Response to reviewers

In this document, associate editor and reviewers comments are in black, while our answers are in blue.

Associate editor:

Dear Authors,
Both Reviewers agree that your manuscript requires only minor revisions and that it represents a significant contribution to the field.
You are now invited to upload a revised version of your manuscript incorporating your responses to the Reviewers comments.
Best regards,
Julia Uitz

Thank you very much for handling our manuscript. Please find below a point-by-point response to all comments from both reviewers.

Reviewer 1:

The study by Pinti et al provides a detailed analysis showcasing the importance of fish and other metazoa in the global ocean carbon cycle. This is an important study as it goes beyond just looking at zooplankton to also quantifying contributions of higher trophic levels. The modelling work is also able to capture the diel vertical migrations of different organisms, which is not a trivial process to express computationally. The paper is very well written with clear figures and logical conclusions and is an impressive amount of work. I believe this work will make a valuable contribution to the scientific community. I have very few comments:
Thank you very much for your comment and for taking the time to review our manuscript.

- The authors state in abstract the paper is of global scale, and in the paper acknowledge it does not cover the poles. i think this should be mentionned upfront to make sure readers are aware of this early on. The poles are important in cycling of carbon with large biomasses of metazoa (e.g. Yang et al 2022).
ok. We modified the second sentence of the abstract to "...near-global (global ocean minus coastal areas and high latitudes) carbon fluxes and sequestration by fish and..." (l. 3)

- line 143, do fish ingest zooplankton in the mesopelagic or only at surface? How have you defined strongest trophic coupling?
Fish can ingest zooplankton both in the mesopelagic and at the surface. However, the feeding rates will be very different because of temperature, light and oxygen effects on the different metabolic rates of animals. Strongest coupling simply refers to the largest flow of carbon between two functional groups. We added a reference to figure 1 in that sentence for clarity (now l. 145).

- line 170 - define efficient, what does it mean in this context? Arguable most efficient is from primary production conversion of CO2 to organic matter, and then final sequestration.
We mean that it will be sequestered the longest (i.e. longest residence time scale). We modify "stored more efficiently" to "stored for a longer time" to avoid confusion (now l. 173).

Reviewer 2:

In this work, Pinti et al try to identify taxa and pathways mainly involved in carbon storage using a pelagic food web model. This is an important topic and an excellent scientific work. There is no doubt that this paper will be of strong impact in the scientific community. I especially appreciated that the authors take into account functional groups including jellyfish and the potential impact of bathypelagic fish in the discussion. I also appreciated information provided in the supplementary materials but felt a little bit difficult to read the main paper without the model detailed in the main text.
Thank you very much for your comment and for taking the time to review our manuscript.

Very minor questions/comments:

Is it possible to have more than one Nash equilibrium in this case?
Yes, it is theoretically possible to have several Nash equilibria in this case (depending on initial conditions). We investigated this with a number of different initial conditions, and did not find several equilibria in any of the set ups tested. We will add a comment about this to the section of the SI talking about Nash equilibria (section 1.5).

The comparison with Nowicki publication seems to have a major difference without fish and jellies which can strongly modify the similarities between these works. This is notified but I am not sure if the comparison of figures between these two works is realistic then.
While we agree that both studies are different, the comparison with Nowicki was provided because it is the only other study we know of that estimates the sequestration of carbon mediated by different pathways of the biological carbon pump on a global scale. We can still compare the relative importance of different pathways (eg fecal pellets vs. respiration) with Nowicki's study, as we do in the discussion.

The discussion about how this work could provide baseline for future assessments for fishing (L263 and then 323) is extremely short. In particular, the authors state that the main uncertainty in their work is about mesopelagic fish biomass. This potential bias is taken into account and highlighted at the beginning and in the discussion, and by doing so they highlight the need of a better estimate in biomass. Could you develop a little bit based on your model results what would happen for carbon sequestration if you decrease the biomass by 50% as mentioned from St john2016?
It is a bit hard to predict what will happen to carbon export and sequestration as a harvest rate does not linearly relates to a biomass decrease. However, you are right that our discussion was a bit thin on that topic. We can expend the discussion after l. 323 to talk about the difficulties of relating the harvest rate to carbon export and sequestration: "The exact form of this trade-off is hard to assess, as the rate of biomass harvest cannot be equated to the biomass inventory -- and thus to the export rate and inventory of sequestered DIC. Indeed, if the harvest can be done sustainably and without affecting the total biomass, then it is possible that it has relatively little impact on carbon sequestration" (now l. 325-328).