# Math model suggests fishing out older members may destroy collective fish school memory

March 19 2014, by Bob Yirka

A school of sardines in Italy. Credit: Wikimedia / Alessandro Duci

(Phys.org) —A team of researchers from Denmark and Italy has created a mathematical model that suggests that if older members of a school of fish are removed, the school may no longer be able to find its way to

migration targets. In their paper published in *Journal of the Royal Society: Interface*, the researchers describe how they created a model based on stochastic networks and how it revealed that older members in a school of fish may hold the information necessary for the school to find its way to migration areas.

Stochastic adaptive networks are networks that behave according to the whims of its individual members. In this new effort, the researchers applied lessons learned in the past regarding such networks to schools of fish. They did so by programming in three major factors of fish swimming in schools: the relative strength of linking interactions between individual fish, the percentage of older fish relative to those that were younger, and how strong a preference the older fish had for particular migratory destinations. By adjusting the constraints, the researchers were able to see which factors were most critical in allowing or preventing a particular school from functioning as a viable unit, and most specifically, whether they were able to migrate to where they needed to go to survive.

In analyzing what they'd observed, the researchers noted that two of the factors—cohesion of the group, and the presence of older fish—were more important to school survival than any particular migration destination. They noted also that removal of the older fish tended to damage the collective memory of the group and prevented the school from migrating at all. In the real world, that would mean that if fishermen catch the older fish that hold the memories of where to go when it's time to migrate, the rest of the school won't know what to do, and likely as a result, will die without even trying.

The model might explain, the researchers note, why it is that when a population of fish is decimated (such as bluefin tuna in the 60s) and then efforts are made to help them repopulate, such efforts are oftentimes unsuccessful because there is no way to reintroduce the lost collective

memory.

The researchers next plan to improve their model by adding data obtained from real life studies of fish populations, including those that have been overfished. The hope is that a model can be constructed that will help prevent collapse of other fish species due to current fishing techniques.

**More information:** Fishing out collective memory of migratory schools, *J. R. Soc. Interface* 6 June 2014 vol. 11 no. 95 20140043. rsif.royalsocietypublishing.or … ntent/11/95/20140043

**Abstract**
Animals form groups for many reasons, but there are costs and benefits associated with group formation. One of the benefits is collective memory. In groups on the move, social interactions play a crucial role in the cohesion and the ability to make consensus decisions. When migrating from spawning to feeding areas, fish schools need to retain a collective memory of the destination site over thousands of kilometres, and changes in group formation or individual preference can produce sudden changes in migration pathways. We propose a modelling framework, based on stochastic adaptive networks, that can reproduce this collective behaviour. We assume that three factors control group formation and school migration behaviour: the intensity of social interaction, the relative number of informed individuals and the strength of preference that informed individuals have for a particular migration area. We treat these factors independently and relate the individuals' preferences to the experience and memory for certain migration sites. We demonstrate that removal of knowledgeable individuals or alteration of individual preference can produce rapid changes in group formation and collective behaviour. For example, intensive fishing targeting the migratory species and also their preferred prey can reduce both terms to a point at which migration to the destination sites is suddenly stopped.

The conceptual approaches represented by our modelling framework may therefore be able to explain large-scale changes in fish migration and spatial distribution.