Abstract

In this thesis, some prey-predator models have been studied in different environments. Prey-predator relationships are the natural phenomenon of any ecological system. Also, in different environments, behaviors of species are different. In this thesis, those natural phenomenons are discussed by some mathematical models.

Firstly, prey-predator three species models have been discussed with vertebral and invertebral predators. Different type functional responses have been considered to formulate the mathematical model for predator and generalist predator. A numerical example has been considered to illustrate the proposed system. The stability of the system has been analyzed using some graphical representations.

Then, the effects on prey-predator with different functional responses have been studied. The effects on prey of two predators which are also related in terms of prey-predator relationship has been investigated. Different types of functional responses are considered to formulate the mathematical model for predator and generalist predator of the proposed model. Harvesting effort for the generalist predator is considered and the density dependent mortality rate for predator and generalist predator are incorporated in the proposed model. Local stability as well as global stability for the system are discussed. To evaluate Hopf bifurcation in the neighborhood of interior equilibrium point, different bifurcation parameters have been analyzed. Some numerical simulations and graphical figures are provided to verify our analytical results with the help of different sets of parameters.

Also, prey-predator three species fishery model with harvesting including prey refuge and migration have been analyzed. Prey-predator system with Holling type II functional response for the predator population including prey refuge region has been analyzed. Also a harvesting effort has been considered for the predator population. The density-dependent mortality rate for the prey, predator and generalist predator has been considered. The equilibria of the proposed system have been determined. Local and global stabilities for

the system have been discussed. The analytic approach is used to derive the global asymptotic stabilities of the system. The maximal predator per capita consumption rate has been considered as a bifurcation parameter to evaluate Hopf bifurcation in the neighborhood of interior equilibrium point. Also, fishing effort is chosen to harvest predator population of the system as a control to develop a dynamic framework to investigate the optimal utilization of the resource, sustainability properties of the stock and the resource rent are earned from the resource. Some numerical simulations have been presented to verify the analytic results; and the system has been analyzed through graphical illustrations.

Then a prey-predator model with a reserve region of predator where generalist predator cannot enter have been exemplified. The predator population which consumes the prey population with Holling type II functional response and generalist predator population consumes the predator population with Beddington-DeAngelis functional response. The density-dependent mortality rate for prey and generalist predator are considered. The equilibria of proposed system are determined. Local stability for the system is discussed. The environmental carrying capacity is considered as a bifurcation parameter to evaluate Hopf bifurcation in the neighborhood of interior equilibrium point. Here the fishing effort is used as a control parameter to harvest the predator population of the system. With the help of this control parameter, a dynamic framework is developed to investigate the optimal utilization of resources, sustainability properties of the stock and the resource rent. A numerical simulation has been presented to verify the analytical results and the system is analyzed through graphical illustrations.

Also a Holling-Tanner prey-predator model has been considered with Beddington-DeAngelis functional response including prey harvesting. Gestational time delay of predator and the dynamic stability of time delay preventing system are incorporated into the system. The equilibria of the proposed system are determined and the existence of interior equilibrium point for the proposed system is described. Local stability of the system with the magnitude of time delay at the interior equilibrium point is discussed. Thereafter, the direction and the stability of Hopf bifurcation are established with the help of normal theory and

center manifold theorem. Furthermore, profit function is calculated with the help of bionomic equilibrium and it is optimized using optimal control. Some numerical simulations are introduced to verify the validity of analytic results of the proposed model.

A prey-predator system with stage structure of predator has been considered. In the proposed model, prey of immature predator and that of mature predator are different. Consumption rate of prey by the immature predator has been described by Holling type II functional response and consumption rate of prey by the mature predator has been described by Holling type III functional response. Both preys obey logistic growth rate. Immature predator transfers to mature predator at a constant rate. Mortality rate of immature predator and mature predator are different. Local stability of the system has been discussed. Transform rate of immature predator to mature predator is considered as bifurcation parameter. Some numerical simulations have been presented to verify the analytic results and the system has been analyzed through graphical illustrations.

Key Words: Prey-predator model; Holling type I, type II, type III Functional response; Beddington-DeAngelis functional response; Holling-Tanner Model; Interior equilibrium point; Gestation Time delay; Routh-Hurwitz criterion; Local stability; Global stability; Lyapunov Function; Hopf bifurcation; Harvesting; Optimal control.