



**Natural Resources Science & Management 311:
*Restoration Ecology in Greater Yellowstone***

3 semester credits

Academic Credit

All courses offered through the Wild Rockies Field Institute are accredited through the University of Montana and the School for Extended and Lifelong Learning. Each Wild Rockies Field Institute course is approved and supported by University of Montana departmental leadership and faculty.

Estimated Course Contact Hours and Academic Work Time

The time ranges below describe daily student requirements for participation on our courses. These ranges are approximate and vary with assignments, field learning opportunities, and environmental conditions:

- *Instructional Contact Hours:* 2-4 hours of formal classroom-style work per course day. This includes lectures, discussion-based classes, guest-speaker presentations, individual meetings with course instructors or teaching assistants, and academic exercises not involving field exploration.
- *Field / Laboratory Contact Hours:* 2-4 hours per course day. This includes field explorations and exercises, site visits, local guest speakers, and opportunistic instruction as relevant examples of course concepts and issues arise.
- *Individual Academic Work:* 2-6 hours per day. This includes completing required readings, individual writing assignments, research investigation associated with course assignments, reviewing peer work.
- The average of Instructional and Field / Laboratory contact is 5.5 hours per day. Each of our 3-credit courses is developed with approximately 67 contact hours.

Course Dates

June 24 - July 13, 2019

Location

This course takes place in the Greater Yellowstone Ecoregion of Montana on successive explorations of the Red Rocks National Wildlife Refuge, Yellowstone National Park, and the Snowcrest Mountain Range.

Instructors

Kelsey Patterson: M.S. Environmental Studies, University of Montana; B.A. Environmental Studies University of Oregon.

James Mauch: M.S. Geology, Utah State University; B.S. Earth Science, Montana State University

Teaching Assistant

Ben Warzon: B.A. Environmental Studies, Montana State University

Course Description

The course consists of two backpacking trips and an interlude of front-country camping. In addition to stream sampling and restoration work, course activities will include natural history studies in the course area, hiking, and low impact backcountry camping skills in bear country. Immersion in the mountain landscape of the area will allow course participants to experience the landscape as a continuum that includes both the pristine and the heavily impacted.

On this course students will study restoration ecology in the context of the Greater Yellowstone Ecosystem, a vast area that is home not only to humans, but to diverse organisms including many threatened or declining species (i.e. whitebark pine, whooping cranes, and fluvial arctic grayling) as well as species that are showing signs of recovery (i.e. bison and wolves). Through experience, observation, reading, discussion and restoration work, students will examine how human uses of the land (such as logging, development, recreation, road-building, mining, and agriculture) affect ecological systems, and explore the role of restoration in repairing ecological damage.

We will begin the course by studying ecology, natural history, and public lands policy during a backpacking trip in Yellowstone National Park. During this trip, we will discuss the fundamentals of ecology, restoration ecology, conservation biology, and natural resource policy which will provide a foundation for our restoration work and our exploration of the scientific, social, and ethical dimensions of ecological restoration during the second half of the course.

In the second part of the course we will work collaboratively with federal agencies on specific restoration projects- these vary from year to year, depending on agency needs. Past classes have helped control exotic lake trout in Yellowstone Lake; aided restoration efforts in the Red Rocks Wildlife Refuge; assisted with wetland habitat and native plant restoration projects; constructed a fence to protect a sensitive riparian area from livestock damage; mitigated erosion problems on trails and roads; assisted with mine restoration and control of exotic plants; and helped to close and restore forest roads in grizzly bear habitat. In addition to these hands-on projects, the class will meet with a variety of guest speakers and visit with Yellowstone National Park employees to examine topics such as wolf re-introduction, bison management, and fire ecology. We will car camp during this portion of the course, and readings and discussions will focus on the role of monitoring in ecological restoration; the political, social and administrative challenges in restoration; and ecological restoration's ethical and policy dimensions.

In the third section of the course, we will return to the backcountry for a six-day backpacking trip in the Snowcrest Mountain Range. During this time, we will synthesize our experiences and explore philosophical questions in restoration ecology in greater depth. Each student will develop a final project that focuses on restoration of a familiar area or home place, applying knowledge and ideas from the course. Prior to the course, students will want to start thinking about an ecosystem near their home that is in need of restoration and gathering information about that ecosystem for use in this project. Past papers have been written on topics such as wetland restoration, mine tailings, stream restoration, and forest ecology.

Course Instructional Plan

A variety of instructional techniques are used during the course to challenge and inspire students coming from a wide range of academic and personal backgrounds. Traditional lectures and discussion formats during the initial stages allow a rapid survey of the topics to be explored on the course. Individual assignments such as vegetation studies and natural history journaling combine experiential and academic modes to explore basic ecological concepts. The combination of experiential and academic learning continues in the restoration project section in

which students put abstract concepts into practice on a variety of real-world projects in cooperation with public land managers. An array of restoration practitioners provide guest lectures and lead discussions on the complexities of restoration activity within a multi-ownership management scheme. These speakers include staff from the USGS, USFWS, USFS, NPS, along with local conservation groups and private landowners. The final projects require students to develop a site-specific restoration proposal that synthesizes restoration ecology concepts with the course experiences.

Academic Objectives

Each student will:

1. Understand the fundamental concepts of restoration ecology, conservation biology, natural history and natural resource policy;
2. Work with public lands managers and private landowners on restoration projects, and we will participate in monitoring projects to help evaluate past restoration work;
3. Complete readings and participate in discussions focused on the ethical, political, and economic dimensions of restoration work;
4. Integrate restoration ecology—along with geography, Native American perspectives, conservation biology, and community-based conservation—into their final papers and projects on the future of the Y2Y region.

Course Requirements and Evaluation

Students will be required to complete readings and facilitate group discussions on pertinent topics throughout the course. Students will work collaboratively for the Yellowstone management plan and write-up. A practical field exam and a written midterm exam will test students individually for mastery of subject matter, as well as for an understanding of restoration ecology, theory, and applications. All students will earn letter grades for the course. Students will be required to complete the following:

- **Participation, 25%:** Separated into academic and experiential participation (e.g. restoration projects) on the course. Graded using a descriptive rubric.
- **Field Journal, 25%:** Detailed daily observations; notes on readings; questions and discussion points in preparation for class; responses to instructor journal prompts.
- **Plant Study, 5%:** Comprehensive exploration of the natural history and cultural importance of individual plant species.
- **Citizen Letter, 5%:** A concise advocacy letter on an issue explored on the course written to a public official, community, interest group, or news outlet.
- **Midterm Exam, 15%:** Written examination designed to assess student's comprehension and engagement with academic material including readings, discussions, guest speakers, and experiences.
- **Final Essay, 25%:** Students will select one of two final project options: 1) A final essay answering, "what is good ecological restoration?" or 2) Select a degraded landscape and create a restoration plan (more details provided on course).

Disability Services for Students

The University of Montana is an equal opportunity education provider and will provide reasonable accommodations for any student taking this course for academic credit. Students with disabilities, who are taking courses through the Wild Rockies Field Institute, may request reasonable accommodations by contacting their field instructors. For questions, concerns, or additional information, students may also contact Roger Maclean, Dean, UM School of Extended and Lifelong Learning: 406-243-2983 or roger.maclean@umontana.edu.

Course Itinerary

Day 1-2: Course convenes in Bozeman, MT at 9am. Equipment checks, food purchasing, and introduction to Greater Yellowstone Ecosystem with Charles Drimal. Drive to Timber Camp above Jardine.

Days 3-5: Wolf watching in the Lamar Valley with Rick McIntyre. Readings and discussions on wolf ecology and management. Backpacking in Yellowstone National Park along Lamar River and Cache Creek. Readings and discussions focus on restoration ecology, conservation biology, and management of endangered species.

Day 6: Backpack out. Front-country camping outside of Gardiner or Jardine.

Day 7: Discussion of plant community ecology and restoration with researcher Dan Kotter. Travel to West Yellowstone for resupply and front-country camping at West Yellowstone KOA.

Day 8: Conversations about bison restoration from multiple perspectives. Front-country camping at Red Rock Lakes NWR.

Day 9-11: Restoration work with Kyle Cutting at Red Rock Lakes National Wildlife Refuge, participating in hands-on restoration work in the Centennial Valley Sandhills. Front-country camping in Red Rock Lakes NWR. Written midterm exam on Day 11.

Day 12-16: Backpack in the Snowcrest Range. Readings and discussions on climate change, mountain pine beetle and whitebark pine dynamics, pika conservation, and restoration in wilderness. Students will learn about wilderness management, restoration ethics, and citizen science.

Day 17: Resupply in Dillon, MT. Students work on final projects. Front-country camping at Dillon KOA.

Day 18: Visit the Berkeley Pit, overview of Clark Fork Watershed superfund site. Travel to Dry Cottonwood Creek Ranch and tour restoration work along the Upper Clark Fork. Students work on final projects. Front-country camping at Dry Cottonwood Creek Ranch.

Day 19: Continue overview of Dry Cottonwood Creek Ranch projects. Visit Thomas Ranch and the Upper Clark Fork Superfund site. Students work on final projects. Front-country camping at Thomas Herefords Ranch.

Day 20: Students turn in final projects. Return to Bozeman by 4pm. Course concludes.

Course Readings

These readings are from the 2017 field season. Note that readings are adapted and updated each year to reflect current issues.

Foundations of Ecology, Restoration Ecology and Conservation Biology

- Clewell, Andre and James Aronson. 2013. *Ecological Restoration: Principles, Values, and Structure of an Emerging Profession, Second Edition*. Island Press.
 - o Ch. 1: Overview p. 3 – 13
 - o Ch. 3: Disturbance and Impairment p. 33 – 51
 - o Ch. 4: Recovery p. 73-87
 - o Ch. 5: Ecological Attributes of Restored Ecosystems p. 89 - 112

o Ch. 7: Ecological References p. 135 - 154

- Flores, Dan. 2001. The West that Was, and the West that Can be: Western Restoration in the Twenty-first Century, in *The Natural West: Environmental History in the Great Plains and Rocky Mountains*. Norman, OK: University of Oklahoma Press, pp. 183 - 200.
- Vellend, Mark. 2010. Conceptual Synthesis in Community Ecology. *The Quarterly Review of Biology*, 85(2): 183 – 206

Wolves

- Mech, David L. 2012. Is science in danger of sanctifying the wolf? *Biological Conservation* 150: 143 - 149.
- Stahler, Erin and Doug Smith. 2015. Wolves, in *Yellowstone Resources and Issues Handbook* p. 208 - 215.
- Ripple, William J. and Robert L. Beschta. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. *Biological Conservation* 145: 205 - 213.
- Painter et al. 2015. Recovering aspen follow changing elk dynamics in Yellowstone: evidence of a trophic cascade?"
- Marshall, Kristin N., N. Thompson Hobbs, and David J. Cooper. 2013. Stream hydrology limits recovery of riparian ecosystems after wolf reintroduction. *Proceedings of the Royal Society B*.

Bison

- Plumb and Sucec, 2006. A Bison Conservation History in the U.S. National Parks. *Journal of the West*, 45(2), p. 22 - 28
- McKean, Andrew. 2013. Butting Heads over Bison. *Montana Outdoors* Nov-Dec 2013, p. 34 - 39.
- Blanton et al. 2015. Chapter 1: The Population, in Eds. P.J. White, R.L. Wallen and D.E. Hallac, *Yellowstone Bison: Conserving an American Icon in Modern Society*, 1 – 17.
- Wallen, R.L, P.J. White and C. Geremia. 2015. Chapter 7: Ecological Role, in Eds. P.J. White, R.L. Wallen and D.E. Hallac, *Yellowstone Bison: Conserving an American Icon in Modern Society*, 107 – 117.

Stream Restoration

- Lave, Rebecca, Martin Doyle, and Morgan Robertson. 2010. Privatizing stream restoration in the US. *Social Studies of Science*, 40(5): 677-703.
- Miller, Nathaniel. 2010. The Pit. *VQR*, Fall 2010: 139-153.
- Beechie, T. G. Pess, P. Roni and G. Giannico. 2008. Setting River Restoration Priorities: A Review of Approaches and a General Protocol for Identifying and Prioritizing Actions. *North American Journal of Fisheries Management*, 28(3): 891 – 905.
- *Silver Bow Creek Newsletter*, Spring 2014.
- Dickson, Tom. 2016. Open or Close? Why Connectivity is essential for native fish populations—except when it isn't. *Montana Outdoors* May – June 2016.

Restoring Vegetation

- Renkin, Roy. 2016. Vegetation, in *Yellowstone Resources and Issues Handbook*, p. 139 – 155
- Dillard, Annie. Of Frogs and Flowers, excerpt from *Pilgrim at Tinker Creek: An American Childhood*. Quality Paperback Book Club, 1990.
- Runyon, et al. 2014. Aspen Restoration Using Beaver on the Northern Yellowstone Winter Range under Reduced Ungulate Herbivory.

- Davis, S.C., and K.A. Cutting. Creating Grazing Habitat Management Strategies for a National Wildlife Refuge. *College of Agriculture and Extension Research Report*.
- USFWS. 2016. *Sagebrush Ecosystems*.
- Wagner, Victoria et al. 2016. Herbicide usage for invasive non-native plant management in wildland areas of North America. *Journal of Applied Ecology*, 2016: 1-7.
- Lieberman, Lucy, Beth Hahn, and Anne Carlson. *Saguaro Wilderness: the aerial application of herbicides used to combat non-native invasive buffelgrass in the Sonoran Desert*.

Climate Change and Whitebark Pine

- Harris, James et. al. Ecological Restoration and Global Climate Change. 6 pp.
- Cohen, Elisabeth, Roy Renkin and Ann Rodman. 2014. Climate Change, in *Yellowstone Resources and Issues Handbook* p. 80 – 98
- Sheppard. 2014. How Climate Change Threatens Grizzlies. *Mother Jones*. 8 pp.
- Logan et.al. 2010. Whitebark Pine Vulnerability to Climate-Driven Mountain Pine Beetle in the GYE. 7 pp.
- Romme, William H., Monica G. Turner. 2015. Ecological Implications of Climate Change in Yellowstone: Moving into Uncharted Territory? *Yellowstone Science*, 23(1): 6 – 12.
- Romme, William H., Monica G. Turner. 1991. Implications of Global Climate Change for Biogeographic Patterns in the Greater Yellowstone Ecosystem. *Conservation Biology*, 5(3): 373 - 386

American Pika

- Beever, Erik et.al. 2011. Contemporary Climate Change Alters the Pace and Drivers of Extinction, in *Global Change Biology*. 16 pp.
- Wilkening, Jennifer L. et al. 2015. Alpine biodiversity and assisted migration: the case of the American Pika (*Ochotona princeps*). *Biodiversity*, 16(4): 224-236.
- Schwartz, Mark W. et al. 2012. Managed Relocation: Integrating the Scientific, Regulatory, and Ethical Challenges. *Bioscience*, 62(8): 732-743.

Restoration in Wilderness

Cole, David N. 2000. Paradox of the primeval: Ecological restoration in wilderness. *Ecological Restoration*, 18(2): 77-86.

Frontiers in Ecology Forum: Managing the wild: should stewards be pilots?

Marris, Emma. 2011. The End of the Wild. *Nature*, 469: 150 – 152.

Stephenson, Nathan L. and Constance I. Millar. 2011. Climate change: Wilderness' greatest challenge. *Park Science*, 28(3): 34-37.

Human and Ethical Dimensions of Restoration

- Higgs, Eric. 1997. What is Good Ecological Restoration? *Conservation Biology*, 11(2), April, p. 338-348.
- Higgs, Eric, et al. 2014. The changing role of history in ecological restoration. *Frontiers in Ecology*, 12(9): 499- 506.
- Metcalf, et al. 2015. The Role of Trust in Restoration Success. *Restoration Ecology* (Forthcoming) (10p.)
- Hobbs, Richard J. 2016. Degraded or just different? Perceptions and value judgments in restoration decisions. *Restoration Ecology*, 24(2): 153-158.
- Burchfield, Jim. Finding Science's Voice in the Forest, pp. 236-243 in *Across the Great Divide: Explorations in Collaborative Conservation and the American West*. Washington, DC: Island Press.

- Hilderbrand, Robert H., Adam C. Watts, and April M. Randle. 2005. The Myths of Restoration Ecology. *Ecology and Society*, 10(1): 19.
- Hobbs, Richard J., Eric Higgs and James Harris. 2009. Novel Ecosystems: implications for conservation and restoration. *Trends in Ecology and Evolution*, 24(11): 599 - 605

Enrollment

Enrollment in this course will be limited to twelve students. There are no academic prerequisites for this course. No backpacking or camping experience is required, but a reasonable level of fitness will be necessary to complete the course.

Sponsoring Organization

The Wild Rockies Field Institute (WRFI) is an independent, nonprofit educational organization founded in 1993. Our mission is to broaden the nature of a liberal arts education; teach critical thinking about social and environmental issues; to foster understanding of and respect for natural and human communities; and to cultivate a sense of place that encourages personal, social and environmental responsibility. WRFI courses seek to understand the complex relationships between ecological processes and human actions. To varying degrees within each course, students study local ecology, policies directing public lands management, and ethics that underlie social relationships to the land. Our courses combine traditional classroom teaching methods – including lectures, readings, discussions, papers, and exams – with experiential explorations of the landscapes and communities we visit. We encourage careful observations, critical thinking, thoughtful dialogue, and exploration of diverse perspectives in order to develop the capacity for engaged citizenship in our students.

Wild Rockies Field Institute; P.O. Box 7071, Missoula, MT 59807. (406) 549-4336