Response of phytoplankton to multi-species mariculture: a case study on carrying capacity of shellfish in Sanggou Bay

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Abstract:

A multi-species model for shellfish polyculture in Sanggou Bay used for large-scale long-line cultivation of the Chinese scallop *Chlamys farreri*, the Pacific oyster *Crassostrea gigas* and the kelp *Laminaria japonica* is presented. The model includes key physical, biological processes and nutrients release from the bottom. The physical processes are the transports of matters through the system boundary. The main biological process is the primary production. By the bay-scale ecosystem model, the seasonal fluctuation of phytoplankton biomass in 1994 is explicitly simulated. Furthermore, if the kelp culture scale is kept constant, virtual shellfish farms are funded in the bay when the Chinese scallop and the Pacific oyster scales are adjusted. Responses of phytoplankton to large-scale shellfish culture in these virtual polyculture systems are simulated. If the phytoplankton biomass is less than 8.2mg.m^{-3}, these shellfish will not growth. And according to these simulated results, the expand multiple of scallop culture k and the expand multiple of oyster culture y are determined. Considering the room limitation, the carrying capacity for scallop and oyster are determined as k= -0.2765y+4.6905 and $0.1333k + 0.0066y \leq 0.6675$, in terms of k and y. While, k (y) is equal to 1, the culture scale of scallop (oyster) is 8.8×10^9 individuals (66ha, with density 59ind.m^{-2}), and the kelp culture scale is 3300ha with density 12ind.m^{-2}.

Keywords: Multi species model; Kelp; Chinese scallop; Pacific oyster; Carrying capacity