

Otolith Exchange Results Of European Anchovy (*Engraulis encrasicolus*) 2014

Date: November 2014- March 2015

Coordinators: Begoña Villamor, [IEO-
Spain] and Andres Uriarte, [AZTI-Spain]

Background

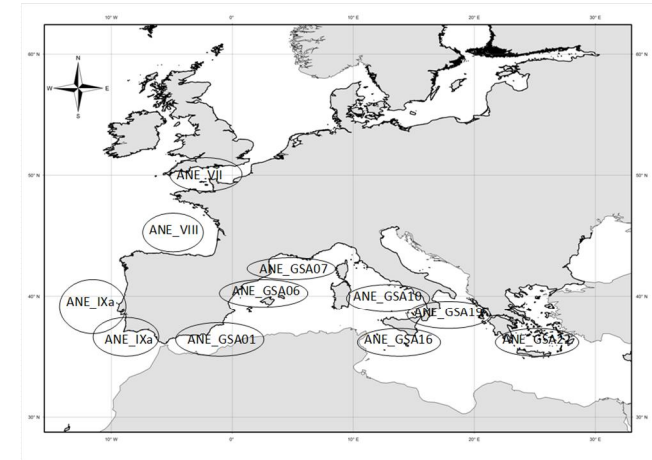
- ✓ 2014 PGCCDBS identified the need of a full-scale European Anchovy (*Engraulis encrasicolus*) otolith exchange to take place in 2014.

- ✓ Last exchange was carried out in 2009, followed by a workshop in Mazara del Vallo (Sicily, Italy), in the same year.

- ✓ Objective of the present exchange:
 - ✓ Evaluate consistency of anchovy age readings between institutes, from Atlantic and Mediterranean areas.

Workshop Procedure

- ✓ Samples used:
- ✓ 576 images of entire otoliths, distributed in 10 sets from different anchovy distribution areas (Atlantic & Mediterranean) and collected by all labs
- ✓ digital images -> calibration exercise via WebGR was used



- ✓ Number of participants involved in the age reading:
18 readers from 8 institutes (6 countries): 9 expert readers (readers for >5 years), 1 medium reader (4 years) and 8 trainee readers (1 year)
- ✓ Numbers of participants delivering data for “assessment”:
14 readers (5 of the Bay of Biscay; 3 of IXa; 1 of Alboran Sea and Western Mediterranean; 1 of Gulf of Lion; 2 of Strait of Sicily; 1 of Southern Thyrrenian and Ionian Sea; 2 of Aegean Sea; 1 of Adriatic Sea)
- ✓ Participants’ coverage: Readers from France, Spain, Portugal, Italy, Slovenia and Greece – thus covering the sampling area quite well

Results

Analyses were performed for the total areas and each area.

For each area

- ✓ overall age reading were analyzed
- ✓ and three additional analyses were performed:
 - Analysis only with the expert group,
 - analysis referring to intermediate and training group
 - and analysis only with area readers in those areas where there were more than one reader (Bay of Biscay, IXa area, Strait of Sicily, Southern Tyrrhenian, Western Ionian and Aegean Sea).

✓ **Overall agreement** is 65.5% for all readers, 66.7 % for intermediate & training readers, and 71.8% for the expert group. The analysis including all age readers revealed an **overall CV** of 58.2%.

✓ **By area:** The agreement with the modal age of all readers and for intermediate & training readers was low (between 59 and 74%) and CV was high (between 31 and 127%).

✓ In the case of the expert group, also reveals agreements and CV highly variable, depending on the areas, showing the highest agreement in the area VII and VIII, with 80% agreement in both cases, and high variation of CV (73% and 22% respectively).

% Agreement

Set	All readers	Intermediate&Training readers	Expert readers	Area readers
Total	65.5%	66.7%	71.8%	
ANE_VII	66.7%	60.9%	80.4%	
ANE_VIII	74.3%	71.3%	80.8%	90.9%
ANE_IXa	68.5%	65.4%	76.4%	75.7%
ANE_GSA01	58.9%	62.5%	63.5%	
ANE_GSA06	60.9%	66.2%	59.6%	
ANE_GSA07	73.4%	72.6%	75.1%	
ANE_GSA10	62.9%	68.9%	62.0%	67.3%
ANE_GSA16	58.5%	61.0%	59.9%	85.6%
ANE_GSA19	61.9%	68.9%	60.2%	73.5%
ANE_GSA22	70.0%	67.1%	78.3%	97.1%

CV

Areas	All readers	Intermediate&Training readers	Expert readers	Area readers
Total	58.2%	48.6%	51.8%	
ANE_VII	127.6%	90.0%	73.9%	
ANE_VIII	45.1%	44%	22.4%	11.4%
ANE_IXa	49.1%	43.9%	34.7%	33.0%
ANE_GSA01	58.7%	45.6%	71.1%	
ANE_GSA06	49.9%	38.5%	59.2%	
ANE_GSA07	31.3%	34.1%	30.3%	
ANE_GSA10	67.2%	51.2%	86.7%	58.1%
ANE_GSA16	78.7%	40.7%	73.8%	11.2%
ANE_GSA19	60.9%	50.1%	73.3%	55.3%
ANE_GSA22	55.7%	71.6%	42.8%	6.7%

Bias

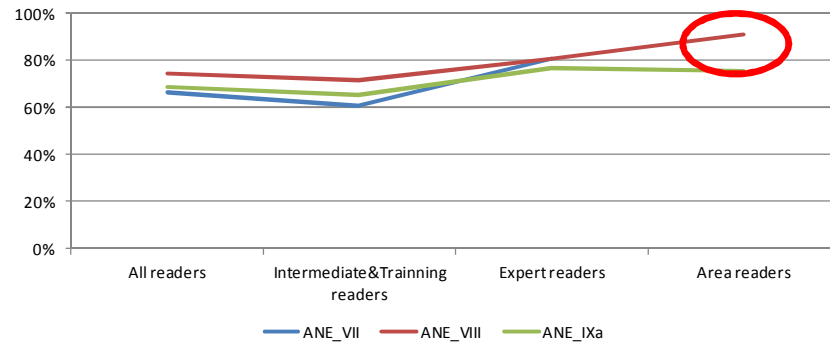
Areas	All readers	Intermediate&Training readers	Expert readers	Area readers
Total	0.11	0.16	0.08	
ANE_VII	0.27	0.24	0.10	
ANE_VIII	0.11	0.17	0.00	0.03
ANE_IXa	0.21	0.15	0.18	0.04
ANE_GSA01	0.07	0.13	0.08	
ANE_GSA06	0.07	0.19	-0.01	
ANE_GSA07	0.06	0.19	0.10	
ANE_GSA10	0.10	0.11	0.06	-0.05
ANE_GSA16	0.26	0.26	0.18	-0.13
ANE_GSA19	-0.04	0.03	0.12	0.04
ANE_GSA22	0.06	0.20	0.04	-0.03

Results

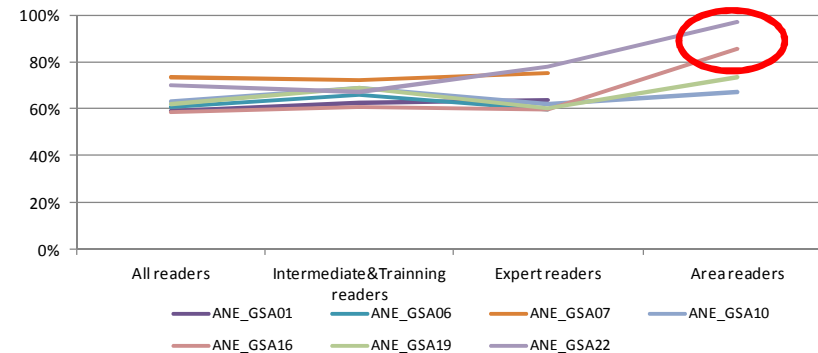
✓ In general, the results of the expert group improved compared to those of intermediate & training group in all areas.

✓ The results of the area readers group are much better (higher % agreement and lower CV) than the other groups of readers (including expert group). This may mean that there are different criteria reading between areas, so that when comparing only the readers in their expertise area they are more accurate because they all follow the same criteria reading.

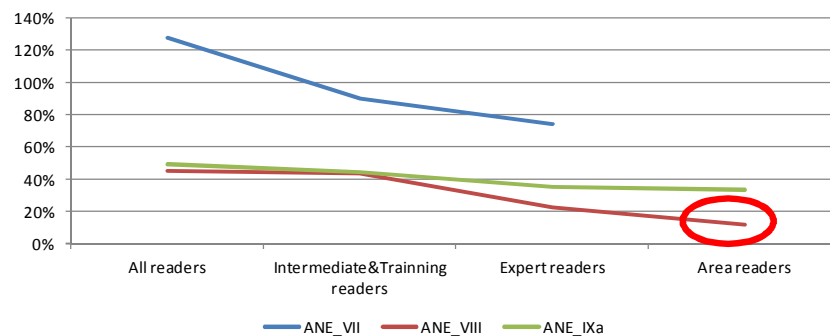
Atlantic Areas- % Agreement



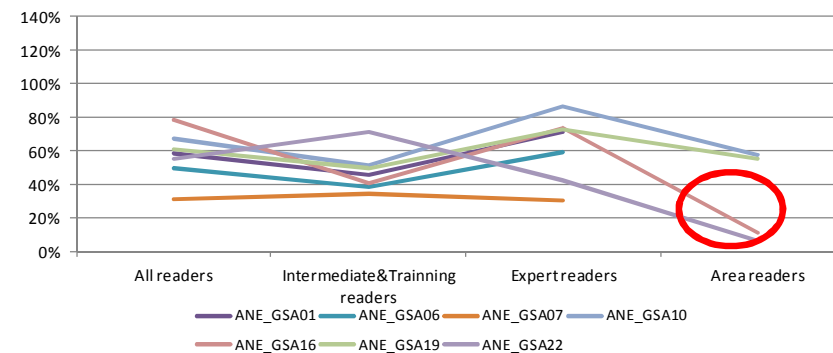
Mediterranean Areas - % Agreement



Atlantic Areas- CV



Mediterranean Areas - CV



✓ Analysis only done with the area readers group shows a higher overall agreement and low CV for **Bay of Biscay readers** and **Aegean readers** (91% & 97% of agreement; CV of 11.4% & 6.7%, respectively).

Results

Comparing the results of Exchange 2014 with that of 2009:

- ✓ Only 6 readers of the participants in the 2009 exchange and workshop were also participating in the current exchange of 18 participants.
- ✓ However, the results of the recent exchange show no decline of agreement but a slight improvement in all areas, especially in the IXa, and a significant improvement in the CV (lower variability) in all areas.

Set	Area	2009		2014	
		% Agreement	CV	% Agreement	CV
ANE_VIII	Bay of Biscay (all readers)	72%	85%	74%	45%
ANE_VIII	Bay of Biscay (BB readers)	89%	13%	91%	11%
ANE_IXa	Gulf of Cadiz & Portugal Coast	58%	68%	69%	49%
ANE_GSA01	Alboran Sea	61%	100%	59%	59%
ANE_GSA07	Gulf of Lion	72%	37%	73%	31%

The age compositions estimated by each age reader for the whole group show that some readers are interpreting the age structure of anchovy distinctly from the majority of readers. There seems to be a difference of criteria among some readers of the Mediterranean and the Atlantic areas. In particular there seems to be a difference of criteria among some readers (Mediterranean Readers 9, 10, 18 & 19 and Atlantic Reader 16) which tend to age older the fishes than the rest of the readers.

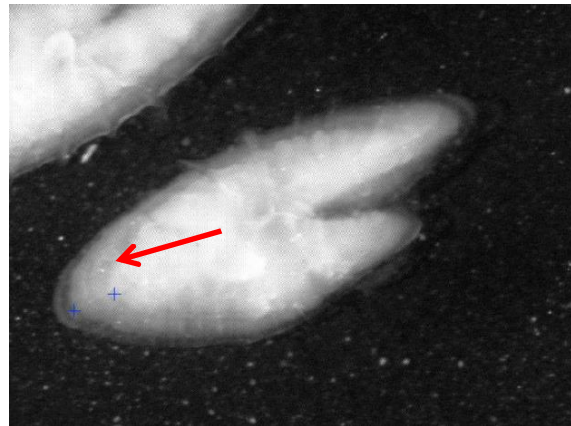
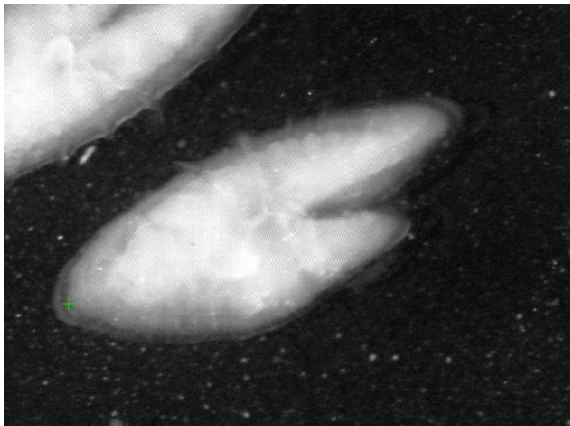
Total areas																			
	Sp AU	Sp IR	Fr PG	It SG	Sp PT	Sp CD	Sp JT	It PC	It LC	Sp AA	It SM	It MP	Gr CM	Fr EB	Po ES	Gr DP	SI TM	It PG	
Age	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	TOTAL
0	160	32	50	81	130	50	134	64	63	46	48	63	69	41	30	75	66	36	1238
1	294	329	343	277	340	294	374	254	207	291	320	296	315	268	195	342	185	89	5013
2	92	187	156	190	93	208	60	186	189	213	202	208	176	153	217	154	236	204	3124
3	25	26	24	27	13	21	7	50	73	25	6	8	16	41	116	5	81	197	761
4	-	-	1	-	-	-	-	5	10	-	-	-	-	2	15	-	6	46	85
5	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3	-	-	1	5
0-5	571	574	574	575	576	573	575	559	543	575	576	575	576	505	576	576	574	573	10226

Results

The differences are primarily explained:

✓ Difficulties in differentiating between true annual rings and false rings (or checks), mainly the first annual ring

Bay of Biscay (VIII): r5020b8.jpg

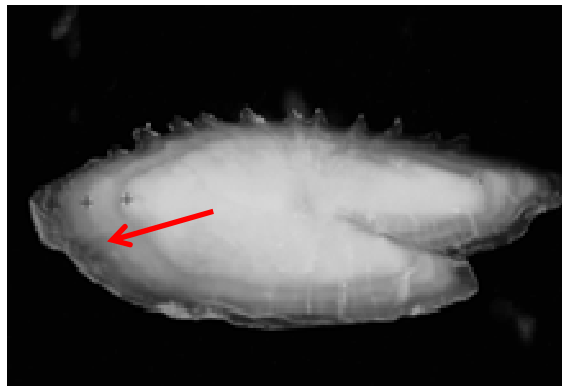
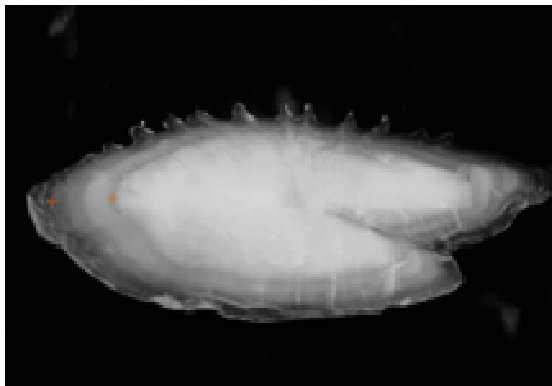


15.0 cm, female, caught March 2013, **67% agreement Age 2** (Readings: 1 -3 years).

Conventional birthdates: 1st January;
6 readers do not agree with the modal age (4 expert readers).

Modal age 1 for area readers (50% agreement) **and modal age 2 for expert readers** (56% agreement).

Southern Tyrrhenian: GSA10_10.jpg



14.0 cm, male, caught August 2013, **67% agreement Age 2** (Readings: 1 to 3 years).

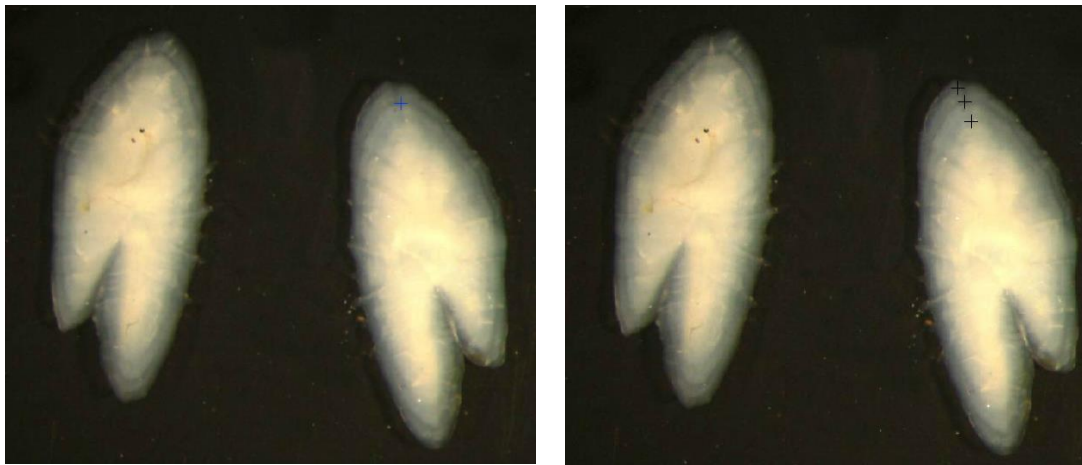
Conventional birthdates: 1st July
5 readers do not agree with the modal age (1 expert reader).

Modal age 3 for area readers (100% agreement) **and modal age 2 for expert readers** (78% agreement).

Results

✓ Insufficient typical annual growth pattern recognition and insufficient criteria regarding the otolith edge that can be expected to be seen along the year

Division IXa: IPMA_ANEIXaCN_8B.jpg



16.5 cm, female, caught September 2011,
44% agreement Age 1 (Readings: 1 to 3 years).

Conventional birthdates: 1st January
10 readers do not agree with the modal age
(3 expert readers).

Modal age 1 for area readers (100% agreement) **and modal age 1 for expert readers** (67% agreement).

Results

✓ In addition it is observed that the different conventional birth dates between areas (in the Atlantic in January and in the Mediterranean in June or July) produces some difficulties for some readers (including expert readers) in determining the ages (mainly at ages 0) when the reader changes the conventional birthday which is accustomed.

Aegean Sea: ANE20062014_1_49.jpg



9.0 cm, male, caught June 2014, **50% agreement Age 0** (Readings: 0-1 years).

Conventional birthdates: 1st June;
9 readers do not agree with the modal age
 (5 expert readers).

Modal age 0 for area readers (100%
 agreement) and **modal age 1 for expert
 readers** (56% agreement).

Conclusions

- ✓ Overall agreement between all readers and areas is very low, 65.5%. CV= 58.2%
- ✓ By areas, the agreement with the modal age of all readers was low (between 59 and 74%) and CV was high (between 31 and 127%)
- ✓ In the case of the expert group, agreements and CV highly variable, depending on the areas, showing the highest agreement in the area VII and VIII, with 80% agreement in both cases, and high variation of CV (73% and 22% respectively)
- ✓ The results of the area readers group are much better than the other groups of readers (including expert group), mainly for Bay of Biscay readers and Aegean readers (91% & 97% of agreement; CV of 11.4% & 6.7%, respectively)
- ✓ Comparing the results of Exchange 2014 with that of 2009, there has been a small increase of the level of agreement (particularly for IXa) and a decrease of CV
- ✓ There seems to be a difference of criteria among some readers (Mediterranean Readers 9, 10, 18 & 19 and Atlantic Reader 16) which tend to age older the fishes than the rest of the readers.

Impact on stocks assessment and advice

✓ There is analytical assessment for all anchovy stocks, except in the areas VII, IXa and GSA10. In Ixa & GSA10 trend based qualitative assessment, but in a short time analytical assessment will be made for these stocks.

✓ The agreement between **B&B (VIII) assessment readers** and modal age is above 84%. Reader 15 is reading for assessment, though she have only read anchovy for a year (agreement of 88%)

Modal age of Expert Readers

Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19
----------	----------	----------	----------	----------	----------	----------	----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

ANE_VIII: Bay of Biscay (in green B&B assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	90.0%	90.0%	84.3%	75.7%	90.0%	91.2%	75.7%	73.5%	51.4%	94.3%	54.3%	51.4%	82.9%	87.9%	74.3%	77.1%	57.1%	20.3%	73.3%
RANKING	3	3	7	10	3	2	10	13	16	1	15	16	8	6	12	9	14	18	

✓ The agreement between **IXa assessment reader** and modal age is very variable among readers, between 94% and 38%. Reader 8 (agreement of 94%) is reading for assessment in the Gulf of Cadiz (IXa South), which is the most important fishing area in IXa and the only for which an assessment is carried out . Anchovy is very scarce in other parts of the IXa. Reader 16 have only read anchovy for a year mainly from western part of Subdivision IXa.

ANE IXa: Gulf of Cadiz & Portugal coast (in green IXa assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	91.3%	94.6%	73.9%	81.5%	94.6%	67.4%	93.5%	58.2%	52.2%	60.9%	60.9%	65.9%	85.9%	38.3%	38.0%	90.2%	33.7%	14.1%	66.6%
RANKING	4	1	8	7	1	9	3	13	14	11	11	10	6	15	16	5	17	18	

Impact on stocks assessment and advice

✓ For the Alboran Sea and Western Mediterranean areas there is single local reader achieving a 81% of agreement for the Alboran Sea, but dropping to only 43% for Western Mediterranean

Modal age of Expert Readers

Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19
----------	----------	----------	----------	----------	----------	----------	----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------	-----------

ANE GSA01: Alboran Sea (in green GSA01 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	57.1%	80.0%	51.4%	44.3%	81.4%	82.6%	60.9%	64.7%	27.1%	77.1%	50.0%	47.1%	61.4%	0.0%	30.0%	62.9%	49.3%	8.7%	54.3%
RANKING	9	3	10	14	2	1	8	5	16	4	11	13	7	18	15	6	12	17	

ANE GSA06: Western Mediterranean (in green GSA06 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	46.7%	68.3%	60.0%	86.7%	43.3%	80.0%	36.7%	73.7%	38.8%	88.3%	61.7%	65.0%	85.0%	51.7%	16.7%	81.7%	41.7%	6.7%	57.5%
RANKING	12	7	10	2	13	5	16	6	15	1	9	8	3	11	17	4	14	18	

✓ Also, only there is 1 assessment reader for Gulf of Lion stock, though she have only read anchovy for a year (agreement of 78%)

ANE GSA07: Gulf of Lion (in green GSA07 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	63.2%	92.1%	81.6%	86.8%	71.1%	92.1%	76.3%	71.1%	39.5%	89.2%	60.5%	73.7%	78.9%	78.4%	78.9%	68.4%	63.2%	40.5%	72.5%
RANKING	14	1	5	4	11	1	9	11	18	3	16	10	6	8	6	13	14	17	

✓ The agreement between Strait of Sicily assessment readers and modal age is below 70%. Reader 12 & 13 are reading for assessment, though they have only read anchovy for a year (agreement of 68 & 67% respectively) they showed a high internal cross consistency (86% of agreement between them).

ANE GSA16: Strait of Sicily (in green GSA16 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	58.7%	75.4%	48.5%	63.6%	74.2%	60.6%	66.7%	54.7%	36.4%	63.6%	68.2%	66.7%	66.7%	50.0%	27.3%	81.8%	34.8%	12.1%	56.1%
RANKING	11	2	14	8	3	10	5	12	15	8	4	5	5	13	17	1	16	18	

Impact on stocks assessment and advice

✓ For the Southern Tyrrhenian and Western Ionian areas there is single local assessment reader achieving a 80% and 89% of agreement for these areas respectively.

ANE GSA10: Southern Tyrrhenian (in green GSA10 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	57.4%	49.1%	60.0%	83.3%	67.3%	65.5%	43.6%	80.0%	45.5%	63.6%	63.6%	69.1%	72.7%	50.9%	32.7%	76.4%	51.9%	14.5%	58.2%
RANKING	11	14	10	1	6	7	16	2	15	8	8	5	4	13	17	3	12	18	

ANE GSA19: Western Ionian (in green GSA19 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	55.6%	51.9%	43.6%	65.5%	72.7%	50.9%	52.7%	88.5%	56.4%	43.6%	69.1%	58.2%	67.3%	34.5%	30.9%	65.5%	61.8%	27.3%	55.2%
RANKING	10	12	14	5	2	13	11	1	9	14	3	8	4	16	17	5	7	18	

✓The agreement between Aegean Sea assessment readers and modal age is below 70%. Reader 14 & 17 are reading for assessment, though they have only read anchovy for a year (agreement of 65 & 60% respectively) and have an very high internal consistency of 97% (both from the same institute).

ANE GSA22: Aegean Sea (in green GSA22 assessment readers)

MODAL experts	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 8	Reader 9	Reader 10	Reader 11	Reader 12	Reader 13	Reader 14	Reader 15	Reader 16	Reader 17	Reader 18	Reader 19	ALL
% agr.	90.0%	54.3%	92.9%	65.7%	97.1%	51.4%	94.3%	100.0%	57.1%	52.9%	77.1%	67.1%	65.7%	98.6%	48.6%	60.0%	60.0%	25.7%	69.8%
RANKING	6	14	5	9	3	16	4	1	13	15	7	8	9	2	17	11	11	18	

In general, under a few exceptions in some stock, it seems that the experience of readers determines the interpretation they make of the otolith structure and the level of agreement achieved with the rest of expert readers.

It is therefore recommended, as far as possible, that only the age readings of the most expert readers by areas are used for the assessment inputs and second that new readers pass a training processes from validated set of otoliths of the area they have to work with

Recommendations for future work

✓ Organise ageing workshop to increase the agreement and accuracy of age readings of the laboratories involved in stock assessment of these pelagic species:

a) Review information on anchovy age estimations, otolith exchanges, workshops and validation work done so far.

b) Analyse the results of the exchanges 2014

c) Analyze growth increment patterns and update the guideline for the interpretation anchovy otoliths

d) Create a reference collection of well defined otoliths

e) Address the generic ToRs adopted for workshops on age calibration

✓ Looking to the future preparation of the workshop in 2016, it is suggested that validation studies could be made and submitted to this workshop, especially studies of progression of length frequency modes throughout time, as is one of the most basic analyses which can provide reliable information on growth, particularly of young, fast-growing fish. Further, this method is low cost and takes advantage of data routinely obtained in fishery studies (length). Other studies such as on counting of daily growth marks in otoliths or others would be also welcome.