Modern Statistical Models in Ecology
IBIO 860
Spring 2020

Instructor: Elise Zipkin
Office: 219A Natural Science Building
E-mail: ezipkin@msu.edu

Class: Tues 3:00-4:50 in 314 Ernst Bessey Hall
Office Hours: By appointment

Description

This graduate level course provides an introduction to modern statistical models used in the analysis of population and community dynamics in ecology. The class will cover some theory but will primarily focus on practical applications including model development and analysis using the programs R and JAGS. The first quarter of the class will review (generalized) linear models and (generalized) linear mixed models and their use in ecology. The remainder of the course will explore more advanced topics including state-space models, mark-recapture models, binomial mixture models for estimating population abundance and demographic rates from count data, single- and multi-species occupancy models for the analysis of species distributions, and data integration models.

Learning Objectives

1. Comprehend and explain the breadth of current techniques in ecological statistical modeling as they pertain to the estimation of species' status and dynamics.
2. Develop and analyze ecological models for the analysis of populations and communities.
3. Demonstrate the ability to communicate quantitative approaches clearly and effectively to an audience of peers.
4. Code using command-line, open source software.
5. Apply modeling approaches to real and simulated data, including data types that are commonly collected during ecological research.

Recommended Background

The prerequisite for this course is IBIO 830 and 831 (or equivalent material). The course assumes familiarity with probability distributions and generalized linear models. I will review these topics during the first portion of the course but students with deficiencies in their backgrounds should expect to spend extra time reviewing statistical concepts. This course also assumes familiarity with R; students should be comfortable with command line programming.

Course books

The course will utilize chapters from Kéry (2010), Kéry and Schaub (2012), and Kéry and Royle (2016). Course lectures will be provided but purchasing the books is an option for a more in-depth discussion of the topics covered in class. These books are also available from MSU's library including electronic copies.

Kéry, M. (2010) *Introduction to WinBUGS for ecologists*: a *Bayesian approach to regression, ANOVA, mixed models, and related analyses.* Academic Press.
Kéry, M., & Schaub, M. (2012) *Bayesian population analysis using WinBUGS: a hierarchical perspective*. Academic Press.
Kéry, M., & Royle, J.A. (2016) *Applied hierarchical modeling ecology (Vol 1)*. Academic Press.

Course website
All class materials will be posted to the course's D2L website including lab materials and homework. Homework should be submitted via the D2L site.

Grades
Course grades are based on: class participation, lab assignments, and a final project.

Participation (25%): To earn full credit for participation students are required to: serve as a discussant for an assigned scientific paper (10%), contribute to class discussions, and provide feedback to other students during their preliminary presentations (see below; 15%).

Lab assignments (40%): Most weeks we will be building models using R and JAGS during class. On some occasions, exercises will be assigned and due the following week.

Final projects (35%): The objective of this class is for participants to gain an understanding of appropriate model choice for a given research problem and to gain the necessary skill set to implement such models. To that end, students will conduct a project based on their specific research interests. Ideally, this project should complement ongoing research (i.e., pick something that will help you with your dissertation or at least be an interesting side project!). Grades for the final project will be based on two components: a preliminary presentation (15%) and a final paper (20%). For the preliminary presentation, students should prepare a 10-minute talk outlining the study system and questions as well as some ideas for analysis. The class will discuss the project and provide feedback on potential analyses. For the final paper, students should prepare a ~10 page paper focusing on the analyses they conducted and results of their project. The paper should contain introduction, methods, results, and discussion sections. However, the paper's grade will primarily be determined by methods and results sections.

IBIO 860
Tentative Syllabus
Spring 2020

Jan 7	**Introductions**
Jan 14	**Refresher – Model building and analysis** Kéry (2010) Chapters 1-5
Jan 21	**Generalized linear models – Modeling regressions, t-tests, and ANOVAS** Kéry (2010) Chapters 6-9
Jan 28	**Generalized linear models – Linear mixed effects models and more** Kéry (2010) Chapters 12-14
Feb 4	**State-space models – Separating process from sampling error** Kéry and Schaub (2012) Chapter 5
Feb 11	**Capture-recapture models – Estimating abundance in a closed population** Kéry and Schaub (2012) Chapter 6
Feb 18	**Capture-recapture models – Open population dynamics** Kéry and Schaub (2012) Chapter 7
Feb 25	**Binomial mixture models – Estimating abundance from count data** Kéry and Schaub (2012) Chapter 12
Mar 3	***Spring Break***
Mar 10	**Binomial mixture models – Estimating demographic parameters** Kéry and Royle (2016) Chapter 6
Mar 17	**Occupancy models – Single species distributions** Kéry and Schaub (2012) Chapter 13
Mar 24	**Occupancy models – Extinction and colonization dynamics** Kéry and Royle (2016) Chapter 10
Mar 31	**Multi-species occupancy models** Kéry and Royle (2016) Chapter 11
Apr 7	**Preliminary presentations**
Apr 14	**Data integration – Integrated population models** Kéry and Royle (2016) Chapter 11
Apr 21	**Data integration – Integrated distribution models and beyond**
Apr 30	**Final papers due!**