

**Review of “Efficient removal of phosphorus and nitrogen in sediments of the eutrophic Stockholm Archipelago, Baltic Sea”
by Helmond et al.
MS# bg-2019-376**

General comments/requests (in random order):

- 1) The authors present bottom water nitrate as one controlling factor of benthic denitrification. What about nitrate formed during benthic nitrification as one controlling factor? Very little is mentioned about it. Please do, and discuss nitrification as a control of benthic denitrification in these sediments.
- 2) Lines 421-436 and elsewhere: Denitrification rates decreased going seaward, and the authors explained this by lower bottom water nitrate concentrations and lower organic C content of sediment along the transect going seaward. However, it is generally assumed that in coastal and shelf sediments availability of nitrate controls denitrification rates since there often is no shortage of organic C in such sediments – at least not to limit benthic denitrification. Also, in coastal and shelf sediments, the nitrate consumed in denitrification is mostly produced during nitrification in the sediments rather than being nitrate from the bottom water (cf. e.g. papers by Seitzinger (et al.)). The 18 mm oxygen penetration depth in sediment of Ingaröfjärden should allow active nitrification so that the lower bottom water nitrate concentration there should not lead to a decreased denitrification rate. Could the authors please discuss in their paper this apparent inconsistency between what has been generally found and what was found in the present study?
- 3) The measurements were made in March, which is late winter. This period should be among the most oxygenated of the year; the vertical stratification is weak and mixing/ventilation of bottom waters should be facilitated. In addition, bottom water temperature is at its minimum, the spring bloom has not started yet, and there should be very little fresh organic matter in sediments. Can the authors please include a discussion in their paper on this and especially on to what extent the results presented are representative on an annual scale? In my opinion, the results represent a late winter situation, and fixed N removal and retention of P in sediments most likely are very different than in e.g. summer-fall when bottom water oxygen levels and quantity of fresh organic matter in sediments can be completely different. The authors should make this very clear in their paper.
- 4) Section 4.3 Implications: Although this section includes some interesting discussions, I cannot see that it is relevant in this paper. This section consists of discussions and speculations far beyond what can be found warranted based on the original results of this paper. This paper is not a review paper. Please focus the discussion, and the presentation of implications, on the results obtained in *this* study (carried out in March 2017).
- 5) Section 4.3 Implications: “...artificial reoxygenation of bottom waters (e.g. Stigebrandt and Gustafsson, 2007) will not be a long-term effective measure towards improving the water quality of the (coastal) Baltic Sea.” Please explain how the

results of this paper justify this statement. If the authors cannot convincingly do this, this statement should be removed.

- 6) Lines 536-538: "Further reductions in P and N inputs are necessary to ensure a reduction in the frequency of hypoxic events. Eventually this will lead to a larger surface sedimentary P sink and will be key to maintaining the efficient N filter and avoiding additional P and N recycling." I agree that this is one important measure to improve the environmental status of coastal systems and that it should be done, BUT please explain to what extent the results of this study justify this final conclusion.

Other comments by line number:

Line 24-25: What other form(s) of P make up the remaining 50-70% (i.e. the major fractions) of P burial? Please make this clear already in Abstract.

Line 31-32: Regardless whether this statement in general is correct, what evidence does this paper provide that this statement is correct? What level of removal or retention of N and P would have occurred in the studied area if bottom waters had been better oxygenated (natural or manmade)? I do not think this statement is warranted based on the results this paper presents, so I suggest it is deleted unless the authors convincingly can argue that it is warranted. See also above.

Line 390: Remove "rate" in the beginning of this line.

Lines 412-413: "...and the increasing role of sediments as a NO₃⁻ sink along the estuarine gradient". Please clarify this text. In which direction are you meaning the estuarine gradient goes? Landward or seaward?

Lines 414-415: "...reduction in organic matter quality as shown by a concomitant reduction in surface sediment N and organic C contents". Does organic matter *quality* necessarily go down when *contents* of N and organic C go down? Please explain.

Lines 440-451 (and later in Discussion): What did Bonaglia et al. (2017; BG) report on DNRA and its importance as a nitrate reducing process in Baltic sediments?

Lines 534-535 (and elsewhere): "Combining our process measurements with available monitoring data, it is likely that N in the Stockholm Archipelago undergoes seasonal cycles of removal and retention." What do you mean with "retention" of N here? Did you intend to write *recycling* (e.g. through DNRA)?

Table 4 head. "DN is nitrate supplied from nitrification". DN does not exist in the Table, so why is it mentioned in the Table head?

Table 4: Anammox is incorrectly spelled. Should be anammox.