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Corresponding Author: Professor Kevin John Flynn, PhD

Corresponding Author's Institution: Institute of Environmental Sustainability

First Author: Kevin J Flynn, PhD

Order of Authors: Kevin J Flynn, PhD; Kevin John Flynn, PhD

Is there any value in external and internal resource ratios? - implications for modelling eutrophication events and harmful algal blooms

Kevin J Flynn[a]

[a] Institute of Environmental Sustainability, Department of Pure and Applied Ecology, Swansea University, Swansea SA2 8PP, U.K. k.j.flynn@swansea.ac.uk

Tel +44 1792 295726
Fax +44 1792 295447

Abstract

The relationship between the nutrient N:P ratio and the development of P-limitation in phytoplankton is explored using a multi-nutrient quota-based model including a photoacclimative function. The relationship between nutrient N:P and cellular P-status depends on the concentration of both the input and also of the residual nutrient concentrations. Oligotrophic waters require a lower nutrient N:P to avoid P-limitation of growth than do eutrophic waters. In highly eutrophic systems which may support the growth of dense algal blooms, and/or in systems in which light is rapidly attenuated due to other factors (sediment loading, gelbstoff), P-limitation may not be developed even in high N:P systems due to light limitation. This is more likely in systems subjected to higher rates of washout, in which phytoplankton growth rates must remain elevated. There are also instances in which elevated residual nutrient N:P can develop in systems supplied with nutrients in accordance with the Redfield N:P ratio, with no elevation of phytoplankton N:P. Ultimately the only diagnostic for phytoplankton nutrient stress is cellular physiology (C-fixation, C:N:P); the only nutrient parameters of consequence are concentrations of individual nutrients and not the ratio of them. Resource-ratios appear as system outputs of dubious utility; they are not system drivers.

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