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The cover image is of tending water and listening at Water Bar in Greensboro, North Carolina, courtesy Shanai Matteson, Works Progress, and Water Bar & Public Studio.

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Editors

Contact Us

Open Rivers
Institute for Advanced Study
University of Minnesota
Northrop
84 Church Street SE
Minneapolis, MN 55455

Telephone: (612) 626-5054
Fax: (612) 625-8583
E-mail: openrvrs@umn.edu
Web Site: http://openrivers.umn.edu

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TEACHING AND PRACTICE

MOSQUITOES, MUCK, AND MUSSELS: A LOOK INTO SCIENTIFIC RESEARCH

By Lea Davidson, James Doherty, Laura Gould, and Hayley Stutzman

In 2014, the University of Minnesota, Macalester College, and the Minnesota Department of Natural Resources began work on a multi-year study of mussel health in selected Minnesota rivers. The research, funded by the Legislative-Citizens Commission on Minnesota Resources, combined experimental study with field investigation to explore relationships between specific indicators of water quality and biological measures of the health of particular organisms. Mussels are bottom-dwelling filter feeders, and are therefore important "indicator species" of stream water quality. The work described in this article was a significant component of the broader, three year project.

– Patrick Nunnally, Editor

The aspiring young undergraduate scientists envision fieldwork as a romantic escape from the office cubicle, classroom desk, and seemingly endless pile of homework. Working alongside experts in their field, they anticipate working in the wildest regions of the world: dense tropical forests, remote mountain ranges, and distant glacial rivers. They see themselves on the forefront of groundbreaking discoveries: truly shattering the scientific community with a cure for Malaria, discovery of a new species, or theory of planetary evolution. Envisioning numerous publications and grad school offers, becoming leaders in their field and gaining tenure, the

Field work in the Minnesota basin differed from that of the St. Croix. The rivers were murkier and often lined by agricultural land. Image courtesy of Mark Hove.

undergraduate scientists see the ease and simplicity of a straightforward and successful career trajectory.

Spending a hot summer day clothed entirely in neoprene, amid swarms of mosquitoes, wading into the dark, murky brown waters of agricultural rivers, is not what young scientists have in mind when they envision cutting edge research. Though an extreme example, this was one of our many experiences conducting fieldwork throughout the rivers of southwestern Minnesota. As undergraduates at Macalester College, in Saint Paul, Minnesota, we worked alongside professors Dan Hornbach (an ecologist), Kelly Macgregor (a geomorphologist) and Mark Hove (a University of Minnesota and Macalester College biologist), studying the relationship between suspended bed sediment and native freshwater mussel populations. Geographically, our fieldwork spanned the Cottonwood, Le Sueur, and Chippewa Rivers, tributaries in the Minnesota River basin, as well as the Snake River of the St. Croix River basin. Searching for freshwater mussels, we measured mussel growth rings to gather information regarding growth rate and establishment success, while collecting sediment samples to inform our understanding of the composition of the riverbed.

This was hard work. But it was also important work. Monitoring of native freshwater mussel populations provides insight into the health of a river system. Without mussels, streams lose an important source of riverbed stability, because mussels anchor the sediment as they burrow. Mussels also filter the water column, converting suspended particulate matter into biodeposits. Furthermore, the data we collected on the state of mussel populations in these river systems contributed to an ongoing database of the Minnesota DNR.

Outside of Mora, Minnesota, students work together to gather quadrat data in the Snake River. Image courtesy of Mark Hove.

What exactly does a summer in the rivers of rural Minnesota look like? Each week in the field begins with the packing of Big Blue, our trusty transportation to our research sites across the state, with the tools and equipment we had Macgyvered: an inner tube covered in mesh for towing instruments, a net designed for aquatic insect capture reimagined for particulate sediment collection, pieces of pool noodle attached to dive weights to mark quadrat locations. Next we'd drive to a site, often stopping on the way to drop our belongings off at a local hotel, our new home for the next night or two. Upon arrival, we'd wriggle into our neoprene wetsuits, ideally in a windy area where the mosquitoes wouldn't find us, and securely tuck mosquito nets into our necklines as our final form of protection. With equipment in hand, we looked more like astronauts ready to step foot on the moon than undergrads about to go snorkeling for mussels.

A Day in the Field with Laura

The first time going underwater in the Snake River, where we began the summer, was a mix of experiences. For starters, it was breathtaking, both literally and figuratively. Before this summer, I had never snorkeled and had never seen a mussel filtering in a stream bed. The first *Lampsilis cardium* (the species of native mussel species, and honestly could only identify that species if I was lucky. As the summer progressed, allowing for countless opportunities to learn through exposure and from my brilliant professors, the world beneath the river's surface was no longer such a mystery. Despite an identical routine, the experience differed greatly in the

The research team wade their way downstream to their first quadrat point at a site along the Cottonwood River. Image courtesy of Mark Hove.

when they were right in front of our faces. It was the hottest days of summer, the rivers were smellier, and the fish more aggressive. Instead of exploring the underwater world with our snorkels, we pawed the ground blindly trying to feel the difference between rock and mussel. Here, we perfected the two-person digger technique, where in swift currents one member of the team braced themselves against the force of the water while the other used their leg as a guide and anchor to get enough leverage to dig up the sediment. By the time we finished gathering data at any site, we were always ready for a drink and snack to replenish our energy lost from swimming, digging, snorkeling, lugging equipment, and walking in weight belts, all under the summer sun. When we finished our last site of the day, we were itching to get out of our suits, wash off the river water, and fill our growling stomachs. There was nothing romantic about conducting fieldwork in rural Minnesota, yet it was truly an unforgettable and incredible experience. Spending time in ecosystems on the brink further reinforced the importance of conservation.

Crunching the Numbers

Most weeks we didn't spend more than three days in the field, and albeit exhausting, the other two days were spent in the lab at Macalester College. Here, we began the long process of sifting through and digitizing our data, requiring initial long hours using Excel before we could analyze our data in more interesting programs such as JMP and Gradistat.

Field work in the Minnesota basin differed from that of the St. Croix. The rivers were murkier and often lined by agricultural land. Image courtesy of Mark Hove.

Our sediment data required more physical manipulation. After hauling many bags of what appeared to be sand into the lab, we poured the sediment into metal pans to dry in an oven. We initially weighed, then sifted the sediment through sieves of various mesh sizes, before weighing the total amount of sediment collected in each one. This allowed us to understand specifically what sediment grain size was present at each research location, and connect this to our data on mussel density, species, and size at each site.

The main goals of our data analysis was to determine trends in mussel diversity, abundance, and growth in relation to sediment composition across the rivers. Our quadrat data confirmed findings from previous summers that mussel were more dense in the Snake River. This data was further inputted into the Minnesota DNR mussel database for future use in monitoring native freshwater mussel populations in these rivers. The measurements of growth rings and sex taken during our searches for *L. cardium* were used to compare trends in mussel growth rates and maximum growth size across the different rivers. Findings related to bed sediment composition provided representative information on mussel habitat, a factor influencing overall growth and population success.

After digging up everything in the quadrat, the load is lifted out of the water and dumped onto the mesh covered middle of the inner tube. Here, the sediment is thoroughly searched for mussels (live or dead) and shell fragments, and assessed for sediment composition. Image courtesy of Mark Hove.

Looking to the Future

While our work during summer 2017 produced many answers, it simultaneously opened the door to twice as many questions. We learned the "what"—what was happening to mussels, these benthic communities, and in the separate river basins as a whole. But what it left us with were the "whys"—what were the reasons behind these changes in bedform composition? Why were mussels in the Minnesota River basin initially growing more rapidly? And why were we seeing fewer mussels in the entirety of this system? Though our work allowed us to connect some of the dots, it produced more intriguing questions for pursuit. This is one of the main reasons many of us find science so exhilarating; the quest to find the answers never ceases.

The work we do continually sparks our own curiosity. It was exciting to share the interest in the fascinating workings of mussels with the greater public. We often interacted with locals while out in the field, knocking on front doors to ask if we could walk through fields and making conversation with passing fishermen. Many times people were amused to see us decked out in wetsuits, digging in the river, but simultaneously genuinely interested in the "clams" in their own backyards. They, too, are curious, about the details of the environment in which they live, and why these details could be interesting to strangers snorkeling in their river. For many of these communities, environmental issues are close to

Ready for a day in the field, the student researchers stand on the banks of the Snake River. Image courtesy of Mark Hove.

the heart, as their livelihoods centered around either farming or tourism in the form of outdoor recreation. Regardless of environmental protections, the Minnesota and St. Croix River basins have undergone varying levels of environmental alteration over the past century. Engagement with communities affected by change is often overlooked by those in power, but often these opinions and observations are among the most valuable. We not only gained important tips—like which sections of the river to avoid due to swarms of mosquitoes—but also learned about changes these communities have observed from many generations living on the banks of the Minnesota and the St. Croix Rivers.

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About the Authors

Lea Davidson is a senior biology major and geology minor at Macalester College in Saint Paul, Minnesota. Her academic interests lie in human-environmental interaction, specifically via conservation biology and geomorphic processes.

James (Mac) Doherty is a junior geology major and data science minor at Macalester College in Saint Paul, Minnesota. He enjoys being outside, drinking good coffee, and learning about hydrogeologic issues.

Laura Gould is a senior environmental studies and geography double major at Macalester College in St. Paul, Minnesota. She loves learning about ways to better connect people with their environment, specifically through food and agriculture.

Hayley Stutzman is a senior biology major and statistics minor at Macalester College in St. Paul, Minnesota. She is interested in finding creative solutions to environmental problems and likes doing data analysis.