

Modelling the influence of the environment on the interannual variability in biological performances of the Pacific oyster *Crassostrea gigas* cultivated in the Baie des Veys estuary (France)

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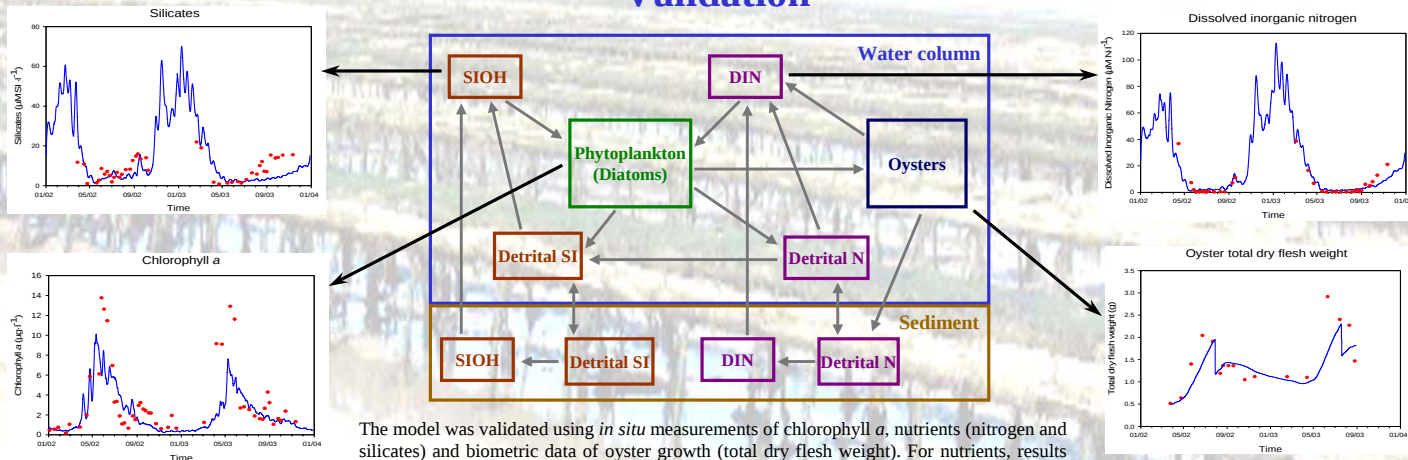
Context

Massive oyster mortalities were brought back throughout the world since 1940. Variable according to years mortalities can reach 50 % of cultivated oysters. The "Baie des Veys", located on the French coast of the English Channel, is an open estuary and intertidal ecosystem (37 km²) which is influenced by four rivers and sustains an **important oyster farming activity** (10 500 tons). In this ecosystem, some **year to year differences** in the phytoplankton dynamics and in the biological performances of cultivated oysters were observed. Recent works showed a significant correlation between oyster mortalities and river flows. The aim of this work was to assess the **influence of environmental factors** such as watershed supplies or meteorological variations on the **inter-annual variability of oyster physiological status**.

Methods

In order to assess whether environmental variability may significantly affect ecosystem dynamics, a **box model** was developed. This model simulates the Baie des Veys nutrient-phytoplankton-oyster food web by **coupling a primary production model** that simulates trophic resources (phytoplankton dynamics) and an **oyster ecophysiological model** (Dynamic Energy Budget model, Kooijmann, 2000) that simulates oyster growth and reproduction. Once validated, this coupled model will allow us to study the influence of environmental conditions on the biological performances of cultivated oysters.

Validation



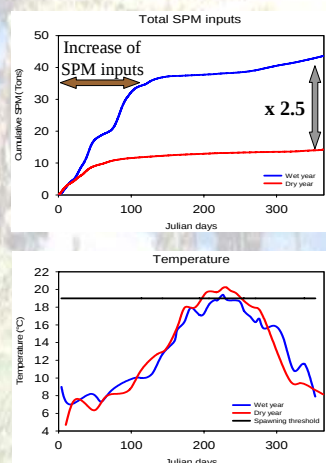
The model was validated using *in situ* measurements of chlorophyll *a*, nutrients (nitrogen and silicates) and biometric data of oyster growth (total dry flesh weight). For nutrients, results showed a good fit between model and measurements although nutrient concentration was a slight under-estimated in late summer and autumn. In the same way, an adequate fit was obtained for chlorophyll *a* and oyster dry weight, nevertheless, a slight under-estimation was also observed in spring.

Application

In order to study the influence of **environmental variability** on **oyster biological performances**, phytoplankton dynamics and oyster growth were simulated for two years with **very contrasted environmental and meteorological conditions** :

- ✓ 2001 which is a **wet year** with high river inputs and low temperature
- ✓ 2003 which is a **dry year** with low river inputs and high temperature

Forcing functions

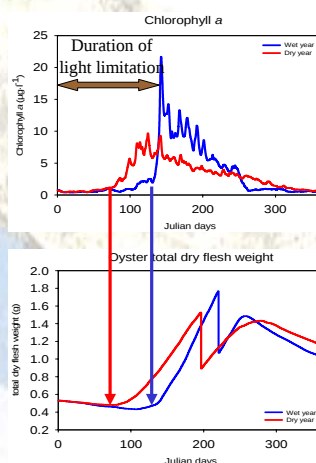


During the wet year freshwater inputs are 2.5 times higher than during the dry year what implies :

- ✓ Increase of SPM brought by rivers
- ✓ Increase of nutrients brought by rivers

In summer time water temperature is always higher during the dry year. The black line represent the spawning threshold fixed to 19 °C. In the dry year the threshold is reached sooner than in the wet year.

Ecosystem dynamics



In the wet year, the increase of SPM inputs leads to an increase of the duration of light limitation in the bay. The beginning of the bloom is delayed in the wet year.

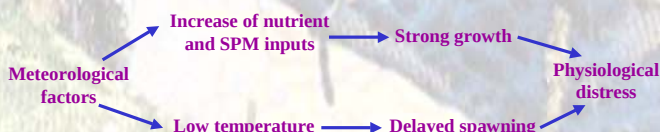
The increase of nutrient inputs lead to a stronger chlorophyll *a* concentration during the spring bloom.

As for phytoplankton dynamics, before spawning :

- ✓ Oyster growth is delayed in the wet year
 - ✓ Oyster growth is the highest in the wet year
- Interannual differences were highlighted in the period of spawning. Spawning is activated by temperature, what explains that in the dry year spawning is one month sooner than in the wet year.

Conclusion

2001 (wet year) was characterized by an important mortality event whereas in 2003 (dry year) mortality was low. Results indicate a modification of oyster physiology in relation to modifications of environmental conditions.



Acknowledgements

The authors would like to thanks Philippe Cugier for discussions about the ecological model and Stéphane Pouvreau for helping us to make the model « DEBly » correct.

I would prefer French cheese rather than phytoplankton !!!



	Environment		Phytoplankton			Oysters			
	Rivers	Temperature				Growth		Spawning	
	Inputs	Spawning threshold	Period	Intensity	Quantity	Period	Quantity	Period	Quantity
Wet year	+	Later	Later	+	~	Later	+	Later	~
Dry year	-	Sooner	Sooner	-	~	Sooner	-	Sooner	~

Legend : + : increase, - : decrease, ~ : equal

The above table summarizes the main features highlighted in this study. In general, results highlighted an influence of river inputs on the development of phytoplankton blooms and oyster growth and a significant influence of temperature on spawning.