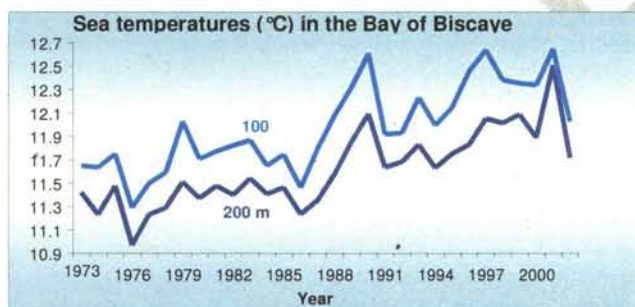


2.3 Impact of climatic and anthropogenic changes on living resources in the Bay of Biscay

Dr Philippe Goulettquer

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Fisheries and aquaculture are of major importance to the coastal communities throughout the Bay of Biscaye. Almost half of French fishermen rely on catches from the Bay which achieve an estimated first sale value of more than €525m annually. Moreover, emblematic species such as eels have an additional economic as well as social value for coastal communities. Similarly, the main French shellfish rearing areas are located within the Bay of Biscaye. They contribute predominantly to the yearly spat (mussel & oyster) recruitment, used to sustain the entire French shellfish industry. These activities have a direct impact on ecosystem functioning and biodiversity. Meanwhile, drastic environmental changes have been reported over the last 30 years, including a climate change pattern inducing additional ecosystem changes. Nutrient inputs from freshwater outputs have qualitatively and quantitatively changed affecting coastal communities (e.g., impacts on benthic communities, or *Solea solea* population dynamics (nursery grounds)). The average seawater temperature has increased by 1.5°C over the last 25 years in subsurface and deeper waters.



Biogeographic patterns have also changed (e.g. macroalgae, exotic species). Fishing effort combined with climate change has induced significant side-effects on fishery landings, whereas most of the fishing stocks are presently overexploited. The ratio of boreal vs subtropical species has also evolved. An on-going research project (CHALOUPE) using an ecosystemic approach and funded by the ANR (French 'National Research Agency') aims to improve understanding of interactions among fishing effort, climate change, recruitment patterns and socio-economic issues including governance. Comparisons with the fisheries of Morocco (upwelling) and French Guyana are also being carried out. Moreover, climate variability has increased significantly as characterized by drought and storm events, leading to landward intrusion of seawater in estuaries and irregular flooding of coastal wetlands. Risks associated to species introduction by ballast water and sediment discharges have, therefore, increased.

Irregular shellfish recruitment over the last 10 years has led to industry disruptions. For example, there was almost no recruitment of shellfish in 2007 due to a cold summer. This has prompted the shellfish industry to request a national research project to improve our understanding of oyster recruitment variability (VELYGER), and then to propose remediation options. It will include an assessment of seawater acidification on larval survival rate. In contrast, the seawater temperature increase has a direct impact on the shellfish stocking biomass and the subsequent carrying capacity as well as on uncontrolled expansion of the pacific cupped oyster along the Atlantic coastline. Actually, *Crassostrea gigas* has become an invasive species

in several regions as it colonises new areas in a northerly direction. Similarly, a change in pluviometry patterns has led to earlier primary production lagged with secondary production. Besides *C. gigas*, the number of exotics and IES along the Atlantic coastline has increased from 104 to 153 in 2002 and 2006 respectively. The oyster driller *Ocenebrellus inornatus* and predator *Rapana venosa* are both examples of uncontrolled expansion of exotics. *O. inornatus*, likely introduced 30 years ago at the same time as *C. gigas*, has only recently become invasive due to temperature increases and worsened by shellfish transfers.

Besides the seawater quality, relationship between HAB occurrences and climate changes should be investigated. Demonstration that pycnoclines and seawater stratification are correlated with the confinement of several phytoplanktonic blooms of harmful algae should prompt the scientific community to assess links between further oceanic current pattern changes resulting from climate change and variability (EC 6th Framework Programme HABIT project). Moreover, further research will likely require the development of regional-scale models to develop new projections and climate feedbacks, to simulate further impacts on living resources (cooperation among oceanography, meteorology, ecology etc.) and exotics and to facilitate future decision-making and new management options.



Species should not be studied in a single way, but as full part of the environment where they thrive.

Alexander Von Humboldt, 1793 !



Impact of climatic & anthropogenic changes on living resources in the Bay of Biscaye

Ifremer

P. Gouletquer, Ifremer
'Marine and Coastal Biodiversity'
National Coordinator

MarinERA Workshop September 12, 2007, Madrid, Spain

Bay of Biscaye...

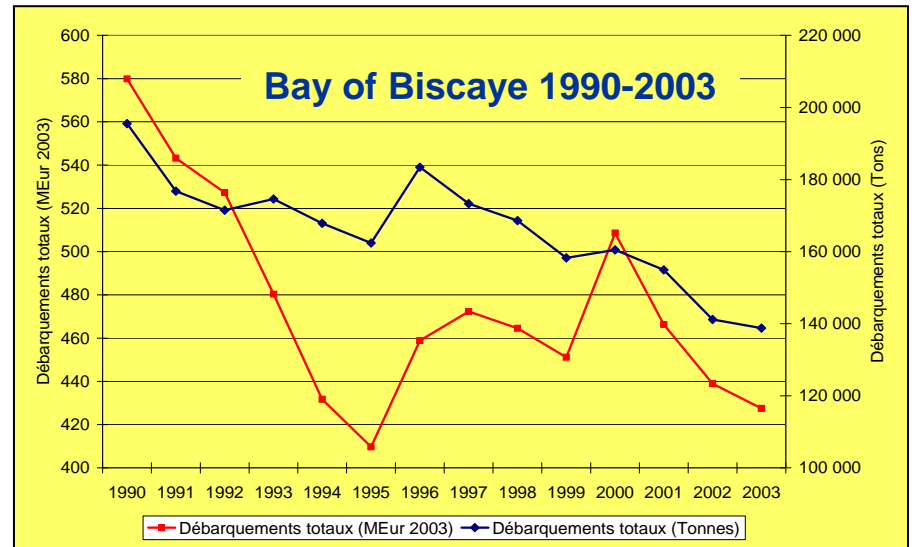
.....focus of a large exploitation of living resources

- **Fisheries**

- 42% of the French fleet (2200 units)
- 6400 fishermen (46%)
- 150 sp harvested
- 50% of the fishery landings based upon 5 sp.
- Highly concentrated production
78% of the landings by >12m boats
- Exchange values - 525M€ & high investment

- **+ Coastal fisheries**

- Eel & glass eel, squids, shellfish (>1.5M€ without glass-eels)



(Thébaud & Le Guyader, 2005)

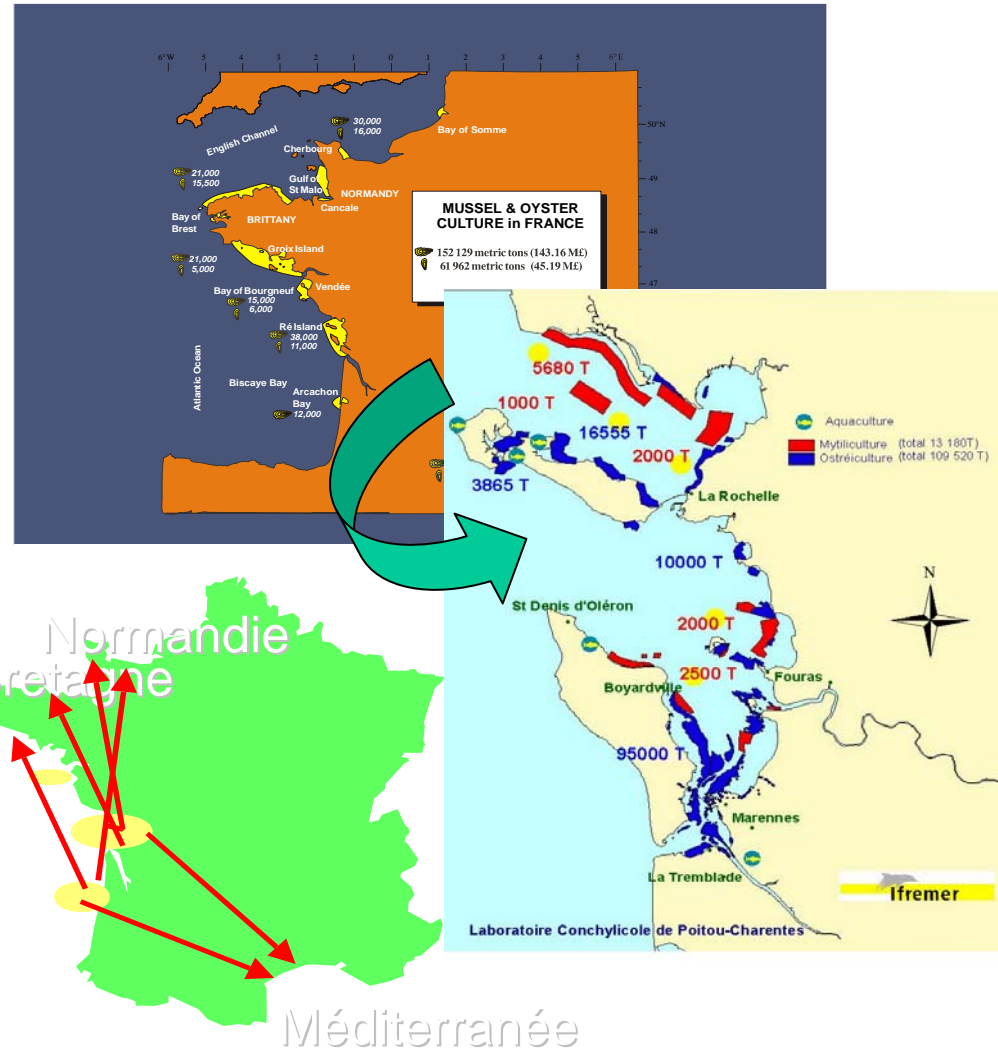


Bay of Biscaye...

.....focus of a large exploitation of living resources

- **Aquaculture**

- Major Oyster & Mussel rearing areas
- Bay of Marennes Oleron = 1257 companies, 2300 ha leasing grounds + 2100 ha oyster ponds – 200M€ exchange values
- Main leading centers for spat settlement (sustain the whole shellfish industry)



However, major environmental changes...

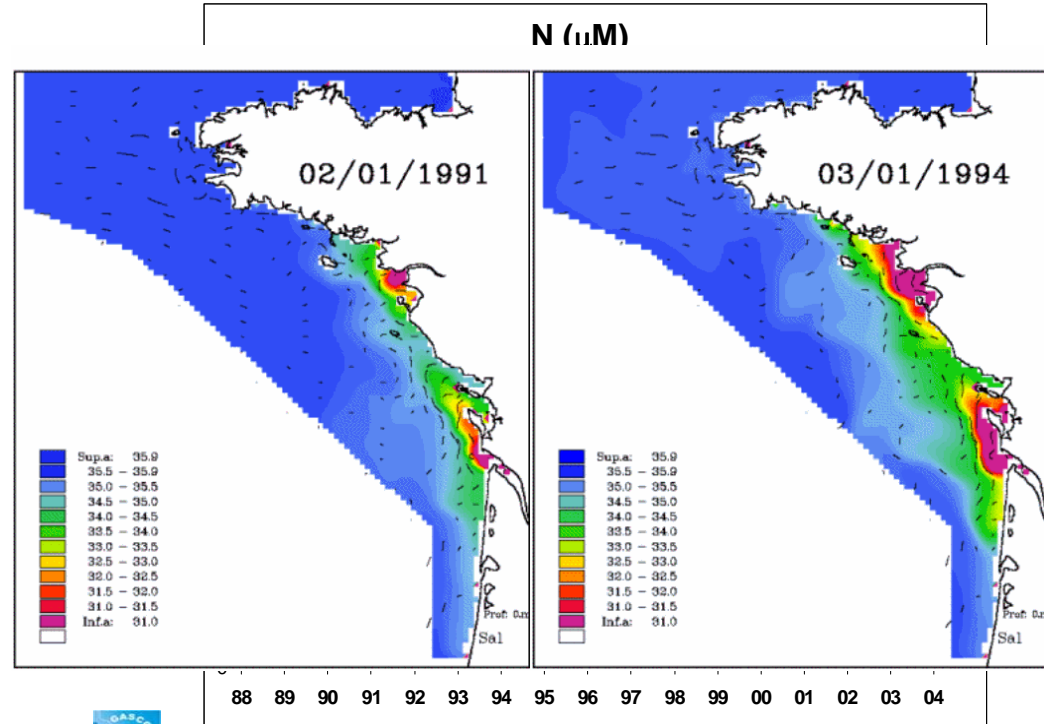
- **Freshwater inputs: quality & quantity**

- Major global change over the last 30 years
- Nitrogen : + 70 %, +1,6 % / year (agriculture..)
- Phosphate : -30 % in 16 years (- 2,2 % / year (improved sewage treatment plants...))

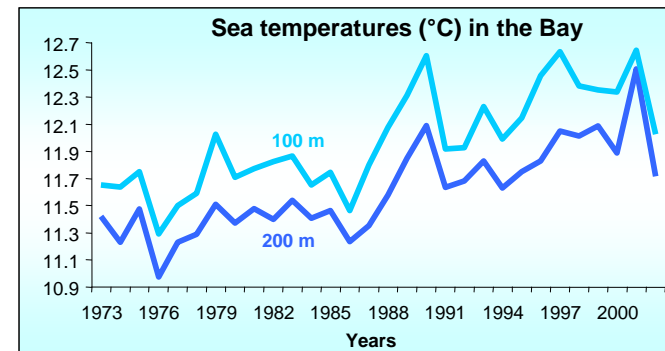
- **Seawater temperature increase** over the last 25 years (+1.5°C) in costal & deeper areas

- **Increased climate variability** (droughts, storms..)

- **Biogeographic changes** (macroalgae..)



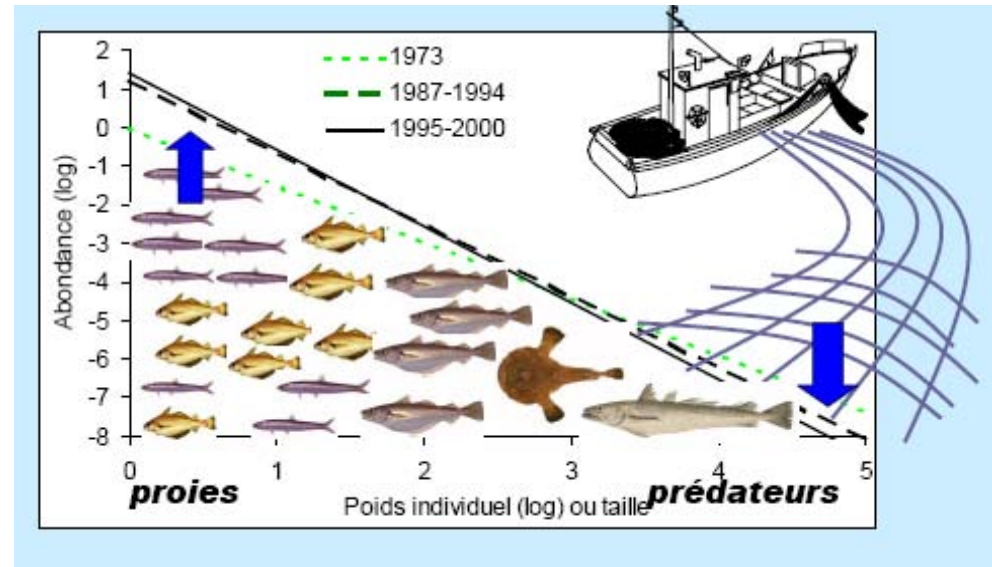
(Blanchard et al., 2005)



Combined impact of fishing effort and climatic change...

- Overfishing of the main stocks in the Bay of Biscaye...
- Concomitant climate change
 - Decrease of number of individuals and boreal species (large species)
 - Increase of % of individuals & subtropical species (small species)
 - Recruitment pattern changes
- Occurrence of exotic species shifting northwards...

Cheilopogon cyanopterus (flying fish..),
Cubiceps gracilis



National Research Program (ANR CHALOUPE)

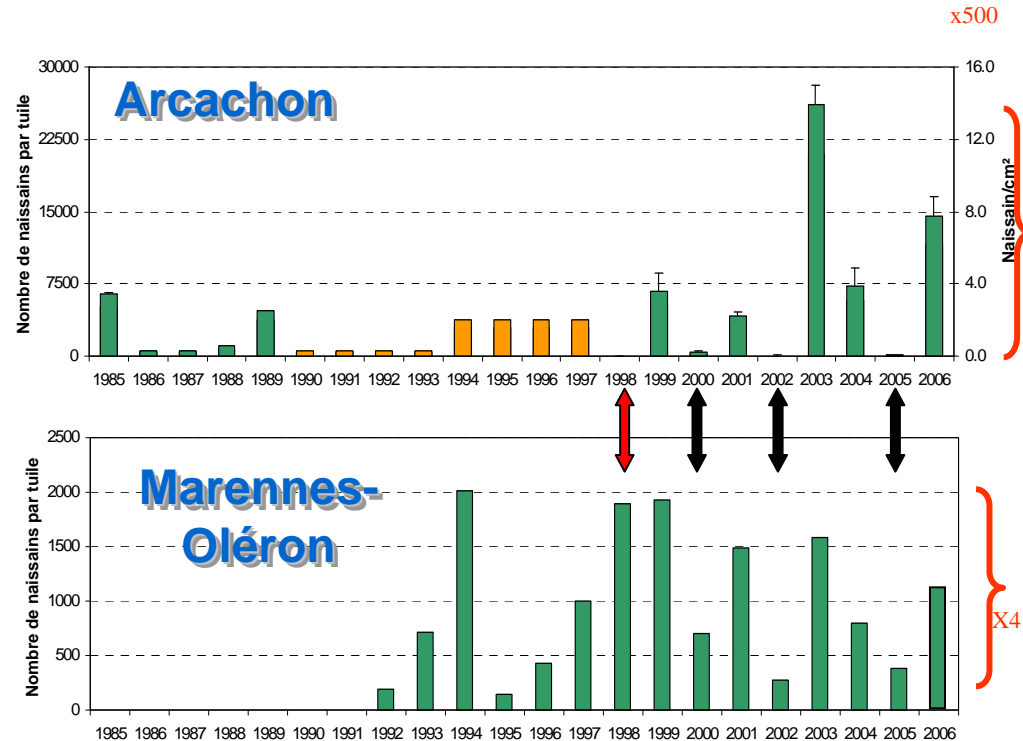
(Blanchard et al, 2005)

Ecosystemic approach for improved understanding of interactions among fishing effort, climate change – recruitment pattern & social-economic issues including governance



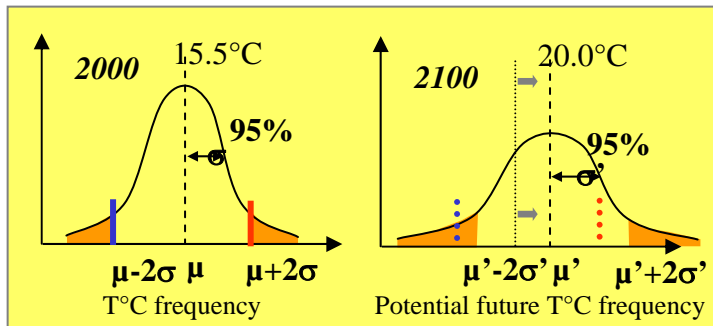
Combined impact of aquaculture and climatic change...

- *Climate variability: (main irregular recruitment over the last 10 years)*
- *Landward intrusion of seawater in estuaries (increased salinity leading to increased oyster larval mortality rate !)*



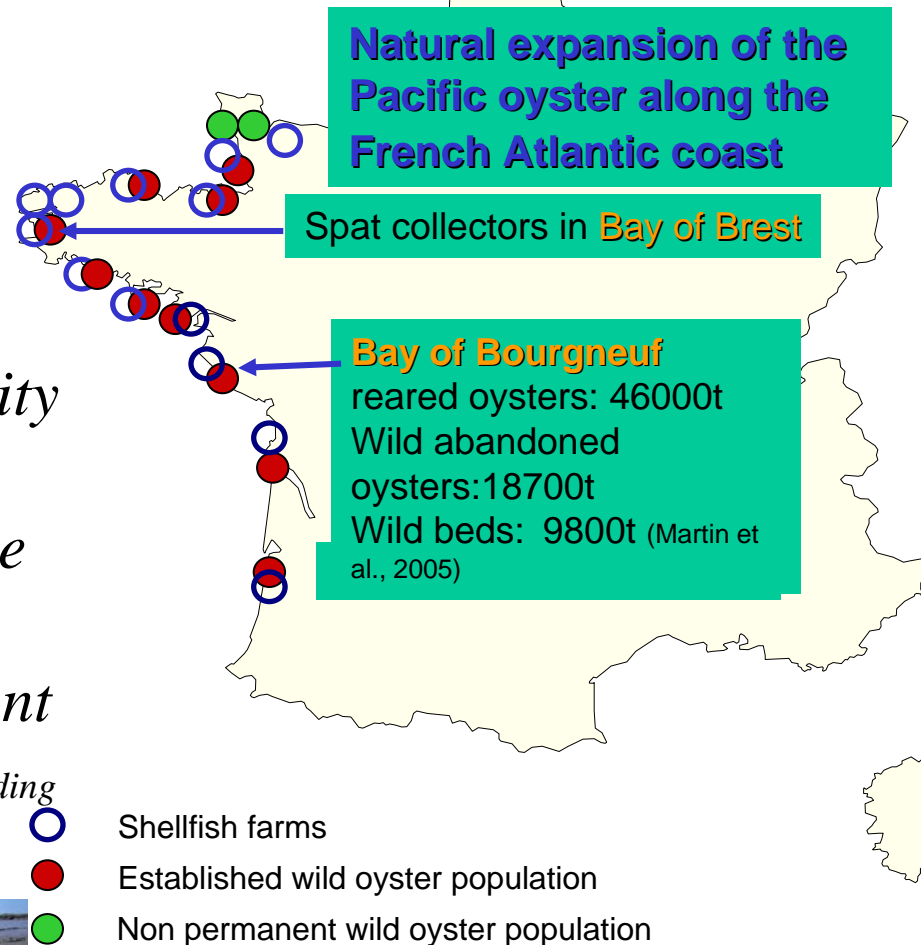
Recruitment intensity in the 2 main spat collecting areas

Pouvreau et al., 2007 – **National Program VELYGER** ...for improved understanding of recruitment variability & climatic changes including effect of seawater acidification on larval survival rate



Combined impact of aquaculture and climatic change...

- Expansion of *C. gigas* along European coastline (mussel too...!)
- Increased physiological activity - effect on carrying capacity (1.5°C # 15000 t oysters) in the Marennes Oleron Bay)
- Changes in natural recruitment
- Potential for new species (including pathogens!) ???



Ifremer - L. Coïc

From Hily, Lejart, 2006.

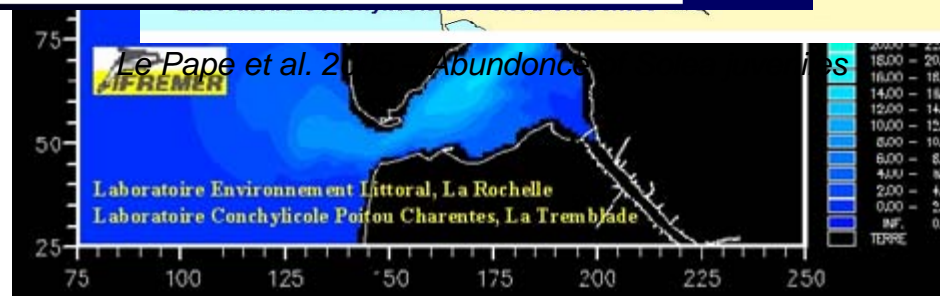
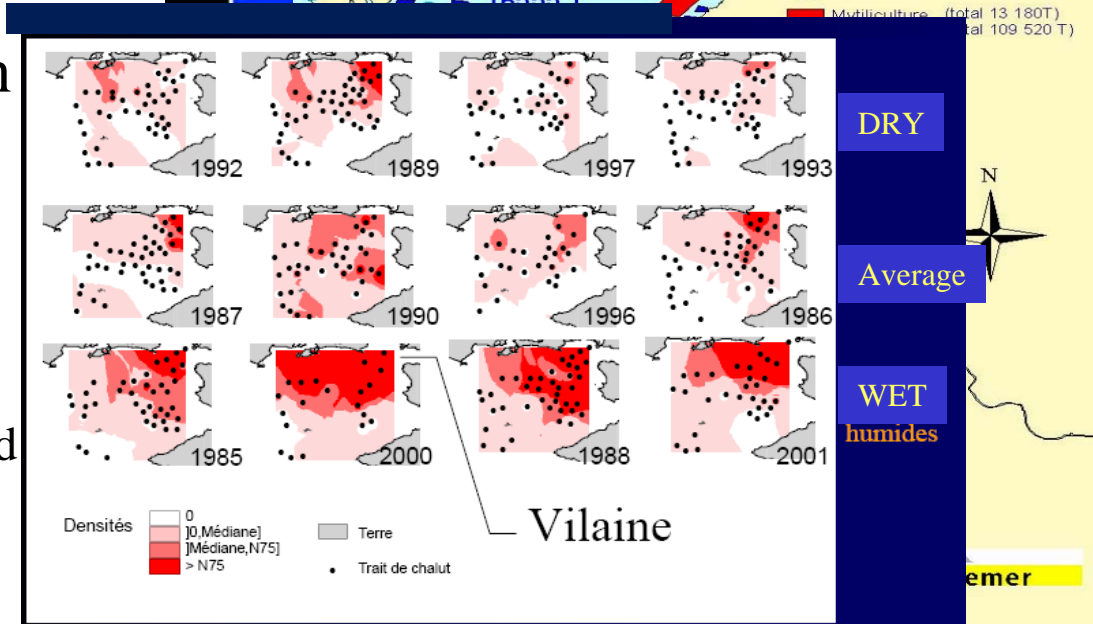
National Research Program PROGIG focusing on the *C. gigas* expansion (genetic & envirt.)

Additional impact of environmental changes.....

Side effects of reduced freshwater inputs & changed nutrient ratios on

.....

- Primary productivity level (carrying capacity..)
- Dystrophic - eutrophication process, HABs (phycotoxins..) and therefore on community structures..... (prey variability for Solea juveniles)
- Sediment & Ballast waters impact...
La Rochelle: main deepwater harbor along the Bay of Biscaye area & Rochefort : 1.2M m³ ballast water a year... at the near vicinity of shellfish farming...as a vector for potential secondary introductions of exotic species!



The issue of Exotic Species....

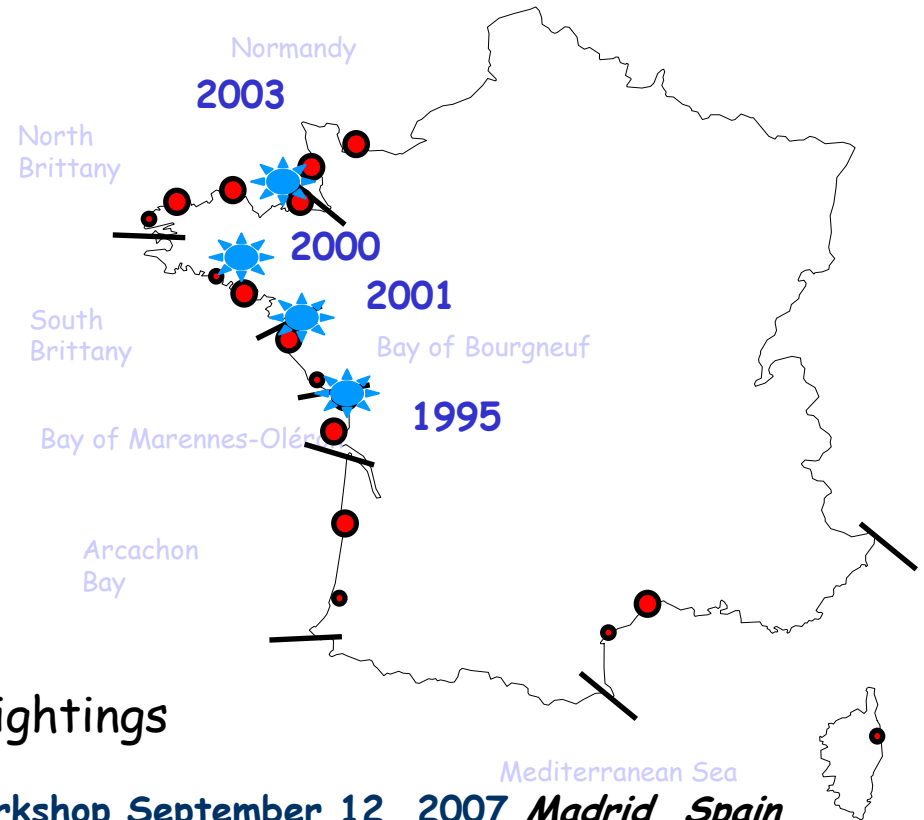
- **Non indigeneous established species:**
104 (2002) ... now 153 (2006) (cf EU project IMPASSE – DAISIE - ...)
- **Latest being:** 1. new genus-species sponge (*Celtodoryx girardae* - Gulf of Morbihan) (unknown origin), 2. new muricid *Trunculariopsis trunculus* (Bay of Arcachon) (origin Medit. or/and Algarve)
- **Main vectors :** ballast waters, commercial activity & species transfers, aquaculture
- **Main problems**
 - Asian oyster driller *Ocinebrellus inornatus*
 - Gastropod predator of oyster *Rapana venosa*, (Adriatic Sea) reproductive activity demonstrated on the Atlantic coastline



Risk associated with shellfish transfers

- *Ocenebrellus inornatus* first detection in 1995 in Marennes Oleron Bay
- Recent results demonstrated the major role of oyster importation as vector of the exotic species *Ocenebrellus inornatus* from USA into France more than 30 years ago
- ...and its expansion along the French Atlantic coastline due to cultural practices as well as climatic changes during the 90s' (temperature threshold...)

Martel et al, 2004



★ *Ocenebrellus inornatus* sightings

Potential impact of environmental & climatic changes.....

- Effects of climatic changes on current pattern and gyre distribution in the Bay of Biscaye
- Relationships with HABs and phytoplanktonic distribution (case study *Dinophysis acuminata*) – distribution within the water column not homogeneous – (see EU research project HABILIT 6 - EC + US National Science foundation cooperation) – *Karenia mikimotoi* vs pycocline layers & confinement..(ALTOX research project EC Interreg NEMEDA - GEOHAB)

And further research questions & cooperation to be addressed....

- Modeling approach at a regional level to develop climate projections (cf IPCC) & feedback effects - this requires stronger cooperation between meteorology – oceanography – ecology research (ecosystemic approach)...& coupling terrestrial with coastal models... ..

Summary

- *Climate change and anthropogenic factors assessments demonstrate the on-going side – effects on biodiversity...*
 - *Affecting Species distribution*
 - *Inducing pattern changes ...from 'exotics' to 'invasive'*
 - *Providing new environmental conditions suitable for Exotics & community changes with direct impact on exploited living resources as well as on ICZM issues...*

- *Further research will likely require the development of regional models to obtain new projections & climate feedbacks, so as to simulate further impacts on living resources (cooperation among oceanography, meteorology, ecology...) & exotics*
 - » *...so as to facilitate further decision-makings !*

Thanks for your attention !!

lfremer

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MarinERA Workshop September 12, 2007, Madrid, Spain