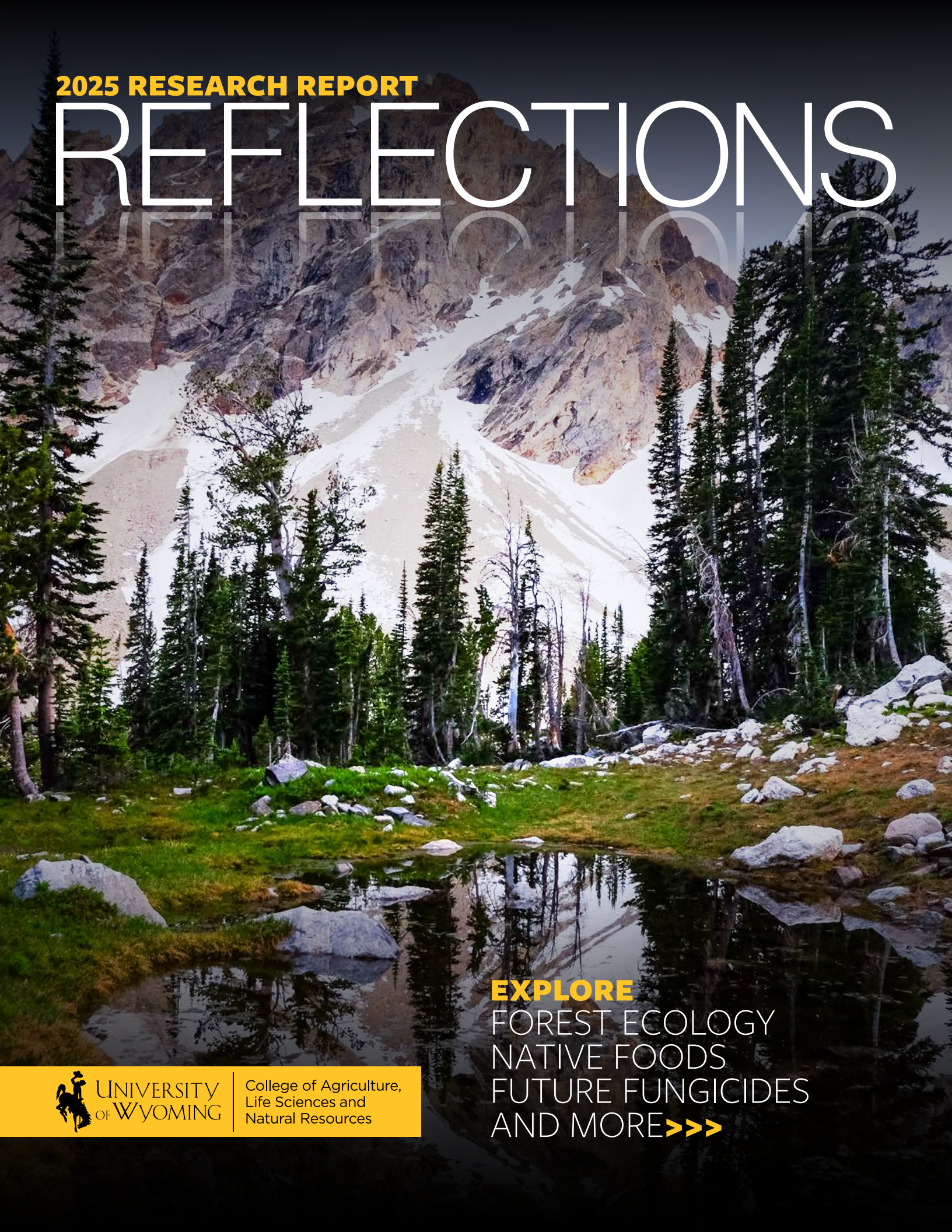
2025 RESEARCH REPORT

REFLECTIONS



EXPLORE
FOREST ECOLOGY
NATIVE FOODS
FUTURE FUNGICIDES
AND MORE>>>

UNIVERSITY OF WYOMING
College of Agriculture, Life Sciences and Natural Resources

REFLECTIONS

University of Wyoming | College of Agriculture, Life Sciences and Natural Resources

Kelly Crane—*Dean*
Eric Webster—*Associate Dean & Director of the Wyoming Agricultural Experiment Station*

Please visit our website at www.uwyo.edu/uwag

Editors
Brooke Ortel
Maya Gilmore
University of Wyoming Extension

Designer
Jeremy Cain
University of Wyoming Extension

Mountain West Farm Bureau Mutual Insurance Company
Supported in part by
Mountain West Farm Bureau Endowment

Cover: Upper Paintbrush Canyon in Grand Teton National Park. Photo by Tucker Furniss.

FEATURES

From the Director

The past 12 months have been a great year for the University of Wyoming College of Agriculture, Life Sciences and Natural Resources (CALSNR). The reorganization of CALSNR has broadened our research efforts such that it guarantees there is something of interest to everyone in Wyoming. The 2025 edition of *Reflections* continues to show a small but in-depth look at each of our departments within CALSNR.

I am pleased that *Reflections* highlights work from eight graduate students from six different departments. The research features a look at angler spending across the state, a new approach to developing fungicides, restoration of native shrublands in Grand Teton National Park, the impact of high-fat diets, how temperature regulation in mice affects social behaviors, and an investigation into the causes of canine dysautonomia. Our graduate students are the future leaders in our disciplines, and I am sure these articles will spark interest from the reader.

The research highlighted by CALSNR faculty encompasses research conducted by each department within the college. Each of the projects in this edition sparks an interest in me and I hope it does the same for you. I am particularly interested in the work Jill Keith is doing concerning restoring Shoshone ancestral food gathering and how Donna Harris is employing drones in dry bean and soybean research. Outside traditional agricultural research, *Reflections* dives into Alzheimer's disease, forest dynamics, and malaria vaccines.

I hope you enjoy the new issue of *Reflections*, and I think there is something for everyone. I believe our research provides positive outcomes that improve the lives of Wyoming residents. I am excited for the future of the University of Wyoming College of Agriculture, Life Sciences and Natural Resources.

Eric Webster
Director, Wyoming Agricultural Experiment Station

THE SCIENCE OF SNUGGLING

What Huddling Mice Can Teach Us about Body Temperature Regulation

written by **Brooke Ortel**, *University of Wyoming Extension*

If you've ever stayed home sick, you've probably experienced the unpleasant temperature swings that accompany a fever. You may remember feeling chilled, then warming up as your fever spiked—a well-established process governed by the autonomic nervous system.

But maybe you also wrapped up in a blanket to keep warm. The science behind this kind of behavioral response is less well understood.

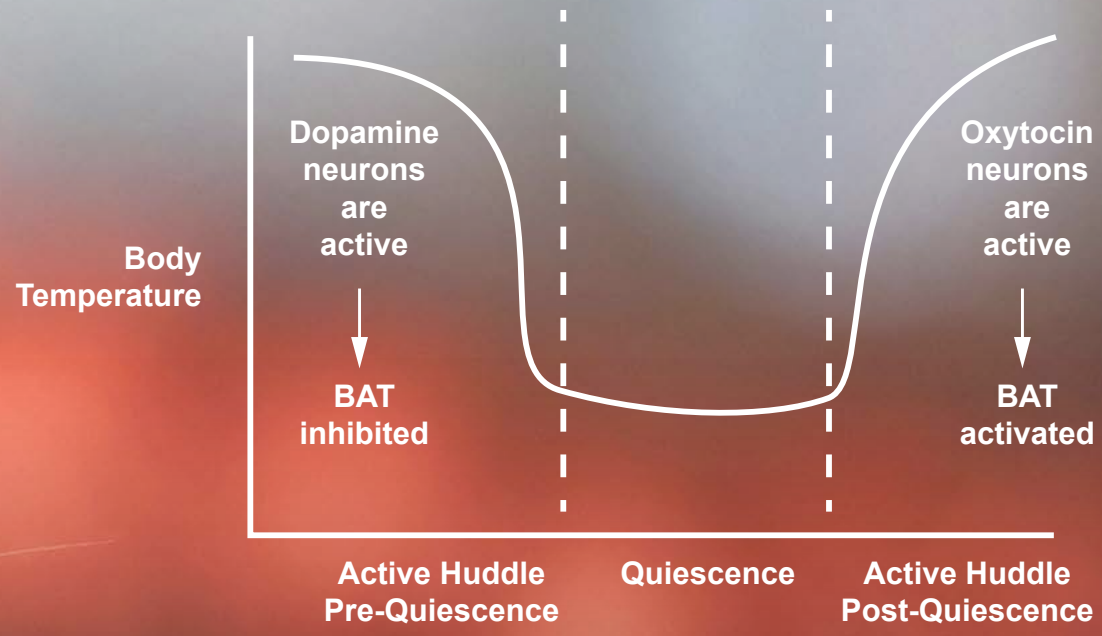
"Although it seems like the same thing, there are two different brain regions involved," says Baizar Alamiri, a PhD student in the UW Department of Zoology and Physiology. "While we understand much about the body's automatic responses, a major scientific gap is understanding how the brain influences behaviors that manage body temperature."

HUDDLING MICE

Thermoregulation, the ability to maintain a stable body temperature, allows humans and animals to adapt to changing environmental conditions.

To better understand the behavioral component of this process, Alamiri conducted several experiments observing "huddling" in groups of mice. Huddling, in which mice snuggle together before and after sleep, is considered a social behavior, but may also play a role in thermoregulation.

Jason Landen, a former PhD student in Alamiri's lab group, had discovered an unexpected relationship between huddling and body temperature. He found that as mice snuggled together before sleep, their body temperature



decreased. During periods of quiescence (sleep), their body temperature remained constant. As they woke up and began actively huddling again, their body temperatures rose.

Alamiri, who began her PhD program in 2023, was curious about the neural circuitry underlying these temperature changes. With a background in astrophysics, mathematics, and biomedical engineering, she brought a unique perspective to the puzzle.

PROMISING NEURAL PATHWAYS

As Alamiri combed the scientific literature, two research papers on thermoregulation in rats caught her attention. The first study found that as body temperature increased, the neurotransmitter oxytocin sent signals from the hypothalamus to a specific area of the brainstem. The second study observed the neurotransmitter dopamine sending signals from the hypothalamus to the same region of the brainstem as body temperature decreased.

While the signals came from different areas of the hypothalamus, they both ultimately activated an area of the brainstem responsible for regulating heat production in brown adipose tissue (BAT). This fatty tissue, located in the upper back and other parts of the body, activates in cold environments to help keep you warm.

The rat studies suggested that oxytocin raised body temperature by activating BAT, while dopamine lowered body temperature by inhibiting heat production in BAT.

Oxytocin and dopamine are most often studied in the context of social bonding and motivation respectively. But, given their connection to thermoregulation, Alamiri wondered what role they might play in behavioral responses to temperature change—such as huddling.

THE BRAIN, BODY, AND SOCIAL BEHAVIOR

In a series of "thermo-challenges," Alamiri showed that both oxytocin and dopamine interact with neurons responsible for thermoregulation in mice. She exposed mice to hotter and cooler environments, then analyzed their response using a variety of genetic, molecular, surgical, and brain imaging techniques.

Alamiri's results were consistent with the research papers she'd read about thermoregulation in rats. In the mice she studied, dopamine-related brain activity in the hypothalamus and brainstem increased in warm conditions to prevent overheating and oxytocin-related activity increased during cold exposure to help maintain warmth.

Next, Alamiri set out to determine how these neural pathways might be connected to the huddling behaviors Landen had shown were correlated to temperature shifts. Specifically, she wanted to see if dopamine activity increased as the mice's body temperature dropped during pre-quiescent huddling and if oxytocin activity increased during post-quiescent huddling.

As Alamiri suspected, the changes in temperature and neurotransmitter activity occurred in tandem with changes in group behavior. When mice huddled together before sleep, dopamine pathways activated to help lower body temperature, inhibiting BAT heat production. When the mice huddled together after sleep, oxytocin pathways activated to increase body temperature.

Alamiri's results didn't explain why the mice's body temperatures dropped while huddling before sleep and rose while huddling after sleep. But her research provides a foundation for future studies examining the brain's role in thermoregulatory behavior.

"This connection between brain chemistry and social behaviors shows how temperature control is more than a simple physical response," Alamiri notes. "It is a complex process that integrates sensory information, brain activity, and social interaction."

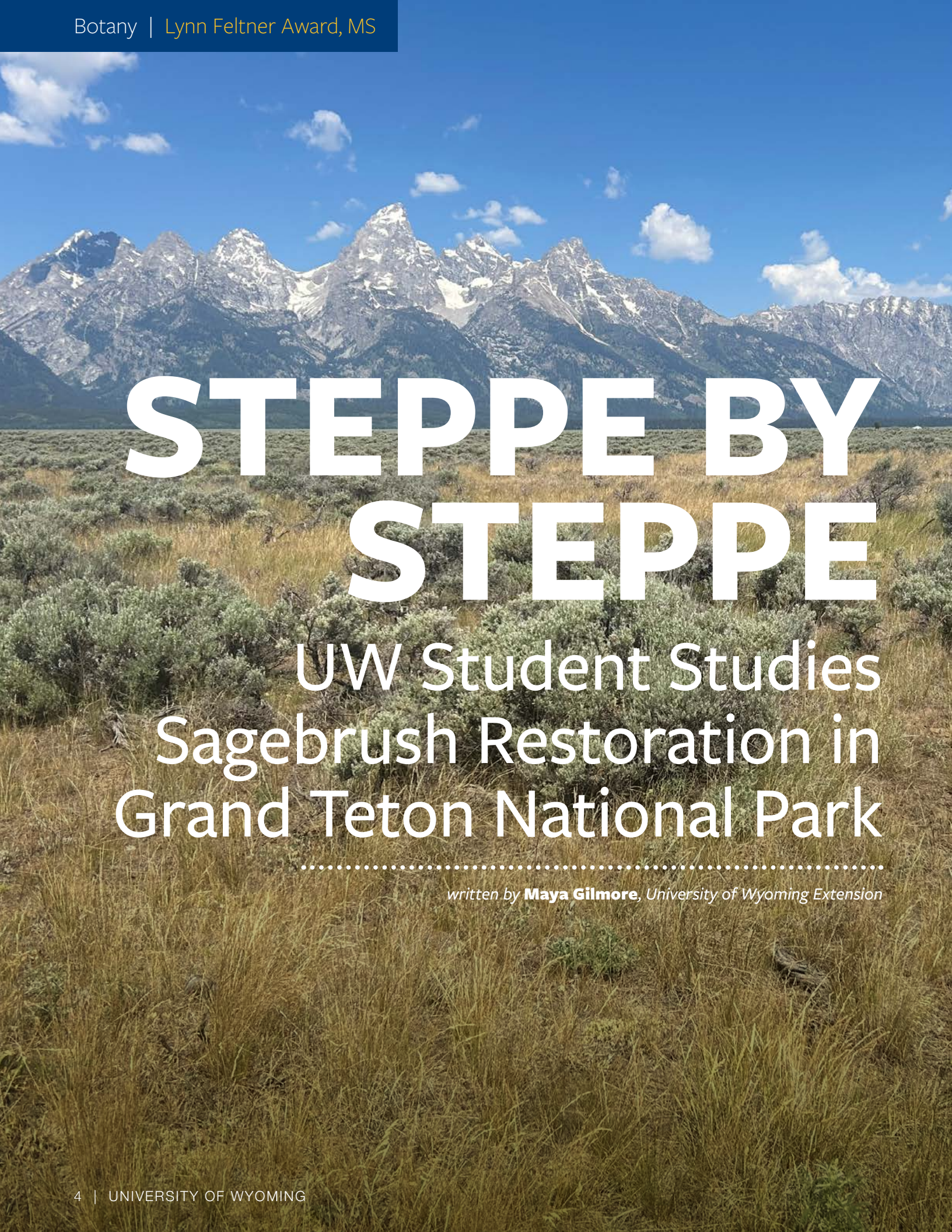
APPLICATIONS TO HUMAN HEALTH

That's probably true for both mice and humans.

"A lot of what's been discovered in mice and rats is similar to what's in human bodies, especially with hormones and the brain," Alamiri comments. "Understanding these systems could have broader applications, such as managing temperature control in certain metabolic disorders."

A wide variety of health conditions in humans, from diabetes to autism, are associated with imbalances in body temperature. "If we can get an idea of the correlation between brain and behavior—if we understand that very well like we do with automatic routes in the brain...then it could give us a route for some therapeutics to help find treatments for these patients," Alamiri concludes. ■

This research was conducted in Adam Nelson's lab. For inquiries about Alamiri's work, contact her current faculty advisor, Brandon Roberts, at brandon.roberts@uwyo.edu.



STEPPE BY STEPPE

UW Student Studies Sagebrush Restoration in Grand Teton National Park

written by **Maya Gilmore**, *University of Wyoming Extension*

Driving down Wyoming highways, the landscape often seems vast and empty, nothing but sky and a few scattered bushes.

But those scattered bushes are more vital than they appear at first glance. Wyoming is one of the largest remaining strongholds of the sagebrush steppe ecosystem. Many of the state's iconic animals, including sage-grouse and pronghorn, require sagebrush steppe to survive.

While sagebrush steppe is important, there's less of it today than there used to be.

Anne Beeman, a graduate student in Daniel Laughlin's research lab in the Department of Botany, collaborated with Grand Teton National Park managers Laura Jones and Erik Kramer to investigate the most effective ways to restore lost acreage of sagebrush steppe.

WILDLIFE HAVENS

Sagebrush steppe ecosystems receive most of their moisture as snowfall and are typically flat with few trees. Though shrubs are a key component of these systems, they also contain grasses, wildflowers, and even mosses and lichens.

These surprisingly complex ecosystems are vital for the survival of many animals, including large hooved mammals, or ungulates. Pronghorn subsist primarily on sagebrush foliage throughout the year. Other ungulates, including deer and elk, rely on sagebrush in the winter, when grasses and other forage plants are dead. Bitterbrush, another common shrub in this system, also serves as critical winter forage for ungulates and a resource for many insect species.

"It's really easy for people, especially in Wyoming, to take [sagebrush steppe] for granted, but there are some studies that identify sagebrush as one of the most imperiled ecosystems in the western U.S.," says Beeman.

Wildlife tourism and hunting are a huge part of Wyoming's economy. Without sagebrush steppe ecosystems, the large mammals that support these industries would disappear.

RESTORING GRAND TETON'S VALLEYS

Grand Teton National Park is famous for its mountain peaks and evergreen forests, but the park is home to significant swathes of sagebrush steppe as well.

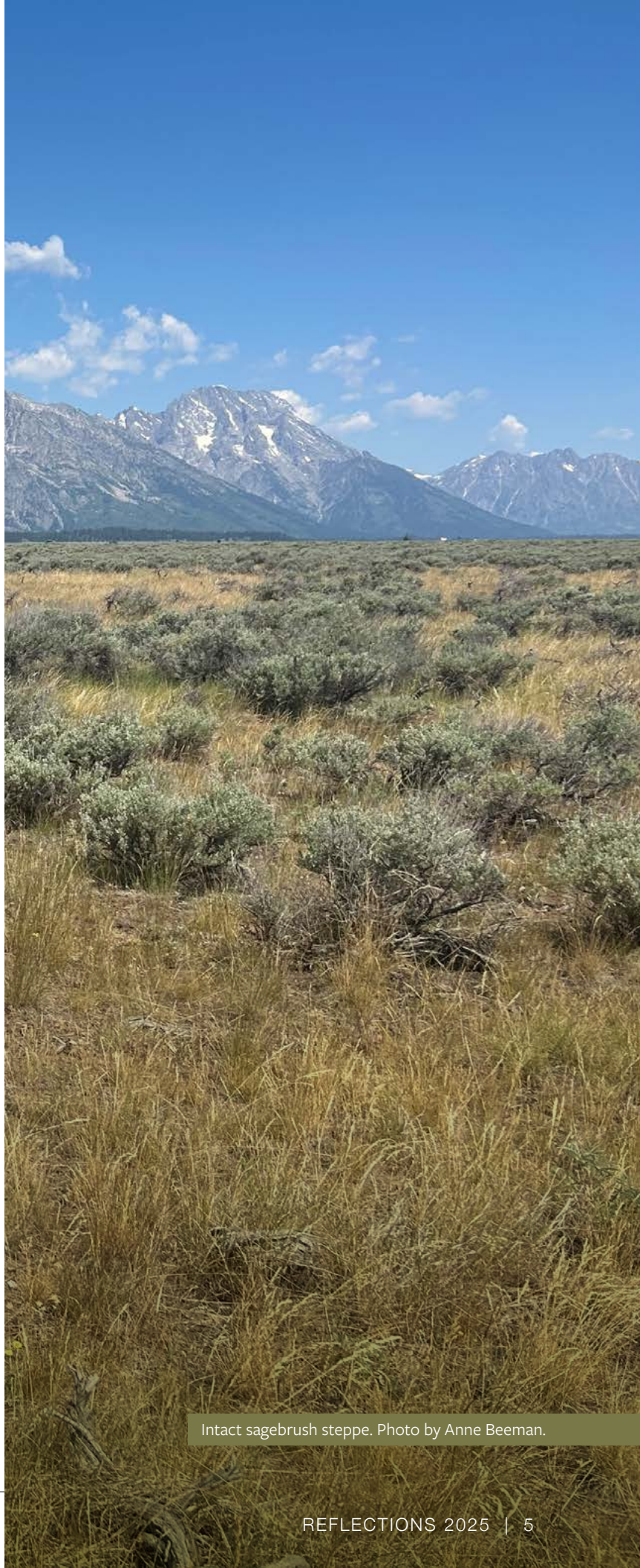
But there used to be more. In the mid-1800s, much of the park's steppe ecosystem was converted to acres of smooth brome, a non-native grass used for livestock forage.

In 2009, National Park Service managers began working on restoring 4,500 acres of these pastures back to sagebrush steppe. Over the past 16 years, park managers have observed that some restoration methods have been more successful than others. Some restored areas now boast many sagebrush plants and other shrubs, but others have more native grasses than managers prefer or contain more invasive plants.

Several years ago, park managers reached out to the Laughlin lab to determine the most effective techniques to restore the sagebrush steppe ecosystem in Grand Teton National Park.

SELECTING SEEDS

Beeman's project investigated the impacts of different native seed mixes, ways of planting seeds, and soil characteristics. She wanted to understand how these factors influenced how many shrub seeds took root in the first few years of restoration (early succession).



Intact sagebrush steppe. Photo by Anne Beeman.

Technician Skyler Meinholz helps set up a plot before data is collected. Technicians are UW and Grand Teton National Park employees who helped Beeman carry out field research. Photo by Anne Beeman.

Technicians Dillon Romero and Skyler Meinholz examine a quadrat, a frame with a standard area that helps researchers survey the distribution of plants within the larger study site. Photo by Anne Beeman.

In 2022, park managers removed smooth brome from an area and established 38 different plots, each 30 square meters in size. Some plots were tilled, and some were not. Untilled plots were seeded using a broadcast seeding method, which spreads seeds evenly over the soil and then mechanically presses them into the soil with rollers. Tilled plots used a drill seeding method, which relies on a machine that inserts each seed into the soil at the preferred depth for that plant species.

Park managers then planted two different native seed mixes. One contained a higher percentage of grass seeds, while the other had a higher percentage of forb (broad-leaved, non-woody flowering plant) seeds. In both mixes, about 10% of the seeds were shrub seeds. Each of the mixes included exactly the same grass, forb, and shrub species; only the proportion of grasses to forbs changed.

Managers didn't just seed sagebrush. They also included other shrub species—antelope bitterbrush and several kinds of rabbitbrush—in the seed mixes. Sagebrush and bitterbrush both shape the structure, resilience, and biodiversity of the sagebrush steppe. Unfortunately, both of these shrubs can be difficult to establish during restoration.

EARLY SUCCESSIONAL SUCCESS

Beeman collected data on the area different species covered in each plot, the total number of shrubs, the size of the shrubs, and the soil properties of each plot after two years of growth.

Overall, more shrubs grew in untilled plots planted with grass-dominant seed mixes than in all other treatment combinations. Plots with heavier clay content tended to contain fewer sagebrush plants, but also contained larger bitterbrush individuals. More bitterbrush plants took root in tilled plots than untilled plots. On the other hand, more sagebrush grew in untilled soils.

Beeman's research suggests that particular restoration methods were slightly more effective at some restoration objectives than others, though all of the restoration methods she assessed in the study resulted in some shrub establishment. Additionally, none of her plots had significantly more non-native or invasive plants than any of the others. These results may help park staff decide which restoration techniques to use in certain areas of the park going forward.

"This is only the beginning of the story," says Beeman. "Now we have a really good understanding of the establishment and seedling growth of these important shrubs across treatments in early succession, but it'll be really important to continue monitoring and see what happens in these plots in five, ten years." ■

To learn more, contact faculty advisor Laughlin at daniel.laughlin@uwyo.edu.

UW Life Sciences Program Trains the Next Generation of Researchers

written by **Maya Gilmore**, *University of Wyoming Extension*

Undergraduate student in the Life Sciences Program's Introduction to Ecological Research course led by Jamie Crait and Chris North explores beaver ponds in the Medicine Bow National Forest just east of campus. (UW Photo.)

From atmospheric sciences to zoology, the Life Sciences Program helps University of Wyoming undergraduates prepare for their futures.

Faculty in the Life Sciences Program teach over 2,000 UW students from more than 85 degree programs each year. The Life Sciences Program helps build a foundation in scientific concepts like cell biology, genetics, evolution, and ecology that are important to students from many fields.

"[The Life Sciences Program] often gets overlooked, but it's a huge part of student success in the biological fields," says Amy Rhoad, instructional professor in the Department of Veterinary Sciences and a teacher of several Life Sciences Program courses.

BUILDING NEW SKILLS

In addition to imparting information about scientific concepts, the Life Sciences Program teaches students critical thinking, scientific communication, ways to break down and analyze information, and research skills. Students learn how to read and write scientific papers, how to collect and interpret data, and how to formulate and test a scientific hypothesis.

"In LIFE 1010, I was introduced to the fundamentals of scientific writing, which have become incredibly valuable as I advanced in other courses, such as Animal Biology, as well as in the research lab I am part of," says Lauren Lynde, a UW sophomore majoring in microbiology. "These experiences have not only enhanced my ability to engage with scientific literature but have also provided me with the confidence and skills needed to succeed in my coursework, research, and future career."

LEARNING HOW TO LEARN

Rhoad and other Life Sciences Program course instructors keep up with research on the most effective ways to teach students about science. Current research suggests that students remember and apply information better when they come up with their own research questions, learn about scientific concepts through stories, and experience active, hands-on education.

Rhoad leads many hands-on activities in her courses. In Animal Biology, for example, she asks students to try to find an item in a dark room, and then has them try again after wearing an eyepatch. After a short period of time, the cells in the eye covered by the eyepatch become very sensitive to light. Once removed, the newly light-sensitive cells can help the person find the item more easily.

By experiencing how their eyes adapt to light directly, students better understand the phenomenon and are more likely to remember that information than if it were only provided through a lecture or text.

MENTORING NEW CODERS

In the past two years, the Life Sciences Program has also begun to integrate the coding program R into its curriculum. By mentoring students through their first coding experiences, the program gives UW undergraduates a head start on digital literacy and data analysis skills that are vital in many fields.

The Life Sciences Program also harnesses research tools to continually improve their educational approaches. For example, Rhoad plans to conduct a research study on the impact of introducing R to undergraduates. "Freshmen are usually not quite to that level where they're ready to really dive in, but the earlier we introduce it, the more they can build on those skills," says Rhoad. Ultimately, she hopes that juniors and seniors who have been exposed to R for three or four years can become more proficient and more able to use coding as a tool to answer specific research questions.

By implementing and refining new ideas like coding and hands-on education, the Life Sciences Program embodies what it strives to teach: there's always more to learn. ■

To learn more, contact Rhoad at asaville@uwyo.edu.

A high-elevation, whitebark pine-dominated forest in the southern Sierra Nevada. Photo by Joan Dudney, UC Santa Barbara.

A CENTURY OF DATA SUGGESTS WHITEBARK PINES MAY BE IN PERIL

written by **Brooke Ortel**, *University of Wyoming Extension*

Whitebark pines tend to grow slowly and live long, sometimes surviving for more than 1,000 years. Unlike most trees, they thrive in cold, windy subalpine environments.

But, despite their historic longevity, the future of these fascinating trees is uncertain. In addition to their susceptibility to scourges like white pine blister rust, whitebark pines are highly sensitive to environmental changes. As extreme weather events increase in both frequency and severity, whitebark pine populations have grown increasingly vulnerable to extinction.

According to a new study led by UW researchers, this heightened risk is partly because many different whitebark pine populations are responding to environmental changes in sync. The researchers found that as events like widespread drought have grown more common, growth patterns in whitebark pines across the Sierra Nevada range have become increasingly synchronous.

McKnight turns an increment borer to core a large foxtail pine near Tyndall Creek. Photo by Jennifer Cribbs, 2022 field crew leader.

McKnight and 2022 field crew member Alexander Markosian make the descent down Shepherd's Pass after a 9-day field campaign in Sequoia National Park. Photo by Jennifer Cribbs, 2022 field crew leader.

THE PROBLEM WITH SYNCHRONY

The new study quantified what's known as spatial synchrony, analyzing to what extent geographically distinct populations of trees responded similarly to change. In this case, the researchers focused on how tree populations responded to fluctuations in temperature and precipitation.

"Spatial synchrony arises when dynamics between these populations—for instance, growth patterns—fluctuate in unison through time," says Kaitlyn McKnight, a PhD student in the botany department who led data analysis for the study. "If you have separate populations operating in synchrony, there's the possibility that they will simultaneously collapse, whereas if they're operating asynchronously, one population might be declining, but another population might be increasing."

For example, if extreme drought conditions persisted across an entire region, tree populations growing synchronously across that region would experience concurrent declines. As such events become more common, regional populations could decline dramatically, even if some smaller, less synchronized populations managed to weather the drought conditions. These effects could be exacerbated in the future if factors like variable winter precipitation or higher summer temperatures are triggering increased growth synchrony.

"Even if populations don't all crash together, our results show they're all likely responding to the same environmental drivers," says Lauren Shoemaker, an assistant professor in UW's botany department. "That's concerning from a conservation standpoint because if they're all operating together, a drought could knock them all back at the same time. It means that local extinctions could become regional, or even occur across species."

TIME TRAVEL THROUGH TREE RINGS

Previous studies have shown that environmental conditions, including temperature and precipitation, affect spatial synchrony. Shoemaker and McKnight built upon these findings to investigate how changes in precipitation and temperature over the past century drove changes in tree growth synchrony.

To assess changes in spatial synchrony over time, they studied 20 geographically distinct populations of whitebark pines across the Sierra Nevada range. The study spanned more than a century of tree growth as well as hundreds of kilometers of mountainous terrain.

McKnight analyzed 118 years of tree-ring data collected by researchers at the University of California, Santa Barbara, and University of California, Davis, from more than 320 whitebark pines. She also obtained data on annual winter precipitation and summer temperatures from local weather stations across the study period.

Then, she crunched the numbers. Using a statistical tool known as wavelet analysis, McKnight quantified how temperature and precipitation influenced growth synchrony over time.

ANCIENT TREES, MODERN ANALYSIS

"Wavelet analysis is borrowed from physics and mathematics. It's basically a way to break down time series data—in this case, from tree

McKnight and 2022 field crew member Mackenzie Nye core and collect needles from a lodgepole pine in the Kern River Valley. Photo by Jennifer Cribbs, 2022 field crew leader.

McKnight looks at the core she just extracted from a whitebark pine on a research plot near Tyndall Creek. Photo by Jennifer Cribbs, 2022 field crew leader.

rings—so that we can look across different time scales," McKnight explains. "We're able to capture how synchronous the 20 populations are with one another across our entire time series from 1900 to 2018, at different scales of time."

Within the study period, McKnight examined 10-year, 20-year, and 30-year intervals to detect patterns that might not have been noticeable across annual periods. Ultimately, she found that synchrony in whitebark pine growth across the 20 populations has increased dramatically in recent decades.

"We found evidence of increased synchrony, particularly in the latter half of the time series, about 1950 onwards. These increases were particularly seen on decadal and multi-decadal timescales," she comments.

McKnight's results also suggested that precipitation and temperature influenced changes in tree growth synchrony—an observation that may not bode well for whitebark pines if extreme weather events and rising summer temperatures grow more common.

"The story with precipitation was really clear, where we saw increases in precipitation synchrony driving increases in growth synchrony," she notes.

The pattern with temperature wasn't quite as simple, as the researchers did not observe increases in temperature synchrony. Instead, they discovered an indirect pattern correlating increasing summer temperatures with increased precipitation synchrony. "Temperature is also driving growth synchrony, but it's doing so indirectly through its relationship to precipitation synchrony," McKnight explains.

In the face of current and predicted climatic changes, these findings aren't great news for the whitebark pine, which is already listed as endangered.

For land managers, though, studies of spatial synchrony may be useful in targeting conservation efforts. "If there's options for where you put your money, you might want to choose the population that's least synchronous with everything else since it is responding differently," Shoemaker notes. "This could indiciate differences in microclimate conditions that can buffer the response of the trees to future changes in environmental conditions."

GOING GLOBAL

Unfortunately, whitebark pines in the Sierra Nevada range probably aren't the only trees whose extinction risk may increase due to spatial synchrony. With that in mind, McKnight is extending the analysis to include 89 different tree species around the world.

With access to global datasets, she says, "we can look even further back in time, so we can study historic synchrony patterns and see how they're different from current patterns. For some of these species, you can go back a thousand years or even older." ■

To learn more, contact Shoemaker at lshoema1@uwyo.edu.

In addition to mapping all trees in the plot, the researchers also mapped all 5-needle pine seedlings. They were excited to find 900 seedlings per hectare in Paintbrush Canyon, a hopeful sign of forest resilience even as adult trees are being killed by bark beetles. Photo by Britt Hays.

Seeing Both the Forest and the Trees

UW Researchers Map the Forests of Grand Teton National Park

written by **Brooke Ortel**, *University of Wyoming Extension*

Research partners Sara Germain and Tucker Furniss aren't in danger of missing the forest for the trees—or the trees for the forest. Instead, they're interested in the connections between individual tree health and overall forest health.

Their current research project focuses on long-term monitoring and mapping of trees in Grand Teton National Park. The goal is to establish baseline metrics for forest health and demographics, which will then serve as a basis for tracking changes over time.

"There aren't a lot of forests in Wyoming, so it's important that we understand how to keep the forests that we do have healthy," says Germain, an assistant professor in UW's botany department. "By studying in depth not only what's killing them but [also] if they're recovering and how quickly, we're hoping to keep that resource available for the public."

Measuring recruitment (how many new seedlings are taking root), establishment, growth, and mortality will potentially offer clues about how the forest responds to environmental changes. Germain and Furniss will track both slow-acting processes, like tree growth, and fast-acting processes, like bark beetle outbreaks and wildfires.

Over time, their data may offer clues about how changing forest demographics correlate with environmental factors like temperature, precipitation, fungal diseases, and pest infestations.

MAPPING TREES

In addition to collecting annual demographic data, Germain and Furniss are painstakingly mapping the locations of tens of thousands of trees and individually tagging each one with a stainless steel tree tag. While time consuming, mapping each tree relative to its neighbors with a high degree of accuracy will allow the researchers to quantify processes like competition and the spread of infectious diseases.

"It's a unique approach," says Furniss, an assistant professor in the Department of Ecosystem Science and Management. "You get to know the forest, you get to know the trees."

Last summer, he, Germain, and a team of UW students mapped and tagged more than 16,000 trees in Grand Teton National Park. Their study area includes both a large, 25-hectare (nearly 62 acres) plot and several smaller 1-hectare plots. By the time they finish mapping in summer 2025, they will have tagged about 30,000 trees in the larger plot, plus approximately 2,000 trees and seedlings in each of the smaller plots.

Going forward, Furniss and Germain will visit each tagged tree annually to measure growth and mortality as well as perform tree "autopsies" and wellness checks.

So far, they have observed about 17 different species in the plots. The large plot contains mostly conifers like Douglas fir, subalpine fir, and lodgepole pine as well as hardwoods, including aspen, Rocky Mountain maple, and grey alder.

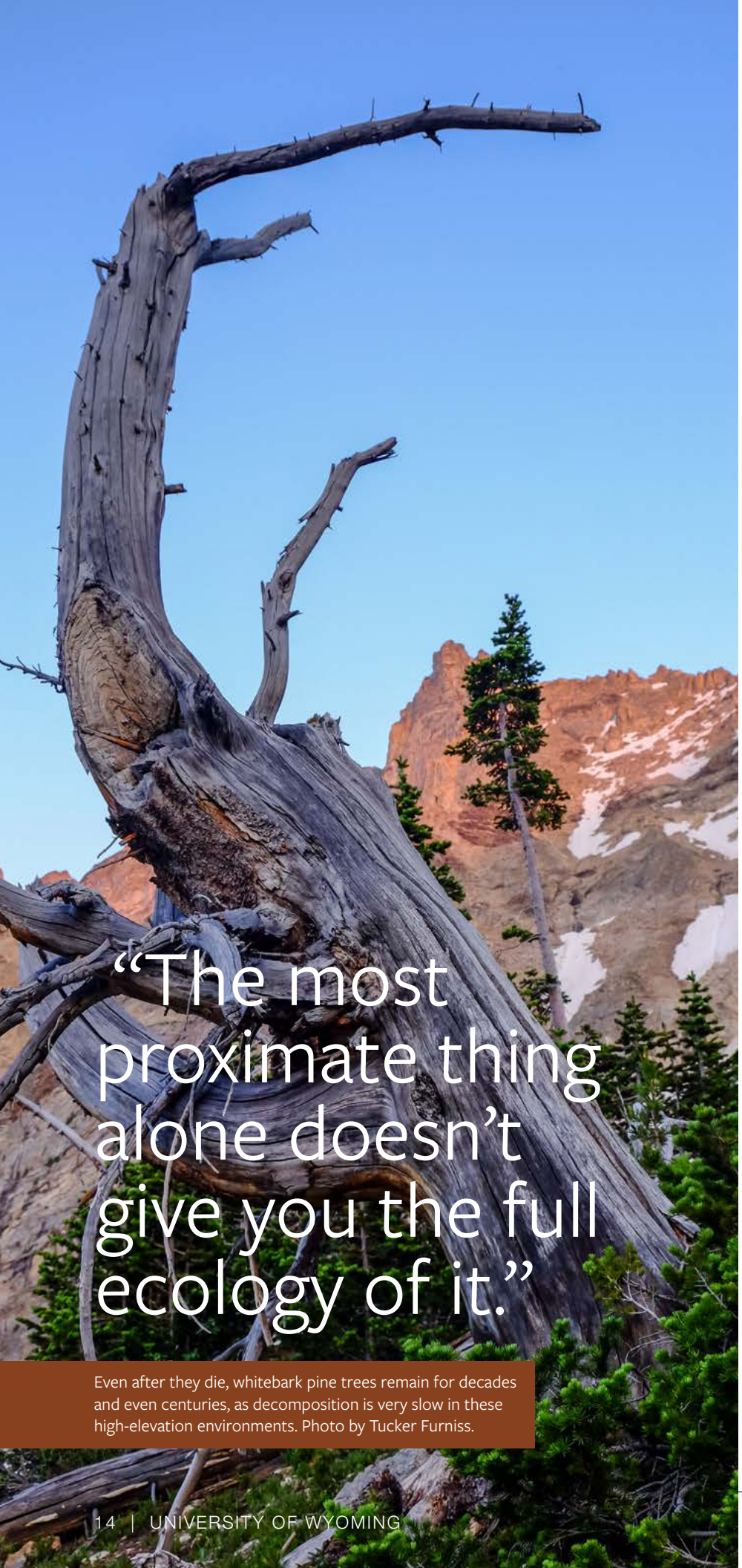
Furniss and Germain intentionally selected an older forest for their study site. "You can learn a lot from an old forest that you could also learn in a young forest, but you can't learn from a young forest about old trees," Germain explains. "By choosing an older forest, we're able to study both big trees and little trees."

The sheer size of the large study plot is unusual in forest ecology studies, Furniss notes, but provides significant advantages.

Smaller plots are less likely to include larger, older trees and typically don't provide opportunities to look at the interactions between larger

Sara Germain studies the dynamics of large trees, like this ponderosa pine, because they are the most important for carbon sequestration and produce the most seeds for regeneration after disturbance. Photo by Tucker Furniss.

Tucker Furniss teaches graduate students how to use the high-accuracy Trimble GPS unit to map the plot's grid corners. Photo by Sara Germain.



Even after they die, whitebark pine trees remain for decades and even centuries, as decomposition is very slow in these high-elevation environments. Photo by Tucker Furniss.

trees. “You need a big plot to study big trees,” Germain comments. “We’re really interested in understanding the dynamics of these large trees because they are the most important for things like carbon sequestration and producing seeds for continued forest regeneration, and also for wildlife.”

SCALING UP, SCALING DOWN

While Germain and Furniss work side by side, collecting data as a team, they each have their own set of research questions.

Germain’s approach focuses on the growth and health of individual trees, as well as their relationships to one another. “The direction I tend to go in my own individual work is to try to understand the individual traits of these trees using dendroecological methods,” she says. “I’m taking tree cores, I’m looking at tree rings, I’m looking at this fine physiological scale to figure out why some trees die and others survive.”

While Germain zeroes in on individual trees, Furniss zooms out to apply the data at a landscape scale. In his field, vegetation structure and dynamics are often studied using remote sensing techniques. But, he says, without on-the-ground data to complement satellite imagery, it’s difficult to create accurate landscape-scale models. “Knowing exactly what’s happening on the ground, we can use all the field-based data to calibrate remote sensing and then scale that understanding to bigger landscapes,” he explains.

Furniss also works with process-based models, which allow scientists to predict future landscape-scale changes. These tools incorporate ecological variables like tree growth, mortality, competition, disease, and wildfire. The measurements Furniss and Germain record in the field can be used to calibrate existing models and generate better predictions.

FOREST FORENSICS

In their annual surveys, Germain and Furniss will perform wellness checks on each of the thousands of tagged trees in their study plots. They’ll note whether a tree is under attack from bark beetles, whether it’s fighting a fungal infection—and whether it’s still alive.

When they encounter a dead tree, Germain and Furniss will conduct a comprehensive pathology exam and extract a tree core to help determine what caused its death. These fine-toothed “autopsies,” which rely on both long-term field observations and lab analysis, allow the researchers to reconstruct the arc of an individual tree’s story.

“There might be something that weakens the tree, something that weakens it further, and then something that kills it. We try to disentangle that story. The most proximate

PhD student Jared Friedman extracts a tree core from a dead whitebark pine for later dendroanatomical analysis. Photo courtesy of Jared Friedman.

Graduate students and field technicians pose in front of the Tetons on their hike to the plot for another day of plot installation. Photo by Tucker Furniss.

thing alone doesn't give you the full ecology of it," Furniss says.

Ultimately, piecing together these individual stories can help researchers better understand the forest as a whole.

GLOBAL COMPARISONS

While Furniss and Germain's research focuses on Wyoming forests, their work is also part of a larger global effort to track and compare forest health across much larger spatial and temporal scales.

Their 25-hectare plot in Grand Teton National Park is one of 79 sites in the Smithsonian's international ForestGEO (Forest Global Earth Observatory) network. It's the first ForestGEO site in the Rocky Mountain region and is one of only six ForestGEO sites in the western U.S.

The ForestGEO network currently includes 29 countries, 12,000 tree species, and a total of approximately 7 million trees. Scientists at all sites follow the same research collection protocols and parameters, making the data readily comparable.

"It helps us do research that is both very targeted and place based, and also because it's part of a network that shares protocols, we can do collaborations at regional and global scales," says Furniss.

PARTNERING WITH PARK MANAGERS

In a collaboration closer to home, Germain and Furniss are working with park managers to test the effectiveness of different forest management strategies.

For example, one of their smaller study plots includes a stand of whitebark pines currently undergoing natural regeneration. In other areas of the park, park managers have planted whitebark pine seedlings started in greenhouses. Comparing the two methods may provide new insight into what management methods might work best in different situations.

"We're able to do things that are directly relevant to people managing [the forest] and to the public. It's a cool opportunity to be able to do science and still feel rooted in things that are useful and actually helping the forests," Germain comments. ■

To learn more, contact Germain at sgermain@uwyo.edu or Furniss at tucker.furniss@uwyo.edu.

Donna Harris walks the dry bean plots at the Powell R&E Center and takes notes. This image was taken by a drone programmed by her lab group.

Drones Drive Wyoming Crop Research

Accelerating the development of high-performing dry beans and soybeans

written by **Brooke Ortel**, *University of Wyoming Extension*

You've probably seen or heard of people using drones for tasks ranging from aerial photography and film production to firefighting and search-and-rescue missions. Maybe you've even flown one yourself.

In the hands of UW researchers, unmanned aerial vehicles (UAVs) are also advancing plant-breeding experiments. Led by Donna Harris, assistant professor of plant breeding and genetics in the Department of Plant Sciences, a team of scientists is using drones to help speed the development of soybean and dry bean varieties.

For soybeans, the team is working to develop UAV-based methods to assess drought tolerance. In dry beans, they are examining whether canopy temperature can be used as a fast method to predict the potential yield of different varieties prior to harvest.

DATA COLLECTION WITH DRONES

Currently, Harris's team employs two types of drones: a thermal sensor drone that records the temperatures of plant canopies and a multispectral drone that can detect subtle discolorations in the plants that might not be visible to the human eye.

The multispectral drone allows researchers to assess vegetation indices, which quantify plant health and growth. Normalized difference vegetation index (NDVI) values, for example, allow researchers to

evaluate vegetation health (greenness) and density by measuring the difference between near-infrared and red light. NDVI and other vegetation indices can help predict whether a particular variety will tolerate drought conditions.

The thermal drone detects infrared radiation and captures thermal images showing temperature variation among plants. “With that drone, we are able to fly over all our research plots and acquire temperature readings on a plot-by-plot basis,” explains Price Akiina, a PhD student in Harris’s lab. “It gives us an idea of the variation in canopy temperature across plots.”

Harris’s team still uses handheld instruments to check these parameters as well, but they’ve found it’s much faster and more accurate to use the drones—especially when the experiment involves more than 600 plots of soybean plants.

CANOPY TEMPERATURE AND YIELD

Harris’s lab group first used drones to study temperature and yield in dry beans. Previous research on other crops had identified a negative correlation between the plants’ canopy temperature and yield. Higher canopy temperatures were associated with lower yield and lower canopy temperatures were associated with higher yield.

In a study funded by the Wyoming Bean Commission, Harris and her colleagues set out to determine if this correlation held true for dry beans. “Is there a way we can predict yield without having to go into the field and combine every plot?” she wondered. “Can we go in and look at varieties we haven’t tested before and be able to predict yield based purely off canopy temperature?”

Starting in 2022, Harris’s team collected three seasons of field data at UW’s research and extension centers in Sheridan and Powell. Over the past three years, they’ve examined canopy temperature and yield in 17 varieties of dry beans with different maturity rates.

So far, their results suggest that yes, canopy temperature and yield are correlated in commercial dry bean varieties currently on the market. Across all the varieties, the correlation between canopy temperature and yield has been as high as 84%, though the strength of correlation has varied based on the year and location.

The team’s results suggest that plant breeders may be able to use canopy temperature to determine which varieties should advance to the next year of yield testing. If only the varieties with the highest yield were selected and harvested, time and cost—the two biggest challenges in a breeding program—could be significantly reduced.

However, Harris cautions, more research is needed to determine the optimal timing for data collection and whether adding vegetation indices could improve the model.

SLOW-WILTING SOYBEANS

While Harris gathered dry bean data in Wyoming, a fellow plant breeder was investigating soybean varieties in Georgia.

Zenglu Li, a professor of soybean breeding and genetics at the University of Georgia, has been studying promising soybean lines with a desirable slow-wilting trait. “That means that in the field, when all the normal soybean varieties are wilting from lack of water, this particular

Multispectral drone flies overhead at the Powell R&E Center’s field day in 2024. Photo by Jeremy Cain.

PhD student Price Akiina starts to fly the drone over dry bean plots at the Sheridan R&E Center. Photo by Donna Harris.

variety will not wilt," Harris explains. "It can withstand a lot of drought conditions before it will begin to wilt."

But Li had a problem: it was difficult to properly simulate drought conditions in Georgia's humid climate. Fortunately, Harris was happy to help, setting up a study site at the Sheridan R&E Center's Wyarno Farm, a dryland farm with no irrigation.

Initially, Li asked the UW team to collect canopy-wilting data. Typically, this kind of analysis requires visiting individual field plots and estimating the percentage of plants wilted, with zero denoting no visible wilting and 100% indicating all of the plants wilted completely.

Considering her lab's recent success with using drones for data collection, Harris wondered if it might be more efficient—and potentially more accurate—to employ drones for this type of work.

In partnership with UGA, Harris's team piloted a new method for gathering canopy-wilting data. They also discovered a positive correlation between canopy temperature and canopy wilting, suggesting that canopy temperature could potentially act as a proxy for canopy wilting.

Going forward, using temperature as a proxy for wilting will allow researchers to more efficiently eliminate varieties that perform worst in drought conditions and concentrate their efforts on the most promising lines.

Images from the drones were also run through a machine learning (ML) model. Sixty-six percent of the time, the model accurately predicted canopy wilting scores using images collected by the drones. These estimates will continue to become more accurate as the researchers add data to the ML model, Harris notes.

"It's going to be huge for plant breeders," she says. "We can use a combination of plot images from the drone, as well as multispectral and canopy temperature data, to determine how drought resistant a particular variety might be."

THE GENETICS OF DROUGHT TOLERANCE

Li's lab had already identified regions of the soybean genome that may contain genes related to the coveted slow canopy-wilting trait. The

The fast-wilting soybean parent, pictured at left, succumbs to drought more quickly than its slow-wilting counterpart, pictured at right. Photos by Donna Harris.

next step is to look at specific proteins and genes in these regions to understand the underlying mechanisms.

"The slow canopy-wilting line may not necessarily be a very appealing line for a farmer to grow," Harris explains. "It's probably not your highest-yielding line, and it's definitely not going to fit every maturity group that farmers grow across the U.S. Our main goal is to find those genes that are involved and then quickly move those genes through cross-pollination into high-yielding varieties for farmers."

UW PhD student Clement Nyam is leading the investigation at a molecular level. His project involves exposing slow and fast canopy-wilting soybeans to drought conditions and identifying genetic differences in how they respond to stress. To figure out which genes are involved in drought response, he'll take RNA samples at different time points in the canopy-wilting process, comparing changes in gene activities in the slow canopy-wilting variety versus the fast canopy-wilting variety. Ultimately, observing differences in how the two varieties respond will help him identify which genes influence the wilting rate.

One step "downstream" from the RNA level, postdoctoral researcher Ilyas Ahmad will apply similar research methods to identify proteins regulating the slow canopy-wilting trait. Observing differences in protein abundance as the slow and fast canopy-wilting lines undergo stress testing will allow him to determine which proteins might be associated with the slow canopy-wilting trait.

Better understanding both the genes and proteins associated with slow canopy wilting will ultimately allow the researchers to develop new varieties of drought-tolerant soybeans.

Much remains to be discovered, but heading into the 2025 field season, one thing is certain: drones will play a key role in the plant breeders' success. ■

To learn more, contact Harris at donna.harris@uwyo.edu.

Note the plant diversity in this grazed natural grassland. Photo by Chandan Shilpakar.

Managed Grazing May Be the Key to Improving Soil Health at Reclaimed Mining Sites

written by **Brooke Ortel**, *University of Wyoming Extension*

Todd Heward's family has been ranching in Shirley Basin, Wyoming, for more than a century. "We've watched success, and we've watched failure," he says. "You learn that way."

For decades, Heward has grazed cattle near and on reclaimed uranium mine sites, observing changes in the landscape over time. He's seen mining sites reclaimed in the '80s planted with monocultures of crested wheatgrass. He's seen other reclaimed sites deteriorate to bare ground over the decades. In more recent years, he's seen newly retired mine lands planted with a mix of grasses, forbs, legumes, and sometimes shrubs.

And, under his conscientious management, Heward has seen former mining sites slowly return to grasslands with healthy soil and diverse plant communities. The key to successful reclamation, it turns out, may be carefully managed rotational grazing.

COLLABORATIVE STEWARDSHIP

In addition to grazing cattle on his own property, Heward leases reclaimed mine lands from Ur-Energy, an active mining company, and the U.S. Department of Energy.

In 2014, the Department of Energy's Office of Legacy Management (DOE-LM) recruited UW researchers to help assess soil and plant health at the reclaimed mining sites. The project brought together agency staff, soil scientists, ecologists, and local ranchers.

"Our project explores how carefully managed cattle grazing and fostering robust grass growth can enhance soil health, increase biodiversity, and support sustainable agriculture on these post-mining landscapes," explains Chandan Shilpakar, who joined the project in 2021 as a PhD student in UW's plant sciences program. "Our primary goal was to understand grazing as a tool that can help improve ecosystems in these reclaimed mine lands."

Throughout the project, he worked closely with Heward, who designed and implemented the grazing system used in several study sites. Heward, it turns out, had been fine-tuning grazing practices in the area for years and was happy to lend his expertise (and livestock) to the study.

"What I feel proud about is that everyone owns it," Shilpakar comments. "The mining industry is serious about their job. Todd has been taking care of [the land]. The Department of Energy is very sensitive about what is happening in the study area...It's not just me going in the field and deciding what can be done."

MEASURING SUCCESS

Shilpakar monitored chemical, physical, and biological indicators of soil health at five sites, three of which were on reclaimed mine land. Two natural grassland plots on Heward's property served as control sites. In total, Heward estimates, the project represents nearly 10,000 acres of reclaimed mine lands.

Across the former mining sites, reclamation efforts began at different times, some in the 1980s and others as recently as 2010. Grazing also began at different times, starting as early as 2007 or as recently as 2021. While it added a layer of complexity, the staggered timing provided valuable comparisons in studying ecological succession over time.

Initially, the researchers recorded the types and number of different plants growing at the sites. In 2021, when Shilpakar joined the project, the study expanded to include forage productivity and soil heath. In addition to tracking plant growth, Shilpakar's group assessed soil bulk density, which serves as an indicator of soil compaction, and soil texture. They limited the investigation to the top 30–45 centimeters of soil to avoid potential exposure to radioactivity.

Shilpakar, Heward, and their collaborators also assessed soil nutrient content, measuring levels of nitrogen, phosphorous, and carbon. As they examined nutrient cycling in the post-mining sites, they found that the sites with a wider variety of plant species also tended to have higher carbon content.

"We were trying to determine, does a small diverse [plant] community sequester more carbon," Heward explains. "We learned that the more diverse the plant community and the better your plant health is, the better your carbon sequestration is."

Finally, the researchers examined the soil's biological health. In other words, how were the microbes in the soil doing? Were there enough microbes to ensure carbon and nutrient cycling processes were carried out?

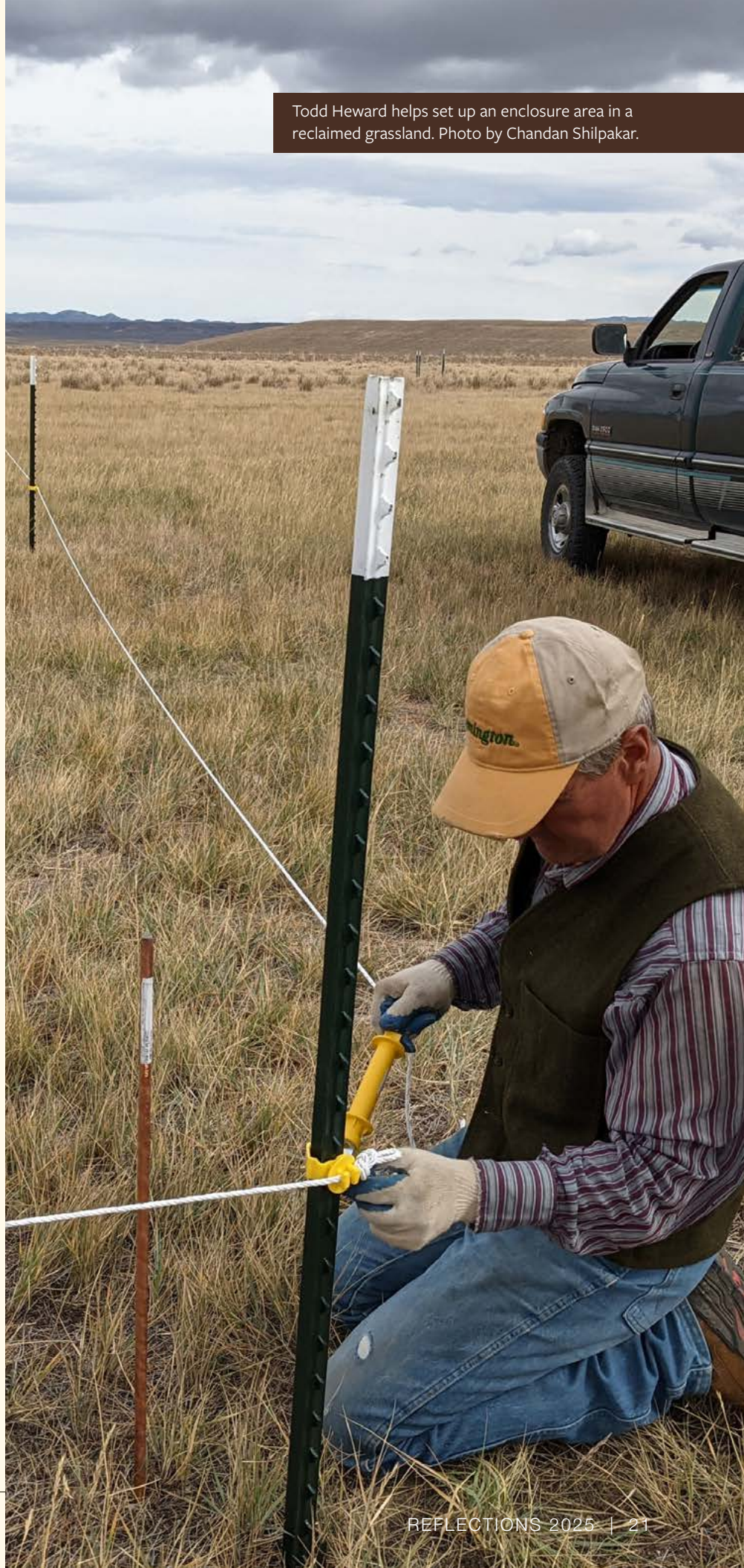
Encouragingly, the soil microbes appeared to be thriving in the grazed areas. Along with higher soil carbon levels, the grazed areas had larger populations of soil microbes, indicating that livestock manure had likely boosted nutrient cycling processes.

BENEFITS OF MANAGED GRAZING

"One of the most encouraging outcomes has been the improvement of soil health under a long-term rotational grazing system," says Shilpakar. "Our observations indicate that integrating livestock at low intensities has increased the organic matter in the soil without damaging the existing vegetation."

That's potentially good news for both reclamation agencies and ranchers. If properly managed grazing doesn't interfere with—and can even amplify—reclamation efforts, former mine lands could help support local livestock production.

"The native grassland that had not been grazed for 50 years was poor as far as forage quality and productivity and things of that



Todd Heward helps set up an enclosure area in a reclaimed grassland. Photo by Chandan Shilpakar.

Cattle graze reclaimed grassland in the study area. Photo by Todd Heward.

“The longer the study, the longer the time we’re on the land, the more we learn.”

Todd Heward | Wyoming Rancher

nature compared to the stuff we have grazed for a hundred years,” Heward notes.

But it’s important to remember that grazing is a double-edged sword, he and Shilpakar caution. Without Heward’s careful management, the study areas could have easily been overgrazed, with potentially disastrous consequences for soil health. “You have to manage it for it to be effective,” he explains.

Heward’s grazing management strategies revolve around three key principles: time, timing, and rest. He’s found that the best results occur when grazing intensity, duration, and season of use are rotated between different areas. For instance, he might allow high-intensity grazing for a short time in one area, followed by an 18-month rest period. In another location, he might implement a longer, less intense grazing period and a shorter recovery time.

In a reclaimed area that he began grazing in 2007, Heward remembers observing only a few plant species across the whole area—the majority was filled with crested wheatgrass. Today, plant diversity is slowly increasing in the grazed areas. In some cases, areas once planted with monocultures now boast up to nine different grass species.

In the natural areas unexposed to mining, Shilpakar’s team has documented about 60 plant species, 18 of which are quite common. Ultimately, that level of diversity is the goal for the reclaimed plots, Heward says.

Over time, he has observed some native grasses returning to the grazed reclamation sites without even being replanted. He says that’s the fun part for him—seeing natives like prairie June grass, Indian ricegrass, and needle and thread returning to the area on their own.

“Reclamation is a huge part of Wyoming,” he says. “I think people watch projects like this and the success that comes and try to use that in their own operations...It’s beneficial for us that that ground and those [plant] communities be as healthy as possible. We don’t want them to fall apart.”

The second phase of the project launched in 2025 and will continue into 2026, providing two additional years of data collection—but it won’t necessarily end there. “The longer the study, the longer the time we’re on the land, the more we learn,” Heward comments.

Either way, he’ll continue his life’s work of tending to land and livestock. “I love to watch [ecological] succession. I love to watch livestock at work,” he says. ■

Shilpakar is now an assistant professor of forage science at Lincoln University in Missouri. To learn more about ongoing work on the mine land reclamation project, contact him at shilpakarC@lincolnu.edu.

From Diagnostics to Research, Wyoming State Vet Lab Safeguards Human and Animal Health

written by **Brooke Ortel**, *University of Wyoming Extension*

The state of Wyoming may not have a veterinary school—but it does have a veterinary lab. This unique facility serves as a hub for veterinary diagnostics, training, and research.

While some Wyoming residents might not realize it, the Wyoming State Veterinary Laboratory (WSVL) plays a key role in safeguarding human and animal health, both on an individual basis and statewide.

SERVICE TO THE STATE

The lab's primary mission is to provide timely, accurate, accessible, and affordable diagnostics to Wyoming residents and veterinarians. "We offer a service that is designed to help the public," says Alexandra Brower, WSVL director. "WSVL has been providing animal diagnostics for the state of Wyoming for nearly 80 years. This long history has created deep connections with many animal producers and veterinarians."

Every year, WSVL staff perform diagnostic tests on more than 100,000 animal tissue samples, from small bits of tissue to stomach contents and even whole bodies. Many of the animal diseases diagnosed at the vet lab—including brucellosis, plague, Q-fever, tularemia, anthrax, and highly pathogenic avian influence (HPAI)—are zoonotic, meaning they can spread to humans.

While most diagnostic tests come with a fee, the WSVL provides rabies testing of animal tissue samples free of charge. The lab also processes more than 165,000 blood samples annually, largely for federally regulated diseases like brucellosis and equine infectious anemia.

Most samples are sent in by veterinarians, though the WSVL also works directly with Wyoming producers. In 2024, for example, the lab worked with private veterinarians to diagnose the first confirmed anthrax cases in Wyoming cattle since the 1970s. As a result, the outbreak was successfully contained.

During the COVID-19 pandemic, WSVL staff tested thousands of human samples in the lab's biocontainment facility—not a typical role for a university-affiliated veterinary laboratory.

The decision was both unconventional and indicative of the lab's commitment to serving Wyoming communities. "Taking on that role, as well as being responsible for all the rabies testing in the state, is unusual and above and beyond for a veterinary lab," Brower comments.

LOCAL, STATE, AND FEDERAL NETWORKS

In February 2025, staff at the Wyoming State Veterinary Laboratory diagnosed HPAI in chickens that were linked to the state's first human case of HPAI.

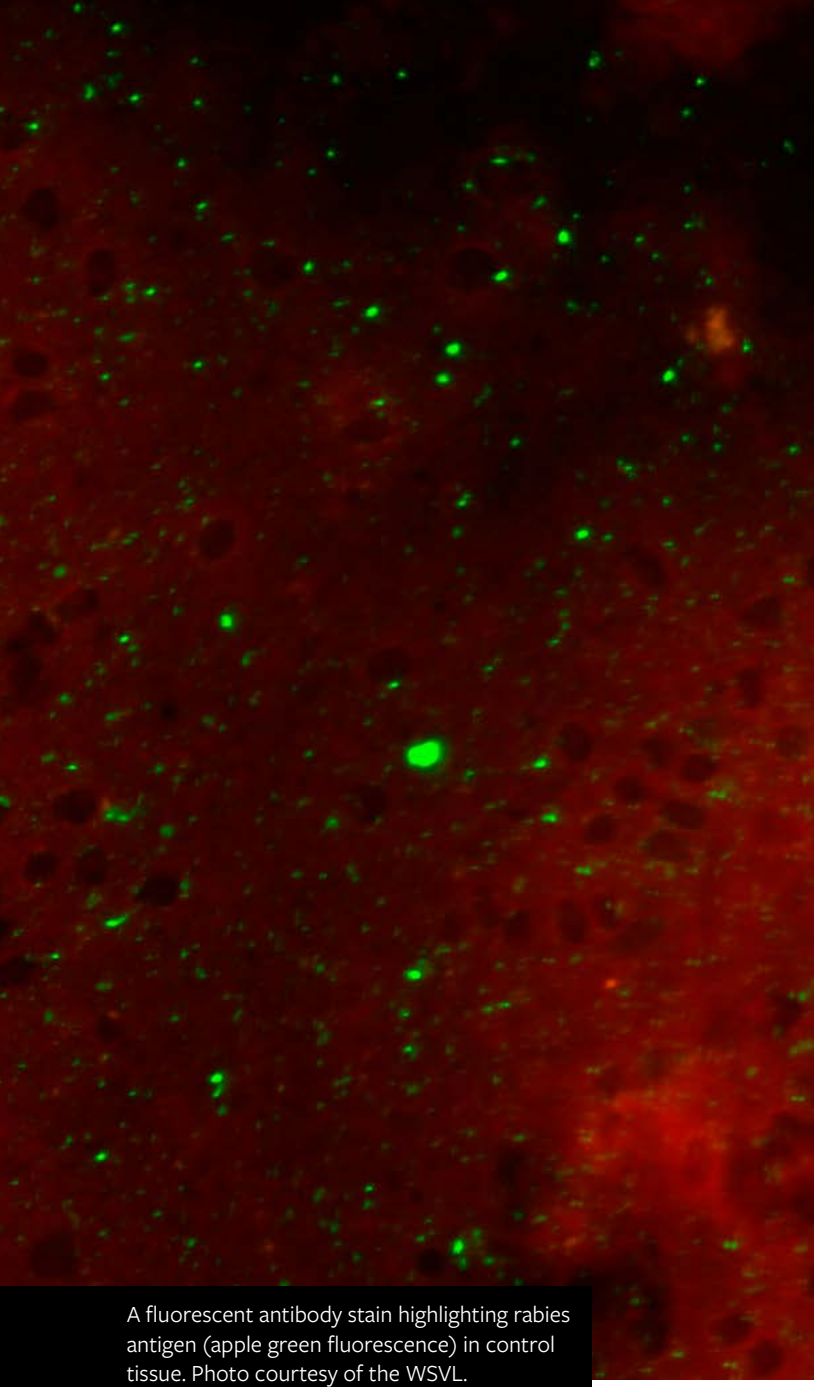
While most confirmed cases in humans have been mild, prompt diagnoses of zoonotic diseases can help public health officials respond more effectively to potential outbreaks.

In these situations, the WSVL provides critical diagnostic testing and interfaces with federal and state agencies to help ensure public safety.

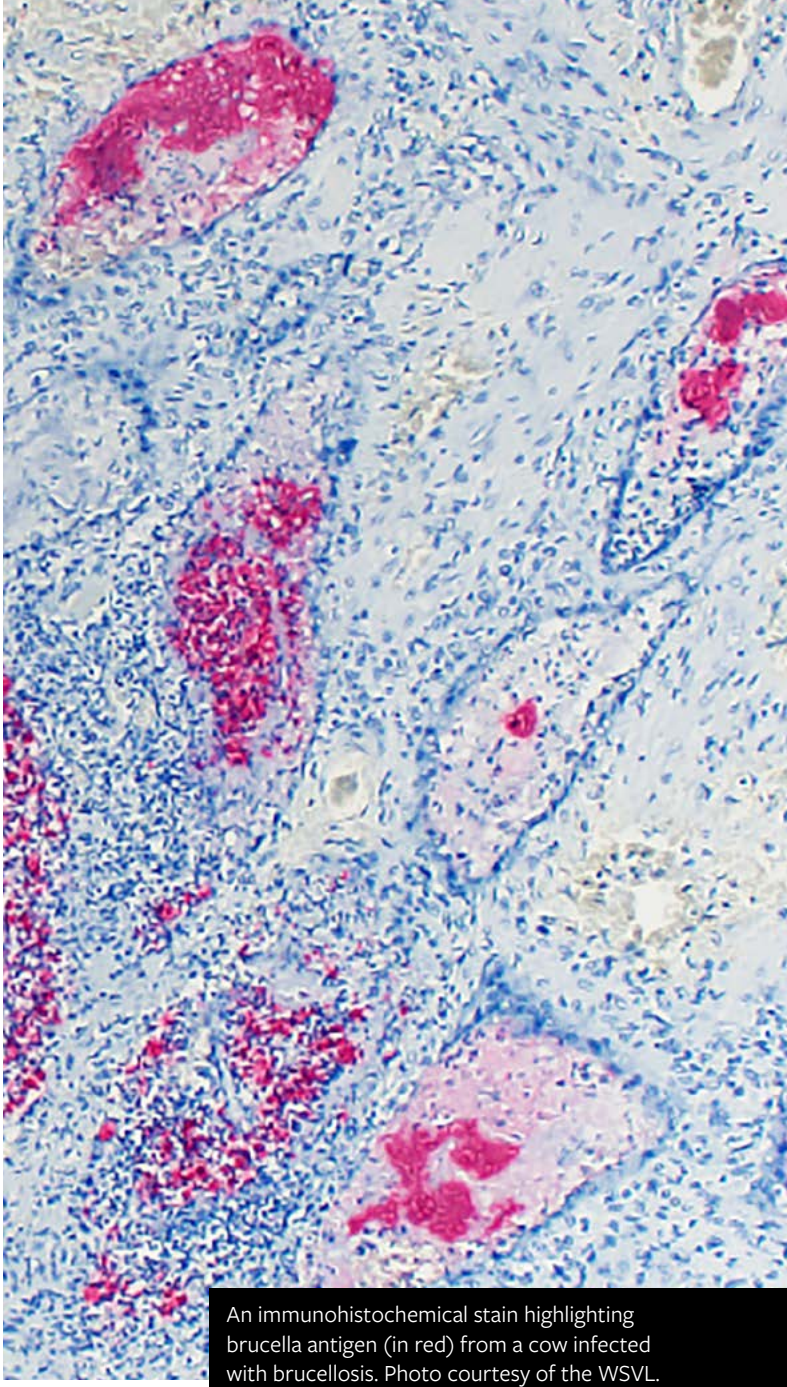
"Because suspicion is not a diagnosis, sample testing must be conducted before planning and responses to animal illness can take place," Brower explains. "Reaching a diagnosis is the necessary step that allows practitioners to treat patients, and public health and regulatory entities to take actions that control human and animal disease."

In order to efficiently diagnose and respond to disease outbreaks, the WSVL works closely with both private veterinarians and state entities such as the Wyoming Livestock Board, Wyoming State Veterinarian's office,

Brian Dominguez of the WSVL's sequencing and bioinformatics unit holds a reusable flow cell used to perform maintenance on DNA sequencing equipment. Photo by David Keto.



A fluorescent antibody stain highlighting rabies antigen (apple green fluorescence) in control tissue. Photo courtesy of the WSVL.



An immunohistochemical stain highlighting brucella antigen (in red) from a cow infected with brucellosis. Photo courtesy of the WSVL.

the Wyoming Department of Health, and the Wyoming Game and Fish Department.

In addition to state agencies, the WSVL regularly interfaces with federal entities, including the USDA, CDC, and National Veterinary Services Laboratories (NVSL).

After WSVL staff receive and test a sample, they share the results with the submitter, often a veterinarian. In cases like HPAI, where the test results may have a wider impact on human and/or animal health, samples are also sent to NVSL to confirm the diagnosis, then reported to the appropriate regulatory agencies.

As part of its engagement on the federal level, the WSVL is a member of the National Animal Health Laboratory Network (NAHLN), an organization formed after 9/11 to respond to biosecurity threats. Each year, members of the diagnostics team are required to complete proficiency testing, ensuring they are prepared to diagnose diseases regulated by the network.

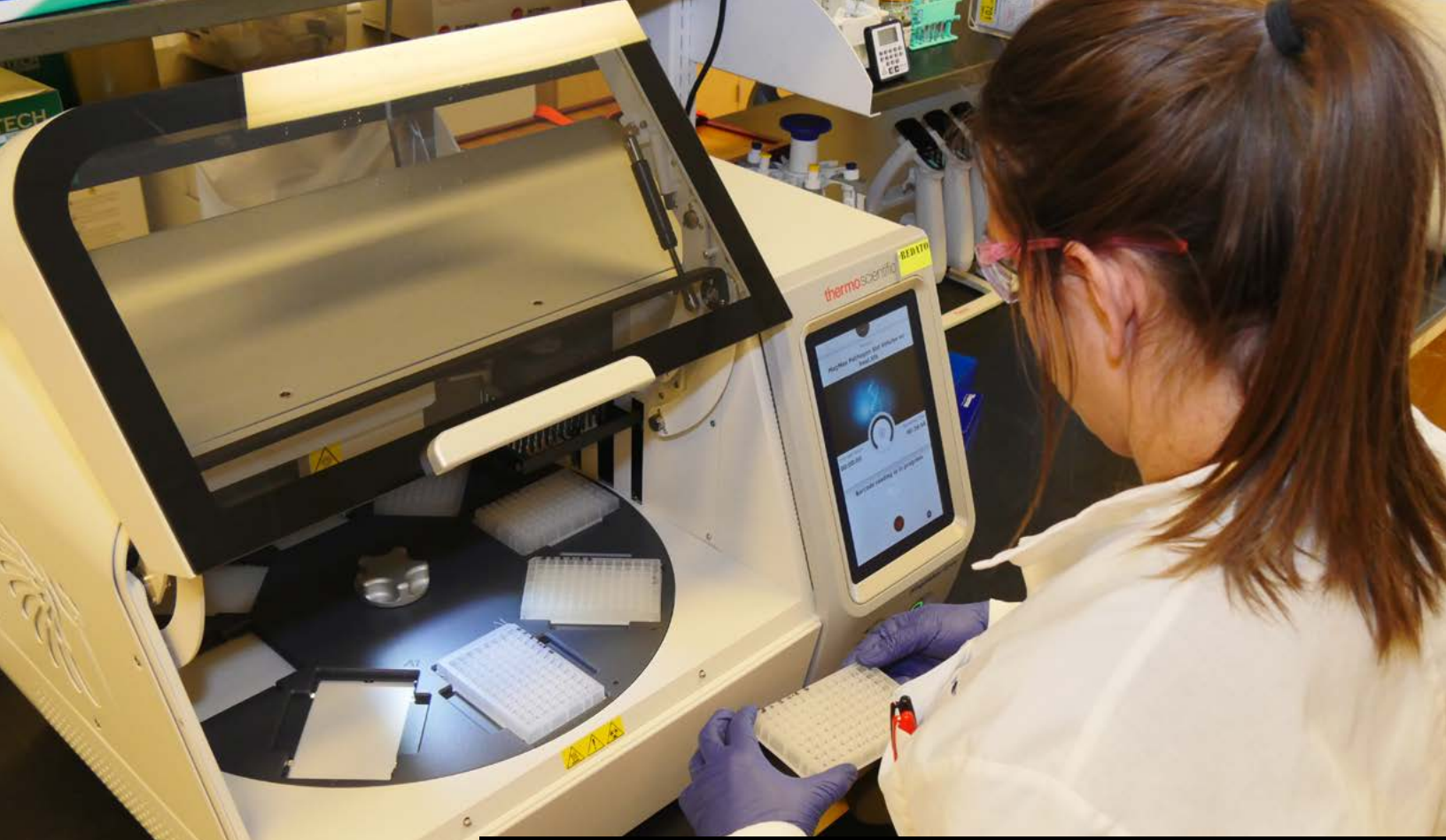
ADVANCED BIOSECURITY FACILITIES

To maximize safety and minimize exposure to highly infectious pathogens, the WSVL boasts a highly secure biocontainment facility known as a Biosafety Level-3 (BSL-3) lab. Across the country, only a few facilities of this type exist in university-affiliated diagnostic labs.

The BSL-3 facility allows faculty and technicians to safely study and diagnose infectious diseases. In particular, BSL-3 labs are approved for study and diagnosis of select agents, or federally regulated microbes. To prevent the spread of these diseases, security and procedures in the facility are regulated by the CDC and FBI.

At the WSVL, the BSL-3 is used for diagnoses, necropsies, and vaccination research related to diseases like HPAI and brucellosis. In this highly secure environment, WSVL staff also run diagnostics for potential cases of Q-fever, plague, tularemia, anthrax, and other infectious diseases transmitted by wild and domestic animals. In 2021, COVID-19 testing was conducted in the facility.

"The Wyoming State Veterinary Laboratory is unique in that it gives us the option to use



Equipment used to process samples in the virology lab is loaded and prepped. Photo by David Keto.

enhanced biosafety to do our work, mitigating the risk of human exposure while allowing us to work on important disease outbreaks," Brower comments.

Enhanced biosafety facilities provide an opportunity not only to diagnose diseases like HPAI, but also to conduct follow-up research. These investigations can help scientists better understand disease transmission and pathogenesis, and even develop vaccines.

"The BSL-3 labs at WSVL provide the ideal environment to explore these questions following high biosafety and biosecurity standards," Brower notes. "Our lab's ability to study these infectious agents in such a setting is not only critical for understanding how a virus like HPAI behaves but also for developing more effective prevention and control strategies to protect both human and animal health."

TRAINING THE NEXT GENERATION

Most faculty in UW's vet sciences department are stationed at the WSVL, serving as instructors and mentors as well as researchers and diagnosticians.

For students interested in pursuing a career in veterinary sciences, animal production, or animal health regulation, the WSVL provides key training opportunities. Many of the students who work in the lab go on to serve Wyoming communities.

When Brower toured veterinary practices across the state in 2024, she was amazed to find that in most clinics, at least one staff member had received diagnostic training at the WSVL.

"Whether it was veterinary technicians or people who had gone off and gotten their degrees and come back as vets or other staff members, there were people all over the state that had been UW students and had worked in our lab," she says. "They all had very positive memories about individuals they worked with in the lab, research that they had done, things that they had learned."

COMMUNITY CONNECTIONS

In addition to providing students with training opportunities, the WSVL maintains close relationships with stakeholders across the state.

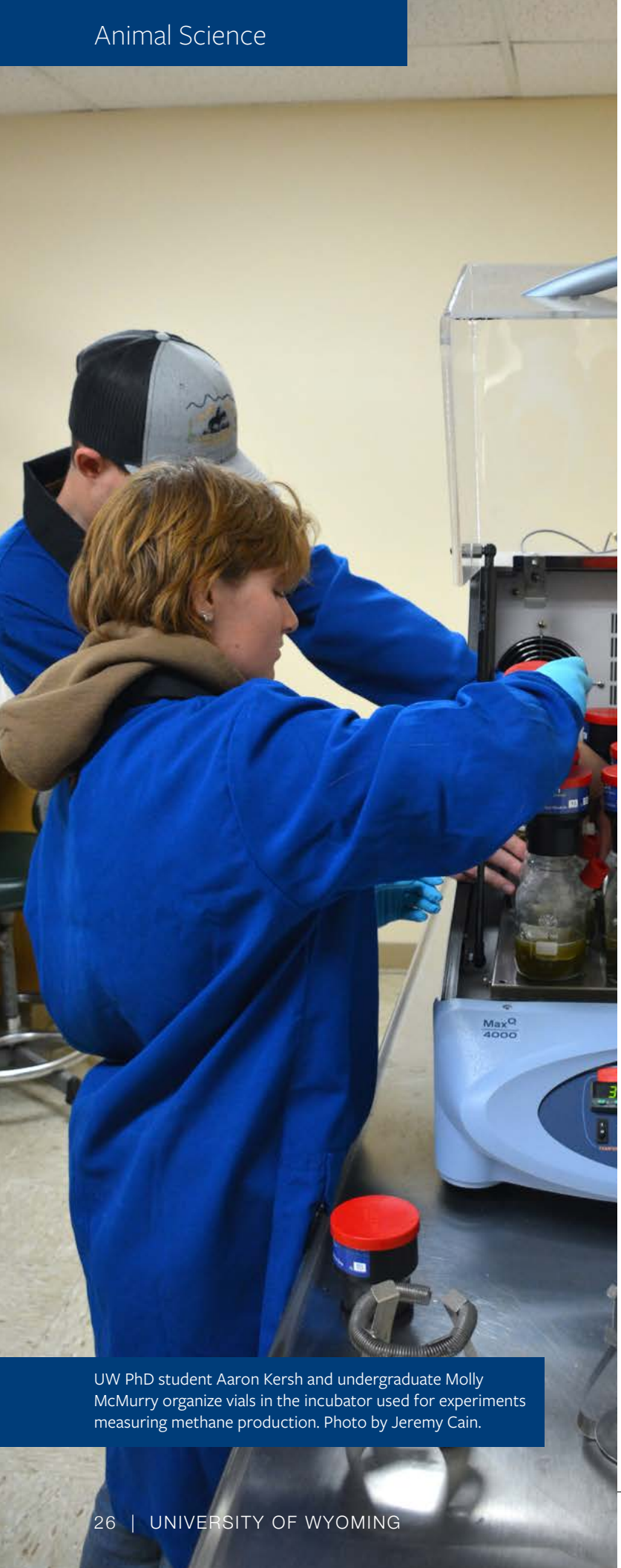
"The relationships the laboratory has with the state's animal health community increase the likelihood that individuals will reach out with questions related to animal disease diagnostics and will submit samples for testing," Brower notes. "Identification of animal disease outbreaks, including the current HPAI outbreak, have occurred because of WSVL's strong community connection."

The vet lab also facilitates learning opportunities for Wyoming residents. WSVL faculty and staff provide continuing education for veterinarians at the Wyoming Veterinary Medical Association's annual meetings, engage with youth at university-sponsored STEM events, and attend producer meetings like the Wyoming Stock Growers Convention. Currently, the WSVL is developing a continuing education seminar and wet lab for producers and veterinarians interested in learning more about emerging issues, such as Johne's disease.

"We want to communicate with and learn from our vets and our producers about current strategies for testing, for diagnosis, and for treating animal diseases," Brower says. "There are more complex diseases that require a collaborative approach, so it's important to ensure the communication infrastructure is set up to best manage them. In many cases you can't just treat them with antibiotics and have them go away."

Going forward, Brower hopes to expand outreach efforts to better serve Wyoming veterinarians and producers. She encourages Wyomingites to reach out and inquire about the vet lab's services. ■

To learn more about the Wyoming State Veterinary Laboratory, visit www.uwyo.edu/wyovet or call (307) 766-9925.



UW PhD student Aaron Kersh and undergraduate Molly McMurry organize vials in the incubator used for experiments measuring methane production. Photo by Jeremy Cain.

Invasive Scourges like Cheatgrass Unlikely to Compromise Forage Nutrition

written by **Brooke Ortel**, *University of Wyoming Extension*

As many Wyoming residents have experienced firsthand, invasive plants like cheatgrass increase wildfire risk and compete with native species for water and nutrients. In some cases, they can also be toxic to grazing animals.

While these scourges pose serious threats to agricultural operations, a new study[1] by UW scientists may provide some reassurance for Wyoming sheep producers. Nutritionally, the researchers found, eating a higher proportion of at least some of these plants is unlikely to hinder livestock performance. The sheep rumen, it turns out, is quite resilient.

Previous research indicates that the High Plains region is likely to experience warmer temperatures and higher atmospheric carbon dioxide concentrations in the future. Unfortunately, studies also suggest that invasive species like cheatgrass and Dalmatian toadflax will thrive under such conditions.

Paulo De Mello Tavares Lima, an assistant professor in the UW Department of Animal Science, noticed a gap in the literature: how might the expansion of invasive plant populations affect livestock nutrition and performance?

"Why not evaluate the nutritional value?" he wondered. "Maybe ruminants can thrive even in the high presence of these forages."

DETERMINING DIGESTIBILITY

Lima's research focuses primarily on precision livestock management, but he also studies ruminant nutrition and methane emissions. His goal is to support domestic ruminant production, especially of sheep, in Wyoming and worldwide.

Lima's latest research[2] suggests that sheep performance will likely not suffer even if they consume a higher proportion of cheatgrass and Dalmatian toadflax. Furthermore, consumption of these forages may not result in higher methane emissions than consumption of native species—a potential boon for both animal productivity and the environment.

Starting in December 2024, Lima ran multiple trials "in vitro," simulating a sheep's digestive process by combining rumen fluid

1 This project was inspired by discussions between Lima's lab group at UW, Huw Jones of Aberystwyth University in Wales, and John Pickett of Cardiff University in Wales. Through a collaborative grant between UW and Cardiff University, Lima's lab will continue to partner with Cardiff University in the next stages of research.

2 This work is supported by the Hatch Act of 1887 (Multistate Research Fund), project award no. 1025808, from the USDA's National Institute of Food and Agriculture.

and dried forage samples in an anerobic environment. Through these lab experiments, he analyzed the gas production, digestibility, and nutrient content associated with each forage type.

"For most parameters, the invasive forages are comparable to the native grasses," Lima found. His results indicate that cheatgrass and Dalmatian toadflax are just as digestible as native forages like Western wheatgrass, suggesting they may be a viable forage resource for domestic ruminants.

That's potentially good news because if the invasive forages were less digestible than their native counterparts, the animals would likely consume less feed and their performance might suffer.

MONITORING METHANE

Lima also observed that the two invasive forages produced about the same amount of methane emissions as native forages.

Methane production is a direct product of the digestive process, he notes, so emissions are influenced by digestibility. "But in this case, we had some indication that the digestibility of these forages was just as high as that of the native grass," he says.

While the livestock industry tends to get a bad rap for contributing to the release of heat-trapping gases like methane, Lima's research may indicate that sheep production—which helps sustain communities in Wyoming and around the world—is not necessarily incompatible with a healthy environment.

Perceptions of the livestock industry aside, it's possible that lower methane production may increase animal productivity. "In terms of animal production, the carbon that is converted to methane is carbon that is not utilized by the animal to grow," Lima explains. "So, you're losing some of the energy potential of the feed provided to the animal."

IMPLICATIONS FOR THE SHEEP INDUSTRY

Lima's study suggests that, even in the face of warming temperatures and increased carbon dioxide concentrations, Wyoming sheep production will likely remain sustainable. If invasive grasses like cheatgrass and Dalmatian toadflax continue to spread across the landscape, grazing management may look a little different, but the animals will adapt.

"The main take-home message in terms of animal nutrition is that unless the animals are eating almost the entirety of their diet from these plants, they can cope without issues," Lima says.

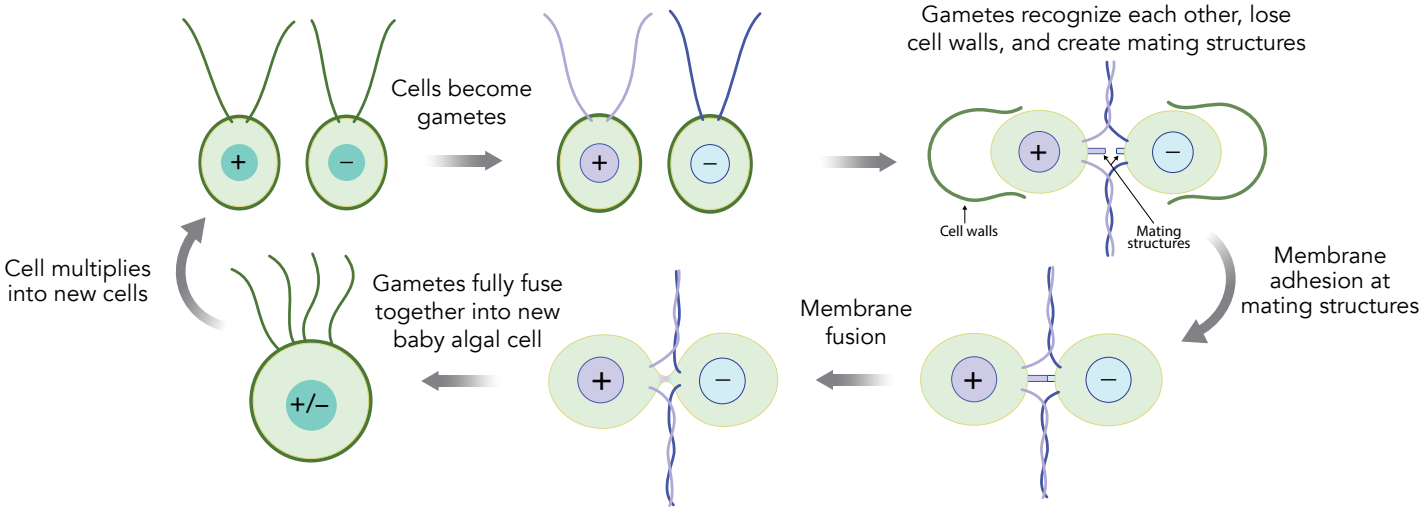
His results may be useful for producers who are trying to optimize forage nutrition while minimizing the negative impacts of invasive plants. Cheatgrass, for example, has a short life cycle and loses nutritional value quickly. Its nutritional value peaks in late winter through early spring; later in the season, livestock tend to lose interest in the grass and it becomes a fire hazard. Implementing a targeted grazing system that encourages heavy grazing of cheatgrass early in the season could potentially provide decent-quality forage while also reducing fuel for wildfires.

In previous field trials, Lima and UW partners observed sheep grazing invasive species under various conditions. Although Dalmatian toadflax contains compounds that can be toxic to grazing animals if consumed in large amounts, livestock typically avoid consuming large quantities of the plant. Nutritionally speaking, consumption of Dalmatian toadflax and cheatgrass can be compatible with decent animal productivity, Lima concludes—a hopeful sign for the sheep industry. ■

To learn more, contact Lima at pdemello@uwyo.edu.

Vials are prepared for an experiment measuring digestibility and methane emissions of different types of forages. Note the feed bag inside the vial and buffer solution injection. Photo by Jeremy Cain.

The *Chlamydomonas reinhardtii* life cycle. Graphic by Jen Pinello.



Studying Algal Reproduction Could Help Prevent the Spread of Malaria

written by **Maya Gilmore**, *University of Wyoming Extension*

Most life forms we are familiar with, including plants, animals, fungi, and many single-celled organisms, rely on sexual reproduction to continue their species.

In many organisms, sexual reproduction may appear relatively straightforward. Two parent organisms each produce a specialized cell—like sperm and eggs in humans—that contains half their genetic material. Then, these two specialized cells, also known as gametes, merge together to form the beginnings of a new organism.

But how exactly do those gametes come together and fuse to create new life? That's what Jen Pinello, an assistant professor in UW's molecular biology department, set out to investigate.

Surprisingly, her research may also hold the key to preventing the infectious spread of deadly diseases, such as malaria.

THREE STEPS, THREE PROTEINS

Pinello is studying the proteins and molecular processes of sexual reproduction in a single-celled green alga called *Chlamydomonas reinhardtii*.

All gametes are enveloped in a membrane that separates their cellular contents from the outside world. Like almost all other gametes, *Chlamydomonas* gametes must perform three steps to successfully complete sexual reproduction: first, they find an appropriate gamete to partner with; next, the membranes of the two gametes adhere to each other; and finally, the two membranes fuse together.

During reproduction, *Chlamydomonas* gametes rely on three essential proteins—MAR1, FUS1, and HAP2—to adhere and fuse their membranes. If any of these three proteins are missing, *Chlamydomonas* gametes cannot successfully come together and produce a baby alga.

FUS1 is located on one type of *Chlamydomonas* gamete (in scientific literature, this type is referred to as +), and MAR1 and HAP2 are located on the other (– type). Once two gametes of these different types have recognized each other, FUS1 and MAR1 attach to each other to adhere the two gametes together. Then, HAP2 fuses the gamete membranes together.

WHY STUDY REPRODUCTION IN GREEN ALGAE?

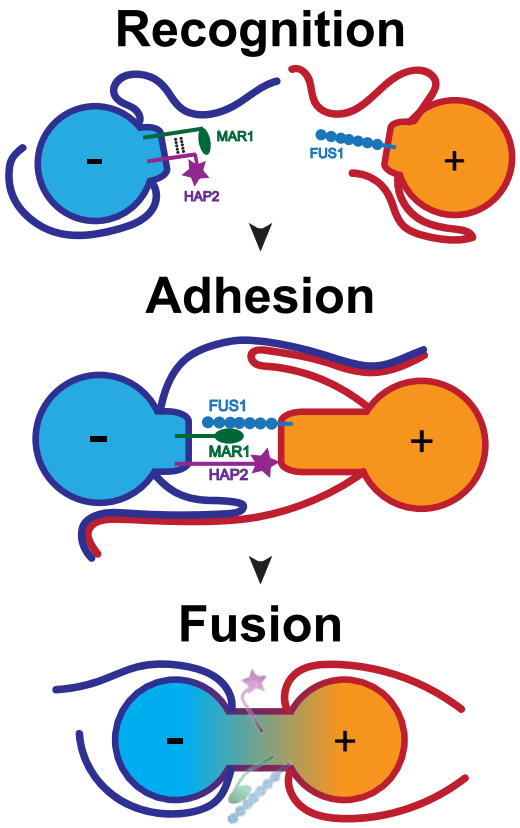
Pinello and her colleagues recently discovered MAR1. This discovery makes *Chlamydomonas* the only organism so far in which scientists have identified the proteins required for gametes to adhere and fuse together.

Scientists have identified many proteins essential for sexual reproduction in different organisms, but they have struggled to determine exactly what those proteins are doing—or even which step of sexual reproduction (gamete recognition, adhesion, or fusion) they are participating in.

SPECIES-SPECIFIC PROTEINS

HAP2 is necessary for gamete fusion in many different organisms, including flowering plants, insects, and single-celled parasites—such as those that cause malaria. FUS1 is used by fewer organisms. It's found only in algae and plants. Finally, MAR1 is only found in *Chlamydomonas* and other closely related algal species.

Pinello and her colleagues have discovered that after MAR1 and FUS1 proteins adhere two gametes together, HAP2 changes form. HAP2 cannot fuse *Chlamydomonas* gametes together until it has changed form. Pinello's research suggests HAP2's changes may rely on cues from MAR1 to prevent HAP2 from fusing together gametes of different species.



The three key proteins and steps of *Chlamydomonas* gamete fusion. First, the two gametes recognize each other; next, the gametes adhere to each other; and finally, they fuse together. Graphic by Jen Pinello.

WHICH CAME FIRST, THE VIRUS OR THE EGG?

HAP2 is an ancient protein that was likely present in the very first eukaryotic cells (cells that contain a nucleus where their genetic information is stored).

Pinello and other researchers have discovered that HAP2 has an eerily similar structure to the proteins that some viruses, including dengue and Zika, use to invade cells. To infect organisms, these viruses must first fuse their membrane with that of a target cell. HAP2 is used during reproduction, while these virus proteins are used during infection, but both have the same function: they fuse cell membranes together.

The structural similarities between HAP2 and these viral fusion proteins are very unlikely to be a result of chance, which strongly suggests that these proteins share a common ancestor.

This finding begs the question: did this "common ancestor" protein first help infect other cells, or did it assist with sexual reproduction? In other words, which came first, the viral fusion protein or the egg?

The answer might imply that sexual reproduction originated from a viral infection. On the other hand, perhaps a virus stole its fusion protein from the gametes of a primordial cell.

One way or another, the protein HAP2 has a lot to tell us about how membrane fusion has shaped the evolution of life and disease.

Other species may have their own version of MAR1. Learning more about how these adhesion proteins regulate HAP2 may help scientists understand reproduction in many kinds of species and perhaps even prevent parasitic reproduction.

"I think what's great about this work is that it's got these really basic fundamental findings that are important for understanding reproduction at the molecular level in a wide majority of eukaryotic species, but then there's also these applied aspects where this research could lead to new strategies to defeat parasitic diseases like malaria," says Pinello.

THE BIRDS AND THE BEES...AND MALARIA

Malaria is a disease caused by single-celled parasites from the genus *Plasmodium*. Symptoms of malaria include fever, fatigue, and seizures. *Plasmodium falciparum* is one of the deadliest species that causes malaria infections in humans. This species alone kills about 600,000 people annually, most of whom are infants and young children.

In humans, *Plasmodium* parasites replicate asexually in the liver and red blood cells. When a mosquito bites an infected human, *Plasmodium* cells are transferred from the human to the mosquito.

Inside the mosquito's gut, *Plasmodium* gametes reproduce sexually. When the mosquito bites another human, the next generation of parasites are passed on to another victim.

A NEW KIND OF VACCINE

Historically, malaria vaccines have only targeted the asexual stages of the *Plasmodium* lifecycle that happen within humans. The two existing vaccines reduce the risk of a severe infection or death for some, but not all, individuals. Additionally, existing vaccines usually don't provide complete immunity to the parasite even when they reduce symptoms. This means that even vaccinated people with no visible malaria symptoms can be infected and transmit the parasite to someone else.

A vaccine that targets HAP2 could prevent infected individuals, even those with a mild form of the disease, from spreading the parasite to others.

"It's time to consider the entire malaria life cycle—sexual and asexual forms—and create a new type of vaccine," says Pinello. "You have to target at least two different things, one to prevent parasite spread and one to prevent disease in the individual."

A mosquito that bit a person who had received this new type of vaccine would consume anti-HAP2 antibodies along with its bloodmeal. Antibodies, which act as the guards of the immune system, would stop *Plasmodium* from reproducing in the mosquito's gut—preventing the mosquito from transmitting the parasite to any other humans. This could help protect whole communities, including infants, who do not benefit much from current malaria vaccines.

To generate the best possible vaccine against HAP2, one of the first steps is to find which parts of the HAP2 protein are exposed before HAP2 fuses gamete membranes together. Exposed parts of the protein could serve as a target for antibodies.

Pinello's research on *Chlamydomonas* reproduction could ultimately help identify these vulnerable sites on HAP2 proteins and inform vaccine design. ■

To learn more, contact Pinello at jpinello@uwyo.edu.

A New Approach to Fungicide Development Could Help Protect Crops and Human Health

written by **Brooke Ortel**, *University of Wyoming Extension*

Have you ever opened your fridge to discover that those strawberries you bought last week are now coated with an unappetizing layer of gray fuzz?

Those unlucky berries were probably infected with gray mold, a disease caused by the fungus *Botrytis cinerea*. This fungal pathogen can wreak havoc not only in your fridge or kitchen, but also in high-humidity environments like commercial greenhouses.

Fungal diseases threaten crop production, food security, and human health worldwide. Gray mold alone afflicts more than 200 plant species, including agricultural crops, and results in more than $10 billion in losses annually.

Unfortunately, the problem isn't going away—in fact, it's growing. Many fungal pathogens have flourished with shifting weather and precipitation patterns. At the same time, heavy use of conventional fungicides has resulted in widespread fungicide resistance.

"The rise of fungicide-resistant fungal pathogens poses a significant threat to human health and agriculture," says Seungmee Jung, who graduated from UW in 2024 with a PhD in molecular biology. "The risk of a potential fungal pandemic is a pressing concern."

But, thanks to Jung's lab group, future fungicides may be safer, more effective, and much less vulnerable to the development of resistance.

A "SELF-EATING" PROCESS

The new fungicide candidates discovered by Jung's team target a cellular process known as autophagy, which recycles old, faulty, or unnecessary cell components and helps cells maintain homeostasis. Broken down to its Greek roots, the term translates to "self eating."

Autophagy occurs in all eukaryotic organisms (those whose cells contain a nucleus), from baker's yeast to human beings. "It's a nutrient-recycling process in the cell that allows the cell to maintain their healthy status," Jung explains. "Autophagy processes are boosted under stressful conditions like starvation or infection."

In fungi, autophagy also affects pathogenicity. Previous studies have shown that many fungal pathogens lose their ability to cause disease when genes related to autophagy are deleted.

Many fungi are known for swiftly adapting to environmental conditions and nimbly evolving resistance to existing fungicides. But even these seemingly invincible pathogens would struggle to dodge a chemical treatment that blocked autophagy.

"Autophagy is a very basic process on a cellular level, so that means it's really hard to change as time goes on," Jung explains. "Autophagy is not only important for their pathogenicity but also very important for their life cycle. So it would be really hard for them to just 'delete.'"

DISRUPTING THE FUNGAL LIFE CYCLE

In a fungal cell, the first step in autophagy is the formation of an autophagosome, a cellular "container" that forms a membrane around unnecessary cell materials and hauls them away to be digested and recycled.

The enzyme ATG4 plays a pivotal role in this process by cleaving apart a specific protein, ATG8, which then facilitates the formation of a lipid membrane around the materials to be recycled. Without ATG4 to activate the process, ATG8 cannot form this membrane and autophagy cannot be completed.

To identify chemical compounds that might disrupt autophagy, Jung and her colleagues first developed a molecular "sensor" to indirectly monitor ATG4 activity. To deploy the sensor, the researchers attached two proteins to ATG8, then measured changes in energy transfer between the two proteins when a potential fungicide compound was introduced.

In this BRET (bioluminescent resonance energy transfer) system, one of the proteins acts as an energy donor, while the other functions as an energy receptor. Energy transfer depends on the distance between the two proteins, Jung explains. If the proteins are close to each other—as they are before ATG4 cleaves ATG8 apart—the energy donor can transfer more energy to the receptor. If the proteins are farther away from one another—as they are after ATG4 cleaves ATG8—the energy donor transfers less energy to the receptor.

If the potential fungicide compound didn't interfere with ATG4 splitting ATG8, the proteins affixed to ATG8 would wind up farther apart, resulting in a lower BRET ratio. But if the chemical inhibited ATG4's ability to cleave ATG8, the proteins would remain close together and the BRET ratio would be higher.

The researchers' goal was to identify compounds with high BRET ratios, as they were likely blocking autophagy in the cell. "These compounds bind directly to fungal ATG4 enzymes, disrupting their activity and impairing pathogen development and infection structures," Jung explains.

IDENTIFYING ANTIFUNGAL COMPOUNDS

In their search for an effective autophagy inhibitor, Jung's team screened more than 2,400 chemical compounds using the BRET system. Ultimately, they identified several compounds that inhibit autophagy in fungi that cause diseases like gray mold, rice blast fungus, white mold, and brown rot.

One of the chemicals Jung's team tested has been under clinical trial for potential use in human medicine. Hopefully, this will allow for the development of fungicides that are less harmful to human health than existing options.

The chemicals that most effectively blocked autophagy included a molecule known as ebselen and several closely related compounds.

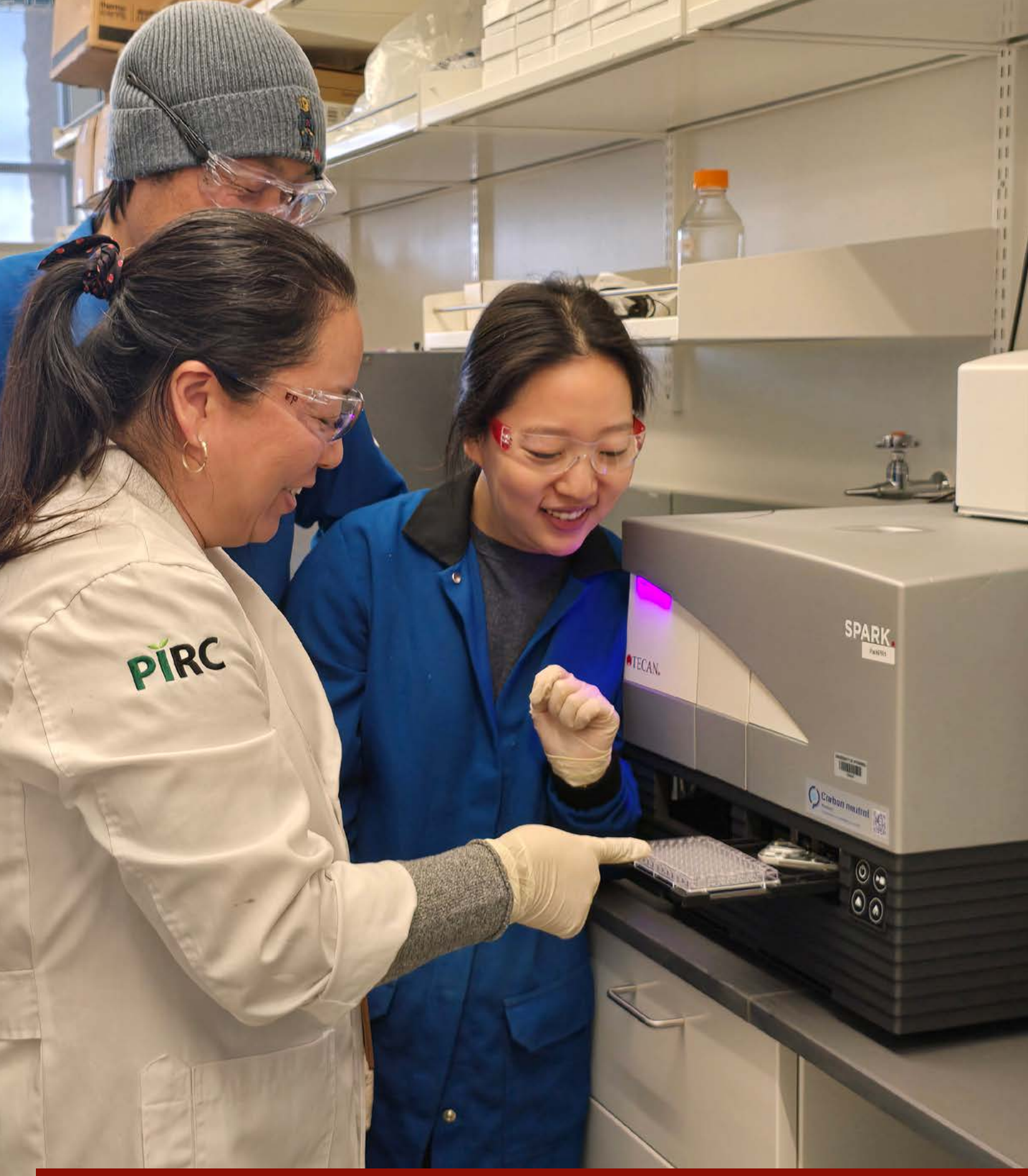
Initial experiments occurred "in vitro," meaning that the researchers tested the process using lab-grown proteins found in fungi cells. Successful candidates were then tested in actual fungi cells. Lastly, to mimic fungicide application, the researchers sprayed the finalists onto host plants, then exposed those plants to fungal pathogens.

Autophagy was completely blocked in the fungal pathogens when the compounds were applied, Jung reports—a promising sign for potential use as a fungicide. Ebselen, for example, effectively prevented fungal infection in grapes, strawberries, tomatoes, rice, and roses.

"By targeting the autophagy process in fungal pathogens, we not only reduce crop loses but also protect human health...while minimizing environmental impact," Jung concludes.

After nearly a decade of work developing, testing, and using this BRET sensor, she's already busy designing a second-generation sensor to study autophagy in animals, including humans. She hopes her work will ultimately benefit human health as well as crop production. ■

To learn more, contact Jung at sjung4@uwyo.edu.



L–R: Eunsook Park, assistant professor of molecular biology, Jongchan Woo, research scientist and developer of the BRET sensor, and Seungmee Jung, postdoctoral researcher, use the BRET sensor to test compounds that may be suitable for use as fungicides. Photo courtesy of Seungmee Jung.

Research technician Willa Bonds slices a mouse brain on a freezing microtome, a specialized instrument used to cut thin sections of tissue with minimal damage. Photo by Harrison Edwards.

Circadian Disruption in Alzheimer's Patients May Be Explained by Newly Discovered Neural Pathway

written by **Brooke Ortel**, *University of Wyoming Extension*

For Alzheimer's patients and caregivers, late afternoon and evening can be a particularly challenging time. Rather than winding down at the end of the day, people with Alzheimer's often exhibit increased agitation, aggressive behaviors, and a tendency to wander.

This clinically recognized phenomenon is known as sundowning, and often contributes to the decision to institutionalize patients rather than continue home care.

DISRUPTION OF CIRCADIAN RHYTHMS

Sundowning is highly correlated with phase delay, a disruption in circadian rhythms that shifts the timing of rest periods. Alzheimer's patients typically go to bed later than peers of the same age without the condition. They also experience the drops in body temperature and locomotor activity associated with resting phases on a later time schedule.

Although both sundowning and phase delay in Alzheimer's patients are well documented, their underlying causes have remained unclear. But, thanks to a researcher in UW's Department of Zoology and Physiology, that may change.

A NOVEL NEURAL CIRCUIT

Assistant professor Trey Todd and his lab recently discovered a neural circuit linking an area of the brainstem known to show early indicators of Alzheimer's disease to the hypothalamus, an area of the brain that regulates circadian rhythms.

Todd didn't initially set out to investigate Alzheimer's disease, though he had studied the neuroanatomy of circadian rhythms in mice for years. But, as he examined the neural pathways associated with rhythms like body temperature and sleep phases, he noticed these brain areas also sent signals to an area of the hypothalamus associated with aggressive behaviors.

Trey Todd holds a test tube containing a mouse brain. His research on the neural circuitry of circadian rhythms may provide clues to preventing and treating sundowning in Alzheimer's patients. Photo by Willa Bonds.

This observation piqued his interest in sundowning. "In late afternoon to early evening, right when they should be winding down for the day, Alzheimer's patients can become much more agitated," he says. "The thought was, given the circuitry we saw, are these people more reactive, and more likely to be agitated at that time of day, because there's a disruption somewhere in that circuit?"

To test the theory, he first conducted aggression testing in mice at different times in the day. Sure enough, they were more aggressive at certain points in their circadian rhythm.

With further experimentation, Todd determined that disrupting the neural circuit linking the brainstem and hypothalamus triggered heightened aggression at times when mice were usually less aggressive.

Mice with genes mutated to mimic Alzheimer's pathology were more aggressive at the beginning of their rest phase, a time when they would typically be less aggressive—similar to how Alzheimer's patients exhibit sundowning symptoms leading up to bedtime.

"It's not a perfect model, but it's a way of showing that in an animal with a similar brain structure and pathology, they're showing similar circadian disruption and are more aggressive at a certain time of the day," he explains.

Todd also found that increased aggression and circadian dysfunction developed much earlier in female mice than males. Since two-thirds of Alzheimer's patients are women, this discovery may help researchers better understand why women are more likely to develop the condition.

PRACTICAL APPLICATIONS

In 2023, Todd received a five-year, $1.8 million grant from the National Institutes of Health to fund further research. Current experiments include inducing Alzheimer's pathology solely in the areas of the brain involved in the neural pathway he discovered, rather than across the brain. So far, he says, there's strong preliminary evidence indicating that if Alzheimer's pathology occurs only in that pathway, phase delay and increased aggression still occur, suggesting the pathway is key to triggering phase delay and sundowning.

> "I hope that my research leads to even better suggestions for people who have loved ones who are encountering Alzheimer's."

Previous studies have shown that people who ultimately develop Alzheimer's disease may exhibit phase delay and circadian disruption decades before they begin experiencing memory loss. A better understanding of the neural pathways disrupted by the disease may help researchers develop strategies for prevention and treatment of sundowning, potentially easing the challenges faced by caregivers and reducing institutionalization rates.

"If you have people that are at risk for Alzheimer's disease and you know they're phase delayed, then you probably also know they're starting to get pathology in this brainstem area and we need to do everything we can to slow that progression," Todd explains.

According to a 2022 report by the Alzheimer's Association, an estimated 6.5 million Americans ages 65 and older suffer from Alzheimer's dementia. For the most part, treatment is limited to managing symptoms.

Todd's findings may help change that. "I hope our research may point to methods for earlier detection and interventions that could slow the progression of the disease," he comments. "Actually knowing the brain areas that might be involved should lead to better outcomes."

As he continues to study neural circuitry and circadian rhythms in mice, Todd hopes that one day his work will positively impact human patients. "I hope that my research leads to even better suggestions for people who have loved ones who are encountering Alzheimer's," he comments. ■

To learn more, contact Todd at wtodd3@uwyo.edu.

A view across Shirley Basin looking at a fire in the Laramie Mountains. Photo by David Keto.

Water, Weather, and the Future of Wyoming Agriculture

Needs assessment may help producers and service providers plan ahead

written by **Brooke Ortel**, *University of Wyoming Extension*

Water, weather, wildfire—the list goes on. For Wyoming residents, especially those involved in agriculture, these environmental factors directly impact lives and livelihoods.

Extreme weather events, including drought, have always been a challenge in Wyoming's notoriously harsh climate. Today, these challenges have grown even more pronounced. In Wyoming and regionally, the frequency and severity of extreme weather events have increased relative to historical averages, as have temperatures.

As producers across the state face increased risk of severe drought, water shortages, and related issues, how can staff at land management agencies, conservation districts, county extension offices, and other local organizations help them plan ahead?

To find out, UW Extension invited representatives from these organizations to participate in focus groups as part of a statewide needs assessment.

LISTENING TO LOCALS

From June 2023 to May 2024, UW Extension conducted six focus group sessions facilitated by county extension educators across the state.

These sessions brought together agricultural technical service providers (TSPs) who regularly engage with Wyoming residents on topics related to weather, climate, or water availability. While participants came from a variety of backgrounds and represented different areas of the state, they all interacted professionally with Wyoming's agricultural community.

Participating TSPs included staff from conservation districts; state and federal land management agencies; the USDA's Farm Service Agency (FSA) and Natural Resources Conservation Service (NRCS); nonprofits; private consulting firms; a community college; and a tribal organization.

"One interesting thing about running focus groups of the technical service provider community in Wyoming is that many of our focus group participants also had a ranch or farm operation," says Kristi Hansen, UW Extension water resource economics specialist. "They were in the room because they worked for a state, local, or federal agency but they also spoke with great knowledge about conditions on the ground because they are living with those conditions as producers themselves. [That] seems like a huge strength that might not happen everywhere."

IDENTIFYING CHALLENGES

The needs assessment is part of a larger four-year project led by Hansen and former UW Extension specialist Windy Kelley. Funded by the USDA's National Institute of Food and Agriculture (NIFA), the initiative brings together local TSPs, social scientists, extension educators, ag economists, and climate and weather variability specialists. Ultimately, the goal is to connect TSPs and producers with relevant resources, tools, and educational programming to help them prepare for and respond to extreme weather events and changing water availability.

When asked what weather, climate, and water topics would be most important to their clients in the future, all focus groups identified drought as the number one issue. Many participants specifically voiced concerns about the impacts of drought on rangelands and forage supply.

TSPs also brought up future challenges related to water availability, water storage, and competition for water between different sectors of the economy. Related concerns included changes in rainfall, snowpack, growing seasons, length and severity of winters, wildfire risk, and flooding.

"More than ever before, agricultural producers and their local TSPs need timely, science-based, and region-specific information and technologies to enable them to make informed decisions," the researchers observe.

Unfortunately, many existing resources don't translate well to Wyoming conditions and crops. Focus group participants emphasized the need for locally relevant, accessible information on weather variability and water availability.

FIRST, A BETTER FORECAST

Every focus group called for the establishment of additional weather stations across the state. The existing network doesn't provide the location-specific precision their clients need, the TSPs reported. Precipitation, soil moisture, and other key factors vary widely across the state and access to location-specific data is critical.

The TSPs also highlighted a need for better forecasting, especially in "medium-term" time horizons. "The weather report tells us how things are going to be in the next five to ten days, and we have long-term projections of changes in trends or variability, but many of these technical service providers were really interested in better forecasting in the medium term, three to six months out," Hansen comments.

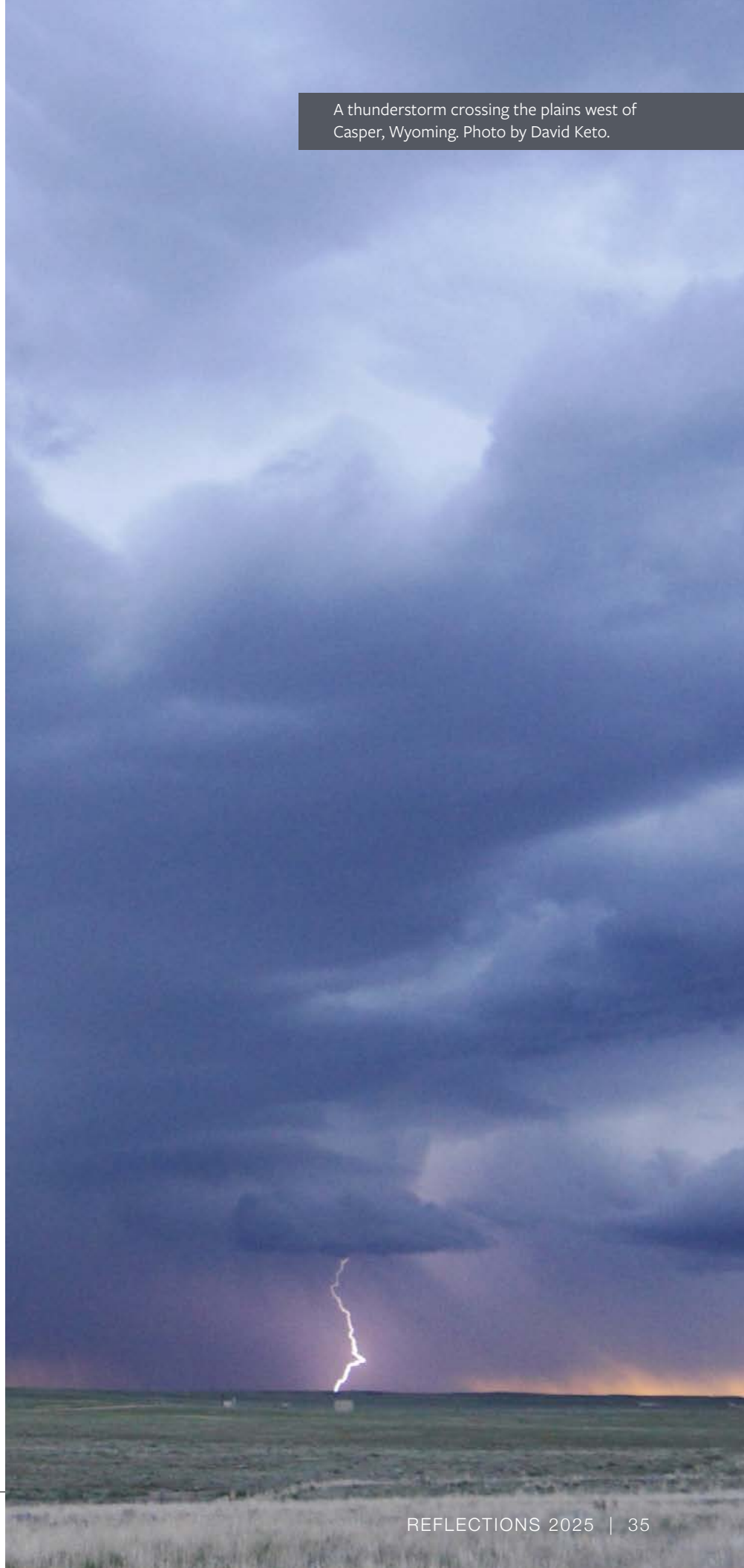
Improved forecasts could help producers make more informed decisions about crop selection, grazing management, and irrigation practices for the coming season.

A ONE-STOP DATA SHOP

Participants across all focus groups recommended the creation of an accessible "one-stop shop" housing resources related to weather and climate variability. Participants also emphasized the need for user-friendly tools to help translate data into actionable information.

These resources would potentially benefit both producers and TSPs. A software app that calculated windchill, for example, could be useful in helping FSA employees determine a producer's eligibility for weather-related federal insurance programs.

In some cases, TSPs noted, tools are already available but may not be easy to find, use, and apply to specific local scenarios.



A thunderstorm crossing the plains west of Casper, Wyoming. Photo by David Keto.

Extension educators inspect a weather station during a tour of an ag operation in southeast Wyoming. Photo by David Keto.

The general consensus was, "There's a lot of information out there. It's hard to know what is most valuable and useful for your particular purpose," says Hansen. A data hub integrating existing resources and new, user-friendly tools could help ease these difficulties.

LEARNING FROM PEERS

Across focus groups, participants were interested in learning more about weather and climate variability. Many TSPs concluded that peer-to-peer networking could help them build knowledge and better serve their clients.

The focus groups themselves gave TSPs a chance to learn from one another and identify overlaps—and gaps—in the knowledge and services they bring to clients. "All of the focus groups recognized the need to improve cooperation and build relationships both within the TSP community but then also with landowners, with producers," Hansen notes.

She hopes the needs assessment will inspire more peer-to-peer learning among TSPs. As participants themselves pointed out, sharing knowledge and identifying ways to develop complementary programming could help everyone better serve their communities.

> "Knowledge about future weather and climate conditions has economic value."

Overall, Hansen was "really impressed by the depth of knowledge and thoughtfulness on the part of the focus group participants. Helping the agricultural community and working together across agencies to help them was definitely important to them."

UNDERSTANDING THE ECONOMICS

On a farm or ranch, tools like better precipitation forecasts and a more robust weather station network have direct economic impacts.

"Comments made by TSPs in this needs assessment suggest some of the most important ways that better information could improve economic outcomes for producers," Hansen notes. "Knowledge about future weather and climate conditions has economic value, if producers are able to use it in their decision-making to reduce costs or increase production."

The needs assessment provided a starting point for determining what kinds of future economic research might be most useful to Wyoming producers.

TSPs brought up questions about how changing water availability might affect financial bottom lines, how extreme weather in Wyoming and elsewhere might affect agricultural input costs, and under what conditions new technology might provide cost-effective solutions.

As an agricultural economist, Hansen is eager to dig into these questions. She hopes her work will benefit both TSPs and producers as they navigate Wyoming's weather- and water-related challenges. ■

To learn more, contact Hansen at kristi.hansen@uwyo.edu.

A fly fisherman reads the water on the Big Horn River near Thermopolis, Wyoming. Photo by David Keto.

Weather and Wildfires May Alter Angler Spending in Wyoming

written by **Maya Gilmore**, *University of Wyoming Extension*

Wyoming is a fishing hotspot, with waterways that are world famous for their plentiful, unique species of fish and beautiful scenery. Angling brings millions of dollars into the state through fishing license sales and money spent on hotels, campsites, guiding services, restaurants, tackle shops, and tourist keepsakes.

But what happens if Wyoming waterways get warmer, smokier, or more crowded? As a graduate student in the UW Department of Agricultural and Applied Economics, Patrick Hofstedt set out to find out how anglers might react to environmental changes in the Snake River Basin of Teton County.

A SNAPSHOT OF TETON COUNTY ANGLERS

In 2023, Hofstedt sent a survey to 5,000 anglers who bought a license through the Wyoming Game and Fish Department to assess what aspects of their fishing trips these anglers valued. He found that anglers in Teton County could be categorized into two main groups.

Anglers from the "nature lovers" group tend to come from out of state. They're willing to travel to take a fishing trip, want to avoid wildfire smoke and other anglers, and enjoy navigating to scenic spots that are difficult to access. If the Snake River Basin became more crowded or suffered more wildfires, these anglers would likely visit other fishing spots instead.

Members of the "friendly neighbors" group tend to be Wyoming residents. They take trips close to home and want easy access to fishing spots. Anglers in this group care a little less about avoiding wildfire smoke and other anglers. They also aren't as picky about particular fish species or how many fish they catch.

THREE CLIMATE SCENARIOS

Currently, angling brings about $90 million into Teton County annually. But, as Wyoming weather and environmental conditions shift, the economics of angling may shift as well. Hofstedt's study analyzed how the spending of current Teton County anglers would change in three scenarios identified by the Wyoming Anticipating Climate Transitions (WyACT) grant.

In the first scenario, Teton County would be less impacted by climatic changes than other areas in the West. This could attract new anglers and members of the "friendly neighbors" group might fish a little more. However, Teton County could potentially lose over $6 million from current "nature lovers" who dislike crowding.

In the second scenario, the Snake River Basin would become warmer and smokier from more frequent wildfires. This scenario would have the greatest economic impact on Teton County, reducing current angler spending by more than $8 million.

Finally, in a shrinking snowpack scenario, water temperatures would warm as snow melted earlier. All fish would be less abundant, and anglers would see more brown trout than some of the fish the Snake River is famous for, such as the Yellowstone cutthroat. This would reduce current angler expenditures by about $6.5 million.

PREPARING FOR THE FUTURE

Understanding what kinds of changes may be in store for Wyoming fishing allows local businesses and municipalities to prepare for each of the possible scenarios. For example, if scientists see indications that the Snake River Basin is likely to experience less dramatic temperature changes than surrounding areas, Teton County might consider infrastructure improvements to handle a greater volume of anglers and recreation in the area.

"The way I think about it is adapting to create an experience that is still attractive to a lot of anglers, even given changes that may come to pass," says Hofstedt.

For example, fishing guides might scope out less smoky, more scenic spots with slightly less fish to appeal to the nature lover group. Eventually, if waters warm, guides may even be able to hit the water a little earlier in the year, extending the fishing season and mitigating profit losses.

Local business owners who currently focus on fishing might want to diversify their incomes by adding new activities, like rafting, which could appeal to some friendly neighbors.

Hofstedt believes that fishing will remain an important part of Wyoming recreation regardless of future environmental conditions. For many anglers, he says, "A bad day fishing is better than a good day at the office." ■

To learn more, contact faculty advisor Kristi Hansen at kristi.hansen@uwyo.edu.

Two members of the RSAFG dig for biscuitroot in the Red Desert. Photo by Jill Keith.

GATHERING COMMUNITY

UW Supports Shoshone Ancestral Food Study

written by **Maya Gilmore**, *University of Wyoming Extension*

For thousands of years, Shoshone people traveled across the West every year, hunting and gathering along the way.

Ancestral Shoshone diets relied on resource management, understanding seasonal food cycles, and hunting and gathering practices rooted in reciprocity and relationality. As colonial governments restricted Shoshone people to a tiny fraction of their ancestral homelands, native peoples were forced to adapt to foods like flour, sugar, or canned meats.

Today, many families rely on the Food Distribution Program on Indian Reservations (FDPIR), also known as commodities, as well as monthly mobile food distributions from food banks. The majority of these items are nonperishable, highly processed, and have a long shelf life, while perishable options are limited.

In 2020, a grassroots group called the Restoring Shoshone Ancestral Food Gathering (RSAFG) spearheaded a community-based research study that collected data about how eating traditional Shoshone foods impacted the health and wellness of Shoshone participants.

Jill Keith, associate professor of human nutrition and food, worked with the group to design the study, secure grant funding, gather food, and analyze data.

"Intuitively, people from the community know that an indigenous diet is healthier than a Western diet," says Keith. "But having that data helps with getting funding, pulling together information about culturally relevant foods, and reclaiming that knowledge."

SEASONS TO SCOUT, GATHER, PROCESS

RSAFG members began preparing for the study in 2019. Using traditional methods, they gathered foods on the Wind River Indian Reservation and as far afield as the Grand Tetons and the Red Desert.

"We had different people who knew these different aspects of collecting the plants properly," says John Mionczynski, a founding member of the RSAFG. "It was a group effort to gather these foods in a way close to the way Shoshone elders did hundreds of years ago."

Mionczynski is not Shoshone but is familiar with ancestral Shoshone foods because of his long-standing personal interest in wild foods and career as a wildlife biologist. He helped the group find and identify certain plants.

Gathering and preparing food for the winter took many months, and the group supplemented gathered foods by buying some foods, like bison meat.

Most members of the RSAFG are Shoshone. Some of the RSAFG members who helped gather foods were also participants in the study, eating a 50% traditional Shoshone diet for a month.

PLANNING TRADITIONAL MENUS

The study aimed to create a traditional Shoshone menu that provided half of participants' total caloric intake for a month. During the first month of the study, 10 of the 19 participants ate a 50% traditional Shoshone diet, while the other half of the group ate what they would normally eat. Then, during the next month, the other 9 participants switched to the 50% Shoshone diet and the first group returned to their normal diet. All participants kept a food diary tracking what they were eating.

Each week, those eating the traditional Shoshone diet received bags of Shoshone foods gathered, processed, and preserved by the RSAFG. They also received daily menus and recipes that described several ways to prepare ingredients. Each menu was designed to provide a certain number of servings of grains, proteins, and other nutrients.

At the beginning of the study and at the end of each month, UW researchers helped collect data like height, weight, waist circumference, body mass index (BMI), blood pressure, and

GETTING TO KNOW SHOSHONE FOODS

Chokecherries are a staple of ancestral Shoshone diets. They are eaten fresh, used as tea, and dried into patties that provide nutrients and flavor throughout the winter. Chokecherries are very high in antioxidants and have been found to lower blood pressure.

Biscuitroot is a plant related to carrots with a root that can be dried and ground down into flour. The Shoshone traditionally used a mano and metate, stone tools somewhat like a mortar and pestle, to grind roots. During this study, the group ground some of the flour using a mano and metate.

Juniper, pine, and Douglas-fir needles make teas that are a good source of vitamin C.

Limber pines don't drop their cones every year, but when they do, they drop cones en masse. In 2019, the RSAFG gathered hundreds of pinecones and then harvested the pine nuts by hand.

Other foods that participants consumed during this study included hawthorn berries, huckleberries, bitterroot, camas root, cattail, fireweed, sego lily bulbs, wild mint, wild onions, rose hips, yampah root, buffalo, deer, elk, and salmon.

Chokecherries on the Wind River Indian Reservation. Photo by Jill Keith.

levels of cholesterol and blood sugar from all 19 participants.

Participants also filled out a survey that assessed their feelings of wellness and cultural connectedness.

INTERRUPTED BY THE PANDEMIC

The study took place from January through March of 2020. The group was able to collect data at the beginning of the study and after the first month, but could not collect data after the second month due to COVID-19 restrictions.

Researchers asked participants to mail in certain data, like waist circumference and the survey about cultural connectedness and mental wellness, but were not able to conduct the final blood draw. "We definitely lost a pretty significant chunk of data that people were really interested in," says Keith. "People that were following the diet wanted to know, 'What happened to my blood glucose?' They wanted to see if it made a difference."

Based on the data they did have, the researchers found that there were positive trends in all areas measured. On average, participants had lower cholesterol and lower BMIs, and felt more resilient and more connected to their culture. However, the study did not find statistically significant results in any of the factors it measured. The positive trends could be a result of chance.

FOOD AS MEDICINE

Though the RSAFG did not find statistically significant evidence that eating a Shoshone diet is healthier than a Western diet, the study allowed the group to restore and spread knowledge of how to gather foods in a traditional way. The study also enacted Shoshone treaty rights to use their ancestral lands and gather ancestral foods.

The process had a major impact on participants. Denyse Ute, a participant in the study who is now a member of the RSAFG, commented that participants "felt more connected to culture, which is inseparable to the land. We became more familiar with traditional foods and different ways to prepare and use them, gained a greater understanding of roots, herbs, wild vegetables, and game meats, and strengthened our relationships to ancestral knowledge and the land."

The 2020 study is part of a food sovereignty movement led by native people across the U.S. and Canada. As part of this movement, the RSAFG will continue to promote access to traditional foods and medicines in a variety of creative ways. These efforts include showcasing Shoshone ancestral foods at intertribal conferences, putting together recipe books, growing some native foods closer to home, or even conducting other studies about the benefits of certain traditional foods. ■

To learn more, contact the RSAFG at restoring.shoshone.food@gmail.com or contact Keith at jkeith5@uwyo.edu.

How Diet Can Influence Brain Health

written by **Maya Gilmore**, *University of Wyoming Extension*

Eating a high-fat diet can put metaphorical cracks in a mouse's circadian rhythms and cause poor sleep. This may affect their neurons, making it harder for them to think at certain times of day. Illustration by Maya Gilmore.

Eating a balanced diet is tricky at the best of times. When we're stressed, sleep-deprived, or emotional, it's even easier to reach for convenient, but fatty, foods.

Unfortunately, high-fat diets are linked to obesity, diabetes, cardiovascular diseases, and other health problems. High-fat diets can also cause poor sleep.

Prince Peter Wormenor, a graduate student in the Department of Zoology and Physiology, wanted to understand how high-fat diets and their accompanying sleep disruptions change the brain. Specifically, he examined the prefrontal cortex, the part of the brain responsible for regulating emotions, learning, and cognition.

If high-fat diets influence the prefrontal cortex, they might create a vicious cycle: the diet disturbs one's sleep, which makes it more difficult to regulate emotions or think clearly, which then leads to impulsive decisions—such as eating more high-fat foods.

UNHEALTHY NEURONS BEFORE BED

Wormenor set up an experiment where some mice were fed a normal diet and others were fed a high-fat diet for one week. Wormenor used light boxes to create different "time zones"—half of the mice were experiencing evening lighting conditions when he examined them, while the other half were exposed to morning conditions.

After a week, Wormenor looked at individual neurons in each mouse's prefrontal cortex, examining key indicators of neuron health and function.

Neurons from male mice fed high-fat diets showed indications of poor health when they were waking up. However, neurons examined right before the mice fell asleep were even less healthy than neurons examined when the mice woke up.

Typically, a mouse's neurons are less excitable as the mouse goes to sleep in comparison to when the mouse is fully awake. Wormenor found that male mice fed a high-fat diet had significantly more neuron activity when they were going to sleep than male mice fed a normal diet.

"Consumption of a high-fat diet in itself is not a good thing, but you can have a more adverse effect at a particular time of day than at another time of day," says Wormenor. In other words, eating bacon might make it harder to think throughout the day, but it may have more of an impact on your brain when you're going to bed than when you're waking up.

In contrast, whether they were tested in the morning or evening, female mice who were fed a high-fat diet had similar neural health to female mice who ate a normal diet. While it's possible that diet changes might eventually impact female mice, no significant changes were observed after one week.

BREAKING THE VICIOUS CYCLE

Though this study was focused on short-term consequences of a high-fat diet on the prefrontal cortex, Wormenor's research could have implications for the entire brain. "When one region is affected or influenced negatively, you would expect a change in the way other regions are impacted also," says Wormenor.

Ultimately, Wormenor's findings might help researchers develop behavioral interventions that give people more tools to break the vicious cycle of poor dietary habits and poor sleep. If decision-making is most compromised in the evening, figuring out strategies to avoid eating at night might help people who struggle with their diets. Changing when we eat might make it easier to regulate emotions and sleep—and pick different foods next time. ■

To learn more, contact faculty advisor Brandon Roberts at brandon.roberts@uwyo.edu.

Spring Sendele with her dog Moose, who is a survivor of canine dysautonomia. Photo courtesy of Spring Sendele.

UW Researchers Investigate Elusive Canine Disease

written by **Maya Gilmore**, *University of Wyoming Extension*

When a beloved pet gets sick, it's only natural to ask what caused their illness. Unfortunately, we don't always know the answer.

Canine dysautonomia (CD) is a devastating condition that disrupts autonomic functions, such as digestion and heart rate. The disease has a high fatality rate, and its cause is unknown. In the U.S., a few hundred dogs a year suffer from CD.

Maedeh Rafiee, who earned her doctorate in veterinary science from Islamic Azad University in Tehran, Iran, returned to academia to study CD as a graduate student at UW. "Owners lose their pets because of canine dysautonomia," says Rafiee. "I felt it was my responsibility to contribute to solving this problem."

Rafiee is a member of Jonathan Fox's veterinary science lab. Rafiee and other members of Fox's lab are working with a veterinarian at Kansas State University to uncover CD's cause, with the goal of eventually preventing the disease.

DEFEATING THE AUTOPILOT

CD attacks the body's "autopilot," or autonomic nervous system, which regulates vital processes like digestion, swallowing, heart rate, and bladder control.

CD is a neurodegenerative disease. It kills neurons, and those neurons, once destroyed, don't grow back. Though it's possible for dogs to survive CD, survivors often have permanent issues like incontinence or digestive problems.

Most pet owners first notice CD due to gastrointestinal symptoms. The autonomic nervous system, damaged by CD, can't effectively regulate normal intestinal movements. This can cause symptoms like vomiting, diarrhea, and loss of appetite.

A NEEDLE IN A HAYSTACK

Dogs are much more likely to contract CD in certain geographic regions. In the U.S., the disease is present in the Midwest, extending into eastern Wyoming and eastern Colorado. This regional distribution implies that the disease is related to an environmental factor, rather than being passed from animal to animal.

Previous research on CD suggests that rural dogs that spend time significant time outdoors are at increased risk. Researchers believe the cause may be something in the soil. Many dogs ingest some soil while they're digging—and perhaps ingest whatever causes CD as well.

Rafiee suspects a soil-dwelling microbe that produces some kind of neurotoxin may cause CD. But there are thousands of soil-dwelling microbes—and the researchers would also need to identify microbes that can produce neurotoxins.

To accomplish this difficult task, Rafiee and her colleagues collected samples of fecal matter from dogs with dysautonomia and dogs without dysautonomia. They grew, or "cultured," microbes from each of the samples to attempt to find soil microbes that are present in sick dogs, but absent in healthy dogs.

Rafiee and her colleagues identified some soil bacteria that were present in the fecal matter of dogs with dysautonomia that so far do not appear to be present in the fecal matter of healthy dogs. The research team is now conducting follow-up studies to try to pin down whether these bacteria produce neurotoxins—and perhaps cause CD.

CREATING NEW TREATMENTS

If Rafiee and her colleagues find the cause of CD, they could develop ways to prevent CD and diagnose it earlier. Scientists might even be able to create a vaccine that could be used in high-risk areas.

Though CD is a rare disease, those impacted by canine dysautonomia want to understand and find new treatments for it. During UW's last Giving Day campaign, Fox's lab received tens of thousands of dollars from grassroots donors in support of this research.[1]

"We're in the 21st century. It's really unusual to have a disease we have so little understanding of despite all the effort," Fox comments. "But there's been so many advances in research methods and disease diagnostics. We think it should be possible to figure out this disease soon."

Figuring out the cause of CD could have implications beyond dogs. Other animals, including rabbits, cats, and horses, suffer from dysautonomia. Understanding the disease in dogs could help researchers understand dysautonomia in these species as well. ■

To learn more, contact faculty advisor Fox at jfox7@uwyo.edu.

1 This research is also supported by a grant from the American Kennel Club.

University of Wyoming | College of Agriculture, Life Sciences and Natural Resources
DEPT. 3354, 1000 E. UNIVERSITY AVE.
LARAMIE, WY 82071

Nonprofit Organization
U.S. POSTAGE
PAID

College of Agriculture, Life Sciences and Natural Resources

agnews

EDUCATION | RESEARCH | EXTENSION

GROWING PEOPLE, KNOWLEDGE & COMMUNITIES

UW | uwagnews.com

Visit uwagnews.com for the latest updates from the University of Wyoming College of Agriculture, Life Sciences and Natural Resources.