8-2016

August 2016 news items

Office of Vice President for Research

2016 Archived news items

Freshwater specialists keep fresh waters ... fresh

Contact: Paula M. Davis

Aug. 24, 2016

Read more about WMU researchers and their ongoing work in the WMU Magazine.

KALAMAZOO, Mich.—Using a remotely operated underwater vehicle, an ROV, **John Lutchko** helps explore the subsurface waters around Traverse City, including in Grand Traverse Bay, a bay of Lake Michigan.

WMU student and NMC staffer, John Lutchko, center, explains the finer points of piloting one of the community college's remotely operated submarine vehicles in the West Arm of Grand Traverse Bay in Traverse City. WMU senior Alexis Lee, left, has her hands on the controls as fellow student Sarah Ballard looks on. They used the sub to view quaggi mussels, an invasive species in the Great Lakes.

"Research is so fascinating, and there's plenty to be done," says Lutchko, who this summer will be the first graduate of a joint degree program in freshwater science and sustainability offered by WMU and Traverse City-based Northwestern Michigan College.

The linked degrees, an associate from NMC that leads to a bachelor's from the University, prepare students to become the next wave of professionals who will solve problems related to freshwater quality, availability and use.

Lutchko has been a top student in both schools. This year, he was named WMU's environmental and sustainability studies Presidential Scholar, a designation that is the highest academic honor the University bestows on undergraduates. And after earning his associate degree, NMC hired him as its marine technology lab coordinator and primary ROV pilot.

"These two programs have been so engaging," he says. "Whether it's watershed science at NMC, where we do field work, or freshwater ecology, or (WMU Professor **Charles Ide**'s class on Human Impacts on the Great Lakes), getting out and doing work. That's the way you learn for sure."

VIEWING INVADERS

Dr. Hans VanSumeren, head of NMC's Great Lakes Water Studies Institute, explains to WMU students the workings of the remotely operated submarine vehicle shown in the foreground.

On a sunny Saturday morning in June, as part of the human impacts course, WMU students took turns learning how to pilot an ROV while aboard the Northwesterner, NMC's 56-foot research vessel.

Research and monitoring dives in Traverse City underscore what a gem Michigan's freshwater lakes are and, importantly, such excursions reveal some of the invasive species that threaten them, including quagga mussels, gobies and other invaders.

In the West Arm of Grand Traverse Bay, not far from the community college's Great Lakes Campus, students searched for the Nyord, a boat that sank in the 1970s.

Intently gazing at a screen that displayed live video from an ROV, WMU student **Sarah Ballard** followed Lutchko's directions for remotely "flying" the vehicle, her hands operating what looked like a joystick.

"Don't use the up thruster," Lutchko advised. "Thrusters kick up debris. Let it float up."

Ballard complied.

"Now go back and forth."

Soon enough, the murk cleared, uncloaking life some 50 feet beneath the surface of West Bay. Lutchko gestured to a tiny fish that darted into the frame.

"See the goby?"

"I see the goby … right … there," a rapt Ballard responded slowly, trying to discern shapes on screen.

Indigenous to the Black and Caspian seas, gobies are not welcome in Michigan's Great Lakes and inland waters, as these bottom-dwellers eat the eggs of native fish and compete with native species for food and habitat.

The point of viewing the shipwreck that day was to see firsthand the proliferation of quagga mussels, a habitat-destroying invader that students learned is profuse in the Great Lakes Basin. About the size of a quarter in adulthood, the bivalves came over in ballast water of transoceanic ships.

"These organisms have very few natural predators here and they just thrive," says Ide, the biological sciences professor who teaches the human impacts course.

Quaggas, and the also-invasive zebra mussel, filter feed, which increases water clarity. This may sound beneficial, or even benign, but clearing subsurface waters like this allows algae to grow at increasingly greater depths.

Students found that the Nyord is caked in quaggas, one example of a widespread problem.

"There's a quadrillion quagga mussels (in the Great Lakes Basin), and they're here to stay," Lutchko says.

“You can’t just go and kill them all because you’re going to kill a lot of other things in the process. There is nothing we can do; but we have to keep an eye on what’s going on. That’s where the monitoring comes in.”

HOLISTIC AND HANDS-ON

Like this weekend in Traverse City, along with classroom-based instruction, freshwater science and sustainability students get direct experiences in some of the ecosystems they are learning about and may go on to encounter in watershed management, environmental consulting or the other fields they will be prepared to pursue.

“Building a cohort of good scientists who have multidisciplinary skills is what this is all about,” says **Dr. Hans VanSumeren**, director of NMC’s Great Lakes Water Studies Institute and co-founder of the community college’s freshwater studies degree, the first associate degree of its kind in the nation when it was established in 2009.

Several years ago, NMC and WMU officials began talks about joining forces in a program of study that could lead from a two-year degree at NMC to a bachelor’s degree at WMU. The program launched in 2014.

“The program covers biology and ecology, but it’s also got policy, data processing, oceanography, climate (science), business and communication. It’s holistic. Industry wants people who know how to do a lot of stuff,” VanSumeren says.

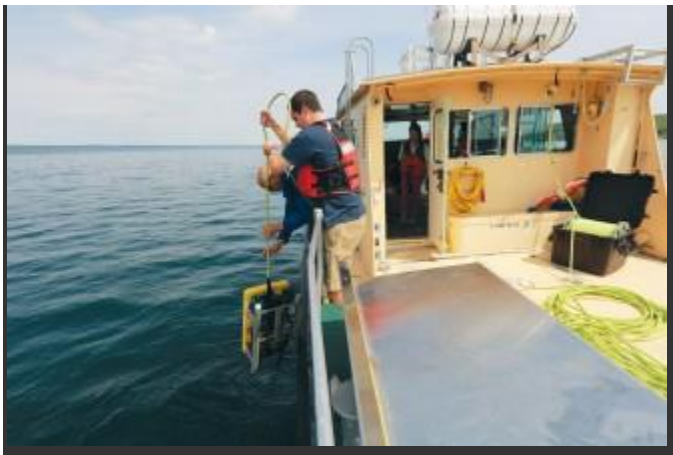
With its surrounding Great Lakes containing 20 percent of the world’s surface freshwater, “Michigan would have to be the best place in the country, and maybe in the world, to study freshwater,” says **Dr. Steve Kohler**, professor of biological sciences and director of WMU’s Environmental and Sustainability Studies program.

“One, there’s the quantity. But the other reason is the diversity of systems. The diversity of types, both the lakes and rivers, is outstanding. You have different ecosystems to study. We can’t show students tropical systems, but we can show them just about everything else.”

Students who want to complete all of their freshwater science and sustainability studies in Traverse City may enroll at NMC and earn an associate degree, then transfer to WMU-Traverse City to complete the final two years of coursework required for a bachelor’s degree.

Students also may enroll in the bachelor’s-only version of the program offered on WMU’s main campus in Kalamazoo.

A DESIRE ‘TO KEEP FRESH WATERS ... FRESH’



WMU biology major Zack Ladwig helps VanSumeren retrieve a submarine.

Taking Ide’s class was an eye-opening experience for **Sierra Porter**, a sophomore majoring in freshwater science.

The course is based on Ide’s years of research funded by Environmental Protection Agency grants. In addition to invasive species, his students learn about how pollutants, such as polychlorinated biphenyls—PCBs—in the Great Lakes and inland waters impact ecosystem and human health.

Each student had a capstone project; Porter’s presentation was on persistent organic pollutants, such as PCBs. Though production of these industrial chemicals has been banned in the U.S. for almost 40 years, they persist in the environment.

“Now, more PCBs come into Lake Michigan from other parts of the world through weather,” Ide says. “They come over the lake and get rained down. So, it’s like a global problem.”

PCBs have been found in animal tissue, including that of eagles, water fowl and game fish. The contaminant is one of the reasons state government issues advisories on how much and what type of fish are safe to eat.

As an example of just one ill effect, for a developing fetus, high concentrations of PCBs can interfere with receptors that tell the brain and muscles how to use calcium.

“If your brain isn’t using calcium right, in human development, the brain doesn’t develop properly,” Ide explains

So, a child may be born with learning disabilities and low IQ.

“The PCB contamination has really opened my eyes,” Porter says. “I want to get more in depth and learn about what other contaminants aren’t being brought to the surface. Why aren’t they being talked about? Why isn’t anything being done about these?”

When she completes her degree, Porter hopes to “work toward keeping our fresh waters, just as they say, fresh.

“I’m not sure where that’s going to take me in life, but being in science is always a thrill, and to study in this program has already given me many opportunities to meet other scientists with the same dream as mine.”

For more information about freshwater science degree options, go to wmich.edu/academics/undergraduate/freshwater or contact Dr. Steve Kohler at steve.kohler@wmich.edu or (269) 387-2987, and NMC’s Great Lakes Water Studies Institute at (231) 995-3333 or visit nmc.edu/water.

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Multitalented microbiology student highly lauded for her scholarship

Contact: Paula M. Davis

Aug. 24, 2016

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KALAMAZOO, Mich.—**Carol Beaver** has long been the inquisitive sort, a creative mind fueled by versatility and the notion that there is always something new to discover. Her past professions speak to this. After earning a music degree, the viola player taught general music in an elementary school. For quite a different challenge, she later joined the U.S. Marine Corps, working as an aircraft mechanic on combat jet ejection seats.

“Maybe because I was more interested in science and how things are put together,” she says.

In ensuing years, Beaver focused on mothering three children and managed a restaurant. But she longed to return to school and at WMU found a new passion—environmental microbiology—while completing a biomedical sciences degree.

Carol Beaver has long been the inquisitive sort, a creative mind fueled by versatility and the notion that there is always something new to discover.

“I think I became interested in microbiology because there are a lot of organisms that are not known and named, and I figured there’s a good chance that I would find something new,” she says.

Beaver now is in the homestretch of completing a doctorate at WMU and already is distinguishing herself as a scientific investigator, racking up a series of awards. Her latest accolades include being named a Gwen Frostic doctoral fellow for 2016-17 and receiving the MPI Outstanding Graduate Research Award. And the Department of Biological Sciences nominated her for the 2016 department-level Graduate Research and Creative Scholar Award, sponsored by the Graduate College and the Graduate Studies Council.

“Western has been a great place to be,” Beaver says. “I’ve been given opportunities here that I wouldn’t have had going somewhere else. For one, there aren’t many people who work in biogeophysics. The whole field is new.”

In her doctoral studies, Beaver has been conducting research at the famed Bemidji, Minnesota, oil spill site with biological sciences **Professor Silvia Rossbach** and **Dr. Estella Atekwana**.

Atekwana is a former WMU professor who pioneered the sub-discipline of biogeophysics and is today an Oklahoma State University geological researcher. Biogeophysics is concerned with how microorganisms, such as bacteria, influence geological material, such as sediment and rock. Only during the last few decades have scientists recognized this interaction.

Rossbach's and Atekwana's labs collaborate in research on the Bemidji oil site, a forested area that was heavily contaminated when a pipeline rupture in 1979 caused more than 100,000 gallons of oil to surge into the land. Because the oil leaked into what is a remote area near Bemidji and does not impact community drinking water, the petroleum was not completely cleaned up so that scientists could study how such oil spills are naturally degraded by microorganisms. What U.S. Geological Survey and academic researchers have discovered on site has been used to address oil spills around the globe, according to the USGS.

WMU researchers, including Beaver, are working to contribute to that body of knowledge.

"I find it very interesting what microbes can do to the environment," Beaver says. "I think that for a lot of the problems we have today, some of the solutions might be found in encouraging or manipulating microbes to deal with some of these environmental situations.

"With an oil spill, a lot of times, the only way you can fix it is by the microbes breaking it down and degrading everything and turning it into carbon dioxide, or methane, to get rid of the contamination," she explains.

Her research involves analyzing how this natural remediation affects certain geophysical characteristics of the surrounding environment.

“And if they do affect them, what geophysicists could do is put probes in the ground and use them to monitor the bioremediation. It would be a lot cheaper and a lot less invasive to stick a probe in the ground and watch it all the time versus continually digging long cores.”

Rossbach, Beaver’s graduate advisor and mentor, says her student “has really achieved at a high level.”

“Carol’s research will have great impact on not only one, but two disciplines, microbiology and geophysics.”

Learn more about WMU's biomedical sciences programs at wmich.edu/biology/academics.

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Degree research evolves into new company for WMU alumni in semiconductor industry

Contact: Paula M. Davis

Aug. 25, 2016

Read more about WMU researchers and their ongoing work in the WMU Magazine.

KALAMAZOO, Mich.—**Dr. Deepak Ravindra** became a business owner at the same time he completed his doctoral degree through a unique collaboration with a faculty researcher focused on developing methods to machine extremely hard and brittle materials.

Ravindra worked with **Dr. John Patten**, former chair of WMU’s manufacturing and engineering department, to launch Micro-Laser Assisted Machining Technologies LLC in July 2012. The new technology they have developed utilizes a diamond-cutting tool capable of focuses gigawatts of laser power onto a concentrated surface to soften the material so a diamond can easily cut it.

“People cut with diamonds, people cut with lasers—we merged the two into a hybrid device,” Patten says.

Dr. Deepak Ravindra displays one of Micro-LAM's diamond-cutting tools.

The technology could replace the current method for making advanced engineered ceramics and semiconductors smooth—a lengthy and expensive polishing process.

"In the machining industry, materials are getting better, but the manufacturing of them is getting trickier," said Ravindra, who earned his bachelor's, master's and doctoral degrees at WMU.

"When I entered the Ph.D. program, I was looking for a dissertation project in which I solved either a societal or industrial problem. Three to four companies that we were already working with had a grant for this kind of research, so we collaborated. John submitted an NSF proposal and was awarded close to $1 million, so I decided to do my Ph.D. along those lines."

The CEO peers inside a laser-assisted machining setup at the company.

As part of the process to launch a business, in March 2012 Patten and Ravindra were selected to attend an Innovation Corps boot camp hosted by Stanford University and the National Science Foundation with their product, where they were required to interview a minimum of 100

potential customers. Acceptance into I-Corps came with a $50,000 grant to help. The NSF provided another $850,000 to get the company off the ground, which has already received state-level recognition as a semifinalist in the Accelerate Michigan business plan competition. Micro-LAM now leases a manufacturing facility owned by Battle Creek Unlimited, an economic development and business assistance resource in Battle Creek, Michigan.

Within two years of completing his Ph.D., Ravindra had engaged with about 160 prospective companies to identify 25 as strategic partners—a group that has a cumulative value of about $100 billion.

“We have grown from a one-person company to a staff of nine, which includes WMU graduate and undergraduate students,” he said. “I am very proud of WMU, and almost everyone working with me has a WMU connection. It is a great sense of accomplishment to see things happen and to make an impact in such a short period of time.”

As a young man new to WMU’s campus, Ravindra said his goals were very lofty and he aspired to “solve every problem on the face of the earth.” He soon figured out how little he knew about the engineering world he intended to enter, but said he found plenty of chances to learn what he needed to know to become a successful researcher and business owner.

“In WMU’s engineering college, even as undergraduates, we were taught to engage very closely with industry,” Ravindra said. “Many students at other universities don’t get to do that, which can cause a huge disconnect between the academic and real worlds. Students need that engagement to become marketable. They need to have meaningful senior research projects and to go through the entire process to see how things work in a commercial setting. It is important to me that my company inspires a spirit of entrepreneurship in our employees.”

And well remembering his own academic roots, Ravindra also is “paying it forward” with current WMU students; more than a dozen have interned at Micro-LAM since its inception.

For more information about the WMU College of Engineering and Applied Sciences, visit wmich.edu/engineer.

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The other potent greenhouse gas

Contact: Paula M. Davis

Aug. 25, 2016

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KALAMAZOO, Mich.—Carbon dioxide is often discussed as the driving force behind global climate change.

Research has shown that excessive carbon in the atmosphere as a result of humanity's unrestrained penchant for burning fossil fuels is contributing to throwing the Earth's climate systems out of whack. And human activity has increased the warming effect of atmospheric carbon, according to climate scientists.

"We're dialing up Earth's thermostat in a way that will lock more heat into the ocean and atmosphere for thousands of years," says **Jim Butler**, director of the National Oceanic and Atmospheric Administration's Global Monitoring Division.

But there's another critical atmospheric gas that is made much more potent due to that locked-in heat, affecting where clouds rain and how often they rain, leading to flooding in some places and drought in others.

The increased concentration of atmospheric carbon just happens to be the start of the whole climate change process, explains **Dr. Todd Ellis**, assistant professor of geography and an expert in atmospheric science, with specialties in weather research and climate education.

“Water vapor—the gas form of water—is a way more potent greenhouse gas than anything that comes out of the fuel we use,” he says.

This doesn’t take humanity off the hook for creating a global climate conundrum; human activity just started an unfortunate chain reaction.

As Butler remarked, extra carbon dioxide in the atmosphere also puts extra energy into the Earth’s surface, warming the planet’s crust and its huge store of surface water. The Earth earned its colloquial moniker the Blue Planet because of this huge store of water; some 70 percent of the surface is covered by it.

“When the surface is a little warmer and the air near the surface is a little warmer, more water vapor can exist there,” Ellis says. “We call it the water vapor feedback. A little change in the things we control create much bigger changes in the amount of water vapor.

“So, we care about the greenhouse gases we make. But it’s the effect of those greenhouse gases on the big one—water—that tends to drive energy. It also changes where it precipitates and how often, pretty substantially in fact.”

RISING WATERS

By way of example, for the past several years, parts of Texas, namely the Houston area, have dealt with devastating floods. During the spring of 2015, rain came down in torrents, resulting in property damage in wide swaths and even fatalities.

A dog plays in standing flood waters near Houston.

Again in the spring of 2016, torrential rain came for the region, with much the same result. In Harris County (Houston is the county seat), 240 billion gallons of rain dropped onto the community during one 24-hour period in mid-April that year, according to the Harris County Flood Control District. Harris and surrounding counties were deemed a federal disaster after storms waylaid the area for several days.

While one can't point to a single weather event like this one and conclude it is the result of climate change, patterns matter, Ellis says.

"Houston has had a bunch of these (rain events) over the last decade and a half. ... That is something we can point directly to climate change and its impacts on water vapor. You put more water into the atmosphere, and then the right system comes along, and it's got all of that extra water to tap into and turn into rain."

Harris County is in southeast Texas, just 50 miles from the Gulf of Mexico. As a result of its proximity to the gulf, there is a ready supply of surface water to be converted to water vapor, and so the air is often near its maximum limit of moisture, Ellis explains.

"The primary thing that defines that upper limit (of water vapor) is the temperature. As the atmosphere warms, that limit is just going to keep going up, increasing the amount of water vapor that can hang around in the atmosphere waiting for some system to come along and tap into it."

So, that's a wet area getting even more so. But how does climate change result in arid places becoming more parched?

Think back to elementary school Earth science lessons on the hydrologic cycle. In this process, water evaporates from the surface, moves through the atmosphere, condenses as clouds and

returns to Earth as precipitation. But as the climate warms, studies have shown that the water cycle slows down.

“If you could put a tracking tag on a single water vapor molecule and watch it go through that whole cycle, you’d see that for a doubling of carbon dioxide, (the molecule’s) journey is slowed by a few days,” Ellis explains.

So, a process that would normally take seven days, for instance, could take nine or 10. While that delay doesn’t seem very substantial, Ellis says “the impact is essentially how easy is it for us to see rain form and when it does form, how much rain falls.

“When storms occur, more rain falls, but that, in turn, deprives other areas from accessing that water. So it has two impacts put into one simple phrase: The wet areas get wetter and the dry areas get drier.”

While Houston’s water-related woes offer an example of what can happen with an overabundance of precipitation, other areas of the western United States have suffered from ongoing dry conditions.

During 2016, Lake Mead, the largest man-made reservoir in the United States when at capacity, hit its lowest level since it was created some 80 years ago. Thanks to about 16 years of drought coupled with demand for water, the lake was at 37 percent of its capacity in May 2016, according to the U.S. Bureau of Reclamation’s Lower Colorado Region. Formed by the Hoover Dam, the reservoir serves Arizona, California and Nevada. When this resource shrinks, the impact is felt by people, animals and business, including agricultural industry.

FOLLOW-ON EFFECTS

There are myriad ways both scarcity and excessive water lead to suffering and economic stress.

“Those stresses hit all of us, but it’s going to hit the people who are already at a socio-economic disadvantage first because there’s no safety net. That works both within our own society and when looking at countries as a whole,” Ellis says, pointing to the crisis that led refugees from Syria to flee for safe havens in Europe.

"While the refugee crisis around Syria has more to do with war than it does water, that is a part of the world that has had civilizations collapse because of lack of rainfall in the past. ...

“Pakistan has had the opposite situation, really significant flooding, and they don’t have the infrastructure to deal with it either. So it really starts to bleed into some significant geopolitical questions in places where you don’t want to have those kind of extra stresses,” he says.

Ellis opines that in a changing climate, understanding how water moves is one of the most important questions there is.

“There are a lot of important questions to be asked about climate change, but water is a resource for all of us. And none of us as humans has figured out how to live without it yet.”

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