

BioNews

Keeping you updated on
what's happening in the
Department of Biology
Fall 2017



Photo by Danielle Murry-Knowles, IU Biology

Beloved undergraduate advisor—and animal lover—Mary Ann Miller communes with one of her squirrel friends outside of Jordan Hall before work. Miller retired earlier this year, but she hopes her "kids" will continue to keep in touch.

Editor's note Changes

This issue of *BioNews* is mostly about changes—within the department and beyond.

Personnel shifts have occurred. Clay Fuqua completed his term as chair this summer; Greg Demas seamlessly assumed the role. New student advisors have stepped in as stalwarts retired. Read more on page 3.

Ellen Ketterson is heading up the Environmental Resilience Institute to tackle major environmental threats to Hoosier health and economy (page 2) thanks to a \$55 million IU Grand Challenges grant.

Mark Sheehan (Phillips Lab) led the herculean task of documenting change among 30,000 trees as he and his small team performed the second "tree census" on a 62-acre plot in Lilly-Dickey Woods (page 4).

Ten to twenty percent of cacao (chocolate) crop loss worldwide is due to the fungal pathogen *Phytophthora palmivora*. Graduate student Natalie Christian (Clay Lab) may have found an easy fix (page 6).

The IU Herbarium collection is going digital (page 6), and the Biotechnology Program is once again under Biology's roof (page 8).

And, last but not least, learn how IU Biology alum Mary Ann Tellas is changing the face(s) of science (page 7).

Terri Greene, *BioNews* editor



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PREPARED FOR ENVIRONMENTAL CHANGE

Resilient Ecosystems, Livable Communities, and Healthy Hoosiers



Image by David Orr, Blue Aster Studios, 2016

Prepared for environmental change

by P. David Polly

Climatic and environmental change present a serious challenge for the world. The "Prepared for Environmental Change" Grand Challenges initiative aims to put IU at the forefront of research on (1) climatic and environmental change, (2) the impacts on human communities and the natural world, and (3) solutions to resiliently prepare for the coming century. IU Biology is playing a leading role. Distinguished Professor Ellen Ketterson is director of the initiative and the new Environmental Resilience Institute that serves as its focal point. Distinguished Professor Keith Clay and Associate Professor Heather Reynolds are team leaders, and several more of the department's faculty will play key research roles. Their work is instrumental in organizing research activities of nearly 100 faculty members spread across 32 departments and two campuses of the IU system.

The initiative will attract outstanding new talent to IU through key faculty hires as well as faculty research fellows and scientists still in training. Sixteen new faculty hires will be made over the next five years, including ones in climate modelling, conservation biology, environmental law, risk and disaster modelling, urban environmental planning, and environmental communication. Three hires will be in Biology. One will be a biologist working on dispersal and behavioral phenology—including the patterns and mechanisms of animal movements, specifically the emerging areas of phenology, plasticity, adaptive responses to environmental change, behavior and evolution, and tracking. Another will work on shifts in the ranges of native and invasive species with environmental change. A third will work on host-parasite interactions in natural systems (disease ecology). A fourth hire in vector-borne diseases may be split between Biology and School of Public Health.

Twelve research fellows will join the Environmental Resilience Institute and be housed in affiliated departments. These posts will be filled by top-rank independent scholars who will lead research associated with the initiative's goals. Three of these fellows will reside in Biology, the first of whom has already been appointed. Adam Fudickar is carrying out research that aims to understand the ability of animals to adapt to changes in climate and habitat. His group is working to identify the genetic and physiological mechanisms that underlie the responses of animals to these changes and to contribute to a greater understanding of how animals adapt to a rapidly changing planet.

In addition to hiring, the initiative will support infrastructural improvements to research facilities. The Kent Farm property at IU Bloomington will be expanded to enhance lab space and to install state-of-the-art aviaries for migration ecology research. A Motus tower system will be installed in Indiana to track movements of birds using coordinated automated radio telemetry. Environmental chambers in which temperature and photoperiod can be manipulated to mimic climate change will be acquired, and lab facilities in the Center for the Integrated Study of Animal Behavior will be upgraded.

The "Prepared for Environmental Change" initiative represents one of the largest single investments ever in Indiana University's research capacity. It is unique in developing solutions based on sound scientific data with an understanding of the social, cultural, and political contexts that will facilitate their success. It will make Indiana University a leader in research on environmental change and the state of Indiana a model for innovating resiliency and prosperity in the face of rapid environmental flux.

P. David Polly is associate director of the initiative/ERI as well as the leader of its Dynamic Earth Systems Group. His research contribution is primarily in the area of species' geographic distributions responses to climate change. Polly is a professor of geological sciences and an adjunct professor of biology at IU Bloomington.

The initiative will support fundamental research on the processes of climatic, biotic, and societal responses to changing climates and environments.

Objectives include:

- building an advanced environmental modeling and forecasting program through big data collection and innovative use of IU supercomputing resources
- implementing a leading-edge wildlife and disease monitoring system through new small-scale technologies, high-tech sensors, and advanced biology laboratories focused on environmental indicators
- establishing public-private conservation partnerships to create continuous wildlife corridors in each of Indiana's critical wildlife ecosystems—including river watersheds, tallgrass prairies, and farmlands
- developing and implementing urban and rural environmental resiliency projects to demonstrate sustainability programs for rural towns, urban waterways and greenspaces, utilities, and farmers—becoming the go-to resource for Indiana's mayors and businesses for tools and resources to understand coming challenges and threats and to implement policies and programs for resiliency; and
- engaging Indiana residents in a public dialogue about environmental change through statewide social surveys, humanities-based public exhibitions, journalism programs, and research-based communication strategies.

Demas takes the helm

On July 1, 2017, Greg Demas stepped into the role of chair of the IU Department of Biology. Demas assumed the position upon Professor Clay Fuqua's completion of his four-year term as the head of the department.

Fuqua, in expressing his support, said that Demas will provide forward-looking, proactive leadership as chair for the Department of Biology, building on his excellent track record of accomplishments as associate chair for research and facilities over the past five years. Fuqua noted that this experience had given Demas extensive familiarity with virtually all aspects of the department.

As part of his great leadership qualities," Fuqua added, "Greg is balanced and fair as well as committed to making sure the department remains a productive and harmonious environment for our many students, faculty, and staff members. Greg is a tremendous researcher, educator, and colleague. I have every confidence that the department will thrive under his guidance and continue to enhance its educational and research capacities in the life sciences."

Demas is a professor of biology. He has been with the department since 2001 and maintains an active research lab. He is interested in how hormones and the immune system interact within the brain to regulate biological and behavioral outcomes in animals. This work is often, but not always, conducted within the context of seasonality, as most animals display pronounced seasonal changes in a wide range of biological responses including breeding, immune and sickness responses, and social behaviors. More recently, his lab has begun studying the role of the gut microbiome on the development of offspring social behavior.

Demas is already hard at work in his new role. Among his goals as chair are:

- Continued recognition and support for excellence in research
- Improving and expanding facilities
- Maintaining strong graduate programs that attract the top students
- Increasing emphasis on undergraduate education and research
- Renewed efforts to increase student, staff, and faculty diversity
- Recognition of the vital contributions of teaching faculty
- Recognition of the importance of skilled professional and support staff

Professor Scott Michaels replaces Demas as associate chair for research and facilities. Professor Rich Hardy continues as the associate chair for teaching.



Courtesy: phone

► Gregory E. Demas

Professor of Biology
Evolution, Ecology, and Behavior

Education

Postdoctoral Fellow, NSF Center for Behavioral Neuroscience, Georgia State University, 1998-2001; Ph.D. in Biopsychology, Johns Hopkins University, 1998

Recent accomplishments

Exemplar Award, Center for the Integrative Study of Animal Behavior, 2016; Animal Behavior Society Fellow, 2015; American Association for the Advancement of Science, 2013

Roots

Born in Philadelphia and grew up in suburban Philadelphia in the small town of Broomall near Villanova, PA

What you might not know about him

Brews his own beer. He started the hobby as a graduate student living in a one-room efficiency apartment in Baltimore.

Changes—and an award—in student advising, advocacy



Terri Greene, IU Biology



Terri Greene, IU Biology



Terri Greene, IU Biology



Courtesy photo



IU Communications



Courtesy photo

Undergraduate advising:

Mary Ann Miller (left) retired in April after advising 6000+ undergrads in Biology since 1998.

Danielle Murry-Knowles was named IU College of Arts and Sciences 2016-17 Advisor of the Year.

Graduate advising:

Gretchen Clearwater (left) retired in August after serving as advisor for graduate affairs for 25 years!

Mary White Wolf hit the ground running on September 1 as IU Biology's new advisor for graduate affairs.

Student advocacy:

This summer—after 19 years as Biology's student ombudsperson—Associate Professor Emeritus **Michael Tansey** (left) passed on the student advocacy role to **Rich Holdeman**, senior lecturer of biology.

IU scientists measure nearly 30,000 trees to learn more about forests, climate

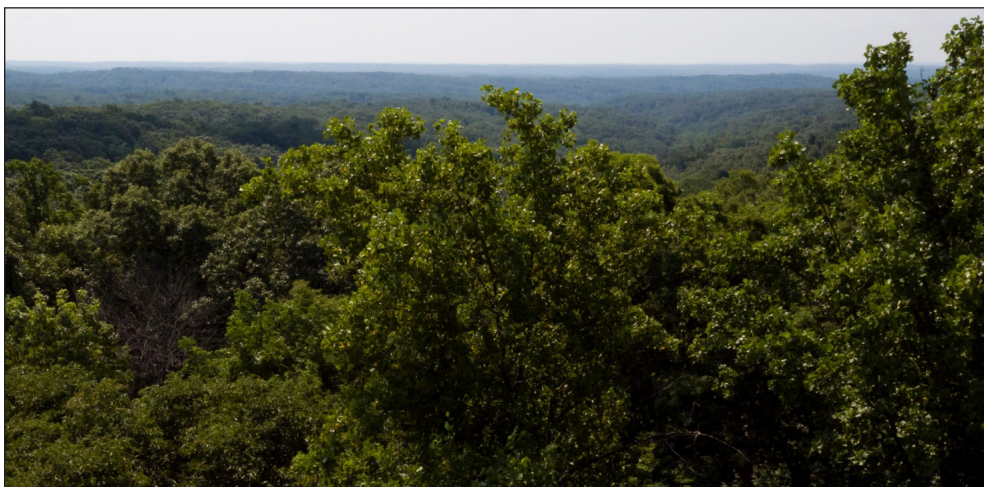
Small team spends summer conducting 'tree census' on IU-owned land deep within one of the state's oldest forests as part of global research project

by Kevin Fryling

A small team of Indiana University researchers took on a seemingly insurmountable task this summer: physically measuring the size and location of every tree in 62 acres of land deep within one of the state's oldest forests.

The site of the project is Lilly-Dickey Woods, part of the IU Research and Teaching Preserve in Brown County, Indiana, and one of only 51 plots of land in the ForestGEO network—a global network of forests whose study is funded by the Smithsonian Institution to advance knowledge about how trees grow and react to changes in the environment. The site is also one of only several forests in the network in the Midwest, providing vital data about how environmental change impacts forests in the central U.S.

"We've never bothered to count how many trees we're going through every day; we're all just working so breathlessly," said Mark Sheehan, a technician in the IU Bloomington College of Arts and Sciences' Department of Biology, who leads the four-person team tasked with measuring nearly 30,000 trees in three months. "Some days it goes fast; other days you're crawling on your hands and knees under a dense thicket of pawpaw trees."



Clockwise: Mark Sheehan, a technician in the lab of IU professor Richard Phillips, leads the team conducting the tree census in Lilly-Dickey Woods; each of the nearly 30,000 trees in the woods is marked with a small metal tag; a bird's-eye view of Lilly-Dickey Woods, a part of the IU Research and Teaching Preserve in the heart of Brown County. Photos by James Brosher, IU Communications

The remoteness of the forest is a challenge. Located about 45 minutes outside Bloomington in the heart of one of the few old-growth forests in the state, the worksite requires hiking nearly a mile into the deep woods—or a bumpy jeep ride down a log-strewn dirt road. Another challenge is weather and wildlife: Temperatures regularly rose into the 90s this summer, and insects such as yellow jackets—a swarm of which temporarily sidelined a crew member with multiple stings—posed a threat.

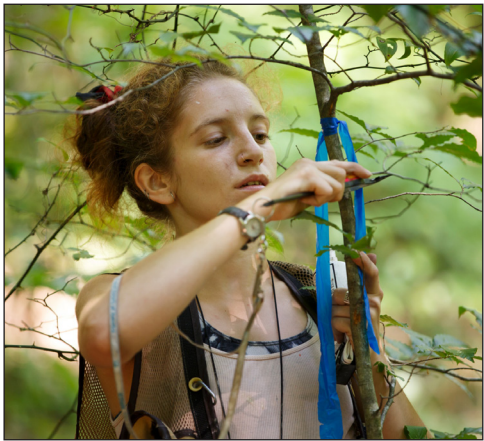
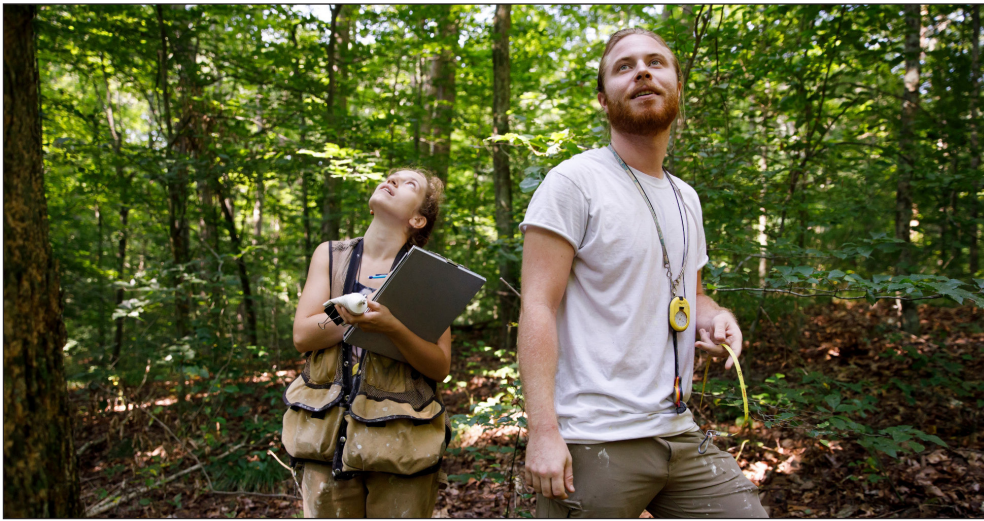
Yet Sheehan said it's rare that anyone mentions the hard work or the heat. "Honestly," he said, "we all feel privileged to spend every day working out in nature."

Nor is this the first time that IU researchers have tackled the herculean task. This year's project is a follow-up to the first "tree census" conducted on the site over five years ago. The differences in tree growth and deaths between then and now reveal vital information about tree species on the rise or fall in Indiana.

That first tree census was completed over the course of three months in 2012. This year's task is also a three-month job, although project leaders note that if a single person were to attempt it, the census could easily require a year.

In addition to Sheehan, IU scientists on the project are graduate student Carson Hoogewerf and forest ecology technicians Matthias Gaffney and Aubree Keurajian, who joined IU for the summer to participate in the project. IU faculty members involved in the effort are Richard Phillips, professor in the Department of Biology and director of the IU Research and Teaching Preserve, and Keith Clay, an IU Distinguished Professor [of Biology] who served as director of the preserve from 2002 to 2014. The initial tree census was led by then-IU Ph.D. student Dan Johnson [MS Environ Std '07; PhD'13] who returned this summer for part of the project.

"The long-term collection of data from forests across the globe is incredibly



Clockwise: IU forest ecology technicians Aubree Keurajian and Matthias Gaffney gaze up at the forest canopy during their work recording the size and location of every tree over 10 centimeters in diameter in Lilly-Dickey Woods; Keurajian affixes a marker to a tree after measuring the width; Gaffney measures a trunk as part of the tree census. Photos by James Brosner, IU Communications

important to scientists studying the impact of changing temperatures and carbon dioxide levels on the environment," Phillips said. "You can't prove that something has changed if you're missing baseline data to compare your observations against."

The project also recently marked a major milestone: the publication of the first study to draw upon data from multiple sites in the ForestGEO network. Clay, Phillips, and Johnson are among the co-authors on the paper in the internationally acclaimed journal *Science*.

By analyzing more than 3,000 species and nearly 2.4 million trees in 24 forest plots worldwide, the study found that trees growing in areas with a high concentration of the same species fare poorly compared to trees growing in areas with a greater diversity of species. The paper also

reported that this effect persists across both tropical and temperate forests—although a strong diversity of species appears especially important in cooler forests in countries such as the U.S. and Canada.

"This study shows that the dense aggregation of similar tree species is unhealthy due to factors such as the transmission of pathogens from older to younger trees through root networks," Clay said. "Basically, plants do better in their 'neighbor's' soil."

The findings demonstrate how the loss of tree species can harm forests, especially in temperate zones with less diversity. Lilly-Dickey Woods has about 36 tree species, for example. A tropical forest, by contrast, can easily contain over 400.

For the team working in Brown County, Sheehan said the forest's

complex lifecycle is written in the landscape. Small saplings in sun-dappled patches of dirt stretch toward the light beside fallen forest giants whose collapse only recently freed the younger trees to grow. The loss of the older trees is due partly to the natural cycle of life and death, but also to environmental factors such as the invasion of the tree-killing emerald ash borer and a major statewide drought in 2012.

The meticulous collection of data from the woods empowers scientists to untangle the impact that these and other factors have on the forest in Indiana, Phillips said. It will also reveal the diversity of the forest's species, shedding light on larger trends in forest health across the state and the world.

Lastly, Clay added that none of the research in Lilly-Dickey Woods could take place without a generous gift to the university 75 years ago. Two Brown County neighbors—J.K. Lilly, a scion of the Indiana pharmaceutical manufacturer Eli Lilly and Co., and Marcus Dickey, the personal secretary and biographer of Indiana poet James Whitcomb Riley—donated adjacent plots of land to then-IU Chancellor Herman B Wells in 1942 with the promise that the forest remain in a natural state for use in art and biological research.

IU's careful stewardship of the land over the past 75 years and, more recently, the inclusion of the woods in a global project to understand the impact of environmental change on our planet is a powerful testament to the endurance of this agreement, Clay said.

This year's tree census at Lilly-Dickey Woods was completed in September.

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Kevin Fryling—news and media specialist for science at IU Communications—connects people to information about IU's latest discoveries in biology and other sciences. Among his many skills and responsibilities is translating science-speak to AP style.



Photo by Sam Roy, Indiana University

Natalie Christian is the lead author on the recent paper "Exposure to the leaf litter microbiome of healthy adults protects seedlings from pathogen damage," published in the *Proceedings of the Royal Society B* (<http://rspb.royalsocietypublishing.org/content/284/1858/20170641>). Contributing to the paper are her Ph.D. mentor Keith Clay and colleagues at the Smithsonian Tropical Research Institute.

Christian will receive her Ph.D. in Evolution, Ecology, and Behavior in December 2017. As a graduate student, she has been a member of Keith Clay's lab. In 2016 she was the recipient of a Smithsonian Institution Predoctoral Student Fellowship and an NSF Doctoral Dissertation Improvement Grant.

Study provides hope for cacao farmers

Every species of plant sampled to date hosts a fungal microbiota in its leaves. These fungi, known as endophytes, can play many roles for plants—influencing functions such as pathogen and herbivore resistance, drought tolerance, and competitive ability. Despite their importance for plant physiology and fitness, it is unclear how endophyte communities are transmitted and assemble in nature to interact within their hosts and affect plant health.

Natalie Christian and colleagues manipulated local environmental factors and showed that leaf litter exposure and vertical stratification have dramatic effects on the microbiome of cacao trees, the source of chocolate. Furthermore, the resulting microbial communities had large effects on plant health. Christian infected the experimental plants with *Phytophthora palmivora*, a common cacao pathogen, and found that seedlings previously exposed to litter from cacao adults experienced reduced pathogen damage—an effect attributable to microbiota transferred from litter that enriched the seedling microbiome with fungal species that in turn enhanced pathogen resistance. Analogous ideas of "seeding" a healthy microbiome into hosts have been documented in human microbiome studies, including fecal transplants and maternal transmission of a healthy microbiome to infants.

Their results provide hope for cacao farmers. *P. palmivora*, the fungal pathogen used in this study, infects cacao tissue and is responsible for 10 to 20 percent of cacao crop loss worldwide. "While further field studies are definitely needed," Christian explains, "on cacao farms where leaf litter and plant debris are removed from the field, boosting the health of seedlings may be as easy as returning the leaf litter to transfer protective microbes to the young plants."



Hear more about the study in an interview with Christian on CBC Radio, "Chocolate gets fungus armour from their parents": <http://go.iu.edu/1H1w>

IU Herbarium goes digital by Eric Knox

The Indiana University Herbarium was established in 1885 as a research museum that now holds over 150,000 dried, pressed plant specimens mounted on large sheets of acid-free paper with attached labels that record the original collection information, any subsequent taxonomic changes, and indicators of additional research done with particular specimens.

In the past, specimens were sent on loan from one herbarium to another, or botanists would make extended visits to herbaria in order to study the specimens and record the collection information, which would then be synthesized in published floras or research articles. Technological advancements in computing and digital photography now allow us to unlock this vast storehouse of information and make it publicly available in ways that are useful to scientists, students, and the general public.

We are in the fourth year of the five-year IU Herbarium Digitization Project. The project started with an inventory and curation of all specimens. The current phases involve photographing specimens using a high-resolution digital camera and transcribing the label information into a searchable database. Finally, the geographic coordinates of each specimen's collection site will be estimated so that the information is available through map-based applications. All current work is available through a data portal run by the Consortium of Midwest Herbaria (<http://midwestherbaria.org>).

Want to know more about this project? Visit <http://go.iu.edu/1JMh>.



Photo by Emily Sterneman

Eric Knox (left) instructs Maggie Vincent on how to affix a label to a specimen sheet.

Eric Knox is a senior scientist with the IU Department of Biology and director of the IU Herbarium. Knox is a Fellow of the Indiana Academy of Science and recipient of the George R. Cooley Award from the American Society of Plant Taxonomists.

Alumni profile: Mary Ann Tellas

Changing the face(s) of science

Twenty-five years ago James P. Holland, professor of biology at Indiana University Bloomington, tapped Mary Ann Tellas to assist with a new science program for minority high school students.

The Summer Enrichment Program (eventually named after Holland to honor his legacy) exposes promising, high-performing, underrepresented high school students with interests in STEM disciplines to an in-depth look at the process of science on the IU Bloomington campus during the summer. Students attend lectures, take part in discussions, and participate in hands-on laboratory procedures. They also learn about scientific careers and how to prepare for a successful college experience.

Tellas, who grew up in Bloomington, received her B.A. in biology from IU in 1986. Holland was her instructor for a freshman biology class. She recalls being impressed by Holland's knowledge and his joy in sharing that knowledge with the students. In 1992 she was honored that he remembered her and asked her to help with SEP. Tellas was teaching high school biology then—she earned her M.S. Educ. in secondary science education from IU in 1996—and was the first teacher in SEP, assisting with lab activities under the direction of Holland and other IU professors.

Tellas was appointed director of SEP in 2006. Her dedication to, compassion for, and persistence in teaching reflect those characteristics of her mentor. Holland, who died in 1998, would be proud to see the scope to which Tellas has taken the program and the success of the student participants.

In 2008 funding was obtained to create a second program, which was renamed Jim Holland Summer Science Research Program in 2012. Rising underrepresented high school students spend a full week immersed in a research lab, culminating with a poster session during which they present their scientific research. SSRP participants are selected from former SEP participants. A third program, the Jim Holland Research Initiative in STEM Education, was launched in 2016. RISE builds upon the first two programs by offering high school seniors a two-week experience, including time spent on STEM career and college planning.

Earlier this year, Tellas, who is currently teaching high school biology in the Indianapolis area, was presented with the IU Bloomington Martin Luther King Jr. Celebration Building Bridges Award which, according to the award website, "recognizes those . . . who capture Dr. King's vision, spirit, and leadership in ways big and small—right here at IU and in our own community." Consistent with her modesty about her role in the programs, Tellas was quick to note that it is a team effort and that she shares the honor with others equally committed.

Without Mary Ann at the helm, I'm not sure the programs would be as successful and meaningful to the participants as they have been," comments Jeremy Bennett, former associate director of

the Holland programs. "For me, it's most rewarding to see former participants matriculate to IU as undergraduates, especially those who further participate in formal research/scholarship programs. It is evidence that we're accomplishing exactly what we set out to do."

When grateful students who have completed one or more of the programs share their success stories with Tellas, she tells them that she's proud of them—but not surprised.



Photo by Terri Greene, IU Biology

Mary Ann Tellas

Of the 117 SSRP participants from 2008-2011 and 2013-2015—104 responded to a recent survey. The following data is based on the 82 responders who had graduated from high school.

- 100% enrolled or attended a post-secondary institution of higher learning (including 1 military)
- 68% majored in a STEM discipline
- 51% graduated with a 2-year or 4-year degree (the rest had yet to graduate at the time of the survey) and of the group of graduates, about 67% graduated with a degree in STEM
- 8 students attended graduate or medical school

In addition, the inaugural ten RISE students, who graduated May 2017, are all attending post-secondary institutions of higher learning. Six are attending IU Bloomington. This group of students amassed over \$783,000 in academic scholarships!

"I truly love this work," says Tellas. "I can think of nothing else that I would rather do than to encourage young people of color that they are intelligent, creative, and innovative with unique skills and talents that are so needed in a field that would benefit so much from their contributions. It is truly an honor and a privilege to be associated with the mission and legacy begun by Dr. Holland—to open doors, to break down barriers, and to change the face of science."

Jeremy Bennett contributed to this story. Bennett is human resources coordinator for IU Biology and former associate director of the Holland programs.

943 SEP students
2002-2017

68/79

Lilly/SSRP students
2008-2011/2013-2017


18 RISE students
2016-2017



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Visit <https://biology.indiana.edu/news-events/newsletters> to access the current issue with class notes and a few extras as well as past issues of IU Biology newsletters.

Contact information changed? Notify Kathy Wyss at kwyss@indiana.edu or 812-855-6195.

Update your record with the IU Alumni Association at <https://myiu.org/my-profile/alumni-directory>.

Biotechnology back in Biology

The Biotechnology degree program, which had been a part of IU's Molecular and Cellular Biochemistry Department for a while, is back in Biology.

Biotechnology, simply put, is technology based on biology. It prepares students for careers in the life sciences. Students study cellular and biomolecular processes to develop technologies and products to improve lives and our environment. In addition to the rapid advances in therapies for diseases, in diagnostics, and in improvements to agriculture products—the biotechnology industry has provided strong job growth throughout the United States.

The program offers a B.A. and B.S. in biotechnology. Students may pursue a combined B.S./M.S. to maximize research opportunities. A one-year M.S. degree is offered as well. And, a minor is available to students obtaining a degree in other fields who want exposure to this rapidly growing and highly employable field.



Courtesy photo

Ben Maurey [MS'16] credits the training he received in the Biotechnology master's program as the reason he obtained a research technician position at Perelman School of Medicine at the University of Pennsylvania. "It was the technical lab skills and the ability to learn or develop new protocols that distinguished me from other applicants," he wrote.