UNIVERSITY OF MONTANA

VISION

RESEARCH, INNOVATION AND IMAGINATION | 2022

UM ACHIEVES R1 RESEARCH STATUS

UM STUDENTS CHASE ECLIPSE ACROSS CHILE

BIG DATA FOR COWBOYS | NEW EAR INFECTION PRODUCT | POOLS AND RACISM

CONTENTS

INNER VISION

4-5 / **GR1Z CELEBRATION**
UM celebrates top-tier 'R1' research status.

6-9 / **QUICK LOOKS**
University science highlights from the past year.

10-13 / **BALLOON SCIENCE**
UM staff and students travel to Chile to study total solar eclipses.

14-17 / **FROM EAR AID TO ARTIFICIAL SKIN**
UM researcher makes breakthroughs using product-oriented research.

18-21 / **RESILIENCY THROUGH RESTORATION**
Researchers study attitudes about river restoration along Montana's Clark Fork.

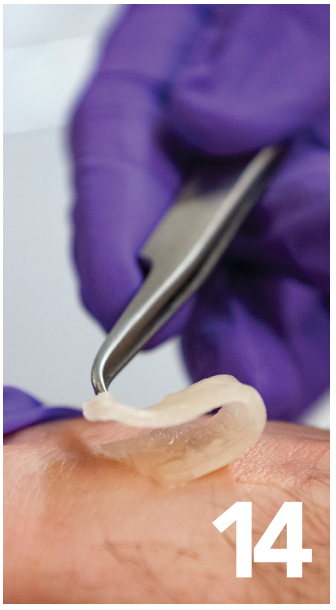
22-23 / **STUDENT SPOTLIGHT**
Scholarly research has become an integral part of a UM education for many students.

24-27 / **WHERE BIG DATA MEETS COWBOY BOOTS**
A powerful free web app developed by UM is revolutionizing how rangelands are managed.

28-29 / **CONTESTED WATERS**
Professor makes a splash using swimming pools to study the racial history of the U.S.

30-31 / **(H)ELLO TO LEARNING**
A UM professor has developed free resources to stimulate young minds.

32-35 / **JOINT JAZZ PROJECT**
A professor and former student collaborate on a saxophone album.



VISION is published by the University of Montana Office of the Vice President for Research and Creative Scholarship and Marketing and Communications.

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ON THE COVER:
Hannah Woody, a UM student majoring in biology with an astronomy minor, inflates a weather balloon at night during a study of atmospheric gravity waves during an eclipse in Chile. Read the full story on page 10. (Photo illustration by Carl Spangrude and Peter Zalewski)

MESSAGE FROM THE VICE PRESIDENT

Welcome to another edition of Vision, the magazine of research and creative scholarship for the University of Montana, which comes out during an exciting time for UM. In a major milestone, our University is now a top-tier "R1" research institution. The honor was conferred this year by the Carnegie Classification of Institutions of Higher Education organization. UM was upgraded to the "Doctoral Universities: Very High Research Activity" classification, also known as R1.

That puts us in some pretty good company. Across the U.S., only 146 degree-granting institutions are ranked in this elite group. And research continues to grow at UM, with record research spending this year of $122 million and submitted proposals of $286 million. Of course, the real joy in seeing our research portfolio grow is the amazing research and creative outcomes of those projects and the impact they have – both socially and economically – on our region and state.

University researchers helped the state respond to the COVID-19 pandemic. When the number of cases swamped the state testing lab, we converted our Murdock Trust-funded genomics core into a federally certified testing facility. Working with the state and the National Guard, the lab conducted over 10,000 COVID-19 tests for the local community. Currently, the lab is helping the state identify COVID-19 variants and has received $740,000 in funding from the National Institutes of Health for variant testing among our state and tribal communities.

In addition, researchers in the UM Center for Translational Medicine were awarded $2.5 million in funding from NIH to identify and advance a COVID-19 vaccine candidate. For these reasons the University was recognized as one of the top 10 universities in the world in responding to the pandemic.

UM continues to lead in statewide entrepreneurship and workforce development. Through our Accelerate Montana program, the Women's Entrepreneurship and Leadership Lab (WELL) – under the director of Morgan Slemberger – has received several grants to grow entrepreneurship among women and tribal communities. The Women's Business Center is funded by a grant from the U.S. Small Business Administration and will have business advisers in Missoula, Great Falls and Fort Belknap. WELL also recently received an $850,000 grant to support Indigenous women looking to start or grow a business in Montana. UM was one of only six organizations in the U.S. to receive this Google.org award.

Our UM trajectory is positive. In this issue you will discover a number of fascinating research and creative projects at UM that highlight our good work. Thanks for reading, and Go G**R1**Z!

Scott Whittenburg
UM Vice President for Research
and Creative Scholarship

GR1Z

UM CELEBRATES **TOP-TIER 'R1' RESEARCH STATUS**

In a milestone achievement for UM, the University is now a top-tier "R1" research institution.

The honor was bestowed by the Carnegie Classification of Institutions of Higher Education organization. The University was upgraded to the "Doctoral Universities: Very High Research Activity" classification, also known as R1.

UM celebrated the achievement with an R1 party on Feb. 25. President Seth Bodnar and Vice President Scott Whittenburg spoke to a University Center Ballroom brimming with happy researchers, scholars, students and staff members, who were entertained by the campus Chamber Chorale, a UM jazz band and lab-coat Monte while munching on cookies shaped like science flasks.

Since the Carnegie classification system was created in 1970, generations of UM administrators and researchers have striven toward the goal of achieving R1 status. Of the roughly 4,000 degree-granting institutions across the U.S., only 146 (about 3.7%) are ranked in this elite group.

"UM reaching R1 status is a great testament to the quality of our faculty, staff and students," Whittenburg says. "Being one of the top research universities in the country also will help us recruit new students and faculty to campus."

The R1 classification will last for five years, and then Carnegie will reevaluate. It is possible to return to R2 status if current high standards are not maintained.

"Earning R1 validates the impressive research and hard work of many outstanding people at the University of Montana," Bodnar says. "This classification puts us in good company among the top research institutions in the world. UM has become many things during its 129-year history, and now we can add to that our status as a nationally and globally known center for research."

Carnegie uses a variety of factors to determine whether a university qualifies for R1 status, including research spending, staffing levels to support the research enterprise and the number of doctorates awarded by the institution.

Research spending at UM has soared in recent years. The $55 million reported in fiscal year 2014 swelled to a UM-record $122 million this past year. Whittenburg said UM is the sixth-fastest growing research university in the nation, known for its work in wildlife biology, forestry, pharmacy, chemistry, climate change and more.

"One nice feature of the Carnegie designation is that the research dollars and doctorates are not limited to the STEM disciplines," Whittenburg says. "Research and doctoral completion in the humanities, social sciences and other fields contributed significantly to UM's attainment of the R1 designation."

UM President Seth Bodnar (left) congratulates Scott Whittenburg, vice president for research and creative scholarship.

QUICK **LOOKS**

UNIVERSITY OF MONTANA

Research by the Numbers

UM research highlights for fiscal year 2021 include:

TOTAL **GRANT DOLLARS** SPENT:

$122 million

All-Time Record for UM

NATIONAL RANKING FOR MOST-CITED PAPERS GLOBALLY: #47

Source: 2021 CWTS Leiden Ranking

PERCENTAGE **RESEARCH INCREASE** SINCE 2014:

121%

TOTAL NUMBER OF **PUBLICATIONS** BY **UM RESEARCHERS: 1,055**

NATIONAL RANKING FOR 2014-19 RESEARCH GROWTH: #6

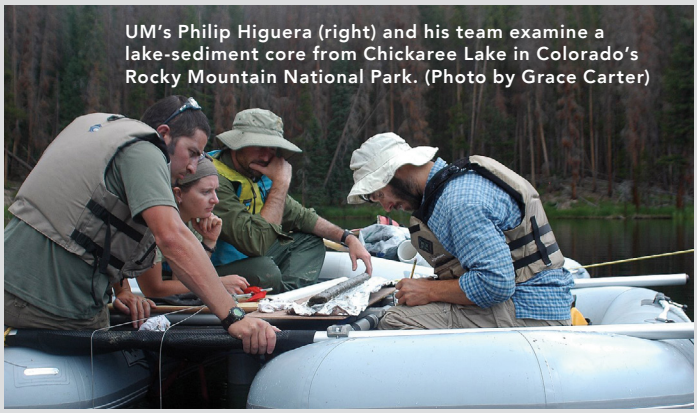
Rocky Mountain Forests Burning More Now Than Any Point in Past 2,000 Years

Following 2020's extreme fire season, high-elevation forests in the central Rocky Mountains now are burning more than at any point in the past 2,000 years, according to a UM study published in the Proceedings of the National Academy of Sciences.

Researchers from UM and the University of Wyoming analyzed a unique network of fire-history records to understand how 21st-century fire activity compares to wildfires in the past. The findings highlight that burning in recent decades in high-elevation forests of northern Colorado and southern Wyoming is unprecedented over the past several millennia.

As fire paleoecologists – scientists who study historical ecosystems – the team uses charcoal found in lake sediments to piece together the fire history of forests across the Rocky Mountains. The idea, says lead author and UM Professor Philip Higuera, is understanding the past is key to understanding changes we see today and how forests may change in the future.

When 2020's massive fire season hit, its ferocity startled Higuera and his co-authors – UM doctoral candidate Kyra Wolf and UW Professor Bryan Shuman. Wildfires in Colorado burned through October – unusually late in the year. By November, the 2020 wildfires alone were responsible for 72% of the total area burned



UM's Philip Higuera (right) and his team examine a lake-sediment core from Chickaree Lake in Colorado's Rocky Mountain National Park. (Photo by Grace Carter)

in high-elevation forests since 1984 in their study region, and Colorado had seen three of its largest fires on record.

"As the 2020 fire season unfolded, we realized we already had a well-defined understanding of the fire history of many of the places burning, based on over 20 lake-sediment records our teams had collected over the past 15 years," says Higuera, professor of fire ecology in the W.A. Franke College of Forestry and Conservation. "When the smoke settled, we thought 'Wow, we may have witnessed something truly unprecedented here.' So we combined the existing records for the first time and compared them to recent fire activity. To our surprise, 2020 indeed pushed fire activity outside the range of variability these forests have experienced over at least the past two millennia."

Study Investigates Why People Pick Certain Campsites

Those in love with the outdoors can spend their entire lives chasing that perfect campsite. New research suggests what they are trying to find.

Will Rice, a UM assistant professor of outdoor recreation and wildland management, used big data to study the 179 extremely popular campsites of Watchman Campground in Utah's Zion National Park. Campers use an online system to reserve a wide variety of sites with different amenities, and people book the sites an average of 51 to 142 days in advance, providing hard data about demand.

Along with colleague Soyoung Park of Florida Atlantic University, Rice sifted through nearly 23,000 reservations. The researchers found that price and availability of electricity were the largest drivers of demand. Proximity to the adjacent river and ease of access also affected demand. Other factors – such as views of canyon walls or number of nearby neighbors – seemed to have less impact.

The work was published in the Journal of Environmental Management.

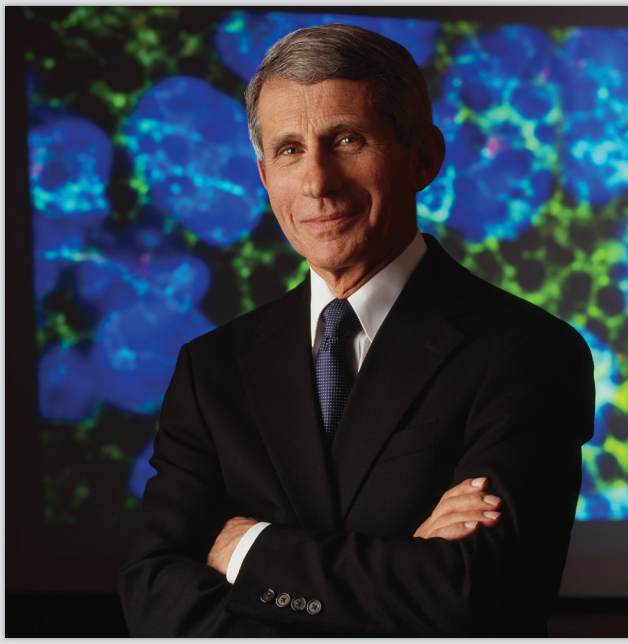
"This study demonstrated the power of using the big data of outdoor recreationists' revealed preferences to build models of decision-making, and did so in a setting that is incredibly relatable to many Americans," Rice says. "For instance, anyone who has ever picked a campsite within a campground has certainly dealt with the dilemma of proximity to the restroom. I mean, we want to be close enough to make navigation easy in the middle of the night, but not so close that we're smelling it and listening to the door open and close all night."

He says past studies on recreation decision-making have relied on surveying people about their stated preferences – basically asking them what they like. This study broke new ground by using revealed preferences – observations of people's actual decision-making – made possible by the Recreation Information Database. That database contains facts about all bookings made through the federal Recreation.gov site, which makes reservations for many national parks across America.

The researchers studied these site variables at the Watchman Campground: distance to the nearest dump station; distance to the nearest restroom, trash or recycling station, or water spigot; whether it was a walk-in site; price and electricity; number of neighboring campsites within a 40-meter radius; campsite shading; access to the nearby Virgin River; direct access to canyon walls; and views of canyon walls. These variables were broken into three setting categories: managerial, social and ecological.

Certain amenities at sites influenced how early they are reserved, on average. For instance, good views of the canyon walls increase the average booking window by three days. Price, access to electricity and ease of access also increase how early sites are reserved, demonstrating their popularity.

Rice says their work and new research model can help park managers make better decisions about campground design and recreation planning.



Universities are places for the open exchange of ideas and knowledge, and UM virtually hosted two leaders in 2021 trying to tackle some of our biggest problems. In February, Dr. Anthony Fauci, the country's leading infectious disease specialist, spoke about developments in the fight against COVID-19 as part of three "Pandemic Dialogues" hosted by UM's Mansfield Center. Then last summer, former U.S. Vice President Al Gore discussed climate change as part of a speakers series hosted by UM's Max S. Baucus Institute. He shared the event with Baucus, the former Montana U.S. senator and ambassador to China.

Faculty Member Appointed to Prestigious National Health Council

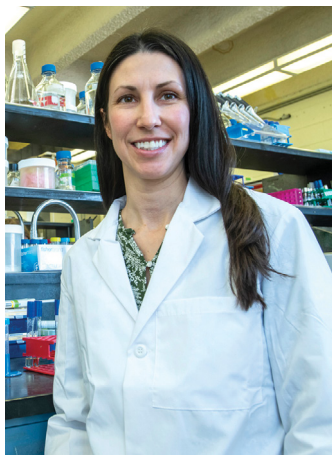
Dr. Andrij Holian, a UM professor of toxicology in the Department Biomedical and Pharmaceutical Sciences and director of the Center for Environmental Health Sciences in the Skaggs School of Pharmacy, was invited to serve on an influential National Advisory Environmental Health Sciences Council in 2021.

NAEHSC advises high-level federal government leaders such as the secretary of the U.S. Department of Health and Human Services, the director of the National Institutes of Health and the director of the National Institute of Environmental Health Sciences on research, training and other matters significant to meet national research goals.

In the announcement on Holian's invitation to join the council, NIEHS acknowledged the UM professor's outstanding scholarship, academic accomplishments and experienced leadership in the fields of toxicology, inflammation and the immune response, and signal transduction pathways in tissue injury.

"Being able to contribute to setting research priorities and program balance at NIH is both exciting and daunting," says Holian of his invitation. "This would not have been possible without the many exciting contributions of outstanding students and staff that I have had the privilege of working with at the UM Center for Environmental Health Sciences over the years."

Research Reveals How Bacteria Defeat Drugs That Fight Cystic Fibrosis



UM researcher Laura Jennings helped discover a strategy used by bacteria to defeat antibiotics and other drugs used to fight infections caused by cystic fibrosis.

UM researchers and their partners have discovered a slimy strategy used by bacteria to defeat antibiotics and other drugs used to combat infections afflicting people with cystic fibrosis. The research was published last year in the journal Cell Reports.

Cystic fibrosis is a life-threatening disease that causes persistent lung infections and limits a person's ability to breathe over time. A common strain of bacteria, *Pseudomonas aeruginosa*, often thrives in the lungs of people with cystic fibrosis, as well as in wounds from burns or diabetic ulcers. Once a P. aeruginosa infection is established, it can be incredibly difficult to cure, despite repeated courses of antibiotics.

Dr. Laura Jennings, a research assistant professor in UM's Division of Biological Sciences and an affiliate with the University's Center for Translational Medicine, says their research showed that the stubborn germs living in the lungs of cystic fibrosis patients create a self-produced carbohydrate slime. And this slime makes the bacteria more resistant to the antibiotics prescribed by doctors, as well as drugs that reduce the thickness of mucus.

"We found the first direct evidence that these carbohydrates are produced at the sites of infection," Jennings says. "We showed that one of the carbohydrates, called Pel, sticks to extracellular DNA, which is abundant in the thick mucus secretions prominent in cystic fibrosis lungs.

"This interaction makes a slimy protective layer around the bacteria, making them harder to kill," she says. "As such, it reduces the pathogen's susceptibility to antibiotics and drugs aimed at reducing the thickness of airway mucus by digesting DNA."

Glacier Retreat May Produce New Salmon Habitat

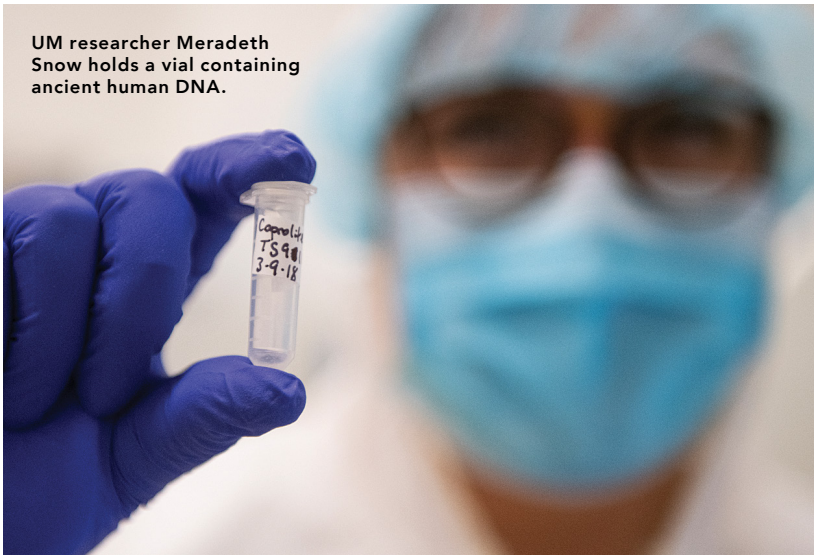
For decades, climate change has had detrimental impacts on Pacific salmon populations. Spawning streams are overheating, and droughts are drying up salmon habitats entirely, impacting many food webs from the Rocky Mountains and Coast Ranges to the Pacific Ocean.

But in a new study involving researchers at the UM Flathead Lake Biological Station, scientists discovered warming trends may offer one silver lining, if only for a while: The retreat of glaciers in the Pacific mountains of western North America potentially could produce more than 6,000 kilometers of new Pacific salmon habitat by the year 2100.

"Climate change alters the shape and dynamics of stream ecosystems," says Diane Whited, an FLBS scientist whose role in the study focused on spatial modeling of potentially accessible stream habitat once glaciers have receded. "This information is crucial for managing the future of salmon habitat and productivity."

The work was led by Simon Fraser University and published in Nature Communications.

Under a moderate climate scenario, the loss or reduction of those glaciers may reveal around 6,150 kilometers of potential new salmon habitat throughout the Pacific mountains of western North America by the year 2100 – a distance nearly equal to the length of the Mississippi River.



UM researcher Meradeth Snow holds a vial containing ancient human DNA.

Research Reveals Ancient People Had More Diverse Gut Microorganisms

Only an anthropologist would treasure millennia-old human feces found in dry caves.

Just ask Dr. Meradeth Snow, a researcher and co-chair of the UM Department of Anthropology. She is part of an international team, led by the Harvard Medical School-affiliated Joslin Diabetes Center, that used human "paleofeces" to discover that ancient people had far different microorganisms living in their guts than we do in modern times.

Snow says studying the gut microbes found in the ancient fecal material may offer clues to combat diseases like diabetes that afflict people living in today's industrialized societies.

"We need to have some specific microorganisms in the right ratios for our bodies to operate effectively," Snow says. "It's a symbiotic relationship. But when we study people today – anywhere on the planet – we know that their gut microbiomes have been influenced by our modern world, either through diet, chemicals, antibiotics or a host of other things. So understanding what the gut microbiome looked like before industrialization happened helps us understand what's different in today's guts."

This new research was in Nature last year. Snow and UM graduate student Tre Blohm were among the 28 authors of the piece from around the globe.

Snow says the feces they studied came from dry caves in Utah and northern Mexico. So what does the 1,000-year-old human excrement look like?

"The caves these paleofeces came from are known for their amazing preservation," she says. "Things that would normally degrade over time look almost brand new. So the paleofeces looked like, well, feces that are very dried out."

Snow and Blohm worked hands-on with the precious specimens, suiting up in a clean-room laboratory at UM to avoid contamination from the environment or any other microorganisms – not an easy task when the tiny creatures are literally in and on everything. They would carefully collect a small portion that allowed them to separate out the DNA from the rest of the material. Blohm then used the sequenced DNA to confirm the paleofeces came from ancient people.

The senior author of the Nature paper is Aleksandar Kostic of the Joslin Diabetes Center. In previous studies, he found modern industrial diets may lead to less-diverse gut biomes and diabetes, and he wanted ancient human gut DNA to compare with modern samples. Almost 40% of microbial species in the ancient samples had never been seen before. •

QUICK **LOOKS**

Cornerstone **UM humanities programs** received a windfall $499,000 grant from the National Endowment for the Humanities. The funding comes from the federal government's American Rescue Plan, which awards funding for national programming in the humanities that "are an essential component of economic and civic life in the United States." The grant, "Making the Humanities Public: Racial Justice, Death in a Time of COVID and Sustaining Native Scholarship," will be led by Dr. Tobin Miller Shearer, UM professor of history, African-American studies and the Humanities Institute.

UM researcher **Angela Luis** was awarded a $2.5 million NSF grant to study how diversity of competitor species affects infectious disease transmission in wildlife – specifically hantavirus in deer mice. The associate professor of population and disease ecology will use the grant to learn more about how to predict increases in hantavirus in rodents, and, ideally, help prevent its spread to humans.

UM's **startup incubator MonTEC** earned an $850,000 grant from Google.org to support Indigenous women looking to start or grow a business in Montana. MonTEC will use the funds in collaboration with Salish Kootenai College and Blackfeet Community College to develop online programming in a variety of subjects to support new and existing female-owned businesses. "We will use this generous grant from Google to support and supplement the existing strength of Indigenous women by providing them with culturally empowering online courses," said Morgan Slemberger, UM director of Women's Entrepreneurship & Leadership.

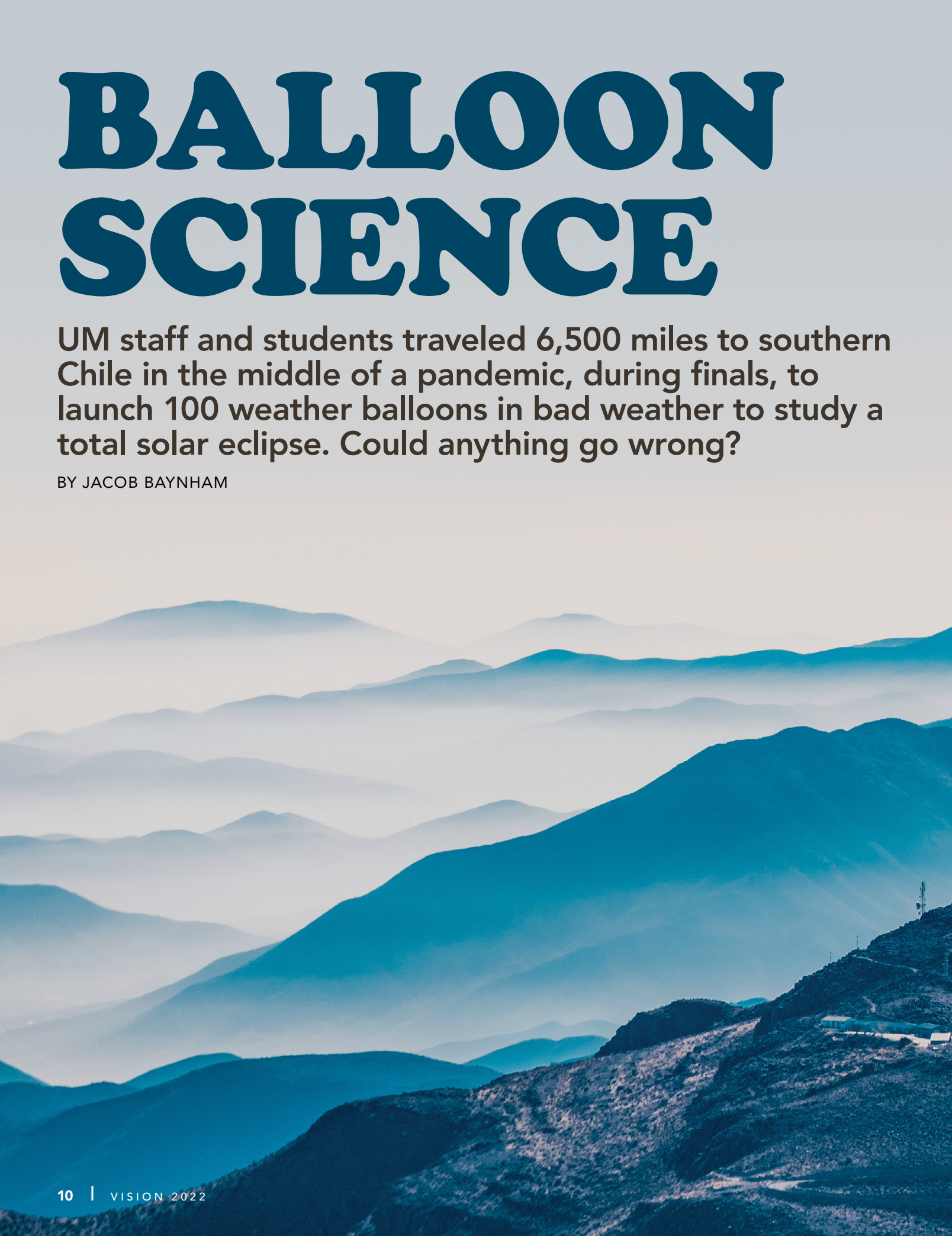
UM's **spectrUM Discovery Area** has received a $250,000 Museums for America project grant from the Institute of Museum and Library Services. It will fund a three-year project, allowing spectrUM and tribal partners from across Montana to develop inclusive museum experiences that engage visitors with Indigenous science and culture. Led by spectrUM Director Jessie Herbert-Meny, the project will deepen and explore cross-cultural approaches to science education while embedding Indigenous science and ways of knowing throughout spectrUM's new museum location at the Missoula Public Library.

UM geosciences Assistant Professor **Hilary Martens** has received a prestigious grant from NASA's Earth Surface and Interior Division. She will use the $443,000 award to examine the relationship between the ocean tides and changes in the shape of the Earth. The project will use GPS to measure how the Earth flexes and deforms under the shifting weight of ocean water.

BALLOON SCIENCE

UM staff and students traveled 6,500 miles to southern Chile in the middle of a pandemic, during finals, to launch 100 weather balloons in bad weather to study a total solar eclipse. Could anything go wrong?

BY JACOB BAYNHAM



It wasn't the easiest time to travel. Before she could board her flight for Santiago, Chile, last December, UM student Hannah Woody first had to visit the Chilean consulate in San Francisco to get documents allowing her to travel between regions. When she got back to Missoula, she had to self-isolate for 10 days and finish her finals remotely. Then came the mandatory COVID-19 test, 24 hours of N-95 masked flights to Chile, another COVID test in a Santiago hotel and one more day of isolation until she got her results.

Only at that point could Woody and the rest of her research team – a dozen students and five staff members from UM and three other universities – pack their rental vans and drive nine hours to their final destinations: two remote towns in southern Chile that lay in the direct path of a total solar eclipse, the only total eclipse in 2020. The team's mission was to launch hourly weather balloons before, during and after the eclipse to detect and observe stratospheric gravity waves – a meteorological phenomenon that happens when air cools and contracts, creating ripples in the atmosphere that can change the reliability of weather forecasts.

Nine months earlier, all of that was unknown to Woody, a senior biology major with a minor in astronomy. In the spring of 2020, a professor encouraged her to apply for an internship with the Montana Space Grant Consortium to get better at coding.

"I applied not really knowing what it was," she recalls. "Most people hadn't heard about atmospheric gravity waves. I certainly hadn't."

In the first weeks of the internship, Woody and the other interns pored over papers on fluid dynamics, atmospheric science and gravity waves. Woody learned how to write scripts of code. She studied up on common terrestrial and meteorological sources for gravity waves – things like mountains, storm fronts, convection and wind shear.

Then came 10 weeks of hands-on experience launching weather balloons on the UM Oval. The balloons are 4 feet in diameter on the ground and rise to about 100,000 feet – halfway through the stratosphere – before they burst. They carry a palm-sized scientific instrument called a radiosonde that relays meteorological data to a computer on the ground.

The culmination of the internship was a two-week field campaign to Chile for which the team had received almost

The team launched many of their 2019 research balloons near observatories like this one high in the Andes Mountains. (Photo by Jaxen Godfrey)

Jen Fowler with Montana Space Grant Consortium (far right) helps her student team prep a research balloon test launch on the UM Oval.

$700,000 from the National Science Foundation. But when the pandemic hit, all bets were off. Summer turned to fall, and the pandemic only worsened. Woody and the other students assumed there would be no way they could go down to Chile to apply their new skills during the eclipse.

"Things just fell apart," Woody says. "Throughout the fall, I told my partner, I'm definitely not going to Chile. Then the University approved our travel, and Chile opened its borders. It all came together about a month before we left."

If the pandemic thought it was going to derail a rare opportunity to detect eclipse-driven atmospheric gravity waves, then it had underestimated the resourcefulness of two key people at UM: Jen Fowler and Carl Spangrude.

"We're both optimists, probably unreasonably so," says Fowler, who directed UM's Autonomous Aerial Systems Office before leaving the University in October to take a job with NASA. "We started writing up safety protocols. We started asking the Chilean government, what would it take to allow us to do this?"

Spangrude, a 2019 UM graduate who now serves as UM's remote sensing director for the Montana Space Grant Consortium, wasn't going to be deterred. He worked with the U.S. Embassy in Santiago and the Chilean Consulate in San Francisco. He even explored the possibility of launching balloons from a U.S. Naval ship. Finally, the Chilean ministry of science and the Ministry of Health approved their entry.

"We were not going to stop trying," Spangrude says. "Jen and I thought, how are we going to navigate this? We can problem solve. We can make it work. People who achieve great things are the ones who do that. They figure out a way to make it work when everyone else is telling them they're crazy."

Scientifically, the stakes were high. Fowler and Spangrude had been in Chile for an eclipse in 2019, launching weather balloons from the southern edge of the Atacama Desert. During that field campaign, they documented the first eclipse-induced atmospheric gravity waves. The concept of eclipses producing gravity waves had been around since 1970, but they had never been definitively recorded in the stratosphere. Now they wanted to do it again.

"Without replicating that, there's no way to say it wasn't a fluke," Spangrude says. "Our methods were rigorous, but the sample size was one campaign."

That's why it was imperative to get back to Chile for the 2020 eclipse, which would also pass from west to east, crossing an ocean and then the Andes, in almost the same geographical location as in 2019. Back-to-back eclipses with such similar attributes wouldn't happen again for another 27 years.

"The 2019 and 2020 eclipses were the one opportunity for us to do this work in our careers," Spangrude says.

So with binders full of contingency plans, Spangrude, Fowler and the rest of the group flew down to Chile in December to conduct their research. They booked lodging through Airbnb and arranged to have 5-foot helium tanks purchased and delivered through the University of Santiago. They were in communication with the Chilean version of the Federal Aviation Administration to make sure the balloons didn't upset any flight plans.

"We had this planned down to the minute," Spangrude says. "There was no detail too small. There were so many things that could've gone wrong. If we got shut down it was going to be because of something beyond our control."

By the time the actual eclipse drew near, the two teams were in position, one on the coast and the other at the feet of the Andes. Even though the students came from four different universities, they had all trained to launch the balloons in the same way. The teams divided into night and day shifts.

"We call it game day when the launches start," says Fowler. "Filling balloons with helium is pretty loud. We're yelling at each other. The launch site is separate from the sleeping quarters and food. Every 30 minutes you're doing something."

The process itself was pretty repetitive. The launch crew consisted of three different positions. One person prepped the radiosonde by entering initial weather data and ensuring it was connected by radio signal to a laptop on the ground. The second position filled the balloon to a precise pressure and then released it. The third position recorded current meteorological measurements on the ground station to help initialize the radiosondes. Once the balloon burst at the end of each flight, the radiosonde would fall back to earth on a parachute. The team did not retrieve them – all the data were transmitted via radio signal – but information on the back of the devices enables people to return them to UM if they are found.

"We did musical chairs on what position we were doing," Woody says. "Switching roles helped keep you awake. Going outside on a 40-degree night would kind of wake you up a little more."

Fowler, Spangrude and professors from other universities were acting in support roles, in case anything went wrong. In the mornings, Fowler fried up dozens of eggs to feed the night shift that was coming off work and the day shift that was starting. At both sites, the students themselves filled and launched the balloons and recorded the data, one launch each hour for a nine-hour shift.

Periodically Fowler and the others would take a computer down to the local internet cafe to upload data to the cloud to be quality checked by the team's mission control, a group of students holed up with coffee, fruit and granola bars at the University of Idaho. That's where Graham Moss, then a UM senior in physics, spent the eclipse. He couldn't get his passport in time to go down to Chile, so he took advantage of high-speed internet to provide the teams with weather forecasting and early data analysis.

"We spent basically all hours of the night and the eclipse campaign waiting for data to come in," Moss says. "We'd look at data to see if there were any problems with it, and we were able to run that data through some of the gravity wave detection algorithms."

Woody, who was working the night shift at the coastal site, woke up to witness the eclipse itself. It was the first eclipse she'd seen, and the experience was profound. Although the day was cloudy, there was a tiny break in the clouds right at totality, so the team could look directly at the eclipse crescent without dark glasses.

"All the frogs and crickets started chirping as it got really dark," Woody recalls. "It got really still. The wind stopped. You just feel this immense force of this eclipse moving over you. Then it passed. The animals quieted down, it got breezy again, and it was back to business."

On the day of the eclipse, windy rainy weather rolled in. The extra moisture changed the amount of helium the balloons needed to rise at the ideal rate of 5 meters per second. And the wind sometimes whipped the balloons over the towering Andes so quickly that the radio signal was lost before the balloon flight was complete, creating holes in the data.

Once Fowler and the team returned to the U.S., they realized that the weather was caused by a rare phenomenon called an atmospheric river, a narrow band of heavy moisture that happened to coincide with the totality of the eclipse. Very little data exists on atmospheric rivers in South America. They are more difficult to predict ahead of time than eclipses.

"We got an entire data set of hourly radiosondes from the evolution to the dissipation of an atmospheric river," Fowler says. "It added a whole other dimension to our data."

Currently, the team is busily modeling their 2020 data to detect eclipse-induced atmospheric gravity waves. So far they haven't definitively identified one, but they have several likely candidates. The research is leading to at least six different student-written academic papers, and some of the student participants – Hannah Woody and Graham Moss included – were invited to present at the next American Geophysical Union conference, one of the world's largest scientific gatherings.

What's more, two upcoming eclipses in 2023 and 2024 offer additional opportunities for atmospheric gravity wave research. Spangrude is a key leader of the NASA-funded $7 million Nationwide Eclipse Ballooning Project, which will include funding for UM student researchers.

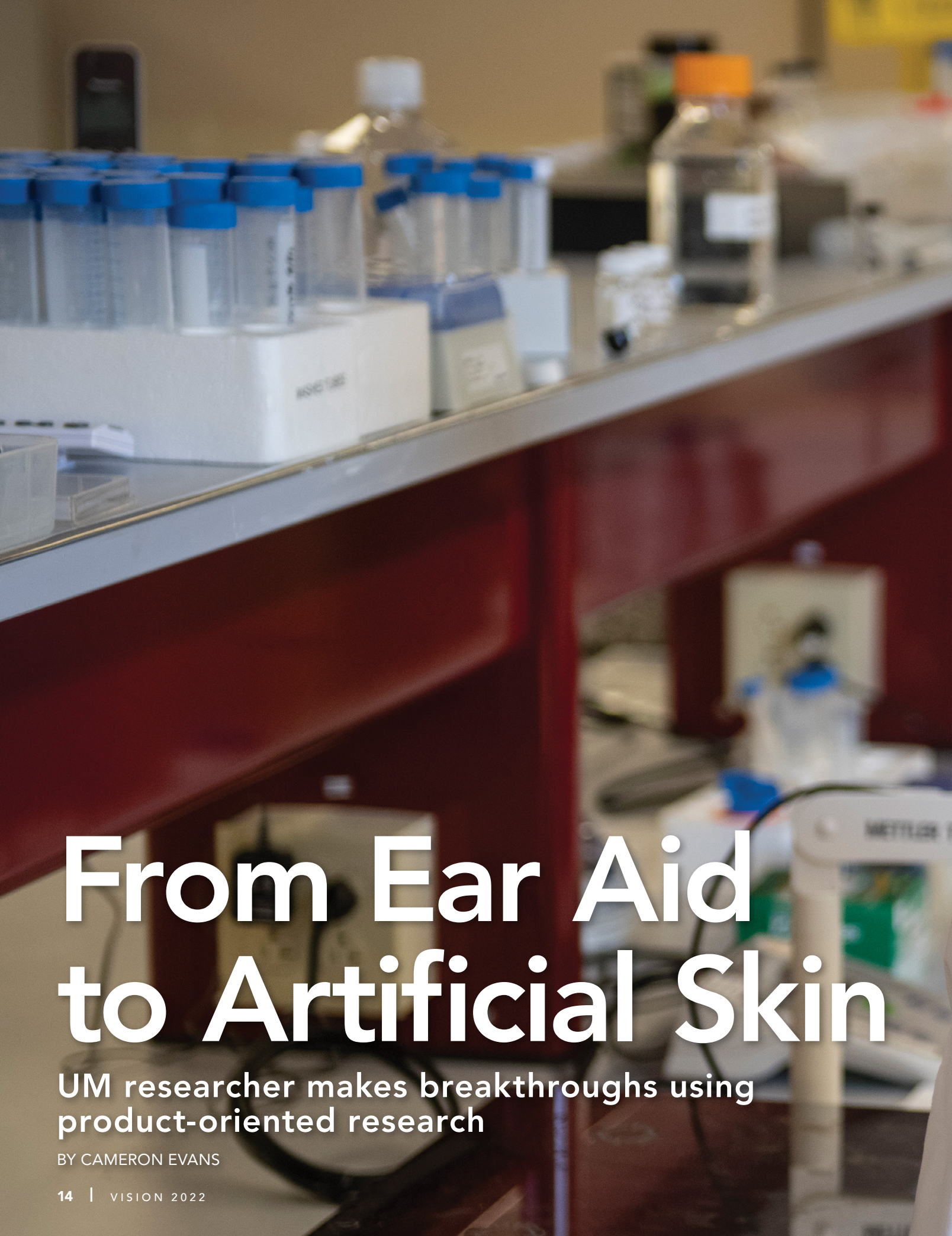
In the end, Fowler and Spangrude were able to do what seemed impossible – conduct rigorous scientific research in another country during a pandemic. The team's data provides a valuable contribution to atmospheric science. Weather forecasts will improve when these waves are better understood. Spangrude is inspired by the fact that the effort was all student-driven.

"It was a proof case to have undergraduates lead the research," he says. "We were demonstrating that undergraduate students have much more capability to do rigorous meaningful science."

Meanwhile, students like Woody walked away with a foundational scientific experience of a lifetime. Woody, who plans to do graduate work in astrobiology, also did what she set out to do: improve her coding skills.

"I really enjoy being able to code," Woody says. "I don't have to sweat knowing coding as I move into a STEM field. I'm going to be able to keep up." •

Carl Spangrude of the Montana Space Grant Consortium takes a selfie with members of the research team preparing to launch a weather balloon in Chile. Also pictured are (back, left to right) UM student Thomas Colligan, UM BOREALIS flight director Deborah Ross, MSGC Assistant Director Jen Fowler and physics student intern Jaxen Godfrey.



From Ear Aid to Artificial Skin

UM researcher makes breakthroughs using product-oriented research

BY CAMERON EVANS

Researcher Monica Serban and science workers in her UM lab are creating several commercial products ready for transfer to the marketplace.

The Serban lab is developing a biomaterial-based skin substitute for large burns and abrasions that also could deliver drugs to injured areas.

What started as a routine visit to the vet to treat a canine ear infection turned into a breakthrough development for UM researcher Monica Serban.

As a mother who was working full time as an assistant professor at that time in the University's Biomedical and Pharmaceutical Department, Serban couldn't fathom taking on the task of tackling her dog and applying antibiotic drops to its ear twice a day for 10 days to treat the infection. So she decided to take on a different type of challenge: creating a single application antibiotic delivery system to treat ear infections in both dogs and humans.

"I asked if there was some kind of formula that could be applied at the vet's office and was told there was nothing on the market that could do that at that time," Serban says. "That's what gave me the idea to try to make this ourselves."

Serban had just moved to Missoula to transition from working for a company that manufactured medical devices for academia. She got to work and eventually formulated a gel-like antibiotic delivery system that only requires one application and does not need to be refrigerated.

The formulation liquefies when shaken or inserted through a syringe and then quickly returns to a gel when it reaches the site of the infection. That ensures that it will stay in place if the dog shakes his or her head after application, unlike the antibiotic ear drops that pet owners currently rely on.

Drawing from her background in commercial product development, Serban started doing market research and realized that there was an opportunity to use the delivery system to administer antibiotics to humans. Serban found the single-use delivery system could be particularly useful for military personnel, patients in nursing homes and people who have hand tremors that make it difficult for them to apply ear drops. Because the delivery system does not need to be refrigerated, it would also be suitable for use in resource limited settings such as rural areas or developing countries.

As the project grew in scope, Serban also honed her ability to apply her knowledge from working in the industry to her research at UM.

"We're very focused on applied research," Serban says. "Most of our projects are focused on solving medical problems. All of them are intended to lead to products."

Serban says there are not many universities that support the product-oriented and commercialization-based research that her lab conducts, which she says makes UM unique.

"We're doing a good job of daring to be different and pushing the boundaries of what was considered the norm in academia," she says.

Morgan Weidow is an undergraduate researcher in Serban's lab who studies human biology with a business administration minor. She says working on the project to develop a skin substitute has changed her perspective on research.

"Coming in as a freshman, you think that research is only done at a bench side, but research is so many things and can bring in so many fields and subjects and individuals," Weidow says. "At the core of it all, you just have to ask questions and then pursue them."

Conducting product-oriented research also has enabled Serban's lab to receive funding through commercialization grants, including a $4.8 million grant from the Office of Naval Research to explore systems to prevent hearing loss among U.S. sailors and Marines, which could be renewed for one additional year to provide nearly $7.3 million in funding.

Serban's lab also received a $1.4 million commercialization grant from the National Institutes of Health after a medical journal that was impressed by the drug delivery system to treat ear infections selected Serban's paper for an immediate press release.

The grant has allowed Serban's lab to continue with the product development phase for the delivery systems to treat ear infections. The lab currently is working on creating product specifications to understand how the manufacturing process would work and how they would be able to scale up production from the small scale that is done in the lab. They also are working on licensing the technology based on its field of use so that it could be used by different companies for veterinary or human purposes.

Serban says her lab aims to have the delivery system ready for technology transfer to the marketplace and subsequent commercialization via field-of-use licensing within the next two

years, although she noted the timeline will depend on factors such as how the Food and Drug Administration decides to regulate it.

Serban says there are several companies interested in licensing the technology and that it would likely take less time for the delivery system for dogs to reach the market because veterinary medical devices are not regulated by the FDA to the same extent as human products. The approval process for the human market would depend on whether a company wants to move forward with the gel only or the gel with medication as a product.

Her lab also continues to make headway on other research.

In one project, the lab is working in collaboration with several research groups on a noise-level-triggered drug dosing and delivery system to prevent hearing loss among U.S. sailors and Marines. The first-of-its-kind system would respond in real-time to harmful sound levels and noninvasively deploy hearing protective agents to prevent trauma.

Serban says it could revolutionize the noise-induced hearing loss protection field.

In another project, Serban and her team are working on developing a biomaterial-based skin substitute for large burn and abrasion wounds that would be able to deliver drugs topically. The project is supported by a $60,000 grant from the M.J. Murdock Charitable Trust.

Like the other projects, the development of a bioengineered, large-skin-wound management system would be particularly useful for the military. The product would look and feel like skin but would include additional features to promote wound healing, suture-free fixation and enable localized drug delivery.

"In theory, by applying antibiotics or painkillers onto this device, it would get them into the deep tissue and hopefully eliminate the need of taking systemic medication that can lead to various side effects," Serban says.

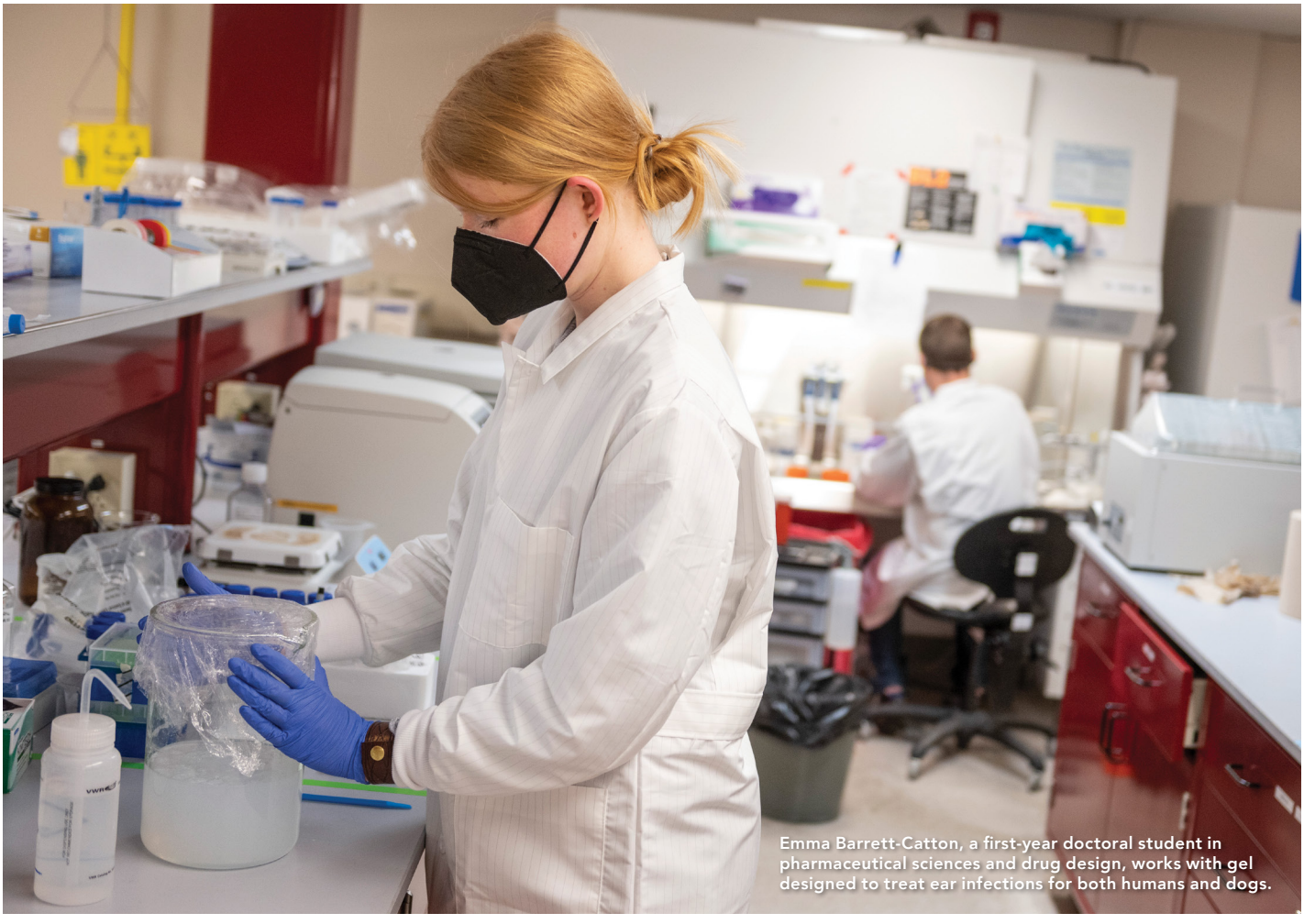
Researchers working on the project currently are developing prototypes, and Weidow says she has started reaching out to a network of military medics at Fort Sam Houston in Texas where many medics receive training.

"We're hoping to collaborate and do some interviews with them where we're kind of viewing them as our end user so we can gear our product design toward what will be the best and most efficient application for them in the field," Weidow says.

Serban noted that there currently are no emergency, large-surface, skin-wound-management products available for first responders and that this product would be another first of its kind.

Meanwhile, Weidow's student experience working in a UM lab has transcended her expectations.

"It has been really fun as a business student to do a focus group design and customer exploration and market research," Weidow says. "I never would have imagined that I would have been able to do those things in a lab as an undergrad or apply research to the real world and see the human impact." •

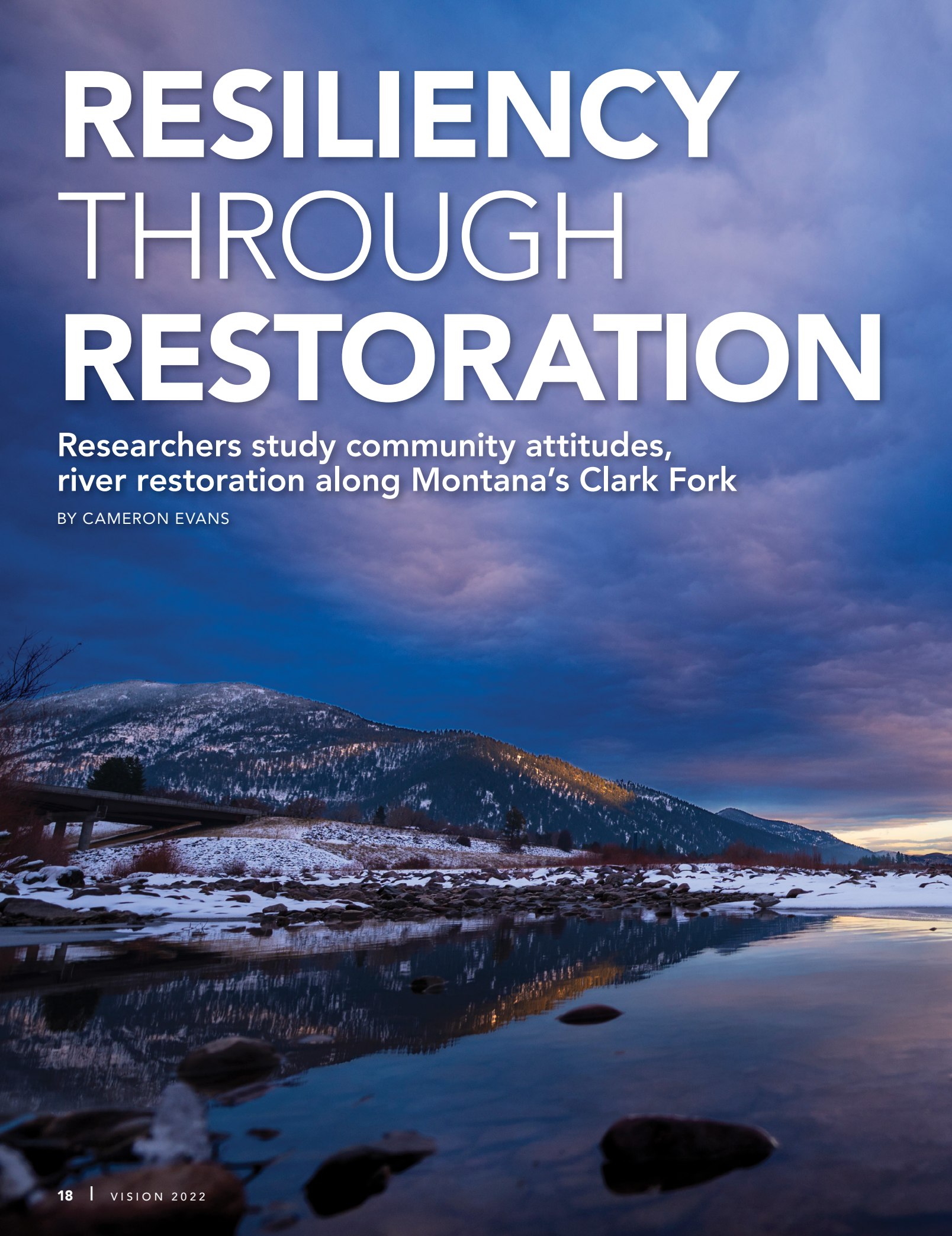


Emma Barrett-Catton, a first-year doctoral student in pharmaceutical sciences and drug design, works with gel designed to treat ear infections for both humans and dogs.

RESILIENCY THROUGH RESTORATION

Researchers study community attitudes, river restoration along Montana's Clark Fork

BY CAMERON EVANS



The sky fades on the shortest day of the year in 2021 at the confluence of the Blackfoot and Clark Fork Rivers. The river has flown freely since 2008, when the Milltown Dam was removed, creating one of the nation's greatest restoration success stories.

UM scientists Maury Valett and Libby Metcalf, shown here along the snowy banks of the Clark Fork River in Milltown State Park, are key researchers for the Montana Consortium for Research and Environmental Water Systems, or CREWS, a wide-ranging project to study the state's water systems and quality issues.

Mining and smelting operations at the headwaters of the Clark Fork River delivered copper and electricity to the United States for over a century, creating a sense of pride for area residents. But 100 years after a massive flood washed millions of tons of toxic sediment downstream, landmarks such as the smelter stack in Anaconda that once represented livelihood, well-being and economic health have come to symbolize a century of contamination.

The impacts of the region's mining legacy – on both western Montana's Clark Fork River and the communities that dot its banks – is one focus of the Consortium for Research on Environmental Water Systems, a five-year, $20 million project funded by the National Science Foundation's Established Program to Stimulate Competitive Research. Led by principal investigator and UM Professor Ragan Callaway, CREWS research brings together faculty, student and postdoctoral researchers from eight Montana universities and tribal colleges to study and inform decision-making about water systems and quality issues across the state.

One of those researchers is Libby Metcalf, the Joel Meier Distinguished Professor of Wildland Management at UM's W.A. Franke College of Forestry and Conservation. Her social science research explores how communities respond to and recover from water contamination. Along the Upper Clark Fork, a stretch of river flowing roughly from Butte to Missoula, Metcalf's research is associated with a cluster of cleanup and restoration projects – collectively the largest Superfund site in the nation – to remove toxic metals from the floodplain and restore riparian vegetation.

One such effort, the completed removal of Milltown Dam and restored floodplain at the confluence of the Clark Fork and Blackfoot rivers, often is touted as one of the nation's greatest restoration success stories. The former dam site and floodplain near Missoula are now a state park and popular recreation area.

Yet in studying the successes of the Milltown Dam removal and how those lessons could be applied to the other Superfund sites in the region, Metcalf learned that upstream communities had very different feelings about Superfund work. In communities such as Anaconda and Deer Lodge, much of the cleanup remains to be completed, and poor engagement with local communities throughout the process has eroded trust and engagement among residents.

"It feels unfair to people," Metcalf says. "It feels like they've tried to engage and they've tried to change things, but the timing of it all is just so slow that it just kind of burns people out."

The finding that attitudes about Superfund cleanup vary widely by community became the basis for Metcalf's current research, which explores how collective memories of mining help or hurt communities like Anaconda or Deer Lodge.

"I'm interested in how they wrestle with the fact that their livelihoods were made with that (smelter) stack and yet that stack harmed human health in the past and may be holding them back from being a thriving community like they once were," Metcalf says.

Despite the ways mining has degraded communities, Metcalf says, people remain hopeful and have a deep love for their communities.

Metcalf's team, which includes doctoral student Megan Moore and postdoctoral researcher Amanda Bailey, has interviewed almost 60 people in Deer Lodge and Anaconda with the goal of understanding what communities want to see in the Superfund process.

"I'm looking at if we could have done engagement different or better in these areas and if we have an issue of trust," Metcalf says. "And then how can we use this information to propel us into a more successful project as we continue through this Superfund?"

Metcalf and the CREWS team's social science research is interwoven with the project's ecosystems science research, which at UM is led by Maury Valett, a professor of systems ecology and a CREWS co-principal investigator.

Valett says the work on the CREWS project is being done in close communication with the state as it remediates and restores the Clark Fork while working to understand the many variables affecting the river.

"What my lab is trying to do is figure out how the fertilization effect that comes from the nitrogen coming into the river interacts with the poisoning effect of the metals to influence the algae that grows, the insects that eat it and the insects that are trapped," Valett says. "And then what about the trout?"

Within this question, Valett and his faculty and graduate student collaborators are studying the distribution of nitrogen in the Upper Clark Fork and its role in causing the river to "bloom green" with algae. This work complements the research of team members in the Colman, DeGrandpre and Hall labs at UM and UM's Flathead Lake Biological Station, all part of the CREWS ecosystem science team on the Clark Fork River. Valett Lab findings suggest that sewage inputs are an important source of nitrogen and that cattle feces and urine also contribute, although the team is still working to figure out where cows get their nitrogen. Additional research is examining the number of fish per river mile and exploring why fish counts have declined over the last 30 years. Valett notes that trout populations are declining in the Clark Fork even as the water quality improves in some areas, and says there are many more factors at play.

"The state and other states are recording a large decline in brown trout, so it may not be the metals that are the smoking gun," Valett says. "Maybe it has to do with heat because all these rivers are warming up."

Through CREWS, Valett has partnered with the state's Natural Resource Damage Program to lead the Upper Clark Fork Working Group. The group is made up of Montana University System researchers and state agencies, including Montana Fish, Wildlife and Parks; interested groups such as Trout Unlimited; and private industry professionals who work on ecological restoration. The goal is to get everyone communicating and collaborating on Clark Fork River restoration efforts, including local residents. Valett says this collaboration across groups and with the state will help the state meet Superfund goals on the Clark Fork River.

The former location of Milltown Dam upstream from campus has become a place for first-year students to experience fishing as part of UM's Big Sky Experience.

"It feels really meaningful to be in a position where you can align and work with the state," Valett says.

While Valett and research collaborators work to understand the interrelated impacts of mining on the health of the Upper Clark Fork, CREWS researchers across the state are exploring similar questions affecting other water systems, specifically agriculture in central Montana's Judith River Watershed and energy extraction in eastern Montana's Powder River Basin. The CREWS social science team, co-led by Metcalf and Montana State University's Julia Haggerty, explores the role of and impacts on communities across these diverse sites.

Reflecting NSF EPSCoR's emphasis not only on scientific research itself, but also on building statewide research capacity, the CREWS project provides research training for undergraduate, graduate and postdoc researchers across Montana. And in parallel with the research, a CREWS broader engagement team brings hands-on science experiences, teacher professional development and other efforts to increase diversity and participation in STEM to communities across the state, focusing particularly on regions where CREWS research takes place.

"That's where we need to understand the communities along the river and what they value," Valett says. •

STUDENT SPOTLIGHT:

SCHOLARLY RESEARCH BECOMES AN INTEGRAL PART OF A UM EDUCATION FOR MANY STUDENTS. HERE ARE A FEW HIGHLIGHTS.

BY NATHALIE WOLFRAM

AUDREY GLENDENNING

Federal legislation recently restored the National Bison Range to the Confederated Salish and Kootenai Tribes.

Such changeovers are more common than many people realize, says Audrey Glendenning, a graduate student in resource conservation. Glendenning's master's thesis explores the legal framework for restoring federal public lands to tribes, an issue that is both fascinating and urgent because, she says, "There are so many different Indigenous groups that historically accessed what are now public lands."

Glendenning's promise as an emerging environmental policy scholar also earned her distinction as a Wyss Scholar for Conservation in the American West, an honor that carries financial support for her graduate education at UM. Then as a 2021 Baucus Climate Scholar, Glendenning interned with the Brookings Institution, where she explored data on ambient air monitors on tribal lands to help understand how tribes interact with the Clean Air Act. With her internship mentor, she also co-authored a publication on the fraught economics of the federal Black Lung Disability Trust Fund for afflicted coal miners.

Ultimately, Glendenning hopes to parlay her graduate research into a career with a conservation nonprofit in the West, ideally in the Rockies or the Crown of the Continent ecosystem that she has come to love through her experience at UM.

MIYA FORDEH

When COVID-19 shut down indoor gatherings, UM's Montana Repertory Theatre sought out creative ways to continue engaging audiences. Enter Miya Fordeh, a senior media arts major, who,with her longtime friend and collaborator Clarissa Spain, built GoPlay! – an app for location-based performance.

Think of GoPlay! like Pokemon GO or geocaching for live performance, Fordeh says. The app launched as a vehicle for "The Phantom Bride," a 12-part play that took audiences on a walking tour of downtown Missoula and the Hip Strip. The Rep also can use the app for ticket sales, calendar listings and information about arts events around town.

While Fordeh had long cultivated her passion for the visual arts, she credits Michael Musick, associate professor of media arts, for sparking her interest in coding through his design-focused teaching style.

Fordeh loves applied projects like GoPlay! because, "You never feel quite content with your work no matter what you finish," she says. "As technology and real-world conditions change, there are always improvements and new approaches to try."

With the GoPlay! project behind her, Fordeh now works with Michael Cassens, UM assistant professor of media arts, on a new project to make online design instruction more accessible for educators and students.

NICOLE BEALER

For wildlife biology major Nicole Bealer, undergraduate research at UM has meant scaling the craggy mountains of western Wyoming to study bighorn sheep. Bealer spent last summer as part of a team studying why some bighorn sheep succumb to pneumonia while others can carry the pathogen and still survive.

The work involved monitoring three herds, fitting them with radio collars and investigating those that died. The team also searched for newborn lambs, alerted by birth canal devices implanted earlier in the spring by other researchers.

"If they are born at 6 a.m., we are up at 6 a.m. to find the ewe and the baby so we can capture and collar it," Bealer says. "It made for some exciting days with long hikes and elevation."

Bealer cultivated an interest in wildlife biology as a junior in high school, when she had the opportunity to study mule deer and mountain lions in Colorado. Her budding research resume includes tracking mountain lions and their kittens and improving population monitoring techniques of the elusive wolverine.

TAYLOR GOLD QUIROS

The environmental legacy of Butte's Copper Kings runs through western Montana via the Clark Fork River, where metal contamination has vexed human and ecological communities for over a century.

Doctoral student Taylor Gold Quiros is part of a $20 million, multi-university effort to study and inform management decisions about Montana's waters, including the Upper Clark Fork. Led by principal investigator and UM wildlife biology Professor Ray Callaway, the Consortium for Research on Environmental Water Systems is funded by the federal Established Program to Stimulate Competitive Research.

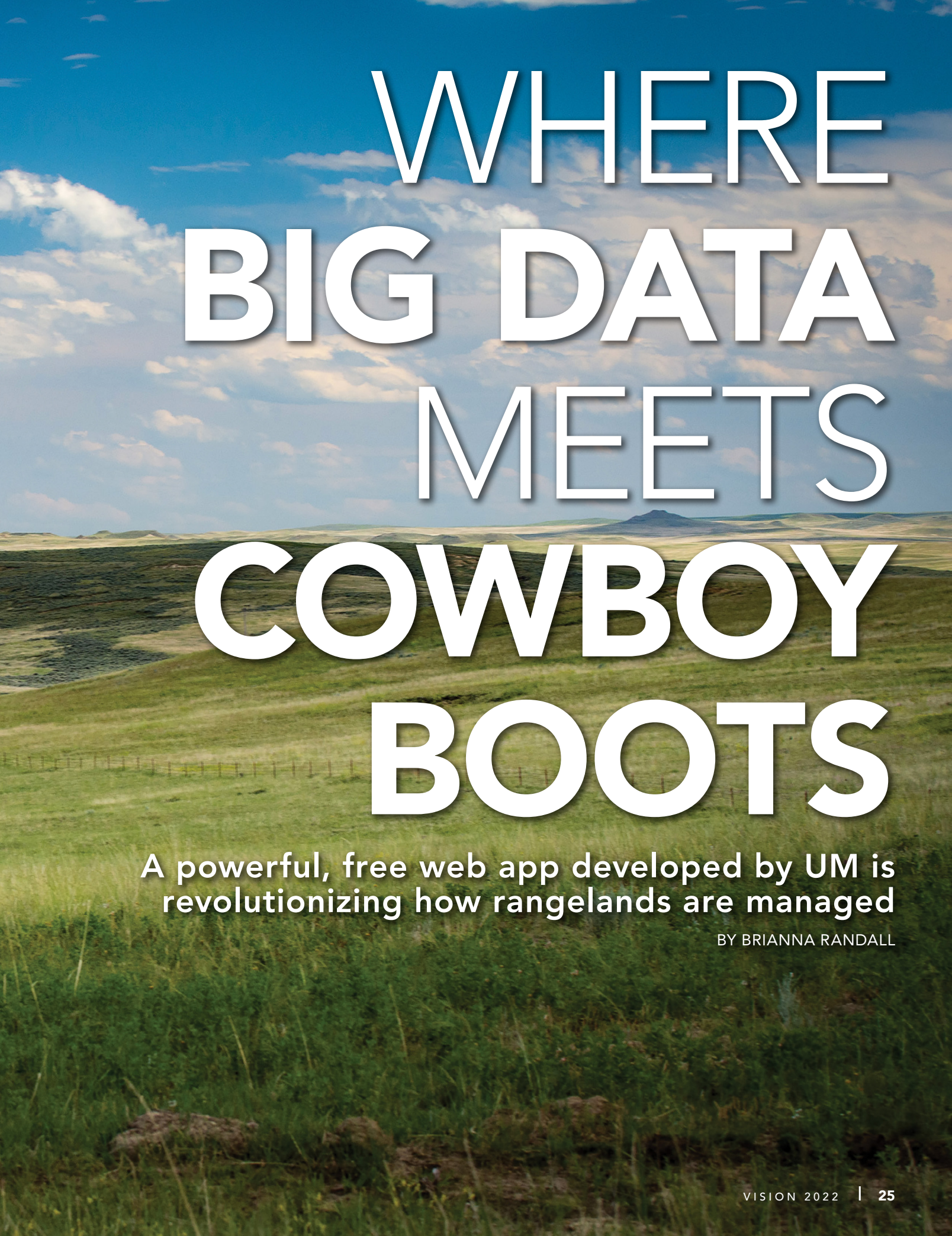
Mentored by UM biology Professor Maury Valett, Gold Quiros studies how fish communities and the greater food web on the Upper Clark Fork River have been influenced by the effects of copper mining. Her field work takes her onto the river by boat to count, identify and catch fish, which she dissects to see how much copper and other metals they have ingested.

EITON KOGOYA

As a student in UM's English Language Institute, Eiton Kogoya learned how Indigenous peoples in Montana work to preserve their languages and cultures. For Kogoya, the experiences of Montana tribes hit close to home, which for him is over 7,000 miles from Missoula, in Papua on the island of New Guinea.

As a native speaker of Lani, the language of the Indigenous tribe of the same name, Kogoya saw an imperative "to protect my language" as younger generations increasingly speak Indonesian as a first language. So at the suggestion of English Language Institute Director Sara Schroeder, he started a podcast.

In the "Lani Wone-Bahasa Lani-Lani Language Podcast," Kogoya tells stories and speaks with his family and elders from his community about their culture, history, customs and life experiences. Episodes range from a couple of minutes to over 40 and are recorded entirely in the Lani language. They have reached the ears of listeners who Kogoya says are primarily based in Indonesia, as well as his many friends and acquaintances studying at universities across the U.S. •



WHERE BIG DATA MEETS COWBOY BOOTS

A powerful, free web app developed by UM is revolutionizing how rangelands are managed

BY BRIANNA RANDALL

Sage grouse strut during their elaborate mating dances while cattle graze in the background. (Photo by Ken Miracle)

To get deeper into the weeds – as well as the vital grasses and shrubs they replace – Brady Allred realized he needed to zoom out. All the way to space.

"To move the needle on rangeland conservation, I wanted to better understand what was happening on these landscapes – not just on one plot in the backyard, but across the whole continent," says Allred, a rangeland ecologist and professor in the University's W.A. Franke College of Forestry and Conservation.

Rangelands are places where wildlife or livestock graze on grasses and shrubs. Think rolling waves of grass and the vast sagebrush sea. These lands cover one-third of the United States, producing food, fiber and important ecosystem services. Unfortunately, they also are some of the most imperiled ecosystems on Earth.

"Our goal is to conserve large, intact rangelands," says Allred, gesturing at colorful maps splayed across his laptop in UM's Interdisciplinary Science Building. "This is where our beef comes from, where carbon is stored, where wildlife lives. But to be successful, we first need to know what kind of vegetation grows where, how much and how it's shifting."

Allred teamed up with fellow UM researchers David Naugle, a wildlife biologist, and Matthew Jones, a remote sensing specialist, to create a revolutionary web app called the Rangeland Analysis Platform, which tracks vegetation and its production over time and space. Known as RAP, it pairs data from satellite imagery with thousands of on-the-ground field plots to show how plant communities have changed across the western half of the U.S.

Plants – especially native perennial grasses – provide the foundation for productive and profitable rangelands. But there hasn't been an accurate and easy way to see how much grass is growing across large landscapes. Instead, landowners and resource managers had to leaf through 50-year-old resource surveys or laboriously cut, dry and weigh the plant material growing on a square meter of ground to get an estimate for a parcel of land. As for satellite imagery datasets or models that analyzed vegetation at broad scales, the information would normally come as enormous, unwieldy, often intractable files – ones that require special training to process.

Now, thanks to RAP, tracking plant growth across time and space is as simple as a few clicks of a mouse.

"We're definitely not the first people to propose harnessing satellite data as a way to monitor vegetation," Allred says. "We were simply able to serve it up in a way that makes it easy for everyone to use."

Part of what makes RAP revolutionary is that it's powered by Google Earth Engine, which lets anyone instantaneously visualize vegetation cover across the lower 48 states. The app gives an estimate of the percentage of annuals, perennials, shrubs, trees or bare ground. Data can be displayed and downloaded for a baseball-diamond-sized pasture or for the entire Great Plains – all in less than one minute.

Plus, app users can compare how plants have changed from year to year all the way back to 1984, when Landsat satellite imagery first began, or even month to month. This is handy for showing where unwanted trees are taking over prime prairie, where plows have removed native plants over the past decade or where invasive cheatgrass is increasing wildfire risk in the western U.S.'s Great Basin.

Private landowners across the West are finding immense value in being able to track vegetation. A rancher in Wyoming can quickly

UM researcher Brady Allred led the creation of the Rangeland Analysis Platform.

create a map showing where to target weed treatments and then evaluate whether it boosted range health. A farmer in Kansas can calculate how much grass has been lost to encroaching eastern redcedar trees. A livestock owner in Oregon can see how a bad drought affected high-elevation pastures.

Government agencies also are jumping at the chance to use this powerful app. Public land managers like the Bureau of Land Management and the U.S. Forest Service are using RAP to track the health of grazing allotments, evaluate outcomes from restoration projects and identify where to conserve habitat for imperiled species like sage grouse. The USDA's Natural Resources Conservation Service is integrating RAP into its field assessments on private agricultural lands to help create sustainable grazing plans that protect water, soil and grass.

According to RAP co-creator Naugle, who is also a science adviser for NRCS Working Lands for Wildlife, the app gives "supporting evidence" for how, where and why to conserve rangelands in the American West.

"From a wildlife perspective, we need large, resilient, interconnected landscapes," Naugle says. "RAP gives us a way to surgically address the biggest threats facing these at-risk biomes: encroaching trees, invasive annual grasses and land conversion."

In the Great Plains, Naugle points to landowner-led groups who are using RAP to plan prescribed burns that will keep eastern redcedar at bay and restore prairies. In eastern Montana's grasslands, the Nature Conservancy is using RAP to pinpoint where conservation easements can protect biodiverse grasslands from being plowed up to become marginal cropland.

RAP's online platform also includes a tool that overlays an area's resilience and resistance to stressors like drought or wildfire.

"RAP is providing the spatial context for targeting almost $1 billion of federal Farm Bill conservation investments in the West," says Naugle. "It's big data meets cowboy boots, and it's a win for everyone."

Scientists also are using RAP to answer important research questions. For instance, Joseph Smith with UM's Numerical Terradynamic Simulation Group – which has designed software for NASA environmental monitoring satellites – is using RAP to better predict wildfires. He recently published a RAP-powered study that evaluated how much of the Great Basin has been overtaken by highly flammable cheatgrass, which helps resource managers identify and maintain remaining strongholds of healthy, native plants.

Another NTSG researcher, Scott Morford, is using RAP to model yield gaps on rangeland – how much grass the land could produce versus how much it actually produces – which is the first step for understanding how and where to restore the land's productivity.

Allred says the team plans to continue to improve and build upon these datasets, as well as create new ones.

"All of us believe in the co-production of science," Allred says. "That means first listening to what people need from researchers, and then going the very last mile to get that information into their hands so they can change the world." •

CONTESTED WATERS

Professor Jeff Wiltse makes a splash using swimming pools to study the racial history of the U.S.

BY CARY SHIMEK

Jeff Wiltse's unusual area of expertise came to him in a dream.

While in graduate school getting pressure to come up with a strong dissertation topic, he spent Thanksgiving break with the family of his girlfriend (now wife) in Hershey, Pennsylvania. Sleeping in a windowless basement room, he dreamed of researching the history of the private, suburban swimming pool in Seattle where he spent much of his childhood. It was a place of happy memories, but later he came to wonder about its sameness. All the swimmers had been middle class. And white.

"Huh?" he thought when he woke up. "I wonder if anyone has written about the history of swimming pools? I bet it would be fascinating."

A quick review of the literature confirmed his sleeping mind had stumbled into unexplored academic territory. It became an excellent dissertation in 2002, the same year he joined the faculty of the UM Department of History. Then in 2007 he published a full book, "Contested Waters: A Social History of Swimming Pools in America."

Published by the University of North Carolina Press, "Contested Waters" became something of an academic best-seller. It was reviewed by The New York Times, The Washington Post, the Economist, Atlantic Monthly and even People Magazine. It has sold over 8,000 copies

to date and proved its staying power by still selling 855 units in the past year. The book offers a comprehensive public history of swimming pools in the U.S., from the mid-19th century to the present. And it uses pools as a lens through which to view the history of race relations in America.

And if a race-related incident happens at a pool anywhere in the U.S., UM's Wiltse is the expert on the topic. He's done interviews with 20 national and international media outlets in the past year – from National Geographic and USA Today to the Los Angeles Times. HBO's "Vice News" covered him, and a video by Al Jazeera featuring his work has 1.4 million views.

"What happens at swimming pools tells us a lot about what's happening with our communities and broader society," Wiltse says. "Swimming pools provide an accurate reflection of who we are as a people."

Swimming pools are intimate spaces where we see one another partially clothed and share a body of water. They also are socially intimate, in that people are together for hours and have ample time to interact.

"I'm a firm believer that pools are an important community institution that have the potential to bring people together – to foster vibrant community life across social lines," Wiltse says. "But when people segregate themselves at private swim pools, they aren't serving that function anymore. Instead they reinforce social differences and divisions."

Wiltse's research revealed that the earliest public pools were segregated along gender lines, but, at least in the Northeast, Blacks and whites swam together. Then there came a historical moment when officials decided the sexes should swim together, and that's when racist attitudes began to exclude Black people and other minorities from these treasured community spaces.

Egregious racial incidents occurred when Black people and other minorities tried to use public pools. One of the worst took place in Pittsburgh, where the city opened a gigantic leisure resort pool at Highland Park in 1931. When a group of teen African-American males tried using it, a white mob of about 200 men attacked the teens in the pool, punching and kicking them and pushing them underwater to simulate drowning.

"They literally beat them out of the water," Wiltse says. "And when they tried to resist and come back later, the whites would wait for them outside. They would pelt them with rocks and beat them with sticks and clubs. This went on for days and days. The police officers stationed at the pool allowed the beatings to occur. They did arrest people, but the people they arrested were the Black victims of the violence, charging them with inciting a riot."

A more famous event took place in 1964 in St. Augustine, Florida, during the height of the civil rights movement. African Americans and other protesters tried to use a "whites only" pool, and the hotel manager poured acid in the water to try driving them out. When Rev. Martin Luther King Jr. and Rev. Ralph Abernathy arrived and confronted the hotel manager about the incident, the two icons were hauled off to jail together for fighting for the right to swim.

The racism didn't need to be so blatantly violent, Wiltse says. When the courts finally determined that public pools couldn't exclude Black taxpayers, city planners in places like Maryland would choose to cancel planned public pool projects. Instead, private suburban club pools would spring up, which for decades could still legally exclude people on the basis of race.

Racist swimming pool policies have had effects that echo across generations in the U.S. During the 19th century, people of African ancestry generally were more accomplished swimmers than people of European ancestry. Today, African Americans are half as likely to know how to swim as whites, and Black children are three to six times more likely to drown than white children, depending on their ages. Wiltse's research shows that a primary cause of these contemporary disparities is the pervasive racial discrimination that occurred at swimming pools during the middle decades of the 20th century.

This history casts a long shadow. "Everyone has this shared experience with swimming pools," he says. "My scholarship shows the extent to which African Americans had limited access to swimming pools and swim lessons, and I've been able to connect what that means to the present. I think that's why this work continues to attract attention."

So much attention, in fact, that in 2021 Fairmont Waterworks in Philadelphia opened up a 4,700-square-foot public history exhibit titled "Pool: A Social History of Segregation." Largely based on Wiltse's work, the exhibit highlights Black voices and swimming greats such as 2016 Olympian Simone Manuel, the first Black woman to win an individual gold medal in swimming.

"Dr. Jeff Wiltse's work both inspired and informed the landmark exhibition," says Victoria Prizzia, the exhibit director. "He served as the project's primary content expert and consulted with the creative team on all aspects of the history presented within the exhibition and programs. (His) fundamental contributions helped to shape the entire visitor experience of the exhibition, from exhibit graphics to multimedia narratives."

Wiltse teaches UM's courses on Montana history, and his next book – already in the works – will highlight the history of Big Sky Country. But he appreciates having an academic specialty that continually makes ripples beyond the state on the national and even international stages.

"Really, it's been like a dream," he says. •

(H)ELLO TO LEARNING

UM professor develops free resources to stimulate young minds

BY CAMERON EVANS

Research shows that embedding opportunities for conversations with children throughout everyday routines such as doing laundry or grocery shopping can greatly benefit children using a tool that's completely free: talking.

That's why Allison Wilson, a UM assistant professor of early childhood education, started a project aimed at increasing the number of language-rich interactions between young children and families in everyday spaces and routines.

The project, Everyday Language and Learning Opportunities (ELLO), provides families with free conversation prompts on pocket-sized cards and on signage at community spaces such grocery stores, libraries and trails, among other places. The conversational learning method targets children ages 2 to 6 and is based on the knowledge that language is central to all aspects of a child's development, including attachment, early literacy and math skills, and social-emotional development.

"We know that conversational exchanges between children and caregivers are really predictive of later academic and life outcomes," Wilson says. "Just exposure to vocabulary, even when young children aren't talking back yet, is building context to access when they're learning to read."

The resources are free and easy for families to incorporate into existing routines. They are available to download on ELLO's website: www.helloello.org. They include conversation cards and posters available in English, Marshallese, Russian and Spanish, as well as story cards available in English and Salish.

"We're not asking families to do something extra or new, but rather just enhance these basic routines and familiar outings into something more meaningful through talking," Wilson says.

The community-centered resources draw up language-rich conversations that are thematically tailored to frequent family routines such as going to the grocery store or the laundromat, riding public transit, eating meals together or doing laundry.

Outdoor displays called "learning trails" include signs around local parks that have prompts tailored to outdoor spaces. They ask children to talk about light and shadow and how it changes throughout the day.

While grocery shopping, families might spot a sign popping out of a basket of oranges in the produce section with colorful, child-friendly characters and an illustrated eagle that says through a speech bubble, "I spy oranges. What else can you tell me about what's around us?"

Research on early childhood development shows that childhood growth of conversation and social skills is best supported when engaged in sustained, language-rich experiences such as those modeled by ELLO. In addition to priming kids for learning, the conversations help kids develop communication skills linked to their capacity to express their feelings and thoughts.

Wilson started project ELLO about five years ago when she was teaching in Spokane, Washington, where it remains active. She brought ELLO with her to Missoula three years ago when she accepted a new job teaching at UM. In Montana, Wilson began building partnerships with community organizations such as United Way's Zero to Five Initiative and Healthy Start Missoula, among other organizations that are interested in promoting positive outcomes for young children and families.

The COVID-19 pandemic stalled the installation of some of the community resources in Missoula, but Wilson found other ways to keep the project moving. She secured grant funding from the Headwaters Foundation, which enabled her to print 1,000 sets of the conversation cards to distribute through community partners in Missoula County, as far down as Hamilton and over the Butte Silver Bow County areas as well.

The card sets were distributed at farmers' markets by local community agencies or through home visits for programs such as Early Head Start with the help of Missoula County.

Anna Semple is director of Healthy Start Missoula, a collaboration between the Missoula Forum for Children and Youth and the Missoula City-County Health Department. She helped distribute the conversation card sets throughout Missoula County in April. Semple placed some of the cards and donated books in Little Free Libraries throughout Missoula's Invest Health neighborhoods, the lowest-income neighborhoods in the city, and spread the word using Facebook neighborhood groups. Semple says all of the cards were gone when she went back to check, which she considers a success.

"ELLO is such a great resource because it takes small activities that you do all the time with your child and things that might not be very child-centered and provides opportunities for families to engage in a way where children can learn," Semple says.

Families can pull the cards out anywhere they go. One of the cards, for example, asks children to sort the items in a grocery cart and lists different categories such as size, color, frozen or raw, canned or boxed, and edible or inedible.

The prompts also embed math vocabulary into conversations, which Wilson says is predictive of later reading rates. Some of the grocery store prompts ask kids to estimate how many different types of vegetables there are, how many items are in the cart or how many people they think are in the store. Even if kids are still learning to count, ELLO encourages kids to think about concepts like more or less.

"Some of those really basic things, like counting how many apples are in the cart, lay the foundation for learning," Semple says. "They're things that are really easy to do but if parents don't realize what they are, they might just skip over that conversation. They might not realize how important that is or how they can be priming their children for learning."

The cards can be tailored to different ages. The front of each card suggests simple vocabulary words for toddlers to use to talk about their surroundings, whereas the back of each card contains open-ended questions to promote more advanced conversation with preschool-aged children.

"We just want families and kids to talk more with each other," Wilson says.

The ELLO materials are designed as a starting point for continued conversations. The project promotes a basic model where adults start with an open-ended question (how, why, what) that needs more than a one-word answer. Adults then repeat the child's answer, and then build on the child's response with a longer sentence to build vocabulary. From there, adults and parents are encouraged to continue asking questions and repeat the cycle.

Wilson says she chose to focus on talking as a tool to build language and promote positive outcomes for children because it's accessible to all families.

"It's something that's free," Wilson says. "Families don't have to go out and purchase fancy toys or fancy curriculum, or even necessarily have access to child care in order to talk with their kids. It's something that all families can do." •

UM's Allison Wilson, who studies early childhood education, holds some of the conversation-learning pieces she developed to help young kinds with language development.

JOINT JAZZ PROJECT

Professor, former student collaborate on album emulating saxophone greats

BY CORY WALSH

The trumpeter Clark Terry summed up his approach to music with three words: imitate, assimilate, innovate.

All three ideas flow in the creation of "Emulation," a new album that places classic and contemporary jazz saxophonists' styles over modern electronic beats. The multigenerational collaboration was sparked by Dr. Johan Eriksson, a professor of saxophone and jazz studies in UM's School of Music, and his former student and alum, producer Jake Syrenne, who now lives in Boulder, Colorado.

In each of the six tracks, Eriksson wrote and played in the soloing language of an influential saxophonist. He picked roughly one artist per decade, moving from the 1930s forward, starting with two legends of vastly different temperaments – the quicksilver bebop innovations of Charlie Parker and the dusk-lit balladry of Lester Young, and ends with the technically accomplished but measured work of contemporary tenorist Mark Turner.

During a collaboration that blossomed during the pandemic, Eriksson sent full compositions and recordings to Syrenne, who created a diverse set of electronic arrangements as the backing.

Jazz as a Way of Thinking

In the classroom, Eriksson doesn't just train his students in music theory and instrumental techniques.

"What I'm really doing is teaching them how to learn efficiently," he says. Learning how to navigate a particular set of chord changes shows them "how to identify the underlying structures to any given problem, and how to build the needed skill set to overcome that problem," he says.

The concept for this project had been formulating in his mind for almost a decade, and it happened that a former student would be the perfect collaborator – someone who spoke the same language of theory and jazz style as Eriksson but knew electronic music, too.

"He's the only one that I could think of that I could have done this project with," Eriksson says.

Syrenne entered the program when the Bachelor of Arts in jazz was in its early years. By his junior year, he began to question whether he wanted to pursue jazz exclusively in his musical career. Instead, he wanted to take that knowledge and pivot into other directions.

"I could utilize everything I've learned and broaden my scope, so to speak," he says. That's taken the form of his current career, in which he plays saxophone in various styles of live bands and also works in electronic music production.

Eriksson sees that development as a natural one. "We were learning why Coltrane sounds the way he does and how to do it, and now he's using those types of skill sets in something that sounds completely different from anything that John Coltrane ever did," he says.

Remote Collaboration

While the classic model for recording jazz involves players together in a studio, the nature of this project took advantage of technology to work remotely during the pandemic.

The concept – master stylists over electronic beats – grew out of Eriksson's teaching.

A key part of his work in the classroom is to "help students become proficient in various genres and styles, and the best way to do that is to imitate and analyze the masters of whatever genre in which you're attempting to be proficient."

The idea of starting with players from much earlier eras like Parker and Young was deliberate. When students first enter the program, they might think the sultry style of Young, perhaps most widely heard in his work with Billie Holiday, can seem dated.

"I wanted to show that these players' language can sound modern," he says. Graft it onto a musical backing that's more familiar to students, and they'll hear it differently. It highlights "the underlying principles they've mastered, their sense of rhythm, harmony, voice leading – those things will never go out of style."

After selecting the subject musicians, Eriksson transcribed solos by each and composed pieces that captured elements of their style. Take Sonny Rollins, a tenor saxophonist with a career reaching from the 1940s to the present. While his boisterous voice is easy to identify on a recording, crafting solos required a deeper look into how his solos really work.

He decided to focus on Rollins' 1950s period, which has distinct traits from his later ones. Eriksson says some key components are Rollins' extreme rhythmicality, often more like a drummer, and his use of space and motifs. He'll take a number of small musical ideas, and over the course of a solo build, develop and revisit them in a highly structured way. Eriksson zoomed in on an unusual rhythmic figure in "St. Thomas," his famous calypso-inspired tune, as an example. The historical memory of a particular player had to figure in as well, since Rollins had absorbed ideas from prior greats like Parker and Young.

"If you know their playing styles, you will see it and hear it in his playing," he says.

That became more complex as Eriksson moved toward contemporary musicians. Someone like Turner had looked back to complex West Coast players like Warne Marsh and Lennie Tristano and novel ways of playing over the beat. The project also shows how the technical innovations progressed over time – Turner often plays in the altissimo register, a demanding range for saxophonists that's not heard in Parker's work.

"It poses challenges that the earlier stuff does not have, but the earlier stuff has challenges that the modern stuff doesn't have as well," he says.

Pointing back to his original concept for placing styles in new contexts, he says students naturally listen to music for their era – yet, you can't start teaching math at calculus. They need to start earlier and move forward.

Eriksson then wrote full tunes, with a melody and chord changes and recorded them with a click track. Next, he transcribed his solos and sent the recordings and scores to Syrenne.

In a classic jazz recording or live performance, one can usually hear the spontaneous give and take between a soloist and accompanist.

For this project, Syrenne had to create the backing tracks for completed performances, and Eriksson gave him free rein.

Syrenne wanted dynamic, warm textures and sound designs that would support the compositions. For the track in the style of Kenny Garrett, he produced a track that has a driving forward motion "like we are cruising along at this speed," Syrenne says. (He even added effects on the horn, as Garrett did.) He used big drum machine sounds, like a classic Roland 808 used in early hip-hop and house.

"That one's absolutely something you can play in a club," he says.

For Turner and Young, he wanted something more organic. He took samples of live drummers and looked for ways to introduce that sense of swing or looseness, a common feature of live-electronic hybrid music in Colorado.

"You don't want it to be rigid, on a grid, so to speak ... you want those little differences in between the backbeat to make it sound human," he says.

Young's bluesy notes and rhythm and sense of quietude lent themselves to a micro-genre that's big on YouTube.

"What's really popular right now, and what incorporates a lot of those colors harmonically, and a lot of those sounds is low-fi hip-hop," he says.

An Album as a Recruiting Tool

The album is now available on streaming platforms, Spotify included, which means that without any marketing it can organically reach people around the country or outside the United States.

For Eriksson, it's potential is in recruiting, something the two discussed early on. Syrenne asked him who the audience was, and Eriksson says he only had one target market in mind.

"I want to do this for the high school student that's going, 'Why should I go into jazz?'" Eriksson says. They can hear the foundational jazz languages over contemporary styles, and relate to the musical skills that jazz builds.

Syrenne says his collaboration with his former professor was rewarding, a prime example of "imitate, assimilate, innovate." •

Johan Eriksson, a professor of saxophone and jazz studies, used the 2020 pandemic year to collaborate with his former student and UM alum Jake Syrenne to create "Emulation."

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