Advances in revealing population connectivity in small pelagic fishes of the Humboldt Current System using otolith-based ecological markers

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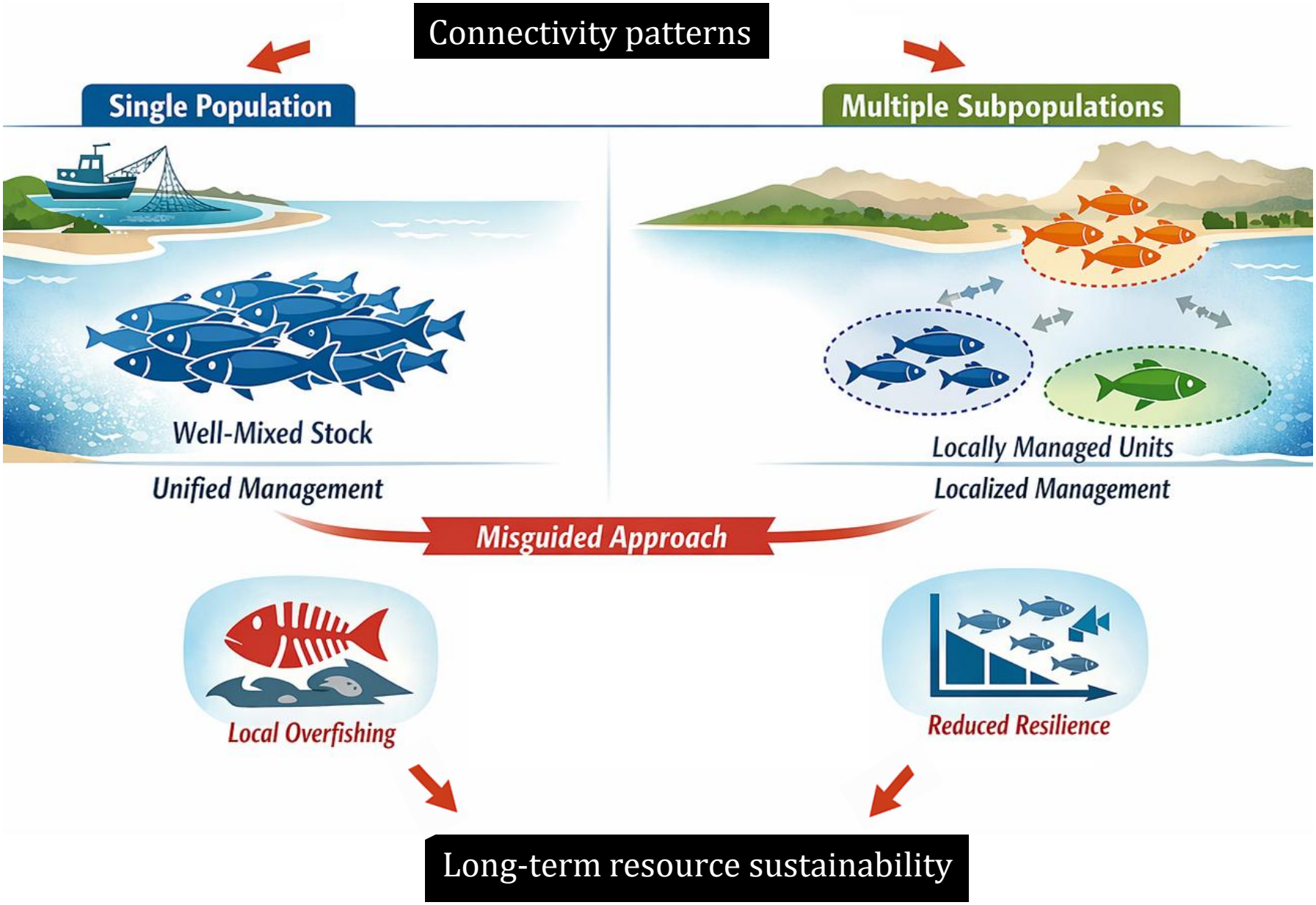

Connectivity patterns
Single Population
Multiple Subpopulations
Well-Mixed Stock
Unified Management
Locally Managed Units
Localized Management
Misguided Approach
Local Overfishing
Reduced Resilience
Long-term resource sustainability

Despite their ecological and economic role

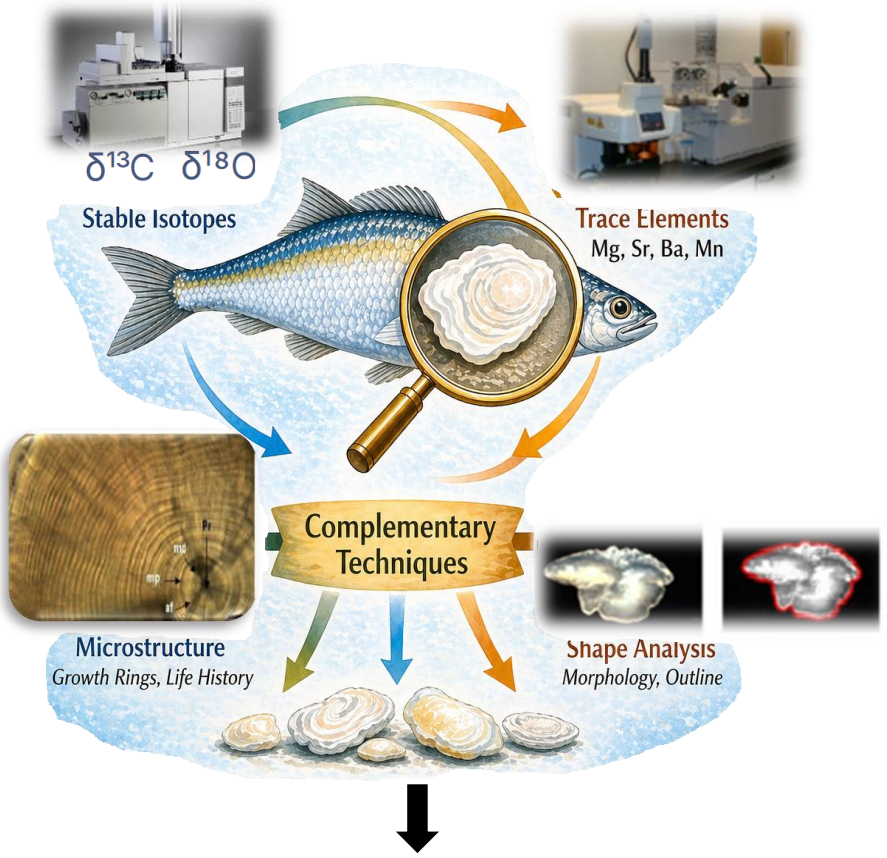
Until a decade ago, population connectivity patterns in these three clupeoids were not well known yet

Purpose

Summarize the main findings from the following 3 research project funded by Chilean Fishery Research Agency (SUBPESCA):

- *FIPA 2015-22 Anchoveta*
- *FIPA 2018-16 Chilean Common Sardine*
- *FIPA 2021-16 Falkkand sprat*

To reveal spatial differentiation among population units of these three species, using otolith-based markers



Reliable information

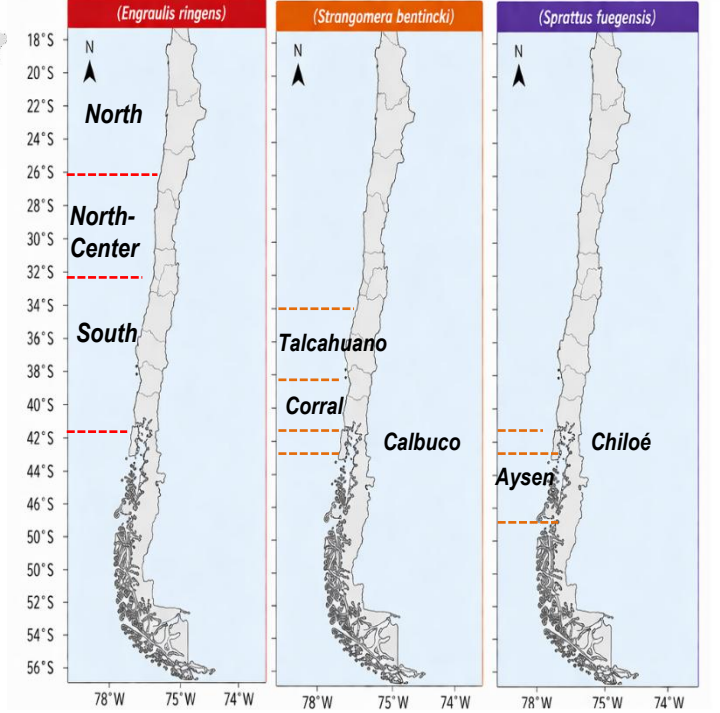
Useful for management

Sampling and methods

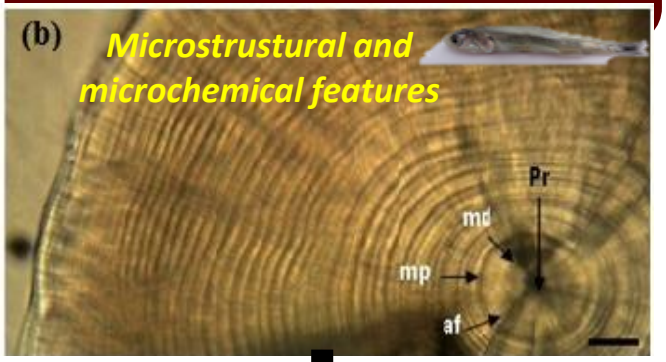
- *FIPA 2015-22*
- *FIPA 2018-16*
- *FIPA 2021-16*

- Early juveniles and adult fish of the same birth cohort
- Hydroacustic surveys
- Fishery biological monitoring

IFOP-Chile

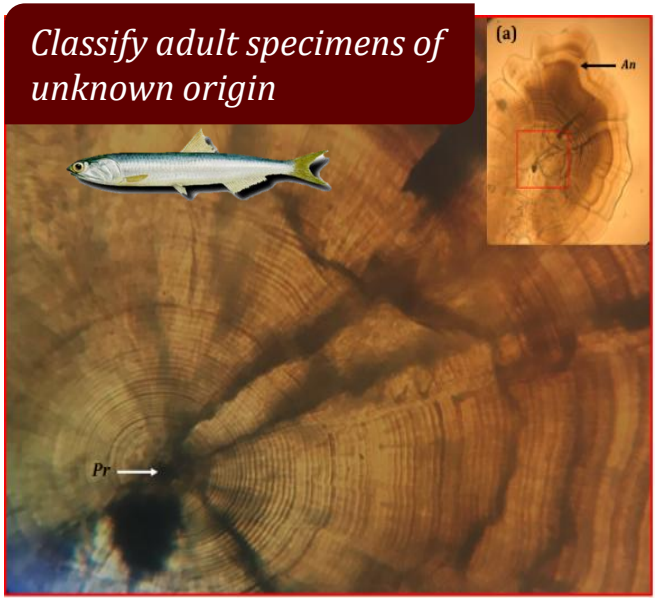


Discriminatory capacity of otolith markers from a sample of juveniles with known origin

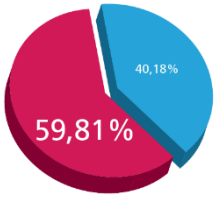


Classification Algorithms

Classify adult specimens of unknown origin

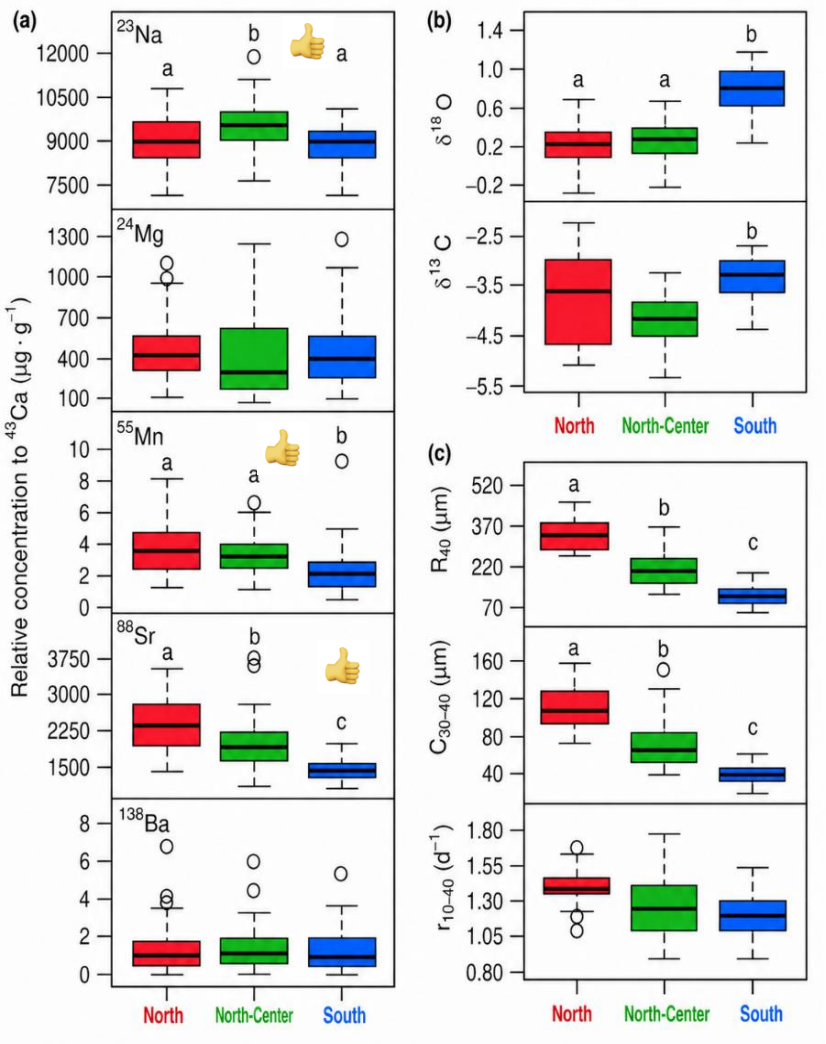


Determine mixing leves

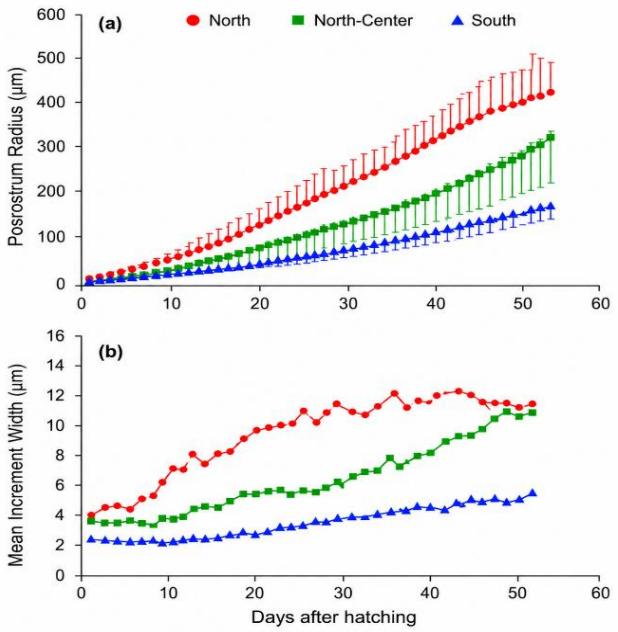


Anchoveta (Microchemestry and microstructure)

p<0.001



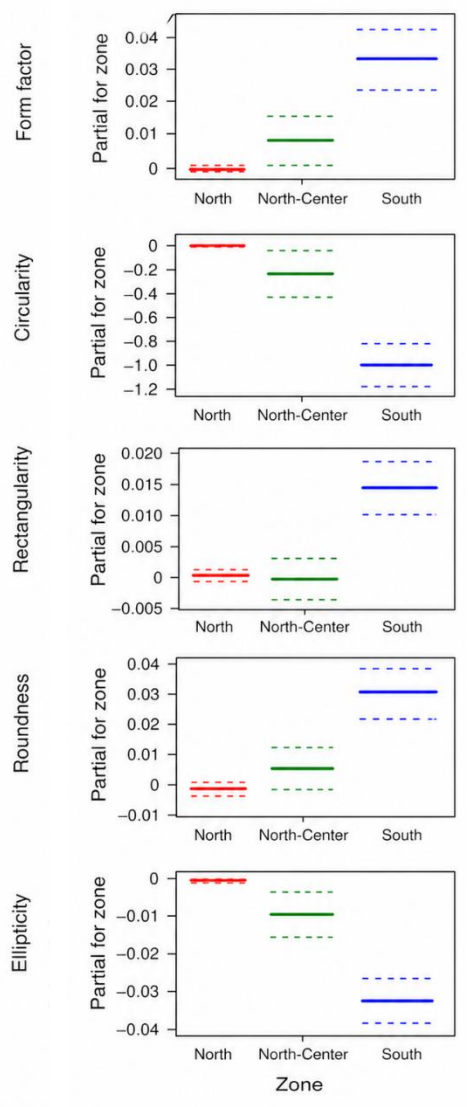
Modified from Garcés et al. (2019)

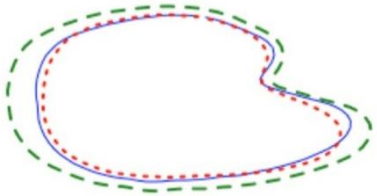


- Highly significant differences were found (MANOVA p<0.001) among zones in most trace element, stable isotopes and microstructural indices from early juveniles

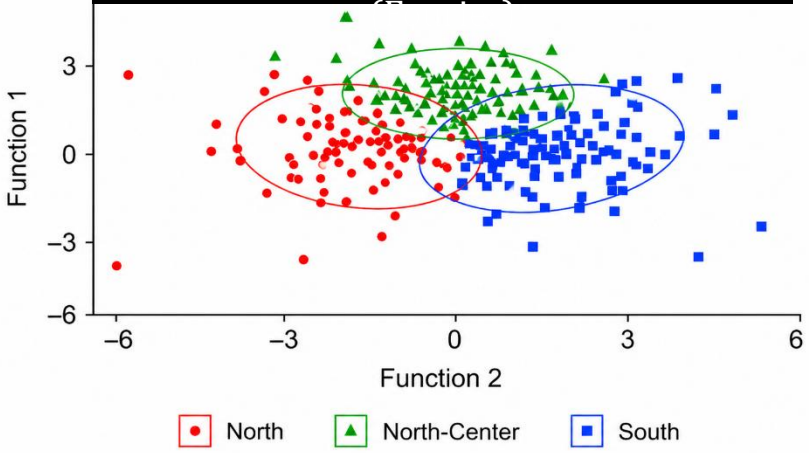
Anchoveta (otolith shape análisis)

GAM (p<0.01)





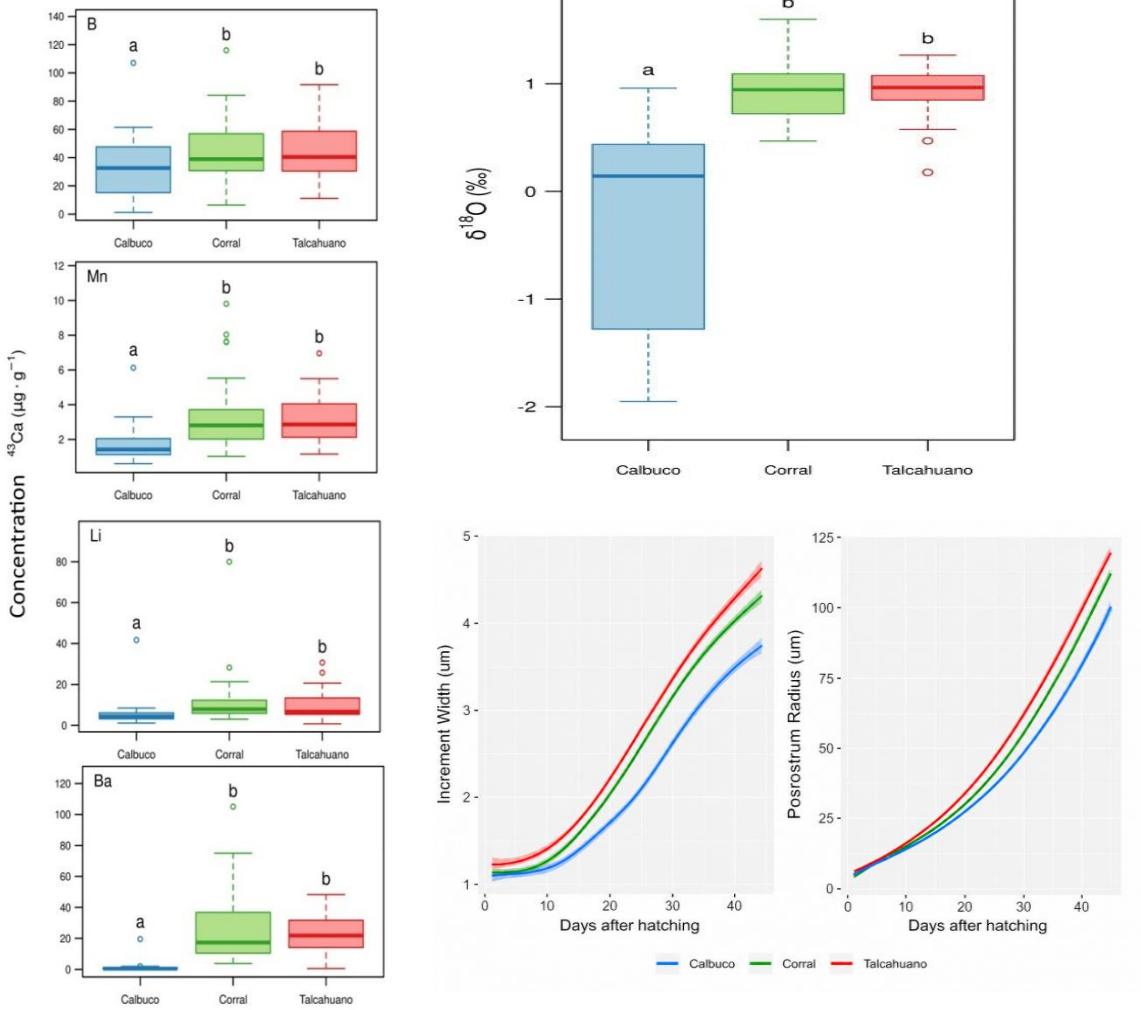
LDA of elliptical Fourier descriptors



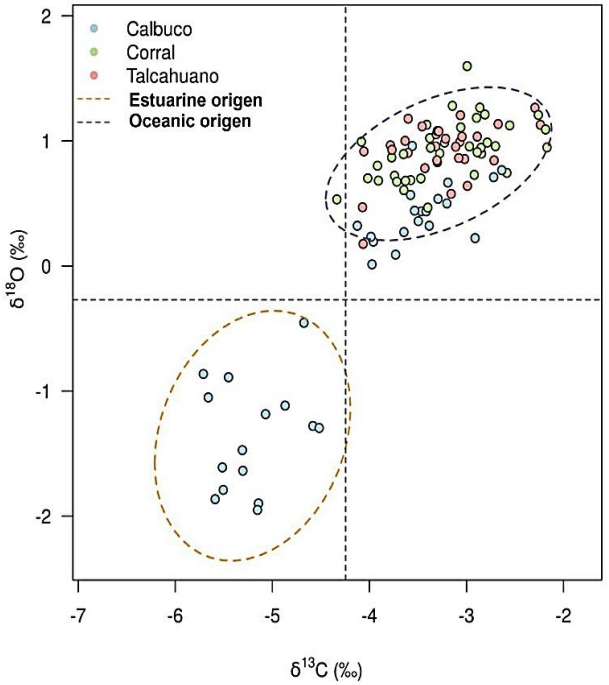
Modified from Cerna et al. (2019)

❖ Basic shape indices and the sagittal otolith outline showed significant differences (P<0.001) between the three zones

Common sardine (Microchemestry and microstructure)



- Tacahuano vs Corral (MANOVA p> 0.05).
- Estuarine vs Oceanic origen

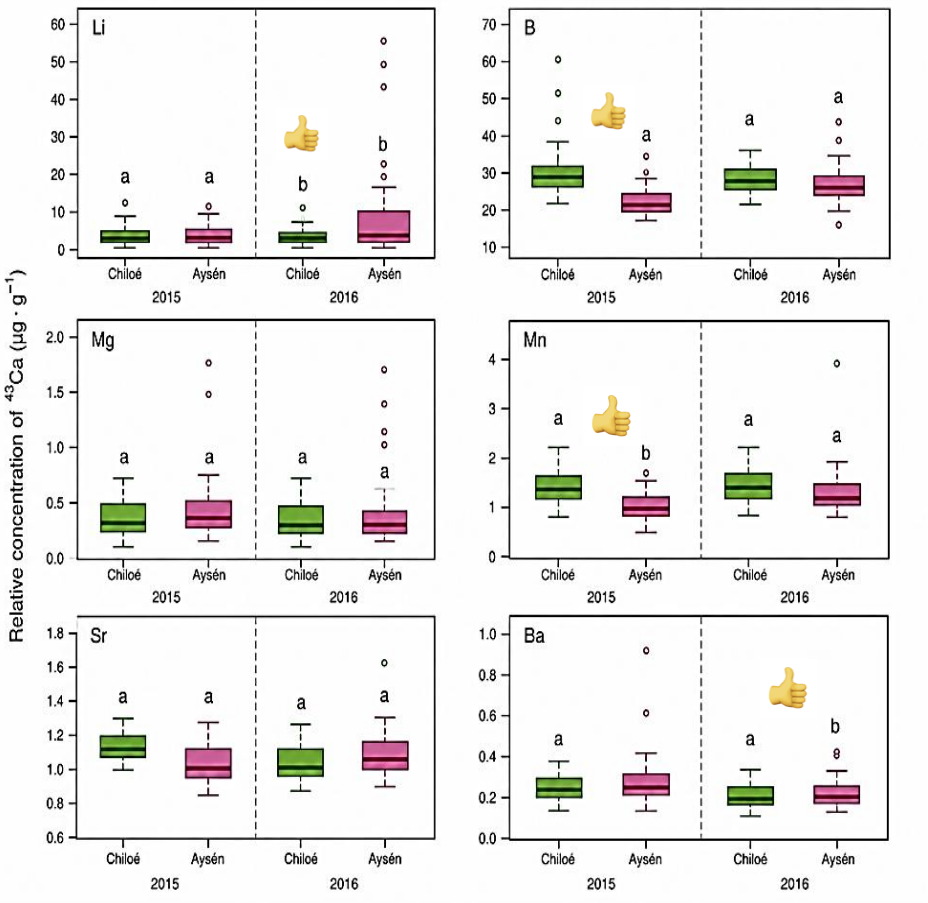


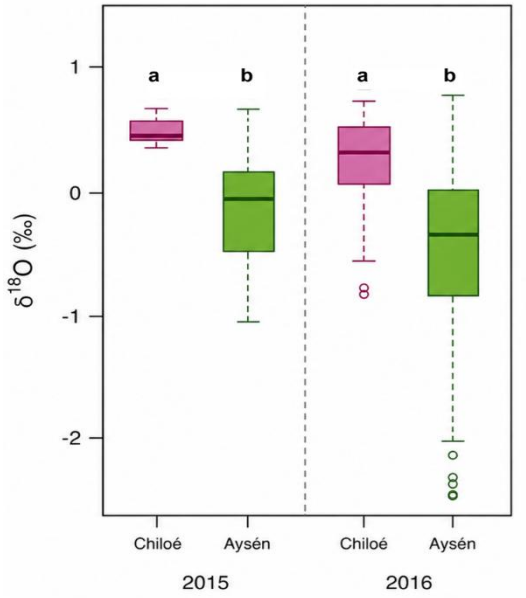
- (MANOVA p<0.001) in most trace element, stable isotopes and microstructural indices, between Calbuco and northmost zones.

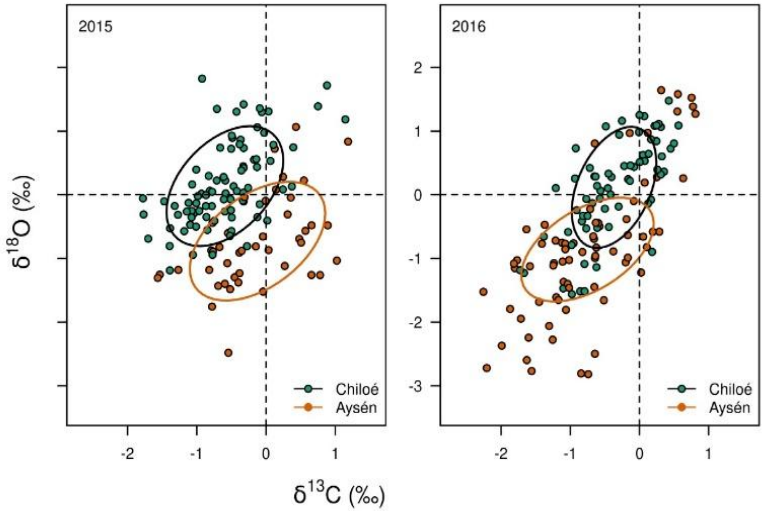
- Otolith contour (MANOVA p> 0.05)

Falkland sprat(Microchemestry)

p<0.001

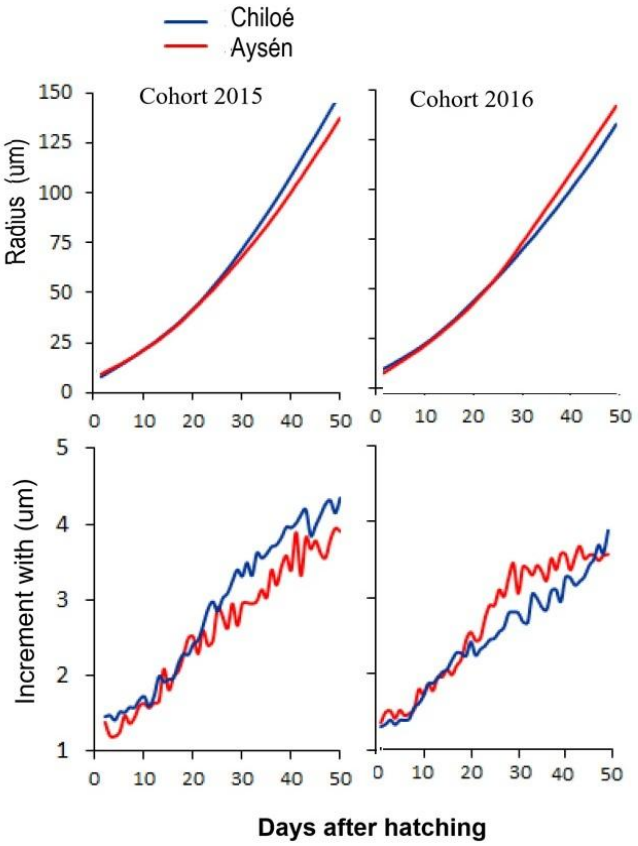


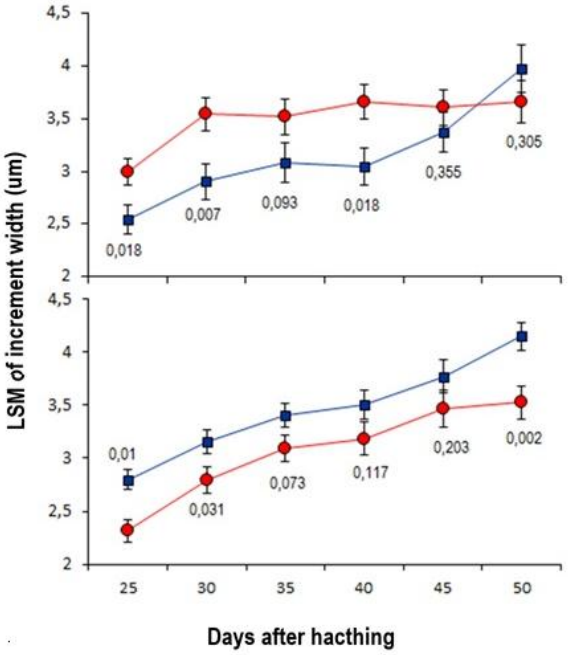




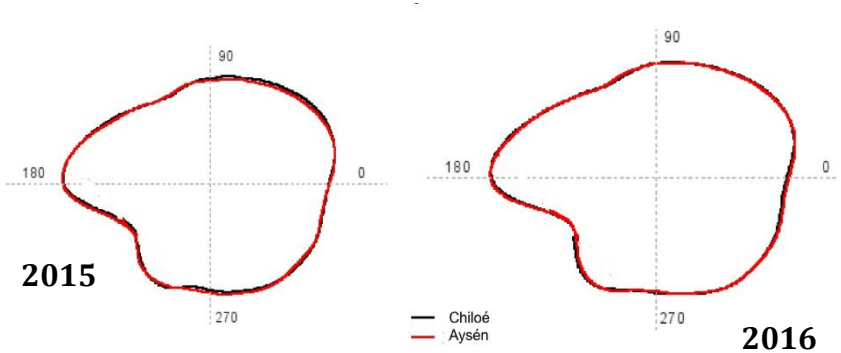
- (MANOVA p<0.001) in most trace element, stable isotopes and microstructural indices, between Calbuco and northmost zones.
- Tacahuano vs Corral (MANOVA p> 0.05)

Falkland sprat(microstructure & otolith countour)



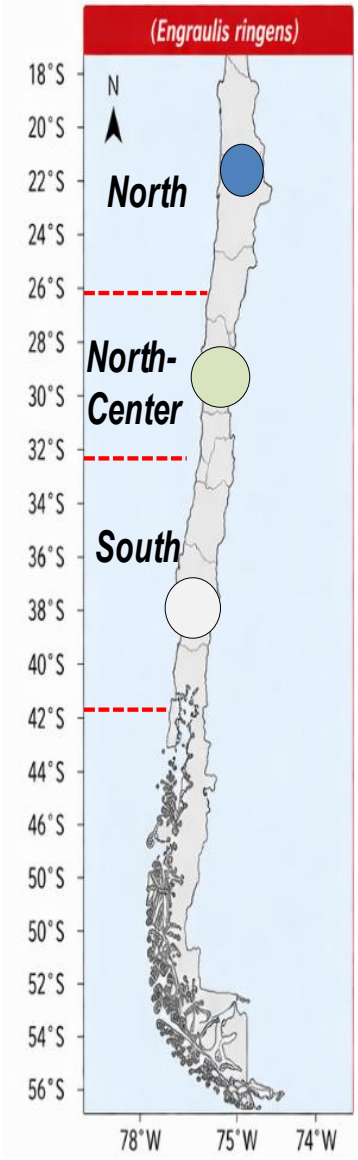


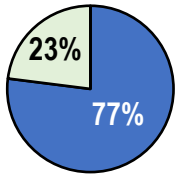
- (MANOVA p<0.001) microstructural indices, between Calbuco and northmost zones (Talcahuano & Corral
- Tacahuano vs Corral (MANOVA p> 0.05)

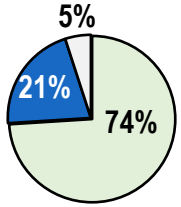


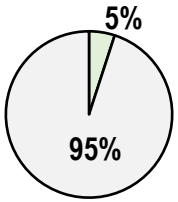
- Otolith contour using wavelet (MANOVA p> 0.05)

Mixing Levels

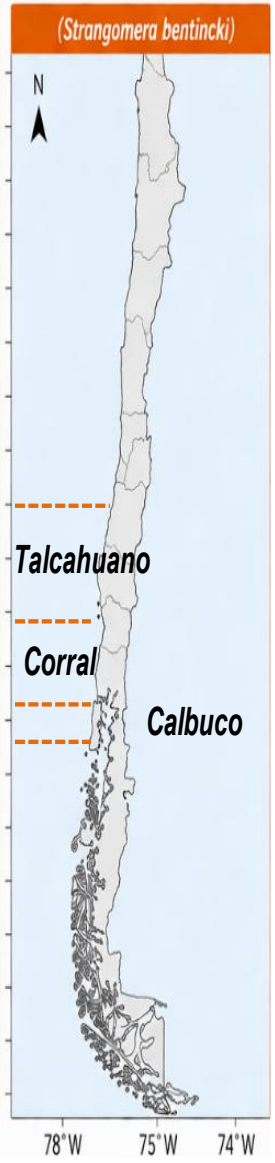








The South Zone is a clearly separate demographic unit (<5% mixing with the other zones). Between the North and North-Central zones there is moderate mixing (21–26%).

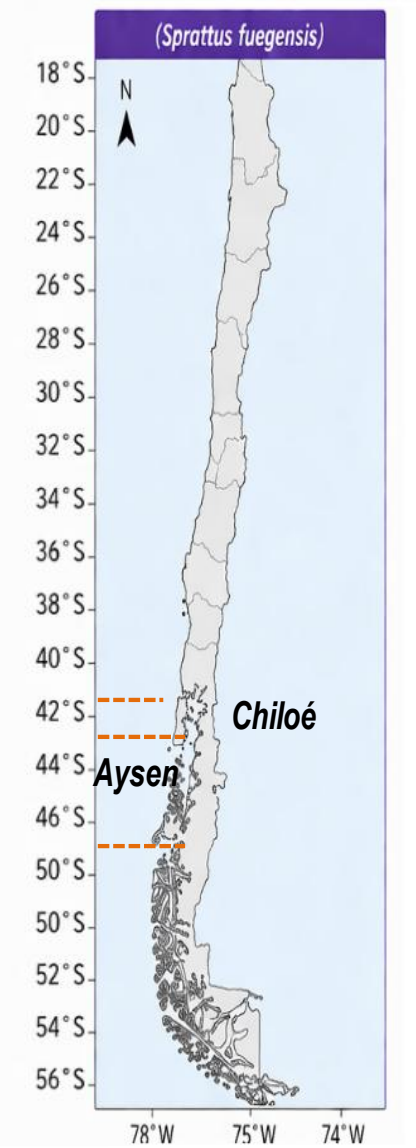


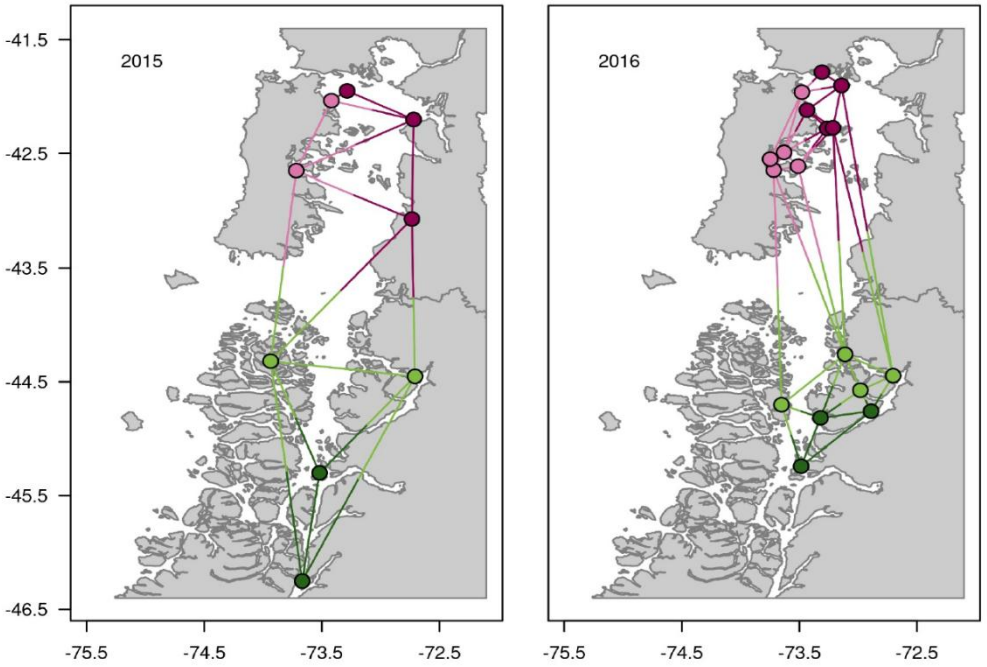
Contribution from the Inner Sea of Chiloé (estuarine zone)

Contribution from the coastal-oceanic zone (oceanic zone)

Two demographic origins are identified: estuarine (Inner Sea of Chiloé) and coastal-oceanic (Corral–Talcahuano). The oceanic unit acts as a source population and the estuarine unit as a sink population.

Mixing Levels (Falkand sprat)





Two demographic units are well segregated, with high fidelity to origin. Connectivity is asymmetric, with a greater contribution from Chiloé to Aysén (12–35%) than from Aysén to Chiloé (0–11%).

Final remarks

Management implications

Engraulis ringes	Zone specific manegment (North, North-Center, South)
S. Bentinki	Conserve de inner sea of Chiloé as a key reproductive reservoir, because its protection would favor the resilience of stock exploited in Chiloé and Corral
S. fueguensis	Manage at the of demographic units (Chiloé and Aysen), considering asymmetric connectivity in management decisions

Discriminatory power of otolith-based markers

Otolith microstructure and machochemestry	High consistency between juveniles and adults are useful to estimate mixing levels using an integrated approach
Basic shape indices & Otolith countour	Level of resolution is specie-specific likely related to the extent of environmental variation of contrasted geographic areas

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Thank you for your attention