ECOSYSTEM ECOLOGY

BIOL/ENVI 394 - Spring 2020 - Macalester College




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Disclaimer: Please consider this syllabus a living document! Moodle will serve as the formal record in this course, and I look forward to building a dynamic learning environment with you.

KEY COURSE INFORMATION

- **Instructor:** Dr. Christine Sierra O'Connell (she/her/hers), coconnell@macalester.edu
- **Class:** MWF 2:20-4:30 AM; OLRI 243
- **CSO's Office Hours:** OlRi 248; T 1:15-2:15 PM; F 11 AM-12 PM; by appt
- **Texts:** Principles of Terrestrial Ecosystem Ecology, 2nd Edition (Stuart Chapin, Pamela Matson, Peter Vitousek); additional readings will be available through Moodle
- **Course Prerequisites:** MATH/STAT 155, and either BIOL/ENVI 285 or ENVI 240. Recommended: CHEM 111 or CHEM 115. Alternately, permission of instructor.

COURSE DESCRIPTION AND LEARNING GOALS

How are ecosystem carbon stocks responding to climate change? What controls primary production? How is agricultural land use change altering the nitrogen cycle? How do ecosystems respond to elevated atmospheric CO2 concentrations, and how does nutrient availability affect this CO2 response? What is the relationship between biodiversity and ecosystem function? These are all questions that ecosystem ecologists seek to answer. In this course, we will investigate the principles and processes that govern the structure and function of ecosystems, with an emphasis on how nutrients, water and energy cycle through ecosystems. Ecosystem ecology is interdisciplinary in nature, and draws from fields such as physiological, microbial and community ecology, soil science, atmospheric science, and geology. We will cover both fundamental principles and recent, cutting-edge research that focuses on global change drivers (e.g., climate change, nitrogen deposition, land use change, and altered disturbance regimes).

This class will be aimed at a high level, roughly equivalent to an early graduate school course. Though my goal is not to turn you all into ecosystem ecologists (though that would be great!), I hope that we will push your skills and knowledge base so that you can take a baseline understanding of ecosystem ecology forward in your careers.

Some specifics: The course will begin by providing some background on climate and soils, and then will focus on element cycling, particularly carbon and nutrient cycles. We will examine the energy base of ecosystems – what controls carbon fixation by plants and what is the fate of that fixed carbon. We will

[1] Photos all licensed via Creative Commons: Amazon rainforest (CIFOR), soil pit (UK College of Agriculture, Food & Environment), Indonesian mangrove (CIFOR Forest News)

discuss human dependence on fixed carbon, as well as how humans are altering the chemistry of the atmosphere in ways that are changing photosynthesis, plant growth, and climate, with further implications for ecological systems. We will study nutrient inputs to, cycling through, and losses from ecosystems, and the factors that influence nutrient limitation of ecosystems. We will discuss the relevance of nutrient limitation to understanding the sustainability of global fertilizer supplies, as well as the potential for increasing agricultural yields to meet human demand for food. We will also study how increased production of reactive nitrogen is having ecological consequences far beyond the systems where it is used. We will study biological interactions and perturbations, including those resulting from human-induced global environmental changes – the transfers of energy from primary producers to higher trophic levels and how herbivory and disturbances such as fire affect primary production and nutrient cycling. Finally, we will discuss how biological invasions, and losses of biodiversity alter ecosystem processes.

This is an exciting and important time to study ecosystem ecology; I am looking forward to diving in with you all!

After completing this course, students should be able to:

- Understand the flows of water, energy, and elements through terrestrial ecosystems; the nature of resource limitation; and the role of terrestrial ecosystems in global processes, such as global cycles of carbon and nitrogen
- Understand that scientific understanding is always changing and increasing, and that there are uncertainties and controversies in ecosystem ecology, including around issues that impact society
- Discuss, draw conclusions from and critique primary literature in order to draw conclusions about the state of understanding of some issue in ecosystem ecology
- Conduct analyses in R/RStudio and interface with scientific data
- Develop a short-term research project and explore preliminary findings
- Work productively in groups and create supportive, effective communities based on open communication, engagement, and sharing of responsibilities
- Build a community of learning where challenges are met with thoughtful, open discussion and collaboration

COURSE REQUIREMENTS AND ASSESSMENTS

Participation, Lab Activities and Required Reading (20%): A large portion of this class relies on students participating in large and small groups, which requires people to be prepared and focused for class time, supportive of each other and engaged with the material. In order to ensure that we get as much as possible out of class time, please read all "required" readings, many of which will be accompanied by a low-stakes reading response assignment or pre-quiz on Moodle. This grading category will include Mini-Quizzes, Reading Responses, Pre-Quizzes and other low-stakes means of measuring participation. This portion of your grade will also include worksheets and other responses from the "lab" portion of class.

> MiniQuizzes (MQ): MQs will occur intermittently and test knowledge from the previous few class meetings. After completing each quiz, students will confer with their neighbor and resolve answers together. We will go over answers as a class after the paired discussions. MQs are graded Credit/No Credit.

Pre-Quizzes: These will be a few questions on Moodle prior to class meetings that will guide you to ensure that you walk into class having understood the key vocab/ideas from the reading, and thus save us from lengthy lecture time. Pre-quizzes are graded Credit/No Credit.

Examinations – Midterm 1 (15%), Midterm 2 (15%) and Final (20%): There will be three exams that will take place during class time. Exam questions will require you to think critically and synthesize information presented during the course, and therefore, all exams are cumulative (though I think synthetic is a more helpful way to think about them).

Independent Research Mini-Project (30%): This class will include significant class time and support for you to delve into independent research. Over the course of the project, you will develop a research question within ecosystem ecology, define an experimental design and hypothesis, implement methods and preliminarily answer your question, via an original analysis using at least two different sources of data (collected or, more likely in the winter, drawn from the literature/publicly available datasets). Research projects will culminate in short written summaries and presentations to your peers. Further details forthcoming.

COURSE NORMS AND EXPECTATIONS

Class meetings and attendance: You are expected to attend every class. If you are unable to attend class for an academic (i.e., a field trip for another class) or personal (your discretion) reason, please email Christine *before* that class meeting.

Late work policy: Some assignments in this class cannot be accepted if they are missed – MiniQuizzes are completed in class (no make ups) and Reading Responses are meant to support in-class discussion. For most other assignments (and unless otherwise noted), your grade will be lowered by half a letter grade for every day late. If you need accommodation or flexibility on deadlines, please email or see me ahead of time and accommodations can be arranged.

Developing your voice and being a team member**:** Science requires a balance of confidence and humility – this is as true for undergraduates as it is for researchers at leading institutions. We will need confidence to pursue and develop new ideas and approaches, to thoughtfully critique ideas, and to follow your curiosity. Science also requires humility and patience - with yourself, others, and the material. Individually, in groups, and as a class, we will identify our limitations, ask for help and guidance, listen to thoughtful, appropriate criticism from others, and reflect on our improvement and setbacks. As you develop your thoughts and opinions in this class, be mindful that we are also collectively creating an open, accepting community of learning and growth.

Ecosystem Ecology is a new class and I envision it as a place to grow and experiment with how you all can get the most out of this course experience. For everyone to do that successfully, the class needs to be a welcoming, supportive, and inclusive environment grounded in mutual respect of the individuals that comprise the class and their ideas.

If you at any point feel there is something about the class that is keeping you from success, I encourage you to reach me by email, in person, or through a designated student '**ombudsman**'.

I also encourage you to take care of yourselves through the semester - eat well, sleep well, and take breaks as needed. If you are feeling overwhelmed, need academic or mental health support, prioritize those needs.

Academic support: Works in Progress peer-support or MAX Center
Disability Services: 651-696-6275 or disabilityservices@macalester.edu
Student Support: Office of Student Affairs at 651-696-6220 studentaffairs@macalester.edu

COURSE ENVIRONMENT

Learning environment and inclusivity. My goal is to promote an inclusive learning environment where diverse perspectives are recognized, respected, and seen as a source of strength. Part of that effort includes a recognition that all humans have implicit biases, and it is our responsibility to do our best to identify them in ourselves and take actions to mediate them. If something in or about this class makes you feel unwelcome, please see me, a trusted faculty or staff member, or a college administrator.

Names and pronouns. You should be addressed in the manner that you prefer. If you want to make sure I address you with a particular name and/or pronoun please let me know.

Title IX. Macalester College is committed to providing a safe learning environment for all students that is free of discrimination, sexual harassment, sexual assault, domestic violence, dating violence, and stalking. Further details are explained in the college's Title IX regulations (https://www.macalester.edu/titleix). If you, or someone you know, experiences a Title IX violation, know that Macalester has staff trained to support you. Macalester faculty members are "responsible employees," which means that if you tell me about a Title IX violation, I must share that information with the Title IX Coordinator. Still, you will control how your case is handled, including whether or not you wish to pursue a formal complaint. Our goal is to make sure you are aware of the range of options available to you and have access to the resources you need (Title IX Office, 651-696-6258) including, if you wish, confidential sources on campus who are not subject to the mandatory reporting requirement (see list of "Confidential On-Campus Support" at https://www.macalester.edu/violenceprevention/support/).

Accessibility. I want all students to have fair and equitable access to the learning opportunities in this course. If there are aspects of the instruction or design of this course that result in barriers to your inclusion or to accurate assessment of achievement, please notify me as soon as possible. Students are also welcome to contact the disability service office to discuss a range of options to removing barriers in the course, including accommodations (contact Disability Services, 651-696-6275 or disabilityservices@macalester.edu). Once you have a letter of accommodations, please see me so that we can implement an action plan. Furthermore, I know that at times personal issues, stress, health problems or life circumstances may impact your ability to perform academically. Please contact the Office of Student Affairs at 651-696-6220 (studentaffairs@macalester.edu) for support and ask them to get in touch with your instructors.

Other helpful information to support your experience in the class:

• Concerns on content or experience in the class → find me or our class ombudsman before/after class; attend office hours; email to set up a time to meet in person

• Need additional writing support → Check out MAX Center for writing tutors or Works in Progress peer review program (Kagin Commons, first floor)

• Are you absent due to an unexpected event (sickness, family issue) → Contact me by email as soon as possible to set up a time to talk about options

• Absence due to religious observance → Please let me know you will be observing ahead of time, so that you can obtain course materials ahead of the absence

• Do you need to sleep? Of course you do. Take care of yourself. If you are feeling overwhelmed about the scheduling or pace of this course, please let me know.

COURSE SCHEDULE (VERY TENTATIVE!) – SEE NEXT PAGE

All readings, assignment descriptions, and other information about the course will be on Moodle.			
Week: Topic	**Monday**	**Wednesday**	**Friday**
			1/24 First day!
A: Global Overview	1/27 Climate	1/29 Soils I	1/31 Soils II
B: Crops and resources	2/3 Photosynthesis Mini-Quiz	2/5 GPP	2/7 Respiration/NPP
	2/10 Elevated CO_2 Mini-Quiz	2/12 Isotopes in ecology	2/14 Human dependence on NPP
	2/17 **MIDTERM 1**	2/19 Decomposition	2/21 Soil organic matter
C: System interactions	2/24 Methane	2/26 Nutrient inputs	2/28 Nutrient cycling I
	3/2 Nutrient cycling II Mini-Quiz	3/4 Nutrient losses and limitation	3/6 Human perturbations to the N cycle
	3/9 Sustainability of the P cycle Mini-Quiz	3/11 Plant nutrient use/uptake	3/13 Water cycling I
SPRING BREAK	3/16 Happy Spring Break!	3/18 Happy Spring Break!	3/20 Happy Spring Break!
D: Into the future	3/23 Water cycle II	3/25 Trophic interactions Mini-Quiz	3/27 Eutrophication
	3/30 **MIDTERM 2**	4/1 Project Workshop	4/3 Herbivory
E: Realizing sustainable agriculture	4/6 Biodiversity and ecosystem processes; invasion	4/8 Fire, disturbance and succession I	4/10 Fire, disturbance and succession II
	4/13 Project Workshop Mini-Quiz	4/15 Landscape ecology and remote sensing in ecology	4/17 Climate change I
	4/20 Climate change II Mini-Quiz	4/22 Global carbon cycle	4/24 **No Class meeting (Earth Day climate strike)*** *Possible swap with 4/22*
14: Solutions-A-Thon!	4/27 **Project presentations I**	4/29 **Project presentations II**	5/1 Final class: the future of ecosystem science
15: Last Week	5/4 **FINAL EXAM*** *Note that this takes place on the last day of class*		