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AGE COMPARISONS OF CAPELIN OTOLITHS BY NORWEGIAN AND RUSSIAN AGE READERS 1999-2003 - A REVIEW

Institute of Marine Research - IMR

Polar Research Institute of Marine Fisheries and Oceanography - PINRO

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Age comparisons of capelin otoliths by Norwegian and Russian age readers 1999-2003 – a review

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Introduction and background

Experts from the two labs IMR in Bergen and PINRO in Murmansk met for the first time in 1984 to discuss age determination of capelin. It was concluded that no systematic differences existed between the labs (Gjøsæter, 1985). Analyses during the following years showed that during the joint autumn surveys there were, seemingly, small differences between the age readings on the different participating vessels. Up to 1993, the reported catch statistics by age group (Figure 1) also showed no sign of bias in age reading. On the other hand, judged from catch-at-age data reported to the ICES Northern Pelagic and Blue Whiting Working Group from the winter capelin fishery in the years following the fishing moratorium 1994-1998 (Figure 2-3) and from scientific surveys during the winter-spring period, large discrepancies were found, which could not be attributed to differences in length (Figure 4). Normally, PINRO reported higher ages than IMR. To check the presence of systematic differences between the otolith readers at the two laboratories and to study the reasons for such differences, a capelin otolith workshop was organised and hosted by PINRO in autumn 1999 (Gjøsæter and Ushakov, 2000). During that workshop it was decided to start an otolith exchange program and to organise biannual workshops. The second workshop was hosted by PINRO in November 2001 (Gjøsæter *et al.* 2002), and the third in October 2003. The present report sums up the results and conclusions so far, both from the otolith exchange program and the three workshops.

Material and methods

Three experts from PINRO (Elena Tereschenko, Rima Maslova, and Tatyana Prokhorova (replacing Galina Kvach from 2000) and two (later 3) from IMR (Bente Røttingen, Jostein Røttingen (Jan Henrik Nilsen replacing Jostein Røttingen in 2003) and Jaime Alvarez (from 2003) have read most of the otoliths during the interchange and during the two workshops. Capelin researchers Dmitry Prozorkevich, Nikolay Ushakov (PINRO) and Harald Gjøsæter (IMR) also read some otoliths, and participated in the analysis of the results. All the otoliths from Norway were prepared according to standard procedures at IMR, which means that the otoliths were embedded in the mounting medium Entelan®. Some otoliths from Russia were also prepared in this way; others were kept dry in envelopes and read soaked in a solution of alcohol and glycerine. The results were recorded on standard spreadsheets for otolith reading comparisons (Eltink, 2000) and were analysed according to the guidelines in Eltink *et al.*, (2000).

[1] IMR, Bergen, Norway
[2] PINRO, Murmansk, Russia

Exchange program

Period	Norwegian otoliths	Russian otoliths
Workshop 1999	200	16
Winter 2000	50	50
Autumn 2000	50	175
Winter 2001	50	50
Autumn 2001	50	100
Workshop 2001	100	80
Winter 2002	50	50
Autumn 2002	50	50
Winter 2003	50	125
Workshop 2003	250	114

Results

The analysis spreadsheet (Eltink, 2000) contains numerous tables, figures and tests, which can be used to scrutinise various aspects of the age reading comparisons (Eltink et al., 2000). However, for a crude overview, the table depicting inter-reader bias and the plots of each reader's results compared to the median results have been found to be useful. In Figures 5-30, these two entities are shown for each of the comparisons.

The general impression is that better agreement was reached on otoliths from the autumn season than from the winter season, and that there has been an improvement over the period of otolith exchange. In most cases, almost full agreement (> 95%) among all readers was reached for autumn otoliths during recent years. The variation among readers was very small for otoliths with modal age 2 and 3, while those with modal age 4 caused some more variation.

Otoliths sampled during winter-spring season are in general more difficult to interpret. Some readers showed certainty of bias when compared to modal age, especially during the first years of otolith exchange. It was not always the same readers that were at variance with the others; this varied from sample to sample. Between reader bias was found both within and between laboratories, although reader #1 and #2, the main readers at the IMR, very seldom showed inter-reader bias.

The differences between number-at-age in the catch statistics depicted in figures 2 and 3 were found to stem from the fact that the Russian otoliths included in the age-length keys used in those fishery seasons were read by one particular reader who has now retired from the lab. Those otoliths have been re-read, and the new results were much more in accordance with the Norwegian age readings from those seasons.

There has been a substantial improvement in the agreement on age reading during the period of otolith exchange and workshops. There is now what could be called "full agreement" on otoliths from the autumn season, which means that the inter-reader variability in each lab is very small, but as large as that between laboratories. Concerning otoliths from the fishing season, there are still some disagreements, but much less than there was previously.

Conclusions so far

It is concluded that for the time being, there does not seem to be any systematic differences between the age readings of capelin at PINRO and IMR. However, to monitor possible changes in this situation, the labs will continue to exchange otoliths according to established procedures. Workshops will be organized every second year, as part of the quality assurance of age reading of capelin.

Reference List

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Figures

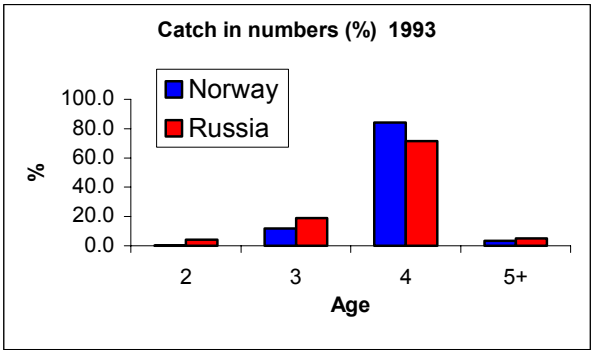

Figure 1. Catch-in-numbers by age from the Norwegian and Russian fishery 1993

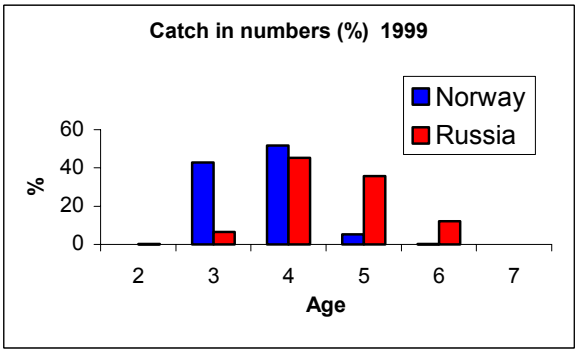

Figure 2. Catch-in-numbers by age from the Norwegian and Russian fishery in 1999.

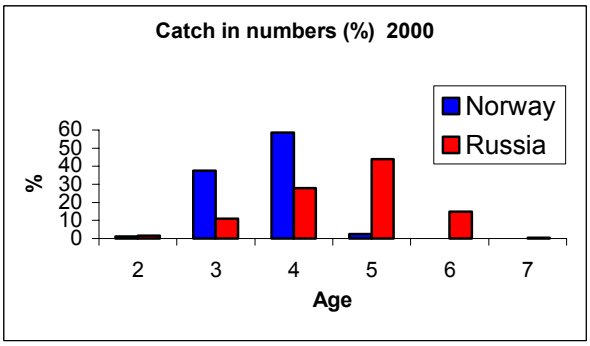

Figure 3. Catch-in-number by age from the Norwegian and Russian fishery in 2000.

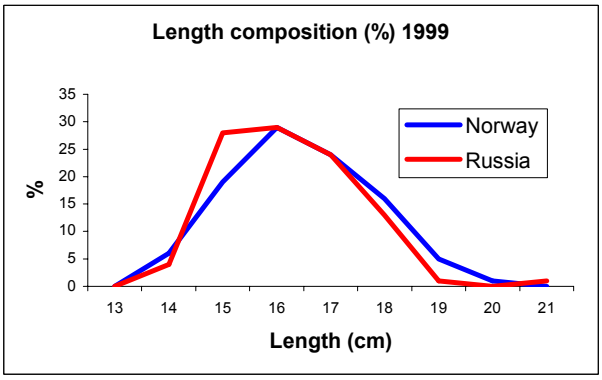

Figure 4. Length composition of catches from the Norwegian and Russian fishery in 1999.

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JR Reader 2	N HG Reader 3	R LT Reader 4	R RM Reader 5	R DP Reader 6	R NU Reader 7	R GK Reader 8
Reader 1		–		*	–			–
Reader 2				*	–			–
Reader 3								
Reader 4					–			**
Reader 5								**
Reader 6								
Reader 7								
Reader 8								
MODAL age	–	–		–	–			*

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

Figure 5. Winter otoliths from 1999 workshop

Barents Sea capelin - spring otoliths workshop 1999

Figure 1 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.

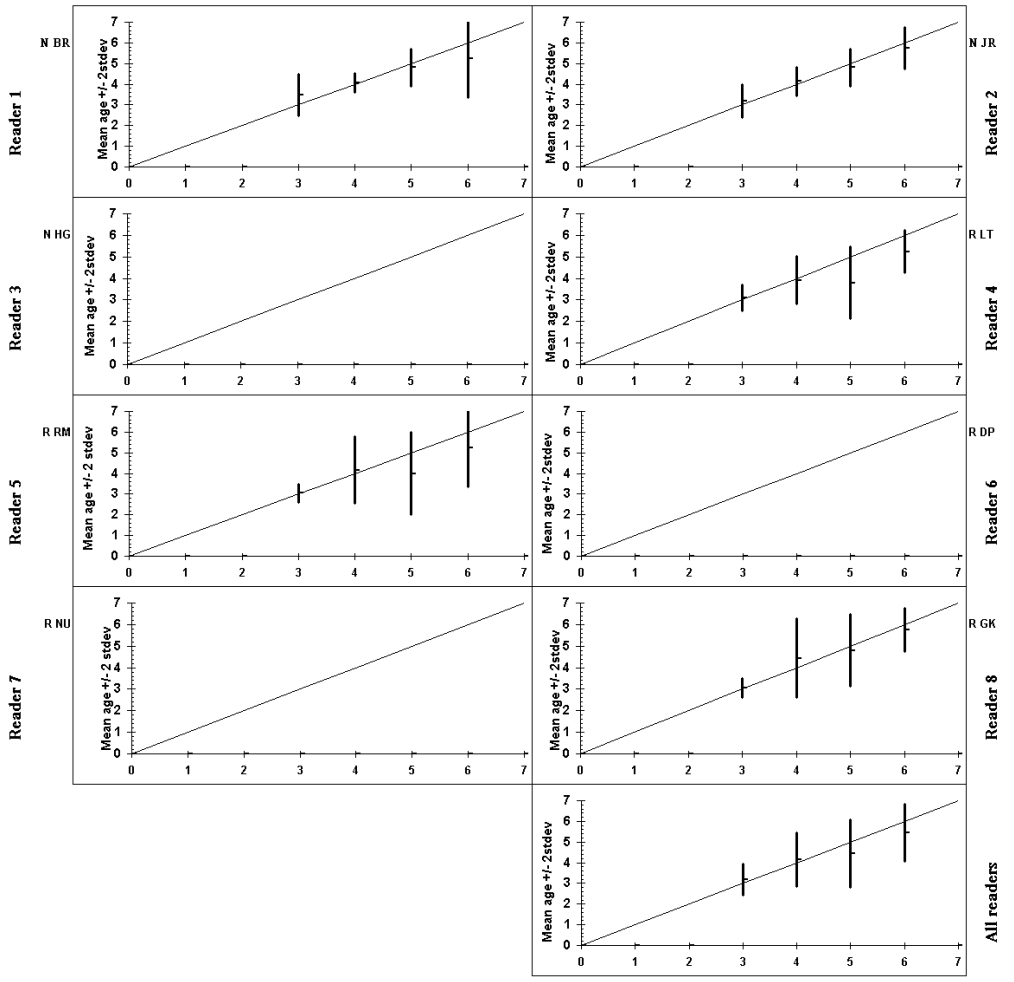

Figure 6. Winter otoliths from 1999 workshop

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JR	N HG	R LT	R RM	R DP	R NU	R GK
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8
Reader 1		–		–	**			**
Reader 2				–	**			**
Reader 3								
Reader 4					**			**
Reader 5								
Reader 6								
Reader 7								
Reader 8								
MODAL age	–	*		–	**			**

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

Figure 7. Autumn otoliths from workshop 1999

Barents Sea capelin - autumn otoliths, workshop 1999

Figure 1 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.

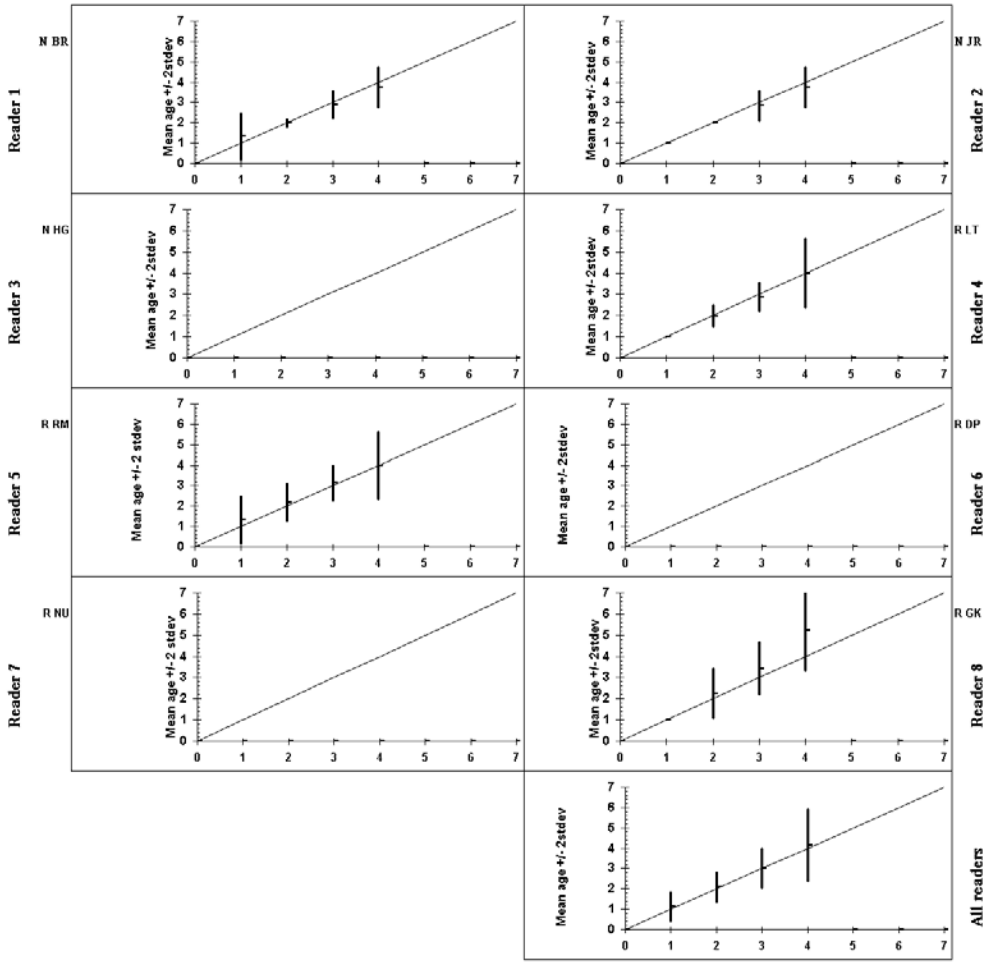

Figure 8. Autumn otoliths from 1999 workshop

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JR Reader 2	N HG Reader 3	R LT Reader 4	R RM Reader 5	R DP Reader 6	R NU Reader 7	R TP Reader 8
Reader 1		–	*	**	**	–	–	**
Reader 2			**	**	–	–	–	**
Reader 3				**	*	–	–	**
Reader 4					*	**	**	–
Reader 5						**	*	*
Reader 6							–	**
Reader 7								**
Reader 8								
MODAL age	–	–	*	**	**	–	–	**

– = no sign of bias (p>0.05)

* = possibility of bias (0.01<p<0.05)

* * = certainty of bias (p<0.01)

Figure 9. Otoliths from winter 2000

Barents Sea capelin - PINRO/IMR exchange winter 2000

Figure 1 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.

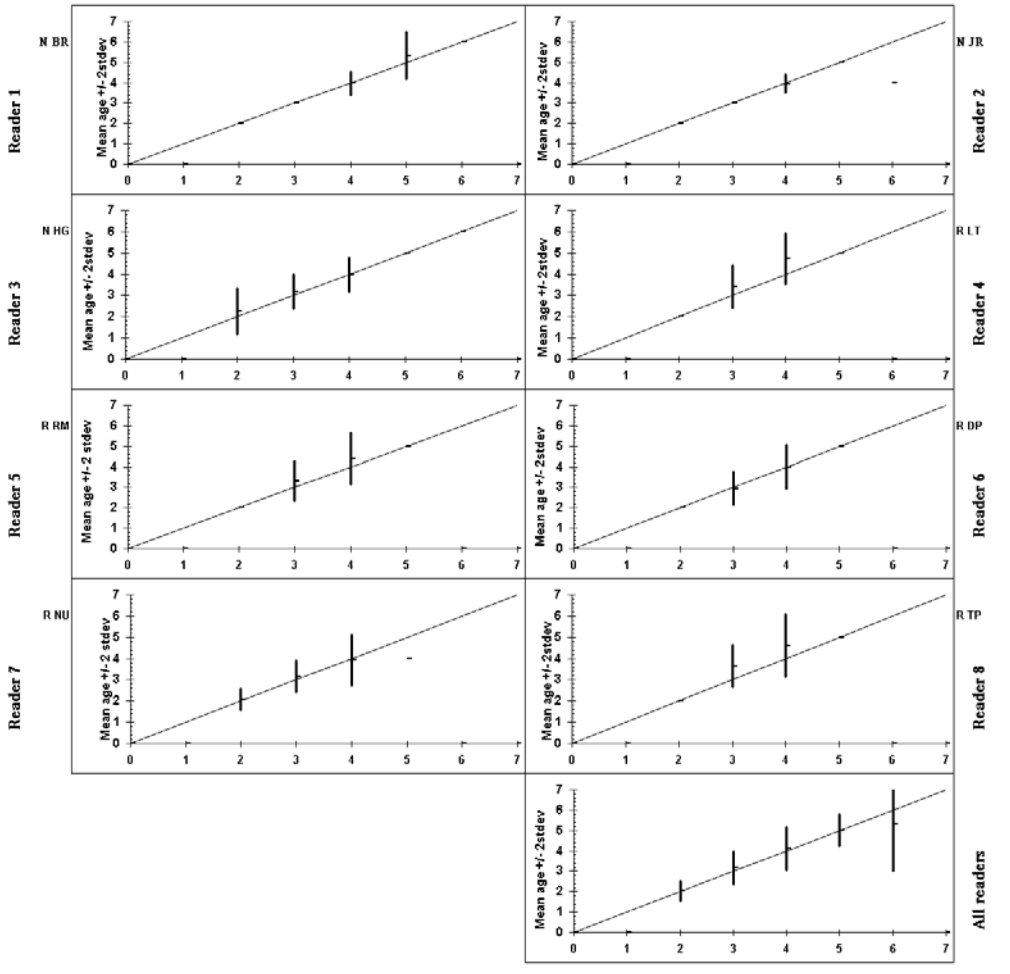

Figure 10. Otoliths from winter 2000

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JR	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8
Reader 1		–	–	–	–	–	–	–
Reader 2			–	–	–	–	–	–
Reader 3				–	–	–	–	–
Reader 4					–	*	–	–
Reader 5						–	–	
Reader 6							–	
Reader 7								
Reader 8								
MODAL age	–	–	–	–	–	–	–	–

– = no sign of bias (p>0.05)

* = possibility of bias (0.01<p<0.05)

* * = certainty of bias (p<0.01)

Figure 11. Otoliths from autumn 2000

Barents Sea capelin - PINRO/IMR exchange autumn 2000

Figure 1 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.

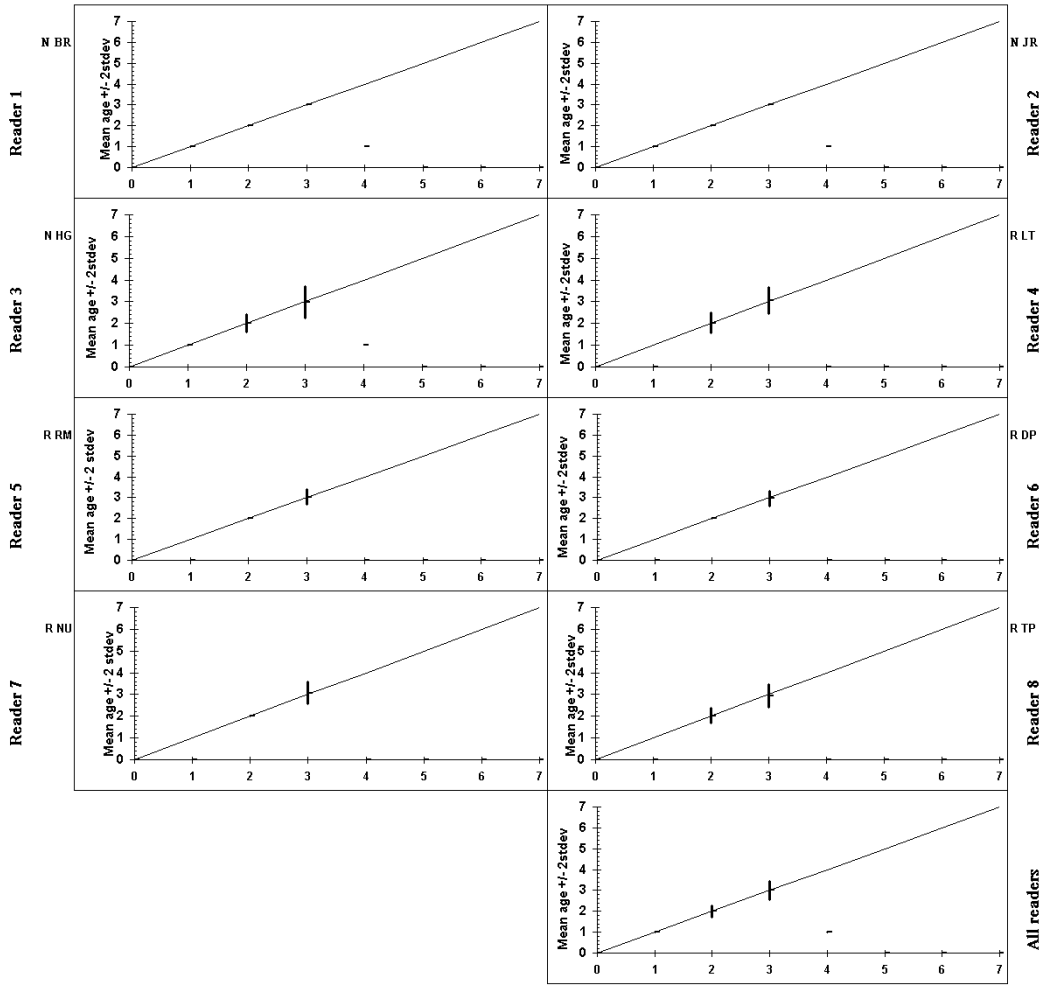

Figure 12. Otoliths from autumn 2000.

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JR	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8
Reader 1		**	**	**	–	**		**
Reader 2			*	–	–	–		–
Reader 3				–	–			*
Reader 4					–	–		–
Reader 5						**		**
Reader 6								*
Reader 7								
Reader 8								
MODAL age	**	–	*	–	–	*		*

– = no sign of bias (p>0.05)

* = possibility of bias (0.01<p<0.05)

* * = certainty of bias (p<0.01)

Figure 13. Otoliths from winter 2001

Barents Sea capelin - PINRO/IMR exchange winter 2001

Figure 1 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.

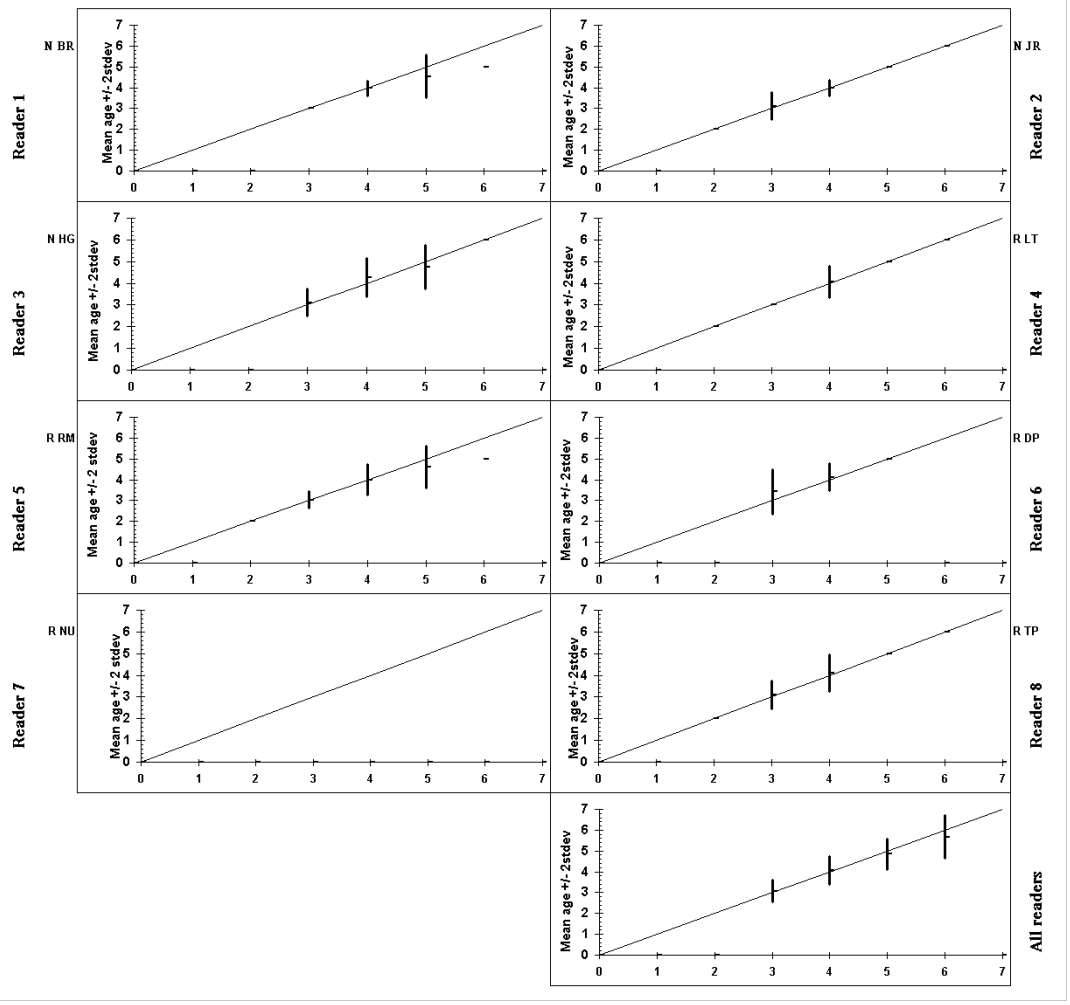

Figure 14. Otoliths from winter 2001

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JR	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8
Reader 1		–	–	–	–			–
Reader 2			–	–	–			–
Reader 3				–	*			–
Reader 4					–			–
Reader 5								*
Reader 6								
Reader 7								
Reader 8								
MODAL age	–	–	–	–	–			–

– = no sign of bias (p>0.05)

* = possibility of bias (0.01<p<0.05)

* * = certainty of bias (p<0.01)

Figure 15. Otoliths from autumn 2001.

Barents Sea capelin - PINRO/IMR exchange autumn 2001

Figure 1 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.

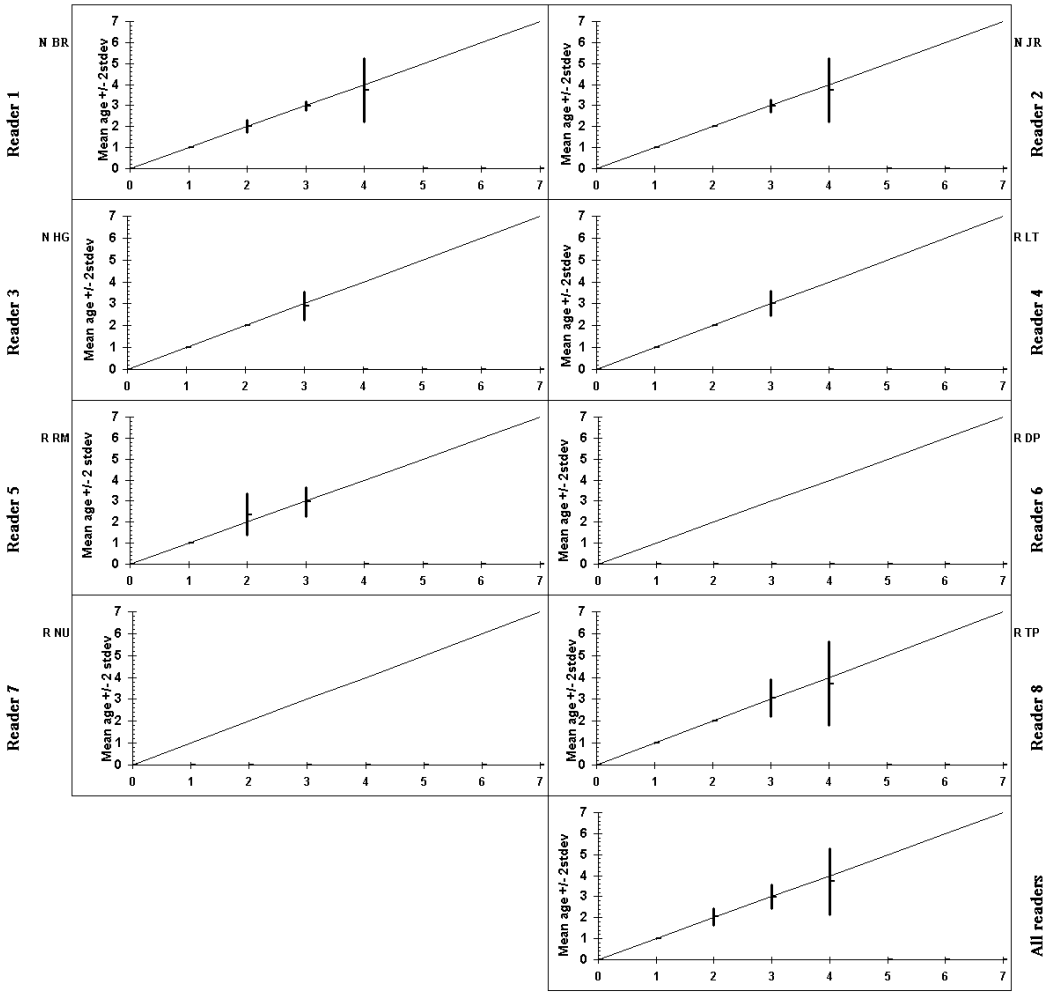

Figure 16. Otoliths from autumn 2001

Inter-reader bias test and reader against MODAL age bias test

	N BR	N JR	N HG	R LT	R RM	R DP	R NU	R TP
	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8
Reader 1		*	**	*	*	_	**	*
Reader 2			_	**	**	_	**	**
Reader 3				**	**	_	*	*
Reader 4					_	_	**	_
Reader 5						**	**	_
Reader 6							_	_
Reader 7								**
Reader 8								
MODAL age	_	*	*	**	*	_	**	*

_ = no sign of bias (p>0.05)

* = possibility of bias (0.01<p<0.05)

** = certainty of bias (p<0.01)

Figure 17. Winter otoliths from 2001 workshop

Barents Sea capelin - winter otoliths, 2001 workshop

Figure 1 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.

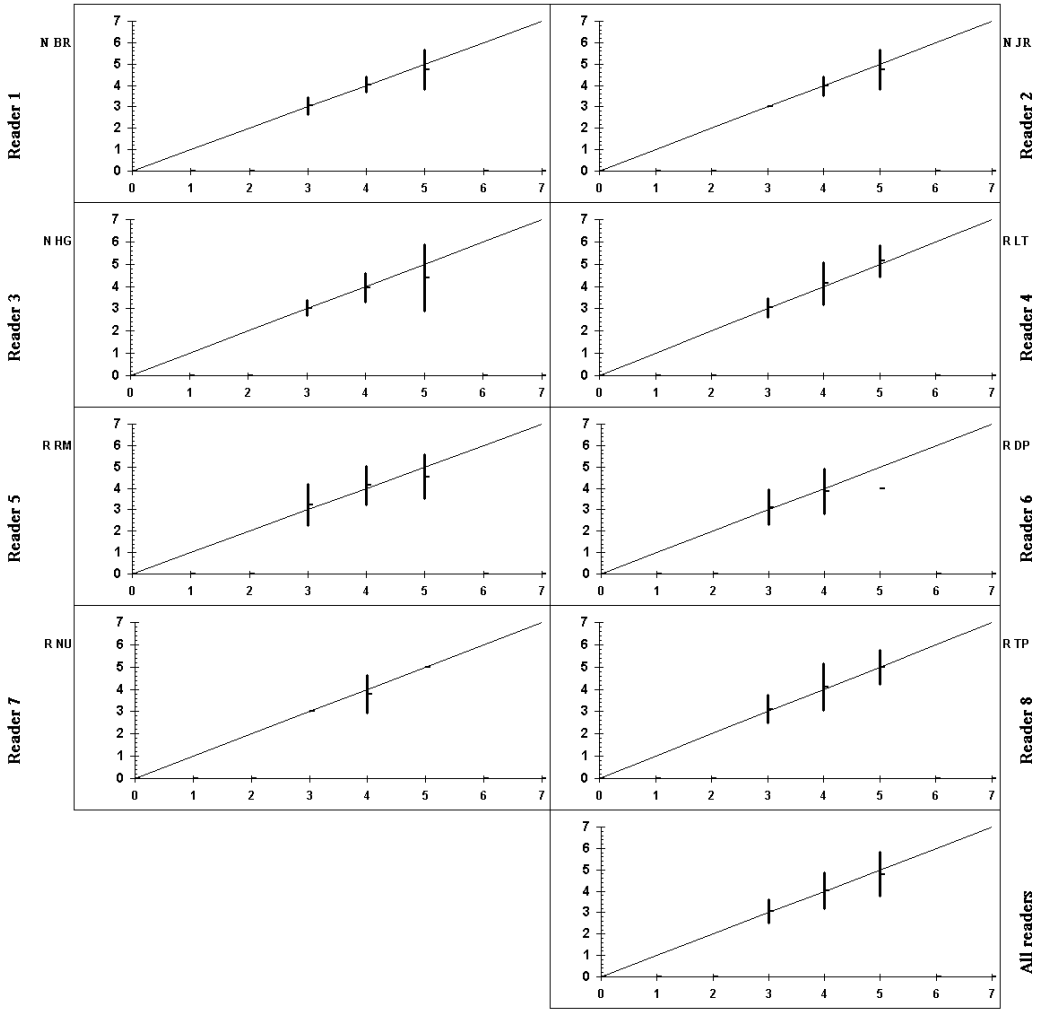

Figure 18. Winter otoliths from 2001 workshop.

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JR Reader 2	N JA Reader3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		–		**	–	–	–	**	–
Reader 2				**	–	–	–	**	–
Reader3									
Reader 4					**	**	**	**	**
Reader 5						–	–	**	–
Reader 6							–	**	–
Reader 7								**	–
Reader 8									**
Reader 9									
MODAL age	–	–		**	–	–	–	**	–

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

Figure 19 Otoliths from winter 2002

Barents Sea capelin - PINRO/IMR exchange winter 2002

Figure 1 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.

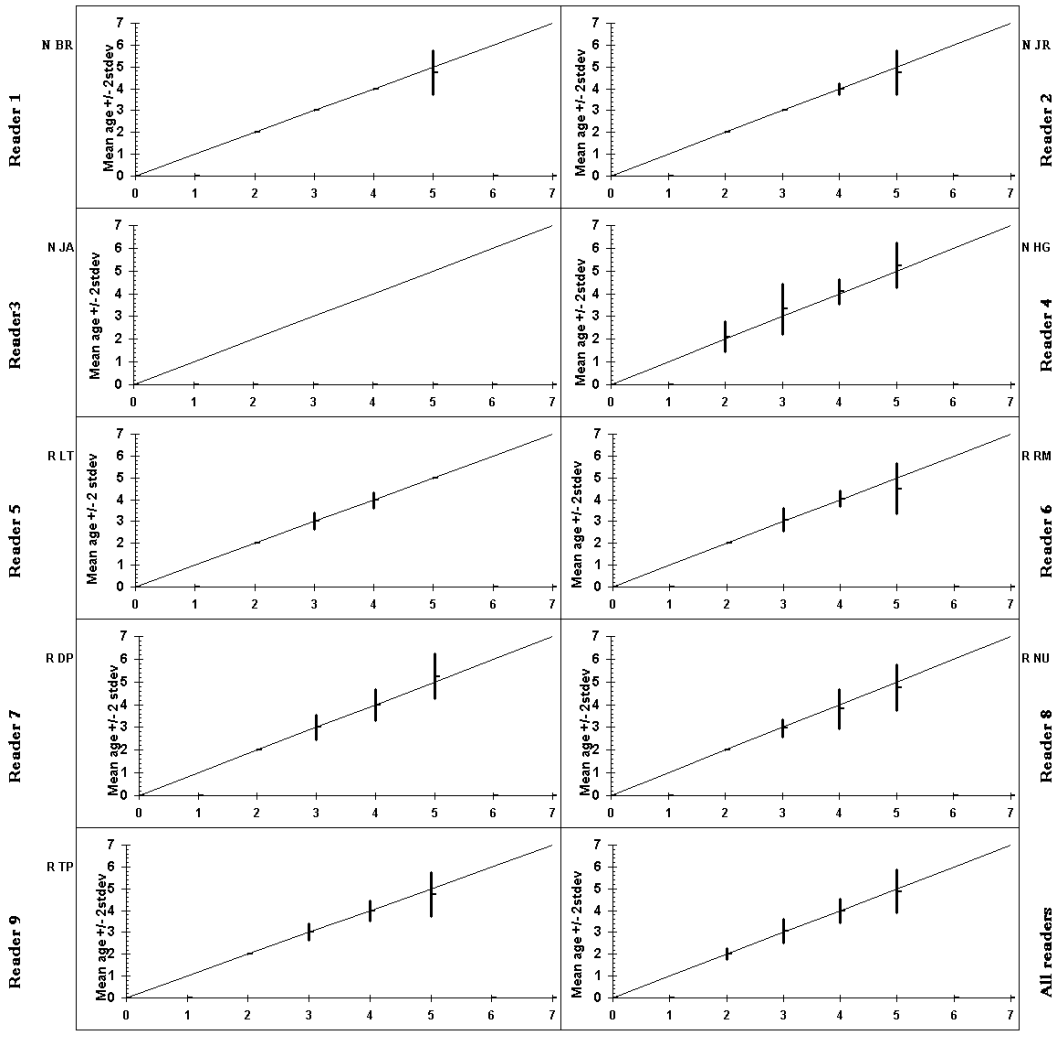

Figure 20 Otoliths from winter 2002

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN+JR Reader 2	N HG Reader 3	N JA Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		–	–	–	–	–			–
Reader 2			–	–	–	–			–
Reader 3				–	–	–			–
Reader 4					–	–			–
Reader 5						–			–
Reader 6									–
Reader 7									
Reader 8									
Reader 9									
MODAL age	–	–	–	–	–	–			–

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

Figure 21 Otoliths from autumn 2002

Barents Sea capelin - PINRO/IMR exchange autumn 2002

Figure 1 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.

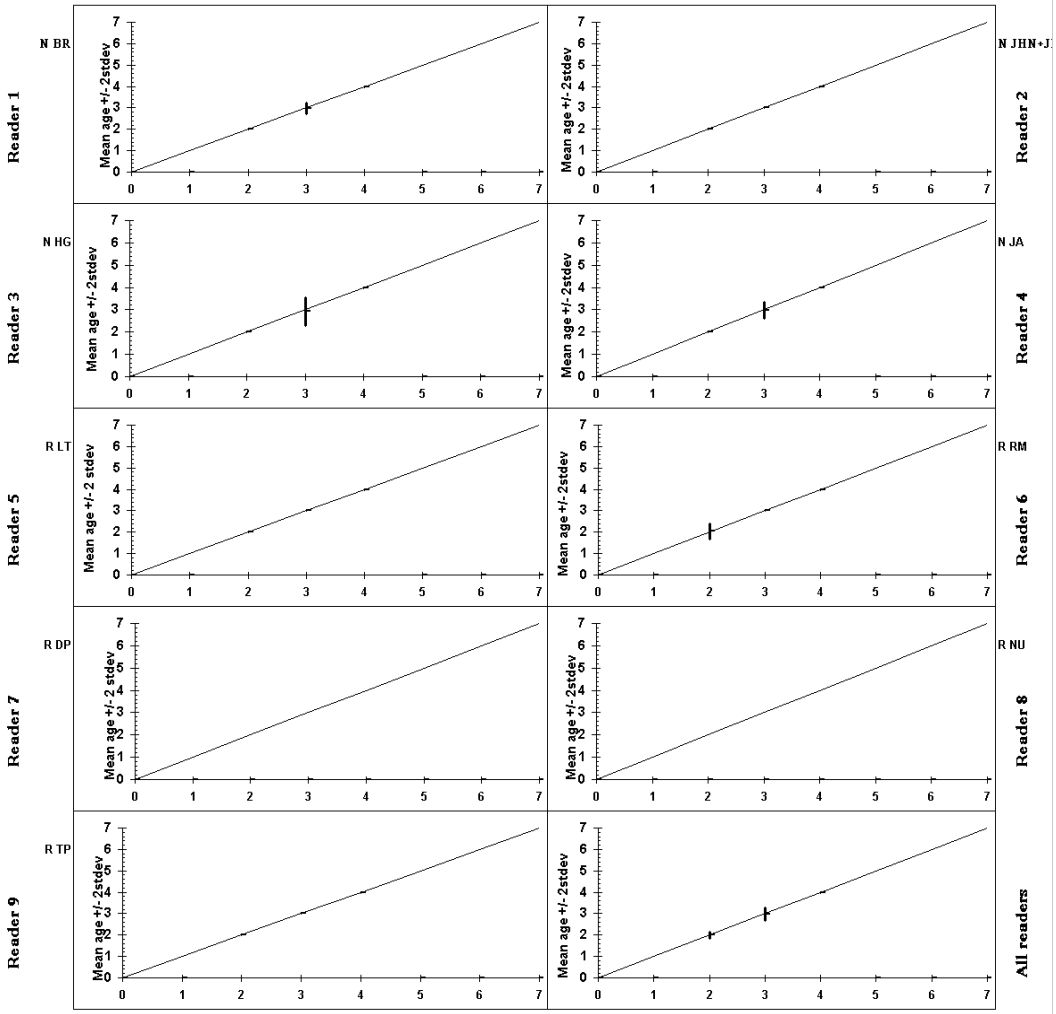

Figure 22 Otoliths from autumn 2002

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN Reader 2	N JA Reader 3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		–	–	–	–	**		–	–
Reader 2			–	–	–	**		–	–
Reader 3				–	–	**		–	–
Reader 4					–	**		–	–
Reader 5						*		–	–
Reader 6								**	**
Reader 7									
Reader 8									–
Reader 9									
MODAL age	–	–	–	–	–	**		–	–

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

Figure 23 Otoliths from winter 2003

Barents Sea capelin - PINRO/IMR exchange winter 2003

Figure 1 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.

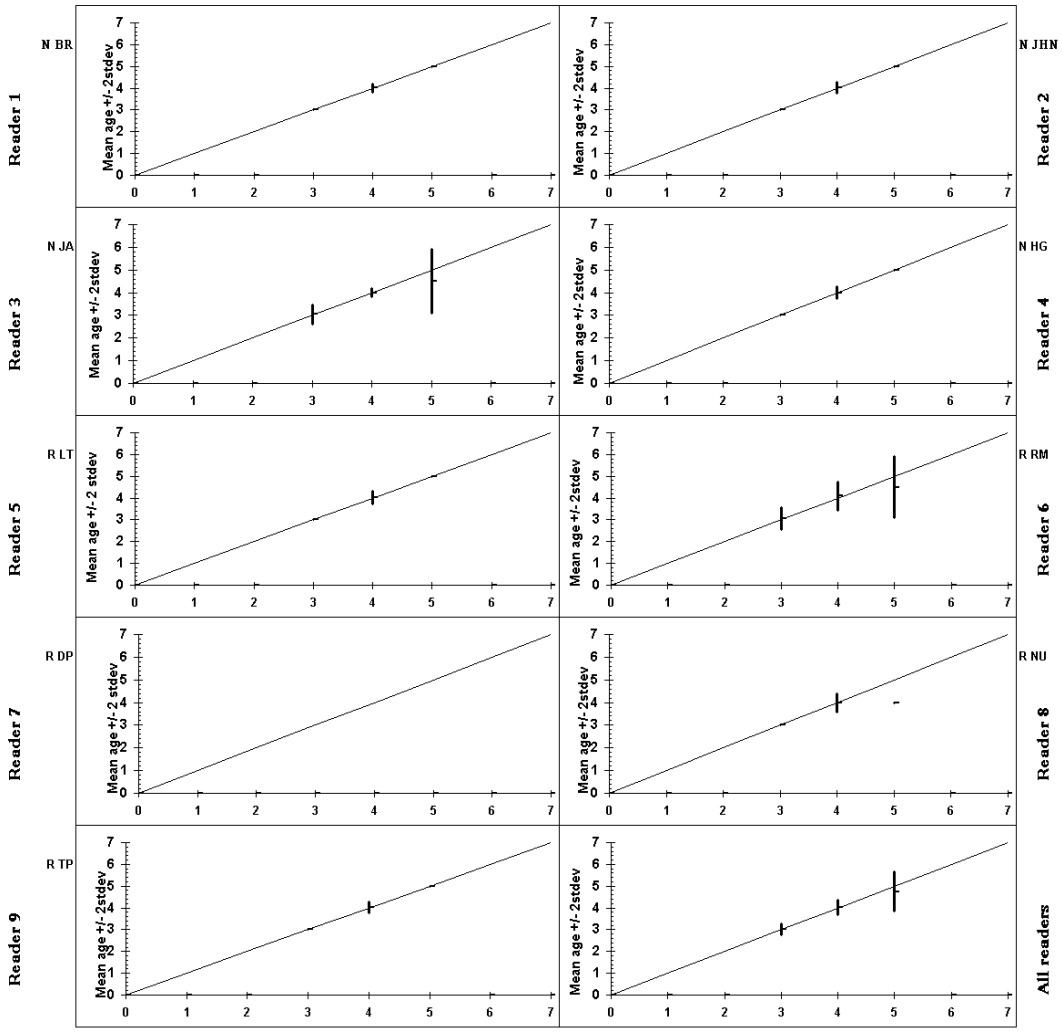

Figure 24 Otoliths from winter 2003

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN Reader 2	N JA Reader3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		–	–		*	–			–
Reader 2			–		–	*			–
Reader3					–	*			–
Reader 4									
Reader 5						**			–
Reader 6									*
Reader 7									
Reader 8									
Reader 9									
MODAL age	–	–	–		*	–			–

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

Figure 25 Otoliths from 2003 workshop (winter otoliths, east)

Barents Sea capelin - winter otoliths (east), 2003 workshop

Figure 1 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.

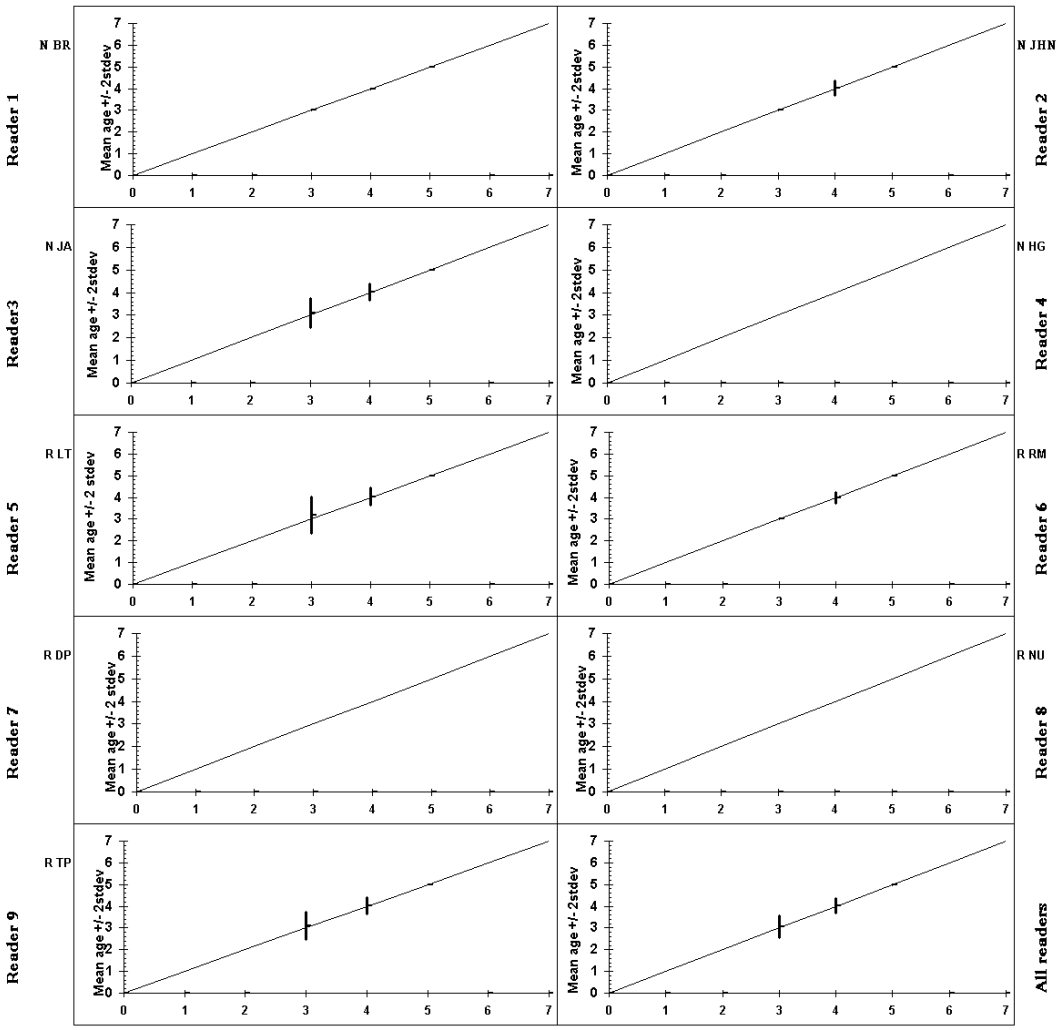

Figure 26 Otoliths from 2003 workshop (winter otoliths, east)

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN Reader 2	N JA Reader3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		–	–		**	–			**
Reader 2			–		**	–			**
Reader3					**	–			**
Reader 4									
Reader 5						**			–
Reader 6									**
Reader 7									
Reader 8									
Reader 9									
MODAL age	–	–	–		**	–			**

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

Figure 27 Otoliths from 2003 workshop (winter otoliths, west)

Barents Sea capelin - winter otoliths (west), 2003 workshop

Figure 1 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.

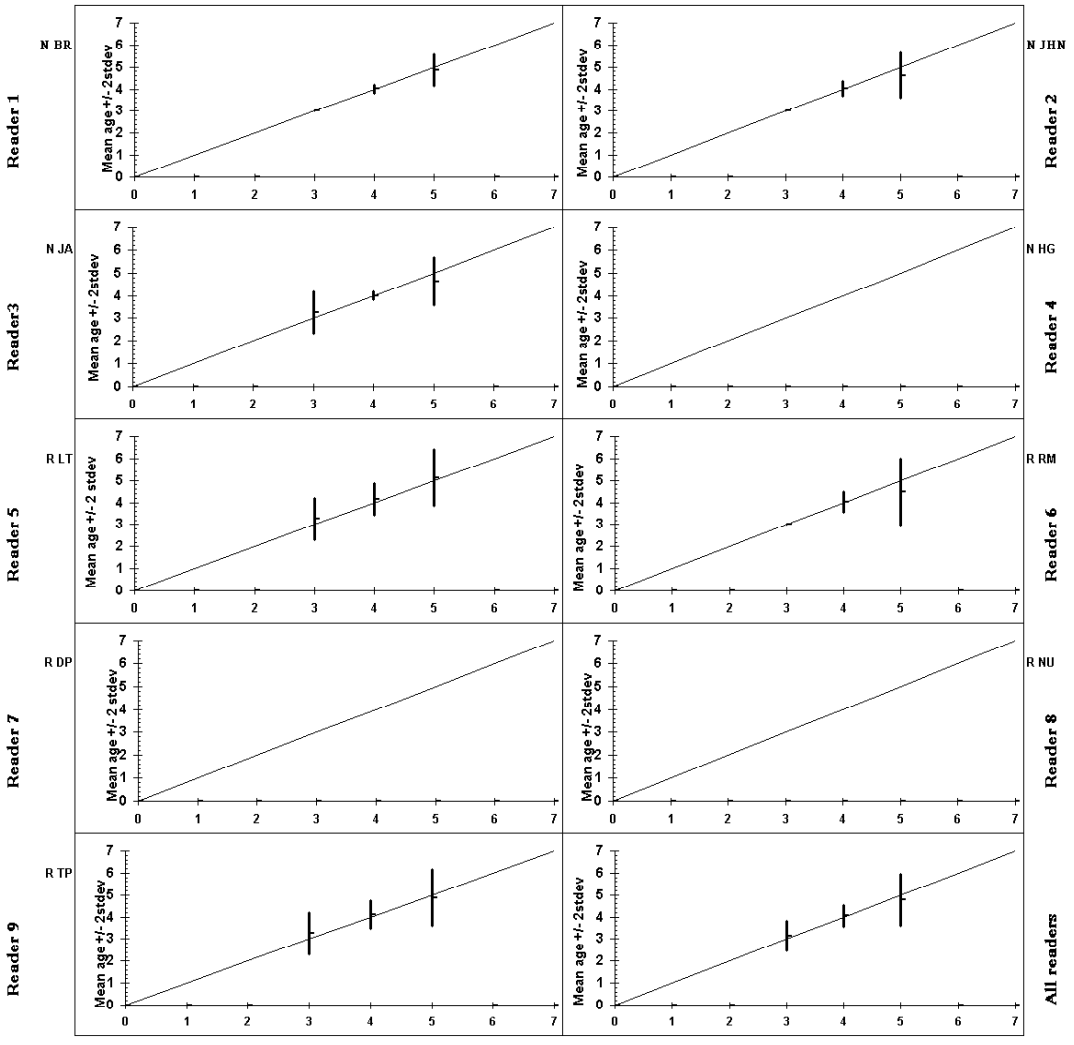

Figure 28 Otoliths from 2003 workshop (winter otoliths, west)

Inter-reader bias test and reader against MODAL age bias test

	N BR Reader 1	N JHN Reader 2	N JA Reader3	N HG Reader 4	R LT Reader 5	R RM Reader 6	R DP Reader 7	R NU Reader 8	R TP Reader 9
Reader 1		–	–		–	–			–
Reader 2			–		–	–			–
Reader3					–	–			–
Reader 4									
Reader 5						–			–
Reader 6									–
Reader 7									
Reader 8									
Reader 9									
MODAL age	–	–	–		–	–			–

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

Figure 29 Otoliths from 2003 workshop (autumn otoliths)

Barents Sea capelin - autumn otoliths, 2003 workshop

Figure 1 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.

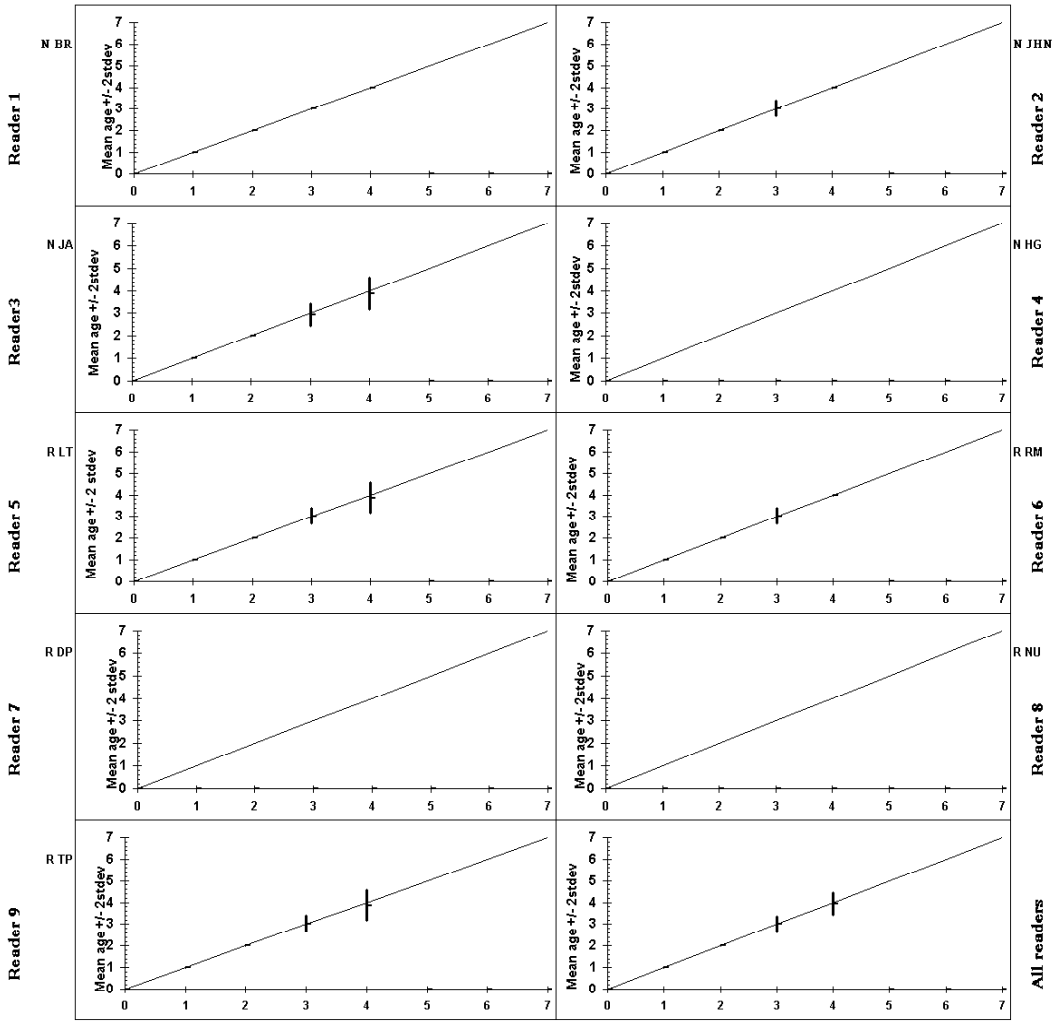

Figure 30 Otoliths from 2003 workshop (autumn otoliths)

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1/2003
Aglen, A., Alvsvåg, J., Halland, T.I., Høines, Å., Nakken, O., Russkikh, A. and Smirnov, O. 2003. Investigations on demersal fish in the Barents Sea winter 2003. Detailed report. IMR/PINRO Joint Report Series, No. 1/2003. ISSN 1502-8828. 53 pp.

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