

## ***Interactive comment on “The nitrogen pendulum in Sandusky Bay, Lake Erie: Oscillations between strong and weak export and implications for harmful algal blooms” by Kateri R. Salk et al.***

### **Anonymous Referee #2**

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The manuscript reports on measurements of nitrogen cycling and assimilation processes in Sandusky Bay. The work is important because it reports a simultaneously measured rates of denitrification, nitrogen fixation and loads to the bay which allows the relative importance of the processes to be assessed. It was found that in general nitrogen fixation rates were higher than nitrogen loss through denitrification. As such, the bay generally acts as a net source of nitrogen to Lake Erie rather than a sink. My only major comment is that I think that the budget could have been presented more clearly to better highlight how the bay modulates nitrogen inputs to Lake Erie.

Specific comments

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Abstract I suggest referring to dissimilatory nitrate reductive processes as opposed to assimilation

Use of 'pendulums' not really the right term in my opinion. As elaborated on below, I think the key point is that the system is a modulator of nutrient inputs.

Estuary, in a freshwater lake? How about mixing zone?

Pg 3 line 5 – I don't think estuary is generally accepted as a term for rivers entering freshwater lakes – I suggest mixing zone.

Methods Isotope analysis delta<sup>15</sup>N values are mentioned in the methods, why? The isotope pairing equations use excess ratios of M/Z 29/28 and 30/28 for N<sub>2</sub> and 45/44 and 46/46 for N<sub>2</sub>. I suggest deleting all ref to del <sup>15</sup>N and explaining which masses were monitored and how excess ratios were calculated. It also not clear why N<sub>2</sub> was also measured with MIMS or how these data were used.

Phytoplankton N uptake <sup>15</sup>NH<sub>4</sub>/NO<sub>3</sub> contamination of <sup>15</sup>N<sub>2</sub>. You state that uptake of contamination would have made up less than 5% of measured rates. This depends on the rates. Is this even the case for the lowest measured rates? The main thing that convinced me your data were probably ok, was the fact you could measure low rates in 2016.

Budget I don't think converting sediment process rates to volumetric rates is meaningful – these should either be shown as areal rates or total mass for the whole system.

Line 5 pg 8 – I agree with your point about TKN in the river, but what about in Sandusky Bay? As mentioned below, I think the system is really a modulator that converts NO<sub>x</sub> to organic matter and this will be shown clearly in the TKN data if available.

For the nitrate loads, at what time interval were concentration and flow measured? How were these data interpolated to calculate loads?

Discussion N removal processes. This was generally good and I agree with the ar-

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guments. I felt, however this section could have been a little more quantitative. For example, it is argued that the increase in the N:P was driven in a large part by denitrification. I suggest the authors undertake a back of the envelope calculation to show how the change in the mass of NO<sub>3</sub> in the water column over this period of NO<sub>3</sub>- drawdown compares with total denitrification measured over the same period. Also of relevance here is that Dw (water column driven denitrification) and Dn (water column driven denitrification) are not reported. The breakdown of these is important when considering the drawdown rate of NO<sub>x</sub>.

Budget I think there was a missed opportunity with the budget to integrate the findings a little more clearly. I suggest that for each period process rates were measured, a budget be undertaken (could be daily or perhaps monthly basis). These budget terms could then graphed to highlight the change from high catchment inputs to high internal inputs via N fixation as flows decreased through to August. This would also highlight the relatively minor importance of denitrification as a sink compared to the inputs. Although the phytoplankton assimilation measurements are a nice part of the paper, I don't think they can be used meaningfully in the budget because they were taken in 2016 when phytoplankton biomass was higher.

I think the discussion at line 20 on pg 15 could also talk a little more about the system as a transformer of nitrogen importing DIN and exporting algal biomass as well as N derived from nitrogen fixation. At the moment it is a bit repetitive and not as interesting as it could be. I don't really think the term N pendulum is correct, it really modulates the inputs depending on residence time, with a net export of nitrogen from nitrogen fixation. This finding is consistent with a previous study of a shallow eutrophic lake which often showed net exports of total nitrogen, most likely due to nitrogen fixation.

Cook, P.L.M., K.T. Aldridge, S. Lamontagne, and J.D. Brookes. (2010). Retention of nitrogen, phosphorus and silicon in a large semi-arid riverine lake system. *Biogeochemistry*, 99: 49-63.

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The last paragraph of the discussion is quite speculative, I suggest remove.

Figures Figure 2, micro symbol now appears as milli.

Figure 3 micro symbol as above

Figure 4 the letters showing statistically significant groupings are unclear. ^ is carat, not carrot

Figure 5a. Why are these rates reported volumetrically? They should be areal as for Fig 3.

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