



European Fish Ageing
Network

**Newsletter
TACADAR**
(Towards accreditation and certification of
age determination of aquatic resources)
2002 - 2005



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www.efan.no/tacadar/

Newsletter Editor:
E. Moksness

Objectives

To stimulate the achievement of a higher
level of quality within and integration
between the member institutions of
TACADAR, concerning fish age
determination.

**European
Commission**
Concerted Action
(Q5CA-2002-01891)

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1. Preface

Dear TACADAR colleagues,

The deadline (1 April 2005) for the plenary meeting in TACADAR, 25-29 July 2005 in Enniskillen, Northern Ireland is coming up. Please signed up, Looking forward to see you all there.

In June is the ASLO meeting in Santiago de Compostela, Spain, 19-24 June 2005 with a special session on Biomineralization, please check the ASLO homepage for details.

The progress report (TACADAR) for the period 1 October 2003 – 30 September 2004 has been approved by Brussels. The cost statement, is still being evaluated.

The main contribution in this issue is the report from a questionnaire on current practices. I believe it should be of some value to the work in TACADAR.

See you all in Enniskillen.

2. Quality Control and Quality Assurance in Fish Age Estimation Laboratories: Results of a Questionnaire on Current Practices

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February, 2005

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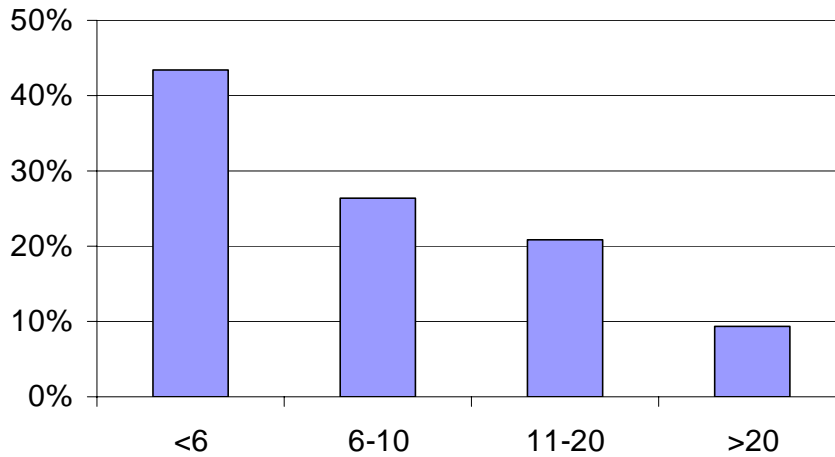
SECTION A: BACKGROUND TO YOUR LABORATORY	4
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* Brief comments on the results are provided throughout the document. These are in italics and prefixed with an asterix.

SECTION A: Background to your laboratory

A-1

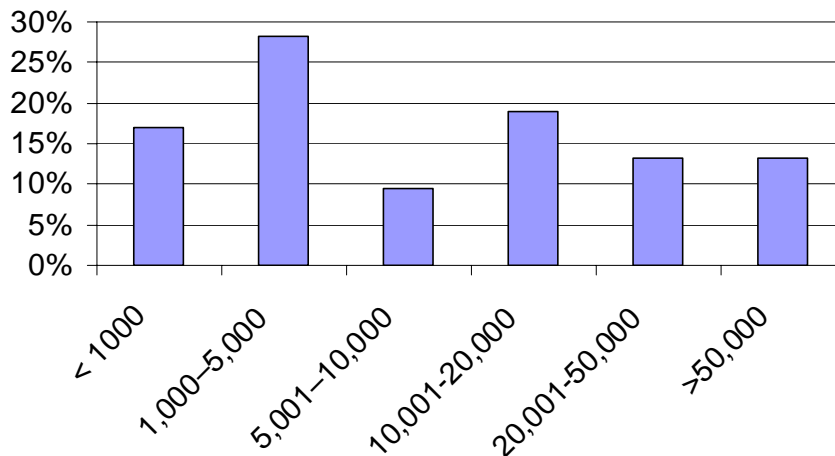
For how many species are age estimates usually undertaken each year at your laboratory?



* - Most labs work on 10 or fewer species

A-2

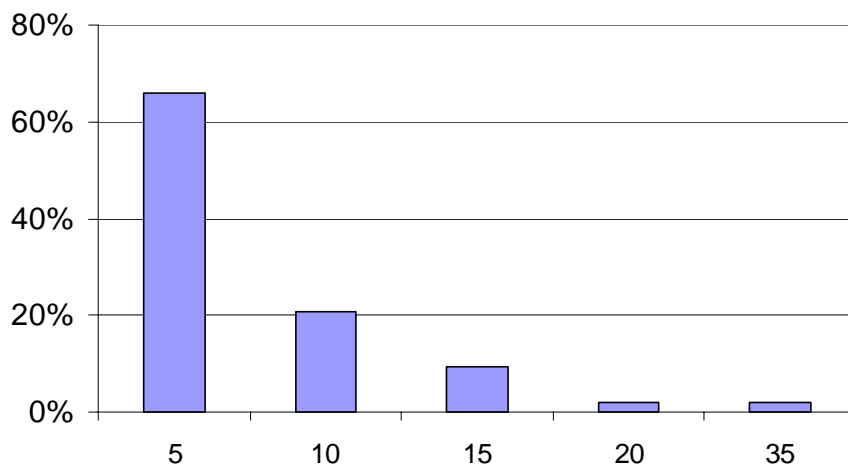
How many age estimates are generated annually at your laboratory (including training and re-reading)?



* - There is a wide range of outputs from labs from quite small to very large

A-3

How many full-time staff normally work on tasks directly related to age estimation in your laboratory (include staff involved in sample preparation and reading but not, for example, collection of otoliths or stock assessment)?

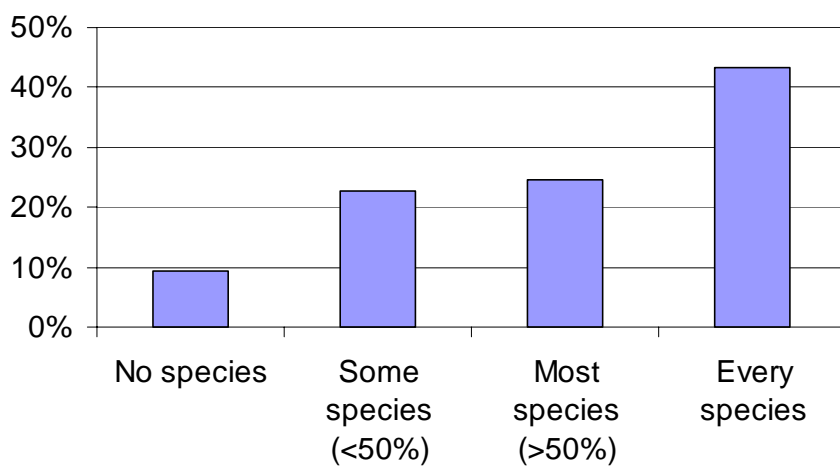


* - Most labs are small to moderate in size but there are some large ones.

A-4

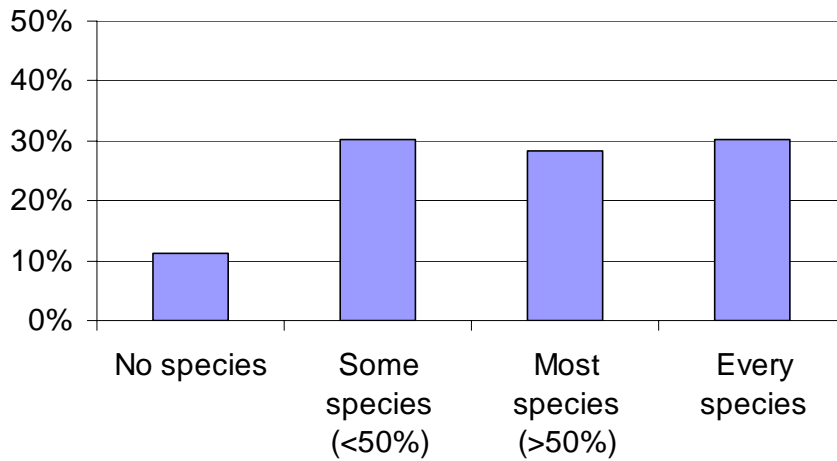
Do you have documented procedures for the following?

4A Technical protocols (e.g. sample preparation)



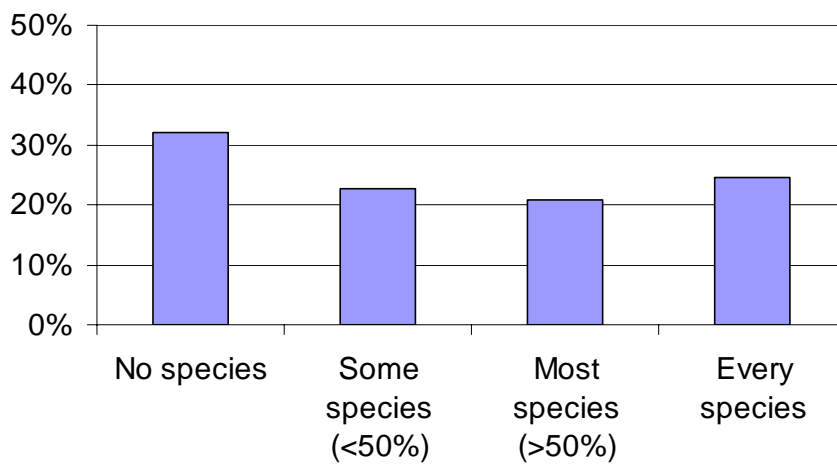
* - Most labs have this aspect documented

A-4b Age reading procedures (structure interpretation)



* - This not as well documented

A-4c Quality control procedures



* - And this aspect even less well documented

A-5

From which habitats are the species you work on taken?

	Freshwater	Estuarine/Marine	Both
No species	16	9	13
Some species (<50%)	8	3	13
Most species (>50%)	4	13	1
Every species	5	24	4
Total	33	49	31

A-6

Does your laboratory provide age estimates based on daily or annual increments?

	Daily only	Annual only	Both daily and annual
No species	16	2	17
Some species (<50%)	11	4	16
Most species (>50%)	2	13	1
Every species	1	30	0
Total	30	49	34

SECTION B: Staff training

B-1

Approximately what numbers of samples would you consider it necessary for a staff member to read to become consistent at age estimation for a new species?

(Fill in all appropriate cells; give a range if necessary)

(Note, where a range has been given I have used the lowest value of that range for the following summaries. Ranges given were almost always within the chosen group ranges anyway.)

New Staff members

	<100	100-500	501-1000	>1000
Species with clear increments	32%	47%	11%	9%
Moderately difficult species	28%	38%	11%	23%
Difficult species	28%	26%	19%	26%

(n=53)

** A wide spread of values, but with the a surprising number of labs using small sample numbers for training staff. But there is some bi-modality in the distribution, some labs using much larger numbers than others.*

Experienced Staff members

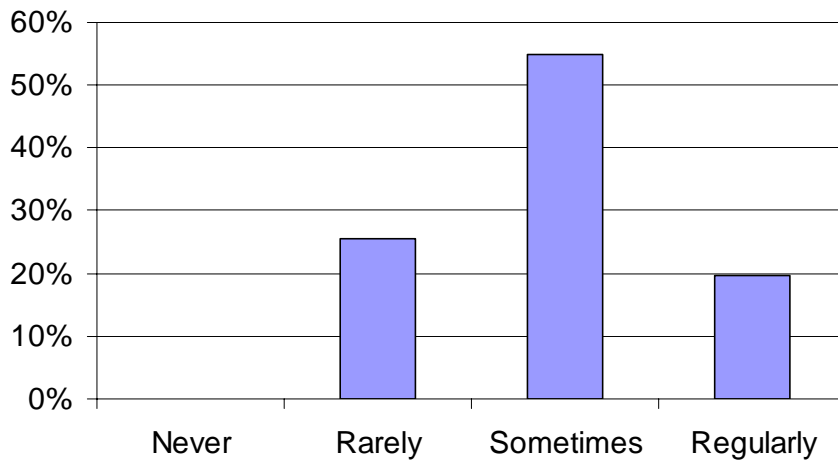
	<100	100-500	501-1000	>1000
Species with clear increments	49%	43%	2%	6%
Moderately difficult species	38%	40%	11%	11%
Difficult species	28%	43%	8%	21%

(n=53)

** Again a wide spread of values with similar bi-modality. Most labs gave values of < 500 samples, but some expecting to use >1000 samples.*

B-2

Do you find that it is difficult to train staff to the required degree of consistency in age estimation?



B-3

What approaches do you use for training new staff in undertaking age estimates on a species?

100% of respondents use all techniques

Verbal instructions, written instructions, & Examination of previously aged material or reference sets

B-3e Other methods used

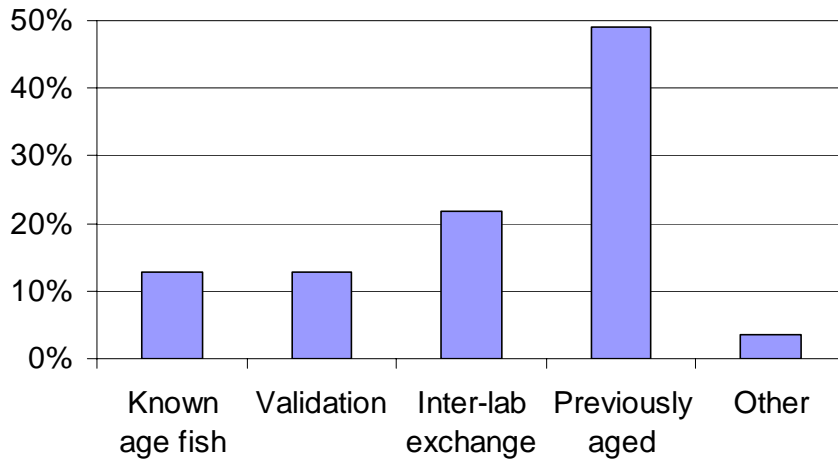
After training rereading of previously read material, random control by an experienced reader
Altogether ageing with an experience research or technician, revision and correction of error- and ageing precision analysis
Annotated images from training set
Archived samples, dual-headed scope, digital images
Coaching-read together
Comparison and discussion of readings with an experienced reader, including examining together those samples where age estimates vary widely between readers.
Comparisons of results
Co-reading on double microscope and many otolith exchanges
Correlated literature; training at international laboratories
Training courses with experts
Examination of new material together with new staff
Experienced reader checks the trainee readings and discuss discrepancies
Lit searches
Papers with pictures & diagrams
Photodocumentation of samples is a must for demonstration and reference.

Within and without precision testing is necessary as they progress to assess biases all towards working to meet set precision level goals.
Reading periodical control
Simultaneous ageing of samples between trainer and trainee using image analysis system
Simultaneous reading of samples
Stored otolith images
Structure exchange and workshops
Team reading using displayed images
Trainee and trainer examine and discuss otoliths together
Training on discussion scope with led pointer
Training sessions with experienced age readers
Tuition using twin eyepiece training microscope
Working parallel with experienced readers
Working parallel with experienced readers. Working with materials with semi known ages, from time series
Working with experienced agers, testing using known aged fish and reading available literature.
Yes hands on discussion at microscope with tv monitor

SECTION C: Reference sets

C-1

What are the main sources of the reference collections used in your laboratory?



Other

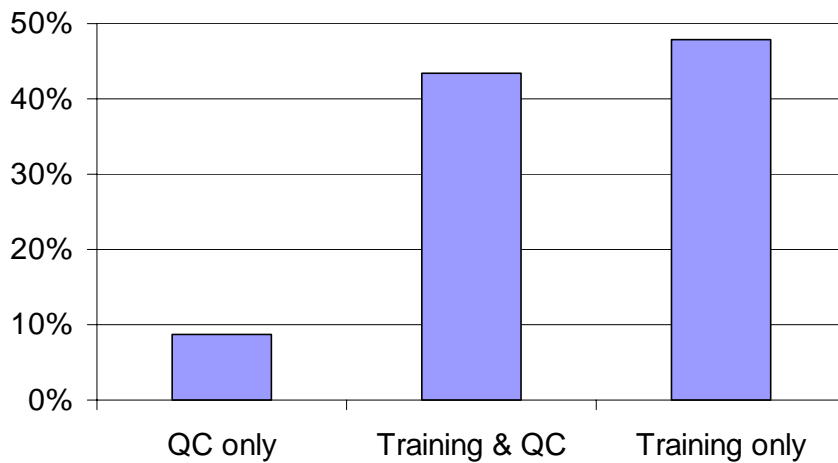
historical otolith exchange going back to the 1960's

All of the above & samples aged by other laboratories

** Minority of labs have access to known age fish or those used in validation studies.*

C-2

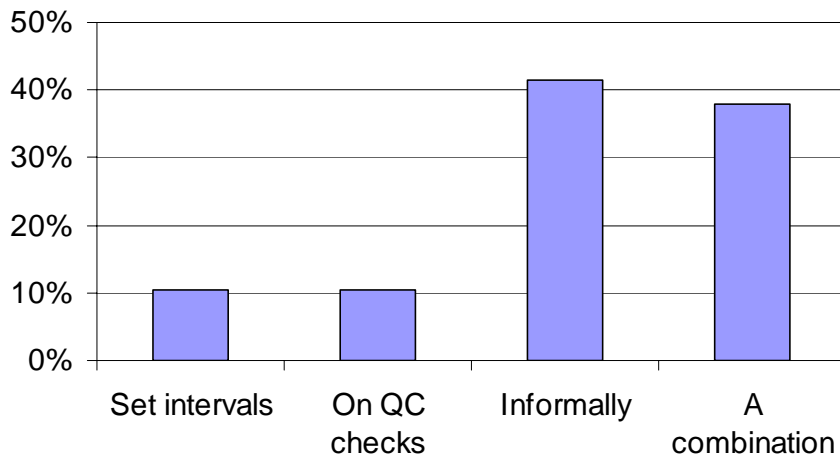
How are the reference collections used in your laboratory?



** Surprising that a large proportion of labs only use reference collections for training.*

C-3

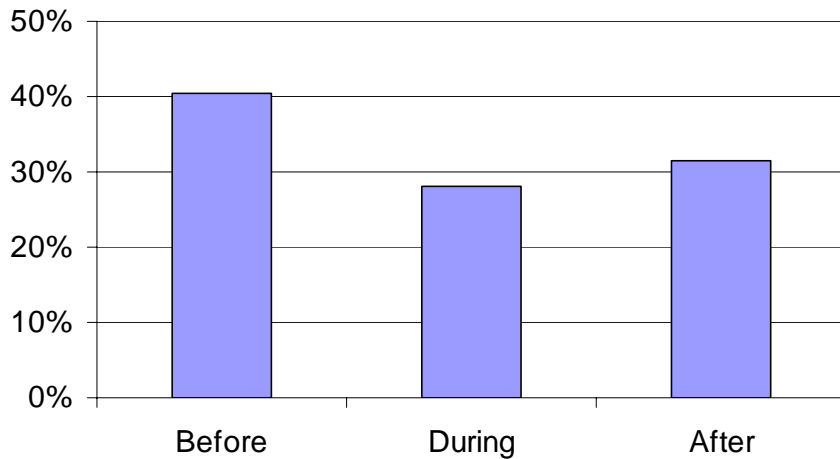
If you use reference collections for quality control, how is the timing and frequency of their use prescribed?

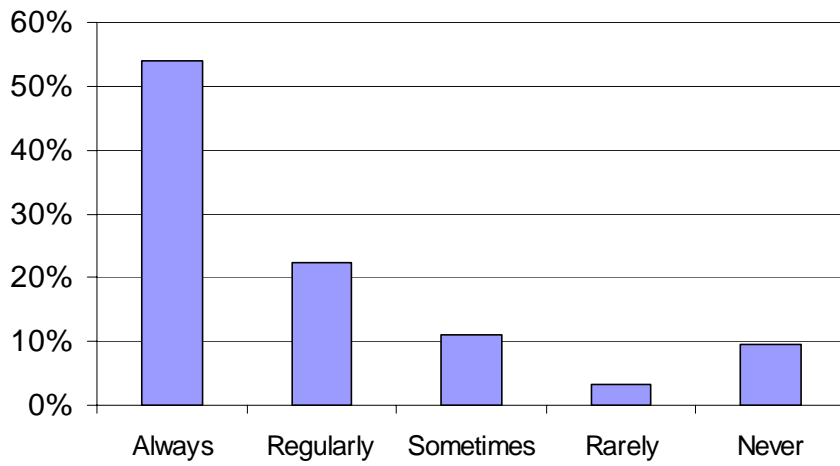


** Even among those labs that use reference collections for QC, a low proportion have their use as a standard procedure.*

C-4

If you use reference collections for quality control, at what stages are these used during age estimation of new samples? (Select answer to each stage)



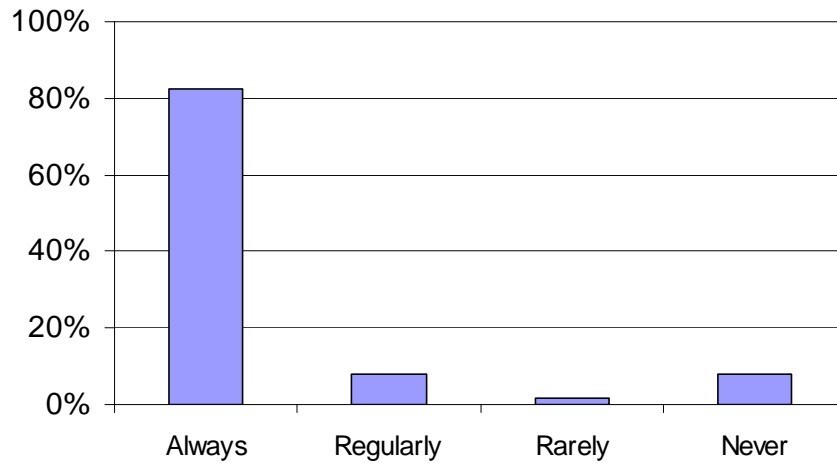
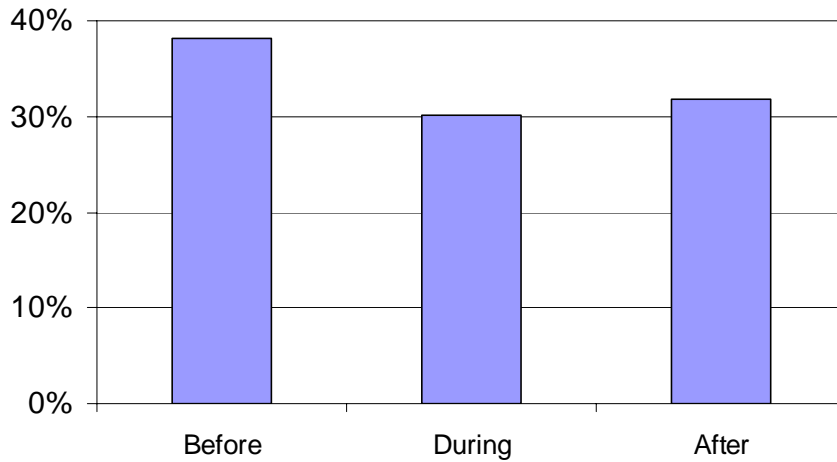


C-4	Before	During	After
Always	5	14	15
Regularly	10	1	3
Sometimes	7		
Rarely	1	1	
Never	1	3	2

* Checks done during and after readings were more likely to be done (their application was more prescriptive?) than those done before reading.

C-5

Are readers aware when reading it that the material is part of a reference set?



C-5	Before	During	After
Always	23	14	15
Regularly	1	1	3
Rarely		1	
Never		3	2

* The standard is for readers to know when their reading is being evaluated by use of a reference set.

C-6

How many of the reference set are usually examined during this process? (Give a range if it varies with readers, species or other factors)

Training

	<50	50-100	101-500	>500	N
Species with clear increments	44%	32%	20%	4%	25
Moderately difficult species	39%	35%	22%	4%	23

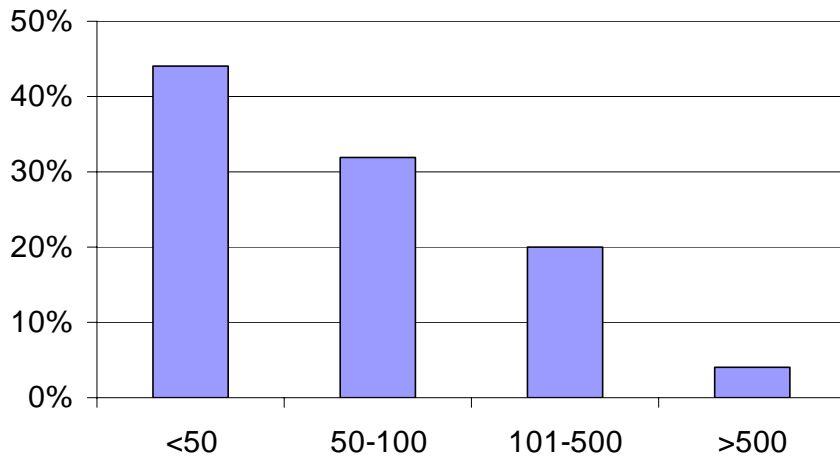
Difficult species	37%	21%	26%	16%	19
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QC

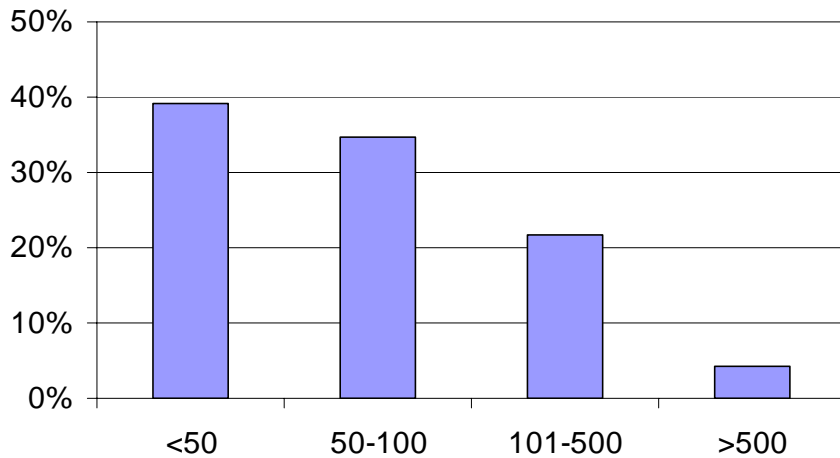
	<50	50-100	101-500	>500	N
Species with clear increments	41%	41%	18%	0%	17
Moderately difficult species	44%	28%	28%	0%	18
Difficult species	40%	20%	40%	0%	15

	Species with clear increments	Moderately difficult species	Difficult species
Training	6A	6B	6C
QC	6D	6E	6F

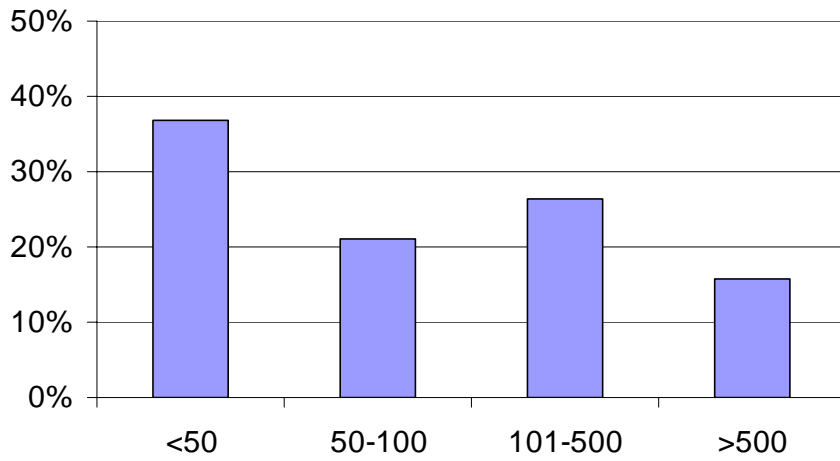
6A



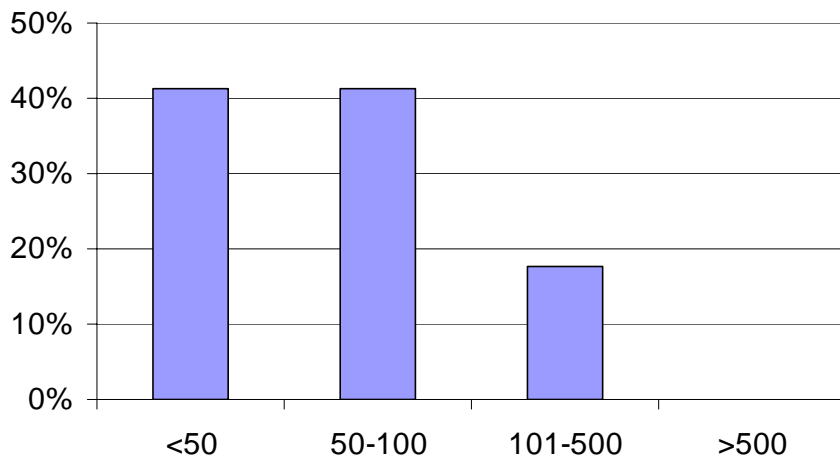
C-6B



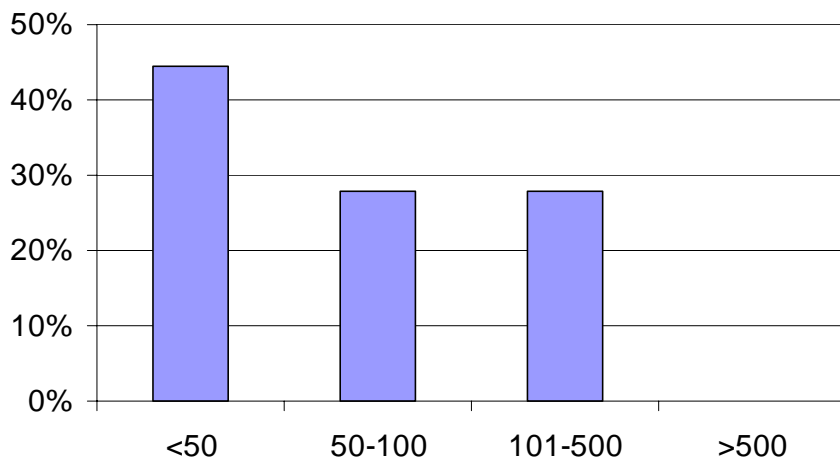
C-6C



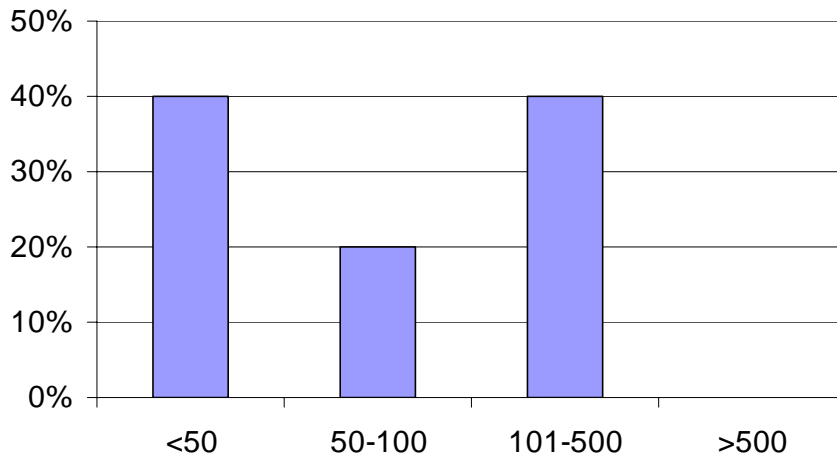
C-6D



C-6E

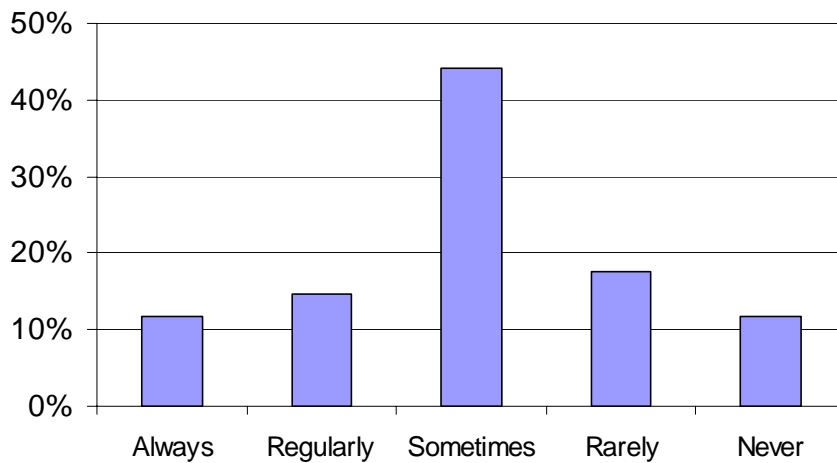


C-6F



C-7

Are these reference sets updated with new samples?



** Updating of reference sets is done by most labs, but not as a matter of course.*

C-8

Is the same reference set used for training and ongoing precision testing?

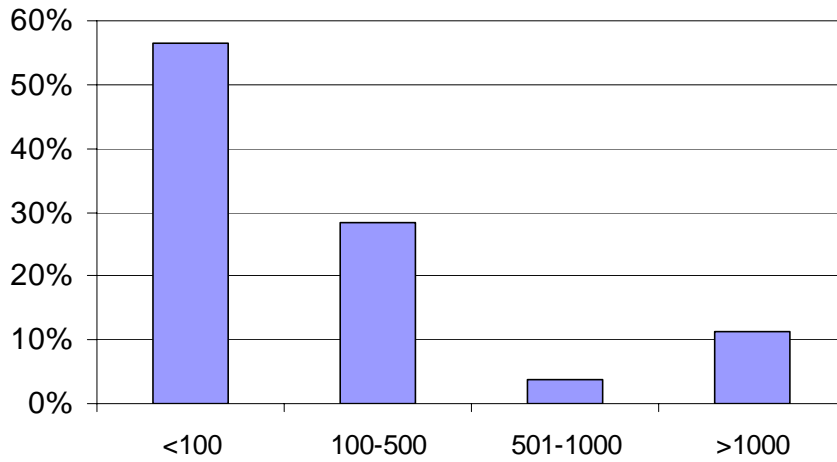
N=30

No	50%
Yes	50%

** Two options selected with equal frequency.*

C-9

How many samples are there in your reference sets? (Give a range if necessary)



* Most reference sets relatively small but some have tens of thousands.

C-10

How many samples do you think it is necessary or desirable to have in a reference set?

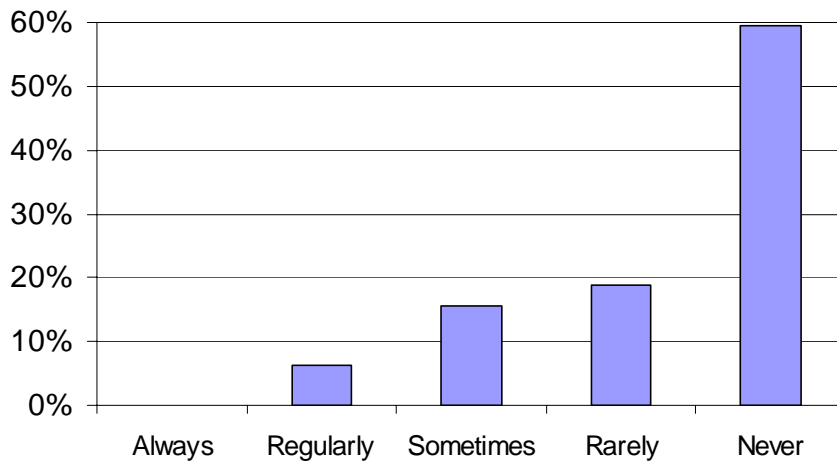
Minimum	<50	50-100	101-500	>500	N
Species with clear increments	32%	48%	16%	3%	31
Moderately difficult species	25%	53%	16%	6%	32
Difficult species	17%	31%	41%	10%	29

Maximum	<50	50-100	101-500	>500	N
Species with clear increments	14%	38%	34%	14%	29
Moderately difficult species	10%	23%	40%	27%	30
Difficult species	4%	21%	39%	36%	28

* Most labs would apparently like larger reference sets than they currently have, and the more difficult the species, the larger the reference set desired.

C-11

Have you had examples of readers remembering the ages of individual fish in a reference set?



** This is a rare usually a rare event but apparently regularly happens in some circumstances.*

C-12

If you do not use reference collections at all, what are the reasons that you do not?

Don't have funding to develop/use collections	5%
Don't have time to develop/use collections	42%
No useful material available	5%
Not seen as important	5%
Reference set not used for snapper or kahawai in	5%
Other (describe below)	37%

C-12 b

Instead 3 readers read each set to determine final agreed age.
As we do simultaneous ageing and resolving of problems
Comprehensive training is given to new people. Random samples are checked for quality control.
For other species
I typically am the only reader in the lab.
Inadequate staffing
Large variation between years and areas, makes it difficult
Up to now, we use the method of training new staff working parallel with an experienced reader using current materials. We usually work with materials from time series (semi-known age) and we have found those suitable for training
We are in the process of setting up reference collections
We have not used reference collections for a variety of reasons (see attached)
We're not usually involved in routine age estimation studies
Working with new species, new age range
Would require input from other labs involved in deep-water fish ageing

** Time is the most common reason for not using reference collections, among a range of other reasons. Some of these reasons do not address the issues that reference sets would address e.g. using extra readers.*

SECTION D: Reading protocols

D-1

What data are available to readers during the reading of unknowns?

	Explicitly provided	Not provided, but likely to be known	Provided only for 2nd or later readings
None	17%	6%	8%
Fish length	47%	8%	17%
Fish weight	32%	4%	8%
Otolith weight		6%	4%
Fish sex			
Month/Date of collection	68%	9%	6%
Year of collection	70%	13%	4%
Area/stock from which samples collected	60%	17%	2%
Age composition of previous year's samples		40%	4%
Expected increment widths		26%	
Previous size-at-age data		32%	6%
Other (describe below)	9%		2%

Maturity
maturity stage
maturity stages of some species
no data on expected increment widths, liable to change depending on growing conditions; however, readers are trained to introduce this implicit knowledge in growth patterns and hence in age readings
sample type, fishing gear
Species and fish ID #

** There is clearly a large range of data available to readers, with the "likely to be known" categories significant. Relatively few examples of using data after initial readings.*

D-2

Does this vary with batches or species?

Yes- 43%; No - 55%

Area and date
Availability of previous data on the area/stock
Availability of the data
Fish weight, sex and maturity is not always collected.
For some species this inform may not always be available
For what purposes the aging is done

Marine species ages are entered directly on to a database by keyboard at ageing
Origin of samples
Otoliths tend to be historical collections - not all info is always available e.g. Fish sex
Practices of different readers.
Previous precision and accuracy comparisons
Sample type
Sex can be known, e.g., Hoki females & males are selected and prepared separately
Source of samples
Species
Species/season
The species coordinator
Type of sample collection

D-3

Do you have an established birth-date for the species you usually read?

All	60%
Most	12%
Some	17%
None	12%

* Significant number of species being aged where birth-dates are not assigned.

D-4

Are adjustments to the estimated ages (that incorporate edge type, date of capture, and birth-date) made during reading or after?

After	31%
During	69%
Grand Total	100%

* Clear majority of adjustments done during reading but significant proportion done later.

D-5

What details are usually recorded with each age estimate?

None	4%
Reader id	85%
Date of reading	64%
Time of reading	13%
Reading order	38%
Increment widths	32%
Readability/reader confidence	62%
Area/orientation used for increment counts	28%
Measure(s) of total size of structure (e.g. transect length)	32%
Edge type	66%
Comments	70%
Presence, number or position of 'false' increments	21%
Other	15%

* After reader id, comments is the next most common, followed by edge type, reading date and readability (these categories the only ones above 60%). Other details are mostly infrequently recorded (all less than 40% of respondents).

D-6

Do readers re-read a proportion of each new sample for estimates of precision?

D-6	Total
Always	17%
Regularly	13%
Sometimes	31%
Rarely	13%
Never	25%

** Precision is always or regularly estimated in a minority of cases (30%). A significant number of labs never estimate precision.*

D-7

If so, what size of sample is usually re-read? (Give values in whichever cells are appropriate to your situation)

	Number	% of sample
Minimum	7A	7B
Fixed	7C	7D

A N=10

5	10%
10	20%
20	10%
50	60%

D-7B N=18

5	11%
10	44%
20	28%
25	11%
30	6%

D-7C N=5

30	20%
50	60%
250	20%

D-7D N=10

1	10%
10	10%
20	30%
100	50%

** A large variation the numbers/percentages of samples which are re-read.*

D-8

Do you use secondary readers within the laboratory?

Always	19%
Regularly	19%
Sometimes	38%
Rarely	12%
Never	12%

* Large range in frequency with which secondary readers are used.

D -9

If you use secondary readers, for what purpose are the their results used?

N=47

Corroboration of primary reader's data	34%
Calculation of inter-reader precision estimates	6%
To keep another staff member familiar with a species as a contingency	4%
A combination of the above	43%
Other (describe below)	13%

1 and 2
A combination of the above
all fish are aged by two separate readers
Consistency
in order to ensure all otoliths are read; sometimes to corroborate ages
Quality control using percentage agreement and bias.
Re-reading mostly limited by the limited number of potential readers
Secondary readers used with new species for training purposes
see comments
Usually undergraduate/Msc students undertaking work as part of project
We don't use "secondary readers" in the traditional meaning. But in our laboratory, at least two age readers are familiar with each species that is regularly age determined. The purpose is to secure the knowledge and experience of species and to give the possibility for readers to consult each other when problems occur.

* Secondary readers used for a variety of purposes, and not usually just to estimate precision.

D-10

What size (number or %) of sample are usually read by secondary readers?

	Number	% of sample
Minimum	10A	10B
Fixed	10C	A0D

D-10A

N=12

1	8%
10	8%
50	67%
150	8%
200	8%

D-10B

N=22

5	9%
10	50%
15	5%
20	18%
50	5%
100	14%

D-10C

N=2

30	50%
250	50%

D-10D

N=14

1	7%
10	7%
20	29%
25	7%
100	50%

* Very variable responses. A significant proportion re-read all samples

D-11

Do you attempt to resolve discrepancies in age estimates from re-reading?

N=49

Always	45%
Regularly	24%
Sometimes	20%
Rarely	6%
Never	4%

* Most labs regularly or always examine discrepancies.

D-12

If it is done, what process do you used for resolving these differences?

2 readers working on the same samples
Both readers sit down together and re-age the fish without knowledge of previous age estimates. If readers agree on an age it is assigned. If readers can't agree the fish is not assigned an age.
Can send samples away to another ager or look at a second structure for the sample
Careful examination
Compare ages between three reads, attempt to determine problem areas on otolith.
Compare readings, and discuss while looking at specimens together. If no agreement reached and there is a large discrepancy, specimen will normally be discarded, if the discrepancy is small the primary readers estimate will be used.
Comparison with other otoliths
Communal reading and discussion.
Consultation, post-reading statistical analyses
Co-rereading
Discrepancies are checked for early on, before reading of unknowns commences; each reader's results are cross-checked with the other's and with earlier results for the same otoliths, if available (e.g. Re-reading of protocol sets etc). For snapper we would state always for D11, other spp "regularly"
Discussion

Discussion among experienced readers
Discussion at the microscope
Discussion between readers
Discussion of marks and criteria. Discard if agreement not reached.
Discussion, bringing in the 3rd age-reader
If large discrepancy look at age length data to see which reader is more likely to be correct, and at least one reader re reads otoliths. If small difference, both re-read. If discrepancy is greater than 3 years after both have re-read then discard otolith reading from data set. This usually only occurs with otoliths which are very difficult to read.
Joint reading by both readers and/or bringing in a third party.
Marks analysis: distance, false increments; fish size, sex
Most discrepancies arise from lack of familiarity with a new species - most species we look at are 'difficult'
Must have agreement with 2 or more readers, up to a maximum of 4 different readers
Otolith is read again and if no agreement is reached it is discarded
Otoliths are shown to other experienced readers.
Reader review and dual-headed scope.
Reading the piece or by an special binocular (for two people a the same time) or by screen
Recount, discussion of features
Rejecting not coincident readings
Re-read the structures that differ between 1st and 2nd reader
Re-reading
Re-reading ages from several structures, if possible (e.g. Scales and otoliths)
Retesting with reference collection, discussion between primary and secondary reader
Review of otoliths with ancillary data and between reader discussion
See written comments provided separately
Separate reading, then combined discussion
Specific processes (ie quality control programme) not in use, at present we discuss with another reader if uncertain after re-reading
Structure analysis with readers together. Discards of no matching.
The altogether reading and discussion of the different estimation
The readers examine the structures together and analyse the form and location of the ring, growth of fish etc.
The tester/2nd reader first tries to resolve differences. If they can't, the sample is given back to 1st reader to resolve. If not then, the 2 readers get together to resolve. Once the test is over both readers have access to each other's age data. So
Third reading followed by supervisor intervention

** Mostly informal processes are used.*

D-13

Have you had examples of reader drift that went undetected?

Sometimes	11%
Rarely	28%
Never	21%
Unsure	40%

* Reader drift that went undetected for a while, is uncommon. But interpretation of these data is tricky (how many have never looked for it, how many are always looking for it and therefore it never goes undetected?).

D-14

Do you record any measure of confidence in the age estimates of individuals?

Always	24%
Regularly	4%
Sometimes	27%
Rarely	6%
Never	39%

** No clear predominant practice on this question. Similar proportions between always/regularly (28%), sometimes/rarely (33%), and never (39%).*

SECTION E. Post-reading analyses

E-1

What error detection methods do you employ? (Select more than one as appropriate)

Only 1 respondent said none.

	Always	Regularly	Sometimes	Rarely	Never	N
Comparison of estimates for reference sets	14%	36%	18%	14%	18%	22
Comparison of growth curves/parameters	10%	43%	29%	14%	5%	21
Inspection of scatter plots	29%	49%	23%	0%	0%	35
Examination of age composition	29%	39%	26%	5%	0%	38
Examination of age-length keys	39%	25%	22%	11%	3%	36
Examination of mean lengths-at-age	34%	34%	28%	3%	0%	32
Other (please describe below)	20%	40%	40%	0%	0%	5

Other:

length x ring ray values plot inspection

** Most labs are regularly or always employing a range of the measures listed.*

E-2

What criteria or process do you have for the rejection or re-examination of outliers?

Formal	18%
Informal	76%
None	6%

** Clear majority use informal decision making process about the treatment of outliers.*

E-3

What measure(s) do you use to evaluate results from re-read material?

None	15%
CV	36%
Index of average percent error	30%
Age bias plots	34%
Regression analysis	17%
Percent agreement	49%
Other (please describe below)	13%

agreement with mode
Disagreement among 3 readers
During re-reading, the age of deviating individuals is redetermined, some can be abandoned.
Known-age data us used to indicate re-reads. The 1st reader will also indicate fish they would like a 2nd opinion of.
No standard process, depends on seriousness of error, judgement by project leader
symmetric test
We have used paired t-tests as well.

** Percent agreement still the most common method used; CV, IAPE, and age bias plots at similar but lower frequency.*

E-4

What levels do you consider indicate an acceptable level of precision? (Give value for whichever measure of precision you usually use; use a range if it varies among species)

	Species with clear increments	Moderately difficult species	Difficult species
Not assessed	4A	4B	4C
CV	4D	4E	4F
Index of average percent error	4G	4H	4I
Percent agreement	4J	4K	4L

E-4D

N=12

0.5	8%
2	17%
3	8%
4	8%
5	33%
10	17%
20	8%

E-4E

N=13

2	8%
3	8%
4	8%
5	15%
7	15%
8	8%
10	15%
20	23%

E-4F

N=11

4	9%
5	18%
7	9%

10	45%
20	9%
30	9%

E-4G

N=10

2	20%
3	10%
4	10%
5	50%
10	10%

E-4H

N=10

3.5	10%
4	10%
5	40%
6	10%
10	20%
12	10%

E-4I

N=10

5	50%
7	10%
10	30%
15	10%

E-4J

N=23

5	9%
7	4%
75	13%
80	22%
85	4%
90	17%
95	26%
99	4%

E-4K

N=23

5	4%
10	4%
50	4%
60	9%
70	13%
75	4%
80	22%
85	4%
90	17%
95	13%

100	4%
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E-4L

N=23

5	4%
20	9%
30	4%
35	4%
50	9%
60	9%
65	4%
70	9%
75	13%
80	13%
85	9%
90	9%
95	4%

* Large range of values considered acceptable. Tendency for bi-modal distributions. Most labs would consider that acceptable values would differ among species. But a significant minority (eight of 43 respondents who gave an answer for all three species categories) gave the same value as acceptable for species with different difficulty.

E-5

Do you have predetermined thresholds for levels of error or precision for which remedial action is taken?

N=49

Yes	24%
No	61%
Unsure	14%

* *Minority of labs have predetermined threshold levels.*

Comments:

Above the threshold, a qc check against the reference collection is forced
Clear(95%) mod(90%) difficult(80%) - % agreement needed to avoid re-reading samples
If more than 10% in error a second reader is called up on
If precision is below certain target levels then the 2nd reader will review ages not included in the precision test (based on biases) to try & reveal which of the 2 readers is off track. When this is determined, the 2 readers work together to resolve differences and reinforce consistent application of established criteria.
Must have 100% agreement of 2 or more readers.
Re-reading
Yes, at the daily level (for 10 % of age estimates); no for annual ages, so far (not necessitated in our (limited) field of research)

E-6

Do you provide data on the level of reading precision to users of the data?

N=48

Always	27%
Regularly	10%
Sometimes	27%
Rarely	6%
Never	29%

* Users are informed at least some of the time by the majority of labs, but only 1 in 4 always do it, and just under a third never do it.

E-7

Are these data incorporated into modelling or assessments?

N=48

Always	17%
Regularly	17%
Sometimes	29%
Rarely	8%
Never	23%
Don't know	6%

* Similar proportions to the previous question. Data provided at a frequency which approximates its frequency of use.

E-8

Do you use statistical data correction or smoothing?

N=43

Always 0%	
Regularly	2%
Sometimes	7%
Rarely	12%
Never	79%

Richards et al. - 2

Other -1

Loess smoother in S+

Note that although ageing error may be considered explicitly in modelling or stock assessments in our laboratory, estimated age data are not "corrected"

If an error in data is found and can be identified

* Statistical correction is a rarely used option.

E-9

If you record them, are measures of confidence used in any analysis? (e.g. to exclude age estimates that the reader considers unreliable)

N=36

Always	14%
Regularly	19%
Sometimes	31%
Rarely	
3%	
Never	
33%	

* Most labs (64%) use these measures at least sometimes, but only 1 in 7 always do so, and one third never do.

E-10

Are data on the measures of confidence given to the users of the data?

N=37

Always	19%
Regularly	14%
Sometimes	24%
Rarely	
3%	
Never	
41%	

* Data are provided at a lower frequency than might be suggested by its frequency of use.

3. Meetings in 2005

The third Plenary meeting in TACADAR

25 - 29 July 2005, Enniskillen, Northern Ireland

Local host:

Willie McCurdy

Department of Agriculture and Rural Development

Aquatic Systems Group

18a Newforge Lane

Belfast BT9 5PX, UK

Tel.: +44 2890 255472

Fax: +44 2890 382244

Mobil: +44 7719532942

E-mail: Willie.McCurdy@dardni.gov.uk



Special Sessions for ASLO 2005 Summer Meeting:

Website: <http://www.aslo.org/meetings/santiago2005/>

SS27 Biomineralized Tissues in Marine and Freshwater Organisms

Organizers: Beatriz Morales-Nin, CSIC/UIB-IMEDEA, (beatriz.morales@uib.es) and Erlend Moksness, Institute of Marine Research, Flødevigen Marine Research Station, (moksness@imr.no)

The biomineralized tissues are key players in the organisms as structural components as well as ionic reservoirs of fundamental elements such as Calcium. Moreover, calcified structures such as otoliths and statoliths form part of the sensorial system and represent a part of the organisms interaction with the environment. The formation of these tissues is related to the environmental conditions as well as to the organism metabolism. Certain biominerals are not reabsorbed during the organism life and can last for a long time after the death, thus having the potential to act as registers of both the organism

and the environmental conditions. In molluscs, corals and fish the biomineralized tissues have been extensively studied for age determination. Recently their microchemical composition has been employed for paleostudies, to identify natal habitats, and to explore ecological traits. However, many questions remain unresolved concerning the present situation (biomineral fluxes, growth rates) and the future in the context of global change. How is the increase acidification going to affect the calcium budget at the sea? How is this going to affect the organisms? The developments in several research fields such as stoichiometry, modelling, environmental and biological studies, make a session on biomineralization in the context of global change a timely issue.



Registration form

3rd TACADAR Plenary Meeting

25 – 29 July 2005

General information

Meeting (Venue): **Enniskillen Campus of the College of Agriculture, Food and Rural Enterprise**
Enniskillen, County Fermanagh, Northern Ireland, UK

Contact person: Willie McCurdy DARD Aquatic Systems Group, Belfast
Direct line Tel: +44 28 90 25 55 13
Tel: +44 28 90 25 54 72; Fax: +44 28 90 25 50 04
e-mail: Willie.McCurdy@dardni.gov.uk

Start: 25 July 2005

End: 29 July 2005

Name:.....

Representing TACADAR Member No.:

Address:.....

City/State/Zip:.....

Country:.....

Email:.....

Date of arrival:.....(College accommodation will be available from Sunday 24 July)

Date of departure:.....

Number of single college rooms required.....(Euro 35-43 per day per person, for room, breakfast, and lunch.)

Additional persons: See note on alternative accommodation.

All persons attending the meeting, please return this form to:

Erlend Moksness
TACADAR
Institute of Marine Research
Flødevigen Marine Research Station
N-4817 His, Norway

Alternative accommodation:

Members who do not wish to stay in the College rooms and who wish to stay in hotel or guest house accommodation, please contact the Fermanagh Tourist Information Centre directly, for advice on the most suitable accommodation for your needs and to make reservations. (Daily lunch at the college will cost Euro 7.5 -15.)

Fermanagh Tourist Information Centre, Wellington Road, Enniskillen, BT74 7EF, Co. Fermanagh,

http://www.fermanagh.gov.uk/index.cfm?website_Key=47&Category_key=134&Page_Key=337

Tel: +00 44 28 66 32 31 10 Fax: +00 44 28 66 32 55 11 Email: tic@fermanagh.gov.uk

DEADLINE FOR REGISTRATION: 1 April 2005