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

Meeting details: Tuesday 4 (10:40 – 11:30) and Thursday 4 and 5 (10:40 – 12:35), Room 1027

Instructor: Dr. Rachel Mallinger

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Office Hours: By appointment, 2110 Steinmetz Hall

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 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, develop a research proposal, and will additionally present to the class on 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 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 project.
6. Communicate science in written and oral formats.

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 proposal), and additional readings (for research proposal and discussion) as further outlined below.

	Undergraduate (500 points total)	**Graduate (600 points total)**
participation	60 pts	60 pts
quizzes (8)	80 pts	80 pts
leading discussion	NA	100 pts
research project paper	120 pts	120 pts
paper 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 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 a 45-min class period focused on discussion of the assigned scientific papers. Graduate students are expected to design a structured and creative class period that involves all students in discussion. In addition, on the day of discussion, graduate students will turn in an annotated bibliography with a minimum of 10 papers including at least 8 primary non-review papers on the discussion topic. The annotated bibliography will be worth 20 of the 100 points assigned for leading discussion.

Research proposal: In groups of 3-4, you will be generating a research question and carrying out field work to collect preliminary data and test or develop research protocols. We will learn about research methods in class, visit sites near Steinmetz Hall for observation and data collection, and have time in class to work as groups. Students should additionally expect to work with group members outside of class time. While research projects will be developed in groups, students will write up **individual research proposals** including a background, justification, objectives, methods, preliminary observations/data, 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. Undergraduate student proposals should be 4-5 pages in length (excluding reference list or images) and with a minimum of 3 scientific references, while graduate student papers should be 7-8 pages in length (excluding any tables, figures, images, or references list), with a minimum of 10 scientific references and a minimum of 1 preliminary figure or table. Additional criteria will be distributed in class.

Grade distribution:

Grade	Points (undergraduate)	Points (graduate)	Percentages
A	470 - 500	564 - 600	94.0 - 100
A-	450 – 469.99	540 – 563.99	90.0 – 93.99
B+	430 – 449.99	516 – 539.99	86.0 – 89.99
B	415 – 429.99	498 – 515.99	83.0 – 85.99
B-	400 – 414.99	480 – 497.99	80.0 – 82.99
C+	380 – 399.99	456 – 479.99	76.0 – 79.99
C	365 – 379.99	438 – 455.99	73.0 – 75.99
C-	350 – 364.99	420 – 437.99	70.0 – 72.99
D+	330 – 349.99	396 – 419.99	66.0 – 69.99
D	315 – 329.99	378 – 395.99	63.0 – 65.99
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	Jan 7 - T	Course introduction	Kearns and Inouye 1993: pages 1-6		
1	Jan 9 - Th	Plant mating systems	Eckert et al. 2010	**Graduate students sign up for leading discussion by 1/14**	discussion (instructor-led)
2	Jan 14 - T	Plant floral traits and rewards	Ishii et al. 2008		
2	Jan 16 - Th	Plant-pollinator coevolution and pollination syndromes	Anderson and Johnson 2008		discussion
3	Jan 21 - T	Plant-pollinator networks	Memmott 1999		
3	Jan 23 - Th	Pollinator behavior: learning and recruitment	Knauer and Schiestl 2015		discussion
4	Jan 28 – T	Pollinator behavior: optimal foraging theory	Cakmak et al. 2009		

4	Jan 30 – Th	Pollinator behavior: pollination efficacy	Barrios et al. 2016		discussion
5	Feb 4 – T	Local and global trends in plant-pollinator interactions	Bawa 1990		
5	Feb 6 – Th	Crop pollination and managed bees	Rader et al. 2012		discussion
6	Feb 11 – T	Introduction to pollinator declines and conservation	Potts et al. 2010; Colla et al. 2012		
6	Feb 13 – Th	Research methods	selected sections from Kearns and Inouye 1993 and Dafni 1992		**Outside second period**
7	Feb 18 – T	Midterm	Midterm		
7	Feb 20 – Th	Pollinator stressors: land-use change	Steffan-Dewenter et al. 2002; Krauss et al. 2003 (for discussion)		discussion
8	Feb 25 – T	Pollinator stressors: pathogens **Research group formation	Singh et al. 2010; Wilson and Carril 1.7		
8	Feb 27 – Th	visit sites around campus for developing research proposal			**Field and Fork (first period), NATL (second period)**
9	Spring break				
10	March 10 – T	time for project planning in groups		**General research topic due at end of class in hard copy**	
10	March 12 – Th	Pollinator stressors: climate change, invasive species, managed bees	Kudo and Ida 2013		discussion
11	March 17 – T	observations/preliminary data collection			**Outside**
11	March 19 – Th	observations/preliminary data collection			**Outside**
12	March 24 – T	Developing a proposal/ scientific writing	Schimel 2001 pages 3 – 34; proposal (to be assigned)		
12	March 26 – Th	Pollinator stressors: pesticides	Rundlof et al. 2015		discussion
13	March 31 – T	**NO CLASS**			
13	April 2 – Th	Pollinator conservation: conservation plans and policies	Colla and MacIvor 2016; Inouye et al. 2017; state plan (to be assigned)		Conservation plan activity

14	April 7 – T	Pollinator conservation: integrated crop pollination	Brittain et al. 2013	**proposal rough drafts due for peer-review by Monday 4/6 at 11:59 pm via Canvas**	
14	April 9 – 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
15	April 14 – T	Honey bees: Tour of Honey Bee Lab and guest lecture			
15	April 16 – Th	Native bees and other native insect pollinators: biology and identification workshop	sections from Wilson and Carril 2016 (1-1.6)	**Research proposals due by 4-16 at 11:59 pm via Canvas**	Meet in Lab 2218
16	April 21 - T	Guest lecture/open topic			
16	April 23 - Th	Reading day – **NO CLASS**			
finals week		Final exam			

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.

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.

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.

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

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

Schimel, 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

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.

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