

## ***Interactive comment on “The real limits to marine life: a further critique of the Respiration Index” by B. A. Seibel and J. J. Childress***

**Anonymous Referee #1**

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The analysis presented by Seibel and Childress of the biological relevance of the Respiration Index (RI) hits the nail squarely on its head: biological systems are not irrevocably tied to the type of simple (and, as the authors argue, simplistic) chemical equation given by the RI. The large change in free energy associated with oxidation of reduced carbon compounds (glucose is used as an appropriate example in the analysis presented here) makes the RI approach to predicting limits to marine life misleading and irrelevant. Moreover, as Seibel and Childress document, using almost a century of data on the multi-faceted topic of aerobic respiration, which includes oxygen uptake from the environment, oxygen transport in the extra- and intracellular fluids, and oxygen utilization within the cell, organisms have numerous mechanisms for regulating oxygen acquisition, transport, and utilization. These processes for acquiring, transporting and utilize oxygen may be uncoupled from the level (partial pressure) of carbon dioxide in

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the environment or organism's extra- and intracellular fluids. Aerobic organisms are thus not tied to the constraints suggested by the RI hypothesis. It might be worth adding information on the relative solubilities of oxygen in aqueous and lipid “fluids.” The higher solubility of oxygen in lipids than in aqueous solutions may play an important role in the transport of oxygen to its sites of utilization. Lipids provide a further basis for organisms' ability to avoid being chained to a simple RI-based limitation to aerobic metabolism. Furthermore, as the authors indicate in the concluding section of their analysis, reliance on the RI to predict future effects of climate change may be misleading (I am not sure the word “dangerous” is the best to use here). There seems little doubt that significant biological effects of falling oxygen levels are likely to occur (and may already be occurring, as the Rosa and Seibel papers show) due to climate change. The RI is a poorly suited perspective for predicting and evaluating these effects of falling oxygen. The real-world situation, which involves changes in pH, pCO<sub>2</sub>, and temperature, mandates a more comprehensive analytical approach than allowed by the RI hypothesis. In summary, this succinct analysis of the RI puts the roles of carbon dioxide and oxygen partial pressures into a biologically realistic context, one that can effectively predict and explain mechanistically why variations in oxygen partial pressure, in concert with changes in carbon dioxide partial pressure in some contexts, help to set limits to marine life.

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