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"Vision 2018" (2018). *Vision*. 18.

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# VISION

UNIVERSITY OF MONTANA

Research, Innovation & Imagination 2018



UM WATER WARRIORS  
DEFEND AGAINST  
INVADING MUSSELS

BERKELEY PIT CURE | UM'S GLOBE THEATRE | PROTECTING ELEPHANTS



**VISION** is published annually by the University of Montana Office of the Vice President for Research and Creative Scholarship and University Relations. It is printed by UM Printing & Graphic Services.

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**On the Cover:**  
The crew of the Jessie B., the  
flagship research vessel of UM's  
Flathead Lake Biological Station,  
works to detect signs of invasive  
mussels in the largest freshwater  
lake in the western United States.  
See page 10 for more.

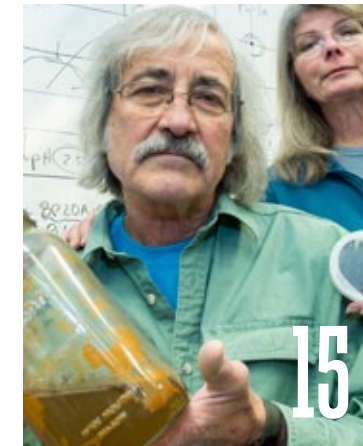
28

Switchback Records, a student-run,  
hands-on record label in the UM  
College of Business, offered the  
band Rotgut Whines a chance to  
record Elvis songs.

Photo by Jeffrey Neubauer/  
Neubauer Media



# CONTENTS



## INNER VISION

**4 / MESSAGE FROM THE VICE PRESIDENT**  
The University's research enterprise continues to exhibit  
amazing growth with \$89.3 million in new funding.

**5-9 / QUICK LOOKS**  
University science highlights from the past year

**10-14 / THE WATER WARRIORS**  
World-class scientists at UM's Flathead Lake Biological  
Station defend against harmful invasive mussels.

**15-17 / LIFE FROM THE PIT**  
A toxic Superfund site may offer the key to a  
new antibiotic.

**18-21 / BUILDING THE GLOBE AT UM**  
Shakespeare's classic theater stage rises on campus.

**22-23 / STUDENT SPOTLIGHT**  
Graduate and undergraduate students play a vibrant role  
in UM research and scholarship.

**24-27 / TEA FOR ELEPHANTS**  
UM effort uses an inspired business idea to protect an  
endangered species.

**28-29 / MAKING MUSIC**  
Student-run Switchback record label offers  
industry training.

**30-31 / MAKING MONTANA MORE JUST**  
The Montana Justice Initiative mobilizes campus to  
examine and improve Montana's criminal justice system.

**32-34 / EMPOWERED PARTNERSHIPS**  
UM program enhances impact using a tribal Maker Truck  
and new community location.



## 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 big news is that the University has a new president, Seth Bodnar, who started in January. He graduated first in his class from West Point, received both the Rhodes and Truman scholarships, and earned two master's degrees from the University of Oxford. His wife, Chelsea Elander, is a fifth-generation Montanan, pediatrician, fellow Rhodes Scholar and graduate of Oxford and Harvard Medical School. Chelsea and Seth have three children.

The research enterprise at the University continues to show amazing growth. UM brought in \$89.3 million in new funding during the past fiscal year, which supports our research, entrepreneurship and statewide outreach missions. University researchers also set a record for research expenditures at \$88.2 million – a 12 percent increase from the previous year's \$78.5 million record total. The new expenditure total is 50 percent higher than the 2014 fiscal year amount of \$58.3 million. The productivity of our faculty is on par with elite institutions anywhere.

These metrics indicate UM continues on a path to become one of the nation's top-tier research universities – Carnegie Research 1. That classification also requires an increase in the number of doctorates produced. The fall semester graduate and professional student enrollment is up 10 percent over last year, and the largest graduate school in the state of Montana now houses 2,326 students – also a record for the University.

UM continues gaining national and international recognition in the arts, humanities, social sciences and business. The University's Montana Repertory Theatre celebrated its 50th anniversary in 2017 with a series of performances of "To Kill a Mockingbird" in China in front of large audiences to rave reviews. The article in this issue covering the School of Theatre and Dance's presentation of Shakespeare's "As You Like It" showcases a new project for the department: the construction of a set that mimics



London's old Globe Theatre. Another Vision story on the student-run Switchback record label focuses on student entrepreneurial efforts in UM's Entertainment Management program in our newly renamed College of Business.

Research and creative scholarship at UM are robust and growing. 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

## UM Sets Research Funding Record for Third Straight Year

Research continues to surge at a record pace at the University of Montana, with the institution setting a record for external funding for the third year in a row.

UM brought in nearly \$89.3 million in new funding during the past fiscal year to support homegrown Montana research, entrepreneurship and statewide outreach. This exceeds the previous year's record of \$86 million.

University researchers also set a record for expenditures from previously awarded grants and contracts in the amount of \$88 million – a 12 percent increase from the previous year's \$78.5 million record total. The new expenditure total is 50 percent higher than the 2014 fiscal year amount of \$58.3 million.

The number of proposals submitted by faculty for research support also increased, from 684 proposals last year to 716 in 2017.

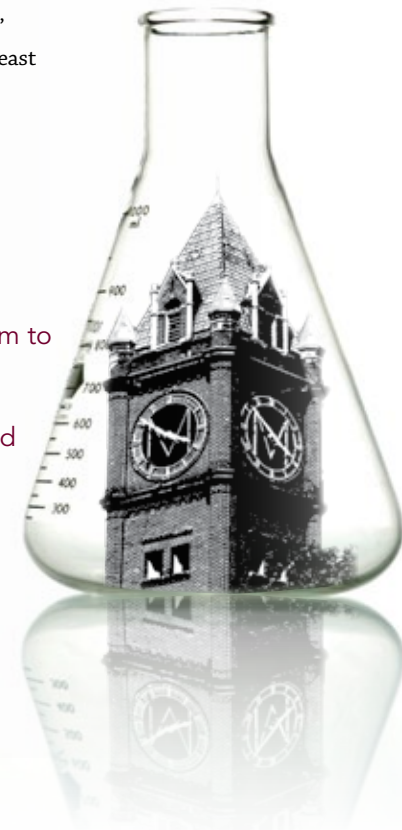
**Scott Whittenburg**, UM vice president for research and creative scholarship, says these benchmarks all indicate that research at UM will continue to grow.

"Our upward trajectory indicates that the University of Montana continues to recruit and retain the best researchers from across the country and

internationally," he says. "The productivity of our faculty is on par with elite institutions anywhere."

In fiscal year 2017, 15 faculty members had at least \$1 million in research expenditures. The top five earners were:

- **Reed Humphrey**, College of Health Professions and Biomedical Sciences, **\$6.9 million.**
- **Vida Wilkinson**, Missoula College, **\$5.4 million.**
- **Ragan Callaway**, Experimental Program to Stimulate Competitive Research, **\$4.2 million.**
- **F. Richard Hauer**, Center for Integrated Research on the Environment, **\$4.2 million.**
- **Donald Loranger**, Defense Critical Language and Culture Program, **\$3.2 million.**



## Two Pillars of the University Research Community Retire



Running



Stanley

Two long-standing and lauded scientists recently retired from the University. UM Regents Professor of Ecology **Steve Running** and geosciences Professor **George Stanley** made great contributions to their fields and to campus.

Running, who first joined UM in 1979, is a world-renowned expert in climate change. He and his lab, which housed the Numerical Terradynamic Simulation Group, wrote software for environmental satellites in NASA's Earth Observing System. His work on climate science shared a Nobel Peace Prize in 2007. In fact, it was Running's early NASA grants that necessitated bringing both the internet and email to UM, and he received UM's first official email address. He also launched the nation's

first academic program in climate change at UM – a program that's experienced 50 percent growth since 2009.

Stanley is a paleontologist lured to UM from the Smithsonian Institution in 1982. Here in Montana, he founded the UM Paleontology Center, which houses the oldest and most diverse paleontology research collection in the state. During his tenure at UM, he and his students made major fossil discoveries. As an international expert in fossil coral reefs and mass extinction, Stanley has traveled the world in pursuit of his research. He has been honored as a UM Distinguished Scholar, was the first recipient of the UM Dennison Faculty Award and is a Fellow of the American Association for the Advancement of Science.





C.M. Russell's "When the Land Belonged to God" (Courtesy of the Montana Historical Society)

## MontanaPBS Produces Definitive C.M. Russell Documentary

MontanaPBS recently unveiled a new documentary about Montana cowboy artist Charles M. Russell (1864–1926). The three-hour program was screened in seven locations across Montana in September and October and premiered on public television statewide in November.

"C.M. Russell and the American West" is the first major film exploration of Russell's life, art, writings and enduring legacy. The film tells Russell's story through interviews with scholars, biographers and experts, along with archival photographs, film,

and actor-voiced writings and recollections of Russell by his wife, Nancy, friends and fellow cowboys.

The documentary reintroduces Russell to a 21st-century audience and affirms his standing as a major American artist. The film suggests that Montanans' lasting affection for Russell comes from his ability to show Montanans what they remembered, or wanted to remember, about the land and the history they shared. In the documentary Russell biographer John Taliaferro says Russell was successful and revered because he was genuine.

"Charlie Russell lamented the loss of a West that has passed," Taliaferro says, "but then went on to convince us and convince himself



Charles M. Russell as a young man (Montana Historical Society)

that that West, that mythic West, had been quite real. And the way he was able to convince us really was because he was so authentic himself."

Four well-known film and television actors lent their voice talent to the project: Academy Award-winner and UM alumnus J.K. Simmons is the narrator; Montana resident Bill Pullman ("Sinners," "Independence Day")

voices the writings and reminiscences of Russell; Kathy Baker ("The Right Stuff," "Picket Fences") is Nancy Cooper Russell; and popular supporting actor Dylan Baker ("The Good Wife," "The Americans," "Spiderman 2" and "Spiderman 3") is the voice of Russell's friend and protégé Joe De Yong.

**Gus Chambers**, the UM-based co-producer and director of the documentary, searched photograph and film archives, filmed interviews, directed re-creations, captured Montana landscapes evocative of Russell's art and edited the film.

Co-producer and script writer **Paul Zalis** spent four years assembling a coalition of art and film historians, Russell biographers, curators, art museum personnel, collectors,

cowboys and cowgirls, and ardent fans to tell the story.

Brian Dippie, a history professor at the University of Victoria in British Columbia and a noted Russell scholar, says Russell had an innate ability to turn his own nostalgia into a national nostalgia.

"It was an idea about loss, nostalgia, sentiment and a glowing vision of what it would have been like to be there when the world was young," Dippie says. "Russell had the rare ability to project his realization of his youthful dreams, his fantasies, his realities, and make them the world's."

Key to Russell's success was his wife, Nancy, who successfully promoted his art to well-heeled patrons across the country, making him the highest-paid artist in America at the time of his death in 1926. Russell wrote of his wife: "Without her, I would probably have never attempted to soar or reach any height, further than to make a few pictures for my friends and old acquaintances in the West. She is the business end, and I am the creative. She lives for tomorrow, and I live for yesterday."

Several partner institutions and private art collectors provided access to the best, and sometimes obscure, pieces of Russell's art. Two Montana museums, the C.M. Russell Museum in Great Falls and the Montana Historical Society, were central to the film's success.

MontanaPBS is a statewide collaborative public television service of UM and Montana State University.

## Center Searches Military Bases for Potential Endangered Species

The Center for Integrated Research on the Environment (CIRE) at UM is surveying the habitat of four potentially federally listed species on the Travis and Beale Air Force bases in California.

CIRE researchers are studying the western spadefoot toad, foothill yellow-legged frog, western pond turtle and tricolored blackbird on the Travis and Beale Air Force bases. Through the project, the team is determining the geographic locations of the species and surveying habitat characteristics to help the military better understand what species and habitats are present on its installations.

"This information will assist the base in the management and conservation of listed threatened and endangered species," says **Penn Craig**, a Travis AFB natural and cultural resources manager.

The CIRE team is conducting visual surveys for the species, installing song meters at several locations to detect toad and bird vocalizations, and collecting water samples for environmental DNA (eDNA) sampling – a tool used to monitor for the genetic presence of an aquatic species – for the spadefoot toad and western pond turtle.

Once data are collected, the team conducts eDNA analysis in a UM genetics lab. They also plan to pioneer the development of a DNA primer to detect spadefoot toad DNA in water samples.

"Within the last 10 years, eDNA as a tool has just skyrocketed," says **Winsor Lowe**, CIRE project principal investigator and UM professor of aquatic ecology. "There is a lot of demand for eDNA sampling in the management agencies."

CIRE has had a busy year. The center also is studying the effects of aircraft noise on sage grouse at an Idaho air base, and it has taken a lead role in restoring a gun from the USS Maine, a historic warship that sank in 1898.



CIRE ecologist Alisa Wade samples water at an air base.

## UM Earns Worldwide Ranking for Research

The research coming out of UM is among the best in the nation and world, according to recent rankings by the National Taiwan University.

Of the more than 4,000 research institutions worldwide, NTU ranks the top 800 universities based on their production of scientific papers and the impact of those papers.

UM is highly ranked in the field of agriculture, which includes agricultural sciences, environment/ecology, and plant and animal science. UM also ranks highly in the subject areas of environment/ecology, geosciences, and plant and animal science.

"The NTU ranking is another indicator of the world class faculty at the University of Montana," says **Scott Whittenburg**, UM vice president of research and creative scholarship. "Faculty publications, the citation of those articles by other researchers and the high impact of those journals are primary indicators of quality and demonstrate that our

faculty and students are conducting research on par with leading institutions around the world."

NTU ranking is considered a reliable source for universities devoted to scientific research. It is entirely based on scientific papers, reflecting scientific performance from three perspectives: research productivity – the number of faculty publishing research in journals; research impact – the number of citations those publications receive from other researchers; and research excellence.

The 2017 NTU rankings for UM follow:

- **Field of agriculture, world ranking: 123, U.S. ranking: 45**
- **Subject of environment/ecology, world ranking: 73, U.S. ranking: 31**
- **Subject of geosciences, world ranking: 161, U.S. ranking: 56**
- **Subject of plant and animal science, world ranking: 165, U.S. ranking: 47**



Artist unknown, "Helmet Painted with Flags and Battle Scenes," courtesy of Hayes Otoupalik

## Major Exhibit Explores Montana's Role in World War I

UM's Montana Museum of Art & Culture presented a powerful exhibition this past fall commemorating America's involvement in World War I.

"Over There! Montanans in the Great War," taking place 100 years after the U.S. entered the so-called "Great War," included more than 200 artifacts and works of art related to the lives of four Montanans who experienced the war's victories and degradations firsthand. In addition, the exhibition explored the concept of how "the Enemy" was portrayed during the war.

The four individuals from or closely tied to Montana featured in the exhibition included Glasgow-born William Belzer, celebrated aviator and one of America's first flying aces; Great Falls widow Josephine Hale, who served as a Red Cross nurse and became a notable painter in France; Sidney F. Smith, "doughboy" and hero of the infamous "Lost Battalion"; and James Watson Gerard, U.S. ambassador to Berlin until America's declaration of war, who was married to Mary Daly of the famous mining family.

The UM museum's Permanent Collection was featured in this exhibition through objects related to Hale, including her nurse's uniform, photographs and works of art.

"By focusing on four Montanans who played major roles in the conflict, the exhibit reminds us that we are never isolated from important international events," says **Harry Fritz**, UM history professor emeritus.

The exhibition was complemented by eight additional lectures and films, including an opening reception by **H. Rafael Chacón**, the UM professor of art history and criticism who spent six years planning the project. In addition, nearly 50 tours for UM students and the general public took place.



A University of Montana-led team prepares a balloon launch in Wyoming before the Aug. 21 solar eclipse.



## Montana Research Group Harvests Stellar Eclipse Data

When the nation paused Aug. 21 to observe the spectacle of a total solar eclipse turning day to night across the middle of the country, research teams from Montana were busy gathering some of the best data resulting from the event.

Based at UM, **Jennifer Fowler** is assistant director of the Montana Space Grant Consortium, a NASA-funded organization intended to boost aerospace research and education. Fowler says her organization took three teams to the “path of totality” in Wyoming, where they launched 24 research balloons to study the eclipse.

“We gathered the highest spatial and temporal resolution of atmospheric data at our site compared to other research teams

in the path of totality,” Fowler says. “We did some great science, and there may be breakthroughs and papers resulting from that data we gathered that day. Stay tuned.”

She says their 40-person research team divided into three groups to study the eclipse in north, central and south Wyoming. The groups were located in or near the towns of Lusk, Fort Laramie and Veteran.

“These locations were chosen to give the proper spatial resolution for our data,” Fowler says. “The goal was to be as close to the north and south edges of the eclipse path, and the central site was as close to the central line as possible.”

The groups arrived at their respective sites Aug. 18 to begin site surveys and system tests. Balloon data collecting was done Aug. 20-22.

The work included 19 radiosonde balloon launches. Also used by the National Weather Service, radiosondes are instruments flown to gather temperature, relative humidity and GPS measurements. Using GPS, the sensors

infer pressure, wind speed and wind direction.

“These measurements will be used for a wide variety of projects, both current and future,” Fowler says. “The temporal resolution of our launches is unmatched for this eclipse.”

She says they started launching balloons from the central site in six-hour increments 24 hours before the eclipse. Then all sites launched four balloons from “first contact” of the eclipse to shortly after the moment of totality on Aug. 21. The final launch was on Aug. 22 to complete the baseline dataset.

Besides 19 radiosonde launches, there were five launches of larger balloons. Those balloons went up just prior to totality with payloads that included cameras, ultraviolet sensors, temperature sensors and tracking equipment.

“This was one of the most rewarding experiences I have had, because we got to see many different pieces and years of problem-solving come together flawlessly to make a novel system work,” says **Frederick Bunt**, a UM graduate student.

## Antarctic Sea Spiders Use Guts to Move Oxygen

To keep blood and oxygen flowing throughout their bodies, most animals depend on a beating heart. But UM researchers reported this past summer that sea spiders use a strange alternative: They move blood and oxygen throughout most of their bodies by pumping their guts.

The sea spiders have an unusual gut in the first place, the researchers say.

“Unlike us, with our centrally located guts that are all confined to a single body cavity, the guts of sea spiders branch multiple times and sections of gut tube go down to the end of every leg,” says UM Associate Professor **Arthur Woods**. “In effect, sea spiders’ guts

are ‘space-filling’ and ubiquitous in their bodies in the same way that our circulatory systems are space-filling and ubiquitous.”



UM researcher Art Woods holds an Antarctic sea spider in his UM lab.

So, how do they use that branching system to move fluids? The answer is gut peristalsis. In fact, the human gut also uses peristalsis – waves of involuntary constriction and relaxation of muscles – to mix gut contents and move them along. Sea spiders, which take in oxygen directly through their cuticles, show peristaltic waves that are much more vigorous than needed for digestion.

Woods’ team made that discovery after an Antarctic mission. He realized the sea spiders’ hearts beat weakly. Their hearts didn’t move blood beyond the spiders’ central portion. In contrast, he noticed, their guts showed very strong waves of peristaltic contractions.



Biologist Doug Emlen in a scene from “Nature’s Wildest Weapons: Horns, Tusks and Antlers.” (Photo by Stuart Dunn)

## UM Animal Weaponry Research Featured on BBC, ‘NOVA’

The BBC and ‘NOVA’ teamed up this past year to feature the animal-weaponry research of **Doug Emlen**, a professor in UM’s Division of Biological Science. Both organizations produced hourlong documentaries using much of the same footage.

The British BBC version aired in April and was titled “Nature’s Wildest Weapons: Horns, Tusks and Antlers.” The “NOVA” version on PBS premiered in November with an episode called “Extreme Animal Weapons.” Both programs were inspired by Emlen’s 2014 book, “Animal Weapons: The Evolution of Battle.”

Emlen has spent decades investigating how weapon-bearing species developed extreme ways to gouge and gore one another using their natural weapons. The BBC documentary explores how animal arms races may relate to their human equivalents – all the way up to nuclear warheads. Featured subjects in the film include Darwin’s and Rhinoceros beetles, which have pitchfork-like horns that measure one-third the length of their bodies; American elk, who deplete their skeletons to grow enormous antlers; and the U.S. Air Force’s development of the long-range Minuteman III nuclear missile, Earth’s most lethal weapon to date.

Sporting a Griz hat, Emlen took viewers to various locations in Montana and Washington, including a ranch with elk overlooking Flathead Lake and a building in Three Forks crammed with 17,000 shed antlers called Jim’s Horn House.

## GLIMPSE

UM was awarded a two-year \$300,000 grant from the National Science Foundation to launch a pilot project to enhance American Indian participation in science, technology, engineering and math (STEM) fields. **Aaron Thomas**, director of UM’s Native American Research Laboratory, says the funding will establish the American Indian Traditional Science Experience on the Flathead Indian Reservation. A separate UM research team also was awarded a \$1.8 million grant to promote professional success for Native American faculty in the STEM fields. The National Science Foundation awarded UM and partner institutions the collaborative, four-year research grant for the Willow Alliances for Graduate Education and the Professoriate. Salish Kootenai College in Pablo and Sitting Bull College in Fort Yates, North Dakota, as well as UM, form the alliance.

Research by UM postdoctoral fellow **Shane Campbell-Staton** appeared this past year in the journal *Science*. Campbell-Staton, a National Science Foundation Postdoctoral Fellow, was the lead author of a report titled “Winter storms drive rapid phenotypic, regulatory and genomic shifts in the green anole lizard.” His research focused on the effects of natural selection in green anole lizards after an extreme cold weather event in the southeastern United States during the winter of 2013-14.

The UM Paleontology Center has partnered with internet producer Hank Green to launch “EONS,” a new weekly YouTube series that explores the billion-years-plus history of life on Earth. Green serves as host of “EONS” alongside Paleontology Center Collections Manager **Kallie Moore** and science writer Blake de Pastino. The series premiered June 26. It can be viewed at <https://www.youtube.com/eons>.

A recent study authored by UM’s Bureau of Business and Economic Research and the U.S. Forest Service Rocky Mountain Research Station concludes that increased costs and lower recovery of valuable grades of lumber combine to make beetle-killed trees remain unharvested. It found if a stand is determined to be economically and environmentally suitable for salvage harvesting, there is substantial financial risk in delaying harvesting.

UM chemistry Assistant Professor **Lu Hu** received a \$406,000 NSF grant for a three-year project, which aims to study the chemical composition and evolution of western wildfire smoke. The study employs a C-130 research aircraft that flies straight into wildfire smoke.

“Methods in Stream Ecology” was nominated for a prestigious PROSE Award, an annual accolade that recognizes the best in professional and scholarly publishing by the Association of American Publishers’ Professional and Scholarly Publishing Division. The two-volume book, co-edited by UM Professor **Ric Hauer** and University of Notre Dame Professor Gary Lamberti, is the primary source for understanding and managing river and stream ecosystems. Hauer says the book is the most widely used stream ecology book worldwide and is a primary driver of high-level research at a variety of levels.

Understanding how wild animals and plants survive in changing environments is the focus of a new collaboration between researchers at UM and the University of Nebraska-Lincoln. The network of researchers that are part of UNVEIL – Using Natural Variation to Educate, Innovate and Lead – aims to advance understanding of how organisms cope with environmental challenges and how complex traits arise from variation in genomes. Network members will collaborate on three core research projects.

The Consul General of Japan, Yoichiro Yamada, recently presented UM Professor Emerita **Judith Rabinovitch** with the Foreign Minister’s Commendation for 2017 in Helena. Rabinovitch was recognized for her contributions promoting Japanese studies research in the United States. She has devoted herself to promoting Japanese language and studies, notably by serving as a member of the editorial advisory board for *Japan Review*.

Researchers in the UM geosciences department received a \$750,000 NASA EPSCoR grant to develop and apply remote sensing technologies to study hydrology on Montana’s agricultural lands. The research will provide insight into the state agricultural system’s resiliency to drought while studying the impact of agricultural activity on the hydrologic cycle, water security and other users. •



# THE WATER WARRIORS

World-class scientists at UM's Flathead Lake Biological Station defend against harmful invasive mussels

By DILLON TABISH

Call it good timing.

Jim Elser arrived at the shores of Yellow Bay in the spring of 2016 as the new director of the Flathead Lake Biological Station, the University of Montana's storied and world-renowned research facility.

Elser brought with him a lengthy resume as a distinguished scientist and one of the world's foremost experts in freshwater ecology. He also came with a colleague: Cody Youngbull, a physicist and entrepreneur with a Ph.D. in condensed matter physics who was developing state-of-the-art robotic sensor technology that could be used in water environments.

A few months after their arrival, the first detection of destructive aquatic invasive mussels occurred in Montana.

The discovery – first in Tiber Reservoir in north-central Montana and then in Canyon Ferry Reservoir near Helena – prompted a feverish reaction as Montanans began coming to terms with the potential for a dire scenario in one of the last places without infested waters.

The minuscule mussels, which cling to boats and other watercraft, can colonize

rapidly and threaten to unleash ecological and economic consequences in Montana's bodies of water. Many other lakes across the U.S., including the Great Lakes and Lake Mead, have fallen victim to mussel infestation, which leads to cascading effects throughout the ecosystem, including deleterious impacts to the food web and water clarity. Most noticeably, mussels promote the growth and spread of deadly algae blooms and crash fish populations.

Once zebra and quagga mussels become established in a water body, they are nearly impossible to eradicate. Luckily, they haven't yet been found in Flathead Lake or its tributaries.

In the wake of the Tiber Reservoir discovery, state agencies scrambled to set up protocols and procedures to combat the spread of these invading mussels while also trying to figure out how many other areas across Montana were affected.

That's when Elser and his team of scientists rose to the forefront of Montana's mussel defense.

The Flathead Lake Biological Station, one of the oldest and most respected field stations in

the country, already was well equipped to address the new invasive threat, boasting some of the best scientific minds when it comes to tracking and identifying invasive species and studying landscape connectivity.

But with Elser and Youngbull now in the mix, this corner of Montana is now home to a Dream Team of scientists and innovators at the most opportune and pivotal time.

"It is sort of a strange congruence of events," Elser says. "I knew about Cody and was interacting with him and knew he was developing this (sensor) technology. It's not entirely coincidental but the fact that his instrument arrives in Montana the same year that mussel detection first occurs is sort of an interesting coincidence. It was very timely."



Jim Elser, Flathead Lake Biological Station director, holds a display of a pipe coated with invasive mussels.



Colton Kyro, a UM senior in ecosystem science and restoration (center), prepares to take a water sample aboard the Flathead Lake Bio Station's Jessie B. research vessel. His co-workers are eDNA coordinator Dulaney Miller (left) and research specialist Phil Matson.



To properly understand the Flathead Lake Biological Station's leading – and comprehensive – role in helping detect and prevent the spread of invasive mussels across Montana, it requires an in-depth look at all of the work being conducted at the Yellow Bay facility.

"I'm sure a lot of people who drive by the sign for (FLBS) at Yellow Bay have no idea that the groundbreaking research done there has both been acclaimed around the world and been instrumental in protecting clean water in the lake and watershed," says Robin Steinkraus, executive director of the Flathead Lakers, a nonprofit organization devoted to protecting the Flathead watershed.

Start with Shawn Devlin and Phil Matson, equally esteemed FLBS faculty members and scientists who are experts at sampling for what's called environmental DNA, or eDNA, which includes bits and pieces of genes that can be traced in the environment, including in water.

Using a research vessel on Flathead Lake, Devlin and Matson can drop fine-mesh nets underwater and collect everything from feces to scales and even microscopic

cells from all types of aquatic species. Once the nets gather samples from across a body of water, the scientists take the particulates and insert them into a machine at the biological station. This machine – a revolutionary tool that is at the forefront of mussel defense strategies – has mapped out invasive mussel DNA, and this provides scientists a chance at identifying matches with particulates collected in the lake.

The machine can detect an organism at any life stage. In the case of mussels, this complex procedure helps scientists identify locations where potential colonies could exist and halt their spread before spawning.

The extent of the team's resources even includes scuba equipment and divers, all helping to detect potential threats as soon as possible.

"It's like cancer. The earlier you detect it, the more likely you are to remove it and prevent it from spreading," says Gordon Luikart, an FLBS professor of conservation ecology and genetics. "In the water, with invasive species, we want early detection so we can stop their spread, eradicate them, slow or suppress the spread as early as possible."

If there's anyone in the world who understands the power of eDNA research and its potential game-changing ability in slowing the spread of invasive species, it's Luikart.

Luikart first discovered the potential harm of invasive species as a student earning his doctorate at UM in the late 1990s. His lab, under the direction of Fred Allendorf, was involved in one of the first research projects in the nation that involved collecting DNA out of the water.

"I knew about the tool and the exciting novelty of being able to gain info without even seeing organisms in water but you can detect their presence," he says.

He brought his expertise to the FLBS nearly a decade ago and continued his work studying all the ways that DNA identification could help solve significant questions on the landscape or riverscape, such as the status of endangered fish and wildlife populations.

Luikart's pioneering DNA-based research to understand the ecology and conservation of native fish and wildlife species has earned him uncommon praise and placed him in some of the most respected publications and journals in his field. He was listed as one of the "highly cited researchers" in the 2015 and 2016 editions of "The World's Most Influential Scientific Minds," an honor that highlights researchers who have produced work that is most frequently acknowledged by peers. Highly cited papers rank in the top 1 percent by citations for their field and year of publication.

"He's a tenacious expert," Elser says of Luikart. "He's very influential in his field, and he's done a lot of important work on trout fisheries and endangered species."

As Elser describes it, Luikart's eDNA detection system is one of the most important tools in the fight against invasive mussels.

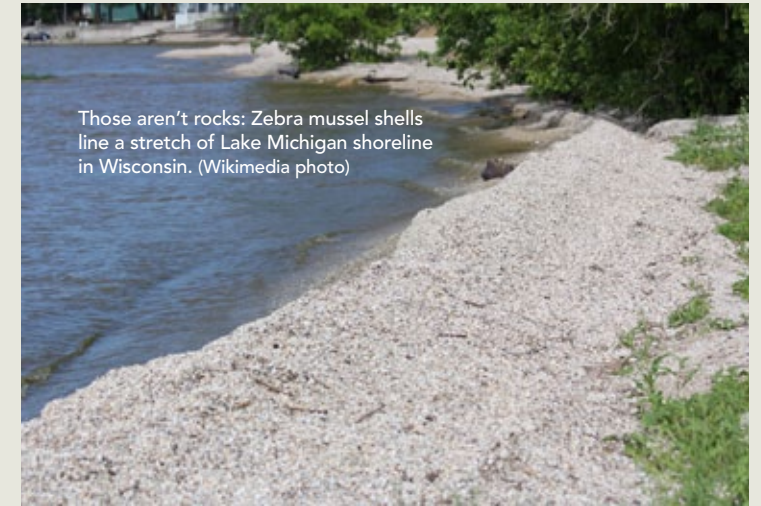
"We don't think there's any other way to do early detection that's practical," Elser says. "It's the only hope."

Yet a significant challenge still remains with underwater detection, and that's where Youngbull's emergence is equally fateful and potentially revolutionary in its own right.

"The biggest challenge is collecting and

## WHAT ARE INVASIVE MUSSELS?

Zebra mussels originated in the Black and Caspian sea drainages between Europe and Asia. The small shelled creatures were first detected in the U.S. in the mid-1980s after ships from Europe incidentally transferred the species in ballast water into the Hudson River in New York. Quagga mussels came from Ukraine and first invaded the U.S. in 1988, when they were discovered in Lake St. Clair between Ontario and Michigan. By 2014, the mussels had infested rivers and lakes in 29 states, primarily by clinging to recreational boats and traveling through connected river systems.



Those aren't rocks: Zebra mussel shells line a stretch of Lake Michigan shoreline in Wisconsin. (Wikimedia photo)

### Reproductive Potential

Mussels can reproduce all year but most often spawn in summer if it's cold in winter, like in Montana. In a five-year lifetime, a single quagga or zebra mussel will produce about 5 million eggs – 100,000 of which reach adulthood.

### How Do They Spread?

Adult mussels attach to recreational boats and equipment, such as anchors and bait buckets, and cling to new subsurfaces, such as docks, rocks and aquatic objects before creating a colony. Boats that are moored or held in a slip are much more likely to harbor zebra and quagga mussels than day boats. Larvae flow downstream and also can be transported in water carried by recreational boats, trailers and other equipment. Zebra mussel larvae can be carried in boat bilge water, live wells, bait buckets and engine cooling water systems even if the boat has been in infested water for only a short time.

### Threats

As filter feeders, mussels remove food and nutrients from the water column very efficiently, leaving little or nothing for native aquatic species, including fish. They can devastate native species by stripping the food web of plankton, which has a cascading effect throughout the ecosystem. Lack of food has caused populations of salmon, whitefish and other species to plummet.

Mussels quickly clog pipes, ruin boat motors and damage aquatic recreational equipment. They also cover boat docks and rocky beaches; their razor-sharp shells cover entire shorelines, creating hazardous conditions for swimmers, boaters, beachgoers and other users.

Mussels are having devastating economic effects on municipal and residential drinking water delivery systems, power plant intakes and industrial facilities that use raw surface water across the U.S. The U.S. Fish and Wildlife Service estimates that if mussels invade the Columbia River, they could cost hydroelectric facilities alone up to \$250 million to \$300 million annually. This does not include costs associated with environmental damages or increased operating expenses to hatcheries and water diversions.

According to research conducted in 2014 by UM, Flathead Lake's pristine identity had an estimated \$6 billion to \$8 billion impact on shoreline property values and is worth roughly \$1.6 billion in "nature-based tourism" in Flathead and Lake counties. •



A plankton tow net sample taken from Montana's Flathead Lake



processing lots of samples and being able to get the numbers and frequency you need to have a high probability of detection,” Luikart says.

In other words, to collect the eDNA for analysis, scientists still need to conduct old-fashioned blue-collar work by dragging nets across the lake. It requires a lot of time-consuming work and a period of waiting until results are analyzed in a lab.

Enter Youngbull.

He is developing a sensor device that can detect past and present signs of life in the depth of the lake, as well as study eDNA in the water. Youngbull has been developing this novel technology for the past decade and was putting the finishing touches on the newest prototypes in fall 2017. These sensor devices can be rigged to a buoy or other platform and collect samples from the water. The devices break down the samples into thousands of microscopic droplets that contain DNA information that can be shared on a network in real time.

In other words, no need to float around the lake with nets anymore and wait for lengthy analysis.

“The whole field of eDNA is simply exploding. That time is coming, and this instrument will play a key role in that,” Youngbull says.

This technology, when it’s fully rolled out, will revolutionize the defense against invasive mussels. It also will lead to an array of other innovations, all based at the Flathead Lake Biological Station. Station members are hoping to build a space that will be solely dedicated to the sensor technology and welcome all types of researchers, students and entrepreneurs who hope to create innovative sensor technology. Right now the equipment is located in space that isn’t optimal.

“We want to bring engineering students together with ecology students and teach the principles of sensor design and manufacturing with ecology,” Elser says.

Youngbull and his team also could contract out their work to private companies seeking to develop their own sensor technology, creating a new revenue stream for the biological station, which is always seeking funding mechanisms that can keep the facility at the forefront of discovery and innovation.

All of this is exciting, but the fact remains that Montana is under siege, and the team of scientists at the biological station is well aware of the looming threat.

If mussels were detected in a lake like Flathead, it would not necessarily spell disaster, but it would require an immediate and comprehensive response. And that’s where and when the FLBS team would prove itself priceless.

“If we detect mussels early, eradication is possible,” Luikart said. “For example, it’s possible they would be attached only on a boat or on a floating dock that can be removed from the water and decontaminated.”

There are some chemical treatments that can be used to eliminate small mussel colonies. There’s also the onerous task of physically removing mussels and de-watering areas where small colonies have established. Also, small populations can be susceptible to simple extinction due to water and weather conditions. Montana’s state and tribal agencies are responsible for responding to detections and eradicating any populations, but the FLBS is ready to help at a moment’s notice.

Luikart says the station could assist with an infestation using its scuba divers, boats, equipment and detection technologies to pinpoint mussel locations. FLBS also could provide underwater videos to monitor and localize mussel colonists.

Funding remains a significant challenge statewide as Montana tries to mount its best mussel defense and convince residents it is worth taking the threat seriously. Many experts say the cost of prevention is wholly minor compared to the future impacts from mussel infestation, which can range in the tens of millions of dollars annually, in the Flathead area alone.

There is urgency, but there is hope, thanks to the passionate scientists living

and working in Yellow Bay.

“With mussels, it is depressing. A lot of people think we have an inevitably gloomy view. They may get here eventually, but what does ‘eventually’ mean? Thirty years? Well, that’s worth fighting for,” Elser says.

As Elser knows, preventing every single minuscule mussel from entering Montana’s waters is essentially impossible. It’s a challenging effort as check stations across the state try to inspect each and every boat. In 2016, the check stations conducted 37,000 inspections and turned up five boats contaminated with zebra or quagga mussels.

Mother Nature has a way of defending itself, but assisting her in every way possible definitely helps, Elser says.

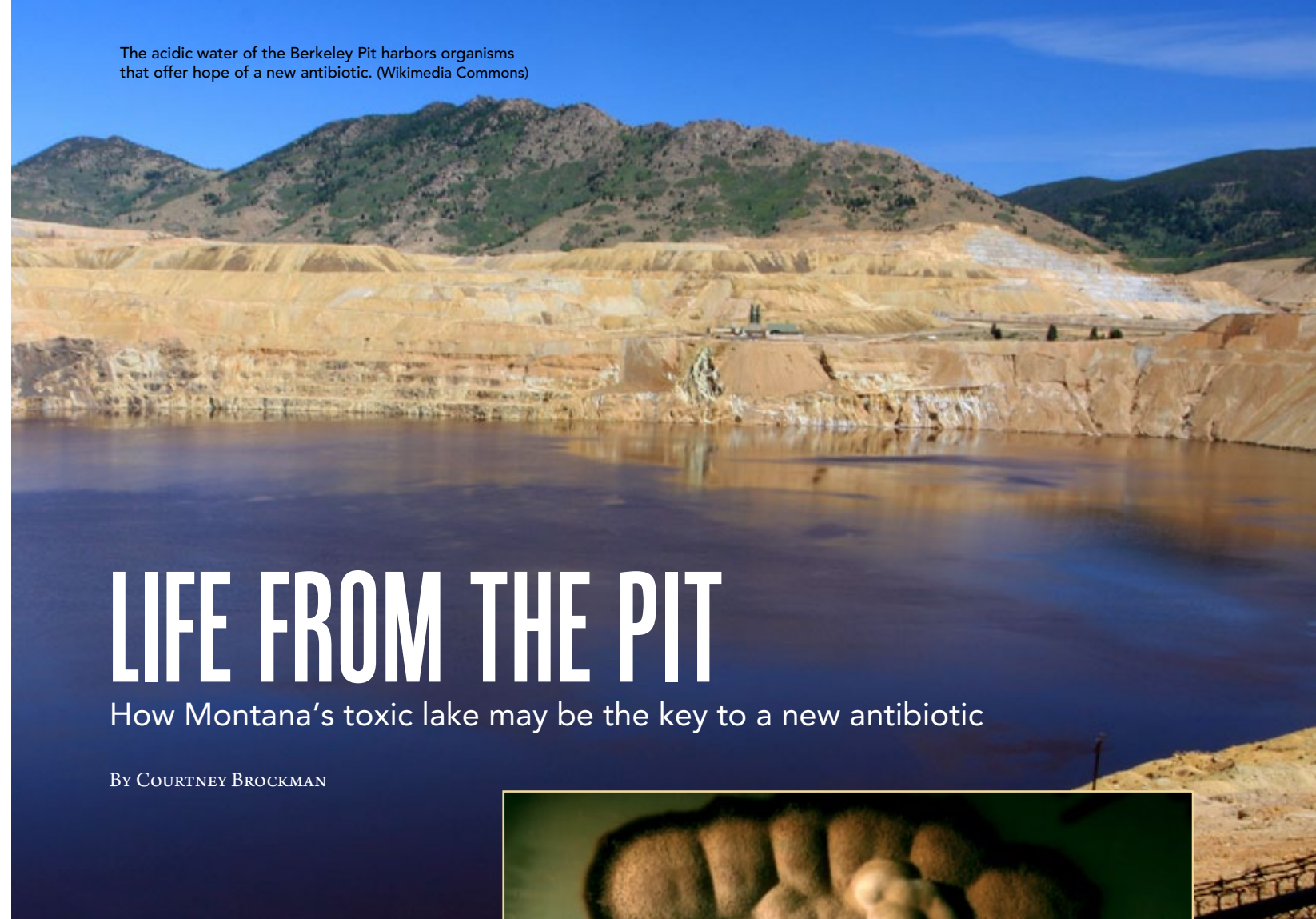


Researcher Cody Youngbull has developed new technology to detect invasive mussel DNA in bodies of water. (Photo by Zane Lindstrom)

“I’m worried about mussels,” he says. “I’m concerned about them. It occupies a lot of my time and thoughts. But I’m not resigned to the situation.

“I’m convinced that we can hold it off for quite some time, hopefully in our lifetime and our children’s lifetimes. I’m willing to fight for that and spend money for that, and I hope others will be, too.” •

The acidic water of the Berkeley Pit harbors organisms that offer hope of a new antibiotic. (Wikimedia Commons)



# LIFE FROM THE PIT

How Montana’s toxic lake may be the key to a new antibiotic

BY COURTNEY BROCKMAN

The circumstances that led Don and Andrea Stierle to begin studying the Berkeley Pit were simple: They were out of money. The professors and natural products organic chemists – a husband and wife team – had worked everywhere, from the waters off the coast of Bermuda to the forests of the Pacific Northwest.

Their quest: find new microorganisms containing drug potential.

But now, with limited funding, they looked no farther than a mile from their lab at Montana Tech of the University of Montana in Butte for their next project.

“We were luckier than most people in our field, because we had the Berkeley Pit,” Andrea says.

The Berkeley Pit, part of the largest Superfund site in North America, is filled with a soupy, brownish liquid comprised of high concentrations of iron, copper and other metal salts. The pit’s walls are rich in iron pyrite – or fool’s gold – which produces



A fungus derived from toxic Berkeley Pit water

an unceasing acidic broth. Because of the lake’s low pH of 2.5, no one had thought before to look for life within such a toxic environment.

But a colleague collecting samples found something growing on a stick submerged in the pit’s “uninhabitable” waters. He brought it to the Stierles’ lab for identification, and the blue-green blob turned out to be an alga. It was the summer of 1995.

This was a time when other scientists sought life in deep sea vents and other less-than-hospitable environments. Thirty years before, Thomas Brock had found life in the hot, acidic pools of Yellowstone National Park.

“We knew these organisms growing in extreme environments had secrets to share,” Andrea says.

But the Stierles never guessed that they





Don and Andrea Stierle, shown here in their UM lab with Berkeley Pit water and organisms cultured from it, have spent their careers tracking microorganisms with potential health benefits.

would still be making important discoveries from the pit's microbes more than 20 years later.

**The Berkeley Pit sits in the Boulder Batholith near Butte, a city built by copper.** During Butte's heyday in the late 1800s and early 1900s, the world demanded copper wires to transmit electricity, mines pulled metals day and night, and miners dropped deeper into the Earth as the ore in the rock diminished.

Butte switched to open-pit mining in 1955, which allowed large quantities of rock to be removed, concentrated and processed. The result was the Berkeley Pit – a mile-wide, half-mile-deep crater that has become Montana's deepest lake.

Pumps kept the Pit dry until they shut down in 1982, and water flowed back in within a year. Today, the water has risen to just 71 feet below the critical 5,410-foot mark, where it can seep into surrounding aquifers.

At one point, boats dropped long cables with collecting vials down to the sediment of the pit to take water samples, but monitoring ceased in 2013 after sloughing

caused a 30-foot tidal wave to take out the pier and dump an estimated 820,000 tons of material into the pit.

The Stierles' pit water samples were gathered by the Bureau of Mines and Geology in July 1995 and spring 1996.

"And something happened between those two collections," Andrea says.

Exhausted from their long migration from the Arctic and attracted to what looked like a body of fresh water, 342 snow geese landed in the pit during a snowstorm on Nov. 15, 1995. Exposure to the toxic water killed them.

The 1996 pit water samples yielded a new murky, charcoal-colored yeast that absorbed metals from the water – something reported only once before by a Japanese scientist who had taken rectal swabs from a goose. The Stierles theorized that the geese expelled the yeast to make themselves more aerodynamic for take-off.

"To put it indelicately, they all pooped," Andrea says.

A year later, the yeast was gone from the water samples. When thousands of other snow geese died in the pit in November 2016, the Stierles were unable to obtain a

sample. But what they have found in the previous samples will keep them busy for a lifetime.

The Stierles have used several techniques for isolating fungi and bacteria from the pit water.

"We didn't know whether these guys were just incidental – if they just happened to land in the pit, and we just happened to grab them – or if they could thrive under these hostile conditions," Don says.

Fungi in the pit could have come from the air as spores, from bird feathers or from rotting, carbon-containing mining timbers from old drifts and shafts. When the Stierles created broths with pit water in them, they found that 90 to 95 percent of the fungi grew just as well in the extreme broth as in a conventional broth. Some grew even faster.

The Stierles cultivated each of the fungi under a variety of conditions to test their secondary metabolism.

Most bacteria and fungi produce secondary metabolites, or natural products, they can survive without – such as the caffeine in a coffee plant or the nicotine of a tobacco plant. Compounds such as these may help fight diseases in humans.

Fungi in the pit could have come from the air as spores, from bird feathers or from rotting, carbon-containing mining timbers from old drifts and shafts.

But little is known about the secondary metabolism of organisms living in extreme environments.

In the early pit fungi samples, Don discovered some of the compounds produced could potentially target metastatic cancer, inflammation and post-stroke brain damage. But there was no antibiotic activity.

Last fall, the Stierles looked at two new fungi. They had little bioactivity.

"They were the most boring organisms we had ever looked at," Andrea says.

They then decided to grow them together to see if they would produce a new compound in competition with each other.

**Each petri dish** where two or more fungi are co-cultured becomes a fighting ring for resources. All fungi and bacteria, which contain more genes than usually expressed, have the potential to produce many more compounds when challenged by other organisms.

"It's cool turning on these genes that are obviously there and produce antibiotics that weren't turned on until they got associated with a competitor," Don says.

In the pit, where life is sparse, fungi do not have to compete with other organisms for resources. But when two are put into a broth in close proximity, they become aware of each other through chemical quorum sensing – the fungi's form of communication.

"It's going to be worth the energy investment to create an antibiotic to kill that other guy, so that you get all the 'cookies' – all the nutrients," Andrea says.

In a lab at UM in Missoula, where the Stierles moved in 2009, the two fungi sit in petri dishes – one a nondescript dull brown and the other containing a slight hint of green. When the two were grown together, something interesting happened.

The fungi produced several new classes of compounds, and one of which resembled a known antibiotic. The Stierles sent it to colleague Nigel Priestley, a UM organic chemistry professor, who tested it against a suite of pathogenic bacteria and yeasts.

Priestley found the compound was active against *Bacillus anthracis*, a couple of

*Streptococcus* strains and a few yeasts. But it was more active against drug-resistant strains of *Staphylococcus aureus* MRSA – community and hospital-acquired antibiotic-resistant bacteria – than anything else.

Although structurally similar to other antibiotics, the Stierles and Priestley noticed the compound did not contain the sugar groups of most. The discovery excited them.

"We really aren't generating new antibiotics faster than old ones are becoming obsolete due to resistance," Priestley says. "Any time we can get a new structural class of antibiotics, there is hope that a new antibiotic will eventually make it to the clinic."

**Antibiotic resistance** has been known since the day Alexander Fleming accidentally discovered penicillin in the early 1940s.

According to Fleming's notes, a spore of the fungus *Penicillium* fell as a contaminant onto a petri dish streaked with *Staphylococcus aureus*, creating a zone of inhibition that killed the bacterium. But within the cleared zone, Fleming noted there were a few colonies of *Staph* growing that already had become resistant to the penicillin produced by the *Penicillium* spore.

Today, more than 23,000 people in the U.S. die annually from drug-resistant bacteria. Groups all over the world are looking at different ways to fight bacteria and come up with new modes of targeting bacteria, such as using bacteriophages – viruses that kill bacteria.

"Any time you're dealing with disease, it's a chemical, biological chess match," Andrea says. "And each side is kind of bringing a new arsenal, a new strategy into the game. As chemists, as scientists, this is our game. This is what we bring to it."

The Stierles have isolated 12 antibiotic compounds from the two co-cultured Berkeley Pit fungi. Most antibiotics find something unique to target in a pathogenic bacterium, such as an enzyme, to disrupt protein synthesis or another process.

"To our surprise, it didn't touch protein synthesis. It did not bind to the ribosome. It is nothing like any known macrolide antibiotic," Andrea says.

For now, the Stierles are trying to learn how exactly the compound works as an antibiotic. First they must test if the compound is toxic to mammalian cells and whether it can be metabolized and made into an orally available drug. Then, they must find a pharmaceutical company interested in investing in the drug.

One pharmaceutical company has contacted them, and they are collaborating with UM's Division of Biological Sciences to eventually do a genomic study of the two fungi. They also have submitted a grant with a new biotech company to look at the gene clusters within the fungi.

The Stierles, who believe collaboration is essential, have received their funding through individual grants and support from UM's Center for Biomolecular Structure and Dynamics. And their lab on campus is just big enough to do the work needed.

"The University of Montana has been a good move for us," Andrea says.

**The Stierles visit Butte**, where they still have a house, on most weekends, and sometimes find themselves at the edge of the Berkeley Pit, just as they did 37 years ago during their honeymoon.

"It is a bleak, bizarre landscape," Andrea says. "And it's hauntingly beautiful in some ways."

Above the mine sits the Granite Mountain Memorial, dedicated to the 168 lives lost in one of the worst hard-rock mining disasters in the United States in 1917. The last names match the names of many present-day Butte families.

But, despite its toxicity, the Stierles believe the Berkeley Pit is a lesson on how to approach problems.

"We like the idea of reminding people that even contaminated sites have value," Andrea says. "A toxic waste dump can harbor fungi and bacteria that produce compounds that could cure cancer, fight inflammation and even be the next antibiotic. So it's the unexpected; it's looking at something in a way that nobody else has looked at it before." •



# BUILDING THE GLOBE AT UM

Shakespeare's  
classic theater stage  
rises on campus



Actors perform in Shakespeare's "As You Like It" on UM's new stage that mimics London's Globe Theatre.

Inset: Theater Professor Alessia Carpoca designed this model of the stage design before construction launched.



set that mimics London's old Globe Theatre – the space where Shakespeare staged many of his plays.

"In the past 10 years, so many towns have built their own re-creation of the Globe," says Alessia Carpoca, professor of theater and head of design and technology at UM. "And we thought, 'Why not us?'"

Carpoca worked all spring to design the classic Globe replica, and now students and professors made it a reality. Besides its appeal as a throwback to Shakespeare's time, the set is notable because it's a permanent structure that UM can reuse in productions for years to come.

Its basic elements include a raised rectangle stage with a trap door and columns on either side of the stage that extend to a garden-style roof. The back walls consist of a second-story balcony and several openings that can be constructed as doors or windows depending on what's needed for a given production.

Designing the set was no small feat. The original Globe was built in 1599 by Shakespeare's theater company, The Lord Chamberlain's Men, and it was a palatial three-story structure with surround seating and an actual roof supported by large columns. In 1613, the Globe was destroyed in a fire after a cannon misfired during a production of "Henry VIII." It was rebuilt the following year and then torn down in 1642 by the Puritans to build tenements. It took centuries for its next incarnation, built in 1997. There are now Globe Theatres all over the world, in almost every major city.

UM's version was created inside the Masquer Theatre, the black box space in the PAR/TV Center, which has constraints when it comes to scale. Designing stairs is particularly arduous because steps require a certain width-to-height ratio to make them safe and easy to climb. Carpoca had to keep readjusting the Globe model she

BY ERIKA FREDRICKSON

There's nothing more quintessential to the world of theater than a Shakespeare production. And, like all good theater programs, UM's School of Theatre and Dance tackles the Bard every year or so, often with a modern twist.

In 2016, for instance, audiences witnessed "Romeo and Juliet" done with a nicely nuanced teen-pop flair. Other years have seen a 1950s James Dean-style treatment of "Hamlet," a version of "A Midsummer Night's Dream" that spanned

the ages (and fashions) from 1660 to the present, and a "Much Ado About Nothing" that was set in 1840s-era Mexico. As it turns out, the possibilities with Shakespeare are endless. And that's why *sometimes* the best twist is to take a production back to its roots.

This past year, UM's School of Theatre and Dance presented Shakespeare's "As You Like It" in classic style. What makes the UM production extra special, is that it marked the kickoff of a new project for the department: the ongoing construction of a



was working with in order to condense a serviceable staircase, raised stage and trap door into a 17-foot-high room.

"In set design, there are always technical challenges, but this was the first time where an inch made a difference," Carpoca says. "With every other design in theater, what's it going to matter if you make something an inch smaller? But here it did."

The Globe replica is being built by UM technical director Brian Gregoire with help from students. When it comes to the theater department's sets, Gregoire acts as engineer, construction foreman and carpenter, deciding how best to achieve the design and mentoring the students through the process. Usually, the sets they build aren't meant to last.

"A lot of the sets we do for the school are one-offs," he says. "We build it, it goes into place, and then we tear it down, never to be seen again."

For the Globe replica, Gregoire had to reconsider the materials, swapping in steel for wood in some cases and generally approaching the set like he would for a touring company, which must rebuild their

sets on new stages night after night. The set will be built in sections, so that it can be broken down and reconstructed easily. Those sections will be housed in storage at Fort Missoula inside old cell blocks.

The permanent nature of the Globe replica offers a few important benefits: It cuts down on waste and saves money. But one of the most valuable aspects of the Globe replica is its potential for education. It's a structure many Shakespeare festivals use, and knowing how to work with it gives tech students a leg up when they leave UM for a career (see sidebar).

John Kenneth DeBoer, a UM associate professor and director for "As You Like It," says he had the good fortune as a student to take classes from a teacher who was a set designer as well as a theater historian.

"She spent a lot of time pointing us to the ways the stage influenced the literature," he says. "Your staging is a constraint to the kinds of stories you can tell, so working within those constraints allows writers to awaken their imaginations."

UM's never had a space that really captured the kind of picture box for which

Shakespeare wrote his plays, so the Globe replica offers that opportunity.

"The tendency right now is to bring Shakespeare to modern audiences and to give it a modern concept and design," DeBoer says. "And we've done a lot of that, and we've done it quite successfully. So I was thinking with 'As You Like It,' 'Let's forget about all of that and try to go back to the roots of his work.'"

Students started building the set as soon as they arrived for fall semester. For some, it was a little like getting thrown into the deep end of the pool.

"Some people have amazing skills when they come – maybe they've worked on a farm," Carpoca says. "Then there are people who have never held a hammer, and they're all in the same class. And they need to make costumes and build sets for a Shakespeare play in a month. That's part of the fun and part of the importance of the practical training. It takes a lot of time and a lot of patience, but it's very rewarding because you see results immediately. After two weeks you have something tangible."

To complement the hands-on experience,

students take art history classes in which they learn about the sets they're building. They got a precise sense of what the Globe Theatre is and the reasons behind the design. There's also a talk back at the end of the show when students can ask questions about the set and critique it.

The set was completed for the production of "As You Like It," but Carpoca says other features can be added onto it over time. She hopes that in the future, the set can even be put up downtown or in a park where it will get greater community exposure.

It also will provide an opportunity for all students in the theater department to immerse themselves in the tradition of Shakespeare and gain a deeper understanding of how a space like the Globe can cultivate good theater, no matter the era.

"The main idea is to go back to the roots, but that doesn't mean we can't do more modern interpretations," Carpoca says. "It is quite flexible if you're creative. And that's how Shakespeare used the space. It is about imagination." •

## UM THEATER TECH OFFERS OPPORTUNITIES

Actors get a lot of attention in the world of theater, but those who work behind the scenes reap major rewards when it comes to a career in the field. Technical theater students have a high placement rate both in terms of entering graduate school and in the job market.

Carpoca, who received a BFA in scenography and art history at the Academy of Fine Arts of Rome, gained invaluable hands-on knowledge of set design while earning her MFA at Northwestern.

"Every program in the U.S. has a physical theater and generally more than one," she says. "They usually have a large proscenium stage and then also a black box like the Masquer. So you get to experience working in different types of spaces, and that's useful. You can learn every technique you want."

At UM, tech students hit the ground running as soon as they enter the program, doing hands-on projects (like the Globe replica) and often working their way up from being a design assistant to designing their own shows.

Carpoca said 100 percent of UM's technical theater students work summer jobs in their field (if they choose to), mostly in summer stock companies that come to interview them during the department's "professional weekends" held in late January. Last year, 25 companies from around the Northwest (and a few from the East Coast) showed up to interview UM students, including Alpine Theatre Project, Bigfork Summer Playhouse, Fort Peck Summer Theatre, Grandstreet Theatre and the Idaho Shakespeare Festival.

A large majority of students work for at least one company for multiple summers, and some of them keep working for these companies for many years after graduation in different capacities, often starting from a tech position then going into design. A lot of times they end up freelancing, working for multiple companies throughout the year since those companies often hire on a show-by-show basis. And even major companies, such as the Santa Fe Opera or Oregon Shakespeare Festival, hire theater techs on contract, but still, those jobs are plentiful when you have the skills to do them.

"Except for the students who insist on staying in Missoula," Carpoca says, "all others are able to work in the field immediately upon graduation." •



Professor Alessia Carpoca works in UM's Scene Shop.



Technical theater students and others add the finishing touches to UM's new Globe stage.



Students play a vibrant role in UM's research enterprise. The following profiles offer a glimpse into recent student work.

## Moses Leavens

A molecular biologist by trade, Moses Leavens now combines his background in chemistry, biology and mathematics to study proteins.

Now a fifth-year biochemistry Ph.D. student, Leavens began his graduate career intending to study viruses, and he nearly joined a lab researching the deadly Rift Valley Fever virus. But he liked the challenge of learning biophysics and wanted to work with a variety of instruments.



MOSES LEAVENS

Today, he and his research group study how proteins fold. When the proteins that our body needs form, they first leave ribosomes in the cell as linear, amino acid sequences. As these chains lengthen, they take on what is called secondary structure. This structure varies considerably, with patterns of complex sheets and helices taking form depending on the function of the final protein. Some proteins may only share 20 percent of the same linear sequence yet take on a very similar structure. Leavens and his group work to explore the physical basis of this process in which seemingly random sequences giving rise to specific, functional structure.

A Sloan scholar and one of just a few students selected nationally into the Amgen Scholars Program at Massachusetts Institute of Technology, Leavens is a member of the Chippewa-Cree Nation. In 2014, his presentation "Biophysical Analysis of the Ubiquitin: Associate Domain One" earned top honors at the national American Indian Science and Engineering Conference.

## Brit Garner

Twice a week, hundreds of thousands of viewers tune into "SciShow Psych," co-hosted by UM alumnus Hank Green and Brit Garner. Green, a YouTube superstar and the creator of "SciShow," holds a master's in environmental studies from UM. Garner, a third-year doctoral student in wildlife biology, similarly fuses her scientific training with performance and creativity.

Originally from Florida, Garner earned her B.S. in zoology at the University of Florida, then continued up the coast for a master's in marine biology at UNC-Wilmington, where she taught biology and physiology courses at a nearby community college.

Seeking a change, Garner joined the master of fine arts program at Montana State University, where she focused on filmmaking in science and natural history. "I packed up my Honda Civic and drove to Bozeman, Montana. I didn't even know where Bozeman was on a map," she says.

Her first-year project at MSU included a video interview with Gordon Luikart, a conservation geneticist at UM. The project sparked her interest, and by that summer she had relocated to Missoula to pursue a graduate degree in wildlife biology.

Garner's research combines big data analytics and algorithmic problem-solving with wildlife conservation. Conservation efforts are constrained by limited time and money, so her approach is to build tools that ensure the resources of those programs are used as efficiently and effectively as possible.

Her passions for teaching, science and performance continue to drive her work outside the classroom and the lab. In Missoula, she has performed with the Missoula Community Theatre, taught the undergraduate lecture course Wildlife and People, co-founded the Missoula Interdisciplinary Science League and shared her research experiences with K-12 students as part of UM's We Are Montana in the Classroom role-model initiative.

Whether on "SciShow Psych" or in the classroom or the lab, "Let people see that you're excited about things," she says.

## Jackson Crawford

During the fall 2017 semester, undergraduate economics major Jackson Crawford was busy editing footage for a documentary on renewable energy. As part of his capstone project, he traveled to Cape Town, South Africa, for six months to study and create a film as an apprentice of well-known producer Michael Murphey.



BRIT GARNER



JACKSON CRAWFORD

Thanks in part to support from UM's Office of Research and Creative Scholarship and a scholarship from the Davidson Honors College, his main expense in Cape Town other than rent was his rental car. Even with the company's policy of staying within a 200-kilometer radius, Crawford was able to visit nine renewable energy generation sites and interview policy directors, local officials and other key renewable energy players in his vicinity.

No stranger to travel, Crawford once spent a semester of high school abroad in Austria. "It totally changed me. I was so young, I didn't know anything," he says. When he came back the first time, a now-bilingual high school senior, the travel bug had already set in. "I wanted to go further out of my comfort zone," he says of his most recent destination, the second-most populated city in South Africa.

A Bozeman native and a lifelong lover of photography, Crawford hopes to continue combining the broad, analytical approach of his economic interests, his passion for sustainability and creative outlets in informative and useful ways. When he graduates in December, he hopes to work with PBS making educational videos. As for his next trip abroad, he has his sights set on Southeast Asia.

## Nora Saks

In September 2017, listeners of National Public Radio's "All Things Considered" broadcast heard a grim tale from Montana: "In August, the Missoula County health department took the unprecedented step of advising the entire town of Seeley Lake to evacuate due to smoke; air there has been classified as 'hazardous' levels for 35 days [since] August 1."

The writer behind that story, which described the scramble to equip K-12 schools in smoke-afflicted communities with HEPA air filtration units, was Nora Saks, a second-year graduate student in the UM School of Journalism's Environmental Science and Natural Resource Journalism program.

Saks took a roundabout pathway into journalism. Her undergraduate degree in environmental studies from the University of Toronto first led her to organic farming. "I was drawn to it because it was very hands-on; it was visible," she says.

Saks spent time up and down the East Coast working several farming internships and apprenticeships.

The roles varied: She educated communities on the benefits of diversified farming and on issues of food justice, worked with refugee families on building food access and grew produce for small-scale community-supported agriculture programs.

A lifelong affinity for writing and creative arts brought her to the Salt Institute for Documentary Studies in Maine, then to UM. She recently returned from a three-month internship with an NPR community radio station in Alaska, but quickly jumped back into her role as a regular contributor for Montana Public Radio. Her work explores how communities adapt to environmental change, including this year's extreme wildfire smoke. The common thread in her work is the relationships and humanity that define a place.

In the future, she hopes to bring the skills she builds at UM to work on long-form, collaborative and multimedia journalism projects.

## Jenny Lind

While completing her neuroscience Ph.D., Jenny Lind was as engaged in her community as she was at the lab bench. Until she graduated in spring 2017, the Darby native led hands-on neuroscience activities at spectrUM Discovery Area, served as a role model for K-12 students with UM's We Are Montana in the Classroom initiative and hosted a distance-learning session with students from across Montana for Brain Awareness Week.

In the lab, her research explored the glutamate system, an important regulatory body of mammalian nervous systems that plays a role in memory formation, learning and regulation. Specifically, she studied regulators and binding sites in this system. Her research contributes to a better understanding of how those processes work and could ultimately help scientists design more effective drugs for a range of diseases.

Lind now serves as an AmeriCorps VISTA worker at UM's Blackstone LaunchPad, where she connects students and community members with resources and tools to explore entrepreneurship. Ultimately, she hopes to receive an American Academy for the Advancement of Science Policy Fellowship so she can use her science background and communication skills to influence broader policy decisions. •



JENNY LIND



NORA SAKS





Photo by Anshuma Basumatary

# TEA FOR ELEPHANTS

UM effort uses inspired business idea to protect an endangered species

BY MARINA RICHIE

On any given day, 158 million Americans sip tea. Across the world, tea is second only to water as the most popular beverage. Yet few people know the deadly cost of tea production to Asian elephants or the potential of human buying power to save them.

That's changing in 2017 with the launch of Elephant Friendly™ tea certification for plantations. The project gained steam from UM's Broader Impacts Group in the Office of Research and Creative Scholarship, with help from the University's Wildlife Biology Program, Blackstone LaunchPad, MonTEC and College of Business.

This story is one of innovative relationships based on local trust, science, outreach and marketing. Like the best relationships, at the heart lies respect and reverence that bridge the divide of geography and culture.

Leading the way is the first certified tea farmer, Tenzing Bodoza of Assam, India, a state bordering the country of Bhutan. Unlike conventional tea plantations, on his farm there are no electrified fences to block the passage of elephants along ancient

routes or pose electrocution risks. There are no steep-sided ditches to trap elephant calves too young to cross over them safely. Bodoza encourages the great animals to wander through tea rows, knowing the plants are inedible to them. There, they feast on native trees and shrubs that Tenzing plants and maintains for them. To safeguard workers, he built housing on stilts.

As the first to be certified, Tenzing's product value grows, and so does his ability to do even more for elephants, like purchasing additional lands for the protection of wildlife.

Thousands of miles across the Pacific, UM educator Lisa Mills has deftly merged wildlife biology with business to transform tea drinking into a vital conservation act. To establish actual certification for Elephant Friendly tea, she facilitated a UM partnership with the Wildlife Friendly Enterprise Network, which conserves threatened wildlife through contributing to rural community economies. That group holds the trademark and helps set and assure certification standards.

"Elephants are my passion," says Mills of her dedication, which resulted from a 2010 family sabbatical year in Bhutan. Today, she oversees the Wildlife Conservation and Enterprise Program with UM's Broader Impacts Group – an organization that brings scientific research together with public outreach in innovative ways to address some of the greatest conservation challenges facing endangered wildlife species such as Asian elephants.

Her husband is Scott Mills, UM's associate vice president of research for global change and sustainability. They team up on the project, with Lisa at the forefront. Their collective strengths catalyze conservation that's steeped in their intimate experience of living in Bhutan. Scott's tenure at UM dates to 1995, minus a three-year hiatus as a professor at North Carolina State University from 2013 to 2016. His field is wildlife population biology, especially in context of environmental change.

UM's link to rare Asian wildlife began in 2006, when Bhutan biologists sought guidance for studying snow leopards. They chose UM for its globally applicable techniques to count and monitor wildlife like grizzly bears and wolverines found in

small numbers and in remote terrain.

The Bhutan visit led to a Guggenheim Fellowship for Scott in 2010, a life-changing year for the family. Lisa left her position in the UM Division of Biological Sciences to join Scott with their two children to live among the Bhutanese people, eventually interacting with communities across the border in India. There, they saw firsthand how these cultures revere elephants and live in fear of them.

"During that time, Lisa and I really came to grips with the need for game-changing new approaches to conserve some of the world's most iconic species like elephants and tigers," he says. "Without something innovative and different, wild Asian elephants could become extinct in our lifetime."

Lisa began her outreach in Bhutan and India with student lesson plans, games and activities to teach about elephants and their habitat needs. Then, she stepped it up a notch.

"We put cameras and GPS units in the hands of young people from rural villages to document elephant movements," she says. "They could track the elephants to find out when they were killed – or when a house was knocked down or a crop field raided – and give a better sense of the extent of the problems."

Asian elephants have declined at least 50 percent in the past 75 years, with fewer than 50,000 wild elephants struggling to find food, water and shelter among some of the most populated places on the planet. Those numbers are likely much lower, with many deaths going unreported, as Lisa's project revealed. UM wildlife biology students are analyzing thousands of photos of elephant herds and human-elephant conflict incidents to lay groundwork for the ongoing monitoring of elephant populations.

"We started with education and citizen science, but it wasn't making a dent," she says. "Elephants were still dying and so were people."

The couple witnessed the devastation caused by desperate elephants raiding crops and even homes, attracted by the aromas



Scott Mills, a UM researcher and administrator (left), helps measure a ditch as part of developing standards for the Elephant Friendly tea certification program.

of rice or home brew. They brought in wildlife experts to improve mapping of their movements, which led directly to tea estates that offered a vestige of habitat, watering holes and nurseries. Yet elephants still were being poisoned and electrocuted, and their young were dying in drainage ditches, even if these results were unintended – a by-product of a system that makes efficient tea production the primary goal. Where fences blocked them, the elephants became stressed and dangerous to people.

"First, we gave conservation awards to tea companies that did something good for elephants, such as creating elephant watering holes," Lisa says. "But it wasn't enough, so I asked them what else they would do to help elephants."

Their answers led to her epiphany. There had to be financial incentive, where conservation translated into higher profits and an ongoing pot of money to help elephants. The launch of Elephant Friendly tea certification brought Lisa in contact with Tenzing.

"It was amazing to see," says Lisa of her first visit. "Tenzing had learned so much on his own and converted the whole place from conventional methods to organic. He was happy to have elephants come through the area."

His two tea farms resonate with the throaty calls of hornbills and gleam with a lush diversity of plants that shelter tigers as well as elephants, in sharp contrast to the



usual silent monoculture of industrial tea plantations.

Tenzing demonstrates that conservation is profitable, and with the new certification more people are purchasing his flavorful green and black teas, nurtured in his living, healthy soils. The Lake Missoula Tea Company, the first to carry the certified tea, describes the tea as “smooth Indian black. Molasses sweet with citrus and raisin undertones.”

To multiply Tenzing’s success and market the trademark label via Wildlife Friendly Enterprise Network, Lisa turned to UM business students and professors, as well as the Blackstone LaunchPad, a UM-based organization designed to help entrepreneurs launch new businesses. Last spring, an MBA student team developed a business plan as a capstone project in a course taught by Klaus Uhlenbruck, associate dean of the UM College of Business. Students in other

classes also had opportunities to learn about the program and contribute their ideas.

“Lisa spoke in the fall to my class on sustainable business strategies, and the students were mesmerized,” says UM management and marketing Associate Professor Suzanne Tilleman. “I am amazed by the years of work Lisa has put into this and her desire for the certification to go through and protect elephants. It’s rare to

work with an entrepreneur who already has her first supplier, first customer and has done the testing of the proof of concept.”

Now businesses in three U.S. states carry their own lines of certified tea, and products are available in over 17 retail outlets, including cafes, grocery stores, restaurants, zoos and online. UM is exploring the development of branded tea products to help scale up the impacts of the program.

When it comes to assuring best

conservation practices and monitoring, that’s where UM’s top-ranked wildlife biology program is an ideal fit, working with Asian elephant biologists and veterinarians, who advise on retrofitting steep-sided ditches and other practical improvements.

“It is win-win,” Scott says. “We are getting actual change on the ground for elephants. The tea farmers are making money not at the expense of wildlife, but by helping wildlife. Money from consumers will go into a fund to initiate conservation actions beyond the tea plantations.”

“We now have interest in tea plantation certification from more growers, including the second-largest tea producer and other growers in India,” Lisa says. “We also have interest from tea producers in Sri Lanka and Kenya, where companies welcome economic opportunity hand-in-hand with conservation of elephants.”

To assure measurable conservation, UM students will play increasingly significant roles, such as studying elephant movements with remote cameras and monitoring landscapes with remote sensing tools and firsthand data collection. This past spring, the Mills duo led a trip to India with Scott’s doctoral student Alex Kumar and two Indian scientists, who specialize in population ecology and Asian elephants.

“We initiated a project that I think has never been done before for any product sold as helping wildlife,” says Scott. “We are using cutting-edge science to directly connect the Elephant Friendly certification steps to specific outcomes that reverse the decline of elephants.”

It comes back to local trust and relationships, of scientists and tea farmers, of business and conservation, and of consumers of tea to its origin. Progress is measured in every elephant calf that survives, every tea worker saved from rampages and every fragment of habitat saved or restored. At its heart is perhaps the greatest reason for hope – a reverence for elephants. •

“We initiated a project that I think has never been done before for any product sold as helping wildlife. We are using cutting-edge science to directly connect the Elephant Friendly certification steps to specific outcomes that reverse the decline of elephants.”

— Scott Mills



Lisa Mills, the UM educator who helped create an Elephant Friendly tea designation, assists with an injured baby elephant. (Photos courtesy of Lisa Mills)



Find out more at <https://elephantfriendlytea.wordpress.com/>.



Chloe Gendrow performs at the Switchback Records River City Showcase. She was the winner among five bands, earning money for recording-studio time. Her latest album "Glow!" was released in fall 2017. (Neubauer Media image)

# MAKING MUSIC

Student-run Switchback record label offers industry training

BY ALEX STRICKLAND

The landing of the Gallagher Business Building's main staircase is a long way from the D.C. offices of NPR Music and its renowned Tiny Desk Concert series, which has made an otherwise unremarkable workspace into one of the hottest gigs in the music world.

But for 10 minutes each Thursday, that landing – surrounded by a glowing stock ticker and perched above the Biz Buzz cafe – becomes UM's own version of Tiny Desk.

"We've had as many as five musicians on the stairs at once," says Mike Morelli, director of UM's Entertainment Management program. "Rappers, bagpipers, guitarists, you name it."

It's not just for show. Some of the students in Morelli's program are scouting for more than just a quick performance over lunch – they're looking for artists to sign.

## Switchback Records

The words "record deal" might've been anachronistic just a few years ago, but today's music industry is enjoying a massive

resurgence in actual vinyl records alongside the business-model-busting streaming services that put almost every song ever sung at your fingertips. For students looking to get a taste of that full range – plus a lot more – there's Switchback Records, a student-run label that gives UM students an opportunity to scour the valley for talent, sign artists, record, promote, distribute, book shows and everything else involved with taking a musician from "undiscovered" to "the next big thing."

"It's an amazing opportunity for students to be able to walk into a job interview and say, 'I've taken on a project with an artist from start to finish,'" Morelli says. "Students are out there listening and looking at who plays in Missoula. Whose performance did they love?"

It's about a lot more than music, as the current president of Switchback, second-year MBA student Hannah Doerner, can attest.

"As the graduate assistant for the Entertainment Management program, by default I was part of the development of

Switchback from the beginning," she says. "Aside from having Switchback parallel a lot of what I do in the UMEM office, it's been a fantastic way to get hands-on experience in both developing a startup business and working in the music industry. It's been a long process of setting up the framework in order to have Switchback Records function as a working business."

That means Doerner's duties range from administrative tasks related to the label's official status as an Associated Students of UM club to managing students, maintaining relationships with contacts in Los Angeles and watching the bottom line. And, of course, there's the music.

"After graduation I would love to continue working with developing artists who are passionate about their music but may not have the necessary business skills to further their careers without taking their focus away from creating music," Doerner says.

One of the label's first projects was working with a duo of Helena transplants memorably called Rotgut Whines. The

label helped them strategize the launch of their first EP, including the development of marketing tactics, building an electronic press kit, booking gigs at music festivals and recording songs for sync-specific deals.

And because of UMEM's wide network in the professional world, Switchback can offer bands like Rotgut Whines something you might not expect from its office in the basement of Gallagher: a chance to record songs by the King of Rock 'n' Roll himself.

"We have a partnership through an industry adviser with a group called Media Horse that places songs in movies, on TV, things like that," Morelli says. "Media Horse has rights to the Elvis catalog, so we're identifying five or six artists to record Elvis songs, and they're getting mixed and mastered in L.A."

"One of our main goals is to give local musicians an avenue to be seen on a national scale," Doerner says. "Our Elvis 'Missoula to Memphis' project has a ton of possibilities."

And what if a local crooner hits it big for their version of "Blue Suede Shoes" thanks to Switchback? Well, everybody wins.

"The artists signing with Switchback are signing the most artist-friendly contracts in history," Morelli says with a laugh. "It's a 20/80 split for two years. After two years we only get to participate over \$1 million."

## Missoula's Music Scene

For a small college town in the Northern Rockies, Missoula has long punched above its weight when it comes to live music. Whether it was Bonnie Raitt and Jimmy Buffet playing the famed Aber Day Kegger or the Rolling Stones and Paul McCartney packing Washington-Grizzly Stadium (or, for that matter, countless acts stopping by the Top Hat or the Wilma over the years), Missoula is Montana's own version of Music City. And that quantity and quality of acts provides students with some rare opportunities.

"I was at the first show at the new Kettlehouse Amphitheater and counted 13 students working the show that I've taught or will teach," Morelli says. "To say nothing of students who walk into job interviews having worked rigging, sound or something similar for world-class acts."

And because music venues are often theaters, bars, restaurants or event spaces, too, Morelli says that even opportunities that might not seem directly connected to the music business can pay dividends.

"One of my students was a bartender at the Top Hat and ended up touring with the Lil' Smokies," Morelli says. "One of our

program's founders calls him up with a chance to come out to Seattle and run the music at the Central Saloon."

So what about the Spotifys and Pandoras that have upended the music business? How do you get a job at a record label when listeners can get your artists' tracks – and everyone else's – for free or cheap? Would you want to?

"I put in 'Gregorian chant' on my Pandora and eventually get some hard rock song," Morelli says. "And guess what? I usually dig it."

That's because the sophisticated algorithms behind the mix know Morelli perhaps better than he knows himself. And they present an opportunity to craft what he

One of our main goals is to give local musicians an avenue to be seen on a national scale

calls the "perfect grad" for an employer like Ticketmaster, who knows the "live world" of entertainment and has the skills to parse the data that's behind it.

On stage, on screen or spinning at 33 RPM, the world of entertainment is about finding a way to create a moment between artist and fan, no matter the medium. •



## THE MONTANA MAFIA

So how does a UM grad get a foot in the door on the mean streets of Nashville, Los Angeles and New York? Look no further than the "Montana Mafia," a collection of Big Sky Country natives who have fanned out across the entertainment industry and, after careers of hard work and hustle, find themselves in some of the country's most sought-after corner offices.

Those connections include longtime Rolling Stones tour accountant Mike McGinley; Brian Knaff, chairman of TBN Entertainment; Keith Miller, senior VP at William Morris Agency; and Paradigm agent James Yelich. Not bad folks to know when you're looking for a way to get in the door in a cutthroat industry. And many of these big names have given back by lecturing and sharing their expertise with UM Entertainment Management students.

For more on the Montana Mafia, check out a 2008 story in the Montanan magazine at <http://bit.ly/2fhht8M>.

Student-run Switchback Records meets in September 2017 in the UM Entertainment Management office. (Hannah Doerner photo)





# MAKING MONTANA MORE JUST



Faculty members of the Montana Justice Initiative meet in UM's Alexander Blewett III School of Law.

The Montana Justice Initiative mobilizes campus to examine and improve Montana's criminal justice system.

BY JACOB BAYNHAM

Growing up in Gillette, Wyoming, Jake Coolidge had few firsthand opportunities to witness the weaknesses of America's criminal justice system.

"I didn't have to confront those issues," he says. "It's a very white, very conservative community. There's a lot of money there. Everyone's kind of the same."

But when Coolidge enrolled in St. Mary's College in southern Maryland, his eyes were opened. "Racially, it was much more diverse," he says. "There was a lot more poverty. I think I became more aware of how the justice system was actually functioning."

In his first sociology class, Coolidge studied the theory of criminology and determined that crime was a product of society rather than an individual issue. He started to think deeper about how we make laws to create social order, but how the systems that enforce those laws are flawed.

The more he learned, the more he saw. Coolidge noticed a local sheriff's deputy parked his cruiser outside his home, where two flagpoles flew the American and Confederate flags. Coolidge wondered how this might change the way African Americans perceived local law enforcement.

The questions continued. Coolidge finished his bachelor's degree and moved to Missoula to get a master's in sociology and study law at UM. He turned his attention to Missoula's municipal criminal justice system. His master's thesis focused on local panhandling ordinances. Coolidge learned that when people violated these ordinances, they were punished with a fine.

"Fining a panhandler, I don't think that's a reasonable solution," Coolidge says. "But that's how it's handled. And if someone can't pay their fine, they're often sent to jail. And that takes taxpayers' money."

During law school, Coolidge teamed up with the American Civil Liberties Union to co-author an extensive report on the conditions of Montana's county jails. It

took three years to finish, but by then he was committed to criminal justice reform. So it only made sense that when UM's Alexander Blewett III School of Law got the seed money in 2016 to launch an initiative focusing on Montana's justice system, Coolidge was tapped to lead it.

"I made enough of a fuss through my research, writing and education that people knew my main thing was criminal justice reform," he says. "It's kind of a passion of mine. So this was a natural fit."

## The seed money that founded the Montana Justice Initiative

came from former Montana state Sen. Dan Weinberg. During his time in the Legislature representing Whitefish, Weinberg had plenty of opportunities to view the shortcomings of the criminal justice system. As chair of the Public Health Committee, he visited the Montana State Penitentiary in Deer Lodge. He also watched as several prisoners in Montana were found to be innocent. His concerns over these

issues inspired him to found the Montana Innocence Project in 2008.

The project already has helped exonerate a handful of innocent prisoners, and other cases are ongoing. But Weinberg saw the need for another program in the state – one that explored the flaws in the justice system and tried to fix them so that problems like wrongful convictions might be avoided altogether.

"I've been concerned about social justice for my entire adult life," Weinberg says. "While our country has wealth and opportunity that many countries can only dream about, we lock up more people than any country on Earth. And many people, upon leaving prison, are no better off than when they went in. What is it about our history and culture that produces these results?"

For Weinberg, it's a question that demands scrutiny from multiple disciplines – historical, sociological, legal and others.

"How can we make a justice system that is more just?" he says. "Finding that answer is the goal of the Montana Justice Initiative."

## Think tanks and academic

**institutions** like New York University's Brennan Center for Justice have set similar goals. "But we started small," says Coolidge, "and our approach has been uniquely Montanan. We're very much focused on what's happening in Montana."

Coolidge says in many ways Montana is representative of broader national criminal justice problems. Montana has high pretrial incarceration rates, for example, when people stay in jail because they can't afford bond.

"Everyone knows that one's innocent until proven guilty," Coolidge says. "But bond practices don't reflect that. You're innocent until proven guilty if you can post bond. If you can't, you sit in jail, often in terrible conditions. People with money are treated one way; people without money are treated another way."

Montana is also similar to the rest of the country in that relatively few criminal offenses go to trial. "At the most cynical level," Coolidge says, "the prosecutor wants a conviction, the public defender is overworked, and they pursue a plea bargain. The justice system is so overworked right

now that if everyone went to trial, it would fall apart."

Defendants who pursue a plea deal for a felony, however, may jeopardize their voting rights, their immigration status or their eligibility for federal housing.

"Complex decisions about people's lives are being made through judicial efficiency," Coolidge says.

On the other hand, Montana has unique criminal justice issues. Native Americans make up just 7 percent of the state's population, for example, but account for 20 percent of Montana's male inmates and 34 percent of female inmates. Those figures don't even account for the many Native Americans prosecuted through federal court.

Montana also stands apart in its use of private prisons. "Any given year," Coolidge says, "Montana ranks among the top five states for the percentage of prisoners in private custodial care."

One glaring example is the Two Rivers Detention Facility in Hardin, a 464-bed, \$27 million prison that has remained largely empty since its completion in 2007.

"Private prison contractors encouraged it, built the prison and left," Coolidge says. "Similar trends happen in other rural, economically depressed areas. They're very susceptible to private correction facilities."

## The mission of the Montana Justice Initiative

, then, is to shine a light on these problems, understand the forces behind them and suggest ways to solve them.

"People might assume that their local justice systems are doing the best things," Coolidge says, "but often they're not, when you peel back the layers."

To help expose those layers, the initiative is funding four research projects at UM. The first is research by Laurie Walker, an associate professor in the School of Social Work. Walker is looking into the dramatic overrepresentation of Native American women in Montana's prisons. She is working with Native American collaborators on campus and in the community to interview inmates and analyze data to better understand the life circumstances and re-entry needs of incarcerated Native American women.

The initiative also funds a pilot program

by Christina Yoshimura, an associate professor of communication studies, which uses family-based counseling in lieu of adjudication for first-time juvenile offenders. Yoshimura already is getting referrals for likely candidates from local courts and judges.

"It's one idea of how to make the justice system more rehabilitative rather than punitive," Coolidge says.

The initiative also is funding Tobin Miller Shearer, director of UM's African-American Studies program, and one of his graduate students to study primary documents that reveal the role of race in the development of Montana's criminal justice system. Finally, Coolidge is teaming up with the ACLU again to author another report, this one detailing the conditions of Montana's tribal jails.

All of this research will reveal different dimensions of criminal justice in Montana. But what excites Coolidge the most is the educational angle. The initiative plans to create an interdisciplinary graduate seminar exploring Montana's criminal justice system that could begin as early as spring semester 2018. The course will pull together students from across campus and will be taught by a professor from a different discipline each week. Students will tackle some of Montana's most challenging criminal justice issues from different academic perspectives.

Coolidge, who taught criminology courses, is eager to see what they come up with.

"Maybe it's an advanced proposal of a very specific thing to make the justice system better," he says. "Or maybe it's just creating 30 people who go out into their lives with a much stronger understanding of how the justice system is operating."

Either way, Coolidge will count the conversation as a success. And Coolidge's personal journey in criminal justice reform isn't finished. In October, he started working as an attorney at Missoula's Office of the Public Defender.

His successor, D'Shane Barnett, a faculty member in the UM sociology department, says, "Jake did such a great job in laying the foundation of the project and creating a vision of how our work can help Montana become a national example of how to reform a justice system so that it better serves the people. I am very excited to help this project take its next steps." •



# EMPOWERED PARTNERSHIPS

UM program enhances impact via tribal maker truck, new food bank location



Bill Swaney, a SciNation member, and Ruth Ann Swaney, a regular SciNation contributor and champion (right), learn from master weaver Eva Boyd to help create a basket-weaving activity for the maker truck.

BY HOLLY TRUITT

It all started with an idea to convene existing and potential partners from the Flathead Indian Reservation, where the spectrUM Discovery Area has worked since 2007.

Founded a decade ago, spectrUM is UM's hands-on science museum that works to inspire the next generation of Montanans about science, technology, engineering and math (STEM); higher education; and ultimately their futures. At the time, we were reaching over 50,000 people annually. Our museum had grown from a small, on-campus site to a beautiful downtown location. Our celebrated mobile science program had developed to serve three-

quarters of Montana counties and all seven of our state's American Indian reservations. However, as an organization, we felt like we could do more by working collectively with communities to design for greater impact.

Funding from the Alfred P. Sloan Foundation allowed this group of thinkers and doers – Bernie Azure, Whisper Camel-Means, Stephanie Gillin, Lance Hawkins, Cindi Laukes, LeeAnna Muzquiz and Carey Swanberg – to come together monthly to reimagine spectrUM's existing Science Learning Tent at the Arlee Celebration.

To advance our vision of fostering a homegrown, Native STEM workforce, we chose exhibits that aligned with the tribes' economic plan and workforce needs in the health, environmental and tech sectors; changed signage to feature local, Native

STEM role models; and invited other Native STEM career and high school "near-peers" to serve as educators in the tent.

Of our pilot, *The Char-Koosta News*, the official newspaper of the Flathead Nation, wrote: "To say the first year of UM's spectrUM traveling hands-on science and technology learning exhibit at the Arlee Celebration Powwow was a success would be an understatement. It was an overwhelming success that exceeded all involved parties' expectations."

## Co-creating with SciNation

Building on this momentum, SciNation on the Flathead Reservation was born.

With spectrUM as its backbone and Jessie Herbert-Meny, head of spectrUM's STEM Education, managing day-to-day

## A PLACE FOR 'EMPOWER'MENT

EmPower Place is our newest co-created initiative. A vibrant family learning center dedicated to nourishing the bodies and minds of all Missoula children, it is one part science museum, one part library and one part community center. EmPower Place is embedded in the Missoula Food Bank, which serves over 1 in 4 children in Missoula County.

Co-led by the Missoula Food Bank and spectrUM, with leadership and programming support from the Missoula Public Library and other like-minded partners, EmPower Place is rich with hands-on science exhibits, UM STEM role models, books, playful activities and early literacy programming, as well as free meals and snacks for children. Since the grand opening in July, attendance has risen steadily. This summer we saw an average of 147 visitors daily.

Jessica Allred, director of development and advocacy at Missoula Food Bank, helped create EmPower Place and now directs its operations.

"When sharing early renderings of the new building with leadership at spectrUM, possibilities began to percolate of co-

location – wherein we respond to the needs of families visiting our food bank, but also bringing STEM education, mentors and other opportunities to families with limited access," Allred says.

This vision was ultimately made a reality by funding from the Missoula Redevelopment Agency and a grant from the Institute for Museums and Library Services to spectrUM.

This autumn, EmPower Place's collaborative programming is expanding under the careful eye of Allred and spectrUM's resident scientist Amanda Duley to include after-school science clubs rich with STEM role models from UM's We Are Montana in the Classroom initiative. It also will offer an evening co-hosted with UM to help families and students with financial aid and applications for college and scholarships, as well as other college-readiness programming. A pending grant proposal includes scholarships earmarked for children who use the Missoula Food Bank.

"If we could make these systemic, audacious social changes on our own at the Missoula Food Bank, we would have done so a long time ago," Allred says. "Trust in the collective and being open to different paradigms has nurtured true innovation, and our journey toward meaningful change is stronger because of it." •



A youngster enjoys spectrUM's new EmPower Place location.





This "maker truck," the result of a partnership between the Flathead Indian Reservation and UM, pairs Native cultural activities such as drum making and beading with high-tech fabrication and STEM learning.

efforts, SciNation includes members from the tribes' health, natural resources and education departments; local K-12 schools; and UM. Our co-designed programs include our Science Learning Tent at local powwows, Science Bytes that embed STEM enrichment at free summer meal sites on the reservation, community family science nights and a mobile museum that travels to reservation schools.

A few years into our collective work, we realized there was still a gap between the change we wanted to create and our existing programming. Despite the desire to create a homegrown, Native tech workforce, we struggled to offer compelling tech experiences. In response, spectrUM and SciNation partnered with Tribal Education to co-create the Kwul'itkin Maker Truck, a mobile "makerspace" that weaves together cultural and conventional making and tinkering.

Named for the Salish and Kootenai words for "to make," the Kwul'itkin Maker Truck is modeled in part after the SparkTruck, a mobile makerspace developed at Stanford. With funding from the National Science Foundation, the maker truck's activities pair cultural activities like drum making, beading and basket weaving with high-tech fabrication techniques and STEM learning.

Bill Swaney, former head of Tribal Education and SciNation member; Nick Wethington, spectrUM's resident "maker"

and museum manager; and Herbert-Meny drove much of the design of the truck and its activities.

"We worked with SciNation and Tribal Education and brought our ideas for the truck and activities to each tribe's cultural committee," Herbert-Meny says. "Then we co-created with over a half-dozen tribal makers to develop activities that everyone felt excited about and invested in."

After our intensive, yearlong iterative design process, Swaney told me that the project was especially meaningful to him because he was "engaged from the inception of the project to its reality."

Lisa Blank, a research professor at UM's Phyllis J. Washington College of Education and Human Sciences, says preliminary findings suggest that these activities are sparking interest in technology, STEM and design thinking.

Recently, I asked Swaney to describe his greatest aspiration for the truck, and he replied, "I hope the demand for the maker truck on the reservation far exceeds our ability to supply."

If this happens, kids will still be in luck, as we are teeing-up for our next opportunity: partnering with Salish Kootenai College and other community partners to co-create an annual, reservationwide tech challenge with funding from the U.S. Department of Education.

## Montana Constellations

We now serve as the backbone of community-based, co-created initiatives in Missoula, the Bitterroot, the Flathead Reservation and, starting this winter, Billings. These initiatives, along with our original efforts, reach an estimated 200,000 people annually.

I have come to think of these efforts as constellations of hope and change. Each community partner is a unique star joined together by a collective purpose larger than itself, making it – including spectrUM – brighter and more impactful.

It's amazing to see where a small idea, a new way of operating and remarkable community partners have taken us.

*Holly Truitt is the director the University's spectrUM Discovery Area and its parent organization, the Broader Impacts Group. She is passionate about the collective power of community and higher education to transform the lives of the next generation. She regularly speaks, consults, publishes and teaches on co-creating collective change. She is the principal investigator for \$1.3 million in grants to enhance, research and disseminate BIG and spectrUM's community-based collaboration models. •*



"It is only when one ascends the mountains that the grand panorama is unfolded, and the book of nature is spread out, as it were, where an invitation is extended to all who will read."

— Morton J. Elrod,  
naturalist and founder of  
UM's Flathead Lake Biological Station

Flathead Lake as viewed from the east shore.





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