

Interactive comment on “Sequential Nutrient Uptake by Phytoplankton Maintains High Primary Productivity and Balanced Nutrient Stoichiometry” by Kedong Yin and Paul J. Harrison

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Anonymous Referee #1 Received and published: 22 November 2016 This is generally a very well written manuscript that investigates the sequential nutrient uptake strategy by phytoplankton within a coastal system to cope with maintain nutrient stoichiometry and favour growth under potentially limiting conditions. The novel use of a flow through system to sample nutrients continuously from a CTD cast allow for a uniquely high sampling resolution. The authors however rely only reporting nutrient concentrations and nutrient ratios without examining other methods for data analysis. This is particularly important for the nutrient incubation experiments that could have calculated nutrient specific growth rates. Throughout the manuscript the authors refer to high lev-

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els of primary productivity and phytoplankton growth yet fail to provide any estimates for the Strait of Georgia. (Addressed below with references) The demonstration of sequential uptake by phytoplankton to differing nutrient limitation conditions is important in understanding seasonal dynamics of productivity, community succession and nutrient concentrations. The authors mention that different uptake strategies but does suggest explicitly whether the sequential uptake favors either the growth or storage strategy (addressed below). I recommend that this manuscript be accepted; following the address of the minor revisions listed below. Specific comments:

–Reviewer 1: Page 5, Line 109: Please provide estimates of the biological productivity.

#Reply: Values and a reference have been added. Daily production up to 5 g C/ m²/day and annual about >300 g C/m²/yr Harrison, P.J., P.J. Clifford, K. Yin, M. St. John, M.J. Sibbald, L.J. Albright, W.P. Cochlan and P.A. Thompson. Nutrient and plankton dynamics in the Fraser River plume, Strait of Georgia, British Columbia. Mar. Ecol. Prog. Ser. 70: 291-304 (1991). Harrison, P.J., T.R. Parsons, F.J.R. Taylor and J.D. Fulton. Review of Biological oceanography of the Strait of Georgia: Pelagic Environment. Can. J. Fish. Aquat. Sci. 40: 1064 1094 (1983).

–Reviewer 1: Page 6, Line 131: This paragraph gives concentrations of Nitrate and Silicate; however the previous paragraph does not give concentrations of Phosphate. If you are going to switch between a conceptual model and measured concentrations, then please be consistent and give measured concentrations for all nutrients discussed.

#Reply: We have deleted the word “concentration” to be consistent.

–Reviewer 1: Page 7, Line 169: What were the detection limits of the nutrients?

#Reply: NO₃ = 0.1 μM, NH₄ = 0.05 μM, PO₄ = 0.05 μM, SiO₄ = 0.01 μM

–Reviewer 1: Page 7, Line 170: Were the field incubations done in the same year? As the figure captions suggest they were performed in different years. There is also no

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mention of this when you discuss the results of these incubation experiments.

#Reply: The samples were taken in different years, but at the same time of the year. This is noted in the methods now.

–Reviewer 1: Page 9, Line 204: What was the silicate concentration at the surface? Inconsistency with the level of detail when reporting nutrient concentrations and nutrient ratios.

#Reply: The dashed lines for silicate on Fig. 5 were very dim, especially on an Apple Mac. We have fixed this problem.

–Reviewer 1: Page 9, Line 216: Reference to figure 6. . . This figure is the same as figure 5. Unable to give specific comments on the text without the correct figure to refer to. However, stylistically it would make it easier for the reader if you use the references to the time stamps in the same style as figure 5.

#Reply: Yes, there was a mistake with Fig. 6. Figs. 5 and 6 should be different figures. This has been fixed now. We also fixed the problem of dim dashed lines for silicate.

–Reviewer 1: Page 10, Line 230: Was chlorophyll measured? Why was fluorescence not converted to chlorophyll? Increases in fluorescence do not always represent increases in biomass, but can reflect alterations to the photosynthetic apparatus; which in turn is usually driven by the nutritional status of the phytoplankton.

#Reply: Chlorophyll was not measured. An increase in fluorescence usually indicates the increase in biomass in waters, which do not have strong interfering substance such as high concentrations of dissolved organic matter, particularly in the initial incubation phase under sunlight.

–Reviewer 1: Page 10, Line 251: If the diamond symbol represents the presence of phosphate, then the ratio of N:Si does not exceed 3:1 at any time point.

#Reply: Corrected. Thank you.

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–Reviewer 1: Page 11, Line 254: ‘highly productive’ Once again the authors fail to give any values associated with this type of estimate.

#Reply: Revised as “The Strait of Georgia is highly productive, reaching up to 2,700 mg C m⁻²d⁻¹ in August. (Yin et al. 1997a)”

–Reviewer 1: Page 11, Line 272 – 280: This whole section reads like a re-iteration of the results without a closing statement for the reader to take away before moving onto the next section. Consider re-structuring this section.

#Reply: We have revised these sentences into a sentence to summarize the value of the conceptual model to extract information from this sequence of events.

–Reviewer 1: Page 12, Line 290: ‘increase in cellular content’ – An increase in the cellular content of other non-limiting nutrients would only occur if luxury uptake occurs, this is not a direct result of nutrient deficiency. A direct result of nutrient deficiency is changes in intracellular nutrient stoichiometry.

#Reply: We have revised as “Nutrient deficiency results from a decrease in the cellular content of the limiting nutrient and continuous uptake of other non-limiting nutrients.”

–Reviewer 1: Page 13, Line 324: You discuss how different phytoplankton species will either use the ‘growth’ or ‘storage’ strategies; yet here you say that phytoplankton will use ‘storage’ for non-limiting strategies and ‘growth’ for limiting nutrients. Which statement is correct? It seems like the author wants to suggest that the old idea of species specific strategies need to be revised. Suggest a bit more clarification to get this point across to the readers.

#Reply: We have revised this section quite a bit.

–Reviewer 1: Page 14, Line 335: Can you please provide a reference for ‘internal waves in the open ocean’.

#Reply: a reference paper has been added Pomar, L., M. Morsilli, P. Hallock, B. Balà-

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denas. 2012. Internal waves, an under-explored source of turbulence events in the sedimentary record. *Earth-Science Reviews* 111, 56-81.

–Reviewer 1: Page 14, Line 335: Reference for ‘Phytoplankton in the chlorophyll maximum are generally nutrient sufficient’. I don’t necessarily agree with this statement; phytoplankton can exist under steady state nutrient limitation and still exist at the chlorophyll maximum within the water column.

#Reply: Revised as “Phytoplankton in the chlorophyll maximum are frequently exposed to nutrients and . . .”

–Reviewer 1: Page 14, Line 338: How do the phytoplankton sink down? Mixing events? Changes to internal buoyancy?

#Reply: Changes to their internal buoyancy (exchange of heavy ions for lighter ones) and also by clumping since under nutrient deficiency cells produce extracellular carbohydrates that make them sticky and prone to clumping. – Clumping added to the text.

–Reviewer 1: Page 14, Line 350: POC/PON ratios are discussed but there is no mention to how they were measured in the methods.

#Reply: Inserted in the methods — POC and PON in a water sample was filtered onto a GF/F filter and analyzed with a Carlo Erba model NA 1500 NCS elemental analyzer, using the dry combustion method described by Sharp (1974).

Sharp, JH (1974) Improved analysis of particulate organic carbon and nitrogen from seawater. *Limnol Oceanogr* 19:984-989

–Reviewer 1: Figure 1 Caption: I would suggest dropping the text that begins with ‘At T2’. This reads like the discussion of the conceptual profiles that is already mentioned in the introductory text.

#Reply: This figure is important. It will be hard for readers to go back to the text for

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explanations. Therefore, we think that we prefer to keep this legend.

–Reviewer 1: Figure 9A: NH₄ is shown on the figure. Not mentioned in the methods or the figure caption.

#Reply: NH₄ is now in the methods and the figure legend.

–Reviewer 1: Figure 9B: Symbols aren’t consistent between panels making it hard to follow. i.e. Top panel, +N+P is open triangles, and then is a closed circle in the bottom panel with open triangles used for +P+Si.

#Reply: The symbols are now fixed.

–Reviewer 1: Technical comments: Page 5, Line 111: Space required between ‘pynocline.’ and ‘In the Strait’. Page 7, Line 153: Typo ‘florescence’.

#Reply: Corrected. Thank you.

End of reply

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