

Report of the international North Sea cod (*Gadus morhua* L.) otolith small exchange 2011-12

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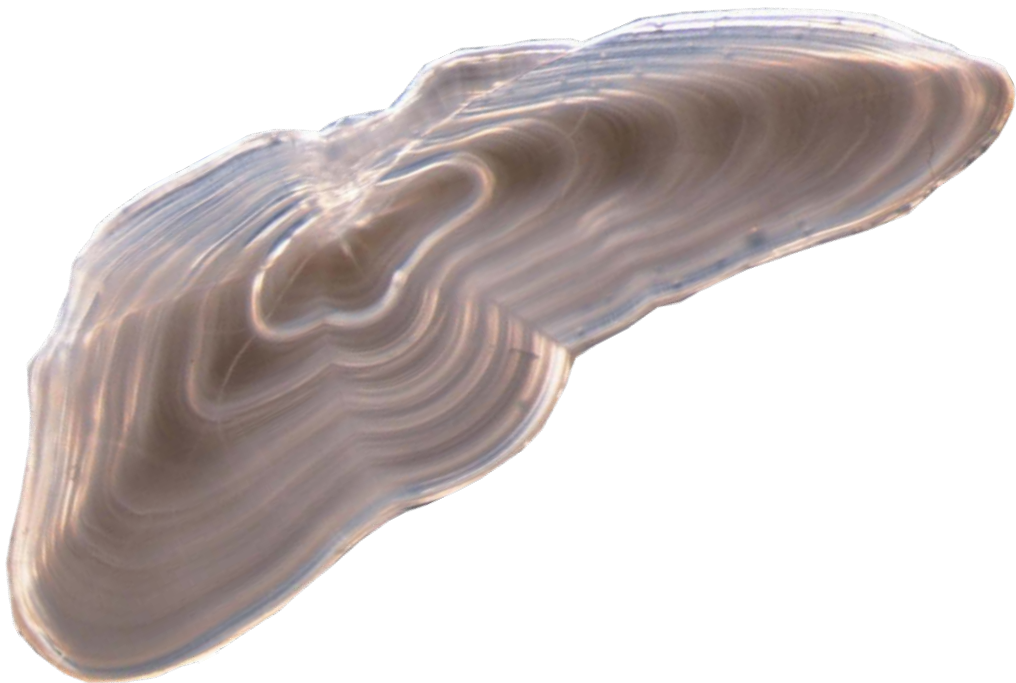


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1. Introduction

The last North Sea cod otolith exchange took place in 2009-2010. The overall result of this exchange was that there were significant variations in North Sea cod age estimates between readers. Both precision and relative biases between readers were better than during the last exchange, but there is still room for improvement, as overestimation of fish ages still seemed to be the problem. The Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS), recommended that a small scale exchange could be circulated to confirm the age reading criteria in the minds of the age readers. Therefore 62 otoliths from the previous exchange were chosen based on the percentage agreement, representing both highly agreed otoliths but certainly also the problematic otoliths; however ensuring a wide and representative modal age distribution.

The institutes participating use different preparation and reading methodology. All otoliths used in this exchange was sectioned, mounted on slides and photographed.

Otoliths from two regions were included in this exchange:

- ICES Division IVa, collected in Q2, Q3 and Q4
- ICES Division IVb, collected in Q2 and Q3

2. Participants

Readers from 6 different research institutes (IMR, Marlab, CEFAS, Swedish Board of Fisheries, Johann Heinrich von Thünen Institute, and ILVA) participated in the exchange. All readers except R10 were involved in the previous reading, and the majority of the readers contribute with age data to stock assessment of North Sea Cod.

Reader	Name	Institution	Degree of exp.	Country	2009-2010
R1	Harald Senneset	Institute of Marine Research	Expert	Norway	X
R2	Hildegunn Mjanger	Institute of Marine Research	Expert	Norway	X
R3	Peter Clark	Marlab	Expert	Scotland	X
R4	Martine Moerman	ILVO – Sea Fisheries Department	Expert	Belgium	X
R5	Dave Brown	CEFAS	Expert	United Kingdom	X
R6	Anne-Marie Palmén Bratt	Institute of Marine Research	Expert	Sweden	X
R7	Ilse Maertens	ILVO – Sea Fisheries Department	Expert	Belgium	X
R8	Friederike Beussel	Johann Heinrich von Thünen Institute	Expert	Germany	X
R9	Rajlie Sjöberg	Institute of Marine Research	Expert	Sweden	X
R10	Ines Wilhelms	Johann Heinrich von Thünen Institute	Intermediate	Germany	

Readers listed according to their agreement to modal age in the last exchange. Reader 10 did not participate in the last exchange, and was placed last. Modal age determined from all expert readers (reader 1-9 of 10).

3. Otolith collection

In this exchange 62 of the sectioned otoliths from the last exchange was annotated using WebGR (<http://webgr.azti.es>). 31 otoliths belong to fish captured in ICES area IVa and 31 from fish captured in ICES area IVb. Further details of position and date of catch, and fish size are given in Appendix II.

Pictures of the otoliths were taken using a 12 megapixels camera attached to a stereo microscope. Images of all otoliths and the corresponding fish data were uploaded to WebGR.

4. Otolith exchange set

4.1. Reading procedure

The otoliths were read in accordance with convention. Birthday was assumed to be January 1st. The readers had available information about fish length, weight, date of catch and position. Only one age estimate was provided per otolith and an age was assigned for all otoliths. Each reader was supposed to interpret the otoliths as an individual and not to see or be influenced by the results produced by other readers. In total everybody should read 62 otoliths.

4.2. Datasheet

Using WebGR no distribution of datasheets or otoliths was necessary.

4.3. Time table

All readers were given 3½ month to complete all annotations.

4.4. WebGR

WebGR is installed on a server within AZTI (Marine and Food Technological Centre) and the image collection of North Sea cod otoliths were uploaded to the programme for all readers to use.

WebGR is Open Source software developed by a consortium of research institutes and software developers from Federal Agency for Agriculture and Food (Germany), which allows everyone to sign up for reading otoliths. WebGR has the advantage that it can be used similar to Paint Shop Pro and GIMP, but instead of creating a layer for each reader in a specified file format, WebGR saves each reader's annotation of each image as a set of xy-coordinates that can be mapped on to that image, but the original image and the associated metadata remain unaltered.

All readers received the WebGR user manual and a quick-read manual (see Appendix IV). When all annotations were completed, a csv-file with the results was extracted and the data inserted into an EFAN-sheet.

5. Results/Discussion

Results for all readers are presented in Appendix III (Tables AIII.1-5).

The AGE COMPARISON.XLSX excel workbook (by Guus Eltink, RIVO, Ijmuiden, The Netherlands) is considered to be the standard method of analyzing precision, accuracy etc. and

thus is the tool used most widely for the analysis of age determination results by individual readers, see Appendix III. The spreadsheets were completed according to the instructions contained in Guidelines and Tools for Age Reading Comparisons by Eltink *et al.* (2000).

Table AIII.1 (Appendix III Table 1) contains the sample information and the input data of the age readings by reader. Readers were tentatively assigned numbers in accordance with their experience levels. The Guus Eltink spreadsheet is set up in such a way that the most experienced reader must be positioned in the left most column thus as you go from left to right the readers are less experienced. If there is no clear mode, modal age is determined by the age estimate of the reader in the leftmost column of Table AIII.1 of the workbook, i.e. the most experienced reader. Therefore, it is important to consider which reader should occupy the leftmost column. In the case of a possible tie on two modal ages from a group of readers, the most experienced reader's determination of the age will take precedence.

10 readers participated in the exchange, and the modal age was calculated from readers 1 to 9 as these were considered the most experienced of the group (see Table AIII.3 Inter-reader bias test and reader against modal age bias test). Only reader 10 was not considered an expert reader of North Sea cod otoliths.

In Table AIII.1 modal ages were calculated for each otolith read, along with percentage agreement, mean age and precision CV, where *percentage agreement* = $100 \times (\text{no. of readers agreeing with modal age} / \text{total no. of readers})$ (for each otolith) and *precision CV* = $100 \times (\text{standard deviation of age readings} / \text{mean of age readings})$ (for each otolith).

Percentage agreement ranged from 40 to 100% with an average of 78%, compared to 66% (35-100%) found in the 2009/2010 exchange. Of the 62 otoliths, 38 were read with at least 80% agreement and 18 of these were read with 100% agreement. The precision CV ranged from 0% (corresponding to 100 % agreement in readings) to 28%, with an average of 8.0%. In 2009/2010 an average CV of 14.7 was found.

Table AIII.2 examine the readings of individuals at each modal age and summarises the number of otoliths read, the precision CV, percentage agreement and relative bias of each reader. All of the 620 age readings requested were supplied during this exchange. Six readers had CV below 10% and four readers had CV between 10 and 13%. Percentage agreement showed similar variation. Readers 1-3 and 5 tend to be more consistent over all ages and this is apparent in the percentage agreement table where they achieve over 80% agreement in average over all the ages. Readers 4, 6-8 and 10 also perform well achieving over 70% agreement. For all readers the percentage agreement relative to the modal age ranged from 40 to 95%, while the CVs ranged from 4.3 to 12.9%. These results are better than what was obtained in 2009/2010. During this exchange the majority of the readers contribute age data to the stock assessment of North Sea Cod, which would explain the improvement.

The relative bias tables demonstrate the difference between the mean age for each age group and the modal for each age group. It can be seen that readers 1-3 and 6 show little relative bias (± 0.1). Reader 5 tends to underestimate, while readers 4 and 7-10 overestimate. All in all there is a tendency to overestimate the fish age (0.10), which is similar to what was found in 2009/2010 (0.08).

Figure AIII.1 is a graphical representation of the relative bias table in Table AIII.2. The data for each reader which is plotted in Figure AIII.1 is derived from Table AIII.6. In these age bias plots any deviation of the points from the solid line indicates a bias when the reader's age estimates are compared with the modal age. Points above and below the line indicate a

positive and negative bias, respectively. The vertical bars are drawn plus and minus two standard deviations from the mean age. Short bars indicate consistency of reading at a given modal age. Figure AIII.2 are graphical representation of the coefficient of variation and percentage agreement tables in Tables AIII.2. In the overall ranking table, readers 2, 1 and 3 are ranked in the top three positions for CV, percentage agreement and relative bias.

Figure AIII.3 show the distribution of the age reading errors in percentage by Modal age as observed from the whole group of age readers in an age reading comparison to Modal age.

Table AIII.3 show the age compositions and the mean length-at-age obtained by each reader and all readers combined and also the “inter-reader bias test” and the “reader against modal age bias test”. There are no clear trends towards which length classes were over- or underestimated (see Mean length at age table in Table AIII.3 and Figure AIII.5).

The “inter-reader bias test” is presented in the bottom panel of Table AIII.3. Of 45 possible combinations, 15 (33%) were found significantly different (certainty of bias, $p < 0.01$), 7 (16%) had a possibility of bias ($0.01 < p < 0.05$), while 23 (51%) had no sign of bias ($p > 0.05$). The corresponding figures from 2009/2010 were 66, 10 and 24%, respectively, indicating that the relative bias between the readers were larger during the present reading. When comparing each reader to modal age, the percent showing certainty of bias, possible bias and no bias were 30, 20 and 50, which is also better than the results from 2009/2010 being 59, 0 and 41%.

The majority of the readers were considered to be experts in North Sea cod otolith aging, and there were little difference in the number of cases of bias among the readers. There were, however, few signs of bias between some readers from the same institutes, e.g. between readers 1 and 2 from IMR, 4 and 7 from ILVO and readers 8 and 10 from Johan Heinrich von Thünen Institute. Similar findings were made in 2009/2010, suggesting that there is still a laboratory-specific different interpretation of the otolith structures.

The age readings are summarised by month of sampling in Table AIII.4. Samples were mainly obtained in three months. Highest percentage agreement and lowest CVs were found for otoliths collected in May, August, September and October, but it should be noted that this may be due to the low number of samples from these months. Table AIII.5 summarise the results by the sample origin in terms of ICES division. There does not seem to be any clear differences between otoliths sampled in ICES areas IVa and IVb.

6. Conclusion/Recommendations

It would be generally accepted that an agreement level with the modal age between age readers of at least 90% would be desirable and achievable. Readers with some amount of experience should achieve this and any lower than this figure is cause for concern especially for those supplying ages to an ICES working group.

The overall percentage agreement for this exchange was 78% and the overall precision CV was 8.0%, which is not satisfactory. It is, however, better than what was obtained in the 2009/2010 exchange and the results corresponds with the previous results from only the group reading for assessment. No readers achieved more than 90% agreement with the modal age but four readers achieved between 80 and 90%.

Overestimation of ages was previously a main problem when interpreting ages of North Sea cod, but this was improved in both the previous and the present reading. Compared to the

previous reading in 2009/2010 there was a low inter-reader bias, as well as for each reader compared to modal age. This may be because all but one of the readers in this exchange are considered expert readers, and all except the intermediate reader participated in the previous exchange.

There were less signs of bias between readers from some institutes, e.g. from IMR, ILVO and Johan Heinrich von Thünen Institute. This suggests that there is good agreement between readers who possibly interpret age readings in much the same way probably because of similar training received. There was, however, probability of bias between the two readers from Swedish Board of Fisheries. In the overall ranking table (AIII.2), readers 1 and 2 from IMR are ranked among the top positions for CV, percent agreement and relative bias, which reinforces the former point.

The preparation method was the same for all otoliths. All otoliths were sectioned and photographed and ages were decided from the images. Readers who are familiar with the broken method mentioned a difficulty in reading from images, but this didn't seem to have any effect on the results.

The results suggest that more workshops are needed to standardize the age reading between laboratories. The guidelines and manuals developed during an earlier workshop have not yet had the intended effect on the quality of the age reading. It should be investigate why in order to improve the guidelines and manuals and/or the implementation of them at the different institutes.

The use of WebGR for this exchange was recommended by PGCCDBS. WebGR is a tool new to most readers, but few problems arose during the reading. It was commented that the images of this exchange were good for image analyses and using WebGR was a much simpler way of carrying out an exchange without the problems of sending the actual otoliths around Europe.

7. References

Eltink, A.T.G.W. 2000. Age reading comparisons. (MS Excel workbook version 1.0 October 2000) .

GUIDELINES AND TOOLS FOR AGE READING COMPARISONS. Eltink A.T.G.W., A.W. Newton, C. Morgado, M.T.G. Santamaria and J. Modin, 2000. Guidelines and Tools for Age Reading. (PDF document version 1.0 October 2000).

Appendix I Contact addresses

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Appendix II Collection of otoliths

Date	ICES	Position	Otolit	Fish	Fish	Date	ICES	Position	Otolit	Fish	Fish
09.10.2008	IVa	60.26N- 01.28E	1	4460	72	13.07.2009	IVb	57.17N- 05.59E	63	8765	93
09.10.2008	IVa	60.26N- 01.28E	2	3085	67	13.07.2009	IVb	57.17N- 05.59E	66	9210	98
31.07.2008	IVa	60.37N-01.44E	5	3765	73	13.07.2009	IVb	57.17N- 05.59E	71	8725	92
31.07.2008	IVa	60.37N-01.44E	6	5040	79	13.07.2009	IVb	57.17N- 05.59E	74	9265	99
31.07.2008	IVa	60.37N-01.44E	8	4615	77	26.08.2009	IVb	56.41N-05.04E	76	8510	94
31.07.2008	IVa	60.37N-01.44E	11	5415	81	26.08.2009	IVb	56.41N-05.04E	77	12560	106
31.07.2008	IVa	60.37N-01.44E	14	8120	92	26.08.2009	IVb	56.41N-05.04E	78	1490	53
28.09.2008	IVa	60.18N-02.04E	23	2728	63	26.08.2009	IVb	56.41N-05.04E	79	1940	60
28.09.2008	IVa	60.18N-02.04E	24	4518	78	26.08.2009	IVb	56.41N-05.04E	81	1250	49
28.09.2008	IVa	60.18N-02.04E	25	4632	73	26.08.2009	IVb	56.41N-05.04E	82	1195	49
28.09.2008	IVa	60.18N-02.04E	26	3474	65	26.08.2009	IVb	56.41N-05.04E	83	1165	49
24.07.2008	IVa	60.18N-02.04E	27	3922	71	26.08.2009	IVb	56.41N-05.04E	84	785	44
24.07.2008	IVa	60.48N-01.27E	28	13364	102	26.08.2009	IVb	56.41N-05.04E	88	8385	95
24.07.2008	IVa	60.48N-01.27E	29	3624	68	26.08.2009	IVb	56.41N-05.04E	90	10005	97
24.07.2008	IVa	60.48N-01.27E	30	3492	69						
						31.04.2008	IVb	57.25N-07.25E	91	9715	95
16.04.2009	IVa	60.20N-02.10E	33	6325	80	31.04.2008	IVb	57.25N-07.25E	92	4340	79
16.04.2009	IVa	60.20N-02.10E	34	5690	79	31.04.2008	IVb	57.25N-07.25E	95	2780	68
16.04.2009	IVa	60.20N-02.10E	36	4340	75	31.04.2008	IVb	57.25N-07.25E	96	2570	67
16.04.2009	IVa	60.20N-02.10E	38	9995	98	31.04.2008	IVb	57.25N-07.25E	99	13740	108
16.04.2009	IVa	60.20N-02.10E	40	7895	95	31.04.2008	IVb	57.25N-07.25E	102	12680	106
16.04.2009	IVa	60.20N-02.10E	41	10940	100	06.05.2008	IVb	56.54N-05.51E	104	7040	87
16.04.2009	IVa	60.20N-02.10E	43	5565	77	06.05.2008	IVb	56.54N-05.51E	105	7790	89
16.04.2009	IVa	60.20N-02.10E	45	7585	87	06.05.2008	IVb	56.54N-05.51E	107	1960	60
16.04.2009	IVa	60.20N-02.10E	46	15220	113	06.05.2008	IVb	56.54N-05.51E	108	675	39
16.04.2009	IVa	60.20N-02.10E	47	4985	77	06.05.2008	IVb	56.54N-05.51E	109	4700	77
16.04.2009	IVa	60.20N-02.10E	49	5980	85	06.05.2008	IVb	56.54N-05.51E	111	8550	89
16.04.2009	IVa	60.20N-02.10E	51	5505	79	06.05.2008	IVb	56.54N-05.51E	113	7980	89
16.04.2009	IVa	60.20N-02.10E	53	5400	78	06.05.2008	IVb	56.54N-05.51E	114	10325	99
16.05.2009	IVa	60.35N-02.17E	54	5880	83	06.05.2008	IVb	56.54N-05.51E	116	1775	59
16.05.2009	IVa	60.35N-02.17E	58	5655	82	06.05.2008	IVb	56.54N-05.51E	117	9085	91
16.05.2009	IVa	60.35N-02.17E	59	5460	81	06.05.2008	IVb	56.54N-05.51E	119	7650	84

Appendix III Guus Eltink spreadsheet data analyses for all readers

Table AIII.1

Appendix III:

International North Sea Cod reading 2012, AGE

RANGE

Table 1

Stratum	Sample		Fish	Fish	Sex	Landing	Norway Harald Senneset	Norway Hildegunn Mjanger	Scotland Peter Clark	Belgium Martine Moerman	United Kingdom Dave Brown	Sweden AnneMari e Palmén Bratt	Belgium Ilse Maertens	Germany Friederike Beussel	Sweden Rajlie Sjöberg	Germany Ines Wilhelms	MODAL	Prosent enighet	Presisjon
	year	no	no	length			Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	(R1-R9)		CV
Iva	2008		1	72		10	2	2	2	2	2	3	2	2	2	2	2	90 %	15 %
Iva	2008		2	67		10	3	3	3	4	3	3	4	3	3	3	3	80 %	13 %
Iva	2008		5	73		7	4	4	3	4	2	6	3	4	5	4	4	50 %	28 %
Iva	2008		6	79		7	3	3	3	4	3	3	3	4	5	4	3	60 %	20 %
Iva	2008		8	77		7	3	4	3	4	3	4	3	4	4	4	4	60 %	14 %
Iva	2008		11	81		7	4	4	4	4	4	4	4	3	4	4	4	90 %	8 %
Iva	2008		14	92		7	5	6	5	6	5	5	6	5	7	6	5	50 %	12 %
Iva	2008		23	63		9	3	3	3	4	3	3	3	3	4	3	3	80 %	13 %
Iva	2008		24	78		9	3	3	3	3	3	3	3	3	4	4	3	80 %	13 %
Iva	2008		25	73		9	3	3	3	4	3	3	3	3	4	3	3	80 %	13 %
Iva	2008		26	65		9	3	3	3	3	3	3	3	3	3	3	3	100 %	0 %
Iva	2008		27	71		7	4	3	3	4	3	4	4	3	5	3	4	40 %	19 %
Iva	2008		28	102		7	7	8	9	9	6	6	9	8	10	9	9	40 %	17 %
Iva	2008		29	68		7	4	3	4	4	4	3	4	4	4	5	4	70 %	15 %
Iva	2008		30	69		7	3	3	4	3	3	3	3	3	3	3	3	90 %	10 %
Iva	2009		33	80		4	4	4	4	4	4	4	4	4	4	4	4	100 %	0 %
Iva	2009		34	79		4	4	4	4	4	4	4	5	4	4	4	4	90 %	8 %
Iva	2009		36	75		4	5	4	4	5	4	5	4	5	4	5	4	50 %	12 %
Iva	2009		38	98		4	6	6	6	6	6	6	7	6	6	6	6	90 %	5 %
Iva	2009		40	95		4	7	6	6	7	6	6	7	6	6	6	6	70 %	8 %
Iva	2009		41	100		4	8	10	10	10	9	9	9	9	11	10	9	40 %	9 %
Iva	2009		43	77		4	4	4	4	4	4	4	4	4	4	5	4	90 %	8 %
Iva	2009		45	87		4	5	5	5	5	5	5	5	5	5	5	5	100 %	0 %
Iva	2009		46	113		4	10	10	9	10	10	9	10	10	10	10	10	80 %	4 %
Iva	2009		47	77		4	4	4	4	4	4	4	4	4	4	4	4	100 %	0 %
Iva	2009		49	85		4	4	4	4	4	4	5	4	5	5	5	4	60 %	12 %
Iva	2009		51	79		4	3	4	4	4	4	4	4	4	4	4	4	90 %	8 %
Iva	2009		53	78		4	4	4	4	4	4	5	4	5	5	5	4	60 %	12 %
Iva	2009		54	83		5	6	6	6	6	6	6	7	6	6	7	6	80 %	7 %
Iva	2009		58	82		5	5	5	5	5	5	5	5	5	5	5	5	100 %	0 %
Iva	2009		59	81		5	5	5	5	5	5	6	5	5	5	5	5	90 %	6 %
Ivb	2009		63	93		7	6	6	6	6	6	6	6	6	6	6	6	100 %	0 %
Ivb	2009		66	98		7	6	6	6	6	6	6	6	7	7	6	6	80 %	7 %
Ivb	2009		71	92		7	7	7	7	7	7	7	7	7	7	7	7	100 %	0 %
Ivb	2009		74	99		7	7	7	7	8	7	8	7	8	8	8	7	50 %	7 %
Ivb	2009		76	94		8	4	4	4	4	4	5	4	4	5	4	4	80 %	10 %
Ivb	2009		77	106		8	6	6	5	6	6	6	6	6	7	7	6	70 %	9 %
Ivb	2009		78	53		8	4	4	4	4	4	4	4	4	4	4	4	100 %	0 %
Ivb	2009		79	60		8	4	4	4	4	4	4	4	5	5	4	4	80 %	10 %
Ivb	2009		81	49		8	4	4	4	4	4	4	5	4	4	4	4	90 %	8 %
Ivb	2009		82	49		8	4	4	4	4	4	4	4	4	4	4	4	100 %	0 %
Ivb	2009		83	49		8	4	4	4	4	4	4	4	4	4	4	4	100 %	0 %
Ivb	2009		84	44		8	2	2	2	2	2	2	2	2	2	2	2	100 %	0 %
Ivb	2009		88	95		8	5	5	5	6	5	6	8	6	5	6	5	50 %	17 %
Ivb	2009		90	97		8	4	4	4	4	4	4	4	4	4	5	4	90 %	8 %
Ivb	2008		91	95		4	6	7	6	6	5	7	6	7	6	7	6	50 %	11 %
Ivb	2008		92	79		4	7	5	5	7	5	6	6	6	5	5	5	50 %	14 %
Ivb	2008		95	68		4	4	4	4	4	4	4	4	4	4	4	4	100 %	0 %
Ivb	2008		96	67		4	5	5	5	5	4	5	5	4	4	5	5	70 %	10 %
Ivb	2008		99	108		4	6	6	5	6	5	6	6	5	7	6	6	60 %	11 %
Ivb	2008		102	106		4	6	6	6	6	6	6	6	6	6	6	6	100 %	0 %
Ivb	2008		104	87		4	5	5	5	6	5	5	6	5	6	5	5	70 %	9 %
Ivb	2008		105	89		4	5	5	5	5	5	5	5	5	5	5	5	100 %	0 %
Ivb	2008		107	60		4	3	3	3	3	3	3	3	3	3	3	3	100 %	0 %
Ivb	2008		108	39		4	3	3	3	3	3	3	3	3	3	3	3	100 %	0 %
Ivb	2008		109	77		4	6	5	5	6	5	5	6	5	5	6	5	60 %	10 %
Ivb	2008		111	89		4	8	6	6	8	6	5	6	7	7	7	6	40 %	15 %
Ivb	2008		113	89		4	6	5	5	6	5	5	6	5	5	5	5	70 %	9 %
Ivb	2008		114	99		4	7	7	7	7	7	7	7	8	8	7	7	80 %	6 %
Ivb	2008		116	59		4	4	3	4	4	3	3	4	4	3	4	4	60 %	14 %
Ivb	2008		117	91		4	5	5	5	5	5	5	5	5	5	5	5	100 %	0 %
Ivb	2008		119	84		4	5	5	5	5	5	5	5	5	5	5	5	100 %	0 %
Total read							62	62	62	62	62	62	62	62	62	62		78.2%	8.0%
Total NOT read							0	0	0	0	0	0	0	0	0	0			

Table AIII.2

Table 2 The number of age readings, the coefficient of variation (CV), the percent agreement and the RELATIVE bias are presented by MODAL age for each age reader and for all readers combined. A weighted mean CV and a weighted mean percent agreement are given by reader and all readers combined. The CV's by MODAL age for each individual age reader and all readers combined indicate the precision in age reading by MODAL age. The weighted mean CV's over all MODAL age groups combined indicate the precision in age reading by reader and for all age readers combined.

International North Sea Cod reading 2012, AGE

NUMBER OF AGE READINGS											
MODAL	Norway Harald Senneset	Norway Hildegunn Mjanger	Scotland Peter Clark	Belgium Martine Moerman	United Kingdom Dave Brown	Sweden AnneMarie Palmén	Belgium Ilse Maertens	Germany Friederike Beussel	Sweden Rajlie Sjöberg	Germany Ines Wilhelms	TOTAL
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	
0	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-
2	2	2	2	2	2	2	2	2	2	2	20
3	9	9	9	9	9	9	9	9	9	9	90
4	22	22	22	22	22	22	22	22	22	22	220
5	13	13	13	13	13	13	13	13	13	13	130
6	10	10	10	10	10	10	10	10	10	10	100
7	3	3	3	3	3	3	3	3	3	3	30
8	-	-	-	-	-	-	-	-	-	-	-
9	2	2	2	2	2	2	2	2	2	2	20
10	1	1	1	1	1	1	1	1	1	1	10
11	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	62	62	62	62	62	62	62	62	62	620

COEFFICIENT OF VARIATION (CV)											
MODAL	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines	ALL Readers
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	
0	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-
2	0 %	0 %	0 %	0 %	0 %	28 %	0 %	0 %	0 %	0 %	7.5 %
3	0 %	0 %	11 %	15 %	0 %	0 %	11 %	11 %	20 %	14 %	9.2 %
4	9 %	9 %	9 %	5 %	14 %	16 %	11 %	13 %	13 %	13 %	8.8 %
5	12 %	5 %	0 %	12 %	6 %	8 %	15 %	10 %	13 %	8 %	6.8 %
6	11 %	5 %	7 %	11 %	7 %	8 %	8 %	10 %	8 %	8 %	7.2 %
7	0 %	0 %	0 %	8 %	0 %	8 %	0 %	8 %	8 %	8 %	4.3 %
8	-	-	-	-	-	-	-	-	-	-	-
9	9 %	16 %	7 %	7 %	28 %	28 %	0 %	8 %	7 %	7 %	12.9 %
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	7.9 %	5.7 %	6.2 %	8.9 %	8.2 %	10.9 %	9.9 %	10.4 %	12.1 %	10.1 %
RANKING		3	1	2	5	4	9	6	8	10	7

PERCENTAGE AGREEMENT											
MODAL	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines	ALL
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	
0	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-
2	100 %	100 %	100 %	100 %	100 %	50 %	100 %	100 %	100 %	100 %	95 %
3	100 %	100 %	89 %	56 %	100 %	100 %	89 %	89 %	56 %	78 %	86 %
4	86 %	86 %	86 %	95 %	82 %	68 %	82 %	73 %	68 %	68 %	80 %
5	77 %	92 %	100 %	54 %	92 %	77 %	54 %	77 %	77 %	77 %	78 %
6	80 %	90 %	80 %	80 %	80 %	80 %	70 %	60 %	60 %	60 %	74 %
7	100 %	100 %	100 %	67 %	100 %	67 %	100 %	33 %	33 %	67 %	77 %
8	-	-	-	-	-	-	-	-	-	-	-
9	0 %	0 %	50 %	50 %	50 %	50 %	100 %	50 %	0 %	50 %	40 %
10	100 %	100 %	0 %	100 %	100 %	0 %	100 %	100 %	100 %	100 %	80 %
11	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	83.9 %	88.7 %	87.1 %	75.8 %	87.1 %	74.2 %	77.4 %	72.6 %	64.5 %	71.0 %
RANKING		4	1	2	6	2	7	5	8	10	9

RELATIVE BIAS											
MODAL	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines	ALL
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	
0	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-
2	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.05
3	0.00	0.00	0.11	0.44	0.00	0.00	0.11	0.11	0.56	0.22	0.16
4	-0.05	-0.14	-0.14	0.05	-0.23	0.18	0.00	0.09	0.23	0.23	0.02
5	0.31	0.08	0.00	0.54	-0.08	0.23	0.62	0.08	0.15	0.23	0.22
6	0.30	0.10	-0.20	0.30	-0.20	0.00	0.30	0.20	0.40	0.40	0.16
7	0.00	0.00	0.00	0.33	0.00	0.33	0.00	0.67	0.67	0.33	0.23
8	-	-	-	-	-	-	-	-	-	-	-
9	-1.50	0.00	0.50	0.50	-1.50	-1.50	0.00	-0.50	1.50	0.50	-0.20
10	0.00	0.00	-1.00	0.00	0.00	-1.00	0.00	0.00	0.00	0.00	-0.20
11	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	0.05	-0.02	-0.06	0.27	-0.18	0.08	0.19	0.11	0.34	0.26
RANKING		2	1	3	9	6	4	7	5	10	8

Overall ranking											
	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines	
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	
Ranking Coefficient of Variation	3	1	2	5	4	9	6	8	10	7	
Ranking Percentage Agreement	4	1	2	6	2	7	5	8	10	9	
Ranking relative bias	2	1	3	9	6	4	7	5	10	8	
OVERALL RANKING	3	1	2	6	4	6	5	8	10	9	

Table AIII.3

International North Sea Cod reading 2012, AGE

Table 3 Upper table: The age compositions estimated by each age reader and all age readers combined.Middle table: The estimated mean length at age by age reader and by all age readers combined.Lower table: Bias tests: non-parametrically with a one-sample Wilcoxon rank sum test. The inter-reader bias test and the reader against MODAL

AGE COMPOSITION											
	Norway Harald Reader 1	Norway Hildegunn Reader 2	Scotland Peter Clark Reader 3	Belgium Martine Reader 4	United Kingdom Reader 5	Sweden AnneMarie Reader 6	Belgium Ilse Reader 7	Germany Friederike Reader 8	Sweden Rajlie Reader 9	Germany Ines Reader 10	TOTAL
0	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-
2	2	2	2	2	3	1	2	2	2	2	20
3	11	12	11	5	12	12	10	10	6	8	97
4	19	19	20	25	19	15	19	18	19	17	190
5	11	12	15	8	14	15	9	15	17	16	132
6	10	10	8	13	9	13	12	8	7	9	99
7	6	4	3	4	3	3	6	4	6	6	45
8	2	1	-	2	-	1	1	3	2	1	13
9	-	-	2	1	1	2	2	1	-	1	10
10	1	2	1	2	1	-	1	1	2	2	13
11	-	-	-	-	-	-	-	-	1	-	1
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	62	62	62	62	62	62	62	62	62	620

MEAN LENGTH AT AGE											
	Norway Harald Reader 1	Norway Hildegunn Reader 2	Scotland Peter Clark Reader 3	Belgium Martine Reader 4	United Kingdom Reader 5	Sweden AnneMarie Reader 6	Belgium Ilse Reader 7	Germany Friederike Reader 8	Sweden Rajlie Reader 9	Germany Ines Reader 10	ALL
0	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-
2	58.0	58.0	58.0	58.0	63.0	44.0	58.0	58.0	58.0	58.0	58.1
3	68.1	65.9	67.7	62.2	66.7	66.0	67.6	66.6	59.8	63.4	65.9
4	70.9	72.6	71.3	71.4	71.8	69.7	71.9	70.8	70.5	69.6	71.1
5	84.5	84.0	87.6	82.0	88.3	84.4	78.8	84.3	82.0	82.3	84.0
6	95.3	96.8	94.6	94.4	96.7	93.6	93.3	94.4	93.9	95.8	94.8
7	94.3	96.3	96.7	91.3	96.7	95.3	94.3	93.5	97.5	94.0	94.9
8	94.5	102.0	-	94.0	-	99.0	95.0	100.0	99.0	99.0	97.7
9	-	-	107.5	102.0	100.0	106.5	101.0	100.0	-	102.0	103.4
10	113.0	106.5	100.0	106.5	113.0	-	113.0	113.0	107.5	106.5	108.2
11	-	-	-	-	-	-	-	-	100.0	-	100.0
12	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0

Inter-reader bias test and reader against MODAL age bias test											
	Norway Harald Reader 1	Norway Hildegunn Reader 2	Scotland Peter Clark Reader 3	Belgium Martine Reader 4	United Kingdom Reader 5	Sweden AnneMarie Reader 6	Belgium Ilse Reader 7	Germany Friederike Reader 8	Sweden Rajlie Reader 9	Germany Ines Reader 10	
Reader 1											
Reader 2	—										
Reader 3	—	—									
Reader 4	**	**	**								
Reader 5	**	*	—	**							
Reader 6	—	—	—	—	**						
Reader 7	—	*	**	—	**	—					
Reader 8	—	—	*	—	**	—	—				
Reader 9	*	**	**	—	**	*	—	*			
Reader 10	*	**	**	—	**	—	—	—	—		
MODAL (R1-R9)	—	—	—	**	*	—	*	—	**	**	

— = no sign of bias ($p > 0.05$)
 * = possibility of bias ($0.01 < p < 0.05$)
 * * = certainty of bias ($p < 0.01$)

Table AIII.4

International North Sea Cod reading 2012, AGE

Table 4 Otoliths read, CV's, percentage agreement and RELATIVE bias by month and by MODAL age.

NUMBER OF OTOLITHS													
MODAL (R1-R9)	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Nr of otoliths
0	-	-	-	-	-	-	-	-	-	-	-	-	0
1	-	-	-	-	-	-	-	-	-	-	-	-	0
2	-	-	-	-	-	-	-	1	-	1	-	-	2
3	-	-	-	2	-	-	2	-	4	1	-	-	9
4	-	-	-	10	-	-	5	7	-	-	-	-	22
5	-	-	-	9	2	-	1	1	-	-	-	-	13
6	-	-	-	6	1	-	2	1	-	-	-	-	10
7	-	-	-	1	-	-	2	-	-	-	-	-	3
8	-	-	-	-	-	-	-	-	-	-	-	-	0
9	-	-	-	1	-	-	1	-	-	-	-	-	2
10	-	-	-	1	-	-	-	-	-	-	-	-	1
11	-	-	-	-	-	-	-	-	-	-	-	-	0
12	-	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	-	-	-	-	-	-	-	-	-	0
14	-	-	-	-	-	-	-	-	-	-	-	-	0
15	-	-	-	-	-	-	-	-	-	-	-	-	0
TOTAL	0	0	0	30	3	0	13	10	4	2	0	0	62

COEFFICIENT OF VARIATION (CV)													
MODAL (R1-R9)	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Mean CV
0	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	0 %	-	15 %	-	-	7.5%
3	-	-	-	0 %	-	-	15 %	-	10 %	13 %	-	-	9.2%
4	-	-	-	7 %	-	-	17 %	5 %	-	-	-	-	8.8%
5	-	-	-	6 %	3 %	-	12 %	17 %	-	-	-	-	6.8%
6	-	-	-	8 %	7 %	-	3 %	9 %	-	-	-	-	7.2%
7	-	-	-	6 %	-	-	4 %	-	-	-	-	-	4.3%
8	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	9 %	-	-	17 %	-	-	-	-	-	12.9%
10	-	-	-	4 %	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean CV	-	-	-	6.5%	4.3%	-	12.2%	6.1%	9.9%	14.1%	-	-	7.9%

Weighted Note: Higher CV's might be expected during months of opaque material deposition and during the juvenile phase, when false rings may occur.

PERCENTAGE AGREEMENT													
MODAL (R1-R9)	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Agreement
0	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	100 %	-	90 %	-	-	95.0%
3	-	-	-	100 %	-	-	75 %	-	85 %	80 %	-	-	85.6%
4	-	-	-	80 %	-	-	62 %	91 %	-	-	-	-	79.5%
5	-	-	-	80 %	95 %	-	50 %	50 %	-	-	-	-	77.7%
6	-	-	-	68 %	80 %	-	90 %	70 %	-	-	-	-	74.0%
7	-	-	-	80 %	-	-	75 %	-	-	-	-	-	76.7%
8	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	40 %	-	-	40 %	-	-	-	-	-	40.0%
10	-	-	-	80 %	-	-	-	-	-	-	-	-	80.0%
11	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	-	-	-	77.7%	90.0%	-	67.7%	86.0%	85.0%	85.0%	-	-	78.2%

Weighted

RELATIVE BIAS													
MODAL (R1-R9)	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Mean bias
0	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	0.00	-	0.10	-	-	0.05
3	-	-	-	0.00	-	-	0.30	-	0.15	0.20	-	-	0.16
4	-	-	-	0.10	-	-	-0.22	0.09	-	-	-	-	0.02
5	-	-	-	0.16	0.05	-	0.60	0.70	-	-	-	-	0.22
6	-	-	-	0.18	0.20	-	0.10	0.10	-	-	-	-	0.16
7	-	-	-	0.20	-	-	0.25	-	-	-	-	-	0.23
8	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	0.50	-	-	-0.90	-	-	-	-	-	-0.20
10	-	-	-	-0.20	-	-	-	-	-	-	-	-	-0.20
11	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	-	-	-	0.13	0.10	-	-0.01	0.14	0.15	0.15	-	-	0.10

Weighted

Table AIII.5

International North Sea Cod reading 2012, AGE

Table 5 Otoliths read, CV's, percentage agreement and RELATIVE bias by stratum and MODAL age.

NUMBER OF OTOLITHS														
MODAL (R1-R9)			SAMPLING STRATA											Nr of otoliths
	IVa	IVb	C	D	E	F	G	H	I	J	K	L		
0	-	-	-	-	-	-	-	-	-	-	-	-	0	
1	-	-	-	-	-	-	-	-	-	-	-	-	0	
2	1	1	-	-	-	-	-	-	-	-	-	-	2	
3	7	2	-	-	-	-	-	-	-	-	-	-	9	
4	13	9	-	-	-	-	-	-	-	-	-	-	22	
5	4	9	-	-	-	-	-	-	-	-	-	-	13	
6	3	7	-	-	-	-	-	-	-	-	-	-	10	
7	-	3	-	-	-	-	-	-	-	-	-	-	3	
8	-	-	-	-	-	-	-	-	-	-	-	-	0	
9	2	-	-	-	-	-	-	-	-	-	-	-	2	
10	1	-	-	-	-	-	-	-	-	-	-	-	1	
11	-	-	-	-	-	-	-	-	-	-	-	-	0	
12	-	-	-	-	-	-	-	-	-	-	-	-	0	
13	-	-	-	-	-	-	-	-	-	-	-	-	0	
14	-	-	-	-	-	-	-	-	-	-	-	-	0	
15	-	-	-	-	-	-	-	-	-	-	-	-	0	
TOTAL	31	31	0	0	0	0	0	0	0	0	0	0	62	

COEFFICIENT OF VARIATION (CV)														
MODAL (R1-R9)	SAMPLING STRATA													Mean CV
	IVa	IVb	C	D	E	F	G	H	I	J	K	L		
0	-	-	-	-	-	-	-	-	-	-	-	-	-	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	15 %	0 %	-	-	-	-	-	-	-	-	-	-	7.5%	
3	12 %	0 %	-	-	-	-	-	-	-	-	-	-	9.2%	
4	11 %	6 %	-	-	-	-	-	-	-	-	-	-	8.8%	
5	5 %	8 %	-	-	-	-	-	-	-	-	-	-	6.8%	
6	7 %	7 %	-	-	-	-	-	-	-	-	-	-	7.2%	
7	-	4 %	-	-	-	-	-	-	-	-	-	-	4.3%	
8	-	-	-	-	-	-	-	-	-	-	-	-	-	
9	13 %	-	-	-	-	-	-	-	-	-	-	-	12.9%	
10	4 %	-	-	-	-	-	-	-	-	-	-	-	-	
11	-	-	-	-	-	-	-	-	-	-	-	-	-	
12	-	-	-	-	-	-	-	-	-	-	-	-	-	
13	-	-	-	-	-	-	-	-	-	-	-	-	-	
14	-	-	-	-	-	-	-	-	-	-	-	-	-	
15	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mean CV	10.0%	5.9%	-	-	-	-	-	-	-	-	-	-	7.9%	

Weighted

PERCENTAGE AGREEMENT														
MODAL (R1-R9)	SAMPLING STRATA												Agree- ment	
	IVa	IVb	C	D	E	F	G	H	I	J	K	L		
0	-	-	-	-	-	-	-	-	-	-	-	-	-	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	90 %	100 %	-	-	-	-	-	-	-	-	-	-	95.0%	
3	81 %	100 %	-	-	-	-	-	-	-	-	-	-	85.6%	
4	73 %	89 %	-	-	-	-	-	-	-	-	-	-	79.5%	
5	85 %	74 %	-	-	-	-	-	-	-	-	-	-	77.7%	
6	80 %	71 %	-	-	-	-	-	-	-	-	-	-	74.0%	
7	-	77 %	-	-	-	-	-	-	-	-	-	-	76.7%	
8	-	-	-	-	-	-	-	-	-	-	-	-	-	
9	40 %	-	-	-	-	-	-	-	-	-	-	-	40.0%	
10	80 %	-	-	-	-	-	-	-	-	-	-	-	80.0%	
11	-	-	-	-	-	-	-	-	-	-	-	-	-	
12	-	-	-	-	-	-	-	-	-	-	-	-	-	
13	-	-	-	-	-	-	-	-	-	-	-	-	-	
14	-	-	-	-	-	-	-	-	-	-	-	-	-	
15	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mean CV	75.8%	80.6%	-	-	-	-	-	-	-	-	-	-	78.2%	

Weighted

RELATIVE BIAS														
MODAL (R1-R9)			SAMPLING STRATA											Mean bias
	IVa	IVb	C	D	E	F	G	H	I	J	K	L		
0	-	-	-	-	-	-	-	-	-	-	-	-	-	
1	-	-	-	-	-	-	-	-	-	-	-	-	-	
2	0.10	0.00	-	-	-	-	-	-	-	-	-	-	0.05	
3	0.20	0.00	-	-	-	-	-	-	-	-	-	-	0.16	
4	0.02	0.02	-	-	-	-	-	-	-	-	-	-	0.02	
5	0.18	0.23	-	-	-	-	-	-	-	-	-	-	0.22	
6	0.20	0.14	-	-	-	-	-	-	-	-	-	-	0.16	
7	-	0.23	-	-	-	-	-	-	-	-	-	-	0.23	
8	-	-	-	-	-	-	-	-	-	-	-	-	-	
9	-0.20	-	-	-	-	-	-	-	-	-	-	-	-0.20	
10	-0.20	-	-	-	-	-	-	-	-	-	-	-	-0.20	
11	-	-	-	-	-	-	-	-	-	-	-	-	-	
12	-	-	-	-	-	-	-	-	-	-	-	-	-	
13	-	-	-	-	-	-	-	-	-	-	-	-	-	
14	-	-	-	-	-	-	-	-	-	-	-	-	-	
15	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mean	0.08	0.13	-	-	-	-	-	-	-	-	-	-	0.10	

Weighted

Table AIII.6

Table 6 TABLES FOR PLOTTING THE AGE BIAS PLOT FIGURES OF FIGURE 1

International North Sea Cod reading 2012, AGE

For plotting Fig. 2

2STDEV												STDEV
MODAL	Harald Senneset	Hildegunn Mjanger	Scotland Peter Clark	Martine Moerman	Kingdom Dave	AnneMarie Palmén	Ilse Maertens	Friederike Beussel	Rajlie Sjöberg	Ines Wilhelms	2STDEV	
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	ALL	ALL
0	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-
2	0.000	0.000	0.000	0.000	0.000	1.414	0.000	0.000	0.000	0.000	0.447	0.224
3	0.000	0.000	0.667	1.054	0.000	0.000	0.667	0.667	1.453	0.882	0.788	0.394
4	0.750	0.703	0.703	0.426	1.057	1.329	0.873	1.053	1.057	1.057	0.964	0.482
5	1.261	0.555	0.000	1.320	0.555	0.877	1.739	0.987	1.377	0.877	1.113	0.557
6	1.350	0.632	0.843	1.350	0.843	0.943	0.966	1.265	1.033	1.033	1.091	0.545
7	0.000	0.000	0.000	1.155	0.000	1.155	0.000	1.155	1.155	1.155	0.860	0.430
8	-	-	-	-	-	-	-	-	-	-	-	-
9	1.414	2.828	1.414	1.414	4.243	4.243	0.000	1.414	1.414	1.414	2.644	1.322
10	-	-	-	-	-	-	-	-	-	-	0.843	0.422
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-

MEAN AGE												ALL
MODAL	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines		
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10		
0	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-
2	2.00	2.00	2.00	2.00	2.00	2.50	2.00	2.00	2.00	2.00	2.05	2.05
3	3.00	3.00	3.11	3.44	3.00	3.00	3.11	3.11	3.56	3.22	3.16	3.16
4	3.95	3.86	3.86	4.05	3.77	4.18	4.00	4.09	4.23	4.23	4.02	4.02
5	5.31	5.08	5.00	5.54	4.92	5.23	5.62	5.08	5.15	5.23	5.22	5.22
6	6.30	6.10	5.80	6.30	5.80	6.00	6.30	6.20	6.40	6.40	6.16	6.16
7	7.00	7.00	7.00	7.33	7.00	7.33	7.00	7.67	7.67	7.33	7.23	7.23
8	-	-	-	-	-	-	-	-	-	-	-	-
9	7.50	9.00	9.50	9.50	7.50	7.50	9.00	8.50	10.50	9.50	8.80	8.80
10	10.00	10.00	9.00	10.00	10.00	9.00	10.00	10.00	10.00	10.00	9.80	9.80
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	4.77	4.71	4.66	5.00	4.55	4.81	4.92	4.84	5.06	4.98	4.83

MEAN AGE +2STDEV												ALL
MODAL	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines		
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10		
0	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-
2	2.000	2.000	2.000	2.000	2.000	3.914	2.000	2.000	2.000	2.000	2.50	2.50
3	3.000	3.000	3.778	4.499	3.000	3.000	3.778	3.778	5.009	4.104	3.94	3.94
4	4.705	4.566	4.566	4.472	4.830	5.511	4.873	5.144	5.284	5.284	4.99	4.99
5	6.569	5.632	5.000	6.859	5.478	6.108	7.355	6.064	6.531	6.108	6.33	6.33
6	7.650	6.732	6.643	7.650	6.643	6.943	7.266	7.465	7.433	7.433	7.25	7.25
7	7.000	7.000	7.000	8.488	7.000	8.488	7.000	8.821	8.821	8.488	8.09	8.09
8	-	-	-	-	-	-	-	-	-	-	-	-
9	8.914	11.828	10.914	10.914	11.743	11.743	9.000	9.914	11.914	10.914	11.44	11.44
10	-	-	-	-	-	-	-	-	-	-	10.64	10.64
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-

MEAN AGE -2STDEV												ALL
MODAL	Norway Harald	Norway Hildegunn	Scotland Peter Clark	Belgium Martine	United Kingdom	Sweden AnneMarie	Belgium Ilse	Germany Friederike	Sweden Rajlie	Germany Ines		
(R1-R9)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10		
0	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-
2	2.000	2.000	2.000	2.000	2.000	1.086	2.000	2.000	2.000	2.000	1.603	1.603
3	3.000	3.000	2.444	2.390	3.000	3.000	2.444	2.444	2.103	2.340	2.367	2.367
4	3.204	3.161	3.161	3.619	2.716	2.853	3.127	3.038	3.170	3.170	3.059	3.059
5	4.047	4.522	5.000	4.218	4.368	4.354	3.876	4.090	3.776	4.354	4.102	4.102
6	4.950	5.468	4.957	4.950	4.957	5.057	5.334	4.935	5.367	5.367	5.069	5.069
7	7.000	7.000	7.000	6.179	7.000	6.179	7.000	6.512	6.512	6.179	6.373	6.373
8	-	-	-	-	-	-	-	-	-	-	-	-
9	6.086	6.172	8.086	8.086	3.257	3.257	9.000	7.086	9.086	8.086	6.156	6.156
10	-	-	-	-	-	-	-	-	-	-	8.957	8.957
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-

Table AIII.7

Table 7 Agreed collection	
Criterion 80% agreement	
MODAL AGE	n
0	0
1	0
2	2
3	8
4	14
5	6
6	5
7	2
8	0
9	0
10	1
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
	38

Figure AIII.1

International North Sea Cod reading 2012, AGE

Figure 1 In the age bias plots below the mean age recorded ± 2 stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

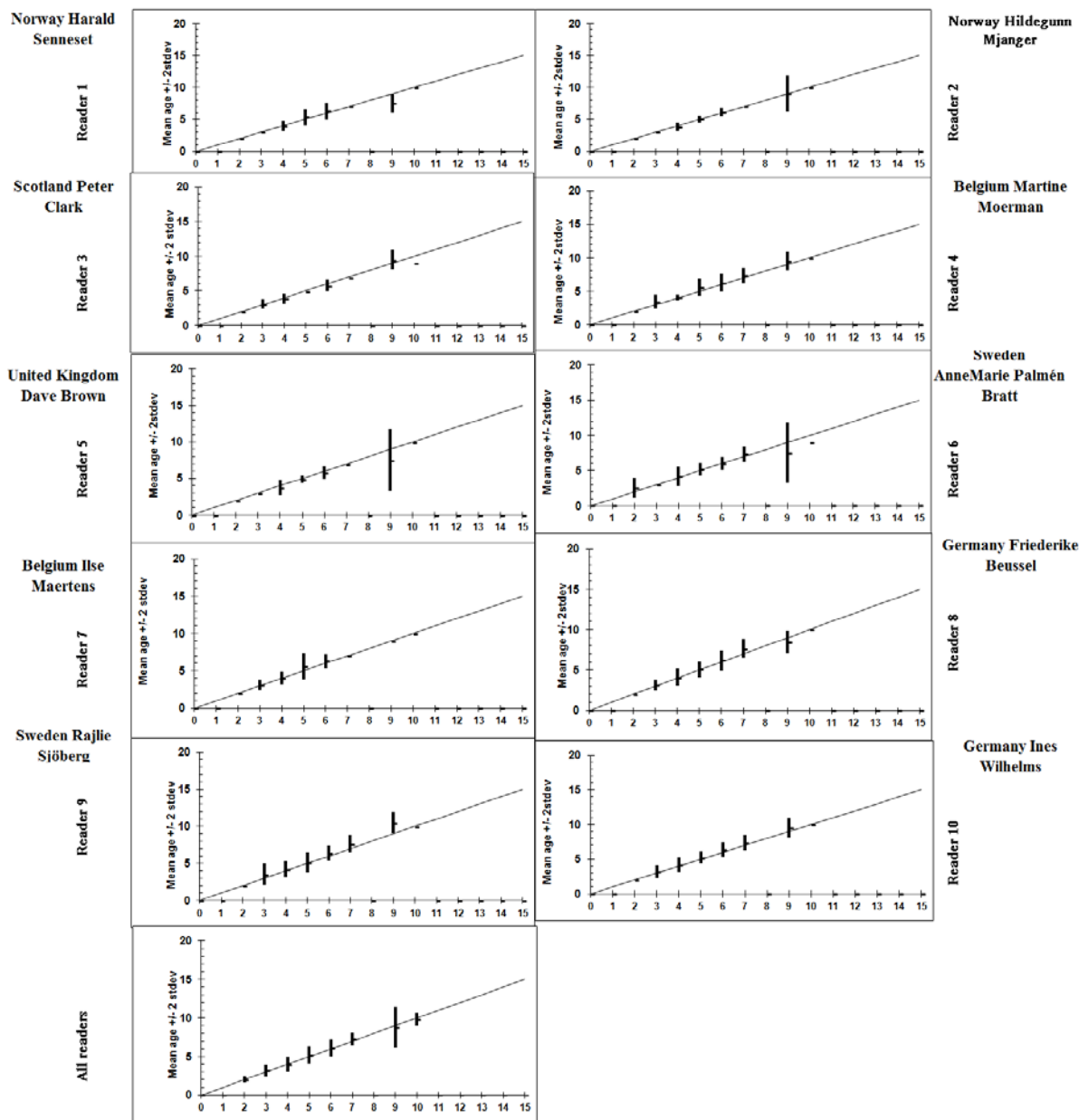


Figure AIII.2

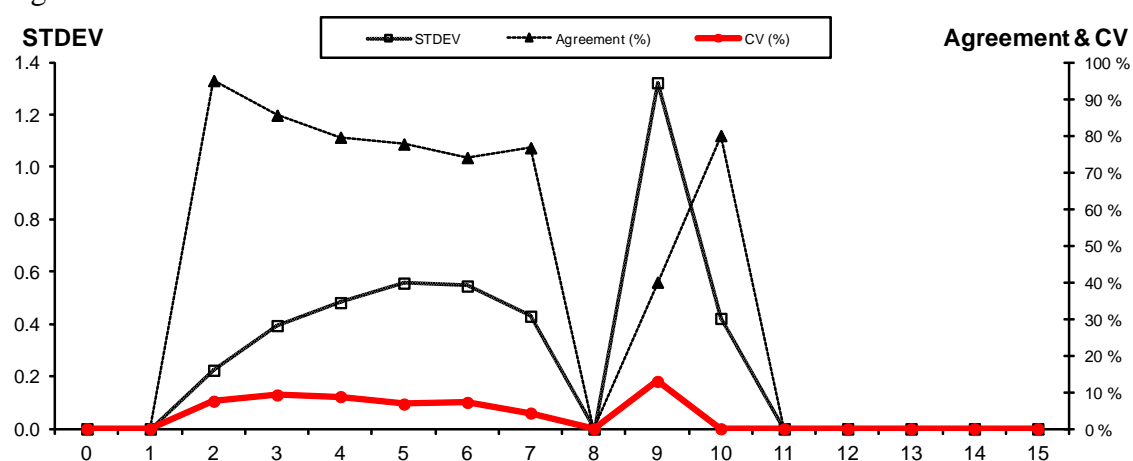


Figure 2 The coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) are plotted against MODAL age. CV is much less age dependent than the standard deviation (STDEV) and the percent agreement. CV is therefore a better index for the precision in age reading. Problems in age reading are indicated by relatively high CV's at age.

NOTE: Reduce the range of the ages (in this case 1-13) to remove the lines towards the x-axis.

Figure AIII.3

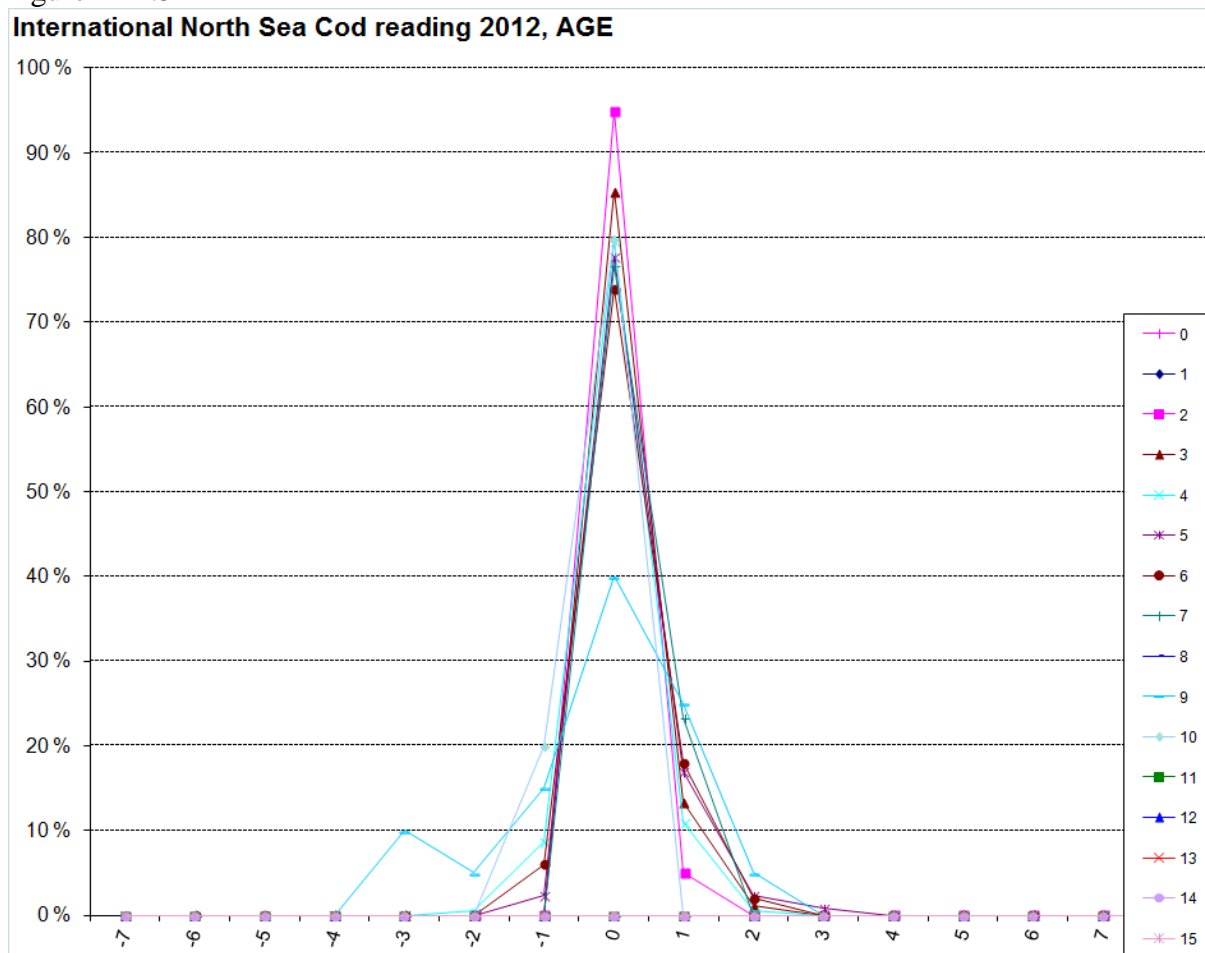


Figure 3 The distribution of the age reading errors in percentage by MODAL age as observed from the whole group of age readers in an age reading comparison to MODAL age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no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

Figure AIII.4

International North Sea Cod reading 2012, AGE

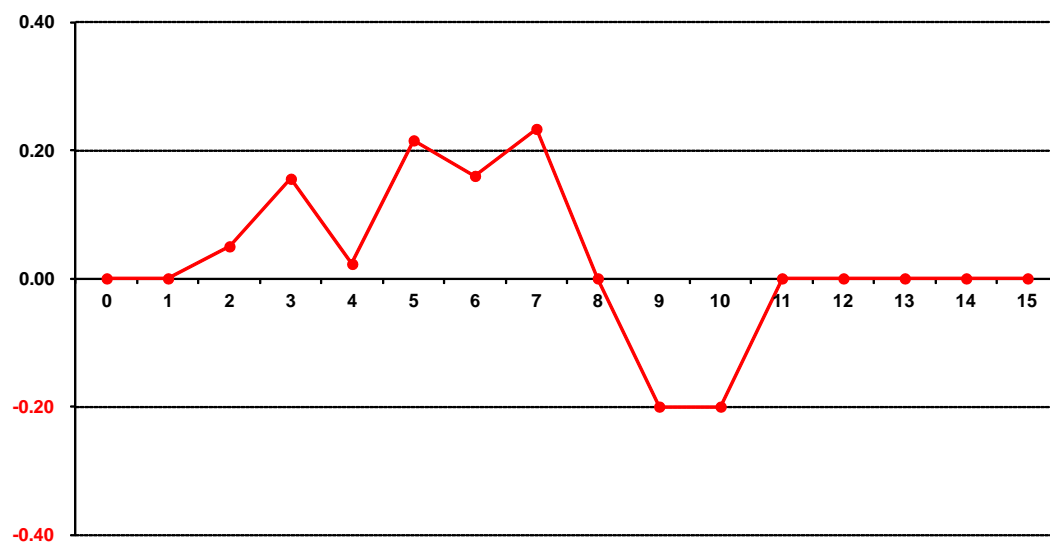


Figure 4 The RELATIVE bias by MODAL age as estimated by all age readers combined.

NOTE: Reduce the range of the ages (in this case 1-13) to remove the lines towards the x-axis.

Figure AIII.5

International North Sea Cod reading 2012, AGE

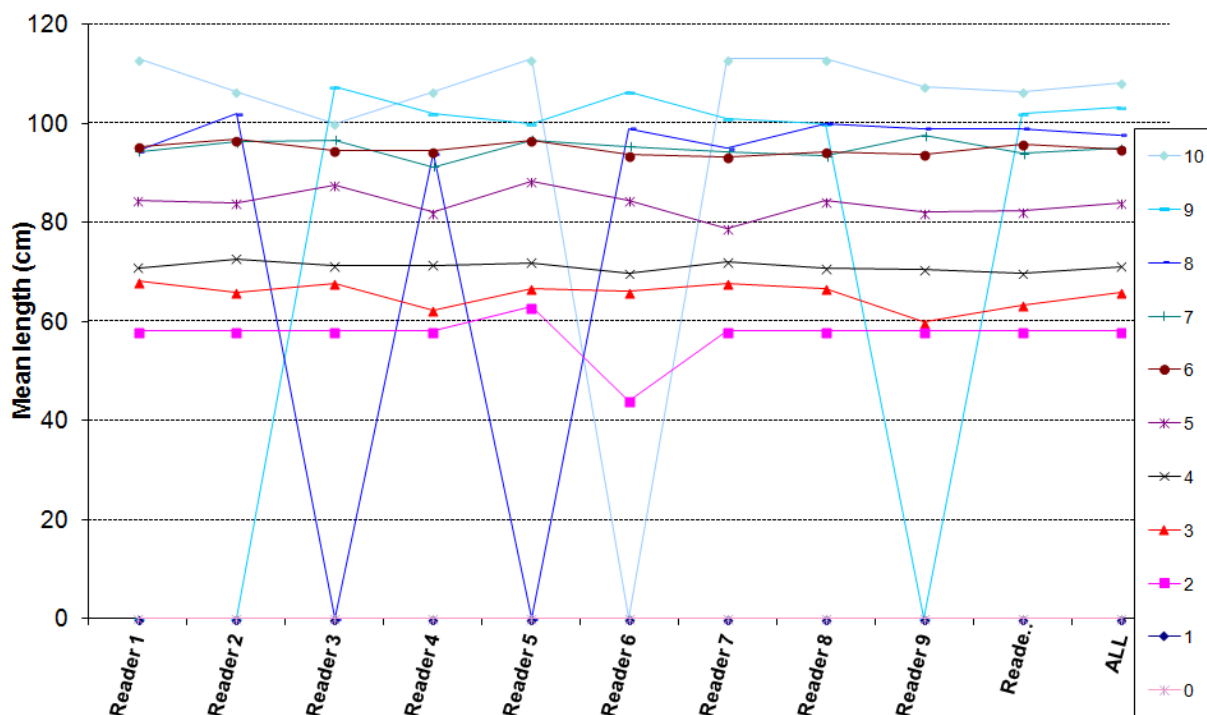


Figure 5 The mean length at age as estimated by each age reader.

Short introduction to WebGR

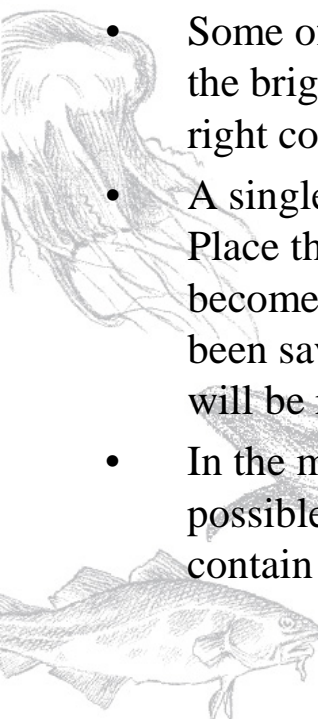
Jane A. Godiksen

First time

- Open the website (<http://webgr.azti.es>) using Firefox (Internet Explorer and WebGR does not work together. You can download Firefox at www.mozilla.org)
- Register new user (in the menu to the left), and activate the account following the link sent to your email
- In the menu to the left, chose “Search” and click on “List all workshops”
- Send an email to the manager of the workshop of interest for access
- The manager will then include the age reader as a participant for the workshop/reading exercise

From second time and onwards

- Open the website (<http://webgr.azti.es>)
- Log in
- Chose “My calibration exercises” in the menu to the left
- Chose “annotate” in the left column of the “Calibration exercise list” under the workshop of interest
- Start annotating. Remember to write in the age, this is not done automatically by the programme. Each annotation is ended by clicking “Finalize”. This will registre the age in the programme. If you press ”Save” the annotation will only be available to yourself, and it will be possible to change the annotation later before finalizing.
- Some of the pictures may be small and very dark. It is possible to change the brightness and contrast in WebGR to improve the picture. In the upper right corner is a zoon function.
- A single wrong placed annotation can be removed by “re-annotating” it. Place the curser over the annotation to be deleted and when the cross becomes “bold” click on it, and it will disappear. If the annotations has been saved, just remove the annotation and click “Update”, and new age will be recorded (see next page for visualization).
- In the menu “Help” within WebGR (not at the annotation pages) it is possible to download a user manual for WebGR. Page 10 and forwards contain a description of how to annotate.



Delete annotations

WebGR Online-Annotating-Tool - Mozilla Firefox

File Rediger Vis Historikk Bokmerker Verktøy Hjelp

WebGR Online-Annotating-Tool

webgr.azti.es/annotation/make/index/CAEX_ID/195/

Mest besøkt Gmail HInnsiden Google Scholar WoS W LibWaterloo WebGR

Annotation Compare Images

Image: cod01.jpg

Fish: cod01

Count Age Accepta

3 3

1) Mark this area to see annotations

Attribute

CAPTURE_DATE	01.10.2008
LENGTH	720 mm
MAGNIFICATION	30
IMAGE_COMMENT	image scale mm

3) Delete a single point by re-annotating when the cursor is placed over the annotation and it appears "bold"

Role: Coordinator

Species: Gadus morhua

Area: North Sea

Type of Structure: otolith

show imageset definition

Brightness: 0

Contrast: 0

Color: 0

Reset

Annotate

Group

WS-Ref

WebGR-Ref

Update

Save

Finalize

Export

Delete

Age: 3

3

Exit

SOME RIGHTS RESERVED

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creative commons

4) Update an already saved age after deletion/insertion of a single annotation

2) Delete all saved annotations on an image. To do this annotations needs to be visible – see 1)

