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Modeling, Estimation, and Control Related Issues in Physical and Biological Applications

Understanding the Dynamics of Amphibians and Associated Diseases Using a Structured Modeling Approach

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Abstract: We present a general class of Susceptible-Infected (SI) structured population models that applies to problems arising in ecology, epidemiology and cell biology. The SI model consists of a system of quasilinear hyperbolic partial differential equations coupled with a system of nonlinear ordinary differential equations. We develop a second-order highresolution finite difference scheme to approximate the solution of the model. Convergence of the numerical approximations to a weak solution with total bounded variation is proved. This model is then applied to understand the dynamics of amphibians with Chytridiomycosis. Chytridiomycosis is an emerging disease caused by the fungal pathogen Batrachochydrium dendrobatidis (Bd) that poses a serious threat to frog populations worldwide. Studies have shown that inoculation of anti-Bd bacterial species Janthinobacterium lividum (JI) can mitigate the impact of the disease. We will test using model simulations several JI inoculation strategies and their effect in controlling Bd impact on frogs. Furthermore, we demonstrate how temperature may play an important role in the disease dynamics and the disease effect on frog population.