**References: Population Models**

Books:

Clark, J.S. 2007. *Models for Ecological Data*. Princeton Univ. Press, Princeton NJ.

Intermediate-level text, emphasizing plants and hierarchical Bayesian methods.

Cousens, R. and Mortimer, M. 1995. Dynamics of Weed Populations. Cambridge Univ. Press

Application of these ideas to weeds. Chap 5 describes population models.

Daley, D.J. and Gani, J. 1999. Epidemic Modelling. Cambridge Univ. Press.

Application of these ideas to diseases. More mathematical than the other books in this section.

Haddon, M. 2001. Modelling and Quantitative Methods in Fisheries. Chapman and Hall/CRC, Boca Raton

Introduction to models in fisheries, many include density dependence (stock-recruitment)

Hilborn, R. and Walters, C. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Chapman and Hall, New York.

Older, but a very readable review of models. pre-MCMC Bayesian methods.

Nisbet, R. M. and Gurney, W. S. C. 1982. *Modelling Fluctuating Populations* Wiley, Chichester.

Comprehensive summary of continuous time models. Mathematical details and lots of insight.

Nowak, M.A. and May, R.M. 2000. *Virus Dynamics*. Oxford Univ. Press

Application to virus populations. Currently, very active area of research. Quite readable.

Royama, T. 1992. Analytical Population Dynamics. Chapman and Hall, London.

Theory and examples, mostly involving differential equations for continuous time.

Williams, B.K., Nichols, J.D. and Conroy, M.J. 2002. *Analysis and Management of Animal Populations*. Academic Press, San Diego.

Huge compendium of all sorts of quantitative techniques. Source of two of the readings for this section of material.

Structured Populations:

Caswell, H. 2001, *Matrix Population Models: Construction, Analysis, and Interpretation*, 2nd. ed. Sinauer, Sunderland MA.

Comprehensive treatise on all aspects of matrix models for structured populations. My lectures draw heavily from this book.

Horvitz, C.C. and Schemske, D.W. 1995. Spatiotemporal variation in demographic transitions of a tropical understory herb - projection matrix analysis. Ecol Monogr 65:155-192.

One example (the first?) of the megamatrix approach to spatial and temporal variability.

Tuljapurkar, S. and Caswell, H. (eds). *Structured-Population Models in Marine, Terrestrial, and Freshwater Systems*. Chapman and Hall, New York.

Edited volume that provides overview of all approaches (matrix, stochastic matrix, delay-differential equation, partial differential equation) for modeling structured populations.

Stochastic models:

Dennis, B. and Costantino, R. F. 1988. Analysis of steady-state populations with the Gamma abundance model: application to *Tribolium*. Ecology 69:1200-1213.

Develops a stochastic differential equation version of the logistic model. The stationary distribution of population size is a Gamma distribution.

Kaye, T.N. and Pyke, D.A. 2003. The effect of stochastic technique on estimates of population viability from transition matrix models. Ecology 84: 1464-1476

Estimates stochastic log lambda from different stochastic models (variants of random element, random matrix) for 5 different species. Estimate of mean depends on the model, but ranking does not.

Nakaoka, M. 1996. Dynamics of age- and size-structured populations in fluctuating environemnts: applications of stochastic matrix models to natural populations. Researches in Population Ecology 38:141-152.

Summarizes and compares published applications of stochastic matrix models. Many are random sequence of environments models, some are random matrix models.

Tuljapurkar, S. 1990. *Population Dynamics in Variable Environments*. Lecture Notes in Biomathematics, #85, Springer-Verlag, New York.

Source for much of the theory of random sequence of environments models.

Computing:

Bolker, B.M. 2008. *Ecological Models and Data in R* Princeton Univ. Press.

Covers use of R for standard statistical methods and basic theory (likelihood, simulation).

Kennedy, W. J., Jr. and Gentle, J. E. 1980. *Statistical Computing.* Marcel Dekker, Inc. New York

Chapter 6 is a pretty comprehensive list of ways to generate discrete and continuous random numbers.

Estimating parameters:

Easterling, M. R., Ellner, S. P., and Dixon, P. 2000, Size-specific sensitivity: applying a new structured population model. Ecology 81:694-708.

Develops and uses a non-parametric regression approach for individuals with continuous stages (e.g. size) to reduce the bias-variance tradeoff.

Raftery, A. E., Givens, G. H., and Judith, E. Z. 1995. Inference from a deterministic population dynamcis model for Bowhead Whales (with discussion). Journal of the American Statistical Association 90:402-430.

Uses Bayesian methods to combine data from different sources. The population model is quite complex, so I find the paper hard to follow.

Vandermeer, J. 1978, Choosing category size in a stage projection matrix. Oecologia 32:79-84.

Bias vs. variance tradeoff in converting a continous size measure into discrete stages.

Wood, S. N. 1994. Obtaining birth and mortality patterns from structured population trajectories. Ecological Monographs 64:23-44.

Describes an inverse method of estimating stage-specific parameters from non-marked individuals.

Elasticity:

Enright, N. J., Franco, M. and Silvertown, J. 1995. Comparing plant life histories using elasticity analysis: the importance of life span and the number of life-cycle stages. Oecologia 104:79-84.

Empirical evaluation of how model structure influences elasticity coefficients. Has references to the early 1990's debate on evolutionary interpretations of elasticity.

deKroon, H., van Groenendael, J. and Ehrlén, J. 2000. Elasticities: a review of methods and model limitations. Ecology 81:607-618.

Overview article that starts a collection of articles on elasticity.

Bayesian approaches:

Gelman, A., Carlin, J.B., Stern, H.S. and Rubin, D.B. 2003 *Bayesian Data Analysis*, 2nd. ed. Chapman and Hall, London.

My favorite text on Bayesian methods.

Gelman, A. and Hill, J. 2007. *Data Analysis using Regression and Multilevel/Hierarchical Models*. Cambridge Univ. Press, Cambridge.

Very readable introductory treatment of hierarchical linear models, but covers a lot of ground. Includes R code. Very quickly becoming the first place I look for practical Bayesian advice.

Ludwig, D. 1996. Uncertainty and the assessment of extinction probabilities. Ecological Applications 6:1067-1076.

Uses Bayesian methods to incorporate effects of uncertainty into simple population dynamics models.

McCarthy, M.A. 2007. Bayesian Methods for Ecology Cambridge Univ. Press.

Introductory text covering Bayesian versions of intro methods followed by 3 case studies on mark-recapture and population modeling. Has a tutorial on running WinBUGS

Meyer, R. and Millar, R.B. 1999. BUGS in Bayesian stock assessments. Can. J. Fish. Aquat. Sci. 56: 1078-1086

Describes a state-space model and parameter estimating for it using bugs. Renate and Russ have coauthored a variety of other papers applying hierarchical Bayes methods to fisheries models.

Ver Hoef, J. M. 1996. Parametric empirical Bayes methods for ecological applications. Ecological Applications 6: 1047-1055.

Introductory illustration of a Bayesian approach to a combining trend information and single estimates in a population monitoring problem. Part of a special feature on applications of Bayesian methods in ecology. First paper in that feature (by Ellison) is an introductory exposition of Bayesian methods, written for biologists.

Applications (a few of a very large number):

Crowder, L. B., Crouse, D. T., Heppell, S. S., and Martin, T. H. 1994. Predicting the impact of turtle excluder devices on loggerhead sea turtle populations. Ecological Applications 4:437-445.

Uses elasticity to evaluate different conservation options. Apparently responsible for major policy change: reducing mortality of older individuals (TED's) instead of increasing nesting success.

Davis, A. S., Dixon, P.M., and Liebman, M. 2004. Using matrix models to determine cropping system effects on annual weed demography. Ecological Applications. 14: 655-668.

One of three papers applying matrix models to weed demography in different crop rotations (corn/soybean, corn/soybean/triticale, ...). This paper compares prospective (sensitivity and elasticity) to retrospective (Life Table Response Experiment) approaches. Other two papers will appear in Weed Science.

Doak, D., Karieva, P., and Klepetka, B. 1994. Modeling population viability for the desert tortoise in the western Mojave Desert. Ecological Applications 4:446-460.

Uses a random-matrix stochastic model to evaluate consequences of environmental variability and compare management options.

Dixon, P., Friday, N., Ang, P., Heppell, S., and Kshatriya, M. 1997. Sensitivity analysis of structured-population models for management and conservation. pp 471-514 in Tuljapurkar, S. and Caswell, H. (eds). *Structured-Population Models in Marine, Terrestrial, and Freshwater Systems*. Chapman and Hall, New York.

Three examples of using sensitivity analysis to evaluate management strategies. Third example presents Tuljarpurkar's method in an abbreviated but readable form and compares deterministic and stochastic estimates of elasticity.

Wooten, M.B., Wikle, C.K, Dorazio, R.M. and Royle, J.A. 2007. Hierarchical spatiotemporal matrix models for characterizing invasions. Biometrics 63:558-567.

A hierarchical model for population growth and spread, illustrated by data on the Eurasian Collared-Dove.

Concerns:

Bierzychudek, P. 1999. Looking backwards: assessing the projections of a transition matrix model. Ecological Applications 9:1278-1287.

Uses long term data to assess whether population projection matrices constructed in 1978 predicted future fates of two populations. One model did; the other did not. Problems include inadequate data and lambda not representing short-term dynamics.

Lubben, J., Tenhumberg, B., Tyre, A. and Rebarber, R. 2007. Management recommendations based on matrix population models: the importance of considering biological limits. Biological Conservation 141:517-523.

Example that cautions to not ignore biology. A transition matrix that ignores senescence gives misleading recommendations.

Mills, L.S., Doak, D.F, and Wisdom, M.J. 1999. Reliability of conservation actions based on elasticity analysis of matrix models. Conservation Biology 13:815-829.

Argues for caution in translating elasticity/sensitivity into management decisions. Elasticities depend on all the elements in a matrix, so changes in one poorly estimated number can change the ranking of elasticities.