EAS 539: Landscape Ecology

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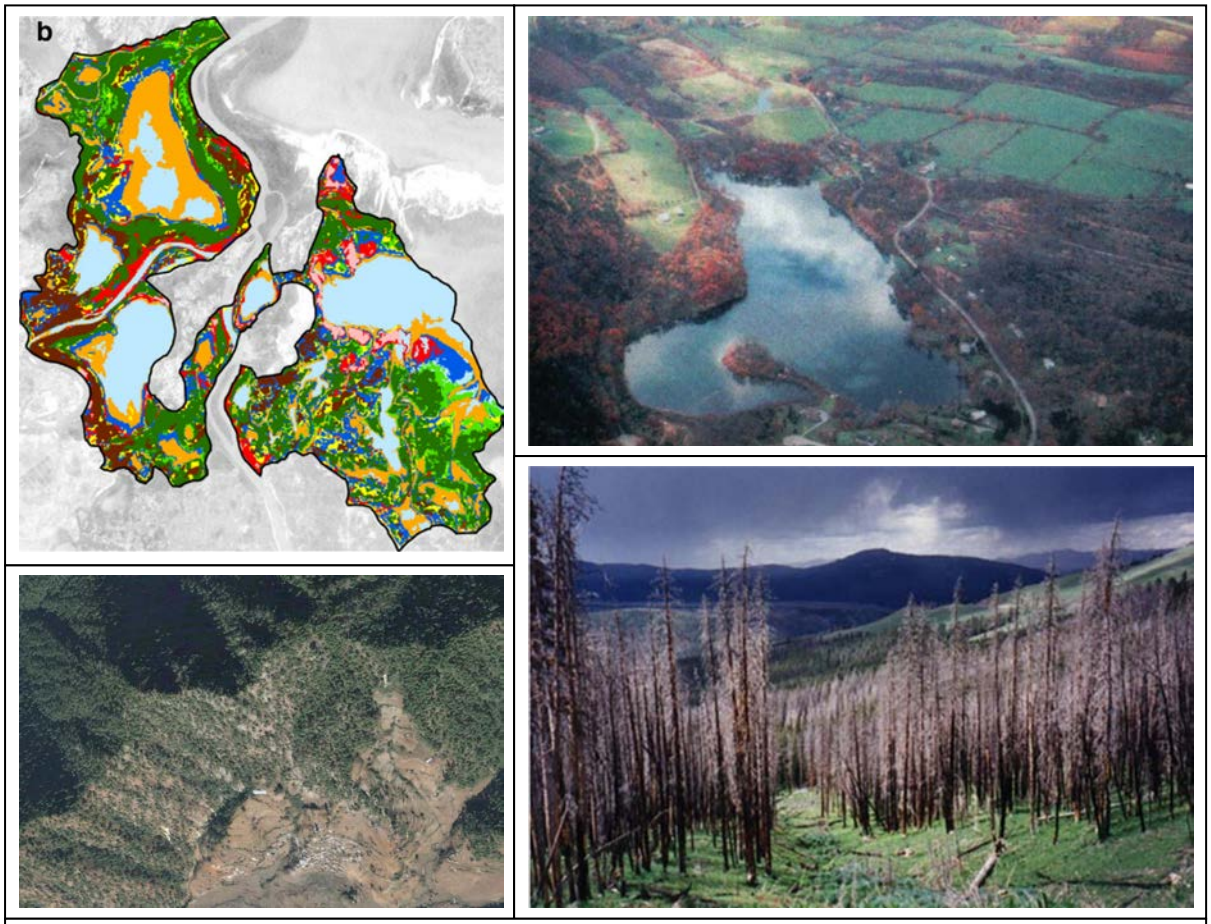
Winter 2020 A, 2 credit hours
Class meets Tuesday and Thursday 2:30 – 3:50 Jan 9th – Feb 25th (Dana 1028)



Images, clockwise from top left: Wetland plant functional types around Poyang Lake, China, Dronova et al. 2012; Mixed use U.S. landscape, Cadenasso et al. 2003; Yellowstone fire of 1988, AnneMullen.com; Google Earth image of a rural village in the Himalaya

Description

Landscape ecology is a question-driven discipline in which the central question is 'how does landscape structure affect ecological processes?' This includes ecological processes at the population, community, and ecosystem levels. At the population level, we might ask whether landscape structure affects reproduction or dispersal. At the community level we might ask whether landscape structure affects predator-prey interactions or the success of invasive species. At the ecosystem level we might ask whether landscape structure affects NPP (net primary productivity), evapotranspiration, or carbon sequestration.

This course takes an approach that is inquiry-based, evidence- and applied research-oriented, as opposed to theory-driven. We consider the questions that landscape ecology addresses and we analyze

studies in the primary literature that have addressed these questions. We examine papers that focus on a variety of ecological systems and habitats including wetlands, grasslands, forests, and human-dominated, multiple-use landscapes. Assigned readings emphasize current literature while lectures and class discussion will cover topics from some additional foundational papers and texts. Although theory or modeling are not the focus of the course, we will introduce and discuss some theoretical concepts and models as needed in order to convey the fundamental principles in the field.

This course has these main areas of focus:

1. Does landscape structure, including variability in both space and time, affect ecological processes? We consider ecological processes at the population, community, and ecosystem levels.
2. What are the characteristics of landscape structure that are used to address question #1? These include patch sizes and distances, the nature of edge-influenced area and patch-interior area, the nature of the landscape matrix as it affects different species, and other topics.
3. What are the causes of landscape structure and heterogeneity, both natural and human-caused? Natural causes include physiographic variability and disturbance regimes. Human causes include resource extraction, land use / land cover change, habitat fragmentation, and others.

Learning goals, approaches and outcomes

By the end of this course you will have learned to recognize and to formulate the types of questions that are asked in landscape ecology and describe some of the methods used to address them effectively. You will have learned to understand many of the key concepts in landscape ecology and how to use and apply them correctly to current questions and issues in the field. You will improve your ability to read and critically evaluate papers in the primary ecological literature. You will come away with a new understanding of scale, environmental heterogeneity, and how these interact with ecological processes at levels of organization from population, to community, to ecosystem processes.

You will improve your ability to communicate questions and articulate concepts in class discussion. You will improve your skill to communicate effectively through presentations by conducting critical peer evaluations of other students, by giving your own presentation, and by receiving peer feedback.

Two primary approaches are used: question-driven learning, and the use of case studies from the primary literature. We will see how the questions of landscape ecology are addressed through the range of methods used by practitioners, including empirical studies and modeling studies. In some weeks there is an assigned reading and assigned critical review that presents a case study of an investigation into a question in landscape ecology. You will write a brief critical analysis of the paper before class, then the instructor will present the key points from the assigned paper as well as illustrations from other case studies that addressed similar questions. In your presentations and peer evaluation of other students' presentations, you will further engage with question-driven case studies of research in landscape ecology.

You are encouraged to ask questions and make comparisons in class. As we discuss research case studies, various theories will be presented and discussed as they arise. Students will see the role of theory as an effort to generalize from empirical and modeling studies and synthesize understanding so it can be used in applied problems. You will be assessed in your ability to draw on fundamental principles,

key concepts, and to understand landscape ecology questions and approaches in your critical analyses, class presentations, and on the exam.

Assignment: 4 review summaries of assigned readings

Students will complete brief review summaries of 4 assigned readings that present case studies of current research in landscape ecology. Where these are assigned, give yourself enough time to read, fully understand, and reflect on the reading. Write a 300 to 450 word review summary of the assigned reading and **upload this as an assignment in Canvas at least two hours before the class it was assigned for**. The purpose of this assignment is to develop a brief but thoughtful summary of the paper and to suggest questions or criticisms that could be discussed in class. In your summary, address these points: What question in landscape ecology does the paper address? What methods did the authors use? How does the authors' design of the research or interpretation of results draw on key concepts in the field? In your summary, explicitly and correctly use at least three key terms or concepts from our key-concepts handout. Write these reviews using your highest level of insight. State some questions or criticisms that you have, after reading this paper, that could be used as inroads for class discussion (thus the need to submit the analyses at least 2 hours prior to class.) These will be graded in Canvas each week to provide immediate feedback.

Assignment: Student presentation of an applied paper in landscape ecology

Each student will present to the class an applied paper in landscape ecology and answer brief questions. Students may select any paper from the course reading list with an asterisk (*) or use a different paper that you find on your own, with prior instructor approval. The presentation must run TBD minutes. Then, depending on the time available, answer audience questions about your paper for 2-3 minutes. In your presentation, use PowerPoint slides and provide an introduction, a methods section, results, and your interpretation and analysis. What landscape-ecology questions does the paper address? What level of organization does it focus on? In your presentation, link to theories and concepts we have covered in the course; explicitly and correctly use at least three concepts from our key-concepts handout. This may seem like a lot to squeeze in, but it is important to BE BRIEF and very economical with your words. *<u>These are not "informal" presentations</u>. This is an opportunity to practice using your best professional presentation skills and practice keeping to the time period allotted.* (See the rubric that will be used by the instructor and your peers to assess these presentations.)

Note: bring your presentation on a flash drive before the start of class so they can all be loaded onto the instructor's computer in advance. Please include your <u>last name</u> in the filename.

Assignment: Peer evaluation of presentations

The ability to make a clear and effective presentation is an important communication skill for both academics and professionals. We will spend some class time learning and discussing effective presentation skills. **Students will anonymously peer-evaluate one another's presentations using a rubric provided by the instructor.** Evaluate the evidence you saw concerning how well the presenter understood the paper, evaluate the quality of the analysis presented and the clarity and effectiveness of the presentation skills. Peer evaluations will be turned into the instructor. Put your name at the bottom of the evaluation rubric; the instructor will remove these names and pass all of the evaluations to the presenter, together with the instructor's comments and evaluation. Your evaluations will be graded based on your level of engagement and usefulness of the observations and feedback you provide to the other students in your comments.

Exam

There will be one exam, given in class on the last day of class. Its purpose is to assess the learning of fundamental concepts and principles from lectures and readings; the understanding of how concepts and theory are applied to study problems and issues in landscape ecology, as covered in readings, lectures, class discussion, and student presentations; and the ability to correctly articulate questions and apply key concepts in the critical analysis of ecological issues and questions in landscapes. It will include multiple choice, short answer questions, and a short essay.

Grading

Grade will be based on 4 critical reviews of assigned readings (100 points), presentation of an applied paper and answering questions (125 points), one exam (125 points) and class participation (50 points). This totals 400 points.

Class participation: Learning requires a willingness to examine one's own pre-conceived notions or assumptions and to expand one's foundation or framework to build the conceptual structure for new knowledge. This is demanding. It requires energy, effort, and focus. It requires an interest in engaging with a topic, grappling with new ideas, questioning and challenging others, and striving to think in new ways. Students are expected to show a high level of engagement and participation in the learning process. Ask questions during lecture and discussions. Respond to questions posed by the instructor. Follow up or respond to questions posed by other students. Instead of being passive onlookers, actively challenge one another.

Each week, listed on the syllabus is a discussion question. We will discuss these questions as a class on the second class meeting of the week; depending on the timing of other class activities these discussions will range in duration. Think about each week's question in advance and be prepared to contribute something to the discussion.

Syllabus and Schedule

Week 1. Landscape structure and the questions of landscape ecology

Thurs Jan 9
Tues Jan 14

This week focuses on introductory material including landscape structure, metrics, and scale.

Assigned reading: Skim, and begin to use the handout Currie 2014, Key concepts in Landscape Ecology. (Continue to refer to this throughout the course and use it on other assignments.)

Week 2. Does landscape structure affect population processes?

Thurs Jan 16. Assigned reading: Mueller et al. 2014. (Review summary #1 due 2 hours before class.)

Tues Jan 21

Discussion question: In assessing the effects of landscape structure on population-level processes, do we need to study each species individually? Or is it possible to use "model" species?

Week 3. Does landscape structure affect community processes?

Thurs Jan 23. Assigned reading: Schippers et al. 2014. (Review summary #2 due 2 hours before class.)

Tues Jan 28

Discussion question: How does one identify the "right" scale to study an ecological question?

Week 4. Does landscape structure affect ecosystem processes?

Thurs Jan 30. Assigned reading: Scheller et al. 2012. (Review summary #3 due 2 hours before class.)

Tues Feb 4. Discussion question: What does it mean to say that ecosystem-level processes are, or are not, affected by landscape structure?

Week 5. What drives spatial heterogeneity? The roles of disturbance and human activities

Thurs Feb 6. Assigned reading: Foster et al. 1998 (b), Ecosystems 1: 497-510. (Review summary #4 due 2 hours before class.)

Tues Feb 11. Discussion question: If land use history and disturbance history are critically important, how does one design ecological studies to confront these factors?

Week 6. Student presentations

Thurs Feb 13. Student presentations

Tues Feb 18. Student presentations

Week 7. Exam

Thurs Feb 20. Student presentations

Tues Feb 25. Final exam, in class.

Assigned and optional readings

This list serves multiple purposes. First, it contains some historical and overview papers that you can read to learn more about landscape ecology and its history. Second, readings with an asterisk (*) may be used for student presentations of applied papers for the presentation assignment. (Others on this list are either papers that are already assigned, or that provide historical overviews or are unsuitable for student presentations for other reasons.) All of the papers on this list can be found on the course Canvas site.

Brady, M., Sahrbacher, C., Kellermann, K., and Happe, K., 2012, An agent-based approach to modeling impacts of agricultural policy on land use, biodiversity and ecosystem services: Landscape Ecology, v. 27, p. 1363-1381.

*Bergman, K.-O., J. Dániel-Ferreira, P. Milberg, E. Öckinger and L. Westerberg (2018). Butterflies in Swedish grasslands benefit from forest and respond to landscape composition at different spatial scales. Landscape Ecology 33(12): 2189-2204.

*Buenau, K.E., Rassweiler, A., and Nisbet, R.M., 2007, The effects of landscape structure on space competition and alternative stable states: Ecology, v. 88, p. 3022-3031.

Cadenasso, M.L., Pickett, S.T.A., Weathers, K.C., and Jones, C.G., 2003, A Framework for a Theory of Ecological Boundaries: BioScience, v. 53, p. 750-758.

Currie, W. S. 2014. Key concepts in landscape ecology. Unpublished document.

Currie, W.S., Kiger, S., Nassauer, J.I., Hutchins, M., Marshall, L.L., Brown, D.G., Riolo, R., and Robinson, D.T. 2016. Multi-scale heterogeneity in vegetation and soil carbon in exurban residential land of southeastern Michigan, USA. Ecological Applications 26(5):1421-1436.

Chen, J.Q., Brosofske, K.D., Noormets, A., Crow, T.R., Bresee, M.K., Le Moine, J.M., Euskirchen, E.S., Mather, S.V., and Zheng, D. 2004. A working framework for quantifying carbon sequestration in disturbed land mosaics. Environmental Management, v. 33, p. S210-S221.

Chen, J., and Saunders, S., 2006, Ecology of multiple ecosystems in time and space, in Chen, J., Saunders, S., Brosofske, K.D., and Crow, T.R., eds., Ecology of Hierarchical Landscapes: From Theory to Applications: New York, New York, USA, Nova Science Publishers, Inc., p. 1-36

*Cheruvelil, K.S., Soranno, P.A., Webster, K.E., and Bremigan, M.T., 2013, Multi-scaled drivers of ecosystem state: quantifying the importance of the regional spatial scale: Ecological Applications, v. 23, p. 1603-1618.

DeFries, R., Rovero, F., Wright, P., Ahumada, J., Andelman, S., Brandon, K., Dempewolf, J., Hansen, A., Hewson, J., and Liu, J., 2010 (a), From plot to landscape scale: linking tropical biodiversity measurements across spatial scales: Frontiers in Ecology and the Environment, v. 8, p. 153-160.

DeFries, R., Karanth, K.K., and Pareeth, S., 2010 (b), Interactions between protected areas and their surroundings in human-dominated tropical landscapes: Biological Conservation, v. 143, p. 2870-2880.

*Dronova, I., Bergen, K., and Ellsworth, D., 2011, Forest Canopy Properties and Variation in Aboveground Net Primary Production over Upper Great Lakes Landscapes: Ecosystems, v. 14, p. 865-879.

*Foster, D.R., Motzkin, G., and Slater, B., 1998 (a), Land-use history as long-term broad-scale disturbance: Regional forest dynamics in central New England: Ecosystems, v. 1, p. 96-119.

Foster, D.R., Knight, D.H., and Franklin, J.F., 1998 (b), Landscape patterns and legacies resulting from large, infrequent forest disturbances: Ecosystems, v. 1, p. 497-510.

*Fuentes-Montemayor, E., K. Watts, N. A. Macgregor, Z. Lopez-Gallego and K. J. Park. 2017. Species mobility and landscape context determine the importance of local and landscape-level attributes. Ecological Applications 27(5): 1541-1554.

*Galitsky, C. and J. Lawler. 2015. Relative influence of local and landscape factors on bird communities vary by species and functional group. Landscape Ecology 30(2): 287-299.

*Gardiner, R., G. Bain, R. Hamer, M. E. Jones and C. N. Johnson. 2018. Habitat amount and quality, not patch size, determine persistence of a woodland-dependent mammal in an agricultural landscape. Landscape Ecology 33(11): 1837-1849.

*González, E., L. Buffa, M. T. Defagó, S. I. Molina, A. Salvo and G. Valladares. 2018. Something is lost and something is gained: loss and replacement of species and functional groups in ant communities at fragmented forests. Landscape Ecology 33(12): 2089-2102.

*Graham, J. B., J. I. Nassauer, W. S. Currie, H. Ssegane and M. C. Negri. 2017. Assessing wild bees in perennial bioenergy landscapes: effects of bionergy crop composition, landscape configuration, and bioenergy crop area. Landscape Ecology 32: 1023-1037.

Harper, K.A., Macdonald, S.E., Burton, P.J., Chen, J., Brosofske, K.D., Saunders, S.C., Euskirchen, E.S., Roberts, D.A.R., Jaiteh, M.S., and Esseen, P.-A., 2005, Edge Influence on Forest Structure and Composition in Fragmented Landscapes. Conservation Biology, v. 19, p. 768-782.

He, H.S., and Mladenoff, D.J., 1999, Spatially explicit and stochastic simulation of forest-landscape fire disturbance and succession: Ecology, v. 80, p. 81-99.

*Ibáñez, I., Silander, J.A., Wilson, A.M., LaFleur, N., Tanaka, N., and Tsuyama, I., 2009, Multivariate forecasts of potential distributions of invasive plant species: Ecological Applications, v. 19, p. 359-375.

*Iwamura T, Possingham HP, Chadès I, Minton C, Murray NJ, Rogers DI, et al. 2013. Migratory connectivity magnifies the consequences of habitat loss from sea-level rise for shorebird populations. Proceedings of the Royal Society B: Biological Sciences 280:20130325.

*Johnstone, J.F., Hollingsworth, T.N., Chapin, F.S.I., and Mack, M., C. , 2010, Changes in fire regime break the legacy lock on successional trajectories in Alaskan boreal forest: Global Change Biology, v. 16, p. 1281-1295.

*Krishna, P.H., Reddy, C.S., Singh, R., and Jha, C.S., 2014, Landscape level analysis of disturbance regimes in protected areas of Rajasthan, India: Journal of Earth System Science, v. 123, p. 467-478.

*Little, C. J. and F. Altermatt. 2018. Landscape configuration alters spatial arrangement of terrestrial-aquatic subsidies in headwater streams. Landscape Ecology 33(9): 1519-1531.

MacArthur, R.H., and Pianka, E.R., 1966, On optimal use of a patchy environment: The American Naturalist, v. 100, p. 603-609.

*Maresh Nelson, S. B., J. J. Coon, C. J. Duchardt, J. R. Miller, D. M. Debinski and W. H. Schacht. 2018. Contrasting impacts of invasive plants and human-altered landscape context on nest survival and brood parasitism of a grassland bird. Landscape Ecology 33(10): 1799-1813.

*Miller, J. E. D., A. R. Ives, S. P. Harrison and E. I. Damschen. 2017. Early- and late-flowering guilds respond differently to landscape spatial structure. Journal of Ecology.

Mueller, T., Lenz, J., Caprano, T., Fiedler, W., and Bohning-Gaese, K., 2014, Large frugivorous birds facilitate functional connectivity of fragmented landscapes: Journal of Applied Ecology, v. 51, p. 684-692.

National Academy of Sciences, 2010, Landscapes on the Edge. New Horizons for Research on Earth's Surface: Washington, DC, Committee on Challenges and Opportunities in Earth Surface Processes. National Research Council of the National Academies. Available online: http://www.nap.edu/openbook.php?record_id=12700

Nowacki, G.J., and Abrams, M.D., 2008, The Demise of Fire and “Mesophication” of Forests in the Eastern United States: Bioscience, v. 58, p. 123-138.

Opdam, P., S. Luque, J. Nassauer, P. H. Verburg and J. Wu. 2018. How can landscape ecology contribute to sustainability science? Landscape Ecology 33(1): 1-7.

Parrott, L., and Meyer, W.S., 2012, Future landscapes: managing within complexity: Frontiers in Ecology and the Environment, v. 10, p. 382-389.

Pickett, S.T.A., and Cadenasso, M.L., 1995, Landscape ecology: Spatial heterogeneity in ecological systems: Science, v. 269, p. 331-334.

*Planty-Tabacchi, A.-M., Tabacchi, E., Naiman, R.J., Deferrari, C., and Décamps, H., 1996, Invasibility of Species-Rich Communities in Riparian Zones: Conservation Biology, v. 10, p. 598-607.

Ravenscroft, C., Scheller, R.M., Mladenoff, D.J., and White, M.A., 2010, Forest restoration in a mixed-ownership landscape under climate change: Ecological Applications, v. 20, p. 327-346.

Ricketts T. H. 2001. The matrix matters: Effective isolation in fragmented landscapes. The American Naturalist 158(1):87-99

*Robinson, D.T., Brown, D.G., and Currie, W.S., 2009, Modelling carbon storage in highly fragmented and human-dominated landscapes: Linking land-cover patterns and ecosystem models: Ecological Modelling, v. 220, p. 1325-1338.

*Rodrigues, A., Koeppl, H., Ohtsuki, H., and Satake, A., 2009, A game theoretical model of deforestation in human-environment relationships: Journal of Theoretical Biology, v. 258, p. 127-134.

Romme, W.H., Everham, E.H., Frelich, L.E., Moritz, M.A., and Sparks, R.E., 1998, Are Large, Infrequent Disturbances Qualitatively Different from Small, Frequent Disturbances?: Ecosystems, v. 1, p. 524-534.

Scheller, R.M., Kretchen, A.M., Van Tuyl, S., Clark, K.L., Lucash, M.S., and Hom, J., 2012, Divergent carbon dynamics under climate change in forests with diverse soils, tree species, and land use histories: Ecosphere, v. 3, p. Article 110:1-16.

Schippers, P., van Teeffelen, A.J.A., Verboom, J., Vos, C.C., Kramer, K., and WallisDeVries, M.F., 2014, The impact of large herbivores on woodland–grassland dynamics in fragmented landscapes: The role of spatial configuration and disturbance: Ecological Complexity, v. 17, p. 20-31.

Strayer, D.L., Power, M.E., Fagan, W.F., Pickett, S.T.A., and Belnap, J., 2003, A Classification of Ecological Boundaries: BioScience, v. 53, p. 723-729.

*Theobald, D.M., Crooks, K.R., and Norman, J.B., 2011, Assessing effects of land use on landscape connectivity: loss and fragmentation of western U.S. forests: Ecological Applications, v. 21, p. 2445-2458.
*Theobald, D.M., and Romme, W.H., 2007, Expansion of the US wildland-urban interface: Landscape and Urban Planning, v. 83, p. 340-354.
*Thompson, J.R., Foster, D.R., Scheller, R., and Kittredge, D., 2011, The influence of land use and climate change on forest biomass and composition in Massachusetts, USA: Ecological Applications, v. 21, p. 2425-2444.
*Weathers, K. C., M. L. Cadenasso and S. T. A. Pickett. 2001. Forest Edges as Nutrient and Pollutant Concentrators: Potential Synergisms between Fragmentation, Forest Canopies, and the Atmosphere. Conservation Biology 15(6): 1506-1514.
Wirsing, A.J., and Ripple, W.J., 2010, A comparison of shark and wolf research reveals similar behavioral responses by prey: Frontiers in Ecology and the Environment, v. 9, p. 335-341.
Wu, J., 2013, Landscape sustainability science: ecosystem services and human well-being in changing landscapes: Landscape Ecology, v. 28, p. 999-1023.
Wu, J., 2013, Key concepts and research topics in landscape ecology revisited: 30 years after the Allerton Park workshop: Landscape Ecology, v. 28, p. 1-11.
*Wu, J.G., and Levin, S.A., 1994, A Spatial Patch Dynamic Modeling Approach to Pattern and Process in an Annual Grassland: Ecological Monographs, v. 64, p. 447-464.
*Xiao, J., Davis, K.J., Urban, N.M., Keller, K., and Saliendra, N.Z., 2011, Upscaling carbon fluxes from towers to the regional scale: Influence of parameter variability and land cover representation on regional flux estimates: Journal of Geophysical Research: Biogeosciences, v. 116, p. G00J06.

Additional Course Expectations

Computers and phones

1. Please take care if you use computers during class. This class has a lecture-discussion-presentation format. When you are looking at a laptop screen, the lack of eye contact makes it harder for you and the speaker to engage in question-driven active learning. Open screens tend to make students feel and act as though they are passive onlookers. Keyboard clicking is also distracting to others.
2. Phones should be silenced and put away at the start of class.

Attendance and due dates

Attendance in class is expected. Students are responsible for material covered and information given in class. Missed classes will be counted against class participation and the class exercises from that day.

Critical reviews of readings will not be accepted late. It is important for students to thoughtfully read these assigned papers and prepare these brief reviews prior to class; the instructor also needs time to see these reviews before class to prepare discussion points.

The exam can not be missed; a missed exam will be given a zero grade.

If a student misses class on the day he or she is scheduled to make a presentation, no make-up will be allowed and a zero grade will be given for the presentation.

Exceptions can be made in the case of medical emergencies or other emergencies.

Academic and professional integrity

Students are expected to understand and follow Rackham guidelines for academic and professional integrity. Take a few moments to familiarize yourself with these rules, outlined here: https://www.rackham.umich.edu/current-students/policies/academic-policies/section10

Students should pay particular attention to rules regarding plagiarism and original work. Students may work together on assignments, may ask for help from students or others outside the class, and may draw on any information in the library or on the internet. However, the assignment that you present and turn in must be your own individual work in your own words. **You may not borrow from published work in any assignments without clearly attributing it to the authors.** The way to attribute ideas or results in published work is to cite the source. If you copy a source word for word, cite the source and *also* put the text in quotation marks. Similarly, you may clearly cite work that you find on web pages (list the URL and the date as you would a citation), but you may not borrow text, figures, or other graphics from a web page without clearly attributing it to the source.