Interpretation of Ensemble Forecasting Study on the Response of Fish Distribution in the Yellow and Bohai Seas of China to Climate Change

Jinni Wu ✉

Cuixi Academy of Biotechnology, Zhuji, 311800, China

✉ Corresponding author email: 2314548193@qq.com

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Abstract This article provides an academic review of the research titled "Ensemble projections of fish distribution in response to climate changes in the Yellow and Bohai Seas, China" Ensemble prediction of fish distribution in response to climate change in the Yellow and Bohai Seas. In order to determine the geographical distribution pattern and potential suitable habitats for fish in the Yellow and Bohai Seas, this study established a spatial distribution set model for 22 important fish species using 3185 valid distribution records extracted from multiple databases and 9 environmental variables. The research results provide a theoretical basis for predicting climate driven changes in the range of fish activity in one of the most severely affected marine ecosystems in the world, and can be extended to developing climate adaptive management strategies. This review mainly summarizes the main contents and innovations of the study, puts forward academic suggestions for the future research direction of the study, and quantifies the impact of climate change on marine Species distribution.

Keywords Climate change; Fish distribution; Ensemble model

Climate change has become one of the important driving forces that pose the greatest long-term threat to marine ecosystems in this century. The global fishery resources are facing challenges such as overfishing, habitat degradation, and pollution, and the physiological and chemical changes in water conditions further exacerbate this problem. Therefore, studying the impact of climate change on fish resources, especially on fish distribution, is crucial for effective fisheries management. Climate change has a wide and profound impact on the distribution of marine fish. The rise in ocean temperature, the increase in ocean acidification, changes in ocean circulation, and disturbances in marine ecosystems all have direct and indirect impacts on the habitat and survival status of fish. These impacts involve habitat selection, migration patterns, success rate of reproduction, and population size of fish. Understanding these impacts is of great significance for developing effective fisheries management and protection measures, as well as strategies to adapt to climate change. Further research and monitoring will help to better understand the impact of climate change on the distribution of marine fish, and take corresponding management and protection measures to ensure the sustainable use of fish resources and the health of marine ecosystems.

This review interprets the research content and main findings of the article "Ensemble projections of fish distribution in response to climate changes in the Yellow and Bohai Seas, China". This study aims to predict the impact of climate change on the distribution of 22 important fish species in the Yellow Sea and Bohai Sea regions by constructing an integrated model (Figure 1), in order to provide scientific basis and management strategies (Barnett et al., 2019). The research results indicate that climate change has a significant impact on the distribution of fish, and the geographical distribution of fish will undergo significant changes in the future (Albouy et al., 2012). The integrated method of species distribution models (SDMs) was adopted, combining information from multiple models to predict the spatial distribution of 22 important fish species in the Yellow Sea and Bohai Sea regions. This study constructed an integrated model using 3185 valid distribution records and 9 environmental variables from multiple databases. The study evaluated the accuracy of the model and analyzed the main environmental factors affecting fish distribution.
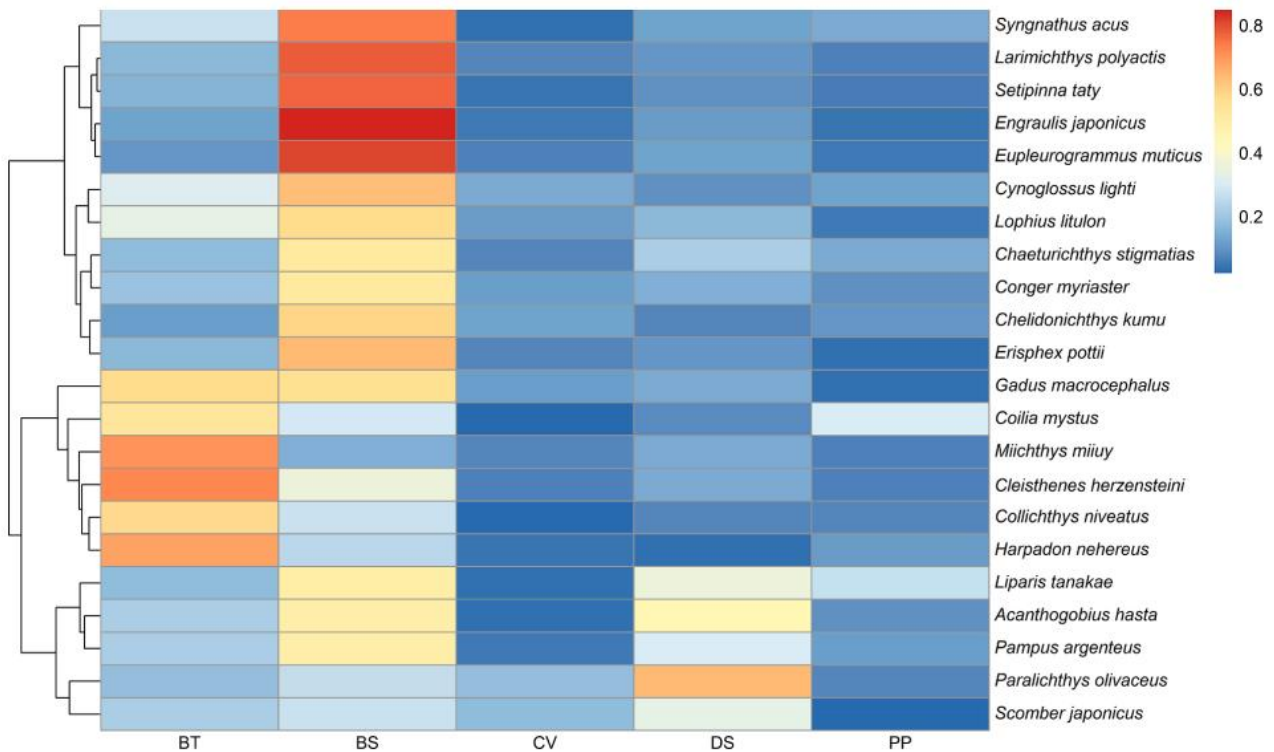
Figure 1 Impact of climate change on the distribution of 22 important fish species in the Yellow and Bohai Sea regions (Chen et al., 2023)

This review will provide a detailed review of the study. Firstly, it outlines the main content of the study, analyzes the innovative points of the study, and the contributions of its research field. Secondly, it provides its own opinions on the research direction of the paper, summarizes the impact of climate change on the distribution of marine fish (taking the Yellow Sea and Bohai Sea of China as an example), and provides comprehensive awareness and understanding for everyone, encouraging individuals to take initiative and actively address global climate challenges, making contributions to the sustainable development of marine life.

1 Overview of Research Content

The research content of this article aims to predict the impact of climate change on fish distribution in the Yellow Sea and Bohai Sea regions of China by constructing an integrated model. To achieve this goal, the research team collected 3 185 effective fish distribution records and 9 environmental variables, and used the integrated method of species distribution models (SDMs) for modeling and prediction. The research results show that the constructed integrated model exhibits high accuracy in predicting fish distribution, with evaluation indicators including average AUC, Kappa, and TSS values of 0.97, 0.82, and 0.84, respectively.

The study also identified the main environmental factors affecting fish distribution, and found that salinity and temperature near the seabed (Figure 2) are important factors affecting fish distribution. At present, the number of important fish species in the Yellow Sea and Bohai Sea is relatively low in the Bohai Sea and relatively high in the Yellow Sea. However, future predictions indicate that with the impact of climate change, the geographical distribution of fish will undergo significant changes. The prediction results indicate that there will be interspecific differences among different fish species, and the number of species with reduced distribution will be greater than that with expanded distribution. The occupied areas of coastal and temperate fish are expected to shrink, while scattered areas in the central and southern Yellow Sea, coastal waters near the Shandong Peninsula, and the northern East China Sea may experience an increase in important fish populations (Allouche et al., 2006).
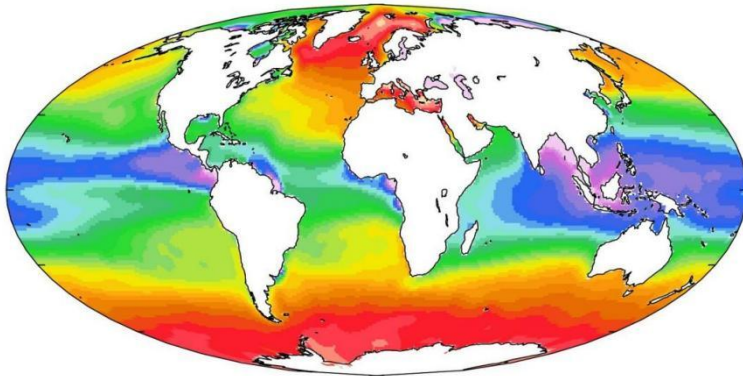
Sea−surface density [kg m^{-3}]

Figure 2 Changes in global marine salinity distribution

2 Innovation Points and Contributions

2.1 Innovations of this study

This study adopted an integrated model approach to predict the response of fish distribution, which is an innovative method that combines the results of multiple models. By integrating multiple models, researchers can obtain more accurate and reliable results in prediction and reduce the limitations of a single model. This study also conducted specific and in-depth research on the Yellow Sea and Bohai Sea regions in China, analyzing the current distribution of fish and considering the impact of multiple environmental factors on fish distribution, including factors such as salinity and seabed temperature. Finally, an integrated model was used to predict future trends. Through these innovations, researchers can gain a more comprehensive understanding of the impact of climate change on fish distribution, which not only provides scientific basis for fisheries management and protection in the region, but also has significant implications for sustainable fisheries management strategies.

2.2 Contributions to the research field

This study proposes an integrated model approach that reveals the impact of climate change on fish distribution through the prediction of integrated models. This method integrates the results of multiple models, improving the accuracy and reliability of predictions. The application of this method has reference significance for other researchers to conduct research in similar fields, providing new methods and foundations for future research. In addition, this provides new insights into the response mechanisms of fish to the environment and provides reference for similar research fields.

3 Subsequent Research Directions

Although this study considered some major environmental factors, there are still other factors that may have an impact on fish distribution. Subsequent research can further explore and consider the impact of more environmental factors, such as water quality, tides, and currents, on the distribution of marine organisms, in order to gain a more comprehensive understanding of the driving factors of fish distribution. In addition, in addition to predicting changes in the spatial distribution of fish, research directions can attempt to predict changes in fish communities (Figure 3). This involves considering the interactions and competition between multiple species, as well as the impact of food chains and ecological networks, which can provide a deeper understanding of the impact of climate change on the entire ecosystem.

This study mainly focuses on the Yellow Sea and Bohai Sea regions in China. In fact, the research scope can be extended to other ocean regions, attempting to improve the accuracy and stability of the integrated model. By introducing more models, improving the algorithm and parameters of the model, and adding more validation data, the adaptability and generalization of the study can be increased, and the differences and commonalities of fish distribution in different regions can be compared. This will help to comprehensively understand the impact of climate change on global fish distribution and provide cross regional management strategies.

Figure 3 Marine fish community

4 Summary

Climate change is an important driving force affecting species distribution, therefore quantifying the impact of climate change on species distribution is necessary for effective fisheries management. The impact of climate change on marine ecosystems has become apparent, including increased seawater temperature and ocean acidification (Clark et al., 2020). Studying the impact of climate change on the distribution of marine fish helps to better understand and respond to the impact of climate change on marine ecosystems and fisheries industries, as well as to protect and manage the sustainability of marine resources. This study provides a scientific basis for formulating relevant policies and management measures, which helps to achieve ecological protection, sustainable development of fisheries, and climate change adaptation.

The research on "Ensemble projections of fish distribution in response to climate changes in the Yellow and Bohai Seas, China" aims to explore the impact of climate change on fish distribution in the Yellow Sea and Bohai Sea areas and predict potential changes in suitable habitats in the future by establishing ensemble models. The article uses 3 185 valid distribution records and 9 environmental variables, and provides valuable information about the spatial distribution of fish through extensive data analysis and model construction.

The research results indicate that climate change has had a significant impact on the distribution of fish in the Yellow Sea and Bohai Sea. The accuracy of the ensemble model is high, and salinity and temperature near the seabed are the main environmental factors affecting the distribution of fish (Du et al., 2021). The research methods include species distribution models and ensemble prediction frameworks, which are widely used in studying the impact of climate change on species distribution. But the article mentions some related research challenges and limitations, and points out the direction of future research. Overall, this article is of great significance for understanding the distribution of fish species in the Yellow Sea and Bohai Sea and their response to climate change, especially in the context of global biodiversity loss. This research is crucial for enhancing understanding of fishery resources and potential marine habitats.

References

Albouy C., Guilhaumon F., Araújo M.B., Mouillot D., and Leprieur F., 2012, Combining projected changes in species richness and composition reveals climate change impacts on coastal Mediterranean fish assemblages, Glob. Chang. Biol, 18(10): 2995-3003.
https://doi.org/10.1111/j.1365-2486.2012.02772.x

Allouche O., Tsoar A., and Kadmon R., 2006, Assessing the accuracy of species distribution models: prevalence, kappa and the true skill statistic (TSS), J. Appl. Ecol, 43(6): 1223-1232.
https://doi.org/10.1111/j.1365-2664.2006.01214.x

Barnett L.A., Jacobsen N.S., Thorson J.T., and Cope J.M., 2019, Realizing the potential of trait-based approaches to advance fisheries science, Fish Fish, 20(5): 1034-1050.
https://doi.org/10.1111/faf.12395

Chen Y.L., Shan X.J., Gorfine H., Dai F.Q., Wu Q., Yang T., Shi Y.Q., and Jin X.S., 2023, Ensemble projections of fish distribution in response to climate changes in the Yellow and Bohai Seas, China, Ecological Indicators, 146: 109759.

https://doi.org/10.1016/j.ecolind.2022.109759

Clark N.J., Kerry J.T., and Fraser C.I., 2020, Rapid winter warming could disrupt coastal marine fish community structure, Nat. Clim. Chang, 10(9): 862-867.

https://doi.org/10.1038/s41558-020-0838-5

Du P.H., Gascuel D., Reygondeau G., Stock C., and Cheung W.W.L., 2021, Climate-induced decrease in biomass flow in marine food webs may severely affect predators and ecosystem production, Glob. Chang. Biol, 27(11): 2608-2622.

https://doi.org/10.1111/gcb.15576