Age and Maturity Update of Pacific Mackerel (*Scomber japonicus*)

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Project Goal

Generate updated information on age and maturity of Pacific Mackerel for consideration in the 2023 benchmark stock assessment

Section 1: Ageing dataset and estimates of ageing errors (2012-2022)

Section 2: Estimates of length and age at maturity (2010-2021)

Section 1: Ageing Dataset and Estimates of Ageing Errors

Ageing Dataset in the 2019 Pacific Mackerel Assessment

- Fishery port landing samples (2008-2017): CDFW readers
- Fishery ageing error vector (SD-at-Age): CDFW double readings
- CPS survey samples (2012-2017): ages estimated using annual age-length key derived from the fishery port landing ageing dataset
- Trawl survey ageing error (SD-at-Age): same as fishery ageing error vector

Survey Age Data Summary

- Otoliths collected by surface trawl during CPS summer surveys (2012-2022)
- A maximum of 25 otoliths per trawl
- A total of 1,762 otoliths aged
- Primary SWFSC readers: Readers 17 and 18

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Survey Ageing Criteria

Assumption: Annulus visible on the otolith are deposited annually in conjunction with seasonal change

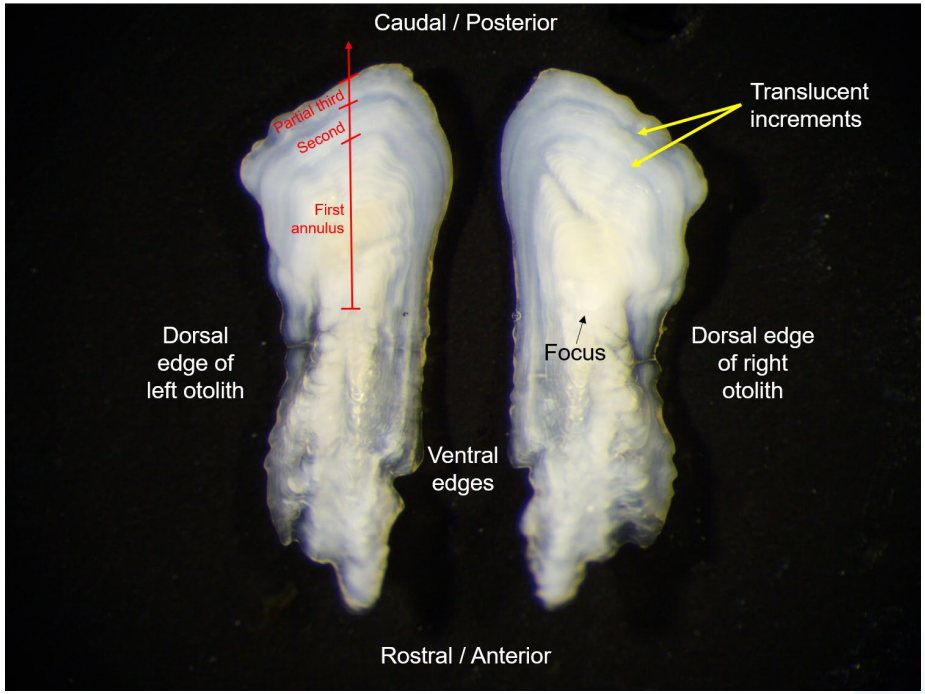
Annulus: The interface between an inner translucent growth increment and the successive outer opaque growth increment. One year of growth consists of the combination of one opaque and one translucent increment.

Natural variability in appearance

- Check marks vs. annuli
- Increment spacing, otolith size/shape
- Seasonal changes in margin
- Old vs. young otoliths
- Regional differences

Final Age assignment

- July 1 Birthdate
- Catch Date



Survey Ageing Errors

Model: Agemat (Punt 2008)

Software: NorthwestAgeingError R package (Thorson 2012)

Age readings:

Corroborated age readings (CA=SWFSC Readers 15, 17,18)

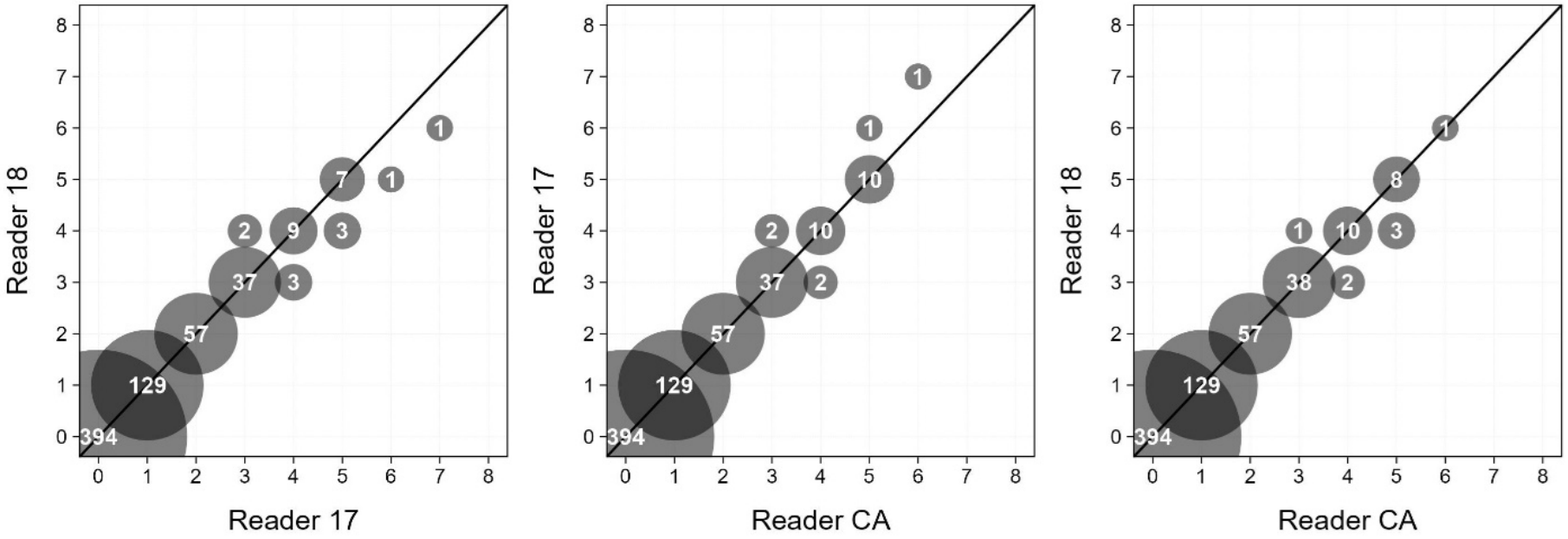
Reader 17 readings

Reader 18 readings

Assumption: CA readings are unbiased

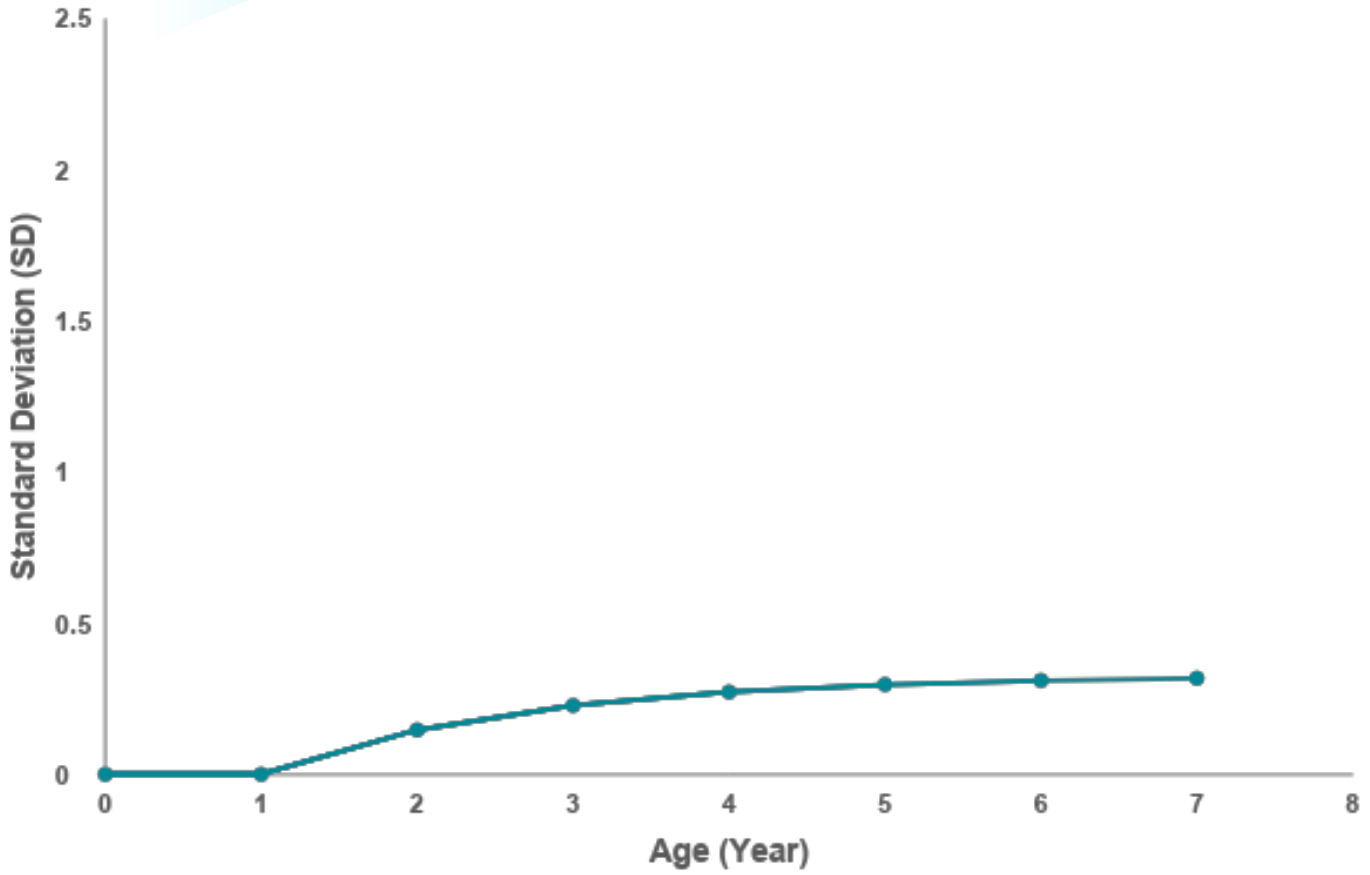
Survey Bias Plots

A total of 643 otoliths were triple read from samples collected in 2012-2022



(Preliminary results prepared for the STAR Panel; See Appendix A in Kuriyama et al. 2023 DRAFT)

Survey Standard Deviation-at-Age



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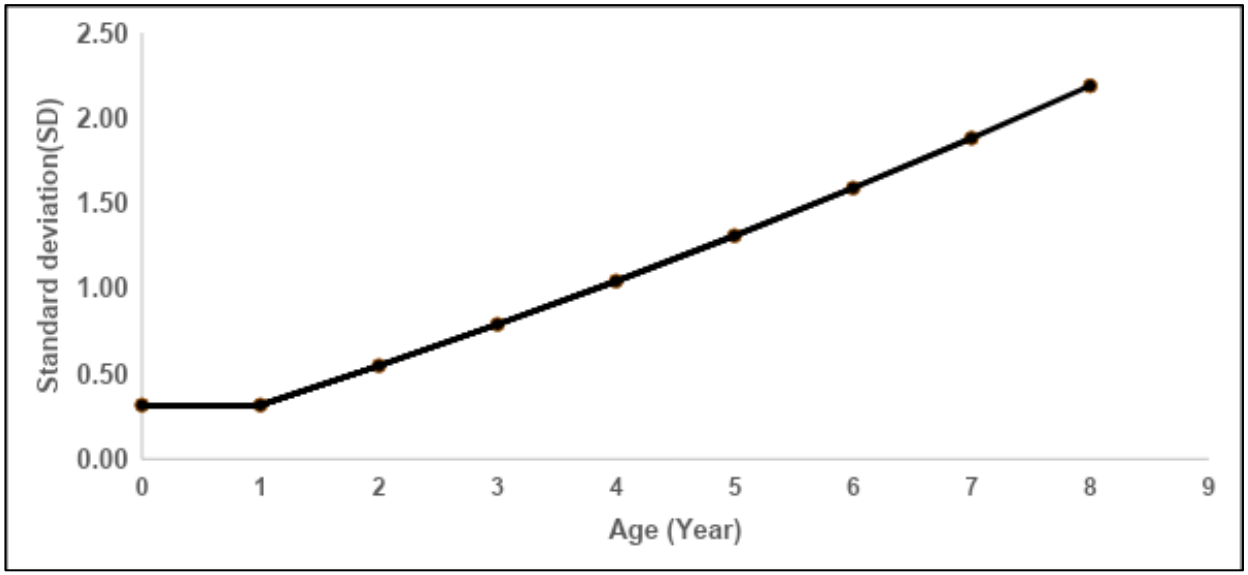
Fishery Data (CDFW)

- Fishery port landing samples: up to 12 monthly samples from 2008 to 2022
- Number of otoliths aged: 9,422
- Number of CDFW readers: 2-3 depending on year
- Fishery ageing error vector (SD-at-Age): same as in 2019 Assessment



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Section 2: Length and Age at Maturity

Background

- Multiple batch spawner, indeterminate fecundity, asynchronous oocyte development, high spawning frequency (Knaggs and Parrish 1973; Dickerson et al. 1992)
- Most spawning from Point Conception to Cabo San Lucas (Moser et al. 1993)
- Protracted spawning season with regional variations:

  California: year-round; late April – August peak (Ahlstrom 1959; Kramer 1969; Knaggs and Parrish 1973; MacGregor 1976; Schaeffer 1980)

  Vizcaino Bay: year-round; March - August; June peak (Kramer 1960; Moser et al. 1993; Gluyas-Millán 1994)

  Cabo San Lucas: late fall to early spring (Moser et al. 1993)

- Previous estimates of maturity

  Most females are mature by age 2 (Dickerson et al. 1992)

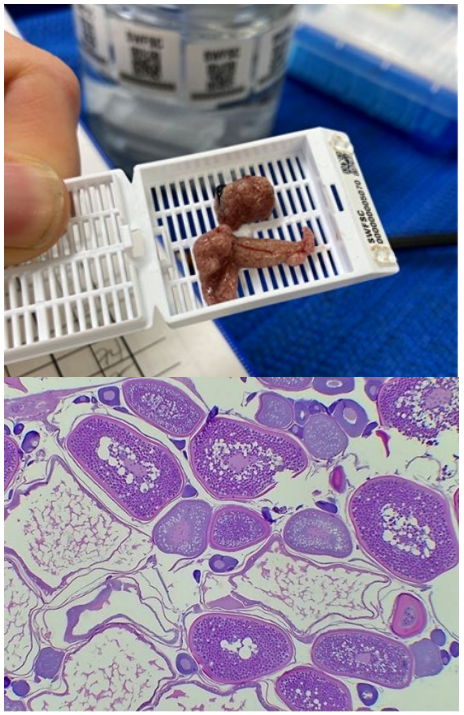
  L_{50} = 270 mm FL; A_{50} = 2.2 yrs (Crone and Hill 2015; Crone et al. 2019)

Methods

Samples from spring and summer CPS surveys (2010-2021)

Standard histological techniques (Humason 1972) and reproductive classification criteria (Brown-Peterson et al. 2011) used to assess gonads and assign maturity

Length and age at maturity estimated from logistic, non-linear regression (McBride 2016)



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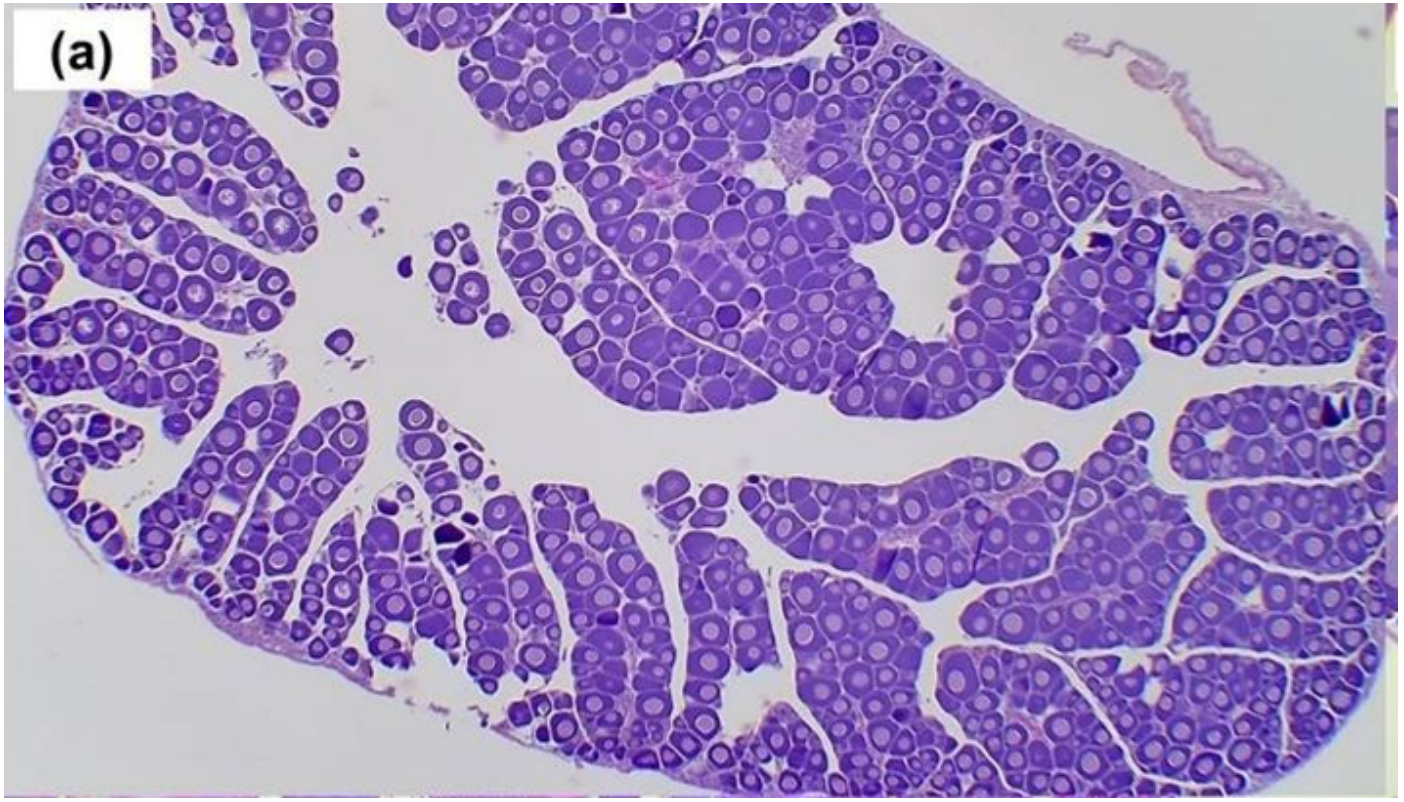
Immature Females (never spawned)



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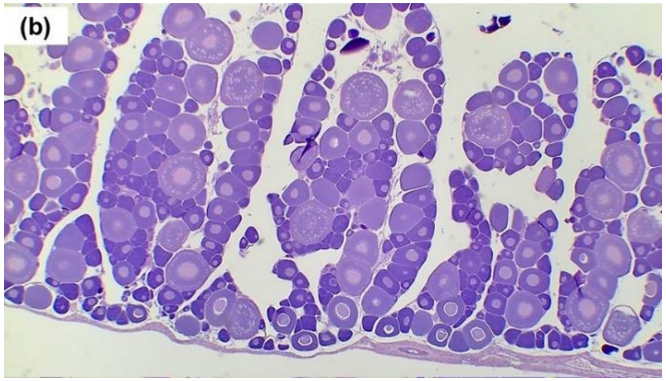
Mature Females



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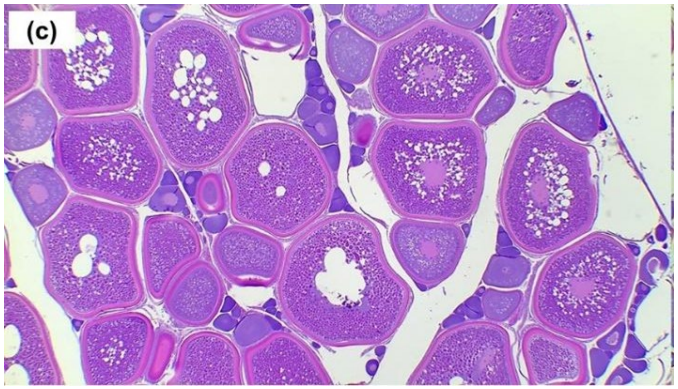
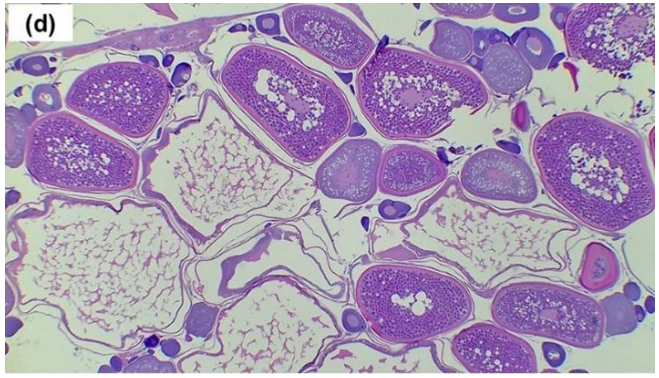
Developing



Spawning Capable

Gonadal Development



Actively Spawning

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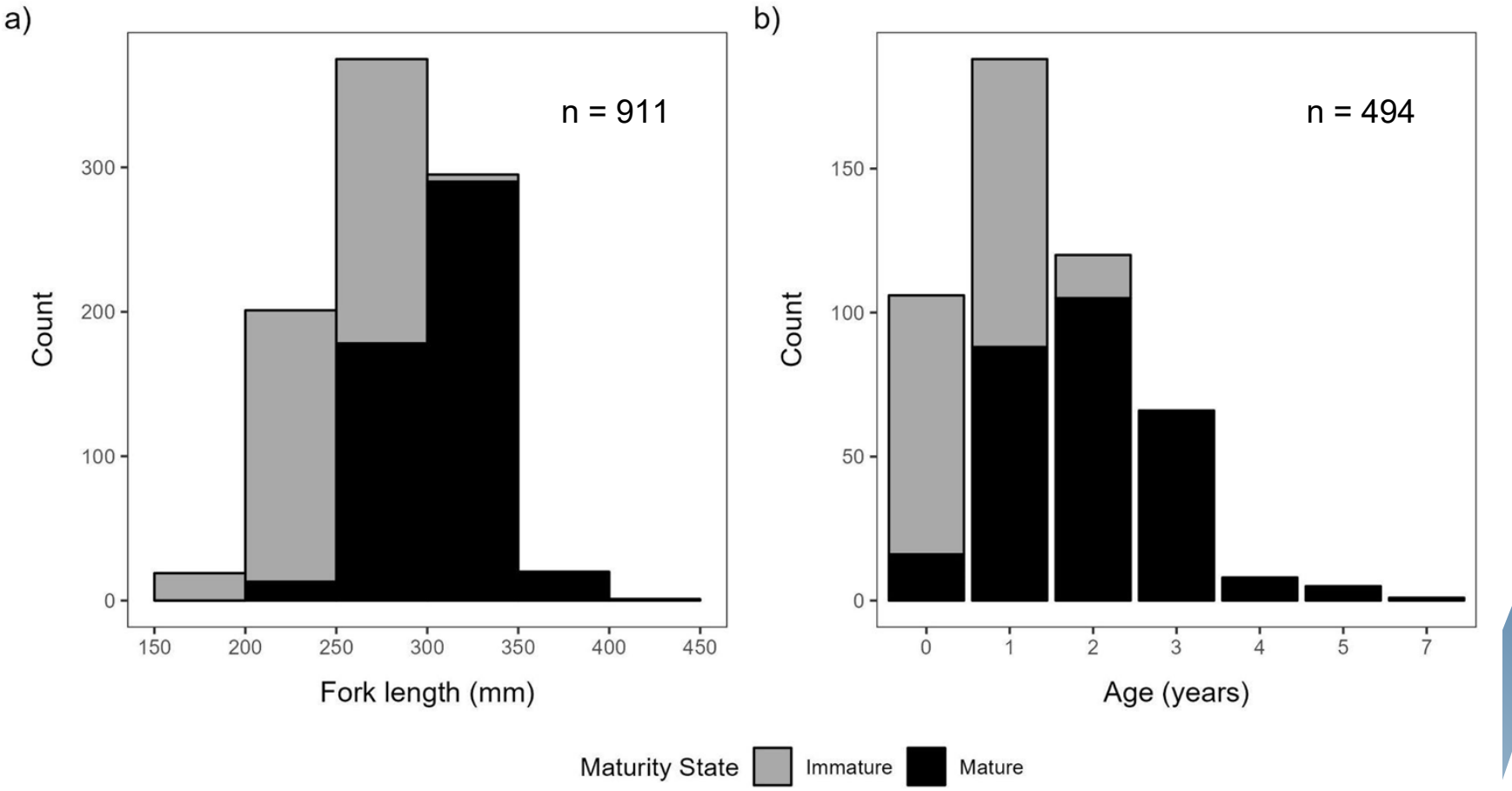
Length and Age Distributions by Maturity State



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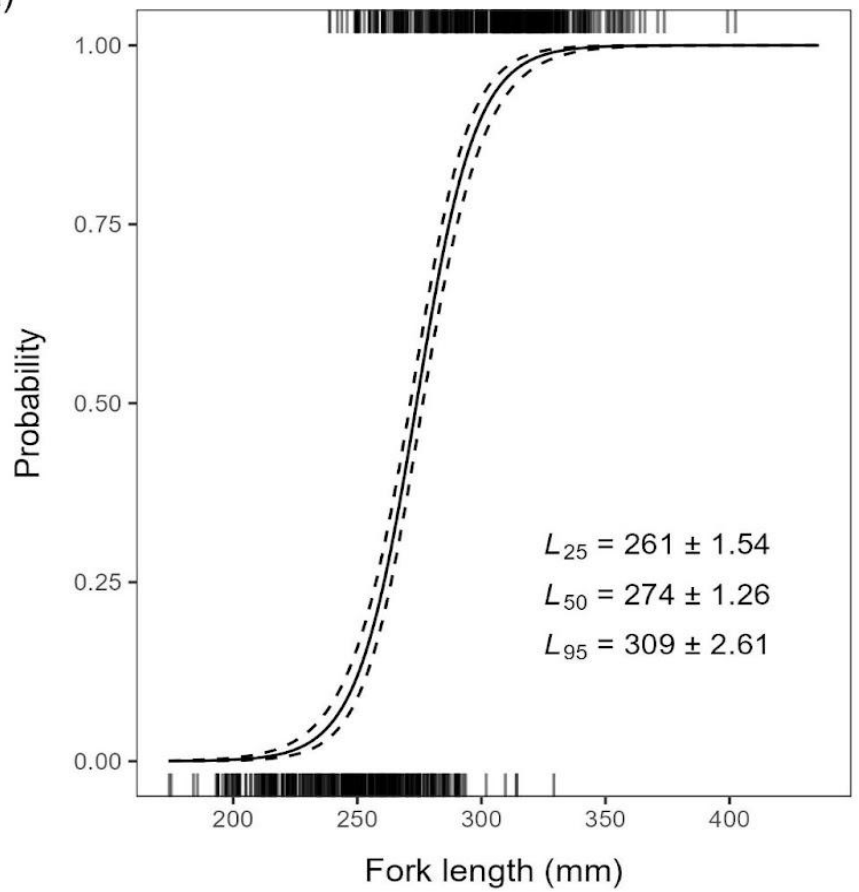
Length at Maturity

a)



Fork-length bin	Mean predicted probability	Standard deviation
151-200 mm FL	0.00083	5.34e-04
201-250 mm FL	0.03	3.22e-02
251-300 mm FL	0.52	2.54e-01
301-350 mm FL	0.97	2.52e-02
351-400 mm FL	0.99	4.11e-04
401-450 mm FL	0.99	6.32e-06

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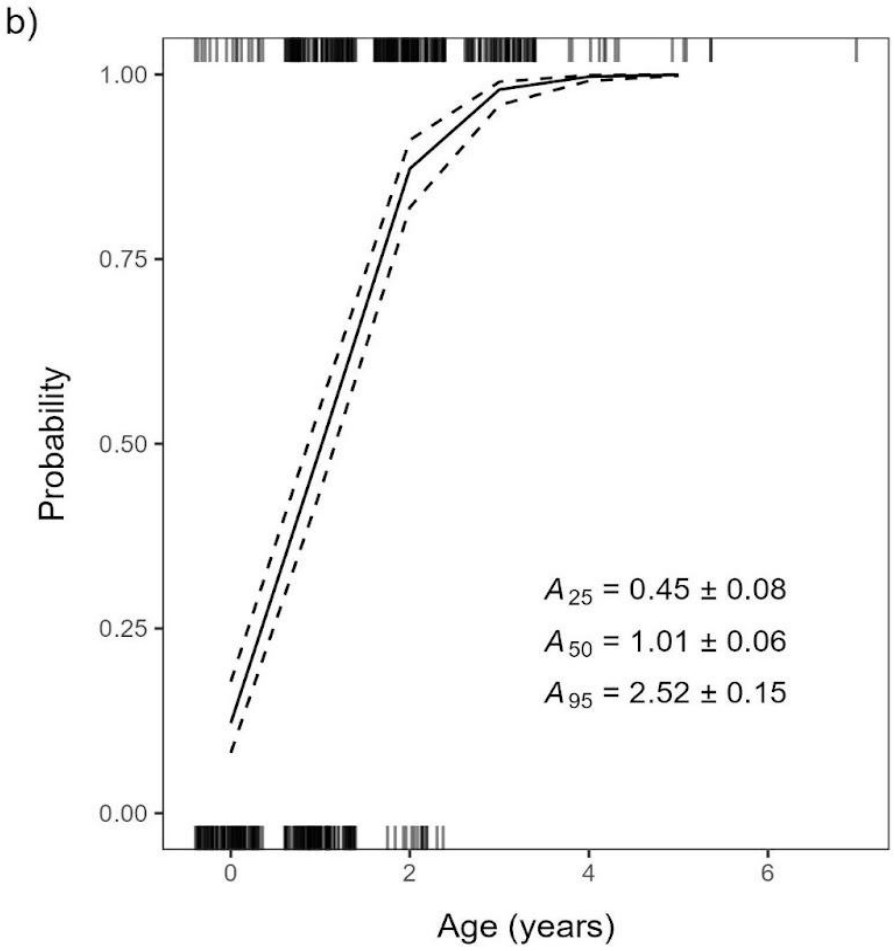
Age at Maturity



Age (years)	Predicted probability	95% confidence interval
0	0.12	0.08-0.17
1	0.49	0.43-0.55
2	0.87	0.82-0.91
3	0.98	0.95-0.99
4	0.99	0.99-0.99
5	0.99	0.99-0.99

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Acknowledgments

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