

Final Results of the Mackerel (*Scomber scombrus*, L.) Otolith Exchange Programme in 1994.

by

Begoña Villamor(1) and Manolo Meixide (2)

- (1). Instituto Español de Oceanografía. Centro
Oceanográfico de Cantabria. Apdo 240. 39080 Santander. Spain
- (2). Instituto Español de Oceanografía. Centro
Oceanográfico de Vigo. Apdo 1552. 36280 Vigo. Spain

ABSTRACT

The 1993 Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy agreed to carry out a mackerel otolith exchange programme to solve the problems found in readings.

A total of 398 pairs of otoliths was exchanged, 200 of which came from the western area (ICES Divisions VIa and VIIbc) and 198 were from the southern area (ICES Divisions VIIc and VIIIa), (JH1 and JH2) and 198 were from the southern area (ICES Divisions VIIc and VIIIa). The comparison of otolith readings of the two areas was carried out separately.

The results show an unacceptable variability in mackerel age determination between the readers from different countries.

The average general agreement between readers was low in the two areas, 47% for the western area and 51% for the southern area. Agreement between readers varies between 19% and 71% for the western area and between 4% and 81% for the southern area.

Standard deviations by age groups increase considerably for age groups >5 years for the western area sample and for ages >3 years for the southern area sample.

The bias plots of each reader against the modal age show great variability in the samples from the two areas, above all in older ages. Furthermore, they permit the identification of which readers are biased, and at what ages.

The coefficient of variation, CV, and the Average Percentage Error, APE, of all ageings, with otoliths ordered according to modal age, is very similar in both areas (except in some young ages in the southern area) and remains at around 0.1. (Villanor & Meixide, 1994)

Wilcoxon's test shows that bias exists between most readers in both samples.

Considering the importance of the age readings in the assessment, new investigations are necessary to increase agreement, and to standardize ageings.

INTRODUCTION

The last mackerel otolith exchange was carried out in 1985 (Dawson, 1986) and the results indicated an unacceptably low level of agreement for fish ages >10 years. A workshop was subsequently held in Lowestoft in June 1987 to resolve these differences (Anon., 1987).

In the 1993 Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy, the separable VPA results of the Western Mackerel Stock suggested that there must have been difficulties in interpreting ages of old fish, since a very high fishing mortality at age 9 appeared in 1992. This is the 1983 age class, which is weak, while the adjacent 1984 age class is strong. Problems otherwise appeared in the ages of mackerel from Division IXa. (Anon., 1993).

The Working Group recommended that a new mackerel otolith exchange be carried out in 1994, since there are now new otolith readers in some laboratories. This exchange was organized by Begoña Villanor, IEO, Santander (Spain).

The otolith readers who have participated in this otolith exchange are:

Elena Seliverstova PINRO, Murmansk	Russia
Helga A. Gill Institute of Marine Res., Bergen	Norway
Kurt Jensen Danish Institute for fish. and Marine Res., Hirtshals	Denmark
Doug Beveridge Marine Laboratory, Aberdeen	UK (Scotland)
Alec Watson Fisheries Laboratory, Lowestoft	UK (England)
Elizabeth Barnwall	

Dept. of Marine, Fisheries Res. Centre, Dublin Ireland

Jan Beintema
RIVO, IJmuidem The Netherlands

Iñaki Rico
AZTI-SIO, San Sebastian Spain (Basque Country)

Begoña Villamor
IEO, Santander Spain

Maria Manuel Martins
IPIMAR, Lisbon Portugal

This paper presents the results and analysis of the 398 otoliths read by the above mentioned readers in the otolith exchange.

MATERIAL AND METHODS

A sample of 398 pairs of otoliths were examined. Of these otoliths, 200 came from the western area (ICES Divisions VIa and VIIbc) caught between January and April, covering a length range from 25 to 46 cm; 198 were from the southern area (ICES Divisions VIIc and IXa), caught from January to April and in September, covering a length range from 18 to 48 cm.

Only the otoliths and corresponding dates of capture were sent to the readers of each country. Fish lengths were not sent, since this information could have some influence on otolith readings.

The otolith readers gave an absolute value to each pair of otoliths wherever possible. Doubtful ages were indicated by the mark "7" after the age, and otoliths which were too difficult to be aged or which had been damaged in transit were assigned the mark "-". Doubtful ages were included in the analysis. In some cases, Norway, Ireland and Russia assigned the age as 15+ at age 15 or greater, and these readings were not included in the analysis.

Otoliths damaged in transit and those rearlings in which a mode was not obtained were excluded from the analysis, and so 198 otoliths from the western area and 188 otoliths from the southern area have been analyzed.

The comparison of otoliths from the two areas was made separately. An Excel spreadsheet was used for this purpose (Eltink, 1994).

From each otolith mean age, mode, range and standard deviation have been estimated. The percentage of agreement between individual readers, the mean percentage of agreement of each reader compared to all readers and the mean percentage of agreement of all readers have been calculated. Those readers who have a higher mean percentage of agreement with all readers than the mean agreement of all readers are considered the "best" readers.

The cumulative age composition as a percentage has been calculated so that it is independent of the number of otoliths unread by each reader and the age

composition in number of each reader, of all readers (based on the modes obtained from all readers) and that of the best reader (based on the modes obtained for the best readers) have also been calculated. The cumulative age composition shows which readers are closer to agreement and the ages at which agreement is lower.

The percentage of disagreement by one year, by two or more years in the age readings of each reader compared with the rest of the readers have been calculated. Furthermore, the mean disagreement by one year and by more than two years of each reader and the mean disagreement by one year and by more than two years of all readers have also been calculated.

The mean length at each mackerel age was estimated by each reader to show differences in growth curves obtained for each reader.

Functional regressions have been made between age readings of each reader. Readers whose age readings show a close agreement will have values of 1 and 0 for the slope and intercept respectively.

The frequency distribution of standard deviations of estimated ages has also been estimated. The standard deviations have been ordered by age groups (0-2, 3-5, 6-8, 9-11, 12-14 and 15+) for all readers and for the best readers.

As well as all these comparisons made on the spreadsheet, the following methods have been carried out:

- Age bias plots average age $\pm$ 2 standard deviations of each age reader and all age readers is plotted against modal age.
- To find out the bias between readers Wilcoxon's test was done for each pair of readers.

These last methods are some of the procedures recommended by the Workshop on Sampling Strategies for age and maturity (Anon., 1994).

- The Notched Box and Whisker plot is represented, and is an exploratory data analysis that summarizes a set of observations and is particularly useful for comparing parallel batches of data.

RESULTS

1- Western Area otoliths exchange sample

The readings of each reader together with the basic information concerning each otolith (year, sample number, otolith number, fish length and month of capture) are shown in Table 1.1, as are the mean age, mode, range and standard deviation for each otolith. Of the 198 otoliths examined, 163 were assigned an age by all readers and only 33 were assigned the same age by all readers.

The readers from The Netherlands, England, Norway, Spain (IEO), Ireland, Denmark and Russia have a higher average percentage of agreement with all

readers than the average general percentage of agreement (see Table 1.1 and 1.5) and are considered the best readers.

Table 1.2 shows the cumulative age composition as a percentage for each individual reader, for all readers and for the best readers. The reader from Portugal is observed to have a totally different age composition to the rest of the readers from age 3. In the rest of the readers the closest agreement is at ages 2, 3, 4 and 6 and from age 7 there is greater variability (Figure 1.1).

In Table 1.3 the age composition in number for each reader is shown. The reader from Portugal has not assigned any ages over 8 years. In Figure 1.2 the reading of each reader can be compared with the ages obtained from the modes of readings of the best readers.

The average length by age of each reader is shown in Table 1.4 and Figure 1.3. It can be seen that the reader from Portugal has assigned much younger ages than the rest of the readers. The rest of the readers show higher agreement at ages 2, 3, 4 and 6 and variability is greater from age 7.

The percentage of agreement between readers is presented in Table 1.5 and varies between 19% and 71%. The average general percentage of agreement of all readers is low (47%). The highest agreements are found in the readers from The Netherlands and Spain (IE0) (71%) and the readers from Ireland and Norway (71%). The readers from Scotland, Spain (AZTI) and Portugal have a lower average percentage of agreement than the average general agreement, the reader from Portugal presenting the lowest agreements with 22% of average agreement with the rest of the readers.

The average general disagreement by 1 year is 26% (Table 1.6). The highest disagreements are found in the reader from Spain (AZTI) (31%). This indicates an error in reading technique or problems in the interpretation of the hyaline/opaque edge of the otolith.

The average disagreement by 2 or more years between readers is 27% (Table 1.7). The highest disagreement is found in the reader from Portugal, with 61% of average disagreement with the rest of the readers. This indicates an error in reading technique or little experience of reading.

If the otoliths were read using the same criteria the functional regression slope should be 1 and the intercept should be 0. The values of regression obtained (Tables 1.8 and 1.9) show a high level of agreement between readers, except in the case of the reader from Portugal for whom large deviations are observed.

Nevertheless, the disagreements are better illustrated by calculating the standard deviations by age group (Tables 1.10 and 1.11). In Figure 1.4 the frequency distribution of the standard deviations has been drawn based on the readings of all readers providing information on the current level of precision of readings by age groups and showing how the standard deviations increase for ages >3 years. In Figure 1.5 the frequency distribution of the standard deviations has been drawn based on the readings of the best readers providing information on the maximum level of precision of readings by age

groups, and showing that the standard deviations increase for ages >5 years despite the standard deviations diminishing in all age groups in comparison with Figure 1.4.

By modal age are presented the average age recorded, the standard deviation and number of age readings by reader and of all readers (Table 1.12). The age bias plots of each age reader against the modal age present great variability, above all in older ages in many of the readers (Figures 1.6). The most biased readers are 2, 3, 7 and 8 (Scotland, England, Spain (AZTI) and Portugal). The age bias plots of all age readers is also plotted (Figure 1.7), and show greater bias from age 9.

The results of Wilcoxon's test from analyzing bias between readers is shown in Table 1.13. As can be seen there is a clear bias between most readers.

The Notched Box and Whisker plot (Figure 1.8) indicate that if the age readings of all readers were the same the graphs of all readers would be the same. It can be seen that the age readings from Portugal are completely different to those of the rest of the readers. The readings from Russia and Derunark are observed to be similar, as are those from England and Spain (AZTI).

2- Southern Area otoliths exchange sample

The readings of each reader together with the basic information concerning each otolith (year, sample number, otolith number, fish length and month of capture) are shown in Table 2.1, as are the mean age, mode, range and standard deviation for each otolith. Of the 188 otoliths examined, 148 were assigned an age by all readers and only 3 were assigned the same age by all readers.

The readers from The Netherlands, Scotland, Norway, Spain (IEO), Ireland and Russia have an higher average percentage of agreement with all readers than the average general percentage of agreement (see Tables 2.1 and 2.5) and are considered the best readers.

Table 2.2 shows the cumulative age composition as a percentage for each individual reader, for all readers and for the best readers. As seen in the western area, the reader from Portugal has a totally different age composition to the rest of the readers from age 2. In the rest of the readers the cumulative age composition shows great variability at all ages (Figure 2.1).

In Table 2.3 the age composition in number for each reader is shown. The reader from Portugal has not assigned any ages over 7 years. In Figure 2.2 the reading of each reader can be compared with the ages obtained from the modes of readings of the best readers.

The average length by age estimated from the age readings of each reader is shown in Table 2.4 and Figure 2.3. It can be seen that the reader from Portugal has assigned much younger ages than the rest of the readers. The rest of the readers show higher agreement at ages 4, 6 and 9 and show great

variability in young ages (1 to 3 years).

The percentage of agreement between readers is presented in Table 2.5 and varies between 4% and 81%. The average general percentage of agreement of all readers is low (51%). The highest agreements are found in the readers from Norway and Spain (LEO) (81%) and the readers from Russia and Norway (76%). The readers from England, Spain (AZTI), Portugal and Denmark have a lower average percentage of agreement than the average general agreement, the reader from Portugal presenting the lowest agreements with 18% of average agreement with the rest of the readers.

The average general disagreement by 1 year is 28% (Table 2.6). The highest disagreements are found in the readers from England (34%), Spain (AZTI) (31%) and Denmark (35%). This indicates an error in reading technique or problems in the interpretation of the hyaline/opaque edge of the otolith.

The average disagreement by 2 or more years between readers is 21% (Table 2.7). The highest disagreement is found in the reader from Portugal, with 59% of average disagreement with the rest of the readers. This indicates an error in reading technique or little experience of reading.

The values of regression obtained (Tables 2.8 and 2.9) show a high level of agreement between readers, except in the case of the reader from Portugal for whom large deviations are observed.

The disagreements are better illustrated by calculating the standard deviations by age group (Tables 2.10 and 2.11). In Figure 2.4 the frequency distribution of the standard deviations has been drawn based on the readings of all readers providing information on the current level of precision of readings by age groups and showing how the standard deviations are quite high for all age groups, increasing greatly for ages >3 years. In Figure 2.5 the frequency distribution of the standard deviations has been drawn based on the readings of the best readers and providing information on the maximum level of precision of readings by age groups, and showing that the standard deviations increase for ages >5 years despite the standard deviations diminishing in all age groups in comparison with Figure 2.4.

By modal age are presented the average age recorded, the standard deviation and number of age readings by reader and of all readers (Table 2.12). The age bias plots of each age reader against respect to the modal age present great variability, above all in older ages in many of the readers (Figure 2.6). The most biased readers are 3, 7, 8, 9 and 10 (England, Spain (AZTI) Portugal, Denmark and Russia). The age bias plots of all age readers is also plotted (Figure 2.7) and show greater bias from age 9.

The results of Wilcoxon's test from analyzing bias between readers is shown in Table 2.13. As can be seen there is a clear bias between most readers. The bias between reader is lower in the sample of the southern area than in that of the western area.

The Notched Box and Whisker plot (Figure 2.8) indicate that if the age readings of all readers were the same the graphs of all readers would be the same. It can be seen that the age readings from Portugal are completely

different to those of the rest of the readers. The readings from The Netherlands, Scotland, Spain (LEO), Ireland and Denmark are observed to be similar, as are those from England and Norway, and those from Russia and Spain (AZTI).

CONCLUSIONS

The results of the present paper show a low level of agreement between the readings of the different readers in the two samples. Of the 386 otoliths examined, only 311 were assigned ages by all ten readers, and in only 36 otoliths was the same age assigned by all readers.

Portugal has a very different criteria of reading to that of the rest of the readers, constantly assigning much younger ages. This can be seen in both the age composition and in the average lengths estimated in both samples, as well as in the values obtained in the functional regression.

The average lengths present higher variability from age 7 in both samples, and furthermore, in the southern area the young ages (1 to 3 years) show great variability. The growth curve of the reader from Portugal is totally different to that of the rest of the readers.

The average disagreements by 1 year between readers are similar in both samples, 28% in the western area and 26% in the southern area.

The average disagreements by 2 or more years between readers are somewhat higher in the western area (27%) than in the southern area (21%), owing to the fact that in the western area sample there was a greater number of old fish than in that of the southern area. Portugal presents a very high average disagreement with the rest of the readers (61% in the western area and 59% in the southern area), which means that this reader used a very different otolith reading criteria to that of the rest of the readers.

The values obtained from the functional regression indicate that the otoliths were read using similar criteria with the exception of the reader from Portugal, who presents great deviations in the results.

The standard deviations estimated by age groups are low for the young ages (0 to 2 years) in the western area sample and after these ages they begin to increase. In the southern area sample the standard deviations are high in all age groups. Considering the readings of the best readers the standard deviations diminish. Despite this, the standard deviations are high from age 5.

The age bias plots of each age reader against the modal age presents great variability in the two samples, above all in old ages in many readers. The age bias plots of all age readers show greater bias from age 9.

The coefficient of variation, CV, and the Average Percentage Error, APE, of all ageings, with otoliths ordered according to modal age, is very similar in both areas (except in some young ages in the southern area) and remains at around 0.1 (it may be important for the assessment that CV does

not increase with age, since some tuning methods assume CV constant with age).(Villamor & Meixide, 1994)

Wilcoxon's test shows that bias exists between most readers in the two samples.

The Notched Box and Whisker plot indicate that quite a lot of differences exist between the age readings of all readers in the two samples, above all in the western area.

The absence of bias is a minimum requirement and in view of the results and considering the importance of the age reading in the assessment, new investigations are necessary to increase agreement and to standardize ageings.

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Tab1.1 WESTERNAREA .MACKEREL rom Dv .Vla and Vllb,c and rom January • April

Year	Sample	Foil no	F-h login	Caten monilo	Ne er React	Scrttand Reade'2	Eogland R-der	Noowoy Re er	Sp(IEO) Readet\$	I fland Rudf>re	Sp(AZTTj RuO&r7	Portugal R 6er8	De4lmarc ReadfirP	Rus... Ruder1C	Aoorerage	Modo	Rano<STDF
00	00	●	2	33	8	6	6	8	6	6	6	6	8	8	500	e	1 030
00	00	●	3	350	6	6	6	6	6	6	6	6	8	8	570	e	3 016
00	00	●	4	359	6	7	3	3	3	3	3	3	3	3	300	e	0 000
90	00	●	5	38e	6	7	3	3	3	3	3	3	3	3	380	e	2 080
90	00	●	6	382	5	7	3	3	3	3	3	3	3	3	540	e	1 040
00	00	●	7	383	5	7	3	3	3	3	3	3	3	3	Ja.?	●	2 080
00	00	●	8	379	5	7	3	3	3	3	3	3	3	3	480	●	1 040
00	00	●	9	388	5	7	3	3	3	3	3	3	3	3	840	9	1 048
00	00	●	10	387	6	7	3	3	3	3	3	3	3	3	570	9	1 048
00	00	●	11	368	6	7	3	3	3	3	3	3	3	3	580	e	2 080
00	00	●	12	360	5	7	3	3	3	3	3	3	3	3	756	7	184
00	00	●	13	361	5	7	3	3	3	3	3	3	3	3	550	5	1 050
00	00	●	14	40	14	5	13	12	13	12	12	8	12	12	1213	13	2 045
00	00	●	15	40	14	5	13	12	13	12	12	8	12	12	500	5	1 045
00	00	●	16	403	8	10	7	10	8	9	9	5	10	10	880	8	10 273
00	00	●	17	409	8	10	7	10	8	9	9	5	10	10	840	e	15 155
00	00	●	18	409	8	10	7	10	8	9	9	5	10	10	770	8	6 155
00	00	●	19	418	8	10	7	10	8	9	9	5	10	10	900	9	● 110
00	00	●	20	427	8	10	7	10	8	9	9	5	10	10	757	8	5 168
00	00	●	21	427	8	10	7	10	8	9	9	5	10	10	a40	8	● 111
00	00	●	22	420	9	11	7	9	8	12	11	6	8	8	1014	12	8 270
00	00	●	23	42	9	11	7	9	8	12	11	6	8	8	e22	10	8 ve
00	00	●	24	437	10	12	7	10	10	11	8	6	8	8	944	12	8 275
00	00	●	25	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	26	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	27	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	28	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	29	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	30	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	31	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	32	437	10	12	7	10	10	11	8	6	8	8	300	3	0 000
00	00	●	33														

92	3S	1S	281	3	/	/	1	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	e	000
92	3S	18	287	3	/	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	0	000
92	3S	17	2111	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	0	000
92	3S	18	2117	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	0	000
92	3S	19	2117	3	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	0	000
92	3S	20	2111	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	0	000
92	3S	21	307	3	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	200	2	0	000
92	3S	22	308	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	300	3	0	000
92	3S	23	310	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	200	3	0	000
92	3S	24	318	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	300	3	0	000
92	3S	25	384	3	e	8	●	6	5	6	4	3	7	e	e	30	e	4	118					
92	8	1	328	2	3	3	3	3	3	3	2	2	3	3	3	280	3	1	040					
92	e	2	348	2	5	5	5	5	5	5	5	3	e	S	480	S	3	070						
92	e	3	346	2	■	4	4	4	4	4	4	3	4	4	390	4	1	030						
92	92	4	343	2	●	●	3	4	4	4	3	3	4	4	370	●	1	046						
92	92	6			S	S	5	5	5	5	5	3	S	5	480	5	2	089						
92	92	6	S	352	2	5	S	4	5	5	●	●	5	4	50	5	1	050						
92	92	6	7	383	2	5	●	3	4	4	●	4	3	4	3	4	2	057						
92	92	6	6	372	2	5	●	3	4	4	●	4	3	4	4	4	2	057						
92	92	8	7	378	2	8	9	5	g	8	g	6	4	8	9	9	3	168						
92	92	e	10	375	2	6	7	7	7	7	7	7	5	7	8	7	3	075						
92	92	e	10	372	2	9	8	9	9	8	11	S	S	9	9	9	4	155						
92	92	8	12	38S	2	6	6	6	9	8	5	8	3	8	8	8	6	018						
92	92	8	13	373	2	S	S	●	5	5	8	7	4	4	8	8	5	133						
92	92	e	13	380	2	e	9	1	9	8	5	8	8	8	8	8	8	133						
92	92	8	15	391	2	10	11	10	12	10	13	7	8	10	11	1000	10	7	200					
92	92	8	15	390	2	e	5	5	ts	6	e	5	4	6	8	550	ts	2	007					
92	92	8	17	393	2	11	13	12	13	12	13	11	5	13	13	1180	13	0	233					
92	92	0	18	402	2	9	9	8	9	7	8	7	e	6	9	780	9	3	128					
92	92	8	19	408	2	8	9	e	7	8	7	7	5	7	7	710	7	●	104					
92	92	e	20	408	2	11	12	6	12	11	12	10	5	11	11	1030	11	7	210					
92	92	8	21	408	2	9	9	8	9	6	9	8	e	9	g	840	9	3	0112					
92	92	8	22	413	2	9	10	9	9	9	9	9	7	9	9	869	9	3	074					
92	92	8	22	410	2	9	10	9	9	9	9	9	8	g	10	944	9	8	208					
92	92	6	24	431	2	11	13	12	13	12	13	11	5	g	13	1120	13	8	240					
92	92	6	25	458	2	17	14	14	16	15	15	13	7	18	7	114	18	10	318					
92	92	28	1	318	3	4	S	5	8	5	e	S	4	5	e	S20	6	2	on					
92	92	28	2	318	3	4	S	5	8	5	e	4	●	S	5	480	5	1	(040)					
92	92	28	3	379	3	6	6	5	6	8	6	5	4	e	8	560	6	2	0LU					
92	92	28	●	388	3	6	6	6	e	8	e	5	4	6	e	510	S	2	064					
92	92	26	6	387	3	5	6	e	7	e	8	4	7	e	e	SA0	S	5	138					
92	92	28	6	383	3	7	6	8	8	7	6	7	5	7	8	710	7	S	094					
92	92	26	7	385	3	6	6	6	ts	e	e	e	5	7	7	510	6	2	054					
92	92	28	8	398	3	6	8	8	8	8	6	7	5	7	9	700	6	●	116					
92	92	26	9	<400	3	6	6	4	e	e	7	5	4	S	6	550	E	3	092					
92	92	28	10	387	3	7	8	6	8	8	9	8	4	a	10	780	8	6	158					
92	92	28	11	407	3	7	9	1	8	7	9	7	S	8	8	750	7	4	112					
92	92	26	13	404	3	6	7	6	7	e	e	e	5	7	e	620	8	2	080					
92	92	28	14	407	3	8	11	11	11	e	11	11	5	6	g	867	a	6	17e					
92	92	26	15	413	3	7	11	7	9	7	7	6	5	9	g	717	7	●	127					
92	92	28	15	428	3	12	11	10	10	10	13	9	e	g	10	1000	10	8	237					
92	92	28	11	424	3	13	13	8	13	13	13	11	e	8	13	1110	13	7	2511					
92	92	28	18	435	3	12	15	9	10	12	11	10	4	10	10	1030	10	11	285					
92	92	26	19	439	3	11	14	12	12	12	12	11	8	11	10	1130	12	8	197					
92	92	28	20	439	3	12	14	12	13	12	12	12	e	13	13	1210	12	8	211					
92	92	26	21	440	3	10	11	9	12	11	9	5	12	13	13	1022	11	8	225					
92	92	28	22	449	3	13	19	11	15	15	15	13	S	15	15	1325	15	1	380					
92	92	26	23	453	3	15	18	15	14	15	15	15	7	15	11	113	15	11	293					
92	92	26	24	453	3	13	10	15	15	15	13	S	13	15	11	1238	13	10	318					
92	92	28	25	488	3	10	8	8	10	10	11	Q	5	8	10	869	10	8	168					
92	92	30	1	1S7	3	S	6	5	S	5	S	4	5	5	5	500	S	2	045					
92	92	30	2	388	3	6	6	6	8	5	e	5	4	S	5	550	6	2	067					
92	92	30	3	392	3	8	7	6	6	e	7	5	4	7	6	600	6	3	089					
92	92	30	●	383	3	g	10	9	9	8	Q	e	S	9	g	850	9	S	128					
92	92	30	5	391	3	8	10	8	9	g	9	7	5	9	8	830	9	S	138					
92	92	30	6	406	3	8	9	9	8	8	9	7	4	8	9	830	9	5	155					
92	92	30	7	407	3	9	9	10	8	8	8	5	9	8	8	850	9	S	128					
92	92	30	6	405	3	8	8	8	8	8	8	5	8	8	9	820	9	4	117					
92	92	30	9	10	3	/	7	7	7	7	7	S	8	7	7	890	7	3	070					
92	92	30	10	409	3	7	6	7	7	7	8	7	4	6	7	630	7	3	0VO					
92	92	30	11	412	3	8	8	8	8	8	8	e	4	8	8	780	8	●	<20					
92	92	30	12	<1V	3	10	14	14	13	11	11	1	1	11	11	780	8	●	<20					
92	92	30	13	2e	3	9	8	8	8	8	11	7	S	10	7	813	8	6	178					
92	92	30	14	4n	3	S	8	9	9	9	g	8	8	10	7	810	9	11	111					
92	92	30	15	420	3	14	16	14	13	14	14	11	5	13	14	810	9	11	111					
92	92	30	16	422	3	8	9	9	8	8	8	8	e	11	9	1260	11	2U	111					
92	92	30	17	438	3	11	1S	13	11	11	12	S	<0	9	9	863	1	●	111					
92	92	30	18	438	3	9	11	9	10	10	12	8	e	10	11	1133	1	6	176					
92	92	30	19	440	3	12	13	13	12	12	12	12	6	12	13	960	10	6	162					
92	92	30	20	433	3	9	5	5	7	7	5	●	6	6	6	1180	2	5	137					
92	92	30	21	435	3	11	9	9	9	8	9	a	●	9	8	576	5	5	140					
92	92	30																						

[illegible][illegible]

[illegible]

Table 1.6. WESTERN AREA. Agreement (%) of otolith readings.

Reader	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Mean per reader
Reader 1		5611>	1>0%	71%	5<%	7.11.	\$2.	55%			51%
Reader 2			Qu4e-3	Rtao.r5		Ill'lo		'L. .6<, 10			46%
Reader 3			4211.	81%	.a...						48%
Reader 4											53%
Reader 5											54%
Reader 6											51%
Reader 7											43%
Reader 8											22%
Reader 9											50%
Reader 10											51%
Reader 11											47%

Table 1.6. WESTERN AREA. Disagreement of one year (%) beiWHn otolith readings. This could be due to misinterpretation of the hyaline/opaque edge of the otolith.

Reader	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Mean per reader
Reader 1		21.1	21.1	22.1	36%	1.11	1.11	3010			26%
Reader 2			21.1	22.1	36%	1.11	1.11	3010			25%
Reader 3				22.1	36%	1.11	1.11	3010			27%
Reader 4					36%	1.11	1.11	3010			26%
Reader 5						1.11	1.11	3010			27%
Reader 6							1.11	3010			27%
Reader 7								3010			31%
Reader 8									3010		17%
Reader 9										3010	26%
Reader 10											26%

Table 1.7. WESTERN AREA. Disagreement of two or more years (%) beiWMn otolith readings

Reader	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Mean per reader
Reader 1		27%	2001.	19%	7%	16%	23%	51%	17%		23%
Reader 2			31%	15%	11%	11%	851.	24%			25%
Reader 3				11%	11%	11%	11%	11%			24%
Reader 4					11%	11%	11%	11%			21%
Reader 5						11%	11%	11%			20%
Reader 6							11%	11%			22%
Reader 7								11%			26%
Reader 8									11%		61%
Reader 9										11%	22%
Reader 10											27%

Table 1.8. WESTERN AREA. Slope from functional linear regressions of age determinations (should be close to 1). A deviation from 1 indicates that certain age groups are aged older or younger.

Reader	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Mean per reader
Reader 1		0.86	0.89	0.89	0.86	0.73	0.33	0.61	0.82		0.91
Reader 2			0.89	0.89	0.86	0.73	0.33	0.61	0.82		0.77
Reader 3				0.89	0.86	0.73	0.33	0.61	0.82		1.00
Reader 4					0.86	0.73	0.33	0.61	0.82		0.89
Reader 5						0.73	0.33	0.61	0.82		0.92
Reader 6							0.33	0.61	0.82		0.86
Reader 7								0.61	0.82		1.10
Reader 8									0.82		2.59
Reader 9										0.82	0.99
Reader 10											0.97

Table 1.9. WESTERN AREA. Intercept from functional linear regressions of age determinations (should be close to 0). A deviation from 0 indicates a consistent misreading of 1 or more years or that certain age groups are aged older or younger.

Reader	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Mean per reader
Reader 1		-0.69	0.10	-0.41	-0.01	-0.13	0.55	1.49	0.28	0.14	0
Reader 2			0.55	0.12	0.55	0.54	0.90	1.85	0.75	0.81	0
Reader 3				0.12	0.55	0.54	0.90	1.85	0.75	0.81	0
Reader 4					0.55	0.54	0.90	1.85	0.75	0.81	0
Reader 5						0.54	0.90	1.85	0.75	0.81	0
Reader 6							0.90	1.85	0.75	0.81	0
Reader 7								1.85	0.75	0.81	0
Reader 8									0.75	0.81	0
Reader 9										0.81	0
Reader 10											0

Reader 1: -0.11, -0.86, -0.52, -0.00, -0.42
Reader 2: 0.00, 0.15, 0.48, 0.00, 0.136

	.016
	.372

	.016
	.372
	-.001

Table 1.10. WESTERN AREA. Frequency distribution of STOEV from all readers.

Silt interval OSO	<i>i</i>	AGE 3-5	<i>!</i>	AGE 9-11	<i>!!</i>	AGE 15+
0-21	21	1	0	0	0	0
21-120	120	6	33	8	2	0
120-200	200	2	18	5	0	0
200-300	300	0	0	10	6	2
300-318	318	0	0	0	0	0
318-420	420	0	0	0	0	2
420-500	500	0	0	0	0	0
500-600	600	0	0	0	0	0
600-680	680	0	0	0	0	0
2< .0 61 45 7 9 ...!!!U						

Table 1.11. WESTERN AREA. Frequency distribution of STOEV from the readers with an agreement above average.

Silt interval OSO	AGE 0-2	<i>A</i>	<i>!!</i>	AGE 12-14	<i>!</i>
0-21	21	2	7	3	0
21-120	120	10	22	3	0
120-200	200	2	25	10	0
200-300	300	0	6	5	2
300-318	318	0	0	3	0
318-420	420	0	0	0	0
420-500	500	0	0	0	0
500-600	600	0	0	0	0
600-680	680	0	0	0	0
0. 111 20 1 21 10 ...!!!U					

MACKEREL (Div. VIa and VIIc) EXCHANGE SA\FPLE First rea<Hn

Table 1. By modal age of the pruned by age. The following table shows the number of fish by age class by reader and of all fish.

REA001

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	3.00	4.05	5.19	5.77	7.06	7.94	8.96	10.13	11.20	12.00	12.87	12.75	14.40
2nd dev	-	-	0.00	0.00	0.58	2.08	1.17	0.88	1.45	2.06	1.77	1.88	2.21	2.00	4.43	1.79
n	0	0	22	12	12	18	26	17	18	19	16	10	8	8	4	5

READER 2

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	3.00	4.17	5.31	6.31	8.00	8.06	10.06	11.18	11.90	13.63	13.83	15.00	17.00
2nd dev	-	-	0.00	0.00	1.15	0.98	1.98	2.73	2.88	4.55	3.00	3.48	2.36	3.88	2.31	5.28
n	0	0	22	12	12	16	26	16	16	17	16	10	8	8	4	3

READER 3

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	3.00	3.67	4.75	5.62	6.71	7.84	8.47	8.88	10.00	10.75	11.56	12.50	11.60
2nd dev	-	-	0.00	0.00	0.98	0.99	1.38	1.37	2.42	2.15	3.42	2.98	4.75	4.37	3.48	4.16
n	0	0	22	12	12	16	26	17	18	19	18	10	8	9	4	5

READER 4

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	3.00	4.30	5.29	6.24	7.54	8.06	10.06	11.18	11.90	13.63	13.83	15.00	17.00
2nd dev	-	-	0.00	0.00	1.90	0.94	1.08	1.54	1.54	2.73	3.00	3.48	2.36	3.88	2.31	5.28
n	0	0	22	12	10	14	25	16	16	17	16	10	8	8	4	3

READER 5

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	3.00	4.00	5.08	5.85	6.94	7.88	8.78	10.18	11.20	12.25	12.87	13.25	14.80
2nd dev	-	-	0.00	0.00	0.00	1.15	0.74	0.88	0.88	1.78	1.31	1.84	0.93	2.65	1.91	1.15
n	0	0	22	12	12	16	26	17	18	18	16	10	8	8	4	4

READER 6

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	3.00	4.17	5.19	6.27	7.24	8.17	9.22	10.63	11.00	12.38	13.14	13.80	14.90
2nd dev	-	-	0.00	0.00	1.15	1.06	1.86	1.86	2.90	1.10	2.28	1.88	1.83	1.80	2.00	2.00
n	0	0	22	12	12	16	26	17	18	18	18	10	8	7	4	4

READER 7

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	2.92	3.75	4.81	5.46	6.71	7.72	7.85	9.06	9.70	10.88	11.56		
2nd dev	-	-	0.00	0.58	1.24	1.50	1.29	1.37	2.36	2.45	1.71	2.12	2.77	2.87	0.00	8.88
n	0	0	22	12	12	16	26	17	18	18	18	10	8	9	4	5

READER 8

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.05	2.92	3.60	3.84	4.35	4.89	4.87	5.32	5.43	4.75	5.43	5.67	4.87	8.00
2nd dev	-	-	0.43	0.58	0.85	1.12	1.38	1.20	1.85	1.50	1.70	2.07	3.24	2.42	1.15	2.45
n	0	0	22	12	12	16	26	16	16	16	16	8	7	8	2	6

READER 9

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.05	3.00	3.92	5.19	6.00	7.00	8.06	8.88	9.31	11.10	11.43	11.93	12.50	13.75
2nd dev	-	-	0.43	0.00	0.58	1.06	1.50	1.99	2.11	2.13	1.75	1.98	3.24	4.00	3.48	5.00
n	0	0	22	12	12	16	26	16	16	16	16	10	7	8	4	4

READER 100

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.00	2.92	3.75	4.81	5.46	6.71	7.72	7.85	9.06	9.70	10.88	11.56		
2nd dev	-	-	0.00	0.58	1.24	1.50	1.29	1.37	2.36	2.45	1.71	2.12	2.77	2.87	0.00	8.88
n	0	0	22	12	12	16	26	17	18	18	18	10	8	9	4	5

ALL READERS

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	-	2.01	2.98	3.92	5.01	5.80	6.93	6.00	6.66	6.48	10.37	11.38	11.98	12.22	12.43
2nd dev	-	-	0.23	0.28	1.21	1.52	1.72	2.35	3.04	3.29	3.81	4.25	5.11	4.76	5.58	7.33
n	0	0	220	120	118	158	209	185	171	183	158	94	74	82	37	40

G00/100

0IA '0'3'1 _____

HC6t BS tC-.Q, fl: **n** S6 . z0 ,I.0

Table 1.13. Results of Wilcoxon's test of the sample of Divisions VIa and VIIbc.

READERS	2	3	4	5	6	7	8	9	10
1	**	**	**	-	**	**	**	-	-
2		**	-	**	**	**	**	**	**
3			**	**	**	*	**	**	**
4				**	**	**	**	**	**
5					**	**	**	-	-
6						**	**	**	*
7							**	**	**
8								**	**
9									*
10									

* : Absence of bias
 * : Possibility of bias
 ** : Certainty of bias

Table 2.1. SOUTHERN AREA. MACKEREL from Oliv. VIIIc -IXa and from February -April and September.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
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Agreement about aver-ot?

Table 2.2. SOUTHERN AREA. Cumulative age composition by region in percentage. Cumulative age composition of all and best readers obtained from the modes.

	ft	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
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3	7	4	15	5	1	•	7	52	12		•	4
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5	111	19	27	18	16	113	15	2&	34	211	20	16
e	32	2•	18	29	28		38	20	3	18	31	ss
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10	7	5	•	8	9		8		3	13	13	9
11	5	11	8	2	7		s		10	3	8	7
12	5		3	5					8	9	7	5
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Tab2.4. SOUTHERN AREA. 1\Nn n11h aby otolilh rtadet (without C())(Eon DI meaured below).

	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12
0	203	202	202	202	202	202	202	202	202	202	202	202
1	1es	f.2	f.	24 2	24 1	202	28	f.	20 5	31 o	f.	f.
2	242	266	353	289	202	20	28	357	253	31 o	31 o	26
3	339	376	35 o	367	318	316	382	37 3	33 7	332	37	374
4	362	358	365	355	357	358	382	357	358	359	358	357
5	357	363	383	369	386	386	37 8	42 3	373	37 5	370	386
7	400	400	39 e	3i 1	398	385	33	438	399	391	351	394
6	388	38&	391	391	382	389	352	433	38 4	386	391	388
8	3e	380	3	40 4	399	401	406		403	407	403	396
10	434	423	42.	416	41 o	438			426	413		
9	41'	41 o	415	415	41 3	41.	420		41 o	42 o	413	41 1
	431	424.	443	434		. S	429		432	429	431	429
13	0	436	433	448	435	1			445		435	435
12	32	430	438	435	433	U0	433		427	433	431	432
14	435	448	448		434		445		441		441	432
15	43 5	42 3	428		449						435	435

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Findings.

Mean per reader
52%
57%
49%
64%
58%
56%
50%
18%
48%
58%
51%

SOU
mls

Mean per reader
26%
26%
34%
24%
24%
30%
31%
23%
35%
25%
28%

SOI

Mean per reader
18%
17%
17%
12%
19%
15%
19%
59%
16%
18%
21%

SOU
A d

Mean per reader
0.94
0.86
0.98
0.91
0.83
0.97
1.02
2.10
1.00
1.01
1.06

SO
A c

Mean of reader
-0.11
0.22
0.31
0.66
0.31
0.28
.009
.081
.061
.016

Table 2.10. SOUTHERN AREA. Frequency distribution of STDEV from all readers.

size		AGE	AGE	AGE	AGE	AGE
		0-2	3-4	5-6	7-8	9-11
125	100	1	1	1	0	0
175	150	19	22	30	3	0
225	200	6	15	6	0	0
275	250	0	1	1	8	1
325	300	0	0	0	4	3
375	350	0	0	0	0	0
425	400	0	0	0	0	0
475	450	0	0	0	0	0
525	500	0	0	0	0	0
575	550	0	0	0	0	0
		36	5	57	28	8

Table 2.11. SOUTHERN AREA. Frequency distribution of STDEV from the readers with an agreement above average.

size		AGE	AGE	AGE	AGE	AGE
		0-2	3-4	5-6	7-8	9-11
125	100	15	23	15	5	2
175	150	0	0	6	5	2
225	200	0	0	0	2	1
275	250	0	0	1	0	1
325	300	0	0	0	0	0
375	350	0	0	0	0	0
425	400	0	0	0	0	0
475	450	0	0	0	0	0
525	500	0	0	0	0	0
575	550	0	0	0	0	0
		36	52	58	31	9

MACKEREL (Div.VIIIc and IXa) EXCHANGE SA. .PLE Fit readings.

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Tobsa1...,1:Sy modal age -prese-nled lltl otwugt age recorded, the stdev and number of
agor ingaby readef anc <<al!rert..
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REAOR 1

$$\text{AG} \ll \text{-orded } \begin{matrix} \text{frlod:il} & - & 0 & & 1 & & 1 \\ & & 0,2t & & 2.01 & & \\ & & & & & & e' \end{matrix}$$

2	3	4	5	6	7	8	9	10	11	12	13	14	15
3.50	3.25	4.09	5.40	5.97	7.19	8.00	8.92	9.83	11.29	11.50	13.00	14.00	15.00
1.41	1.00	0.77	2.09	1.41	1.31	1.83	3.11	1.04	2.51	2.45			0.00
2	4	33	22	31	18	10	12	8	7	6	1	1	2

1 0 **READER 2**

[illegible]

1-Share:

Modl1 a:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A:	1.14	2.50	1.27	3.70	.SS	5.47	0.1a	7.40	e.00	a.00	-an	10.50	7.00	13.00	12.00
2'1Y	1.0	1.41	1.00	0.1	1.01	1.40	2.14	0.5.8	1.0	1.70	•a	10.1	1.1	1.1	5.88
n	10	2			20	10	10	10	10	10	7	1	1	1	1

1 READER 42

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		7	14			31	H	27	18	e	10	S1	1	S	1	0
												7	1	0	1	0

READER **i**

	REAOER i																								
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n	0.00	0.53	1	0.00	-	1.08	150	10	1	140	Z	4.11	3.21	1.	-	-	-	-	-	-	-	-	-	-	-
			14	2	2		1&				E	-	-	-	7	0						1	1	2	

READERi

	READER <i>i</i>															
1h4o1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Alt OMIM	000	1	207	210	BO	408	545	10	00	110	100	100	100	100	100	1200
2"tdw	0,00	0,11	1	1	1,1	0,1	1,11	1,17	1,1	1,14	000	2,14	1	1	0000	1200
	20	1	2	1	33	20	10	10	13	1	7	0	1	1	2	00

A horizontal number line with arrows at both ends. There are two major tick marks labeled '0' and '1'. A third tick mark is located exactly halfway between 0 and 1, representing the fraction 1/2.

Modal	0	1	1		6	-	7	1	●	10	.	1	12	U	te	10			
Ao...>N>G	0.00	1.14	2.00		4.00	4.10	5.83	1.00	1.10	1.7	j	12S	U	j	iO	1	10.00	12.00	1.250
y,y,d	D.00	0,,	000		1-1.40	1.1	.78	.83	1.	1.32	1.77	2.43	1	2.30					4.24
n		,,	1	2		1	1)		10	2t		1	10		1	1	1	2	2

REAORDER 8

[illegible]

RE.ADE.R 11

READER11

If oct11:oge D. 1 1 2 j 1 v f 7 1 10 H 12

1.00 1.200 2.00 1.325 .og 1. GS e 1 7'9 ao 1 s& t3l .u 10.07 10.00

7' 0.1 0.00 1.00 0.17 0.1t 0 0 1 1 2 127

11 1!! 12 11 J3;t 20 31 te 10 13 6 7 e 1 1 -1.41

READSR1

[illegible]

AI.LREADERS

ALL READERS														
Md Oa	0	J	1	a	1	?	1	t	J	10	H	12	"	"
AQ,.....rddo	012	141	1	s										
				ua	1.0	6.1	861							
Z'tdt	0.88	\,D	U10	1.01	1.2	1.1	2.04	2.51	2.84	4.72	6.72	5.04	5.04	U71
n	1:0	1:0	1t	1e	W	1c	1 2t1	163	"	84	67	5	10	"

Table 2.13. Results of Wilcoxon's test of the sample of Divisions VIIIc and IXa.

READERS	2	3	4	5	6	7	8	9	10
1	-	**	*	-	-	**	**	-	**
2		**	-	-	-	**	**	-	**
3			**	**	**	-	**	**	**
4				**	-	**	**	**	**
5					**	**	**	-	**
6						**	**	-	**
7							**	**	**
8								**	**
9									**
10									

* : Absence of bias
 * : Possibility of bias
 ** : Certainty of bias

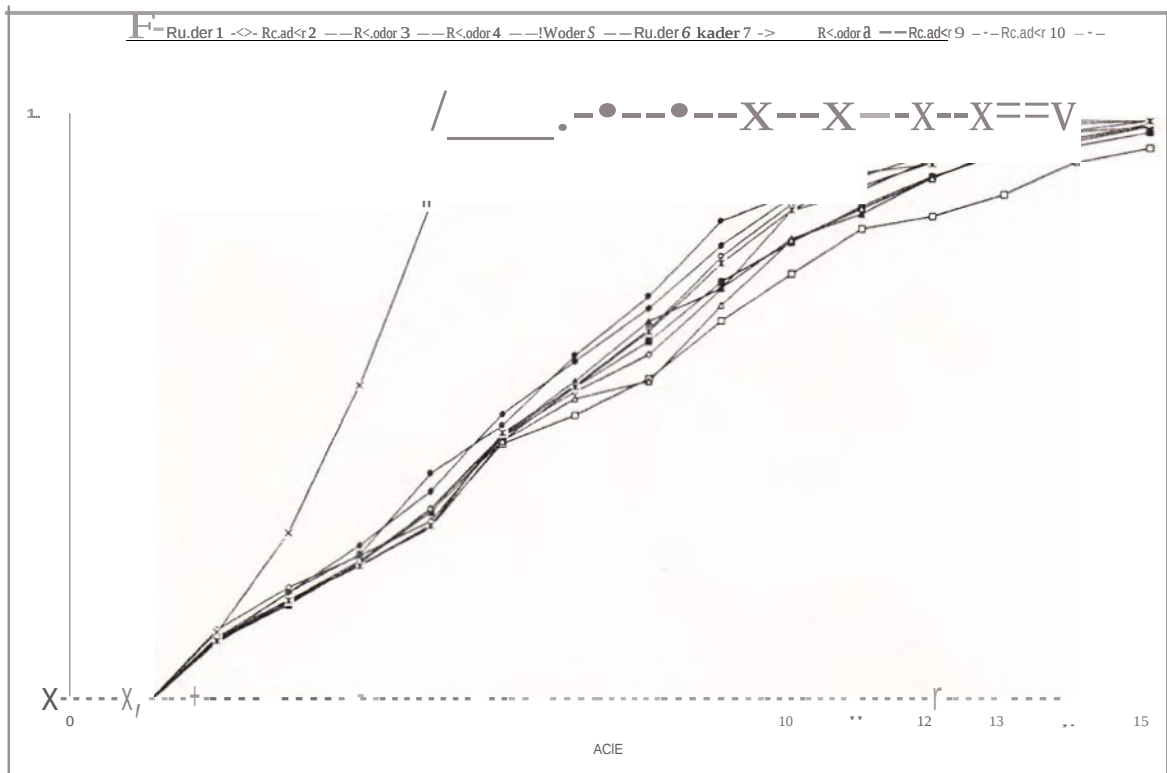


Figure 1.1. W!STfRH AREA.CumiN11n — compoaltlon by age .eld.r In percentage.

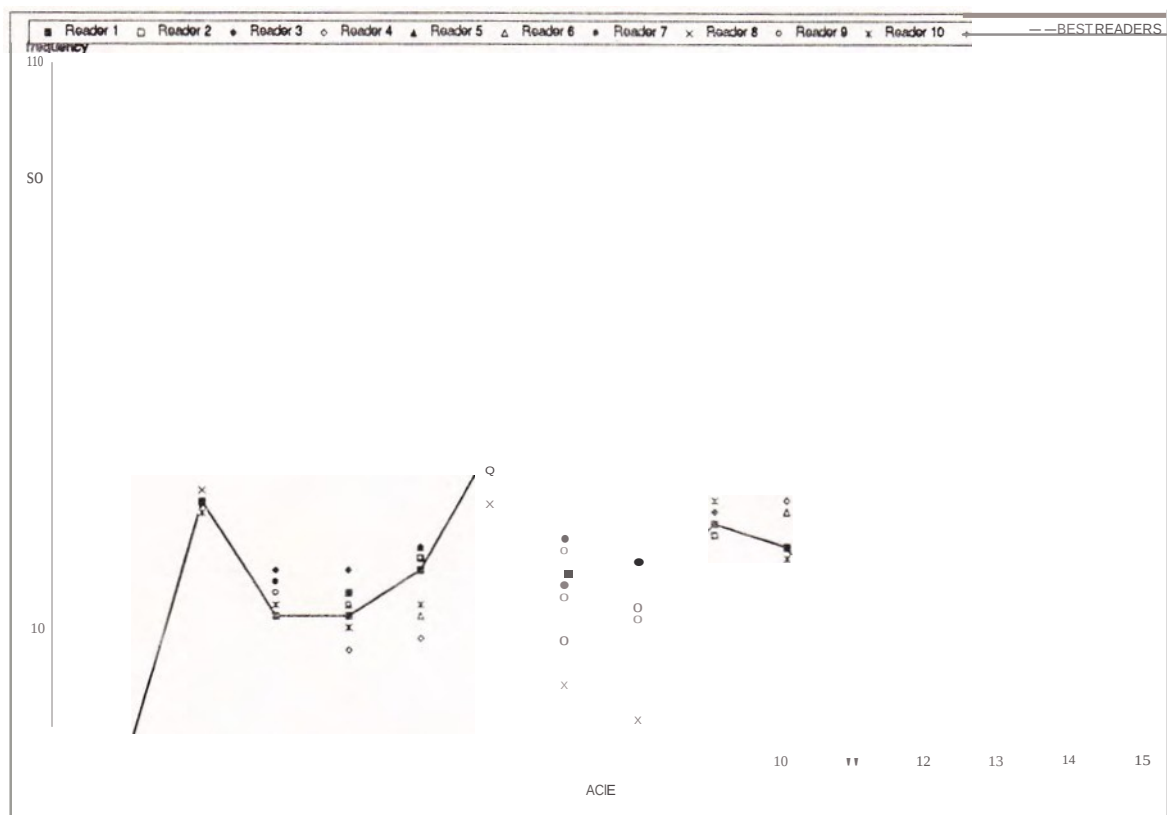


Figure 1.2. W!STfRH AAEA .Aoe composllonInnnumbers of olclllhs .eldby otclllh reld.r. Aoe ccmposlton from "IM>st relde.s" 1& obtained from leldel\$ above av"* .I• agr-..en1(\$M Tat>r.5).

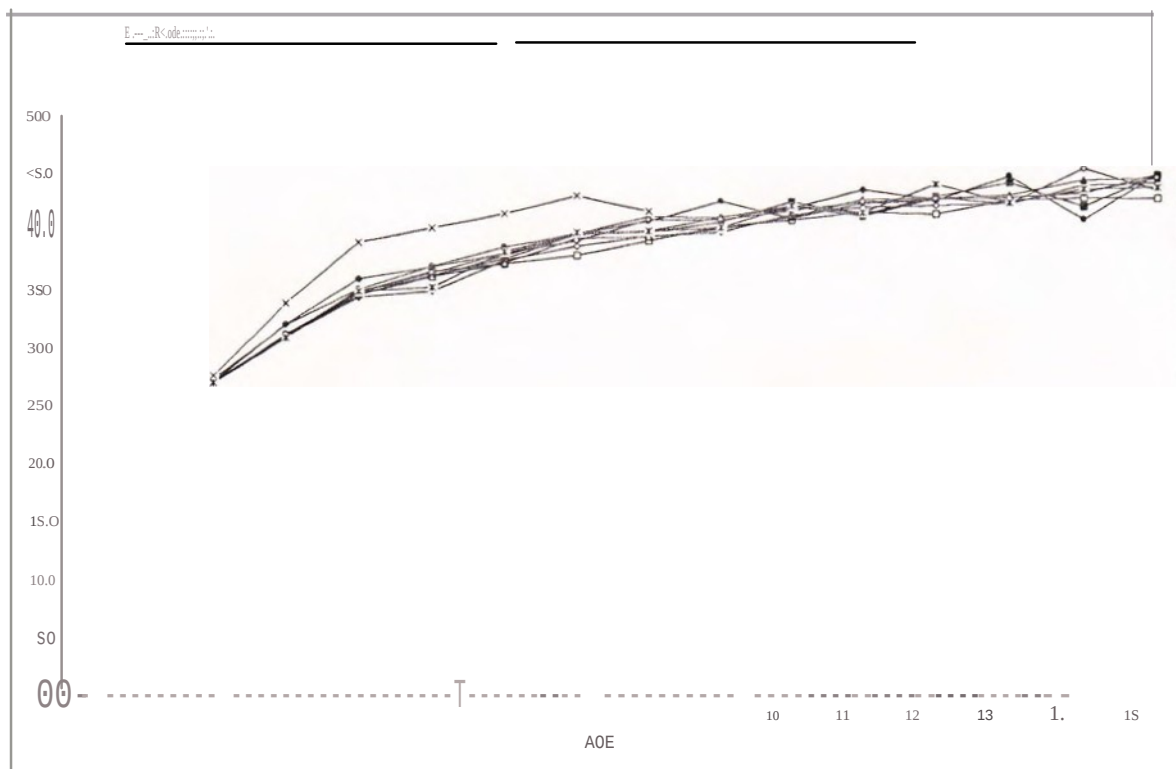


Figure 1: S. WESTERN AAEA. Mean length/age by otolith core (without correction for measurement below).

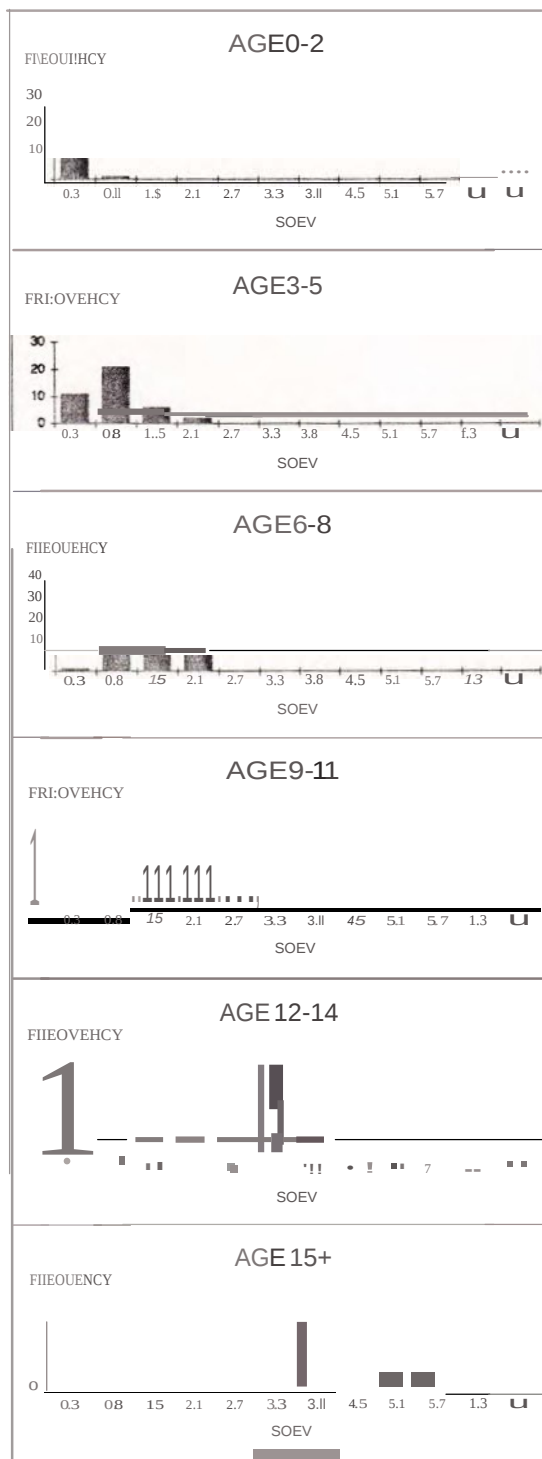


Figure 14. WESTERN AAEA. Frequency distribution of STDEV for all 10m life readers with an age-point above av.

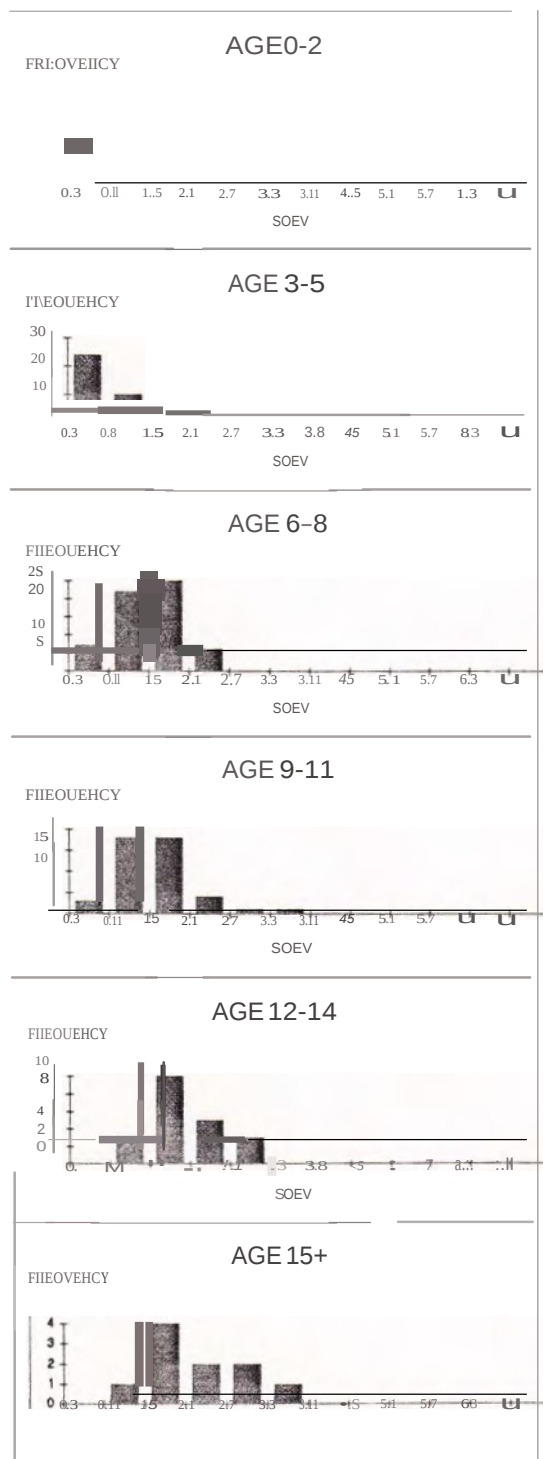


Figure 15. WESTERN AAEA. Frequency distribution of STDEV for all 10m life readers with an age-point above av.

MACKEREL (Div. VIa and VIIbc) EXCHANGE SAMPLE First readings.

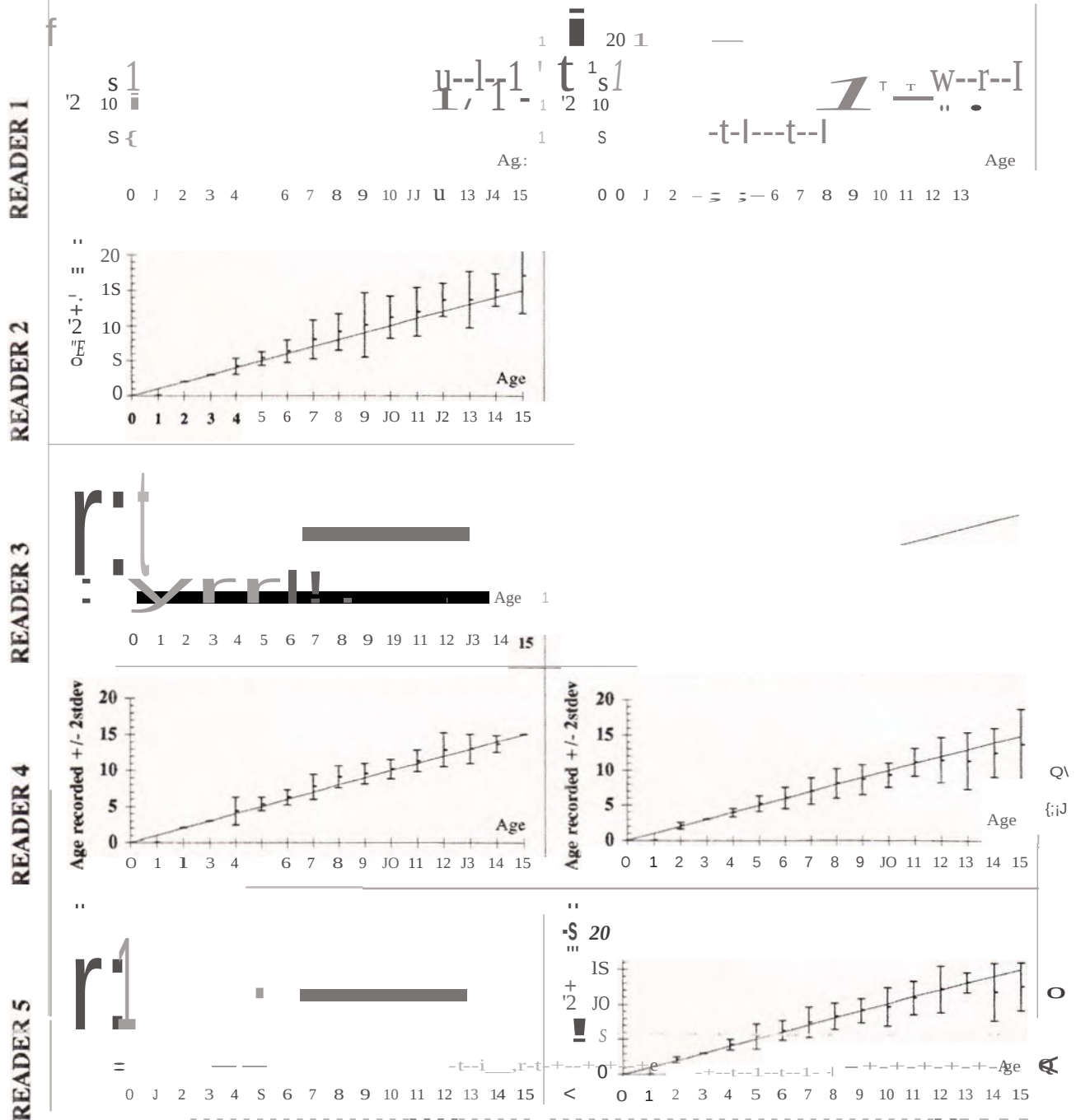


Figure 1.1 - In above age bias plots average age $\pm$ 2stdev of each age reader is plotted against modal age.

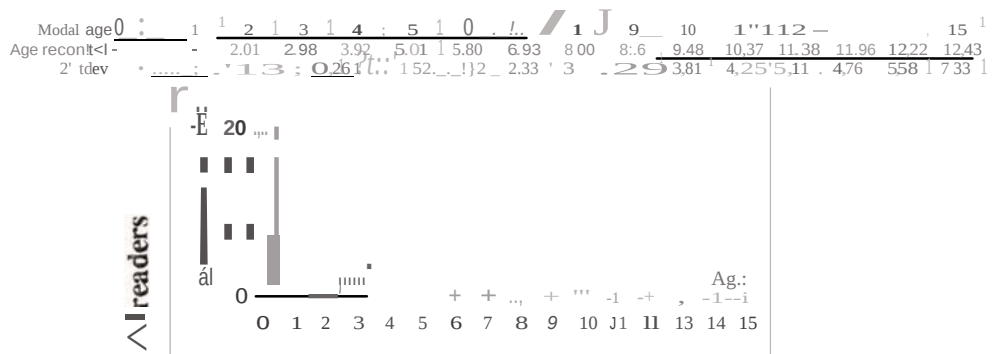


Figure 1.1 - In above age bias plot average age $\pm$ 2stdev of all age readers is plotted against modal age.

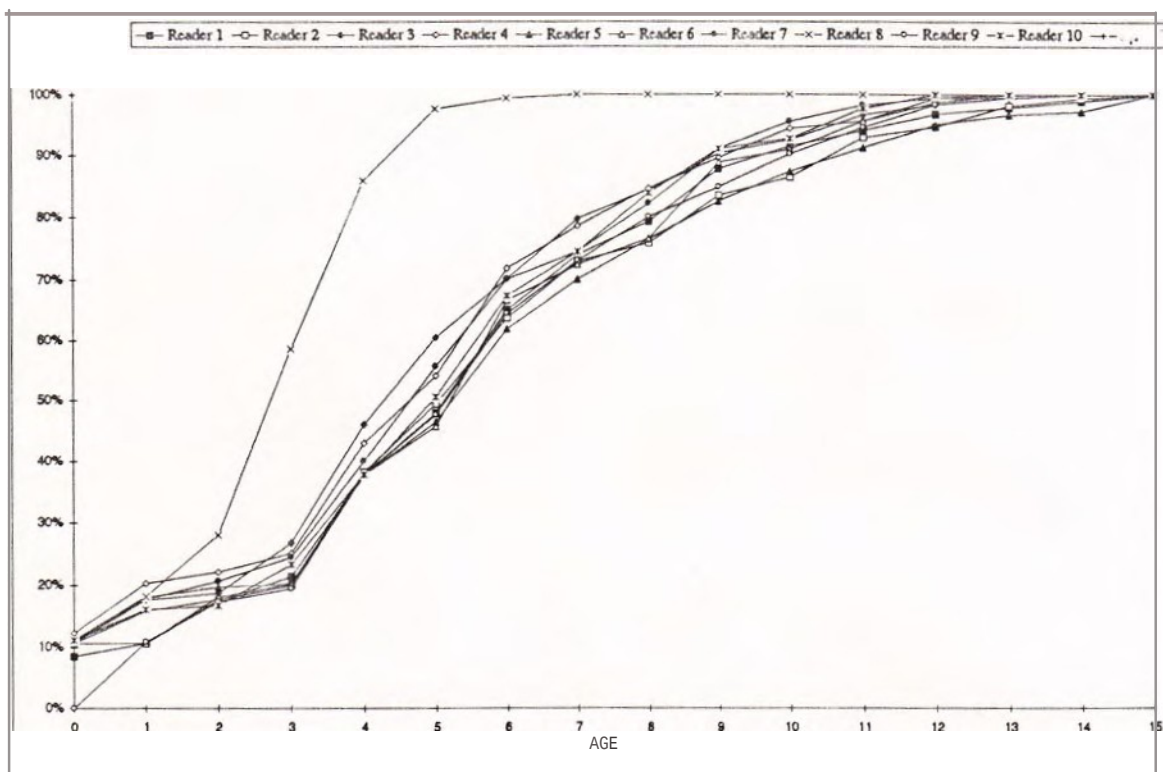


Figure 2.1. SOV11fRN AREA. Cumulative age composition by age reader in percentage.

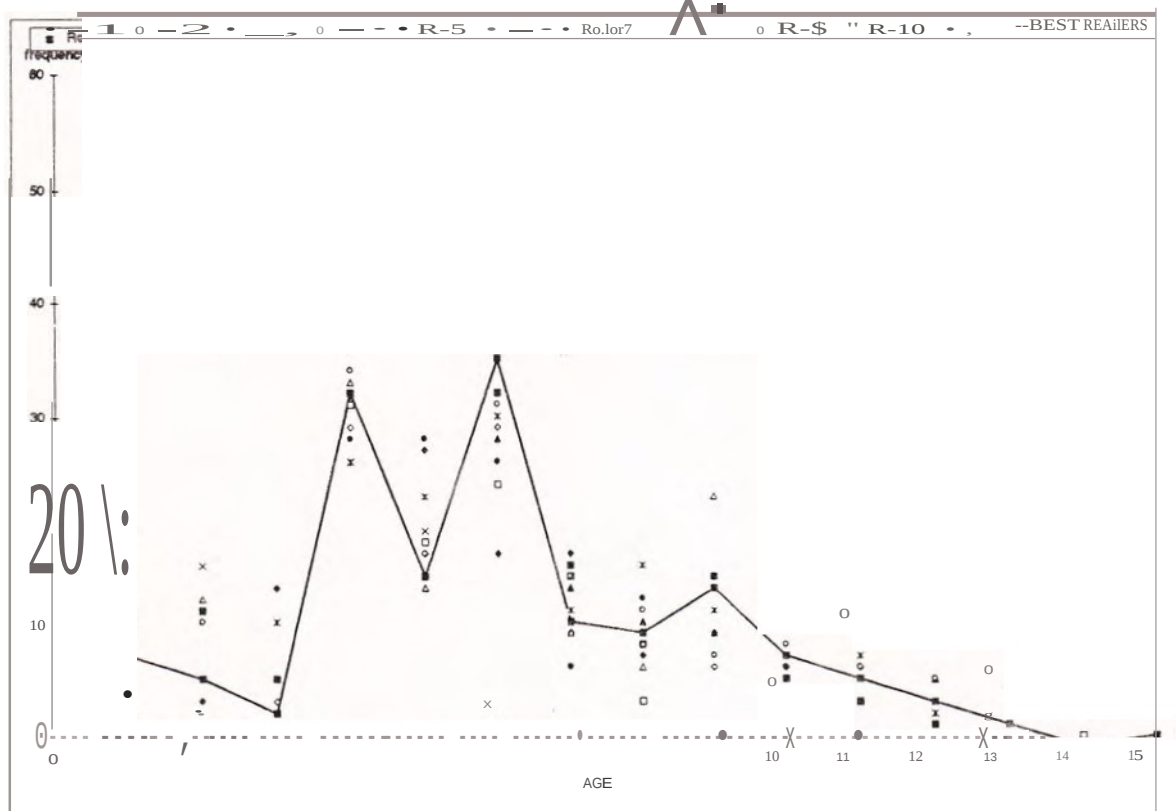


Figure 2.2. SOV11fRN AREA. Age composition in number of otoliths read by otolith reader. Age composition from "Most read" is obtained from ... above average age < 6 mm (see Table 5).

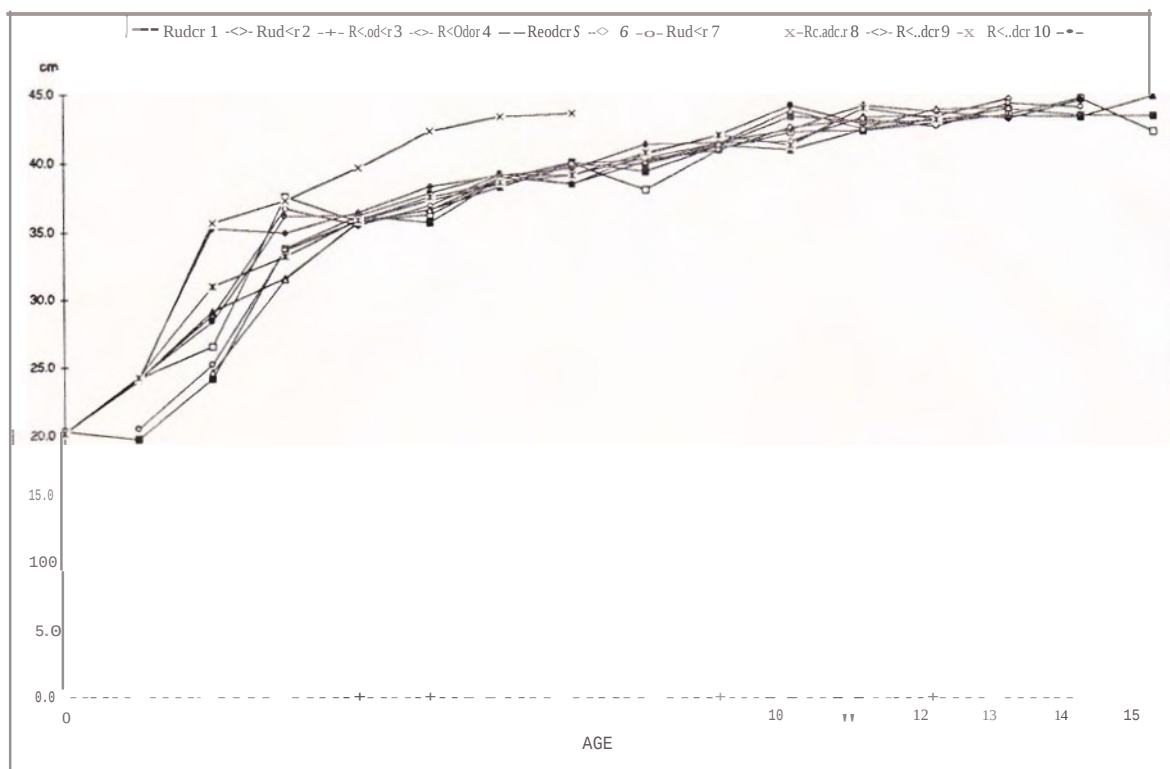
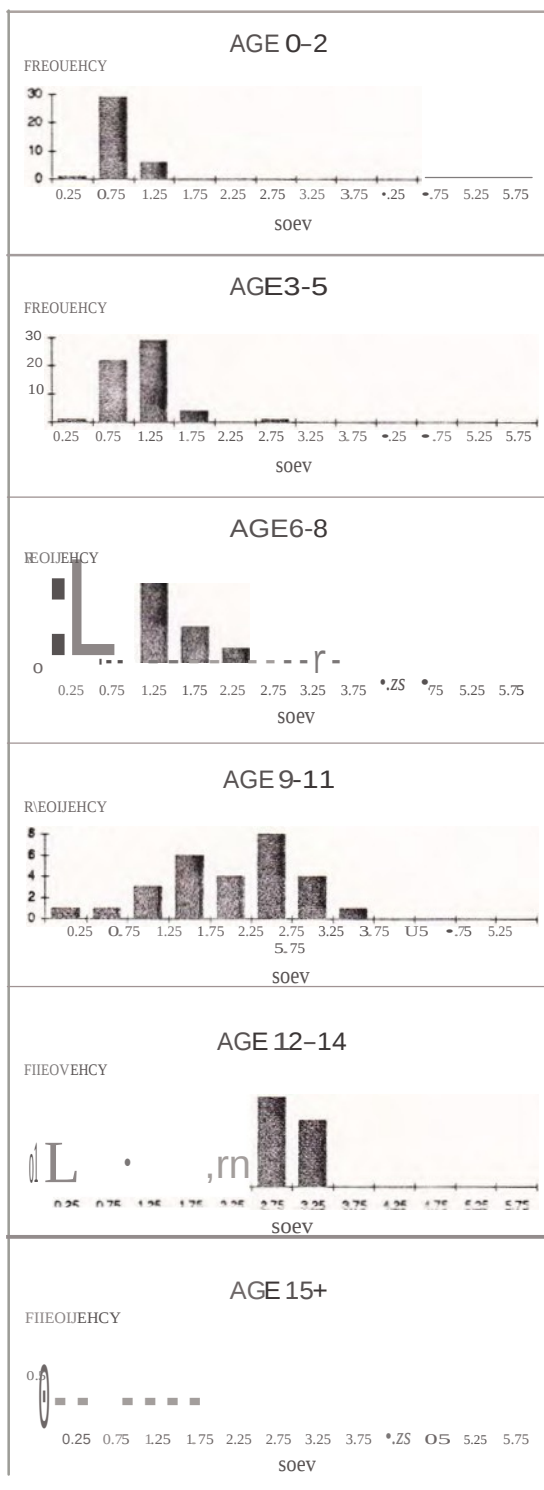


Figure 2.3. SOUTHERN AREA. JMant age by 010111 reader (wt1hoU1conoection lof !!leUUred below).



AgUr@ 2.4.

SOUTHERN AREA. Frequency distribution of STDEV from all 11 years.

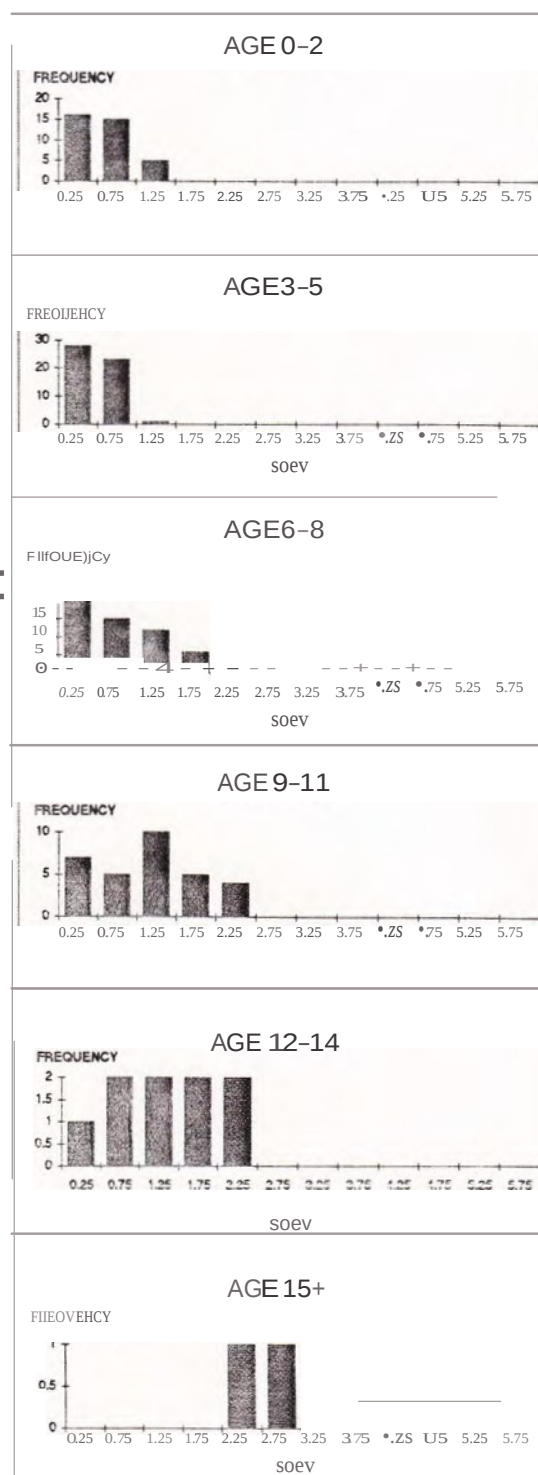


Fig.-25.

SOUTHERN AREA. Frequency distribution of STDEV from the years with an average less than 1 above average.

ACKEREL (Div.VIII) EXCHANGE S L E First readings.

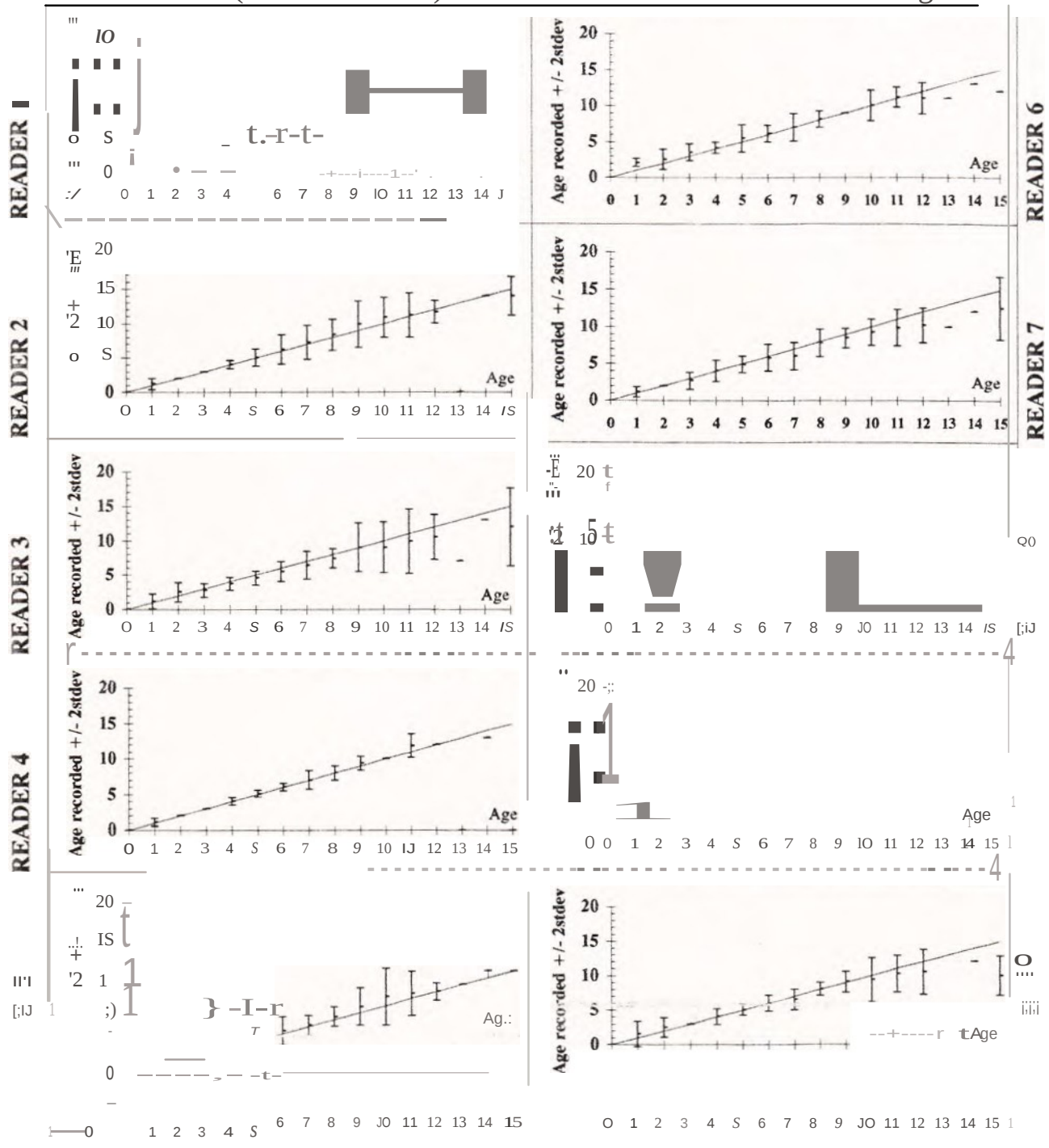


Figure 2. b In above age bias plots average age $\pm$ 2stdev of each age reader is plotted against modal age.

Modal age 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
 Age recorded 0.12 1.01 1.32 3.03 3.69 8.9 2.79 6.1 9.1 8.84 9.1 10.34 10.39 9.86 10.0
 2*stdv 0.86 1.1 1.16 1.01 1.20 1.78 2.0 2.51 2.84 3. 4.5 4.72 5.7 5.87 5.87

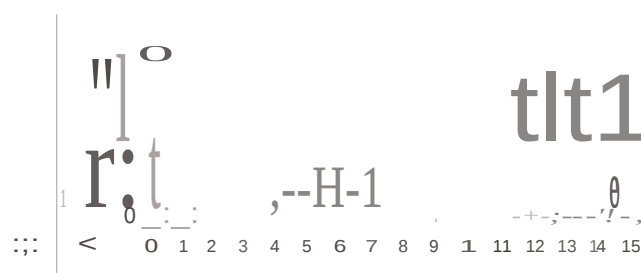


Figure 2. 1 In above age bias plot average age $\pm$ 2stdev of all age readers is plotted against modal age.