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# Population Dynamics in Aquatic Environments: Spatial Heterogeneity and Optimal Harvesting

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**Abstract :** This paper deals with plankton-fish dynamics where the fish population is growing logistically and nonlinearly harvested. The interaction between phytoplankton and zooplankton population is considered to be Crowley-Martin type functional response. It has been assumed that phytoplankton grows logistically and is affected by a space-dependent growth rate. Conditions for the existence of a positive equilibrium point and their stability analysis (both local and global) have been discussed for the non-spatial system. We have discussed maximum sustainable yields as well as optimal harvesting policy for maximizing the economic gain. The stability and existence of Hopf –bifurcation analysis have been discussed for the spatial system. Different conditions for turning pattern formation have been established through diffusion-driven instability analysis. Numerical simulations have been carried out for both non-spatial and spatial models. Phase plane analysis, the largest Lyapunov exponent, and bifurcation theory are used to numerically analyzed the non-spatial system. Our study shows that spatial heterogeneity, the mortality rate of phytoplankton, and constant harvesting of the fish population each play an important role in the dynamical behavior of the marine system.

**Keywords :** optimal harvesting, pattern formation, spatial heterogeneity, Crowley-Martin functional response
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