ABSTRACT

The Role of Refuge Prey and Allee Effect in Stabilizing an Eco-Epidemiological System With Non-Linear Incidence Rate

By
Taleb Gaber
NIM : 24010122419005
Master of Mathematics Study Program Faculty of Science and Mathematics Dinonegoro University

Eco-epidemiological models provide insights into factors influencing disease transmission and host population stability. This study developed two eco-epidemiological models to investigate the impacts of prey refuge availability and an Allee effect on dynamics. Model A incorporated these mechanisms, while Model B did not. Both models featured predator-prey and disease transmission and were analysed mathematically and via simulation. Model equilibrium states were examined locally and globally under differing parameter combinations representative of environmental scenarios. Model A demonstrated globally stable conditions within certain parameter ranges, signalling refuge and Allee effect terms promote robustness. Bifurcation analyses revealed qualitative shifts in behaviour triggered by modifications like altering predator mortality rate. Model A manifested a transcritical bifurcation indicating critical population thresholds. An additional bifurcation type appeared when refuge and Allee stabilizing impacts were absent in Model B. Findings showed disease burden and host persistence positively associated with refuge habitat, reducing predator-prey encounters. High Allee threshold had resultedin the extinction of the three species. Simulations aligned with mathematical predictions. Model A underwent bifurcations at critical predator death rates impacting prey outcomes. Insights into ecological tipping points enhance understanding of managing wildlife infectious diseases amid changing environments. This work provides a valuable framework to minimize transmission given resource availability or demographic alterations, generating testable hypotheses.

Keywords: Allee Effect; Prey Refugee; Predator-Prey; Eco-Epidemiological Model; Nonlinear Incidence Rate; Local Stability; Global Stability; Hopf Bifurcation; Transcritical Bifurcation.