Working Document to the 2006 ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS)

2005 ANCHOVY OTOLITH EXCHANGE PROGRAMME FROM SUBAREA VIII

(First Draft -24 February 2006- to be reviewed by the Group)

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1- INTRODUCTION:

After the 2001 exchange programme and the 2002 workshop made within PELASSES project, it was considered the convenience of organizing an exchange programme of anchovy otoliths during 2005, in order to ascertain the current level of precision among institutes and the difficulties that the age reading of anchovy otoliths may still present. In addition, in the Ostende meeting (1-4 March 2005) of the ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS) (ICES CM 2005/ACFM:15) it was agreed (section for Planning of future age-reading workshops) to carry out exchange programmes for otolith reading for anchovy in 2005 and a workshop in 2006 (in Spain).

To that purpose an exchange programme of anchovy otoliths was organized in 2005 between AZTI, IEO, IFREMER, coordinated by the former institute. The results of this exchange programme will be discussed and serve as a starting point for the organisation of a small workshop on anchovy age determination in this year 2006.

This paper presents the results of the exchange programme on anchovy otoliths coordinated by AZTI from January to July 2005.

2- OBJECTIVES:

The exchange will have the following objectives for the Subarea VIII (Bay of Biscay):

1- Evaluate current precision in otolith age reading of anchovy among readers from fishery and survey samples throughout the year with otoliths mainly from 2004 and a few of 2003.
2- Identify major difficulties in anchovy otolith interpretation for age determinations concerning observed disagreements (otolith edge recognition and/or identification of true rings or checks).

3- Report results to the MHSAWG meeting in September and/or potentially to a subsequent workshop on anchovy age determination that may take place subsequently to facilitate the discussions and progress of work.

3- MATERIAL AND METHODS

PARTICIPANTS AND QUALIFICATION OF READERS

There were 6 readers participating in the exchange of otoliths, who had different levels of experience reading anchovy otoliths.

Here, it follows a list of participants along with a summary of their experience:

Andrés Uriarte, (Coordinator, AZTI): He reads anchovy otoliths since 1984. He is in charge of the Monitoring of the fishery on the Bay of Biscay anchovy operating in the Basque Country.

Iñaki Rico, (AZTI): Reading Bay of Biscay anchovy otoliths since about 1990 with the former reader. He is in charge of biological sampling of anchovy in AZTI.

Begoña Villamor, B. (IEO): She is reading Bay of Biscay anchovy otoliths since 2003. In the Lab of Santander, she takes care of the biological monitoring pelagic fisheries in this area.

Marian Blanco (IEO): She started reading anchovy otoliths after the 2002 workshop. She works at Santander with Begoña Villamor and takes care of reading the anchovy otoliths.

Patrick Grellier (IFREMER): He started reading anchovy otoliths in 2001. He was trained by P. Prouzet is in charge of reading the anchovy otoliths collected during the spring acoustic surveys of IFREMER.

Erwan Duhamel, (IFREMER): He has been reading anchovy otoliths from the Bay of Biscay since 2002. He is in charge of the monitoring of the commercial French fishery, including the age readings of the anchovy otoliths from the sampling of catches throughout the year.

For the current otolith exchange, all readers made the age determination of the otoliths without looking at the lengths of the anchovies.

SETS OF OTOLITHS: The definitive adopted sets of otoliths were the following ones:

A Total of 510 otoliths were used in the exchange exercise, coming from:

SET A) IEO   30 otoliths from the first half of 2004
              and 120 otoliths from the second half of the year,
                     60 from the south of the Bay in July August 2004
                     and 60 from the north of VIIIb in September and October 2003,
              covering as much as possible all range of lengths (and hence ages).

SET B) AZTI 150 otoliths from the first half of 2004:
                     90 from the south of the Bay
                     and 60 from the VIIIb north from BIOMAN2004

SET C) IFREMER: 120 otoliths from 2004: PELGAS 2004 first half of the year,
                     90 otoliths from samples from Commercial Catches 2° half of 2004.

PREPARATION OF THE SETS OF OTOLITHS:
As agreed in previous exchanges and directly among readers of anchovy otoliths, these
otoliths are mounted entire within Eukit on black slides of 10 pairs of otoliths each.
Otoliths are mounted with the sulkus facing down.

For each subset of otoliths selected above, a general description of the set in terms of
geographic origin, months and length range has to be provided.

Each black slide with otoliths was labelled by a unique code to which all otoliths were
referred. Additional code for the exchange programme at the back of the each slide
containing a slide identification + Institute of origin + month of captures was inserted.

And for each selected otolith the information available was:
   -   Slide identification code where it is contained
   -   Month of capture
   -   And although And Optionally: Length, weight and sex, no reader made use of this
       information.

AGE DETERMINATION PROCEDURES

During the 2002 workshop the validation and methodology of age reading defined in AZTI
was presented and adopted (Uriarte et al. 2002 AZTI ms), although it has not been properly
published. So people are believed to follow in general terms the guidelines collected in the
WD reporting that workshop (Uriarte et al. 2002)

For the purposes of the current exchange, each reader received forms to be fulfilled in excel files in two ways: with and without length or sex data, although we agreed reading the otoliths without regarding the length.

Each reader indicated:
- the age assigned to each otolith
- otolith edge (hyaline –H- or opaque –O-),
- reliability of age determination: 0-sure, 1- doubtful and 2-very doubtful or difficult.
- Optionally and for some difficult otoliths, for discussion purposes, the reader could add the measures of the radius to the true annual rings on the posterior edge of the otolith, although this was not made.
- Presence of checks in a last column labelling them according to their relative position to the previous true annual rings. For instance a 08 indicates a check placed at about 80 % of the 0 group suspected growth. For instance 15 will indicate the presence of a check placed at about 50% of the 1 year old suspected growth. Etc. (This is the way of naming checks in AZTI).
- Remarks such as: if the length was used to help age determination (by putting the word "Length"); Any other comments as Reason for difficulties etc.

The idea was to clearly understand how the otolith rings were interpreted by the readers in order to facilitate understanding agreements and discrepancies.

Minimum knowledge for age determination is:
  a) Conventional birth dates for increasing in one year the age of an anchovy, when trespassing that date, is 1st of January.
  b) Spawning time is usually in spring and maximum growth in spring and summer.
  c) True Annual rings will be those formed in winter each year. Other rings may be present or appear throughout the year and cause problems in age determination (checks).

DATA ANALYSIS:
All data were analysed using the Workbook Age Reading comparisons of Eltink (2000) and following the recommendations of the Guidelines and tools for age reading comparisons (Eltink et al 2000)

So far and concerning the interpretations of agreements and disagreements, the radius measurements have not been compared among readers for individual otolith examples particularly suitable for discussions.

4- RESULTS

The preparation of the sets of otoliths and submission to the coordinator was completed during January 2005 and the exchange programme was completed by the End of July.

Table 4.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the Bay of Biscay region along with the ageing produced by each reader. The last two columns give the Modal age, the percent of agreement relative to Modal age and the Precision of reading as the Coefficient of Variation in relation to the average age. The Average percentage of agreement across all ages and readers is 90.9 % and the average CV equals 13.9%.

Table 4.2 shows that almost all otoliths were read by the participants (first sub-table ther in), although two readers left about 5% of the otoliths not read. CV is maximum at age 0 (of about 49%), but due to a single reader not working with otoliths of this year class. For the rest of age CV are quite constant around 13% or less. However the percentage of agreement to the modal age clearly diminishes with age (**Figure 4.1**). The sub-table of relative bias indicates overall minor bias, with a negative trend for older ages (so usally a bit underestimated) (see also **Figure 4.2 & 3**). Nevertheless the absolute level of biass is relatively small and the readers did not significantly diverge on average from the modal age according to **Figure 4.4.**

The most remarkable bias for age 1 (a very abundant age class in the population) is positive (0.16) and come from readers 2 and 3 (from IEO & IFREMER). This feature implies production of a bit older age composition by these readers in comparison with the others (**Table 4.3** top panel). On the contrary, for age 2 (still a relatively abundant age class in the population) the most remarkable bias come from readers 6 and 7 (from AZTI). This feature implies production of a bit younger age composition by these readers in comparison with the others (**Table 4.3** top panel). This is probably the reason why the age readings of readers 3, 5 and 6 significantly differ from that of the rest of the group (**Table 4.3** bottom panel).

Mean lengths at age resulting from each reader's readings appear in **Table 4.3** middle panel. This table and **Figure 4.5** it is shown that except for age 3 of reader 2 and age 4 of readers 1,2 and 3, mean length at age increases with age.

In relation to Modal age, the two AZTI readers have the highest overall ranking in reading performance (**Table 4.2** bottom panel), they resulted to be ones most in agreement with the modal age, with the smallest coefficient of variation and biases.

Tables 4.4 and **5** show that the precision and the degree of agreement with the modal age decreases along the year, worsening in summer and autumn; this being particularly due to the readings on age 1 and 2. The bottom panel also show that the biases increases during the second half of the year for these two ages, being maximum in October and November.

4- DISCUSSION

The sets of otoliths examined in the exercise were otoliths arising from the most recent monitoring of the fishery landings and from recent surveys mostly during 2004. Therefore they are indicative of the common troubles encountered in these years.

The Average percentage of agreement across all ages and readers (90.9 %) and the average CV (13.9%) is quite good in comparison with the results of the last Exchange carried out in 2001, when Average percentage of agreement was 83 % and the average CV was 30% (Uriarte 2001). They are quite similar to (a bit worse than) the results achieved after the last workshop held in 2002 (Uriarte et al. 2002) when an agreement among readers of 92% with a CV of about 10% was managed.

The sub-table of relative bias (in table 4.2) indicates overall minor bias, with a negative trend for older ages to be underestimated (see also **Figure 4.2 & 3**).

Some noticeable bias was seen for readers 2 and 3 (and partly reader 1 as well) regarding modal age 1 determinations (from IEO & IFREMER, -positive bias) and for readers 5 and 6 (from AZTI, negative bias) regarding modal age 2 determinations. These features imply production of older and younger age composition by these sub-group of readers in comparison with the others respectively (**Table 4.3**). In order to look for the reasons of these discrepancies, **Tables 4.6** and **4.7** present the summary results of CV, agreement and bias for the readers on the sets of otoliths for the first and second half of the year respectively:

- During the first half of the year (**Table 4.6**) the percentage of agreement is high (93%) and precision is high (CV low - 8.1%-) with a small amount of bias (0.03), only noticeable and negative for ages 3 and 4 (particularly for age 3 in readers 1 & 2). All readers (except nº2, have agreement with the modal age determination higher than 92%, and the overall best ranking readers are nº 5 and 6.
- During the second half of the year (**Table 4.7**) the percentage of agreement is lower (87.7%) and precision decreases (to 22.1 %) with a small amount of bias (0.04), but already noticeable since age 2. Still the overall best ranking is achieved by readers nº 5 and 6. The problems with the age 1 determinations for readers 2 and 3 (and partly for reader 1) originate here, as shown by the poor CV and percentage of agreement for these readers with the modal age 1. The bias for these readers on the determination of age 1 is positive. Nevertheless the highest among those biases (concerning reader 3) has no implications for the estimation of fishery catch at age statistics because this reader has no responsibilities in determination of age composition of catches for the second half of the year. Similarly the problems with the age 2 determinations for readers 5 and 6 (and partly 4) originate in the second half of the year, as shown by the poor CV and percentage of agreement for these readers with the modal age 2. The maximum biases at age 2 amount to about -0.38 and are due to readers 5 and 6 (AZTI readers). According to **Table 4.4** the major disagreements, CV and biases appear for age 1 and for age 2 from August to November, being maxima in the two last months. It can be concluded that therefore that the discrepancies between these two set of readers are probably quite

symmetrical, restricted the second half of the year and regarding the interpretation of a certain amount of otoliths in dispute whether they are of age 1 or 2. In **Table 4.8** it is shown that the otoliths in dispute between reader range between 8 and 30, which may double or halve the amount of age 2 for the second half of the year, with a lesser relative impact on age 1 (upper panel). The progression of mean length at age for readers 4, 5 and 6 seem to be more coherent than for readers 1 to 3 (for which differences between mean length at ages 1 and 2 during the second half of the year are minimal).

The potential bias that the above conflicting results on age determination may induce on the fishery statistics of catches at age seem to be fortunately not too relevant:
For the first half of the year, the age determination for the bulk of catches and for direct surveys are controlled by readers 4, 5 and 6 who show the better overall ranking (table 4.6). The small negative bias detected on ages 3 and 4 deserves however some review in order to achieve a better agreement between readers (and particularly for the first two readers, from IEO)
For the second half of the year, Reader 3 has no responsibility on the monitoring of the fishery. On the other hand, the amount of catches from August to October monitored by readers 1 and 2 and readers 5 and 6 are minor (jointly about 4% of the international catches). Nowadays, it is reader 4 (from IFREMER) the one who has the largest responsibilities in age determination of anchovy catches taken during the second half of the year, corresponding to about 25% of the international annual catches. This reader shows a bias of about -0.29 on age 2 determinations during the second half of the year, which would lead to increase in about 50% the amount of age 2 pointed out by readers 5 and 6 (AZTI) (table 4.8) in that period. This amount of age 2 is in addition still about 25% below the numbers at age 2 suggested by readers 1 and 2 (IEO) for the second half of the year.

The above results certainly reveal that the Institutes more heavily involved in the estimations of the age composition of catches and surveys are on average doing quite well, but they have still some noticeable discrepancies particularly for the oldest groups (3+) and for the for the second half of the year. These results stress the need of a workshop to clarify the source of discrepancy and improve the degree of precision and accuracy of age readings particularly for the second half of the year.

The ultimate reasons of these discrepancies have not yet been examined over individual otolith cases of disagreement and their examination are left for the next coming workshop.

5- Conclusions and improvements for the next coming workshop in 2006.

- The Average percentage of agreement (90.9 %) and CV (13.9%) are quite good and quite similar to the results achieved in the 2002 workshop (agreement of 92% with a CV of 10%)

- During the first half of the year the percentage of agreement is high (93%) and precision is high (CV low - 8.1%-) with a small amount of bias (0.03).

- For the first half of the year, the age determination for the bulk of catches and for direct surveys are controlled by readers 4, 5 and 6 who show the better overall ranking (table 4.6). There is only a small negative bias detected on ages 3 and 4 which deserves further discussion for the next workshop.

- During the second half of the year the percentage of agreement is lower (87.7%) and precision decreases (to 22%) with a small amount of bias (0.04), but already noticeable since age 2: there are two sets of readers symmetrically diverging during the second half of the year on the allocation of a certain amount of otoliths either to age 1 or 2.
- Depending on the correct reading of those otoliths the percentage in catches of the 2 years old could doubled or halved for the second half of the year.

- The ultimate reasons of these discrepancies have not yet been examined over individual otolith cases of disagreement and their examination are left for the next coming workshop.

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TABLES AND FIGURES :

Set of Table1 is seen as annex 1 of this report.
Annex 1 (**Table 4.1)** details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the Bay of Biscay region along with the ageing produced by each reader. The last two columns give the Modal age, the percent of agreement relative to Modal age and the Precision of reading as the Coefficient of Variation in relation to the average age.

See file Annex1.XLS

Table 4.2 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.

ANCHOVY exchange 2005 All set

This is NOT the Age composition of readings

NUMBER OF AGE READINGS

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	TOTAL
0	15	15	12	15	15	15	87
1	375	375	359	361	375	375	2220
2	83	83	81	75	83	83	488
3	32	32	32	31	32	32	191
4	4	4	4	3	4	4	23
5	-	-	-	-	-	-	-
Total 0-15	509	509	487	485	509	509	3008

COEFFICIENT OF VARIATION (CV) — **VS. Modal age**

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL Readers
0	0%	0%	181%	0%	0%	0%	49.0%
1	34%	52%	33%	21%	7%	9%	13.0%
2	19%	19%	16%	25%	23%	19%	13.5%
3	16%	24%	10%	14%	15%	13%	10.0%
4	0%	16%	13%	0%	13%	0%	9.1%
5	-	-	-	-	-	-	-
Weighted mean 0-15	29.4%	42.8%	32.3%	20.3%	10.2%	10.5%	13.9%
RANKING	4	6	5	3	1	2	

PERCENTAGE AGREEMENT — **VS. Modal age**

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	100%	100%	75%	100%	100%	100%	97%
1	93%	85%	84%	95%	99%	99%	93%
2	89%	90%	89%	80%	80%	86%	86%
3	88%	69%	91%	94%	81%	84%	84%
4	100%	50%	75%	100%	75%	100%	83%
5	-	-	-	-	-	-	-
Weighted mean 0-15	92.1%	85.1%	85.4%	92.8%	94.9%	96.1%	91.1%
RANKING	4	6	5	3	2	1	

RELATIVE BIAS — **BIAS RELATIVE TO MODAL AGE**

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	0.00	0.00	0.25	0.00	0.00	0.00	0.03
1	0.09	0.12	0.16	0.04	0.01	0.01	0.07
2	-0.02	-0.04	0.04	0.00	-0.13	-0.14	-0.05
3	-0.09	-0.25	-0.03	-0.10	-0.06	-0.03	-0.09
4	0.00	-0.50	-0.25	0.00	-0.25	0.00	-0.17
5	-	-	-	-	-	-	-
Weighted mean 0-15	0.06	0.06	0.13	0.03	-0.02	-0.02	0.04
RANKING	4	5	6	3	2	1	

Overall ranking

	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6
Ranking Coefficient of Variation	4	6	5	3	1	2
Ranking Percentage Agreement	4	6	5	3	2	1
Ranking Relative bias	4	5	6	3	2	1
OVERALL RANKING	4	6	5	3	2	1

	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	
Mean Ranking	4.00	5.67	5.33	3.00	1.67	1.33	
absolute value of the bias	0.06	0.06	0.13	0.03	0.02	0.02	

ANCHOVY exchange 2005 All set
Table 4.3

Upper table: The age compositions estimated by each age reader and all age readers combined.

Midle 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 bias   test.

AGE COMPOSITION

	Age	IEO-BV Reader 1	IEO-MB Reader2	REMER-P Reader 3	REMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	TOTAL
	0	16	32	9	16	15	15	103
	1	355	325	309	352	387	384	2112
	2	96	104	128	78	72	77	555
	3	34	39	38	35	30	27	203
	4	8	9	4	4	5	6	36
	5	-	-	-	-	-	-	-
Total	0-15	509	509	488	485	509	509	3009

MEAN LENGTH AT AGE

	Age	IEO-BV Reader 1	IEO-MB Reader2	REMER-P Reader 3	REMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
	0	131.9	143.6	127.8	131.0	130.3	130.3	134.6
	1	151.1	151.0	149.2	150.5	150.5	150.3	150.5
	2	166.0	166.7	164.6	168.1	173.4	172.6	168.0
	3	172.8	164.9	174.6	175.3	174.7	176.8	172.9
	4	157.9	153.4	167.5	181.0	179.8	179.8	167.1
	5	-	-	-	-	-	-	-
Weighted mean	0-15	154.9	154.9	155.0	154.7	154.8	154.8	154.9

Percentage of Agreement and Inter-reader bias test and reader against M

	IEO-BV Reader 1	IEO-MB Reader2	REMER-P Reader 3	REMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6
Reader 1		—	∗ ∗	—	∗ ∗	∗ ∗
Reader2	83.1%		—	—	∗ ∗	∗ ∗
Reader 3	81.1%	78.1%		∗ ∗	∗ ∗	∗ ∗
Reader 4	86.2%	81.9%	79.4%		∗ ∗	∗ ∗
Reader 5	87.8%	82.3%	81.6%	90.9%		—
Reader 6	88.8%	82.7%	82.0%	91.8%	97.6%	
MODAL age	∗ ∗	∗	∗ ∗	—	∗	—

Bias test signs	—	= no sign of bias (p>0.05)
	∗	= possibility of bias (0.01<p<0.05)
	∗ ∗	= certainty of bias (p<0.01)

ANCHOVY exchange 2005 All set

Table 4.4 Otoliths read, CV's, percentage agreement and RELATIVE bias by month and by MODAL age.

NUMBER OF OTOLITHS

MODAL age	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	-	-	-	-	-	-	-	-	-	-	15	-	**15**
1	-	-	-	37	131	46	27	52	25	27	30	-	**375**
2	-	-	-	26	18	13	3	8	4	3	8	-	**83**
3	-	-	-	5	18	1	-	-	1	-	7	-	**32**
4	-	-	-	2	2	-	-	-	-	-	-	-	**4**
5	-	-	-	-	-	-	-	-	-	-	-	-	**0**
TOTAL	0	0	0	70	169	60	30	60	30	30	60	0	**509**

COEFFICIENT OF VARIATION (CV)

MODAL age	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	-	-	-	-	-	-	-	-	-	-	49%	-	**49.0%**
1	-	-	-	9%	8%	4%	9%	13%	36%	28%	23%	-	**13.0%**
2	-	-	-	8%	13%	9%	7%	30%	8%	27%	22%	-	**13.5%**
3	-	-	-	11%	11%	14%	-	-	33%	-	2%	-	**10.0%**
4	-	-	-	12%	6%	-	-	-	-	-	-	-	**9.1%**
5	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mean CV Weighted	-	-	-	8.8%	8.8%	5.5%	9.2%	15.3%	32.6%	28.2%	27.1%	-	**13.9%**

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

PERCENTAGE AGREEMENT

MODAL age	1 Jan	2 Feb	3 Mar	4 Apr	5 May	6 Jun	7 Jul	8 Aug	9 Sep	10 Oct	11 Nov	12 Dec	Agree-ment
0	-	-	-	-	-	-	-	-	-	-	97%	-	**96.6%**
1	-	-	-	94%	96%	97%	93%	93%	82%	84%	84%	-	**92.7%**
2	-	-	-	92%	85%	91%	94%	72%	92%	72%	71%	-	**85.7%**
3	-	-	-	86%	80%	83%	-	-	67%	-	98%	-	**84.3%**
4	-	-	-	75%	91%	-	-	-	-	-	-	-	**82.6%**
5	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mean CV Weighted	-	-	-	92.3%	93.3%	95.4%	92.7%	90.4%	82.6%	83.2%	86.8%	-	**91.1%**

RELATIVE BIAS

MODAL age	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	-	-	-	-	-	-	-	-	-	-	0.03	-	**0.03**
1	-	-	-	0.07	0.06	0.03	0.06	0.05	0.04	0.17	0.16	-	**0.07**
2	-	-	-	0.01	0.05	0.01	-0.06	-0.21	-0.08	-0.28	-0.29	-	**-0.05**
3	-	-	-	-0.17	-0.07	-0.17	-	-	-0.50	-	-0.02	-	**-0.09**
4	-	-	-	-0.25	-0.09	-	-	-	-	-	-	-	**-0.17**
5	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mean Weighted	-	-	-	0.02	0.04	0.03	0.05	0.01	0.01	0.13	0.05	-	**0.04**

ANCHOVY exchange 2005 All set

Table 4.5   Otoliths read, CV's, percentage agreement and RELATIVE bias by stratum and MODAL age.

NUMBER OF OTOLITHS													
MODAL			**SAMPLING STRATA**										**Nr of**
age	semestre 1	semestre 2	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**otoliths**
0	-	15	-	-	-	-	-	-	-	-	-	-	**15**
1	214	161	-	-	-	-	-	-	-	-	-	-	**375**
2	57	26	-	-	-	-	-	-	-	-	-	-	**83**
3	24	8	-	-	-	-	-	-	-	-	-	-	**32**
4	4	-	-	-	-	-	-	-	-	-	-	-	**4**
5	-	-	-	-	-	-	-	-	-	-	-	-	**0**
TOTAL	**299**	**210**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**509**

COEFFICIENT OF VARIATION (CV)													
MODAL			**SAMPLING STRATA**										**Mean**
age	semestre 1	semestre 2	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**CV**
0	-	49%	-	-	-	-	-	-	-	-	-	-	**49.0%**
1	7%	21%	-	-	-	-	-	-	-	-	-	-	**13.0%**
2	10%	21%	-	-	-	-	-	-	-	-	-	-	**13.5%**
3	11%	6%	-	-	-	-	-	-	-	-	-	-	**10.0%**
4	9%	-	-	-	-	-	-	-	-	-	-	-	**9.1%**
5	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mean CV	**8.1%**	**22.1%**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**13.9%**

Weighted

PERCENTAGE AGREEMENT													
MODAL			**SAMPLING STRATA**										**Agree-**
age	semestre 1	semestre 2	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**ment**
0	-	97%	-	-	-	-	-	-	-	-	-	-	**96.6%**
1	96%	88%	-	-	-	-	-	-	-	-	-	-	**92.7%**
2	90%	77%	-	-	-	-	-	-	-	-	-	-	**85.7%**
3	81%	94%	-	-	-	-	-	-	-	-	-	-	**84.3%**
4	83%	-	-	-	-	-	-	-	-	-	-	-	**82.6%**
5	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mean CV	**93.5%**	**87.6%**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**91.1%**

Weighted

RELATIVE BIAS													
MODAL			**SAMPLING STRATA**										**Mean**
age	semestre 1	semestre 2	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**bias**
0	-	0.03	-	-	-	-	-	-	-	-	-	-	**0.03**
1	0.06	0.09	-	-	-	-	-	-	-	-	-	-	**0.07**
2	0.02	-0.21	-	-	-	-	-	-	-	-	-	-	**-0.05**
3	-0.10	-0.08	-	-	-	-	-	-	-	-	-	-	**-0.09**
4	-0.17	-	-	-	-	-	-	-	-	-	-	-	**-0.17**
5	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Mean	**0.03**	**0.04**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.04**

Weighted

Table 4.6 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.

ANCHOVY exchange 2005 SET A, B and C Semestre 1

This is NOT the Age composition of readings

NUMBER OF AGE READINGS

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	TOTAL
0	-	-	-	-	-	-	-
1	214	214	207	205	214	214	1268
2	57	57	55	51	57	57	334
3	24	24	24	23	24	24	143
4	4	4	4	3	4	4	23
5	-	-	-	-	-	-	-
Total 0-15	299	299	290	282	299	299	1768

COEFFICIENT OF VARIATION (CV) VS. Modal age

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL Readers
0	-	-	-	-	-	-	-
1	36%	48%	21%	18%	0%	10%	7.3%
2	21%	15%	19%	21%	15%	9%	10.0%
3	19%	25%	10%	14%	17%	16%	11.4%
4	0%	16%	13%	0%	13%	0%	9.1%
5	-	-	-	-	-	-	-
Weighted mean 0-15	31.5%	39.6%	19.5%	17.8%	4.4%	9.9%	8.1%
RANKING	5	6	4	3	1	2	

PERCENTAGE AGREEMENT VS. Modal age

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	-	-	-	-	-	-	-
1	94%	91%	97%	97%	100%	99%	96%
2	88%	91%	85%	84%	91%	96%	90%
3	83%	63%	92%	96%	75%	79%	81%
4	100%	50%	75%	100%	75%	100%	83%
5	-	-	-	-	-	-	-
Weighted mean 0-15	92.0%	88.0%	93.8%	94.3%	96.0%	97.0%	93.5%
RANKING	5	6	4	3	2	1	

RELATIVE BIAS BIAS RELATIVE TO MODAL AGE

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	-	-	-	-	-	-	-
1	0.09	0.16	0.04	0.03	0.00	0.01	0.06
2	0.00	0.02	0.04	0.14	-0.02	-0.04	0.02
3	-0.13	-0.25	0.00	-0.09	-0.08	-0.04	-0.10
4	0.00	-0.50	-0.25	0.00	-0.25	0.00	-0.17
5	-	-	-	-	-	-	-
Weighted mean 0-15	0.05	0.09	0.03	0.04	-0.01	-0.00	0.03
RANKING	5	6	3	4	2	1	

Overall ranking

	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6
Ranking Coefficient of Variation	5	6	4	3	1	2
Ranking Percentage Agreement	5	6	4	3	2	1
Ranking Relative bias	5	6	3	4	2	1
OVERALL RANKING	5	6	4	3	2	1

Table 4.7

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.

ANCHOVY exchange 2005 2nd Half of the Year

This is NOT the Age composition of readings

NUMBER OF AGE READINGS

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	TOTAL
0	15	15	12	15	15	15	87
1	161	161	152	156	161	161	952
2	26	26	26	24	26	26	154
3	8	8	8	8	8	8	48
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
Total 0-15	210	210	197	203	210	210	1240

COEFFICIENT OF VARIATION (CV) — VS. Modal age

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL Readers
0	0%	0%	181%	0%	0%	0%	49.0%
1	32%	56%	37%	25%	11%	8%	20.6%
2	14%	25%	10%	27%	35%	31%	21.1%
3	0%	26%	12%	12%	0%	0%	6.0%
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
Weighted mean 0-15	25.9%	47.4%	41.0%	22.6%	12.8%	9.8%	22.1%
RANKING	4	6	5	3	2	1	

PERCENTAGE AGREEMENT — VS. Modal age

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	100%	100%	75%	100%	100%	100%	97%
1	91%	78%	68%	93%	99%	99%	88%
2	92%	88%	96%	71%	54%	62%	77%
3	100%	88%	88%	88%	100%	100%	94%
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
Weighted mean 0-15	92.4%	81.0%	73.1%	90.6%	93.3%	94.8%	87.7%
RANKING	3	5	6	4	2	1	

RELATIVE BIAS — BIAS RELATIVE TO MODAL AGE

MODAL age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	0.00	0.00	0.25	0.00	0.00	0.00	0.03
1	0.09	0.07	0.33	0.06	0.01	0.01	0.09
2	-0.08	-0.15	0.04	-0.29	-0.38	-0.38	-0.21
3	0.00	-0.25	-0.13	-0.13	0.00	0.00	-0.08
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
Weighted mean 0-15	0.06	0.02	0.27	0.00	-0.04	-0.04	0.04
RANKING	5	2	6	1	3	4	

Overall ranking

	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6
Ranking Coefficient of Variation	4	6	5	3	2	1
Ranking Percentage Agreement	3	5	6	4	2	1
Ranking Relative bias	5	2	6	1	3	4
OVERALL RANKING	4	5	6	3	2	1

	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	
Mean Ranking	4.00	4.33	5.67	2.67	2.33	2.00	Drag these f
absolute value of the bias	0.06	0.02	0.27	0.00	0.04	0.04	number of a

ANCHOVY exchange 2005 2nd Half of the Year
Table 4.8

Upper table: The age compositions estimated by each age reader and all age readers combined.

Midle 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 bias   test.

AGE COMPOSITION

Age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	TOTAL
0	16	32	9	16	15	15	103
1	149	128	106	152	170	170	875
2	35	37	74	28	16	17	207
3	10	12	9	7	9	8	55
4	-	1	-	-	-	-	1
5	-	-	-	-	-	-	-
Total 0-15	210	210	198	203	210	210	1241

MEAN LENGTH AT AGE

Age	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6	ALL
0	131.9	143.6	127.8	131.0	130.3	130.3	134.6
1	158.4	157.9	157.0	157.4	157.3	157.3	157.6
2	160.1	164.0	160.6	168.5	172.5	173.2	164.1
3	184.0	178.7	187.7	189.7	189.4	190.0	185.9
4	-	145.0	-	-	-	-	145.0
5	-	-	-	-	-	-	-
Weighted mean 0-15	157.9	157.9	158.4	157.9	157.9	157.9	158.0

Percentage of Agreement and Inter-reader bias test and reader against M

	IEO-BV Reader 1	IEO-MB Reader2	FREMER-P Reader 3	FREMER-E Reader 4	AZTI-AU Reader 5	AZTI-IR Reader 6
Reader 1		—	* *	—	* *	* *
Reader2	80.0%		* *	—	—	—
Reader 3	72.2%	68.7%		* *	* *	* *
Reader 4	83.7%	75.4%	65.7%		—	—
Reader 5	85.7%	76.2%	66.2%	91.1%		—
Reader 6	87.1%	77.1%	67.2%	91.6%	98.6%	
MODAL age	*	—	* *	—	—	*

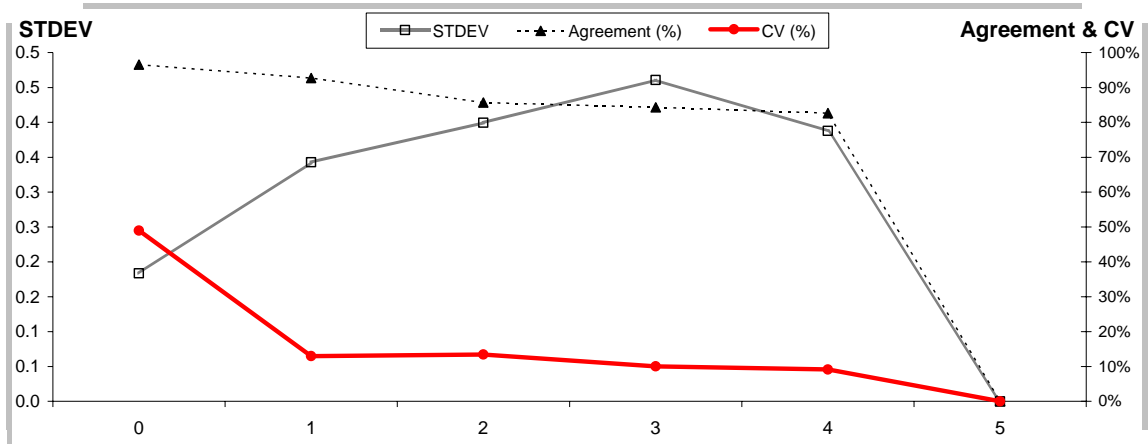| Bias test signs	—	= no sign of bias (p>0.05)
	*	= possibility of bias (0.01<p<0.05)
	* *	= certainty of bias (p<0.01)

Figure 4.1 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.
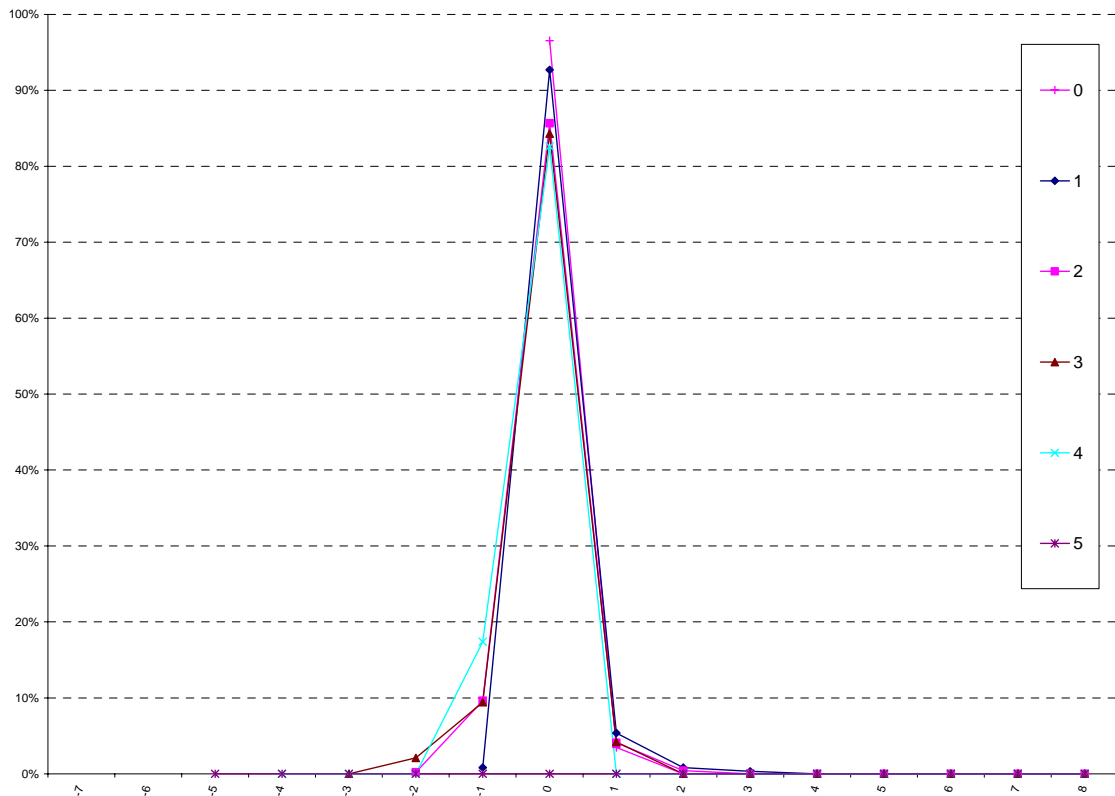
ANCHOVY exchange 2005 All set

Figure 4.2 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.
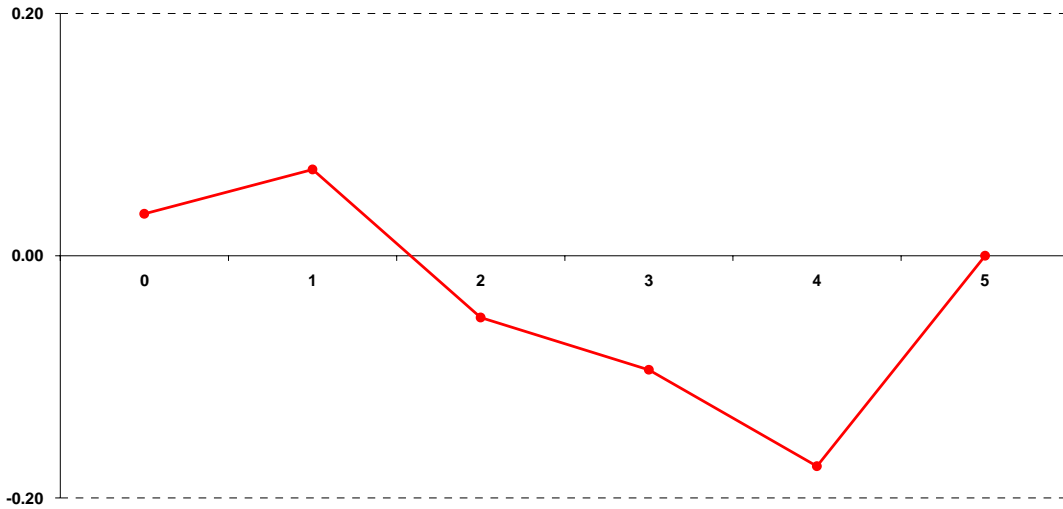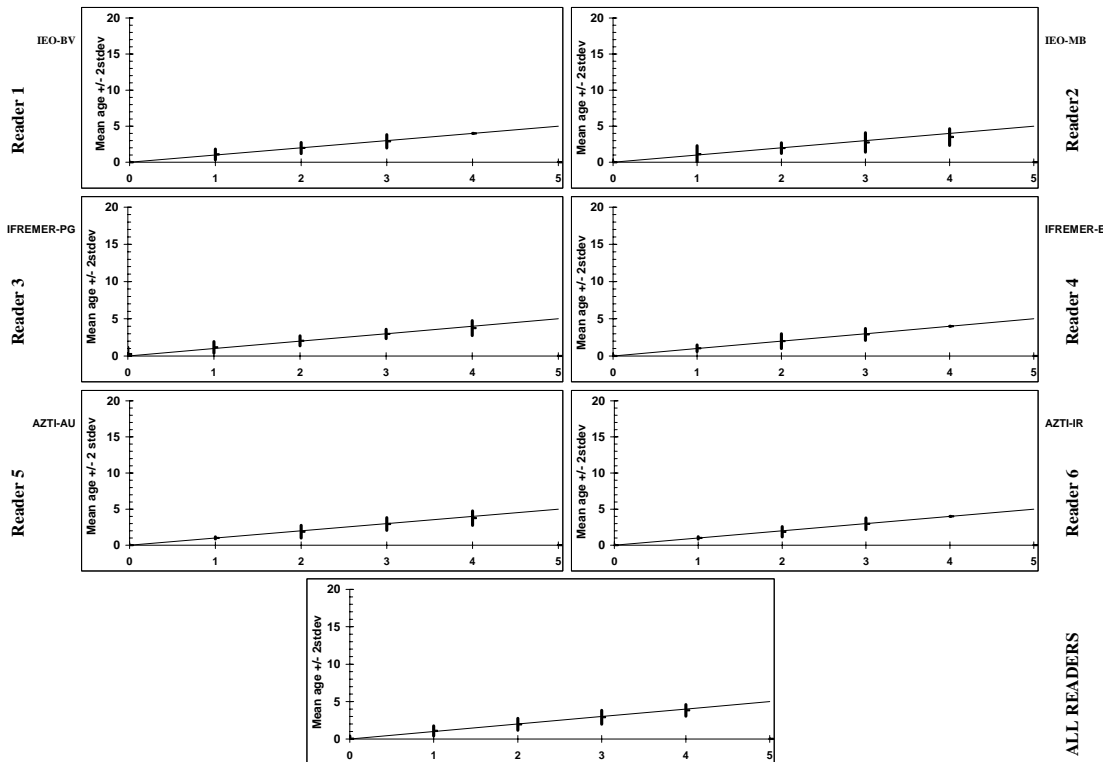
ANCHOVY exchange 2005 All set

Figure 4.3   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.

ANCHOVY exchange 2005 All set

Figure 4.4   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.
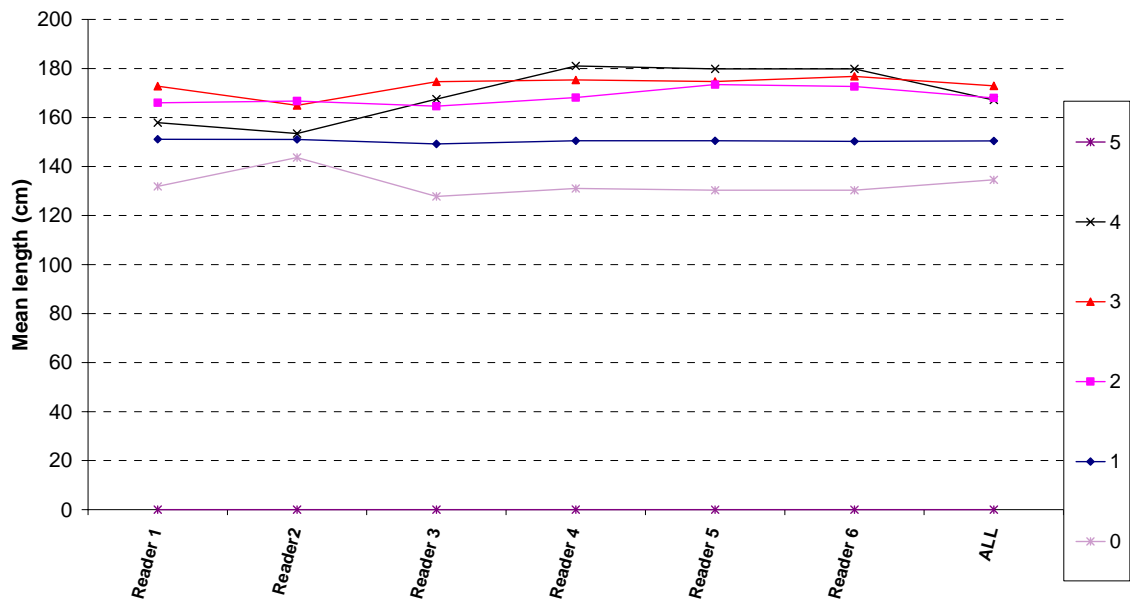
ANCHOVY exchange 2005 All set

Figure 4.5   The mean length at age as estimated by each age reader.