NEWS FROM CREWS: JUDITH RIVER WATERSHED

SPRING 2022

IN THE FIELD

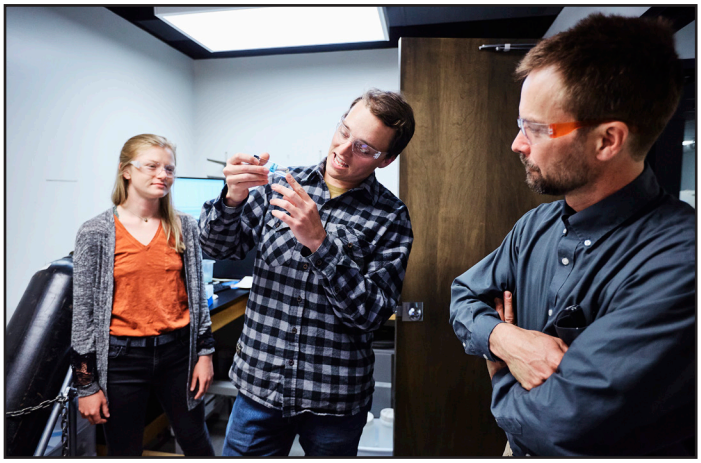
During 2021, our team of graduate students and undergraduate interns continued to investigate nitrate processing in stream-riparian corridors by observing solute concentrations in ground and surface waters and continuous sensing of stream chemistry. In the riparian corridor, MSU graduate student Caitlin Mitchell coordinated the installation of groundwater sampling wells, which provide perspective on the variation in specific chemical processes. This effort will ultimately help build confidence in our understanding of how riparian systems mitigate nitrate loading from cultivated terrace soils to surface waters. The team also sampled for water isotopes at each site, which provides a fingerprint for water at that location. In conjunction with winter sampling of snow and previous rain data, these water isotope analyses provide insight into water movement through the Moccasin terrace landform.

Working in the streams, MSU graduate student Madison Foster supervised use of high-frequency sensors to measure a suite of stream solute concentrations every 15 minutes, including nitrate, dissolved oxygen, dissolved carbon dioxide (CO_2), and electrical conductivity. As a part of the large sensor deployment campaign, autonomous CO_2 sensors were also co-located with other sensors. Qipei Shangguan, a graduate student working in the DeGrandpre Lab at UM, analyzed this high frequency CO_2 data. His aim is to examine temporal dynamics of CO_2 fluxes in relation to metabolism, landscape connectivity, and other important biogeochemical processes. In addition, undergraduate student Zoe Durkin focused on an initial exploration of water level variation as part of her summer internship research, and undergraduate student Sean Williams investigated spatial variation in surface water nitrate concentrations.

From L-R, undergraduate research intern Zoe Durkin and CREWS graduate students Skye Keeshin and Caitlin Mitchell use a YSI multiparameter water quality meter to measure conductivity, temperature, dissolved oxygen, and pH in Louse Creek. *Photo credit: Madison Boone*

Overall, our preliminary analyses demonstrate how both stream channel nitrate processing and connections between the stream channel and low nitrate riparian groundwaters collectively influence how stream corridors may reduce nitrate export downstream. We are eager to dig deeper into this rich dataset. Much of the initial analysis of this work, including the undergraduate internship research, was presented at the virtual meeting of the Montana Chapter of the American Water Resources Association in late October 2021 to an audience of state water managers and policy makers. Graduate students Caitlin and Madison will present further progress on this work at the Montana Aquatic Research Colloquium in early April.

IN THE LAB



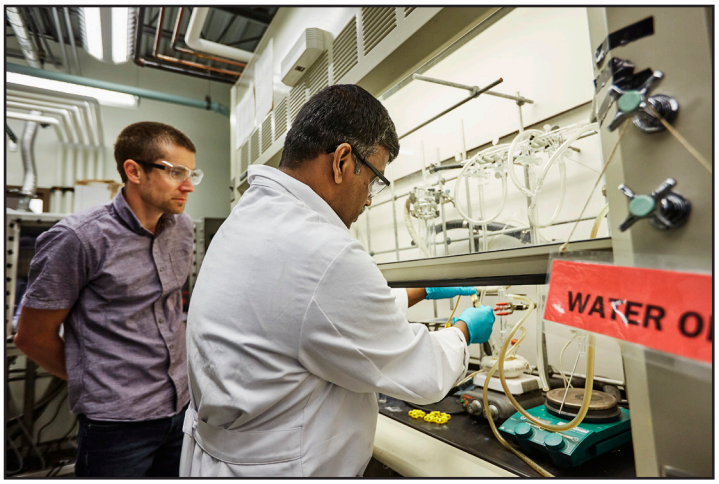
CREWS graduate students Madison Foster and Skye Keeshin and EAL Analytical Chemist and Lab Manager Toby Koffman examine and discuss a JRW water sample. *Photo credit: Adrian Sanchez Gonzalez*

In 2021 the MSU Environmental Analytical Lab (EAL) received 301 field samples. In these samples, they measured 24 analytes using five lab instruments. Because not all analytes were requested for all samples, the EAL ran 6377 total analyses. Although delayed by an issue with one of the lab instruments, all analyses were completed in late February. In addition to the field samples, the lab received 381 samples from sensor calibration and physical chemistry experiments. With these, they measured 1 to 3 analytes using two instruments. In total, they completed 1095 analyses from the sensor calibration and physical chemistry experiments. Overall, the grand totals for 2021 JRW projects included 645 samples and 7472 measurements. Several graduate students and undergraduates assisted with these measurements in the EAL, gaining valuable experience with analytical instruments.

IN THE LAB (CONT.)

Recent work in the Walker lab at MSU has focused on analyzing the effect herbicides have on lipid bilayer membranes using time-resolved and steady-state fluorescence spectroscopy. Specifically, the herbicide in question is Dicamba, an auxinic herbicide commonly found in measurable concentrations in Montana waterways. Using steady-state fluorescence spectroscopy, recent work has shown evidence of photodegradation of Dicamba over approximately 30 hours. Current efforts are focused on finding the exact degradation product using Mass-Spectrometry. Once a degradation product is known, the lab can more accurately analyze the specific chemical interactions that occur when Dicamba is introduced to a model biological membrane.

Current efforts in the Grumstrump lab are directed toward further elucidation of nitrate reduction mechanisms in natural and controlled composition water samples. Preliminary results show that nitrate reduction on the promising material, g-C3N4, exhibits little sensitivity to pH on product yield or reaction kinetics. In surface water samples obtained from the JRW, g-C3N4 substantially reduces nitrate concentrations, provided a sufficient dissolved organic carbon concentration exists to supply electrons in the overall catalytic cycle. Another ongoing thrust is examining the role of naturally occurring iron oxides in driving reduction of aqueous nitrite (NO_2^-) in the presence of dissolved sacrificial reductants.



CREWS postdoctoral researcher Shelton Varapragasam prepares model iron oxide nano materials to evaluate photocatalytic activity of naturally-occuring minerals in the JRW. *Photo credit: Adrian Sanchez Gonzalez*

IN THE COMMUNITY

Municipal water pump house in Roundup, MT. Roundup's public water source is a defunct coal mine. *Photo credit: Grete Gansauer*

The Judith River Watershed social science team has been busy writing up findings, preparing for a new round of data collection, and staying in touch with our local research partners in the Judith region. This past year, the team celebrated the publication of two articles. The first article, entitled "Social memory and infrastructure governance: A century in the life of a rural water drinking system," was published in *Environmental Research: Infrastructure and Sustainability*. The paper examines how shared social memories of water hardship impacts water governance decision making in the town of Denton (Haggerty et al., 2021).

The second paper, "Beyond city limits: Infrastructural regionalism in rural Montana, USA," was published in *Territory, Politics, Governance*. It analyzes the political geography of the Central Montana Regional Water Authority and its proposed regional water pipeline system (Gansauer & Haggerty, 2021). The team is currently in the final stages of preparing a third publication for submission. This article uses region-wide interview data to articulate the community resilience dynamics associated with drinking water governance in the Judith region.

In addition to writing about their recent findings, the JRW social science team collaborated with the Upper Clark Fork River (UCFR) CREWS social scientists throughout 2021 to develop a survey which assesses water quality perceptions, community resilience, and social trust. The survey will be dispersed in the winter 2022 with the goal of generating a comparative dataset across the UCFR and JRW regions. Finally, the team continued to stay connected to local research partners and participants through monthly meeting attendance and multiple field site visits in the summer and fall. In the coming year, the team anticipates the publication of at least one paper and looks forward to diving into quantitative analysis of survey data.

For more information about the Montana NSF EPSCoR CREWS project and the CREWS-JRW team please visit https://www.mtnsfepscor.org/projects/crews or contact Madison Boone at madison.boone@montana.edu