ARCtic Marine Resources and Climate Change: Environmental, Socio-Economic Perspectives and Governance

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Project aims

Climate change puts natural, social, and commercial structures in the Arctic under pressure. We aim to provide an analysis of physical and biological changes, economic analysis of fisheries agreements subject to these changes, and an analysis of governance and legal frameworks. ARC-Change will provide a model for cross- and interdisciplinary research involving scientists from physics, biology, economics, political science and law. The project will contribute to a synthesized and integrated understanding of opportunities and challenges in a changing Arctic and the development of robust governance and legal frameworks.

Project structure

WP1: effects of climate change on the physical and biological environment with focus on aspects relevant for economic activities

WP2: analysis of economic and socio-economic consequences of environmental changes for fisheries and international fisheries management

WP3: analysis of resource governance institutions and law on national and international level in a changing Arctic

Approach in WP1

- focus on commercially important species (e.g. North Atlantic cod, capelin, haddock, herring)
- use of existing observations and literature to assess relevant ranges of variables for fish distribution at different life stages (e.g. spawning vs feeding sites)
- downscaled climate model scenarios to analyse shifts in potential spawning, recruitment and feeding areas
- assess the consequences of spatial shifts e.g. regarding larval drift, connectivity between different regions
- assess ecosystem impact using a ecosystem model
- further method development

Approach in WP2

- quantitative and qualitative assessments of the viability of profitable fisheries in the Arctic and sub-Arctic
- use of profitability surveys (Norwegian Directorate of Fisheries) for information on landing & price of fish, vessel characteristics, expenditure (fuel & labour)
- econometric modelling: how do shocks to environmental and economic parameters impact the ecosystem?
➡ integrated economic analysis of ecosystem production, interaction and fisheries behaviour
- game theory approach towards existing and potential agreements over shared fisheries resources in the Arctic/sub-Arctic
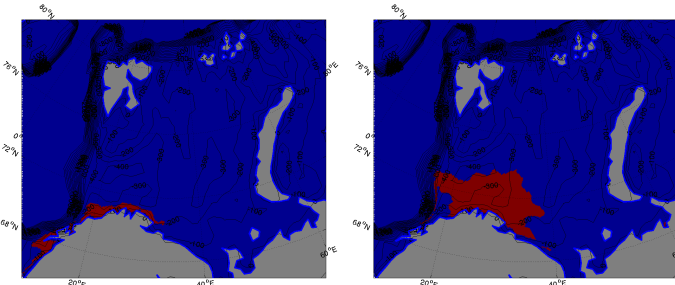
Preliminary results

Fig. 1: Potential spawning areas for North Atlantic cod shown in red during 2010-2019 (left) and 2060-2069 (right).
Criteria used: $4 < T < 6$ and $34 < S < 34.8$ in 150 m depth.

Habitat preferences for North Atlantic cod along the Norwegian coast during spawning (Brander, 2005):
- time of year: Feb-May, with main period end of March/early April
- depth: 60-150 m
- water temperature: 4-6 degree C
- preferrably between upper, cool, fresh coastal water and warmer, more saline Atlantic Water & close to the sea floor
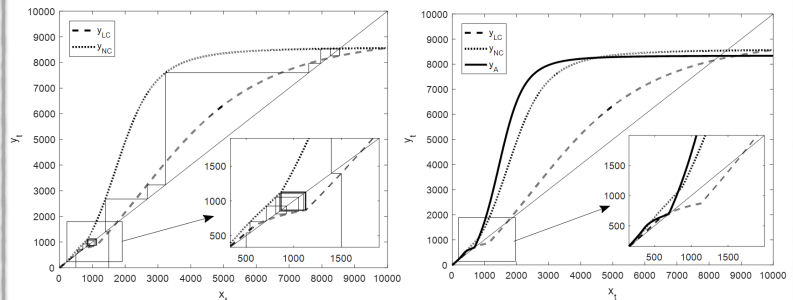
Preliminary results

Fig. 2: Influence of seasonal variations (e.g. in price, expenditure, technology, biological productivity, ...) on the optimal escapement in a fishery scenario with two seasons (winter/summer).
x_t = biomass; y_t = optimal escapement; y_{LC} = management rules for the low-cost season; y_{NC} = rules for normal costs; y_A = annual management rules, i.e. no seasonal variations

Arctic fisheries have strong seasonal variations, and as part of WP2, we develop methods for rigorous treatment of seasonality in fisheries management. The method allows for seasonal effects in prices, expenditures, gear use, biological or environmental conditions. Preliminary results show significant effects on optimal escapement rules from seasonal variations and suggests that management regulations that ignore these variations may turn out detrimental for management objectives.

References
Brander (2005): Spawning and life history information for North Atlantic cod stocks. ICES Cooperative Research Report No. 274, 152pp.

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