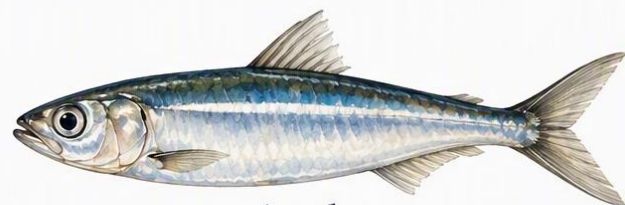


# Climate impact on Small pelagic fish

Guillem Chust

Head of Global Change in Marine Ecosystems

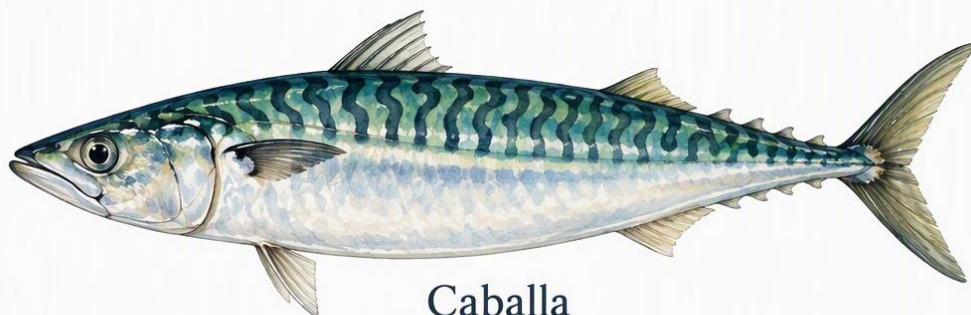
AZTI – Marine Research



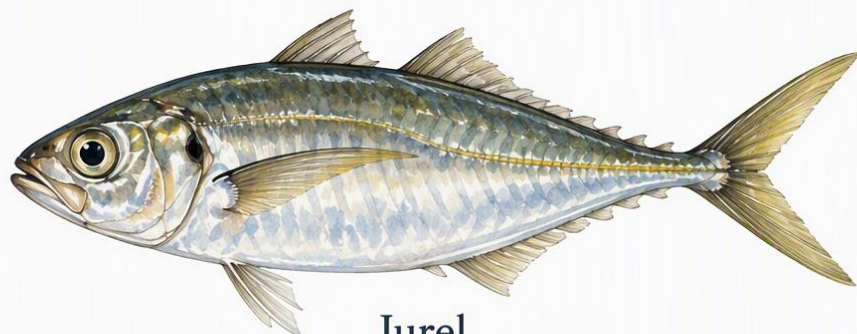
**Anchoa**  
(*Engraulis encrasicolus*)



**Sardina**  
(*Sardina pilchardus*)



**Caballa**  
(*Scomber scombrus*)



**Jurel**  
(*Trachurus trachurus*)

Image generated with Copilot



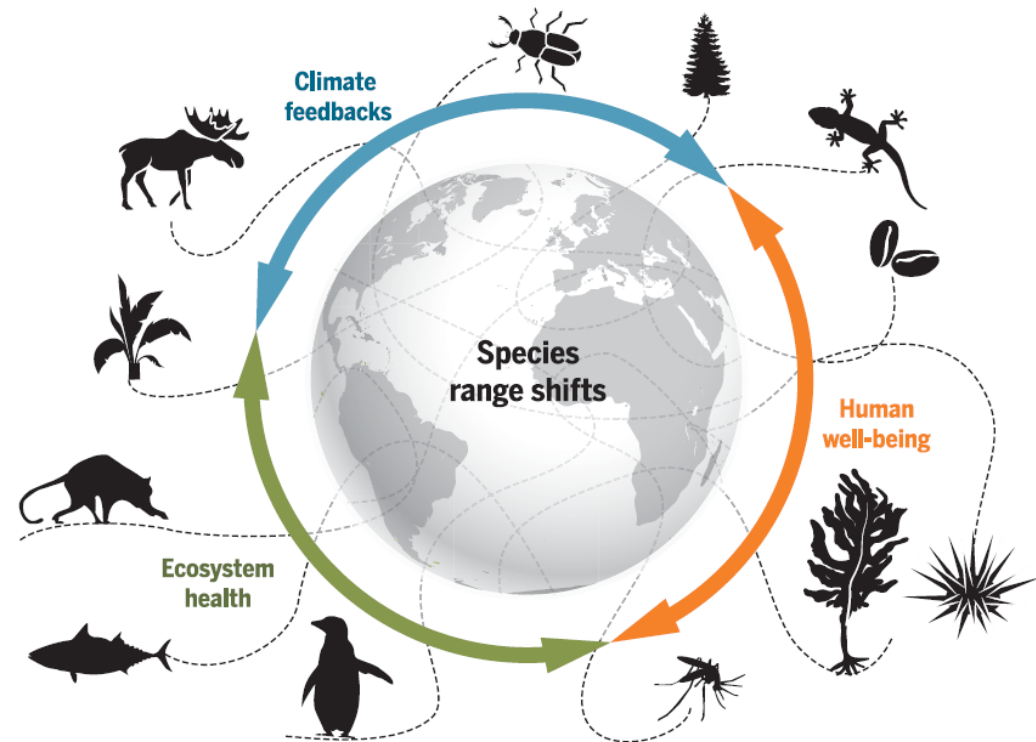
Réunion du Groupe de Travail des espèces  
pélagiques et ICCAT

13 octobre 2026 – Faro/ En ligne

# How global warming will affect marine biodiversity and resources?

- ☐ Warmer
- ☐ Less alkaline
- ☐ Fresher
- ☐ Deoxygenation
- ☐ More stratified
- ☐ Changes in Primary production
  - ☐ Regionalised
- ☐ Sea level rise
- ☐ Extremes
  - ☐ Regionalised
- ☐ ...

Global climate change is redistributing life on Earth

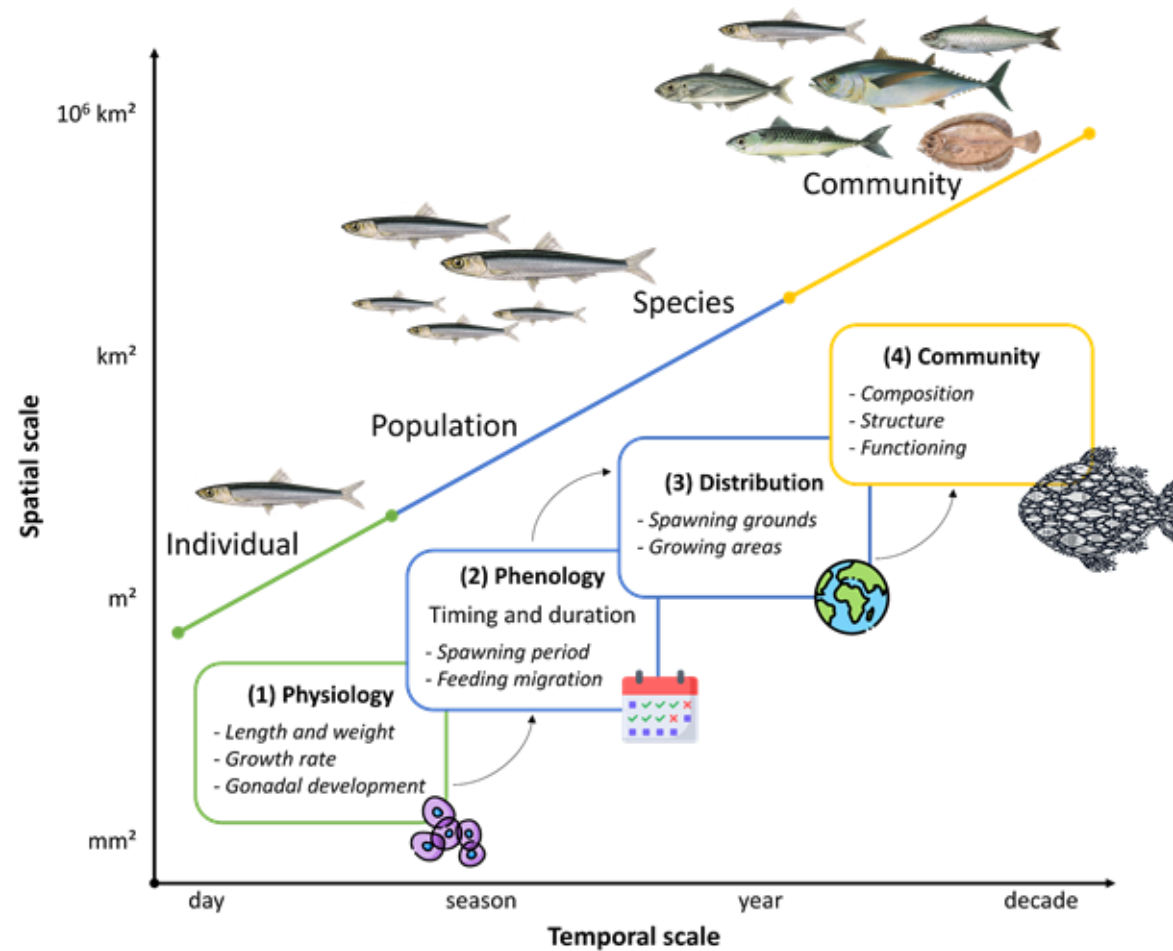


*Pech et al. 2017*

Local fisheries



# Main biotic responses to climate change



# Universal ecological responses to global warming

Poleward shifts

Deepening in some fish

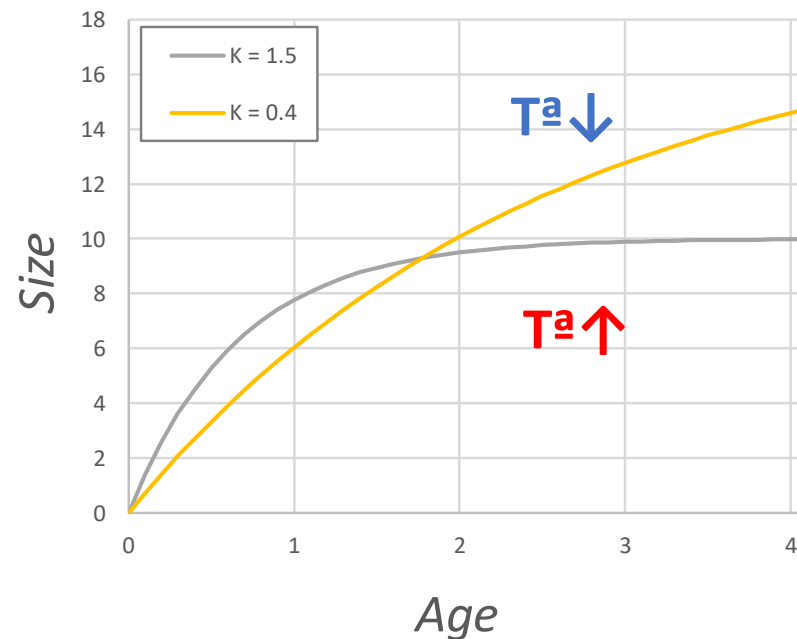
Seasonal shifts in life cycle

Size reduction

*Daufresne et al. 2009*



Expansion rate for  
marine species:  
72 km / dec  
(*Poloczanska et al.*  
2013)



*Pauly and Cheung (2018)*

# The Marine Observatory of Climate Change of the Bay of Biscay

## Climate Change Indicators

### Marine physical-chemical indicators

1. Sea temperature
2. Salinity
3. Mixing and stratification layer
4. Oxygen
5. Nutrients
6. Mean sea level
7. Wave

### Atmospheric indicators

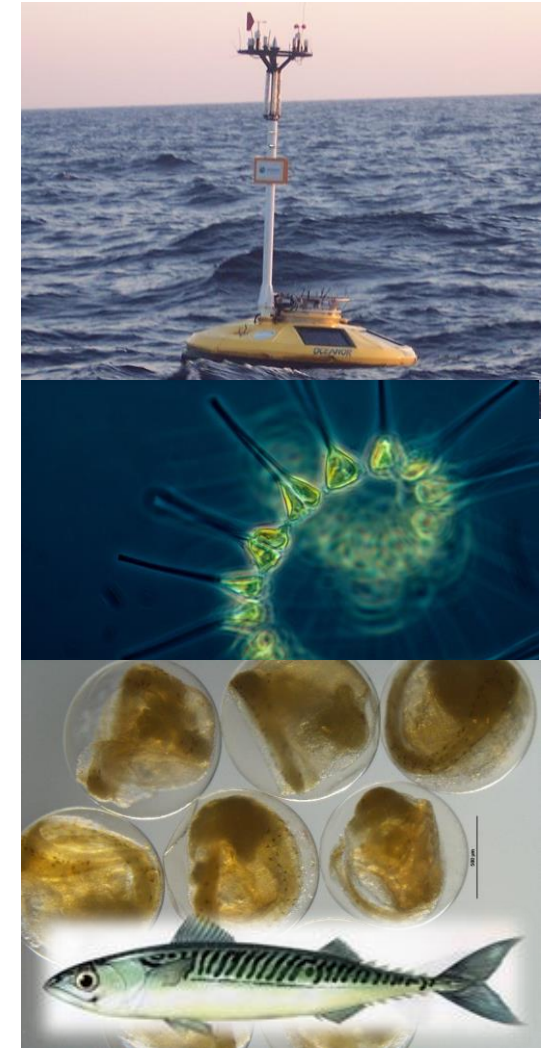
8. Air temperature
9. Solar radiation and sunshine hours
10. Wind
11. Rainfall and river flows

### Coastal geomorphological indicators

13. Coastline
14. Beaches and sandy areas

### Marine biological and ecological indicators

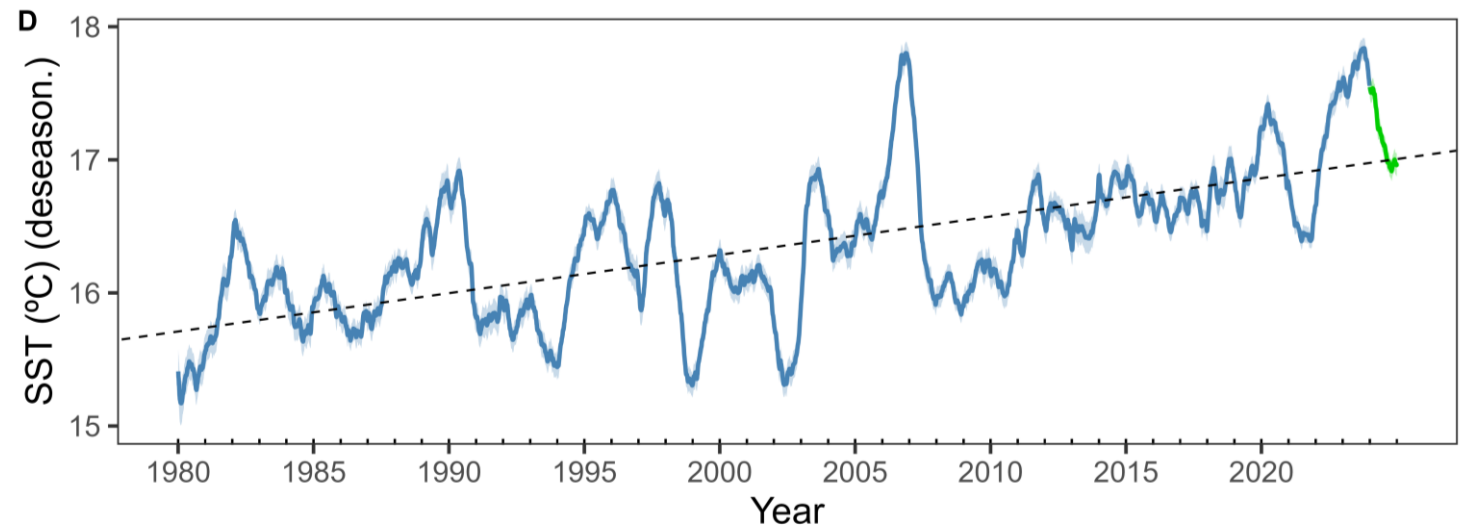
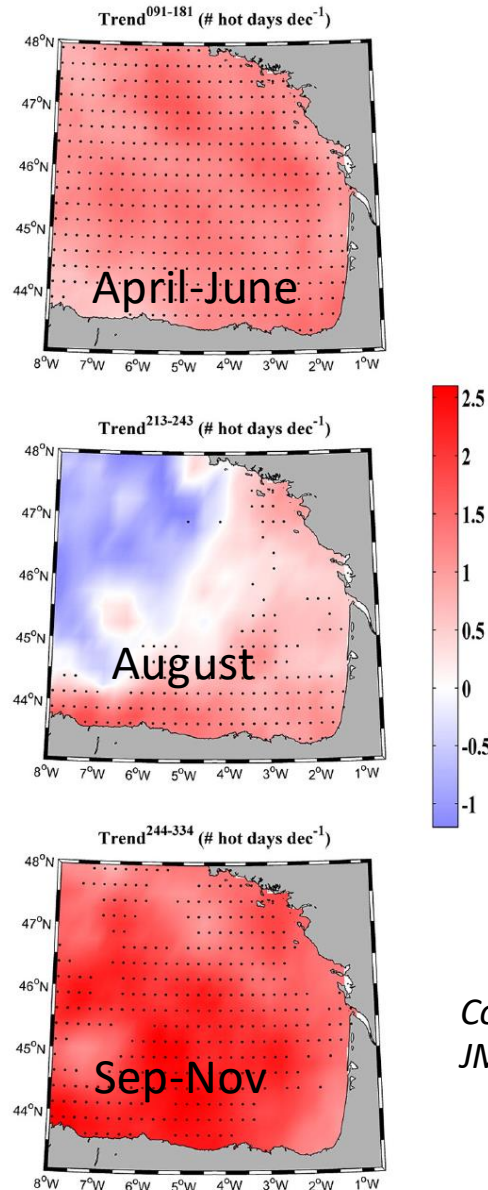
15. Bacteria
16. Phytoplankton
17. Macroalgae
18. Benthic macroinvertebrates
19. Pelagic, demersal and diadromous fish



# Is warming the Bay of Biscay?

Sea Surface temperatura of the San Sebastián Aquarium

0.28°C/década (1980-2024)



Costoya et al. 2015  
JMS



Goikoetxea et al. 2009. *Continental Shelf Research*  
González, et al. 2008. *Revista de Investigación Marina*  
Chust et al. 2022. *Science of the Total Environment*

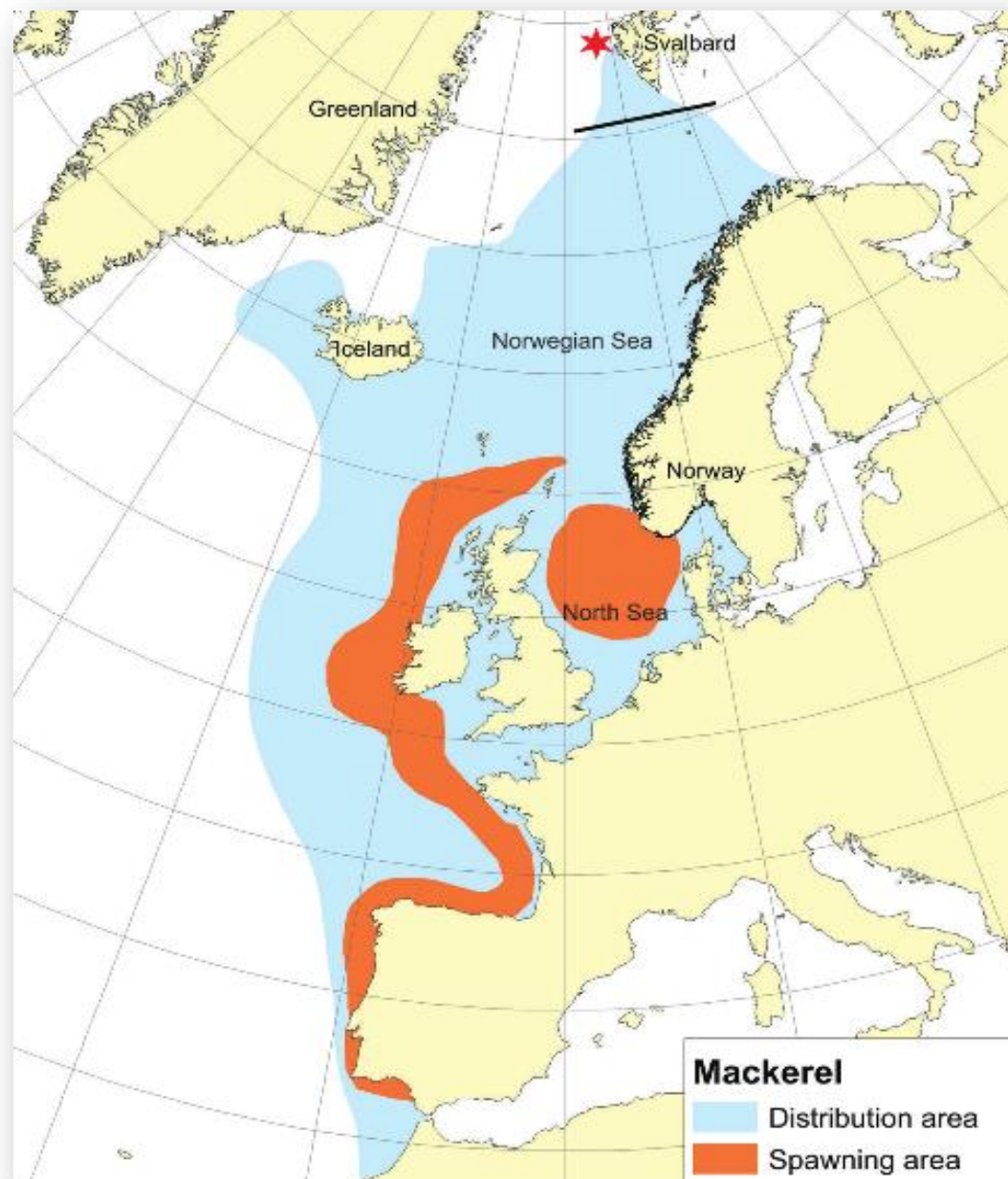
## Poleward shift of the NE mackerel (*Scomber scombrus*) spawning



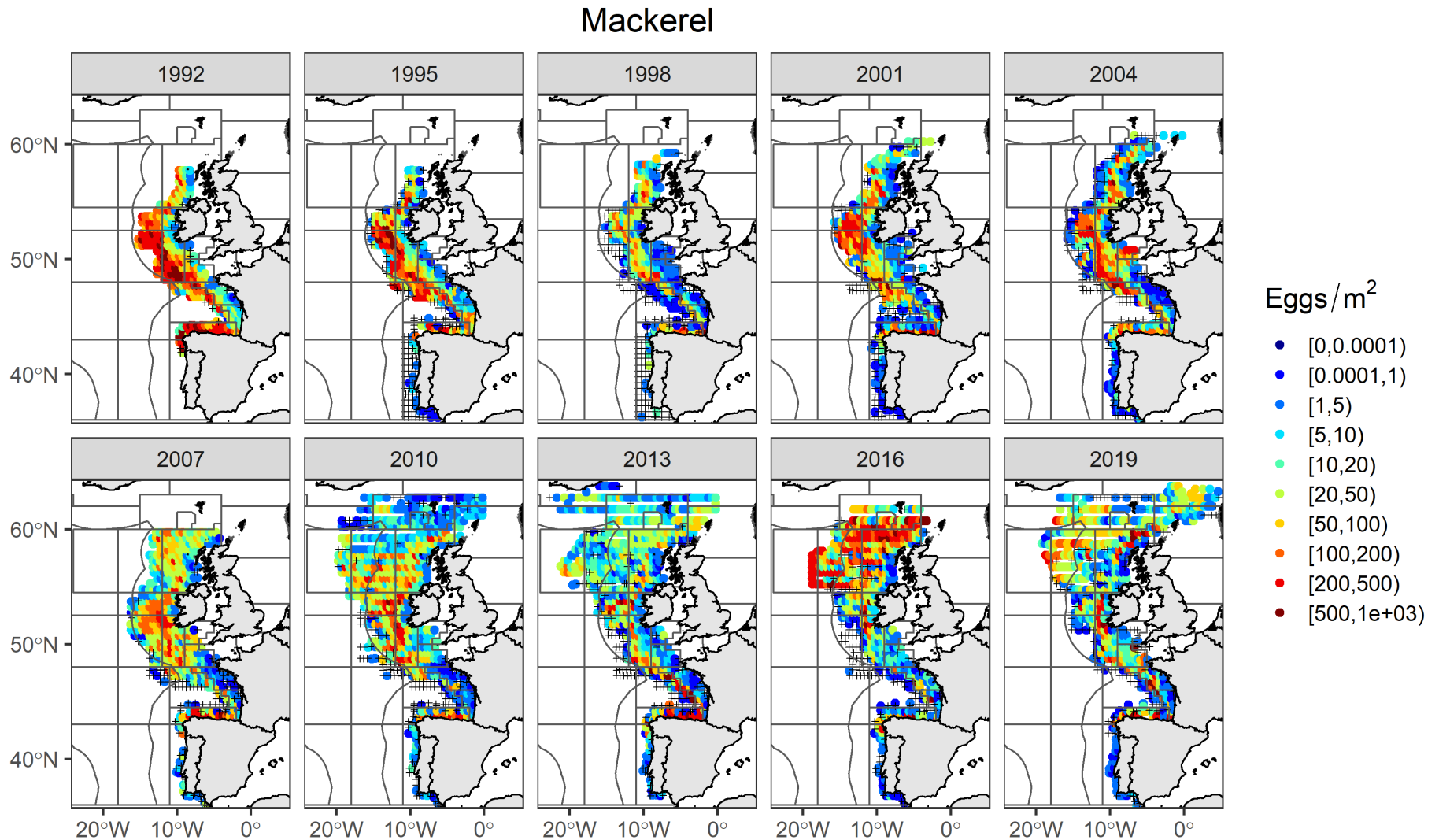
**Spawning: Jan - Jul**

**3 components :**

- North Sea
- Western
- South

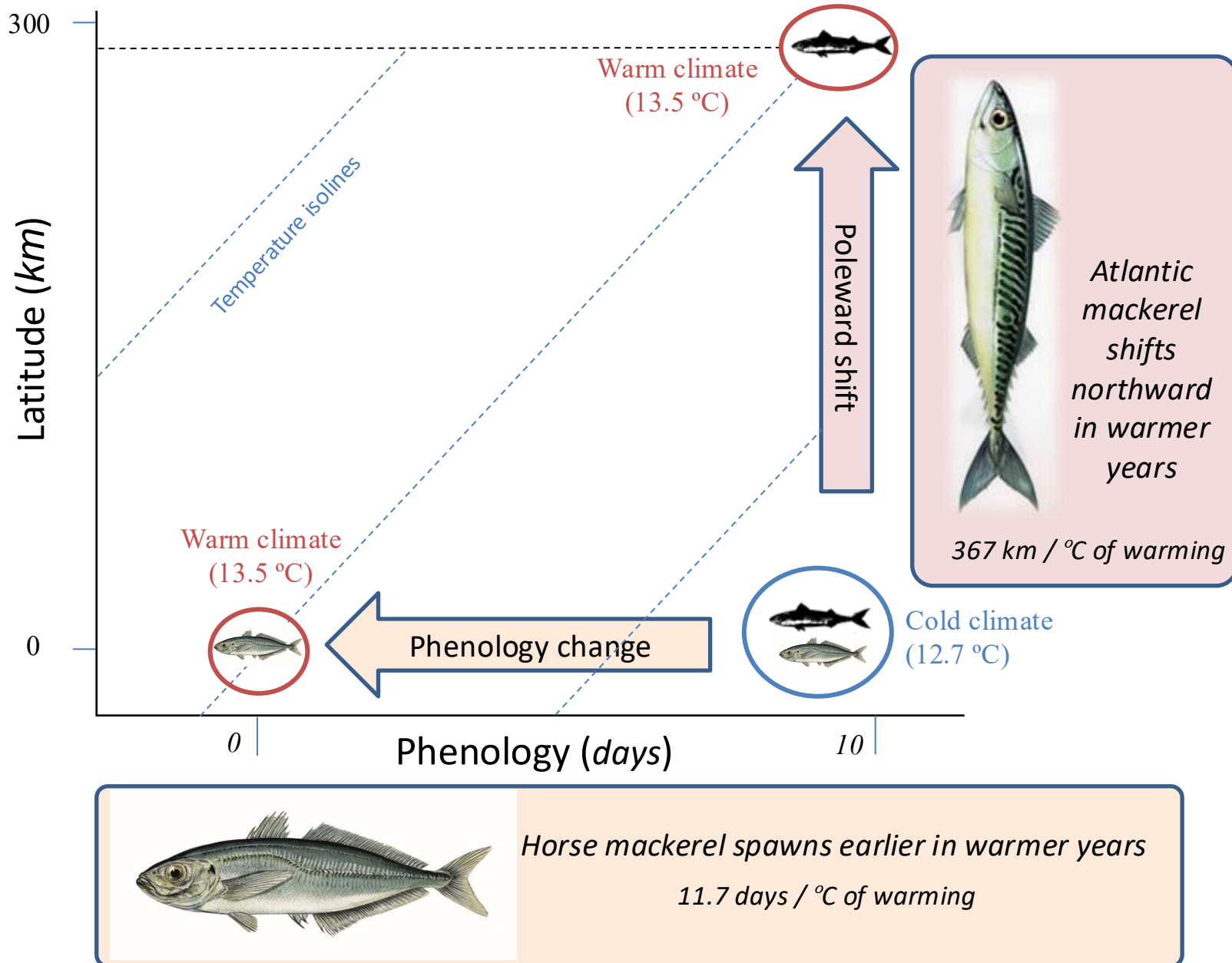


## The Atlantic mackerel and “choke species”

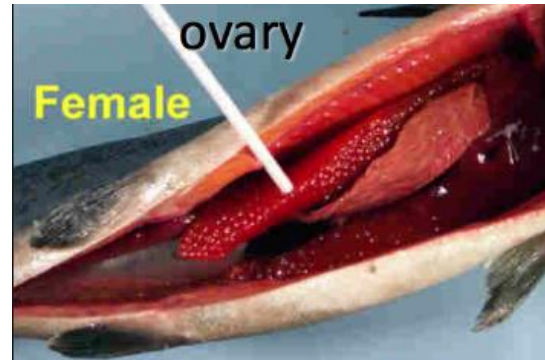
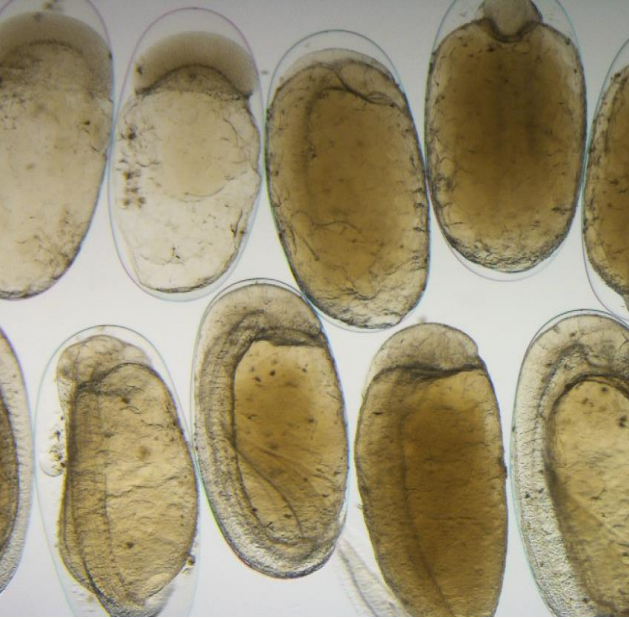


Changes in distribution, if they result in changes in the proportion of a stock located within each TAC area, can result in a mismatch between regional stock abundances and quotas allocated by RS which can, in turn, lead to extensive discarding or a ‘**choke species**’ effect in fisheries (Baudron and Fernandes 2015)

## Species acclimatization pathways



# European Anchovy: spawning phenology

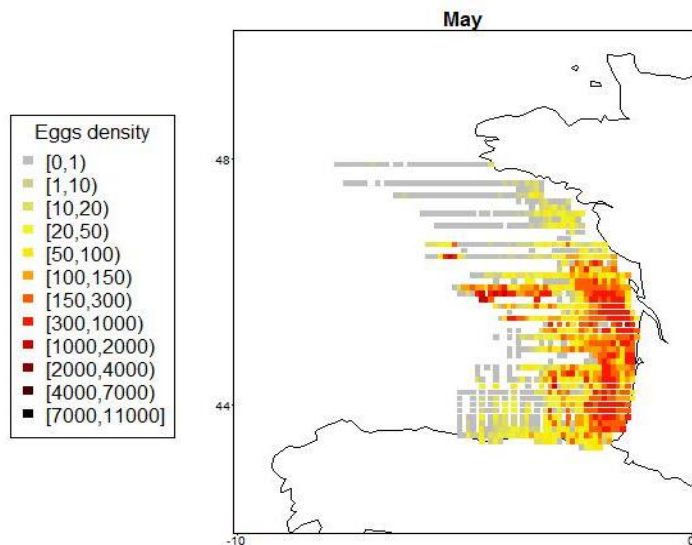


Spawning peak

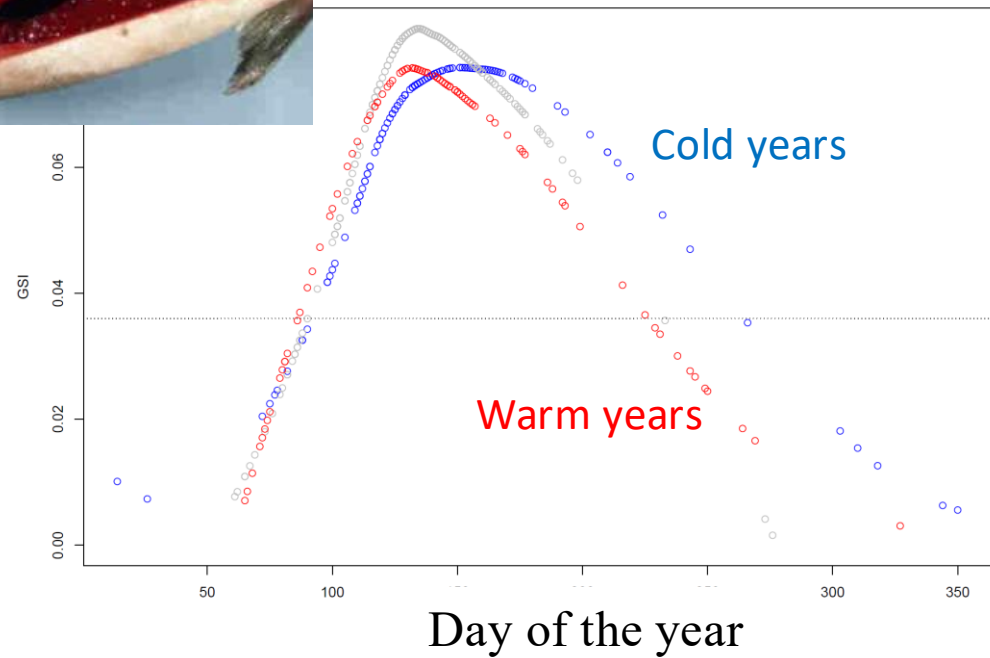


earlier 6 days/ddecade

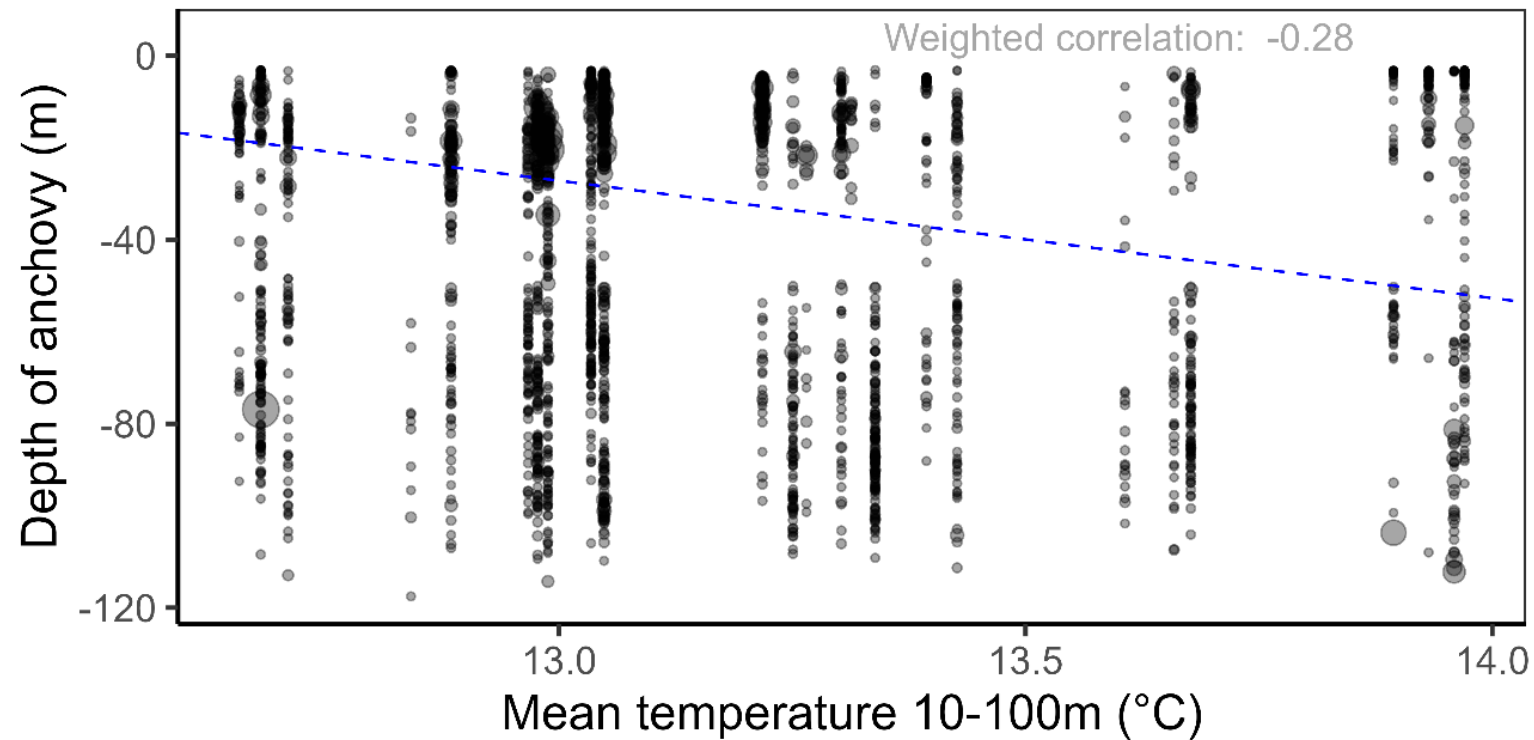
## Spawning distribution



GSI



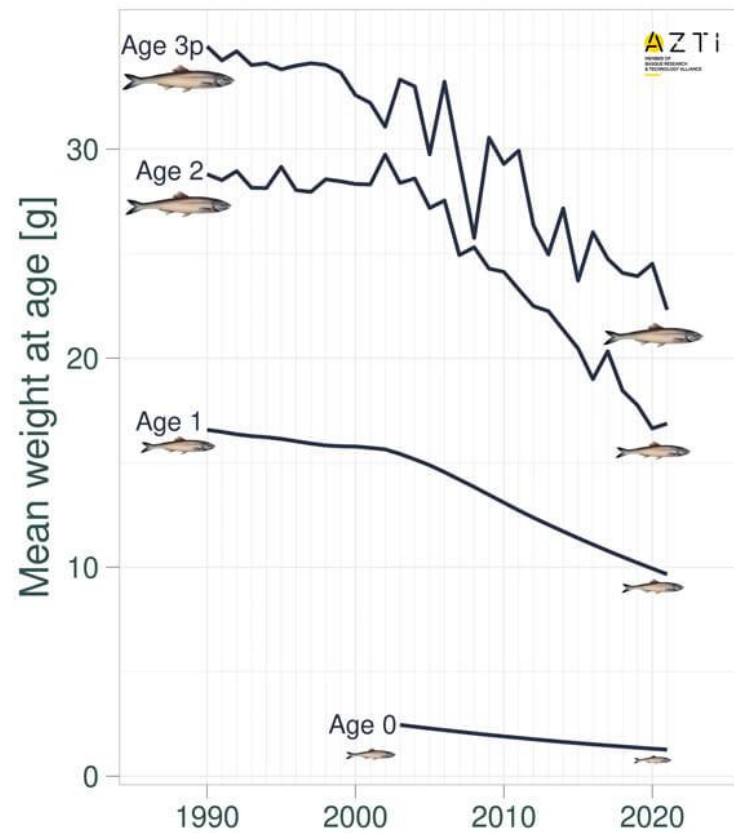
## Anchovy shoals deepen with rising temperatures



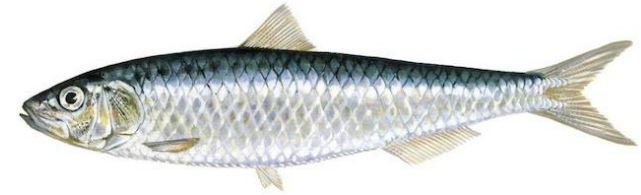
## Shrinking body size of European anchovy and sardine in the Bay of Biscay



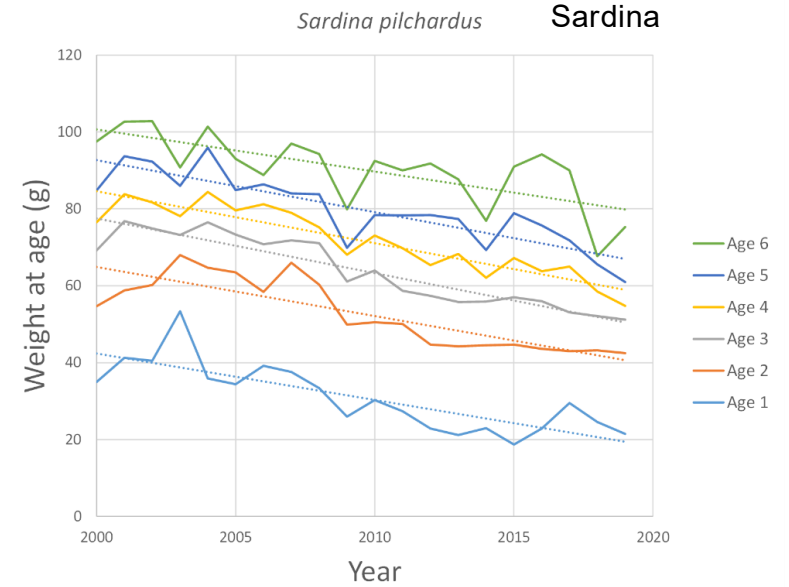
Anchoa



Taboada et al. 2024 GCB



Sardina

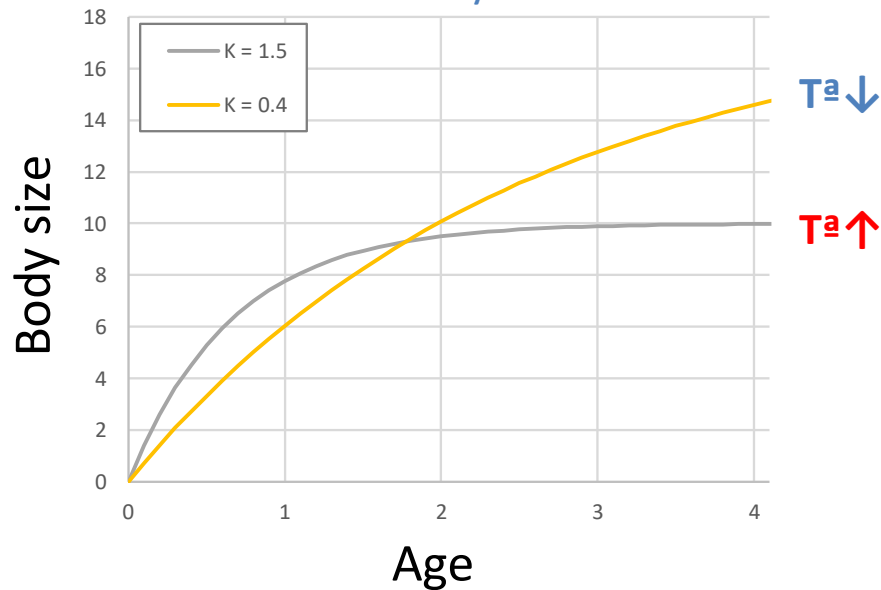


Chust et al. 2022 STOTEN

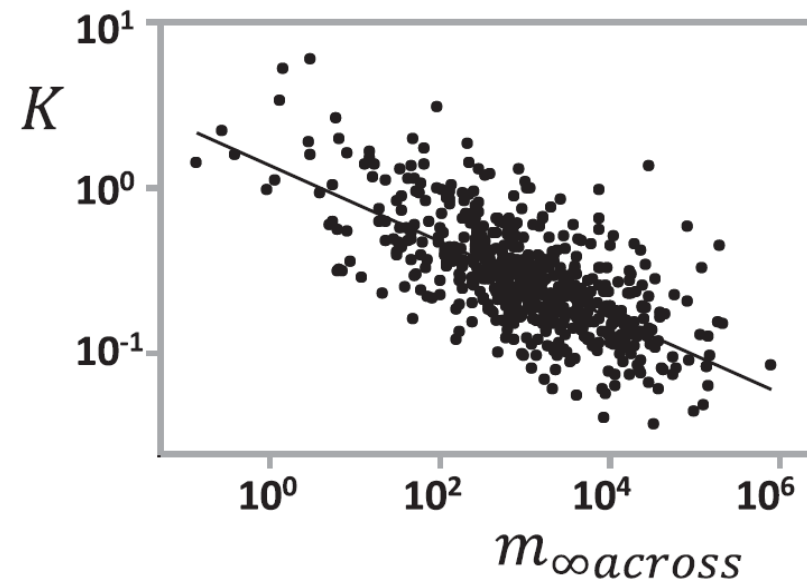
## Body size and Growth response to warming

- Temperature increases initial growth but decreases body size (Atkinson, 1994, 1997)
- Fish size is decreasing due to climate change (Perry et al. 2005)

Growth curves following von Bertalanffy model

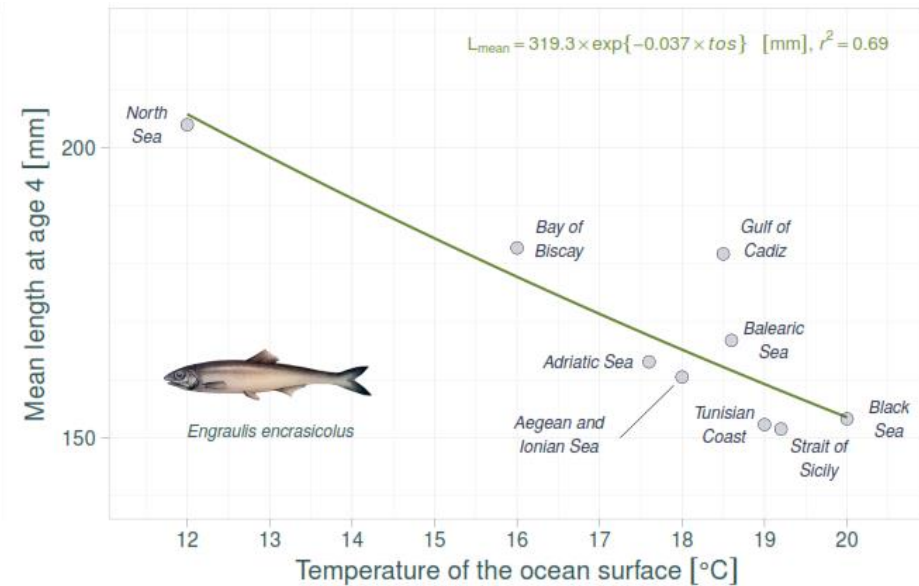
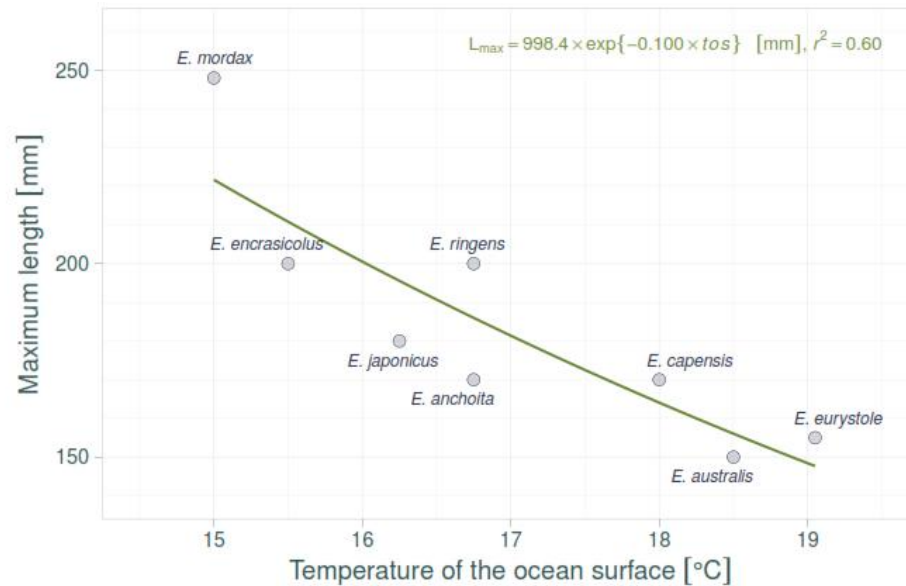


Body size is negatively related to growth in fishes (576 species)

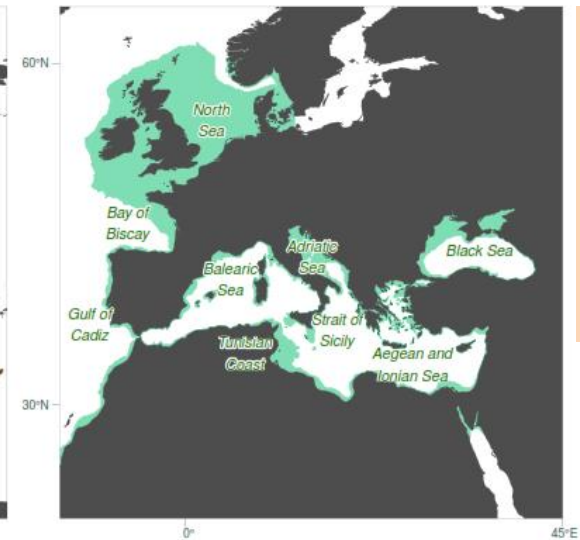
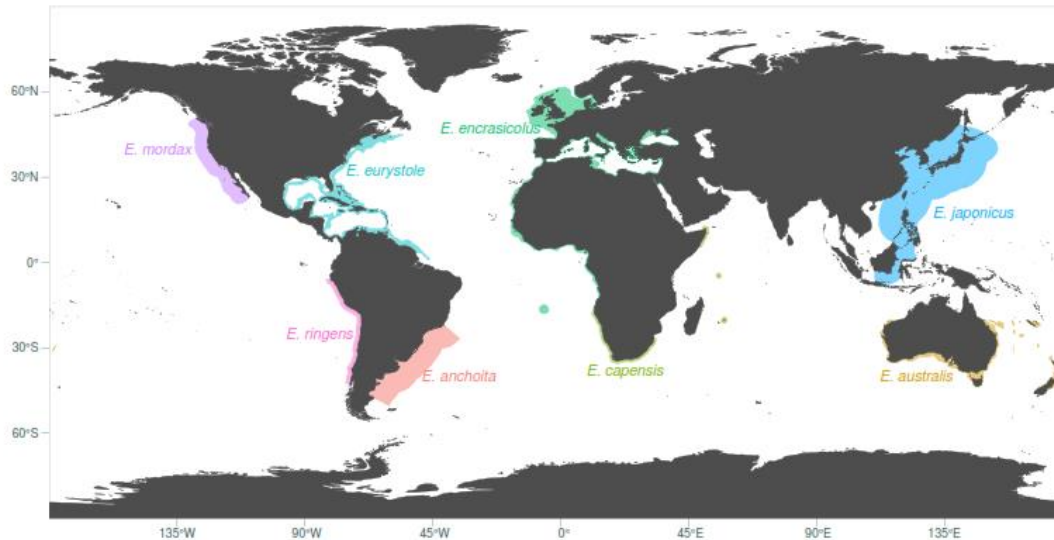


*Silby et al 2015 PNAS*

## Ecogeographical patterns in the variation of anchovy body size with temperature



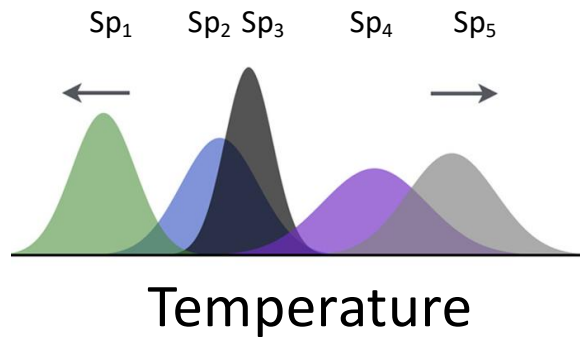
Length of different anchovy species is smaller with region temperature



Individuals in populations in northern (colder) seas are larger

# Community Temperature Index (CTI)

- a measure of the average thermal affinity of ecological communities, weighted by the relative abundance



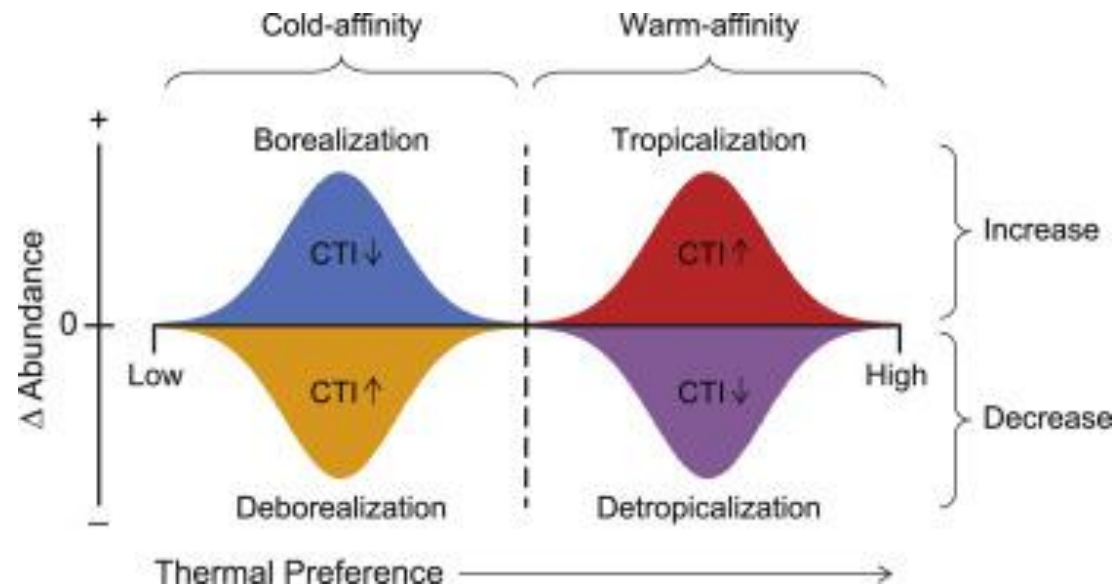
$$CTI = \sum_{s=1}^n Temp.pref_s \times Relative.Abundance_s$$

where the number of species in the community is  $n$  and each species ( $s$ ) has a temperature preference and a relative abundance in the community

**$H_1$  : If ocean warming,  
CTI is expected to increase over time**

Villarino et al. 2020 MEPS  
Chust et al. 2024 Nature Comm

## Underlying processes

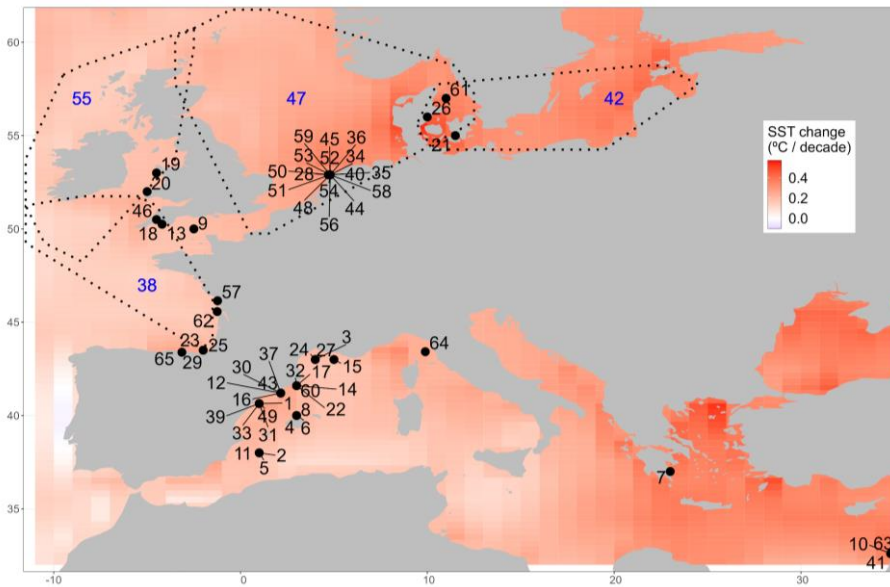


- Tropicalization: increasing warm affinity species
- Deborealization: decreasing cold affinity sp.
- Borealization: increasing cold affinity sp.
- Detropicalization: decreasing warm affinity sp.

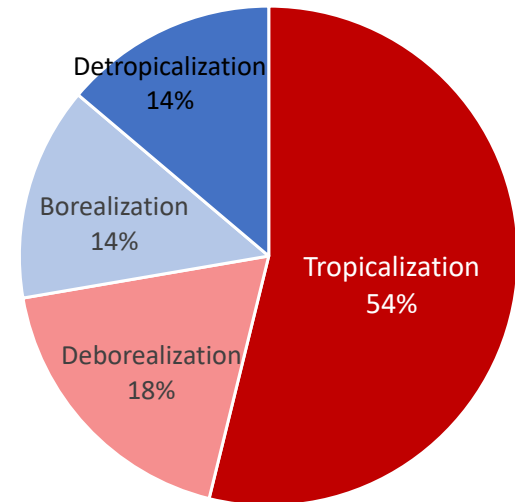
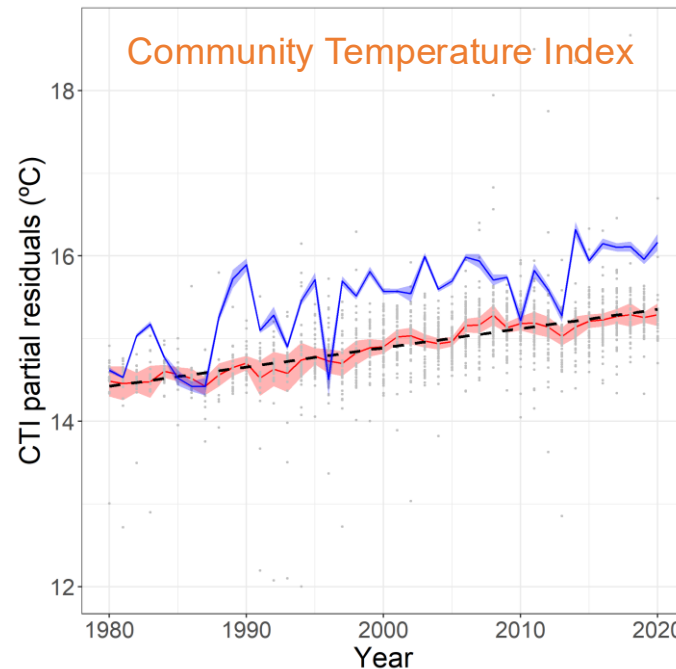
CTI increase => Tropicalization and/or Deborealization

McClellan et al. 2021

# Cross-basin and cross-taxa patterns of marine community tropicalization and deborealization in warming European seas



- 65 Biodiversity time series (1980-2022)
- 1817 species
- Zooplankton, benthos, pelagic and demersal invertebrates
- 418 species of fish (pelagic, demersal, estuarine)





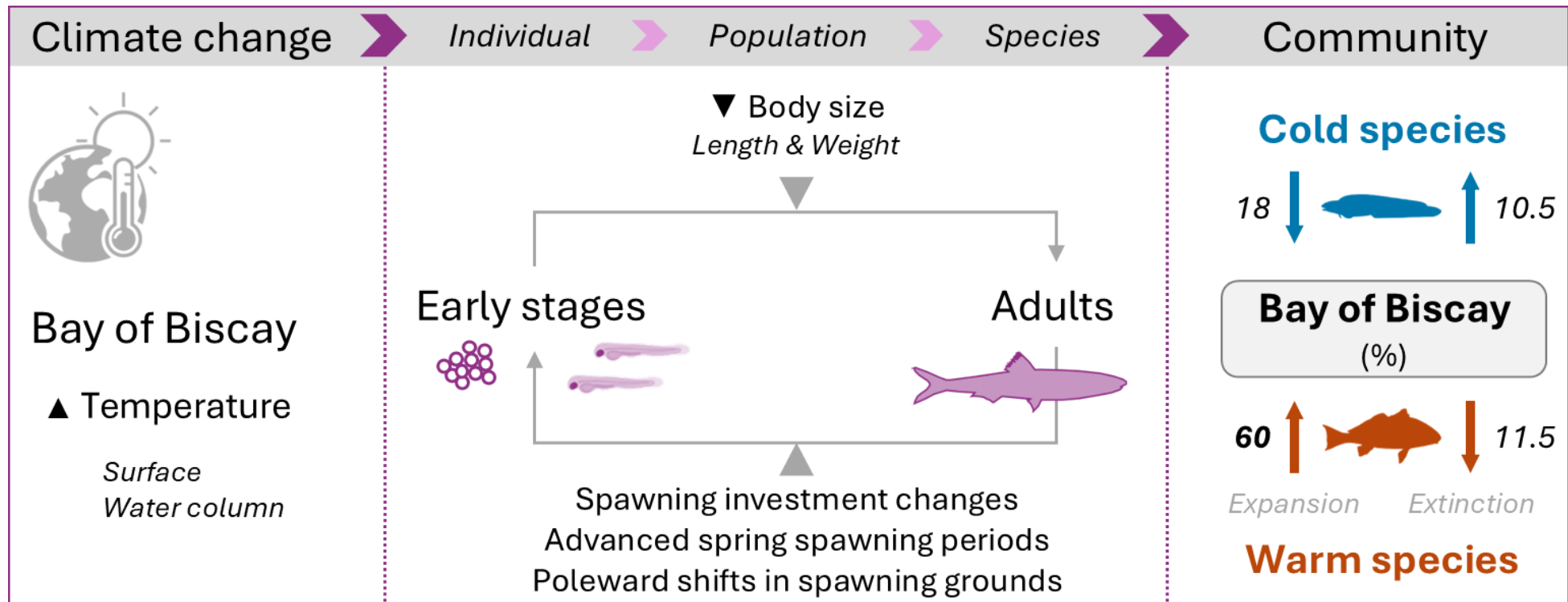
Pez de San Pedro (*Zeus faber*)

Chavo (*Capros aper*)



## Trends in fish communities over the last three decades in the Bay of Biscay

- We defined and analysed 41 biological indicators related to ocean warming for >200 species



- 24 of the 41 biological indicators (59%) significantly aligned with the expected impact of ocean warming on marine fish.
- Observed trends reveal a clear signature of broad-scale process (i.e. ocean warming) impacting the overall fish communities.

## Conclusions, perspectives and knowledge gaps on climate change impacts on small pelagic species

1. A gradual shift associated with CC starting in the 1980s, with a **warming of the sea surface down to 100 m depth in the Bay of Biscay** (0.10-0.25 °C per decade).
2. This warming may have impacted on benthic and fish communities, favouring warm-water species (**tropicalization**) relative to cold-water species (**deborealization**).
3. Weight at age for anchovy and sardine decreased in the last two decades.
4. **In anchovy, juvenile growth accelerate and adult body size reduces with sea warming.** Other interacting factors might be involved (density dependence, selective mortality).
5. **Poleward distributional shifts and phenological adjustments are universal ecological responses to ocean warming that need to be addressed in an integrated manner** since phenology depends on the latitudinal location. Efforts should be made to explore which biological traits determine each specific acclimatization pathway.
6. **The future of fish stocks at global scale under climatic scenarios is relatively uncertain due to the heterogeneity of primary production response to warming** across biogeographic provinces, combined with the complexity of bottom-up control and trophic amplification to higher trophic levels.

# Thank you for your attention!

## Acknowledgements

- *H2020 Mission Atlantic: Mapping and assessing present and future status of Atlantic marine ecosystems under climate change and exploitation (No 862428)*
- *H2020 FutureMARES: Climate Change and Future Marine Ecosystem Services and Biodiversity (Contract No. No 869300 )*
- *EU LIFE integrated (Project LIFE-IP URBAN KLIMA 2050: Systemic implementation of the CC action in the Basque Country for increased urban resilience as full territory enabler)*
- *NaturKlima (Diputación Foral de Gipuzkoa)*
- *FP7 MEECE: Marine Ecosystem Evolution in a Changing Environment (Contract No. 212085)*
- *FP7 EURO-BASIN: European Union Basin-scale Analysis, Synthesis and Integration (Contract No. 264933).*
- *Basque Government (project CLIPES)*

