Small pelagic fish fitness relates to local environmental conditions and trophic variables

Elena Lloret-Lloret,

M. Albo-Puigserver, J. Giménez, J. Navarro, M.G. Pennino, J. Steenbeek, J.M. Bellido and M. Coll

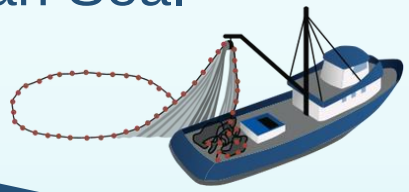
10th November 2022

Introduction

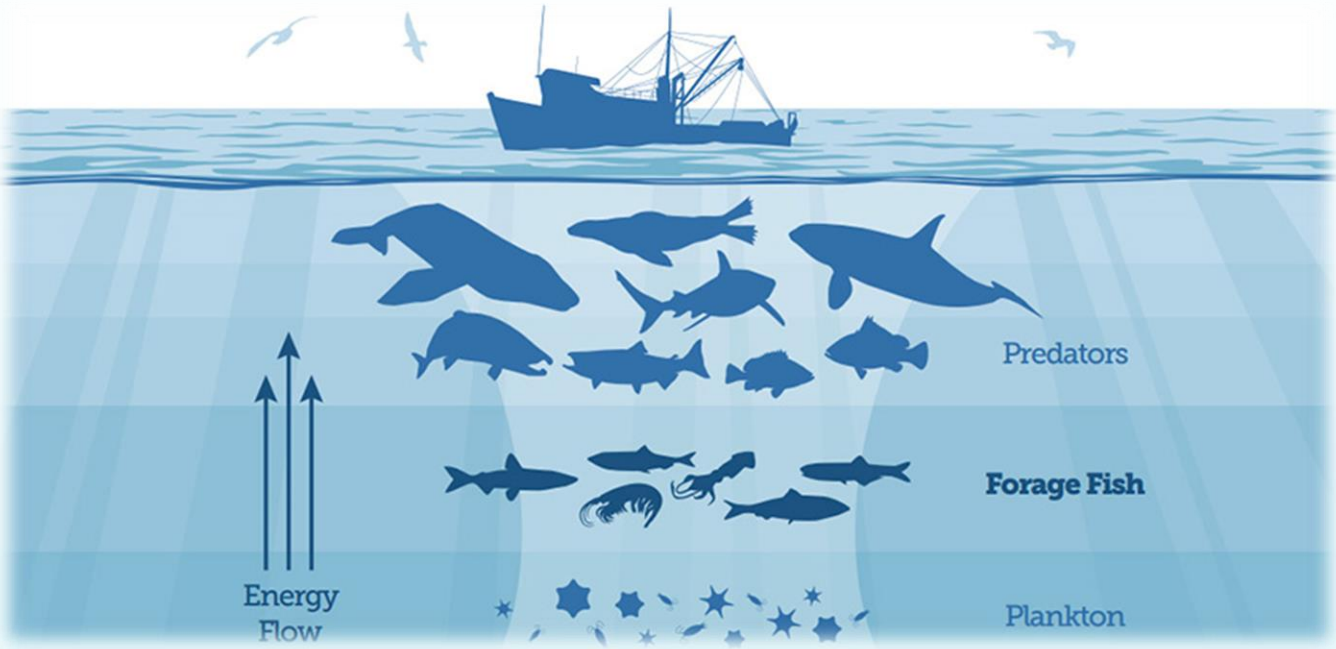
- Small Pelagic Fish (SPF)

- Important for the commercial fisheries worldwide and critical for food security in many communities.

- SPF represent 44.3% of the catch in the Mediterranean Sea.

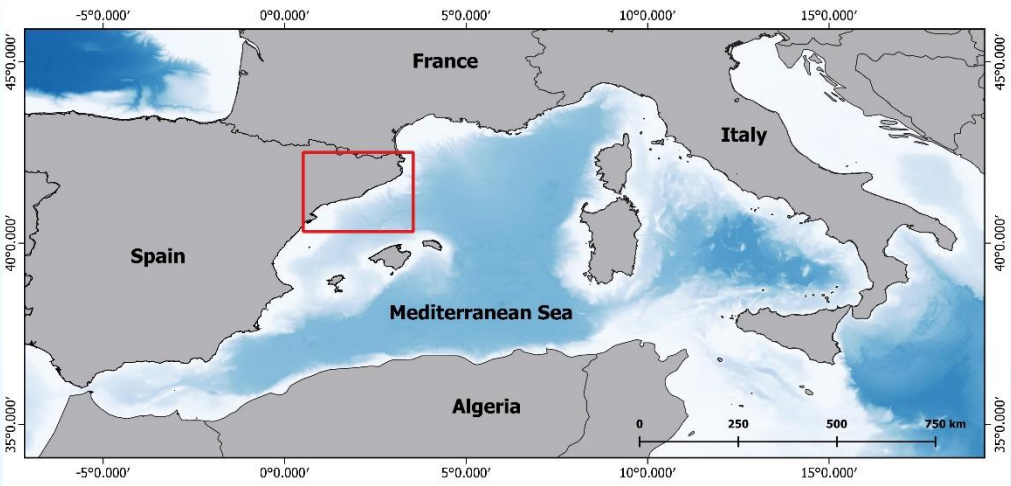


- Ecological importance



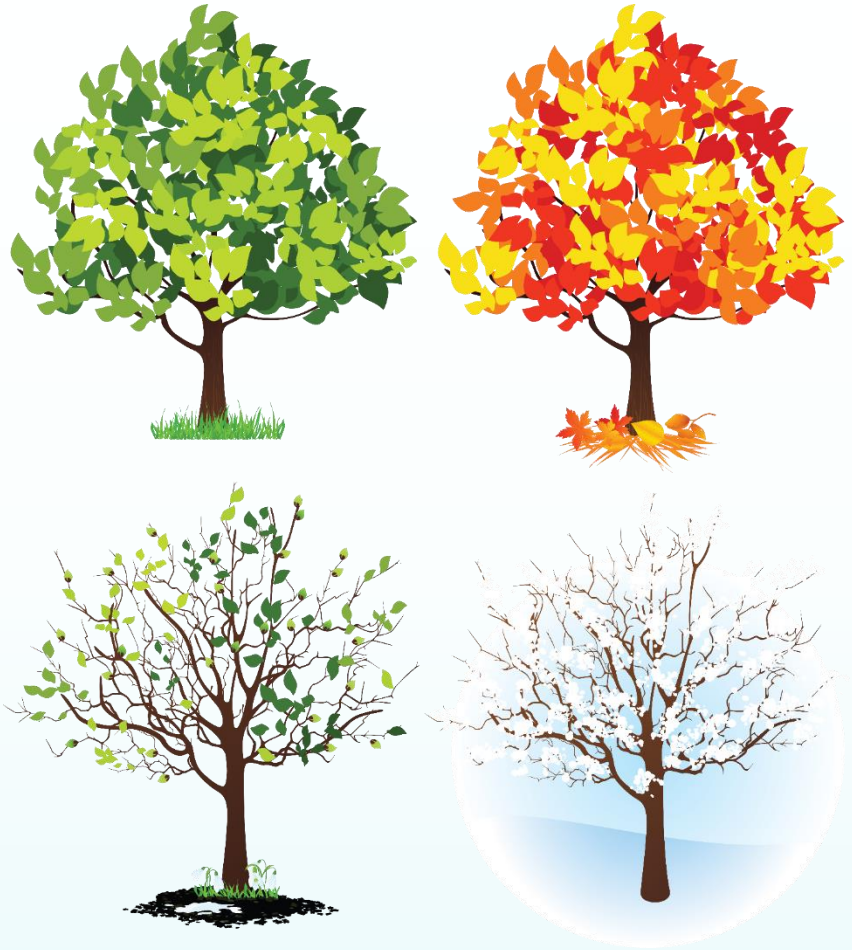
Problematic

- Changes in biomass, abundance, growth patterns and body condition in sardines and anchovies in specific areas of the Mediterranean Sea.



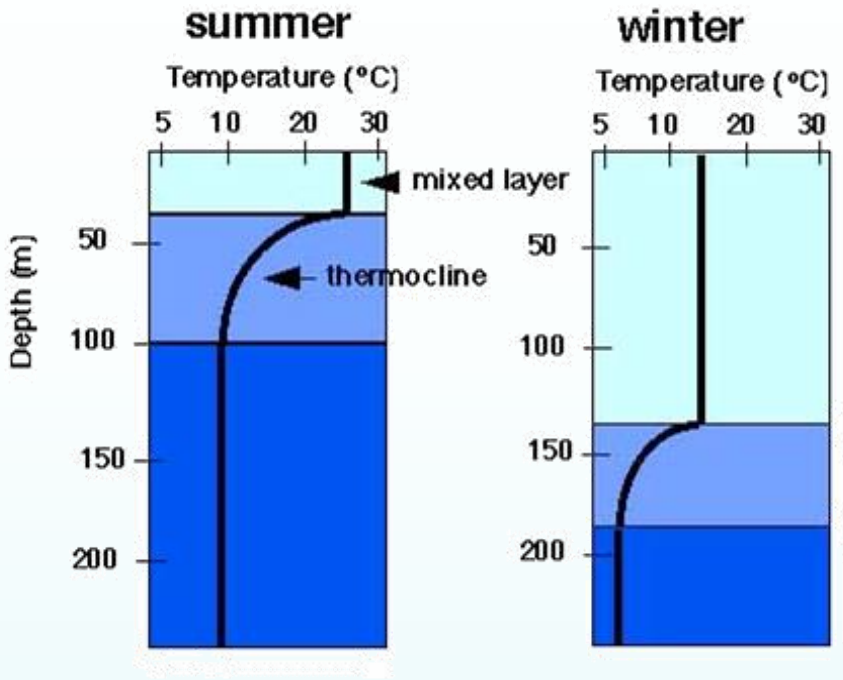
Saraux, C. et al. (2019). Small pelagic fish dynamics: A review of mechanisms in the Gulf of Lions. *Deep. Res. Part II* 159, 52–61. doi:10.1016/j.dsr2.2018.02.010.
Coll, M., et al. (2019). Who is to blame? Plausible pressures on small pelagic fish population changes in the northwestern Mediterranean Sea. *Mar. Ecol. Prog. Ser.* 617–618, 277–294. doi:https://doi.org/10.3354/meps12591

- Environmental variables have seasonal and spatial variations.
- The Northwestern Mediterranean Sea is characterized by strong seasonality.



https://cellcode.us/quotes/pacific-ocean-water-temperature-graph.html

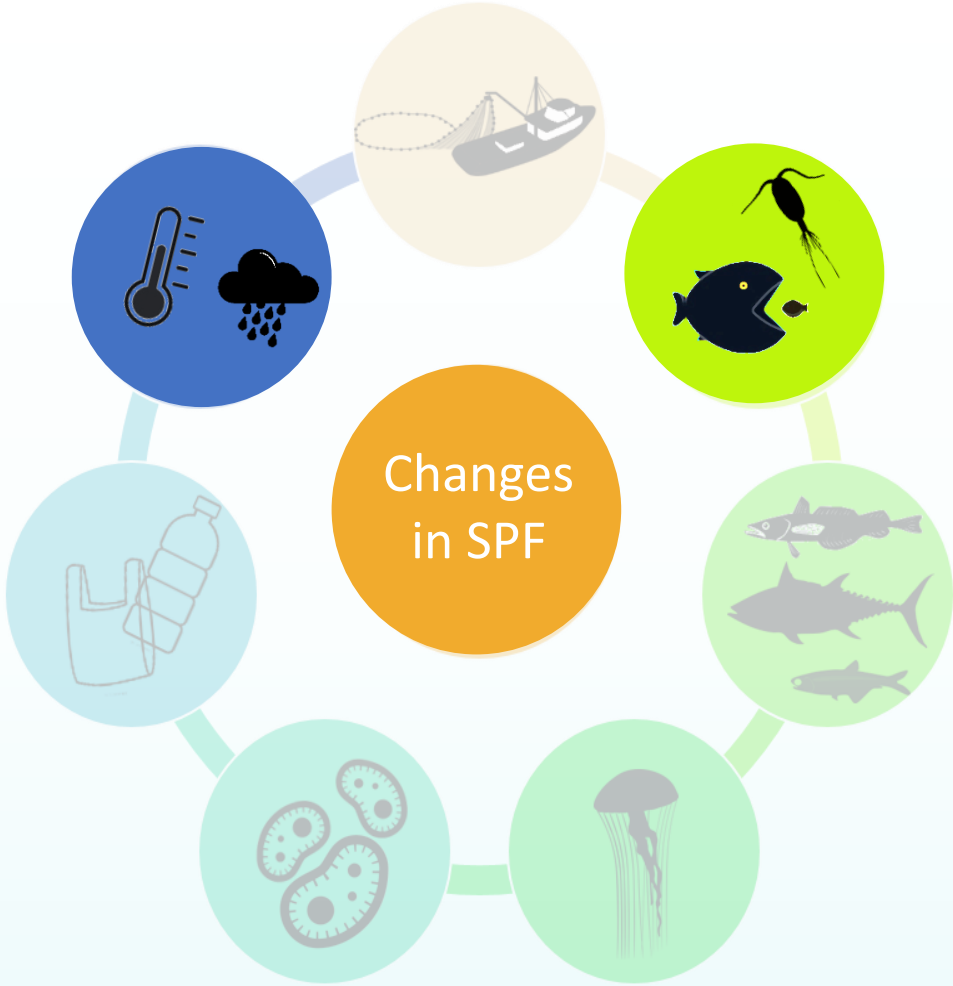
- Environmental variables have seasonal and spatial variations.
- The Northwestern Mediterranean Sea is characterized by strong seasonality.



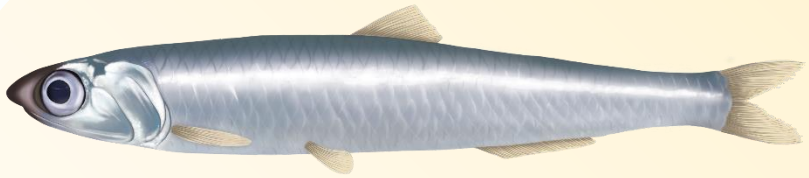
https://cellcode.us/quotes/pacific-ocean-water-temperature-graph.html

Objective

Investigate the **seasonal** patterns of **fish fitness** (in terms of body condition and reproduction activity) of **European anchovy** and **European sardine** along a **latitudinal gradient** in the Northwestern **Mediterranean Sea.**



Focal species

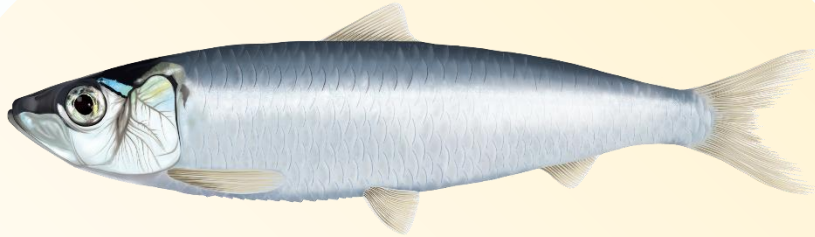


European anchovy

Engraulis encrasicolus

Income-breeder

Reproduction in spring/summer



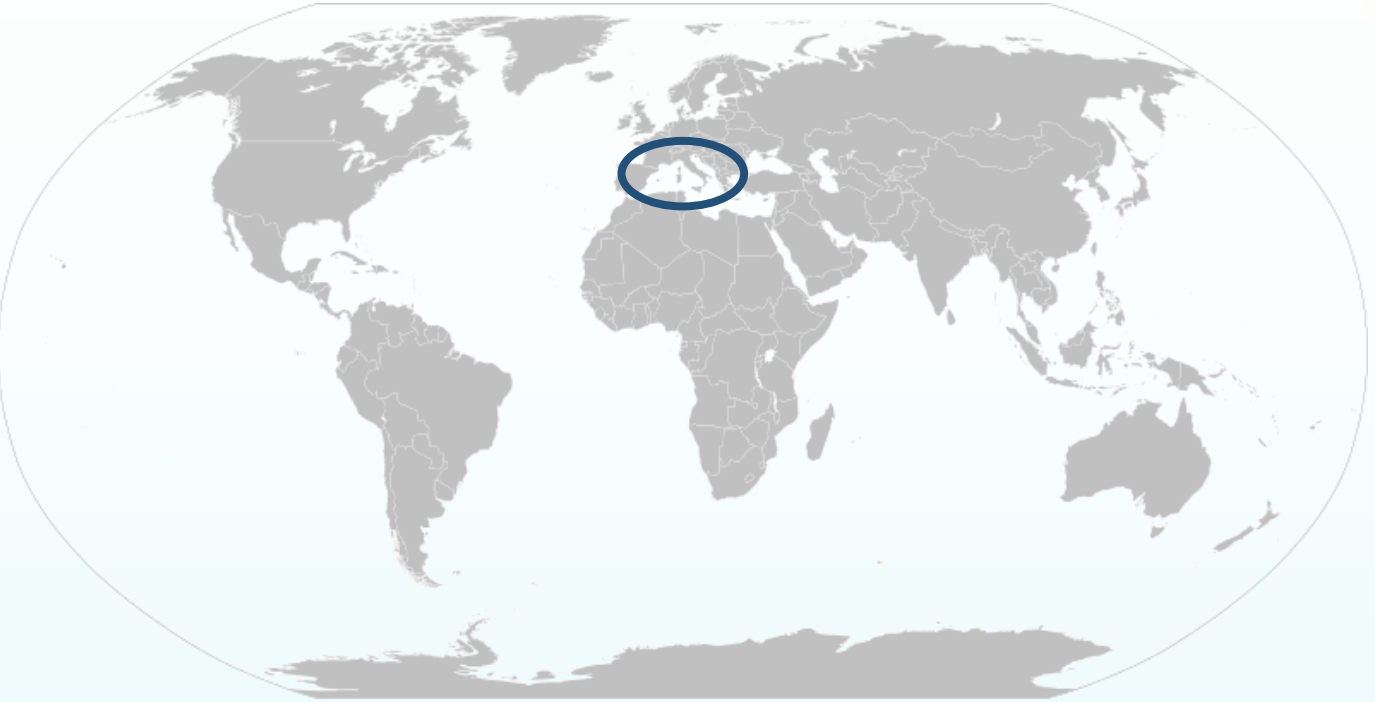
European sardine

Sardina pilchardus

Capital-breeder

Reproduction on winter

Sampling



2 species

Anchovy

Sardine

3 areas

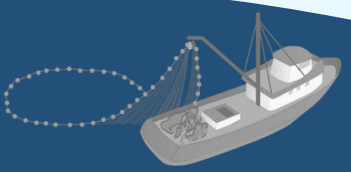
- L'Escala
- Barcelona
- Tarragona

One year data
2018-2019

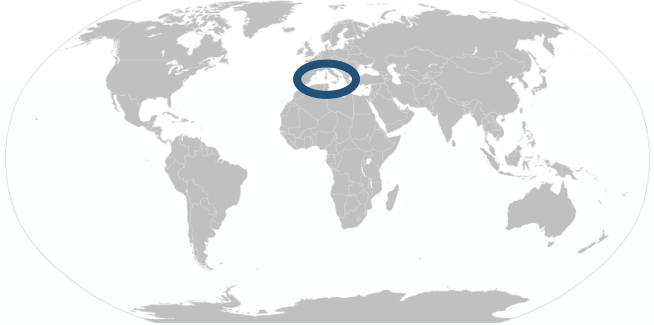
Monthly

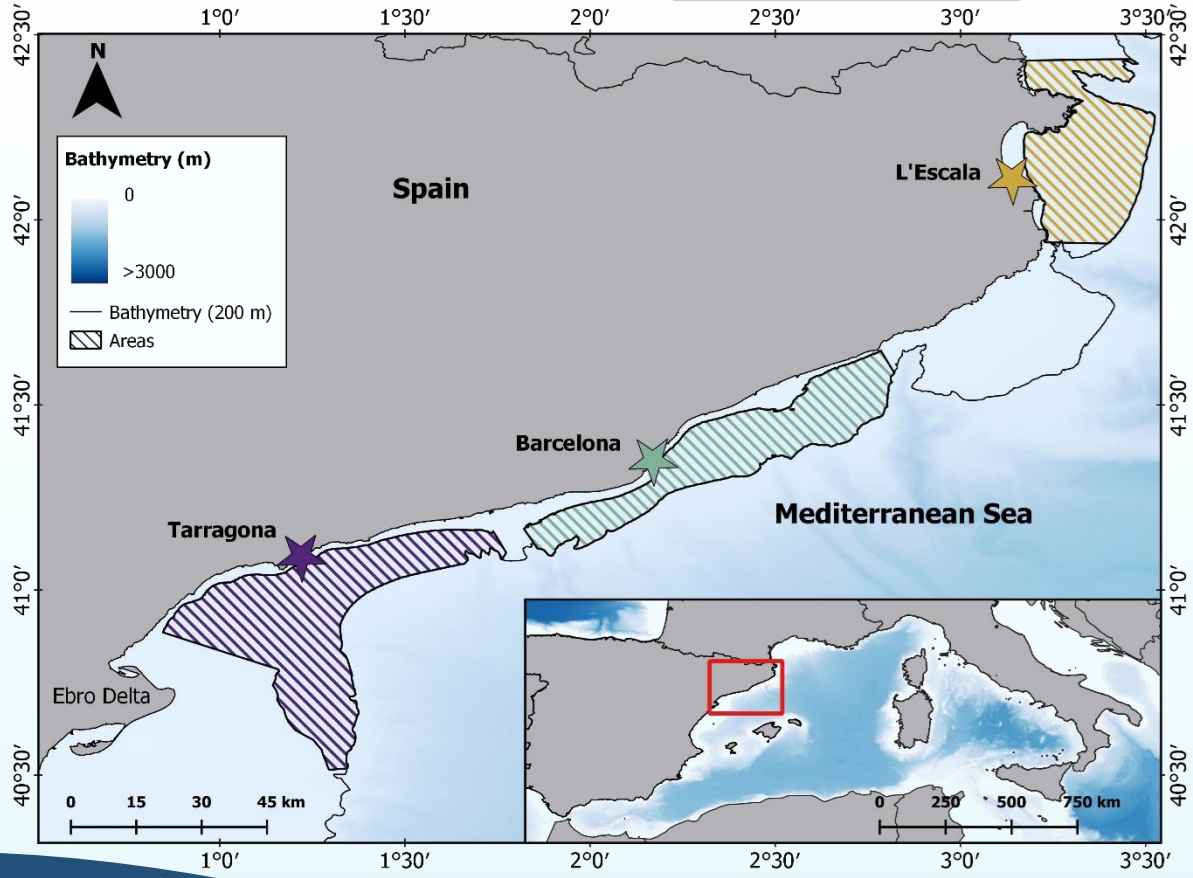
Seasonal

- Summer
- Autumn
- Winter
- Spring



Sampling





2 species

Anchovy

Sardine

3 areas

- L'Escala
- Barcelona
- Tarragona

One year data 2018-2019

Monthly

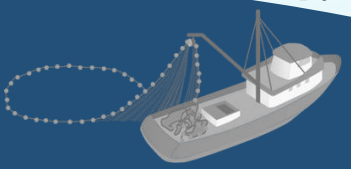
Seasonal

Summer

Autumn

Winter

Spring



Methodology

Body condition index (Kn)

$K_n = W/Wr$

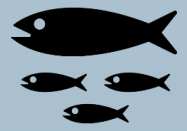
Based on length-weight relationship

Le Cren

Mean fatmeter values

Estimate for lipid content

Gonadosomatic index (GSI)

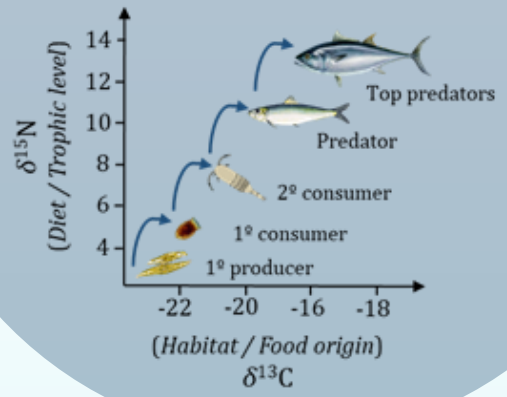


$$GSI\ \% = 100 * \frac{Gonad\ weight}{Total\ weight\ without\ gonad}$$

Trophic signature

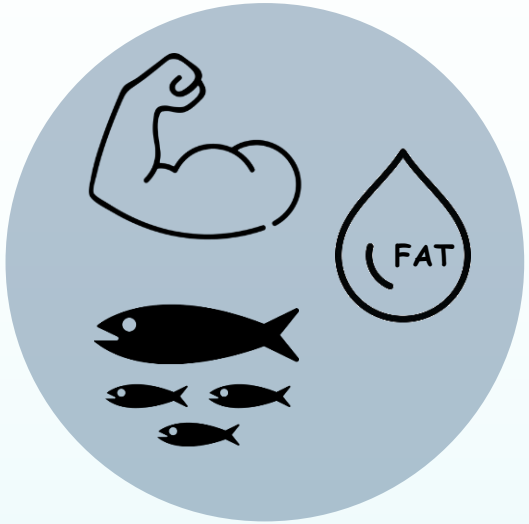
as a proxy for diet

$\delta^{15}N$
$\delta^{13}C$



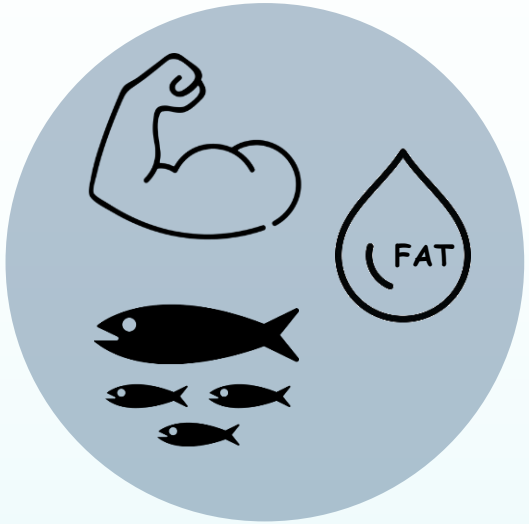
Methodology

Mean fatmeter values
Le Cren relative condition index (Kn)
Gonadosomatic index (GSI)



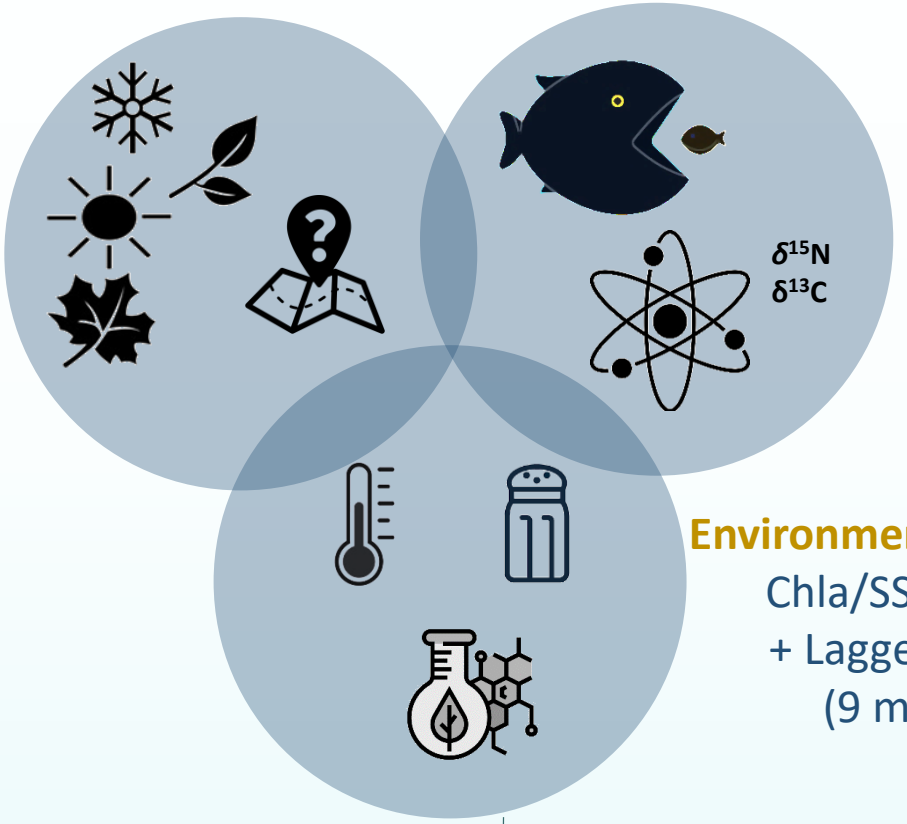
Methodology

Mean fatmeter values
Le Cren relative condition index (Kn)
Gonadosomatic index (GSI)



Spatiotemporal factors

Trophic signature
as a proxy for diet



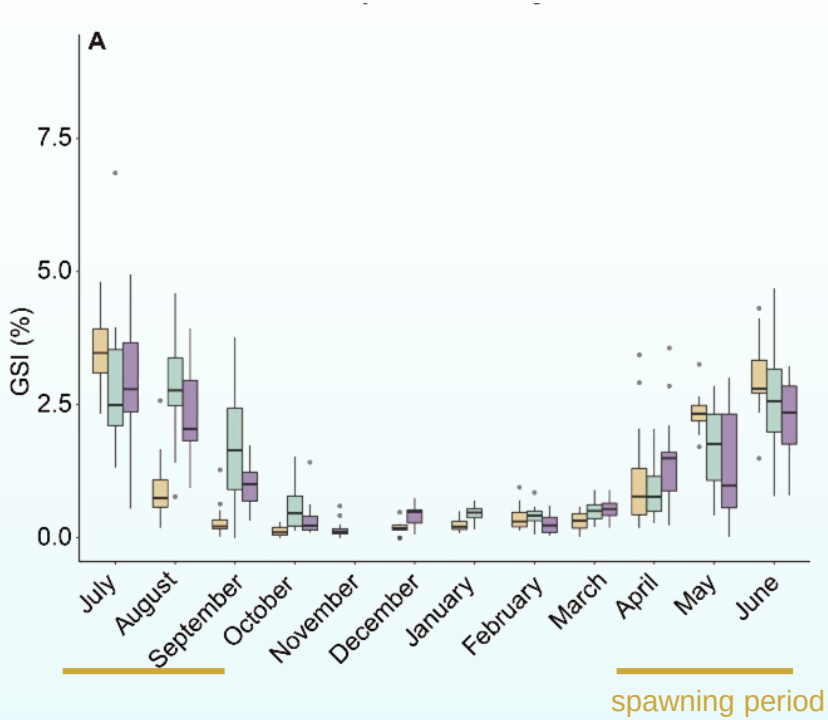
Environmental variables
Chla/SST/Salinity
+ Lagged in time
(9 months)

Generalized Additive Models (GAMS)

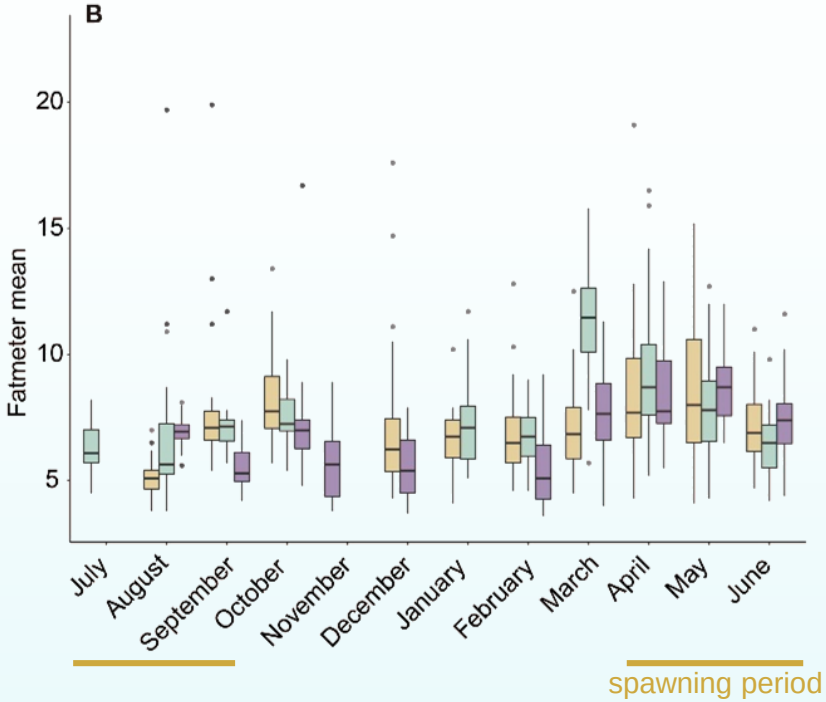
Results

L'Escala
Barcelona
Tarragona

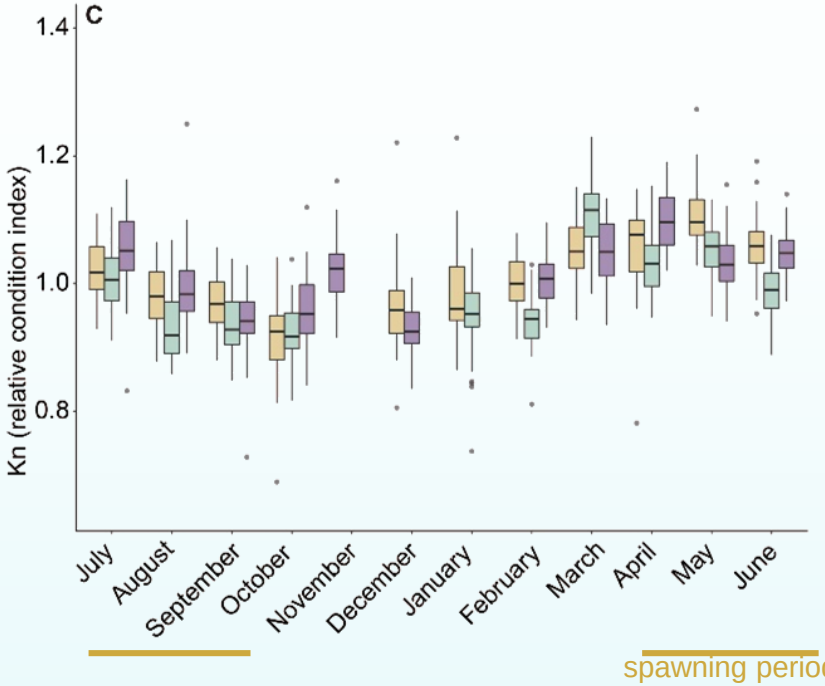
GSI



Fatmeter mean



Kn



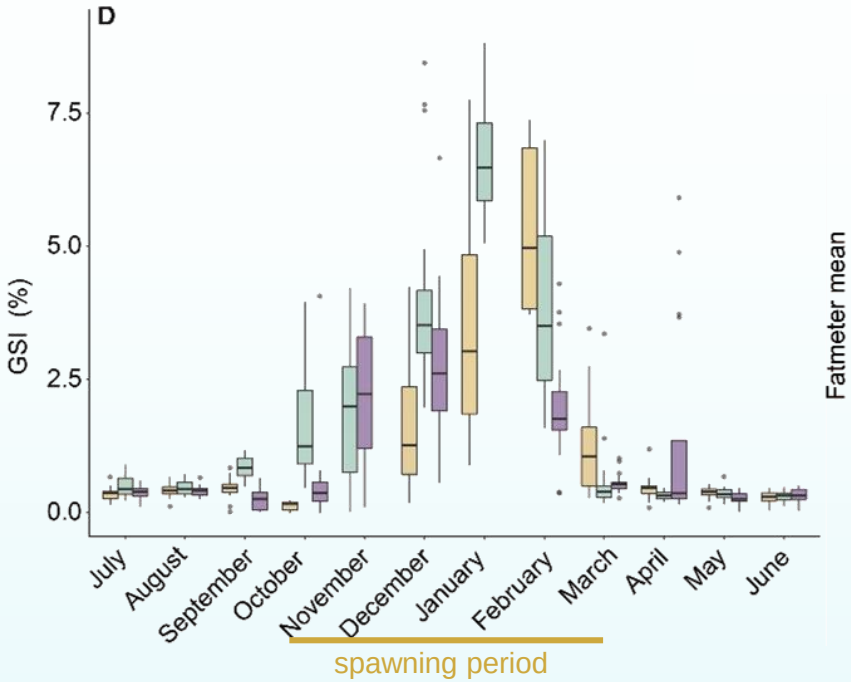
One year data
2018-2019

Anchovy

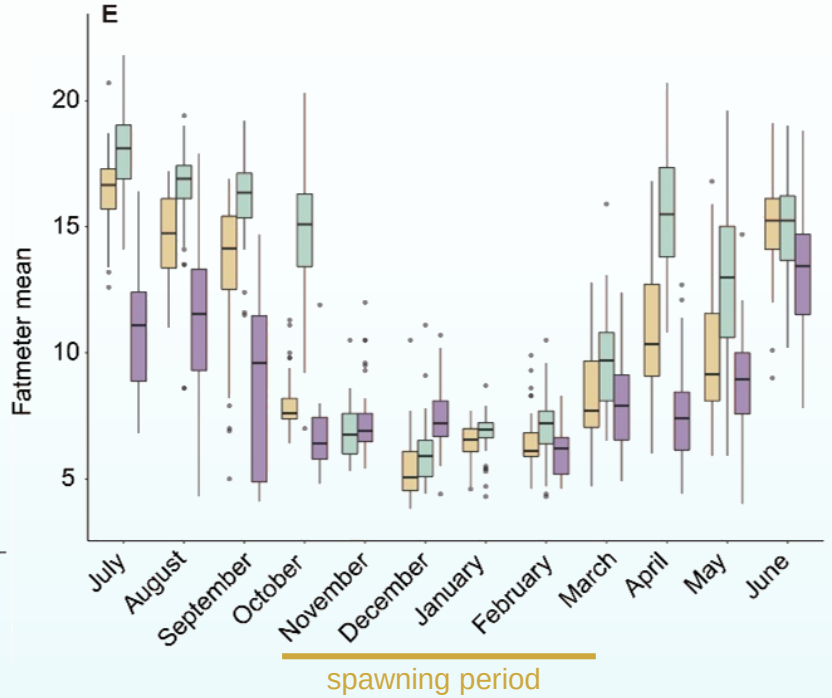
Results

L'Escala
Barcelona
Tarragona

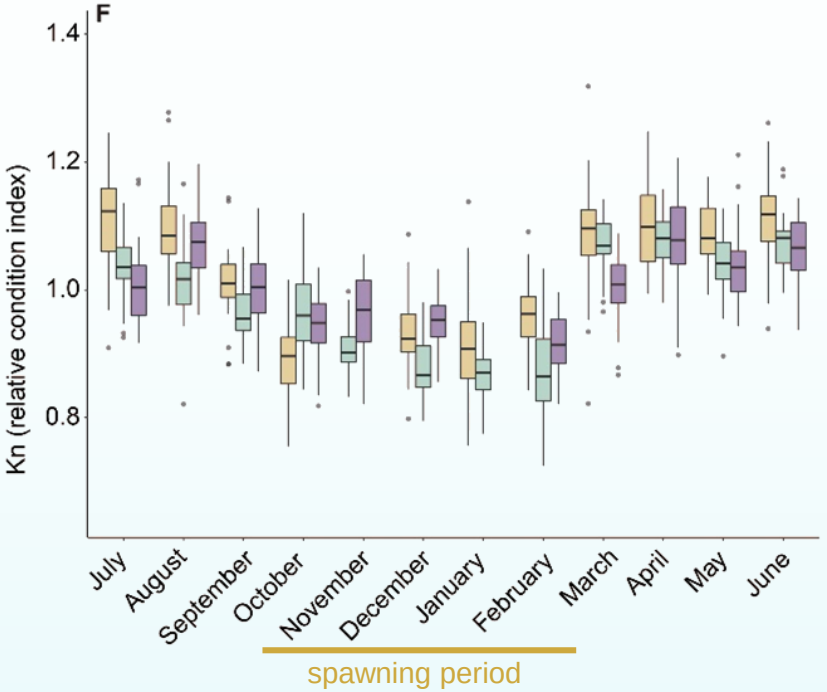
GSI



Fatmeter mean



Kn



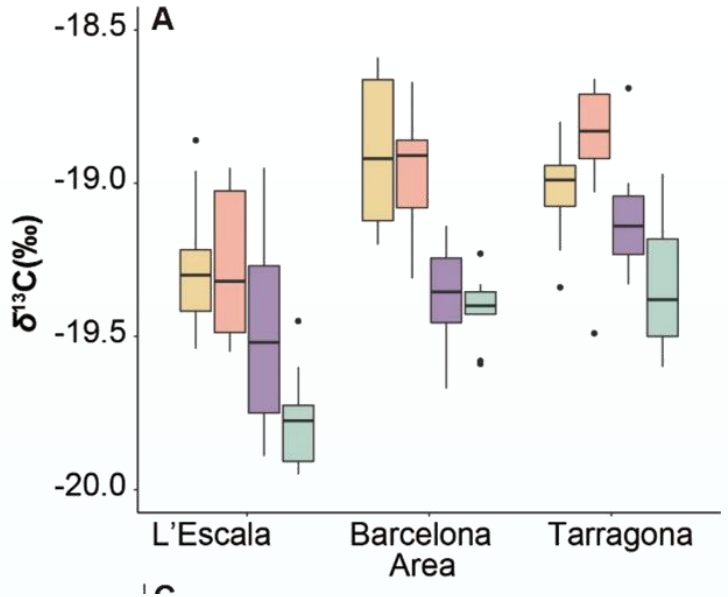
One year data
2018-2019

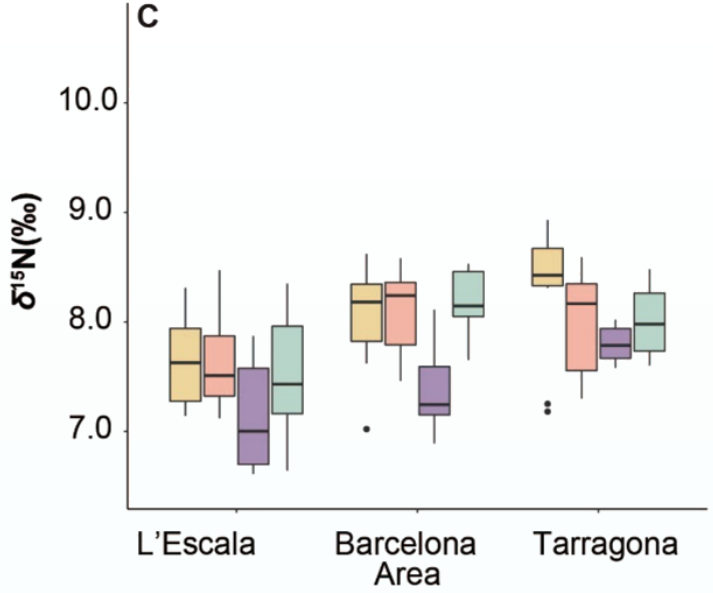
Sardine

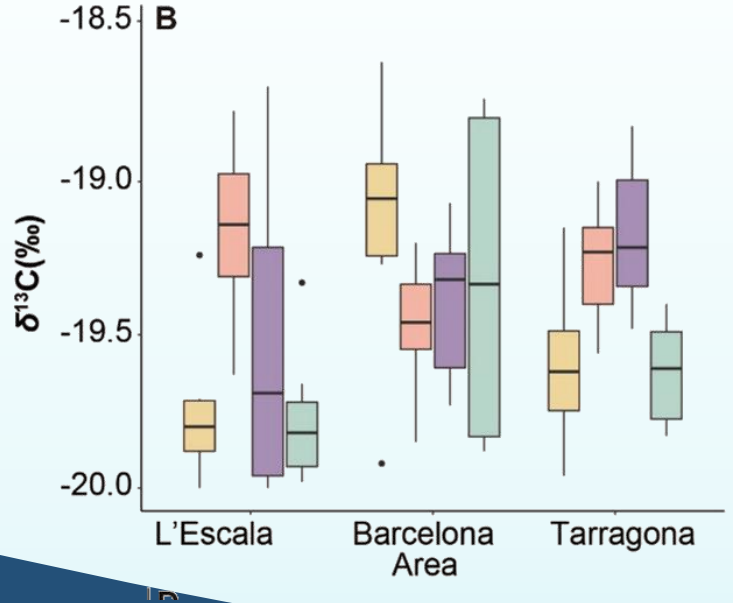
Results

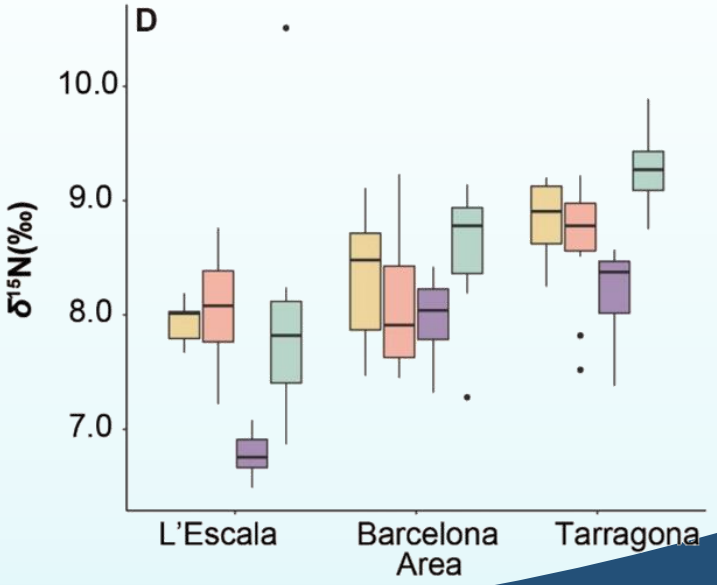
Anchovy

Sardine









Summer

Autumn

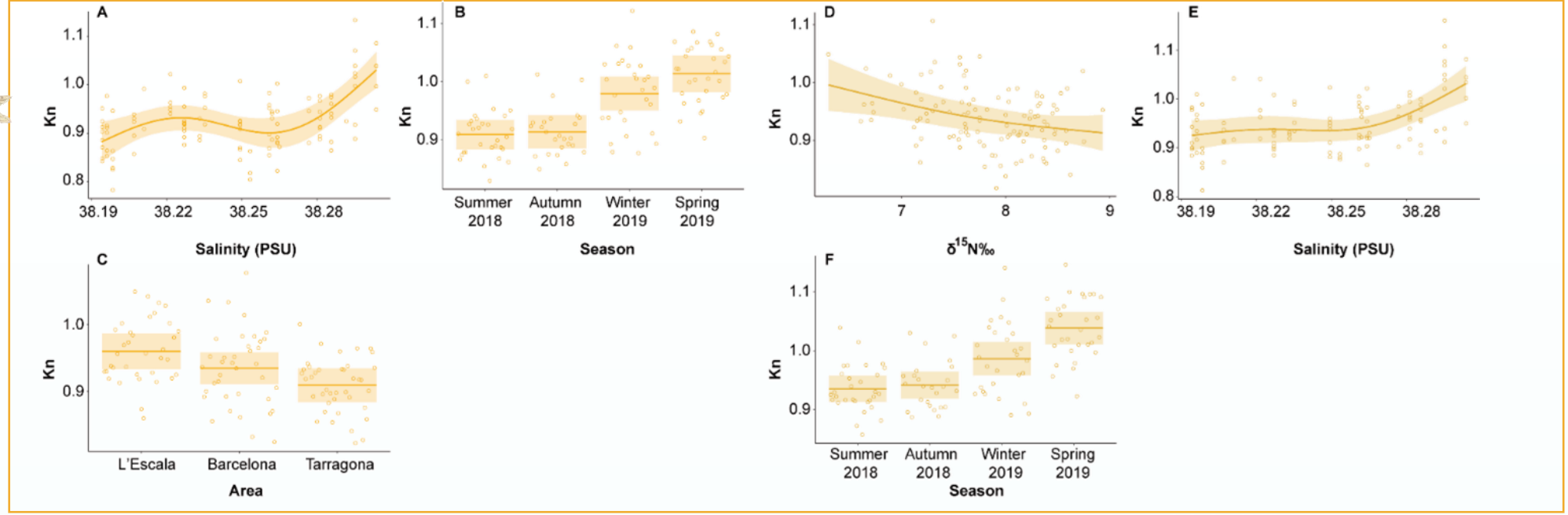
Winter

Spring

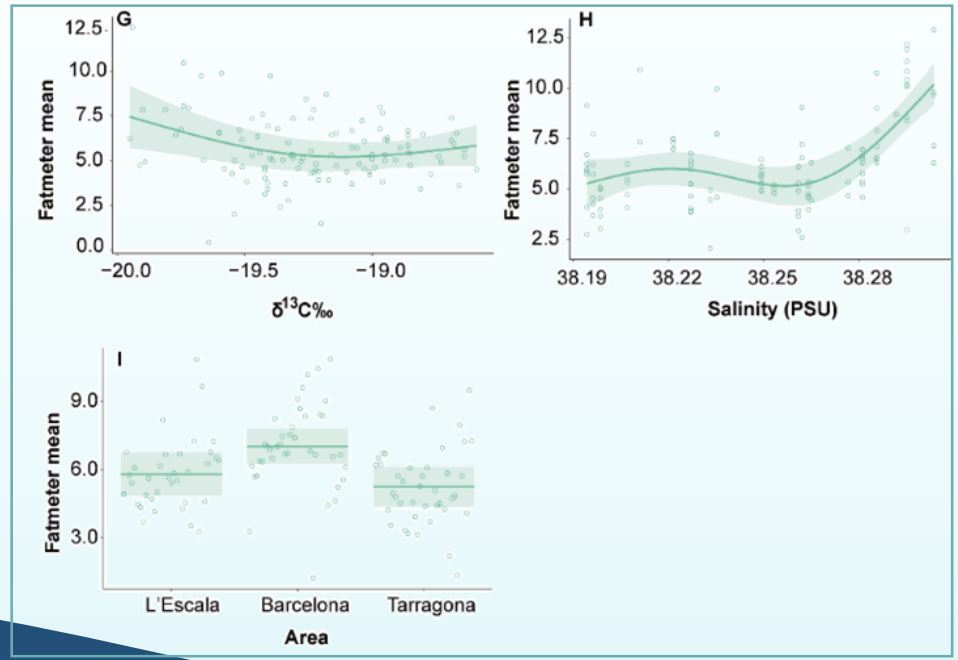
One year data 2018-2019

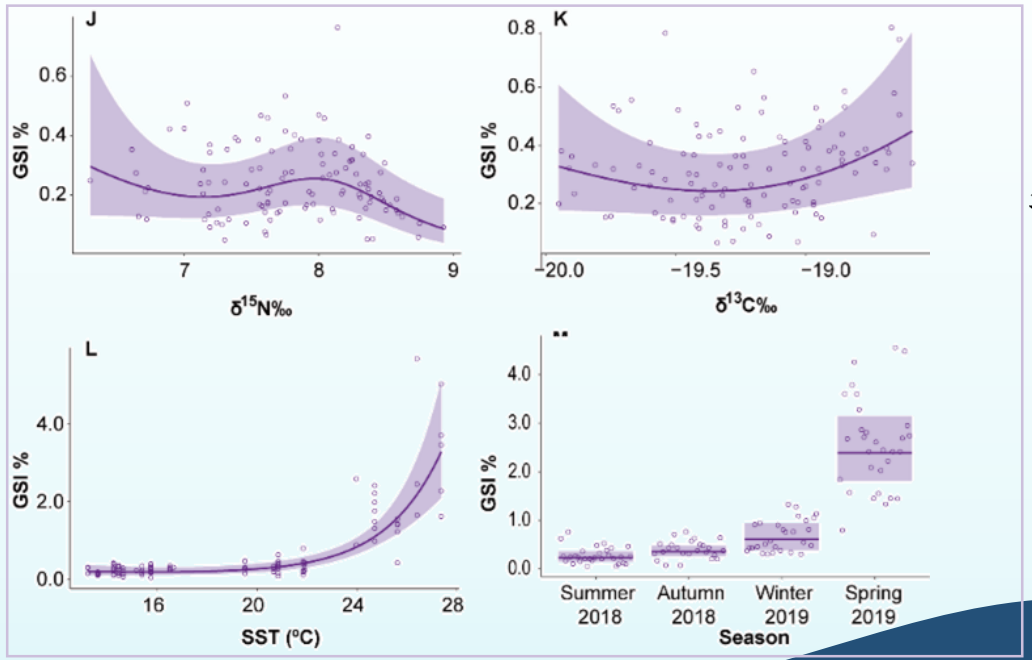
Anchovy

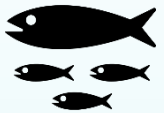
Kn



Fatmeter mean



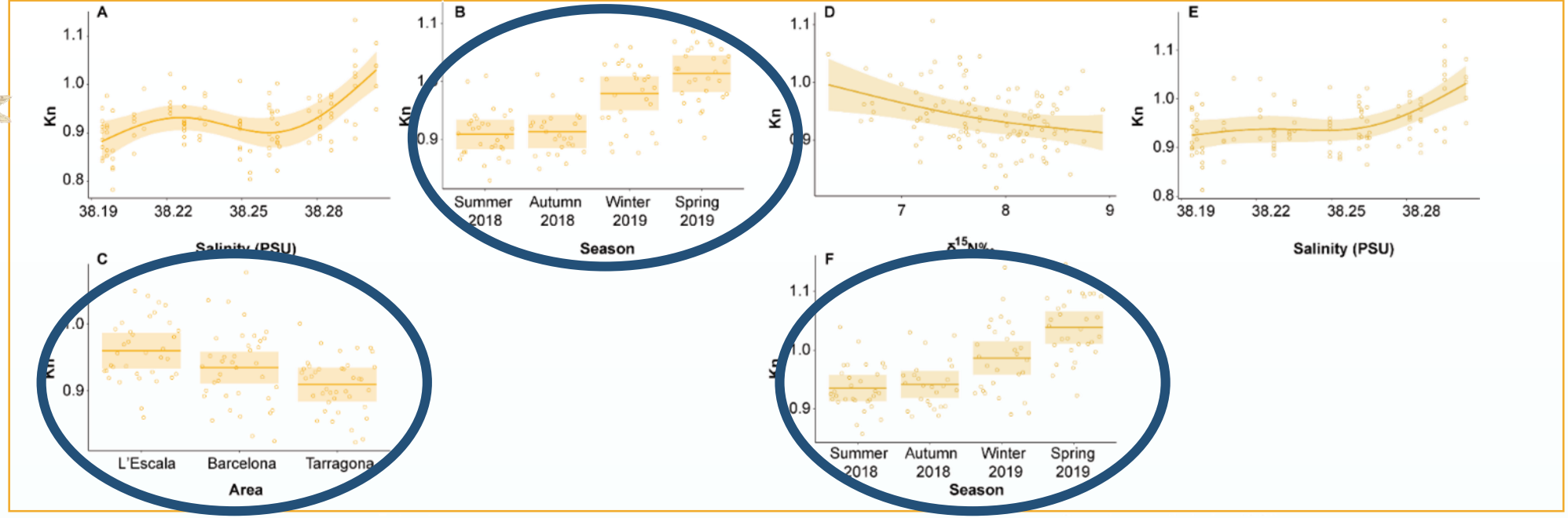




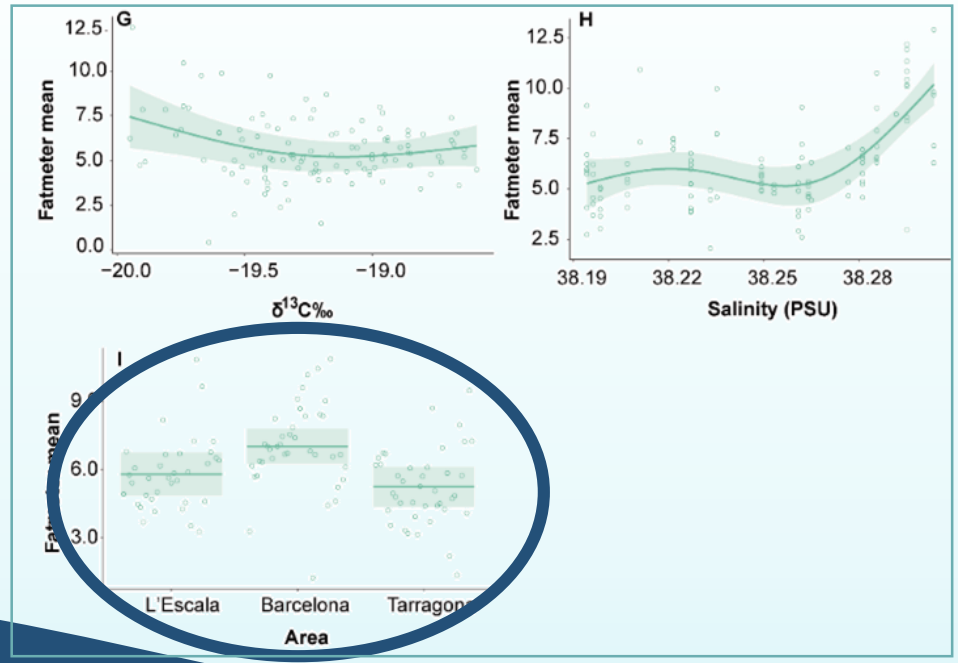
GSI

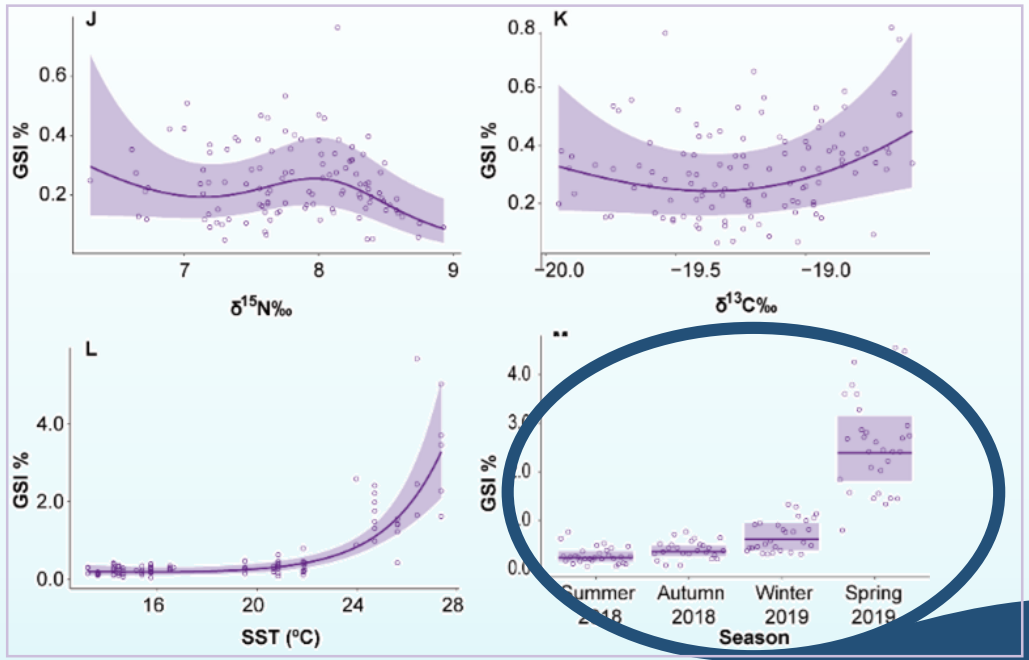
Anchovy

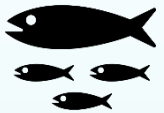
Kn



Fatmeter mean



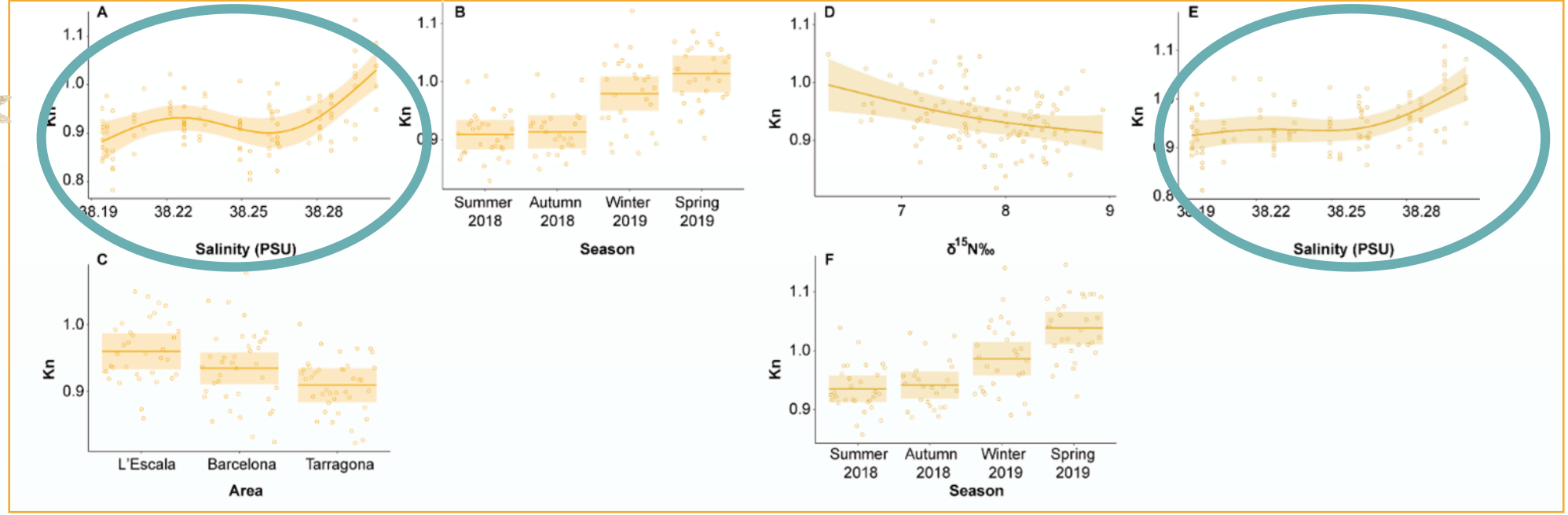


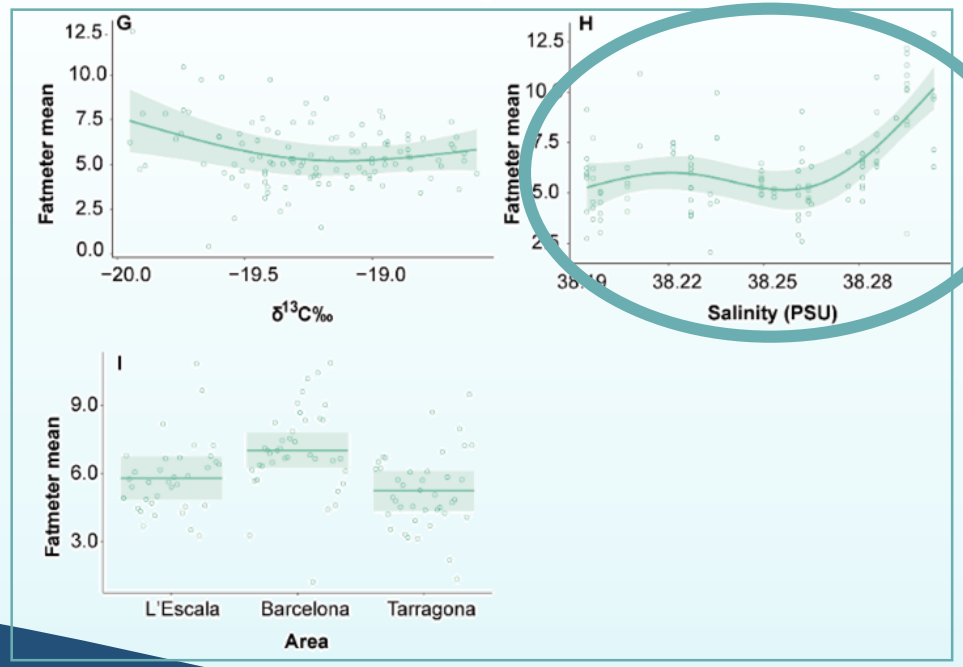


GSI

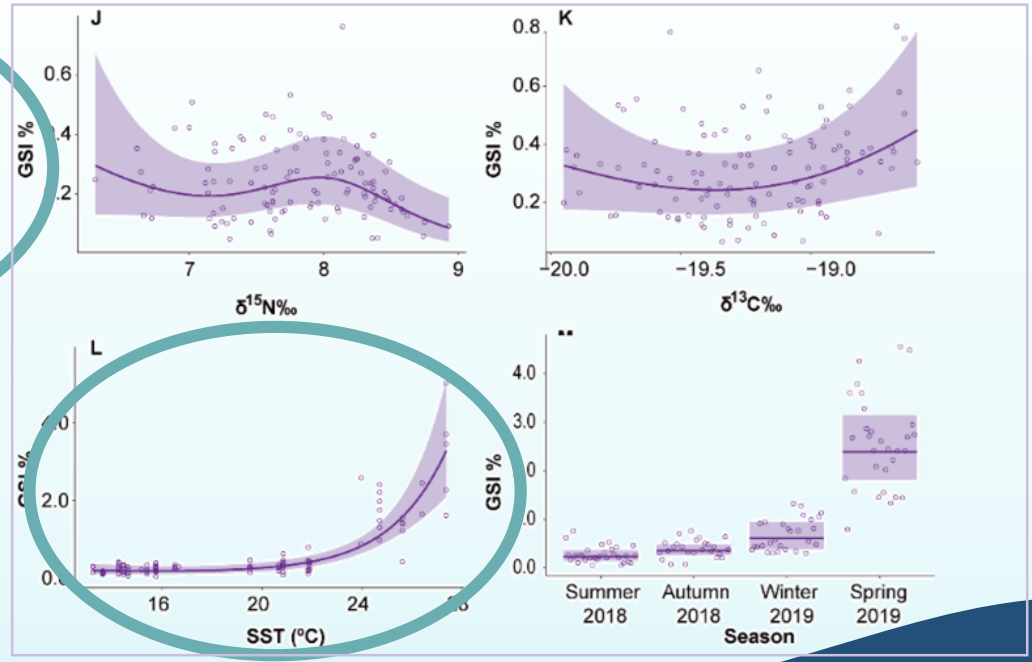
Anchovy

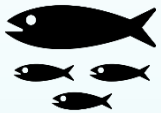
Kn





Fatmeter mean

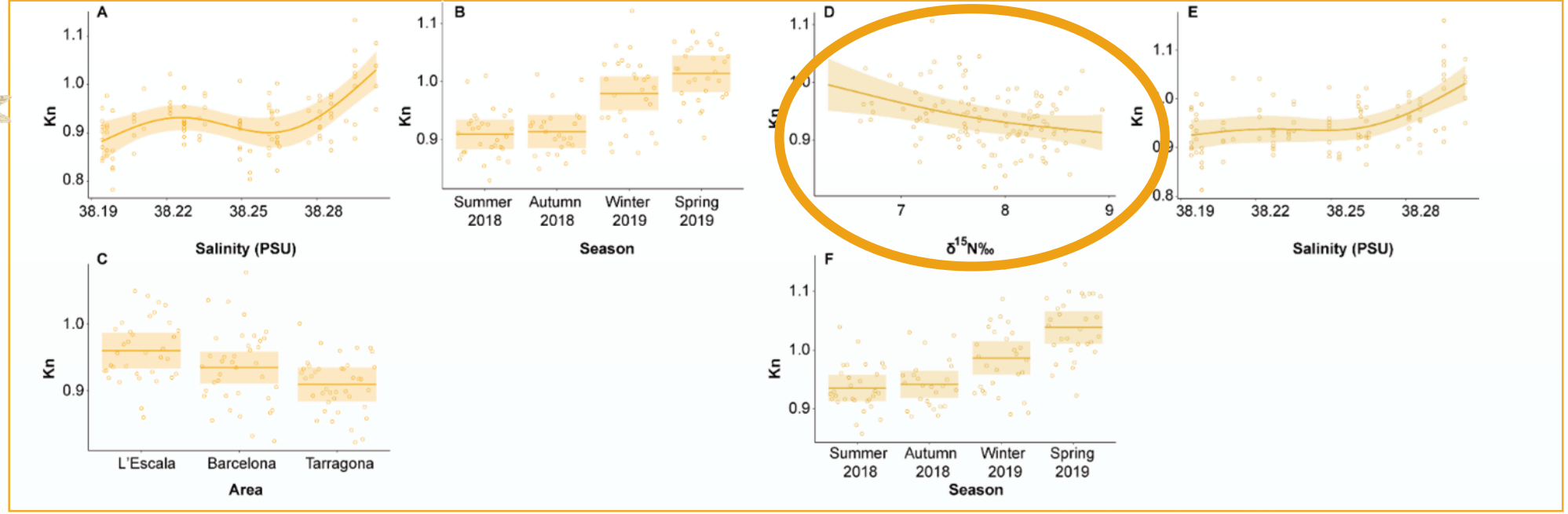


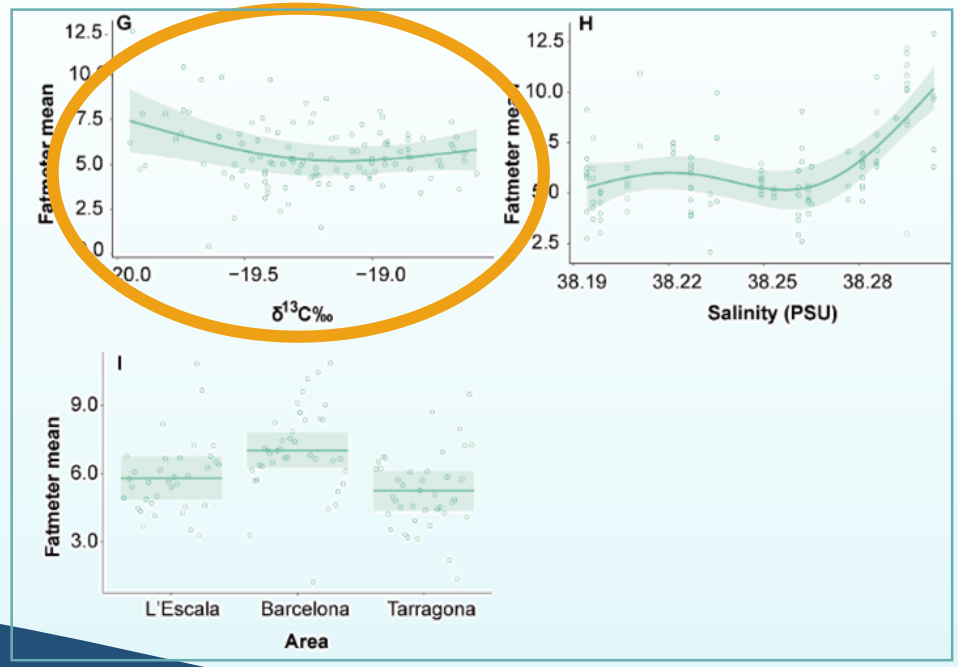


GSI

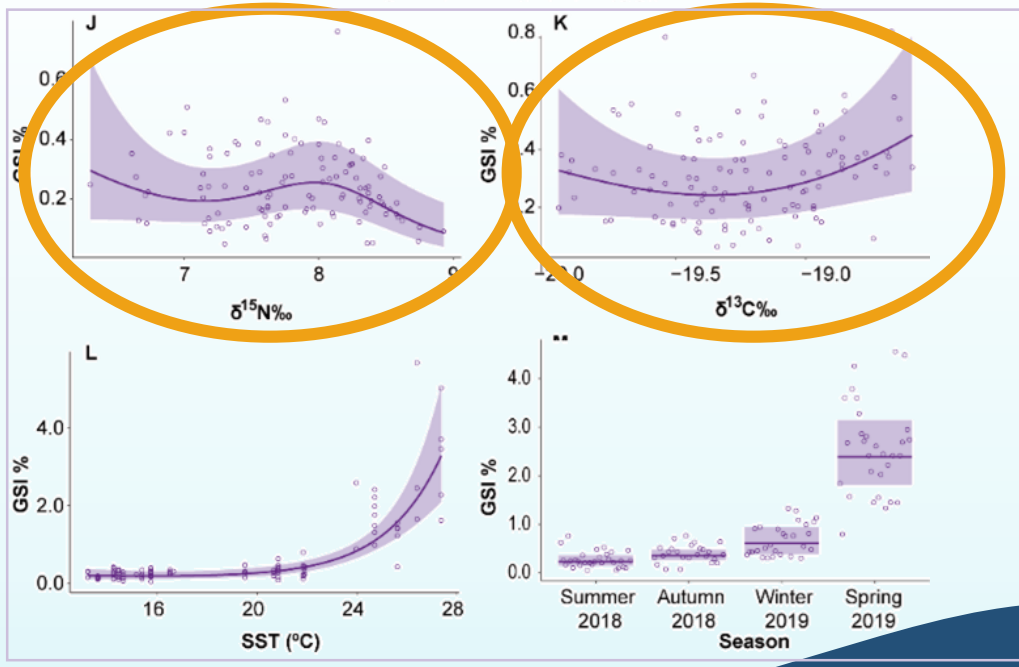
Anchovy

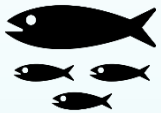
Kn





Fatmeter mean

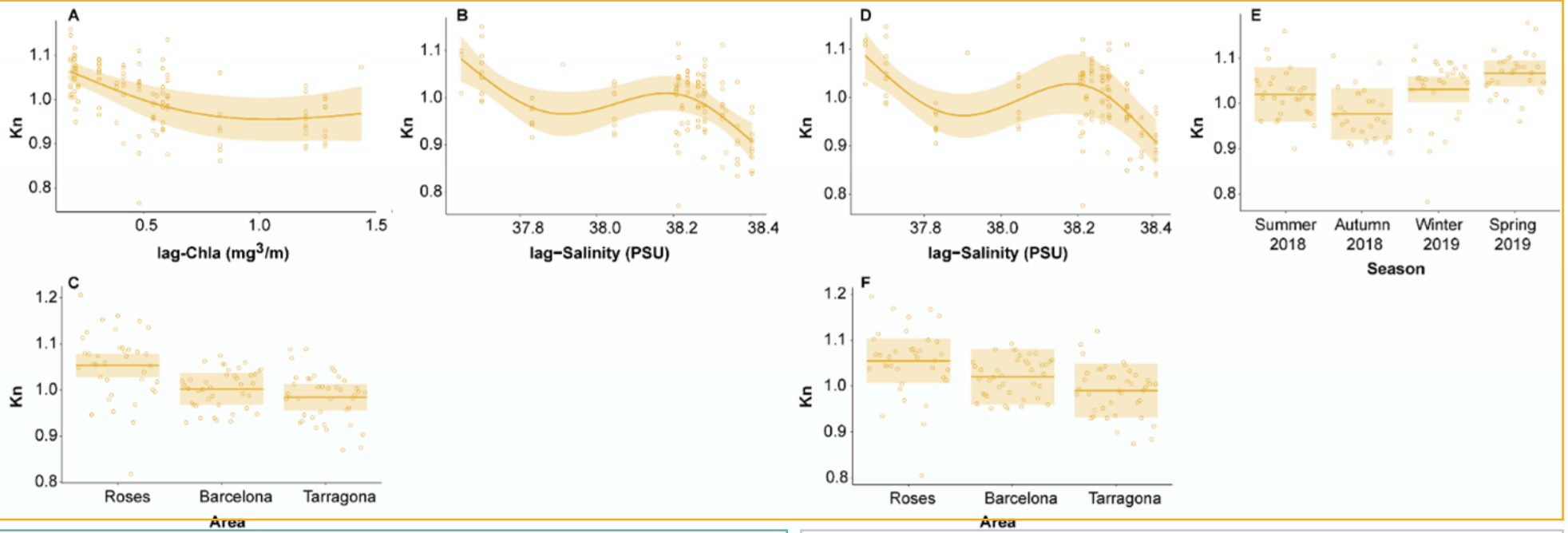




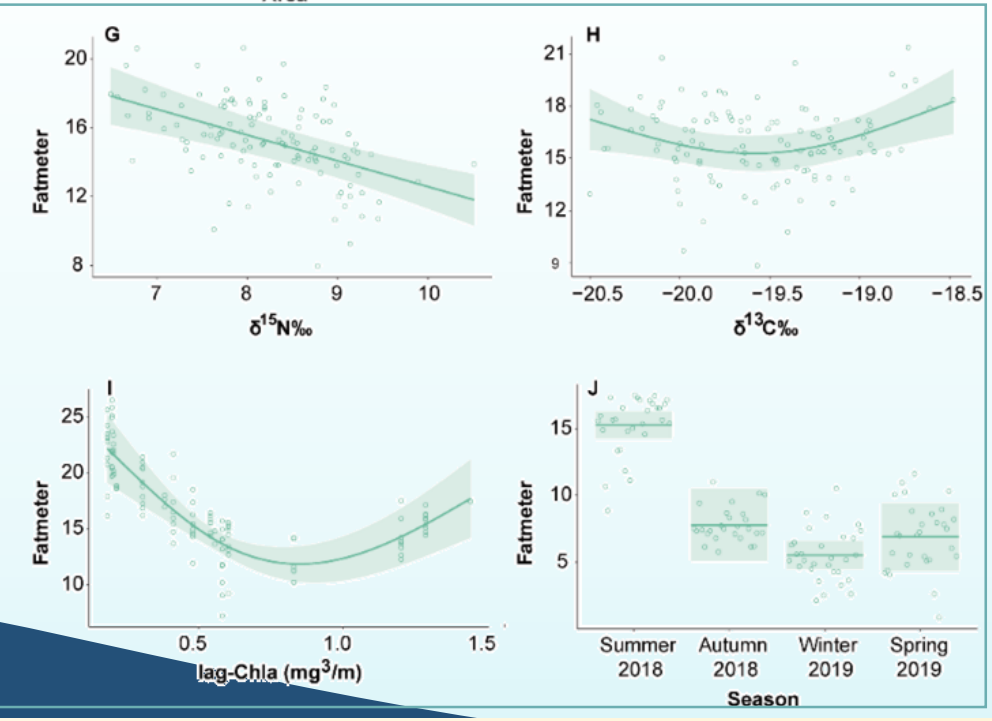
GSI

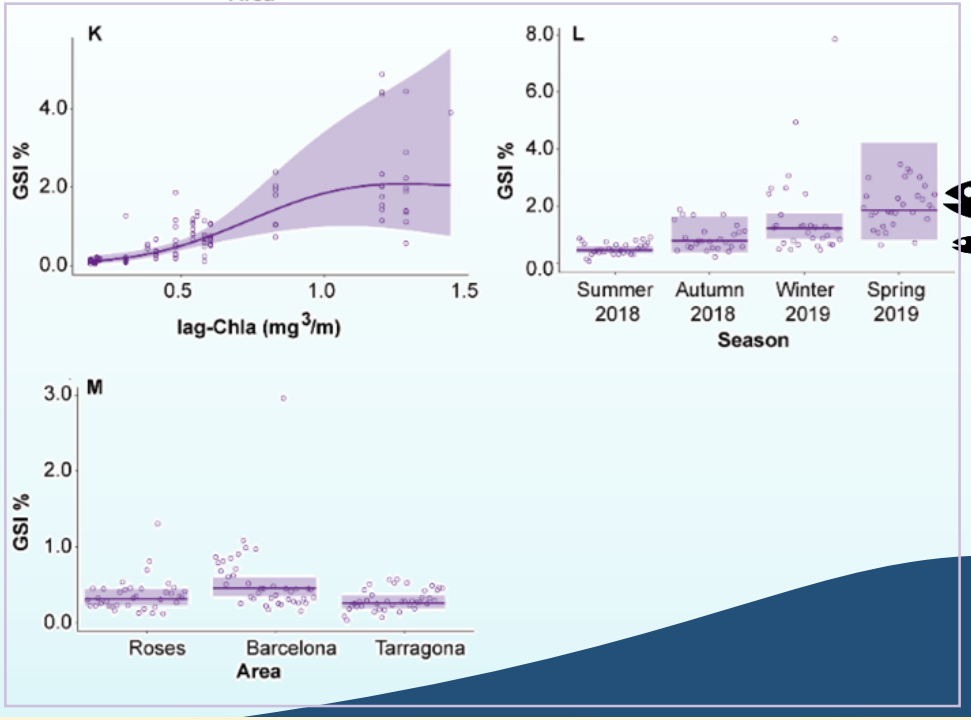
Sardine

Kn



Fatmeter mean

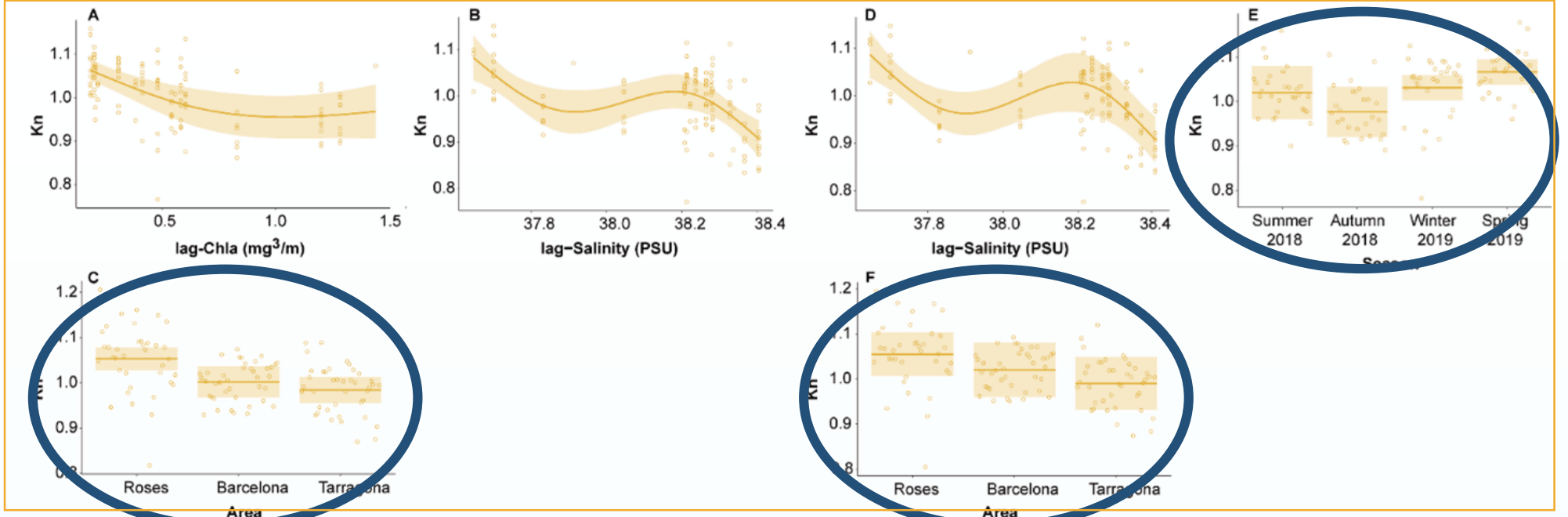




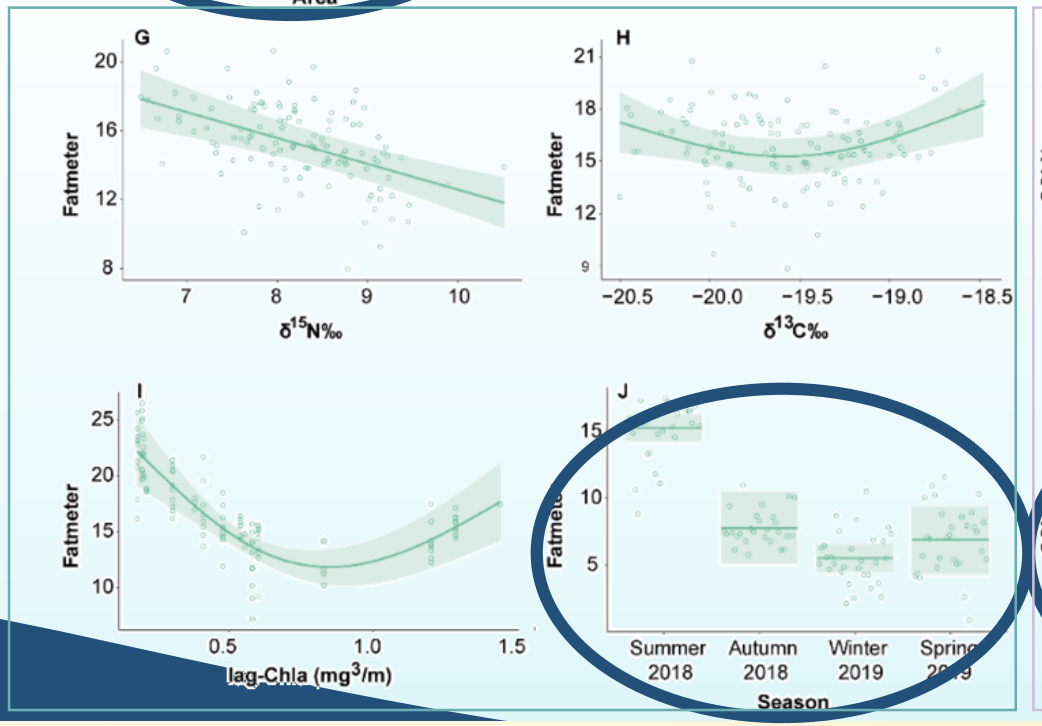
GSI

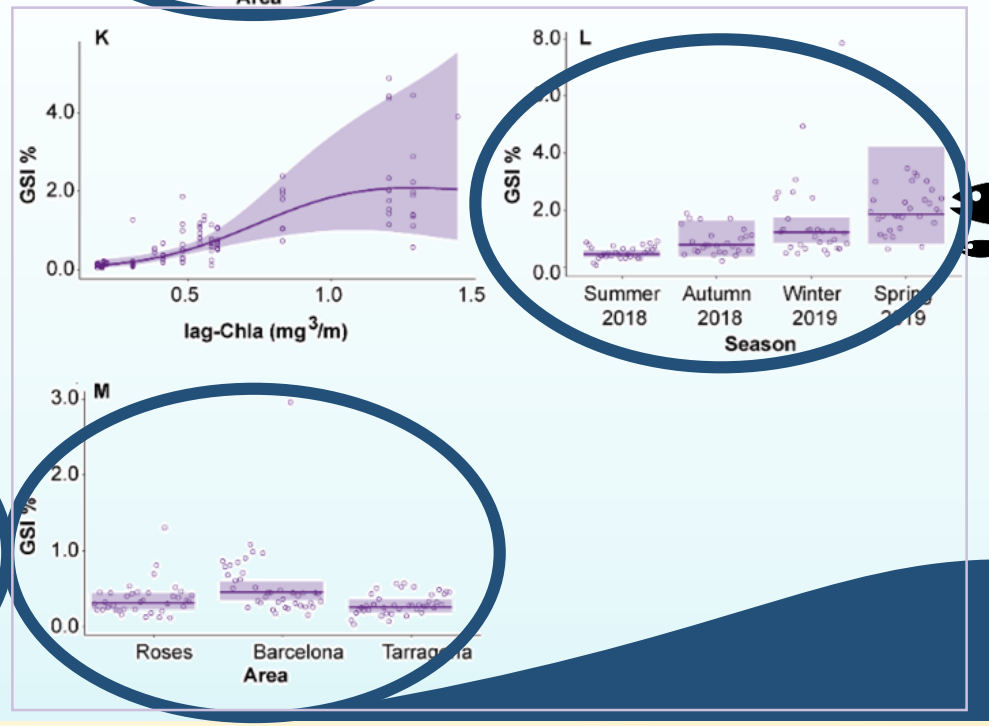
Sardine

Kn



Fatmeter mean

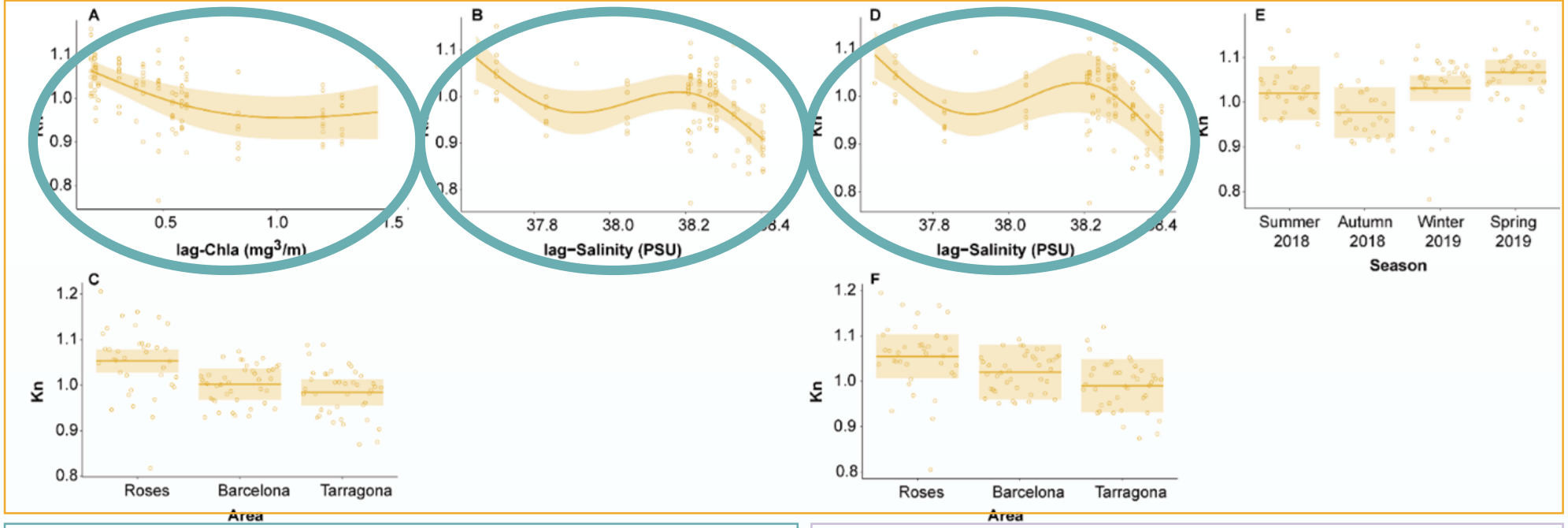




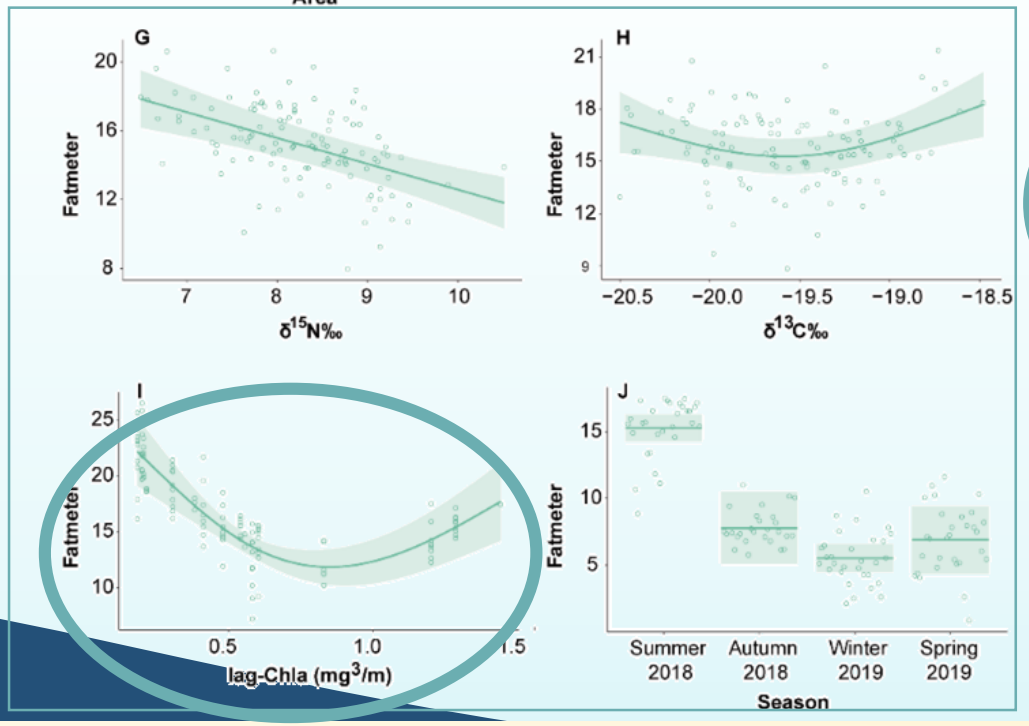
GSI

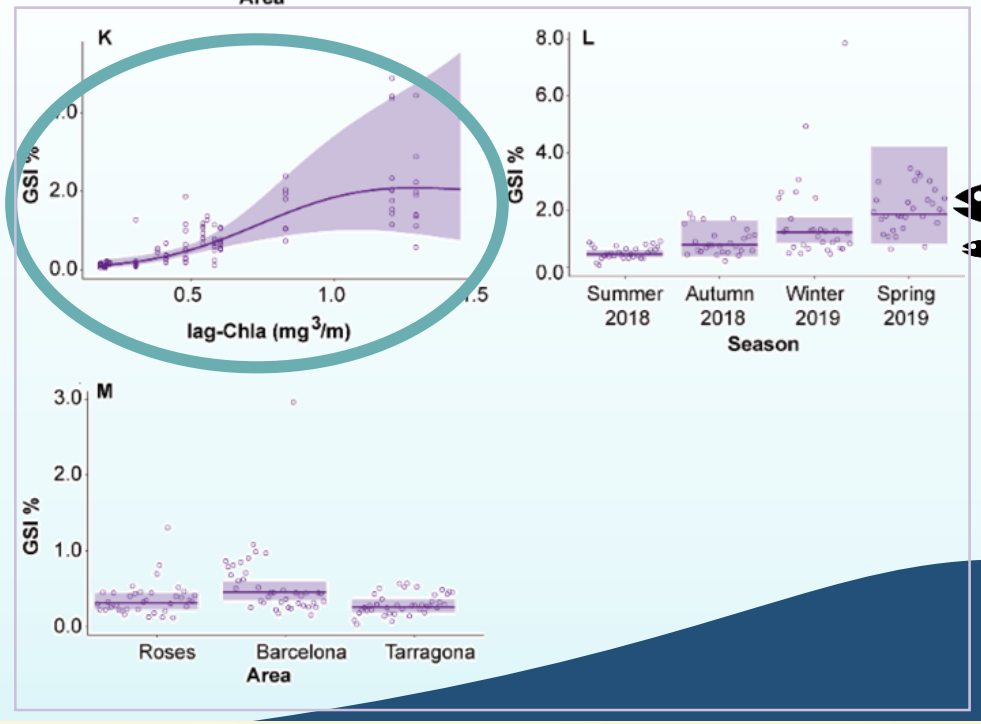
Sardine

Kn



Fatmeter mean

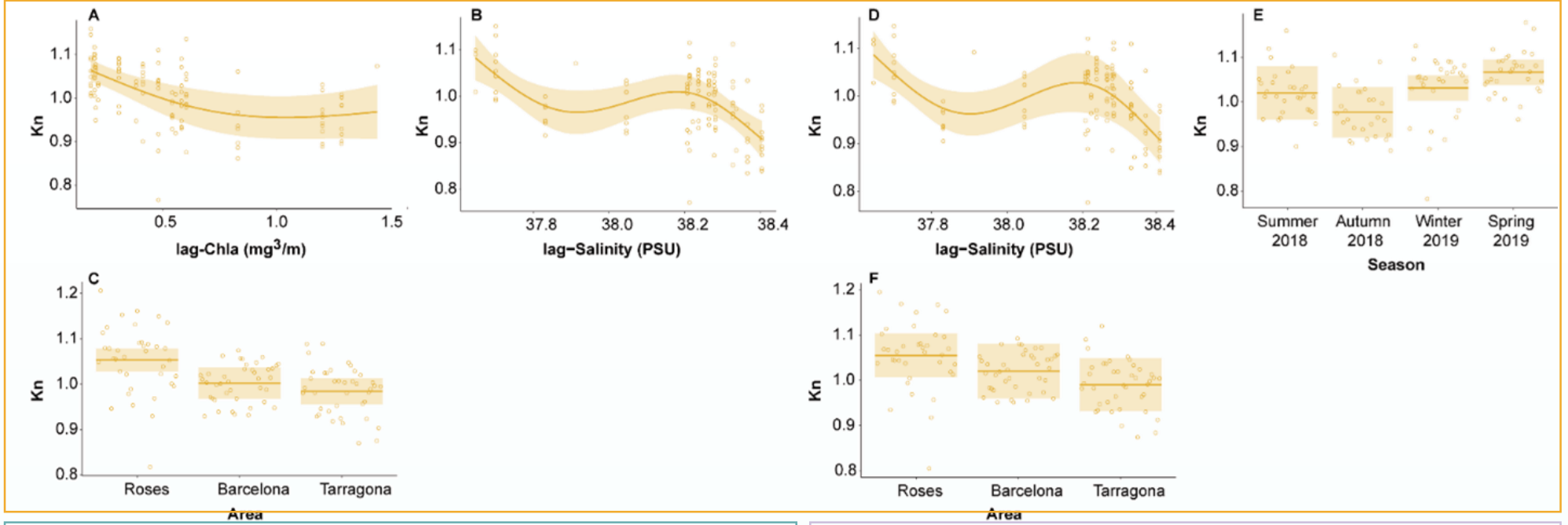




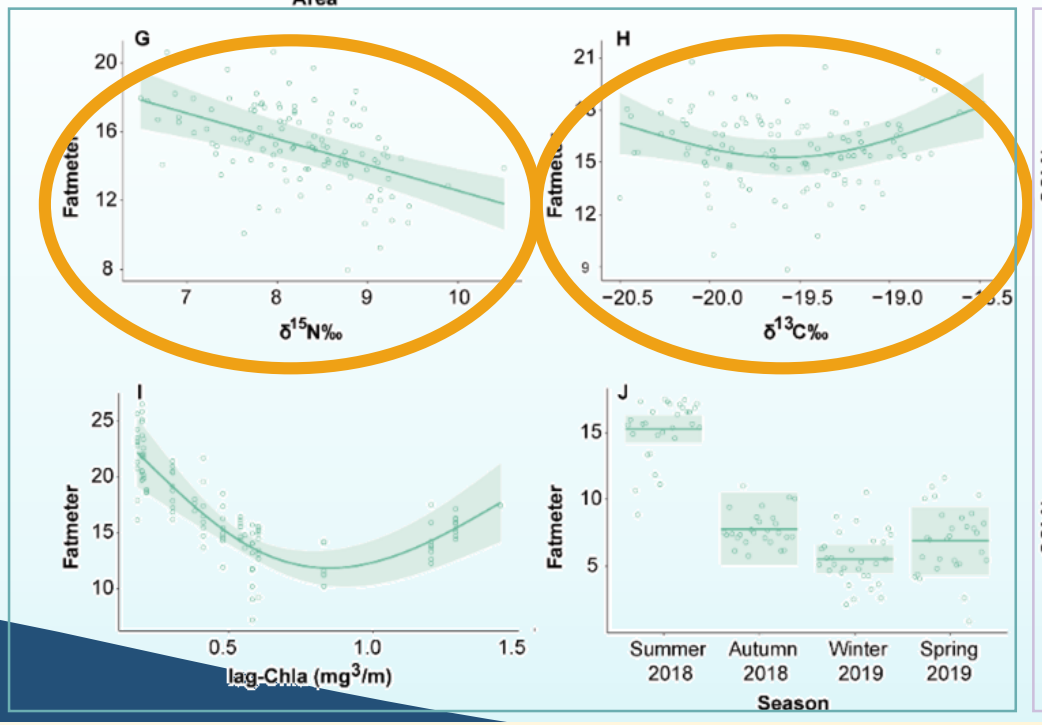
GSI

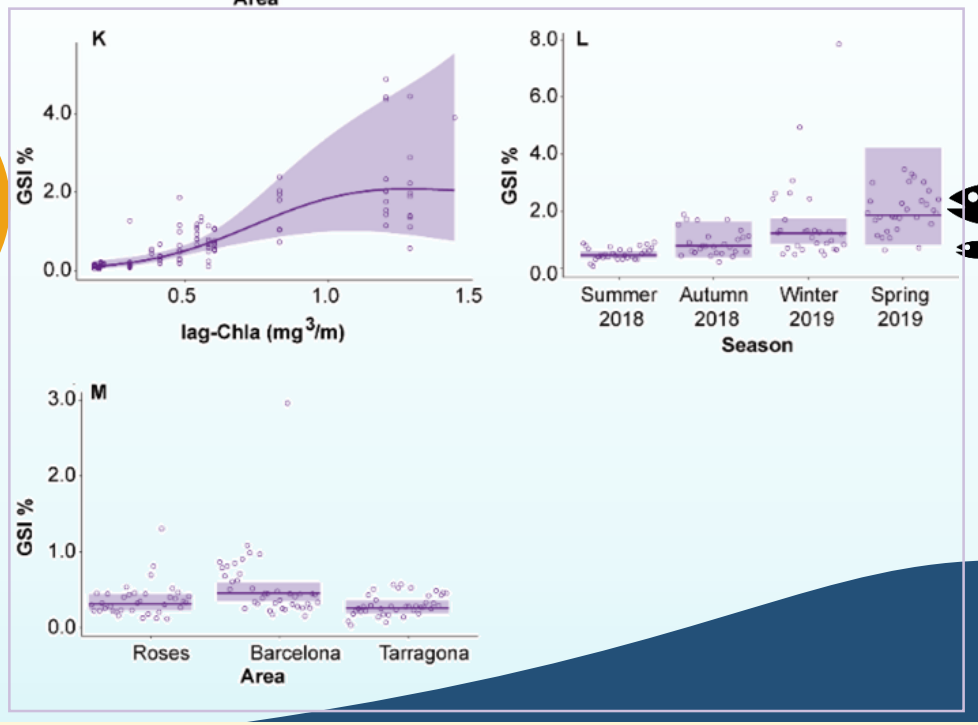
Sardine

Kn



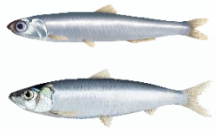
Fatmeter mean





GSI

Discussion



- ✓ **Spatial and temporal variations in fitness indexes**
- ✓ Lower fat reserves at the end of the reproductive period
- ✓ Higher and longer-lasting fat reserves in Barcelona
  - ✓ → **river influence ?**
- ✓ **Regional variations but not always latitudinal**
  - ✓ local scale processes

Discussion

✓Spatial and temporal variations in fitness indexes

✓Lower fat reserves at the end of the reproductive period

✓Higher and longer-lasting fat reserves in Barcelona

- ✓ → **river influence ?**

✓**Regional variations but not always latitudinal**

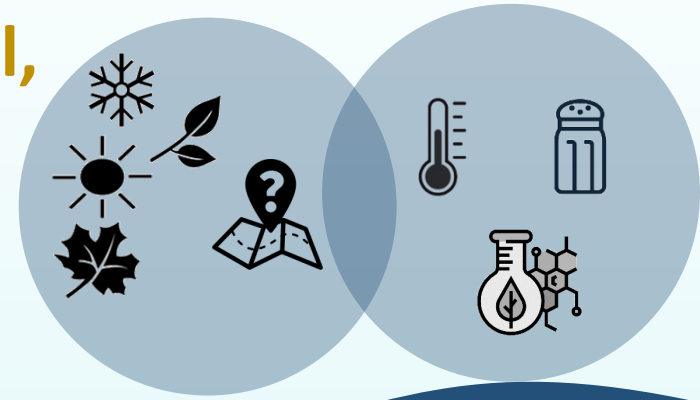
✓local scale processes

✓Energetic indexes explained by environmental, spatial and seasonal factors

✓Concurrent variables

✓Lagged variables

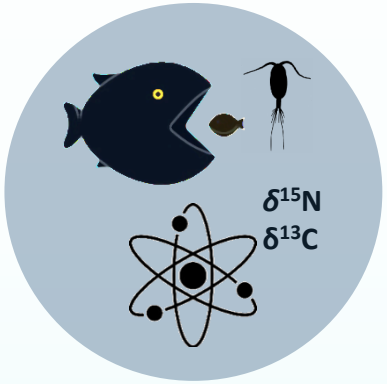
✓Importance of the accumulation of resources before reproduction



Discussion

✓Spatial and temporal variations in isotopic values

- ✓Both species rely on **planktivorous** diet but have **intra annual-variations**
- ✓**Latitudinal pattern** in $\delta^{15}N$



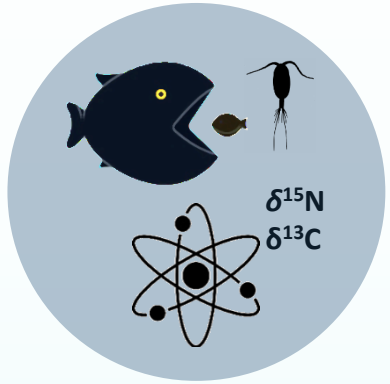
Discussion

✓Spatial and temporal variations in isotopic values

- ✓Both species rely on **planktivorous** diet but have **intra annual-variations**
- ✓**Latitudinal pattern** in $\delta^{15}N$

✓Trophic variables also explained the observations

- ✓**Correlation between diet and fitness→ Bottom-Up**
- ✓Trophic variables were more important for **anchovy**
- ✓**Effect of $\delta^{15}N$**
  - ✓**Isotopic signatures are not always necessarily a representation of the energetic content of the prey**
- ✓The changes in river discharge and other anthropogenic factor may have impacted the quality of plankton



Take-home messages

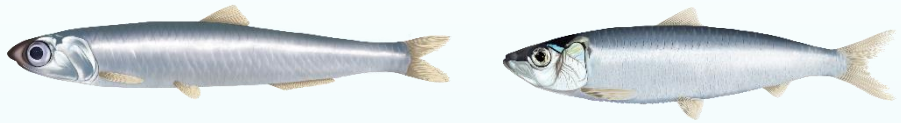
- ✓Importance of looking at spatio-seasonal factors at local scale to better understand regional differences.
- ✓In addition to environmental variables, trophic variables also contributed to explain observations **showing that variation in prey abundance, composition and quality can impact their fitness**.
- ✓Results underline the potential vulnerability of SPF to local spatio-temporal environmental changes.

Aknowledgements

- E.L.-L.was supported by a **FPU grant** (FPU1704395, Spanish Ministry of Education associated).
- J.N. was supported by the Spanish National Program Ramón y Cajal (RYC-2015-17809).
- This study is a contribution to the **PELWEB project** (“Winners, losers and shifts of PELagic food WEB changes in the western Mediterranean Sea: from ecosystem consequences to future projections”, CTM2017-88939-R, 2018-2020) and **PELCAT** (CAT 152CAT00013, TAIS ARP059/19/00005.
- We thank all the graduate and undergraduate students who participated in the samples and data collection of the PELWEB project: **Elena Fernández-Corredor, Mariona Garriga** and **Sara Gerez**.
- We acknowledge the ‘Severo Ochoa Centre of Excellence’ accreditation (CEX2019-000928-S) to the Institute of Marine Science (ICM-CSIC).

- Illustrations of anchovy and sardina are credit of **Amparo Hidalgo**

ahg_ilustración / https://amparoh.com/



*****Infographics and icons for the presentation are credit of:

https://www.cleanpng.com/
phylopic.org/
https://www.shutterstock.com/
https://adioma.com
https://www.uclipart.com//
https://pixabay.com/vectors/workout-icons-fitness-weight-lifting-5497868/
https://es.m.wikipedia.org/wiki/
https://www.visualpharm.com/free-icons/bacteria-595b40b65ba036ed117d17da

Thank you for listening!

For further questions and comments please contact:

elloret@icm.csic.es

@ElenaLloret3

Contents lists available at ScienceDirect

Progress in Oceanography

journal homepage: www.elsevier.com/locate/pocean

Small pelagic fish fitness relates to local environmental conditions and trophic variables

E. Lloret-Lloret [a,b,*], M. Albo-Puigserver [a,c], J. Giménez [a], J. Navarro [a], M.G. Pennino [d], J. Steenbeek [e], J.M. Bellido [f], M. Coll [a,e]