

Dr Spencer Barrett
Editor-in-Chief of *Proceedings B*

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Lysekil, 2022-04-22

Dear Dr Barrett,

Please find attached the original manuscript entitled '*Evaluating drivers of spatiotemporal individual condition of a bottom-associated marine fish*' by Max Lindmark, Sean C. Anderson, Mayya Gogina and Michele Casini. I confirm that the presented material is new and has not been published or submitted for publication elsewhere.

This manuscript, submitted for consideration as a Research article in *Proceedings of the Royal Society B: Biological Sciences*, investigates the drivers of an important body condition trait associated with fitness of organisms. In poor condition, fish grow slower, have higher natural mortality rates, and produce less offspring. Atlantic cod in the Baltic Sea have undergone a major reduction in the average condition since early 1990s. This has been linked to detrimental environmental conditions (declines in sea bottom oxygen concentration), competition, and lack of food, but detailed understanding of responses has been missing.

Here, we evaluate for the first time the ability of several standardized biotic and abiotic covariates on spatial scales ranging from fine to basin scale to explain variation in individual-level condition, using geostatistical models that explicitly account for latent spatial and spatiotemporal processes. Furthermore, we model changes in the spatial distribution of cod to quantify the magnitude of environmental changes cod have experienced in the last 3 decades.

Our results support previous studies in that oxygen is positively and depth at catch is negatively associated with condition. However, by calculating weighted oxygen concentrations using our species distribution model and gridded oxygen predictions, we also show that cod on average have experienced oxygen concentrations above previous estimates and also above proposed thresholds for negative effects on condition. Moreover, trends in experienced oxygen using the weighted approach differ from trends in the environment, which highlights the importance of accounting for the heterogenous distribution of species when estimating environmental conditions of species.

Moreover, biotic and abiotic covariates have relatively small effects compared to latent spatial and spatiotemporal variation. Our novel approach to model individual-level body condition within a spatiotemporal framework reveals persistent low-spots of body condition (in the deep and low-oxygen areas), and that body condition declined in the whole area. This suggests that there are drivers acting at both local and large spatial scales. Collectively, these findings provide new a perspective on the condition variation of organisms across large spatial scales. In the case of fishes, analyses such as these are critical for fisheries management, since condition is a key biological trait affecting mortality and reproductive output.

We are grateful for your consideration of our manuscript, and we look forward to hearing from you.

Yours sincerely,
Max Lindmark