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Interactive comment on “Organic N and P in eutrophic fjord sediments – rates of mineralization and consequences for internal nutrient loading” by T. Valdemarsen et al.

Anonymous Referee #2

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The manuscript discusses the importance of internal nutrient loading in the recovery of eutrophic estuaries by examining the mineralisation of organic nitrogen (ON) and phosphorus (OP) buried in the sediment. The magnitude of the internal loading of ON and OP was investigated in a two year experiment spanning a number of different sediment types found within the Odense Fjord. Cores were kept oxic throughout the experimental phase in which sediment porewater profiles, dissolved nutrient fluxes and anaerobic jar experiments (anaerobic mineralisation rates) were periodically measured over the two year period. The authors concluded that internal nitrogen loading is of minor importance (6% external N) and DIN fluxes stabilised after 50-200 days, alternatively internal phosphorus loading is potentially a source of P (36% external P)

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and PO43- fluxes throughout the two year period were variable and P efflux could be sustained over years which may be important for the management of P.

The principles within the manuscript are not necessarily novel, however, the authors do provide further understanding of internal nutrient loading which is an important measure in the management of these systems and the potential for a delayed response after reducing external inputs. The manuscript is generally well written some areas could be shortened. There are, however, some limitations in the experimental design, possibly unavoidable due to the required length of the experiment but they do raise the question as to how relevant long term laboratory experiments are to the natural environment. Some of these limitations have been discussed briefly in the discussion and more thoroughly in the partner paper on carbon mineralisation published in the Marine Ecology Progress Series (Vol. 503: 41–58, 2014) however these need to be addressed more thoroughly. My specific comments are listed below:

Page 15114 Line 1 – Station 5 represents sandy sediment which has been collected in a closed core. Measuring fluxes in sediment within closed cores is based on diffusion principles, however in the natural environment processes within sandy sediments are not only governed by diffusion but also advective flow. This will likely alter the estimate of nutrient effluxes from the sediment depending on residence time of the porewaters etc. The difference of this site to the others is briefly touched on in the discussion (15124 – line 14) however it is not discussed in terms of an experimental limitation and how this influences the interpretation of the results at this site and requires further comment.

Page 15114 Line 20 – What was the density of the macrofauna at each of the sites? In the literature macrofauna play an important role in nutrient cycling in the Odense Fjord turning over large volumes of sediment annually if this also applies to these sites excluding them from your experiments (even though it would be challenging to include them in a long term experiment such as this) could drastically change your estimates ON and OP released from the sediment. This also changes the redox conditions at

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the sediment surface where burrowing macrofauna can increase the depth of oxygen penetration and nutrient transport into the sediment and in turn potentially influence your mineralisation rates. I am uncertain here how relevant to natural conditions your estimates of internal nutrient loadings are having excluded all macrofauna from your experiments. This requires further discussion.

Page 15114 Line 11/25 - The authors state that at the time of sampling the in situ temperature was 10 – 12oC, however the experimental conditions were set to 15oC I am uncertain why this temperature was chosen. Furthermore the authors then extrapolate annual ON and OP release under these conditions where on an annual cycle temperatures in the Odense Fjord range from ~3 - 19oC. Bacterial populations could also vary throughout this time based on temperature differences. The influence of temperature on mineralisation rates should be something that is considered and discussed further particularly when temperature regulation is quite easy to manipulate in an experimental setup.

Page 15117 Line 6 – Was there a control to compare the rate of aerobic and anaerobic mineralisation to confirm that anaerobic mineralisation measurements were representative of all mineralisation within the fjord? This would not be an issue for deep anaerobic sediments but in aerobic surface sediments an aerobic mineralisation measurement should have been considered.

Page 15126 Line 15 – The authors mention that the missing NH₄⁺ could be lost due to nitrification-denitrification coupling. I do agree the missing NH₄⁺ in the oxic fluxes is most likely accounted for by nitrification however in Figure 6 it does not appear that nitrification and denitrification are strongly coupled with most of the NO₃⁻ released from the sediment after ~20 days. Possibly revise this statement. Page 15128 Line 3 – The authors state in the discussion that the sandy sediments are the most important for the total fjord release of N (39%) I would note that this estimate probably has the most uncertainty out of all sites due to the absence of advective flow in these estimates. This statement is also made about P release (Line 16).

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Page 15129 Line 17 – As mentioned by the previous referee (S. Hietanen) – the authors need to explore further how a change in the N:P ratio from high internal P loading could potentially result in N₂ fixers dominating the system and be a long term management issue.

Specific Comments technical corrections:

Page 15120 Line 6 – This line is not essential. Why Fe(III) was measured is already mentioned in the introduction.

Page 15124 Line 25 subscript on numbers instead of superscript

Page 15138 - Table 2 is missing the average TP:TN ratios

Page 15147 - Figure 6 is not essential it is explained well in results.

Page 15125 Lines 1-2 are not necessary this is clear in the previous sentence and was set out in the introduction

Page 15141 - Table 5 should ON and OP degradation or any of the other measurements here be time integrated? the units are in mmol m⁻²

Page 15127 Line 13 – Normal text for N-1 should be superscript

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