# Estimation of age-at-length of bigeye from the WCPO

## Based on otolith annual increment counts

**Presenter: Jessica Farley**

IATTC Workshop on age and growth of BET and YFT in the Pacific Ocean
23 January 2019

**OCEANS AND ATMOSPHERE**
www.csiro.au

# WCPO BET ageing history (CSIRO/SPC)

| Year | Project | Publication |
|---|---|---|
| 1990s | SPC daily ageing and tagging data (SPC)<br>VB composite model | Lehodey & Leroy (1999) |
| 1990s - early 2000s | Sr-marking experiment - daily & annual age validation) (CSIRO/SPC) | Clear et al. (2000) |
| 2000s | Australian AFZ age & growth study (CSIRO/SPC) | Farley et al. (2006) |
| 2009-2011 | WCPFC pilot project (SPC/CSIRO/FAS)<br>Preliminary growth curve | Nicol et al. (2011) |
| 2012-2017 | Full project (CSIRO/FAS/SPC)<br>Daily-annual age comparison study | Farley et al. (2017)<br>Williams et al. (2013) |
| 2018 | Updated growth (CSIRO/FAS/SPC/NRIFSF) | Farley et al. (2018) |

# Outline

1. Otoliths analysed
2. Otolith sectioning and reading
3. Calculating biological (decimal) age
4. Results

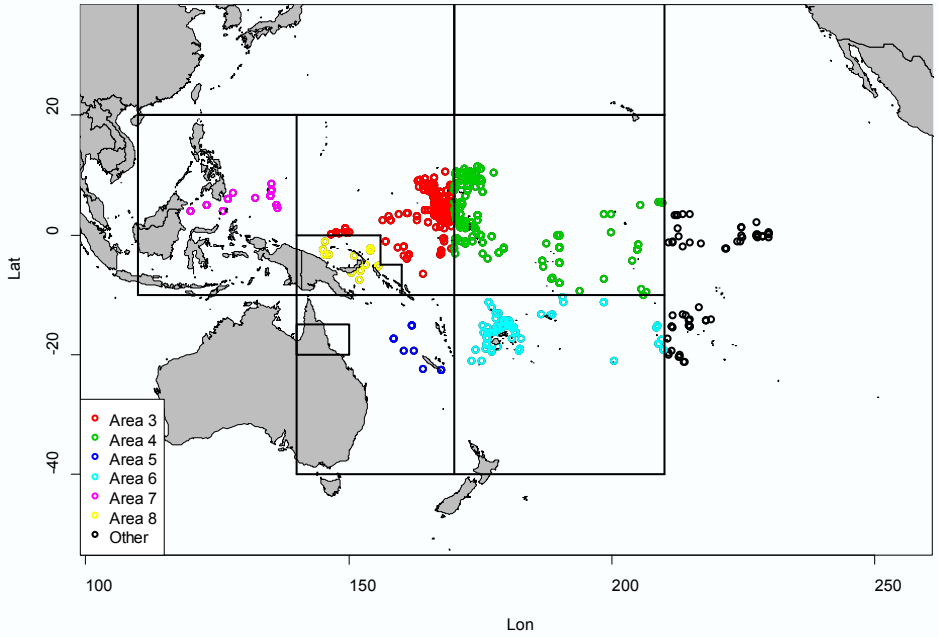
# Otoliths aged

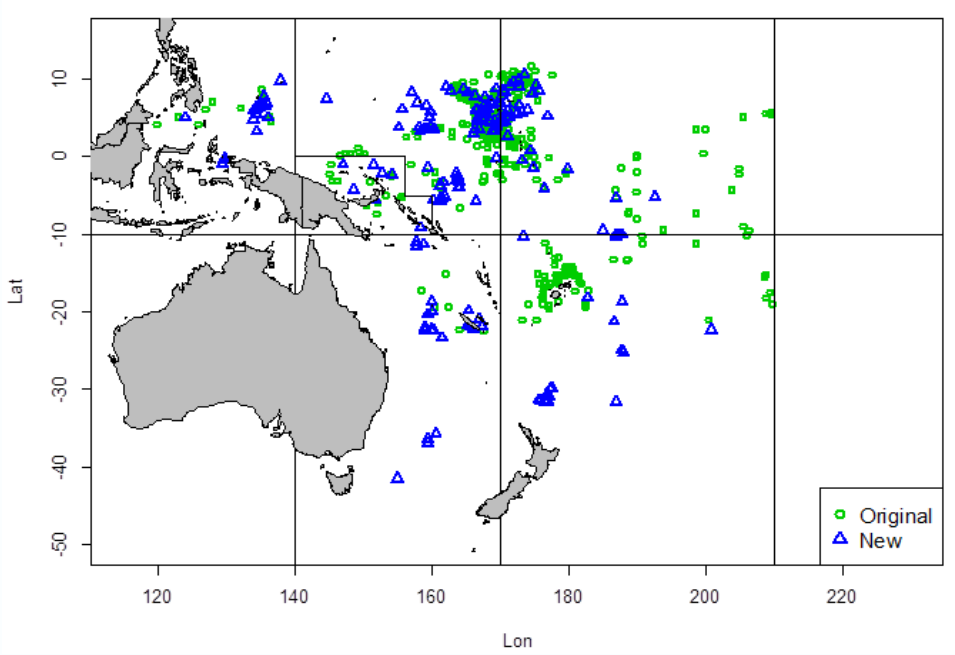
WCPO

- 28-183 cm
- 1186 annual age
- 30 FAS daily <1 yr
- 28 SPC daily <1 y

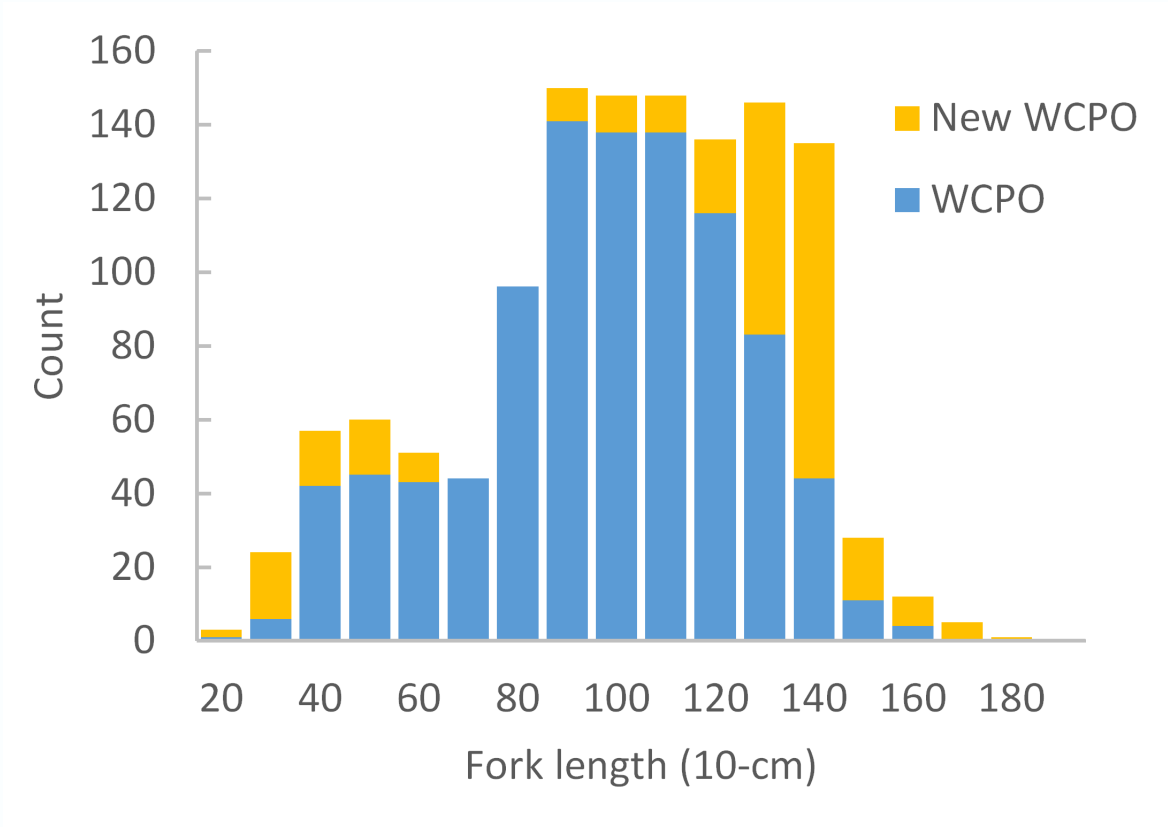
EPO

- 63-192 cm
- 68 annual age



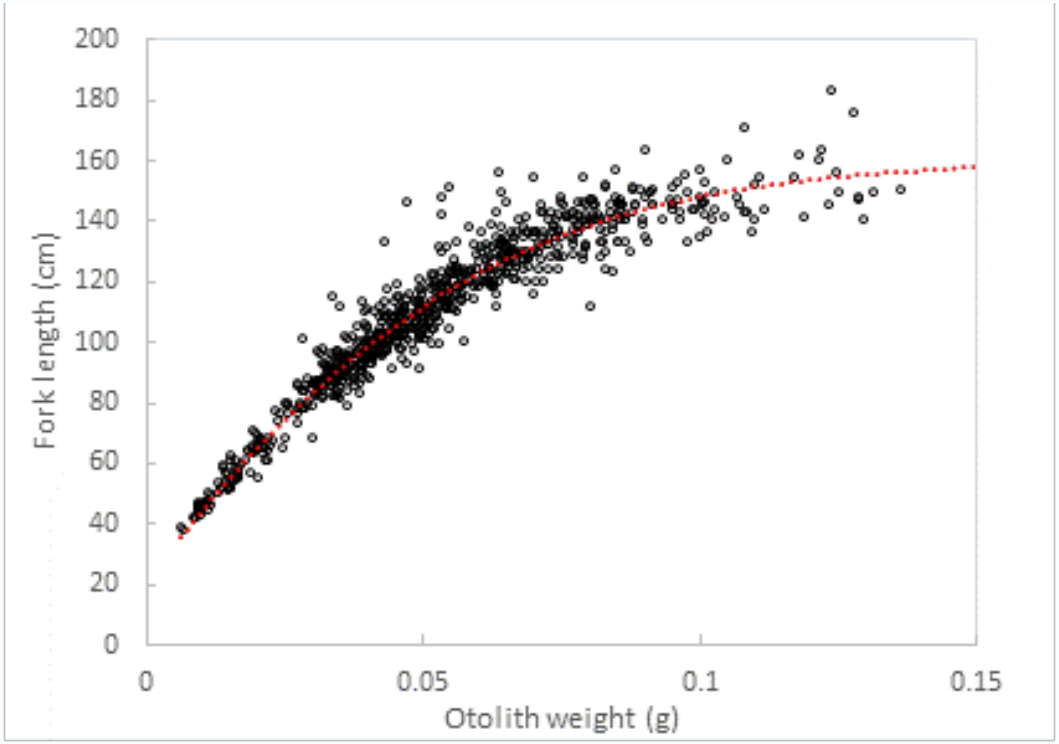
# Length frequency of aged BET



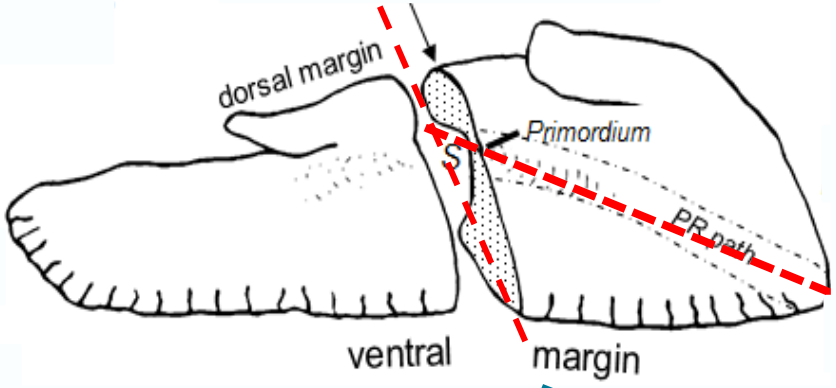
# Otolith weighing, sectioning and reading:

- annual
- daily

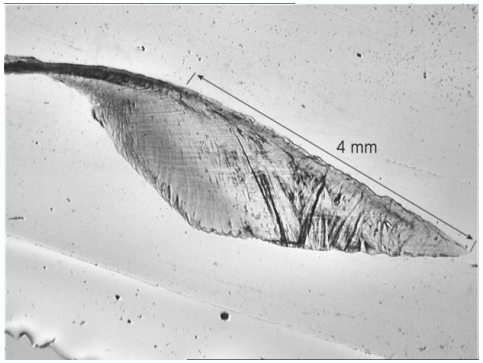
# Weigh all whole otoliths



# Sectioning planes

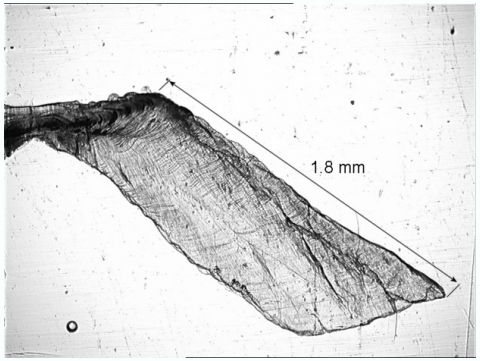



Frontal (longitudinal) section




Daily age

Transverse section




Daily and annual age

Otolith images from Williams et al. (2013).

# Fish Ageing Services (FAS)

Daily age

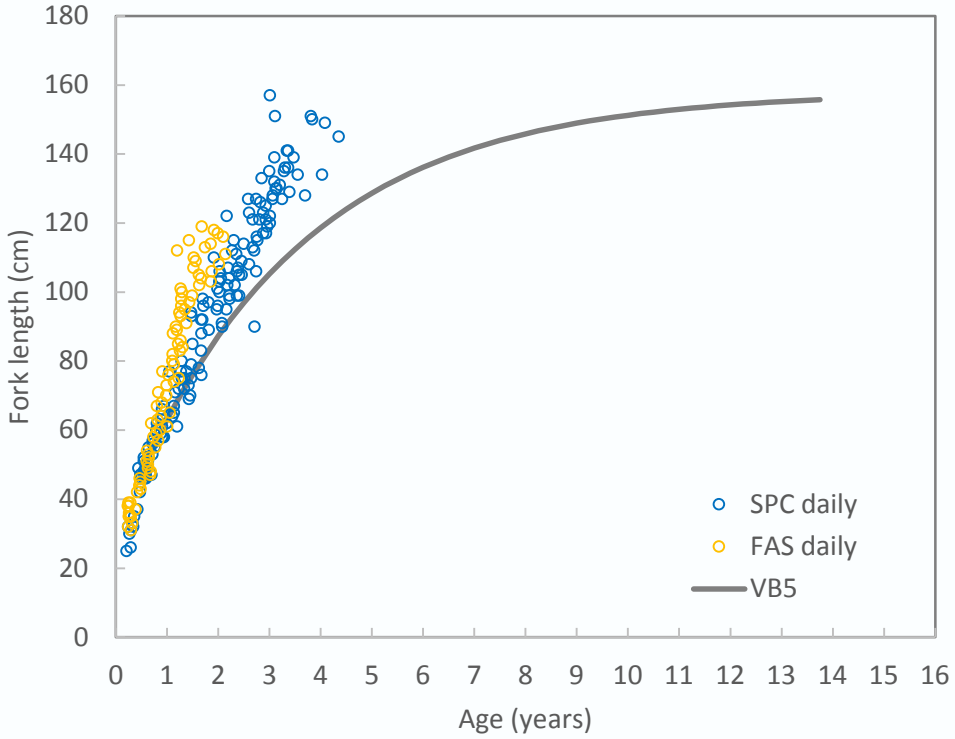
1. Single **frontal** section: age estimate (70 otoliths)
2. Singe **transverse** section: confirm location of 1st 1-2 annual increments

- Confident to age ~300 days (30 otoliths)
- The arrow marks the general area that microincrement interpretation became difficult (split zones and multiple zones that converged)

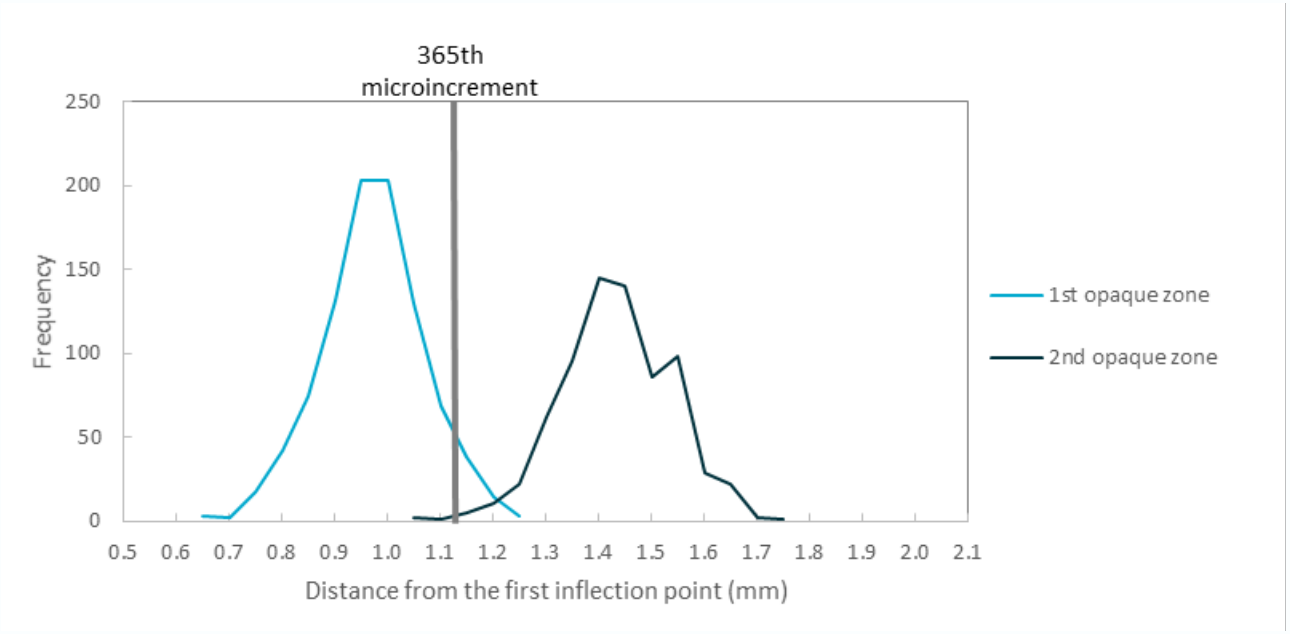
Frontal: 101 cm FL, count = 623

Transverse: 83 cm FL, count = 457

# 1. Length at daily age (FAS and SPC)



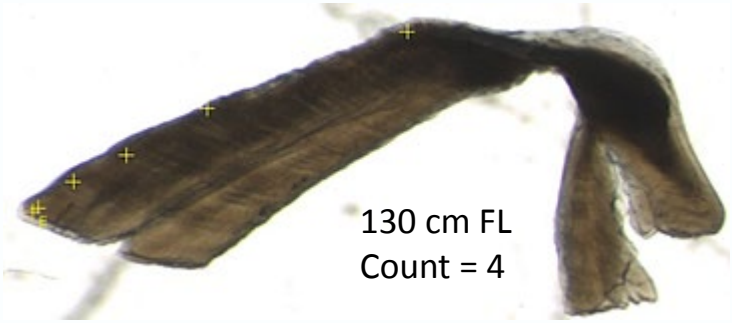
# 2. Locate first 1-2 annual zones

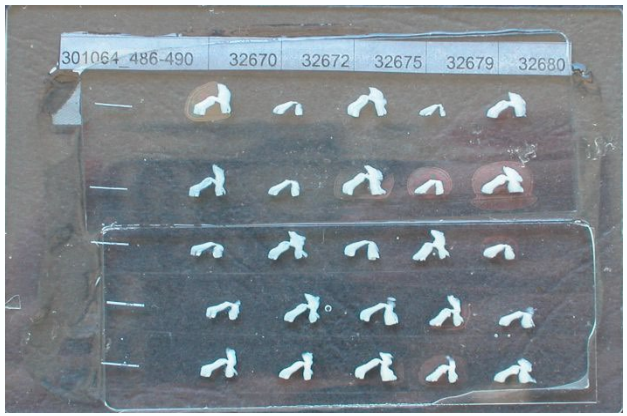


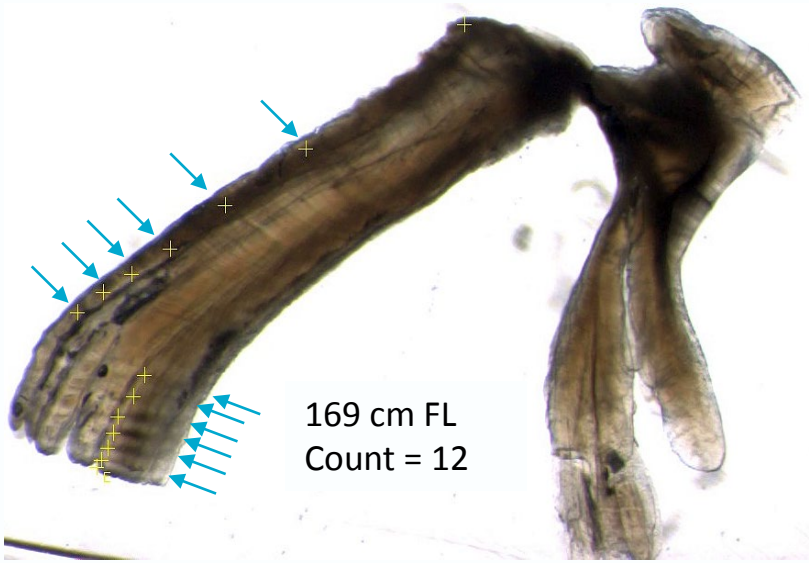
# Fish Ageing Services (FAS)

Annual “age”

- Multiple **transverse** sections
- 2 counts of opaque zones & final “age”
- Last zone only counted if complete
- Edge type (narrow T, wide T or opaque)
- Readability score (0-5)
- Marked images & measurements



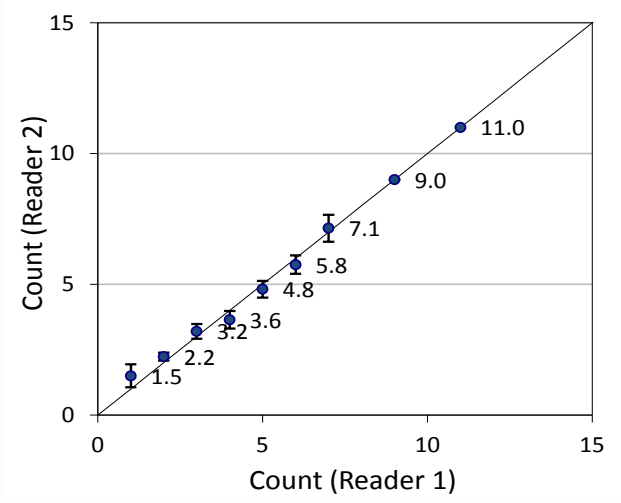



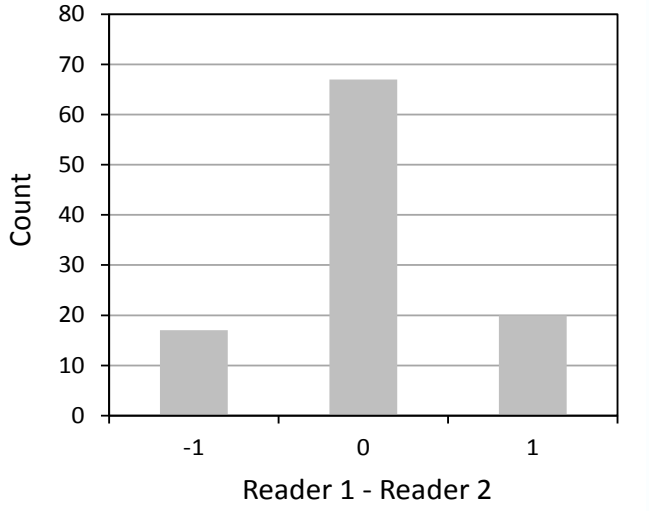



# Otolith reading

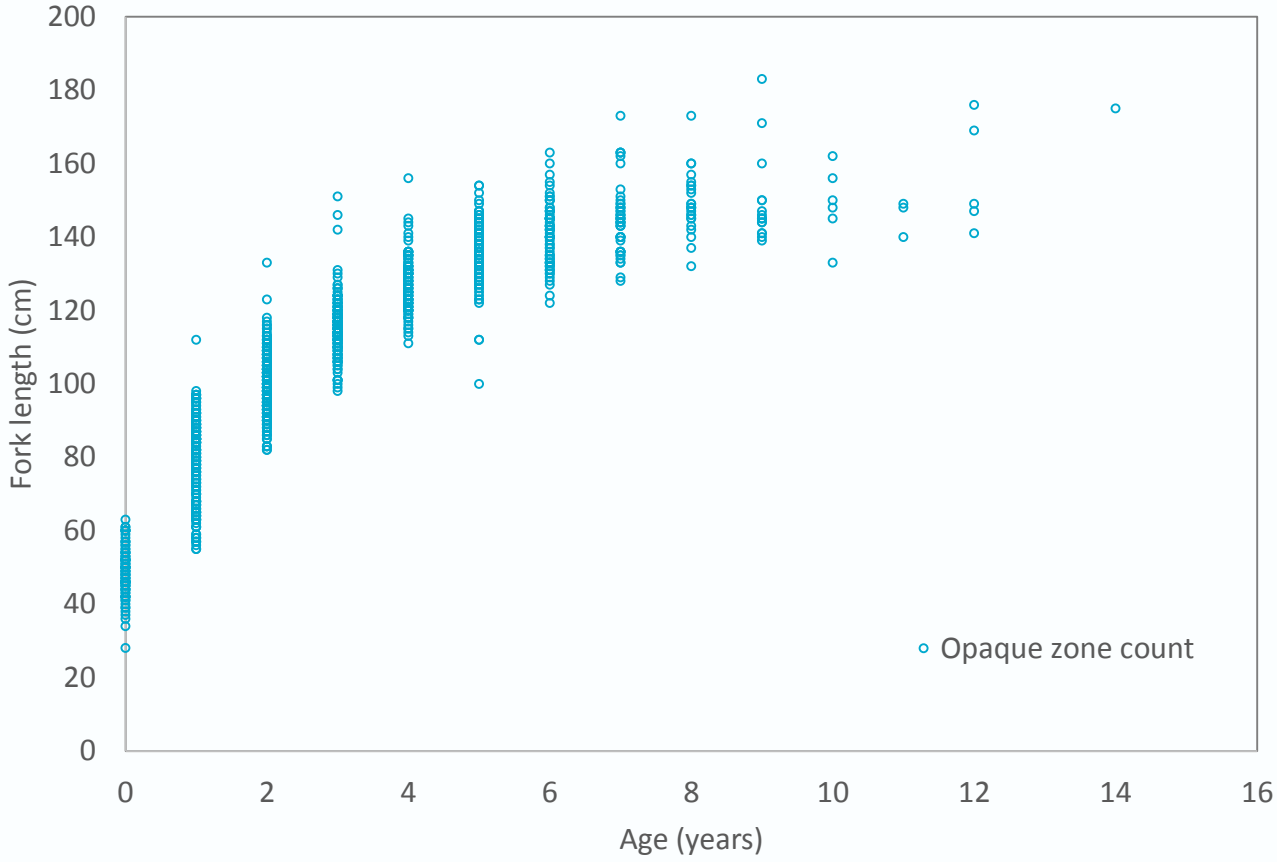
Precision & bias

- Cross-lab comparison (10%)
- Intra-reader CV 7.55%
- Inter-reader CV 7.52%
- No systematic bias
- 64.4% agreement

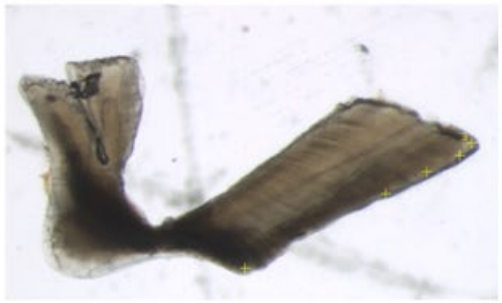


# Length at “age” (count)

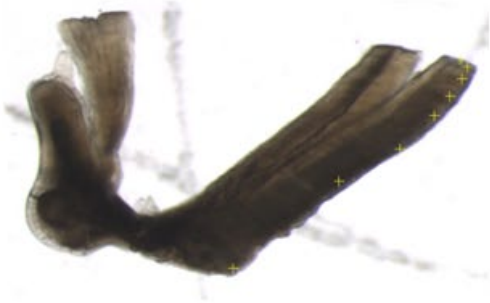


# Variation in age at length (130-133 cm)



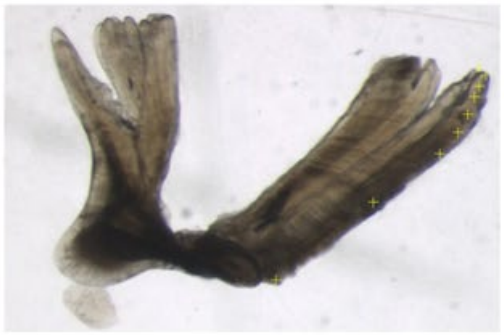
FAS14316. Count = 3, age = 3.27 yrs, male 130 cm

FAS14229. Count = 4, age = 3.83 yrs, male 130 cm



FAS14619. Count = 5, age 5.31 yrs, male 130 cm

FAS1704. Count = 5, age = 5.95, female 131 cm



FAS14624 Count = 6, age = 6.29 yrs, male 131 cm

FAS14109 Count = 13, age = 13.57 yrs, male 133 cm

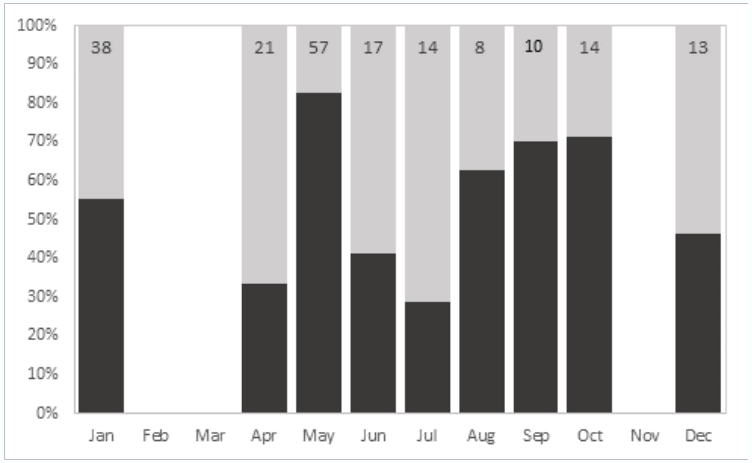
# Calculating biological (decimal) age

# Biological age from annual counts

- The number of opaque zones counted in otoliths is not necessarily the fish's biological age
- Convert counts to decimal age using an algorithm that accounts for:
  - Birth date
  - Timing of year that opaque zones form
  - Otolith edge type
  - Catch date

# Birth date & increment formation period

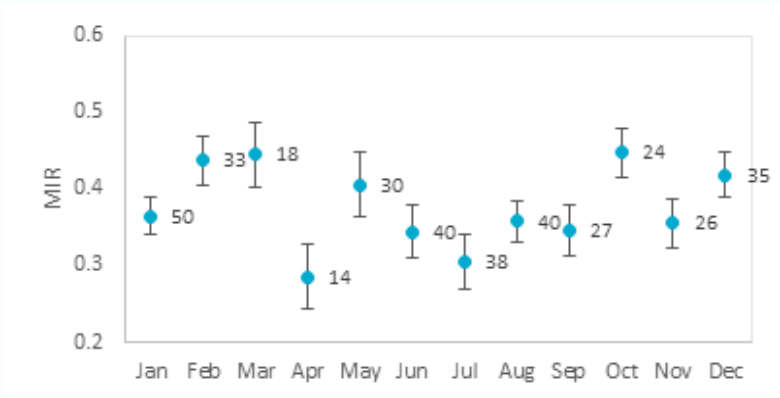
July 1



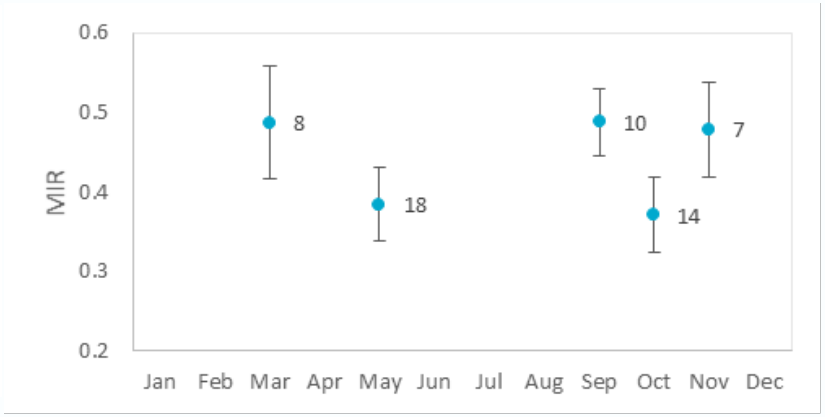

Non spawning

Spawning

July 1




10°N to 10°S




South 10°S

# Age algorithm

$$a = (n + b) + r/365$$

## From Eveson et al. (2004)

- $a$ = decimal age
- $n$ = count opaque zones
- b = “adjustment” (criteria in table below)
- $r$ = capture date (days since last birthday; **July 1**)

Opaque zones completed Apr-Sep (**July 1** as midpoint)

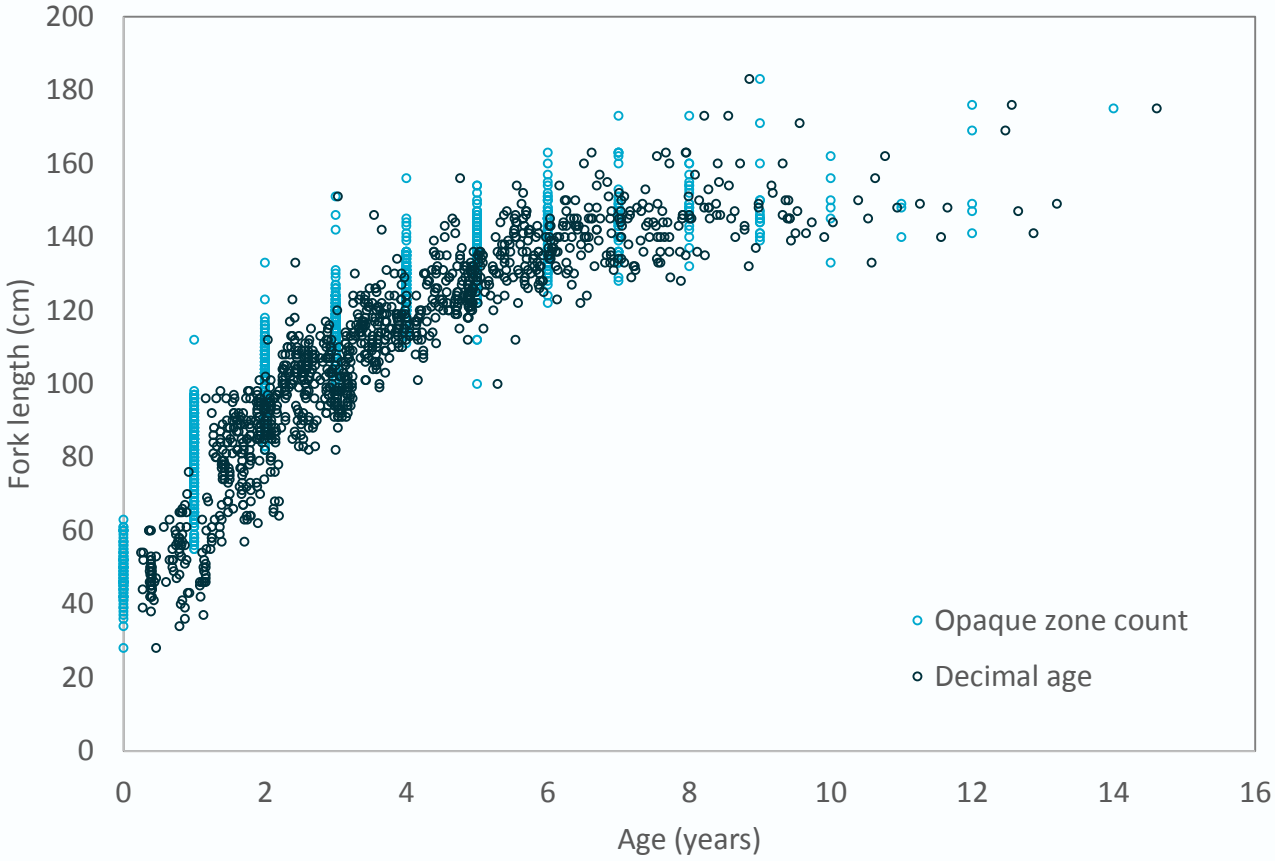
- need to adjust depending if zone has been deposited & counted, or not
- Use edge type to decide

| Catch month | JANUARY TO MARCH | APRIL TO JUNE | JULY TO SEPTEMBER | OCTOBER TO DECEMBER |
|---|---|---|---|---|
| Wide or Intermediate | 0 | 0 | +1 | 0 |
| Narrow | 0 | -1 | 0 | 0 |

# Examples of age calculation

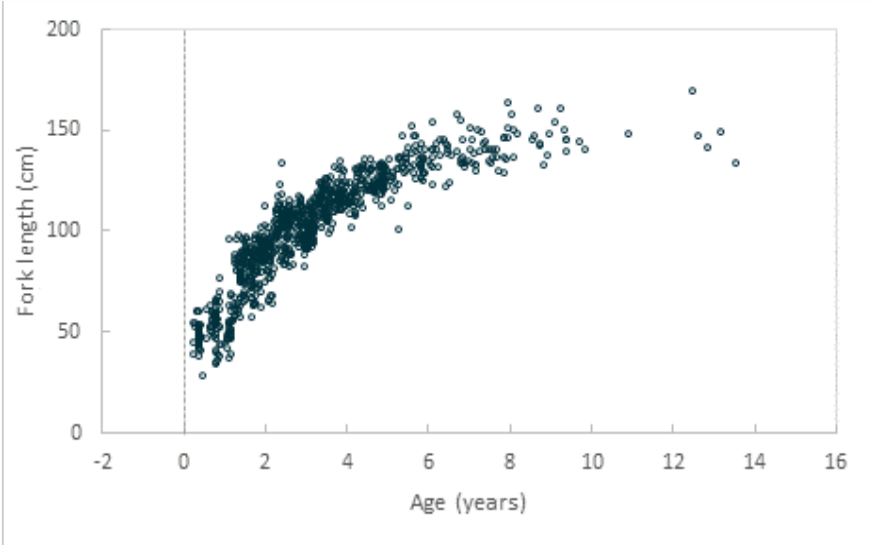
| Fish | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **Nominal birth date** | 1 July 2010 | 1 July 2010 | 1 July 2010 | 1 July 2010 |
| **Last birthday** | 1 July 2011 | 1 July 2011 | 1 July 2012 | 1 July 2012 |
| **Date caught** | 1 June 2012 | 1 June 2012 | 1 Aug 2012 | 1 Aug 2012 |
| **Day of capture after last birthday *(r)*** | 336 | 336 | 31 | 31 |
| **Zone count (*n*)** | 1 | 2 | 1 | 2 |
| **Edge type** | Wide | Narrow | Wide | Narrow |
| **Count adjustment (*b*)** | 0 | -1 | +1 | 0 |
| **Decimal age (*a*)** | 1.92 | 1.92 | 2.08 | 2.08 |

# Zone count vs decimal age

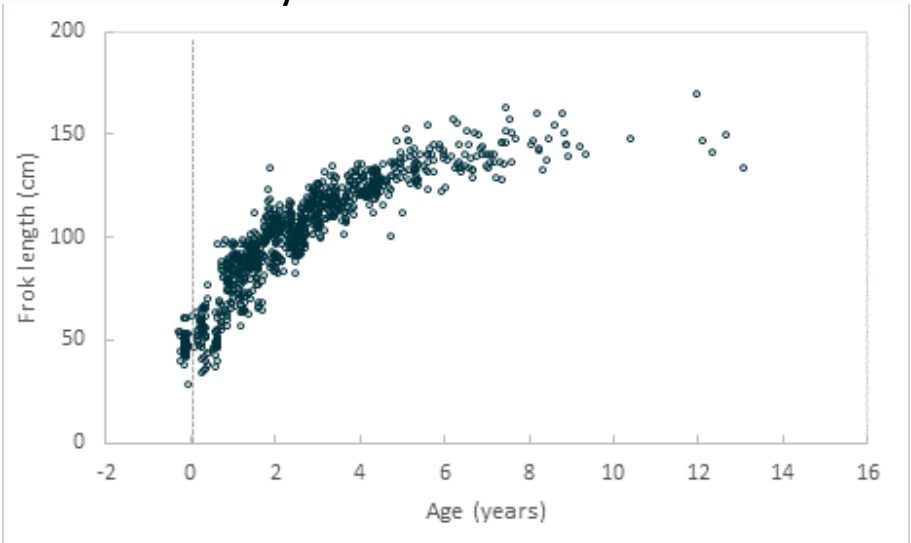


# Different birth dates

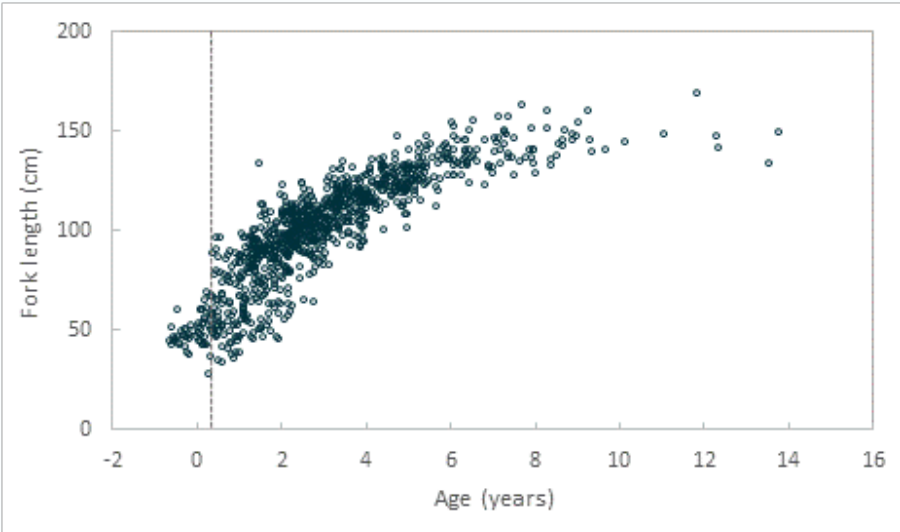
July 1 birthdate



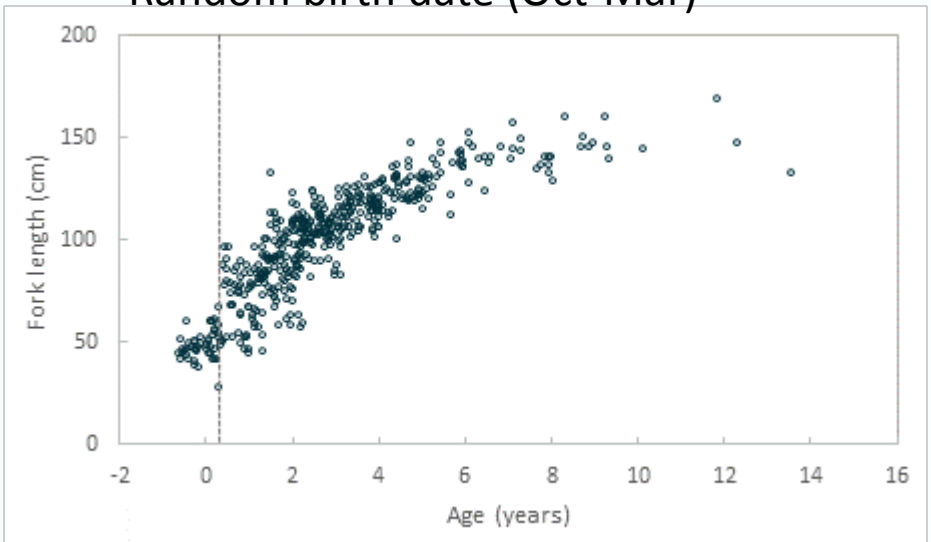

January 1 birthdate




Random birth date

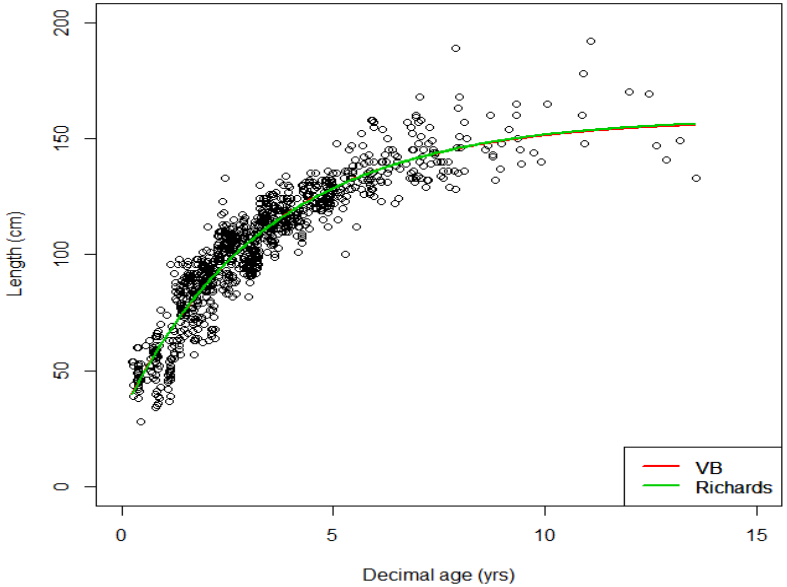


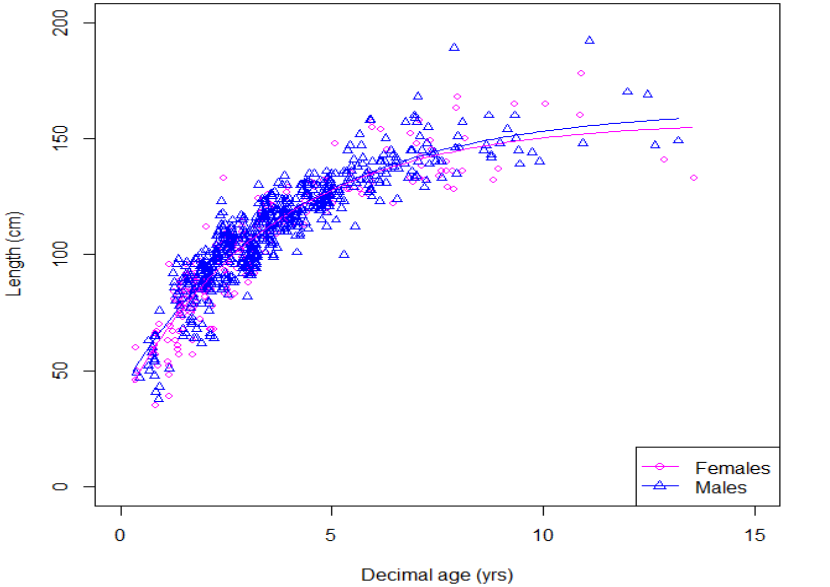

Random birth date (Oct-Mar)



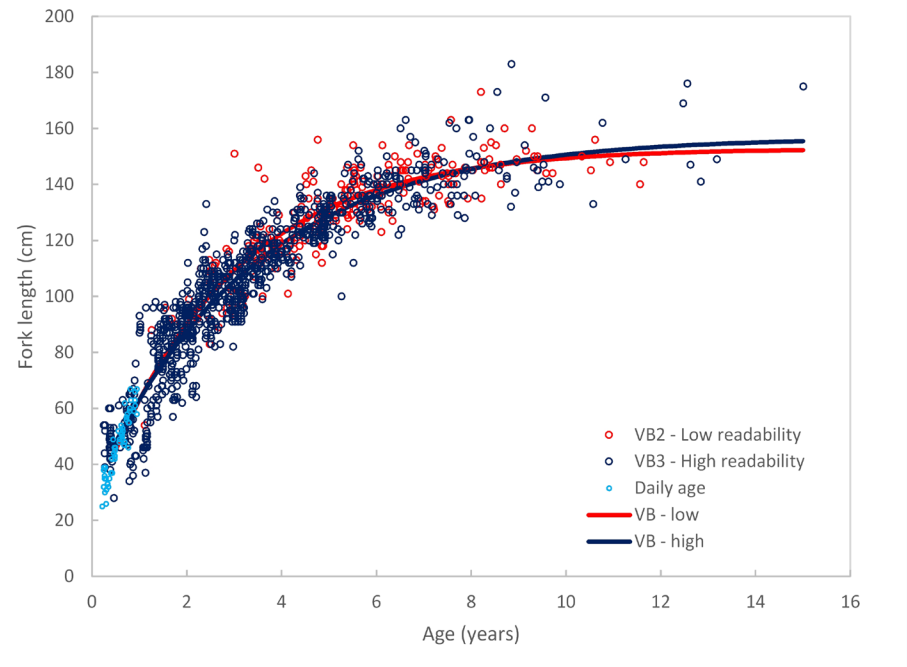
# Results

# Growth by sex; diff models



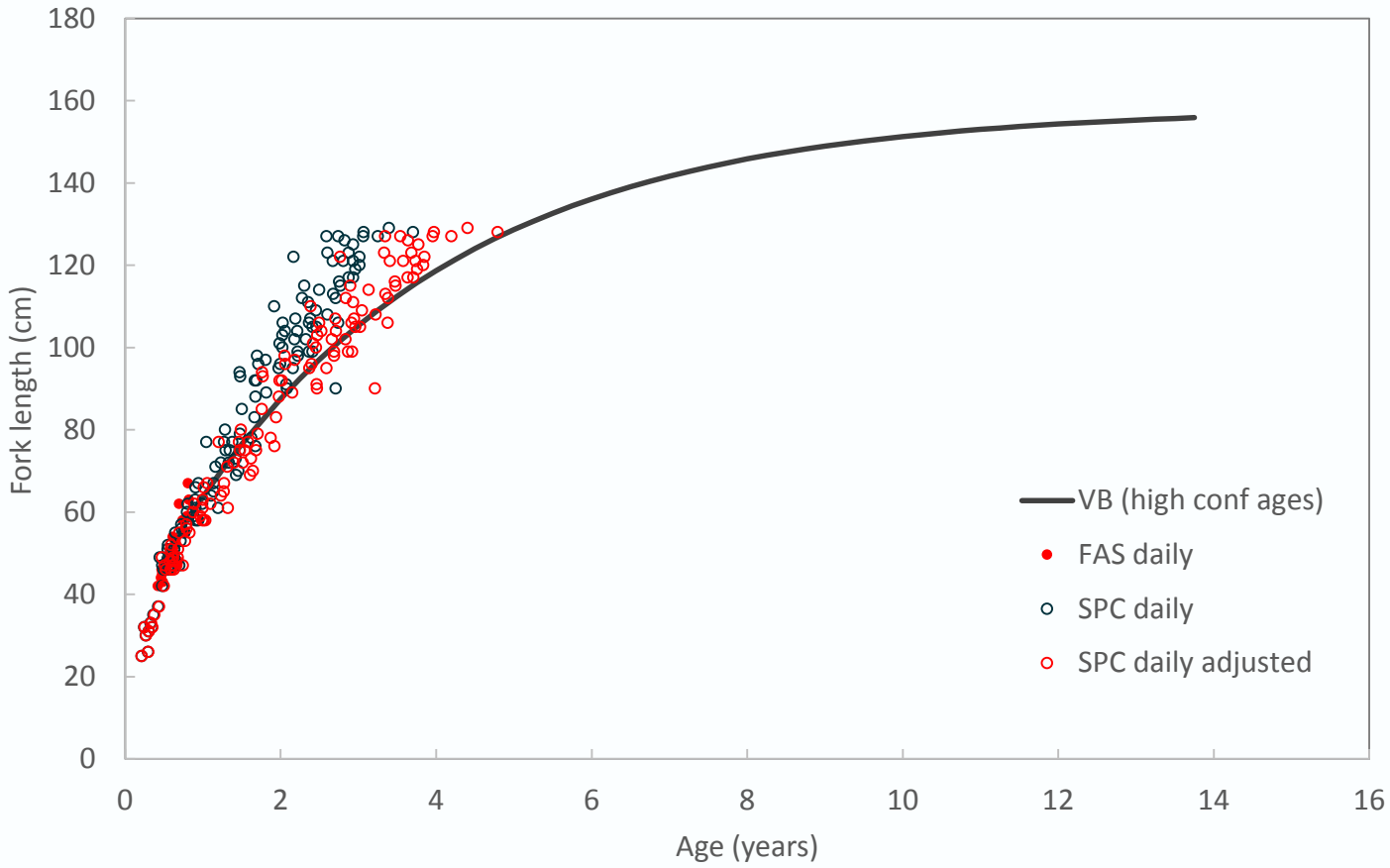
# Length-at-age & VB curves



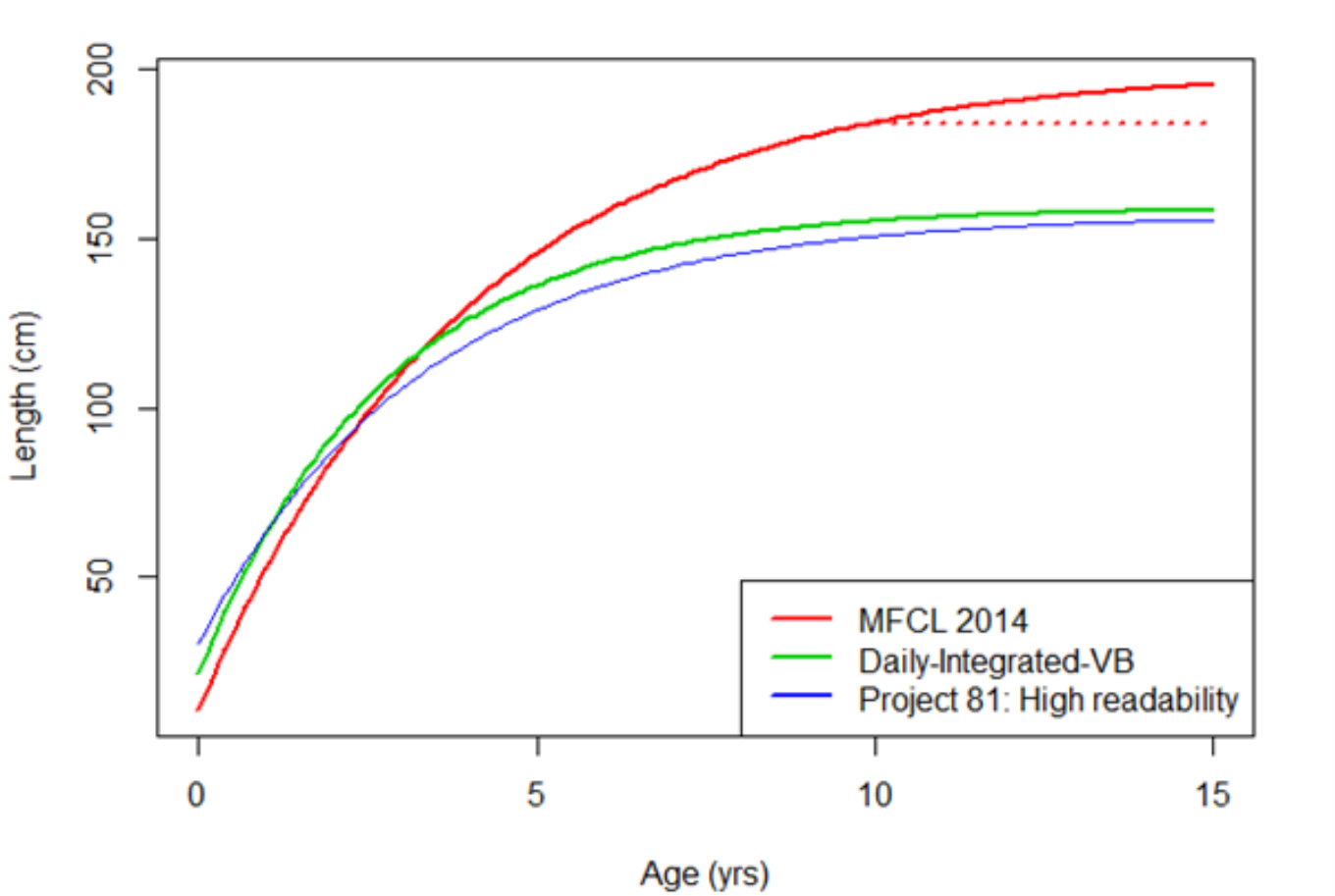

| MODEL | Data | n | $L_\infty$ | k | $t_0$ | σ |
|---|---|---|---|---|---|---|
| **VB1** | Project 81 | 1244 | 156.9 (1.7) | 0.307 (0.010) | -0.69 (0.04) | 9.3 (0.22) |
| **VB2** | Project 81 low readability | 318 | 152.9 (1.6) | 0.361 (0.015) | -0.47 (0.05) | 8.0 (0.32) |
| **VB3** | Project 81 high readability | 984 | 156.9 (1.7) | 0.301 (0.010) | -0.71 (0.04) | 9.4 (0.21) |

# SPC daily age underestimated by ~8-30.%

## Adjust for fish sizes 72-129 cm FL



# Comparing growth curves



# WCPO & EPO