NRE 589 Ecological Restoration

Winter Term 2016 • 4 Credits
Lectures: Tu/Th 10-11:30am, 2024 Dana
Labs: Th 2:30-5:30pm, 2024 Dana

Ecological restoration, allied with the creation of ecosystem-scale wilderness reserves, represents the main hope that the organic quality of wildness may someday be resurrected in human souls and in all life-places on planet Earth. -- Stephanie Mills, In Service of the Wild

Description. Restoration ecology is a relatively new discipline that integrates principles from ecology, engineering, economics, landscape architecture, and select social sciences to repair ecosystems that have been degraded, damaged, or destroyed. The goal is to restore the structure of biological communities and the ecological functions and ecosystems services they provide. This course will cover advanced topics in ecological restoration for graduate students (M.L.A., M.S. and Ph.D.) who see themselves practicing or participating in restoration projects during their careers. Using a combination of lectures, readings, field trips, and project work, we will cover the conceptual and theoretical foundations that underlie restoration efforts, and link these to the real-world applications in past and ongoing restoration projects. We will take advantage of projects ongoing in Michigan and the upper Midwest to reinforce principles discussed in class.




Objectives

- Understand the philosophies and ecological principles of restoration efforts.
- Evaluate current management practices and technique that are used in restoration projects.
- Learn the practical elements of restoration planning, include site assessment, implementation, monitoring and adaptive management.
- Become aware of the current uncertainties and ongoing controversies in restoration ecology.

Instructors

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Prerequisites. Students must have taken (a) NRE 509 (Ecology) … or … (b) NRE 436 (woody plants) with either NRE 430 (soil ecology) or NRE 547 (forest ecology) … or … (c) an equivalent course sequence in ecology. We will assume that students in this class are proficient with all topics covered in the

introductory ecology text Stiling, Peter. 2014. Ecology: Global Insights and Investigations. 2nd edition. McGraw Hill. In addition, we will assume students have an equivalent of college-level algebra, are familiar with basic statistics (distributions, probabilities, how to calculate means/variances, t-tests, least squares regression, etc.), and are proficient with the use of spreadsheets like Microsoft Excel. For those who need to brush up, we would be happy to recommend refresher tutorials upon request.

Course readings. Pdfs of required readings for each lecture discussion will be posted on Canvas (https://canvas.umich.edu) in advance of class. Students will need to read these materials prior to class to prepare for discussion, and students will be tested on these readings on the final exam. There is no required textbook for this course; however, we do recommend several texts for students who need extra help with the concepts covered in this class:

Howell, E.A., J.A. Harrington, and S.B. Glass, Introduction to restoration ecology. 2012, Washington, DC: Island Press. xv, 418 p.

Apfelbaum, S.I., A.W. Haney, and Society for Ecological Restoration International., Restoring ecological health to your land. The science and practice of ecological restoration. 2010, Washington, DC: Island Press. xvii, 240 p.

Apfelbaum, S.I., A. Haney, and SpringerLink, The Restoring Ecological Health to Your Land Workbook. 2012, Island Press/Center for Resource Economics: Washington, DC. [Available as an e-book from the UM library.]

Course expectations

Attendance. Attendance in lecture is strongly encouraged, as we will cover material in class that students will not be able to get from any other source. Attendance in labs is mandatory. Any student who misses two or more labs will be given a failing grade for the course.

Class etiquette. Please turn cell phones off at the beginning of each class. Put away all computers during lectures and do not web surf or email during class.

Academic integrity. We will adhere to the University of Michigan's Policy Statement on Academic Integrity, which students are responsible for reading and understanding https://canvas.umich.edu.

Late & make-up policy. Deadlines will be strictly enforced, and late work will have grades penalized at 10% per day. Extensions to deadlines will only be granted for those who provide documentation of a valid, university approved excuse.

Grading. The grading scale will be A = 90-100%, B = 80-89.9%, C = 70-79.9%, D = 60-69.9%. We reserve the right to curve grades upward at the end of the semester; however, this grading scale gives the minimum percentages required for students to assure themselves of a particular grade. Grades will be assigned based on student performance in the four categories outlined below.

1. *Class discussions* (100 pts): The goal of discussion is reinforce points made in lecture with real-life examples, and help students develop an understanding of contemporary issues and controversies in restoration. Discussions are student led, with points divided into two parts:

   Lead a discussion (50 pts). Students will be assigned to a discussion and lecture date. Each student/team will be responsible for …

- Thoroughly reading and understanding the paper associated with lecture.
- Emailing the professor 5 days before discussion with a list of 3-5 discussion questions, and a statement of the objective (main point) for the discussion.
- Posting the discussion questions on the course website 3-days before discussion.
- Providing a concise (5 min) summary at the beginning of discussion.
- Leading a lively and engaging class discussion.

Participation (50 pts). Each student is responsible for coming to class having read the assigned paper or material, with answers to the discussion questions ready, and with additional questions or comments. Participation will be monitored and graded.

2. Design a restoration project (150 pts). Working in groups of 2-4, students will choose a degraded local habitat in need of restoration, visit the site, and then design a restoration plan.

Written report (100 pts). Each group will write a 10-page report with the following components: (1) assessment of the problem, (2) statement of restoration goals/targets, (3) restoration plan describing what should be done, (4) a description of the monitoring plan. Grades will be assigned based on the completeness and detail of the project design, and ability to integrate principles discussed in lecture and lab to the restoration proposal. **Proposals are due on Tuesday, 14-Apr by 5:00-pm EST. Proposals must be uploaded to the Canvas DropBox using the name of one team member (preferably the first author).** More details about expectations for the project will be provided in class.

Class presentations (50 pts). Groups will present their restoration proposal in a 15-min talk at the end of the semester. Grades will be assigned based on the clarity and professionalism of the presentation, and the ability to convincingly justify the restoration proposal. **A copy of the PowerPoint presentation must be uploaded to the Canvas DropBox using the name of one team member (preferably the first author).**

3. Final Exam (100 pts). The final exam will cover all content of lectures and reading assignments. Format will include multiple-choice, true/false, short answer, calculations, and essay questions.

4. Laboratory (300 pts, 12 lab exercises x 25 pts. each). Students must read assigned materials prior to coming to lab. Although students should be able to complete most laboratory exercises within the allotted 3-hr time slot, **lab write-ups are due by 2:00pm EST the week following each lab, and must be uploaded to the student's Canvas DropBox.** For example, the write-up for the Metapopulation lab on 14-Jan must be uploaded to the Canvas DropBox by 2pm EST on 21-Jan.

COURSE SCHEDULE

Date	Lecture Topic	Readings	Lecturer	Lab
Th, Jan-7	Intro to ecological restoration	[1, 2]	Cardinale/Grese	Review (math, statistics, spreadsheets, modeling)
Part 1. Principles of Ecology				
Tu, Jan-12	Assumptions, targets, & goals	[3, 4]	Cardinale	
Th, Jan-14	Mitigating habitat loss	[5]	Cardinale	Source-sink population dynamics [6]
Tu, Jan-19	Establishing suitable habitat	[7]	Cardinale	
Th, Jan-21	Creating ecological heterogeneity	[8]	Cardinale	Quantifying heterogeneity [Chapter 7, ref 9]
Tu, Jan-26	Managing invasive species	[10]	Cardinale	
Th, Jan-28	Matching appropriate scales	[11, 12]	Cardinale	Scale detection [Chapter 10, ref 9]
Tu, Feb-2	Restoring biological structure & function	[13, 14]	Cardinale	
Th, Feb-4	Re-establishing natural variation	[15, 16]	Cardinale	Developing reference points
Part 2. Restoration planning				
Tu, Feb-9	Guest lecture: Dave Borneman – Prioritizing sites for restoration	[17, 18]		
Th, Feb-11	Project design and management	[19-21]	Grese	Prioritizing Species & Habitats [6]
Tu, Feb-16	Regulations and policy	[22, 23]	Grese	
Th, Feb-18	Aesthetics and design	[24-26]	Grese	Project planning (Massasauga rattlesnakes)
Tu, Feb-23	Use of volunteers in restoration	[27-29]	Grese	
Th, Feb-25	Project monitoring & evaluation	[30, 31]	Cardinale	Designing a monitoring program
Part 3. Applications & techniques				
Tu, Mar-8	Forest restoration	[32, 33]	Grese	
Th, Mar-10	Grassland restoration	[34, 35]	Grese	Ecosystem Spatial Models: Fire
Tu, Mar-15	Controlling invasive species	[36, 37]	Grese	
Th, Mar-17	Stream restoration	[38]	Cardinale	Assistance on group projects
Tu, Mar-22	Lake & wetland restoration	[39, 40]	Cardinale	
Th, Mar-24	Guest Lecture: Steven Handel			Restoration site design
Tu, Mar-29	Guest Lecture: John Hartig, Detroit River International Wildlife Refuge			
Th, Mar-31	Prescribed burns	[41, 42]	Grese	Field trip: Prescribed burn, Nichols Arboretum

Tu, Apr-5	Horticulture for restoration	[43, 44]	Bill Schneider	
Th, Apr-7	Botanical gardens & arboreta	[45, 46]	Grese	Field trip: Matthaei Botanical Gardens (alt. burn)
Tu, Apr-12	Breeding, stocking & re-introduction	[47]	Cardinale	
Part 4. Student projects				
Th, Apr-14	Project presentations			Field trip: Urban stream restoration
Tu, Apr-19	Project presentations			
W, Apr-27	Exam, 10:30-am to 12:30-pm			

Reading list. Pdfs of the required readings will be posted on the class Canvas website.

1. Perring, M.P., et al., *Advances in restoration ecology: rising to the challenges of the coming decades.* Ecosphere, 2015. **6**(8): p. 1-25.
2. Suding, K., et al., *Committing to ecological restoration.* Science, 2015. **348**(6235): p. 638-640.
3. Benayas, J.M.R., et al., *Enhancement of Biodiversity and Ecosystem Services by Ecological Restoration: A Meta-Analysis.* Science, 2009. **325**(5944): p. 1121-1124.
4. Moreno-Mateos, D., et al., *Structural and Functional Loss in Restored Wetland Ecosystems.* Plos Biology, 2012. **10**(1).
5. Schultz, C.B. and E.E. Crone, *Patch Size and Connectivity Thresholds for Butterfly Habitat Restoration.* Conservation Biology, 2005. **19**(3): p. 887-896.
6. Welden, T.M. and C. Welden, *Spreadsheet exercises in ecology and evolution*. 2002, Sunderland, MA, USA: Sinauer Associates, Inc.
7. Johnson, D.B. and K.B. Hallberg, *Acid mine drainage remediation options: a review.* Science of The Total Environment, 2005. **338**(1–2): p. 3-14.
8. Palmer, M.A., H.L. Menninger, and E. Bernhardt, *River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice?* Freshwater Biology, 2010. **55**: p. 205-222.
9. Gergel, S.E. and M.G. Turner, *Learning landscape ecology : a practical guide to concepts and techniques*. 2002, New York: Springer. xix, 316 p.
10. Ewel, J.J. and F.E. Putz, *A place for alien species in ecosystem restoration.* Frontiers in Ecology and the Environment, 2004. **2**(7): p. 354-360.
11. Legleiter, C.J., *A geostatistical framework for quantifying the reach-scale spatial structure of river morphology: 2. Application to restored and natural channels.* Geomorphology, 2014. **205**: p. 85-101.
12. Lane, D.R. and H. BassiriRad, *Diminishing Spatial Heterogeneity in Soil Organic Matter across a Prairie Restoration Chronosequence.* Restoration Ecology, 2005. **13**(2): p. 403-412.
13. Wright, J., et al., *Restoring biodiversity and ecosystem function: will an integrated approach improve results?*, in *Biodiversity and Human Impacts*, S. Naeem, et al., Editors. 2009, Oxford University Press. p. 167-177.
14. Rey Benayas, J. and J. Bullock, *Restoration of Biodiversity and Ecosystem Services on Agricultural Land.* Ecosystems, 2012. **15**(6): p. 883-899.
15. Poff, N.L., et al., *The natural flow regime.* BioScience, 1997. **47**(11): p. 769-784.
16. Poff, N.L. and J.V. Ward, *Implications of streamflow variability and predictability for lotic community structure - a regional analysis of streamflow patterns.* Canadian Journal of Fisheries and Aquatic Sciences, 1989. **46**(10): p. 1805-1818.
17. Seastedt, T.R., R.J. Hobbs, and K.N. Suding, *Management of novel ecosystems: are novel approaches required?* Frontiers in Ecology and the Environment, 2008. **6**(10): p. 547-553.
18. Zedler, J.B., J.M. Doherty, and N.A. Miller, *Shifting Restoration Policy to Address Landscape Change, Novel Ecosystems, and Monitoring.* Ecology and Society, 2012. **17**(4): p. 14.
19. Howell, E.A., J. A. Harrington, and S.B. Glass, *The master plan*, in *Introduction to Restoration Ecology*. 2012, Island Press: Washington, D. C.
20. Howell, E.A., J. A. Harrington, and S.B. Glass, *The site plan*, in *Introduction to Restoration Ecology*. 2012, Island Press: Washington, D. C.
21. Conservancy, T.N., *The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success*, T.N. Conservancy, Editor. 2000.
22. BenDor, T.J., J. Sholtes, and M.W. Doyle, *Landscape characteristics of a stream and wetland mitigation banking program.* Ecological Applications, 2009. **19**: p. 2078-2092.

23. Palmer, M.A., *Reforming watershed restoration: science in need of application and applications in need of science.* Estuaries and Coasts, 2009. **32**: p. 1-17.
24. Gobster, P.H., et al., *The shared landscape: what does aesthetics have to do with ecology?* Landscape Ecology, 2007. **22**(7): p. 959-972.
25. Hill, D. and T.C. Daniel, *Foundations for an ecological aesthetic: Can information alter landscape preferences?* Society & Natural Resources, 2008. **21**(1): p. 34-49.
26. Junker, B. and M. Buchecker, *Aesthetic preferences versus ecological objectives in river restorations.* Landscape and Urban Planning, 2008. **85**(3-4): p. 141-154.
27. Miles, I., W.C. Sullivan, and F.E. Kuo, *Psychological benefits of volunteering for restoration projects.* Ecological Restoration, 2000. **18**(4): p. 218-227.
28. Grese, R.E., et al., *Psychological benefits of volunteering in stewardship programs*, in *Restoring Nature: Perspectives from the Social Sciences and Humanities*, P.H. Gobster and R.B. Hull, Editors. 2000, Island Press: Washington, D. C. . p. 265-280.
29. Cohn, J.P., *Citizen science: Can volunteers do real research?* Bioscience, 2008. **58**(3): p. 192-197.
30. Howell, E.A., J. A. Harrington, and S.B. Glass, *The monitoring plan*, in *Introduction to Restoration Ecology*. 2012, Island Press: Washington, D. C. p. 277-296.
31. Block, W.A., et al., *Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife.* Restoration Ecology, 2001. **9**(3): p. 293-303.
32. Sarr, D.A. and K.J. Puettmann, *Forest management, restoration, and designer ecosystems: Integrating strategies for a crowded planet.* Ecoscience, 2008. **15**(1): p. 17-26.
33. Fahey, R.T., et al., *Evaluating Restoration Baselines for Historically Fire-protected Woodlands Within a Northeastern Illinois Prairie Peninsula Landscape.* Natural Areas Journal, 2014. **34**(2): p. 166-177.
34. Allison, S.K., *When Is a Restoration Successful? Results from a 45-Year-Old Tallgrass Prairie Restoration.* Ecological Restoration, 2002. **20**(1): p. 10-17.
35. Gerla, P., et al., *Talking Big: Lessons Learned from a 9000 Hectare Restoration in the Northern Tallgrass Prairie.* Sustainability, 2012. **4**(11): p. 3066.
36. Barbier, E.B., et al., *Implementing Policies to Control Invasive Plant Species.* Bioscience, 2013. **63**(2): p. 132-138.
37. Davis, M., et al., *Don't judge species on their origins.* Nature, 2011. **474**(7350): p. 153-154.
38. Palmer, M.A., et al., *Standards for ecologically successful river restoration.* Journal of Applied Ecology, 2005. **42**(2): p. 208-217.
39. Zedler, J.B., *Progress in wetland restoration ecology.* Trends in Ecology & Evolution, 2000. **15**(10): p. 402-407.
40. Sondergaard, M., et al., *Lake restoration: successes, failures and long-term effects.* Journal of Applied Ecology, 2007. **44**(6): p. 1095-1105.
41. Bowles, M.L. and M.D. Jones, *Repeated burning of eastern tallgrass prairie increases richness and diversity, stabilizing late successional vegetation.* Ecological Applications, 2013. **23**(2): p. 464-478.
42. Pyke, D.A.M.L.B. and C.D. Antonio, *Fire as a restoration tool: a decision framework for predicting the control or enhancement of plants using fire.* Restoration Ecology, 2010. **18**: p. 274-284.
43. Breed, M.F., et al., *Which provenance and where? Seed sourcing strategies for revegetation in a changing environment.* Conservation Genetics, 2013. **14**(1): p. 1-10.
44. Broadhurst, L.M., et al., *Seed supply for broadscale restoration: maximizing evolutionary potential.* Evolutionary Applications, 2008. **1**(4): p. 587-597.
45. Hardwick, K.A., et al., *The Role of Botanic Gardens in the Science and Practice of Ecological Restoration.* Conservation Biology, 2011. **25**(2): p. 265-275.

46. Heywood, V.H., *The role of botanic gardens as resource and introduction centres in the face of global change.* Biodiversity and Conservation, 2011. **20**(2): p. 221-239.
47. Seddon, P.J., D.P. Armstrong, and R.F. Maloney, *Developing the science of reintroduction biology.* Conservation Biology, 2007. **21**(2): p. 303-312.