Wikno, 16th–20th September 2025

HOW NOT TO TRIM THE BRANCH YOU ARE SITTING ON: TWO MODELS OF A MYOPIC MARINE ECONOMY WITH A REALISTIC FISH DYNAMICS

Vikas Kumar[1], **Agnieszka Wiszniewska-Matyszkiel**[2]

[1]Department of Mathematics, Ramjas College, University of Delhi
[2]Institute of Applied Mathematics and Mechanics, University of Warsaw, Banacha 2, 02-097 Warsaw
[1]vikaskharwar51@gmail.com, [2]agnese@mimuw.edu.pl

ABSTRACT

Markets are variable. If firms in a market face losses, they gradually disappear. It is also widely assumed in economic theory that copies of profitable firms are established proportionally to the profit. This process is usually considered in a market environment which is constant and any changes of the environment are examined as a jump with consequences illustrated by a comparative statics. This cannot be applied to firms operating in industries based on common renewable resources, like e.g. fishing in open access marine fisheries. First of all, the biomass of the caught species evolves as a result of fishing. Besides, interactions between various species constituting its ecosystem have to be taken into account, which substantially increases the complexity of the problem even if the firms considered are myopic. In this paper, we model such a market, with the firms fishing the top predator in a tritrophic food chain. The dynamics of the number of firms is proportional to single firm's profit. The firms interact within the structure of two different economic organizations of the market: the perfect competition, in which firms do not take into account their influence on the market, and the Cournot oligopoly, in which each of the firms knows how its decisions influence the price. Both dynamic models are analysed with various dynamical tools such as stability and bifurcation analysis. We are especially interested in the case when the population without the top predator results in a stable steady state or a stable limit cycle while introduction of the top predator results in chaotic dynamics, which corresponds to introduction of an invasive species. We answer the question how changes of the model parameters can result in stabilizing the three species system and how those changes can be obtained by various constant over time policies of a regulatory institution. Due to multiple bifurcations, controlling the resulting chaos to a stable steady state was possible within either intervals of policy parameters or even a sum of disjoint intervals.