Evolution of Northeast Arctic cod (*Gadus morhua*) in response to concurrent fisheries and climate stressors.

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Currently looking for Post-doc opportunities!

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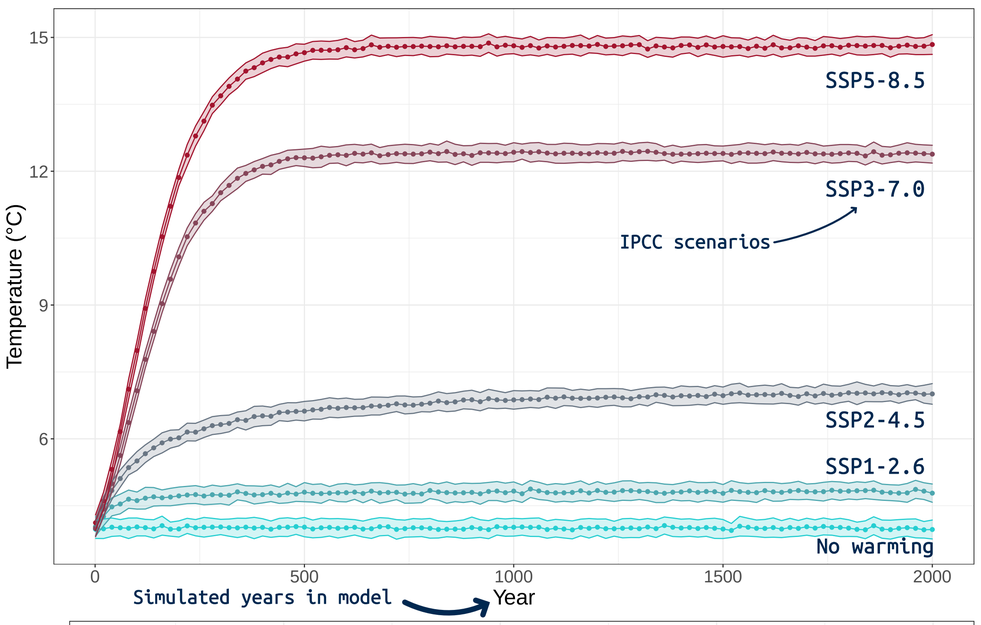
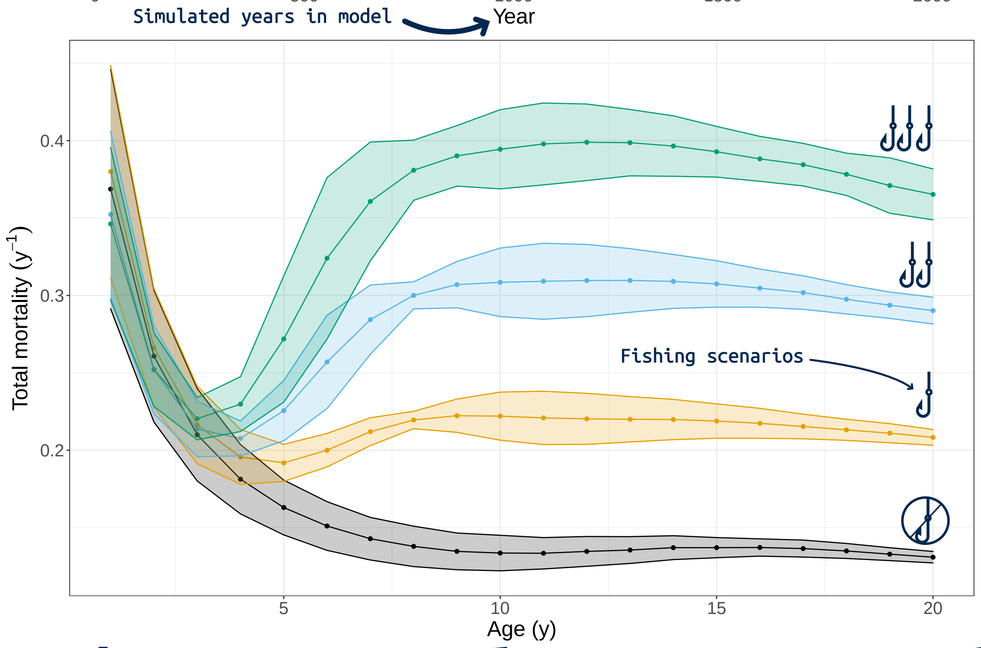




Fisheries and climate warming are both well studied stressors of fish, with the potential to cause evolution for faster pace of life (*e.g. Enberg et al. 2009; Holt and Jørgensen 2014*), though temperature response in Arctic species may differ from the global average.

Northeast Arctic Cod (NEAC) is a population of Atlantic cod (*Gadus morhua*) that inhabits the Barents Sea, representing the lower thermal range limit of this species.

Using various levels of climate warming and fishing intensity as input, we tested the evolutionary response of NEAC using an Individual-Based Model.

Preliminary results (below) supports previous studies finding that increased fishing leads to faster pace-of-life, but builds on this by showing that, for a species in the colder end of their thermal range, warming temperatures can potentially mitigate the effects of fishing.

Modelling process overview

Input

Individuals acquire energy, and will differ in maturation schedule.

-Some will mature early, sacrificing growth.

- Some will delay maturation and mature at larger sizes

Fishing disproportionately targets larger fish. This incentivises early maturation, as backloading reproduction becomes less profitable

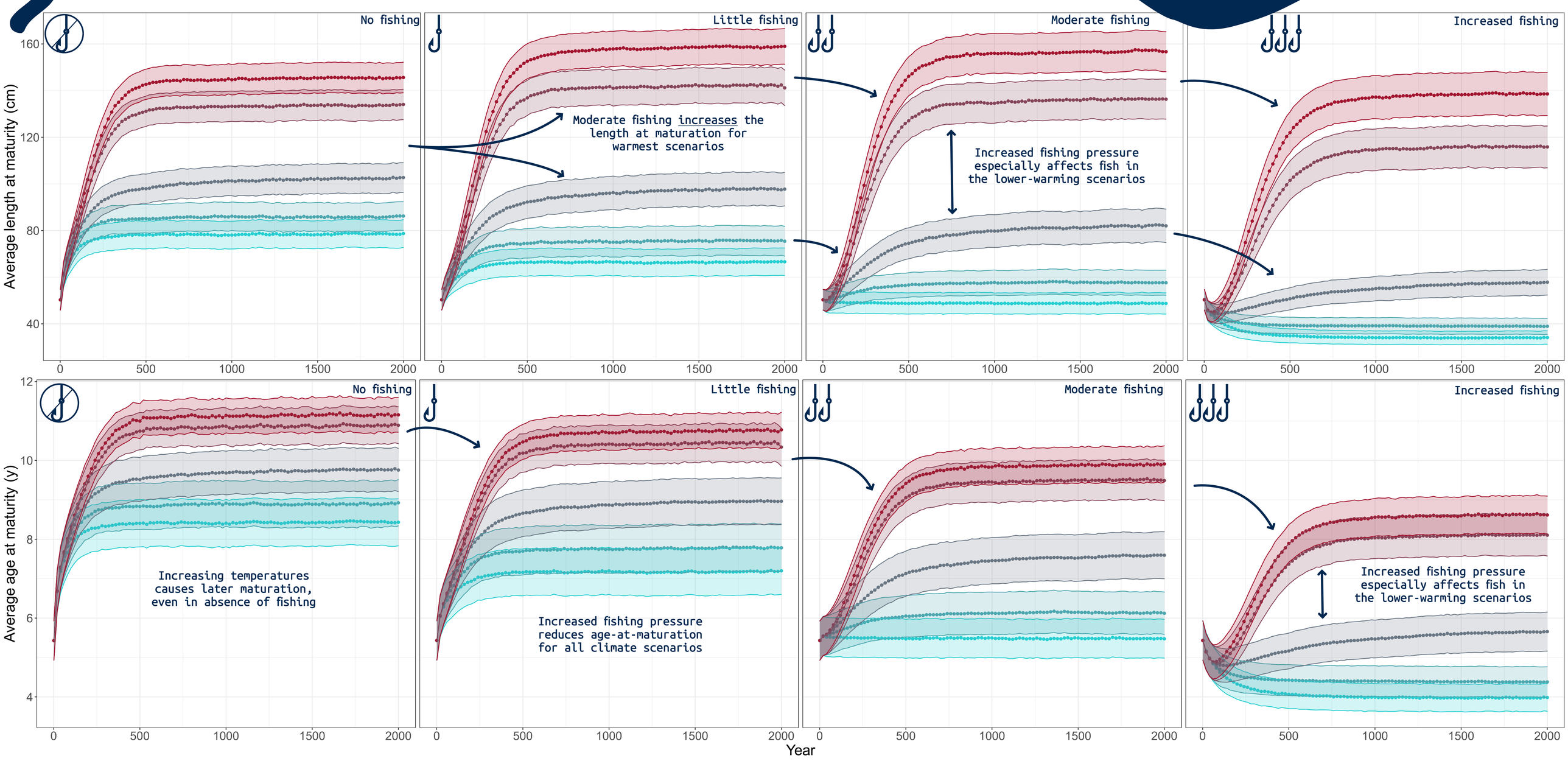
Higher temperatures reduces stress, lowering mortality (not shown). This reduces incentive for early maturation

Natural mortality is especially high for small individuals, and larger individuals have higher relative fecundity; growing large fast is a good idea!

Fisheries mortality is especially high for larger individuals, and delaying maturation too much might result in no offspring at all; growling large fast might not be a good idea!

Individuals who strike the right balance between delaying maturation and reproductive success produce more offspring carrying their traits.

As a result, the model mimics natural selection, and optimal trait combinations gradually become population norms over time, leading to the life-histories shown in the plots below."



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Enberg, K., Jørgensen, C., Dunlop, E. S., Heino, M., & Dieckmann, U. (2009). Implications of fisheries-induced evolution for stock rebuilding and recovery. *Evolutionary Applications*, *2*(3), 394–414. https://doi.org/10.1111/j.1752-4571.2009. 00077.x

Holt, R. E., & Jørgensen, C. (2014). Climate warming causes life-history evolution in a model for atlantic cod (*Gadus morhua*). *Conservation Physiology*, *2*(1), 1–16. https://doi.org/10.1093/conphys/cou050