Short Course: Advances in Management and Remediation of Contaminated Sediments

Thursday, June 20, 2013
McMaster University, Hamilton, ON
Burke Sciences Building (BSB) Room B103

This short course will cover a variety of advancements in the management and remediation of contaminated sediment. Specific topics covered in the course will include: considerations in sediment management, evaluation and management of ecological and human health risk; adaptive management approaches for sediment remediation; advances in monitoring contaminated sediment, design and modeling of sediment caps, evaluation and use of amendments to enhance risk reduction, and monitored natural recovery (MNR) and enhanced MNR. Both local and international case studies will be used as key examples throughout the talks. The course will include lectures by leading sediment practitioners and hands-on training with sediment cap models. There will also be group break-out activities giving course attendees a chance to utilize learned techniques. Lap top computers will be required for the sediment cap model component of the course.

Speakers

Danny Reible, PhD, PE - University of Texas at Austin: *Overview of Sediment Management; sediment modelling (with hands on portion)*

Matt Graham, MSc, PGeo - Environment Canada: *Environment Canada sediment direction*

Erin Hartman, PE - Environment Canada: *Specific Local (Ontario) Project Examples*

Tamara Sorell, PhD - Geosyntec Consultants Inc.: *Risk Management and Monitoring (including field sampling/ approaches)*

Tom Krug, PE - Geosyntec Consultants Inc.: *Amendments and bioaugmentation processes*

Matt Vanderkooy, MSc - Geosyntec Consultants Inc.: *Passive samplers and Biodegradation (PCBs)*

John Hull, PE - Aquablok: *Adaptive Sediment Management - Does what you're doing make sense?*

CONFERENCE PROGRAM

Friday, June 21st, 2013

Time	Location	Schedule Item
8:00 - 8:30	Michael G. DeGroote Centre for Learning and Discovery (MDCL)	Main entrance: **Registration** SE Hallway: A/V and poster set-up
8:30 - 8:45	MDCL Room 1110	**Opening Remarks**
8: 45 - 9:30	MDCL Room 1110	***Regulatory toxicology: A splash of this and a dash of that*** **Lisa Taylor** Environment Canada
9:30 - 10:15	MDCL Room 1110	***Changes in environmental attitudes of industry - Past motivation and future direction*** **Gordon Craig** G.R. Craig & Associates Inc.
10:15 - 10:45	MDCL - SE Hallway	**Posters** and Morning Break (Student poster judging)
10:45 - 11:30	MDCL Room 1110	***Wastewater, watersheds and the War of 1812: Win, lose or tie?*** **Mark Servos** University of Waterloo
11:30 - 12:00	MDCL Room 1110	***Annual General Meeting*** & SETAC North America update
12:00 - 1:00	MDCL - SE Hallway	***Lunch***
1:00 - 2:00	Meet in SE Hallway	***Lab Tours/ Cootes Paradise Hike***

CONFERENCE PROGRAM

Friday, June 21st, 2013 (cont'd)

Time	Location	Schedule Item
2:00 - 2:20	MDCL Rooms 1009 & 1010	***Concurrent Platform Presentations*** **Sessions A & B**
2:20 - 2:40		
2:40 - 3:00		
3:00 - 3:20		
3:20 - 3:45	MDCL - SE Hallway	**Posters** and Afternoon Break (Student poster judging)
3:45 - 4:00	MDCL - SE Hallway	**Book Draw**
4:00 - 4:20	MDCL Rooms 1009 & 1010	***Concurrent Platform Presentations*** **Sessions C & D**
4:20 - 4:40		
4:40 - 5:00		
5:00 - 5:20		
5:20 - 5:40	MDCL 1009	Student Judges meet
	MDCL - SE Hallway	Take down posters
5:45 - 7:00	**The Phoenix** (Refectory Building)	***Student Awards Social and BBQ***

Platform Presentations

Time	Session A: Aquatic Systems - Metals Toxicity MDCL Room 1009
2:00 – 2:20	**Investigating multi-metal interactions at the gill of the rainbow trout: The next step in the development of the Biotic Ligand Model** *Tellis, Margaret S., Kevin V. Brix & Chris M. Wood McMaster University, Hamilton, ON
2:20 - 2:40	**Effects of water quality parameters on Cu toxicity to rainbow trout and development of a chronic Biotic Ligand Model** Ng, Tania Y.-T.[1], M. Jasim Chowdhury[2] & Chris M. Wood[1] [1]Dept. of Biology, McMaster University, Hamilton, ON [2]International Lead Zinc Research Organization, Durham, NC
2:40 – 3:00	**Water-only toxicity of salts and metals to two size ranges of *Hexagenia spp.*** *Stevack, Kathleen [1,2], Kim Mahon[2], Trudy Watson-Leung[2] & David Poirier[2] [1]University of Waterloo, Waterloo, ON [2]Laboratory Services Branch, Ontario Ministry of the Environment, Toronto, ON
3:00 – 3:20	**Behaviour and nickel bioaccumulation: Is there a link?** *Leonard, Erin M.[1], Julie Marentette[2,3], Sigal Balshine[2] & Chris Wood[1] [1]Department of Biology, McMaster University, Hamilton, ON [2]Department of Psychology, McMaster University, Hamilton, ON [3]Aquatic Contaminants Research Division, Environment Canada, Burlington, ON

*** Student presentation**

Platform Presentations (cont'd)

Time	Session B: Risk Assessment - Site-specific Considerations MDCL Room 1010
2:00 – 2:20	**Site-specific Water Quality Objective for nitrate: The recalculation procedure** Nesbitt, Richard A. & Neil J. Hutchinson Hutchinson Environmental Sciences Ltd., Kitchener, ON
2:20 - 2:40	**Alternative Tier II SSROs that acknowledge non-contaminant effects** Zajdlik, Barry.A.[1] & Gladys Stephenson[2] [1]Zajdlik & Associates Inc. [2]Stantec Consulting Ltd.
2:40 – 3:00	**Implementation of the results of ecotoxicity assessments: Site-specific application to support management decisions** Stephenson, G.L. Stantec Consulting Ltd., Guelph, ON
3:00 – 3:20	**Use of species sensitivity distributions (SSDs) in risk assessment** Phillips, Harriet, Stacey Fernandes, Mo-ki Tai & Katherine Woolhouse SENES Consultants, Richmond Hill, ON

Platform Presentations (cont'd)

Time	Session C: Methodologies in Environmental Toxicology MDCL Room 1009
4:00 - 4:20	**Ecological screening assessment approach for inorganic substances in the Chemicals Management Plan's Substance Groupings Initiative** Beking, Michael A. Ecological Assessment Division, Environment Canada, Gatineau, QC
4:20 - 4:40	**Forensecology** Bowman, Michelle F. Forensecology, Guelph, ON
4:40 - 5:00	**Generating ecotoxicity data to identify risks associated with ecological receptor exposure to bioremediated site soils contaminated with petroleum and metals** Angell, Robin A.[1], Kathryn Bessie[2], Emma J. Shrive[1], Melissa Whitfield Aslund[3] & Gladys L. Stephenson[1] [1]Stantec Consulting, Ltd., Guelph, ON [2]EBA, A Tetra Tech Company, Calgary, AB [3]Intrinsik Environmental Sciences, Inc., Mississauga, ON
5:00 - 5:20	**Contaminant transport and pathways model for assessment of current and future risks in the Beaverlodge Lake area, Canada** Fernandes, Stacey[1], Bruce Halbert[1], Caroline Hamer[1], Harriet Phillips[1] & Michael Webster[2] [1]SENES Consultants Limited, Richmond Hill, ON [2]Cameco Corporation, Saskatoon, SK

Platform Presentations (cont'd)

Time	Session D: Organic Substances - Sampling, Analysis & Toxicology MDCL Room 1010
4:00 - 4:20	**PFOS, PFOA and other fluorinated compounds in environmental samples – Overcoming sampling and analytical challenges** Obal, Terry, Adam Robinson & Sin Chii Chia Maxxam Analytics, Mississauga, ON
4:20 - 4:40	**Analysis of the uptake of triclosan and triclocarban in plants grown in biosolids-amended soil** *Prosser, R.[1], L. Lissemore[2], L. Sabourin[3], E. Topp[3] & P. Sibley[1] [1]University of Guelph, School of Environmental Sciences, Guelph, ON [2]University of Guelph, Laboratory Services Division, Guelph, ON [3]Agriculture and Agri-food Canada, Southern Crop Protection and Food Research Centre, London, ON
4:40 - 5:00	**Improved analytical method for the determination of an extended list of PAHs by high-resolution GC-MS** McNeil, Ed, Kim Bennett, Betsy Cliffe & Shawn Heier Maxxam Analytics, Mississauga, ON
5:00 - 5:20	**Sublethal toxicity and bioaccumulation of two pharmaceuticals and personal care products to the freshwater mussel (*Lampsilis siliquoidea*)** Gilroy, Ève A.M.[1], Klinck, Joel S.[1], Sheena D. Campbell[2], Rodney McInnis[2], Patricia L. Gillis[2] & Shane R. de Solla[1] [1]Ecotoxicology and Wildlife Health Division, Environment Canada, Burlington, ON [2]Aquatic Contaminants Research Division, Environment Canada, Burlington, ON

*** Student presentation**

List of Poster Presentations

Southern Ontario Water Consortium: A platform for innovation and collaboration in the water sector
Deborah MacLatchy[1], Mark Servos[2] & Allen, Evelyn[3]
[1]Department of Biology, Wilfrid Laurier University, Waterloo, ON
[2]Department of Biology, University of Waterloo, Waterloo, ON
[3]Southern Ontario Water Consortium, University of Waterloo, Waterloo, ON

Metal and pharmaceutical mixtures: is ion loss the mechanism underlying acute toxicity and widespread additive toxicity in zebrafish?
Alsop, Derek, Joanna Wilson & Chris Wood
McMaster University, Hamilton, ON

An interdisciplinary approach to evaluating potential risks to aquatic receptors associated with exposure to petroleum hydrocarbon contaminated groundwater at a site located on the floodplain of the Ottawa River
***Brimble, Samantha[1], Natasha Corrin[1], Mike Z'Graggen[1], Siobhan Sutherland[2] & Allison Myatt
[1]Golder Associates Ltd., Ottawa, ON
[2]National Capital Commission, Ottawa, ON

Influence of environmental media on children's blood lead levels in Flin Flon, Manitoba
Cheung, Paul H., Adam M. Safruk & Elliot Sigal
Intrinsik Environmental Sciences Inc., Mississauga, ON

Using the undergraduate laboratory to understand the temporal and spatial distribution of polycyclic aromatic hydrocarbons (PAHs) in surface waters in the Greater Toronto Area
***Choi, Sunmin**, Derek Jackson and Jessica D'eon
Department of Chemistry, University of Toronto, Toronto, ON

Draft Canadian Water Quality Guidelines for the protection of aquatic life for zinc
El-Fityani, Tamzin[1], Susan Roe[2], Ariane Bouffard[3], and Doug Spry[1]
[1]Emerging Priorities Division, Environment Canada, Gatineau, QC
[2]Environmental Emergencies Division, Environment Canada, Gatineau, QC
[3]Ouranos – Consortium sur les changements climatiques, Montreal, QC

*** Student presentation**

List of Poster Presentations (cont'd)

Dissolution of silver nanoparticles in lake mesocosms
*Furtado, Lindsay[1], Md. Ehsan Hoque[2], Beth Cheever[3], Denise Mitrano[4], Jim Ranville[4], Holger Hintlemann[2] & Chris Metcalfe[2]
[1]Environmental and Life Sciences Graduate Program, Trent University, Peterborough, ON
[2]Water Quality Centre, Trent University, Peterborough, ON
[3]Biology Department, Trent University, Peterborough, ON
[4]Department of Chemistry and Geochemistry, Colorado School of Mines, Golden, CO

Geospatial risk assessment of down-the-drain chemicals in Canadian rivers
*Khan, Usman[1,2], Gunther Grill[3], Joseph Ariwi[3], James Nicell[2] & Bernhard Lehner[3]
[1]AMEC Environment and Infrastructure, Pointe Claire, QC
[2]Department of Civil Engineering and Applied Mechanics, McGill University, Montreal, QC
[3]Department of Geography, McGill University, Montreal, QC

Influence of dissolved organic matter source in mitigating the acute and chronic toxicity of Cu to *Hyalella azteca*: Does ecosystem disturbance influence quality?
*Livingstone, Kelly[1], Scott Smith[2] & Jim McGeer[1]
[1]Department of Biology, Wilfrid Laurier University, Waterloo, ON
[2]Department of Chemistry, Wilfrid Laurier University, Waterloo, ON

Investigating whether biosolids-derived triclosan adversely affects the growth of three crop species
*Prosser, R. & P. Sibley
University of Guelph, School of Environmental Sciences, Guelph, ON

Does triclocarban affect the growth of *Raphanus sativus* grown in biosolids-amended soil?
G. Stitt, *Prosser, R. & P. Sibley
University of Guelph, School of Environmental Sciences, Guelph, ON

*** Student presentation**

List of Poster Presentations (cont'd)

Field-derived periphyton communities recover from an acute herbicide exposure: Implications for risk assessment
*****Prosser, R.[1], R. Brain[2], A. Hosmer[2], K. Solomon[1] & M. Hanson[3]
[1]School of Environmental Sciences, University of Guelph, Guelph, ON
[2]Syngenta Crop Protection, Greensboro, NC
[3]Department of Environment and Geography, University of Manitoba, Winnipeg, MB

Quantum dots exhibit less bioaccumulation than free cadmium in *Eisenia andrei*
*****Stewart, David T.R., Katia Oviedo Noguera, Vincent Lee, Sarbajit Banerjee, David F. Watson & Diana S. Aga
Chemistry Department, University at Buffalo, Buffalo, NY

Effects of cadmium and zinc on growth, tolerance, and metal accumulation in *Chara australis*
*****Wegst, Stacia R.[1], Mary Bisson[2], & Diana S. Aga[1]
[1]Department of Chemistry, University at Buffalo, The State University of New York, Buffalo, NY
[2]Department of Biological Sciences, University at Buffalo, The State University of New York, Buffalo, NY

Enzyme kinetics for 2:2 fluorotelomer alcohol oxidation by yeast and equine alcohol dehydrogenases
*****Woo, Gabrielle, Derek Jackson & Jessica D'eon
Department of Chemistry, University of Toronto, Toronto, ON

Effectiveness of intervention programs to reduce children's blood lead levels at mining and smelting sites
Yee, Henry, Chris Bacigalupo & Elliot Sigal
Intrinsik Environmental Sciences Inc., Mississauga, ON

*** Student presentation**

Plenary Speakers

(MDCL Room 1110)

Changes in environmental attitudes of industry - Past motivation and future direction

Gordon Craig

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In the early days of North America settlement industry was encouraged by government to utilize natural resources and bring development and wealth to communities. As populations grew and other demands developed, regulations were created to protect natural resources for multiple uses. Industry then argued that environmental regulations increased costs and reduced their ability to compete nationally and internationally. It is only over the last 50 years that environmental regulations and legal precedents have placed substantial responsibility for the protection of natural resources on industry. In recent decades, product advertising and marketing has engaged the consumer as another stakeholder in shaping industry's attitude regarding environmental management and protection. The financial model for business has expanded with a growing economy and an increase in stakeholders. Fuller cost accounting incorporating the expense and benefit of environmental protection and remediation has changed the equation of profitability. Convergence of the corporate need to make a profit for investors together with meeting consumer environmental needs will continue toward the common goal of economic sustainability.

Wastewater, watersheds and the War of 1812: Win, lose or tie?

Mark Servos

Canada Research Chair in Water Quality Protection
Department of Biology, University of Waterloo, Waterloo, ON
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The Grand River watershed in southern Ontario receives wastewater from 30 municipal wastewater treatment plants as well as runoff from intensive agriculture. The central reaches of the watershed receives effluents from several large treatment plants from the rapidly growing cities of Waterloo, Kitchener and Guelph. These treatment plants differ in their treatment processes and effluent quality. Surveys of the fish populations have revealed a variety of effects on fish physiology, populations and communities downstream of the outfalls. Elevated levels of contaminants (e.g. hormones, pharmaceuticals, etc.) have been observed in surface water and fish collected in association with the effluent discharges. Fish exposed to these effluents in the laboratory or in cages (rainbow trout) have shown a variety of changes in gene expression, biochemistry and ability to respond to a secondary stressor. Wild fish (rainbow and greenside darter) have shown changes in ability to produce sex steroids, and altered somatic indices suggesting changes in energy allocation. Even downstream of a tertiary treatment plant (Guelph) there were subtle changes in relative species abundance and indications of altered food web interactions. Downstream of the Kitchener outfall a very high incidence (>70%) and intensity of intersex has been observed in several species of fish. Assessment of the fish community shows changes in the relative abundance of darters below the outfalls and a shift toward more tolerant, mobile species such as suckers. Municipal wastewaters alter the reproductive performance in wild fish and represent a potential risk to the sustainability of fish populations. Several of the treatment plants in this study are currently undergoing extensive upgrades and this creates an opportunity to examine the effectiveness of major infrastructure investments.

Recognizing it is the Bicentennial of the War of 1812, lessons learned from local history will be applied to how we should manage wastewater for environmental sustainability in the future!

Regulatory toxicology: A splash of this and a dash of that

Lisa Taylor

Method Development and Applications Unit, Environment Canada
S&T Laboratories, Ottawa ON
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If only problem solving in environmental science was as easy as following a recipe. Our soufflés would rise every time! The consequences of a flop however, are much more severe than a rumbly belly. Held no longer is the view of 'too many chefs in the kitchen' as today's issues (e.g., fracking, oil sands, climate change, wastewater treatment, and personal care products) are best managed by involving multiple disciplines. Two case studies will be presented that exemplify a team approach to satisfying regulatory requirements under the Canadian Environmental Assessment Act and the Fisheries Act, where I was a key ingredient (i.e., half a cup of aquatic toxicology). Environment Canada's standardized biological test methods were an integral component of these case studies and while somewhat akin to a recipe, their interpretation and application can enlist collaborations with toxicologists, biologists, chemists, modellers, statisticians, hydrologists, policy analysts, and lawyers. I will discuss our challenges, who else had a say, what worked and what didn't, as keys to the recipe for success.

Platform Presentations

(in alphabetical order by family name of presenter)

Generating ecotoxicity data to identify risks associated with ecological receptor exposure to bioremediated site soils contaminated with petroleum and metals

Angell, Robin A.[1], Kathryn Bessie[2], Emma J. Shrive[1], Melissa Whitfield Aslund[3] & Gladys L. Stephenson[1]

[1]Stantec Consulting, Ltd., Guelph, ON
[2]EBA, A Tetra Tech Company, Calgary, AB
[3]Intrinsik Environmental Sciences, Inc., Mississauga, ON, Canada
E-mail: robin.angell@stantec.com

Key Words: soils ecotoxicity, bioremediation, petroleum hydrocarbons, metals

Ecotoxicity assessments were conducted using agronomic species, to provide ecologically relevant information with which to identify potential risks associated with exposure of soil organisms to bioremediated site soils contaminated with petroleum hydrocarbons (PHCs) and metals. A phased approach was taken to determine whether exposure to the site soils resulted in adverse effects, and whether these adverse effects were attributable to contaminants remaining in the site soils.

Testing was conducted to account for variability due to physico-chemical differences between reference control soils, and between the control and contaminated soils. Adverse effects were observed for test organism performance in the contaminated site soils when compared to that in the reference control soil(s). Further testing was conducted, and metals co-contamination and nutrient availability were eliminated from consideration as potential explanatory variables. However, there was not a monotonic increase in test organism response with increased PHC concentrations in soil; therefore, further analysis was conducted to identify the potential explanatory variables for each toxicity endpoint. Partial least squares (PLS) regression procedures were applied to available site and toxicity test data, and lent further weight-of-evidence to that generated by ecotoxicity testing. It was concluded from the results of the PLS regression analysis that the adverse biological effects observed for test organisms exposed to the site soils were attributable to pedological influences unrelated to co-contamination with metals and, for the most part, not solely attributable to PHCs.

Ecological screening assessment approach for inorganic substances in the Chemicals Management Plan's Substance Groupings Initiative

Beking, Michael A.

Ecological Assessment Division, Environment Canada, Gatineau, QC
E-mail: Michael.Beking@ec.gc.ca

Key Words: metals, ecological assessment

Under the *Canadian Environmental Protection Act, 1999*, the Minister of the Environment and the Minister of Health jointly assess the risks that chemical substances may pose to Canadians and/or their environment. There are approximately 23,000 substances on Canada's Domestic Substances List (DSL). About one thousand inorganic and/or metal-containing substances were identified as priorities for screening assessment through categorization of the DSL, based on ecological and/or human health concerns. Under the first phase of the Chemicals Management Plan (CMP) launched in 2006, substances identified as the highest priority were evaluated individually as part of the Challenge Initiative. The second phase of the CMP, launched in 2011, includes the Substance Groupings Initiative, where the Government of Canada plans to assess and manage, where appropriate, the potential human health and ecological risks associated with nine groupings of substances. By assessing substances as groupings, a number of efficiencies will be gained. Three of the groupings are based on inorganic moieties of potential concern: the cobalt-containing substance, selenium-containing substance, and boron-containing substance groupings. These groupings will be further described and the moiety-based approach that is being applied to assess their ecological risk will be discussed, as well as current progress. All Substance Groupings Initiative screening assessments are to be completed by 2016.

Forensecology

Bowman, Michelle F.

Forensecology, Guelph, ON
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Key Words: aquatic ecosystems, multiple stressors

The overarching goal of environmental toxicology is logically evolving from documenting overall impact to isolating specific stressors. This evolution is essential for effective ecosystem management and restoration and is especially important in the face of evolving environmental stressors. Forensic Ecology or Forensecology involves developing novel tools for environmental toxicologists. What is in our toolbox and what is missing?

Contaminant transport and pathways model for assessment of current and future risks in the Beaverlodge Lake area, Canada

Fernandes, Stacey[1], Bruce Halbert[1], Caroline Hamer[1], Harriet Phillips[1] & Michael Webster[2]

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[2]Cameco Corporation, Saskatoon, SK
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Key Words: fate and transport, modelling

The Beaverlodge Lake region is an area in northern Canada which has been affected by past uranium mining and milling activities. Remediation activities have occurred; however, there are residual radionuclide and metal issues in the watersheds of the area. Water and sediment quality modelling has been performed using a proprietary computer code called LAKEVIEW in order to predict future environmental conditions. LAKEVIEW consists of a contaminant dispersion model, which predicts future water column and sediment concentrations, and a pathways assessment model, which calculates the resulting risk to human and ecological receptors that may frequent the area. This combined model predicts not only current base case conditions but is used to inform the development of area-specific fish and water consumption advisories and to assess conditions which may result from implementation of a wide range of remedial measures.

The results of the assessment indicate that, in the downstream environment, radionuclide concentrations are generally not a concern while there are potential risks to human health related to consumption of fish containing selenium and drinking water containing uranium. Potential risks to ecological receptors are due primarily to predicted bioaccumulation of selenium. Further simulations indicate that the majority of these risks are unlikely to be quickly mitigated regardless of remedial strategy employed.

Sublethal toxicity and bioaccumulation of two pharmaceuticals and personal care products to the freshwater mussel (*Lampsilis siliquoidea*)

Ève A.M. Gilroy[1], Klinck, Joel S.[1], Sheena D. Campbell[2], Rodney McInnis[2], Patricia L. Gillis[2] & Shane R. de Solla[1]

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Key Words: PPCPs, freshwater mussels, chronic toxicity, bioaccumulation

We investigated chronic sublethal toxicity and bioaccumulation of a lipid regulator: Rosuvastatin (RSV), and a fluoroquinolone antibiotic: Moxifloxacin (MOX) using 2 year-old sub-adult freshwater mussels (*Lampsilis siliquoidea*). Our assessment involved a suite of endpoints including behaviour (filtering frequency), algal clearance rate, dissolved oxygen consumption, haemocyte (blood cell) count and viability, glutathione S-transferase (GST) activity, and bioaccumulation.

Exposure (0.001-100 mg/L) to both compounds caused a concentration-dependent decrease in filtering activity. The effects of exposure to MOX were noticeable from the beginning of the 3-week exposure, while those of RSV were not detectable until week 2. A level of recovery appeared to be present in some MOX exposed mussels, which increased filtering activity during the 2nd and 3rd weeks; however this may also be the result of food stress. No recovery was observed in RSV exposures. Filtering behaviour had a concomitant, concentration-dependent decrease in clearance rate, quantified by the disappearance of an algae suspension over time. These behavioural responses were not reflected by significant changes in oxygen consumption. A slight decrease in haemocyte viability was observed in mussels exposed to the highest RSV concentration, but no other differences in concentration or viability were observed. GST activity measured in the digestive gland of mussels did not show differences among treatments. Bioconcentration factors indicate low potential for bioaccumulation, consistent with their log K_{OW}, and suggest drug metabolism, particularly in the case of MOX.

Behaviour and nickel bioaccumulation: Is there a link?

Leonard, Erin M.[1], Julie Marentette[2,3], Sigal Balshine[2] & Chris Wood[1]

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[2]Department of Psychology, McMaster University, Hamilton, ON
[3]Aquatic Contaminants Research Division, Environment Canada, Burlington, ON
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Key Words: nickel, bioaccumulation, behaviour, fish

Traditionally water quality guidelines/criteria are based on acute (and sometimes chronic) lethality tests. However, this approach will only protect species against physiological death (e.g. mortality, failed recruitment) and does not consider the role of ecological death, which can greatly affect the survival of an animal in nature. Ecological deaths can occur at much lower concentrations, as the organism itself may not be overtly harmed but cannot perform normal behaviours to forage for food, evade predators or search for mates. Therefore, we investigated the impact of acute (96-h) Ni exposure on the behaviour of two freshwater fish species, the round goby (*Neogobius melanostomus*) and rainbow trout (*Oncorhynchus mykiss*) and compared these values with Ni bioaccumulation in various organs. Round gobies were sensitive to Ni, exposure exhibiting a significant decline in movements per minute correlated to the lowest observable effect concentration (LOEC), at least 13 fold below the acute toxicity concentration. The behavioral effect of acute Ni exposure on rainbow trout was unclear. We also determined that a physiological endpoint such as bioaccumulation could be linked to the ecological endpoint of behaviour within and across species.

(NSERC Strategic Grant, Rio Tinto Alcan, Environment Canada)

Improved analytical method for the determination of an extended list of PAHs by high-resolution GC-MS

McNeil, Ed, Kim Bennett, Betsy Cliffe & Shawn Heier

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Key Words: polyaromatic hydrocarbons (PAH), toxic equivalency factors (TEF), soil, water, tissue, air, high resolution GC-MS

A need to analyze for a list of PAHs (polyaromatic hydrocarbons) beyond the standard list of 16 compounds has arisen. Not long ago, the State of Washington Administration Code added 18 new PAHs to the list, 5 of which have toxic equivalency factors (TEFs) equivalent to benzo[a]pyrene, long considered to be the most toxic of the PAHs. In addition, another 5 new PAHs were found to have TEFs of 10, when compared to benzo[a]pyrene.

Maxxam Analytics will show that it has expanded the list to include the 18 additional PAHs, demonstrate the results of method validations in soil, water and tissue samples and discuss experimental results and background issues. In addition, the results of a soil sample taken next to Highway 401 in Ontario will be discussed and some new preliminary results involving recent air analysis will be reported.

Site-specific Water Quality Objective for nitrate: The recalculation procedure

Nesbitt, Richard A. & Neil J. Hutchinson

Hutchinson Environmental Sciences Ltd., Kitchener, ON
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Key Words: site-specific water quality objective, nitrate-N, recalculation procedure, CCME long-term freshwater guideline

The release of the 2012 CCME nitrate guideline raised nitrate as a new concern for assessment of municipal wastewater discharges. Assimilation modelling for a proposed wastewater treatment plant (WWTP) that will discharge into a southern Ontario river identified nitrate concentrations in excess of the long-term freshwater Canadian Water Quality Guideline for nitrate-N, 3 mg/L, for several days at a time.

An analysis was conducted to assess the implications of this exceedance to aquatic life in the receiving watercourse in support of the approvals process. The applicability of the guideline value was found to be inappropriate for the watercourse as not all species and families used to determine the guideline value calculated using a Type A Species Sensitivity Distribution (SSD) were present. The recalculation procedure was employed and several species were excluded from a site-specific SSD to produce a site-specific water quality objective (SSWQO) of 5.04 mg/L nitrate-N. The site-specific SSD was generated using the USEPA SSD Generator Version 1 (2012), applying the log-probit cumulative density function model to mean plotting positions to generate the line of best fit and x-y intercepts.

The narrative associated with the existing long-term guideline also fails to indicate a duration at which aquatic life is significantly impacted. Implications of short and long-term nitrate-N exposures were assessed and a supplementing narrative was produced to qualify the SSWQO: Nitrate-N must not exceed a geometric mean concentration of 5.04 mg/L over a 7 day period in the watercourse. Using the SSWQO and narrative it was determined that discharges from the WWTP will not pose a risk to aquatic life in the receiving watercourse resulting from nitrate exposure.

Effects of water quality parameters on Cu toxicity to rainbow trout and development of a chronic Biotic Ligand Model

Ng, Tania Y.-T.[1], M. Jasim Chowdhury[2] & Chris M. Wood[1]

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Key Words: copper, trout, toxicity, biotic ligand model

The biotic ligand model (BLM) is used worldwide for water quality assessment. This study aims to develop a chronic BLM for predicting copper toxicity to rainbow trout in soft water. We determined the influence of water quality parameters (Ca, Mg, Na, DOC and pH) on acute and chronic Cu toxicity by measuring survival, growth, whole body Cu, Na concentrations and expression of ion transport genes in the juvenile trout.

Mortality was a sensitive endpoint exhibiting clear dose-response relationships to Cu. The 30 d LC_{50}, LC_{20}, and LC_{10} of Cu in baseline soft water were 8.2, 5.2, and 4.0 mg l^{-1}. Ca (3 mM) increased 30 d LC_s by 8-10 fold. It was also protective against the effects of Cu (10 mg l^{-1}) on molecular endpoints (mRNA expression and/or activity of branchial Na/K ATP_{ase}, and ECaC). DOC (0.2 – 10 mg C l^{-1}) increased the 30 d LC_s by 24-30 fold. Na and Mg showed weak or no protection against Cu toxicity in the soft water conditions tested. Acute toxicity of Cu was relatively constant across pHs except for a 2- to 3-fold higher LC_{50} at pH 5.0 and a 3- to 4-fold higher LC_{50} at pH 8.5. This pattern of protective effect of pH was not captured by the current BLM. The results were used to develop a chronic BLM that predicts Cu toxicity over a wide range of water chemistry

(ICA, CDA, NiPERA, IZA, ILZRO, Teck, Vale, Xstrata, NSERC CRD).

PFOS, PFOA and other fluorinated compounds in environmental samples – Overcoming sampling and analytical challenges

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Key Words: perfluorinated compounds (PFC), environmental contamination, soil and water sampling, LC-MS/MS, PFC analysis

Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and related perfluorinated compounds (PFCs) have received a substantial amount of attention, not only because they are recognized as ubiquitous environmental contaminants, but also because these compounds persist, bioaccumulate and cause toxicity in some animal studies. PFCs are of particular interest recently because of their emergence as compounds of environmental concern at airport sites across Canada. It is important that we investigate and develop a greater understanding of their behaviour to ensure representative sample collection, reliable analytical measurement and ultimately effective treatment of compounds.

Because of the physical and chemical behaviour of PFCs in aqueous sample matrices, they pose unique analytical challenges. These same physical and chemical characteristics extend these challenges to field sampling protocols and, if not taken into consideration, lead to unreliable sample integrity and data variability. Ultimately, analytical data will not be representative of the true site condition.

This presentation will review historic information about the use and distribution of these compounds in the environment, highlighting practical considerations for soil and water sampling, and demonstrating best analytical practices to produce results that are both reliable and representative.

Use of species sensitivity distributions (SSDs) in risk assessment

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Key Words: risk assessment, aquatic biota, species sensitivity distribution

Species sensitivity distributions (SSDs) are being used more frequently in the setting of water quality objectives (for example, the CCME water quality objective for cadmium and uranium). The SSD method is the preferred approach in the development of the water quality objective as it uses all available toxicity data (provided these data pass quality control criteria) for a wide range of species. In general, the CCME selects the 5th percentile of the SSD curve for the water quality objective. The intent of this presentation is to discuss how SSDs can be used within a risk assessment to evaluate possible effects on aquatic species. Although an overview of the development of an SSD will be provided, the primary focus will be on the application within the risk assessment process. Different approaches can be used to develop site-specific SSDs, these include:

- Consideration of the biota that are included in the development of the SSD
- Consideration of the level of protection that is appropriate
- Adjustments of the toxicity data to account for factors such as hardness

Example applications of the site-specific SSDs will be discussed, as well as how the use of this approach can be integrated into an assessment of potential effects on aquatic biota within a risk assessment.

Analysis of the uptake of triclosan and triclocarban in plants grown in biosolids-amended soil

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Key Words: triclosan, biosolids, phytoaccumulation

Triclosan (TCS) and triclocarban (TCC) are antimicrobial chemicals that are present in a variety of personal care products. Due to the relatively high persistence and hydrophobicity of TCS and TCC, the chemicals partition into the solid portion of municipal sewage. TCS and TCC continue to persist after the solid sewage is processed into biosolids. There is concern about whether TCS and TCC are taken up in roots and translocated throughout plants that are grown in biosolids-amended soil. In order to answer this question, a modified method was developed to analyze triclosan and triclocarban residues in biosolids, soil, and plant tissue. Soybean (*Glycine max*), radish (*Raphanus sativus*), and carrot (*Daucus carota*) were then grown in soil amended with dewatered anaerobically-digested biosolids. Amendment rates followed the best management practices employed in the province of Ontario in Canada. Biosolids were spiked with increasing quantities of TCS to produce a range of environmentally relevant exposures. Plants were harvested midway through their life cycle and at maturity. Root, stem, edible portion of the plant, and soil were analyzed. In addition to the plants grown in growth chambers, carrot, green bell pepper (*Capsicum annuum*), cucumber (*Cucumis sativus*), and tomato (*Solanum lycopersicum*) were grown in a field amended with dewatered anaerobically-digested biosolids in 2011 and radish, carrot, and tomato were grown in 2012. The soil and edible portion of these plants were harvested when the plant reached maturity for the analysis of TCS and TCC residues. Residues of TCS up to 61 ng/g dry weight (dw) were found in plant tissue grown under controlled conditions. Residues of TCS and TCC were found in edible portions of plants grown in field up to 5.6 and 5.7 ng/g dw, respectively.

Implementation of the results of ecotoxicity assessments: Site-specific application to support management decisions

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Key Words: petroleum hydrocarbons, toxicity tests, risk, site-specific management decisions

Ecotoxicity tests can be conducted on a site-specific basis to generate scientifically-defensible data that can be used to either quantify the risk associated with contaminated matrices at the site or make decisions regarding the management of the site/risks. The advantages of using site-specific data rather than generic toxicity data gleaned from the literature, or other studies, include increased accuracy, relevance, and certainty. Although toxicity tests are perceived as costly and time consuming, the implementation of the data generated from such tests are generally cost effective in the sense that site closure is obtainable and, in some cases, the savings in terms of money and resources are high. A case study will be presented which highlights the advantages and limitations of the implementation of site-specific ecotoxicological results for managing a site historically contaminated with crude oil from a pipeline break 18 years ago.

Water-only toxicity of salts and metals to two size ranges of *Hexagenia spp.*

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Key Words: *Hexagenia* spp., acute toxicity, salts, metals

Hexagenia spp. are standard test organisms used routinely in sediment toxicity testing. *Hexagenia* are valuable test organisms based on their ecological importance. *Hexagenia* are good candidates to be utilized in water-only test methods, however little is known about *Hexagenia's* sensitivities to water-only chemical exposures. Testing was undertaken within the Ontario Ministry of the Environment (MOE) Aquatic Toxicology Unit (ATU) to investigate the acute toxicity of a battery of compounds to *Hexagenia* through water-only exposures. These tests support method development for a water-only *Hexagenia* test, as well as updating sensitivity data necessary to strengthen the current MOE sediment toxicity method and bioaccumulation method.

Toxicity tests were conducted based on the standard Environment Canada acute lethality test method for evaluating the toxicity of effluents to *Daphnia magna* with the following modifications: 96 h duration, 23 +/- 2 °C, and silicone tubing for substrate. *Hexagenia* of two size ranges were used in testing (4-6 mg w.w. and, 20-30 mg w.w.). Exposures were comprised of a variety of chlorinated and non-chlorinated salts. In all cases except for sodium chloride the smaller *Hexagenia* were more sensitive than the larger *Hexagenia*. Sodium sulphate was observed to be more toxic than sodium chloride while potassium chloride was observed to be more toxic than potassium sulphate. Small *Hexagenia* were more sensitive to ammonium chloride than large *Hexagenia*. Future directions for this project include investigations with a variety of metals, as well as continuing the investigation of ammonia toxicity at varying temperature and pH levels.

Investigating multi-metal interactions at the gill of the rainbow trout: The next step in the development of the Biotic Ligand Model

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Key Words: multi-metal uptake, rainbow trout, BLM

The Biotic Ligand model (BLM) has provided us with improved ability to predict toxicity of individual metals to organisms in freshwater systems. The model has been instrumental in allowing us to regulate metals with increased accuracy. However in reality organisms are often simultaneously exposed to multiple metals, which interact with each other and biotic ligands resulting in effects that are additive, non-additive, or antagonistic. These interactions are not accounted for in current predictive modeling.

The present research characterizes potential competitive and non-competitive interactions between metals for short-term uptake/binding to the biotic ligand. Standard 3-h gill metal binding tests with Zn, Cd, Cu, Pb, Ni and Ag were performed *in vivo* on freshwater rainbow trout (*Onchorynchus mykiss).* Radiolabelled metals were presented at a range of concentrations, establishing Michaelis-Menten relationships, and then the tests were repeated in the presence of a potentially competing second "cold" metal at the approximate 96 h LC50 concentration.

Metals with similar routes of transport across the gill were hypothesized to compete with each other for uptake. Our research on binary metal mixtures yielded surprising results. In some mixtures non-competitive inhibition was observed while in several cases the addition of a second metal to the exposure actually stimulated metal uptake. The mechanisms behind these interactions remain unclear, but highlight the need for extensive work to be performed on characterizing multi-metal interactions in order to improve the regulation of metals in the environment.

Acknowledgements: Environment Canada MITHE Program

Alternative Tier II SSROs that acknowledge non-contaminant effects

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Key Words: petroleum hydrocarbons, site-specific, multi-collinearity, non-contaminants

In Canada, Tier II soil petroleum hydrocarbon (PHC) guidelines allow for limited modifications to account for site-specific variables. However, the most sensitive pathway that invariably drives PHC guidelines is direct soil contact, and for this pathway modification by site-specific variables is disallowed. We analyzed soil toxicity test data from three PHC-contaminated sites using a combination of data reduction and model averaging procedures, collectively described as DRAMA, in order to objectively deal with multicollinearity and model selection issues. DRAMA results showed that non-contaminants were more strongly correlated with observed toxicity tests responses than PHCs and even the effect of a specific site. The DRAMA procedure may be useful in deriving generic equations describing how pedologic variables affect PHC toxicity. This can allow for derivation of site-specific remediation objectives for total PHCs.

Notes

Poster Presentations

(in alphabetical order by family name of presenter)

Southern Ontario Water Consortium: A platform for innovation and collaboration in the water sector

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Key Words: water, innovation, ecotoxicology, analytical techniques

Announced in August 2011 and currently under development, the Southern Ontario Water Consortium (SOWC - www.sowc.ca) was created with the goal of building an integrated platform for research, development, testing, and demonstration of water and wastewater technologies and services.

The platform will include facilities for research and development related to watershed management, wastewater treatment, ecotoxicology, drinking water treatment, analytical techniques, and sensor development. It will encompass a series of facilities located primarily within the Grand River watershed but also in many other Southern Ontario areas. The facilities will be linked with a large computational and data resource invested by IBM and installed at the University of Toronto for the processing, analysis, storage, and distribution of the data produced across the platform.

The key to the SOWC project is the integration of all elements of water management into a single platform enabled by a sophisticated data generation, processing, and management environment.

The Ecotoxicology node, led by Wilfrid Laurier University, focuses on assessing water quality and its impact on aquatic biota using biological and chemical analytical tools, to improve water quality and aquatic ecosystem health.

The Analytical Techniques node, led by the University of Waterloo, provides the ability for analysis, research and development of techniques for the identification of novel contaminants across the various SOWC nodes.

Metal and pharmaceutical mixtures: Is ion loss the mechanism underlying acute toxicity and widespread additive toxicity in zebrafish?

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Key Words: toxicity of contaminant mixtures, *Danio rerio*

The acute toxicities and mechanisms of action of a variety of environmental contaminants were examined with zebrafish larvae (*Danio rerio*; 4-8 days post-fertilization). Toxic interactions were observed between metals. For example, the addition of a sublethal level of nickel (15% of the LC_{50}, one third of the LC_{01}) to all copper treatments decreased the copper 96 h LC_{50} by 58%, while sublethal copper exposure (6% of the copper LC_{50}, 13% of the LC_{01}) decreased the cadmium 96 h LC_{50} by 47%. The effects of these metal mixtures, as well as copper and ammonia mixtures, were typically additive or greater than additive. Larvae exposed to cadmium, copper or nickel experienced whole-body ion loss. Decreases were greatest for Na^+ followed by K^+ (as high as 19% and 9%, respectively, in 24 h). Additive toxicity between copper and pharmaceutical compounds such as fluoxetine (Prozac™), β-naphthoflavone, estrogen and 17α-ethinylestradiol were also observed. Similar to metals, acutely-toxic concentrations of fluoxetine, β-naphthoflavone and ammonia all decreased whole body Na^+ and K^+. Overall, whole body Na^+ loss showed the greatest correlation with mortality across a variety of toxicants. We theorize that a disruption of ion homeostasis may be a common mechanism underlying the additive acute toxicity of many contaminants in fish.

An interdisciplinary approach to evaluating potential risks to aquatic receptors associated with exposure to petroleum hydrocarbon contaminated groundwater at a site located on the floodplain of the Ottawa River

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Key Words: ecological risk assessment, petroleum hydrocarbons, floodplain

An ecological risk assessment (ERA) was conducted for a site with petroleum hydrocarbon (PHC) impacted groundwater located on the floodplain of the Ottawa River. The risk assessment used an interdisciplinary approach to characterize the potential for exposure of aquatic receptors to PHC-contaminated groundwater discharging to the river during flooding conditions and to evaluate the potential for toxic effects associated with this exposure.

The approach involved (1) a hydrological assessment to determine the spring flood regime at the site; (2) an interpretation of contaminant fate and transport in the subsurface; (3) an aquatic habitat assessment, species at risk and fish spawning assessment; (4) an interpretation of potential risks to aquatic receptors based on literature toxicity values; and, (5) an interpretation of potential risks to aquatic receptors based on results of site-specific toxicity testing. Acute lethality tests were conducted as well as chronic reproduction, survival and growth tests following Environment Canada test protocols for selected fish and invertebrate species.

It was determined that the river does not reach the source of contamination at the site during peak flooding. As such, aquatic receptors would not be exposed to the highest PHC concentrations on-site. Acute and chronic toxicity thresholds were established using the results of the toxicity testing. Potential risks to all aquatic receptors were considered to be low when taking into account the potential for exposure, site-specific toxicity thresholds and conservatism used in the risk assessment.

Influence of environmental media on children's blood lead levels in Flin Flon, Manitoba

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Key Words: blood lead levels, children, biomonitoring, environmental sampling

A follow-up biomonitoring study was undertaken in Flin Flon, MB and surrounding communities to investigate young children's (under 7 years of age) exposure to lead. This study was completed in response to recommendations from an extensive Human Health Risk Assessment and an initial biomonitoring study conducted in 2009. One component of the follow-up study was to examine the potential influence of various environmental media on children's blood lead levels (BLLs). Lead exposure is associated with a broad spectrum of health outcomes, most notably neurodevelopmental effects in children. These effects have been reported in children with low BLLs. Outdoor soil, indoor dust, and tap water were collected from homes of participating children and analyzed for lead. In addition, a portable X-ray fluorescence analyzer was used to analyze painted surfaces at the home for the presence of lead-based paint. Household environmental sampling data were paired with children's BLLs from a total of 82 households. Three of the measured environmental media (soil, indoor dust, and paint) were found to be significantly correlated to BLLs. However, despite these statistically significant associations, the variability in BLLs was poorly explained by these factors. Dust lead concentrations did not appear to be correlated to lead concentrations in outdoor soil or paint. This analysis indicates that the environmental factors measured are poor predictors of children's BLLs in the Flin Flon area and may only have a slight influence on BLLs.

Using the undergraduate laboratory to understand the temporal and spatial distribution of polycyclic aromatic hydrocarbons (PAHs) in surface waters in the Greater Toronto Area

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Key Words: polycyclic aromatic hydrocarbons, organic contaminants, urban surface waters, undergraduate teaching

Is it possible to perform fundamental research in an undergraduate laboratory environment? I believe that given the right environment and research questions, the answer is yes.

CHM410 Analytical Environmental Chemistry is an undergraduate and graduate level course focused on the analysis of trace compounds in the environment. I believe this class is the perfect venue in which to engage senior undergraduate students in fundamental research. The analysis I propose is the measurement of polycyclic aromatic hydrocarbons (PAHs) in surface waters within the Greater Toronto Area. Sources and sinks of PAHs to urban surface waters are not well understood. Groups of 2-4 students will be provided with appropriate sampling containers and asked to collect 4 L of surface water from a lake or river of their choosing. The water samples will be filtered through glass fiber filters and extracted using solid-phase extraction disks, followed by analysis by GC-MS. Method optimization details and preliminary results will be presented here.

After the lab is completed students will have access to all of the data generated and use it to draw conclusions regarding inputs of PAHs to the environment or their distribution in the Toronto area. The most exciting aspect of this lab is that in future years students would have access to the measurements made previously, allowing them to perform a temporal analysis of PAH contamination.

Draft Canadian Water Quality Guidelines for the protection of aquatic life for zinc

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Key Words: zinc, water quality guidelines, metals

Canadian Water Quality Guidelines (CWQGs) are developed under the auspices of the Water Quality Task Group (WQTG) of the Canadian Council of Ministers of the Environment (CCME). CWQGs for protection of aquatic life provide benchmarks for the quality of the ambient environment. Where the CWQG is met there is low likelihood of adverse effects to aquatic life. Following the CCME protocol (2007), updated draft guidelines (short-term and long-term) for protection of aquatic life for zinc (Zn) were developed. Zinc had a large toxicity dataset that was evaluated and screened according to standard criteria. Toxicity modifying factors were examined, but only hardness had sufficient data to develop empirical relationships, and only long-term data met the statistical requirements to derive a hardness-correction equation. Guideline values were derived using a species sensitivity distribution (SSD). Several model curves were evaluated and tested for goodness-of-fit. The short-term benchmark concentration is set at the 5th percentile on the SSD curve. The long-term guideline for zinc is an equation that can be adjusted based on local water hardness. The draft guidelines for Zn will be posted shortly for public and peer review.

Acknowledgement: Patti Orr, Minnow Environmental Inc.

Dissolution of silver nanoparticles in lake mesocosms

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Key Words: silver nanoparticles, mesocosms, dissolution, speciation

The environmental risks associated with the release of silver nanoparticles (AgNPs) into the environment are uncertain, due to various transformations that can alter toxicity. It is particularly important to understand the extent of AgNP dissolution, that is, the release of ionic silver (Ag+) from the nanoparticle as a result of surface oxidation. It has been suggested that the toxicity of AgNPs is entirely due to the release of Ag+. The objective of this study was to use various methods to quantify AgNP dissolution and the resulting concentrations of free and complexed Ag+ in mesocosms (2 m diameter x 2 m depth) that were installed in Lake 239 at the Experimental Lakes Area (ELA) in Ontario. In two of the mesocosms spiked with a single addition of 50 nm polyvinylpyrrolidone (PVP) capped AgNPs at a nominal concentration of 80 ug/L, water samples were collected over 21 days post-addition for analysis by Single-Particle-Inductively-Coupled-Mass-Spectroscopy (SP-ICP-MS), Asymmetric Flow Field Flow Fractionation with on-line ICP-MS (AF4-ICP-MS), and ultrafiltration.

SP-ICP-MS indicated that the mean size of AgNPs declined over time from 50 to 30 nm over 21 days, which may indicate particle dissolution. AF4-ICP-MS results are consistent with particle dissolution as there was an increase over time of particles in the 1-10 nm size range. However, very little dAg was detected using ultrafiltration, likely due to binding of Ag+ to organic ligands such as DOC or plankton. The formation of Ag complexes was verified using MINEQL+ analysis. The results illustrate that dissolution of AgNPs to release Ag+ is expected to occur when AgNPs enter surface waters, but speciation of Ag+ will reduce the levels of the toxic free ion.

Geospatial risk assessment of down-the-drain chemicals in Canadian rivers

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Key Words: geo-spatial, contaminant fate modeling, risk assessment

Sewage treatment plants are the most significant source of down-the-drain chemicals to the environment; however, little is currently known about the spatial and temporal distribution of such chemicals within the Canadian environment. Geospatial exposure models such as “Great-ER” for Europe or “ISTREAM” in the U.S. can help to predict the occurrence and fate of contaminants in the environment, offering the potential to identify “hot-spots” of high concentration and high risk in surface water ecosystems. With a mandate from Health Canada, the overall goal of the current study was to develop a similar geo-spatially explicit contaminant fate model for Canada. The basis of the developed model is a global, high-resolution hydrographic database of river networks (HydroSHEDS), as well as river reach scale discharge estimates, derived by downscaling from an integrated global hydrological model (WaterGAP). The developed model was applied to all river reaches in the provinces of Ontario and Quebec by incorporating the geo-location of more than 1200 domestic wastewater treatment plants (WWTPs). The model allows for the cumulative effects assessment of municipal wastewater discharges on surface waters by estimating predicted environmental concentrations (PECs) of contaminants in rivers and streams; the relation between the discharge of WWTPs and river flow as an indicator of dilution; and the percentage of wastewater in the river course. An analysis of the sensitivity and uncertainty of the model, as well as a validation of the model results against measured river flows and reported concentrations from literature revealed an acceptable model performance and errors within expected margins, which are deemed suitable for the envisioned applications. Overall, the developed model holds the potential to be used as part of the Canadian government’s Chemical Management Plan for down-the-drain chemicals.

Influence of dissolved organic matter source in mitigating the acute and chronic toxicity of Cu to *Hyalella azteca*: Does ecosystem disturbance influence quality?

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Key Words: copper, dissolved organic matter, *Hyalella*, BLM

The potential for aquatic ecosystem recovery as a result of dissolved organic matter (DOM) protecting against metal toxicity has become a significant area of research in environmental toxicology. It is a well-characterized relationship that DOM binds free metal ions, making them unavailable for toxic action and a reduction in toxicity is seen. Less understood is source variability and how the upland terrestrial environment influences that protective capacity (quality). The aim of this study is to examine the influence of land disturbance (logging, fire, smelter emissions) on DOM quality by comparing the protective capacity of different sources on Cu toxicity and bioaccumulation in *Hyalella azteca*. Acute (96h) and chronic (28d) toxicity tests were done according to standard (Environment Canada) methods, and were completed in duplicate (acute) or triplicate (chronic) using 10 *Hyalella* aged 2-9 d added to solutions of Cu (0-4µM) and DOM sources at a DOC concentration of 5mg C/L (acute) or 7mg C/L (chronic). Test solutions were maintained at pH 7.2±0.1, 21ºC, and 13mg/L $CaCO_3$ hardness. Tests showed significant variability among sources, with disturbed sites offering less protection than reference sites. These results were complemented with 6h Cu uptake/binding experiments and optical characterizations (excitation-emission matrix spectroscopy, absorbance at 340nm and fluorescent indices). This project contributes toward an improved understanding of DOM quality characteristics, which can potentially be used to improve predictions of Cu toxicity in freshwater ecosystems.

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Investigating whether biosolids-derived triclosan adversely affects the growth of three crop species

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Key Words: triclosan, biosolids, phytotoxicity

Biosolids used in the amendment of agricultural fields have been shown to regularly contain triclosan (TCS), a broad-spectrum antimicrobial chemical, at relatively high concentrations. There is little data on the toxicity of TCS to terrestrial plants. Soybean (*Glycine max*), carrot (*Daucus carota*), and radish (*Raphanus sativus*) plants were grown under controlled environmental conditions in TCS-spiked soil or soil amended with TCS-spiked biosolids. Seedling emergence was monitored. Shoot length, root length, shoot dry and wet weight, and root dry and wet weight were measured midway through the life cycle and at maturity for each plant species. The yield of soybean plants (number of seed pods, number of seeds, total mass of pods, and total mass of seeds) at maturity was also measured. Seedling emergence was significantly lower in some triclosan-spiked soil and triclosan-spiked biosolids treatments compared to control treatments ($p<0.05$). Triclosan exposure did not significantly adversely affect any of the growth parameters in soybean, carrot, or radish plants relative to control plants ($p>0.05$). In general, growth parameters were higher in biosolids treatments but only significantly higher in one biosolids treatment of soybean plants ($p<0.05$). There was no significant difference in measures of soybean plant yield across treatments ($p>0.05$). No concentration-response relationship was observed across triclosan treatments. Results indicate that biosolids-derived triclosan does not have a significant adverse effect on the growth of the three species of plants examined in this study.

Does triclocarban affect the growth of *Raphanus sativus* grown in biosolids-amended soil?

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Key Words: triclocarban, phytotoxicity, seedling emergence, biosolids

Triclocarban (TCC) is an antimicrobial compound used in a range of personal care products. It has been shown to be present in biosolids used to amend agricultural fields at concentrations up to 51µg/g dry weight (dw). Few studies have investigated the toxicity of TCC to terrestrial plants. In order to determine the phytotoxicity of TCC on radish (*Raphanus sativus*), plants were grown in soil amended with TCC-spiked medium for 21 days. Soil was amended with soil or biosolids amendments spiked with TCC at nominal concentrations of 7, 21, 63, 189, 567, and 1701 µg/g dw. TCC concentration had no significant adverse effect on any of the parameters measured; seedling emergence, development stage, bulb length, or root and shoot length wet weight, or dry weight ($p>0.05$). Amendment of soil with biosolids did cause significant increases in shoot wet weight, dry weight and length, and root wet weight ($p<0.05$). The results of this study indicate that the current concentrations of TCC in biosolids do not pose a risk to the health of radish plants under current biosolids application policies and practices.

Field-derived periphyton communities recover from an acute herbicide exposure: Implications for risk assessment

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Key Words: periphyton, atrazine, recovery, risk assessment

Periphyton communities are an integral, yet under-appreciated, component of freshwater ecosystems, and in recognition of their foundational role, it is becoming more common to include periphyton in toxicity testing and risk assessment. This study characterized the acute response and recovery of field-derived periphyton to atrazine by measuring the quantum yield of photosystem II (PSII) with pulse amplitude modulated fluorometry. Periphyton samples were collected from upwards of six agricultural stream sites across the Midwestern United States in the summer of 2011 and 2012. Periphyton was exposed to atrazine (10 to 320 µg/L) while inhibition of PSII yield was measured at different time intervals (from 2h up to 48h). Subsequently, the periphyton exposure media was replenished (with control media) in order to assess recovery upon atrazine removal at 24h to 48h post-exposure. Sensitivity to atrazine varied with site and date of sampling but EC10 and EC50 values for PSII quantum yield did not differ significantly with exposure interval. Only the highest test concentration (320 µg/L) still demonstrated greater than ~5% inhibition at 48h, however all other test concentrations exhibited recovery within ~5% of control levels, typically within 24h. The rapid physiological recovery of the periphyton community upon atrazine removal implies that acute effects may not result in significant or sustained impacts on either periphyton structure or function in a lotic ecosystem. For ecological risk assessment, this means relying on acute direct effects data alone may result in overly conservative estimates of toxicity, especially for primary producers.

Quantum dots exhibit less bioaccumulation than free cadmium in *Eisenia andrei*

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Key Words: Bioaccumulation, Quantum Dots, Earthworms, Nanotoxicology

Engineered nanomaterials (ENM), including quantum dots (QD), are playing an increasingly important role in research and product development. As these materials are added to more products, their environmental effects will need to be assessed to ensure proper handling. Impacts of ENM on cell cultures have been extensively studied but whole organism studies are likely to be more relevant when elucidating environmental fate and toxicity. This work addresses the uptake behavior of cadmium selenide QD in an artificial soil environment by *E. andrei* earthworms. Earthworms, after one week or four weeks of exposure to QD, were acid digested and analyzed by inductively coupled plasma mass spectrometry. In addition, positive control samples consisting of worms exposed to cadmium nitrate and to selenious acid for the same period of time were also analyzed. Earthworms had accumulated cadmium and selenium from the enriched soil over both time periods, with 9.6 ± 0.8 and 6.2 ± 0.9 fold accumulation respectively after four weeks. The metal concentrations also increased with exposure time, indicating further uptake of metal ions might occur with longer exposure. The mole ratio of cadmium to selenium in the QD exposed worms (6.2 ± 0.5) is closer to the ratio seen in positive control worms (7.2 ± 0.6) than to the pure QD (1.8). These results suggest that the worms likely take up cadmium and selenium after QD disintegration in soil. Importantly, bioaccumulation of cadmium and selenium is reduced in the QD exposed worms compared to the positive control worms.

Effects of cadmium and zinc on growth, tolerance and metal accumulation in *Chara australis*

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Key Words: Phytoremediation, *Chara australis*, cadmium, zinc

Cadmium is a toxic heavy metal of worldwide concern. Elevated Cd levels can arise from both natural and anthropogenic sources. The use of plant-based cleanup techniques is becoming increasingly accepted for the cleanup of heavy metals. Therefore the macroalga *Chara australis* was investigated for its abilities to take up Cd from contaminated sediments and water in aqueous systems. This study investigates the effects of plant growth, metal tolerance, and uptake of Cd independently and in combination with Zn. *Chara* has been found to have increased survival during Cd exposure in the presence of Zn. This effect was not due to competition with Cd uptake, since there was no difference in the amount of Cd taken up in the presence and absence of Zn. We propose that Zn alleviates stress in the plant by increasing resistance to Cd, in particular by increasing glutathione concentration. Furthermore, we determined that the plants are not discriminating against any of the Cd isotopes during uptake, and the uptake profile matches that of the natural isotope distribution.

Enzyme kinetics for 2:2 fluorotelomer alcohol oxidation by yeast and equine alcohol dehydrogenases

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Key Words: perfluorinated acids, fluorotelomer alcohols, biotransformation, enzyme kinetics

Fluorinated organic compounds are globally ubiquitous and bioaccumulative. The ester hydrolysis product of one class of commercial fluorinated compounds is the fluorotelomer alcohol (FTOH). FTOH oxidation to its aldehyde is the first step in the biotransformation pathway to the perfluorocarboxylic acids (PFCAs). This pathway produces electrophilic intermediates that can form adducts with biological nucleophiles. Here we examine the enzyme kinetics of 2:2 FTOH oxidation by alcohol dehydrogenases (ADHs) using yeast and mammalian equine ADH models with different substrate specificities. 2:2 FTOH does not appear to interact with yeast ADH due to steric effects of the bulky fluorine substituents, but was found to be a strong competitive inhibitor of equine ADH butanol oxidation with a measured K_i of 0.7946 ± 0.1731 mM. Neither ADH catalyzed FTOH oxidation at measurable rates, suggesting that the electron-withdrawing fluorinated tail disrupts key steps in the ADH catalytic mechanism. Our results indicate that ADH enzyme catalysis of FTOH oxidation is negligible, and that other mechanisms such as the cytochrome P450 enzymes may be responsible for this first step of FTOH biotransformation.

Effectiveness of intervention programs to reduce children's blood lead levels at mining and smelting sites

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Key Words: lead, risk mitigation, smelter, mining

There is general agreement that blood lead levels (BLLs) less than 10 µg/dL in children are associated with adverse neurological effects. Children residing near mines and smelters may have an increased likelihood of experiencing elevated BLLs as a result of exposure to deposited lead in indoor and outdoor environmental media. In an effort to reduce BLLs in children, lead intervention programs have been implemented in communities near mines and smelters around the world. A review was conducted to examine the effectiveness of these intervention programs at reducing BLLs in children. Specifically, the review examined lead intervention programs at the following sites: Broken Hill, Australia; Torreón, Mexico; Port Pirie, Australia; La Oroya, Peru; Flin Flon, Manitoba; and, Herculaneum, USA. These intervention programs involved a multi-faceted approach and included the implementation of multiple primary and/or secondary measures, such as smelter emission controls, dust control measures, residential soil remediation, and education programs. In general, the most effective measure to reduce BLLs in children was emission reduction (i.e., primary prevention). The implementation of secondary measures (e.g., educational programs) assists in reducing BLLs in children; however, used in the absence of primary prevention, these types of secondary measures have been shown to provide limited effectiveness.

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