Introduction

Population dynamics is a branch in science which studies interactions between species in the ecosystem () . Predator-prey systems are part of population dynamics, which studies species, one (or more) of which (predators) feeds on the other (prey). The revolutionary model to describe this relationship was proposed in the 1920s independently by Lotka () and Volterra (). They describe the system as having periodic cycles of growth and decay of the two populations, with the predator population trailing behind the prey by 90 degrees in the cycle.

Despite the popularity of the Lotka-Volterra model, it has a lot of limitations, as described in literature (), hence more refined and realistic models have been studied by ecologists and mathematicians since. In this paper, one adaptation of the original Lotka-Volterra model is studied, where Allee effect and intraspecific competition are taken into account for the predator population dynamics, while the prey population dynamics remains as originally proposed by Lotka-Volterra. The model is originally proposed by Bodine.

Allee effect is the effect of population density on its fitness (Allee). In the context of this model, the predator per capita growth rate will decrease the stronger the Allee effect is. This, combined with increased intraspecific competition in greater predator population densities, leads to great punishment for the predator population. This introduces the possibility of the predator having negative per capita growth rate and becoming extinct. On the other hand, as pointed out by Hofbauer and Sigmund, the fate of the population depends mostly on what happens when the density is small. Here two potentially contrary but at the same time consequent conditions are observed - a large population going extinct due to its excessive rather than insufficient size. This interesting phenomenon will be the main focus of analysis. In addition, the effect of small prey populations and conditions where the prey can go extinct will be explored .

In short, the purpose of this paper is to study the stability of the proposed new model, defined as the ability of the two populations to coexist, and provide a critical assessment on how realistic the system is.

Section 2 of the paper describes the model, its assumptions and implementation. Section 3 studies its stability and and the setup of the experiments for the analysis. In Section 4, the results are presented and the following discussion and the model limitations are in Section 5. Last but not least, the final section concludes the paper with the main emphasises from the analysis.

* What is stability in the sense of populations - as opposed to the populations reaching a stable point and converge to an equilibrium, the model will be looking at the populations being able to co-exist with each other
* Looking for conditions where the equation parameters enable this co-existence with time to explore under what conditions the system is stable
* As pointed out by Hofbauer and Sigmund, the fate of the population depends mostly on what happens when the density is small - what conditions will help it recover from a population crisis.
* We will examine what are the effects when one of the populations goes extinct - show cases of both predators and prey
* Can the prey go extinct
* What happens when initially a population is small - what can result in its growth and what to its diminishing
* Compare the model with Lotka-Volterra model?
* Discuss the limitations of the model

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Model

* Description
* Assumptions
* Equations
* Equilibrium analysis
* Implementation
* Experiments (parameter table)

Results

Discussion

* Limitations

Conclusion