ECOLOGY & EVOLUTIONARY BIOLOGY

Explorations

eeb.bio.utk.edu

FALL 2017 NEWSLETTER

Fire SPARKS Life

In late November of 2016, a single spark started a fire on a mountain in the Great Smoky Mountains National Park that quickly became one of the largest natural disasters in the history of Tennessee. For faculty in the Department of Ecology and Evolutionary Biology, the fires sparked unique opportunities for ecological research and discovery from fungi and soil microbes to plant communities and invasive ecology.

"Fungi are an understated, but essential part of the environment," says Professor Karen Hughes, who is working to understand why a new group of rapidly growing "fire-response" fungi are appearing.

Fires are rare in the Smokies mainly due to a change in perception of fire and its role in ecosystem health. The high-intensity fires that raged through the Smokies destroyed most fungi in the fire zones.

"We are identifying fire-response fungi that may be 'new to science' and documenting other fungi that are enhanced rather than destroyed by fire," Hughes says. "The health and recovery of the forest depends on fungi being restored to the soil. The normal processes of decomposition and symbiosis must be re-established if forests are to recover."

The soil these fungi grow in is the focus of Jen Schweitzer's research in the Smokies.

"Our research is focused on the dual impacts of the effects of fire and urbanization on soils, soil microbial communities, and soil-plant interactions," says Schweitzer, associate professor.

Fire and urbanization are two widespread disturbances that are increasing due to climate change and the growing number of people living in cities. The proximity of Gatlinburg to the Smokies provides Schweitzer and her team a unique opportunity to study their impacts together.

"An additional opportunity with these sites in the urban-wildland fire gradient is to examine the independent and combined roles of fire and urbanization as selective forces on plant evolution," Schweitzer says. "There is almost no information about population-level evolutionary responses to these disturbance events. With increasing disturbance around the globe, understanding the long-term evolutionary consequences of fire on plants is critical."

Understanding what happens to plant communities after a fire event is what Mona Papeş is out to discover.

"The basic goal is to understand how fire affects plant communities in terms of number and abundance of species," says Papeş, assistant professor.

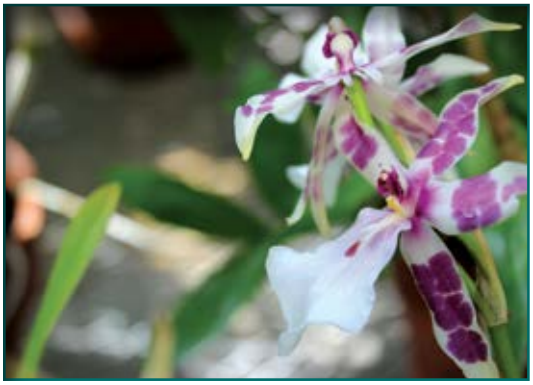
In areas of high-intensity burns, the forest canopy changed from completely closed to completely open. Papeş and her team are assessing and comparing the recovery of plant communities in the low-, mid-, and high-intensity areas to reference, unburned sites with the goal of documenting any shifts in the plant communities.

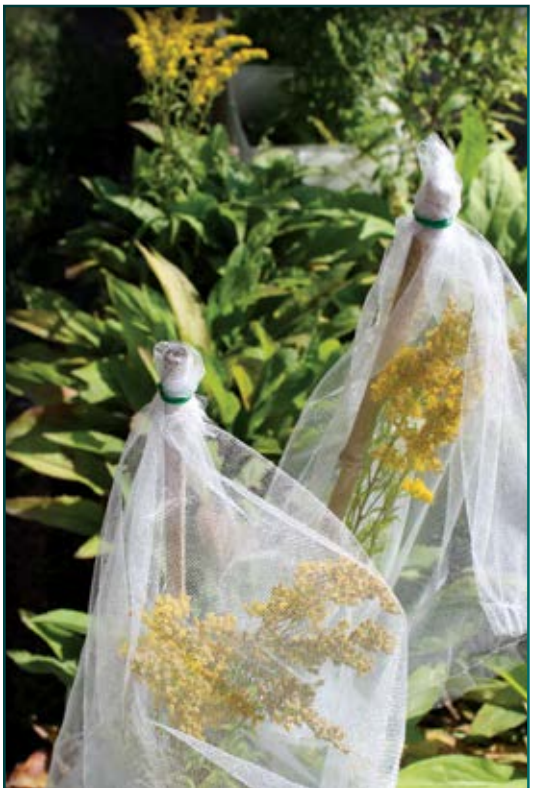
"We are interested in the number of plant species, as well as the abundance of species," Papeş says. "This will allow us to forecast the trajectory of understory plant communities under different intensity fires in the future, which may or may not affect how we use fire as a forest management tool."

The devastation of the fires still hangs in the air for many people who call the area around the Smokies home. If there is one lesson learned, it is that nature is resilient, and in the Park, it is making a comeback. Whether it will look the same in the future is still an unknown, but EEB researchers are rolling up their sleeves and digging in to find out.

what's inside:

GREENHOUSE RESEARCH: **Plant Petting Zoo**





This fall, students and faculty in the Department of Ecology and Evolutionary Biology will be able to conduct plant research in seven state-of-the-art greenhouses after a year and a half of renovations and expansions to bring the facilities up to modern standards critical for plant research.

"We are extremely grateful for the support of Dean Lee and the college, which helped provide the needed resources to transform our greenhouses at Hesler and Senter Halls into Research I facilities," says Susan Kalisz, EEB department head.

Greenhouses are essential to teaching and research in the department. For years, the original six greenhouses were in various states of disrepair. The lack of insect screens allowed easy access for pest insects and easy escape of beneficial insects, which counteracted any attempt to keep pests in check using natural control methods. Pebble-floor drainage made it difficult to prevent the entry and growth of pest plants and additional insects. Today, each greenhouse has a solid concrete floor with metal drain channels and is bug-proof thanks to the addition of insect screens to the ridge vents and exhaust fans.

"All our greenhouses are now effectively closed systems, which is critical when controlling variables in research projects," says Jeff Martin, greenhouse and garden facility manager. "Now our researchers determine what goes in and out of the greenhouses; not nature."

The diverse collection of flowering plants, ferns, and mosses reflects the diversity of research and teaching opportunities in the department. Greenhouses feature plants from tropical, temperate, and arid climates and range from avocado and mangos to orchids and water lilies. Faculty use the outdoor fern and moss gardens to study their unique botanical traits and in classes focused on student skills in plant identification.

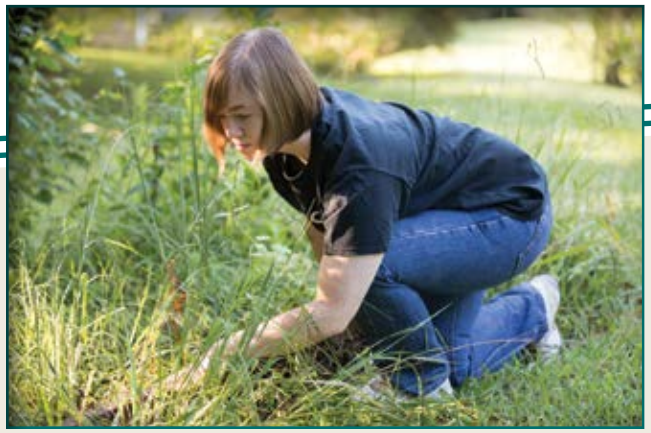
"Our greenhouse complex now provides the winning combination of the plant growth expertise in our knowledgeable staff; excellent, controlled research facilities; and terrific teaching resources in a living collection," Kalisz says.

Nate Kingsley, a senior EEB major, is one of the many students benefiting from the renovations and diversity of the greenhouses.

Ethan Marks (left) and Nate Kingsley (right) share Chancellor Davenport's excitement about the variety of plants in the greenhouse.

"I've always had a passion for organisms and the natural world. Being an EEB student has been a great way to understand how all the pieces of the living world interact," Kingsley says. "I've had many opportunities for stimulating hands-on research in the labs and engaging biodiversity collections in the herbarium and greenhouses. My favorite organisms are flowering plants, so working with our incredible live collection at the greenhouses has allowed me to get first-hand experience dealing with the cultivation and maintenance of these incredibly diverse organisms."

Martin encourages anyone interested in seeing the greenhouses to visit or set up a tour. **Visit eeb.bio.utk.edu or call 865-974-3065 for more information.**



Researching Animal Behavior

By her senior year **Hannah Anderson**, an EEB major, had already been involved in several projects. She started in the Riechert Lab where she continues to maintain a large population of spiders under the guidance of graduate student Angela Chuang. Frequently left in charge of the lab in Angela's absence, Hannah has been learning many of the more practical concerns required for maintaining a living population in a lab setting and the process of collecting living samples.

Hannah has also been involved in a project in the Simberloff Lab exploring the behavior of the native green anole and responses to the invasive brown anole. Though her time on this project was relatively brief, it provided invaluable knowledge regarding the study of animal behavior in a natural setting and the complications therein. The grant application process and protocol review by the Institutional Animal Care and Use Committee (IACUC) also gave Hannah additional experience.

Hannah did not stop there. In the fall of 2016, she took a Comparative Animal Behavior lab, where groups work together to create research projects. Though the class is over, Hannah has not let the project end. With the help of Professor Todd Freeberg, Hannah works directly with graduate student Johnathan "Alex" Grizzell and uses all of the experience she has gained up to this point to help design a field experiment exploring the behavioral responses of native birds to anthropogenic noise. During background research, Hannah noticed something odd in the scientific literature. Studies on the effects of anthropogenic noise on various organisms used modulated white noise as a replacement for anthropogenic noise. There were virtually no studies, except for one on frogs, that tested whether or not white noise was a suitable replacement for anthropogenic noise. Using a playback experiment, Hannah is attempting to prove that the two are not equivalent when it comes to Carolina chickadees and tufted titmice. Hannah intends to use her experience as a fully involved data gatherer and data coder for further research and to publish before she enters graduate school.

Ecology of Pollen Grains

Chandler Brown, an undergraduate working in the Williams Lab, entered his first plants-focused class already intrigued by the evolution of these beautiful organisms. He came to college for this class. With the acquaintance of Professor Joe Williams, his foot was in the door.

He started on a promising project on the dispersal ecology of pollen grains. When pollen disperses, it is either in a sexually immature bicellular state or in a sexually mature tricellular state. Researchers hypothesize that tricellular pollen has a higher water content than bicellular pollen because pollen is typically arrested in development at the bicellular stage when it undergoes dehydration in preparation for dispersal. If pollen fails to undergo dehydration, development might proceed to the mature tricellular stage. To understand pollen water content, Chandler compared the size of fresh mature pollen to its oven-dried size and to its fully hydrated size in 30 species. If fresh pollen is closer to its dried size, it must disperse in a very dehydrated state. Conversely, if it is close to its hydrated size it must have high water content. Pollen with high water content is metabolically active and can germinate faster. As such, metabolically active pollen has a higher competitive ability, an advantage that might explain why tricellular species originated from bicellular species in multiple instances.

This project has allowed Chandler to gain many new insights into biology and a sense of responsibility and independence while working in the lab and field. The research done in a lab allows students to develop broad skills necessary for almost any profession. Chandler learned various methods that might be applicable in many biological labs and more specifically in his field of plant biology. In addition to being honored with the knowledge of natural history in the field, he was offered a summer research grant based on the significance of his project, which allowed him to make a living within the EEB program before getting his degree. He is considering graduate school, and with this honor's thesis project under his belt, his chances of being accepted have increased. He is very appreciative of all the great opportunities offered to him throughout his undergraduate career and looks forward to his future in plant research.

STUDENT NEWS GRADUATE

One of the most important metrics when measuring the success of a department is external funding. Usually, this means looking at how much grant money faculty receive, but our EEB students have an excellent record in winning prestigious grants and fellowships. The following are just a few examples from the past academic year.

Three EEB students won three-year National Science Foundation (NSF) Graduate Research Fellowship Program awards:

» Patrick McKenzie
Finishing undergraduate in the Armsworth Lab

» Rachel Swenie
New PhD student in the Matheny Lab

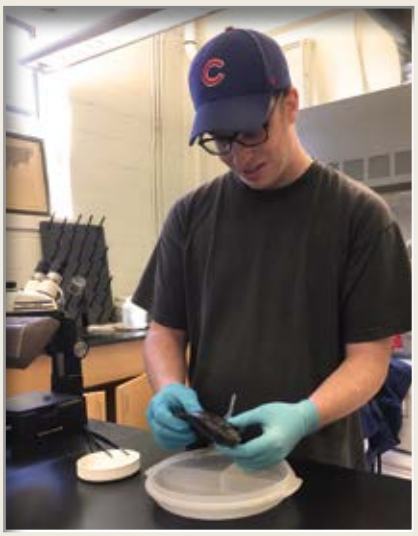
» Morgan Roche
PhD student in the Kalisz Lab

» Shelby Scott (Gross Lab) was awarded a three-year National Defense Science and Engineering Graduate (NDSEG) Fellowship.

Below we feature the work of graduate students **Alannie-Grace Grant** (Kalisz Lab) and **Sam Borstein** (O'Meara Lab) who received two-year NSF Doctoral Dissertation Improvement Grant (DDIG) awards. Because the NSF-DDIG awardees have advanced to candidacy in the PhD program, they have more fully developed research agendas.

Dietary Specialization and Evolutionary Patterns

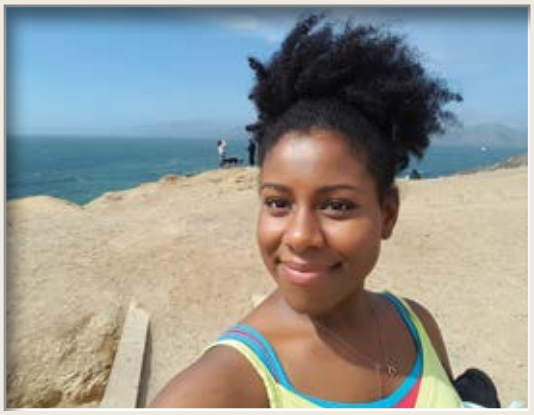
Sam Borstein is studying how dietary specialization may affect evolutionary patterns using ray-finned fishes as a study system because they are extremely diverse in their feeding habits and prey on a wide variety of resources. How effectively they feed is closely connected to their physical anatomy, especially how well the fish can maneuver and capture prey. Some physical traits can lead to increased speciation or decreased extinction rates, but may limit possible flexibility in diet evolution.



Sam's NSF-DDIG funding allows him to generate genomic sequence data to understand how species of ray-finned fishes are related, which will provide an evolutionary framework to study how diet evolution effects phenotypic evolution in fishes.

"Fish predominantly use two methods to capture prey, either biting at a food source or sucking prey into their mouths," Sam says. "Feeding can occur in a fraction of a second, so to investigate how fish feed, we need to use high-speed video cameras."

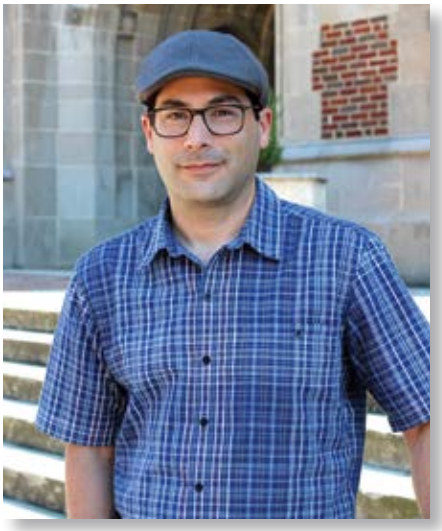
Results so far suggest fish species that feed on a single food source have faster rates of morphological evolution and more unique combinations of traits. This indicates that while species may specialize to feed on a single food type, it does not constrain their morphological evolution, and multiple food sources may help limit the effects of direct competition.



Modeling Climatic Difference in Plants

Alannie-Grace Grant is modeling the climatic differences between closely related self-fertilizing and cross-fertilizing angiosperm plants. Her results show that self-fertilizing species live in a wider range of climatic zones and in warmer, drier regions than cross-fertilizing species. She hypothesizes that the reduced size of self-fertilizing species and potential for faster development rates may strongly affect photosynthetic water use efficiency (an indicator of physiological stress) or the species' ability to reproduce before dry late-season conditions. Using the genus *Collinsia* as a model system, the NSF DDIG award will provide funds to perform experiments on self-fertilizing and cross-fertilizing plants in different climatic conditions.

Alannie-Grace will use the new plant growth chambers in EEB greenhouses to grow plants in a range of specifically programmed conditions, controlling light, water, and temperature. She will also explore how climatic conditions across the species' geographic range may affect carbon acquisition by performing stable isotope analysis on herbarium specimens from different locations across the species' range with the assistance of the UT Herbarium and the UT Stable Isotope Laboratory. Alannie-Grace is able to dedicate all her time to her research thanks to a UT Program for Excellence and Equity in Research Fellowship and UT Chancellor's Top-Off Funds.



MIKE BLUM

Rats. Fish. Mud. Though not readily apparent, water is the thread that ties all three together for new Associate Professor Michael Blum, who works on post-disaster infectious disease, conservation of at-risk freshwater fish on oceanic islands, and coastal restoration.

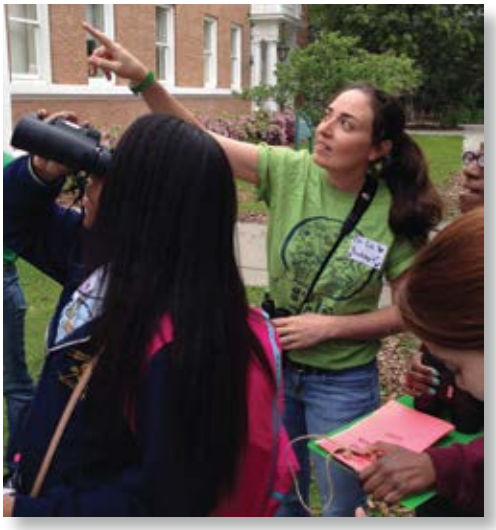
Trained as an evolutionary geneticist, Blum began his academic career studying the stability and formation of butterfly hybrid zones across the Neotropics. He has since pursued research that leverages ecology and evolutionary biology to improve urban and coastal sustainability.

Blum regularly works with researchers in a variety of disciplines to rethink how society views and manages water. Blum's work in response to the 2010 Deepwater Horizon oil spill is well known, but his work on rats in New Orleans often garners greater public interest.

"Rats are fascinating, and everyone has a rat story," says Blum, who is leading a team that is undertaking what is arguably the most extensive scientific study of urban rodents ever attempted.

Blum's team investigates how decision-making during responses to catastrophic disasters can ripple forward to shape human well-being decades afterwards. Blum works with colleagues to develop modeling tools to improve disaster response and post-disaster decision-making.

"I'm incredibly excited to be joining EEB," Blum says. "The department is an exceptional community of scholars with a demonstrated global impact. There are amazing opportunities for collaboration."



LIZ DERRYBERRY

A songbird belting out its song is what motivates new Assistant Professor Elizabeth Derryberry's research program.

"People always smile when I tell them we study bird song and then immediately ask if I can identify this one bird that always wakes them up in the morning," Derryberry says.

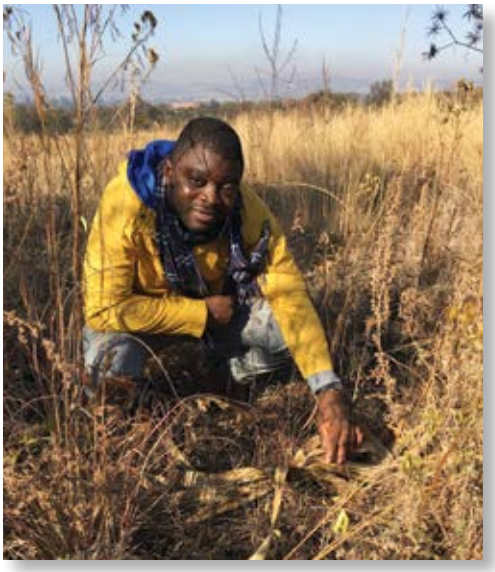
Apart from its general appeal to the public, bird song is a fascinating behavior with many parallels to human language.

"Many birds learn their song from their parents," Derryberry says. "A bird's song has become an important model for how traits can change through mistakes and innovations made across generations – known as cultural evolution – not just genetic changes."

Because cultural evolution can happen much more rapidly than genetic evolution, researchers use culturally evolving traits to measure rapid responses to environmental change. Derryberry examines how songs change in response to noise pollution, which is a global issue.

"One of the best parts of this project was that I had the opportunity to conduct an experiment to test whether cultural evolution really can explain these changes in song over time," Derryberry says.

Derryberry looks forward to pursuing her research at UT as the research breadth and strength of EEB promises many great collaborations.



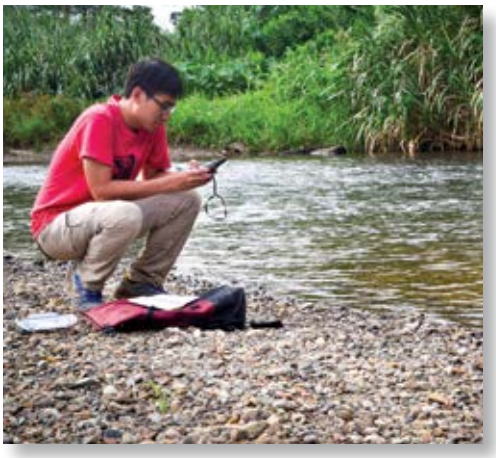
OROU GAOUE

A simple, but intriguing question led Orou Gaoue to embrace a career in academia: how do we know if a species will go extinct and when will it go extinct? Beyond this simple question, Gaoue's research is motivated by the desire to understand how humans affect the abundance and distribution of species and how species' responses to human activities affect future human choices.

"I have always been interested in how we can use simple mathematics to understand the ecological functioning of plant populations, measure to what extent human activities contribute to the extinction of species, and what can we do about it," says Orou Gaoue, a new assistant professor in EEB.

Gaoue is no stranger to Knoxville. From 2011 to 2013, he was a postdoctoral fellow at NIMBioS before leaving Knoxville to join the faculty at the University of Hawaii at Manoa. Four years later, Gaoue is excited to return because of the opportunity to work with an exciting group of students and colleagues with a deep interest and extensive experience in conservation science.

"People often ask me why someone would leave the warm and beautiful weather of Hawaii to come back to the Tennessee Valley," Gaoue says. "The opportunity to be part of a developing cluster in conservation biology and to collaborate on projects to tackle some of the most pressing world conservation problems is too good to refuse."



XINGLI GIAM

Increasing demand for food, energy, and raw materials drives rapid environmental change with profound impacts on biodiversity around the world. Xingli Giam, a new assistant professor in EEB, focuses on characterizing and mitigating anthropogenic impacts on the environment with a particular emphasis on tropical and freshwater ecosystems.

Giam combines fieldwork with the development and application of cutting-edge theoretical, statistical, and meta-analytic modeling tools to conduct interdisciplinary research that has real policy impact. Giam joined EEB in February and has been developing research projects spanning different ecological and human systems.

These projects include uncovering climate change impacts on the unique fish fauna of Southern Appalachia, identifying hotspots of rare fishes to inform conservation priorities in the Upper Tennessee drainage, and examining the impacts of coal mining on aquatic biodiversity and local communities in two of the five largest producers of coal in the world – the United States and Indonesia.

Coming from a postdoctoral research position at the University of Washington, Giam is thrilled to join EEB because of its very special community.

“There is an amazing, warm, and inclusive group of faculty and graduate students whose research interests complement mine and with whom I can form exciting collaborations,” Giam says.

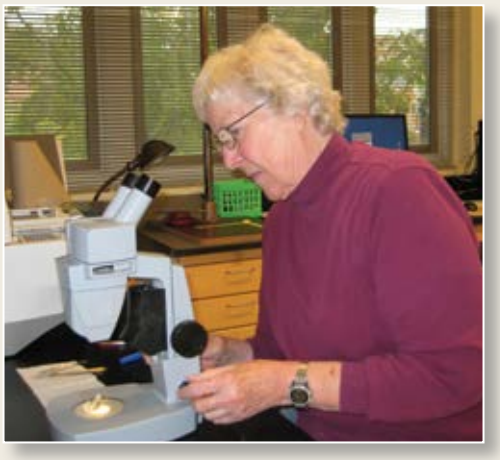
MONA PAPEŞ

Investigating the effects of the 2016 fires on understory plant communities in the Great Smoky Mountains National Park is the focus of Assistant Professor Mona Papeş research. After spending nearly six years at Oklahoma State University, Papeş’ research focus shifted when she joined EEB in January 2017 and traded the Cross-Timbers and Great Plains ecoregions for the Appalachian and Blue Ridge ecosystems.

Her study will compare plant species richness and abundance on sites selected across regions of low, medium, and high fire intensityto unburned reference sites. The main objective is to determine whether significant differences exist in plant community changes across the fire gradient as these communities recover from the fire.

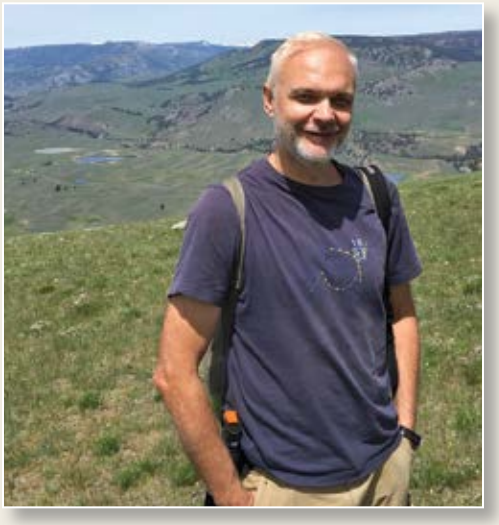
This work is part of a larger EEB initiative to investigate the effects of the 2016 fire on organisms and ecosystems in the Park.

FACULTY HONORS



KAREN HUGHES

The American Academy for the Advancement of Science elected Professor Karen Hughes as a Fellow and recognized her contributions to research on biodiversity and biogeography of fungi and her contributions to the discipline.



SERGEY GAVRILETS

The American Academy of Arts and Sciences elected Professor Sergey Gavrilets as a Fellow. His research focuses on population genetics, adaptation, speciation, coevolution, diversification, phenotypic plasticity, and sexual conflict.

To read more news about our professors, please visit us online.

eeb.bio.utk.edu

Alumni SPOTLIGHT

UT Ties Still Strong for IUCN Chief Scientist

When **Thomas Brooks** ('98) graduated from the University of Cambridge with a degree in geography, he wanted to focus his PhD work on tropical conservation. There was one problem – no one in the United Kingdom was interested in taking him on as a student.

"I wrote to several professors to explore my options, but in those days, conservation science was often seen as requiring a biology degree," Brooks says.

He got a break when one of the professors recommended he contact Stuart Pimm in the Department of Ecology and Evolutionary Biology at UT.

"The professor said he heard Pimm was recruiting graduate students to work on multidisciplinary conservation," Brooks says. "The rest is history!"

Brooks now serves as the chief scientist of the International Union for the Conservation of Nature (IUCN). He has had a distinguished national career in conservation biology that all started in 1994 when he left his home in the United Kingdom to attend graduate school in the United States; a place he had visited only once before.

He arrived on campus during a period of transition for the department, but quickly settled into his PhD work on predicting bird extinctions following tropical deforestation. His time in EEB was fundamental in setting him on his current career path, and he credits Pimm for much of it.

"He insisted that his graduate students learn skills in grant writing, peer review of manuscripts, and, above all, in writing scientific papers," Brooks says.

The rigorous PhD work paid off. Brooks has authored over 200 publications and has secured approximately $9 million in major grants, including one from the National Geographic Society, which funded his PhD fieldwork in Kenya.

His most enduring memory of his time in Tennessee, however, is the genuine friendliness he experienced with everyone he met.

"Knoxville was a wonderfully hospitable place to work through the great challenges and joys of PhD research," Brooks says.

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

ECOLOGY AND EVOLUTIONARY BIOLOGY ENRICHMENT FUND

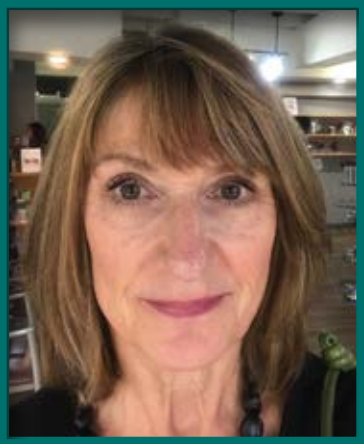
This is our primary fund and supports instructional and academic programs within the department, including:

- **Undergraduate and graduate research**
- **Travel funds for students to participate in meetings and workshops**
- **Departmental activities in need of support**

If you have specific philanthropic goals, you may want to consider one of our other funds:

- **Mulholland Post-Doctoral Fellowship in Environmental Sciences**
- **Graduate Research in Ecology and Evolution Fund**
- **H. R. DeSelm Graduate Award Fund**
- **D. Etnier Ichthyology Collection 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 at 865-974-3065. 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.



"Thank you for your support of ecology and evolutionary biology at UT!"

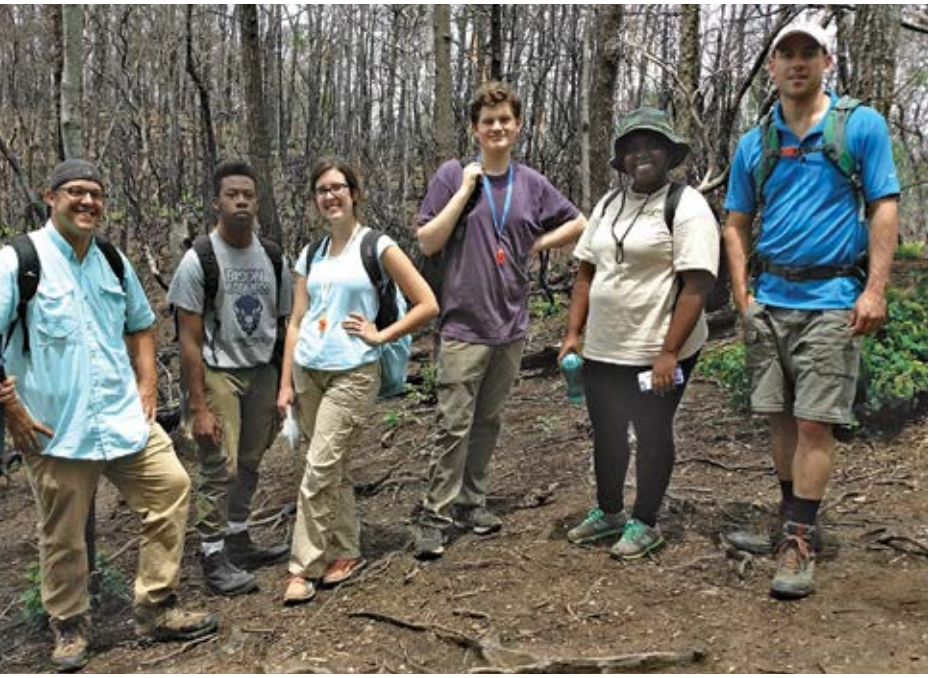
Susan Kalisz
Professor and
Department Head

THE UNIVERSITY OF TENNESSEE KNOXVILLE
COLLEGE OF ARTS & SCIENCES

DEPARTMENT OF ECOLOGY AND EVOLUTIONARY BIOLOGY
569 Dabney Hall
1416 Circle Drive
Knoxville, TN 37996

Non-Profit Org.
U.S. Postage
PAID
Permit No. 481
The Univ. of Tenn.
Knoxville, TN

Cover Story: FIRE SPARKS LIFE
EEB students have the opportunity to conduct post-fire research in the Great Smoky Mountains National Park.



Social Shout-Outs

You don't have to wait until the fall newsletter to find out what's going on in EEB.

Check out the news blog on our website at **eeb.bio.utk.edu/news-events**.

For Facebook, follow us at **facebook.com/EEBatUTK**.

If you prefer Twitter, we're **@UTK_EEB**.

Explorations

ECOLOGY AND EVOLUTIONARY BIOLOGY FALL NEWSLETTER