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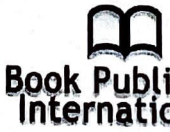

Editor(s)

Dr. Hari Mohan Srivastava

Professor,
Department of Mathematics and Statistics, University of Victoria, Canada.
Email: harimsri@math.uvic.ca;

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Chapter 1
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Holling Type Response Function in Fishery Modelling with Optimal Harvesting Policy

Dipankar Sadhukhan[1*]

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Abstract

In this paper, we have considered a very general Holling type predator-prey system with selective harvesting and where both of the species follow logistic growth. The uniform boundedness of the system has been studied together with the conditions of existence. Also, we have obtained the criteria for local stability of various equilibrium points then considering suitable Lyapunov function, the global stability of the system has been discussed. After that using Pontryagin Maximal Principle, we have studied the optimal harvesting policy for the system. At the end, the problem has been illustrated through some numerical examples. Finally, we have discussed the problem with the help of a numerical example by using arbitrary feasible parametric values and using MATLAB, we observed from stability diagram (Fig. 1) and phase portrait (Fig. 2) that as the values of p decreases, the steady state value of Prey population increases. This is quite good result for ecological sustainability of species. Our model may be extended by incorporating time delay and stochasticity in the system.

Keywords: Prey-predator system; stability; bionomic equilibrium; optimal harvesting; Holling type response.

1 Introduction

The way which was first introduced by Lotka [1] and Volterra [2] in population biology, is in recent time a very important branch in modern science. From the simplest model of Lotka-Volterra, researchers gradually developed different kinds of population models which are more realistic and much needful for demand-supply chain in between human population and natural resources. To serve these purpose Jogensen [3] has done the pioneering work for the dynamical behaviour of population biology. Since then the population biology has started to take a formal shape. Now-a-days in population biology the study of fishery and harvesting plays an important role. Fish and fishery products are important for maintaining a healthy diet [4] and are a major source of nutrition for hundreds of millions of people worldwide [5,6]. For this purpose, bio economic modelling is a dynamic area of study in biomathematics. Initially the techniques of formulating the model and its solution procedure have been discussed by Clerk [7,8].

After that many researchers have worked with several single and multi-species interacting population model with more than one state variable. The problem of combine harvesting of two ecologically independent species first studied by Clerk [7]. Also, some multi species harvesting models have been developed by Mesterton-Gibbons [9]. Then many types of combined harvesting of two and three species have also been discussed by Chowdhuri and Kar [10-12], Kar et al. [13], Sadhukhan et al. [14] etc.

In this present work, we have considered a prey predator model with selecting harvesting of prey population only and having logistic growth rate for both species with the assumption that the predator has some other source of food except the prey under consideration, which is more realistic for real life phenomenon like shark, salmon, harring etc. type of fishes. The importance of predation as a regulatory process in marine systems has been well documented [15,16,17]. Till now almost all researchers have considered simple response functions like Holling type II and ratio dependent function. But in the present model we have considered a general type of

[1]*Department of Mathematics, Haldia Government College, Haldia-721657, W.B., India.*
[*]*Corresponding author: E-mail: dipankar.sadhukhan2@gmail.com;*