

**Decreasing trend in size for small pelagic
fish across European waters :
Bioenergetic modeling to explore
the underlying processes
from individual to population scale**

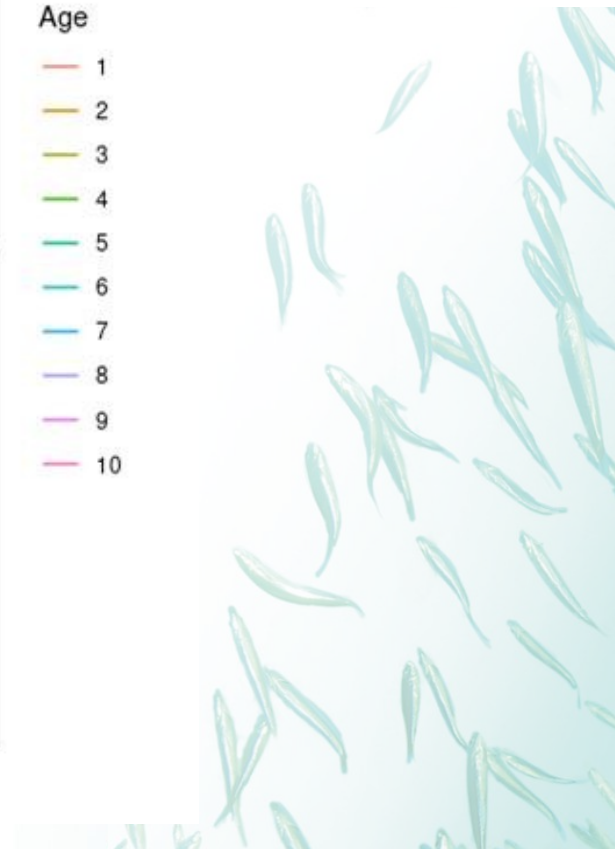
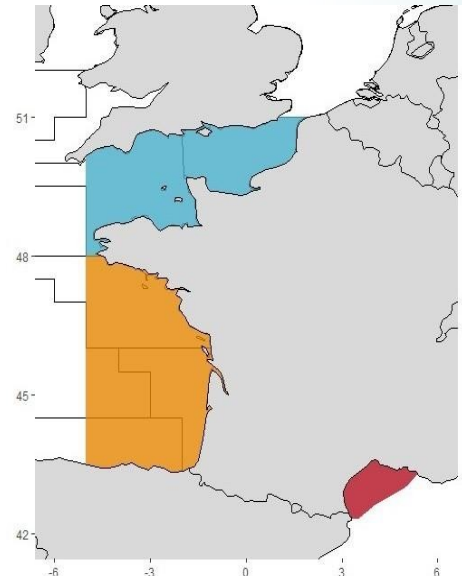
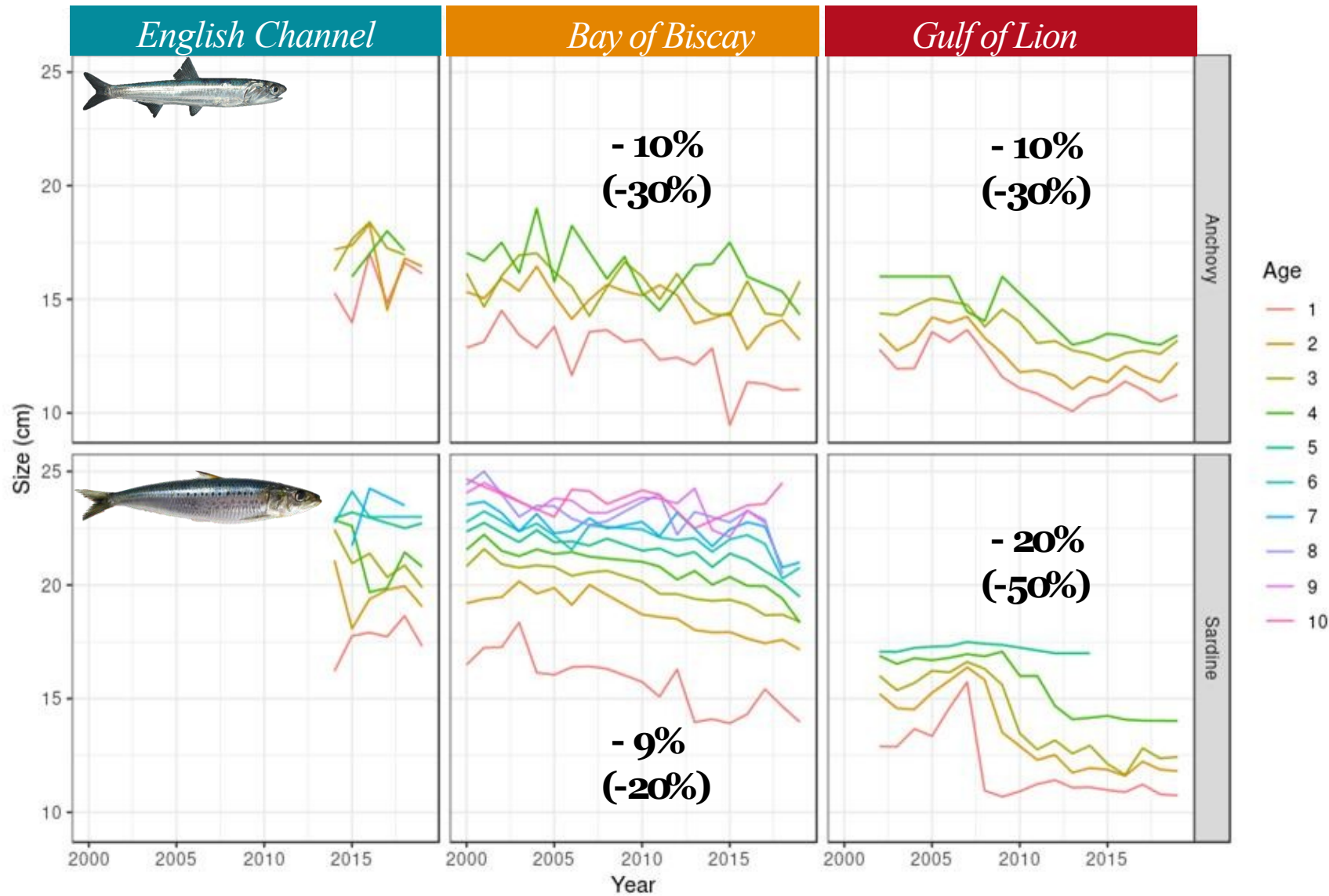
Clara Menu

Laure Pecquerie, Cedric Bacher, Mathieu Doray, Tarek Hattab, Jeroen van der Kooij, Martin Huret

Decreasing trend in size for SPF



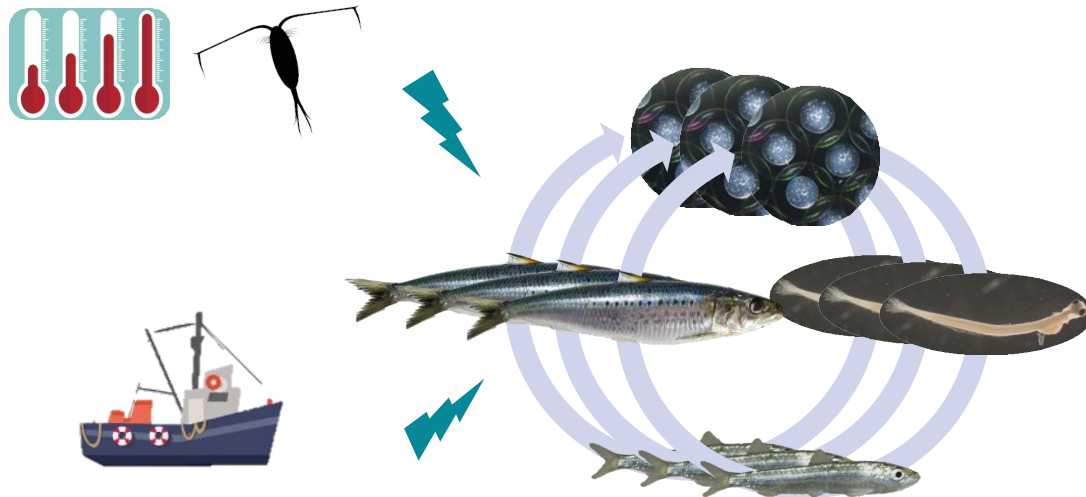
Decrease in length (weight)



Hypotheses to explain the decrease in size



- A change in **planktonic communities** (quantity and/or quality)
- A change in **density-dependence** affecting growth
- A change in **natural or fishing mortality**, selective according to individual size or body condition



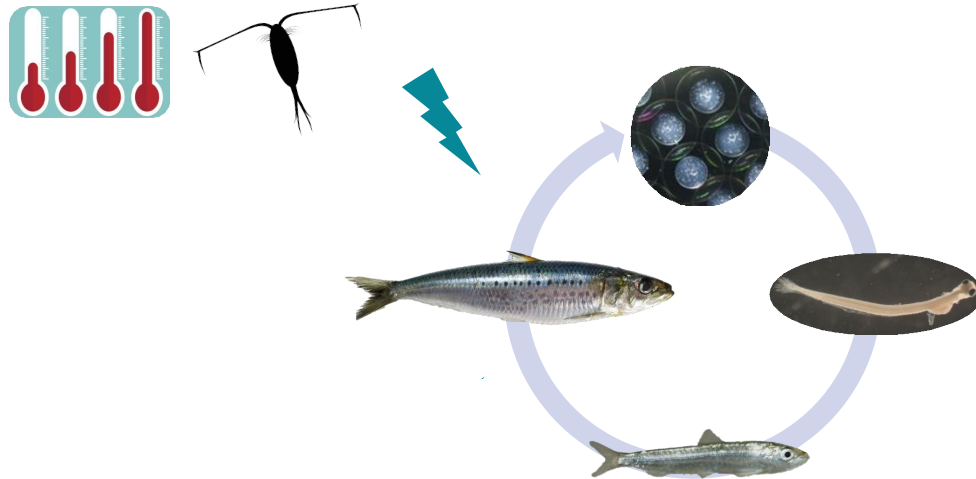
(Brosset et al., 2016 ;
Saraux et al., 2019 ;
Véron et al., 2020 ;
Boëns 2022)



Hypotheses to explain the decrease in size



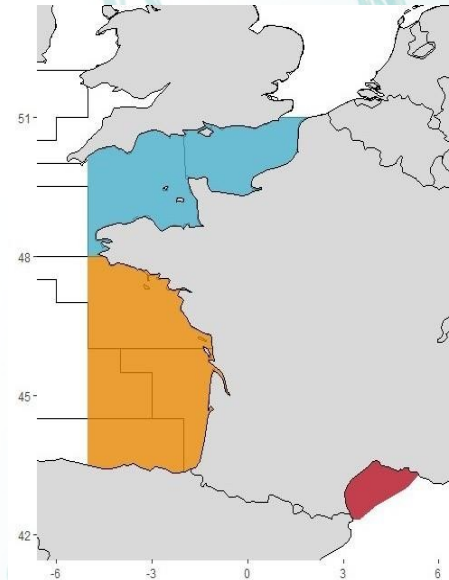
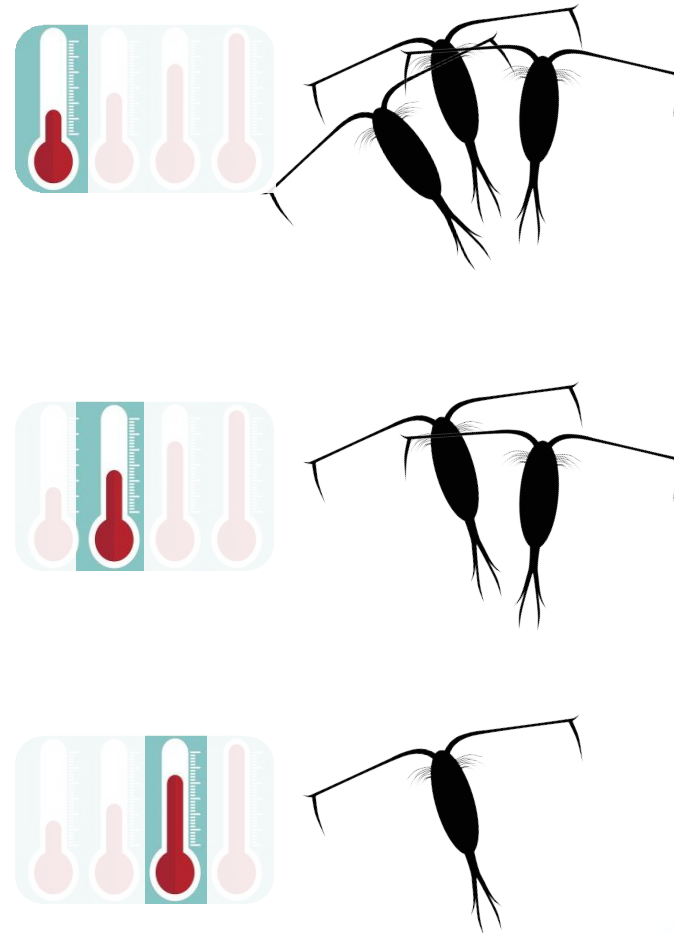
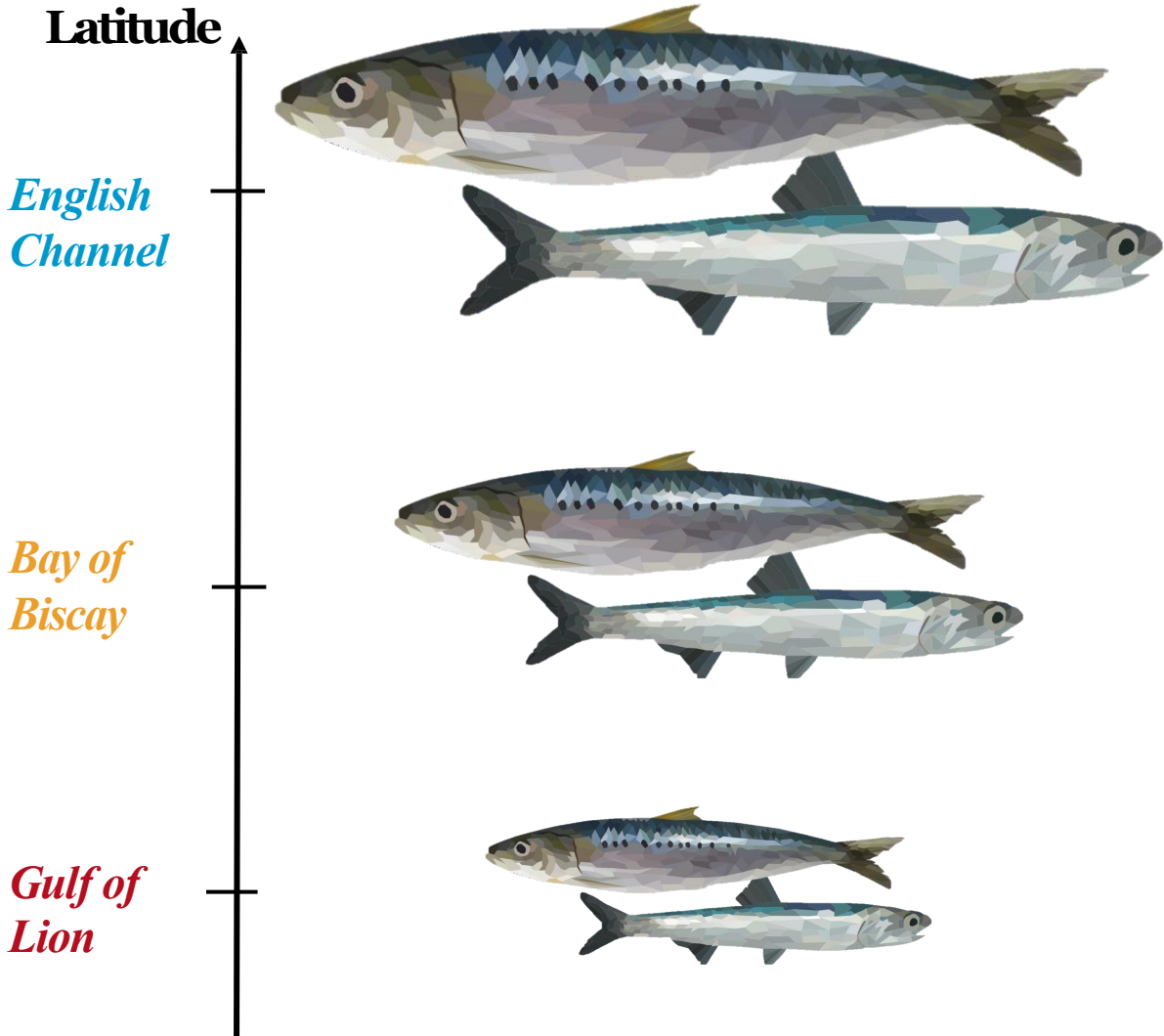
- A change in **planktonic communities** (quantity and/or quality)
- A change in **density-dependence** affecting growth
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(Menu et al. in revision)

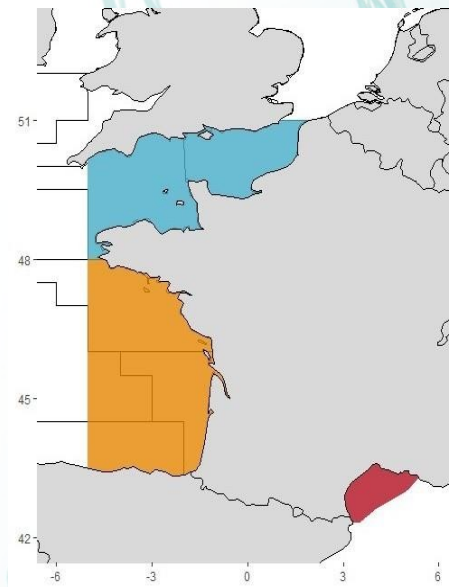
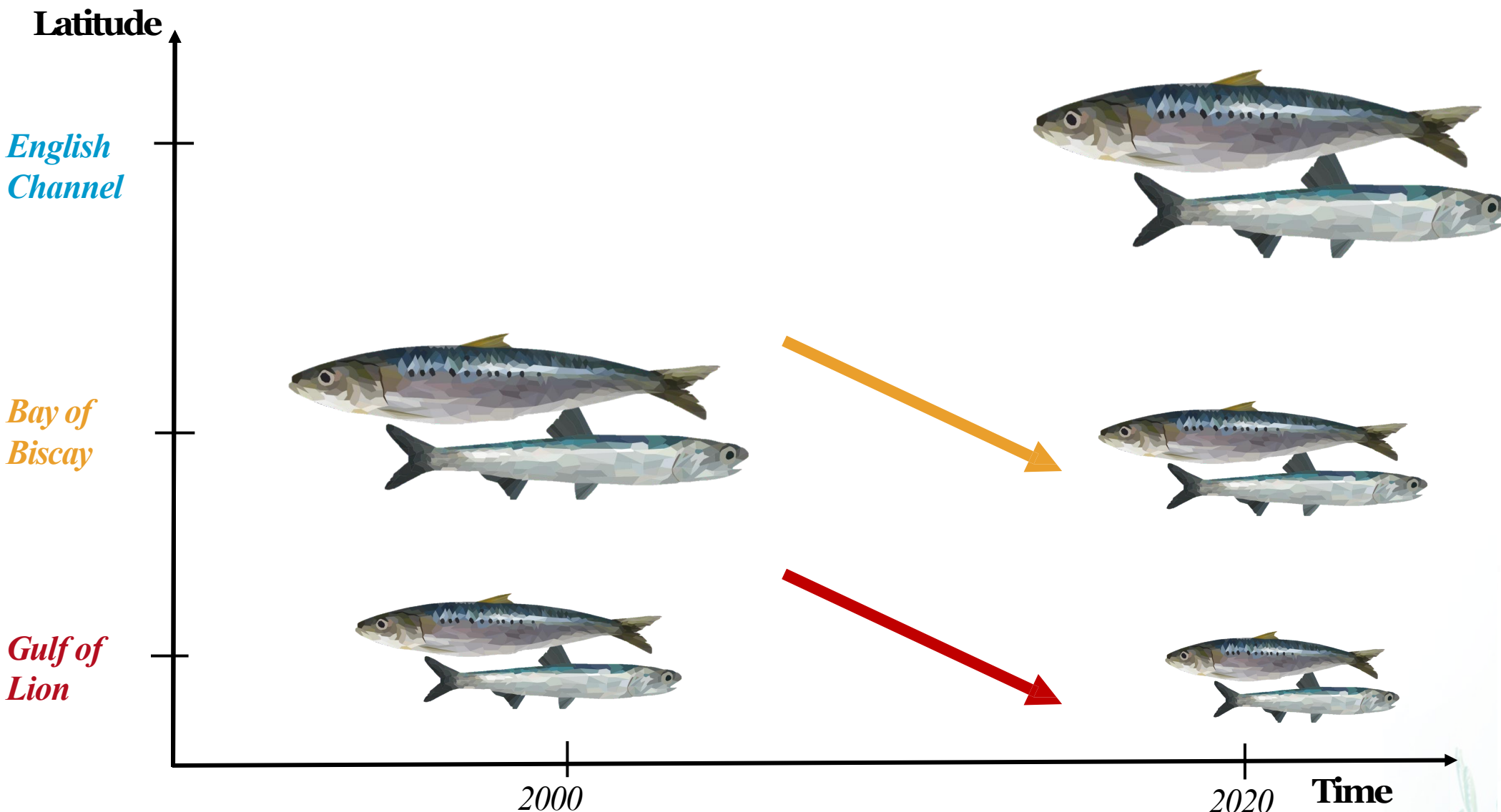


Spatial variability in size and body condition



(Atkinson and Sibly, 1997; Kingsolver and Huey, 2008)

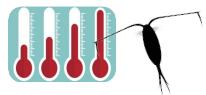
Spatial variability in size and body condition



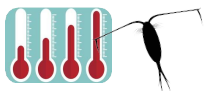
Methods

Environment

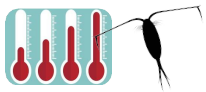
English Channel



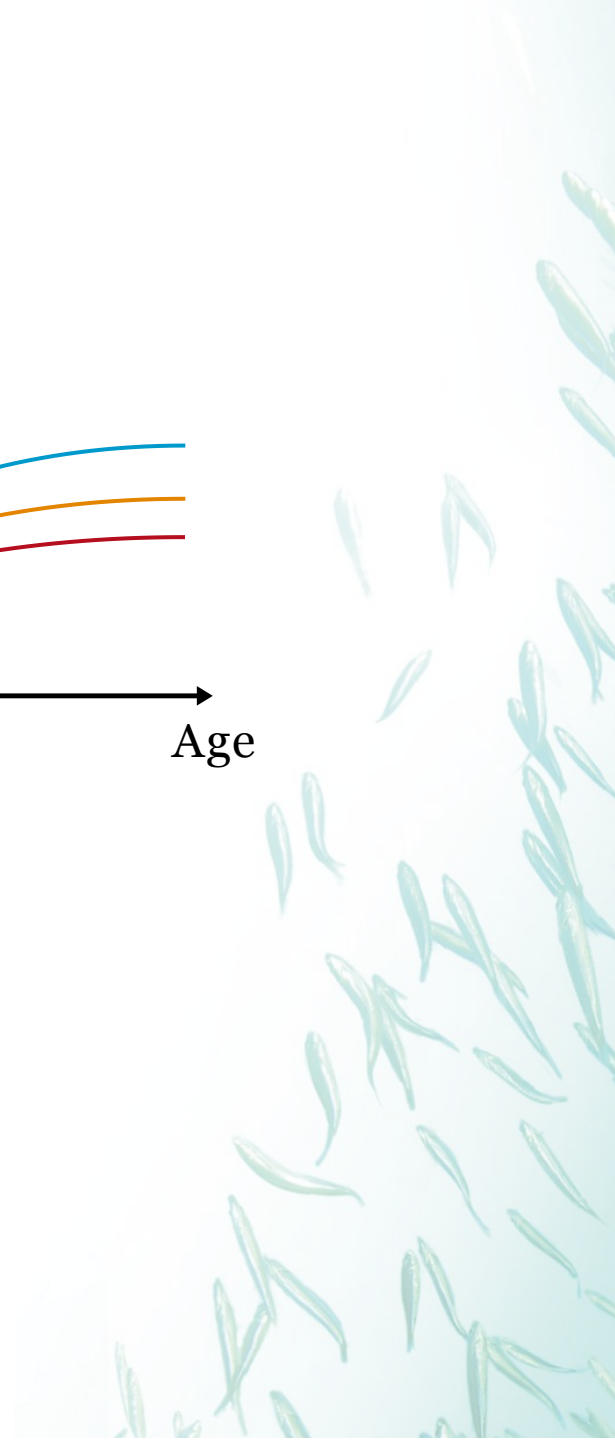
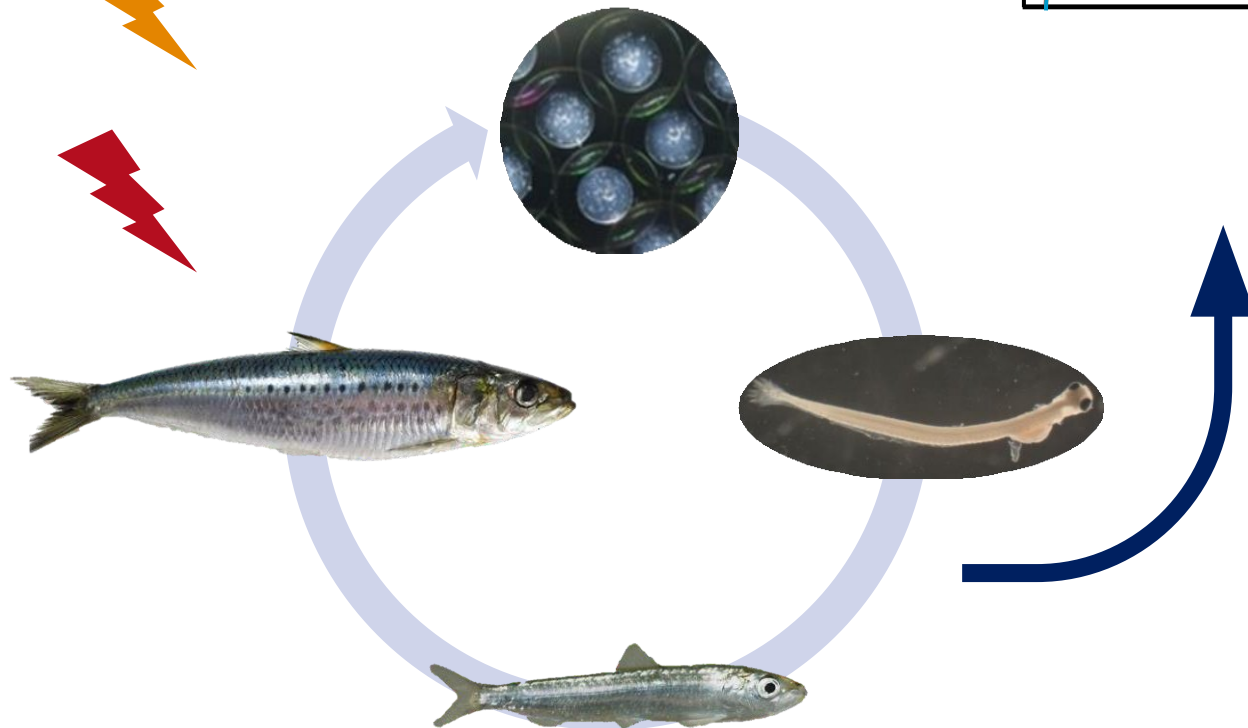
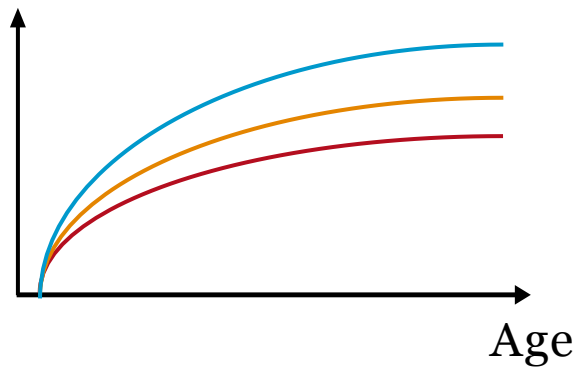
Bay of Biscay



Gulf of Lion



Length



Methods

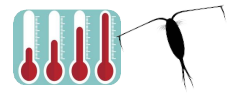
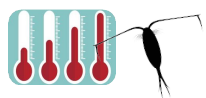


Environment

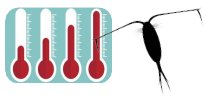
2000-2005

2010-2015

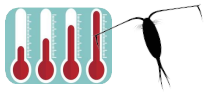
English Channel



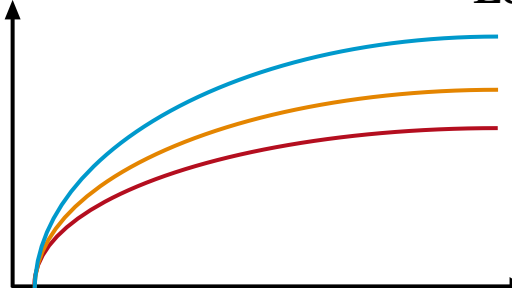
Bay of Biscay



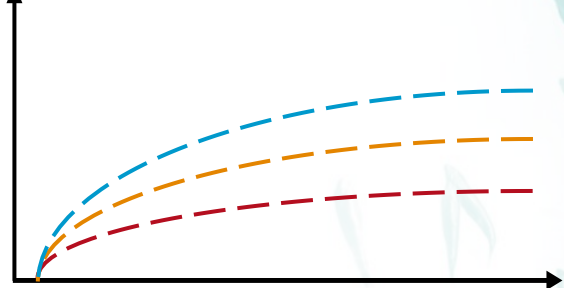
Gulf of Lion



Length

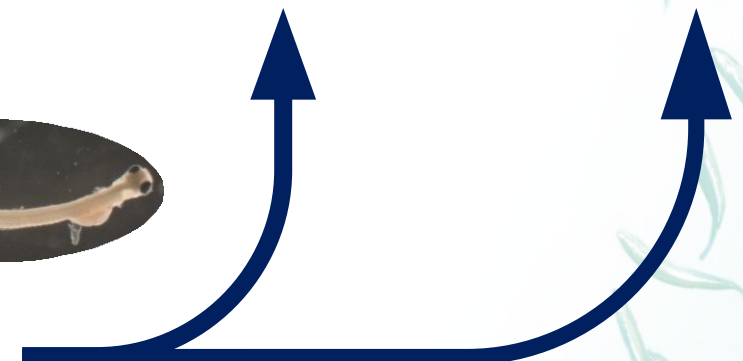
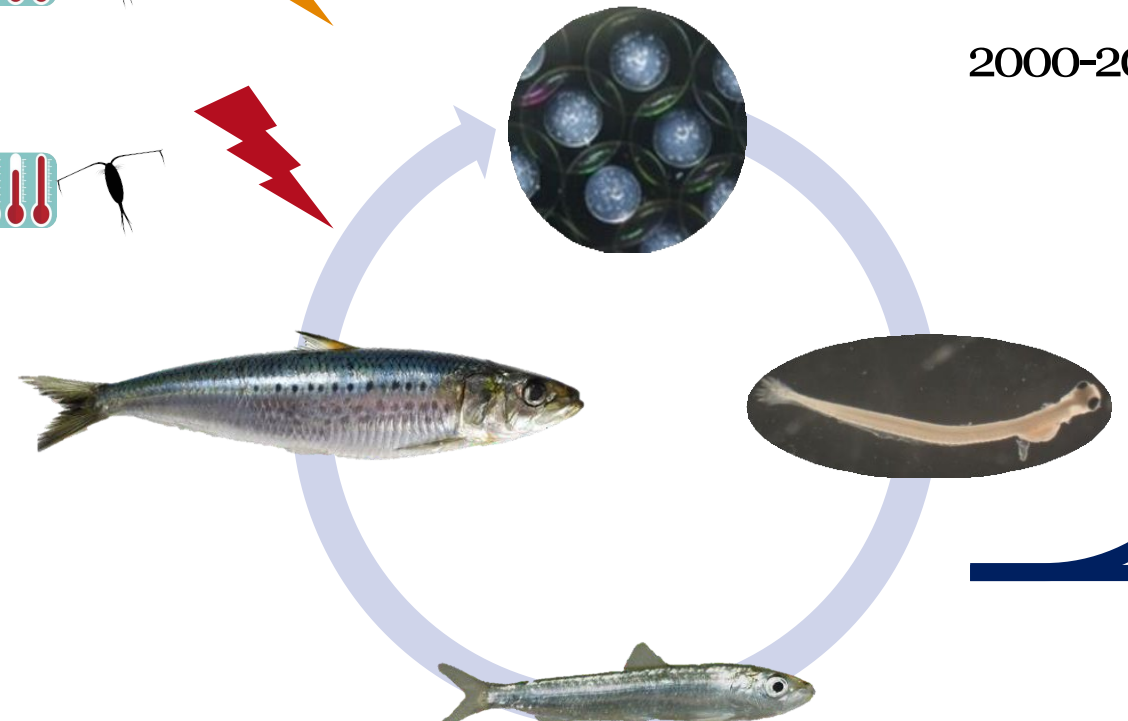


Length



2000-2005

2010-2015



Methods

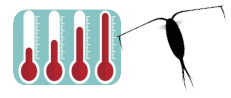
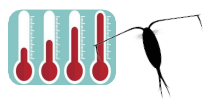


Environment

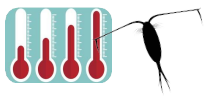
2000-2005

2010-2015

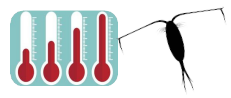
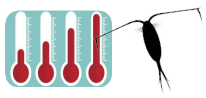
English Channel



Bay of Biscay



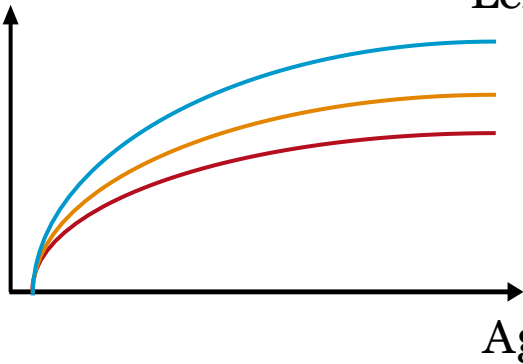
Gulf of Lion



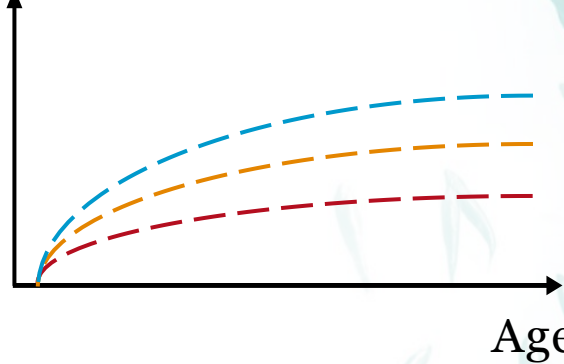
POLCOMS-ERSEM

SEAPODYM

Length

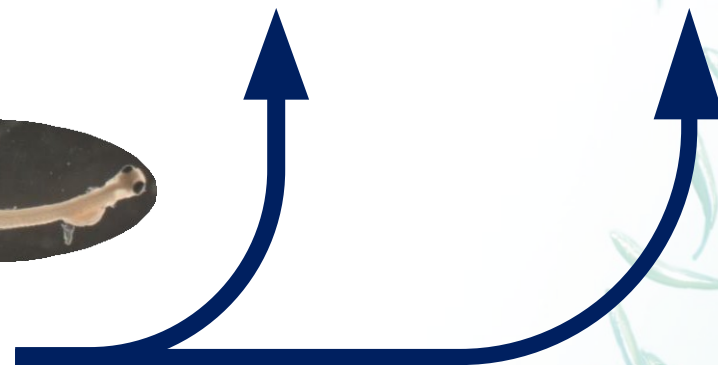
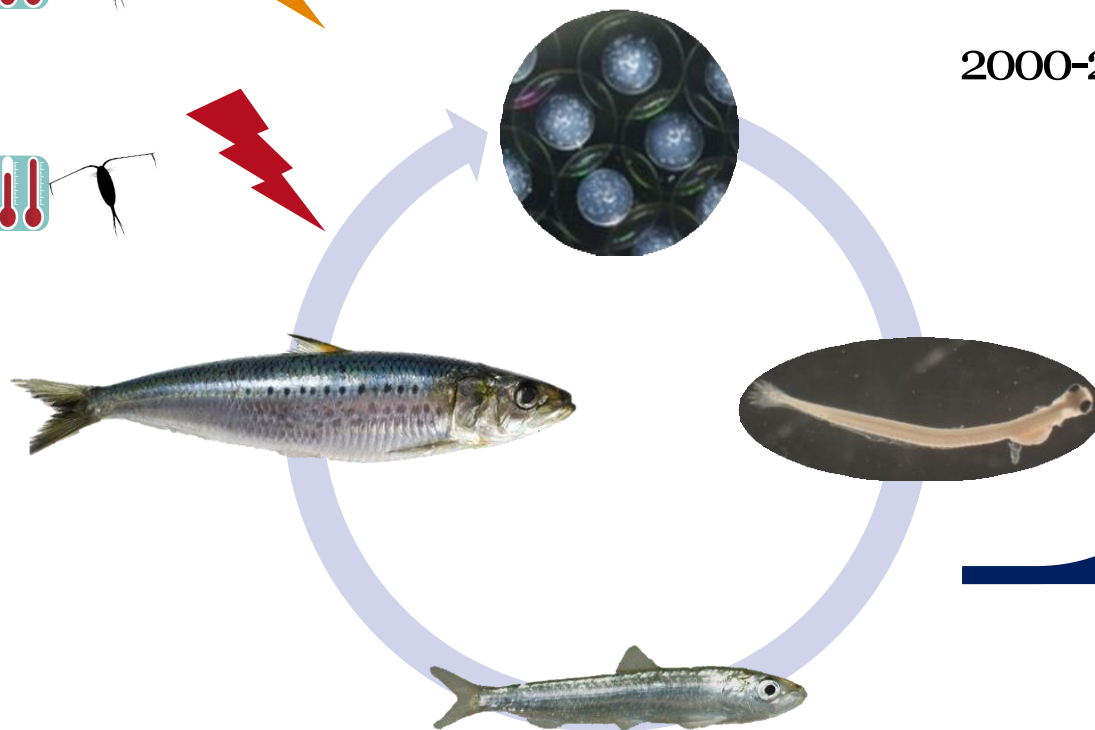


Length



2000-2005

2010-2015



Methods

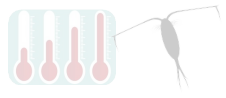
Environment

2000-2005

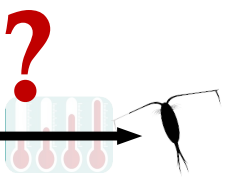
2010-2015

Length

English Channel



Bay of Biscay

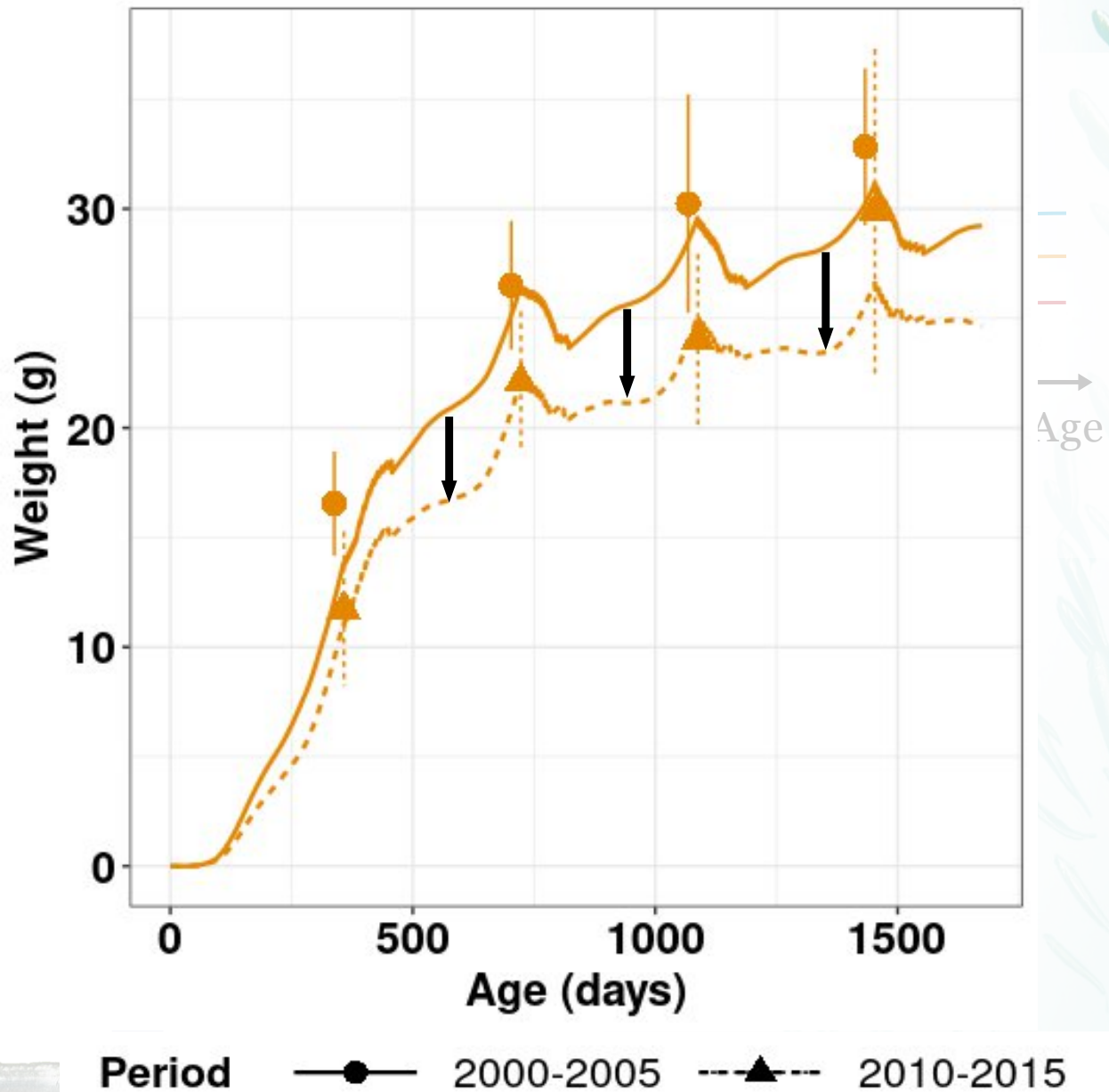


Gulf of Lion



POLCOMS-ERSEM

SEAPODYM

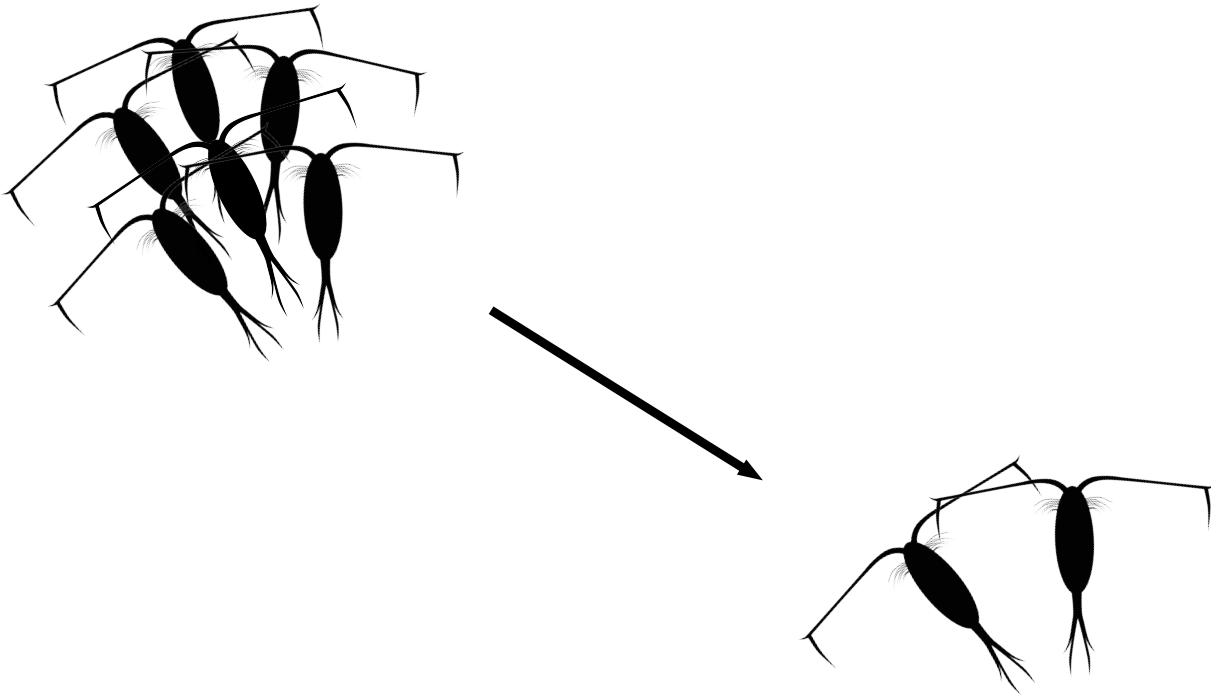


Scenario : a change in zooplankton



SC1 : decrease in quantity

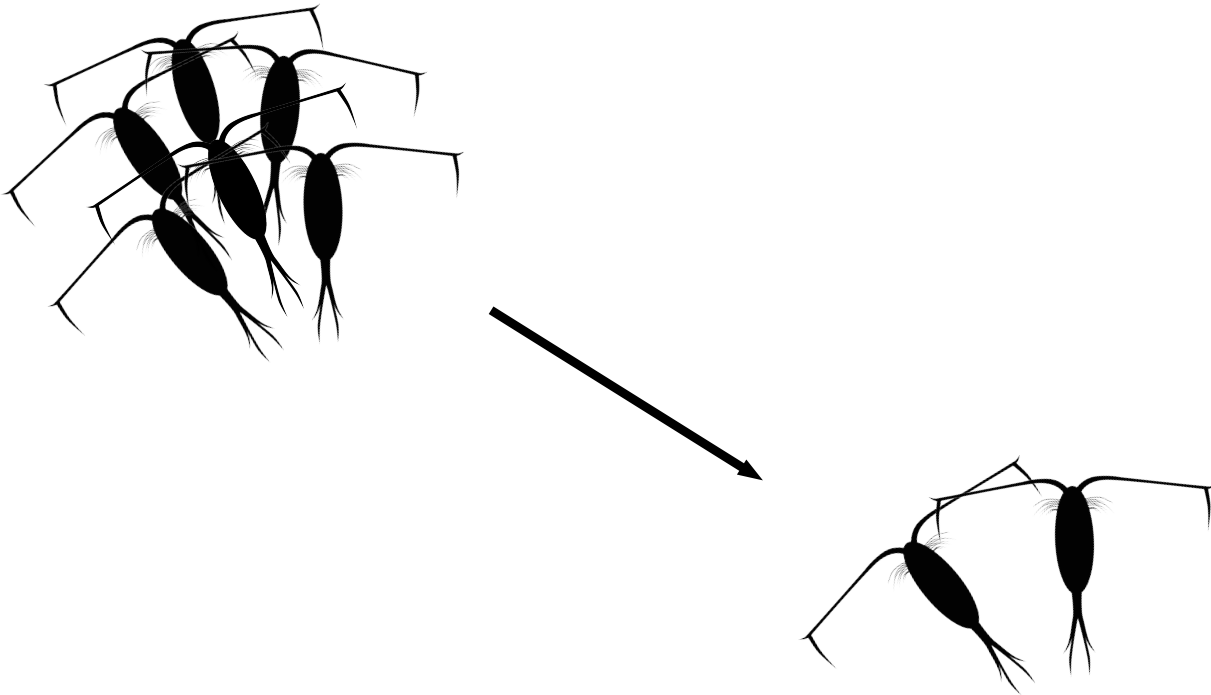
SC2 : decrease in quality



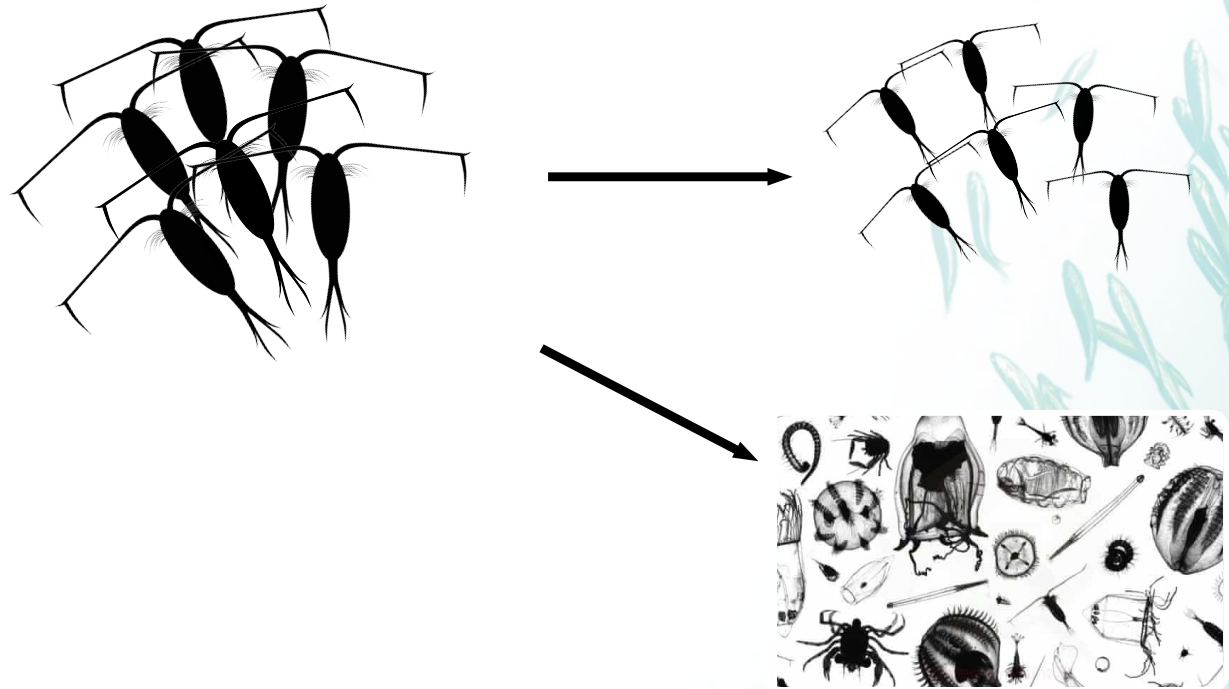
Scenario : a change in zooplankton



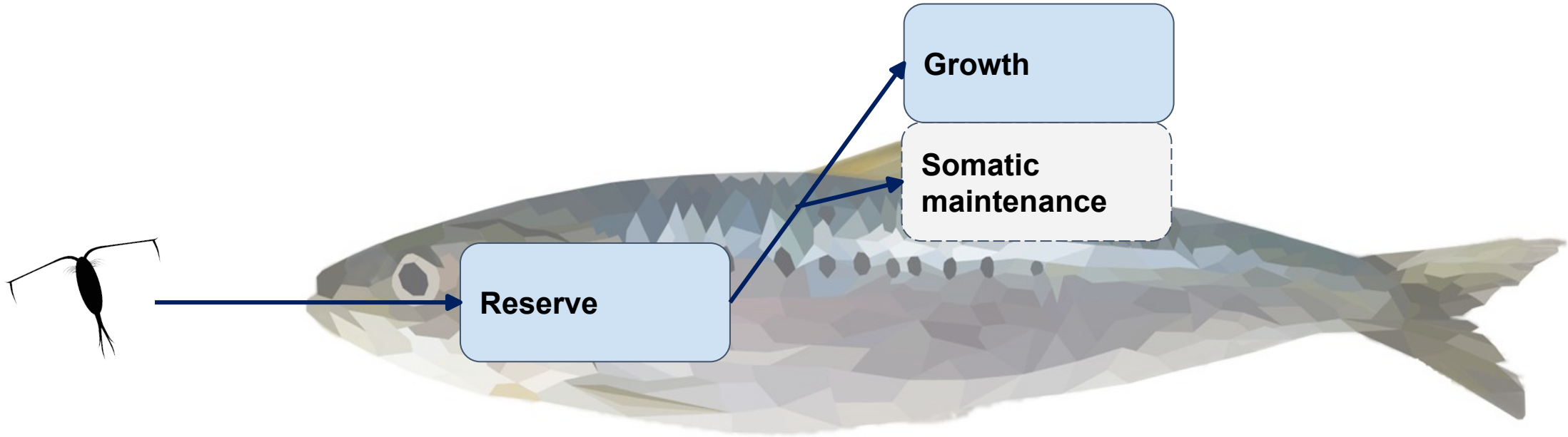
SC1 : decrease in quantity



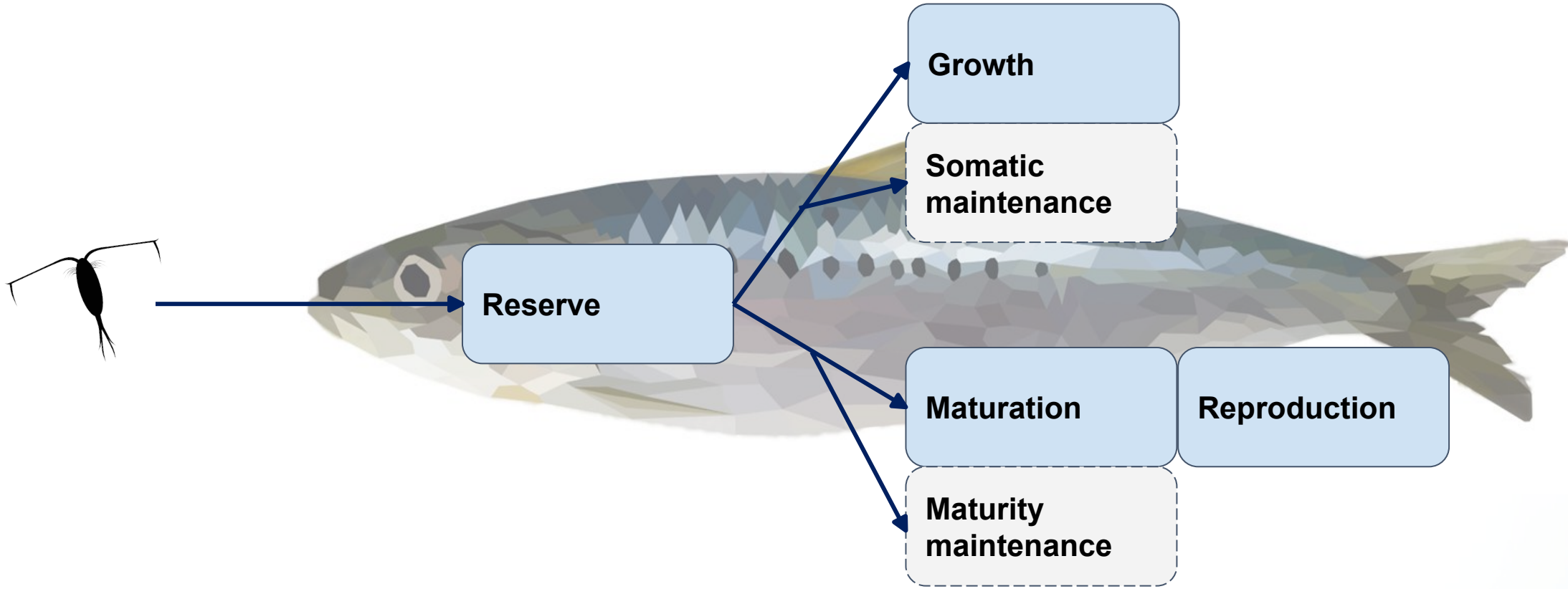
SC2 : decrease in quality



Dynamic Energy Budget theory (DEB)



Dynamic Energy Budget theory (DEB)



Reserve

Growth

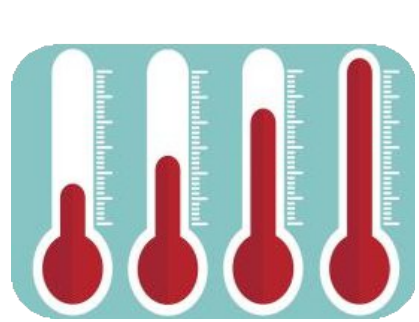
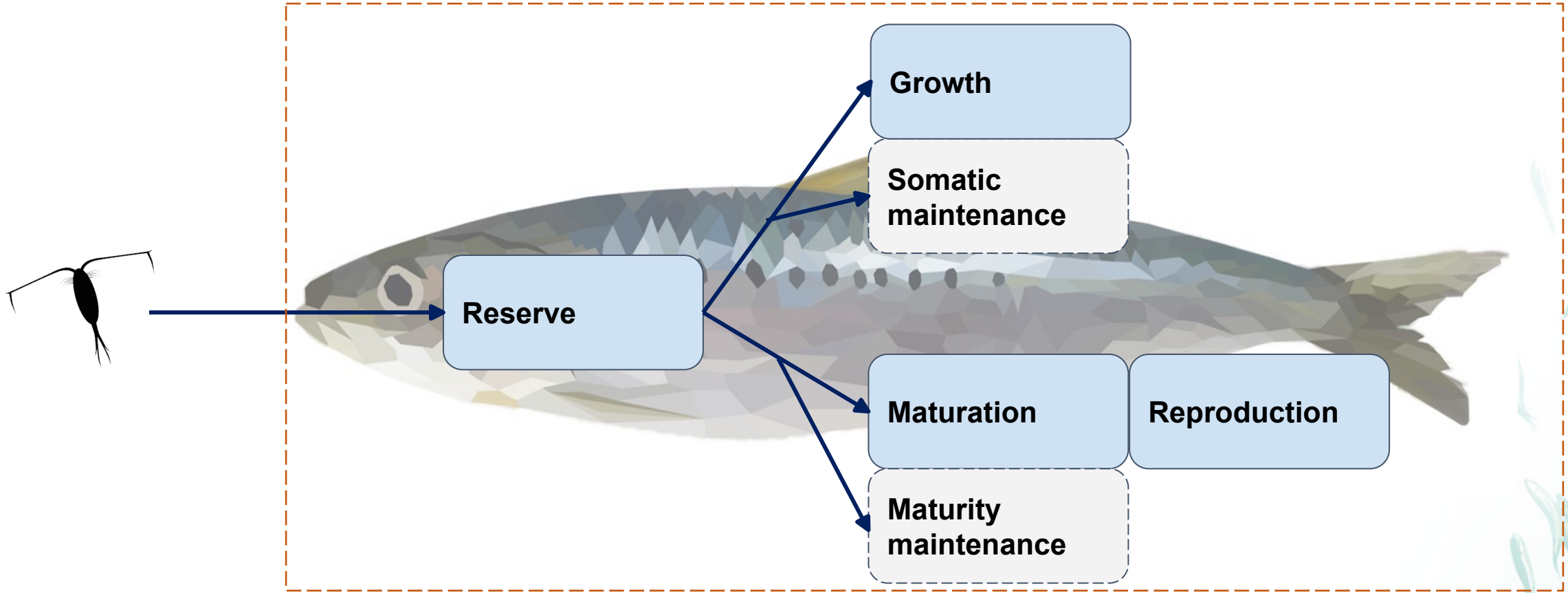
**Somatic
maintenance**

Maturation

Reproduction

**Maturity
maintenance**

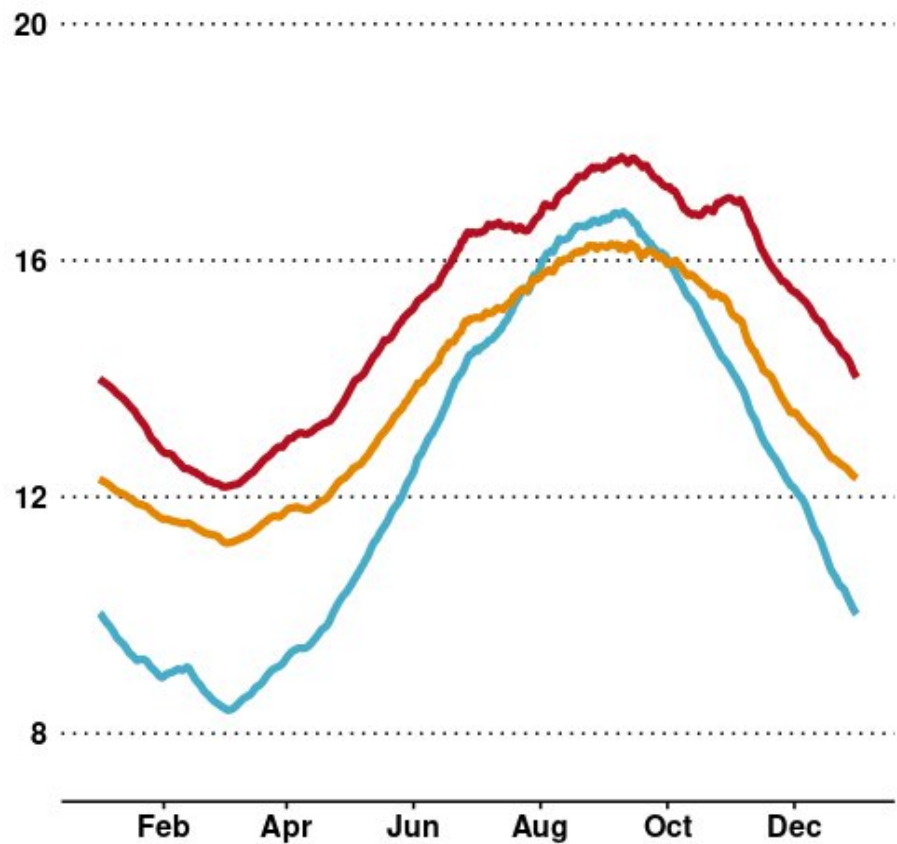
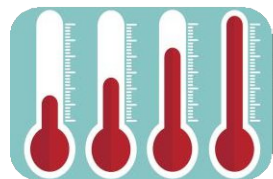
Dynamic Energy Budget theory (DEB)



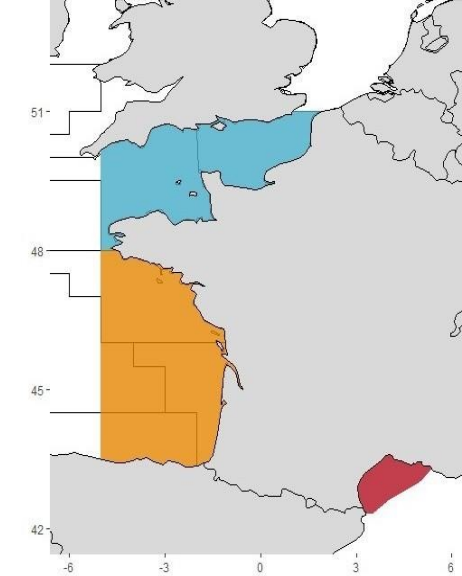
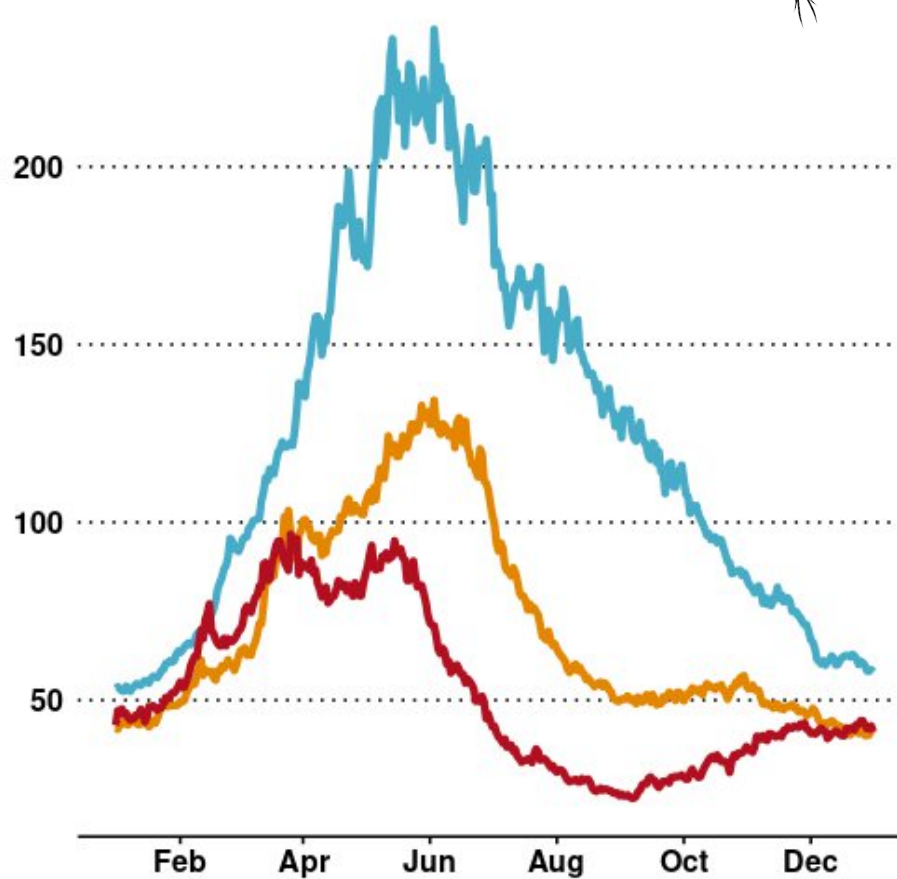
A strong spatial variability



Temperature (°C)



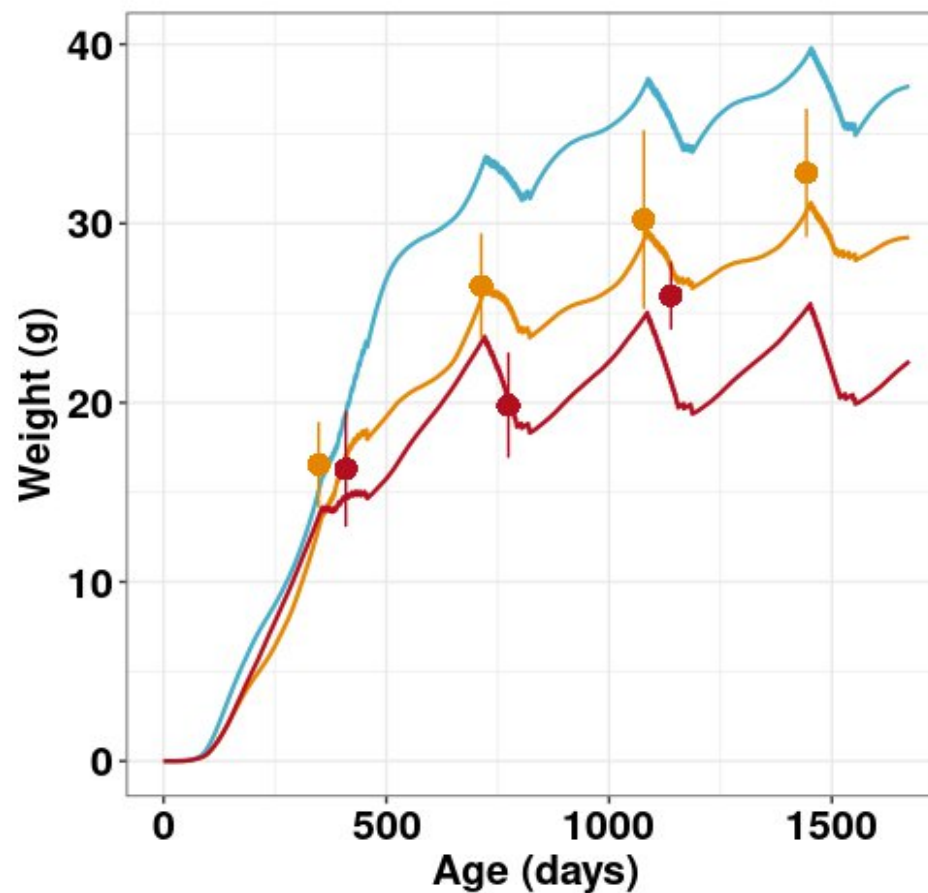
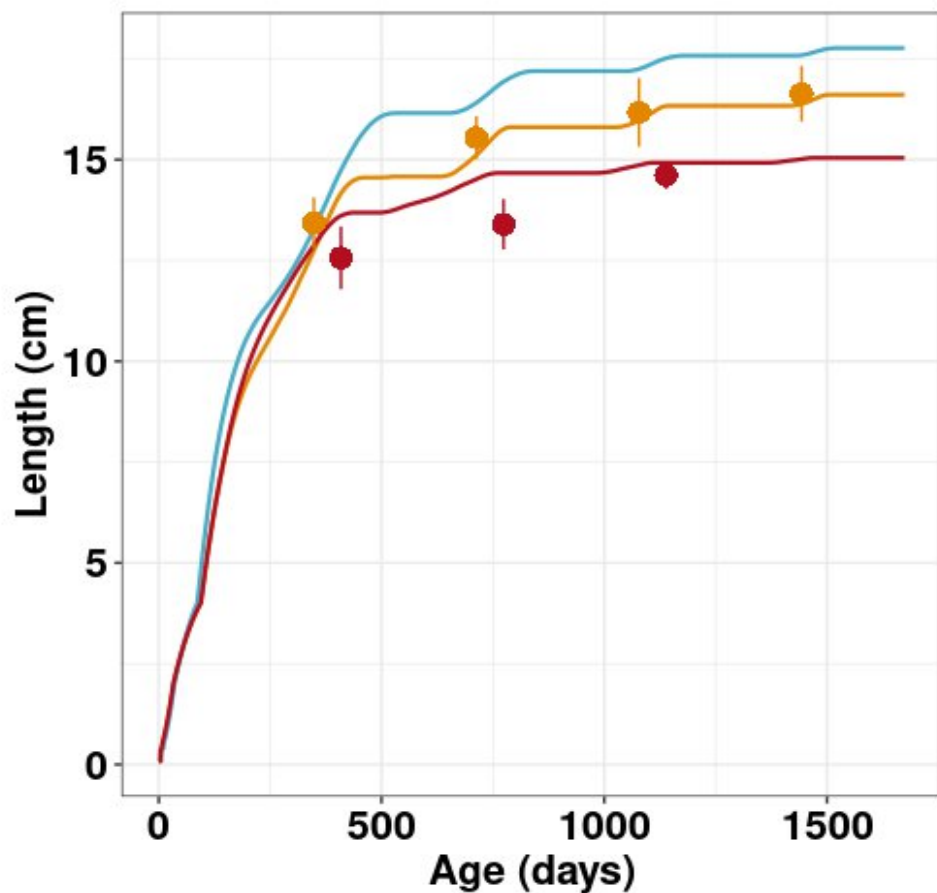
Zooplankton (mgC.m⁻³)



A strong spatial variability



Anchovy



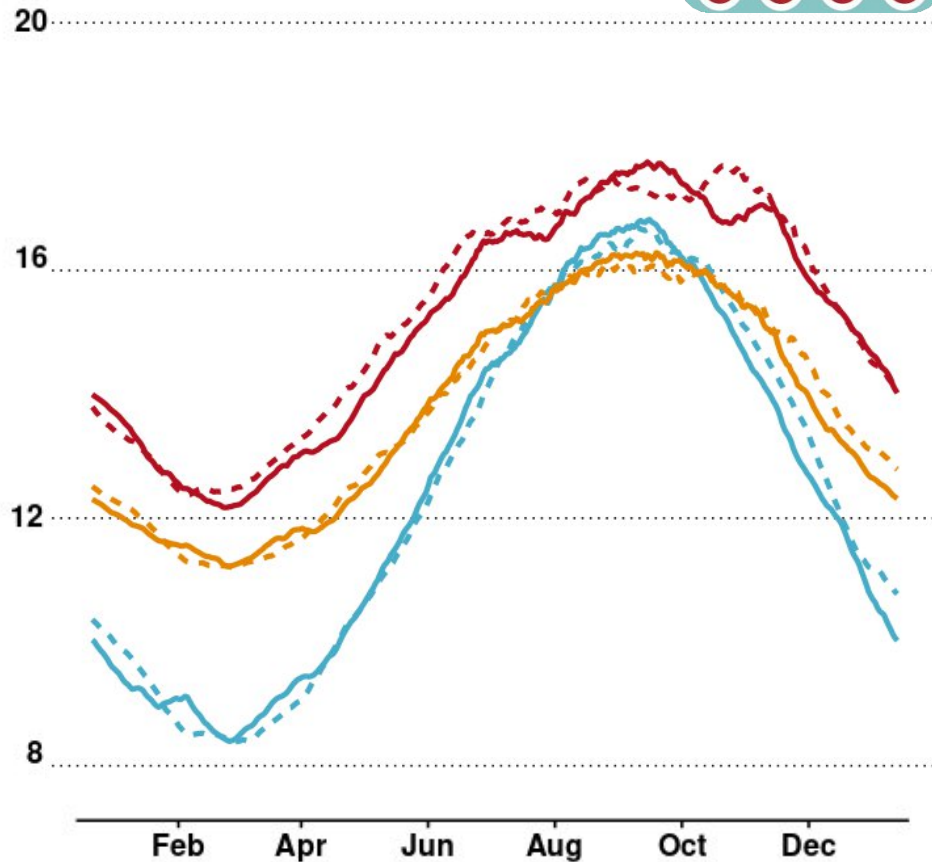
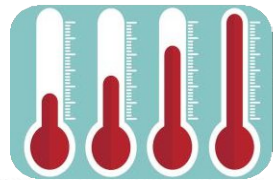
Area — English Channel — Bay of Biscay — Gulf of Lion

Period —●— 2000-2005 —▲— 2010-2015

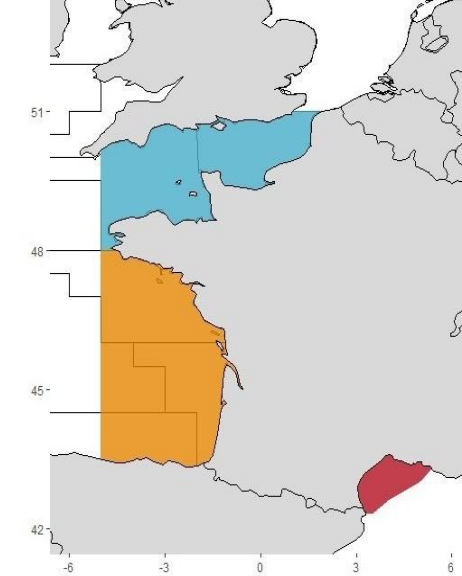
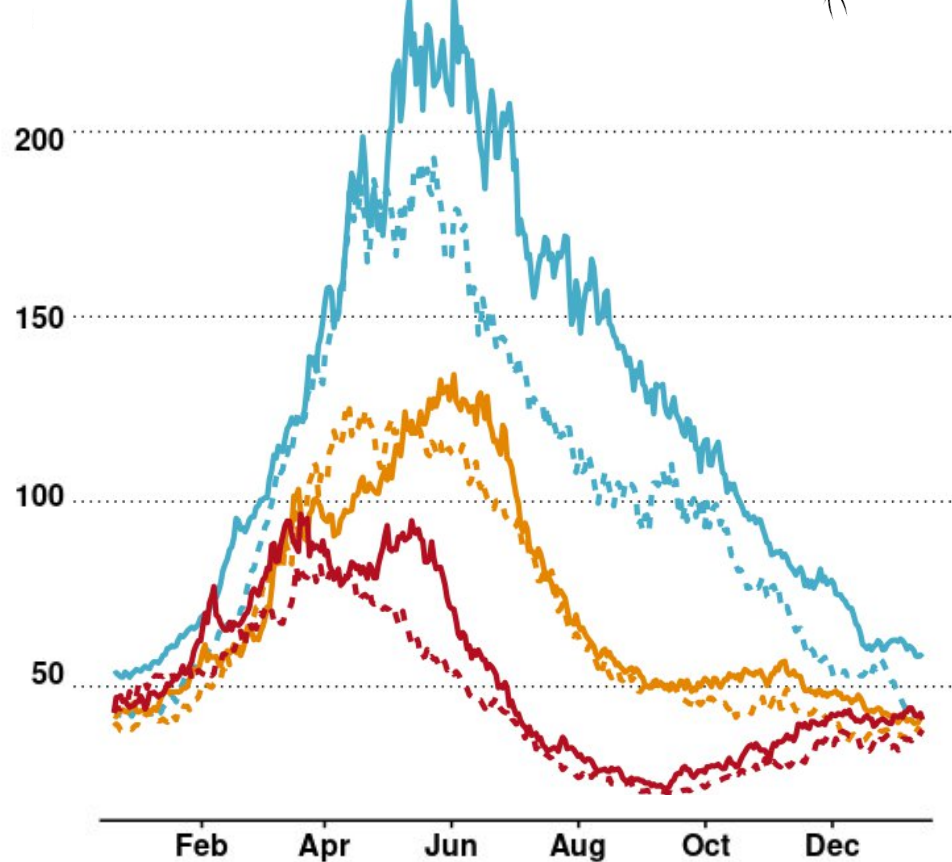
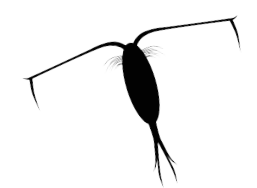
A low temporal variability



Temperature (°C)



Zooplankton (mgC.m⁻³)

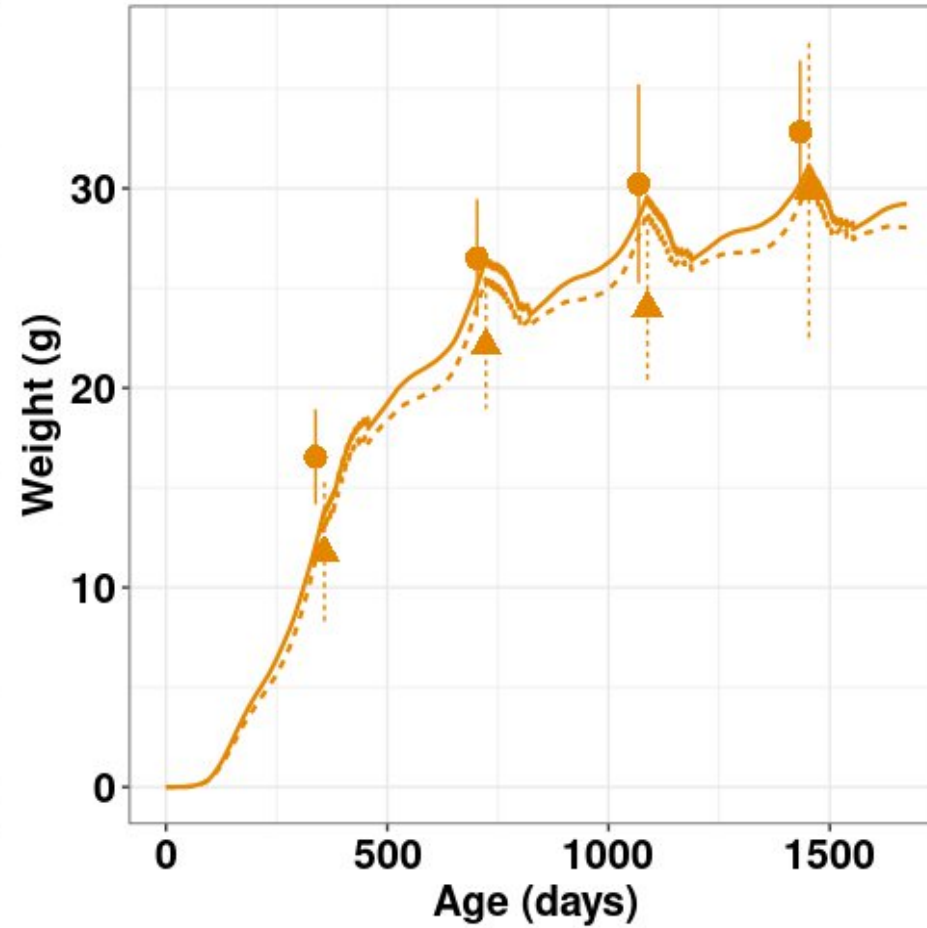
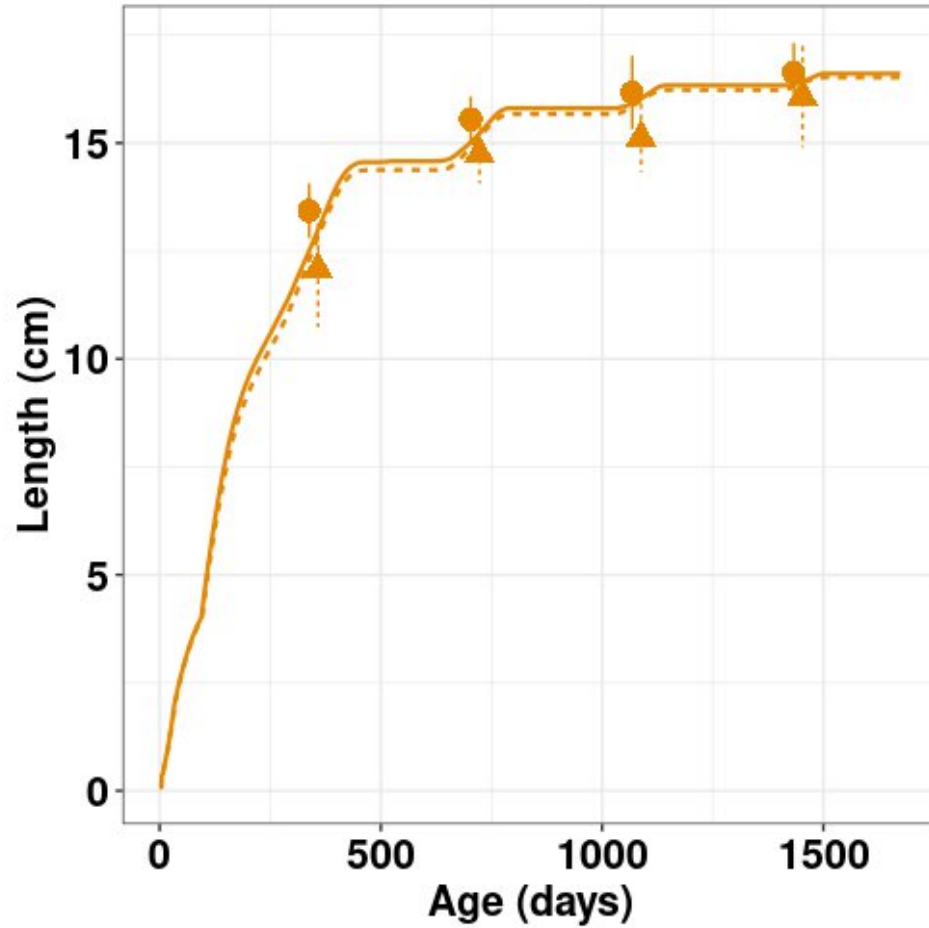


Period — 2000-2005 2010-2015



A low temporal variability

Anchovy



Area — English Channel — Bay of Biscay — Gulf of Lion

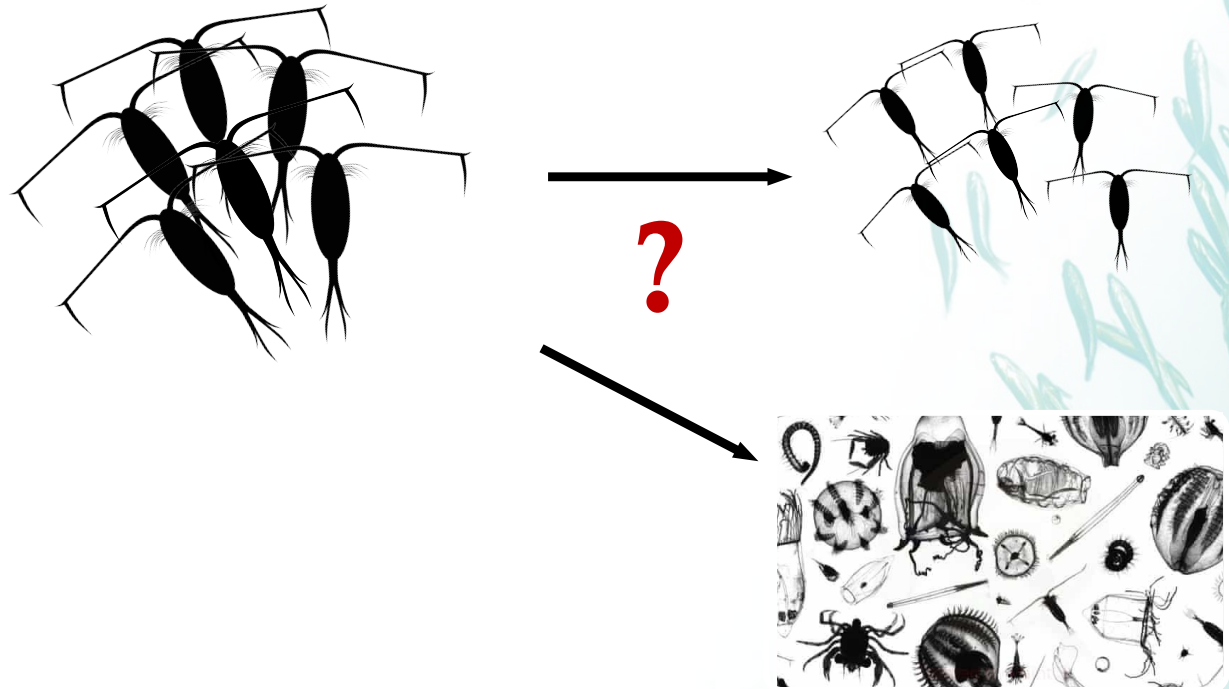
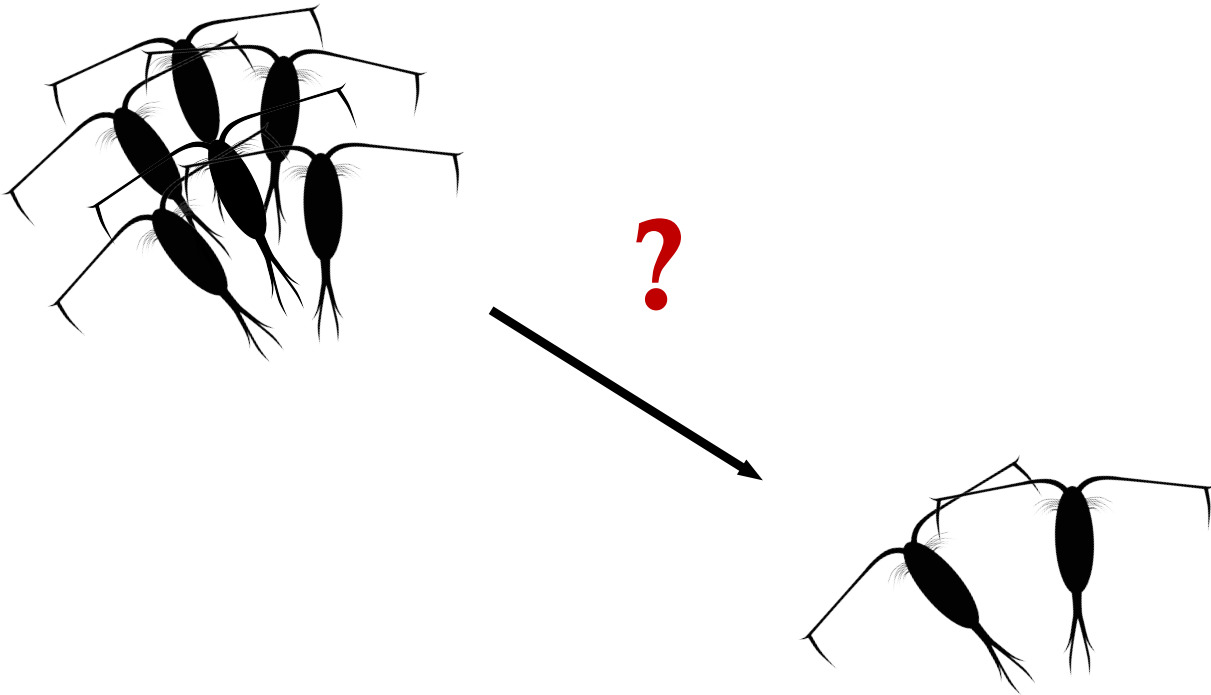
Period —●— 2000-2005 —▲— 2010-2015

Scenario : a change in zooplankton



SC1 : decrease in quantity

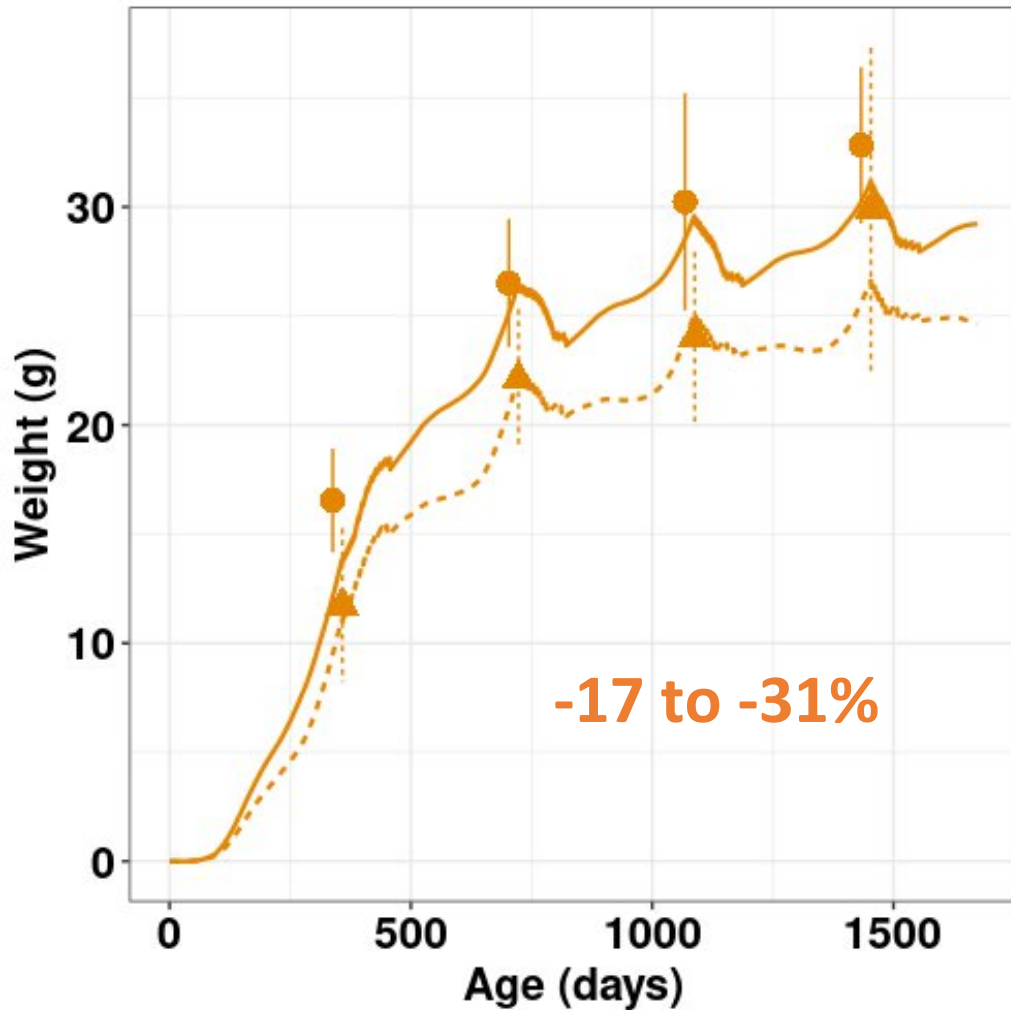
SC2 : decrease in quality



Scenario : a change in zooplankton



SC1 : decrease in quantity



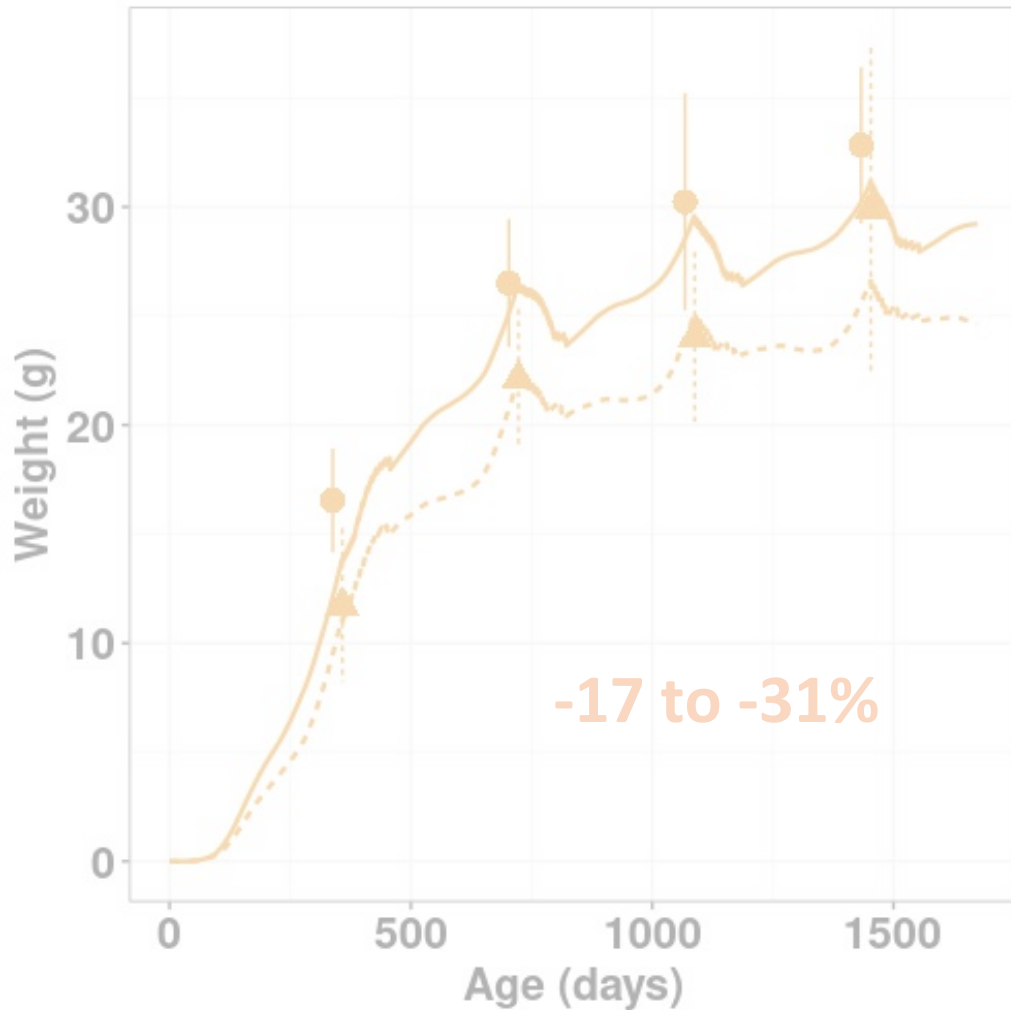
SC2 : decrease in quality



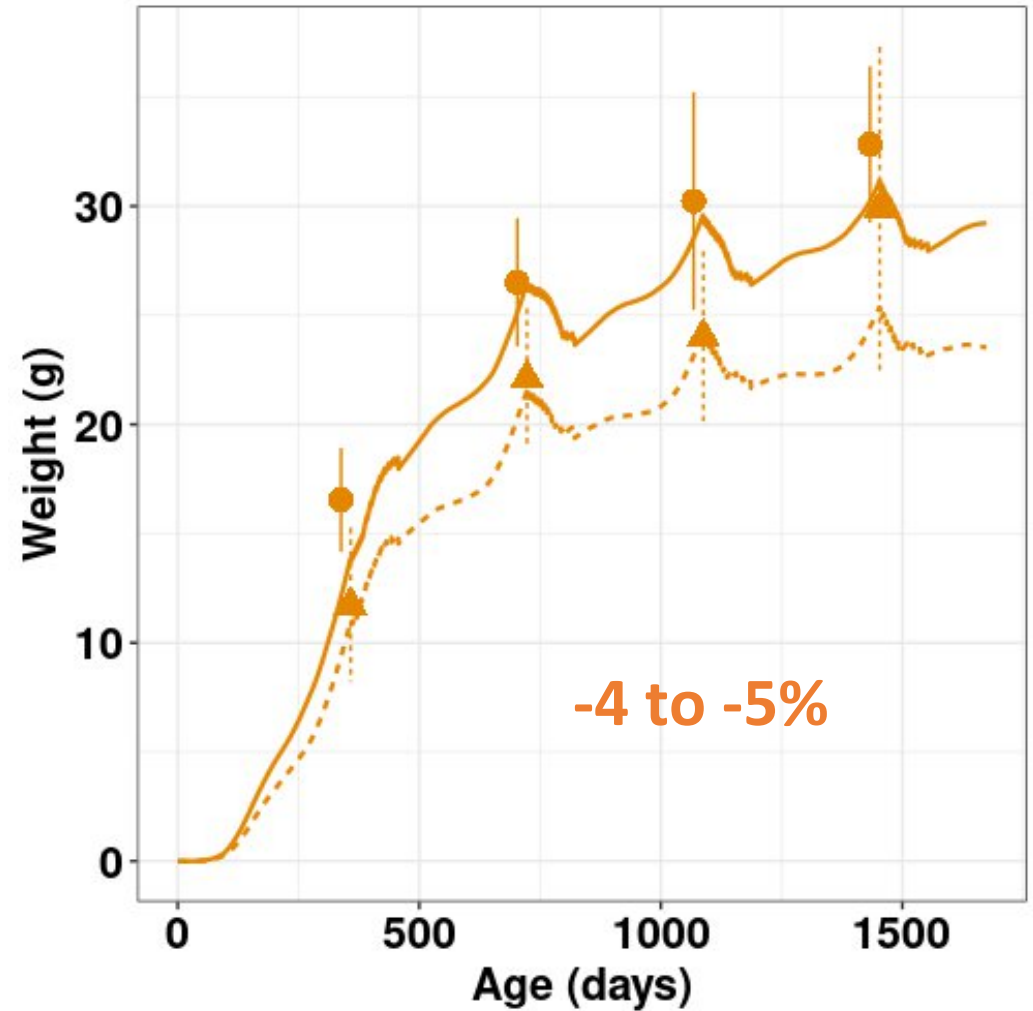
Scenario : a change in zooplankton



SC1 : decrease in quantity



SC2 : decrease in quality

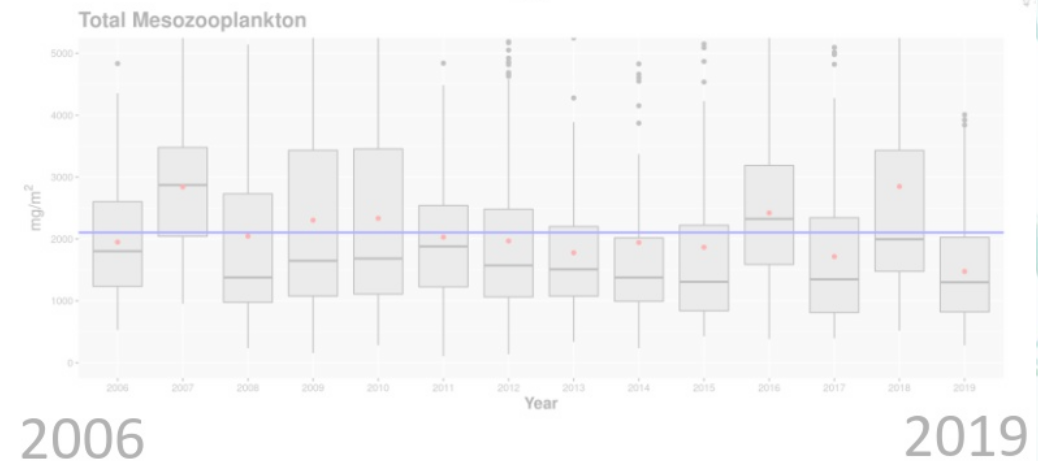


Discussion



A change in **planktonic communities**
(quantity and/or quality)

- Decrease in **quantity**: **-17 to -31%** in the Bay of Biscay in 10 years
Realistic ?



(Schmidt et al., 2020)

Discussion

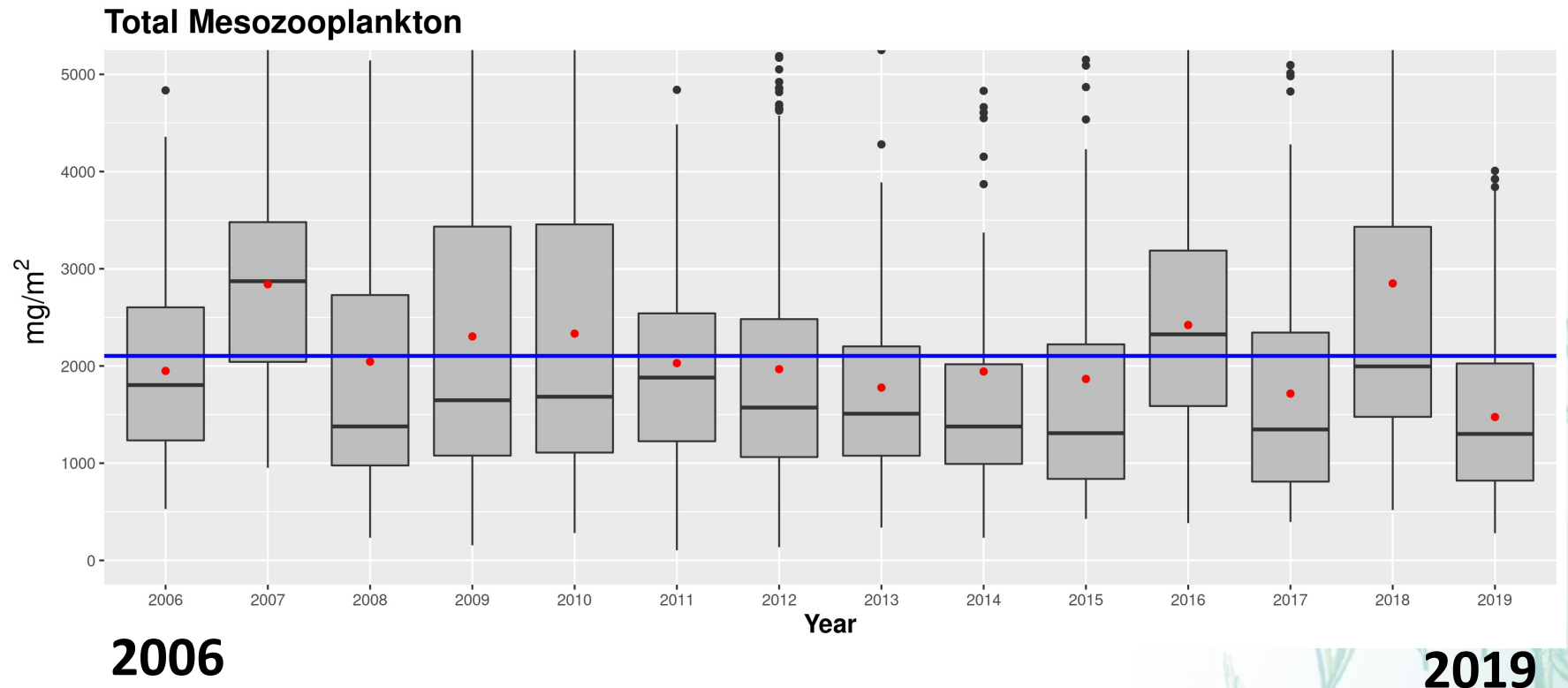


A change in **planktonic communities**
(quantity and/or quality)

- Decrease in **quantity**: **-17 to -31%** in the Bay of Biscay in 10 years

PELGAS

No temporal trend in
mesozoo biomass



Discussion



A change in **planktonic communities**
(quantity and/or quality)

- Decrease in **quality** : **-4 à -5%** in the Bay of Biscay
-15 à -17% in the Gulf of Lion

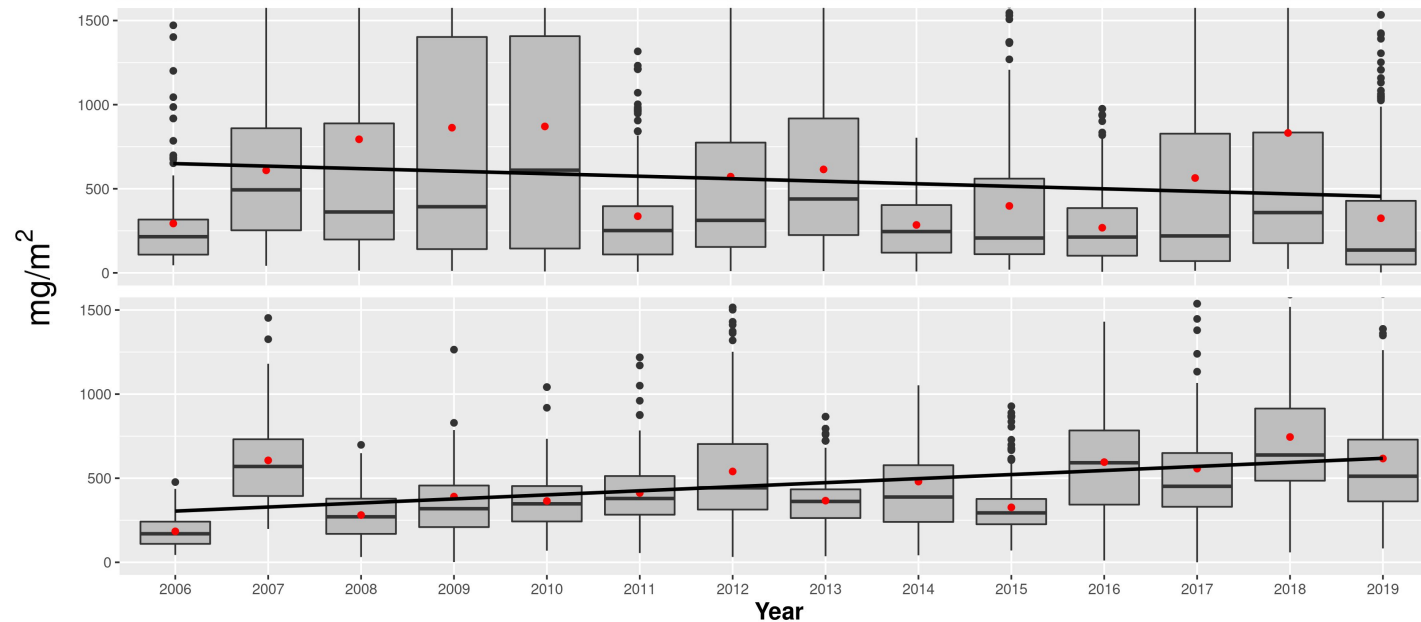


Discussion



A change in **planktonic communities**
(quantity and/or quality)

- Decrease in **quality** : **-4 à -5%** in the Bay of Biscay
-15 à -17% in the Gulf of Lion



PELGAS

– Decrease 1000 > zoo > 2000 µm
(biomass)

– Increase 200 > zoo > 500 µm
(biomass)

2006

2019

Individual to population scale



- **Planktonic communities** (quantity and/or quality)
 - Impact on population dynamics ?
(DEB-IBM)

Individual to population scale



- **Planktonic communities** (quantity and/or quality)
 - Impact on population dynamics ?
(DEB-IBM)
- **Density-dependence** impacting growth

Individual to population scale

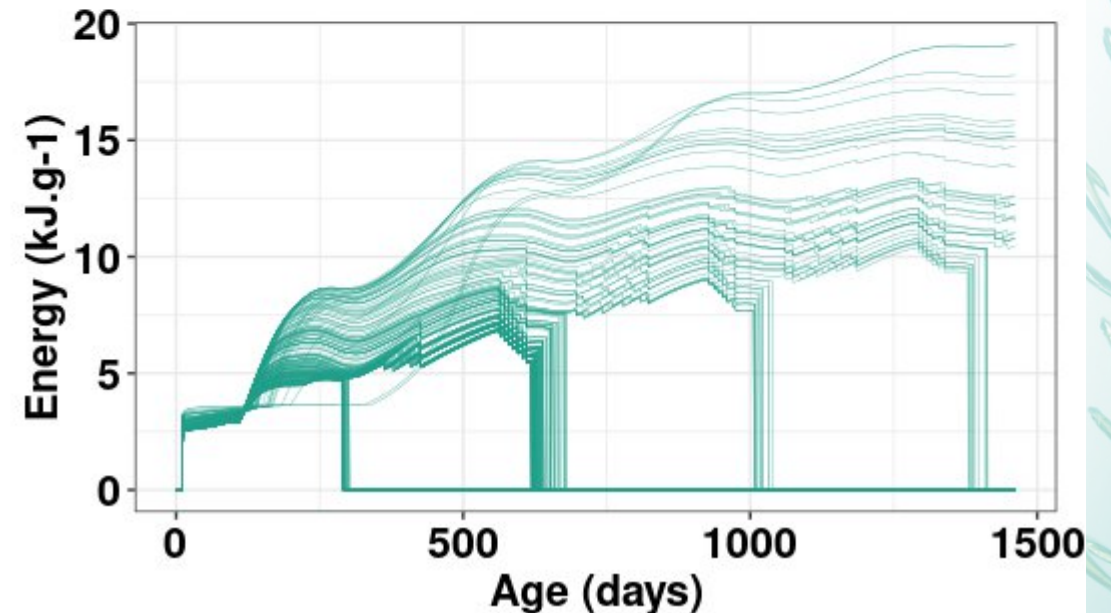
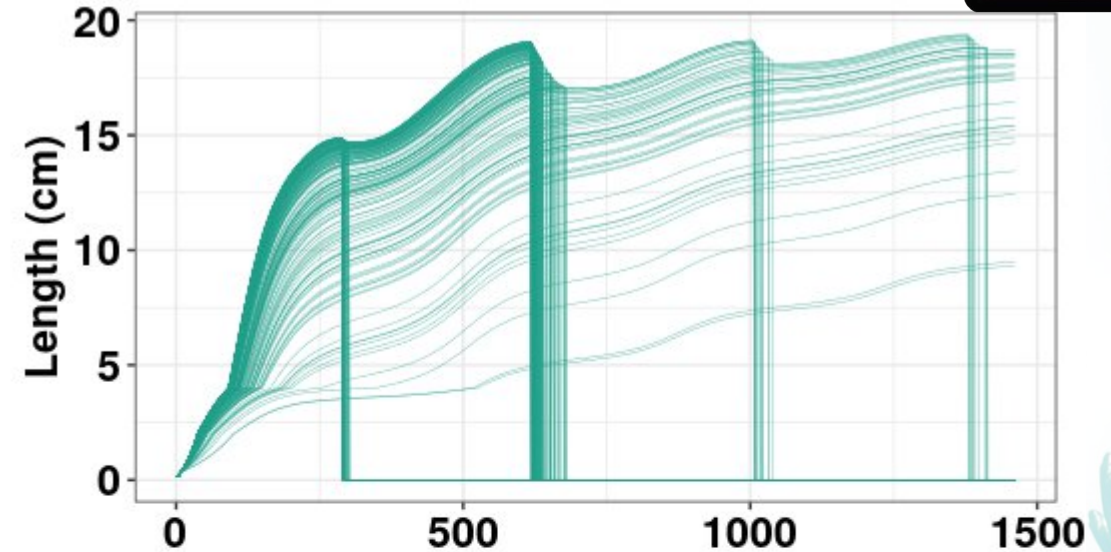


- **Planktonic communities** (quantity and/or quality)
 - Impact on population dynamics ?
(DEB-IBM)
- **Density-dependence** impacting growth
- **Selective mortality** according to size or body condition
 - Inter-individual variability (DEB parameters)

Individual to population scale

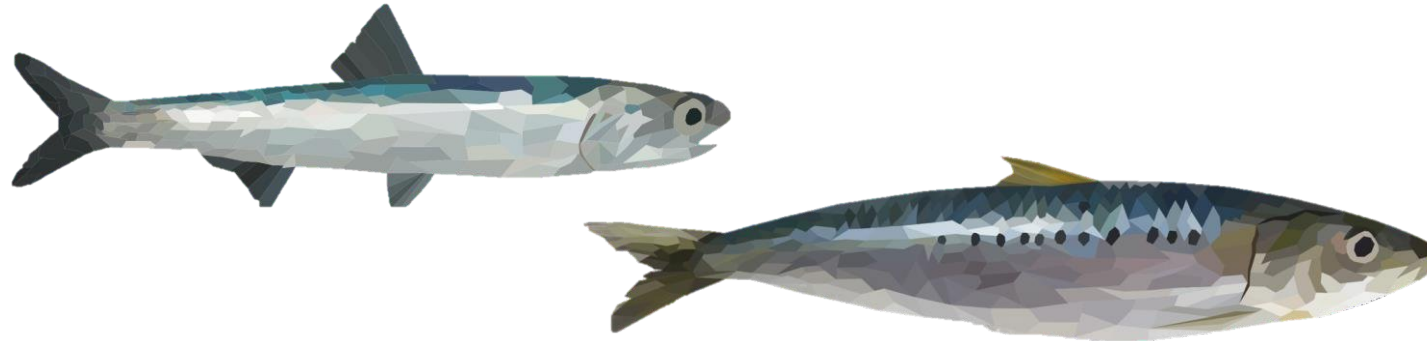


- **Planktonic communities** (quantity and/or quality)
 - Impact on population dynamics ? (DEB-IBM)
- **Density-dependence** impacting growth
- **Selective mortality** according to size or body condition
 - Inter-individual variability (DEB parameters)



(Bueno-Pardo et al., 2020 ; Boëns, 2022)

Thank you for your attention



Clara Menu

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