Vision 2023

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UNIVERSITY OF MONTANA
VISION
RESEARCH, INNOVATION AND IMAGINATION I 2023

UM'S NATIVE STEM ADVANTAGE

RISK-TAKING WOLVES

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ON THE COVER:
Dr. Aaron Thomas, a UM chemistry professor with Navajo roots, has garnered millions in grants for innovative programs to promote Indigenous STEM education across Montana and beyond. The UM sweatshirt logo he wears was designed by Benji Headswift, a UM alumnus and Northern Cheyenne tribal member. Learn more about UM’s Native STEM Advantage on page 10.
Welcome to another edition of Vision, the magazine of research and creative scholarship for the University of Montana. This issue comes at an exciting time for UM. We just finished our first year as a top-tier “R1” research institution. I’m happy to report that the research enterprise at UM continues to grow. Over the past decade, expenditures from research grants have more than doubled, and this past year we set another record for UM of $126 million. And the trend will continue for the next several years as our research awards reach new heights.

I want to personally thank our faculty, students and staff for continuing to make UM a place where world-class research is recognized. Of course, the real joy in seeing our research portfolio grow is the amazing scientific and creative outcomes of those projects and the impact they have – both socially and economically – on our region and state. The University and the Office of Research and Creative Scholarship recently identified several new areas of potential growth based upon existing faculty research strength and trends in national funding priorities. Three of those programs are the subject of articles in this year’s magazine.

The Montana Climate Office, part of the W.A. Franke College of Forestry and Conservation, is a national leader in soil moisture and climate studies. Led by Dr. Kelsey Jencso, the office provides data critical for flood monitoring in the Upper Missouri River Basin that it important for state ranchers and farmers. Dr. Brent Ruby and his team in the Montana Center for Work Physiology and Exercise Metabolism in the College of Health provide important physiological data for firefighters and active-duty military personnel under the extreme conditions of heat and altitude. They now are extending their efforts to arctic conditions, which is a new national priority. Finally, Dr. Dianne Burke in Missoula College leads CyberMontana, which works closely with the Montana National Guard and state leaders to protect state agencies and businesses against cyber-attacks.

Lastly, I’d like to highlight our cover story and the work of Dr. Aaron Thomas, director of UM’s Indigenous Research and STEM Education. Thomas has been relentless in securing external funding for our support of tribal communities and Native American students attending UM. He best exemplifies the University’s commitment to a central component of our mission, inclusive prosperity.

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 GR1Z!

Scott Whittenburg
UM Vice President for Research and Creative Scholarship
RESEARCH BY THE NUMBERS
UM HIGHLIGHTS FOR FISCAL YEAR 2022

$126 MILLION
TOTAL GRANT DOLLARS SPENT

129% INCREASE
IN RESEARCH FUNDING SINCE 2014

#9 NATIONALLY FOR RESEARCH GROWTH
AMONG R1 UNIVERSITIES SINCE 2014

#52 NATIONALLY FOR SCIENTIFIC IMPACT OF PUBLICATIONS

#152 GLOBALLY FOR MULTI-UNIVERSITY RESEARCH COLLABORATION

THREE MOST CITED UM JOURNAL ARTICLES FROM 2022:

• “National identity predicts public health support during a global pandemic” by Alex Metcalf, associate professor, Department of Society and Conservation (Nature Communications; 52 citations)

• “Complete genomic and epigenetic maps of human centromeres” by Daniel Olson, Ph.D. student, Department of Computer Sciences (Science; 38 citations)

• “Mechanisms of woody-plant mortality under rising drought, CO2 and vapour pressure deficit” by Anna Sala, professor, Division of Biological Sciences (Nature Reviews Earth & Environment; 30 citations)

UM WAS NAMED A TOP-TIER ‘R1’ RESEARCH INSTITUTION LAST YEAR

It was the culmination of a decades-long goal for UM, and the surge has only gained momentum in the first six months of the 2022-23 fiscal year.
During the past decade, expenditures from research grants have more than doubled at the University. This past fall reported research expenditures were a record $126 million, up $4 million from the year before. UM experienced a 129% increase from the $55 million reported in 2014.

Scott Whittenburg, UM vice president for research and creative scholarship, was a chief architect of the University’s bid to earn R1 status from the Carnegie Classification of Institutions of Higher Education. Only about 3.7% of degree-granting institutions across the U.S. earn the designation. Of the 146 R1 universities, UM ranks No. 9 for research growth since 2014.

Whittenburg says the amount of new external funding received by UM in the first six months of this fiscal year is up 18% over where it was a year ago. The award volume stands at $99 million, compared to $84 million at this time last year.

“So our trajectory looks strong — poised for another record,” he says. “We expect this trend to continue for the next several years as our research awards continue to reach new heights.”

The number of research proposals submitted in the first six months is about even, 260 this year compared to 263 a year ago. However, the amount of external funding requested, also called the proposal volume, is $151 million this year compared to $123 million last year.
RESEARCH SHOWS PARASITE MAY CREATE RISK-TAKING WOLVES IN YELLOWSTONE

New research from a UM student and his partners suggests that a common parasite associated with cats turns Yellowstone National Park wolves into risk takers, who when infected are much more likely to disperse across the landscape and become pack leaders.

The story caught fire with media outlets worldwide, with both CNN and NPR picking it up. The research originally was published in the journal Communications Biology.

"I've been blown away by it," says Connor Meyer, a wildlife biology doctoral student in UM's Ungulate Ecology Lab, part of the W.A. Franke College of Forestry & Conservation. "I'm surprised and grateful, but it's been a bit of a nerve-wracking experience with all the attention."

Meyer and his team created the story sensation by studying a single-celled creature named Toxoplasma gondii—often nicknamed the "mind-control parasite." It prefers to live in felines, and infected cats spread spore-packed oocysts in their feces. T. gondii—which Meyer calls "toxo" for short—is the reason pregnant people aren't supposed to clean the litterbox. Human immune systems usually keep it in check, but the parasite causes sickness that can be dangerous to fetuses, as well as those who are immunocompromised, such as HIV/AIDS patients.

Meyer and his fellow lead author, Yellowstone park biologist Kira Cassidy, started a study of the prevalence of T. gondii among park wolves in spring 2021. They discovered a toxo-positive wolf becomes more of a risk taker—11 times more likely to disperse from its original pack and 46 times more likely to become a pack leader.

Yellowstone wolves are among the most studied animals in the world. Since they were reintroduced in 1995, park managers have taken blood samples every time a wolf is captured and collared. Meyer and his team wound up testing blood from 243 wolves for toxo antibodies with assistance from a Cornell University diagnostics lab. They also used data from long-term and ongoing Yellowstone Wolf Project research. More than 27% of the wolves they looked at—about 74 individuals all told—were infected with T. gondii.

The researchers first suspected wolves were getting infected by eating elk, their chief prey. But when they tested more than 100 elk, none were positive for the parasite.

"Eventually we found the most significant predictor of infection with wolves was when their range overlapped areas with high mountain lion density," Meyer says. "So, with no elk testing positive, we hypothesized they were getting infected directly by cougars."

Yellowstone wolves can slay and eat mountain lions, but there only have been 10 or so documented cases of that since 1995. Meyer says it's more likely wolves they get toxo infection by nosing around "scrape sites," where cougars defecate and mark their territory.

"We also have a litter box theory," he says. "Almost anyone who has a dog and cat at home knows that, if the dog gets an opportunity, they are going to raid the litter box. We don't have direct evidence of wolves eating mountain lion scat, but we have lots of photos of wolves at mountain lion scrapes. Wolves eat lots of things, so we don't think it's much of a stretch."

A 2022 study conducted by BBER found "Yellowstone" contributed significantly to the state's economy, but when the more recent study was extended to include the impact of visitor spending, these effects changed dramatically, according to Patrick Barkey, director of BBER.

"Extending our previous analysis to include the impacts of tourism spending was eye-opening," Barkey says.

Among its results, the study found that the combination of visitor spending and film production spending associated with the production of "Yellowstone" in Montana resulted in:

- $730.1 million in spending to the state’s economy.
- $44.5 million in state tax revenues directed in whole or in part to the general fund.
- 2.1 million visitors to Montana in 2021 whose decision to visit was the result of the show.
QUICK LOOKS

PRENTISS NAMED TO AMERICAN ACADEMY OF ARTS AND SCIENCES

Anna Prentiss has made a career out of sifting through layers of history to reveal the daily lives of ancient people. Her efforts have led to layers of accolades.

The UM archaeologist and anthropologist already holds the rank of Regents Professor — the top professor rank awarded by the Montana University System — and she was only the fourth Montanan ever elected to the American Academy of Arts and Sciences.

Previous members of the academy, founded in 1780, include Benjamin Franklin, Charles Darwin, Albert Einstein and Martin Luther King Jr. The prestigious organization is both an honorary society that recognizes and celebrates the excellence of its members and an independent research center that convenes leaders to address significant challenges.

“I’m honored and humbled to have my life’s work honored in this way,” Prentiss says. “I think this is another indicator that the research and scholarship at UM has impacts far beyond the borders of Montana. We can compete with anyone in the world.”

Other Montana scholars elected to the American Academy of Arts and Sciences include UM’s Fred Allendorf and Doug Emlen.

Prentiss earned her archaeology doctorate from Simon Fraser University in 1993. She joined the UM faculty in 1995 and became a full professor in 2009. The state Board of Regents approved her promotion to Regents Professor of Anthropology in 2018.

Her research interests include hunter-gatherers, village societies, ancient technology, evolutionary theory, and the method and theory of archaeology.

Her fieldwork has taken her and the scores of UM students she has mentored around globe, from British Columbia and Alaska to Patagonia. She also served as a visiting scholar in the McDonald Institute for Archaeological Research at the University of Cambridge, England.

Prentiss has written and co-authored eight books, including 2017’s “The Last House at Bridge River,” which details a comprehensive study of a single-floor aboriginal home in British Columbia during the 19th-century Fur Trade period.

Prentiss says her robust research agenda was developed as a byproduct of collaborations and partnerships with Canadian First Nations and Montana tribes.

“Dr. Prentiss is strongly deserving of being a member of the American Academy of Arts and Sciences,” says Scott Whittenburg, UM vice president for research and creative scholarship. “Her work spans multiple disciplines and includes both research and creative scholarship.”

ELSER EARNS NATIONAL ACADEMY OF SCIENCES HONOR

Jim Elser became the first person from UM officially inducted into the prestigious National Academy of Sciences last year. He was only the second person to be inducted from Montana.

Elser directs the University’s Flathead Lake Biological Station and serves as the station’s Bierman Professor of Ecology. During his induction ceremony last spring in Washington, D.C., he signed his name in the NAS register, which features the signatures of NAS members dating back to the mid-19th century.

“We are so pleased that the scientific community recognized Professor Elser as one of our country’s most important scientists,” UM President Seth Bodnar says. “The UM family proudly celebrates this well-deserved recognition.”

NAS is a private, nonprofit institution first established under a congressional charter signed by President Abraham Lincoln in 1863. It recognizes achievements in science by election to membership, and provides science, engineering and health policy advice to the federal government and other organizations.

Elser was elected by current members of the academy in 2019. He has since joined them virtually to advise the nation on matters relating to science, engineering and medicine.

His attendance at the induction ceremony marked the first time he has engaged other NAS members face-to-face in an official capacity.

UM’s Jim Elser signs the NAS register in Washington, D.C.
In a bumper crop for UM, three University researchers—Brandon Cooper, Lu Hu and Hilary Martens—earned prestigious awards from the National Science Foundations’ Faculty Early Career Development Program. CAREER awards are one of the most prestigious NSF awards, given to promising early career faculty members to provide a foundation for a lifetime of leadership integrating education with research.

Endosymbionts are little critters that actually live inside the cells of other organisms. Cooper, a UM evolutionary geneticist, earned a $1.5 million award to study these organisms—especially how they interact with their hosts and the environment—which could help improve health for a huge swath of the world’s population.

Cooper’s lab works on the most common known endosymbionts in nature, studying how they survive and persist inside the hidden world of a cell’s interior. Specifically, he and his lab members study endosymbiotic Wolbachia bacteria, which infect about half the insects on the planet. When placed inside mosquitoes, Wolbachia variants block arboviruses that cause human diseases such as dengue. Cooper says the World Health Organization recommends further developing Wolbachia biocontrol efforts like the World Mosquito Program, which aims to protect 500 million people from disease by 2030 by establishing pathogen-blocking Wolbachia in mosquito populations.

“Our work assesses Wolbachia-host interactions in many natural systems to better understand how these bacteria spread and establish,” Cooper says. “Our broader research goal is to understand why Wolbachia are the most common endosymbionts in nature.”

Atmospheric chemist Lu Hu earned his $800,000 CAREER award to take a deep dive into the true nature of the smoke that clouds our Western skies.

He joined UM in 2017, when he and his collaborators immediately embarked on a research project that involved flying a plane through smoke billowing off active wildfires. The plane carried a mass spectrometer instrument to minutely analyze what was in the smoke.

Hu is most interested in volatile organic compounds. VOCs in their gas phase can diffuse, transform and travel. Many can have direct negative impacts on human health. Science has the ability to measure about 150 VOCs in the atmosphere, but there are many more to discover.

“We cannot measure VOCs well,” Hu says. “This project will work to improve our analytical skills—to improve our use of mass spectrometry—to better quantify them. With all our current models, we still cannot predict the formation of ozone when we have wildfire smoke.”

“Some VOCs in wildfire smoke are classified as a group of substances called furans, which possibly can be carcinogenic. Furans are produced during combustion processes like power generation and burning fossil fuels. Hu says the lifetime for most furans is about an hour, after which they “react out” and transform into other things that also are potentially harmful. When the analytics improve, Hu then hopes to update and improve air quality models.

Martens, a geosciences researcher, earned a $700,000 CAREER award. She and her team study the ebb and flow of ocean tides and the massive forces they exert on the Earth due to their weight, which actively changes the shape of our planet. By tracking the daily, centimeter-scale changes in Earth’s shape, the research can provide new information on the internal structure of our planet, with implications for its formation and evolution, as well as surface hazards such as earthquakes.

“This new funding will allow us to advance our models so we can account for regional variations in structure,” says Martens, noting that some regions of South America, for example, are particularly stable thanks to areas called cratons. These cratons resist tectonic forces leading to large earthquakes.

“We are hoping to shed more light on the density of cratons,” Martens says. She also will use part of her funding to enhance student access to the Griz Shared Computer Cluster, a super computer developed for computational processes and models like those that Martens uses in her research.
SEEN ON CAMPUS

Global icon Dr. Jane Goodall spoke to a massive crowd on the UM Oval in June 2022 as part of the President's Lecture Series. The researcher, who discovered that chimpanzees make and use tools, gave a talk titled “Hope Through Action.”

Three Grizzlies Earn One of Nation's Top STEM Awards

When the National Science Foundation announced the awardees and honorable mentions for its 2022 Graduate Research Fellowships Program, the list included two UM students and one alum—all of them women.

The awards are among the most prestigious graduate science recognitions in the country. Students named NSF Graduate Research Fellows are provided five-year fellowships with the NSF, including three years of financial support, an annual stipend of $34,000 and a cost of education allowance of $12,000 to the student’s current institution.

Awards are given to graduate students pursuing research-based master’s and doctoral degrees in science, technology, engineering or math at accredited U.S. institutions. “UM has had a lot of success attracting GRFP award winners due to the quality of our STEM programs and faculty members, who recruit from a national pool of high-quality graduate student candidates,” says Ashby Kinch, dean of UM’s Graduate School. “We are delighted to see the success of our students as researchers—both the undergraduates who leave here to pursue graduate degrees and then ones who bring their GRFP to UM to pursue their graduate research with our excellent community of faculty and student researchers.”

The NSF named two current UM graduate students and one graduate student at the University of California, Davis, who received her undergraduate degree from UM.

• Allison Monroe studies Indigenous knowledge and environmental sustainability as a graduate student in the Department of Environmental Studies, housed in UM’s College of Humanities and Sciences.
• Grace Erba received her undergraduate degree at UM. She studied wildlife biology and committed to a doctoral program in wildlife biology.
• Emily Leonhardt received her undergraduate degree in 2017 in wildlife biology from UM and now researches life sciences at UC Davis.

Condoleezza Rice and Michael McFaul, two leading voices on democracy, presented the 2022 Mansfield Lecture, “Fostering Freedom at Home and Abroad.” Rice was secretary of state under President George W. Bush, and McFaul was ambassador to Russia under President Barack Obama.

Mark Trahant, editor-at-large of Indian Country Today, presented the School of Journalism's 2022 Dean Stone Lecture. His talk was titled “Crafting a Narrative of Indigenous Excellence.”
UM Assistant Professor Will Rice is a self-avowed "campground nerd."

But camping is more than Rice’s avocation: It’s also his vocation, and as a researcher in outdoor recreation and wildland management, he studies the science and art of camping, including how campers actually pick their campsites and the seismic changes taking place in U.S. national parks due to COVID-19.

That research, conducted with colleagues around the country and at the W. A. Franke College of Forestry & Conservation, found a park system strained by the exploding popularity of outdoor recreation and struggling to find ways to balance park protection with equitable access to all.

As Rice puts his work: “We are studying people trying to have fun to make sure they, and everyone else, can keep having fun or start having fun, without destroying the things that allow them to have fun.”

Using federal camping data and mobile device location technology – with funding secured from UM’s Center for Population Health Research – Rice and his partners were able to more closely correlate the ethnicity and income of campers with their ability to access campground sites. The research looked at five national park campgrounds across the country that offered campsites both through the park system’s reservation platform, Recreation.gov, and on a first-come, first-served basis.

The analysis found that on average campers accessing sites that require reservations came from areas with significantly higher portions of white residency and higher-incomes than those accessing sites not requiring reservations. The reasons for these outcomes are many and are based on everything from technology to workforce dynamics.

“To use these systems you need high-speed internet, which can be a problem for some campers – particularly in remote places like we have in Montana,” he explained. “You also need flexibility to plan your trip for six months from now. People with lower-income jobs often don’t have the ability to set vacations that far in advance.”

UM researcher Will Rice led a study that found the National Park System online campground reservation system favors higher-income white campers.

Dr. Xiong Xiong, a visiting researcher at UM’s Flathead Lake Biological Station, studied microplastics in Montana’s beloved Flathead Lake. His team found Flathead is now home to microplastics, and new microplastic particles are arriving every day. Levels were lower than in lakes in densely populated areas, but similar to or higher than lakes studied in other less-densely populated areas of the world.

FLBS researchers Maité Arroita, Joanna Blaszczak, Alice Carter, Lauren Koenig and Bob Hall also were part of a scientific team that used modern environmental sensor technology to track stream vital signs in near real-time. The new system acts almost like a Fitbit for monitoring the nation’s freshwater ecosystems, allowing researchers to better predict how freshwater vital signs might shift with land development, climate change and other disturbances.

Researchers Ashley Ballantyne and John Kimball published findings in Nature Communications that suggest a strong warming trend in northern regions has increased plant growth, which has offset rising CO2 emissions from thawing permafrost. Kimball says the study shows the need for global Earth-system models that better predict regional responses and feedbacks resulting from climate change.

The University of Montana was named among the top academic institutions in Montana and the best in the world. The University has made the list every year since the world ranking began in 2003. This year, UM ranked between 701 and 800 in the study out of 2,000 universities worldwide, and between 169 and 179 nationally.

Last summer, wildlife researchers at the W. A. Franke College of Forestry and Conservation reviewed hunting regulations for all 50 states with a goal of recommending how to simplify and streamline rules often laden with jargon and geography. The team’s work was made possible through a grant from the Council to Advance Hunting and the Shooting Sports.

UM recently secured $5.1 million in federal grants from the Health Resource and Service Administration, leading to the formation of a new UM Office of Health Research & Partnership. The office will use the HRSA funding for programs to bolster the health care workforce and increase access to quality health care in rural and underserved parts of Montana.
Dr. Aaron Thomas was inspired by his father, who went to college despite growing up in a Navajo reservation home with no electricity and running water. Now a chemistry professor at an R1 research institution, Thomas asks, “How do I help other Native kids also make it this far?” (Photos by Tommy Martino)
Aaron Thomas recalls how his dad, a welding engineer, was always fixing things. If something broke, he wanted to at least try to fix it. And as a young kid, Thomas came along to grab tools and help his dad out.

"It got me interested in going into that type of field," Thomas says. "Welding engineering wasn’t quite what appealed to me, but I liked chemistry in high school, so I decided to be a chemical engineer."

Thomas’ dad had grown up on the Navajo reservation in a hogan with no electricity and water and endured the Indian boarding schools. But he was the first in his family to go to college and pave the way, and that helped Thomas see that kind of future for himself.

Thomas earned his B.S. in chemical engineering from Stanford and a Ph.D. from the University of Florida. He taught at the University of Idaho before transferring to UM in 2013. He was focused on NASA-based research and his own gas-and-biological-separations research when he starting noticing the first-year Native students he worked with often didn’t return the second year. Looking at UM’s statistics, Thomas saw it was as trend – especially in math and science. And he started to feel an increasing responsibility to turn that tide.

"I was thinking, I’ve been able to make it this far," he says. "How do I help other Native kids also make it this far?"

That question led Thomas on an increasingly powerful quest to support Indigenous students in STEM research and transform UM into a model for cultural change. Over the past decade, he has helped design programs and win prestigious grants to break down barriers for Native students to earn degrees, connect to and share their cultures, and thrive.

Now the director of UM Indigenous Research and STEM Education, Thomas facilitates a staggering number of research programs and initiatives that serve this purpose with support from UM faculty and leaders. (He is the first to say he doesn’t do it alone.) The initiatives strategically engage Native K-12 students in STEM activities to cultivate interest early. Through summer programs and STEM curriculum, student cohorts participate in programs designed to teach science and math through the lens of Indigenous knowledge so when they do enter college, they are prepared. Other funding supports programs for Native students once they get to college.

The recently launched Indigenous First Year program creates...
cohorts of first-year Native students who participate in a freshman seminar, weekly study tables and tutoring, and mentoring by peers, faculty and tribal community members. The hope, Thomas says, is to encourage an inviting community that fosters social and academic success.

These initiatives for Native K-12 and first-year college students were funded through the Montana American Indians in Math and Science (MT AIMS) program, which Thomas launched with a $3.3 million grant five years ago and recently extended with a $250,000 gift from the Cognizant Foundation. In October 2020, Thomas helped secure a $740,000 National Science Foundation award to diversify STEM on campus.

In August 2022, he procured $10 million to fund a six-state collaborative to increase representation of Alaska Native and Native Americans in STEM disciplines.

Then this past November, Thomas and several colleagues secured a prestigious $2.5 million grant from the Howard Hughes Medical Institute. Thomas says the money will fund childcare, emergency funding, tutoring and seminars – among other support for Native students – and guide UM in designing approaches for hiring and retaining Native faculty.

One of the most ambitious goals of the HHMI grant is infusing Indigenous knowledge into the curriculum, teaching and administrative practices at UM.

"The idea is to start with Indigenous culture first and then find the science to fit the culture," Thomas says. "So if we think about cultural ceremony, language, song, story – start there and then find what is it in the science and the math that fits those."

That might mean a chemistry class that studies the chemical compounds of traditional medicinal plants, but in which students also learn the ways Indigenous people have known and understood the same chemical properties.

Frederick Peck, an associate professor of mathematics at UM, works with Thomas on the MT AIMS program. He helps Native middle school kids understand mathematics through activities such as traditional games. Native games were already mathematical, he notes. By using western mathematics to illuminate the number systems, the kids come to understand the Indigenous knowledge of numbers systems, too.

MT AIMS is part outreach, part research. Using measuring instruments, Peck and his colleagues hope to answer questions about the effectiveness of this kind of outreach. What qualifies as a culturally sustaining activity, and will it help Native students in STEM fields?

"It all connects to some bigger question we're trying answer about the world we live in. And I think that is a way you can think about implementing Native culture into these kinds of science areas."

Peck also works on the HHMI program on campus to foster Native support and institutional change.

"I think the institutional change activities are the ones that are the most exciting," Peck says. "Western ways of doing science and mathematics are often presented as the way to do science and mathematics, but really it's a way. There's traditional ways of knowing and doing in mathematics and science that developed over many millennia. And those got marginalized through a lot of active work by western folks."

Important to these programs is the funding and support for faculty looking to make culture changes in their classrooms. It's a lot of work, but at the core is the idea that everyone benefits. Non-Natives are enriched by a new perspective and also can reflect on their own cultural knowledge.

"If a student comes from a ranching community they can see, 'Oh, we were also scientists and mathematicians in our own ways as well,'" Thomas says. "And then perhaps they can identify a little bit more closely with our Native students."

The University has seen an uptick in enrolled Native students campus-wide, and the research of some Ph.D. students is beginning to align with the rise of Indigenous STEM education programs.

Sierra Paske is a doctoral student in chemistry whose research is focused on characterizing compounds of traditional medicinal plants. She worked as a camp counselor for the MT AIMS summer camps and sees the indigenous STEM initiatives as a way to make science fun for all kids.

An enrolled member of the Standing Rock Lakota Sioux tribe, Paske grew up in a city with no direct interaction with medicinal plants. College has been a way for her to study the...
medicinal plants just outside her door and connect them to her Indigenous heritage. She sees her research as a piece of the puzzle that can be shared within the growing network of programs that Thomas and others are building.

“One of the reasons I love chemistry is because chemistry is in literally everything we interact with on a daily basis,” she says. “It all connects to some bigger question we’re trying answer about the world we live in. And I think that is a way you can think about implementing Native culture into these kind of science areas. Everything is interconnected regardless of where you come from.”

Opportunities to share research are vital to the vision for Indigenous STEM education. Thomas hosts the Sloan Indigenous Graduate Partnership Program, where Native students discuss their work. Nicole Benally, a Navajo Ph.D. student in forestry, gave her Sloan presentation on Indigenous food sovereignty. Her background is in agriculture and soil science, but over the years she has seen the way western science falls short when it comes to tribal communities. Her research explores the disconnect.

“As an extension agent, I learned there wasn’t a lot of tribal-relevant science data,” she says. A lot of her research is about getting to the root – even breaking basic definitions like the term “food sovereignty,” which is often conceived of differently in tribal communities than its use in social science programs. She is both skeptical and hopeful that academia is ready to make big changes.

“In my mind, western science is based off of Indigenous knowledge and systems,” she says. “Agriculture that’s focused on the nitrogen cycle and covered crops is based off the plains tribes’ ways of understanding that cycle. I hope the grants provide more opportunity to validate Indigenous cultures and their languages and knowledge systems and prioritize them just as much as the western science we learn now.”

It’s clear that a lot of hard work has gone into creating these initiatives, and more hard work is required to shepherd them forward. Peck is one of several people who helped Thomas build these programs with funding, but he says it’s Thomas’ persistence and vision – and his ability to build trust – that makes the engine run.

“To be a Native family and put your kid on a bus and send them to the University involves a massive amount of trust,” Peck says. “Especially given the history of not just boarding schools but universities historically taking advantage of American Indians. That trust does not happen overnight. All the money in the world wouldn’t matter if people didn’t trust Aaron.” •
WEATHER WARNINGS

SNOWPACK AND SOIL-MONITORING PROJECT PROVIDES NEW DATA TO PREDICT FLOODS AND DROUGHT

By Cameron Evans

The Cooney Reservoir Station, located south of Columbus on the southern border of Stillwater County, was installed last summer. The station is part of a 200-unit network being built by UM’s Montana Climate Office. (Photos by Kevin Hyde)
WEATHER WARNINGS

Record snowfall in the Rocky Mountains in the winter of 2011, followed by near-record spring rainfall in central and eastern Montana, resulted in catastrophic floods that caused billions of dollars of damage along the Upper Missouri River Basin.

The flooding led to federal studies and initiatives to understand how to better predict floods. Eventually a $21 million contract was awarded to UM’s Montana Climate Office to install a network of over 200 weather stations to monitor snowpack and soil moisture in the basin.

The Army Corps of Engineers awarded the multiyear contract to the climate office in September 2020 to install weather monitoring stations throughout eastern and central Montana to better predict flooding in the future. The contract is part of a larger collaboration with climate offices in Wyoming, South Dakota, North Dakota and Nebraska to install a total of 540 weather monitoring stations across five states.

“What happened in 2011 was that we had an undermeasurement of winter snowpack and soil moisture in our plains,” says Kelsey Jencso, the Montana state climatologist and W.A. Franke Chair of Hydrology in UM’s forestry college. “There’s a lot of snowpack and stored soil moisture in our plains, and that’s critical to understand when we think about snowmelt runoff in the spring and summer because that water flows through the Missouri River system and to our neighboring states.”

Jencso leads a climate office team installing weather stations in the Upper Missouri River Basin.

The Army Corps contract to install 205 stations expands on the Montana Mesonet Project, a grassroots project that started with a road trip Jencso took with his family in 2016 to install six weather stations at Montana State University Agriculture Research Centers. Kevin Hyde, the Mesonet monitoring-station developer at the climate office, quickly helped grow the network to 110 stations through federal, tribal, state and private partnerships. This effort served as a foundation for the larger project.

The climate office installed the first station under an Army Corps contract in Bozeman in 2020, followed by 10 more stations in 2021 and eight in 2022. The MCO will add another 32 stations in 2023, half of which will be in the Musselshell watershed and the rest on private and tribal lands. The office is seeking new sites and partners to house stations in 2024 and beyond.

When the project is complete, there will be one station for every 500 square miles in central and eastern Montana. The stations will provide data for areas that have been notoriously underrepresented and undermeasured with climate data, including tribal lands in the region.

“Historically, Montana hasn’t had a lot of information about our plains,” Jencso says. “Our goal is to expand our ability to monitor conditions so that we can make timely actions in response to drought, fire and floods and agricultural losses.”

The stations monitor soil moisture and snowpack, as well as air temperature, relative humidity, barometric pressure, wind speed and direction, lightning strikes, solar intensity and precipitation.

Through better monitoring, the state will have a better picture of conditions going into the winter and be able to better predict flooding based on spring temperatures and snow melt.

“I think we’re going to see a huge increase in our capacity to get early warnings about flood prone conditions going into the spring every year because of the development of this network,” says Kyle Bocinsky, the climate office director of climate extension and a research faculty member in UM’s Department of Society and Conservation.

State mesonets have installed a total of 81 of the 540 stations funded by the Army Corps contract thus far after just finishing the second of seven installation seasons, says Catherine Wiechmann, Mesonet Project coordinator for the UM-based Center for Integrated Research on the Environment.

The data from each station are publicly available and are transmitted every five minutes to the five different climate offices and then entities such as the Army Corps website, the National Oceanic and Atmospheric Administration’s flood forecast centers, river forecast centers and the Bureau of Reclamation. The goal is to use these data in operational models and to improve daily weather, flood forecasts and drought assessment.

“The implementation model is working really well,” Wiechmann says.
Understanding Drought

Montana is always in varying degrees of drought, and data shows the state experiences extreme drought conditions more often because of climate change. The Montana Climate Assessment in 2017 found that the state will see, on average, an increase in temperature of upwards of 5°F by mid-century, and a slight increase in precipitation.

“One of the key outcomes of climate change is that it is going to get drier,” Jencso says. “But some years are going to be wetter than others, and we have to take advantage of those opportunities and be able to adjust.”

The stations will help Montanans understand local conditions in real time and aid resource management, as well as seasonal decision-making with farming, tourism and recreation.

Jencso says the Governor's Drought and Water Supply Advisory Committee monitoring sub-committee that he sits on already uses data from the existing stations on a weekly basis.

“A great example is this year,” Jencso says. “We had an OK snowpack, we had decent spring precipitation, but because we were still in a drought from the previous year, we lacked soil moisture at depth.”

The data from stations across the state showed the deeper soil reservoir was depleted, meaning there was a strong likelihood that Montana would progress into bad drought conditions by mid and late summer, which Jencso says “is exactly what happened.”

“It was a good early warning of drought conditions,” he says. “This is critical because the weekly drought maps released by the National Drought Monitor, in coordination with state drought task forces, trigger billions of dollars in federal programs that support producers during times of drought.”

Community and Tribal Partnerships

The Montana Climate Office partners with farmers, ranchers, tribes and local watershed groups to place the stations and fill information gaps for conditions in rural areas.

“We’re looking for stakeholders who see the value in the data for use in their local community,” Jencso says.

For farmers, the data will improve precision agriculture by helping predict the best times to plant and harvest by showing water availability for plants. Measurements of wind speed and direction can help determine how much pesticide and fertilizer to apply.

Jencso says a next step will be building simple, easy-to-use tools and applications to help people get key takeaways from the data and make decisions quickly. The climate office will use those tools in partnership with tribes to ensure that tribes can use the data gathered on tribal lands.

“Historically, we’ve had incredibly sparse monitoring on tribal land,” Bocinsky says. “We’re committed to making sure these data get back to land managers, emergency coordinators and extension agents in Native nations so that they can make use of it.”

Bocinsky currently works with the Assiniboine and Sioux tribes to include climate projection information in their new hazard mitigation plan, and the climate office will install eight new stations on the Fort Peck reservation.

The office also will work with Blackfeet Community College to integrate data into student training. Although not directly tied to the Army Corps project, the climate office also is partnering with the Confederated Salish and Kootenai Tribes on the Flathead Reservation to establish a station and co-develop a drought dashboard tool.

“It’s a pilot for how we could establish this network west of the divide,” Bocinsky says.

The Army Corps contract is funding the construction of the stations, but it doesn’t include the modeling and forecasting efforts for stakeholders to use the data. Jencso says improving modeling around the data is a major goal of his office.

“It’s a construction project, and it’s going to be a monstrous undertaking to build these stations,” Jencso says. “We don’t want to build all of these and then have them go dark in five years when this project ends. We’ll need state interest and support to bolster this network and its value.”
HIDDEN TREASURES
UM UPGRADES ZOOLOGICAL MUSEUM FOR 125TH ANNIVERSARY

By Rasquel Roberts
Photos by Ryan Brennecke
1. Oldest Specimens: These Spotted Sandpipers date from the 1880s and early 1900s.
2. Rarest Specimen: This Russian desman was collected in Kazakhstan.
3. Largest Specimens: The museum boasts some hefty items, including a walrus skull, moose pelt and elephant tooth.
4. The museum contains vials of collected parasites – some tiny, and some not so little.
If you happen to be a researcher looking to study the fur follicles of *Ovis canadensis*, there’s a good chance your quest will start and end at UM – not just because the Treasure State is home to Montana bighorn sheep, but because the University has a zoological museum with an international reputation for its vast collection of animal specimens and a muscular online database to access it.

And by "vast" we mean more than 22,000 intact specimens and thousands upon thousands of claws, clavicles and cranial pieces from animals as diverse as grizzly bears, pelicans, kangaroos and hummingbirds.

Celebrating its 125th anniversary this year, the Philip L. Wright Zoological Museum is both a time capsule of species from decades past and a living laboratory for students and researchers to study biodiversity, anatomy, evolution and emerging diseases.

“Our specimens give us a snapshot in time,” says museum curator Angela Hornsby as she opens a drawer lined with toucans and other vibrantly hued birds. “This isn’t just a loon chick – it’s a loon chick from a specific place and time. With it, we can ask questions not only about growth and development of loons, but we can ask questions about the population it was in and what the environment was like at that time.”

Every specimen that comes into the collection – some are donated by other collections, some from researchers and many from the public – goes through a prep and preservation room staffed by students and volunteers, all members of an appropriately named Carcass Club. (One of its more famous alums is Emily Graslie, star of the popular science YouTube series “The Brain Scoop,” whose work inspired UM to start an internship program to support interdisciplinary student projects in the museum.)

The center of attention for most visitors to the prep room is a desk-sized plastic box that’s home to a carcass-cleaning crew of Dermestid beetles, known for their ability to strip a skull to the bone in just a few days and a favored tool of taxidermists. The beetles spend their entire life cycle in the lab’s box, breeding, laying eggs and eating.

“This colony has been going strong for at least 15 years,” said Hornsby. “They are the hardest workers in here.”

Once crammed into a single campus classroom, the museum has undergone a transformation the past few years thanks to a grant from the Natural Science Foundation and funding from Friends of the Philip L. Wright Zoological Museum. The museum more than doubled its footprint, and that original classroom location has been unearthed and is now a more spacious study laboratory for students.

The physical expansion and upgrades, though, are only one part of the story, says Jeff Good, the museum’s faculty director and a professor in biological sciences and wildlife biology.

Its preeminence has been bolstered, too, thanks to the updated online database, curated as well by Hornsby, that allows researchers and others to see what the museum has in its collection and when and where a specimen was collected.

“There is one camp in this field that thinks ‘don’t touch, it’s my job to preserve and protect this collection’ and another camp that believes a collection is only as useful as it is used and accessible to promote science, and we are very much in that second camp,” Good says. “We’ll take small clips of tissue and send for DNA analysis, for example, as long as it promotes the science and doesn’t compromise the specimen.”

The work of the museum, Good adds, has never been more critical as climate change intensifies and the globe continues to warm.

“Museums like UM’s provide a valuable baseline but only if you have people collecting contemporary specimens,” he said. “So, it’s important that we continue to collect and preserve because there’s never been a time when things are changing so quickly. This collection will continue to be critical as we monitor and respond to continuing changes in the northern Rockies and in Montana.”
5. Biggest Collection: The museum stores a huge variety of small mammals such as deer mice and shrews.
6. Oddities: The museum is home to some unusual things, including this fully preserved vampire bat in a jar.
7. Strangest Specimens: We’ll have to go with the albino skunk. (There is also a two-headed fish.)
8. Other Strange Specimens: The museum has emperor penguins!
9. Employee Favorite Specimen: This sengi may look like a shrew, but it’s more closely related to elephants.
PEAK PERFORMANCE

MILITARY FUNDS UM LAB TO BETTER PREP SOLDIERS FOR EXTREMES OF ALTITUDE, HEAT AND COLD

By Cary Shimok

Walter Hayles, who studies the effects of extreme altitude on human performance, stands atop Mount Everest in spring 2022.
Last spring UM scientist Walter Hailes was on top of the world — literally. An experienced climbing guide, he summited Mount Everest, enjoying spectacular 360-views of the highest mountains on Earth.

Hailes says the memory is hazy. Even with sufficient oxygen, the mind plays tricks at that ultimate altitude. He can’t precisely remember how long they lingered on top. Maybe a half hour? But it was wonderful up there: sunny, little wind and a balmy (for Everest) -25 F.

“It was perfect,” Hailes says. “I even took my gloves off to take pictures.”

Hailes often works with high altitudes. At UM he is part of the Montana Center for Work Physiology and Exercise Metabolism (WPEM), which recently earned $9 million in grants from the U.S. Air Force and Army to investigate ways to improve the performance of service personnel working in extremes of altitude, heat and cold. A big part of the work is to understand any differences in how male and female bodies deal with such challenges.

The center is directed by Brent Ruby, a former Ironman triathlete who has long studied the limits of human endurance among wildland firefighters, soldiers and athletes. The center’s modern WPEM exercise lab was tacked onto McGill Hall in 2007 and includes a 10-by-10 climate-controlled environmental chamber. WPEM also employs a series of solar-powered Airstream trailers as mobile labs for fieldwork.

“We’ve been doing lab and field-based research funded in part from the U.S. military since 1996,” Ruby says. “We’ve shown we can work faster and much cheaper, and we are a lot more flexible in how we can get these big projects done. It’s also challenging to do these projects with service personnel, so we find surrogate populations.”

The scientific stand-ins for America’s elite military personnel usually are super-fit male and female athletes. Ruby says they are working on a heat adaptation study that will be done in their campus lab. An altitude-adaption study already launched last summer at Hawaii’s Mauna Kea volcano. Another cold and physical stress study will happen in Alaska.

Getting more data on females during these projects will be groundbreaking.

“I would say 90% of the data out there is with 18- to 24-year-old men,” says Robert “Trey” Coker, another WPEM researcher. “There is a huge gap in knowledge when it comes to energy expenditure, how muscles maintain their resiliency in these environments and what happens when you add ridiculous amounts of physical activity.”


Heat

The WPENM environmental chamber can crank to 120 F. Researcher Dustin Slivka says the military wants strategies to help personnel of both sexes adapt quickly to extreme heat. During a seven-day study, research subjects will go into the heat chamber. One group will come in once a day for an hour and a half. Another group will come in three times a day for shorter sessions.

“We are trying to see what is the best strategy to get them to a heat-tolerant level that’s the most efficient,” Slivka said. They will monitor the subjects with skin and rectal monitors. (Slivka says rectal is the gold standard for this type of work.) They also use swallowed thermostat pills that provide temperature data to a watch over a 24-hour period.

“We have found in a previous study that women do acclimate differently than men,” he says. “This has made some researchers say, ‘Hey, we have to be more careful with females in the heat.’ But some of our data suggests women may be better at acclimating to heat than men. Female body cycles already require them to deal with more temperature changes than men, and we are investigating what is different about females that may allow them to acclimate better than men.

“Anytime the data doesn’t look like men, some assume it’s worse. But we think that those with that interpretation should be cautioned. We’ll learn more.”

Cold

What does extreme cold exposure do to overall energy expenditure in combination with physical activity, and is it different between the sexes? UM will investigate this during two upcoming endurance races in Alaska and the Yukon.

The Alaska Mountain Wilderness Ski Classic is an unsupported cross-country ski race lasting five to seven days that crosses an icy mountain range. The Mountaine Yukon Arctic Ultra is 430 miles of skiing, biking or hiking that is marginally supported over 12 to 14 days. Temperatures can plunge to -50 F and colder. Only about 20 extreme athletes do each race, and usually half of those sign up to be studied by UM’s Coker and his crew. The athletes agree to provide regular urine samples as they compete.

“It’s easy to store urine at that temperature – it freezes pretty quick,” Coker says. “We will have them drink a harmless stable isotope that is like a tracer bullet. This labels their hydrogen and oxygen. The hydrogen comes off in a predictable way, but the oxygen changes in proportion to energy expenditure. The method helps us trace metabolically what is taking place in real time.”

Ruby says they have used the isotope-tracing technique on other projects but never before in an extreme cold environment.

“It’s underrepresented in the literature,” he says.

Altitude

Most U.S. military bases are located at sea level. During the War in Afghanistan, troops would fly from places like Florida to forward operating bases at 9,000 feet, where they would carry heavy loads on missions to heights at 14,000 feet with few days to acclimate.

“We don’t want them presenting with acute mountain sickness or pulmonary edema and all the other bad things that can happen to them,” Slivka says. This past summer, WPENM conducted experiments in Hawaii. Research subjects from Missoula (elevation 3,200 feet) slept at 9,000 feet and then took daily hikes on the slopes of Mauna Kea, which rises to almost 14,000 feet.

Everyone slept with a tent over the bed, with half getting extra oxygen pumped into the tent and half getting normal room air. Hailes said their working hypothesis is that those with boosted oxygen will sleep and perform better atop the volcano.

“The big negative is that maybe those people won’t acclimate as well because they are not getting as much time with lower blood oxygen,” he said. “They are spending nine hours in a tent with oxygen, so maybe it hampers their long-term acclimation. Maybe we’ll find its better to suffer for three days, and then you perform better than those who didn’t suffer.”

As the studies progress, UM will provide strategies that should help the military achieve peak performance for its personnel – male or female – no matter the environment.

Upcoming UM research will study the implications of loads and environmental and nutrient stress on protein synthesis and muscle metabolism. The work may improve performance among military personnel, extreme athletes and others.
CYBERMONTANA: DIGITAL DEFENDER

UM PROGRAM TRAINS STUDENTS TO PROTECT AGAINST ONLINE THREATS

By EricaFredrickson

Jace Reddick, a client experience manager for UM Information Technology, was a University student hired as a full-time technician before being promoted to his current role. His department is charged with protecting UM from cybersecurity attacks.
CYBERMONTANA: DIGITAL DEFENDER

Dianne Burke, a faculty member at UM’s Missoula College, directs CyberMontana, which aims to elevate cybersecurity education across Big Sky Country.

To those of us outside the cybersecurity world, Dianne Burke’s background sounds a bit like something out of a John Grisham novel. As a forensic analyst, she has spent part of her career digging through hard drives and searching networks for evidence on behalf of attorneys in major court cases across Montana and, occasionally, out of state. And she’s not going to lie: It was an interesting job.

“It’s like this big puzzle,” she says. “You poke around all over the computer, and you find a thread here and a thread there, and you just keep pulling those until you find what you’re looking for—or until you can definitively say it’s not there.”

Now the director of UM’s CyberMontana and faculty member at Missoula College, Burke and her eight-person team are helping to elevate cybersecurity education in Montana through four initiatives that cover a wide-range of learners, from K-12 kids to college students to workers in private and public sectors.

CyberMontana is a state hub funded in 2021 by the Legislature through the American Rescue Plan Act. The hub is both a response to a rise in cybersecurity threats across the world and to a higher demand for cybersecurity workers. There is a global shortage of nearly 3 million cybersecurity workers and a national shortage of 400,000. It’s also a way to harness in-state resources and partners, including Missoula College, which has been designated by the National Security Association as a Center of Academic Excellence, and where cybersecurity education is a natural fit.

One initiative is a young learners program that looks to increase the pipeline through K-12 summer STEM camps. The summer camps feature hands-on activities to investigate cryptography, password cracking and geotagging, among other topics. Burke says it’s particularly important to focus on girls under the age of 13 or 14, when they still are engaged with and confident in science and math skills. Getting them interested early would add to the pool of prospects down the line.

“If we can get them interested, then we’ve got a whole other gender that we can add,” Burke says. “Cybersecurity is mostly older white guys. With summer STEM camps, we get an equal number of girls participating.”

For juniors and seniors in high school, the young learners initiative offers dual enrollment into early college cybersecurity courses and results in a Certificate of Technical Studies in cybersecurity from Missoula College.

A second initiative offers adults a one-year certificate of Applied Science in Computer Support or a two-year Associate of Applied Science degree in IT and Network Security, as well as a CTS in Cloud Computing and Cyber Security. Those who need a shorter timeframe can take the Cyber Rapid Training program, which prepares students for entry-level positions.

The third initiative is workforce development training for workers already in the cybersecurity field. These are modules, courses, hands-on labs and assessments in topics like intrusion detection and digital forensics, as well as multiple certification options such as “certified ethical hacker.”

And the fourth initiative is security awareness training for businesses and their employees in which they learn to spot phishing emails, consider password protections and other security issues.

On the horizon, Burke says, CyberMontana is creating a website called Cyber 406 that will serve as a kind of one-stop shop for the state’s cybersecurity resources.

All these initiatives are an attempt to make a broad range of people fluent in cybersecurity. After all, Burke notes, it’s not just people in tech who need to know this stuff. There are half a million Montanans in the workforce, and at least 95% of those workers use computers for their jobs.

“They are the front line of defense in terms of cybersecurity,” she says.

Cyber threats have evolved from targeting businesses to being nearly indiscriminate. More devices at our reach come with more potential entryways for those threats. In her cybersecurity classes, Burke discusses “the internet of things” to show how vulnerable we all are to attacks. A case study in England connected a simulated smart home to the internet. It received 12,000 attacks in one week and suffered a breach.

“And so that’s one of the things that we try and impress upon students is to think about the data that you have,” Burke says. “Think about the way that it could be compromised. Think about how it can be turned around and used against you. It’s not just large profile targets. Anybody can be the subject of this.”

Missoula College students get a chance to engage with cybersecurity education in other ways, too. Montana Cyber Range is a virtual resource that allows participants to practice defending against cyber threats by way of lab exercises, simulations and competitions. On campus, the Cyber Gym hosts events where people from across the state come to engage in competitions.

And, finally, the Strategic Operation Center is a configuration that allows real-time monitoring of real-life computers. SOC is just getting started, but Burke says the plan is to expand it so that, with supervision, students will help monitor government and private industry security across the state.

UM’s Information Technology services offers another obvious partner to the cybersecurity programs. Zach Rossmliter, chief information officer at UM for CyberMontana, says students working toward degrees or certificates have the opportunity to get job experience on campus at the help desk or in other IT areas.
Shown here in a campus data center, UM Chief Information Officer Zach Rossmiller says partnering his Information Technology unit with CyberMontana will offer students valuable learning opportunities.

While UM can't compete with high-paying IT salaries off campus, Rossmiller says what they do provide students are valuable skills they can't easily obtain elsewhere. Fellowships, internships and hands-on work bolster confidence and provide experience that will make their resumes rise to the top.

"Then when they graduate, they can basically write their own salary and get placed in a highly compensated position," he says. "My dream is that CyberMontana can help us pull in students from not just UM but from anywhere across Montana."

That includes tribal colleges, he says, for students who can gain strong IT and cybersecurity experience and bring those skills back to their communities.

Collaborators also are a major component to CyberMontana. Jason Emery started working for Missoula County 10 years ago, and as chief information officer has developed the cybersecurity program there.

"I came from banking prior to this, so it was kind of beat into us that we do cybersecurity," he says. "We didn't really have a choice. And I think now the county is to the point where we're really a leader when it comes to cybersecurity in the public sector." Emery helped develop Missoula College's long-term degree and continuing education. He says it's highly beneficial for the county to have access to certification for employees interested in upskilling, as well as a pipeline of students and access to the college's resources.

"I think there was a misunderstanding in years past of, 'Who cares about a little medium-sized county in Western Montana? We're not a target,'" Emery says. "But that's completely untrue."

Keeping up with "bad actors" who are constantly evolving their tactics requires cutting-edge education — and not just the standard Google certification. Leveraging higher education skillsets and local programs help fill in the gaps.

"We hope to continue to have collaboration with the University in evolving that program," he says. "I think using that to continually develop our pool of applicants and trying to develop our own workforce is going to be extremely valuable for the foreseeable future."

Sam Wolf, who went through Missoula College's technical certification program for cybersecurity last summer, is now a cybersecurity engineer working with Emery for Missoula County. She already had some background in cybersecurity when she started the 12-week program, but it helped provide context to do her job better.

"It was a great opportunity for me to fill my knowledge gaps and see what it is that I don't know and what I need to learn more about," she says. "I knew how to protect the house, but I didn't really know how the house was built — and that is what this accelerated program offered."

Wolf says an overall lesson she took from taking the accelerated course was that a cybersecurity career might seem out of reach, but often it isn't.

"Talent acquisition and retention is obviously a big issue, and speaking as someone who's relatively new to the field, I imagine a lot of people see a job like 'computer specialist' at the county, and their first thought might be, 'I'm not qualified for that,'" Wolf says. "And that's where I think programs like what CyberMontana offers can come in, because people are getting not only the skills, but also more confidence within this field."
STUDENT SPOTLIGHT

Research, innovation and imagination are common threads for many scholarly undergraduate and graduate students at UM.

Here are a few of the many standouts:

Izabela Garcia-Arce

It took moving from the Southern California seaside to snow-capped Montana for Izabela Garcia-Arce, a lifelong surfer from San Diego, to find blood relatives who, too, have saltwater in their blood.

Garcia-Arce was set on the path to pursue a master's in environmental studies at UM after reading “A River Runs Through It.” As she voyaged inland, it became clear that Garcia-Arce also is haunted by waters and fueled by writing.

In UM's environmental writing program, Garcia-Arce explored her interest in outdoor adventure, gender identity, social justice and her Mexican-American heritage.

After becoming editor of Camas, UM’s student-run literary magazine, her successes led to prestigious scholarships for writing workshops held in stunning natural settings. During her last summer as a student, she found creativity kayaking between wooded islands in the Salish Sea.

Later, inspired by UM’s Ethics and Restoration class, Garcia-Arce designed a research project in Mexico that let her explore the best surfing spots on the Baja Peninsula. She ended up finding long-lost relatives who also are creatures of the sea. Garcia-Arce’s deep affinity for the ocean always made her an outlier among her immediate family.

“They were covered with these ocean tattoos and would spend every day in the boat on the water,” she says. “It was awesome to meet other Mexican people who shared passions that sometimes made me feel isolated.”

Sophia Rodriguez

For Sophia Rodriguez, studying communicative sciences and disorders is about more than getting a college degree and finding a good job. It’s personal.

Rodriguez grew up with a cousin, Lauren McDonald, who has level 3 autism, the most severe form that greatly impairs her verbal and nonverbal communication.

“She gets up every day and she smiles, and she has to face a world that judges her and makes things so hard for her,” Rodriguez says. “She is my motivation for so much of what I do.”

Rodriguez came to UM to learn how to help those like her cousin who have specialized needs. She became the student director of MOSSAIC (Mentoring, Organization, and Social Support for Autism/All Inclusion on Campus) and through her work addressing social inequalities and creating more inclusive spaces, she was selected for the 2022 cohort of Newman Civic Fellows. Fellows are campus leaders who commit to finding solutions for challenges facing communities locally, nationally and internationally.

After Rodriguez earns her degree, she plans to become a speech language pathologist and work with children with specialized needs. All of her career plans and passions stem from her cousin, whose strength motivates Rodriguez to make the world more inclusive.
Luke Santore
For seven years, Luke Santore worked on and off as a wildland firefighter. The work was grueling, the conditions dangerous and the lifestyle isolating. But it was the off season he dreaded most, when the mental health issues and chemical dependencies that drove him to drop out of UM’s forestry program several times crept in.

“I had mental health and learning disorders that went undiagnosed for a long time, and I came from a family that had access to care,” he says. “What if you don’t have that access? Undiagnosed mental conditions, of course, aren’t unusual.” Santore sought treatment and by 2020, he was back in school for good, switching his major to sociology. After experiencing positive life changes due to mental health care, Santore says social justice became his primary motivation and reason for pursuing sociology.

Santore re-entered the Davidson Honors College and dug deeper into firefighter mental health for his capstone project. Based on his interviews, Santore’s study found possible solutions to make firefighting a more sustainable career. He graduated cum laude in spring 2022 and began graduate school in fall. Santore will continue his sociological training and likely build on his work studying firefighter mental health.

Nick Mills
Nick Mills didn’t have to look farther than his hometown to pursue his passion for the outdoors and wildlife.

“I chose to stay in Missoula because of the University of Montana’s world-class wildlife biology program,” Mills says. “I realized I wanted to protect the areas I loved.”

Mills found a way to do just that by combining policy and science. UM’s Master of Public Administration and Wildlife Biology programs created a joint degree – the first of its kind nationally – to address the need for wildlife biology and public and nonprofit administration professionals.

The program allows students to earn both a four-year bachelor of science in wildlife biology and a two-year master’s degree in public administration in just five years. An internship requirement prompts students to apply their classroom skills out in the wild. For Mills, that meant working with the White House Council on Environmental Quality to advise the president on environmental justice and climate change policies while advancing job growth and economic development.

“I gained the ability to listen to diverse sets of stakeholders and then to come up with solutions for bigger picture decisions,” Mills says. Together, the program and internship formed a launchpad for his dream career.

Elani Borhegyi
Elani Borhegyi, an environmental science and sustainability student, came to UM to study biology and natural sciences.
STUDENT SPOTLIGHT

Over time, Borhegyi discovered a passion for restoration ecology, environmental justice and climate change, and how all three are connected.

"I want to work at the intersection of all three," Borhegyi says. "I realized I want my career to not just be about science, but about how ecology impacts us in our everyday lives and how we are a part of the ecosystem."

With minors in climate change studies, wilderness studies, Spanish and biology, Borhegyi dove deep into their passions both on and off campus. They served as president of the Climate Response Club, organizing the Four Sisters Garden at the Missoula PEAS Farm.

Borhegyi also helped draft UM's Sustainability Action Plan, building collaboration across student groups, raising awareness around social justice and protesting on the front line at a pipeline project through Minnesota.

Their endeavors led Borhegyi to earn an Udall Scholarship, considered one of the top recognitions awarded to students in fields related to Native American nations or the environment.

Now a senior, Borhegyi is writing a thesis on reimagining society's relationship to the environment in the face of climate change.

Wyatt Walters

When Wyatt Walters retires, he hopes to reflect on his life as one in service to others. That is, if he isn't too busy starting a whole new career.

A senior biology student with a biochemistry minor, Walters also is completing a Franke Global Leadership Initiative certificate and is in the Davidson Honors College. He's worked in an Alzheimer's care center and helped research the disease, volunteered for youth-gearied organizations and is a certified nursing assistant. Each pursuit builds on his dream of becoming a pediatrician serving kids in rural Montana.

"Kids crack me up; they're so darn funny," Walters says. "It never feels like work."

Walters hails from a small town near Great Falls. His career dreams stem from growing up on a cattle ranch and being raised by two medical professional parents.

The GLI certificate's "Beyond the Classroom" learning requirement tested Walters' ambitions, taking him into rural villages around Kabale, Uganda, for a medical internship. Volunteering at pop-up HIV and maternal clinics, he cared for lines of patients while making do with a lack of resources.

Walters' experience confirmed he's on the right track and inspired him to serve with Doctors Without Borders in the future. But for now, he plans to take a gap year after graduation to earn his EMT license before applying to medical school.

Walters has his "retirement plan" figured out, too: teaching high school biology and inspiring more students to love science.

Katherine Wendeln

Katherine Wendeln lives and breathes wildlife and the outdoors. Her majors are in ecology and organismal biology, coupled with environmental science and sustainability, a wildlife biology minor, plus certificates in the Franke Global Leadership Initiative and Northern Rockies Outdoor Leadership programs.

That passion took Wendeln to remote landscapes where the flora and fauna seldom see a human face. After completing her freshman year at UM, she journeyed via floatplane from Kodiak, Alaska, to Shuyak Island to conduct backcountry conservation work.

"I saw more bears than people that summer," Wendeln says. Her next two summers were spent river guiding throughout Alaska, showing tourists the natural beauty of the rivers and the creatures who rely upon them.

While Wendeln treasures her remote adventures at Shuyak Island, she realized it's human connections from shared outdoor experiences that drive her. As she prepares for graduation in spring 2023, Wendeln hopes to continue spreading her passion for wildlife and the environment through outdoor education.

"If I look back and know I've even impacted one person, they see value in these ecosystems, that would be really special," Wendeln says.
Holli Holmes
Waterfowl enthusiasts travel far and wide to feast their eyes upon the colorful plumage of an aptly-named harlequin duck. Wildlife biology graduate student Holli Holmes sees the sight regularly, thanks to her research in Glacier National Park.

Harlequin ducks are hardy arctic or subarctic seabirds that migrate inland to breed in fast moving whitewater mountain streams. Despite that hardiness, populations are declining.

Holmes' research aims to discover why.

"Managers feel like they don't really have their fingers on the pulse," she says.

Holmes' work investigates non-invasive survey methods for studying harlequin duck populations in their breeding range. The research compares environmental DNA, game cameras and foot surveys to find which method is the most effective — and practical — tool to guide management and conservation.

Holmes began her master's at UM in spring 2023 to learn about the analytical side of being a biologist and derive deeper meaning from her data. She says the program's faculty, resources and reputation made UM a no-brainer.

Long term, Holmes' goal is to become a land manager and get involved with place-based conservation.

"One person can’t change the world, but one person can start to make ripples in a community," Holmes says.

Melanie Sandoval
Despite working in Salish language revitalization for over two decades, Melanie Sandoval would never call herself fluent. There is always more to learn.

Learning is Sandoval's lifelong passion and purpose. It's reflected in her relentless pursuit of both learning and teaching Salish — a language that she, like many tribal members, didn't learn growing up. Only about 11 speakers, all elders, are left at the Flathead Reservation.

"That's when we get to a crisis state," Sandoval says. "It's like a race against time."

Sandoval threw herself into that race over 20 years ago by earning an associate's degree in Native American Studies at Salish Kootenai College and an elementary education bachelor's at UM. She then co-founded Nkwusm, the Salish Language Immersion School in Arlee. Since 2018, she's been a language instructor for Salish Kootenai College's Salish Language Educator Development Program, helping future teachers develop their skills.

Sandoval has since returned to UM for a linguistics master's degree. The program is helping her better understand Salish and develop more effective methods of teaching it to her community, a journey that is difficult and emotional, but also healing.

"I would love to be able to hear Salish spoken freely in the community at any event, or at the store, or from grandparent to grandchild or from husband to wife," Sandoval says.

Li Qin "Shirley" Tang
Li Qin "Shirley" Tang, an international educational leadership Ph.D. candidate, is no stranger to higher education, having taught English for 20 years at China's Jilin Normal University. Tang says she's learned new ways to conduct and understand her research at UM, largely thanks to support and guidance from her college of education faculty.

"They are really amazing," Tang says. "So helpful, really friendly and most importantly, they're full of erudition."

Tang discovered a second hometown in Missoula, finding rhythm in teaching classes at UM, publishing papers, giving presentations and getting involved with the Chinese Students' Association of UM.

In China, Tang taught under the International Scholarly Exchange Curriculum, a method of higher education reform. Her research at UM is a comparative study of ISEC teachers and non-ISEC teachers. Tang is curious if there's a difference between the critical thinking skills of the two groups, and if distinctions like age, years teaching, discipline or gender play a role.

Tang hopes her research can help Chinese professors improve their education practices and critical thinking.

"My research results will offer some reference for these stakeholders," she says.

Tang is on track to defend her dissertation in spring 2023. After, she plans to teach in the U.S. •
After experiencing the deaths of her grandparents due to sudden severe sickness in Vietnam, Dr. Anh Nguyen became extremely interested in ways to predict future health problems. In graduate school, this led her to research better equipment to study sleep.

Sleep studies was an area where she and her adviser, Dr. Tam Vu at the University of Colorado Boulder, saw a need for new data-sensing technology. Traditionally, sleep-study equipment is expensive and specific to the clinical environment, and it requires medical staff to monitor the output. Nguyen and Vu researched the market for anything already out there. In the lab, they experimented with electrical components to develop something that could collect signals from the body, but with a portable, efficient and less-intrusive design.

“We wanted to reduce that time and work so that people can use it at home and buy the system at a lower cost than what they usually sell at the hospital,” Nguyen says. “We also want people to track their health day by day compared to when you go to the hospital, where you just have a snapshot of your health at that time.”

The first time she visited a pediatric sleep laboratory, Nguyen saw for herself the real-life impacts their technology could have. “It’s more meaningful when you see a kid that has to be hooked up with a lot of wires to evaluate their sleep quality,” she says. “And when you see them trying to go to sleep with those kind of wires – it’s very difficult.”

Nguyen, a recently hired assistant professor in UM’s computer science department, is continuing her work building wearable
and mobile systems that capture physiological signals and provide better understanding of the human body's health. The monitoring device prototype features sensors that fit inside the ear and capture brain waves, eye movements and muscle contraction during sleep. Another version is a headband that captures even more data, such as sleep posture, oxygen saturation and heart rate. These devices provide data on the body, and the information can be used by medical professionals to make recommendations. But the devices offer another benefit that makes them unique: They provide sleep solutions through biofeedback.

“On top of tracking your sleep quality, the device has been developed to give stimulation so that you fall asleep faster, sleep deeper during the night and wake up feeling more refreshed,” Nguyen says.

The acoustic stimulation comes in the form of music and other sounds and sometimes a human voice that helps with guided breathing. It’s all designed to help improve each phase of sleep. People who deal with racing thoughts before they go to bed would be treated to calming sounds to counter the brain activity. When the person has moved onto the next stage of sleep, the device provides another form of acoustic stimulation to improve that stage. The deep sleep stage is especially important.

“On top of tracking your sleep quality, the device has been developed to give stimulation so that you fall asleep faster, sleep deeper during the night and wake feeling more refreshed.”

“This is when our body tries to recover, where we can improve the memory in our brain,” Nguyen says. “There is research that says if you play acoustic sounds at the deep sleep phase it can help you boost memory performance. So that is another reason to do the stimulation.”

Nguyen’s goal is designing and implementing novel, practical and industrial-level hardware and software to realize closed-loop personalized sleep care through high-fidelity brain tracking and just-in-time brain stimulation wearables. But sleep is just one area in which this closed-loop technology can be applied. The same signals can help evaluate all kinds of health issues, including how a person focuses and how a person’s body processes stress, and it provides ways to alleviate those problems. In this way, a wearable device might benefit a person with attention-deficit/hyperactivity disorder or post-traumatic stress disorder. Nguyen currently is working with potential students – many of them in Vietnam – interested in machine learning, mobile systems and smart healthcare. Those who come to UM to study under Nguyen will work with her on the devices, getting hands-on work in the lab and experience with submitting research proposals for human experiments, as well as finding subjects and doctors willing to collaborate.

Jesse Johnson, chair of the Department of Computer Science, says Nguyen’s work covers a wide range of desired interests among students. Her work with hardware appeals to students looking for something tangible.

“It’s a tremendous asset to have a new professor who’s very competent at the computing platform level all the way up to the level of abstraction we see in software,” he says. “The idea of wearable computing related to biometrics is something a lot of our students are interested in.”

Johnson says Nguyen was recruited not only for her sleep research, but for her potential to interact with other departments on campus – from researching the health effects smoke has on wildland firefighters to the effects of trauma on warfighters.

“She’s gonna do great things here,” he says.

Nguyen has worked with Brian Loyd and Andy Kittelson at UM’s School of Physical Therapy and Rehabilitation Science to develop an application to track the rehabilitation progress of patients who have vestibular system disorders. The technology will provide simple, precise measures of gaze and postural stability and remotely monitoring patient adherence to vestibular exercises.

She also has collaborated with Dustin Slivka of UM’s School of Integrative Physiology and Athletic Training. The project examines human thermoregulation by collecting and analyzing data on how their performance interacts with different heat exposure environments.

Nguyen’s dreams for this technology are big. Right now she can capture a range of body signals, including brain waves. Next, she wants to figure out how to collect data from the Vagus nerve, which regulates internal organ functions, such as digestion, heart rate and respiratory rate, as well as vasomotor activity and reflex actions, such as coughing, sneezing, swallowing and vomiting. She wants to experiment with stimulation that can help the body fix deficits and function better, but also: “It’s important to recover faster. Because in some cases, recovering faster can be lifesaving.

And for Nguyen, there is always a human element at the core of her work. For a short time, she worked with Thuy Thanh Truong, an entrepreneur and technology influencer who developed cancer. Truong experienced poor sleep after her chemotherapy sessions. But as they all worked to increase her sleep quality, she recovered faster for subsequent sessions. Truong eventually passed away, but she had become a friend and provided more evidence to Nguyen that these devices could change the way people heal.

“She shared her positive energy and enthusiasm to make the device developed in a research lab become an actual tool in the future through her real demand as a cancer patient,” Nguyen says.

“It’s a tremendous asset to have a new professor who’s very competent at the computing platform level all the way up to the level of abstraction we see in software.”

There is major value to a system that provides a predictable metric for doctors to evaluate a patient’s ability to do their next chemotherapy. And it can provide a way to improve sleep and help a patient recover so they can continue their therapy – that’s beyond measure.

“When we monitor our health, the question is, ‘How can we react to that information?’” she says. “We don’t want to just look at it. We want to see if we can do something for it.”
Criminal justice reform initiatives in the U.S. focus primarily on urban jurisdictions. Rarely do they include or mention rural and Indigenous communities or populations. The Rural Justice Initiative at UM’s Alexander Blewett III School of Law focuses on this largely overlooked demographic in criminal justice law and policy. Launched in 2020, RJI collaborates with local, state and Tribal stakeholders to support evidence-based criminal justice policy that integrates the needs and experiences of rural and Indigenous communities.

Law Professor Jordan Gross, the RJI director, says the initiative does this in two ways. It hires and trains graduate student research assistants to work on projects with community stakeholders, and it offers a graduate public-policy course – Interdisciplinary Criminal Justice Reform – which enrolls students from a wide range of disciplines on campus. Gross co-supervises RJI research assistants and teaches the course with Dr. Laura Kirsch, a forensic psychologist and adjunct professor in the UM Department of Psychology.

RJI’s inaugural research project looked at pretrial release and detention decision making and the use of algorithmic pretrial risk assessment tools in Montana courts. “We are currently collecting data and analyzing the results of a study of Montana judges’ practices and opinions regarding pretrial decision-making and the use of pretrial risk assessment tools,” says Tori Hill, a third-year law student and research assistant. “These data are important because research shows that whether a defendant is released before their trial can have a huge impact on the outcome of their case. Counties in rural areas with smaller budgets also have a budgetary interest in keeping their jail population low.”

Pretrial risk-assessment tools are based on algorithms and are designed to provide objective, empirical evidence to help judges decide if someone accused of a crime should be detained in jail or released into the community pending their trial, and, if released, what conditions a trial court should order to increase the likelihood a released defendant will show up for trial and protect public safety. Gross explained that risk-assessment tools have been around for a while in the U.S. criminal justice system.

“There is a perception that risk-assessment tools – a centerpiece of a lot of contemporary bail reform – are a new

“What we’re doing is an example of how faculty can work across disciplines and how universities can train students across disciplines to tackle society’s most pressing social issues.”
administration and policy, psychology, public health, social work and sociology.

Gross and Kirsch routinely invite guest instructors into the classroom to enhance and inform the student learning experience. “Learning firsthand from criminal justice professionals who work together every day in this space is key to becoming effective in this area of public policy,” Gross says.

The course benefits from regular appearances by Dr. Jackson Bunch, a UM sociology faculty member, who teaches students about the overlap between victims and offenders in criminal justice systems. Recent instructors included Missoula County Attorney Kirsten Pabst and Brian C. Smith, trial division administrator for the Office of the State Public Defender. Together, they conducted a mock voir dire to help the ICJR class learn first-hand about jury selection in Montana courts. Like RJ’s research assistants, ICJR students solve problems in interdisciplinary collaborative teams.

“The idea is to give students an opportunity to conduct criminal justice research and form collaborative relationships with students in other disciplines as part of their graduate education,” Kirsch says. “Jordan and I have different skillsets and experiences within the criminal justice arena. When we co-teach, we show students different perspectives that highlight how interdisciplinary the criminal justice system really is. This also shows students how to connect with other professionals with different backgrounds and areas of expertise and learn to work together in a team environment.”

“I’ve learned to see and approach issues pertaining to social injustice from different perspectives through my involvement with RJ,” says Gabriella J. Stotz, a fourth-year clinical psychology doctorate student. “This experience has been invaluable for me to become a more clinically and culturally competent and humble scientist-practitioner in the future.”

RJ’s signature approach to everything it does – research, teaching and learning – is collaborative interdisciplinary problem-solving, Gross says. “What we’re doing is an example of how faculty can work across disciplines and how universities can train students across disciplines to tackle society’s most pressing social issues,” she says.

RJ is sponsored by the Angora Ridge Foundation. Based in Whitefish, the Foundation supports causes such as justice, recreation, environmental, education and conservation.

What’s next for the initiative? In collaboration with stakeholders and leveraging the time and talents of students in the fall 2022 ICJR class, RJ is taking a deep dive into jury selection in Montana courts.

“We know that Indigenous people are grossly overrepresented as defendants in criminal cases and severely underrepresented on criminal juries in Montana,” Gross says. The question she and Kirsch seek to answer is what changes can be made in our jury selection laws and policies to ensure all Montanans enjoy a right to a jury of their peers.

RJ is on the job and expects to provide a report on these issues to stakeholders this year.