

Controllability of a harvested prey-predator system with time delay

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Abstract

Stage structure models have received much attention in recent years, i.e. models which take into accounts the facts that individuals in a population belong to either immature or mature classes. In these models, the age of maturity is represented by a time delay, which leads to systems of retarded functional differential equations. Harvesting has also generally a strong impact on population dynamics of a harvested species. The severity of this impact depends on the nature of the implemented harvesting strategy which in turn may range from the rapid depletion to the complete preservation of a population. The exploitation of biological resources and harvesting of population species are common practiced in fisheries, forestry, and wildlife management. Problems related to the exploitation of multi-species systems are interesting and difficult both theoretically and practically.

In this paper, we have considered a prey-predator model with Holling type of predation and harvesting of predator species. We have not made any case studies, but in particular, we have in mind Hilsa fisheries in India and Bangladesh. Here we have established that when time delay is zero, a unique positive equilibrium exists and globally asymptotically stable, provided the harvesting effort must lie in a certain interval. We also observe that when the time delay is small both the prey and predator populations reach periodic oscillations around the equilibrium in finite time then converges to their equilibrium values. As the delay increases, oscillations are also increases and when the maturation delay is too long, the positive steady state disappears and the consumer population dies out. As in the non-delay case, the harvesting effort has an effect of stabilizing the equilibrium. We have also discussed the effects of by-catch of the immature species. We see that small by-catch of juveniles does not change the stability but above some critical value, consumer population dies out.