Theme Session P Report 2024

Climate impacts and adaptation responses in marine fishery systems

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Session synopsis

Climate change is having profound impacts on marine ecosystems and fisheries through ocean warming, marine heatwaves, ocean acidification, increasing storminess, sea level rise, and other effects. As climate change permeates marine ecosystems and extends into fisheries, fishing industry participants, communities, and management systems are adapting to changes in species availability, fishing conditions, and shoreside infrastructure. While climate adaptation is ongoing in fisheries around the world, adaptation approaches have not been broadly characterised. This theme session aimed at building an understanding of the nature of climate change impacts on marine fisheries, and the specificities of the climate adaptation responses from fisheries, communities, and management bodies.

Theme session P received 40 submissions, 36 for oral presentation and 4 for poster presentation. Overall, the contributions received met the expectations set by the theme session aims. After selection, 21 oral presentations and 12 posters were presented during the 2024 ICES ASC. The contributions fell loosely into four categories: (i) nature of climate change impacts, (ii) examples of climate adaptation to address those impacts, (iii) managerial consequences of climate impacts, and (iv) socio-economic implications of climate impacts on fisheries.

Contributions on the nature of climate change impacts covered both regional and large areas, with many focusing on distribution and taxonomic changes at the community scale, although a few documented growth and mortality changes. These studies documented large scale changes in fish communities' distribution, functional biodiversity, and species composition driven by rising temperatures, both in European waters and in the Northeast US. These large-scale changes often resulted in topicalization or deborealisation of fish communities, with ecosystem implications such as loss of thermal refugia. Studies exploring climate-induced changes in growth highlighted temperature-driven spatio-temporal changes in fish growth observed throughout European waters in southern (Mediterranean Sea), mid-range (Celtic Sea), and northern (Baltic Sea) latitudes, as well as in the northwestern Atlantic. These studies documented temperature-induced changes in maximum body length, age at maturation, and mortality, but with discrepancies regarding the direction depending on species and location.

Examples of adaptation spanned a wide range of topics including monitoring, modelling, and community actions. Contributions showed examples of how long-term monitoring data are being summarised into ecological indictors to inform managers on the state of ecosystems and allow for identifying possible climate-induced vulnerabilities. Several presentations demonstrated how climate change is being considered in a variety of models. Examples showed how single-species stock assessment models are being adapted to include environmental covariates and to evaluate and develop climate-resilient Harvest Control Rules (HCR), as well as the challenges of such approaches. Other model advances included using climate and prey fields to predict high productivity areas of small pelagic fish, using environmental models to assess the influence of abiotic factors like temperature and wind on catch composition, and using artificial intelligence to train deep learning models to predict future catch potential based on projected environmental variables, which can inform the development of sustainable management strategies. Contributions on how to utilise inputs from the fishing industry included an example of how the end-to-end ecosystem model Atlantis can be used to simulate adaptation strategies gathered from fisher interviews and assess their impacts and feasibility.

Other contributions showcased adaptation efforts that extend into the broader fisheries sector and fishing communities. One presentation characterized climate adaptation strategies that are being employed or considered by fishery participants, industry businesses, fishing communities, and management system in the Northeast U.S. Further, two examples of climate change impact assessments were presented in both data-rich developed nations (UK) and data-poor emerging ones (Sri Lanka). These impacts assessment demonstrated how information from a wide variety of sources and on multiple topics can be summarised to identify and rank the main threats and opportunities from climate change, providing a useful tool for managers to plan future adaptation.

Two contributions also featured examples of managerial consequences of climate change impacts for which adaptation will be needed but will likely prove challenging. The first example used game theory to investigate the consequences of fish stocks shifting their distribution across management boundaries and concluded that if species' range shifts happen rapidly, transboundary sharing agreements between neighbouring countries are at risk of collapsing. The second summarised the growing competition for maritime space between existing fisheries, and offshore wind farms which are rapidly expanding in an effort to curb carbon emissions. This example highlighted the ongoing challenges facing coexistence between maritime space users.

The socio-economic consequences of climate change impacts on fisheries, and in particular, the capacity of adaptation from fishing communities, were well documented in our theme session. Contributions highlighted that not all fishing communities are equal in facing climate change, with small scale fishers (SSFs) and artisanal fisheries being particularly vulnerable to climate change, due in part to lack of resources and possibility to relocate. One example in the Mediterranean Sea depicted the decline in SSFs' diversification tactics and loss of climate resilience, which highlights the need for strategy diversification that anticipates new adaptive opportunities to face climate and biodiversity-loss risks preventing maladaptation. Another example presented a framework based on existing climate adaptation actions for SSFs, that classifies the adaptation strategies according to five categories: Institutional, Communication, Livelihood, Risk Resilience, and Science; and applied it to a case study of small-scale octopus fishers in Mexico. This example highlighted a general lack of research focusing on the equity implications of current governance structures. Lastly, one contribution investigated the impact of gender on climate change adaptation. This example documented fisheries in Maine where men and women's roles in fishing communities often differ, yet gender is rarely considered when developing adaptation strategies which can lead to inequalities and maladaptation. Accounting for gender can help design more equitable adaptation in fisheries-based food systems.

Conclusion

Contributions to this session demonstrated that impacts of climate change on species distributions, ecological communities, and biological processes such as growth and mortality are being observed across the North Atlantic. Adaptation efforts are emerging at multiple levels, from individual harvesters adjusting their fishing behaviours to scientists adapting modelling approaches and developing new information products to account for climate change in decision-making. It is likely that a combination of adaptation approaches by multiple types of actors at different levels will be needed for climate-resilient fisheries, and there is no 'one-size-fits-all' tool. Managerial consequences of climate change are already emerging in terms of conflicts between stakeholders, and these are likely to become more frequent and complex. Socio-economic consequences of climate change in fishing communities were well documented and showed that small-scale and artisanal fisheries are particularly at risk from climate change. Failure to consider gender aspects of fisheries may limit the ability to properly assess and manage risk in ways that recognize differential effects to distinct groups of fishery participants. Understanding how climate change impacts and adaptation responses will affect ecosystem dynamics, fisheries productivity and management, and social and economic

outcomes for individuals and communities are relevant to multiple themes in the ICES Science Plan. Further efforts to document both climate impacts and adaptation efforts, understand feedbacks between them, and evaluate the effectiveness of adaptation measures will be critical future science advances.