Contract: WP4-SYSMS-1101

Zooplankton response to NW Mediterranean hydroclimatic changes from 1966 to 2010

Pieter Vandromme[1], Lars **Stemmann**[1], Carmen García-Comas[2], Laure Mousseau[1], Franck Prejger[1], Ornella Passafiume[1], Marc Picheral[3] and Gabriel Gorsky[3]

[1] Université Pierre et Marie Curie-Paris 6, UMR9073, Observatoire Océanologique de Villefranche sur Mer, BP 28, 06234 Villefranche sur Mer, France. E-mail: vandromme@obs-vlfr.fr
[2] Institute of Oceanography, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd., Taipei 10617, Taiwan
[3] CNRS UMR9073, Observatoire Océanologique de Villefranche sur Mer, BP 28, 06234 Villefranche sur Mer, France

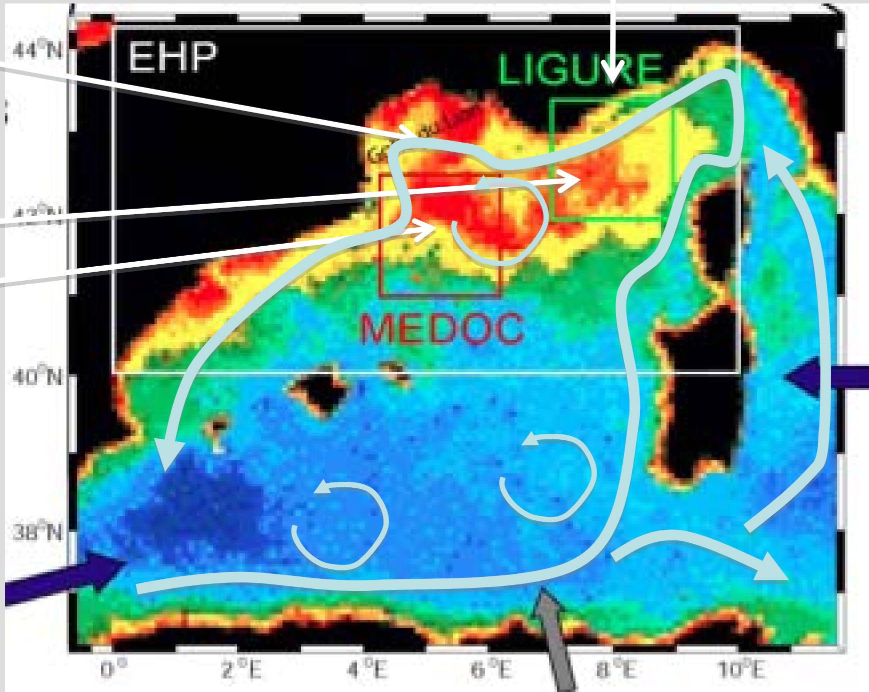
The NW Mediterranean sea: CONTEXTE AND CHALLENGE

- **functions like a mini ocean**
  - **change in anthropic input (notably N/P ratio) notably from Rhône river**
  - **changes in climate that change heat flux and water budget (1980's dry and 2000' dry), winter mixing and winter convection (MEDOC and LIGURE)**

sampling site

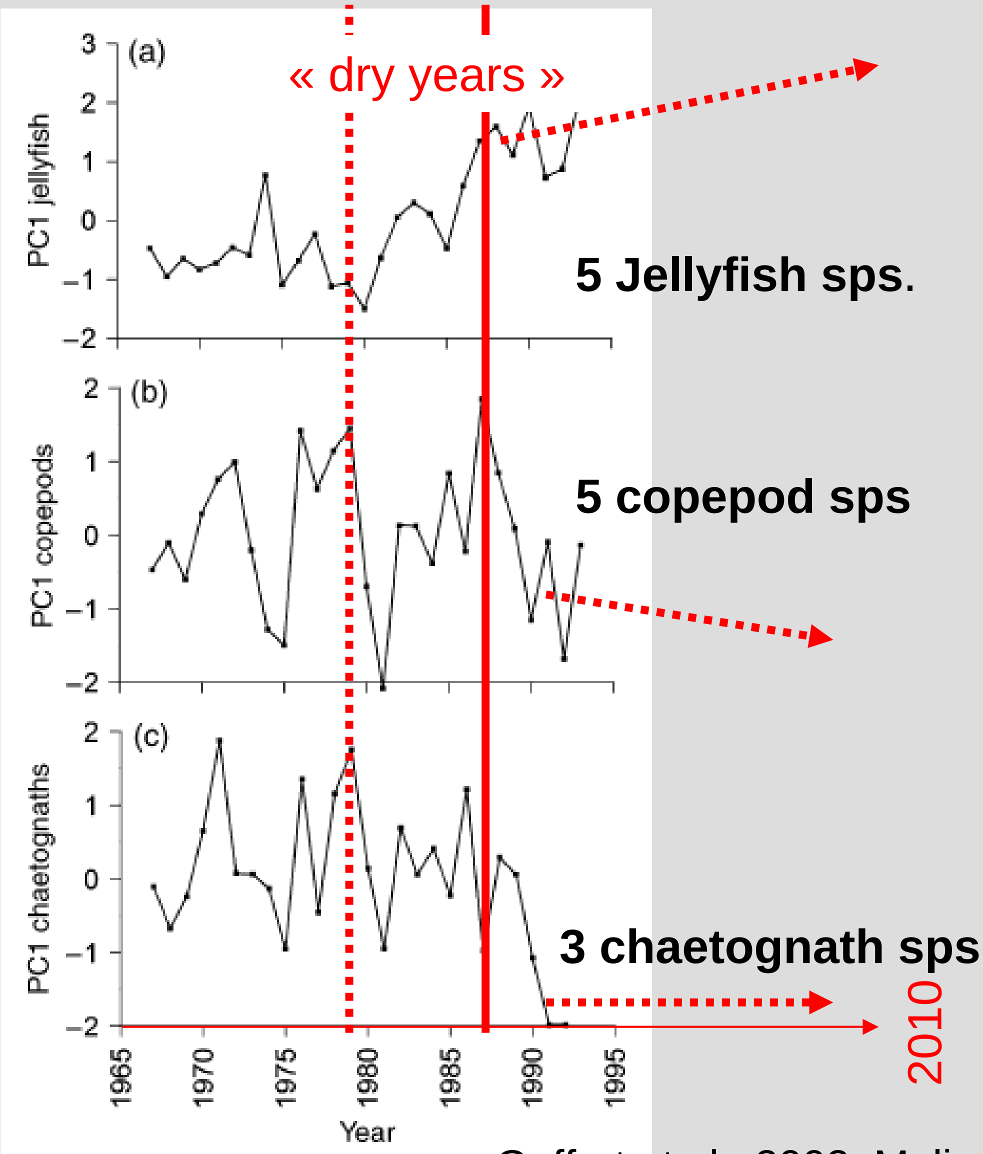
Bloom in Rhône river plume

Bloom in convection areas



The Ligurian bassin and the Point B sampling site are isolated from strong continental inputs.

1967-1993 Long term zooplankton time series at Point B



Shift and reorganization of zooplankton community at the end of the ‘80s (1987 shift year) toward an oligotrophic system.

What about the whole jellyfish, chaetognath and copepod populations?

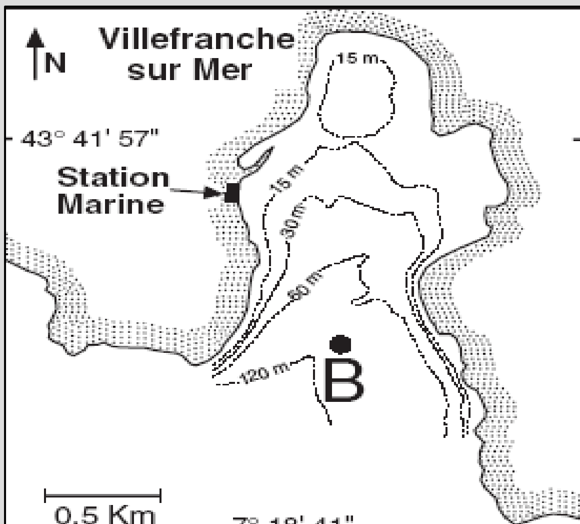
Is oligotrophy confirmed after 17 more years of observations?

Goffart et al., 2002, Molinero et al., 2005 and 2008, Conversi et al., 2010

4 net collections since 1966

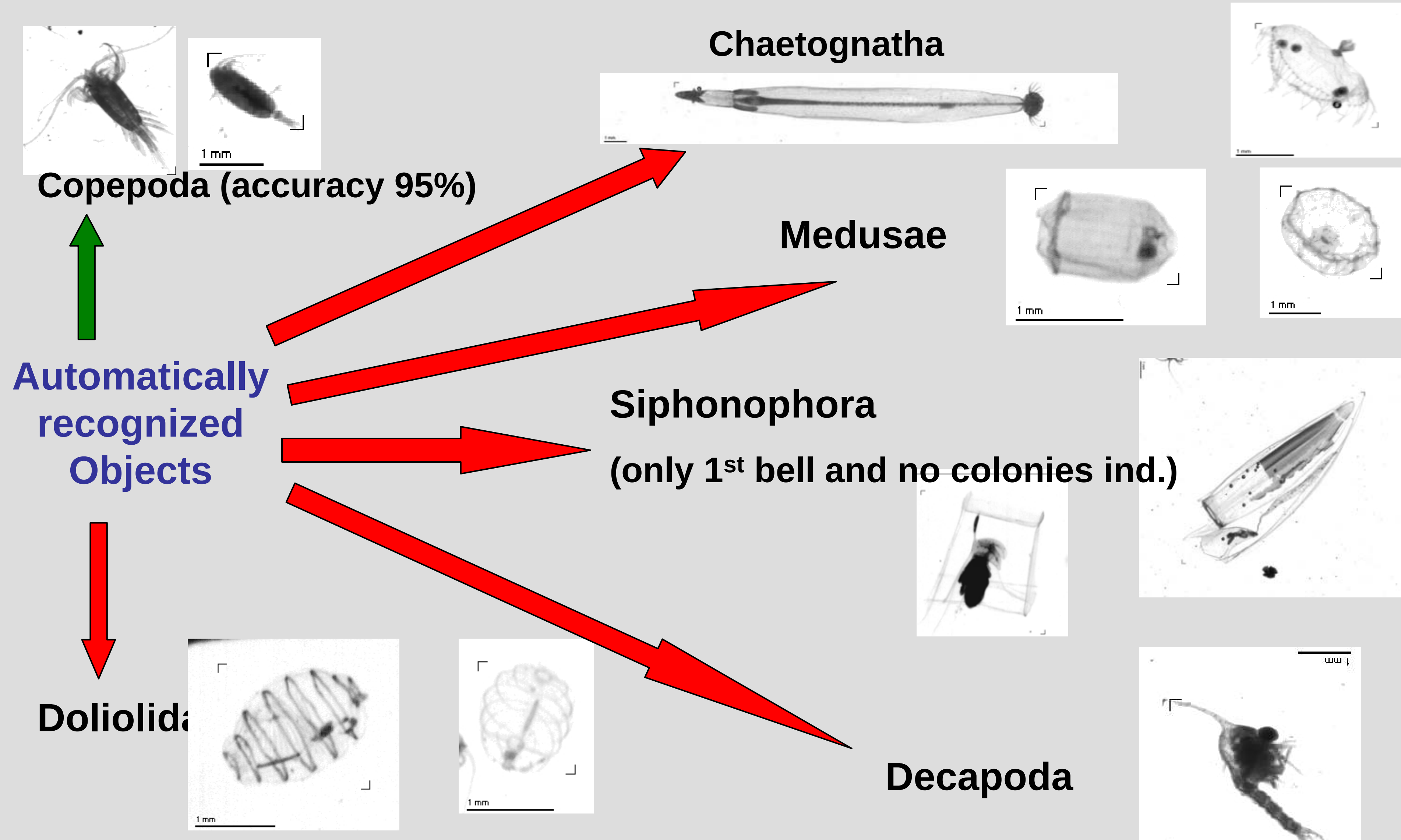
TS1: 1966-2011, Regent Net (680µm mesh), oblique hauls, daily sampling
TS2: 1966-2003, Juday Bogorov net (330 µm mesh), vertical hauls, daily sampli
TS3: 1995–2006, WP2 net (200µm mesh), vertical hauls, weekly sampling
TS4: 2003-2011, WP2 net (200µm mesh) , vertical hauls, daily sampling

More than **20000** net samples but pooled in weekly jars (>**5000** jars).



Point B time series is one of longest and most complete
→ too many samples to analyse in a traditionnal way.
TS 2, 3 and 4 have been completely digitalized with the ZOOSCAN.

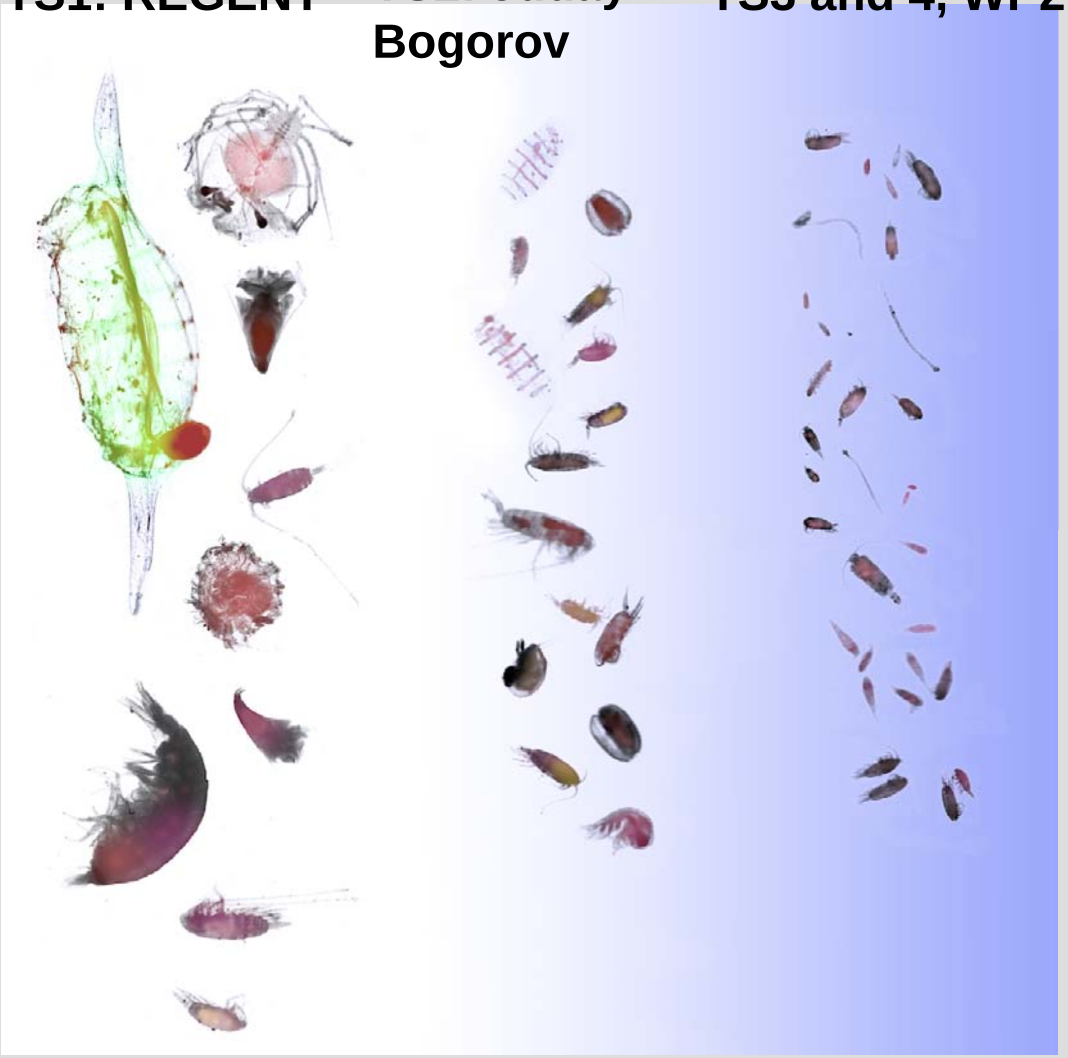
Automatic recognition followed by manual validation for all groups but copepods (TS1, TS2 and TS3)



For TS4, we validate in 40 groups but >100 can be achieved (Gorsky et al., 2010)

Why collecting using 3 nets ?

TS1: REGENT **TS2: Juday Bogorov** **TS3 and 4, WP2**



Different nets do not collect the same community

Most abundant organisms are small in the Med. sea.

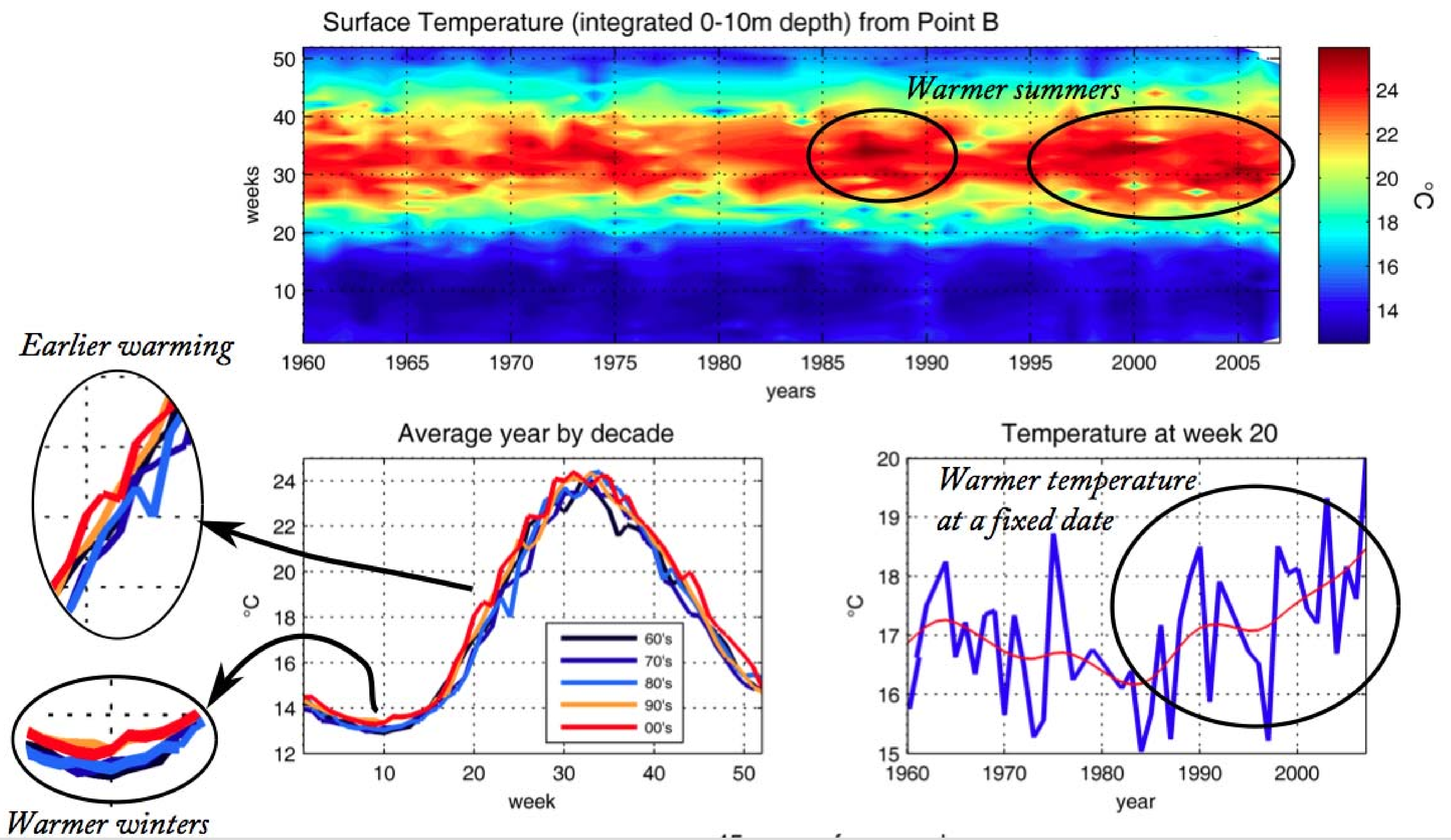
BUT

plankton abundances not directly comparable.

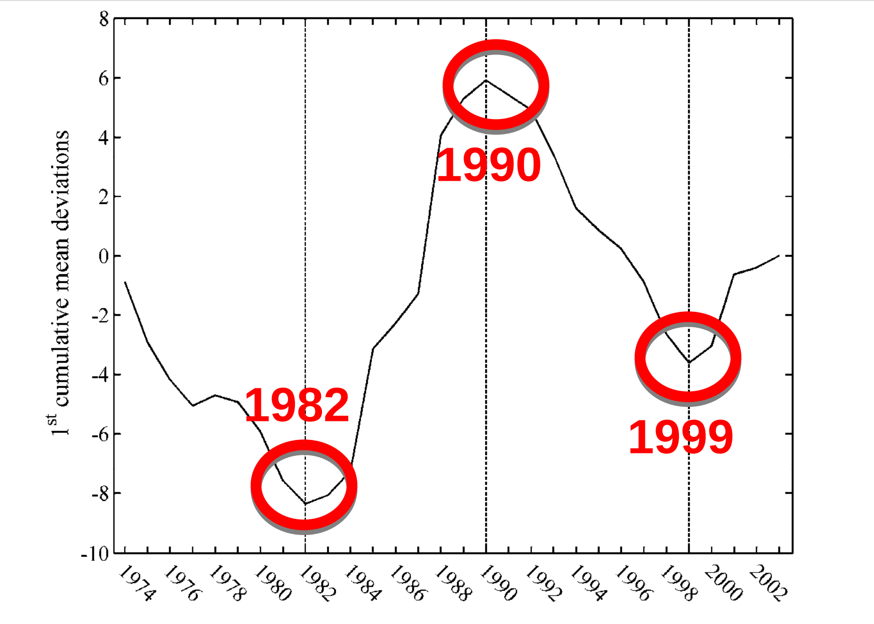
Image analysis may provide a solution by measuring all organisms.

Fore more on combining nets results→ March 16, W5, Automated visual plankton dentification.

A warming Ligurian Sea



TS2: 1974-2003 zooplankton in JB nets



1st PC **Zooplankton dataset** (40%):

Copepod, Decapod, siphonophore, hydromedusae, chaetognathe

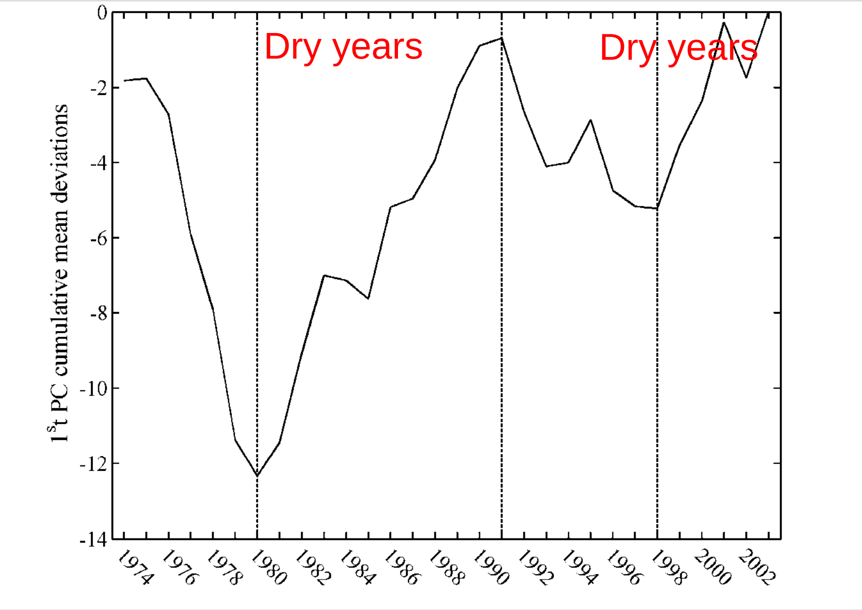
1974-1980: ↓ copepods and Jellies

1980-1990: ↑ All groups (phyto. 2 peaks)

1990-1998 ↓ All groups

1998-2003 ↑ All groups (phyto. 2 peaks)

(Carmen et al., in revision)



1st PC **Environmental dataset** (33%):

20,50m Temp. and Sal., atm.P, Ek.D., Rain, Sun

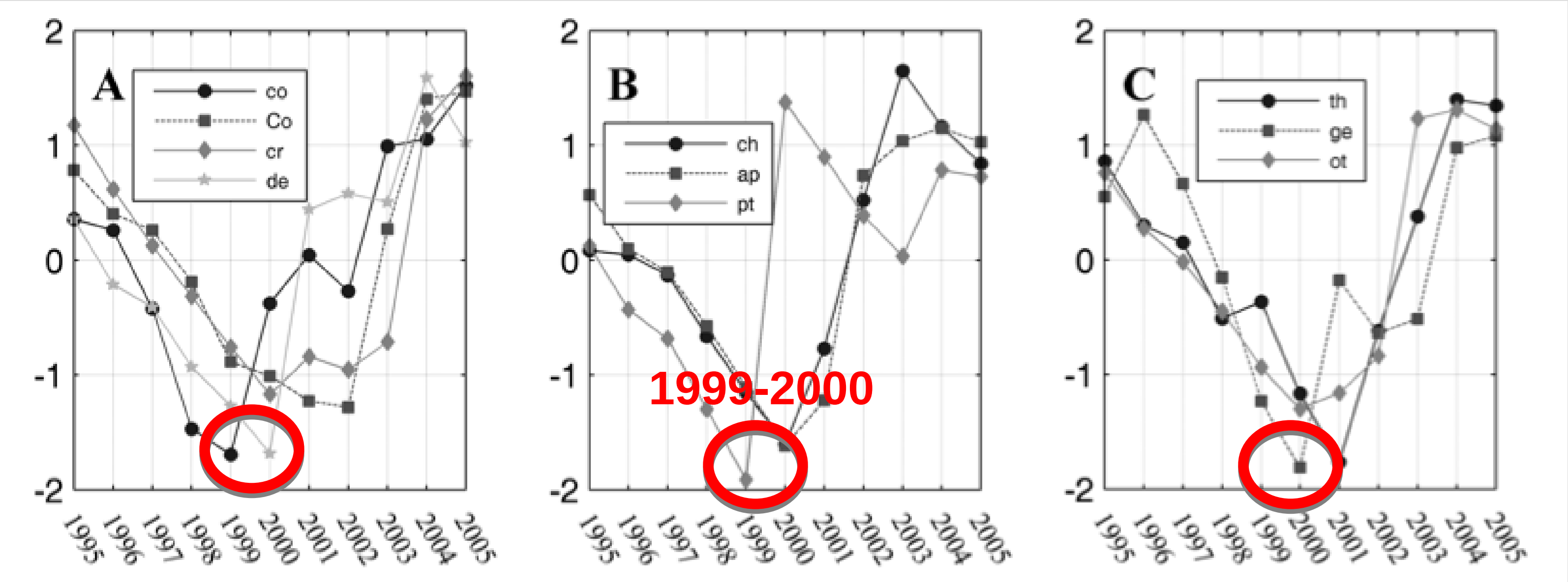
1974-1980: ↓ Salinity and Temp.

1980-1990: ↑ Salinity and Mean Temp .autumn

1990-1998 ↓ Salinity and ↑ Temp

1998-2003 ↑ Salinity

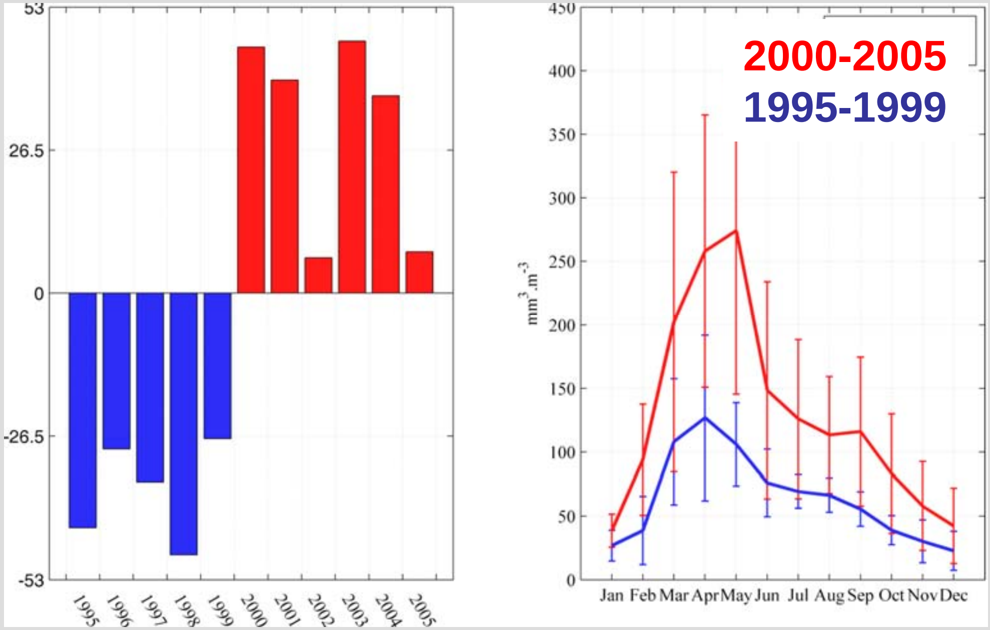
TS3: 1995-2005 zooplankton in WP2 nets



(Vandromme et al., in revision)

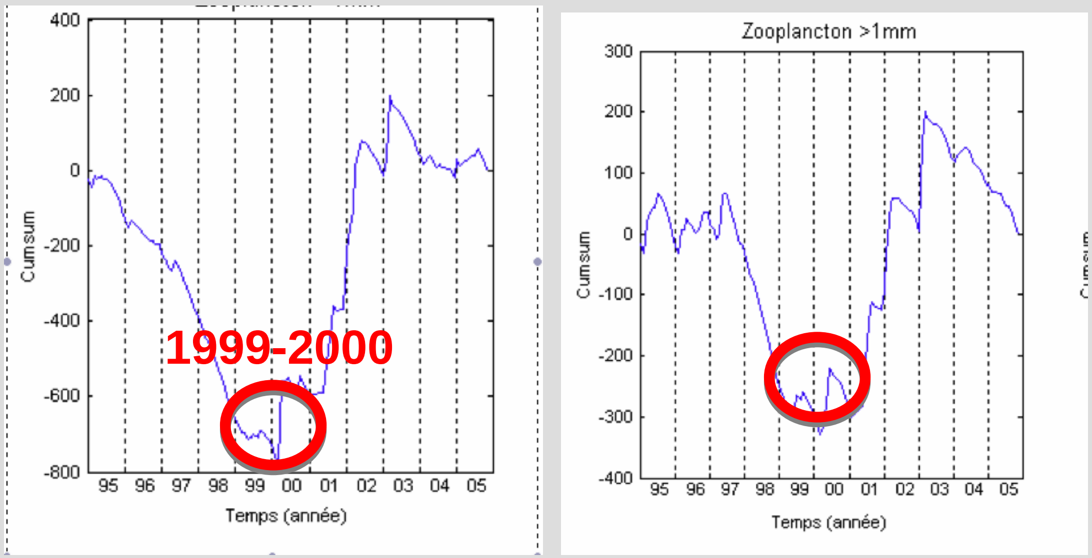
Cumulative sum of annual anomalies of the ten identified taxonomic groups**.**

Annual anomalies of total plankton biovolume
and
average seasonnality of biovolume for the two periods.



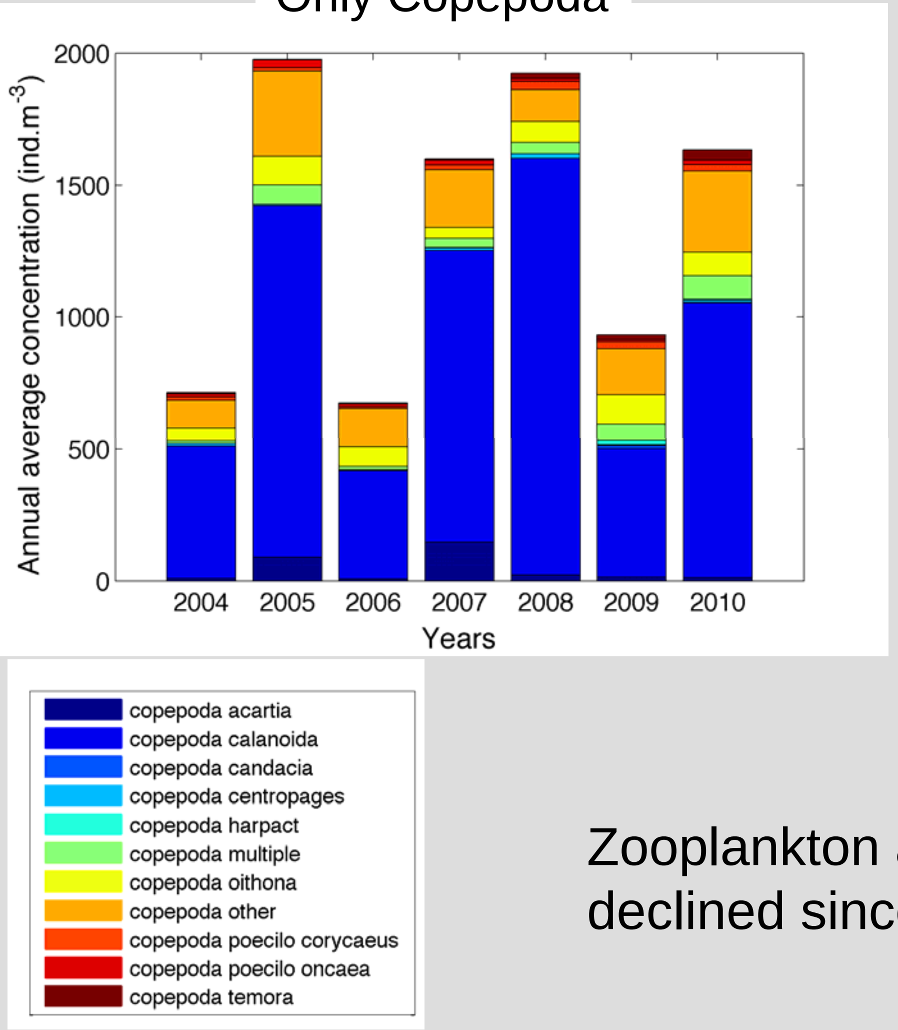
TS1 : 1995-2005 zooplankton in Regent net

Cumulative sum of annual anomalies of two size classes of zooplankton in **Regent net** (Stemmann et al., in prep)

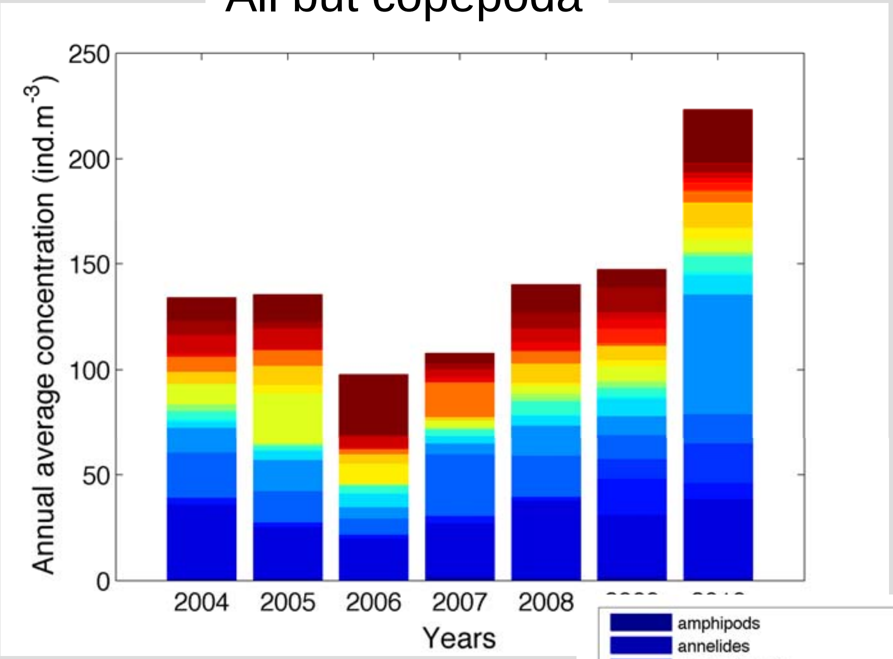


TS4 : 2004-2011 zooplankton in WP2

Only Copepoda



All but copepoda

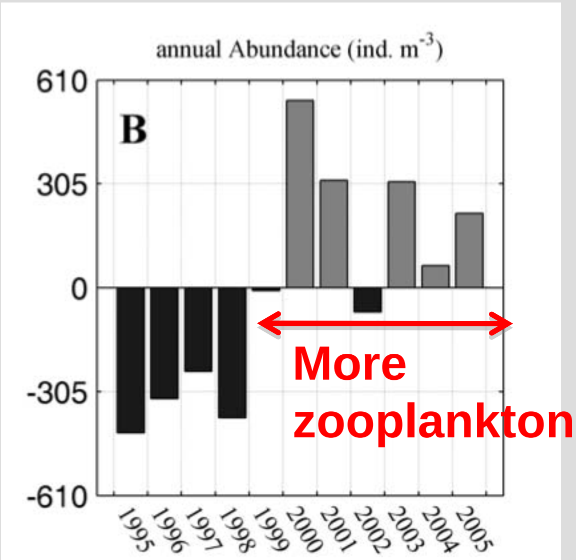


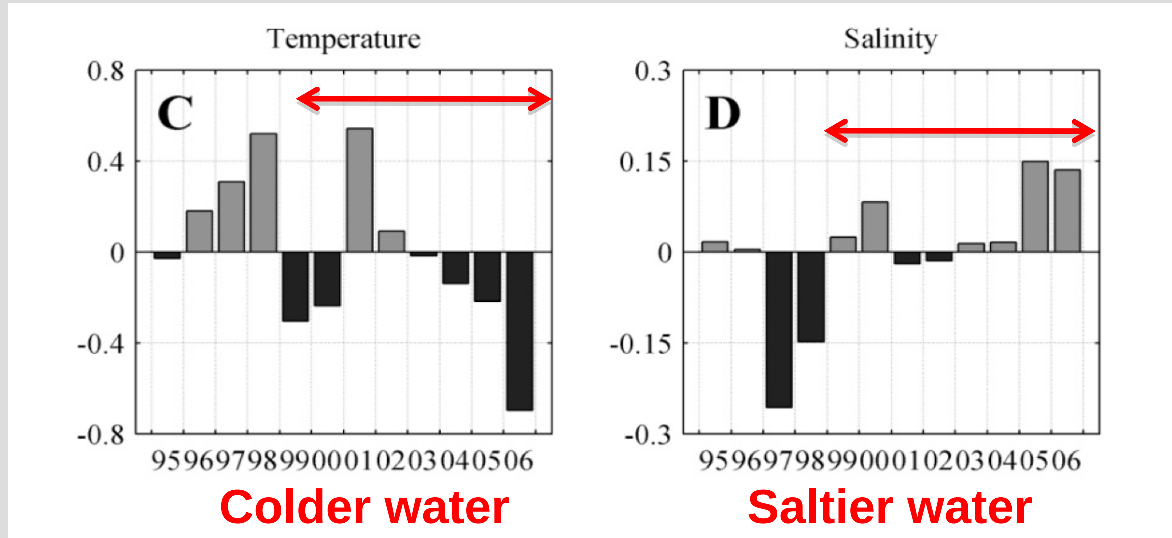
Zooplankton abundances have not declined since 2004

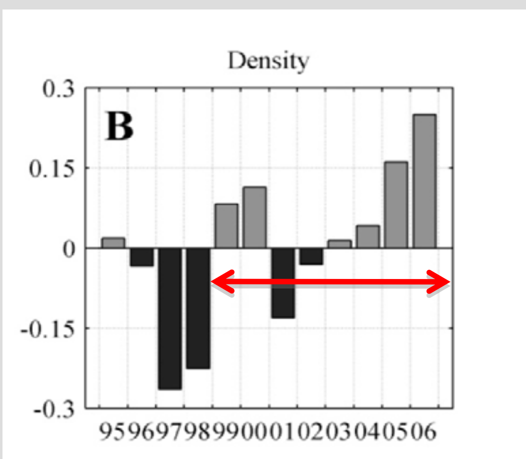
- the shift toward less zooplankton in late 80's observed by previous authors is confirmed.
- we observe a more recent shift in late 90's (confirmed in three independent nets) toward higher zooplankton concentration, therefore the "oligotrophisation" due to more stratification is not yet confirmed.

- in a warming Mediterranean Sea, what caused the different shifts ?
- can we extrapolate to the whole NW Mediterranean Sea ?

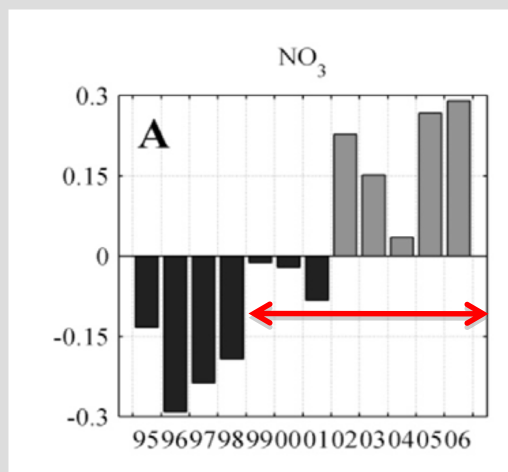
1995-2006: link with environmental data in WINTER (weeks 4-17)



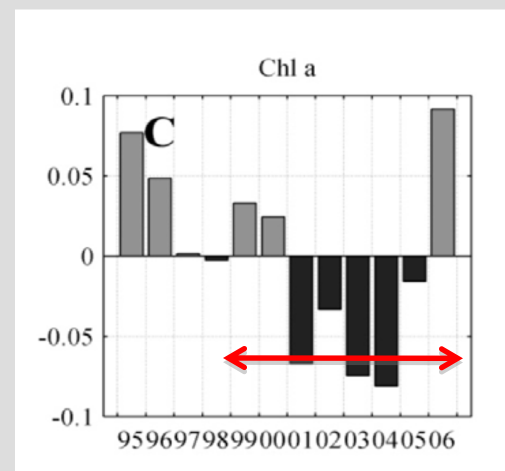




Denser water



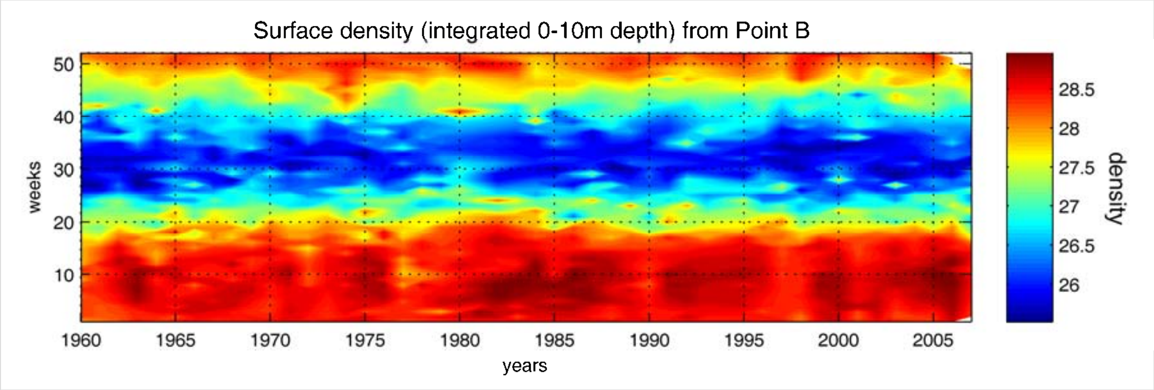
More nitrate



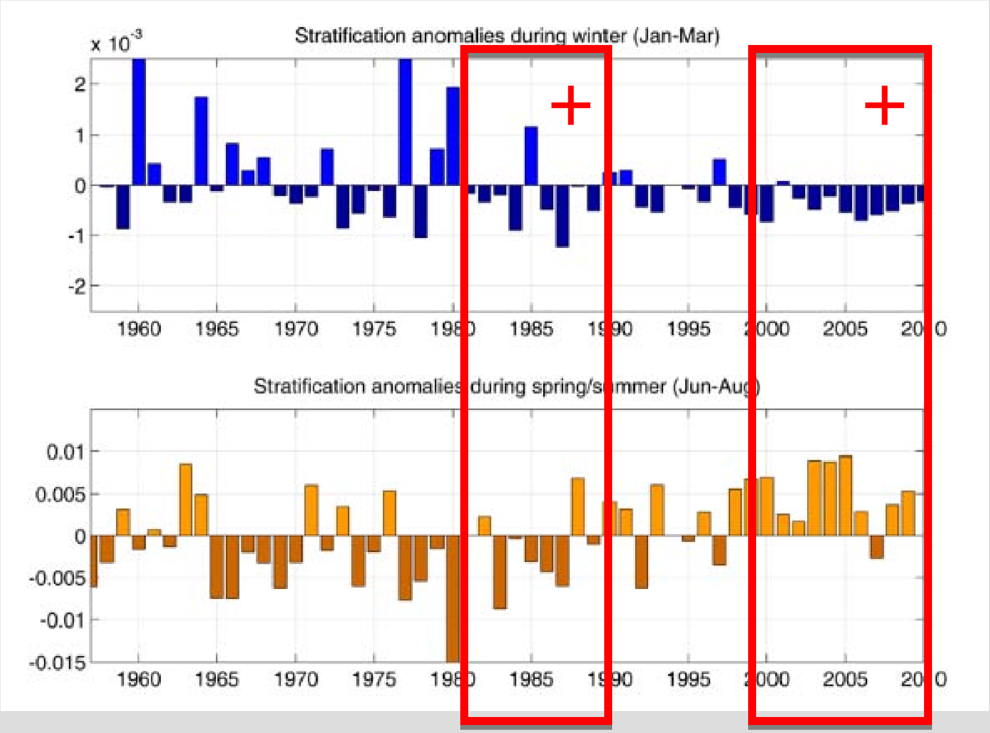
Less Chla

(Vandromme et al., in revision)

Trend to more winter mixing and consequences for the ecosystem



Denser water in winter colder and saltier (close to intermediate Mediterranean water)

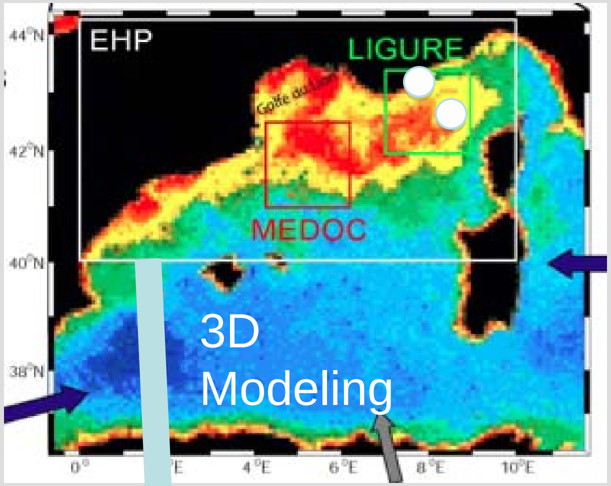


Less stratification in winter
→ more nutrient for phytoplankton production and zooplankton

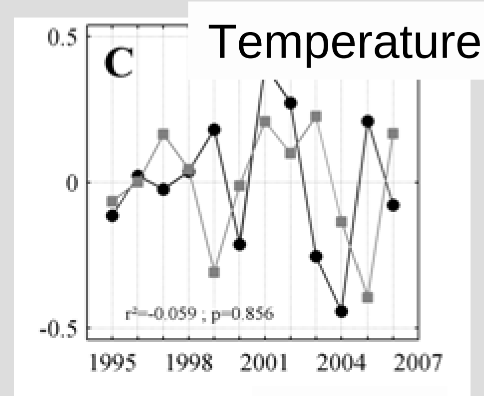
More stratification in summer
→ better for jellyfish which feed on more preys

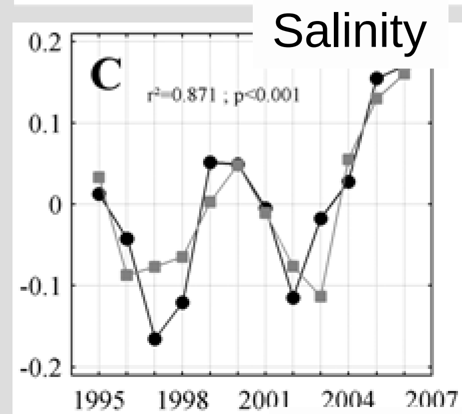
Stemmann et al., in prep

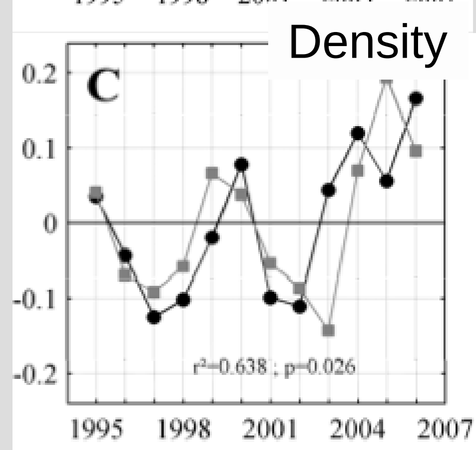
Extrapolation to the whole NW Mediterranean sea

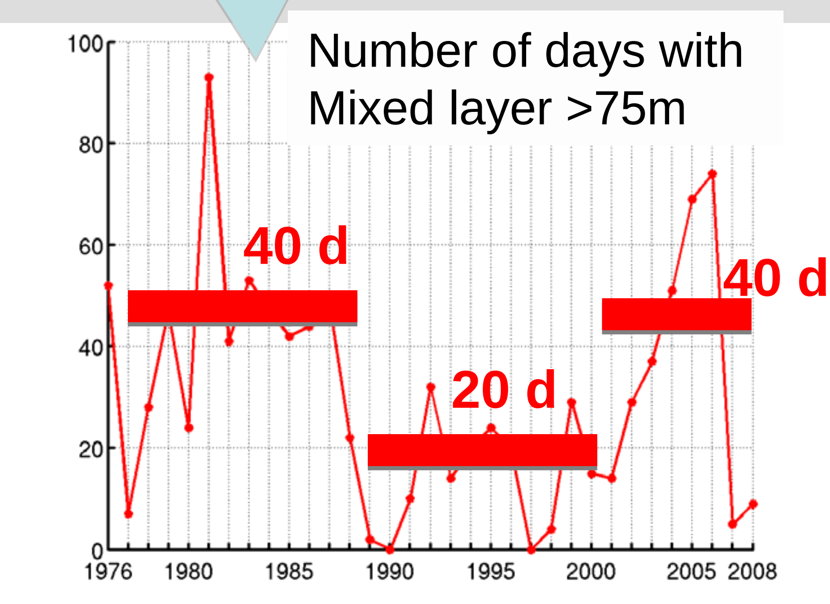


DYFAMED and Point B time series









(SYMPHONIE 3D model forced by ERA40 ciimatic model, Augier 2011)

- Zooplankton changes are closely linked to hydroclimate, and a bottom-up control is suggested (Comas et al., in revision) and in addition a top-down control of Zoo on Phyto (Vandromme et al., in revision).

- The stronger winter mixing in dry years (winter low T and high S) may be the principal factor to initiate the bloom and zooplankton development in spring despite the increase in summer stratification (and annual temperature).

- This may be a general pattern across the NW Mediterranean Sea.

- How long will that be ?