

St. Croix Watershed Research Station Highlights of 2015 - 2016



Sentinels of global change

Most people think of remote boreal lakes, such as those found in Minnesota's Boundary Waters Canoe Area, as pristine ecosystems that are protected from human impacts, but new research led by Station scientist Adam Heathcote is changing the way we view these ecosystems. In a recently completed project, Heathcote, Station Director Dan Engstrom, and an international team of colleagues demonstrated that these lakes are being altered by human-induced global change. Using data from remote lakes across North America, including many from northeastern Minnesota, the research team showed a doubling in the rate at which these lakes sequester (bury) carbon in their sediments over the last 100 years. These changes are linked to fertilization of the forest and lakes by atmospherically deposited nitrogen (released by industrial pollution) and may become even greater in response to a warming climate. On its face, increasing CO₂ burial may seem like a good story, but it is unclear what effect these changes are having on



Station scientist Adam Heathcote breaking through early November ice to sample a remote lake in northern Québec

the lakes themselves. Where is this additional carbon coming from? Are these lakes becoming more tea-colored from increasing watershed runoff? Are nuisance algae blooms becoming more frequent due to nitrogen fertilization? The boreal forest is the largest land biome and home to the largest concentration of liquid freshwater on Earth. This means that understanding how global change will impact these lakes is important both to our understanding of the cycling of greenhouse gases and to the future of our most precious resource: fresh water.



Sleuthing the St. Croix watershed

"Come, Watson, come! The game is afoot," said Sherlock Holmes in *The Adventure of the Abbey Grange*. So it is with our investigation into nutrient sources entering Lake St. Croix. These nutrients feed algae blooms that foul the waters, and to stop the blooms, we must find and treat the source, not just the symptoms. To do this, scientist Jim Almendinger is using a watershed modeling program called SWAT (Soil and Water Assessment Tool). However, it could be a contraction of "Sherlock" and "WATson", because the model has a two-fold purpose. The "Sherlock" purpose is to identify nutrient sources by simulating the rainfall-runoff processes that carry sediment and nutrients from uplands into the river. The model can trace nutrients upstream and uphill to their source.

Once these sources are identified, the "Watson" purpose is to try to heal these sources. (Remember, Watson was a medical doctor

with field experience in the British colonies.) Agricultural best management practices (BMPs) will be simulated in the SWAT model to estimate how to treat these sources to reduce their delivery of sediment and nutrients. Every gain that can be made in the greater watershed will help offset possible impacts of the new Stillwater bridge and subsequent development. The Sherlock portion of the project has been recently completed with the final polishing of the St. Croix SWAT model (see figure). The Watson portion has just begun and should be complete by March 2016.



Big lake surprises

It's hard enough to study an average lake, but how do you study one the size of Lake of the Woods? At 60 miles wide, where do you begin? Working in collaboration with the Minnesota Pollution Control Agency and other partners, we started where we often do - with the sediment record. We mapped it, cored it, and analyzed the sediments to determine that the lake has had a rough past trying to deal with excess nutrients from industry and cities up until the 1970s. Pollution controls significantly reduced nutrient loading to the lake, but those legacy nutrients still lurk in the sediments. Is that why the lake continues to have nutrient-loving diatoms and large blue-green algae blooms? In June, Station scientists Adam Heathcote and Mark Edlund set out to answer that guestion. Bucking four- and five-foot waves in an 18-foot boat, they installed three permanent monitoring buoys and sediment traps in southern Lake of the Woods that would record temperature and dissolved oxygen profiles every 30 minutes all summer - that's 150,000 data points! What they learned was front page news in Canada and Minnesota – Lake of the Woods stratifies many times each summer, and when it does, oxygen levels plummet in the bottom waters. That pulls phosphorus out of the sediments into the water and, when the wind howls, those nutrients and sediments are mixed into the water to fuel algae blooms. Using conventional monitoring, we never would have learned how often stratification occurs and how it drives nutrient cycling. One buoy was left in the lake for the winter, and the others will be redeployed next year to continue our study on how Minnesota's second biggest lake behaves.



Edlund and Heathcote prepare a sediment trap for deployment in Lake of the Woods

Reaching out / sharing our science



Greg Seitz paddling the St. Croix with daughter Annika

Science does not always speak for itself, and doing important environmental research isn't enough on its own to inform the public and policy-makers but sharing that work can provide a better understanding of our water-quality problems and their possible solutions. Ongoing Station communication efforts include the annual Research Rendezvous, public and Friends events, and a stellar record of scientific publications. We have now launched several new electronic and social media outreach projects. A new quarterly electronic newsletter called "Field Notes" has succeeded a print edition, and a Station blog and Facebook page are updated weekly. Greg Seitz, a well-known science and environmental writer (creator of St. Croix 360), is producing all of these products in close collaboration with our scientific staff. In addition, our scientists currently

contribute to public discourse on water quality through dozens of presentations to public audiences each year, at scientific conferences around the world, and to many citizen groups and advisory or legislative panels in the State and region. By explaining the methods our scientists use to answer important water-guality guestions, and what their work reveals about challenges and solutions, we can help the region better protect the St. Croix River and watersheds far and wide.



oxygen-free chamber

(right) Lab manager Michelle Natarajan with Icaro Macedo



Interns contribute to research

Introducing a new generation of scientists to environmental research has been the Research Station's main educational goal since the inception of its research program in 1995. In 2015 and 2016, several college-level students gained hands-on experience with our staff scientists. Icaro Macedo of Brazil worked with Lab Manager, Michelle Natarajan, for two months, following a year studying at the University of Wisconsin-River Falls. Icaro learned analytical techniques while assisting staff scientists with work on phosphorus cycling in Minnesota lakes. He has returned to Brazil to complete his undergraduate degree in marine geology.

Lauren Mitchell joined the Station as a full-time Water Resources Intern in May, 2015. Lauren earned her undergraduate degree from the University of St. Thomas, with majors in Environmental Science and Biology and a minor in Geology. She has already participated in sediment core sampling on South Center and Kansas lakes and works on all the major laboratory equipment completing analyses for Research Station projects. Lauren will work with us through 2016.