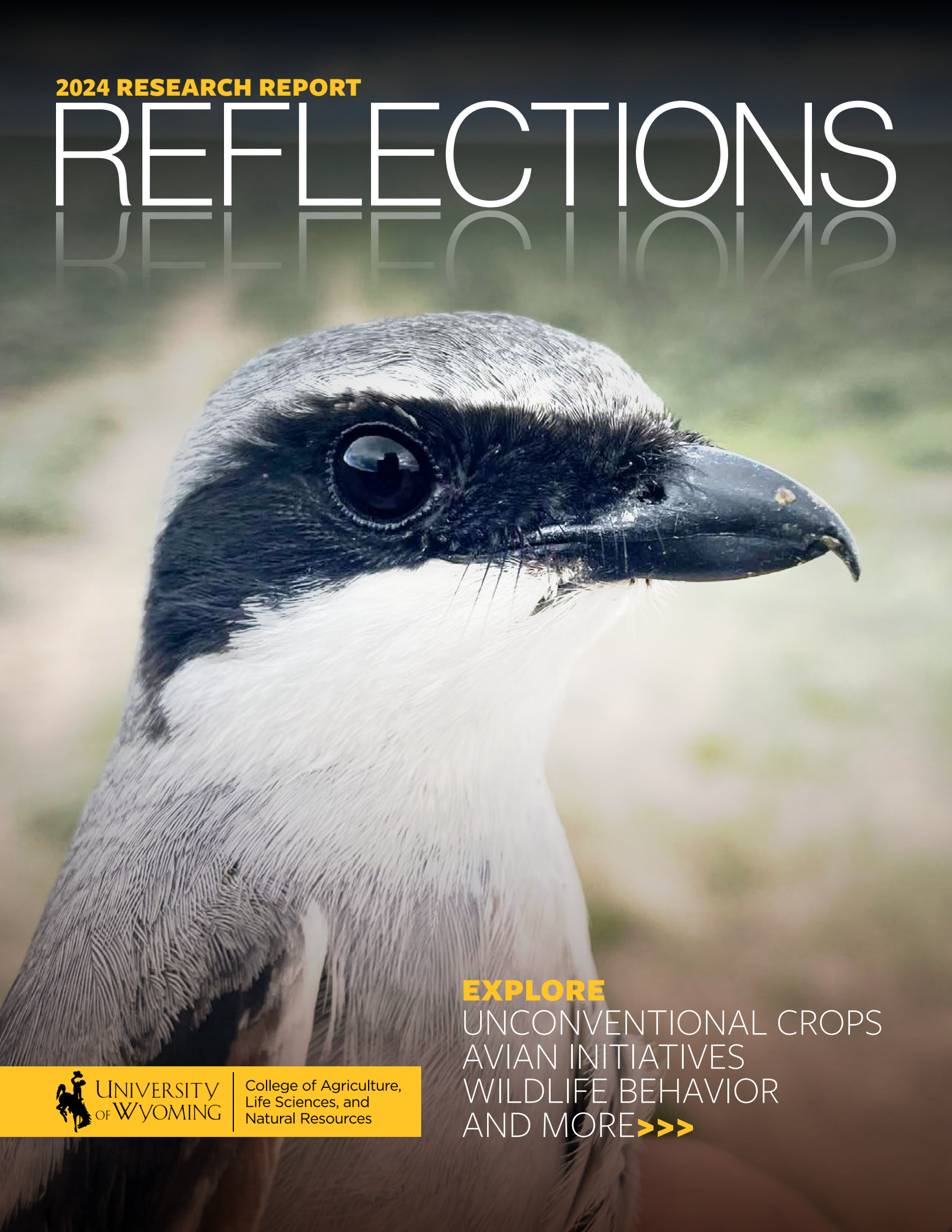
2024 RESEARCH REPORT

REFLECTIONS



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

REFLECTIONS

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

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Cover: Loggerhead shrike south of Pinedale, Wyoming. Photo by Erik Schoenborn.

FEATURES

12 **Bison reintroduction provides clues about animal learning, memory**

18 **Birds of a feather learn together**
WYOBIRD program empowers students, contributes to international databases

22 **Army ants and hungry birds**
UW students study species interactions in central Panama

26 **The Wyoming Cooperative Fish & Wildlife Research Unit**

30 **How do Wyoming bumble bees respond to heat stress?**

34 **Changes in snowpack predicted to affect snowmobiling in Wyoming**

2 Are hops a viable crop in Wyoming?

4 Reaping soil health benefits: Kernza outdoes annual wheat

6 UW Vertebrate Museum salvages and safeguards Wyoming's unique creatures

8 Pressed plants preserve history

9 Small bugs add up to big discoveries

10 Headed west: Swift fox moves into unconventional habitat

16 Urbanization in Mongolia affects one of the world's oldest protected spaces

20 Ever wondered how many birds collide with windows?

25 High-stakes karaoke: Understanding the duets of chestnut-backed antbirds

32 High-altitude globeflower exhibits unexpected response to habitat change

36 Connecting nutrition and mental health in the western U.S.

37 Ribosomes could help explain a broad spectrum of depression

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). As I wrote last year, CALSNR was completing a two-year reorganization with the addition of the Department of Zoology and Physiology and the Department of Botany, along with the Life Sciences Program. You will notice that this year's edition of *Reflections* features many of our new faculty and graduate students in these departments.

Highlighted research includes the economic impact of Wyoming's snowmobile recreation industry, the impact of wildlife migration in Wyoming, and the Wyoming Bird Initiative for Resilience and Diversity, to name a few. As you will see in this issue, CALSNR is more than just traditional agriculture. The college has a diverse faculty conducting research, extension, and teaching programs across a wide array of topics.

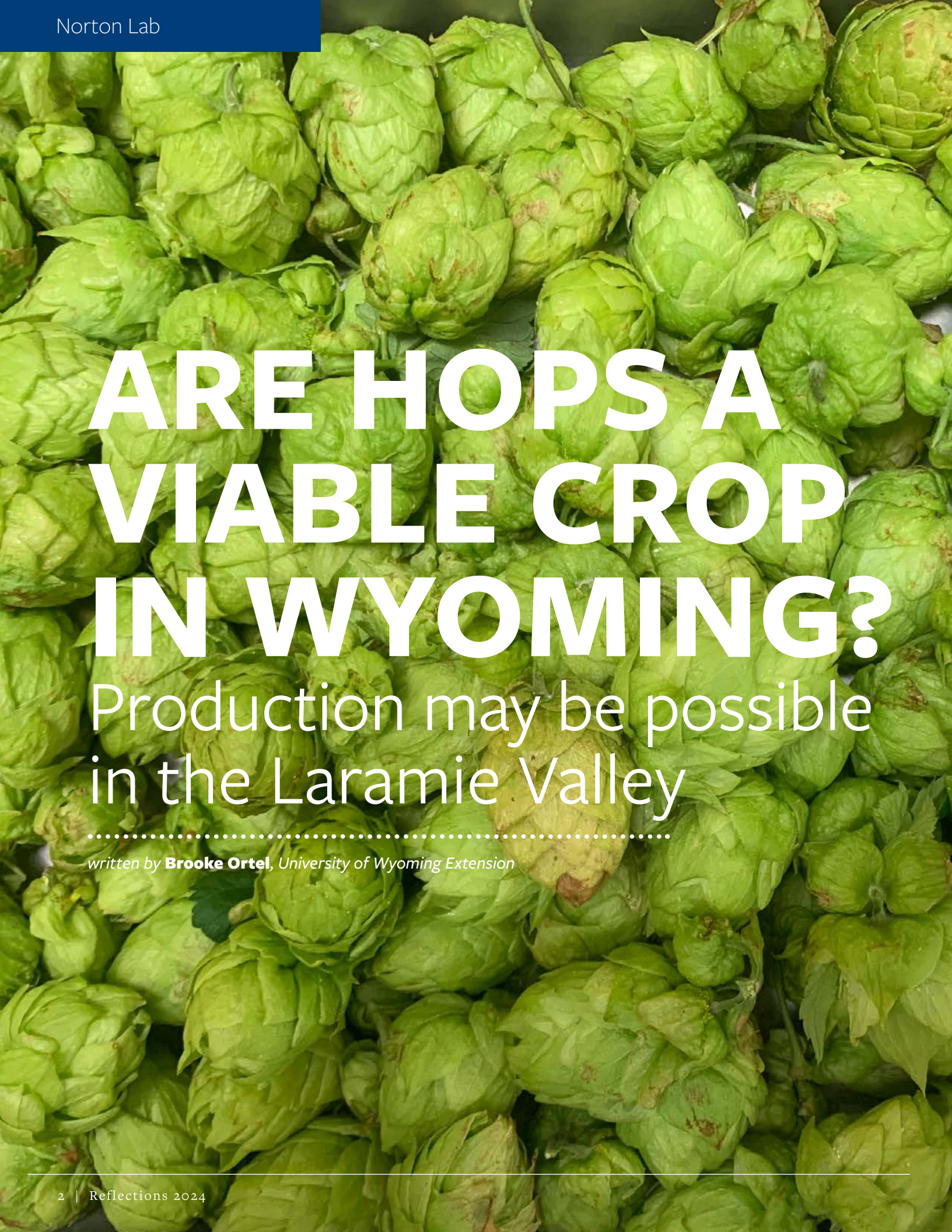
It's always exciting to see our faculty recognized by groups outside the University of Wyoming. This year, Dr. Andrew Kniss, plant sciences department head and weed scientist, was awarded the Harold P. Alley Award at the Wyoming Weed and Pest Council fall conference. This award recognizes an individual who has provided support, leadership, motivation, and education toward the advancement of weed and pest control programs in Wyoming. It is named for long-time UW weed scientist Harold Alley.

Dr. Beth Fowers, research scientist located at the Sheridan Research and Extension Center, was awarded the Outstanding Professional Staff Award from the Western Society of Weed Science. Dr. Don Jarvis, professor of molecular biology, was awarded the Rosalind Kornfeld Award for Lifetime Achievement in Glycobiology from the Society of Glycobiology. This prestigious award is given to a scientist who, throughout their professional career, has made outstanding contributions to the science of glycobiology.

Finally, Dr. Chris Bastian, professor of agricultural and applied economics, was named a Fellow of the Western Agricultural Economics Association. I want to offer my congratulations to all these individuals for their hard work and dedication to the University of Wyoming and their chosen fields.

I hope you enjoy the new issue of *Reflections*, and I think there is something for everyone in this edition. I believe our research is providing positive outcomes that improve the lives of Wyoming residents. I am excited for the future of CALSNR.

Eric Webster
Director, Wyoming Agricultural Experiment Station



ARE HOPS A VIABLE CROP IN WYOMING?

Production may be possible in the Laramie Valley

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

As a high-altitude state known for its harsh climate, Wyoming isn't an ideal location for growing hops, the small pinecone-like flowers produced by the hops plant. These odd flowers are a key ingredient in the beer-brewing process, producing bitter flavors and unique aromas.

While microbreweries have gained popularity across Wyoming, hops production has not. For brewers interested in experimenting with wet hops, which requires starting the brewing process within 24 hours of harvest, the lack of local hops presents a challenge.

Urszula Norton, a professor of plant sciences based in Laramie, saw this conundrum as an opportunity for local producers and brewers—if growing hops at 7,200 feet in a cold, windy, low-humidity location was feasible.

So far, her research suggests that it's possible, though commercial production may not be practical in the Laramie Valley.

A CHALLENGING ENVIRONMENT

When graduate student Rhett Greenwald began working on Norton's project in 2022, only four of seven hops varieties at ACRES Student Farm had survived their first year. As he monitored the remaining plants for growth and yield quantity and quality, the data looked promising—until hail decimated the crop. The following year, a May snowstorm damaged the vines; while they recovered, yield remained low.

Norton and Greenwald have donated several small batches of hops to a local brewery. While the samples were well received, the researchers recognize that larger-scale production could be challenging in Laramie's harsh and often unpredictable weather conditions. "Brewers have valid concerns about whether quantity and quality could be guaranteed," Greenwald comments.

Of the four hops varieties that Greenwald tested, Zeus performed the best, closely followed by Chinook and Centennial. Cascade did not perform well and is not recommended for production in the Laramie Valley.

MEASURING SUCCESS

To assess plant performance and health, Greenwald monitored the chlorophyll content in the plants' leaves, taking measurements every other week during the growing season. Hops plants grow best when provided a trellis structure to climb, and by the end of the summer, data collection meant climbing a ladder to reach the top of the towering vines.

At the end of each season, Greenwald gathered yield data, weighing the freshly harvested hops, then recording their oven-dried weight as well. To determine quality, he measured the levels of alpha and beta acids in both fresh and dried hops.

"Alpha and beta acids lend themselves to the aromatic component of beer and also the bittering and preserving aspect," Greenwald explains. "Those secondary metabolites can be affected by cultivation practices like tillage, production management, and fertilization as well as environmental factors like heat stress and drought stress."

Different varieties of hops are characterized by different levels of alpha and beta acids. For a local grower to succeed, they'd need to produce hops with consistent levels of these compounds. Quality-wise, the hops grown in Laramie yielded fairly standard levels of alpha and beta acids, though harvest quantity was limited.

BIOCHAR YIELDS PROMISING RESULTS

In addition to analyzing plant productivity and yield, Greenwald quantified soil fertility using measurements of soil moisture and plant-available nitrogen. This data was used to compare how hops performed with different soil treatments, namely the addition of biochar.

Hops plants are considered heavy feeders, meaning that commercial producers often treat them with nitrogen fertilizer at specific growth stages. Greenwald and Norton did not fertilize the plants in their study. Instead, they treated half the plants with biochar, short for biological charcoal.

Biochar is generated by burning organic materials in a low-oxygen environment. Research suggests that biochar can act as a slow-release fertilizer, capture nutrients, and sequester carbon in the soil. Biochar may also have anti-fungal and anti-disease properties.

Greenwald's experiment is likely the first to investigate how biochar affects hops plants. For his research, Greenwald used biochar produced locally from dead cottonwood trees. He found that the plots with added biochar had higher chlorophyll content and higher soil moisture than the plots without biochar. The plants with biochar also produced higher quality and quantity yields.

Since the soil amended with biochar had greater water and nutrient retention, it may reduce the amount of conventional fertilizer required to boost hops production, Greenwald notes. This could have both economic and environmental benefits.

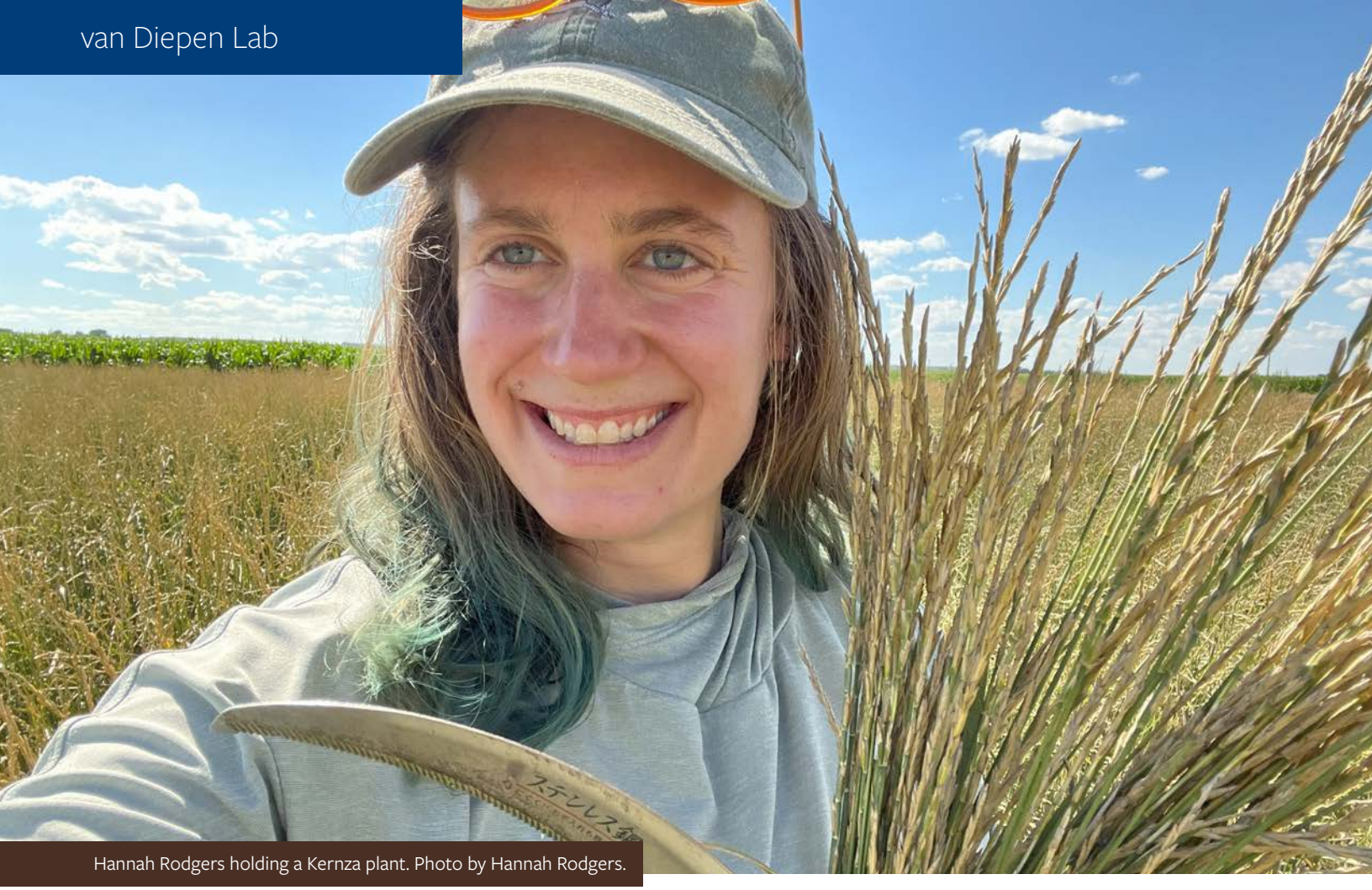
A HOPEFUL FUTURE

While the Laramie Valley might not be the ideal location, Norton and Greenwald's research demonstrates that hops production is indeed possible in Wyoming.

"If they can grow as well as they did in Laramie's tough environment and elevation, there's really good potential for them throughout the state, especially with the increase in microbreweries and home brewers," Greenwald says. ■

To learn more, contact Norton at unorton@uwyo.edu.

Hops study site at ACRES Student Farm in Laramie. Flags indicate the individual plants. Photos by Rhett Greenwald.



Hannah Rodgers holding a Kernza plant. Photo by Hannah Rodgers.

REAPING SOIL HEALTH BENEFITS: KERNZA OUTDOES ANNUAL WHEAT

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

Most of the foods humans eat come from just a handful of plants. In fact, more than half the plant-based calories humans consume come from wheat, maize, and rice—and all of these plants are annuals, which must be re-planted every year.

In contrast, almost all native ecosystems around the globe rely heavily on perennial plants, which grow for multiple years, protecting the soil from too much agitation and providing a reliable harvest.

Thirty years ago, the Land Institute, a Kansas-based nonprofit, had an idea: What if we developed perennial grain crops, which combine the environmental benefits of native plants with the agricultural needs of modern humans? One of the first plants the Land Institute developed was Kernza, a perennial grain crop originating from intermediate wheatgrass.

SOIL SCIENTISTS INVESTIGATE WYOMING KERNZA

Kernza is exactly what graduate students Hannah Rodgers and Alex Fox set out to research in Linda van Diepen's soil microbial ecology lab. Rodgers' project focuses on the impact of Kernza on soil health in southeast Wyoming wheat farms.

In southeast Wyoming, wheat farms use a wheat-fallow system. Farmers plant a field of wheat; after harvest, they do not plant anything in that field for 14 months so as to store soil water for the next crop.

Rodgers compared wheat-fallow fields, wheat-fallow fields that were planted to Kernza at the beginning of the study in 2021, and wheat-fallow fields that were planted to perennial grasses 10 years ago. These final re-planted perennial grass fields serve as a proxy for healthy native grasslands. "There's been a ton of studies that show that within about 10 years, perennial grasses can improve soil health to about 90% of native ecosystems," says Rodgers.

Though Rodgers' study did not demonstrate a change of that magnitude within a year of planting Kernza, she did find some early indications that the Kernza crop had healthier soil than the annual wheat it was planted next to.

SOIL HEALTH FINDINGS

First, the researchers observed a higher ratio of fungi to bacteria in the Kernza fields relative to the wheat fields. More fungi is an indicator of healthier soil, because more fungi means more hyphae (thin tendrils similar to plant roots). The hyphae help the soil stick together and allow it to hold onto water more effectively. This water retention is especially important in a dry environment like southeast Wyoming.

Participants at a field day organized by Hannah Rodgers near Albin, Wyoming, in June 2023. Participants are walking through a field of Kernza interseeded with alfalfa. Photo by Hannah Rodgers.

Rodgers also found there was greater depth stratification in the Kernza fields. Depth stratification means that the soil built up a surface layer with more organic matter, higher fertility, and higher microbial activity. Rodgers explains, "In the native system, you can even see a thin thatch layer on the soil surface that's protecting the soil beneath it." This surface layer improves water filtration, helps young plants start growing, and prevents erosion.

In contrast, conventional wheat often requires tillage, which mixes up this surface layer with deeper, less productive layers and leaves the soil vulnerable to erosion. Even just one year in, Kernza had started to form a surface layer, making the soil less vulnerable.

Rodgers also looked at the amount of organic matter, particularly labile (mobile) organic matter pools. Labile pools can be an early indicator of changes in soil health. Higher organic matter pools also indicate more stored carbon. Rodgers found higher labile organic matter pools in the soil around Kernza roots than in the soil around wheat roots.

STRONG ROOTS

One of Rodgers' most interesting findings was that Kernza had greater root biomass than both the wheat and perennial grass plants nearby. "We often breed plants that put energy into seeds, and we really don't know how that affects the roots," says Rodgers. "It's very hard to study that, because our food plants don't have a close comparison to wild species."

Kernza's large roots could present a fascinating opportunity to quantify just how crops' roots adapt as researchers change their fruit and seeds. Microbes associated with plant roots help plants access nutrients and water in tough times, so any adaptations or selection for root-associated microbes might be especially relevant in difficult terrain like Wyoming.

KERNZA'S FUTURE IN THE WEST

Difficult terrain is one of the biggest reasons that Kernza might present a meaningful opportunity for Wyoming farmers. "We're really thinking about it more in this region as a crop for risk management," says Rodgers.

Wheat is expensive up front—it requires that farmers buy seed every year, then spend time planting and managing weeds. Meanwhile, Kernza requires fewer passes with a tractor and competes with weeds better than wheat. In a dry year, Kernza can provide good-quality forage for livestock even if it does not produce many seeds.

In recent years, variability in precipitation and volatile markets have led to crop abandonment and made wheat-fallow systems less viable. Kernza may not produce as much good-quality seed as wheat in a good year, but it's more flexible, costs less to implement, and is better for the soil.

Though Rodgers' study is nearly complete, Kernza is just getting started. "Kernza acreage is increasing year after year—more and more groups are starting to market products that include Kernza," Rodgers comments. "A brewery in Fort Collins has a Kernza beer; small bakeries are starting to use it. It's getting better and better, and with the really rapid progress on the breeding side, I think that'll really push it forward."

A new study in Colorado will continue to examine Kernza in dry Mountain West conditions. There are even efforts to get Kernza added to the USDA's Conservation Reserve Program, which pays farmers to plant fields with crops that are more sustainable. From roots this strong, Kernza is bound to keep on growing.

For more information about Kernza in Wyoming, visit Kernzawyoming.org or follow @kernzawyoming on Instagram. ■

To learn more, contact van Diepen at linda.vandiepen@uwyo.edu.

Within the display collection, the University of Wyoming Museum of Vertebrates highlights the different birds and mammals that graduate and undergraduate students prepare in the museum. Photo by Beth Wommack.

UW Vertebrate Museum Salvages and Safeguards Wyoming's Unique Creatures

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

The University of Wyoming Museum of Vertebrates is exactly what it sounds like: a museum dedicated to preserving vertebrate species. Other collections on UW's Laramie campus, like the Geological Museum and the Anthropology Museum, also include some vertebrate samples, but their focus is on ancient history, rather than modern morphology or recently extinct species.

There are three kinds of collections in the vertebrate museum: dry collections, tissue samples (often organs) that are stored cryogenically, and wet collections. The dry collection contains preserved mammals and birds, skeletons, skins, nests, eggs, and scat. The wet collection includes whole reptiles, amphibians, fish, parasites, or parts of animals stored in ethanol. In total, the museum hosts about 22,000 specimens from 865 different species.

Though it may sound grim, these collections serve an important function. "We don't understand what we're doing to this world," says Beth Wommack, curator and collections manager of the UW Museum of Vertebrates. "Understanding how animals are reacting to the changes in the environment will help us mitigate our effects."

Wommack's goal is not just to expand databases, but also to treat animals with respect by carefully preserving and displaying them. By preserving vertebrate specimens, animals are remembered again and again—not just when they first perish, but whenever someone accesses that specimen, for as long as the collection lasts.

"A lot of research is interested in asking a specific question, you take measurements and then go away—but with a vertebrate museum, that animal isn't just there for that one question, it's there to understand that species, that habitat, that time period, for any question someone has in the future," says Wommack.

UW's vertebrate museum recently became part of the Ranges Project, an effort funded by the National Science Foundation that brings together vertebrate museum specimens from across North America and Mexico. The grant focuses on digitizing data on mammal specimens. This information, also known as attribute data, could include an animal's body size or where it was found.

"We're probably the smallest collection in the Ranges Project," admits Wommack. But the UW Museum of Vertebrates' roughly 7,600 mammals fill an important gap. Wyoming is a unique environment, from the species that call it home to its physical and social landscapes. As curator of the vertebrate museum, Wommack has forged personal relationships with salvagers, hunters, and the Wyoming Game and Fish Department—relationships that likely wouldn't exist outside of Wyoming.

The UW Museum of Vertebrates plans to help preserve that unique environment for quite some time. Since 2011, the museum has been housed in the Berry Biodiversity Conservation Center. Faculty curator Matt Carling helped design the museum with extra cabinets and room to grow into the new space.

Though the vertebrate museum may not have collections as extensive as other museums on campus, it is already used by researchers, elementary school students, community members, and even art or history students who may look at the specimens from another perspective. UW's vertebrate museum will remain a place where Wyoming communities can learn from all of Wyoming's exceptional creatures. ■

To learn more, contact Wommack at ewommack@uwyo.edu.

Volunteer working in the vertebrate museum labs. Photo by David Keto.

A specimen of Wyoming paintbrush (*Castilleja linariifolia*), the state flower of Wyoming. Specimens like this are preserved in the herbarium collection as a permanent record of the diversity and distribution of plants in Wyoming and the Rocky Mountain region. Photo by David Keto.

PRESSED PLANTS PRESERVE HISTORY

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

With more than 1.4 million specimens, the Rocky Mountain Herbarium (RMH) is one of UW's most impressive museum collections. About 900,000 of the herbarium's specimens are cataloged online through a public database portal, and over 400,000 also have images available online.

Herbaria are plant museums. Botanists press and preserve whole plants, then record data about who collected the sample, where and when it was found, elevation and site description, and other identifying information.

Though all museums catalog history, the Rocky Mountain Herbarium's history permeates every aspect of the Aven Nelson building. The structure was named after botanist Aven Nelson, who founded the herbarium in 1894. Today, the herbarium is poised to take over the Aven Nelson building's second floor.

The herbarium needs the space. Many of the RMH's samples have been lurking on top of museum cabinets for years, unprotected and difficult to access. A recent National Science Foundation grant has helped fund the efforts to expand the museum's footprint and digitize images of samples along the way. "As we move specimens as part of the expansion process, we're capturing images. That not only protects them, it increases accessibility by getting them out of cardboard boxes and into both our physical and digital collections to use," says David Tank, the herbarium's current director. "That's a big job."

"Big" is perhaps an understatement. The RMH has a history of active, focused collection efforts. Under the leadership of former director Ron Hartman, students in UW's floristics program would collect hundreds of samples a day throughout a summer.

This history of fieldwork allows current students a unique opportunity: the chance to go out and re-survey areas that were first surveyed decades ago and see what's changed. For example, thanks to the work of past floristics students, botanists have an excellent snapshot of just when invasive species first appeared on the ground. This wealth of historical data also gives them tools to make data-informed hypotheses about what might shift going forward as new species show up and ecosystems change. RMH's collections help not only to preserve species diversity in the present, but are also invaluable in perpetuity.

All museums are an investment from the past in an unpredictable future. Tank and other botanists remain dedicated to protecting and expanding the rich legacy of the Rocky Mountain Herbarium for years to come. ■

To learn more, contact Tank at dtank@uwyo.edu.

Several of the display cases in the Insect Gallery. Upper cases, left to right: local butterflies, tropical sunset moths, and mega-moths of Wyoming. Lower cases, left to right: assorted beetles, metallic jewel beetles, and scarab beetles. Photo by Scott Shaw.

SMALL BUGS ADD UP TO BIG DISCOVERIES

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

The fourth floor of the agriculture building may seem an unlikely place to find one of UW's most unusual museums. Yet that's where you'll find the UW Insect Gallery. The gallery displays tableaus of specimens, facts, and even live insects.

Scott Shaw, professor of entomology and curator of the UW Insect Museum, began setting up the public gallery soon after arriving at the university in 1989. Its opening in 1993 celebrated 100 years of entomological studies at UW; in October 2023, several new exhibits were added to mark its 30th anniversary.

At first glance, the museum's behind-the-scenes research collections may seem less interesting than the gallery. The cramped rooms are filled with towering museum cabinets and lined with books and other accoutrements of the insect-collecting trade.

Despite the small space, the collection contains more than a million preserved specimens from around the world, including over 500 type specimens—the first examples ever found of newly discovered species.

The insect collection got its start in 1892 with zoology professor Frank Niswander, but has grown exponentially over the last 130 years, supported in part by several National Science Foundation grants. Entomologists of past centuries tended to collect museum specimens by venturing out with a net, favoring large species, but newer passive methods allow present-day entomologists like Shaw to discover tiny new species. These novel methods include flight-intercept traps, which are large mesh tents that funnel flying insects into ethanol jars, instantly preserving them.

"A lot of other collections may be physically bigger or older, but we've been concentrating on really small things to increase the likelihood we'll archive species that aren't well represented," explains Shaw.

In particular, Shaw studies parasitic *Aleiodes* wasps, tiny beneficial insects that lay their eggs inside caterpillars. The UW Insect Museum also boasts an impressive collection of robber flies and grasshoppers, as well as neotropical species.

In the Insect Gallery, you can find display cases filled with big, charismatic bugs, like butterflies, cicadas, and colorful beetles. Though Shaw's microscopic wasps may not be as pretty, they're a good reminder that even the tiniest creatures are worth understanding and preserving.

"We're a long, long way from knowing everything there is to discover about insects, and even Wyoming species," says Shaw. But one has to imagine that more than 500 new species and more than a million specimens have made a bit of a dent. ■

To learn more, contact Shaw at braconid@uwyo.edu.

A collared female with three of her kits at the Laramie study site in the shortgrass prairie, which is considered conventional swift fox habitat. Photo by Kelsie Buxbaum.

HEADED WEST: SWIFT FOX MOVES INTO UNCONVENTIONAL HABITAT

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

In Wyoming, a feisty five-pound canid known as the swift fox is expanding into new territory.

A native of the Great Plains, the swift fox can be found in shortgrass prairie habitats from Texas to Canada. In Wyoming, this prairie-dog-consuming critter typically wasn't found west of Shirley Basin—until recently. Swift fox populations have now been observed in shrubland habitats as far west as Riverton.

Currently, it's unclear why swift foxes are moving into less favorable habitats, or how this shift might affect their diet and behavior. A group of researchers in the UW Department of Zoology and Physiology, including graduate student Kelsie Buxbaum, aims to learn more.

BREAKING CONVENTION

As small canids, swift fox prefer landscapes where they can spot predators from a distance and quickly dive into the safety of a burrow. With relatively flat topography and plentiful food sources, shortgrass prairie provides an ideal habitat. But in locations like Riverton, swift fox populations have settled in areas with tall sagebrush and significant variation in topography, both of which reduce visibility.

To find out how this habitat change affects swift fox populations, Buxbaum is comparing habitat use and diet in three different study areas: Laramie, the Shirley Basin, and Riverton. The Laramie site is classified as conventional habitat, while the Shirley Basin site is a mosaic of shortgrass prairie and shrubland. The Riverton site represents a completely unconventional habitat consisting mostly of tall sagebrush.

"We're looking at how swift fox utilize landscape features similarly or differently in each habitat type—which features they potentially select or avoid," Buxbaum explains. Her group uses GPS collars to track swift fox movement and then uses remote sensing data to pair locations with vegetation types.

DIET ANALYSIS

Buxbaum also seeks to better understand how habitat changes affect the swift fox's diet. In both the Laramie and Shirley Basin study sites, researchers have observed sizable prairie dog colonies, an important food source for swift fox. In contrast, the Riverton site appears absent of prairie dog activity.

Starting in August 2021, Buxbaum's group collected 250 scat samples, which are currently undergoing DNA analysis at the United States Forest Service National Genomic Center. This analysis will indicate what types of food—insects, plant matter, or different types of mammals—swift fox consume in different habitats and seasons.

Buxbaum predicts that in unconventional habitat types, swift fox are likely consuming other rodents, such as kangaroo rats and wood rats, as well as members of the rabbit family.

COUNTING KITS

In spring 2022, Buxbaum began tracking kit populations at each study site, using GPS collars and VHF (very high frequency) technology to locate individual dens. She installed game cameras at each den to monitor the number of kits observed and when those kits came aboveground. The latter will allow researchers to estimate when the kits were born.

"The reproductive aspect is an important metric that will be used by Bureau of Land Management[1] biologists to help reduce impacts on swift fox," says Buxbaum. "It's also a metric that can be used to assess the general fitness of an individual and population."

MANAGEMENT IMPLICATIONS

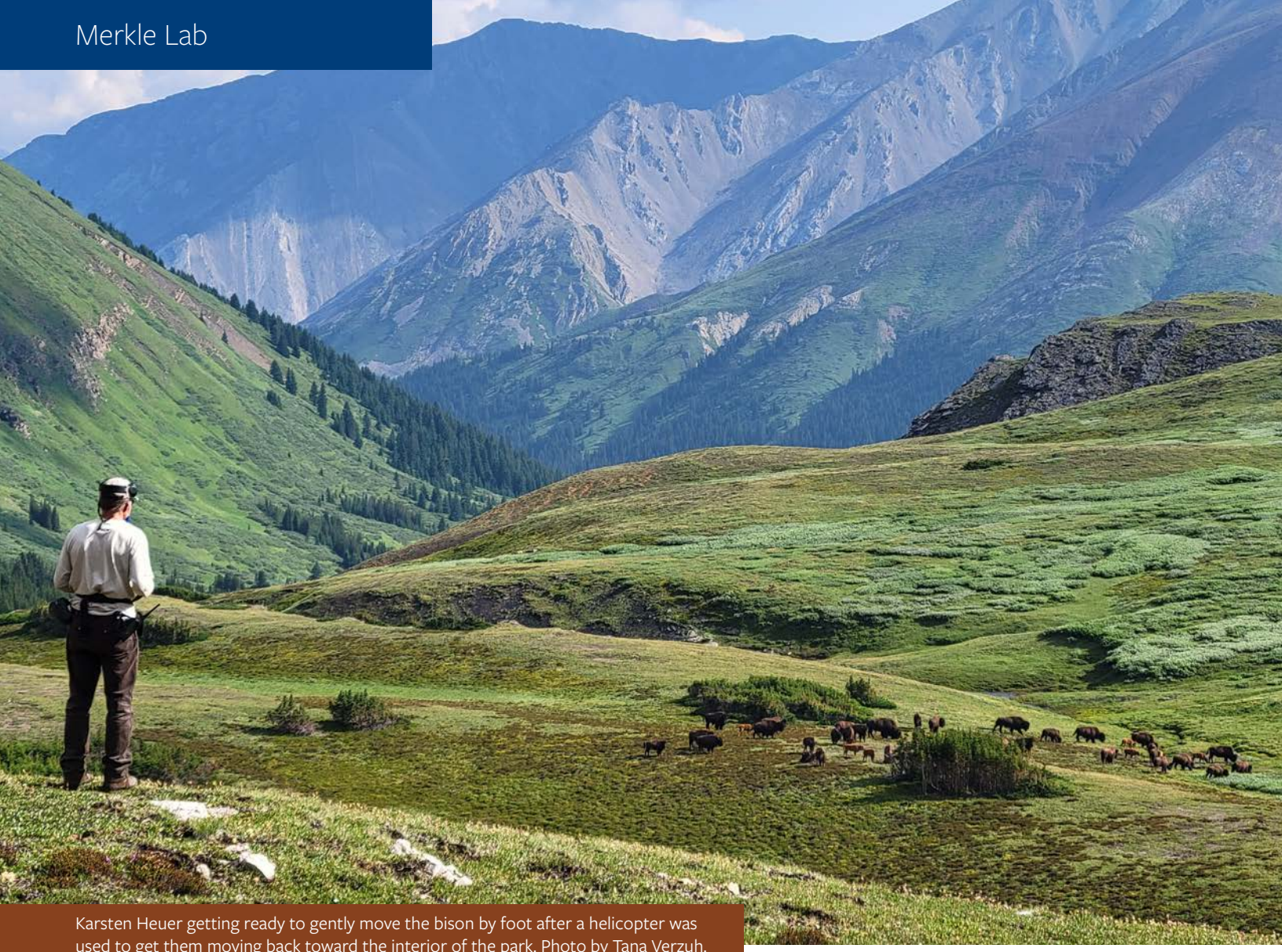
The Bureau of Land Management considers the swift fox a sensitive species, and Buxbaum's project is part of a larger effort to understand how swift fox populations respond to habitat changes. Her research may ultimately have implications for swift fox management in areas experiencing ground disturbance associated with energy development.

"It's a great opportunity because not only are we learning more about the fundamentals of swift fox ecology and life history, but we're also working hand in hand with the Bureau of Land Management to better manage landscapes for swift fox," Buxbaum comments. ■

To learn more, contact faculty advisor Joe Holbrook at joe.holbrook@uwyo.edu.

1 The Bureau of Land Management provided the majority of funding for this project.

An adult swift fox fitted with a GPS collar that allows researchers to track its movements. Data from these collars is used to determine space use, habitat selection, and den locations. Photo by Joe Holbrook.



Karsten Heuer getting ready to gently move the bison by foot after a helicopter was used to get them moving back toward the interior of the park. Photo by Tana Verzuh.

Bison Reintroduction Provides Clues about Animal Learning, Memory

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

If you've ever moved, you might remember mapping out new routes to work, the grocery store, and other key locations. Perhaps it took you a couple trips to get completely oriented.

You're not alone. Many animals—including the bison recently reintroduced to Banff National Park—go through a similar process when adjusting to a new habitat.

Reintroduction programs are often touted as a way to mitigate biodiversity loss, but the prospect of large, highly mobile animals wandering outside park boundaries poses safety concerns for both humans and bison.

REINTRODUCTION PROGRAMS

Unintended dispersal (e.g., free-roaming bison) is one of the reasons that reintroduction programs are often unsuccessful, says Tana Verzuh, a PhD student in the UW Department of Zoology and Physiology and Program in Ecology and Evolution.

Verzuh studies animal spatial learning, the process by which animals learn and memorize their surroundings. Starting in 2020, she has worked with Parks Canada to evaluate the effectiveness of different management tools in helping reintroduced bison learn—and remember—the boundaries of their new home. "If we are seeking to alter an animal's behavior, we need them to learn," she says. "But with reintroduction, we also don't want to overstress them because we want them to settle."

In 2017, 16 bison from Elk Island National Park were transported to Banff National Park. The bison were contained in a large enclosed pasture for a year and a half, allowing them to gradually adjust to their new environment before they were released into the park's full expanse—more than 2,500 square miles, 96 percent of which is considered wilderness.

The Parks Canada team monitored the herd

Tana Verzuh, Dillon Watt (Parks Canada), Sean Elliott (Parks Canada), and Bryan Macbeth (Parks Canada) take vitals and biological samples while fitting a collar on a female bison in the backcountry of Banff National Park while Adam Zier-Vogel (Parks Canada) keeps an eye out for curious bison. Photo by Karsten Heuer.

and employed various management techniques to ensure the animals remained within the park's boundaries. Meanwhile, Verzuh used GPS collars and remote sensing data to track each bison's behavior as they explored their new home.

HAZING AND STRESS

For researchers interested in understanding animal learning and memory, reintroduction programs present a unique opportunity. Reintroduction allows researchers to observe how animals move through and settle into a completely unfamiliar environment—and how management techniques affect this process.

The most successful management strategies use "hazing" methods that are stressful enough to be effective, but not so stressful that they discourage reintroduced animals from settling into their new environment, Verzuh notes.

In Banff National Park, the Parks Canada team used a variety of hazing strategies to prevent the bison from straying beyond the park's boundaries. Hazing techniques were implemented on foot, on horseback, and via helicopter.

Verzuh's team predicted that exposure to stronger negative stimuli, such as helicopters, would cause greater stress responses in the reintroduced bison than less invasive tactics, such as guiding the animals back into the park's inner region on foot.

Their data supported this hypothesis. Specifically, they found that hazing on foot, hazing on horseback, or installing fencing in strategic locations was less effective at changing behavior than using helicopters or employing multiple forms of hazing in combination.

The researchers found that helicopter and combined hazing techniques increased the speed and duration of the bison's movement, but the effects diminished after about 36 hours. "Bison are a social species, so blowing groups

apart can be really stressful—but we found that wasn't happening," Verzuh explains. "We saw an increased stress response, but it wasn't elevated or prolonged, and we didn't see a really negative effect on group dynamics."

That's largely due to how Parks Canada team members used the hazing techniques, she says. They intentionally avoided pushing the animals too hard, taking care to never induce a full-out sprint.

When stressed, animals tend to select safe habitats, such as places that provide cover or familiar locations. However, even when helicopter hazing was employed, Verzuh didn't observe significant changes in habitat selection, suggesting that the bison were stressed enough to avoid the hazing area but not so much that they were prevented from settling into their new environment.

EFFECTIVE MANAGEMENT

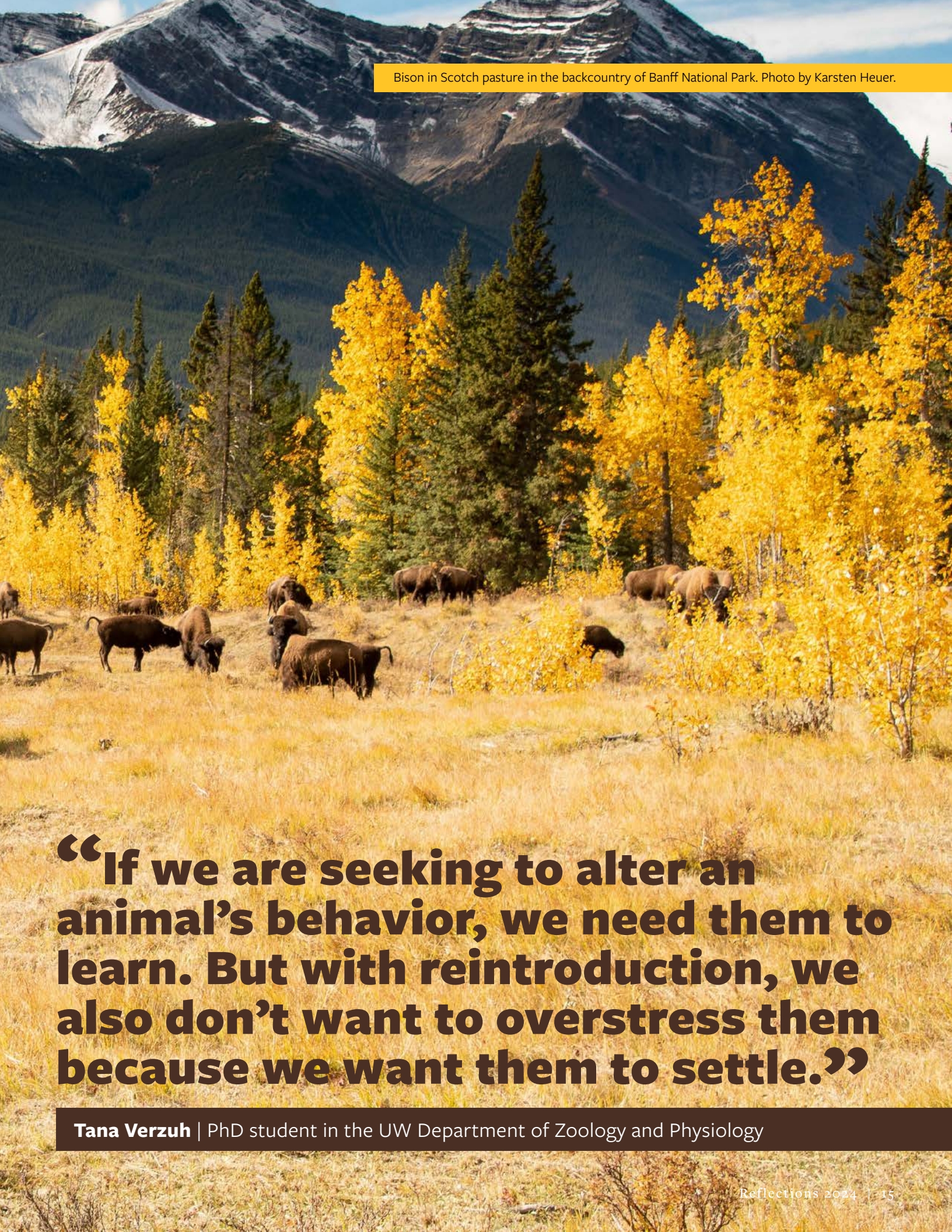
For a management program to be truly successful, reintroduced animals must learn to consistently avoid the areas where hazing occurred, not just flee in the moment.

The bison in Verzuh's study continually returned to locations where they encountered low-stress management techniques, indicating a lack of associative learning. In contrast, they rarely, if ever, returned to locations where they experienced helicopter hazing or combined hazing.

Verzuh's results suggested that higher stress management techniques, when implemented thoughtfully, were most effective at promoting long-term associative learning. "This active management has really helped successful reintroduction," she concludes. "They still explore once in a while, but they've settled on the landscape."

Currently, more than half of reintroduction programs fail. But Verzuh is hopeful that using animal learning to inform management strategies will facilitate better outcomes. "If we evaluate different tools through the framework of animal learning, we can select more effective tools based on behavioral changes," she says. ■

To learn more, contact faculty advisor Jerod Merkle at jmerkle@uwyo.edu.



Bison in Scotch pasture in the backcountry of Banff National Park. Photo by Karsten Heuer.

“If we are seeking to alter an animal’s behavior, we need them to learn. But with reintroduction, we also don’t want to overstress them because we want them to settle.”

Tana Verzuh | PhD student in the UW Department of Zoology and Physiology

Urbanization in Mongolia Affects One of the World's Oldest Protected Spaces

Dogs and wolves interact in an urban-wildland interface

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

Outside Ulaanbaatar, the capital of Mongolia, lies one of the world's oldest wildlife reserves, the Bogd Khan Mountain Strictly Protected Area (BMSPA). Now a UNESCO biosphere reserve, the area's protected status stretches back to the 12th century, when restrictions on timber harvest and hunting were first imposed.

Today, stray dogs from the rapidly expanding city are encroaching upon what has long been considered a sacred mountain and wildlife sanctuary.

URBAN-WILDLAND INTERFACES

In collaboration with the Mongolian Academy of Sciences, UW graduate student Jeff Dolphin[1] conducted two seasons of field research to investigate concerns about stray dogs competing with wolves for ecological resources. The goal was to gather data that local administrators could use to inform management decisions and prevent conflict between dogs, wolves, and local herders.

The International Union for Conservation of Nature (IUCN) categorizes Mongolian wolves as a near-threatened population. The BMSPA, which is approximately 417 square kilometers in size, is thought to harbor one to two wolf packs. Despite a monthly removal program initiated by BMSPA officials, stray dogs continue to be found in the reserve.

In 2022 and 2023, Dolphin's team worked with the Mongolian Academy of Sciences to set up and monitor 72 trail cameras at 36 survey stations in the BMSPA. Cameras were monitored from April through August each year. The photos and video footage captured with these cameras was used to assess the spatial and temporal ranges of stray dogs and wolves in the area.

ON CAMERA

In 2022, stray dogs were recorded in only 3 of the 36 survey stations while wolves were recorded at 20 survey stations. The following season, stray dogs were detected on camera at 8 survey stations, but wolves were detected at only 17, possibly indicating that a pair of wolves in the area had moved farther up the mountain and away from human activity.

In general, Dolphin's team found that the number of dog detections was highest near urban areas, but overlapped with wolves in both space and time. The number of wolf detections increased as distance from the city increased. Wolf detections decreased closer to the city and near areas with more humans and livestock.

In addition to the study area in BMSPA, the Mongolian Academy of Sciences is using cameras to monitor three other sites on the outskirts of Ulaanbaatar. Unlike the BMSPA, these sites do not have protected status, Dolphin notes.

SURVEY RESULTS

Dolphin's team also conducted surveys in person and online to learn more about the impacts and public perception of wolves and stray dogs near the BMSPA. "We're coming from a western scientific perspective, but they have management strategies they've practiced within their culture," says Dolphin.

While in Mongolia, he interviewed 15 herders living near the BMSPA, all of whom reported suffering livestock losses to wolves in the past. Twenty-seven other local residents, including government employees, completed surveys online or in person.

Many herders rely on guard dogs to protect cattle, goats, and other livestock, but wolf predation remains a problem. While setting up cameras in 2023, Dolphin observed a single wolf and freshly killed calf in the protected area.

Even though wolves pose a threat to livestock, most locals do not seem to favor complete eradication. "Bears have already been eliminated from the BMSPA," Dolphin comments. "It would be a shame to lose any more wildlife in the oldest protected space in the world and eventually just be left with an empty mountain void of its wildlife." ■

To learn more, contact faculty advisor John Koprowski at jkoprows@uwyo.edu.

1 Dolphin is a graduate student in the UW Department of Zoology and Physiology and works closely with John Koprowski, dean of the Haub School of Environment and Natural Resources. Several generous donors provided funding for Dolphin's research through the Koprowski Lab, and he also received funding from the American Center for Mongolian Studies.

A wolf in the BMSPA recorded via camera trap. Photo courtesy of Jeff Dolphin.

Interviewing a local herder about wolves in the BMSPA. This interviewee believed the wolves in the BMSPA had already hybridized with a breed of hunting dog called a taiga. Photo by Jeff Dolphin.

After spotting the remains of a domestic calf killed by a wolf, researchers installed a camera nearby, capturing an image of the wolf when it returned to feed. Photo courtesy of Jeff Dolphin.

Mary De Aquino, PhD student in Corey Tarwater's lab, holding a spotted towhee at the fall bird-banding station. Photo by Ted Brummond.

BIRDS OF A FEATHER LEARN TOGETHER

WYOBIRD program empowers students, contributes to international databases

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

Who hasn't had their attention caught by the darting movement of a hummingbird, the call of a chickadee, or the slow circling of a bird of prey?

The new Wyoming Bird Initiative for Resilience and Diversity (WYOBIRD) program was built for exactly this kind of observation. "Science is really about having curiosity, connecting with the natural world—wanting to understand what we see around us," comments Corey Tarwater, director of WYOBIRD and an associate professor in the UW Department of Zoology and Physiology.

WYOBIRD's mission is to conduct novel research on birds, train undergraduate and graduate students, and share science through public outreach. Through the WYOBIRD initiative, students get a hands-on introduction to ornithology in addition to gaining marketable skills, a sense of community, and a chance to direct their own education. They also have opportunities to gain ornithology skills through workshops, invited speakers, and fieldwork.

Students help determine what projects and presentations WYOBIRD introduces. "I've been really surprised how meaningful WYOBIRD is for students," says Tarwater. "It's a phenomenal experience, being able to play a bigger role in their education."

That's the other thing about WYOBIRD: its reach goes beyond the Department of Zoology and Physiology, and even beyond UW. Students from any department are welcome to join WYOBIRD, which can provide internship hours. WYOBIRD will introduce paid undergraduate internships this fall, with the hope of adding more paid undergraduate and graduate opportunities as the initiative continues to grow.

Students in the program participate in WYOBIRD's research projects, conduct public outreach, and receive support for their own independent research. Currently, the program has two major research projects—a nest box study and a fall bird-banding station.

Tree swallow nestlings. Photo by Katie Schabron.

NEST BOX STUDY

The nest box study was set up 10 years ago as a collaboration between the Boy Scouts of America, the Audubon Society, and a UW graduate student. The Boy Scouts created enough birdhouses for about 400 tree swallow nestlings in the Hutton National Wildlife Refuge, a beautiful pond-filled area 20 minutes outside Laramie.

For the past 10 years, Audubon has checked the nest boxes and compiled data. "They were happy to let us take it over so we could give undergrads experience with how research is conducted and how nest box studies work," says Tarwater.

Twice per week, students check up on the nests and record whether there are eggs or nestlings, as well as the birds' behaviors, such as feeding their young—or group attacking the erstwhile researchers!

Some of the data WYOBIRD collects is entered into NestWatch database, a nationwide nest-monitoring program that allows large-scale comparisons of the breeding biology of birds across the United States.

Students remove birds from a mist net at the fall bird-banding station. From left to right, undergraduate intern Therese Turner, MS student Erin Stewart, and MS student Kim Jordan. Photo by Erik Schoenborn.

FALL BIRD BANDING

WYOBIRD's other research project follows a similar model. From August to October, WYOBIRD members banded birds by the Laramie River to try to understand birds' fall migrations.

Graduate students with a background in banding ran the program, with help from WYOBIRD faculty. The program also trained six undergraduate interns, providing undergraduates with hands-on practice and graduate students with mentorship experience.

Twice a week, members of WYOBIRD set up mist nets to temporarily capture migrating birds. Mist nets are like see-through volleyball nets that catch birds without harming them. Birds were measured, aged, sexed, and banded with a unique number. This band allows other mist-netting efforts to track specific birds or species, and it gives WYOBIRD the chance to see if the bird comes back next year. After its band was applied, each bird was let go to continue on its migration.

WYOBIRD netted about 800 birds of 50 different species in 2023, and 25 people participated in the banding process. They gathered information about Wyoming's unique place in fall migration cycles and contributed to a larger understanding of fall migrations across North and South America.

Through collaboration and community, WYOBIRD demonstrates that we aren't just limited to questions about our own little nest box. Together, the sky is the limit. ■

To learn more, contact Tarwater at corey.tarwater@uwyo.edu.

Ever Wondered How Many Birds Collide with Windows?

Undergrad researcher aims to find out

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

Thunk! As you peer out the window, a small feathered object hits the glass and bounces to the ground. It's another bird-window collision. But do you know what kind of bird it is? And how many of its kind bonk into windows annually?

These are the questions driving Katie Schabron's research. An undergraduate researcher in the UW Department of Zoology and Physiology, she became involved in the UW Bird-Window Collision Project[1] in 2023.

With funding from the Wyoming Research Scholars Program (WRSP) and NASA, Schabron has developed and implemented data collection protocols for observing and recording bird-window collisions on UW's Laramie campus.

Window strikes kill approximately 300 to 900 million birds annually, and Schabron hopes that her research will ultimately help reduce fatal collisions on campus.

BIRD BEHAVIOR AND MORTALITY

In summer and fall 2023, Schabron monitored 82 building facades (some of which were different sides of the same building) on UW's Laramie campus. She visited 28 locations daily, observing bird movement and behavior at each site. She also counted the number of dead or injured birds present.

Schabron selected data collection sites that maximized the number of facades she could safely observe for five minutes without interruption by vehicle traffic. At each site, she recorded the date, time, species, starting height, and final height of every bird observed in a five-minute interval.

Heights were estimated in the field[2] by comparing a bird's flight path to the height of a nearby facade. If a bird struck a window, Schabron also noted whether it flew away, was injured, or died.

While she's still working on statistical analysis, her data looks promising so far, with far fewer collisions and mortalities than predicted. This might be because there are fewer high-rise buildings in Laramie compared to other university campuses, because there are simply fewer birds passing through campus, or some combination of factors.

"One of my personal predictions is that if buildings are closer together, there will be fewer mortalities because birds can't achieve higher speeds," Schabron adds. "If they do strike, they can recover from that."

ENVIRONMENTAL FACTORS

Schabron is also tracking various environmental factors that could potentially affect the number of collisions in a particular location. These factors range from a building's color and the number of windows on a facade to the presence of different tree species. The goal is to determine whether building features, nearby plantings, or other environmental conditions can be modified to help reduce collisions.

"Ideally, I'd like to find the drivers behind window strikes, specific to species, and determine if there are different deterrents to put on buildings," Schabron says. "I would love to see UW have zero bird mortalities."

CITIZEN SCIENCE

As she gathered data over the summer, Schabron also helped test and refine an app designed to facilitate citizen science. The app allows students and community members to monitor bird-window collisions as they walk around campus.

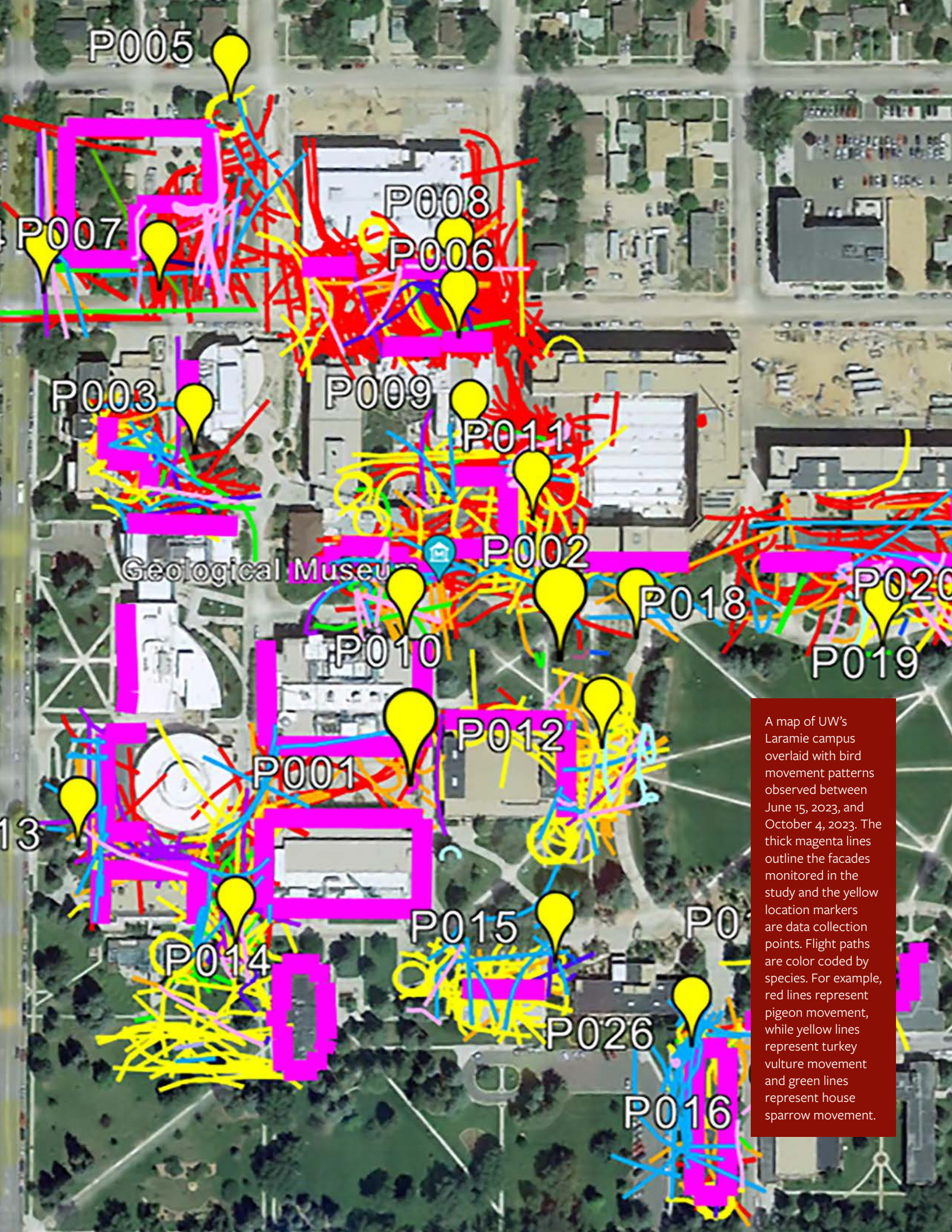
"If you see a bird that you think may have struck a window, you can go through stages on the app and send data to us," Schabron explains. "It's a new part of our project and we're hoping to get more people involved."

To get started, download the Epicollect5 mobile app (available for both Android and Apple devices) and search for "UW Bird Window Collision Report." Anyone can report a collision, and it only takes a minute or two! ■

To learn more, contact faculty advisor Patrick Kelley at patrick.kelley@uwyo.edu.

1 The UW Bird-Window Collision Project is part of WYOBIRD, the Wyoming Bird Initiative for Resilience and Diversity. To learn more, visit wyobird.org.

2 During data analysis, heights approximated in the field are validated using the exact dimensions of campus buildings.



A map of UW's Laramie campus overlaid with bird movement patterns observed between June 15, 2023, and October 4, 2023. The thick magenta lines outline the facades monitored in the study and the yellow location markers are data collection points. Flight paths are color coded by species. For example, red lines represent pigeon movement, while yellow lines represent turkey vulture movement and green lines represent house sparrow movement.

Bicolored antbird (*Gymnopithys bicolor*). Bicolored antbirds are the species most commonly seen at ant swarms at the students' field sites. Photo by Liz Howard.

Eciton burchellii ant nest, or "bivouac," in the base of a palm. Photo by Liz Howard.

ARMY ANTS AND HUNGRY BIRDS

UW students study species interactions in central Panama

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

In Wyoming, "trampling" brings to mind an angry bull—but in the tropical rainforest of Panama, thousands of small insects trample across the forest floor, changing the entire dynamic of the ecosystem in their wake.

Eciton burchellii is a species of army ant that marches across the rainforest in swarms up to 30 meters across, sending prey species fleeing in every direction. The unfortunate prey is snatched up not just by the ants themselves, but by hordes of birds that follow swarms around in hopes of an easy lunch.

But just how do birds interact with these intense little insects? Undergraduates Liz Howard and Bri Agenbroad and graduate students Michael Castaño Diaz and Mary De Aquino set out to learn more about bird-ant interactions in Panama's Soberanía National Park.

Howard, Agenbroad, and De Aquino are part of Corey Tarwater's avian ecology and behavior lab. Tarwater is an associate professor in the University of Wyoming Department of Zoology and Physiology. Castaño Diaz is part of UW's behavioral complexity lab, run by assistant research scientist Patrick Kelley of the Department of Zoology and Physiology. The students' research is primarily funded by a National Science Foundation grant. Fieldwork has been ongoing for several years and is supported by 18 field technicians from all over the world.

Ocellated antbird (*Phaenostictus mcleannani*). This species is a highly specialized ant follower and obtains almost all its food at ant swarms. Photo by Liz Howard.

BACKGROUND: BIVOUACS AND BIRDS

Since army ants cover a lot of ground, they create their own mobile homes. Every night, ants form a bivouac, which is a nest created with the worker ants' bodies to protect the queen, eggs, and larvae. Even when ants are swarming, part of the colony always remains behind in the bivouac.

Across the neotropics, 462 bird species have been recorded attending army ant swarms. Up to 20 species and 60 individuals have been spotted at a swarm at the same time. Some birds get almost all their food by following around army ant swarms; others attend only when it's convenient.

During their fieldwork in Panama, the students look for lines of ants to track down two to five bivouacs at the beginning of each week. In the morning, they return to the bivouac locations they marked the night before in order to observe and study the swarms.

FOUR (OR MORE) RESEARCH QUESTIONS

Each of the four students is focusing on a specific research question. Agenbroad is studying how species compete for food during the maintenance phase, which is when the swarm is in full swing, charging across the landscape. Certain birds may show up to the swarm, but then be excluded from eating their fill. What allows one bird to successfully snatch up more prey than another, and what influences the overall level of competition at swarms?

De Aquino is also studying the maintenance phase, but her focus is on how bird species share resources at swarms, what roles different species play, and how these groups are impacted by species loss. For example, different species may target different kinds of prey, or different areas of the swarm. Some species might be aggressive antagonists, attacking other birds in the flock. If one of these species is removed, how will other birds divide up remaining prey?

Castaño Diaz is investigating the recruitment phase, or when birds are showing up to the swarm. He is examining how the presence or absence of certain species might influence who else attends. Certain bird species may be less likely to be present at the swarm if they hear a lot of antagonist birdcalls, for example. Castaño Diaz is also examining how birds find swarms, and in particular which birds check the bivouacs, and how often.

Finally, Howard is investigating the spatial distribution of birds, ants, and prey. In one of the first studies of army ant swarms, back in the 1970s, researchers predicted that dominant birds should be found in the area with the greatest amount of food, but no one has tested this idea. Howard is examining where in the swarm birds prefer to forage, and whether these patterns differ for different bird species. She's also studying where the most prey is being flushed up and how different prey species flee from the swarms.

AN UNDERSTUDIED KEYSTONE SPECIES

Eciton burchellii is considered a keystone species. This means these ants have a disproportionate effect on the ecosystems around them, and their removal might send the whole system crashing down—like a keystone in a stone arch. "Today we have a lot of silent forests, because keystone species are disappearing or extirpated from that forest," says Castaño Diaz.

In addition, the students' research focuses on understanding how species interactions change the system as a whole. "If we focus on just one species, probably we won't know its context," says Castaño Diaz. "It's not enough to just have a big forest. You have to understand and conserve the interactions between species to conserve ecosystem function."

Though army ants are vital to the survival of many other species of birds, mammals, and even fish, they are understudied in comparison to temperate species. In fact, there are huge gaps in even basic information about many tropical species.

Army ant bivouac under a fallen log. Photo by Liz Howard.

Male spotted antbird (*Hylophylax naevioides*). This species is facultative, meaning they forage at ant swarms frequently, but don't rely on them for all of their food. Photo by Liz Howard.

"Understanding how these ecosystems work now can prepare us to manage and protect them and the species within them," Howard notes.

OVERTURNING ACCEPTED KNOWLEDGE

In the case of *Eciton burchellii*, the students are already beginning to see that some previous beliefs about ant swarms and birds may be off base. For example, while previous research claimed that the middle of the swarm was the best place for birds to forage, Howard's research seems to indicate that birds are most likely to hang around the edges of the swarm, because there is more prey in these locations.

In addition, the students observed that ant swarming behaviors may fluctuate more often than previously thought. Army ants switch between an active phase, where they are nomadic and swarm every day, and a statary phase, where ants primarily keep their bivouac in one location. In the statary phase, ants may have reduced food needs and activity. Army ant literature claims that the active phase tends to last about two weeks, and the statary phase lasts about three weeks. The students found that while ants sometimes followed this pattern, sometimes each of these phases only lasted a few days. "It's a great example of coming up with more questions as you're trying to figure things out," comments De Aquino.

The students have worked together to build on previous knowledge and answer questions about the army ants' unique contributions to their habitat and interactions with their avian hanger-ons. They look forward to coming up with even more questions after the conclusion of this field season in July 2024. ■

To learn more, contact Tarwater at corey.tarwater@uwyo.edu.

Erin Stewart holding a male chestnut-backed antbird in Soberanía National Park, Panama. Photo by Kimberly Jordan.

HIGH-STAKES KARAOKE

Understanding the duets of chestnut-backed antbirds

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

In the tropical lowland forests of central Panama, you may encounter a singing competition with stakes higher than *American Idol*. It's here that chestnut-backed antbirds sing duets to defend their territories.

Chestnut-backed antbirds are small insectivores that form long-term pair bonds, a lifelong monogamous relationship between male and female birds. The pairs live together year-round on territories that average about 10 square acres. The birds are common in central Panama, and they're vocal, which makes them easy to locate.

All of these factors made chestnut-backed antbirds the perfect candidates for Erin Stewart's master's research. "In general, I was really interested in this project because there's a lot of gaps in knowledge of the basic life history of tropical species," explains Stewart, a graduate student in the UW Department of Zoology and Physiology. Almost all bird studies focus on the breeding season, but Stewart wanted to understand how birds behave when it's not the breeding season. Additionally, Stewart wanted to look at a species where females participate in territory defense, rather than just focusing on male singing.

For chestnut-backed antbirds, a territory challenge is more of a dance-off than a knife fight. The birds rarely get closer than about 5 meters from each other. Primarily, they counter-sing at each other, but sometimes they also fan their wings, displaying white wing bars on the front of their wings. "Counter-singing" is where the duets come in: males start singing a tune, and then females back them up to prove that they're not worth messing with.

Stewart wanted to understand these defensive duets. Do mated pairs sing in synchrony, in order to prove they are very in tune with each other? Or do they sing sequentially, to make it very clear any intruders will be facing the wrath of two birds, not just one?

To investigate this question, Stewart recorded the birds' duets. Then, she set up recordings of duets with more overlap between the male and the female, and recordings with less overlap. She placed these recordings in the middle of the birds' territories to see how aggressively they responded to each kind of recording.

Stewart found that birds tend to sing sequentially, and they tend to respond more aggressively to sequential songs. Numerical advantages, rather than synchronicity, are more threatening for this species.

Over the course of her six-month-long study, Stewart also discovered other new facts about chestnut-backed antbirds. Previously, two- and three-note songs were the most common and substantiated calls, with four-note songs rarely recorded. Stewart documented one- and four-note songs as well.

Also, although it's generally thought that females of most species of birds are less aggressive and follow the male's lead when singing to defend their territory, in this species, it varied from pair to pair. Sometimes, females would start singing before males, or they would even respond alone.

Stewart's research demonstrates that there's much more to know about nature's karaoke routines, particularly in the neotropics. ■

To learn more, contact faculty advisor Patrick Kelley at patrick.kelley@uwyo.edu.

The Wyoming Cooperative Fish & Wildlife Research Unit

What is it and what does it do?

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

From tracking migratory mule deer and sagebrush sparrows to monitoring cutthroat trout populations, the Wyoming Cooperative Fish and Wildlife Research Unit conducts research with a purpose. For faculty and students in this research group, scientific inquiry is directly guided by questions and concerns raised by wildlife and fisheries managers in Wyoming.

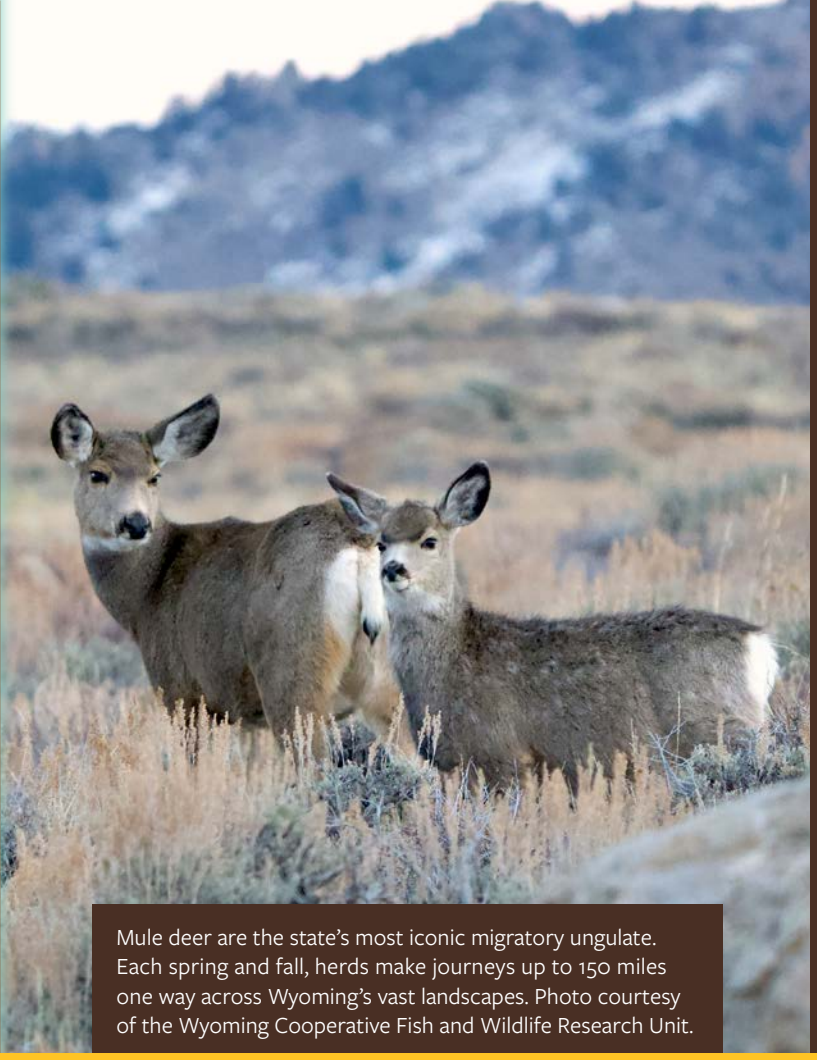
The unit's mission is twofold: 1) to conduct rigorous applied research that serves the needs of Wyoming's current wildlife managers and 2) to nurture the next generation of wildlife managers.

Unit faculty and graduate students work closely with state and federal agencies, including the Wyoming Game and Fish Department, U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Forest Service, and Wyoming Parks Department.

"They come to us with an issue they want to address, and we develop a project, recruit and train students, and gather the information the state needs to better manage that species," explains Matt Kauffman, unit leader and professor of zoology and physiology.

The Cooperative Fish and Wildlife Research Unit is a U.S. Geological Survey (USGS) program but also functions as part of the UW Department of Zoology and Physiology, now housed in the College of Agriculture, Life Sciences, and Natural Resources. More than a third of zoology and physiology graduate students conduct research in the unit.

"We're training the wildlife managers of the next generation," says Kauffman. "Our graduate students get instruction and guidance from their graduate committee here on campus, but they also get real on-the-ground training and perspectives from the wildlife managers they work with."



Mule deer are the state's most iconic migratory ungulate. Each spring and fall, herds make journeys up to 150 miles one way across Wyoming's vast landscapes. Photo courtesy of the Wyoming Cooperative Fish and Wildlife Research Unit.

Capturing Wyoming's wild ungulates requires a lot of coordination. Here, Kauffman and Wyoming Game and Fish biologist Doug McWhirter work with helicopter pilot David Rivers to describe priority areas for capture of mule deer outside Cody, Wyoming. Photo courtesy of the Wyoming Cooperative Fish and Wildlife Research Unit.

THE WYOMING COOPERATIVE FISH & WILDLIFE RESEARCH UNIT

The Kauffman Lab:
Mule deer migration and more

Kauffman's research focuses primarily on migration, especially that of mule deer and other ungulates. A co-founder of the Wyoming Migration Initiative, he is currently leading a long-term study on the whys and hows of ungulate migration in Wyoming.

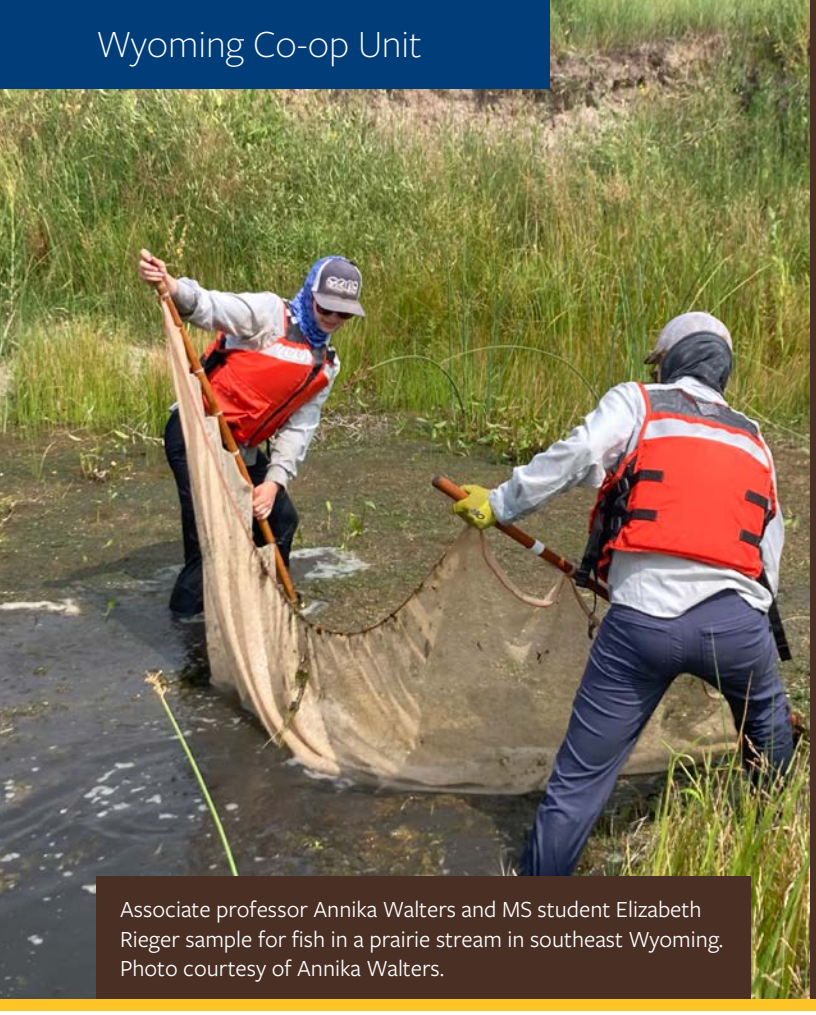
His group seeks to better understand the benefits of migration and how migration patterns are learned, especially as seasonal routes are increasingly impacted by human development. Currently, Kauffman's team is tracking mule deer that migrate long, medium, and short distances, using mortality and nutrition data to evaluate how these migrations influence herd survival and health.

In a study of mule deer migrations from the Red Desert to Hoback, the researchers found that the deer were quite faithful to their annual routes. Long-term measurements of fat gain, reproduction, and overwinter survival suggested that herds completing this long-distance migration have a much higher rate of population growth than deer remaining in the Red Desert year-round.

"Another major effort by my group is to understand how animals learn to migrate," Kauffman notes. "The assumption is that they learn from their mothers, but we've never been able to test that because it's very hard to track young animals."

Kauffman's team is using GPS collars to track female mule deer, elk, and moose, as well as their young. Over the next couple years, they'll use this data to understand whether the young animals inherit and follow the migration patterns of their mothers.

Kauffman also leads the national Corridor Mapping Team (CMT), a USGS-funded collaboration between state, federal, and tribal partners. Since releasing its first reports in 2020, the CMT has mapped the migrations and seasonal ranges of 182 unique ungulate herds in the western U.S. To learn more, contact Kauffman at mkauffm1@uwyo.edu.



Associate professor Annika Walters and MS student Elizabeth Rieger sample for fish in a prairie stream in southeast Wyoming. Photo courtesy of Annika Walters.

A boreal toad is held for examination. Photo by Annika Walters.

THE WYOMING COOPERATIVE FISH & WILDLIFE RESEARCH UNIT

The Walters Lab:

Understanding Wyoming's native fish

Annika Walters, associate professor of zoology and physiology, leads the unit's applied fisheries ecology program, focusing primarily on native fish conservation.

Walters frequently conducts research on the cutthroat trout, Wyoming's primary native sport fish. Her team is currently assessing the best ways to monitor trout populations and the relative importance of different habitat types, among other topics.

Her group also studies how drought, human activity, and other disturbances affect native fish populations. By observing how fish respond to these stressors, the Walters lab provides managers with data they can use to help mitigate the effects of environmental changes.

Walters and her students often conduct localized studies that help inform management decisions in specific locations. In some cases, that might mean assessing options to relocate populations of a species of conservation concern. In other cases, Walters' group might monitor how stocking fish affects existing aquatic communities over time or observe how fish evolve in a closed environment like an alpine lake.

Sometimes these projects require considerable sleuthing, using both historical records and genetic analysis. For example, Walters is currently working with the Wyoming Game and Fish Department and colleague Catherine Wagner to assess Yellowstone cutthroat trout stocking history and identify unique genetic populations.

While Walters' primary research focus is on native fish, she also studies amphibians like boreal toads. Amphibians are declining at a greater rate than any other invertebrate in the world, she notes, and it's important to understand how they're adapting—or not adapting—to changing environmental conditions.

In a recent study, Walters and colleague Anna Chalfoun found that toads suffering from a fungal infection tended to favor more exposed habitats, selecting hotter, drier locations over the cool, moist, protected habitats they usually prefer. This behavior may be a form of self-medication to prevent the fungi from flourishing, Walters explains, and may offer insight into toad survival.

To learn more, contact Walters at annika.walters@uwyo.edu.

PhD student Emily Shertzer holding a Brewer's sparrow with a freshly applied geolocator used to track migratory movements and overwintering area. Photo by Anna Chalfoun.

A sage thrasher's nest and eggs. Photo by Anna Chalfoun.

THE WYOMING COOPERATIVE FISH & WILDLIFE RESEARCH UNIT

The Chalfoun Lab:

Looking out for sensitive non-game species

Associate professor and assistant unit lead Anna Chalfoun studies wildlife-habitat relationships in western songbirds and other non-game species. Her research is guided by the following questions: Why do animals choose the habitats they do, and how well do they survive and reproduce in those habitats? What happens when humans alter those habitats?

Many of Chalfoun's research projects address what's known as human-induced rapid environmental change (HIREC). Currently she is leading a long-term project investigating how energy development in western Wyoming affects three declining songbird species that rely on sagebrush habitats. Specifically, she's monitoring the survival and reproductive rates of the sagebrush sparrow, Brewer's sparrow, and sage thrasher. Her group has helped identify areas where these species tend to have the highest reproductive success as well as providing insight into how natural gas development affects the birds.

Chalfoun and her students also recently expanded the study to track migration routes and determine whether individuals return to the same nesting sites in Wyoming. "Now we're trying to better understand migration routes, where exactly they go in the winter, what the annual survival rates are, and what factors influence return to the same breeding sites," she explains.

Chalfoun frequently works with animals identified by the Wyoming Game and Fish Department's State Wildlife Action Plan as species of greatest conservation need (SGCN). "My task is to help provide information on sensitive non-game species that our state and federal cooperators have deemed may be at risk," she says. In addition to songbirds, these animals may include amphibians, reptiles, raptors (hawks, eagles, and owls), and small mammals like the American pika and pygmy rabbit.

For example, Chalfoun's group recently collaborated with the Wyoming Natural Diversity Database (WYNDD) to study the habitat preferences of the northern long-eared bat. Their research showed that female bats preferred different types of roosting sites depending on factors such as whether they had pups or were lactating. Ultimately, this work has implications for forest management in sites suitable for maternal roosting.

To learn more, contact Chalfoun at achalfou@uwyo.edu. ■

How Do Wyoming Bumble Bees Respond to Heat Stress?

Tracking bee behavior with RFID technology

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

Whether it's in a security badge or livestock ear tag, you've probably encountered some form of RFID (radio frequency identification) technology. What you probably haven't seen is a bumble bee wearing a tiny RFID "backpack" as it flits from flower to flower collecting pollen.

But that's exactly what Sabrina White, a PhD student in the UW Department of Zoology and Physiology, plans to observe this summer at the Red Buttes Environmental Biology Laboratory outside Laramie. As part of her research on how Wyoming bumble bees respond to heat waves, she's using RFID tags to track their movement in and out of hives.

HEAT STRESS AND FORAGING BEHAVIOR

Unlike honeybees, bumble bees have an annual life cycle. Their colony lives for just one season; only the queen overwinters and emerges to start a new colony the next year. It's one of the reasons they're well suited to cold climates, including the mountains of Wyoming and even the Arctic.

Bumble bees can also air condition and heat their own colonies, fanning their wings to cool the hive and vibrating to stay warm. But as extreme weather events, including heat waves, become more common, how will these plucky little pollinators respond?

That's the question driving White's research. "I'm looking at sublethal temperatures that are realistically going to be experienced and how that affects foraging behavior and colony success," she explains.

White has chosen to focus on *Bombus huntii*, a bumble bee commonly found in Laramie. "I want to use local bees because it's important to understand how wild populations behave as opposed to using lab-reared colonies of non-native bees, which can't be released here," she says.

BEES WITH BACKPACKS

Since even the smallest GPS units aren't small enough for bumble bees, White settled for using RFID tags to track movement in and out of the hive. While the tags can't track foraging paths, they can be used to record when bees enter and exit the hive.

In order to record data, White must painstakingly glue 1.2-millimeter RFID "backpacks," complete with tiny coiled antennas, onto each bee's back. Unable to find premade antennas well suited to the task, White designed her own, hand-coiling and soldering them to each tag. This summer, she'll tag 25 bees per hive for up to 50 hives (it currently takes about an hour to make 10 tags).

The tiny tags function like encoded license plates, says Steve Barrett, professor of electrical and computer engineering and vice provost for undergraduate education at UW. Data from these license plates is stored on an SD card in an Arduino microcontroller system.

"These are little bitty computers that are really inexpensive but very powerful," Barrett explains. "Sabrina equipped the processor with an SD card, which is like giving a computer a hard drive. When a bee leaves, the time is logged, this data is put onto the hard drive, and when the bee comes back, data is captured again. It's a great way to gather lots of data."

COLLABORATION ACROSS COLLEGES

When White ran into difficulties setting up the Arduino and RFID system, she reached out to Barrett to see if he could help, initiating an ongoing interdepartmental collaboration. Both Barrett and colleague Laura Oler, a lecturer in electrical and computer engineering, have worked closely with White to refine the circuit board and code required to run the system.

Not only has the collaborative effort helped take White's data collection system to the next level, it's also led to new opportunities for undergraduates in UW's engineering program. One of these students designed a system that delivers electricity to the hives at the Red Buttes lab, including an alert system that notifies White if the power goes out.

Barrett and Oler are excited to continue forging partnerships with researchers in other colleges. "It's great to have projects where we can contribute our expertise to a problem and make something useful for somebody's research," Oler comments. "We would love to find more collaborations where we could do these kinds of things."

TRACKING BEHAVIOR IN THE WILD

After the trial run last year, White looks forward to starting the first of four seasons of data collection. In the spring, she'll catch emerging queen bees in Laramie and nurture them at ACRES Student Farm until they're ready to begin building a colony. Later in the season, after the colony has been transported to Red Buttes and the worker bees are large enough to easily transport their RFID backpacks, White will tag a random subset of workers.

Bees undergoing experimental treatment will be exposed to a hot water bath at a set temperature for 45 minutes, which is the average length of a foraging trip. This process simulates a foraging trip during a heat wave. The behavior of the treated bees will be compared to that of control bees who were removed from the hive for 45 minutes but not exposed to the water bath.

While the simulated heat waves are below lethal temperatures, White predicts they may affect how much pollen and nectar foragers bring back to the colony. "I'm expecting them to potentially forage less, maybe doing fewer foraging trips or bringing back less resources from those trips," she says. "Hopefully they can compensate and the colonies do fine. But it's still important to know how bee colonies can be affected by changing climate. If we know that, we might be able to predict how populations will change in the future." ■

To learn more, contact faculty advisor Michael Dillon at michael.dillon@uwyo.edu.

Sabrina White working on the initial design for the UHF (ultrahigh frequency) RFID system for tracking the bumble bees. Photo courtesy of Sabrina White.

A *Bombus huntii* worker is tagged with an RFID tracker. A soft sponge is used to gently push the bee against the metal mesh in this tube, allowing researchers to attach the "backpack" to its back and preventing movement while the glue dries. Once the tags are properly attached, the workers are returned to their colonies. Photo by Sabrina White.

A young colony of *Bombus huntii* reared from a queen caught in Laramie. The queen is larger than her daughters and can be seen in the lower left of the photo. The yellow cells contain immature bees (pupae and larvae), from which adult bees will emerge. Photo by Sabrina White.

From left to right: Jane Smith, Dusty Gannon, Mary Uhl, and Megan Szojka survey alpine plant communities within an experimental block. Photo courtesy of Megan Szojka.

High-altitude Globeflower Exhibits Unexpected Response to Habitat Change

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

Have you ever headed to the mountains to escape the heat? On a warm summer day, it's hard to deny the appeal.

While plants can't move to higher ground on a whim, their geographic range may shift over time in response to changing environmental conditions. Climate change is one factor that can initiate this process, which is also known as range expansion. As climate conditions shift, optimal habitat for a particular species may also shift, pushing them into new territory.

In this new territory, they may interact with organisms that didn't inhabit their previous home ranges. For example, warming temperatures might prompt a subalpine globeflower to creep into an alpine environment populated with plants it hadn't previously encountered.

Range expansion isn't inherently problematic, but the process has accelerated due to climatic changes, especially in high-altitude environments.

"The issue is when warming is so extreme that habitat at the top of the mountain is at risk of disappearing completely, or there's so much encroachment that habitat disappears," explains Megan Szojka, a PhD student in the UW Department of Botany. "When you have all these stratified habitats on a mountain, eventually the top one is going to have no more space to expand its range."

This stratification of habitats is one of the reasons alpine ecosystems are ideal for studying range expansion. Moving up a mountainside, distinct habitat types exist in close proximity to one another.

WHY STUDY THIS FLOWER?

From a conservation standpoint, it's important to understand what happens as subalpine species spread to new environments and interact with lingering alpine plants.

Szojka's research focuses on how the subalpine globeflower *Trollius albiflorus* responds to habitat changes that could be induced by climate change. Currently this species mainly occurs below the tree line, which provides a clear marker signaling the upper limit of its range. It also has distinctive flowers, so it's easily recognizable.

While Szojka is gathering data at Niwot Ridge near Boulder, Colorado, results from her study may have implications for subalpine plants across a larger region. *Trollius albiflorus* is found in Wyoming as well, including in the Snowy Range.

"This story is about *Trollius*, but in general, species across the subalpine will all be experiencing this. Hopefully my research will elucidate patterns that are reflective of the whole community's range expansion," she explains.

Szojka's research questions are twofold: First, what aspects of climate change help or hinder this plant's range expansion into the alpine? Second, how do interactions with other species influence these outcomes?

To find out, she transferred a group of *Trollius albiflorus* plants from a subalpine habitat to a location above the treeline, then exposed subsets of the transplants to different treatments, including combinations of warming, shading by neighboring plants, increased snowpack, and added nitrogen.

THE EXPERIMENT

In 2021, Szojka's team painstakingly transplanted nearly 300 individual globeflower plants from their subalpine habitat to a test site a few hundred feet higher. Data collection began in summer 2022 and will continue through summer 2024.

The globeflowers were transplanted into 48 plots, each about one square meter in size. The researchers used a snow fence to emulate the effects of higher snowpack at the beginning of the growing season, a change predicted to occur in this area due to later season snowstorms.

For plants exposed to warming treatments, plexiglass chambers were used to create miniature greenhouses. Lastly, some plots were treated with nitrogen fertilizer to mimic the effects of atmospheric nitrogen deposition from industrial activities.

Szojka's experimental design also accounted for the interaction between the transplanted globeflowers and their new alpine neighbors, a variable that turned out to be key to the transplants' responses to warming temperatures.

In each plot, half of the transplants' roots were surrounded with PVC pipe to prevent them from interacting with the roots of other plants. In the other half of every plot, the community's roots were permitted to grow without restriction.

COMMUNITY OVER COMPETITION

Since the current alpine environment is colder than the globeflower's preferred habitat, Szojka hypothesized that warming would improve the transplants' performance. But that wasn't the case. "It turns out that warming is super detrimental to our species," she says. "They do extremely poorly in warming situations alone."

However, when the transplanted globeflowers were permitted to interact with other plants in their new community, they tolerated warming conditions much more readily. Szojka's results suggest that the negative effects of warming temperatures were mitigated by the presence of alpine species.

"We expected competition, but to the contrary, interactions between species really help," she notes. In general, the globeflowers fared best in situations where they could interact with alpine species and received heavier snowpack.

HUNGRY HERBIVORES

Szojka didn't set out to study how elk affected the transplanted globeflowers, but it turned out these large herbivores were determined to munch their way into her study.

She noticed a significantly higher proportion of herbivory events in locations where the transplanted globeflowers performed best. Unfortunately for the globeflower, the elk consistently targeted the biggest, healthiest plants.

"You'd expect that the healthiest plants would produce the most seeds and carry the population forward to the next year, but herbivory events are stopping the ability of any really healthy plants to contribute," Szojka says. "For the *Trollius* population to expand its range, it may be more reliant on the plants just squeaking by versus the ones doing super well."

WHAT'S NEXT?

Szojka's research suggests that interactions with alpine plants positively affect the globeflower's ability to weather warming temperatures. Her next objective is to investigate the mechanism behind these positive interactions. First of all, is that facilitation happening aboveground or belowground?

A community of roots can work together, collectively bringing more water and nutrients to the surface than a single plant—essentially "getting more for everybody." But facilitation can also happen aboveground, where plants can shade one another, decreasing evaporation and keeping the soil moist.

This summer, Szojka plans to quantify shading effects as well as monitoring soil moisture and temperature. The goal is to parse whether community interactions primarily benefit globeflowers underground, aboveground, or a combination.

Trollius albiflorus is a globeflower found in the Colorado and Wyoming subalpine. Photo by Megan Szojka.

Either way, Szojka's results suggest that a subalpine species like *Trollius albiflorus* may benefit from interactions with alpine plants as its range shifts in response to changing climate conditions.

"Overall, there's a lot of hope and it's great news that the alpine community helps rather than hinders range expansion," Szojka concludes. "Given enough time, even with the elk, I think they should be able to expand their range." ■

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

Snowmobiling on Togwotee Pass Continental Divide Trails. Photo courtesy of the Wyoming State Trails Program.

Changes in Snowpack Predicted to Affect Snowmobiling in Wyoming

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

For many Wyoming visitors and residents, winter isn't just snow season—it's also snowmobiling season.

This type of seasonal recreation can be an important source of economic activity, especially in the state's small rural communities. Snowmobilers rent rooms at local hotels, eat at local restaurants, and purchase fuel and supplies at local stores.

But what happens if there's not enough snow to ride? And, on the flip side, how might rural communities benefit if they consistently receive more snow?

ECONOMIC IMPACTS OF WINTER RECREATION

Every 10 years, the Wyoming State Trails Program works with UW to collect economic data associated with snowmobile and off-road vehicle (ORV) use on public land. In 2023, a group of researchers in the UW Department of Agricultural and Applied Economics partnered with atmospheric scientist Bart Geerts and his team[1] to take the investigation a bit further.

"I wanted to figure out how future changes in climate may change how we go about economic development and tourism in the state," says Anders Van Sandt, community development specialist in the Department of Agricultural and Applied Economics.

"Tourism is one of the top three industries in Wyoming and winter tourism tends to be really seasonal," he continues. "The more you can extend the season or add on in different seasons to retain employment means keeping jobs in rural communities."

In collaboration with fellow agricultural economics professor Chris Bastian and graduate student Kelsey Lensegrav, Van Sandt used survey data and climate predictions to examine how changes in snowpack could affect Wyoming's economy.

CORRELATING SNOW DEPTH AND SPENDING

Surveys were sent to randomly selected resident and non-resident snowmobilers who registered with the Wyoming State Trails Program. Respondents were asked about their preferred snowmobiling sites, how much they spent on snowmobiling equipment and travel, and what impacted their enjoyment of snowmobiling (e.g., preferences for certain types of trails) during Wyoming's 2020–2021 snowmobiling season.

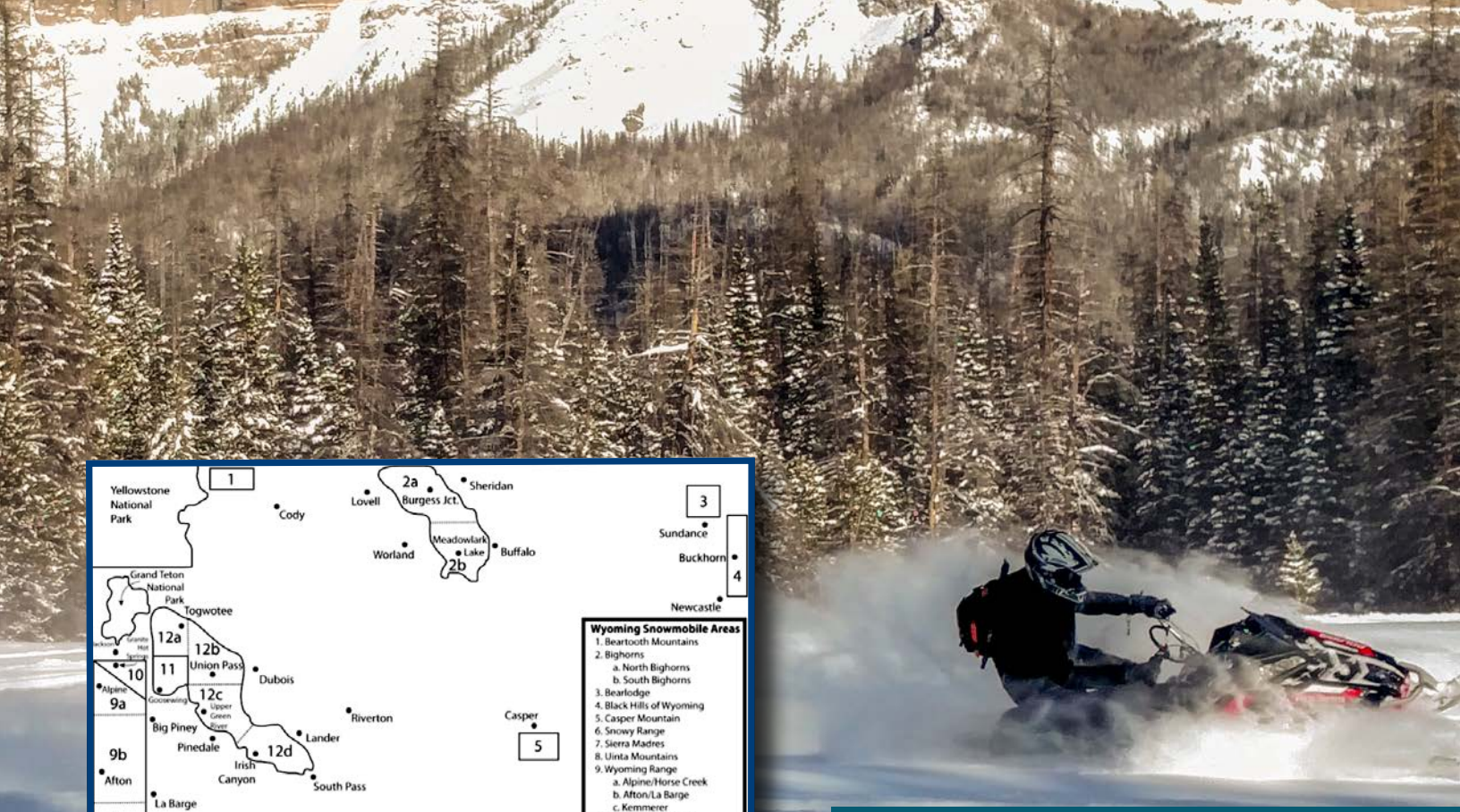
Based on survey results, the researchers developed economic models to predict how changes in snow depth could affect snowmobiler spending at 18 sites across Wyoming. To cover a wide variety of scenarios, they used nine different climate models with varying predictions for mid-century and end-of-century snow depth. Entering different snow depths into their economic model, they generated predictions about how snowmobiler activity might influence local economies in each set of conditions.

RESIDENTS AND NON-RESIDENTS

In this study, snowmobiler behavior and spending were broken down into two categories: resident and non-resident. Results suggested a clear divide in the predicted behavior and spending patterns of residents versus non-residents.

In nearly all mid-century and end-of-century predictions, the number of non-resident trips and value of non-resident expenditures were predicted to increase relative to the 2020–2021 baseline. Meanwhile, snowmobiling trips and expenditures associated with Wyoming residents were expected to decline.

1 Bart Geerts is a professor of atmospheric science in the UW College of Engineering and Physical Sciences. For this project, his collaborators included Stefan Rahimi, assistant professor of atmospheric science, and Kinsale Day, an undergraduate student at the time of the study.



Left: Wyoming snowmobile areas containing trails managed by the Wyoming State Trails Program. Image courtesy of Chris Bastian. **Above:** Snowmobiling on Togwotee Pass Continental Divide Trails. Photo courtesy of the Wyoming State Trails Program.

Overall, this pattern could potentially benefit Wyoming's economy at a statewide level. While resident snowmobiling brings economic activity to rural communities, it represents movement within the state's economy. Non-resident spending, on the other hand, introduces new dollars into the state.

The current and predicted decline in resident registrations doesn't necessarily mean a decline in trail use, Van Sandt notes. Locals may be more inclined to buy tracks for their ORVs rather than owning both snowmobiles and ORVs, for example.

GAINS AND LOSSES

Although Wyoming's non-resident snowmobiling industry is likely to grow at a statewide level despite changing snow depth, models suggest that economic impacts will vary by community. "Given the models the climate scientists established, we found that there are sites that gained and some that decreased in snow," says Bastian.

Based on mid-century and end-of-century climate predictions, 5 to 6 of the 18 study sites were deemed unlikely to maintain the recommended 8 inches of snow during the snowmobiling season. Unsurprisingly, those sites will likely experience reduced demand and snowmobiler spending.

Results also suggested that sites predicted to receive more snow could benefit economically from changing environmental conditions. The Snowy Range, for example, is expected to experience increases in both snow depth and non-resident snowmobiling expenditures.

While the study indicated that some Wyoming snowmobiling sites may suffer economically from reduced snowpack, the state's altitude may help it outperform neighboring states like Montana and Idaho.

"Our estimates may actually be conservative in the sense that we focused just on the state of Wyoming," Bastian explains. "A number of the states surrounding us are probably going to experience net loss and Wyoming is generally predicted to be a net gainer in some high-elevation sites. So, we may see a higher influx into the state from non-residents than we captured in this study."

PLANNING AHEAD

Bastian and Van Sandt are hopeful that their research will positively contribute to trail management and economic planning in communities that serve as "gateways" to outdoor recreation opportunities.

For some communities, that might mean pivoting to focus on other types of outdoor recreation. "For places that will likely lose snowpack, there may be some recreation substitution," Bastian comments. With less snow, perhaps a longer ORV season will help compensate for the loss of snowmobiler spending, he suggests. In other locations, maybe the market for cross-country skiers will expand even if the snow depth can no longer support snowmobiling.

Regardless, the circumstances and response will vary by community. While some local economies may grow in response to increased demand for snowmobiling-related amenities, other communities may shrink as residents migrate elsewhere to find work.

"We can provide information that's relevant, but the communities are the ones who come up with ideas on what to do next," Van Sandt notes. "If they have this information ahead of time, they may have a better chance of transitioning to a slightly different-looking economy in the future." ■

To learn more, contact Bastian at bastian@uwyo.edu.

The WRMHNN 2023 conference planning committee. From left to right: Alison Brennan, Montana State University; Cassandra Nguyen, University of California Davis; Annie Lindsay, University of Nevada, Reno; Carrie Ashe, Montana State University; Grace Shearrer, University of Wyoming.

Western Region Mental Health & Nutrition Network

Connecting Nutrition and Mental Health in the Western U.S.

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

How do diet and mental health influence one another? It turns out there's a lot of connections, especially when a person may already be dealing with food insecurity or a condition like depression or anxiety.

It's not unusual for a nutrition specialist to notice a client struggling with potential mental health challenges, or for a mental health specialist to be concerned that a patient is facing food insecurity. However, without the proper training and resources, it can be tough for professionals in either field to know how to best serve their clients.

"We see people who work in mental health spaces wanting to give nutrition advice, but they're not sure what to say, and we see people in nutrition noticing mental health issues and wanting to help," explains Grace Shearrer, assistant professor of family and consumer sciences at UW.

Shearrer, who is also a faculty member in UW's neuroscience program, interacts with professionals in both fields on a regular basis. Searching for ways to better integrate mental health and nutrition in practice, she and Mandy Marney, director of UW Extension, helped launch the Western Region Mental Health and Nutrition Network (WRMHNN) in 2023.

Funded by the USDA's Agriculture and Food Research Initiative, the network connects specialists in fields related to mental health with specialists in fields related to nutrition. The goal is to address food and nutrition insecurity in tandem with mental health challenges.

As co-chair of the WRMHNN steering committee, Shearrer helped organize the network's first annual conference, bringing together more than 60 experts, including researchers and extension personnel from each state in the western U.S.

Attendees identified the following areas as key to building the network's foundation and impact:

1. Professional development and training;
2. Community-based programs to be delivered through university extension offices and other organizations;
3. Standardized metrics to better compare mental health and nutrition studies;
4. Analysis of existing research on the suicide epidemic.

Shearrer encourages mental health professionals, nutrition experts, extension personnel, and community members to engage with the network. To learn more, visit www.wrmhnn.org. ■

For more information, contact Shearrer at gshearre@uwyo.edu.

The same neurotransmitter "ingredients" may exist in both stressed and not-stressed mice, but the ribosomes of the mouse that is not stressed are able to utilize these "ingredients" more effectively. Image by Maya Gilmore.

Ribosomes Could Help Explain a Broad Spectrum of Depression

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

Depression is one of the most common mental illnesses in the United States. Unfortunately, while contemporary medicine has developed medications for mood disorders like depression, most target only one form of depression. Medications like SSRIs (selective serotonin reuptake inhibitors), for example, work best for mild or moderate depression and don't have much effect on those suffering from severe depression.

"Depression is a spectrum disorder," says Ram Shukla, assistant professor in the UW Department of Zoology and Physiology. "To explain this spectrum nature, we need to have a component that is equally diverse." Shukla and graduate student Karthik Swaminathan propose that ribosomes could be this component.

"Ribosomes are the internal machinery that translate DNA info to proteins," explains Swaminathan. Proteins make up everything from hormones to enzymes like serotonin to muscle cells. The purpose of DNA is to encode information that is used to build a person's body. DNA can create several kinds of ribonucleic acids (RNA) in order to do this. One of these is "messenger" RNA (mRNA), which in turn uses ribosomes to make a protein.

As an analogy, DNA and mRNA are the recipe, ribosomes are a cook, and proteins are the meal.

Past research into depression has focused on neurotransmission and receptor-based theories. In essence, these theories argue that someone who is depressed does not have enough serotonin, a neurotransmitter, in their brain, or the receptors in their brain are not sensitive enough to serotonin or other neurotransmitters. However, this does not adequately explain the complexity of mood disorders, particularly treatment resistance. If the problem is "not enough carrot," then it is unclear why current "carrot-boosting" drugs do not work reliably.

Since serotonin and other neurotransmitters are made in part by ribosomes, Shukla and Swaminathan suggest, instead of figuring out one recipe for one ingredient for one kind of depression, why not try to understand how one of the cooks is cooking?

Using this framework, Swaminathan is investigating ribosomal heterogeneity in stressed mice. As mice become stressed, their ribosomes may begin "cooking" in a different way, which could explain some of the complexity of mood disorders. Swaminathan and Shukla's current study builds on their previously published research, which established similarities between human depression and mouse stress.

If ribosomes are involved, their research could be used to create drugs that work across the spectrum of depression, helping with both very severe and more mild forms of the illness. And if ribosomes in one part of the brain play a role in depression, ribosomes might be a factor in other mental illnesses as well. Though their current research focuses on mood disorders, Swaminathan and Shukla also see the possibility of generalizing this research to other mental disorders, such as schizophrenia. ■

To learn more, contact Shukla at rshukla@uwyo.edu.

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