Working Document to ICES Workshop on Age reading of European anchovy (WKARA). Mazara del Vallo, Italy, 9–13 November 2009

RESULTS OF THE ANCHOVY OTOLITH EXCHANGE PROGRAMME FROM ATLANTIC AND MEDITERRANEAN AREAS

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1- INTRODUCTION

Exchanges, workshops and checks of the procedures for age determination of European anchovy otoliths in Atlantic areas have been made in the past in the Bay of Biscay (Astudillo et al 1990; Villamor and Uriarte, 1996; Uriarte, 2002a; Uriarte et al., 2002, 2006 and 2007) and the Gulf of Cadiz (Garcia, 1998; Uriarte et al., 2002). However, no proper exchanges or workshops on reading procedures of European anchovy otoliths have been held before in Mediterranean areas.

The Planning Group on the Commercial Catch, Discards and Biological Sampling (PGCCDBS) meeting in March 2008 identified anchovy as one of the species requiring confirmation of the ages being assigned by Fisheries Institutes. The planning group indicated that a workshop on anchovy should be organized in 2009.

Before a workshop on age reading is held, the convenience of organizing an anchovy otolith exchange programme is considered in order to ascertain the current level of precision among institutes and the difficulties presented by the age reading of anchovy otoliths. The results of the workshop should serve as starting input for the Workshop on anchovy age reading. For this reason an anchovy otolith exchange programme was

organized by the IEO between May and October 2009 in advance of the workshop on anchovy age determination to be held in Mazara del Vallo (Italy), 9-13 November.

This paper presents the results of the anchovy otolith exchange programme coordinated by the IEO from May to October 2009.

2- OBJECTIVES

The exchange programme pursued the following common objectives for all areas, Subarea VIII (Bay of Biscay), Division IXa (Gulf of Cadiz), North of Morocco, Alboran Sea, Strait of Sicily, Adriatic Sea and Gulf of Lyon (Although the analysis was done separately by area):

1- To evaluate the current precision in anchovy otolith age reading among readers of the fishery and survey samples throughout the year .
2- To identify major difficulties in anchovy otolith interpretation for age determination concerning observed disagreements (otolith edge recognition and/or identification of true rings or checks).
3- To report results to the Workshop on anchovy age determination to take place in November in order to facilitate discussions and progress of work.

3- MATERIAL AND METHODS

3.1 PARTICIPANTS AND QUALIFICATION OF READERS

15 readers with different levels of experience of anchovy otolith reading participated in the otolith exchange, from different research institutions from France, Spain, Portugal and Italy and from the different areas concerned (Tables 3.1.1). These differences may to some extent explain some of the reasons for the differing degrees of agreement among readers. Annex 1 to this report details the full identification of the participants.

Table 3.1.1. The names of the exchange participants with reader's identification (ID), their associated institution/laboratory, country, level of experience of anchovy ageing and areas where they have experience.

Name	Institute/Laboratory	Country	Reader ID	Anchovy Experience	Stock/Area of expertise
Iñaki Rico (IR)	AZTI/ San Sebastian	Spain	R1	**	Bay of Biscay (Subarea VIII)
Erwan Duhamel (ED)	IFREMER/ Lorient	France	R2	**	Bay of Biscay (Subarea VIII)
Clara Dueñas (CD)	IEO/ Santander	Spain	R3	*	Bay of Biscay (Subarea VIII)
Charo Navarro (CN)	IEO/ Santander	Spain	R4	*	Bay of Biscay (Subarea VIII)
Milagros Millán (MM)	IEO/ Cadiz	Spain	R5	**	Gulf of Cadiz (IXa South)
Jorge Tornero (JT)	IEO/ Cadiz	Spain	R6	*	Gulf of Cadiz (IXa South)
Eduardo Soares (ES)	IPIMAR/Lisbon	Portugal	R7	*	Gulf of Cadiz (IXa South) and Portugal area (IXa C-CN)
Delfina Morais (DM)	IPIMAR/Lisbon	Portugal	R8	*	Gulf of Cadiz (IXa South) and Portugal area (IXa C-CN)
Ana Giraldez (AG)	IEO/ Málaga	Spain	R9	**	Alboran Sea
Pedro Torres (PT)	IEO/ Málaga	Spain	R10	**	Alboran Sea
Jean-Herve Bourdeix (JB)	IFREMER/ Sète	France	R11	*	Gulf of Lion
David Roos (DR)	IFREMER/ Sète	France	R12	*	Gulf of Lion
Walter Basilone (WB)	IAMC-CNR/ Sicily	Italy	R13	**	Strait of Sicily
Fortunata Donato (FD)	ISMAR-CNR/ Ancona	Italy	R14	**	North Adriatic Sea
Tomaz Modic (TM)	ZZRS	Slovenia	R15	*	North Adriatic Sea

**Experienced reader (>4 years)
* Early reader (<=4 years)

Seven readers (** in Table 3.1.1) were considered experienced for purposes of anchovy age reading (>4 years) comparison. The remainder were considered early readers (<= 4 years) (* in Table 3.1.1), although within this category there are readers with different levels of experience in anchovy otolith reading, from 3 years, such as readers R3 and R15, to none, such as readers R7, R8 and R12, the latter group of readers being involved in anchovy otolith reading for the first time. Table 3.1.1 also shows that stock/areas where readers are regularly involved in this activity and some of them (R1, R2, R3, R5, R10, R11, R13, R14 and R15) are responsible for the preparation of anchovy age-length keys (ALK) used in stock assessment in their respective countries.

3.2 SETS OF OTOLITHS

280 otoliths were analysed for age assignment, distributed in 7 sets from different anchovy distribution areas (Figure 3.2.1)**.**

The definitive adopted sets of otoliths were as follows:

SET A) OTOLITHS FROM THE BAY OF BISCAY. IEO-Santander supplied 40 otoliths mounted in Eukitt:

- 20 otoliths from the first half of the year in April-May 2006 (Length range: 105-180 mm)
- 20 otoliths from the second half of the year in September-October 2006 (Length range: 105-181 mm)

SET B) OTOLITHS FROM GULF OF CADIZ. IEO-Cadiz supplied 40 otoliths mounted in Eukitt:

- 20 otoliths from the first half of the year in January-June 2007 (Length range: 84- 161 mm)
- 20 otoliths from the second half of the year in July-November 2007 (Length range: 72- 180 mm)

SET C) OTOLITHS FROM NORTH OF MOROCCO. IEO- Cadiz supplied 40 otoliths: Otoliths mounted in Eukitt.

- 20 otoliths from the first half of the year in January-June 1997 (Length range: 101- 167 mm)
- 20 otoliths from the second half of the year in July-December 1997 (Length range: 87- 166 mm)

SET D) OTOLITHS FROM ALBORAN SEA. IEO-Málaga supplied 40 otoliths mounted in Eukitt.

- 20 otoliths from the first half of the year in February-May 2007 (Length range: 125- 165 mm)
- 20 otoliths from the second half of the year in August-September 2007 (Length range: 124 – 182 mm)

SET E) OTOLITHS FROM ADRIATIC SEA. ZZRS (Slovenia) and ISMAR-CNR (Ancona, Italy) supplied 40 otoliths kept dry in small tubes.

- ISMAR-CNR: 20 otoliths from the first half of the year in January-May 2008 (Length range: 105-140 mm)
- ZZRS: 20 otoliths from the first half of the year in June (Length range: 117- 147 mm)

The sample from the Adriatic Sea was divided in two:

SET E-1 Otoliths mounted in Eukitt

SET E-2 Otoliths in alcohol.

SET F) OTOLITHS FROM STRAIT OF SICILY. Otoliths from the Strait of Sicily could not be supplied for the exchange. They will be supplied in the workshop.

SET G) OTOLITHS FROM GULF OF LYON. IFREMER-Sète, supplied 40 otoliths mounted in Eukitt.

- 20 otoliths from the first half of the year in March-April 2009 (Length range: 105- 125 mm)
- 20 otoliths from the second half of the year in July 2008 (Length range: 150- 165 mm)

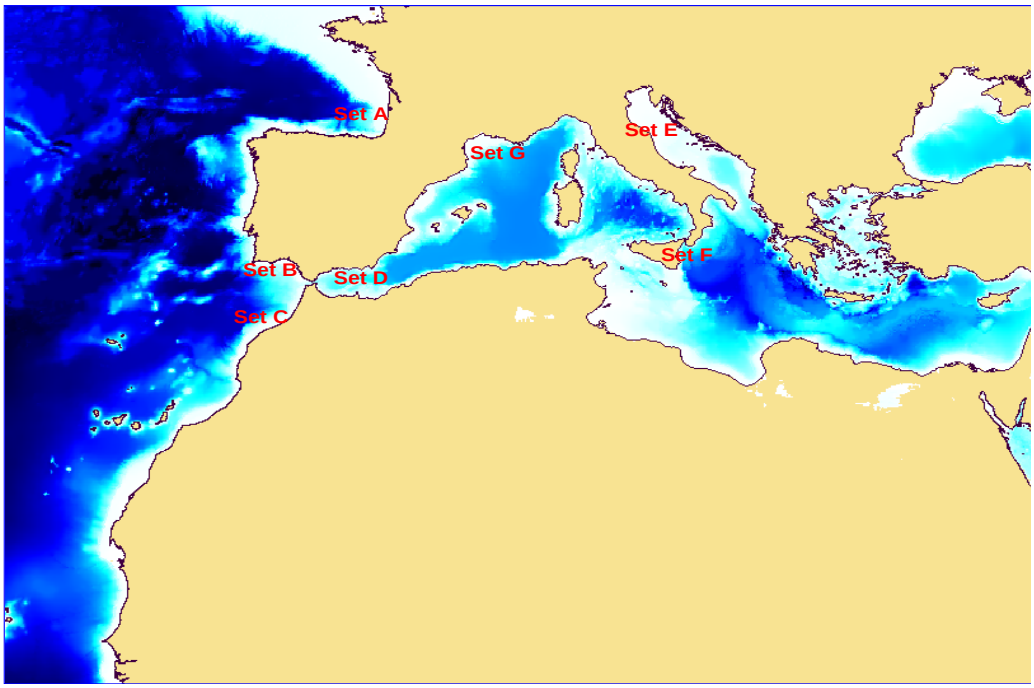

Figure 3.2.1: Collection areas of 2009 otolith exchange sample sets

Table 3.2.1 shows the samples analysed by each reader.

Table 3.2.1- List of age readers and samples analysed

Name	Reader ID	Set A	Set B	Set C	Set D	Set E-1	Set E-2	Set G
Iñaki Rico (IR)	R1	√	√	√	√	√	√	√
Erwan Duhamel (ED)	R2	√	√	√	√	√	-	√
Clara Dueñas (CD)	R3	√	√	√	√	√	√	√
Charo Navarro (CN)	R4	√	√	√	√	√	√	√
Milagros Millán (MM)	R5	√	√	√	√	√	√	√
Jorge Tornero (JT)	R6	√	√	√	√	√	√	√
Eduardo Soares (ES)	R7	√	√	√	√	√	√	√
Delfina Morais (DM)	R8	√	√	√	√	√	√	√
Ana Giraldez (AG)	R9	√	√	√	√	√	-	√
Pedro Torres (PT)	R10	√	√	√	√	√	-	√
Jean-Herve Bourdeix (JB)	R11	√	√	√	√	√	-	√
David Roos (DR)	R12	√	-	-	-	-	-	√
Walter Basilone (WB)	R13							
Fortunata Donato (FD)	R14	√	√	√	√	√	√	√
Tomaz Modic (TM)	R15	√	√	√	√	√	√	√

3.3 PREPARATION OF THE SETS OF OTOLITHS.

Institutes use different methods of sample preparation and reading techniques in anchovy ageing. Some institutes mount entire otoliths in Eukitt on black slides before examining them under reflected light, while others examine the whole otolith in alcohol. As far as possible the preparation methods chosen for the exchange sample sets were those the participants were most familiar with.

In order to compare otolith preparation methods, the sample from the Adriatic Sea was divided in two: E-1) the left otolith mounted in Eukitt and E-2) the right otolith kept dry in small tubes to be examined in alcohol.

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

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

And for each selected otolith the information available was:

- the identification code of the slide where it is contained
- month of capture
- length, weight, sex and maturity.

3.4 AGE DETERMINATION PROCEDURES

Each reader received forms to fill in with length and maturity data in Excel files. We recommended reading the otoliths without regarding length, but if the reader usually does take length into account or is unfamiliar with the sets of otoliths and/or the otolith is particularly difficult, then the reader may want to have a look at the size of the specimen.

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.
- Presence of checks in the 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. 15 will indicate the presence of a check placed at about 50% of 1 year old suspected growth, etc. This is the way of naming checks in Bay of Biscay anchovy (Uriarte, 2002b).
- Remarks such as, whether length was used to help age determination (by putting the word "Length"); Any other comments, such as reason for difficulties etc.

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

Minimum knowledge for age determination is:

a) Conventional birth dates for increasing by one year the age of an anchovy, when trespassing that date, is **1st of January** for Atlantic areas, Bay of Biscay, Gulf of Cadiz and North of Morocco (Sets A, B and C) and for Gulf of Lyon (Set G). Nevertheless, it is **1st of June** for Adriatic Sea (Sets E-1 and E-2) and **1st of July** for Alboran Sea (Set D) and Strait of Sicily (Set F).
b) Spawning time is usually in spring for Atlantic areas and in spring-summer for Mediterranean areas. 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).

3.5 DIGITISED IMAGES

Digitised images were also sent in the exchange corresponding to the otoliths of each set and properly identified. This is an excellent method of checking how each individual reader arrives at their estimated age because each reader assigns the annual images according to their own interpretation, to be discussed in the workshop. It is also a good method of establishing a reference collection of anchovy otoliths.

All readers were asked to mark each annual ring on each digitised image. To mark the annual rings in images, we used the program Paint Shop Pro. Instructions on using Paint Shop Pro were provided in the protocol of 2009 Anchovy Otolith Exchange (Annex 1). It was strongly recommended to mark the images at the time of reading the otolith under the microscope.

3.6 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)

4- RESULTS

The preparation of the sets of otoliths and submission to the coordinator was completed during June 2009 and the exchange programme was completed by the end of October. This report presents the results of all readers, except those of reader R13 (from Laboratory of Sicily), due to lack of time for the analysis following a delay at the end of the exchange.

4.1. Readability of the otoliths

Overall, 43% of the otoliths from sets A-E and G, covering the Atlantic area between the Bay of Biscay and North of Morocco and Mediterranean have medium readability while 39% and 18% were considered good and difficult, respectively (Table 4.1.1). Samples from the northern Atlantic areas, Bay of Biscay (set A), have the clearest structure with high percentages of good otoliths (51%). The structure of otoliths is more complex in the Gulf of Cadiz (set B) and Alboran Sea (set D) where 26 % and 27% of the otoliths were considered difficult respectively.

Otoliths at age 2 present less clear structures in all areas except in the Gulf of Lyon (set G), where otoliths at age 1 are more difficult (Figure 4.1.1).

Table 4.1.1. Otolith readability (%) by Set and Total.

Percentages

Readability	Set A	Set B	Set C	Set D	Set E-1	Set E-2	Set G	TOTAL
Good	51	29	42	33	37	38	42	39
Medium	35	45	43	40	47	51	42	43
Difficult	14	26	15	27	16	11	16	18

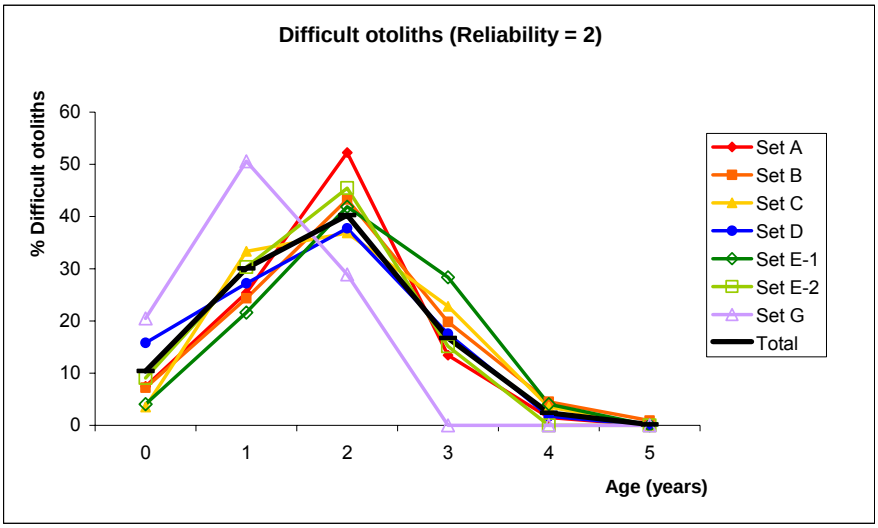

Figure 4.1.1. Percentage of difficult otoliths by age group by sets and in all data pooled.

4.2 SET A: Results on Otoliths from the Bay of Biscay

4.2.1. All readers

Table 4.2.1.1 details length, sex and month of landing of the set of otoliths selected for the exchange programme from the Bay of Biscay region (set A) along with the ageing produced by each reader. The last two columns give modal age, the percentage of agreement relative to modal age and precision of reading as the coefficient of variation in relation to the average age.

The average percentage of agreement across all ages and readers in this set is 72.2 % and the average CV equals 85%, with higher values in the youngest groups (201% at age 0 and

43 % at age 1) (Table 4.2.1.2). The pattern of precision with age was variable among readers (Table 4.2.1.3). Mean agreement with the modal age decreased from 77% at age 0 to 46% at age 3 (Table 4.2.1.2).

From age bias plots (Figure 4.2.1.1) it was observed that among all readers, R1, R2, and R5, were some of those that showed less biased readings. In general, all readers showed a trend to overestimate the younger fish and underestimate the older ages (age 3).

Among experienced readers, agreement varied from 47% (R2-14) to 95% (R1-R5) (Table 4.2.2.4). Among these readers, R14 showed signs of bias in all cases of inter-reader bias test (versus R1, R2, R5, R9 and R10). Readers against modal age showed percentage values of agreement ranging from 57% (R14) to 93% (R1, R2 and R5) (Table 4.2.2.4). All experienced readers except R14 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 7.5% (R7) to 92% (R11). Readers R3, R4, R6 , R11 and R12 showed no signs of bias against modal age.

Table 4.2.1.1. **Anchovy Otolith SET A_Bay of Biscay** (All readers)

Stratum	year	Sample no	Fish no	Fish length	Sex	Landing month	Spain VR Reader 1	France EG Reader 2	Spain CO Reader 3	Spain CA Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy_Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	MODAL age	Percent agreement	Precision CV
Semester 1	2006	IEO-BB 1	1	108.0	M	4	1	1	1	2	1	1	2	2	1	1	1	1	-	2	1	1	71%	36%
Semester 1	2006	IEO-BB 1	2	109.0	M	4	1	1	1	2	1	1	3	2	1	1	1	1	-	1	1	1	79%	48%
Semester 1	2006	IEO-BB 1	3	180.0	F	4	2	3	2	2	2	2	3	2	3	3	2	2	-	2	4	2	64%	27%
Semester 1	2006	IEO-BB 1	4	151.0	F	4	2	2	2	2	2	2	2	2	2	2	2	2	-	2	3	2	93%	13%
Semester 1	2006	IEO-BB 1	5	107.0	M	4	1	1	1	1	1	1	3	2	1	1	1	1	-	1	1	1	86%	48%
Semester 1	2006	IEO-BB 1	6	119.0	F	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	3	1	79%	48%
Semester 1	2006	IEO-BB 1	7	105.0	M	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	2	1	79%	35%
Semester 1	2006	IEO-BB 1	8	142.0	M	4	2	2	2	2	2	2	3	2	2	2	2	2	-	2	2	2	93%	13%
Semester 1	2006	IEO-BB 1	9	128.0	F	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	2	1	79%	35%
Semester 1	2006	IEO-BB 1	10	139.0	M	4	2	2	3	2	2	2	3	2	2	2	2	2	-	2	3	2	79%	19%
Semester 1	2006	IEO-BB 2	11	158.0	F	5	2	2	2	2	2	1	2	2	1	2	2	2	-	2	2	2	86%	20%
Semester 1	2006	IEO-BB 2	12	132.0	F	5	1	1	1	1	1	1	2	3	1	1	1	1	-	1	3	1	79%	55%
Semester 1	2006	IEO-BB 2	13	121.0	F	5	1	1	1	1	1	1	2	2	1	1	1	1	-	-	2	1	77%	36%
Semester 1	2006	IEO-BB 2	14	145.0	M	5	2	2	2	2	2	2	3	2	2	2	2	2	-	2	2	2	93%	13%
Semester 1	2006	IEO-BB 2	15	147.0	M	5	2	2	2	2	2	2	3	2	1	2	2	2	-	2	3	2	79%	23%
Semester 1	2006	IEO-BB 2	16	140.0	M	5	2	3	1	1	2	2	3	2	2	2	2	2	-	2	3	2	64%	30%
Semester 1	2006	IEO-BB 2	17	136.0	F	5	2	2	2	4	2	2	4	2	2	2	3	2	-	2	2	2	79%	32%
Semester 1	2006	IEO-BB 2	18	135.0	F	5	3	3	3	2	2	2	3	3	2	2	3	2	-	2	2	2	57%	21%
Semester 1	2006	IEO-BB 2	19	175.0	F	5	3	3	1	1	3	3	2	3	1	2	-	2	-	2	3	3	46%	37%
Semester 1	2006	IEO-BB 2	20	165.0	F	5	1	1	1	1	1	1	3	2	1	1	1	1	-	-	3	1	77%	55%
Semester 2	2006	IEO-BB 3	21	105.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	1	0	0	79%	199%
Semester 2	2006	IEO-BB 3	22	111.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	-	0	0	85%	244%
Semester 2	2006	IEO-BB 3	23	105.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	1	0	0	79%	199%
Semester 2	2006	IEO-BB 3	24	118.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	-	2	0	77%	205%
Semester 2	2006	IEO-BB 3	25	110.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	1	0	0	79%	199%
Semester 2	2006	IEO-BB 3	26	114.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	1	1	0	71%	164%
Semester 2	2006	IEO-BB 3	27	105.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	-	0	0	85%	244%
Semester 2	2006	IEO-BB 3	28	116.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	-	0	0	85%	244%
Semester 2	2006	IEO-BB 3	29	114.0	I	10	0	0	0	0	0	0	1	1	0	0	0	0	-	1	0	0	79%	199%
Semester 2	2006	IEO-BB 3	30	141.0	I	10	0	0	0	0	1	1	1	1	0	0	0	0	-	-	2	0	62%	143%
Semester 2	2006	IEO-BB 4	31	158.0	F	10	1	2	2	1	1	1	2	2	2	2	2	2	-	-	3	2	62%	34%
Semester 2	2006	IEO-BB 4	32	181.0	F	10	1	1	1	1	1	1	2	2	1	2	1	2	-	2	2	1	57%	36%
Semester 2	2006	IEO-BB 4	33	156.0	F	10	1	2	1	2	1	1	3	3	2	2	2	2	-	2	2	2	57%	36%
Semester 2	2006	IEO-BB 4	34	130.0	M	10	0	0	0	0	0	0	2	1	0	0	0	0	-	1	0	0	79%	214%
Semester 2	2006	IEO-BB 4	35	126.0	F	10	0	0	0	0	0	0	1	1	0	0	0	0	-	1	1	0	71%	164%
Semester 2	2006	IEO-BB 4	36	165.0	F	10	1	1	1	1	1	1	2	2	2	2	1	1	-	3	3	1	57%	48%
Semester 2	2006	IEO-BB 4	37	170.0	M	10	1	1	1	1	1	1	2	2	2	2	1	1	-	3	3	1	57%	48%
Semester 2	2006	IEO-BB 4	38	159.0	F	10	1	1	1	3	1	1	3	3	2	2	2	2	-	2	3	1	36%	43%
Semester 2	2006	IEO-BB 4	39	160.0	F	10	1	1	2	1	1	1	2	2	2	-	1	2	-	-	2	1	50%	35%
Semester 2	2006	IEO-BB 4	40	156.0	M	10	1	1	2	2	1	1	3	2	1	-	1	2	-	-	2	1	50%	42%
						Total read	40	40	40	40	40	40	40	40	40	38	39	40	0	30	40		72.2%	84.5%
						Total NOT read	0	0	0	0	0	0	0	0	0	2	1	0	40	10	0			

Table 4.2.1.2. **Anchovy Otolith SET A_Bay of Biscay** (All readers). Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	12	201.4	77	0.25
1	15	43.2	68	0.4
2	12	23.3	75	0.11
3	1	-	46	-0.77
4	0	-	-	-
5	0	-	-	-
Total	**40**	**84.5**	**72.4**	**0.24**

Table 4.2.1.3. Anchovy Otolith SET A_Bay of Biscay (All readers). The number of age readings, the coefficient of variation (CV), the percentage agreement and RELATIVE bias are presented by MODAL age for each age reader and for all readers combined.

Anchovy Otolith SET A_Bay of Biscay (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
	0	12	12	12	12	12	12	12	12	12	12	12	12	-	7	12	163
	1	15	15	15	15	15	15	15	15	15	13	15	15	-	11	15	204
	2	12	12	12	12	12	12	12	12	12	12	12	12	-	11	12	167
	3	1	1	1	1	1	1	1	1	1	1	-	1	-	1	1	13
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	40	40	40	40	40	40	40	40	40	38	39	40	0	30	40	547

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
	0	0%	0%	0%	0%	346%	346%	27%	0%	0%	0%	0%	0%	-	0%	160%	201.4%
	1	0%	0%	31%	46%	0%	0%	21%	16%	36%	37%	24%	36%	-	49%	35%	43.2%
	2	27%	20%	30%	37%	21%	26%	20%	18%	27%	14%	18%	0%	-	0%	26%	23.3%
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	8.1%	6.0%	20.7%	28.4%	110.3%	111.7%	21.9%	11.6%	21.6%	16.9%	14.8%	13.6%		18.1%	68.8%	84.5%
	RANKING	2	1	8	11	13	14	10	3	9	6	5	4		7	12	

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	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	100%	100%	100%	100%	92%	92%	0%	0%	100%	100%	100%	100%	-	0%	67%	77%
	1	100%	100%	87%	73%	100%	100%	0%	0%	73%	69%	93%	73%	-	55%	20%	68%
	2	75%	75%	67%	75%	83%	75%	25%	83%	75%	92%	83%	100%	-	100%	50%	75%
	3	100%	100%	0%	0%	100%	100%	0%	100%	0%	0%	-	0%	-	0%	100%	46%
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	92.5%	92.5%	82.5%	80.0%	92.5%	90.0%	7.5%	27.5%	80.0%	84.2%	92.3%	87.5%		56.7%	45.0%	72.4%
	RANKING	1	1	8	9	1	5	14	13	9	7	4	6		11	12	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	0.00	0.00	0.00	0.00	0.08	0.08	1.08	1.00	0.00	0.00	0.00	0.00	-	1.00	0.50	0.25
	1	0.00	0.00	0.13	0.33	0.00	0.00	1.33	1.13	0.27	0.31	0.07	0.27	-	0.64	1.20	0.40
	2	-0.08	0.25	0.00	0.00	-0.17	-0.25	0.83	0.17	-0.08	0.08	0.17	0.00	-	0.00	0.58	0.11
	3	0.00	0.00	-2.00	-2.00	0.00	0.00	-1.00	0.00	-2.00	-1.00	-	-1.00	-	-1.00	0.00	-0.77
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	-0.03	0.08	-0.00	0.08	-0.03	-0.05	1.05	0.78	0.03	0.11	0.08	0.08		0.43	0.78	0.24
	RANKING	2	8	1	6	4	5	14	12	3	10	9	6		11	13	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
anking Coefficient of Variation	2	1	8	11	13	14	10	3	9	6	5	4		7	12
anking Percentage Agreement	1	1	8	9	1	5	14	13	9	7	4	6		11	12
Ranking Relative bias	2	8	1	6	4	5	14	12	3	10	9	6		11	13
OVERALL RANKING	1	2	4	10	5	9	14	11	7	8	5	3		12	13

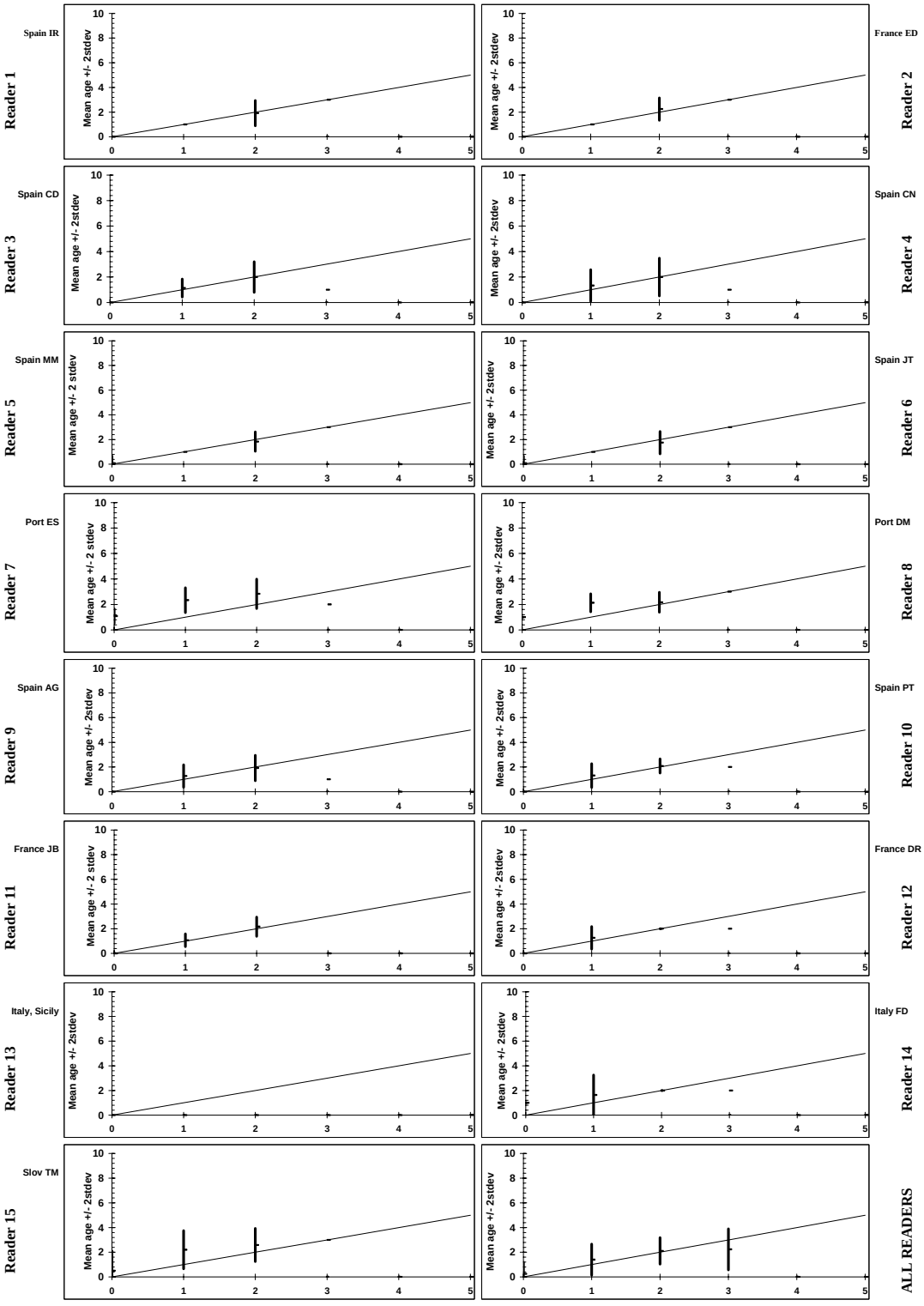

Figure 4.2.1.1. Anchovy Otolith SET A_Bay of Biscay (All readers). Age bias plots.

Table 4.2.1.4. **Anchovy Otolith SET A_Bay of Biscay (All readers)**. Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	92.5	–	–	–	–	–	**	**	–	–	–	–		**	**
Reader 2	90.00%	92.5	–	–	–	–	**	**	–	–	–	–		*	**
Reader 3	84.50%	82.50%	82.5	–	–	–	**	**	–	–	–	–		**	**
Reader 4	77.50%	75.00%	77.50%	80	–	–	**	**	–	–	–	–		–	**
Reader 5	95.00%	85.00%	80.00%	77.50%	92.5	–	**	**	–	–	–	–		**	**
Reader 6	92.50%	82.50%	77.50%	75.00%	97.50%	90	**	**	–	–	–	–		**	**
Reader 7	7.50%	15.00%	15.00%	12.50%	7.50%	5.00%	7.5	*	**	**	**	**		**	–
Reader 8	27.50%	25.00%	27.50%	27.50%	27.50%	25.00%	65.00%	27.5	**	**	**	**		*	–
Reader 9	72.50%	77.50%	72.50%	67.50%	72.50%	75.00%	15.00%	25.00%	80	–	–	–		**	**
Reader 10	76.30%	81.60%	73.70%	71.10%	76.30%	73.70%	21.10%	31.60%	89.50%	84.2	–	–		*	**
Reader 11	89.70%	89.70%	82.10%	79.50%	84.60%	82.10%	10.30%	25.60%	79.50%	81.60%	92.3	–		*	**
Reader 12	80.00%	80.00%	82.50%	77.50%	80.00%	77.50%	15.00%	32.50%	80.00%	92.10%	87.20%	87.5		**	**
Reader 13															
Reader 14	50.00%	46.70%	43.30%	50.00%	53.30%	50.00%	36.70%	60.00%	50.00%	63.30%	53.30%	66.70%		56.7	–
Reader 15	40.00%	45.00%	45.00%	40.00%	42.50%	40.00%	32.50%	37.50%	42.50%	47.40%	38.50%	50.00%		43.40%	45.0
MODAL age	–	–	–	–	–	–	**	**	–	–	–	–		**	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
**	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.2.2. Bay of Biscay readers

Set A was also analysed with only the readers involved in Bay of Biscay anchovy (R1-AZTI, R2-IFREMER, R3-IEO and R4-IEO) in order to compare with other otolith exchanges and workshops previously held.

The average percentage of agreement across all ages and Bay of Biscay readers in this set is 88.8 % and the average CV equals 12.9%, with higher values in the older group (38% at age 3) (Tables 4.2.2.1 & 4.2.2.2).). CV is minimum at age 0 and increases slightly with age and the percentage of agreement diminishes with age. Mean agreement with the modal age decreases from 100% at age 0 to 63% at age 3 (Table 4.2.2.2). Relative bias indicates that older ages tend to be underestimated (Tables 4.2.2.2 & 4.2.2.3). This phenomenon is particularly relevant for readers R3 and R4, as also shown in Figure 4.2.2.1. This feature implies the production of a younger age composition by these readers in comparison with the others.

From age bias plots (Figure 4.2.2.1) it was observed that among all readers R1 was the one who showed the least biased readings.

Agreement varied from 75% (R2-R4) to 90% (R1-R2) (Table 4.2.2.4). These readers showed no signs of bias in all cases of the inter-reader bias test. Readers against modal age showed percentage values of agreement ranging from 80% (R4) to 98% (R1) (Table 4.2.2.4). No readers showed any sign of bias against modal age.

Table 4.2.2.1. **Anchovy Otolith SET A_Bay of Biscay** (Bay of Biscay readers)

Stratum	Sample year	Sample no	Fish no	Fish length	Sex	Landing month	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	MODAL age	Percent agreement	Precision CV
Semester 1	2006	IEO-BB 1	1	108.0	M	4	1	1	1	2	1	75%	40%
Semester 1	2006	IEO-BB 1	2	109.0	M	4	1	1	1	2	1	75%	40%
Semester 1	2006	IEO-BB 1	3	180.0	F	4	2	3	2	2	2	75%	22%
Semester 1	2006	IEO-BB 1	4	151.0	F	4	2	2	2	2	2	100%	0%
Semester 1	2006	IEO-BB 1	5	107.0	M	4	1	1	1	1	1	100%	0%
Semester 1	2006	IEO-BB 1	6	119.0	F	4	1	1	1	1	1	100%	0%
Semester 1	2006	IEO-BB 1	7	105.0	M	4	1	1	1	1	1	100%	0%
Semester 1	2006	IEO-BB 1	8	142.0	M	4	2	2	2	2	2	100%	0%
Semester 1	2006	IEO-BB 1	9	128.0	F	4	1	1	1	1	1	100%	0%
Semester 1	2006	IEO-BB 1	10	139.0	M	4	2	2	3	2	2	75%	22%
Semester 1	2006	IEO-BB 2	11	158.0	F	5	2	2	2	2	2	100%	0%
Semester 1	2006	IEO-BB 2	12	132.0	F	5	1	1	1	1	1	100%	0%
Semester 1	2006	IEO-BB 2	13	121.0	F	5	1	1	1	1	1	100%	0%
Semester 1	2006	IEO-BB 2	14	145.0	M	5	2	2	2	2	2	100%	0%
Semester 1	2006	IEO-BB 2	15	147.0	M	5	2	2	2	2	2	100%	0%
Semester 1	2006	IEO-BB 2	16	140.0	M	5	2	3	1	1	1	50%	55%
Semester 1	2006	IEO-BB 2	17	136.0	F	5	2	2	2	4	2	75%	40%
Semester 1	2006	IEO-BB 2	18	135.0	F	5	3	3	3	2	3	75%	18%
Semester 1	2006	IEO-BB 2	19	175.0	F	5	3	3	1	1	3	50%	58%
Semester 1	2006	IEO-BB 2	20	165.0	F	5	1	1	1	1	1	100%	0%
Semester 2	2006	IEO-BB 3	21	105.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	22	111.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	23	105.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	24	118.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	25	110.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	26	114.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	27	105.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	28	116.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	29	114.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 3	30	141.0	I	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 4	31	158.0	F	10	1	2	2	1	1	50%	38%
Semester 2	2006	IEO-BB 4	32	181.0	F	10	1	1	1	1	1	100%	0%
Semester 2	2006	IEO-BB 4	33	156.0	F	10	1	2	1	2	1	50%	38%
Semester 2	2006	IEO-BB 4	34	130.0	M	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 4	35	126.0	F	10	0	0	0	0	0	100%	0%
Semester 2	2006	IEO-BB 4	36	165.0	F	10	1	1	1	1	1	100%	0%
Semester 2	2006	IEO-BB 4	37	170.0	M	10	1	1	1	1	1	100%	0%
Semester 2	2006	IEO-BB 4	38	159.0	F	10	1	1	1	3	1	75%	67%
Semester 2	2006	IEO-BB 4	39	160.0	F	10	1	1	2	1	1	75%	40%
Semester 2	2006	IEO-BB 4	40	156.0	M	10	1	1	2	2	1	50%	38%
					Total read		40	40	40	40		**88.8%**	**12.9%**
					Total NOT read		0	0	0	0			

Table 4.2.2.2. Anchovy Otolith SET A_Bay of Biscay (Bay of Biscay readers). Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	12	0	100	0
1	18	20	83	0.19
2	8	11	91	0.13
3	2	38	63	-0.63
4	-	-	-	
5	-	-	-	
Total	**40**	**12.9**	**88.8**	**0.08**

Table 4.2.2.3. Anchovy Otolith SET A_Bay of Biscay (Bay of Biscay readers). The number of age readings, the coefficient of variation (CV), the percentage agreement and the RELATIVE bias are presented by MODAL age for each age reader and for all readers combined.

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	TOTAL
	0	12	12	12	12	48
	1	18	18	18	18	72
	2	8	8	8	8	32
	3	2	2	2	2	8
	4	-	-	-	-	-
	5	-	-	-	-	-
Total	0-15	40	40	40	40	160

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	ALL Readers
	0	0%	0%	0%	0%	0.0%
	1	22%	45%	33%	45%	19.8%
	2	0%	17%	17%	31%	10.6%
	3	0%	0%	71%	47%	38.0%
	4	-	-	-	-	-
	5	-	-	-	-	-
Weighted mean	0-15	10.0%	23.5%	21.7%	28.7%	12.9%
	RANKING	1	3	2	4	

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	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	ALL
	0	100%	100%	100%	100%	100%
	1	94%	83%	83%	72%	83%
	2	100%	88%	88%	88%	91%
	3	100%	100%	50%	0%	63%
	4	-	-	-	-	-
	5	-	-	-	-	-
Weighted mean	0-15	97.5%	90.0%	87.5%	80.0%	88.8%
	RANKING	1	2	3	4	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	ALL
	0	0.00	0.00	0.00	0.00	0.00
	1	0.06	0.22	0.17	0.33	0.19
	2	0.00	0.13	0.13	0.25	0.13
	3	0.00	0.00	-1.00	-1.50	-0.63
	4	-	-	-	-	-
	5	-	-	-	-	-
Weighted mean	0-15	0.03	0.13	0.05	0.13	0.08
	RANKING	1	4	2	3	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4
anking Coefficient of Variation	1	3	2	4
anking Percentage Agreement	1	2	3	4
Ranking Relative bias	1	4	2	3
OVERALL RANKING	1	3	2	4

Table 4.2.2.4. **Anchovy Otolith SET A_Bay of Biscay** (Bay of Biscay readers). Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

	Reader 1	Reader 2	Reader 3	Reader 4
Reader 1	97.5	–	–	–
Reader 2	90.00%	90.0	–	–
Reader 3	84.50%	82.50%	87.5	–
Reader 4	77.50%	75.00%	77.50%	80.0
MODAL age	–	–	–	–

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

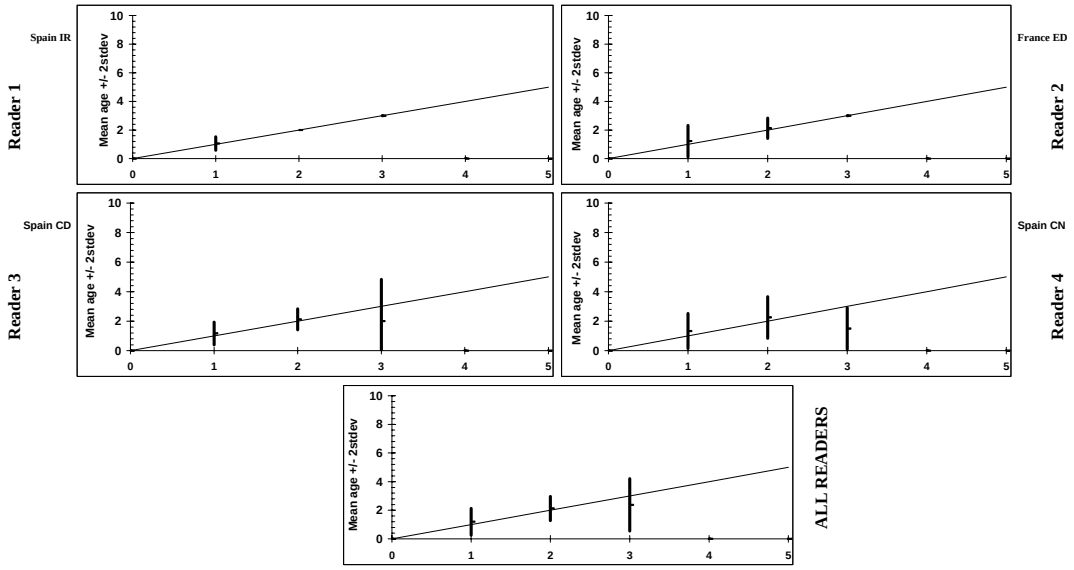


Figure 4.2.2.1. Anchovy Otolith SET A_Bay of Biscay (Bay of Biscay readers). Age bias plots.

4.3. SET B: Results on Otoliths from Gulf of Cadiz

Table 4.3.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the Gulf of Cadiz region (set B) along with the ageing made 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 in this set is 58.3 % and the average CV equals 68.1%, with higher values in all ages, and overall in the youngest groups (165.7% at age 0 and 58.0 % at age 1) (Table 4.3.2). The pattern of precision with age was variable among readers (Table 4.3.3). Mean agreement with the modal age decreased from 60% at age 0 to 42% at age 3 (Table 4.3.2).

From age bias plots (Figure 4.3.1) it was observed that among all readers, R1 was the one who showed the least biased readings. In general, all readers showed a tendency to overestimate the younger fish and underestimate the older ages (age 2 and 3).

Among experienced readers, agreement varied from 21% (R9-R2 and R10-R2) to 73% (R9-R10) (Table 4.3.4). Among these readers, R9 showed signs of bias in all cases of inter-reader bias test (versus R1, R2, R5, and R14), except versus R10. Readers against modal age showed percentage values of agreement ranging from 36% (R14) to 83% (R5) (Table 4.3.4). Among experienced readers, only readers R5 and R14 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 36% (R15) to 86% (R6). Readers R3 and R6 showed no signs of bias against modal age.

Table 4.3.1. **Anchovy Otolith SET B_Gulf of Cadiz**

Stratum	Sample year	Sample no	Fish no	Fish length	Sex	Landing month	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	MODAL age	Percent agreement	Precision CV
Semester 1	2007	IEO-GC 1	7	117	Female	1	1	2	2	2	1	1	2	3	1	1	2	-	-	2	4	2	46%	49%
Semester 1	2007	IEO-GC 1	10	84	Female	1	1	2	1	3	1	1	1	2	1	1	2	-	-	1	1	1	69%	47%
Semester 1	2007	IEO-GC 2	6	137	Female	2	1	2	1	2	2	2	1	3	1	1	2	-	-	2	3	2	46%	41%
Semester 1	2007	IEO-GC 3	1	121	Male	2	2	2	2	2	2	2	2	3	1	1	2	-	-	2	3	2	69%	29%
Semester 1	2007	IEO-GC 3	8	101	Female	2	1	2	2	2	1	1	2	2	1	1	2	-	-	1	3	1	46%	40%
Semester 1	2007	IEO-GC 4	5	97	Male	3	1	2	1	1	1	1	2	2	1	1	-	-	-	1	1	1	75%	36%
Semester 1	2007	IEO-GC 4	8	128	Female	3	1	2	3	3	1	1	3	3	1	1	2	-	-	-	4	1	42%	52%
Semester 1	2007	IEO-GC 5	3	158	Male	3	3	3	2	3	3	2	2	3	1	2	3	-	-	2	4	3	46%	31%
Semester 1	2007	IEO-GC 5	7	143	Female	3	2	2	2	2	2	2	2	3	1	1	2	-	-	-	4	2	67%	38%
Semester 1	2007	IEO-GC 5	9	132	Male	3	2	2	2	1	2	2	1	2	1	1	2	-	-	-	2	2	67%	30%
Semester 1	2007	IEO-GC 6	3	134	Male	4	2	2	3	1	2	2	1	2	2	1	2	-	-	-	3	2	58%	35%
Semester 1	2007	IEO-GC 7	1	138	Female	5	2	2	2	2	1	1	2	2	1	1	2	-	-	2	4	2	62%	43%
Semester 1	2007	IEO-GC 7	7	98	Male	5	1	2	2	1	1	1	1	1	1	0	-	-	-	-	1	1	73%	49%
Semester 1	2007	IEO-GC 8	3	112	Male	5	2	2	2	2	1	1	1	2	1	0	2	-	-	2	4	2	54%	56%
Semester 1	2007	IEO-GC 8	6	125	Male	5	2	2	2	2	2	2	1	2	1	1	2	-	-	-	4	2	67%	41%
Semester 1	2007	IEO-GC 9	1	161	Male	6	3	3	1	2	3	3	2	2	1	2	-	-	-	2	3	3	42%	34%
Semester 1	2007	IEO-GC 9	3	150	Male	6	3	2	2	2	1	2	2	2	1	2	2	-	-	2	2	2	77%	26%
Semester 1	2007	IEO-GC 9	6	143	Female	6	3	2	3	4	2	2	2	2	1	2	2	-	-	-	3	2	58%	33%
Semester 1	2007	IEO-GC 10	3	115	Male	6	1	1	1	3	1	1	2	2	1	1	1	-	-	1	3	1	69%	53%
Semester 1	2007	IEO-GC 10	5	86	Male	6	1	1	1	1	1	1	2	2	0	0	1	-	-	1	1	1	69%	58%
Semester 2	2007	IEO-GC 11	4	162	Female	7	2	3	1	1	3	3	1	2	1	2	3	-	-	1	2	1	38%	45%
Semester 2	2007	IEO-GC 11	5	170	Female	7	2	3	0	3	2	2	0	1	1	2	-	-	-	3	3	2	33%	61%
Semester 2	2007	IEO-GC 11	6	152	Male	7	2	2	0	2	2	2	0	2	1	1	2	-	-	2	2	2	69%	50%
Semester 2	2007	IEO-GC 11	8	163	Female	7	2	2	1	1	1	1	0	1	1	1	2	-	-	-	-	1	64%	51%
Semester 2	2007	IEO-GC 11	10	144	Male	7	3	4	1	3	1	1	1	3	2	3	3	-	-	2	2	3	38%	45%
Semester 2	2007	IEO-GC 12	4	158	Male	7	2	2	1	2	2	2	1	2	1	1	2	-	-	2	3	2	62%	34%
Semester 2	2007	IEO-GC 13	3	180	Female	7	2	3	1	2	2	2	1	2	2	2	3	-	-	-	5	2	58%	47%
Semester 2	2007	IEO-GC 14	2	106	Male	9	1	1	1	0	1	1	1	2	0	0	1	-	-	-	1	1	67%	69%
Semester 2	2007	IEO-GC 15	2	132	Male	9	2	2	1	2	1	1	1	2	0	0	2	-	-	2	2	2	54%	55%
Semester 2	2007	IEO-GC 15	3	103	Male	9	1	-	0	1	1	1	1	2	0	0	-	-	-	-	3	1	50%	94%
Semester 2	2007	IEO-GC 15	4	93	Male	9	1	0	0	0	0	0	1	1	0	0	0	-	-	1	0	0	69%	156%
Semester 2	2007	IEO-GC 16	1	125	Male	10	1	1	0	1	0	0	0	1	0	0	-	-	-	-	3	0	55%	145%
Semester 2	2007	IEO-GC 16	5	121	Male	10	1	0	0	1	0	0	0	1	0	0	0	-	-	1	3	0	62%	163%
Semester 2	2007	IEO-GC 17	3	118	Male	10	1	1	0	2	1	1	0	2	1	0	1	-	-	1	2	1	54%	71%
Semester 2	2007	IEO-GC 17	9	107	Female	10	1	0	0	1	1	1	0	1	0	0	1	-	-	-	1	1	58%	88%
Semester 2	2007	IEO-GC 18	5	96	Female	11	1	0	1	1	0	0	0	1	0	0	0	-	-	1	1	0	54%	112%
Semester 2	2007	IEO-GC 18	9	72	etermin	11	0	0	0	0	0	0	0	1	0	0	0	-	-	0	0	0	92%	361%
Semester 2	2007	IEO-GC 19	3	129	Female	11	1	-	1	1	0	0	0	2	0	0	-	-	-	-	2	0	50%	118%
Semester 2	2007	IEO-GC 19	4	136	Female	11	2	1	1	4	0	0	0	3	0	0	1	-	-	2	3	0	38%	105%
Semester 2	2007	IEO-GC 20	5	147	Female	11	2	2	1	1	2	2	1	2	1	1	2	-	-	2	2	2	62%	31%
						Total read	40	38	40	40	40	40	40	40	40	40	33	0	0	26	39		58.2%	68.1%
						Total NOT read	0	2	0	0	0	0	0	0	0	0	7	40	40	14	1			

Table 4.3.2. **Anchovy Otolith SET B Gulf of Cadiz**. Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	7	165.7	60	0.57
1	13	58	59	0.27
2	17	41.2	59	-0.16
3	3	36.5	42	-0.66
4	0	-	-	-
5	0	-	-	-
Total	**40**	**68.1**	**58.3**	**0.07**

Table 4.3.3. Anchovy Otolith SET B Gulf of Cadiz. The number of age readings, the coefficient of variation (CV), the percentage agreement and the RELATIVE bias are presented by MODAL age for each age reader and for all readers combined.

Anchovy Otolith SET B_Gulf of Cadiz (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
	0	7	6	7	7	7	7	7	7	7	7	5	-	-	5	7	86
	1	13	12	13	13	13	13	13	13	13	13	10	-	-	7	12	158
	2	17	17	17	17	17	17	17	17	17	17	16	-	-	11	17	214
	3	3	3	3	3	3	3	3	3	3	3	2	-	-	3	3	38
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	40	38	40	40	40	40	40	40	40	40	33	0	0	26	39	496

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
	0	58%	155%	125%	118%	0%	0%	265%	55%	0%	0%	224%	-	-	71%	81%	165.7%
	1	33%	50%	80%	63%	48%	48%	75%	30%	69%	106%	44%	-	-	0%	57%	58.0%
	2	25%	16%	55%	35%	28%	25%	54%	24%	40%	54%	12%	-	-	14%	30%	41.2%
	3	0%	17%	43%	22%	49%	50%	35%	22%	43%	25%	0%	-	-	0%	33%	36.5%
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	31.3%	48.7%	74.4%	57.7%	31.0%	29.9%	96.2%	31.3%	43.0%	59.0%	53.0%			19.7%	47.4%	68.1%
	RANKING	4	8	12	10	3	2	13	5	6	11	9			1	7	

PERCENTAGE AGREEMENT

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	14%	67%	57%	29%	100%	100%	86%	0%	100%	100%	80%	-	-	20%	29%	60%
	1	85%	33%	54%	54%	92%	92%	38%	23%	69%	46%	50%	-	-	100%	50%	59%
	2	76%	88%	47%	71%	71%	76%	35%	71%	12%	24%	94%	-	-	91%	29%	59%
	3	100%	67%	0%	67%	67%	33%	0%	67%	0%	33%	100%	-	-	0%	33%	42%
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	70.0%	65.8%	47.5%	57.5%	82.5%	82.5%	42.5%	42.5%	45.0%	45.0%	78.8%			69.2%	35.9%	58.3%
	RANKING	4	6	8	7	1	1	11	11	9	9	3			5	13	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	1.00	0.33	0.43	1.14	0.00	0.00	0.14	1.43	0.00	0.00	0.20	-	-	1.00	1.71	0.57
	1	0.15	0.58	0.08	0.54	0.15	0.15	0.23	0.85	-0.31	-0.38	0.60	-	-	0.00	0.92	0.27
	2	0.00	0.12	-0.41	0.00	-0.29	-0.24	-0.76	0.18	-0.94	-0.88	0.06	-	-	0.09	1.12	-0.16
	3	0.00	0.33	-1.67	-0.33	-0.67	-1.00	-1.33	-0.33	-1.67	-0.67	0.00	-	-	-1.00	0.00	-0.66
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	0.23	0.32	-0.20	0.35	-0.13	-0.13	-0.33	0.58	-0.63	-0.55	0.24			0.12	1.08	0.07
	RANKING	5	7	4	9	2	2	8	11	12	10	6			1	13	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
anking Coefficient of Variation	4	8	12	10	3	2	13	5	6	11	9			1	7
anking Percentage Agreement	4	6	8	7	1	1	11	11	9	9	3			5	13
Ranking Relative bias	5	7	4	9	2	2	8	11	12	10	6			1	13
OVERALL RANKING	4	6	7	8	2	1	12	9	9	11	5			3	13

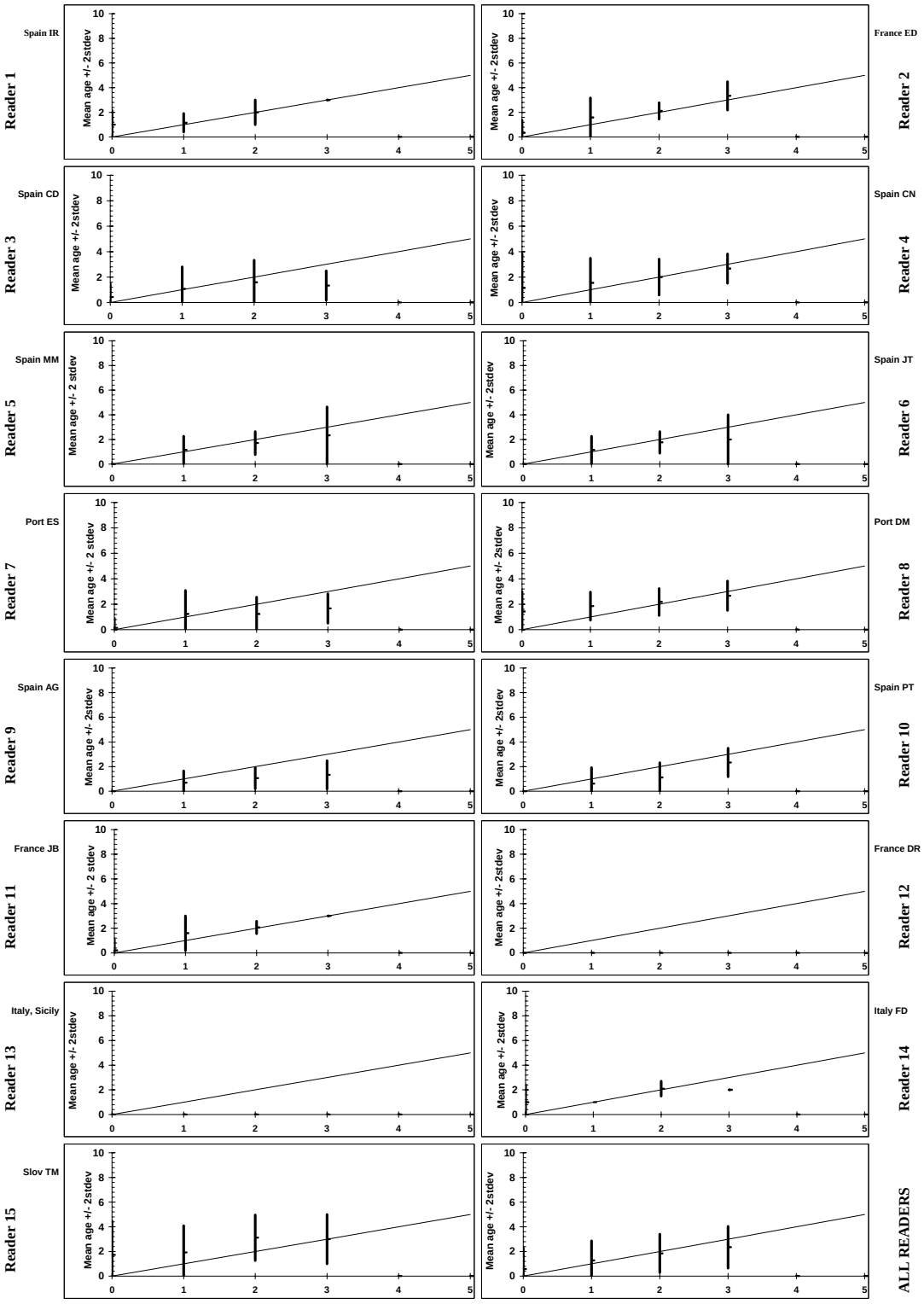


Figure 4.3.1. **Anchovy Otolith SET B Gulf of Cadiz**. Age bias plots.

Table 4.3.4. Anchovy Otolith SET B Gulf of Cadiz . Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

.

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	70.0	–	*	–	**	**	**	*	**	**	–			–	**
Reader 2	52.60%	65.8	**	–	**	**	**	–	**	**	–			–	**
Reader 3	40.00%	47.40%	47.5	**	–	–	–	**	**	*	–			**	**
Reader 4	52.50%	47.40%	45.00%	57.5	–	*	**	–	**	**	–			–	–
Reader 5	62.50%	55.30%	40.00%	40.00%	82.5	–	–	**	**	**	**			–	**
Reader 6	60.00%	55.30%	45.00%	40.00%	95.00%	82.5	–	**	**	**	**			–	**
Reader 7	25.00%	34.20%	60.00%	37.50%	40.00%	45.00%	42.5	**	**	–	**			*	**
Reader 8	47.50%	42.10%	22.50%	50.00%	30.00%	30.00%	27.50%	42.5	**	**	*			*	**
Reader 9	30.00%	21.10%	37.50%	25.00%	52.50%	50.00%	40.00%	12.50%	45.0	–	**			**	**
Reader 10	30.00%	21.10%	40.00%	30.00%	45.00%	50.00%	47.50%	17.50%	72.50%	45.0	**			**	**
Reader 11	60.60%	93.90%	48.50%	54.50%	63.60%	63.60%	33.30%	48.50%	21.20%	24.20%	78.8			–	**
Reader 12															
Reader 13															
Reader 14	69.20%	57.70%	50.00%	65.40%	46.20%	53.80%	38.50%	42.30%	30.80%	30.80%	53.80%			69.2	**
Reader 15	38.50%	28.90%	28.20%	33.30%	30.80%	33.30%	12.80%	35.90%	15.40%	15.40%	30.30%			42.30%	35.9
MODAL age	*	**	–	*	–	–	*	**	**	**	*			–	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
**	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.4. SET C: Results on Otoliths from North of Morocco

Table 4.4.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the North of Morocco region (set C) along with the ageing made 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 in this set is 63.9 % and the average CV equals 61.6%, with higher values in all ages, and overall on the youngest groups (171.8 % at age 0 and 45 % at age 1) (Table 4.4.2). The pattern of precision with age was variable among readers (Table 4.4.3). Mean agreement with the modal age decreased from 76% at age 0 to 58% at age 2 (Table 4.4.2). In principle, only ages ranging from 0 to 2 appeared

From age bias plots (Figure 4.4.1) it was observed that among all readers, R3 and R10 were the ones that showed less biased readings. In general, all readers showed a tendency to overestimate the younger fish (age 1). Among the experienced readers, this tendency was apparent for R2 and R14 but not for the other four readers.

Among experienced readers, agreement varied from 33% (R2-R5) to 88% (R1-R9) (Table 4.3.4). Among these readers, R9 showed signs of bias in all cases of inter-reader bias test (versus, R2, R5, R10 and R14) except versus R1. Readers against modal age showed percentage values of agreement ranging from 47% (R2) to 90% (R1) (Table 4.3.4). Among experienced readers, only readers R5 and R14 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 7.5% (R8) to 83% (R3). Readers R3 and R6 showed no signs of bias against modal age.

Table 4.4.1. Anchovy Otolith SET C North of Morocco

Stratum	Sample year	Sample no	Fish no	Fish length	Sex	Landing month	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	MODAL age	Percent agreement	Precision CV
Semester 1	1997	NM 1	3	137	Female	1	2	2	2	3	2	2	2	4	2	2	2	-	-	2	3	2	77%	27%
Semester 1	1997	NM 1	4	141	Female	1	1	1	1	1	2	2	1	3	1	1	1	-	-	-	3	1	67%	53%
Semester 1	1997	NM 1	8	158	Male	1	2	2	1	2	3	3	1	3	1	1	2	-	-	-	3	2	33%	43%
Semester 1	1997	NM 1	10	154	Male	1	2	2	1	3	2	2	2	3	2	2	2	-	-	2	2	2	77%	24%
Semester 1	1997	NM 2	3	132	Female	1	1	2	2	3	2	2	1	3	1	2	2	-	-	2	2	2	62%	33%
Semester 1	1997	NM 2	6	123	Female	1	2	2	3	3	2	2	2	3	2	2	2	-	-	-	3	2	67%	21%
Semester 1	1997	NM 2	8	118	Male	1	1	1	1	1	1	1	1	2	1	1	1	-	-	-	-	1	91%	28%
Semester 1	1997	NM 3	1	113	Female	1	1	1	1	2	1	1	1	2	1	1	1	-	-	1	1	1	85%	33%
Semester 1	1997	NM 3	7	101	Male	1	1	1	1	1	1	1	1	3	1	1	1	-	-	1	1	1	92%	48%
Semester 1	1997	NM 3	9	108	Female	1	1	1	1	1	1	1	2	2	1	1	1	-	-	1	2	1	77%	36%
Semester 1	1997	NM 4	1	137	Male	4	2	1	1	2	2	1	2	3	1	2	1	-	-	2	3	2	46%	41%
Semester 1	1997	NM 5	4	156	Male	4	1	2	1	1	1	1	2	2	1	1	1	-	-	1	2	1	69%	37%
Semester 1	1997	NM 5	6	162	Male	4	1	1	1	1	2	2	1	3	1	1	2	-	-	2	3	1	54%	48%
Semester 1	1997	NM 6	3	167	Female	5	1	2	1	1	1	1	2	3	1	2	2	-	-	1	2	1	54%	43%
Semester 1	1997	NM 6	7	127	Male	5	1	2	1	2	1	1	2	3	2	1	2	-	-	1	2	1	46%	40%
Semester 1	1997	NM 7	2	133	Female	5	1	2	3	2	3	3	2	4	2	2	2	-	-	2	3	2	54%	32%
Semester 1	1997	NM 7	5	134	Male	5	1	2	1	2	1	1	1	3	1	2	2	-	-	1	4	1	54%	56%
Semester 1	1997	NM 8	2	150	Male	6	1	2	1	1	3	3	2	2	1	2	2	-	-	1	2	2	46%	41%
Semester 1	1997	NM 8	7	148	Female	6	1	2	1	2	1	1	1	2	1	1	2	-	-	1	-	1	67%	37%
Semester 1	1997	NM 9	4	123	Male	6	1	2	1	2	1	1	2	2	1	1	2	-	-	1	2	1	54%	36%
Semester 2	1997	NM 10	8	156	Male	7	1	2	1	1	1	1	1	2	1	1	2	-	-	2	2	1	62%	37%
Semester 2	1997	NM 10	10	163	Female	7	1	2	1	1	1	1	1	2	1	2	2	-	-	2	2	1	54%	36%
Semester 2	1997	NM 11	2	143	Male	8	1	-	1	1	1	1	0	3	1	1	-	-	-	-	2	1	70%	66%
Semester 2	1997	NM 11	10	147	Male	8	1	2	1	1	1	1	1	2	1	2	-	-	-	2	3	1	58%	45%
Semester 2	1997	NM 12	3	161	Female	8	1	2	1	1	1	1	1	2	1	2	2	-	-	1	2	1	62%	37%
Semester 2	1997	NM 12	6	166	Male	8	1	2	1	1	1	1	1	2	1	1	2	-	-	2	2	1	62%	37%
Semester 2	1997	NM 13	2	152	Female	9	1	2	1	2	1	1	2	3	1	1	2	-	-	2	3	1	46%	44%
Semester 2	1997	NM 13	5	156	Male	9	1	-	1	1	1	1	1	2	1	1	1	-	-	-	2	1	82%	34%
Semester 2	1997	NM 13	6	161	Female	9	1	2	1	1	1	1	1	2	1	1	2	-	-	2	2	1	62%	37%
Semester 2	1997	NM 13	7	165	Female	9	1	2	1	1	1	1	2	2	1	-	2	-	-	-	3	1	55%	44%
Semester 2	1997	NM 14	5	132	Female	10	1	2	1	2	1	1	1	2	1	1	2	-	-	2	3	1	54%	43%
Semester 2	1997	NM 14	10	123	Female	10	1	-	1	2	1	1	1	3	1	2	-	-	-	1	3	1	64%	53%
Semester 2	1997	NM 15	1	87	Male	11	0	0	0	0	0	0	0	0	0	0	0	-	-	0	0	0	100%	0%
Semester 2	1997	NM 15	9	94	Female	11	0	0	0	0	0	0	0	0	0	0	0	-	-	1	0	0	92%	361%
Semester 2	1997	NM 16	4	98	Female	11	0	1	1	1	1	1	0	2	0	0	1	-	-	1	2	1	54%	81%
Semester 2	1997	NM 16	9	102	Female	11	0	1	0	0	0	0	0	1	0	0	0	-	-	1	2	0	69%	169%
Semester 2	1997	NM 17	7	112	Male	12	0	1	0	0	0	0	0	1	0	0	0	-	-	-	2	0	75%	195%
Semester 2	1997	NM 18	2	117	Male	12	0	1	1	2	0	1	0	2	0	0	1	-	-	1	2	0	38%	95%
Semester 2	1997	NM 18	8	128	Female	12	0	-	0	0	0	0	0	2	0	0	-	-	-	-	2	0	80%	211%
Semester 2	1997	NM 19	5	134	Male	12	1	1	1	1	1	1	0	2	0	0	1	-	-	-	3	1	58%	85%
						Total read	40	36	40	40	40	40	40	40	40	39	36	0	0	30	38		64.1%	61.6%
						Total NOT read	0	4	0	0	0	0	0	0	0	1	4	40	40	10	2			

Table 4.4.2. **Anchovy Otolith C North of Morocco**. Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	6	171.8	76	0.34
1	26	45	63	0.38
2	8	32.8	58	0.07
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
Total	**40**	**61.6**	**63.9**	**0.31**

Table 4.4.3. Anchovy Otolith SET C North of Morcco. 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.

Anchovy Otolith SET C_North of Morocco (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
	0	6	5	6	6	6	6	6	6	6	6	5	-	-	4	6	74
	1	26	23	26	26	26	26	26	26	26	25	23	-	-	20	24	323
	2	8	8	8	8	8	8	8	8	8	8	8	-	-	6	8	102
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	40	36	40	40	40	40	40	40	40	39	36	0	0	30	38	499

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
	0	0%	91%	245%	245%	0%	245%	0%	89%	0%	0%	224%	-	-	67%	77%	171.8%
	1	20%	29%	0%	36%	25%	25%	53%	21%	36%	48%	31%	-	-	36%	30%	45.0%
	2	32%	19%	51%	31%	22%	31%	26%	21%	36%	19%	19%	-	-	22%	20%	32.8%
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	19.6%	35.7%	46.9%	66.4%	20.8%	59.4%	39.8%	31.0%	30.4%	34.5%	55.1%			37.3%	35.4%	61.6%
	RANKING	1	7	10	13	2	12	9	4	3	5	11			8	6	

PERCENTAGE AGREEMENT

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	100%	40%	83%	83%	100%	83%	100%	33%	100%	100%	80%	-	-	25%	33%	76%
	1	96%	35%	100%	69%	92%	92%	62%	0%	88%	68%	39%	-	-	60%	8%	63%
	2	63%	88%	25%	38%	63%	50%	75%	13%	50%	88%	88%	-	-	83%	38%	58%
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	90.0%	47.2%	82.5%	65.0%	87.5%	82.5%	70.0%	7.5%	82.5%	76.9%	55.6%			60.0%	18.4%	63.9%
	RANKING	1	11	3	8	2	3	7	13	3	6	10			9	12	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	0.00	0.60	0.17	0.33	0.00	0.17	0.00	1.00	0.00	0.00	0.20	-	-	0.75	1.33	0.34
	1	-0.04	0.65	0.00	0.31	0.08	0.08	0.15	1.35	-0.04	0.16	0.61	-	-	0.40	1.33	0.38
	2	-0.38	-0.13	-0.25	0.38	0.38	0.25	-0.25	1.13	-0.50	-0.13	-0.13	-	-	-0.17	0.63	0.07
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	-0.10	0.47	-0.03	0.33	0.13	0.13	0.05	1.25	-0.13	0.08	0.39			0.33	1.18	0.31
	RANKING	4	11	1	8	5	5	2	13	7	3	10			9	12	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
anking Coefficient of Variation	1	7	10	13	2	12	9	4	3	5	11			8	6
anking Percentage Agreement	1	11	3	8	2	3	7	13	3	6	10			9	12
Ranking Relative bias	4	11	1	8	5	5	2	13	7	3	10			9	12
OVERALL RANKING	**1**	**9**	**4**	**9**	**2**	**7**	**6**	**11**	**3**	**4**	**13**			**8**	**11**

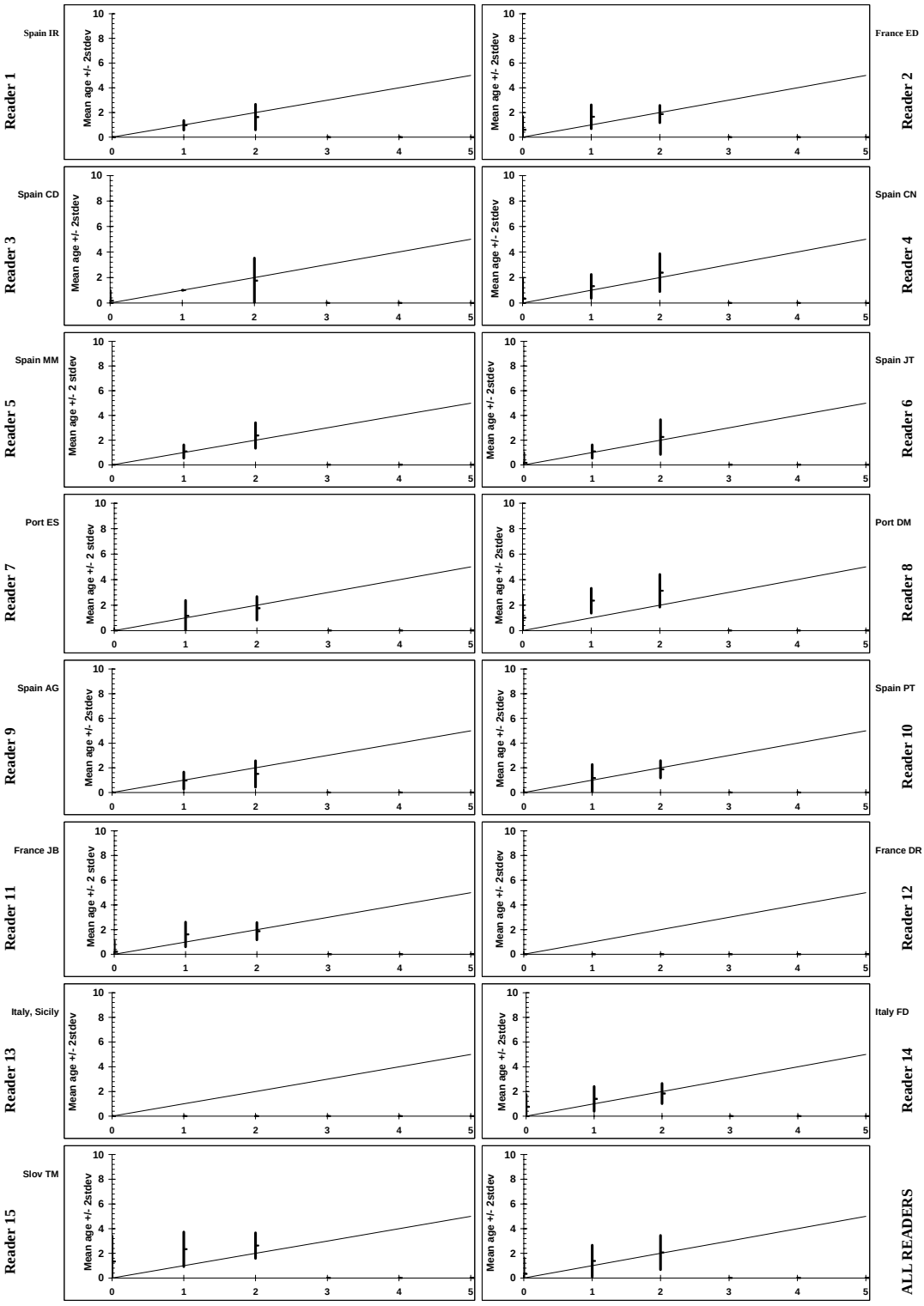


Figure 4.3.1. **Anchovy Otolith SET C North of Morocco**. Age bias plots.

Table 4.4.4. Anchovy Otolith SET C North of Morocco. Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	90.0	**	–	**	–	*	–	**	–	–	**			**	**
Reader 2	36.10%	47.2	**	–	*	*	**	**	**	**	–			–	**
Reader 3	80.00%	38.90%	82.5	**	–	–	–	**	–	–	**			**	**
Reader 4	62.50%	47.20%	62.50%	65.0	–	–	–	**	**	–	–			–	**
Reader 5	82.50%	33.30%	80.00%	55.00%	87.5	–	–	**	*	–	–			–	**
Reader 6	77.50%	38.90%	85.00%	52.50%	95.00%	82.5	–	**	*	–	–			–	–
Reader 7	70.00%	50.00%	57.50%	52.50%	60.00%	55.00%	70.0	**	*	–	**			–	**
Reader 8	5.00%	44.40%	7.50%	25.00%	7.50%	7.50%	17.50%	7.5	**	**	**			**	–
Reader 9	87.50%	38.90%	80.00%	60.00%	75.00%	75.00%	77.50%	5.00%	82.5	*	**			**	**
Reader 10	71.80%	52.80%	64.10%	51.30%	66.70%	61.50%	69.20%	15.40%	74.40%	76.9	**			–	**
Reader 11	44.40%	86.10%	47.20%	55.60%	47.20%	52.80%	52.80%	33.30%	47.20%	58.30%	55.6			–	**
Reader 12															
Reader 13															
Reader 14	53.30%	60.00%	56.70%	40.00%	60.00%	60.00%	40.00%	26.70%	50.00%	50.00%	60.00%			60.0	**
Reader 15	13.20%	44.40%	18.40%	21.10%	21.10%	21.10%	28.90%	57.90%	15.80%	26.30%	41.70%			30.00%	18.4
MODAL age	*	**	–	*	–	–	*	**	**	**	*			–	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.5. SET D: Results on Otoliths from Alboran Sea

Table 4.5.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the Alboran Sea region (set D) along with the ageing made 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 in this set is 60.6 % and the average CV equals 99.8%, with higher values in all ages, and overall in the youngest groups (200.6 % at age 0 and 58.4 % at age 1) (Table 4.5.2). The pattern of precision with age was variable among readers (Table 4.5.3). Mean agreement with the modal age decreased from 72% at age 0 to 47% at age 2 and 54% at age 3 (Table 4.5.2).

Age bias plots show that there was a general tendency among all readers to overestimate the age of younger fish and underestimate the older fish (Figure 4.5.1). R2 was the one who

showed the least biased readings. Among the experienced readers, readers R1, R5, R9 and R10 underestimated the older fish (ages 2 and 3), while reader R14 overestimated ages 1 and 2.

Among experienced readers, agreement varied from 15% (R14 versus R5, R9 and R10) to 90% (R9-R10) (Table 4.5.4). All these readers showed bias between them. Readers against modal age showed percentage values of agreement ranging from 33% (R14) to 87% (R2) (Table 4.5.4). Among experienced readers, only reader R2 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 10% (R15) to 87% (R11). Readers R7 and R11 showed no signs of bias against modal age.

Table 4.5.1. **Anchovy Otolith SET D Alboran Sea.**

Stratum	Sample year	Sample no	Fish no	Fish length	Sex	Landing month	Spain IB Reader 1	France RD Reader 2	Spain LD Reader 3	Spain CP Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy SeMa Reader 13	Italy FD Reader 14	Slov TM Reader 15	MODAL age	Percent agreement	Precision CV
Semester 1	2007	AS 1	1	160	Male	2	1	1	2	3	1	1	1	3	1	1	1	-	-	-	3	1	67%	57%
Semester 1	2007	AS 1	2	161	Female	2	1	1	1	2	1	1	1	2	1	1	1	-	-	2	3	1	69%	47%
Semester 1	2007	AS 1	3	138	Female	2	1	1	2	2	0	0	1	2	0	0	1	-	-	2	2	2	38%	80%
Semester 1	2007	AS 1	4	141	Female	2	1	1	2	2	0	0	1	2	0	0	1	-	-	2	2	2	38%	80%
Semester 1	2007	AS 1	5	165	Female	2	1	-	1	2	2	2	1	1	1	1	-	-	-	3	2	1	55%	44%
Semester 1	2007	AS 1	6	134	Male	2	0	0	0	0	0	0	0	0	0	0	0	-	-	-	2	0	92%	346%
Semester 1	2007	AS 1	7	125	Male	2	0	0	1	2	0	0	0	0	0	0	0	-	-	1	2	0	69%	168%
Semester 1	2007	AS 1	8	145	Female	2	0	0	0	2	0	0	0	1	0	-	0	-	-	-	2	0	73%	180%
Semester 1	2007	AS 1	9	140	Male	2	0	0	2	2	0	0	0	0	1	-	0	-	-	2	2	0	58%	129%
Semester 1	2007	AS 1	10	148	Female	2	0	0	1	2	1	0	0	0	0	0	0	-	-	-	2	0	67%	160%
Semester 1	2007	AS 2	11	135	Male	5	0	0	1	1	0	0	0	0	0	0	0	-	-	-	2	0	75%	195%
Semester 1	2007	AS 2	12	137	Male	5	0	0	0	1	0	0	0	0	0	0	0	-	-	1	2	0	77%	205%
Semester 1	2007	AS 2	13	139	Male	5	0	0	0	1	0	0	0	0	0	0	0	-	-	-	3	0	83%	266%
Semester 1	2007	AS 2	14	137	Male	5	1	1	2	3	1	1	1	0	0	1	1	-	-	2	2	1	54%	68%
Semester 1	2007	AS 2	15	143	Female	5	0	0	0	1	0	0	0	0	0	0	0	-	-	-	3	0	83%	266%
Semester 1	2007	AS 2	16	135	Male	5	0	1	2	2	0	0	1	2	1	1	1	-	-	2	3	1	38%	75%
Semester 1	2007	AS 2	17	141	Male	5	0	1	1	2	0	0	0	1	0	1	1	-	-	2	2	0	38%	95%
Semester 1	2007	AS 2	18	137	Male	5	0	0	1	1	0	0	0	0	0	0	0	-	-	2	2	0	69%	168%
Semester 1	2007	AS 2	19	133	Male	5	0	0	1	1	0	0	0	0	0	0	0	-	-	1	2	0	69%	169%
Semester 1	2007	AS 2	20	127	Male	5	0	0	0	0	0	0	0	0	0	0	0	-	-	1	2	0	85%	260%
Semester 2	2007	AS 3	21	182	Female	8	2	2	3	2	2	2	3	2	2	1	2	-	-	6	4	2	62%	50%
Semester 2	2007	AS 3	22	172	Female	8	2	-	2	2	1	1	1	2	1	1	-	-	-	-	2	2	50%	35%
Semester 2	2007	AS 3	23	168	Male	8	2	2	1	2	1	1	2	3	1	1	2	-	-	3	3	2	38%	43%
Semester 2	2007	AS 3	24	166	Female	8	2	-	2	1	1	1	1	2	1	1	-	-	-	-	3	1	60%	47%
Semester 2	2007	AS 3	25	172	Female	8	2	3	2	3	1	1	1	2	2	2	2	-	-	3	4	2	46%	42%
Semester 2	2007	AS 3	26	137	Female	8	1	1	1	1	1	1	1	2	1	1	1	-	-	1	2	1	85%	33%
Semester 2	2007	AS 3	27	141	Female	8	1	1	0	0	1	1	1	2	0	0	1	-	-	-	3	1	50%	98%
Semester 2	2007	AS 3	28	124	Male	8	1	1	2	2	1	1	1	1	2	1	1	-	-	1	3	1	69%	47%
Semester 2	2007	AS 3	29	130	Female	8	1	1	0	1	1	1	1	1	0	0	1	-	-	-	3	1	67%	87%
Semester 2	2007	AS 3	30	131	Male	8	1	1	0	0	1	1	1	1	1	-	1	-	-	1	3	1	75%	74%
Semester 2	2007	AS 4	31	167	Female	9	2	2	4	2	2	2	2	3	2	2	2	-	-	3	4	2	69%	32%
Semester 2	2007	AS 4	32	167	Female	9	2	2	1	3	1	1	2	3	1	1	2	-	-	2	3	2	38%	43%
Semester 2	2007	AS 4	33	169	Female	9	2	2	3	3	1	1	2	3	2	-	2	-	-	-	4	2	45%	40%
Semester 2	2007	AS 4	34	168	Female	9	2	2	3	3	1	1	3	3	2	2	2	-	-	3	4	2	38%	36%
Semester 2	2007	AS 4	35	164	Female	9	2	3	3	3	1	1	3	3	2	2	2	-	-	3	3	3	54%	32%
Semester 2	2007	AS 4	36	158	Female	9	1	2	2	2	1	1	2	2	1	1	2	-	-	-	3	2	50%	39%
Semester 2	2007	AS 4	37	161	Female	9	2	2	3	2	1	2	3	3	2	2	2	-	-	2	4	2	62%	33%
Semester 2	2007	AS 4	38	158	Female	9	1	2	1	1	1	1	3	2	1	1	2	-	-	2	3	1	54%	48%
Semester 2	2007	AS 4	39	170	Female	9	2	2	3	3	1	1	2	2	1	1	2	-	-	3	3	2	38%	41%
Semester 2	2007	AS 4	40	149	Male	9	1	1	1	2	1	1	2	1	1	1	1	-	-	1	2	1	77%	36%
					Total read		40	37	40	40	40	40	40	40	40	36	37	0	0	27	40		**60.7%**	**99.8%**
					Total NOT read		0	3	0	0	0	0	0	0	0	4	3	40	40	13	0			

Table 4.5.2. **Anchovy Otolith D Alboran Sea**. Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	13	200.6	72	0.43
1	13	58.4	63	0.28
2	13	45.7	47	-0.06
3	1	-	54	-0.62
4	-	-	-	-
5	-	-	-	-
Total	**40**	**99.8**	**60.6**	**0.19**

Table 4.5.3. Anchovy Otolith SET D Alboran Sea. 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.

Anchovy Otolith SET D_Alboran Sea (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
	0	13	13	13	13	13	13	13	13	13	11	13	-	-	7	13	**161**
	1	13	11	13	13	13	13	13	13	13	12	11	-	-	9	13	**160**
	2	13	12	13	13	13	13	13	13	13	12	12	-	-	10	13	**163**
	3	1	1	1	1	1	1	1	1	1	1	1	-	-	1	1	**13**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Total	0-15	**40**	**37**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**36**	**37**	**0**	**0**	**27**	**40**	**497**

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
	0	0%	361%	106%	59%	361%	0%	0%	244%	361%	332%	361%	-	-	37%	17%	**200.6%**
	1	41%	28%	69%	63%	41%	41%	49%	50%	66%	47%	28%	-	-	42%	18%	**58.4%**
	2	25%	27%	36%	21%	58%	59%	39%	21%	57%	62%	21%	-	-	41%	26%	**45.7%**
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Weighted mean	0-15	**21.3%**	**143.6%**	**68.8%**	**46.5%**	**149.2%**	**32.6%**	**28.7%**	**102.6%**	**157.2%**	**137.4%**	**141.8%**			**39.1%**	**19.8%**	**99.8%**
	RANKING	**2**	**11**	**7**	**6**	**12**	**4**	**3**	**8**	**13**	**9**	**10**			**5**	**1**	

PERCENTAGE AGREEMENT

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	100%	92%	46%	15%	92%	100%	100%	85%	92%	91%	92%	-	-	0%	0%	**72%**
	1	85%	91%	38%	31%	85%	85%	85%	38%	69%	83%	91%	-	-	44%	0%	**63%**
	2	77%	75%	38%	62%	15%	23%	46%	54%	46%	33%	83%	-	-	40%	23%	**47%**
	3	0%	100%	100%	100%	0%	0%	100%	100%	0%	0%	0%	-	-	100%	100%	**54%**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Weighted mean	0-15	**85.0%**	**86.5%**	**42.5%**	**37.5%**	**62.5%**	**67.5%**	**77.5%**	**60.0%**	**67.5%**	**66.7%**	**86.5%**			**33.3%**	**10.0%**	**60.6%**
	RANKING	**3**	**1**	**10**	**11**	**8**	**5**	**4**	**9**	**5**	**7**	**1**			**12**	**13**	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	0.00	0.08	0.62	1.23	0.08	0.00	0.00	0.15	0.08	0.09	0.08	-	-	1.43	2.15	**0.43**
	1	0.00	0.09	0.15	0.54	0.00	0.00	0.23	0.54	-0.15	-0.17	0.09	-	-	0.67	1.69	**0.28**
	2	-0.23	-0.08	0.38	0.38	-1.00	-0.92	-0.08	0.46	-0.69	-0.83	-0.17	-	-	0.90	1.23	**-0.06**
	3	-1.00	0.00	0.00	0.00	-2.00	-2.00	0.00	0.00	-1.00	-1.00	-1.00	-	-	0.00	0.00	**-0.62**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Weighted mean	0-15	**-0.10**	**0.03**	**0.38**	**0.70**	**-0.35**	**-0.35**	**0.05**	**0.38**	**-0.28**	**-0.33**	**-0.03**			**0.93**	**1.65**	**0.19**
	RANKING	**4**	**1**	**9**	**11**	**7**	**7**	**3**	**10**	**5**	**6**	**2**			**12**	**13**	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Ranking Coefficient of Variation	2	11	7	6	12	4	3	8	13	9	10			5	1
Ranking Percentage Agreement	3	1	10	11	8	5	4	9	5	7	1			12	13
Ranking Relative bias	4	1	9	11	7	7	3	10	5	6	2			12	13
OVERALL RANKING	**1**	**3**	**8**	**12**	**9**	**5**	**2**	**9**	**7**	**6**	**3**			**13**	**9**

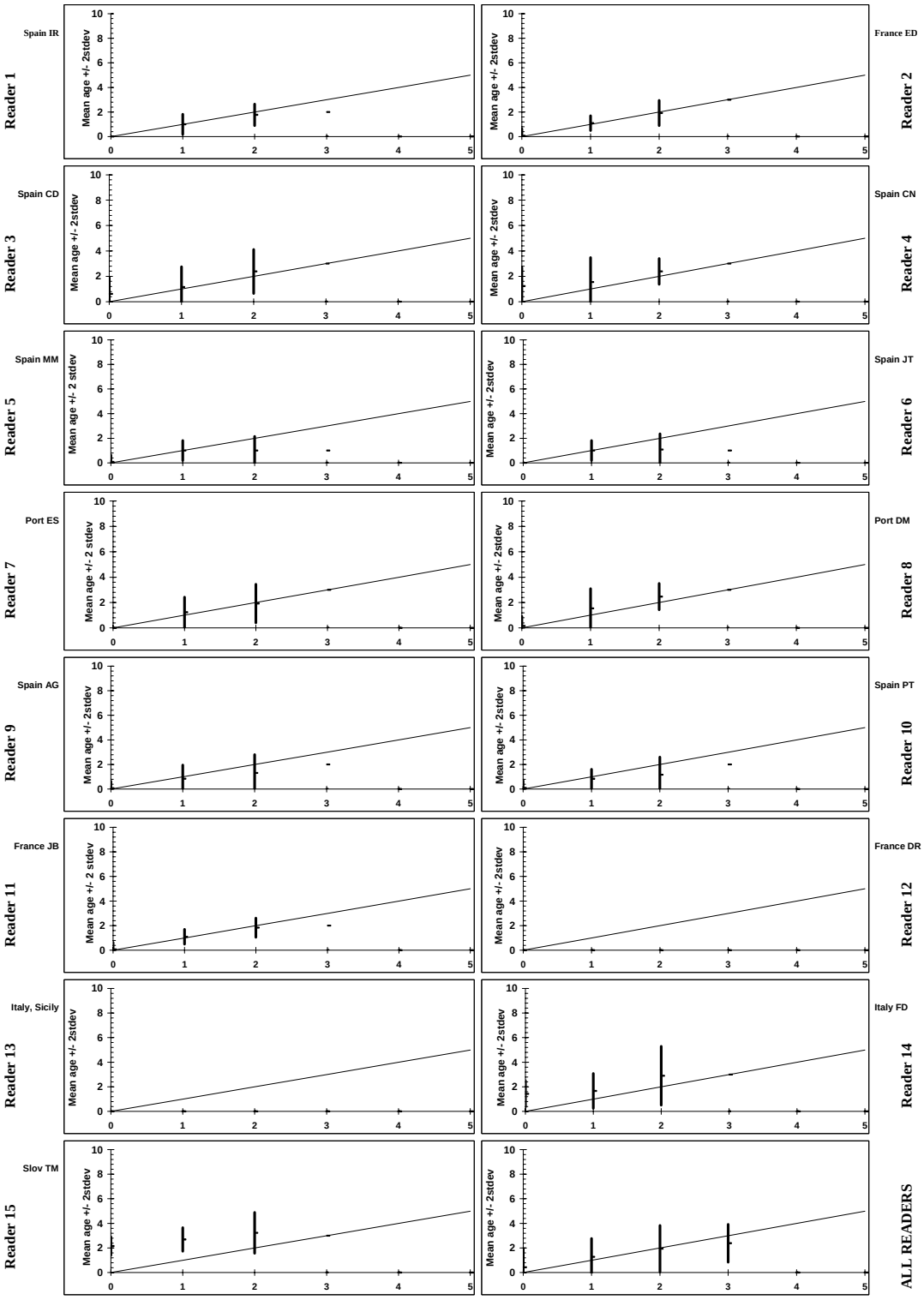


Figure 4.3.1. **Anchovy Otolith SET D Alboran Sea**. Age bias plots

Table 4.5.4. Anchovy Otolith SET D Alboran Sea. Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	85.0	*	**	**	*	*	–	**	–	*	–			**	**
Reader 2	83.80%	86.5	**	**	**	**	–	**	*	**	–			**	**
Reader 3	35.00%	32.40%	42.5	*	**	**	*	–	**	**	*			*	**
Reader 4	25.00%	29.70%	50.00%	37.5	**	**	**	–	**	**	**			–	**
Reader 5	65.00%	59.50%	32.50%	22.50%	62.5	–	**	**	–	–	**			**	**
Reader 6	70.00%	64.90%	30.00%	25.00%	95.00%	67.5	**	**	–	–	**			**	**
Reader 7	72.50%	81.08%	35.00%	27.50%	60.00%	62.50%	77.5	*	*	**	–			**	**
Reader 8	52.50%	56.76%	47.50%	37.50%	37.50%	40.00%	50.00%	60.0	**	**	**			*	**
Reader 9	67.50%	59.50%	42.50%	25.00%	67.50%	72.50%	55.00%	40.00%	67.5	–	*			**	**
Reader 10	66.70%	58.30%	44.40%	22.20%	69.40%	75.00%	55.56%	41.67%	88.90%	66.7	**			**	**
Reader 11	89.20%	94.60%	32.40%	24.30%	59.50%	64.90%	78.38%	56.76%	65.90%	63.90%	86.5			**	**
Reader 12															
Reader 13															
Reader 14	22.20%	33.30%	44.40%	51.90%	14.80%	18.50%	22.22%	44.44%	14.80%	14.80%	25.90%			33.3	**
Reader 15	2.50%	2.70%	20.00%	35.00%	2.50%	2.50%	7.50%	20.00%	0.00%	0.00%	0.00%			33.30%	10.0
MODAL age	*	–	*	**	**	**	–	**	*	**	–			**	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.6. SET E: Results on Otoliths from North Adriatic Sea

4.6.1. SET E-1. Otoliths mounted in Eukitt

Table 4.6.1.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the North Adriatic region (set E-1) along with the ageing made 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 in this set is 55.4 % and the average CV equals 72.2%, with higher values in all ages, and overall on the youngest groups (151.2% at age 0 and 53.9% at age 1) (Table 4.6.1.2). The pattern of precision with age was variable among readers (Table 4.6.1.3). Mean agreement with the modal age is quite similar between ages, 59% at age 0, 55% at age 1 and 54% at age 2 (Table 4.6.1.2). In principle, only ages ranging from 0 to 2 appeared.

Age bias plots show that there was a general tendency among all readers to overestimate the age of younger fish and underestimate the older fish (Figure 4.6.1.1).

Among experienced readers, agreement varied from 11% (R2 versus R9 and R10) to 95% (R9-R10) (Table 4.6.1.4). All these readers showed bias between them. Readers against modal age showed percentage values of agreement ranging from 32% (R2) to 83% (R1) (table 4.6.1.4). Among experienced readers, reader R5 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 15% (R15) to 78% (R6). Readers R3 and R7 showed no signs of bias against modal age.

Table 4.6.1.1 Anchovy Otolith SET E-1 North Adriatic Sea (eukitt).

	Sample		Fish	Fish		Landing	Spain IR	Spain EC	Spain CD	Spain CA	Spain MM	Spain JT	Port ES	Port DM	Spain AG	Spain PT	France JB	France DR	Italy SoBo	Italy FD	Italy TM	MODAL	Percent	Precision
Stratum	year	no	no	length	Sex	month	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	age	agreement	CV
Semester 1	2008	NA 1	1	120	-	1	0	1	0	0	0	0	0	1	0	0	1	-	-	1	2	0	62%	143%
Semester 1	2008	NA 1	2	125	-	1	0	1	2	2	0	0	0	1	0	0	1	-	-	1	2	0	46%	108%
Semester 1	2008	NA 1	3	125	-	1	0	-	0	0	0	0	0	0	0	0	-	-	-	-	2	0	90%	316%
Semester 1	2008	NA 1	4	135	-	1	1	2	2	2	1	1	0	2	1	1	2	-	-	2	3	2	46%	50%
Semester 1	2008	NA 2	1	110	-	2	0	1	1	1	0	0	1	1	0	0	1	-	-	1	1	1	62%	82%
Semester 1	2008	NA 2	2	110	-	2	0	1	1	0	0	0	1	0	0	0	0	-	-	1	1	0	62%	132%
Semester 1	2008	NA 2	3	135	-	2	1	2	2	2	1	1	1	2	1	1	2	-	-	2	2	2	54%	34%
Semester 1	2008	NA 2	4	135	-	2	1	2	2	2	1	1	0	2	1	1	2	-	-	2	2	2	54%	45%
Semester 1	2008	NA 3	1	115	-	3	0	1	1	0	0	0	0	0	0	0	1	-	-	0	0	0	77%	190%
Semester 1	2008	NA 3	2	130	-	3	0	2	2	1	0	0	0	1	0	0	1	-	-	1	2	0	46%	108%
Semester 1	2008	NA 3	3	130	-	3	0	2	1	2	0	0	0	1	0	0	2	-	-	1	2	0	46%	106%
Semester 1	2008	NA 3	4	140	-	3	0	1	1	1	0	0	0	1	0	0	1	-	-	-	2	0	50%	115%
Semester 1	2008	NA 4	1	105	-	4	0	1	1	0	0	0	0	2	0	0	1	-	-	0	1	0	62%	143%
Semester 1	2008	NA 4	2	110	-	4	0	2	1	3	1	1	0	2	1	1	2	-	-	-	3	1	42%	70%
Semester 1	2008	NA 4	3	120	-	4	1	1	1	2	0	0	0	1	0	0	1	-	-	1	2	1	46%	94%
Semester 1	2008	NA 4	4	135	-	4	1	1	1	3	1	1	1	2	1	1	1	-	-	2	2	1	69%	47%
Semester 1	2008	NA 5	1	110	-	5	1	1	2	2	1	1	1	2	1	1	1	-	-	1	3	1	69%	47%
Semester 1	2008	NA 5	2	115	-	5	0	1	2	2	1	1	0	2	0	0	1	-	-	1	2	1	38%	82%
Semester 1	2008	NA 5	3	130	-	5	1	1	2	2	1	1	1	2	1	1	1	-	-	2	3	1	62%	45%
Semester 1	2008	NA 5	4	140	-	5	1	1	1	1	0	0	0	2	0	0	1	-	-	2	2	1	38%	95%
Semester 1	2008	NA 6	1	125	Female	6	1	2	2	2	1	1	1	3	1	1	2	-	-	1	2	1	54%	43%
Semester 1	2008	NA 6	2	126	Male	6	1	2	1	1	1	1	1	2	1	1	2	-	-	2	2	1	62%	37%
Semester 1	2008	NA 6	3	124	Male	6	1	2	1	1	1	1	2	2	1	1	1	-	-	1	2	1	69%	37%
Semester 1	2008	NA 6	4	130	Female	6	1	2	0	1	1	1	1	3	1	1	2	-	-	-	2	1	58%	58%
Semester 1	2008	NA 6	5	144	Male	6	1	2	2	2	1	1	1	3	1	1	2	-	-	-	2	1	50%	42%
Semester 1	2008	NA 6	6	119	Male	6	2	3	1	2	1	1	2	3	1	2	2	-	-	2	3	2	46%	39%
Semester 1	2008	NA 6	7	127	Male	6	2	3	2	3	3	3	2	4	2	2	3	-	-	2	3	2	46%	25%
Semester 1	2008	NA 6	8	117	Male	6	1	2	1	2	1	1	2	2	1	1	2	-	-	1	2	1	54%	36%
Semester 1	2008	NA 6	9	124	Male	6	1	2	1	1	1	1	1	3	1	1	2	-	-	-	3	1	67%	53%
Semester 1	2008	NA 6	10	141	Female	6	1	2	1	1	1	1	1	3	1	1	2	-	-	2	2	1	62%	45%
Semester 1	2008	NA 7	11	129	Male	6	1	2	1	1	1	1	2	3	1	1	2	-	-	2	3	1	54%	48%
Semester 1	2008	NA 7	12	127	Female	6	1	2	2	3	1	1	2	4	1	1	2	-	-	2	3	1	38%	50%
Semester 1	2008	NA 7	13	132	Male	6	1	2	1	2	1	1	2	3	1	1	2	-	-	2	3	1	46%	44%
Semester 1	2008	NA 7	14	132	Male	6	2	2	1	2	2	2	2	3	2	2	-	-	-	2	2	2	83%	21%
Semester 1	2008	NA 7	15	136	Male	6	1	2	1	1	1	1	2	2	1	1	2	-	-	1	2	1	62%	37%
Semester 1	2008	NA 7	16	117	Male	6	1	2	1	2	3	1	2	4	1	1	2	-	-	1	2	1	46%	52%
Semester 1	2008	NA 7	17	133	Female	6	2	-	1	2	2	2	1	3	1	2	-	-	-	2	3	2	55%	37%
Semester 1	2008	NA 7	18	147	Female	6	2	3	1	2	1	1	2	3	2	2	2	-	-	2	5	2	54%	50%
Semester 1	2008	NA 7	19	124	Male	6	1	2	1	2	1	1	2	2	1	1	1	-	-	2	3	1	54%	43%
Semester 1	2008	NA 7	20	137	Female	6	1	2	2	3	2	2	2	3	1	1	3	-	-	1	2	2	46%	39%
						Total read	40	38	40	40	40	40	40	40	40	40	37	0	0	34	40		55.6%	72.2%
						Total NOT read	0	2	0	0	0	0	0	0	0	0	3	40	40	6	0			

Table 4.6.1.2. **Anchovy Otolith SET E-1 North Adriatic Sea (eukitt).**. Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	9	151.2	59	0.53
1	22	53.9	55	0.38
2	9	37.9	54	-0.11
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
Total	**40**	**72.2**	**55.4**	**0.3**

Table 4.6.1.3. Anchovy Otolith SET E-1 North Adriatic Sea (eukitt).. 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.

Anchovy Otolith SET E-1_North Adriatic Sea (Eukitt) (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
0	9	8	9	9	9	9	9	9	9	9	8	-	-	7	9	**113**
1	22	22	22	22	22	22	22	22	22	22	22	-	-	18	22	**282**
2	9	8	9	9	9	9	9	9	9	9	7	-	-	9	9	**114**
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Total 0-15	40	38	40	40	40	40	40	40	40	40	37	0	0	34	40	**509**

COEFFICIENT OF VARIATION (CV)

MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
0	0%	37%	71%	130%	0%	0%	300%	86%	0%	0%	53%	-	-	68%	47%	**151.2%**
1	41%	28%	43%	41%	60%	41%	62%	33%	48%	48%	32%	-	-	34%	24%	**53.9%**
2	34%	22%	34%	20%	47%	47%	65%	24%	38%	34%	21%	-	-	18%	35%	**37.9%**
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Weighted mean 0-15	30.0%	28.8%	47.2%	56.1%	43.7%	32.9%	116.2%	42.9%	35.0%	34.2%	34.4%			36.9%	31.9%	**72.2%**
RANKING	2	1	11	12	10	4	13	9	7	5	6			8	3	

PERCENTAGE AGREEMENT

MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
0	100%	0%	22%	56%	100%	100%	89%	33%	100%	100%	13%	-	-	29%	11%	**59%**
1	86%	32%	68%	41%	82%	86%	45%	9%	82%	82%	41%	-	-	50%	5%	**55%**
2	56%	63%	56%	78%	33%	33%	56%	33%	33%	56%	71%	-	-	89%	44%	**54%**
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Weighted mean 0-15	82.5%	31.6%	55.0%	52.5%	75.0%	77.5%	57.5%	20.0%	75.0%	80.0%	40.5%			55.9%	15.0%	**55.4%**
RANKING	1	11	8	9	4	3	6	12	4	2	10			7	13	

RELATIVE BIAS

MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
0	0.00	1.25	1.00	0.67	0.00	0.00	0.11	0.78	0.00	0.00	1.00	-	-	0.71	1.56	**0.53**
1	-0.14	0.68	0.23	0.73	-0.05	-0.14	0.18	1.41	-0.18	-0.18	0.59	-	-	0.50	1.32	**0.38**
2	-0.44	0.38	-0.44	0.22	-0.44	-0.44	-0.67	0.78	-0.67	-0.44	0.29	-	-	-0.11	0.78	**-0.11**
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Weighted mean 0-15	-0.18	0.74	0.25	0.60	-0.13	-0.18	-0.03	1.13	-0.25	-0.20	0.62			0.38	1.25	**0.30**
RANKING	3	11	6	9	2	3	1	12	6	5	10			8	13	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Ranking Coefficient of Variation	2	1	11	12	10	4	13	9	7	5	6			8	3
Ranking Percentage Agreement	1	11	8	9	4	3	6	12	4	2	10			7	13
Ranking Relative bias	3	11	6	9	2	3	1	12	6	5	10			8	13
OVERALL RANKING	**1**	**7**	**9**	**12**	**4**	**2**	**6**	**13**	**5**	**3**	**10**			**7**	**11**

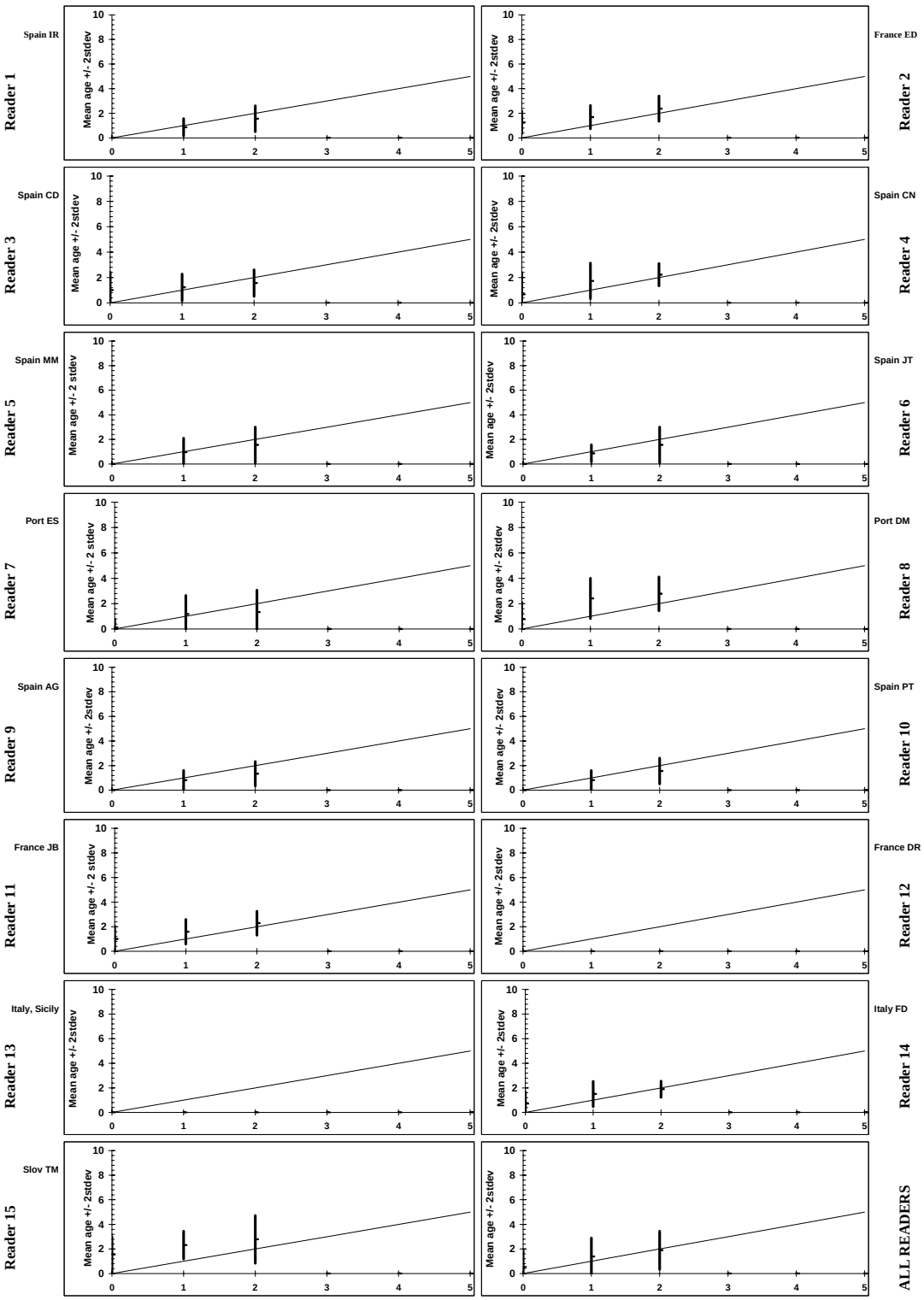


Figure 4.6.1.1. **Anchovy Otolith SET E-1 North Adriatic Sea (eukitt).**. Age bias plots.

Table 4.6.1.4. Anchovy Otolith SET E-1 North Adriatic Sea (eukitt).. Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	82.5	**	**	**	–	–	–	**	–	–	**			**	**
Reader 2	15.80%	31.6	**	–	**	**	**	**	**	**	–			*	**
Reader 3	40.00%	42.10%	55.0	*	*	**	–	**	**	**	*			–	**
Reader 4	42.50%	39.50%	50.00%	52.5	**	**	**	**	**	**	–			–	**
Reader 5	77.50%	18.40%	40.00%	37.50%	75.0	–	–	**	–	–	**			**	**
Reader 6	80.00%	18.40%	42.50%	37.50%	97.50%	77.5	–	**	–	–	**			**	**
Reader 7	60.00%	39.47%	30.00%	40.00%	55.00%	55.00%	57.5	**	*	–	**			*	**
Reader 8	10.00%	42.11%	27.50%	37.50%	7.50%	7.50%	17.50%	20.0	**	**	**			**	–
Reader 9	87.50%	10.50%	42.50%	35.00%	85.00%	87.50%	62.50%	7.50%	75.0	–	**			**	**
Reader 10	92.50%	10.50%	37.50%	40.00%	85.00%	87.50%	62.50%	7.50%	95.00%	80.0	**			**	**
Reader 11	27.00%	81.10%	40.50%	51.40%	21.60%	21.60%	32.43%	40.54%	18.90%	21.60%	40.5			–	**
Reader 12															
Reader 13															
Reader 14	44.10%	50.00%	41.20%	47.10%	29.40%	32.40%	41.18%	44.12%	35.30%	41.20%	52.90%			55.9	**
Reader 15	5.00%	52.60%	27.50%	40.00%	10.00%	10.00%	22.50%	40.00%	5.00%	5.00%	37.80%			29.40%	15.0
MODAL age	*	**	–	**	–	*	–	**	**	*	**			**	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.6.2. SET E-2. Otoliths in alcohol

Set E-2 is the same sample as the set E-1 and corresponds to the right otolith kept dry in small tubes to examine them in alcohol. Only 9 readers read this sample. Table 4.6.2.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the North Adriatic region (set E-2) along with the ageing made by each reader. This set was not read by all readers, only by 9 out of 15, of which only 3 were expert readers (R1, R5 and R14).

The average percentage of agreement across all ages and readers in this set is 60.2 % and the average CV equals 63.3%, with higher values in all ages, and overall in the youngest groups (132.9% at age 0 and 46.1% at age 1) (Table 4.6.2.2). The pattern of precision with age was variable among readers (Table 4.6.2.3). Mean agreement with the modal age increased from 55% at age 0 to 67% at age 3 (Table 4.6.2.2).

Age bias plots show that there was a general tendency among all readers to overestimate the age of younger fish and underestimate the older fish (Figure 4.6.2.1).

Among experienced readers, agreement varied from 44% (R14 versus R1 and R5) to 83% (R1-R5) (Table 4.6.2.4). Among these readers, R14 showed signs of bias in all cases of inter-reader bias test (versus, R1 and R5). Readers against modal age showed percentage values of agreement ranging from 50% (R14) to 80% (R1) (Table 4.6.2.4). Among experienced readers, reader R5 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 20% (R15) to 80% (R6). Readers R3 showed no signs of bias against modal age.

Table 4.6.2.1 Anchovy Otolith SET E-2 North Adriatic Sea (alcohol).

Fish no	Fish length	Sex	Landing month	Spain XX Reader 1	France XX Reader 2	Spain XX Reader 3	Spain XX Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy Sandy Reader 13	Italy FD Reader 14	Slov TM Reader 15	MODAL age	Percent agreement	Precision CV
1	120	-	1	0	-	0	0	0	0	1	1	-	-	-	-	-	0	1	0	67%	150%
2	125	-	1	0	-	1	2	0	0	1	1	-	-	-	-	-	2	2	0	33%	87%
3	125	-	1	0	-	0	0	0	0	1	1	-	-	-	-	-	1	2	0	56%	131%
4	135	-	1	1	-	1	3	1	1	2	2	-	-	-	-	-	2	2	1	44%	42%
1	110	-	2	0	-	1	1	0	0	1	1	-	-	-	-	-	1	1	1	67%	75%
2	110	-	2	0	-	0	0	0	0	1	1	-	-	-	-	-	1	2	0	56%	131%
3	135	-	2	1	-	1	2	1	1	2	2	-	-	-	-	-	2	2	2	56%	34%
4	135	-	2	1	-	1	3	1	1	1	1	-	-	-	-	-	2	2	1	67%	50%
1	115	-	3	0	-	0	0	0	0	1	1	-	-	-	-	-	0	1	0	67%	150%
2	130	-	3	0	-	2	1	0	1	1	1	-	-	-	-	-	-	2	1	50%	76%
3	130	-	3	0	-	0	0	0	0	1	1	-	-	-	-	-	-	2	0	63%	151%
4	140	-	3	0	-	0	0	0	0	1	1	-	-	-	-	-	-	2	0	63%	151%
1	105	-	4	0	-	1	2	0	0	1	1	-	-	-	-	-	0	2	0	44%	107%
2	110	-	4	1	-	2	1	1	0	1	1	-	-	-	-	-	1	2	1	67%	54%
3	120	-	4	0	-	1	2	0	1	1	1	-	-	-	-	-	2	2	1	44%	70%
4	135	-	4	1	-	1	2	1	1	1	1	-	-	-	-	-	2	2	1	67%	38%
1	110	-	5	1	-	1	3	1	1	2	2	-	-	-	-	-	1	3	1	56%	52%
2	115	-	5	1	-	1	1	1	1	1	1	-	-	-	-	-	1	1	1	100%	0%
3	130	-	5	1	-	1	3	1	0	2	2	-	-	-	-	-	2	2	2	44%	57%
4	140	-	5	0	-	0	1	0	0	1	1	-	-	-	-	-	-	3	0	50%	138%
1	125	Female	6	1	-	2	0	1	1	1	1	-	-	-	-	-	1	2	1	67%	54%
2	126	Male	6	1	-	1	1	1	1	1	1	-	-	-	-	-	1	2	1	89%	30%
3	124	Male	6	2	-	1	2	1	1	2	2	-	-	-	-	-	2	2	2	67%	30%
4	130	Female	6	1	-	1	2	1	1	2	2	-	-	-	-	-	-	2	1	50%	36%
5	144	Male	6	1	-	1	2	1	1	1	2	-	-	-	-	-	2	3	1	56%	47%
6	119	Male	6	2	-	1	3	1	1	2	2	-	-	-	-	-	1	2	2	44%	42%
7	127	Male	6	2	-	2	3	3	3	3	3	-	-	-	-	-	2	3	3	67%	19%
8	117	Male	6	1	-	1	2	1	1	2	2	-	-	-	-	-	1	2	1	56%	36%
9	124	Male	6	1	-	1	1	2	2	1	1	-	-	-	-	-	2	2	1	56%	36%
10	141	Female	6	1	-	1	0	1	1	1	1	-	-	-	-	-	-	2	1	75%	53%
11	129	Male	6	1	-	1	2	1	1	1	1	-	-	-	-	-	2	2	1	67%	38%
12	127	Female	6	1	-	2	2	1	1	1	1	-	-	-	-	-	2	2	1	56%	36%
13	132	Male	6	1	-	1	1	1	1	1	1	-	-	-	-	-	2	2	1	78%	36%
14	132	Male	6	1	-	1	2	2	2	2	2	-	-	-	-	-	1	2	2	67%	30%
15	136	Male	6	1	-	1	1	1	1	1	1	-	-	-	-	-	-	3	1	88%	57%
16	117	Male	6	1	-	1	2	2	1	1	1	-	-	-	-	-	-	3	1	63%	50%
17	133	Female	6	1	-	1	2	2	2	1	2	-	-	-	-	-	2	3	2	56%	38%
18	147	Female	6	2	-	1	2	2	2	2	3	-	-	-	-	-	3	3	2	56%	30%
19	124	Male	6	1	-	1	2	1	1	2	2	-	-	-	-	-	1	3	1	56%	47%
20	137	Female	6	2	-	1	1	2	1	1	2	-	-	-	-	-	2	3	2	44%	42%
			Total read	40	0	40	40	40	40	40	40	0	0	0	0	0	32	40		60.3%	63.3%
			Total NOT read	0	40	0	0	0	0	0	0	40	40	40	40	40	8	0			

Table 4.6.2.2. **Anchovy Otolith SET E-2 North Adriatic Sea (alcohol).**. Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	9	132.9	55	0.59
1	22	46.1	64	0.30
2	8	37.9	54	-0.28
3	1	-	67	-0.33
4	-	-	-	-
5	-	-	-	-
Total	**40**	**63.3**	**60.2**	**0.23**

Table 4.6.2.3. Anchovy Otolith SET E-1 North Adriatic Sea (alcohol).. 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.

Anchovy Otolith SET E-2_North Adriatic Sea (Alcohol) (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
	0	9	-	9	9	9	9	9	9	-	-	-	-	-	6	9	78
	1	22	-	22	22	22	22	22	22	-	-	-	-	-	17	22	193
	2	8	-	8	8	8	8	8	8	-	-	-	-	-	8	8	72
	3	1	-	1	1	1	1	1	1	-	-	-	-	-	1	1	9
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	40	0	40	40	40	40	40	40	0	0	0	0	0	32	40	352

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
	0	0%	-	198%	159%	0%	0%	0%	0%	-	-	-	-	-	122%	32%	132.9%
	1	41%	-	33%	54%	51%	39%	35%	36%	-	-	-	-	-	34%	26%	46.1%
	2	36%	-	0%	30%	36%	57%	26%	17%	-	-	-	-	-	34%	22%	37.9%
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	29.5%		63.0%	71.3%	35.1%	32.9%	24.5%	23.0%						49.4%	25.9%	63.3%
	RANKING	4		8	9	6	5	2	1						7	3	

PERCENTAGE AGREEMENT

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	100%	-	78%	67%	100%	100%	0%	0%	-	-	-	-	-	50%	0%	55%
	1	86%	-	82%	36%	77%	86%	77%	73%	-	-	-	-	-	47%	9%	64%
	2	50%	-	0%	63%	50%	38%	75%	88%	-	-	-	-	-	63%	63%	54%
	3	0%	-	0%	100%	100%	100%	100%	100%	-	-	-	-	-	0%	100%	67%
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	80.0%		62.5%	50.0%	77.5%	80.0%	60.0%	60.0%						50.0%	20.0%	60.2%
	RANKING	1		4	7	3	1	5	5						7	9	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	0.00	-	0.22	0.56	0.00	0.00	1.00	1.00	-	-	-	-	-	0.67	1.89	0.59
	1	-0.14	-	0.18	0.59	-0.05	-0.05	0.23	0.27	-	-	-	-	-	0.53	1.14	0.30
	2	-0.50	-	-1.00	0.13	-0.50	-0.75	-0.25	0.13	-	-	-	-	-	-0.13	0.38	-0.28
	3	-1.00	-	-1.00	0.00	0.00	0.00	0.00	0.00	-	-	-	-	-	-1.00	0.00	-0.33
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	-0.20		-0.08	0.48	-0.13	-0.18	0.30	0.40						0.34	1.13	0.23
	RANKING	4		1	8	2	3	5	7						6	9	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
anking Coefficient of Variation	4		8	9	6	5	2	1						7	3
anking Percentage Agreement	1		4	7	3	1	5	5						7	9
Ranking Relative bias	4		1	8	2	3	5	7						6	9
OVERALL RANKING	**1**		**5**	**9**	**3**	**1**	**4**	**5**						**7**	**8**

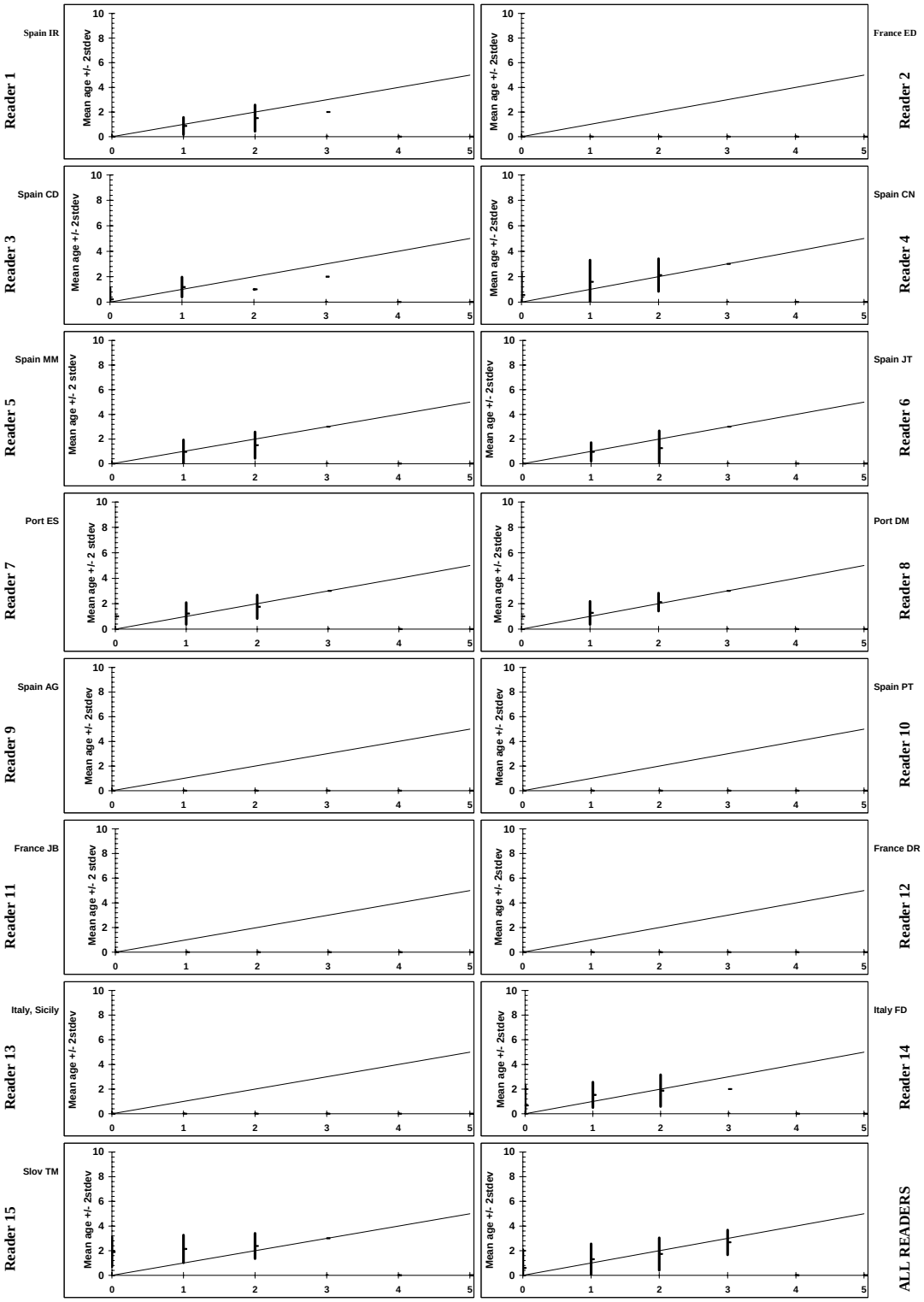


Figure 4.6.2.1. **Anchovy Otolith SET E-2 North Adriatic Sea (alcohol).**. Age bias plots.

Table 4.6.2.4. Anchovy Otolith SET E-1 North Adriatic Sea (alcohol).. Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	80.0		–	**	–	–	**	**						**	**
Reader 2															
Reader 3	70.00%		62.5	**	–	–	**	**						**	**
Reader 4	35.00%		35.00%	50.0	**	**	–	–						–	**
Reader 5	82.50%		62.50%	40.00%	77.5	–	**	**						**	**
Reader 6	72.50%		67.50%	40.00%	85.50%	80.0	**	**						**	**
Reader 7	45.00%		42.50%	45.00%	37.50%	45.00%	60.0	–						–	**
Reader 8	40.00%		35.00%	45.00%	37.50%	40.00%	90.00%	60.0						–	**
Reader 9															
Reader 10															
Reader 11															
Reader 12															
Reader 13															
Reader 14	43.80%		37.50%	46.90%	43.80%	37.50%	34.38%	46.88%						50.0	**
Reader 15	7.50%		15.00%	37.50%	10.00%	10.00%	32.50%	35.00%						46.90%	20.0
MODAL age	*		–	**	–	*	**	**						*	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.7. SET G: Results on Otoliths from Gulf of Lyon

Table 4.7.1 details the length, sex and month of landing of the set of otoliths selected for the exchange programme from the Gulf of Lyon region (set G) along with the ageing made 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 in this set is 71.5 % and the average CV equals 37.4%, with higher values in all ages, and overall in the youngest groups (40.9 % at age 1) (Table 4.7.2). The pattern of precision with age was variable among readers (Table 4.7.3). Mean agreement with the modal age decreased from 74% at age 1 to 46% at age 3 (Table 4.7.2). Otoliths of age 0 were not available.

Age bias plots show that there was a general tendency among all readers to overestimate the age of younger fish and underestimate the older fish (Figure 4.7.1). Readers R5 and R6 were those that showed the least biased readings.

Among experienced readers, agreement varied from 50% (R14-R9) to 98% (R1-R5) (Table 4.7.4). Among these readers, R9 and R14 showed signs of bias in all cases of inter-reader bias test. Readers against modal age showed percentage values of agreement ranging from 58% (R14) to 98% (R5) (Table 4.7.4). Among experienced readers, readers R1, R5 and R10 showed no sign of bias against modal age.

Among the early readers, percentages of agreement with the modal age ranged from 13% (R15) to 98% (R6). Readers R3, R6, R7, R11 and R12 showed no signs of bias against modal age.

Table 4.7.1. Anchovy Otolith SET G Gulf of Lyon.

	Sample		Fish	Fish		Landing	Spain IR	France ED	Spain CD	Spain CN	Spain MM	Spain JT	Port ES	Port DM	Spain AG	Spain PT	France JB	France DR	Italy, Sicily	Italy FD	Slov TM	MODAL	Percent	Precision
Stratum	year	no	no	length	Sex	month	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	age	agreement	CV
Semester 1	2009	GL 1	1	115	Female	3	1	1	1	2	1	1	2	2	1	1	1	1	-	2	2	1	64%	37%
Semester 1	2009	GL 1	2	115	Male	3	1	2	1	3	1	1	2	2	1	1	2	2	-	2	2	2	50%	39%
Semester 1	2009	GL 1	3	125	Female	3	1	1	1	1	1	1	2	1	1	1	1	1	-	2	3	1	79%	48%
Semester 1	2009	GL 1	4	120	Female	3	1	1	1	1	1	1	2	2	1	1	1	1	-	2	3	1	71%	47%
Semester 1	2009	GL 1	5	105	etermin	3	1	2	1	1	1	1	2	2	1	1	2	2	-	2	2	1	50%	35%
Semester 1	2009	GL 1	6	110	etermin	3	1	2	1	1	1	1	2	2	1	1	2	2	-	1	2	1	57%	36%
Semester 1	2009	GL 1	7	110	Female	3	1	1	1	1	1	1	2	1	1	1	1	1	-	1	2	1	86%	32%
Semester 1	2009	GL 1	8	120	Male	3	1	1	1	1	1	1	2	1	1	1	1	1	-	1	3	1	86%	48%
Semester 1	2009	GL 1	9	115	Male	3	1	1	1	3	1	1	2	2	1	1	1	1	-	2	3	1	64%	51%
Semester 1	2009	GL 1	10	125	Male	3	1	1	1	1	1	1	2	1	1	1	1	1	-	-	3	1	85%	49%
Semester 1	2009	GL 2	11	105	Female	4	1	2	1	1	1	1	3	3	1	1	2	1	-	1	2	1	64%	51%
Semester 1	2009	GL 2	12	115	Female	4	1	1	1	1	1	1	3	3	1	1	1	1	-	1	2	1	79%	55%
Semester 1	2009	GL 2	13	115	Female	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	2	1	79%	35%
Semester 1	2009	GL 2	14	105	Female	4	1	-	1	1	1	1	3	3	1	1	2	1	-	1	2	1	69%	53%
Semester 1	2009	GL 2	15	120	Male	4	1	1	1	1	1	1	2	2	1	1	1	1	-	2	2	1	71%	36%
Semester 1	2009	GL 2	16	115	Female	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	1	1	86%	32%
Semester 1	2009	GL 2	17	115	Female	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	1	1	86%	32%
Semester 1	2009	GL 2	18	110	Female	4	1	1	1	1	1	1	2	2	1	1	1	1	-	1	3	1	79%	48%
Semester 1	2009	GL 2	19	115	Female	4	1	1	1	1	1	1	1	2	1	1	1	1	-	2	3	1	79%	48%
Semester 1	2009	GL 2	20	105	Male	4	1	2	1	1	1	1	3	3	1	1	2	1	-	1	3	1	64%	54%
Semester 2	2008	GL 3	21	165	Female	7	2	2	3	3	2	2	1	3	2	3	3	2	-	4	3	2	43%	30%
Semester 2	2008	GL 3	22	165	Female	7	2	3	2	2	3	3	1	3	2	2	3	2	-	3	3	3	50%	27%
Semester 2	2008	GL 3	23	165	Female	7	2	2	2	2	2	2	1	3	1	-	2	2	-	-	-	2	73%	28%
Semester 2	2008	GL 3	24	165	Female	7	2	2	1	2	2	2	1	2	2	2	2	2	-	2	3	2	79%	25%
Semester 2	2008	GL 3	25	150	Female	7	1	1	1	1	1	1	1	3	1	1	1	1	-	2	2	1	79%	48%
Semester 2	2008	GL 3	26	150	Female	7	1	1	1	1	1	1	1	2	1	2	1	1	-	2	2	1	71%	36%
Semester 2	2008	GL 3	27	150	Female	7	1	1	1	1	1	1	1	2	1	2	1	1	-	1	2	1	79%	35%
Semester 2	2008	GL 3	28	150	Female	7	1	1	1	1	1	1	1	2	1	2	1	1	-	2	2	1	71%	36%
Semester 2	2008	GL 3	29	150	Female	7	1	1	1	1	1	1	1	2	1	2	1	1	-	2	2	1	71%	36%
Semester 2	2008	GL 3	30	150	Female	7	1	1	1	1	1	1	1	2	1	2	1	1	-	1	2	1	79%	35%
Semester 2	2008	GL 4	31	150	Female	7	2	2	2	2	2	2	2	2	2	-	2	2	-	2	2	2	100%	0%
Semester 2	2008	GL 4	32	150	Female	7	1	1	1	1	1	1	2	2	1	2	1	1	-	2	2	1	64%	37%
Semester 2	2008	GL 4	33	150	Female	7	3	3	1	3	3	3	1	3	2	2	2	2	-	2	2	3	43%	32%
Semester 2	2008	GL 4	34	155	Female	7	2	3	2	3	2	2	1	2	2	2	1	2	-	-	3	2	62%	31%
Semester 2	2008	GL 4	35	155	Female	7	1	1	1	1	1	1	1	2	1	1	1	1	-	1	2	1	86%	32%
Semester 2	2008	GL 4	36	155	Female	7	2	2	2	3	2	2	1	2	1	2	2	2	-	-	3	2	69%	29%
Semester 2	2008	GL 4	37	155	Female	7	2	2	2	3	2	2	1	2	1	1	2	-	-	2	3	2	62%	33%
Semester 2	2008	GL 4	38	155	Female	7	1	1	1	1	1	1	1	2	1	2	1	1	-	2	2	1	71%	36%
Semester 2	2008	GL 4	39	160	Female	7	1	1	1	1	1	1	1	2	1	1	1	1	-	1	2	1	86%	32%
Semester 2	2008	GL 4	40	160	Female	7	2	2	2	2	2	2	1	2	1	2	2	2	-	2	4	2	79%	34%
						Total read	40	39	40	40	40	40	40	40	40	38	40	39	0	36	39		71.5%	37.4%
						Total NOT read	0	1	0	0	0	0	0	0	0	2	0	1	40	4	1			

Table 4.7.2. **Anchovy Otolith SET G Gulf of Lyon**. Percentage of agreement with the modal age across all ages and readers, CV and reading bias.

Modal Age	Otolith N	CV	% Agreement	Bias
0	-	-	-	-
1	29	40.9	74	0.30
2	9	27.6	68	0.00
3	2	29.2	46	-0.64
4	-	-	-	-
5	-	-	-	-
Total	**40**	**37.4**	**71.5**	**0.19**

Table 4.7.3. Anchovy Otolith SET G Gulf of Lyon. 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.

Anchovy Otolith SET G_Gulf of Lyon (WKARA 2009_Otolith Exchange)

NUMBER OF AGE READINGS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	TOTAL
	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1	29	28	29	29	29	29	29	29	29	29	29	29	-	28	29	**404**
	2	9	9	9	9	9	9	9	9	9	7	9	8	-	6	8	**119**
	3	2	2	2	2	2	2	2	2	2	2	2	2	-	2	2	**28**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0-15	**40**	**39**	**40**	**40**	**40**	**40**	**40**	**40**	**40**	**38**	**40**	**39**	**0**	**36**	**39**	**551**

COEFFICIENT OF VARIATION (CV)

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL Readers
	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1	0%	31%	0%	37%	0%	0%	38%	28%	0%	35%	33%	24%	-	35%	25%	**40.9%**
	2	18%	16%	32%	21%	18%	18%	36%	20%	36%	37%	25%	0%	-	35%	22%	**27.6%**
	3	28%	0%	47%	28%	0%	0%	0%	0%	0%	0%	28%	0%	-	28%	28%	**29.2%**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	**5.4%**	**26.0%**	**9.5%**	**32.9%**	**4.0%**	**4.0%**	**35.4%**	**24.6%**	**8.2%**	**33.6%**	**30.8%**	**17.9%**		**34.4%**	**24.9%**	**37.4%**
	RANKING	**3**	**9**	**5**	**11**	**1**	**1**	**14**	**7**	**4**	**12**	**10**	**6**		**13**	**8**	

PERCENTAGE AGREEMENT

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1	100%	86%	100%	93%	100%	100%	34%	14%	100%	76%	83%	93%	-	54%	7%	**74%**
	2	89%	89%	67%	44%	89%	89%	22%	78%	44%	57%	78%	100%	-	83%	25%	**68%**
	3	50%	100%	0%	50%	100%	100%	0%	100%	0%	0%	50%	0%	-	50%	50%	**46%**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	**95.0%**	**87.2%**	**87.5%**	**80.0%**	**97.5%**	**97.5%**	**30.0%**	**32.5%**	**82.5%**	**68.4%**	**80.0%**	**89.7%**		**58.3%**	**12.8%**	**71.5%**
	RANKING	**3**	**6**	**5**	**8**	**1**	**1**	**13**	**12**	**7**	**10**	**8**	**4**		**11**	**14**	

RELATIVE BIAS

	MODAL age	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15	ALL
	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1	0.00	0.14	0.00	0.10	0.00	0.00	0.79	1.03	0.00	0.24	0.17	0.07	-	0.46	1.21	**0.30**
	2	-0.11	0.11	-0.11	0.56	-0.11	-0.11	-0.78	0.22	-0.56	-0.14	0.00	0.00	-	0.33	0.88	**0.00**
	3	-0.50	0.00	-1.50	-0.50	0.00	0.00	-2.00	0.00	-1.00	-1.00	-0.50	-1.00	-	-0.50	-0.50	**-0.64**
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Weighted mean	0-15	**-0.05**	**0.13**	**-0.10**	**0.18**	**-0.03**	**-0.03**	**0.30**	**0.80**	**-0.18**	**0.11**	**0.10**	**-0.00**		**0.39**	**1.05**	**0.19**
	RANKING	**4**	**8**	**6**	**9**	**2**	**2**	**11**	**13**	**10**	**7**	**5**	**1**		**12**	**14**	

Overall ranking

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
anking Coefficient of Variation	3	9	5	11	1	1	14	7	4	12	10	6		13	8
anking Percentage Agreement	3	6	5	8	1	1	13	12	7	10	8	4		11	14
Ranking Relative bias	4	8	6	9	2	2	11	13	10	7	5	1		12	14
OVERALL RANKING	**3**	**7**	**5**	**9**	**1**	**1**	**14**	**11**	**6**	**10**	**7**	**4**		**12**	**12**

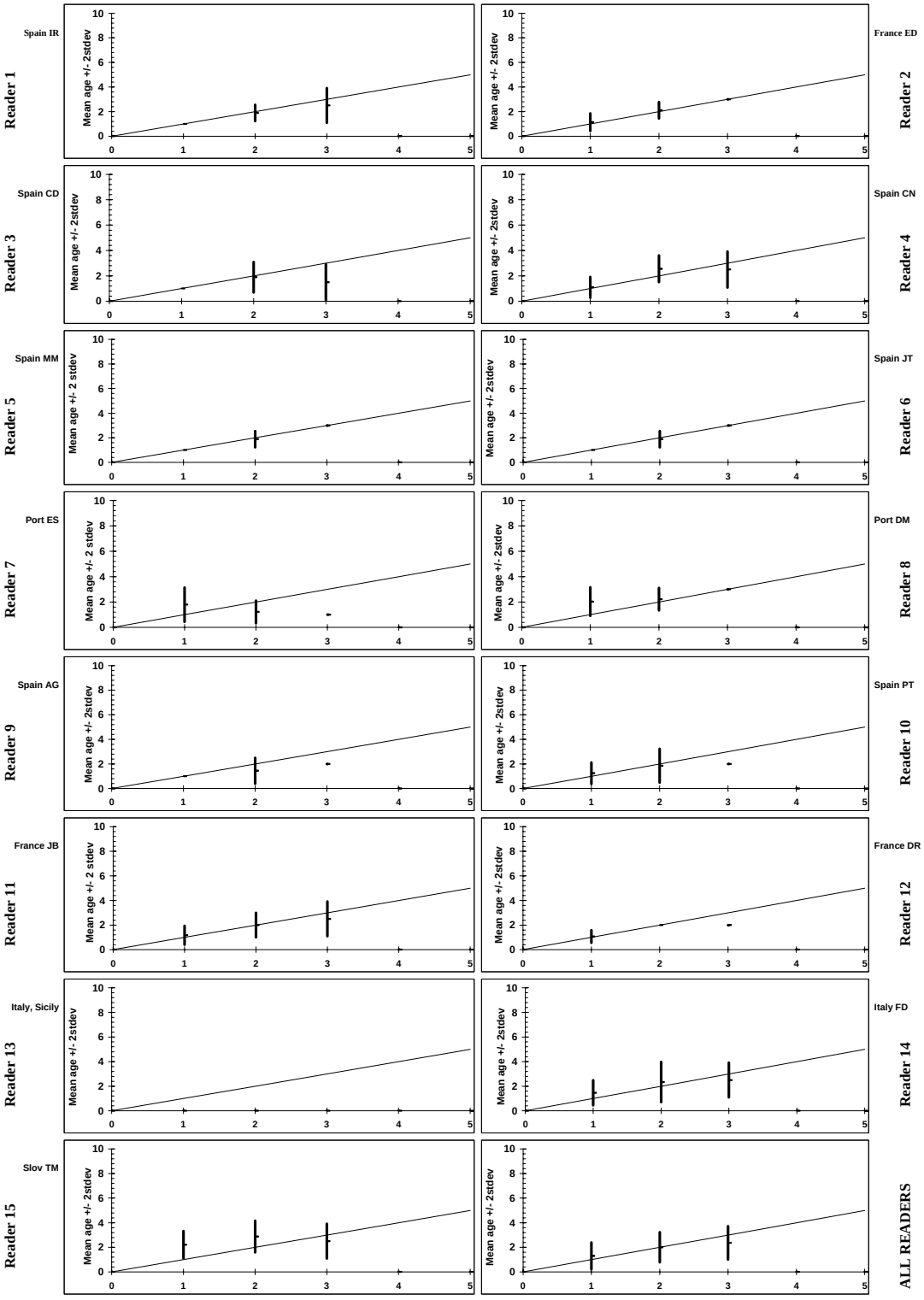


Figure 4.7.1. **Anchovy Otolith SET G Gulf of Lyon**. Age bias plots.

Table 4.7.4. Anchovy Otolith SET G Gulf of Lyon. Percentage of Agreement and Inter-reader bias test and reader against MODAL age bias test.

	Spain IR Reader 1	France ED Reader 2	Spain CD Reader 3	Spain CN Reader 4	Spain MM Reader 5	Spain JT Reader 6	Port ES Reader 7	Port DM Reader 8	Spain AG Reader 9	Spain PT Reader 10	France JB Reader 11	France DR Reader 12	Italy, Sicily Reader 13	Italy FD Reader 14	Slov TM Reader 15
Reader 1	95.0	*	–	*	–	–	–	**	*	–	–	–		**	**
Reader 2	82.10%	87.2	*	–	*	*	–	**	**	–	–	*		*	**
Reader 3	92.50%	74.40%	87.5	*	–	–	*	**	–	*	*	–		**	**
Reader 4	82.50%	71.80%	80.00%	80.0	*	*	–	**	**	–	–	–		–	**
Reader 5	97.50%	84.60%	90.00%	80.00%	97.5	–	–	**	*	–	–	–		**	**
Reader 6	97.50%	84.60%	90.00%	80.00%	100.00%	97.5	–	**	*	–	–	–		**	**
Reader 7	27.50%	35.90%	32.50%	30.00%	27.50%	27.50%	30.0	**	**	–	–	*		*	**
Reader 8	27.50%	35.90%	25.00%	25.00%	30.00%	30.00%	42.50%	32.5	**	**	**	**		**	–
Reader 9	87.50%	69.20%	82.50%	75.00%	85.00%	85.00%	37.50%	17.50%	82.5	**	**	*		**	**
Reader 10	73.70%	52.60%	73.70%	63.20%	71.10%	71.10%	15.79%	42.11%	73.70%	68.4	–	–		*	**
Reader 11	75.00%	92.30%	75.00%	67.50%	77.50%	77.50%	37.50%	35.00%	67.50%	57.90%	80.0	–		–	**
Reader 12	89.70%	84.60%	84.60%	76.90%	87.20%	87.20%	35.90%	30.77%	84.60%	68.40%	84.60%	89.7		**	**
Reader 13															
Reader 14	52.80%	50.00%	50.00%	52.80%	55.60%	55.60%	36.11%	52.78%	50.00%	58.30%	52.80%	55.60%		58.3	**
Reader 15	7.70%	23.10%	10.30%	23.10%	10.30%	10.30%	25.64%	48.72%	10.30%	28.90%	28.20%	17.90%		41.70%	12.8
MODAL age	–	*	–	*	–	–	–	**	*	–	–	–		**	**

–	= no sign of bias (p>0.05)
*	= possibility of bias (0.01<p<0.05)
* *	= certainty of bias (p<0.01)
	= percentage of reading agreement between each reader and the MODAL age

Experienced readers in red colour

4.8 Images

A group of images by area was selected for discussion in the next workshop. Three groups of images were selected:

- A group with high agreement of the annual rings (with >80 agreement of expert readers) and which showed the ring structure most clearly
- Another set of images of those otoliths in which expert readers agreed on the age but not on the true ring.
- And a final group of images with many discrepancies in the age assigned.

Figures 4.8.1 to 4.8.3 show, as an example, these three sets of images for the Bay of Biscay.

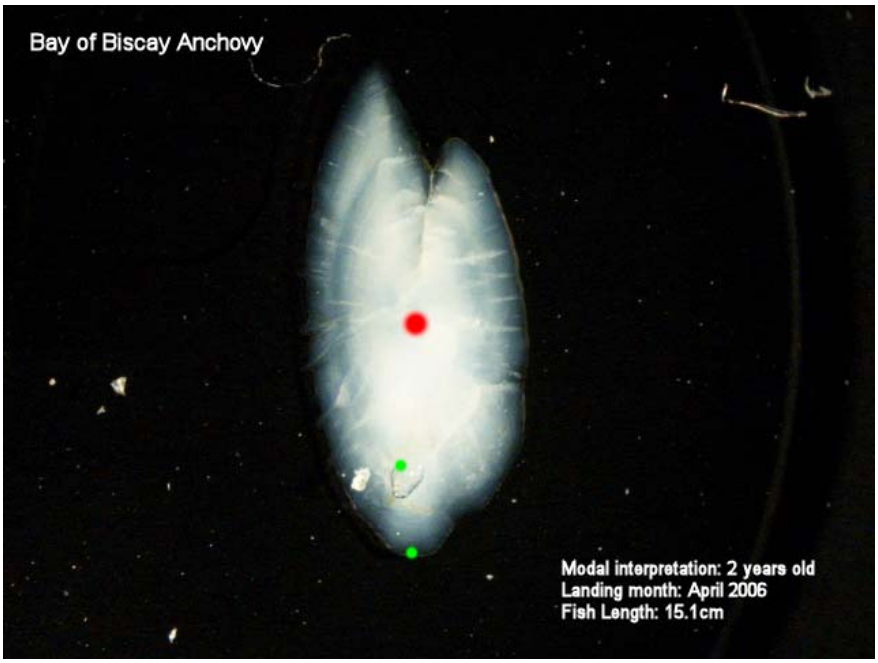


Figure 4.8.1. SET A Bay of Biscay: Otolith image with high agreement of the annual rings (with >80 agreement of expert readers). Image with nucleus (red large dot) plus two annular rings (green dots).

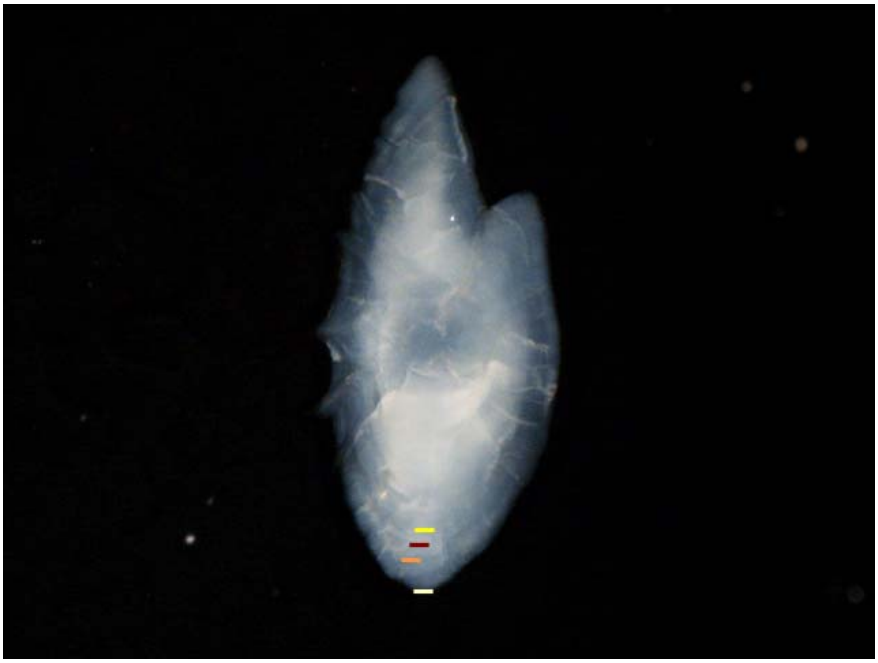


Figure 4.8.2. SET A Bay of Biscay: Otolith image in which expert readers (different colours) agreed on the age (1 year old) but not on the true ring. Landing month: May 2006; Fish length: 121 mm; Modal age: 1 year old

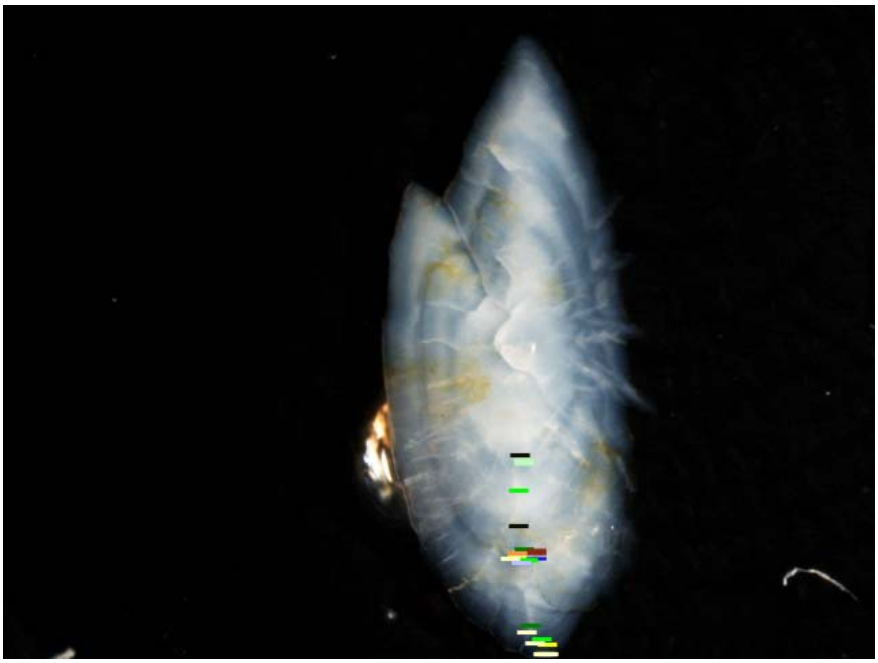


Figure 4.8.2. SET A Bay of Biscay: Otolith image with many discrepancies in the age assigned (1, 2 or 3 years old). Landing month: October 2006; Fish length: 159 mm; Modal age: 1 year old.

5- DISCUSSION

5.1 Set A Bay of Biscay (All readers).

The average percentage of agreement across all ages and readers (72.4%) and the average CV (84.5%) was much worse than the results achieved following the last exchange and workshop (Uriarte et al., 2006) when an agreement among readers of 90-92 % with a CV of about 9-14% was achieved.

The exchange results revealed a poor level of precision (CV 85%) and agreement among readers (72%). The general trend of readers to be less precise in younger ages was observed with very high values at all ages (CV> 20%). The relative bias indicated overall high bias with a negative trend for older ages to be underestimated (Tables 4.1.1.2 and 4.1.1.3). Some noticeable bias was seen for readers R3, R4, R7, R9, R10, R12 and R14 regarding modal age 3. These features imply the production of younger age composition by these readers in

comparison with the others. Readers R7, R8 and R15 tend to overestimate ages considerably.

The best ranking readers are those who are responsible for the anchovy fishery and surveys in the Bay of Biscay

The high CV found and the negative bias detected in the oldest ages deserves review in order to achieve better agreement between readers.

5.2 Set A Bay of Biscay (Bay of Biscay readers).

For consistency in the readings from readers with responsibility in Bay of Biscay anchovy (R1, R2, R3 and R4), readings were analysed separately and compared with those of other exchanges and workshops carried out previously.

The average percentage of agreement across all ages and readers (88.9%) and the average CV(12.9%) was quite similar to the results achieved after the last exchange held in 2005 (Uriarte et al., 2006a), when the average percentage of agreement was 90.9% and the average CV was 13.9%. They are a little worse than the results achieved after the last workshop, held in 2006 (Uriarte el al., 2006b), when agreement among readers of 92 % and a CV of about 9% was achieved.

The relative bias indicates overall minor bias with a negative trend for older ages to be underestimated (Tables 4.1.2.2 and 4.1.2.3). Some noticeable bias was seen for readers R3 and R4 regarding modal age 3. These features imply the production of a younger age composition by these readers in comparison with the others. The negative bias detected in age 3 deserves some review in order to achieve a better agreement between readers .

The readers with the best ranking and highest agreement are the readers who are responsible for the Spanish (R1-AZTI and R3-IEO) and French (R2-IFREMER) fishery

and surveys. Reader R4 has been involved in reading anchovy otoliths for a year but is not responsible within the IEO.

The above results reveal that the institutions most involved in the estimation 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.

5.3 Set B Gulf of Cadiz.

The average percentage of agreement across all ages and readers (58%) and the average CV (68%) was much worse than the results achieved following the last exchange and workshop (Uriarte et al., 2002) when agreement among readers 84-88 % with a CV of about 41-26% was achieved.

The exchange results revealed a poor level of precision (CV 68%) and agreements among readers (58%). The major disagreement arose from the ageing of the oldest age group (age 3, which showed 42% agreement).

The general tendency of readers to be less precise in younger ages was observed, with very high values at all ages (CV> 20%). The relative bias indicates overall minor bias with a negative tendency for older ages to be underestimated (Tables 4.3.2 and 4.2.3). Some noticeable bias was seen for readers R3, R5, R6, R7, R9 and R10 regarding modal age 2 and 3. These features imply the production of a younger age composition by these readers in comparison with the others. Some of these readers are responsible for the anchovy fishery and surveys in the Gulf of Cadiz (R5 and R6 from IEO, and R7 from IPIMAR). Reader R15 tends to overestimate ages considerably.

The high CV found and the negative bias detected in older ages deserves review in order to achieve a better agreement between readers.

5.4 Set C North of Morocco.

The exchange results revealed a poor level of precision (CV 62%) and agreements among readers (64%). In principle only ages ranging 0 to 2 appeared and hence those results are rather poor for a fish with a life span of two years. The major disagreement arose from the ageing of the oldest age group (age 2, which showed 58% agreement).

The general tendency of readers to be less precise in younger ages was observed, with very high values at all ages (CV> 20%). The relative bias indicates overall high bias (Tables 4.1.1.2 and 4.1.1.3). In general, all readers showed a tendency to overestimate the younger fish. Some noticeable negative bias was seen for eight readers regarding modal age 2, but none of them is responsible for the anchovy fishery in the North of Morocco. Readers R8 and R15 tend to overestimate ages considerably.

The high CV found and the high bias detected in younger ages deserves review in order to achieve a better agreement between readers.

5.5 Set D Alboran Sea.

The exchange results revealed a poor level of precision (CV 99%) and agreements among readers (61%). The major disagreement arose from the ageing of the oldest age group (age 2, which showed 47% agreement).

The general tendency of readers to be less precise in younger ages was observed, with very high values at all ages (CV> 20%). The relative bias indicates overall high bias, with a negative tendency for older ages to be underestimated (Tables 4.5.2 and 4.5.3). Some noticeable bias was seen for readers R1, R5, R6, R9, R10 and R11 regarding modal age 2 and 3, and also R9 in modal age 1. These features imply a production of younger age composition by these readers in comparison with the others. Some of these readers are responsible for the anchovy fishery and surveys in the Alboran Sea (R9 and R10 from IEO). Readers R14 and R15 tend to overestimate ages considerably.

The high CV found and the high bias detected in the older ages deserves review in order to achieve a better agreement between readers.

5.5 Set E-1 Adriatic Sea (Otoliths mounted in Eukitt)

The exchange results revealed a poor level of precision (CV 73%) and agreements among readers (56%). The disagreement is very similar between ages. In principle, only ages ranging from 0 to 2 appeared.

The general tendency of readers to be less precise in younger ages was observed, with very high values at all ages (CV> 20%). The relative bias indicates overall high bias, with a negative tendency for age 2 to be underestimated (Tables 4.6.1.2 and 4.6.1.3). Some noticeable bias was seen for readers R1, R5, R6, R9 and R10 regarding modal age 1 and 2, and R3 and R14 regarding modal age 2.. These features imply the production of a younger age composition by these readers in comparison with the others. Readers R8 and R15 tend to overestimate ages considerably. Some of these readers are responsible for the anchovy fishery and surveys in the Adriatic Sea (R14 from Italy and R15 from Slovenia)

The high CV found and the high bias detected on ages deserves review in order to achieve a better agreement between readers.

5.5 Set E-2 Adriatic Sea (Otoliths in Alcohol)

Set E-2 is the same sample as set E-1 and corresponds to the right otolith kept dry in small tubes to be examined in alcohol. The exchange results revealed a poor level of precision (CV 63%) and agreements among readers (60%). This was slightly better than the sample E-1 mounted on Eukitt. In principle, in this set E-2 ages 0 to 3 appeared, however in the set E-1 only ages 0 to 2 appeared.

The general tendency of readers to be less precise in younger ages was observed, with very high values at all ages (CV> 20%). The relative bias indicates overall high bias, with a negative tendency for ages 2 and 3 to be underestimated (Tables 4.6.2.2 and 4.6.2.3). Some noticeable bias was seen for readers R1, R3 and R14 regarding modal ages 2 and 3, and R5 and R6 regarding modal ages 1 and 2. These features imply production of younger age composition by these readers in comparison with the others. Reader R15 tended to overestimate ages. Some of these readers are responsible for the anchovy fishery and surveys in the Adriatic Sea (R14 from Italy and R15 from Slovenia).

The high CV found and the high bias detected on ages deserves review in order to achieve a better agreement between readers.

5.6 Set G Gulf of Lyon.

The exchange results revealed a poor level of precision (CV 38%) and agreements among readers (72%). The major disagreement arose from the ageing of the youngest age group (age 1, which showed 74% agreement). Age 0 was not available and only ages ranging from 1 to 3 appeared.

The general tendency of readers to be less precise in younger ages was observed, with very high values at all ages (CV> 20%). The relative bias indicates overall high bias, with a negative tendency for age 3 to be underestimated (Tables 4.7.2 and 4.7.3). Some noticeable bias was seen for all readers, except R2 and R8, in modal age 3, and some of them also in modal age 2. Some of these readers are responsible for the anchovy fishery and surveys in the Gulf of Lyon (R11 and R12 from IFREMER). Readers R15 tend to overestimate ages considerably.

The high CV found and the high bias detected in ages deserves review in order to achieve a better agreement between readers.

6- CONCLUSIONS

- For all areas the average percentage of agreement and CV does not seem to be satisfactory: Most of the anchovy otoliths were not well classified by most of the readers during the 2009 exchange, excluding the results of the readers of the Bay of Biscay (BB readers) in Set A, which seem to be satisfactory.

SET- Area	% Agreement	Precision CV
SET A- Bay of Biscay (All Readers)	72.20%	84.50%
SET A- Bay of Biscay (BB Readers)	88.80%	12.90%
SET B- Gulf of Cadiz	58.20%	68.10%
SET C- North of Morocco	64.10%	61.60%
SET D- Alboran Sea	60.70%	99.80%
SET E-1- North Adriatic (Alcohol)	60.30%	63.30%
SET E-1- North Adriatic (Eukitt)	55.60%	72.20%
SET G- Gulf of Lyon	71.50%	37.40%

  - Possibly the success of the readers of the Bay of Biscay in set A, compared with the other sets, is because exchanges and workshops have been conducted since 1990 in this area, and there are sufficient criteria for the interpretation of anchovy otoliths.
  - The exchange results revealed that the level of precision and agreement for sample E-2, in alcohol, was slightly better than the sample E-1 mounted on Eukitt.

- In general for all areas, the relative bias indicates overall high bias, with a negative tendency for older ages to be underestimated. Otoliths at age 2 present a less clear structure in all areas, except in the Gulf of Lion where otoliths at age 1 is more difficult.
- In general, R8 and R15, and in some cases R7 and R14, tend to overestimate ages considerably.
- The reasons that might explain the agreement and discrepancies appearing in the exchange may be: a) Difficulties in differentiating between true annual rings and

false rings (or checks), b) Insufficient typical annual growth pattern recognition and insufficient criteria regarding the otolith edge that can be expected to be seen along the year.

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

REFERENCES:

Astudillo, A. P. Lucio, P. Prouzet and A. Uriarte, 1990. Summary of the results concerning the otolith reading exercise on anchovy held in San Sebastián (Spain) in January 1990. *Working Document to the 1990 ICES Working Group on the assessment of the Stocks of sardine, horse mackerel and anchovy. Copenhagen, 20 - 29 June, 1990*.

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

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) *Internet: http://www.efan.no*

GARCIA SANTAMARÍA, T., 1998: Anchovy (*Engraulis enceasicolus* L.) otolith exchange. *EFAN Report* 4 -98.

ICES, 2008. Report of the planning group on commercial catches, discards and biological sampling (PGCCDBS) *ICES CM 2008*/ACOM:29.

Uriarte, A. 2002. 2001 Anchovy Otolith Exchange programme from Subarea VIII and Division IXa. *Annex to PELASSES report- EU study Project -EC DG XIV Contract nº99/010.*

Uriarte, A. 2002b. Descripción y validación de la metodología de determinación de la edad en la anchoa del golfo de Vizcaya mediante el examen de sus otolitos y estudio de su crecimiento anual. *Manuscrito Interno AZTI.*

Uriarte, A., M. Blanco, O. Cendrero, P. Grellier, M. Millán, A. Morais, I. Rico. 2002.Report of the Workshop on anchovy otoliths from subarea VIII and division IXa *Annex to PELASSES report EU study Project -EC DG XIV Contract nº99/010 and Working Document to the ICES Working Group on the assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 10-19 September 2002*.

Uriarte, A., M. Blanco, E. Duhamel, P. Grellier, I. Rico, B. Villamor. 2006. 2005 Anchovy Otolith Exchange Programme from Subarea VIII. *Working Document to the 2006 ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS*).

Uriarte, A., C.Dueñas, E. Duhamel, P. Grellier, I. Rico1, B. Villamor. 2007. 2006 Anchovy Otolith Workshop. *Working Document to the 2007 ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS*).

Villamor B. and A. Uriarte, WD 1996. Results of the Anchovy (*Engraulis enceasicolus* L.) exchange programme in 1996. *WD to the 1996 ICES WG on the assessment of mackerel, horse mackerel, sardine and anchovy. Copenhagen, 13-22 August 1996*.

Annex 1:

2009 Anchovy Otolith Exchange Guide Document

ANCHOVY OTOLITH EXCHANGE PROGRAMME FROM ATLANTIC AND MEDITERRANEAN AREAS

Coordinated by Begoña Villamor in May-October 2009

1- INTRODUCTION

The Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS) meeting in March 2008, identified anchovy as one of the species requiring confirmation of the ages being assigned by Fisheries Institutes. The planning group indicated that a workshop on anchovy should be organized in 2009.

Before a workshop on age reading is held it has been considered the convenience of organizing an exchange programme of anchovy otoliths in order to ascertain the current level of precision among institutes and the difficulties that the age reading of anchovy otoliths present.

To that purpose an exchange programme of anchovy otoliths is organized by IEO between May and October 2009 before a workshop on anchovy age determination is held in Mazara del Vallo (Italy), 9-14 November.

2- OBJECTIVES

The exchange will have the following common objectives for the Subarea VIII (Bay of Biscay), for division IXa (Gulf of Cadiz), North of Morocco, Alboran Sea, Strait of Sicilia, Adriatic Sea and Gulf of Lion (Although the analysis will be made separately by areas):

4- Evaluate the current precision in otolith age reading of anchovy among readers of fishery and surveys samples throughout the year .
5- Identify major difficulties in anchovy otolith interpretation for age determinations concerning observed disagreements (otolith edge recognition and/or identification of true rings or checks).

6- Report results to the Workshop on anchovy age determination that will take place in November to facilitate the discussions and progress of work.

4- MATERIAL AND METHODS

SETS OF OTOLITHS: The definitive adopted sets of otoliths (Figure 1)are the following ones:

SET A) OTOLITHS FROM THE BAY OF BISCAY. IEO Santander, 40 otoliths: 20 otoliths from the first half of the year in April-May 2006; 20 otoliths from the second half of the year in September-October 2006; covering as much as possible all range of lengths (and hence ages). Otoliths mounted in Eukitt.

SET B) OTOLITHS FROM GULF OF CADIZ. IEO Cadiz, 40 otoliths: 20 otoliths from the first half of the year in January-June 2007; 20 otoliths from the second half of the year in July-November 2007. Otoliths mounted in Eukitt.

SET C) OTOLITHS FROM NORTH OF MOROCCO IEO Cadiz, 40 otoliths: 20 otoliths from the first half of the year in January-June 1997; 20 otoliths from the second half of the year in July-December 1997. Otoliths mounted in Eukitt.

SET D) OTOLITHS FROM ALBORAN SEA. IEO Málaga, 40 otoliths: Otoliths mounted in Eukitt. IEO Málaga TO DEFINE IT

SET E) OTOLITHS FROM ADRIATIC SEA. ZZRS, Slovenia, 40 otoliths: 40 otoliths from the first half of the year in June 2008.

SET E-1 Otoliths mounted in Eukitt

SET E-2 Otoliths in alcohol.

SET F) OTOLITHS FROM STRAIT OF SICILY. IAMC- CNR Mazara, 40 otoliths. Otoliths mounted in Eukitt. IAMC-CNR TO DEFINE IT

SET G) OTOLITHS FROM GULF OF LYON. IFREMER, Sete, 40 otoliths. Otoliths mounted in Eukitt. IFREMER TO DEFINE IT.

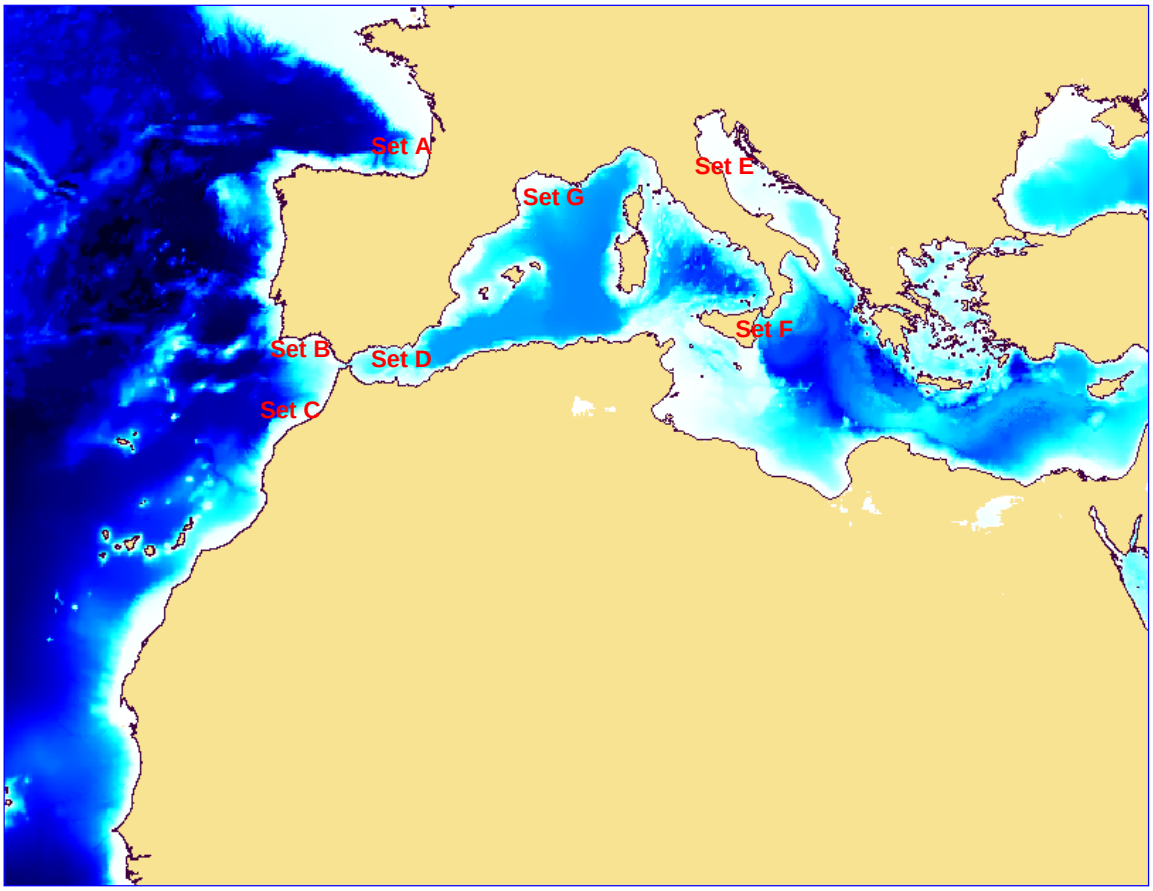


Figure 1: Collection areas of 2009 exchange otolith sample sets

IEO- Santander, Spain, will digitise images of all the otoliths and compile them on a CD

PREPARATION OF THE SETS OF OTOLITHS

Institutes use different methods of sample preparation and reading techniques in the ageing of anchovy. Some Institutes mount the entire otoliths within Eukit on black slides before examining them under reflected ligth; others examine the whole otolith in alcohol. In as much as it was possible, the preparation methods chosen for the exchange sample sets, were those that the participants were most familiar with.

In order to compare methods of otoliths preparation, the sample from the Adriatic Sea was divided in two: E-1) the left otolith mounted in Eukitt and E-2) the right otolith kept dry in small tubes to examine them in alcohol.

The sets of otoliths should be sent to IEO before 20th May in order to start the exchange of the material by 1st June. 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 has to be labelled by a unique code to which all otoliths has to be referred (The code of the sample for instance). We will assure that the code is unambiguous and, if necessary we will add an additional code for the exchange programme at the back of each slide containing a slide identification + Institute of origin + month of captures.

And for each selected otolith the required information is:

- Slide identification code where it is contained
- Month of capture
- Length, weight and sex.

QUALIFICATION OF READERS

In this section we want to get from the readers information about their experience reading the otoliths from the areas worked out in this exchange programme and their practice in handling the anchovy otoliths in preparing and mounting the otoliths. To that purpose we

have attached a file named ***Reader Document.doc*** that we ask every reader to answer and send back to us. This should help to understand the different degrees of agreement among readers and to qualify expert readers for each area of work.

The participant identifications are detailed in section 5 of this exchange programme.

AGE DETERMINATION PROCEDURES

Each reader receives the forms to be fulfilled in excel with biological data in the SET_X_***Forms.xls*** where X refer to the set A, B, C, D, E, F and G defined above.

We recommend reading the otoliths without regarding the length, but if the reader usually does take into account the length or is unfamiliar with the sets of otoliths and/or the otoliths are particularly difficult, then the reader may want to have a look to the size of the individual. We are not against that at all but if the reader use the length, we would want to know it. In that case put the word "Length" in the Remarks column.

Each reader will indicate in the respective columns:

- 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.
- Presence of checks in a last column labelling them according to their relative position to the 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 Bay of Biscay Anchovy).
- Remarks such as: if the length was used to help in the age determination (by putting the word "Length"); Any other comments as the reasons for the difficulties, etc.

The idea is understand with clarity how the otolith rings have been interpreted by the readers in order to facilitate the interpretation of agreements and discrepancies.

Minimum knowledge for age determination is:

d) Conventional birth dates for increasing in one year the age of an anchovy, when trespassing that date, is **1st of January** for Atlantic areas, Bay of Biscay, Gulf of Cadiz and North of Morocco (Sets A, B and C) and for Gulf of Lyon (Set G). Nevertheless, is **1st of June** for Adriatic Sea (Sets E-1 and E-2) and **1st of July** for Alboran Sea (Set D) and Strait of Sicily (Set F).
e) Spawning time is usually in spring for Atlantic areas and in spring-summer for Mediterranean areas. Maximum growth in spring and summer.
f) 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).

Readers are recommend to mark the true rings in the image of the otolith, at the same time as they are reading that actual otolith under the microscope.

DIGITISED IMAGES

All digitised images are on a CD and held in a folder which has six subfolders, one for each collection:

1) Bay of Biscay (BB) Exchange, Images are labelled as follows: anchovy 1 BB, anchovy 2 BB, etc.
2) Gulf of Cadiz (GC) Exchange, Images are labelled as follows: anchovy 1 GF, anchovy 2 GF, etc.
3) North of Morocco (NM) Exchange, Images are labelled as follows: anchovy 1 NM, anchovy 2 NM, etc.
4) Alboran Sea (AS) Exchange, Images are labelled as follows: anchovy 1 AS, anchovy 2 AS,….
5) North Adriatic Sea (NA) Exchange, Images are labelled as follows: anchovy 1 NA, anchovy 2 NA,….
6) Strait of Sicily Exchange (SS), Images are labelled as follows: anchovy 1 SS, anchovy 2 SS,….

7) Gulf of Lyon Exchange (GL), Images are labelled as follows: anchovy 1 GL, anchovy 2 GL…

All readers are asked to mark every ring on each digitised image. To mark the annual rings on the images, you will need the program Paint Shop Pro.

A line should be placed on the ring at the posterior (post-rostrum) of the otolith image. If there are two otoliths in the image, mark the one on the left. The instructions about using Paint Shop Pro are provided in appendix 1. A table with the colour assigned to each individual is provided in appendix 2. As mentioned earlier, you are strongly recommended to mark the images at the same time as you are reading at the otolith live.

It is essential that readers do not mark the images directly but use a raster layer (See appendix 1, point 3); each layer will correspond to a reader. Everyone is asked to save a copy of their interpretation of the images on a personal CD for discussion purposes at the workshop, this should be kept by each individual. A copy of the CD should be sent to me.

At times the digitised images would be not as clear as the live images, so you are strongly advised to mark the images at the same time as you are reading the otolith under the microscope.

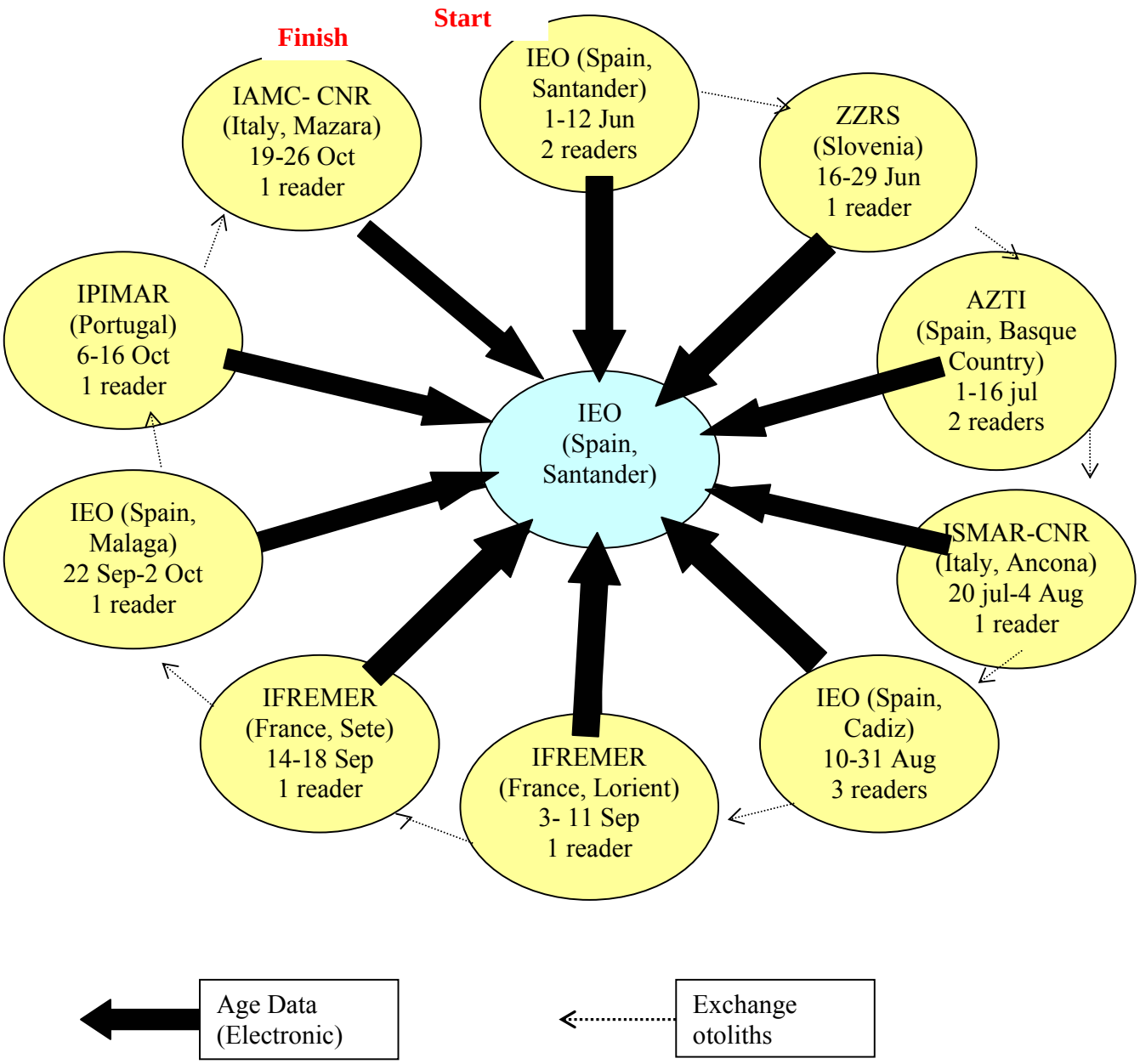
DATA ANALYSIS

All data will be 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)

4- AGENDA FOR THE EXCHANGE OF OTOLITHS

The preparation of the sets of otoliths and submission to the coordinator has to be completed during the month of May.

I have tried to take participants preferences for dates when they would be available to read into consideration and thus I have established the reading schedule as shown below.



The exchange will start the first of June and will end by the first of October. About 10-15 days by institute are assured to make the age reading for all the sets of otoliths.

When the ageing is complete, please send the otoliths samples and the original CD onto the next Institute on the reading schedule list and email the completed age data sheets to begona.villamor@st.ieo.es . Also a copy of the CD with your interpretations of the images should be sent to me as well by post. When sending the otoliths, please do it by Express mail (not ordinary post) in order to speed the exchange reception (after submission) and to avoid any loss or damage of the material. A notification should be made by mail every time the otoliths are sent among the participants. This notification should be sent to the receiver of the otoliths as well as to the coordinator in order to follow the progress of the exchange programme.

The forms to be fulfilled by each partner will be sent to every participant by first June, so that the only material to be received will be just the collection of otoliths and their descriptive material.

Since we are so delayed in getting this exchange started, I would encourage all participants to read the otoliths and mark the images as soon as they are received and then send them promptly onto the next institute.

Good luck with your readings!

5- LIST OF PARTICIPANTS

Please verify the following of addresses (including e-mails) and notify any mistake you may detect.

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Apendix 1: Instructions for using Paint Shop Pro.

1. Open Paint Shop Pro.
2. Open the image you want to mark.
3. Right down click layers, new raster layers. Type your name in as the layer name.
4. Right up click on the colour palette toolbar. Click on either of the two colour boxes and the colour grid on the left appears. Each reader will be assigned a unique colour (see appendix 2). To get the right colour, write the assigned numbers in the three colour fields, Red (R), Green (G) and Blue (B).
5. Left click on the paintbrush icon on the tool palette toolbar. A new toolbar appears with the tool options. Choose them as follow:
    - Shape: horizontal line
    - Size: 15
    - Hardness: 50
    - Step: 10
    - Density: 100
    - Thickness: 25
    - Rotation: 90
    - Opacity: 100
    - Mixing way: normal
6. Mark annual growth rings (not checks) on the external side of the hyaline rings.
7. Save the image with its original name, but adding your own name at the end, as file Paint Shop Pro, NOT as a jpg image.

Appendix 2: The Colour to be used by each reader for annotating images

Country/Laboratory	Reader	Colour	R	G	B
France/IFREMER Lorient	Erwan Duhamel ED)	Brown	128	0	0
Spain/AZTI	Iñaki Rico (IR)	Orange	255	147	67
Spain/IEO Santander	Clara Dueñas (CD)	Dark Yellow	255	255	0
	Charo Navarro (CN)	Light Yellow	255	255	192
Portugal/IPIMAR	Eduardo Soares (ES)	Turquoise	0	255	255
	Delfina Morais (DM)	Red	255	0	0
Spain/IEO Cadiz	Milagros Millan (MM)	Blue	0	0	255
	Jorge Tornero (JT)	Lilac	192	192	255
Spain/IEO Málaga	Ana Giraldez (AG)	Purple	64	0	64
	Pedro Torres (PT)	Pink	255	0	255
France/IFREMER, Sete	Jean-Herve Bourdeix (JB)	Green	192	255	192
	David Roos (DR)	Black	18	15	6
Italy/ ISMAR-CNR	Fortunata Donato (FD)	Dark Green	0	128	0
Slovenia/ZZRS	Tomaz Modic (TM)	Light Green	0	255	0
Italy/IAMC-CNR	Walter Basilone	Teal	7	147	129