# Syllabus

## Spatial Ecology*

**This course is part of my teaching wishlist. Coming to a University near you in the (hopefully) not so distant future.*

## Course Description

Arguably, all of ecology is inherently spatial. Spatial gradients affect ecological processes and emerging patterns; as such, explicitly accounting for space when interpreting ecological patterns to make inference on underlying processes is a must in modern ecology. This graduate course will walk students through concepts and applications in spatial ecology, pairing theory with practice through exercises in R. Proficiency in spatial ecology requires understanding of fundamental principles, familiarity with spatial data formats, and knowledge of quantitative methods for the analysis of patterns in space. This course aims to provide all three. The course is articulated in five sections: (I) Spatial patterns in ecological data; (II) Landscape metrics and connectivity; (III) Spatial population and community dynamics; (IV) Species-habitat relationships; (V) Animal movement.

## Learning Objectives

By the end of this course, students will be able to:

1. Appropriately use terminology and explain concepts in spatial ecology;
2. Critically evaluate the relevance of spatial processes in ecological systems and conservation problems;
3. Manage and manipulate geospatial data reproducibly;
4. Use statistics and computer software to quantify and predict ecological dynamics across space.

## Prerequisites

1. A basic ecology course
2. An upper-level statistics course
3. An introductory programming course
4. An introductory GIS course (preferred)

## Instructional Methods

**Lectures:** Each week, we will meet twice for one hour at a time to cover theory and concepts.

**Labs:** Each week, we will meet once for two hours to practice hands-on exercises that apply the concepts covered during lecture.

## Course Resources

**Textbooks:**

- Fletcher, R., Fortin, M.J. 2018. *Spatial Ecology and Conservation Modeling – Applications with R.* Springer Nature Switzerland. ISBN: 978-3-030-01988-4
- Hooten, M.B., Johnson D.S., McClintock, B.T., Morales, J.M. 2017. *Animal Movement – Statistical Models for Telemetry Data.* CRC Press. ISBN: 978-1-4665-8214-9

**Software:** Students should have access to a computer with the software R and RStudio installed. Both of these are free and open source, and will need to be installed separately. For instructions on how to install R, see: https://ecorepsci.github.io/reproducible-science/index.html#r. For instructions on how to install RStudio, see: https://ecorepsci.github.io/reproducible-science/index.html#rstudio.

## Course Schedule

**Introduction**

**Week 1**

- Welcome, logistics
- What is spatial ecology?
- LAB: Introduction to geospatial data in R

**Part I: Spatial Patterns in Ecological Data**

**Week 2**

- Scale
- Causes of landscape pattern
- LAB: Landscape patterns across scales

**Week 3**

- Geostatistics
- Spatial point patterns
- LAB: Point process models

**Week 4**

- Spatial dependence and autocorrelation
- Accounting for spatial dependence in ecological models
- LAB: Modeling spatial autocorrelation

**Part II: Landscape metrics and connectivity**

**Week 5**

- Habitat loss and fragmentation
- Spatial prioritization and reserve design
- LAB: Landscape metrics

**Week 6**

- Structural and functional connectivity
- Connectivity and wildlife conservation
- LAB: Least-cost paths, circuit theory, patch-based networks

**Part III: Spatial population and community dynamics**

**Week 7**

- Metapopulations
- Source-sink dynamics
- LAB: Metapopulation models

**Week 8**

- Species-area relationships
- Island biogeography
- LAB: Modeling spatial community dynamics

**Part IV: Species-Habitat Relationships**

**Week 9**

- Species distribution models
- Climate change and range shifts
- LAB: Fitting SDMs: statistics vs machine learning

**Week 10**

- Habitat selection theory
- Functional responses
- LAB: Resource Selection Functions

**Part IV: Animal movement**

**Week 11**

- Eulerian and Lagrangian perspectives
- Movement metrics and path geometry
- LAB: Processing animal movement data

**Week 12**

- Mechanistic movement models
- Mechanistic movement models (cont'd)
- LAB: Random walks (and their variations)

**Week 13**

- Behavioral segmentation
- Behavioral segmentation (cont'd)
- LAB: Hidden-Markov Models for animal movement

**Week 14**

- Home ranges
- Utilization distributions
- LAB: Quantifying home ranges

**Week 15**

- Step selection functions
- Redistribution kernels
- LAB: Integrated step-selection analysis

**Conclusion**

**Week 16**

- Where we've been and where we're going