

Evolution of an exploited resource (Manila clam in the Arcachon Bay) in response to natural and anthropogenic sources of change

Nathalie Caill-Milly, Frank D'Amico, Olivier Guyader, Noëlle Bru, Juan Bald Garmendia, Cécile Dang

Evolution of an exploited resource (Manila clam in the Arcachon Bay) in response to natural and anthropogenic sources of change

N. Caill-Milly¹, F. D'Amico², O. Guyader³, N. Bru⁴, J. Bald Garmendia⁵, C. Dang⁶

¹Ifremer HOS-LRHA - FED 4155 - MREA - Anglet (France), ²Univ. Pau & Pays de l'Adour - UMR ECOEOP - FED 4155 - MREA - Anglet (France)
³Ifremer UMR 105 AMURE - Brest (France), ⁴Univ. Pau & Pays de l'Adour, UMR-UMR CNRS 5142 - FED 4155 - MREA - Pau (France),
⁵AZTI - Txarria / Unidad de Investigación Marítima - Pasaia (Spain), ⁶Aquatic Animal Health - School of Biological Sciences - University of Queensland - Brisbane (Australia)

Context

Practical aspects:

- 2018: historical annual production comprised between 500 and 1000 tonnes for an estimated value of 1.5 M€. Manila clam (*Ruditapes philippinarum*) stock exploited in the Arcachon Bay constitutes an important socio-economic resource for Aquitaine region.
- Since 2010, a long-term monitoring program, associating scientists and professional has been conducted in order to improve knowledge on the dynamics of this species and provide additional elements to validate the management decision.
- Several mathematical tool for modeling fisheries:
- Among the tools developed is a simulation model specifically built for this resource on the basis of the dynamic paradigm (Muller et al., 2009; Ding, 2009).
- Since the model "fisher" integrates mechanistic relationships among climatic, biotic and anthropogenic components based on the factors considered as predominant for the stock dynamics, it is proposed to analyse the response of the system subjected to changes.
- These changes are considered through the choice of 7 scenarios involving socio-economic and climatic evolution alone or together.
- A sensitivity analysis of the model and an evaluation of the sustainability of the socio-ecological system is undertaken for further decisions with management actors of this resource.

Model description

The stock and flow diagram integrates a simple aging chain with natural mortality and fishing captures for each length class. The fishing captures of a length class depends on the fishing effort on the clam, the capture volume direction, the number of fishing licenses and the capture volume by license and on the selling price.

Currently, one environmental parameter is considered in the model: sea water temperature.

Parameterization, uncertainty and tested scenarios

The table below presents the values of the parameters for each length class used in the model:

Parameter	Unit	Value	Source
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
β	year ⁻¹	0.2	0.2 (Muller et al., 2009)
γ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
δ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϵ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ζ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ξ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
\omicron	year ⁻¹	0.2	0.2 (Muller et al., 2009)
π	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ρ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
σ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
τ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
υ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϕ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
χ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ψ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ω	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ϑ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
η	year ⁻¹	0.2	0.2 (Muller et al., 2009)
θ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ι	year ⁻¹	0.2	0.2 (Muller et al., 2009)
κ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
λ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
μ	year ⁻¹	0.2	0.2 (Muller et al., 2009)
ν	year ⁻¹	0.2	0.2 (Muller et al., 2009)