

METHODS IN ECOLOGY (BIO 22): SUMMER 2024

STAFF

Kathryn L. Cottingham (@KathyCottingham on Slack; LSC 008A; 603-646-0216)

Student hours: M, T & F mornings 11 am - noon by appointment (LSC basement couches)

W & F immediately after class + Tuesdays x-hours if we don't all meet (LSC 135)

Craig D. Layne (LSC 121)

Ridhi Chandarana (student hours: W 11:30-12:30 in LSC 109, or email for an appointment)

COURSE OVERVIEW

Methods in Ecology is an intermediate-level course that puts into practice the foundational knowledge from Biology 16 about what ecology is and what its big questions, core theories, and major concepts are. You will learn how professional ecologists work through the various steps of the scientific process by conducting research projects that use two key research approaches (observations and experiments) in diverse study systems (lakes, streams, meadows, forests, and a greenhouse).

Working together, we will develop your abilities to (1) ask interesting and answerable questions and develop hypotheses about the answers to those questions; (2) design studies to answer those questions, collect the data, analyze the results, and draw appropriate conclusions; (3) present the findings using figures, tables, written text, and oral presentations; and (4) critically evaluate how things went and decide what to do next. Each of those four tasks has multiple component parts, so we'll spend each week emphasizing one or more of the parts before we put the whole process together at the end of the term.

While the skills involved in this course are particularly relevant to students planning to take upper-level courses in ecology -- including our Foreign Study Program, independent research, or an Honors thesis -- most of them are also transferable to other fields of science and your general ability to use the scientific process as a way to learn about the world.

Prerequisite: Bio 16 (Ecology). If you have not yet taken introductory ecology, please contact the instructor as soon as possible, as this course assumes prior familiarity with that material.

*This is the working syllabus as of the start of class on 21 June 2024.
Changes after the first day of class will be flagged with colored text.*

LEARNING OBJECTIVES

Course level

At the end of this course, you will be able to:

- Ask and answer interesting ecological questions in both new and familiar study systems
- Explain the concepts of “multiple working hypotheses”, “strong inference”, and “inference space” and use them in your own ecological research
- Design, conduct, analyze, and interpret a research study that yields a conclusive and trustworthy answer to an ecological research question
- Present any or all components of a research study in a clear and engaging oral presentation or written scientific report
- Critically evaluate and improve your own, and others’, research questions, hypotheses, study designs, analyses, results, and conclusions

My reach goal is for you to also synthesize the lessons learned from our individual units into a “meta” perspective that informs your own future research in ecology:

- Explain the strengths and weaknesses of observations and experiments as ecological research approaches
- Discuss the importance of temporal and spatial scale in influencing the design, results, and conclusions of an ecological study
- Describe how the system in which a study is conducted, including the natural history of the focal organisms, can influence not only how the study is done, but also its results and conclusions

Unit-level

The specific ‘hard’ skills we seek to develop along the way to the course-level objectives include:

- Creating and maintaining a practice of field journaling
- Developing an interesting and answerable ecological question and framing that question so that any answer would be interesting
- Finding, reading, synthesizing, and appropriately citing scientific articles relevant to a particular research question
- Developing multiple testable working hypotheses about the answer to a question based on the literature as well as your own observations, intuition, and prior experience
- Creating, maintaining and using a reference management database (Zotero)
- Applying the principles of study design to developing observational and experimental studies that yield reliable results despite logistical constraints
- Planning graphical and statistical analyses in advance of data collection or analysis
- Preparing spreadsheets that facilitate data entry, metadata creation, and analysis
- Collecting data in the field and in the lab using a variety of tools and approaches
- Entering data into spreadsheets accurately and efficiently
- Using JMP software to explore and analyze data
- Developing and captioning visualizations for exploratory data analysis (figures and tables)
- Choosing which inferential statistical analyses to do and how to report them in captions or the main text in ways that emphasize the biology and biological effects, not P-values
- Interpreting the results of the exploratory data analysis and statistical analyses
- Drawing conclusions, including the ‘inference space’ for those conclusions, and interpreting them in the context of prior work
- Critically evaluating the scientific process you just completed: what went well, what can go better in the future, how might you change things to improve
- Identifying concrete next steps: new questions, hypotheses, study designs, etc.
- Presenting your study clearly, precisely, and concisely in presentations and in writing
- Providing constructive feedback to others on their questions, hypotheses, study design, analysis plans, analyses, and interpretations

Additionally, we will work on ‘soft’ skills such as:

- Self-confidence: everything we cover can be learned and just takes practice. Yes you can!
- Collaborating with others on ecological research projects: working well in teams
- Time management: especially meeting deadlines & keeping up with projects at different states of completion
- Persistence, tenacity, and resilience: science is hard. Not everything works. Learning how to learn from ‘failure’ and move on is an important part of being a scientist.
- Meta-cognition and self-assessment: what are you learning and how can you improve?

COURSE MEETINGS & ATTENDANCE POLICY

Meetings

We will meet during our regularly scheduled MWF “12” course time and Monday laboratory period, as well as during some of the x-hours.

“**Lectures**”: Mondays, Wednesdays, and Fridays, 12:50-1:55 pm, LSC 135

- Please come to the M class period ready for that day’s lab activities, in case we need the flexibility to head out early to seize good weather conditions

Laboratories: Monday afternoons, 2:10-6:10 pm, starting in LSC 102.

- See [Lab Schedule](#) for information about what to expect, wear, and bring to each lab session

x-Hours: selected Tuesdays 1:20-2:10 pm (see [Calendar](#) for details), LSC 135

- Please avoid making other commitments during the x-hours – we need that time available for ‘bonus’ lessons in some weeks, plus they are built-in opportunities for group time and student hours.

Attendance

This is a small class that moves quickly and includes strong interdependencies among students due to the prevalence of group work. If you need to miss class entirely, you will miss material and -- perhaps more importantly -- we will miss you and your contributions. As such, your prompt attendance (in person or remote) is expected at our scheduled course meetings unless you have made alternative arrangements due to illness, other medical reasons, or other time conflicts.

That said, I do ask, for the health and safety of our class community, that you please not attend class when you are sick with any potentially contagious respiratory illness or when you have been instructed by Student Health Services to stay home.

We have multiple mechanisms in place to make sure you don’t miss anything important!

- If you are feeling well enough, all class meetings can be turned into a hybrid class meeting (in class + on zoom) with a little bit of notice. Just send an email before ~12 pm and I’ll make it so. The zoom link is available [here](#) or through [Canvas](#).
- If you are not feeling well or unavailable during our course meeting time, all of my iPad notes are posted to the class calendar by the end of that day and I am happy to catch you up in a brief conversation once you are back.

If you need to miss class without prior warning, please reach out as soon as you can to check in and make sure that we can keep you up-to-date.

Also, whether you are physically present at class or participating remotely, please try to give class your full attention. We realize that having computers/tablets/phones open during class can present numerous distractions and opportunities to multi-task. Multi-tasking that keeps you from participating fully in whole-class and small-group activities is strongly discouraged. Please set your devices to Do Not Disturb mode at the start of class and refrain from messaging non-class members during the scheduled class and lab periods.

GENERAL INFORMATION

Course Website

The [course calendar](#) is designed to be a one-stop shop to this course that leverages the extensive use of [Canvas](#) and Google Drive to distribute digital materials for this course and manage electronic submission of assignments. Details will be discussed at our first few course meetings; please speak up if something is confusing or missing, since my relationship with Canvas leans towards antagonistic. Each course participant should ensure that they will be emailed Canvas announcements immediately upon posting and also check the Canvas and calendar sites regularly, especially before each scheduled class meeting.

JMP (pronounced “Jump”) Statistical Software

All students will become familiar with this user-friendly, point-and-click (but also scriptable) program that makes it easy to do analyses in real-time during class periods. There is a campus-wide site license for this software that makes it free. Mac users should start here: <https://services.dartmouth.edu/TDCClient/1806/Portal/KB/ArticleDet?ID=64613> and PC users should start here:

<https://services.dartmouth.edu/TDCClient/1806/Portal/KB/ArticleDet?ID=64626>.

If you run into trouble with the licensing, please contact help@dartmouth.edu; for other questions, contact Professor Cottingham. You will need to have JMP running on your computer no later than our W 26 June course meeting.

Course Materials

There is no required textbook for this course. Instead, we will rely on a variety of resources:

- The book “[How to Do Ecology](#)” may be quite useful and is available online through the library. We’ll flag when particular chapters dovetail well with class activities.
- Books on ecology accessed through the Dartmouth libraries – use the catalog to identify potential resources, then request that they be delivered from storage the next day. If you’re new to ecology, or it’s been awhile since you took Bio 16, obtaining a copy of an overview text may be particularly helpful.
- Books on statistics available through the Web (google “open textbooks for statistics”). We will provide you with sufficient background for all statistical analyses done in this course, but some of you may want to consult additional resources for more information.
- We can also put older copies of ecology and statistics texts in the entryway of LSC 102 if you would like; please tell us if that would be helpful!
- Specific peer-reviewed articles that we either require or recommend, available through Canvas. These will be announced on the class calendar, handouts, or assignments; note that you will need to be logged in to eduroam (on campus) or connected through the VPN client to access most of these papers. If you will be living off campus this summer, please be sure that you know how to use the VPN software!
- Peer-reviewed articles that you track down on your own using library-based resources. Note that we will have a special x-hour on Tuesday, July 9, to develop the skills you’ll need to find peer-reviewed papers for your preparatory and synthesis assignments.

- Web-based resources, but note that most websites are not checked for accuracy. Please evaluate what you access this way critically!

Help

Methods in Ecology is a subject best learned by doing -- falling behind in the early weeks of this course will be extremely problematic. Immerse yourself in the material. Do not be afraid to seek help early and often! Help can be obtained from the teaching staff during scheduled class or student hours, or by appointment. Note that we strongly encourage you to work in groups for much of this course, since much can be learned from comparing how different people address the same problem. The instructions for each quantitatively graded assignment will clearly spell out when it is and is not appropriate to work with others (see also [HONOR PRINCIPLE](#), below).

HONOR PRINCIPLE

Dartmouth's new campus-wide [Academic Honor Principle](#) (effective 1 July 2024) and the new undergraduate Arts & Sciences [Academic Honor Policy](#) (effective 18 June 2024) will apply to all work you submit for evaluation in this course. Please read them carefully as there are changes.

All work you turn in must be your own unless the assignment is explicitly identified as a group activity. We will work hard to make these identifications clear and consistent; when in doubt, ask!

All sources, including images, must be attributed following formats that will be provided to you; [this resource](#) may also be helpful.

It is not appropriate to use any type of generative artificial intelligence (Gen AI) unless it is specifically approved in advance and in writing by the professor. We may explore tools like Elicit or ChatGPT this term, but only within specific parameters.

You are allowed to:

- Discuss any preparatory or skills assessment assignments with classmates, so long as ideas from others are acknowledged appropriately. In this context, “discuss” means real-time synchronous contact, either in person or via conferencing apps/software. For example, a group of 2-3 students might get together to look for references that might be appropriate for “learn about the system” assignment, divvy up the most interesting-looking papers among group members, and then compare notes on what they've found in those papers. Alternatively, they might meet to compare notes about data analysis plans before we dive into a data set. However, the actual writing of answers must be done independently.
- Use ideas from the class discussions and shared Canvas discussions in your individual assignments, so long as they are appropriately acknowledged.
- Share electronic files associated with data analysis (e.g., Google spreadsheets, Excel graphs, JMP output, model output) or group presentations (e.g., Google slides).

You may not:

- Access the online Canvas course discussions before you have completed your own postings.

- Share any text-based electronic files for written assignments that go beyond data analysis: introductory material, interpretations, conclusions, etc.
- Discuss the weekly reflections, end-of-unit synthesis assignments, or end-of-term portfolio submission with classmates outside of class time.

Other situations will be spelled out as the term proceeds, since it may not be possible to anticipate all such questions. If you have any questions about the Honor Principle, please contact Prof. Cottingham as soon as possible after the question arises.

COURSE REQUIREMENTS

As noted above, this is an immersive experience in ecological methodology. We are asking you to work steadily throughout the term by spending several hours preparing for each course meeting, engaging fully during class, and then synthesizing and reflecting on our activities after class. While we will have near-daily preparatory assignments or skills assessments, much of the evaluation will be formative -- focused on providing you with constructive feedback -- until near the end of the term, once you have a chance to develop your skill sets. There are two primary graded summative assessments: (1) a student-led group greenhouse experiment that will run through much of the term and result in a formal oral presentation and a complete scientific report and (2) an individual end-of-term portfolio assembled from updated components of your end-of-unit synthesis exercises. There will also be weekly reflections that include self-assessments and a component evaluating your contributions to making a positive course environment. Each of these planned methods of assessment is explained in more detail below.

Skills assessment (35%)

As outlined in the [Learning Objectives](#), we are looking to develop your ability to think and act like an ecologist by developing a variety of specified skills. We will use this category of assignment to prepare you for work at class, probe how your skills are developing, and provide you with constructive feedback on how to do things even better. Numeric assessments will happen only in the latter part of the term; otherwise, we plan to use a check, check plus, check minus system to signal truly exceptional or underperforming submissions. You can anticipate that most submissions will receive a “check”, indicating adequate competency given the stage of the term.

Out-of-class preparation for in-class activities (17%)

Advance preparation is essential to this course running smoothly. To maximize productivity during our in-class time, you will come to most class meetings having completed some sort of assignment. Especially on Fridays and Wednesdays, the preparatory assignment may involve either posting to a Canvas discussion board (and responding to others' posts) or filling out and uploading worksheets that ask you to think about -- and plan for -- what we'll be doing in class that day. Early in the term, we will try to indicate roughly how much time we think you might spend on each assignment so you know what we're expecting.

You are also expected to prepare for the laboratory sessions; for example, you should come to lab able to identify local invertebrates in the stream and forest labs and plants in the meadows lab, as described in the preparatory worksheets for those weeks. We may probe your readiness for these identifications with low-stakes online quizzes.

Please do your best to complete all of these pre-class assignments on time. We know that life happens, and if you need to miss one or two here or there, just upload an explanation into Canvas or send an email and we will make an appropriate note. Missing three or more of these assignments, or repeatedly submitting them after the due date, will decrease your final grade in this category.

Field journaling (8%)

Keeping a good field notebook is an essential skill for field ecology. We will provide you with field notebooks to use throughout the course to take notes on your field and lab studies as well as make natural history observations in each of the systems we explore. Our TA Ridhi Chandarana will be your point of contact for this particular skill. In week 1, she will discuss core concepts and expectations for your field notebooks.

We currently anticipate having you submit your field journals for formative feedback twice during the term (targeting July 9 and July 30), and then to submit your completed journal for summative review (a rubric will be provided) on August 16.

During-class activities (10%)

Bio 22 assumes active participation of all students throughout the term. We will assess how the in-class activities are going both by observing your work and from reading your self-assessments. Almost everything we do at class/lab during the term could contribute to this score. During lab, students are responsible for learning new skills and putting them into practice. After a data analysis session, we may call on one or more groups of students to present their findings regarding the current dataset and then ask for peer comments on that work. At the end of a unit, students will share parts of their synthesis assignments with one another both by giving short oral presentations of their primary figures and by contributing to group discussions of the assignment. Some weeks, we will have small and large group discussions to formulate the exact questions, hypotheses, and/or sampling plans for the following week's lab. We'll take notes on how things are going; you can assume that this is all going fine ("check") unless you hear directly from the teaching staff.

Data wrangling (5%)

Most of our Monday lab sessions and some of our Tuesday x-hours will result in both notes and numeric data that reside on data sheets or in field notebooks. We will need that information to be entered into an organized Google sheet before class on Wednesday in order to analyze the data and begin to interpret our findings. As such, you will be asked to enter the data, upload photographs of it, or scan your datasheets in order to acquire an "exit ticket" from the lab or x-hour. Please do not depart LSC 102 without making your data available to the teaching staff.

Then, after each lab, individuals or teams of students will be responsible for completing sample processing and having the data entered into appropriate Google spreadsheets by 10 AM on Tuesday or Wednesday morning. Students will share responsibility for data entry in two ways:

- In weeks where we will pool data from the entire class to answer the research question, designated students will enter the data into pre-formatted spreadsheets. Volunteers are encouraged; if necessary we will assign you to a week once class enrollment stabilizes. If

you know that a particular week will be bad for you, please let us know and we'll do our best to accommodate your schedule. If you have a busy term, volunteer to help out early!

- In weeks where data will be collected and analyzed separately by groups of students, each group will be responsible for entering its data into the spreadsheet before the deadline.

Your score in this component will be based on always obtaining your “exit ticket” before heading out from lab and contributing in a timely fashion to data entry.

Weekly reflection assignments (10%)

Each week, individual students will complete some sort of self-assessment and reflection exercise that asks you to engage in metacognition about that week's material. For example, we will ask about your personal goals for the course, including both skills and grades, at the beginning of the term, and then have you reflect back on these long-term goals at intervals during the term. You may also be asked to reflect on how the week has gone, what the “muddiest points” currently are, or what skills you most want to work on next week (and why) and whether you made progress on the previous week's goals. The goal is to help you solidify your understanding of the course material so far and how it fits with your emerging ideas about the scientific process in ecology.

At the end of the term, you may be asked to put together your own "field guide to being an ecologist" that summarizes your take on how to do each step of the scientific process, what you've learned and what you want to remember going forwards. This might be particularly useful for those of you going on the FSP in January.

These assignments will be read and commented on, but not graded beyond having been completed so long as they are taken seriously. You can skip one week if you need to; just upload a “SKIP WEEK” note in Canvas.

End-of-unit synthesis assignments (10%)

At the end of the major system units (lakes, streams, meadows, and possibly forests, we're still figuring that out), we will ask each of you to synthesize your findings from that study system by completing a worksheet that breaks the components of a scientific paper (Introduction, Methods, Results, and Discussion) down into smaller pieces. Additional questions on these assignments will ask you to integrate what you've learned with the course goals, including thinking about follow-up questions, hypotheses, and studies to test those hypotheses.

These synthesis assignments will typically be due by 11 am on Mondays as typed documents complete with embedded figures and captions. Our evaluations will emphasize providing you with constructive feedback on where you're at in terms of developing the components of a research paper and making progress towards the course goals. As with the [Skills Assessments](#), we plan to use a check, check plus, check minus system to signal truly exceptional or underperforming submissions, and anticipate that most submissions will receive a “check”, indicating adequate competency given the stage of the term. The summative assessment of this work will happen as part of the end-of-term portfolio.

You must do each of these assignments. Moreover, because late submissions will slow down progress in other areas, we ask you to please discuss potentially late submissions with Prof. Cottingham before the assignment is due is at all possible.

End-of-term portfolio (20%)

This major summative assessment will ask you to develop a combined portfolio of your best work on the various observational and experimental studies across the term, write a justification as to why you chose each particular element of the portfolio, and write short essays on the topics outlined as “reach goals” on the [course-level learning objectives](#) page.

You will receive much more information about this component by August 2, but briefly, we intend for you to integrate the formative feedback on your end-of-unit synthesis assignments into a “greatest hits” research paper that includes an Introduction, Methods, Results (including figures and tables), and Discussion -- but not necessarily all from the same system -- together with the justification and essays. Please ask if you want to know more sooner!

Extended group greenhouse experiment (15%)

Throughout much of the term, teams of 2-3 students will work together to complete a well-designed and executed experiment with basil plants in the LSC Greenhouse, doing the entire study on their own with help from the teaching staff and greenhouse staff. The major summative assessments included with this component will be an oral presentation during the last laboratory period as well as a complete written scientific paper with Introduction, Methods, Results, and Discussion. We’re still working on all of the details, but will provide an initial overview in week 2 and the complete details in week 5.

Contributions to a positive course environment (5%)

We all need to work together to make this class a positive place for learning. Everyone should behave professionally, treat others with courtesy and respect, and refrain from using profanity or socially offensive language. As the term gets going, we will discuss class norms for how to behave in the classroom, lab, and out in the field, as well as in online spaces such as Canvas discussions and shared Google documents; if needed, we can revisit those norms during the term. Being on time, especially for lab sessions, and coming prepared for that day’s activities are also important. Finally, should there be members of the class who are at high risk for complications from SARS-CoV-2 or other respiratory illnesses, we may strongly recommend that everyone wear a well-fitting respirator during indoor class meetings, especially in the LSC 135 classroom.

Detailed instructions on self-evaluation of this component will be provided near the middle of the term, and evaluations will be submitted via a confidential Google form at the end of the term.

Summary: weighting of different assessment tools

Your final grade will be based on the points earned across the different methods of assessment and weighted as follows:

Method of Assessment	Contribution to Final Grade	Summative Assessment
Skills assessment, primarily via	35%	

Method of Assessment	Contribution to Final Grade	Summative Assessment
pre-class and during-class work		
out-of-class prep assignments	17%	
field journaling	8%	X
during-class work	10%	
Data wrangling	5%	
Weekly reflection assignments	10%	
End-of-unit synthesis assignments	10%	
End-of-term portfolio	20%	X
Extended group greenhouse experiment	15%	X
Contributions to a positive course environment	5%	

The “X” in the summative assessment indicates a category for which a numeric grade will be assessed near the end of the term. Proficiency in both the core course goals and the “reach” goals is expected in order to earn an “A” grade.

IMPORTANT RESOURCES

(this text is standard campus language unless indented and labeled as an addendum)

Student Accessibility Services

Students requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; [Apply for Services webpage](#); student.accessibility.services@dartmouth.edu; 1-603-646-9900) and to request that an accommodation email be sent to me in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with me to determine relevant details such as what role SAS or its [Testing Center](#) may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

Addendum: I am happy to adjust this course to meet your needs. Please send me an email to schedule a meeting as early in the term as possible so that we can work together to identify what changes might be needed within the context of the current course structure and supports.

Religious Observances

Dartmouth has a deep commitment to support students' religious observances and diverse faith practices. Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me as soon as possible—before the end of the second week of the term at the latest—to discuss appropriate course adjustments.

Mental Health & Wellness

The academic environment at Dartmouth is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including: the [Counseling Center](#) which allows you to book triage appointments online, the [Student Wellness Center](#) which offers wellness check-ins, and your [undergraduate dean](#). The student-led [Dartmouth Student Mental Health Union](#) and their peer support program may be helpful if you would like to speak to a trained fellow student support listener. If you need immediate assistance, please contact the counselor on-call at (603) 646-9442 at any time. Please make me aware of anything that will hinder your success in this course.

Addendum: I encourage you to use these resources to take care of yourself throughout the term, and to speak to me if you experience any difficulties. Adjustments to the schedule are possible!

Textbook Costs, Printing, and Financial Difficulty

If you encounter financial challenges related to this class, please let me know. We have some resources to help.

Title IX

At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all community members have equal access to Dartmouth's educational and employment opportunities. We strive to promote an environment of sexual respect, safety, and well-being. Through the Sexual and Gender-Based Misconduct Policy (SMP), Dartmouth demonstrates that sex and gender-based discrimination, sex and gender-based harassment, sexual assault, dating violence, domestic violence, stalking, etc., are not tolerated in our community.

For more information regarding Title IX and to access helpful resources, visit Title IX's website (sexual-respect.dartmouth.edu). As a faculty member, I am required to share disclosures of sexual or gender-based misconduct with the Title IX office.

If you have any questions or want to explore support and assistance, please contact the Title IX office at 603-646-0922 or TitleIX@dartmouth.edu. Speaking to Title IX does not automatically initiate a college resolution. Instead, much of their work is around providing supportive measures to ensure you can continue to engage in Dartmouth's programs and activities.