**Course Syllabus**
**Hierarchical Modeling in Ecology (FW/STAT 673)**

Fall 2019
Tues/Thurs 12:30-1:45 PM
Room: 132 Wagar

**Instructor**: Prof. Mevin Hooten
Office: 201 Wagar
Office Hours: Tues/Thurs 2:00-4:00 PM

Credits: 3

**Prerequisites**: STAT 420 or ESS 575

A working knowledge of the R statistical computing environment will be necessary to succeed in this course. Students should also have familiarity with matrix notation and basic vector/matrix operations (i.e., linear algebra).

**Course Description:**

This course focuses on statistical ecological modeling using common forms of data collected in ecological and environmental studies. After a short review of necessary probability, statistics, and computing, we focus on Bayesian model building and implementation for a variety of studies. Examples include mark-recapture and occupancy models, integrated population models, and animal movement models emphasizing the spatial, temporal, and multivariate aspects of analysis. We will generally cover material in the textbook by Hooten and Hefley (2019) listed below.

This course extends statistical and computational methods from Models for Ecological Data (ESS 575) and Bayesian Statistics (STAT 670), to make ecological inference using complex forms of data. Therefore, to make progress in the course, we assume a general understanding of probability and statistical computing. The focus is on ecological applications, but many of the concepts and models are transferrable to other areas of biology and environmental science. A preliminary review highlights the most important aspects of the prerequisites. Students should have access to their own computer and a familiar working installation of R.

This course does not use "automatic" Bayesian software to fit models. A solid framework for building custom algorithms is provided so that students can fit any correctly specified Bayesian model they develop.

**Recommended Texts**:

- Hooten, M.B. and T.J. Hefley. 2019. Bringing Bayesian Models to Life. Chapman and Hall/CRC.

- Hobbs, N.T. and M.B. Hooten. 2015. Bayesian Models: A Statistical Primer for Ecologists. Princeton University Press.

**Academic Integrity:**

This course will adhere to the Academic Integrity Policy of the General Catalog and the Student Conduct Code.

**Topics**:

- Bayesian modeling basics
- Bayesian computation
- Regression models
- Generalized linear models
- Bayesian model selection and averaging
- Bayesian model checking
- Common forms of dependence
    - Spatial models
    - Temporal models
- Models for animal movement
    - Resource selection models
    - Dynamic animal movement models
- Mixture models
- Models for occupancy
    - Hierarchical occupancy models
    - Reparameterized occupancy models
    - Spatial occupancy models
    - Occupancy dynamics
    - Multispecies occupancy models
- Models for abundance
    - Closed population models
    - N-mixture models
    - Spatial capture-recapture models
    - Population dynamics
- Models with multiple sources of data
    - Integrated population models
    - Integrated disease models
    - Integrated animal movement models

**Evaluation**:

Student grades will be based on quizzes and a sequence of bi-weekly reports that involve short-answer, essay, mathematical derivations, computer programming, data analysis, and paper summary/discussion. Scoring is based on the quality of writing, mathematical expressions, model building, programming, and completeness.

- Reports must be prepared using some form of TeX language.
- Reports will be prepared by rotating pair groups.
- By the end of the day that reports are due, each group member must email me a brief description of their collaborator's strengths (why this person is a good collaborator). These reports will be compiled and used to determine a collaborator score that will account for 20% of the course grade. These emails are kept anonymous.
- R software is used for all statistical analysis and code should be attached to the report as an appendix.