FOREST & WILDLIFE RESEARCH CENTER 2021

ANNUAL REPORT

MISSISSIPPI STATE UNIVERSITY™

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ANNUAL REPORT

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

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

MISSISSIPPI STATE UNIVERSITY™
FOREST AND WILDLIFE RESEARCH CENTER

ON THE COVER: Prescribed fire at the MSU Bulldog Forest Andrews Forestry and Wildlife Laboratory. (Photo by David Ammon)

CONTENTS

FROM THE
DIRECTOR

GREETINGS FROM the Forest and Wildlife Research Center (FWRC) at Mississippi State University. This has been a great year in the FWRC. I am honored to lead this growing and vibrant organization as permanent director and dean of the College of Forest Resources after serving as interim for 18 months.

Our faculty, staff, and students continue to conduct vital research and outreach to meet the needs of landowners and industry while protecting our state's natural resources. Each day, we work to fulfill our mission of conserving, managing, and utilizing the forest, forest products, wildlife, and fisheries resources for the betterment of all Mississippians. We appreciate your continued support in this endeavor

Forest lands and the products they produce are a key component of Mississippi's economy contributing to the prosperity and quality of life for all Mississippians. The 19.2 million acres of our state's forest lands held by 125,000 forest landowners produce a farmgate value of $1.3 billion, making forest resources among the top three most important agricultural products in the state. These forest lands support a $13.2 billion-dollar industry that provides over 61,000 jobs with nearly $3 billion payroll and $5 billion induced and indirect economic impacts. In addition to the wood products, these forest lands provide a myriad of environmental goods and services including clean water, carbon sequestration, nutrient cycling, pollination services, and wildlife habitat. Hunting, fishing, and wildlife watching generates another $2.7 billion in economic impacts and 66,000 jobs for the state.

In this annual report, we have highlighted a handful of the 127 active research projects that FWRC scientists are pursuing. While CFR is MSU's smallest college, we have one of the university's largest research portfolios. This is a testimony to the value of the research our scientists conduct to improve natural resources, advance the economy, and enhance the quality of life for all Mississippians. And the FWRC is an economic engine. For every dollar we receive in state funding, an extra $1.84 is generated in extramural funding, bringing additional capital to our state.

In addition to the research our scientists conduct, we are also the training grounds for growing the next generation of natural resource leaders. In 2021, we had 144 of the best and brightest graduate students and six post-docs from all over the globe. Our CFR graduate and undergraduate students are integral to the FWRC research program. We are teaching the next generation of natural resource professionals to think critically, work in teams, and make discoveries that inform natural resource management.

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

Thank you for your generous support!

L. WES BURGER
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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STEVE BULLARD
Professor
Associate Director

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JESSICA L. TEGT
J. MORGAN VARNER

GLOBAL/
NATIONAL
IMPACT

Raging Fires

FWRC SCIENTISTS STUDY THE EFFECTS OF NATURAL DISTURBANCES ON FOREST ECOSYSTEMS

BY MEG HENDERSON

WILDFIRE HAS ALWAYS been a part of the ecosystem. It is a self-thinning and self-cleaning process that creates balance in the environment. Before humans settled fire-prone areas in the western United States, wildfires in that region were smaller, less intense, and more frequent. Today, megafires, exacerbated by climate change and fire suppression practices, are an increasingly common threat to communities.

DR. QIN MA, assistant professor in the Department of Forestry, has been studying how wildfires impact evapotranspiration, or water usage by vegetation, to demonstrate the value and benefits of practicing forest management practices, including prescribed burns and thinning, and to incentivize restoration projects. The rate of evapotranspiration is an indicator of an ecosystem's health and how it will react to future drought and fire events.

Ma has a background in geography and did her graduate studies at the University of California, Merced, where she focused on studying wildfires using remote sensing. From 2017 to 2020, Ma and her team of scientists from UC examined satellite imagery of forests within the Sierra Nevada and Southern Cascade ranges before and after major fires between 1985 to 2017 to track changes in evapotranspiration as a result of these fires.

The team's research, published last year in the Journal of Hydrology, found that there were differences in the percentages of evapotranspiration over a 15-year period after a fire, depending on burn severity and forest density before the fire. Analyzing the historical data, Ma and her team also found that taking forest management actions such as thinning or controlled burns would result in a reduction in evapotranspiration, mitigating the impact of continued drought and future wildfires.

"In the central valley of California, agriculture depends on water from snowmelt runoff or from ground water," Ma said. "Trees take the water from mountain snowmelt first. If there are too many trees in the forest, there will not be as much water left for agricultural use. Our ecosystem needs balance to ensure adequate water supplies for our forests and our agricultural land."

After arriving at MSU, Ma expanded her focus to include how forests respond to other natural disasters, such as drought and hurricanes. She is using aerial images to monitor the forest height and using LiDAR sensors on backpack and drones to calculate tree density, height, and biomass. She is using the similar methods from her wildfire studies to examine how forests react to these natural disasters, such as hurricane Michael in 2018, and how they grow back afterwards.

"We want to observe and monitor these ecosystems, and we want to find solutions so the next generation can enjoy these forests." Ma said.

In the classroom, Ma hopes that her own research will inspire her students to pursue studies in forestry.

"When people think of forestry, they think of going out into the field," she said. "But a lot of the work of monitoring forests involves computer skills and sophisticated technologies, so there are many aspects and opportunities to explore." ■

This work is funded by the National Science Foundation, the UC Water Security and Sustainability Research Initiative, the USDA National Institute of Food and Agriculture, and the California Strategic Growth Council through the Innovation Center for Ecosystem Climate Solutions, and the McIntire-Stennis Program.

Wildfire burning in California. (Stock photo)

IN THE FIELD:
CURRENT APPLIED RESEARCH

Break the Bottleneck

FROM FOREST FLOOR TO MILL DOOR, FWRC RESEARCHERS KEEP WOOD MOVING

BY VANESSA BEESON

WHEN THE I-40 BRIDGE CLOSURE severed a main transportation artery through Memphis in May 2021, the Arkansas Trucking Association estimated a daily loss of $2.4 million for the state's trucking industry. While Mississippi bridges aren't making national headlines, they do cause headaches for the logging industry. Approximately 226 of Mississippi's bridges are closed because of structural decline. Many more have reduced weight limits. FWRC researchers aim to determine how to streamline transportation from the forest to the state's wood baskets so the timber and logging industries make and save more with each and every haul.

TimberMart-South, which studies stumpage and delivered wood data, reported recently that the trucking rate across the South is $0.15 per ton per mile.

DR. ERIC MCCONNELL, an assistant professor in the forestry department and project co-principal, said that adds up quickly.

"At 27 tons per load, this equates to $4.05 per mile. Thus, every ten miles adds $40, on average regionally, to the cost of the load," he said.

McConnell points out that while many of the challenges the logging industry faces have been addressed over the years, infrastructure's impact on the industry is unknown.

"Trucking issues have plagued the industry for more than a decade. While solutions have continually been sought from the perspectives of workforce training, financial needs, and standing of firms, little has been conducted around how infrastructure impacts the industry," he said.

Approximately 40 percent of the cost of logging is tied up in transportation. In 2020, while the state's total timber value was $1.2 billion, the harvesting and transportation value exceeded $665 million, according to a recent MSU report produced by **DR. JOHN AUEL**, former assistant extension professor.

"If hauling costs are lower, the price paid for standing timber will be better, timber producers will get a better harvest with a more complete utilization of resources and, ultimately, the land's value will improve from a timber investment standpoint," McConnell said.

DR. ROBERT GRALA, forestry professor and co-principal investigator, said the team will assess how transportation stacks up from forest to mill.

"We'll assess the location of mills, determine how much wood is available within the procurement zone, evaluate that at the regional average haul of 50 miles and then see what the optimal routes would be for them to recover that timber and how it compares to bridges and roads within the radius and decide if there are barriers for optimization," he said.

DR. SHAUN TANGER, assistant forestry professor and extension specialist at the Coastal Research and Extension Center, is the principal investigator on the work. The two-year study aims to help timber producers, sawmills, and state transportation authorities alike, while also tackling a major priority of the Mississippi Forestry Commission.

"We hope to streamline logging transportation systems to keep them sustainable and profitable and keep the wood moving. We will assess routes and bridges, where truck weight and size are limited, and where many are in imminent need of repair and likely to be closed, and effectively are increasing hauling distance and transportation cost to the selected mills. In this way, we can select the most impactful routes for wood procurement and identify bridges and road links which should be prioritized for repairs," he said.

Ultimately, the team hopes to expand the research regionally, offering online training to show other states how to perform a similar analysis. Tanger also expressed excitement in the project's potential to be expanded in scope across other industries.

"We are building a blueprint for how infrastructure impacts one industry across the state. This could grow into a much larger analysis inclusive of many industries across the state and region," Tanger said. ■

This work is sponsored by the USDA Forest Service.

A logging truck leaves the woods. FWRC and Extension scientists are working to streamline logging transportation systems to keep them sustainable and profitable. (Photo Submitted)

COLLABORATION:
INDUSTRY PARTNERSHIP

Carbon Sink

ASSISTING FOREST LANDOWNERS IN MARKETING THEIR TREES

BY TAYLOR VOLLIN

NEARLY TWO-THIRDS of global greenhouse gas emissions are from carbon dioxide according to the United States Environmental Protection Agency (EPA). In the U.S., that number jumps to 80 percent. Trees store or sequester carbon, which reduces the amount that is released in the atmosphere. According to the U.S. Forest Service, America's forests sequester 866 million tons of carbon a year, which is roughly 16% of the U.S. annual emissions. As one of the most heavily forested nations, with nearly one-third of the land covered in trees, the U.S. is uniquely positioned to reduce carbon on a large scale.

Researchers in MSU's Forest and Wildlife Research Center are working to quantify carbon sequestration by forests to help the 11 million private forest landowners make the best decisions to promote sustainability from both an economic and environmental standpoint.

DR. BRUNO SILVA, assistant professor of forest management and economics at MSU, and his team are building a timber supply model to help landowners better understand how they can market their forest while maximizing profits. Dr. Silva said he and his team are working with multiple companies such as NCX, a company that connects landowners with corporations interested in the carbon sequestration of a landowner's trees.

"NCX comes to landowners and gives them a payment to postpone the harvest of their trees," Dr. Silva said. "Postponing one year allows the timber to continue growing, storing additional carbon. You then are making money for that stored carbon."

The team is helping landowners better understand if postponing harvest is the right decision for them. Dr. Silva said part of the goal is to determine how these decisions will affect the timber market.

"We are investigating the impact of the carbon market merging with the timber market," Dr. Silva said. "The decision starts with the landowners wanting to know if they should cut now or wait, and our tool will allow a landowner to see market trends and make the most profitable decision. Our goal is to then answer how their decision will affect the timber market."

Dr. Silva notes that the answer will vary for small- and large-scale producers. Landowners must weigh the costs and benefits of whether signing with a carbon program is the best option for them.

"A small landowner doesn't have the same scale as a large one, so it will depend on the forest. Carbon is a good source of income for landowners, since timber markets are more restricted in comparison to large-scale landowners," Dr. Silva said. "Landowners are allowed to make profit, and contribute to further reducing carbon dioxide. But there's a cost to postpone one year, and that's considered a risk in the model."

Co-principal investigator **DR. SHAUN TANGER**, assistant forestry professor and extension specialist stationed at the Coastal Research and Extension Center, added that the team is working to help determine which landowners would benefit from these programs.

"There are major things a landowner takes into consideration when deciding whether or not to postpone. That's what we're digging into now," Tanger said. "We want to map everything out, so

we can see who should and shouldn't be doing this, under what circumstances, and what price tag to put on their trees."

Landowners are offered a one-year agreement from NCX to postpone their tree harvest. Tanger said NCX essentially acts as a broker for companies wanting to reduce the carbon in the atmosphere. Landowners are then asked to put a price on their units, they are matched with consumer companies, and an auction is then held where a market price is determined. After the one year is up, landowners are able to harvest like they planned the previous year or re-enroll for another year.

Tanger said marketing trees for carbon sequestration offers social benefits.

"Natural methods for carbon sequestration are the cheapest, most effective way of keeping carbon out of the atmosphere," Tanger said. "Extending tree rotations has a social benefit of holding that carbon an additional year. There are other ecosystems that sequester carbon, but timberlands offer the most bang for the buck."

The research is something Tanger believes landowners will be able to easily implement, noting the model offers a simple way for landowners to make the best decision.

"Landowners will be able to understand the model because it's very straightforward," he said. "Landowners can wrap their head around the formulas we are developing and then they're able to figure out what their reservation price should look like. We are giving them something simple to use that improves the success of these programs and are excited to be working on this." ■

This research is funded by International Paper.

Dr. Bruno Silva, assistant forest management and economics professor, in the John W. Starr Memorial Forest. (Photo by David Ammon)

PROFILE

GRADUATE STUDENT

DARCEY COLLINS

BAUXITE, ARKANSAS

Diversifying Pine Plantations

GRADUATE RESEARCH AIMED TO EXPAND AND MODERNIZE MULTIPLE SPECIES PLANTING

BY GRACE JONES

FROM A SMALL, historic town known for its abundant source of Bauxite and a large producer of aluminum during World War II, **DARCEY COLLINS** grew up surrounded by hardwood forests and pine plantations. Collins follows in her father's and grandfather's footsteps as she pursues a life dedicated to protecting and enhancing forests.

While she was compelled to attend Louisiana State University—her family's alma mater— a visit to Mississippi State changed her trajectory.

"After my first visit, I thought, 'This is like home.' It was a very comfortable place for me. In interacting with forestry professors and students, people were friendly here and seemed to want me here," Collins said.

Collins has delved into the college's many opportunities. She is an officer in the Forestry Graduate Student Association, a member of the MSU Student Chapter of the Society of American Foresters, and involved in multiple research projects beyond the primary research she has been conducting since the start of her graduate program.

Her passion for research was ignited in Fall 2019, when the then-senior forestry major was accepted as an undergraduate research scholar. She attributes the forestry department, along with her interactive, helpful professors, and her interest in hardwood silviculture as factors influencing her decision to pursue a master's at MSU.

Her research focuses on diversifying managed forests by planting multiple hardwood species under a pre-existing canopy and observing growing success. She hopes to successfully establish mixed-species under an existing canopy, to benefit nonindustrial private landowners interested in transitioning away from single species pine plantations with the increase in revenue from the desirable higher timber values of hardwoods. The practice would also benefit wildlife habitat.

"We planted shortleaf pine, sweetgum, and four different oak species underneath an established canopy that had already been thinned," Collins explained.

The planting site is privately owned, within the boundaries of the Bankhead National Forest in Northern Alabama. This pine plantation is an old mining site, which initially raised concerns about the survival rate since the soil was not as healthy as initially desired.

Nevertheless, after planting right before spring, Collins noted, "a greater than 90 percent survival of seedlings."

Collins said the work would have been daunting without the help of professors and peers.

"I have had a lot of help in this, and I am involved in every step. I facilitated the seedling purchase, found the contractors, and planned and organized everything," Collins said.

The planning was an exciting endeavor for Collins to undertake. She committed most of her

time to the success of this research by traveling to Georgia to purchase seedlings for the crop, driving over two-and-half hours to plant and observe the crop, over six times for the duration of two to four days.

Collins hopes to study what eventually happens to the seedlings to determine their response to the planting.

"I want good survival. At this point, all we can measure is the survival related to the canopy cover that the seedlings are experiencing and their growth during this first growing season. I am curious to see how these trees respond to sudden light. In theory, they should do really well, but only time will tell," Collins said.

While she plans to graduate in Spring 2022 and won't necessarily see the long-term fruits of her labor, she hopes to stay in touch to learn the final outcome.

"Ultimately, our hope is that this research can help us recommend the best mixtures to private landowners who are interested in restoring historic forest types or interested in moving toward mixed-species management while also being able to restore native species without sacrificing management," she said.

Upon graduation, Collins will leave the Bulldog family to begin her job as a forester with Georgia-Pacific in Monticello, Mississippi. Focusing on procurement of roundwood for the Georgia-Pacific mills in the area, Collins continues to embrace her passion for forestry." ■

This research is funded by the Forest and Wildlife Research Center, the National Fish and Wildlife Foundation, Cumberland Plateau Stewardship Fund, and the National Institute for Food and Agriculture, U.S. Department of Agriculture, McIntire Stennis project.

Darcey Collins inspects one of the newly planted seedlings. (Photo by David Ammon)

PROFILE

UNDERGRADUATE STUDENT

ASHLYN NAYLOR

CHATTANOOGA, TN

Investigating Soil Health in Forest Restoration

UNDERGRADUATE STUDENT ASHLYN NAYLOR EXCELLING IN SOIL RESEARCH

BY KATHLEEN FORMAN

HAILING FROM Chattanooga, Tennessee, **ASHLYN NAYLOR** is a natural resource and environmental conservation major who spends her free time exploring the land that she is learning to protect. Her love for the outdoors started at a young age despite her parents not fully understanding her fascination with nature.

"I grew up making mud pies, playing outside, catching lizards and things," Naylor recalled.

During her high school years, Naylor and her friends would pack up the car and explore the outdoors as much as they could. Growing up with the Appalachian Mountains in her backyard, there was plenty to explore. The summer of her senior year of high school, Naylor worked at a Conservation Legacy branch, Southeast Conservation Corps, where she restored hiking areas, built bridges, and expanded trails. She enjoyed the work so much, she traveled back to work at the Southeast Conservation Corps as an undergraduate student.

At Mississippi State, Naylor is in her senior year and has worked in **DR. COURTNEY SIEGERT'S** laboratory for over a year. Siegert is an associate professor in the Department of Forestry and scientist in the Forest and Wildlife Research Center. Naylor said the work has opened her eyes to the field of forestry.

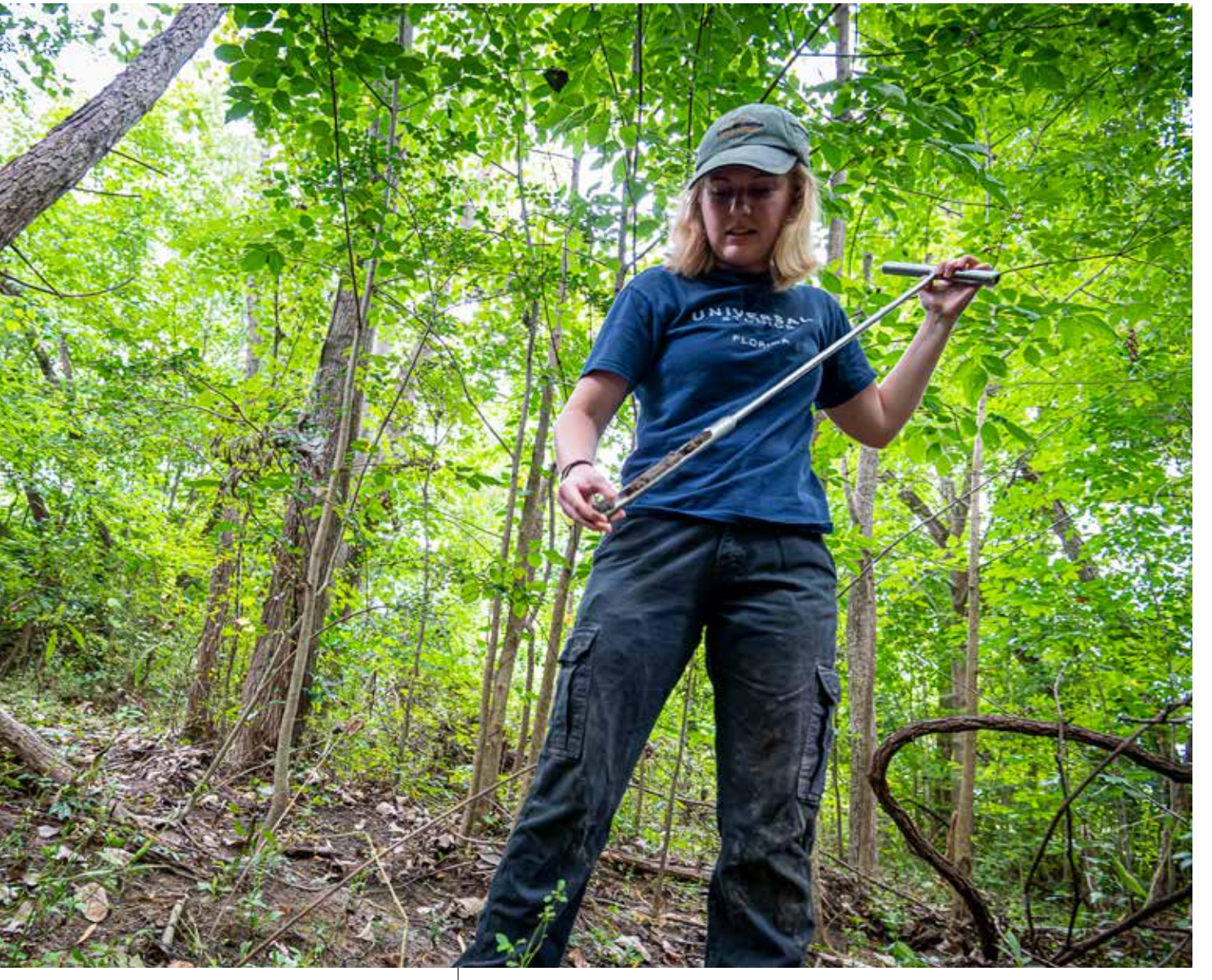
"I am a soil technician, so I go out and gather soil samples. I then prepare them for collecting volumetric water content, which is detecting how much water is in the soil," Naylor said. "We weigh out a very small amount after they've been dried and look for nitrogen content as well as carbon content."

Naylor's work contributes to a research project entitled "Forest restoration effects and impact on water quality and soil health." The research examines the effects of forest thinning on the forest's soil. When fertilizer and sediment from restoration efforts combine and then runoff or seep into groundwater or surrounding waterways, it can cause algae blooms that kill aquatic species.

"The goal is to analyze effects of forest restoration," Naylor explained. "We want to determine if the environment is helped or hurt by restoration efforts. It's important to understand the impacts of restoration and whether or not we leave it alone or go in and restore."

Naylor is assisting with other projects such as monitoring the sap flow in willow trees, and growing eastern cottonwoods and monitoring the groundwater, soil, and insects that affect those plots.

"We measured soil respiration," Naylor said on her eastern cottonwood project. "We evaluated the groundwater samples. We also took



Ashlyn Naylor takes a soil sample in the forest. (Photo by David Ammon)

soil samples, which we do yearly, and collected insect specimens because we were looking for a specific insect that could impact cottonwoods."

After graduation, Naylor plans to further her education and eventually obtain master's and doctoral degrees. Her time in Siegert's laboratory has inspired her to stay involved in soil research after graduation.

"I've really enjoyed working for Dr. Siegert because she's so inspirational," Naylor said. "All the professors have such contagious energy, they love what they do. The women of the lab are so inspiring and hardworking."

In her free time, Naylor enjoys visiting national and state parks. Her personal favorites are the Grand Canyon and the Adirondack Park in New York. Naylor's work in Siegert's lab has helped her gain a greater understanding of the science behind nature.

"One of my favorite things about the natural resource and environmental conservation major is that I get to learn more about chemistry and organic chemistry and how those sciences contribute to life." ■

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
- Bioproducts Deterioration and Preservation
- Bioproducts Testing and Evaluation
- Building Materials and Composites

FACULTY

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ADAM SENALIK
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ALEX WIEDENHOEFT

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Washed in Wood

FWRC SCIENTISTS EXPLORE NATURAL MATERIALS FOR WATER PURIFICATION

BY MEG HENDERSON

SAFE DRINKING WATER is something often taken for granted. Few are aware of the chemical processes that make water safe to use and consume at the turn of the tap.

Historically, water treatment plants have relied on petrochemicals to filter out contaminants, such as toxic metals and dyes, that are present in local water sources. But an unwanted result of this capability is that these treatments create their own waste, since they are made from nonrenewable resources. A research team at Mississippi State is examining natural, renewable resources that purify water just as effectively as their man-made counterparts.

DR. EL BARBARY HASSAN, professor in the Department of Sustainable Bioproducts, has led this effort over the last few years. Hassan's team includes **DR. XUEFENG ZHANG**, an assistant research professor; **DR. ISLAM ELSAYED**, sustainable bioproducts postdoctoral associate, and **DR. CHANAKA NAVARATHNA**, chemistry postdoctoral associate. The MSU team partnered with Dr. Gregory T. Schueneman, supervisory research materials engineer at the USDA Forest Products Laboratory.

Hassan and his team developed the chemical process of converting cellulose and chitin, two natural and renewable materials, into gel-based adsorbents designed to remove toxic substances from water. They chose these materials because of their worldwide abundance. In this study, the adsorbents were tested for their effectiveness at removing the common industrial pollutants arsenic, a heavy metal, and Methylene blue, an organic contaminant, from water.

"Cellulose exists in every tree, and trees are about 45 percent cellulose," Hassan said. "And chitin comes from the exoskeleton of shrimp and other anthropods. These are natural compounds."

Toxic metals, such as lead, mercury, and arsenic, end up in local water sources as industrial pollution runs off into lakes, rivers, and reservoirs. According to Hassan, these toxins are a threat to human health and aquatic life worldwide, mostly in developing countries, but also in the United States.

"Most hydrogels are made of synthetic polymers, which come from petrochemicals and are not renewable," Hassan said. "This is problematic. It is better for nature, and for us, if we can replace the synthetic polymers with natural polymers."

At present, most water treatment facilities

around the world rely on activated carbon, to filter toxins from drinking water. However, Hassan is beginning to see a shift toward adopting hydrogel and aerogel-based filtering methods—evidence of a movement toward making the water treatment industry more sustainable.

"There is growing interest, and I see more companies starting to produce hydrogel and aerogel-based solutions for water treatment," Hassan said. "It's just not on a large scale yet because the process is still in its beginning stages. We are contacting companies to implement our technology on a larger scale."

Hassan has some plans for further research on this front.

"We were focused on one technique when we conducted this study, but now we're considering process improvements for a sustainable solution," he said.

Zhang added that the team is exploring other purposes for these adsorbent materials.

"This aerogel adsorbent could also be used as an air filter or mask to remove dust, bacteria, and virus from the air," he said. "Our future research will focus on fabricating aerogel-based green masks and testing their protective performance against viruses." ■

This research is funded by the USDA Forest Products Laboratory.

Graduate student Alhassan Ibrahim, left, and Dr. Islam Elsayed, postdoctoral associate, load rice straw in a dryer to produce renewable biofuels and biochar adsorbents. (Photo by Dominique Belcher)

IN THE FIELD:
CURRENT APPLIED RESEARCH

A Coat of Different Colors

FWRC RESEARCHERS SEEK TO IMPROVE STANDARDS IN WOOD COATING EVALUATIONS

BY VANESSA BEESON

OFTENTIMES, A SIMPLE question leads to more questions than answers. That was the case when sustainable bioproducts researchers began testing coatings that could temporarily protect cross-laminated timber, or CLT.

DR. BETH STOKES, sustainable bioproducts associate professor, and her team evaluated 39 coatings and chose 12 representative types. From there, five consistently performing coatings were tested in the field at the Sustainable Bioproducts complex at MSU. The naturally exposed samples were evaluated every month for six months and then every three months after that.

Stokes said visually assessing damage was a challenge.

"It's subjective to evaluate a piece of coated wood and say it's in the process of failing. Different standards for each degradation and a different way to examine each characteristic make the process difficult even for someone with a lot of experience," she said.

While researchers answered the initial question and provided recommendations for CLT manufacturers and builders on what coatings to use to protect CLT temporarily, the process proved arduous enough that the team knew there had to be a better way. Cue the second question: how to build a better system to assess coatings?

"The big picture reason for the research kept getting bigger. We needed to do a better job of assessing the damage with better tools like higher quality photographs and the application of computer modeling to predict color change. This research could have an endless impact on many industries," Stokes said.

The team set about building an artificial intelligence model to better predict color change based on the visual assessment of coated CLT.

DR. GABRIELLY DOS SANTOS BOBADILHA, a post-doctoral associate with the department, has played a vital role in the work, from visually assessing samples to training undergraduates. Her work, which was the subject of a sustainable bioproducts doctorate she earned in 2020, provided the data that the artificial neural network needed to predict color change.

Bobadilha took the lead on visual analysis of the characteristics including flaking, erosion, checking, cracking, mildew, and color change that indicate the coatings are breaking down. She also found a mold expert in Sweden to test the samples for mold.

"We found that transparent, water-based, alkyd/acrylic resin performed the best, with mold growth completely prevented and weight loss caused by a common fungus at 1.33 percent. While the coating isn't designed to withstand long term decay, it may offer short term protection during transport, storage, and construction," Bobadilha said.

Since color change is the best indicator of coating degradation, the team sought to better understand how the visual analysis of all the characteristics interacted with color change.

"If our visual analysis grades could predict color change, it would be precise and reliable. Using artificial intelligence, we tried to establish reliable methods based on the visual data to predict color change," she said. "We also wanted to know which

variable contributed the most for the model to be reliable and found it was coating type that impacted the color change the most."

The model proved to be 95 percent accurate at predicting color change. Results showed coating as the most important feature in the color change model with erosion, checking, and flaking all being of equal importance. The findings showed that coating properties, visual appearance, and time of exposure were all associated with discoloration.

DR. DERCILIO "JOE" LOPES, sustainable bioproducts assistant research professor, helped build the AI model.

"Our goal was to create a deterministic, numeric, repeatable, robust approach to determine the durability of the coated CLT," Lopes said.

Now the team has submitted a proposal to the USDA in hopes of creating a system where users could snap a photo of the damage and have an app that detects and classifies damage simultaneously.

Contributors include Dr. Mojgan Nejad of Michigan State University, Drs. Katie M. Ohno and Grant Kirker from the USDA Forest Products Lab, and Dr. Sheikh Ali Ahmed from Linnaeus University in Sweden. The research resulted in three peer-reviewed articles appearing in BioResources; Coatings; and Holzforschung, a leading wood research and technology journal. ■

The research was funded by the Forest and Wildlife Research Center and a U.S. Endowment for Forestry and Communities grant.

Dr. Gabrielly Dos Santos Bobadilha applies a coating to cross-laminated timber. (Photo by David Ammon)

COLLABORATION:
INDUSTRY PARTNERSHIP

Pelletizing Pine

IMPROVING ALTERNATIVE ENERGY PRODUCTS

BY GRACE JONES

THE U.S. EXPORTED nearly 7.26 million metric tons of wood pellets in 2020, up five percent from 2019, according to the USDA Foreign Agricultural Service. Due to the rising interest in this energy source across the globe, researchers in the Forest and Wildlife Research Center seek to develop a cost-effective reliable material that is sturdier in transport and burns cleaner when consumed.

U.K.-based renewable energy company Drax has partnered with **DR. JASON STREET**, associate professor in the Department of Sustainable Bioproducts, to discover solutions to common problems seen in wood pellets, such as pellet deterioration during transport.

"We are attempting to create a hotter burning wood energy pellet that has less off-gassing when compared to traditional wood pellets. The idea is to see if we can transform low-value products into high-value products and increase profitability values for timber producers," Street said.

They started their research by testing alternative additives in the pelletizing process. Traditionally, cornstarch is used as an additive to produce pellets. Street and his team began with materials like biochar, bio-oil, sweet potato, vegetable oil, and other various additives to produce pellets in a laboratory.

After attempting the production process in a laboratory setting, they transitioned to an industrial-sized production to mirror the normal production process of pellets.

"We were trying to produce pellets on a lab scale using a novel pneumatic system and then a hydraulic system to try and improve the pressure and mimic the temperatures," Street said.

They found that their team could mimic one aspect of the industrialized mill production process at a time but incorporating multiple aspects of industrial-sized production wasn't ideal in the laboratory setting.

The team accessed an industrial-sized mill at the MSU Pace Seed Lab and obtained data that would be more useful for industries using large equipment instead of only testing with bench-top lab systems.

"Using the Sprout Waldron mill allows industrial pellet producers to be able to determine the outcome they can expect in power requirements and pellet quality. We have found that the characteristics of pellets made using a lab bench-top press and small heated die to produce pellets do not compare as well to the characteristics of pellets made with industrial equipment," Street said.

Tyler Lowe, an industrial and systems engineering graduate student who works in the lab, explained that with this research, they can utilize natural resources, which helps satisfy the regulations the industry has established.

"A lot of the additives we are trying in the

different wood pellets are materials that are not being utilized anymore. We are taking waste products, recycling and reusing them, and creating recycled products that are enhancing the pellets," Lowe said.

The production process for wood pellets is meticulous. The team had to closely analyze many variables that affect the outcomes, such as the additives used, the moisture content of the pellets, and the pressure and heat applied to the pellets.

"One thing that surprised me was all the different tests we had to conduct. There are so many different aspects of the pellets, like the moisture content, you have to learn to understand the dynamic between the wood and additives being used," Lowe said.

Now, the bio-oils and biochar researched are in the approval process. This will determine if the production and additives meet the environmental criteria set forth by Drax.

"There is a great potential for wood energy pellets to help improve heating systems. We reported the potential we found during production using certain additives," Street said.

After three years of research, the partnership with Drax is yielding results. The researchers have found ways to make a better, stronger pellet that burns cleaner and costs less. ■

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

Dr. Jason Street holds pellets manufactured in the Department of Sustainable Bioproducts. (Photo by David Ammon)

PROFILE

GRADUATE STUDENT

LON YEARY

MADISON, WISCONSIN

Communicating the Value of Wood Products

SUSTAINABLE BIOPRODUCTS DOCTORAL STUDENT PASSIONATE ABOUT WOOD SCIENCE RESEARCH

BY VANESSA BEESON

LON YEARY was born in Quantico, Virginia and moved often as a child but Madison, Wisconsin is the place he considers home. His dad, Lon M. retired after a 30-year career with the U.S. Marine Corps, and joined the USDA Forest Products Lab and Northern Research Station, where he served as deputy director until his retirement in early 2022. The younger Yeary said time spent in the Forest Products Laboratory from eighth grade on is what shaped his passion for communicating the value of wood products.

"Being around the lab and wood science intrigued me. When I decided to enter a civil engineering undergraduate program, I began working as a summer engineering intern in the lab's advanced wood engineering department. I enjoyed the research process and developed a desire to pursue wood science research," he said.

Yeary earned his bachelor's in civil engineering from the University of Wisconsin-Platteville. When it came time to decide on grad school, Dr. Bob Ross, supervisory research general engineer at the lab and Yeary's mentor, recommended he check out the sustainable bioproducts department at Mississippi State. As a bass fishing enthusiast, former college football player, and avid sports fan. Lon enrolled in the College of Forest Resources at Mississippi State.

Now Yeary is pursuing a sustainable bioproducts doctorate and non-thesis civil engineering master's concurrently. Since beginning the programs in 2018, he has conducted three projects. He plans to graduate in May 2022.

In his first project, he performed a case study on a light frame wood truss roof collapse of a 50-year-old experimental building, which was published in Wood and Fiber Science in 2021.

"The building's wood trusses had a compression member that was exceptionally long, thin, and unbraced which made it susceptible to buckling. Additionally, the sheathing on top of the framing was under designed. The plywood was not thick enough to support the loads that high wind and rain events placed on it. When these events occurred, rather than the water running off the roof, it bowed the roof sheathing and trusses retaining water on the roof, which led to the building's slow but eventual demise," he said.

His second project focused on developing a two-way support system for CLT building connections that resists both sheer and uplift.

"The two-way system includes angle brackets and lag screws placed continually along the length of the wall. The size, spacing, and layout are dependent on what loads the wall is being designed to carry," he said. This type of work aims to increase CLT's ease of use and thus grow its adoption.

His third project focuses on reinforcing steel fasteners in wood laminates. Yeary points out that wood is weakest perpendicular to the grain and that weak spot is a common reason for premature and unexpected failure. Because fasteners are an area of stress concentration, failure in their vicinity is not uncommon. He also noted that when wood fails in tension perpendicular to the grain, it is a rapid failure that occurs without warning.

"By adding reinforcement, the fastener should behave more consistently, have more strength perpendicular to the grain of the wood, and

Lon A. Yeary tests lumber strength. (Photo by David Ammon)

fail in a more controlled manner that would indicate there is an issue before failure occurred," Yeary explained.

Yeary said his main goal is to improve wood structures while also educating people about the value of them.

"While I want to improve the performance of wood structures, I'm also excited to get out into the professional world and showcase how durable and versatile wood can be. I feel strongly that the future is in wooden structures and I'm excited to see how far we can take them," he said.

Yeary appreciates the connectivity of the sustainable bioproducts department.

"Working in sustainable bioproducts has been refreshing because it's such a good community and everyone collaborates and works well together. I've enjoyed MSU and I'm very happy that I came here. This is the right spot for me," he said. ■

This research is funded by the Forest and Wildlife Research Center and the U.S. Department of Agriculture.

PROFILE

UNDERGRADUATE STUDENT

JACOB WEST

BRANDON, MISSISSIPPI

From the Desert to the Forest

MILITARY VET SET TO START TIMBER CAREER WITH SUSTAINABLE BIOPRODUCTS DEGREE

BY VANESSA BEESON

JACOB WEST grew up in Mississippi surrounded by forests. Surprisingly, the Brandon, Mississippi native was more than 7,300 miles from home in the middle of the desert when he decided to study sustainable bioproducts at Mississippi State.

"I was stationed in Kuwait with the Mississippi National Guard when Dr. Keenum and Major Gen. Boyles announced that Mississippi National Guard service members could attend MSU full-time for free," West said.

While he had attended some college, the offer of free tuition was exactly what he needed to double down on his goal of finishing his bachelor's degree, to acquire the skills necessary to begin his own forest products enterprise.

"I had been an electrical engineering major before beginning at MSU. I chose sustainable bioproducts because I love the outside and everything to do with forestry and the degree gave me the opportunity to explore the wood products side of the industry," he said.

For his senior project, the undergraduate researcher sought to create a bioplastic based from kenaf, a fast-growing, fibrous plant.

"In today's eco-friendly world, it is both environmentally essential as well as economically beneficial to develop more cost effective, fully biodegradable, and environmentally safe products that are more naturally sustainable than traditionally manufactured, petroleum-based plastics," West said.

Plastic's negative impact on the environment has led to the development of biodegradable plastics made from natural materials, which inspired West to explore kenaf as an option for creating a bioplastic.

"Because of its resistance to disease and pests, its adaptation to varied climates, and its weed tolerance, kenaf is an excellent crop and can be used as an additive in the development of sustainable and environmentally safe products," he said.

West worked with Cale Garlich, a sustainable bioproducts undergraduate who will graduate in May of 2022, to create a formula using kenaf along with polylactic acid, or PLA, a thermoplastic polyester derived from a corn extract, which is used in the production of bioplastics. The team created, heated, and tested molds with varying levels of kenaf added to PLA.

"We found the best mold was the 99 percent PLA and one percent kenaf," West explained. "We found that not a lot of kenaf is needed to have a successful, durable product. The data showed that kenaf, in small quantities, dramatically strengthened the PLA product."

While the sample size was small, West said the research shows promise.

"Natural fiber-reinforced polymer composite materials are rapidly growing both in terms of their industrial applications and fundamental research because they are renewable; sustainable; completely, or partially recyclable; and biodegradable," he said. "Kenaf is a product that meets these requirements. It exhibits low density, non-abrasiveness during processing, high specific mechanical properties, and biodegradability."

West said he sees opportunity for further exploring kenaf in the development of bioplastics.

"It is evident that continued research and development of kenaf and PLA applications in the manufacturing sector is an advantageous path toward sustainability in the current plastic-dependent, manufacturing world," he said.

For now, however, the December 2021 graduate is excited to open a company in his hometown of Brandon.

"I got married August 2021 and I plan to start my own business. First, I'll focus on producing mulch and I'd like to eventually branch out as a timber producer. I'm happy to complete my degree and look forward to seeing how it will help me as I establish and grow my forest products business." ■

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

Jacob West works with ground kenaf. (Photo Submitted)

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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FRANCISCO VILELLA
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DAVID WISE
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MARK WOODREY
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EMERITUS

DAVID BURRAGE
LOUIS D'ABRAMO
ERIC D. DIBBLE
DONALD C. JACKSON
HARRY JACOBSON
JEANNE C. JONES
RICK KAMINSKI
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MENGHI LI
H. RANDALL ROBINETTE
HAROLD SCHRAMM
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MICHAEL CONNER
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TRAVIS DEVAULT
BRIAN DORR
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Eyes in the Skies

FWRC SCIENTISTS LOOK TO DRONES TO IDENTIFY POTENTIAL FLIGHT DISRUPTIONS

BY MEG HENDERSON

IT'S BEEN a dozen years since the "Hudson Bay Miracle" made history with an emergency landing of a passenger plane after it collided with a flock of Canada geese during takeoff. To prevent such hazardous incidents, airport biologists strive to mitigate aircraft-wildlife strikes. Knowing what is inhabiting the landscape and monitoring that wildlife in a common way among airports is essential for informing mitigation efforts.

Traditionally, biologists have surveyed wildlife at airports, taking visual counts of birds and mammals. But, as a team of MSU and USDA researchers have shown, modern technology can make that work easier and produce a more accurate scope of wildlife activity on airport properties.

Since May of 2020, **DR. RAYMOND IGLAY**, principal investigator and assistant professor of wildlife ecology, and his team have investigated small Unmanned Aircraft Systems, more commonly known as sUAS or drones, to improve the methodology of monitoring wildlife in airport environments.

"As biologists, we have to count animals that are often many in number, hidden or camouflaged, and moving around us. So, it's hard to get an accurate count. This leads to something called observer or sampling bias," Iglay said. "But, we're focusing on learning how and where to fly a drone to count animals, run the collected images though computer software designed to detect these animals, know exactly what animals are in the picture, where they are within the landscape, and their number. Essentially, we hope to reduce bias to improve accuracy."

Improving the accuracy of wildlife surveys at airports can translate to saved lives and reduced damage to aircraft.

The team's goal is to standardize the methodology and develop best practices for flying the drones, capturing images, and identifying animals in the images without disturbing animals.

Currently, the team is developing selection criteria for the drone models and sensors most appropriate for wildlife species hazardous to aircraft. They are also running field experiments to investigate associated human observer bias with counting animals including detecting animals in drone-captured images and accurately identifying them compared to using computers for animal detection and identification. The project focuses on sampling birds and mammals during the daytime using cameras and at night using thermal sensors.

To train computers to correctly identify species, the team will compare computer and human observations of captured images from a series of decoy set ups. They have run tests at the H. H. Leveck Animal Research Center and other MSU properties and hope to test at Bryan Airport in Starkville and Golden Triangle Regional Airport, if approved.

The team has spent much effort to ensure the captured images are identified accurately.

"We don't have an image repository to ensure accuracy, and this presents a challenge in teaching the computer to identify species by their characteristics," said Iglay. "To keep up with rapidly changing technologies, it's essential to constantly update computer models with new images to improve automated classification of animals from imagery."

DR. KRISTINE EVANS, assistant professor of conservation biology, said standardizing methods with dynamic species can be challenging.

"The big challenge is that animals move whether naturally or in response to the sound or sight of the drone," she said. "That can be an issue when we try to monitor the animals and get accurate species identification and counts."

Evans said that collaboration is key to solving this noting the work is a collaborative effort on three

fronts. First, this effort is part of a larger research collaboration among MSU, the Ohio Field Station of USDA/APHIS Wildlife Services National Wildlife Research Center (USDA/APHIS WS NWRC), and the Federal Aviation Administration, or FAA. Specifically, Dr. Bradley Blackwell, research wildlife biologist, field station and project leader, and Dr. Morgan Drabik-Hamshare, research biologist of USDA/APHIS WS NWRC, work closely with MSU team members regarding project synthesis and development, related research endeavors, and coordinating research outputs and outcomes. Second, Dr. Wesley Major, airport safety specialist, and Mike DiPilato, airport research specialist of FAA provide further guidance regarding sUAS, related research, policy guidelines, and other airport operations and safety perspectives. Internally, MSU team members represent different departments across campus.

"This is a perfect example of interdisciplinary work. We biologists are working side by side with computer engineers," said Evans. "We draw from each other's strengths, and I don't think we could be doing what we're doing without that collaboration."

While the aviation industry stands to gain direct benefits from the study, the research has broader benefits as well.

"We aim to provide FAA with deliverables that will allow them to monitor wildlife using sUAS and inform mitigation efforts regarding aircraft-wildlife strikes," said Iglay. "But our methods have broader applications, to government agencies, academic researchers, and industry."

DR. SATHISH SAMIAPPAN, assistant research professor in the Department of Electrical and Computer Engineering, **DR. SANTAHAN KRISHNAN BOOPALAN**, postdoctoral associate, as well as **DR. LANDON JONES** and **DR. JARED ELMORE**, both research associates in the Department of Wildlife, Fisheries and Aquaculture, are collaborators on the research. ■

This research is funded by two cooperative agreements with the USDA/APHIS Wildlife Services National Wildlife Research Center Ohio Field Station, who has an interagency agreement with the FAA. This research is complemented by a third cooperative agreement with Dr. Samiappan as lead investigator and one cooperative agreement pending under the direction of Dr. Evans.

A drone comes in for a landing. (Photo Submitted)

IN THE FIELD:
CURRENT APPLIED RESEARCH

Leveling the Field

RESEARCH DESIGNED TO CREATE BENEFICIAL DYNAMICS BETWEEN LAKE MANAGEMENT AND WATER REGIMES

BY GRACE JONES

THE SAM D. HAMILTON Noxubee Refuge is a beloved area for many to enjoy, especially the beautiful and multi-purposeful Bluff Lake that greets visitors as they arrive. The waterway attracts visitors to enjoy its spillway, plant habitats, birds, and other wildlife, along with an occasional alligator sighting. While the lake attracts many anglers and observers, it is also an optimal location for research.

DR. MIKE COLVIN, associate professor, **DR. J. BRIAN DAVIS**, James C. Kennedy Endowed Associate Professor in Waterfowl and Wetlands Conservation, and their team of graduate students in the Department of Wildlife, Fisheries and Aquaculture, are working on a project that will assess the impact management practices have on fisheries, birds, and plant communities in Bluff Lake. The outcome of the research will be a model to assist managers in making informed decisions.

"We want to formally link management decisions to objectives," Colvin said. "By manipulating Bluff Lake's water levels, we can determine what happens to species and habitat when the levels are low and then again when the water is released. With this information, we can create a model for land managers to use."

The research will create a dual-purpose framework that could be modeled by other reservoirs by demonstrating projected outcomes between water quality, drawdown dates, and overall relationships of the fishery, water, and habitat. The study simultaneously aims to find management objectives for fish communities, birds, and other wildlife to live in harmony.

Victoria Starnes, Colvin's former master's student who graduated in May 2020, focused her efforts on assessing how significant changes in water levels affected the waterfowl and fish in the lake.

"To understand how fish respond, a comprehensive assessment was conducted to determine how drastic changes in water volume affect the response of common sportfish, including how they assemble together, how they feed, and their condition," Starnes said. "Likewise, it is important to determine how these drawdowns effect angler effort and catch. Both the assessment of fisheries and anglers are needed to develop the model," Starnes said.

As the research began, water drawdowns were conducted to achieve bird and duck community habitat objectives for feeding. Drawdowns allow plant communities to be exposed to sunlight, which results in the growth and production of food for bird communities. However, this objective is not beneficial to fish communities. This pushed the researchers to determine how they could manage water levels to maintain a successful fishery habitat in the lake while working to also grow plant communities.

"The question that aroused this research was how do we balance keeping the water levels high enough for anglers while trying to create mudflats for duck habitat? How do we take care of the fish and balance that with waterfowl management?" Davis said.

Their research team conducted bathymetry, the study of water depths, of Bluff Lake to measure high and low water levels. They scoped water level changes around the lake. They identified

the layout of the lake, which contributed to building a model to see how much water they could release and how long the levels could be lowered before needing to be restored.

After three years of dedicated research focused on fish, water levels, and plant communities in Bluff Lake, Colvin finds promise in the research.

"With our model, we can adequately quantify possible outcomes and incorporate that into how we evaluate the relative benefit of different potential water releases that can be done out of a reservoir," Colvin said.

Davis explained that since Bluff Lake did not undergo water drawdowns in 2019 or 2020, the planned de-watering could not be executed. Yet, their research team has compiled enough data to develop a model on how to successfully manage fish and fishery goals along with shore and water bird needs and plant communities while monitoring the water levels of the lake.

"We wanted to create an environment that met the needs of fish and fishery as well as shore and water birds while equipping lake managers with a model that can act as a how-to guide for altering water levels within reservoirs to create dual benefits with fish and water bird communities," Davis said.

Colvin and Davis, along with their team, have created this real-world, applicable model that unifies communities like Bluff Lake and provides the information needed to apply to other reservoirs where fish and birds cohabitate based on structured decision making. ■

This research was sponsored by United States Fish and Wildlife Service.

A Great Blue Heron overlooks Bluff Lake. (Photo by Megan Bean)

COLLABORATION:
INDUSTRY PARTNERSHIP

Protecting the South's Signature Wildlife

FWRC RESEARCHERS ASSESS ADVERSE IMPACTS ON DEER POPULATIONS

BY VANESSA BEESON

AS THE STATE LAND MAMMAL of Mississippi, white-tailed deer is the South's most significant wildlife species. The important economic and cultural resource contributes to Mississippi's $1.14 billion-dollar hunting industry, with an estimated 280,000 deer harvested each year. FWRC researchers seek to determine how weather and disease impact deer populations so the Mississippi Department of Wildlife, Fisheries, and Parks, or MDWFP, can make informed management decisions to protect them for years to come.

DR. DANA MORIN, assistant professor in the Department of Wildlife, Fisheries and Aquaculture and population ecologist, is studying how the historic backwater flooding of 2019 affected the population. She's also studying how chronic wasting disease, or CWD, impacts it.

"Wildlife managers need ways to measure how CWD and long-duration floods affect deer density and population growth," Morin said.

The team's three-pronged approach assesses deer population density through fecal sampling from transects, passive camera surveys, and collaring deer. The study areas include a tri-county region in the South Delta, across Warren, Issaquena, and Sharkey counties; Benton County; and Chickasaw County.

While the South Delta experienced historical long-term flooding in 2019, Benton is considered the state's biggest CWD hot spot while Chickasaw, with no flooding or CWD cases, will serve as the project's control. Density will be estimated following harvest and fawn recruitment in Benton and Chickasaw counties while changes in density from year to year will be estimated in the South Delta. Researchers will build heat maps of population density across each area.

Considered the gold standard for estimating population density, "Spatial Capture-Recapture" methods combine spatially referenced detections of individuals to estimate how many deer are in each area. To achieve this, the team is collecting fecal pellets along transects with precise location data where each pellet pile is found and identifying individual deer in each area from the DNA of the pellets.

"We will identify individual deer and then estimate the population density based on the repeated detection of those individuals, which will allow us to evaluate the impact of factors including CWD and flooding while also validating different methods for estimating deer density with passive, or non-baited camera surveys," Morin said.

She hopes the team can also identify populations more or less susceptible to CWD. The detection of a Prnp gene in an individual's DNA can indicate if an animal can produce prions, the misfolded protein that causes CWD.

CWD, specifically, has impacted how deer population dynamics are studied in the state.

"When CWD is detected in an area, an immediate mitigation strategy is to suspend all supplemental feed," Morin said. "Unfortunately, supplemental feed is how we entice deer to participate in camera surveys that estimate population size."

To that extent, Morin is testing six types of non-baited passive camera surveys.

"While camera surveys have become less expensive and easy to use, the methods of estimating population density with them have not caught up to the technology's availability and use. This is a good opportunity to evaluate methods and make sure we use these tools effectively," Morin said.

DR. STEVE DEMARAIS is assisting with the third aspect of the two-year study by collaring a total of 20 white-tailed deer with GPS trackers, so Morin can include movement rates into her population models. Five bucks and five does will be collared in both the South Delta region and Benton County. The Taylor Chair in Applied Big Game Research and Instruction said the deer they've already collared have provided some interesting insight.

"From a previous study, we learned that some bucks have a sedentary home range while others are mobile, opting for more than one home range and traveling miles between the two," Demarais said. "One of our collared bucks was mobile and traveled 18 miles between two home ranges, including swimming the Mississippi River twice."

He said Morin's work will help inform land managers as they navigate the challenges long-term flooding and CWD can present in deer management.

"Knowing the deer population size and monitoring it over time allows us to determine if harvest or other factors like long-term flooding and CWD impact populations, which will inform management decisions for each specific population," Demarais said. "This study will give MDWFP the vital information they need while also helping us determine the best ways to use non-baited camera surveys to effectively measure population dynamics." ■

This research is funded by the Mississippi Department of Wildlife, Fisheries, and Parks and the MSU Forest and Wildlife Research Center.

Capture crew technicians and graduate student take measurements and attach a GPS tracking collar on a chemically immobilized deer. (Photo Submitted)

PROFILE

GRADUATE STUDENT
MADELYN MCFARLAND
BATON ROUGE, LOUISIANA

Water Birds in the Wetlands

GRADUATE STUDENT EXAMINES BIRDS' USAGE OF MARSH TERRACES

BY KATHLEEN FORMAN

BORN AND RAISED in Baton Rouge, Louisiana, **MADELYN MCFARLAND**, master's student in the Department of Wildlife, Fisheries and Aquaculture, is no stranger to the problems concerning southern Louisiana's coastal loss. From an early age, McFarland understood the importance of wildlife conservation as she watched the coast and the wildlife it supports disappear before her eyes. Now she is working to fight against the land loss in her home state.

"There's a saying about Southern Louisiana that we lose a football field worth of land every 100 minutes," McFarland said.

After receiving her bachelor's degree in natural resource ecology and management at Louisiana State University, McFarland went to work. Her passion for wildlife conservation led her to Washtenaw County, Michigan where she interned with Ducks Unlimited in their Great Lakes Atlantic Regional Office for a year.

"When I got up there and I got to work, I found I enjoyed that facet of conservation," McFarland said. "I had always been research-heavy coming from the academic realm, but the way Ducks Unlimited approaches conservation is boots-on-the-ground."

McFarland described boots-on-the-ground conservation as any physical or hands-on activity that restores or enhances the ecosystem rather than a passive approach to management. She found this hands-on method resonated with her and found a graduate study program at Mississippi State that prioritized active conservation.

DR. BRIAN DAVIS, James C. Kennedy Endowed Associate Professor in Waterfowl and Wetlands Conservation, offered McFarland the opportunity to work on a restoration project in her backyard of Southern Louisiana.

The project, entitled "Avian Use of Marsh Terraces in Gulf Coastal Wetlands," examines how birds benefit from marsh terraces built in that area. Marsh terracing is a common restoration technique in which earthen ridges are constructed in the marsh to protect against land loss and erosion.

McFarland and the research team spent the summers of 2019 and 2021 surveying the man-made structures for secretive marsh birds, which included species such as black rail, least bittern, and purple gallinule. These species, amongst others, were used to see how marsh terraces compared to natural landscapes in maintaining an ideal habitat for the birds. McFarland and her research team are now analyzing the field data collections.

"Going back to boots-on-the-ground work, one of the things that drew me to this opportunity,

Madelyn McFarland looks for wildlife on marsh terraces. (Photo Submitted)

besides the fact that I get to work in my home state on something that is going to benefit such a large issue, is that our research is going to help better inform how we use terraces as a restoration technique," McFarland said. "This is a common restoration technique in South Louisiana, but there's little information on how these terraces work not just for wildlife habitat, but how they affect the surrounding marsh of a site."

McFarland's research was entered into the Society of Wetland Scientists' Conference student competition and she was awarded the 2021 Best Student Oral Presentation award where she competed against top researchers from around the country. After obtaining her master's degree, McFarland hopes to continue to work in active conservation and make an impact in the fight against coastal land loss. ■

This research is funded by the National Academies of Sciences, Engineering, and Medicine. Ducks Unlimited, Louisiana Department of Wildlife and Fisheries, and the Forest and Wildlife Research Center contributed as research partners. In addition to McFarland and Davis, the research team includes Dr. Mark Woodrey, Mississippi Agricultural and Forestry Experiment Station scientist; Dr. Anna Linhoss, former Mississippi Agricultural and Forestry Experiment Station scientist; Dr. Adam Skarke, MSU associate professor of geosciences; Dr. Robert Moorhead, director of MSU's Geosystems Research Institute; and Dr. Mike Brasher, MSU alumnus and waterfowl scientist with Ducks Unlimited.

PROFILE

UNDERGRADUATE STUDENT
KIM LOWERY
OCEAN SPRINGS, MISSISSIPPI

Saving Songbirds and Pollinators

INCREASING HABITATS FOR SOUTHEASTERN BIRDS AND BEES

BY VANESSA BEESON

KIM LOWERY GREW UP fishing and hunting with her family, developing an avid love of the outdoors. That passion led her to Mississippi State as a wildlife, fisheries and aquaculture major concentrating in conservation biology.

The undergraduate researcher has now developed a love for research during her time at MSU, first studying ways to improve pollinator populations across the Black Prairie Belt region and then assisting on a project studying how Bachman's sparrows and other birds use the Sam D. Hamilton Noxubee Wildlife Refuge.

"Both research experiences pushed me out of my comfort zone and gave me opportunities beyond the work," she said.

On the most recent project involving Bachman's sparrows, Lowery assisted Holly Todaro, a wildlife, fisheries and aquaculture master's student, as they studied habitat selection for the species of conservation concern. Bachman's sparrows are a sharply declining songbird that only occurs in burned, open-canopy pine forests.

"The main goal is to better understand how the species selects habitat in their home range so we're evaluating how they use grass cover for nesting, leaf litter for foraging, shrub cover, and perches, which are important during the breeding season for attracting mates," she said.

Lowery said uncovering the work has been exciting.

"There isn't a lot of knowledge about how Bachman's sparrows use resources, so this study will add new information that can be applied across their entire range," she said. This work will help inform improved habitat management recommendations for this species and others like it.

As a funded undergraduate research scholar the previous year, Lowery finished up a three-year project aimed to help restore pollinator habitat. While Conservation Reserve Program CP42—Pollinator Habitat pays landowners to convert row-crop land to native prairie habitat, seed mixes can be expensive and establishment rates vary. Lowery helped evaluate establishment rates of pollinator plants in order to determine the best performers while also analyzing how prescribed fire impacted the response and growth of the plants.

"Our project evaluated establishment rates and response to prescribed fire management of 30 recommended pollinator-friendly plant species within the Black Belt Prairie region in Clay County, Mississippi from 2018 to 2020," she explained.

The team created several experimental plots replicated over four blocks and studied stem densities over time.

"We found that Plains Coreopsis, Butterfly Milkweed, White Prairie Clover, Black-eyed Susan, and Illinois Bundleflower exhibited greatest stem densities in the first growing season after planting in 2018. Half of the 30 species had significant declines in log count of stems across the 11 survey weeks, and only two species exhibited positive trends," she said.

In the second growing season, Plains Coreopsis and Black-eyed Susan decreased while Narrowleaf Sunflower and Evening Primrose showed some of the greatest stem densities, Lowery noted. In essence, some plant species

Kim Lowery tags a songbird. (Photo Submitted)

did well right after planting, and others took some time to establish on plots, which is important knowledge to share with landowners who want to make sure their investment in establishing pollinator habitat pays off.

"Information from our research will help develop and target regionally effective seed mixes, increasing effectiveness, efficiency, and landowner buy-in to CP42, specifically in the Black Belt region of Mississippi," she said.

The work has resulted in a journal article currently being submitted to peer-reviewed publications.

"I enjoy helping create new information for the conservation world that people maybe haven't heard about. Also, helping on a peer-reviewed publication has been exciting. It's interesting to be a part of that process and see how it works," she said.

In addition to Todaro, MSU collaborators on the Bachman's sparrow project include **DR. KRISTINE EVANS, DR. MARK MCCONNELL, DR. SCOTT RUSH, DR. DANA MORIN**, with assistance from students Sydney O'Donald, Cara Stewart, Craig Sklarczyk, Rebecca Bracken, Brad Thornton, and Kyle Watkins. Refuge staff involved in the work include Steven Lewis, biologist, and Travis Carpenter, manager.

MSU individuals involved in the pollinator project include **DR. KRISTINE EVANS, DR. LESLIE BURGER, DR. WES BURGER, DR. CARLOS RAMIREZ-REYES**, with assistance from students, Isabella Burger and Will Pigot. Collaborators outside of MSU include Mr. Jimmy Bryan and Prairie Wildlife, Inc. staff, particularly Carl Cole. ■

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

KENNEDY CHAIR

Duck and Cover: Nesting Box Research

MSU RESEARCHERS CROSS STATE LINES FOR EXPANSIVE, MULTI-SPECIES NESTING BOX AND EGGSHELL RESEARCH

BY KATHLEEN FORMAN

TAYLOR GIBSON, currently pursuing a master's degree in Department of Wildlife, Fisheries and Aquaculture, was raised with curiosity and respect for wildlife and fishing. As a child, he dreamed of becoming a marine biologist, but as he grew older, he realized his true passion is waterfowl.

After graduating from Mississippi State with a wildlife, fisheries and aquaculture bachelor's degree, Gibson went to work. He worked with Ducks Unlimited in North Dakota, the Florida Fish and Wildlife Conservation Commission, and then with the Louisiana Department of Wildlife and Fisheries. Ultimately, when given the choice to come back and conduct research with his undergraduate advisor, **DR. BRIAN DAVIS**, Gibson described his decision as "easy pickings."

Gibson's research project, which is entitled "Nest Box Use And Reproduction Of Wood Ducks And Other Cavity-Nesting Ducks In Mississippi," is a collaborative effort with eight states including Mississippi, Maryland, Delaware, North and South Carolina, Georgia, Florida, and Louisiana. College athletic rivalries with universities such as Louisiana State University, Clemson University, and the University of Delaware are set aside to collaborate on this study to examine wood duckling production and survival in nest boxes.

"We seek to evaluate, in Mississippi specifically, biotic and abiotic characteristics that may influence box use and reproduction in wood ducks, black-bellied whistling ducks, and hooded mergansers," Gibson said. "We do this all with artificial nest boxes."

When gathering data, Gibson and his three undergraduate technicians travel to their two Mississippi research sites: the Sam D. Hamilton Noxubee National Wildlife Refuge, and York Woods in Charleston, Mississippi. At these sites, Gibson and his team monitor the boxes that provide supplemental nesting sites for the three species of cavity-nesting ducks in the area. They then band the hens residing in the nesting boxes and candle the eggs to determine their incubation stage. On the estimated eggs' hatch date, they travel back to the research sites to catch the ducklings and secure a web tag on their foot. Associated information for each web-tagged duckling includes the hatch date, the nesting box from which the duckling hatched, the size of the hen, along with other data such as local habitat conditions.

"Besides the population information we obtain, we can use this data to calculate the actual cost of a female wood duck and duckling based on the cost of the nest box and nest box programs," said Davis, the James C. Kennedy Endowed Associate Professor in Waterfowl and Wetlands Conservation and Gibson's major professor. "We know from earlier work that it is pretty efficient and worth the money."

Another benefit to nesting boxes is that they

can serve as a unique teaching tool. Students can travel to the boxes and gain firsthand wildlife experience.

In addition to the collaborative research program, Gibson is also conducting research testing the eggshell strength of wood ducks, hooded mergansers, and black-bellied whistling ducks, all of which can be found in the nesting boxes. Gibson also works closely with **DR. PRATIMA ADHIKARI**, an assistant professor in the Department of Poultry Science, to determine the precise pressure needed to force the eggshells to crack.

"I am anxious to compare the data because we have all three of these species nesting in these boxes and a lot of the eggs will get cracked," Gibson said on his eggshell strength study. "When they get cracked, many hens will abandon the nest which leads to complete nest failure."

The research has never been conducted on such a large scale, and Gibson expressed excitement on seeing the data come in over the next few years. With the support of the James C. Kennedy Waterfowl Chair and other partners including the Mississippi Department of Wildlife, Fisheries, and Parks, Gibson and Davis will be able to continue their research into both wood duckling production and eggshell strength.

"There's been a few studies on eggshell thickness, but no one's really done anything with these three species and their eggshell strength," Davis said. "The multiple years of studying duckling production and recruitment in these really different eight geographical regions will give us very exciting data to analyze." ■

This research is funded by the James C. Kennedy Endowed Chair in Waterfowl and Wetlands Conservation, the Nemours Wildlife Foundation, and the Mississippi Department of Wildlife, Fisheries and Parks.

Taylor Gibson inspects a nest box. (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.

No Refuge for Wild Pigs

FWRC RESEARCHERS SEEK TO REMOVE PIGS FROM REFUGE SYSTEMS

BY VANESSA BEESON

AN ESTIMATED POPULATION of six million wild pigs has been reported across 35 states, according to the USDA Animal and Plant Health Inspection Service. The U.S. Fish and Wildlife Service (USFWS) estimates that the invasive animals are a problem for at least 75 of its national wildlife refuges. That's why FWRC researchers are establishing a plan to combat wild pigs on protected lands.

The three-pronged approach includes studying movements, genetics, and early detection to effectively manage wild pigs on bottomland and upland forested landscapes in the Sam D. Hamilton Noxubee National Wildlife Refuge (Noxubee NWR).

DR. RAY IGLAY, assistant professor in the Department of Wildlife, Fisheries and Aquaculture and FWRC researcher, said the work serves as a road map for figuring out how many pigs inhabit Noxubee NWR while informing management practices for control.

"Ideally, we'll learn where pigs are, what they're doing in the landscape, and potentially monitor that over the long term. Monitoring can be a guide to controlling," Iglay said. "Aspects of this work can be combined and applied to help other refuges complete a rapid assessment on pig damage and population density with relative ease."

Iglay is most excited about applying the work in a larger setting.

"I'm excited to see this research applied to a larger scale study of standardized data collection. If we can estimate and control the wild pig population at Noxubee NWR, will it work elsewhere?" he said.

TYLER EVANS, a wildlife, fisheries and aquaculture doctoral student under Iglay's direction, has made the work his dissertation's focus.

"Our goal is to effect positive change in the wild pig realm not only on Noxubee NWR but also other lands in the NWR system and similar landscapes where wild pigs present a threat to sensitive ecosystems," Evans said.

The Salem, Ohio native graduated with a bachelor's degree at West Virginia University and master's degree at Penn State University, both in wildlife. After working in various wildlife positions in Ohio, Pennsylvania, and West Virginia, Evans was drawn to the prospect of studying wild pigs in Mississippi.

"Having considerable experience with large mammals, I jumped at the opportunity to work with wild pigs and earn a doctoral degree at Mississippi State. It's a dream come true," he said.

To better understand how sounders, or families of pigs, move throughout the landscape, Evans is collaring ten sows with GPS collars equipped with accelerometers and magnetometers.

"We chose females because they're more measured in their movements. The accelerometer provides triaxial movements, like a Fitbit,

which shows what the pigs are doing while the magnetometer gives us a more accurate picture of exactly where the pigs are moving on the landscape," Evans said.

The team is also building exclosures across Noxubee NWR to study how flora responds to simulated pig removal.

On the genetics front, non-grain attractants are being used to collect hair samples at 20 barbed wire "hair snares".

"We're measuring how often we detect the same individuals, the capture frequency of those individuals, and how related the pigs are," Evans explained. "We'll use this information to estimate wild pig abundance on Noxubee NWR."

The team also plans to analyze stomach contents of more than 100 pigs from Mississippi and Missouri to better understand the ecological impact pigs have on a landscape. The pigs were processed, data was analyzed, and consumed seeds were identified from research efforts led by **DR. JESSICA TEGT**, former assistant professor, **DR. SANDRA CORREA**, assistant professor, and **DR. BRONSON STRICKLAND**, St. John Family Endowed Professor of Wildlife Management. The team is producing a paper from the research in the *Journal of Visualized Experiments*. Makenzie Sanabria, an undergraduate research scholar who graduated in 2021, took the lead on much of this work addressing reviewer comments and working on the associated video.

Lastly, Evans conducted a full census of transect surveys across Noxubee NWR to identify wild pig rooting and wallowing, thus providing a baseline of wild pig damage on the landscape.

"We hope this information helps us develop subsampling techniques refuge staff can use to rapidly monitor changes in wild pig distributions," Evans said.

MSU collaborators include Dr. Garrett Street, associate professor; Dr. Melanie Boudreau, postdoctoral associate; and Oliver Fleming, wildlife, fisheries and aquaculture major. U.S. Fish and Wildlife Service collaborators include Travis Carpenter, Noxubee NWR's project leader, and T. Bryan Watkins, USFWS wildlife biologist. ■

This research is funded by FWRC and U.S. Fish and Wildlife Service.

A barbed wire "hair snare" captures hair to detect individual hogs. (Photo Submitted)

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DISSERTATIONS

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DeVries, R. J. 2020. Range-wide growth and diet of Pallid Sturgeon and sympatric Shovelnose Sturgeon. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Madduri, S. B. 2020. Development of low-cost adsorbents from biomass residues for the removal of organic contaminants and heavy metals from aqueous solutions. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Ratcliff Jr., J.T. 2020. Mechanical properties of southern pine over five decades. Dissertation, Department of Sustainable Bioproducts, Mississippi State University.

Richardson, B. 2020. Improved monitoring and decision-making to manage atypical *Aeromonas hydrophila* in catfish aquaculture ponds. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Shamaskin, A. C. 2021. Bridging data gaps for strategic conservation of Gulf of Mexico coastal region landscapes. Dissertation, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University.

Temple, N. 2021. Improving the cost-effectiveness of water wave measurements and understanding of its impact on natural and restored marsh communities. Dissertation, Department of Wildlife, Fisheries and Aquaculture, 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

82
Master's students (Fall 2020)

47
Doctoral students (Fall 2020)

45
Faculty (FY21)

RESEARCH PROJECTS

127
Projects Active (FY21)

68
Research Sponsors (FY21)

147
Refereed Publications (FY21)

$10,353,308
Total Sponsored Research Funding (FY21)

RESEARCH SPONSORS

3B Chair Company
American Conifer Society
Amite County Board of Supervisors
Anthony Hardwoods
Arch Wood Protection Inc.
Cargill Industries
Carnes Frames
Chickasaw County Board of Supervisors
Cooperative Ecosystems Studies Units
Dakota Matting and Environmental Solutions
Delta Farm
Drax Biomass International Inc.
Evermark LLC.
Florida International University
Forrest County Board of Supervisors
Fusion Furniture
FuturaGene
Harrison County Board of Supervisors

TOTAL FWRC FUNDING, FY21

$15.96M

35.20% STATE APPROPRIATIONS
02.53% FEDERAL APPROPRIATIONS
62.23% GRANTS AND CONTRACTS

Idaho Forest Group

Indiana Department of Natural Resources

IntegriCo Composites

International Paper Foundation

Jernigan Copeland

Jones Companies

Lane Furniture

Magnolia Upholstery Designs

Maibec Inc.

Maine Department of Inland Fisheries & Wildlife

Michigan Department of Natural Resources

Mississippi Department of Wildlife, Fisheries, & Parks

Mississippi Tree Farm Committee

Mississippi Wildlife, Fisheries, and Parks Foundation

Mississippi Implementation Committee for the Sustainable Forestry Initiative

National Fish and Wildlife Foundation

National Science Foundation

Nisus Corporation

North American Wood Pole Council

North Carolina State University

Purdue University

Quality Assurance International

Quality Mat Co.

Signature Systems

Stone County Board of Supervisors

Sustainable Forestry Initiative Inc.

The Jones Center at Ichauway

The National Academies of Sciences, Engineering, Medicine

Timber Products Company

Timber Products Inspection Inc.

United Furniture Industries/Lane Home Furnishings

U.S. Department of Commerce National Oceanic and Atmospheric Administration

U.S. Department of Energy

U.S. Department of the Interior

U.S. Fish and Wildlife Service

U.S. Geological Survey

University of Georgia

University of Puerto Rico

USDA Agricultural Research Service

USDA Animal & Plant Health Inspection Service

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

Waste Revelation

Wildlife Conservation Society

Wilkinson County Mississippi

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