Annex B: Margin of error for the SMILE model used for the new aquaculture sites proposal in Mill Bay.

There is no agreed industry standards for the validation and calibration of ecosystem models such as SMILE (ECOWIN) which are multi parameter ecosystem models however, extensive calibration and validation tests are undertaken.

Nutrients

Comparisons of three forms of dissolved nitrogen were made between monthly observations and daily EWN model outputs for different EWN boxes (Fig. 1). These figures show the validation for ammonia, nitrate, and nitrite concentrations in several EcoWin boxes within Carlingford Lough some with and some without shellfish farming. Concentration of dissolved nutrients was higher close to the main freshwater flow into the Lough (the Newry rivers) and lower in the boxes closer to the ocean.

The pattern of seasonal variation for the three forms of dissolved nitrogen is reasonably well reproduced across the boxes. Ammonia predictions slightly overestimate the measured values in the warmer months. The model is able to reproduce summer nitrate observations but underestimates nitrate in colder months, especially in the inner parts of the Lough. The model fits reasonably well the nitrite measured data, although it tends to slightly overestimate them.

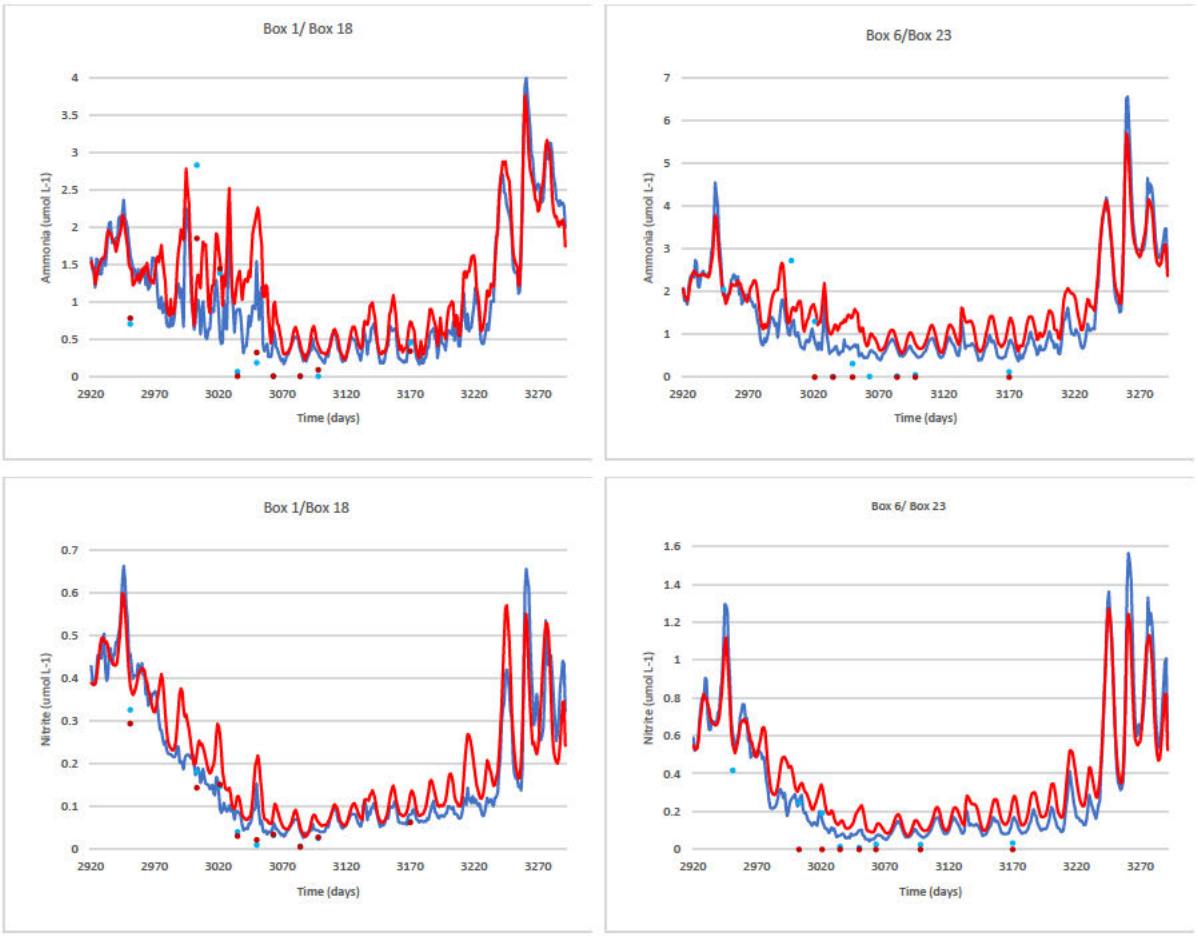

Fig. 1. Ammonia and nitrite concentrations in four model boxes of Carlingford Lough. The lines represent the EWN simulations and the dots are AFBI measured data. In blue we show the surface boxes; in red the bottom boxes.

Chlorophyll and Particulate Organic Matter

Both chlorophyll and POM are key variables in EcoWin, since they constitute the food that shellfish need in order to grow. Fig. 2 and Fig. 3 show the validation curves for these two state variables.

EWN results suggest both chlorophyll and POM levels are highest the closer the mouth of the main river discharging to the Lough, i.e. the Newry River. POM values then decrease to values between 2 and 5 mg L^{-1} in Carlingford Lough with greater values always at the bottom boxes. Simulated chlorophyll also decreases as we move towards the ocean, with higher chlorophyll in the surface boxes. The influence of the Newry with respect to these two variables is stronger in spring (chl-a) and winter (POM).

The match between observed and simulated data is acceptable both with respect to numeric range and temporal variability. Chlorophyll concentration is well matched, although EWN overestimates the spring phytoplankton bloom. Simulated POM values are within the measured range, with occasional outliers attributed to acute rainfall events. POM is overestimated at the mouth of the lough, which has no effect on shellfish growth.

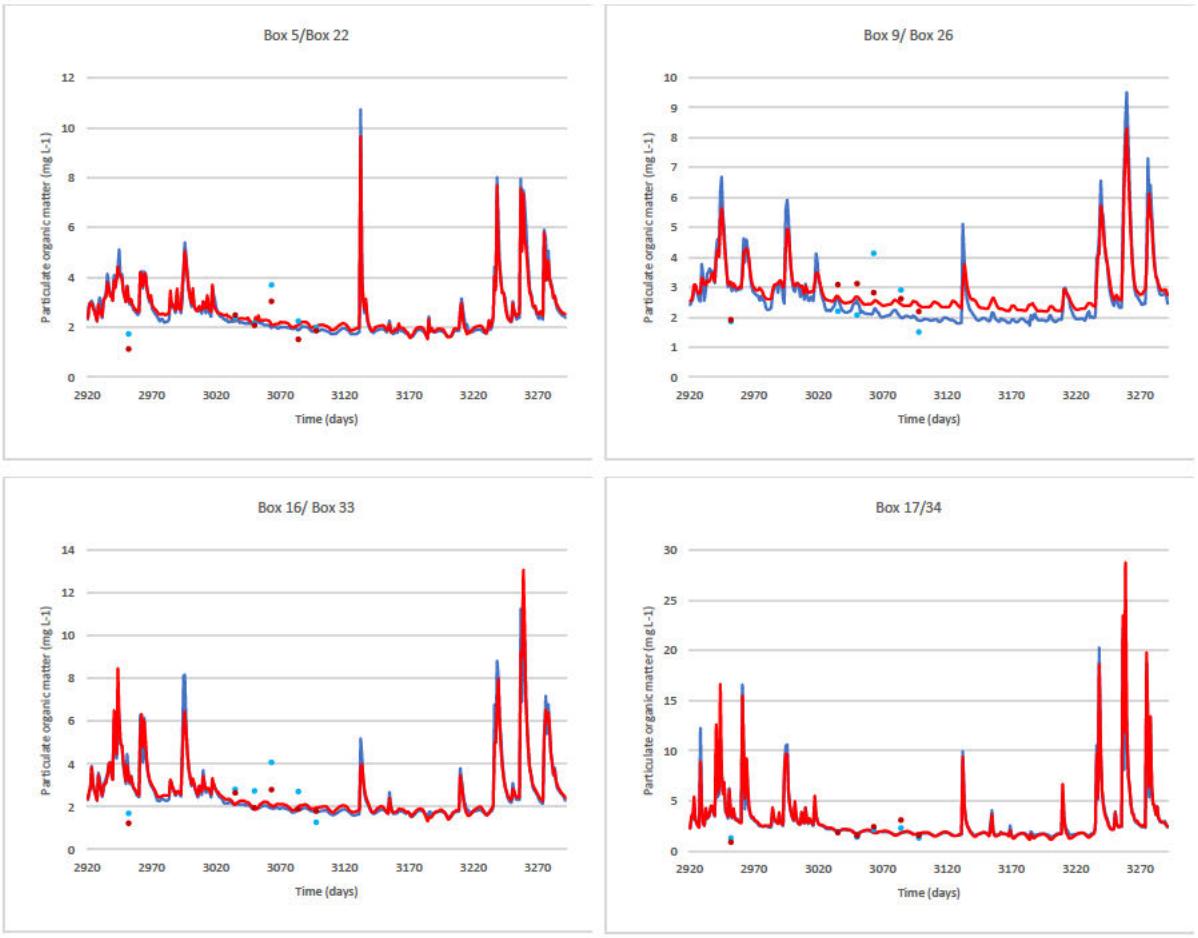

Fig. 2. Particulate organic matter concentration in eight model boxes located in the inner part of Carlingford Lough. The lines represent the EWN simulations and the dots are AFBI measured data. In blue we show the surface boxes; in red the bottom boxes.

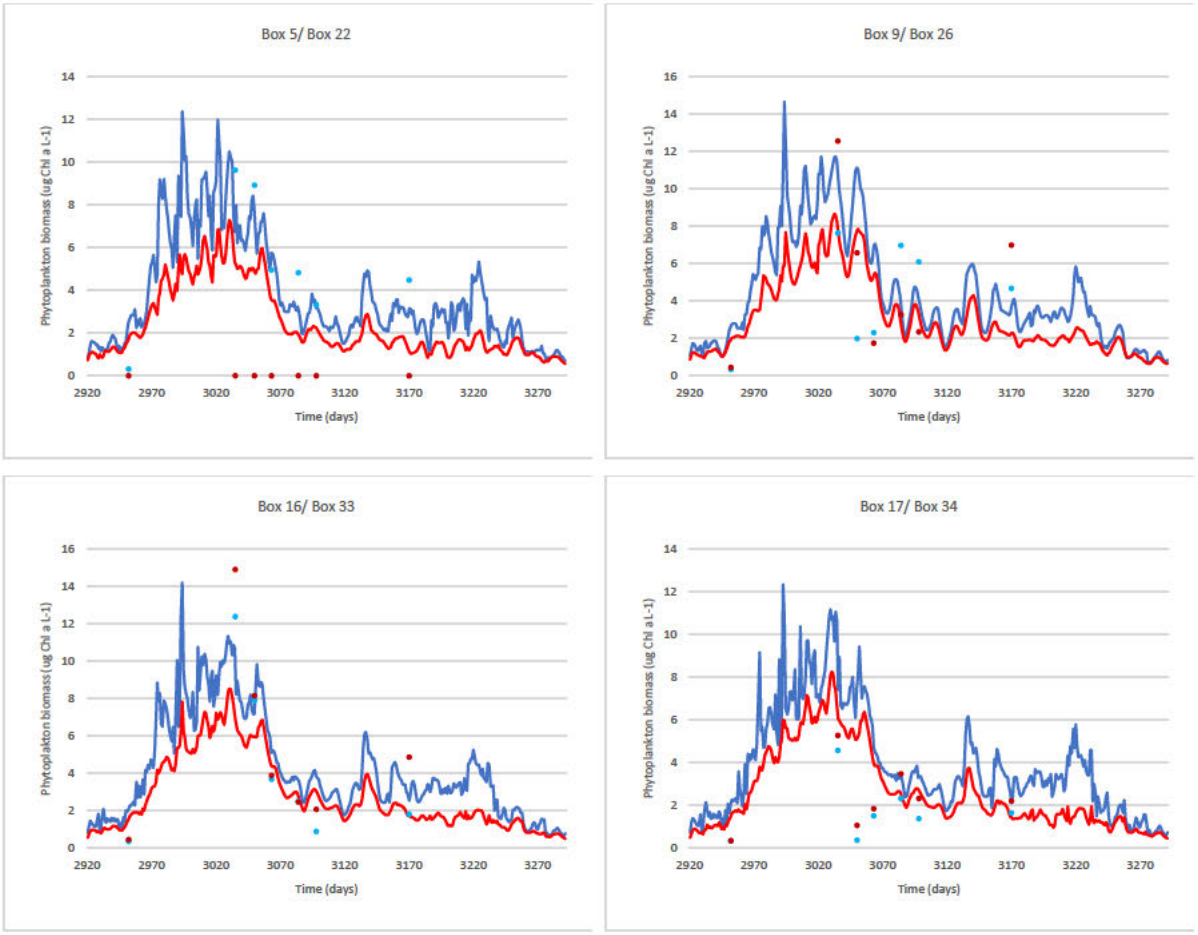

Fig. 3 Chlorophyll concentration in eight model boxes located in the inner part of Carlingford Lough. The lines represent the EWN simulations and the dots are AFBI measured data. In blue we show the surface boxes; in red the bottom boxes.

Individual growth model

Validation of individual growth in EWN was tested by using constant environmental drivers (temperature, salinity, and food) in both EcoWin and WinShell (the application used for running the AquaShell model), to ensure a perfect match.

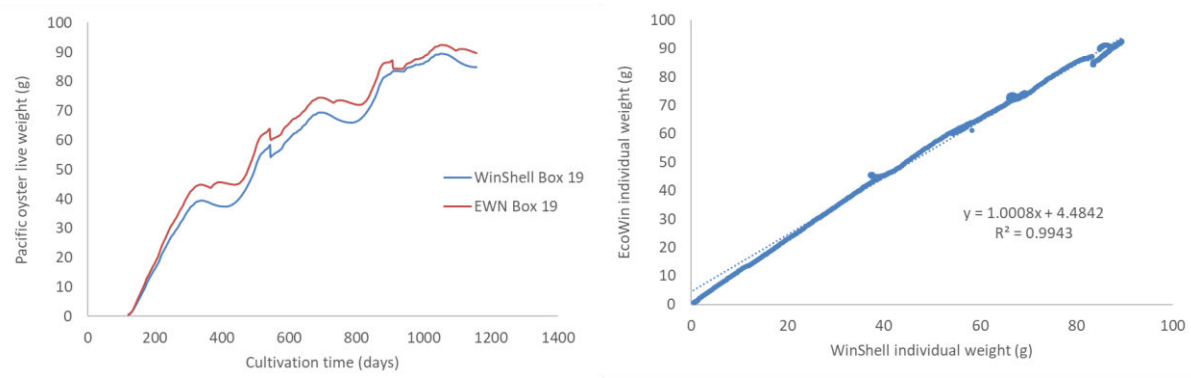

Fig. 4 Comparison of Pacific oyster growth outputs from EcoWin and AquaShell models in Box 19 for the 1037-day growth period.

At a second stage, the fully loaded EWN models were used to extract time series of driver variables with a daily frequency. These were then loaded into WinShell, allowing both models to run growth trials with realistic system data and compare growth profiles (Fig. 4).

The match is near perfect, with and an r2 of 0.994, and therefore a correlation coefficient of nearly 1. The slight differences in growth curves are due to the population dynamics, which are not taken into account in WinShell (Fig. 4).

Harvestable biomass of shellfish

Harvestable biomass of shellfish is one of the key indicators that provides support for decision-makers. There are no intermediate data points that can be measured for this kind of output, so verification is based on the declared harvest at each EWN box.

One of the associated issues in any system where aquaculture takes place, is that there are interannual fluctuations in harvest. To take into account the interannual fluctuations in harvest, the project team analysed the landings for blue mussel, Pacific and native oyster data over the period of the last five years (2017-2021), in order to arrive at the best estimate of shellfish harvest at both Loughs.