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This paper helps fill an emerging need: synthesizing what is known from other areas of study (here, ocean acidification) to shed light on the emerging topic of ocean alkalinity enhancement. The authors have done a prodigious amount of work to cull results from the literature that fit into their study parameters. Similar to Ries et al (2009), the paper seeks to identify different calcification responses by taxa when alkalinity is amended. But the synthesis leaves me with more questions than answers, in a way, because the most apt summary of the results is: "it's complicated" (see Fig. 5). Each taxonomic group includes anywhere from 1-5 different types of responses (linear -, linear +, etc.). I'm not particularly surprised by this, though, because since the Ries et al. proposed response curves kicked off this area of inquiry, numerous studies have pointed to metabolic and other complex physiological mechanisms being affected by ocean acidification, and calcification being kind of a metric describing changes in these other mechanisms. In 15 years of study, though, the community still has not really established whether more calcification leads to a biologically "better" outcome-- like greater survival or reproduction, or better quality as a food item for predators etc. So I feel as though calcification can't really be used as an indicator of biological harm/benefit from OAE. I don't agree that "winners and losers" can be identified given all these points.

Response: We thank the reviewer for taking time to act as a public commenter on this. The line of thought is appreciated because it forces us to think more about how to make this work much more applicable, making sure we are addressing the gaps that would prevent the application of current work to the field or experimental settings. We believe that we have provided an added value to our manuscript by broadening the discussion and conducting some additional analyses related to the regulatory settings. We will integrate all the additional comments in the paper upon the next submission.

We only partially agree with the reviewer about calling the study 'complicated', we would rather characterized these responses as 'variable' while also showing the emerging patterns from this study. The steps of grouping the responses into the categories aim towards reducing the complexity and arranging the response into functional categories that are easier to handle. Using the response categorization with the aim of unifying, which was previously done in OA research, we now proposed a similar assessment that could unify different categories of species responses under OAE. Such work essentially leads to recognizing the most pertinent group of negatively impacted species that we are potentially most concerned about with the OAE field applications.

As per calcification response not being a 'good indicator of the OAE harm/benefit', we respectfully disagree with the reviewer. Calcification is a primary pathway of the organismal sensitivity to OA/OAE, which can act as an early warning response, and is directly implicated in growth and (abnormal) development across most of the marine calcifiers. Calcification also underlies the ecological success of numerous marine calcifiers. A large number of studies have strongly proven that OA affects the adaptability, growth or survival of larvae and juvenile economically important mollusks through the process of calcification and related acid-base balance (IPCC WGII, 2022; Vargas et al. 2022). Numerous studies also clearly show that the threshold for calcification occurs at similar pH/ Ω_{ar} values as the

thresholds for metabolic and energy metabolism processes (Lutier et al., 2022; Bednaršek et al., 2019; 2022). Furthermore, the implications of processes, both between and within biological levels are important. Ducker and Falkenberg (2020) recognized the importance the feedbacks moving between biological levels from "higher" to "lower" levels (e.g., compromised immune system affecting metabolic pathways) and within-level feedback cycles (e.g., reduced individual growth affecting energy expenditure affecting reduced individual growth. In the case of our study the changes in the process of calcification and development may subsequently affect metabolic or energetic rates (e.g. Stumpp et al., 2011; Ducker and Falkenberg, 2020). The level of calcification also directly addresses the level of susceptibility to predation, which impacts the mortality at the individual level but then leads to an altered size of the overall population. This summarizes the value of calcification as the proxy towards indicating organismal fitness, and this directly relates back to OAE effects as harmful or beneficial for the species.

We have refrained from labeling positive responders as being 'winners' and negative responders as being 'losers'. Such cautious wording is warranted given the high uncertainty of how the individual responses would play out in ecological interactions. However, we kept 'positive' and 'negative' responders, as this is clearly indicative of the individual responses to the carbonate chemistry change. This has led to the following changes in the title now reading 'Unifying framework for assessing sensitivity of marine calcifiers to ocean alkalinity enhancement categorizes responses and identifies biological thresholds - importance of precautionary principle' and section 4.2 header is: 'Synthesizing biological response under OAE additions identifies positive and negative responders. Discussion on whether positive responders can be considered winners is kept in section 4.5, paragraph 1.

However, there are several points that this dataset and paper make that I wholeheartedly agree with: despite nearly 20 years of biological studies about OA, we don't have a clear idea of what will happen to marine organisms as a result of OAE; it is logical to anticipate there may be threshold responses due to the results of OA studies, and those thresholds may be lower than we had anticipated (also, by analogy, the OA community spent much effort on examining the role of natural and induced variability on OA, and it's reasonable to think variability may affect physiology at the other end of the pH scale also, but that's outside the scope of this study); there could be implications of OAE for the biological carbon pump that deserve more study; and making taxon-wide predictions or even place-based predictions about biological outcomes from OAE is nearly impossible. I would be hard pressed to use the outcomes of this study to identify what an ecological "safe operating space" for OAE experiments would be, as it pools species from many places into broad taxonomic groups and points to 40% of all species in the synthesis having neutral responses.

My recommendations for this paper include: a careful polishing for style and usage, because I saw a number of small errors and awkward phrasings that made the paper a bit harder to read; and revisions that "lean in" to the uncertainty and scatter that the synthesis uncovered. The authors are in a good position to show the magnitude of the challenge to draw comprehensive conclusions at this time from the OA literature regarding biological safety. I think by spending so much effort reporting details like the % of a taxon that had this vs. that response the results may be misinterpreted by people overly optimistic about whether OAE studies can be conducted in a biologically precautionary way. Data limitations and

experimental bounds from the OA literature both mean the existing data compiled probably aren't sufficient to provide community-wide guidance.

Response: The review has not initially been conducted as a handbook for a safe operating space (for this, a lot more biological research needs to happen), but rather to propose the unifying assessment of species responses in three major categories. Such meta-analyses heavily rely on the use of data and knowledge generated during the OA research and allows for making more accurate predictions of biological responses under OAE. Having less uncertainty in the predictions related to OAE is of absolute importance, because of quick, multi-stakeholder (including industrial partners), advancements of the OAE field applications that are not followed quickly enough by the generated understanding of OAE effects from the scientific community.

This analysis helps us quickly recognize where potential concerns and gaps related to OAE implementations are. As such, hard numbers per functional group are less relevant, compared to the idea that OAE implementation would not necessarily mean a positive outcome for all the species. In fact, we strongly emphasized that in 60% of the cases we expect non-neutral responses that could imply some sort of ecological implications and we also caution that even neutral responses need to be tested in the lab to assure their neutrality. As such, we do not believe that our results are represented as overly optimistic, but rather imply a strong precautionary principle.

We were additionally challenged by the reviewer's conclusion of the irrelevance of the paper's results towards the community-wide guidance. As such, we have now added two sections in the body of the manuscript: first, a whole chapter on the efforts to be considered prior to conducting the field work. Second, we conducted further analyses, i.e. a case study that determines the guidance on predicting the suite of biological responses before the OAE field application. We have done this by taking regulatory standards and legislation on pH exceedance in account. We have considered the US Environmental Protection Agency's rule of not exceeding a pH of 9 for waste water entering the coastal ocean (see NPDES manual, 2010) and analyzed which species could be compromised because of added OAE because of the pH threshold exceedance in the relevant space-time exposure. Based on the analyzed calcification at pH, we infer that this pH 9 is not an issue for the positive responders, although it does create the conditions that favor the calcification during the exposure period to exceeding threshold. However, it could, e.g. if the exposure occurred over a duration period that matters for calcification, induce the challenges for the parabolic and negative responders, in particular for a few identified species that could have their calcification reduced, e.g. dinoflagellates (*Prorocentrum, Heterocapsa*) and foraminifera (*Marginopora*). We believe that both of these added components greatly increased the guidance for the community considering OAE field application.