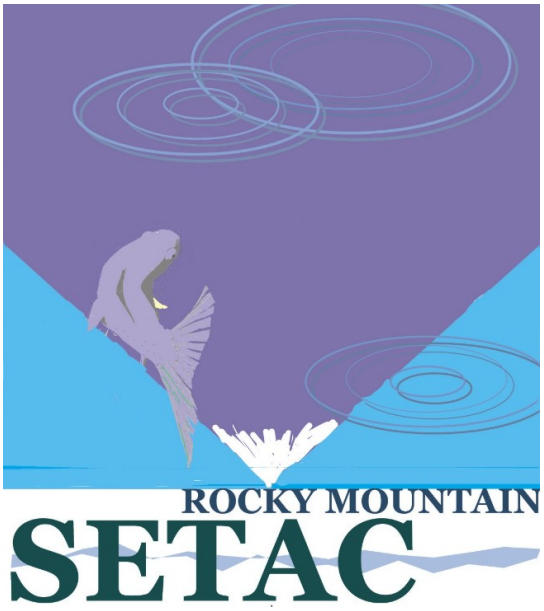

34th Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry

5 May 2023, 9am-3:30pm

University of Colorado Denver
Student Commons Building, Room 1600
1201 Larimer St
Denver, CO 80204

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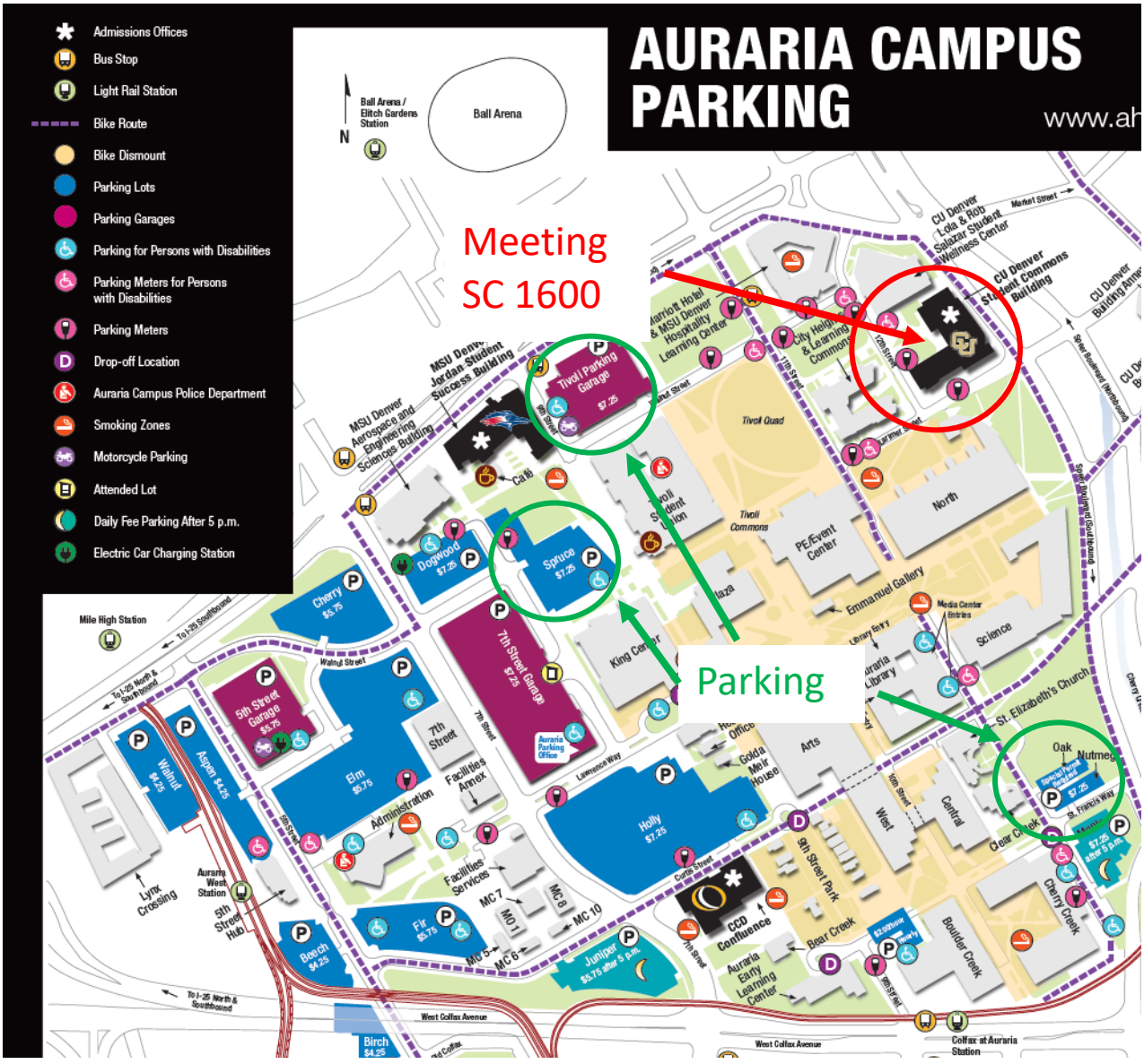

RMSETAC Meeting Schedule Friday, 5 May 2023

9-9:30 Registration and Coffee

9:30-10:00 Introductions and Networking

10-10:15 Greetings and SETAC Updates

10:15-10:35 **Andrea Kingcade**, Colorado Department of Health and Environment. *Colorado's oil and gas health information and response program.*

10:35-10:55 **Carmen Villarruel[*], ** Colorado School of Mines. *Quantification of Bioaccessable and Environmentally Relevant Trace Metals in Structure Ash from a Wildland Urban Interface Fire.*

10:55-11:15 **Taylor Beach & Lindsey Muniz[*], ** Colorado State University. *Pre and post remediation analysis of benthic macroinvertebrate size spectra in the Upper Arkansas River.*

11:15-12:15 Poster Social

12:15-1:45 Lunch (on your own) and Board of Directors Meeting

1:45-2:05 **Kelsey Barton**, Colorado Department of Health and Environment. *PFAS exposure pathways and assessment in Colorado.*

2:05-2:25 **David Pillard, ** Ecotox Consulting. *Considerations in amphibian toxicity models and testing strategies for use in ecological risk assessments.*

2:25-2:45 **Alan Vajda**, University of Colorado Denver. *Complex-Mixture Uptake and Integrated Organismal Effects in Fish Exposed to a PFAS-Impacted Hydrological Gradient.*

2:45-3:00 **Board of Directors Election**

3:00-3:15 Student Awards

3:30 Meeting Adjourns

[*]**indicates consideration for best student poster or presentation**

<u>Posters</u>

Adams, William, Red Cap Consulting. *Review of Selenium-Mercury Interactions.*

Bolerjack, Matt , Colorado Parks and Wildlife. *Reduced predator avoidance of Colorado's native plains fish after a 24- hour exposure to diesel fuel.*

[*]**Craig, Kelsey,** Adams State University. *Microbial community profiling in San Luis Valley streams.*

[*]**Lusk, Leah**, University of Colorado Denver. *PFAS contaminated groundwater impacts on fish hepatic histopathology.*

Romero, Jessica, University of Colorado Denver. *DNA sequencing reveals bacteria and mechanisms involved in 1,4-dioxane degradation in the biological treatment system of the Lowry Landfill Superfund Site.*

[*]**White, Trinity**, Colorado State University. *Bioremediation and environmental racism.*

[*]**Yang, Zhaoxun,** Colorado School of Mines. *Exploring attenuation of acid mine drainage water by a photosynthetic microbial mat.*

[*]**indicates consideration for best student poster or presentation**

Adams, William

Review of Selenium-Mercury Interactions

William J. Adams, Red Cap Consulting, Lake Point, Utah, USA

Alexandra Duguay, Rio Tinto, Montreal, Quebec, Canada

There are two over riding factors that should be consider when reviewing selenium (Se) and mercury (Hg) in aquatic life: (1) Protective effects of Se against Hg toxicity have been demonstrated in all animal models evaluated (fish, birds, mammals and plants); and (2) the two elements in biological tissues can be converted to an insoluble, non-bioavailable form as mercury selenide. Since interactions between Se and Hg and their molar ratios in seafood are essential factors in evaluating risks associated with dietary Hg and Se, considering either element alone is an inadequate approach to assessing risk to a given organism. The data presented in this review show that most fish tissues in the wild contain Se/Hg ratios >1.0. When the molar ratio of Se/Hg is <1.0 in the diet of animals and humans there is evidence that Hg toxicity can be expressed, and that this toxicity is the likely result of Se deficiency and excess reactive oxygen species. Data are presented showing that Se toxicity is reduced when Hg is added to the diet with a focus on fish. Deng et al. (2008), demonstrated that splittail fish were able to tolerate Se without effects up to 35 µg Se/g, whereas diets with no Hg showed Se effects at 6.6 µg Se/g and higher. Since both elements are common in natural environments and ecosystems multiple discharges, both elements should be measured and evaluated when performing risk assessments. EPA tissue thresholds for Se toxicity have been derived primarily from studies where the fish were not exposed to Hg, which maximizes the potential for Se toxicity resulting in thresholds which are protective, but also conservative.

Presentation Format: **Poster**

Barton, Kelsey

PFAS exposure pathways and assessment in Colorado

Kelsey Barton, Colorado Department of Public Health and Environment, Toxicology and Environmental Epidemiology Office, Department of Environmental Health and Sustainability, 4300 Cherry Creek South Drive, Denver, Colorado 80246, Kelsey.Barton@state.co.us

Kristy Richardson, Colorado Department of Public Health and Environment, Toxicology and Environmental Epidemiology Office, Department of Environmental Health and Sustainability, 4300 Cherry Creek South Drive, Denver, Colorado 80246, Kristy.Richardson@state.co.us

Per and polyfluoroalkyl substances (PFAS) are a class of chemicals that are persistent in the environment, bioaccumulative in humans, plants and wildlife, and ubiquitous in environmental media and human serum. Some PFAS have also been associated with health effects such as altered immune function, decreased infant birth weight, increased cholesterol and increased risk of certain types of cancer. Since contamination was first discovered in 2016, the Colorado Department of Public Health and Environment (CDPHE) has been working to identify and reduce PFAS exposures. CDPHE has adopted a multi-faceted approach to address PFAS contamination throughout the state including: screening hazardous waste sites, public water systems and fish to identify PFAS contamination and determine if completed exposure pathways exist; pursuing data from a variety of media to facilitate more complete exposure assessments involving multiple routes of exposure; supporting the Federal Facilities Unit and impacted communities in risk assessment activities; developing and supporting policies to manage and reduce PFAS release into the environment; and, developing and disseminating an array of resources to more effectively communicate risk and uncertainty associated with PFAS exposure in Colorado.

Presentation Format: **Oral**

Beach, Taylor*
Muniz, Lindsey*

Pre and post remediation analysis of benthic macroinvertebrate size spectra in the Upper Arkansas River

Authors and Contact Information:
Taylor M. Beach, Department of Fish, Wildlife, & Conservation Biology, Colorado State University, Fort Collins, Colorado 80523, tbeach@rams.colostate.edu

Lindsey N. A. Muniz, Department of Fish, Wildlife, & Conservation Biology, Colorado State University, Fort Collins, Colorado 80523, lindsey.muniz@colostate.edu

William H. Clements, Fish, Department of Fish, Wildlife, & Conservation Biology, Colorado State University, Fort Collins, Colorado 80523, william.clements@colostate.edu

Justin P. F. Pomeranz, Department of Environmental Science, Colorado Mesa University, Grand Junction, Colorado 81501, jpomeranz@coloradomesa.edu

The relationship between body mass and abundance of organisms within a system is defined as size spectra. This pattern illustrates how energy flows through an ecosystem by indicating that there are fewer large individuals compared to small ones. Body mass-abundance distributions are relatively consistent across natural communities and habitats, with evidence suggesting that anthropogenic disturbances, such as stream degradation through mining, alter the slope of the size spectra. Some researchers have proposed that body mass-abundance relationships are useful indicators of ecological function and may provide a better understanding of the energetics within benthic communities. Size spectra has previously been used as a biomonitoring tool within degraded freshwater streams but remains understudied because of limited pre-treatment data and post-restoration monitoring. Here, we analyze the size spectra of benthic macroinvertebrate communities from the Upper Arkansas River before and after water quality remediation and habitat restoration conducted over a 30-year period. We take into account the streams' significant history, including the initial discharge of metal concentrations, the listing of the stream as an USEPA Superfund Site, the remediation of metal contamination, and large scale habitat restoration projects. Our results show that macroinvertebrate size spectra approached reference conditions soon after improvements in water quality and habitat were observed, supporting the use of this new approach for ecological assessments. This study is the first to document the application of size spectra to assess responses to remediation and restoration efforts in freshwater streams.

Presentation Format: Oral

***To be considered for best student poster/presentation**

Bolerjack, Matt

Reduced predator avoidance of Colorado's native plains fish after a 24- hour exposure to diesel fuel.

Matt Bolerjack, Colorado Parks and Wildlife, 303-882-3709, matt.bolerjack@state.co.us

Pete Cadmus, Colorado Parks and Wildlife, pete.cadmus@state.co.us

Acute water quality standards for the protection of aquatic life are almost exclusively based on standardized single-species laboratory exposures. These often consider only mortality after 96 hours as an endpoint. The discounting of sub-lethal effects is largely because regulators assume that organisms will recover after an acute or sub-acute exposure event. This is not a safe assumption in the natural environment. In this study we examined if sub-acute (24 hr) exposure to diesel fuel oil at sub-lethal levels can manifest into mortality when in the presence of a predator. Plains Minnow (*Hybognathus placitus*. State Endangered), Fathead Minnow (*Pimephales promelas,* ubiquitous*)*, and Flathead Chub (*Platygobio gracilis;* a Colorado Species of Concern) were exposed to sub-lethal levels of diesel fuels for 24 hours. Following exposures, exposed minnows were paired with non-exposed minnows and large bodied predators that co-occur within Colorado's surface waters. The short-term sub-lethal exposure to diesel fuel resulted in significantly reduced predator avoidance. Loss of effective predator avoidance behavior after exposure to a toxicant would not be noticed in a standardized single-species experiment, nor would it be considered in derivation of acute standards, however it clearly manifests into acute mortality.

Presentation Format: Poster

Craig, Kelsey*

Microbial community profiling in San Luis Valley streams

Authors and Contact Information:
Kelsey Craig, Adams State University

Dr. Benita Brink, School of Science, Technology, Engineering and Math, Adams State University

Dr. David Bertolatus, School of Science, Technology, Engineering and Math, Adams State University

A microbiome is made up of microorganisms, mainly bacteria, archaea, fungi, protists, and viruses, that live within and interact with the environment. The composition of a stream microbiome can impact various ecological processes and overall stream health. This research project investigated the differences and similarities of the microbiomes in San Luis Valley creeks that are impacted by different land-use practices. DNA was isolated from sediment from four different creeks, two in the San Juan mountain range and two in Sangre de Christo mountains. The 16S ribosomal RNA marker was used for sequencing because it is a highly conserved gene in bacteria and archaea. 16S sequences were used to identify the presence and relative abundance of microbial taxa. Shannon diversity indices were calculated for each creek. Overall, 116 different bacterial classes were present in one or more samples. There was a small overall difference in Shannon diversity. The relative abundance of the top 20 taxa indicates a more varied composition of bacteria in the streams. Additional analyses will evaluate potential function differences between these microbiomes.

Presentation Format: Poster

***To be considered for best student poster/presentation**

Kingcade, Andrea

Colorado's oil and gas health information and response program

Andrea Kingcade, Colorado Department of Public Health and Environment, Toxicology and Environmental Epidemiology Office, Department of Environmental Health and Sustainability, 4300 Cherry Creek South Drive, Denver, Colorado 80246, Andrea.Kingcade@state.co.us

Kristy Richardson, Colorado Department of Public Health and Environment, Toxicology and Environmental Epidemiology Office, Department of Environmental Health and Sustainability, 4300 Cherry Creek South Drive, Denver, Colorado 80246, Kristy.Richardson@state.co.us

The Colorado Oil and Gas Health Information and Response Program was created in 2015 based on recommendations from the Governor's Oil and Gas Task Force by the Colorado Department of Public Health and Environment. The program's goal is to provide residents with objective health science information and to evaluate the levels of air pollutants near oil and gas operations. This program collects self-reported health symptoms related to oil and gas operations to inform air sampling investigations. These investigations characterize the types and amounts of air pollutants that people living near oil and gas operations breathe. Air sampling results are compiled into screening level risk assessments and communicated to the public through reports, dashboards and fact sheets. Since 2015, the Oil and Gas Health Information and Response Program has responded to over 1,200 concerns and completed more than twenty-two investigations. Currently available air monitoring data have determined low levels of risk from long-term exposures at the levels measured in Colorado communities based on health guideline values for the specific compounds that have been measured. Public concern remains high in some areas near oil and gas development and several questions remain unanswered related to short-term exposures and cumulative impacts.

Presentation Format Preference: Oral

Lusk, Leah*

PFAS contaminated groundwater impacts on fish hepatic histopathology

Leah Lusk, Department of Integrative Biology, University of Colorado Denver, Denver, Colorado, 80217, leah.lusk@ucdenver.edu

Anshu Mehta, Department of Integrative Biology, University of Colorado Denver, Denver, Colorado, 80217

Taha Malik, Department of Integrative Biology, University of Colorado Denver, Denver, Colorado, 80217

Cason Haffner, Department of Integrative Biology, University of Colorado Denver, Denver, Colorado, 80217

Alan Vajda, Department of Integrative Biology, University of Colorado Denver, Denver, Colorado, 80217

This study explores the effects of endocrine disrupting chemicals (EDCs) on fathead minnows, aiming to improve our understanding of the impact of environmental toxicology on fish. Mobile laboratory experiments were conducted in 2018 and 2019 to expose fish to waters containing chemicals from a nearby legacy fire-training area (FTA), a known source of per- and polyfluoroalkylated substances (PFAS). Liver samples were collected and analyzed to identify the pathologies resulting from chemical exposure. The study found morphological changes in hepatocyte histopathology in male and female fish exposed to FTA-contaminated groundwater, compared to those exposed to relatively uncontaminated reference water (REF). The study was able to identify the consistent occurrence of apoptosis, degeneration, congestion, sinusoidal distention, hepatocytic hypertrophy, and lipid vacuolization in liver samples, and slides with these conditions were compared to healthy hepatocytic characteristics. The exact lethality and concentration of pollution were unknown and will be identified in future studies. The research is significant as it can help integrate findings on the exposure and effects of EDCs in humans. The study's findings have implications for human health as the chemicals that are contaminating water that may be consumed by populations living in these areas may have adverse impacts. Identifying the harmful effects of EDCs such as PFAS can lead to their removal from FTAs and other disposal sites and inspire the use of safer alternative treatments. This analysis is highly valuable in endocrine disruptive studies on direct hepatic toxicity.

Presentation Format: Poster

***To be considered for best student poster/presentation**

Pillard, David

Considerations in amphibian toxicity models and testing strategies for use in ecological risk assessments

David A. Pillard, Ecotox Consulting, Fort Collins, Colorado 80521, David@ecotoxconsulting.com

Mark S. Johnson, United States Defense Center for Public Health – Aberdeen, Toxicology Directorate, Aberdeen Proving Ground, Maryland 21010, mark.s.johnson.civ@health.mil

Amphibians are a key component of wetland ecosystems, inhabiting roles as valuable predators as well as prey. Amphibians are particularly challenging given their multi-phasic existence that enables some species to exist in aquatic and terrestrial habitats. Amphibians face multiple stressors including not only exposure to potential toxic contaminants but also habitat destruction, invasive species, pathogens, and complications associated with climate change. Using data from amphibian toxicity testing in environmental risk assessment applications can help to build robust risk management decisions regarding hazardous substances released to the environment. Toxicity testing protocols that use larval amphibians are predominantly exposures through test compounds administered to the water. However, for terrestrial forms (e.g., frogs, toads, salamanders) test methods can include procedures where test compounds are mixed into soil and sediments. Oral exposure routes for adult amphibians are complicated by practical considerations in exposing prey and inadvertent soil ingestion. A review of current test protocols and amphibian models and endpoint sensitivity will be presented as well as advantages, disadvantages, and uncertainties.

Presentation Format: Oral

Romero, Jessica

DNA sequencing reveals bacteria and mechanisms involved in 1,4-dioxane degradation in the biological treatment system of the Lowry Landfill Superfund Site

Jessica L. Romero, University of Colorado Denver, Department of Integrative Biology, Denver, Colorado 80204, Jessica.Romero@ucdenver.edu ;

Timberley Roane, University of Colorado Denver, Department of Integrative Biology, Denver, Colorado 80204, Timberley.Roane@ucdenver.edu ;

Christopher S. Miller, University of Colorado Denver, Department of Integrative Biology, Denver, Colorado 80204, Chris.Miller@ucdenver.edu

1,4-dioxane (dioxane) is an organic chemical frequently found in waste from industrial and municipal sources, which has led to widespread contamination of groundwater and drinking water. Physical removal methods poorly remove dioxane due to its properties, whereas chemical removal methods often risk the formation of toxic byproducts. Biodegradation has become a promising method to effectively degrade dioxane without the disadvantages of other methods. Until 1980, the Lowry Landfill outside of Denver, Colorado accepted a range of industrial and municipal waste. Disposal practices contaminated the surrounding groundwater with dioxane, leading to the designation of the landfill as a Superfund Site in 1984. To remediate contaminated groundwater, an on-site pump-and-treat wastewater treatment plant and biological treatment system were constructed, which rely on microorganisms to degrade dioxane. This project aimed to identify potential dioxane-degrading bacteria and the mechanisms by which they remove the chemical in the treatment plant. Samples from the treatment plant bioreactor were collected over three years. DNA was extracted from samples and underwent high-throughput 16S rDNA and metagenomic shotgun sequencing. 16S rDNA sequencing showed bioreactor bacterial communities dominated by Nitrospirales, Burkholderiales, Rhizobiales, Nitrososphaerales, and Pseudonocardiales. Metagenomic shotgun sequencing produced several medium- and high-quality metagenome-assembled genomes, some of which were from taxa related to known bacterial dioxane degraders, such as *Pseudonocardia* and *Mycobacterium*. Novel protein-coding genes with high similarity to known dioxane-degrading genes were detected and contain amino acid residues potentially conferring dioxane degradation capabilities. Further identification of dioxane-degrading bacteria and biodegradation mechanisms can improve the remediation of dioxane-impacted sites.

Presentation Format: Poster

Vajda, Alan

Complex-Mixture Uptake and Integrated Organismal Effects
in Fish Exposed to a PFAS-Impacted Hydrological Gradient

Alan Vajda, Department of Integrative Biology, University of Colorado Denver, Denver, Colorado, 80217, alan.vajda@ucdenver.edu

We deployed mobile fish-exposure laboratories to a legacy fire-training area (FTA) to evaluate environmental PFAS mixture uptake in the background of complex contaminant chemistry. Our experiments provide evidence of site-specific effects on PFAS mixture uptake and biomarker responses. For those PFAS detected at both the REF and FTA sites, with few exceptions BCFs were generally consistent between sites. Previous laboratory studies of PFAS uptake investigated single compounds or a simple mixture and may not accurately reflect the effects of complex environmental mixtures on uptake dynamics. This project yields high quality, kinetic-based BCF values for a variety of PFAS with a common model aquatic vertebrate across under conditions representing site-specific environmental complexity. During our investigation, we identified a suite of organism-level effects at the FTA site consistent with PFAS exposure, including the disruption of hepatic lipid profiles, testis cell proliferation and apoptosis, and sperm performance, as well as inter-individual differences in PFAS mixture uptake. Future studies proposed here will build on previous work by conducting dose-responsive integrated effects assessments to establish linkages between aqueous PFAS concentrations, PFAS body burden, cellular and molecular biomarkers, and adverse organismal impacts.

Presentation Format Preference: Platform

Villarruel, Carmen*

Quantification of Bioaccessable and Environmentally Relevant Trace Metals in Structure Ash from a Wildland Urban Interface Fire

Carmen M. Villarruel, Colorado School of Mines, Department of Chemistry and Geochemistry, Golden, Colorado 80401. cvillarruel@mines.edu

Linda Figueroa, Colorado School of Mines, Department of Civil and Environmental Engineering, Golden, Colorado, 80401. lfiguero@mines.edu

James Ranville, Colorado School of Mines, Department of Chemistry and Geochemistry, Golden, Colorado 80401. jranvill@mines.edu

Wildfires at the Wildland Urban Interface (WUI) are increasing in frequency and intensity, driven by climate change. Structures in the WUI are intermixed with vegetation and are therefore at higher risk of destruction during wildfires. In spite of rapid WUI expansion and increase in wildfire activity, no studies have characterized metal content in ash generated from burned structures to determine potential risk to human and environmental health.
This study analyzed trace metal concentration in ash from structures burned by the Marshall Fire, a WUI fire that destroyed over 1000 structures in Boulder County Colorado, compared to background soils. Pseudo-total metals, environmentally labile metals, and respiratory bioaccessable metals were quantified using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Pseudo-total and environmentally labile metals were extracted using an acid digestion and water leach respectively. Inhalation bioaccessability was assessed using a Simulated Epithelial Lung Fluid (SELF) based on a modified Gamble's Solution, to mimic the extracellular lung environment. Ash from structures contained significantly more total copper and lead than surrounding soils. The water leach showed that significantly more nickel and chromium were liberated in ash than in soils, representing the fraction that could be released by runoff from heavy rain or snow, impacting aquatic toxicity of surface waters. The SELF leach showed that copper and nickel, which have been linked to adverse health effects in humans, were significantly more bioaccessable in ash than in soils. These results suggest that structure ash is a significant source of trace metals that can negatively impact the health of both humans and the environment.

Presentation Format: Oral

***To be considered for best student poster/presentation**

White, Trinity*

Bioremediation and environmental racism

Trinity White (trinmw@colostate.edu)

The use of microbes and fertilizers with bioremediation is increasing in popularity as a cheap and easy solution to different types of pollution worldwide. Bioremediation is the use of microbes within an environment to remove toxins and has most popularly been used to clean up oil from oil spills. Bioremediation is a reasonable avenue for removing pollution from the environment and can be employed to help solve environmental racism. A large part of this environmental disparity is due to socioeconomic factors. Areas with high pollution correspond in large to areas with cheap land prices. Companies that produce more of these hazardous waste products purchase land there. Since these areas are cheaper to live in they often have a statistically higher amount of minorities. However, after these plants are built most individuals living in these areas do not have the resources to move away, subsequently experiencing more pollution.
There are three specific areas of pollution that affect marginalized communities more than others; air pollution, soil contamination, and decreased integrity of drinking water. A broad analysis of these pollution routes not only demonstrates what a marginalized individual is exposed to in one day but also, emphasizes the importance of a better system needed to clean up our world.

Presentation Format: Poster

***To be considered for best student poster/presentation**

Yang, Zhaoxun*

Exploring attenuation of acid mine drainage water by a photosynthetic microbial mat

Zhaoxun Yang, Department of Civil and Environmental Engineering, Colorado School of Mines, Golden, Colorado, 80401, zyang2@mines.edu

Brenna Bourque, Department of Chemistry, Colorado School of Mines, Golden, Colorado, 80401, bbourque@mines.edu

Gary Vanzin, Department of Civil and Environmental Engineering, Colorado School of Mines, Golden, Colorado, 80401, gvanzin@mines.edu

James F. Ranville, Department of Chemistry, Colorado School of Mines, Golden, Colorado, 80401, jranvill@mines.edu

Jonathan O. Sharp, Department of Civil and Environmental Engineering, Colorado School of Mines, Golden, Colorado, 80401, jsharp@mines.edu

Acid mine drainage (AMD) and other acidic metal-impaired waters pose long-term threats to human health and ecosystems. According to Colorado Department of Public Health and Environment in 2017, there were 1,800 miles of streams impaired due to AMD-related contaminants. Nature-based solutions, such as passive treatment by unit process open water (UPOW) wetlands, offer a cost-effective and environmental-friendly treatment approach, especially for rural areas with abandoned mines. Previous investigations have shown that these wetlands are capable of metal attenuation (above 80% in most cases) at ecotoxicological concentrations at circumneutral to basic pHs in both batch and flow-through systems. However, more information is needed on the treatment potential of UPOW wetlands in AMD and the corresponding toxicological effects on the microbiological drivers of attenuation processes by the photosynthetic microbial mat ('biomat') that colonize UPOW wetlands. Batch microcosms of biomat dosed with increasing copper concentrations showed that the biomat was capable of >90% copper attenuation and acid neutralization at copper concentrations of 0.1-10 ppm. Biological activity indicators of photosynthesis, specifically, the diel cycles of dissolved oxygen were strongly inhibited when the copper concentration was above 5 ppm. Changes in some taxa of the microbial consortium were also observed. To assess these geochemical and toxicological impacts on the biomat with environmentally relevant waters, ongoing experiments aim to challenge lab flow-through systems with copper-rich acidic waters and field-derived acid mine drainage in Colorado. The overall goal is to understand the limitations and applications of this nature-based treatment system in AMD treatment locally and beyond.

Presentation Format: Poster

***To be considered for best student poster/presentation**

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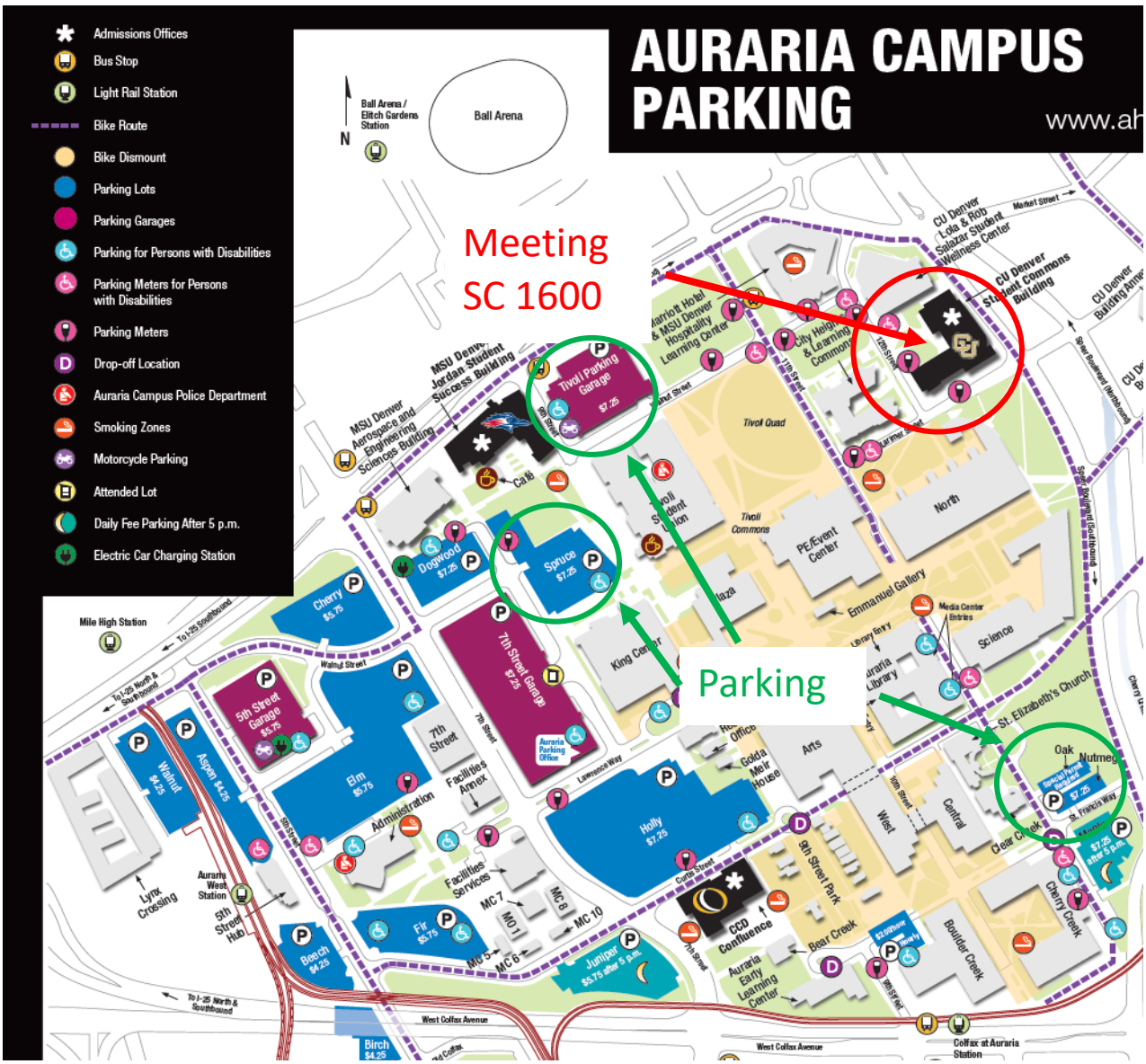

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