

# From fine-scale spatial growth to regional perspective: understanding small pelagic fish dynamics in the NW Mediterranean

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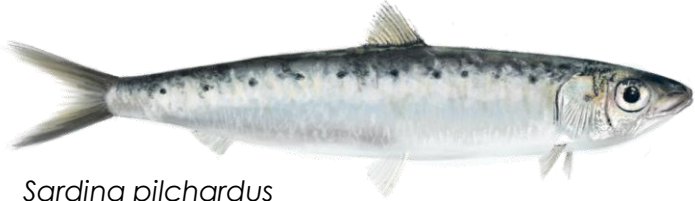


*Sardina pilchardus*



*Engraulis encrasicolus*

# 1. Introduction



*Sardina pilchardus*



*Engraulis encrasicolus*



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Sea temperature shapes differences in European sardine (*Sardina pilchardus*) growth in two adjacent areas in the NW Mediterranean Sea

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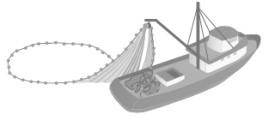
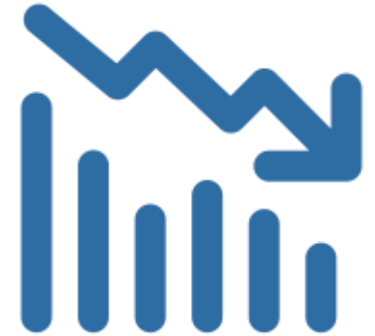
<https://doi.org/10.1016/j.marenvres.2025.107396>

(ongoing work)

## Current situation of small pelagic fish in the NW Mediterranean

Strong decline in biomass, closely linked to reduced individual growth over the past two decades → major socioeconomic consequences

Several hypothesis:



**Fishing pressure** → would not explain this decline → size shift occurred under moderate exploitation, and biomass remained low even after fishing activity ceased in 2010 in the Gulf of Lions



**Top-down** control linked to predator recovery → ruled out



(Van Beveren et al., 2017 )



**Competition** among pelagic species (e.g. *Sardinella aurita*, Jellyfish blooms).

(Albo-Puigserver et al., 2017; Tilves et al., 2018 )



**Bottom-up** control → the most accepted, but direct evidence is still lacking.

(Brosset et al., 2016; Saraux et al., 2019; Garcia et al., 2023; Menu et al., 2023)



## Life cycle of the species in the Mediterranean

Fish growth is driven by both extrinsic and intrinsic factors

Contrasted life-history strategies:

### Sardine:

Capital breeder

Reproduction in winter

Rebuilding energy reserves in spring-summer

### Anchovy:

Income breeder

Reproduction in spring and summer



*Sardina pilchardus*

Reproduction

Reproduction



Phytoplankton bloom



*Engraulis encrasicolus*

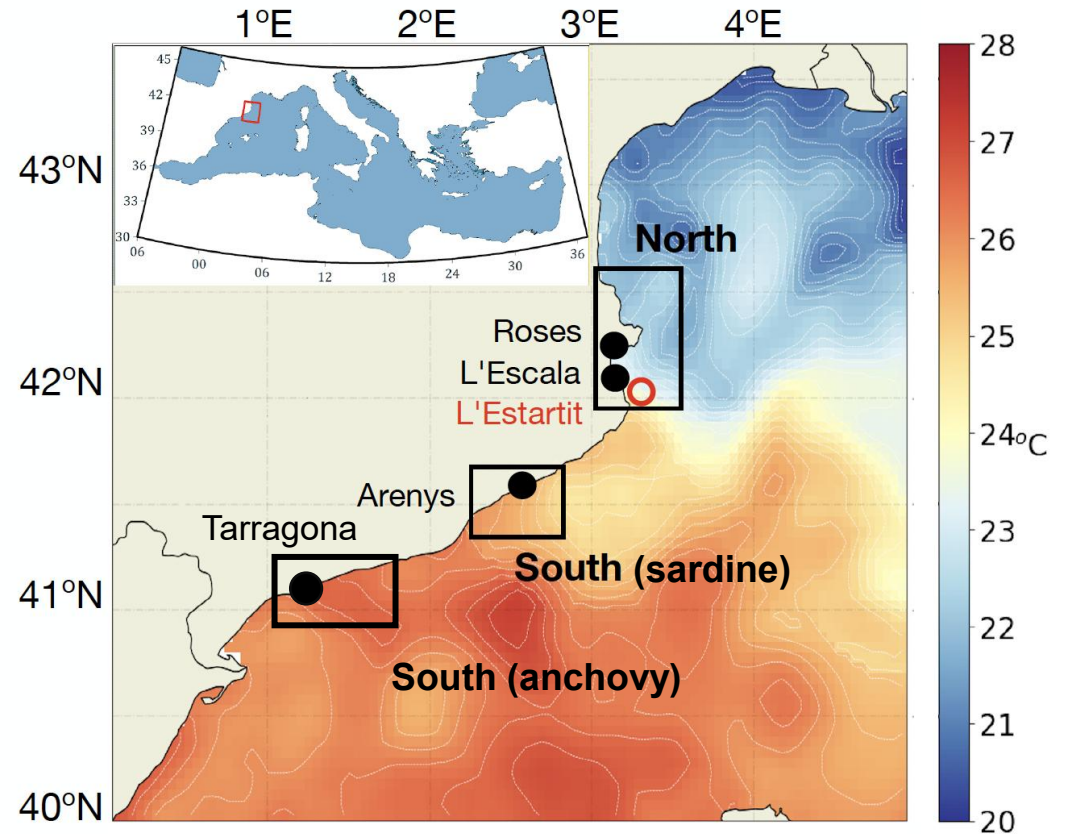


Reproduction

Phytoplankton bloom

# Aim

1. To assess the **growth performance** of sardine and anchovy **in two nearby areas**, under similar fisheries management but different environmental conditions.
2. To evaluate the **role of** sea surface **temperature** and **chlorophyll-a** (proxy for primary production) and the **biological traits of species** (age at first maturity, spawning period and body condition).
3. To analyse **long-term environmental trends** to shed light on the underlying causes of the small pelagics decline in the NW Mediterranean.

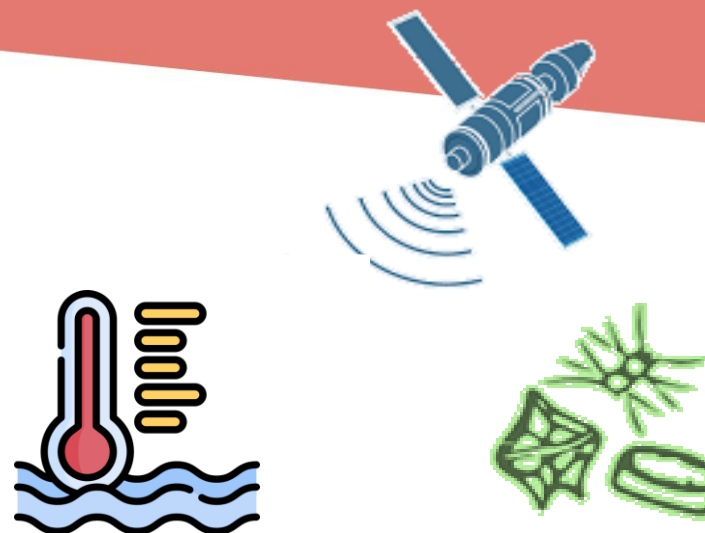


## 2. Materials and methods

### To characterise the environment

- combining satellite-derived sea surface temperature and chlorophyll-a with long-term *in situ* temperature records.

<http://www.meteoestartit.cat>



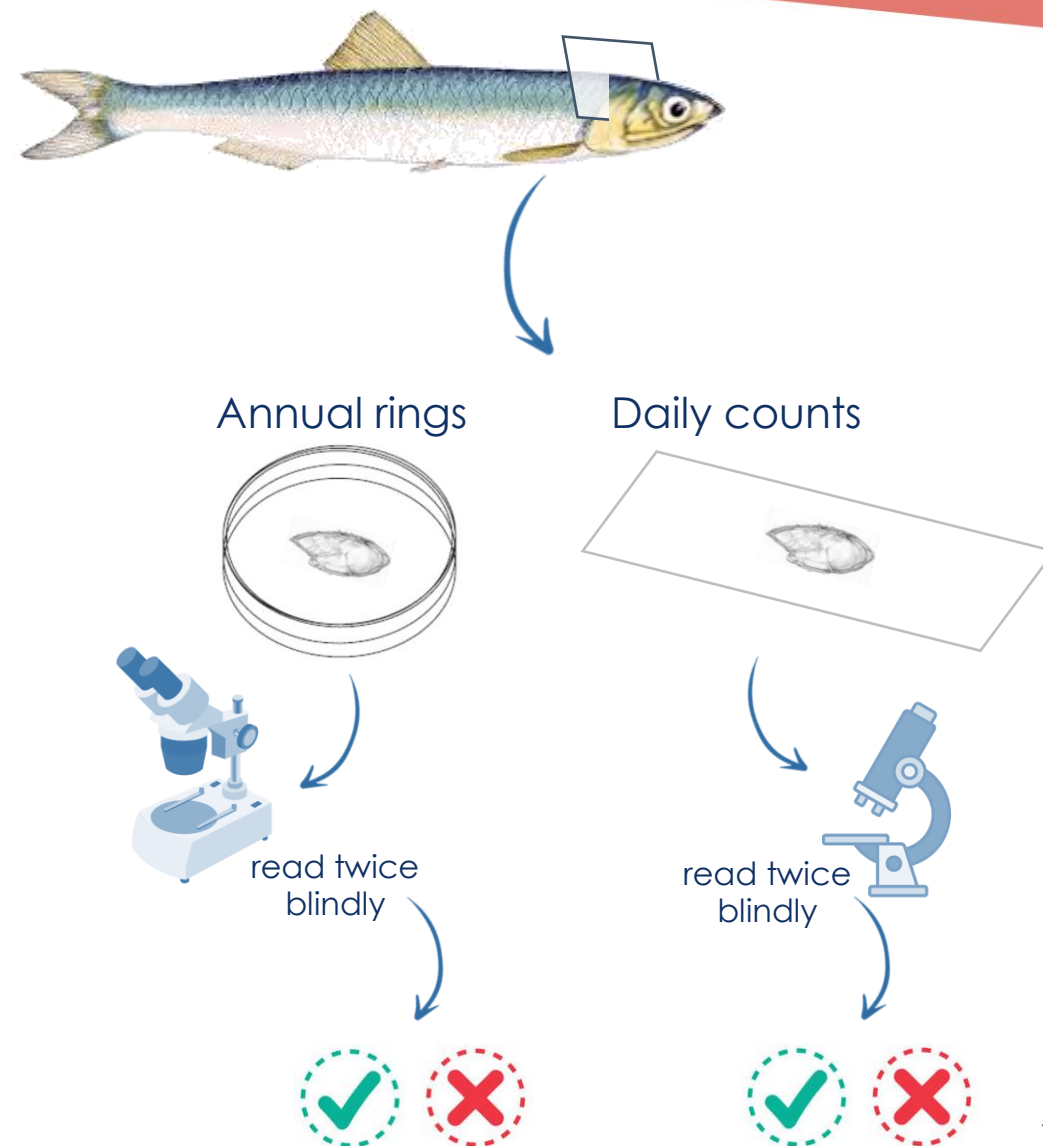
### Fish sampling

- Fish were extensively sampled in both areas. We measured size, weight and gonad weight:
  - GSI
  - Le Cren / Fulton's condition index

	<b>Sardine</b>	<b>Anchovy</b>
Sampling period	Oct 2016 – Oct 2018	Jan 2022– Mar 2023
Measured (n)	7887	4519
Biologic analysis (n)	2573	2661
Growth analysis (n)	1323	2403

### Fish growth

- Right sagitta was analysed
- Each otolith was read twice blindly by the same experienced reader
- Age was determined following reference protocols  
(Carbonara and Follesa, 2019)
- Measures:
  - Otolith size
  - Number of translucent rings → check identification
  - Daily readings in young individuals
  - Otolith edge condition → to determine the periodicity and timing of ring formation



### 3. Results and discussion

#### Growth timing

Based on otolith margins:

#### Sardine

growth in spring and summer

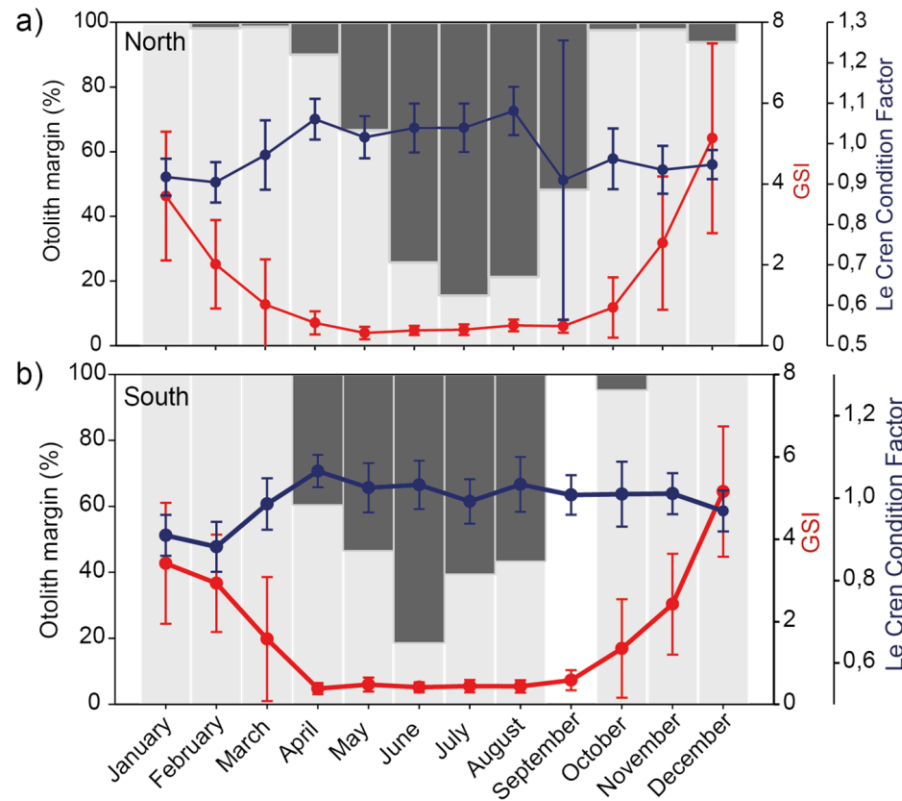
#### Anchovy

growth mainly in early spring, but:

→ N : secondary growth phase in autumn

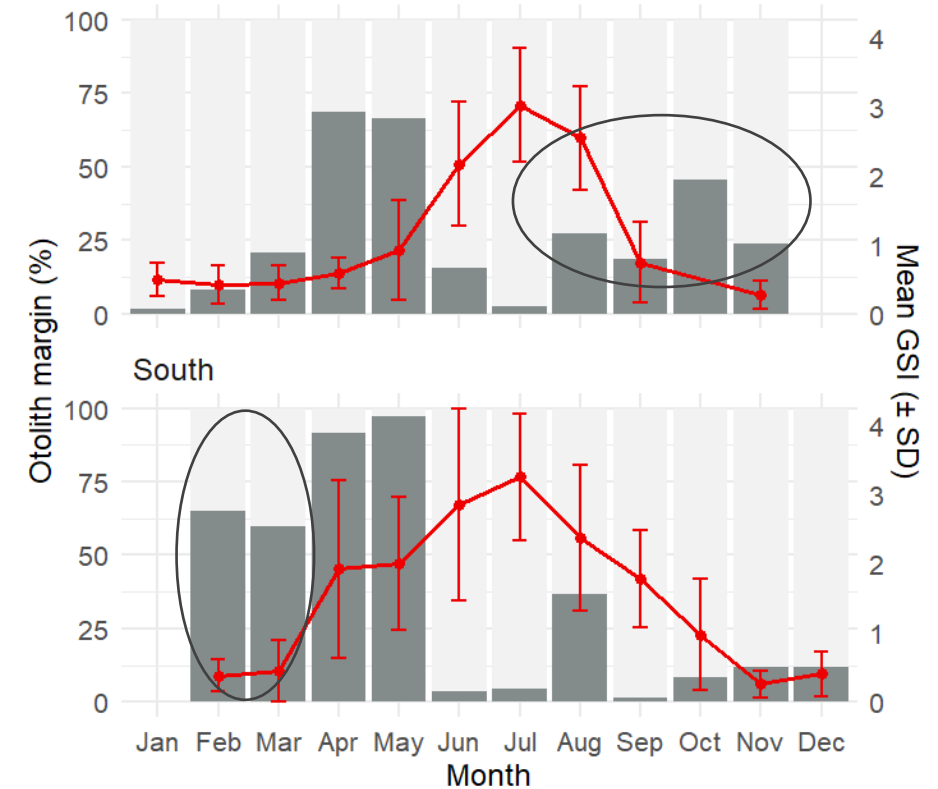
→ S: start earlier, February and March

#### Sardine



#### Anchovy

##### North



## Growth performance

In the south, both species reach larger sizes at age than in the north

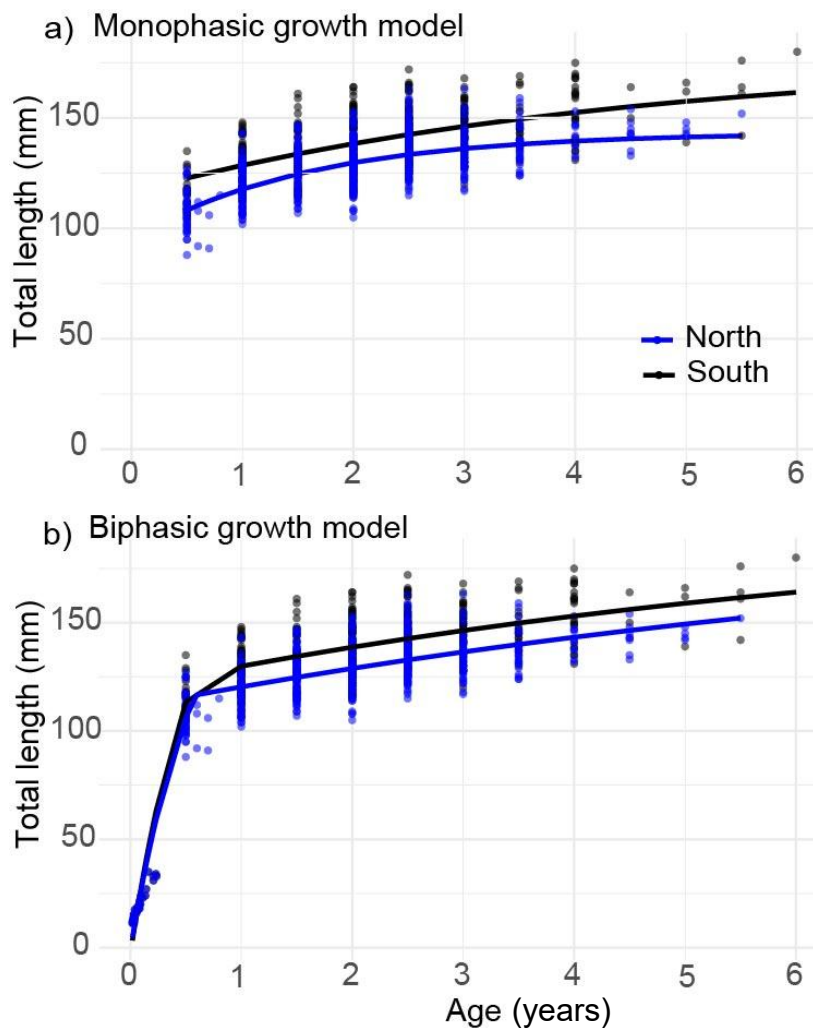
### key messages

- Differences are established within the first year of life → importance of early life stages when estimating growth.

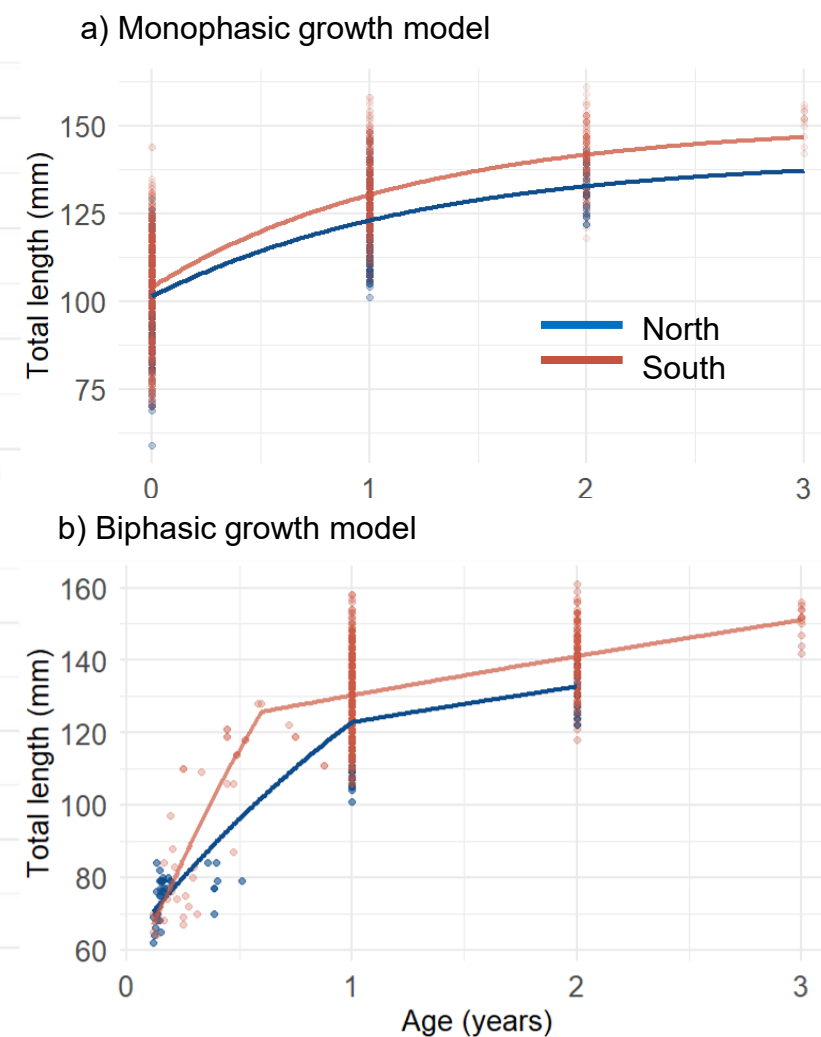
-Sardine reaches older ages than anchovy, consistent with previous works.

(Morales-Nin and Pertierra, 1990, Ventero et al., 2017)

### Sardine



### Anchovy



## Other biological traits

$L_{50}$  is attained within the first year of life in both species and areas

### Sardine

	$L_{50}$
N	<10,4*
S	<10,4*

### Anchovy

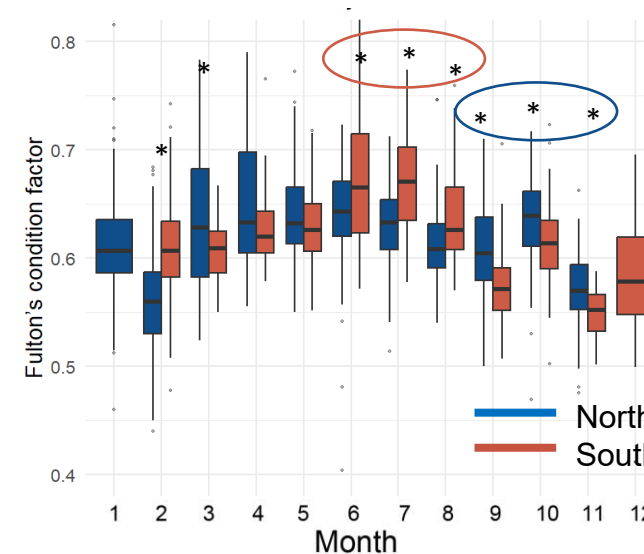
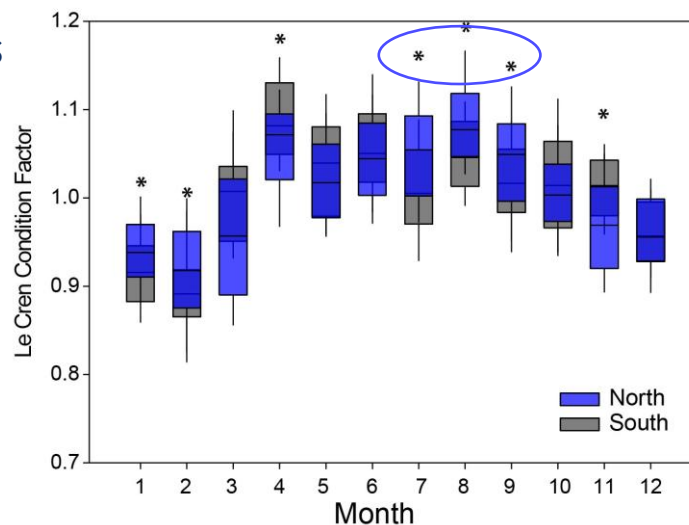
	$L_{50}$
N	9,9
S	9

### Body Condition:

**Sardine** from the N has higher values in summer

**Anchovy** from the S has better condition from June-Aug, but lower in autumn

→ differences in growth are not explained by condition



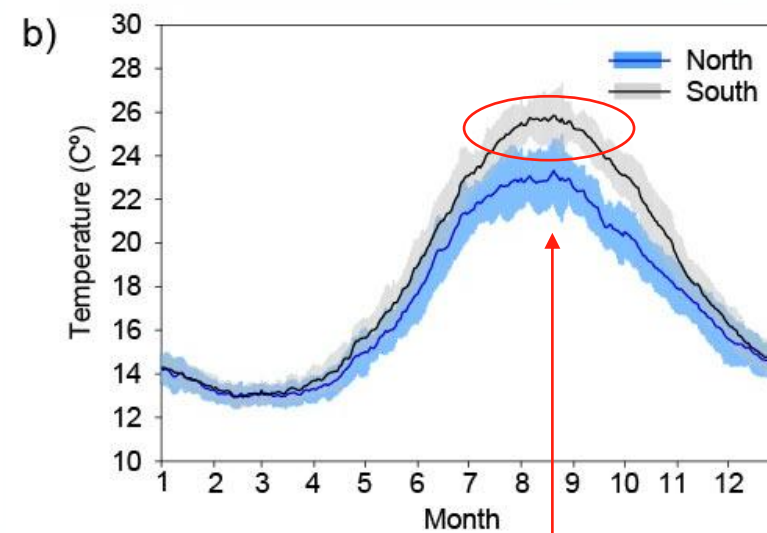
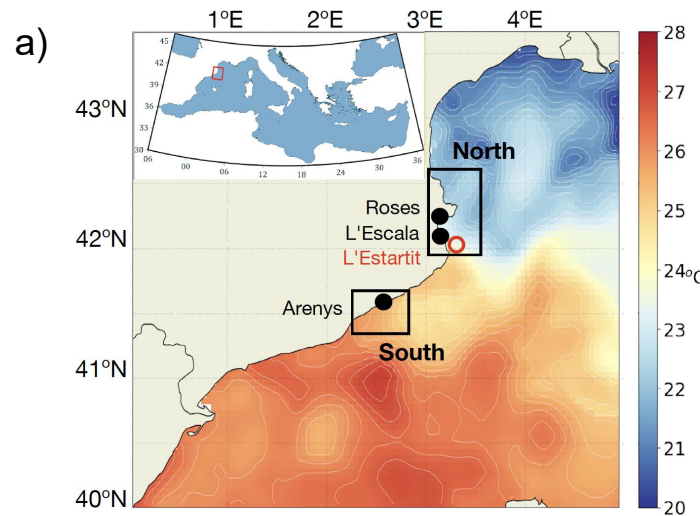
**Overall, since intrinsic traits appear similar, the growth differences are most likely driven by environmental conditions**

## Environmental context

### Sea Surface Temperature

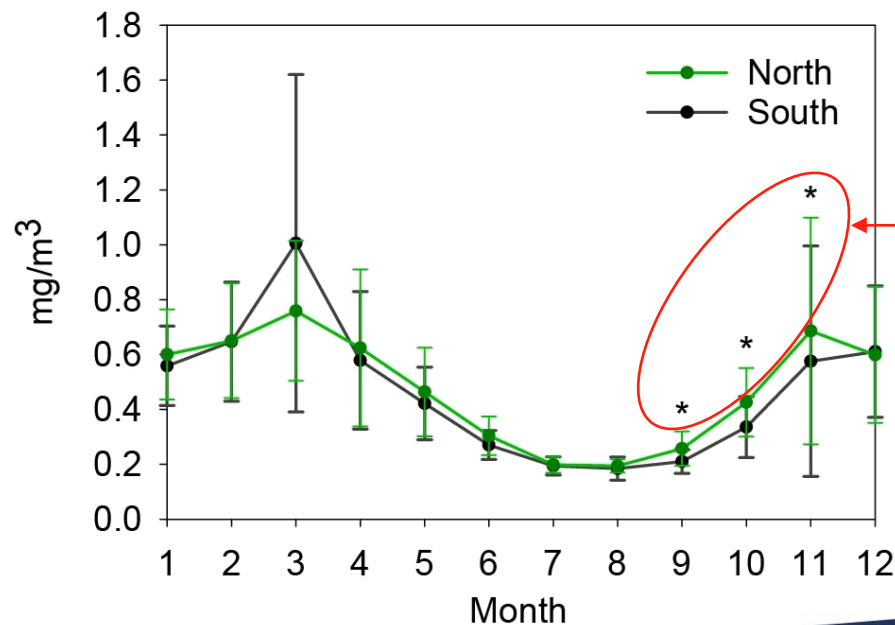
North is colder than the South, especially during spring and summer  
 → marked thermal front

(López-García et al., 1994, Sabatés et al., 2018)



### Chlorophyll - a

Chlorophyll-a concentrations are similar, but late-summer/autumn values are higher in the north.



#### For sardine:

optimal growth temperatures for juvenile growth (24°C) attained for several months in the South

(Schismenou et al., 2016)

#### For anchovy:

the earlier increase in primary production in the north in autumn may explain the secondary growth peak in that period and the higher body condition

## So, what does this study tell us about the current small pelagics decline at the regional scale?

Both study areas belong to the same GFCM Geographical Sub-Area (GSA 6) used for stock assessment

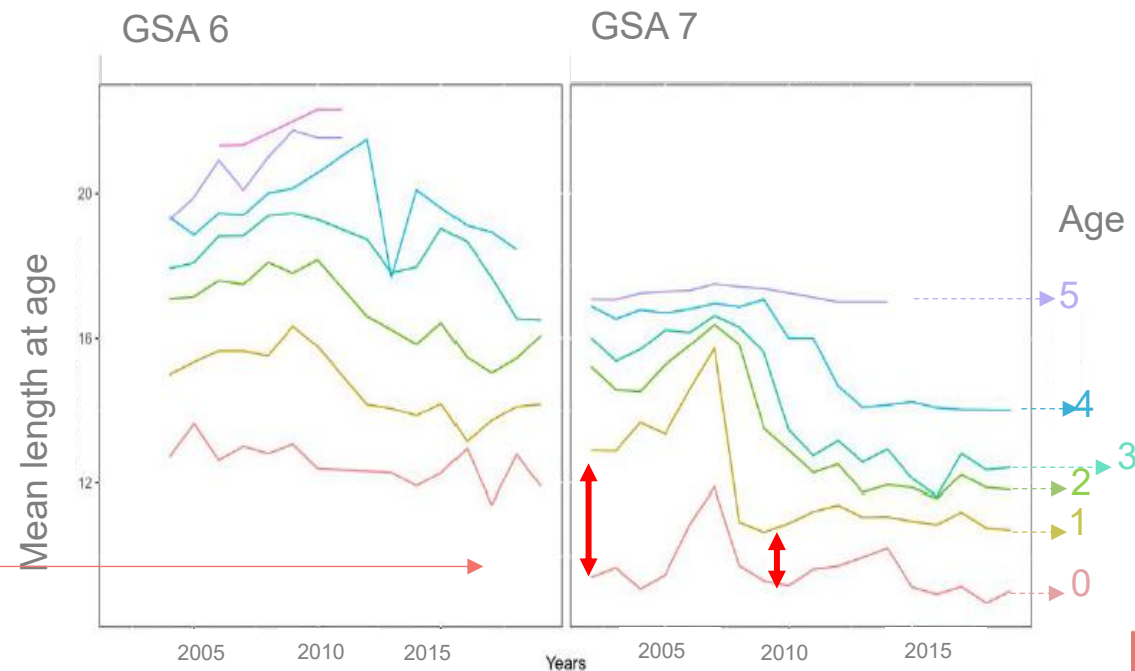
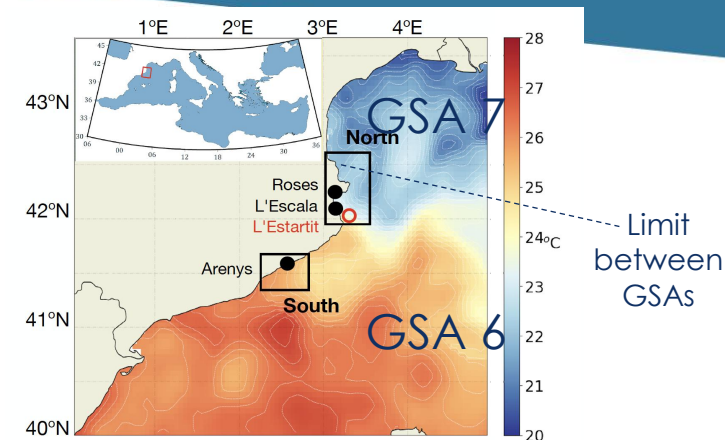
However, based on temperature and growth patterns observed:

North area its similar to GSA 7

South area represents the GSA 6

GFCM reports indicate that a marked decline in sardine growth occurred around 2008

going into to their results, this decline is caused by reduced growth between ages 0 and 1



## So, what does this study tell us about the current small pelagics decline at the regional scale?

In the 50's sardine maturation occurred between the 1<sup>st</sup> and 2<sup>nd</sup> year of life

(Lee, 1961; Aldebert and Tournier, 1967)

A shift in age at first maturity may have occurred around 2007/08

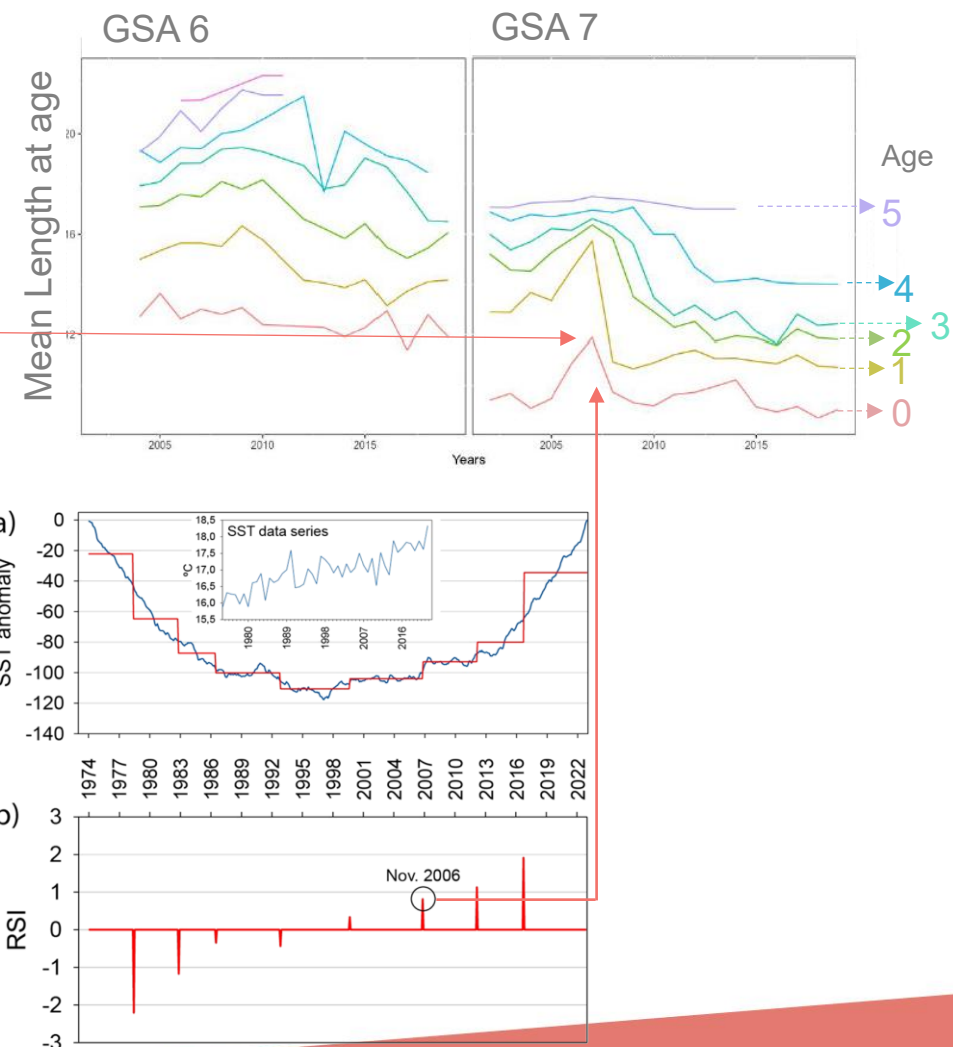
consistent with previously reported shift in size at maturity

(Brosset et al., 2016)

### Temperature regime shift analysis

The reduction in growth match a temperature regime shift detected in late 2006 and early 2007

Such abrupt change in growth has not been reported for GSA 6 → since 2002, sardine mature within 1<sup>st</sup> year



# So, what does this study tell us about the current small pelagics decline at the regional scale?

## Bottom-up hypothesis and primary production phenology

Time series evidences an overall decline in productivity, already reported in the NW Mediterranean (Nunes et al., 2018; Salgado-Hernanz et al., 2022)

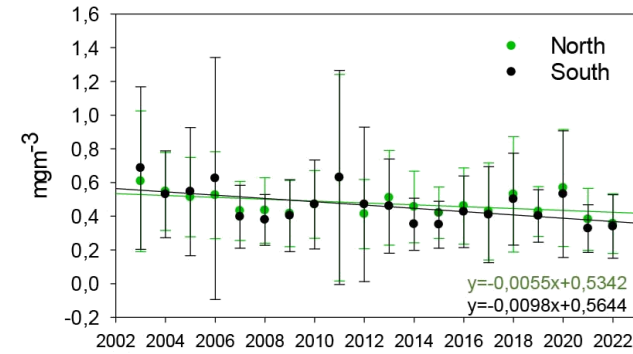
## But, what about phenology?

### Starting day of the productive period

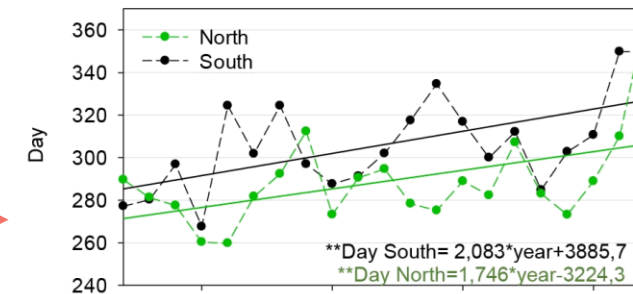
High-productivity conditions are now **starting** later in the year in both areas.

### Ending day of the productive period:

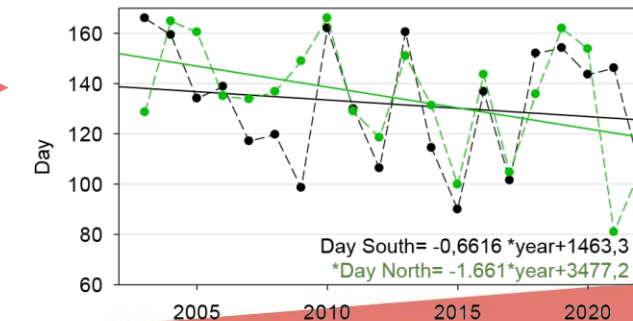
North area → productive period ends 1 months earlier  
 South area → no statistical trend



a) First day Chla > 0.4mgm<sup>-3</sup>



b) Last day Chla > 0.4mgm<sup>-3</sup>



Take-home message: to highlight the value of local studies, often undervalued, yet essential for uncovering processes that may be overlooked at broader spatial scales.

# Thank you very much!

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