University of Wisconsin-Madison
ADVANCED LANDSCAPE ECOLOGY
Zoology/Forest/Botany 879
3 credits

Course Description, Spring Semester 2018
[*Date: 16 January 2018*]

COURSE DESIGNATIONS & ATTRIBUTES:
Counts toward 50% graduate coursework requirement

MEETING TIME: The course meets from **8:50 to 10:45 on Wednesdays and Fridays** in Room 158, Birge Hall. The room is off the main lobby, go down the hall to the left (east) as you enter from the main doors; the classroom will be straight ahead at the end of that hallway.

INSTRUCTIONAL MODE:
All face-to-face

CREDIT HOURS:
This class meets for two 115-minute class periods each week over the spring semester and carries the expectation that students will work on course learning activities (reading, writing, problem sets, studying, etc.) for about 6 hours out of classroom for every class period. The syllabus includes more information about meeting times and expectations for student work.

INSTRUCTOR:
Dr. Monica G. Turner, Department of Integrative Biology, 432 Birge Hall
(Tel: 608-262-2592; turnermg@wisc.edu)

COURSE DESCRIPTION:
Landscape ecology emphasizes spatial patterning - its development and importance for ecological processes - and often focuses on large regions. Concepts, methods, and applications of landscape ecology will be learned through lectures, readings, exercises in quantitative approaches, and an independent project.

PREREQUISITES:
Graduate or professional standing

RECOMMENDED:
- General Ecology (e.g., Zoo/Bot/For 460 or equivalent) ***is necessary to succeed in this class.***
- Familiarity with landscape ecology (e.g., Principles of Landscape Ecology, For/Zoo/Bot 565 or equivalent)***is necessary to succeed in this class.***
- Familiarity with statistics is strongly recommended, and some knowledge of geographic information systems (GIS) and simulation modeling is desirable.

CLASS SIZE: Admission limited to 20 students.

COURSE LEARNING OUTCOMES:
At the end of this course, students will be able to

- understand and evaluate current concepts and literature in landscape ecology;
- explain the basis of spatial pattern analysis using continuous and categorical spatial data;
- use standard software packages, including Fragstats, GS+ and Conefor and properly interpret results;
- conduct independent research in landscape ecology, including proposal, implementation, oral presentation, and written manuscript;
- run and interpret results of simple landscape models; and
- effectively lead group discussions of scientific topics.

GRADING:
Grades will be based on the laboratory exercises (40%), class participation (10%), leading discussion (10%), and the final project (40% total: oral presentation 10%, written report 30%). Numerical grades will be assigned to letter grades as follows: 93-100 (A), 90-92 (AB), 83-89 (B), 80-82 (BC).

OBJECTIVES:
Landscape ecology is a sub-discipline of ecology that emphasizes spatial patterning–its causes, development, and importance for ecological processes. The field has grown tremendously and matured over the past 25 years. Landscape ecology often (but not always) focuses on ecological dynamics over large regions. Students will delve into the current concepts, methods, and applications of landscape ecology through (1) class lectures; (2) reading and discussion of literature reflecting state-of-the-art research in the field; (3) completion of hands-on exercises designed to provide experience with some of the quantitative tools of landscape ecology; and (4) completion of an independent research project that allows students to develop or apply these tools and concepts in their own studies.

The Advanced Landscape Ecology course emphasizes the current state-of-the-science of landscape ecology and covers common quantitative methods used in landscape ecology; it is recommended for advanced graduate students who are conducting research in this area and <u>not</u> for students who seek an introduction or general overview of the field. The 2-credit course, Principles of Landscape Ecology (565), taught in alternate springs by Dr. David J. Mladenoff provides an overview of the background and concepts of landscape ecology. The principles course provides an introduction for students who wish to gain familiarity with landscape ecology. ***Knowledge equivalent to what is covered in Principles of Landscape Ecology is assumed as the basis for Advanced Landscape Ecology. Students who have no background in landscape ecology should take 565 instead!***

COURSE STRUCTURE:
Class meetings will generally include either a lecture followed by student-led discussion of assigned readings, or hands-on computational exercises designed to introduce students to the quantitative methods used in landscape ecology. ***<u>Important</u>: Because UW-Madison no longer makes the computer labs available for classes without a hefty hourly fee, students will need to bring their own laptops to class on Friday lab days. Mac computers should also be configured to run Windows programs, as some programs are written only for PCs.*** There are classes reserved for oral presentations of the independent projects at the end of the semester (those are always fun!)

ABSENCE POLICY:

Attendance is recorded at each class meeting. If you have an anticipated absence (e.g., planned conference travel or necessary field work), please let me know before the class that you will miss. If you are unexpectedly absent (e.g., illness), please inform me at your earliest convenience and let me know what happened.

For lecture/discussion classes that are missed, students are responsible for the material that was covered in class and for completing the readings. A summary of the assigned readings (one single-spaced page maximum for each assigned paper) should be submitted no later than one week after the missed class. The summary should include a brief statement of what was covered in the paper, your thoughts on the primary contribution(s) of the paper, any insights that were new for you, and questions that were raised in your mind by the paper. I want your thoughts about the readings, not just a repetition of what the authors wrote.

For labs that are missed, students must still complete the lab exercise and turn in the report. Depending on the timing of the due dates and the travel/illness, the deadline may be extended. Students should check with me and confirm arrangements.

READING ASSIGNMENTS:
This course emphasizes readings from the recent primary literature, and four papers will be assigned each week for discussion. ***Every student is expected to have read the assignments before class and be prepared to discuss the papers; students should anticipate occasional short reading quizzes.*** Responsibility for leading discussion will be rotated among all students. Discussion leaders should raise questions or issues to be discussed; be prepared with an evaluation of the significant contributions of the paper; and facilitate discussion among the group (see notes below). Readings from the primary literature will be on Box through the UW web site and can also always be accessed through the electronic collections of the library.

The 2nd edition of LANDSCAPE ECOLOGY IN THEORY AND PRACTICE (Turner and Gardner 2015) will be used as reference for the class. It is available in print and as an eBook from the Springer website. In addition, the library copy is on reserve at Steenbock, and another copy will stay on "local reserve" on the conference table in my lab (430 Birge Hall). You will especially need it for the quantitative chapters. Students are expected to be familiar with the text material, as it is the foundation for discussion of the primary literature.

Turner, M. G., and R. H Gardner. 2015. LANDSCAPE ECOLOGY IN THEORY AND PRACTICE, 2nd edition. Springer, New York.

LEADING DISCUSSION:
Each student will have the opportunity to lead the class discussion of assigned weekly readings. All students will have read the papers prior to class, so discussion leader(s) should **not** provide a detailed review of the paper. The discussion leader(s) should provide a brief summary of the main topic of the paper, just to remind everyone of which paper is being considered. Here are some tips for being effective at leading discussion.

i. Summarize for yourself some of the important points about the paper. It's often useful to have a set of questions that you answer while planning discussion. For example, consider the following: What is the main conceptual contribution of the paper? Why might it be important or influential? Is it a representative example? Does it propose a new direction or idea? How does this paper relate to other papers or general concepts with which you are familiar? Are there any new approaches represented? Are there any problems with the study? How does this reflect the current state of the science?

ii. Prepare in advance some open-ended questions that you can pose to the group to get the discussion going. Remember that questions with a "yes" or "no" answer do not facilitate a discussion! Feel free to call on people if there is silence!

iii. Keep the discussion moving by including all members of the group (this means calling on reticent members of the group and gently redirecting away from individuals who may dominate the conversation) and by curtailing discussion that goes off into tangents or dead ends.

iv. Try to summarize and synthesize as things go along. It's often helpful to use a mechanism like, "So far, we've identified the following main contributions of this paper: ….

v. Be careful not to dominate the discussion. You are a facilitator, and it is harder to do this well than you might expect. You can allow some silence. Encourage discussion by asking question of the group, not by making pronouncements.

vi. You are welcome to come up with activities, or try out some new discussion techniques on us. We make good guinea pigs. Be creative, use your imagination!

PARTICIPATING IN DISCUSSION:
Discussions are only effective for all when everyone is prepared and has perspectives to contribute. ***Everyone is expected to have read the assignment before class and given thought to the paper's content and context.*** A good strategy for being prepared is to write down a couple of questions or observations about each paper as you are reading it. This class benefits tremendously from the diverse interests and backgrounds of the students, and we all learn a lot by listening to one another.

Note: I ask all participants to ***minimize use of the word "like"*** unless it is appropriately used for a simile. Use of "like" has increased widely throughout society, and it has easily surpassed other habits of speech such as "um" or "anyways". The "like" habit is something all of us have to some degree, but now is the time in your professional development to vanquish it!

COFFEE AND SNACKS:

Coffee and snacks are key discussion lubricants for graduate classes that meet in the morning, and we have a tradition of this in the Advanced Landscape Ecology. Monica will provide coffee and tea; traditionally, we've had each student sign up for a day to bring a snack for each of the non-laboratory classes. Competition for the best tasting treat can be fierce! *Help from the class to set up and to clean up the coffee pot and the room at the end of each class period is encouraged and appreciated.* We are expected to leave the room in better order than we found it. Thanks for your cooperation in this!

LABORATORY EXERCISES:

A set of hands-on exercises will be assigned to provide students with experience in various aspects of landscape ecology, particularly the quantitative analyses and modeling often used in landscape ecology. Labs will take place during Friday class periods (see syllabus for dates). Concise written reports will be turned in for each exercise the following week. Lab exercises will be from the 2nd edition of LEARNING LANDSCAPE ECOLOGY:

Gergel, S. E. and M. G. Turner, editors. 2016. LEARNING LANDSCAPE ECOLOGY, 2nd edition. Springer-Verlag, New York.

Make sure ***always to read the lab exercise prior to coming to the class session***. You will not usually complete the lab during the time period, but you'll get going on it. Write-ups must be short—your gain comes from doing the lab and thinking about it, and I don't want to make extra busy work. Rule of thumb should be ~2 pages of prose (typed, single space, but excluding figures, tables and references) unless you are told otherwise. Write-ups are due the following week after the lab was completed. Instructions that are particular for each lab will be given in class.

INDEPENDENT PROJECTS:

Project Objectives: Students will use landscape-level theory or approaches in an area of particular interest to them, thereby allowing them to apply what they are learning to their own research. Ideally, the project provides an opportunity for students to augment their research (e.g., thesis or dissertation work). Students will also gain experience with the primary phases of conducting a research study: preparation of a proposal; execution of the study; preparation of a paper based on the study; and oral presentation of the results in the format suitable for a scientific meeting. All graduate students should have as many opportunities to "practice" all of these aspects of professional science as much as possible!

Topics: Recognizing that there is likely a wide array of interests represented in the class, the choice of topic for the project is not restricted. However, approval of a student's selection is required. Samples of projects might be: (1) analyses of spatial pattern of vegetation or land use in a study landscape; (2) synthesis of literature on how an organism responds to changes in habitat heterogeneity, with development of field-testable hypotheses, recommendations for conservation, or reserve design; (3) development of a model to address an interaction between pattern and process; (4) preparation of a management plan for a large heterogeneous landscape.

Format for Project Proposals: Proposals must be typewritten, double spaced with one-inch margins and 12-pt type with a **2-page maximum length,** excluding references. The following should be clear and succinct: Introduction/Background; Question(s); Methods; and Expected Results. Proposals will be due in the fifth week of the semester.

Format for Project Reports: Reports must be double-spaced with one-inch margins, and will be due during finals week. Projects should **not exceed 10 pages** of main-body text excluding the cover sheet, abstract, acknowledgements, references, figures, and tables. The format should *exactly* follow that required for submission to the journal LANDSCAPE ECOLOGY, which is available on the journal's website. Pay careful attention to ALL details in the instructions to authors (which you must do any time you submit your own manuscript for publication.)

Guidelines for Oral Presentations: Presentations should be 10 minutes in length, to be followed by a 5-minute question period. **Always** time your talk in advance, as you would in preparation for a presentation at a scientific meeting. Make your presentation (typically in Powerpoint) as you would for a scientific meeting; that is, provide general context, clearly state the question, describe your methods, present results, and draw conclusions. Presentations will be done in class during the final two weeks of the semester. The 'audience' will also provide feedback to each presenter.

Due Dates: See course syllabus for due dates for project proposals, final papers, and presentation dates.

ADVANCED LANDSCAPE ECOLOGY
Syllabus, Spring 2018

Wednesdays (8:50-10:45): Lecture + discussion of readings from the recent primary literature
Fridays (8:50-10:45): Generally a lab exercise
Classes meet in 158 Birge Hall (all the way to the left [east] off the main 1st floor lobby).

Dates	Topics, labs (blue), due dates (red)	Text chap.	Discussion readings or Lab
Wed Jan 24	Course overview and logistics	--	--
Fri Jan 26	(1) Scope of landscape ecology; foundations and scale concepts	1	Jenerette and Shen 2012 Pulsford et al. 2017 Rose et al. 2017 Wu 2017
Wed Jan 31	(2) Causes of landscape pattern	2	Phillips 2007 Bürgi et al. 2017 Finsinger et al. 2017 Lawler et al. 2015
Fri Feb 2	Lab #1 *Introduction to Markov models*	--	LLE Chap. 8, Urban and Wallin
Wed Feb 7	(3) Quantifying pattern I	4	Burnicki 2012 Cushman et al. 2008 Almeida et al. 2016 Liu et al. 2016
Fri Feb 9	Lab #2, *Understanding landscape metrics, part 1* *Lab #1 write up due.*	--	LLE Chap. 4, Cardille & Turner
Wed Feb 14	(4) Quantifying pattern II	4	Remmel and Csillag 2003 Eigenbrod et al. 2011 Gage and Cooper 2017 Kupfer 2012
Fri Feb 16	Lab #2, continued	--	LLE Chap. 4, Cardille & Turner
Wed Feb 21	(5) Spatial statistics *Independent project proposals due.*	5	Vasquez et al. 2012 Anderson et al. 2013 Berry et al. 2015 Smithwick et al. 2012
Fri Feb 23	Lab #3, *Scale detection using semivariograms and autocorrelograms* *Lab #2 write up due.*	--	LLE Chap. 5, Palmer & McGlinn

Wed Feb 28	(6) Landscape models	3	DeAngelis and Yurek 2017 Gustafson 2013 Sleeter et al. 2017 Daniel et al. 2016
Fri Mar 2	Lab #4, *Neutral landscape models* *Lab #3 write up due.*	--	LLE Chap. 6, Gardner
Wed Mar 7	(7) Disturbance and landscapes I	6	Paritsis et al. 2013 Harvey et al. 2016 Bebi et al. 2017 Meentemeyer et al. 2012
Fri Mar 9	Lab #5, *Disturbance and landscape structure, part 1* *Lab #4 write up due.*	--	LLE Chap. 11, Turner & Simard
Wed Mar 14	(8) Disturbance and landscapes II	6	Duncan et al. 2010 Johnstone et al. 2016 Bowman et al. 2015 Seidl et al. 2014
Fri Mar 16	Lab #5, cont'd	--	LLE Chap. 11, Turner & Simard
Wed Mar 21	(9) Organisms and landscapes I	7	Fahrig 2017 Haddad et al. 2017 Prevedello et al. 2016 Ferrante et al. 2017
Fri Mar 23	Lab #6, *Landscape connectivity and network analysis* *Lab #5 write up due.*	--	LLE Chap. 12, Lookingbill & Minor
Mar 26- Mar 30	**Spring Break – No classes!**	**--**	**--**
Wed Apr 4	(10) Organisms and landscapes II	7	Hall and Beisinger 2014 Auffret et al. 2017 Leonard et al. 2017 Samsing et al. 2017
Fri Apr 6	Lab #7, *Advances in quantifying landscape connectivity*	--	LLE Chap. 14, Saura & de la Fuente
Wed Apr 11	(11) Landscape heterogeneity and ecosystem processes *[US-IALE meeting this week, Chicago]*	8	Crum et al. 2016 Buffam et al. 2011 Murray et al. 2014 Turetsky et al. 2017
Fri Apr 13	Report out from US-IALE conference *Lab #7 write up due.*	--	--
Wed Apr 18	(12) Landscape pattern and ecosystem services	9	Boesing et al. 2017 Renard et al. 2015

			Qiu et al. 2018 Schulte et al. 2017
Fri Apr 20	(13) Future directions in landscape ecology	10	Wu 2014 Hahn et al. 2014 Standish et al. 2014 Van Zanten et al. 2016
Wed Apr 25	Student presentations	--	TBA
Fri Apr 27	Student presentations	--	TBA
Wed May 2	Student presentations	--	TBA
Fri May 4	Student presentations	--	TBA
Mon May 7	*Final written project report due by 12:00 pm CDT in hard copy.*	--	

ADVANCED LANDSCAPE ECOLOGY (879)
Readings, Spring 2018

TEXT

Turner, M. G. and R. H. Gardner. 2015. LANDSCAPE ECOLOGY IN THEORY AND PRACTICE, 2nd edition. Springer-Verlag, New York.

WEEKLY DISCUSSION READINGS

[*All readings can be downloaded from Box; see email for link*]

(1) Friday, January 26 – Scope of landscape ecology, conceptual issues, scale, foundations

Nice background for landscape ecology of aquatic and marine systems:

Eros, T., and E. H. Campbell Grant. 2015. Unifying research on the fragmentation of terrestrial and aquatic habitats: patches, connectivity and the matrix in riverscapes. Freshwater Biology 60:1487-1501. *[Landscape ecology is not all "land;" the concepts developed in landscape ecology are also applied in aquatic and marine systems. This paper talks generally about landscape ecology concepts and applications, but in a different system.]*

Jelinski, D. E. 2015. On a landscape ecology of a harlequin environment: the marine landscape. (Editorial) Landscape Ecology 30:1-6. [*Another treatment of landscape ecology concepts from a non-terrestrial viewpoint.]*

For discussion:

Jenerette, G. D., and W. Shen. 2012. Experimental landscape ecology. Landscape Ecology 27:1237-1248. [*Nice overview of the role of experimentation in landscape ecology, and a good theme to keep in mind throughout the semester.*]

Pulsford, S. A., D. B. Lindenmayer and D. A. Driscoll. 2017. Reptiles and frogs conform to multiple conceptual landscape models in an agricultural landscape. Diversity and Distributions 23:1408-1422. [*Jumping ahead a bit, but this paper is nice because it references diverse concepts, in landscape ecology; good reminders of foundational work.*]

Rose, K. C., R. A. Graves, W. D. Hansen, B. J. Harvey, J. Qiu, S. A. Wood, C. Ziter, and M. G. Turner. 2017, Historical foundations and future directions in macrosystems ecology. Ecology Letters 20:147-157. [*Macrosystems is the new "buzz word", but it builds directly on foundational work in landscape ecology. What is different? What is the same? How does scale factor in?]*

Wu, J. 2017. Thirty years of *Landscape Ecology* (1987-2017): retrospects and prospects. Landscape Ecology 32:2225-2239. [*Current EIC of the journal reflects back on its growth; interesting to compare and contrast Tables 1 and 2.*]

(2) Wednesday, January 31 – Causes of landscape pattern

Good background (highly recommended):

Jackson, S. T. 2006. Vegetation, environment and time: the origination and termination of ecosystems. Journal of Vegetation Science 17:547-557. [*Well written essay. Good thinking on long-term change and links to paleoecology.*]

For discussion:

Phillips, J. D. 2007. The perfect landscape. Geomorphology 84:159-169. [*Really interesting conceptual paper that makes the point that every landscape is unique, and many contingencies lead to the development of any particular landscape pattern.*]

Bürgi, M., L. Östlund, and D. J. Mladenoff. 2017. Legacy effects of human land use: ecosystems as time-lagged systems. Ecosystems 20:94-103. [*Recent perspective on the importance of historical perspective in understanding contemporary systems*.]

Finsinger, W., T. Giesecke, S. Brewer, and M. Leydet. 2017. Emergence patterns of novelty in European vegetation assemblages over the past 15,000 years. [*A paleo perspective, appreciating how landscapes have changed through deep time, is important. This is one example, but there are many…and you should know the long-term history of your study region, wherever it is.*]

Lawler, J. J., D. D. Ackerly, C. M. Albano, M. G. Anderson, S. Z. Dobrowski, J. L. Gill, N. E. Heller, R. L. Pressey, E. W. Sanderson, and S. B. Weiss. 2015. The theory behind, and the challenges of, conserving nature's stage in a time of rapid change. Conservation Biology 29:618-629. [*Nice synthesis of multiple factors that drive species assemblages and are themselves changing; addresses a shifting template and requires a landscape perspective.*]

(3) Wednesday, February 7– Quantifying pattern I

Good background (highly recommended):

Li, H., and J. F. Reynolds. 1995. On definition and quantification of heterogeneity. Oikos 73:280-284. *[Nice conceptual treatment of heterogeneity; older paper, but good food for thought on what is being quantified, and one with which you should be familiar.]*

Li, H. and J. Wu. 2004. Use and misuse of landscape indices. Landscape Ecology 19:389-399. *[Synthesis of issues associated with quantifying landscape patterns, and you should be aware of all of these!]*

For discussion:

Burnicki, A. C. 2012. Impact of error on landscape pattern analyses performed on land-cover change maps. Landscape Ecology 27:713-729. [*Accuracy of the data used in any landscape analysis will influence the results, and this is especially important when you want to quantify how landscapes change over time.*]

Cushman, S. A., K. McGarigal, and M. C. Neel. 2008. Parsimony in landscape metrics: strength, universality and consistency. Ecological Indicators 8:691-703. *[Addresses the correlations among metrics and unique contributions of different kinds.]*

Almeida, D., J. Rocha, C. Neto, and P. Arsénio. 2016. Landscape metrics applied to formerly reclaimed saltmarshes: A tool to evaluate ecosystem services? Estuarine, Coastal and Shelf Science 181:100-113. [*Landscape metrics are used in a wide range of settings, not only in terrestrial landscapes, here, in salt marshes.*]

Liu, Z., C. He, and J. Wu. 2016. General spatiotemporal patterns of urbanization: an examination of 16 world cities. Sustainability 8:41. [*Landscape metrics often accompany studies of land use/land cover change; this analysis looks at urbanization.*]

(4) Wednesday, February 14 – Quantifying pattern II

Remmel, T. K. and F. Csillag. 2003. When are two landscape pattern indices significantly different? Journal of Geographical Systems 5:331-351. [*Addresses the key issue of statistical significance when comparing metrics, which has been problematic in many studies. Does reading this change your assessment of last week's readings on LULC change?*]

Eigenbrod, F., S. J. Hecnar and L. Fahrig. 2011. Sub-optimal study design has major impacts on landscape-scale inference. Biological Conservation 144:298-305. [*Lays out practical issues associated with using landscape metrics as predictors*]

Gage, E. A. and D. J. Cooper. 2017. Relationships between landscape pattern metrics, vertical structure and surface urban heat island formation in a Colorado suburb. Urban Ecosystems 20:1229-1238. [*A bit out of the ordinary, an example showing ways in which landscape metrics can be used as predictors—last week's readings had them as the descriptors of change.*]

Kupfer, J. A. 2012. Landscape ecology and biogeography: Rethinking landscape metrics in a post-FRAGSTATS landscape. Progress in Physical Geography 36:400-420. [*Nice paper for synthesis points and discussion of metrics based on network theory, which we will get to in lab when considering organism movements.*]

(5) Wednesday, February 21 – Spatial statistics

Vasquez, G. M., S. Grunwald and D. B. Myers. 2012. Associations between soil carbon and ecological landscape variables at escalating spatial scales in Florida, USA. Landscape Ecology 27:355-367. [*Geostatistics are increasingly used to quantify spatial heterogeneity in soil attributes, this is a nice example of how the are used.*]

Anderson, D. P., M. G. Turner, S. M. Pearson, T. P. Albright, R. K. Peet and A. Wieben. 2013. Predicting *Microstegium vimineum* invasion in natural plant communities of the southern Blue Ridge Mountains, USA. Biological Invasions 15:1217-1230. [*Example of how spatial autocorrelation in the residuals of an analysis that includes many environmental co-variates can be informative about landscape dynamics, here an incipient invasion process.*]

Berry, L. E., D. A. Driscoll, J. A. Stein, W. Blanchard, S. C. Banks, R. A. Bradstock, and D. B Lindemayer. 2015. Identifying the location of fire refuges in wet forest ecosystems. Ecological Applications 25:2337-2348. [*Variograms are only one method used in this study, but it demonstrates how they can contribute to a broader approach.*]

Smithwick, E. A. H., K. J. Naithani, T. C. Balser, W. H. Romme, and M. G. Turner. 2012. Post-fire spatial patterns of soil nitrogen mineralization and microbial abundance PLoS ONE 7(11):e50597. [*Down in the weeds on the methods, but demonstrates how spatial statistics can be run across multiple variables to generate insights on pattern-process.*]

(6) Wednesday, February 28 – Landscape models

Good background (highly recommended):

Strayer D. L., H. A. Ewing and S. Bigelow. 2003. What kind of spatial and temporal details are required in models of heterogeneous systems? *Oikos* 102:654-62. [*Excellent treatment of the conceptual issues associated with introducing spatial complexity into models.*]

Gardner, R. H., and D. L. Urban. 2007. Neutral models for testing landscape hypotheses. Landscape Ecology 22:15-29. [*Gardner was lead author of the original neutral landscape model paper; this is a nice summary of the those models, which you will run in lab.*]

For discussion:

DeAngelis, D. A. and S. Yurek. 2017. Spatially explicit modeling in ecology: A review. Ecosystems 20:284-300. [*Recent review by one of the pioneers of spatially explicit individual-based models in landscape ecology, important context for how spatial models have evolved.]*

Gustafson, E. J. 2013. When relationships estimated in the past cannot be used to predict the future: using mechanistic models to predict landscape ecological dynamics in a changing world. Landscape Ecology 28:1429-1437. *[Commentary by a forest landscape ecologist who has been developing and applying spatial models. These points remain important as scientists try to model no-analog future conditions.]*

Sleeter, B. M., T. S. Wilson, E. Sharygin, and J. T. Sherba. 2017. Future scenarios of land change based on empirical data and demographic trends. Earth's Future 5: 1068-1983. [*Example of how land-cover change models can be developed and applied; there many kinds of landscape model.]*

Daniel, C. J., L. Frid, B. M. Sleeter, and M-J Fortin. 2016. State-and-transition simulation models: a framework for forecasting landscape change. Methods in Ecology and Evolution 7:1413-1423. [*Overview of the STSM approach for spatial modeling; more sophisticated approach compared to the first order Markov chain.*]

(7) Wednesday, March 7 – Disturbance and landscapes I

Good background:

Turner, M. G. 2010. Disturbance and landscape dynamics in a changing world. Ecology 91:2833-2849. [*Overview of the importance of disturbance in landscapes, with examples from Yellowstone.*]

For discussion:

Paritsis, J., A. Holz, T. T. Veblen, and T. Kitzberger. 2013. Habitat distribution modeling reveals vegetation flammability and land use as drivers of wildfire in SW Patagonia. Ecosphere DOI: 10.1890/ES12-00378.1. [*Vulnerability to disturbance may vary with landscape position; this paper considers a variety of independent variables that may aid spatial prediction of probability of fire occurrence.*]

Harvey, B. J., D. C. Donato and M. G. Turner. 2016. Drivers and trends in spatial patterns of burn severity in forests of the US Northern Rocky Mountains (1984-2010). Landscape Ecology 31:2367-2383. [*Uses landscape metrics to test for changing disturbance-generated spatial patterns in burned forests of the Northern Rockies.*]

Bebi, P., R. Seidl, R. Motta, M. Fuhr, D. Firm, F. Krumm, M. Conedera, C. Ginzler, T. Wohlgemuth, and D. Kulakowski. 2017, Changes of forest cover and disturbance regimes in the mountain forests of the Alps. Forest Ecology and Management 388:43-56. [*Analyzes forest cover and disturbance regimes over the past millennia in the Alps.*]

Meentemeyer, R. K., S. E. Haas, and T. Vaclavik. 2012. Landscape epidemiology of emerging infectious diseases in natural and human-altered ecosystems. Annual Review of Phytopathology 50:379-402. [*Landscape or spatial epidemiology has emerged as an interesting area of research that overlaps with landscape ecology and disturbance.*]

(8) Wednesday, March 14 – Disturbance and landscapes II

Good background:

Fraterrigo, J. M. and J. A. Rusak. 2008. Disturbance-driven changes in the variability of ecological patterns and processes. Ecology Letters 11:756-770. [*Nice conceptual treatment focused on gaining insights from variability, along with practical guidance on how to assess it.*]

For discussion:

Duncan, S. L., B. C. McComb, and K. N. Johnson. 2010. Integration ecological and social ranges of variability in conservation of biodiversity: past, present, and future. Ecology and Society Vol15/iss1/art5/. [*Adds the social part of the equation to the historical range of variability concept.*]

Johnstone, J. F., C. D. Allen, J. F. Franklin, L. E. Frelich, B. J. Harvey, P. E. Higuera, M. C. Mack, R. K. Meentemeyer, M. R. Metz, G. L. W. Perry, T. Schoennagel, and M. G. Turner. 2016. Changing disturbance regimes, climate warming and forest resilience. Frontiers in Ecology and the Environment 14:369-378. [*Current thinking on how forest resilience could be compromised in the future as climate and disturbance regimes change.*]

Bowman, D. M. J. S., G. L. W. Perry, and J. B. Marston. 2015. Feedbacks and landscape-level vegetation dynamics. TREE 30:255-260. [*Feedbacks on the landscape between post-disturbance vegetation and future disturbance occurrence/severity is a hot topic.*]

Seidl, R., D. C. Donato, K. A Raffa, and M. G. Turner. 2016. Spatial variability in tree regeneration after wildfire delays and dampens future bark beetle outbreaks. Proceedings of the National Academy of Sciences 113:13075-13080. [*Disturbance interactions remains a hot topic, and most are implicitly considered as negative; this highlights a dampening interaction.*]

(9) Wednesday, March 21 – Organisms and landscapes I

Good background:

Tscharntke, T., J. M. Tylianakis, T. A. Rand, R. K. Didham, L. Fahrig, et al. 2012. Landscape moderation of biodiversity patterns and processes – eight hypotheses. Biological Reviews 87:661-685. [*Synthesizing landscape effects on biodiversity, good ideas within!*]

Dormann, C. F., O. Schweiger, I. Augenstein and many others. 2007. Effects of landscape structure and land-use intensity on similarity of plant and animal communities. Global Ecology and Biogeography 16:774-787. [*Example of recent studies moving beyond single-species analysis to consider communities.*]

Thaker, M., A. T. Vanak, C. R. Owen, M. B. Ogden, S. M. Niemann and R. Slotow. 2011. Minimizing predation risk on a landscape of multiple predators: effects on the spatial distribution of African ungulates. Ecology 92:398-407. [*Paper on how spatial heterogeneity influences pred-prey interaction in an African landscape with multiple predators and multiple prey.*]

McCune J. L. and M. Vellend. 2015. Using plant traits to predict the sensitivity of colonizations and extirpations to landscape context. Oecologia 178:511-524. [*Landscape ecology has long focused on how composition and configuration affect species or guilds; the recent emphasis on plant traits offers additional response variables to consider in analyses. This study also illustrate effects of landscape context.*]

For discussion:

Fahrig, L. 2017. Ecological responses to habitat fragmentation per se. Annual Review of Ecology, Evolution and Systematics 48:1-23. [*Fahrig is one of the leaders in research on how organisms*

respond to landscape patterns; her earlier paper on the Habitat Amount Hypothesis triggered spirited discussion.]

Haddad, N. M., A. Gonzalez, L. A. Brudvig, M. A. Burt, D. J. Levey, and E. I Damschen. 2017. Experimental evidence does not support the Habitat Amount Hypothesis. Ecography 40:48-55. [*Current debate about the relative importance of composition (amount) vs. configuration on organisms, specifically Fahrig's 2013 paper advancing the Habitat Amount Hypothesis.]*

Prevedello, J. A., N. J. Gotelli, and J. P. Metzger. 2016. A stochastic model for landscape patterns of biodiversity. Ecological Monographs. [*Modeling approach, how does this inform debate about the Habitat Amount Hypothesis?*]

Ferrante, L., F. B. Baccaro, E. B. Ferreira, M. F de Oliveira Sampaio, T. Santos, R. C. Justino and A. Angulo. 2017. The matrix effect: how agricultural matrices shape forest fragment structure and amphibian composition. Journal of Biogeography 44:1911-1922. *[Landscape context, or the matrix, can influence presence or abundance of many species, and local and surrounding features are typically considered in resource selection functions or occupancy models.*]

SPRING BREAK

(10) Wednesday, April 4 – Organisms and landscapes II

Good background:

Manel, S. and R. Holderegger. 2013. Ten years of landscape genetics. TREE 28:614-621. [*Landscape genetics has become a big deal with lots of potential remaining. This literature has grown tremendously, and the application of molecular techniques to understand species distributions and migration patterns, or to assess local selective forces, is very promising.]*

For discussion:

Hall, L. A., and S. R. Beisinger. 2014. A practical toolbox for design and analysis of landscape genetics studies. Landscape Ecology 29:1487-1504. [*It is important to be aware of the capabilities offered by landscape genetics studies.*]

Auffret, A. G., Y. Rico, J. M. Bullock, D. A. P. Hooftman, R. J Pakeman, M. B. Soons, A. Suarez-Esteban, A. Traveset, H. H. Wagner, and S. A. O. Cousins. 2017. Plant functional connectivity – integrating landscape structure and effective dispersal. Journal of Ecology 105:1648-1656. [*Connectivity has to be related to the particular organism or process being considered. Good recent perspective on plant dispersal.*]

Leonard, P. B., R. W. Sutherland, R. F. Baldwin, D. A. Fedak, R. G. Carnes, and A. P. Montgomery. 2017. Landscape connectivity losses due to sea level rise and land use change. Animal Conservation 20:80-90. [*Sticking with the theme of connectivity and networks, this is an interesting study of how landscape structure changes with two different drivers, has an applied bent.]*

Samsing, F., I. Johnsen, T. Dempster, F. Oppedal, and E. A. Treml. 2017. Network analysis reveals strong seasonality in the dispersal of a marine parasite and identifies areas for coordinated management. Landscape Ecology 32:1953-1967. [*Example of how network modeling is used in an important spatial marine system.*]

(11) Wednesday, April 11 – Ecosystem processes

Crum, S. M., L. L. Liang, and G. D. Jenerette. 2016. Landscape position influences soil respiration variability and sensitivity to physiological drivers in mixed-use lands of Southern California, USA. JGR: Biogeosciences 121:2530-2543. [*Example of how landscape position can influence an ecosystem process rate.*]

Buffam, I., M. G. Turner, A. Desai, P. J. Hanson, J. Rusak, N. Lottig and S. R. Carpenter. 2011. Integrating aquatic and terrestrial components to construct a complete carbon budget for a north temperate lake district. Global Change Biology 17:1193-1211. [*Example of building a regional C budget by including all major ecosystem types, which is seldom done; focus here is on spatial heterogeneity of vertical fluxes.*]

Murray, B. D., C. R. Webster, and J. K. Bump. 2014. A migratory ungulate facilitates cross-boundary nitrogen transport in forested landscapes. Ecosystems 17:1002-1013. [*Animals are often vectors of nutrient movements across heterogeneous landscapes, affecting heterogeneity of nutrient pools and transformations.*]

Turetsky, M. R., J. L. Baltzer, J. F. Johnstone, M. C. Mack, K. McCann, and E.A.G. Schuur. 2017. Losing legacies, ecological release, and transient responses: key challenges for the future of northern ecosystem science. Ecosystems 20:23-30. [*Although this focuses on the boreal, the general questions illustrate frontiers at the interface of landscape ecology and ecosystem ecology.*]

(12) Wednesday, April 18 —Landscape pattern and ecosystem services

Boesing, A. L., E. Nichols, and J. P. Metzger. 2017. Effects of landscape structure on avian-mediated insect pest control services: a review. Landscape Ecology 32:931-944. [*Effects of landscape pattern on species interactions, here pest control, is an area of much current interest.]*

Renard, D., J. M. Rhemtulla, and E. M. Bennett. 2015. Historical dynamics in ecosystem service bundles. Proceedings of the National Academy of Sciences 112:13411-13416. [*Nice study integrating land-use change, supply of ecosystem services, and consideration of variation over both space and time in a mixed-use landscape. These issues are fundamental to studies of landscape sustainability.*]

Qiu, J., S. R. Carpenter, E. C. Booth, M. Motew, S. C. Zipper, C. J. Kucharik, X. Chen, S. P. Loheide II, J. Seifert, and M. G. Turner. 2018. Scenarios reveal pathways to sustain future ecosystem services in an agricultural landscape. Ecological Applications 28:119-134. [*One of the synthetic papers from a 5-yr research project focused on the Yahara Watershed.*]

Schulte, L. A., J. Niemi, M. J. Helmers, M. Liebman, J. G. Arbuckle, D. E. James, R. K. Kolka, M. E. O'Neal, M. D. Tomer, J. C. Tyndall, H. Asbjornsen, P. Drobney, J. Neal, G. Van Ryswyk, and C. Witte. 2017. Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn-soybean croplands. Proceedings of the National Academy of Sciences 114:11247-11252. [*Manipulating the landscape to enhance ecosystem services in the agricultural upper Midwest.*]

(13) Friday, April 20 – Future directions in landscape ecology

Wu, J. 2014. Urban ecology and sustainability: The state-of-the-science and future directions. Landscape and Urban Planning 125:209-221. [*Overview of urban ecology, which is a growing direction within landscape ecology.*]

Hahn, M. B., E. S. Gurley, J. E. Epstein, M. S. Islam, J. A. Patz, P. Daszak, and S. P. Luby. 2014. The role of landscape composition and configuration on *Pteropus giganteus* roosting ecology and Nipah virus spillover risk in Bangladesh. American Journal of Tropical Medicine and Hygiene 90:247-255. [*The intersection of landscape ecology and human health issues, including infectious diseases, is an exciting interdisciplinary frontier. Again, lots of opportunity to explore these new dimensions!]*

Standish, R. J., R. J. Hobbs, M. M. Mayfield, B. T. Bestelmeyer, K. N. Suding, L. L. Battaglia, V. Eviner, C. V. Hawkes, V. M. Temperton, V. A. Cramer, J. A. Harris, J. L. Funk, and P. A. Thomas. 2014. Resilience in ecology: Abstraction, distraction, or where the action is? Biological Conservation 177:43-51. [*Thresholds, regime shifts, and 'new normals' will continue to challenge landscape ecologists in the decades ahead.*]

Van Zanten, B. T., D. B. Van Berkel, R. K. Meentemeyer, J. W. Smith, K. F. Tieskens, and P. H Verburg. 2016, Continental-scale quantification of landscape values using social media data. Proceedings of the National Academy of Sciences 113:12974-12979. [*Data from social media are increasingly used for landscape assessments, especially of cultural ecosystem services. What are pros and cons of this kind of data?*]