

RNR/ECOL/GEOS 433/533

Forest Ecology

Biological Sciences East 225

M/W 12:30-1:45 pm

Land Acknowledgement: *We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.*

If you are interested in reading more about Land Acknowledgements, a good article is “*So you want to acknowledge the land? Some notes on a trend, and what real justice could look like*”, by Summer Wilkie, published in High Country News, April, 2021

Forest Ecology is a 3-unit course in which the objective is to develop a better understanding of how forests work. Forests provide many benefits to humanity, including wood, water resources, and habitat for wildlife. In addition, they play a key role in the global carbon cycle. A 2018 U. S. National Academies of Sciences report advocates for using afforestation, reforestation, and improved forest management as “Negative Emissions Technologies” to draw CO₂ out of the atmosphere. At the same time, we see forests dying in response to drought and going up in smoke in massive wildfires. Can we restore the Earth’s climate system with forests, and preserve the many benefits to humanity provided by forests? The course begins with a survey of the diversity of forests at the global scale. We’ll then consider forests from the ground up (soils and ecohydrology), proceeding to the physiology of individual trees, what controls tree growth, followed by forest demography, including forest stand development, regeneration, and tree mortality, then landscape-scale processes (disturbance ecology), succession, and resilience ecology, ending with forests as ecosystems. Forest models, forest management, forest wildlife, and forest restoration will be considered throughout.

Instructor

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Office Hours: Tu 2-3 pm and Weds 3:30-4:30 pm and by appointment.

Office phone: 621-0778

My office hours are your time to speak with me. In the fall, 2021 semester, office hours will be conducted in person on Tuesdays and via zoom on Wednesdays. If you have something you’d like to discuss and the office hours are incompatible with your schedule, drop me a line and we’ll find a time to meet.

The prerequisite for this course is ECOL 302, or RNR 316, or an equivalent course.

Web Site (<https://d2l.arizona.edu/d2l/home/1083826>)

The D2L course website will have the readings, assignments, schedules, announcements, etc. Powerpoint lectures will be posted to the website after they are given. Grades will be available on the course D2L website.

Course communication will be conducted via email and announcements to the D2L course website.

Course Format and Teaching Methods

This course will be a mixture of interactive, question-driven lecture, in-class discussion of readings, and student presentations in the second half of the semester (place-based consideration of forests, evidence for forest “greening” vs. “browning”), and a final, student-led synthesis.

My objective in the classroom is first and foremost to maximize your learning. I view my role in the classroom as part guide (navigating existing knowledge about forests and the current limits of that knowledge), part coach (providing structure), part cheerleader (giving encouragement), and part gym buddy (accountability). To do my job well, and better yet, improve, I have relied on pedagogical resources on critical thinking, cognitive learning, and evidence-based teaching methods. If you’re interested in accelerating your learning, I strongly encourage you to take a look at some of these resources:

The Foundation For Critical Thinking defines “critical thinking” in terms of skill at examining one’s own (and others’) thinking to improve it. To quote, “*Much of our thinking, left to itself, is biased, distorted, partial, uninformed, or downright prejudiced.*” They describe nine elements of thought (point of view, purpose, question at issue, information, interpretation and inference, concepts, assumptions, implications and consequences) and nine intellectual standards to assess skill in critical thinking (clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness). <http://www.criticalthinking.org>

The cognitive domain of learning includes six “levels”: knowledge, comprehension, application, analysis, synthesis, evaluation, and creation. <https://thesecondprinciple.com/instructional-design/threedomainsoflearning/>

Explore six evidence-based learning strategies that you can use to improve your learning: retrieval practice, spaced practice, elaboration, interleaving, metacognition, and a growth mindset. <https://academicaffairs.arizona.edu/l2l>

Course Objectives

Students will gain an understanding of the ecology of forests, including:

The diversity of forests around the world and how climate shapes where forests are found

The factors that control the growth of trees, and the metrics and patterns of tree growth

The causes of tree mortality, and contrasting patterns of regeneration in different forest types

The process of forest stand development (self-thinning)

Disturbance processes in forests, ecological succession, and resilience ecology

The forest ecosystem concept, including pools and fluxes of energy and nutrients, as well as ecosystem stability and complexity

The role of forests in the global carbon cycle, and the most important scientific uncertainties about the feedback between climate and forests.

Expected Learning Outcomes

Undergraduate students will be able to:

Demonstrate knowledge and understanding of (describe, explain) the processes and drivers governing forest dynamics.

Apply understanding of forest processes to local examples.

Evaluate the evidence for divergent views about forest trends from the scientific literature (journals and other scholarly works), and think critically about drivers and processes underlying those forest trends, including identifying and assessing the key assumptions and uncertainties at issue.

Synthesize what is known about the past, present, and future role of forests in the global carbon cycle, including proposing what kinds of research are needed to address scientific uncertainties.

Graduate students:

Graduate students enrolled in RNR 532 will be expected to meet the learning outcomes described above for 400-level students, and demonstrate a higher level of cognitive learning.

Beyond recalling or remembering, can you demonstrate understanding? For example, can you explain why coniferous vs. broadleaf forest are found where they are found? Beyond understanding, can you apply an idea in a new way? For example, can you apply what you've learned about how climate influences forests to predict how climate change should affect forests (their geographic distribution, their structure or composition...)? Beyond applying an idea, can you analyze it (e.g., identify critical assumptions) or evaluate evidence for an idea (e.g., identify critical predictions and supporting or refuting data)? For example, can you identify the key assumptions that lead to contrasting predictions about how forests will respond to climate change? Beyond analysis or evaluation, can you synthesize information and create something new (e.g., a hypothesis that reconciles conflicting evidence for forest trends)?

Makeup Policy for Students Who Register Late

Students who register after the first class meeting may make up missed assignments/quizzes. The deadline for doing so is the end of the 4th week of class.

Required Texts or Readings

All required readings will be available on the D2L course website.

400-level Course Work – Total 400 pts

1. Exams (200 points)

There will be one **midterm exam [date]** and a **final exam**. The final will be cumulative. Topics covered in class, by guest speakers, and in the assigned readings will be fair game. The format will be mixed and may include: matching, fill-in, multiple choice, short answer, and essay. Be prepared to synthesize ideas, rather than just regurgitate information. There will be no make-up exams. During exams, **you will be able to consult your own notes and the reading material**, but not use outside sources or the internet. The exam will be divided into a set of questions over which groups of 3-4 people may interact with one another, discuss the questions, and compose their answer, followed by a set of questions on which each student works on their own.

The final exam will be [DATE] and [TIME].

See the University of Arizona's Final Exam Regulations <https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information> and Final Exam Schedule <http://www.registrar.arizona.edu/schedules/finals.htm>

2. Forest Ecology Journal (100 points)

You will be asked to answer a question 10 times during the semester (worth 10 pts each). This may be at the beginning of class – particularly to motivate you to be on time to class and prepared – but may be at the end of class (as an “exit ticket” or “minute paper”). The goal of this is to devote time to reflection on class material (hence “Forest Ecology Journal”). By the end of the semester, you will have a personal “journal” with ten entries comprising your answers to key questions about forests. A significant fraction of

your grade is based on this journal because the design of the course requires active engagement with class material. Journal entries will be graded by the instructor, TA, or self-graded (following a rubric).

3. Student Presentation (100 points)

Student Presentations will be in the second half of the semester; they will address a variety of topics, including key scientific uncertainties about forests and their feedback on climate. Some of these presentations will take a debate format on a particular topic, followed by a student-led synthesis. Take the example of the controversy over whether boreal forests are “greening” vs. “browning” with warming temperatures: we will hear a student presentation on the evidence for boreal forest greening, followed by a student presentation on the evidence for boreal forest browning, then a third student group (along with the instructor) will facilitate a synthesis discussion. **You are required to meet with the instructor during office hours twice in the semester: in week 4 (10 points) to discuss the topic and receive key citations and advice, and in week 8 (10 points) to stay on track with the development of your presentation, and get feedback on powerpoint slides.**

Graduate Student 500-level Course Work – Total 500 pts

Requirements

Graduate students will be expected to read more than undergraduates on a regular basis. In addition, grads will turn in a **6-page, single-spaced essay (100 pts)** on their Student Presentation topic (*with at least 10 citations from the primary literature*). Graduate students will be expected to play a leadership role in the student-led synthesis discussions regarding forest “greening” vs. “browning” in the second half of the semester. Otherwise, coursework for graduate students includes the same requirements and workload as RNR 432: the mid-term and final exams (200 pts), Forest Ecology journal (100 pts), and student presentation (100 pts), for a total of 500 pts.

Estimated Workload – Undergraduates and Graduates

Students should anticipate spending 135 hours on activities related to this course. These hours break down roughly as follows: 37.5 hours of “in-class” time; 52.5 hours on reading materials and videos; 20 hours preparing the student presentation (and essay, for grads); 7.5 hours studying for each exam; 5 hours of self-evaluation; and 5 hours on communication with the instructor and other students.

Grading Scale and Policies

Grades will be distributed as follows:

Undergraduate coursework: ≥ 90% (360-400 pts) A, 80-89% (320-359 pts) B, 70-79% (280-319 pts) C, 60-69% (240-279 pts) D, ≤ 59% (≤239) E

Graduate coursework: ≥ 90% (450-500 pts) A, 80-89% (400-449 pts) B, 70-79% (350-399 pts) C, 60-69% (300-349 pts) D, ≤ 59% (≤299) E

The final grade will reflect the percentage earned out of 400 points total possible for undergraduates and 500 points total for graduate students (as delineated above in Course Work). Grades will not be curved, which means it is possible for every student to earn an ‘A’ in the class. I genuinely hope that every student will meet those high expectations.

Assignments are due *no later than the beginning of lecture* on the due date, unless otherwise noted. Late assignments will be penalized 10% for each day they are late (this includes being late to lecture on the due date). There will be no ‘make up’ exams or ‘extra credit’. I realize that you have lives (bicycles do break down, people get sick, stuff happens). In exceptional cases, and **particularly if arrangements are made in advance**, I will consider your unique situation.

Incomplete (I) or Withdrawal (W):

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

Dispute of Grade Policy

If you wish to dispute a grade on a paper, project, or exam, you must contact me within one week of receiving the grade.

Honors Credit

Students wishing to contract this course for Honors Credit should email me to set up an appointment to discuss the terms of the contract. Information on Honors Contracts can be found at <https://www.honors.arizona.edu/honors-contracts>.

Scheduled Topics/Activities

Class	Topic	Reading / Guest speaker
Aug 22	Forest Ecology – the Big Questions; course logistics, expectations, and classroom environment	
24	Forests, A World Tour: Boreal forests	Required: https://en.wikipedia.org/wiki/Taiga Optional: https://e360.yale.edu/features/will-russias-forests-be-an-asset-or-obstacle-in-the-climate-fight
29	Forests, A World Tour: Temperate forests	Required: Currie and Bergen 2008 Optional: Silander 2001, https://en.wikipedia.org/wiki/Temperate_forest
31	Forests, A World Tour: Tropical forests	Online resources for scavenger hunt: https://en.wikipedia.org/wiki/Tropical_forest# https://striresearch.si.edu/rainforest/ https://education.nationalgeographic.org/resource/rain-forest
Sept 7	Soils (physical properties with respect to water and nutrients), Soil ecosystem, Soil health	Ch. 10, Kimmins' Forest Ecology
12	Mycorrhizae (competition, cooperation, or biological marketplace?)	Required: "The Social Life of Forests", by Ferris Jabr (The New York Times); Optional: "How Trees Talk To Each Other", TED talk by Dr. Suzanne Simard; "Lessons from fungi on markets and economics", TED talk by Dr. Toby Kiers; see also "Unearthing the Secret Superpowers of Fungus", by Somini Sengupta (The New York Times), and Dr. Kiers' organization the Society for the Protection of Underground Networks (SPUN)
14	What controls tree growth? Limiting	Required: Fatichi et al. 2014

	Factors; Source- vs. sink-limitation	
19	The Soil-Plant-Atmosphere continuum; How do trees do it? moving water 100 m up. Tallest trees	Dr. Jia Hu Required: Koch et al. 2004, plus a 5-minute video “How Trees Bend the Laws of Physics” by Veritasium Optional: Maple syrup mechanics – xylem, sap flow, and sugar content, by The Botanist in the Kitchen
21	Metrics and Patterns of individual tree growth; Biggest trees	Required: Bowman et al. 2013 Optional: Stephenson et al. 2014
26	A Tree Is Born (“Recruitment” or “Regeneration”)	TBD
28	What makes a tree die? Oldest trees	Connor Bernard, PhD student, Oxford University
Oct 3	Drought-induced mortality	Required: Choat et al. 2018 Optional: Allen et al. 2015 (really, really long!)
5	Competition-induced mortality – the -3/2 thinning Law	TBD
10	Forest succession, Forestry growth and yield models (forest growth slows with stand age; Bekuzi matrices)	Dr. Justin DeRose , reading TBD
12	Mid-Term Exam	
17	Landscape processes – fire regimes and fire restoration	Dr. Chris Guiterman , reading TBD student presentation: amazing fire adaptations
19	Landscape processes – fire cont’; Pinaleno Mtns, the Mogollon Rim (4FRI), the 2020 Bighorn fire (Santa Catalina Mtns)	Dr. Molly Hunter , required reading: Taylor et al. 2021 place-based student presentations
24	Landscape processes – insects (Pinaleno Mtns cont’)	reading TBD
26	Forest Landscape Models	No required reading Optional: Urban et al. 1987, Shifley et al. 2017
31	Forest as Ecosystem – systems thinking, forest ecosystem models; biggest C stocks and fluxes; respiratory costs and night-time temperatures	Reading: TBD Student presentation: nitrogen in forest ecosystems

Nov 2	Forest Ecosystem Stability, Complexity – ASS theory, type conversion, resilience	Required reading: “Ecosystem Stability I” Ch. 20 in <i>Forest Ecosystems</i> by Perry, Oren, and Hart 2008
7	Role of Forests in the Global C Cycle –The Land C sink and its uncertain future	Dr. David Moore , reading TBD
9	Boreal Forests – Greening or Browning? (Marchand et al. 2018)	Student presentations: evidence from each side + synthesis Required reading: TBD
14	The Amazon – Risk of Type Conversion? (Baccini et al. 2017)	Student presentations: evidence from each side + synthesis Required reading: Lovejoy & Nobre 2018 and Amigo 2020
16	CO ₂ Fertilization Effect (Schimel et al. 2015, Walker et al. 2020)	Student presentations: evidence from each side + synthesis (Coaching by Dr. Kelly Heilman + Dr. Evans) Required reading: Walker et al. 2020 or Cabon et al. 2022
21	Forest Regrowth from Disturbance – how much of the Land C sink? (Pugh et al. 2019)	Student presentations: evidence from each side + synthesis Required reading: Pugh et al. 2019
23	Forest Ecosystem Models – the problem of scaling	Required: Silva and Lambers 2021 Optional: Scholes 2017
28	Conventional forest management and its evolution (“decadent” forests, the rise of ecological forestry), Forest Restoration	TBD: Hirt 1994, Hays 2007, DeRose and Long 2014, Naudts et al. 2016, Fahey et al. 2018
30	Indigenous Forest Management Practices	Jaime Yazzie
Dec 5	Can Forests Save the Climate System?	Student-Led Synthetic Discussion
7	Review Session	

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Classroom Behavior Policy

Students and instructors have a shared responsibility to foster a positive learning environment in the classroom. I ask you to help me create a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to learn. We are in a time of growing awareness of the racism, sexism, homophobia, and colonialism that are woven into the culture and institutions of this country. Please join me in identifying and questioning the stereotypes, prejudices, and implicit biases that arise from this history and cultural milieu, so that we can create a classroom that

reflects a commitment to fairness and equity, where uniqueness is appreciated, and where all have a voice and a sense of belonging.

On that note, be aware of how you use your voice in the classroom. Some of you may be quick to participate in class (raise your hand, volunteer your thoughts); others may be shy. If you fall at the extremes of this distribution of voluntary participation, I ask you to try to move to the center. ***If you are normally quick to participate, please hold back and give others a chance to step in. If you are normally hesitant, please challenge yourself to step a little outside your comfort zone and share your thoughts.*** I will at times call on people to attempt to create a class environment in which everyone's voice is heard.

Texting, the use of social media, and websurfing during class time is not allowed. The two and a half hours we have together each week to learn about forests and the role they can play in climate repair are precious; don't waste that time or dilute the class environment with distractions. Infractions of this ban on social media will be enforced, on the first and second time with a warning, and upon the third (or subsequent) infraction, by being asked to leave the classroom for that class period.

University-wide Policies

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>.

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences for groups of more than three students that are pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <http://policy.arizona.edu/employmenthuman-resources/attendance>.

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520) 621-3268 to explore reasonable accommodation.

If our class meets at a campus location, please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Please note the University's commitment to creating and maintaining an environment free of discrimination, as specified at <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>.

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: <https://deanofstudents.arizona.edu/policies/code-academic-integrity> and <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>

Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Confidentiality of Student Records

<http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>