR C (Section 4). A presentation of the overall results and outcomes of the 2010 WKARP was given on the first day of the workshop. Recommendations and follow-up actions have been addressed where possible. WKARP2 provided images of both whole and sectioned otoliths for the readers in both the 2020 exchange and the 2021 workshop exercise in an attempt to draw conclusions on the best age reading method for North Sea and Skagerrak plaice. WKARP2 also reviewed any validation work carried out on this stock since 2010.

b) Collect information on participating laboratory procedures

The following is an update (previously compiled by WKARP) to the procedures applied by the participating laboratories who are routinely reading North Sea and Skagerrak plaice and providing age data for stock assessment purposes.

Laboratory procedures

Plaice otoliths from the North Sea and Skagerrak areas are aged using 2 different preparation methods:

1. Whole otolith method: Both otoliths are put in a container (black or transparent) filled with a clear fluid (water, oil, alcohol).
2. Sectioned otolith method: Otoliths are embedded in resin (with or without black stain added) and then sectioned through the nucleus. The thickness of the slides range between 0.45 and 0.6 mm, with some using a glass coverslip as well.

The methods used by each country are outlined below:

Belgium

Two otoliths are collected from each fish and placed in an otolith plate. Before reading, the otoliths are submerged in tap water overnight (time may vary). The liquid is absorbed in the translucent zones and thus increasing the transparency of these rings, making the contrast between opaque and translucent zones more pronounced.

Then, the symmetric otolith (when possible) is removed from the otolith plate with tweezers and cleaned by rubbing off most of the dirt/blood with the fingers. Routinely, only one otolith is taken, but for unclear or difficult samples, both are used. The otolith is then placed in a water-filled black embryo dish with the concave (proximal) side down so that the nucleus is clearly visible and viewed under the stereomicroscope using reflected light. Reflected light shows the translucent rings as darker rings.

Otoliths are then photographed by using the LAS image acquisition software using the digital camera mounted on the stereomicroscope. A calibrated scale bar is set on the image according to

[9] https://www.ices.dk/community/Pages/PGCCDBS-doc-repository.aspx#gui.

the magnification used for the sample set. The magnification depends on the size of the otoliths. The ocular of the microscope has a standard magnification of 10x which is combined with the magnification setting used.

Denmark

Two preferably whole otoliths from each fish are placed in wells in a black plastic tray, broken can also be used. Each tray has 50 wells (5 rows of 10 wells in each).

Only whole otoliths are used. The whole otoliths are placed in distilled water with a few drops of soap per litre (added to break the surface tension), for around 2 hours and then read under a stereolup with reflective light at magnifications between 6,3 and 10.

We read the translucent (non-growth) rings on both rings, when possible. The asymmetric otolith are read towards the anterior end, and the symmetric otoliths are read towards the dorsal posterior edge, but both otoliths are taken in to considerations when aging. Often the otoliths are flipped over and the backside are used to double-check.

Biological factors are used when outliners needs to be checked.

- AQ scores a used when assessing the readability of the otoliths;
- AQ1 Rings can be counted with certainty;
- AQ2 Rings can be counted with difficulty and some doubt;
- AQ3 Rings cannot be counted, the calcified structure is considered unreadable - no age assigned;
- Edge structures are noted on all otoliths.

Norway

All otoliths are collected at the IBTS surveys Q1 and Q3 in the North Sea (4a) and Skagerrak (3a20). Both the otoliths are collected from the fish and kept in paper envelopes. If possible, the otoliths are read whole at the survey immersed in milli Q-water and read immediately using reflected light. Otoliths that are difficult to read are taken onshore and sectioned at the laboratory. At the laboratory the most symmetric otolith are embedded in epoxy, and sectioned through the nucleus using a Buehler IsoMet low speed cutting machine. The cuts are attached to an objective glass and examined using transmitted light and milli Q-water.

UK (England)

Otoliths are embedded in resin (without added black stain) and then sectioned through the nucleus. One is mounted in black resin, which is then sectioned and mounted on a clear glass slide with a glass coverslip. The thickness of the slides range between 0.5 and 0.6 mm. Otoliths are mounted in rows dependant on size of otoliths (6–12 otoliths per row). The sectioned otoliths are read using transmitted light using a microscope.

France

Both sagittal otoliths are collected and stored in small paper envelopes.

Plaice otoliths can be analysed without any preparation. All whole otoliths are placed in tap water and read on a black background, using a stereomicroscope with reflected light.

Images are taken with ICY software, and then used for reading and annotating with TNPC software.

Sweden

Both otoliths are collected, cleaned carefully, and put in plastic trays or in paper envelopes. Generally, Sweden reads the otoliths whole. The otoliths are placed in water or ethanol in a black

dish and read in a stereomicroscope using reflected light. The otoliths are not soaked before reading.

If the otoliths are difficult to read or have obvious "cliff edge" issues, they are broken transversally, through nucleus, using pliers. The broken otolith is placed in plasticine, and a drop of propylene alcohol is applied on the cross-section to facilitate reading.

Germany (Bremerhaven)

Both otoliths are collected from all fish if it's possible. We take fish starting from 4cm up.

Afterwards the otoliths are cleaned with water and freed from any other remains and put into a clean Eppendorf vial and leave it open for drying.

The time for drying depends on the otolith size (10–24h).

Directly before reading we put them 20 min in water and let them soak. Max. soaking time 2h. We read the whole otolith, uncut, uncoloured, unburned in water with reflected or transmitted light. Which light is used depends on their readability. We read the digital photographic picture and the three-dimensional live picture directly under the microscope, to visualize possible edge which are incredible on two-dimensional pictures. We read the translucent winter rings. It might be helpful to use bigger/older otolith´s as a reference to identify real 0 or 1 age.

The Netherlands

Both otoliths are collected from all fish. The otoliths from surveys are collected in paper envelopes with sample ID (i.e. haul or equivalent) and fish numbers on.

For market sampling, otoliths are collected in plastic containers with sixty holes, ten in a row. Both otoliths of one fish are put in one hole. Each hole has a number corresponding to the fish number per sample.

For both market and surveys, one otolith (the symmetric one is preferred) of each pair is embedded in black resin and sectioned through the nucleus. The other otolith is stored in paper envelopes. Three resin strips, containing 10 sectioned otoliths each, are glued to a glass slide using clear resin. No coverslip is used. Before taking a picture, the sections are lubricated with a thin layer of (sewing machine) oil. The sections are photographed using reflected light. A picture is taken of each otolith. On each sample (photo) the scale is set. After photographing the otoliths slides are stored in plastic containers in the WMR archive. Photos are also stored in a digital archive.

Reading the otoliths is done using the program SmartDots. A line (with maximum one hook in it) is set by the age reader from the centre over the longest part of the rings on the otolith (if possible, if not it is noted in 'Edit Notation' as 'deviating reading line'). Annotations (bullets) are set at the border between the translucent and opaque rings. After finishing the whole sample the year classes will be added to the samples and read into the WMR database during the next night.

c) Classify age reading performance

Using the descriptions provided by WGBIOP the age reading performance for North Sea and Skagerrak plaice can be categorized as 'medium'. Both age reading guidelines and an age reading manual exist. The former referring to the age reading methods, quality control procedures and image capture techniques, the later referring to interpretation of the otolith growth pattern observed when estimating the final age of the fish. With respect to an agreement on what is the best-suited age reading method to be applied to this stock, WKARP2 concludes that there is no advantage in sectioning plaice in fish below the age of 6. For older fish and especially where the otoliths are increasing in thickness as opposed to growing in the horizontal plane and thus causing a cliff edge effect, sectioning is advised to ensure that the outermost rings can be clearly

identified and included in the count of age. When comparing the levels of agreement and precision across previous exchanges and workshops there is little change. For some readers, issues remain with the correct identification of the first winter ring but it is hoped that the discussions held during WKARP and the reference collection will help to rectify these. Unfortunately not all of these readers attended the 2021 workshop.

No reference target values for levels of agreement exist for the ple.27.420 stock. Cooperation between the stock assessor for ple.27.420 and WKARP2 was established following the 2020 exchange and correspondence on age reading issues relevant to stock assessment has been ongoing.

The stock coordinator of the plaice North Sea stock gave a presentation on the use of plaice age in stock assessment and issues related to this. With the development of the standardized reporting script from SmartDots, AEM's (age reading error matrices) have now become an output from SmartDots events which can be integrated into the stock assessment models. In cooperation with The ICES Workshop on the use of Ageing and Maturity Staging Error Matrices in Stock Assessment (WKAMEMSA; ICES, 2022), it was discussed if the stock could be used as a case study for integration of ageing errors in the stock assessment. As a benchmark is foreseen in 2022, the stock coordinator agreed to take up this work and to use the results of this workshop as input in the SAM model. The stock was added to the WKAMEMSA recommendation list as a possible case study. WKARP2 have provided the stock assessor with both the empirical AEM's and the raw data output from both the 2020 exchange and 2021 workshop exercise. The incorporation of these data into the model runs will allow for an evaluation of the age reading performance and its effect on the stock assessment.

d) Resolve interpretation differences between readers and laboratories

Unfortunately, not all readers who competed in the 2020 North Sea and Skagerrak plaice exchange attended the 2021 workshop. This makes it extremely difficult to rectify any disagreements that exist on the interpretation of the otolith growth patterns. The results showed that age readers from some laboratories are in disagreement with modal age more often compared to others and the national age reader coordinators were present from these institutes. It is the responsibility of these national coordinators and their age readers to come to an agreement on what follow up actions need to be taken.

e) Validation studies on age estimations

WKARP2 reviewed recent validation studies carried out for plaice, this included work carried out on juvenile plaice from the Baltic and on juvenile plaice from a fjord in the Skagerrak. In preparation for WKARP2 (Section 4.3.1) samples were collected with the aim to provide measurement guidelines for the readers to follow when identifying the first winter ring. This aim was not fulfilled, mostly due to poor image quality. It is however hoped that once a standardized set of guidelines for image taking are defined then this work could be taken up again.

f) Create or update an ageing manual

WKARP2 reviewed the age reading manual compiled by WKARP in plenary and updated it (Section 5.2). The main change is that the break and burn method has been removed as this is not a method applied when reading North Sea plaice. The description of age reading methods applied in the laboratories reading otoliths from North Sea plaice are described in the age reading guideline (Section 5.1). Investigations into soaking time for whole otoliths and staining and sectioning otoliths were carried out in preparation for WKARP and are described in Section 3.2.

g) Collate agreed age reference collection.

A subgroup of WKARP2 will continue to compile a reference set for North Sea plaice (Section 5.3).

h) Formulate follow-up actions

A number of follow up actions are recommended by WKARP2:

- The updated guidelines and manual are followed, especially with respect to the preparation methods applied when age reading.
- The collection of age 0 and age 1 fish is to be extended in order to facilitate further investigations of the first winter ring formation. Images of the otoliths should be taken following an agreed protocol.
- A small workshop on image taking techniques be organized, the outcome of which should be a protocol with a set of clear and standardized procedures to be followed by all laboratories for correct calibration, light settings etc, when taking images of otoliths for age reading and growth studies.
- WGBIOP should include North Sea and Skagerrak plaice in their list of stocks which are prioritized for validation studies
- Outcomes from the work planned for the ple.27.420 benchmark, where both the empirical AEM's (age error matrices) and the raw data output from the 2020 exchange and 2021 workshop exercises will be incorporated into the assessment model runs, are considered when planning future exchanges and workshops.
- The national age reader coordinators are responsible for follow-up actions with their readers if there are concerns about the levels of accuracy and precision.
- Once the reference collection has been compiled and available on SmartDots it is be used for readers to make quality control checks of their own readings.

In addition, the following formal recommendations will be made:

- WGBIOP to organize a small workshop on otolith image capture techniques. The outcome of which should be a protocol with a set of clear and standardized procedures to be followed by all laboratories when taking images of otoliths for age reading and growth studies. This should happen as soon as possible.
- WGSMART to implement the reference collection module development and WGBIOP to agree on what a reference collection should be comprised of.
- WGBIOP to include a validation study on 1st winter ring formation in its prioritizing table.

7 Conclusions

Workshop 2 on age reading of North Sea plaice (*Pleuronectes platessa*)

WKARP2 was due to take place as a physical workshop but initial plans were hampered due to travel and meeting restrictions because of the COVID-19 pandemic. The workshop was postponed with the hope of being able to meet physically but eventually, it was agreed that an online workshop should be held.

Prior to WKARP2, the 2020 North Sea and Skagerrak plaice exchange was also delayed due to COVID-19, but the use of the SmartDots platform[10] where readers can annotate and compare images of otoliths facilitated both calibration exercises (prior to and during the workshop). An R script produces a standardized set of results which are included in this workshop report.

Results from the 2020 North Sea and Skagerrak plaice exchange, based on the multistage modal age approach which incorporates a weighting based on age reader expertise (ICES, 2019), based on all readers and all samples combined give an overall CV of 47%, PA of 72% and APE of 27%. The high CV values at modal ages 0, 1 and 2 (partly attributable to the inclusion of the CVs at modal age 0) are most concerning, as this indicates issues with correct interpretation of the first winter ring at younger ages which can subsequently lead to incorrect interpretation issues as the fish become older. Results based only on advanced readers (those providing age data for assessment purposes) were similar, with and overall positive bias, indicating a tendency for readers to overestimate the age compared with modal age. Presentation and discussion of annotated images was aimed at clarifying some of the reasons for the disagreement between readers. Results by area (27.3.a.20 and 27.4) and age reading method (whole and sectioned) were also discussed. Levels of agreement were higher for the North Sea samples and similar for both age reading methods, the general trend of positive bias also similar. These results need to be considered in light of the fact that readers were asked to read otoliths from all areas and methods. An additional analysis was aimed at providing results which reflect the bias in the age data used for stock assessment purposes, thus only using data from advanced readers using their routine age reading methods. Stock level results are similar to an overall PA of 73% and CV of 32%. Overall reader bias is positive overall at 0.06, ranging from 0.08 to 0.28 at modal ages 0 to 7 (with the exception of modal age 4 which is negative) and individual reader bias ranging from −0.52 to 0.89. A smaller age reading exercise was carried out on SmartDots during the workshop (2021 North Sea and Skagerrak Plaice, ID 402). The traditional approach was then applied when calculating modal age as the SmartDots R script has yet to be updated with the multistage modal age approach. Again, a series of analyses considering expertise, area and reading method were carried out. Similar levels of PA and CV were reached compared to the 2021 exercise. For advanced readers the PA for whole otoliths is 74% and CV 20% (highest at modal ages 1, 2 and 3) and for sectioned otoliths is 74% and CV 14% (highest at ages 1 and 2). A comparison of results between the traditional modal age approach and the multistage modal age approach showed little difference, as there were only seven samples with multimodal ages. This should not be considered a true test of the differences between the two methods.

Participants provided information on their respective laboratory procedures for age reading of plaice belonging to the stock ple.27.420. Methods applied are either whole otoliths read with reflected light or sectioned otoliths with reflected light. Preparations carried out in advance of the workshop also provided sectioned otoliths which had also been stained, but the group

[10] https://www.ices.dk/data/tools/Pages/smartdots.aspx

concluded that staining sectioned plaice otoliths does not improve the readability. The group also concluded that sectioning otoliths from young fish (age 0–6) does not provide added benefit compared to reading the whole otoliths, but could lead to an overestimation of age compared to whole otoliths. In terms of applying measurement guidelines in future, whole otoliths would probably be easier to work with as many laboratories are not sectioning otoliths routinely. However, for institutes who are sectioning otoliths, it would be relevant to include also sectioned samples in future exchanges. As in the workshop of 2010, it was concluded that sectioning of otoliths from fish above the age of 6 could be beneficial, as it can be easier to identify the growth structures closer to the otolith edge, as the otoliths begin to increase in size vertically as opposed to horizontally. Investigations into otolith soaking time when reading whole otoliths indicates that prolonged soaking (24 hours) will increase the transparency of the otoliths and contrast between growth structures is reduced, this could lead to incorrect estimation of age. Further work is required to find the optimal soaking time which is likely to be dependent on the size of the otolith. A set of age reading guidelines and a manual was agreed upon and this should be followed by all laboratories age reading plaice from the ple.27.420 stock.

A review of validation studies on first winter ring formation was carried out and preparations for the workshop also attempted to clarify difficulties related to this issue. No definitive conclusions can be drawn but it has been identified that the size of the first winter ring can fall within a wide range and is attributable to variations in fish growth, habitat, temperature and spawning behaviour. Further work is needed before any measurement guidelines can be established.

Communication of the stock assessment-related age reading issues with the stock assessor is ongoing. The ple.27.420 stock assessor gave a presentation at the workshop and age-related concerns were discussed. Data has been provided which can be tested in the assessment model runs and should be considered in the 2022 benchmark.

A WKARP2 subgroup has been formed to establish a reference collection of agreed age plaice otoliths. They will cooperate with ICES WGSMART (Working Group on SmartDots Governance) and ICES WGBIOP (Working Group on Biological Parameters) to establish a reference set module in SmartDots plus a set of criteria which should be met when creating a reference set to be used for future training and calibration purposes. Discussions on otolith image quality concluded that a small workshop is required to establish a set of guidelines to be followed when taking images for calibration exercises, validation work, reference collections and routine age reading. The workshop should focus primarily on calibration of image formats, lighting and scale bars.

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Annex 2: Resolutions

WKARP2 – Workshop 2 on age reading of North Sea plaice (*Pleuronectes platessa*)

2020/WK/DSTSG11 The **Workshop 2 on age reading of North Sea plaice (*Pleuronectes platessa*)** (WKARP2), chaired by Ulrika Beier*, Netherlands, and Julie Coad Davies*, Denmark, will be established and meet online 6–10 December 2021 to:

a) Review results and outcomes of the 2020 North Sea Plaice exchange (SmartDots ID 281); (Science Plan codes: 5.1, 5.2);

b) Review and compare existing methods for age reading of North Sea plaice (Science Plan codes: 5.1, 5.2);

c) Review information on age estimations, otolith exchanges, workshops, and validation work done so far; (Science Plan codes: 5.1, 5.2);

d) Review existing guidelines and ageing criteria and compile an updated age reading manual with reference image sets; (Science Plan codes: 5.1, 5.2);

e) Address the generic ToRs adopted for workshops on age calibration; (Science Plan codes: 5.1, 5.2). WKARP2 will report by [TBD] for the attention of DSTSG, WGBIOP, and WGSMART.

Supporting information

Priority	Age determination is essential in fish stock assessment where estimates of growth and mortality rates are utilized in the models. Reliable age estimates are thus required to support suitable management and advice procedures. Age data are provided by national laboratories using internationally agreed ageing criteria and it is necessary to ensure that guidelines and criteria are agreed upon and followed. Therefore, otolith exchanges should be carried out on a regular basis and if reoccurring problems exist then an age reading workshop should be organized to address and solve these issues.
Scientific justification	The general aim of the workshop is to standardize the age determination criteria followed in national age reading laboratories and to identify and address existing and potential problems in the age determination of *Pleuronectes platessa*. Examination of levels of accuracy and precision across readers and laboratories is required to improve the quality of the age data as input into stock assessment models. Analysis of the variability of the growth patterns observed in the otoliths can support the age determination process and provide biological parameter-related information relevant to the stock assessment. Validation studies based on these patterns can result in a true age determination and a review of validation studies to date will be made. The results of the 2020 North Sea plaice age reading exchange will be presented and discussed and will form the basis of an analysis of the most suitable method for age reading of North Sea plaice.
Resource requirements	No specific resource requirements beyond the need for participants to prepare for and partake in the meeting.
Participants	Given its relevance to the EU Data Collection Framework (DCF) and the ICES quality assurance process, the workshop is expected to attract interest from ICES Member States. The workshop aims to bring together international experts on plaice age reading and scientists involved in assessment in order to assess the accuracy and precision of the age data used as input into stock assessment.

Secretariat facilities	Report formatting and online meeting coordination.
Financial	No financial implications.
Linkages to advisory and science committees	ACOM.
Linkages to other groups	WGBIOP, WGSMART.
Linkages to other organizations	There is a direct link with the EU DCF.

Annex 3: Results of the 2020 North Sea plaice exchange

Table A3.1. Advanced readers – stock level analysis. SampleID and sample origin with reader ID, reading method (s = sectioned and w = whole), readers age per sample. For each sampleID modal age, PA (percentage agreement) and CV (co-efficient of variation) are given.

SampleID	Sample origin	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	Modal age	PA %	CV %
148_CDDR09_PLE_4B_D_S_226291	NSEA	0	0	0	0	1	1	0	0	0	-	0	0	80%	211%
149_CDDR09_PLE_4B_D_S_226292	NSEA	0	0	0	0	1	1	0	0	0	-	0	0	80%	211%
145_CDDR09_PLE_4B_D_S_226275	NSEA	0	0	0	0	0	-	0	0	0	-	0	0	100%	0%
146_CDDR09_PLE_4B_D_S_226278	NSEA	0	0	0	0	1	4	0	0	0	-	0	0	80%	254%
147_CDDR09_PLE_4B_D_S_226279	NSEA	0	0	0	0	1	2	0	0	0	-	0	0	80%	225%
111_BYDR02_PLE_4B_D_S_2018030510103	NSEA	2	2	3	3	2	2	2	1	2	-	2	2	70%	27%
112_BYDR02_PLE_4B_D_S_2018030510104	NSEA	1	1	1	3	1	1	1	1	2	-	1	1	80%	52%
119_BYDR02_PLE_4B_D_S_2018030510144	NSEA	4	4	4	4	4	4	4	4	4	-	4	4	100%	0%
120_BYDR02_PLE_4B_D_S_2018030510157	NSEA	4	4	4	4	4	5	4	4	4	-	4	4	90%	8%
2019_101001_035	NSEA	12	6	12	11	8	12	11	7	11	-	6	12	30%	27%
2019_101003_042	NSEA	5	6	5	6	7	8	6	5	6	-	6	6	50%	16%
2019_101005_025	NSEA	7	7	7	7	-	7	5	5	7	-	5	7	67%	16%

SampleID	Sample origin	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	Modal age	PA %	CV %
2019_101012_032	NSEA	8	6	8	8	-	10	9	8	8	-	0	8	56%	40%
2019_101013_006	NSEA	10	10	10	10	-	11	11	9	10	-	10	10	67%	6%
2019_101019_028	NSEA	6	5	7	6	-	7	5	5	7	-	5	5	44%	16%
2019_101023_053	NSEA	7	8	8	9	-	9	9	8	9	-	7	9	44%	10%
2019_101037_042	NSEA	6	7	8	7	-	9	12	6	7	-	5	7	33%	28%
2019_101034_040	NSEA	7	7	7	7	-	8	7	7	7	-	7	7	89%	5%
2019_101035_027	NSEA	16	7	17	8	-	16	15	5	14	-	7	16	22%	41%
2019_101034_008	NSEA	10	10	9	10	-	9	10	10	9	-	8	10	56%	8%
2019_101037_007	NSEA	12	10	11	9	-	14	15	9	10	-	9	9	33%	20%
2019_1400123_218	NSEA	7	5	5	5	-	7	6	5	5	-	5	5	67%	16%
2019_1400129_308	NSEA	1	2	1	2	-	4	2	2	1	-	2	2	56%	49%
2019_1400130_313	NSEA	10	5	9	8	-	10	8	-	6	-	-	10	29%	24%
2019_1400164_600	NSEA	1	1	1	1	-	-	2	1	1	-	1	1	88%	31%
2019_1400005_094	NSEA	1	1	1	1	-	3	1	1	2	-	1	1	78%	53%
2019_1400002_032	NSEA	9	4	8	8	-	10	8	8	8	-	8	8	67%	20%
2019_1400004_081	NSEA	7	5	7	7	-	7	7	7	8	-	7	7	78%	11%
137_BTS01_PLE_4B_2019082621773	NSEA	2	2	2	3	2	3	2	2	2	-	2	2	80%	19%

SampleID	Sample origin	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	Modal age	PA %	CV %
143_BTS01_PLE_4B_2019082621771	NSEA	5	5	5	5	5	5	5	5	6	-	5	5	90%	6%
142_BTS01_PLE_4B_2019082621772	NSEA	4	4	4	4	4	5	4	4	4	-	4	4	90%	8%
140_BTS01_PLE_4B_2019082621761	NSEA	4	3	3	3	3	4	3	3	3	-	3	3	80%	13%
139_BTS01_PLE_4B_2019082621759	NSEA	3	3	3	3	3	3	3	3	3	-	3	3	100%	0%
141_BTS01_PLE_4B_2019082621762	NSEA	4	4	4	4	4	4	4	4	4	-	4	4	100%	0%
2019_1400051_913	NSEA	8	8	8	8	-	8	8	7	8	-	7	8	78%	6%
2019_1400052_928	NSEA	8	5	8	8	-	8	9	7	8	-	5	8	56%	19%
2019_2200117_172	NSEA	1	1	1	1	-	1	1	1	1	-	1	1	100%	0%
2019_2100026_152	NSEA	1	1	1	1	-	1	1	1	1	-	1	1	100%	0%
2019_2100041_230	NSEA	1	1	1	2	-	1	1	1	1	-	1	1	89%	30%
2019_2100037_198	NSEA	1	1	1	1	-	1	1	1	1	-	1	1	100%	0%
151_BYDR07_PLE_4B_D_S_2019110710124	NSEA	2	2	2	2	2	2	2	2	2	-	1	2	90%	17%
155_BYDR07_PLE_4B_D_S_2019110710135	NSEA	2	2	2	4	3	3	4	2	4	-	2	2	50%	33%
152_BYDR07_PLE_4B_D_S_2019110710109	NSEA	3	3	3	3	3	4	3	3	3	-	2	3	80%	16%

SampleID	Sample origin	R04 NL S	R18 DK W	R10 NL S	R12 BE W	R02 SE W	R16 GB S	R14 BE W	R04 NL W	R08 SE W	R10 NLD W	R06 DK W	Modal age	PA %	CV %
150_BYDR07_PLE_4B_D_S_20191107 10101	NSEA	2	2	2	2	2	2	3	2	2	-	2	2	90%	15%
153_BYDR07_PLE_4B_D_S_20191107 10114	NSEA	3	2	3	3	4	3	4	3	3	-	2	3	60%	22%
154_BYDR07_PLE_4B_D_S_20191107 10115	NSEA	3	3	3	4	4	4	4	3	4	-	3	3	50%	15%
157_BYDR07_PLE_4B_L_M_201911 0710497	NSEA	5	5	5	5	5	6	5	5	5	-	5	5	90%	6%
156_BYDR07_PLE_4B_L_M_201911 0710459	NSEA	5	5	5	5	5	6	5	5	5	-	5	5	90%	6%
106_PTCT04_PLE_4C_D_M_201705 1110262	NSEA	1	2	1	1	1	1	1	1	1	-	1	1	90%	29%
108_PTCT04_PLE_4C_D_M_201705 1110272	NSEA	1	2	1	3	1	1	1	1	1	-	1	1	80%	52%
107_PTCT04_PLE_4C_D_M_201705 1110264	NSEA	1	1	1	1	1	1	1	1	1	-	1	1	100%	0%
104_BYDR03_PLE_4C_D_M_201803 2910300	NSEA	1	1	1	3	1	-	1	1	1	-	1	1	89%	55%
105_BYDR03_PLE_4C_D_M_201803 2910301	NSEA	1	1	1	3	1	1	1	1	1	-	1	1	90%	53%
103_BYDR03_PLE_4C_D_M_201803 2910299	NSEA	1	1	1	3	1	1	1	1	1	-	1	1	90%	53%
101_BYDR03_PLE_4C_D_M_201803 2910297	NSEA	1	1	1	2	1	0	1	1	1	-	1	1	80%	47%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
102_BYDR03_PLE_4C_D_M_2018032910298	NSEA	1	1	1	4	1	1	1	1	1	-	1	1	90%	73%
116_BYDR03_PLE_4C_L_M_2018032910318	NSEA	3	3	3	3	3	3	3	3	3	-	3	3	100%	0%
123_BYDR03_PLE_4C_L_M_2018032910312	NSEA	5	4	5	5	4	5	4	4	5	-	4	5	50%	12%
115_BYDR03_PLE_4C_L_M_2018032910317	NSEA	3	3	3	4	3	3	3	3	4	-	3	3	80%	13%
124_BYDR03_PLE_4C_L_M_2018032910324	NSEA	5	5	5	5	5	5	5	5	5	-	5	5	100%	0%
117_PTCT04_PLE_4C_D_S_2018052110001	NSEA	3	4	1	3	3	2	3	1	3	-	3	3	60%	37%
109_PTCT04_PLE_4C_D_S_2018052110003	NSEA	1	2	1	1	1	1	1	1	2	-	1	1	80%	35%
110_PTCT04_PLE_4C_D_S_2018052110006	NSEA	1	2	1	3	1	1	1	1	2	-	1	1	70%	50%
118_PTCT04_PLE_4C_D_S_2018052110004	NSEA	3	3	2	3	3	2	3	2	3	-	3	3	70%	18%
113_PTCT04_PLE_4C_D_S_2018052110026	NSEA	2	2	3	2	2	2	2	2	2	-	2	2	90%	15%
114_PTCT04_PLE_4C_D_S_2018052110030	NSEA	2	2	2	3	2	2	2	2	2	-	2	2	90%	15%
125_PTCT04_PLE_4C_D_S_2018052110029	NSEA	5	4	5	5	4	5	5	5	5	-	4	5	70%	10%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
121_PTCT04_PLE_4C_D_S_2018052110038	NSEA	4	4	4	4	4	4	4	4	4	-	4	4	100%	0%
122_PTCT04_PLE_4C_D_S_2018052110040	NSEA	4	4	4	4	4	4	4	4	4	-	4	4	100%	0%
126_PTCT04_PLE_4C_D_S_2018052110037	NSEA	5	5	5	5	5	6	5	5	5	-	5	5	90%	6%
2019_101009_050	NSEA	7	7	7	7	-	7	7	7	7	-	7	7	100%	0%
2019_101009_021	NSEA	9	9	9	9	-	9	9	9	9	-	9	9	100%	0%
2019_101011_048	NSEA	9	8	9	8	-	9	8	8	9	-	6	9	44%	12%
2019_101016_014	NSEA	7	8	7	8	-	9	9	8	10	-	8	8	44%	12%
2019_101027_055	NSEA	5	5	5	5	-	7	5	3	4	-	4	5	56%	23%
2019_101028_016	NSEA	7	7	7	7	-	7	7	7	7	-	7	7	100%	0%
2019_101032_050	NSEA	6	6	6	6	-	7	6	6	6	-	6	6	89%	5%
2019_101033_033	NSEA	8	7	6	7	-	8	8	6	8	-	6	8	44%	13%
2019_101041_031	NSEA	6	5	5	6	-	8	8	5	6	-	5	5	44%	20%
2019_101042_060	NSEA	8	7	8	7	-	9	8	6	7	-	4	8	33%	20%
2019_101045_020	NSEA	10	-	10	10	-	10	10	10	10	-	10	10	100%	0%
138_BTS01_PLE_4C_2019082620601	NSEA	2	2	3	2	1	2	2	2	2	-	2	2	80%	24%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
144_BTS01_PLE_4C_2019082620593	NSEA	5	5	5	5	5	5	5	5	5	-	5	5	100%	0%
2019_101047_012	NSEA	7	7	7	8	-	10	8	7	8	-	7	7	56%	13%
127_DYFS01_PLE_4C_2019091610018	NSEA	0	0	0	1	0	0	0	0	0	-	0	0	90%	316%
128_DYFS01_PLE_4C_2019091610019	NSEA	0	0	0	0	0	0	0	0	1	-	0	0	90%	316%
129_DYFS01_PLE_4C_2019091610036	NSEA	0	0	1	0	1	0	0	0	1	-	0	0	70%	161%
130_DYFS01_PLE_4C_2019091610044	NSEA	-	0	0	0	0	0	0	0	1	-	0	0	89%	300%
134_DYFS01_PLE_4C_2019091610033	NSEA	1	1	1	1	1	1	1	1	1	-	1	1	100%	0%
133_DYFS01_PLE_4C_2019091610032	NSEA	1	-	1	1	1	1	1	1	1	-	1	1	100%	0%
131_DYFS01_PLE_4C_2019091610045	NSEA	0	0	0	0	0	1	0	0	1	-	0	0	80%	211%
132_DYFS01_PLE_4C_2019091610031	NSEA	1	1	1	1	1	1	1	1	1	-	1	1	100%	0%
136_DYFS01_PLE_4C_2019091610047	NSEA	1	1	1	1	2	1	1	1	1	-	1	1	90%	29%
135_DYFS01_PLE_4C_2019091610042	NSEA	1	1	1	1	2	2	1	1	2	-	1	1	70%	37%
2019_4100009_175	NSEA	2	2	2	2	-	-	2	2	2	-	2	2	100%	0%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
2019_2100002_026	NSEA	1	1	1	1	-	2	1	1	1	-	1	1	89%	30%
2019_101051_029	NSEA	8	8	8	8	-	8	9	8	8	-	8	8	89%	4%
2019_101053_057	NSEA	11	7	9	7	7	9	8	7	7	-	7	7	60%	17%
2019_101054_036	NSEA	6	6	6	6	6	6	7	6	6	-	6	6	90%	5%
2019_101053_037	NSEA	9	8	10	9	8	9	10	8	9	-	8	9	40%	9%
2019_101052_043	NSEA	8	5	7	9	-	7	9	6	8	-	5	8	22%	22%
2019_101052_002	NSEA	9	7	9	9	-	9	10	7	9	-	8	9	56%	12%
2019_2100081_309	NSEA	1	1	1	1	-	1	1	1	1	-	1	1	100%	0%
2019_101058_003	NSEA	7	6	7	8	6	8	6	6	7	-	6	6	50%	12%
2019_101058_020	NSEA	9	8	10	9	7	10	10	8	10	-	7	10	40%	14%
2019_101063_049	NSEA	9	5	9	8	7	9	7	6	8	-	6	9	30%	19%
20110816 11 31mm	SKAG	-	0	-	0	0	-	0	0	-	0	0	0	100%	0%
20110816 14 41mm	SKAG	-	0	-	0	0	-	0	0	-	0	0	0	100%	0%
20110816 5 41mm	SKAG	-	0	-	0	0	-	0	0	-	0	0	0	100%	0%
20110816 7 47mm	SKAG	-	0	-	0	0	-	0	0	-	-	0	0	100%	0%
20110816 4 67mm	SKAG	-	0	-	0	0	-	0	0	-	0	0	0	100%	0%
20121116 13 73mm	SKAG	-	0	-	1	0	-	0	0	-	0	0	0	86%	265%
20121116 4 91mm	SKAG	-	0	-	1	0	-	0	0	-	0	0	0	86%	265%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
20121116 9 92mm	SKAG	-	0	-	1	0	-	0	0	-	0	0	0	86%	265%
20121116 14 103mm	SKAG	-	0	-	2	0	-	0	0	-	0	1	0	71%	184%
20121116 6 109mm	SKAG	-	0	-	1	0	-	0	0	-	0	0	0	86%	265%
7058561_ALA_RLX_X0	SKAG	-	9	-	10	9	-	10	8	-	9	8	9	43%	9%
IBTS_2016_50	SKAG	-	8	-	10	7	-	10	8	-	8	-	8	50%	14%
7448341	SKAG	-	10	-	11	11	-	12	10	-	10	10	10	57%	7%
7462156_ALA_RLX_B0	SKAG	-	4	-	4	4	-	4	4	-	4	4	4	100%	0%
7453931_ALA_RLX_BB	SKAG	-	7	-	7	7	-	7	7	-	7	7	7	100%	0%
7467697	SKAG	-	10	-	11	10	-	11	11	-	10	10	10	57%	5%
7467690	SKAG	-	9	-	11	9	-	11	9	-	9	9	9	71%	10%
7517367_ALA_RLX_XX	SKAG	-	5	-	6	5	-	6	5	-	5	5	5	71%	9%
7517370_ALA_RLX_XX	SKAG	-	5	-	5	5	-	5	5	-	5	5	5	100%	0%
7506518	SKAG	-	6	-	7	6	-	7	7	-	6	7	7	57%	8%
7506495	SKAG	-	8	-	9	8	-	9	8	-	8	8	8	71%	6%
7506488	SKAG	-	7	-	7	7	-	7	7	-	7	7	7	100%	0%
7535780	SKAG	-	4	-	4	4	-	4	4	-	4	4	4	100%	0%
7535720	SKAG	-	15	-	14	14	-	19	13	-	14	13	14	43%	14%
7535729	SKAG	-	15	-	14	13	-	15	14	-	15	14	15	43%	5%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
7535731	SKAG	-	6	-	10	7	-	11	7	-	9	9	7	29%	22%
7535730	SKAG	-	15	-	14	13	-	16	14	-	15	13	15	29%	8%
7526490	SKAG	-	4	-	4	4	-	5	4	-	4	3	4	71%	14%
7526489	SKAG	-	5	-	5	-	-	5	5	-	5	5	5	100%	0%
7526461	SKAG	-	4	-	3	4	-	3	3	-	4	3	3	57%	16%
7526436	SKAG	-	5	-	8	5	-	6	5	-	5	7	5	57%	21%
7526445	SKAG	-	7	-	9	6	-	7	6	-	6	9	6	43%	19%
7526453	SKAG	-	11	-	11	11	-	11	10	-	11	11	11	86%	3%
7536974	SKAG	-	3	-	3	3	-	4	3	-	3	3	3	86%	12%
7536961	SKAG	-	5	-	5	5	-	7	5	-	5	5	5	86%	14%
7537965	SKAG	-	2	-	2	4	-	4	2	-	3	2	2	57%	35%
7537961	SKAG	-	8	-	11	8	-	11	7	-	8	8	8	57%	18%
7536940	SKAG	-	7	-	10	9	-	12	10	-	10	8	10	43%	17%
7537912	SKAG	-	10	-	15	12	-	15	13	-	14	12	15	29%	14%
7536934	SKAG	-	8	-	12	8	-	12	8	-	11	9	8	43%	19%
7576864	SKAG	-	6	-	6	6	-	6	5	-	6	6	6	86%	6%
7567071	SKAG	-	9	-	12	10	-	11	9	-	10	9	9	43%	12%
7566949	SKAG	-	8	-	12	9	-	15	7	-	11	10	10	14%	26%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
7566946	SKAG	-	10	-	10	10	-	13	10	-	10	10	10	86%	11%
7584783	SKAG	-	4	-	4	4	-	4	4	-	4	4	4	100%	0%
7584739	SKAG	-	8	-	8	9	-	9	8	-	8	7	8	57%	8%
7591902_ALA_RLX_XX	SKAG	-	3	-	4	4	-	5	4	-	4	6	4	57%	22%
7591898_ALA_RLX_BX	SKAG	-	7	-	12	8	-	13	9	-	6	3	8	14%	42%
7591892_ALA_RLX_XX	SKAG	-	3	-	3	3	-	4	3	-	3	5	3	71%	23%
7591913_ALA_RLX_XX	SKAG	-	5	-	7	5	-	6	5	-	5	11	5	57%	35%
7591896_ALA_RLX_0X	SKAG	-	11	-	13	12	-	16	13	-	13	-	13	50%	13%
7587433	SKAG	-	2	-	3	4	-	4	4	-	3	2	4	43%	29%
7587429	SKAG	-	1	-	2	3	-	3	1	-	1	2	1	43%	48%
7613943_ALA_RLX_XX	SKAG	-	4	-	4	4	-	4	3	-	4	3	4	71%	13%
7613940_ALA_RLX_0B	SKAG	-	3	-	4	4	-	4	3	-	4	3	4	57%	15%
7608712	SKAG	-	5	-	5	5	-	6	5	-	6	5	5	71%	9%
7608710	SKAG	-	6	-	7	6	-	7	7	-	6	6	6	57%	8%
7600760	SKAG	-	7	-	9	7	-	10	9	-	9	9	9	57%	13%
7600772	SKAG	-	3	-	2	4	-	5	5	-	5	5	5	57%	29%
7608520	SKAG	-	8	-	12	10	-	13	9	-	12	9	12	29%	18%
7608776	SKAG	-	8	-	8	8	-	8	8	-	8	8	8	100%	0%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
7651531	SKAG	-	7	-	7	7	-	7	6	-	7	7	7	86%	6%
7651528	SKAG	-	7	-	9	7	-	9	7	-	8	7	7	57%	12%
7651541	SKAG	-	10	-	10	10	-	11	10	-	10	10	10	86%	4%
7641086	SKAG	-	4	-	4	5	-	4	4	-	4	4	4	86%	9%
7641064	SKAG	-	2	-	2	3	-	2	2	-	2	2	2	86%	18%
7641011	SKAG	-	10	-	10	11	-	11	10	-	11	10	10	57%	5%
7641014	SKAG	-	6	-	7	7	-	7	5	-	4	4	7	43%	24%
7641022	SKAG	-	11	-	12	11	-	14	11	-	10	12	11	43%	11%
7641019	SKAG	-	8	-	9	8	-	10	8	-	9	8	8	57%	9%
IBTS_2018_42	SKAG	-	8	-	8	8	-	9	8	-	8	8	8	86%	5%
7664368_ALA_RLX_X0	SKAG	-	2	-	3	2	-	3	2	-	2	2	2	71%	21%
7664369_ALA_RLX_XB	SKAG	-	3	-	3	3	-	3	3	-	3	3	3	100%	0%
7664361_ALA_RLX_XX	SKAG	-	3	-	3	3	-	3	3	-	3	3	3	100%	0%
7664360_ALA_RLX_XX	SKAG	-	3	-	4	3	-	4	3	-	3	3	3	71%	15%
7664357_ALA_RLX_XX	SKAG	-	5	-	5	5	-	5	5	-	3	5	5	86%	16%
7664473_ALA_RLX_0X	SKAG	-	1	-	1	1	-	0	1	-	1	1	1	86%	44%
7715884_ALA_RLX_XX	SKAG	-	2	-	3	2	-	1	2	-	1	1	2	43%	44%
7689175_ALA_RLX_0X	SKAG	-	8	-	8	8	-	9	8	-	8	8	8	86%	5%

SampleID	Sample origin	R04 NLS	R18 DKW	R10 NLS	R12 BEW	R02 SEW	R16 GBS	R14 BEW	R04 NLW	R08 SEW	R10 NLDW	R06 DKW	Modal age	PA %	CV %
7704741_ALA_RLX_XX	SKAG	-	4	-	4	4	-	4	4	-	4	4	4	100%	0%
7704738_ALA_RLX_XX	SKAG	-	2	-	4	3	-	3	2	-	2	2	2	57%	31%
7704739_ALA_RLX_XX	SKAG	-	2	-	4	3	-	3	2	-	2	2	2	57%	31%
7797926_ALA_RLX_0X	SKAG	-	1	-	1	1	-	1	1	-	1	1	1	100%	0%
7797927_ALA_RLX_BX	SKAG	-	1	-	1	2	-	1	1	-	1	1	1	86%	33%
7799588_ALA_RLX_XX	SKAG	-	1	-	1	1	-	1	1	-	1	1	1	100%	0%
7893098_ALA_RLX_0X	SKAG	-	11	-	12	10	-	11	11	-	11	10	11	57%	6%
7916345_ALA_RLX_0X	SKAG	-	9	-	10	9	-	10	9	-	10	9	9	57%	6%
DIS_2019_28	SKAG	-	2	-	2	1	-	2	2	-	1	1	2	57%	34%
COM_2019_02	SKAG	-	1	-	2	1	-	2	2	-	1	1	1	57%	37%
IBTS_2020_349	SKAG	-	6	-	7	5	-	6	8	-	4	6	6	43%	22%
														72.1%	**32.0%**

Annex 4: Results of the 2021 North Sea plaice workshop exercise (SmartDots ID 402)

All readers – North Sea and Skagerrak – Whole otoliths (Section 4.3.2.1)

Table A4.1. Data overview for all readers including modal age and statistics per sample.

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
106_PTCT04_PLE_4C_D_M_2017051110262	402	95		11/05/2017	27.4.c	1	1	1	2	1	1	1	1	1	1	1	2	1	1	1	0	1	1	82	40	21
110_PTCT04_PLE_4C_D_S_2018052110006	402	190		21/05/2018	27.4.c	1	1	4	1	1	1	1	1	1	-	2	1	1	1	1	3	2	1	75	62	46
125_PTCT04_PLE_4C_D_S_2018052110029	402	240		21/05/2018	27.4.c	4	5	4	5	5	5	5	4	-	-	5	5	5	5	5	4	5	5	73	10	8
126_PTCT04_PLE_4C_D_S_2018052110037	402	260		21/05/2018	27.4.c	5	0	5	5	5	5	5	5	5	-	5	5	4	5	5	5	5	5	88	27	14

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
127_DYFS01_PLE_4C_2019091610018	402	87		16/09/2019	27.4.c	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	100	-	-
131_DYFS01_PLE_4C_2019091610045	402	160		16/09/2019	27.4.c	0	0	0	0	0	0	0	0	0	-	0	0	1	0	0	0	0	0	94	-	-
137_BTS01_PLE_4B_2019082621773	402	196		26/08/2019	27.4.b	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	94	12	6
138_BTS01_PLE_4C_2019082620601	402	131		26/08/2019	27.4.c	1	0	2	2	2	1	2	2	0	-	1	2	2	2	2	-	1	2	60	51	44
145_CDDR09_PLE_4B_D_S_226275	402	160		14/12/2016	27.4.b	1	0	0	0	0	0	0	0	0	-	0	0	0	-	0	-	1	0	86	-	-
146_CDDR09_PLE_4B_D_S_226278	402	170		14/12/2016	27.4.b	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	88	-	-

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
151_BYDR07_PLE_4B_D_S_20191107 10124	402	180		07/11/2019	27.4.b	1	1	2	1	1	1	2	1	1	2	1	1	1	1	2	2	1	1	71	36	32
152_BYDR07_PLE_4B_D_S_20191107 10109	402	240		07/11/2019	27.4.b	2	3	2	3	3	3	3	3	2	3	3	3	2	3	2	2	3	3	65	19	17
153_BYDR07_PLE_4B_D_S_20191107 10114	402	260		07/11/2019	27.4.b	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3	-	3	3	88	12	8
154_BYDR07_PLE_4B_D_S_20191107 10115	402	260		07/11/2019	27.4.b	3	3	3	4	4	4	4	3	3	4	4	3	4	4	3	3	4	4	53	15	14
155_BYDR07_PLE_4B_D_S_20191107 10135	402	220		07/11/2019	27.4.b	3	2	2	4	2	3	4	3	2	3	2	2	-	2	2	2	3	2	56	28	25
156_BYDR07_PLE_4B_L_M_2019110 710459	402	392		07/11/2019	27.4.b	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	5	94	5	2

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
157_BYDR07_PLE_4B_L_M_2019110710497	402	377		07/11/2019	27.4.b	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
7058561	402	350	F	13/03/2015	27.3.a.20	9	8	9	9	9	8	9	10	8	8	9	8	7	8	8	8	8	8	53	8	7
7302034	402	170	F	24/05/2016	27.3.a.20	2	1	1	1	1	1	1	1	1	1	-	1	-	2	1	2	2	1	73	36	31
7453931	402	340	F	02/02/2017	27.3.a.20	7	7	7	7	7	7	7	7	7	-	7	7	7	7	7	7	7	7	100	0	0
7461887	402	260	M	13/02/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
7462156	402	200	U	27/01/2017	27.3.a.20	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	100	0	0

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7464935	402	290	F	15/02/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	94	5	2
7517367	402	260	F	21/03/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
7517370	402	280	F	21/03/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	94	5	2
7591855	402	450	F	27/09/2017	27.3.a.20	7	6	7	6	7	6	7	6	6	7	7	7	6	6	6	7	7	7	53	8	8
7591866	402	360	F	27/09/2017	27.3.a.20	10	11	11	10	11	10	12	11	10	10	11	10	10	11	10	-	10	10	56	6	5
7591869	402	350	F	27/09/2017	27.3.a.20	9	9	8	9	9	9	11	9	9	9	9	9	9	9	9	-	8	9	81	7	3

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7591872	402	340	F	27/09/2017	27.3.a.20	9	10	10	11	10	10	11	10	10	9	10	11	10	10	10	-	7	10	62	10	6
7591873	402	330	M	27/09/2017	27.3.a.20	9	12	9	12	5	8	12	8	9	6	10	5	9	8	5	-	6	9	25	29	23
7591882	402	300	F	27/09/2017	27.3.a.20	6	6	6	6	6	6	7	6	5	6	6	4	-	6	6	-	6	6	80	11	6
7591886	402	340	F	27/09/2017	27.3.a.20	6	6	6	6	6	6	6	5	5	5	5	5	6	6	6	-	5	6	62	9	8
7591887	402	330	F	27/09/2017	27.3.a.20	-	4	5	6	5	5	5	5	4	4	5	5	5	4	5	-	5	5	67	12	9
7591888	402	300	F	27/09/2017	27.3.a.20	4	8	5	9	3	4	8	3	3	3	6	3	6	3	3	-	5	3	44	44	36

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7591892	402	320	M	27/09/2017	27.3.a.20	3	4	3	7	3	3	4	5	3	3	5	3	-	3	3	-	5	3	60	32	25
7591896	402	370	F	27/09/2017	27.3.a.20	13	14	13	15	14	13	14	13	13	13	14	14	13	14	12	-	12	13	44	6	5
7591898	402	320	F	27/09/2017	27.3.a.20	8	9	8	12	11	9	18	7	-	9	8	10	9	9	7	-	6	9	33	30	20
7591902	402	310	M	27/09/2017	27.3.a.20	4	4	4	4	4	4	5	4	3	3	5	4	-	4	3	-	4	4	67	15	9
7591906	402	280	F	27/09/2017	27.3.a.20	5	5	6	5	5	5	6	5	5	5	5	5	5	5	5	-	5	5	88	7	4
7591909	402	330	M	27/09/2017	27.3.a.20	11	15	10	14	15	15	17	14	13	15	0	14	15	15	15	-	10	15	44	31	20

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7591913	402	340	F	27/09/2017	27.3.a.20	5	7	6	5	5	5	6	5	5	5	5	7	6	5	5	-	6	5	62	13	11
7591914	402	350	F	27/09/2017	27.3.a.20	7	5	6	6	7	7	8	7	5	-	6	7	5	7	8	-	5	7	40	16	14
7613940	402	340	F	12/11/2017	27.3.a.20	4	3	3	3	3	3	3	3	3	-	4	3	3	3	3	3	3	3	88	11	7
7613943	402	280	M	12/11/2017	27.3.a.20	4	5	5	5	3	5	5	5	3	-	5	4	4	3	3	3	4	5	44	21	19
7664357	402	270	M	31/01/2018	27.3.a.20	4	5	3	5	3	5	5	5	3	-	5	3	4	5	4	4	4	5	44	20	17
7664360	402	240	M	31/01/2018	27.3.a.20	3	3	2	3	3	3	4	3	3	-	3	3	3	3	3	3	3	3	88	12	4

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7664361	402	230	M	31/01/2018	27.3.a.20	3	3	2	3	3	3	3	3	3	-	3	3	3	3	3	-	3	3	93	9	4
7664366	402	150	M	31/01/2018	27.3.a.20	3	4	2	2	2	4	4	2	2	-	4	2	4	3	2	3	2	2	50	32	29
7664367	402	200	M	31/01/2018	27.3.a.20	-	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	2	2	100	0	0
7664368	402	180	M	31/01/2018	27.3.a.20	2	2	2	2	2	3	3	2	2	-	2	2	2	2	3	2	2	2	81	18	14
7689175	402	340	F	22/02/2018	27.3.a.20	7	8	6	8	8	7	8	10	6	-	6	8	7	8	8	6	5	8	44	17	14
7704735	402	160	M	07/04/2018	27.3.a.20	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	2	2	100	0	0

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7704738	402	230	M	07/04/2018	27.3.a.20	2	2	2	2	2	2	2	2	2	-	-	2	3	2	4	2	2	2	87	25	16
7704739	402	240	F	07/04/2018	27.3.a.20	3	2	2	3	2	2	3	2	2	-	3	2	2	2	4	3	2	2	62	26	22
7704741	402	220	M	07/04/2018	27.3.a.20	4	4	4	4	4	4	4	4	4	-	4	4	4	4	4	4	4	4	100	0	0
7713754	402	280	M	13/02/2018	27.3.a.20	4	6	5	4	2	5	6	5	3	-	6	3	4	5	6	-	4	4	27	27	23
7715886	402	240	F	14/02/2018	27.3.a.20	5	5	5	5	5	5	5	5	5	-	5	5	5	5	5	5	5	5	100	0	0
7715887	402	270	F	14/02/2018	27.3.a.20	4	4	4	4	4	4	4	4	3	-	4	4	-	4	4	4	4	4	93	7	3

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7753919	402	260	M	17/07/2018	27.3.a.20	4	4	4	5	4	4	5	5	4	-	4	4	5	4	4	5	5	4	62	11	11
7796556	402	230	M	17/10/2018	27.3.a.20	3	3	3	4	3	3	3	3	3	-	3	3	4	3	3	3	3	3	88	11	7
7796560	402	250	F	17/10/2018	27.3.a.20	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3	100	0	0
7797926	402	140	U	12/08/2018	27.3.a.20	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	100	0	0
7797927	402	170	U	12/08/2018	27.3.a.20	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	100	0	0
7799577	402	250	M	19/10/2018	27.3.a.20	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	100	0	0

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7799580	402	220	M	19/10/2018	27.3.a.20	2	2	1	2	1	2	2	1	1	-	3	1	2	2	2	-	2	2	60	34	28
7893098	402	390	F	25/02/2019	27.3.a.20	10	11	11	12	10	12	11	11	11	-	11	11	10	11	11	10	10	11	56	6	5
7916345	402	400	F	01/04/2019	27.3.a.20	9	9	9	9	9	10	10	9	8	-	9	10	8	9	9	10	9	9	62	7	5
PLE_2019_101001_035	402	317	M	21/01/2019	27.4.b	9	11	5	11	10	11	13	8	-	8	11	10	8	9	11	-	6	11	33	23	18
PLE_2019_101009_021	402	410	F	21/02/2019	27.4.c	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	94	3	1
PLE_2019_101011_048	402	284	M	25/02/2019	27.4.c	7	8	7	9	8	8	9	7	8	7	8	8	8	8	6	7	8	8	53	10	8

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101013_006	402	436	F	25/02/2019	27.4.b	10	10	10	10	10	10	10	10	10	10	11	11	9	10	10	9	10	10	76	5	2
PLE_2019_101023_053	402	303	M	08/04/2019	27.4.b	-	9	8	8	8	9	9	9	9	5	-	8	6	9	5	-	7	9	43	19	15
PLE_2019_101027_055	402	285	M	26/04/2019	27.4.c	4	4	4	4	6	5	6	5	3	4	-	5	0	4	4	3	4	4	50	34	21
PLE_2019_101028_016	402	391	F	10/05/2019	27.4.c	7	7	7	7	7	7	8	7	7	7	7	7	7	7	8	-	7	7	88	5	3
PLE_2019_101032_050	402	311	F	24/05/2019	27.4.c	6	6	6	6	6	6	6	6	5	6	6	5	5	6	6	6	6	6	82	7	5
PLE_2019_101033_033	402	336	F	21/06/2019	27.4.c	7	6	6	-	7	7	6	7	6	6	7	7	7	7	8	7	6	7	56	9	8

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101034_008	402	428	F	24/06/2019	27.4.b	9	9	8	9	10	9	10	9	9	9	10	10	9	9	9	9	9	9	71	6	4
PLE_2019_101034_040	402	364	F	24/06/2019	27.4.b	7	7	7	8	7	7	7	7	6	7	7	7	7	7	7	7	7	7	88	5	2
PLE_2019_101037_007	402	462	F	24/06/2019	27.4.b	9	11	9	10	13	10	11	13	9	9	9	9	9	10	10	9	9	9	53	14	10
PLE_2019_101041_031	402	305	M	15/07/2019	27.4.c	5	6	5	5	6	6	6	6	5	5	6	6	6	6	6	6	6	6	71	8	7
PLE_2019_101042_060	402	300	M	19/07/2019	27.4.c	7	7	6	7	7	6	7	7	6	7	6	7	6	7	6	-	7	7	62	8	7
PLE_2019_101045_020	402	398	F	23/08/2019	27.4.c	10	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	94	2	1

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101047_012	402	444	F	06/09/2019	27.4.c	7	7	7	8	7	8	8	7	7	8	8	8	-	8	7	8	8	8	56	7	7
PLE_2019_101051_029	402	411	F	04/10/2019	27.4.c	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	9	8	94	3	1
PLE_2019_101052_002	402	452	F	07/10/2019	27.4.c	7	8	7	9	9	9	9	9	-	7	8	8	9	8	7	10	9	9	44	11	10
PLE_2019_101052_043	402	357	M	07/10/2019	27.4.c	8	8	5	7	8	9	8	6	6	6	8	7	8	8	7	8	6	8	47	15	13
PLE_2019_101053_037	402	336	M	07/10/2019	27.4.c	8	10	8	8	9	9	10	9	8	8	10	8	8	8	8	-	8	8	62	10	8
PLE_2019_101058_003	402	377	F	11/11/2019	27.4.c	6	6	6	7	5	7	6	5	5	5	6	6	7	6	6	6	6	6	59	11	7

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101058_020	402	392	F	11/11/2019	27.4.c	8	11	7	11	10	8	10	9	8	8	8	10	8	8	6	8	6	8	47	18	14
PLE_2019_101063_049	402	302	M	09/12/2019	27.4.c	6	8	6	8	7	8	8	6	7	6	7	8	-	7	8	-	7	8	40	12	10
PLE_2019_1400002_032	402	289	M	20/08/2019	27.4.b	8	8	8	8	8	8	8	8	8	7	8	7	8	8	7	8	8	8	82	5	4
PLE_2019_1400004_081	402	349	F	20/08/2019	27.4.b	7	7	7	7	7	7	7	7	6	7	-	7	7	7	7	7	7	7	94	4	2
PLE_2019_1400051_913	402	279	F	05/09/2019	27.4.b	8	8	8	8	8	8	8	7	8	8	8	7	7	8	8	-	7	8	75	6	5
PLE_2019_1400052_928	402	286	M	05/09/2019	27.4.b	5	8	6	9	8	9	8	6	5	5	8	5	8	8	4	6	4	8	35	26	24

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_1400130_313	402	375	F	07/08/2019	27.4.b	7	8	-	7	8	9	-	0	5	8	-	5	0	8	6	-	-	8	33	51	38
PLE_2019_1400164_600	402	198	F	14/08/2019	27.4.b	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	88	30	19
PLE_2019_2100037_198	402	157	M	15/10/2019	27.4.b	1	1	1	1	1	1	1	1	1	1	1	-	2	1	1	1	1	1	94	24	11
PLE_2019_2100041_230	402	148	F	15/10/2019	27.4.b	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	2	1	94	24	11
PLE_2019_2200117_172	402	135	F	18/09/2019	27.4.b	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	94	26	12
PLE_2019_4100009_175	402	168	F	18/09/2019	27.4.c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	94	12	5

Table A4.2. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	all
0	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.25	0.00	0.00	0.00	0.50	0.18
1	0.09	-0.09	0.36	0.18	0.00	0.00	0.09	0.00	0.00	0.14	0.10	0.10	0.11	0.09	0.18	0.27	0.27	0.11
2	0.20	0.00	-0.09	0.27	-0.09	0.27	0.55	0.00	-0.36	0.33	0.30	-0.09	0.30	0.09	0.45	0.22	0.09	0.14
3	0.11	0.67	-0.11	1.22	0.00	0.11	0.78	0.22	-0.22	0.00	0.56	0.00	0.38	0.00	-0.11	-0.20	0.44	0.23
4	-0.12	0.12	0.00	0.12	0.00	0.25	0.75	0.25	-0.62	-0.25	0.43	-0.12	-0.50	0.12	0.00	-0.17	0.12	0.02
5	-0.23	-0.29	-0.07	0.07	-0.29	0.00	0.14	-0.07	-0.38	-0.11	0.00	-0.07	-0.29	-0.21	-0.21	-0.36	0.00	-0.14
6	-0.20	0.00	-0.20	0.00	-0.20	0.20	0.20	-0.40	-1.00	-0.60	-0.20	-0.80	0.00	0.00	0.00	0.00	-0.20	-0.20
7	0.00	-0.50	-0.38	-0.14	0.00	-0.25	0.12	-0.12	-0.88	-0.17	-0.29	0.00	-0.50	-0.12	0.12	0.00	-0.38	-0.20
8	-0.62	0.31	-0.92	0.31	0.15	0.23	0.50	-0.85	-0.92	-0.75	0.00	-0.54	-1.00	-0.08	-1.00	-0.56	-1.00	-0.40
9	-0.38	0.33	-0.67	0.67	0.22	0.11	2.00	0.11	-0.14	-1.12	0.00	-0.33	-0.44	-0.11	-1.22	0.40	-1.00	-0.09
10	-0.25	0.25	0.00	0.25	0.25	0.00	0.75	0.25	0.00	-0.25	0.50	0.50	-0.25	0.25	0.00	-0.50	-0.75	0.06
11	-1.50	0.00	-3.00	0.50	-1.00	0.50	1.00	-1.50	0.00	-3.00	0.00	-0.50	-2.00	-1.00	0.00	-1.00	-3.00	-0.91
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	0.00	1.00	0.00	2.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	-1.00	-	-1.00	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-4.00	0.00	-5.00	-1.00	0.00	0.00	2.00	-1.00	-2.00	0.00	-15.00	-1.00	0.00	0.00	0.00	-	-5.00	-

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	all
Weighted Mean	**-0.20**	**0.07**	**-0.31**	**0.30**	**-0.02**	**0.10**	**0.57**	**-0.13**	**-0.45**	**-0.36**	**-0.03**	**-0.15**	**-0.25**	**-0.03**	**-0.21**	**-0.09**	**-0.29**	**-0.07**

All readers – Skagerrak – Whole otoliths (Section 4.3.2.2)

Table A4.3. Data overview including modal age and statistics per sample for all readers.

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7058561	402	350	F	13/03/2015	27.3.a.20	9	8	9	9	9	8	9	10	8	8	9	8	7	8	8	8	8	8	53	8	7
7302034	402	170	F	24/05/2016 23:35:59	27.3.a.20	2	1	1	1	1	1	1	1	1	1	-	1	-	2	1	2	2	1	73	36	31
7453931	402	340	F	02/02/2017 15:31:56	27.3.a.20	7	7	7	7	7	7	7	7	7	-	7	7	7	7	7	7	7	7	100	0	0
7461887	402	260	M	13/02/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
7462156	402	200	U	27/01/2017	27.3.a.20	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	100	0	0
7464935	402	290	F	15/02/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	94	5	2
7517367	402	260	F	21/03/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
7517370	402	280	F	21/03/2017	27.3.a.20	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	94	5	2
7591855	402	450	F	27/09/2017	27.3.a.20	7	6	7	6	7	6	7	6	6	7	7	7	6	6	6	7	7	7	53	8	8

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7591866	402	360	F	27/09/2017	27.3.a.20	10	11	11	10	11	10	12	11	10	10	11	10	10	11	10	-	10	10	56	6	5
7591869	402	350	F	27/09/2017	27.3.a.20	9	9	8	9	9	9	11	9	9	9	9	9	9	9	9	-	8	9	81	7	3
7591872	402	340	F	27/09/2017	27.3.a.20	9	10	10	11	10	10	11	10	10	9	10	11	10	10	10	-	7	10	62	10	6
7591873	402	330	M	27/09/2017	27.3.a.20	9	12	9	12	5	8	12	8	9	6	10	5	9	8	5	-	6	9	25	29	23
7591882	402	300	F	27/09/2017	27.3.a.20	6	6	6	6	6	6	7	6	5	6	6	4	-	6	6	-	6	6	80	11	6
7591886	402	340	F	27/09/2017	27.3.a.20	6	6	6	6	6	6	6	5	5	5	5	5	6	6	6	-	5	6	62	9	8
7591887	402	330	F	27/09/2017	27.3.a.20	-	4	5	6	5	5	5	5	4	4	5	5	5	4	5	-	5	5	67	12	9
7591888	402	300	F	27/09/2017	27.3.a.20	4	8	5	9	3	4	8	3	3	3	6	3	6	3	3	-	5	3	44	44	36
7591892	402	320	M	27/09/2017	27.3.a.20	3	4	3	7	3	3	4	5	3	3	5	3	-	3	3	-	5	3	60	32	25
7591896	402	370	F	27/09/2017	27.3.a.20	13	14	13	15	14	13	14	13	13	13	14	14	13	14	12	-	12	13	44	6	5
7591898	402	320	F	27/09/2017	27.3.a.20	8	9	8	12	11	9	18	7	-	9	8	10	9	9	7	-	6	9	33	30	20
7591902	402	310	M	27/09/2017	27.3.a.20	4	4	4	4	4	4	5	4	3	3	5	4	-	4	3	-	4	4	67	15	9
7591906	402	280	F	27/09/2017	27.3.a.20	5	5	6	5	5	5	6	5	5	5	5	5	5	5	5	-	5	5	88	7	4
7591909	402	330	M	27/09/2017	27.3.a.20	11	15	10	14	15	15	17	14	13	15	0	14	15	15	15	-	10	15	44	31	20
7591913	402	340	F	27/09/2017	27.3.a.20	5	7	6	5	5	5	6	5	5	5	5	7	6	5	5	-	6	5	62	13	11
7591914	402	350	F	27/09/2017	27.3.a.20	7	5	6	6	7	7	8	7	5	-	6	7	5	7	8	-	5	7	40	16	14

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7613940	402	340	F	12/11/2017	27.3.a.20	4	3	3	3	3	3	3	3	3	-	4	3	3	3	3	3	3	3	88	11	7
7613943	402	280	M	12/11/2017	27.3.a.20	4	5	5	5	3	5	5	5	3	-	5	4	4	3	3	3	4	5	44	21	19
7664357	402	270	M	31/01/2018	27.3.a.20	4	5	3	5	3	5	5	5	3	-	5	3	4	5	4	4	4	5	44	20	17
7664360	402	240	M	31/01/2018	27.3.a.20	3	3	2	3	3	3	4	3	3	-	3	3	3	3	3	3	3	3	88	12	4
7664361	402	230	M	31/01/2018	27.3.a.20	3	3	2	3	3	3	3	3	3	-	3	3	3	3	3	-	3	3	93	9	4
7664366	402	150	M	31/01/2018	27.3.a.20	3	4	2	2	2	4	4	2	2	-	4	2	4	3	2	3	2	2	50	32	29
7664367	402	200	M	31/01/2018	27.3.a.20	-	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	2	2	100	0	0
7664368	402	180	M	31/01/2018	27.3.a.20	2	2	2	2	2	3	3	2	2	-	2	2	2	2	3	2	2	2	81	18	14
7689175	402	340	F	22/02/2018	27.3.a.20	7	8	6	8	8	7	8	10	6	-	6	8	7	8	8	6	5	8	44	17	14
7704735	402	160	M	07/04/2018	27.3.a.20	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	2	2	100	0	0
7704738	402	230	M	07/04/2018	27.3.a.20	2	2	2	2	2	2	2	2	2	-	-	2	3	2	4	2	2	2	87	25	16
7704739	402	240	F	07/04/2018	27.3.a.20	3	2	2	3	2	2	3	2	2	-	3	2	2	2	4	3	2	2	62	26	22
7704741	402	220	M	07/04/2018	27.3.a.20	4	4	4	4	4	4	4	4	4	-	4	4	4	4	4	4	4	4	100	0	0
7713754	402	280	M	13/02/2018	27.3.a.20	4	6	5	4	2	5	6	5	3	-	6	3	4	5	6	-	4	4	27	27	23
7715886	402	240	F	14/02/2018	27.3.a.20	5	5	5	5	5	5	5	5	5	-	5	5	5	5	5	5	5	5	100	0	0

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
7715887	402	270	F	14/02/2018	27.3.a.20	4	4	4	4	4	4	4	4	3	-	4	4	-	4	4	4	4	4	93	7	3
7753919	402	260	M	17/07/2018	27.3.a.20	4	4	4	5	4	4	5	5	4	-	4	4	5	4	4	5	5	4	62	11	11
7796556	402	230	M	17/10/2018	27.3.a.20	3	3	3	4	3	3	3	3	3	-	3	3	4	3	3	3	3	3	88	11	7
7796560	402	250	F	17/10/2018	27.3.a.20	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3	100	0	0
7797926	402	140	U	12/08/2018	27.3.a.20	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	100	0	0
7797927	402	170	U	12/08/2018	27.3.a.20	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	100	0	0
7799577	402	250	M	19/10/2018	27.3.a.20	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	100	0	0
7799580	402	220	M	19/10/2018	27.3.a.20	2	2	1	2	1	2	2	1	1	-	3	1	2	2	2	-	2	2	60	34	28
7893098	402	390	F	25/02/2019	27.3.a.20	10	11	11	12	10	12	11	11	11	-	11	11	10	11	11	10	10	11	56	6	5
7916345	402	400	F	01/04/2019	27.3.a.20	9	9	9	9	9	10	10	9	8	-	9	10	8	9	9	10	9	9	62	7	5

Table A4.5. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	all
1	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.25	0.25	0.06

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	all
2	0.33	0.29	-0.14	0.14	-0.14	0.43	0.57	-0.14	-0.14	-	0.67	-0.14	0.43	0.14	0.71	0.33	0.00	-
3	0.29	0.86	0.00	1.57	0.00	0.14	1.00	0.29	0.00	0.00	0.86	0.00	0.67	0.00	0.00	0.00	0.57	0.37
4	0.00	0.33	0.17	0.17	-0.33	0.17	0.67	0.33	-0.50	-0.50	0.50	-0.17	0.25	0.17	0.17	0.25	0.17	0.11
5	-0.22	0.10	0.00	0.10	-0.40	0.00	0.20	0.00	-0.50	-0.14	0.00	-0.10	-0.30	-0.30	-0.30	-0.43	-0.10	-0.14
6	0.00	0.00	0.00	0.00	0.00	0.00	0.50	-0.50	-1.00	-0.50	-0.50	-1.50	0.00	0.00	0.00	-	-0.50	-
7	0.00	-1.00	-0.33	-0.67	0.00	-0.33	0.33	-0.33	-1.00	0.00	-0.33	0.00	-1.00	-0.33	0.00	0.00	-0.67	-0.33
8	0.00	0.00	-0.50	0.50	0.50	-0.50	0.50	2.00	-1.00	0.00	-0.50	0.00	-1.00	0.00	0.00	-1.00	-1.50	-0.15
9	-0.25	0.75	-0.50	1.50	-0.50	0.00	3.75	-0.75	-0.33	-1.00	0.00	-0.50	-0.25	-0.25	-1.50	1.00	-1.75	-0.03
10	-0.50	0.50	0.50	0.50	0.50	0.00	1.50	0.50	0.00	-0.50	0.50	0.50	0.00	0.50	0.00	-	-1.50	-
11	-1.00	0.00	0.00	1.00	-1.00	1.00	0.00	0.00	0.00	-	0.00	0.00	-1.00	0.00	0.00	-1.00	-1.00	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	0.00	1.00	0.00	2.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	-1.00	-	-1.00	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-4.00	0.00	-5.00	-1.00	0.00	0.00	2.00	-1.00	-2.00	0.00	-15.00	-1.00	0.00	0.00	0.00	-	-5.00	-
Weighted Mean	**-0.08**	**0.26**	**-0.16**	**0.44**	**-0.14**	**0.08**	**0.82**	**0.04**	**-0.39**	**-0.30**	**-0.06**	**-0.14**	**-0.04**	**0.00**	**-0.08**	**-0.03**	**-0.36**	0.01

All readers – North Sea – Whole otoliths (Section 4.3.2.3)

Table A4.6. Data overview including modal age and statistics per sample.

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
106_PTCT04_PLE_4C_D_M_20170511 10262	402	95		11/05/2017	27.4.c	1	1	1	2	1	1	1	1	1	1	1	2	1	1	1	0	1	1	82	40	21
110_PTCT04_PLE_4C_D_S_201805211 0006	402	190		21/05/2018	27.4.c	1	1	4	1	1	1	1	1	1	-	2	1	1	1	1	3	2	1	75	62	46
125_PTCT04_PLE_4C_D_S_201805211 0029	402	240		21/05/2018	27.4.c	4	5	4	5	5	5	5	4	-	-	5	5	5	5	5	4	5	5	73	10	8
126_PTCT04_PLE_4C_D_S_201805211 0037	402	260		21/05/2018	27.4.c	5	0	5	5	5	5	5	5	5	-	5	5	4	5	5	5	5	5	88	27	14
127_DYFS01_PLE_4C_2019091610018	402	87		16/09/2019	27.4.c	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	100	-	-
131_DYFS01_PLE_4C_2019091610045	402	160		16/09/2019	27.4.c	0	0	0	0	0	0	0	0	0	-	0	0	1	0	0	0	0	0	94	-	-

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
137_BTS01_PLE_4B_2019082621773	402	196		26/08/2019	27.4.b	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	94	12	6
138_BTS01_PLE_4C_2019082620601	402	131		26/08/2019	27.4.c	1	0	2	2	2	1	2	2	0	-	1	2	2	2	2	-	1	2	60	51	44
145_CDDR09_PLE_4B_D_S_226275	402	160		14/12/2016	27.4.b	1	0	0	0	0	0	0	0	0	-	0	0	0	-	0	-	1	0	86	-	-
146_CDDR09_PLE_4B_D_S_226278	402	170		14/12/2016	27.4.b	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	88	-	-
151_BYDR07_PLE_4B_D_S_20191107 10124	402	180		07/11/2019	27.4.b	1	1	2	1	1	1	2	1	1	2	1	1	1	1	2	2	1	1	71	36	32
152_BYDR07_PLE_4B_D_S_20191107 10109	402	240		07/11/2019	27.4.b	2	3	2	3	3	3	3	3	2	3	3	3	2	3	2	2	3	3	65	19	17

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
153_BYDR07_PLE_4B_D_S_20191107 10114	402	260		07/11/2019	27.4.b	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3	-	3	3	88	12	8
154_BYDR07_PLE_4B_D_S_20191107 10115	402	260		07/11/2019	27.4.b	3	3	3	4	4	4	4	3	3	4	4	3	4	4	3	3	4	4	53	15	14
155_BYDR07_PLE_4B_D_S_20191107 10135	402	220		07/11/2019	27.4.b	3	2	2	4	2	3	4	3	2	3	2	2	-	2	2	2	3	2	56	28	25
156_BYDR07_PLE_4B_L_M_20191107 10459	402	392		07/11/2019	27.4.b	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	6	5	94	5	2
157_BYDR07_PLE_4B_L_M_20191107 10497	402	377		07/11/2019	27.4.b	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	0	0
PLE_2019_101001_035	402	317	M	21/01/2019	27.4.b	9	11	5	11	10	11	13	8	-	8	11	10	8	9	11	-	6	11	33	23	18

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101009_021	402	410	F	21/02/2019	27.4.c	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	94	3	1
PLE_2019_101011_048	402	284	M	25/02/2019	27.4.c	7	8	7	9	8	8	9	7	8	7	8	8	8	8	6	7	8	8	53	10	8
PLE_2019_101013_006	402	436	F	25/02/2019	27.4.b	10	10	10	10	10	10	10	10	10	10	11	11	9	10	10	9	10	10	76	5	2
PLE_2019_101023_053	402	303	M	08/04/2019	27.4.b	-	9	8	8	8	9	9	9	9	5	-	8	6	9	5	-	7	9	43	19	15
PLE_2019_101027_055	402	285	M	26/04/2019	27.4.c	4	4	4	4	6	5	6	5	3	4	-	5	0	4	4	3	4	4	50	34	21
PLE_2019_101028_016	402	391	F	10/05/2019	27.4.c	7	7	7	7	7	7	8	7	7	7	7	7	7	7	8	-	7	7	88	5	3

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101032_050	402	311	F	24/05/2019	27.4.c	6	6	6	6	6	6	6	6	5	6	6	5	5	6	6	6	6	6	82	7	5
PLE_2019_101033_033	402	336	F	21/06/2019	27.4.c	7	6	6	-	7	7	6	7	6	6	7	7	7	7	8	7	6	7	56	9	8
PLE_2019_101034_008	402	428	F	24/06/2019	27.4.b	9	9	8	9	10	9	10	9	9	9	10	10	9	9	9	9	9	9	71	6	4
PLE_2019_101034_040	402	364	F	24/06/2019	27.4.b	7	7	7	8	7	7	7	7	6	7	7	7	7	7	7	7	7	7	88	5	2
PLE_2019_101037_007	402	462	F	24/06/2019	27.4.b	9	11	9	10	13	10	11	13	9	9	9	9	9	10	10	9	9	9	53	14	10
PLE_2019_101041_031	402	305	M	15/07/2019	27.4.c	5	6	5	5	6	6	6	6	5	5	6	6	6	6	6	6	6	6	71	8	7

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101042_060	402	300	M	19/07/2019	27.4.c	7	7	6	7	7	6	7	7	6	7	6	7	6	7	6	-	7	7	62	8	7
PLE_2019_101045_020	402	398	F	23/08/2019	27.4.c	10	10	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	94	2	1
PLE_2019_101047_012	402	444	F	06/09/2019	27.4.c	7	7	7	8	7	8	8	7	7	8	8	8	-	8	7	8	8	8	56	7	7
PLE_2019_101051_029	402	411	F	04/10/2019	27.4.c	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	9	8	94	3	1
PLE_2019_101052_002	402	452	F	07/10/2019	27.4.c	7	8	7	9	9	9	9	9	-	7	8	8	9	8	7	10	9	9	44	11	10
PLE_2019_101052_043	402	357	M	07/10/2019	27.4.c	8	8	5	7	8	9	8	6	6	6	8	7	8	8	7	8	6	8	47	15	13

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101053_037	402	336	M	07/10/2019	27.4.c	8	10	8	8	9	9	10	9	8	8	10	8	8	8	8	-	8	8	62	10	8
PLE_2019_101058_003	402	377	F	11/11/2019	27.4.c	6	6	6	7	5	7	6	5	5	5	6	6	7	6	6	6	6	6	59	11	7
PLE_2019_101058_020	402	392	F	11/11/2019	27.4.c	8	11	7	11	10	8	10	9	8	8	8	10	8	8	6	8	6	8	47	18	14
PLE_2019_101063_049	402	302	M	09/12/2019	27.4.c	6	8	6	8	7	8	8	6	7	6	7	8	-	7	8	-	7	8	40	12	10
PLE_2019_1400002_032	402	289	M	20/08/2019	27.4.b	8	8	8	8	8	8	8	8	8	7	8	7	8	8	7	8	8	8	82	5	4
PLE_2019_1400004_081	402	349	F	20/08/2019	27.4.b	7	7	7	7	7	7	7	7	6	7	-	7	7	7	7	7	7	7	94	4	2

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_1400051_913	402	279	F	05/09/2019	27.4.b	8	8	8	8	8	8	8	7	8	8	8	7	7	8	8	-	7	8	75	6	5
PLE_2019_1400052_928	402	286	M	05/09/2019	27.4.b	5	8	6	9	8	9	8	6	5	5	8	5	8	8	4	6	4	8	35	26	24
PLE_2019_1400130_313	402	375	F	07/08/2019	27.4.b	7	8	-	7	8	9	-	0	5	8	-	5	0	8	6	-	-	8	33	51	38
PLE_2019_1400164_600	402	198	F	14/08/2019	27.4.b	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	88	30	19
PLE_2019_2100037_198	402	157	M	15/10/2019	27.4.b	1	1	1	1	1	1	1	1	1	1	1	-	2	1	1	1	1	1	94	24	11
PLE_2019_2100041_230	402	148	F	15/10/2019	27.4.b	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	2	1	94	24	11

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_2200117_172	402	135	F	18/09/2019	27.4.b	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	94	26	12
PLE_2019_4100009_175	402	168	F	18/09/2019	27.4.c	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	94	12	5

Table A4.7.Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	all
0	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.25	0.00	0.00	0.00	0.50	**0.18**
1	0.00	-0.14	0.57	0.29	0.00	0.00	0.14	0.00	0.00	0.17	0.14	0.17	0.17	0.00	0.29	0.29	0.29	**0.14**
2	0.00	-0.50	0.00	0.50	0.00	0.00	0.50	0.25	-0.75	0.33	-0.25	0.00	0.00	0.00	0.00	0.00	0.25	**0.02**
3	-0.50	0.00	-0.50	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	-0.50	0.00	-0.50	0.00	-0.50	-1.00	0.00	**-0.26**
4	-0.50	-0.50	-0.50	0.00	1.00	0.50	1.00	0.00	-1.00	0.00	0.00	0.00	-2.00	0.00	-0.50	-1.00	0.00	**-0.21**
5	-0.25	-1.25	-0.25	0.00	0.00	0.00	0.00	-0.25	0.00	0.00	0.00	0.00	-0.25	0.00	0.00	-0.25	0.25	**-0.13**
6	-0.33	0.00	-0.33	0.00	-0.33	0.33	0.00	-0.33	-1.00	-0.67	0.00	-0.33	0.00	0.00	0.00	0.00	0.00	**-0.18**
7	0.00	-0.20	-0.40	0.25	0.00	-0.20	0.00	0.00	-0.80	-0.20	-0.25	0.00	-0.20	0.00	0.20	0.00	-0.20	**-0.12**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R28 GB-SCT	R30 DE	R32 DK	R34 NO	R36 FR	R38 SE	R42 NO	R44 DE	all
8	-0.73	0.36	-1.00	0.27	0.09	0.36	0.50	-1.36	-0.91	-0.82	0.10	-0.64	-1.00	-0.09	-1.18	-0.43	-0.90	**-0.43**
9	-0.50	0.00	-0.80	0.00	0.80	0.20	0.60	0.80	0.00	-1.20	0.00	-0.20	-0.60	0.00	-1.00	0.25	-0.40	**-0.12**
10	0.00	0.00	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	-0.50	0.00	0.00	-0.50	0.00	**-0.03**
11	-2.00	0.00	-6.00	0.00	-1.00	0.00	2.00	-3.00	-	-3.00	0.00	-1.00	-3.00	-2.00	0.00	-	-5.00	-
Weighted Mean	**-0.31**	**-0.12**	**-0.47**	**0.16**	**0.10**	**0.12**	**0.31**	**-0.30**	**-0.51**	**-0.40**	**0.00**	**-0.16**	**-0.46**	**-0.06**	**-0.34**	**-0.13**	**-0.22**	**-0.13**

All readers – North Sea – Sectioned otoliths (Section 4.3.2.4)

Table A4.8. Data overview including modal age and statistics per sample.

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
106_PTCT04_PLE_4C_D_M_20170511102 62	402	95		11/05/2017	27.4.c	1	1	-	1	1	1	1	1	0	1	1	1	0	-	0	1	77	57	46
110_PTCT04_PLE_4C_D_S_20180521100 06	402	190		21/05/2018	27.4.c	1	1	-	1	1	1	1	2	1	-	1	2	1	-	-	1	82	34	25
125_PTCT04_PLE_4C_D_S_20180521100 29	402	240		21/05/2018	27.4.c	5	5	-	5	5	5	5	6	5	5	5	5	6	-	5	5	85	7	5

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
126_PTCT04_PLE_4C_D_S_2018052110037	402	260		21/05/2018	27.4.c	5	5	-	5	5	5	5	6	5	5	5	5	6	-	5	5	85	7	5
127_DYFS01_PLE_4C_2019091610018	402	87		16/09/2019	27.4.c	0	0	-	0	0	0	0	0	0	0	0	0	0	-	0	0	100	-	-
131_DYFS01_PLE_4C_2019091610045	402	160		16/09/2019	27.4.c	0	0	-	1	0	0	0	1	0	0	1	1	0	-	-	0	67	-	-
137_BTS01_PLE_4B_2019082621773	402	196		26/08/2019	27.4.b	2	2	-	3	2	2	2	3	2	2	2	2	3	-	2	2	77	20	16
138_BTS01_PLE_4C_2019082620601	402	131		26/08/2019	27.4.c	1	0	-	1	2	1	2	2	1	1	3	2	2	-	2	2	46	50	42
145_CDDR09_PLE_4B_D_S_226275	402	160		14/12/2016	27.4.b	0	0	-	1	0	0	0	1	0	0	0	1	0	-	-	0	75	-	-

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
146_CDDR09_PLE_4B_D_S_226278	402	170		14/12/2016	27.4.b	1	0	-	1	0	0	0	2	-	1	0	1	0	-	1	0	50	-	-
151_BYDR07_PLE_4B_D_S_2019110710124	402	180		07/11/2019	27.4.b	2	1	-	2	1	1	2	2	1	1	2	1	2	-	1	1	54	36	34
152_BYDR07_PLE_4B_D_S_2019110710109	402	240		07/11/2019	27.4.b	3	3	-	3	3	4	3	4	3	3	4	3	2	-	3	3	69	18	12
153_BYDR07_PLE_4B_D_S_2019110710114	402	260		07/11/2019	27.4.b	3	3	-	3	3	3	3	3	3	3	3	3	3	-	3	3	100	0	0
154_BYDR07_PLE_4B_D_S_2019110710115	402	260		07/11/2019	27.4.b	4	3	-	3	4	4	4	4	3	4	4	4	3	-	4	4	69	13	12
155_BYDR07_PLE_4B_D_S_2019110710135	402	220		07/11/2019	27.4.b	2	2	-	2	2	2	4	2	2	2	3	3	3	-	3	2	62	27	23

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
156_BYDR07_PLE_4B_L_M_20191107104459	402	392		07/11/2019	27.4.b	5	5	-	7	5	5	5	5	5	5	5	5	5	-	6	5	85	11	7
157_BYDR07_PLE_4B_L_M_20191107104497	402	377		07/11/2019	27.4.b	5	5	-	5	5	5	5	5	5	5	5	5	5	-	5	5	100	0	0
PLE_2019_101001_035	402	317	M	21/01/2019	27.4.b	11	12	-	12	12	12	13	12	11	11	12	12	12	11	10	12	57	6	5
PLE_2019_101009_021	402	410	F	21/02/2019	27.4.c	9	9	-	9	9	9	9	9	9	9	9	9	9	9	9	9	100	0	0
PLE_2019_101011_048	402	284	M	25/02/2019	27.4.c	7	9	-	9	9	9	9	8	9	8	8	9	8	8	8	9	50	8	7
PLE_2019_101013_006	402	436	F	25/02/2019	27.4.b	9	10	-	10	10	10	10	10	10	10	10	10	10	10	10	10	93	3	1

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101023_053	402	303	M	08/04/2019	27.4.b	7	8	-	9	8	8	9	8	-	-	6	5	7	5	-	8	36	20	16
PLE_2019_101027_055	402	285	M	26/04/2019	27.4.c	5	6	-	6	6	6	6	6	6	5	5	6	5	5	5	6	57	9	9
PLE_2019_101028_016	402	391	F	10/05/2019	27.4.c	7	7	-	7	7	7	7	7	7	7	7	7	7	7	7	7	100	0	0
PLE_2019_101032_050	402	311	F	24/05/2019	27.4.c	7	6	-	6	6	6	6	6	6	6	6	7	6	6	6	6	86	6	4
PLE_2019_101033_033	402	336	F	21/06/2019	27.4.c	8	7	-	7	8	7	6	7	8	6	8	8	7	6	7	7	43	11	9
PLE_2019_101034_008	402	428	F	24/06/2019	27.4.b	9	10	-	11	11	9	10	10	9	9	11	10	9	-	9	9	46	9	7

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101034_040	402	364	F	24/06/2019	27.4.b	8	7	-	7	7	7	7	7	7	7	9	7	7	-	8	7	77	9	6
PLE_2019_101037_007	402	462	F	24/06/2019	27.4.b	12	10	-	11	13	11	11	14	13	9	9	12	12	-	10	11	23	14	11
PLE_2019_101041_031	402	305	M	15/07/2019	27.4.c	7	6	-	6	6	6	6	7	5	7	7	5	6	-	5	6	46	12	9
PLE_2019_101042_060	402	300	M	19/07/2019	27.4.c	8	8	-	8	8	8	7	8	8	8	7	8	8	-	8	8	85	5	3
PLE_2019_101045_020	402	398	F	23/08/2019	27.4.c	10	10	-	10	10	10	10	10	10	10	10	10	10	-	10	10	100	0	0
PLE_2019_101047_012	402	444	F	06/09/2019	27.4.c	7	7	-	8	7	7	8	7	7	7	9	7	7	-	7	7	77	9	6

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101051_029	402	411	F	04/10/2019	27.4.c	8	8	-	8	8	8	8	8	8	8	8	8	7	-	6	8	85	8	5
PLE_2019_101052_002	402	452	F	07/10/2019	27.4.c	8	9	-	9	9	9	8	9	9	10	9	9	8	-	10	9	62	7	5
PLE_2019_101052_043	402	357	M	07/10/2019	27.4.c	7	8	-	7	8	7	8	7	7	6	7	6	7	-	6	7	54	10	7
PLE_2019_101053_037	402	336	M	07/10/2019	27.4.c	10	10	-	10	10	9	9	9	9	9	10	8	10	-	9	9	46	7	6
PLE_2019_101058_003	402	377	F	11/11/2019	27.4.c	7	7	-	7	5	7	6	7	6	5	8	7	7	-	8	7	54	14	11
PLE_2019_101058_020	402	392	F	11/11/2019	27.4.c	8	9	-	9	11	9	10	10	9	7	11	10	9	-	9	9	46	12	9

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_101063_049	402	302	M	09/12/2019	27.4.c	8	10	-	10	7	9	8	9	9	8	8	8	9	-	8	8	46	10	9
PLE_2019_1400002_032	402	289	M	20/08/2019	27.4.b	-	9	-	10	8	9	9	9	9	9	10	8	8	-	9	9	58	7	5
PLE_2019_1400004_081	402	349	F	20/08/2019	27.4.b	6	7	-	7	7	7	7	7	7	6	7	7	6	-	8	7	69	8	6
PLE_2019_1400051_913	402	279	F	05/09/2019	27.4.b	8	8	7	7	8	8	8	8	7	7	8	8	7	8	7	8	60	7	6
PLE_2019_1400052_928	402	286	M	05/09/2019	27.4.b	8	8	-	7	8	8	8	8	8	7	8	8	7	7	7	8	64	7	6
PLE_2019_1400130_313	402	375	F	07/08/2019	27.4.b	9	10	-	9	10	10	9	9	9	8	8	10	8	8	8	8	36	9	7

Fish ID	Event ID	length	sex	Catch date	ICES area	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	Modal age	PA %	CV %	APE %
PLE_2019_1400164_600	402	198	F	14/08/2019	27.4.b	2	1	-	1	1	1	1	1	1	1	1	1	1	2	1	1	86	32	21
PLE_2019_2100037_198	402	157	M	15/10/2019	27.4.b	1	1	-	1	1	1	1	1	1	1	1	1	1	2	1	1	93	25	12
PLE_2019_2100041_230	402	148	F	15/10/2019	27.4.b	1	1	-	1	1	1	1	1	1	1	1	1	1	3	1	1	93	47	23
PLE_2019_2200117_172	402	135	F	18/09/2019	27.4.b	0	1	-	1	1	1	1	0	1	1	1	1	1	1	1	1	86	42	29
PLE_2019_4100009_175	402	168	F	18/09/2019	27.4.c	2	2	-	2	2	2	2	2	2	2	1	2	2	-	2	2	92	14	7

Table A4.9. Relative bias table represents the relative bias per modal age per reader, the relative bias of all readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	all
0	0.25	0.00	-	0.75	0.00	0.00	0.00	1.00	0.00	0.25	0.25	0.75	0.00	-	0.50	-

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R20 NO	R30 DE	R32 DK	R36 FR	R38 SE	R42 NO	R44 DE	all
1	0.14	0.00	-	0.14	0.00	0.00	0.14	0.14	-0.14	0.00	0.14	0.14	0.00	1.00	-0.17	-
2	-0.25	-0.50	-	0.00	0.00	-0.25	0.50	0.25	-0.25	-0.25	0.25	0.25	0.50	-	0.25	-
3	0.00	0.00	-	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.50	0.00	-0.50	-	0.00	-
4	0.00	-1.00	-	-1.00	0.00	0.00	0.00	0.00	-1.00	0.00	0.00	0.00	-1.00	-	0.00	-
5	0.00	0.00	-	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.50	-	0.25	-
6	0.33	0.00	-	0.00	0.00	0.00	0.00	0.33	-0.33	0.00	0.00	0.00	-0.33	-0.50	-0.67	-
7	0.14	0.14	-	0.14	0.00	0.00	0.00	0.00	0.00	-0.71	0.86	0.00	-0.14	-0.50	0.29	-
8	0.00	0.57	-1.00	0.29	0.14	0.43	0.14	0.29	0.17	-0.33	-0.43	-0.14	-0.43	-1.00	-0.67	-0.13
9	-0.50	0.29	-	0.57	0.57	0.00	0.14	0.14	0.00	-0.29	0.71	0.00	-0.29	-0.50	0.00	-
10	-0.50	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
11	1.00	-1.00	-	0.00	2.00	0.00	0.00	3.00	2.00	-2.00	-2.00	1.00	1.00	-	-1.00	-
12	-1.00	0.00	-	0.00	0.00	0.00	1.00	0.00	-1.00	-1.00	0.00	0.00	0.00	-1.00	-2.00	-
Weighted Mean	**-0.02**	**0.06**	**-1.00**	**0.24**	**0.14**	**0.06**	**0.12**	**0.32**	**-0.04**	**-0.25**	**0.20**	**0.10**	**-0.08**	**-0.25**	**-0.11**	**-0.13**

Advanced readers – North Sea and Skagerrak – Whole otoliths (Section 4.3.2.5)

Table A4.10. Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	all
0	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	**0.25**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	all
1	0.09	-0.09	0.36	0.18	0.00	0.00	0.09	0.00	0.14	**0.09**
2	0.11	0.00	-0.10	0.10	-0.10	0.20	0.40	-0.10	0.00	**0.06**
3	0.10	0.50	-0.20	1.20	-0.10	0.10	0.80	0.20	0.00	**0.29**
4	-0.14	-0.14	-0.14	0.14	0.29	0.14	0.57	0.14	-0.25	**0.07**
5	-0.29	-0.20	-0.07	0.00	-0.47	0.00	0.20	-0.07	-0.11	**-0.11**
6	0.00	0.29	-0.14	0.33	0.14	0.57	0.43	-0.14	-0.43	**0.12**
7	0.00	-0.22	-0.22	0.22	0.11	0.00	0.56	-0.11	0.14	**0.05**
8	-0.56	0.56	-1.00	0.22	0.33	0.33	0.50	-1.00	-0.75	**-0.15**
9	-0.38	-0.11	-0.67	0.33	0.67	0.11	1.67	0.33	-0.88	**0.12**
10	-0.25	0.25	0.00	0.25	0.25	0.00	0.75	0.25	-0.25	**0.14**
11	-1.50	0.00	-3.00	0.50	-1.00	0.50	1.00	-1.50	-3.00	**-0.89**
12	-3.00	0.00	-3.00	0.00	-7.00	-4.00	0.00	-4.00	-6.00	**-3.00**
13	0.00	1.00	0.00	2.00	1.00	0.00	1.00	0.00	0.00	**0.56**
14	-	-	-	-	-	-	-	-	-	**-**
15	-4.00	0.00	-5.00	-1.00	0.00	0.00	2.00	-1.00	0.00	**-1.00**
Weighted Mean	**-0.21**	**0.06**	**-0.32**	**0.28**	**-0.03**	**0.09**	**0.56**	**-0.14**	**-0.36**	**0.00**

Table A4.11. Age error matrix (AEM) for Skagerrak and North Sea, whole otoliths.

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Age 0	0.9394	0.01053	0.01235	-	-	0.007812	-	-	0.01282	-	-	-	-	-	-
Age 1	0.0303	0.91579	0.06173	-	-	-	-	-	-	-	-	-	-	-	-
Age 2	0.0303	0.06316	0.81481	0.08235	-	0.007812	-	-	-	-	-	-	-	-	-
Age 3	-	-	0.07407	0.74118	0.08333	0.023438	-	-	-	-	-	-	-	-	-
Age 4	-	0.01053	0.03704	0.10588	0.78333	0.070312	-	-	-	-	-	-	-	-	-
Age 5	-	-	-	0.02353	0.10000	0.828125	0.14516	0.01266	0.03846	0.01266	-	0.05882	0.1111	-	-
Age 6	-	-	-	-	0.03333	0.054688	0.66129	0.10127	0.06410	-	-	-	0.1111	-	-
Age 7	-	-	-	0.01176	-	0.007812	0.12903	0.73418	0.10256	0.05063	-	-	-	-	-
Age 8	-	-	-	0.02353	-	-	0.06452	0.12658	0.58974	0.15190	-	0.11765	0.2222	-	-
Age 9	-	-	-	0.01176	-	-	-	0.02532	0.10256	0.59494	0.08333	0.05882	0.2222	-	-
Age 10	-	-	-	-	-	-	-	-	0.06410	0.08861	0.72222	0.17647	-	-	0.1111
Age 11	-	-	-	-	-	-	-	-	0.02564	0.05063	0.16667	0.41176	-	-	0.1111
Age 12	-	-	-	-	-	-	-	-	-	0.01266	0.02778	0.11765	0.3333	-	-
Age 13	-	-	-	-	-	-	-	-	-	0.02532	-	0.05882	-	0.5556	-
Age 14	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3333	0.2222
Age 15	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1111	0.4444
Age 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1111

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Age 18	-	-	-	-	-	-	-	-	-	0.01266	-	-	-	-	-

Advanced readers – Skagerrak – Whole otoliths (Section 4.3.2.6)

Table A4.12. Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	all
1	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**
2	0.33	0.29	-0.14	0.14	-0.14	0.43	0.57	-0.14	-	**-**
3	0.29	0.86	0.00	1.57	0.00	0.14	1.00	0.29	0.00	**0.46**
4	0.00	0.00	0.00	0.20	0.00	0.00	0.40	0.20	-0.50	**0.03**
5	-0.30	0.18	0.00	0.00	-0.64	0.00	0.27	0.00	-0.14	**-0.07**
6	0.00	0.00	0.00	0.00	0.00	0.00	0.50	-0.50	-0.50	**-0.06**
7	0.00	-1.00	-0.33	-0.67	0.00	-0.33	0.33	-0.33	0.00	**-0.26**
8	-1.00	0.00	-2.00	0.00	0.00	-1.00	0.00	2.00	-	**-**
9	-0.25	-0.25	-0.50	0.75	0.50	0.00	3.00	-0.25	-0.33	**0.30**
10	-0.50	0.50	0.50	0.50	0.50	0.00	1.50	0.50	-0.50	**0.33**
11	-1.00	0.00	0.00	1.00	-1.00	1.00	0.00	0.00	-	**-**
12	-3.00	0.00	-3.00	0.00	-7.00	-4.00	0.00	-4.00	-6.00	**-3.00**
13	0.00	1.00	0.00	2.00	1.00	0.00	1.00	0.00	0.00	**0.56**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	all
14	-	-	-	-	-	-	-	-	-	-
15	-4.00	0.00	-5.00	-1.00	0.00	0.00	2.00	-1.00	0.00	-1.00
Weighted Mean	**-0.19**	**0.16**	**-0.26**	**0.34**	**-0.24**	**-0.02**	**0.72**	**-0.06**	**-0.48**	**0.00**

Table A4.13. Age error matrix (AEM) for Skagerrak, whole otoliths.

Modal age	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Age 1	0.9697	0.05455	-	-	-	-	-	-	-	-	-	-	-	-
Age 2	0.0303	0.78182	0.03448	-	0.01064	-	-	-	-	-	-	-	-	-
Age 3	-	0.10909	0.74138	0.02381	0.03191	-	-	-	-	-	-	-	-	-
Age 4	-	0.05455	0.12069	0.88095	0.06383	-	-	-	-	-	-	-	-	-
Age 5	-	-	0.03448	0.09524	0.80851	0.11111	0.04	-	-	-	-	0.1111	-	-
Age 6	-	-	-	-	0.07447	0.83333	0.24	0.125	-	-	-	0.1111	-	-
Age 7	-	-	0.01724	-	0.01064	0.05556	0.68	0.250	0.02857	-	-	-	-	-
Age 8	-	-	0.03448	-	-	-	0.04	0.500	0.17143	-	-	0.2222	-	-
Age 9	-	-	0.01724	-	-	-	-	-	0.60000	0.11111	-	0.2222	-	-
Age 10	-	-	-	-	-	-	-	0.125	0.08571	0.50000	0.25	-	-	0.1111
Age 11	-	-	-	-	-	-	-	-	0.05714	0.33333	0.50	-	-	0.1111
Age 12	-	-	-	-	-	-	-	-	0.02857	0.05556	0.25	0.3333	-	-
Age 13	-	-	-	-	-	-	-	-	-	-	-	-	0.5556	-

Modal age	1	2	3	4	5	6	7	8	9	10	11	12	13	15
Age 14	-	-	-	-	-	-	-	-	-	-	-	-	0.3333	0.2222
Age 15	-	-	-	-	-	-	-	-	-	-	-	-	0.1111	0.4444
Age 17	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1111
Age 18	-	-	-	-	-	-	-	-	0.02857	-	-	-	-	-

Advanced readers – North Sea – Whole otoliths (Section 4.3.2.7)

(Table X: Data overview for all readers including modal age and statistics per sample. – Excluded.)

Table A4.14. Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	all
0	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	**0.25**
1	0.00	-0.14	0.57	0.29	0.00	0.00	0.14	0.00	0.17	**0.11**
2	-0.33	-0.67	0.00	0.00	0.00	-0.33	0.00	0.00	0.00	**-0.15**
3	-0.33	-0.33	-0.67	0.33	-0.33	0.00	0.33	0.00	0.00	**-0.11**
4	-0.50	-0.50	-0.50	0.00	1.00	0.50	1.00	0.00	0.00	**0.11**
5	-0.25	-1.25	-0.25	0.00	0.00	0.00	0.00	-0.25	0.00	**-0.22**
6	0.00	0.40	-0.20	0.50	0.20	0.80	0.40	0.00	-0.40	**0.19**
7	0.00	0.17	-0.17	0.67	0.17	0.17	0.67	0.00	0.17	**0.20**
8	-0.50	0.62	-0.86	0.25	0.38	0.50	0.57	-1.38	-0.75	**-0.13**
9	-0.50	0.00	-0.80	0.00	0.80	0.20	0.60	0.80	-1.20	**-0.01**

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	R28 GB-SCT	all
10	0.00	0.00	-0.50	0.00	0.00	0.00	0.00	0.00	0.00	**-0.06**
11	-2.00	0.00	-6.00	0.00	-1.00	0.00	2.00	-3.00	-3.00	**-1.44**
Weighted Mean	**-0.22**	**-0.04**	**-0.39**	**0.22**	**0.18**	**0.20**	**0.39**	**-0.22**	**-0.30**	**0.00**

Table A4.15. Age error matrix (AEM) for North Sea, whole otoliths.

Modal age	0	1	2	3	4	5	6	7	8	9	10	11
Age 0	0.9394	0.01613	0.03846	-	-	0.02941	-	-	0.01429	-	-	-
Age 1	0.0303	0.88710	0.07692	-	-	-	-	-	-	-	-	-
Age 2	0.0303	0.08065	0.88462	0.18519	-	-	-	-	-	-	-	-
Age 3	-	-	-	0.74074	0.2222	-	-	-	-	-	-	-
Age 4	-	0.01613	-	0.07407	0.5556	0.08824	-	-	-	-	-	-
Age 5	-	-	-	-	0.1111	0.88235	0.15909	-	0.04286	0.02273	-	0.1111
Age 6	-	-	-	-	0.1111	-	0.59091	0.03704	0.05714	-	-	-
Age 7	-	-	-	-	-	-	0.15909	0.75926	0.08571	0.06818	-	-
Age 8	-	-	-	-	-	-	0.09091	0.16667	0.60000	0.13636	-	0.2222
Age 9	-	-	-	-	-	-	-	0.03704	0.11429	0.59091	0.05556	0.1111
Age 10	-	-	-	-	-	-	-	-	0.05714	0.09091	0.94444	0.1111
Age 11	-	-	-	-	-	-	-	-	0.02857	0.04545	-	0.3333
Age 13	-	-	-	-	-	-	-	-	-	0.04545	-	0.1111

Advanced readers – North Sea – Sectioned otoliths (Section 4.3.2.8)

(Table X: Data overview for all readers including modal age and statistics per sample. – Excluded.)

Table A.4.16. Relative bias table represents the relative bias per modal age and advanced reader, the relative bias of all advanced readers combined per modal age and a weighted mean of the relative bias per reader.

Modal age	R02 SE	R04 NL	R06 DK	R08 SE	R10 NL	R12 BE	R14 BE	R18 DK	all
0	0.25	0.00	-	0.75	0.00	0.00	0.00	1.00	-
1	0.00	-0.14	-	0.00	0.14	0.00	0.14	0.14	-
2	0.00	-0.25	-	0.25	-0.25	-0.25	0.50	0.25	-
3	0.00	0.00	-	0.00	0.00	0.50	0.00	0.50	-
4	0.00	-1.00	-	-1.00	0.00	0.00	0.00	0.00	-
5	0.00	0.00	-	0.50	0.00	0.00	0.00	0.50	-
6	0.33	0.00	-	0.00	0.00	0.00	0.00	0.33	-
7	0.14	0.14	-	0.14	0.00	0.00	0.00	0.00	-
8	-0.17	0.33	-1.00	0.17	-0.17	0.17	0.00	0.17	-0.06
9	-0.80	0.17	-	0.17	0.33	0.17	0.00	0.00	-
10	-0.50	0.00	-	0.25	0.25	-0.50	-0.25	-0.25	-
11	1.00	-1.00	-	0.00	2.00	0.00	0.00	3.00	-
12	-1.00	0.00	-	0.00	0.00	0.00	1.00	0.00	-
Weighted Mean	**-0.08**	**0.00**	**-1.00**	**0.18**	**0.08**	**0.00**	**0.06**	**0.26**	**-0.06**

Table A4.17. Age error matrix (AEM) for North Sea, sectioned otoliths.

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12
Age 0	0.75000	0.06122	-	-	-	-	-	-	-	-	-	-	-
Age 1	0.21429	0.83673	0.10714	-	-	-	-	-	-	-	-	-	-
Age 2	0.03571	0.10204	0.78571	-	-	-	-	-	-	-	-	-	-
Age 3	-	-	0.07143	0.8571	0.2857	-	-	-	-	-	-	-	-
Age 4	-	-	0.03571	0.1429	0.7143	-	-	-	-	-	-	-	-
Age 5	-	-	-	-	-	0.89286	0.04762	0.02041	-	-	-	-	-
Age 6	-	-	-	-	-	0.07143	0.80952	0.06122	-	-	-	-	-
Age 7	-	-	-	-	-	0.03571	0.14286	0.75510	0.13953	0.02439	-	-	-
Age 8	-	-	-	-	-	-	-	0.16327	0.72093	0.12195	-	-	-
Age 9	-	-	-	-	-	-	-	-	0.09302	0.68293	0.21429	-	-
Age 10	-	-	-	-	-	-	-	-	0.04651	0.14634	0.71429	0.1429	-
Age 11	-	-	-	-	-	-	-	-	-	0.02439	0.07143	0.4286	0.1429
Age 12	-	-	-	-	-	-	-	-	-	-	-	0.1429	0.7143
Age 13	-	-	-	-	-	-	-	-	-	-	-	0.1429	0.1429
Age 14	-	-	-	-	-	-	-	-	-	-	-	0.1429	-

Annex 5: Meeting agenda

Agenda WKARP2 6th – 10th December 2021 (updated 8th December) Meeting times are CET

Monday 6th December 2021

10:00 – 10:30	Welcome, setup, agenda and report outline
10:30 – 10:40	Recap of WKARP (2010) - Julie
10:40 – 11:00	Presentation of Biology – Ulrika and Marcel
11:00 – 11:30	Presentation of results from 0 and 1 year olds - Julie
11:30 – 12:00	Presentation from stock assessor of ple.27.420 Chun Chen (IMARES)
12:00 – 13:00	Lunch
13:00 – 14:00	Present and discuss results from the 2020 exchange
14:00 – 14:15	Coffee
14:15 – 15:30	Present and discuss results from the 2020 exchange

Tuesday 7th December 2021

10:00 – 10:20	Presentation of validation done by Sweden.
10:20 – 10:50	Presentation of results on the edge analysis from the 2020 exchange
10:50 – 11:20	Compare and discuss growth differences between areas (results from 2020 exchange)
11:20 – 12:00	Presentation of the WKARP age reading protocol.
12:00 – 13:00	Lunch
13:00 – 14:30	Chairs work: updating the protocol based on mornings discussion Subgroup/participants work: updating their country specific information and addition of measurement guidelines to the updated protocol (ask participants to be prepared with their text)
14:30 – 14:45	Coffee
14:45 – 16:00	Updated protocol discussed and agreed upon in plenary

Wednesday 8th December 2021

10:00 – 14:30	Age reading exercise on SmartDots (following updated protocol) (Includes lunch break)
Lunch	
14:30 – 15:00	Discussion among readers of 2021 age reading exercise
15:00 – 15:20	Presentation of validation study by Germany on Baltic plaice
15.20 – 15.40	Presentation of method comparison study by Norway

Thursday 9th December 2021

10:00 – 11:00	Presentation and discussion of the age and growth results from the age reading exercise
11:00 – 12:00	Presentation and discussion of the method comparison results from the age reading exercise
12:00 – 13:00	Lunch
13:00 – 13:30	Plenary discussion (open for suggestions)
13:30 – 15:00	Plenary discussion on images to be added to the reference collection followed by subgroup work to prepare the images (1 per age group per Q) and text for the report.

Friday 10th December 2021

10:00 – 12:00	Report writing (participants will be assigned sections of the report to work on)
12:00 – 13:00	Lunch
13:00 – 14:00	Discuss and agree on follow-up actions and/or recommendations
14.00 – 14:30	Wrap up and close the meeting