Tool name
SMILE model (Sustainable Mariculture in northern Irish Lough Ecosystems) using EcoWin.NET, 3D hydrodynamic models, catchment models, and individual growth modelling software.

Tool type
Dynamic modelling framework.

Short description of the tool
The SMILE model was developed in 2007 and it enables the application of an integrated framework for the determination of sustainable carrying capacity within the shellfish production areas for which it was developed (namely, Carlingford Lough, Strangford Lough, Belfast Lough, Larne Lough and Lough Foyle) (Ferreira *et al,* 2007). The SMILE model framework includes a 3D hydrodynamic model, a shellfish growth simulation model, a biogeochemical model, and an aquaculture-specific ecological model, and may include detailed catchment modelling for analysis of pressure, state, and response.

Source (where/ link)

Contact Longline Enviroment Ltd, http://longline.co.uk

Licence cost or other type of costs (e.g. maintenance)

Context-dependent, please use contacts above.

General requirements (technical and input data)
Input data based on experimental data for target cultivated organisms and specifically designed monitoring campaigns for acquisition of oceanographic and biogeochemical data, as appropriate for systems being simulated.

Management dimension for which the tool could be used

☒ Policy / Management

☒ Environmental

☒ Economic / Market

☐ Other sectors

Main functionality

☐ Site identification	☒ Modelling
☐ Mapping	☒ Stakeholder engagement
☐ Economic analysis	☒ Ecosystem services assessment
☒ Scenario analysis	☐ Other: (Please specify)

Fields of application (i.e. issue to be solved)
SMILE is used primarily to provide data to help inform management decisions looking at stocking density and potential areas for expansion of aquaculture based on food availability. SMILE is also

used as an ecosystem health tool, providing data from scenarios to indicate potential impacts of changes in the ecosystem, e.g impact on water quality with changes to shellfish cultivation in the system. When the outputs of SMILE are coupled with other environmental data sources in the AkvaVis model, it can be used for site identification for aquaculture sites.

Circumstances in which it can be implemented (strength and opportunities)

The SMILE model is used in annual management reports used to support stocking decisions. It is also used routinely as part of the cumulative assessment carried out for each of the sea loughs. Results from SMILE scenarios form part of the Habitat Regulation Assessments (HRAs) required for all new shellfish aquaculture applications. SMILE has also been used to show how shellfish aquaculture can provide an important ecosystem service to help maintain good water quality.

Limitations

Dynamic models are capable of reproducing ecosystem processes to the extent of (a) the understanding of those processes and the capacity to simulate them; (b) the quality of data underpinning calibration and validation.

All such models are in general terms limited in: (i) the inability to accurately forecast future weather patterns, since these condition water flows, temperature profiles, underwater light climate, primary production, spatfall, etc.; (ii) the capacity to predict social responses, which are incorporated in EcoWin.NET with respect to the human interaction with the natural system, particularly for aquaculture activities.

Technical skills needed to operate the tool

General computer operating system, interface, and applications skills, particularly knowledge on operation and manipulation of spreadsheets.

Background knowledge needed to implement the tool

Implementation and tool development is beyond the scope of the typical model user, since it requires knowledge of different modelling packages and computer simulation languages. Tuning of input data and parameterization of a number of model processes is possible for experienced users.

How can the tool contribute to the Ecosystem Approach to Aquaculture

Please select the EAA steps that the tool can contribute:

1. ☒ Scoping
2. ☒ The identification of issues and opportunities
3. ☒ Prioritisation of issues
4. ☐ Objectives
5. ☒ Management actions
6. ☒ Monitoring

How can the tool contribute to the MSP

Please select the MSP steps that the tool can contribute:

1. ☐ Define goals and objectives

2. ☒ Gather data and define current conditions

3. ☒ Identify issues, constraints, and future conditions

4. ☒ Develop alternative management actions

5. ☒ Evaluate alternative management actions

6. ☒ Monitor and evaluate management actions

7. ☐Refine goals, objectives and management actions

AquaSpace case studies in which it has been implemented

Case study name:

Carlingford Lough, UK

Reference and link to case studies report:

http://www.aquaspace-h2020.eu/

Other bibliographic references

Ferreira, J.G., Corner, R.A., Moore, H., Service, M., Bricker, S.B., Rheault, R. 2017. Ecological carrying capacity for shellfish aquaculture—Sustainability of naturally occurring filter-feeders and cultivated bivalves. Journal of Shellfish Research, In Press.

J. P. Nunes, J. G. Ferreira, S. B. Bricker, B. OLoan, T. Dabrowski, B. Dallaghan, A. J. S. Hawkins, B. OConnor, T. OCarroll. 2011. Towards an ecosystem approach to aquaculture: assessment of sustainable shellfish cultivation at different scales of space, time and complexity. Aquaculture, 315, 369-383.

J.G. Ferreira, A.J.S. Hawkins, P. Monteiro, H. Moore, M. Service, P.L. Pascoe, L. Ramos, A. Sequeira 2008. Integrated Assessment of Ecosystem-Scale Carrying Capacity in Shellfish Growing Areas. Aquaculture, 275, 138-151.

A. Sequeira, J.G. Ferreira, A.J. Hawkins, A. Nobre, P. Lourenço, X.L. Zhang, X. Yan, T. Nickell 2008. Trade-offs between shellfish aquaculture and benthic biodiversity: A modelling approach for sustainable management. Aquaculture, 274, 313-328.

Ferreira, J.G., Hawkins, A.J.S., Monteiro, P., Service, M., Moore, H., Edwards, A., Gowen, R., Lourenco, P., Mellor, A., Nunes, J.P., Pascoe, P.L., Ramos, L., Sequeira, A., Simas, T., Strong, J. 2007. 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. pp 100. Available at. ecowin.org/smile

TOOL FACTSHEET

H2020