FOREST & WILDLIFE RESEARCH CENTER 2017

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: Oxbow lakes are historically and biologically significant and aesthetically beautiful. (*Photo by David Ammon*)

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from the

DIRECTOR

The Forest and Wildlife Research Center (FWRC) at Mississippi State University is dedicated to conserving, managing, and utilizing the forest, forest products, wildlife, and fisheries resources of Mississippi for the betterment of our citizens.

This work is not possible without the generous help of our friends and supporters, appropriations through the state legislature, and private research sponsors. In fiscal year 2017, we had 111 sponsors support 290 projects. This support is essential as state agencies struggle with declining budgets. Grants, contracts, and federal appropriations represented over 58% of our funding. That means that for every dollar we receive in state support, we generate $1.42 in extramural support. We are proud of the return on investment we provide to the taxpayers of Mississippi. This level of funding would not be possible without the hard work, reputation, and relationships our scientists have built over the years with conservation partners in the U.S. and abroad.

Forestry and natural resources are an economic powerhouse for Mississippi. The forest and forest products industries contribute $12.8 billion to the state's economy each year. An additional $2.7 billion is generated annually from hunting, fishing, and wildlife viewing activities. This contribution correlates with the outstanding research conducted by FWRC scientists and students.

And, our College of Forest Resources students, at both the undergraduate and graduate level, are fully immersed in the FWRC research program. We are training the next generation of leaders to think critically, work in teams, and solve problems related to natural resource management. We are dedicated to this mission and are excited about the future of natural resource management. Evidence of this training is exemplified by our alumni who lead federal and state agencies, corporations, and non-profit organizations, among other entities. For example, Tony Tooke, forestry alumnus, was named chief of the U.S. Forest Service this year. We are proud of Tony and all of our alumni who are leading the charge in managing and sustaining our natural resources. Thank you all for the example you set for our students and the manner in which you represent Mississippi State.

I hope you enjoy this annual report, which is a glimpse of the projects FWRC scientists are tackling to improve habitats and natural resources while finding new ways to utilize our forest resources. As you read, you will see the passion that our faculty, staff, and students have for understanding, conserving, and appreciating our natural resources. We will continue in these endeavors and encourage your continued participation.

Thank you for your generous support!

George M. Hopper
Dean and Director

FORESTRY

The Department of Forestry conducts research to sustainably manage and utilize forest resources. This includes developing new practices to expand the growth of timber resources. As the second largest agricultural commodity in the state, the department works to increase awareness of the economic importance of natural resources. The department actively works with the Mississippi Forestry Commission, U.S. Forest Service, forest industry, and other universities to reduce risk of insect, disease, and natural disasters. The department also studies the effect of timberlands on carbon sequestration, water quality, alternative plantings, and wildlife habitat.

AN INSECT'S FOOTPRINT

Carbon consequences of pine beetle infestations

Mercedes Siegle-Gaither measures stemflow from a loblolly pine tree. (*Photo submitted*)

Southern pine beetle infestations kill thousands of trees and can be economically devastating for timber producers. Average annual tree mortality in the U.S. often exceeds 100 million board feet of sawtimber and 30 million cubic feet of pulpwood. While timber producers lose an estimated $43 million dollars annually because of the pest, the economic loss of one of the worst outbreaks on record, which occurred between 1999 and 2002, came in around one billion dollars by some estimates. While the tree mortality and economic impact of these pests are well studied, the insect's impact on forest carbon storage and cycling is less investigated.

Researchers in the Forest and Wildlife Research Center are trying to learn more about how this pest impacts the nutrients released from dying trees in the forest. Drs. Courtney Siegert and Heidi Renninger, both assistant professors in the forestry department, are trying to learn more about how pine beetle infestations affect forest carbon sequestration at the local level.

Given the limited research knowledge on the impact of nutrient and water cycles around individual trees, the team, which has included three master's students and two undergraduate researchers, sought to learn more. The group simulated a pine beetle attack on 37 forested acres on the John W. Starr Memorial Forest in Winston County, Mississippi.

"Pine beetles burrow into the trees and lay their eggs in the outer layer beneath the bark of the cambium. The eggs develop into larva and create tunnels around the tree, which prevents the tree from sending food and energy storages downward into the roots," Siegert said. "We simulated this process by girdling individual loblolly pines with a chainsaw."

For the past two years, Siegert has been monitoring the water fluxes that come from the tree canopy, called throughfall, and that run down the tree trunks, called stemflow. Renninger has been monitoring the rates of the trees' water uptake from the soil.

"Now that most of the trees have died, Dr. Renninger's data collection is complete. I will continue monitoring throughfall and stemflow after rainfall events at least until the end of this growing season," Siegert said.

She went on to explain that when rainfall events occur, throughfall and stemflow cause the trees to leach carbon and that not all of that carbon is created equal.

"Carbon like simple sugars and carbohydrates is very easily decomposed while other carbon like lignin and tannins takes much longer," Siegert said.

She added that different types of carbon can help determine whether or not the dying trees create biogeochemical hotspots that prime the area for decomposer communities to move in.

"As trees die, they release an abundance of nutrients into the soils, which can create favorable conditions for the decomposer communities to come in and start to break down the biomass," Siegert explained. "We are looking closely at this process at the individual tree level to see what consequences it bears on carbon cycles and budgets."

While the data collection and analysis is still ongoing, Siegert has noticed some initial differences in the carbon released in throughfall compared to stemflow.

"We are seeing that stemflow relative to throughfall has more carbon in it but that the carbon is harder for decomposer communities to break down."

Siegert said she hopes the work will ultimately inform big picture questions involving forest carbon sequestration.

"There are a lot of unknown questions about how disturbances like this impact nutrient cycles. For instance, we don't know if the carbon from an event like this gets released back into the atmosphere, which would have a negative climatic impact; or if it gets converted back into organic carbon stored in a terrestrial carbon pool, which would be better for the environment," she said. "This is a first attempt at investigating how pine beetle disturbances might impact the carbon budgets in the Southeast. ❖

This research is funded by the McIntire-Stennis Federal Capacity Grant.

A GOOD NEIGHBOR

How midstory hardwoods might protect longleaf seedlings

Longleaf pines are one of the longest living species of southern pine. Individual trees can live to around 250 years. While these trees have a long life, researchers in the Forest and Wildlife Research Center are concerned with getting longleaf pine seedlings established. Dr. John Willis, assistant forestry professor, is studying the relationship between longleaf pine seedlings and midstory hardwoods in order to determine if the relationship helps the seedlings become initially established.

"From a big picture standpoint, restoration of longleaf pine ecosystems is very important," Willis said. "Essentially one quarter of all herbaceous plant species in North America are found in longleaf pine ecosystems and many of those species are endemic to longleaf pine systems, meaning they don't thrive elsewhere."

Longleaf pine ecosystems were once the dominant forest cover type on the southeastern coastal plain, covering 91 million acres. Willis said that over the past 70 to 80 years 98 percent of the historical longleaf range has been lost. Longleaf pine ecosystems occupy a little over three million acres today.

While restoration efforts are ongoing in pockets across the Southeast, Willis said there are many different variables that can cause restoration efforts to fail.

Longleaf pine seedlings in North Carolina. (*Photo submitted*)

"There are several avenues to failures with longleaf pine restoration." he said. "These very dynamic ecosystems can be difficult to manage sustainably. It is well-established that fire does play a critical role in releasing longleaf pine, but there are lots of interactions that we don't really understand. In our research, we hope to quantify some of these understudied interactions that make the system function."

Since longleaf pines are shade intolerant, a prescribed fire typically minimizes the presence of hardwoods on a site being prepared for restoration. However, a few years ago in the sandhills of North Carolina, Willis and his team observed longleaf regeneration underneath hardwoods.

"On a particular dry site with sandy soil in North Carolina, we noticed longleaf regeneration underneath midstory hardwoods," Willis said. "While we aren't debating the species' need for light, we wanted to further explore the relationship between longleaf pine seedlings and midstory hardwoods, as longleaf on xeric sites does not behave the same way as it does on mesic sites. Fire will still be necessary to release the longleaf; the real question is how frequently prescribed fire should be applied to release the established seedlings. If our observations hold true, current management practices could be inadvertently constraining longleaf regeneration."

Willis pointed out that a research site with conditions in Florida demonstrated a facilitative relationship between midstory hardwoods and longleaf pine seedlings. Willis took his observation in North Carolina and insights garnered from previous studies like the one in Florida and decided to dig deeper.

Willis and his team, which includes master's student Jacob Henry and David Schnake, MSU alumnus and forest manager with the North Carolina Department of Agriculture and Consumer Services, are examining the early impacts of midstory hardwoods on longleaf seedling establishment on dry sites in North Carolina. Branson Wetzstein and Justin Yow, undergraduate research scholars, are also part of the research.

The four-year study, now in its second year, will evaluate longleaf pine seedlings grown on plots with and without midstory hardwoods for variable lengths of time.

The team is evaluating the seedlings' performance characteristics to see how the facilitative relationship between the trees works and how long it lasts. They are also studying seedlings in relation to seed predation.

"There are some thoughts that the midstory hardwoods may be facilitating longleaf germination because the larger tree's litter conceals the seeds from small mammals. Conversely, it may be that the turkey oak draws in more wildlife because of its acorns," Willis said.

While it is too early in the research to tell exactly how the hardwoods are helping the seedlings, Willis hopes to eventually discover important mechanistic functions that could inform future management practices when it comes to the restoration efforts of longleaf pine ecosystems.❖

This research is funded by the North Carolina Department of Agriculture and Consumer Services.

MADE IN CHINA

Globalization leads to friction in the bedroom furniture industry

America imported 39 percent of China's bedroom furniture exports in 2012. (*Photo submitted*)

WHILE YOUR BEDROOM FURNITURE MAY NOT have a "Made in China" sticker on it, there's a good chance the trees grew seas away, and that it was manufactured into your beloved bedroom set in a Chinese factory. However, with an influx of affordable Chinese furniture coming into America in the last ten years, policymakers have placed limits on the pricing of imported furniture.

Dr. Changyou Sun, Forest and Wildlife Research Center forestry economics professor, examined how limits set in 2008 have impacted the industry today.

"With innovations in ready-to-assemble packing technology, firms are able to manufacture and ship large quantities of wooden bedroom furniture. China is the leader in this industry, and the United States is the largest importer," Sun said.

America imported 39 percent of China's wooden bedroom furniture exports in 2012—up from 26 percent in 1997. But with increasing trade comes increasing tension.

"Manufacturers in the United States felt that the large quantities of Chinese furniture were being priced at less-than-fair values, which injured the furniture industry as a whole," Sun said.

When an exporter floods the market with products that are under priced, it is known as dumping. Dumping can cause domestic products to lose value with consumers, because the pricing is so much lower than other options.

"American furniture firms and labor unions created a petition to protest the less-than-fair pricing, which they presented to the International Trade Commission in 2005," Sun explained.

In order to offset this problem, duty was imposed on individual Chinese firms to bring furniture prices to fair levels alongside domestic manufacturers. The duty ranged from less than one percent to nearly 200 percent.

When the duty was reexamined by two administrative reviews in 2010 and 2015, it was determined to be necessary; experts decided that lifting it could cause a re-occurrence of the damage that had occurred in 2004. Further, researchers found that while the duty had caused a slight depression in China when it was first imposed; ultimately, manufacturers had diversified their exports, sending goods to Canada, Brazil, Vietnam, and Indonesia instead.

However, China isn't the only country that could come under fire for dumping. As developing countries like Vietnam take advantage of low labor costs to produce inexpensive products, they too could find themselves limited by a duty.

"While China has been forced to diversify by the duty, Vietnam has taken over as leader, with low prices and rapid growth in the United States' market," Sun said.

Furniture isn't the only product that has caused friction between China and the United States. Coated paper products, or glossy paper suitable for graphics, from China, Indonesia, and Korea were also investigated for anti-dumping in order to prevent domestic manufacturers from being harmed.

"With increasing globalization, it makes sense for developing countries to use their low labor wages to their advantage, and then ship products around the world," Sun said. "As demand increases for these products, it is often filled by imported goods."

American paper manufacturers filed a petition to curtail dumping of paper products in 2006. When the International Trade Commission decided not to impose duty on the importing countries, importation grew even faster.

"When a second investigation was initiated that targeted only China and Indonesia, the International Trade Commission found that the low prices and high import rates were injuring domestic manufacturers, and imposed duties," Sun explained.

However, this time the solution that had worked so neatly with bedroom furniture proved more complicated.

"Other suppliers like Korea and Germany soon sprang up to take their place," Sun said. "This demonstrates that market competition can be more complicated than expected, especially as globalization increases and countries rely more and more on each other for imports and exports." ❖

This research is funded by the Wood Utilization Research program and USDA Forest Service.

WIDE OPEN SPACES

Understanding the value and benefits of waterfront property

Enjoying the beach, the sound of the waves, the rising and falling of the tides, the feel of the salt laden air is a recreational pastime that millions of Americans enjoy each year. The benefits of waterfront open space are numerous: environmental stability, recreational opportunity, economic stimulus, and enhanced quality of life for residents and visitors alike.

However, with growing populations and increased urbanization, land use is changing and beach and waterfront access is quickly becoming a sea of high-rise condominiums.

A recent multi-state project was conducted to examine coastal residents' interest in preserving open waterfront space in Mississippi and Alabama.

Mississippi State University scientists in the Forest and Wildlife Research Center included Dr. Jason Gordon, forestry associate extension professor; Dr. Robert Grala, forestry professor; and forestry doctoral student Ram Dahal. Dr. Daniel Petrolia, an associate professor of agricultural economics in the MSU' Mississippi Agricultural and Forestry Experiment Station, along with scientists from Jackson State University and the University of South Alabama also participated in the study.

"Open spaces, such as beaches and river greenways, are difficult to quantify in monetary terms," Gordon said. "What is the value of the beach to residents and visitors? Because open spaces are considered public goods, it is hard to define their value, their benefits aren't traded in markets. However, policymakers and land managers need this information to make informed decisions regarding land use."

To begin the study, scientists conducted eight facilitated group sessions—one from each of the five coastal counties and three with underrepresented groups—to gather data for the development of a mail survey to be sent to Mississippi-Alabama coastal residents.

The survey was designed to quantify residents' willingness to preserve waterfront open space in coastal regions. Using the contingent valuation method, researchers are able to estimate a citizens' willingness to pay for support of waterfront open space preservation based on survey responses.

"In the survey, we presented a hypothetical scenario of a ballot initiative where residents would vote for or against the establishment of a public fund to purchase waterfront land," Gordon said. "The goal of the public fund, as described in the survey, is to promote and protect small-scale waterfront businesses, coastal habitat, and water quality. If the ballot initiative passed, each household would be required to make a one-time payment added to their water bill for the waterfront land fund."

Results indicated that the majority of respondents believed that open space was of moderate to major importance in preserving coastal character of their community. Additionally, over half of those surveyed were willing to pay for a fund to preserve open waterfront space.

Interestingly, most survey participants believed that coastal storms and a changing economy were more of a threat to waterfront open space than residential growth. Additionally, about 71 percent of those surveyed believed that working waterfronts were threatened in their community.

Overall, the study found that the majority of respondents valued waterfront open space preservation as critical to their community's history and culture and they were willing to pay to support these areas.

Scientists are still working on the qualitative analysis which addresses fair access to open space, regardless of race and social class.

"This is one of the few open space studies that applies mixed quantitative and qualitative approaches to produce a comprehensive understanding of residents' attitudes towards waterfront open space and urban growth," Gordon said. "Open space planning in growing urban areas is as much an environmental justice concern as it is an aesthetic or economic issue."

Scientists expect the findings to be helpful to city planners and policymakers when considering how to combine open waterfront access and other land uses. ❖

Beach front property in Biloxi, Mississippi. (*Photo by Megan Bean*)

This project was funded by Mississippi-Alabama Sea Grant Consortium.

WHAT LIES BENEATH THE SURFACE

Understanding how trees use water and nutrients

At eye level, trees stand noble, providing habitat for wildlife and creating a canopy of shade and color. But underneath the soil, bark, and leaves, trees are actively working. Water and nutrients move through the roots, up through the xylem—or wood tissue—into the leaves. The leaves take in the water and then release it through transpiration as they open their pores on the underside of the leaf to take in carbon dioxide for photosynthesis.

The process is quite a feat given that trees are moving water against gravity, up the tree to the top. But how much water does the tree need? And how many nutrients are making it through to the leaves?

These questions and others are the subject of an ongoing study by Forest and Wildlife Research Center assistant forestry professor Dr. Heidi Renninger and her graduate student Zeima Kassahun.

With changes in climate creating extreme precipitation, flooding and prolonged drought, finding out which trees are more resilient to changes in the environment and use water wisely is important in understanding the future of hardwood forest ecosystems.

The study site is on the John W. Starr Memorial Forest, near the MSU campus. It is a high terrace bottomland hardwood forest with heavy clay soils. Flooding occurs on the site during the winter. The scientists have equipped the study trees with sensors to determine the sap flow or movement of water through the tree. They are recording measurements every 30 seconds.

"We measured sap flow of eight hardwood species, as well as soil moisture continuously over the course of a year," Renninger said. "The time period included drought conditions as well as extended saturated soil conditions."

The purpose of the study is to determine how trees adapt and survive in changing climates. Understanding how individual species perform under these conditions could assist in replanting and allow scientists to model how the ecosystem may look under varying environmental conditions in the future.

While the study is ongoing, early results suggest some species are more adept at handling extreme weather conditions.

"Our study found that cherrybark oak uses the most water during the growing season, using nearly 20 percent more water than the next highest user, swamp chestnut oak," Renninger said.

To understand how trees perform in drought, scientists study the relationship between vapor pressure deficit and water use under different soil moisture conditions.

"Vapor pressure deficit is the difference between 100% humidity conditions at a given air temperature and the actual relative humidity, or how dry the air feels," Renninger explained. "We expect that when vapor pressure deficit is high and the air is drier, there would be higher sap flow as trees need more water to keep up with transpiration. But if we don't see a relationship between vapor pressure deficit and sap flow, we suspect that those trees have shut down their transpiration due to drought stress and will not do well under dry conditions."

Preliminary results indicate that winged elm, American elm, cherrybark oak, and shagbark hickory are more negatively affected by drought conditions while willow oak, swamp chestnut oak, and green ash are more drought tolerant.

Scientists also looked at which trees were the first to lose their leaves during extended drought conditions, indicating the tree has stopped functioning for the growing season.

"Willow oak, cherrybark oak, and shagbark hickory were the first to lose their leaves at the end of the growing season when extended drought conditions occurred," Renninger said.

Of all the species studied, green ash had the lowest water-use efficiency, which is an estimate of the amount of productivity per unit water lost, compared to the other species.

Once complete, the study will allow scientists to predict an individual species' ability to adapt to changing climate. This information will help land managers understand which trees will be the most successful under future climate conditions. ❖

This research is funded by the McIntire-Stennis Federal Capacity Grant.

Forestry graduate student Zeima Kassahun measures sap flow on a study tree in the John W. Starr Memorial Forest. (*Photo submitted*)

Graduate Student Profile:

Mercedes Siegle-Gaither

HOMETOWN: Montello, WI

GO WITH THE FLOW

Tracking the path water takes through the forest

When a raindrop falls into a forest, where does it go? This is one of the questions Dr. Courtney Siegert and graduate student Mercedes Siegle-Gaither addressed in their recent research using isotopes to track water pathways through forests. In particular, they examined how different species retained water on and within tree surfaces such as leaves and bark.

"This research is important for understanding how species composition impacts the way water flows through a forest. It's of particular importance for water scarce areas, especially as regions like California see periods of greater and greater drought," Siegert said. "Trees are essentially storage compartments of water."

Siegert and Siegle-Gaither used stable isotopes because their changing composition in trees indicates to researchers how evaporation of water stored on leaves and bark has taken place. High temperatures and low humidity can cause high rates of evaporation, leaving heavier isotopes behind.

In order to conduct her research, Siegle-Gaither had to wait until a storm of at least 12 milliliters had passed through.

"Then I'd hurry out to my study site and collect water samples in 20 milliliter vials from six different tree species," Siegle-Gaither explained.

In terms of how species altered the isotope composition, differences were small.

"The variations are very small between species. However, we did find a correlation between bark thickness and water retention. Trees with thicker bark hold more water than trees with thinner bark," Siegle-Gaither said.

Siegert and Siegle-Gaither are still exploring exactly how species impacts water flow.

"We're trying to figure out why different bark types impact water retention. We suspect it could be something as simple as the way the bark funnels water down to the roots," Siegert said.

They also categorized the storm types, to see whether storm origin had any effect on water isotopes.

Siegle-Gaither describes how localized thunderstorms have rainfall with much heavier isotopes than storms that originate from the coast or from the middle of the U.S. Differences in the rainfall isotopes further complicate the interpretation of stemflow isotopes, but Siegle-Gaither is working to untangle that mystery.

While the exact mechanism of canopy water transport remains unknown, Siegert and Siegle-Gaither have amassed a huge amount of data that may help contribute to solving it.

"This was a very ambitious project, and we analyzed a lot of data. Now we'd like to determine the physical mechanisms by which water moves. Mercedes did an excellent job working through a difficult project," Siegert said.

Siegle-Gaither first became interested in water by learning about its occupants: she worked with the U.S. Navy's Marine Mammal Program to help train sea animals in swimmer defense and object retrieval.

"I had no idea the Navy used seals and dolphins for these kinds of things until I had the opportunity to get involved. It really made me passionate about marine life, and helped me realize the importance of water in a system," Siegle-Gaither said.

She received her bachelor's degree in Biology from the University of Wisconsin–La Crosse, and after her stint with the U.S. Navy, came to Mississippi State University to study forestry.

"Mercedes is the hardest working and most dedicated graduate student I've had," Siegert said in praise of her. "She's always asking questions, she's active in the lab, and she still found time to help mentor other graduate and undergraduate students and act as president of the MSU Graduate Student Association during the 2016-2017 school year."

When Siegle-Gaither isn't studying the flow of water through forests or helping others in the department, she works on developing her own non-profit alongside another MSU doctoral student, Jordan McMahon: ConserVANtion. Through ConserVANtion, which takes place in a van, she hopes to inspire people to get outside and foster awareness for conservation and sustainability. ❖

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

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WILDLIFE, FISHERIES & AQUACULTURE

The Department of Wildlife, Fisheries and Aquaculture develops and conducts research on game and nongame species; ecology; wildlife diseases; endangered species conservation; ecological restoration; invasive species management; habitat reclamation, restoration, and management; conservation education; human dimensions; geospatial technologies in wildlife and fisheries sciences; landscape ecology; and wildlife and fish recreation. The department is the research arm for the Mississippi Department of Wildlife, Fisheries and Parks and works with a variety of governmental and non-governmental agencies to manage wildlife populations and habitat.

A NATIONAL TREASURE

Mississippi's oxbow lakes provide insight into the past

An oxbow lake is essentially a river cutoff. It's often a horseshoe-shaped lake that forms after a river cuts through a meander bend to shorten its course. Dr. Steve Miranda, adjunct fisheries professor in the Forest and Wildlife Research Center's wildlife, fisheries and aquaculture department, began investigating oxbow lakes in the Delta in 2006 when the U.S. Army Corps of Engineers asked him to conduct a biotic integrity inventory of the bodies of water.

"All of these lakes have different water quality characteristics but water quality is difficult to measure," Miranda said. "By looking at the composition of the fish assemblage you can get a good idea of the environmental characteristics of the lake, including depth, availability of oxygen, and temperature. Fish in lakes with poorer water quality tend to have species that are more tolerant of harsher environments."

In a systematic series of studies, Miranda's team has spent nearly a decade cataloging the biotic integrity of approximately 60 to 70 lakes in and around the Yazoo River Basin. One recent study evaluated the effects of water withdrawals for irrigation on characteristics of the aquatic environment. The Mississippi Department of Environmental Quality wanted to determine a threshold lake depth to where water could be withdrawn from a lake with minimal impact on the lake's water quality and fish assemblage. Miranda's team analyzed the biotic integrity data they had collected to identify that threshold.

"Once lake maximum depth reaches about six feet or less, change happens rapidly," Miranda said. "The fish community, algae, oxygen levels, temperature, and lake productivity all begin to change quickly at this point, which lets us know we shouldn't withdraw water in lakes below this depth."

While the biotic integrity research provides answers to manage water quality today, Miranda is also interested in what these lakes can tell us about the past. Oxbow lakes dot the Mississippi Delta like the pattern of a patchwork quilt. According to Miranda, that pattern tells a story. He explained the existing lakes and the scars of lakes past tell the story of ancient waterways that traversed the landscape more than 10,000 years ago.

"Some of these lakes are young lakes around 50 years old, while other lakes, called paleochannels, are more than 10,000 years old," Miranda said. "These older lakes tell the story of how large river systems like the Mississippi meandered over time."

To dig deeper into the research, Miranda determined there was an essential need for an inventory of all the lakes in the Mississippi Alluvial Valley from Cairo, Illinois to Baton Rouge, Louisiana. Michael Rhodes, a master's student in the department, is currently using GIS data to build such an inventory. Other collaborators on the project include FWRC wildlife, fisheries and aquaculture professor Dr. Kristine Evans, Dr. Qingmen Meng with the MSU Geosystems Research Institute, Yvonne Allen with the U.S. Fish and Wildlife Service, and Dr. Jack Killgore, with the U.S. Army Corps of Engineers.

Thus far the team has identified 1,450 lakes, defined as bodies of water at least five acres across that contain water year-round. They have grouped the lakes into categories according to morphology and depth. One such category seems to correlate with the identification of paleochannels.

"Some lakes over the course of 30 years have shrunk and expanded more frequently. The shrinking is likely caused by drought cycles and suggests these lakes are shallow. Deep lakes with steep banks can't really shrink like that," Miranda explained. "I suspect, because of this shrinking pattern, this category might contain most of the paleochannels linked to ancient river systems."

Miranda said the inventory will help scientists and citizens restore, protect, and preserve what he calls a national treasure.

"These waters are historically and biologically significant and aesthetically beautiful. In my mind, the beauty of the Mississippi Delta is comparable to Yellowstone National Park and the Grand Canyon." Miranda said. "These lakes represent our geological history. They are also a unique characteristic of the Mississippi Alluvial Valley, which is home to nearly 50 species of mammals, 60 percent of all bird species in the contiguous U.S., 45 species of reptiles and amphibians, and 37 species of mussel. Additionally, 136 species of fish depend on the river and floodplain system, and nearly 100 fish species have been documented in oxbow lakes and backwaters." ❖

This research is funded by the U.S. Army Corps of Engineers and the MS Department of Environmental Quality.

Oxbow lakes are historically and biologically significant. (*Photo courtesy of the Mississippi Cooperative Research Unit Corner*)

NO LONGER STUMPED

Mineral stumps improve white-tailed deer nutrition

Young bucks find an unlikely meal in mineral stumps. (*Photo by Steve Gulledge*)

It has long been a mystery why white-tailed deer devour the sprouts from recently cut stumps. Now Dr. Marcus Lashley, Forest and Wildlife Research Center assistant professor in the wildlife, fisheries and aquaculture department, has figured out why—and developed a simple, cost-effective management technique to help support white-tailed deer during seasons of poor forage.

The tree species that populate southeastern forests are notoriously nutrient-poor—deer tend to prefer nutrient-rich forbs—a herbaceous, flowering plant other than a grass. However, Lashley had noticed that even when forbs were available, deer still preferred to browse the sprouts from cut hardwoods when available.

"I first came up with the idea for this project when I was a kid sitting on a tree stand. I had cut down several hardwood trees, and noticed that deer were eating from the stump. I was curious about why, because the species I cut are traditionally considered poor for deer. I carried that question with me through school until I finally had the opportunity to answer it," Lashley said.

Lashley and his graduate student, Don Chance, answered his life-long question by cutting a range of differently sized red maples (a tree species that is common in southeastern forests, and known for being nutritionally poor) and measuring the nutrient quality of the leaves before and after cutting.

They also monitored the stumps' attractiveness to deer by placing cameras at each stump site and recording how deer interacted with the stumps.

Sure enough, the growth from cut stumps was twice as nutritious as a forb with several nutrients and highly attractive to deer. Lashley attributes this to a process called up-regulation.

Trees maintain a balance of nutrients throughout the roots and above ground foliage. When the tree gets cut, the nutrients get redistributed, and the tree "up-regulates" the nutrients in its roots into the few sprouts on the stump, which leads to highly nutritious forage for wildlife and other species.

"This process mimics the top kill that would historically be caused by seasonal wildfires," Chance explained. "As the summer dries out and plants begin to lose their nutrients, lightning strikes cause wildfires, which kill off the above-ground foliage and stimulate new growth. Like with the cut stumps, this new growth is highly nutritious."

Lashley and Chance believe that this process is part of why deer's peak lactation occurs later in the summer—they are able to get the nutrients they need in order to produce milk for offspring. This suggests that the wildfire-regrowth cycle has occurred for millennia and impacted the timing of when deer breed and give birth.

This new understanding of "mineral stumps," as Lashley has dubbed them, will enable hunters and other forest managers to better assist deer herds and other herbivores when their usual forage begins to lose its nutrition.

"This management technique is incredibly simple: it only requires a chainsaw and some gas. The beauty of it is that anyone can do it," Lashley said. ❖

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

REELING IN IMPACTS

Understanding the human dimensions of hunting and fishing

As one of the most popular recreational activities in America, fishing ranks in the top five among youth and adults. Perhaps it is the thrill of the tug on the line when catching a largemouth bass or the excitement of captivating a trout with a handmade fly. Whatever the reason, over 35 million Americans enjoyed fishing in 2016, according to U.S. Fish and Wildlife Service.

The 2016 national survey conducted by the federal agency found that 40 percent of the U.S. population participated in some form of fishing, hunting or other wildlife-associated recreation, including birdwatching and outdoor photography. These individuals spent about $156.3 billion on expenditures, making outdoor recreational activities big business for states with resources to support the demand.

Dr. Kevin Hunt, Forest and Wildlife Research Center professor in wildlife, fisheries and aquaculture, has spent his career analyzing the social and economic impact of hunting and fishing. His work is in human dimensions, an area of research that analyzes social and economic information to inform, evaluate, and provide scientific basis for policies and goals.

"We study the number of days people spend in the recreational activity, how satisfied they are with the resources, how they view policies affecting those resources, and the economic impact of the activity," Hunt said. "This information often drives policy, may influence marketing decisions, and can potentially increase economic growth in an area."

Human dimension studies of wildlife, fisheries, and wildlife watching are conducted on multiple levels: national, statewide, species, and resource.

The U.S. Fish and Wildlife Service conducts a national survey on hunting, fishing, and wildlife watching every five years. This national survey is broken down into statewide analysis, however, the information provided in these analysis is broad.

The focus for Hunt and colleagues in the FWRC's Human Dimensions Laboratory are at the state, species, and resource level. Scientists in the laboratory have conducted surveys in Mississippi, Arkansas, Texas, and Puerto Rico. Their work includes hunting and fishing participants.

"Statewide surveys gather information in a variety of areas: demographics, use patterns, preferred species, participation in clubs and tournaments, reasons for hunting/fishing, attitudes about the resource, and general management tools," Hunt said.

Statewide information is useful for state agency leadership as they formulate policy about the resource.

The statewide survey also allows scientists to probe deeper into species-level anglers. Once a statewide survey is conducted, the responses are segmented by preferred species, giving researchers a customized list of participants to contact for species-specific topics.

"While the information from statewide surveys help justify and guide policies, species- level studies can shape management plans or provide economic impact and valuation for a particular species," Hunt said.

Several species-level studies have been conducted by the Forest and Wildlife Research Center. A 2006 study revealed that white-tailed deer hunting generated $978 million in sales of equipment and other hunting-related expenditures in Mississippi. The sport also supported some 33,000 jobs in the state. A similar study on waterfowl hunting determined that the sport provided an economic impact of $86.8 million to the state.

Scientists have also conducted resource-level studies, which include a particular lake, reservoir, stream, or stretch of river.

For example, a Mississippi study on the Grenada and Sardis Reservoirs revealed a combined economic impact of $7.98 million, supporting 126 full- and part-time jobs. Most recently, a study on Lake Fork Reservoir in Texas found that the popular bass fishing destination contributed a total economic impact of $18.8 million to the state.

"Understanding the social benefits and economic impact of a resource allows policy makers to consider the ramifications of potential land-use actions/policies on recreational hunting or fishing activity," Hunt said.

Ultimately, having information from all four of the human dimension surveys provides the big-picture of the resource, guiding policy and management decisions.

"The need for timely scientifically-based social, cultural, and economic information from hunters and anglers is essential for making decisions that are biologically sound and palatable to stakeholders," Hunt said. "The Human Dimensions Laboratory can provide this information to help state agencies optimize the resources and realize the economic impacts from these resources." ❖

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

Over 35 million Americans enjoy fishing. (*Photo courtesy of TakeMeFishing.org*)

A SAFE LANDING

Scientists work to reduce wildlife-plane collisions

The FAA reported 13,215 collisions between birds and aircraft in 2015. (*Photo submitted*)

Headlines read, "Miracle on the Hudson," and photos showed 155 passengers and crew standing on the wings of the Airbus as it floated in the most unlikely places, Manhattan's Hudson River. The January 2009 incident was caused by a flock of Canada geese that flew into both engines of the commercial airline.

While this particular incident made headline news, the nearly three dozen bird-plane collisions that happen each day in the United States go largely unnoticed. The Federal Aviation Administration reported 13,215 collisions between birds and aircraft in 2015.

Scientists in the Forest and Wildlife Research Center, along with colleagues in the Wildlife Services, National Research Center of U.S. Department of Agriculture's Animal and Plant Health Inspection Service, are working to protect the landing and takeoff for passengers who share the friendly skies with a host of birds.

With airports occupying over 1,200 square miles of grassland, larger than the state of Rhode Island, there is a lot of ground to cover to ensure that large birds, noted as extremely hazardous by the FAA, are not present.

To this end, scientists began a project in 2014 to plant areas around airports in switchgrass. A native perennial warm-season grass, switchgrass is used as forage for livestock, soil conservation, biofuel feedstock, and poultry bedding. Although it is often hard to establish, once a stand is achieved, its benefits for airports are numerous.

"The potential savings to the airport include reduced manpower in maintain the grass areas, reduced fuel in mowing, and growing a perennial grass that can be used for other purposes," said Dr. Ray Iglay, assistant research professor in the Forest and Wildlife Research Center's wildlife, fisheries and aquaculture department. "The other obvious benefit is to try to reduce large birds and mammals from using the space."

Six airports agreed to participate in the study: Dayton International Airport and nearby Wright-Patterson Air Force Base, both in Ohio; Detroit Metro Airport and Gerald R. Ford International Airport in Michigan; Columbus Air Force Base in Mississippi; and Naval Air Station Whiting Field in Florida. The four northern sites were established in 2015 and 2016. The two southern sites failed to establish.

Thus far, the results of the switchgrass stands compared to the control or mowed areas demonstrate minimal differences between treatments. The FAA categorizes birds by hazard categories: extremely high, very high, high, moderate, low, and very low.

"In the breeding bird point counts, there was little difference in the three highest hazard categories of bird use between switchgrass plots and mowed grass," Iglay said. "The breeding bird line transects also showed little difference in the three highest hazard categories among treatments."

Given the slow establishment of switchgrass, scientists are hopeful that as the grass dominates the plots, differences will become more apparent.

In addition to birds, mammals also can cause problems on the runway. The FAA reports 2,207 strikes of terrestrial mammals by airplanes during 2015. Mammals involved are usually deer or coyote.

"Data from 2016 are being analyzed but 2015 data suggest that there was no difference in the number of mammals visiting the switchgrass or control site," Iglay said. ❖

In addition to Iglay, the research team includes Dr. Jerry Belant, Forest and Wildlife Research Center professor of wildlife, fisheries and aquaculture and USDA-APHIS scientists Travis L. DeVault, Bradley F. Blackwell, and Michel L. Begier. Dr. James A. Martin, a scientist at the University of Georgia is also a part of the project. Data collection will continue into 2018. The U.S. Department of Defense funded the project.

HOTEL PARASITE

Understanding the host-parasite relationship in alligators

They begin the journey homesteading with a snail. They emerge from the snail as tiny microscopic worm-like parasites traveling through the water looking for the next host. They swim through the skin of the gar, the top of the food chain among fish. Inside the gar, they take up residency inside the ovaries. Gar have few predators, except for the American alligator. The alligator consumes the gar, digests it, but the trematode *Odhneriotrema incommodum* survives and moves up the esophagus to make its home on the tongue of the gator.

The phenomenon of the relationship of the trematode and the alligator is not new; although scientists are not sure how long it has existed.

"When you think of the alligator being a prehistoric creature, occupying the earth for millions of years, perhaps this host-parasite relationship has been in existence for that long or has evolved over time," said Dr. Scott Rush, Forest and Wildlife Research Center assistant professor in wildlife, fisheries and aquaculture.

Once inside the mouth of the alligator, the trematode attaches, looking like a leech approximately one-inch long. On average, an alligator has about five of the trematodes attached to its tongue, with some having more or less. It does not appear that the trematode has any serious negative effect on the alligator.

The trematode was first described in 1856. Historically, scientists have used measurements and features to describe and classify parasites, such as this trematode. The problem with using measurements and features to describe a parasite is that they change over the life of the organism. Therefore, species are defined by ranges of measurements whose taxonomic utility have been the subject of considerable debate. Thus has been the story of the trematode *O. incommodum*. It has been moved to different classifications throughout its history until now.

Ethan Woodyard and Scott Rush examine trematodes in the mouth of an alligator. (*Photo by David Ammon*)

Scientists in the Forest and Wildlife Research Center have conducted DNA sequencing on the trematode and are beginning to work on others found within the reptile.

Rush, along with Ethan Woodyard, a College of Forest Resources undergraduate student majoring in wildlife, fisheries and aquaculture; and Thomas Rosser, assistant research professor in the MSU College of Veterinary Medicine; began working on the project in 2015.

"I am interested in what eats what and how that structures ecosystems," Rush said. "This is a neat way to look at that and see how the parasites move from intermediate host to host and trace those dietary patterns."

Scientists point out the value of the study in understanding the dynamics of the food chain.

"If you what to know what eats what, you can look inside the stomach for the contents to determine what an animal has eaten in the last few days," Woodyard said. "However, this trematode has been known to live inside the mouth of the alligator for up to two years which gives you a different picture of what the alligator consumes."

Alligators also have the ability to speed up or slow down their digestive process, depending on their needs, making it difficult to determine when the alligator consumed a meal.

Working with colleagues at Nicholls State, the scientists obtained gar to look for this trematode in the ovaries and to determine if the gar was, in fact, the intermediate host of the same parasite found in the mouth of the alligator.

"We were able to sequence the parasites in the gar and then obtained alligators from a processing plant in Port Gibson, Mississippi, to sequence the parasites in the alligator," Rush said.

Based on the DNA sequencing, scientists confirmed several species of parasites to be the same in both the gar and the alligator. However, research continues to sequence other parasites found in the alligator.

Alligators are often known as ecosystem engineers because of the way they manipulate hydrology and influence plant communities. However, the average 1,000-pound reptile could more aptly be described as hotel parasite, with numerous host-parasite relationships existing in its lungs, intestines, and mouth.

"The adult alligator is a good place for parasites because no one is eating alligators," Woodyard said. "However, it is difficult to determine the intermediate source of the parasite because alligators eat so much."

The team will continue working on the alligator, contributing to science by performing DNA-sequencing of all the parasites found.

"This information will help scientists quickly distinguish among the numerous parasites found in the alligator," Rush said. "It will also contribute to our body of knowledge on the host-parasite relationship." ❖

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

Graduate Student Profile:

Mariela Gantchoff

HOMETOWN: Buenos Aires, Argentina

BLUEPRINT FOR REBUILDING

The reestablishment of a regional black bear population

Over the last several decades, Mississippi's black bear population has slowly begun to rebuild. This has brought about a need for researchers to learn more about how black bears move through the landscape. Jerrold Belant, MSU Dale H. Arner Professor of Wildlife Ecology and Management and FWRC scientist, is one researcher currently leading the charge in studying ways to help facilitate a successful recolonization of these large carnivores in the Magnolia State.

One aspect of the research has been a regional connectivity analyses conducted by Mariela Gantchoff, a doctoral student under Belant's direction.

"Mariela's black bear research joins an overall goal of understanding the environmental and anthropogenic drivers of carnivore distribution and abundance to help facilitate their conservation and coexistence with humans," said Belant, who is also the director of the MSU Carnivore Ecology Laboratory.

Gantchoff is pursuing a doctoral degree in forest resources with a concentration in wildlife, fisheries, and aquaculture with an anticipated graduation date of summer 2018. The Buenos Aires, Argentina native earned her master's at MSU studying medium-sized native carnivores and invasive herbivores in Patagonia, Argentina. When it was time to explore a doctoral program, she stayed on with the Carnivore Ecology Lab to study Mississippi's black bears.

"In many places, populations of large carnivores are decreasing. In Mississippi, the numbers of black bears are actually increasing," Gantchoff said. "This project was a unique opportunity to study a large carnivore recolonization, which is pretty uncommon."

Gantchoff's work was part of a larger cooperative effort that began in 2008 between MSU and the Mississippi Department of Wildlife, Fisheries, and Parks.

"The overall goal is to understand black bear recolonization within the state by studying habitat selection, movements, dispersal, and the reproductive biology of females, including litter size and survival," Gantchoff said. "We hope to be able to provide reliable scientific data to guide future black bear management strategies throughout the state."

Gantchoff developed a regional model that predicted how bears might move across certain landscapes, hoping to help identify areas that bears might move through as the species' population increases.

"Landscape connectivity is vital for animals that live in human-modified landscapes. As the black bear population increases, these animals will expand their range. Currently, the bear's actual and projected movement paths are completely unknown. We are hoping these analyses will help identify areas that facilitate regional movement," she said.

The model encompasses Mississippi, Missouri, Arkansas, Louisiana, and a small part of Texas. Gantchoff developed a movement resistance layer that detailed whether the land was agricultural, urban, forested, or other. She included highways, roadways, rivers, and riparian corridors. She then modeled how individual dispersers might move through the landscape given the estimated resistances. To validate the model, she overlaid citizen-reported sightings of black bears and compared the predicted probability of movement between bears sightings and random locations.

"The greater the model density value, the higher the probability of an animal moving through the area, so in theory these areas would most facilitate connectivity," she said. "I compared model density values between bear locations and random locations. Bear sightings had higher model density values. The areas predicted to be more likely to have bears actually had more bear sightings, which indicated that the model had good performance characterizing areas that bears will use at a coarse scale."

Another aspect of the model focuses on what Gantchoff calls pinch points.

"Pinch points are bottlenecks of movement. We can compare these points against highways and roads and determine areas that might have a higher probability of human-bear collisions," she said. "I have the locations of bear crossing signs that the state of Mississippi installed a few years ago. The locations of these signs correspond very well with areas that the model indicated were identified as pinch points. Though it is a small number of signs, the relationship is encouraging."

Gantchoff hopes the project will help in recolonization efforts while reducing the potential for future human-bear conflict. From an ecological standpoint, she hopes her research will contribute to conservation management practices that also protect wildlife beyond bears.

"Bears are a good umbrella species. Protecting areas for bears can also help other forest and riparian species," she said. ❖

This research was funded by Federal Aid in Wildlife Restoration and Safari Club International Foundation.

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SUSTAINABLE BIOPRODUCTS

The Sustainable Bioproducts Department conducts research to advance natural resource-based manufacturing practices. By improving products and developing new products, the department extends the sustainable utilization and stewardship of forests and other natural resources. The department also works to extend the use of natural resources through the development of wood preservation methods and new uses for underutilized forest resources.

PULPWOOD PILE UP

As industry shrinks, researchers seek solutions

Scientists are working to find new uses for sawmill residues. (*Photo by David Ammon*)

As the paper industry shrinks, sawmills find themselves buried beneath piles of what are known as sawmill residuals: the materials that are left over from lumber produced from logs. These piles are ever-growing, and have the power to shut down a sawmill for days as workers scramble to find a way to use or market them, which usually includes transporting the co-products to pulp mills, particleboard plants, pellet mills, or landfills: all costly solutions.

In response to this growing issue, Dr. Rubin Shmulsky, department head of the Forest and Wildlife Research Center's sustainable bioproducts department, is working to find alternative uses for sawmill residuals.

"We have explored a number of avenues, including burning for electricity, the creation of pellets for use in electric power plants, and as a product to help stabilize and improve soil fertility," Shmulsky stated.

The goal of most sawmills is to get the most from every log harvested, which both saves money and keeps production sustainable.

"In an effort to maximize the yield from the forest, we need to squeeze as much as possible from every log. Sawmills produce a number of co-products that aren't lumber, including pulp chips, bark, and green sawdust, to name a few," Shmulsky explained.

In the past, pulp chips from the sawmill were used to make paper. However, in a shrinking domestic pulp and paper industry, sawmills struggle to find places to send their co-products.

"Pulp and paper mills in the United States have closed and been moved to South America and Asia, where it's cheaper to manufacture. They're also larger and more consolidated," Shmulsky said. "The pulp and paper market is shrinking in this digital age—there has been a global effort to minimize paper usage. Newspapers are fewer and smaller and people read things on their phones or computers. On top of that, environmental regulations are very strict."

Stakeholders have begun to call for research on the best way to market and use their ever-growing piles of sawdust.

"In the last two to three years, we have heard a strong call from stakeholders to come up with good uses for sawmill residuals. This issue is on everyone's plate," Shmulsky said.

And while electrical generation is a tempting alternative, it comes with real issues: sawmill residuals make for relatively poor burning material—green sawdust is very wet, and bark tends to be gritty, leading to issues with environmental regulations.

Thankfully, a solution seems possible. Research has found that when laced with small amounts of nitrogen, sawmill residuals can make soil more productive, stable, and increase its moisture holding capacity.

"The most promising solution we've found so far is soil amendment. By adding nitrogen to sawmill residuals and disking them into the soil, we've seen more productive, stable soil. This is a boon all around—it generates a demand for residuals, which helps sawmills, and it creates better soil for farmers," Shmulsky explained.

Dr. Hamid Borazjani, a sustainable bioproducts professor in the Forest and Wildlife Research Center, used his expertise in soil science to determine the ratio needed to produce the best compost.

"This idea started with a collaboration we did with a company in Leland, Mississippi. It can make compost for agriculture or vegetable gardens. They spend about $600 a month to get rid of sawdust. We figured out that they can compost on-site and actually save a lot of money," Borazjani said.

Composting sawmill residuals also may kill two birds with one stone: the waste produced by poultry makes an excellent source of nitrogen.

"In Mississippi the number one industry is poultry. And in order to compost, you need a nitrogen source. Poultry waste makes a perfect nitrogen source. In addition, most big poultry production companies and most big sawmills as well as most nurseries are located in south Mississippi, so transportation costs aren't an issue," Borazjani explained.

Now that researchers have settled on a promising use for the sawmill residuals, the next step is getting the word out.

"Right now we're working mostly on making sure this information gets into the right hands, so that it can make a difference in the industry," Shmulsky said. ❖

This research was funded by the FWRC, the USDA Agricultural Research Service and the USDA Forest Service Forest Products Lab.

INSIGHT INTO PINE

Learning more about southern lumber

SOUTHERN YELLOW PINE IS A MULTIBILLION DOLLAR industry and accounts for 15 percent of the world's lumber production. Researchers in the Forest and Wildlife Research Center's sustainable bioproducts department are in the fourth year of a five-year study focused on evaluating southern yellow pine lumber. Dr. Dan Seale, Warren S. Thompson Professor of Wood Science and Technology, and Dr. Rubin Shmulsky, professor and department head, lead the research. Their team, which has included up to a dozen graduate students and numerous research associates, tested more than 2,000 pieces of southern yellow pine lumber of 2x4 to 2x10 sizes.

The team characterized each piece of lumber and entered data into a comprehensive database that includes initial grade, certified grade, rings per inch, percent latewood, presence of pith, major strength reducing defect, major grade reducing defect, and any other knots within a specified test span. They also completed non-destructive testing by studying longitudinal and transverse vibration of the lumber to determine stiffness and strength. They are in the process of finishing up small property tests on clear specimens, which includes evaluating bending, tension, compression parallel to the grain, compression perpendicular to the grain, specific gravity, and sheer.

The research results have evolved into the development of a smart phone app, which will ultimately help carpenters better evaluate the strength of individual pieces of lumber in a consumer setting. The team recently received two grants totaling $1,800 from the Mississippi State University Entrepreneurship Center in order to help further the app's development.

Seale said the expansive research project has been a tremendous wealth of experience for all who have been involved, especially the graduate students.

"It's been unique for them. Some of them have gotten a real lesson in work ethic," Seale said. "It's been an incredible opportunity for hands-on experience and has increased the demand of these graduates as they enter the workforce," Seale said.

Seale also pointed out that the students have greater insight into lumber's impact on the larger economy.

"One thing that they have all garnered out of the project is a clear understanding that if we can make lumber more valuable, the land that grows the trees will be more valuable and landowners will get more dollars when they sell timber."

One student on the project, Frederico França, joined the team in August 2014. He graduated with his doctoral degree in August 2017. França worked mainly on the non-destructive tests. He accepted a position as an assistant research professor within the department in August 2017 and will dig deeper into the research in his new role.

"From a testing standpoint, longitudinal and transverse vibration used in determining board stiffness is already well explained. Vibration as it relates to strength testing is not as well explained," he said. "We hope to discover more insight in that area."

França will also begin testing lumber for a staircase study.

"In the staircase project, we will collect and test samples of current wood species that are used in staircase construction and compare our results and analysis with existing data," França said. "The ultimate goal will be to partner with the Stairbuilders and Manufacturers Association in developing metrics that could be used in a certification system for lumber used to construct staircases." ❖

The broader southern yellow pine lumber study is funded by the U.S. Department of Agriculture's Agricultural Research Service. Participating collaborators include the USDA Forest Products Laboratory, the Southern Pine Inspection Bureau, the Timber Products Inspection Agency, the Southern Forest Products Association, the Southeastern Lumber Manufacturers Association, and the Mississippi Forestry Association. The staircase research study collaborators include the Stairbuilders and Manufacturers Association and the USDA Forest Products Laboratory.

Research associate Amy Rowlen conducts a small property test. (*Photo by David Ammon*)

PROTECTING RESOURCES

Sustainable bioproducts champion of wood preservation

Long-term wood preservation test in an outdoor laboratory. (*Photo by David Ammon*)

FOREST PRODUCTS ARE BIG BUSINESS IN MISSISSIPPI, accounting for more than 57,000 jobs with a total economic output of over 11 billion dollars. Wood preservation research at MSU helps extend the life of those products.

"In general, society agrees that sustainability is good. The longer we make things last, the better. The field of wood preservation seeks to do just that," said Dr. Rubin Shmulsky, professor and head of the sustainable bioproducts department. "Conceptually, if we can make wood products last twice as long, then we have to harvest only half the trees. When we make products last four, five, or even six times longer, then forest sustainability continues to grow."

For more than 60 years, the Forest and Wildlife Research Center's Department of Sustainable Bioproducts has been doing its part to ensure wood products last as long as possible.

"Of the department's dozens of patents, many deal with enhancing wood's durability and long-term performance," Shmulsky said. "MSU's unique laboratory can test many aspects of wood durability from laboratory fungal tests to outdoor termites and from microscopic bacterial DNA to full-scale decades-long evaluations of utility poles and railroad ties."

Dr. Darrel Nicholas, sustainable bioproducts professor, has been studying wood preservatives most of his career. Nicholas has evaluated wood durability across several climates including such places as Mississippi, Michigan, and even Hawaii. Currently, Nicholas and the MSU team have research test plots at Dorman Lake just south of Starkville; near Saucier, Mississippi at the U.S. Forest Service Research Station; and in Hilo, Hawaii, in partnership with Viance, LCC, an industry leader in wood treatment. Other MSU researchers have plots in such places as Florida, Georgia, and Texas.

Nicholas began his career in Hawaii where he served as vice president and director of research for the Honolulu Wood Treating Company. Following this, he moved to Michigan Technological University, where he continued research in development of new wood preservatives and was awarded a two million dollar research grant from the Electrical Power Research Institute. Following this, he accepted a position at Mississippi State University where he has been since 1981. Since that time, he has developed patents for alternatives to chromated copper arsenate (CCA), which was the industry standard in wood preservation for a number of years. He also led a team of six MSU scientists in a project sponsored by the U.S. Army aimed at the development of a wood pallet for packaging materials that was chemical and abrasion resistant and could be decontaminated from toxic warfare chemicals.

"I've spent thirty years helping develop alternatives for CCA. During our research, it became apparent that the existing test methodology needed to be improved," Nicholas said. "That work led to our development of accelerated test methods based on mechanical properties of wood."

In a compression strength soil block test, Nicholas and his team decreased the amount of test time from 12 weeks to four. Field testing timelines were reduced by approximately 50 percent with the team's accelerated methodology in unsterile soil contact tests.

His MSU research led to the award of patents concerning the development of improved wood preservatives. On the academic side, Nicholas has edited and co-edited five books written on wood preservation. He has also written three specific standards for the American Wood Protection Association (formerly, the American Wood-Preservers' Association).

"The standards I helped develop include E-22, which deals with use of compression strength loss in measuring decay; E-23, which discusses an accelerated method for testing preservatives exposed to soil contact; and E-27, which covers a method for accelerating a field test," said Nicholas, who has also worked on modifying other standards as well.

Currently, his research is focused on studying copper-tolerant fungi, in a collaborative project with Dr. Juliet Tang at the USDA Forest Service Forest Products Laboratory in Starkville, Mississippi.

"We are studying which genes regulate copper tolerance in fungi that effectively identifies metabolic chokepoints that have the likelihood of interfering with copper tolerance and identifies which steps in metabolism are being differentially regulated to allow fungal survival on copper. This may permit us to identify inhibitors that regulate these genes. This approach is much more precise compared to arbitrary screening of chemicals that we have done in the past," he said.

As leaders in wood preservation, researchers like Nicholas continue to evaluate and develop products, processes, and other techniques to improve wood durability.❖

This research is funded by the McIntire-Stennis Federal Capacity Grant.

NATURAL FOOD PROTECTION

Scientists create green bio-based film

THE FIRST MANMADE PLASTIC WAS DERIVED FROM cellulose in 1862, when Alexander Parkes developed a material that could be molded when heated and retained its shape when cooled, according to the American Chemistry Council. The discovery of plastics would come years later, quickly displacing cellulose with synthetic compounds derived from petrochemicals.

Plastic packaging has been used extensively in protection of food products to maintain nutrients, color, aroma, and taste while also creating a barrier to extend shelf life and quality. It also allows for easy transport. However, the use of plastic, an often disposed material, has evolved into mountains of waste. Since mass production of plastics began, 8.3 billion metric tons have been produced with 6.3 billion metric tons or 13 trillion pounds becoming plastic waste, according to a recent report in the National Geographic.

Scientists in the Forest and Wildlife Research Center hope to go back to basics and create bio-based packaging from cellulose that is environmentally-friendly, biodegradable, renewable, and abundant in nature.

Dr. El Barbary Hassan, Forest and Wildlife Research Center associate professor in sustainable bioproducts, worked with graduate student Bhawna Soni, to develop bionanocomposite films with enhanced mechanical and barrier properties. Bionanocomposites are composite materials that contain biological substances and particles with at least one of those being a nanometer in size.

To make the bionanocomposite films, Hassan looked at chitosan, a natural derivative of chitin, which is found in the shells of crustaceans. It is the second most abundant polysaccharide found in nature after cellulose.

"Chitosan has numerous advantages and properties, including antimicrobial activity. It has been used to produce biodegradable films to extend the shelf life of food and prevent contamination," Hassan said. "However, despite its numerous advantages and unique properties, the chitosan films are poor barriers to gas and water vapor, restricting its use in packaging applications."

Several scientists have examined the combination of chitosan and cellulose for bionanocomposite films in food packaging; however, water vapor permeability and transparency were not previously examined.

"Chitosan-cellulose combinations are compatible due to structural similarity, which results in fibers with the physiochemical properties of chitosan and the mechanical properties of cellulose fibers," Hassan said.

Hassan and Soni extracted one type of cellulose nanofiber called TEMPO-oxidized cellulose nanofibers from cotton stalks. They combined the TEMPO-oxidized cellulose nanofibers with chitosan from shrimp to produce bionanocomposite films.

Bhawna Soni examines biofilm. (*Photo submitted*)

Packaging films of different compositions of the cellulose nanofibers and chitosan were developed, and then tested for oxygen permeability, tensile strength, water vapor permeability, thermal stability, and antimicrobial activity.

"We were able to create bionanocomposite films that have reduced moisture and oxygen transmission properties," Hassan said. "The produced nanocomposite films possessed higher thermal stability, mechanical properties, transparency, and flexibility when compared to 100 percent chitosan films."

Results from the study found that the nanocellulose/chitosan combination created a feasible, green, and effective transparent biodegradable film that can be used for packaging of food products. ❖

This research is funded by the McIntire-Stennis Federal Capacity Grant.

IF THE LUMBER FITS

Researchers design lumber meant for the South

Scientists investigate cross-laminated timber for use in the south. (*Photo submitted*)

With the invention of cross-laminated timber (CLT), a composite of multiple layers of lumber glued together to form panels, new doors have opened for building in the South. Forest and Wildlife Research Center scientists in the sustainable bioproducts department, Dr. Rubin Shmulsky, department head and Dr. Hyungsuk Thomas Lim, assistant professor, are exploring new ways that CLT could be optimized for the humid, hot environment of the south, as well as how native trees could be utilized as building material.

"At Mississippi State, scientists are researching a variety of aspects related to CLT. These include opportunities for using southern pine as a raw material, studies on strength and stiffness performance, as well as long term building and CLT panel durability and protection," Shmulsky said.

CLT could help diversify the market for domestic timber in the United States, which is important as more and more pulp and paper production is moved overseas.

"As this technology becomes developed and adopted, it offers a new and increased outlet and market for domestic timber which, in turn, supports sustainable forestry practices," Shmulsky said.

The current trend is toward tall wood buildings—or wooden buildings that are over five stories high. CLT may be the perfect material for these buildings, as it has many positive attributes, such as fire resistance and rapid construction times, that facilitate tall wood construction.

"Tall wood buildings are seeing a renaissance around the world. In the U.S., this movement and adoption is in its infancy, but is growing quickly. CLT is a relatively new building product that facilitates architectural freedoms that were previously unattainable. It allows the design and construction of tall wood buildings with performance, aesthetic, and cost characteristics that make it attractive into the future," Shmulsky explained.

Another opportunity for housing innovation begins right here in Mississippi.

"Here in Mississippi, the population isn't highly concentrated, so we may not need tall residential buildings as much as other places—here people are able to spread out. Instead, considering the climate and on-site construction costs, pre-fab housing would be a better fit" Lim said. "The idea is to build to fit the state or region, not vice versa."

With his research, he hopes to develop longer lasting, cost effective buildings.

While steel is currently used to construct pre-fab homes, uses of structural wood products such as CLT could reduce the cost even further. The manufactured wood products could also be engineered to better deal with moisture, a boon for the humid south.

"There are big differences from region to region when it comes to what buildings must withstand. Up in the Pacific Northwest, we have to build structures those can withstand earthquakes. In the South, we're more worried about tornadoes, flooding, and high humidity. The idea is to tune the product to our climate," Lim said.

He uses his background in wood science to examine what is happening on a microscopic level in the material, and then combines that with an engineering perspective to get an idea of how the product will perform.

"First I'd like to look into the structural performance of CLT panels constructed utilizing local softwood and hardwood species, and examine the feasibility of using these products for pre-fab housing. Subsequently, the energy performance and termite resistance of these wood products need to be evaluated in order to help them penetrate into the Southern United States construction market," Lim said.

He hopes that in time, the research will eventually contribute to the construction of easy-to-assemble, affordable housing throughout Mississippi. ❖

This research was funded by the USDA Forest Products Laboratory.

Graduate Student Profile:

Julianna Stratton

HOMETOWN: Coeur d'Alene, Idaho

ENGINEERING WOOD NATURALLY

Scientists develop natural wood adhesives

CABINETRY, FURNITURE, FLOORING, SIDING, ROOF sheathing, and wall sheathing are all made from composite lumber, often termed engineered wood. These products include particleboard, plywood, and oriented strandboard; all formed from strands, particles, fibers, or veneer of wood bound together with an adhesive.

Formaldehyde adhesives are the most common used in composite manufacturing, however, the glue can generate airborne fumes, leading to respiratory distress.

Many companies are looking for alternatives to formaldehyde that are environmentally-friendly, safer for consumers, and cost-competitive.

Julianna Stratton, a graduate student in sustainable bioproducts, is working to find low-formaldehyde or formaldehyde-free adhesives for the composite market. She is looking to nature for bonding materials that will also provide protection from termites.

Working with Dr. Beth Stokes, Forest and Wildlife Research Center sustainable bioproducts assistant professor, and scientists in the USDA Agricultural Research Service, Stratton is investigating the use of cottonseed protein isolate created from gin waste as a potential adhesive component.

Stratton is also researching the guayule plant as either an adhesive component or termiticide additive. A flowering shrub native to the southwestern United States and Mexico, the guayule plant is used as an alternate source of latex for rubber that is hypoallergenic.

"Previous tests have been done at other laboratories to measure the strength of cottonseed protein isolate on a small scale but not in the form of a composite board," Stratton said. "We have developed a pilot-scale composite product."

Now that the team is further along in development of a composite board, they will put the test boards through a series of durability tests—exposure to termites, water, and fungi—as well as tests to ensure it can hold fasteners.

If successful, the research could produce a termite resistant composite board from all natural products that would have use in external and internal applications.

"Because both additives are derived from natural products, they are more environmentally-friendly and could prove useful for industry in meeting both the requirements of reduced emission standards and the desires of the consumer," Stratton said.

The research is ongoing, but preliminary results look promising for an engineered product made from renewable, natural components.

For Stratton, the promise of sustainability is one of the reasons she pursued this particular path. She was interested in graduate work that would allow her to apply her chemistry degree in a manner that improved the environment.

In her master's degree, she monitored pentachlorophenol, a wood preservative used to treat utility poles. Prior to our understanding of the environmental impacts of the chemical, treatment leached into the ground. Now the chemical is applied differently.

"I was able to use numerous techniques to monitor cleanup of a site that has been under remediation for two decades," Stratton said. "Now, in my doctoral degree, I am working to develop a new product that is environmentally-friendly. Both projects have allowed me to fundamentally improve the environment."

Stratton is open to what the future holds and her educational background will provide numerous opportunities to continue her work of sustaining and improving the environment. ❖

Julianna Stratton (left) and Beth Stokes examine an engineered wood sample. (*Photo by David Ammon*)

This research is funded by the USDA Agricultural Research Service.

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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 conflicts, and expands educational opportunities for students interested in human dimensions of wildlife and fisheries conservation.

THE SQUEAL ON PIGS

Accelerometers give insight into feral pig management

Feral hogs are captured in a pen for research. (*Photo by Steven Tucker*)

Mississippi state researchers are going whole hog on Mississippi's feral swine problem. With the use of accelerometers, a movement tracking device attached alongside GPS collars, Garrett Street, assistant professor in the Forest and Wildlife Research Center's wildlife, fisheries and aquaculture department, is working to uncover new insights into how feral swine use the landscape.

Further discovery of feral swine movement patterns may help researchers refine management techniques—an important ecological and economical venture due to the destructive nature of swine.

Graduate student Jane Dentinger explains, "Pigs cause an estimated 1.5 billion dollars' worth of damage each year to farmers in the United States, as well as trampling valuable habitat for wildlife and carrying disease. This number includes both direct damage, and the costs of management and removal of pigs."

Despite the steep cost to health, pocket and habitat, people and wild pigs have a long history—they were introduced to the United States by early Spanish explorers, and with the help of humans have rapidly spread across the United States. Since their initial introduction, humans have continued to help their spread by releasing them around the country for sport. Their high birth rates and adaptability only contribute to their spread.

"It's really difficult to control their populations. They reproduce two to three times a year, with six to eight piglets in each litter. Even with aggressive management techniques, their range continues to grow," Dentinger said.

Street and Dentinger hope to provide state managers with more efficient management techniques with their new work using accelerometers, which will give managers insight into how the animals use landscapes.

In order to get a beat on how pigs move, they built a secure enclosure, equipped with everything the pigs needed to survive and a variety of habitats for the pigs to interact with. They then trapped wild pigs and attached accelerometers and GPS collars to them, so that their movements would be recorded as they moved within the pen.

In addition, they set up cameras along the outside of the enclosure, so that pig movements and behaviors could be visually verified.

While GPS collars have given researchers a peek into the lives of wildlife in the past, accelerometers take it to another level.

"With GPS collars, you could see when and where an animal was at certain points, but not everything in between—we could see that a pig was in a corn field, and so we'd assume that it was eating, but there was no real way to verify that," Street said.

The accelerometers record movements at sub-second intervals, and by matching the movements to behaviors observed in the pen, they will be able to develop a model that detects behavior from their collars without the need of direct observation.

"You can see a pig walking—each step causes a small rise and fall in the data. Same with eating—you can see the motion of the head as the animal rips at foliage," Street explained.

This level of knowledge is unprecedented, and will allow researchers to better understand how wildlife use the resources around them.

"While in the past we could surmise why an animal was in a certain place, there were still mysteries. It makes sense that a pig would visit a corn field in the middle of the summer, but why does a pig visit it in the winter, when there doesn't appear to be any resources? Data from the accelerometer will help us answer questions like that," Street said.

This is only the first step in the research. Once Street and Dentinger have developed models that will interpret accelerometer data, they will conduct a capture-recapture study with pigs in the wild and use their accelerometers to determine exactly how pigs behave across their ranges. They then will be able to figure out how pigs in the wild, unconstrained by fences, utilize the landscape.

"We hope that this data will help managers figure out how to capture pigs more efficiently. Pigs are incredibly destructive and rapidly expanding their range, and we hope that our research will be able to slow or even halt that expansion," Street said. ❖

This research was funded by the Mississippi Agriculture and Forestry Experiment Station, the Samuel Roberts Nobel Foundation, and the Mississippi Department of Wildlife, Fisheries and Parks, with support from the Swansea Laboratory for Animal Movement.

TRAINING THE FRONT LINES

National Training Academy housed at MSU

A new partnership between Mississippi State University and the U.S. Department of Agriculture's APHIS Wildlife Services program has made the university home to a national training academy.

In fall of 2016, MSU President Mark E. Keenum and USDA/APHIS Wildlife Services Deputy Administrator William H. Clay signed a "Resolution for Collaboration" to create a national training academy housed at Mississippi State. APHIS—the Animal and Plant Health Inspection Service—provides a wide range of functions, including protecting and promoting U.S. agricultural health, regulating genetically-engineered organisms, administering the Animal Welfare Act, and carrying out wildlife damage management activities.

The Wildlife Services National Training Academy, or NTA, is the country's first academy dedicated to training, instruction and safely resolving human-wildlife conflicts and safety-related risks. The NTA, headquartered at Mississippi State in the Center for Resolving Human-Wildlife Conflicts, can train up to 1,200 USDA/APHIS Wildlife Services personnel currently tasked with responding to human-wildlife conflicts across the U.S.

Keenum said the partnership highlights MSU as a national leader in the emerging field of human-wildlife conflicts.

"Our Center for Resolving Human-Wildlife Conflicts is the first of its kind to host such a training academy among research-oriented land grant universities specializing in finding resolutions to these conflicts, through research, education and outreach," Keenum said. "This partnership broadens our reach, providing essential training to those personnel in the field every day formulating resolutions to human-wildlife conflicts."

Human-wildlife conflicts occur in all 50 states and cause an estimated $22 billion dollars in damage annually to agricultural crops and man-made infrastructure. That number will only climb as human and wildlife populations continue to increase.

The comprehensive, standardized and integrated training program includes in-house and regional training in the form of workshops, seminars, field instruction and web-based learning. Classes, which began in spring 2017, typically include around 15 participants and cover safety-related topics including human-wildlife conflict prevention and resolution training; firearm safety; pyrotechnics, explosives, and chemical immobilization; and all-terrain vehicular safety. Classes have been held in Mississippi, Ohio, New Hampshire, Colorado, and Arizona. Upcoming classes will take place in Texas and Nebraska. Instructors Chad Dacus and Scott Edwards are MSU College of Forest Resources alumni earning both their bachelor's and master's degrees at the university. They each spent more than a decade with the Mississippi Department of Wildlife, Fisheries and Parks before joining the collaborative effort between USDA/APHIS Wildlife Services and MSU.

"There are over 1,200 dedicated Wildlife Services professionals across the United States that serve as our nation's wildlife damage management experts. The NTA serves as the central training portal to aid Wildlife Services leadership in designing, coordinating, and providing training nationally with specially-designed and standardized courses," Edwards said. "As Wildlife Services employees expound on their elite skill sets through specifically-tailored training, their individual professionalism level further rises and will continue to positively impact public perception, which has an indirect and positive impact on all wildlife professionals."

The NTA additionally serves as a model for state and federal agencies to partner with academic institutions to create and deliver specialized training for their employees, Edwards added. ❖

Participants learn firearm safety at an NTA workshop. (*Photo courtesy of NTA*)

This research is funded by USDA APHIS.

Graduate Student Profile:

Trevon Strange

HOMETOWN: Long Island, New York

CLOSING THE EDUCATION GAP

Determining the skills wildlife professionals need

We attend school in order to prepare ourselves for the future. But what if our education doesn't prepare us to succeed as professionals? Graduate student Trevon Strange and his advisor, Dr. Jessica Tegt, wildlife, fisheries and aquaculture assistant extension professor, are examining this question in the hopes that they will be able to address the gap between the education wildlife professionals receive, and the skills they actually need throughout their careers.

"You might have a certain skill set from a university, but it may not apply to what wildlife professionals actually need in order to thrive throughout their careers," Strange explained. "That's why I'm analyzing the gap between university training and professional skill sets. The goal is to maximize their ability to work in the field."

He works with the Wildlife Services National Training Academy, using a gap analysis, or a technique that compares two groups in order to determine competency and performance level. He will list the attributes of current graduates, list the factors that need to change in order to maximize their abilities in the workforce, and highlight the gaps that exist in order to help wildlife programs address the needs of their students.

"This will better equip universities with an understanding of the skills needed in the field for future modifications to undergraduate programs, and it will allow the National Training Academy staff to design programs that best suit the needs of wildlife professionals," Tegt explained.

Coming from a small, liberal arts university for his undergraduate education, Strange understands what it is like to succeed without a wildlife emphasis.

"I studied pre-veterinary medicine at Tuskegee University. My undergraduate program didn't have a very strong wildlife program, so the university showed vet students what other career options there were—aside from being a traditional vet—by sending them out on internships," Strange said.

That was how he ended up at Mississippi State University, where he worked with Dr. Fred Cunningham through the National Wildlife Research Center, assisting with feral swine toxicant rice trials and cormorant research in Wisconsin.

The next summer he returned, this time to analyze feral swine stomach contents with Tegt, as part of a team informally dubbed "Team Guts and Glory."

"The feral swine content analysis was my favorite—it was really interactive, and I was able to experience a different aspect of the field from traditional veterinary medicine," Strange explained.

Eventually Strange would like to merge his passions for wildlife and veterinary medicine by becoming a wildlife vet—a goal sparked by outdoor activities with his grandfather.

"I fell into this field because of my grandfather. He grew up hunting in upstate New York with his friends. When I was born, he brought me with him to hunt and fish and it grew on me. I fell in love with the field, and knew I wanted to study wildlife," Strange said.

After her experience with Strange as an intern, Tegt decided to bring him on as a master's student.

"The first thing that I noticed about Trevon is that he asks a lot of questions—and natural inquiry is essential to pursuing graduate education. When I met Trevon, he was already putting himself in a good position for networking with professionals in different areas of wildlife research and expressed an unwavering willingness to do whatever it takes to pursue his education," Tegt said in praise of her graduate student.

She also feels that his unique combination of fieldwork, veterinary medicine, and human dimensions will set him apart from the crowd.

"When Trevon graduates, his experience and knowledge will set him apart from other professionals in his field. He will have the scientific grounding for wildlife management, but he will also have the rarer background in human dimensions of wildlife. This will give him great insight into the ways humans interact with our natural resources and the ability to make recommendations for best management practices," Tegt stated.

Not only will Strange's education set him up to succeed: it will also benefit wildlife students around the nation by helping them get the education they need as well. ❖

This research is funded by USDA APHIS.

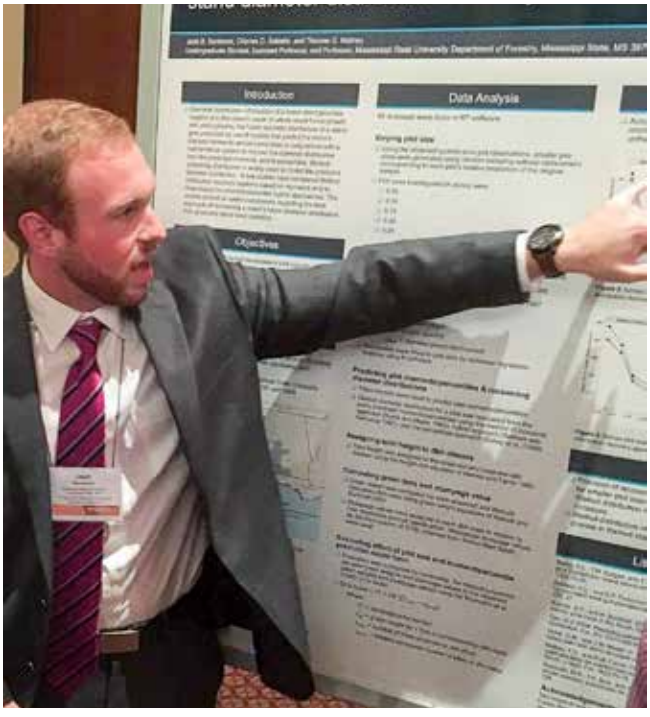
UNDERGRADUATE RESEARC

Undergraduate students in the College of Forest Resources step outside of the classroom to engage in hands-on research with scientists in the Forest and Wildlife Research Center. The opportunity is made possible by the Undergraduate Research Scholars Program, now in its third year.

LEAH LEONARD

HOMETOWN: *Olive Branch, Mississippi*

Leonard, a forestry major with a wildlife management concentration, hopes to graduate in Spring 2018. As an undergraduate research scholar, she studied ways to improve growth and yield models in bottomland hardwoods. She investigated how well stand table projection or STP methods of forest growth and yield prediction performed in red oak-sweetgum bottomland hardwoods stands by analyzing data collected from 1981-2005. Two approaches of STP were investigated: the traditional STP, which evaluates groups of trees based on diameter classes and an alternative approach of implementing STP, which evaluates individual trees regardless of class. Leonard found in her analysis no clear advantage of carrying out STP on individual trees. "STP on individual trees can be time and labor intensive. Our main goal in the research is to find ways to maximize efficiency when predicting the future value of timber, which will hopefully inform best management practices for foresters in the future," Leonard said. Leonard was under the direction of Dr. Charles O. Sabatia, assistant forestry professor.



JOSH BANKSTON

HOMETOWN: *Brandon, Mississippi*

Bankston, a forestry manager with a forest management concentration, graduated in May 2017. As an undergraduate research scholar, he studied ways to better predict the value of timberland. "There are several methods for finding certain perimeters in predicting stand diameter distribution and we are trying to find the best combination of these methods that yield the most accurate results so that companies can better implement management decisions," Bankston said. He studied data collected from loblolly pine stands across Alabama, Arkansas, Louisiana, and Mississippi. He examined how various plot sizes, recovery methods used to obtain predicted diameter distribution, and different forms of moment or percentile prediction equations affected the precision of model development. The results showed precision is generally lower for smaller plot sizes. While Bankston concluded quarter-acre plot size was shown to yield the most accurate results, he said the slight increase in precision may not prove to be worth the extra money when a smaller plot size can be used and yield similar results. He was under the direction of Dr. Charles O. Sabatia, assistant forestry professor, during the research and will continue on at MSU pursuing a master's in forestry with a concentration in forest biometrics under the direction of Dr. Laura A. Grace, forestry professor.

BRENT CHANEY

HOMETOWN: *Starkville, Mississippi*

Chaney, a senior majoring in natural resource and environmental conservation, studied the effects of feral hogs on water quality. After rain events, he collected in-ground water samples from an enclosure where wild hogs were kept. He also took water samples from a nearby stream. Instream sampling results gave little support that feral hogs impacted water quality. The variability of nutrient concentrations and bacterial abundances below the enclosure did increase over time. Given the study's limited sample size and inherent environmental variability, more research is warranted to further investigate feral hog watershed utilization patterns. Chaney was under the direction of Drs. Garrett M. Street, assistant professor, and Beth H. Baker, assistant extension professor, both in the Department of Wildlife, Fisheries and Aquaculture.

Kelly Magee, Lake Charles, Louisiana native, is a sophomore sustainable bioproducts major. As an undergraduate research scholar, he studied test methodologies with newly developed wood-based construction products under the direction of Dr. C. Elizabeth Stokes, assistant professor in the Department of Sustainable Bioproducts.

Jacob Jones, Humnoke, Arkansas native, is a senior wildlife, fisheries, and aquaculture major. As an undergraduate research scholar, he studied refining egg collection and hatching protocols for Gulf killifish under the direction of Dr. Peter Allen, associate professor in the Department of Wildlife, Fisheries and Aquaculture.

Isabella Durham, Prattville, Alabama native, is a junior wildlife, fisheries and aquaculture major. As an undergraduate research scholar, she studied habitat selection in microorganisms under the direction of Drs. Garrett Street and Marcus Lashley, assistant professors in the Department of Wildlife, Fisheries and Aquaculture, and Dr. Natraj Krishnan, assistant professor in the Department of Biochemistry, Molecular Biology, Entomology and Plant Pathology in the College of Agriculture and Life Sciences.

Ricks Burton, Hernando, Mississippi native, is a senior forestry major. As an undergraduate research scholar, he studied impacts of best management practices on water quality in the Catalpa Creek watershed under the direction of Dr. Courtney Siegert, assistant professor in the Department of Forestry.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FWRC authors in bold

THESES

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BY THE NUMBERS

PEOPLE

88
Masters students

48
Doctoral students

51
Faculty

RESEARCH PROJECTS

290
Projects Active During FY17

111
Research Sponsors

157
Refereed Publications

$8.76M
Total Sponsored Research Funding

RESEARCH SPONSORS

Albany Industries
Alta Forest Products
American Bird Conservancy
American Furniture Manufacturing
Andersen Corporation
Anthony Hardwood
Appalachian Regional Commission
ArborGen, LLC
Arch Wood Protection, Inc.
Architectural Testing, Inc.
Arkansas Game and Fish Commission
Association of Zoos and Aquariums
Audubon Mississippi/National Audubon Society
Autolog, Inc.
BASF Corporation
Boone and Crockett Club
Caterpillar
Cooperative Ecosystems Studies Units
Cox Industries, Inc.
Ducks Unlimited, Inc.
DuPont
Embark
EnSafe
Flexsteel Industries
FuturaGene
Genics Inc.
Grassbuilt
Grassland Oregon
GS Research, LLC
Harrison County Board of Supervisors
Heritage Home Group, LLC
HH Group Holdings

TOTAL FWRC FUNDING, FY17

$15M

41.02% STATE APPROPRIATIONS
05.60% FEDERAL APPROPRIATIONS
52.75% GRANTS AND CONTRACTS
00.63% SALES

HM Richards, Inc.
HomeStretch
Independent Furniture Supply
Intertek Testing Services NA Ltd.
Iowa Department of Natural Resources
ISK Biosciences Corp.
Jeld-Wen Windows and Doors
Jones County Board of Supervisors
Kansas Department of Wildlife Parks & Tourism
Kiln Drying Systems
KMC-Bernuth, Inc.
Kop-Coat, Inc.
Koppers Holdings Inc.
Koppers, Inc.
Lanxess Corp.
Lincoln County Board of Supervisors
Lonza Wood Protection
LP Corp.
Lybrand Consulting, LLC
Martco, LLC
Michelman Inc
Michigan Department of Natural Resources
Mississippi Department of Wildlife, Fisheries & Parks
Mississippi Forestry Commission
Mississippi Land, Water and Timber Resources Board
Mississippi Tree Farm Committee
Mississippi Wildlife, Fisheries and Parks Foundation
Missouri Department of Conservation
Monsanto Company
MS Implementation Committee for the Sustainable Forestry Initiative
National Council for Air and Stream Improvement, Inc.
National Forest Foundation
National Geographic Society
National Oceanic and Atmospheric Administration
National Science Foundation
Nisus Corp.
North Carolina Department of Agriculture
NTA, Inc.
Pacific Motion, LLC
Penta Task Force
Perry County Board of Supervisors
POET, LLC
Railway Tie Association
Renewable Sciences, LLC
Robert M Hearin Foundation
Rooms To Go
Sierra Pacific Industries
Southern Ionics
Structured Fibre
Sustainable Forestry Initiative, Inc.
Temple-Inland
Tennessee Valley Authority
Timber Products Inspection (TPI)
United Furniture Industries
United States Army Corps of Engineers
United States Bureau of Land Management
United States Department of Labor
United States Department of the Interior
United States Department of the Treasury
United States Fish and Wildlife Service
United States Geological Survey
United States National Park Service
University of Houston - Institute for NanoEnergy
USDA Agricultural Research Service
USDA Animal & Plant Health Inspection Service
USDA APHIS National Wildlife Research Center
USDA Farm Service Agency
USDA Forest Products Laboratory
USDA Forest Service
USDA Natural Resources Conservation Service
USDA National Institute of Food and Agriculture
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