FOREST & WILDLIFE RESEARCH CENTER 2020

ANNUAL REPORT

MISSISSIPPI STATE UNIVERSITY™
FOREST AND WILDLIFE RESEARCH CENTER

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ANNUAL REPORT

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The Forest and Wildlife Research Center is a unit in the Division of Agriculture, Forestry, and Veterinary Medicine at Mississippi State University.

The mission of the Forest and Wildlife Research Center is to promote, support, and enable the management, conservation, and utilization of forest and other natural resources to benefit the stakeholders of Mississippi, the nation, and the world.

MISSISSIPPI STATE UNIVERSITY™
FOREST AND WILDLIFE RESEARCH CENTER

ON THE COVER: Railroad ties at the John W. Starr Memorial Forest, Dorman Lake Test facility are exposed to varying environmental conditions and preservatives to determine their service life. See our story on page 20. (Photo by David Ammon)

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FROM THE
DIRECTOR

THANK YOU for your continued support of the Forest and Wildlife Research Center (FWRC). Our faculty, staff, and students have demonstrated their unwavering commitment to delivering research and outreach that meets the needs of landowners and industry alike while also training tomorrow's natural resource professionals during extraordinary times. And these truly are unprecedented times. I am so proud of the resiliency shown by our faculty, staff, and students to continue our mission of conserving, managing, and utilizing the forest, forest products, wildlife, and fisheries resources for the betterment of all Mississippians.

It is my honor to lead such an incredible team of individuals. For 15 years, Dr. George Hopper led the College of Forest Resources (CFR) and the FWRC. Under his capable leadership, the CFR and FWRC experienced unprecedented growth and prosperity, despite repeated budget setbacks. During his tenure, our enrollment more than doubled, as did virtually every measure of research productivity. We are a much stronger institute today because of his visionary leadership and steady hand.

While I served alongside Dr. Hopper as associate director of the FWRC for the past decade, in his retirement, I was asked to assume the role of interim dean and interim director. Fortunately, I have assumed the reins of a vibrant and extraordinarily productive organization. During my 28 years with CFR/FWRC and 10 years on the FWRC leadership team, I have come to personally know many of you as stakeholders, partners, and friends. For those I have yet to meet, I look forward to building new friendships in the future.

I am in the enviable position of assuming leadership at a pivotal point in our organizational history. Over the past decade, FWRC has shown steady growth in productivity and prominence. But now we are at an inflection point, poised to achieve an even steeper trajectory in outcomes and impact. In the past year, we've filled seven faculty positions across our three departments. Our new crop of forestry, sustainable bioproducts, wildlife, and fisheries scientists are exceptionally talented and highly motivated. Our faculty have recruited more than 150 of the best and brightest graduate students and post-docs from all over the globe. Our CFR graduate and undergraduate students are integral to the FWRC research program. We are training the next generation of natural resource professionals to think critically, work in teams, and make discoveries that inform natural resource management.

Forest lands and the products they produce are a key component of the Mississippi economy contributing to the prosperity and quality of life for all Mississippians. The 19.7 million acres of forest lands held by 125,000 forest landowners produce a farmgate value of $1.13 billion, making forest resources among the top three most important agricultural products in the state. These forest lands support a $13.2 billion-dollar industry that provides over 61,000 jobs with nearly $3 billion payroll and $5 billion induced and indirect economic impacts. In addition to the wood products, these forest lands provide a myriad of environmental goods and services including clean water, carbon sequestration, nutrient cycling, pollination services, and wildlife habitat. The fish and wildlife produced by these lands generate another $2.7 billion in economic impacts and 66,000 jobs for the state.

In this annual report, we have highlighted a handful of the 255 active research projects that FWRC scientists are pursuing. We have segmented these projects into those with a global/national impact, applied research in the field, collaborations with industry partners, and graduate and undergraduate student profiles. I know you will enjoy delving deeper into our research and gaining a better understanding of how we are making an impact in our state. Our research betters the lives and livelihoods of Mississippians, extends the life of wood products, and provides habitat for wildlife. For every dollar we receive in state funding, an extra $1.54 is generated in extramural funding, bringing additional capital to our state.

As you read, you will see the passion that our faculty, staff, and students have for understanding, conserving, and utilizing our natural resources. We will continue in these endeavors and encourage your continued participation.

As we work together towards these shared priorities, I look forward to coming to know each of you at a deeper and more meaningful level.

Thank you for your generous support!

L. WES BURGER
INTERIM DIRECTOR

FORESTRY

The Department of Forestry conducts research to sustainably manage and utilize forest resources. The department conducts research in these strategic areas:

Forest Biology and Watershed Management

- Silviculture for Ecosystem Services
- Mixed species management
- Stand dynamics
- Commercial thinning
- Tree physiology
- Restoration and ecosystem productivity
- Ecohydrology
- Hardwood and pine management

Forest Economics, Management, and Policy

- Monetary valuation of ecosystem services
- Utilization of woody biomass
- Assessing forest operations and businesses
- Trade and anti-dumping policies
- Timber markets
- Multiple resource management

Forest Measurements and Spatial Ecology

- Impacts of natural and human disturbance
- Measuring and assessing woody biomass
- Assessments of large scale afforestation
- Forest stand growth and yield
- Carbon sequestration

FACULTY

DONALD L. GREBNER
Head and George L. Switzer Professor of Forestry

HEATHER ALEXANDER
Associate Professor

JOHN B. AUEL
Assistant Extension Professor

BRUNO DA SILVA
Assistant Research Professor

STEPHEN C. GRADO
George L. Switzer Professor of Forestry

ROBERT GRALA
Professor, James R. Morton Fellow in Forestry

JOSHUA GRANGER
Assistant Professor

JAMES E. HENDERSON
Professor and Head, Coastal Research and Extension Center

AUSTIN HIMES
Assistant Professor

JOHN D. KUSHLA
Extension/Research Professor

QIN (CHRISTINE) MA
Assistant Professor

ERIC MCCONNELL
Assistant Professor

IAN A. MUNN
Sharp Professor of Forestry, CFR Associate Dean

ADAM POLINKO
Assistant Professor

KRISHNA POUDEL
Assistant Professor

HEIDI RENNINGER
Assistant Professor

RANDALL ROUSSEAU
Extension/Research Professor, James R. Morton Fellow in Forestry

BRADY SELF
Associate Extension Professor

COURTNEY SIEGERT
Associate Professor

CHANGYOU "EDWIN" SUN
George L. Switzer Professor of Forestry

SHAUN TANGER
Assistant Professor

JIA YANG
Assistant Professor

EMERITUS

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WILLIAM ELAM
DAVID L. EVANS
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SCOTT D. ROBERTS
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RAY A. SOUTER
MARTIN A. SPETICH
MIKE R. STRUB
JESSICA L. TEGT
J. MORGAN VARNER

GLOBAL/
NATIONAL
IMPACT

Forestry Fair Trade

OVERCOMING THE KNOWLEDGE BARRIERS AROUND TEMPORARY TRADE BARRIERS

BY REAGAN POSTON

THANKS TO the ever-increasing availability of information through technological connectivity, the globalization of industry was all but guaranteed. Still, as countries advance their political and economic power at varying speeds, some nations become particularly vulnerable to malicious international trade practices such as dumping and subsidies. To counteract these unfair practices, oftentimes, temporary trade barriers, otherwise known as TTBs, are employed. However, when it comes to the factors that influence the implementation of TTBs in the global forest products industry and how those barriers impact the domestic industry, there was, until recently, a lack of information.

DR. CHANGYOU "EDWIN" SUN, professor of forest economics, began parsing through the decades' worth of international trade and intervention data compiled by the World Bank Database to understand the trends and address the disparity in information.

"This study measures the extent, pattern, and degree of temporary trade barriers that are being implemented in the forest products industry around the globe. To my knowledge, no one has documented TTBs on forest products at this scale before," Sun said.

Once a mass of relative trade data was gathered, the researchers employed two statistical models to analyze the underlying patterns. The first model, known as a two-step sample selection model, assessed the correlation between TTBs in developed versus developing countries, while the second model, known as a probit model, honed in more specifically on factors including industry employment, forest coverage rate, inflation, and imports/exports surrounding paper and non-paper forest products.

Among developing countries, the use of TTBs declined as imports increased, forest coverage rate expanded, and the inflation rate improved. In developed countries, the same was mostly true, though developed countries proved more likely to increase TTBs to protect the domestic forest products industry as exports increased. Despite these commonalities, the analysis revealed many trends and complexities surrounding temporary trade barriers, making it difficult to cite a single, dominant factor as to why TTBs are enforced.

"What we can learn from this study is that global competition in the forest products industry is complicated and that countries and individual corporations will implement whatever solutions are available to them when they have a problem, even if it means temporarily banning trade with individuals. Even in Mississippi, landowners and

manufacturers need to understand the global competition. They're not untouched by it," Sun said.

Alongside Sun, the research team included **DR. XUFANG ZHANG**, a 2018 MSU Ph.D. graduate who conducted this study as part of her dissertation and now works at Texas A&M Forest Service as a forest economist. Zhang played a crucial role in both data collection and dissemination of the research and shared how the implications of this study highlight the potential misuse of TTBs.

"Countries with a large capacity in the forest products industry, such as high employment or a high GDP per capita for forest products, may be more inclined to utilize TTBs to protect their domestic forest product industry. Thus, domestic firms may be more concerned with proving unfair trade actions of forest exporters rather than improving their own efficiency, which would create economic tension not only globally but domestically as well," Zhang said.

With the potential tensions that could arise from the misuse of TTBs, research that strives to understand both the factors that encourage their adoption and the ramifications of their adoption is more important than ever.

"For those of us directly invested in our domestic forest products industry, this research provides insights about the patterns that influence the participation and demand for trade barriers. Having a deep understanding of these patterns is one of the best ways for our forest products firms to stay both prosperous and ethical, especially in this competitive global market," Zhang said. ■

This research was funded in part by the USDA Forest Service, Pacific Northwest Research Station, and Southern Research Station.

IN THE FIELD:
CURRENT APPLIED RESEARCH

Powering Renewable Energy in the Southeast

FWRC RESEARCHERS MEASURE ECONOMICS, ECOLOGICAL BENEFITS OF PRODUCING BIOFUELS

BY VANESSA BEESON

THE USE of renewable energy has increased threefold in the U.S. in the last 20 years, now accounting for 11 percent of total energy consumed nationally. Renewable energy, which plays a major role in reducing greenhouse gas emissions, relies largely on biomass. In fact, the U.S. Energy Information Administration said biomass powered 43 percent of the nation's renewable energy used in 2019. Scientists in MSU's Forest and Wildlife Research Center hope to find ways to optimize biomass production for landowners in the Southeast.

The team—led by **DR. HEIDI RENNINGER**—received a $2.5 million grant from the Department of Energy to study how to produce better, hardier hybrid poplars and eastern cottonwoods harvested for biomass energy. The researchers will use precision conservation tools to measure both economic and ecological benefits of growing trees to convert to renewable biofuel. The team will study poplar and cottonwood plantations across the Southeast leveraging existing sites and planting new ones in Mississippi, Louisiana, and Tennessee.

Renninger, an assistant professor in the Department of Forestry, explained why short rotation hybrid poplar and eastern cottonwood trees are ideal for this use.

"These trees can grow between 20-40 feet in two to three years, at which time they are then coppiced, or cut back. The cut trees—which have a lot of biomass—are harvested to be used to make liquid biofuels while the coppiced trees grow into a new crop."

She said the team hopes the research will lead to an economic model that landowners can use to determine if a bioenergy crop would be a right fit for their marginal land.

"We hope to find ways to make growing these trees for renewable energy more profitable for landowners, which in turn will help the emerging biofuel industry," Renninger said. "In order to do that, we need resilient trees that can grow on different landscapes under different circumstances."

DR. AUSTIN HIMES, assistant forestry professor on the project, noted that the Southeast is primed for a burgeoning biofuel production industry.

"I'm excited about how this research might help emerging ecosystem service markets currently being developed in the Southeast, an area that geographically makes sense for a strong biofuel industry because of its close proximity to the chemical conversion market serving the oil industry," he said.

He said that after quantifying the ecosystem services the trees provide, the team can build an economic model that will help landowners determine if participating in an ecosystem services exchange program is right for them.

"If landowners are able to monetize on some

of these services in the future, those benefits become part of a value-added process, which reduces the production cost of biomass, making it more competitive with fossil fuels," he said.

Himes said the team will explore how different hybrids affect outcomes.

"In this project, we'll study the effects of the diversity of tree species on productivity and environmental benefits and impact," he said.

To assess ecosystem services, the team will focus on water and soil quality as well as wildlife habitat. **DR. COURTNEY SIEGERT**, associate forestry professor, will measure nutrient and water intake of the trees, carbon sequestration, and greenhouse gas emissions while **DR. RAY IGLAY**, wildlife, fisheries and aquaculture assistant professor, will use indicator species such as carabid beetles to measure wildlife benefits across the sites. **DR. QIN MA**, assistant forestry professor, will use remote sensing to compile a detailed snapshot of data collected via LiDAR, which stands for light detection and ranging, and uses lasers to measure variable distances. Hyperspectral imaging, which analyzes a wide spectrum of light, will also be used.

Ma explained how the data will be collected and used to build the economic model.

"We'll cover the crown by collecting data with UAVs fitted with LiDAR and hyperspectral imaging capabilities, then we'll walk the forest with a backpack that is equipped with the same technology," Ma explained. "The data shows us how fast the trees are growing, how much water and nutrients they're using, how much carbon they're storing and much more. It gives us a complete picture."

Ma said the team will then use algorithms to match both data sets accurately so they can estimate the physical and spectral aspects of the trees from above and below.

"All of this will be used in an economic model to better estimate both the productivity of the trees while also quantifying the ecosystem services they provide," she added. ■

This research is funded by the U.S. Department of Energy. Collaborators include University of Tennessee and Louisiana Tech University. Greenwood Resources is providing access to the company's hybrid poplar cuttings.

Assistant Forestry Professor Heidi Renninger measures photosynthesis and transpiration rates of Populus leaves using a portable photosynthesis system. (Photo by David Ammon)

COLLABORATION:
INDUSTRY PARTNERSHIP

Ash's Fight for Life

PREPARING FOR EMERALD ASH BORER'S INVASION

BY TAYLOR VOLLIN

TREES ARE all around us, giving off oxygen, storing carbon, and giving life and shelter to wildlife. But what would a world without trees look like? Species like the American chestnut and elm have nearly disappeared due to the introduction of invasive pests and fungus. Ash species find themselves in a similar position with the emerald ash borer. That's why researchers are finding ways to aid in control of the insect and plan for long-term restoration efforts when an invasion does take place.

Native to Asia, the emerald ash borer eats into the bark of ash species, making channels and laying eggs in between the wood and the bark.

"In a sense, the insect strangles the tree, so it cannot move food and water as readily through its system," said **DR. JOSHUA GRANGER**, an assistant professor in the MSU Department of Forestry.

There is almost a 100 percent mortality rate within four to six years for ash populations once the insect invades.

While scientists do not know how to stop the pest from killing ash trees, they have learned that diversifying stands provides forest managers with control and restoration efforts. The researchers sought to understand what might replace the ash once it is gone.

Granger said he wanted to bring attention to the risk of losing some minor ash species, especially ones in Mississippi. The hypothesis of the research is that these minor ash trees have a niche specific habitat—an area or position that is exactly suitable for a small group of trees of the same type.

"I suspected that these niche specific habitats are highly susceptible to emerald ash borer, and with that, their community is at a greater risk of facing disturbance and being more severely impacted," Granger said.

The team used the Shannon-Wiener diversity index method which characterizes species diversity in a given community to analyze data from the Forest Inventory and Analysis program. In this case, samples were taken from 37 states supporting at least one of the six native ash species found in the eastern United States. The team found that plots with white, green, and blue ash had a higher tree species diversity than those with black, Carolina, or pumpkin ash.

Granger said the research demonstrates just how niche specific these species are.

"The research clearly shows that black, Carolina, or pumpkin ash don't have large ranges. They are very niche specific so there are not a lot of native alternatives for replacing them," Granger said.

Though emerald ash borer has not yet made its way to Mississippi, it can be found in Alabama, Tennessee, and Louisiana, meaning it is only a matter of time before it reaches the Magnolia State. Containing five of the six ash species, Granger said Mississippi will be at great risk when the time comes.

"Ash trees are common in urban settings as they are fast growers and provide a nice canopy," Granger said. "When the emerald ash borer does arrive in the state, it will impact our communities severely, including the MSU campus which has a large population of ash trees."

Treatments to prevent the insects from inhabiting the trees are possible, but they are expensive. Granger said the best method is

to prepare ahead of time and incorporate other species into forested stands.

"The big thing to do is to prepare ahead of time. Look at ways that you can incorporate other native or valued species into the system," Granger said. "You have to look to alternatives to plant so that we don't have 100 percent mortality for the species."

A partnership that began in Tennessee and diverged both north and south, Granger teamed with Dr. John Zobel, his former adviser while he was a doctoral student at the University of Tennessee. Zobel is now an assistant professor in the University of Minnesota's Department of Forest Resources. Zobel extracted usable data to determine where the ash was and what could replace it by taking data from the Forest Inventory and Analysis program to calculate the Shannon-Wiener diversity index and an index of species evenness. Zobel said he was eager to work on such a crucial situation.

"It's a very interesting ecological question because this insect is such a huge factor in the future of forestry in that it may remove all of ash in a long-term, if not permanently," Zobel said. "That is huge in forestry to lose a species like that."

He continued, "The question is, they fill an ecological niche on the landscape, what's going to happen if what they are facilitating on the landscape goes away? It's just really interesting to me to get involved in this large-scale, catastrophic type of question."

Despite the tragic issue at hand, Zobel said the partnership with Granger and MSU was ideal, considering the friendship they have built over the years.

"What I love about the collaboration with Josh and continuing on other projects as we speak is that he asks really pertinent questions that will be relevant to managers and scientists for years to come," Zobel said. "He has a knack for asking a good questiom, I mine the data for answers, and we develop solutions together. It's just a very symbiotic partnership." ■

This research was funded by the McIntire-Stennis Cooperative Forestry Program. Data was collected from the Forestry Inventory and Analysis Program.

Assistant Forestry Professor Joshua Granger discusses the fate of ash trees with students Clayton Hale (left) and Darcey Collins (right). (Photo by David Ammon)

PROFILE

GRADUATE STUDENT

CLAYTON HALE

NOLENSVILLE, TENNESSEE

Conserving Rare, Woody Plant Species

GRADUATE RESEARCH EXPLORES SITE SUITABILITY TO ENHANCE SURVIVAL OF RARE CEDARS

BY TAYLOR VOLLIN

CLAYTON HALE developed a passion for research as a lead undergraduate research assistant at the University of Tennessee. When Hale's UT mentor joined the forestry faculty at MSU, Hale found his home in the Magnolia State studying rare woody plant species.

His research is looking at the Atlantic white-cedar, mountain stewartia, and Miller's witch alder. These three species are rare and may soon be considered one of the triad descriptors used for disappearing species: species of conservation concern, threatened, or endangered. Species of conservation concern are those where there is a substantial concern about the species' capability to persist over a long term. Threatened species are those likely to become endangered within the foreseeable future. Endangered species are in danger of extinction throughout all or a significant portion of its range.

The Nolensville, Tennessee native is wrapping up research on Atlantic white-cedar to evaluate regeneration of the species 15-years after Hurricane Katrina. He said the work will help coastal land managers better understand how hurricanes can affect Atlantic white cedar stands.

"Atlantic white cedar thrives in wet, lowland sites, working well in coastal areas. I'm trying to get an idea of the regeneration, conservation, and management objectives for this tree to help land managers know what to do if their stand gets hit by a hurricane," he said.

The study took post-Hurricane Katrina data of Atlantic white cedar and compared it to recent data collected at the Grand Bay National Wildlife Refuge.

"I'm comparing the number of cedars, the diameter distribution of the cedars, and the number of young cedars," Hale said.

The study showed that Atlantic white cedar has increased in density across the study site, which Hale believes is because disturbances such as hurricanes change the forest ecosystem, possibly allowing more access to sunlight and freeing up space for the species to grow.

For the mountain stewartia, a small tree native in low to mid-elevations in the southern Appalachian Mountains and regions from Mississippi to Virginia, Hale is developing a habitat suitability map. Mountain stewartia is often overlooked

by land managers, resulting in insufficient habitat and distribution descriptions used in restoration and conservation. Modeling a species habitat suitability map may help locate previously undocumented populations.

"A habitat suitability map essentially layers different maps that have associated data," Hale said. "I have occurrence points from where we know there has been stewartia. Through that and a technique called maximum entropy, we can model where other suitable habitats would be for the species."

He found that approximately 33 percent of the highest suitability for mountain stewartia occurs within public lands.

Hale said he also hopes to develop methodology that would provide land managers with information on the best areas for these rare species.

"While I'm doing this for mountain stewartia, I am also working on methodology for any rare species where we can use data such as herbarium records to model current and potential locations for tree species," he explained.

Hale is also defining the species ecology and status for Miller's witch alder, while simultaneously developing a habitat suitability model. This small shrub species is found in southern Alabama and the Florida Panhandle.

He hopes his research resonates with both conservationists and those who may not be familiar with the species.

"Each of these species has intrinsic value," Hale said. "My research tackles smaller aspects that land managers might readily apply. We're applying ecological theory and modeling that can hopefully be used to conserve these species in the field." ■

This research was funded by the McIntire-Stennis Cooperative Forestry Program. Hale's research is under the direction of Dr. Joshua Granger.

Clayton Hale measures the diameter of a cedar tree. (Photo Submitted)

PROFILE

UNDERGRADUATE STUDENT

ADAM WADE

SCOOBA, MISSISSIPPI

The Effects of Prescribed Fire

UNDERGRADUATE STUDENT EXAMINES HOW PRESCRIBED FIRE CHANGES BARK CHARACTERISTICS AND TREE QUALITY

BY VANESSA BEESON

ADAM WADE used a difficult circumstance to redefine himself professionally. When the Scooba, Mississippi native was laid off from his position at an electric supply warehouse, he embraced the chance to study forestry—something that had always been at the back of his mind. In 2016, at age thirty-six, Wade started over as a freshman pursuing an associate degree in forestry from East Mississippi Community College. Four short years later, he's graduated with that associate degree plus a bachelor's degree in forestry from Mississippi State and is now pursuing his doctoral degree in the Department of Sustainable Bioproducts. He credits his undergrad research experience in MSU's Department of Forestry as an essential stepping stone to the work he's engaged in today.

Under the direction of **DR. COURTNEY SIEGERT**, associate professor in the Department of Forestry, Wade studied tree bark characteristics in upland tree species to determine if prescribed fire, a common silviculture technique to manage for desirable upland tree species, influenced those characteristics. Wade was most interested in how well the bark from different species under different prescribed fire cycles absorbed water and if exposure to fire changed the rate of absorption.

"Bark absorbs water similar to a sponge and each species has a maximum storage capacity of water that can be held in the bark," Wade said. "In fact, some mature trees can store more than 26 gallons of water in their bark, which is about as much water as you would use in a 10-minute shower."

Wade said there is a known connection between fire tolerance and the bark's physical properties such as thickness, density, and porosity.

"These physical properties simultaneously influence rainfall interception and canopy storage, so they are of interest across a range of disciplines, including how they interact with the silviculture practice of prescribed burns," Wade said. "While these characteristics are innate to a species, it is unknown whether repeated exposure to fire facilitates physical change in bark structure and whether these changes are consistent among species, so that's the question we sought to answer."

Wade collected samples from mature pine, oak, hickory, and sweetgum trees from sites across the Bankhead National Forest in Double Springs, Alabama and at a smaller test site in Starkville, Mississippi. He studied samples from three-year and nine-year prescribed fire cycles as well as samples collected on sites that hadn't experienced any prescribed burns. He analyzed the samples for bulk density, porosity, water storage capacity, and hygroscopicity, which is the amount of water vapor the bark absorbs from the air when it isn't raining.

"The preliminary findings suggest that bark structure does indeed change with repeated exposure to fire leading to increases in water storage capacity and slower evaporation," Wade said. "Bark that does a better job of storing water translates to a healthier tree, which supports the big picture idea that prescribed fire is an effective way to improve the quality of trees."

Wade, who chose a forest products concentration as part of his bachelor's, credits a wood anatomy class as igniting his passion for graduate school and said his work as a forestry undergrad researcher was pivotal in preparing him for that next step.

"I knew research would be a big part of grad school. When Dr. Siegert approached me about the possibility of research, I jumped at it because I knew it would be a good foot in the door and a

Adam Wade examines wood from the Kribbs collection. Wade is working on machine vision technologies to recognize wood species. (Photo by Dominique Belcher)

good experience to prepare me for that next level of research," he said.

The work obviously paid off, culminating in a forthcoming publication in *Frontiers for Young Minds*. The team also has a published paper in *Trees—Structure and Function* and presented at the American Geophysical Union held virtually in December 2020. In addition to Siegert, visiting professor, Dr. Anna Ilek, of the Department of Forest Sites and Ecology at Poznán University of Life Science in Poland, contributed to the work.

After graduating with a bachelor's degree in forestry in 2020, Wade immediately began an accelerated doctoral program in the Department of Sustainable Bioproducts in June. In this program, Wade is working under the direction of **DR. FRANK OWENS**, assistant professor in the department, and collaborating with Dr. Prabu Ravindran from the Department of Botany, University of Wisconsin, and Dr. Alex C. Wiedenhoeft from the Center for Wood Anatomy Research, USDA Forest Service, Forest Products Laboratory, both located in Madison, Wisconsin. Wade's graduate project is focused on helping to make the Xylotron device, which uses computer vision and artificial intelligence, a better tool to accurately identify wood specimens in the field to help deter illegal logging and combat illegal import and export of wood species regulated by the Convention on International Trade in Endangered Species, or CITES. ■

Wade's undergraduate research in the Department of Forestry was funded by the Forest and Wildlife Research Center; the National Science Center in Poland; and the McIntire-Stennis Cooperative Forestry Program.

SUSTAINABLE BIOPRODUCTS

The Department of Sustainable Bioproducts conducts research to advance natural resource-based manufacturing practices. The department conducts research in these strategic areas:

- Artificial Intelligence and Forensic Wood Identification
- Biofuels, Chemicals, and Energy
- Bioproducts and the Environment
- Bioproducts Deterioration and Preservation
- Bioproducts Testing and Evaluation
- Building Materials and Composites

FACULTY

RUBIN SHMULSKY
Head and Warren S. Thompson Professor of Wood Science and Technology

H. MICHAEL BARNES
Warren S. Thompson Professor of Wood Science and Technology

FREDERICO FRANÇA
Assistant Research Professor

TAMARA FRANÇA
Assistant Professor

EL BARBARY HASSAN
Associate Professor

YUN SANG KIM
Assistant Professor

HYUNGSUK THOMAS LIM
Assistant Professor

DERCILLO "JOE" LOPES
Assistant Research Professor

DARREL D. NICHOLAS
Professor

FRANK OWENS
Assistant Professor

R. DAN SEALE
Warren S. Thompson Professor of Wood Science and Technology; James R. Moreton Fellow in Sustainable Bioproducts

C. ELIZABETH "BETH" STOKES
Assistant Professor

JASON STREET
Assistant Professor

JILEI ZHANG
Warren S. Thompson Professor of Wood Science and Technology

XUEFENG "JASON" ZHANG
Assistant Research Professor

EMERITUS

TERRY L. AMBURGEY
HAMID BORAZJANI
SUSAN V. DIEHL
LEONARD L. INGRAM JR.
MOON KIM
DUANE LYON
PHILIP H. STEELE
FRED TAYLOR

ADJUNCT

ZHIYONG CAI
PATRICK DONAHUE
MICHAEL DOWD
NATHAN IRBY
GRANT KIRKER
IRIS MONTAGUE
ROBERT ROSS
ADAM SENALIK
JULIET TANG
XIPING WANG
ALEX WIEDENHOEFT

GLOBAL/
NATIONAL
IMPACT

Knots Untangled

DISCOVERING HOW KNOTS AFFECT LUMBER'S STIFFNESS AND STRENGTH

BY VANESSA BEESON

PICKING A TWO-BY-FOUR from a lumber stack at your local home improvement store only takes a minute. How that piece arrived there, however, is part of a much larger story. Lumber is one of Mississippi's most important commodities and part of a $13.12 billion-dollar industry that employs over 61,000 people in Mississippi alone. Researchers in MSU's Forest and Wildlife Research Center hope to untangle how knots—remnants of where branches grew while the tree was alive—affect the stiffness and strength of this important commodity.

DR. RUBIN SHMULSKY, professor and head of the Department of Sustainable Bioproducts, said commercial stakeholders asked MSU to study knots, which can be a strength-reducing characteristic in lumber that causes it to be downgraded.

"The larger the knot, the greater the amount of strength reduction. While visual grading factors that into account, sometimes multiple knots appear in close proximity on a single piece of lumber. In those cases, none may be big enough to trigger a grade degradation, but collectively they may reduce board stiffness or strength," Shmulsky said.

The team set out to investigate the role multiple knots in close proximity play on affecting lumber stiffness and strength in an effort to increase the value of southern pine.

"We are trying to determine, to the closest degree possible, how stiff and strong every stick of lumber is, before it actually gets broken. The better and more reliably we can predict these strength and stiffness values, the more each piece of lumber—and in turn each acre of timberland—is ultimately worth," Shmulsky said.

In a series of studies spanning several years, Shmulsky along with **DR. DAN SEALE**, professor, and **DR. JASON STREET**, assistant professor, led a team of graduate students as they analyzed southern pine boards produced at a local Mississippi sawmill to determine if small clusters of knots impacted lumber stiffness and strength.

Street helped students select statistical models for the studies and taught them lumber testing standards and how to use the software to analyze data. He also reviewed the data and helped them understand the significance of the findings.

"A larger knot or multiple knots that are close together can cause lumber to rupture with less load when compared to lumber that has no knots," Street explained.

In a previous study, Marcela Barbosa, a master's student who graduated in December 2018, analyzed nearly 300 samples of southern yellow pine to determine the modulus of rupture, which measures strength, and modulus of elasticity, which measures stiffness, in lumber with multiple knots in close proximity. Barbosa found that the presence of multiple knots significantly affects the strength properties and established parameters to better predict both modulus of rupture and modulus of elasticity.

Now Street is directing Yali Li, a current doctoral student, who continues work studying multiple knots in close proximity in southern yellow pine.

"In this study, we're using a finite element analysis to draw a 3-D model of southern yellow pine lumber and measure its strength rating.

Graduate student Yali Li and Assistant Sustainable Bioproducts Professor Dr. Jason Street examine the strength of lumber. (Photo by David Ammon)

After that, we'll add knots to the model and look at how they affect strength," Street explained.

Street said the team is aiming for accuracy with attention to fine grain detail.

"We want to be as accurate as we can be to predict the strength rating, so we hope to use the entire knot volume. Right now mechanical testing just measures the surface area of a knot. We eventually want to recreate the knot's volume as it occurs throughout the entire piece of lumber," he said.

Street said the research's ultimate goal is to find a more accurate way of measuring the mechanical properties of lumber so that a more particular strength rating can be associated with each piece produced. He noted that the work might help researchers develop non-destructive evaluation technologies and provide a means to begin to assess the potential detrimental impacts on strength and stiffness that are caused by multiple knots in close proximity.

"Some pieces of lumber may be given a lower grade than what they actually are because of a certain feature. If lumber can be graded more accurately, in respect to depicting the actual strength of the lumber, a sawmill could receive more money for the lumber cut from stronger logs. In turn, the value of timberland can potentially increase," he said.

"Also, by knowing how these factors interrelate, one can envision that forest management practices could be amended slightly to avoid producing trees with multiple branches in close proximity—to the extent possible or practical," he added. ■

This research was funded by the Forest and Wildlife Research Center and the USDA Forest Service Forest Products Laboratory in Madison, Wisconsin.

IN THE FIELD:
CURRENT APPLIED REASEARCH

Life of a Wooden Crosstie

EXAMINING THE SIGNIFICANCE AND PRESERVATION OF WOODEN CROSSTIES

BY TAYLOR VOLLIN

THE LIFE OF a railroad crosstie sees nearly 20 years of service. Through harsh conditions such as rain, heat, and snow, the backbone of the rails is built to last. But just how long should they carry the load?

Researchers from the Forest and Wildlife Research Center and the Railway Tie Association have set out to determine how durable railroad ties are by exposing them to different conditions and preservatives.

DR. BETH STOKES, an assistant professor in the Department of Sustainable Bioproducts, said her team aims to determine the reliability of the wooden crossties being produced through research.

"Our research will determine if we can produce a reliable, structurally sound product that is going to last more than the average lifespan once we put it into use in a track. How can we tailor that product to the needs of different environments? So, the overall idea is that we expose the ties, treated with various preservatives, to conditions they would experience while in use," Stokes said.

The studies—one in its eighth year and the other in its twelfth—are carried out at the John W. Starr Memorial Forest's Dorman Field Site outside of Starkville and at the Formosan Termite Testing Facility at the Mississippi Agricultural and Forestry Experiment Station's McNeill Research Unit in coastal Mississippi. The team looks at full-sized railway ties made of different wood species, such as red oak and sweetgum, which have been treated with different protective systems. The ties are brought to the field site and placed on a prepared surface where they are subjected to any weather conditions that occur during the length of the test. The ties will go through rain, wind damage, high humidity, and possibly snow or ice.

These studies will go on for up to 20 years, each tie being checked twice a year. When checked, the team looks at the amount of

damage that has occurred, whether termites have moved in, if there is any decay occurring, the color of the ties, whether the metal plates have loosened, and if they remain structurally intact.

Stokes, one of the principal investigators on the projects, said the team wants to understand how long-lasting the resources are, and how they can be best used.

"One of the things we're assessing is how to make crossties as sustainable as possible," Stokes said. "We want to use our wood resources most appropriately across North America, and that's the direction we're moving in: proving the durability of wooden ties over other materials such as concrete or steel."

Once a crosstie has been removed from the tracks, there are still a number of ways they are used. From retaining walls to landscape timbers, crossties retired from the track still have usefulness, and perhaps one of its most important services is its ability to sequester carbon.

Ashley Goodin, the executive director of the Railway Tie Association, said the data from this research conveys the value of wooden crossties to not only the industry but also in terms of forest management.

"This data helps us communicate the value of a wooden crosstie and its longevity to the railroads for its use," Goodin said. "Wooden ties are great tools for carbon sequestration, so you are talking about responsible forest management practices allowing you to harvest timber and use that timber for a service life of 20-25 years in track before it is turned into another valuable product."

Goodin said the research reinforces the significance of wooden crossties, as well as Mississippi State's partnership in the work.

"The third-party research from MSU continues to reinforce that wooden crossties are the best choice for the railroads," Goodin said. "This also adds value to the research program between Mississippi State and the US Forest Products Service Laboratory, and it reinforces MSU's validity, as well as their due diligence and care in these long-term studies that are vital to our industry." ■

This research is funded by the Railway Tie Association and member companies of the Southern Pressure Treaters' Association.

Assistant professor Dr. Beth Stokes and rehired retiree Michael Sanders discuss the cross tie study with Ashley Goodin, executive director of the Railway Tie Association. (Photo by Karen Brasher)

COLLABORATION:
INDUSTRY PARTNERSHIP

Opening an Envelope

INVESTIGATING THE DURABILITY OF CROSS-LAMINATED TIMBER WALL ENVELOPES

BY REAGAN POSTON

WHILE MISSISSIPPI STATE continues to lead the pack in sustainable bioproducts research, there sometimes exists a disconnect between green, sustainable construction and the building codes that regulate it. Despite building codes requiring preservative treatments for wood with ground contact, little to no research has been done to test the long-term durability of treated or untreated cross-laminated timber walls.

DR. HYUNGSUK "THOMAS" LIM, an assistant professor in the Department of Sustainable Bioproducts and researcher in the Forest and Wildlife Research Center, has been working to fill that research gap with a study on the durability of cross-laminated timber wall envelopes.

Cross-laminated timber, otherwise known as CLT, is a sustainable building material formed by layering lumber in an alternating pattern of parallel and perpendicular directions. Because it is wood, it can be a more affordable alternative to masonry, concrete, or steel in the construction of larger buildings. In addition to being a more cost-effective alternative, the use of CLT reduces the carbon footprint of construction while simultaneously contributing to the forestry industry.

"The project is about developing building technology and figuring out the best ways to install these renewable products so that the structure has maximized durability," Lim said. "CLT is being used in residential, industrial, educational, and civic buildings, as well as many other types of structures. Maximizing the durability of CLT could help expand its applications in the building and construction industry of the Southeast."

Though the study is still in its early stages, Lim and his research team are busy finalizing the treatment designs to be tested. After that, the CLT wall envelope replicates and treatments will be studied for termite, water, and fungal damage. The team will assess visual damage at various points along the building envelope including at ground contact, on panels, around wall fasteners, and on each layer of timber. The tests will run for a duration of one, two, and three years, after which, Lim hopes to use the findings to help stakeholders estimate the structural performance of full-scale CLT buildings.

"Typically, when CLT is used, it is used for the upper floors of mid- and high-rise buildings due to concerns about moisture durability. Of course, here in the Southeast, there is little demand for very tall buildings, so understanding and improving CLT's durability so that it's suitable for ground-floor construction could lend confidence to engineers, architects, and builders interested in sustainability," Lim said.

FWRC researchers have partnered with scientists at the USDA Forest Products Laboratory in hopes of gathering the best minds for CLT research. One such scientist is **DR. JULIET TANG**, a 2011 MSU graduate of the Department of Sustainable Bioproducts and current research forest products technologist at the USDA Forest Products Laboratory. Tang is serving as the program manager and has been working closely with Lim from project conception.

"One thing we're especially interested in is testing physical barriers for termites. There have been plenty of studies documenting the long-term effectiveness of chemical soil drenches, but our study will focus on the extent to which stainless steel mesh barriers deter termites or if impermeable membrane barriers are capable of blocking termites from sensing the wood. Moisture damage will also be assessed with both of these methods," Tang said.

She also shared how much of an impact this research could have on the sustainability of building and construction in the Southeast.

"There's already so much that is advantageous about CLT. Its greatest quality is its ability to store massive amounts of carbon, preventing its release back into the atmosphere. Due to its thickness and solid bulk, CLT is more fire resistant than frame building construction. The charred surface burns slowly and predictably, so you don't see fire spreading uncontrollably to other building compartments," Tang said. "One issue, however, is that, here in the Southeast, we have a lot of pressure from termites and decay fungi. These biological risk factors mean that CLT might need some additional protection. Dr. Lim and I are hopeful that the work we're currently doing can move CLT one step closer to becoming a durable, eco-friendly option for construction right here at home." ■

This research is funded by the USDA Forest Products Laboratory, with materials provided by Shuqualak Lumber and Henkel Corporation.

Assistant professor Dr. Thomas Lim examines the alignment of the hydraulic cylinders of a cold press used for making cross laminated timber. (Photo by David Ammon)

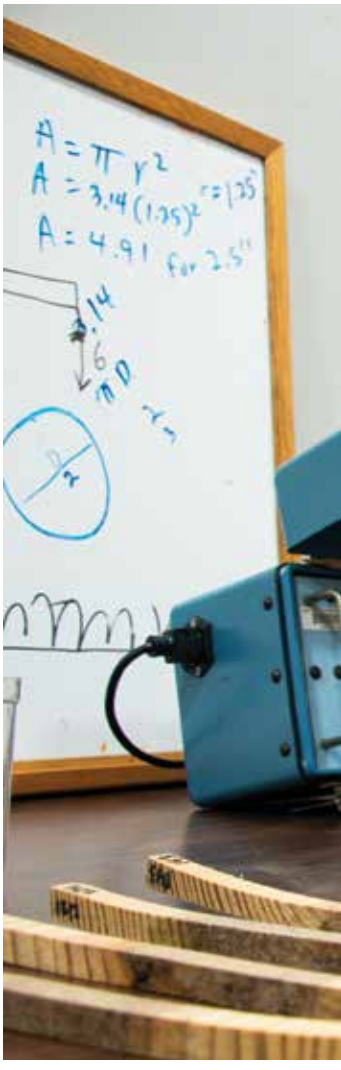
PROFILE

GRADUATE STUDENT
BRIANNA DUQUETTE
BELLE CHASSE, LOUISIANA

Decaying Away Strength

GRADUATE STUDENT STUDIES HOW BROWN ROT COMPROMISES WOOD IN TENSION PERPENDICULAR TO THE GRAIN

BY VANESSA BEESON



A SWING OF the bat led to a swing of the pendulum. **BRIANNA DUQUETTE**, master's student in the Department of Sustainable Bioproducts, earned an athletic scholarship to play softball first for Meridian Community College where she earned an associate degree, then for the Mississippi University for Women, where she earned a bachelor's in public health education. Now, she's put down her bat and hung up her cleats to swing a pendulum that generates a wave to determine the amount of decay in a wood sample.

Duquette is evaluating how brown rot, a common fungus that decays wood, affects the stress that happens when tension is applied perpendicular to the wood's grain.

"Wood is used extensively for interior and exterior applications in all types of buildings and structures," Duquette explained. "While wood structures are designed to minimize this type of tension, sometimes, despite the best design attempts, stress at connections in timber structures result in stressing the wood in tension perpendicular to the grain."

Duquette said that wood stressed in this manner is considerably weaker than wood where the tension runs parallel to the grain. She adds that the presence of brown rot can exacerbate the tension, resulting in a structural failure.

"Most of the reported research is focused on establishing baseline information for the properties of wood parallel to the grain. While this is important, from a structural inspection standpoint perpendicular to the grain property information can be of greater importance. We hope to investigate the effect decay caused by brown rot has on mechanical properties of wood in this instance," Duquette said.

She also noted that this information will be important as cross-laminated timber, or CLT, increases in use as a building material in the U.S., creating more scenarios where wood may be stressed in this manner.

"A lot of times, this type of tension occurs where wood is connected at a joint, which happens often in CLT," she said.

The team is testing wood samples cut perpendicular to the grain with brown rot and using nondestructive testing to formulate a baseline of strength for each sample. From there, they assess the samples at different time intervals with additional nondestructive testing to see exactly when the brown rot begins to compromise the strength of the wood.

"We want to see how quickly the wood strength is reduced, especially during the early stages of decay. We also want to evaluate the accuracy of using nondestructive testing to assess

Brianna Duquette tests the tension of wood infected with brown rot to determne strength (Photo by Dominique Belcher)

this type of wood decay," Duquette explained.

She said preliminary results indicate that brown rot can affect the strength of wood before the fungus is even visible.

"Early data shows that while we're not yet able to see the decay in some samples, there is still a change in strength and weight, which indicates the damage has already begun," she noted.

Once the team wraps up with nondestructive testing, they'll follow up with destructive testing to get a precise measurement of the actual strength of each sample.

Duquette said the research should help the industry better determine how brown rot affects wood in tension perpendicular to the grain.

"Our goal is to increase knowledge of when to replace wood and offer a nondestructive option to test that wood. This contributes to the durability and protection of wood structures, helping extend the life of the material. The use of nondestructive testing provides an accurate way to detect brown rot decay in wood, allowing the building industry to test their products while in use and replace them when decay is present," Duquette said.

Duquette's research is led by **DR. TAMARA FRANÇA,** assistant professor in the department. **DR. BETH STOKES**, assistant professor in the department, and Dr. Adam Senalik, with USDA Forest Products Laboratory, serve on Duquette's committee. **DR. FREDERICO FRANÇA**, assistant research professor in the department, and Dr. Robert Ross, with the USDA Forest Products Lab, along with Johnny Black, plant superintendent, and Amy Rowlen, research associate III, in the Forest and Wildlife Research Center, have also contributed to the work. ■

The research is funded by the Forest and Wildlife Research Center and the USDA Forest Service Forest Products Laboratory in Madison, Wisconsin.

PROFILE

GRADUATE STUDENT

ALAN SHERRINGTON

VANCOUVER, WASHINGTON

Built to Last

GRADUATE STUDENT TESTS THE STRENGTH OF HARDWOOD COMPOSITES FOR MILITARY USE

BY VANESSA BEESON

ALAN SHERRINGTON grew up on the north bank of the Columbia River in Vancouver, Washington, just outside of Portland, Oregon. He was raised in a forest products family but didn't necessarily see himself in the industry when he left the Pacific Northwest to attend Spring Hill College in Mobile, Alabama.

"My dad has worked in the forest products industry for the last 30 years, many of which have been at Weyerhaeuser, so I grew up familiar with the industry. When it was time for college though, I didn't really think about it as a potential career choice," Sherrington said.

That changed the summer after his freshman year at Spring Hill, when he took a summer internship with Weyerhaeuser in Longview, Washington.

"While looking for a summer job, I was lucky enough to get an internship working as a craftsman and machine operator. After that first summer, I found that I loved the manufacturing side and knew this was an industry that I could enjoy," he said.

During the next two summers, he worked as an intern at the Weyerhaeuser mill in Bruce, Mississippi and while he was a considering grad school and thought about getting an MBA, an MSU alumnus at the mill recommended that Sherrington check out the sustainable bioproducts master's degree offered in the College of Forest Resources. Sherrington met with the team and decided it was a fit. He graduated from Spring Hill with a bachelor's degree in sociology in May 2020 and immediately moved into his master's program in the Department of Sustainable Bioproducts at Mississippi State.

During the summer of 2020, he shadowed researchers in the department to better understand the ins and outs of the testing equipment and processes, assisting doctoral student Marly Carmona Uzcategul evaluating number two grade southern yellow pine structural lumber.

Now, Sherrington is delving into his own research, focused on hardwood composites for military use in a project co-funded by the U.S.D.A. Forest Service and the U.S. Endowment for Forestry and Communities. He's investigating the strength and

Alan Sherrington conducts strength tests on hardwood composites in a sustainable bioproducts department lab at Mississippi State University. (Photo by David Ammon)

durability of American hardwoods and composites to improve truck and trailer decking for the U.S. military.

"Trailer and truck decking gets a lot of wear and tear," Sherrington said. "I will be evaluating the strength and stiffness of different species of hardwoods and composites to see the weight these composites can withstand and their overall strength and durability," Sherrington explained. "We want to find an American hardwood or hardwood composite that withstands the weathering, weight, and friction that comes with moving heavy loads."

Thus far, he's processed 60 samples and plans to test approximately 600 in total.

"Our overall goal is to help enhance the shipping process in and out of military bases through the improvement of truck and trailer decking."

Sherrington says thus far he's enjoyed the work and recommends others explore a future in the sustainable bioproducts industry.

"You can't go ten feet without being around something you study; trees are everywhere. I think it's cool that we are able study them and use them in applications that improve our society in a sustainable way," he said. ■

Sherrington is under the direction of Dr. Rubin Shmulsky, professor and head, and Dr. Dan Seale, professor and James R. Moreton Fellow in Sustainable Bioproducts. Dr. Laya Khademibami, postdoctoral associate, and Franklin Quin, doctoral student, are collaborating on the work as well.

WILDLIFE, FISHERIES & AQUACULTURE

The Department of Wildlife, Fisheries and Aquaculture conducts research to manage wildlife populations and habitat. The department conducts research in these strategic areas:

- Agricultural Wildlife Management
- Backyard Wildlife and Urban Ecology
- Carnivore and Population Ecology
- Conservation Biology
- Conservation Education
- Deer Ecology and Big-Game Management
- Fisheries Science and Management
- Forest and Wildlife Management
- Freshwater River and Streams Management
- Habitat Restoration and Monitoring
- Human-Wildlife Interactions
- Human Dimensions of Fisheries and Wildlife Management
- Invasive Species Ecology
- Native Grasslands and Upland Bird Conservation
- Recreational Fisheries
- Small-Game Management
- Threatened and Endangered Species Recovery
- Veterinary Wildlife Sciences
- Water Quality in Agriculture and Forested Landscapes
- Waterfowl and Wetlands Conservation and Management
- Wildlife Damage Management
- Wildlife and Fisheries Economic Enterprises

FACULTY

ANDREW KOUBA

Head and Dale H. Arner Professor of Wildlife Ecology and Management

SUJA AARATTUTHODIYIL
Assistant Research Professor

PETER ALLEN
Associate Professor

JIMMY AVERY
Extension Professor
Director, Southern Regional Aquaculture Center

CHRISTOPHER AYERS
Instructor

BETH BAKER
Assistant Extension Professor

LOREN W. (WES) BURGER
Dale H. Arner Professor of Wildlife Ecology and Management
Associate Director, FWRC/MAFES
Interim Dean/Director, CFR/FWRC

LESLIE BURGER
Assistant Extension Professor

MICHAEL COLVIN
Assistant Professor

SANDRA B. CORREA
Assistant Professor

CHAD DACUS
Extension Instructor

J. BRIAN DAVIS
James C. Kennedy Endowed Associate Professor in Waterfowl and Wetlands Conservation

STEVE DEMARAIS
Taylor Chair in Applied Big Game Research and Instruction
Dale H. Arner Professor of Wildlife Ecology and Management

MARCUS DRYMON
Assistant Extension Professor

SCOTT EDWARDS
Extension Instructor

KRISTINE O. EVANS
Assistant Professor

TERRENCE GREENWAY
Assistant Professor

ERIC HILEMAN
Assistant Research Professor

STACY HINES
Instructor

KEVIN M. HUNT
Sharp Professor of Human Dimensions

RAY IGLAY
Assistant Research Professor

W. DARYL JONES
Professor

GANESH KARUNAKARAN
Assistant Research Professor

MARK MCCONNELL
Assistant Professor, Bryan Endowed Program for Upland Birds and Prairie Conservation

LEANDRO E. (STEVE) MIRANDA
Professor
Assistant Leader, MS Cooperative Fish and Wildlife Research Unit

CHARLES MISCHKE
Research Professor

DANA MORIN
Assistant Professor

WES NEAL
Extension Professor

SCOTT RUSH
Associate Professor

ANDREW SMITH
Extension Instructor

ERIC SPARKS
Assistant Extension Professor

GARRETT M. STREET
Assistant Professor

BRONSON STRICKLAND
St. John Family Endowed Professor of Wildlife Management

T. ADAM TULLOS
Extension Instructor

FRANCISCO VILELLA
Professor

GUIMING WANG
Professor

DAVID WISE
Research Professor
Director, National Warmwater Aquaculture Center

MARK WOODREY
Assistant Research Professor

EMERITUS

DAVID BURRAGE
LOUIS D'ABRAMO
ERIC D. DIBBLE
DONALD C. JACKSON
HARRY JACOBSON
JEANNE C. JONES
RICK KAMINSKI
BRUCE LEOPOLD
MENGHI LI
JIM MILLER
H. RANDALL ROBINETTE
HAROLD SCHRAMM
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CRAIG TUCKER

ADJUNCT

MICHAEL CONNER
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TRAVIS DEVAULT
BRIAN DORR
KRIS GODWIN
DARREN MILLER
LILY SWEIKERT

GLOBAL/ NATIONAL **IMPACT**

Forest Health Across the Globe

FWRC SCIENTISTS WORK TO RESTORE AND PROTECT FOREST SYSTEMS AND REINTRODUCE WILDLIFE

BY VANESSA BEESON

THIRTY PERCENT of the earth's landmass is covered in forests, which plays an integral role in our survival. From the air we breathe to the soil we depend on to grow food crops to the water we drink, forests provide ecosystem services essential to human health. Additionally, forests are home to a rich biodiversity of fauna and flora. According to the World Wildlife Federation, eighty percent of the world's terrestrial plant and animal species make their home in the forest and a square kilometer of forest may be home to more than 1,000 species. That's why scientists in the Forest and Wildlife Research Center have partnered with the U.S. Forest Service International Programs over the past several years to help improve vital forests globally.

FWRC scientists have embarked on a three-year grant to study forest health and ecosystem services across the globe in the U.S., China, Cambodia, and Argentina, among other locations.

DR. ANDY KOUBA, professor and head of the Department of Wildlife, Fisheries and Aquaculture, is the grant's principal investigator.

"These projects, while different, have a common theme of studying coupled forest-human ecosystems and addressing the fact that, as human populations grow, we're moving ever closer into wildlife habitat, so we need to find a way to live with nature while keeping as much of it intact as possible," Kouba said.

Kouba is involved in two of the grant's projects, both in China. The first project, focused on giant pandas, spans 15 years, and includes **DR. CARRIE VANCE**, assistant research professor in biochemistry, molecular biology, entomology and plant pathology and scientist in the Mississippi Agricultural and Forestry Experiment Station, or MAFES, and **DR. GUIMING WANG**, wildlife, fisheries and aquaculture professor and FWRC scientist.

"China has one of the world's most active forest restoration programs and we're able to directly correlate the impact of these efforts on biodiversity including the giant panda, where we're interested in quantifying animal habitat use and demographics," Kouba said.

He said that while it's challenging to collect information about pandas, who spend much of their time hidden in thick bamboo understory or high elevations, the team is developing a noninvasive method to screen panda feces to collect physiological data.

"This technology will help us collect information in the field about the animal, like individual identity, whether it's male or female, and potential health information, which can be collected quickly and accurately," Kouba said. This technology replaces the need to bring feces back to the lab to conduct expensive molecular genetics work.

The other project, which began in 2009, reintroduces Chinese giant salamanders back into the wild.

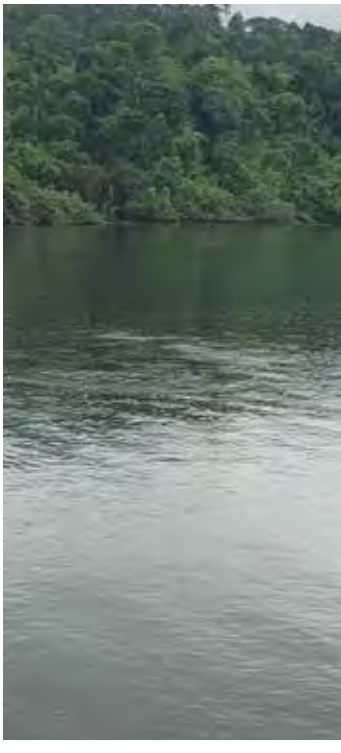
Kouba said the salamander—the world's largest—can grow up to four feet long, weigh more than 60 pounds, and is considered a delicacy in China's food market. Poaching and loss of habitat led the species to be listed as critically endangered.

"In its native habitat, the giant salamander was the top aquatic predator, so removal caused a massive redistribution of the trophic food chain," Kouba said.

Now, the salamanders are raised on farms.

"Farmers are producing approximately 250,000 salamanders a year, which has created an opportunity for us to work with the Chinese government and provincial agencies to start reintroducing some of these animals back into their native habitat," he said.

Kouba said while current challenges including the pandemic and U.S./China relations have paused efforts on both projects, he hopes the work will



resume soon. He said he's been most excited about seeing how well the animals survive once released.

"It's exciting to be able to release animals that have been historically gone from an area for a long time and see them thriving and doing well back in that landscape while watching the aquatic communities change because of that reintroduction, " he said.

Another FWRC researcher on the grant is helping establish a sustainable fishery in Cambodia. **DR. WES NEAL**, extension and research professor in wildlife, fisheries and aquaculture, alongside **DR. PETER ALLEN**, associate professor in the same department, were asked to consult on a project in partnership with the U.S. Forest Service International Programs, the Wildlife Conservation Society, and the Cambodian government to help start a community fishery with villages along the Sre Ambel River in Cambodia.

"A community fishery gives the fishing villages a primary role in the management process and is effective when the government doesn't have the resources to manage a remote fishery," Neal said.

Neal and Allen visited villagers in 2018 and provided recommendations including the implementation of small-scale aquaculture in the villages to remove pressure from the overfished river, which the funding agencies adopted.

Allen spent a semester in 2019 in Chile as a Fulbright, so Neal, whose primary expertise is in natural fisheries, recruited a colleague, Dr. Mike McGee, to participate in the consultation.

"Mike runs a private fish farm in Puerto Rico and is an expert on the Pangasius catfish that we were recommending they use for aquaculture," he said.

The pair made the first of two planned trips in July 2019 to meet again with villagers, tour existing pond resources, and assess the project's feasibility. Aquaculture began in early 2020 with harvest set for completion by the end of 2020.

"To date, everything is going well. Unfortunately, the pandemic has prevented our second trip to assess progress, so the project is currently being conducted virtually," Neal said.

Drs. Neal, **SANDRA CORREA** and Peter Allen received funding from the U.S. Agency for International Development, or USAID, and its Feed the Future Innovation Lab for Fish, housed at Mississippi State, to measure the project's efficacy and continue other efforts along the Sre Ambel River, connecting remotely with in-country partners, until travel to the country can resume.

Neal said the big picture goal is to find ways for the local population to live sustainably while protecting the environment and ecosystem services of the forest and river.

"The villages rely on the river. The aquatic system in turn relies heavily on the flood plain of the forest. The river floods and inundates the forest and fish use that area to spawn so it's all interconnected," Neal explained. "We want to make sure the communities that rely so heavily on these systems can persists in their lifestyles as long as possible. If they are overfishing the river, the river will stop supporting them. Our ultimate goal is to make their food security more stable and this lifestyle more sustainable in an eco-friendly way."

The grant also supports research led by **DR. JOHN RIGGINS**, associate professor in biochemistry, molecular biology, entomology and plant pathology and MAFES scientist, who is studying the European wood wasp, an invasive species affecting pine forests in the Southern Hemisphere. His work centers on monitoring outbreaks in Argentina. ■

Community fishery along the Sre Ambel River in Cambodia. (Photo Submitted)

This research is funded by the U.S. Forest Service International Programs, the Wildlife Conservation Society, and the USAID Feed the Future Innovation Lab for Fish.

IN THE FIELD:
CURRENT APPLIED REASEARCH

Covering the Basics

UNDERSTANDING THE IDEAL HABITAT FOR WILD GAME

BY TAYLOR VOLLIN

THERE IS A common misconception in the hunting world that plentiful food supply equals frequent visits by white-tailed deer or wild turkey to a specific habitat. Hunters plant food plots, place spin feeders, yet don't see the wildlife activity for which they had planned. What is missing from the equation is an equally important factor…cover.

Much like an animal needs food and water, they also need adequate shelter. That is why researchers in the MSU Forest and Wildlife Research Center set out to study how vegetation characteristics including food availability and cover affect intensity of habitat use by animals.

DR. BRONSON STRICKLAND, the St. John Family Professor of Wildlife Management in the Department of Wildlife, Fisheries and Aquaculture and researcher in the Forest and Wildlife Research Center, said the team sought to understand the relationship between food and cover and how to teach people using this new information.

"Our big picture question was not only what is the relationship, but how can we use that to teach people?" Strickland said. "For me, the most important thing is that landowners have options."

The study took place at the Andrews Forestry and Wildlife Laboratory, a 500-acre property that is part of the MSU Bulldog Forest and provided a unique opportunity to examine this research question because the property provides a variety of forest management scenarios that yield various levels of wildlife food and cover habitats. Prior to the experiment, the forest was thinned at differing levels with combinations of herbicide and prescribed fire treatments that provided a range of habitat composition.

As a result, there were sites exclusively offering cover, some exclusively offering food, some providing both, and some providing neither. Eighty camera stations were placed, one camera for every five to six acres, that ran continuously over a year. The cameras recorded when an animal entered the area and the vegetation characteristics in proximity.

The team was initially surprised to find that portions of the property offering both food and cover saw the most animal abundance.

"Most people think it's all about food and that you have to have food since it's a basic requirement for life," Strickland said. "So, I went into this study with the assumption that we were going to see more animals

in the areas that were exclusively food."

In hindsight, however, Strickland noted that the outcomes are understandable as land providing refuge and ease of access to food provide basic necessities for wildlife.

"The places that provided food and cover simultaneously is where we saw a true difference in wildlife abundance," Strickland said. "Those places that could provide refuge without wildlife having to go great distances, exposing themselves to predators, are where we found them."

DR. GARRETT STREET, assistant professor in the Department of Wildlife, Fisheries and Aquaculture, found himself not as the cameraman but as the one interpreting and quantifying the evidence. Street was the brain behind taking the data collected from the cameras and analyzing it.

"My portion of the research was to detect wildlife in the photographs, compile and analyze the data, and then use a mathematical equation to determine probability of wildlife occurrence," Street said.

The findings open the door for a conversation with hunters and landowners on best practices to improve wildlife response. Most importantly, the importance of both food and cover in a habitat is evident.

"Animals are more than just eating machines, you have to think about them through a whole system, whole animal perspective," Street said. "This gives us leverage and evidence to speak to hunters about what they want out of their habitats. If your goal is to have land that is good for hunting and providing these animals with what they need, give them the cover." ■

This work is funded through the Mississippi Agricultural and Forestry Experiment Station, the Forest and Wildlife Research Center, and the MSU Foundation's Bulldog Forest.

Prescribed fire treatment at the Andrews Forestry and Wildlife Laboratory. (Photo by David Ammon)

COLLABORATION:
INDUSTRY PARTNERSHIP

Don't Wing the Future

DESIGNING A PREDICTIVE MAP TO MITIGATE WOODPECKER DAMAGE

BY REAGAN POSTON

POWER COMPANIES across the nation spend millions of dollars each year repairing and replacing utility poles damaged by woodpeckers. Researchers in the Forest and Wildlife Research Center are putting their heads together to develop a predictive map of where such damages will likely occur, giving power companies a proactive and cheaper way to head off damage before the pecking even begins.

The Tennessee Valley Authority keeps the lights on in a seven-state region, serving portions of Tennessee, Mississippi, Alabama, Georgia, Kentucky, North Carolina, and Virginia. Since TVA supplies electricity, if a pole snaps due to woodpecker damage there's a potential for bodily harm, fire or even local impact to the grid.

In order to better understand the scope of the problem, TVA contacted **DR. SCOTT RUSH**, an associate professor in the Department of Wildlife, Fisheries and Aquaculture, to design a unique map that would give them more information as to the locations and trends of woodpecker damage.

Rush, the project's principal investigator, shared TVA's vision of the study.

"TVA is looking for a more efficient and effective way to understand the ecology of woodpeckers," Rush said. "That would allow them to be proactive in their maintenance, which is fiscally responsible because it's cheaper to prevent damage than it is to repair it."

Though woodpeckers undoubtedly damage utility poles, it's likely that they are only exacerbating an existing problem. Rush shared how the damage done by the woodpeckers is speeding up an inevitable process, which may be positioning the birds as an alert system.

"If a woodpecker is being drawn to a pole, there's likely already some structural damage to it. If a tree is rotten with fungi and insects, there's more incentive to drill there, so by getting an understanding of where they're creating damage, we can offer TVA the opportunity to detect trends in the ecologic data and take a proactive approach to the damage," Rush said.

As simple as the goal sounds, a modified species distribution map, such as the one TVA requested, requires an incredible amount of data to make a well-informed prediction.

HANNAH WRIGHT has been working on this study as her master's thesis and played an important role in the culmination of this map and its volume of data. Wright began by combing through various databases for statistics on the woodpecker population in a given area as well as the measure of many different environmental factors such as elevation and temperature. Wright also spent a great deal of time visiting the seven-state service area of TVA, gathering data in-person on numerous damaged utility poles.

Once the massive compilation of data was finished, it was then cross-referenced

with information given by TVA of utility pole damage and replacement to establish trends among the locations and, hopefully, offer reasonable predictions as to what locations the woodpeckers might damage next.

Wright shared how the species distribution map itself is special.

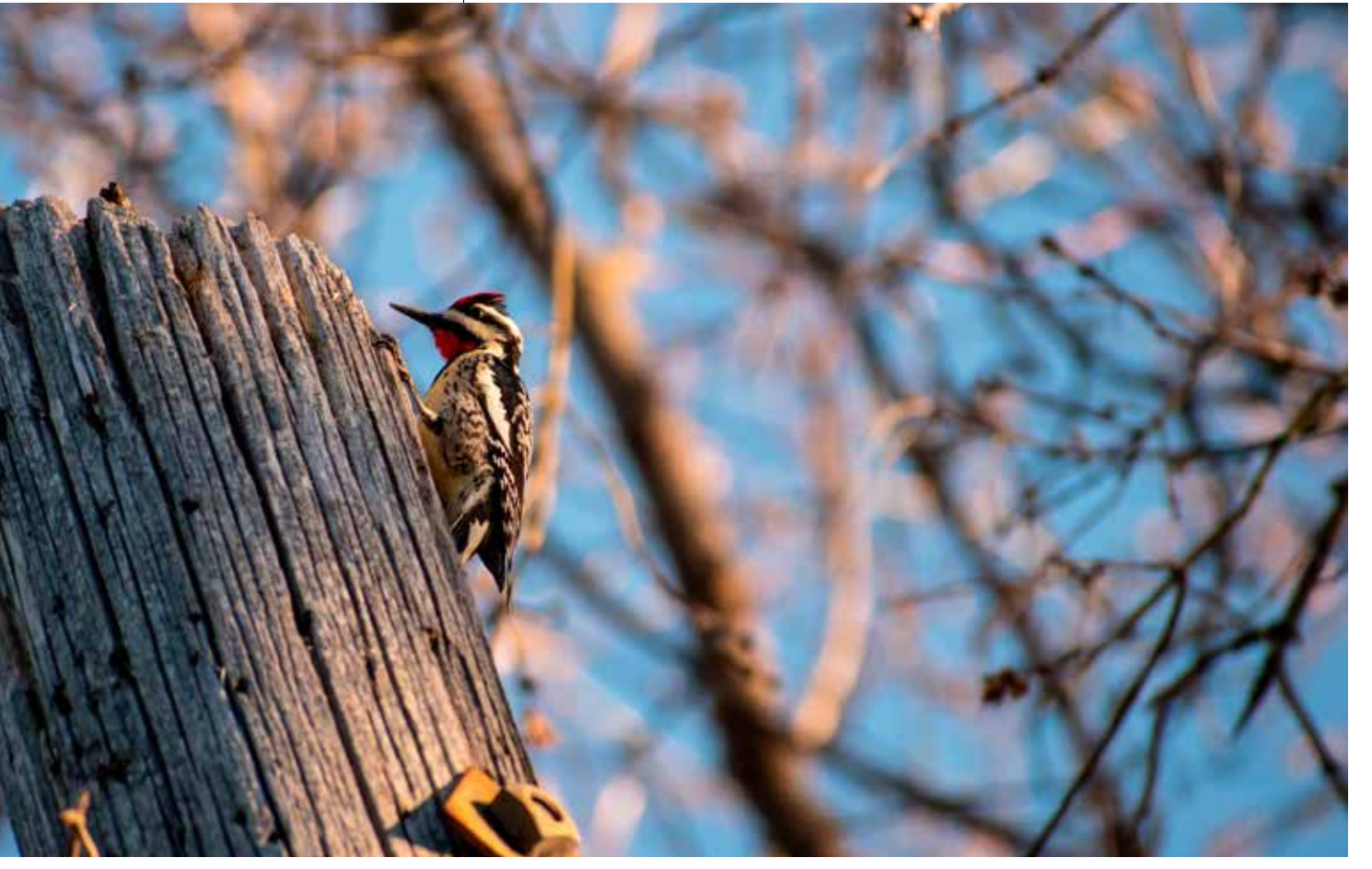
"Most of the time when species distribution maps are being utilized, it's for conservation purposes. That's not to say that this study is anti-conservation. The TVA doesn't ever want to hurt the woodpeckers, but they are causing a problem, and they need to know how to adapt to them in their power structure. It's been interesting applying this tool to a different context, one that's more concerned with a human-wildlife conflict," Wright said.

Though the model was requested for its predictive value, checking the accuracy of predictions in the present can prove difficult. With that in mind, Rush and Wright have organized the model such that it calibrates itself with 80 percent of the data it holds, then produces predictive outputs that the researchers can check against the remaining 20 percent of the actual data. The location outputs are units of about 180-square-feet, a narrow enough margin that maintenance workers at TVA would have only one or two utility poles to check within the area.

While the model is still undergoing minor adjustments before its presented to the TVA for implementation in the field, the researchers are hopeful about its future and its economic benefit to the Tennessee Valley Authority.

"If this model can save the TVA even 20 percent of what they pay to repair woodpecker damage annually, then that's a million dollars for the company that services nearly 10 million people in our neighborhoods," Wright said. "It's fulfilling to work on a project that impacts so many people." ■

This work was funded by the Tennessee Valley Authority, Alabama Ornithological Society, and the United States Geological Survey.



Yellow-bellied Sapsucker Woodpecker on an utility pole. (Stock photo)

PROFILE

GRADUATE STUDENT
ALEXANDRA FIRTH
PHOENIX, ARIZONA

A Bird on the Water is Worth Two to the Farmer

GRADUATE STUDENT EXAMINES HOW AGRICULTURE CAN BENEFIT FARMERS AND THE ENVIRONMENT

BY REAGAN POSTON

FROM THE arid fields of New Mexico to the winter-flooded rice fields of the Mississippi Delta, **ALEXANDRA FIRTH** has developed a passion at the intersection of agriculture and soil conservation.

After graduating with a degree in ecology from Humboldt State in Northern California, the Phoenix native's career as a biological technician took her all over the U.S. and briefly to Europe. It was while working on an organic farm in New Mexico, however, that Firth became interested in how agriculture systems can support the environment and eventually decided to pursue a master's degree in wildlife, fisheries and aquaculture at Mississippi State, which she earned in 2018.

"I witnessed agriculture's impact on natural systems in my travels as a biological technician, but working on the farm in New Mexico is where I really became interested in how agriculture and natural systems affect each other. At Mississippi State, I've been able to put those interests to practice," Firth said.

Her thesis research focused on how agriculture can mutually benefit the farmer and the environment. She designed a study that looked at the extent to which natural resources and agronomic systems are affected by waterfowl in winter-flooded LEISA rice fields [see our story on page 40].

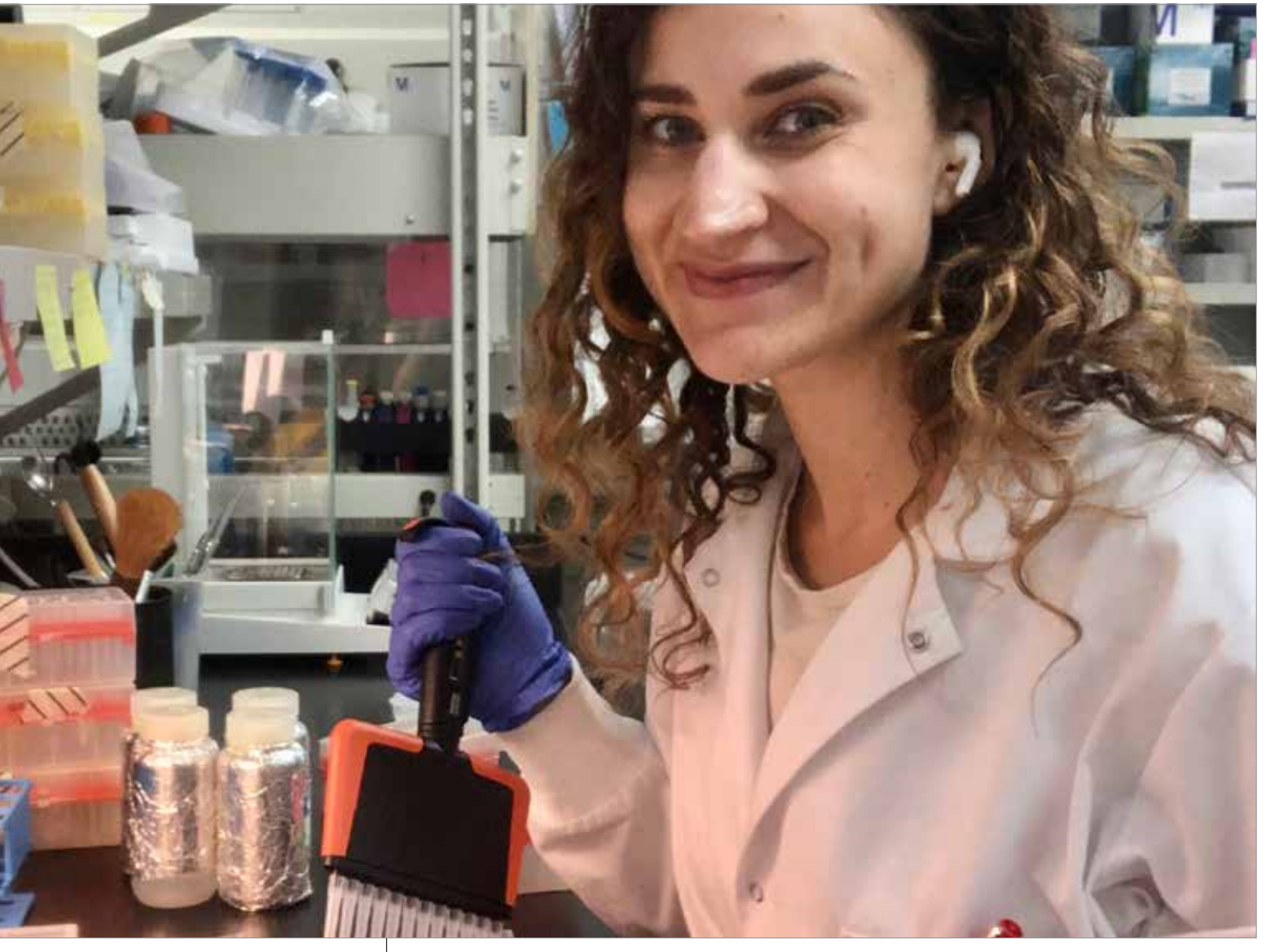
To quantify these effects, Firth and her research team modeled their case study after a producer in the Mississippi Delta who was employing a LEISA method of management. LEISA is a collection of sustainable management practices that adapts the system for a given environment, optimizes the resources already available, and minimizes the changes to the natural environment. The combination of these management practices created habitats for wintering waterfowl, and after a decade of doing this, the producer was reporting improvements in soil health and a reduction in needed fertilizer.

Firth's case study aimed to determine the extent to which the birds were affecting soil health in LEISA fields that had been winter-flooded with rainwater and had not been tilled following harvest. They compared avian populations with that of flooded and non-flooded fields not managed with LEISA practices and consistently saw higher populations in flooded LEISA fields.

Though game cameras on-site captured photos of thousands of birds in a single winter flooded LEISA field, the true measure of the impact of abundant waterfowl is reflected in the soil sampling. Firth, focusing on soil microbiology in her pursuit of a Ph.D., shared the impact of these management practices on the soil.

"Hundreds of birds all occupying the same space leave significant amounts of droppings behind and those droppings are a rich source of organic matter, microbial activity, and nutrients. The fecal matter is incorporated into the soil and has the potential to be used as fertilizer for the following crop. The LEISA flooded fields had more nitrogen, carbon, and microbial diversity and activity, indicating that this type of production system and associated bird use improve soil health," Firth said.

Given that LEISA is a collection of management practices, the benefits cannot be solely



Alexandra Firth prepares samples in the laboratory. (Photo Submitted)

attributed to the birds, but Firth shared how improved soil health can benefit the larger environment in addition to the individual producer.

"To the producer, soil health is obviously important for adequate growing conditions, but improving soil health is one of the biggest things we can do for the environment as well. Soil can sequester carbon, potentially offsetting the effects of climate change. Healthy soil also holds onto nutrients more effectively, lowering fertilizer input needs and nutrient run off into the water," Firth said.

Though this project is a case study with still much to be learned, for Firth, the study offers the opportunity to show producers that, with the right conditions and management practices, agronomic profit and environmental stewardship don't have to be mutually exclusive.

Firth is continuing her research at the intersection of agriculture and conservation as a doctoral student in the College of Forest Resources, expanding her skill set to investigate the effects of cover crops on soil health and water quality in the Mississippi Delta. ■

Firth's committee included Dr. Beth Baker, assistant extension professor; Dr. Brian Davis, James C. Kennedy Endowed Associate Professor in Waterfowl and Wetlands Conservation; Dr. Ray Iglay, assistant research professor, all in the Department of Wildlife, Fisheries and Aquaculture; and Dr. John Brooks, a USDA-ARS scientist. This research was funded by the Monsanto Foundation; the Forest and Wildlife Research Center; the United States Department of Agriculture Southern Sustainable Agriculture, Research & Education; and the United States Department of Agriculture's Agricultural Research Services.

PROFILE

UNDERGRADUATE STUDENT

ANNA GAMBLIN

AKRON, OHIO

It's a Bird, It's a Plane, It's a Problem

UNDERGRADUATE RESEARCH MONITORS VULTURE FLIGHT PATHS TO MITIGATE AVIATION DAMAGE

BY REAGAN POSTON

OVER THE LAST ten years, the Naval Air Station Meridian, or NASMER, has seen upwards of twenty aerial collisions with vultures, 739 near-misses, and an estimated 1,500 near-misses that went unreported. The unstudied habits of these birds mean that such vulture-aircraft collisions, costing as much as $40 million, are difficult to predict and thereby avoid. NASMER sought the expertise of scientists in the Forest and Wildlife Research Center who have now taken on the task of tracking the black vulture population around the base.

ANNA GAMBLIN, a senior wildlife, fisheries and aquaculture major, was raised to appreciate both nature and Mississippi State. Her parents were both MSU alums, so when her own love of wildlife took wing, Gamblin took up the mantle and became a MSU wildlife, fisheries and aquaculture major.

"Coming to Mississippi State, even though it's eight hundred miles from Akron, felt like coming home," Gamblin said.

She started as a student researcher her freshman year and joined the vulture team as an Undergraduate Research Scholar as a junior. Gamblin shared that this research opportunity combined the two things that she loves: learning and conservation.

"There used to be this massive tree outside of my late grandmother's house, and when I would go visit her and spend the night, the birds would sing so loudly that they woke me up. To this day, when I hear birds in the morning, I think of her," Gamblin said. "For me, conservation isn't just preserving wildlife. It's preserving memories like these."

In this study, the vulture population is being monitored primarily through placement of colored, numbered tags of vultures and reporting by citizen scientists. Gamblin has been in the landfills—a favorite habitat of vultures—studying and tagging the birds for four months. By gaining knowledge of where typical vulture flight paths take them and when, Gamblin and her team can offer NASMER the opportunity to adapt their own flight plans and avoid vulture collisions.

The Akron, Ohio native was most excited about the study's research objectives.

"This study has a lot of moving parts. In addition to tagging the vultures for NASMER, we're also observing the vultures' behavior, taking blood samples to observe lead concentrations and the sex of the individuals, and sampling the bacterial communities on the head and in the mouths of vultures, hoping to understand the relationship between the bacteria and the vultures' ability to be in and around and digest rotten food, " Gamblin said.

Gamblin shared how this multifaceted research approach may help dispel some inaccurate assumptions about vultures and lead to more overall understanding of the species.

"People are very rarely clambering to work with vultures, so they're an understudied species. Through this research and getting to help the birds, I've seen things like allopreening between the adults and the young, which shows that, while

Anna Gamblin handles a vulture as part of her research project. (Photo Submitted)

people think they are not clean, they do care for each other and clean themselves and others within their group," Gamblin said.

In order to continue expanding and utilizing this vulture knowledge to mitigate human-wildlife conflicts, the tracker data gathered from this study will be analyzed in three dimensions with the hopes of pinpointing if, when, and why vultures frequent specific areas, both in the air and on the ground. Comparing three-dimensional Navy flight patterns to vulture flight patterns, along with knowing roosting areas, and thermals that facilitate these birds' movements will help minimize vulture strikes and the potential for pilot injury.

DR. SCOTT RUSH, associate professor in the wildlife, fisheries and aquaculture department is the primary investigator on the study, as well as Gamblin's research advisor, shared what an asset she has been to the team.

"She's been doing an excellent job handling research while also taking classes during this semester, never complaining about the heat—or smell—of tagging vultures in landfills," Rush said. "Anna is enthusiastic about working with the birds and gaining insight to some of their unique behaviors, and her interest in differences in behaviors and ecology of the birds provides a significant perspective as we learn ways to help reduce negative vulture-aircraft interactions." ■

This research is funded by the Meridian Airport Authority, the U.S. Department of Defense, and the Forest and Wildlife Research Center.

KENNEDY CHAIR

No Harm, Plenty of Waterfowl

RECREATING WATERFOWL HABITATS TO AID SOIL HEALTH

BY REAGAN POSTON

A **RECENT CASE STUDY** suggests that employing off-season rice production systems as flooded habitats for waterfowl could make the soil healthier and reduce external nitrogen inputs.

DR. BETH BAKER, assistant extension professor, experienced this firsthand when she met a rice farmer in the Mississippi Delta who was utilizing masses of waterfowl in the off-season to help trample rice stubble and reduce fertilizer use.

"This farmer had been using a LEISA approach, which means low-external-input sustainable agriculture. It is a sustainability approach that is more commonly used on small organic farms, which made it noteworthy to me that this farmer was successfully applying it to a large-scale production system and was seeing agronomic benefits. I was interested to know if the circumstances and results could be quantified, recreated, and potentially adopted by a larger population," Baker said.

With that goal in mind, Baker gathered a team of researchers to craft a case study replicating the conditions, and pivotal to the recreation of the LEISA farm was the presence of the waterfowl, in this case, ducks and geese. A key member of the team was graduate student **ALEXANDRA FIRTH**, who brought the research idea into practice. She had the hard task of figuring out how to collect, analyze, and interpret the data and findings with the help of her committee.

DR. BRIAN DAVIS, James C. Kennedy associate professor and waterfowl specialist, a committee member, shared why the combination of flooding and rice stubble in these particular fields attracts waterfowl.

"Flooding the rice fields in winter creates important foraging habitats, and roosting habitat for them at night. Not tilling the stubble into the soil provides more available waste seed. Birds are more likely to choose flooded, non-tilled fields over fallow, non-flooded ones," Davis said.

In addition to the rice fields providing roosting and foraging habitat, their location in the Mississippi Delta is part of the natural migratory path of many waterfowl species such as ducks, geese, and swans. Historic bottomland hardwoods of the Mississippi Delta have mostly been replaced by agricultural crops, including rice, but if rice fields remain flooded in winter, producers ensure that ducks and geese continue their natural migration patterns to this region.

Game cameras installed on-site demonstrated that the flooded LEISA fields had higher bird abundances than their tilled counterparts. Overall, the

Flooded rice fields incorporating LEISA practices saw an increase of 15 geese per hectare per day. (Photo Submitted)

flooded LEISA fields saw upwards of 15 geese per hectare per day, more than twice that of the unflooded LEISA fields, and more than six times that of the unflooded conventional fields.

The birds are not the only ones to benefit from making a home in these rice fields; this case study suggested that waterfowl helped to improve certain soil health parameters, increasing carbon, nitrogen, and microbial activity in the soil through their droppings. This jump in nitrogen equates to less fertilizer costs for the producer.

"Flooding in LEISA fields makes a difference in waterfowl conservation, and of course, the more birds you have, the more they can activate and integrate nutrients in the soil and decompose rice straw, which helps the grower economically. It's really a win-win," Davis said.

Alongside Dr. Davis, Dr. Baker, and Alexandra Firth, the research team included **DR. RAY IGLAY**, assistant professor in the Department of Wildlife, Fisheries and Aquaculture, and Dr. John Brooks, USDA-ARS research scientist. ■

This research was funded by the Monsanto Foundation; the Forest and Wildlife Research Center; the United States Department of Agriculture Southern Sustainable Agriculture, Research & Education; and the United States Department of Agriculture's Agricultural Research Services.

CENTER FOR RESOLVING HUMAN-WILDLIFE CONFLICTS

The Center for Resolving Human-Wildlife Conflicts advances research and applied management of natural-human systems, provides leadership and training for resolving human-wildlife interactions, and expands educational opportunities for students interested in human dimensions of wildlife and fisheries conservation.

A Pelican Breach

RESEARCHERS SEEK TO CURB PELICAN PREDATION ON MISSISSIPPI'S CATFISH FARMS

BY VANESSA BEESON

WHILE THE white pelican is a majestic bird, it can also be a major nuisance to Mississippi catfish farmers. USDA's Animal and Plant Health Inspection Service (APHIS) estimates a pelican would need to consume up to 11 catfish per day to meet its daily energetic requirement. This means an average flock of 250 pelicans would consume roughly 2,750 fish per day, resulting in a daily production loss of nearly $3,000. Couple that with the fact that the birds are host to a variety of catfish parasites including the trematode *Bolbophorus damnificus*, which can cause production losses upwards of 60 percent, and it becomes evident that pelicans can devastate catfish ponds. For scientists to help catfish farmers mitigate pelican predation, more has to be learned about the bird itself. Specifically, FWRC researchers are studying how, when, and where these birds migrate and how certain factors such as wind, thermals, and climate change influence their flight patterns. They hope by answering those questions, they can help catfish farmers better estimate when and where ponds may be at greatest risk for pelican predation.

The research, funded by the U.S. Department of Agriculture, Wildlife Services, Wildlife Research Center, is led by **DR. GUIMING WANG**, professor in the Department of Wildlife, Fisheries and Aquaculture, who said the team sought to answer both a scientific

White pelicans, which have the largest wingspan of all North American birds of up to nine feet, use thermals, or upward currents of warm air, to gain height and soar up to 10,000 feet. (Stock photo)

question and an economic question.

"Scientifically, we want to know how wind and thermals affect pelican spatial distribution and movement across long distances," Wang said. "Answering that question will help us with the economic piece: helping formulate effective management guidelines reducing pelican predation on catfish farms."

White pelicans, which have the largest wingspan of all North American birds of up to nine feet, use thermals, or upward currents of warm air, to gain height and soar up to 10,000 feet. Their range is vast, spanning the length of North America. Researchers studied the annual cycle of different populations of alloheimic migrants of pelicans, which are groups of birds that may share breeding grounds but overwinter in different places. These birds included populations that overwintered in northern U.S. and in the South in Mississippi, Louisiana, and Alabama. They sought to determine if flight patterns changed in annual cycles between alloheimic populations.

The team analyzed data from 72 pelicans that were fitted with GPS collars by USDA APHIS and monitored from 2002-2012, data from the U.S. Geological Survey's Bird Banding Laboratory that spans from 1960-2015, and several years of data from the popular eBird app, a citizen scientist-driven application produced by Purdue University. From there, the team built a model, which shows distribution based on the bird movement, to estimate pelican home ranges across seasons.

"We identified where these birds are during the spring migration, breeding, autumn migration, and wintering periods," said **RYO OGAWA**, a doctoral student on the project. "From there, we compared hourly movement speeds and home ranges of pelicans by wintering population groups and seasons."

The team obtained wind speeds and direction data from the National Centers for Environmental Prediction to calculate least-cost migratory paths of these birds and compare the paths with the actual routes taken according to the GPS-tracked pelicans.

"We found that pelicans exhibited the same movement behaviors such as movement speed and similar home range on their common breeding grounds but different movement behaviors between their separate wintering grounds," Ogawa said. "We also learned that southerly wintering pelicans migrated faster in spring by following northward wind paths more closely than northerly wintering pelicans."

He said the work is a first step in determining how pelican movement impacts catfish producers.

"From here, we'd like to build a risk map that shows when and where pelicans might arrive in areas where there are catfish farms," Ogawa said.

MSU researchers, **DRS. WES BURGER**, **BRIAN DAVIS**, and **BRONSON STRICKLAND**, contributed to the work. Collaborators from the U.S. Department of Agriculture, Wildlife Services, National Wildlife Research Center, Mississippi Field Station at MSU include Tommy King and Dr. Fred Cunningham as well as the now-retired Dr. Marsha Sovada, who fitted pelicans with GPS collars. ■

This research is funded by the U.S. Department of Agriculture, Wildlife Services, National Wildlife Research Center.

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FORESTRY & FOREST PRODUCTS IN MISSISSIPPI

2018 DATA

JOBS (FULL AND PART-TIME)

61,619

VALUE-ADDED

$4.99 BILLION

PAYROLL

$2.96 BILLION

TOTAL FORESTLAND ACRES

19,244,571

PRIVATE OWNERSHIP ACRES

17,080,876

PUBLIC OWNERSHIP ACRES

2,163,692

TAX REVENUE

$925.73 MILLION

TOTAL OUTPUT

$13.12 BILLION

Based on data generated by Dr. Shaun M. Tanger, forestry assistant extension professor, and Mr. Marc Measells, senior forestry extension associate.

BY THE NUMBERS

PEOPLE

74
Master's students (Fall 2019)

43
Doctoral students (Fall 2019)

49
Faculty (FY20)

RESEARCH PROJECTS

255
Projects Active (FY20)

68
Research Sponsors (FY20)

116
Refereed Publications (FY20)

$8,025,478
Total Sponsored Research Funding (FY20)

RESEARCH SPONSORS

- Alabama Audubon/National Audubon Society
- Alabama Department of Conservation and Natural Resources
- Alabama Division of Wildlife and Freshwater Fisheries
- Alternative Fuel Solutions
- Anthony Timberlands
- Arch Wood Protection Inc.
- Barnett
- BASF Corp.
- Bauhaus Furniture Group
- Benton County Board of Supervisors
- Cargill Inc.
- Cate Street Capital Inc.
- Cooperative Ecosystems Studies Units
- Cotton Bayou Marina Inc.
- Delta Farm
- Dow AgroSciences LLC
- Drax Biomass International Inc.
- Ducks Unlimited Inc.
- DuPont de Nemours Inc.
- Eastman Chemical Company
- EnSafe Inc.
- Flexsteel Industries Inc.
- Forest Products Society
- Forrest County Board of Supervisors

TOTAL FWRC FUNDING, FY20

$14.74M

39.35% STATE APPROPRIATIONS

06.19% FEDERAL APPROPRIATIONS

54.46% GRANTS AND CONTRACTS

FuturaGene Ltd.

Genics Inc.

Greene County Board of Supervisors

GS Research LLC

Gulf Coast Ecosystem Restoration Council

INtegriCo Composites of Louisiana LLC.

Jeld-Wen Inc.

JL International Inc.

Joint Fire Science Program

KMG Chemicals inc.

KMB-Bernuth Inc.

Koch Carbon LLC

Kop-Coat Inc.

Koppers Holdings Inc.

KTM Industries Inc.

Lanxess Corp.

Lignotech USA Inc.

Lonza Wood Protection

Mebahiah Inc.

Meridian Airport Authority

Mississippi Department of Wildlife, Fisheries, and Parks

Mississippi Environmental Educational Alliance

Mississippi Forestry Association

Mississippi Forestry Association Foundation

Mississippi Implementation Committee for the Sustainable Forestry Initiative

Mississippi Land, Water and Timber Resources Board

Mississippi Lignite Mining Company

Mississippi Tree Farm Committee

Mississippi Wildlife, Fisheries, and Parks Foundation

Nano-TEK LLC.

National Council for Air and Stream Improvement Inc.

National Fish and Wildlife Foundation

National Science Foundation

National Wild Turkey Federation

Nisus Corp

Northstar Tonewoods Ltd.

NTA Inc.

Oregon State University

Penta Task Force

Puerto Rico Department of Natural and Environmental Resource

Quality Mat Company

Railway Tie Association

Reservoir Fisheries Habitat Partnership

Scott County Board of Supervisors

Siberian Branch of Russian Academy of Sciences

Signature Systems Corporation

Sofamaster LLC

Southern Ionics Inc.

Stein Fibers LTD

Structurlam Mass Timber Corp.

Sustainable Forestry Initiative, Incorporated

Temple-Inland Inc.

Tennessee Valley Authority

Tennessee Wildlife Resources Foundation

The Eppley Foundation for Research

The National Academies of Sciences, Engineering and Medicine

The Nature Conservancy

The Nemours Wildlife Foundation

The University of Maine

Timber Products Co.

Timber Products Inspection Inc.

Trinity Green Derivative Products LLC

Troy Chemical Company

United Furniture Industries

University of Arkansas at Pine Bluff

University of Georgia

U.S. Army Corps of Engineers

U.S. Department of Defense

U.S. Department of the Interior

U.S. Department of the Interior Bureau of Land Management

U.S. Department of the Treasury

U.S. Endowment for Forestry & Communities, Inc

U. S. Environmental Protection Agency

U.S. Fish and Wildlife Service

U.S. Geological Survey

U.S.D.A. Farm Service Agency

U.S.D.A. Agricultural Research Service

U.S.D.A. Animal & Plant Health Inspection Service

U.S.D.A. APHIS National Wildlife Research Center

U.S.D.A. Forest Products Laboratory

U.S.D.A. Forest Service

U.S.D.A. National Institute of Food and Agriculture

U.S.D.A. Natural Resources Conservation Service

Utility Asset Management Inc.

Viance, LLC

Vienna Christmas Design

Walton Family Foundation

Washington State University

Waste Revelation

Weyerhaeuser NR Company

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