Impact of fishing, climate and Allee effect on the collapse and recovery of cod

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Atlantic cod (*Gadus morhua*), a top-predator, key species of the North Atlantic ecosystem and one of the most commercially valuable fish, shows highly contrasting stock states, raising the central question: **What causes some cod stocks to collapse whereas others are resilient?**

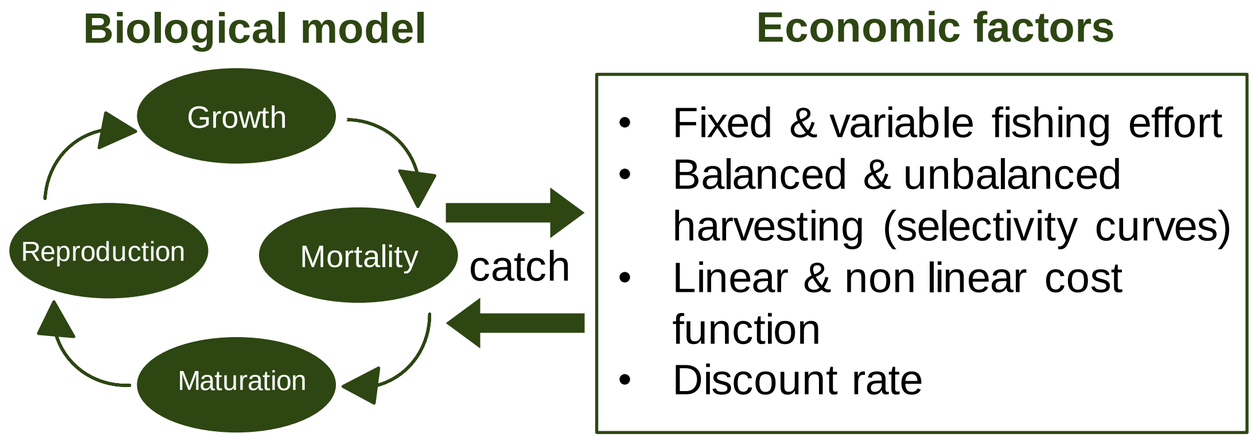
Research questions

What is the relative importance of fishing, climate and Allee effect on the collapse and recovery of cod?

- Does unbalanced harvesting make the population more vulnerable? (fig. 1)
- Are economic drivers or climatic effects more important when pushing a fish stock into collapse?
- How do several drivers (climate, Allee effect, unregulated fishing) act in concert? (fig. 2)
- How does an Allee effect impact open access dynamics?

Approach

We contrast a managed fishery with an open access fishery. A generic, age-structured matrix population model is built, parameterized with ICES Atlantic cod data. TBD: Degree of model generality, population parameters indicative for stock collapse and persistence.



Background: The collapse of Atlantic cod stocks have been mainly linked to **overfishing** and **climate**-induced environmental changes (Drinkwater, 2005). **Allee effects,** the positive relation between population size and per capita growth rate, have been shown to slow down and increase variability of Atlantic cod recovery (Kuparinen *et. al*, 2014). However, these stressors are often analysed in isolation and, in addition, largely separate from socio-economic factors.
Considering both biological and **socio-economic factors** is necessary to understand how a fishery will likely develop given the interdependent changes in fleet and fish stock. For example, a fishery that is left to its own without any harvesting restrictions will increase harvesting effort until all its profits dissipate (**open access**). There is no incentive to conserve the resource (infinite **discount rate**), which can cause severe stock depletion. In order to establish successful fisheries management and stock rebuilding strategies, it is important to understand how different environmental and economic drivers interact and impact fish stock resilience.

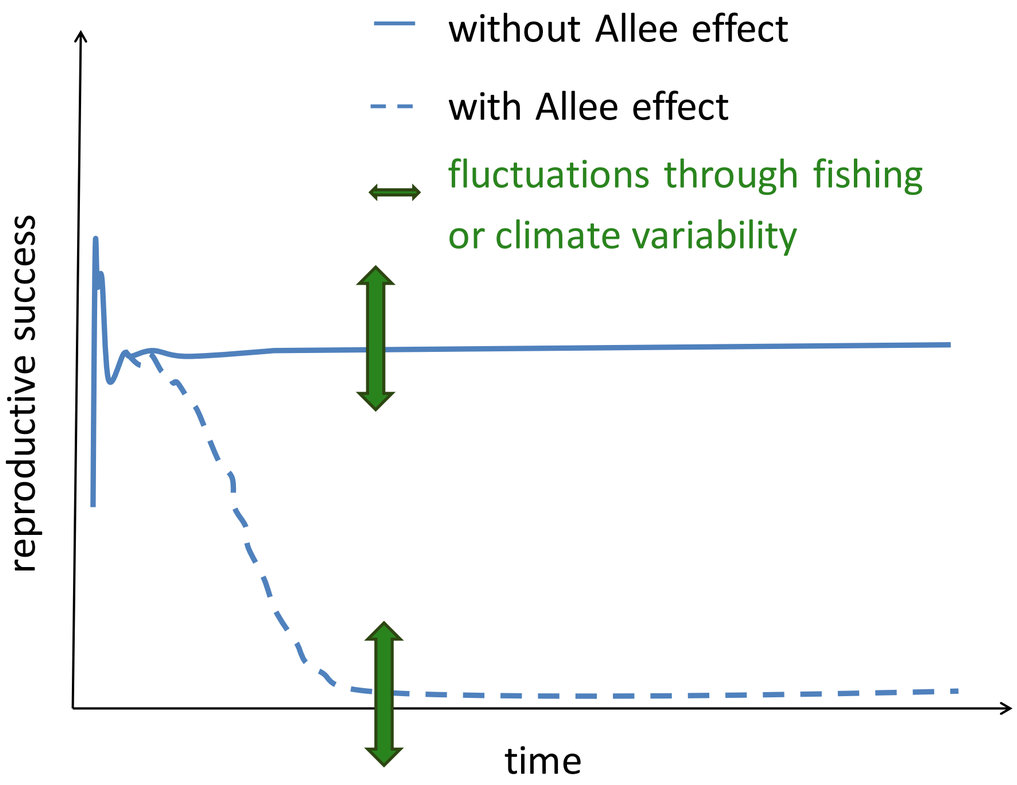


Fig. 1: Reproductive success (recruits/spawner) over time. Increasing fishing and climate variability is expected to increase the risk of the population falling below an Allee effect threshold.

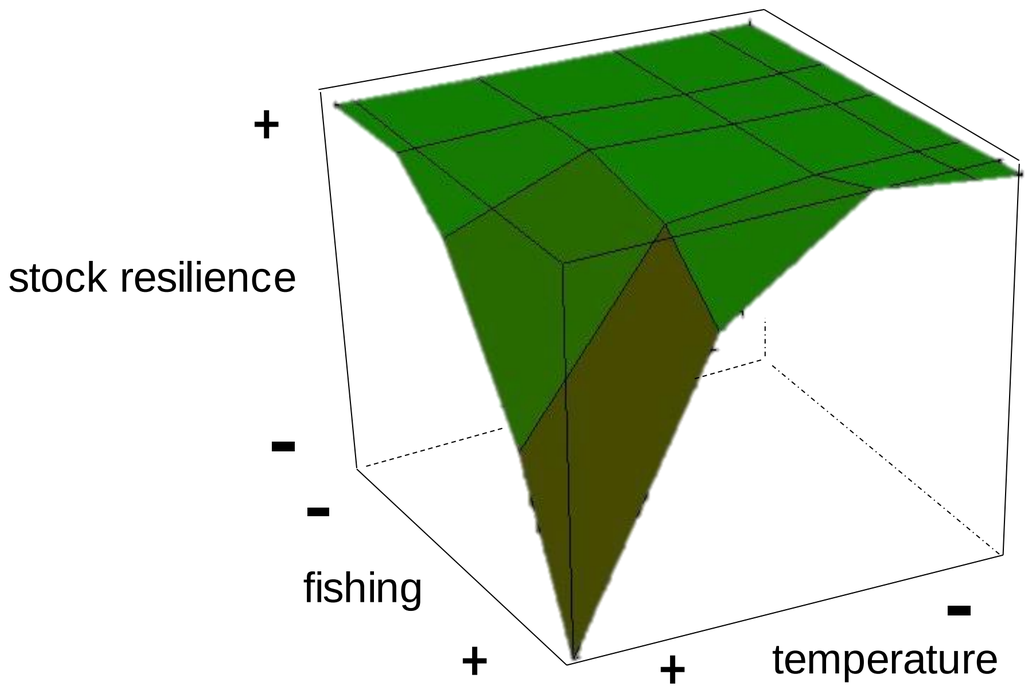


Fig. 2: Conceptual figure showing how fishing and climate may effect stock persistence, with minus sympol indicating a decrease and plus sympol indicating an increase.

Literature cited: Drinkwater, 2005, ICES Journal of Marine Science, 62, 1327–1337, Kuparinen *et. al*, 2014, Conservation Biology 28: 790-798