Landscape Analysis and Modeling

Michael Treglia

Landscape Analysis and Modeling

(BIOL 4383-02/6383-02)

Instructor: Dr. Michael L. Treglia

Course Description:

Understanding spatial relationships across landscapes can provide critical insight into patterns and processes observed in ecology and evolutionary biology. Analytical techniques used in understanding these relationships can detect and help control for spatial biases in data, which may obscure effects of other variables. Results from such analyses can inform future research, and guide efforts for tasks including biodiversity conservation and pest management, among others.

This course will focus on quantifying and controlling for spatial relationships in data, using spatial interpolation techniques to estimate environmental variables at unmeasured points, and modeling habitat and connectivity across landscapes. The main tools we will use are free and open source, including the statistical package, R, and the GIS software, QGIS. Though examples given in the class will focus on ecology and evolutionary biology, most analytical techniques covered can easily be applied to other fields of study, and students will be encouraged to use their own data (or available datasets from their field of study) for assignments throughout the semester.

Here is a tentative list of specific topics that will be covered, which may be adjusted according to student interest: * Intro to Landscape Ecology and GIS * Spatial Dependence and Autocorrelation * Nearest Neighbor Analyses * Spatial Interpolation * Mantel Tests and Spatial Regression * Quantifying Landscape Pattern (“Fragstats”) * Animal Movement * Landscape Connectivity (Network Analysis, Graph Analysis) * Species Distribution Modeling/Environmental Niche Modeling

Time and Location:

TBA

Grading:

Final percentage grades will be calculated based on the below allocation from respective categories:

Item	Due Date*	Percent of Grade
Participation	N/A	5
Reading Quizzes**	N/A	10
Assignments	See Schedule	40
Project Proposal	Day XX	5
Final Paper	April XX	30
Poster	April XX	10
Total		***100***

All items turned in after the due-date will be penalized 5 percent per class-day late, unless a valid excuse is provided.

***Quizzes about reading material will be administered if students are routinely not prepared. If discussion is productive throughout the semester, all students will receive all 'quiz' points, provided they have regularly attended class*

Letter grades will be based on typical A, B, C, D, F scheme:

Percentage of Total Points	Letter Grade
≥90	A
≥80, <90	B
≥70, <80	C
≥60, <70	D
<60	F

Attendance Policy: Students are expected to attend class regularly. Skipping class without excuse will directly contribute to loss of points for Participation, Reading Quizzes (is absent on days of paper discussions), and it may make it more difficult to complete assignments. If students must miss class for any reasons, I encourage them to meet with me and get notes from classmates.

Schedule

Week 1: Intro to Landscape Ecology and GIS

Day 1

- Readings:

  - None

- Agenda:
  - Introductions
  - Logistics
  - Lecture: Introduction to Landscape Ecology and GIS

Day 2 ***Assignment Due: None***

- Readings:
  - Turner, M.G., 2005. Landscape ecology in North America: past, present, and future. *Ecology* 86, 1967-1974.
  - Wiens, J.A., 1989. Spatial scaling in ecology. *Functional Ecology* 3, 385-397.
  - Might switch one of these for Fortin et al 2012 Spatial Statistics paper
- Agenda:
  - Discuss papers (Review this Discussion Question)
  - Notes about Free and Open Source Software (FOSS)
  - Exploring QGIS

Week 2: Spatial Dependence and Spatial Autocorrelation; Nearest Neighbor Analyses

Day 3 ***Assignment 1 Due: Work through QGIS Tutorial and turn in the final map (hardcopy or e-mail)***

- Readings:
  - None or Lichtenstein et al 2002 (TBD)
- Agenda:
  - Stationarity
  - Spatial Dependence and Autocorrelation
    - Brief Introduction to Correlograms, Variograms, Semi-variograms
  - Nearest Neighbor Analyses, Ripley's K, Lacunarity

Day 4

- Readings:
  - [Montgomery, R. A., et al. 2014. Where wolves kill moose: the influence of prey life history dynamics on the landscape ecology of predation. *PLoS ONE* 9:e91414.] (http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0091414)

- Agenda:
  - Tutorial to R
  - Nearest Neighbor Analyses in QGIS or R

Week 3: Quantifying Spatial Autocorrelation (Moran's *i* and Geary's *c*)

Day 5 ***Assignment 2 Due: Nearest Neighbor/Ripley's K Analysis***

- Readings:
  - Bone, C., et al. 2013. A GIS-based risk rating of forest insect outbreaks using aerial overview surveys and the local Moran's I statistic. *Applied Geography* 40:161-170.
- Agenda:
  - Discuss paper
  - Measuring Spatial Autocorrelation
  - Tests for Spatial Autocorrelation (Moran's *i* and Geary's *c*)

Day 6

- Agenda:
  - Lab exercise: Measuring, Visualizing, and Testing for Spatial Autocorrelation

Week 4: Interpolation

Day 7 ***Assignment 3 Due: Spatial Autocorrelation***

- Readings:

Agenda: What is Interpolation? * When might we use Interpolation in Ecology? * Interpolation Methods

Day 8

- Agenda:
  - Spatial Interpolation in R and QGIS

Week 5: Multivariate Relationships (Mantel Tests and Alternatives)

Day 9 ***Assignment 4 Due: Interpolation Exercise***

- Readings:
  - Guillot, G., and F. Rousset. 2013. Dismantling the Mantel tests. *Methods in Ecology and Evolution* 4:336-344.
- Agenda:
  - Discuss paper
  - What are Mantel Tests and what are they used for, and why are they problematic in Ecology?
  - Spatial Regression as an alternative to Mantel Tests

Day 10

- Agenda
  - Spatial Regression in R

Week 6: Fragstats 1 - Describing Landscape Pattern

Day 11 ***Assignment 5 Due: Spatial Regression Exercise***

Day 12

Week 7: Fragstats 2 - Describing Patch Characteristics

Day 13 ***Assignment 6 Due: Fragstats Exercises***

Day 14

Week 8: Network Analysis

Day 15 ***Assignment 7 Due:***

Day 16

Week 9: Animal Movement

Day 17 ***Assignment 8 Due:***

Day 18

Spring Break - Have Fun!

Week 10: Accounting for Spatial Autocorrelation

Day 19 ***Assignment 9 Due***

Day 20

Week 11: Distribution Modeling

Day 21 ***Assignment 10 Due:***

Day 21

Week 12: Integrating Techniques - Landscape Connectivity

Day 22 ***Assignment 11 Due:***

Day 23

Week 13: Work on Projects

Day 25

Day 26

Week 14: Future Directions in Landscape Ecology

Day 27

Day 28

Week 15: Project Presentations

Day 29

Day 30 ***Final Paper Due***

Poster Session Open To The Department

Special Policies (attendance, TU stuff…)