L.W. Botsford
Winter 2013

Expanded Syllabus
WFB 222

Format: Roughly two plus hours of lectures per week, accompanied by up to one hour of discussion.

Grading: Homework (some existing computer models), reading and discussion (25%); One take-home midterm (25%), one take-home final (50%).

Week 1 - Philosophy of the use of models in population dynamics

History of the issue of simple vs. complex models in ecology. Two uses of models, scientific (hypothetico-deductive) and practical applications (primarily inductive) both require realistic (i.e., mechanistic, testable) models that can be related to hypotheses and data. Which variables do we need to include in models? Definition of state and variables needed to represent state. Types of uncertainty, and their role in population resource problems. Accounting for uncertainty in modeling approaches.

Week 2 - Simple models

Simple linear models (density-independent) in both continuous and discrete time, exponential and geometric growth (brief review), stochastic version of discrete time model. Simple nonlinear models (density-dependent), stability, chaotic behavior. Logistic and stock-recruitment models from fisheries. Persistence of these models.

Week 3+ - Linear age structure

Three models: renewal equation, vonFoerster equation and Leslie Matrix. Data sources, life tables. Solution to Leslie matrix. Model behavior in discrete time, i.e., λ, R_0, sensitivity, elasticity. (presumably much review). Lumped approximation. Semelparous case. Echo effect, effects of initial age structure and survival pattern on approach to SAD. Persistence of linear model. Beverton-Holt model from fisheries.

Week 4- - Stage structured models

Justification of stage structure, problems identified early on. Model behavior (similar to age structure).

Week 5 - Size structured models

Justification of size structure, basic model behavior (continuous time and size). How growth and mortality rates shape size distributions. Example of survival through a high mortality (marine larval) stage. An approach to parameter estimation.

Week 6 - Age structured models with density-dependent recruitment

Fundamental conditions for persistence, relationship for linear. How do age structure and shape of density dependence lead to cyclic behavior. Examples from marine populations, tribolium, etc.

Week 7 - Age structure and random environments

Behavior of linear models, nonlinear models. How conditions for persistence change with addition of randomness.

Week 8 - Populations over space - metapopulations

Characteristics of metapopulation behavior regarding stability and persistence. Three basic models, marine examples. Persistence of populations in marine reserves.

Week 9 - Population Viability Analysis

Use of models with random variability in endangered species (ESA and IUCN) in: (1) providing estimating current level of jeopardy, (2) establishing delisting criteria, and (3) planning recovery actions. Quasi-extinction, effects of demographic, environmental stochasticity.. Effects of uncertainty on estimates of probability of extinction, and other decisions. Developments in salmon VPA.

Week 10 - Overfishing and climate effects

Methods for characterizing fishing (Brief review and critique of 3 basic models). Overfishing, precautionary approaches, soures of uncertainty. Sources of uncertainty for populations in marine reserves. Comparison of fisheries management with conservation biology. Effects of climate change on exploited populations.