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Implications of fisheries-induced evolution for stock rebuilding and recovery

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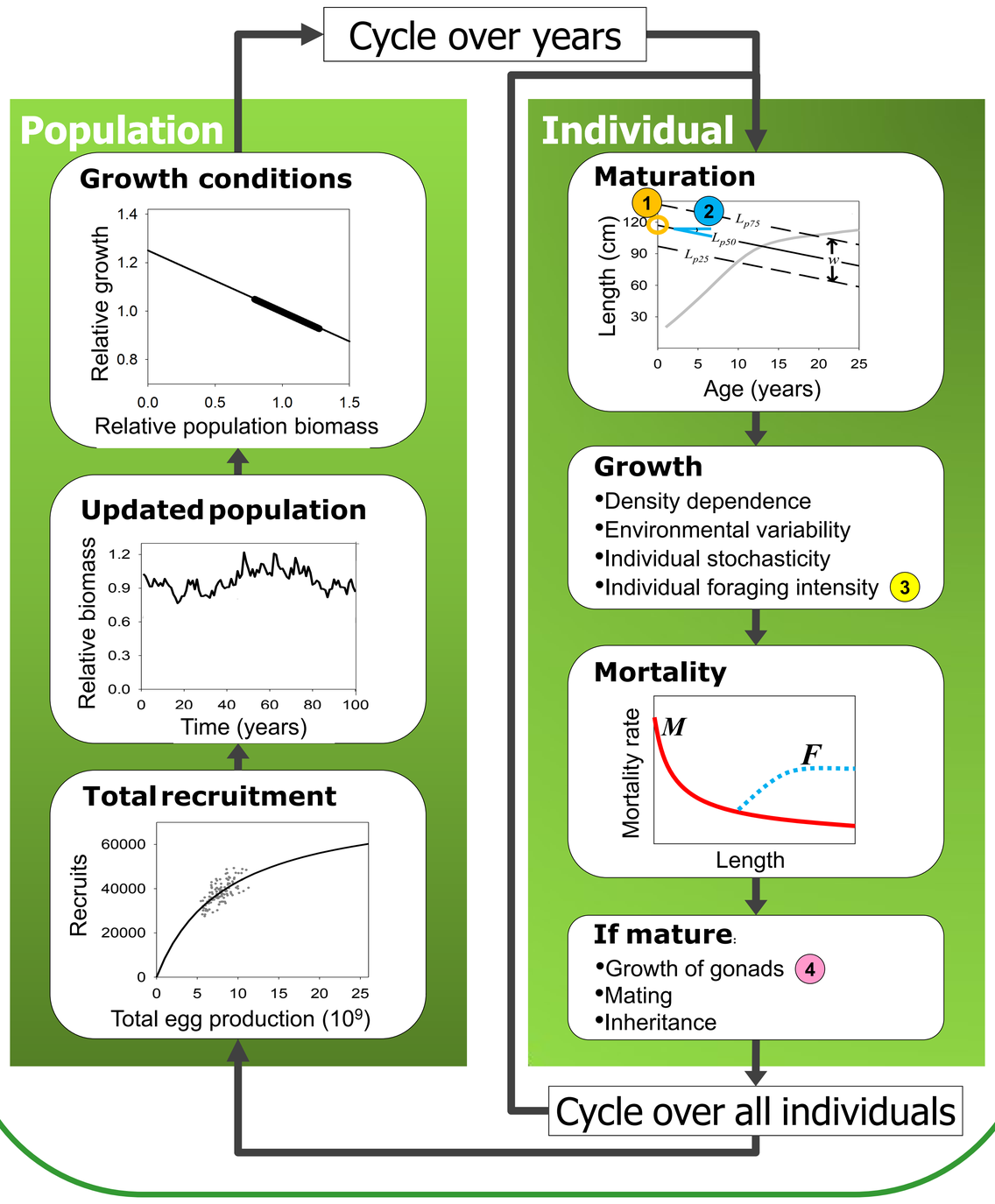
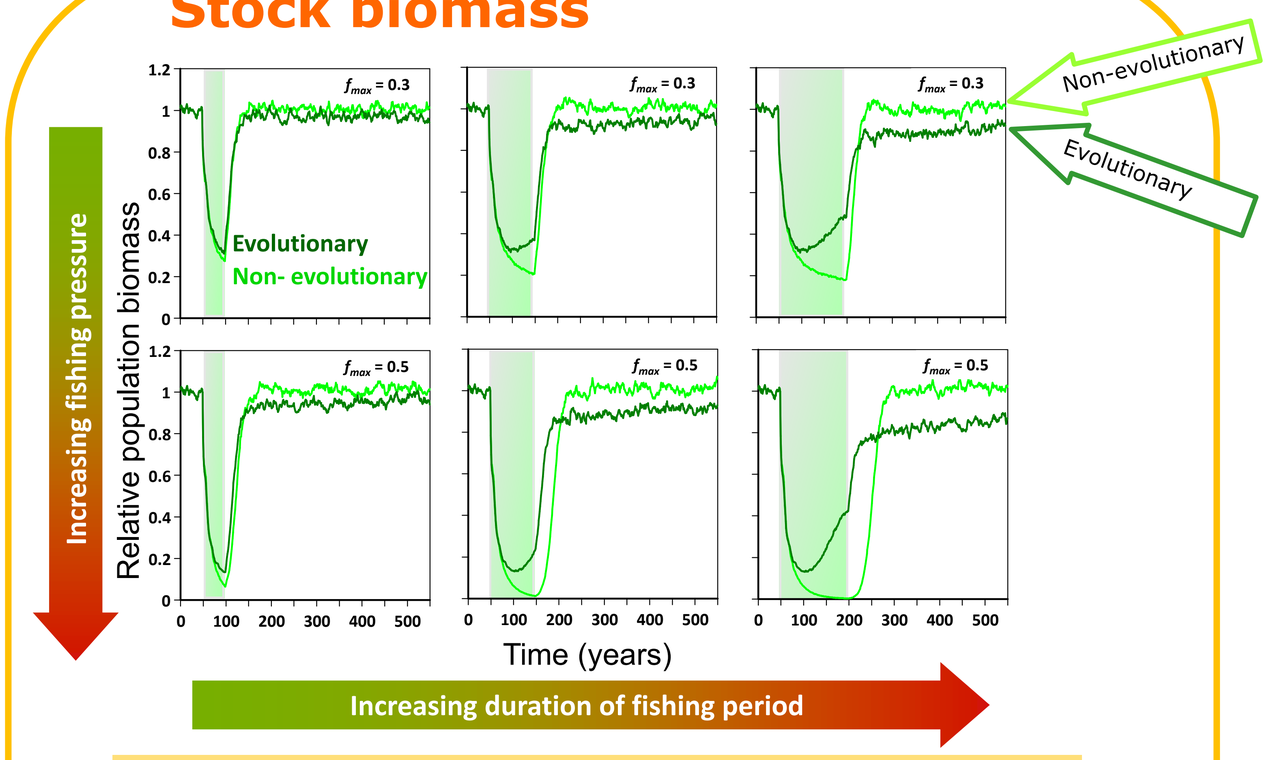
Fishing-induced evolution has the potential to change life-history and other characters of exploited stocks. Here we study the rebuilding and recovery of an exploited stock with en individual-based eco-genetic model parameterized for Atlantic cod. The short term (<20 years) rebuilding of stock biomass was only little affected by fishing-induced evolution. However, the evolving stock recovered to a new demographic equilibrium below the pre-harvest levels, and recovery to pre-harvest levels took thousands of years. These results exemplify the need for proactive management of fishing-induced evolution, as restoration of genetic traits is slow, or may even be impractical.

Model

We use an individual-based model with four evolving life history traits: **1)** intercept of the probabilistic maturation reaction norm (PMRN), **2)** slope of the PMRN, **3)** growth, and **4)** GSI. The model cycle is illustrated in figure below. The model can also be used as non-evolving by 'switching off' evolution. Natural mortality is size-dependent and fishing mortality follows sigmoidal trawl type selectivity with a minimum size limit.

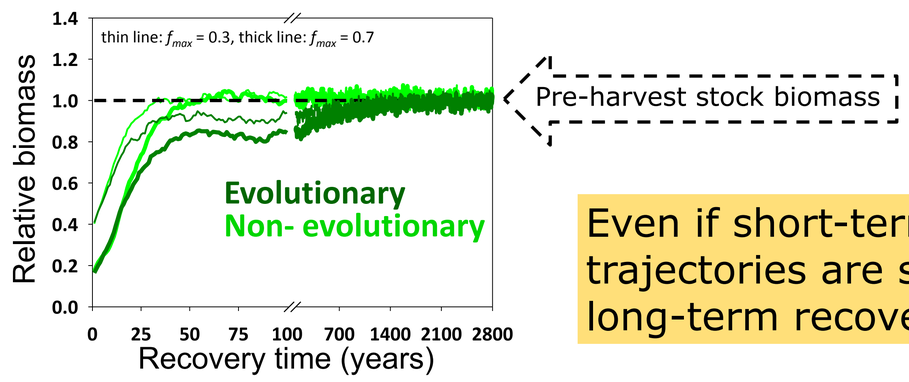


Stock biomass



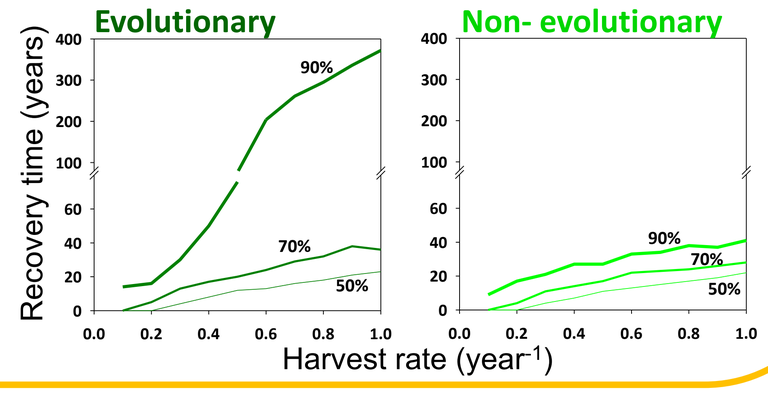
- Increasing harvest pressure and duration increased the difference between evolutionary and non-evolutionary populations
- Because of fisheries-induced evolution, the stock can tolerate a higher fishing pressure

Recovery of stock biomass



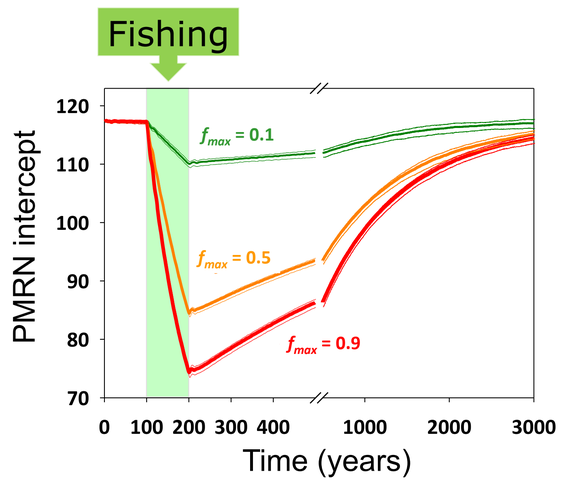
Even if short-term recovery trajectories are similar, long-term recovery is not

Recovery to a given % of pre-harvest stock biomass after 100 years of fishing



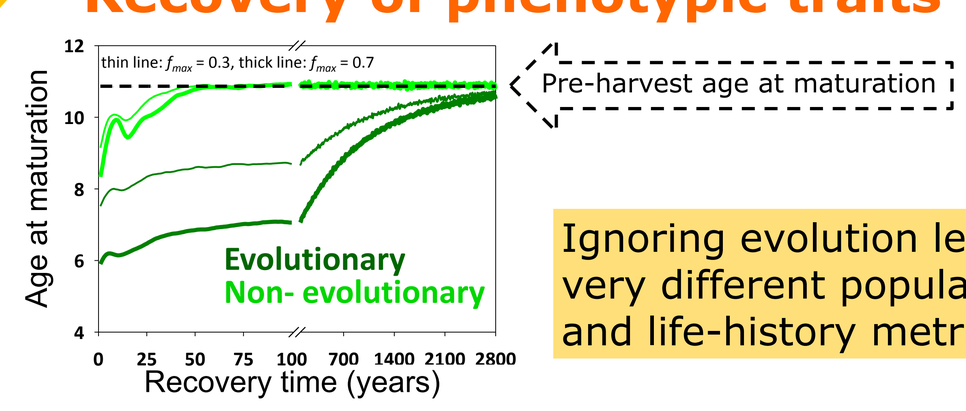
Results

Genotypic changes



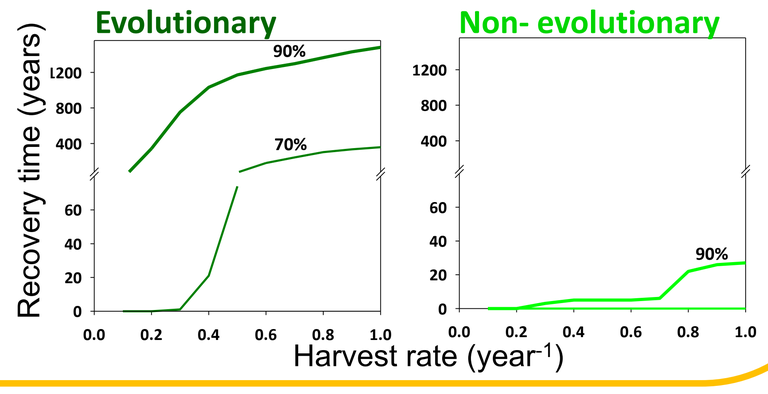
Rate of evolution faster during the fishing period than during the recovery period
→ Recovery of genetic traits very slow

Recovery of phenotypic traits



Ignoring evolution leads to very different population and life-history metrics

Recovery to a given % of pre-harvest age at maturation after 100 years of fishing



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