A three-Dimensional ecological model to optimize shellfish culture in the Baie des Veyes (Normandy, France)

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Introduction
The OGIVE project aims to develop operational tools used to sustain shellfish culture in Normandy.

The objectives of the present study are:
• to develop a 3D ecological model of the Baie des Veyes, which is a pilot site for the OGIVE project,
• to use it to answer a large panel of questions, through scenarios defined in a participatory approach with the main actors of the bay.
Some scenarios were dedicated:
• to examine the effect of modification of the rearing densities on growth performances,
• to explore impact of changes of nutrients inputs from watershed in relation with environmental objectives.

Methods
The ecological model results from the coupling of the MARS 3D hydrodynamical model (Lazure and Dumas, 2008) adapted to the study area (horizontal resolution = 200m), a biogeochemical sub-model simulating primary production (i.e. trophic resources for oysters) and an ecophysiological model simulating oyster growth and reproduction.

Study area
The Baie des Veyes is located on the French Coast of the English channel. It is an open intertidal estuary (37 km²) with an important oyster farming activity (standing stock = 10 200 t) located on the east part of the bay.

Results & Conclusion

1. Standard simulation
Validation of the model for the year 2002:
• Comparison with chlorophyll a data (3 stations of the domain)
• Comparison with oyster growth data (5 stations of the cultivated area)

Good agreement between simulated results and observations
Variation of simulated surface chlorophyll a concentration (mean value = solid line, minimum and maximum values = hashed lines) and comparison with observations (symbols)
Variation of simulated oyster dry flesh mass (live) and comparison with observations (symbols)
Spatial variation of oyster growth in relation with bivalve density and bathymetry

2. Scenarios

a. 30% reduction of the nitrogen inputs watershed (objective supposed to be reached in 2015)

b. 20% reduction of the total oyster biomass

> no major impact on average annual chlorophyll a concentration and thus on oyster growth

> increase of available phytoplankton, on the cultivated area
> heterogeneous increase of oyster dry flesh mass

• In the bay, nitrate inputs from the watershed are very important. Despite a reduction of 30%, nitrogen is still in excess compared with phosphorus and then does not limit primary production.
• Oyster density acts as a negative feedback on oyster growth. An homogeneous 20% reduction of cultivated biomass leads to a spatially heterogeneous increase of growth performance.
• This study completed with scenarios about cultivated area restructuration and competition with other bivalves (cultivated and wild) will provide informations about shellfish culture sustainability related with environment evolution.

References: