NAME of model	**reporter/institute *(a)*:**
FARM – Farm Aquaculture Resource Management	Ana Sequeira, João Gomes Ferreira / IMAR

Short DESCRIPTION of model*:* The intended scope of the FARM model is for shellfish farms (without the use of artificial food) in coastal and estuarine waters. The model runs as a web-based client-server application with a simple interface, hiding complex internal processing which includes transport equations, shellfish individual growth for several species, population dynamics and dissolved oxygen balance. A shellfish farm can be divided into a number of segments, thus allowing testing of spatially variable seed densities, or integrated multi-trophic aquaculture with e.g. finfish and seaweeds. The model allows multiple combinations of cultivated shellfish to be simulated, in order to analyse the balance between faster-growing and economically more attractive species.

Main state variables:
Chlorophyll a (chl *a*), Total Particulate Matter (TPM), Particulate Organic Matter (POM), dissolved oxygen, harvestable shellfish biomass, individual weight and length.

Scale to which applicable: This model is applicable to the farm scale, corresponding in the Comprehensive Studies Task Team (CSTT) scale to zone A – Local scale.

General description: The FARM model is designed in order to determine the appropriate shellfish density for optimal carrying capacity (the greatest sustainable yield of market sized animals within a given time period) in a given farm. The general setting of the model assumes that water is flowing from left to right and transports suspended matter (chl *a* and POM) that is filtered and eaten by the farmed shellfish.
The FARM model allows to calculate the yield of the farm based on:
a) food supply
b) farm size
c) environmental parameters.
and it integrates the ASSETS model, thus being able to assess farm-related eutrophication effects (including mitigation).

Forcing data needed: Values needed for environmental conditions (water temperature, current speed, chl *a*, detrital POM, TPM and dissolved oxygen), farm dimensions (width, length and depth) and cultivation practice (period and seeding densities). The model can function with constant values or with time series.

Possibly relevant INDICATORS *(f)*
For water quality: Chlorophyll *a* and dissolved oxygen are used by the ASSETS module, and removal of POM, TPM and excretion of nitrogenous waste are provided by the mass balance component of FARM. Indicators of economic success include the Total Physical Product (TPP), Average Physical Product (APP) and the facility to calculate optimal stocking by means of marginal analysis using the Marginal Physical Product and the cost structure of the business.

STATUS of model *(g)*

Origin (ator): The development of the FARM model began in 2006 with the objective of preparing a model which took into account the transport of water properties across a shellfish farm (suspended or bottom culture) and which simulated growth as a function of availability of drivers such as chlorophyll *a* and organic detritus. The model incorporates population dynamics, allowing farmers to examine the production of the marketable cohort, and applies a simplified version of the well-tested ASSETS (NOAA/IMAR) eutrophication assessment model in order to evaluate the changes to water quality associated with shellfish production. The individual shellfish models were developed, calibrated and validated by PML, and further

field trials of FARM are currently underway in Scotland, Ireland and China.

Present development state (has been tested, under development, etc):
The FARM model has been tested in Sanggou Bay – China, and Carlingford Lough - northern Ireland (Ferreira et al, 2007a and Ferreira et al, 2007b).

Present use: FARM models for various species are used freely and run directly on the web at http://www.farmscale.org

Claimed robustness and scientific basis of this:
This model was published in the journal Aquaculture: Ferreira et al, 2007a.

IMPLEMENTATION OF MODEL

State of implementation *(h)*
The model has been fully implemented and tested by a range of users.

State of documentation
Web-based (http://www.farmscale.org) together with journal papers (e.g. Ferreira et al, 2007a)

Intellectual property* concerns *(i)
Model can be made available at no charge for research purposes as a web-based client-server application. Model equations are proprietary.

TESTING

Summary of conditions and measurements needed - including critical forcing data *(j)*
Measurements on current speed and food availability.

Criteria for model rejection

Unsuitability for purpose, inapproriate scale.

OTHER models

Used with this model *(k)*
ASSETS screening model (see model description template), EcoWin2000 model for generating boundary conditions (see model description template).

Similar models *(l)*

Other farm-scale models have some similarities but without the same degree of sophistication or application for screening. To our knowledge, there are very few (if any) models running on the web as client-server applications which are of general practical use.

REFERENCES

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

Ferreira, J. G., Hawkins, A. J. S., Monteiro, P., Service, M., Moore, H., Edwards, A., Gowen, R., Lourenço, P., Mellor, A., Nunes, J. P., Pascoe, P. L., Ramos, L., Sequeira, A., Simas, T. And Strong, J., 2007b. SMILE – Sustainable Mariculture in northern Irish Lough Ecosystems – Assessment of Carrying Capacity for Environmentally Sustainable Shellfish Culture in Carlingford Lough, Strangford Lough, Belfast Lough, Larne Lough and Lough Foyle. Ed. IMAR – Institute of Marine Research. 100 pp.