FOREST & WILDLIFE RESEARCH CENTER 2022

ANNUAL REPORT

MISSISSIPPI STATE UNIVERSITY™
FOREST AND WILDLIFE RESEARCH CENTER

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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: Sustainable Bioproducts scientists are working to improve water repellency in paper packaging. (Photo by Dominique Belcher)

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FROM THE
DIRECTOR

THANK YOU for your support of the Forest and Wildlife Research Center at Mississippi State. It is an honor for our organization to be the state's research leader in the conservation, management, and use of the forest, forest products, wildlife, and fisheries resources for the betterment of all Mississippians. We are fortunate to have many partners who support our mission and work alongside our scientists and students to protect and sustain Mississippi's natural resources.

Mississippi is blessed with abundant natural resources and so many of our state's residents help ensure that ecosystems and environments are enhanced and protected. The 19.2 million acres of our state's forest lands held by 125,000 forest landowners produced $1.3 billion in production in 2022. Forest-related economic activity in the state generated 64,544 jobs and over $3.3 billion in income. Our state ranks third in pine pulpwood production and fourth in pine lumber production in the United States. Mississippi has 3,900 certified tree farms in the American Tree Farm System and 22 cities bear the title of Tree City USA. Mississippi State University is a Tree Campus USA, thanks in large part to our forestry faculty, students, alumni, and partners.

Our state's residents value the environmental and economic impacts provided by natural resources.

In this annual report, we highlight a handful of the 130 projects that FWRC scientists are pursuing. We have one of the university's largest research portfolios, ranking 14th nationally for natural resource research. This is a testament to our renowned faculty who are often sought out to conduct research and collaborate on science that matters across the globe and right here at home. Over 62 percent of our funding is from extramural grants. We take state dollars and more than double those with research grants, creating an economic impact in our state.

And our research attracts industry to our state while helping expand existing business. We work with many industries to understand problems and foster solutions to benefit companies and private landowners alike. We have also developed software that allows industries to find the best place to locate in the state, based on workforce and raw material availability, infrastructure, access to markets, and more. We don't do this work in a vacuum. Working with many state partners, new industries are attracted to our state for the quality of resources and people.

In addition to the research our scientists conduct, we also train the next generation of natural resource leaders. In the Fall of 2022, we had 168 graduate students and 434 undergraduates. These students are an integral part of the FWRC research program. It's exciting to see these students grow into tomorrow's natural resource leaders.

The FWRC annual report is segmented into projects that have national and global 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 work and gaining a richer understanding of the impact we are making on the natural world in our state and beyond.

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 toward these shared priorities, I look forward to seeing you soon.

L. WES BURGER
DIRECTOR

FORESTRY

The Department of Forestry conducts research to sustainably manage and utilize forest resources 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

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Head and George L. Switzer Professor of Forestry

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MARTIN A. SPETICH
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JESSICA L. TEGT
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GLOBAL/
NATIONAL
IMPACT

Pest Prediction

ANTICIPATING INVASIVE INSECT IMPACT BEFORE THE THREAT ARRIVES

BY VANESSA BEESON

INVASIVE INSECTS, like the emerald ash borer and the redbay ambrosia beetle, wreak havoc on native ecosystems, kill hundreds of millions of trees, and cost hundreds of millions of dollars per year in lost revenue, management costs, and loss of ecosystem services in North America. A FWRC scientist sees these insects as a cautionary tale as she seeks to rewrite the story. **DR. ASHLEY SCHULZ**, assistant forestry professor, is part of a team working to predict whether insect species will highly-impact North American conifers and hardwoods before they arrive here.

"We set out to predict the next high-impact insect invaders; the insects that are not in North America yet, but, if they do get introduced, can be the next emerald ash borer or redbay ambrosia beetle. Our overarching goal was to determine what factors drive impact of these introduced insects and then use this information to develop models to predict which insects will have significant effects on native tree species should they get imported and introduced into North American forest ecosystems," Schulz said.

Schulz is part of the High-Impact Insect Invasions working group, a consortium of university, governmental agency, and industry experts aimed at predicting invasive insects. Over the last few years, the team has been laying the groundwork for possible models. This includes delving into the factors that make an invasive insect successful. One such factor is insect characteristics, which is well documented. However, the working group, who recognized that there was more to the story, focused on four factors related to trees and insects in North America, including insect traits, host tree traits, evolutionary history between the insect's native range and local host trees, and whether there was a related residing insect on the same host tree as the non-native insect.

"We hypothesized that all insect invasions are driven by at least one of these four factors, but most are likely driven by more than one. Most other studies just focus on insect traits or sometimes host traits, so our study was one of the first to empirically demonstrate the importance of host evolutionary history as a major driver of impact for insects that feed on hardwoods," Schulz said.

Schulz relates an invasive insect finding a suitable native host to a familiar childhood fairy tale.

"We use the phrase 'Goldilocks effect' in science when something falls within certain margins as opposed to the extreme edges of a range (i.e., it's 'just right'). Here, we found a sweet spot for the insect and sour spot for the tree in the evolutionary history between an insect's hosts in its native range and hosts in North America. The insect can identify the tree as a host, but the host is far enough removed from the insect's native host that it likely does not have the co-evolved defense mechanisms necessary to defend itself against the insect," she explained.

The work was published in *Biological Invasions* and the team is now incorporating their models into a new pest predictor tool for i-Tree, a peer-reviewed software suite from the USDA Forest Service and Davey Tree Expert Company that produces forestry analysis and benefits investment tools. Thus far, the team has collected data for generalist insects, which feed on a range of hosts, and developed new models for both generalist and specialist insects, which feed on a narrow range of hosts. The team has a dataset of 300 European insects that have not yet arrived in North America that they plan to run through their models to try and identify any insects that might have a high probability of impact should they arrive in North America.

"These results can have implications for prevention and early detection and can affect federal policy at places such as the USDA APHIS ports of entry in the United States and the Canadian

Food Inspection Agency," Schulz said.

While the team has yet to predict whether an insect will establish in North America should it arrive, they're closer to understanding the factors at play that pave the way for an insect to become high-impact like spongy moth, beech scale, or hemlock woolly adelgid.

"We've built the models and are establishing a baseline that will determine which insects will be risky. Most invaders are not high-impact so there will only be a handful of insect species that might require immediate action. Although we're expecting to only find a few, it's finding out which few are going to be bad that is the big question," said Schulz, who hopes one day the team's work will be adopted and adapted by other countries to develop similar tools to predict impact on their native tree species. ■

The research is funded through the United States Geological Survey John Wesley Powell Center, the USDA Forest Service National Urban and Community Forestry Advisory Council, and the MSU Forest and Wildlife Research Center. Collaborators include the University of Maine, Dartmouth College, the University of Georgia, Colorado State University, Arkansas State University, University of Wisconsin, University of Washington, University of Nebraska, the USDA Forest Service, the United States Geological Survey Southwest Biological Science Center, and Davey Tree Expert Company.

Dr. Ashley Schulz examines a green ash tree at the John W. Starr Memorial Forest. (Photo by Karen Brasher)

IN THE FIELD:
CURRENT APPLIED RESEARCH

Seeing the Forest For the Trees

ASSESSING TIMBERLAND SALES OVER THE LONG TERM

BY MEG HENDERSON

MISSISSIPPI HAS 19.2 MILLION ACRES of forestland, which accounts for 62% of the state's total land area. Nonindustrial private forest landowners own nearly three-quarters of all the forestland in Mississippi, about 70%. Like government and industry owned land, private forestland provides fresh water, habitats for fish and wildlife, recreational opportunities, and wood products. However, frequent resale activity for immediate profit can potentially threaten the long-term stability of timberland management and ecosystems on these properties.

A team of Forest and Wildlife Research Center scientists, led by **DR. EDWIN SUN**, partnered with scientists from The Ohio State University and the University of Georgia to study the turnover of private forest land in Mississippi over 21 years, from 1999 to 2019. Their study, supported by a U.S. Department of Agriculture McIntire-Stennis capacity grant, was the first of its kind nationwide, and it produced empirical answers to the questions that people in the industry were asking about ownership fragmentation.

"Working forests require a long-time commitment and investment, which is typically around 30 years for pine plantations," Sun said. "While we know that increasing forest ownership fragmentation in physical size has been a national trend, we wanted to better understand just how often these lands were changing ownership."

The team studied 18,783 parcels of private forestland located in eight Mississippi counties with varying geographical locations, populations, socioeconomic conditions, and proximity to urban centers. They found that about 46% of these parcels were sold at least once over the 21 years, with the maximum being nine times. The properties that changed ownership during this time were sold an average 1.5times, with an average ownership duration of about five years.

Sun explained that traditionally, an owner would hold a property for 30-50 years, and that long-term ownership allowed for a consistent management plan. In more recent years, however, land ownership is viewed less in terms of a lifetime asset to be passed to the next generation and more in terms of utility and maximizing profits. This perspective has resulted in selling properties when the market conditions ensure a profit. However, profits come at the expense of long-term land management practices. If a new owner comes in every 3-5years with their own priorities and plans, they often lack the knowledge of past management priorities and activities.

"Forest management activities, such as prescribed fire, boundary surveys, and harvesting

timber, are not very frequent. Most of these activities happen once every five or ten years," Sun said. "With properties changing hands frequently, these activities may not take place when they need to."

Some key factors influencing the frequency of land sales are the size of the parcel, proximity of the landowner to the property, and presence or absence of a formed business (e.g., partnership, limited liability company, or corporation). The team found that landowners held onto smaller properties a few years longer than larger ones. Landowners living close to their properties tended to keep it longer than out-of-state landowners. And properties managed under a formed business (e.g., LLC or partnership) were sold more frequently than those without one.

"Because the internet makes buying and selling land relatively quick and easy, I expect that ownership fragmentation will continue to increase in the long term," Sun said. "That's why it's important to analyze the economic patterns of ownership fragmentation and its impacts on ecosystem services."

While further studies are needed to understand the broader impacts of ownership fragmentation on forestland management, timber production, and ecosystems, Sun sees this knowledge having implications for policy improvements, such as tax or cost-share programs, that encourage and reward longer-term ownership.

"Forests play a critical role in maintaining stable ecosystems and mitigating climate change. We believe it is critical for both landowners and policy makers to understand the importance of stable ownership and management of these lands," he said. ■

This research is funded by the USDA McIntire-Stennis capacity grant and the MSU Forest and Wildlife Research Center.

Dr. Edwin Sun outside Thompson Hall on the MSU campus. (Photo by David Ammon)

COLLABORATION:
INDUSTRY PARTNERSHIP

Improving Bottomlands

HOW DIVERSIFICATION OF TREE SPECIES HELPS TIMBER AND WILDLIFE

BY GRACE JONES

BOTTOMLAND FORESTS reduce the risk and severity of downstream flooding by providing areas to store floodwater. They store large amounts of carbon in trees and the soil, and provide critical habitat for waterfowl, migratory birds, wild turkey, and other wildlife. These wetlands also improve water quality by filtering and flushing nutrients, processing nitrates and organic wastes, and reducing sediment before it reaches open water.

To restore efficiency and encourage diversity, scientists in the Forest and Wildlife Research Center are developing, assessing, and restoring bottomlands and wildlife habitat conditions.

DR. JOSHUA GRANGER, an assistant forestry professor, and his team aim to demonstrate novel silvicultural techniques to restore floodplain forests and wildlife habitat across Mississippi and Arkansas.

The research is being conducted on the O'Keefe Wildlife Management Area (WMA) in Lambert, Mississippi; Malmaison WMA near Greenwood, Mississippi; and two private properties in Charleston, Mississippi and Humphrey, Arkansas, respectively. The team has partnered with the National Fish and Wildlife Foundation (NFWF), whose goals to sustain, restore, and enhance wildlife populations, plants, and natural habitats for current and future generations align well with the project.

"We are conducting research predominantly on oak plantations and on older, more natural bottomland hardwood stands. We are studying regeneration of those stands to better the environment for wildlife and improve timber quality," Granger said. "Right now, these stands, and plantations are not benefiting wildlife to their full capacity, and they are not producing a lot of volume in timber. So, partnering with NFWF will enhance our ability to open those stands to regenerate and help them move forward, while creating more benefits for wildlife species, and growth quality in trees."

The team started their research in January of 2021 and plans to continue until December of 2024. Due to travel restrictions from the pandemic, severe weather and flooding, and hunting season restrictions, their research was slightly delayed. Yet, they have conducted and gathered the foundational basis needed to carry out their research goals.

"We have inventoried all our plantations and the wildlife sections, as well as surrounding areas for estimation rates. All baseline data has been achieved, and some areas have already seen basal reductions," Granger explained.

The team plans to restore 344 acres of degraded natural bottomland hardwoods and 400 acres of early-rotation bottomland hardwood plantations across the four sites. The scientists are looking forward to diversifying these stands, which are pure monocultures, by planting multiple species.

"We seek to demonstrate that managing degraded stands and plantations can produce substantial benefits for landowners and wildlife alike by implementing systematic thinning treatments, crown lifting treatments, and interplanting hardwood species to enhance wildlife habitat," Granger explained. "These methods have been long favored for improving tree quality and restoring wildlife habitat, but no large-scale projects within the Lower Mississippi Alluvial Valley have demonstrated the implementation of these practices."

DR. DANA MORIN, assistant professor in the Department of Wildlife, Fisheries and Aquaculture, leads the wildlife monitoring aspect of this project. She is studying swamp rabbits, a commonly used indicator species for assessing the habitat quality of bottomland hardwood forests. Morin and her team are sampling the

study areas, collecting fecal pellets to extract DNA, identify individuals, and estimating rabbit abundance before and after restoration activities to assess how swamp rabbit populations respond.

"The pre-cut surveys indicated likely differences in rabbit activity at the sites, so we expect to see different responses to the treatments, if there are any," Morin said. "The initial surveys also opened up new questions about how the surrounding landscape context influences rabbit activity at each site, which could provide valuable information for future restoration efforts intended to improve habitat for wildlife species, like swamp rabbits."

The team will start underplanting, or planting under the trees with lower-growing plants, this winter once hunting season ends. As the research continues, the researchers are excited to diversify the land while restoring habitats and the environment.

"There needs to be a larger focus and more research on bottomland plantations. In Mississippi, loblolly pine plantations are something we know how to grow efficiently for timber, while bottomland oak and hardwoods plantations are more difficult to grow when aiming for high-quality timber. These areas are susceptible to several disturbance types, and we need to keep them healthy and growing for an array of future uses," Granger said. ■

This research is sponsored by the National Fish and Wildlife Foundation. In addition to Granger, the MSU forestry team includes Drs. Krishna Poudel, assistant forestry professor; Dr. Brady Self, associate extension professor; Dr. Robert Grala, George L. Switzer Professor of Forestry; and Timothy Gatlin, forestry graduate student. Collaborators in the Department of Wildlife, Fisheries and Aquaculture, in addition to Morin, include Dr. Mark McConnell, assistant professor; Dr. Brian Davis, James C. Kennedy Endowed Associate Professor in Waterfowl and Wetlands Conservation; and Chloe Beall, WFA graduate student.

TJ Gatlin, graduate student and Drew Fletcher, undergraduate student, in the Department of Forestry under the direction of Dr. Joshua Granger at one of the study sites. (Photo Submitted)

PROFILE

GRADUATE STUDENT
MAX SCHRIMPF
BEAVERCREEK, OHIO

Reaching Maximum Heights

FORESTRY GRADUATE STUDENT STUDIES ENVIRONMENTAL FACTORS' IMPACT ON PINE GROWTH AND DEVELOPMENT

BY GRACE JONES

SECOND-YEAR MASTER'S STUDENT MAX SCHRIMPF, from Beavercreek, Ohio, took a leap of faith when aspiring to reach his goals as a working forester.

Schrimpf grew up in the Boy Scouts and loved outdoor activities. His continued love for the outdoors eventually led to him receiving a bachelor's degree in forestry from The Ohio State University. Never stepping on Mississippi soil before, Schrimpf transitioned out of his job as a forester and moved to Starkville to pursue his master's in forestry.

"While I was growing up, I didn't realize forestry careers existed, so when I went to college, I started as a meteorology major. Once realizing that wasn't for me, I researched what majors would lead me to working outdoors, focusing on natural resources, and discovering more about nature; and that is how I found forestry," Schrimpf said. "When I graduated college, I had no intention of getting my master's, so I started working as a forester for a conservation district and loved it. One of my professors at Ohio State was a CFR alumna, Dr. Alexis Londo, and she shared how much she loved the forestry program at MSU. That is one reason I investigated this program, to take the next step in my career."

DR. ADAM POLINKO, assistant forestry professor and FWRC scientist, tailored the project to suit Schrimpf's research interests. Schrimpf aims to gain industry knowledge and practice what he learned while earning his master's.

"I am interested in working with private landowners, hardwoods, mixed-species forests, and silviculture, or the growth of forests and how they behave. So, I am studying what environmental factors we can change, like spacing trees when planting, to manipulate how trees form throughout their growth," Schrimpf said. "I am using southern loblolly pine trials that were planted in 1985 to see how the trees grew over time and what spacing changed over time. Studying forests over the long term is vital to understanding how they operate."

Schrimpf explained his research encapsulates five replication plots of the planting trial from 1985 at the John W. Starr Memorial Forest Wildlife Management Area, and he analyzed two of the plots for his research. He is looking at five-, eight-, and ten-foot spacings to identify what trees are living, dead, or need to be cut. From the plots Schrimpf analyzed, he then moved into

the next section of his research, which was computer-based.

"Using the Forest Inventory and Analysis National Program Library (FIA), I am building a model to understand how a mixed-species forest will grow and the procedures we can use to manage a multiple-species forest," Schrimpf said. "We are starting small and only using data from Mississippi, but we aim to have our model used universally with data from the FIA database."

Schrimpf has taken a unique approach to the computational side of his thesis, to replicate a different method to analyze his tree core data.

"Usually when collecting tree core data, you extract the sample with a long hand drill and the sample looks like a straw. From that, you can determine tree age, fire and drought history, and different climatic factors that have affected the tree's growth throughout its life," Schrimpf explained. "Instead of using a tiny microscope to detect the wood's history, we are using a CT scanner to take images of the core, and from there we are using computer programs to analyze the density and history of the wood, a method not commonly used in our field."

Schrimpf plans to graduate in May 2023 and is excited to see where his research and enhanced skill set will lead him.

"Graduate school has been a surreal and unique opportunity for me, and it has helped me learn what I need for the next step in my career," Schrimpf said. "I still am not sure where I will end up, but I know that MSU has helped me prepare for it. The professors and resources here are great, and I love being a part of this program." ■

This research is funded by the Forest and Wildlife Research Center.

Max Schrimpf takes a core sample of a pine tree at the John W. Starr Memorial Forest. (Photo by Karen Brasher)

PROFILE

UNDERGRADUATE STUDENT

LUCAS EVANKO

KERRVILLE, TEXAS

Growing Toward Success

STUDENT RETURNS TO SCHOOL FOR EDUCATIONAL AND PROFESSIONAL GROWTH IN WILDLIFE AND FORESTRY

BY GRACE JONES

FROM KERRVILLE, TEXAS, LUCAS EVANKO, lived in many places before the College of Forest Resources at Mississippi State University became his home-away-from-home.

As a nontraditional undergraduate student, Evanko returned to school to earn his associate and bachelor's degrees, while considering pursuing a master's, after working close to ten years since enrolled as a student.

"I had no intention of attending a four-year program, I decided to go to a community college when I lived in North Carolina," Evanko said. "One day, I tilled a food plot at my hunt club, and I thought about how I could do that forever. So, I started looking for programs and found a wildlife and forestry program at Haywood Community College, and while I was there, I became friends with a professor that encouraged me to push for a bachelor's degree."

Evanko explained he knew nothing about MSU when looking into four-year programs. He applied at the professor's recommendation and sought to get out and explore after a lengthy stay at home during the pandemic.

"After I applied to MSU, the senior admissions coordinator, Cory Bailey, called me and we spoke on the phone for around five hours about my options, the FWRC program at MSU, and about myself. MSU was the only school I applied to that did that, and I just knew that I was supposed to be here," Evanko said.

Since starting at MSU, Evanko has taken advantage of every opportunity. He is the senior representative for the Society of American Foresters student chapter and works in **DR. COURTNEY SIEGERT'S** lab, assisting in multiple research projects. Siegert is an associate professor in the Department of Forestry and FWRC scientist. Evanko also interned and conducted research with Weyerhaeuser this past summer.

"I'm finally doing school the way I wanted to; I am using this as my chance to show the people who've supported and cared for me to witness and be part of my success during my time here," Evanko said. "I want to finish school strong, be involved, and leave Dr. Siegert's lab in a better condition than when I started, which is how I try to approach everything. I love what I've done since I have gotten here. The work I've been a part of doesn't feel like work because of how much I've enjoyed it."

Under Siegert's direction, Evanko has visited and assisted at multiple research sites. Siegert's lab collects soil samples from various projects to quantify how much carbon is currently stored in the soil and how different experimental trials, like planting trees for bioenergy and existing forest restoration programs, increase soil carbon sequestration.

"In Dr. Siegert's lab, we are evaluating productivity and ecosystem services of short rotation Populus production in the Southeast. I've been testing soil quality and water quantity and quality for the Department of Energy funded project

Lucas Evanko examines a pine seedling in the forestry greenhouse. (Photo by Dominique Belcher)

to help quantify ecosystem services associated with biomass products. I've also worked on a bark hygroscopicity project where I measured the amount of water absorbed into bark, which helped answer questions geared toward understanding how much water a tree contains and what percentage of the moisture will be present in bark," Evanko said. "Working on this type of research helped in ways I didn't expect, like understanding more and having insight prior to starting my internship last summer."

After interning for Weyerhaeuser for the summer, Evanko was offered a fulltime position that will start after his graduation in May. Evanko shared he was excited about that opportunity and getting back into the professional, working world.

"I am thankful for the opportunities I've had while working in this lab, and Dr. Siegert has been a huge help with school," Evanko said. "I've learned it is better for us to understand the world we live in because everything is interconnected; if one system goes, we all eventually go. Looking at the bigger picture from insights our research provides helps us better manage and improve our world." ■

This research is funded by the Forest and Wildlife Research Center.

SUSTAINABLE BIOPRODUCTS

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

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

FACULTY

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

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FRANK OWENS
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GLOBAL/
NATIONAL
IMPACT

Forestry Forensics

USING AI TO IDENTIFY WOOD

BY MEG HENDERSON

MANY WOOD ITEMS we import from abroad are incorrectly declared on customs forms. Sometimes it's an honest mistake, but other times, items made from illegally cut timber—commonly from tropical regions like the Congo and the Amazon—are deliberately mislabeled and enter the U.S. and other countries in violation of law. Accurate wood identification plays a critical role in maintaining sustainable wood product value chains and adhering to national laws such as the Lacey Act and international treaties like CITES

Traditionally, wood identification has been the work of wood anatomists, specialists working in laboratories who examine wood with a magnifying glass or microscope looking for combinations of patterns in the wood's minute structure that are more or less unique to the species or genus. Today, FWRC scientist **DR. FRANK OWENS**, an assistant professor in the Department of Sustainable Bioproducts, is finding promise in using artificial intelligence to identify wood. **DR. RUBIN SHMULSKY**, sustainable bioproducts professor and head, and former doctoral student **ADAM WADE** also are working on this project.

"The problem with the traditional method of wood identification is that there are not many wood anatomists, and training takes a long time," Owens said. "And customs agents inspecting wood product shipments typically don't have the skills to do it."

The XyloTron (the prefix "xylo" comes from the Greek xýlon, meaning "wood") was invented by Dr. Alex Wiedenhoeft and a colleague at the USDA Forest Products Laboratory's Center for Wood Anatomy Research in Madison, Wisconsin. The system operates with a XyloScope, an instrument that connects to a laptop computer by USB cable and works like a microscope and high-resolution camera, and computer software using AI to analyze the picture and identify the species or genus. The operator prepares the end grain of a wood sample with a knife to reveal tiny anatomical features, takes a magnified picture of the cross-section, and pushes a button to start the image analysis and classification process, which takes only a few seconds. Wiedenhoeft and his research partner from the University of Wisconsin—Madison, Dr. Prabu Ravindran, design and customize the deep learning algorithms that allow the XyloTron to differentiate among different kinds of wood.

While they are not the only scientists investigating computer vision to identify wood species, the FWRC-based team is taking some innovative approaches to the practice using the XyloTron system.

"We focus on developing systems that can operate reliably in the field," Owens said. "One of the most important issues is image quality consistency. The XyloScope provides consistent lighting, framing, and distance from the lens to the wood, so you don't need to be in a controlled environment to capture quality images."

Wade, who focused his doctoral research on this project, added, "Similar systems require Wi-Fi or a cell phone signal, but with this software, you don't need connectivity on site."

While the speed and accuracy of the XyloTron are much faster and better than most humans,

Owens and Wade acknowledge that it doesn't always identify specimens correctly, so there is still work to be done before the system can be fully commercialized as a timber identification tool for broad use.

"We are evaluating the ability of the computer model to make accurate predictions on wood samples it has never seen before," Wade said. He emphasized that testing the identification software only on wood samples used to train a model is not enough. "Accuracy commonly drops when you show it entirely new specimens."

In short, the tool is promising but not yet ready to replace human expertise. Having prepared and identified over 900 specimens for the study, Wade noted that the computer would also occasionally make surprisingly obvious mistakes in classification. "The more you ask it to do, the more mistakes it makes, and these are errors that a human wouldn't make," he said. "But we are still looking to challenge the XyloTron to do more difficult things and looking for alternative methods of training the AI software."

Breakthrough technology such as AI computer vision is complex and will not be perfected overnight. But it takes scientists like those from FWRC to set the foundation for further research that will radically transform the global fight against illegal logging in the future. ■

This research was funded by the Forest and Wildlife Research Center with partial funding from USDA ARS, the United States Department of State, the USDA Forest Service, the Forest Stewardship Council, and a Wisconsin Idea Baldwin Grant.

Adam Wade uses a Xylotron to examine a wood specimen. (Photo by David Ammon)

IN THE FIELD:
CURRENT APPLIED RESEARCH

Strength In Rings

HOW TREE RINGS IMPACT STRENGTH

BY VANESSA BEESON

ACCORDING TO U.S. Department of Agriculture, 33.9billion board feet of softwood lumber was produced in the U.S. in 2017, the latest year data is available. More than 50% of that is southern yellow pine, also known as southern pine. The strength and quality of southern pine lumber are essential to keep the nation's forest products industry thriving. That's why FWRC researchers seek to understand southern pine characteristics that impact strength and quality.

One lumber characteristic of interest is rings per inch, or RPI. As timber management practices shift over time, trees may grow faster, may be harvested earlier, and ring widths, which indicate the age and growth rate of a tree, can change. Slow growing, older trees often have many rings closer together while younger, faster growing trees have fewer rings that are farther apart. **DR. FREDERICO FRANÇA**, assistant research professor in the Department of Sustainable Bioproducts, and **DR. NATHAN IRBY**, former doctoral student, sought to evaluate whether growing characteristics such as RPI affect strength.

While MSU scientists have extensively studied modulus of rupture, elasticity, shear, and other mechanical properties of lumber, less research has been conducted on compressive strength perpendicular to the grain. RPI and specific gravity, which calculates wood's density, can affect all these properties.

The team evaluated the RPIs and specific gravity of 471 two-by-eight and 306 two-by-ten pieces of dimension lumber. They found an average of four or more rings per inch. Southern Pine Inspection Bureau (SPIB) standard grading rules for southern pine lumber state that lumber with four or more RPI, and 50% summerwood, or 6 RPI and 33% summerwood can be classified as "dense" material, which is stiffer, stronger, and more economically valuable. Summerwood, also called latewood, is typically the denser portion of an annual ring of wood that develops late in the growing season.

Dr. Irby, a three-time College of Forest Resources alumnus, said that the RPI values in the test lumber met SPIB's standard, which states that dense lumber pieces that average not less than four annual rings per inch shall be accepted as dense if the average is at least one-half or more summerwood. This finding would put those pieces as candidate stock for dense classification if they contained at least 50% summerwood.

"We found that RPIs alone do not determine the wood's strength. The combination of rings per inch plus specific gravity was telling, and there was significance. We found that specific gravity itself was a better predictor of compressive strength perpendicular to the grain, but when coupled with rings per inch, it revealed greater significance and impact," Irby explained. This finding corroborates the grade rule which specifies minimum combinations for both RPI and percent summerwood.

Specific gravity is a measure of wood's overall density. Often the percent of summerwood is reported as a surrogate for density.

França said that the big picture goal of the work is to maintain the value of southern yellow pine while finding the intersection between optimal economic productivity and mechanical properties.

"We need more research studies that help increase revenue for the sawmill and timber producer while achieving repeatable and reliable mechanical properties for the consumer," he said.

França added that while RPI does influence

strength, there are other factors at play.

"Softwood lumber, such as that from pine, is typically stiffer and stronger when it contains more rings per inch. In this study, the result did not find that the effect was significant because there are also other variables involved that affect strength. Rings per inch is not the primary factor, but it does influence strength," he explained. "That said, trees that grow a maximum of a quarter inch per year (in radius) maintain four rings per inch."

He said that research like this that connects management practices in the forest to the finished product will only enhance the value of southern yellow pine.

"I am most excited about connecting foresters and the wood science industry through research like this. I would like to link landowners with forest managers, sawmills, and the wood science industry to better position the future of southern yellow pine use in the U.S. As both resource management and in-service uses change and evolve, research helps assure that we have a sustainable supply of pine lumber in perpetuity. It is helpful when we are all on the same page in working toward a common set of goals," he said. ■

This research was funded by USDA Agricultural Research Service, Southern Pine Inspection Bureau, Timber Products Inspection, the USDA Forest Service Forest Products Lab, and the Forest and Wildlife Research Center. Collaborators include Drs. Michael Barnes, Daniel Seale, Rubin Shmulsky, and Edward Entsminger.

Dr. Fred França displays two wood samples where the rings are clearly visible. (Photo by David Ammon)

COLLABORATION:
INDUSTRY PARTNERSHIP

50 Years Testing the Bend and Snap

FWRC RESEARCHERS STUDY 50 YEARS OF SOUTHERN YELLOW PINE PROPERTIES

BY GRACE JONES

SOUTHERN YELLOW PINE is one of the most readily available softwoods in the U.S. and, due to its availability, performance, and affordability, it is used broadly in construction. Questions are frequently asked about structural properties and how they may have changed over time.

Scientists in the Forest and Wildlife Research Center have conducted research to answer these questions and assess the flexural—tendency to bend or deform under load—properties of southern yellow pine from three samples that span over 50 years.

DR. FREDERICO FRANÇA, assistant professor in sustainable bioproducts, specializes in non-destructive testing of wood products. He is part of a team that recently sampled and conducted tests on southern yellow pine and pulled data from specimens collected from the early to mid-1960s from the USDA Forest Service Forest Products Laboratory in Madison, Wisconsin.

"This study has dataset specimens from fifty years ago that we compared to two other research projects we recently conducted," França said. "What is interesting is that the standards for testing wood specimens are the same as they were fifty years ago. So, even though we have technological advancements, the procedures and methodologies for wood testing have not changed, and since we have access to the raw data on the specimens dating back to the '60s, our results can be compared to see if properties have changed over time."

The team evaluated southern yellow pine's density, bending strength and stiffness, as well as compression parallel and perpendicular to the grain. They investigated the extent to which the specific gravity, strength, and stiffness of small clear specimens of southern yellow pine have changed from approximately 1965 to 2015. Some of the wood specimens were studied with compression parallel placement tests, comparable to studs and columns in housing construction, and with compression perpendicular to grain strength, similar to sill plates in houses and railroad ties under the load of a train.

"We design experiments and study properties for testing like this for real-world applications," França said. "Testing with applicability in mind helps us understand how to apply the results such that consumers and companies can safely use wood products."

After comparing the clear wood flexural properties of southern yellow pine taken across approximately five decades, the researchers found an increase in some wood properties and stability, which helped confirm that southern yellow pine remains reliable, strong, and safe for structural uses.

"Wood is such a special product; it acts differently than products like metal. Often it displays different properties, strength, and stiffness, among different sized pieces. So, learning as much as we can about wood products and how they respond and work under force and pressure is important,

especially when applying it to real-world uses," França said. "I was excited that we were able to replicate the same experiments that were conducted so long ago. I look forward to this research continuing and future scientists studying what we found here, just as we have done with our predecessors."

França explained how research that examines the structural evaluation of southern yellow pine timber is imperative for landowners, foresters, sawmills, and consumers to receive accurate information regarding the material's properties. Ultimately, by retaining the inherent wood structural properties over time, southern pine timberland retains and increases its value per acre.

"Our results indicate that southern yellow pine is not getting weaker. While there are differences among the samples, there was no clear trend regarding those differences, which supports the idea that the basic density and bending strength appear stable and reliable over time for wood with similar characteristics," França explained. ■

This research was supported by the USDA Agricultural Research Service, under agreement no. 58-0204-6-001, and the Forest and Wildlife Research Center.

Dr. Fred França conducts testing on a piece of lumber. (Photo by David Ammon)

PROFILE

GRADUATE STUDENT

FRANKLIN QUIN, JR.

STARKVILLE, MISSISSIPPI

A Wider Perspective

MSU STAFF MEMBER RETURNS TO THE CLASSROOM

BY MEG HENDERSON

FRANKLIN QUIN, JR. has been at home in the forest for much of his life. A Tylertown native, he grew up spending much of his time outdoors, from working in his family's garden to participating in 4-H activities.

Quin graduated from Alcorn State University in 1992 with a bachelor's in industrial technology and enrolled in MSU's wood science master's program that fall. After graduating with his master's in 1994, he went to work at a sawmill in Louisiana but returned to MSU two years later when a research associate position opened in the forest products (now sustainable bioproducts) department.

After almost 25 years, Quin decided to return to the classroom while continuing to work as a research associate under **DR. JILEI ZHANG**. In 2020, he enrolled again as an MSU graduate student, this time to work on a doctoral degree in forest resources with a sustainable bioproducts concentration.

"As a research associate, you're always learning through hands-on work, but I was ready to work on other aspects of the research process, such as writing grants and proposals and working with students," he said.

While Quin feels that his years of work as a research associate prepared him well for his doctoral studies, he is also enjoying making the transition back to the academic side of his field and the new challenges that graduate school brings.

"It's exciting for me to be involved in all aspects of the research, from pitching ideas to developing a complete project," Quin said.

Over the last two years, he has contributed to three major projects related to his graduate studies.

In a study directed by **DR. JASON STREET**, an associate professor, Quin has been analyzing the strength and stiffness of the post-to-rail connections in hardwood stairway handrails. He presented the progress of this research to the Stairbuilders and Manufacturers Association Structural Task Group via video conference in 2020.

Quin is also working under **DR. TAMARA FRANÇA**, an assistant professor, on several projects. One examines the development of preservative-treated cross-laminated timber, or CLT, specifically assessing the bonding performance

Franklin Quin places CLT samples in a dryer. (Photo by David Ammon)

and durability of a southern yellow pine CLT panel when post-treated with a copper-based preservative system. He and França are also studying the flexural properties of visually graded Southern pine structural lumber. In this project, they are taking 2 x 8 and 2 x 10 planks and evaluating how various characteristics of the lumber influence its flexural properties, such as bending strength and stiffness.

Two years into his program, Quin is pleased with his mid-career transition and is living proof that you can thrive in a doctoral program even when you've been out of the classroom for a couple of decades.

"I'm enjoying my studies and being on this end of the research process. Seeing the research from all perspectives makes you think about the larger picture and why that research is significant," he said. ■

This research is funded by the Forest and Wildlife Research Center.

PROFILE

UNDERGRADUATE STUDENT

MADELINE (MADDIE) GNANN

SHREVEPORT, LOUISIANA

Repelling Water

UNDERGRADUATE STUDENT STUDIES PAPER-BASED WATER-RESISTANT PACKAGING

BY MEG HENDERSON

A **NATIVE OF SHREVEPORT, LOUISIANA, MADELINE (MADDIE) GNANN** has always felt at home in the outdoors. Throughout her childhood, Gnann spent her summers near Little Rock, Arkansas at Ferncliff, an overnight camp that incorporates conservation and sustainable living into everyday activities. These summers helped shape her worldview and eventually drew her to major in sustainable bioproducts at Mississippi State University.

"I haven't always known what I wanted to do, but I have always wanted to leave a place better than I found it, and that's why I'm majoring in sustainable bioproducts," Gnann said.

During her senior year of high school, Gnann was looking at several different universities, but she said that MSU wasn't really on her radar. After receiving literature in the mail about the sustainable bioproducts program and then visiting campus, she had a strong change of heart.

"After visiting and taking a tour of campus, I just knew that MSU would be a perfect fit," she said.

In her first year at MSU, Gnann was invited by her professor **DR. XUEFENG "JASON" ZHANG** to assist Ph.D. student **OSHANI NAYANATHARA** on a research project developing paper-based water-resistant packaging materials with a method that uses metal ions to repel water.

"We were working with paper, which is usually hydrophilic, meaning it absorbs water. Items like tissues, toilet paper and paper towels are designed to be hydrophilic. They found a way to make paper hydrophobic, which means that it resists water," she said.

Gnann has been assisting Zhang and Nayanathara in the lab, measuring the contact angles of water on the hydrophobic papers and learning how to mix chemical solutions. In addition to this valuable opportunity to conduct research, Zhang invited her to participate in the 2022 Undergraduate Research Symposium, where she gained practical experience in writing an abstract and creating and presenting an academic poster.

"At the time, I didn't realize what an unusual opportunity attending the symposium was for a freshman. Most of the other students were upperclassmen, so it was a big deal for me to participate," Gnann said.

Before coming back to campus to begin her second year, Gnann had an opportunity to return to Ferncliff, this time as a counselor and staff member.

"I always knew that I would come back and help teach children about sustainability, keeping your footprint small, and living green," she said.

She added that she has been able to pass on to her campers what she is learning in her courses, and she sees her work as a counselor as an opportunity to inspire the next generation about the natural world.

Looking forward, Gnann sees herself going to graduate school to continue and deepen her education, but she has a few years to figure out which direction her studies will take her. Whatever that choice may be, she feels that the faculty in the sustainable bioproducts department have given her a solid foundation to succeed.

"In our department, there is always someone who is willing to help. It feels like every single person in the department knows who I am, and it feels good to be recognized and not just another face in the crowd," she said. ■

This research is funded by the Forest and Wildlife Research Center Undergraduate Research Scholars Program.

Madeline Gnann dips paper into a solution to make it hydrophobic. (Photo by Dominique Belcher)

WILDLIFE, FISHERIES & AQUACULTURE

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

CONSERVATION

- Conservation Biology
- Conservation Education
- Invasive Species Ecology
- Threatened and Endangered Species Recovery
- Veterinary Wildlife Sciences

FISHERIES

- Fisheries Science and Management
- Recreational Fisheries

HABITAT

- Agricultural Wildlife Management
- Forest and Wildlife Management
- Habitat Restoration and Monitoring
- Native Grasslands and Upland Bird Conservation

HUMAN DIMENSIONS

- Human-Wildlife Interactions
- Human Dimensions of Fisheries and Wildlife Management
- Wildlife Damage Management
- Wildlife and Fisheries Economic Enterprises

WATER

- Freshwater River and Streams Management
- Water Quality in Agriculture and Forested Landscapes

WILDLIFE

- Backyard Wildlife and Urban Ecology
- Carnivore and Population Ecology
- Deer Ecology and Big-Game Management
- Small-Game Management
- Waterfowl and Wetlands Conservation and Management

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Assistant Research Professor

FERNANDO YAMAMOTO
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EMERITUS

DAVID BURRAGE
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ERIC D. DIBBLE
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ADJUNCT

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LILY SWEIKERT

GLOBAL/
NATIONAL
IMPACT

Turning off the Tap

FWRC RESEARCHER EXAMINES IMPACTS OF CLIMATE CHANGE IN THE AMAZON

BY MEG HENDERSON

THE AMAZON RIVER BASIN is one of the most critical pieces of the Earth's climate system, generating rainfall, lowering land surface temperatures, and influencing global weather patterns. It is known for its unique and irreplaceable biodiversity in plant and animal life. But the rainforests that formed over millions of years have experienced dramatic changes in the last few decades.

The loss of this valuable resource prompted a historic scientific consortium in late 2021 at the 26th United Nations Climate Change Conference, or COP26, in Glasgow, United Kingdom. The Science Panel for the Amazon, or SPA, was a group of over 200 prominent scientists including **DR. SANDRA B. CORREA**, assistant professor in the Department of Wildlife, Fisheries and Aquaculture and FWRC scientist. Their objective was to create a comprehensive report assessing the state and future of the region's ecosystems in response to climate change and human activity.

In 2019, representatives from the eight countries in the Amazonian region convened to discuss the need for creating a path for sustainable development. Jeffrey Sachs, an economist at Columbia University, Director of the Center for Sustainable Development, and senior UN advisor, led the initiative for producing the report. Correa, who is from Colombia and spent two decades conducting research in the Amazon, contributed to two chapters of the report: one describing how the Amazon's ecosystems function and the other focusing on present and future effects of climate change on these ecosystems.

The report presents a comprehensive view of the current literature on Amazonian ecosystems and highlights patterns and trends. The two main trends Correa and her team discussed were an overall reduction in precipitation and increasing temperatures.

"From my own experience and research, one of the patterns that strikes me most is how erratic the changes in river flow patterns have become in recent years," she said. "In the last 20 years, we have seen seasonal flooding and drought patterns become more extreme. And what were once called 'century floods' have happened multiple times within a decade."

Extreme drought, Correa explained, causes temporal fragmentation when river tributaries stay dry, and sediments cannot reach floodplains to fertilize plants. On the other end, massive floods threaten both terrestrial and aquatic animals. Large-scale famine and drowning of wildlife, as was seen in the Mississippi flood of 2019, has become more frequent. Moreover, these severe fluctuations have affected human livelihood, from hunting, fishing, and farming to transportation, as many locations in the Amazon are accessible only by boat.

"We need to achieve a plan for sustainable development that doesn't leave behind the rich indigenous and rural communities. The number of groups and ethnicities in the region is incredibly diverse," Correa said.

Although the impacts of climate change on the Amazon alone are important, the report stresses

the interdependence of the rest of the world on the Amazon's climate. What happens there affects every ecosystem and every person on the planet, Correa pointed out.

"The Amazon's forests are the lungs of the planet—the rainforest acts as a water-pumping system to perpetuate the rainfall cycle and growth of trees, which capture carbon from the air in their stems and leaves," Correa said. "Clearing forestland for timber, farming, and mining and damming rivers for energy creates a drier environment and slows down the growth of existing trees, weakening the forest's carbon sink. These activities have placed so much stress on the system that it is no longer doing what it is supposed to do."

Correa explained that there is a tipping point at which the Amazon will transform from a rainforest to a savanna environment. Recent studies estimate that the pumping system will be effectively shut off when deforestation of the region reaches about 20-25 percent.

The report proposed a number of strategies to slow down and prevent reaching this point, including government commitment to stopping large-scale deforestation, holding off construction of large dams, and reducing CO_2 emissions on a global scale.

"Studying the changes in this ecosystem and how plants and animals respond is critical to its survival," Correa said. "Once we have that knowledge, we can conserve, restore, and adapt."

Correa's work in the Amazon, though 3,000 miles away, provides application in Mississippi, where she studies rivers and aquatic life dependent on these ecosystems.

"How can we apply the lessons learned in the Amazon to the Pascagoula river, which are similar with extended periods of flooding?" Correa said. "Flooded forests provide important habitats for wildlife and fish, and understanding their function provides an opportunity to save these diminishing landscapes. ■

This research is funded, in part, by the Forest and Wildlife Research Center.

Dr. Sandra B. Correa in the Colombian Amazon, 2019. (Photo by Dr. Jorge Garcia Melo)

IN THE FIELD:
CURRENT APPLIED RESEARCH

Caught on Camera

UNDERSTANDING ECOLOGY OF GRAY FOXES AND ASIAN BEAR POPULATION ESTIMATION

BY GRACE JONES

FINDING BETTER WAYS to study foxes and bears in the forest helps animals and humans alike, according to one FWRC population ecologist.

"Coexistence between wildlife and humans is essential to human quality of life. Wildlife can be a boon and nuisance, yet we can't exist without it, and I wouldn't want to," said **DR. DANA MORIN**, assistant professor of wildlife ecology and FWRC scientist motivated to discover the best animal population monitoring methods.

Morin contributed to two studies considering how to utilize camera traps to monitor population trends and understand drivers of population change amongst different species. She and her collaborators from the U.S. Forest Service, Southern Illinois University Carbondale, and the Illinois Natural History Survey studied how competition may contribute to population declines in gray foxes. The other team of species experts with the International Union for Conservation of Nature (IUCN) Bear Specialist Group, established by the Species Survival Commission (SSC), sought to evaluate methods to estimate density and population trends for Asian bear species, including sun, sloth, brown, panda, and Asiatic black bears.

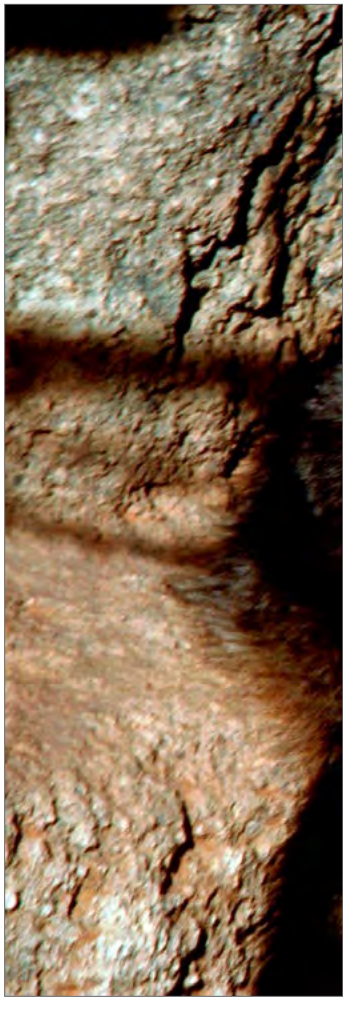
"The gray fox research used a large-scale camera-trap study in Illinois, where interactions among native canid species, mammals in the dog family, and free-ranging domestic dogs were examined," Morin said. "The dataset had 1,188 camera trap stations, which allowed us to answer questions on how different canid interactions can affect populations."

Through Morin's data analysis, potential causes of a decline in gray fox populations were identified. Substantial overlap in space use and temporal activity among gray foxes and other canids suggest competitive exclusion is reducing gray fox populations, but long-term research is required to confirm whether populations will continue to decrease.

"This showed camera trap studies can help describe occurrence and estimate the interactions among species but could not account for long-term population trajectories from those interactions," Morin explained. "Camera traps are a useful tool but are limited in what they provide. Our best camera trap information comes when it is used with existing population trend information or in combination with other data, like observing marked individuals in photographs and telemetry data."

Morin has evaluated combined methods in her current research to discover what density estimation methods are best suited for monitoring a completely different group of animals: Asian bears.

"I worked on this project with the IUCN Bear Specialist Group and species experts to assess how to best implement research to monitor different populations of Asian bear species," Morin said. "Choosing one method was difficult because



Asian bears live in different areas, occur at low densities, and causes of decline, often poaching, are difficult to describe based on the region's data we typically collect. I assessed recently developed "unmarked" density estimation methods, where individuals do not have distinguishable natural or applied marks, using camera traps."

The team found that unmarked estimation methods were unreliable for low density species, the case for most Asian bear populations, but accuracy and precision improved when camera trap data was used in conjunction with additional sampling methods.

"This study was foundational for addressing solutions for using camera traps for population monitoring," Morin said. "For example, we are evaluating these kinds of methods for estimating white-tailed deer densities in Mississippi and expect better results for the more common species."

In addition, the research concluded that detecting population declines in Asian bears or other low-density populations would require sampling at extensive spatial scales, collaborations, and coordination of study designs and sampling protocols.

"My motivations in research are to ensure the right tools are selected, whether camera traps or genetic methods, in order to have accurate answers," Morin explained. "Critically evaluating the methods, we use to monitor common or endangered species is essential for producing reliable results that improve our understanding of a species' population trends." ■

The gray fox research was funded by Illinois Department of Natural Resources, Federal Aid in Wildlife Restoration Project, USDA Forest Service, Pacific Northwest Research Station, and USDA National Institute of Food and Agriculture McIntire Stennis Program. The Asian bear research was supported by USDA National Institute of Food and Agriculture McIntire Stennis Program with additional funding provided by the Research Council of Norway.

A gray fox in the wild. (Photo by US Fish and Wildlife Service)

COLLABORATION: **INDUSTRY PARTNERSHIP**

Thinking Big for Birds

THE TOMBIGBEE FOREST BIRD PARTNERSHIP HELPS BIRD CONSERVATION SOAR IN WORKING FORESTS

BY VANESSA BEESON

OVER 62% OF MISSISSIPPI'S LAND BASE is forested giving the Magnolia State a $13.8 billion dollar forestry and forest products enterprise. While green covers the map, the residents that enjoy the forested landscape are why Forest and Wildlife Research Center scientists are part of the Tombigbee Forest Bird Partnership (TFBP), an effort aimed at celebrating and enhancing avian conservation in the Southeast's working forests.

Emily Jo "EJ" Williams, vice president of the American Bird Conservancy's Southeast and Atlantic Coast region, leads the effort and said the partnership's goals include communicating the value of working forests, sustaining and increasing the conservation value to birds across the landscape, and developing and conducting demonstration and research activities.

"We seek to demonstrate and celebrate the values of sustainable forest management in private working forests for bird conservation and also identify ways to maintain and enhance those values for birds, especially for species in decline," Williams said.

The TFBP covers nearly one million acres in a 75-mile radius around Starkville, including 19 Northeast Mississippi counties and six Northwest Alabama counties. The partnership, which includes International Paper, Weyerhaeuser, The Westervelt Company, C.A. Barge Timberlands, McShan Lumber, Wildlife Mississippi, Alabama Forestry Association, and the Mississippi Band of Choctaw Indians, grew out of another collaboration between the American Bird Conservancy and the Sustainable Forestry Initiative (SFI), a group that promotes sustainable forestry and manages a set of certification standards.

Williams said the TFBP helps landowners learn how their management decisions influence habitat conditions for birds and other wildlife.

"We'll spend a day out with a landowner, and they gain insight into the birds using their land. We can show them how the birds are benefiting from existing sustainable forestry best practices and how we can make enhancements. We celebrate what's good and look for ways to do even more," she said.

Williams also discussed the involvement of the Mississippi Band of Choctaw Indians in the partnership.

"The tribe has about 28,000 acres of forested land. They're in the process of rebuilding their dictionary so we're learning about the cultural importance and names of birds in their language. Additionally, the Choctaw art of basketweaving uses rivercane and the tribe has lost much of this raw material so we're hoping to help them restore rivercane habitat and, in the process, perhaps help birds who were once dependent on it. Improving the cultural and biodiversity value of the landscape is vital," she said.

DR. KRISTINE EVANS, associate professor in the Department of Wildlife, Fisheries and Aquaculture and an FWRC scientist, has long studied forested habitats for landbirds. Most recently, as technical advisory team chair for the East Gulf Coastal Plain Joint Venture, she helped create the East Gulf Coastal Plain Landbird Conservation Plan. Recommendations in the plan detailing long-term population and habitat objectives for 29 prioritized landbird species across six Southeastern states will be utilized by the TFBP partnership.

Evans conducts research and monitoring in collaboration with TFBP partners as well and recently evaluated how forest management activities influence species diversity and abundance at the landscape scale.

"We assessed if young plantation areas could serve as a proxy for grassland and shrubland habitat and enhance the bird communities. We also studied

mature forests to see how the proximity to varied patches of habitat affected bird communities and found that nearness to different habitats bolstered bird populations," she said.

In another project, Evans is assessing plant-pollinator-bird relationships on Weyerhaeuser-managed forests in Mississippi and Westervelt-managed forests in Alabama. The team is in the first year of evaluating diversity of plants, pollinators, and birds to determine important connections between all three.

"Our understanding of the relationships among plants, pollinators, and birds in forest systems is limited. We recognize how a certain interdependence among these organisms often has disproportionate effects on the function of biological systems so a better understanding of functional diversity within this ecosystem may be of great importance in managed forest systems," she said.

Evans pointed out that most timber producers are already focused on sustainability and this partnership aims to increase their ability to further enhance forest and wildlife health.

"Across the southern U.S., 86% of forests are privately owned, many managed for timber production. Working forests are critical to sustainability of biodiversity and economic security in rural southern landscapes, and support many imperiled species," Evans explained. "At one TFBP site, we detected 76 bird species. That's comparable to most protected non-production forests. We seek to raise awareness of the value of these managed forest systems for biodiversity while making small management enhancements that will increase sustainability of forest resources for wildlife without impacting economic returns." ■

The American Bird Conservancy and International Paper fund the partnership with in-kind donations from Weyerhaeuser, the Westervelt Company, and C.A. Barge Timberlands LP. In addition to Evans, Dr. Mark McConnell, MSU assistant professor in wildlife, fisheries and aquaculture, also collaborates on the work.

Dr. Kristine Evans conducts a bird count in a working forest in Oktibbeha County. (Photo by David Ammon)

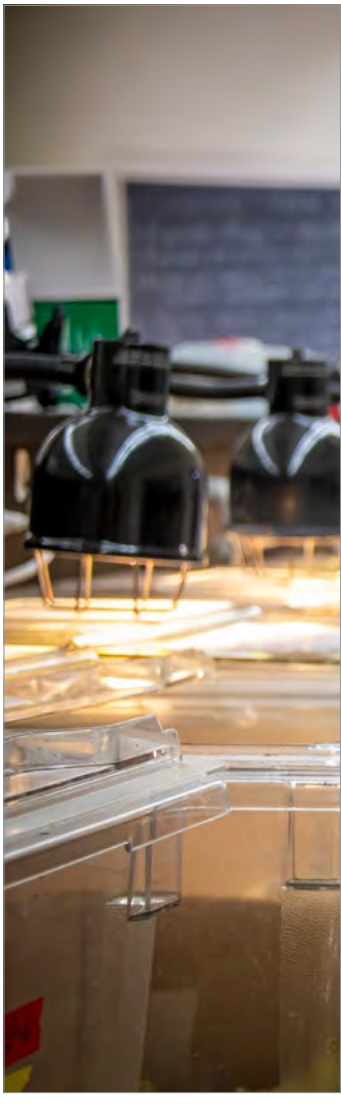
PROFILE

GRADUATE STUDENT
NAMIA STEVENSON
BITBURG, GERMANY

Saving Amphibians

GRADUATE STUDENT FOCUSED ON AMPHIBIAN FERTILITY TO ASSIST CAPTIVE BREEDING PROGRAMS

BY VANESSA BEESON



NAMIA STEVENSON, wildlife, fisheries and aquaculture master's student, studies frogs and toads in MSU's Conservation Physiology Lab. Stevenson's interests were piqued from a 2019 UN report that estimates 40 percent of amphibian species, or 2,000 individual species, are in danger of extinction.

"Amphibians suffer population loss from various causes including pollution, food trade, habitat degradation, and disease," she said.

She explained amphibians are bioindicators that reveal an environment's health.

"As bioindicators, the presence of many amphibians in an ecosystem indicates a healthy environment. However, amphibians absorb environmental toxins through their skin so they're among the first to suffer when an environment is suffering," she said.

Her research seeks to improve fertility in endangered frogs and toads to help amphibian captive breeding programs become more sustainable, genetically diverse, and increase reproductive output to support reintroduction programs. Captive breeding populations are often the last line of defense in keeping a species alive when the number of animals in the wild dwindle critically.

"This research aims to create a baseline protocol, so we can help solve the problem of breeding more amphibians in a more holistic way. Instead of just injecting them with hormones, we track egg maturation and sperm count, so the therapy is more targeted," she said.

Stevenson's master's thesis focuses on the Fowler's toad, a common toad native to Mississippi.

"I'm tracking reproductive cycles whenever the toads produce sperm or eggs, assessing where their levels of estrogen, progesterone, or testosterone lie. I'm trying to match hormone therapies with reproductive cycles to increase fertility. The Fowler's toad is a model species, in which I'm able to refine my methods before applying them to other less common species," she said.

An endocrinology class her first semester at MSU further inspired her choice to track reproductive hormones in amphibians.

"The class sparked my interest in seeing how hormone levels are affected by stress and the environment. This is something that has been studied extensively in animals and even humans, and could really contribute to improved fertility in amphibians," she said.

She collaborates with Fort Worth Zoo, North Carolina Zoo, and Omaha Henry Doorly Zoo to help endangered species. At the North Carolina Zoo, she used a hormone application method developed in Fowler's toads to help Colorado River toads who struggle to reproduce in captivity.

"Our work resulted in the first Colorado River tadpoles hatched at North Carolina Zoo and production of 12 toadlets, which is remarkable because the curator didn't expect any and

Namia Stevenson holds a Fowler's toad in the MSU Conservation Physiology Laboratory. (Photo by David Ammon)

they hadn't been able to reproduce the animals for years. The female had never laid eggs before and hopes for successful natural reproduction were low," she said.

Prior to coming to MSU, Stevenson was a zookeeper at Lincoln Park Zoo in Chicago. She graduated with a bachelor's in wildlife science from Charleston Southern University in Charleston, South Carolina.

Stevenson says this is her first foray into research and she's learning something new every day.

"This program has pushed me to be a better researcher and person. We have different partnerships with zoos around the country and those connections we build are vital for conservation. I didn't think a master's student or even a university could collaborate with zoos on the level which we collaborate," she said.

Stevenson emphasizes that amphibians, as bellwethers of our environment, shouldn't be overlooked.

"As an animal lover, I wish people would appreciate the slimy, less charismatic animals as much as the big fuzzy ones you see in the zoos," she said. ■

In addition to amphibians, the MSU Conservation Physiology Laboratory studies a variety of mammal and fish species and is home to the National Amphibian Genome Bank. Stevenson's research is supported by an Institute of Museum and Library Services (IMLS) American Recovery and Rescue Plan Grant for training the next generation of professionals interested in living collections care and sustainability.

PROFILE

UNDERGRADUATE STUDENT

NATHAN COWLEY

WAKE FOREST, NORTH CAROLINA

Aiming for Success

UNDERGRADUATE STUDENT SETS HIS SIGHTS ON DEER RESEARCH

BY KATHLEEN FORMAN

MANY FRESHMEN ENTERING INTO their first year of college feel like a deer caught in headlights. The hectic class schedules, countless clubs and organizations, and exciting social events can be overwhelming, and it's all too easy to let opportunities slip by. **NATHAN COWLEY**, however, came into his freshman year with laser-sharp focus.

Cowley, a wildlife, fisheries and aquaculture major, has always set his sights on ambitious personal and career goals. Within three weeks of making the move from Wake Forest, North Carolina to Starkville, Mississippi, Cowley secured a research assistant position with the MSU Deer Ecology and Management Lab. He heard of this position from **DR. STEVE DEMARAIS**, professor and Taylor Endowed Chair, who encouraged him to apply for an available research assistantship in his laboratory. Cowley has now worked in the MSU Deer Ecology and Management Lab since his freshman year, assisting in a variety of research projects.

"When I first started, I worked under **MIRANDA HUANG**, a research associate, conducting surveys and processing data for her research on chronic wasting disease in deer," said Cowley. "Since then I've assisted on different research projects as needed, helping manage spreadsheets and process data."

Cowley's work with Huang aims to determine how differing social groups, patterns, and rutting activity may progress the movement of the disease through the population. Huang uses artificial and natural scraping sites to view the intense interaction between deer and their social groups during the season of the rut. Cowley sorts through the data produced by trail cameras to identify individual bucks by their unique antler and body characteristics. He also determines which bucks frequent the same area together, therefore using the same scrapes and possibly passing chronic wasting disease.

"The majority of my work on this first research project was conducted during the Tennessee deer season since the most definitive way to test for chronic wasting disease is by extracting the deer's brain stem or Lymph nodes," said Cowley. "All deer harvested during the season and within the study area were tested at the local check station."

In addition to his work with Huang, Cowley assisted graduate research associate Luke Resop in his study of habitat management and improving wildlife habitats through administering prescribed fire. The research team performed prescribed burns in areas with a wide variety of tree

Nathan Cowley with Lucky, a deer at the MSU Johnie R. Dawkins Memorial Deer Unit. (Photo by Megan Bean)

species. They then surveyed the trees on site and applied heat via a propane tank burner and took notes of factors such as temperature, tree moisture, ground moisture, pressure, canopy cover, tree height, and diameter at breast height. This research is still in progress and results from the study will show the successional growth results of habitat from the prescribed fire.

"At the end of this data collection period, several different sites were surveyed and at least a thousand trees were burned for data purposes," said Cowley. "We also conducted small scale burns on shrubbery to see the effects that windblown fire has on an area as opposed to a non-windblown fire."

Cowley is already focused on a clear path. He is drawn to the scientific side of the wildlife, fisheries and aquaculture major and plans to delve deeper into the "why" behind wildlife behaviors. After graduation, he hopes to work in conservation to further the research and application of wildlife preservation and education of habitat management.

"One of the largest misconceptions of hunting is that sportsman only want to take from the natural resources available and not care for wildlife," said Cowley. "Being an avid sportsman myself for many years now I can testify that this thought process is false. Sportsmen like myself care more, because we want to preserve the activities we all enjoy for the future generations. ■

This research is funded by the Forest and Wildlife Research Center.

KENNEDY CHAIR

The Decline of the Black Duck

UNDERSTANDING HABITAT PREFERENCES OF AN AT-RISK WILDLIFE ICON

BY MEG HENDERSON

APPROXIMATELY 10,000 YEARS AGO, the last glaciers retreated, helping form the northern prairies in North America. Among dozens of waterfowl species, mallards and black ducks settled in what are now Canada and the United States. These species share many common traits, but they remained geographically partitioned until recent history.

"When the glaciers melted, mallards settled in the prairie wetland systems of southern Canada and midcontinental United States, whereas black ducks settled in the northeastern United States, and their breeding ranges were separated by boreal and hardwood forests," said **DR. J. BRIAN DAVIS**, FWRC scientist and James C. Kennedy Endowed Chair in Waterfowl and Wetlands Conservation. "Over time, humans settled these areas and cleared forestland, and mallard populations gradually shifted eastward."

Mallard populations have thrived in the United States, but in contrast, the numbers of what Davis calls the "iconic" American black duck (*Anas rubripes*) have gradually declined over the last 50 years. Annual winter surveys flown by aircraft each year from November through January by the U.S. Fish and Wildlife Service, or USFWS, have documented these declines in historical wintering areas of west-central Tennessee. The number of black ducks, for example, declined from 35,200 to 807, or 98%, between 1990 and 2019 at Tennessee National Wildlife Refuge (TNWR).

In the winters of 2010-11 and 2011-12, the USFWS initiated a study at the TNWR, one of the most important mid-continent waterfowl sanctuary and wintering location for Mississippi Flyway black ducks. The research team including Davis, fellow FWRC scientists, a professor from the University of Tennessee, and former MSU graduate student and lead author **KIRA MONROE**, set out to investigate the habitat selection and patterns of wintering black ducks at the refuge.

"While USFWS had an enormous amount of data on bird numbers over several years, no published study had ever tagged birds with radio transmitters and observed their habitat use on and off the refuge," Davis said.

The team spent two winters radiomarking a total of 111 black ducks. During the second season, they also tagged 14 mallards. The tags provided feedback on the movement and locations of the ducks. In another companion study from the University of Tennessee-Knoxville, graduate students also

observed individual duck behaviors from blinds onsite over two winters.

At the beginning of the study, Davis and his team speculated that mallards could be outcompeting black ducks for food or refuge habitat space. However, the location data and site observations gathered during the study supported no evidence of competition between mallards and black ducks.

"Having ruled out competition from mallards, we came away with two possible hypotheses about the black ducks: one, breeding populations that served these wintering areas were declining, or two, the populations were redistributing, with a number of birds staying further north due to climate change," Davis said.

As the first published study to radiomark black ducks at this primary southernmost wintering site, the team's research lays the foundation for more studies to follow. The study is also valuable from a refuge management perspective. The team observed the specific types of habitats the black ducks prefer and found that, while they did use flooded agricultural land, they preferred native herbaceous wetlands and "scrub-shrub" wetlands over other land cover types.

"Ultimately, we wanted to know whether or not the refuges were meeting the needs of black ducks," Davis said. "From our findings, we suggest refuges provide habitats with a variety of land cover types, particularly the herbaceous and scrub-shrub wetlands." ■

This project was funded by MSU's Forest and Wildlife Research Center and the James C. Kennedy Endowed Chair in Waterfowl and Wetlands Conservation, the U.S. Fish and Wildlife Service, the University of Tennessee Institute of Agriculture, and the Central Hardwoods Joint Venture.

Kira Monroe holding one of her radiomarked black ducks. (Photo Submitted)

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.

Altering a Collision Course

UNDERSTANDING DEER'S FLIGHT RESPONSE TO AVOID VEHICLE COLLISION

BY VANESSA BEESON

IN THE U.S., deer/vehicle collisions cause 1.5 million motor vehicle accidents each year, resulting in 200 fatalities and over a billion dollars in property damage. With 1.75 million deer in Mississippi, deer/vehicle collisions are cause for concern. That's why an FWRC scientist, with lead collaborators from participating agencies, sought to better understand how deer respond to approaching vehicles before a collision occurs.

DR. RAY IGLAY, assistant professor in the Department of Wildlife, Fisheries and Aquaculture and FWRC researcher, was part of a team that evaluated deer responses to approaching vehicles.

The team conducted an opportunistic experiment protocol, recording observations of deer during a six-month period on the National Aeronautics and Space Administration (NASA) Neil Armstrong Test Facility (formerly Plum Brook Station) in Sandusky, Ohio. Observations took place on two lane roads with maximum speeds of 40 miles per hour. Anytime an observer saw a deer in the study area, they could start an observation to include in the study.

The researchers studied flight initiation distance (FID) or the distance from an approaching predator at which the prey flees. They were also interested in behavior associated with crossing the road.

"Flight initiation distance was one response we studied, trying to see at what distance from the vehicle would the deer start moving and initiating that flight or moving away from the threat. That movement could be going across the road or going back into the woods. The crossing the road behavior was also important to us. When they did have a flight initiation from the oncoming vehicle, did they cross the road or move away from the road?" Iglay said.

The team hypothesized animal proximity to the road and group size, speed of approaching vehicle, and environmental

conditions as factors that might impact how quickly a deer responded to an oncoming automobile.

"We studied whether or not the deer had spatial and temporal thresholds of safety and the proximity to the road to see if and when the deer reacted," Iglay said.

The team recorded 328 vehicle approaches toward groups of an average of two deer. While the team found that proximity to the road influenced FID, deer didn't demonstrate spatial or temporal safety thresholds and FID wasn't impacted by either oncoming vehicle speed or environmental conditions.

"Deer responses were variable and did not demonstrate spatial or temporal margins of safety. While the findings supported that deer proximity to the road impacted FID, distance or speed of vehicle or environmental conditions had no apparent effect," Iglay explained.

The team also found that road crossing was influenced by group size and proximity to the road.

"Road-crossing behavior was slightly and positively influenced by group size during the winter. Deer also showed greater FIDs and likelihood of crossing when approached in the road, which indicated the direction of the approaching vehicle likely increased the perceived risk," Iglay said.

He said the research was an opportunity to discover more about deer/vehicle collisions.

"It's exciting to me to help with one piece of the puzzle in mitigating deer/vehicle collisions. The idea is that if we can accurately determine more about a deer's flight initiation distance, we might be able to design vehicles to be more threatening in order to initiate FID faster in the future." ■

Collaborators include Dr. Morgan Pfeiffer, Dr. Bradley Blackwell, and Mr. Thomas Seamans, U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS); Dr. Travis Devault, Savannah River Ecology Laboratory, University of Georgia; Wildlife Services, National Wildlife Research Center, and the Ohio Field Station. This research is funded by FWRC and U.S.D.A. Wildlife Services National Wildlife Research Center.

A white-tailed deer leaps over a fence in front of oncoming traffic. (Stock photo)

FACULTY REFEREED PUBLICATIONS

Forest and Wildlife Research Center faculty produced 157 refereed publications during 2022. For a complete list of publications, visit https://www.fwrc.msstate.edu/publications.

THESES

Andrews, B. M. 2022. The effects of short-term sea level rise on vegetation communities in coastal Mississippi. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Baach, E. 2022. Diversity-productivity relationships in forests of the southeastern United States: Leveraging national inventory data and tree functional traits. Thesis, Department of Forestry, Mississippi State University.

Babik, N. 2022. Photocatalytic degradation of organic contaminants by titania particles produced by flame spray pyrolysis. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Barkley, K. 2021. Optimal control of adaptive wild hogs. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Bates, C. S. 2021. Effects of bonding pressure and lamina thickness on mechanical properties of CLT composed of southern yellow pine. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Bedette, A. P. V. 2022. Attitudes and perceptions of college students and recent college graduates towards forestry and wood products science fields. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Bedwell, E. K. 2021. Impact of economically targeted conservation delivery on agricultural revenue across a range of commodity prices. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Brister, M. 2021. Using precision agriculture to identify overlap in conservation and economic opportunities in agricultural landscapes. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Burger, I. J. 2021. The ART of amphibian conservation: Linking in-situ and ex-situ populations of endangered species through genome banking. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Craig, M. 2022. Consumer attitudes and perceptions towards the use of reclaimed wood. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Dahal, B. 2021. Biomass production of Black Willow (*Salix nigra* Marsh.) and Eastern Cottonwood (*Populus deltoides* Bartr. Ex Marsh.) in the Lower Mississippi Alluvial Valley. Thesis, Department of Forestry, Mississippi State University.

Divya, D. 2021. Phenotypic and genotypic characterization and comparison of *Edwardsiella ictaluri* isolates derived from catfish and ornamental fish species. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Duquette, B. A. 2021. Evaluation of decay effect on tension perpendicular to grain properties of wood. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Gibson, J. T., 2022. Nesting ecology of wood ducks and other cavity-nesting ducks in Mississippi. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Goldsmith, C. D. 2021. Oak regeneration: Impacts of prescribed fire and invasive species. Thesis, Department of Forestry, Mississippi State University.

Hale, C. W. 2021. Regeneration potential and habitat suitability modeling of three imperiled Southeastern U.S. woody plants. Thesis, Department of Forestry, Mississippi State University.

Horowitz, L. B. 2022. Stress response and recovery of Atlantic Tarpon (*Megalops Atlanticus*) to catch-and-release angling. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Huang, M. H. J. 2021. The effects of year-round supplemental feeding of white-tailed deer on sources of disease. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Navarre, B. 2021. Effects of year-round supplemental feeding of white-tailed deer on plant community dynamics. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Neupane, K. 2021. Field durability test of CLT wall envelope using physical barriers against termites and structural performance of nailed hold-down brackets connected to fungus-exposed CLT walls. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Norman, D. A. 2021. Linking remotely-sensed UAS imagery to forage quality in an experimental grazing system. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Palode, B. 2022. Evaluating the role of area, isolation, and human behavior on meso-mammals in a small statistical demographic area. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Sherrington, A. 2022. Determination of flexural strength of structural red and white oak and hardwood composite lumber. Thesis, Department of Sustainable Bioproducts, Mississippi State University.

Starnes, V. R. 2021. A structured approach to water management of a multiuse reservoir. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Subedi, S. 2022. Climate sensitive diameter growth models for major tree species in Mississippi. Thesis, Department of Forestry, Mississippi State University.

Todaro, H. M. 2022. Assessing priority bird response to open pine management in eastern Mississippi. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

VanderBloemen, S. N. 2022. The invasion of bigheaded carps in the Tennessee River and Tennessee–Tombigbee Waterway. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Watkins, K. S. 2022. Quantifying the economic impact of conservation policy changes utilizing precision agriculture tools. Thesis, Department of Forestry, Mississippi State University.

Woodard, S. C. 2021. Impacts of season, single prescribed burn, and winged elm (*Ulmus alata*) encroachment on fuel dynamics in an upland oak stand in northern Mississippi. Thesis, Department of Forestry, Mississippi State University.

Wright, H. C. 2021. Distribution of woodpecker activity relative to wooden utility structure usage in the southeastern United States. Thesis, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Zhou, X. 2021. Characterizing flooding regimes in the lower Mississippi Alluvial Valley over recent two decades. Thesis, Department of Forestry, Mississippi State University.

DISSERTATIONS

Bahsi-Kaya, G. 2021. Synthesis of microcapsules and inclusion complexes consisting of hydrophobic cores and polysaccharidic shells for thermal energy management and packaging. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Collini, R. C. 2022. Exploring the impact of end-user engagement on the diffusion and adoption of a climate resilience tool in the Gulf of Mexico. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Firth, A. G. 2022. Evaluating soil health changes following cover crop and no-till integration into a soybean (*Glycine max*) cropping system in the Mississippi Alluvial Valley. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Hedge, S. G. 2022. Economic aspects of U.S. catfish farming: Technological progress, cost of regulations, and economic contribution. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Holt, C. 2021. Effects of reduced predator abundance on the predator-prey community of a tropical reservoir. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Li, Y. 2021. Computational simulation of Southern pine lumber using finite element analysis. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Milsted, D. 2021. Enhancement of wood properties with EPSILON-Caprolactam, and development of an apparatus for continuous monitoring water vapor sorption and desorption and its resultant wood dimensional changes. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Ogawa, R. 2022. Migration ecology of American White Pelicans: circannual movement, geographic range, and annual survival. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Ott, B. 2021. Effects of acute, chronic, and cyclical hypoxia on the physiology and transcriptome of channel catfish (*Ictalurus punctatus*). Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Petroelje, T. R. 2021. Patterns of carnivore competition, time-to-kill, and predation risk on white-tailed deer fawns in a multi-predator landscape. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Snow, R. D. 2022. Wood properties and utilization of assorted hardwoods. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Spinelli Correa, L. M. 2022. Cross-laminated timber (CLT) mechanical properties evaluation. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Yeary, L. A. 2022. Enhancing the performance of dowel type fasteners and a case study of timber truss failure. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

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

110
Master's students (Fall 2022)

58
Doctoral students (Fall 2022)

47
Faculty (Fall 2022)

RESEARCH PROJECTS

130
Projects Active (FY22)

70
Research Sponsors (FY22)

157
Refereed Publications (CY22)

$14,618,603
Total Sponsored Research Funding (FY22)

RESEARCH SPONSORS

- Alabama Audubon/National Audubon Society
- Alcorn State University
- Anthony Hardwood Composites
- Arch Wood Protection, Incorporated (a Lonza company)
- BASF
- Christmas Tree Promotion Board
- Cooperative Ecosystems Studies Units
- Creosote Council
- Cryptobranchid Interest Group
- Delta Wildlife
- Drax Biomass, Inc.
- Duff Real Estate, LLC
- Eastside Rice
- Ecotrust
- Evermark, LLC
- Institute of Museum and Library Services
- Kop-Coat, Inc.

TOTAL FWRC FUNDING, FY22

$21.26M

27.54% STATE APPROPRIATIONS

03.71% FEDERAL APPROPRIATIONS

68.76% GRANTS AND CONTRACTS

Koppers, Inc.
Lane Home Furnishings
Lonza Wood Protection
Meridian Airport Authority
Michigan Department of Natural Resources
Mississippi Department of Environmental Quality
Mississippi Department of Wildlife, Fisheries, & Parks
Mississippi Development Authority
MJB Wood Group
Modern Mill
National Academy of Sciences
National Council for Air and Stream Improvement, Inc.
National Fish and Wildlife Foundation
National Oceanic and Atmospheric Administration
National Science Foundation
Nemours Wildlife Foundation
North Carolina State University
Office of Juvenile Justice and Delinquency Prevention
Smart Green Utility
Southern Pressure Treaters Association
Taylor Land & Cattle
Tennessee Valley Authority
Texas A&M University
The Eppley Foundation for Research
The Jones Center at Ichauway
Timber Products Co
U.S. Endowment for Forestry & Communities, Inc.
United Furniture
United States Agency for International Development
United States Department of Defense
United States Department of Energy
United States Department of the Interior
United States Environmental Protection Agency
United States Fish and Wildlife Service
United States Geological Survey
University of Southern Mississippi
University of Tennessee
USDA Animal & Plant Health Inspection Service
USDA Farm Service Agency
USDA Forest Products Laboratory
USDA Forest Service
USDA National Wildlife Research Center
USDA National Institute of Food and Agriculture
USDA Natural Resources Conservation Service
Utility Asset Management, Inc.
Viance, LLC
Weyerhaeuser NR Company

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