Review of Forster et al. ‘Bottom fishery impact generates tracer peaks easily confused with bioturbation traces’

General comments

With their study Forster et al. aim to qualitatively assess whether bottom trawling generates peaks in the sediment Chl.a profile that are similar to the characteristic subsurface concentration peaks that are commonly used as indicator of biological bioturbation. To answer their question, the authors conducted two experiments (one ex situ, one in situ) and in situ environmental sampling in the western Baltic Sea. With the results from the ex situ experiment mimicking trawling and the in situ experimental trawls the authors could show that peaks in the sediment Chl.a concentration profile are caused by re-deposition of Chl.a-rich surface sediment through the otter boards (‘flipping sediment over’). The shape of these experimental Chl.a profile corresponds to the shape that is commonly associated with biological bioturbation and similar to the profiles detected in the sediment cores from random in situ sampling in an area that has both, bioturbating bivalves and intense bottom trawling. This highlights the question of physical or biological originality of those Chl.a peaks and the authors discuss implications and potential resolution of it. Because of the similar shape of Chl.a profiles from biological bioturbation and physical trawling in their study area, the authors put their findings into environmental context and present estimates of Chl.-a transport events from bioturbation and trawling. This discussion point is very interesting and I would have liked to read some more about their thoughts and arguments on the biogeochemical and ecological context of their findings.

The research question that the authors pose is realitively specific and ‘technical’ but it raises thoughts on the ecological significance of using tracers like sediment Chl.a concentration as tracer to quantify bioturbation of benthic macrofauna, especially in areas where trawling occurs. The conclusions that the authors draw are consistent with the evidence and arguments they present and they adress the main question. However, I found that the main research question and the conclusions are not very clearly formulated in the main text and not easy to identify for the reader. The combination of ex situ and in situ experiments with environmental sampling build a strong realistic picture in the results though I could not fully grasp how the modelled results (Table 1) fitted into the story. Here I would suggest to provide some more description/explanation so that readers unfamilar with Soetaert et al’s models and Oberle et al’s scenarios can follow. I would also be interested if there exist publications of Chl.a profiles where the peak can clearly be attributed fauna bioturbation, or have shown those in experiments and whether those could be shown/re-drawn here for comparison if data available (e.g. from Morys et al. 2017)? Overall, the manuscript is written well, but a number typos exist and I personally found the sentence structure hard to read and sentences and paragraphs lacked connection and reading flow which it is hard to identify the meaning/relevancy as a reader .

Detailed notes

Title: maybe add ‘in marine sediments’ to end of title, so readers know which environment this is in/about?

Abstract

Line 10: why indroducing local and non-local transport in the abstract when not referring to it any further in the abstract? Instead I suggest to shortly introduce what is meant by tracer peaks as this is something unfamiliar readers might not know about.

Line18: this sounds contradictory to me, as you just stated above that the peaks are not distinguishable. Please clarify what you mean here. I am assuming that when you put your findings into the environmental context of the study area then it becomes apparent that bioturbation is the dominating process generating the tracer peaks, at least in your study area.

Introduction

Overall, I find that the Introduction is lacking flow (paragraphs not well linked) and a clear lead towards the research question and research aim of this study. I think the section would benefit from restructuring the paragraphs and identifying what is important to introduce to readers to understand the topic and what the knowledge gap/research question is. Some aspects currently provided in the Introduction might not be relevant, or at least the relevance is not clear, while some interesting aspects around the tracer peaks and trawling effects come short (especially at line 62).

Line 21-26: I suggest to add that bottom trawling affects ecosystem functions (Epstein et al. 2021)

Line 33-34: What kind of scenarios are presented by Oberle et al. (2016b)?

I cannot see how the second paragraph about difficulties in detecting effects of fishing gear is linked to the research topic of this study. It might help to add a last sentence to that paragraph to show the connection to your research topic about tracer peaks.

Line 39: remove the ‘…’

Line 44: concentration profiles of what and where?

Paragraph 4: Great that tracer distribution and peaks as sign of bioturbation are introduced and explained for less familiar readers. However, I could not quite follow from line 47-51 and how this is relevant. Also the end of the paragraph does not provide a concluding sentence about how this connects to the study focus.

Line 56: ‘.’ after (Aller, 2014) and move sentence of ‘The western Baltic to next paragraph’ because this is a new topic unrelated to bioturbation and tracer peaks.

Line 59: chl-a → Chl-a (as you have introduced the abbreviation). This is the case several times in the manuscript, please correct and make consistent.

Line 61: Peaks of what?

Line 62: *'However, intense trawling raises the question of an alternative origin of the peaks.'* → How so and where is the knowledge gap? Here the Introduction becomes interesting in my opinion.

Paragraph 6: how is this detailed description of A. islandica relevant to your research question?

Line 71: 1999 benthic study → reference missing

Lines72: AFDM abbreviation without explanation (I know what it means, but I am not sure all readers know?)

Materials and methods

Line 81-82: Combine sentences or switch them around, e.g. *We investigated the changes of particle distribution brought about by the mechanic impact of otter trawling. For this, we performed experiments ex situ in a mesocosm mimicking trawl marks to understand the underlying mechanism and in situ by setting trawl marks to provide proof of principle of mechanisms.* (Although this might be repetitive of the last paragraph of the introduction, or could be integrated there).

Line 88: make title 'Ex situ experiment'

Line 93: change to *'from the field site Schnaterman (SM, figure 1)…'* or similar, remove the *'close by?'*

Line 96: is the Corg content relevant? If not, remove, if yes try and provide a value, maybe from previous publications?

Line 106: were controls placed before or after sediment manipulation? I could imagine that the sediment manipulation with the shovel and rake resuspended fine material that may have affected the surrounding surface area from where controls were taken?

Figure 2: A and B not shown in the figure panels, only in the caption

Line 114: make title 'In situ experiment'

Line 119: Can you say anything about how sure you are that the untrawled area that you sampled hasn't been trawled by other fisher boats previously? And if yes, how long before you ran the in situ experiment?

Line 120: *'Five 36 mm inner diameter cores were taken randomly in an area of 1 m² each.*' → of the untrawled area or of the net area of the trawl or both?

Line 134: each 10cm diameter slice was homogenised, right? Slices were not mixed together, I assume.

Line 144: What type of ethanol (quality, purity, manufacturer)?

Line156: Were all models from Soetaert et al. used in your study?

Line 160: Why the grouping and no further interpretation? What is the aim for running this model in your study?

Line 161: remove the ‘&’

Results

Line 166-174: What about the profiles of control, net and furrow from fig 4? They are not mentioned in the text at all but shown in the figure.

Figure 4: Why show shaded area when not relevant for the key results of your study? This raises questions as to what happened there exactly which distracts from your key result in my opinion.

Line 193-201: Are these results (and Table 1) derived from modelling the data? To identify what type transport was present? So you did not use the model to quantify any transport rates? I think this part might need clarification.

Line 195: put ‘net, mounds or furrows’ into brackets, remove the ‘-‘

Table 1: Do I understand correctly that data from Fehmarn Belt are from your study but data from Mecklenburg Bay are from Morys et al.? This is not very clear in caption and table. Also, please clarify that the numbers in the tables depict numbers of profiles.

Figures 4 and 5: Can you please provide figures with a bit higher resolution, so that they are easier to read and features come out more clearly?

Discussion

Overall, paragraphs are really short and not well connected lacking reading flow. Some paragraphs appear puzzled together with random statements that don’t seem connected or where the link to your study results is not apparent.

Subheadings: It would be great if the subheadings already present the key message of the discussion topics, makes it easier for the reader to orientate and grasp the story.

I like the structure of the discussion in Uniqueness, Consequences, Ways to resolve, but the text in these sections does not really relate to the questions that you want to answer (Line 246-247).

Some final concluding thoughts at the end of the discussion would be great.

Line 211-247: I think a lot of this text belongs into the result sections or is repeated from result section and implications of the results are only partly touched upon. I suggest to shorten this text focusing on communcating your key results and conclusion from it and then continue with the following subsections (Uniqueness, Consequences, Ways to resolve) as these are your actual discussion.

Line 215: you mean biogenic?

Line 238: ‘cannot rule out…’ → what implications does this have for your results? Please discuss.

Line250-271 (Uniqueness): This sections has some interesting discussion points but I don't see that the questions of whether *'this problem is unique to our area of investigation in Fehmarn Belt'* is answered.

Line 255: you mean coarse? (found this typo more often, please check and correct)

Line 267: 'Boards and rolls keeping the net gear open.' → I don't understand how this statement is relevant here? This is a good example of a seemingly random sentence, not connected to the content/topic of a paragraph, which happens a lot throughout the manuscript. Please work on the text structure/reading flow.

Line 268: Are you talking about the furrow generated by the trawl here when referring to Morys and Bradshaw? And how is this linked to your results?

Line 270-271: This has been said several times now.

Line 274-294 (Consequences): The authors touch on consequences of bottom trawling in this section, but I thought the question to be answered was what consequences/implications it has that bioturbation-induced peaks and trawl-induced peaks are not distinguishable? I think the latter would be a more suitable discussion topic linked to the research question and key finding of this study.

Line 275-280: This information from Oberle's study needs to be given in the introduction where you refer to it for the first time and on which your study is based on or linked to (if I understood correctly). Then you can refer back to it here in the discussion.

Line 296: Ways to resolve → I read this section in the understanding that this referes to ways to resolve the issue that bioturbation effects and trawl effects can't be distinguished in tracer profile, making their interpretation harder. I like this section and would suggest to elaborate a bit more on why it is important to resolve it and what aspects should be considered in which research contexts. For example, when quantifying and extrapolating bioturbation transport rates based on Chl.a profiles, your results imply that it should be checked whether there is frequent trawling in that area where the extrapolations are done and whether trawling might cause a bias in the bioturbation quantification. I feel, especially in this section, to add a focus on ecological and biogeochemical context (What does this mean?) might work well and shape the manuscript to fit better to the aims and scope of the journal.

Line 297-305: I do not see how this is related to resolving the issue.

Line 307: This is the interesting question for this discussion section, but it needs to be made clear for the reader what the '*issue'* is.

Line 313: 0.1 of what per quarter? Frequency or area?

Line 319-320: Where did you get the probability assumption from or why do you assume this?

Line 333: So the numbers 480 vs 0.4 m^{-2} yr^{-1} reflect transport event per area and time? And what is your conclusion here, how can the issue be resolved?

Literature cited:

Epstein, G., J. J. Middelburg, J. P. Hawkins, C. R. Norris, and C. M. Roberts. 2022. The impact of mobile demersal fishing on carbon storage in seabed sediments. Glob Chang Biol **28**: 2875–2894. doi:10.1111/gcb.16105