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Age validation of yellowfin tuna (Thunnus albacares) in the Indian Ocean using post-peak bomb radiocarbon chronologies

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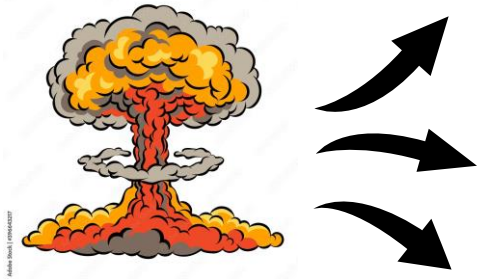
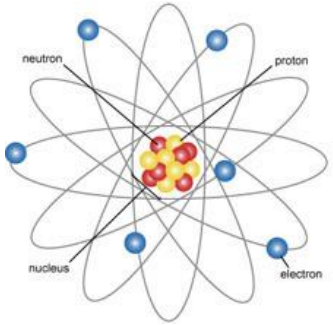
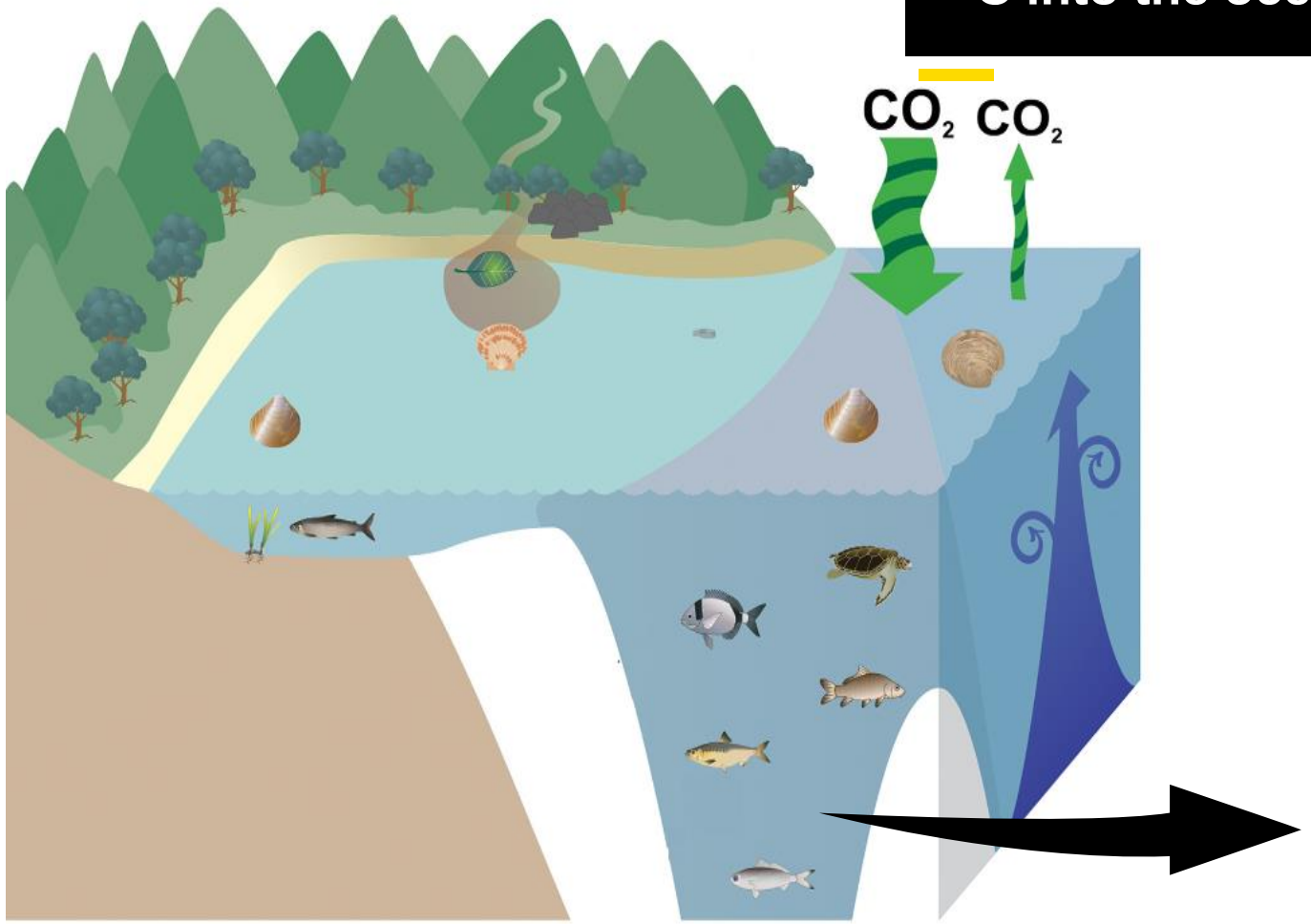


^{14}C



Air-sea exchange introduces bomb-derived ^{14}C into the ocean



Marine biosphere is in equilibrium with sea wáter carbon and introduces ^{14}C in their calcified structures

Otoliths record radiocarbon concentration of their environment

Adapted from Alves et al. 2018

Do the growth increments in otoliths of YFT form annually?

The answer lies in **bomb-derived radiocarbon**.

Most population dynamics models are dependent on age-based parameters

Age estimation of fish is a key area of research in fisheries

Age estimates need to be validated for each species and even for different stocks of the same species

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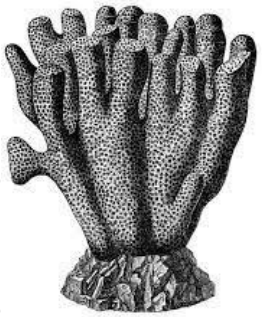
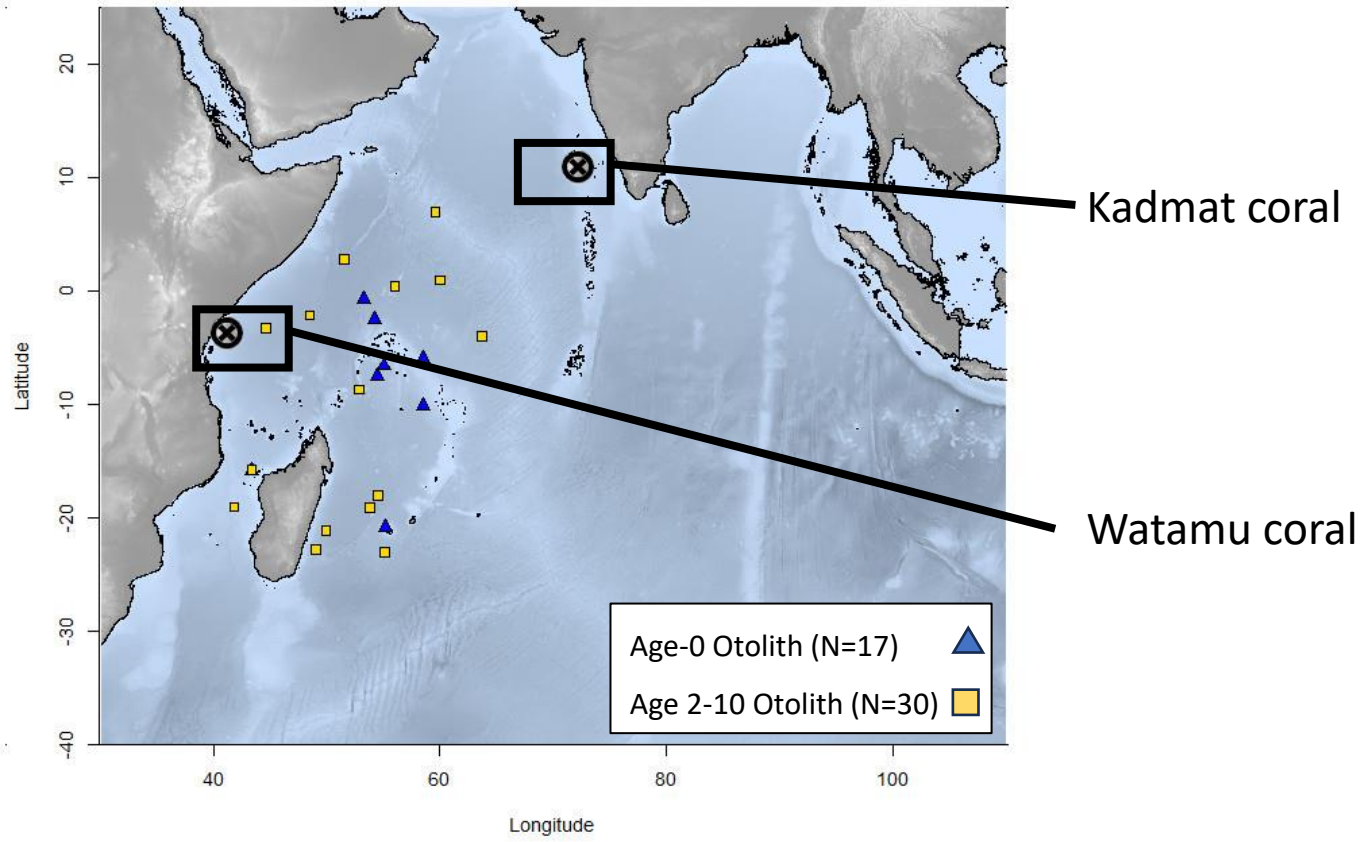
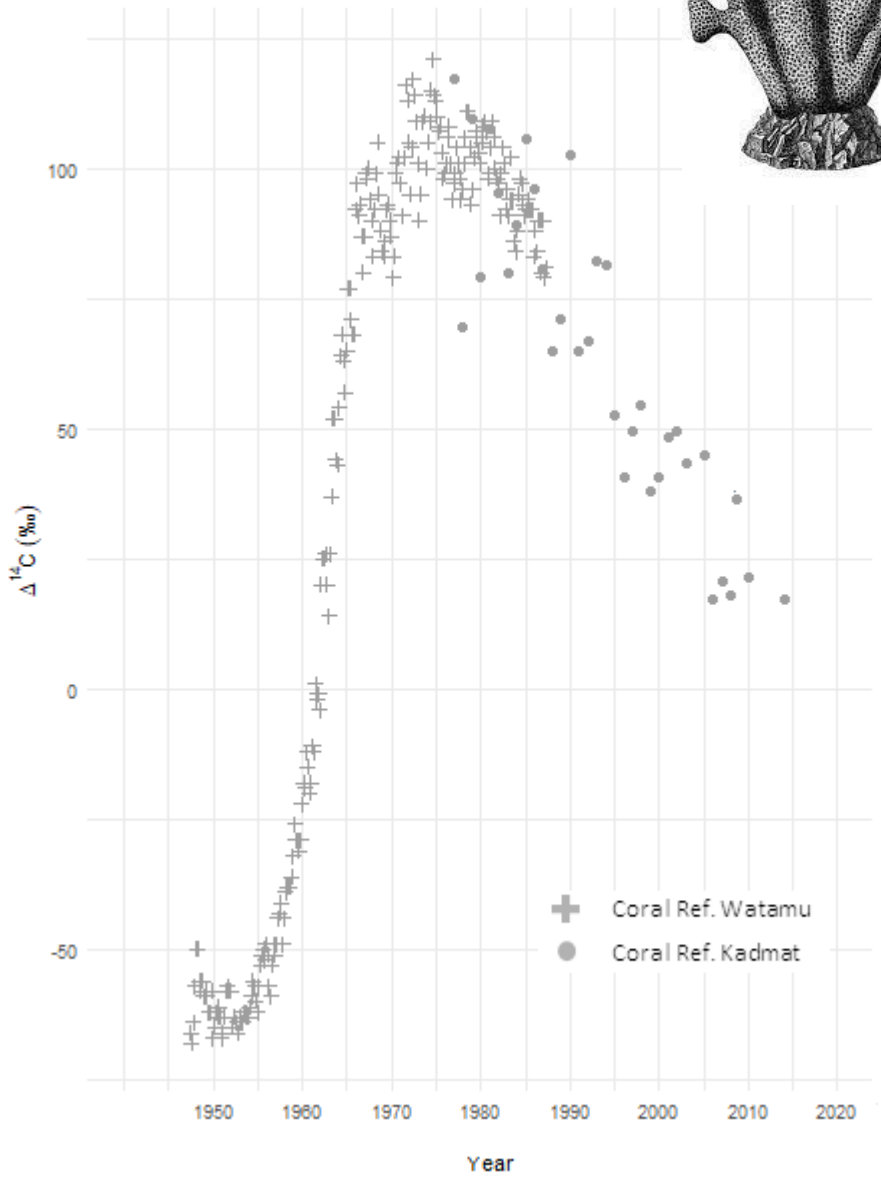
METHODS



Radiocarbon concentration recorded by corals in the Indian Ocean ⊗ ➡

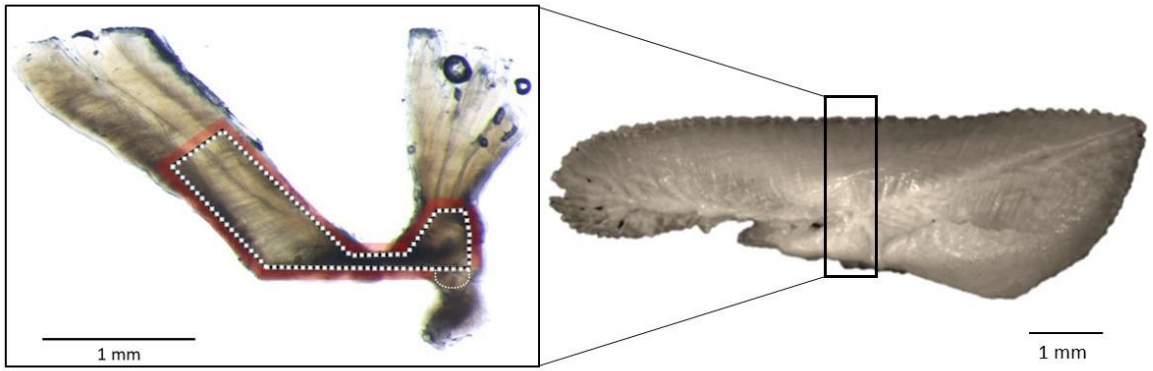




Watamu (Grumet el al. 2002; Kadmat (Rak and Bhusan 2021)

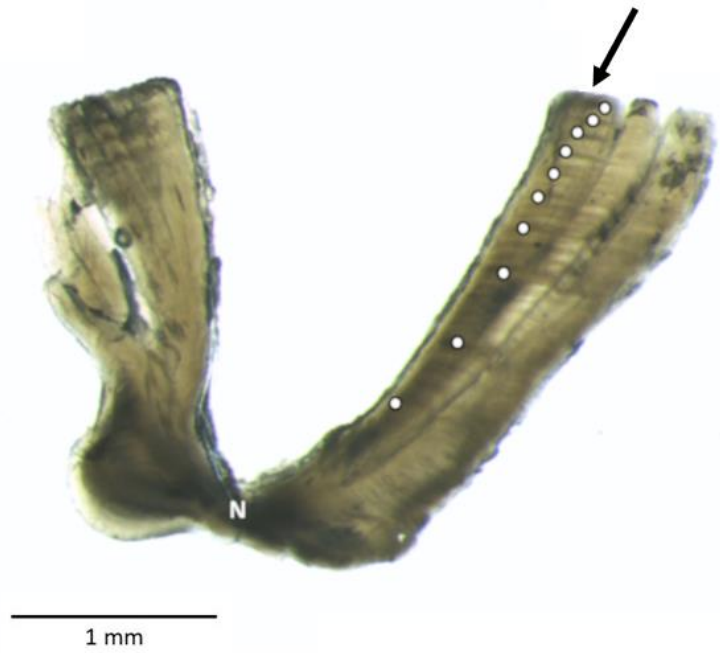
METHODS

Otolith preparation



Oto2

“Jesstimation”



Farley et al. 2021

Oto1

14C measurement by AMS

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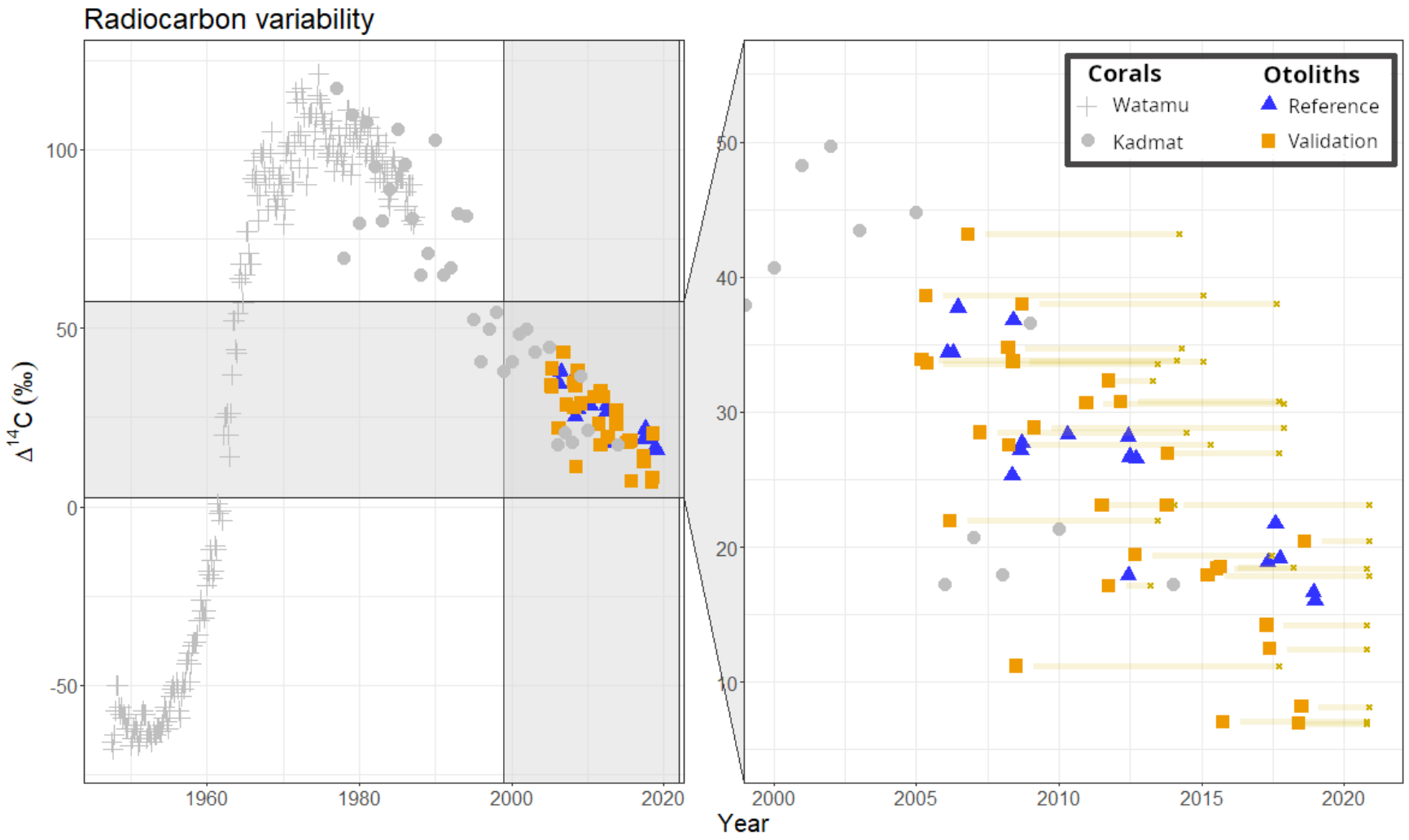
RESULTS



Age-0 (Reference) otoliths

Age 2+ otoliths

Date of capture x

-

Age estimate

=

Estimated birthdated

RESULTS

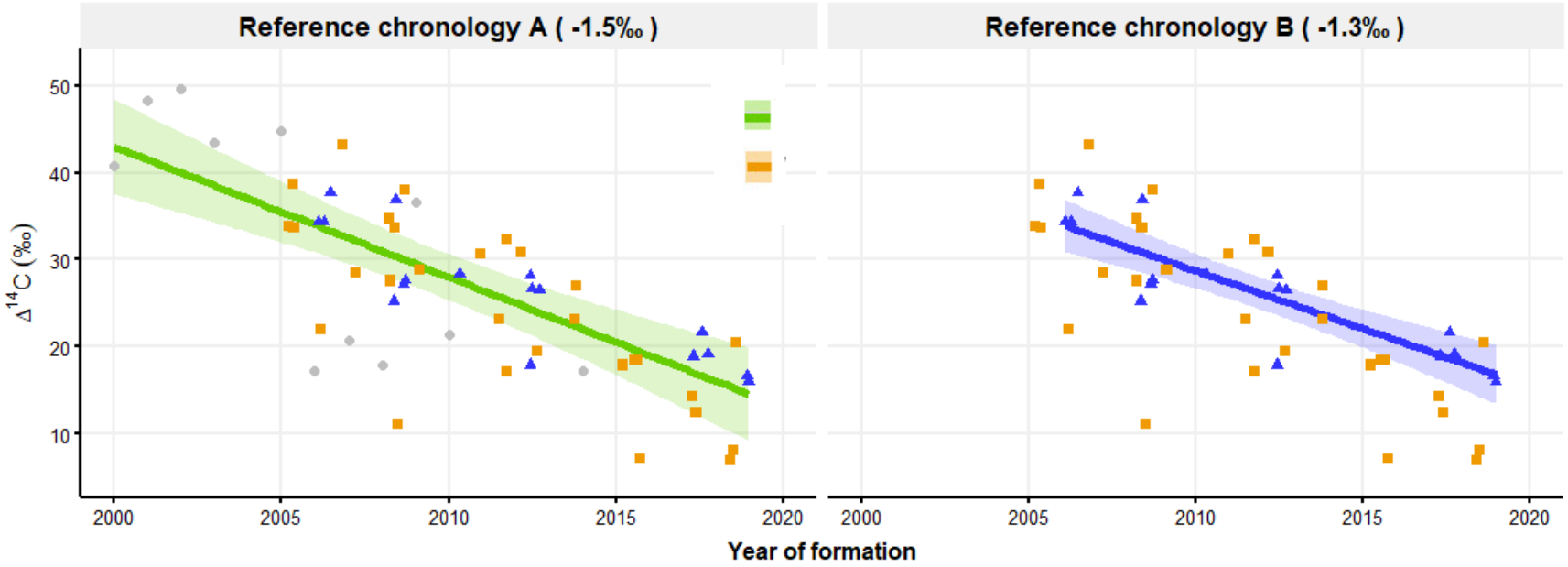
Data

- Corals
- Age-0 (Reference) otoliths
- Age 2+ (Validation) otoliths

Decline rate of corals ≈ decline rate of Age-0 (Reference) otoliths

CORALS + AGE-0 OTOLITHS

AGE-0 OTOLITHS



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RESULTS

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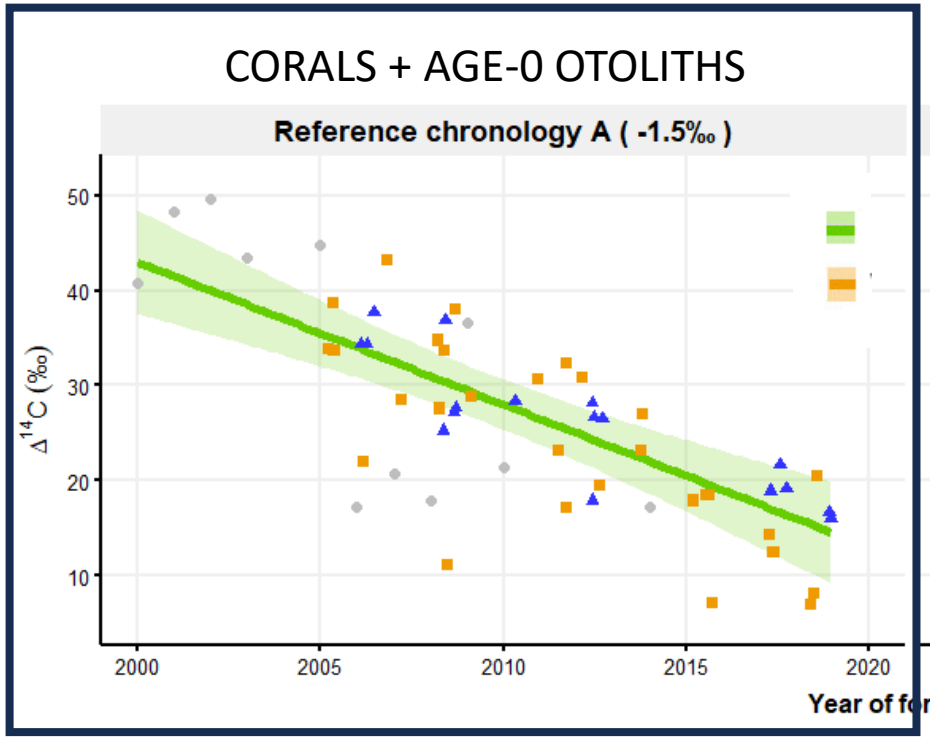
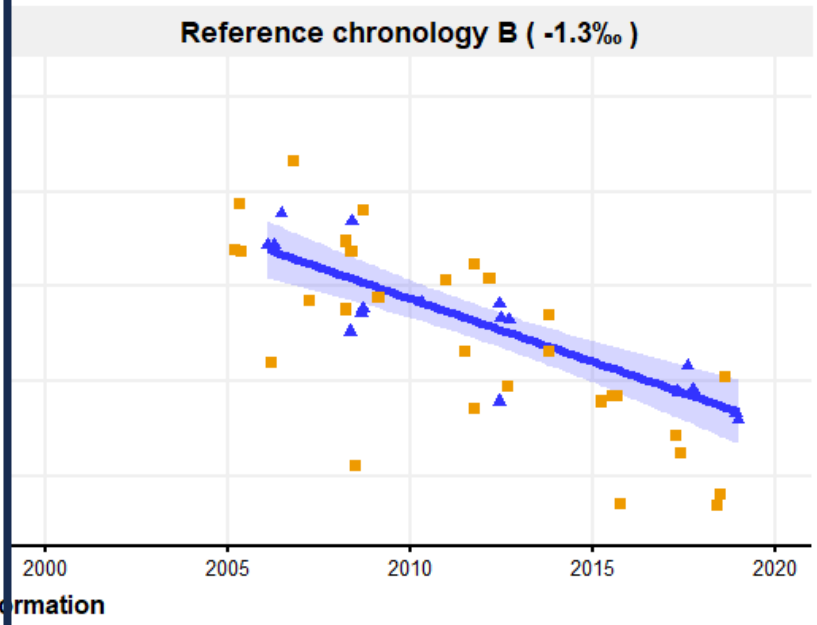
CORALS + AGE-0 OTOLITHS



AGE-0 OTOLITHS



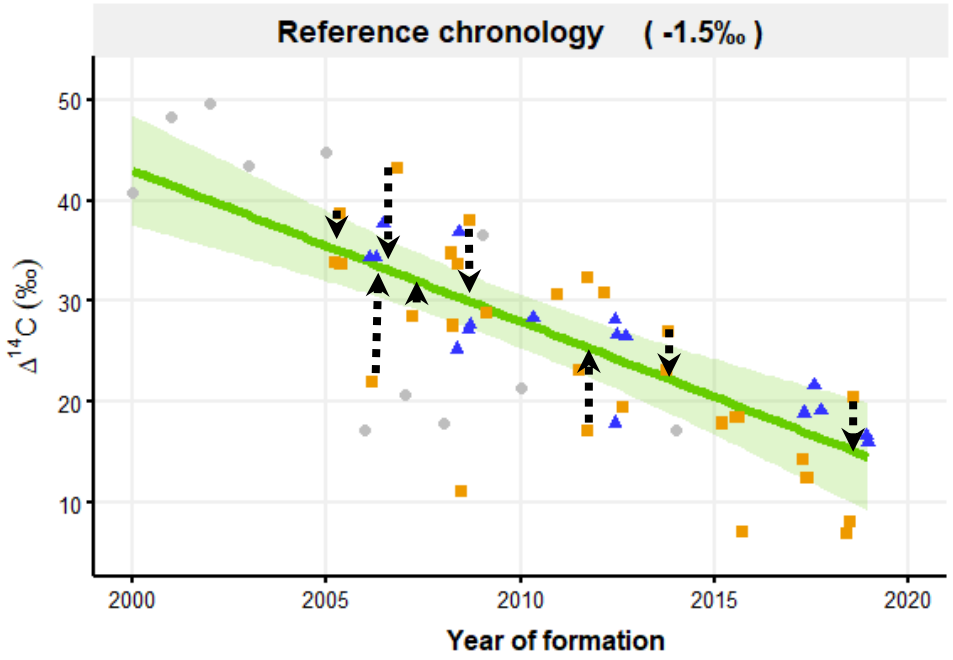
Corals + age-0 otoliths = Western Indian Ocean Δ14C reference chronology

RESULTS- Analysis of residuals

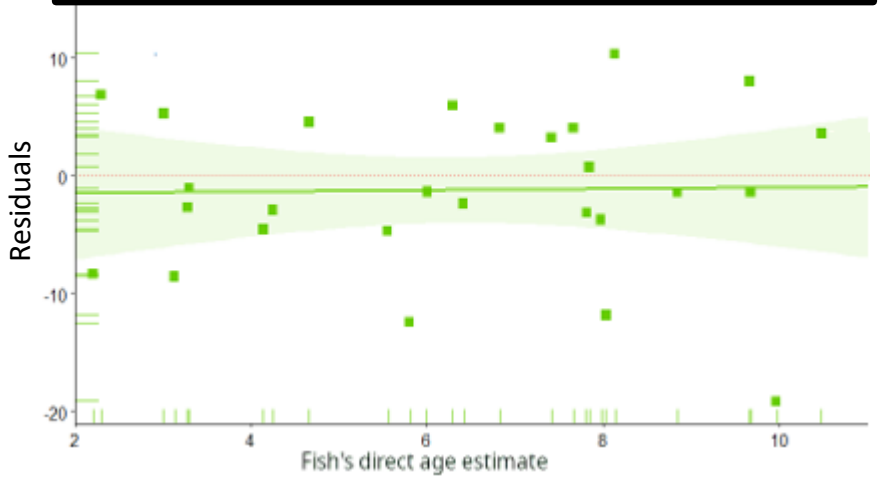
Residuals = Measured $\Delta^{14}C$- predicted $\Delta^{14}C$

Data

- Corals
- Age-0 (Reference) otoliths
- Age 2+ (Validation) otoliths



Residuals > 0 Age was underestimated
Residuals < 0 Age was overestimated



Ageing error does NOT increase with fish' age

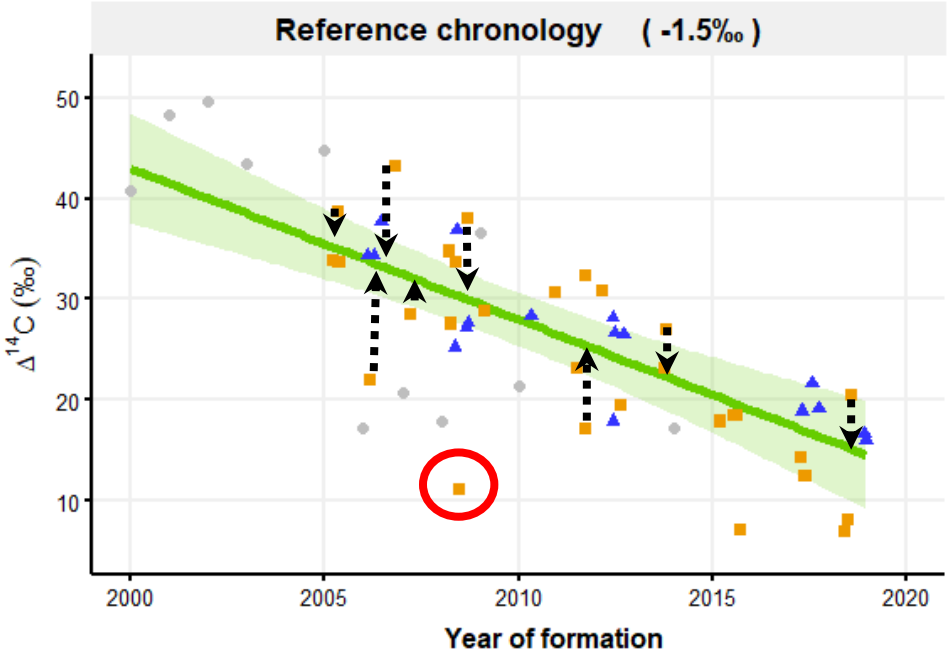
RESULTS- Analysis of residuals

Residuals = Measured $\Delta^{14}C$- predicted $\Delta^{14}C$

Data

- Corals
- Age-0 (Reference) otoliths
- Age 2+ (Validation) otoliths

* One outlier was statistically identified



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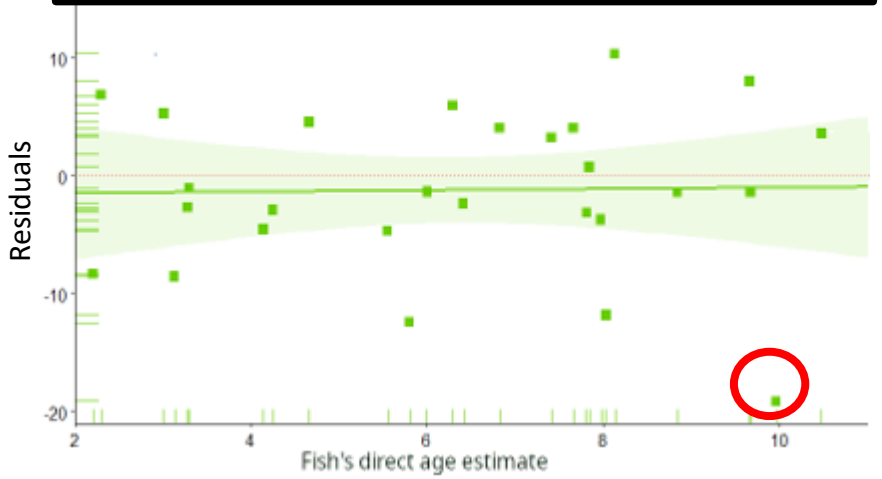

Ageing error does NOT increase with fish' age

AGE-BIAS SIMULATION

Age bias analysis was performed by simulating over and underestimation of the direct age estimates by 1 and 2 years

The resulting Δ14C data with shifted birth years were then projected on the reference curve, and the residual sum of squares (RSS) were compared among the simulations.

Age bias applied	0	+1	-1	+2	-2
Residual sum of squares	RSS	RSS	RSS	RSS	RSS
	1086	1582	1276	1882	1270

Best performed

CONCLUSSIONS

CONCLUSSIONS

- Increments in otoliths of yellowfin tuna from the Indian Ocean are formed annually
- Ageing error does not increase with fish' age
- Analyses of residuals indicate that current age estimations may be slightly overestimated compared to $\Delta^{14}C$-derived ages
- The accuracy of the validation method is limited by the radiocarbon decline rate
- The accuracy of the age validation would benefit by analysing greater numbers and a longer time series of reference otoliths, as well as incorporating otoliths of adult yellowfin tuna with birthdates coinciding with the $\Delta^{14}C$ incline

Funding:

Team:

Age validation of yellowfin tuna (Thunnus albacares) in the Indian Ocean using post-peak bomb radiocarbon chronologies, Manuscript submitted to: Marine Ecology Progress Series-2023-08-006