Mathematical Biology Seminar

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3 pm – 657 CAB

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Deterministic and Stochastic Structured Population Models with Application to Green Tree Frogs

We consider an amphibian population where individuals are divided into two groups: juveniles (tadpoles) and adults (frogs). We assume that juveniles are structured by age and adults are structured by size. This leads to a system of nonlinear and nonlocal hyperbolic equations of first order. An explicit finite difference approximation to this partial differential equation system is developed. Existence and uniqueness of the weak solution to the model are established and convergence of the finite difference approximation to this unique solution is proved.

Several stochastic models are derived from the deterministic population model. Numerical simulation results of the stochastic models are compared with the solution of the deterministic model. These models are then used to understand the effect of demographic stochasticity on the dynamics of an urban green tree frog (Hyla cinerea) population.

We present an infinite-dimensional least-squares approach which compares the deterministic mathematical population model to the statistical population estimates obtained from the field data. To solve the least-squares problem, an explicit finite difference approximation is developed. Convergence results for the computed parameters are presented. Parameter estimates for the vital rates of juveniles and adults are obtained, and standard deviations for these estimates are computed. Numerical results for the model sensitivity with respect to these parameters are given. Finally, the above-mentioned parameter estimates are used to illustrate the long-time behavior of the population under investigation.

Finally, the deterministic model is extended to a dispersal model where individuals disperse between N ponds. An implicit finite difference approximation to this model is developed. Existence-uniqueness of the weak solution to the model is established and convergence of the finite difference approximation to the unique solution is proved.