24th Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry May 19th & 20th, 2011

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Rocky Mountain Chapter of the
Society of Environmental Toxicology and Chemistry
May 19th & 20th, 2011

U.S. EPA Region 8 Headquarters Building
1595 Wynkoop Street
Denver, CO

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Best Student Platform
Jennifer Teerlink
Adam R. Schwindt
Robert B. Reed

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Thursday, May 19th

8:00-8:30 AM:	**Registration and Coffee**
8:30-12:30 AM:	**Short Course: Environmental Toxicology and Chemistry of Nanotechnology by Kathleen Sellers**
12:30-3:00 PM:	Lunch (provided) and **GASLAND- Documentary about natural gas drilling by Josh Fox**
3:00-:	**Discussion about Gasland and Networking at: Euclid Hall (1317 14th St)**

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2011 SHORT COURSE

Environmental Toxicology and Chemistry of Nanotechnology

Kathleen Sellars, Arcadis, Lowell, Massachusetts
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Short Course: Environmental Toxicology and Chemistry of Nanotechnology

At the nanoscale, some common materials behave in unexpected ways: colored materials can become translucent and carbonaceous materials able to conduct electricity. Consequently, manufacturers have brought hundreds of products containing nanomaterials to the marketplace. Beyond the implications for commercial products, "nanosizing" can change the fate and transport of a substance in the environment and perhaps its behavior in biological systems. Scientists are racing to characterize these behaviors and regulators struggle to apply existing paradigms to accommodate nanomaterials – and in many cases, even how to define the term!

This course will help to demystify the developing science of nanotechnology. It will begin with basic information on the properties of common nanomaterials and their fate and transport properties. It will discuss the potential risks in the manufacture, use, and disposal of nanomaterials, including human and ecological toxicological effects. Finally, it will briefly describe the status of developing environmental regulations on nanotechnology. The instructor will use case studies to illustrate critical points.

The instructor, Kathleen Sellers, co-authored and edited the book Nanotechnology and the Environment (Taylor & Francis, 2009). During her 20 years of experience as a chemist and. engineer, Ms. Sellers has worked on developing solutions to a variety of environmental problems. She is particularly intrigued with exploring emerging environmental issues and their solutions, most recently those associated with nanotechnology. She has presented earlier versions of this course to SETAC Europe, AICHE, ASME, and various Fortune 100 companies; each time, the course evolves to reflect the rapidly growing science and regulations on nanotechnology.

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Rocky Mountain SETAC Presents a Film Screening of:

GASLAND- A film by Josh Fox.

http://www.gaslandthemovie.com/

Film: GASLAND

"The largest domestic natural gas drilling boom in history has swept across the United States. The Halliburton-developed drilling technology of "fracking" or hydraulic fracturing has unlocked a "Saudia Arabia of natural gas" just beneath us. But is fracking safe? When filmmaker Josh Fox is asked to lease his land for drilling, he embarks on a cross-country odyssey uncovering a trail of secrets, lies and contamination. A recently drilled nearby Pennsylvania town reports that residents are able to light their drinking water on fire. This is just one of the many absurd and astonishing revelations of a new country called GASLAND. Part verite travelogue, part expose, part mystery, part bluegrass banjo meltdown, part showdown."

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Friday, May 20th:

8:00 – 9:00: **Registration and Coffee**

9:00-9:10 **Greeting from EPA**

9:10-9:45 ***Featured Presentation***: **Kristen Keteles-US EPA Region 8.** Deepwater Horizon Oil Spill: The Search for the Subsea Plume.

9:45-10:00 **Philip Russel-** Englewood WWTP. Unusual toxicity, at a huge scale, at an advanced wastewater treatment facility.

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10:00-10:15 **Norka E. Paden-**GEI Consultants. Do water quality and habitat conditions affect macroinvertebrate communities in headwater streams in southern West Virginia?

10:15-11:15 **Coffee Break and Poster Session**

11:15-11:30 **Jennifer Teerlink**- Colorado School of Mines. Attenuation of arace organic contaminants in onsite wastewater soil treatment units as a function of hydraulic loading rate.

11:30-11:45 **Travis S. Schmidt** – USGS. Contaminants limit ecological potential, not average potential of ecosystems.

11:45-1:15 **Lunch (on your own); RMSETAC officers meeting**

1:15-1:30 **Adam R. Schwindt –** Response of fathead minnow (*Pimephales promelas*) populations to an estrogen used in human birth control.

1:30-1:45 **Mark A. Murphy –** EPA Reion 8. Direct inject analysis of pharmaceuticals and illicit drugs in water at ng/L levels by LC/MS/MS.

1:45-2:00 **Janet Burris-** Update on SETAC North America

2:00-2:15 **Robert B. Reed-** Colorado School of Mines. Detection of engineered metal oxide nanoparticles by single particle – inductively coupled plasma – mass spectrometry.

2:15-2:30 **William H. Clements**- Colorado State University. An evidence-based approach to demonstrate causal relationships between anthropogenic stressors and macroinvertebrate community responses.

2:30- 2:45 **Joseph S. Meyer**- ARCADIS. Toxicity of Cu-Zn mixtures to *Daphnia magna*: test of a multi-metal, multi-site biotic ligand model.

2:45-3:00 **Student Awards and Raffle**

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Deepwater Horizon Oil Spill: The Search for the Subsea Plume.

By:

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Through the Joint Analysis Subsea Monitoring Group, data was collected by NOAA, Academic Institutions, and Contractors to monitor the fate of oil in the subsea following the BP Deepwater Horizon oil spill. As a result of this effort, a subsea plume was detected southwest of the wellhead between 1000 and 1300 meters. Dr. Keteles will discuss the methods used to locate and detect the subsurface plume in the Gulf of Mexico during the spill.

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Unusual Toxicity, at a Huge Scale, at an Advanced Wastewater Treatment Facility

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Toxicity on a huge scale (containers processing 20+ million gallons a day) has been observed in metropolitan south Denver. To be a little more specific, the nitrification process at a major wastewater treatment plant just south of the Denver/Englewood, Colorado, border has experienced significant inhibition on average of 2+ times per year since at least 2002.

The Littleton/Englewood Wastewater Treatment Plant is an advanced return activated sludge facility with a capacity of 50 million gallons per day (MGD). Effluent is chlorinated and dechlorinated before entering the South Platte River just upstream of metropolitan Denver. In 1997 a tertiary nitrification system (NTF) was added to the system to convert ammonia to nitrate. In 2002 a tertiary de-nitrification system was added to the facility to remove nitrate; along with extensive real-time, temporal high resolution instrumentation. Observations made by this new instrumentation indicated nitrification inhibition events that last long enough to result in possible regulatory non compliance for ammonia discharge into the South Platte River. Since 2002 ongoing studies have provided the following information about the events:

1. The events are well documented by high resolution instrumentation that measures ammonia and nitrate (and other constituents) just after the nitrification process at the start of the de-nitrification process. The onset takes about 2 hours to reach maximum effect and 4 to 32 hours before ending. The pattern is a classical example of sublethal toxicity (inhibition).
2. Specific nitrification inhibition has been confirmed by comparative laboratory analyses of water samples collected before and during inhibition events.
3. Acute and Chronic whole effluent toxicity (WET) testing has indicated negative results for all events tested. Bacterial toxicity testing has revealed the same results. The toxicant seems to selectively inhibit nitrifying bacteria.
4. The “agent” causing the toxicity is relatively stable (still present 2+ weeks after initial toxicity testing; samples stored at room temperature).
5. Nitrification inhibition, during events, has been confirmed in other parts of the process stream; including the influent.
6. The “agent” causing the toxicity has been shown to enter that facility through only one of two influent interceptors entering the plant.
7. No measured facility operational variables correlate with the inhibition events.
8. No chemicals that are routinely measured including organic chemicals analyzed by EPA methods 624, 625, and 608 co-vary with the inhibition events.

The cause of the nitrification inhibition has yet to be identified and we are now pursuing the use of chemical partitioning and advanced analytical analyses to identify the source of inhibition. We may also pursue microbiological research methodology. We welcome any suggestions or comments on our efforts to date … or future research.

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Do Water Quality and Habitat Conditions Affect Macroinvertebrate Communities in Headwater Streams in Southern West Virginia?

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Most studies conducted in the extreme headwaters environment focus primarily on terrestrial/aquatic linkages and not the composition of the aquatic communities. We described the benthic invertebrate communities inhabiting the extreme upper reaches of headwater streams in the coal mining region of southern West Virginia. These headwaters are representative of ephemeral or intermittent steams where mountaintop coal mining/valley fill (MTM/VF) operations occur. We sampled 12 headwater streams in three different protected natural areas of southern West Virginia to evaluate the natural variability of their benthic invertebrate communities. A diverse benthic invertebrate fauna was found, consisting of at least 129 benthic invertebrate taxa. Variability analyses revealed low levels of similarity between the invertebrate communities in headwaters streams. Benthic habitat was similar among sites, with the same kinds of habitat features occurring at most sites. Water chemistry parameters also were similar among sites, showing weak relationships to the invertebrate population parameters. pH was low (<6.0) at some sites where EPT taxa were not encountered as frequently, but this was not a consistent pattern. Our study suggests that invertebrate colonization patterns did not appear to be restricted or driven by the slight variations in habitat or water chemistry in these headwater streams.

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Attenuation of Trace Organic Contaminants in Onsite Wastewater Soil Treatment Units as a Function of Hydraulic Loading Rate

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In the United States one quarter of the population currently utilizes onsite wastewater treatment, and also commonly groundwater wells for drinking water. Thus, it is imperative to understand the limitations and capabilities of these systems not only with respect to traditional wastewater contaminants, but also trace organic chemicals (TOrCs). In the most basic form, onsite wastewater systems collect wastewater into an anaerobic tank for primary digestion followed by dispersal to a soil treatment unit (STU) for further treatment utilizing sorption, filtration, and biotransformation processes. A series of bench-scale column experiments were performed to evaluate the efficacy of TOrC attenuation in STUs as a function of hydraulic loading rate. Soil columns (30 cm length X 8 cm in diameter), used to represent STUs, were operated at five loading rates (30, 12, 8, 4, 1 cm/day). Each loading rate was tested on three side-by-side columns, and an abiotic column was operated to evaluate sorptive losses. Columns were initially dosed with raw wastewater to introduce an appropriate microbial community after which they were fed with synthetic wastewater and TOrC spike to provide a consistent influent water quality. Column effluent had reduction of dissolved organic carbon concentrations by >85% with nearly complete oxidation of ammonia to nitrate, comparable to performance of field STUs. Attenuation of TOrC was largely compound specific. Some TOrCs were effectively attenuated at all loading rates tested (i.e., acetaminophen and caffeine) while others were not attenuated at any loading rate tested (i.e., carbamazepine and primidone). However there were a subset of TOrCs that exhibited a correlation between attenuation and hydraulic loading rate (i.e. cimetidine). Results suggest STUs are effective in removing many TOrC, and design and operation can be optimized for maximum TOrC attenuation.

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Contaminants limit ecological potential; not average potential of ecosystems

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2 Fish, Wildlife, and Conservation Biology Department, Colorado State University, Fort Collins, Colorado.

Scientists and managers often employ ordinary least squares (OLS) regression to detect change in aquatic communities due to contaminants. OLS regression detects changes in mean response across a gradient of contamination. However, when the response does not vary uniformly across that gradient (i.e. variance is heterogeneous), as is often the case with biomonitoring data, mean based modeling approaches such as OLS regression poorly characterize the response. Here we evaluate quantile regression as an alternative to OLS regression. We use both approaches to describe changes in the density of two metal-sensitive mayflies (*Rhithrogena* spp. and *Drunella* spp.) and a metal-tolerant caddisfly, *Arctopsyche grandis*, exposed to aqueous metal-mixtures (cadmium, copper, and zinc) and other limiting factors (basin area, site elevation, discharge, and temperature) at 125 streams in Colorado. To test which factor is most limiting to density we evaluated univariate mean and quantile (τ = 0.05-0.95, by increments of 0.05) regression models using a model selection procedure. Unequal variance in density resulted from other factors that constrained density at sites with similar values of the predictor. As a result, all OLS regression models poorly described the responses of the three taxa. Quantile regression however, described processes limiting unique portions of the density distributions. Quantile regression determined that the density of *A. grandis* was limited by other factors while metals limited most quantiles of density for the two mayflies. Quantile regression described that reductions in mayfly density due to increasing metal concentrations were greatest at sites where other factors were not limiting. Where other factors were limiting low mayfly densities were observable despite metal concentrations. We conclude that metals limit potential density, not realized average density, and as a result, quantile regression is better than OLS regression for interpreting the effects of contaminants on aquatic ecosystems.

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Response of fathead minnow (*Pimephales promelas*) populations to an estrogen used in human birth control

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Abstract: Fishes in streams receiving effluent from waste water treatment plants are subjected to chemical stressors that can affect normal reproductive function. Synthetic estrogens represent one component of this effluent which can disrupt reproduction. Cellular and physiological effects are well known but little is known about potential population level consequences of reproductive disruption. We initiated studies to evaluate the effects of 17alpha-ethinylestradiol (EE2), the synthetic estrogen in human birth control, on fathead minnow (*Pimephales promelas*) populations. We constructed 25, 1100L aquatic mesocosms at the CSU Foothills Fisheries Laboratory and 10 male and 10 female fish were introduced to each mesocosm. Treatments consisted of EE2 concentrations ranging from 0, 2.5, 5, 10, and 20ng/L for 105 days with 5 mesocosms per treatment. Fish were allowed to behave naturally during the experiment. Adult survivorship, egg production, numbers and size of offspring, and biomarkers of estrogen exposure were collected during the experiment. Physiological and population level effects were observed at 10 and 20ng/L of EE2 indicating that fish populations can be negatively impacted by environmentally relevant estrogen concentrations.

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Direct inject analysis of pharmaceuticals and illicit drugs in water at ng/L levels by LC/MS/MS

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Scarcely anything is known of the effects or of the levels of Pharmaceuticals and Personal Care Products (PPCPs) and illicit drugs for most ecosystems and very little is known about the potential risks associated with their occurrence. However, their occurrence in the environment is often the same as the persistent pesticides that are widely regulated. It is not unreasonable to ask the questions of their occurrences, metabolic activities in nontarget organisms, and environmental sinks in order to begin to assess potential exposure and risk. Thus, we see the application of newer techniques finding their way into environmental analyses. PPCPs are defining a turning point in environmental analyses and analysts now need to address a much more diverse universe of analytes at increasingly lower levels. The trend towards trace level quantification of environmental contaminants is requiring sophisticated analytical methods with the ability to analyze a wide variety of analytes with increased accuracy and sensitivity. A method is presented using fast LC and tandem MS/MS for the quantitation of over 100 PPCPs and illicit drugs in environmental surface water samples. A variety of surface water samples, including wastewater influent and effluent, were injected directly into the LC/MS/MS. Sample preparation included filtration and addition of internal standards, with no other additional cleanup. This method is a straight forward approach for the analysis and identification of these compounds with excellent sensitivity and ruggedness at low part-per-trillion levels (ng/L). An overview of the results and performance of the method from samples run during 2010 are discussed.

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Detection of engineered metal oxide nanoparticles by single particle – inductively coupled plasma – mass spectrometry

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Increased production and use of engineered nanoparticles (ENPs) suggests increased exposure potential for humans and other organisms in the environment. While production of ENPs has boomed in recent years, methodology for detection and quantification in environmental and biological samples has lagged behind. Single Particle – Inductively Coupled Plasma – Mass Spectrometry (SP-ICP-MS) is a relatively new approach for detecting particulate material in aqueous solutions. It has been shown to be capable of metal quantification in the part-per-trillion range and has been used previously for detection of natural and engineered colloids and metal-containing ENPs such as Au. Data are presented to examine its use for analysis of metal oxide ENPs TiO_2, CeO_2, and ZnO at part-per-trillion levels in moderately hard water and cell culture media. Results for TiO_2 and CeO_2 analysis show a low elemental background signal, allowing differentiation of "pulses" corresponding to single particles in a variety of matrices. Iterative calculations allow quantification of pulses; plotting number of pulses against nominal particle mass concentration yields linear relationships and can be used to quantify ENPs of this type in solution. For ZnO, increasing concentration of ENPs yields a higher background signal, suggesting that these particles tend to dissolve too quickly for analysis.

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An evidence-based approach to demonstrate causal relationships between anthropogenic stressors and macroinvertebrate community responses

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Water resource managers today are challenged to demonstrate causal relationships between changes in water quality and measures of biological integrity such as species richness or community composition. However, because most biological assessments rely exclusively on observational data, these causal inferences are often weak. Numerous evidence-based approaches have been proposed to support causal arguments, but modifications of Hill's criteria have received the most attention in the literature. Using data from several field surveys of benthic macroinvertebrates, we tested the hypothesis that heavy metals were directly responsible for changes in benthic community structure. We first examined relationships between macroinvertebrate community structure and heavy metal concentrations in >300 Colorado streams. Results showed consistent and predictable alterations in community composition along a gradient of metal contamination. These data were supplemented by a set of 17 stream microcosm experiments that established concentration-response relationships and allowed us to estimate community-level LC20 values. Additional evidence for a causal relationship between metals and macroinvertebrate responses was provided by a long-term (20 year) "natural" experiment in which we documented macroinvertebrate responses to the removal of heavy metals. Although these data showed significant improvements in water quality and macroinvertebrates over time, communities remained impaired when metal concentrations exceeded the community-level EC20 values. Finally, to investigate plausibility and coherence of these results, we examined mechanisms responsible for differences in sensitivity among species. Overall, these investigations provided strong evidence that metals associated with historical mining operations were the primary stressors responsible for changes in macroinvertebrate communities.

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Toxicity of Cu-Zn mixtures to *Daphnia magna*: test of a multi-metal, multi-site biotic ligand model

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For decades, a simplistic summation of toxic units based on concentrations of dissolved metals has been used to semi-quantitatively predict the toxicity of metal mixtures. However, that approach tends to over-predict toxicity. In its place, we have been developing a mechanistic model based on tissue residues of metals and the concept that the toxicity of a mixture of metals can be either dose additive or response additive, depending on the mechanisms of action. To calculate tissue residues and thereby predict toxicity across wide ranges of water quality, we have been developing a multi-metal, multi-site biotic ligand model (MMMS BLM) that concurrently accounts for metal-metal competition for binding on dissolved ligands in the water and at sites of toxicity on organisms. In our initial tests, we exposed *Daphnia magna* to mixtures of Cu and Zn in moderately hard reconstituted water containing dissolved organic carbon (DOC; added as Suwannee River fulvic acid) at 3 mg/L, and compared observed mortality to the response-additive mortality predicted from results of concurrent Cu-only and Zn-only toxicity tests. This research has revealed several apparent metal-metal interactions that otherwise might lead to conclusions that metals interact in non-additive ways, yet simple geochemical speciation in the BLM can explain these interactions and reconcile the apparent non-additive toxicity. For example, the toxicity of Cu-Zn mixtures always appeared to be synergistic or additive when based on dissolved metal concentrations, whether Cu was varied while Zn was held constant, or vice versa; whereas in the same tests, the toxicity of the Cu-Zn mixtures always appeared to be antagonistic or additive when based on free-metal-ion concentrations. These preliminary results demonstrate that a MMMS BLM could be an effective tool to help water quality agencies implement more appropriate methods to regulate metal mixtures than the current default, overly conservative toxic-units approach.

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POSTERS

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Reproductive Disruption by Estrogenic Wastewater Effluents

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The reproductive potential of native fishes may be compromised in stream reaches of western states where large volumes of treated wastewater are discharged into relatively small-sized streams. We investigated the impact of City of Boulder wastewater treatment plant (WWTP) effluent on fish reproduction. This effluent contains endocrine-active compounds including nonylphenol, bisphenol A, and synthetic and natural reproductive steroids. We have identified female biased sex ratios, gonadal intersex, asynchronous ovarian development, elevated vitellogenin, and other forms of reproductive disruption in feral white suckers (*Catostomus commersoni*) collected downstream of WWTP effluent but not at reference sites. Analysis of museum specimens collected between 50 and 100 years ago from these sites reveals no evidence of reproductive disruption. We conducted on-site controlled exposure experiments using a mobile flow-through laboratory, exposing adult male fathead minnows (*Pimephales promelas*) to either WWTP effluent, reference water from Boulder Creek upstream of the WWTP, or mixtures of reference water and WWTP effluent (containing an average of 29 ng/L estradiol-equivalents of estrogenicity) for up to 56 days. Exposure to diluted WWTP effluent significantly elevated vitellogenin and suppressed male sex characters after 7 days of exposure. A similar study of possible effects of wastewater effluent from a small mountain community on juvenile brown trout (*Salmo trutta*) showed no increase in vitellogenin. A re-evaluation conducted following a major upgrading of the Boulder WWTP revealed diminished responses to wastewater effluent in adult male fathead minnows.

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Transfer of trace metals from streams to terrestrial food webs by emerging aquatic insects in mineralized alpine ecosystems

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Trace-metal contamination of aquatic ecosystems is a major health and environmental concern globally, leading to alterations of aquatic communities, decreased fisheries, and bioaccumulation in higher trophic levels. In the Rocky Mountains, the geologic processes that affect distribution of metals within central Colorado streams, such as mining and mineralization, are well characterized, but little is known about the repercussions of these effects for neighboring terrestrial ecosystems. Aquatic insects, which represent a large component of stream food webs as larvae, emerge from streams as adults where they are consumed by terrestrial predators such as spiders. Thus, insects can transport metals from aquatic to terrestrial food webs by carrying them within their adult bodies. This study aims to establish the relationships between metal accumulation in riparian predators (web-building spiders), adult aquatic insect production (g C/m2/yr) and bioavailable metals in streams of the Central Colorado Mineral Belt. The outcomes of this study will highlight how geology, human disturbance, and ecological responses of stream and riparian biota determine fluxes of aquatically derived metals to terrestrial food webs. Implications for stream and riparian management in the national forests and parks where this study takes place are discussed.

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Geochemistry and measurement of aqueous arsenic and uranium at a field site undergoing stimulated bioreduction

Rifle, CO is the home of a former uranium and vanadium mill site that was decommissioned as part of the Uranium Mill Tailings Radiation Control Act (UMTRCA). Surface contamination was removed in 1996, but groundwater contamination remains. Current remedial strategies are focused on acetate injections aimed at stimulating microbial growth and reduction of mobile aqueous uranium (VI) to immobile uranium (IV) in the form of uraninite. Passive flux meters (PFM) have been developed to measure uranium and groundwater fluxes at the site, and decreased uranium fluxes and concentrations are seen downgradient from the acetate injection wells. While this biostimulation strategy shows promising potential for remediating uranium contamination, these same reducing conditions have been shown to negatively impact the arsenic chemistry of the site. Reducing conditions release large concentrations of mobile arsenic, potentially due to the reductive dissolution of associated iron minerals or the formation of aqueous thioarsenic species. Determining arsenic speciation under oxidizing and reducing conditions may help to provide an understanding of the source of the high arsenic releases seen at this site. A Dionex AG-16 column with an increasing gradient concentration of sodium hydroxide is used to separate the arsenic species and inductively couple plasma mass spectrometry is used as an arsenic-specific detector. Upgradient samples taken from the oxidized groundwater show low arsenic concentrations mostly present as As(V), while downgradient, reduced samples have high arsenic concentrations composed of As(III), thioarsenic species and other currently unidentified reduced arsenic species. While it is unclear at the moment the exact source, it is clear that reducing conditions responsible for immobilizing uranium will mobilize arsenic, where present, and a better remediation strategy should be developed.

Please consider for best student poster

24th Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry May 19th & 20th, 2011

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SP-ICP-MS and FFF-ICP-MS as powerful analytical techniques to characterize Ag nanoparticles

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One of the most rapidly growing classes of nanoproducts are consumer materials that generate silver ions or contain nanosilver; comprising over 20% of the commercial market. The environmental prevalence of nanomaterials, particularly nanosilver, is expected to increase substantially in the future. Thus, it is imperative to develop techniques capable of determining key characteristics of nanosilver in complex media including, but not limited to, simulated biological matrices, waste water, and biological samples. Of the standard analytical techniques that currently exist, few seem fully capable of determining the concentration, size, and composition of this new class of emerging contaminant. Single particle ICP-MS (SP-ICP-MS), a novel application of ICP-MS, provides number, size, and composition data for colloids and nanoparticles smaller than 100nm. Additionally, field flow fractionation-ICP-MS (FFF-ICP-MS) techniques are able to provide complimentary data well below this size range to as low as a few nanometers. Using both techniques, one may be able to define a full spectrum of silver nanoparticles (Ag-NP), both in concentration and in size, in environmental and biological samples. By using well-characterized and stable silver nanoparticles of discrete sizes from 20 to 100nm; the aforementioned analytical techniques were verified in both simple and complex media yielding characterization of Ag-NP at environmentally relevant (ng/L) concentrations.

Please consider for best student paper award

24th Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry May 19th & 20th, 2011

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Development of single particle inductively coupled plasma-mass spectrometry as a particle size characterization technique for inorganic nanomaterials in environmental systems

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Currently there are few ideal methods for the characterization of nanoparticles at environmentally relevant concentrations in complex matrices. This has led to significant gaps in toxicity studies and exposure assessments. The overall goal of this project is to develop and validate real-time single particle-inductively coupled plasma-mass spectrometry (spICPMS) as a way to size and count metal-containing nanoparticles. The potential benefits of the spICPMS method include its ability to both characterize particle solutions at concentrations relevant to environmental samples and to capture broad or multimodal size distributions. As part of our method validation studies, silver nanoparticle solutions having four different size distributions were analysed by spICPMS and three other established sizing methods, dynamic light scattering (DLS), differential centrifugal sedimentation (DCS) and nanoparticle tracking analysis (NTA). Results from the spICPMS technique demonstrate similar capabilities to size nanoparticles as these other commercially available techniques.

Please consideration for Best Student Poster

24th Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry May 19th & 20th, 2011

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How water hardness and alkalinity can unintentionally impact fathead minnow growth in whole effluent toxicity tests.

R.B. Naddy, A.M. Romero, D.A. Pillard, G.R McNerney.

A series of studies were performed to compare whether different combinations of water hardness and alkalinity in reconstituted laboratory waters could alter the growth of the fathead minnow (FHM), *Pimephales promelas.* The results indicate that FHM growth increased by water hardness above 300 mg/L (as $CaCO_3$). Alkalinity increases alone did not lead to higher FHM growth, although the growth increases due to hardness were influenced by the alkalinity concentration. Calcium:magnesium ratio differences also appeared to result in differences in FHM growth at a given hardness, with higher growth observed for higher magnesium concentrations. These findings can be important in WET testing for dischargers with certain water quality parameters as they can have unintended consequences on sublethal growth effects to FHMs in WET studies. Potential ways to take into account these effects are discussed.

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Risk characterization of nano-nickel in the aquatic environment – exposure modeling using a life-cycle perspective mass-balance approach

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To begin to understand the ecotoxicological implications of nickel associated with nanoparticles, a comprehensive search of the primary literature examining the ecotoxicology of nanoparticles that are composed of, formulated with, or whose production is catalyzed by nickel was conducted and a predicted no effect concentration (PNEC) was derived. A predicted environmental concentration (PEC) of nickel associated with the end uses of nickel nanoparticles and carbon-based nanotubes (CNTs) catalyzed by nickel was also estimated. In the absence of sufficiently detailed emissions data, the PEC was modeled using a mass-balance environmental "compartment" approach in which several simplifying assumptions were made. The approach used a life-cycle perspective to model releases from nanoparticle-containing products into the environment and included the following input parameters: estimated worldwide production volume, allocation of production volume to product categories, particle release from products, and mass transfer coefficients between environmental compartments. The model was also applied to a hypothetical "regional" scenario to explore the model's applicability and utility on different spatial scales. Finally, the current and future environmental impact/risk of nickel associated with nanoparticles was estimated based upon comparison of the PEC to the PNEC and uncertainties were evaluated.