Supplementary Material

**Biological responses of sharks to ocean acidification**

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**Meta-analysis methodology**

We searched the literature for studies that investigated the biological effects of ocean acidification (OA; with less than a 0.5-unit reduction in pH [1]) in sharks using ISI Web of Science database (last access September 10, 2016), and the list of publications used in the present study is shown in Table 1. The relevant keywords included sharks, ocean acidification, carbon dioxide, CO2, and pH. Regarding the biological effects, we clustered them into three major categories: survival, physiology, and behavior. It is worth noting that when an experiment reported several response variables within the above-mentioned categories, we only included one response to avoid pseudoreplication [e.g., in the category “physiology”: oxygen consumption (metabolic) rates or ventilation rates, not both]. Some data points were interpolated from figures with graphical software (im2graph).

The OA effect was calculated for each studied variable as the log-transformed response ratio (LnRR) – i.e., the ratio of the mean effect in the OA treatment to the mean effect in a control treatment [2,3]. Then, the overall mean effect was calculated for each response variable by weighing each individual LnRR by the inverse of the sum of its sampling variance and the between experiment variance, and then calculating the weighted mean (results shown in Figure 1). A random effects categorical meta-analysis was also performed on the effect of elevated CO2 at an elevated temperature for each response variable (results shown in Figure 2). Heterogeneity in mean effect sizes was also determined (QT statistic). All analyses were performed using R software – package Metaphor. It is worth noting that since the Q-test has low power, a meta-analysis based on a small number of studies with large within-study variance might yield a non-significant P-value when the variation between studies is great [4,5]. But this is not the case here (see Figs. 1 and 2). Although there are only a few studies, to date, on the effects of OA and sharks, most of them (>80%) were conducted by the authors of this review, using similar experimental designs and response variables, which should reduce among study variation.

References

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