Interactive comment on "Impact of bottom trawling on sediment biogeochemistry: a modelling approach" *by* Emil De Borger et al.

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General comments:

De Borger et al. address in this manuscript the potential biogeochemical effects of different bottom trawling gear on different seafloor environments. They assess the effect of bottom trawling in different mineralization pathways through a modelling approach. The paper presents several editing mistakes (reference errors, table not properly ordered), and certain aspects in the methodology should be explained in more detail. Nevertheless, the authors provide novel and sound results of the biogeochemical effects of bottom trawling on the seafloor, revealing that different trawling gear types with different penetration depths have similar effects on sediment biogeochemistry. The

authors highlight that the greatest impact on the seafloor occurs just by trawling once, and that management strategies should be aimed at limiting spatial extension of bottom trawling grounds rather than improving technical configurations on trawling gears.

The following remarks and suggestions should help clarify certain aspects of the manuscript.

Specific comments:

1. How would the results change with bottom trawling gear with even greater penetration on the seabed? For instance, bottom trawl doors can penetrate tens of centimeters deep in the sediment, an order of magnitude greater than those you report in this study for the tickler chain (3.2 cm) and pulse wing (1.6 cm) gear types.

2. Section 2.1.2 Model parametrization explains the different sediment cores collected to conduct the modelling approach. In this section, the authors redirect the reader to unpublished papers (De Borger et al., 2020; Toussaint et al., 2020) for additional information of the sampling procedure. Please refrain from referring to unpublished papers and provide all the necessary information of the sampling technique (e.g. subsampling boxcores, sediment analyses, frequency of analyses?). Similarly, please provide any necessary explanations of the steady state fitting procedure (lines 112-113) that is described in the manuscript that is in-preparation (De Borger et al. 2020). Finally, please correct the sources described in Table 2, and explain how the sinusoidal flux of C illustrated in Figure 3A was obtained.

3. Mortality of benthic fauna affects the biogeochemical modelling approach by reducing bioturbation rates. Please comment and address other aspects of how this higher mortality can affect sediment biogeochemistry. For instance, with fewer benthic fauna, wouldn't that increase the burial of organic matter on the seafloor? Moreover, would the electrodes in pulse gear cause greater mortality of benthic species?

4. You mention how the low permeability of muddy sediments affect mineralization

pathways (line 308). Could you elaborate here the effect on coarser and more permeable sediment?

5. Based on your results, how would bottom trawling affect the composition of OC (labile, semi-labile content of OC?). For instance, in line 210-211, do you mean that trawling increases the relative amount of labile OC?

6. Could you elaborate on how your results differ from those modelled by Duplisea et al. (2001)?

7. Finally, this manuscript would benefit by addressing, based on your results, the effects of bottom trawling in different margins. Moreover, considering that bottom trawling now generally occurs at ∼500 m water depth (Watson and Morato, 2013, Fisheries Research), what would be the biogeochemical impacts of bottom trawling?

Technical corrections:

Line 81-82. Is the incoming flux in all model scenario the same, irrespective of the OM content of the seafloor?

Line 120. Note that you refer to Figure 3 before referring to Figure 2. Please amend this.

Line 135, 137. Provide the definition of mud.

Line 114, 181. Please refer to the tables in order of appearance. Currently in the text, you refer to the tables in the following order of appearance: Table 1, 2, 4, 5, 3. Please change the order of the tables so that they are referred to sequentially.

Line 157. Pitcher et al. (2020) do not talk about the penetration depths of different trawling gear. Where do you get these values?

Line 160; 217. Please correct the missing reference source here.

Line 181-183. Specify that the higher remineralization rates here are due to the higher

organic matter content of these sites (MudH, FineH).

Line 195-196. This sentence refers to both Figure 4 and Figure 5.

Lines 231-240. Refer to Table 7 in the text.

Line 238-239. "Trawling frequencies of 1 – 2 y-1 caused increases in the denitrification for the Coarse sediment, and FineH and MudL". Considering the error, denitrification in these sediment types did not increase in these trawling frequencies, only for the MudH sediment, as you mention later on.

Lines 241-245. Where is the data that illustrates this?

Lines 334-335. Just earlier, you mention increases in denitrification, but here you mention that your results are comparable to those of Ferguson et al. (2020) who observed decreases in denitrification. Please clarify that your results, with the exception of MudH, also present decreases in denitrification.

Line 361. Change "resuspended silt" to "resuspended fine-grained sediment", since both silt and clay can be resuspended and preferentially advected away from bottom trawling grounds (Martin et al., 2014, PLoS ONE). You focus on how this kind of effect varies with different bottom trawling gear types, but could you elaborate on how this would affect sediment biogeochemistry?

Line 367-368. Modify "deep and shallow penetrating gear types", since 3 cm of penetration is not considered to be deep.

Table 2: Please provide definition of the acronyms (MGS, SD.9, SD.1, VFines). Could you also give the proportion of sand (2 mm – 63 μm) content (%)? Provide also the grain size ranges to define the proportion of silt and fine-grained sediment. If fine-grained sediment is consistent with the grain size range of clays (< 4 μm), please consider giving it this terminology.

Figure 3: A. Consider using "Day of year" in the axis title. If this carbon flux consists of

only DIC, why is it applicable to both organic and inorganic fluxes? In lines 119-120 you refer to this figure as the carbon flux. Please provide more information. B. Where did the data from this figure come from? C. According to Eq. 3, biota depletion depends on both penetration depth and sediment grain size, but only penetration depth (which varies with different gear) is shown in this figure. Please include the effect of sediment grain size in this figure, since it is a very important parameter, rather than giving it in Table 3.

Consider converting Tables 5 and 7 as figures, since the changes in terms of frequency, gear type, and sediment type would be more visual.

Figure S1: The fitted red lines for FineL-oxygen, MudH-nitrate are not adjusted to the concentration profiles measured.

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