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Evaluating climate change risks to Patagonian and Antarctic toothfish

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Abstract

This paper provides an overview of a new research project to evaluate climate change risks to toothfish in subareas 48.3 and 48.4. The CCAMLR Convention Area is one of the world's most rapidly changing oceanic regions, with major impacts both observed and expected on marine ecosystems due to climate change and consequences for the conservation and management of marine living resources. Focusing on Patagonian and Antarctic toothfish (*Dissostichus eleginoides* and *D. mawsoni*) this project will synthesise and review relevant environmental, biological and fishery information, undertake analyses for an ecological risk assessment of climate change effects on the species, and use this to provide information for decision-makers. Project findings will be submitted to CCAMLR meetings during 2024-25.

Background

The CCAMLR Convention Area is one of the world's most rapidly changing oceanic regions with major impacts both observed and expected on marine ecosystems due to climate change (Chown et al. 2022; IPCC 2022). CCAMLR recognises the need to reduce and manage the effects of climate change within its ecosystem approach to management. Most recently, in 2022, a new Resolution on climate change was adopted (Resolution 36/41) and the Terms of Reference for the scientific Working Groups were re-written such that consideration of the effects of climate change is explicit. However, a gap exists between intention and practical action (Cavanagh et al. 2021).

This project will address the need to integrate climate change considerations into fisheries management with a focus on Patagonian and Antarctic toothfish (*Dissostichus eleginoides* and *D. mawsoni*) in Subareas 48.3 and 48.4.

Longline fisheries for *Dissostichus* species are the primary finfish fisheries in the Convention Area, an area which is currently experiencing unprecedented consequences of global climate change. In this context, understanding potential effects of climate change on these stocks is essential to ensure management strategies can take account of these. Furthermore, climate change risks may be higher for certain stocks and areas than others based on life history and exposure to change.

This project will synthesise relevant environmental, biological and fishery information and use this to undertake a risk assessment of climate-driven change to toothfish populations in Subareas 48.3 and 48.4. Working with stakeholders, we will submit the risk assessment to CCAMLR for consideration in developing management measures, emphasising the need to reduce and manage the risks that climate change presents to toothfish and the wider ecosystem.

Project aims

To evaluate the risks of climate-driven change to toothfish in Subareas 48.3 and 48.4 to inform ecosystem-based fisheries management:

- Establish a knowledge base of relevant environmental biological and fishery information for both species of toothfish and provide a basis for understanding toothfish sensitivity to environmental parameters.
- Undertake an ecological risk assessment of the effects of climate change on toothfish.
- Design a climate change evaluation framework for future toothfish fishery management.

Project methods

Drawing on our experience of the Convention Area as a rapidly changing marine system, and on toothfish as exemplar species, the project will first synthesise existing environmental, biological and fishery information from a range of sources. In June 2023, we held our first project workshop for the team, partners and stakeholders, to identify available information and sources for relevant environmental (e.g., temperature, climate indices), biological (e.g., distribution, life history parameters, physiology) and fishery (e.g., timing, location and management measures) data. We will establish a knowledge base to provide a foundation for understanding the relationships between Patagonian and Antarctic toothfish and environmental parameters. Using the knowledge base we will determine species-environment relationships for both species and, where possible, for different life history stages, providing insights into important determinants of distribution.

We will explore a range of analytical and modelling approaches to statistically explore these relationships and to extend knowledge of the distribution of important areas of suitable habitat (e.g. Freer et al. 2019). Linking these analyses with research into oceanographic retention and connectivity of key life stages (eggs and larvae) will increase understanding of the key drivers of the distribution of both species (e.g. Behrens et al. 2021). Results will be projected under future climate conditions using Coupled Model Intercomparison Project Phase 6 (CMIP6) climate models and Shared Socioeconomic Pathway (SSP) scenarios to assess changes to suitable habitat. This will underpin a risk assessment of climate-driven change to toothfish, based on agreed reference points, and including severity of projected change and certainty across projections, informing decisions, highlighting gaps and guiding future work.

We will develop a preliminary climate change evaluation framework for toothfish, encompassing data acquisition, methodology, analyses and results, through to management recommendations. A second workshop will be convened in 2024/25 to discuss and refine this. This will include evaluating current management, including reviewing how/if existing management measures account for climate change and considering options for reducing risk.

Project outcomes

- A comprehensive knowledge base synthesising relevant environmental, biological and fishery information for toothfish.

In the short-term this resource will be the foundation of the project, facilitating analyses on the relationships between toothfish and environmental parameters, and will also be of value for related

research on toothfish. In addition, much of the information will be useful for similar studies on other species in the region and beyond.

- Evaluation of risks of climate change impacts to populations of both species of toothfish.

This information will be valuable in informing the development of any necessary actions to reduce and manage these potential risks. The risk assessment will be submitted to CCAMLR for consideration in developing management measures, and will also feed into Intergovernmental Panel on Climate Change (IPCC) assessments via peer-reviewed published papers from the project, providing a baseline for future analyses.

- Climate change evaluation framework for the toothfish populations in Subareas 48.3 and 48.4.

The climate change evaluation framework will inform the development of climate response options for ecosystem-based management of toothfish fisheries. Although focussed on Subareas 48.3 and 48.4, the outcomes could also be relevant to other CCAMLR toothfish fisheries. Project findings will be presented at CCAMLR meetings in 2024-25.

Please contact the authors if you would like to know more about the project and/or are interested in becoming involved.

Acknowledgements

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