

# Age reading of tropical tuna otoliths: Bias and uncertainties

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# Otoliths - generalities

## Otoliths

- Calcified stones ( $\text{CaCO}_3$ ) in inner ears of teleost fishes,  
Played role in positioning, speed sensitivity...

## Preparation

- 3D growth by regular increment,  
and proportionally to somatic growth.  
-> Age and growth

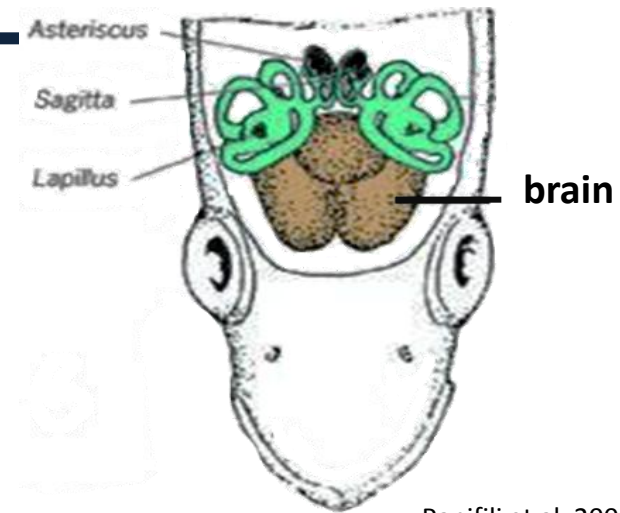
## Readings & Bias

otolith measures

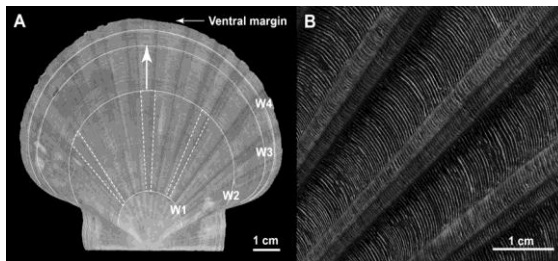
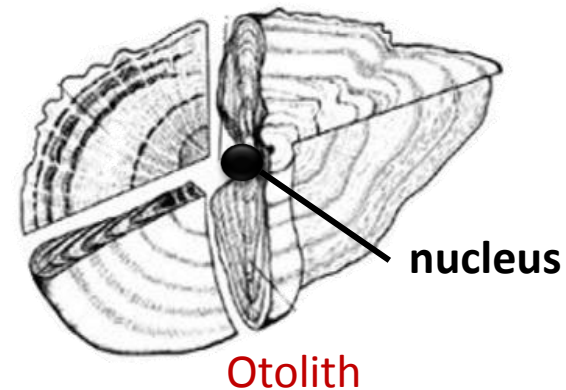
Incrementation rate

Age estimation

- Incorporation of chemicals elements of the  
environment.  
-> Environmental recording

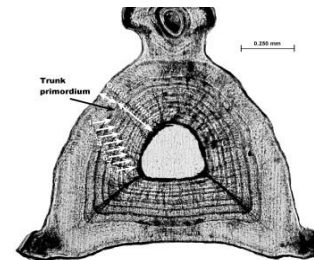


Panifili et al. 2002



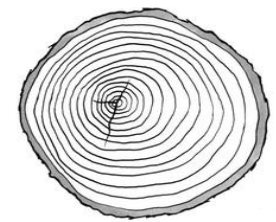
**Bivalves shell**

(From Thébault 2012)



**Dorsal spine**

(From Coelho & Erzini 2007)



**Tree rings**

## Advice

# Otoliths – case of tropical tunas

## Otoliths

## Preparation

- Relatively small and fragile otoliths  
Difficult to read

## Readings & Bias

## Otolith measures

## Incrementation rate

## Age estimation

## Advice

- Previous studies: daily incrementation

YFT Pacific (Wild & Foreman 1980-1985)

BET Atlantic (Hallier et al. 2005)

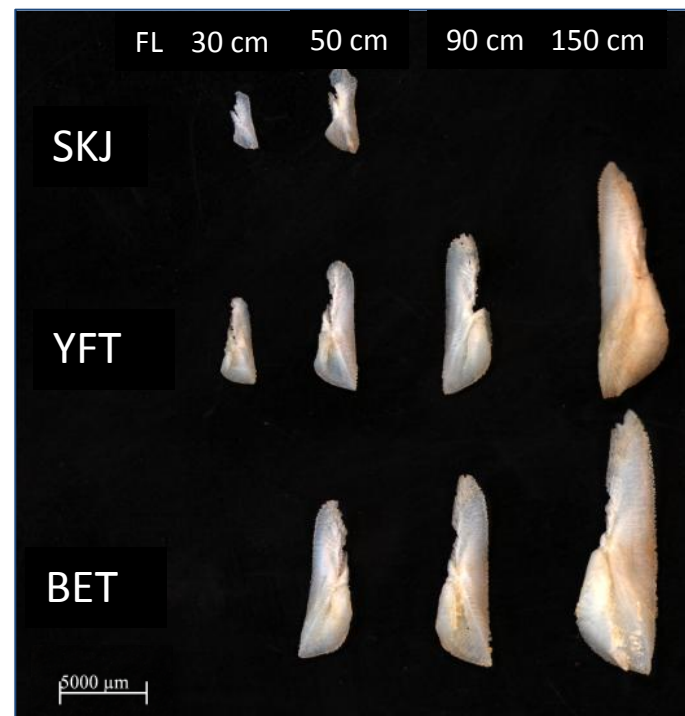
BET East-Pacific (Schaefer & Fuller 2006)

SKJ juvenile Pacific (Kayama et al. 2007)

- **OTC – Oxytetracycline**

Antibiotic incorporated into the calcium at the time of tagging

leaves a permanent mark visible under UV.



# Preparation

Otoliths

Preparation

Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

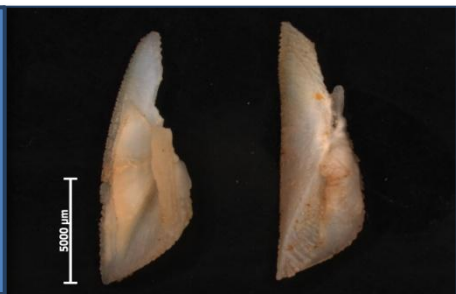
Advice

1



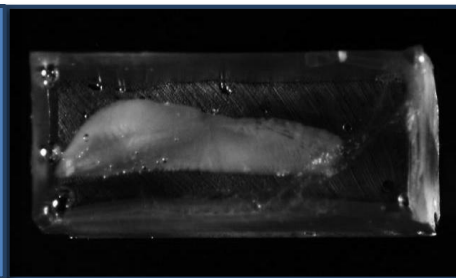
Otolith extraction

2



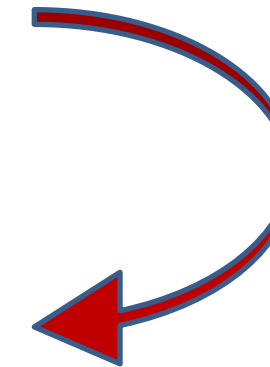
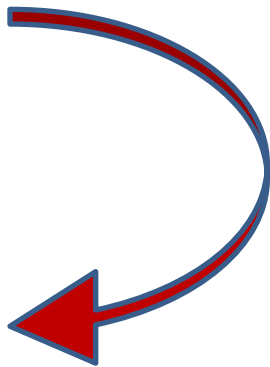
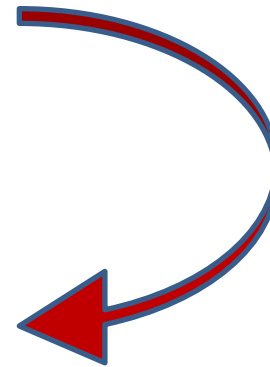
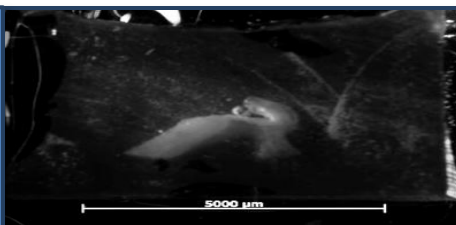
Clean and dry

3



Embedded in resin

4



mold of otoliths



saw



# Preparation

Otoliths

Preparation

Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

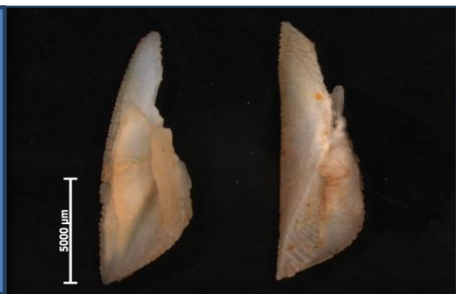
Advice

1



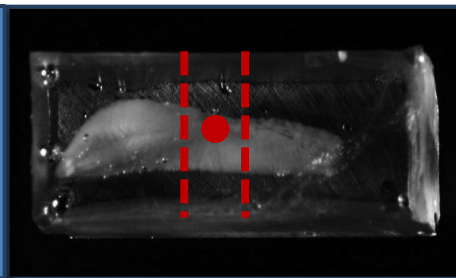
Otolith extraction

2



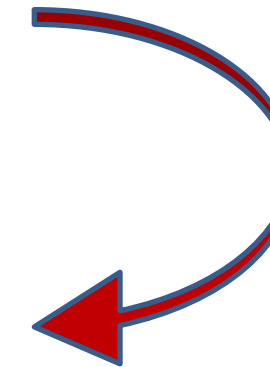
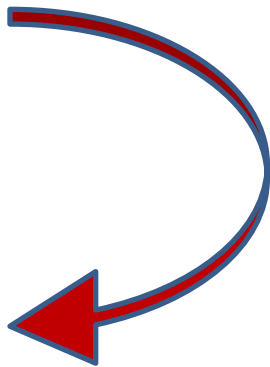
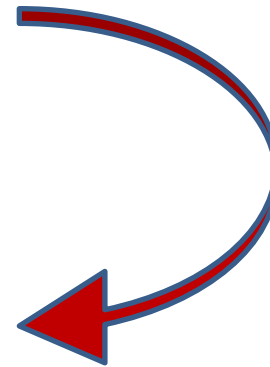
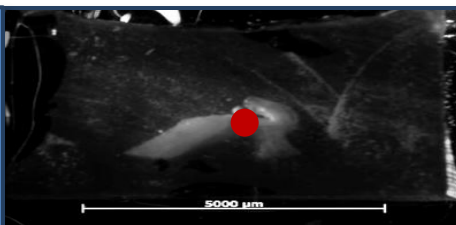
Clean and dry

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Embedded in resin

4



mold of otoliths



saw

# Otoliths

## Preparation

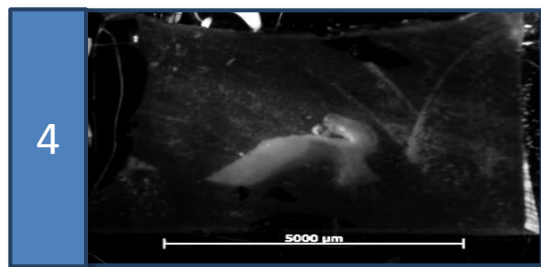
## Readings & Bias

otolith measures

Incrementation rate

Age estimation

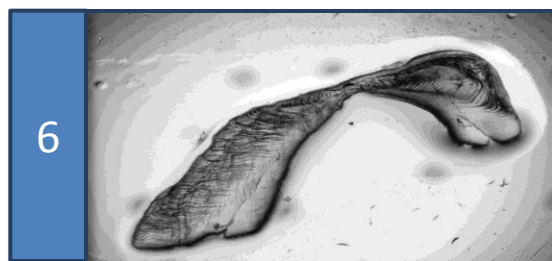
## Advice



Transverse section



Stick on glass slide



Polished slice

## Preparation



hotplate  
& termoplastic resin



polishing disc



EDTA



optical microscope

# Readings - Teams

Otoliths

Preparation

Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice

Different readers  
(personal interpretation, olds/news, ...)

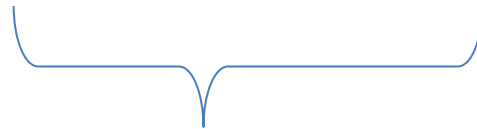


Grouped according to their  
methods of reading

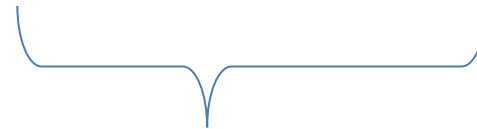
Team 1  
(3 readers)

Team 2  
(2 readers)

Team 3  
(1 reader)



Yellowfin  
Skipjack



Bigeyes

A team = same reading method

# Readings – Transverse section measures

Otoliths

Preparation

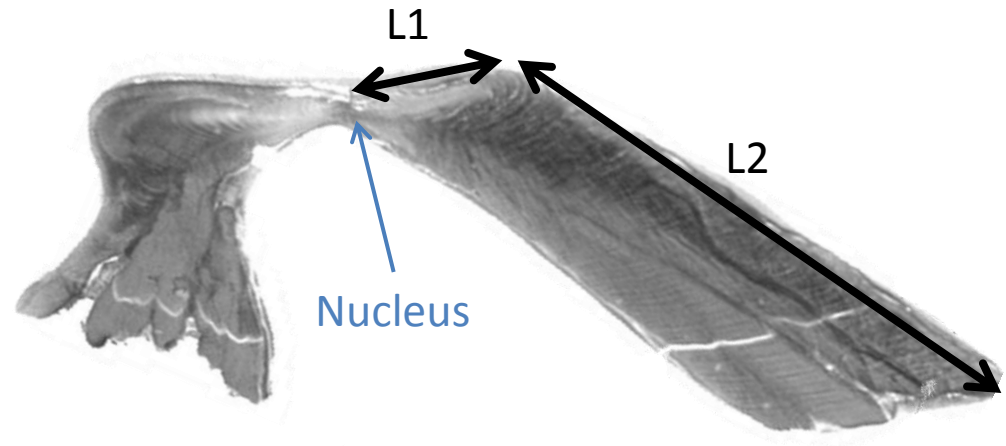
Readings  
& Bias

Otolith measures

Incrementation rate

Age estimation

Advice



$$L1 + L2 = L_{tot}$$

Otolith length, from the nucleus to the edge

Technically:  
Count under binocular

Axiovision software



# Readings – Transverse section measures

Otoliths

Preparation

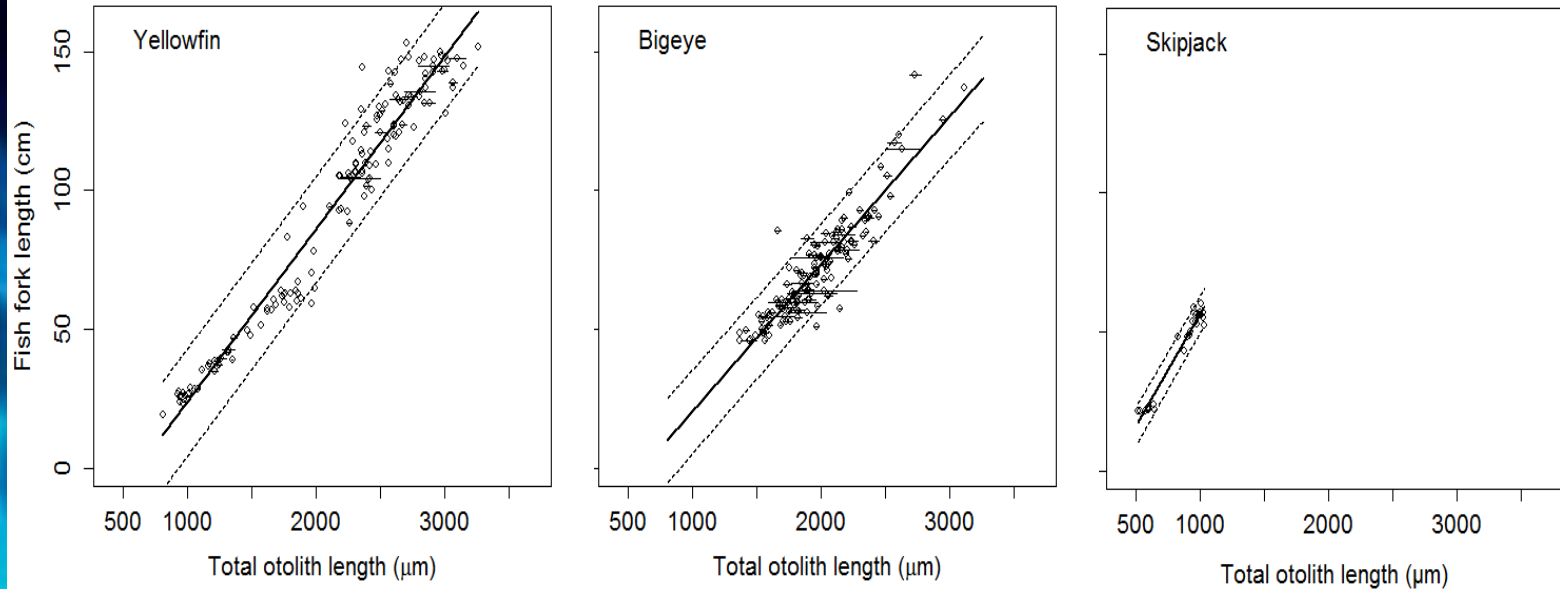
Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice



-> Otoliths grow proportionally to somatic growth

-> Any differences between the measurements of each team

# Readings – Determining increment periodicity (S2)

Otoliths

Preparation

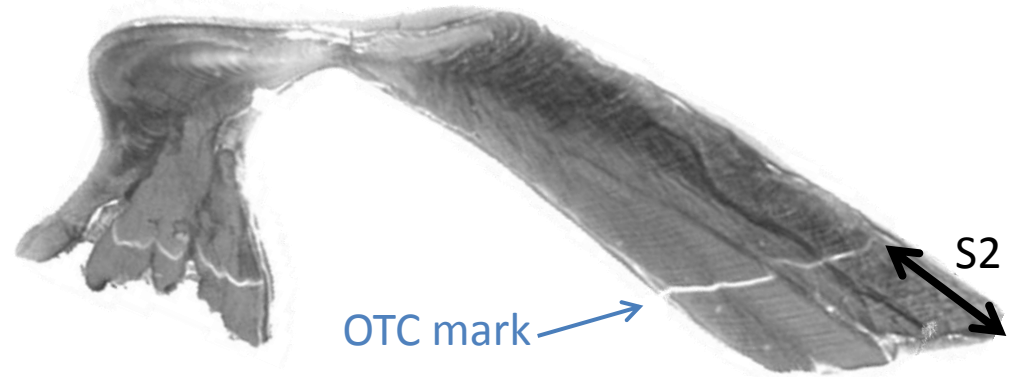
Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice



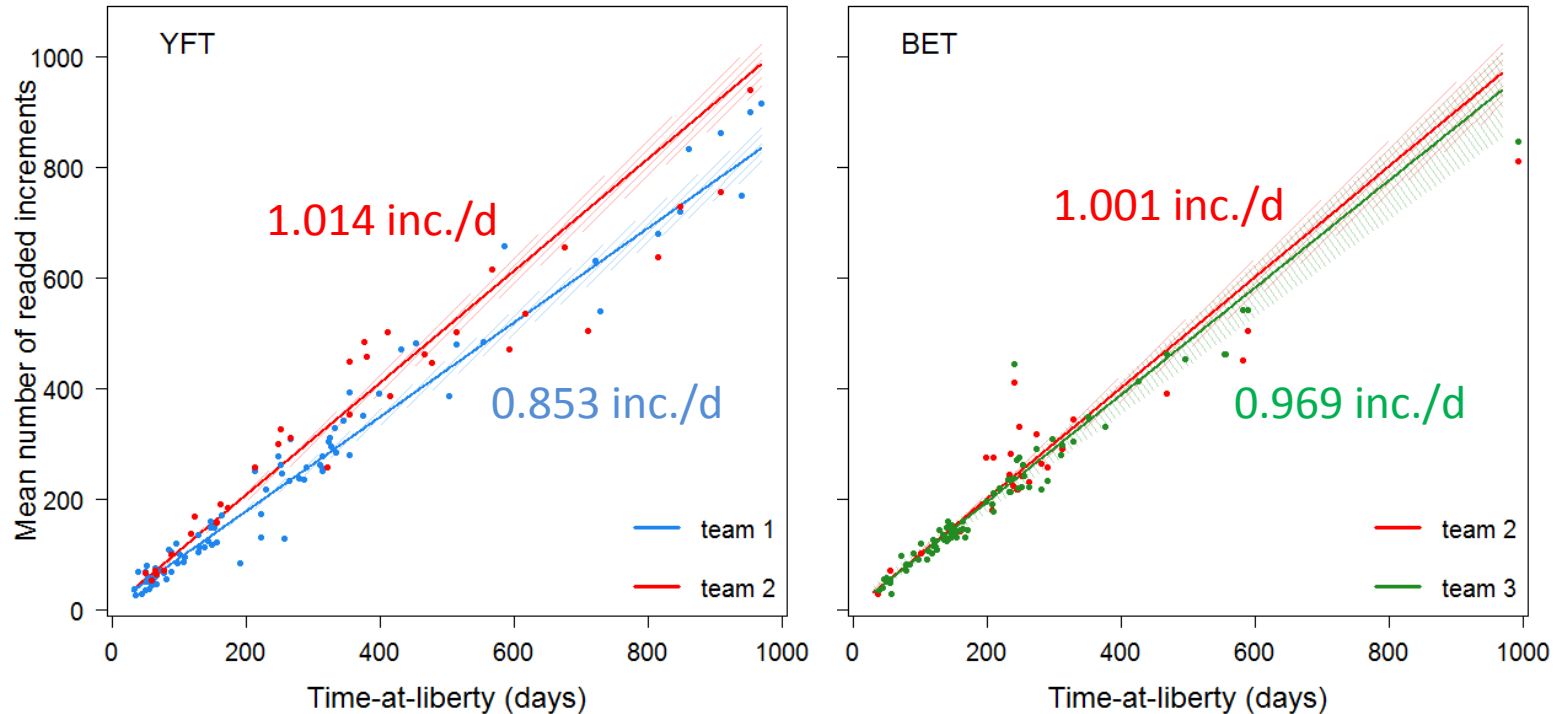
The number of increments between the OTC mark and the edge is compared to the time-at-liberty

Technically:  
Count under optical microscope magX1000  
With UV light

Number of repeated readings: 2 to 6/otolith

# Readings – Determining increment periodicity (S2)

With time at liberty  $\geq 30$  days



-> Incrementation periodicity tested for:

YFT between 49.7 and 131 cm FL

BET between 47 and 125.5 cm FL.

-> Note that is more a validation of a reading method.

# Readings – Determining increment periodicity (S2)

Otoliths

Preparation

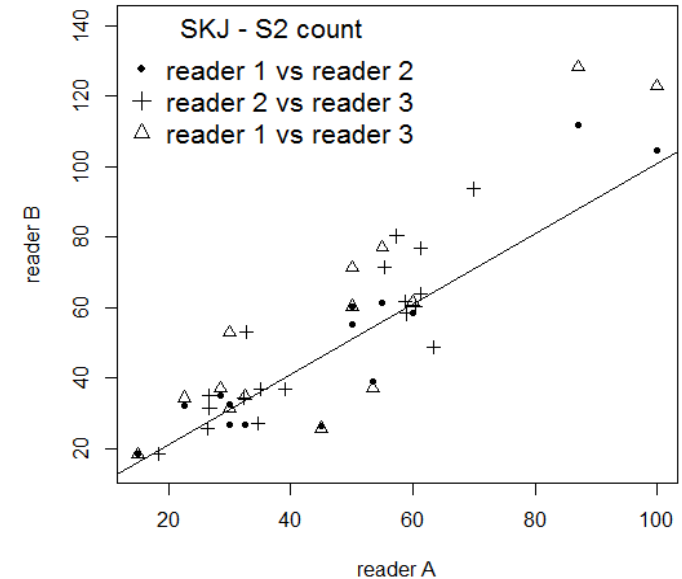
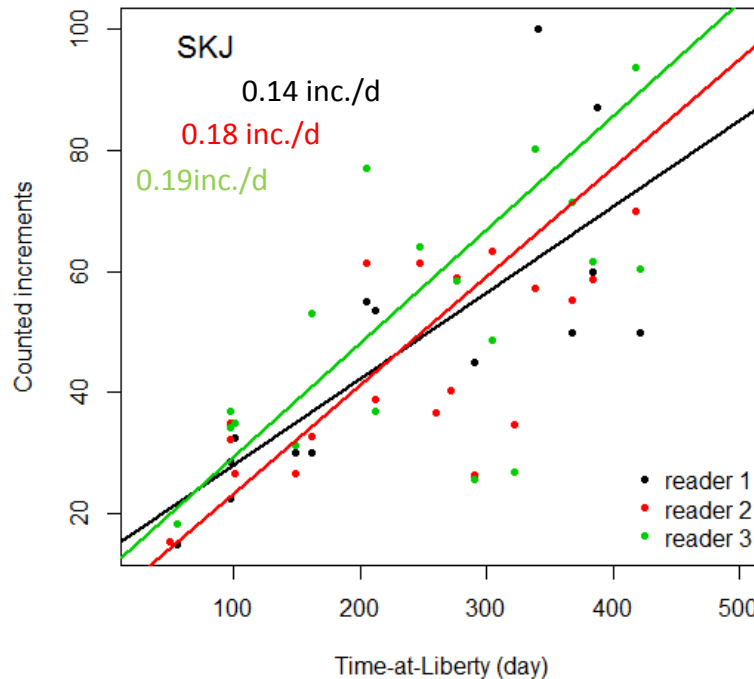
Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice



-> No “daily” incrementation for SKJ between 48.6 and 60.2 cm FL.

-> Large variability of the rate of incrementation (even with good repeatability)

# Readings – Age estimation (Stot)

Otoliths

Preparation

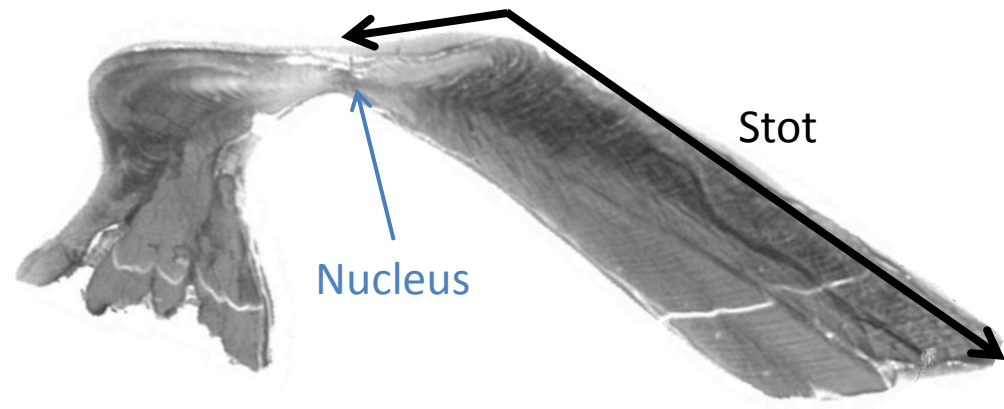
Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice



Number of growth increments between the nucleus and the edge, along the axis of maximal growth.

Technically:  
Count are done with the exactly same method than for the “incrementation validation”.

Number of repeated readings: 2 to 6/otolith



# Readings – Age estimation (Stot)

Otoliths

Preparation

Readings  
& Bias

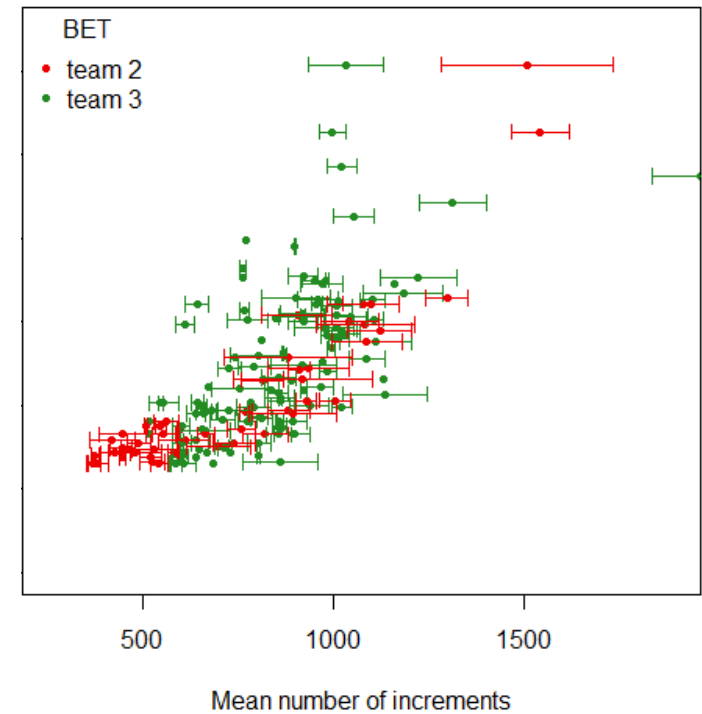
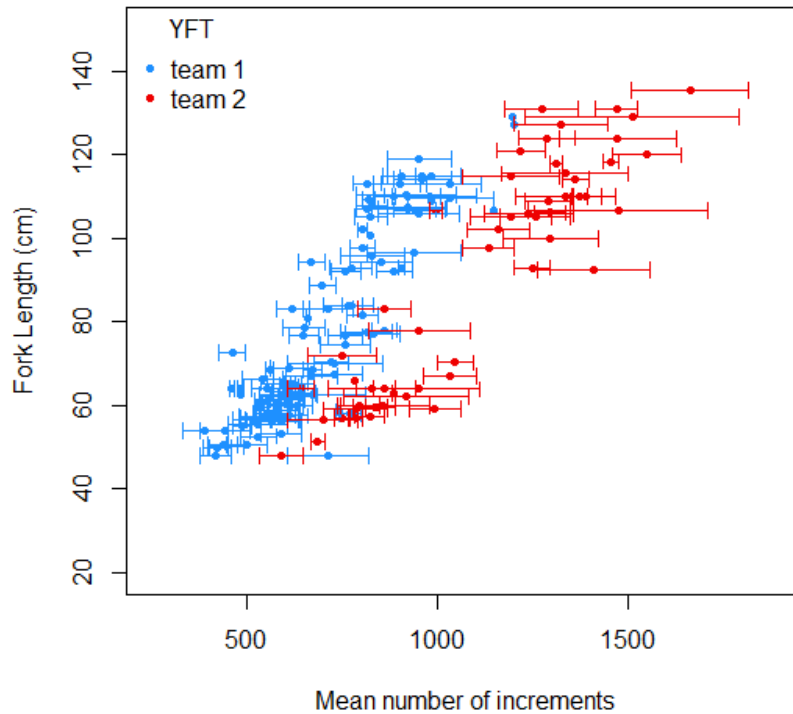
otolith measures

Incrementation rate

Age estimation

Advice

## First results



A team = same reading method.

# Readings – Age estimation (Stot)

Otoliths

Preparation

Readings  
& Bias

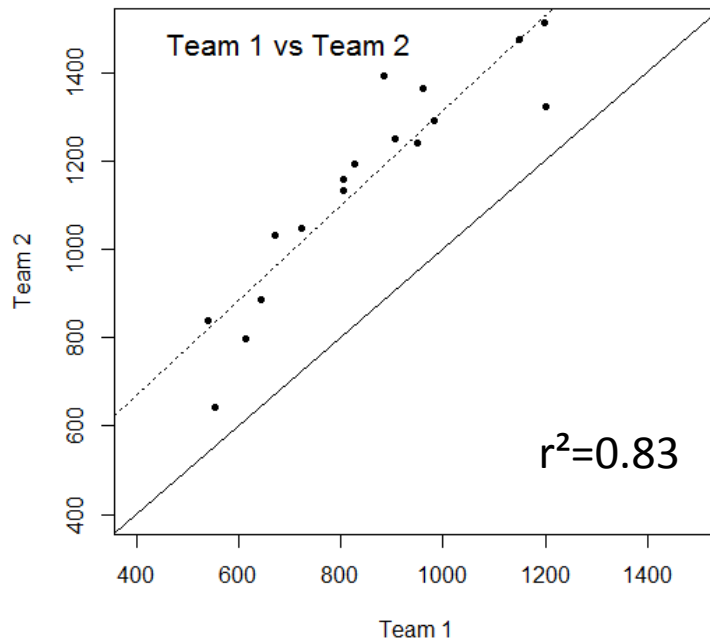
otolith measures

Incrementation rate

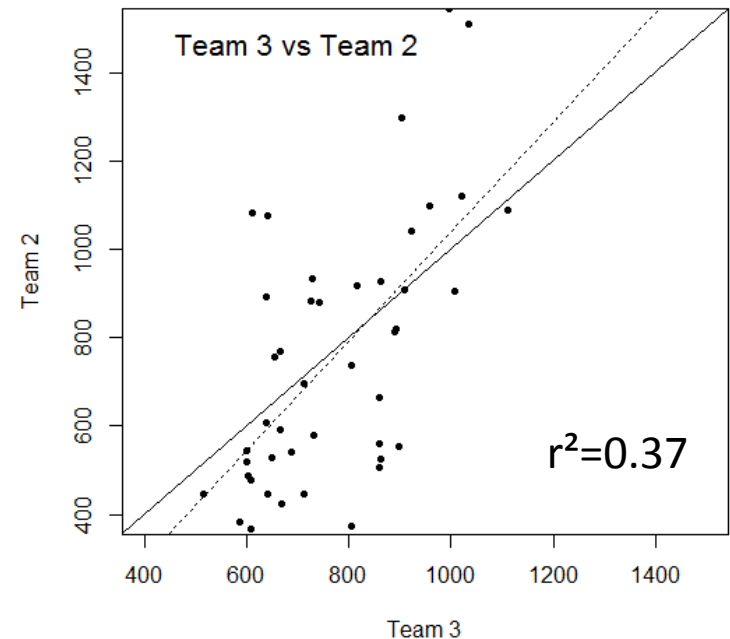
Age estimation

Advice

## Inter-team Comparison



Constant bias  
(Team 2 over-estimation or Team 1 under-estimation ?)



No precision in readings  
(affects reproducibility)

-> Strong influence of the reading method on the age estimation

# Readings – Age estimation (Stot)

Otoliths

Preparation

Readings  
& Bias

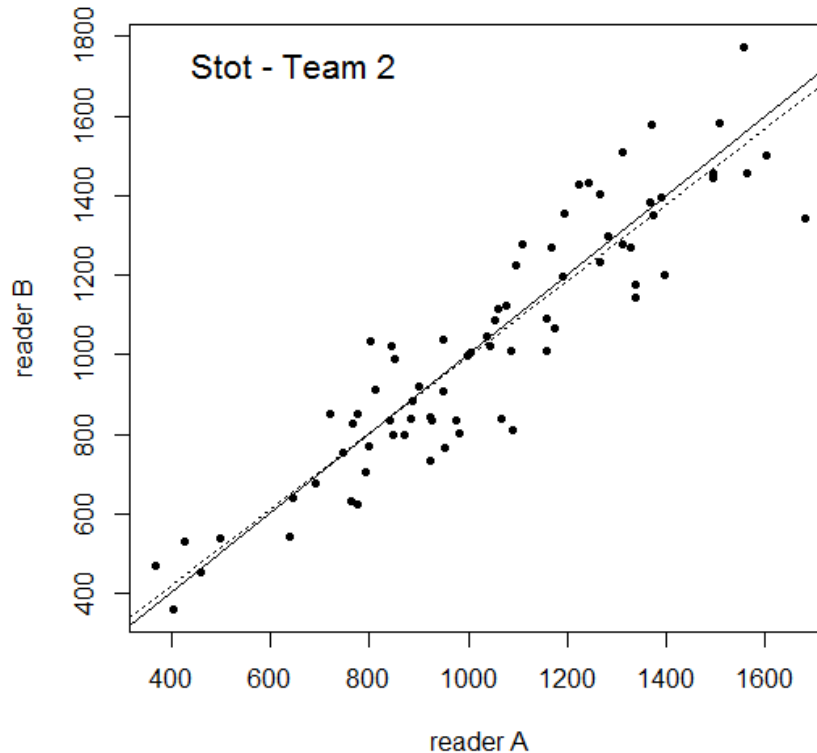
otolith measures

Incrementation rate

Age estimation

Advice

## Intra-team Comparison



-> with same reading method, readers obtain similar count results.

# Readings – Age estimation (Stot)

Otoliths

Preparation

Readings  
& Bias

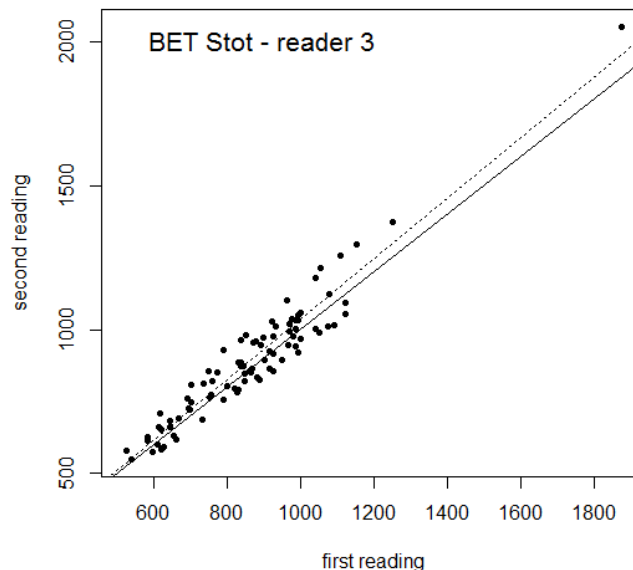
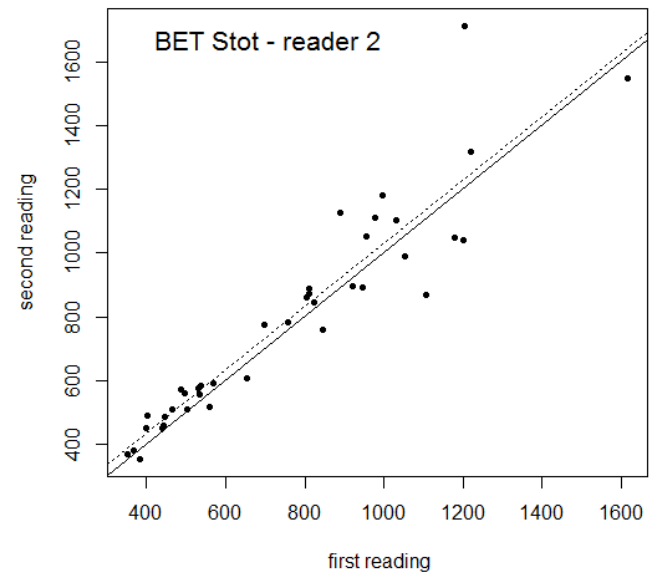
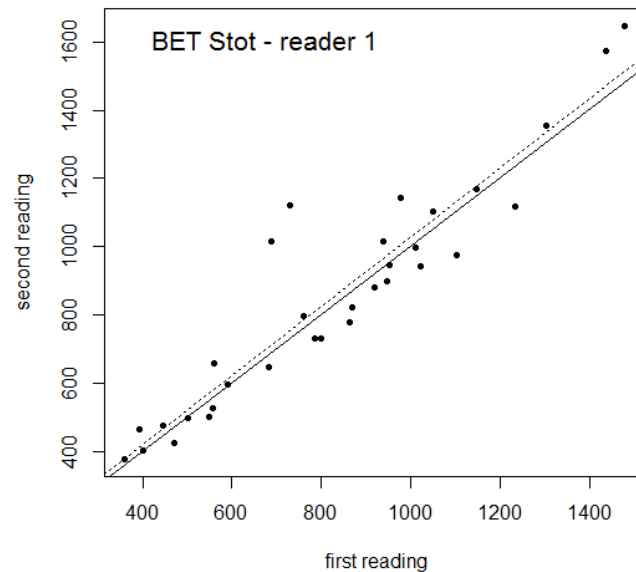
otolith measures

Incrementation rate

Age estimation

Advice

## Intra-readers Comparison



-> each reader is regular in its estimate

# Bias origin

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Otoliths

**Major source of error in age estimation = reading methods**

-> origin of differences between readings methods ?

Preparation

- **Determination of increments to read or not**, in particular after the first deceleration growth : the increments become smaller, and sub-daily increments can be confused with daily increments (no OTC validation at this stage).

Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

- **Quality of the preparation**: influx on estimations on the entire otolith.  
The more preparation is poor, more there will be estimations.

- **Practice of the reader**: after seen many preparations, reading habits can change between the first and the last count.

Advice



# Modeling bias

Otoliths

Some uncertainties have been estimated for establish an ageing error model.

Preparation

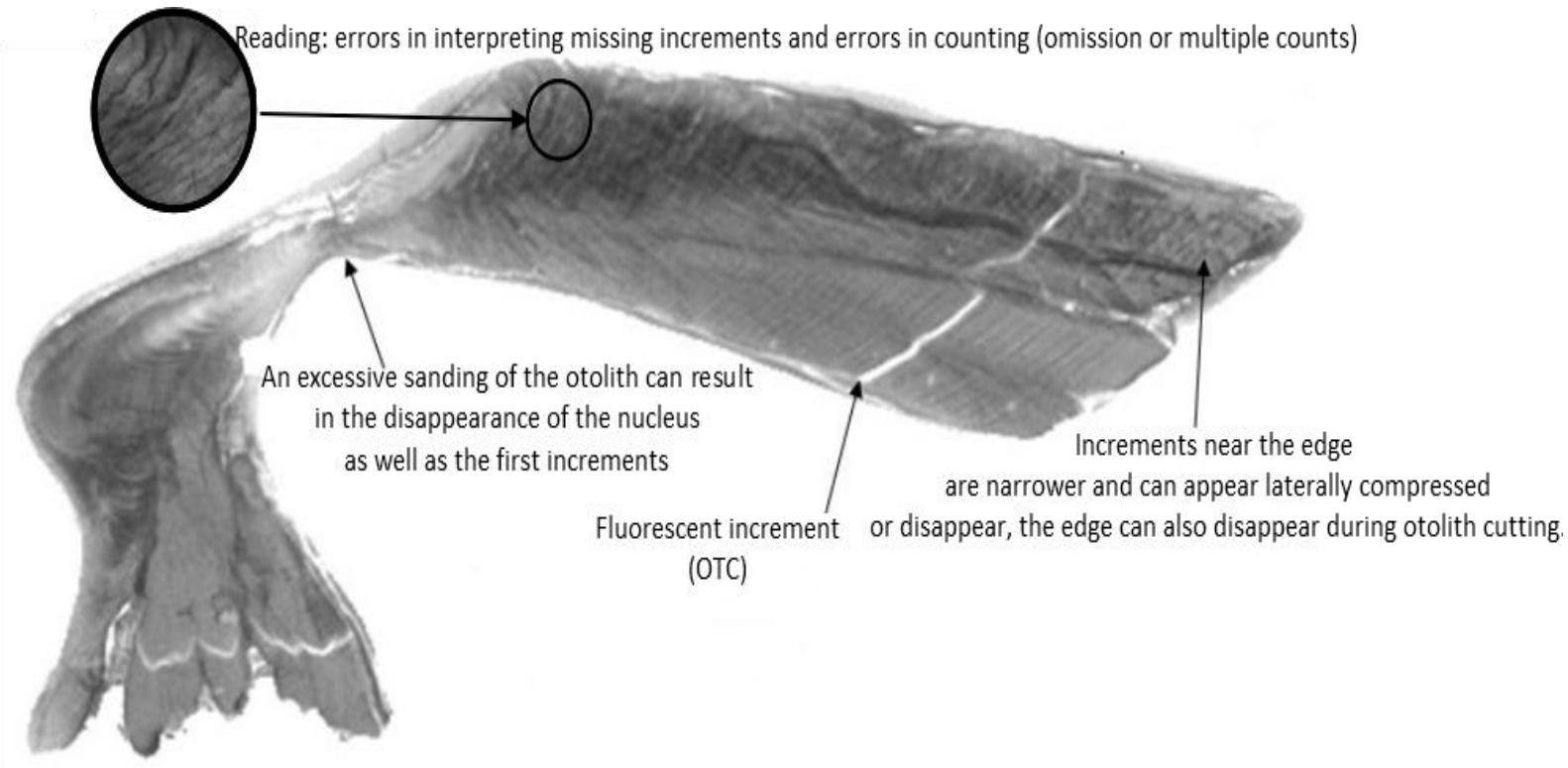
Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice



# Growth curve

Otoliths

Preparation

Readings  
& Bias

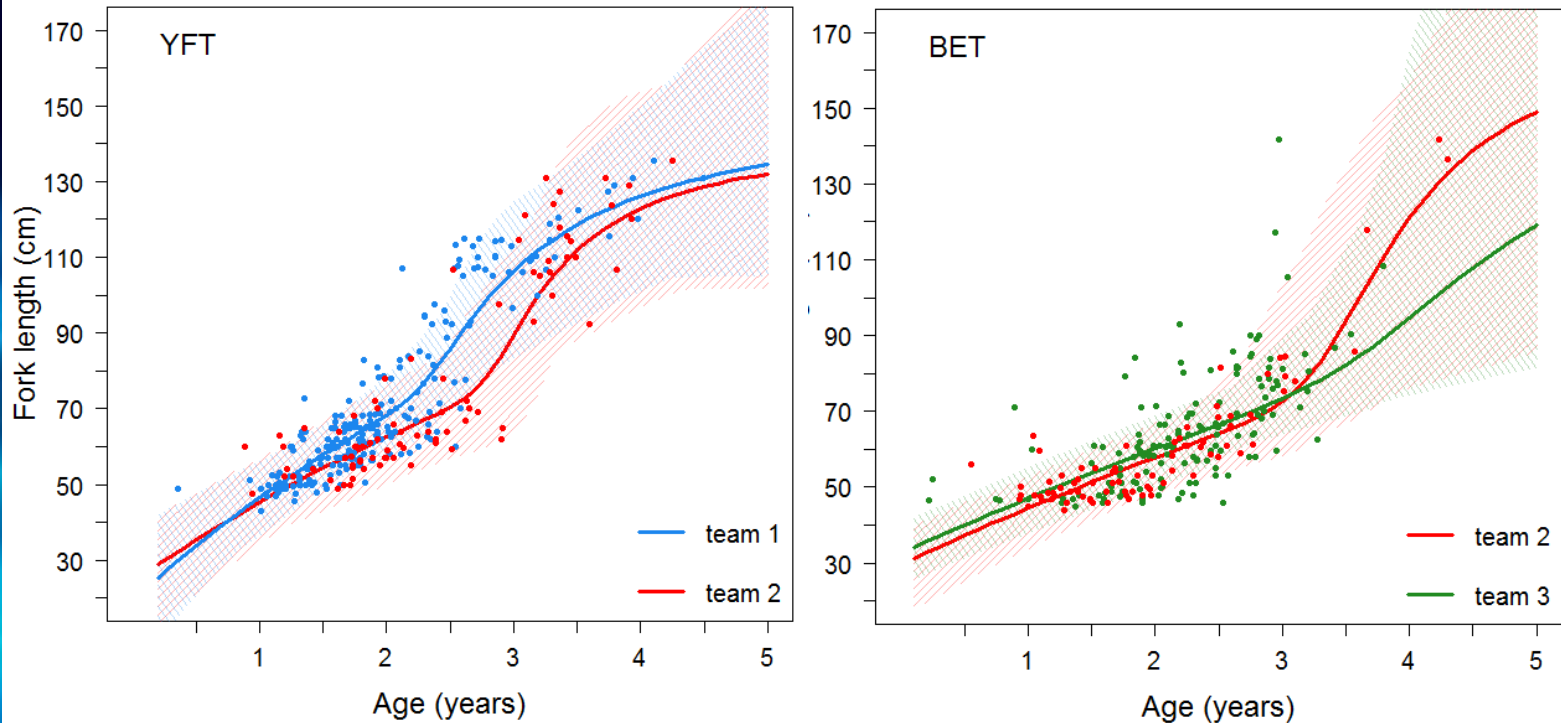
otolith measures

Incrementation rate

Age estimation

Advice

Growth modeling which includes an ageing error model



-> Information missing for biggest individuals (for BET in particular)

-> male/female influence ?

# Some ideas for future use of otoliths

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Otoliths

Preparation

Readings  
& Bias

otolith measures

Incrementation rate

Age estimation

Advice

- Create a **reference collection** of ~500 ind. (Campana 2001) with good and bad preparations, to:

- Inter-laboratories comparison
- Adopt a consensual age estimation (calibration)
- Form new readers and estimate temporal bias of olds readers

- **Note the preparation quality** could be helpful to know what credit can be given to the age estimation.

- **OTC-Mark small fishes** to confirm the rate of incrementation on the entire size range, and to help in determination of the increments at young stages.



**Necessity to adopt a standard ageing method to obtain good informations on growth.**

**Keep in mind that otolith ageing is an estimation !**

Thank you for your attention

