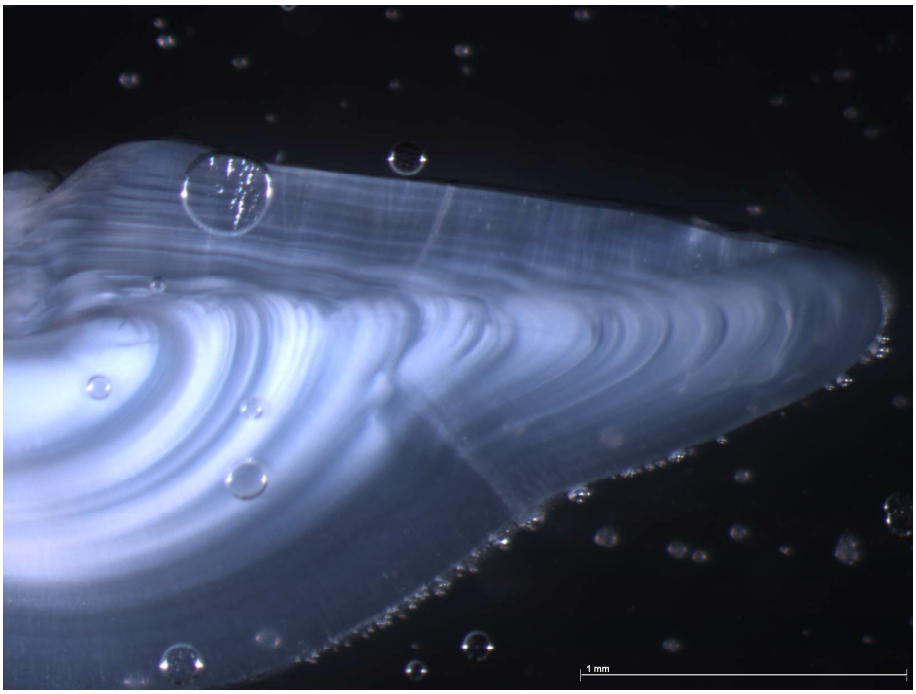
Report of the Roundnose grenadier (*Coryphaenoides rupestris*) Otolith Exchange Scheme 2011



Mahé, K., Elleboode, R., Øverbø Hansen, H., Román Marcote, E., Marull Hernández, E., Teruel Gómez, J., Etherton, M., 2012. Report of the Roundnose grenadier (*Coryphaenoides rupestris*) Otolith Exchange Scheme 2011, 23 pp.

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1. Introduction

The Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS) meeting in 2011 recommended a full exchange :

"7.2.1.2.3 Roundnose grenadier (Coryphaenoides rupestris)

Another workshop was requested by WKARRG (ICES 2007a), but PGCCDBS recommends that another exchange should be arranged in the first instance in 2011 to address the issues that arose during the previous workshop. "

4 countries took part in this exchange :

- Norway
- Spain
- UK England
- France

The objectives of the exchange were:

- to investigate the levels of agreement on age readings
- to analyse the relative differences between age readers

2. Participants

6 readers participated to this exchange (Tab. 1).

Table 1 : List of the readers.

Name	Country	Institute
Romain Elleboode	France	IFREMER
Hege Øverbø Hansen	Norway	IMR
Esther Román Marcote	Spain	IEO
Eva Marull Hernández	Spain	IEO
Josefina Teruel Gómez Mark Etherton	Spain UK England	IEO CEFAS

3. Otolith collection

The otolith collection (n=127; Fig. 1) came from the 2 following sets provided by IMR (Norway) and IFREMER (France) institutes :

- 64 otoliths from Via (Western Scotland), from January to June 2006
- 63 otoliths from IIIa (Skagerrak), from January 2011

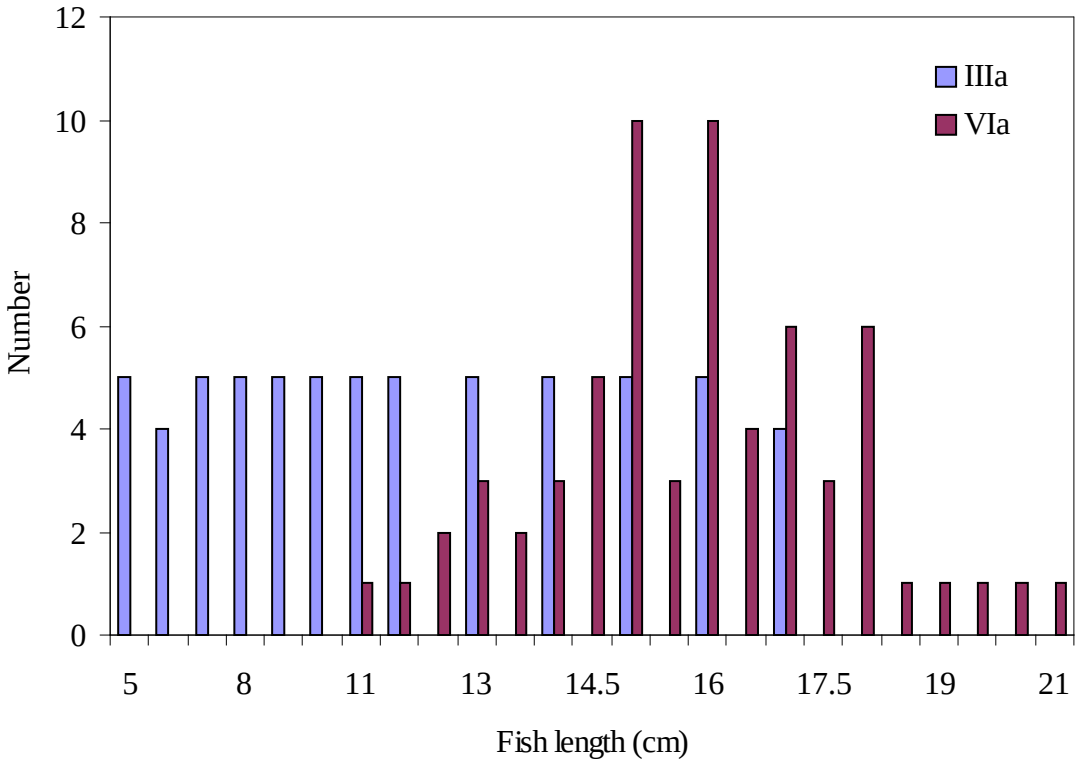


Figure 1 : Histograms of the samples of Roundnose grenadier (*Coryphaenoides rupestris*) per ICES area.

Ifremer laboratory made two digitised images (under transmitted and reflected light) for each otolith. Each reader chose a mode of light to annotate images.

The otolith set from VIa ICES area is the same as one used at the first exchange of roundnose grenadier otolith in 2007 (ICES, 2007a).

4. Reading procedure

Date of birth is conventionally attributed to the 1st of January. One *annulus* consists of one opaque and one translucent zone. For age estimation, translucent zones are counted.

The distance between the *nucleus* and the end of the first translucent ring was measured by all readers. The results show very little differences from one reader to another. On 40 otoliths, distance between the first ring and the *nucleus* is on average 1.68275±0.21423 mm (min: 1.12 mm; max: 2.0755 mm).

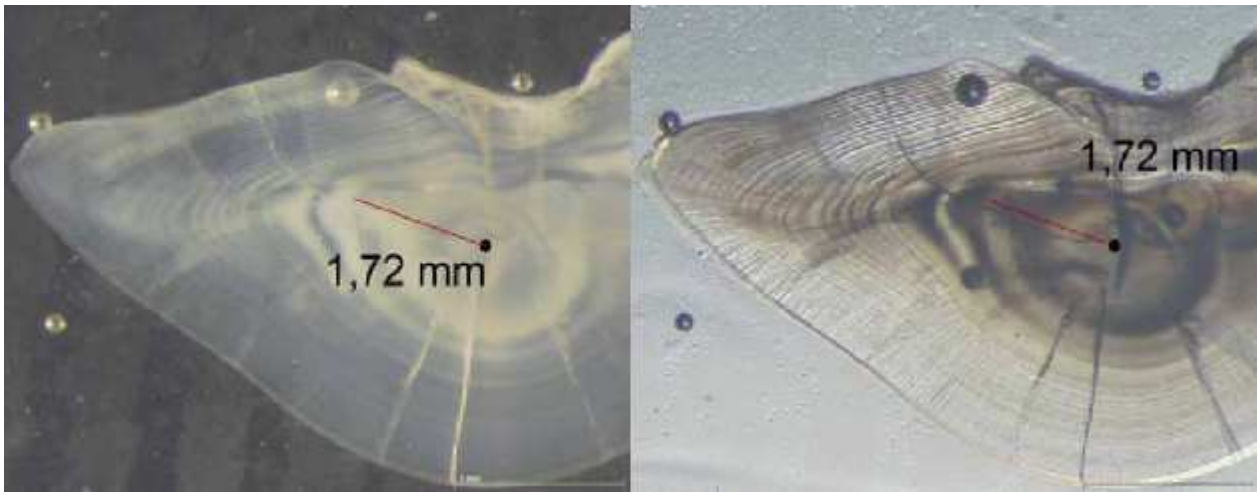


Figure 2 : Image of sectioned otolith (fish with pre-anal fin length of 16.5 cm; n°13). Digitised image with reflected light (A) and transmitted light (B). Black point represented the *nucleus* and the other tip of the red line shows the end of the first ring (*In* WKARRG 2007 see ICES, 2007a).

Each reader must complete the column of age reading quality such as :

AQ1: Easy to age with high precision.

If a scale of 1-100 is applied, where 100 represents the highest readers confidence in age reading and 1 indicates no confidence in the age reading. Age quality 1 (AQ1), will apply to approximately the top 25 % of the possible quality ratings. AQ1 is an indication that the age data is considered reliable for stock assessment.

AQ2: Normal quality.

Age quality 2 (AQ2), will apply approximately to age readings comprised between 25 and 75 percentiles of possible quality ratings. AQ2 is an indication that the age data is sufficiently reliable to be used for stock assessment purposes but an improvement is required.

AQ3: Difficult to age with acceptable precision.

Age quality 3 (AQ3), will apply to approximately the lowest 25 % of the possible quality ratings. AQ3 is an indication that there are serious concerns about the reliability of the age data and/or its value to stock assessment WGs.

5. Results

The spreadsheet (Eltink, 2000) has been completed according to instructions contained in the Guidelines and Tools for Age Reading Comparisons by Eltink *et al.* (2000). Modal ages were calculated for each otolith read, with percentage agreement, mean age and precision coefficient of variation as a definition :

- percentage agreement = 100x(no. of readers agreeing with modal age/total no. of readers).
- precision c. v. = 100x(standard deviation of age readings/mean of age readings).

2 sets were read by all readers but all images were not interpreted by all readers.

5.1. Precision[1]

Precision of age estimated for individual fish expresses by Coefficient of Variation (CV) and percent agreement to modal age. There were high variations in precision of age estimated between individual fish (Tab. 2). The set of otoliths from VIa showed a Coefficient of Variation of 14.9% and a percent agreement to modal age of 29.3%. The set of otoliths from IIIa showed a Coefficient of Variation of 22.6% and a percent agreement to modal age of 30.7%. These results from both areas are very close to those from 2006 (Tab. 2).

Table 2 : Precision of the otolith exchange of roundnose grenadier (*Coryphaenoides rupestris*) by area and exchange year.

Year and ICES area	Number of readers	Number of images	Percentage of Agreement	CV
2007, VIa	11	64	30.2% (0-80%)	12.5% (2-28%)
2011, VIa	6	64	29.3% (0-80%)	14.9% (4-38%)
2011, IIIa	7	63	30.7% (0-80%)	22.6% (4-63%)

There was no fish with 100% agreement and thus, no one CV of 0%.
Appendices 1 and 2 examined the readings of individuals at each modal age and summarise the number of otoliths read, the precision CV, percentage agreement.

[1] Precision is defined as the variability in the age readings. The precision's errors in age readings are better described by the coefficient of variation (CV) by age group. This measure of precision is independent of the closeness to the true age (ICES, 2007b).

5.2. Relative bias (Accuracy) [2]

The minimal requirement for age reading's consistency is the absence of bias among readers and through the time. The hypothesis of an absence of bias between two readers or between a reader and the modal age estimated can be tested non-parametrically with a one-sample Wilcoxon signed rank test.

The tables 3 and 4 showed these analyses for the set coming from respectively ICES areas VIa and IIIa.

Table 3 : Inter-reader bias test and reader against modal age bias test for the set coming from ICES area VIa.

	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6
Reader 1						
Reader 2	**					
Reader 3	**	–				
Reader 4	**	*	–			
Reader 5	*	**	**	**		
Reader 6	**	**	**	**	**	
MODAL	**	**	**	**	**	**

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

Table 4 : Inter-reader bias test and reader against modal age bias test for the set coming from ICES area IIIa.

	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6
Reader 1						
Reader 2	**					
Reader 3	**	*				
Reader 4	**	–	**			
Reader 5	**	**	**	–		
Reader 6	–	**	**	**	**	
MODAL	**	**	**	**	**	**

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

[2] In absence of calcified structures of known age, the age readings can be compared to modal age, which is defined as the age determined for an individual structure whose most of the readers have a preference. Relative bias can be defined as a systematic over- or underestimation of age compared to the modal age. The age reading comparisons to modal age provide a low estimate of relative bias compared to absolute bias, when most readers have a similar serious bias in age reading (ICES, 2007b).

5.3. Age reading quality

Age reading quality was estimated by all readers (Tab. 5 and 6).

Table 5 : Level of Age reading quality by readers and all readers of the otoliths sections of roundnose grenadier (*Coryphaenoides rupestris*) in the Western Scotland (VIa).

Level of Quality	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	All Reader
AQ1		47	1	2	27		2
AQ2	64	13	33	6	24	51	60
AQ3		3	29	11	13	13	2

Table 6 : Level of Age reading quality by readers and all readers of the otoliths sections of roundnose grenadier (*Coryphaenoides rupestris*) in the Skagerrak (IIIa).

Level of Quality	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	All Reader
AQ1	0	0	6	0	3	0	0
AQ2	61	41	34	13	41	34	46
AQ3	2	22	23	50	19	29	17

Almost no image of AQ1 level of quality has been found. Most of the images had a normal quality. The set from the Skagerrak showed 17 AQ3 images (27%), corresponding to age estimate with a poor precision.

6. Executive Summary

The roundnose grenadier (*Coryphaenoides rupestris*) Otolith Exchange 2011 was a second one after the exchange of 2007. It was composed by 2 sets of otoliths from VIa (western Scotland ; n=64, the same as the exchange 2007 used one) sampled from January to June 2006 and otoliths from IIIa (Skagerrak ; n=63) sampled from January 2011. 6 readers participated from Spain (3 readers), UK England (1 reader), Norway (1 reader) and France (1 reader). Only images of otoliths sections were used during this exchange.

The set of otoliths from VIa showed Coefficient of Variation of 14.9% and percent agreement to modal age of 29.3%. The set of otoliths from IIIa showed Coefficient of Variation of 22.6% and percent agreement to modal age of 30.7%. These results from both areas were very close to those from 2006. For the roundnose grenadier in the western Scotland (VIa) and in the Skagerrak (IIIa), there was an important bias between the readers and the modal age. In the western Scotland, with the same sampling between 2007 and 2011, the level of precision was very close in the 2 exchanges (2007 and 2011) but there was a certainly bias between both modal ages and between 2 readings of each reader. The sample from the Skagerrak was composed by younger fish than those of the sample from the western Scotland but the results showed the same bias. Sections of these otoliths remain definitively very difficult to interpret (Fig. 3 and 4).

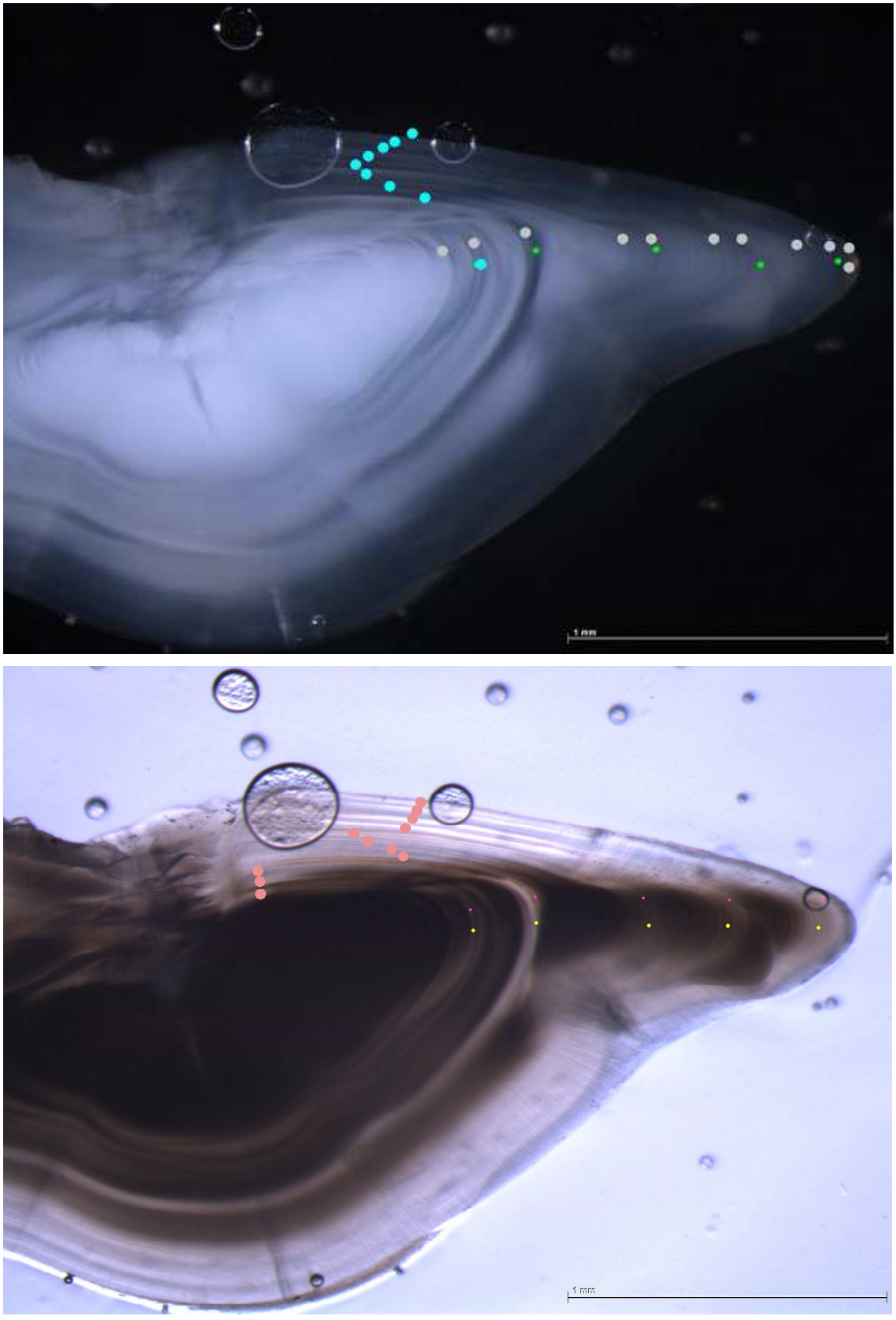


Figure 3 : Otolith section of Roundnose grenadier (fish length : 8 cm) from the Skagerrak (IIIa) : Age estimated from 5 to 11 years.

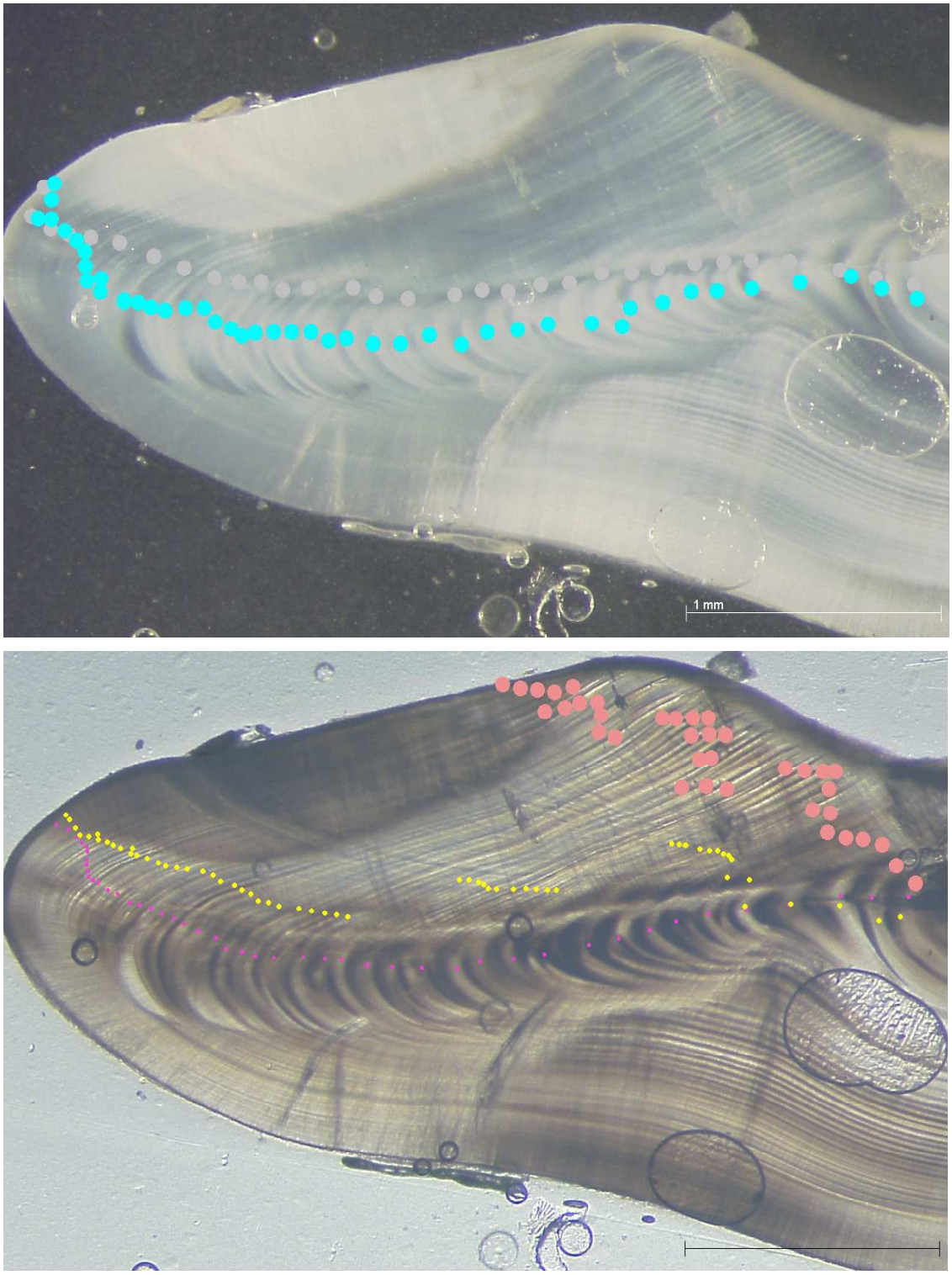


Figure 4 : Otolith section of Roundnose grenadier (fish length : 20 cm) from the western Scotland (VIa) : Age estimated from 22 to 44 years (estimations : 22, 39, 44, 37 and 31).

7. References

Eltink, A. T. G. W., Newton, A. W., Morgado, C., Santamaria, M. T. G., Modin, J., 2000. Guidelines and Tools for Age Reading. **(**PDF document version 1.0 October 2000) Internet : http://www.efan.no

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

ICES, 2007a. Report of the Workshop on Age Reading of Roundnose Grenadier (WKARRG), 4–7 September 2007, Vilm, Germany. ICES CM 2007/ACE:03. 50 pp.

ICES. 2007b. Report of the Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS), 5–9 March 2007, Valetta, Malta. ACFM:09. 115p.

8. Appendix 1 : Details results of Roundnose grenadier from ICES VIa

The number of age readings, the coefficient of variation (CV), the percentage of 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.

NUMBER OF AGE READINGS

	MODAL	Norway HOH	France RE	Spain ER	Spain JT	Spain EM	UK England ME	
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	TOTAL
	0	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-
	8	-	-	-	-	-	-	-
	9	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	-
	11	-	-	-	-	-	-	-
	12	-	-	-	-	-	-	-
	13	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	-
	16	-	-	-	-	-	-	-
	17	-	-	-	-	-	-	-
	18	1	1	1	1	1	1	6
	19	3	3	3	2	3	3	17
	20	1	1	1	1	1	1	6
	21	1	1	1	1	1	1	6
	22	5	5	5	5	5	4	29
	23	10	10	9	8	9	10	56
	24	4	4	4	4	4	3	23
	25	10	10	10	10	10	8	58
	26	11	11	11	11	11	8	63
	27	2	2	2	2	2	1	11
	28	7	7	7	7	7	5	40
	29	4	4	4	4	4	3	23
	30	1	1	1	1	1	-	5
	31	-	-	-	-	-	-	-
	32	1	1	1	1	1	1	6
	34	-	-	-	-	-	-	-
	35	2	2	2	2	2	1	11
	36	-	-	-	-	-	-	-
	37	-	-	-	-	-	-	-
	38	-	-	-	-	-	-	-
	39	1	1	1	1	1	1	6
	40	-	-	-	-	-	-	-
	41	-	-	-	-	-	-	-
	42	-	-	-	-	-	-	-
	43	-	-	-	-	-	-	-
	44	-	-	-	-	-	-	-
	45	-	-	-	-	-	-	-
	46	-	-	-	-	-	-	-
Total	0-46	64	64	63	61	63	51	366

COEFFICIENT OF VARIATION (CV)

	MODAL	Norway HOH	France RE	Spain ER	Spain JT	Spain EM	UK England ME	ALL
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Readers
	0	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-
	8	-	-	-	-	-	-	-
	9	-	-	-	-	-	-	-
	10	-	-	-	-	-	-	-
	11	-	-	-	-	-	-	-
	12	-	-	-	-	-	-	-
	13	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	-
	16	-	-	-	-	-	-	-
	17	-	-	-	-	-	-	-
	18	-	-	-	-	-	-	-
	19	31%	18%	16%	6%	10%	17%	21.7%
	20	-	-	-	-	-	-	-
	21	-	-	-	-	-	-	-
	22	11%	14%	5%	2%	8%	5%	11.9%
	23	26%	17%	6%	5%	11%	15%	19.2%
	24	15%	6%	5%	6%	3%	9%	10.8%
	25	17%	13%	8%	7%	11%	17%	16.5%
	26	15%	14%	5%	8%	6%	16%	11.4%
	27	5%	16%	3%	0%	3%	-	11.3%
	28	22%	11%	5%	11%	8%	6%	13.6%
	29	36%	8%	4%	4%	7%	8%	17.0%
	30	-	-	-	-	-	-	-
	31	-	-	-	-	-	-	-
	32	-	-	-	-	-	-	-
	33	-	-	-	-	-	-	-
	34	-	-	-	-	-	-	-
	35	7%	10%	12%	8%	15%	-	23.0%
	36	-	-	-	-	-	-	-
	37	-	-	-	-	-	-	-
	38	-	-	-	-	-	-	-
	39	-	-	-	-	-	-	-
	40	-	-	-	-	-	-	-
	41	-	-	-	-	-	-	-
	42	-	-	-	-	-	-	-
	43	-	-	-	-	-	-	-
	44	-	-	-	-	-	-	-
	45	-	-	-	-	-	-	-
	46	-	-	-	-	-	-	-
Weighted mean	0-46	17.6%	11.8%	6.0%	5.8%	7.6%	11.2%	13.7%
	RANKING	6	5	2	1	3	4	

PERCENTAGE AGREEMENT

MODAL age	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6	ALL
0	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-
18	0%	0%	100%	100%	0%	100%	50%
19	33%	0%	33%	0%	67%	67%	35%
20	0%	0%	100%	100%	100%	0%	50%
21	0%	0%	100%	100%	0%	0%	33%
22	20%	0%	40%	60%	60%	0%	31%
23	40%	40%	44%	63%	33%	10%	38%
24	50%	25%	50%	50%	0%	0%	30%
25	20%	10%	60%	50%	10%	13%	28%
26	9%	27%	36%	46%	55%	0%	30%
27	50%	0%	0%	100%	0%	0%	27%
28	14%	43%	57%	0%	29%	0%	25%
29	0%	0%	25%	50%	0%	33%	17%
30	0%	0%	100%	0%	100%	-	40%
31	-	-	-	-	-	-	-
32	0%	0%	100%	100%	0%	100%	50%
33	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-
35	0%	0%	0%	0%	0%	0%	0%
36	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-
39	0%	0%	0%	0%	0%	0%	0%
40	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-
Weighted mean	0.46	20.51%	18.75%	46.03%	45.90%	30.16%	13.73%	29.51%
RANKING		1	4	3	2	5	6	

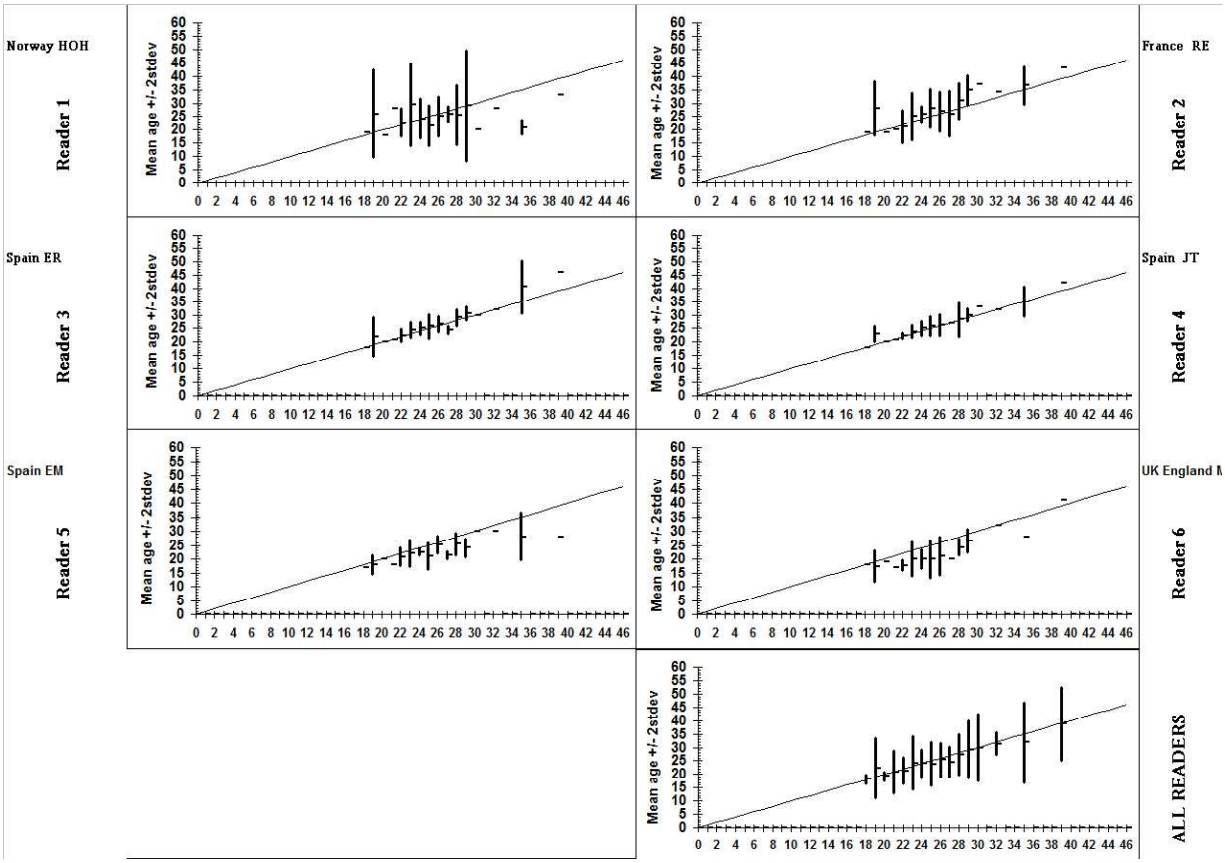
RELATIVE BIAS

MODAL age	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6	ALL
0	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-
18	1	1	0	0	-1	0	0
19	7	9	3	4	-1	-2	3
20	-2	-1	0	0	0	-1	-1
21	7	-1	0	0	-3	-4	0
22	1	-1	0	0	-1	-4	-1
23	6	2	1	1	-1	-3	1
24	0	2	1	1	-2	-4	0
25	-4	3	1	1	-4	-5	-1
26	-1	1	1	0	-1	-5	-1
27	-1	-1	-5	0	-6	-7	-2
28	-3	3	1	0	-3	-4	-1
29	0	6	2	1	-5	-2	0
30	-10	7	0	3	0	-	0
31	-	-	-	-	-	-	-
32	-4	2	0	0	-2	0	-1
33	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-
35	-14	2	6	0	-7	-7	-3
36	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-
39	-6	4	7	3	-11	2	0
40	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-
Weighted mean	0.46	0.28	2.27	1.06	0.72	2.40	3.67	-0.45
RANKING		1	4	3	2	5	6	

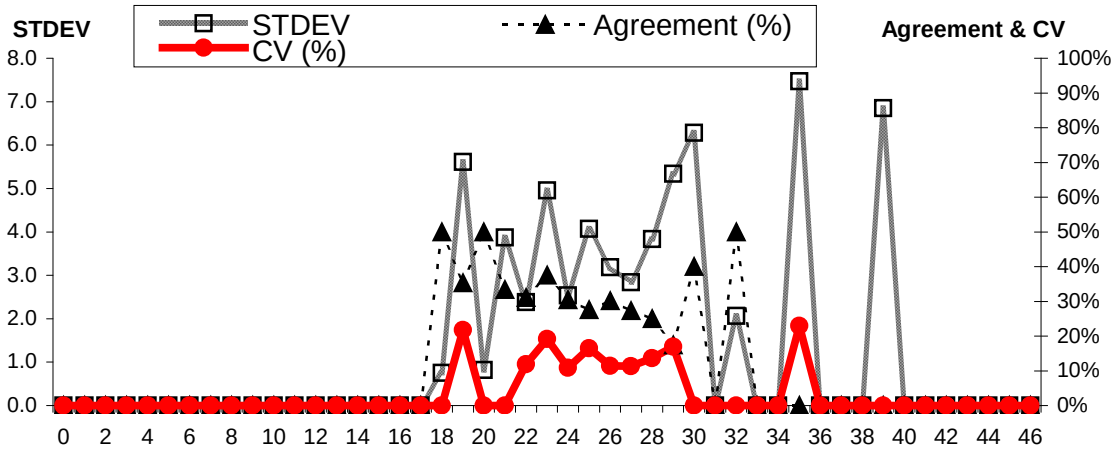
Overall ranking

	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6
Ranking Coefficient of Variation	6	5	2	1	3	4
Ranking Percentage Agreement	1	4	3	2	5	6
Ranking Relative bias	1	4	3	2	5	6
OVERALL RANKING	2	4	2	1	4	6

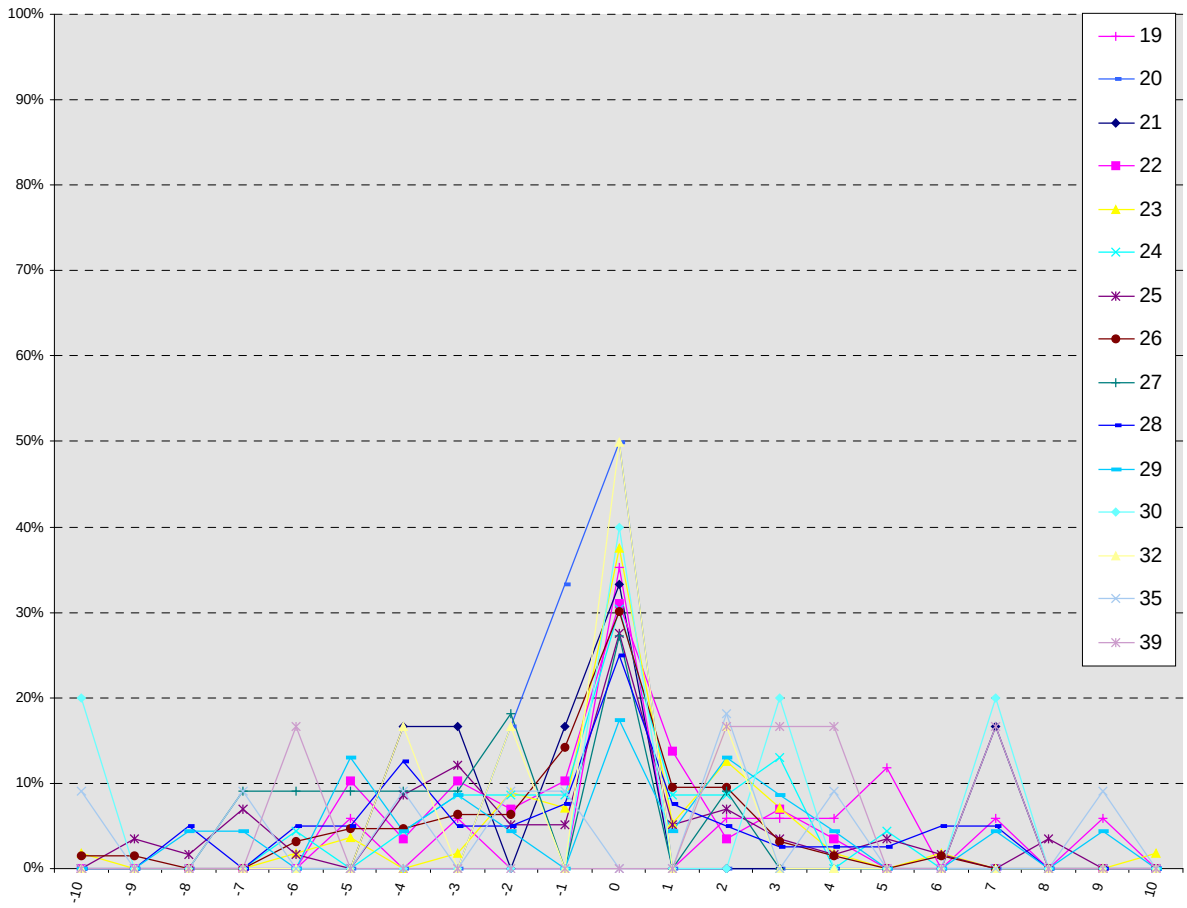
In the age bias plots below the mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between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



The coefficient of variation (CV%), percentage of agreement and the standard deviation (STDEV) are plotted against MODAL age. CV is much less age dependent than the standard deviation (STDEV) and the percentage of 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.



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.



9. Appendix 2 : Details results of Roundnose grenadier from ICES IIIa

The number of age readings, the coefficient of variation (CV), the percentage of 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.

NUMBER OF AGE READINGS

	MODAL	Norway HOH	France RE	Spain ER	Spain JT	Spain EM	UK England ME	
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	TOTAL
	0	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-
	5	2	2	2	2	2	2	12
	6	1	1	1	1	1	1	6
	7	1	1	1	1	1	1	6
	8	4	4	4	4	4	1	21
	9	1	1	1	1	1	-	5
	10	2	2	2	2	2	2	12
	11	2	2	2	2	2	1	11
	12	2	2	2	2	2	1	11
	13	1	1	1	1	1	-	5
	14	1	1	1	1	1	-	5
	15	2	2	2	2	2	1	11
	16	1	1	1	1	1	1	6
	17	6	6	6	6	6	2	32
	18	1	1	1	1	1	1	6
	19	2	2	2	2	2	2	12
	20	5	5	5	5	5	3	28
	21	3	3	3	3	3	2	17
	22	3	3	3	3	3	2	17
	23	2	2	2	2	2	1	11
	24	1	1	1	1	1	1	6
	25	1	1	1	1	1	-	5
	26	-	-	-	-	-	-	-
	27	-	-	-	-	-	-	-
	28	-	-	-	-	-	-	-
	29	1	1	1	1	1	-	5
	30	-	-	-	-	-	-	-
	31	-	-	-	-	-	-	-
	32	-	-	-	-	-	-	-
	34	-	-	-	-	-	-	-
	35	-	-	-	-	-	-	-
	36	-	-	-	-	-	-	-
	37	-	-	-	-	-	-	-
	38	1	1	1	1	1	1	6
	39	-	-	-	-	-	-	-
	40	-	-	-	-	-	-	-
	41	-	-	-	-	-	-	-
	42	-	-	-	-	-	-	-
	43	-	-	-	-	-	-	-
	44	-	-	-	-	-	-	-
	45	1	1	1	1	1	-	5
	46	-	-	-	-	-	-	-
Total	0-46	63	62	63	63	63	34	348

COEFFICIENT OF VARIATION (CV)

	MODAL	Norway HOH	France RE	Spain ER	Spain JT	Spain EM	UK England ME	ALL
	age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Readers
	0	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	
	4	-	-	-	-	-	-	-
	5	0%	24%	8%	0%	0%	0%	37.0%
	6	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-
	8	52%	29%	6%	13%	24%	-	45.9%
	9	-	-	-	-	-	-	-
	10	40%	39%	0%	7%	13%	25%	22.2%
	11	16%	7%	7%	0%	16%	-	45.6%
	12	6%	16%	6%	20%	0%	-	16.9%
	13	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-
	15	28%	38%	27%	41%	0%	-	22.4%
	16	-	-	-	-	-	-	-
	17	25%	8%	13%	10%	17%	4%	13.7%
	18	-	-	-	-	-	-	-
	19	8%	10%	0%	4%	18%	7%	11.2%
	20	7%	9%	8%	3%	6%	6%	8.4%
	21	0%	21%	10%	5%	14%	0%	9.2%
	22	5%	0%	6%	12%	5%	4%	6.9%
	23	42%	12%	0%	6%	21%	-	18.0%
	24	-	-	-	-	-	-	-
	25	-	-	-	-	-	-	-
	26	-	-	-	-	-	-	-
	27	-	-	-	-	-	-	-
	28	-	-	-	-	-	-	-
	29	-	-	-	-	-	-	-
	30	-	-	-	-	-	-	-
	31	-	-	-	-	-	-	-
	32	-	-	-	-	-	-	-
	33	-	-	-	-	-	-	-
	34	-	-	-	-	-	-	-
	35	-	-	-	-	-	-	-
	36	-	-	-	-	-	-	-
	37	-	-	-	-	-	-	-
	38	-	-	-	-	-	-	-
	39	-	-	-	-	-	-	-
	40	-	-	-	-	-	-	-
	41	-	-	-	-	-	-	-
	42	-	-	-	-	-	-	-
	43	-	-	-	-	-	-	-
	44	-	-	-	-	-	-	-
	45	-	-	-	-	-	-	-
	46	-	-	-	-	-	-	-
Weighted mean	0-46	10.9%	9.0%	4.5%	5.3%	6.7%	2.8%	11.2%
	RANKING	6	5	2	3	4	1	

PERCENTAGE AGREEMENT

MODAL age	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6	ALL
0	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	100%	50%	0%	0%	0%	100%	42%
6	0%	100%	0%	0%	0%	100%	33%
7	100%	100%	0%	0%	0%	100%	50%
8	0%	0%	75%	75%	0%	0%	29%
9	0%	100%	100%	0%	0%	-	40%
10	0%	0%	100%	50%	50%	50%	42%
11	0%	50%	50%	100%	0%	0%	36%
12	50%	50%	50%	50%	0%	100%	45%
13	0%	0%	0%	100%	100%		40%
14	0%	100%	100%	100%	0%	-	60%
15	50%	50%	0%	0%	100%	0%	36%
16	100%	0%	100%	100%	0%	0%	50%
17	50%	33%	50%	67%	33%	50%	47%
18	100%	0%	100%	0%	0%	100%	50%
19	50%	50%	100%	50%	0%	0%	42%
20	60%	60%	60%	0%	60%	0%	43%
21	100%	33%	0%	33%	33%	0%	35%
22	67%	100%	33%	0%	33%	0%	41%
23	0%	0%	100%	50%	50%	100%	45%
24	0%	100%	0%	100%	0%	0%	33%
25	0%	0%	100%	100%	0%	-	40%
26	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-
29	0%	0%	100%	100%	0%	-	40%
30	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-
36	-	-	-	-	-	-	
37	-	-	-	-	-	-	-
38	0%	0%	100%	100%	0%	0%	33%
39	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-
45	100%	100%	0%	0%	0%	-	40%
46	-	-	-	-	-	-	-
Weighted mean 0-46	31.75%	32.26%	39.68%	33.33%	19.05%	26.47%	30.75%
RANKING	5	3	1	2	4	6	

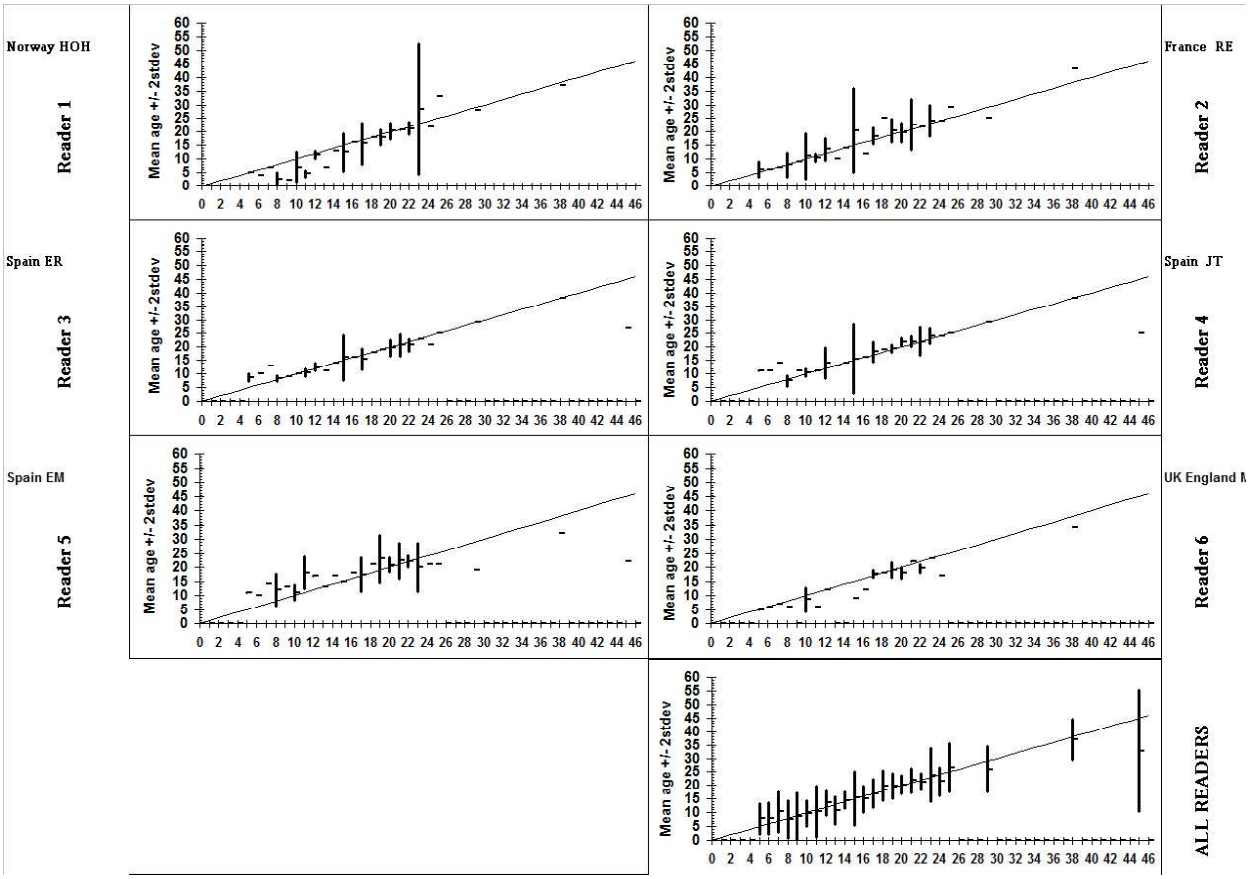
RELATIVE BIAS

MODAL age	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6	ALL
0	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	0	1	4	6	6	0	3
6	-2	0	4	5	4	0	2
7	0	0	6	7	7	0	3
8	-6	0	0	-1	4	-2	0
9	-7	0	0	2	4	-	0
10	-3	1	0	1	1	-2	0
11	-7	-1	-1	0	7	-5	-1
12	-1	2	1	2	5	0	2
13	-6	-3	-2	0	0	-	-2
14	-1	0	0	0	3	-	0
15	-3	6	1	1	0	-6	0
16	0	-4	0	0	2	-4	-1
17	1	2	2	1	0	1	0
18	0	7	0	1	3	0	2
19	-1	2	0	1	4	0	1
20	0	0	0	2	1	-2	0
21	0	2	0	1	1	1	1
22	-1	0	-1	0	0	-3	-1
23	6	1	0	1	-3	0	1
24	-2	0	-3	0	-3	-7	-3
25	8	4	0	0	-4	-	2
26	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-
29	-1	-4	0	0	-10	-	-3
30	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-
38	-1	5	0	0	-6	-4	-1
39	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-
45	0	0	-18	-20	-23	-	-12
46	-	-	-	-	-	-	-
Weighted mean 0-46	-0.92	0.63	-0.30	0.54	0.68	-1.15	0.01
RANKING	5	3	1	2	4	6	

Overall ranking

	Norway HOH Reader 1	France RE Reader 2	Spain ER Reader 3	Spain JT Reader 4	Spain EM Reader 5	UK England ME Reader 6
Ranking Coefficient of Variation	6	5	2	3	4	1
Ranking Percentage Agreement	5	3	1	2	4	6
Ranking Relative bias	5	3	1	2	4	6
OVERALL RANKING	6	3	1	2	4	5

In the age bias plots below the mean age recorded +/- 2stdev 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.



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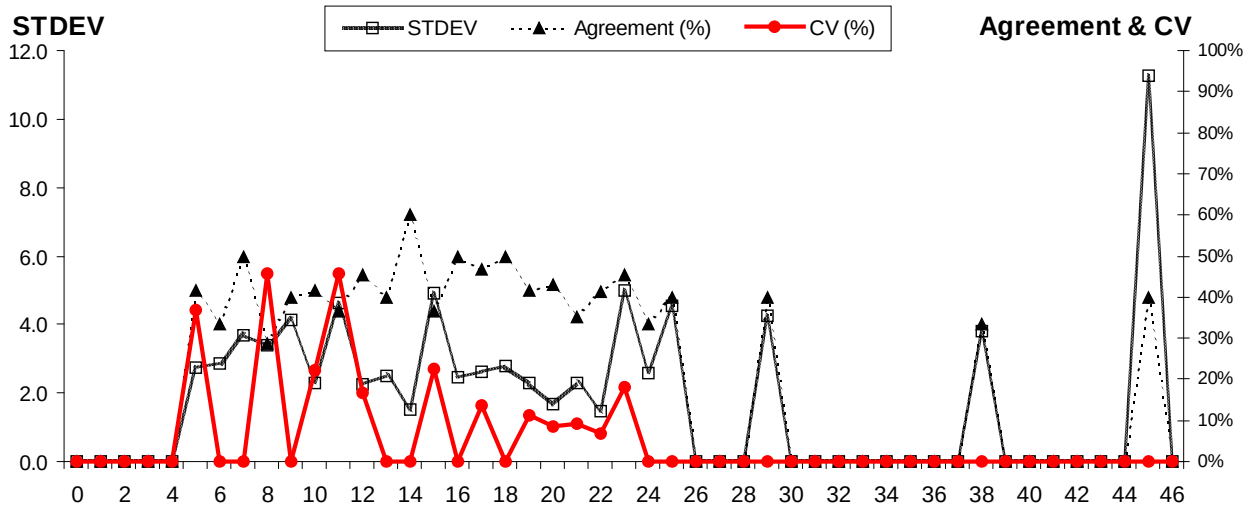

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