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## Mesozooplankton variability in the Bay of Marseille (NW Mediterranean): towards understanding the trophic context of small pelagics

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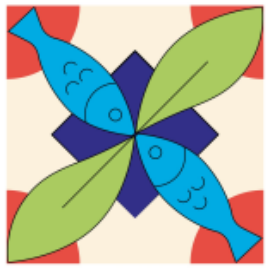
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**SIBECOL**  
**AIL** MEETING  
2022  
3-8 JULY AVEIRO

# Mesozooplankton variability in the Bay of Marseille (NW Mediterranean): towards understanding the trophic context of small pelagics.

**GARCIA Théo**, BĂNARU Daniela, GUILLOUX Loïc, CORNET Véronique, GREGORI Gérald, PERAUD Manon, CARLOTTI François

Institut Méditerranéen d'Océanographie, Aix-Marseille Université, campus Luminy, 13288 Marseille

Financial support: Région PACA (90%), Parc National des Calanques (10%)

Région



Provence-Alpes-Côte d'Azur



## The Bay of Marseille: a particular environment

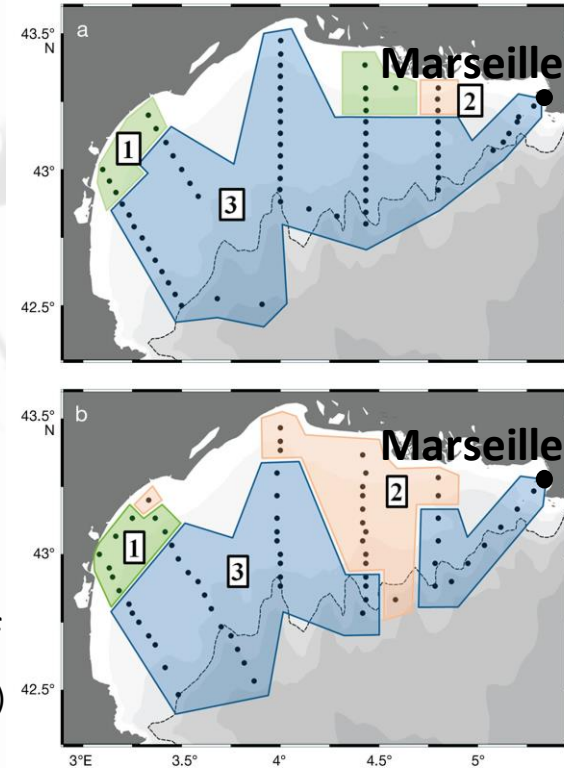


- Under coastal influence...
  - Anthropic pressures
  - Punctual phenomena
- ...and offshore influence:
  - Intrusion of North current
  - Deep convection

# The Bay of Marseille: a particular environment



- Under coastal influence...
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    - Deep convection
- Zooplanktonic habitats characteristic of continental shelf of the Gulf of Lion (Espinasse et al. 2014)





# The Bay of Marseille: a particular environment



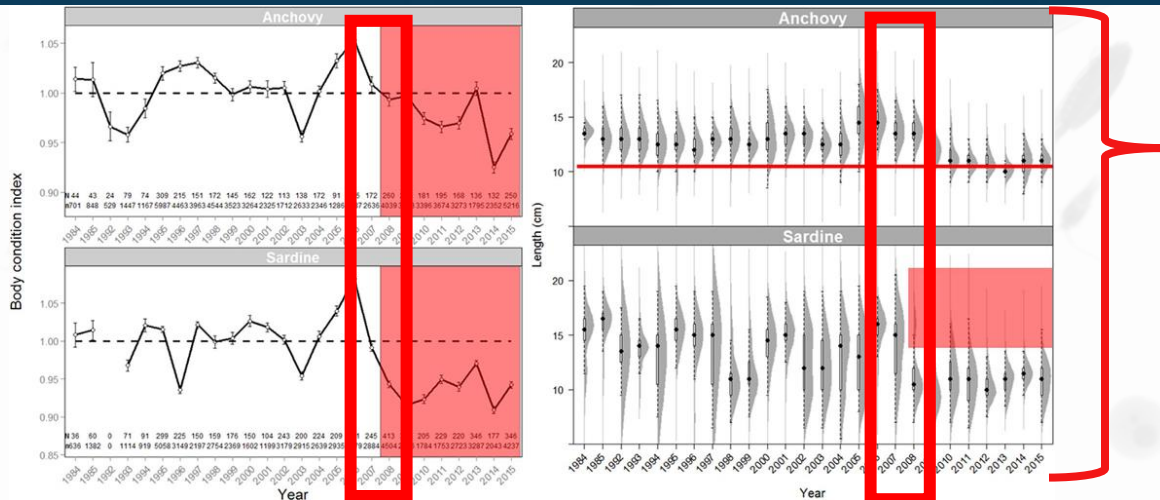
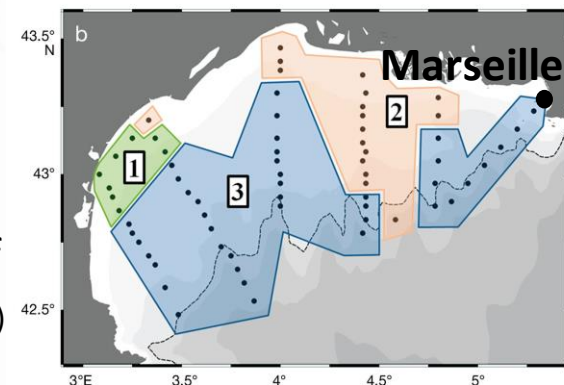
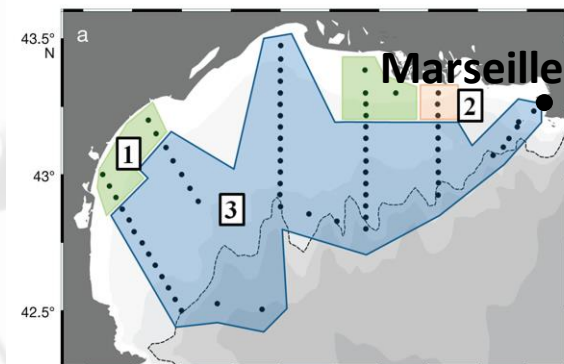
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➤ Zooplanktonic habitats characteristic of continental shelf of the Gulf of Lion (Espinasse et al. 2014)

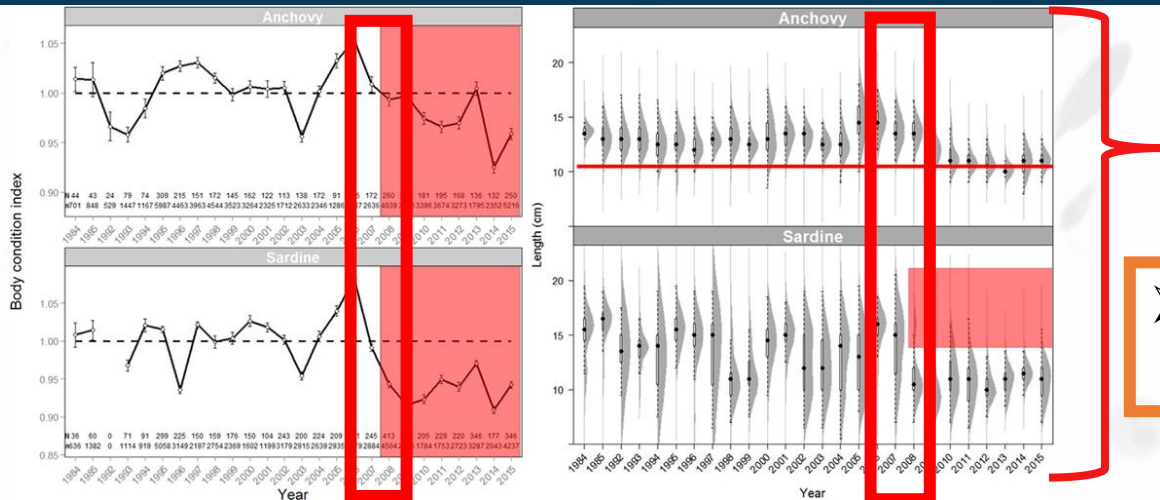
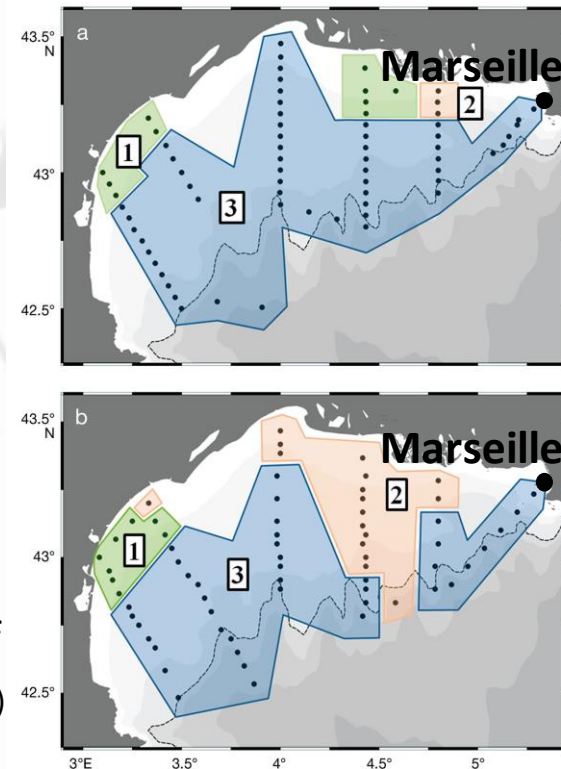


In parallel, diminution of body condition of small pelagic fish in the Gulf of Lion, around 2008 (van Beveren et al. 2014, Saraux et al. 2019)

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In parallel, diminution of body condition of small pelagic fish in the Gulf of Lion, around 2008 (Van Beveren et al. 2014, Saraux et al. 2019)

➤ Since 2005, bi-weekly monitoring of zooplankton and environmental conditions (SOMLIT) in the Bay of Marseille.

The Bay of Marseille monitoring allow to study the detailed biological and physico-chemical zooplankton environment.

### Biological and physico-chemical environment

Nature of the variable	Number of variables	Example
<b>Climatic index</b>	2	West Mediterranean Oscillations
<b>Meteorological</b>	2	Precipitations
<b>Somlit (physico-chemical)</b>	12	Temperature, salinity, oxygene
<b>Microphytoplankton</b> <i>(2010-2013, 2016-2021)</i>	2	Ratio Diat:Dino
<b>Flow cytometry</b> <i>(since 2009)</i>	16	Abundance of picoplankton, picoplankton size
<b>TOTAL</b>	<b>34</b>	

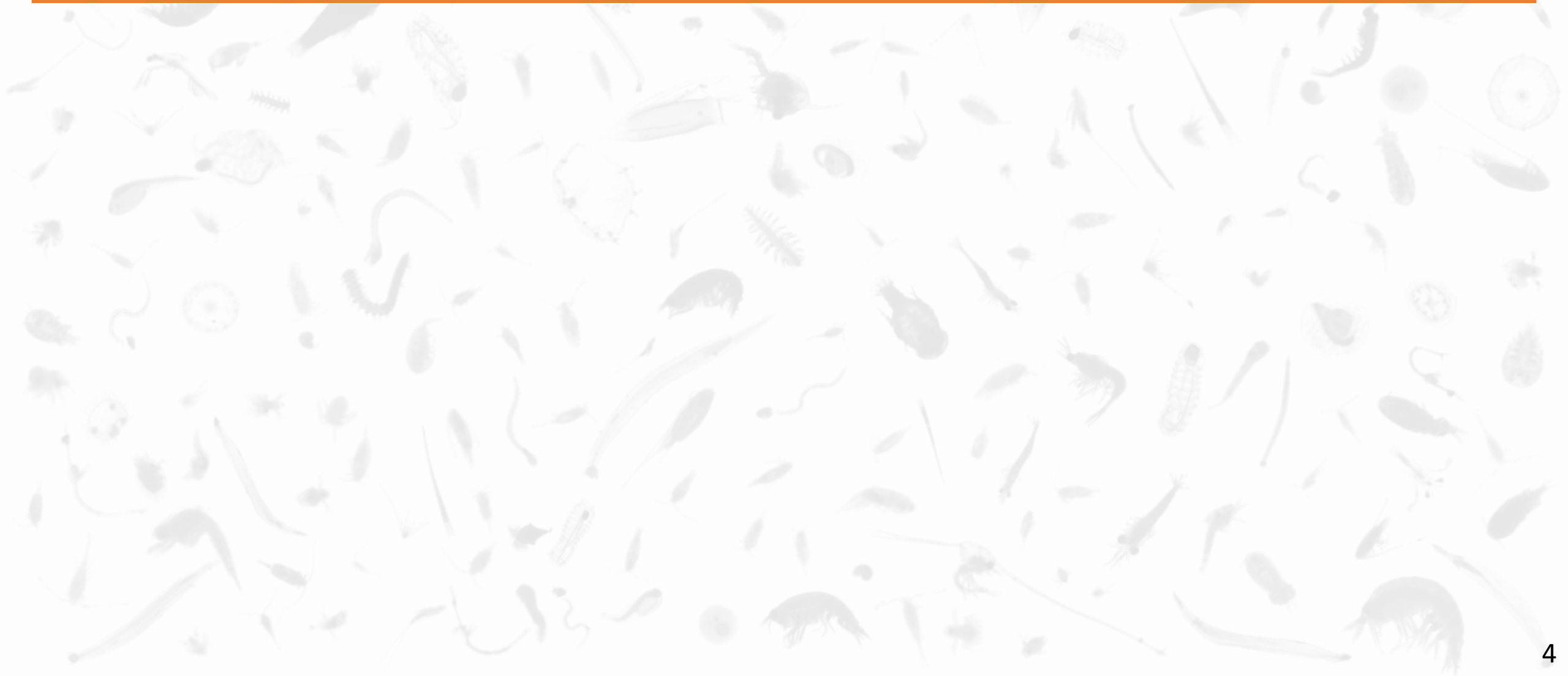
### Zooplankton compartment

Nature of the variable <i>(Acquisition mode)</i>	Nombre of variables	Example or remark
<b>Size class biomass</b> <i>(weighing)</i>	4	Biomass 200-300 $\mu\text{m}$
<b>Community structure</b> <i>(imaging)</i>	3	Indexes derived from abundance tables
<b>Size structure</b> <i>(imaging)</i>	2	Indexes derived from functional PCA of individual size
<b>Abundance</b> <i>(imaging)</i>	14	Abundance of <i>calanoids</i> , total zooplankton
<b>TOTAL</b>	<b>23</b>	



## Aims:

- To explore different modes of zooplankton variations and their link with environmental modification.
- To furnish elements at the understanding of trophic context of small pelagic fish.





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- Interannual evolution
  - Zooplankton: *moving average and shift detection*
  - Link with the environment: *Dynamic factor analysis (DFA)*
- Seasonal variations
  - Zooplankton: *Level plot and dates of quantile 0.3*
  - Link with the environment: *Correlation 2 x 2 between dates of quantile 0.3 and winter mean of environmental variables*

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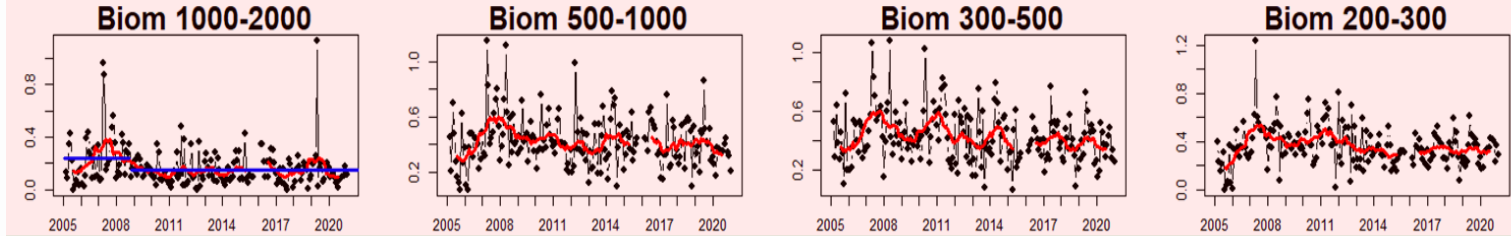
- **Zooplankton: *moving average and shift detection***
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- **Seasonal variations**

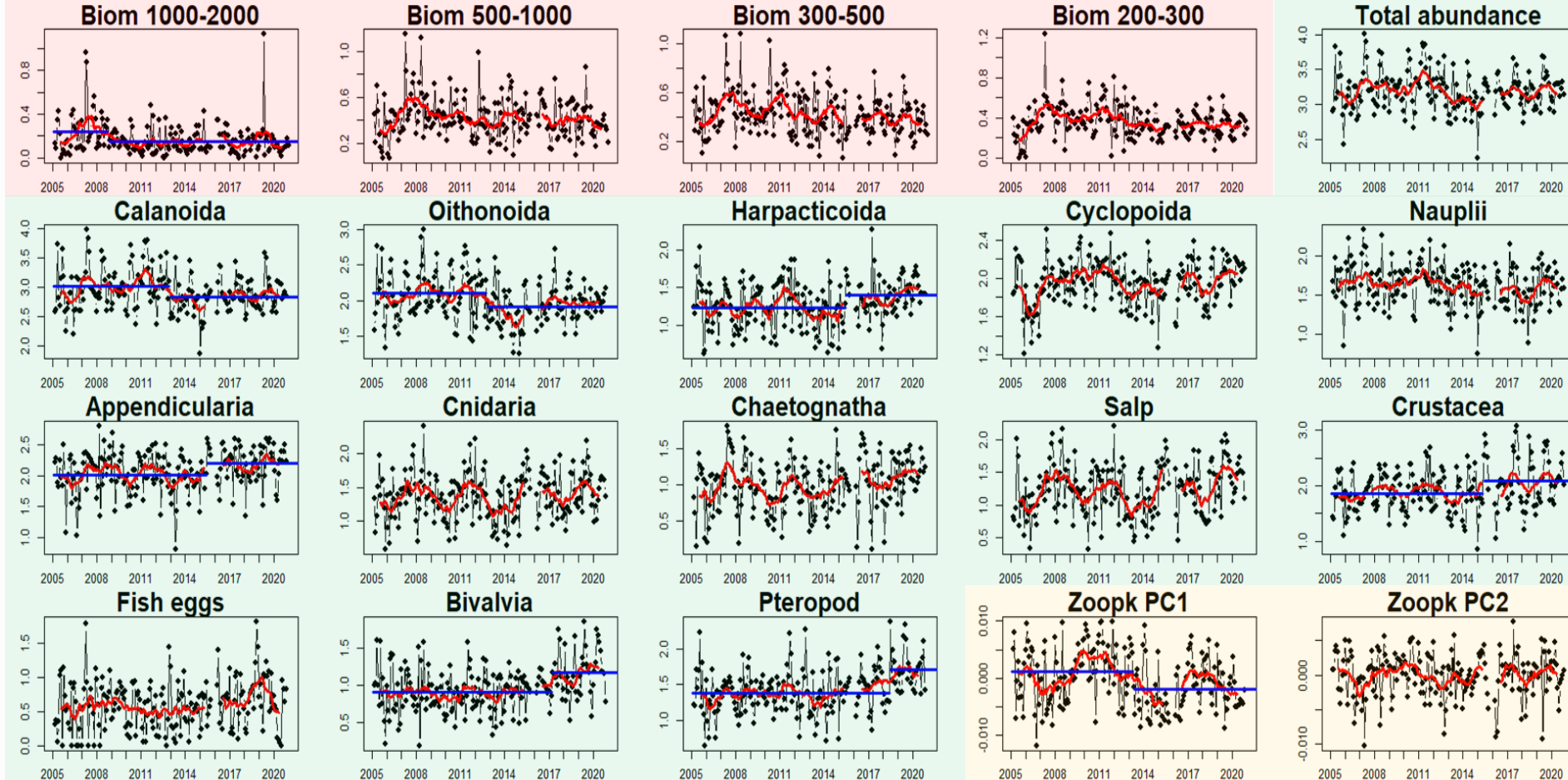
- Zooplankton: *Level plot and dates of quantile 0.3*
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# Univariate analysis of zooplankton series highlight multiple shifts and trends

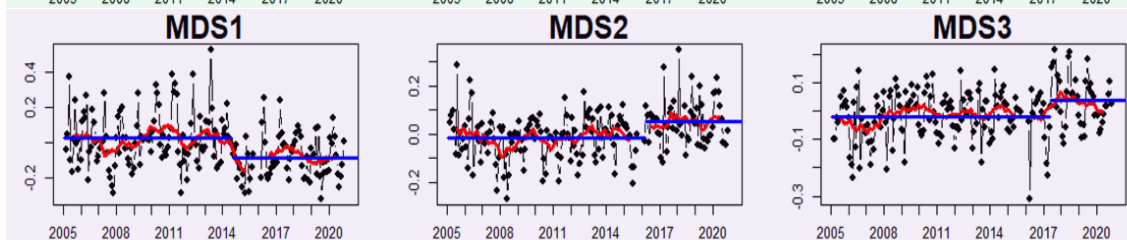
## Biomasses



## Abundances



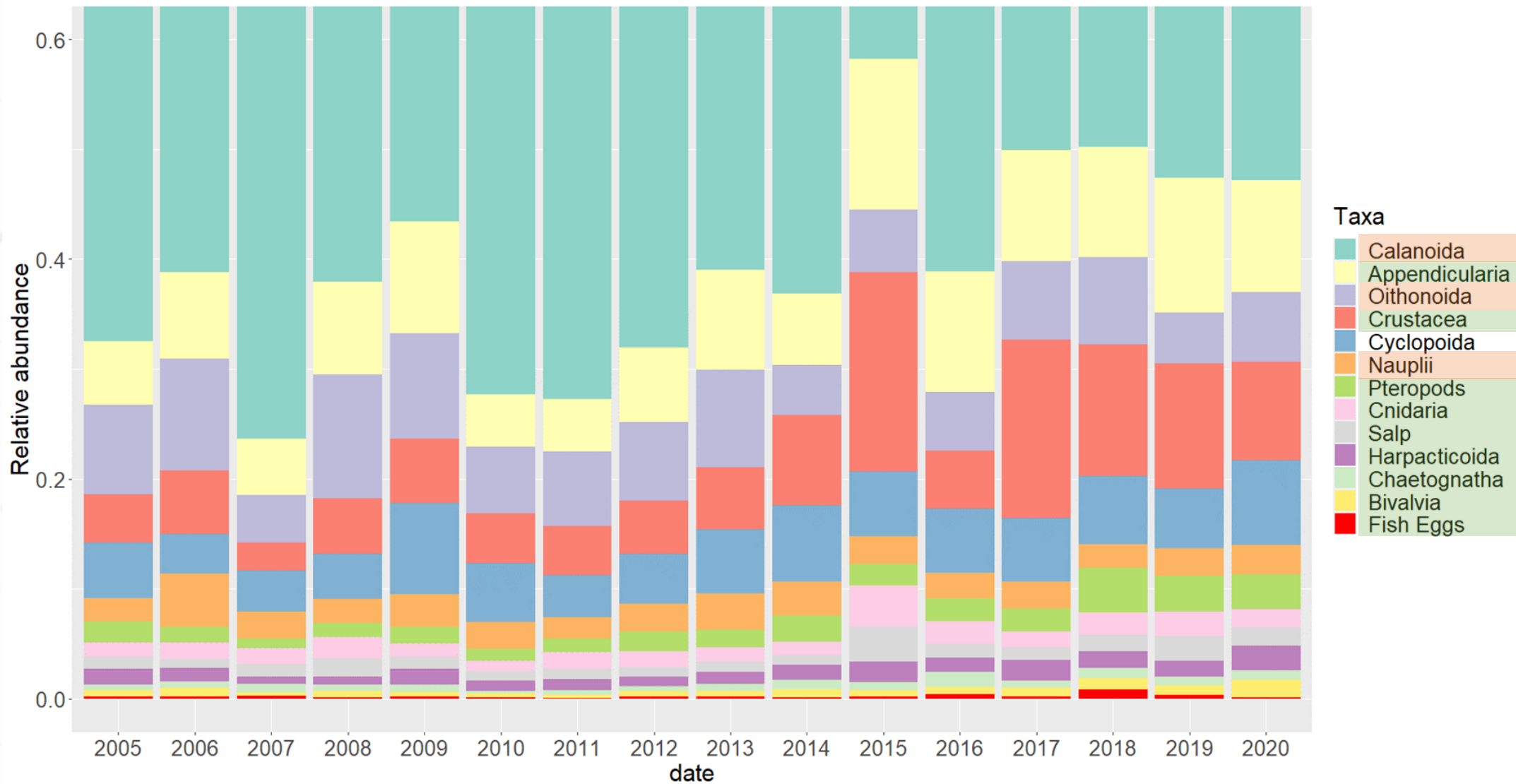
## Size structure



## Community structure

- biomasses
- abundances  
calanoids, nauplii  
copepods, oithonoids  
vs abundances of  
other groups
- Modification of size  
structure and  
community structure
- Multiple shifts  
between 2013-2014

# Univariate analysis of zooplankton series highlight multiple shifts and trends



➤ Diminution of calanoid and oithonoid relative abundance vs increase of other taxonomic groups.



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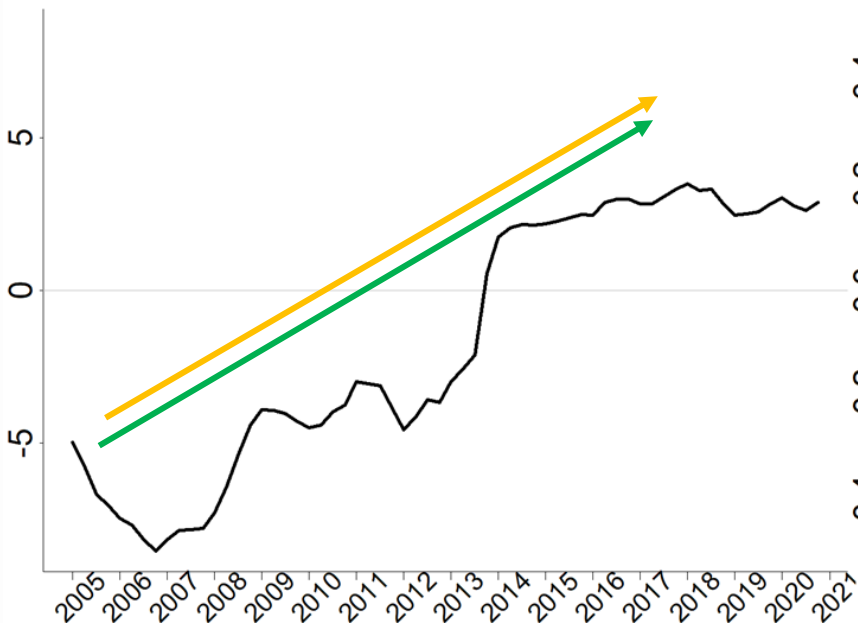
- Zooplankton: *moving average and shift detection*
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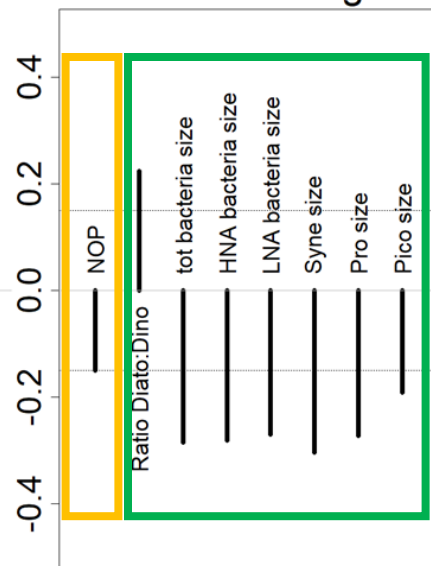
- Zooplankton: *Level plot and dates of quantile 0.3*
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# Trend analysis (DFA) of zooplankton environment variables evidenced 2 commons trends

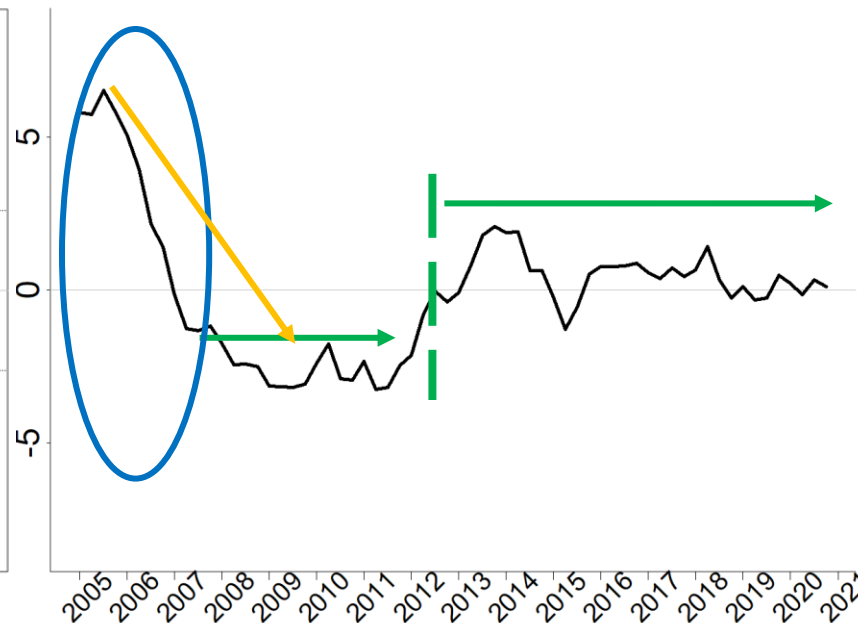
Environmental trend 1



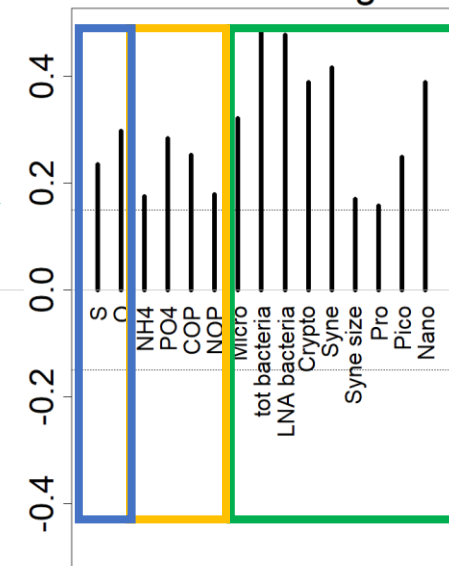
Factor loadings



Environmental trend 2



Factor loadings

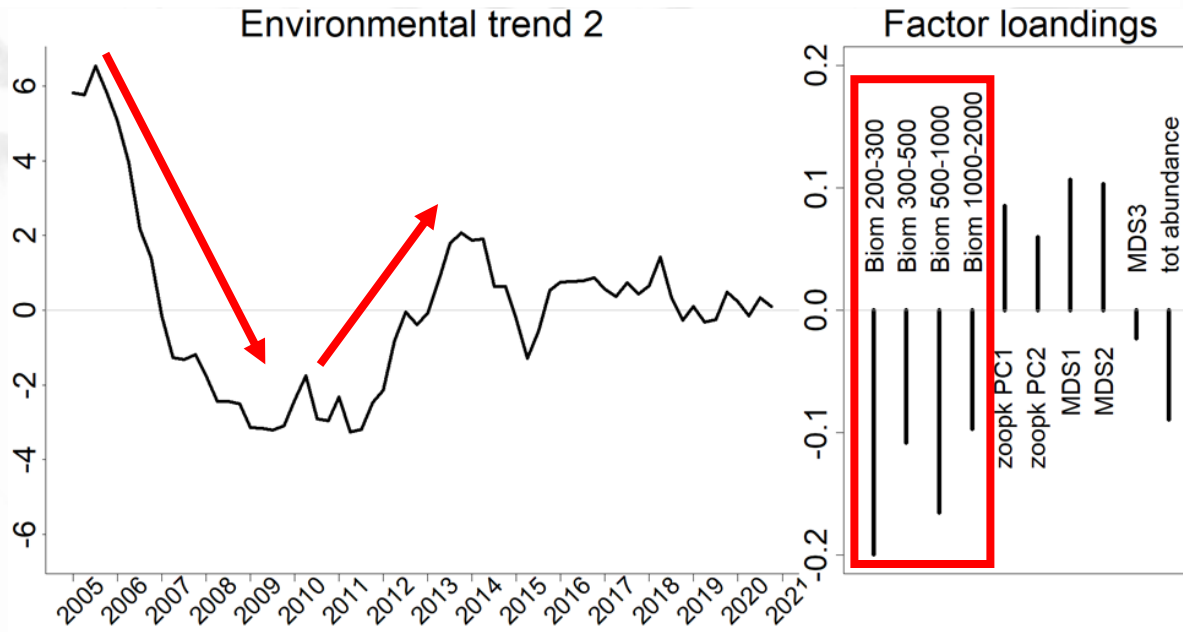
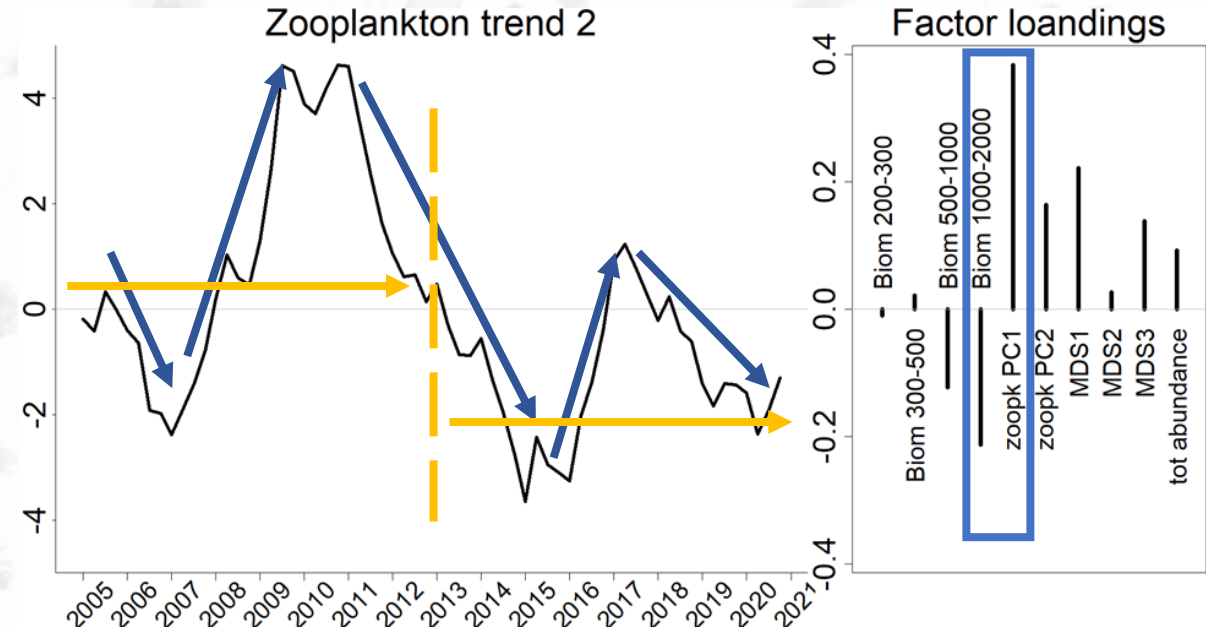
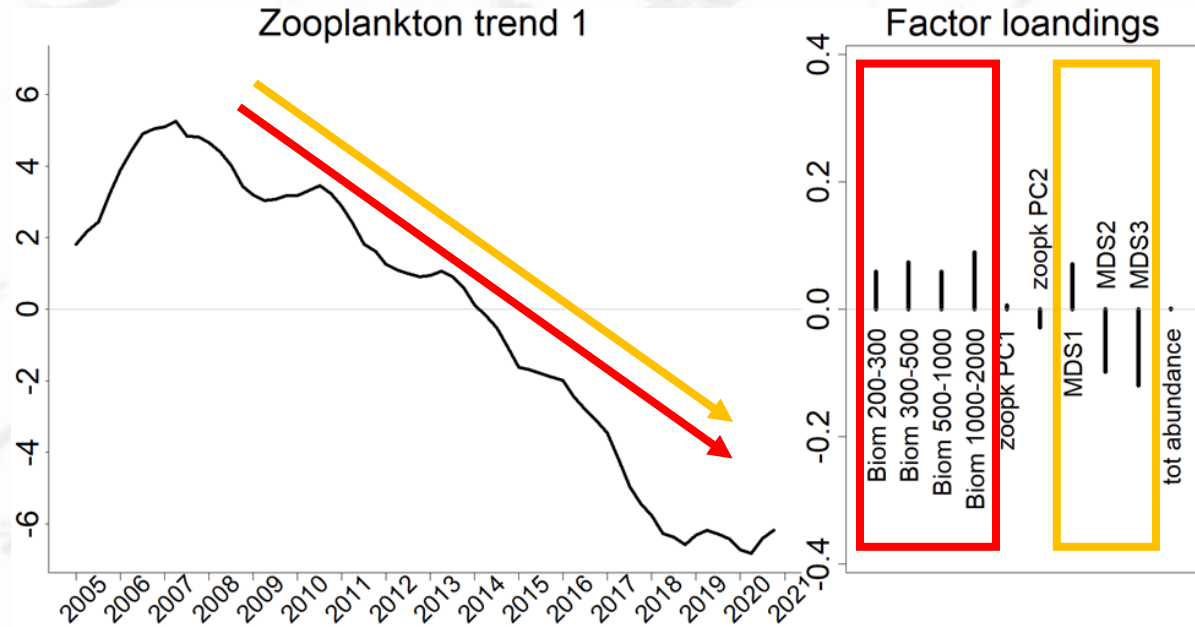


- ↘ of nutrients, particulate and detrital matter.

- Offshore signal of S and O between 2005-2007 (Mayot et al. 2017)

- Modifications of phytoplanktonic community:
  - ↗ abundance
  - ↘ of size
  - ↗ ratio diato : dino

# Trend analysis (DFA) of zooplankton variables evidenced 3 commons trends



- **2 trends inherent to zooplankton + 1 trend explained by environment:**

- biomass
- of size + modification of community structure
- Association between size structure and biomass of bigger size fraction (follow the diminution of bigger size class biomass in 2008)

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- Interannual evolution

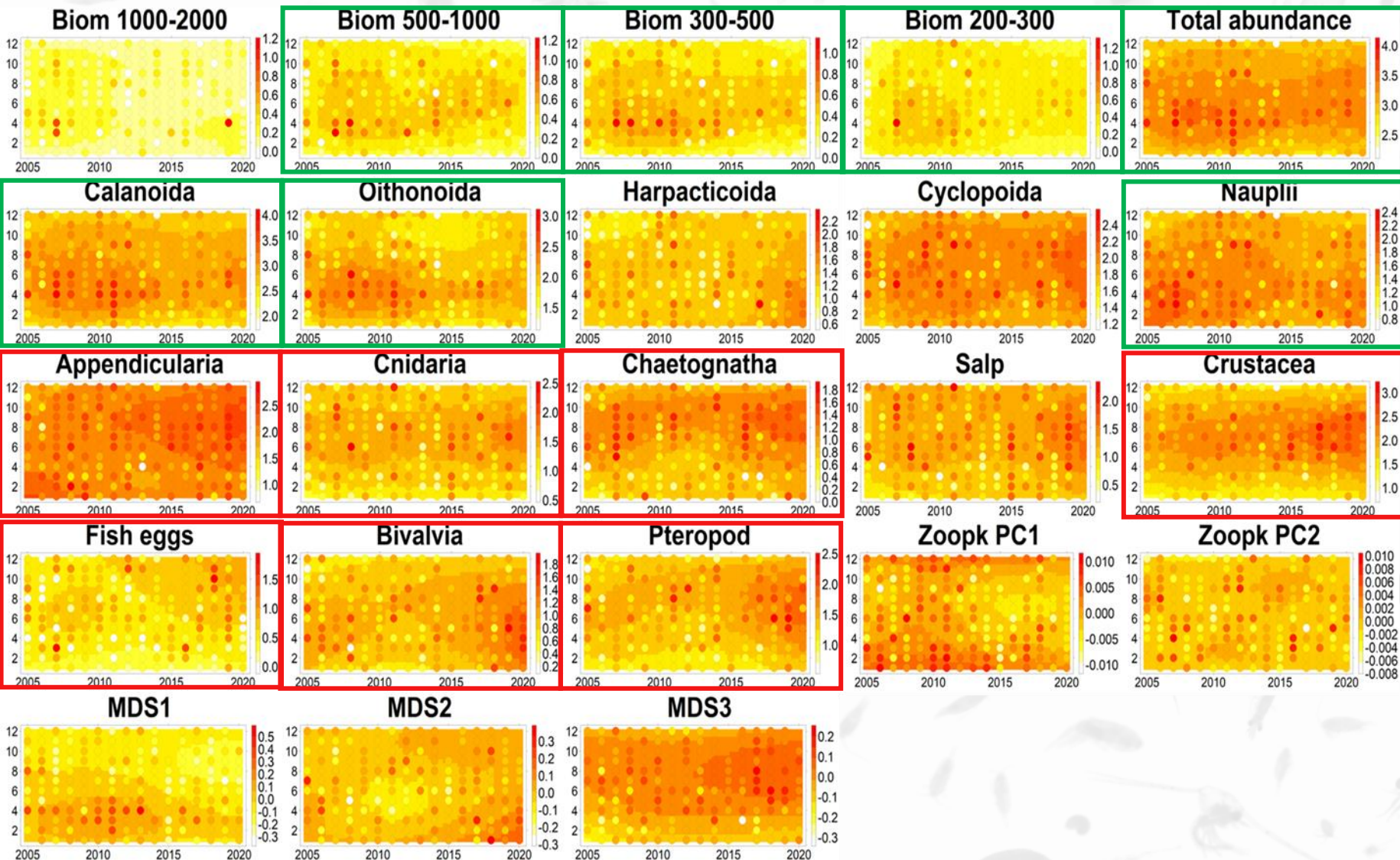
- Zooplankton: *moving average and shift detection*
- Link with the environment: *Dynamic factor analysis (DFA)*

- **Seasonal variations**

- **Zooplankton: *Level plot and dates of quantile 0.3***
- Link with the environment: *Correlation 2 x 2 between dates of quantile 0.3 and winter mean of environmental variables*



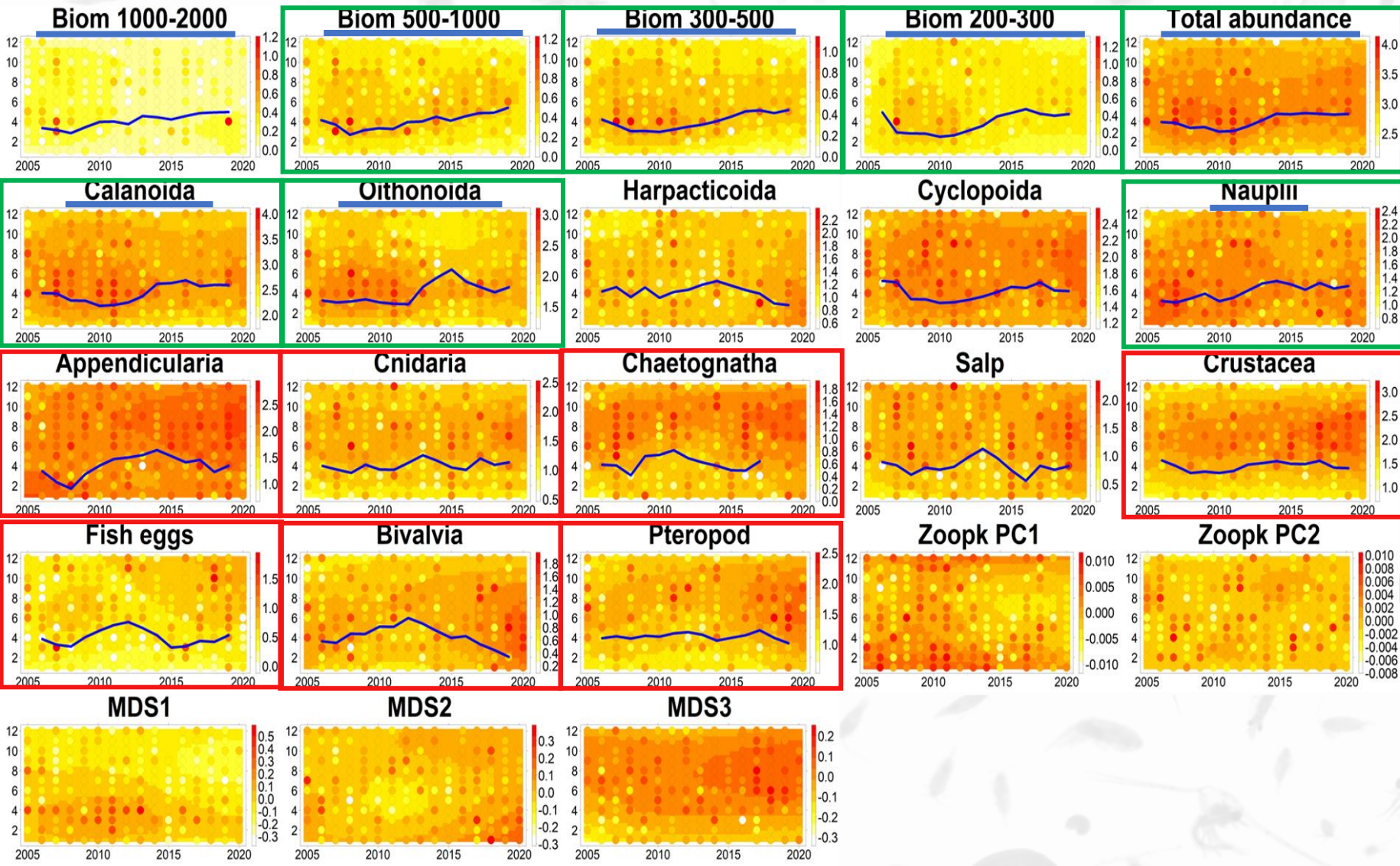
The *level plots* show seasonal pattern in zooplankton compartment. Date of *quantile 0.3* seemed to delayed for some groups on the 2<sup>nd</sup> part of the decade.



- Spring peak vs summer peak
  - Seasonal patterns may change



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- Spring peak vs summer peak
  - Seasonal patterns may change
- Delay of the dates of quantile 0.3

## Aims:

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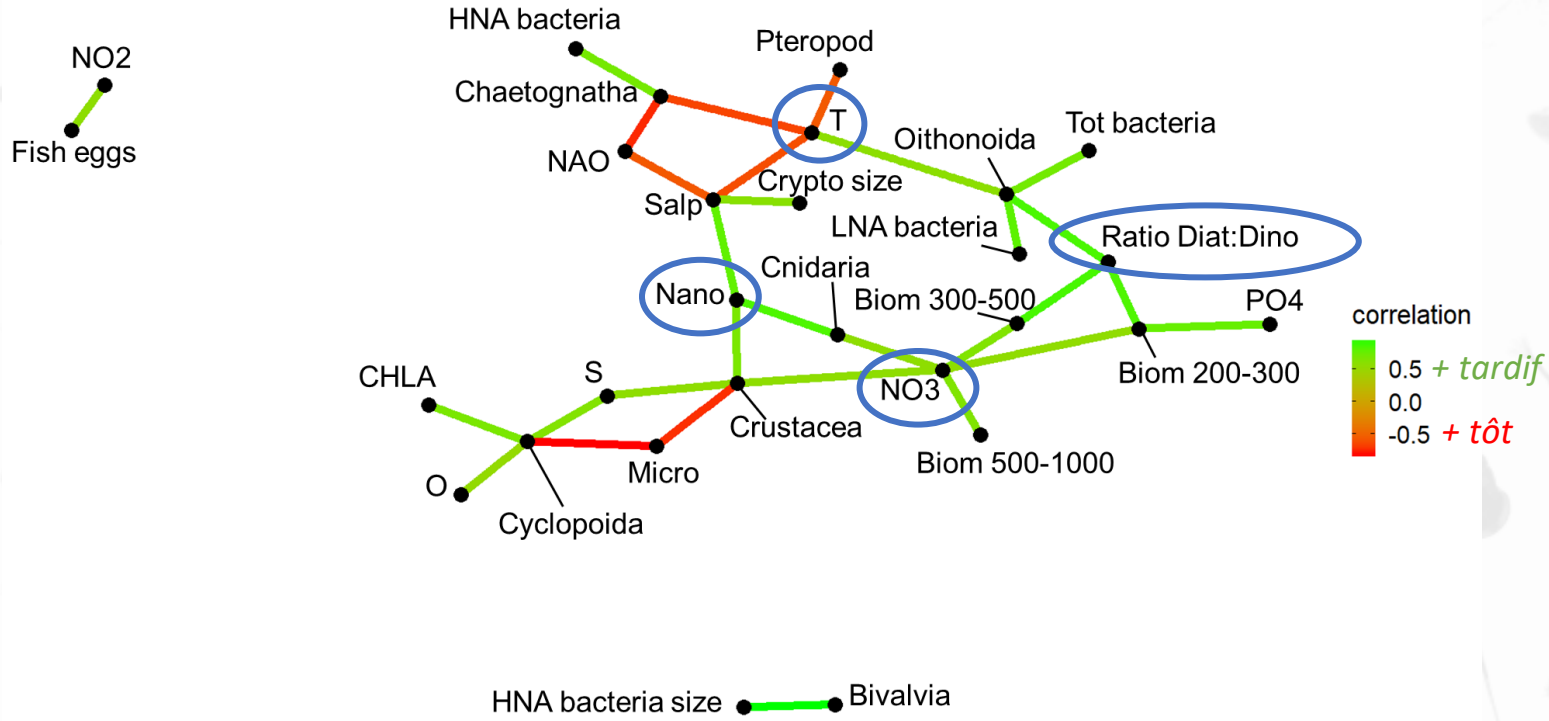
- Interannual evolution

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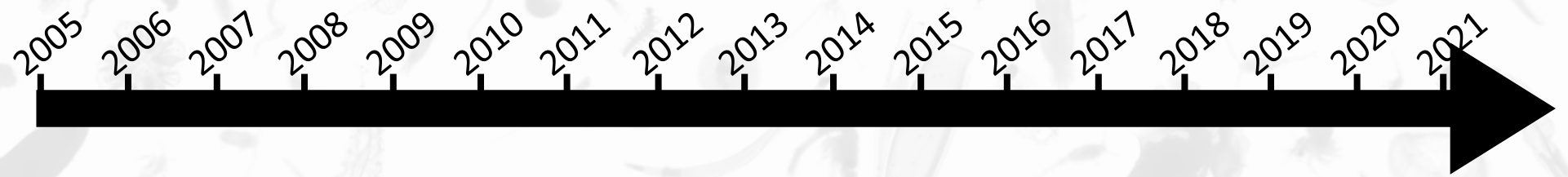
*Dates of quantile 0.3* seemed to be linked with winter values of some environmental variables.



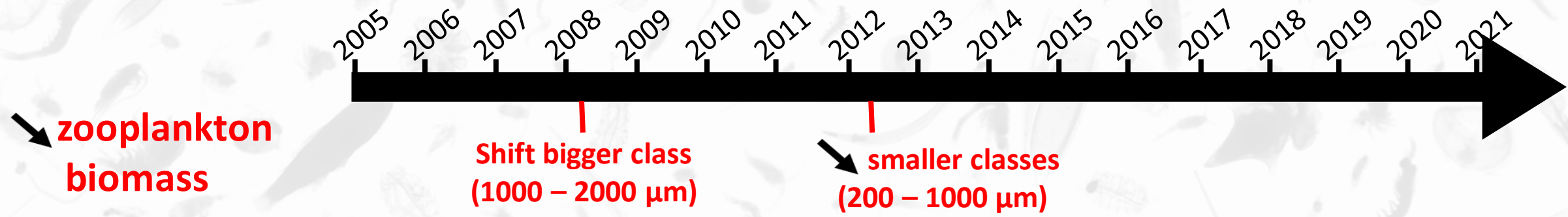
- Structured on variations of :
  - NO<sub>3</sub> concentrations,
  - temperature
  - ratio diat:dino
  - abundance of nanoeukaryotes



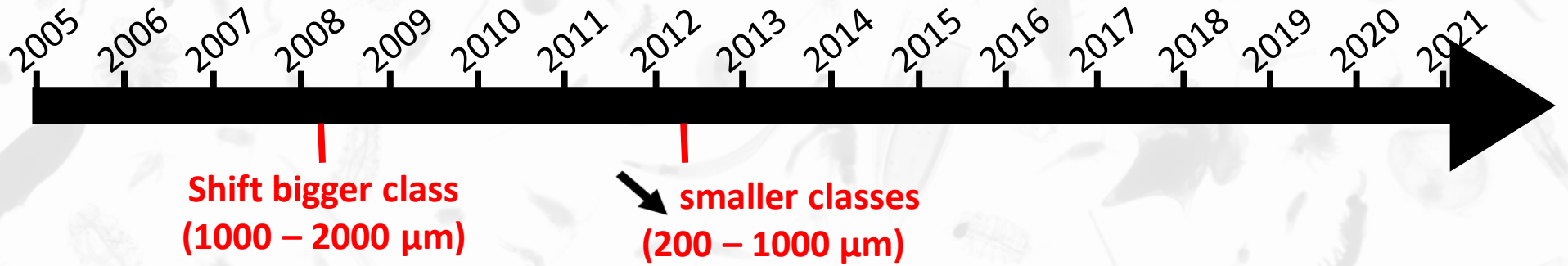
# Conclusions:



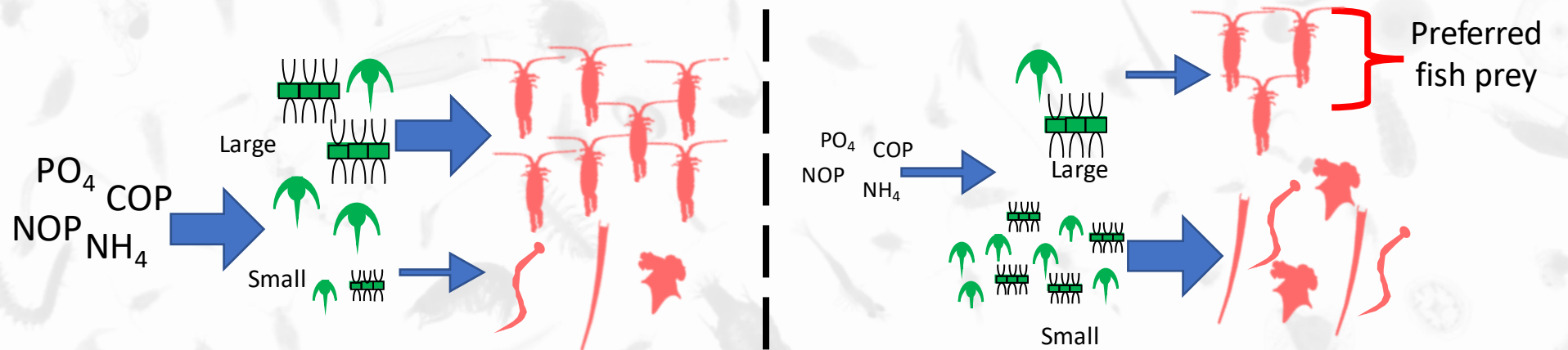
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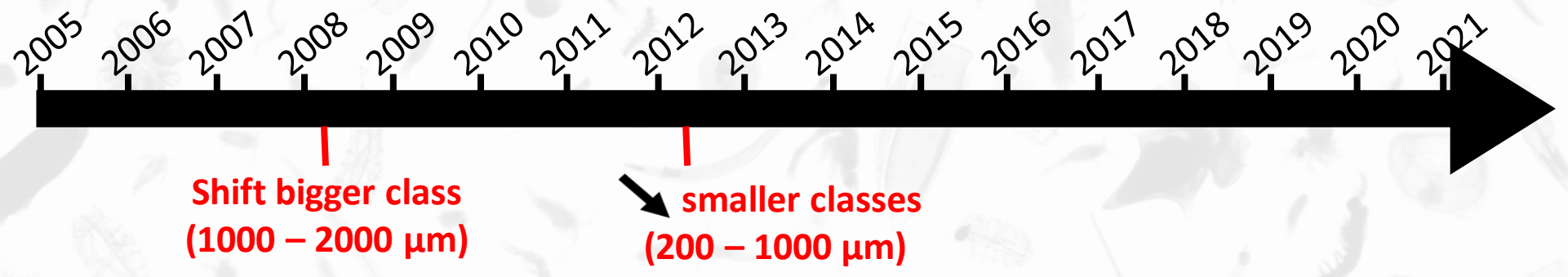
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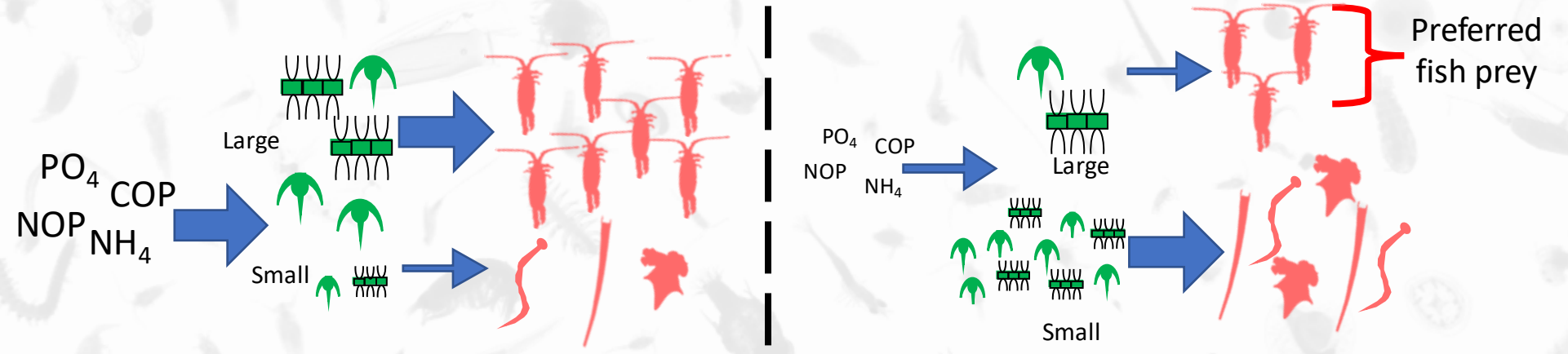
## Bottom-up control of the trophic chain



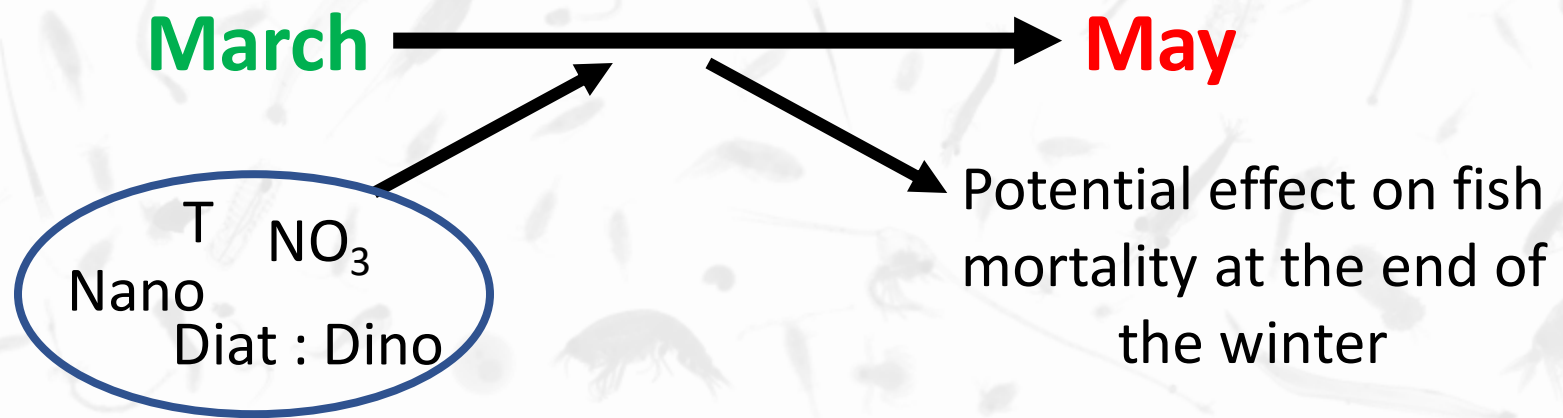
# Conclusions:



## Bottom-up control of the trophic chain

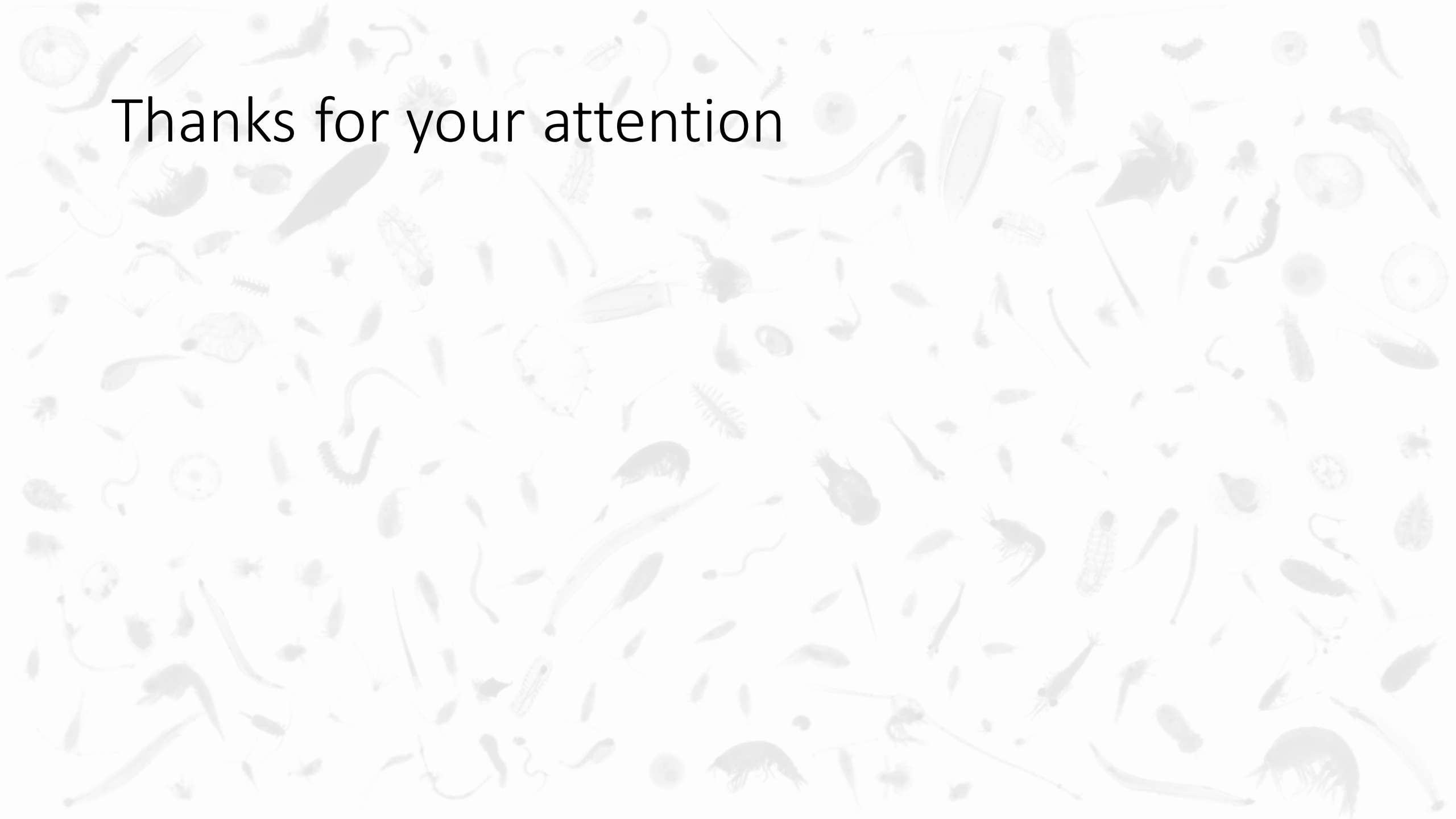


## Delay of the date of quantile 0.3 for preferred fish prey

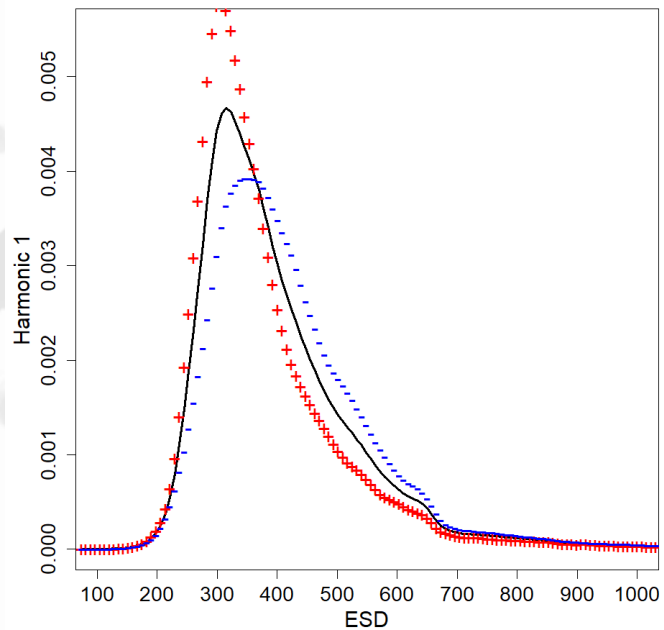




Thanks for your attention



PCA function 1 (Percentage of variability 46.6 )



PCA function 2 (Percentage of variability 21.5 )

