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Interactive comment on "A numerical analysis of the role of the microbial loop in regulating nutrient stoichiometry and phytoplankton dynamics in a eutrophic lake" *by* Y. Li et al.

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I was pleased to receive this paper for review, as the degree to which representation of microbial processes in biogeochemical and ecological models makes a difference is currently an open question, and an important one as explicit incorporation of bacteria in these models is just beginning to emerge as a theme. Direct comparisons of alternative model formulations is required to advance the field, and that is the subject of this paper. I would like to see it published ultimately, but do think it has some weaknesses in its current form.

There are a few points on which the analysis and the discussion around the model

could be improved. Most importantly: 1) It is not clear from the paper whether the model has been validated, or whether the results shown are for the calibration period. I.e. did you use the entire simulation period for model calibration?

2) What calibration procedure was followed? Was it a manual calibration, or did you use some formal method? Which parameters were calibrated? Only those relating to the microbial interactions, or was the whole model recalibrated to adjust for the impacts of the different formulations on other parts of the model?

3) I'd like to see some formal model evaluation metrics. rˆ2 and RMSE are the most commonly used. A range of other options are presented by Bennett et al. (2013) "Characterising the performance of environmental models".

A few points could do with further discussion in the manuscript: 1) Do you have any observational data for observational abundance and biomass? If so, how much do you think this affects the validity of your results?

2) I'd like to see some discussion in the introduction regarding the strength of physiological evidence in the literature supporting formulation (3). How strong is the evidence for bacterial uptake of DIN and PO4, and is there a different metabolic cost to this versus uptake of DOP and DON?

3) Similarly, is the metabolic cost of uptake of C from DOC the same as that for uptake of POC?

4) It is briefly mentioned in the discussion, but I'd like to see a little more on how stoichiometry affects the rate of breakdown of DOM. It would also be worth mentioning recent work on the affect of HUFA and fatty acids in general on food quality. E.g. Perhar et al. 2013 Modeling zooplankton growth in Lake Washington: A mechanistic approach to physiology in a eutrophication model.

5) I'd also like to see discussed the implications of POM as a bacterial substrate. Smaller particles will have more surface area and, presumably, a higher grazing effi-

ciency than larger particles for the same concentration of POM. Do bacteria specialise on consumption of DOC vs POC? Will a high concentration of POM, by providing more substrate, increase the efficiency of bacteria grazing on DOC? At higher local concentrations, do bacteriophages become important? I'm not asking for these points to be added to the model, only discussed.

6) Another point for discussion: Given that this is a lake prone to blooms of buoyant cyano species such as Microcystis, it would be interesting to consider the role of surface blooms and accumulation of organic carbon in the surface film layer. This can produce a very high local concentration of both particulate and labile dissolved organic material at the surface, which is likely to increase bacterial efficiency as well as the potential for cyanophages and bacteriophages to become important. If the bloom is toxic, zooplankton grazing efficiency will be reduced, and if not, it may be increased due to increased concentration of food and substrate for eggs.

7) ANOVA may not be a good statistical test for comparison of different model runs, as the frequency of model output is arbitrary and consecutive points in a time-series are not independent samples. I am led to understand that this gives an arbitrary apparent "n" and can give a misleading p value.

8) I haven't checked the sensitivity analysis method given by Bruce et al. (2006), but it may be worth referring to the Environmental Modelling & Software position paper, "How to avoid a perfunctory sensitivity analysis".

9) (This ties in with my opening remarks about model validation): the more complex model produces a better match to observations, but to what extent is this attributable to a greater number of parameters allowing a better fit, versus the relative virtues of the model? A point for discussion, at least.

10) You mention that bacteria become N and P limited. Is there a role of N fixation in your model? I hope it is already included in your model for N-fixing cyanophytes, but some heterotophic bacteria are also capable of fixing N, so this could be a point for

future refinement (supported by process studies in the lake).

Minor points: 1) What did you use for model initialisation? p 19738, li 11: the mineralisation rates in this formulation aren't really constant, as they are affected by f(T) and f(DO). 2) Equation (3): Is this actually respiration or mortality? Is respired carbon not mostly lost as DIC? 3) Equation (7): It would be worth referring to papers that discuss the implications of alternative zooplankton grazing functions, e.g. the difference between this simple MM function and a function that considers zooplankton clearance rates, which are affected by swimming strategies and speed, etc. Also, the impacts of zooplankton size distribution. 4) Given that the focus is on the microbial loop, I will note only in passing that the representation of NH4/NO3/DON preferences is fairly blunt and does not consider the different metabolic costs that underly this preference. See e.g. my recent MODSIM2013 paper on modelling Trichodesmium for one way to implement this. 5) Section 3.4: some of this would be easier to follow if presented as bar graphs instead of as text.

Typos: p 19735, li 19: "there" should be "their". p 19736, li 8: "loop on" should be "loop for" p 19741, li 3: inconsistent spelling of "mineralization"/"mineralisation"

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