Modelling the effect of food depletion on scallop growth in Sungo Bay (China)

Sungo Bay (China) has a mean depth of 10 m, a total area of 140 km2 and is occupied by several types of aquaculture, whilst opening to the ocean. The production of scallops (Chlamys farreri) cultured on long lines is estimated to exceed 50 000 tonnes (total weight) per year. Selection of sites for scallop growth and determination of suitable rearing densities have become important issues. In this study, we focused on the local scale (e.g. 1000 m) where rearing density, food concentration and hydrodynamics interact. We have developed a depletion model coupling a detailed model of C. farreri feeding and growth and a one-dimensional horizontal transport equation. 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. In the simulations, food concentrations always enabled a substantial weight increase with a final weight above 1.5 g dry weight. Compared to a reference situation without depletion, a density of 50 ind m–3 decreased growth between 0% and 100%, depending on current velocity when maximum current velocity was below 20 cm s–1. The mean ratio between food available inside and outside the cultivated area (depletion factor) varied with the percentage of variation in scallop growth that was due to density. Our model suggests that scallop growth was correlated with maximum current velocity for a given density and current velocity below 20 cm s–1. The model was integrated within a Geographical Information System (GIS) to assist in making decisions related to appropriate scallop densities suitable for aquaculture at different locations throughout the bay. Concepts (depletion), methods (coupling hydrodynamics and growth models), and the underlying framework (GIS) are all generic, and can be applied to different sites and ecosystems where local interactions must be taken into account.

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