Multi-species exploitation with evolutionary switching of harvesting strategies

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Abstract

In this paper, we propose a bioeconomic model which describes a fishery where each of two non-interacting species is harvested by a given group of fishermen during a defined time period. Then each fisherman is allowed by the fishing institution to reconsider the harvesting decision at fixed (discrete) periods of time. The model is motivated by an Italian fisheries management experience performed in the Northern Adriatic Sea, where this kind of "self-adjusting" fishing policy has been proposed to regulate harvesting of two shellfish species. The proposed dynamic model assumes the form of a hybrid system, as the natural growth functions of the two species (in continuous time) are coupled with a discrete time adaptive system, which regulates how agents, period by period, switch from a harvesting strategy to the other according to an evolutionary dynamics mechanism based on profits comparison. In order to obtain some insights into the basic mechanisms of the system, some relevant benchmark cases are analyzed before tackling (mainly numerically) the complete hybrid model. Our results suggest that this kind of myopic and adaptive self-regulation can ensure a virtuous trade-off between profit maximization and resource conservation, driven by cost externalities and market pressure.

Key words: Fisheries management; Mathematical Bioeconomics; Heterogeneous agents; Evolutionary Game theory; Hybrid dynamical systems.