

Interactive comment on “A model for variable phytoplankton stoichiometry based on cell protein regulation” by J. A. Bonachela et al.

Anonymous Referee #2

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The manuscript presents a model of phytoplankton population growth and stoichiometry, based on regulation of nutrient uptake by uptake proteins, which are themselves regulated by the cellular nutrient quotas. The manuscript is well written, but I have concerns regarding the relevance of some important mechanisms under certain common conditions.

While I have some doubts about the "simplicity" of the underlying regulation functions, G and F, I am willing to accept that they are at least plausible, if not mechanistic. I have more serious concerns regarding the regulation of nutrient uptake. In particular, the number of uptake proteins is not so relevant when resource acquisition is limited by diffusion. As indicated in equations 5 and 6, the balance of diffusion and transport limitation is dependent on cell size, as well as ambient resource concentration. Diffusion

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probably being the dominant process when cells are large, or the resource concentration is low (Armstrong 2008). Despite its clear importance, the role of cell size is largely ignored in the manuscript.

The cell radius in Table 3 is given as $0.82 \mu\text{m}$, which corresponds to a prokaryote, or a perhaps very small eukaryote. As r becomes larger, the number of transport proteins will become less important, especially at low resource concentrations. This brings into question the generality of the conclusions. How important is uptake-protein regulation for larger, diffusion limited cells? I would like to see this question answered through additional experiments looking at the model behaviour across a wide range of r . Please also relate the experimental r values to the size of the experimental organisms used for model development and validation.

The meaning of Figure 1 is not clear to me. Where do these lines come from? Are they just schematic, showing broad trends in the literature? The figure should be improved with better explanation, annotation, and specific data examples.

Page 3244, Line 25: Please be a bit more precise about what you mean by symmetric.

Page 3246, Line 21: "Regulation of protein production is the key mechanism underlying the dynamics of the population". This sentence is a bit too strong, as protein regulation is merely one of many interaction environmental, ecological and physiological factors that determine the population dynamics. In some cases, as indicated above, regulation of protein production may be of minimal importance to the dynamics of the population.

Page 3246, Line 22: the parameter n does not appear in table 3.

References Armstrong, RA 2008. Nutrient uptake rate as a function of cell size and surface transporter density: A Michaelis-like approximation to the model of Pasciak and Gavis. *Deep Sea Res I* 55:1311-1317.

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