Growth and distribution of the great scallop *Pecten maximus* in the English Channel: a modelling approach

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Introduction

The great scallop *Pecten maximus* is currently the most important species in landings (as well in tons as in value) for the French inshore fleet of the English Channel. A French scientific program “COMANCHE” funded by the French National Research Agency (ANR) was conducted to improve our knowledge on the great scallop within the English Channel ecosystem. In that context, a modelling approach has been proposed in order to better understand the determinism of the distribution of the great scallop, integrating both physical and trophic constraints. Thus a 3D bio-hydrodynamical model (ECOMARS3D developed at Ifremer) providing environmental conditions has been coupled to a population dynamics model and an individual physiological model of scallop.

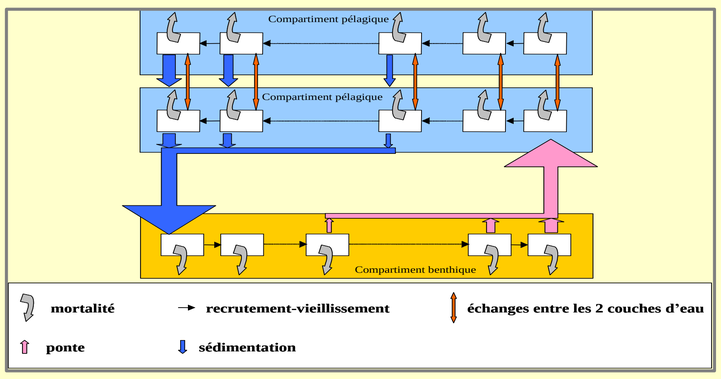
Modelling features

Hydrodynamic model

The hydrodynamic MARS 3D model (Lazure and Dumas, 2008) was used to compute all the Physical properties in the domain: temperature, salinity, current velocity.

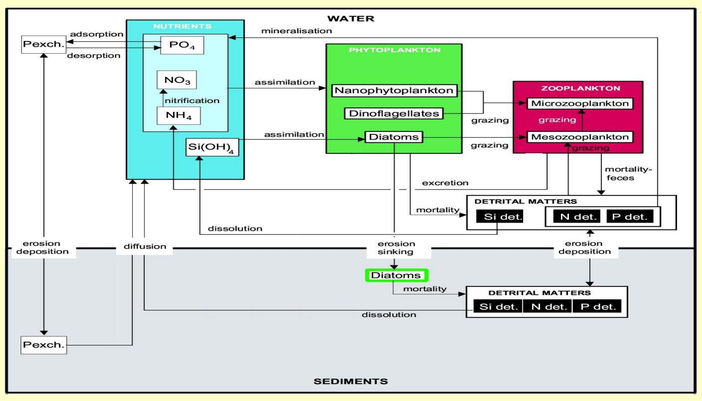
The horizontal spatial resolution is 2 kilometers and the vertical is divided into 10 sigma layers

Population model



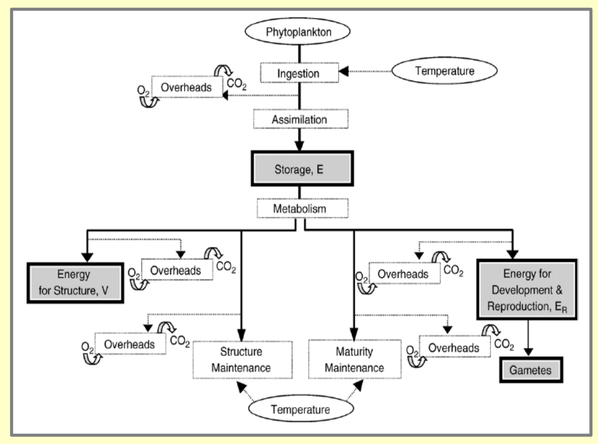
The population model for the scallop described the whole life cycle (planktonic and benthic) using a mechanistic approach (Savina & Ménesguen, 2008). It is structured in age classes and described the dynamics of the density of each age class. Dispersion of larvae and recruitment of adults are conducted by hydrodynamics. Up to now, mortality, fecundity and growth are not linked with environment but are function of parameters respective to this species.

Biogeochemical model



Primary production is based on a NPZD model. 4 nutrients (nitrate, ammonium, phosphate, silicates) are taken into account. 3 phytoplankton groups (diatoms, dinoflagellates, nanophytoplankton) as well as 2 zooplankton sizes (micro and mesozooplankton) are also modelised and detrital matters are splitted between the different elements (N,Si,P).

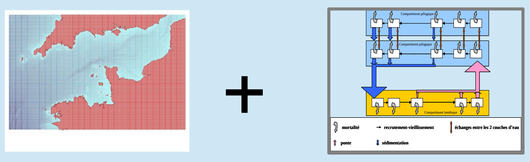
Physiological model



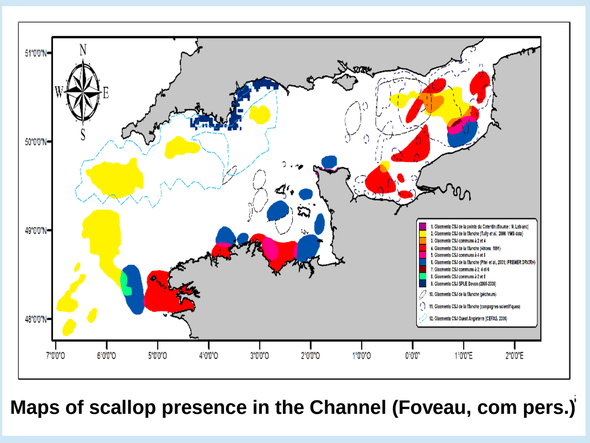
Model Based on the Dynamic Energy Budget Theory. (Kooijman 1986.)
3 state variables are calculated
- Reserves
- Structure
- Reproduction

Results

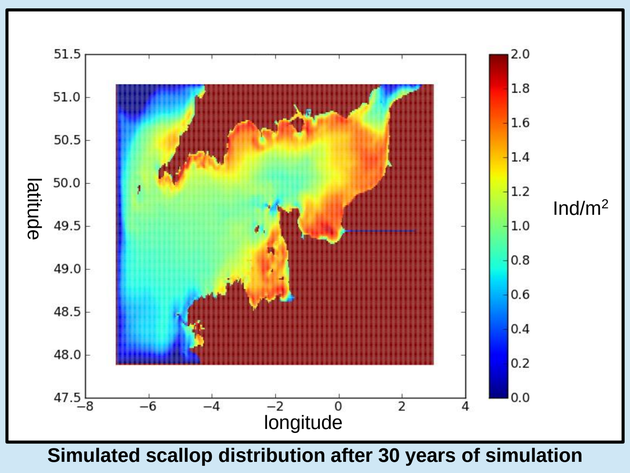
Scallop distribution :



- Recruitment depends on velocity current near the bottom. A mortality density dependance is also taken into account to avoid over concentration.
- Simulation starts with an uniform concentration of adults (3 years old) in the whole domain and a stationnary state is reached after approximately 20 years



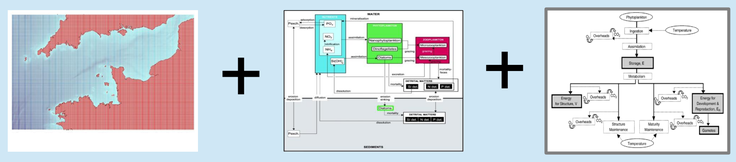
Maps of scallop presence in the Channel (Foveau, com pers.)



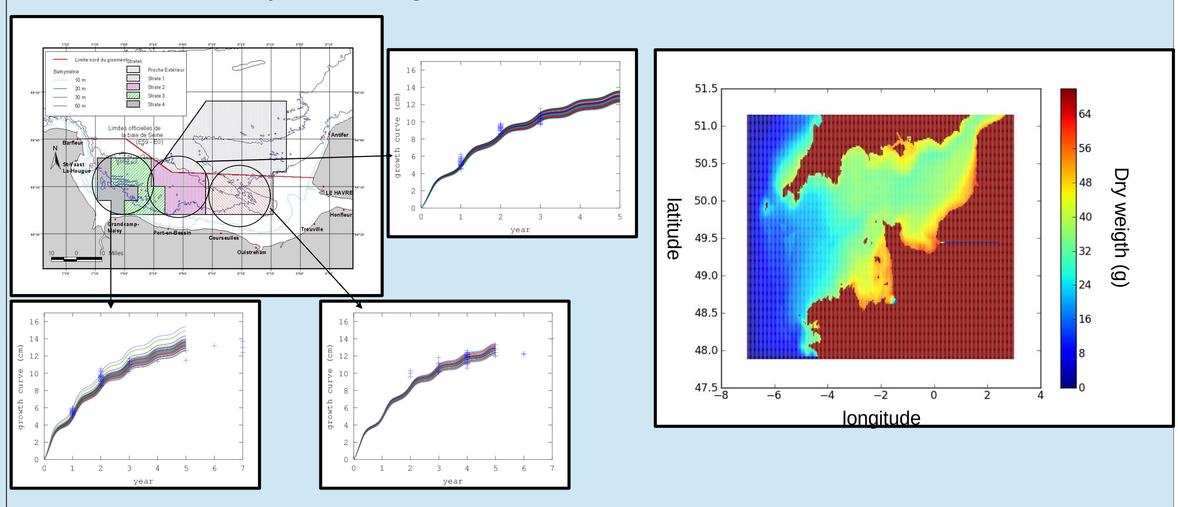
Simulated scallop distribution after 30 years of simulation

Some patterns are easily recognisable between sea compaigns (left) and simulated distribution (right) and the main features of the distribution are captured. Population dynamic characteristics and physical constraints are able to explain most of the presence-absence of *Pecten maximus* in sea channel

Scallop growth :



Bottom temperature and chlorophyll *a* computed with the NPZD model in each mesh of the domain are provided to the scallop DEB model in order to simulate the potential growth



Simulated growth curves obtained in 3 areas of the Bay of Seine (French coast of the English Channel) are compared with in situ data of the same areas (left). A good fitting is obtained and the model seems to be able to simulate the scallop growth over several years.
Mapping the scallop weight obtained after 5 years of simulation (right) gives an idea of the potential growth all over the channel.

Conclusions and perspectives

Two approaches have been used in order to understand the spatial distribution of the scallop in the English Channel. The first one is based on population dynamic and physical mechanisms, the second one on a physiological approach and is linked to trophic ressource. Both of them give interesting informations about processes explaining the known distribution. These two approaches are complementary and the next step will be now to explicitely connect all the models. Thus, the ecophysiological model, by linking environmental conditions to physiological status of individuals, will provide informations about individual fecondity and mortality which will be used as parameters in the dynamic population model.

Lazure, P. & Dumas, F. 2008. Advances in Water Resources 31:233-250. Savina, M., Ménesguen, A., 2007. *Ecol. Model.*, 205, 39-51. Kooijman, S.A.L.M., 1986. J. Theor. Biol. 121, 269–282.