**Introduction to ecological thinking: deciphering patterns and processes**

**Course Description**

This course is an introduction to ecology with a focus on connecting ecological questions to different ecological methods. From early natural history records on animal and plant distributions to the emergence of foundational ecological concepts such as niche and community, ecologists have gradually developed a particular way of thinking to investigate how patterns arise from ecological processes. To accomplish this goal, we need methods that transform qualitative observations and ideas into quantitative measures to enable experiments, field surveys, and mathematical modeling.

We will be examining the patterns and processes in systems—these can be a colony of bacteria in a petri dish, an urban deer population, a forest community, or our terrestrial ecosystem. We will investigate the structure and functioning of these systems to evaluate whether they are stable, unstable, or in transition under external forcing. For example, a population of fish being harvested commercially on a yearly scale can be our system to look at patterns in population growth while understanding how processes like birth and death are involved. As climate change further disturbs this system, an ecological understanding of such systems is crucial for us to make sustainable harvesting policies and preserve resilience in fish populations.

As systems of our focus become more complex, we will discuss relevant concepts and important principles in ecology to guide our exploration. In the end, we will synthesize the power of ecological thinking by discussing how it can be applied to social science, public policy, and even our physical and mental well-being as we battle the climate crisis. You will produce a research proposal on an ecological issue relevant to climate change and practice science communication at the end of this course.

**Objectives**

1. Through reading and classroom activities, you will be able to identify the system of interest given a research question and describe ecological patterns or processes involved.
2. You will discuss the pros and cons of different research methods (experiments, fieldwork, modeling) and connect them to course readings, field trips, and assignments.
3. You will learn to read research papers, summarize the main results, and select relevant sources to back up your argument.
4. You will be able to reflect on what ecological thinking means to you and describe its value to scientific research, public discourse on climate change and issues beyond, and your daily lives throughout the course.

**Format**

This is a flipped course as all lectures are pre-recorded, and we will take advantage of the freed classroom time to do Q & A on lectures and readings, work on assignments, and go on field trips. To facilitate self-assessment of your learning progress, you need to complete classroom assignments designed to address materials included in readings and lectures either independently or in a group. You will complete reports and other assignments which will help you construct your final group project and present it in class. There will be no exams, and your grade will be based on your participation in class activities, different assignments, and your synthesis of course materials. Detailed descriptions are included in Course requirements. Study tips and expected time budget can be found in How to succeed in this course.

**Course requirements**

Pre-requirement:

This course will introduce how to analyze papers containing mathematical modeling. Therefore, a mathematical background (calculus and linear algebra) and programming experience can be helpful, but not necessary. The quantitative aspect of this course emphasizes your understanding of concepts and big pictures, so you are not expected to do any mathematical modeling or analyze equations independently. There will be math primers and extra materials available if you want to be more prepared or to explore further.

Required reading:

No textbook is required. All readings are selected from scientific journals, websites, and book chapters. We will go over how to read different scientific sources in class. Required readings will be posted on Canvas as downloadable pdfs. The details of required/reference texts for each week are listed in Course schedule. You are responsible for the required readings assigned each week before the class during that week.

Lectures (pre-recorded):

The pre-recorded lectures are grouped in weeks and listed in Course schedule. You are responsible to finish watching lectures assigned each week before class. We encourage you to take notes and bring questions into class.

In-class assignments:

There will be instructions on each in-class assignment during class. Assignments can be diverse in form. For example, you might be asked to write 1-2 paragraphs of personal reflection on required readings after group discussion during class. Alternatively, you might work in small groups to complete a problem set or generate a short report together. All in-class assignments are designed to be short for quick submission and engage you with course materials. Details on grading are included in Grading.

Field trips:

Please read Academic Field Trip FAQs and Forms posted on Canvas before our first field trip (see Course schedule). There will be three field trips throughout the entire course—two in local forest areas and one in our local natural history museum. These field trips to forests will introduce you to field methods in ecology and provide opportunities for you to make observations and ask questions in the field. Meanwhile, the museum visit is a great opportunity for you to browse through extensive exhibitions and draw connections between ecology learned in the classroom and science education in the public realm. You will be asked to produce one report from the two forest field trips and another report from the museum visit. You have two weeks to submit each report after the day of the field trip. Instructions on field reports will be provided when the course begins.

Research proposal and presentation:

You will produce a research proposal (1-2 pages, single-spaced) on any ecological issue relevant to anthropogenic climate change based on your interest. This research proposal is due before the final day of class. You need to introduce your research background and explicitly state your research question and hypothesis. You also need to propose methods and include expected results in the proposal. You need to cite at least 5 primary sources from the class reading list and at least 2 sources from your own research in APA format. Detailed guidance and examples will be provided in class. A detailed rubric with examples will be posted on Canvas during the first week of class.

You will present the highlights of your research proposal in a five-minute talk during the final class. The short talks intend to help you practice creating and giving an elevator pitch which is crucial in science communication. Your presentation will be graded by your peers using a rubric which we will discuss in class. You are welcome to incorporate innovative formats rather than traditional keynote/PowerPoint presentations as well.

**Grading**

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| --- | --- | --- | --- | --- |
| **Assignment** | **Percentage** | **Due date** | **Tasks** | **Instructions** |
| In-class assignments | 30% | completed and submitted during class | 10 in-class assignments in total; students can choose to drop any two assignments for final grades | Included in each assignment |
| Field reports | 40% | Each report due two weeks from the day of field trip | 1 report for 2 forest field trips together; 1 report for the museum visit | Rubric will be available |
| Final research proposal | 20% | Last day of class | 1–2-page APA citation format, single-spaced research proposal citing 5+ course readings and 2+ external sources | Rubric and examples will be available |
| Oral presentation | 10% | Last day of class | 5-minute presentation to draw public awareness on an ecological issue under global climate change and sell it to the public | Peer evaluation rubric will be available and discussed in advance |

**How to succeed in this course**

This course will challenge you to think like an ecologist—to describe interesting ecological patterns we observe in nature, gather from media, encounter in conversations, etc. using the language of science. It’s not like a traditional biology course where you are required to memorize facts about organisms and ecosystems and then test on your memory; instead, you will be trained to think about 1) what patterns of concerns under an external disturbance in a system of interest 2) the processes involved in generating such patterns 3) why do we choose certain methods to address a particular question 4) how to use ecological thinking to bridge theory and practice. The course will touch on statistical and mathematical models. But we want you to focus on the ideas behind the equations rather than the technical details.

This course is reading-intensive and requires commitment to spend time both inside and outside the classroom to succeed. You might need some time in the beginning to get comfortable with the flipped classroom format. To help you evaluate whether you should take this course, here is an estimated time budget for a typical week of class:

* Pre-recorded lectures: 1.5-2 hours (broken down into 15-min long videos)
* Reading: 2 hours
* Class time: 3 hours (Q&A on lectures and readings, in-class assignments, or field trips)
* Writing assignment: 2 hours (to finish reports or work on final research proposal, etc.).

This time load will differ from week to week and vary among students. You are always encouraged to ask questions and form study groups. Utilize our class time to assess your learning progress and get work done.

**Accessibility, Diversity, and Inclusion**

Patterns of diversity emerge from different ways in which individuals interact with their environments including other individuals. This is what we see in ecology as well as in higher education. To foster ecological thinking, we need a space that’s accessible to all learners with various interests and backgrounds. We also acknowledge that ecology as a field has been shaped by scholars who had strong and sometimes harmful biases and motivations. To acquire ecological thinking makes it crucial to recognize how research governed by these erroneous ideas in the past had contributed to current social injustice and negative impacts on marginalized groups and communities of color. Building on mistakes, we invite you to advance accessibility, diversity, and inclusion in ecology by applying your ecological thinking to the real world and offer feedback on your experience in this course.

**Course schedule**

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| **Week** | **Date** | **Topic** | **Lectures** | **Readings** | **Class activities** | **In-class assignments** | **Due** |
| 1 |  | Primer: what is ecology |  |  |  |  |  |
| 2 |  | Space and time in ecology: introducing scale |  |  |  |  |  |
| 3 |  | Pattern vs process |  |  |  |  |  |
| 4 |  | Individuals: optimization |  |  |  | NA |  |
| 5 |  | Population: growth and regulation |  |  | Forest field trip 1 |  |  |
| 6 |  | Population: dispersal |  |  |  | NA |  |
| 7 |  | Community: succession |  |  | Forest field trip 2 |  |  |
| 8 |  | Community: species interaction |  |  |  |  | Field report on forests |
| 9 |  | Community: diversity |  |  |  |  |  |
| 10 |  | Biome: climate and niche |  |  | Museum visit | NA |  |
| 11 |  | Biome: landscape effect |  |  |  |  |  |
| 12 |  | Ecosystem: N, C cycles under climate change |  |  |  |  | Field report on museum visit |
| 13 |  | Evaluating systems: stability and resilience |  |  |  |  |  |
| 14 |  | Ecological thinking and its application |  |  |  |  |  |
| 15 |  | Synthesis |  |  | Final presentation | NA | Research proposal |

This syllabus and its course schedule will be adapted based on participant students and relevant programs.