Frontiers in Marine Science

TYPE Editorial
PUBLISHED 11 March 2025
DOI 10.3389/fmars.2025.1579667

Editorial: Food production potential in the changing ocean

Øivind Bergh[1]*, Elisabeth Ytteborg[2] and Lynne Falconer[3]

[1]Institute of Marine Research, Bergen, Norway, [2]Nofima, Tromsø, Norway, [3]Institute of Aquaculture, Faculty of Natural Sciences, University of Stirling, Stirling, United Kingdom

KEYWORDS

aquaculture, climate change, fisheries, marine, seafood

OPEN ACCESS

EDITED AND REVIEWED BY
Stephen J Newman,
Western Australian Fisheries and Marine Research Laboratories, Australia

*CORRESPONDENCE
Øivind Bergh
oeivind.bergh@hi.no

RECEIVED 19 February 2025
ACCEPTED 25 February 2025
PUBLISHED 11 March 2025

CITATION
Bergh Ø, Ytteborg E and Falconer L (2025) Editorial: Food production potential in the changing ocean.
Front. Mar. Sci. 12:1579667.
doi: 10.3389/fmars.2025.1579667

Editorial on the Research Topic
Food production potential in the changing ocean

Ocean and coastal environments are, as with many other environments, vulnerable to climate change (IPCC, 2023). The oceans occupy 70% of the world´s surface, with a vast biomass production potential, but climate stressors affect ecosystem functioning and the health and growth of aquatic organisms. Understanding how climate change will affect marine food production, and possible adaptation strategies is therefore vital. Whereas fisheries yields are stable or declining, aquaculture is believed to play an increasingly more important role in food security, contributing to the supply of high-quality food to meet growing demands in local and regional communities as well as the global population (Aksnes et al., 2017; FAO, 2024). Hence, we must consider how the changing ocean environment supports sustainable food production.

Observational records of ocean heat content show that ocean warming is accelerating (Cheng et al., 2019). Marine heatwaves (MHWs) are anomalous warm seawater events that can substantially affect marine ecosystems (Oliver et al., 2021). The global projections of sea-level rise and coastal flooding show increased levels of vulnerability of many species with these risks increasing as extreme events become more intense (Vousdoukas et al., 2018). However, there are many knowledge gaps regarding climate change impacts on food production, fundamentally because there are many different factors influencing exposure, risk level and adaptation potential (Falconer et al., 2022). Research Topic, like "*Food Production Potential in the Changing Ocean*", are needed to increase the focus and relevance of the topic.

This Research Topic contains seven original research articles and one perspective. Two research articles consider capture fisheries, and the others focus on aquaculture. The studies include a range of experimental, analytical and modelling approaches to address questions aligning to the overall Research Topic.

Demands for increased food production is putting additional pressure on wild populations worldwide, and the overexploitation of fisheries is a major risk. One of the challenges is the multitude of factors that affect population levels, and this Research Topic was investigated by Yulianto et al. Focusing on the blue swimmer crab (*Portunus pelagicus*) in Indonesia, Yulianto et al. combined a range of approaches to assess the sustainability of the fishery and make several recommendations to improve practices through a multi-faceted approach that integrates technology, policy, regulation and monitoring.

In an analysis on fisheries of the Bigeye tuna (*Thunnus obesus*), Ding et al. used predictive models of fish stocks to analyse the effects of climate change on catch. Results revealed relationships between climate factors, in particular El Niño, and the catch of Bigeye tuna. The authors suggest the work could be further expanded with additional data and could contribute to fishery management plans.

In contrast to wild stocks, aquaculture species are held in fixed locations and must be able to tolerate the conditions within their farm environment. Hence, studies that monitor species in a farm setting can help identify conditions that may have an adverse effect. Korus et al. analysed data from bio-loggers implanted in Atlantic salmon (*Salmo salar*) in a commercial fish farm in Canada, to investigate the physiological and behavioural response during two high-temperature events and other production-related factors.

In an experimental study, Le et al. also considered the combination of temperature stress and operational decisions, by studying the effect of feed availability on the growth and nutrient retention of cobia (*Rachycentron canadum*) at higher temperatures. The results show that cobia is sensitive to higher temperatures, and that a lower temperature regime and higher feeding rate resulted in better growth and nutrient retention.

In a modelling study, Stavrakidis-Zachou et al. tested the ability of bioenergetic models to investigate the temperature tolerances of European seabass (*Dicentrarchus labrax*) and meagre (*Argyrosomus regius*), with the wider applicability of the approach also examined in a multi-species comparison. The study demonstrates the value of models investigating thermal tolerance and associated bioenergetic complexities.

In addition to understanding biological impact, models can also be used to investigate how the farming conditions could change, such as increasing temperature and changing salinity. However, farm conditions are influenced by a diverse range of factors, and Falconer et al. use salmon farming locations in Norway to demonstrate the need to consider the local farm-scale context when using climate model projections in aquaculture. The study also presents a new model vetting framework.

The use of future farm-level climate projections to design industry-relevant scientific studies is also highlighted by Ytteborg et al. Ytteborg et al. challenged Atlantic cod (*Gadus morhua*) with higher temperatures, projected to occur within the next 10 – 15 years at a cod farm in Norway. The study revealed the higher temperatures will challenge the health of the cod and reduce resilience to diseases and other production related stressors.

Finally, in their perspective article, Olesen et al. discuss potential innovations in agriculture and aquaculture that could drive a sustainable transformation in European food production through a circular economy approach. The authors suggest more integrated approaches to food production that would reduce greenhouse gas emissions and increase carbon sequestration, emphasising the importance of cross-sectoral approaches and responsible research and innovation.

The wide range of subjects, species, and locations covered by the articles in this Research Topic reflect the complexity of the subject and underscore the major efforts required to secure a sustainable supply of food from the changing ocean. For fisheries, stocks must be managed in a more holistic manner, considering the range of factors, including climate-related variables, that affect stock levels. Such studies can contribute to science-based fisheries management plans. In the case of aquaculture, several studies in this Research Topic show that higher temperatures, individually or in combination with other stressors, have negative effects on growth, stress response and health of the fish species under investigation.

A common theme emerging from this Research Topic is the need for knowledge sharing and co-operation between different disciplines and groups. Researchers, industry and policymakers must build on the science generated through studies to develop evidence-based approaches to accelerate climate action, helping food production sectors to adapt to climate change and implement climate mitigation strategies, with enhanced efforts to reduce emissions.

Author contributions

ØB: Conceptualization, Writing – original draft, Writing – review & editing. EY: Conceptualization, Writing – original draft, Writing – review & editing. LF: Conceptualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research and/or publication of this article. ØB was funded by the OLAMUR project, European Union, Horizon Europe, grant 101094065. EY was funded by Troms and Finnmark County, (TFFK2022-241), LF was funded by a UKRI Future Leaders Fellowship (MR/V021613/1). The views in this paper reflect the views of the the authors only and the funding organisations cannot be held responsible.

Acknowledgments

We would like to thank all the authors, reviewers and editors for their contributions to this Research Topic. We would also like to thank Frontiers for allowing a Research Topic on this urgent and critical matter.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Aksnes, D. L., Holm, P., Bavinck, M., Biermann, F., Donovaro, R., Harvey, P., et al. (2017). *Food from the Oceans - How can more food and biomass be obtained from the oceans in a way that does not deprive future generations of their benefits? Project Report* (Berlin: Science Advice for Policy by European Academies (SAPEA). doi: 10.26356/foodfromtheoceans

Cheng, L., Zhu, J., Abraham, J., Trenberth, K. E., Fasullo, J. T., Zhang, B., et al. (2019). 2018 continues record global ocean warming. *Adv. Atmospheric Sci.* 36, 249–252. doi: 10.1007/s00376-019-8276-x

Falconer, L., Telfer, T. C., Garrett, A., Hermansen, Ø., Mikkelsen, E., Hjøllo, S. S., et al. (2022). Insight into real-world complexities is required to enable effective response from the aquaculture sector to climate change. *PloS Climate* 1, e0000017. doi: 10.1371/journal.pclm.0000017

FAO (2024). *The state of world fisheries and aquaculture - Blue transformation in action* (Rome: Food and Agriculture Organization of the United Nations), 264.

IPCC and Core Writing Team (2023). "Climate change 2023: synthesis report," in *Contribution of working groups I, II and III to the sixth assessment report of the intergovernmental panel on climate change*. Eds. H. Lee and J. Romero (IPCC, Geneva, Switzerland), 184. doi: 10.59327/IPCC/AR6-9789291691647

Oliver, E. C. J., Benthuysen, J. A., Darmaraki, S., Donat, M. G., Hobday, A. J., Holbrook, N. J., et al. (2021). Marine heatwaves. *Annu. Rev. Mar. Sci.* 13, 313–342. doi: 10.1146/annurev-marine-032720-095144

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., Jevrejeva, S., Jackson, L. P., et al. (2018). Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard. *Nat. Commun.* 9, 2360. doi: 10.1038/s41467-018-04692-w1