SUMMER 2025

grow

College of Agricultural & Life Sciences
University of Wisconsin–Madison

Leopold's Wisdom Within Easy Reach

A digital access project gives readers a look inside the original journals that inspired *A Sand County Almanac*

Learn More

Page 20

+

Recent biological systems engineering graduates Cami Guelig BS'25, left, and Amirali Jafari BS'24, who were undergraduates at the time, fabricate an attachment to convert a row planter into a cover crop seeder during a BSE 509 Design Practicum II class in the Agricultural Engineering Laboratory.
Photo by MICHAEL P. KING

Wisconsin's Magazine for the Agricultural and Life Sciences

grow

VOLUME 18, ISSUE 3 | SUMMER 2025

FEATURES

DEPARTMENTS

ON THE COVER The interior of one of Aldo Leopold's original "Shack Journals," which contain passages that inspired the essays published in *A Sand County Almanac*. The journals, now digitized and transcribed, are widely accessible and searchable. Read more on page 20. Photo by MICHAEL P. KING

From top: Illustration by JORDYN VOWELS, photo by MICHAEL P. KING, photo courtesy of UNIVERSITY OF WISCONSIN–MADISON ARCHIVES

DEAN GLENDA GILLASPY

Federally Funded Research Drives America's Dairyland

Photo by **NGUYEN TRAN**

In the mid-1800s — a time when a relatively young country was marked by intense polarization that led to a civil war — American leaders had an idea. They decided to make a collective investment of federal resources to create colleges in every state and territory for the "benefit of agriculture and the mechanic arts," as stated in the legislation known as the Morrill Act.

By the time of the Civil War, the U.S. had a total of 21 universities, where faculty were adhering to the scientific method because they saw that science could drive economic growth through discovery and innovation in the emerging fields of mining and agriculture. To build on their success, Congress passed the Morrill Act in 1862, establishing a network of public universities in every state that could focus on training farmers and providing farms with research and development. It played a foundational role in American agriculture.

The return on the investment is easy to demonstrate. For example, at the time of the Civil War, average corn yields were around 30 bushels per acre; in 2024, that number was 183 bushels per acre. This has happened despite decreases in the number of U.S. farmers and the amount of farmland, meaning agriculture has become more efficient over time, producing enough food to feed our population using fewer workers who are then able to pursue other careers. Also, globally, American consumers today spend the smallest share of household income on food.

When you examine Wisconsin dairy, that success is even more pronounced. Wisconsin is home to roughly 1.3 million milking dairy cows today. Compare this to 2.2 million in 1950. In fact, most Wisconsin counties (save for a few in Northeastern Wisconsin) are actually at an all-time low for cow numbers. Yet, with fewer cows, we are producing more milk. In 1950, Wisconsin was producing 14.8 billion pounds of milk per year, but today the state's dairy farms produce 32.1 billion pounds annually.

How can you make more than double the milk with almost half the cows while contending with rapid urbanization? This is where research and management come in! Both have resulted in more nutritious feed; high-tech selective breeding and genomics; improved cow welfare and comfort; better disease mitigation and sanitation; more effective land stewardship; and more.

All of this is a testament to the success of U.S. agricultural innovation, which has been driven by a partnership between farmers and professors at public land-grant universities. And that's just agriculture. The return on federal investment in research is just as significant when you examine the life sciences and the enormous impact innovation in these fields has had on human and animal health, the environment, and more. But that may need to be a topic for another day.

What's critical now is that federal research funding is in serious jeopardy. We're at a pivotal tipping point. Science funding is at its lowest level in decades, and signs point to more cuts to come. As a result, the economic livelihood and health of our nation's citizens are also in great danger, and it may be extremely difficult to find our way back to prosperity if something doesn't change now.

For our graduates who have continued on to careers in science, thank you for all you do to apply the scientific method in improving businesses, non-profits, schools, and agencies around the world. For those not actively working in science, we know you still use the critical thinking you honed at CALS in your daily lives. To honor this tradition, please consider showing your support for federally funded science through the tools provided by the Wisconsin Foundation and Alumni Association at **go.wisc.edu/support-federal-research**. Your strong voices are more important now than ever.

EDITORIAL STAFF

Managing Editor Nik Hawkins

Writers Nicole Miller MS'06, Caroline Schneider MS'11

Designer Janelle Jordan Naab

Photographer Michael P. King

Editorial Assistants Keegan Gering BSx'26, Emily Odenkirk

CONTACT

42 Agricultural Hall, 1450 Linden Drive
Madison, WI 53706

Grow 608-890-3912, grow@cals.wisc.edu
grow.cals.wisc.edu

CALS 608-262-1251, info@cals.wisc.edu
cals.wisc.edu

College of Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN–MADISON

When Weeds Refuse to Die

Six facts about herbicide resistance that may seem like science fiction

By JED COLQUHOUN PhD'98

A "monstrous" version of waterhemp — a common, herbicide-resistant weed — takes laser fire.
Illustration by JORDYN VOWELS

Synthetic herbicides were introduced to agriculture shortly after World War II. Affordable, reliable, and effective, they rapidly became the mainstay for weed management. Today, however, this strategy is going to seed as herbicide-resistant weeds dominate the landscape. For many years, target-site herbicide resistance was the primary culprit, but metabolic resistance is becoming more common. The mechanisms underlying this problem — and some of the potential solutions — may seem more at home in a science fiction movie than in a farm field.

1 In target-site resistance, the chemical puzzle pieces no longer fit together. Most herbicides control weeds by blocking enzymes critical to a plant's function and growth, such as photosynthesis. In target-site resistance, weeds with a genetic mutation are selected unintentionally. This creates an altered target site where the herbicide compound no longer fits, and the enzyme continues to function. If that altered target site trait is passed on to the next generation via weed seed production, the population becomes herbicide resistant.

2 In metabolic resistance, generalist enzymes "digest" the herbicide before it can damage the weeds. The enzymes break down the herbicide into metabolites that are less mobile and less toxic to the plant and then dump the weakened molecules into plant parts where they are sequestered and rendered inactive. This process may sound more akin to the absorptive abilities of Hollywood's *The Blob* (1958) than a plant.

3 Metabolic resistance is biologically intriguing but agriculturally challenging. The enzymes responsible for metabolic resistance are found in plants and insects (and also humans) and generally attack stressors, which, in the case of weeds, can include herbicides. In practical terms, this makes agricultural weed management very unpredictable: Metabolically resistant weeds can overcome herbicides that chemists have yet to even imagine, a seemingly anticipatory capability that, if we didn't know better, might be mistaken for ESP.

4 The combination of target-site and metabolic resistance has become the norm rather than the exception for some common weeds. For example, waterhemp is not a new weed in Wisconsin agriculture, but it has become more widespread among field crops in recent years and is almost always resistant to at least one herbicide site of action. In cases across the grain belt, a single plant can resist six or more types of herbicides. This leaves farmers with few practical management options, a growing seed bank of resistant weed populations, and reduced crop production.

5 Metabolic enzymatic activities are also not specific to plants and herbicides, which makes for complex resistance scenarios. For example, CALS entomologists have found that some of the fungicides commonly used for potato disease control can upregulate metabolic enzyme production in Colorado potato beetles. The resulting increase in enzymatic activity impairs insecticide performance. It's another sci-fi hallmark: the sometimes-challenging consequences of scientific advancements.

6 Lasers could be a solution to weeds. At CALS, we're working with Wisconsin farmers to adopt innovative weed management strategies, including laser weeders. These machines use high-resolution cameras to scan the ground while rolling across the field; artificial intelligence to separate crops from undesirable plants in real time; and lasers to zap weeds up to every 50 milliseconds with submillimeter accuracy. It may feel speculative, but it's very real — and it's the kind of bold, advanced solution that's needed to keep agriculture thriving.

Jed Colquhoun is professor and extension specialist in the Department of Plant and Agroecosystem Sciences. His research and outreach focus on commercial specialty crop production. He is director of UW's Integrated Pest Management program and a member of Extension's Crops and Soils team.

A Food Fight with Stress

Kate Sun seeks to promote women's health through holistic approaches that incorporate nutrition.

By NICOLE MILLER MS'06

Kate Sun BSx'26 has long been interested in matters of the mind, and she has a sense of purpose to go with it. As far back as her junior year in high school, she knew she wanted to study psychology, with the intent of becoming a therapist in the mental health field.

But Sun is also in tune with her body, and she's willing to listen to what it tells her. While growing up in Denver, Colorado, she was a happy, well-adjusted youth — but she struggled with skin issues, such as rashes, allergies, and eczema.

"At one point, I pretty drastically changed my diet. Within two months, my eczema was gone, and it never came back," Sun says. "That was the first time I thought about nutrition as a whole, and I thought it was so interesting. I started learning more about functional nutrition, how professionals use nutrition to support athletes but also to treat certain disorders."

Sun, who is majoring in nutritional sciences and psychology, chose UW–Madison for the university's strength in these two academic programs as well as its reputation for undergraduate research opportunities. By her sophomore year, Sun had connected with food science professor **Brad Bolling** BS'02, PhD'07, whose lab focuses on bioactive food components and their health benefits.

"At that point, I was really interested in the gut microbiome, dietary bioactives, and food as medicine," Sun says. "I reached out to Brad, and we set up a meeting where he told me about this really cool project in his lab exploring something called cranberry PLP."

Cranberries are chock full of dietary bioactives called polyphenols, compounds that have antioxidant and anti-inflammatory properties. Bolling had discovered a way to isolate and concentrate the polyphenols from cranberry juice, creating an end-product called polyphenol-lecithin precipitate, or PLP.

+ WHAT ARE BIOACTIVES?

Bioactive compounds, which are naturally occurring chemicals commonly derived from plants, activate biological effects in the body that typically promote good health. Compounds called polyphenols, for example, serve as antioxidants — they help neutralize unstable, damage-causing molecules (free radicals) in the body.

Working closely with graduate student **Klay Liu** and researcher **Andrea Noll** MS'20, Sun began exploring whether cranberry PLP could be used to support oral health. The PLP delivery method in this case was chewing gum. Regular polyphenols, when added to gum, get chewed out and swallowed quickly. Not so with PLP.

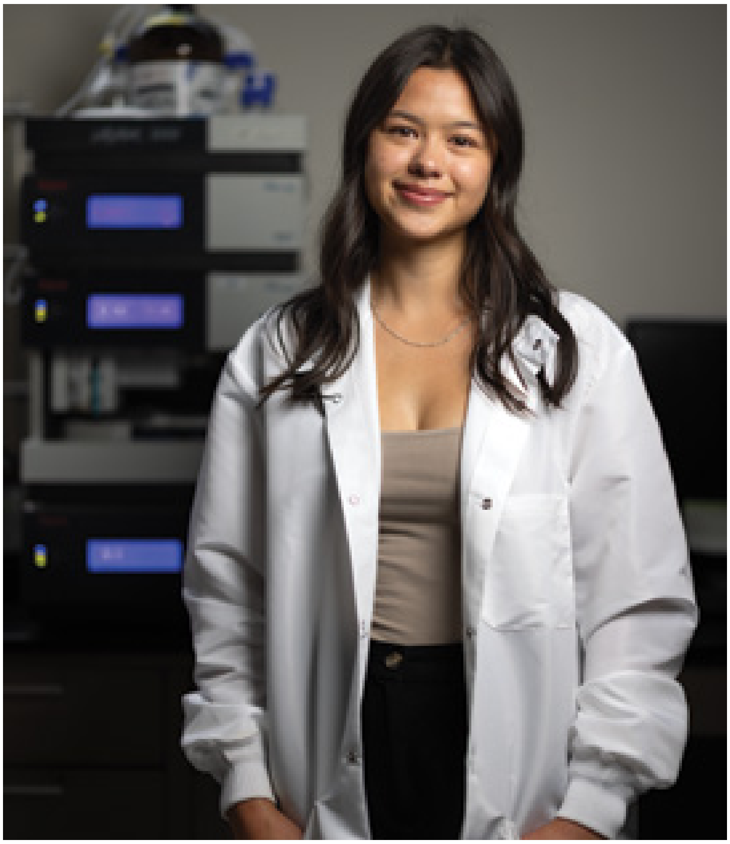
"With PLP, the release of the polyphenols took place much more slowly and steadily over time," Sun says. "So, when people chew this gum, the polyphenols stay in their mouths for longer, and they could possibly help with things like tooth decay, periodontal disease, and gum inflammation."

Sun is now contributing to her third project in Bolling's lab, and she has enjoyed the variety of experiences. Her second project, focused on the chemistry of two polyphenols, was supported by the UW Food Research Institute's Summer Undergraduate Research Program in Food Safety. Through her current project, Sun is enrolling participants in a dietary study and helping them complete food tracking diaries. She's also involved in writing up the team's chewing gum research findings for publication in a scientific journal.

"Kate has been a wonderful contributor to our research group," Bolling says. "She brings enthusiasm and a desire to connect research with practical applications, and she is committed to improving health."

After graduation, Sun plans to continue her education. She may become a registered dietitian or pursue a certificate in functional nutrition or acupuncture. Whatever her next steps, her goal is to work in women's health.

"Society puts us under a lot of stress, and that stress manifests in different ways for different people," Sun says. "I love the idea of being able to work one-on-one with women to develop holistic approaches — including nutritional options — that can help mitigate the impact that stress has on the body and promote optimal wellness."



Undergraduate Kate Sun poses for a portrait in food science professor Brad Bolling's Babcock Hall lab, where she works as a research assistant.

Photo by MICHAEL P. KING

The Water Bear Solution

By harnessing an ancient animal's superpower, CALS scientists find a way to enhance the clarity of advanced imaging technology.

By RENATA SOLAN

Water bears are an ancient group of microscopic animals known for their pudgy, ursine appearance and their uncanny ability to survive under extreme conditions. The molecules underlying this behavior are helping researchers use modern technology to uncover the basic forms and functions of life's building blocks.

Also known as tardigrades, water bears are aquatic microorganisms that can endure blistering heat and severe cold thanks to a set of specialized molecules they produce that protect them from damage. These molecules, called late embryogenesis abundant (LEA) proteins, keep the animals' essential cellular structures and proteins intact, allowing water bears to dry up and go dormant when faced with an uninhabitable environment and then rehydrate and reanimate when it is safe to do so — sometimes decades later. (See "Seven Things Everyone Should Know About . . . Tardigrades," *Grow,* spring 2021.)

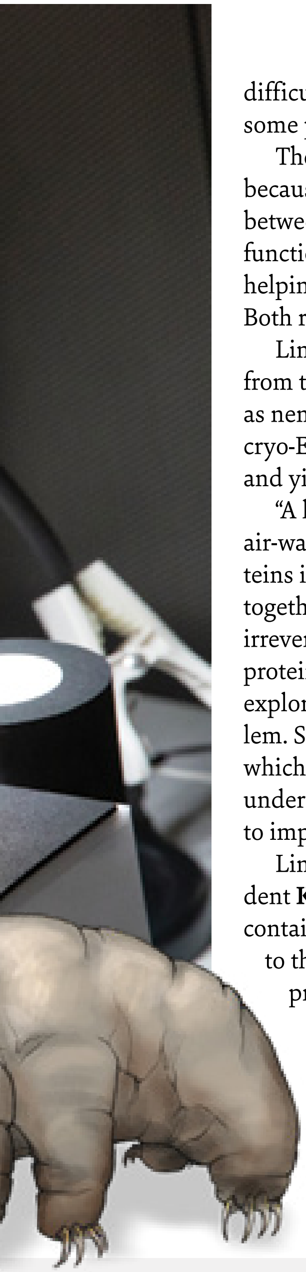
In a study published in September 2024 in *Nature Communications*, a team of scientists led by biochemistry professor **Ci Ji Lim** has found that these same proteins can help solve a major technological challenge when it comes to getting high-quality microscope images of a diversity of other cellular structures and proteins using a technique called cryogenic electron microscopy, or cryo-EM.

The study was supported by funding from the National Institutes of Health, the Wisconsin Alumni Research Foundation, and the UW.

Cryo-EM captures miniscule proteins and other biomolecules at a moment in time by freezing samples in a thin, water-based film before taking images of them using a powerful electron microscope. However, around the edges of a sample, where air meets the water, damage to biomolecules is more likely, making it

Tim Grant demonstrates part of the process of loading samples into the Talos Arctica cryogenic transmission electron microscope at UW's Cryo-EM Research Center.
Photo by MICHAEL P. KING

Tardigrade illustration by JACKI WHISENANT



difficult to clearly determine the structures of some proteins.

The technique is important to Lim's research because he seeks to uncover the relationships between a protein's form (what it looks like) and function (what it does). Cryo-EM also plays a role in helping identify potential targets for drug therapies. Both require capturing clear images.

Lim wondered whether adding LEA proteins from tardigrades and other microorganisms, such as nematodes, to their microscope samples prior to cryo-EM could prevent damage to the biomolecules and yield better images.

"A lot of times, the protein is attracted to the air-water interface," Lim explains. "When proteins interact with this interface, they can clump together along the edges or begin to unfold and irreversibly change their form. There are many proteins that we just haven't been able to fully explore the structures of because of this problem. So, I thought that maybe the LEA proteins, which help proteins in water bears remain robust under challenging conditions, could be harnessed to improve robustness in other contexts."

Lim and his research team — led by graduate student **Kaitlyn Abe** — added LEA proteins to samples containing Polα-primase, a protein that is sensitive to the air-water interface. The team also used LEA proteins to image another protein, PRC2, whose structure has been difficult to capture.

The researchers demonstrated that adding LEA proteins is a cost-effective and efficient way to yield clearer cryo-EM images. Other methods to mitigate damage along the air-water interface can be expensive and laborious and can require scientists to use higher concentrations of the molecules they're studying. LEA proteins allow scientists to use sample concentrations in line with those used with standard sample preparation methods. They could also be used in combination with other protection methods.

"Adding LEA proteins is a readily deployable and cost-effective solution to a bottleneck in cryo-EM research," Lim says. "It is exciting that we got here using proteins that naturally evolved to do a similar job."

Scientists are now trying to better understand how these proteins exert their protective properties.

"What is interesting," says **Tim Grant**, a professor in the Department of Biochemistry who worked with Lim on the study, "is that even with the addition of the LEA proteins, we're still seeing biomolecules along the air-water interface, but they're not unfolding, denaturing, and falling apart. In the presence of LEA proteins, it's possible to solve structures for proteins that would have just fallen apart before."

Grant, who is also an investigator at UW's Morgridge Institute for Research, expects the relationships between biological samples, LEA proteins, and the air-water interface will become sharper as more researchers incorporate LEA proteins into sample processing.

"The air-water interface is a real problem, and water bears have offered a pretty cool solution to resolving that problem," he says.

Lim looks forward to seeing once-tabled research projects reinvigorated. "Now, there's new hope for exploring protein structures that we couldn't before," he explains. "We're expanding the toolbox available to scientists for cryo-EM sample preparation, and there's the potential for us to learn so much more about the structural biology of many proteins that had been challenging to visualize."

NUMBER CRUNCHING

The Great Lakes Bioenergy Research Center (GLBRC), which is based at UW–Madison and is a hub for many CALS faculty, is one of four bioenergy research centers funded by the U.S. Department of Energy. Established in 2007, GLBRC has produced **255 inventions**, including plant-based medicines and plastics made from agricultural waste, highly effective and affordable organic fungicides, more resilient and productive crops, and trees engineered to more easily break down into fuels and chemicals.

GLBRC is developing this portfolio of plant-based products, methods, and tools for use in an emerging U.S. bioeconomy, and dozens of its patents have been licensed to industrial partners. Economic studies have shown that public support for the science behind these patents — particularly the basic research that private industry considers too risky or time-consuming — pays substantial long-term dividends, returning at least $5 in economic gains for every dollar spent. Photo illustration by JANELLE JORDAN NAAB with image by ISTOCK.COM/RATSANAI

A MosAIC of Microbiomes

CALS scientists have helped create a publicly available database of mosquito gut bacteria that could unveil ways to stop the diseases they carry.

By CAROLINE SCHNEIDER MS'11

Vector-borne diseases account for more than 17% of all infectious diseases and cause more than 700,000 deaths annually, according to the World Health Organization. Diseases transmitted by mosquitoes are a major global health issue and include malaria, dengue fever, and serious birth defects caused by the Zika virus. The effects of climate change could increase the spread of these and other mosquito-borne diseases by expanding the geographical range of habitats suitable for mosquitoes.

To better understand the spread of these diseases, researchers from UW–Madison and the United Kingdom have joined forces to create a bacterial Mosquito-Associated Isolate Collection (MosAIC), the first large-scale repository of mosquito-associated microbiomes. The collection, which is freely available to educators and researchers, includes genome data and 392 bacterial isolates that could reveal how different bacteria in the microbiome affect their mosquito hosts, including their ability to spread human pathogens.

Insect microbiomes, which impact how well they can transmit human pathogens, are still poorly understood. The composition of the mosquito microbiome is dynamic and affected by host species, geography, and life stage. As resistance to insecticides among mosquitoes increases, microbiome manipulation stands out as a promising alternative for future disease control measures.

"Despite extensive research on mosquitoes, our understanding of the bacteria in their microbiomes and the roles these bacteria play remains limited," says **Kerri Coon**, assistant professor of bacteriology at CALS and leader of project efforts at UW. "To uncover the complexities of these interactions and their impacts on mosquito biology and disease transmission, we need genome information as well as physical isolates of the same bacteria that can be studied in the lab. MosAIC marks the first time that these paired resources will be available."

+ EXPLORE ONLINE
Learn how to access or contribute to the Mosquito-Associated Isolate Collection (MosAIC) at **go.wisc.edu/mosaic**.

A strain of *Aedes aegypti* mosquitoes feed from a membrane of blood in a research lab insectary in the Hanson Biomedical Sciences Building.
Photo by JEFF MILLER

The MosAIC project was co-led by researchers from UW and Liverpool School of Tropical Medicine, and a paper outlining the work was published in November 2024 in the journal *PLOS Biology*. The collection was generated using material supplied by more than 50 individuals across the globe, including 44 undergraduate students enrolled in a capstone microbiology course in the Department of Bacteriology during the spring 2022 semester.

"When you create a resource like this for the scientific community, you're providing the raw material for creativity and innovation," adds **Holly Nichols**, a graduate student in microbiology who works in Coon's lab. "We look forward to seeing how researchers will incorporate these bacteria into their own work. As we grow the collection, I am reminded that each new isolate could hold the key to ending malaria or dengue transmission."

The collection is administered out of Coon's lab. Future expansions are planned and will continue to be led by Coon, with support from additional collaborators in Central and South America, Africa, South and Southeast Asia, and the Pacific. Additional cohorts of students will also be involved with supplemental funding support through the National Science Foundation's STEM Access for Persons with Disabilities (STEM-APWD) program.

"I never could have imagined how this project would evolve into something that would so beautifully integrate my lab's research and teaching missions, all the while supporting my goal to improve student access to authentic research experiences, especially students underrepresented in STEM fields," Coon says. "I have big plans for this research moving forward. We're even lining up partners to facilitate training opportunities for students from disease endemic countries at UW–Madison and vice versa."

$ FEDERALLY SUPPORTED RESEARCH
This project has been primarily funded by the U.S. National Science Foundation, with additional support from the Biotechnology and Biological Sciences Research Council, part of UK Research and Innovation.

FINDINGS

This prairie strip planted between corn fields is an example of a land conservation method sometimes used in agriculture.
Photo courtesy of IOWA STATE UNIVERSITY

EXTREME WEATHER, CONSERVATION ON THE MINDS OF MIDWESTERN FARMERS

A recent survey conducted by CALS researchers finds that Midwestern farmers are feeling the effects of extreme weather, and they view conservation practices that counter those effects as an important part of their work.

A team from the Department of Forest and Wildlife Ecology led by professor **Adena Rissman** analyzed survey responses from 527 farmers in eight Midwestern states. A large majority of those farmers say they are moderately or extremely concerned about severe weather events, including heavy rainfall and floods (79%) and soil erosion (70%). And 90% think good farmers should minimize soil erosion and nutrient runoff into waterways. Yet only 15% dedicate some cropland to pollinator plants, prairie plants, or trees, which highlights an area of conservation where farmers could use additional support.

The study was supported by the National Science Foundation, the U.S. Department of Agriculture, and the UW.

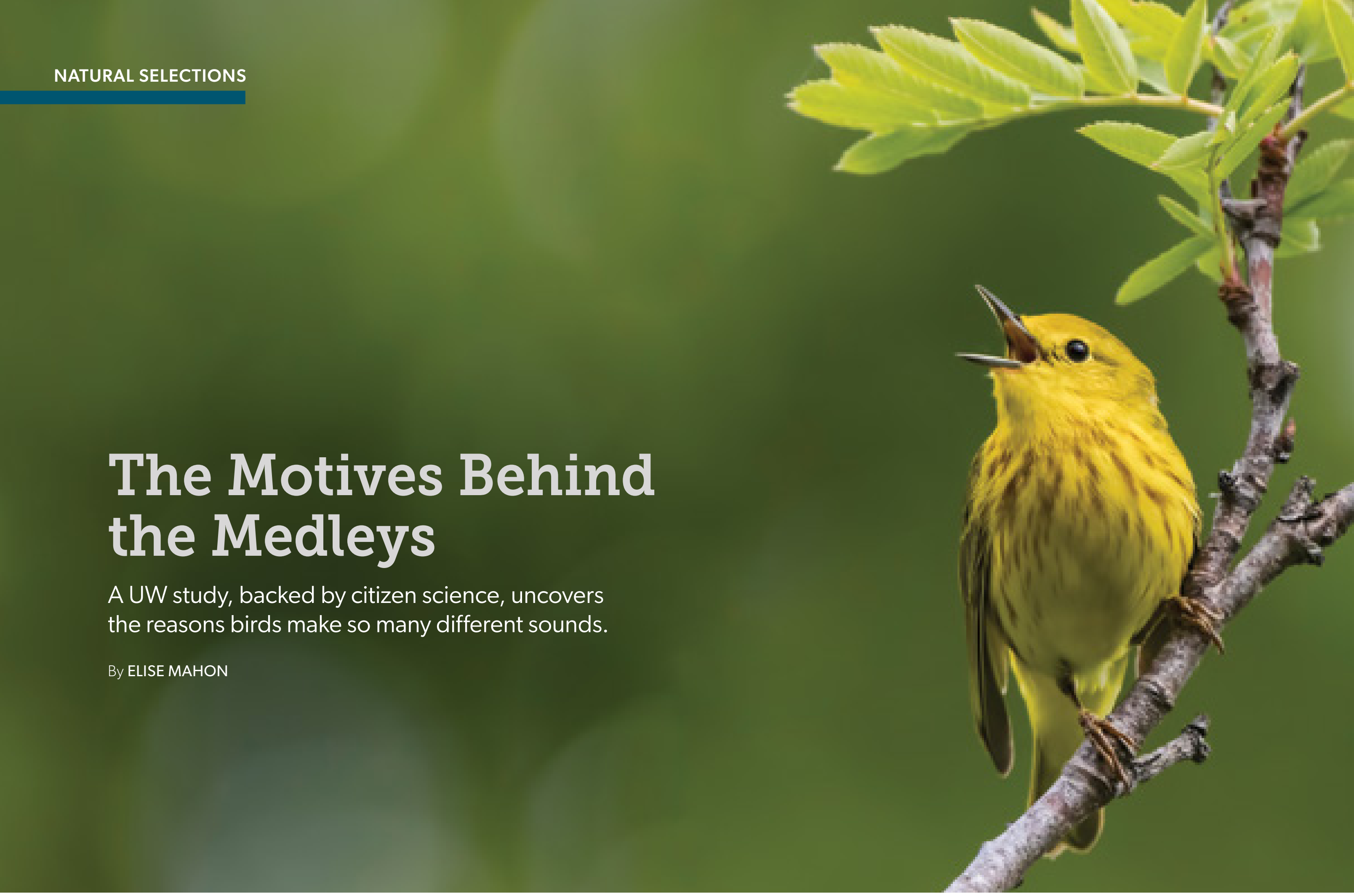
URBAN DEVELOPMENT THREATENS THE STATE'S BEST AGRICULTURAL SOIL

During urban expansion, soil gets covered by roads, buildings, and parking lots, a process called "soil sealing." It reduces the soil's ability to support plant growth, filter water, and provide habitat.

Between 2001 and 2021, as Wisconsin's population grew by almost 10%, soil sealing increased by 20%, according to a recent study from the Department of Soil and Environmental Sciences. On average, the study finds, 17 acres of soil were sealed each day, with 30 acres per day converted to urban land cover. This disproportionately affected soils with high agricultural productivity, and the resulting shift to less productive soils to maintain the total area of cultivated crops could lead to greater reliance on fertilizers and irrigation.

The study, published in June 2024 in *Soil Security*, was supported by the Hatch Multistate Research Fund at the U.S. Department of Agriculture.

+ DISCOVER MORE Read about CALS research at **news.cals.wisc.edu**.



The Motives Behind the Medleys

A UW study, backed by citizen science, uncovers the reasons birds make so many different sounds.

By ELISE MAHON

Birds make sounds to communicate, whether to find a potential mate, ward off predators, or just sing for pleasure.

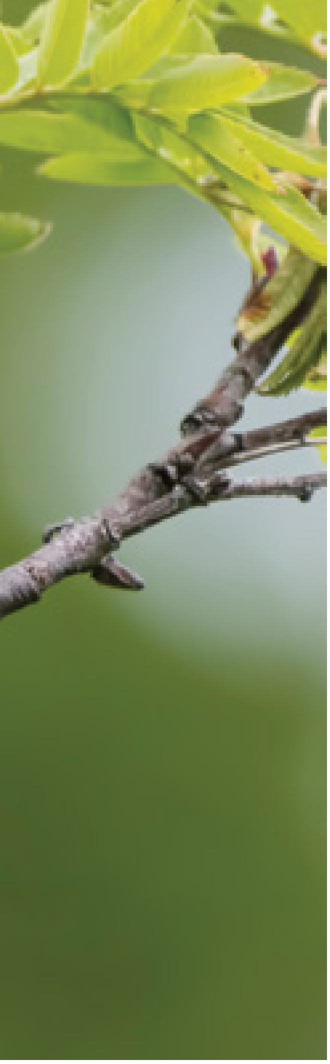
But the conditions that contribute to the immense diversity of the sounds they make are not well understood. CALS researchers have conducted the first-ever global study of the factors that influence bird sounds using more than 100,000 audio recordings from around the world. The new study, published in November 2024 in the journal *Proceedings of the Royal Society B*, revealed insightful patterns for why birds make certain noises and at what frequency.

Hypotheses about the role of habitat, geography, body size, and beak shape in forming bird sounds have been tested on small scales before. But **H.S. Sathya Chandra Sagar (Sagara)** PhD'24, a recent Ph.D. graduate in forestry, and **Zuzana Buřivalová**, professor in the Department of Forest and Wildlife Ecology and the Nelson Institute for Environmental Studies, wanted to see if they held up on a global scale.

Sagara analyzed audio recordings of bird sounds taken by people around the world and submitted to a bird-watching repository called xeno-canto. The analyzed recordings represented 77% of known bird species.

Here are some of the study's major takeaways:

- **Bird species' habitat influences the frequency of the sound they may make — in unexpected ways.** For example, in ecosystems with a lot of rushing water there is a constant level of white noise occurring at a lower frequency. In such cases, researchers found that birds tend to make sounds of higher frequency, likely so their songs won't be drowned out by the water.
- **Bird species living at the same latitudes make similar sounds.** Observing this pattern at a global scale is an important piece of the puzzle in the evolutionary story of bird sounds. It could inspire further research into the aspects of geographic location that influence bird sounds.
- **A bird's beak shape and body mass are important.** Generally, smaller birds create higher frequency sounds while larger birds create lower frequency sounds. The global analysis proved this hypothesis correct and added new information about the nature of the relationship between beak shape, body mass, and sound.
- **Smaller bird species tend to have a wider range of frequencies at which they can make sound as a protection mechanism.** Smaller, more vulnerable birds can benefit from being able to make a range of sounds. Higher frequencies can help them communicate with fellow birds of the same species, while lower frequencies can serve as a camouflage, tricking potential threats into thinking they are larger and less vulnerable than they actually are.



A yellow warbler sings on a summer morning in Southcentral Alaska. Photo by iSTOCK.COM/JHUNTER

The research also contributed to the broader understanding of soundscapes — all of the sounds heard in any particular landscape. Soundscapes are often used as part of conservation studies, but Sagara realized "there's very little that we know about the forces that govern soundscapes."

He hopes this foundational work will provide a platform for future studies to improve conservation efforts by developing ways to monitor the health of an ecosystem through soundscapes.

"In the tropics and all over the world, larger birds tend to be hunted for meat," Sagara says as an example. "Larger birds [tend] to call at a low frequency, and if we don't find any sound in the lower frequency, we could [conclude] there may be more hunting in this landscape."

Next, Sagara hopes to use 24-hour soundscape recordings to understand if some birds modify the timing of their songs, in addition to their frequencies, to communicate with their peers in a landscape crowded with noise. And he notes the important role that birdwatchers and citizen scientists play in providing data for such studies, a critical step in discovering new insights about our natural world.

That's not a cheesehead.

It's a thinking cap.

Use your head to ace our **Final Exam** and you could score a gift box of cheese from the Babcock Dairy Store! Test your CALS knowledge at **grow.cals.wisc.edu**.

FOLLOW-UP

A STEP AHEAD OF THE NEXT PANDEMIC

In "Virus Research Recast," (*Grow*, spring 2022), **Catherine Steffel** described how, in the wake of a global pandemic, CALS scientists had pivoted their research to identify avenues for effectively treating COVID-19. Some of these scientists continue to study related viruses. They're comparing what we know about different coronavirus structures to determine whether therapeutics may be effective across the whole coronavirus family.

"Knowing about differences among coronaviruses gives us important information about what we should be studying if a new coronavirus emerges so that we can be more prepared for the next pandemic," says **Robert Kirchdoerfer**, an assistant professor in the Department of Biochemistry. "SARS-CoV-2 is a beta-coronavirus. There are also alpha-, delta-, and gamma-coronaviruses, which we have far less information about."

Last year, Kirchdoerfer's team published high-resolution images of RNA polymerase, a protein complex key to RNA replication. The researchers examined images of RNA polymerase from the alpha-coronavirus porcine epidemic diarrhea virus (PEDV) and from the gamma-coronavirus infectious bronchitis virus. Comparing these images to past studies of SARS-CoV-2 revealed that the RNA polymerase complexes from alpha-, beta-, and gamma-coronaviruses function similarly. This suggests that antiviral drugs targeting viral polymerase function are likely to be effective across the virus family.

In their study, funded by the National Institutes of Health, they also noted that a part of a protein needed to build viral RNA polymerase was shaped differently in alpha-, beta-, and gamma-coronavirus polymerases. Furthermore, they found that each group of coronaviruses used this part of the protein in different ways

Robert Kirchdoerfer Photo by MICHAEL P. KING

to assemble the RNA polymerase.

"Designing new antiviral drugs begins with key foundational work on the biochemistry of viral targets. To do this, scientists rely on federal funding," Kirchdoerfer says. "Without this support, we will be left without the knowledge, expertise, and strategies to rapidly address newly emerging viruses."

—Renata Solan

What Is the Worth of Clean Water?

An economic analysis finds that, in just two decades, the Clean Water Act helped improve water quality and promoted population growth in most U.S. towns — without breaking budgets.

By SILKE SCHMIDT

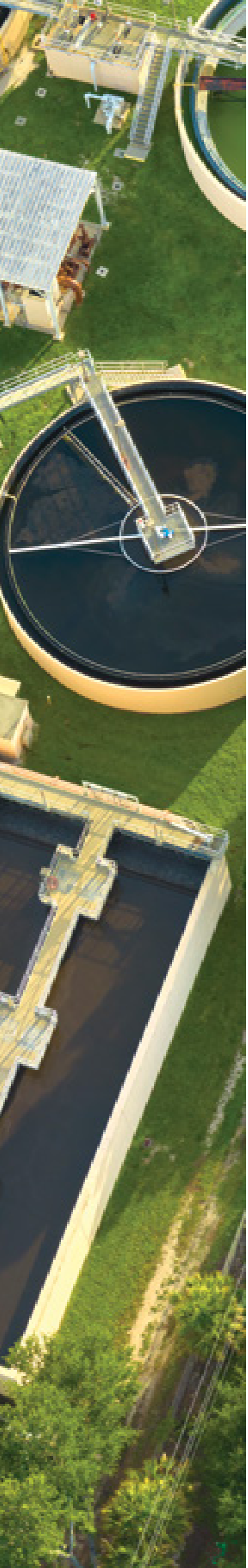
The village of Walton, New York, faced a daunting task in 1972: It had to build a $5.8 million wastewater treatment plant with an annual operating budget of $556,000 and a taxpayer base of 3,700 residents. This was mandated by the federal Clean Water Act, aimed at making U.S. lakes and rivers fishable and swimmable again after decades of pollution with growing volumes of sewage.

More than 50 years later, assistant professor **Rhiannon Jerch** wanted to know if the massive investments in wastewater treatment plants — an estimated $2 trillion with more than 60% borne by local governments — had paid off for Walton and other towns like it.

"The 1972 Clean Water Act applied to all municipal sewage systems, with limited adjustments for their highly variable taxpayer base," Jerch says. "To fully assess its costs and benefits, I wanted to consider the entire universe of American towns, half of which have fewer than 2,000 residents today."

Jerch studies how public goods and services such as transit, water, and wastewater systems affect people and natural resources. The Clean Water Act (CWA), one of several landmark environmental laws passed in the 1970s, is a prime example of a centralized policy with major consequences for local budgets and shared resources.

The core of the CWA is a federal mandate requiring city governments to treat their wastewater with specific technology before discharging it into



An aerial view of a modern water cleaning facility at an urban wastewater treatment plant. Photo by iSTOCK.COM/BILANOL

rivers, lakes, and other bodies of water. In the case of Walton, this meant building a new wastewater treatment plant. In other cases, it meant upgrading existing plants that only utilize *primary treatment*, the physical separation of organic waste from water. The upgrades added *secondary treatment*, biological processes that decompose organic waste, resulting in cleaner surface water and better wildlife protection — but at two to ten times the cost.

Jerch analyzed more than 3,100 cities that, in 1972, had primary treatment plants and populations ranging from a few hundred to over 1 million residents. She combined 25 years of data (1967–1992) from different government agencies to estimate the causal effect of the CWA on three outcomes of interest: the cost of the required upgrades; the resulting improvements in surface water quality (measured as dissolved oxygen levels); and the population growth that might be due, in part, to these improvements.

Because the CWA applied to all cities, Jerch compared a group of cities that had already installed the new technology by 1972 with another group of cities that had to upgrade after the law was passed. This required a statistical trick to ensure that the main difference between the two sets of cities was whether they upgraded before (control) or after 1972 (treatment). Since their other pre-1972 features were similar by design, she could attribute changes in outcome to the new mandate.

Jerch found that local governments financed the upgrades with increases in annual wastewater fees. On average, annual fees increased by threefold — up to $78 per resident — during the 25 years after the CWA. This increase was necessary because some cities did not receive federal CWA grants, or the awarded grants did not cover all costs. However, the increase in wastewater spending from 6% to nearly 20% of city budgets did not reduce the provision of other goods and services. A parallel increase in sales tax and license fee revenues may have covered some of the extra cost. This income, notes Jerch, may partially reflect greater spending on water recreation and waterfront businesses by residents and visitors.

The 20-year improvement in surface water quality near cities that upgraded their wastewater treatment after 1972 was 18% higher than in control cities. Thus, the environmental benefit of the federal mandate was significantly greater than expected if investment decisions had been left up to local governments.

Despite the higher fees, the 20-year population growth in cities that complied with the CWA was at least 13% higher than in control cities, suggesting that cleaner water attracted more residents. This was true for cities of any size, but most of the growth occurred in towns with fewer than 10,000 residents. These smaller towns grew 30% faster than control cities.

To explain why smaller cities might have experienced greater benefits, Jerch used the example of Chicago, located upstream from St. Louis on the Mississippi River. The state of Missouri filed a lawsuit against Chicago for polluting St. Louis water sources at the turn of the century. The city began to invest in secondary wastewater treatment in 1916, decades before the CWA.

Taking legal action against upstream neighbors is difficult and expensive. Since the federal mandate shifted the burden of improving wastewater management to polluters, says Jerch, it was especially helpful for smaller cities with limited means to negotiate for it. Other studies have also found that federal legislation improves the protection of natural resources that span state boundaries, including surface waters and groundwater aquifers.

"Communities of all sizes valued clean water enough to pay much higher fees for wastewater services, making cuts in other public goods and services unnecessary," Jerch says. "Importantly, the water quality improvements achieved by the CWA helped accelerate population growth in the majority of U.S. towns — those with fewer than 10,000 residents — that may not have prioritized investments in clean water without it."

WHITHER the CHILDREN?

With child safety in mind, researchers explore support gaps for farmers' childcare needs.

Story by Nicole Miller MS'06 Illustrations by Jordyn Vowels

When you search Google for "family farms," the dominant images served up show parents and their young children in bucolic agricultural settings, often walking together through verdant or golden fields.

These idyllic family portraits, however, overlook the reality that many farm parents face. Farmwork often involves high-tech equipment, heavy machinery, and large animals. That makes many farms hazardous places — especially for kids.

According to data from the National Children's Center for Rural and Agricultural Health and Safety, a child dies in an agriculture-related incident about every three days, and around 33 injuries occur per day. Common causes of fatalities include transportation incidents with tractors and ATVs and contact with machinery and animals.

For more than 30 years, farm safety experts have been encouraging farm parents to seek dedicated, off-farm childcare. But rural areas tend to be "childcare deserts," with few affordable options nearby. That makes childcare a significant challenge and stressor for farm parents.

"Even though these pictures are often used to celebrate agriculture, they also create hardships for the people who are trying to do this work," says Michaela Hoffelmeyer, an assistant professor in the Department of Community and Environmental Sociology. "Farmers are really struggling because they often have to work off-farm to get health insurance for their families. They may have to drive many miles to find childcare. Recent studies have shown that farmers can feel a real sense of failure and anxiety around not being able to meet the expectations reflected in the images."

Hoffelmeyer is part of a team looking more closely at this issue through involvement in a multi-institution project called "Linking Childcare to Farm Children Safety," which seeks to understand what farm parents do with their children while they work and how these choices impact farm productivity and the safety of their children.

A COLLABORATION ACROSS INSTITUTIONS

The "Linking Childcare to Farm Children Safety" project is co-led by Florence Becot of the Pennsylvania State University and Shoshanah Inwood of The Ohio State University. The project is part of the National Children's Center for Rural and Agricultural Health and Safety, which is based in Marshfield, Wisconsin, and funded by the National Institute for Occupational Safety and Health at the U.S. Centers for Disease Control and Prevention.

Hoffelmeyer's portion of the project aims to get a better sense of the environment in which farm parents make decisions about childcare and farming, looking at how farm organizations, extension services, and agricultural agencies regard childcare. This includes whether these organizations consider childcare as part of the labor that goes into running a successful family farm or as a separate issue — more like a personal or household expense. The goal is to understand how these groups are attending to this issue, the broader implications, and, if needed, steps that could bolster support.

"We found a diversity of views of how farm business organizations perceive the centrality of children and families to overall farm viability," Hoffelmeyer says.

Hoffelmeyer joined CALS in 2023, a strategic addition to the UW Dairy Innovation Hub's faculty roster, to focus on public engagement with agriculture. More specifically, as a member of the Hub's "growing farm businesses and communities" theme area, Hoffelemeyer's role is to explore public awareness and engagement with broadscale social, economic, and ecological issues that are entangled with agriculture.

Hoffelmeyer (they/she pronouns) is a good fit for the job. Before joining UW, their work focused on how various groups access agricultural resources and how structural inequalities influence food production and environmental sustainability, focusing on rural and urban women farmers; LGBTQ farmers; and farm workers. Now, at UW, Hoffelmeyer will continue this work and also expand into new dairy-focused areas, such as robotics and market concentration. The underlying motivation remains the same.

"My driving focus is to improve the agrifood system for everyone, with the goal of serving all farmers and celebrating all people involved in agricultural production," Hoffelmeyer says.

Hoffelmeyer's research on women's farm organizations in the Northeast caught the attention of Florence Becot at Pennsylvania State University. Becot reached out to see if Hoffelmeyer would be interested in collaborating on the "Linking Childcare to Farm Children Safety" project, which launched in fall 2020 with funding from the National Institute for Occupational Safety and Health at the U.S. Centers for Disease Control and Prevention.

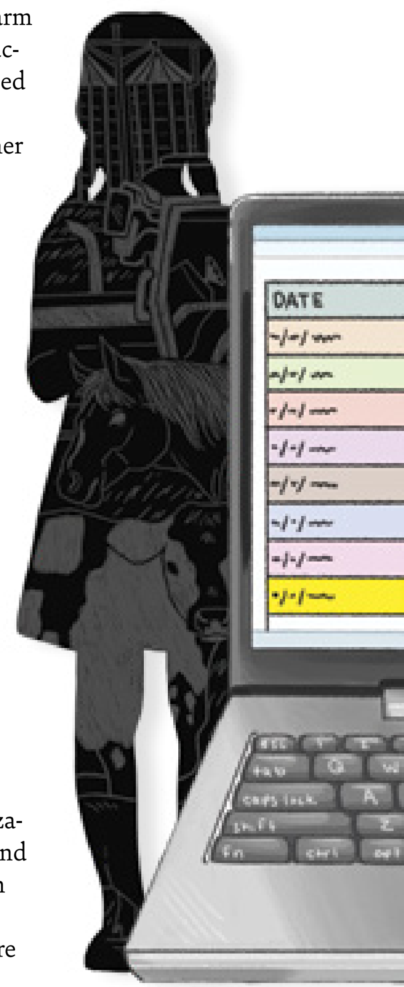
By the time Hoffelmeyer joined in 2023, the researchers had already conducted interviews with key informants, focus groups and a photovoice activity with women farmers, and a survey of farm households. In the survey, which is the first national assessment of childcare for the farm sector, over three-quarters of farm families with children under 18 reported that they had experienced childcare challenges in the last two years. Furthermore, three-quarters of farm families surveyed said they believe farm organizations should represent their needs in national childcare policy discussions. And the overall findings were clear: Farm parents expressed the need for childcare support. In particular, they cited a preference for holistic support that serves their household and childcare needs as part of their broader farm business needs.

Hoffelmeyer was brought onto the project to help assess an existing set of interviews conducted with leaders and service providers in the agricultural sector to uncover how these organizations are responding to and supporting farmers' childcare needs, with a special focus on the gendered dynamics of the situation.

For the UW portion of the study, Hoffelmeyer and their research assistant are taking a second look at interviews conducted with 36 professionals who provide support and educational opportunities to farmers, including farm safety service providers, farm business planning providers, federal and state-level government agencies, and non-profit farmer organizations. Interviewees come from Ohio, Vermont, and Wisconsin, with one-third from the Dairy State. The interviews reveal a diversity of perspectives and approaches.

"Some farm service providers position the presence of children on the farm and the need to provide childcare as liabilities for the success of the farm business. It's portrayed as a tradeoff," says Trish Fisher, a Ph.D. student studying community and environmental sociology, who conducted the analysis. This was the majority view, in fact.

"I think it's the health and safety of the kids on the farm versus the financial productivity of the farm," expressed one farm business organization representative. Fisher and Hoffelmeyer shared this paraphrased remark from an interview to illustrate the tradeoff perspective in a recent presentation.



The initial analysis of the interviews, published in 2022 by Becot and colleagues, found that, when it comes to farm business planning, most interviewees don't incorporate childcare. Instead, children are considered personal or household expenses, and, therefore, outside the purview of a farm business plan.

However, some organizations treat farm viability and the flourishing of the farm family like a united enterprise, considering childcare and health care as integral parts of farm business planning.

In cases where childcare was not actively considered, respondents cited several reasons. They explained that childcare was beyond the scope of their organization's mission, and they expressed having a lack of tools and resources on the topic area. In other cases, they believed other types of professionals or groups were already supporting farmers in this way and are in a better position to handle it. Still others reported a lack of demand from their constituents.

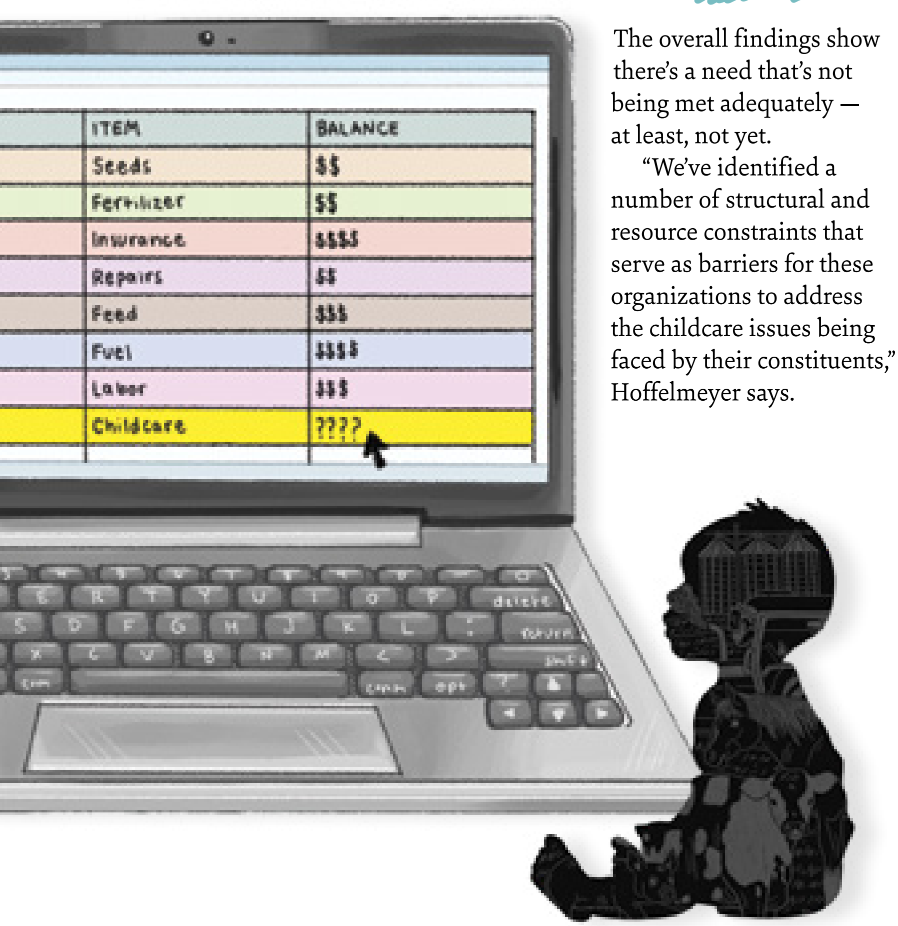
To build on these findings, the Wisconsin team was asked to dig into the interviews anew, exploring what was shared through a gender lens.

"A lot of these farm service organizations shared the sentiment that childcare for farm families is important, but their male farmers are not bringing those issues to the table," Fisher says. "I don't want to paint the wrong picture — this isn't a burden that is universally borne by women. Our collaborators involved in other areas of the overarching project have published findings showing that male partners are often also very worried about child safety. Everybody is extremely stressed about it."

> "I think one of the main themes so far is that … childcare is largely seen as a women's issue rather than a business issue."
>
> – Trish Fisher

At the same time, it's clear that gender dynamics are playing a role.

"I think one of the main themes so far is that, within these organizations that serve farmers, childcare is largely seen as a women's issue rather than a business issue," says Fisher. "So childcare, if it's being addressed, is often being addressed in contexts that are specific to women farmers."



The overall findings show there's a need that's not being met adequately — at least, not yet.

"We've identified a number of structural and resource constraints that serve as barriers for these organizations to address the childcare issues being faced by their constituents," Hoffelmeyer says.

These findings are not surprising to Hoffelmeyer, who has spent a lot of time thinking about underpaid and undervalued labor on farms. "A real issue in farming more broadly is that, while we often take ownership very seriously, we've never taken labor seriously," they say. "If you look back, historically, women have often done a lot of unpaid and invisible labor, whether it was animal rearing or bookkeeping."

Similarly, the tasks involved in social reproduction — such as raising kids, taking care of the elderly — often fall to women and are likewise unpaid and invisible, Hoffelmeyer notes. Yet these are critical tasks required by society to keep families going and for the succession of farms.

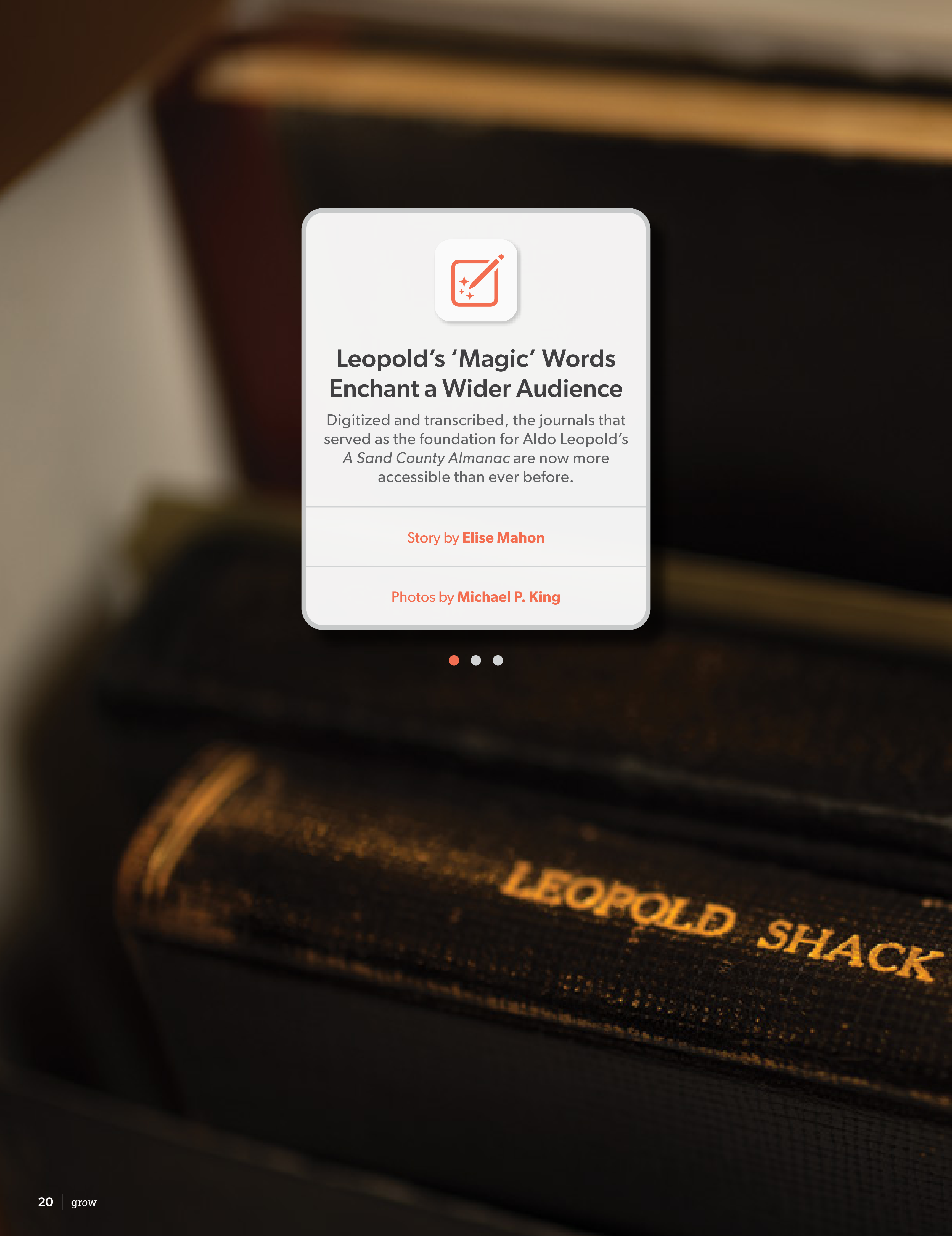
"We tend to value economic involvement more than household involvement [when it comes to ensuring the viability of family farms]," Hoffelmeyer says. "Because of this, there's a lack of support for the people who most acutely feel the need for childcare support. Oftentimes, that's women because of social norms, what people are expected to do."

The next steps involve raising awareness about these issues. For their part, Hoffelmeyer and Fisher shared their initial findings at the 2025 Dairy Summit, a Hub event for farmers, agricultural leaders, and researchers. Hoffelmeyer's collaborators have also been sharing project findings through research briefs, conversations with federal congressional leaders and national farm organizations, and a traveling picture exhibit created with farm women who participated in the study.

As with most complex societal problems, Hoffelmeyer doesn't anticipate a quick fix. "In social sciences research, we often go to the root of the problem — looking at how it began," Hoffelmeyer says. "So, I think instead of offering a solution to a specific problem, we're really asking how did things get to be this way?

"We actually know how to solve a lot of issues. And we even understand the causes of our problems, broadly, but it's often the cultural norms, the social expectations, those kind of dynamics that are preventing change. It takes a long time to change power dynamics and inequality and big global issues."

Yet it's satisfying work for Hoffelmeyer, doing what's possible to help ensure all members of the agricultural community are heard, considered, and supported. g



Leopold's 'Magic' Words Enchant a Wider Audience

Digitized and transcribed, the journals that served as the foundation for Aldo Leopold's *A Sand County Almanac* are now more accessible than ever before.

Story by **Elise Mahon**

Photos by **Michael P. King**

It's a rare opportunity for the public to glimpse the original, handwritten notes and journals of an influential environmentalist, let alone one as renowned as Aldo Leopold. Or, at least, it used to be a rare opportunity. Thanks to a collaboration between UW and the Aldo Leopold Foundation, and to the tireless efforts of dozens of dedicated volunteers, Leopold's famous "Shack Journals" are now widely accessible to the public.

The original Shack Journals — which contain the tight, penciled script of Leopold's detailed observations that inspired the essays he later collected in *A Sand County Almanac* — are housed safely in the UW archives. For decades, anyone who wanted to access the journals had to schedule time to view them in a reading room and carefully scan, page by page, for the reference they needed.

In 2007, the UW Digital Collections Center (UWDCC) began a multi-year process of digitizing all the material in the Leopold Collection so each item could be viewed online. It was a significant step toward greater accessibility. But, years later, staff from UWDCC, UW Archives and Records Management, and the Aldo Leopold Foundation took it even further. In 2022, they recruited a passionate group of volunteers to transcribe all 1,100 handwritten pages of the Shack Journals, making it far easier for researchers, educators, and the public to read and search Leopold's original writings.

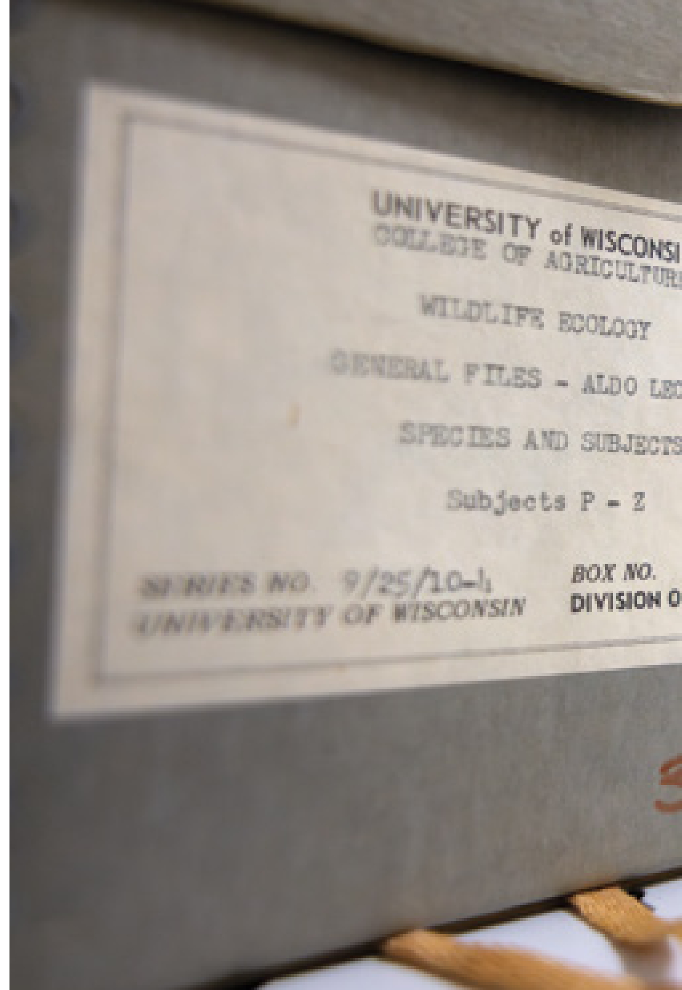
Leopold's connections to Wisconsin, UW, and CALS are strong. He spent years as a professor of wildlife management in the college (the first position of its kind), and his land restoration efforts at the UW Arboretum inspired personal restoration projects carried out at the Leopold Shack on his family's land near Baraboo, Wisconsin. The shack and its surrounding lands, now a National Historic Landmark, remain a hub for ecology and conservation efforts to this day.

Stan Temple was just a young academic when he took on the same professorship Leopold held. Temple quickly connected with the Leopold family, forming bonds through a shared passion for phenology, the study of seasonal phenomena. Leopold took detailed records on the changing seasons in the Shack Journals, and they have been a constant reference for Temple.

"In my capacity as a professor at the University of Wisconsin — and, after my retirement, as a senior fellow at the Aldo Leopold Foundation — I have used the Leopold Collection a lot," Temple says. "But it was always a challenge because so much of the important, raw data that I was looking for was handwritten, and it couldn't be searched easily."

Right: Materials that are part of the Leopold Collection rest on a shelf in the Steenbock Library basement stacks.

Below: Katie Nash, university archivist and head of the UW Archives, pulls a box of materials from the Leopold Collection.



Stanley Temple, professor emerit of forest and wildlife ecology, views one of Aldo Leopold's journals at Steenbock Library.

For example, say someone was curious about when the first spring wildflowers began blooming in 1940, or they wanted to compare sightings of sandhill cranes during Leopold's time to more recent observations. Before this project, a person would have had to click through the digitized journals and search every page of Leopold's handwriting to find mentions. Not anymore.

"Adding the transcriptions is a game changer for research," says Jill Kambs, production manager at the UWDCC. The digitized text allows users to search within the content of Leopold's Shack Journals and other items across the entire UWDCC catalog. For example, one can now search for not only how many times Leopold references chickadees in the Shack Journals but also where chickadees are referenced across resources from authors in other collections.

Sharing both the historical records of Leopold's natural observations as well as his views of the world around him is at the core of the Aldo Leopold Foundation, says executive director Buddy Huffaker. He also notes that the project would not have been possible without the capacity and expertise provided through their partnership with the UWDCC and University Archives and Records Management, which houses the physical copies of the Shack Journals and other pieces of the Leopold Collection.

"It's an unparalleled insight into this brilliant scientific communicator's mind and work," Huffaker says, adding that the journals can be just as significant for people familiar with Leopold's legacy as they can be for newcomers to his ecological efforts.

And none of it would be possible without the manual work of more than 60 devoted volunteers who know firsthand that it's one thing to read Leopold's essays in their final published form, but it's another entirely to read the handwritten notes and observations that inspired them.

Kei Kohmoto spearheaded the coordination of volunteers while she was a fellow at the Aldo Leopold Foundation. She assigned them journal pages for transcription, instructed them on careful methods, and ensured each transcription was meticulously fact-checked.

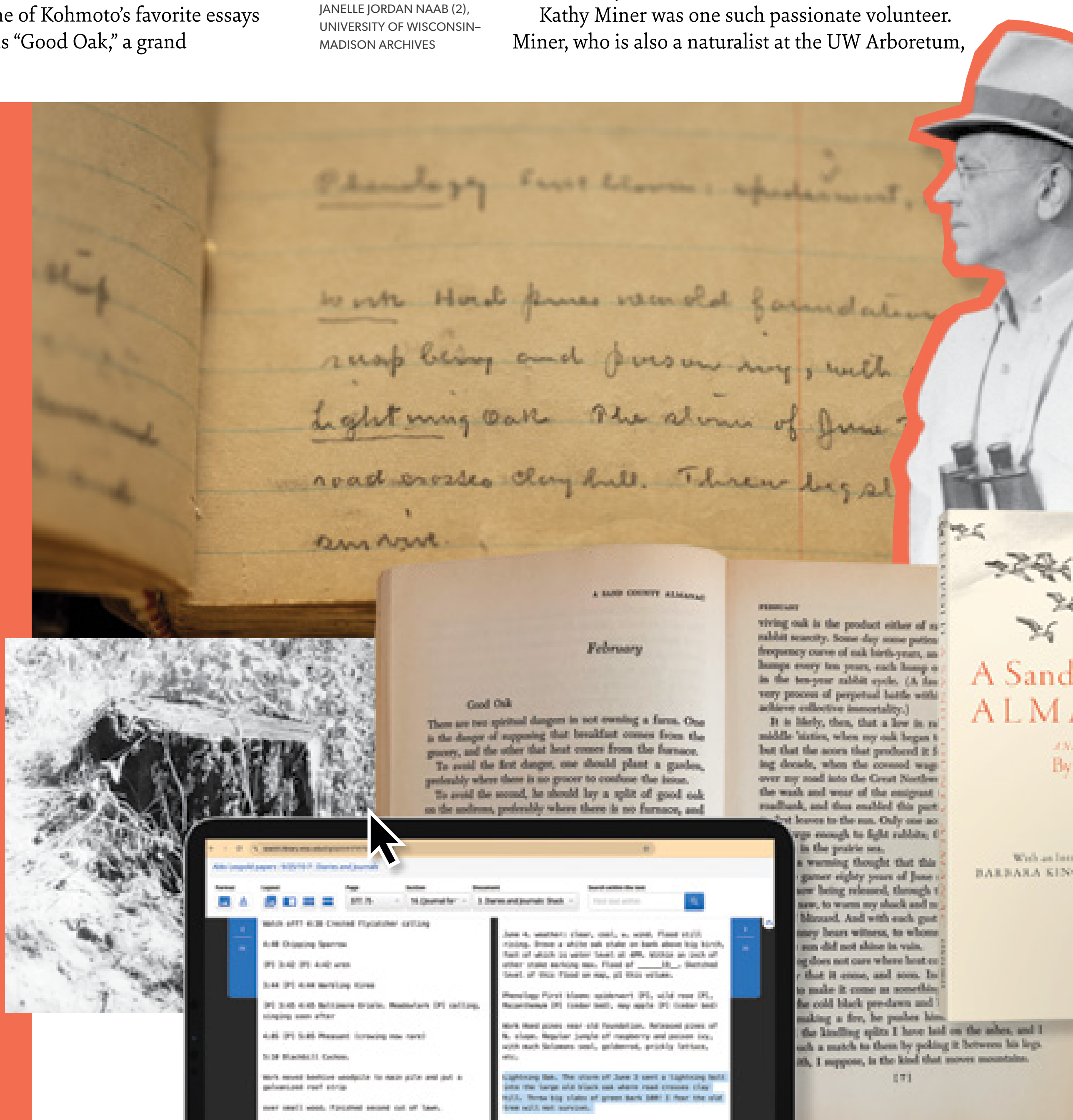
Kohmoto was an undergraduate when she first read *A Sand County Almanac*. For her, reading notes from the Shack Journals, seeing the day-to-day of Leopold's life that underlays his grandiose and beautiful essays, is a unique way to engage with Leopold and his environmental framework.

For example, one of Kohmoto's favorite essays from the almanac is "Good Oak," a grand allegory that Leopold uses to reflect on the passage of time, history, and changes across landscapes. But in the Shack Journals, the roots of this essay can be traced back to an entry simply noting that lightning struck an oak tree on the property. The event is noted in the entry for June 4, 1943, and it reads, "Lightning Oak. The storm of June 3 sent a lightning bolt into the large old black oak where road crosses clay hill. Threw big slabs of green bark 100 [feet]! I fear the old tree will not survive." Sawing through the growth rings of that dead tree while making firewood was how Leopold reflected on the passage of history.

Connecting with Leopold's materials in this way was magical for more than just Kohmoto. "People would always reply back, letting me know how much they enjoy transcribing it and making sure I let them know if any more opportunities arise," Kohmoto says.

Kathy Miner was one such passionate volunteer. Miner, who is also a naturalist at the UW Arboretum,

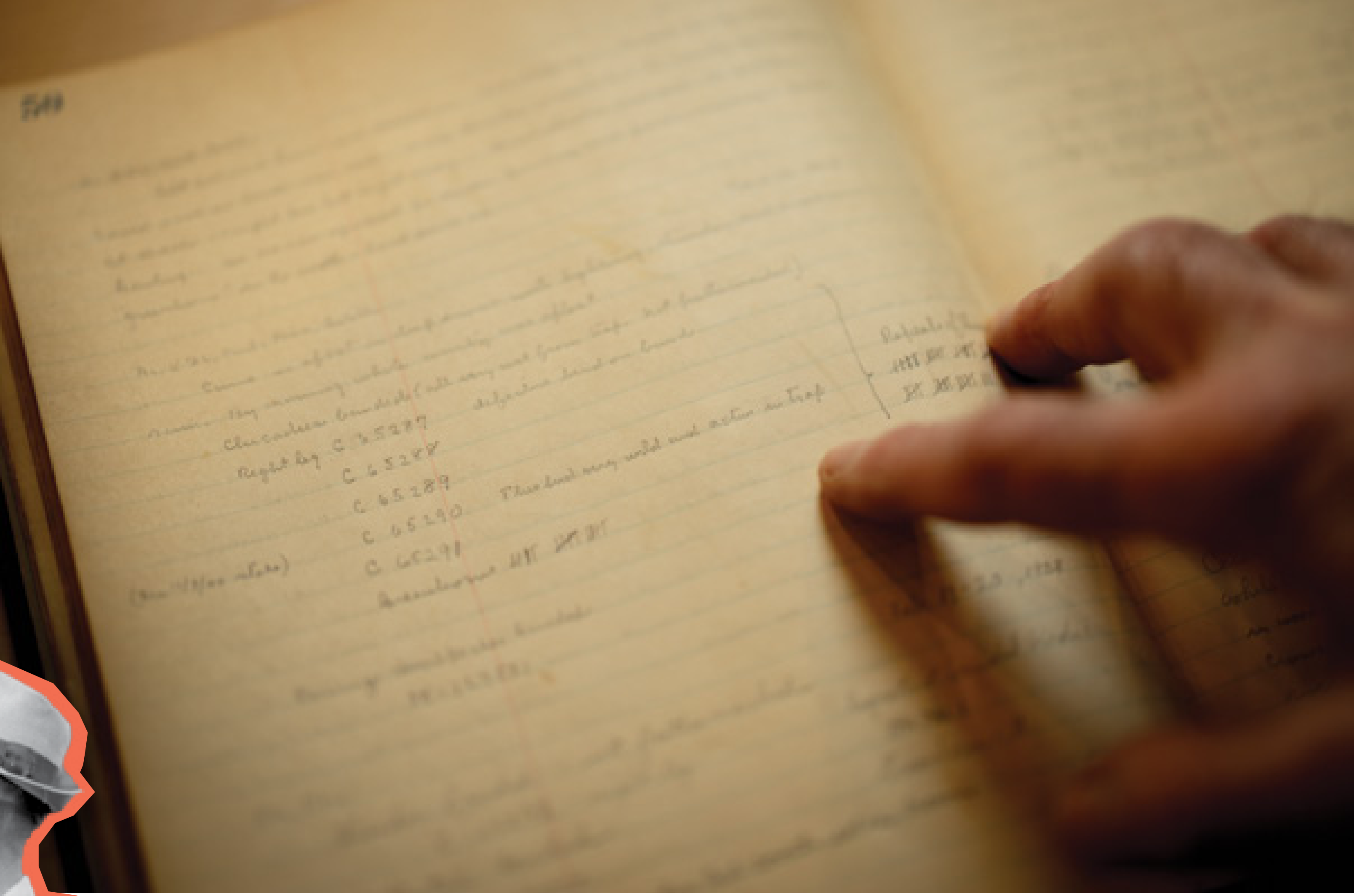
Images below clockwise by MICHAEL P. KING, UNIVERSITY OF WISCONSIN–MADISON ARCHIVES, ALDO LEOPOLD FOUNDATION, JANELLE JORDAN NAAB (2), UNIVERSITY OF WISCONSIN–MADISON ARCHIVES

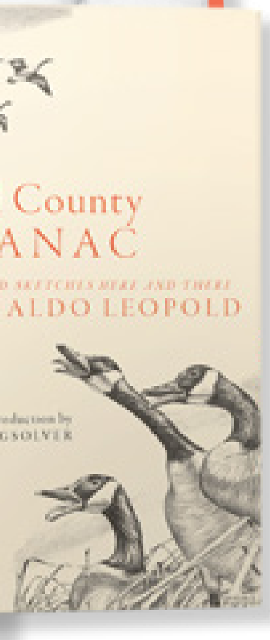


Allegory of the Oak
This original passage (top) from one of Leopold's Shack Journals, dated June 4, 1943, reads, "Lightning Oak. The storm of June 3 sent a lightning bolt into the large old black oak where road crosses clay hill. Threw big slabs of green bark 100 [feet]! I fear the old tree will not survive."

Leopold (shown at top right working in the field circa 1947) and his daughter, Estella, later cut the damaged tree down, and photographer Phil Sander captured an image of the stump circa 1948 (lower left). The experience inspired the reflective essay "Good Oak," which was included in *A Sand County Almanac*. At bottom is the transcription of the passage (highlighted in blue), as seen on the UW–Madison Libraries website.

Browse, search, and read transcriptions of the journals, along with digital scans of original pages, at **go.wisc.edu/leopold-journals**.





Stanley Temple views details of an entry about banded chickadees in one of Aldo Leopold's journals at Steenbock Library.

found her career path thanks to a college course that assigned *A Sand County Almanac* as required reading. She recalls being grabbed by Leopold's rare talent for combining science, data, and discipline with poetic writing.

A passage from the essay "Goose Music," which originally appeared in a Leopold collection called *Round River* but was later included in a special edition of *A Sand County Almanac*, inspires readers to imagine the absence of bird song in an improperly stewarded landscape. It struck a particularly emotional chord with Miner.

Years later, during the digitization of the Shack Journals, Miner was able to read the original manuscripts for that essay. And she was once again immersed in magic when she volunteered to transcribe several pages of the Shack Journals in the latest iteration of the project. On the very first page of her assigned journal section, Miner began transcribing a moment when Leopold's daughter found, in an owl pellet, the band of a chickadee he had banded for tracking purposes a year earlier.

"I suddenly realized that I was typing, exactly, something that had become part of that last essay in the calendar section of the almanac (essay "65290")," Miner says.

The simple description of a banded bird preyed on by an owl became enshrined in *A Sand County Almanac* as the only "evidence of actual murder" of a chickadee Leopold witnessed. Seeing the event in the journal entry and then in the essay brings the whole concept to life. It's not hard to imagine Leopold, poring over his notes, flipping through his journals to choose which details to add to the essays for his now renowned book.

It's also easy to understand why so many volunteers would want to participate in this project. Now, people don't have to pour over and flip through the pages. They can type in and automatically find the references they need, the beloved sections they want to reread, and maybe even new discoveries still waiting in the pages.

"[Leopold's] writing came to my attention at a particularly remarkable point in my life, where it was very meaningful," Miner says. "I guess I'd like that magic to be able to happen to a lot of other people." g

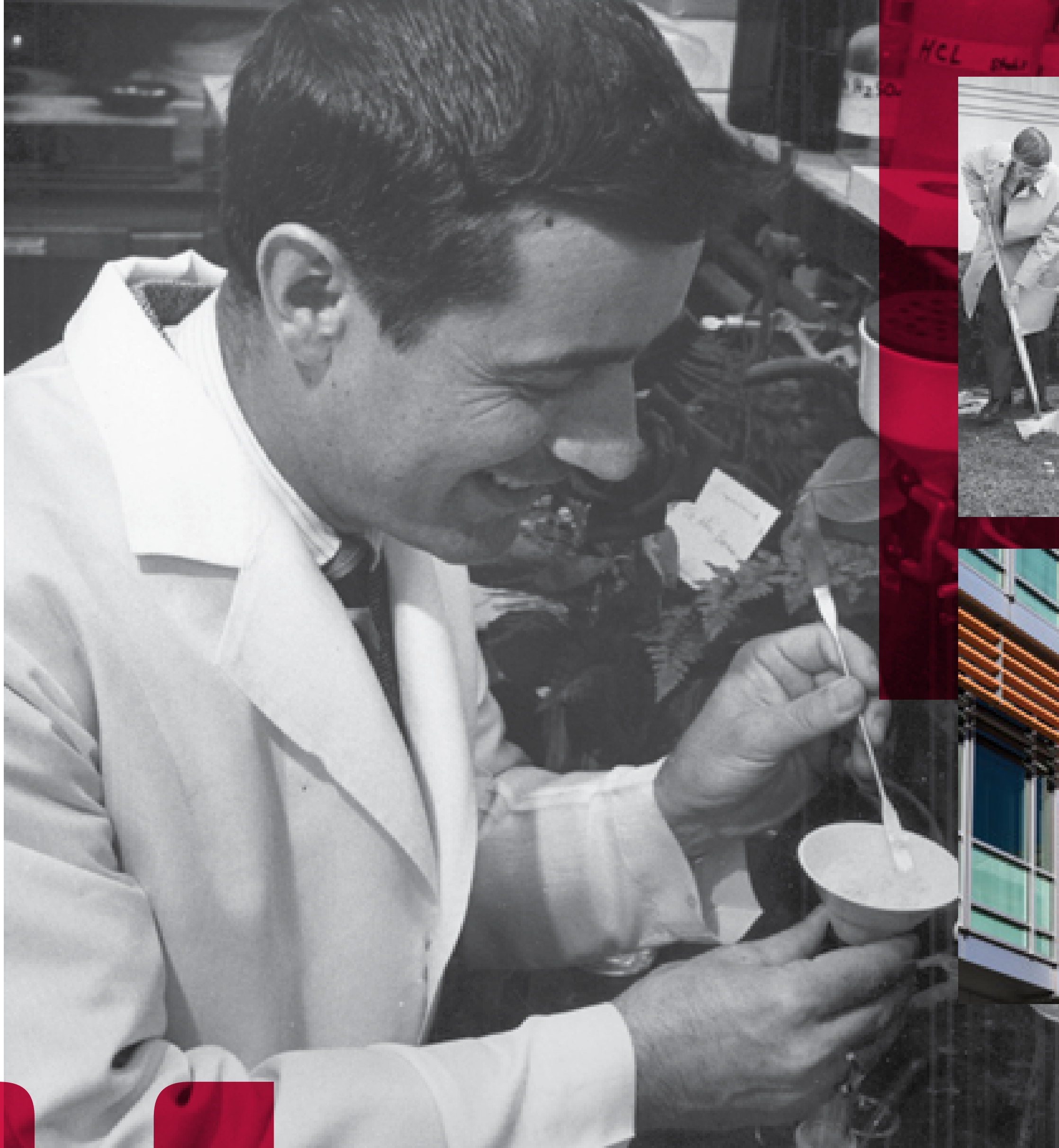
The Walnut Street Greenhouses and the WARF Building are reflected in a bus stop at sunset on the UW campus.

Photo by KEEGAN GERING

A Century of Research Partnerships

CALS scientists are furthering the success and legacy of the Wisconsin Alumni Research Foundation 100 years after its founding.

By Caroline Schneider MS'11



Left: Hector DeLuca, professor of biochemistry, performs a laboratory procedure.

Top: Hector DeLuca, second from left, at the groundbreaking ceremony for the new Biochemistry Building addition in March 1984.

Photos courtesy of UNIVERSITY OF WISCONSIN–MADISON ARCHIVES

Above: The DeLuca Biochemical Sciences Building.

Photo by ALTHEA DOTZOUR

Hector DeLuca left his mark on the UW–Madison campus — literally. The professor emerit and former chair of biochemistry has three buildings that bear his name, recognition of his many research and teaching contributions. His work on vitamin D led to chemical synthesis of vitamin analogs that have been used to treat diseases such as kidney failure, rickets, and osteoporosis. He is listed as an inventor on almost 2,000 patents and founded three biotechnology companies, including Tetrionics, a pharmaceutical ingredients manufacturer acquired by the chemical company Sigma-Aldrich in 2004.

Federal funding helped lay the foundation for DeLuca's many discoveries. During his career, he secured $16.7 million in federal grants through his research. Those funds came from agencies such as the National Institutes of Health (NIH) and paved the way for his inventions.

But, to bring his innovations to the public, DeLuca had another important partner — the Wisconsin Alumni Research Foundation (WARF). WARF is the designated patenting and licensing organization of UW–Madison and was created to ensure university research helps solve problems on and beyond campus. The foundation gives much of the funding earned from licensing back to UW — tens of millions of dollars from DeLuca's technologies alone — to support the cycle of further discovery. WARF is celebrating its 100th anniversary this year and reflecting on a century of helping many researchers, including DeLuca, contribute to the university, the community, and the world.

WARF's Origins in CALS

WARF itself wouldn't exist without another CALS professor of biochemistry, Harry Steenbock. In the early 1920s, Steenbock discovered that certain fats could be fortified with vitamin D by exposing them to UV light. He understood the impact this finding could have on public health and patented the discovery. But, when faced with a commercial offer, he chose not to sell it for profit. Instead, he wanted to find a way to bring earnings from the discovery back to the university. Steenbock partnered with Harry L. Russell, dean of CALS, and Charles S. Slichter, dean of the Graduate School, to develop the idea for a nonprofit, alumni-run corporation that would manage the UW's patents and reinvest the revenue in the university. That idea became WARF, founded in 1925.

Throughout the last 100 years, WARF has evolved and differentiated to support research at various stages through targeted programs. WARF Accelerator supplies resources for inventors and advances them closer to the marketplace. WARF Ventures provides funding to early-stage startups that are commercializing UW technologies. And WARF Therapeutics creates a translational research path to improve the value of potential drugs and medicines in the eyes of investors and research partners.

Each program houses additional opportunities. For example, WARF Named Professorships recognize UW–Madison faculty who make major contributions to research, teaching, and service. The Kellett Mid-Career Awards and H.I. Romnes Faculty Fellowships support faculty who have made key research discoveries. The Fall Research Competition funds cutting-edge investigations carried out by more than 400 faculty throughout the university.

"WARF's programs bridge the gap between federal funding and private investments," explains Emily Bauer, director of licensing at WARF. "The work we do in intellectual property and the resources we provide can help research projects move from discovery to proof of concept to business modeling and beyond."

CALS and UW–Madison secure large amounts of funding for discovery and early-stage research from federal agencies. In 2023–24, the university was awarded $816.8 million in federal research money. Those funds, from agencies such as the Department of Energy (DOE), NIH, National Science Foundation, and U.S. Department of Agriculture, lay the groundwork for discoveries that turn into patentable inventions.

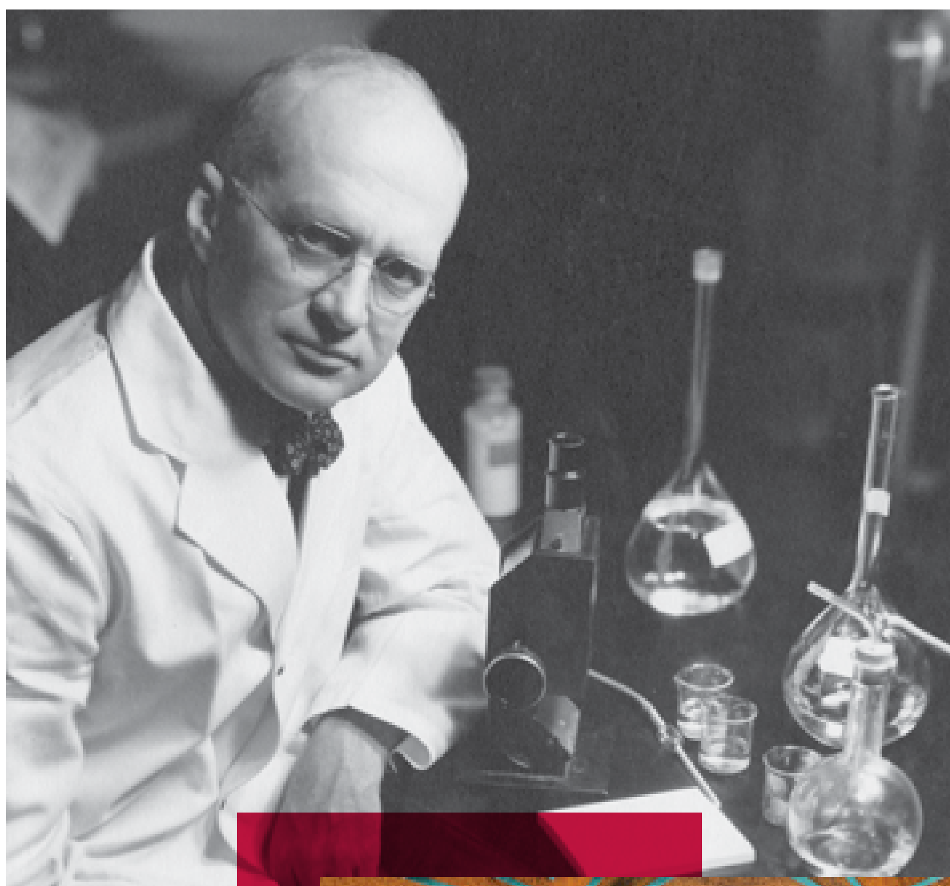
The Bayh–Dole Act helps bring these technologies to the public. Adopted in 1980, it allows universities, small businesses, and non-profit organizations to retain ownership of inventions developed with federal funding. The act was part of Congressional efforts to boost the economy at the time. Before adoption of the act, the government had accumulated more than 25,000 patents, but fewer than 5% of them were commercially licensed. WARF, however, can provide the additional funds and framework to help federal money go the extra mile and ensure that usable innovations reach the market.

Below: Harry Steenbock in his lab.

Photo courtesy of UNIVERSITY OF WISCONSIN–MADISON ARCHIVES

Bottom: Cut into a rusted-steel panel, the molecular model of Vitamin D is one of many graphics and informational displays featured at Alumni Park on the UW campus.

Photo by JEFF MILLER



"WARF patents university technologies based on federally funded research because it is a proven method for getting the innovations out to the world. Government funding supports the basic research but usually not the commercial development," says Kevin Walters, public affairs associate at WARF. "And by allowing university researchers to patent their technologies, discoveries and startups stay in the community. For WARF, this means Wisconsin inventors at a Wisconsin university benefit Wisconsin's people."

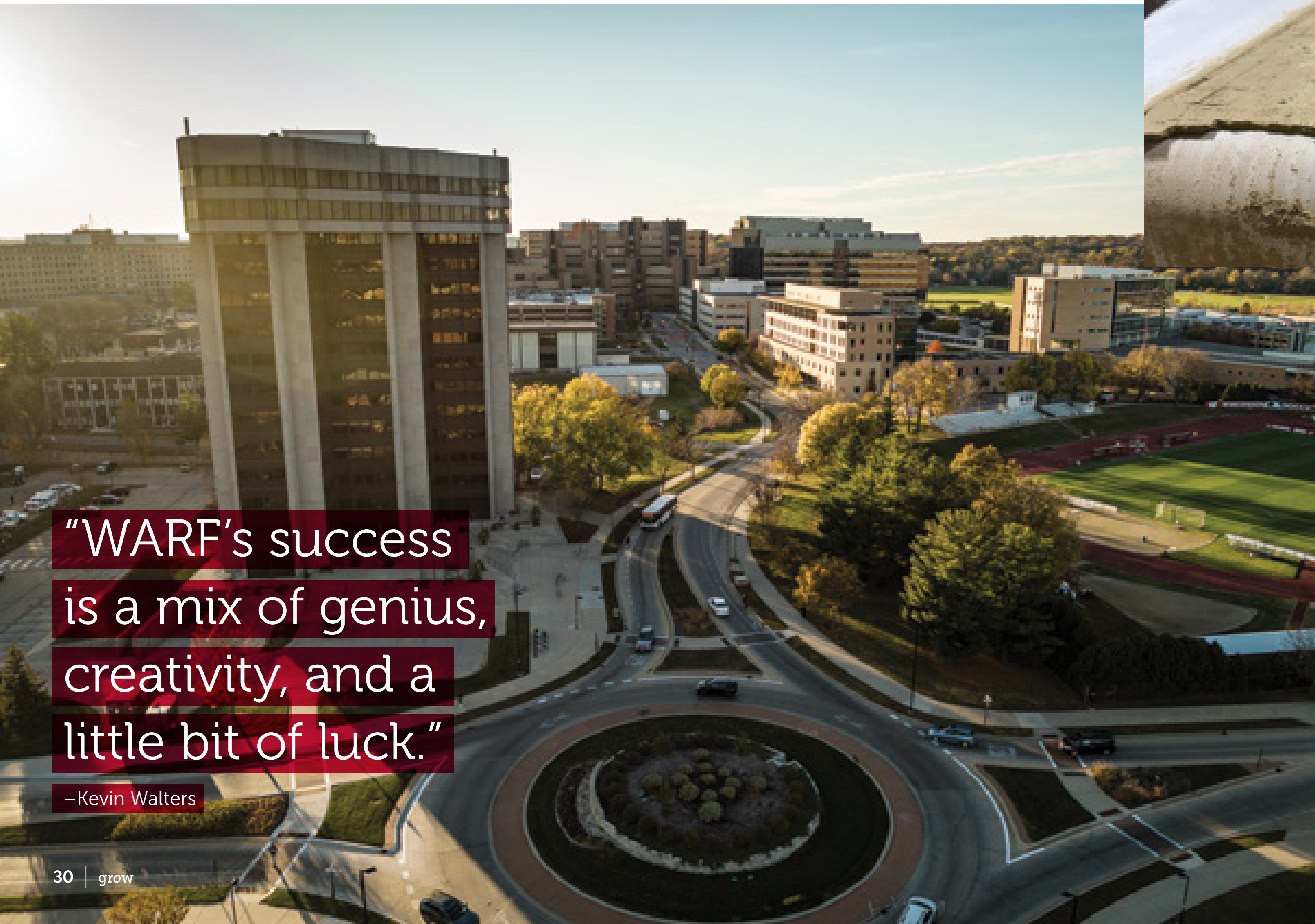
Since 1925, WARF has given UW around $4.5 billion in support and has provided funds for more than 50 campus buildings. In 2024–25, the foundation is supporting UW with $105.4 million, including $41.7 million for research projects; $38.7 million for faculty, staff, and students; and $10 million for various research facilities.

"WARF's success is a mix of genius, creativity, and a little bit of luck," says Walters. "It's inspiring to walk across the CALS campus and see names like Steenbock and DeLuca, great faculty who were critical to WARF and who truly did change the world with their work."

Given its origins in CALS, it's no surprise that the college and WARF have a strong partnership going back a century. That relationship, and the support and funding provided by WARF, continues today. Here are some strong examples of CALS faculty — three among many (see online sidebar, "WARF Collaborators at CALS," for more examples) — who are making advances in various research fields thanks to partnerships with WARF.

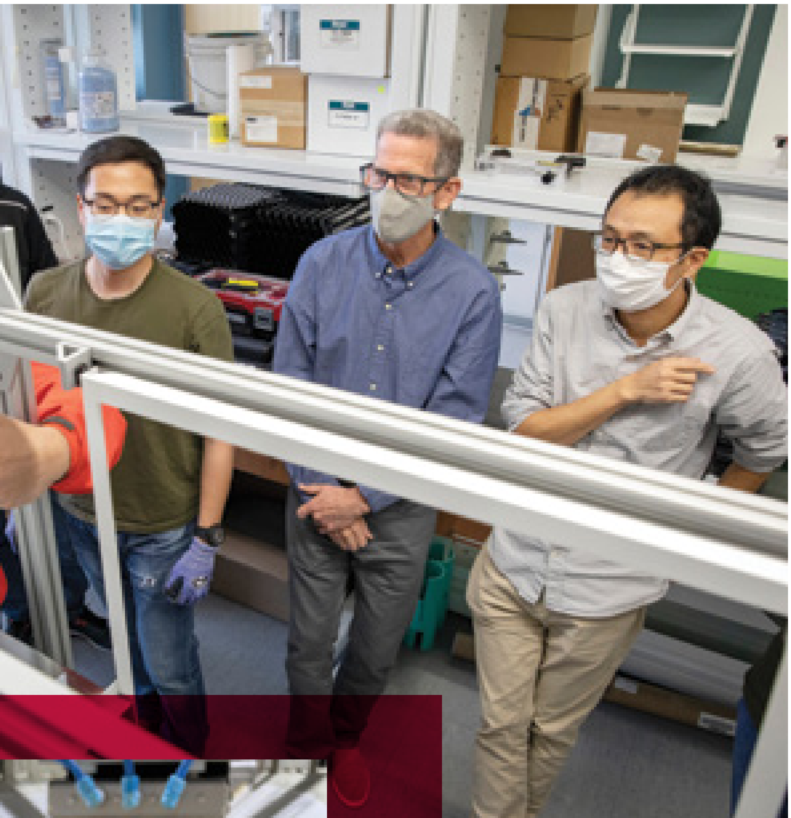
The Carbon Capturer

About five years ago, Rob Anex, professor of biological systems engineering, was looking for new research collaborations. He had studied biofuels and economic analyses of technologies throughout his career, work he has pursued with critical funding from multiple federal agencies — the Department of Energy, the U.S. Department of Agriculture, and the National Science Foundation, among others. But Anex was interested in delving further into technologies that could help address



"WARF's success is a mix of genius, creativity, and a little bit of luck."

–Kevin Walters



Top: Rob Anex, second from right, Bu Wang, far right, and the XPRIZE for Carbon Removal Student Competition team in 2021. Photo by MICHAEL P. KING

Above: A vacuum belt filter at the site of Alithic, a UW spin-off company (based on technology developed by Anex and Wang) that captures carbon and stores it in a concrete replacement. Photo courtesy of ROB ANEX

Left: The WARF Building and the UW Hospital complex as photographed from a drone at sunset. Photo by ALTHEA DOTZOUR

climate change. As he looked for a partner who might be interested in joining him on that path, he came across the work of Bu Wang, associate professor of civil and environmental engineering.

At the time, Wang was investigating industrial mineral wastes called fly ash, trying to control the pH level of the materials. He and his team realized that the calcium in fly ash rapidly carbonates when placed in a solution of sodium carbonate and forms calcite, the primary mineral in limestone. The reaction releases sodium hydroxide, which combines with carbon dioxide in the air to form more sodium carbonate; this reacts with more fly ash, a cascading effect that locks away the carbon dioxide in the ash.

"It didn't work for what Bu was trying to do, but he realized it could work really well for doing direct air capture of carbon, getting carbon dioxide out of the air," Anex says. "It was a great opportunity. We began writing proposals, and we entered the XPRIZE competition with this idea."

Following their discovery, Anex, Wang, and their team formed a spin-off company and entered the 2021 XPRIZE for Carbon Removal Student Competition, supported by the Musk Foundation. As one of the winners, they received $250,000 to continue their work and grow the company.

Throughout the journey from idea to industry, Anex and Wang worked with another key collaborator — WARF. The researchers participated in several of the foundation's "pitch days," where entrepreneurs present their ideas to a panel of judges for feedback, and they received WARF Accelerator money to help further develop and test their technology. As their company grew, WARF provided additional funding through its Ventures program and offered other kinds of assistance.

"In addition to the money, WARF has been very good about helping us meet with investors — reviewing our materials, giving us tips and advice," Anex says. "Beyond programs like Accelerator, they provided contacts and suggestions that went a long way toward the success of this work."

Their company, now called Alithic Carbon Solutions (previously Earth RepAIR), is finding a foothold in the carbon capture field due to its unique process. While other companies use large amounts of energy to capture carbon, Alithic uses the chemical energy of mineral wastes and locks carbon dioxide away in mineral form — all at atmospheric pressure and temperature. The process stores carbon dioxide in the fly ash by essentially turning the calcium in the ash into limestone, which can then be reused as a construction material.

Alithic is building its first pilot plant in Madison this summer and hopes to raise money for a larger pilot plant in Alabama. If that proves to run as expected, Anex and his team want to build an industrial plant capable of taking 25,000 metric tons of carbon dioxide out of the air each year, with plans beyond that for plants that could remove five times more.

While that amount of carbon dioxide is just a small slice of the more than 6 billion metric tons of carbon dioxide the U.S. releases each year, the product created by Alithic's system (called supplementary cementitious material) could also replace up to 70% of traditional cement, the production of which creates large amounts of carbon dioxide. And the technology can be used with feedstocks beyond fly ash, such as steel slag and mine tailings and natural minerals like serpentine or basalt, which provides a lot of flexibility.

Anex is listed as an inventor on three patents for his technologies, two of them licensed by Alithic. The third patent covers a technology capable of reducing carbon dioxide emissions from industrial wastes, such as crushed concrete or coal ash. The work that led to these technologies was funded by the DOE.

"WARF has helped each step of the way and has truly created an entrepreneurial ecosystem on campus," Anex says. "I had a startup company years ago, and it's like night and day, the difference between what's possible when you're scraping for every resource and bit of advice versus what's possible with WARF."

For the Health of Mothers

Laura Hernandez, professor of animal and dairy sciences, is concerned about the health of moms — whether they be mice, cows, or humans. Her lab studies the roles of serotonin, antidepressants, bone health, and the placenta in maternal health.

When Hernandez first came to CALS 14 years ago, she was hot on the trail of serotonin, a monoamine (which functions as a neurotransmitter or hormone) that impacts mood, sleep, appetite, and more, and its effects on calcium in cows. Cows can develop milk fever when the amount of calcium circulating in their blood decreases. However, Hernandez and her colleagues had found that when cows are given a serotonin precursor that the body metabolizes into serotonin, serotonin signaling and calcium levels rebound.

So, Hernandez became increasingly interested in selective serotonin reuptake inhibitors (or SSRIs), a common form of antidepressant. SSRIs block uptake of serotonin from the blood, resulting in increased serotonin signaling. With funding from NIH, Hernandez began investigating if there were further connections between signaling and non-behavioral health, such as the elevated levels of calcium she had seen in cows.

"There's been an underappreciation for the impacts of SSRIs that aren't related to antidepressant behavior," Hernandez says. "That's how my work evolved. I was initially looking at lactation and bone health related to calcium, but then we started also seeing other things happen in animals on SSRIs."

A particular observation in mice set Hernandez and graduate student Rafael Reis Domingues down another path of SSRI investigation. When mice treated with SSRIs had babies, some pups died shortly after birth. At first, the researchers thought it was a lactation problem, but then Hernandez wondered if it wasn't something else that they weren't expecting. They dissected some of the mice that had given birth and found that several pups were still in the uterus.

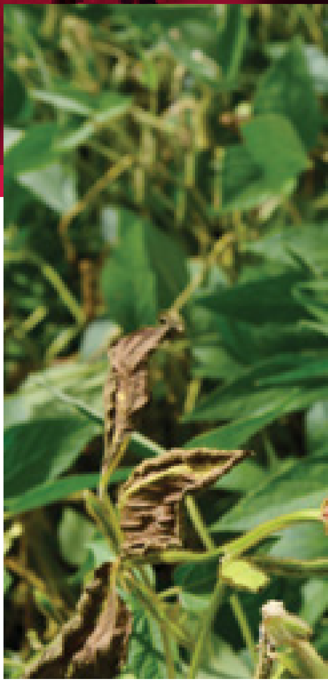
The scientists needed to decipher whether the problem was with the pups or the mother. When they treated mice with SSRIs and a drug called ketanserin, which blocks SSRI effects, they saw reduced pregnancy loss. But why? Domingues set up an experiment to test if the pregnancy losses from SSRI treatments might be due to restricted blood flow to the placenta. They found that, when mice were treated with SSRIs, blood flow to the placenta was reduced. And when ketanserin was given along with the SSRIs, blood flow was restored, as Domingues predicted.

"This was very exciting," Hernandez says. "Rafael chose to use ketanserin because it has already been used to treat preeclampsia in women, and it's known not to reverse the positive effects of SSRIs on behavior. So, these data have important biomedical implications and possible use in the clinic."

WARF agreed. They helped Hernandez, Domingues, and animal and dairy sciences professor and collaborator Milo Wiltbank apply for a patent. That patent will protect the method of using ketanserin in conjunction with SSRIs to prevent adverse pregnancy outcomes. Hernandez is hoping she can secure further funding for the work through the Draper Technology Innovation Fund, a program from UW–Madison's Discovery to Product unit that supports additional research related to WARF-patented technologies. She is also interested in the possibility of working with WARF Therapeutics to develop a plan for translational research and preclinical work.

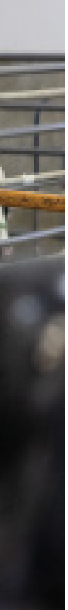
Hernandez's research and own experiences of motherhood have made her a staunch advocate for pregnant women and mothers. That viewpoint keeps her moving forward, even when up against the complexity of human research and doctors who are sometimes reluctant to accept research that changes the medicines they prescribe.

"I don't want to take any options away from pregnant women and mothers. I just want to provide information," Hernandez says. "Women need to have more information to make decisions about their health and their medications and to get the support they need. I want these discoveries to support that mission."



Top left: Professor of animal and dairy sciences Laura Hernandez gives an overview of her cow and calf pairing study at the Dairy Cattle Center during a Dairy Innovation Hub Summit tour of CALS facilities.
Photo by MICHAEL P. KING

Above: Characteristic white mold symptoms include these white, cottony mycelium on the stems of soybean plants.
Photo by DAMON SMITH



Fungus Fighters

Fungal pathogens can cause devastating diseases in plants, animals, and humans, and they can be extremely difficult to eradicate. When it comes to human health, more than a billion people are estimated to become infected with a fungal pathogen each year, with effects ranging from superficial to life-threatening. White-nose syndrome of hibernating bats is caused by fungi and, since its detection in 2006, it has caused the worst mass mortality rates known in mammals, killing millions of bats. Fungal disease has also killed millions of trees in native forests, creating a massive loss of both habitat and natural "sinks" that remove and store atmospheric carbon dioxide.

Farms also face the consequences of fungal pathogens. Sclerotinia stem rot has become a widespread threat to many crops throughout the Midwest. The disease, caused by the fungus *Sclerotinia sclerotiorum*, can significantly limit yields and cause losses of more than 10 million bushels per year in soybeans, a common host.

Mehdi Kabbage, professor of plant pathology, is working to decrease the threats and impacts of fungal pathogens by coming at the complex problem from different directions. First, with funding from the National Science Foundation, he studied why plants succumb to stem rot and sought to uncover the genetic traits of the plants that are resistant to the disease.

"We found that the fungal pathogen can increase the production of reactive oxygen species in its host, which causes plant cell death and gives an advantage to the pathogen," Kabbage says. "To counteract that, we were able to identify genetic targets that slow that process and provide increased resistance to the fungus."

Fortuitously, because reactive oxygen species also play a role in a plant's response to drought, Kabbage and his team — including Damon Smith, professor and extension specialist in plant pathology — found that plants that resist fungal pathogens also are better at withstanding drought. Given the potential utility of such traits in the field, the researchers developed plant cells and whole plants with the resistance traits and worked with WARF to patent the inventions.

Kabbage then looked at how plants fend off fungal infections from another angle. He began working with two researchers formerly at the Wisconsin Energy Institute: scientist Jeff Piotrowski and professor emerit of biochemistry John Ralph PhD'82. With funding from the Department of Energy, Piotrowski and Ralph had identified a class of plant metabolites (small molecules involved in metabolism) called diferulates and wanted Kabbage to test them for antifungal properties.

"We tested these products of plant metabolism in the lab, and we found that a couple of them were really potent antifungal compounds," Kabbage says. "We then moved from cell cultures and tested them in plants, and there, too, they inhibited fungal infections."

With this discovery in hand, Kabbage, Piotrowski, and Ralph turned to WARF to patent another finding and provide the basis of what could be used to treat plants, soils, and even animals with fungal infections.

Now Kabbage and his team are working to make the antifungal compounds more readily accessible. It can be very expensive to produce the molecules, and his team has developed a process for producing the metabolites much more cheaply. While the product is not in a pure form — instead, it's a mixture of metabolites — it's still promising for widespread antifungal use. And with that promise comes the potential for another patent. Kabbage and his team are again working with WARF to bring this latest innovation to market.

"I've been so grateful to WARF and their willingness to recognize good science and get behind it," Kabbage says. "As researchers, we can hear 'no' a lot of other places, but with WARF, we hear 'yes,' and that's incredible. The additional funding and visibility for these discoveries is a game changer." g

Photo by JEFF MILLER

WARF Collaborators at CALS

Throughout its 100 years of operation, WARF has secured around 4,400 patents on behalf of UW researchers and has bolstered the university's budget by $4.5 billion. In addition to the researchers featured in this article, WARF continues to help many other CALS faculty and scientists, such as Anha Skop (pictured far right), by patenting their discoveries and funding ongoing work. Visit **grow.cals.wisc.edu** to learn more.

Photo by MICHAEL P. KING

Target of Opportunity

Jake Brunkard takes aim at the potential power of an ancient cellular process to make plants, people, and pets healthier.

Interview by SUSAN LAMPERT SMITH BS'82

In **Jake Brunkard's** lab in the Genetics-Biotechnology Center, you'll find plants everywhere. The space is filled with grow carts containing tomatoes and *Arabidopsis thaliana*, a member of the mustard family that Brunkard calls "the lab rat" of the plant genetics world. You'll also see *Nicotiana benthamiana*, a tough survivor of the Australian Outback, where it flourishes in rocky soil, high heat, and low-nutrient conditions. The flora (and the science) extend beyond laboratory walls to the university's agricultural research stations, which host maize and soybeans in summer fields, and to UW greenhouses during the cold months.

Brunkard, associate professor of genetics, and his lab concentrate on the TOR cell signaling pathway, by which plants, on a molecular level, sense the availability of nutrients that prompt growth. Eventually, what they learn may help food crops get by with less added nutrients in the form of fertilizer — by lending them some "Outback toughness" genes — thereby making agriculture more sustainable.

What is TOR, and what does it do in plants, animals, and other life forms?

A group of scientists went to Rapa Nui, also known as Easter Island, back in the 1960s. Inspired by the penicillin discovery story, they were looking for useful drugs from microbes. They screened soil from the island and discovered a chemical they called rapamycin. No one knew what it was for, and it turns out it is found in the soil all over the world; but, eventually, it was discovered that it regulates this cellular signaling pathway called TOR, which stands for target of rapamycin. The pathway controls growth, metabolism, and lifespan in all eukaryotic species. In humans, the mTOR (mammalian TOR) pathway is implicated in many cancers, causing cells to grow wildly. Rapamycin is used in cancer treatment and transplant medicine to quell organ rejection. In plants, it regulates growth in response to nutrients and other growth factors. It really does show how basic science can lead to a giant field that has such important implications for human and animal health, and for plant health as well.

Why are you interested in TOR?

First, I'm interested in the evolutionary perspective on this. TOR has been really well studied in mammalian systems and in models, but it's not often studied with an evolutionary perspective on how this signaling pathway, which has existed for a very long time, has evolved or changed or been modulated. One possibility is that plants have evolved a totally new way of sensing nutrients and controlling growth through this TOR pathway, but that's not very satisfying. It seems likely that there are many similarities in the TOR pathway between humans and plants. We're interested in the conserved pathway that's shared across 2 billion years of evolution. How do these things evolve?

What could a better understanding of TOR lead to for crop plants?

It's well-accepted that our agricultural system is not sustainable. To get the crop yields that we get, we have to apply huge amounts of fertilizer to our soils, and fertilizers are finite resources. Phosphorus is a rock that we mine from the earth. In the coming decades, we're going to deplete our phosphorus mines.

The other thing is we apply all this fertilizer, and the plants barely use it. We need to overload the system to get them to take up even a fraction of what we apply. The rest gets into our waterways, and you get those green algal blooms. So, if we could understand better how plants are sensing and responding to nutrients and how they're using those nutrients to make the kernels of the corn (as opposed to the leaves), then there might be ways to tweak the process that would be really useful for agriculture. This could be a way to improve crops that would never be achieved using traditional breeding approaches.

We do a lot of work with an Australian plant, *Nicotiana benthamiana*, which we affectionately call benthi. It grows in rocky deserts. It's just the most robust plant you've ever encountered — it can grow anywhere. And it's a great tool for plant biology because we can grow it easily, anywhere we want to, and it's really easy to transfect with viruses. It has figured out how to make do with less. So, if we can understand better how it does that, maybe we could give a little bit of that ability to some of our agricultural crops.

How would you go about doing that?

To do that, we can use the exact same human drug, rapamycin, because the proteins are the same. We can add rapamycin and other TOR inhibitors to plants and measure what happens in response to inhibiting TOR. We look at gene expression and ask several questions: What genes are being transcribed? Which of those genes are being translated into proteins? Of those proteins, which ones are stable or unstable? How are those proteins being modified? We're trying to really map everything that TOR is doing to control the expression of the genome using those inhibitors.

How does interest in TOR drive studies in your laboratory?

The most honest answer for why I study TOR is that TOR connects to so much of biology in so many different ways. When I was starting my lab, I really wanted to have a simple organizing principle so that when a brilliant student comes along who wants to work on something, we can find a way to make it work with TOR. If a student wants to study some sort of plant disease, we can study that. Or I have a student who wanted to sequence the genome of a plant, so we sequenced the genome of a plant in Australia that he was really excited about. Everything has a connection to TOR in some way. And it's just been a great way to organize a lab around creativity and thinking about dynamic science while not being limited by a topic.

You're working with Dudley Lamming, an associate professor in the UW School of Medicine and Public Health, on a project to create corn and soy protein that is better for human health. Is TOR involved there?

Yes, actually, it is. Dudley is a leader in the rapamycin and mTOR field, and that's how we connected in the first place. Seeds like soybeans make huge amounts of protein from just a couple of genes; there are three to five genes that are making something like 80% of the protein in a seed. We have no idea how that's regulated, but we think TOR is involved for various reasons. So, the secret side project is that I'm trying to understand the regulatory process and whether we could tweak it in some way that could let us modulate the nutritional properties of seeds even further. The goal is to create soy and corn products with lower levels of the essential amino acids isoleucine and histidine to promote weight loss and better glucose tolerance.

Some of these interventions for human health might be tricky to actually implement, and it might be easier to do some of these things with pets, where we can control their diet a little bit more easily. Wouldn't it be cool if some of this not only helps human health but also helps our pets have healthier lives? We're changing the proteins in soybean to make them healthier calories. A lot of what pets eat is soybean and corn that's been ground up into meal. If we can have them eating a healthier version, that'd be incredible. That's a main motivation for that whole project: I've got a 2-year-old puppy, and wouldn't it be cool if I can get him on a healthier diet in just a few years?

$ FEDERALLY SUPPORTED RESEARCH

Jake Brunkard's lab has received federal funding from the National Institutes of Health, the National Science Foundation, and the U.S. Department of Agriculture. His research also has been supported by the nonprofit Howard Hughes Medical Institute and the Wisconsin Partnership Program.

The Poultry Professor

Animal sciences Ph.D. and erstwhile food safety consultant Aaron Bodie is now leveraging a position in academia to help protect the public from common foodborne pathogens.

By HYWANIA THOMPSON

Undergrads, take heed: That career seminar your advisor recommended just might lead you to your actual career. **Aaron Bodie** PhD'22 is case in point. One fortuitous career talk encounter took him from biology classes at the University of Arkansas to graduate studies in meat science at CALS. And from there, he leapt from award-winning food safety consultant to poultry science professor at the University of Georgia. Now he's cementing his place in the food science field.

Bodie began his college career as a biology major at the University of Arkansas (UA). But his fascination with food science can be traced back to a talk about career paths given by **Steve Ricke** PhD'89. Ricke was a professor of food science and director of UA's Center for Food Safety at the time. "I just went to him after this talk and was like, 'Hey, I'm interested based on what you presented — how do I get into this field?' " Bodie says.

"I immediately recognized his enthusiasm and sincerity for wanting to seriously pursue this career track," Ricke says.

Ricke suggested Bodie get lab experience in food safety, and he eventually hired Bodie as an undergraduate laboratory assistant. Bodie also worked as a microbiologist in UA's food science department.

"We started to do a lot of work in poultry as well as ready-to-eat products," Bodie says. "I started to like it, so that's what sparked my interest in continuing my career path toward food safety."

After completing his master's degree in animal science, Bodie was looking for opportunities in the industry, but he couldn't immediately find what he was looking for. Believing further education would help, he began work on his Ph.D. at UA. In 2020, Ricke took a position at CALS as professor of animal and dairy sciences and director of the Meat Science and Animal Biologics Discovery (MSABD) program. He extended offers to Bodie and others to join his lab. Bodie accepted with enthusiasm.

"Aaron was instrumental in moving my program to Wisconsin, and he kept his research going during the move — in the middle of the COVID pandemic and during the opening of the new MSABD building," Ricke says. (See "The Future Holds No Limits for Meat Science at CALS," *Grow*, summer 2021.)

Bodie switched his research focus from *Listeria* and *Salmonella* to *Campylobacter*, a foodborne pathogen that can be found in raw foods (and in especially high numbers in poultry products). "Aaron took on the challenge of optimizing a rapid assay (test) for *Campylobacter* detection and quantification that was critically needed by the poultry industry," Ricke says. "This was a difficult project, but he successfully optimized and standardized the assay to complete his Ph.D. degree."

As it turns out, Bodie was the first from Ricke's MSABD lab to graduate with a Ph.D. "It feels good when I set out to do something and achieve it," Bodie says of his degree. "But that was never on my bucket list — to be the first of anything. I was just trying to do my best in my career, honestly."

Bodie is quick to recognize others for helping him broaden his skills and move his career forward. He cites his MSABD lab mates, former CALS researchers **Dana Dittoe** and **Elena Olson** PhD'24, and his UA mentor, researcher **Peter Rubinelli**. He also credits the members of his thesis committee — Food Research

Institute director **Kathy Glass**, animal biologics professor **Vanessa Leone**, and professor and extension meat specialist **Jeff Sindelar** — for steering him toward graduation and helping him find ways to be a good scientist.

"Of course, Dr. Ricke was also influential to me," Bodie says. "He's a worker, for sure, but he's also a forward thinker; he never discourages any thought he has about science."

Before accepting his current professorship at the University of Georgia (UGA), Bodie served as a food safety consultant. He worked with meat processors to help them comply with standards set by the Food Safety and Inspection Service at the U.S. Department of Agriculture. During that time, Bodie also launched @dr.microfoodsafety on Instagram and other social media outlets, where he posted information and short videos to help inform consumers.

"Society is becoming more health conscious with what they eat, and there is a lot of misinformation floating around," Bodie says. "I think it's imperative for educators and experts in the industry to inform consumers about health, food safety, and quality."

Bodie's work in the industry, as well as his social media presence, caught the attention of The Alliance to Stop Foodborne Illness. In 2023, the organization awarded him a "40 Under 40" award.

At UGA, Bodie is building his lab staff and infrastructure so he can help solve problems in the poultry industry. Some of his current projects include finding ways to detect, quantify, mitigate, and prevent *Salmonella* and *Campylobacter* in poultry. He also wants to find ways to identify where his research can be most helpful and applicable. Social media is a vital part of this process. Although @dr.microfoodsafety is on hold right now, Bodie recently launched @thebodielabgroup on Instagram, and other outlets may follow.

"The goal is to start to get our research out to the masses and a younger generation of students who use more social media," Bodie says.

Ricke is not surprised that Bodie wants to reach larger audiences and diverse age groups with his work. He describes Bodie as passionate and a vital contributor to the success of his MSABD lab, one who often goes the extra mile.

"Aaron repeatedly demonstrated a willingness to contribute to other activities going on in MSABD for implementing various food safety projects," Ricke says. "I believe his accomplishments as a successful Ph.D. in the animal and dairy sciences department represent the type of exceptional student that the University of Wisconsin produces."

Aaron Bodie works in his lab at the University of Georgia, where he is an assistant professor of poultry science. Photo by SEAN MONTGOMERY

ENGAGE

HAVE A FIELD DAY

Summer is the time for "field days" at the CALS Agricultural Research Stations. Over the course of the growing season, stations host more than a dozen public events around the state to share research updates and educational information with agricultural professionals, home gardeners, and others. See the lineup of summer 2025 events at **cals.wisc.edu/field-days**.

ACCOLADES

DYNAMIC DOUBLE-MAJOR DUO

Two CALS alums who double-majored in agricultural journalism and dairy science have made big career moves. **Kylene Anderson** BS'02 has been named editor of *Hoard's Dairyman* magazine, and **Lindsey Worden** BS'07 was selected as the new CEO of Holstein Association USA.

AGRICULTURE ACE

Ron Brooks BS'82, a fifth-generation farmer at the 170-year-old Brooks Farms in Waupaca, Wisconsin, has been named a 2025 Master Agriculturalist. Brooks is a passionate advocate for conservation and land stewardship.

Friday's Philanthropy

A food science alum's legacy gifts will fund full-tuition scholarships and support teaching, research, and outreach at CALS.

By NIK HAWKINS

Students in Food Sci 551 Food Fermentation Lab taste various types of yogurts during a sensory analysis. Food science students can benefit from a scholarship funded by CALS alum Fritz Friday.

Photo by MICHAEL P. KING

Charitable giving is a thread that runs through most of **Fritz Friday's** life.

As a young food science major at CALS in 1954, Friday BS'55 became the first recipient of the Wisconsin Canners Association (WCA) Award. The next year, his mother, Bess, created a scholarship in the name of Friday's recently passed father, Carleton; that scholarship and the WCA award eventually merged. Many years later, when Friday retired as president of the New Richmond-based Friday Canning Company, the business (newly purchased by Chiquita at the time) honored him by creating a scholarship for Wisconsin undergraduates studying agriculture.

These past experiences inspired Friday to make his own donations to CALS in recent years in the form of planned gifts. Also known as estate gifts, planned gifts involve setting up donations to be made to an organization upon one's death.

People who establish such "future gifts" to UW typically have a strong affinity for the university, just like Friday. His planned gifts will supplement the existing Carleton A. Friday Midwest Food Products Association Scholarship Fund and Chiquita Brands Fritz Friday Food Science Scholarship Fund.

The Chiquita Brands Fritz Friday Food Science Scholarship Fund is so named because Chiquita established the fund shortly after buying the Friday Canning Company (FCC). FCC is now owned by Lakeside Foods, a nearly 140-year-old Wisconsin-based business and early CALS partner.

"I've always believed everyone deserves the opportunity for an education," Friday says. "I hope this scholarship support provides a meaningful impact for students now and for future generations."

The income these funds generate will create two full-tuition scholarships for CALS students. The first scholarship is open to students in all agricultural majors at UW–Madison, UW–Platteville, and UW–River Falls; the Chiquita scholarship focuses on CALS students in Friday's chosen field of food science.

"While working to address the grand challenges of today, CALS students are also preparing for the future," says **Jeri Barak**, associate dean for academic affairs. "Scholarships, like those created and bolstered by the Friday family through planned giving, increase access to our dynamic learning community and an education of the highest caliber. We are so grateful for this type of support for the college and its mission."

Planned giving can help CALS pursue strategic goals that extend beyond instruction. In addition to scholarships, Friday has supported two CALS research funds during his lifetime. In 2014, he also established the Friday Fund — another planned gift — which will provide flexible, discretionary financial support for the dean of CALS each year.

"I wanted to find a way to strengthen the quality of the faculty, students, and programs across CALS," Friday says. "This will help the college support emerging opportunities and address unexpected needs in any area, whether research, teaching, or outreach."

Friday's long career includes a sizable list of achievements and contributions that have strengthened his community, the food processing industry, and CALS. As a member of multiple organizational boards — the Food Processors Institute, the Wisconsin Educational Communications Board, Holy Family (now Westfields) Hospital, the CALS Board of Visitors, and more — Friday has made his beneficent mark in many places. His planned gifts extend this positive influence, leaving a lasting, impactful legacy for CALS students, staff, and faculty.

+ YOUR LEGACY CAN LIVE ON

Just like Fritz Friday, you can establish your charitable legacy with a planned gift to CALS. This future gift can be incorporated into your financial, tax, and estate planning in a way that maximizes benefits for you and the college.

Contact Brooke Mulvaney at the UW Foundation at brooke.mulvaney@supportuw.org/608-308-5330, or visit **planmygift.supportuw.org**.


Who Will Lead the
Discoveries of Tomorrow?

College of Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN–MADISON

42 Agricultural Hall
1450 Linden Drive
Madison, WI 53706

grow.cals.wisc.edu

Footprints track through the morning dew on research plots for golf course surfaces at O.J. Noer Turfgrass Research and Education Facility in Verona, Wis. Public "Field Days" showcasing CALS research are being held throughout the summer at O.J. Noer and other agricultural research stations. More at **cals.wisc.edu/field-days**.

Photo by MICHAEL P. KING