ENY 4905/6905: Ecology and Conservation of Pollinators

3 credits

Class time: Tues 10:40 – 11:30 & Thurs 10:40 – 12:35

Instructor: Dr. Rachel Mallinger

2110 Steinmetz Hall

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352-273-3962

Office Hours: Tuesdays 9:30 – 10:30 or by appointment

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, and a field research project.

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 87.5% 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 syndromes, co-evolution, and pollinator foraging behaviors. In the second half of the class, we will discuss threats to pollinators, including stressors such as climate change, land-use change, pesticides, and pathogens, and will learn about recent conservation efforts and policies. Students will conduct an inquiry-based field research project on pollinator ecology, and will teach classmates about a selected pollinator or plant.

Prerequisites: BSC 2010 and 2010 L, with a grade of C- or higher, or equivalent, and junior or senior 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 diversity and function of pollinators in both natural and agricultural systems
2. Explain ecological and evolutionary concepts underlying plant-pollinator interactions, 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 and carry out a field-based research project.
6. Communicate research in the form of a scientific paper and oral presentation.

Additionally, graduate students will be able to:

1. Facilitate classroom discussions

2. Search and evaluate the scientific literature, and assess papers for their importance and relevance to selected topics

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 (lead discussion), a more rigorous assignment (longer and more in-depth research paper), and additional readings (for research paper and discussion) as further outlined below.

	Undergraduate (500 points total)	**Graduate (550 points total)**
participation	50 pts	50 pts
quizzes (8)	80 pts	80 pts
leading discussion	NA	50 pts
research project paper	120 pts	120 pts
paper peer-review	25 pts	25 pts
presentation on pollinator/plant conservation	100 pts	100 pts
midterm exam	125 pts	125 pts

Participation: Grades for participation will be based on in-class activities including short in-class assignments as well as on participation in class discussions of the assigned readings.

Quizzes: There will be 10 unannounced quizzes throughout the semester that will cover the assigned readings for each day, and will take place at the beginning of class prior to discussion or lecture. 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.

***Leading discussion*:** Graduate students will lead discussion on scientific papers assigned throughout the semester. Graduate students will be responsible for **selecting a second reading** to complement the assigned reading listed in the syllabus. Selected papers must be emailed to me at least 1 week prior to the scheduled discussion for approval and dissemination to the rest of the class. On the day of discussion, graduate students leading the discussion will turn in a list of discussion questions that they have prepared for class.

Presentation: Each student will present on a selected pollinator or plant. Presentations should be approximately 10 minutes long and cover the general biology, ecology, and geography of the pollinator or plant, as well as the conservation status or threats to current populations of the pollinator/plant.

Research project paper: In groups of four, you will be generating a research question and carrying out a field lab related to some aspect of pollination biology or pollinator ecology. We will learn about research methods and visit sites near Steinmetz Hall for data collection, followed by time in class to work as groups and collect data. Students may have to collect additional data outside of class time. While projects will be conducted in groups of four, students must write up **individual papers** in the format of a scientific manuscript including an introduction, methods, results, and discussion. Paper drafts will be peer-reviewed in student pairs prior to the due date, and your review of a classmate's paper will account for 25 points of your total course grade. Undergraduate student papers should be 4-5 pages in length, excluding any tables, figures, or references list, with a minimum of 3 scientific references, while graduate student papers should be 7-8 pages in length, excluding any tables, figures, or references list, with a minimum of 10 scientific references. Additional criteria and writing tips will be distributed in class.

Grade distribution:

Grade	Points (undergraduate)	Points (graduate)	Percentages
A	470 - 500	517 - 550	94.0 - 100
A-	450 – 469.99	495 – 516.99	90.0 – 93.99
B+	430 – 449.99	473 – 494.99	86.0 – 89.99
B	415 – 429.99	456.5 – 472.99	83.0 – 85.99
B-	400 – 414.99	440 – 456.49	80.0 – 82.99
C+	380 – 399.99	418 – 439.99	76.0 – 79.99
C	365 – 379.99	401.5 – 417.99	73.0 – 75.99
C-	350 – 364.99	385 – 401.49	70.0 – 72.99
D+	330 – 349.99	363 – 384.99	66.0 – 69.99
D	315 – 329.99	346.5 – 362.99	63.0 – 65.99
D-	300 – 314.99	330 – 346.49	60.0 – 62.99
E	299.99 and below	329.99 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	Jan 8 - T	Course introduction			
1	Jan 10 - Th	Plants: reproduction and pollination	Sakata and Nakahama 2018		discussion (instructor-led)
2	Jan 15 - T	Plants: floral traits and rewards	Fenster et al. 2015		
2	Jan 17 - Th	Pollinators: coevolution and pollination syndromes	Anderson and Johnson 2008		discussion

3	Jan 22 - T	Pollinators: bee diversity and biology	sections from Wilson and Carril 2016		
3	Jan 24 - Th	Pollinator behavior: optimal foraging theory	Cakmak et al. 2009		discussion
4	Jan 29 – T	Pollinator behavior: specialization, flexible foraging, plant-pollinator networks	Memmott 1999, Barrios et al 2016;		
4	Jan 31 – Th	Pollinator behavior: learning, recruitment	Knauer and Schiestl 2015		discussion
5	Feb 5 – T	Tour of Bee Lab with Cameron Jack		**Presentation topic due by 2/5 at 11:59 pm via Canvas**	
5	Feb 7 – Th	Introduction to crop pollination and managed bees	Rader et al. 2012		discussion
6	Feb 12 – T	Research methods: plants and pollinators.	selected sections from Kearns and Inouye 1993		
6	Feb 14 – Th	Midterm		**Midterm**	
7	Feb 19 – T	Introduction to pollinator declines and conservation	Winfree et al. 2009		
7	Feb 21 – Th	Presentations			
8	Feb 26 – T	Presentations			
8	Feb 28 – Th	Presentations			
9	Spring break				
10	March 12 – T	Pollinator stressors: land-use change	Steffan-Dewenter et al. 2002; Krauss et al. 2003		
10	March 14 – Th	Pollinator stressors: pesticides **Research group formation	Rundlof et al. 2015		discussion
11	March 19 – T	Pollinator stressors: pathogens	Singh et al. 2010		discussion OR guest speaker
11	March 21 – Th	visit sites around campus for research project			
12	March 26 – T	Data collection and organization **time for project planning in groups		**Research project outline due at end of class in hard copy**	
12	March 28 – Th	Pollinator stressors: climate change, invasive species, managed bees	Kudo and Ida 2013; Herbertsson et al. 2016 (not for discussion)		discussion
13	April 2 – T	data collection in groups			
13	April 4 – Th	data collection in groups			

14	April 9 – T	Analyzing plant-pollinator data ** time for working in groups on data analysis			
14	April 11 – Th	Pollinator conservation: conservation plans and policies	excerpts from Wisconsin and North Dakota Pollinator Protection Plans		discussion and/or debate
15	April 16 – T	Pollinator conservation: integrated crop pollination	Brittain et al. 2013	**paper rough drafts due for peer-review by Monday 4/15 at 11:59 pm via Canvas**	Guest Speaker
15	April 18 – Th	Pollinator conservation: habitat restoration, pollinator plantings ** paper peer-review in student pairs	Kremen and M'Gonigle 2015	**peer review forms due at end of class in hard copy**	discussion
16	April 23 - T	TBD		**Research papers due by 4/23 at 11:59 pm via Canvas**	
16	April 25 - Th	Reading day – **NO CLASS**			
finals week		Course wrap-up/party			

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

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

Goering, D. 2016. North Dakota Pollinator Plan. North Dakota Department of Agriculture. Bismarck, North Dakota.

Fenster, C.B., Reynolds, R.J., Williams, C.W., Makowsky, R., Dudash, M.R. 2015. Quantifying hummingbird preference for floral trait combinations: The role of selection on trait interactions in the evolution of pollination syndromes. Evolution 69, 1113–1127. https://doi.org/10.1111/evo.12639

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

Kearns, C.A., Inouye, D.W., 1993. Techniques for pollination biologists. University Press of Colorado.

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., Tscharntke, 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

Locke, C., Meils, E., Murray, M. 2016. The Wisconsin Pollinator Protection Plan. Wisconsin Department of Agriculture, Trade, and Consumer Protection. Madison, WI.

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

Rader, R., Howlett, B.G., Cunningham, S.A., Westcott, D.A., Edwards, W., 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. https://doi.org/10.1111/j.1365-2664.2011.02066.x

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

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

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

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

Wilson, J.S., Carril, O.J.M., 2015. The Bees in Your Backyard: A Guide to North America's Bees. Princeton University Press, Princeton.

Winfree, R., Aguilar, R., Vázquez, D.P., LeBuhn, G., Aizen, M.A., 2009. A meta-analysis of bees' responses to anthropogenic disturbance. Ecology 90, 2068–2076. https://doi.org/10.1890/08-1245.1

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