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Exploring Deterministic and Stochastic Behaviors in a Prey–Predator Eco-Epidemic Model with Harvesting and Prey Refuge

Communication Info

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Abstract

This study investigates the dynamics of a prey–predator system in which the predator population is divided into susceptible and infected individuals. The prey population (copepods) grows logistically, while both predator classes (Atlantic horse mackerel) consume prey following Holling type I functional responses, modified by linear and nonlinear prey refuge effects. The deterministic model incorporates disease transmission among predators and differential harvesting efforts applied to each predator class. Equilibrium points and their local and global stability properties are analyzed theoretically. Furthermore, the influence of environmental fluctuations on population persistence is examined by extending the system into its stochastic counterpart. Through numerical simulations, we compare the deterministic and stochastic trajectories to highlight how random perturbations affect the stability of equilibria and long-term species coexistence. The results reveal that infection and environmental noise can substantially alter predator survival and prey abundance, emphasizing the ecological significance of disease and stochasticity in marine ecosystems.

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