Murray State Mathematics and Statistics Colloquium
2003-2004 Academic Year

- Christopher J. Mecklin, Murray State University
  Sept. 12, 2003
  Methods for Estimating and Comparing Biodiversity
  Abstract: A wide variety of indices exist for the measurement of *biodiversity* in ecology. We will briefly review some of the common measures of diversity, such as the Shannon index and the Simpson index. Unfortunately, the arbitrary selection of diversity index can lead to conflicting results. However, both Shannon's and Simpson's measures are special cases of Renyi entropy. Others have developed *diversity profiles*, which use Renyi entropy to graphically compare the diversity index collected from different locations or from the same location over time. We extend this work by using Bayesian methods to estimate Renyi entropy and hence construct *credible diversity profiles*. Several examples using our method will be shown. We will compare our work with existing methods for both the estimation of biodiversity and for testing to see if there have been significant changes in diversity over a given period of time.

- Beth Bradley, University of Louisville
  Sept. 19, 2003
  Mathematical Modeling of Antibiotic Resistance in the ICU
  Subtitle: What not to do when modeling an ICU...Learning from our mistakes.
  Abstract: Hospital acquired infections with resistant bacteria has become a serious problem in the medical community. Over the last few years, the problem has spread outward to community acquired resistant pathogens. A major reason for this is the selective pressure being placed on these bacteria by the use of antibiotics. The most seriously impacted environment is the hospital ICU. We will discuss some modeling assumptions, along with various difficulties encountered in trying to model this complex biological system.

- Matthew Gilliland, Murray State University
  Oct. 13, 2003
  Population Dynamics with Constant Yield Harvesting or What I Did Last Summer!
  Abstract: In this presentation, I speak about my REU experience this past summer. We will discuss the reaction-diffusion equation of biological populations with constant harvesting in one dimension. We focus on the biological models of the logistic growth, strong allee effect, and the weak allee effect and how they affect the reaction diffusion equation. We analyze the equations using the quadrature with Dirichlet boundary conditions, and the method of sub-super solutions.

- Ian Knowles, University of Alabama at Birmingham
  Oct. 27, 2003
  Variational Methods for Inverse Problems
  Abstract: An inverse problem for a differential equation involves finding one or more of the coefficient functions when one has some knowledge of the solution. These problems arise naturally from areas such as non-invasive imaging, both in industry and medicine, landmine detection, earthquake prediction, and in groundwater and oil reservoir modelling, for example. In this talk I'll show how the Dirichlet principle, which asserts that certain differential equations can be solved variationally, can be adapted to solve these inverse problems variationally.

- Hem Raj Joshi, Xavier University
  Feb. 23, 2004
  Optimal Control Applications in Math Biology
  Abstract: We will talk briefly about the optimal control for ODE's and PDE's. As an application, we will give a preliminary report on fish model. In this model, we find an optimal harvesting strategy in a fish population modeled in a parabolic setting (PDE model) with a logistic type growth term and a Dirichlet boundary condition in a multidimensional bounded domain. The harvesting term is the control and our goal is to maximize the profit. We discuss the existence and characterization of an optimal control and derive the optimality system. This problem is linear in the control. The talk will conclude with a numerical illustration.

- Hope McIlwain, Mercer University
  April 9, 2004
  Can you hear the size of the vertices? An inverse spectral problem of Laplacians on weighted graphs
  Abstract: Let G be a simple graph on n vertices. We will define a Laplacian Δ on G which depends on an assignment of a weight to each vertex of G. In this situation, one eigenvalue will always be zero. We fix the remaining $(n-1)$ eigenvalues. We then ask for which graphs we can find a set of weights which generate a Laplacian with the desired spectrum. In particular, we will demonstrate that we can always solve the inverse spectral problem for a three-vertex graph and we will also give a proof that we can always solve the inverse spectral problem for K_4, the complete graph on four vertices.