

ENY 4208/6207: Ecology and Conservation of Pollinators, 3 credits

Meeting details: TBD, Steinmetz Hall

Instructor: Dr. Rachel Mallinger

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Office Hours: By appointment, in person or via Zoom

Course Description: This course will examine interactions between animals and the plants that they pollinate, current threats to pollinator populations, and the conservation of pollinators worldwide. In this course, we will explore these topics through readings, discussion, outdoor observations, and a research proposal.

Course Background: Welcome to Ecology and Conservation of Pollinators! Pollinators are keystone species in both natural and agricultural habitats, responsible for the reproduction of an estimated 87% of flowering plants including many crops. In recent years, documented declines in some pollinator species have heightened awareness of pollinator conservation. In the first half of this course, we will explore the fascinating world of pollination ecology, including plant-pollinator interactions, co-evolution, and pollinator foraging behaviors. In the second half of the class, we will discuss the conservation status of pollinators, including stressors such as climate change, land-use change, pesticides, and pathogens. Students will conduct field observations on pollinator/pollination ecology and develop a research proposal.

Prerequisites: BSC 2010 and 2010 L, with a grade of C- or higher, or equivalent, and junior or senior or graduate student standing, or instructor permission.

College-level general biology is required; a course in botany (e.g. BOT 2010C), ecology (e.g. PCB 4043C) or entomology (ENY 3005) is encouraged but not required.

Learning Objectives: By the end of the class, students will be able to:

1. Describe the role of pollinators in both natural and agricultural systems, and the breadth of animal pollinator taxa.
2. Explain basic concepts of pollination ecology and relate these concepts to observable phenomena in nature.
3. Diagnose factors affecting pollinator populations today, and assess the consequences of pollinator declines for biodiversity and global food production.
4. Analyze, interpret and critique scientific literature.
5. Develop a research proposal.
6. Communicate science in written and oral formats.

Required materials: No textbook is required for this course. Readings for the course will be provided to students via the course website in Canvas.

Grades and assignments:

This course is a joint undergraduate and graduate level course; both graduate and undergraduate students will attend the same on-campus class periods. Graduate students will be expected to do an additional assignment (presentation), a more rigorous assignment (longer and more in-depth research proposal), and additional readings (for research proposal and discussion) as further outlined below.

	<u>Undergraduate (500 points total)</u>	<u>Graduate (600 points total)</u>
participation	60 pts	60 pts
quizzes (8)	80 pts	80 pts
presentation	NA	100 pts
research proposal	120 pts	120 pts
proposal peer-review	20 pts	20 pts
midterm exam	100 pts	100 pts
final exam	120 pts	120 pts

Participation: Grades for participation will be based on in-class activities including short in-class assignments and contribution to class discussions (handing in index cards). 45 participation points will be awarded for in-class activities; the exact number of points for each activity can be found in Canvas. The remainder of 15 points will be awarded for contributing to class discussions with index cards.

Quizzes: There will be 10 quizzes throughout the semester that will cover the assigned readings for each day. Quizzes will be due by the start of class on the assigned date and taken in Canvas. Your lowest 2 quizzes for the semester will be dropped, and your grade for this component will be based on the best 8 of 10 quizzes. These quizzes will only cover the assigned readings (not lecture material).

Research proposal: In small groups, students will brainstorm research questions, carry out field observations, and develop a research topic for a proposal related to pollination ecology or pollinator conservation. Students will then write individual research proposals including a background, justification, objectives and hypotheses, methods, and expected results. Proposal drafts will be peer-reviewed in student pairs prior to the due date, and your review of a classmate's paper will account for 20 points of your total course grade. **A rubric for proposal grading and additional guidance can be found on Canvas.** Graduate students are encouraged to develop proposals related to their thesis or dissertation research, and/or written in the format of a proposal intended to be submitted for funding.

Exams: There will be 2 course exams, an in-class midterm and a take-home final. Exams will include questions from the assigned readings as well as lecture material, and graduate students will have additional exam questions focused on the graduate student readings listed in the syllabus.

Presentation (grad students only): Graduate students will present a **20-minute** presentation to the class on a topic of their choice. This can be on a particular plant, pollinator, research area, or on their own dissertation/thesis project if relevant to the course. Again, graduate students are

encouraged to develop a presentation that could be presented at a conference or for a thesis/dissertation defense provided it is new and not recycled from a previously developed presentation.

Grade distribution:

Grade	Points (undergraduate)	Points (graduate)	Percentages
A	465 - 500	558 - 600	93.0 - 100
A-	450 - 464.99	540 - 557.99	90.0 - 92.99
B+	435 - 449.99	522 - 539.99	87.0 - 89.99
B	415 - 434.99	498 - 521.99	83.0 - 86.99
B-	400 - 414.99	480 - 497.99	80.0 - 82.99
C+	385 - 399.99	462 - 479.99	77.0 - 79.99
C	365 - 384.99	438 - 461.99	73.0 - 76.99
C-	350 - 364.99	420 - 437.99	70.0 - 72.99
D+	335 - 349.99	402 - 419.99	67.0 - 69.99
D	315 - 334.99	378 - 401.99	63.0 - 66.99
D-	300 - 314.99	360 - 377.99	60.0 - 62.99
E	299.99 and below	359.99 and below	59.99 and below

Grades and Grade Points

For information on current UF policies for assigning grade points, see <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Course schedule and due dates:

Week	Date	Topic	Reading	Assignments	Activity
1	Aug	Course introduction, plant mating systems	Willmer Chapter 1		First day activities
2	Aug	Plant mating systems cont.	Eckert et al. 2010; Sakata and Nakahama 2018-Grad only; Willmer Chapter 3 (OPTIONAL)		discussion, quiz
2	Aug	Plant floral traits and rewards	Ishii et al. 2008		Outdoor activity, discussion, quiz
3	Sept	Plant-pollinator coevolution and pollination syndromes	Anderson and Johnson 2008		quiz
3	Sept	Plant-pollinator networks	Memmott 1999		Network

					activity
4	Sept	Native bees and other native insect pollinators	sections from Wilson and Carril 2016 (1-1.6)		
4	Sept	Pollinator behavior: learning and recruitment	Knauer and Schiestl 2015		discussion, quiz
5	Sept	Pollinator behavior: optimal foraging theory	Cakmak et al. 2009		Outdoor activity
5	Sept	Pollinator behavior: pollination efficacy	Barrios et al. 2016		discussion, quiz
6	Sept	Local and global trends in plant-pollinator interactions	Bawa 1990		
6	Sept	Crop pollination and managed bees	Rader et al. 2012		discussion, quiz
7	Oct	Introduction to pollinator declines and conservation	Potts et al. 2010; Colla et al. 2012 – Grad only		
7	Oct	Research methods	selected sections from Dafni 1992		Outdoor activities
8	Oct	Proposal brainstorm in groups			
8	Oct	Outdoor observations		General research topic due by 11:59 pm mid-Oct via Canvas	Outdoor activity
9	Oct	Midterm in class	Midterm	Midterm	
9	Oct	Grad student presentations		Grad presentations due	go over midterm
10	Oct	Developing a proposal/ scientific writing	Schimel 2001 pages 3 – 34; proposal (to be assigned)		
10	Oct	Pollinator stressors: land-use change	Krauss et al. 2003; Steffan-Dewenter et al. 2002 – Grad only		discussion, quiz
11	Oct	Guest lecture/FLEX			
11	Nov	Pollinator stressors: climate change, invasive species, managed bees	Kudo and Ida 2013; Herbertsson et al. 2016 – Grad only		discussion, quiz
12	Nov	Guest lecture 2			
12	Nov	Pollinator stressors: pesticides	Rundlof et al. 2015	Proposal rough drafts due by 11:59 pm early-Nov	discussion, quiz
13	Nov	Pollinator stressors: pathogens	Singh et al. 2010; Wilson and Carril 1.7		Possible outdoor activity
13	Nov	Pollinator conservation: conservation plans and policies	Colla and MacIvor 2016; Inouye et al. 2017; state plan (to be assigned)	Peer reviews due by 11:59 pm mid-Nov	Create a conservation plan

14	Nov	NO CLASS - Available to discuss final proposals			
14	Nov	NO CLASS THANKSGIVING			
15	Nov	Integrated crop pollination	Brittain et al. 2013	Final papers due by 11:59 pm late-Nov	
15	Nov	Pollinator conservation: habitat restoration, pollinator plantings	Kremen and M'Gonigle 2015		Design a pollinator planting, quiz
16	Dec	Class party			Papers returned
	Finals week	Final test		Take home exam due by Wednesday mid-Dec at 11:59 pm	

Full reading list

- Anderson, B., Johnson, S.D., 2008. The Geographical Mosaic of Coevolution in a Plant–Pollinator Mutualism. *Evolution* 62, 220–225. <https://doi.org/10.1111/j.1558-5646.2007.00275.x>
- Barrios, B., Pena, S.R., Salas, A., Koptur, S., 2016. Butterflies visit more frequently, but bees are better pollinators: the importance of mouthpart dimensions in effective pollen removal and deposition. *AoB PLANTS* 8. <https://doi.org/10.1093/aobpla/plw001>
- Bawa, K. S. 1990. Plant-Pollinator Interactions in Tropical Rain Forests. *Annual Review of Ecology and Systematics*. 21: 399–422.
- Brittain, C., Williams, N., Kremen, C., Klein, A.-M., 2013. Synergistic effects of non-*Apis* bees and honey bees for pollination services. *Proc. R. Soc. B-Biol. Sci.* 280, 20122767. <https://doi.org/10.1098/rspb.2012.2767>
- Cakmak, I., Sanderson, C., Blocker, T.D., Pham, L.L., Checotah, S., Norman, A.A., Harader-Pate, B.K., Reidenbaugh, R.T., Nenchev, P., Barthell, J.F., Wells, H., 2009. Different solutions by bees to a foraging problem. *Anim. Behav.* 77, 1273–1280. <https://doi.org/10.1016/j.anbehav.2009.01.032>
- Colla, S. R., and J. S. MacIvor. 2017. Questioning public perception, conservation policy, and recovery actions for honeybees in North America. *Conservation Biology*. 31: 1202–1204.
- Dafni, A. 1992. *Pollination Ecology: A Practical Approach*. Oxford University Press.
- Eckert, C. G., S. Kalisz, M. A. Geber, R. Sargent, E. Elle, P.-O. Cheptou, C. Goodwillie, M. O. Johnston, J. K. Kelly, D. A. Moeller, E. Porcher, R. H. Ree, M. Vallejo-Marín, and A. A. Winn. 2010. Plant mating systems in a changing world. *Trends in Ecology & Evolution*. 25: 35–43.
- Inouye, D., S. Droege, and J. Mawdsley. 2017. Words alone will not protect pollinators. *Science*. 355: 357–357.
- Ishii, H. S., Y. Hirabayashi, and G. Kudo. 2008. Combined effects of inflorescence architecture, display size, plant density and empty flowers on bumble bee behaviour: experimental study with artificial inflorescences. *Oecologia*. 156: 341–350.

- Knauer, A.C., Schiestl, F.P., 2015. Bees use honest floral signals as indicators of reward when visiting flowers. *Ecology Letters* 18, 135–143. <https://doi.org/10.1111/ele.12386>
- Krauss, J., Steffan-Dewenter, I., Tschardt, T. 2003. How does landscape context contribute to effects of habitat fragmentation on diversity and population density of butterflies? *Journal of Biogeography* 30, 889–900. <https://doi.org/10.1046/j.1365-2699.2003.00878.x>
- Kremen, C., M’Gonigle, L.K., 2015. EDITOR’S CHOICE: Small-scale restoration in intensive agricultural landscapes supports more specialized and less mobile pollinator species. *J Appl Ecol* 52, 602–610. <https://doi.org/10.1111/1365-2664.12418>
- Kudo, G., Ida, T.Y., 2013. Early onset of spring increases the phenological mismatch between plants and pollinators. *Ecology* 94, 2311–2320. <https://doi.org/10.1890/12-2003.1>
- Memmott, J., 1999. The structure of a plant-pollinator food web. *Ecology Letters* 2, 276–280. <https://doi.org/10.1046/j.1461-0248.1999.00087.x>
- Potts, S. G., J. C. Biesmeijer, C. Kremen, P. Neumann, O. Schweiger, and W. E. Kunin. 2010. Global pollinator declines: trends, impacts and drivers. *Trends in Ecology & Evolution*. 25: 345–353.
- Rader, R., B. G. Howlett, S. A. Cunningham, D. A. Westcott, and W. Edwards. 2012. Spatial and temporal variation in pollinator effectiveness: do unmanaged insects provide consistent pollination services to mass flowering crops? *Journal of Applied Ecology*. 49: 126–134.
- Rundlöf, M., Andersson, G.K.S., Bommarco, R., Fries, I., Hederström, V., Herbertsson, L., Jonsson, O., Klatt, B.K., Pedersen, T.R., Yourstone, J., Smith, H.G., 2015. Seed coating with a neonicotinoid insecticide negatively affects wild bees. *Nature* 521, 77–80. <https://doi.org/10.1038/nature14420>
- Schimmel, J. 2001. *Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded*. Oxford University Press.
- Singh, R., Levitt, A.L., Rajotte, E.G., Holmes, E.C., Ostiguy, N., vanEngelsdorp, D., Lipkin, W.I., dePamphilis, C.W., Toth, A.L., Cox-Foster, D.L., 2010. RNA Viruses in Hymenopteran Pollinators: Evidence of Inter-Taxa Virus Transmission via Pollen and Potential Impact on Non-Apis Hymenopteran Species. *PLoS ONE* 5, e14357. <https://doi.org/10.1371/journal.pone.0014357>
- Willmer, P. 2011. *Pollination and Floral Ecology*. Princeton University Press.
- Wilson, J.S., Carril, O.J.M., 2015. *The Bees in Your Backyard: A Guide to North America’s Bees*. Princeton University Press, Princeton.

Grad student readings

- Colla, S. R., J. S. Ascher, M. Arduser, J. Cane, M. Deyrup, S. Droege, J. Gibbs, T. Griswold, H. G. Hall, C. Henne, J. Neff, R. P. Jean, M. G. Rightmyer, C. Sheffield, M. Veit, and A. Wolf. 2012. Documenting Persistence of Most Eastern North American Bee Species (Hymenoptera: Apoidea: Anthophila) to 1990–2009. *Kent*. 85: 14–22.
- Herbertsson, L., Lindström, S.A.M., Rundlöf, M., Bommarco, R., Smith, H.G. 2016. Competition between managed honeybees and wild bumblebees depends on landscape context. *Basic and Applied Ecology*. <https://doi.org/10.1016/j.baae.2016.05.001>
- Sakata, Y., Nakahama, N. 2018. Flexible pollination system in an unpalatable shrub *Daphne miyabeana* (Thymelaeaceae). *Plant Species Biology* <https://doi.org/10.1111/1442-1984.12212>

Steffan-Dewenter, I., Munzenberg, U., Burger, C., Thies, C., Tschardt, T., 2002. Scale-dependent effects of landscape context on three pollinator guilds. *Ecology* 83, 1421–1432

Attendance and Make-Up Work

Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

Online Course Evaluation Process

Student assessment of instruction is an important part of efforts to improve teaching and learning. At the end of the semester, students are expected to provide feedback on the quality of instruction in this course using a standard set of university and college criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. Evaluations are typically open for students to complete during the last two or three weeks of the semester; students will be notified of the specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results>.

Academic Honesty

As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: “*We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.*” You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: “*On my honor, I have neither given nor received unauthorized aid in doing this assignment.*”

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>.

Software Use

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Services for Students with Disabilities

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations

within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation

0001 Reid Hall, 352-392-8565, www.dso.ufl.edu/drc/

Campus Helping Resources

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

- *University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, www.counseling.ufl.edu/cwc/*

Counseling Services

Groups and Workshops

Outreach and Consultation

Self-Help Library

Wellness Coaching

- U Matter We Care, www.umatter.ufl.edu/
- *Career Resource Center, First Floor JWRU, 392-1601, www.crc.ufl.edu/*

Student Complaints

Residential Course: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf

Online Course: <http://www.distance.ufl.edu/student-complaint-process>