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Optimality and Sustainability of Delayed Impulsive Harvesting

Optimal and sustainable management of natural resources requires knowledge about the behaviour of mathematical models of harvesting under many different types of conditions. In this talk, we will be investigating the sustainability and optimality of delayed impulsive harvesting. Impulses describe an instantaneous change in a system due to some external effect (like harvesting in a fishery), which has a duration that is negligible compared to the overall time scale of the process. These impulses can then be combined with differential equations (DEs) to form impulsive DEs.

Delays within harvesting can represent a dependency on information that is out of date. Since it is likely that most data used to make harvesting decisions will be at least somewhat out of date, including delays within impulsive conditions is a topic of current interest. A close connection to the dynamics of high-order difference equations is used to conclude that while the inclusion of a delay in the impulsive condition does not impact the optimality of the yield, sustainability may be highly affected and is once again delay-dependent. Maximum and other types of yields are explored, and sharp stability tests are obtained for the model. It is also shown that persistence of the solution is not guaranteed for all positive initial conditions, and extinction in finite time is possible, which provides a possible explanation for observed but unforeseen population collapses. Overall, the results imply that delays within harvesting should be kept short to maintain the sustainability of resources.