

Spring 2015

Volume 5



A Time of Transition

Spring is unfolding around Knoxville as I write this. The annual Spring Wildflower Pilgrimage in the Great Smoky Mountains National Park is underway, the end of the academic semester is just around the corner, and many of our faculty and students are making plans for summer research. The department is making big plans too; we are happy to announce that **Prof. Susan Kalisz** will be joining us this summer as the new Department Head! Kalisz is a world-renowned plant ecologist with interests in a wide range of topics, from mating system evolution to invasive species. She brings with her a



Randy Small, Interim Head

wealth of administrative experience and a great vision for the department.

In this edition of our newsletter you'll read a lot about outcomes: where our graduate students end up after leaving UT; new books published by our faculty; important changes in how we teach and design our curriculum; and current research and outreach by faculty and students. EEB continues to be an outstanding place to work and to study. We are making important contributions to the body of scientific knowledge, to the training of the next generation of scientists, and to the community. We are grateful for your involvement in and contributions to our mission. As always, we welcome news from our friends and alumni. Please take the opportunity to write and let us know where you are and what you are doing. Or, if you are in the neighborhood, stop in and say hello!

Where Do They Go?

Prospective grad students often ask what kinds of jobs our alumni get. The answers are impressive! Our alumni are scientific leaders in the US and in countries across the world, including Canada, Colombia, Brazil, Argentina, Germany, Switzerland, China, Taiwan, Papua New Guinea, New Zealand, and Australia.

EEB has 49 MS students who have graduated since 2000. Some go on to do PhDs and other advanced degrees, at places like Yale, North Carolina State, Virginia Tech, and UT. Other alumni enter a variety of agency, non-profit, and for-profit careers (see list below). Many become high school math and science teachers.

Of the 87 PhD students who graduated from EEB since 2000, over 40% of them are in tenure-track faculty positions, at places like Stanford, Pitt, University of British Columbia, Washington University in St. Louis, and UT. Others work in research institutions like the American Museum of Natural History, Smithsonian, Institute for Polar Research, and ORNL.

Most of our PhD students get a postdoctoral position as a first step, after finishing their degree. Our alumni end up in some of the top institutions in the field, like Harvard, Yale, Duke, Penn, UC Davis, and UT.

The variety of non-academic job opportunities for our alumni is staggering. Many are scientists at agencies like the National Park Service, Forest Service, Fish and Wildlife Service, Environmental Protection Agency, Centers for Disease Control, Department of Transportation, and the Tennessee Valley Authority. Others work for nonprofits like The Wildlife Society, San Diego Zoo, Red Cross, and Institute for Conservation Research. Some work as consultants. Others work for large companies, in fields like scientific software design, GIS, waste management, and biotech.



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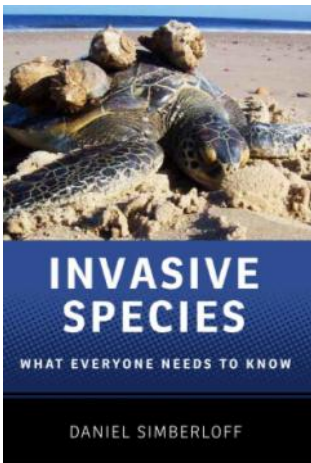


Recommended Reading

Invasive Species: What Everyone Needs to Know

Gore Hunger Professor of Environmental Science **Daniel Simberloff** has published a new book in the Oxford University Press "What Everyone Needs to Know" series, called *Invasive Species*. The book is aimed at a wide audience, to include academics and readers with a general interest.

Of the 7,000 estimated non-native species present in North America, approximately 1,000 are invasive. Clearly, invasive species are in the minority, but their small numbers don't keep them from causing billions of dollars in economic and ecological harm each year. Policymakers and ecologists continue to try to figure out which species might be harmful, which invasive species are doing the most damage, and which of these might respond best to eradication and other control efforts. Invasive species reports and case studies are prevalent in political, environmental, and scientific news cycles, and a significant portion of the public is concerned about the issue.



In this book, Simberloff first covers basic topics such as how non-native species are introduced, which areas have incurred the most biological invasions, and

how the rates of biological invasions have shifted in recent years. He then moves on to the direct and indirect impacts of invasive species on various ecosystems, such as habitat and resource competition, how invasive species transmit pathogens, and how introduced plants and animals can modify a habitat to favor other non-native species. Simberloff's final chapters discuss the evolution of invasive species, the policies we currently have in place to manage them, and future prospects for controlling their spread. The book also contains a section dedicated to the more controversial topics surrounding invasive species: invasive natives, useful non-native species, animal rights versus species rights, and non-native species' impacts on the biodiversity of an ecosystem.

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Prof. Daniel Simberloff has received other accolades in the last year. In January 2015, the International Biogeographic Society Board gave Simberloff the **Alfred Russel Wallace Award** at the IBS biennial meeting in Bayreuth, Germany. The award was established in 2004 to recognize a lifetime of outstanding contributions by an eminent scholar in any subdiscipline of biogeography. In April 2014, he received the **SEC Faculty Achievement Award**, which recognizes one professor with an outstanding record of teaching, research, and scholarship at each of the 14 universities in the Southeast Conference.

Woody Plants of Kentucky and Tennessee

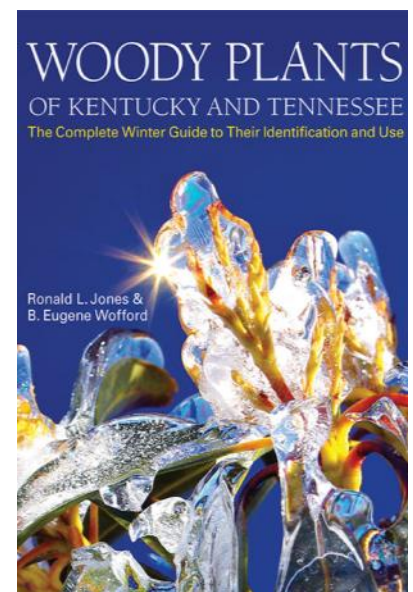
Research Associate Professor **B. Eugene Wofford** (EEB) teamed up with **Ronald L. Jones** (Eastern Kentucky University) to write *Woody Plants of Kentucky and Tennessee: The Complete Winter Guide to Their Identification and Use*.

For centuries people have used trees, shrubs, and woody vines for food, clothing, ritual, construction, scientific study, and more. However, these important plants are easy to overlook during the winter months, when the absence of leaves, fruit, and other distinguishing characteristics makes them difficult to recognize.

This comprehensive volume is the essential guide to woody plants in Kentucky, Tennessee, and surrounding states during the winter season. Featuring color images of more than four hundred species, this detailed botanical resource provides keys to

the genera and species, as well as descriptions of the genera. The species accounts include useful information on Latin meanings, common names, habitats and distributions, and notes on toxicity, nativity, rarity, and wetland status. In addition, authors provide notes on practical uses for the plants, including food, medicine, fiber, and weapons.

Winter identification of woody plants can be a daunting exercise, but Jones and Wofford present clear and authoritative information that can help anyone spot these species in the wild. Whether taken into the field or enjoyed at home, *Woody Plants of Kentucky and Tennessee: The Complete Winter Guide to Their Identification and Use* is a comprehensive and accessible resource for professional and amateur botanists, students, commercial landscapers, homeowners, and outdoor enthusiasts.



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Vision and Change

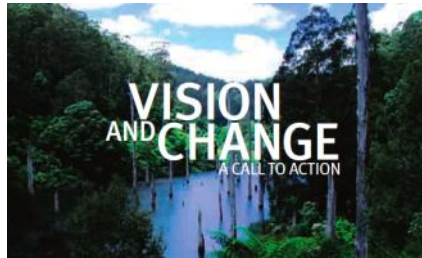
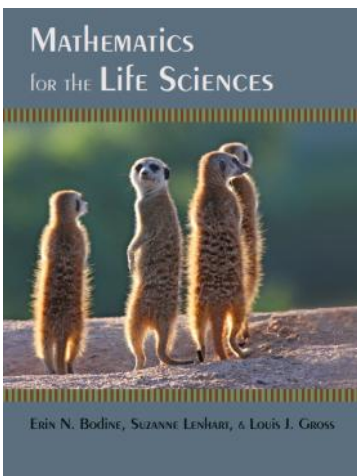
From Lou Gross. The biology of today is stunningly different from what I encountered as an undergraduate. The amount and type of data available from experiments and observations has increased dramatically. There is new emphasis on connecting to other disciplines and integrating the variety of sub-disciplines of biology. Indeed, a recent National Research Council (NRC) report, called *A New Biology for the 21st Century*, emphasized the integration taking place within the life sciences and noted how this enhances our potential for building a world with abundant food, a resilient environment, clean energy, and good health for all.

These strides in biology require a concomitant change in biology education. We need to have less of the “litany of conclusions” and more hands-on exposure to integrated science, based upon theory, hypothesis formulation, and testing. My roots in this go back to a series of workshops I organized in the early 1990s. I brought together leading researchers in math biology to discuss how best to incorporate quantitative methods in the undergraduate life sciences curriculum. I developed a course sequence in mathematics for students entering the life sciences and a set of modules designed for general biology courses to point out how quantitative approaches provide different insights about biology. The course sequence led to a novel textbook I co-authored, *Mathematics for the Life Sciences* (Princeton University Press, 2014), that integrates biological data, computational methods, and a diversity of mathematical topics.

The NRC report *BIO2010* included my quantitative biology education project at UT as one of its exemplar case studies and encouraged inclusion of my set of nine “key quantitative concepts” in all undergraduate biology curricula. Building on this, the NSF and the American Association for the Advancement of Science (AAAS) sponsored the *Vision and Change in Undergraduate Biology Education* project, for which I served on the Advisory Board and was

co-author of the final report. The report has led to hosts of new initiatives to encourage institutions to transform their undergraduate curricula.

These efforts have informed the current changes in undergraduate biology education at UT. We want to ensure that our educational approaches match the broadening perspectives of modern biology.



Biology Curriculum

From Beth Schussler. UT is among the first institutions in the country to implement the recommendations from the 2011 AAAS report, *Vision and Change in Undergraduate Biology Education*. The report features core concepts that unify all sub-disciplines of biology, common scientific skills that students practice in class, and active engagement of students.

Majors now take three introductory biology courses: Organismal and Ecological Biology, Cellular and Molecular Biology, and a stand-alone laboratory course called Skills of Scientific Investigation. The two lecture courses are paired with weekly small-group discussion classes, which are focused on reading figures, interpreting data, and reading scientific articles. Undergraduates, graduate students, postdocs, and faculty worked together to create discussion groups that will help students learn how science is done. EEB graduate students lead the new discussions and help engage students in discussion during lectures. The lab course involves students in all facets of scientific inquiry: experimental design; data analysis; scientific communication in writing; and oral presentation.

UT is cultivating a culture consistent with modern pedagogical practices. Our goal is for all biology majors, including those concentrating in EEB, to leave UT having thoroughly engaged in modern biological concepts and practices.

EEB Curriculum

From Jim Fordyce. The undergraduate curriculum committee worked together with faculty and students to make substantial changes to the EEB curriculum. New course requirements provide students with greater flexibility, so they can tailor their training to suit their professional goals.

While Ecology and Evolutionary Biology students have been required to take Ecology, they were not previously required to take an Evolutionary Biology course. This omission has been remedied; all EEB students now take a new, 200-level course in Evolution. Our graduates should be informed citizens on this unifying principle of biology.

Students used to be required to take upper-division courses from four categories: Evolution, Ecology, Organismal Biology, and Physiology/Chemical Ecology. These somewhat arbitrary divisions unnecessarily restricted students’ course selections. Students can now choose among over 30 EEB courses and over 25 courses from other departments to fulfill their upper-division requirements. We require that students take at least two upper-division courses in field or laboratory methods, to ensure they obtain relevant practical skills. As always, math and statistics are an important component of the program.

We anticipate that the new curriculum will provide the flexible educational experience our students need, to help each student achieve his or her individual career goals.



Active Undergrads

Mariah Patton is grateful for the many opportunities EEB gave her the opportunity to explore. She was involved in a variety of research topics, from White Nose Syndrome in bats (McCracken Lab), to ecophysiology and seed dispersal in ants (Sanders Lab), to plant genetics (Stewart Lab). She also received a Research Experience for Undergraduates award through Colorado State University. She spent her summer at Konza Prairie Long Term Ecological Research Station, studying plant community dynamics with nitrogen limitation. Beyond



Mariah carefully untangles a bat from a mist net, as part of a summer species survey.

Community Structure

Species differ in how they respond to biotic and abiotic factors, and these differences influence abundance, community structure, and broad-scale patterns of diversity. The complex relationship between environmental conditions and biogeographical distributions often relies on large-scale climatic information and macroecological data. Few studies incorporate actual physiological mechanisms and measurements to understand patterns of diversity and predict their distributions in the face of climate change.

Graduate student Lacy Chick is researching trait-based physiological responses to thermal regimes, in order to better predict the effects of a changing climate on ant distributions and community structure. Specifically, she is examining the role of inter-specific and inter-population variation in thermal physiology in shaping the distribution of ant diversity. Lacy's field sites include a latitudinal gradient from Florida to Maine and an elevational gradient of ~1500m in Great Smoky Mountains National Park.

Lacy has found that factors governing community structure vary along gradients. At high elevations, low temperatures limit abundance and species density. At low elevations, less stressful temperatures mean species interactions likely dictate community structure. By coupling field observations with lab measurements, she has determined that environmental limitations are governed by an underlying physiological mechanism

Undergraduate Profile: Mariah Patton

research, Mariah served as EEB's undergraduate representative on the Dean's Student Advisory Council, donned the Wallace head for Darwin Day, and spread the bat conservation message to kids at Boo at the Zoo and Girl Scout Camp Tanasi.

Mariah worked with Assist. Prof. Charles Kwit to revive the Naturalist Club. This club strives to provide an enriching environment where undergraduates can learn about the many opportunities available in the discipline and explore the many interests of the natural world. Participants learn about local research projects, connect with EEB faculty, become aware of REUs and other available scholarships, and form a more collegial cohort. The club also helps forge connections between researchers with similar interests in the College of Arts and Sciences and the Institute of Agriculture. Mariah hopes that future students will shape the club into a haven of growth for young scientists. She feels very lucky to have joined EEB and hopes that other undergraduates recognize the many opportunities available to them.

Mariah is one of many very-involved undergraduates in EEB. While she graduated in December, the legacy of undergraduate involvement and the Naturalist Club will remain and, hopefully, evolve into something even greater in the future.

Graduate Research: Lacy Chick



exerting a filter on community membership. Additionally, her research suggests that variation between populations may be just as important as variation between species when predicting species' responses to warming. These responses may be more conserved in certain ant life stages. Through a common garden experiment, Lacy has found that, regardless of lab rearing temperature, ants maintained geographic variation in thermal limits and showed no evidence of lab acclimation. She is collaborating with colleagues to look at the effects of different warming regimes on ant growth and development and heat-shock protein expression.

Lacy's research indicates that the mechanisms structuring communities vary along gradients. Understanding these mechanisms at the population and genetic levels may be important for predicting future biodiversity patterns for one of the most ecologically important and diverse taxa on earth.



Playing with Snakes

Faculty Research: Gordon Burghardt

I arrived at UT with a PhD in biopsychology and an interest in understanding evolution and behavioral development in reptiles, particularly snakes. Initially, my work was primarily on chemoreception and feeding, foraging, and food preferences in natricine snakes. Snakes rely on chemical cues gathered by tongue flicking, which is a reliable and easily measured behavior. By studying neonate snakes, we can study species, population, and individual differences and the role of genetics and experience in their behavior. I've continued this work off and on for almost 50 years.

However, from one beginning, other questions arose. We started looking at antipredator, social, and other behaviors, discovered that multiple paternity is very common in many species of snakes, and began work on island populations and threatened populations at risk of development and potential hybrid swamping. It turns out that Asian relatives of our natricine snakes can sequester toxins from their toad diets and have reorganized their defensive behavior to signal the threat they can pose to possible predators.

Soon my interests reached beyond snakes. One visit to the Neotropics got me hooked on green iguana social behavior. My students, colleagues, and I did not expect the social complexity we found, from the moment of hatching to adulthood. Our research helped identify behavioral processes and methodologies useful in the conservation of the many endangered

Gordon Burghardt plays with a monitor.



species of iguanas, including *Cyclura* spp. in the Caribbean. I started studying black bears in the Smokies in the 60s when the national park was having problems with them. This led to rearing orphaned cubs and studies on the development of perceptual, social, play, and agonistic behavior and the initiation of the research program that Mike Pelton (FWF) developed into a decades-long field ecology study.

Playful bear cubs and not-so-playful reptiles led to my 30-year focus on understanding play behavior, especially its origins. Recent publications with colleagues have documented play behavior in surprising places, e.g., social play in spiders and object play in cichlid fish. Play may also be an evolutionary and ontogenetic source of rituals, so this possibility is now being studied. I also now study snakes as fear-inducing animals for monkeys and humans and to test the role of play in snake handling religious rituals. I'm thankful to all the fine students and colleagues that helped me explore these problems using field observations, molecular genetics, chemistry, morphology, brain imaging, field ecology, learning and cognitive psychology, modeling, biogeography, radio-tracking, and hundreds of experimental behavioral tests.

Biology of Same-Sex Attraction

Faculty Research: Sergey Gavrilets

The persistence of same-sex coupling seems to contradict one of the fundamental notions of evolution, which states that biological characteristics not beneficial to the survival of the species should disappear over time. Theoretically, the trait should dead-end of its own accord, because homosexual couples cannot produce biological offspring.

Sergey Gavrilets and two colleagues recently addressed this paradox in a paper published in the *Quarterly Review of Biology*. The study focused on epigenetics, a process that causes some genes to have temporary modifications known as epi-marks. Epi-marks are biochemical factors that determine how a gene's characteristics are expressed.

The study claims that epi-marks may regulate the testosterone receptors critical to proper fetal development. In females,

they can shield the fetus from high testosterone levels by decreasing the receptor's sensitivity to the hormone. In males, they can stimulate the receptors when testosterone levels are low. Epi-marks are usually "erased" as the fetus grows, but sometimes they persist and are passed on to the next generation. When this happens, the epi-marks active during a father's development could cause his daughters to be overly sensitive to testosterone. A mother's epi-marks may manifest as a lack of testosterone sensitivity in her sons.

The team developed a mathematical model to demonstrate how these epi-marks can spread throughout the population. Although the model suggests homosexuality can be inheritable, it does not require the existence of a "gay gene."

Gavrilets's article sparked considerable coverage in both scientific and popular media. CNN covered the article, and publications and websites as diverse as *Time*, *US News & World Report*, *Popular Science*, *Cosmos*, and the *New York Daily News* reported the findings. The major focus of Gavrilets's ongoing research is on human origins and social evolution. "It is extremely exciting and also very rewarding to work in these areas, because it attracts the interests not only of scientists but also of the general public," he says.



Read the full press release at quest.utk.edu/2014/biology-of-same-sex-attraction.





Outreach: A Matter of Policy

Four years ago, **Paul Armstrong** collaborated with colleagues in the Colleges of Law, Business and Administration, and Agriculture and Natural Resources to create a forum for bringing together people interested in energy and environmental science and policy. The result was the Baker Center Energy and Environment Forum, and it is still going strong.

The forum meets 4-6 times per semester. Each session begins with a talk by an invited speaker on a science or policy topic in energy or environmental issues. The session then broadens out into general discussion among the participants. The academic speakers are world leaders in their respective fields. Indeed, the speaker list includes a veritable *Who's Who* of ecologists, conservation scientists, physicists, engineers, economists, lawyers, and more. The forum has also featured current and former cabinet members and other public figures.

Armstrong and his co-organizers run a weekly reading group alongside the forum. EEB students discuss energy and environment issues with peers drawn from other disciplines. Discussion topics are diverse, ranging from the evidentiary standard that science must meet to be used in a court of law, to potential uses of social media for tracking emerging environmental trends in real-time.

The forum attracts participation from across UT and beyond. All of the Colleges and 85% of the Departments on campus are represented in the faculty, staff, alumni, and students that attend. The forum also regularly draws participants from Oak

Kudos

We always recognize our graduating students in our newsletter, but it is also important to recognize the excellent work our students do while they are still in the program. So, while we still congratulate our 43 BS, 2 MS, and 9 PhD students who finished their degrees in 2013-14, we also want to acknowledge those students who have received notable fellowships and awards.

Alix Pfennigwerth (Schweitzer Lab) and **Su'ad Yoon** (BS 2014, now a PhD student at University of Nevada) both received Graduate Research Fellowship Program (GRFP) awards from NSF. These prestigious fellowships provide students with 3 years of graduate school funding. **Brian Looney** (Matheny Lab) and **Katie Massana** (O'Meara Lab) received honorable mentions. Across UT this year, only five students received NSF GRFP awards, and only three students received honorable mentions, so EEB did very well!



Other NSF programs that have funded current EEB graduate students include the Doctoral Dissert-



UT's Howard H. Baker Jr. Center for Public Policy is named after the former senator, who died in June 2014.
Photo credit: The Baker Center.

Ridge National Lab, surrounding educational institutions, the general public, nonprofits, and for-profits. Sessions have even attracted sitting elected representatives. One speaker last year glibly described the forum as "perhaps the most interdisciplinary thing we have on the campus after football."

Armstrong and his colleagues established the forum partly in response to their frustration that the community of students and faculty with related interests were strewn across numerous disparate departments and units around the campus, and they had only limited opportunities to interact. Now those same colleagues meet regularly to exchange their different disciplinary perspectives on energy and environmental issues.

tation Improvement Grant (DDIG), Graduate Research Opportunities Worldwide (GROW), and the East Asia Pacific Summer Institute Fellowship (EAPSI).

Many EEB students receive substantial fellowships and grants from sources that are aligned with their research discipline or geography: the Association of Zoos and Aquariums; the American Philosophical Society; the Rocky Mountain Biological Laboratory; the Great Smoky Mountain Conservation Association; and even the Taiwanese government! Students also receive funding from competitive sources within UT: the Institute of Agriculture; the National Institute for Mathematical and Biological Synthesis; and the Program for Excellence and Equity in Research.

Master's Degrees: **Maxwell Rupp**; **Nathan Sutton** (research associate at ORNL).

Doctorate Degrees: **Emily Austin** (postdoc at U. New Hampshire); **Romina Dimarco**; **Phillip Hollingsworth**; **Sara Kuebbing** (postdoc at Yale); **Joe Hughes** (postdoc at Boston U.); **Gwen Iacona** (postdoc at U. Queensland); **Ivan Juric** (postdoc at U.C. Davis); **Jennifer Krauel** (postdoc at Southern Illinois U.); **Rafael Zenni** (researcher at U. Brazil).



Alumni Focus

Marc Cadotte (PhD 2006)

Marc Cadotte holds the TD Chair of Urban Forest Conservation and Biology at the University of Toronto and is the Executive Editor of the Journal of Applied Ecology. He is an ESA Early Career Fellow and was awarded an Early Researcher Award from the Ontario Ministry of Economic Development and Innovation.

The importance of time and place cannot be overstated. Thinking back to those moments that shaped, altered and focused my trajectory, I can only conclude that the luck of being in the right place at the right time was of immense importance. Being a PhD student in EEB at the University of Tennessee had a great impact on my career.

I was a student in Jim Drake's lab, and I had many interactions with the Simberloff lab. As such, I was shaped by the two forces that prepare one for an academic career: independence and critical thinking. With a mix of autonomy and naiveté, my lab mates and I edited a book on theoretical ecology and invasions. I would not necessarily recommend PhD students start editing books, but I am sure that editing a book prepared us well for life in academia.

After leaving UT, I took a postdoctoral position at the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara, CA. I then joined the faculty at the University of Toronto (the other UT). My experiences from my graduate



Marc in a field of Solidago at a Nutrient Network experimental site outside of Toronto. Photo credit: Robin Marushia.

studies were instrumental in building my lab group, as I try to instill independence and critical thinking in my own students.

Currently, my lab focuses on a broad array of questions about the assembly and functioning of ecological communities. We focus on how urbanization, habitat degradation, and species invasions alter multiple forms of diversity (taxonomic, functional and phylogenetic). We relate diversity change to alterations in the delivery of ecosystem functions and services, from carbon sequestration, to pollination, to decomposition and nutrient cycling, to aesthetic and cultural valuation. While the taxa and context for much of my work has changed, the seeds of my interest in communities and how I approach investigating nature were sown in Knoxville.

Giving Opportunities

EEB has several departmental funds to support our vision of excellence in science education.

Ecology and Evolutionary Biology Enrichment Fund

This fund is the primary departmental account. It supports instructional and academic programs within the department, including

- Undergraduate and graduate research;
- Travel funds for students to participate in meetings and workshops;
- Other departmental activities that are in need of support.

If you have specific philanthropic goals, you may wish to consider one of EEB's other funds, a few of which are listed here:



To contribute online,
 please visit **eeb.bio.utk.edu**
 Near the bottom of the webpage, click
Contribute to a big idea. Give to EEB.
The EEB Enrichment Fund is selected by default.
To give to other EEB funds, select "Other," and
indicate the name of the fund.

- Mulholland Post-Doctoral Fellowship in Environmental Sciences**
- Graduate Research in Ecology and Evolution Fund**
- H. R. DeSelm Graduate Award Fund**
- D. Etnier Ichthyology Museum Fund**
- L. R. Hesler Herbarium Support Fund**
- Field Botany Fund** *(also supports ecological field work)*

If you would like more information about any of these funds, or if you wish to support a fund not shown here, please contact the EEB office (865-974-3065) or the College of Arts and Sciences (865-974-2365).

To mail a contribution to EEB, please make your check payable to The UT Foundation, and indicate the fund to which you would like to contribute on the memo line.

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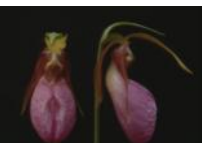


Wildflower Notecards

EEB has worked with retired botany professor Alan S. Heilman to develop a set of eight wildflower notecards. Each card features one wildflower native to Tennessee. The prices include shipping and handling within the US: \$13 for one set, \$24 for two sets, and \$35 for three sets. Please visit **eeb.bio.utk.edu/wildflower-notecards** for information on how to purchase these notecards. All proceeds go to the EEB Enrichment Fund.



*Celebrating our native biodiversity,
these photos were taken in the Great
Smoky Mountains National Park or
along the Blue Ridge Parkway.*



*All photos are from The Botanical
Photography of Alan S. Heilman,
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