2017

Vision 2017

VISION

UNIVERSITY OF MONTANA

Research, Innovation & Imagination 2017

UM UNVEILS BOLD LICHEN DISCOVERY

DRONES ADVANCE FIRE SCIENCE

PROTECTING PEOPLE WITH DISABILITIES

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On the Cover:
UM research on wolf lichen reveals that some of the world's most common lichen species actually are composed of three partners, not the widely recognized two. See page 10 story for more.
(Photo by Tim Wheeler, timwheelerphotography.com)

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Eye in the Sky:
Jennifer Fowler, director of UM's Autonomous Aerial Systems Office (center), pilots a drone above UM's iconic Grizzly Bear statue. She is accompanied by Carl Seielstad (left) and LLoyd Queen of the University's Fire Center, which uses drones for wildfire research and management.
(Photo by Todd Goodrich)

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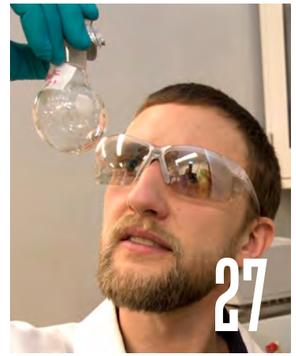

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INNER VISION

MESSAGE FROM THE VICE PRESIDENT

Welcome to this issue of Vision, the magazine that celebrates the vast range of research and creative scholarship by University of Montana faculty and students.

The research enterprise at the University continues to show strong growth, and the visual and performing arts continue to earn accolades for performances across the country. Last year, we announced a record year of research awards amounting to $87 million in funding and a record $78 million for the amount of expenditures from those grants and contracts. Indicators suggest we will likely exceed last year's mark by a significant amount, and the expenditures from those awards also are increasing significantly. In addition to the impact that research has on societal issues, the increased funding drives the overall UM ranking and the amount of performance funding the University receives from the state. These metrics indicate that UM continues on a path to become one of the nation's top-tier research universities – a Carnegie Foundation Research Very High Activity University.

The various stories in this issue demonstrate a hallmark of research and creative activity at UM. Our faculty members are solving big problems in the hard sciences, biomedical sciences, humanities and social sciences. One faculty breakthrough made the cover of Science and was featured in The Washington Post, The New York Times and The Atlantic magazine. Who knew that a fundamental understanding of lichens was wrong! Or that Siamese fighting fish could help our understanding of aggression? Our impact on society is evidenced by The Safety Project, a study by Dr. Rosemary Hughes on the development and evaluation of a violence-prevention program for people with intellectual disabilities. Another significant impact area is our continued assistance for veterans. In this issue, we examine UM's Mind-Body Lab and the important work of Professor Laura Dybdal. Finally, we look at a new initiative on campus to support and promote unmanned autonomous aerial systems, or drones. UM's Fire Center uses drones to study an issue of extreme importance to Montana: wildfires.

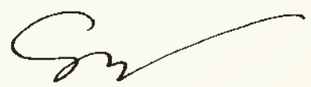
This magazine also showcases Accelerate Montana, a new initiative to support local businesses, as well as recent success in our efforts to work with local companies and

Vice President Scott Whittenburg holds a UM drone.

create new ventures. Accelerate Montana, located in the new Harold and Priscilla Gilkey Building, encompasses UM's Office of Technology Transfer, Blackstone LaunchPad, Montana World Trade Center, Procurement Technical Assistance Center, Small Business Development Center and a new executive education venture called iLEAD. Through Accelerate Montana partners, the University provides support for about 750 companies annually. One example of success from that outreach is the launch of a new startup company, Inimmune, and the transfer of $16 million in research contracts from GlaxoSmithKline to UM and a new proposed Center for Translational Medicine. That interesting story also is featured in this issue.

We share more of our activities and accomplishments online. Be sure to follow our Facebook page at **http://www.facebook.com/umtresearch**, our Twitter account at **http://www.twitter.com/umtresearch** and my blog at **http://research.blog.umt.edu/**.

And Go Griz!



Scott Whittenburg
UM Vice President for Research and Creative Scholarship

University's Funded Research Reaches New Heights

Research is rocking at UM, where for the second year in a row the University set a record for external funding.

UM brought in $87 million in funding during the 2016 fiscal year to support homegrown Montana research, entrepreneurship and statewide outreach, exceeding last year's record total of $83 million.

Scott Whittenburg, UM vice president of research and creative scholarship, says University faculty members and staff reached the record through 684 submitted proposals, which was almost 10 percent more than the previous year.

"We have a growing reputation as a research university, with nationally and internationally renowned scientists," Whittenburg says. "Our students get to work in amazing labs and learn from great researchers, who also regularly inspire budding Montana scientists through dynamic K-12 outreach programs. At the same time, this activity spurs entrepreneurship and attracts new companies to power our economy.

"We couldn't be more excited about our current trajectory in funded research."

In fiscal year 2016, 10 faculty members had at least $1 million in research expenditures. The top five earners were:

- Reed Humphrey, College of Health Professions and Biomedical Sciences, **$6.3 million**
- Vida Wilkinson, Missoula College, **$4.4 million**
- F. Richard Hauer, Center for Integrated Research on the Environment, **$4.4 million**
- Donald Loranger, Defense Critical Language and Culture Program, **$3.6 million**
- Stephen Sprang, Center for Biomedical Structure and Dynamics, **$2.7 million**

UM Ranks High in North America for Ecology Research Productivity

UM ranked No. 5 in North America for its scholarly productivity in the field of ecology, according to a recent study published in the journal Ecosphere.

Ranking ahead of many well-respected research universities such as Harvard, Yale and Princeton, UM's faculty lead the pack in publications, number of citations and the impact of their research moving the field forward.

"The University of Montana, in terms of its productivity and impact on the broad field of ecology, is in the top 3 percent of research institutions in North America," says **Ric Hauer**, director of UM's Center for Integrated Research on the Environment. "The UM ecology faculty is not only running with the big dogs like Harvard, Stanford and Berkeley – but actually is one of the big dogs."

Ecology encompasses topics such as global loss of biodiversity, the interface between climate change and plants and animals, and the impact of humanity on the planet, among other issues.

The study, which was conducted by UM alumna **Megan Keville** under the direction of UM Professor **Cara Nelson** and Hauer, compared 316 North American academic institutions between the years of 2000 and 2014 and ranked them based on the number of papers published in the top-40 ranked ecology journals worldwide. The study and full rankings are online at http://bit.ly/2lQ7BBh.

Although the study shows UM ranked No. 5 on the list, when one normalizes the data based on faculty size, UM rises to the No. 1 position in North America. Most other universities in the top 20 have faculty sizes two to five times larger than UM.

The Flathead River on the U.S.-Canada border.

Research Reveals Importance of Gravel-Bed Rivers

Gravel-bed river floodplains are some of the most ecologically important habitats in North America, according to a study last year by scientists from the U.S. and Canada. Their research shows how broad valleys coming out of glaciated mountains provide highly productive and important habitat for a large diversity of aquatic, avian and terrestrial species.

This is the first interdisciplinary research at the regional scale to demonstrate the importance of gravel-bed rivers to the entire ecosystem.

Professor **Ric Hauer**, director of UM's Center for Integrated Research on the Environment, leads a group of authors who looked at the full continuum of species and processes supported by gravel-bed rivers, from microbes and bull trout to elk to grizzly bears.

The paper, "Gravel-Bed River Floodplains are the Ecological Nexus of Glaciated Mountain Landscapes," was published online in Science Advances at http://bit.ly/2liwicg.

Gravel-bed rivers are found throughout the world in mountainous regions, but the complexity of how they benefit species had not been extensively studied before now.

The team of scientists on the study includes Hauer; **Harvey Locke**, co-founder of the Yellowstone to Yukon Conservation Initiative; UM professors **Vicky Dreitz**, **Mark Hebblewhite**, **Winsor Lowe** and **Cara Nelson**; **Clint Muhlfeld**, research aquatic ecologist from the U.S. Geological Survey; Professor **Stewart Rood** from the University of Lethbridge; and biologist **Michael Proctor** of Birchdale Ecological.

For the entire Yellowstone to Yukon region, which stretches from Yellowstone National Park north into Canada's northern Yukon Territory, gravel-bed river floodplains support more than half the region's plant life. More than 70 percent of the region's bird species use the river plains, while deer, elk, caribou, wolves and grizzly bears use the floodplains for food, habitat and important migration corridors.

"If we think about the Flathead River for example, flowing from British Columbia into the U.S. and along the western edge of Glacier National Park," Hauer says, "we might wrongly imagine that the river is only water flowing in the channel. But, these gravel-bed systems are so much more than that. The river flows over and through the entire floodplain system, from valley wall to valley wall, and supports an extraordinary diversity of life. The river is so much bigger than it appears to be at first glance."

Gravel-bed river systems provide complex habitats for species because of the system's ever-changing features: gravel and cobbles that move with flooding, scoured and changing river channels, and a constant flow of water into and out from the gravels of the river. This water extends across the U-shaped valley bottom often hundreds of meters or more from the river channel and supports a complex food web that includes aquatic species, as well as a vast diversity of avian and terrestrial species. These processes are driven by the river's changes in volume throughout the year.

The gravel-bed rivers also provide essential connectivity across the landscape for both terrestrial and aquatic organisms, which is critical in a time of climate change.

These floodplains also are some of the most endangered landforms worldwide. Human settlement, agriculture, industry and transportation often occur in flat, productive river valleys. While there are many protected areas in the northern Rocky Mountains of the United States and Canada, such as Yellowstone and Banff national parks, humans have altered the structure and function of the gravel-bed river floodplains outside, as well as inside, these protected areas.

"The increasing pressures of climate change mean that species need continued access to intact gravel-bed river ecosystems in order to survive," Hauer says. "These systems must be protected, and those that are already degraded must be restored."

UM Biomedical Center Earns $10.5 Million Grant

A University research center was awarded $10.5 million from the National Institutes of Health.

The major, five-year award will augment UM's Center for Biomolecular Structure and Dynamics, which works to unravel the molecular foundations of biological processes in health and disease. The funding is a Phase II NIH Center of Biomedical Research Excellence (COBRE) award.

"Earning this award is a major success for our faculty," says **Stephen Sprang**, the center director and a UM biology professor. "I want to thank everyone who helped us by proposing outstanding science, building productive core facilities and organizing vibrant activities."

He says the award will provide up to three years of research funding to four faculty investigators. It also will support the BioSpectroscopy Research Laboratory, the Molecular Computational Core, the Protein Expression and X-ray Diffraction Core, small-molecule X-ray diffraction services, and nuclear magnetic resonance and mass spectrometry core facilities.

"Importantly, this funding will provide substantial startup funding for up to two new faculty hires," Sprang says. "This will fulfill critical research and teaching needs in three basic and biomedical science-oriented UM departments. Our initial Phase I funding allowed us to hire five outstanding faculty members who already have done great things here at UM, and we expect similar results from the new additions."

He says the funding also will support the Center for Biomolecular Structure and Dynamics administrative core, which provides pre- and post-grant award service and counseling to the UM researchers who so far have been awarded about $15 million in funding from grants submitted through the center.

Funding also will continue support for the center's seminar sponsorships, a research symposium, a summer graduate fellowship program and semi-annual grant workshops.

Book About Osprey Project Wins National Award

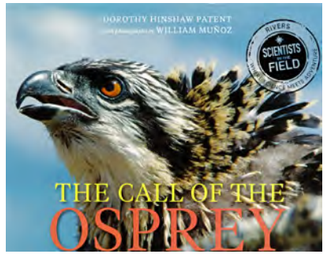
"The Call of the Osprey," a book focusing on UM's Montana Osprey Project, won the 2016 Award for the Best Science Book for Children K-12 from the National Science Teachers Association and the Children's Book Association.

Written by Missoula resident and author **Dorothy Hinshaw Patent** and featuring photos by **William Munoz**, the book is part of Houghton Mifflin Harcourt's "Scientists in the Field" series, which fuels the curiosity children have about the natural world by showing them the cool things scientists do.

During their research for the book, Patent and Munoz spent time in the field and the lab with scientists, seeing how they analyze osprey blood and feather samples for heavy metals.

The Montana Osprey Project was started by **Rob Domenech**, director of the Raptor View Research Institute; **Heiko Langner**, a former UM researcher and director of the Environmental Biogeochemistry Lab; and **Erick Greene**, a UM professor in the Division of Biological Sciences. It focuses on research, education and the conservation of ospreys throughout western Montana, as well as the effects of heavy metal contamination on them.

"That the book is about our research project is incredibly cool and gratifying, and I am so proud of Dorothy and Bill," Greene says.



Students Travel to Vietnam to Study Climate Change

Eight UM students visited Vietnam in January to study climate change impacts and adaptation in the Mekong Delta during the seventh annual Winter Session in Vietnam study abroad field course.

Accompanied by **Nicky Phear**, program coordinator of UM's Climate Change Studies Program, students studied with Vietnamese experts, explored national park lands and worked alongside Vietnamese farmers, who see the impacts of climate change and are innovating new ways to address its effects. Students shared their stories online at https://umvietnamstudy.wordpress.com/.

"Seeing the innovation in climate change adaptation, in a country far less economically poised than the U.S., was both humbling and inspiring," says 2015 participant **Shanti Johnson**. "As we continue to debate climate science locally, in Vietnam, people are already meeting it head-on with ideas that are so simple, yet brilliant – and I've been telling people about them.

"A trip that, for me, started as a whim has now resulted in three years of study and work in Southeast Asia. I have to laugh, because I never thought a winter session course would have that effect."

One of the first programs of its kind in the U.S., Winter Session in Vietnam was launched in 2011 with a grant from the U.S. Department of State. The program has continued to grow during the past six years, building on UM and the Maureen and Mike Mansfield Center's strong institutional ties with Vietnam.

University's Wildlife Biology Program Ranked No. 1

For many years the UM Wildlife Biology Program has been heralded for its excellence. Now, that reputation has migrated across the continent.

Last year, the wildly successful program earned the top spot in a national analysis of places to study wildlife. UM's Wildlife Biology Program – which offers students unrivaled access to hands-on, outdoor learning opportunities – is the No. 1 program in the U.S. and Canada, according to Academic Analytics.

The ranking is based on faculty productivity. UM faculty members were compared to their peers in top programs in two countries based on publications, citations, research grants and notable awards.

"Our faculty members excel as scientists and educators," says **Chad Bishop**, UM Wildlife Biology Program director. "Our people are more productive scientists overall than others at peer institutions, even when some of those peer institutions are generating more grant dollars for research. That speaks volumes to me about the quality of work being performed by our faculty."

The Wildlife Biology Program is an interdisciplinary group of faculty from the College of Forestry and Conservation, the Division of Biological Sciences within the College of Humanities and Sciences, and the Montana Cooperative Wildlife Research Unit. The program also has been recognized as one of three Programs of National Distinction at UM.

"I've talked to a number of people who have been on this campus for years," Bishop says, "and they believe this may be the first time a UM program has been ranked No. 1 by such a distinguished organization."

Academic Analytics is a provider of high-quality, custom business intelligence data and solutions for research universities in the United States and the United Kingdom. The Academic Analytics Database includes information on more than 270,000 faculty members associated with more than 9,000 doctorate programs and 10,000 departments at more than 385 universities in the United States and abroad. These data are structured so they can be used to enable comparisons at a discipline-by-discipline level, as well as overall university performance.

STUDENT EARNS GRANT TO STUDY MOUNTAIN LIONS


Student Lara Brenner works in a UM lab.

UM wildlife biology master's degree candidate **Lara Brenner** was awarded $20,000 last fall from the Summerlee Foundation to investigate the effects of hunting on mountain lions, which also are known as cougars.

Brenner, from Houston, will use a social-ecological approach to understand the public's views of mountain lion hunting. She'll also measure how stressed the cougars are by analyzing hormones in hair samples.

She is advised by Professor **Elizabeth Covelli Metcalf** in UM's College of Forestry and Conservation and also will work with Professor **Creagh Breuner** on the stress-hormone analysis and with **Hugh Robinson**, who directs the landscape analysis lab for Panthera, an organization that protects cat species.

Brenner will conduct research in communities in several different states where cougar hunting restrictions vary. For example, in Montana hunting mountain lions with dogs is allowed, while in Washington dogs are not allowed. Brenner will ask residents how hunting impacts social tolerance for the species.

The Summerlee Foundation supports wildlife research projects.

Research Reveals Importance of Remote Cameras

UM doctoral candidate **Robin Steenweg** shows how remote cameras can transform monitoring wildlife and habitat biodiversity worldwide in a paper published Feb. 1 in the journal Frontiers in Ecology and the Environment.

He and study co-authors, including UM Professors **Mark Hebblewhite** and **Jedediah Brodie**, call for a global network of remote cameras. The researchers believe a large-scale, connected network that collects and manages data from remote cameras could help meet goals to conserve wildlife and other natural resources.

"There is so much remote camera data being collected out there by both research scientists and citizen scientists, we just need to link it together," Steenweg says. He points to examples such as Snapshot Serengeti and Snapshot Wisconsin, which use citizen-collected, remote-camera data to drive conservation.


Robin Steenweg used a remote camera to capture this image.

Researchers and resource managers currently use remote cameras to monitor wildlife all over the world – an estimated 20,000 cameras in 2015 – and more are added daily. Steenweg and colleagues propose regional networks could be pulled together in national and even global biodiversity monitoring systems.

The study is online at http://bit.ly/2kuAyFR.

Project Helps Government Protect Rare Bats

It's not science fiction: **Nate Schwab** listens in on bat chats.

Schwab, a senior bat ecologist at TetraTech in California, works with UM's Center for Integrated Research on the Environment as part of a five-year, $45 million cooperative agreement between the University and U.S. Army Corps of Engineers. The project is to "collect, analyze and apply resource data to implement land rehabilitation and maintenance for optimal management of public lands under control of the Department of Defense."

Bats are the second-most diverse group of mammals in the world, providing billions in pest control, plant pollination and seed dispersal for agriculture. There are about 45 bat species in the U.S., and eight of those are listed as threatened or endangered.

The latest project builds upon a previous CIRE project conducted with the help of Schwab last summer. This first study examined only the northern long-eared bat, surveyed at 14 different U.S. Air Force bases in the central U.S.

"The difference between these two projects is the scale and habitat," says **Mike Keech**, the bat ecology research coordinator for this project. "We are going from 14 to 48 bases and from one species to all threatened bat species. We are essentially looking for what's there."

The purpose of this research is to discover as many possible current habitats for threatened and endangered bat species in the U.S. The DOD is required to follow specific guidelines with animals classified as endangered according to the Endangered Species Act. The CIRE research team is conducting this fieldwork across the southern and eastern portions of the U.S.

The research team set up a series of acoustic monitors – five per base – that operate for several months. These have been set to automatically turn on at a pre-determined time during the hours when these bats are expected to be most active.

— Mona Nazeri

GLIMPSE

Last fall, the UM Creative Writing Program named Bitterroot Salish tribal member, author and Professor **Debra Magpie Earling** its first Native American director since the program's founding in 1920.

UM history Professor **Anya Jabour** was appointed the University's 11th Regents Professor during the Nov. 17 Board of Regents meeting in Missoula. The title is bestowed on faculty members who demonstrate unusual excellence in instruction, scholarship and service. Jabour specializes in U.S. women's history and has been a professor at UM for over 20 years. She also serves as a historical consultant for the PBS Civil War-era miniseries "Mercy Street," which returned for its second season in January.

The Flathead Lake Biological Station has been awarded a $2 million grant to study diversity among insects, crustaceans and other arthropods in river floodplains and how they might be affected by climate change. The four-year, NSF award went to researcher **Gordon Luikart** and co-investigators **Jack Stanford** and **Brian Hand**.

The groundbreaking climate change adaptation research of **L. Scott Mills**, UM associate vice president of research for global change and sustainability, was the focus of a new book by acclaimed young-adult author **Sneed Collard III**. The book, "Hopping Ahead of Climate Change – Snowshoe Hares, Science and Survival," describes Mills' 18 years of research on snowshoe hares, seasonal coat color change and the potential for animals to adapt to climate change. It is intended for ages 10 and older.

Climate change is melting glaciers, reducing sea-ice cover and increasing wildlife activity – with some of the most dramatic impacts occurring in the northern high latitudes. New research by UM affiliate scientist **Adam Young** and UM fire ecology Associate Professor **Philip Higuera** projects an increased probability of fires occurring in Alaskan boreal forest and tundra under a warmer, drier climate. Their work recently was published in the journal Ecography at http://bit.ly/2lTxzqM.

The National Opera Association honored the UM Opera and UM Symphony Orchestra for its 2016 production of Gilbert and Sullivan's "The Gondoliers." NOA named "The Gondoliers" as the Opera Production Competition's third-place winner during the national convention in Santa Barbara, California, in January.

UM's Rural Institute for Inclusive Communities has been awarded a five-year, $1.2 million contract with the University of Kansas that includes funding from the National Institute on Disability, Independent Living and Rehabilitation Research. The contract is part of a larger $4.3 million grant received by KU. It will fund a new center that will focus on modifying home environments and enhancing the personal skills of people with disabilities as a way to increase their community participation.

A UM team has been awarded nearly $3 million in NSF funding to develop an innovative, interdisciplinary graduate training program focused on interactions among food, energy and water. The program, "UM BRIDGES: Bridging Divides across the Food, Energy and Water Nexus," will combine new interdisciplinary course offerings, workshops and internships, international experiences and cutting-edge research to educate future leaders at the food-energy-water nexus and cement UM's status as a leader in this realm. UM faculty members **Laurie Yung** and **Andrew Wilcox** lead the effort.

UM and its partners received a five-year, $20 million grant from the National Institutes of Health to address health disparities facing Native American communities in Montana and Alaska. Faculty members **Kari Harris**, **Erin Semmens** and **Tony Ward** from UM's School of Public and Community Health Sciences and **Lisa Blank** from UM's Phyllis J. Washington College of Education and Human Sciences are part of the grant.

Kasper Hansen, a UM assistant professor in the Department of Biomedical and Pharmaceutical Sciences, received a five-year, $1.6 million grant from NIH. His research focuses on N-methyl-D-aspartate (NMDA) receptors in the central nervous system, which are critically involved in neuronal development, sensory processing, memory and learning. •

OVERTURNING 150 YEARS OF SCIENCE

UM lichen discovery rocks the research world

By Marina Richie

Who's smarter? A lichen or us? We might have big brains, yet for 150 years these complex and mysterious life forms outsmarted scientists.

That changed in 2016. Two University of Montana researchers, working with collaborators scattered across the globe, toppled the long-standing idea that lichens are a product of one alga for photosynthesis and one fungus for structure. They found a second fungus that had escaped detection. The most successful of lichens, it turns out, are a threesome. Or, as The New York Times headline put it, "Two's Company, Three's a Lichen?"

Toby Spribille and John McCutcheon's groundbreaking discovery made the July 29 cover of Science and was featured in The Washington Post and The Atlantic magazine, among many other media outlets.

The study of lichens helped form the foundation for a branch of biology called symbiosis – how different organisms cooperate to do things the individuals alone could not. Today, we know human health depends on symbiosis, from mitochondria powering our cells to gut bacteria aiding digestion. The new finding transformed how scientists perceive the lichen symbiosis.

"The people who have the hardest time understanding our work are lichen specialists, because they've spent so much time thinking that a lichen is defined by its single fungus," says Spribille, a research associate in McCutcheon's microbial genomics and symbiosis lab. "There is a huge historical inertia that says a lichen is made up of two things – one fungus and one alga – and it is often hard to overcome this. It was for us."

He feels empathy for the Swiss botanist Simon Schwendener, whose 1867 concept that lichens consist of two partners was met with disbelief by esteemed scientists. True breakthroughs are rare and serve as reminders that taking a fresh view can swing the floodgates wide to an outpouring of more discoveries.

"We are starting to ask what organisms actually make a lichen, rather than being told what organisms are there," McCutcheon says. "We are giving ourselves permission to go out in nature and look again."

The duo experienced every scientist's dream. Their finding was nowhere on the Internet. It was in no textbook. Maybe it's no accident that one source of funding for the new lichen research comes from NASA, a grant funded through the space program to understand complex organisms in order to detect alien life on other planets. The Austrian Science Foundation also played a key funding role for the four-year study.

A 'EUREKA!' MOMENT

When the two researchers discuss the lead-up to the breakthrough, they tell the whodunit tale with relish. Their complementary talents are another kind of symbiosis. Spribille studies the evolution of lichen symbiosis, a journey that's taken him across North America and Eurasia, including completing a Ph.D. in 2011 from the University of Graz, Austria. He's collected more than 40,000-plus specimens in the field over the past 20 years, starting as a U.S. Forest Service botanist in northwest Montana.

McCutcheon is a symbiosis whiz, known for revealing such microscopic bizarreness as bacteria living within bacteria inside a sap-sucking insect. Both are fascinated by what McCutcheon jokingly refers to as "weird biology."

Lichens so far have not been assembled in the lab. Scientists have tried for years but could never get a single fungus and a single alga to make the complex structures seen in lichens. In addition to this problem, Spribille had noted other findings related to lichens that didn't seem to add up. So Spribille and McCutcheon teamed up to ask a simple question about lichens that live close to the UM campus in the ponderosa pine, Douglas fir and larch forests of Pattee Canyon. Their initial research started with a small incubation grant from the University.

One lichen is brown and looks like a beard hanging off a tree limb. It's known as the edible horsehair lichen (*Bryoria fremontii),* or wila, a traditional Native American food for making pemmican cakes. The second

UM researchers John McCutcheon (top) and Toby Spribille, shown here examining lichen in Pattee Canyon near Missoula, made a discovery that added to our understanding of the forest-loving life form.

Photo by Tim Wheeler, timwheelerphotography.com

Ten lichen species are found in this photo of a ponderosa pine branch. Can you find them?

lichen is yellowish brown and called inedible horsehair lichen (*Bryoria tortuosa)*. Its color marks it as poisonous. The two species make excellent lichens for study because they don't have to be attached to a surface to live and can be snipped off easily for lab analysis.

When scientists from Finland and Canada previously examined the two lichens, they found no difference in the genetic makeup. So how could one be poisonous and the other not? Spribille brought the question to McCutcheon.

"I told Toby, 'I guarantee you, this is an example of a classic microbiological problem,'" says McCutcheon. The two suspected the methods used by their Finnish and Canadian colleagues were simply too coarse to detect fine differences. They were confident that looking at whole genomes would reveal the answer. McCutcheon adds, "I was pretty sure what the answer would be. But as it turned out, I was very wrong."

The two proceeded to sequence 4,000 to 9,000 genes for the alga and fungus of both lichens rather than relying on the four sampled genes of each that are typically used as molecular "bar codes" for species. The prior analysis was correct: McCutcheon was mistaken. No genetic differences existed.

That first finding led them to the next question. Is it a difference in gene expression? Perhaps, they thought. Environmental conditions can cause a single species to produce toxins in some situations but not others. That analysis likewise came up with a resounding answer: No.

There was a third possibility. In Spribille's initial analysis, he had found a second fungus that he'd eliminated as a contaminant. He assumed a rogue fungus must have fallen upon lichens outdoors, which could be expected.

"I would do that differently now," Spribille reflects. "I was looking for two partners, because that is what we had been primed to expect. I didn't pay much attention to the second fungus and didn't even bother to look to see if it was the same fungus in various places."

McCutcheon sees it another way. "That's the point. Sometimes in research, you have a finding that's so confusing you just have to let it sit for a few years, and you loop back to it later."

They re-ran their analysis to see if the genes of the new fungus correlated with the toxic differences of the two lichens.

"There it was," Spribille says. "There was a clear pattern. It was all in the second

> This was the eureka moment if there was one. It's not a contaminant. Most lichens have their own second fungus. We're pulling an organism out of lichens, with almost 100 percent success, that nobody knew existed.

LIKIN' LICHENS

Like space exploration looking for alien life, a journey into the world of lichens offers a dizzying array of outlandish shapes. Lichens can be as flat as sandpaper, as long as a wizard's beard or as crinkled and fantastical as ocean coral. Some hug rocks; others drip from tree branches and trunks. They might be a bright shade of orange or yellow, or a subtle black, gray or tan. An individual lichen may be more than 100 years old. The evolution of lichens traces back some 400 million years, placing them as one of the first land-dwelling organisms.

Lichens self-assemble to form a complex organism able to survive droughts, revive in rain and repel predators. Each one represents a cooperative partnership of an alga and a fungus. Many, it turns out, also harbor a second fungus. The fungi form protective homes for the water-requiring algae, so lichens can thrive in dry climates. The algae, in turn, employ photosynthesis to convert carbon dioxide in the atmosphere into oxygen we breathe. Lichens absorb what's in the air, including pollutants, which convey to scientists the health of the Earth. More than 20,000 identified lichen species add to our planet's tremendous diversity of life. Arctic tundra and cold northern forests host some of the highest diversity.

Three strategies ensure lichens keep going on this planet. They may break off pieces that spread and grow into new lichens. Or a few algal cells surrounded by fungal cells disperse. Fungi also can grow fruiting bodies that produce spores and find the right algal partner to form a new lichen.

MOSS OR LICHEN?

A moss is a plant with parts that work like leaves, stems and roots and contains chloroplasts for photosynthesis. A lichen is a plant-like organism that lacks roots, stems or leaves. The algae provide chloroplasts for photosynthesis. Mosses and lichens are often found growing close together, sharing similar habitats. Lichens benefit from mosses that are like sponges, retaining water.

fungus. Whenever the lichen produced this toxin, it had 12 times more of this additional fungus."

The implications of this were enormous, because it suggested that lichen science had been missing something all along. What seemed like a solid result for the horsehair lichens was only the beginning of showing a wider pattern.

"Having gotten this far, I realized that we really had our work cut out for us to find out if this was a wider thing" Spribille says. Only after sampling many different fresh lichens from around the world to sequence for a second fungus did the broader pattern begin to gel.

"This was the eureka moment if there was one," Spribille says. "It's not a contaminant. Most lichens have their own second fungus. We're pulling an organism out of lichens, with almost 100 percent success, that nobody knew existed."

IT'S ALL ABOUT FRESH EYES

At this point they had only ever "seen" this second fungus in DNA sequence. "We had to see the cells in the lichen or no one would believe us," McCutcheon says.

It turns out that in some cases, the second fungus interlaces with the known fungus in the outer cortex (a waxy outer layer that coats the outside of the lichen) and is hard to tease apart. In others, including the two horsehair lichens, the newly found fungus is the cortex itself.

How could such an obvious fungus be so overlooked? Spribille explained by quickly sketching a classic cross section of a lichen that depicts a stringy fungus layer topped with a middle layer full of colored circles representing alga, and then a third outer (cortex) fungus layer like a line of beads.

"If you were to ask a small child, how many kinds of things do you see, they would tell you three," Spribille says of the sketch.

It's all about fresh eyes and a willingness to question what's presented at face value as correct. If instructed to see one fungus expressing itself in two ways, instead of two unique fungi, most people see what they are taught. Spribille noted that when he leads field trips, the most intriguing questions come from people who haven't yet been trained to think any one particular way about lichens.

The next step in their work is to delve into the symbiotic role of the second fungus in a host of other lichen species. Spribille believes lichens can help unlock the secrets of communication between eukaryotic cells (those cells with membranes surrounding a nucleus and other organelles).

Another benefit of lichen research is their proximity in nature. Spribille and McCutcheon enjoy stepping out into the forest and savoring the up-close wonder of lichens in all their diversity. A typical Montana watershed, valley bottom to mountain top, may harbor as many as 1,000 lichen species, compared to a dozen or so tree species.

"Lichens are one of the most visible and complex symbioses on Earth," says Spribille. "Studying this system potentially gives us a window on how eukaryotic cells talk to each other."

"After this work, the world looks different to me now," says McCutcheon, "and that's pretty exciting." •

WARRIOR POSE

Campus program helps reintegrate student veterans to civilian life

By Jacob Baynham

By the time Casey Christensen arrived at UM in 2013, he was far from a typical student. After 11 years in the Marine Corps, including two tours in Iraq, he was anxious in crowds, prone to anger and too nervous to sit in a public space. If he saw trash in the road when he was driving, he swerved. The stress and trauma of his service had made him hypervigilant. In Iraq, that mindset kept him safe. Back home, it kept him from a normal college life.

The enrollment process had been grueling – all those applications and deadlines. He was the first in his family to go to college. But now that he was finally here, it was hard to focus on his studies when so much else clouded his mind. A campus that was tranquil to others felt like a battlefield to him. That's when a fellow student veteran convinced him to attend a new "mindful resilience" program that trained veterans in meditation, yoga and breathing.

Christensen had never struck a yoga pose in his life. He worried about what other veterans would think of him. But he soon found a sense of camaraderie in the group, and he was surprised to find the exercises familiar. As a Marine, he was used to breathing in cadence during long runs, and he was trained to focus on his breathing at the shooting range. Yoga felt like physical therapy. When he started applying these techniques to his civilian life, he grew less anxious and became a better student.

Three years later, Christensen is training to be a yoga instructor. He started teaching classes to veterans this spring. He still doesn't look the part. He's 36, with a faded olive baseball cap and a smoker's gravelly voice. But he believes in the power of the practice, and his own story is evidence that it works.

"Veterans can be a pretty close-minded group," he says. "Mindfulness and meditation are four-letter words to some of these guys. We need to break that language barrier. A symptom of PTSD is disassociation – the thousand-yard stare. Now we can meditate instead of disassociate."

UM health and human performance Professor Laura Dybdal used her health psychology background to create the Veteran Mindful Resilience Program in 2013 when she recognized the unique

Shawn Grove, director of the University's veteran's office (left), meets with Laura Dybdal, the professor who developed the mindful resilience program, and Glenn Tousignant, a Red Willow yoga instructor, in UM's Mind-Body Lab.

He imagines himself hovering over a forest and visualizes his breath rustling the leaves on its way in, and again on its way out.

challenges veterans faced on campus. Staying afloat in college is hard enough when you're not grappling with chronic pain, depression, sleeplessness and post-traumatic stress, as many veterans are. She conducted a needs assessment of student veterans and determined they could benefit from mindfulness techniques.

"We're trying to foster resilient students – students who can bounce back when they're experiencing anything from test anxiety to severe depression," Dybdal says.

Mindfulness doesn't replace therapy, Dybdal stresses, but it gives student veterans additional tools to reintegrate into civilian life. About 16 to 20 veterans participate in the Mindful Resilience Program each semester, and more than 70 veterans have participated in the program since its launch. Three drop-in classes are offered each week that are taught by instructors from Missoula's Red Willow Learning Center, which partners with Dybdal to offer the program. Workshops also are offered during the academic year that target specific health issues and facilitate social support among student veterans.

She says the participants report improvement on a range of issues. They're sleeping better, they're less anxious, and they're less depressed. They're also better students. "Staying in school is a huge piece," Dybdal says. "The student veterans who have participated are staying in school." One student veteran, who suffers from an autoimmune disease, said the classes help alleviate his chronic pain.

Dybdal says the physiological explanation for why mindfulness helps the body is a relatively new research area. Neuroscientists are still studying the neural mechanisms that explain why brain matter density increases with meditation. However it happens, mindfulness exercises have been shown to create new pathways in the brain, which are healing for someone who has experienced stress and trauma, Dybdal says.

Just like jogging can improve your mental state, your mental state affects your body, too.

"Things like stress and trauma aren't just in the mind, they're in the body," Dybdal says. "If you improve the body, you'll improve the mind. And if you improve the mind, you'll improve the body."

The real-life manifestation of this field of research is visible in UM's Mind-Body Lab – a small area in McGill Hall, where the mindful resilience classes take place. It's an intimate space with a whiteboard, a couch and a research office in the back. Colorful yoga mats are rolled and stacked on the floor beneath shelves of woven rugs, and a stand near the door holds back issues of Mindful magazine. An electric kettle sits on a counter beside boxes of tea. The setting is tranquil and intentionally cultivated to be inviting to student veterans, a group that often uses isolation and avoidance as coping mechanisms.

"Anyone can come to the classes at any time," Dybdal says. "It has to be flexible."

When Shawn Grove came to campus in December 2013 to direct UM's Veterans Education and Transition Services Office, he quickly recognized the value of Dybdal's program. "She really has a heart for veterans," he says. "It's really to the benefit of the University that she has that passion."

Grove attended some of the yoga classes himself, and whenever he meets with the 700 or so veterans on campus, he encourages them to disregard the stereotypes and try it out. "We're trying to get rid of that stigma of yoga being frou-frou or not manly enough," he says. "You're not going to be a weaker person if you're doing meditation or yoga."

And unlike other coping mechanisms, Grove says, mindfulness and meditation don't require any special setting or equipment. "You can do it in the privacy of your own home," he says. "It' doesn't matter what the weather's like. You can do breathing meditation when you're sitting in the classroom. It's portable, and it's free."

Grove served in the Army for five years and experienced combat in Iraq. Crowds are still stressful for him, and he gets anxious in the aisles of Target, where escape routes are limited. He looks for threats where none exist. But now, when he feels nervous, he uses breathing exercises to quiet his mind. He imagines himself hovering over a forest and visualizes his breath rustling the leaves on its way in, and again on its way out.

"If I can take a moment to breathe, to just be chill and calm down, things are fine," he says. "I have a 1-and-a-half-year-old daughter. She loves going to Target. It's not like I can avoid those areas. I've got to be there for her."

Even with the encouraging success of the program, Dybdal plans to do more. She recently conducted a needs assessment for female veterans on campus, some of whom feel like an invisible population, because many people assume veterans are male. Dybdal learned from this assessment that female veterans value social support even more than their male counterparts. In response, Dybdal is offering a gender-specific mindfulness class for women veterans this spring and also partnering with Veterans Affairs to offer a Female Vets Empowerment Circle.

Dybdal and her research assistant Brandy Lumpkin also just finished a study on "mobile mindfulness" – using smartphone apps to teach mindfulness techniques. They researched half a dozen apps that the military developed. Eventually, Dybdal hopes to create an app of her own. She sees apps as a growth area for reaching veterans, who may be intimidated by a group setting but are willing to explore mindfulness on their phones.

Dybdal has found satisfaction in applying mindfulness techniques to a population who finds them so beneficial. "It's a slow process, step-by-step, building a base," she says. "But now we're seeing the fruits of that in people like Casey Christensen."

As for Christensen, he's excited to be teaching yoga to veterans. The language he uses might be different than other yoga classes, but the message will be the same: Mindfulness is the path to finding peace within, even for warriors like him. •

Student Casey Christensen, a veteran who served in Iraq, participates in UM's Veteran Mindful Resilience Program.

EYES IN THE SKY

UM uses drones to study fire behavior

By Erika Fredrickson

(Left) A UM Fire Center drone captures images of students starting a study fire in Georgia this January. (Above) A drone equipped with a thermal sensor hovers over a fire in UM's Lubrecht Experimental Forest. (Photo by Jim Riddering)

On a chilly afternoon in a snowy driveway off Huson's Six Mile Road, two technicians carefully rotate the body of a Firefly drone. Others huddle near a small campfire waiting for the drone to take flight. Everyone on site is part of DroneFire, a University of Montana project looking to use unmanned aerial vehicles (UAVs) – aka drones – in wildfire research and management.

The day's flights serve as a test to see how well the drone performs in cold weather and what kind of imagery the team can capture. The campfire, for instance, isn't just for warmth. It was built to see how well the airborne drone can sense the fire's thermal energy.

"With a satellite, all you can see is about a quarter acre on the ground," says LLoyd Queen, director of UM's Fire Center and a professor of remote sensing in the Department of Forest Management. "But today, I'm guessing we'll see stuff that's about 0.4 centimeters on a side. Our ability to see detail with a drone is phenomenal."

The driveway – and the house nearby – belongs to Tim Wallace, a remote-sensing image analyst for the Fire Center. He stands several feet from the drone, holding a joystick controller and peering at a laptop computer set up on a folding table in the driveway. The Firefly is a kit craft, painted in red, black and white and fitted with rotors made from a 3-D printer at UM's Mansfield Library. Attached to the body is a Sony A6000 SLR digital camera. The drone already has racked up a voyage earlier in the day, successfully circling one ridge of the valley and flying back toward the driveway launch pad before stalling out in the snow. Technicians Natasha Bartha and Matthew Cunningham used a blow dryer on it inside Wallace's house, tested its rotors and then took it outside to recalibrate its sensing system – via rotation – before launching it again.

A NEW TOOL FOR RESEARCH

Once associated solely with military applications, drones have become a widespread technology in science and for commercial and recreational use. For universities, drones provide seemingly endless possibilities.

"There's incredible interest with drones in fire management because people see the utility and potential," says Carl Seielstad, a fire scientist for the Fire Center and an associate professor in UM's W.A. Franke College of Forestry and Conservation.

DroneFire started in July 2016 with support from the Montana Research and Economic Development Initiative. The $900,000 grant allows UM's Fire Center and the university's newly established Autonomous Aerial Systems Office to experiment with drone technology and partner with statewide private industry to develop a drone economy.

Queen, Seielstad and the director of AASO, Jennifer Fowler, wrote the grant and are the principal investigators for the project, which also includes three doctoral students, supporting faculty and eight full-time staff – two of whom are pilots. The funding, which runs through July, allows AASO to train students, pilots and researchers in departments across campus to use drones (see sidebar) and will help build capacity for further drone use in research and development. Most importantly, the state grant has stimulated partnerships for UM with the private sector, including with Missoula-based engineering company Skyefish, Kalispell's SUAT and Hamilton's Commander Navigation.

Seielstad has a background in remote sensing, and his work at UM focuses on fuels characterization: how fuels lie on the landscape, how we measure them, and how the spatial pattern and arrangement of fuels produce fire behavior and the resulting effects. Currently, fire researchers use physics-based, fluid-dynamic models, and drones may change the quality of data going into those models.

The subtle variables on the landscape that drones can capture are significant to understanding fire. They can pick up images of one-hour fuel, which is a quarter inch in size, as well as 10-hour fuel, which is, at a half inch, not much bigger. In addition, the Firefly, for instance, can map 20 acres in just eight minutes.

"We've never really had data like this to look at before," Seielstad says. "Little things on the landscape have big effects on fire behavior. If you have a fuel discontinuity such as a gopher mound in your fuel bed, the fire will come up to that gopher mound and go around it. You can see the effect of that – in terms of eddies and behavior – 30 or 40 feet downwind."

FLYING ROBOTS ABOVE THE FLAMES

Queen's work with DroneFire involves developing and implementing thermal infrared imaging capability. To simulate fire in a lab, researchers take data – like flame height – and feed it into models, but those measurements can be limiting. Thermal cameras on drones allow researchers to measure fires in terms of pure energy, which could help simulate fire events with far more mathematical accuracy.

In mid-January, the DroneFire team completed a series of experiments in Georgia in partnership with The Nature Conservancy to characterize the role of fuel variability in fire behavior and effects.

While UM students applied fire to 1,200 acres of longleaf pine forest, DroneFire used thermal cameras mounted on drones to image the fire as it passed across sensors installed on the ground. The researchers are calibrating drone imagery with field-measured fire energy so that fire behavior

Tim Wallace, a remote-sensing image analyst with the UM Fire Center, prepares to fly a drone over a prescribed burn in Georgia this winter. (Photo by Philip Williams)

OFFICE PROMOTES DRONE USE FOR RESEARCH

Flying drones isn't as easy as it might seem, especially for state institutions like UM. While hobbyists can buy a kit and tinker with a UAV with relatively clear direction from the FAA, state entities working on research have a much bigger challenge. First, researchers must figure out how to fly a drone in a way that will specifically advance their work and where the benefits outweigh the costs. Second, drones used for research activate additional FAA regulations, and navigating those requires a lot of time and energy. Finally, because drone usage on campuses is relatively nascent, figuring out the protocol for working with the University community and partnering with private enterprise has a steep learning curve and takes some heavy lifting.

UM's Autonomous Aerial Systems Office was formed on July 1, 2015, to handle these issues. Under the direction of Jennifer Fowler and assistant director Jaylene Naylor, AASO coordinates and guides faculty, staff and students in implementing unmanned aircraft systems, including drones. They're also working to establish infrastructure and resources to make the technology a sustainable part of aerial research and, on a grander scale, looking toward innovation, entrepreneurship and workforce development opportunities for Montana.

Fowler has a long history with unmanned aircraft, specifically with weather balloons. Working with the Montana Space Grant Consortium, a NASA higher education program, she identified drones as a tool for collecting better weather data. But making the leap to drones wasn't easy. After realizing the complications associated with drone regulations, Fowler and UM Vice President for Research and Creative Scholarship Scott Whittenburg decided to form AASO to build the kind of capacity needed on campus – not just for weather, but for any research project imaginable.

The first six months of the Montana Research and Economic Development Initiative grant revealed plenty of challenges – logging flights and maintaining crafts – to meet FAA requirements.

"It's been a little bit of our hair on fire getting things up and going," Fowler says. "The reporting is onerous, but as a public institution we have to keep our own air worthiness qualifications and certify that everything is air worthy."

But as the office gets its feet on the ground, using drones is becoming easier. AASO, inside the Interdisciplinary Science Building, houses 10 different types of drones, locked in cages. During the past year, the office has offered on-campus demonstrations to help educate students on what drones can do and to bust myths about the technology. They also started incorporating drones into remote-sensing classes. The mounting campuswide interest in drones has forced the office to prioritize projects, but it's a challenge that speaks to the exciting research being done at UM.

Besides DroneFire, which is the first test project for the state grant, the list of drone-related research is diverse, spanning units such as geography, geosciences, wildlife biology, anthropology, art and journalism.

In geography, Anna Klene and her students research permafrost and climate interactions in northern Alaska.

"We want to use the UAVs to allow us to map very small changes in surface elevations and vegetation," she says.

In anthropology, Kelly Dixon looks for ways to map archaelogical digs, while Erick Greene in wildlife biology uses drones to study osprey in their nests. Art Woods in the wildlife biology department studies the microclimatology of insect life cycles, and drones allow him to look at the thermal characteristics of leaves.

And in geology, Andrew Wilcox has paired up with DroneFire to study the different processes that form the Earth's surface. For example, he's interested in modeling flow and sediment transport in rivers and landslides and debris flows on hill slopes.

"Drones are essentially collecting aerial photos but from a much lower elevation and therefore at a much higher resolution," Wilcox says. "And with a drone, if there was a fire-related debris flow or a big flood, we would have the capacity to go out on short notice and study the response of the landscape."

Beyond the realm of science research, UM students and faculty have used drones for art projects and marketing under the FAA's new rules for commercial operations. Navigating the technology and understanding when it's useful is all part of the challenge – and the fun. As UM continues to build its capacity for drones, it seems the sky's no longer the limit. •

This unique drone view of Main Hall was captured by UM's Autonomous Aerial Systems Office.

can be quantified across larger areas, with the goal of improving fuel treatment design to protect life and property.

"With the drone's thermal camera, I could actually see how fuels are arranged in the fire," Queen says. "I can tell what the total energy release is, I can separate heat transfer, and I can basically develop an energy budget. That's the Holy Grail."

As director of the Fire Center, Queen's interested in all areas of management around fire – not just high-profile, big-event wildfires. Prescribed burn projects, for instance, are part of the work, and they require removal of a certain amount of wood, which can be a tedious process. In October, DroneFire lit nearly 100 piles of fuel on fire at UM's Lubrecht Experimental Forest and flew a drone over them – pre- and post-treatment – to collect thermal images, which should provide a more exact measurement of biomass burned in each pile.

"At the core of our charter is that fire is a part of land management," Queen says. "There's the suppression everyone thinks about, but that's a small part of it. There's prevention, planning, mitigation, watershed, the Clean Air Act – all those things that drive the policy and the decision-making."

When the Roaring Lion Fire burned through 13 square miles near Hamilton in August, DroneFire helped the U.S. Forest Service fly a drone over the dwindling aftermath. The idea was to see how well the drone detected hot spots, as well as gauge the best ways to work with an agency and look at ways to iron out protocol. There's still a lot to learn about the role drones will play in fire research, but UM is poised to lead the charge.

"We want to do it, but there's a lot to think about," Seielstad says. "How do we do it? What are we capable of doing and what do we want to do? These are the questions. But if you are going to pick a few places in the world to find answers to those questions – where it's all fire, all the time –Missoula is toward the top. It's a logical place for DroneFire." •

STUDENT SPOTLIGHT

Graduate and undergraduate students play a vibrant role in UM's research enterprise. The following profiles offer a glimpse into recent student research.

Karla Bird

Karla Bird works to pinpoint the factors that contribute to American Indians' persistence in higher education. A doctoral student in UM's educational leadership department, Bird says, "Native American students must leave their tribal communities to seek out higher-level degrees or professional degrees at mainstream institutions." The transition to predominantly white institutions, she says, often results in "experiences of marginality, isolation and alienation for our Indigenous students." Her research aims to help mitigate these challenges. She created a campus climate survey to help understand Native experiences at UM and presented her findings to the Native American Student Advisory Council and at the Phyllis J. Washington College of Education and Human Sciences' fall faculty retreat. At UM's Race and Ethnicity Symposium and DiverseU conference, she shared how U.S. policies have contributed to historical trauma within Indigenous communities. Bird's current research builds on her professional experience in the education and mental health fields. Before her doctoral work, she earned a master's in counselor education at UM and served as a school counselor in her hometown of Browning on the Blackfeet reservation, where she also worked for the GEAR UP college-readiness program. Influenced by her mother, a teacher for over 40 years, Bird was drawn to education for its orientation toward service and empowerment – particularly for communities with limited resources. When she completes her Ph.D., she hopes to serve in a leadership role at a tribal community college, perhaps even to return home to Blackfeet Community College in Browning.


KARLA BIRD

Will Deacy

Will Deacy traveled to Alaska's Karluk basin in 2010 to volunteer on a Kodiak brown bear research project. That year marked the beginning of a steep, seven-year decline in the local bear population that puzzled researchers, including Deacy. "We realized that salmon were an important part of the story, and we didn't have that expertise, so we went after Jack to get that." He was referring to Jack Stanford, then the director of UM's Flathead Lake Biological Station, which is internationally renowned for its large-scale salmon research projects in the Pacific. Although he had never set foot in Montana, Deacy sought out Stanford as a mentor and began chasing a doctorate in systems ecology at UM. During several summers at a remote field site, Deacy and a crew of volunteers collected data that illustrate how bears migrate from one salmon spawning group to the next, or "surf the salmon red wave." This finding that bears follow resource waves may seem intuitive, Deacy says, but it's a new way of thinking about how animals move, and it made the cover of the journal Ecology last spring in an article Deacy co-wrote with Stanford, along with colleagues at the U.S. Fish and Wildlife Service and Oregon State University. Deacy has yet to publish another surprising conclusion from his research. A series of cold, wet years resulted in poor salmon runs and low yields of red elderberry. This scarcity of elderberries, Deacy found, proved crucial in the bears' population decline. Counterintuitively, he found, bears gain weight faster on berries than on salmon. Like the high-protein diets that some humans adopt for weight loss, a diet rich in salmon alone can stymie desirable weight gain in bears. While salmon is an important resource, Deacy found that red elderberry, with its "perfect, moderate amount of protein," is always the bears' first choice. Now a postdoctoral fellow in Oregon, Deacy continues working with the data he collected in Alaska. He writes code to model how a virtual bear responds to changes in the landscape. Ultimately, he sees a place for his research – and a career – in the conservation and management of bears.


WILL DEACY

Jed Syrenne

Neuroblastoma is the deadliest childhood cancer. As a member of Mark Grimes' lab in the Division of Biological Sciences, Jed Syrenne helps study the role of the enzyme tyrosine kinase in determining when this aggressive cancer forms. Or, as Syrenne says, "We don't cure cancer, but we're building the base of knowledge so that someone down the line can." The junior's pathway into Grimes' research lab began when, as a student at Missoula's Hellgate High School, he landed a spot in Associate Professor Tony Ward's lab in UM's Center for Environmental Health Sciences. As part of a pulmonary toxicology project examining the health impacts of asbestos and wood smoke, Syrenne "started small," organizing and cataloging thousands of tubes of exhaled breath condensate and urine samples while learning to operate the machinery used for inhalation human trials. With a Presidential Leadership Scholarship, Syrenne enrolled in UM's Davidson Honors College and continued in Ward's lab through his sophomore year. As a student in Grimes' Cell and Molecular Biology class, Syrenne found himself engrossed with "the molecular orchestra that guides the cell." Supported in part through a Summer Undergraduate Research Fellowship, Syrenne has worked in Grimes' lab ever since. Neuroblastoma research appeals to him, he says, because it merges his interests in neuroscience and math, including graph theory and bioinformatics. Syrenne hopes to pursue graduate studies, with the goal of balancing both research and clinical work.


JED SYRENNE

Lexie Yoder

"Water's always been a huge part of my life," says Lexie Yoder, a Seattle native. It also shaped her graduate research. In 2016, the environmental studies master's student delivered her water conservation recommendations to the Missoula City Council. The accompanying report, "An Overview and Assessment of Water Conservation Approaches for Municipal Water Systems," grew out of an independent study she completed on climate change solutions with Robin Saha, UM associate professor of environmental studies. Through a comparative analysis of successful water conservation approaches in three other municipalities across the nation, Yoder's report outlines strategies for Missoula to save water while maintaining its target of carbon neutrality by 2025. Yoder's academic interest in water originated with an undergraduate study-abroad experience on South Caicos Island in the Caribbean, where she says she was struck by the paradox that "you're surrounded by water, but there's a severe water shortage." As a graduate student, this interest led her to a research project on micro-remediation – the use of fungi to break down pharmaceuticals and cosmetics in wastewater – and then to a summer internship with American Rivers, where she researched potential changes to the federal Wild and Scenic designation. Ultimately, Yoder hopes to bring her expertise back to her home state of Washington to pursue a career in water resource management.


LEXIE YODER

Adam Andis

The U.S. Highway 93 corridor from Evaro to Polson features over 40 wildlife crossing structures built and maintained by the Confederated Salish and Kootenai Tribes to allow animals to safely cross the busy road. Adam Andis, who completed a master's in environmental studies at UM in 2016, refers to this as "context-sensitive planning," meaning that "it's not just about getting there fast and efficiently but also about respecting the ecological integrity of the landscape." But do these wildlife crossing structures work? With support from the Wyss Scholars Program for the Conservation of the American West and a Brainerd Conservation Fellowship, Andis designed a study to find out. Working with his graduate adviser Len Broberg and researchers and wildlife managers with the CSK Tribes, the Montana Department of Transportation and Montana State University, Andis and a group of undergraduate interns and community volunteers monitored wildlife activity at 17 structures. Overall, the team found the structures work. "There's a higher rate of movement through these structures than what you would see randomly in the environment," Andis says. Even so, the results generated as many questions as answers. Even controlling for the size of the structure, variability in the rates of movement through the structures was high, and, Andis says, "there's still so much we don't know about what makes an animal decide to use these or not." Now a doctoral student at the Yale School of Forestry and Environmental Studies, Andis studies amphibian ecology. •


ADAM ANDIS

YOU GOT A PROBLEM WITH ME?

UM scientist looks to Siamese fighting fish for aggression research

By Alex Strickland

Credit: iStock

Some 28 million prescriptions for Prozac were filled in 2013, but getting the drug to the bettas isn't as simple as having them swallow a tiny pill.

Siamese fighting fish – also known as betta fish – are prized in aquariums for their massive colorful fins, easily as big as the fish's body itself. As the name suggests, the little fish are itching to rumble, so getting them to pop those colorful sail-like fins doesn't take much: Catching a glimpse of themselves in a mirror will usually set their fight-or-flight instinct to full attack mode. And it's that hair-trigger aggression and unambiguous display of intent that makes them an ideal animal to experiment with when observing aggressive response is the goal.

UM psychology Professor Allen Szalda-Petree has studied bettas for years, relying on the fish's predilection for battle as a reliable control for looking at the effects of drugs on aggression response and associative learning.

"There's a rich history of working with bettas," he says. "They have a very distinct aggressive response that's easy to identify, which makes them an excellent model."

The fish may be tailor-made for aggression response tests, but Szalda-Petree admits they're not without some drawbacks when compared to more commonly used test subjects like lab rats or mice.

Scientists can run a battery of test scenarios perhaps 40 times in rapid succession with rats, which will behave very similarly for food and, thanks to decades of inbreeding, don't exhibit large personality differences from animal to animal. Szalda-Petree only can run a betta through his test maze perhaps four to six times before needing to wait hours to repeat the experiment.

"You have to be careful not to bleed habituation into the experiments," he says. "The density of exposure has to stay relatively low."

BETTAS AS BASELINES

So Szalda-Petree knows betta fish can be counted on to raise their proverbial hackls with the right provocation, but what will the colorful little fish do when under the influence? Specifically, Szalda-Petree is looking at the influence of fluoxetine, commonly known – and prescribed – as Prozac. The serotonin reuptake inhibitor is used to treat depression, obsessive-compulsive disorder, anxiety and other conditions. Some 28 million prescriptions for Prozac were filled in 2013, but getting

UM psychology Professor Allen Szalda-Petree adjusts the swimways he uses to study aggression in betta fish, as well as the effects of Prozac.

the drug to the bettas isn't as simple as having them swallow a tiny pill.

"They're so small that injection isn't a preferred option, so we mix a specific concentration into a solution and place the fish in the solution," Szalda-Petree says. "We have to make it with water from their own tank because the water in their home environment actually adjusts slightly to the fish itself."

Perhaps unsurprisingly, Szalda-Petree's research has shown that drugging the Siamese fighting fish with fluoxetine diminishes their propensity to live up to their name, reducing and slowing aggressive response.

But one aspect of Szalda-Petree's work goes beyond simply observing the fish displaying aggression – it's watching how their predisposition for fighting gives way to associative learning, something not often assumed about an animal like the betta fish.

An example of associative learning would be sending the fish down a swimway to a "T" intersection, where a left turn would result in an empty tank but a right turn would present a male interloper and the chance for the subject fish to defend its territory. Send the fish down the swimway enough times and it will not only develop a preference for the fighting side, but researchers can start placing cues as to which way the opponent lies before the fish makes it to the intersection.

Eventually, for example, a purple rock placed on the side of the swimway indicating which way to turn for a fight is absorbed as a road sign, and researchers can get a fish to make the turn before they know what lies beyond. Under the influence of fluoxetine, however, the bettas seemed to lose their grasp on the importance, in addition to their subdued aggression response.

"We're looking at 'Is it just motor sedation, or is the drug inhibiting the ability to form associations?'" Szalda-Petree says. "Our hypothesis is that fluoxetine works on serotonin but that it's having a downstream change on dopamine systems, which is highly related to the reward systems."

That could have big implications for the tens of millions of Americans who take regular doses of the drug, and potentially even those who don't, since trace amounts of fluoxetine is found in many municipal water supplies (along with other pharmaceuticals), though Szalda-Petree's work doesn't look specifically at the secondary supply.

Szalda-Petree, along with colleagues and with help from both graduate and undergraduate research assistants, has studies out for review now that have been met favorably, but new challenges await to glean more information from the fish.

"We're looking for ways to keep more motor activity up to observe them for longer," Szalda-Petree says. "A graduate student looked at a priming process where the fish sees a female first to see if it makes them more aggressive."

The idea being that if the bettas start out a confrontation especially ticked, the drop-off from the fluoxetine would be extended, allowing for more time to see effects. •

NOT JUST A TRIP TO THE PET STORE

It's not quite as simple as heading down to the local pet store and grabbing up their supply of betta fish for Szalda-Petree and his researchers. First, they only want male fish, which are more aggressive and hard-wired to defend their territory. Second, even among the male fish, Szalda-Petree wants to weed out those that aren't quick to show for a fight.

"The fish aren't inbred the way lab rodents are, so there's some variability in behavior," he says. "We test up front for the most aggressive fish."

Once those fish are chosen, it's a matter of putting them in a scenario that causes that aggression to flash in the form of puffed-up fins and displays that can make the bettas more than double in apparent size. Another male fish will set them off, but so will a mirror, which has the advantage of being more controlled for researchers. In fact, Szalda-Petree has studied whether the fish are more responsive to an image of themselves or an actual live fish. The results were only slightly in favor of the live fish, meaning a mirror is still a legitimate option for research.

That has advantages, as the tiny fighting fish aren't afraid to do just that, and will puff up, ram and even bite other bettas in a bid for superiority and reproductive victories. But though the fish are famous for brutality, the male bettas take an unexpected role when it comes to the offspring they fight for the right to create – the male fish build "bubble nests" with their saliva, and as soon as a female lays the eggs inside the nest, she's chased away, while the male betta guards its home and protects the eggs until they hatch.

"It's a different take on the male-female role," Szalda-Petree says. "Not a full reversal, but the aggressive males provide all the care for their offspring." •

Kris Short, a UM doctoral student in toxicology, works to produce a vaccine booster in an Inimmune lab at MonTEC.

A BIOTECH BONANZA

UM partnership keeps jobs in Montana

By Cary Shimek

In 1980, a guy named Edgar Ribi started a biotech company in his Hamilton, Montana, garage. He and his partners had figured out how to detoxify a certain component in the cell wall of bacteria, and that knowledge allowed them to create MPL (monophosphoryl lipid A) – a substance that improves the immune response of vaccines.

Ribi Immunochem took off, adding employees and buildings on the edge of town with the lovely Bitterroot Mountains as a backdrop. (Truly, if one starts an advanced biotech company that can exist anywhere, why not locate it in scenic Montana with all the extra outdoor amenities?)

The company experienced two decades of success before being snatched up by Seattle-based Corixa Corp., a company seeking to expand its own programs with a strong portfolio of vaccine boosters such as MPL. Then in 2005, Corixa was in turn purchased by the pharmaceutical giant GlaxoSmithKline, which used MPL in its new HPV vaccine to prevent cervical cancer in women worldwide.

MPL – still manufactured in Hamilton – is used in many of GlaxoSmithKline vaccine products around the globe. Things became complicated two years ago when GSK announced it would buy Novartis Vaccines, another large drug company. A multitude of research and manufacturing sites were acquired, and GSK officials decided they needed to simplify the vaccine side of their business by having just three research-and-development centers in the world. In the U.S., that site was Rockville, Maryland.

This meant the research side of the business in Hamilton would close. Employees were told they could relocate to Maryland or GSK would support them in finding another option.

"Nobody on the team wanted to relocate outside of Montana," says Jay Evans, a native of eastern Washington and former GSK researcher. "We would have lost everybody if we moved our R&D team to Maryland. Most of the team has been together for more than 15 years. We have families and kids, and we love the Montana

CENTER DESIGNED TO NURTURE STARTUPS

As Inimmune workers settled into their new partnership with UM and worked more closely with the University's research enterprise, it became clear that many campus scientists had great ideas but needed assistance moving them forward. The folks at Inimmune, on the other hand, had years of experience translating research from the lab bench to Phase I clinical trials.

So Jay Evans of Inimmune and Scott Whittenburg, UM's research vice president, hatched a plan: Use the teams' experience as the foundation for a new Center for Translational Medicine. The center will help faculty, staff and students across the Montana University System move their research ideas from bench to bedside and provide new medicines for improving the lives of people. The center also will seek to increase funding at UM through new research collaborations and licensing. The center will link resources and expertise across diverse disciplines and departments.

"The people at Inimmune are very interested in helping others generate startup companies," Whittenburg says. "They have good connections to major pharmaceutical companies, so we see a lot of potential for the new center. It's all about trying to create more economic development for our region."

At the end of last year, about 30 UM faculty members already had started attending center meetings. Most are from major research units, but some are from sectors such as computer science, mathematics and business. And partners from other Montana campuses also are welcome.

Evans says the new center, in conjunction with UM's Office of Technology Transfer, can answer a lot of questions: How do I move an idea or research finding to a clinical trial to help people? How do I approach a pharmaceutical company with my idea? How do I patent my idea and then license it to generate revenue for UM? How do I document and archive my research correctly to protect my intellectual property? How do I write a small-business research grant?

Evans says a pitch to a pharmaceutical company structured like an academic research proposal or presentation likely is dead on arrival. The new center can improve proposals with a market analysis, product profile and information on target populations, medical need, safety, manufacturing and scalability.

Researchers may apply for external grants using the center, and a portion of that money from successful applications will be banked to nurture great ideas among those who can't land outside funding. Evans says many of the best translational research ideas aren't great basic academic science that federal funding agencies will support – such as developing a drug – but the idea may result in viable licensing revenue or a new biotech company in Missoula. So the center will help address this funding gap by providing money for preliminary data that might attract assistance from an outside company or a small-business grant.

"The more biotech companies that locate in Montana, the better it will be for everybody," Evans says. "Because if one company falls on hard times and those employees need jobs, then there are other companies to go to. It's good to have a cluster where employees can move back and forth and share ideas." •

Emily Webb, a toxicology graduate student at UM, visits with Montana Gov. Steve Bullock during a tour of the Inimmune facilities last summer.

lifestyle. The team works very well together – we are greater as a team."

So they devised a plan to keep their merry band of researchers together by forming a new company, Inimmune, which would partner with the nearest sizeable research institution, UM in Missoula. Evans, named president and CEO of the fledgling company, knew UM could provide fee-based access to essential research services. He also knew Scott Whittenburg, UM vice president for research and creative scholarship, and the first step was meeting with Whittenburg and Joe Fanguy, UM director of technology transfer.

A complicated yearlong dance began between Inimmune, UM, a fully supportive GSK and the National Institutes of Health. Soon others around campus became involved.

The net result is the transfer of $16 million in NIH contracts to UM. GSK also donated millions in lab and office equipment to the effort. In January 2015, Inimmune opened its doors at MonTEC, UM's business incubator, located across the river from campus. Evans says the availability of laboratory space at MonTEC was key, and Inimmune will remain there for the foreseeable future. The NIH research will relocate to UM's Health Sciences Building on the main campus when a remodel there is completed.

Fifteen former GSK employees now have split appointments between Inimmune and UM. Evans, for example, is also a research professor in UM's Division of Biological Sciences. Faculty appointments purposely were split between various UM research units to promote interdepartmental collaboration. The team now has 23 people working in MonTEC, with more hires expected, and UM grad students have been added to the operation.

"This was a great example of a public-private partnership keeping jobs in Montana," Evans says. "It was a difficult process from a legal perspective, involving a big university bureaucracy, one of the world's largest pharmaceutical companies and the federal government. This only came together because everybody involved wanted to make it happen."

"It was good for the state because we saved 15 good jobs that were going to be lost," Whittenburg says. "This is a growing company, so the long-term benefits to the area should be sizable."

Evans says Inimmune researchers are seeking treatments for everything from autoimmunity and allergies to cancer. The company made a profit during its first year of operation by contracting its services out to other companies, and it has three different products poised for Phase I clinical trials. Company scientists dream of alleviating or even curing food allergies, seasonal allergies and autoimmune diseases such as rheumatoid arthritis, diabetes and Crohn's disease.

"We have very strong preclinical data in animal models," he says. "Of course, going from an animal model to human beings is a big step, but that's how new drugs are advanced with both efficacy and safety as top priorities. Having a strong team and multiple shots on goal is the key to success in this industry, so we have a diverse platform of technologies in development."

Craig Johnson, a senior scientist with Inimmune and now UM, has been with the company since the Ribi Immunochem days. He's excited to get back to doing basic research with a small biotech company.

"When you are purchased by a big pharmaceutical company, often they have their own agenda, and lot of our projects got lost," he says. "Now it's our chance to shine."

Rob Child, the company's business development lead and a UM research scientist, laughingly described moving expensive laboratory equipment in a rickety trailer from Hamilton to Missoula – all in the dead of winter.

"From my perspective, it's almost a best-case scenario how everything has gone," he says. "Now we can take these compounds that were developed and all these years of work and experience and put it together into something we truly own – that we drive ourselves. It's a really hopeful feeling." •

AT GREATER RISK

UM research program helps people with disabilities fend off violence

By Henry Worobec

UM's Rosemary Hughes, the creator of The Safety Project, poses for a picture with Eleanor Bailey (right), who co-presented with Hughes at a Washington, D.C., conference last year.

Rosemary Hughes collaborated on some of the first empirical research studies on interpersonal violence involving disability during the 1990s. What she learned from that research and her work at the Center for Research on Women with Disabilities in Houston has influenced her career ever since.

"Those early findings indicated that persons with physical disabilities face unique, disability-related risks and forms of violence," Hughes says. "They report having their wheelchair or other assistive device taken from them or people withholding medication or refusing to help them when they needed help with essential activities of daily life, such as getting out of bed in the morning.

"That's when I decided to do whatever I could to make a difference."

Even in her daily life, Hughes notices discriminating types of behaviors – violent or otherwise – toward people with disabilities. "My director back in Houston is a woman with a significant physical disability. When I'd go to lunch with her, the waiter would invariably give the check to me even though she made more money than I did."

Asserting their right to be included in whatever affects their lives, people with disabilities have taken up the slogan "Nothing About Us, Without Us." In keeping with that slogan, Hughes is leading The Safety Project, a community-based, participatory research program at UM.

"That means including people who would benefit from the project," she says. "In The Safety Project, people with intellectual disabilities – many of whom refer to themselves as self-advocates – are included in all phases of the research."

Since leaving Houston and returning to her home state of Montana, Hughes has led numerous studies on interpersonal violence against people with a variety of disabilities. She joined UM in 2006 as a senior research scientist at the Rural Institute for Inclusive Communities and is a research professor in UM's Department of Psychology. She is the principal investigator of The Safety Project, a study on the development and evaluation of a violence prevention program for people with intellectual disabilities.

Research strongly suggests that people with disabilities are at greater risk of interpersonal violence than people without disabilities, and in the greater disability community, men and women with intellectual disabilities tend to be at the highest risk for abuse. An intellectual disability is a disability that starts before age 18. It is characterized by significant limitations in intelligence and adaptive behavior, including skills required for understanding the concepts of time, numbers and money. Intellectual disability is common in people with Down syndrome.

"Potential perpetrators may see people with disabilities as 'easy prey' who may not be able to escape or get help easily," Hughes says. "The presence of disability in a person's life increases their vulnerability for violence."

To make a difference, she and her colleagues hope to reduce this violence with The Safety Project.

"Our primary purpose was to create a program that provides safety tools, information about staying safe, understanding the nature of abuse and recognizing abuse when it happens," Hughes says. "Sometimes people in this population experience abusive behaviors so frequently over the course of their lives that it becomes almost normal to them. And it's far from normal. It's a crime."

The National Institute on Disability, Independent Living and Rehabilitation Research funded The Safety Project at UM. The project uses a community-based, participatory research approach to develop an eight-session, safety-awareness group intervention for adults with intellectual disabilities. The group sessions, called Safety Classes, cover a range of safety-related topics that include healthy relationships, as well as information on the nature, types and warning signs of abuse. Participants engage in role playing to learn how to respond to abusive people and situations.

Sometimes people in this population experience abusive behaviors so frequently over the course of their lives that it becomes almost normal to them. And it's far from normal. It's a crime.

"There wasn't anything in the literature that suggested there was a program like this, so it's groundbreaking," Hughes says. "It is exciting and important. It's time to end the silence about violence in the context of disability, particularly for people with intellectual disabilities who face tremendous barriers to accessing safety programs."

She says even if they were to attend a community-based safety program, it's likely that the language used in the presentations would be too complex and the words in the materials would be too difficult to read. So it's important to have a program that is accessible, understandable and, of course, effective for men and women in this community.

In developing The Safety Project, researchers met frequently with a board of nine advisers and three mentors for nearly two years. All of the advisers were people with intellectual disabilities. While Hughes and other researchers use a community-based, participatory research method, The Safety Project pushes it to a new level. Hughes described one of the most valuable aspects of involving the advisers is their assistance in making the curriculum accessible.

"They have taught us how to make the program as understandable as possible for people like them," she says. "They would tell us, 'you have too many words on that slide' or 'instead of the words you could use a picture because we understand pictures really well.' Every word of the eight-session curriculum was vetted by our advisers with intellectual disabilities."

The Safety Project involves self-advocates in every phase of the research – from design and development to implementation and dissemination. On a recent trip to a conference in Washington, D.C., an adviser with Down syndrome joined Hughes as a co-presenter on the project.

"When I go to talk about The Safety Project, I rarely go without a co-presenter from one of our advisory boards composed primarily of people with intellectual disabilities," she says.

In the test round, Safety Classes were conducted at 12 rural and urban centers for independent living around the country, with 170 men and women with intellectual disabilities participating. About 60 percent of the participants stated that they had experienced some type of abuse within their lifetime.

"Sadly, this high prevalence is found in many studies involving people with all types of disabilities," Hughes says.

Upon completion of the eight sessions, about 90 percent of participants said they thought the Safety Class would help them stay safe. Hughes and colleagues found significant changes from pre- to post-tests, including improvements on measures of healthy relationships, safety skills and safety self-efficacy.

The success of the methods used in The Safety Project may well establish a new model for working with the intellectual disability community. With much work still ahead for researchers and advisers alike, Hughes hopes to make The Safety Project widely accessible throughout the country – in communities both urban and rural.

"It's just a very rich experience," Hughes says. "The Safety Project is the most rewarding and enjoyable study that I've conducted over the course of 18 years of this work." •

ACCELERATING MONTANA

New organization offers opportunity to launch businesses to next level

By Alex Strickland

Joe Fanguy, director of Accelerate Montana, speaks during the official launch of UM's economic-development umbrella organization on Jan. 26.

Joe Fanguy is a pusher. Not pushy, mind you – he's from New Orleans and that's just bad manners – but always pushing: a little out of your comfort zone, a little past what you thought was possible, a little toward a path you might not have considered.

But how do you push students with pie-in-the-sky ideas, professors looking to expand ground-breaking research into a commercial ventures and established businesses ranging from multinational corporations to one-man operations? Easy. You pull them in first.

Fanguy, the director of the newly minted Accelerate Montana, oversees a variety of programs ranging from startup incubators to government contract procurement assistance. But no matter whether the business in question is a Silicon Valley-esque startup or a lumberjack looking for more work, the first step is stopping to listen.

"It starts with us trying to build a community," he says. "There's a frontier mindset here that I'm going to help my neighbor, and we're trying to participate in that and overlay it with an entrepreneurial approach."

The mechanisms to do that at UM have always been available, but until recently services from the Office of Technology Transfer to Blackstone LaunchPad were spread across multiple departments across campus. With the creation of Accelerate Montana, those services and others will have a more centralized point of engagement for students, faculty and the community to get information and head toward the specific program best suited for their needs.

Accelerate Montana provides more than an umbrella over campus, however, as it bridges the Clark Fork River to encompass MonTEC, a nonprofit business incubator just across the water from campus. There, in a nondescript office building in the shadow of the new Missoula College building, startups have access to subsidized office space with some of the fastest internet connectivity in the valley. The Montana Code School there also teaches future web developers, and a startup boot camp – known as Accelerate Montana (before the name was usurped by the larger program) – gives budding entrepreneurs a jump start. MonTEC also operates the Mansfield Academy of Global Leadership, which exists within Mansfield Center programming.

On the main campus, Accelerate Montana is located in the new Harold and Priscilla Gilkey Building and encompasses UM's Office of Technology Transfer for faculty looking to take their research to the masses, Blackstone LaunchPad's student-focused entrepreneurship program, the Montana World Trade Center, the Procurement Technical Assistance Center (PTAC), the Small Business Development Center and the University's new executive education venture, called iLEAD.

"Around 750 businesses or entrepreneurs connect with us through the diverse channels annually and have collectively netted nearly $50 million in financing over the past five years," Fanguy says.

MOM-RUN PUBLISHING EMPIRE REACHES BEYOND MISSOULA ROOTS

It's never easy to start a business, much less to keep a steady hand on the reins when the product accelerates into popularity. For Missoula entrepreneurs Elke Govertsen and Dori Gilels, familiarity with the market wasn't necessarily going to help either, since their parenting magazine-cum-modern publishing empire, Mamalode, isn't just published for busy moms – it's run by them.

"Mamalode has grown as our kids have grown," Govertsen says. "Starting a company while the kids were still toddlers was a juggle to say the least. But at the end of the day, our value is that our audience believes in us and sees us as a friend who is right in it with them. They say it takes a village to raise a child, and I would assert the same is true in business."

What started in 2009 as a local Montana magazine is now a national network that has published 25 editions of the magazine, with more than 1,000 contributors and a digital footprint that ranges from website content to podcasts to engaged social media followings. And as Mamalode grew, so too did signs that it was time to move from a virtual office space to a physical one, which led Govertsen and Gilels to MonTEC.

"Three years ago, when we decided to centralize our operations and bring the team together, MonTEC provided the perfect home base – convenient location, affordable rent, office supplies and services, and an opportunity to join a growing community of entrepreneurs," Gilels says. "At MonTEC, we had the opportunity to cultivate a company culture, network with like-minded colleagues and focus on building the business."

Just as 2016 came to a close, Mamalode left the MonTEC building to move into a new space in downtown Missoula.

"We graduated to a new and bigger space of our own – a reflection of where we've been and an illustration of where we're going – thanks, in part, to our time at MonTEC," Gilels says. •

Elke Govertsen and Dori Gilels (right), shown here in their Missoula office, used Mamalode magazine to launch a national business network.

"Everyone from the guy with a gravel truck who wants to work with Patty (Cox) for a Forest Service contract to high-tech stuff through MonTEC."

Those touches also include students and faculty who have used their time at UM to launch successful ventures that range from examining core samples for some of the biggest companies in the world to launching – literally – a Missoula-based drone manufacturing brand.

"For the past five years, we've built a broader suite of business services to provide greater efficiency and enhance impacts in Montana, yes, but we've also built capacity for global projects," Fanguy says. "We've tried to communicate through partnerships, secondary channels and direct outreach, and we feel it's worked."

Accelerate Montana has the built-in advantage of being in Big Sky Country, named the most entrepreneurial state according to the Kauffman Foundation, where open space seems to have the effect of encouraging residents to look beyond the horizon, where others might see fences.

"At the end of the day, it's not super complicated – it's the mindset of the people," Fanguy says. "You've got a kernel and you just keep pushing." •

AIM-ING FOR SUCCESS IN SHALE

Sometimes a business idea is the result of years of dreaming and planning. Other times it's the result of a phone call. When the phone rang and Marc Hendrix and Michael Hofmann picked up, it wasn't just a business idea on the other end but their first client.

The pair was approached by a large oil company bemoaning a lack of available labs for analyzing core samples and soon after they founded AIM GeoAnalytics to fill an obvious need.

"This was 2011, when the shale gold rush was on," says Hendrix (who is a full-time faculty member in UM's geosciences department; Hofmann is a research assistant professor of geology). "Shale is mud rock and historically is not a type that's enjoyed a lot of attention from geologists. It just so happens I studied mud rocks for my Ph.D. and had done some work for industry, and Michael had just come away from five years in a research group at ConocoPhillips."

The pair immediately approached Joe Fanguy through the Office of Technology Transfer, because, as Hendrix says, "neither of us are businessmen, we're trained academics." Fanguy guided them though the ins and outs of basics like contracts and hiring and helped them find a physical space for a lab that would need to handle incoming shipments of core samples from across the globe.

"Originally we rented space at MonTEC, and by the time we left we were occupying one of the bigger spaces in the building," Hendrix says. Now, AIM occupies office space across town, with another geoscience consulting company moving into space next door also owned by the duo. The company's growth hasn't always been easy, but in addition to employing a half-dozen people, UM students are big beneficiaries of AIM's success.

"I've seen more rock in the last five years than I'd seen in the 25 before that," Hendrix says. "I'm able to take full advantage of the information flow at AIM and use that to improve my teaching and position our students so they're more competitive in the hiring market."

Plus, with UM's willingness to help fledgling companies like AIM, Hendrix believes both his company and the University are primed for growth.

"Collaborating with the business community is going to be more and more a critical part of the success of universities across the country," he says. "UM is particularly well-positioned because of our breadth of programs, natural surroundings and the type of folks who are drawn to a place like Missoula. I'm optimistic it's all going to grow as we move forward." •

Michael Hofmann and Marc Hendrix (right), UM geosciences faculty members, pose with drilling core samples housed in their new AIM GeoAnalytics headquarters.

"There is a low mist in the woods —
It is a good day to study lichens."

From the journal of Henry David Thoreau

The powdered sunshine lichen (*Vulpicida pinastri*) displays the vibrant yellows of vulpinic acid.

Photo by Tim Wheeler, a graduate student in John McCutcheon's UM lab, timwheelerphotography.com

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A UM Fire Center drone documents the start of a heat-flux experiment on a controlled burn in Georgia.