ECASA - Model description template

1	**Name of model – Longlines**	*Reporter/Institute (email address)*
1.a	***Effect of mussel longlines***	C. Bacher/IFREMER (cbacher@ifremer.fr)
1.b	*date this form was completed or updated*	5 September 2007

2	**Short DESCRIPTION of model**	
2.a	*Main state variables:*	Mussel growth, food concentration, biodeposition.
2.b	*Scale to which applicable:*	Mussel longline area, ca. 5 km.
2.c	*General description.* *NB: if the model is complicated, or has easily distinguishable components (such as a physical and a biological sub-models) that can be, or have been, used separately, it may be easier to complete one form for each of the main components.*	It combines an ecophysiology model and a box model in order to simulate growth of mussels reared in long lines and advise for the appropriate size and mussel density of the cultivated area. The model was applied in Pertuis Breton for mussels. The growth model was adapted and calibrated from previously published model (Grant and Bacher, 1998) and food transport in the long line area was computed using outputs of a hydrodynamical model (see the related template). Simulations were carried out for different mussel densities and lease sizes to assess their effects on mussel growth. They demonstrated that actual mussel density and lease size had a minor impact on flows of particulate organic matter and phytoplankon and would not decrease food concentration for other cultivated areas. A threefold multiplication of either mussel density or lease size would therefore be a conservative recommendation for managers willing to increase mussel production without having deleterious effect on growth. Another application was carried out in China for scallops (*Chlamys farreri*) cultured on long lines. A detailed model of *C. farreri* feeding and growth and a one dimensional horizontal transport equation have been coupled. The model was applied to assess the effect of some environmental parameters (e.g. food availability, temperature, hydrodynamism) and spatial variability on growth, and to assess the effect of density according to a wide range of hydrodynamical and environmental conditions. The model suggests that scallop growth was correlated with maximum current velocity for a given density and current velocity below 20 cm s^{-1}.
2.d	*Key semi-universal parameters and example values (which should apply at least regionally or for at least one type of water body); summarize any restrictions or reservations about these parameters*	Ecophysiology parameters are not universal (in this case) but a generic version of this model exists (see related template). Spatial Box Model concept and equation are generic and based on simple mass conservation principle.
2.e	*Main forcing data needed -*	• Water temperature.

	initial values of state variables; boundary conditions; inputs; imposed environmental conditions; generalized loss terms. State whether single values or time-series needed.	• Boundary conditions: food concentration, suspended particulate matter. • Hydrodynamical model or current velocity measurements to assess exchange of water between the longline area and the ecosystem.
2.f	*Restrictions to use of model*	None.

3	**possibly relevant INDICATORS and example EcoQOs**	
3.a	***D**river*	
3.b	***P**ressure*	Number of longlines, density of shellfish, size of the farm.
3.c	***S**tate*	Phytoplankton concentration and shellfish growth.
3.d	***I**mpact*	Shellfish growth and production.
3.e	***R**esponse*	Selection of sites suitable for shellfish culture.

4	**STATUS of model** *NB: refers to scientific theory and equation set; distinguish from implementation*	
4.a	*Origin(ator) of model concept and initial formulation:*	Incze et al. (1980).
4.b	*Present status of model, including scientific basis of claimed robustness and key matters still needing study:*	The ecophysiology model is specific, and must be adapted to site and species. Implementation of the model is also specific.
4.c	*Present use:*	The code has only been used in 2 case studies (see description). One of the case studies illustrated how to assess the risk of affecting carrying capacity due to the extension of mussel farms, using Risk Assessment methods in a panel of experts (GESAMP working group 31).
4.d	*Potential use and development in ECASA :*	Can be used to assess effect of animals density and lease size on food concentration, animal growth and biodeposition in shellfish culture.

5	**IMPLEMENTATION of model**	
5.a	*State of implementation :* *(This refers to realization of model theory in numerical algorithms, spreadsheets, computer programs, etc. to provide solutions of the model equations when supplied with appropriate forcing data.*	Matlab code.
5.b	*State of documentation (which describes how to use an implementation as well as giving*	Concepts and methods are explained in the literature. Examples of applications are given in Bacher et al.

	model theory)	(2003), Bacher (2007).
5.c	*Intellectual property concerns - if none stated here, model and implementation will be deemed to freely available on request*	IFREMER is the owner of the software supporting it. ECASA participants have a free access to these tools, which is restricted to be used when carrying the tasks identified within the ECASA contract. Any other use requires the written consent of IFREMER.

6.	**TESTING of model**	
6.a	*Summary of conditions and measurements needed:* *Refer back to 2.e if necessary. Highlight observations needed for model testing.*	Hydrodynamic model (see the template on hydrodynamic model), growth data, boundary conditions (phytoplankton, suspended matter), forcing variable (temperature).
6.b	*Criteria for model rejection*	None

7	**OTHER models**	
7.a	*Used explicitly or implicitly with this model*	Ecophysiology model. Hydrodynamical model.
7.b	*Similar models (which might serve roughly the same purpose in relation to mariculture)*	Model by Ferreira et al. (2007).

8. REFERENCES cited *show in bold the most important paper describing the model*

Bacher C., S. Robert, P. Garen, S. Bougrier, E. Pallas. Using a box model to predict the growth of cultured mussels as a function of mussel density and lease size. Symposium of the American Fisheries Society, Québec, 10-14 août 2003, (summary only).

Bacher C., Grant J., Hawkins A.J.S., Fang C. , Zhu M., Besnard M., 2003. Modelling the effect of food depletion on scallop growth in Sungo Bay (China). Aquat. Living Resour, 16, 10-24.

Bacher, 2007. Risk assessment of the potential decrease of carrying capacity by shellfish farming. http://gesamp.net/page.php?page=24 , case study 6.2.

Ferreira J.G., Hawkins A.J.S, Bricker S.B., 2007. Management of productivity, environmental effects and profitability 3 of shellfish aquaculture — the Farm Aquaculture Resource Management (FARM) model. Aquaculture 264, 160-174.

Grant J., Bacher C. 1998. Comparative models of mussel bioenergetics and their variation at field culture sites. J. Exp. Mar. Biol. Ecol. 219 (1-2) : 21-44.

Incze L.S., Lutz R.A. & Walting L. (1980) Relationship between effect of environmental temperature and seston on growth and mortality of *Mytilus edulis* in a temperate northern estuary. Marine Biology 57, 147-156.