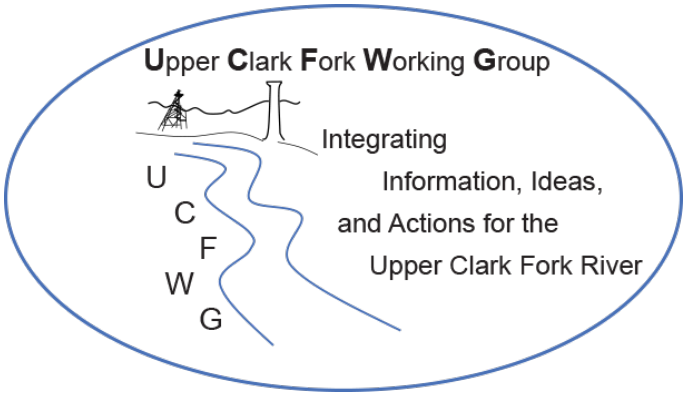


Upper Clark Fork Working Group Winter 2022 Newsletter

The goal of the Upper Clark Fork Working Group (UCFWG) newsletter is to help members learn more about the group, its meetings and activities, and relevant stories and opportunities. Have ideas and stories for upcoming newsletters? Please contact Madison Boone at madison.boone@montana.edu with your newsletter ideas, feedback, and questions.

Letter from the Directors

Dear UCFWG Colleagues,

This last fall the UCFWG was successful in facilitating conversations and relationships centered around the work that is happening on the Upper Clark Fork River and surrounding watersheds. This success is fully attributable to this excellent community of researchers, administrators, and contractors who repeatedly demonstrate their enthusiasm and care for this environment and willingness to work together. It is important to note that this success occurred despite the ongoing pandemic which has hampered more traditional meetings, workshops, and collaborations. Once again, we would like to thank those of you who shared your research during our topic discussion meetings and workshops and to those of you who were able to attend and make the discussion meaningful and insightful.

This fall one of the founders of this community and executive board member, Tom Parker, took a step back from his role in the UCFWG. We would like to once again acknowledge his contribution and the efforts that members from Geum Environmental Consulting have made toward the development of this community. His leadership greatly added to the success of this group. We will continue to see and hear from Tom as he and Geum remain actively engaged with this community.

The UCFWG is looking for individuals interested in helping drive our efforts forward as members of the Executive Committee. In particular, we are hoping to see leaders interested in championing the integration of research, monitoring, and management as has been our theme. Do not, however, be afraid to champion your favorite cause if you are interested in engaging in directing the group and its potential.

We will continue to meet once a month on the second Thursday of the month for the

foreseeable future to discuss various topics starting again this February the 10. For February, we will be inviting short reviews and new introductions for group content. During this spring, we also will sponsor several Workshops in 2022. Please reach out if you have a topic of interest or wish to lead a workshop or topic discussion. We are always excited to hear about your interest in the UCFR and will help facilitate both discussions and workshops.

Thank you, we look forward to seeing you this spring,
Maury Valett and Doug Martin

NEWSLETTER HIGHLIGHTS:

UCFWG Member Spotlight

Meet members of the UCFWG and learn more about their roles and work.

Fall 2021 Topic Discussions

Did you miss a recent UCFWG Topic Discussion? Want to revisit a specific topic or presentation? Find summaries of the most recent Topic Discussions and recording links below!

Upcoming Events and Opportunities

Learn more about upcoming UCFWG events, workshops, and other opportunities of interest, including information about the upcoming February 10 meeting!

UCFWG Member Spotlight

Nathan Cook grew up outside of St. Louis where he developed a love of streams and rivers floating and camping throughout Missouri. He obtained undergraduate and graduate degrees at the University of Wyoming. After working for the Wyoming

Travis Schmidt is a research ecologist working for the Wyoming-Montana Water Science Center. He received a Ph.D. in Ecotoxicology, Fish, Wildlife, and Conservation Biology from Colorado State University. His expertise lies in several fields, including ecology, toxicology, and climate change. He is especially versed in data science, environmental toxicology, water quality, and environmental science. Schmidt is dedicated to understanding how ecosystems respond to both natural and human disturbances. He is currently researching the effects of metals, pesticides, and other contaminants on aquatic and riparian ecological communities.

Game and Fish Department for several years, Nathan moved to Missoula to become a fisheries mitigation biologist with Montana Fish, Wildlife, and Parks. His work has focused on understanding the impacts of mining contamination on fish populations in the Upper Clark Fork River Basin and the response of those populations to restoration. Nathan is currently transitioning to a position with the Montana Natural Resource Damage Program and is excited to continue working on aquatic restoration.

2021 Annual Clark Fork Basin Meeting

From October 20-21, 2021, the United States Geological Survey (USGS) facilitated the Annual Clark Fork Basin Meeting, which invited researchers working on the Clark Fork River to present findings and studies that they are undertaking in the Basin, including many from UCFWG members. The meeting agenda and recordings from each day can be found on the UCFWG website or by clicking on the buttons below.

2021 ANNUAL CLARK FORK BASIN MEETING - DAY 1

2021 ANNUAL CLARK FORK BASIN MEETING - DAY 2

Fall 2021 UCFWG Topic Discussions

September 2021 - "Restoration Field Workshop Recap"

At the September UCFWG Topic Discussion, Tom Parker (Geum Environmental Consulting) gave a recap of the Restoration Workshop held on August 18, 2021. The purpose of the workshop aligned with the overall mission of the working group, which is to share science-based knowledge among people who are working and doing research on the Upper Clark Fork River (UCFR). The workshop was hosted by the Clark Fork Coalition at their Dry Cottonwood Field Center and supported by the University of Montana and the Natural Resource Damage Program. It focused on getting key participants together so that

they could become more familiar with the history and status of remediation and restoration work.

As part of the workshop, the attendees were split into seven groups. Each group visited two sites on the river: one that had been remediated and another that had not yet been remediated. Each person in each group filled out a form for both sections of the river that they looked at. They were asked to describe ecological components that were either present or lacking at the two sites. Parker directed each individual to survey the sites and record what they saw based solely on their own expertise and perspective of the river before discussing with their group. The groups reconvened towards the end of the workshop to summarize what they had found and present their observations.

Parker used these completed forms addressing various ecological components to create a matrix, which mainly compared remediated areas with un-remediated areas. He then presented the common themes that arose from the group's observations. Among these findings, he noted high grass cover, better stream morphology, and willow regeneration in remediated areas. In un-remediated areas, there were contaminated sediments and slickens and an increased number of noxious weeds. Bird diversity was seen in both remediated and un-remediated sites of the river.

Parker also emphasized that all of the current information for each phase of the river can be found on an online map that is broken down into specific field locations. By clicking on a certain phase, one can see which stream bank treatments were completed as part of the remediation work. The map has information such as which areas were planted with nursery-grown vegetation like woody stock, which seed mixes were used in different parts of the floodplain, and when various projects were completed. Vegetation communities have been mapped in each phase and evaluations of the severity of stream bank erosion are also available. Aerial photos from 1955 also allow interested parties to compare those with the current 2019 aerial photos to see how the river has evolved over time. To view the map please visit this link.

Once all of the groups had reconvened to present their observations, they then discussed the next steps and thought of things to consider when moving forward. For instance, one question to consider is how to address unique habitats, such as peatlands, where they overlap with contaminated sediments. Phase 10 of the river, which is un-remediated, demonstrates where peat has developed over areas containing contaminated sediments. It is currently unclear how to address such areas and design restoration projects when there is contamination but also a highly functioning wetland present at that location.

Parker ended his presentation by touching on the overall UCFWG strategic plan goals which must also be kept in mind. These goals include learning more about how metals move through ecosystems, the effects of water quality, biogeochemistry effects on species diversity and food web productivity, and improving overall knowledge of the UCFR habitat, populations, and biological processes. Lastly, he reiterated that the mission of the UCFWG is to improve information management and share science-based knowledge about the river for the purpose of researching, restoring, remediating, and maintaining the river.

WATCH THE SEPTEMBER 2021 RECORDING

October 2021 - "Overview of ARCO Monitoring Activities and Projects"

The focus of the October 2021

UCFWG Topic Discussion was an “Overview of ARCO Monitoring Activities and Projects.” Loren Burmeister and Dave Griffis, Liability Managers with the Atlantic Richfield Company (ARCO), spoke about the work that ARCO is doing throughout the Upper Clark Fork River basin as part of their Super Fund obligations. Loren and Dave began at the top of the drainage with the Butte Mine Flooding Operable Unit (BMFOU). This unit consists of the Berkeley Pit and bedrock alluvial aquifer and includes mine shafts and other workings that feed the Pit. In 2019, ARCO began working with Montana Resources on a pilot project to prove that they could control the Berkeley Pit and underground water and treat it to a level necessary to discharge to Silver Bow Creek. Although they expected it would be successful, it was not until they started the pilot project that they proved its concept and implementation.
As part of their operations at the BMFOU, ARCO moves water across the site and then sends it to the new polishing plant in Butte as the final step. This water is then polished and discharged into Silver Bow Creek. ARCO operates multi-media field filtration vessels year-round to treat water from the Berkeley Pit. These include gravel, sand, and carbon filters that remove larger particles. They also operate reverse osmosis (RO) systems on a seasonal basis depending on influent and stream water conditions. In total, they have six filtration vessels and six RO units, and their treatment capacity is 10 million gallons a day. Since September 2019, the pilot project has treated and discharged over 4.5 billion gallons of BMFOU water and is currently discharging 7 million gallons per day. The water level of the Berkeley Pit and mine shafts across Butte Hill are held at a static level due to these operations. ARCO monitors the discharge of the pilot project daily for several parameters, including whole effluent toxicity (WET), metals and non-metals levels, water temperature, and other physical parameters.

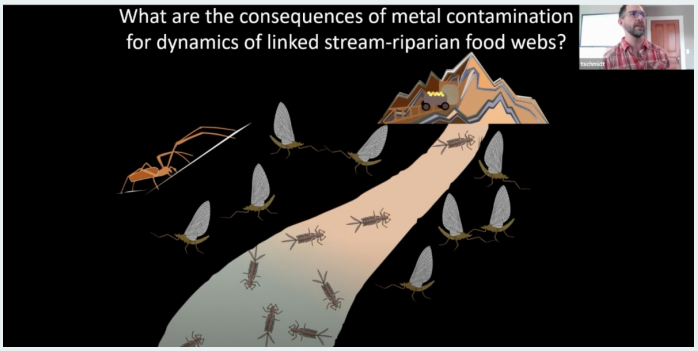
The next operation that Loren and Dave described was the Butte Priority Soils Operable Unit (BPSOU) surface water remedy, which covers most of the Butte Hill. ARCO has been implementing actions in Butte since 1987, with the first actions initially focusing on human health. Over time, though, these actions have evolved to focus on surface water and groundwater. In the late 1990s, ARCO developed three settling basins in Missoula Gulch. Recently, they entered a consent decree with the Environmental Protection Agency (EPA) and State of Montana to bring in a final surface water remedy. This final remedy will require that ARCO builds four additional large retention basins to capture and settle contaminants from the remainder of drainages across the Butte Hill. The retention basins will allow for sufficient detention times for sediments coming off Butte Hill, slow down the water coming off the hill, and meter it out at a slower rate.
Moving further down the drainage, Loren and Dave focused on the Butte treatment lagoons. These lagoons have been in place in various stages since 1996 but have only been at their current full-scale configuration since 2012. Since then, they have consistently treated and discharged water, averaging about 1.8 million gallons per day. The treatment lagoons consist of a combination of influent flows from the BPSOU subdrain, on-site capture, stormwater, the Missoula Gulch drainage, and the West Camp pump station. They have treated and discharged over 5.8 billion gallons of groundwater and stormwater since 2012, with an average treatment flow rate of 1.8 million gallons per day. ARCO monitors metals and non-metals levels, water temperatures, physical parameters, and pH at the lagoons. Next, Loren and Dave spoke about ARCO's work monitoring Butte priority soils. Every month, ARCO monitors

240 wells throughout the Butte Hill. The goals of this monitoring are to have early indicators and look at stream water quality. Through this, they can understand groundwater influences and wet weather impacts, identify areas of additional loading, and examine the benthic community.

The final two projects Loren and Dave talked about were the Warm Springs Ponds and Anaconda surface water remedy. The Warm Springs Ponds have been in place since 1994 and are estimated to treat 360 billion gallons of impacted water. The average treatment flow rates are highly variable and depend on the area's climate conditions. ARCO monitors metals and non-metals levels, nutrients, water temperature, physical parameters, and pH at this site. For the Anaconda surface water remedy, ARCO focuses on smelting impacts, which results in a slightly different remediation approach and strategy because the contaminant source is different. This site is nearly 300 square miles with many mountainous drainages. To date, ARCO has remediated 16,000 acres, restored 15,600 feet of streams and riparian areas, restored and created 4,000 acres of wetland and riparian habitat, developed 43 miles of stormwater channels to control sediment transport, and created 24 ponds to remove sediment from stormwater runoff. There is still more work to be done at the site, though, which includes remediation of the remaining upland and slope areas, construction of 3 miles of additional stormwater control channels, and construction of 9 new sediment ponds.

WATCH THE OCTOBER 2021 RECORDING

November 2021 - "From minerals to spinnerets: Geologic controls on water quality and aquatic-terrestrial linkages"



At the November 2021 UCFWG Topic Discussion, Travis Schmidt, a Research Ecologist with the United States Geological Survey (USGS), presented “From minerals to spinnerets: Geologic controls on water quality and aquatic-terrestrial linkages.” In his introduction, Travis explained that although his background is in traditional toxicology, he is interested in how water quality changes aquatic communities and the related ecological processes and effects. In his career, he has extended this line of questioning to ask what the effect of poor water quality is on adjacent terrestrial food webs. Travis' work extends back to 2003 when he was a Ph.D. student at Colorado State University (CSU). While there, he worked with a team of over 40 researchers to assess the effect of geologic processes on mining impacts, water quality, and ecological health across Colorado. From this work, he felt that metals were an interesting paradigm to add to the literature and continued to collaborate with a core team to develop future research proposals.

After this introduction, Travis then gave a brief overview of the history of mining in Colorado. Miners initially traveled out West to pan for silver and gold in the mid-19th century. However, these miners then began to go after more economically viable resources like ores and consequently started building mine shafts across the state. Currently, there are over 20,000 active and inactive mines scattered throughout

Colorado. Using a map, Travis showed that mines are not randomly distributed on the landscape. Using geologic principles, one can find areas where the metals have concentrated. Travis then specified that he would focus on two kinds of mineral deposits in his talk, polymetallic vein deposits and porphyry.

Travis then moved to talk about the relationship between metals and ecosystems. He explained that metals are found as mixtures in ecosystems and that geologic processes not only affect the chemistry of bedrock and soils but also predicate ecosystems. A problem in metals-ecosystems research is the need to account for changing water quality and mixtures. One criterion used to assess water quality is the continuous chronic criterion, which sets a benchmark based on biological responses. From this criterion, one can develop a cumulative criterion unit (CCU), or toxic unit portion, by adding up the collective fractional toxicities of a suite of metals. A CCU of 1 is at the aquatic life criterion. Anything below a value of 1 is protective of ecosystem health while anything above 1 is not. Travis explained that since the development of the continuous chronic criterion and CCU, science has advanced to account for free ion metal activity in water quality, resulting in the biotic ligand model. This model takes free ion activity and relates it to a theoretical ligand, allowing one to account for free ion active metals that bind to the site of toxic action. Another example of a more recent water quality metric is the chronic criterion accumulation ratio (CCAR), which is developed by taking free ion activity available to bind to biotic ligand in site water and normalized by EPA standards. Although similar to the CCU, the CCAR can better predict ecological effects and describe more variability in ecological communities.

By applying this metric of trace metal bioavailability to a landscape, Travis and his fellow researchers were able to develop a mean of trace metal bioavailability at sites with no hydrothermal alteration and no mineral deposits. They were then able to document sites with one mineral deposit type, a polymetallic vein. In this work, they showed that there was a twofold increase in bioavailable trace metals in a background site. In general, though, this fell below the risk ratio of 1. However, they found that when you mine polymetallic veins, the bioavailability of trace metals is lower at sites affected by propylitic alteration than those with oxidation and alteration.

Consequently, the effect of mining on a single ore type is not going to be the same and is dependent on the hydrothermal alteration associated with it. Working off this data, Travis spoke about testing the assumption that communities are protected by the risk ratio of 1. The research team examined whether emergence patterns of aquatic larvae track the benthic productivity they saw based on water quality, or if other processes were at play driving those relationships. One idea is that if metals kill off larvae at the same rate as adults, then the linkage between the two food webs is severed. However, if this is not the case, then another idea is that emergent aquatic insects are carrying concentrated toxic metals in their bodies to riparian consumers.

Diving in further, Johana Kraus, a member of the research team, quantified the emergent biomass of aquatic insects from streams. She found that as water quality became poorer, there were fewer emergent aquatic insects. She went on to ask whether these numbers result in a change in the number and biomass of riparian consumers. Johana found a decrease in riparian consumers around acid mine drainage-impacted streams. The team then asked what these results mean to contaminate flux, specifically asking whether fewer emergers reduce the amount of metal going into riparian consumers or if they concentrate the metals in their tissues and then transport them to the terrestrial ecosystems. One result they found was a slight decrease in concentration in emerging adults. Second, they found that exposure to riparian consumers was lower due to both fewer bodies flying into the riparian zone and those bodies having lower trace metal concentrations. As a next step, the researchers sought to understand the process driving lower emergent productivity and whether it would track with benthic biomass. Their results countered the common axiom in stream ecology that larval benthic production is linearly a proportion of emergent production.

Instead, they showed that the ability of larvae to persist in trace metal concentrations that appear to be safe does not fully explain what happens to the other half of their life cycle. Likely, these larvae live like zombies and will never make it out of a stream, leaving the research team asking why there is an apparent disconnect between adult emergers and larvae in the stream.

Jeff Wesner, another member of the research team, sought to clarify this question by experimenting with monoclonal mayflies. He exposed larval mayflies to a gradient of zinc concentrations and found that 88% survived to the next life stage. However, when Jeff moved to the subimago life stage, he saw a drop in survival. Thus, he found that when larvae are exposed to trace metals, they may experience latent effects in later life cycles. Jeff also noted that trace metal concentrations in mayfly bodies decreased by a factor of 3 as they went through metamorphosis and that heavier forms of zinc were retained in their bodies moving forward. Johana Kraus built off this work and performed a meta-analysis to identify different types of contaminants and their concentrations in larval versus adult life stages. She found that, in general, metals tended to concentrate in the larval stage versus the adult life stage. In contrast, organic contaminants appear to concentrate in the tissues of adult emergent aquatic organisms. Through this work, she documented the processes by which contaminants in aquatic ecosystems could expose terrestrial consumers to different classes of contaminants.

Travis ended the presentation by outlining a conceptual model for resource managers and ecologists. He shared that trace metals have a strong and profound impact on larval life stages. Cutting off emergent biomass also has a large effect on terrestrial consumers because the emergent biomass sustains and feeds riparian consumers. Travis finished by sharing that while geology is the template by which all ecosystems are shaped, factors like biology can also impact the chemistry of an environment. Ultimately, stream organisms can accumulate metals but then suffer effects in later life stages, consequently decoupling connections between food webs and detrimentally impacting recipient ecosystems.

WATCH THE NOVEMBER 2021 RECORDING

Events and Workshops

Upcoming Topic Discussion Meetings

Topic Discussions are regular meetings that occur on the second Thursday of each month and feature a speaker or set of speakers presenting on a topic related to the UCFR.

Zoom link for all meetings:

https://umontana.zoom.us/j/97494359807

Thursday, February 10 at 12 p.m. -

The February Working Group meeting will be an "open mic" format. Several members would like to inform others about ongoing and upcoming projects. Others have questions they would like to pose to the group to elicit expert input. In addition, we are encouraging participants to share information on projects and ideas that they are pursuing or may wish to initiate. Accordingly, please be prepared to provide a "short" description of any project(s) that you would like to make known to others or requests you may have for information and assistance that others may be able to address. Finally, we will also use this "open mic" opportunity to also identify topics for future meetings.

Upcoming Meeting Dates

- March 10 at 12 p.m.
- April 14 at 12 p.m.

Have a Workshop Idea?

Please take the UCFWG Communication Poll and let us know what you are interested in. We would love to hear from you.

UCFWG Communication Poll

Have an Event you want Advertised to the UCFWG Community?

Send an email to either Madison Boone, madison.boone@montana.edu, or Andrew Hauer, andrew.hauer@umontana.edu, and we will work with you to post your event on our website, newsletter, and send emails to our community.

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