

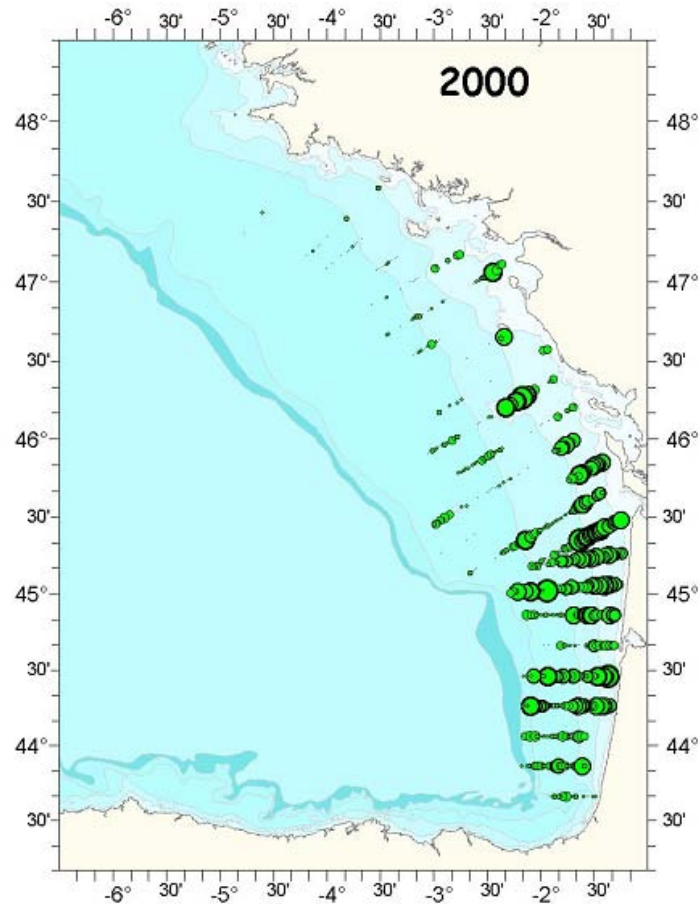
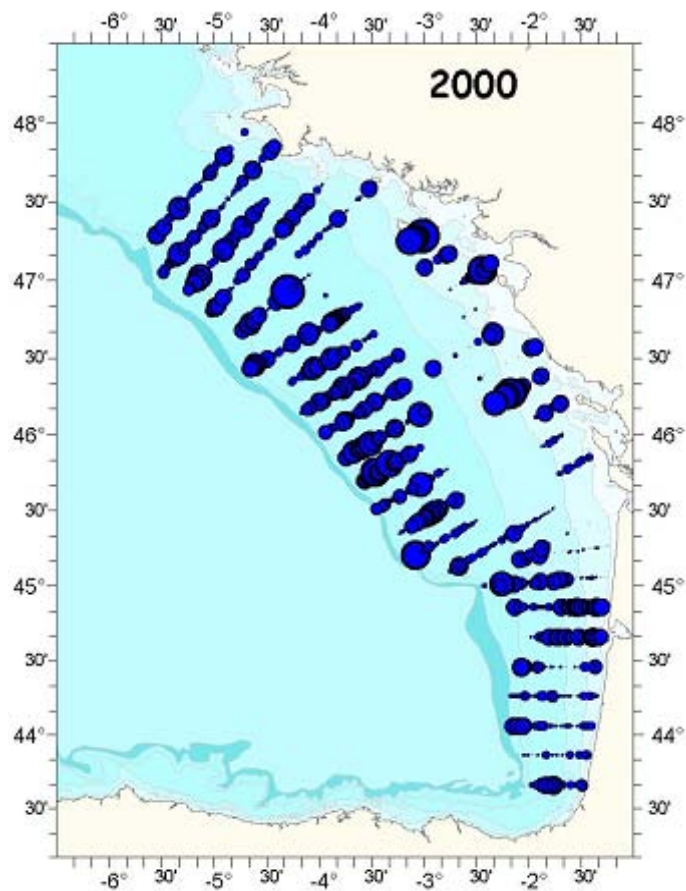
Microbial loop vs short food chains:
what do mesozooplankton enzymatic
indices tell us about differences in food
webs' efficiency and productivity?

Jean-Pierre BERGERON

Daniel DELMAS

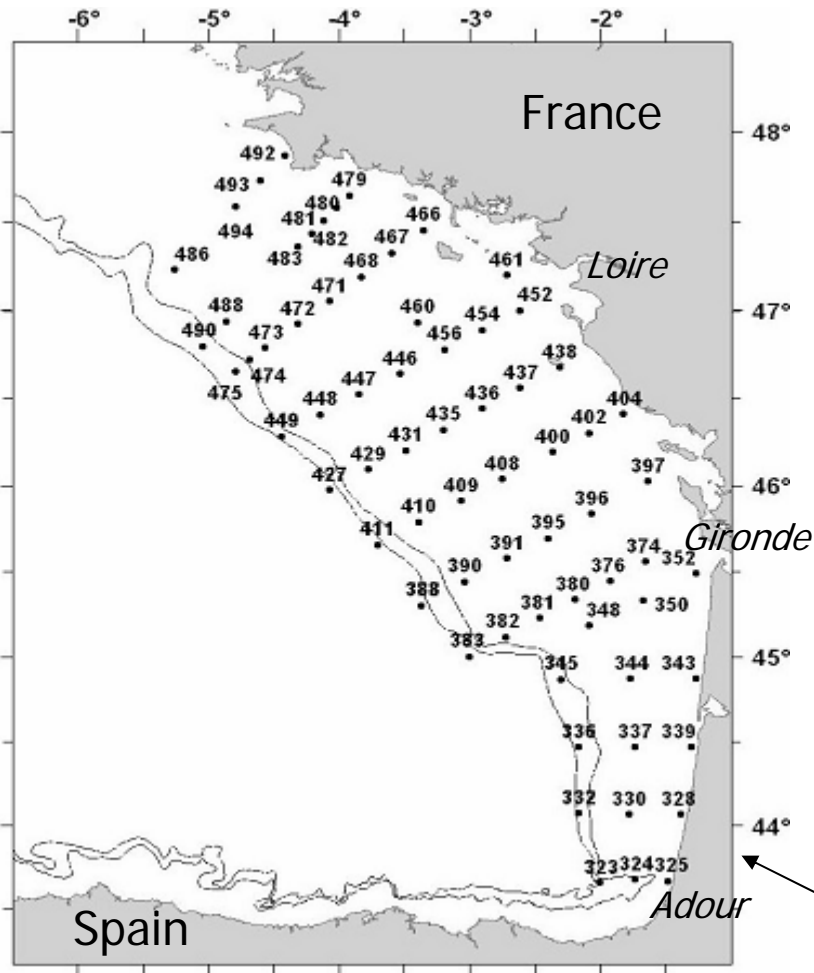
Noussithé KOUETA

Sardine *Sardina pilchardus* (in blue) and anchovy *Engraulis encrasicolus* (in green)



Abundance and spatial distribution of a higher trophic level

French continental shelf of the Bay of Biscay



In spring of the year 2000, on R.V. Thalassa was carried out a fisheries research cruise devoted to small pelagic fish populations abundance and distribution during their breeding season through acoustics.

It gave a first opportunity to simultaneously implement measurements of the activities of three enzymes in mesozooplankton, with the aim of characterizing main features of the biotic environment of these fish species, while data on prime levels of pelagic food webs (nutrients, phytoplankton, bacteria, particulate C and N, etc...) were gathered.

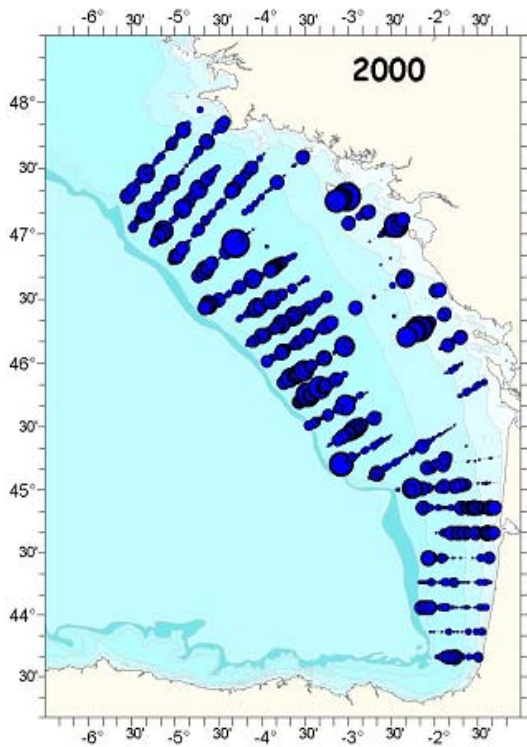
Sampling stations, 200 and 500 m isobaths and locations of significant freshwater inflow.



Enzyme activities as metabolic descriptors

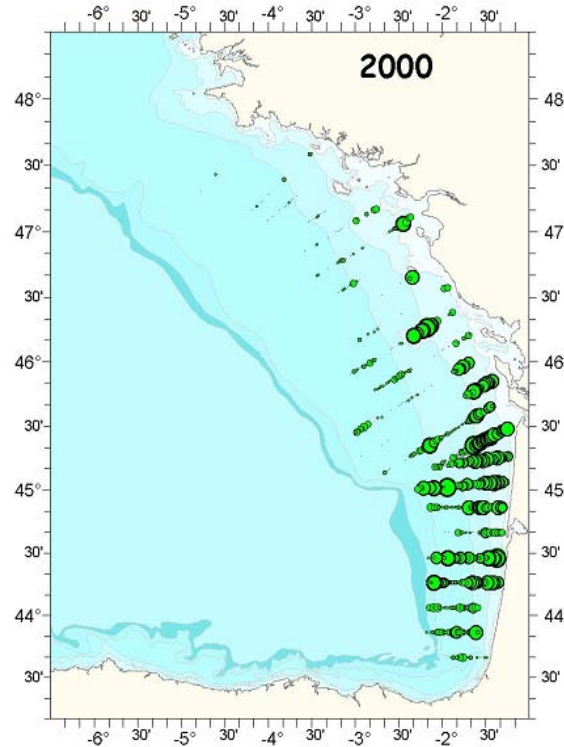
- Enzyme activities are estimated in samples of the whole mesozooplankton community collected with a WP2 net (200 μ mesh size) vertically towed from bottom (200 m when taken beyond the shelf break) to surface. Expressed as specific activities, *ie* related to protein.
- Pyruvate kinase (PK) works at the end of the glycolysis chain, therefore expresses the catabolism of all assimilated carbohydrates, whatever their different initial macromolecular structures.
- Trypsin is a digestive endopeptidase which attacks peptidic links involving basic amino acids (Arginine, Lysine) in proteins.
- Aspartate transcarbamylase (ATC) is specifically involved in early steps of the biosynthesis of pyrimidine bases used to build nucleic acids for cell multiplication and protein synthesis.

Abundance and spatial distribution of two species belonging to a higher trophic level



Sardine

Sardina pilchardus



Anchovy

Engraulis encrasicolus

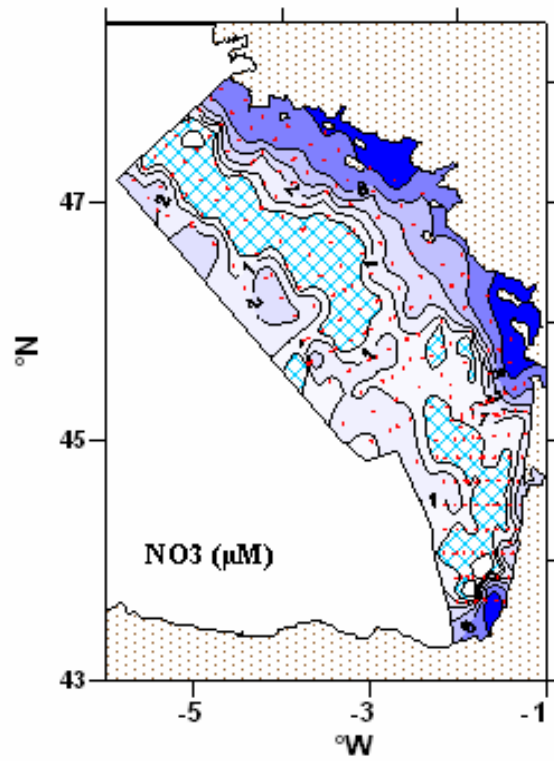
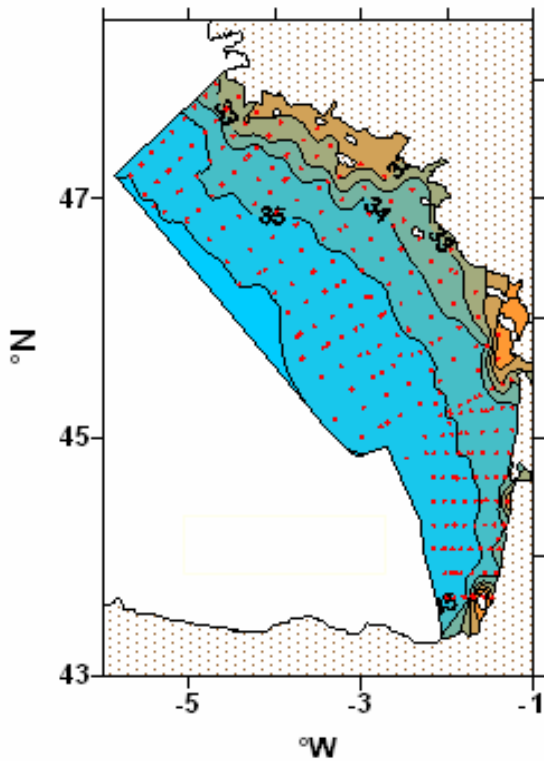
Such a pattern is recurrent in the Bay of Biscay.

Are mesozooplankton enzymatic indices able to support this pattern?

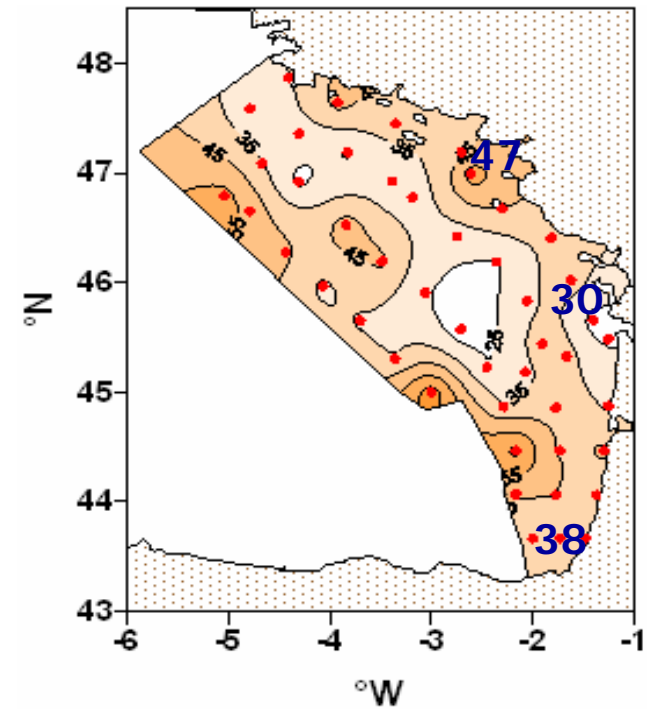
What are they indicating about the functioning of the whole area?

Would it be useful to carry on with applying such an approach in future fisheries research cruises?

Local enrichment of marine areas by outflow of large rivers

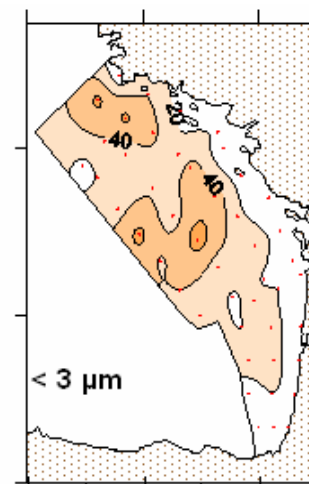
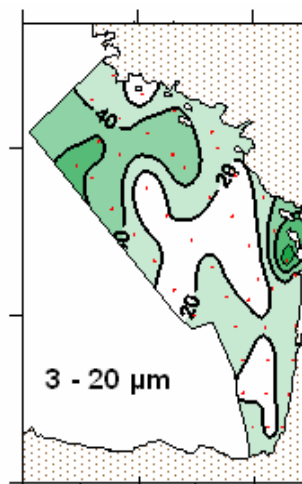
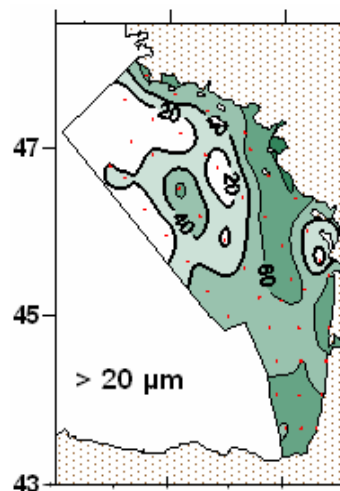
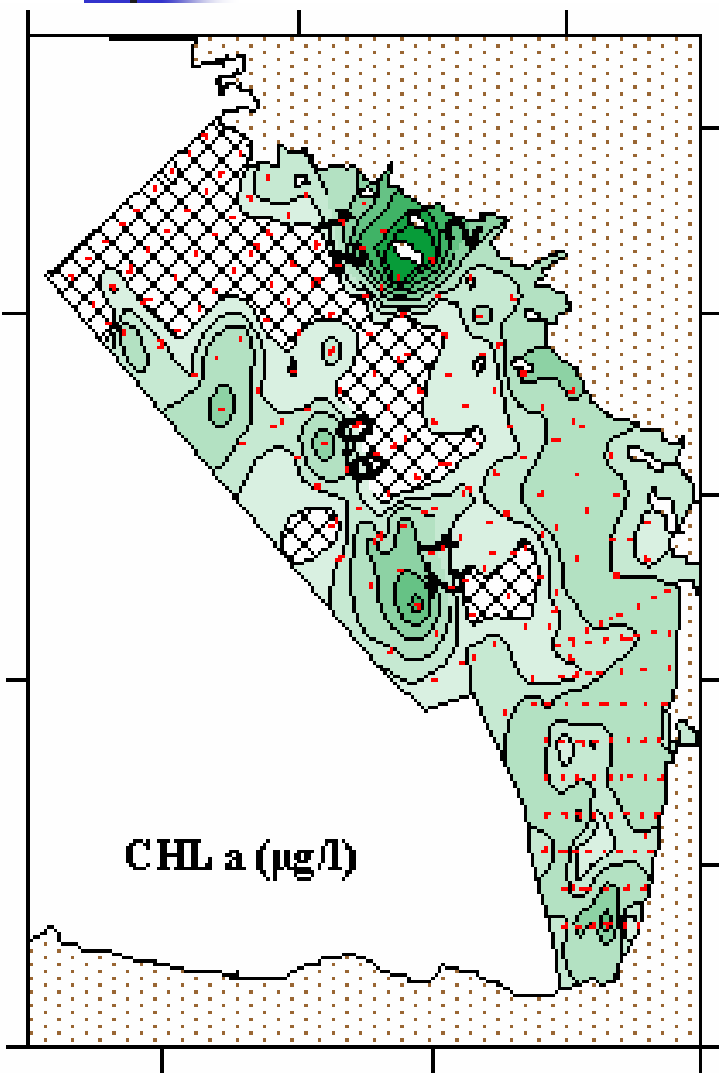


Salinity and nitrate concentration in surface waters of the river plumes indicate location of the two larger rivers in the north and a smaller one in the south



Spatial variations of
Microbial C % POC
(integrated values
through the photic layer)

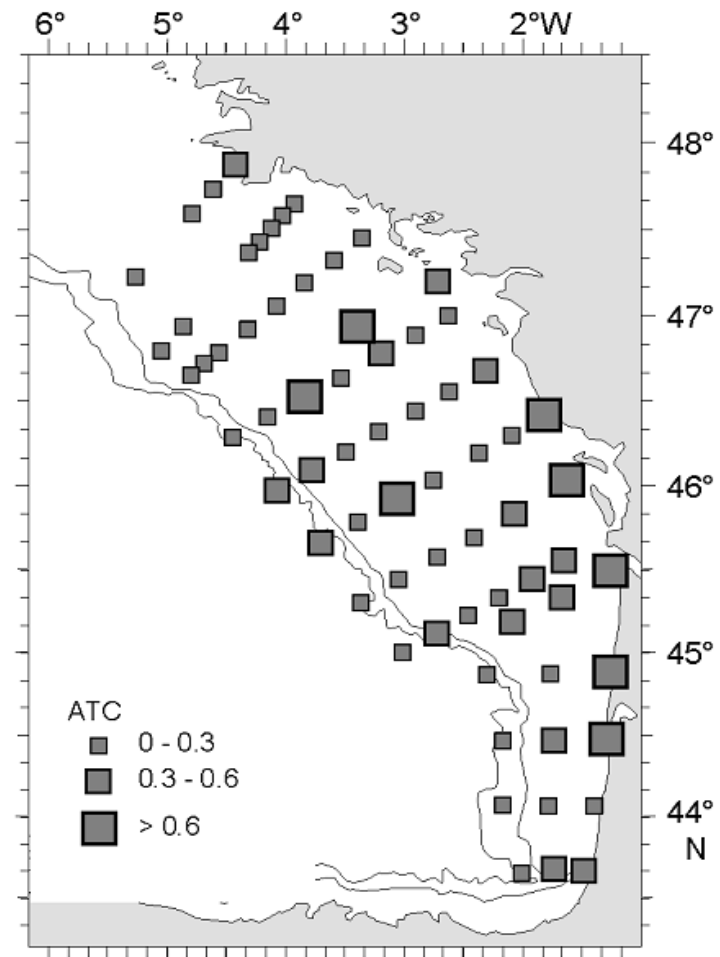
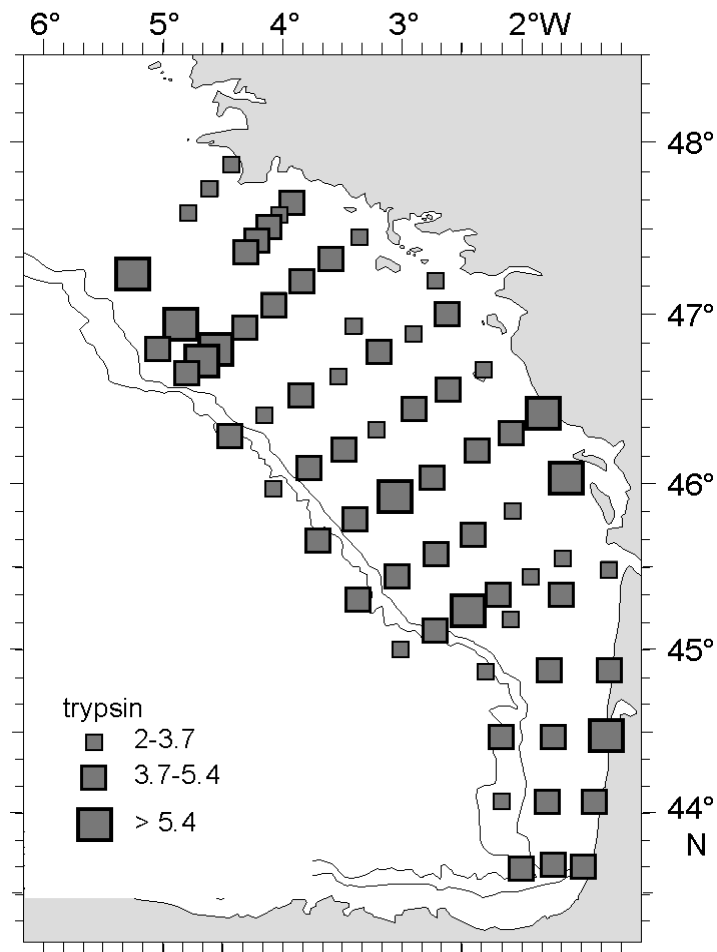
Chlorophyll *a* concentration of surface waters, three main size classes for phytoplankton cells



(... integrated values through the photic layer)

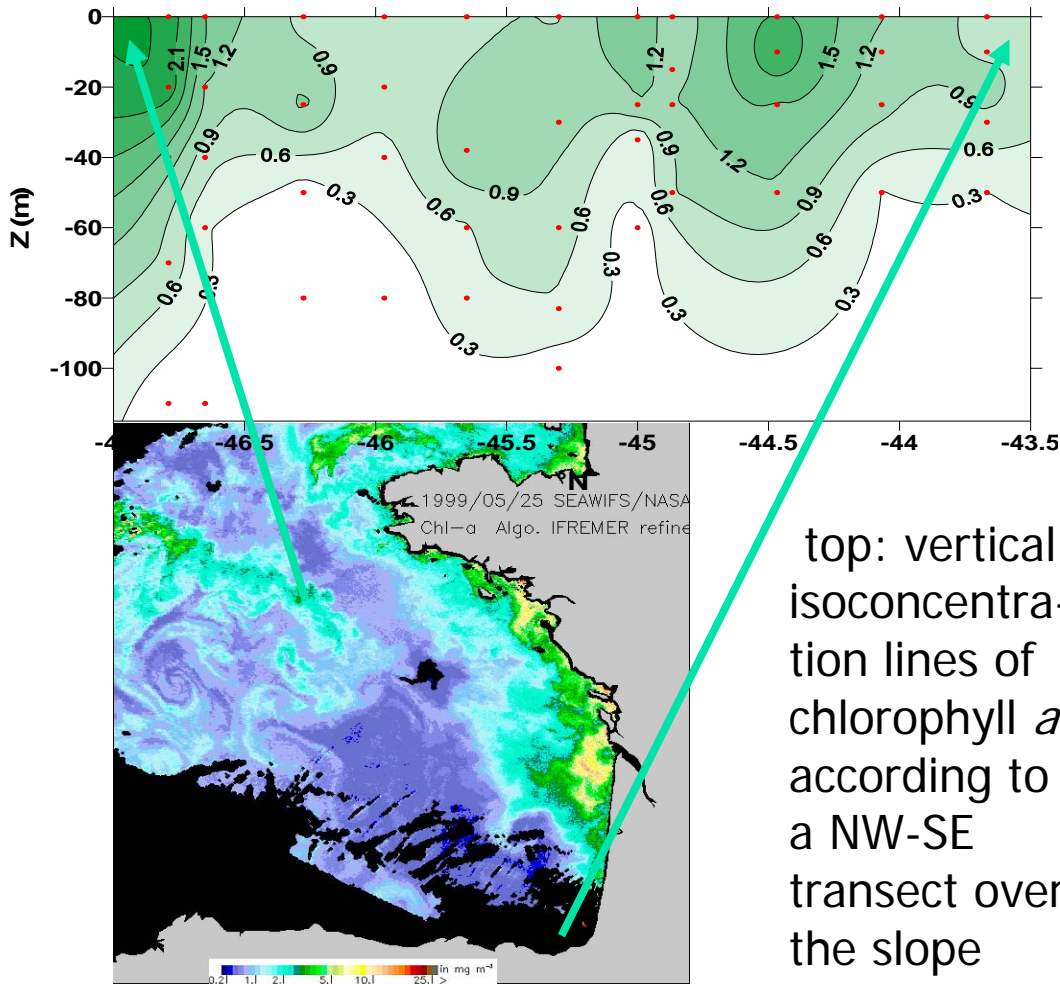
Microphytoplankton, essentially composed of diatoms, dominate in nutrient enriched coastal waters; nanophytoplankton is stimulated at the shelf break, where there is an input of nutrients caused by internal waves; picophytoplankton is dominant in the northern central part, where nutrients are exhausted

Effect of enrichment supplies on mesozooplankton enzyme activities

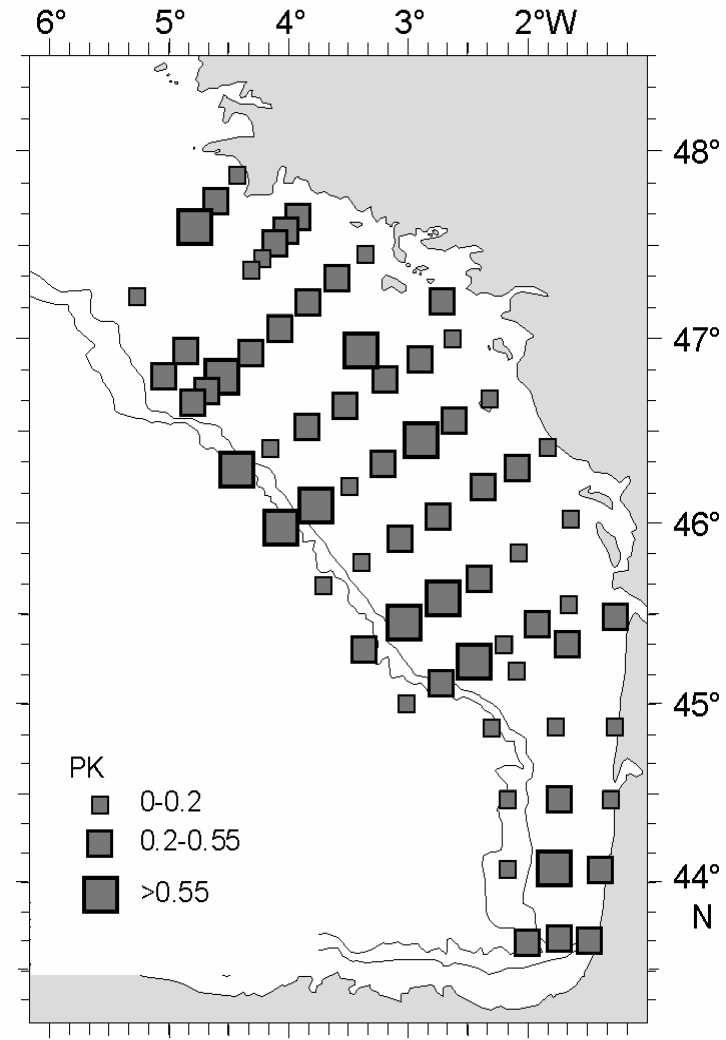


Internal waves induce the upwelling of deep waters along the shelf break

CHI ($\mu\text{g/l}$)



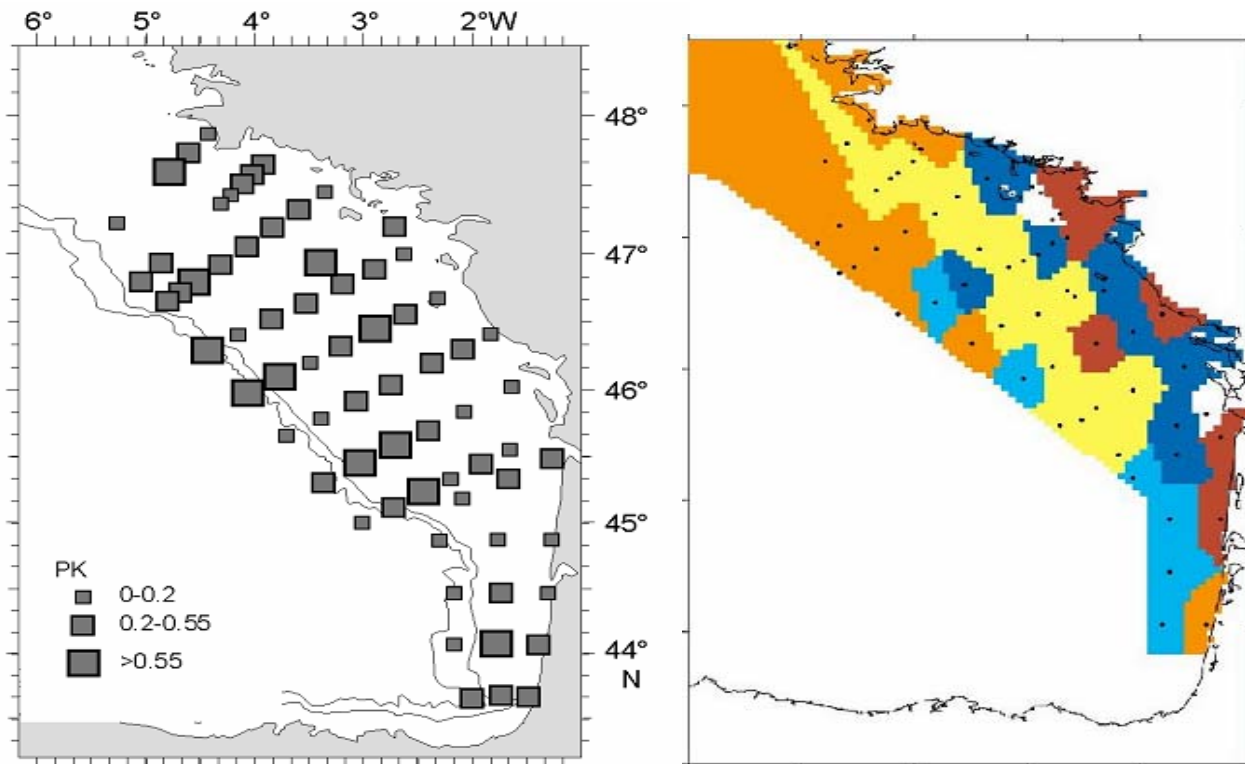
top: vertical isoconcentration lines of chlorophyll *a* according to a NW-SE transect over the slope



A central area where highest PK activities are associated with special hydrological features

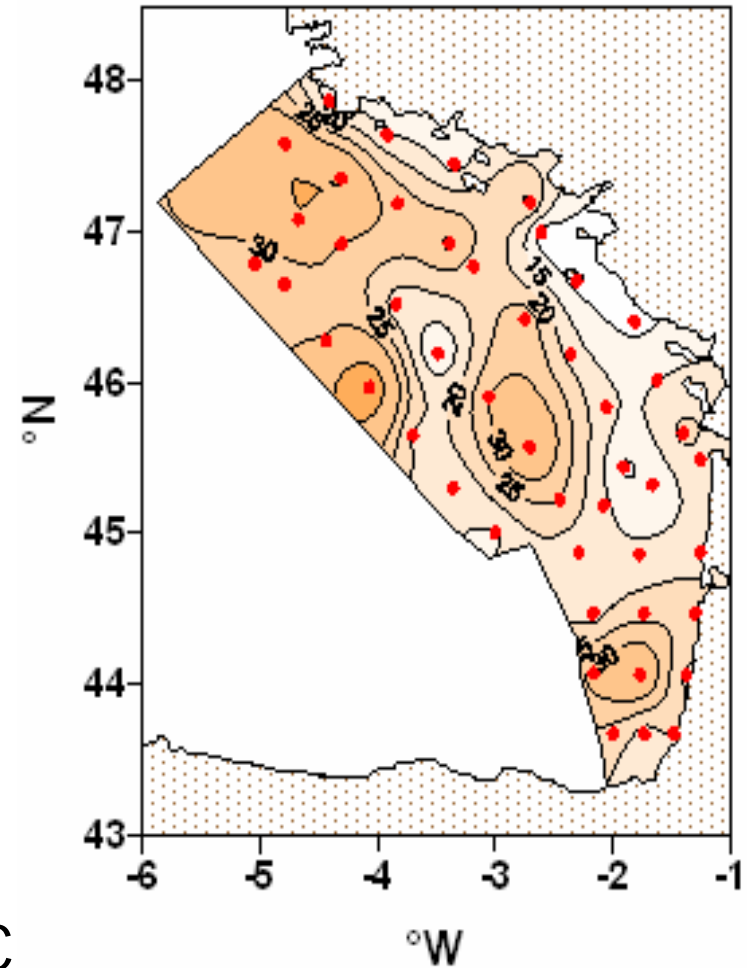
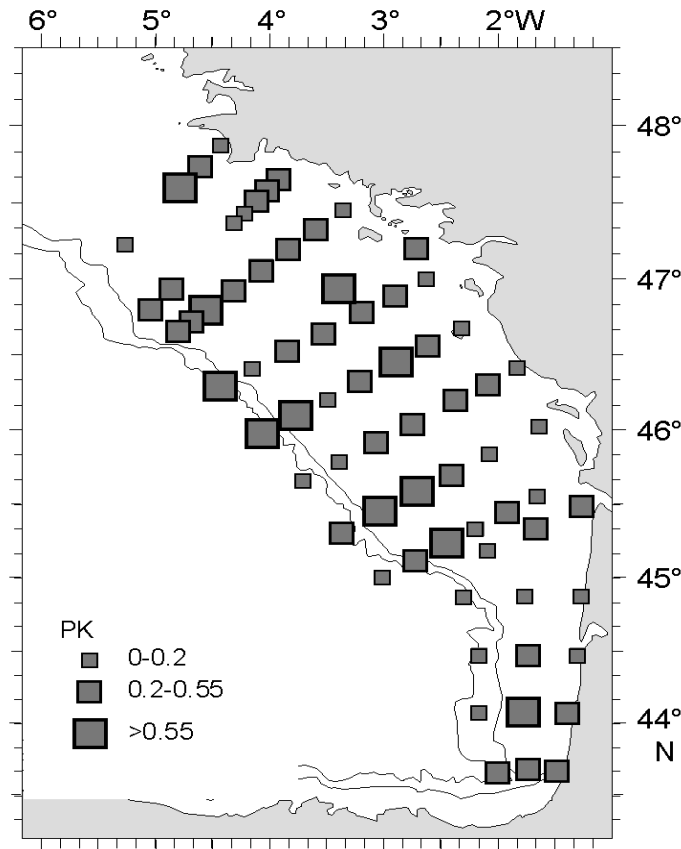
A typology of hydrological structures (Planque *et al.*, 2006*) allowed to characterize a central area (in yellow on figure below) showing special features, notably a deep mixed layer and the greatest stability over time:

some coincidence may be observed with spatial distribution of PK activities among the highest recorded during this cruise.



*Sci Mar, 70S1, 43-50

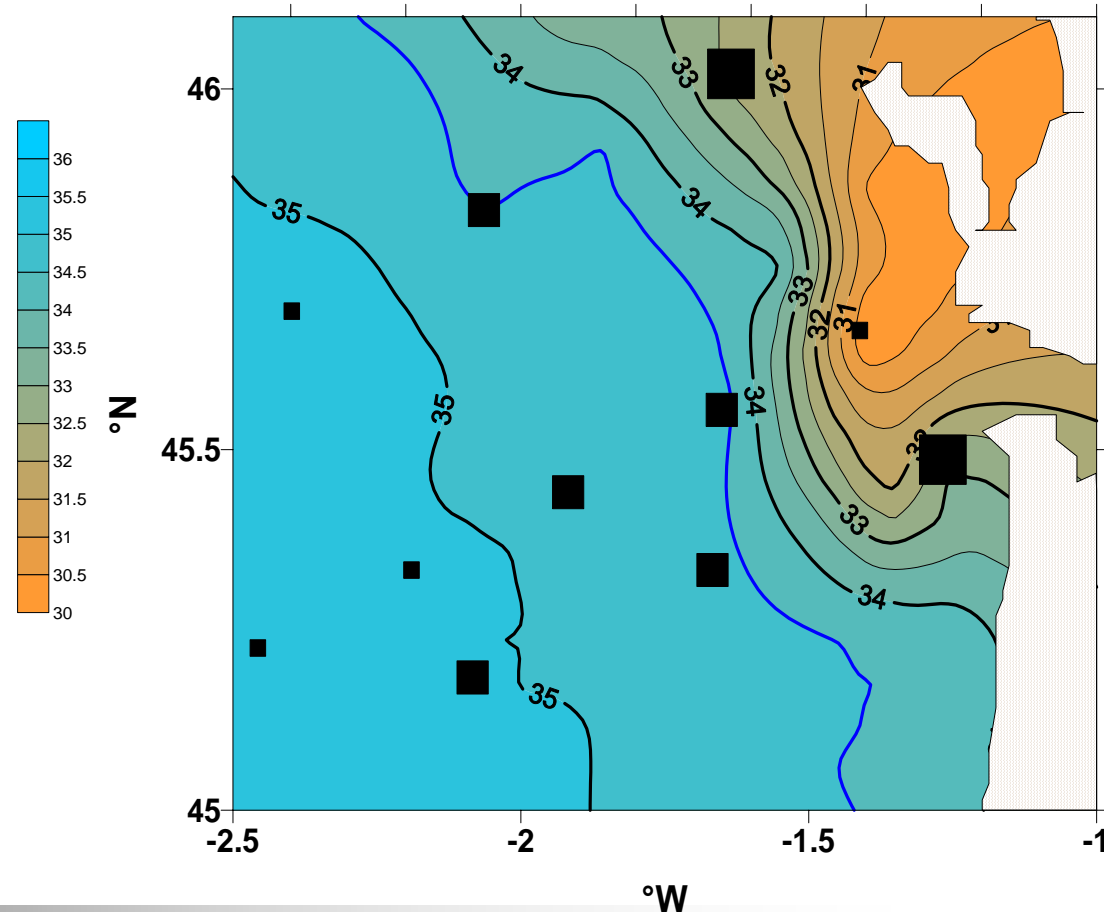
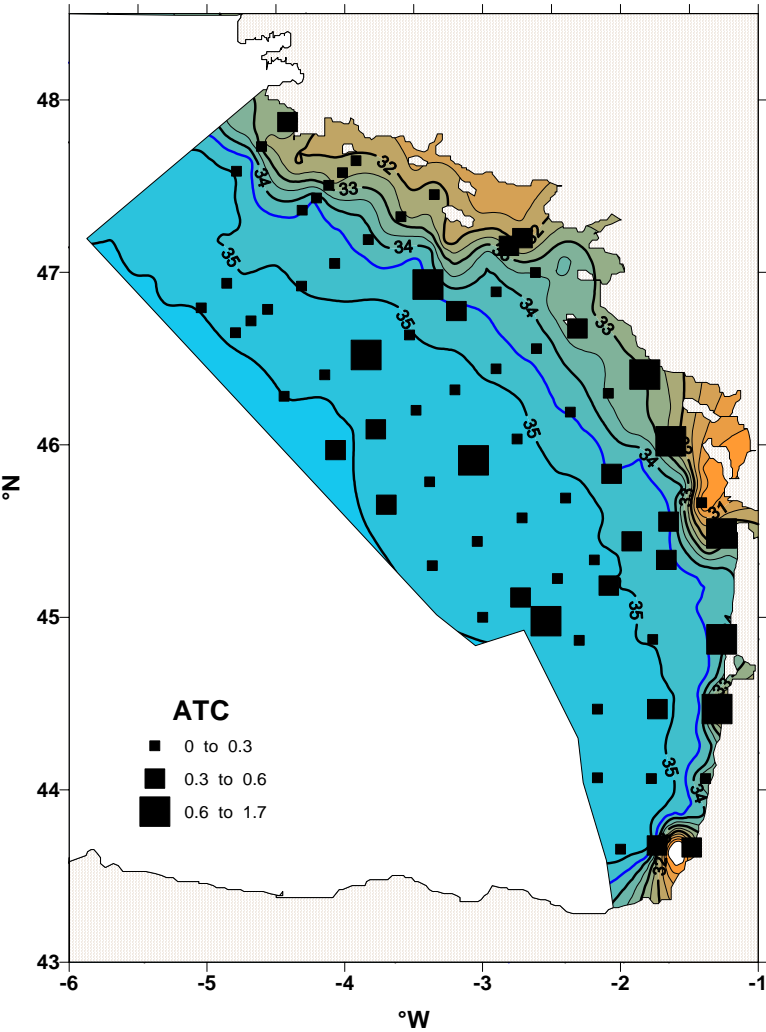
A highly significant correlation ($p < 0.001$)



... links spatial variations of PK to Bacteria C % phytoplankton C

Zooming on ATC specific activities vs salinity variations of surface waters

... under influence of the Gironde outflow:
the two highest values are 1.4 and 1.6;
mean = 0.46 S.D. = 0.03 for 5 smaller





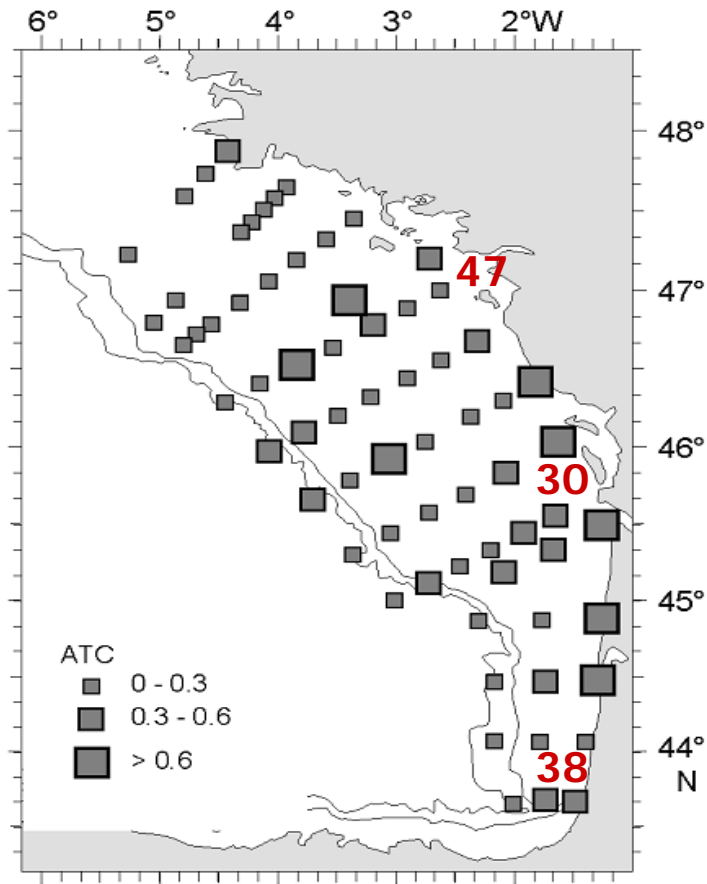
What do mesozooplankton enzymatic indices tell us...

Confirmation that PK activity is enhanced when carbohydrates are likely abundant, i.e. where hydrobiological conditions are such that regeneration processes control the phytoplankton growth (Northern central part of the Bay).

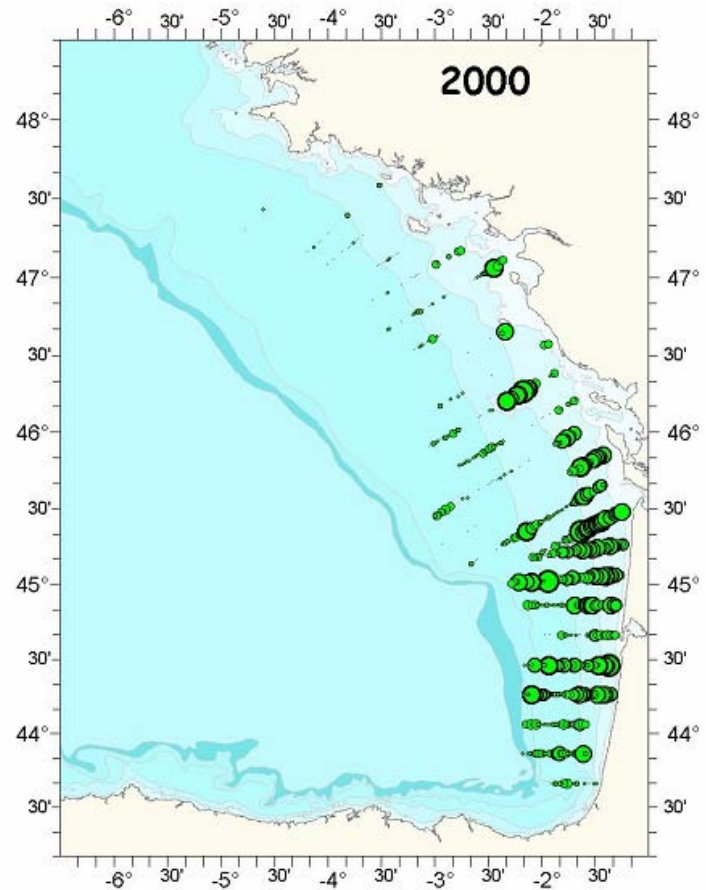
Trypsin potentially reveals protein-rich diet provided either by actively growing phytoplankton or detrital organic particles with their attached micro-organisms (e.g. Gironde Estuary mouth).

ATC is globally correlated with trypsin in coastal areas, otherwise average or high ATC activities look more scattered in the area under diffuse influence of upwelled waters at the shelf break.

... about food web's efficiency



Microbial C % POC



Anchovies in their main breeding area



Acknowledgements

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Finally I would like to **thank you** for your kind attention