

Multi-site fishery models with variable price : From over-exploitation towards a durable fishery

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Abstract : We present a short review of mathematical fishery models. We particularly focus on models with a variable price of the resource due to demand and supply. We study multi-site fisheries with different sites which can be Marine Protected Areas (MPA), fishing zones, Fish Aggregating Devices (FAD) or zones with artificial habitats or reefs. The models are sets of ordinary differential equations describing the time evolution of fish biomass on different sites, fishing efforts and price of the resource. In some cases, we assume that fish as well and fishing boat displacement are fast in comparison to local terms. Taking advantage of time scales, we derive a reduced model, also called the « aggregated model », which describes the time evolution of the total biomass and fishing effort of the fishery at a slow time scale. We focus on the case of a linear decreasing function of the demand function with respect to price. In that case, it is shown that there can exist up to 3 positive equilibria, one of them corresponding to a case of over-exploitation and another one to a sustainable fishery. We show that varying the number of sites can allow to switch from a over-exploitation to sustainable fishery. We also study the effects of the number of MPA on the global activity of a fishery. We illustrate our results with the case of the thiof, an exploited fish species in Senegal with booming price.

References :

AUGER P., LETT C., MOUSSAOUI A. and PIOCH S.. Optimal number of sites in artificial pelagic multi-site fisheries. Canadian Journal of Fisheries and Aquatic Sciences. 67, pp. 296-303, 2010.

AUGER P., MCHICH R., RAÏSSI N., KOOI B. Effects of market price on the dynamics of a spatial fishery model: Over-exploited fishery/traditional fishery. Ecological Complexity, 7, pp. 13-20, 2010.

LY S., MANSAL F., BALDE M., NGUYEN HUU T., AUGER P. A model of a multi-site fishery with variable price : from over-exploitation to sustainable fisheries. *Mathematical Modelling of Natural Phenomena (MMNP)*, 2013, 8 (6), p. 130-142.

LY S., AUGER P. & BALDE M. A bioeconomic model of a multi-site fishery with non linear demand function: Number of sites optimizing the total capture. *Acta Biotheoretica*, 2014, 62 (3), p. 371-384.

MANSAL F., AUGER P. & BALDE M. A mathematical model of a fishery with variable market price. Sustainable fishery/over- exploitation. *Acta Biotheoretica*, 2014, 62 (3), p. 305-323.