Single Population Models

Exponential growth:
- Introduction to differential equations: vector fields and the Euler method
- Malthus, British poor laws and social policy
- Introduced species: pheasants and elephant seals
- Human population growth
- Estimating population size

Age-structured Populations
- Leslie matrices & matrix algebra
- Stability; eigenvectors and eigenvalues
- Conservation of loggerhead turtles
- Stochastic vs. deterministic growth
- Estimating reproductive rates and generation times
- Evolution of life histories

Density dependent growth
- Detecting density dependence
- Density dependent factors

The Logistic model
- Stability analysis
- Analytic solutions
- Non-dimensionalization
- Application to yeast growth
- r, K life strategies and applications to pest control
- Harvesting and relaxation times
- Estimating carrying capacity
- The spruce budworm example
- Effects of changing carrying capacity:
  - Rainfall and wildebeest populations
  - Solar cycles and arctic hares
- Spatial structure and the Levins model
- Other density-dependent models
- Mass action Law and chemical reactions

Interacting Populations

Elementary epidemic models:
- Introduction to systems of differential equations
- Isoclines and basic qualitative behavior
- The SIR epidemic model
- Application to Bombay Plague
- Cross-over epidemic models
- Application to STD’s

Predator-Prey Models
- Intro to stability analysis of systems
Poincare-Bendixon
Average population growth
Effects of ‘general pesticides’
Application to the lynx-hare system
Application to ‘prudent predators’;
Neutral stability and structural instability
Hunting strategies and Holling models
Hopf bifurcation and the paradox of enrichment
Prey switching and trophic levels
Application to ant/larva predation

Further Applications:
Competition Models
Catalytic Reactions and the Michaelis-Menten Equation
Island Biogeography: the Macarthur-Wilson theory

Organisms In Time and Space

The Advection equation
Introduction to PDE: initial conditions; separation of variables
Applications: air pollution, insect control

The Diffusion equation
Ion channels
Insect dispersal

Spatial spread of epidemics
Black Death
Rabies