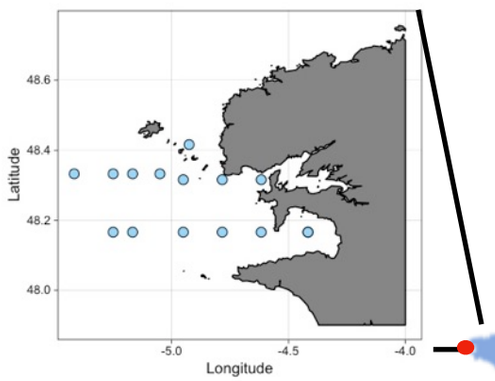
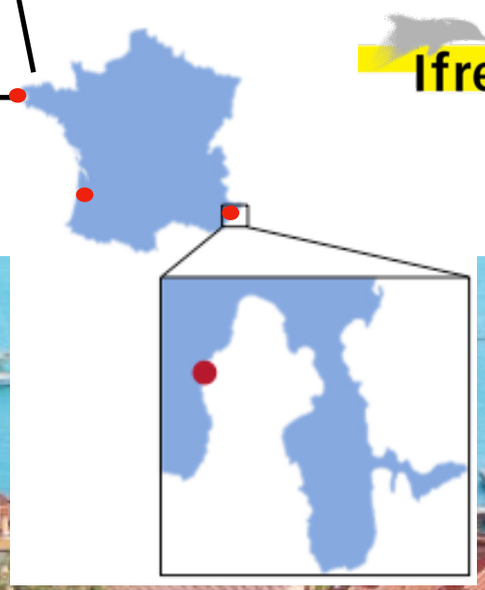
Spatio-temporal variations of the planktonic communities in a North Atlantic Marine Protected Area and their potential links with *Sardina pilchardus* (Walbaum, 1792) catches

Fabio Benedetti[1], Laëtitia Jalabert[1], Marc Sourisseau[2], Beatriz Beker[3], Amanda Elineau[1], Caroline Cailliau[4], Jean-Olivier Irisson[1], Marc Picheral[1], **Lars Stemmann**[1], Patrick Pouline





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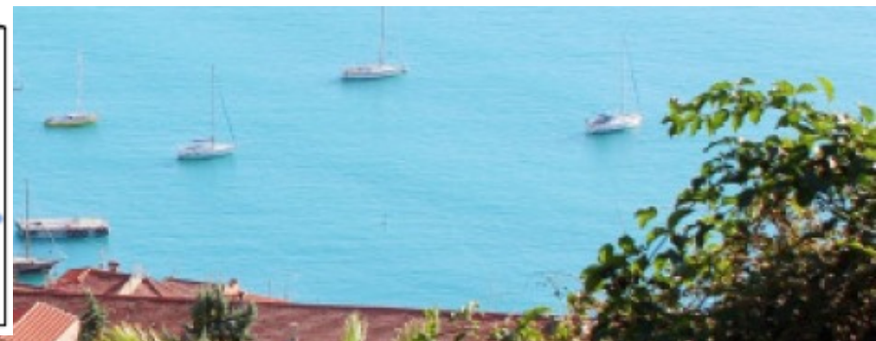
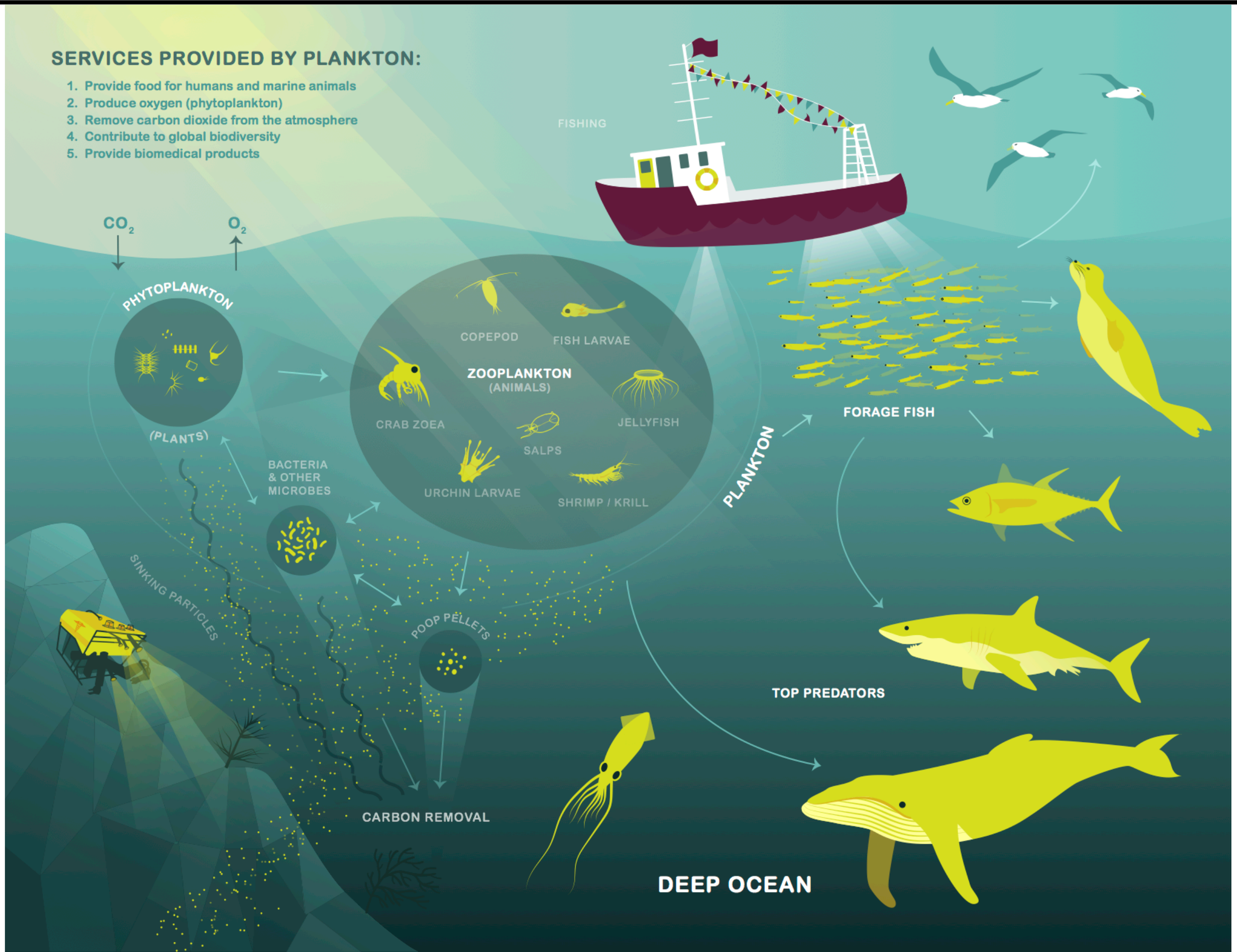
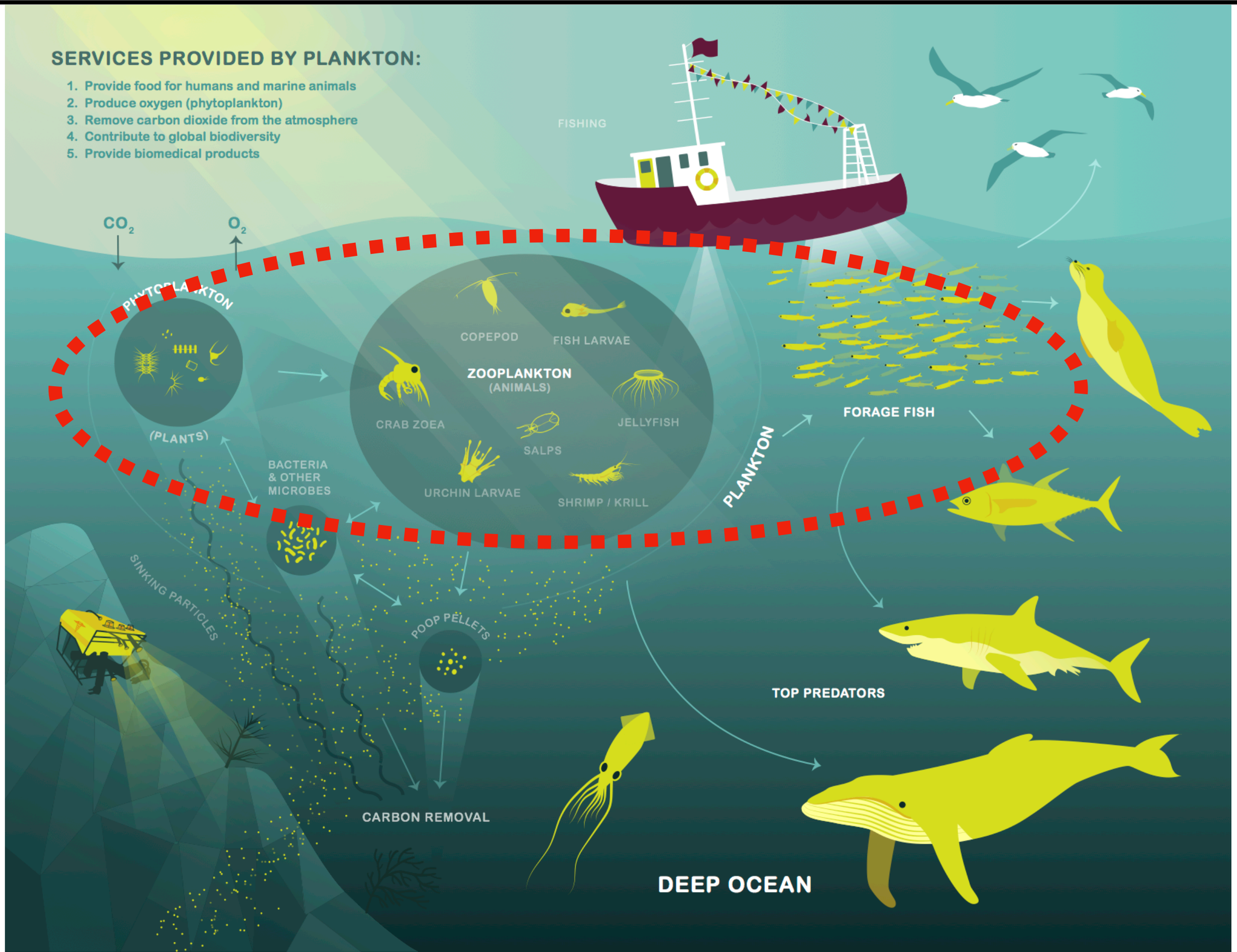
Colloque - COAST
07/11/2017 - Bordeaux




SERVICES PROVIDED BY PLANKTON:
1. Provide food for humans and marine animals
2. Produce oxygen (phytoplankton)
3. Remove carbon dioxide from the atmosphere
4. Contribute to global biodiversity
5. Provide biomedical products
FISHING
CO_2
O_2
PHYTOPLANKTON
(PLANTS)
BACTERIA & OTHER MICROBES
ZOOPLANKTON (ANIMALS)
COPEPOD
FISH LARVAE
CRAB ZOEA
JELLYFISH
SALPS
URCHIN LARVAE
SHRIMP / KRILL
FORAGE FISH
PLANKTON
SINKING PARTICLES
POOP PELLETS
CARBON REMOVAL
TOP PREDATORS
DEEP OCEAN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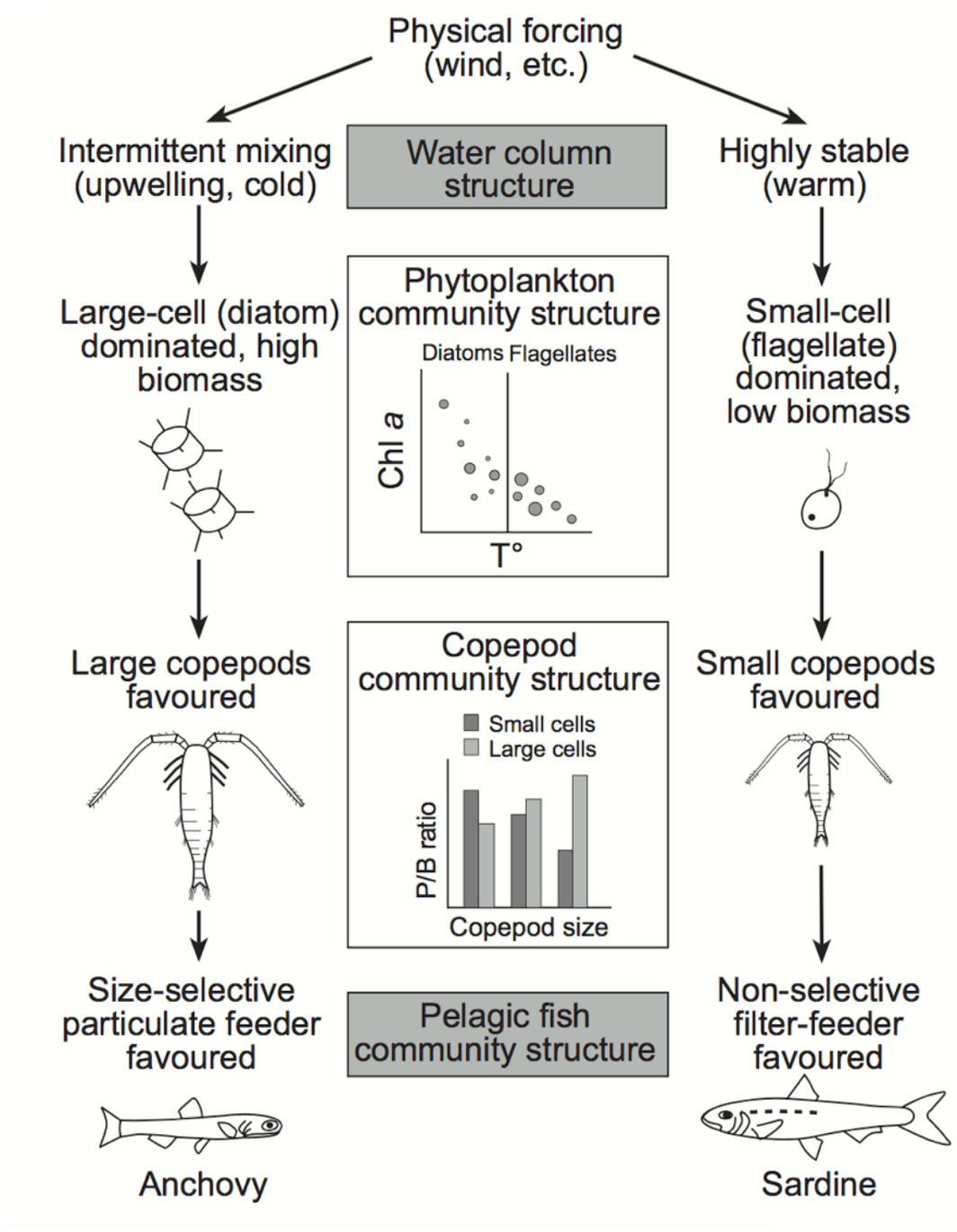
- *Sardina pilchardus* (Walbaum 1972) is an important actor of the marine ecosystem
- Feeds many top predators (marine mammals and birds)
- But is commercially exploited (« bolincheurs »)

- Non-selective filter-feeder that is favoured when smaller plankton develop
- **The Iroise Sea fishing of Sardina presents strong yet unexplained seasonal and inter-annual fluctuations**



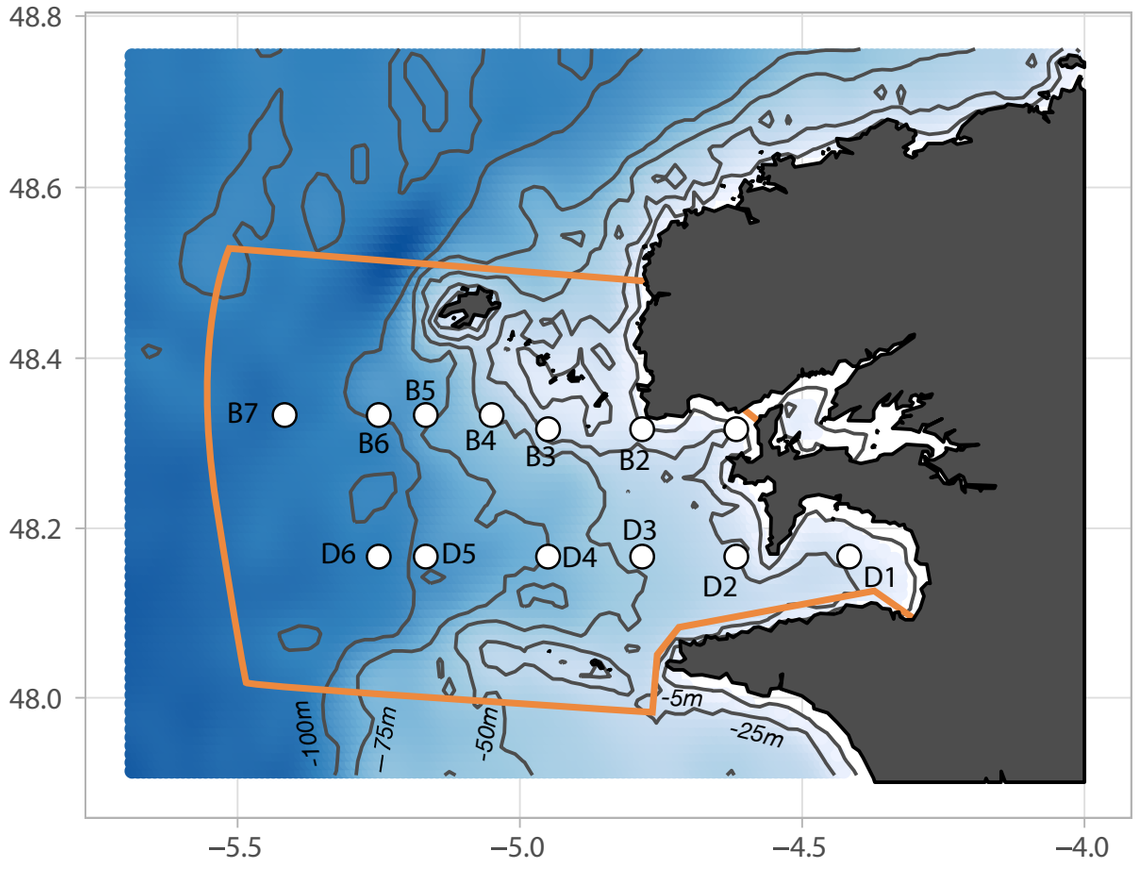
Van der Lingen (2006)

Available data

- from 2011 to 2015 (spring, summer, autumn, 124 stations/time)
  - *In situ* measurements of:
    - temperature (surface+ bottom), salinity, pH, nutrients, Chlorophyll-a, Phaeophytin-a
    - compared to PREVIMER data provided by IFREMER (satellite data re-analysis)
  - Phytoplankton counts from 5L Niskin water samples with diatoms, dinoflagellates and nanoflagellates counts - no picophytoplankton
  - Mesozooplankton abundances, biovolumes, dry weights and composition from WP2 vertical tows

- Monthly sardines catches from IFREMER

Par Naturel Marin de la mer d'Iroise (PNMI)



Imaging data of plankton

✓provide **Indicators of ecosystem status** (abundance, biomass, taxa, size spectra), particularly useful for marine resources management.
✓ can be obtained **for all trophic levels (from bacteria to fish larvae)** using commercially available sensors**.**
✓can be obtained by lab scanners or by in situ sensors, **they provide high frequency data** suitable for spatial monitoring.

These indicators can be used to develop and constrain biogeochemical models, Lagrangian model of particles/plankton transport, population dynamics models and also end to end ecosystem models for fisheries management.

Flowcytobot | Microscopy | Flowcam | Zooscan | UVP

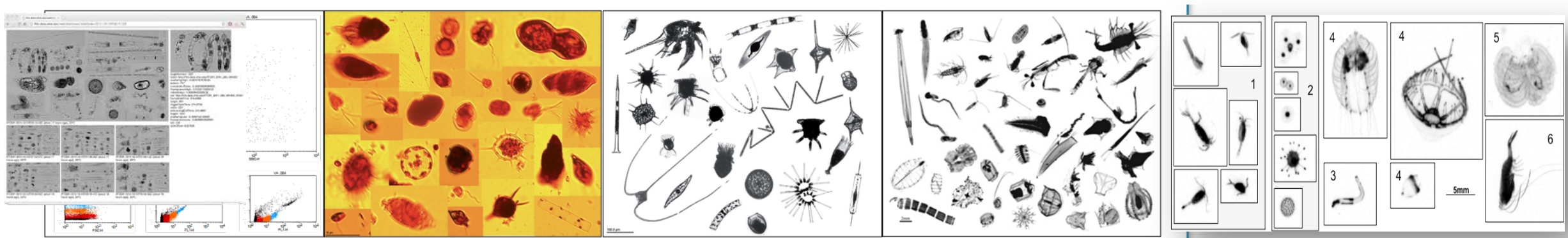
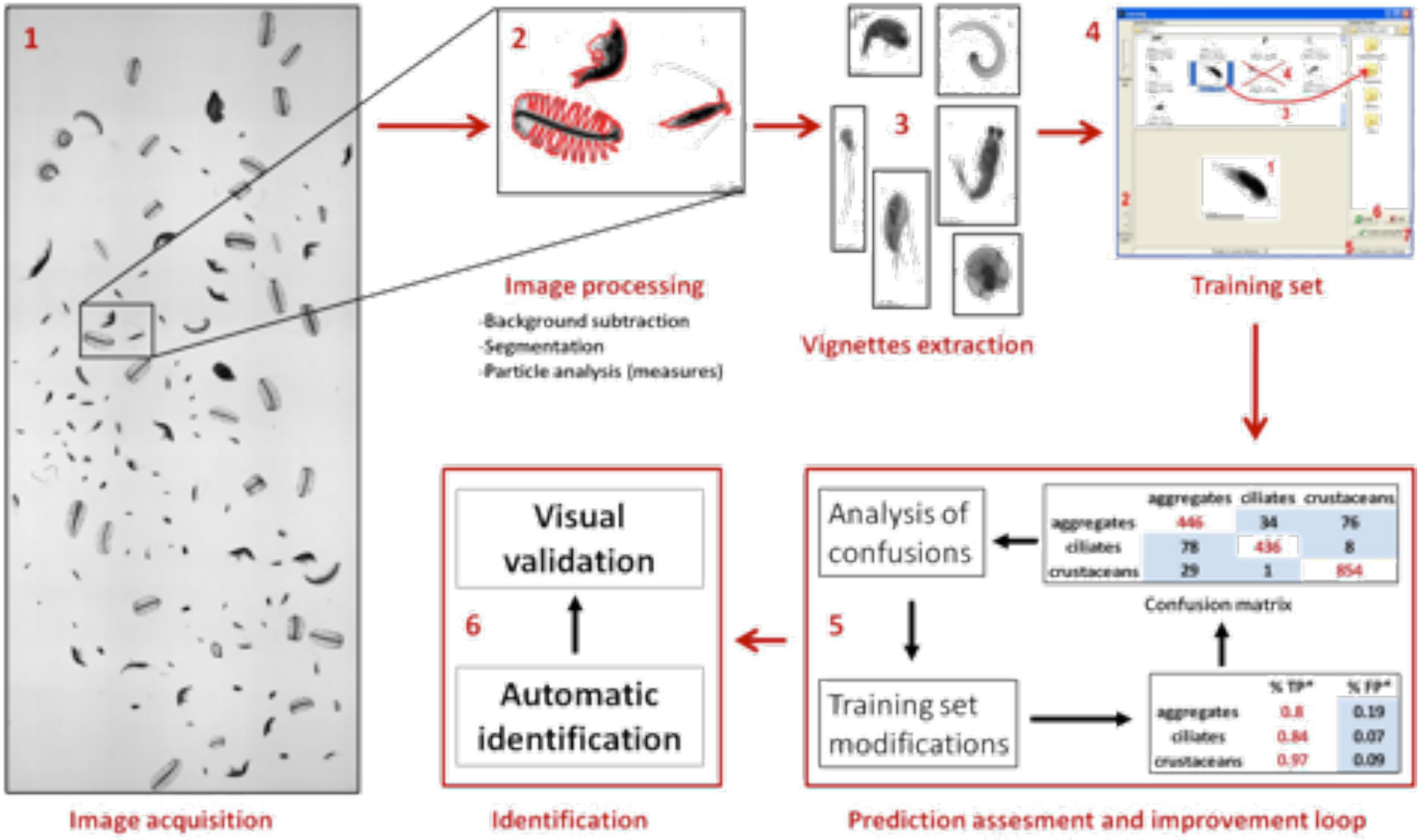
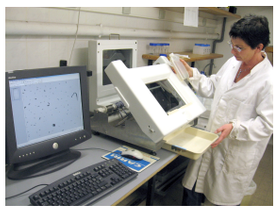


Image analysis, features extraction, automatic recognition and expert validation



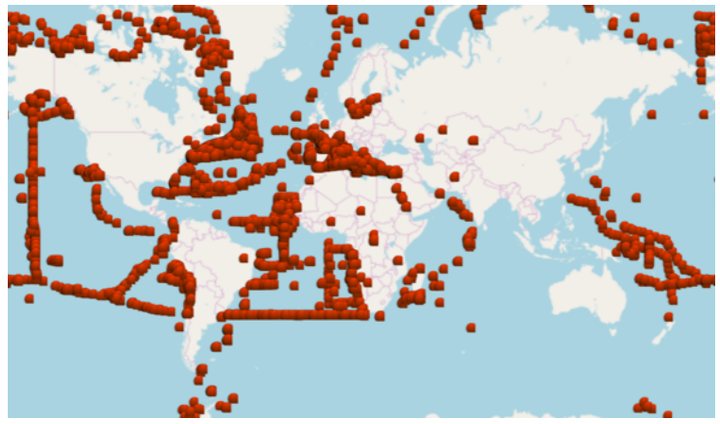
PNMI project ~ 250 000 vignettes, 100 643 are of organisms & 30 plankton categories

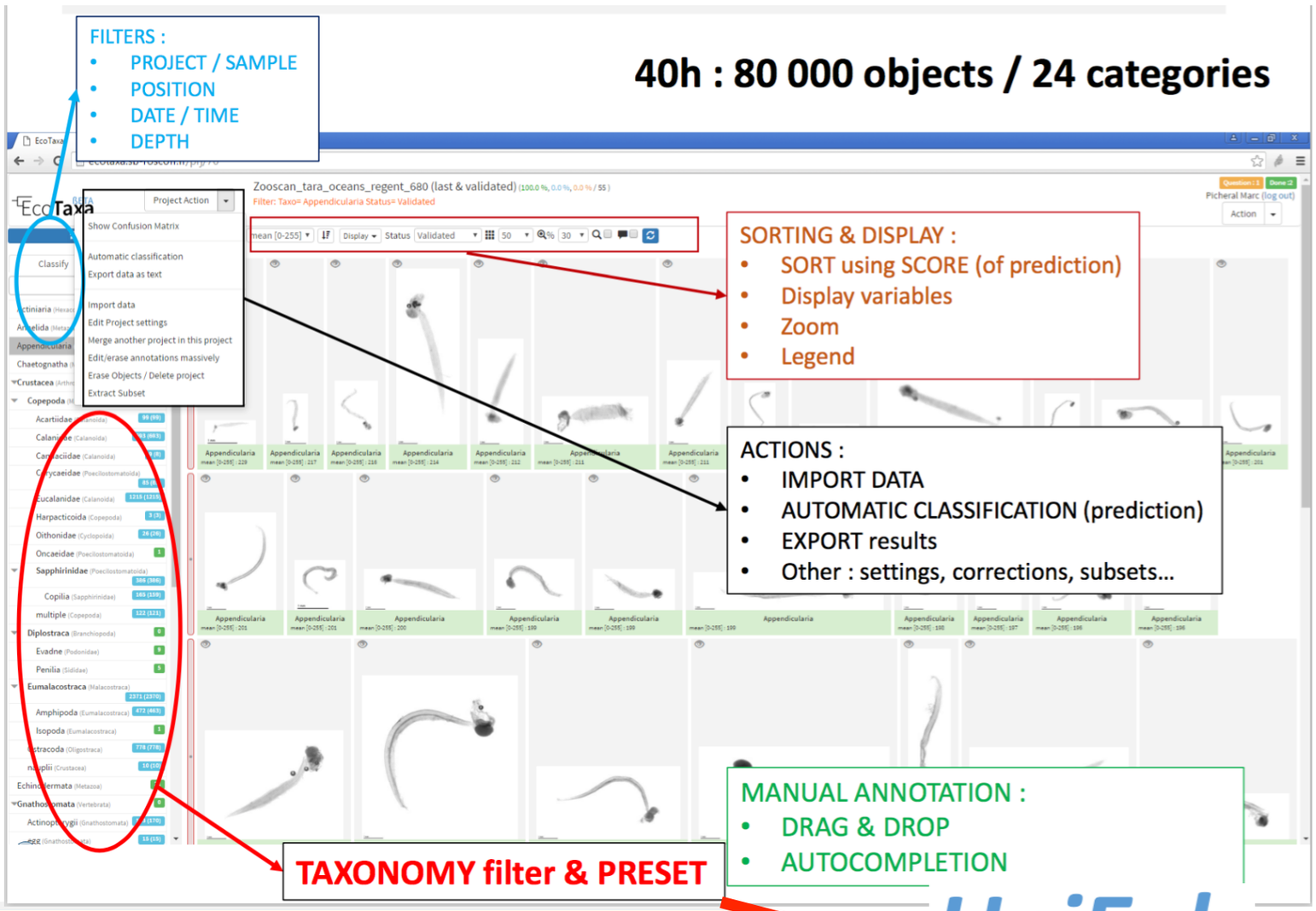


A)

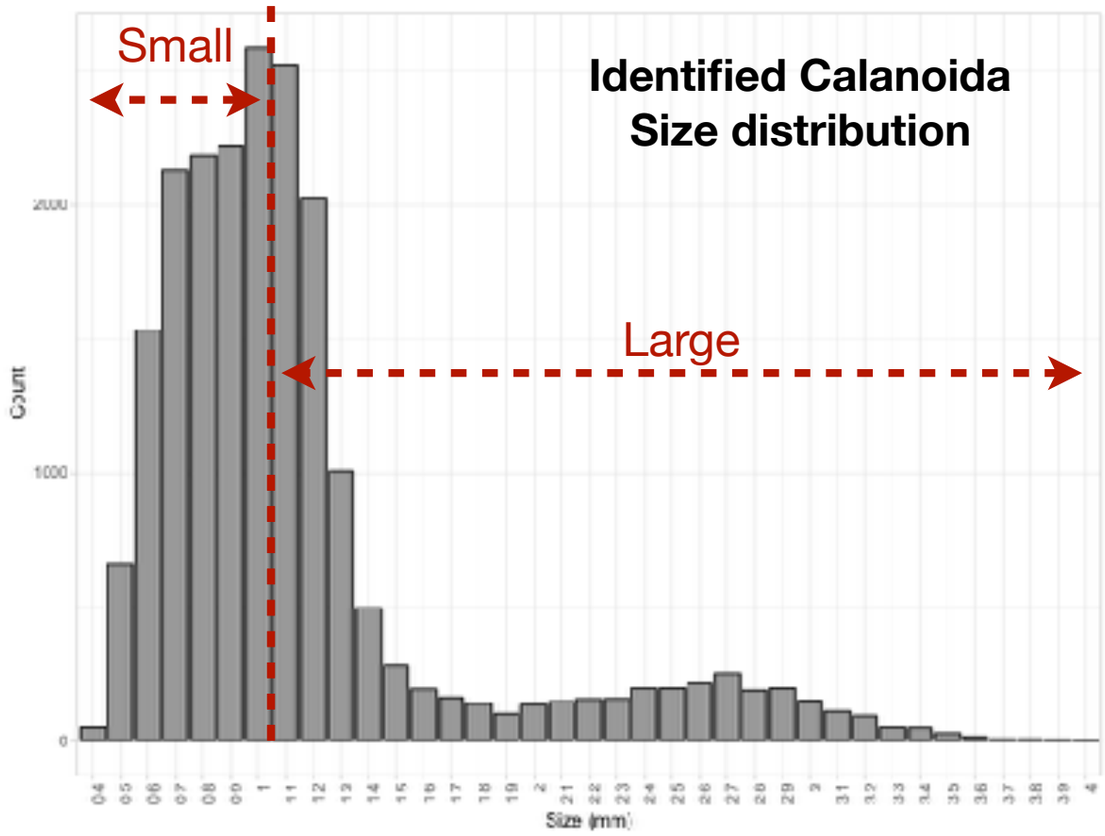
ECOTAXA (>6 10^6 images)

Web based application to semi-automatically sort plankton images in a network (intranet/internet), share image metadata/data in a secured mode and directly connect images to genomic taxonomy (uniEuk).



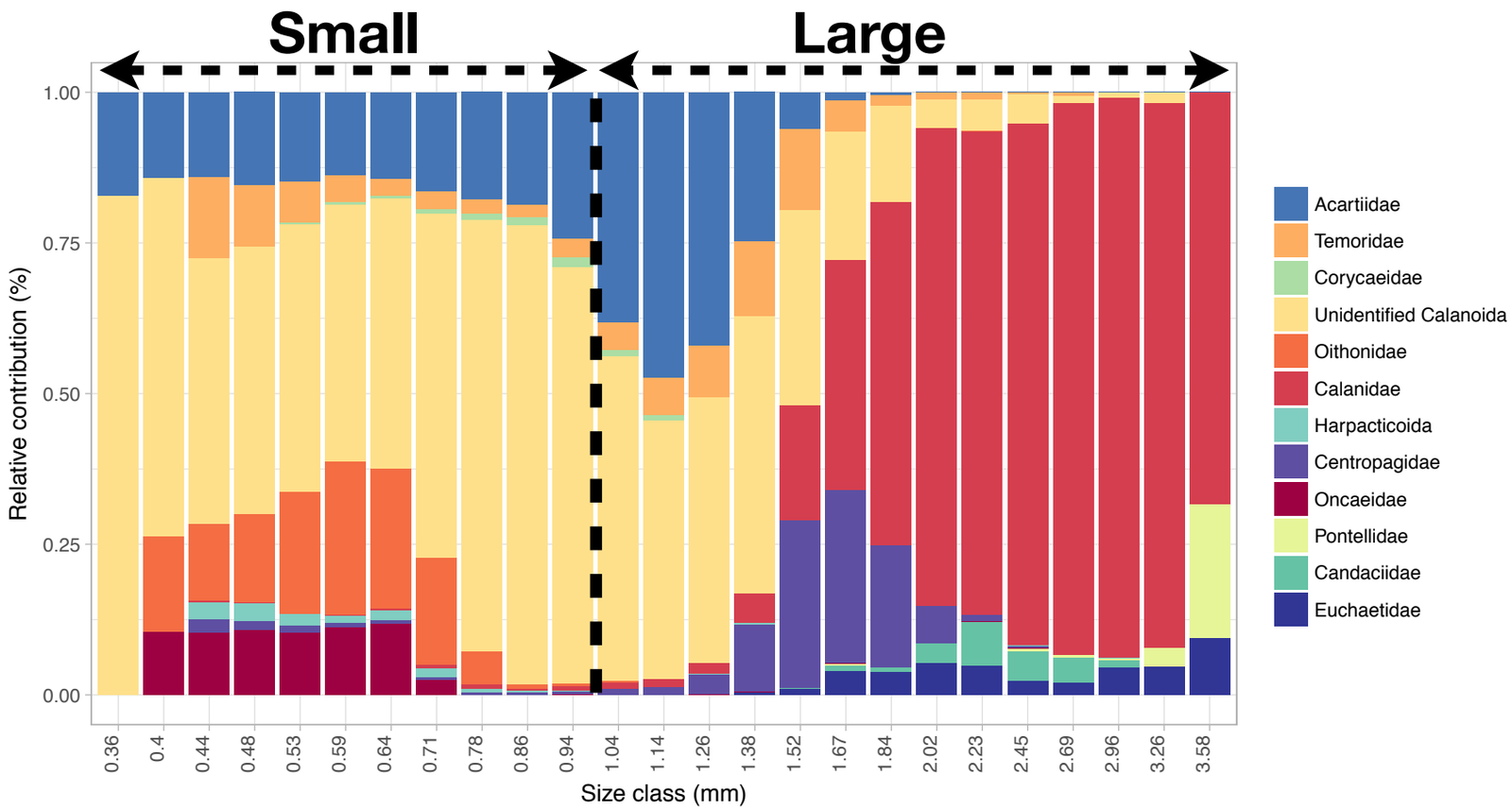


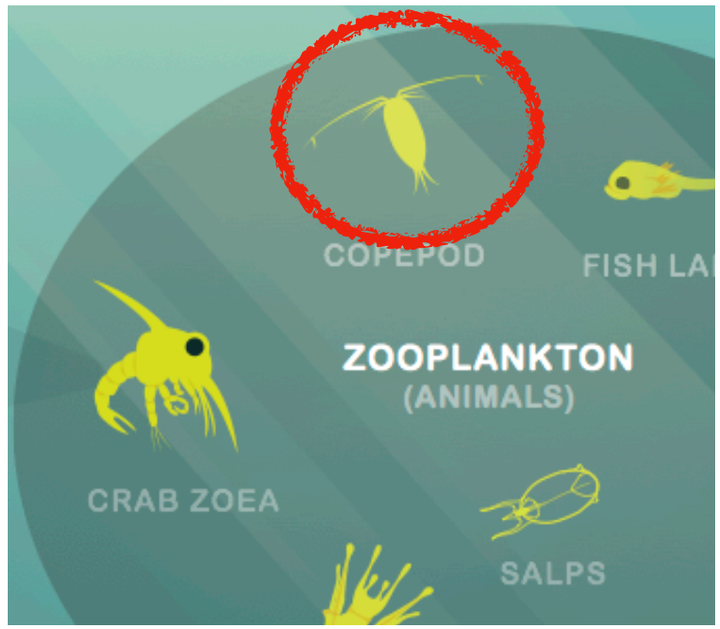
http://ecotaxa.obs-vlfr.fr/explore/



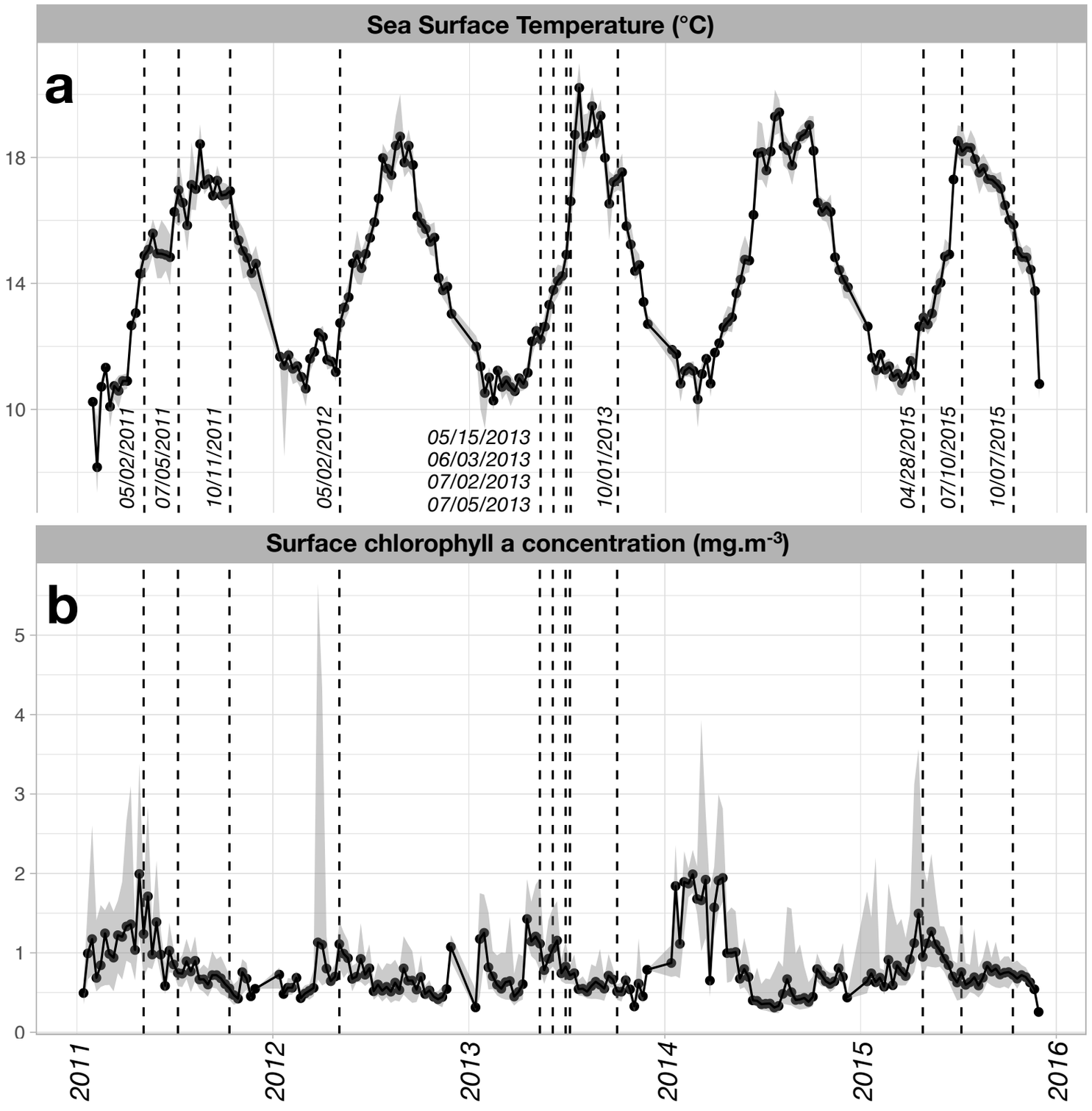
Definition of copepod size distributions and size indices

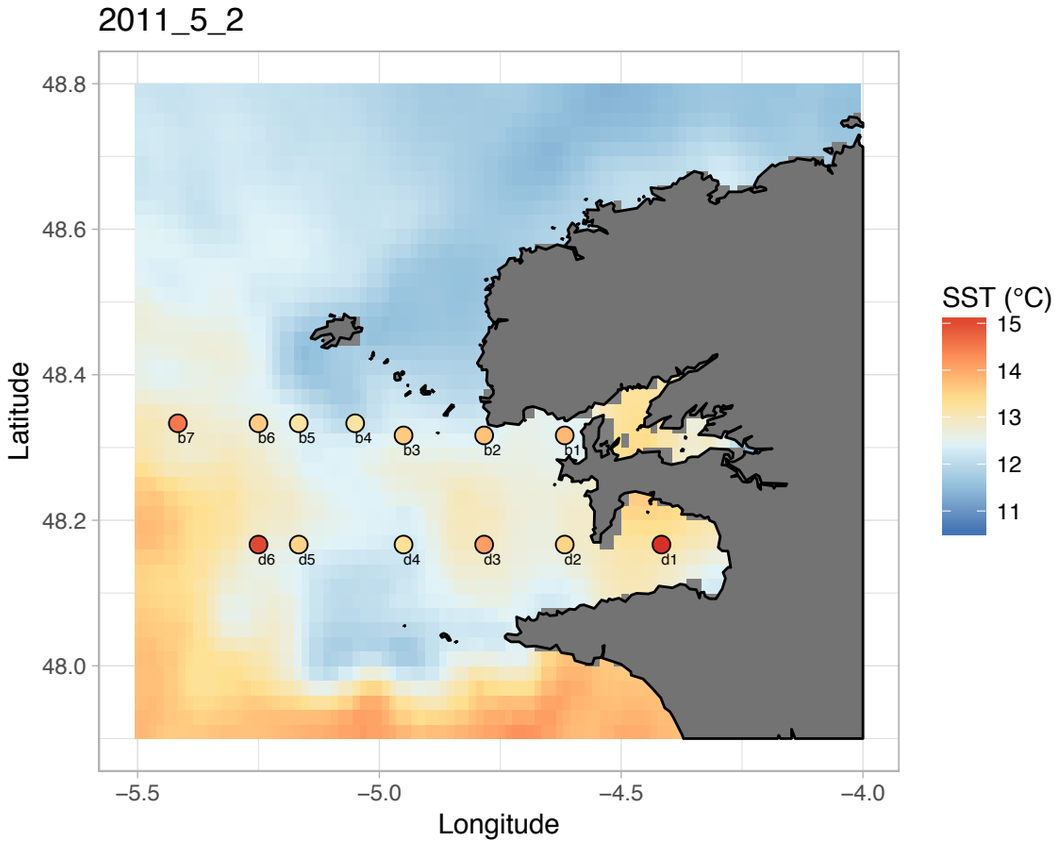
- Mean size
- Ratios (small copepods/ large copepods) of abundances/ bio volumes/ dry weight

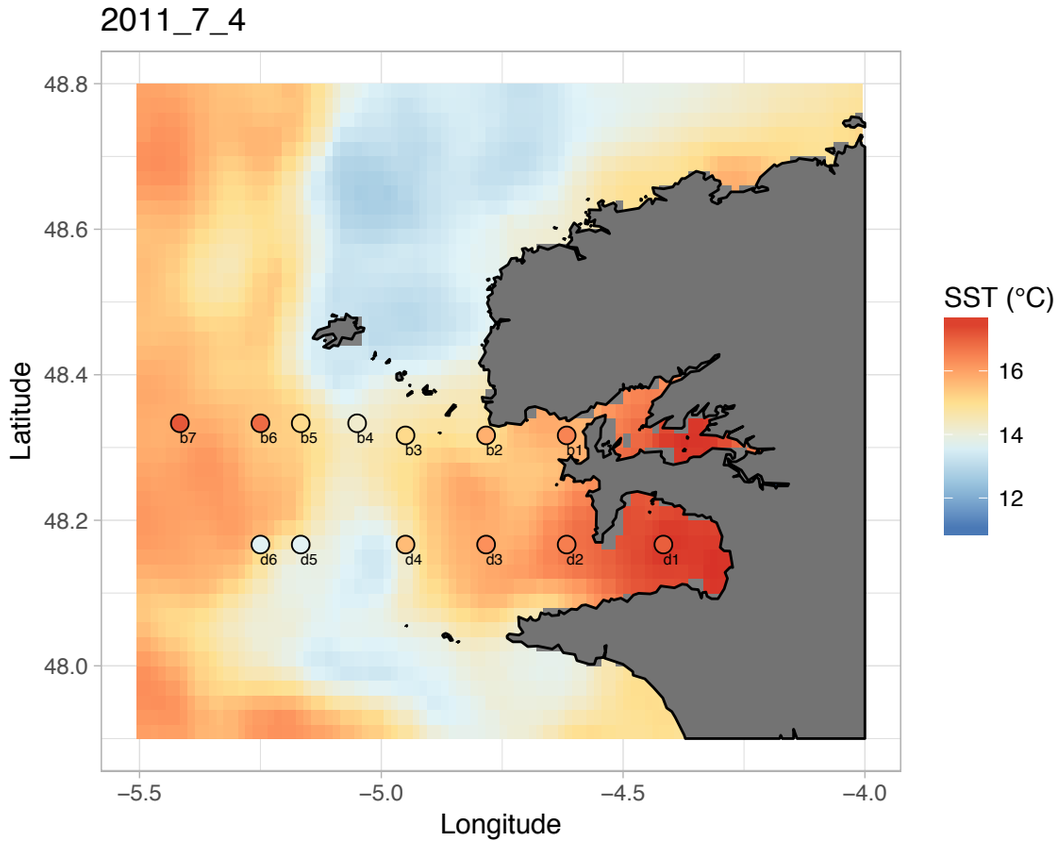


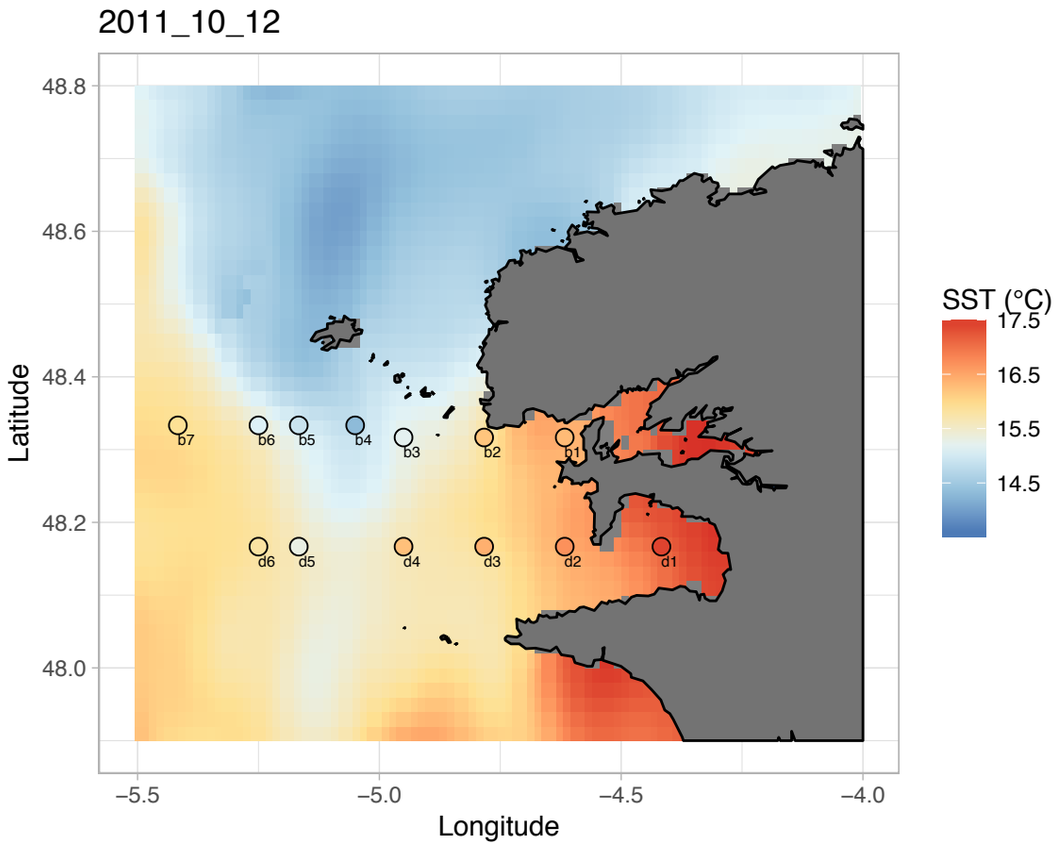


Time series of SST and [Chl-a] - median + quantiles



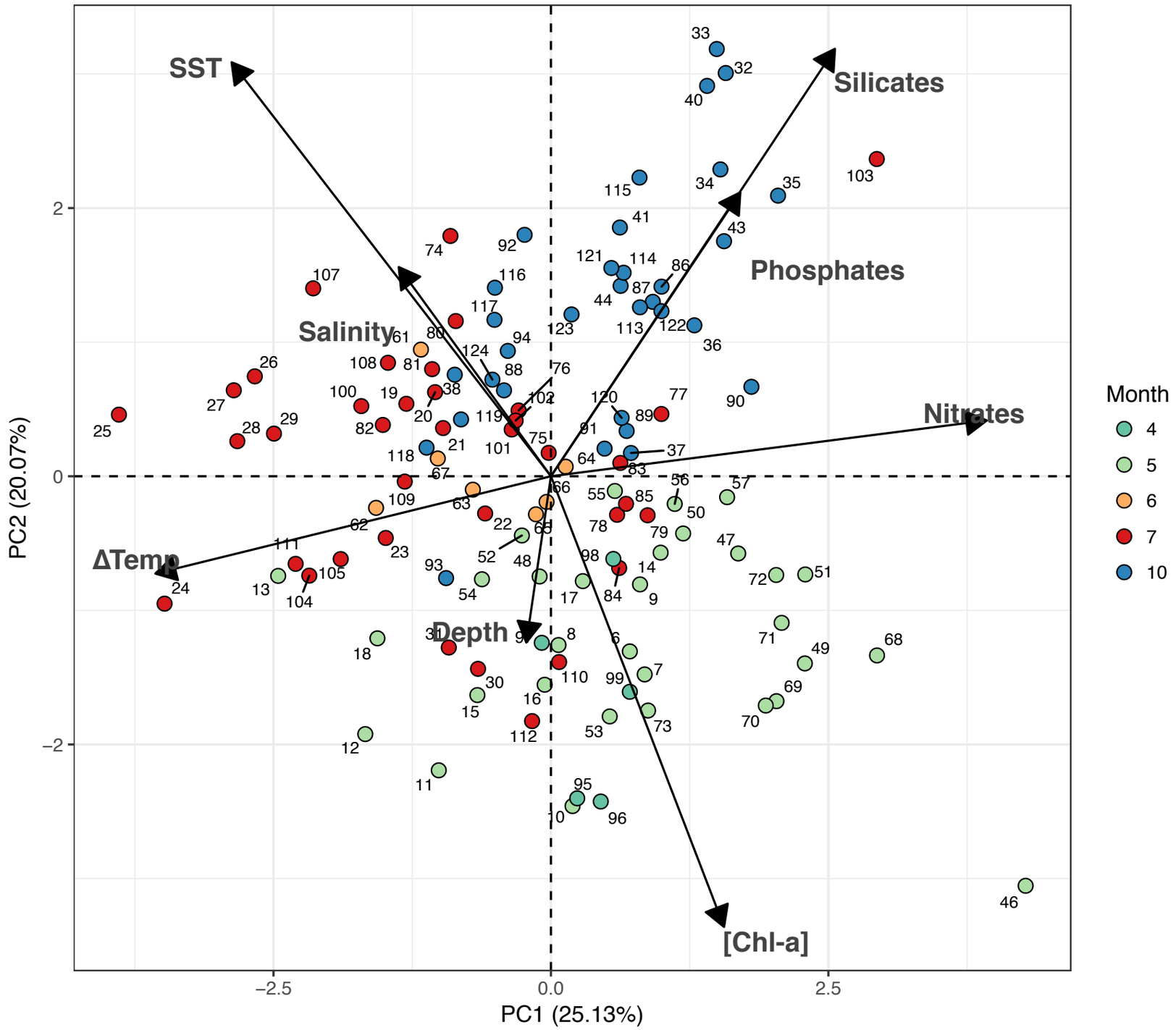






- In situ SST vs. PREVIMER re-analysis
- Pretty good agreement
- Fixed coordinates or model biases could explain discrepancies

Principal Component Analysis (PCA) on cruise hydrobiological data



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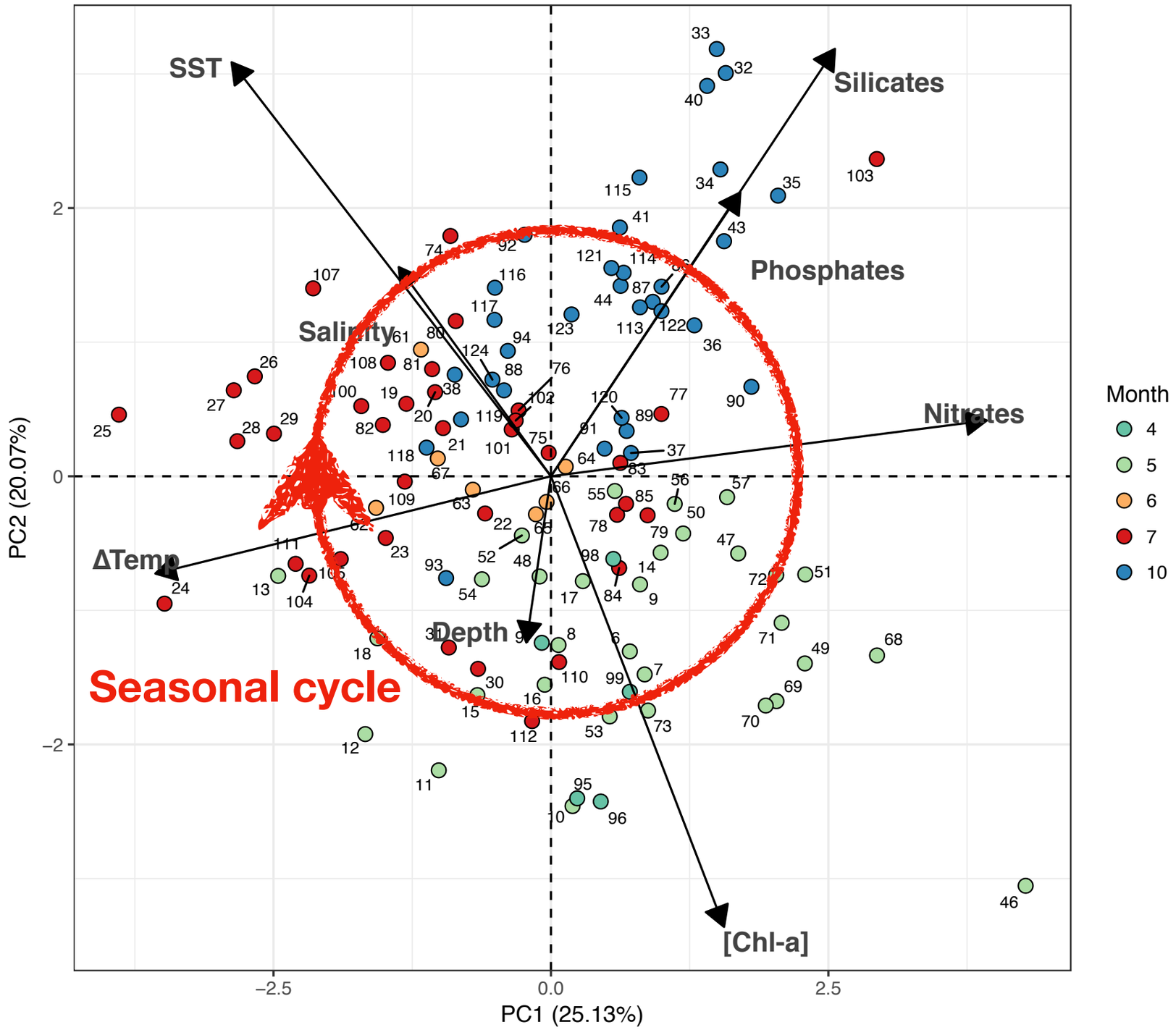
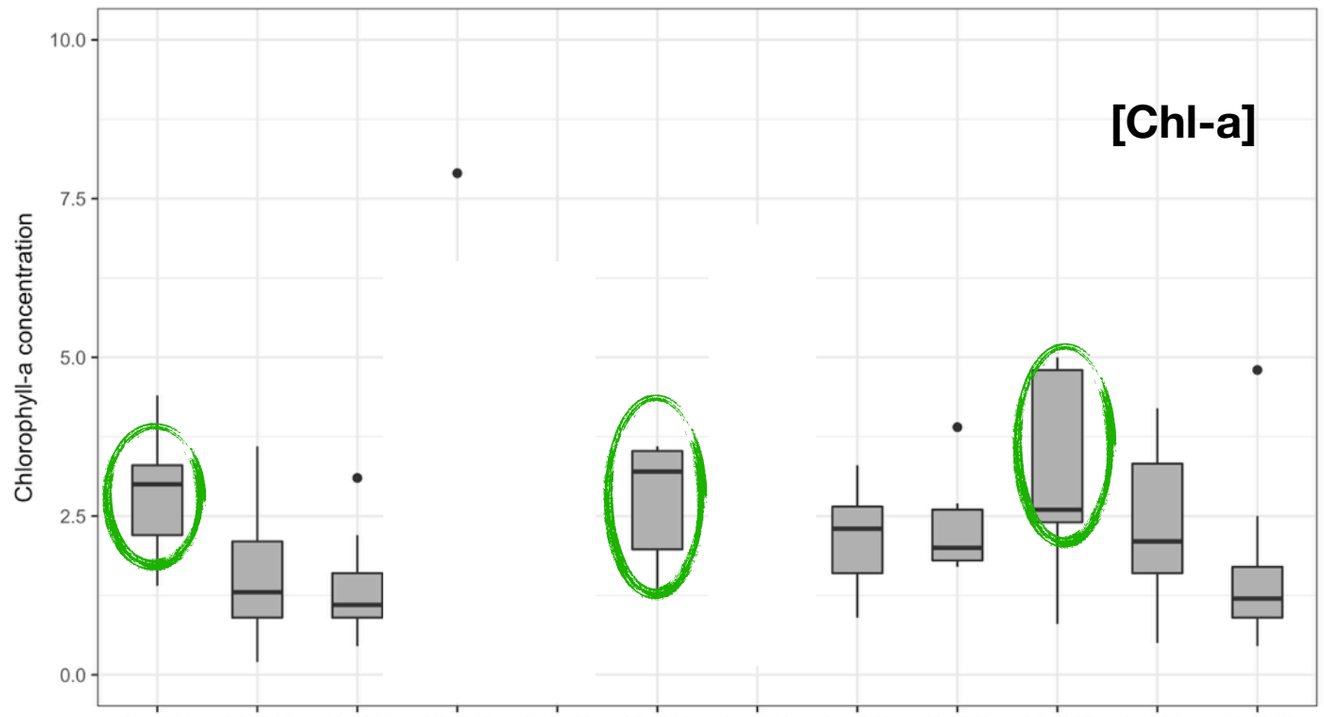
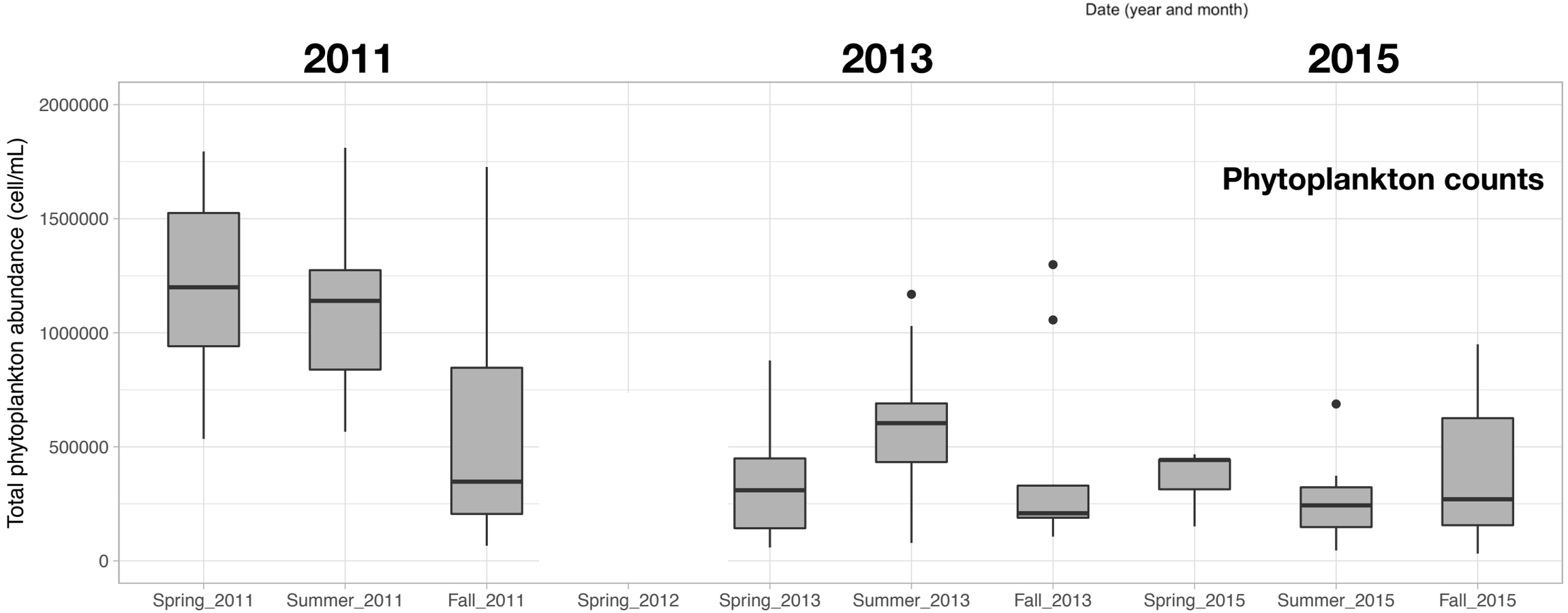


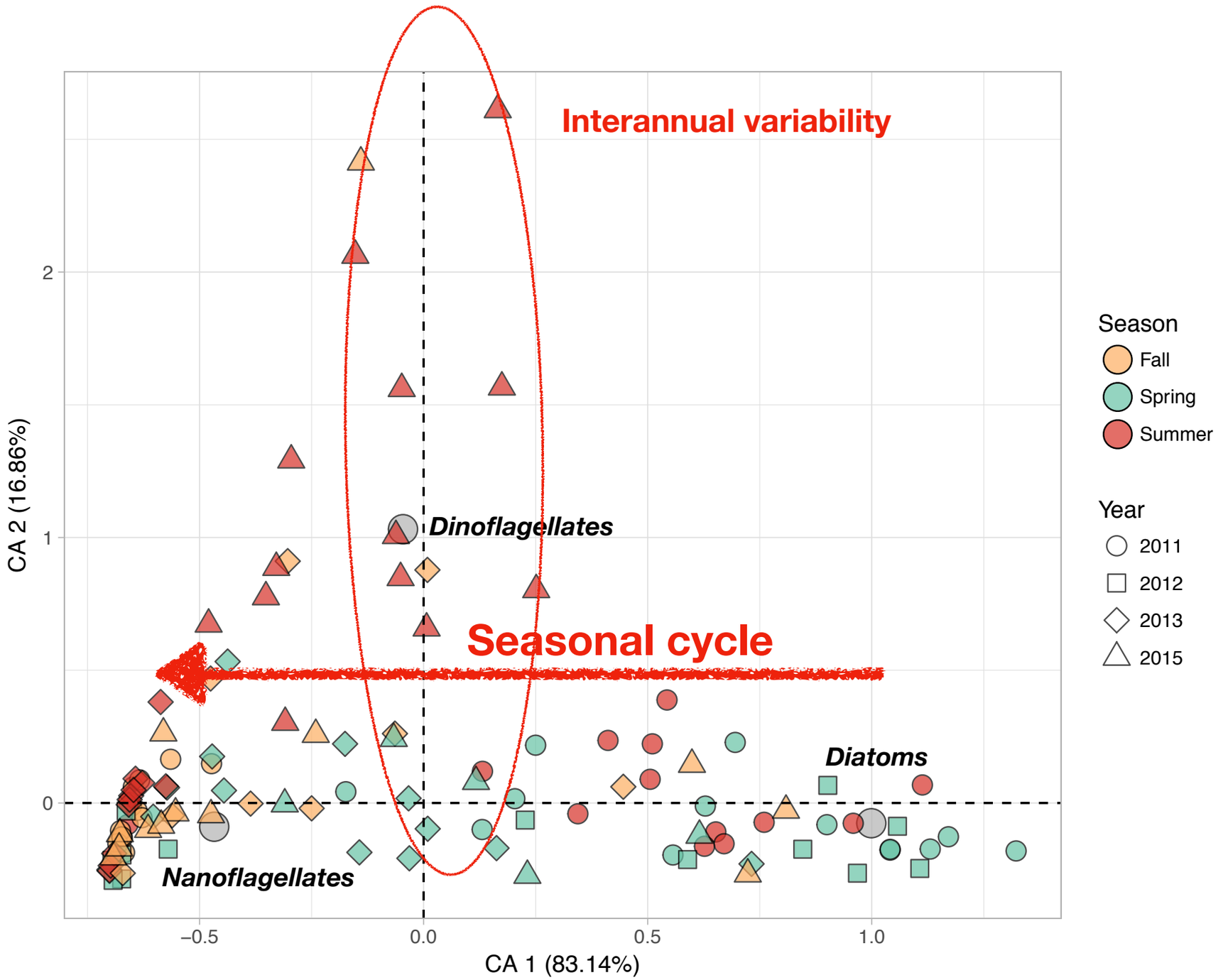
Monthly averages of [Chl-a] and phytoplankton counts

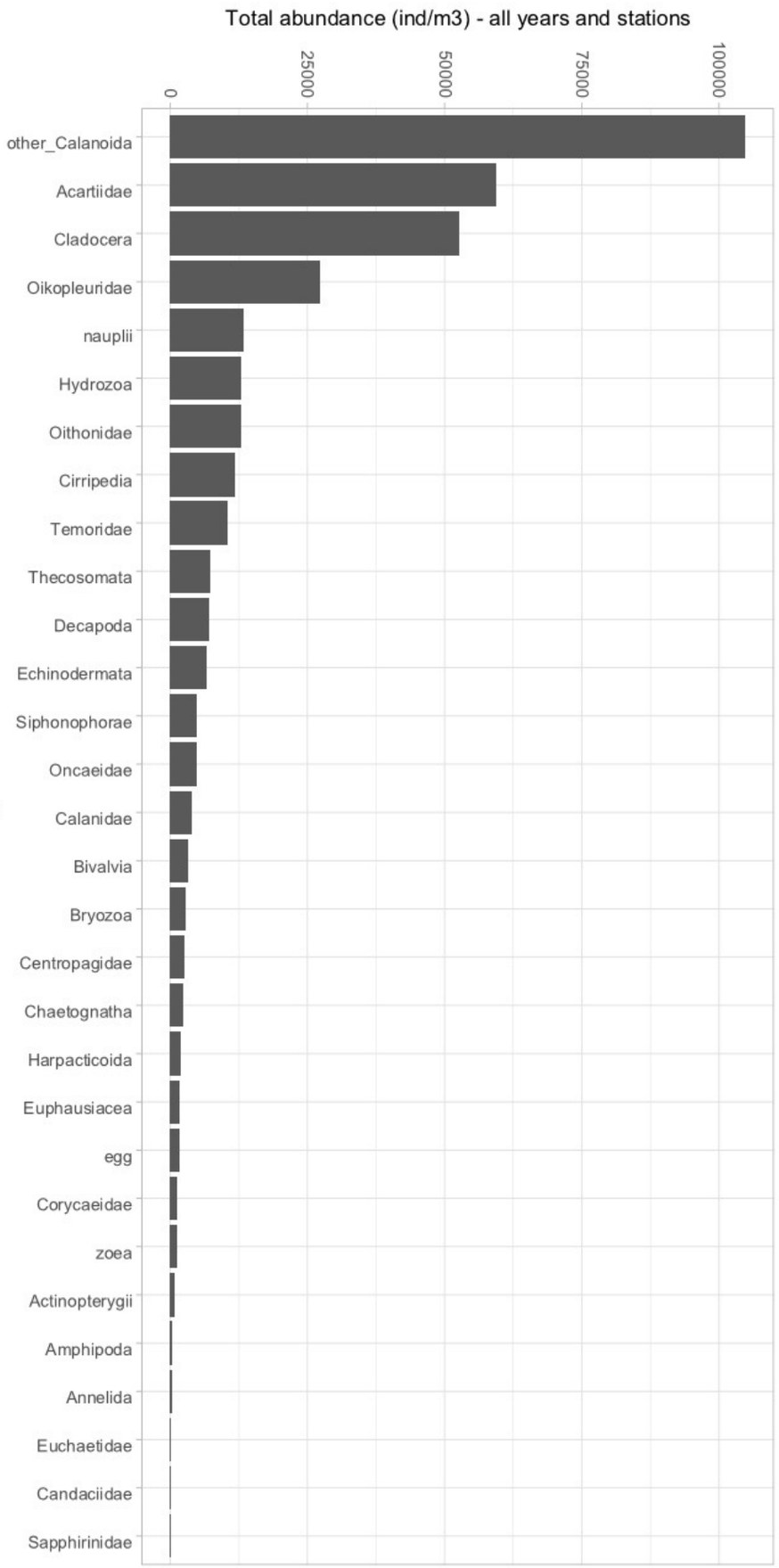
- Seasonal variations too.
- Higher [Chl-a] in spring
- less clear signal on counts





Correspondence Analysis (CA) on large phytoplankton groups counts (not transformed)

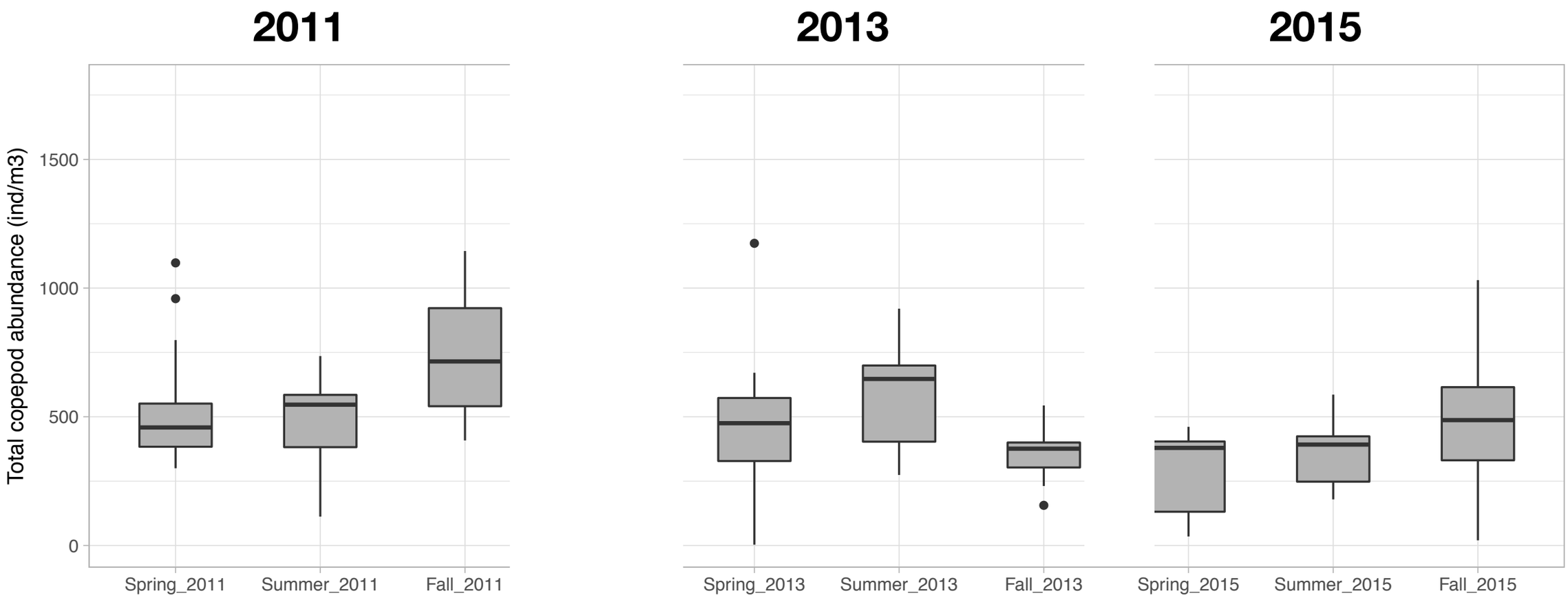




Absolute abundances (ind/m3)

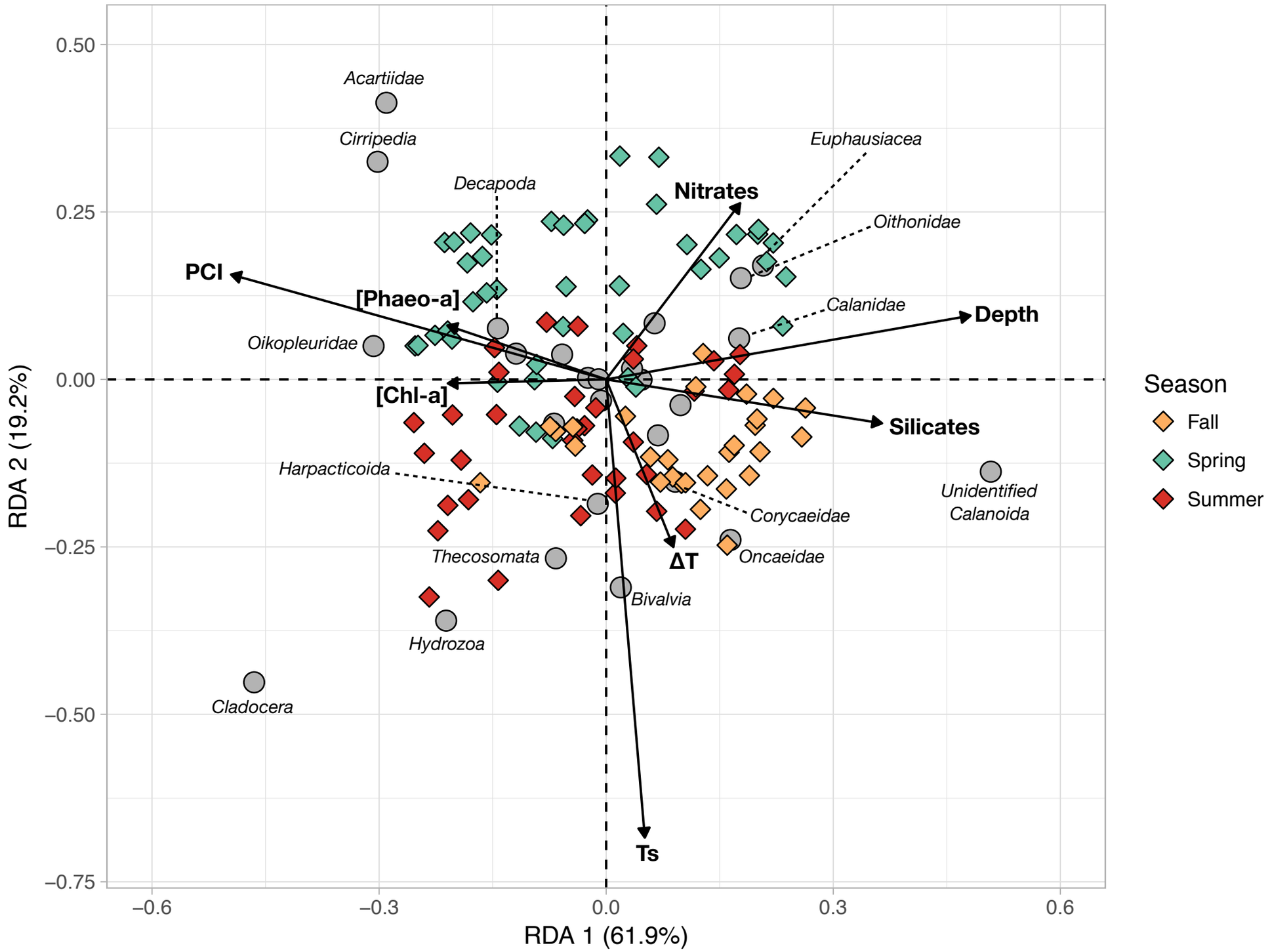
- Dominance of non identified Calanoida (probably Paracalanidae and Clausocalanidae)
- Acartiidae are very abundant too (neritic)
- Appendicularia and Cladocera quite important
- Nauplii ~ Cirripedia
- Actinopterygii contains eggs
- Meroplankton: nauplii, Cirripedia, Decapoda, Echinodermata, Bivalvia, Harpacticoida, Annelida
- Open ocean plankton: Thecosomata, Euphausiacea, Oncaeidae, Calanidae, Corycaeidae, Chaetognatha, Amphipoda…
- **Same orders of magnitude than previous studies (Schultes et al. 2013); but less marked longitudinal gradient (since transects cannot go out side the PNMI).**

Seasonal variations in copepod abundances



- N2011>N2003>N2015
- Exact same pattern for ellipsoïdal biovolumes (Vandromme et *al*., 2012) or dry weights (Lehette & Hernandez-Leon, 2009)

Redundant Discriminant Analysis (RDA), mesozooplankton community structure



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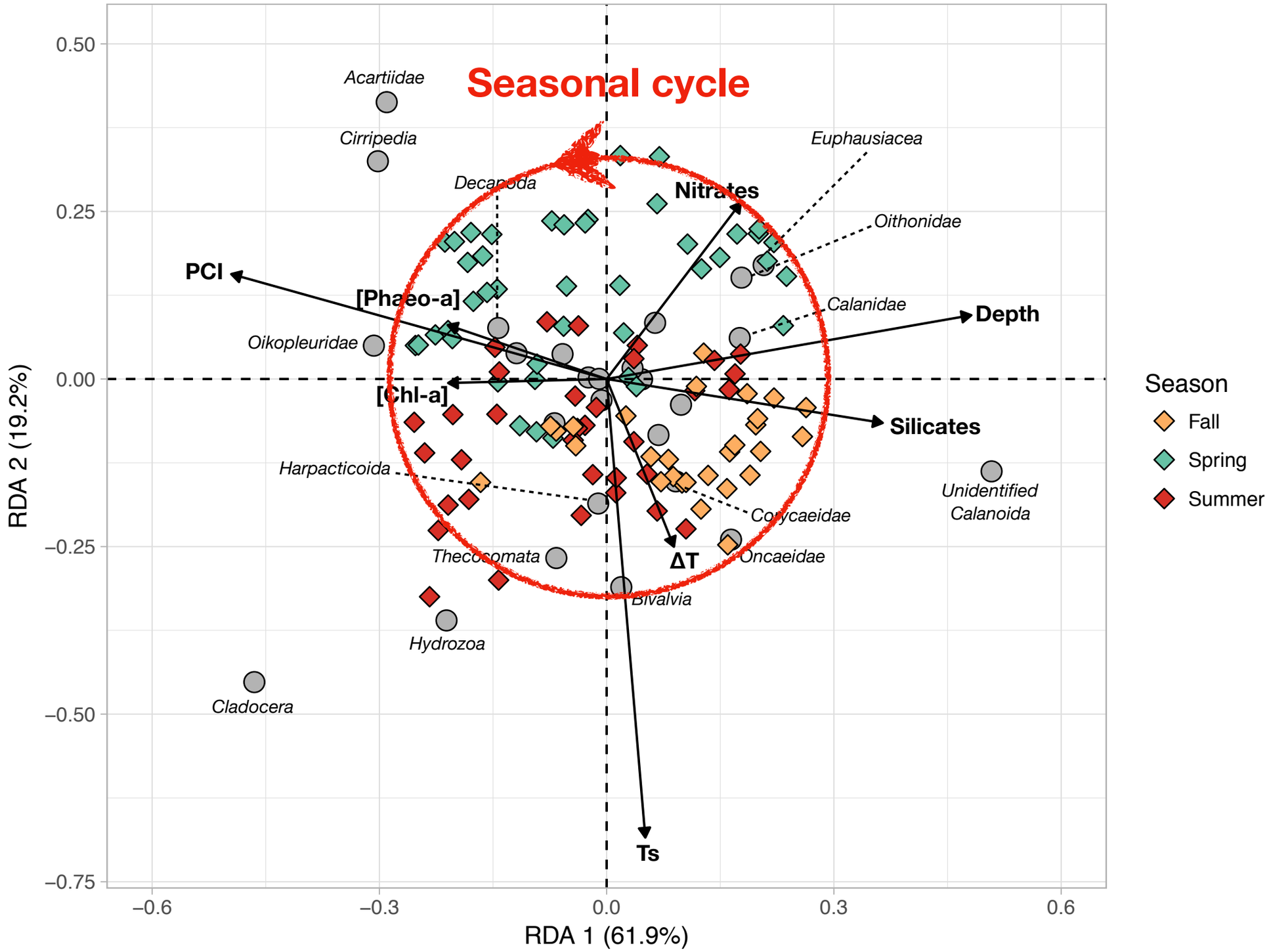
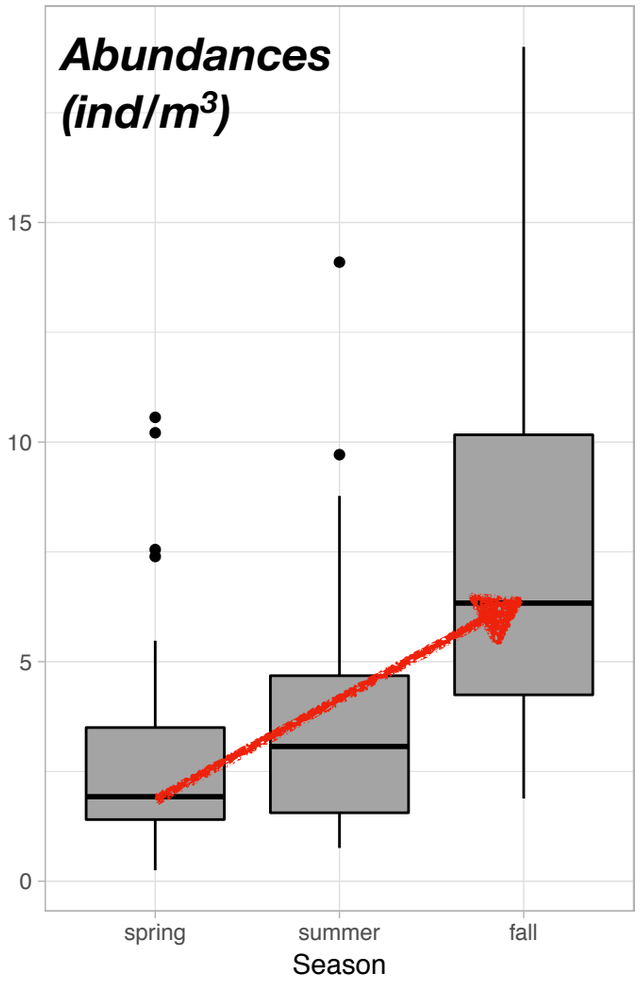
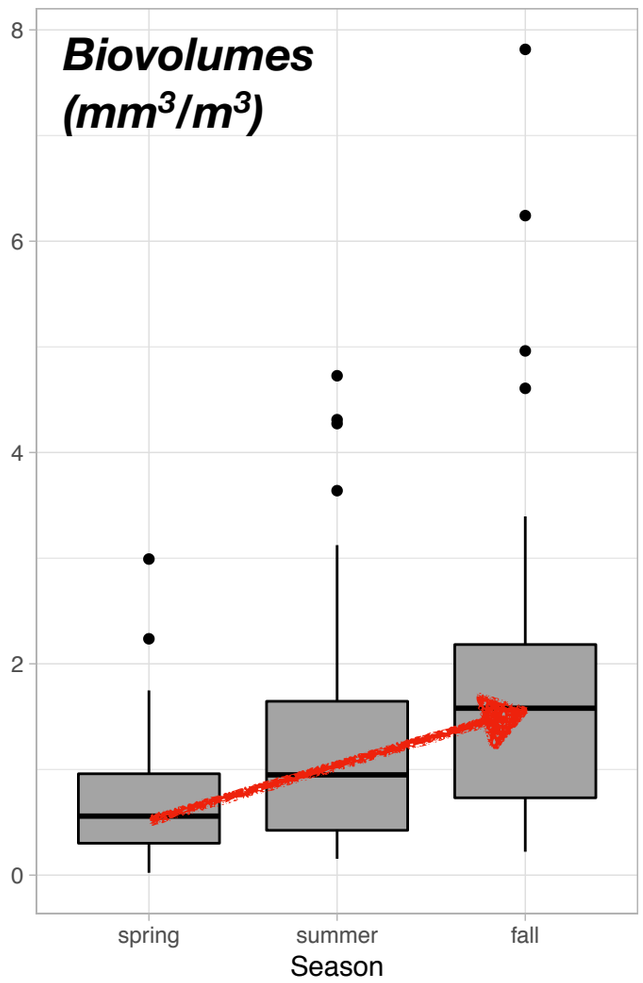
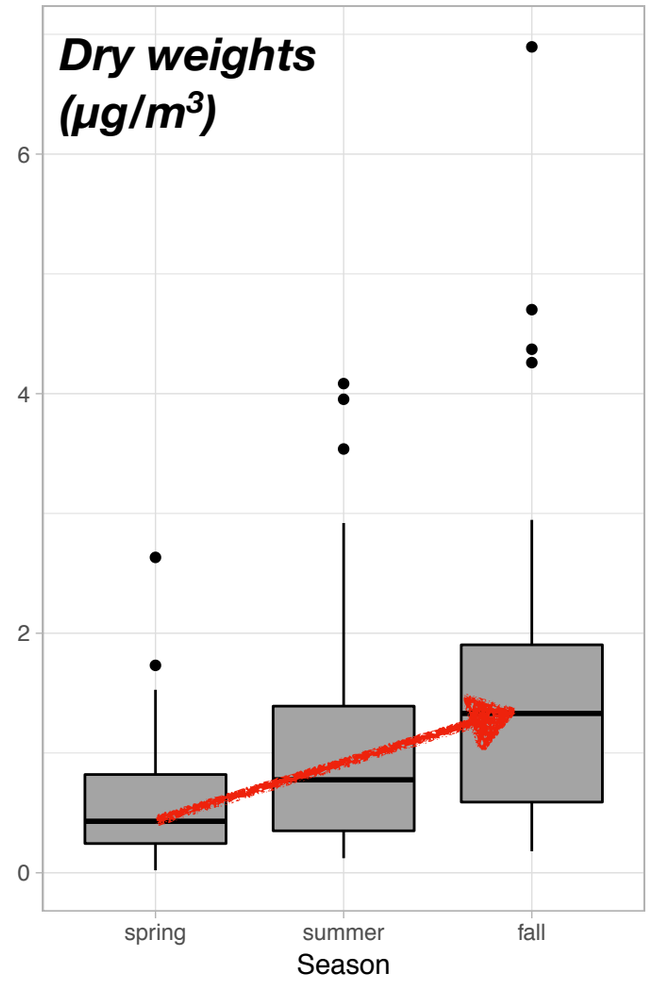


Copepod size ratios seasonal distribution

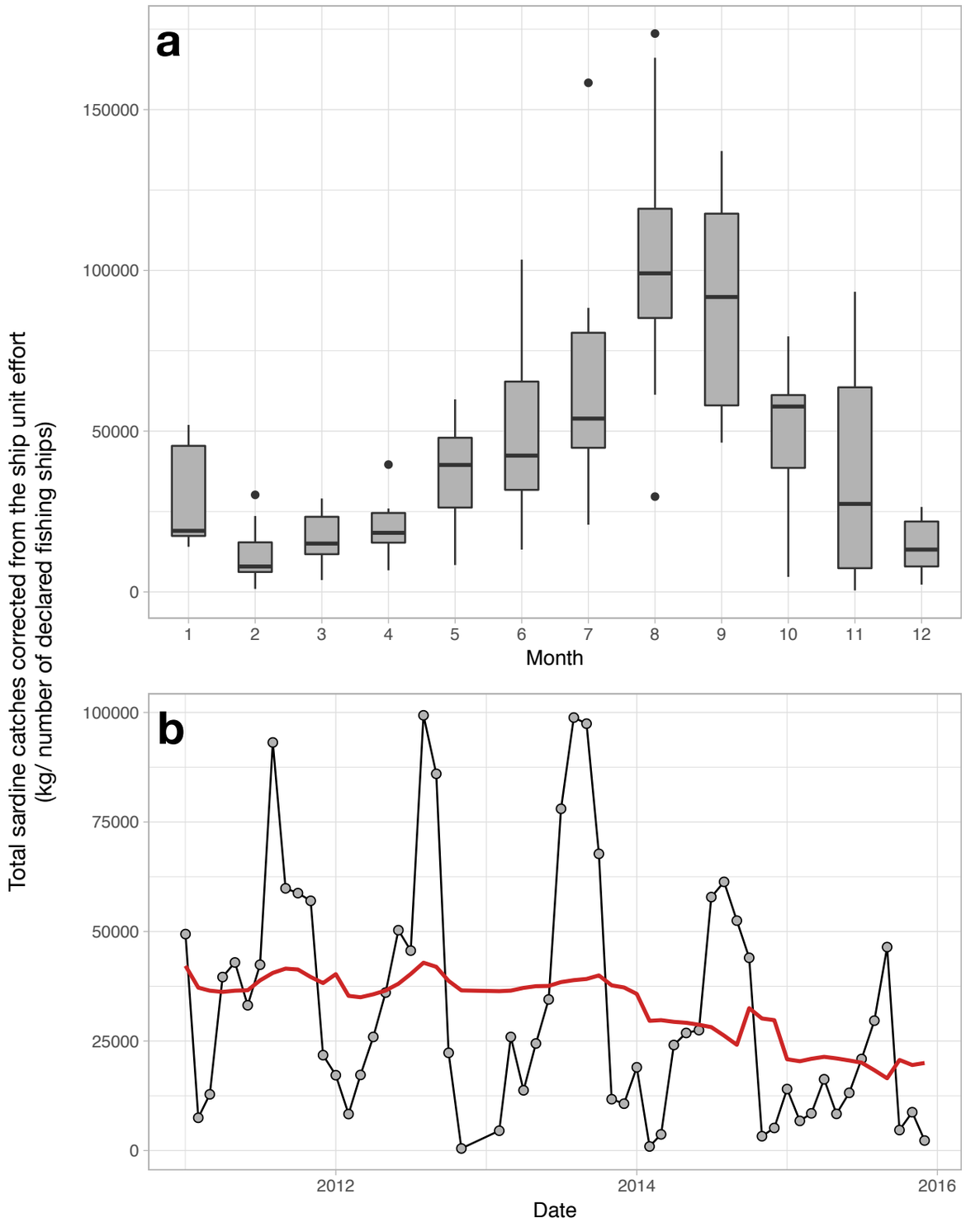






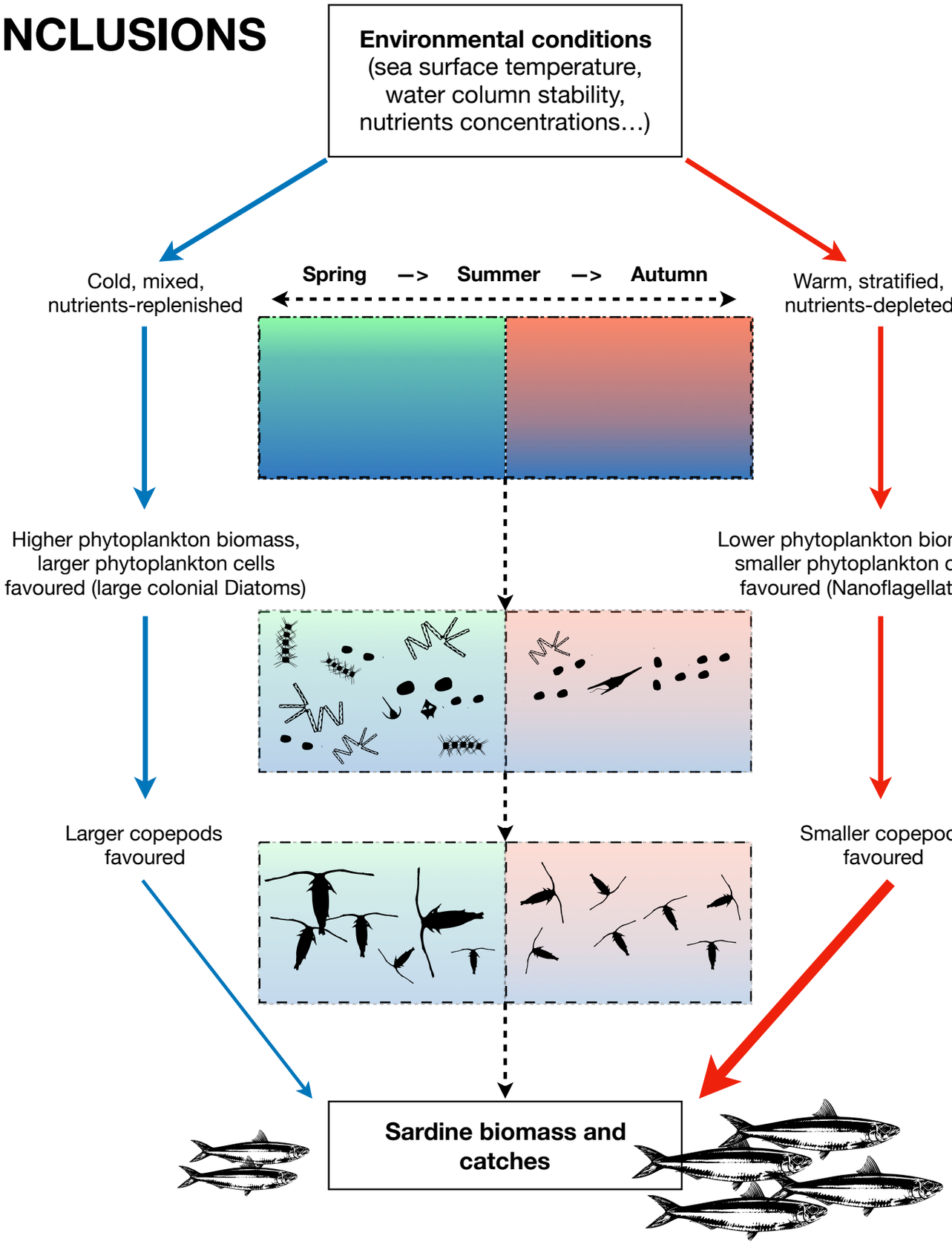
- All clearly displaying significant seasonality !

Monthly landings (CPUE) of sardines landings from fishing in the PNMI (corrected from sampling effort, i.e. number of fishing boast)



- Strong seasonal variations in sardine catches.
- Fishes are present all year long but are too small before summer (and front formation?) for the fishermen.
- Seems like catches have decreased over the past 8 years.
- Data and fishermen agree that 2015 was a dreadful year for sardines…

CONCLUSIONS



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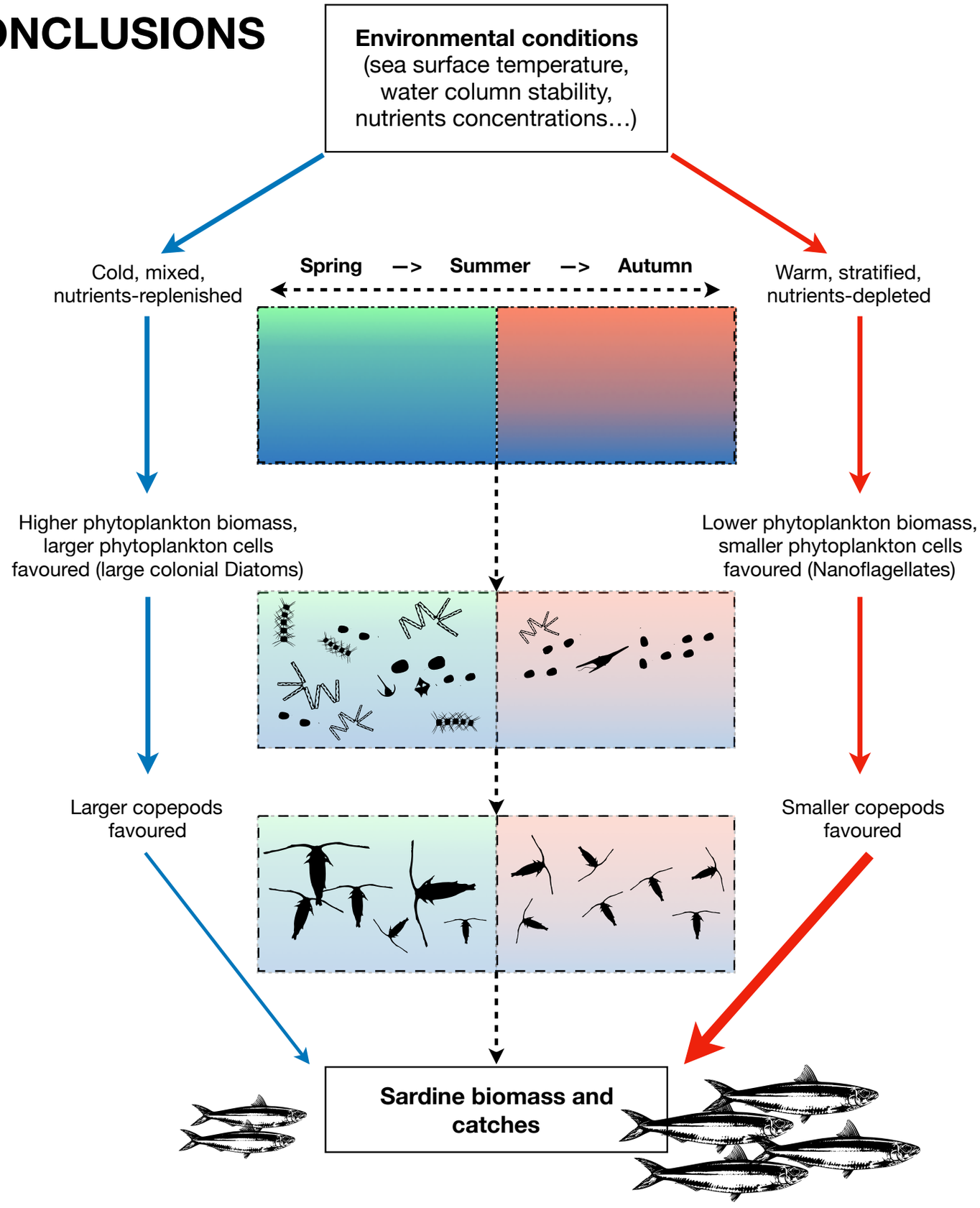
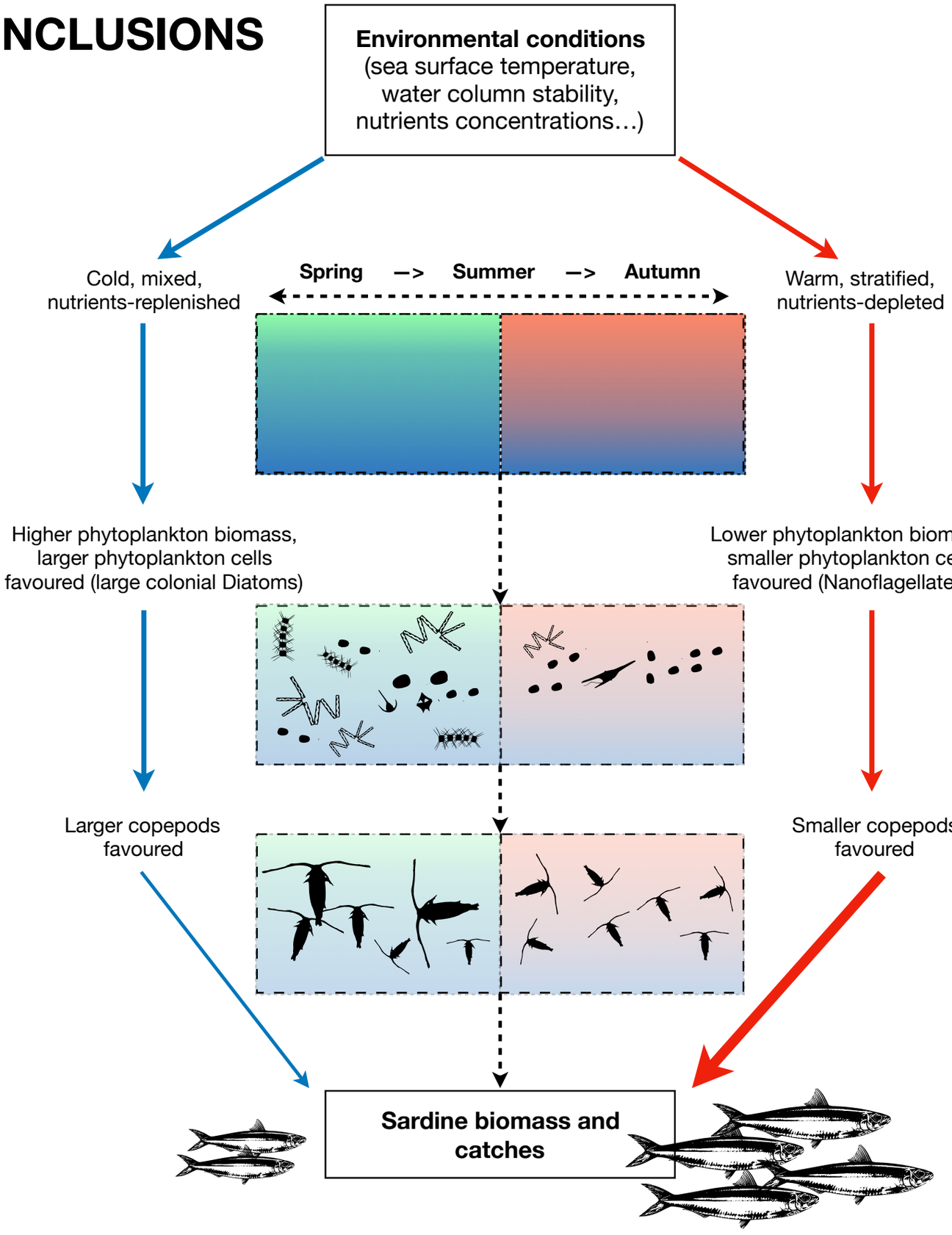


- Can the observed change in zooplankton abundance and size distribution explain the low in sardine catches in 2015 ?
- Continuing the collection will help to better understand the coupled physical/ plankton/fish interactions in this important fishing area

CONCLUSIONS



Thank you

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Parc naturel marin Iroise

Observatoire Océanologique Villefranche sur Mer · 1885 ·

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CONCLUSIONS

- Phytoplankton communities are strongly modulated (in terms of size and composition) by seasonal variations.
- At the first order, mesozooplankton community composition is structured by a west-east depth gradient and [Chl-a]/ Diatoms dominance gradient.
- At the second order, mesozooplankton community composition is structured by seasonal changes in temperature.
- Copepod size ratios (small/large) increase with temperature: smaller copepods dominate in warmer conditions (summer and autumn).
- Monthly variations in sardines landings, probably linked to front formation and changes in the size structure and composition of the plankton community which are beneficial for *S. pilchardus* to build reserves for the coming winter.