Course Syllabus

Landscape Ecology

Course number: ECO621

Instructor: Dr. Kevin McGarigal (mcgarigalk@eco.umass.edu; 577-0655)

Description

This course provides students with an introduction to the discipline of landscape ecology. Landscape ecology might be defined best by its focus on the interplay between spatial pattern and process; specifically, how to characterize spatial pattern, where it comes from, why it matters, and how it changes through time. Thus, this course focuses on the following:

- **Detecting and characterizing landscape patterns.**—Finding the characteristic scale of spatial pattern; defining the elements of pattern; connectedness, fractal geometry, and percolating networks; and how these aspects of pattern are interrelated in landscapes, and how they vary.

- **How patterns develop on landscapes.**—Including the three agents of pattern formation: the physical template of environmental constraints, biotic processes, and disturbance regimes.

- **Landscape dynamics.**—How landscape patterns and processes change through time, including techniques for detecting, analyzing, or simulating landscape change; and modeling populations or communities in landscape mosaics (including spatially implemented metapopulation models).

- **Implications of landscape pattern.**—This is the central set of questions in landscape ecology. We will focus on processes at three levels of organization: Populations and metapopulations, communities, and ecosystem processes.

- **Landscape management.**—How humans approach the management of complex landscapes to achieve management objectives, including two themes central to ecology today: Conservation biology and ecosystem management.

Objectives

The overall goal of this course is to provide students with a working understanding of landscape ecology. The specific objectives are for students to:

- Gain broad understanding of the methods for detecting and characterizing landscape pattern; the causes of landscape pattern, the implications of
landscape pattern to populations, communities and ecosystems, the mechanisms by which pattern and process change through time (i.e., landscape dynamics), and the strategies by which humans manage landscapes;

- Work and learn in an interdisciplinary environment; specifically, to develop problem-solving skills in an interdisciplinary team environment;

- Engage in active, student-directed learning in preparation for professional life; and

- Refine their written and oral communication skills.

Guiding Philosophy

The course objectives listed above largely dictate the teaching and learning method used in this course. Specifically, this course is strongly focused on project-based, student-directed learning. Consequently, learning new material from assigned readings and regurgitating it on exams is de-emphasized. Rather, the emphasis is on sharing knowledge and expertise (both pre-existing and newly acquired) with students from different disciplines (in a small group environment) to address contemporary issues in landscape ecology. The time and energy devoted to this course is largely in the form of interdisciplinary group analysis of data sets (via the use of computer models) and discussion of those results in reference to the concepts learned from lecture and assigned readings, not studying for exams. In addition, in contrast to most courses, the lab projects constitutes the major emphasis for the course. Indeed, lecture is designed, in part, to support the lab projects, not vice versa.

Course Format

The course is logically divided into lecture and lab. There are two 75 minute lectures each week covering the material in the assigned readings, including a review and discussion of the most relevant material with illustrated examples. There is a single 3-hour lab section each week. The purpose of the lab section is to provide students with hands-on experience analyzing real data sets using state-of-the-art landscape analysis software. In addition to the regularly scheduled lecture and lab meetings, special meetings (to be arranged) are required for presentation and discussion of final reports for each of the lab projects (see below). These special sessions are scheduled based on student availability; however, the instructor reserves the right to designate a time slot for these meetings if a common time cannot be agreed upon by all students.

Student Responsibilities

Students are responsible for fully understanding all of the information presented
in this syllabus. If there are any questions regarding this information, it is the
student’s responsibility to bring it to the instructor’s attention before the first
graded assignment. In addition, students are responsible for attending class
(including lectures, labs and special meetings), actively participating in class and
group discussions, and completing all assignments. Students are expected to
collaborate equally to all group projects. In addition, students are required to
meet outside of class with group members to complete lab projects. Students are
expected to meet with their groups outside of class for at least 3 hours per week.
Failure to do any of these things may result in failure of the course (see Grading
System below). Any assigned reading material is to be read before the
appropriate class/lab session. Students are responsible for asking questions
anytime they need clarification (remember, there is no such thing as a bad
question). Finally, and most importantly, students are responsible for sharing
their views, perspectives, opinions, and experiences with the class. Each student
brings to the class a unique world view that has been shaped by their personal
experiences and observations. By sharing this world view, each of us will develop
a broader and more enlightened world view and, as a result, develop a better
understanding of how to apply the principles of landscape ecology to the
management of real landscapes.

Attendance Policies

Students are expected to attend all lectures, labs and special meetings for group
presentations. Although attendance in lectures is not recorded directly, students
are graded on lecture attendance indirectly as described below (see Grading
System). Similarly, although lab attendance is not recorded directly, students are
graded on their participation in the lab projects by their peers (see Grading
System).

Academic Dishonesty Policy

Academic dishonesty (e.g., plagiarism, cheating, fabrication) is a violation of the
regulations of the University and will not be tolerated. In fairness to students who
put in an honest effort, academic dishonesty will be harshly treated. Any form of
cheating whatsoever will result in a score of zero on that grading item. A second
violation will result in an ‘F’ for the course. Consult the bulletin “Undergraduate
Rights & Responsibilities” for further information. To further eliminate any
potential for cheating, grading is in part by peers, as described below (see
Grading System).

How to get Help

The instructor is available to help students in all aspects of the course. In the true
spirit of interdisciplinary teamwork, it is recommended that students seek
information and assistance first from their teammates on a particular assignment
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or lab project. If this is unsatisfactory, students can contact the instructor during the regularly scheduled office hours. If students are unable to meet during that time period, they can arrange to meet the instructor individually by appointment.

Name: Dr. Kevin McGarigal

Office Hours: Tues/Thurs 10:45-12:00 noon

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Grading System

This course utilizes project-based learning and student-directed learning as the primary means of instruction and student evaluation. Consequently, grading is based largely on student participation and performance in student-directed projects. Grading is based on several items; each item is described in detail below.

<table>
<thead>
<tr>
<th>Grading Items</th>
<th>Points</th>
<th>Percentage of course grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily quizzes</td>
<td>30</td>
<td>28%</td>
</tr>
<tr>
<td>Projects 1-6</td>
<td>12 ea</td>
<td>72%</td>
</tr>
</tbody>
</table>

1. **Daily Quizes.**—Class attendance and participation is gauged by daily, in-class quizzes. These are short one- or two-question quizzes completed in class and cover material from the preceding class. These are graded on a pass/fail basis. The proportion of questions answered correctly is multiplied by 100 to determine the total number of points earned for this grading item.

2. **Project 1.**—*Defining the landscape.*—In this project, groups learn the steps and challenges of defining a landscape to meet a pattern-process objective, and evaluate the sensitivity of landscape metrics to landscape definition.

3. **Project 2.**—*Neutral landscape analysis.*—In this project, groups learn to use the program RULE to generate and analyze neutral landscapes in the context of understanding the concepts of continuity and connectivity. Students gain a practical understanding of how to use neutral landscapes to test hypotheses regarding landscape pattern formation; specifically, to test the null hypothesis
that the real landscape(s) is structured randomly, to test whether the
lacunarity pattern of the real landscape(s) varies in comparison to random
and fractal landscapes, and to test whether landscape connectivity varies as a
function of the interplay between species' life history characteristics and the
configuration of habitat

4. **Project 3.**—*Quantifying landscape patch mosaics.*—In this project, groups
learn to use the program FRAGSTATS to quantify the structure of several
local landscapes in the context of characterizing habitat loss and
fragmentation gradients. Students gain a practical understanding of how to
select and compute patch mosaic metrics and even create one of their own.

5. **Project 4.**—*Quantifying landscape point and gradient patterns.*—In this
project, groups learn to quantify spatial point patterns and gradient patterns
using a variety of metrics in the context of characterizing forest canopy
patterns under different land use scenarios.

6. **Project 5.**—*Quantifying landscape connectivity.*—In this project, groups learn
to quantify landscape connectivity using resistant kernels and least cost path
analysis in the context of characterizing connectivity for a focal organism.

7. **Project 6.**—*Metapopulations.*—In this project, groups learn to use a
metapopulation viability model developed in R and interpret the output in the
context of a case study on marbled salamanders in western Massachusetts.
Students gain a practical understanding of metapopulation concepts in the
context of a real-world application. Specifically, students use the model to
examine the potential impacts of a local golf course development project or a
timber harvest scenario on the viability of the metapopulation and to
recommend modifications to minimize impacts.

Based on the cumulative score earned on all grading items, the overall course
grade is determined as follows:

<table>
<thead>
<tr>
<th>Cumulative Score</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>94-100</td>
<td>A</td>
</tr>
<tr>
<td>90-93</td>
<td>A-</td>
</tr>
<tr>
<td>84-89</td>
<td>B</td>
</tr>
</tbody>
</table>
General Guidelines for Assignments

For each of the lab projects, students are organized into interdisciplinary groups. Each group prepares a report. One or two groups are selected to give an oral presentation of their report, the remaining groups are required to hand in a written report. Every member is responsible for contributing equally to the content of the report. The report must be well organized and presented in a clear and concise manner.

Assignments are graded according to the following procedure. First, the entire group receives a score (out of a maximum of 20 points) based on information content (15 points) and presentation (5 points) by the course instructor. MOST IMPORTANTLY, reports must effectively demonstrate that an interdisciplinary approach was used. In other words, the presentation must demonstrates that the entire group discussed the model results and reached consensus over the interpretation of the results. The report must not consist of several separate efforts combined at the end for purposes of the presentation. Moreover, the concepts discussed in lecture must be integrated into the discussion of the results to the extent possible. These are the major challenges and largely determine the grade received for the assignment. Second, each member of the group is evaluated by their peers within the group. Specifically, upon completion of the assignment, each member grades the contribution of each individual to the group effort and assigns a score (as a proportion of the group score) to each individual. The final score for each individual is the product of the instructor score (0-20) and average peer score (0-1).

Readings

Readings come from a single textbook given below, supplemented by several journal papers designed to: 1) expose students to a variety of the "classics" in landscape ecology, 2) expose students to a variety of authors representing a broad spectrum of leaders in the field, 3) fill in a few gaps in the textbook, and 4) provide necessary background material for certain lab projects. Links to the supplemental journal papers are provided with the course schedule on the course
Lecture Schedule

The following lecture schedule remains subject to change and last minute modifications. In addition.

<table>
<thead>
<tr>
<th>No.</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Part 1. Introduction to landscape ecology</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>What is landscape ecology?</td>
<td>Turner (ch 1)</td>
</tr>
<tr>
<td>2</td>
<td>What is a landscape</td>
<td>Turner (ch 1); Wiens (1989)</td>
</tr>
<tr>
<td>3-5</td>
<td>Landscape definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Part 2. Agents of pattern formation</strong></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>The physical template</td>
<td>Turner (ch 2); Swanson et al (1988)</td>
</tr>
<tr>
<td>7</td>
<td>Biotic processes</td>
<td>Turner (ch 2); Watt (1947)</td>
</tr>
<tr>
<td>8-9</td>
<td>Disturbance regimes</td>
<td>Turner (ch 2); Reice (1994); Romme et al (1995)</td>
</tr>
<tr>
<td></td>
<td><strong>Part 3. Landscape dynamics</strong></td>
<td></td>
</tr>
<tr>
<td>10-11</td>
<td>Landscape dynamic concepts</td>
<td>Turner (ch 6); Sprugel (1991)</td>
</tr>
<tr>
<td>12</td>
<td>Landscape modeling</td>
<td>Turner (ch 3); Scheller and Mladenoff (2007)</td>
</tr>
<tr>
<td>13-14</td>
<td>Landscape disturbance-succession models</td>
<td>Turner (ch 3); Perera et al (2015a); Perera et al (2015b)</td>
</tr>
<tr>
<td>15-16</td>
<td>Natural range of variability</td>
<td>Landres et al (1999); Keane (2012); Keane (2013); Keane et</td>
</tr>
</tbody>
</table>
Part 4. Consequences of landscape pattern

17-19  Populations and communities  Turner (ch 7); With and King (2001); Urban et al (2002); McGarigal et al 2016


23-24  Synthesis and summary: take-home messages  Turner (ch 9 & 10)

Lab Schedule

The following lab schedule remains subject to change and last minute modifications.

<table>
<thead>
<tr>
<th>Lab</th>
<th>Topic</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Landscape definition</td>
<td>None</td>
</tr>
<tr>
<td>3-4</td>
<td>Neutral landscapes</td>
<td>Turner (ch 3); Plotnick et al (1993)</td>
</tr>
<tr>
<td>5-6</td>
<td>Analyzing patch mosaics</td>
<td>Turner (ch 4); McGarigal et al (2002)</td>
</tr>
<tr>
<td>7-8</td>
<td>Analyzing point &amp; gradient patterns</td>
<td>Turner (ch 5)</td>
</tr>
<tr>
<td>9-10</td>
<td>Modeling connectivity</td>
<td>TBD</td>
</tr>
</tbody>
</table>