

## ECASA - Model description template

<b>1</b>	<b>Name of model</b>	<i>Reporter/Institute (email address) Daniele Brigolin &amp; Roberto Pastres, DCF-Unive. (brigo@unive.it)</i>
<i>1.a</i>	<b>MG_IBM: <i>Mytilus Galloprovincialis</i> Individual Based model</b>	
<i>1.b</i>	31/7/2007	

<b>2</b>	<b>Short DESCRIPTION of model</b>	
<i>2.a</i>	<i>Main state variables:</i>	Somatic tissue dry weight, gonadic tissue dry weight.
<i>2.b</i>	<i>Scale to which applicable:</i>	Individual.
<i>2.c</i>	<i>General description.</i>  <i>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.</i>	The model is based on an energy budget. The difference between the energy assimilated per unit of time and that used for respiration is allocated for growth or reproduction. Therefore, the model explicitly takes into account the energy invested in the production of gonadic tissues. The energy assimilation rate depends on fry weigh, temperature and seston composition. Influence of water temperature on physiological processes is taken into account by means of the formulation proposed by Solidoro et al. (2000). The respiration rate depends on water temperature and dry weight: the parameters were estimated quantified on the basis of literature specie-specific respiration rate measurements. This model represents an attempt of simulating the growth of <i>Mytilus galloprovincialis</i> using the minimum set of state variables and processes which allow one simulate the energy balance of the mussel, as a function of the external forcings. As a result, it is not as detailed as the models presented by Sholten & Smaal (1998) and Casas and Bacher (2006). However, being based on mussel eco-physiology, it is not as site-specific as the simple empirical model presented in Gangnery et al. (2004), which depends crucially on statistical regression between observed data. Therefore, the model here proposed can be used for predictions, using as input plausible temporal evolutions of the forcing functions.
<i>2.d</i>	<i>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</i>	The respiration rate was determined on the basis of the data presented in (Navarro et al., 1996; Barbariol& Razouls, 2000). The clearance rate and its dependence on water temperature was estimated on the basis of the data reported in (Tušnik, 1985; Widdows et al. 1997) Those data sets refer to specimen collected in the Northern Adriatic. Mediterranean mussel physiology

		Therefore, these parameters and the formulations involved are thought to be representative for the Adriatic basin. The fraction of assimilated energy invested in reproductive tissues was calibrated in this study: therefore, this parameter should not be regarded as semi-universal.
2.e	<i>Main forcing data needed - initial values of state variables; boundary conditions; inputs; imposed environmental conditions; generalized loss terms. State whether single values or time-series needed.</i>	Forcings functions: time series of water temperature, Chl-a and POC concentrations.  Initial dry weight.
2.f	<i>Restrictions to use of model</i>	The model was identified, calibrated and validated over ranges of forcing functions typical of the Northern Adriatic sea. Therefore, even though we feel that the model structure is robust, it may be necessary to recalibrate some parameters in order to apply it to other Mediterranean regions.

<b>3</b>	<b>possibly relevant INDICATORS and example EcoQOs</b>	
3.a	<i>Driver</i>	
3.b	<i>Pressure</i>	The model allows one to estimate the faeces production rate and the excretion rate of a specimen. Therefore, it is possible to use it for estimating the amount of ammonia and POC released by a mussel farm per unit of time.
3.c	<i>State</i>	The model can be coupled with: <ul style="list-style-type: none"> <li>➤ a transport model, in order to estimate: 1) the increase in the concentration of ammonia and due to excretion released by a mussel farm; 2) the depletion of Chla and POC, due to mussel filtration.</li> <li>➤ a deposition model, in order to estimate the fluxes of C, N and P towards the sediment, due to settlement of mussel faeces.</li> </ul>
3.d	<i>Impact</i>	
3.e	<i>Response</i>	

<b>4</b>	<b>STATUS of model</b> <i>NB: refers to scientific theory and equation set; distinguish from implementation</i>	
4.a	<i>Origin(ator) of model concept and initial formulation:</i>	DCF-Unive. Brigolin, D., Dal Maschio, G., Nalin, L. & Pastres, R.
4.b	<i>Present status of model, including scientific basis of</i>	MG-IBM model has been calibrated against a data set

	<i>claimed robustness and key matters still needing study:</i>	collected at the Chioggia (Italy) ECASA study site. The model has been validated against two data sets, collected at Pirano and Strunjan (Slovenia), made available by MBL, Slovenia.
4.c	<i>Present use:</i>	The model can be used at a screening level for site-selection and for predicting the biomass yield of an existing farm, based on scenarios of the forcing functions.
4.d	<i>Potential use and development in ECASA :</i>	The MG_IBM model is the core of the MGCC integrated model, which has been developed for local scale, namely site-selection and EIA of long-line mussel farm and regional scale applications, namely for estimating the overall impact of mussel farming on the pelagic ecosystem and the carrying capacity of a given area.

<b>5</b>	<b>IMPLEMENTATION of model</b>	
5.a	<i>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.</i>	The model was coded in MATLAB. A Visual Basic user-friendly version of the model will be available by the end of the ECASA project.
5.b	<i>State of documentation (which describes how to use an implementation as well as giving model theory)</i>	The state equations and the formulations which relates the energy assimilation rate and respiration rate to the forcing functions are described in detail in (Brigolin, 2007).
5.c	<i>Intellectual property concerns - if none stated here, model and implementation will be deemed to freely available on request</i>	Available to ECASA participant until December 2007. Visual Basic version freely available in 2008.

<b>6.</b>	<b>TESTING of model</b>	
6.a	<i>Summary of conditions and measurements needed: Refer back to 2.e if necessary. Highlight observations needed for model testing.</i>	Time series of Chla POC, water temperature, dry weight. The model output can be compared with length of wet weight observations, based on allometric relationships. However, in this case, further uncertainty in the predictions has to be taken into account, due to the fact that allometric parameters are site-specific and vary according with the age of the mussel and its physiological condition.
6.b	<i>Criteria for model rejection</i>	GOF test proposed by WP4 leader.

<b>7</b>	<b>OTHER models</b>	
7.a	<i>Used explicitly or implicitly with this model</i>	MGCC integrated model
7.b	<i>Similar models (which might serve roughly the same purpose in relation to mariculture)</i>	Mediterranean mussel growth model (Casas and Bacher, 2006)  Shellsim model (Ferreira et al., 2007) and its latest version, developed within the ECASA project.

<b>8. REFERENCES cited</b>	<i>show in bold the most important paper describing the model</i>
Barbariol, V., Razouls, S., 2000. Experimental studies on the respiratory metabolism of <i>Mytilus galloprovincialis</i> (Mollusca Bivalvia) from the Mediterranean Sea (Gulf of Lion). <i>Vie et Milieu</i> 50, 87-92.	
Casas S., Bacher C., 2006. Modelling trace metal (Hg and Pb) bioaccumulation in the Mediterranean mussel, <i>Mytilus galloprovincialis</i> , applied to the environmental monitoring. <i>Journal of Sea research</i> 56, 168-181.	
J.G. Ferreira, A.J.S. Hawkins and S.B. Bricker, 2007. Management of productivity, environmental effects and profitability of shellfish aquaculture -- the Farm Aquaculture Resource Management (FARM) model, <i>Aquaculture</i> 264, 160-174.	
Gangnery, A., Bacher, C., Buestel, D., 2004. Application of a population dynamics model to the Mediterranean mussel, <i>Mytilus galloprovincialis</i> , reared in Thau Lagoon (France). <i>Aquaculture</i> 229, 289-313.	
Navarro, E., Iglesias, J.I.P., Camacho A., Labarta U., 1996. The effect of diets of phytoplankton and suspended bottom material on feeding and absorption of raft mussels ( <i>Mytilus galloprovincialis</i> LMK). <i>Aquaculture</i>	
Sholten, U. and Smaal, A., 1998. Responses of <i>Mytilus edulis</i> L. to varying food concentrations: testing EMMY, an ecophysiological model. <i>J. Exp. Mar. Biol. Ecol.</i> 219, 217-239.	
Solidoro, C., Pastres, R., Melaku Canu, D., Pellizzato, M., Rossi, R., 2000. Modelling the growth of <i>Tapes philippinarum</i> in Northern Adriatic lagoons, <i>Marine Ecology Progress Series</i> 199, 137-148.	
Tušnik, P. , 1985. Raziskovanje bioloških in eko-fizioloških značilnosti školjk <i>Mytilus galloprovincialis</i> Lamarck gojenih v čistem in onesnaženem okolju. Vtoto za biologijo, biotetehniška fakulteta. Ljubljana.	
Widdows, J., Nasci, C. and Fossato, U., 1997. Effects of Pollution on the Scope for Growth of Mussels ( <i>Mytilus galloprovincialis</i> ) from the Venice Lagoon, Italy. <i>Marine Environmental Research</i> 43, 69-79.	