TOXICOLOGY IN THE 21st CENTURY:

APPLICATIONS OF PRAIRIE RESEARCH

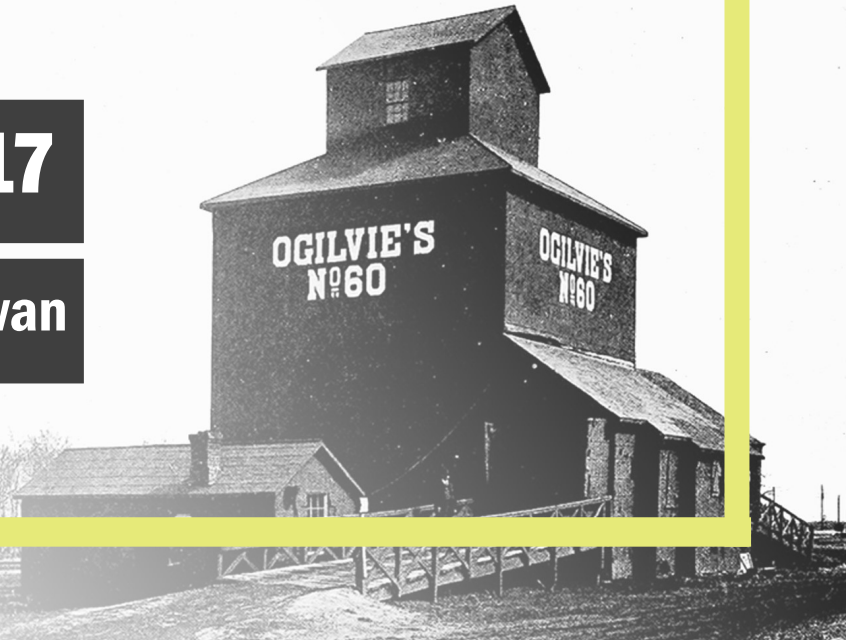
SETAC Prairie Northern Chapter

8th Annual General

Meeting and Conference

June 15 - 16, 2017

University of Saskatchewan



A Message From the President

Welcome!

On behalf of the organizing committee and the Board of the Prairie Northern Chapter of the Society of Environmental Toxicology and Chemistry it is my pleasure to welcome you to our 8th annual meeting. A quick thank you to our generous sponsors, without whom this annual gathering would not be possible. As well, a tremendous thank you for our meeting co-chairs, Erin Maloney and Derek Green, and their team here in Saskatoon for bringing together an outstanding program of science and socializing.

The PNC strives to bring together all stakeholders to collaborate around pressing environmental challenges. This diversity brings a wealth of expertise, resources, and insights from which to draw on and promote strong science to ensure the protection of our shared environment. This has always been the aim of SETAC, and this approach has been a powerful tool in our common goal of a sustainable society.

As always, if you are looking to help guide the chapter, or have ideas for how we can grow and be more engaged, please do contact myself. The Board and I have many ideas about how we can go about this, but this is your PNC! We are especially interested in student driven initiatives and opportunities to expand training and interactions amongst all sectors.

Again, many thanks to our sponsors and tireless volunteers who helped bring this event together, and we look forward to seeing you all next in year in Lethbridge for our 9th annual meeting.

Mark Hanson, Ph.D.

President, SETAC PNC

SETAC PNC Board

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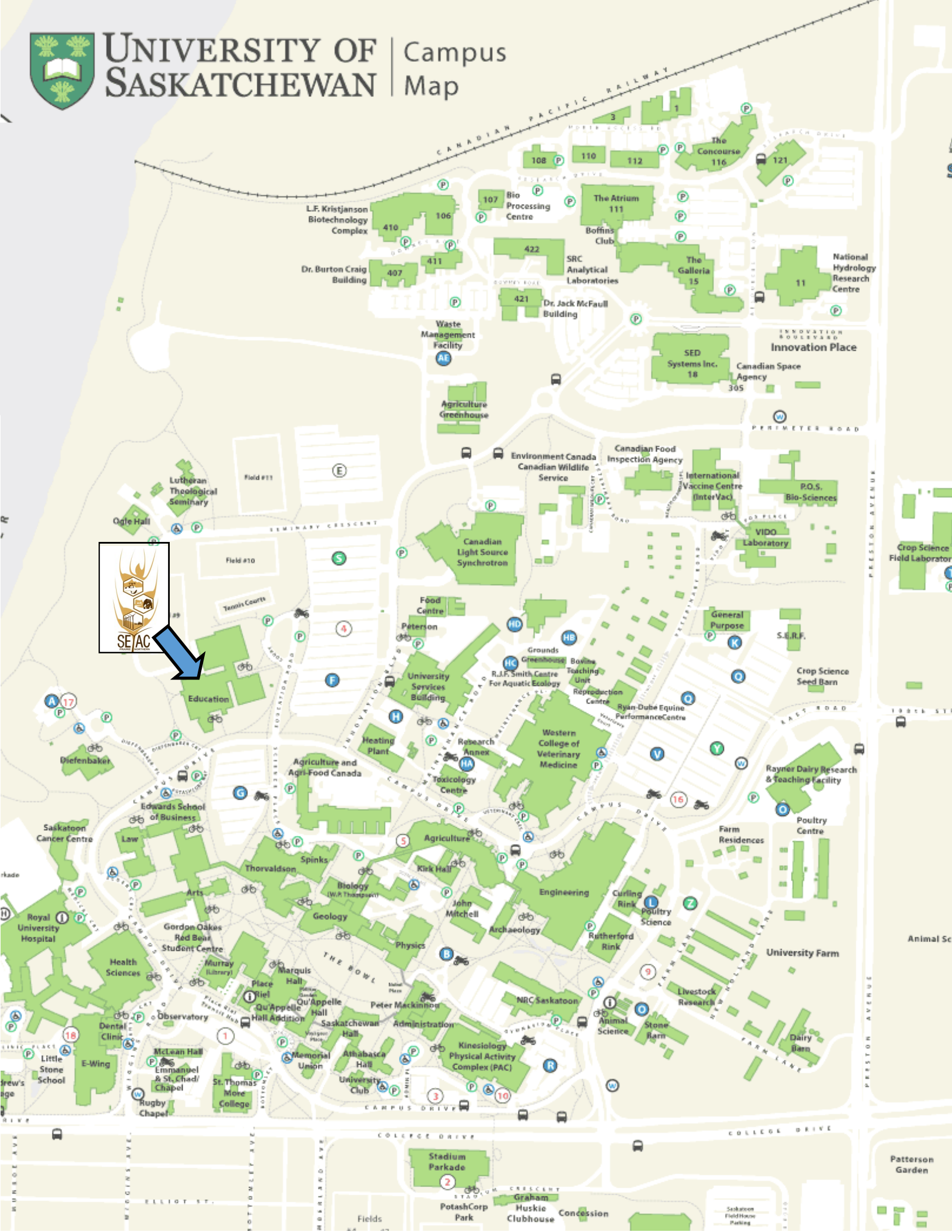
The 8th Annual Chapter Meeting of SETAC Prairie-Northern | June 16, 2017

TOXICOLOGY IN THE 21st CENTURY: APPLICATIONS OF PRAIRIE RESEARCH

7:30 - 8:25	**Registration Table Open | Quance Theatre**
8:30	Opening remarks from Dr. Mark Hanson (U of M) and greetings from SETAC Board of Directors' Dr. Karsten Liber (U of S).
8:45	Plenary: Dr. Vincent Palace, International Institute for Sustainable Development - Experimental Lakes Area **Planning and Conducting Environmental Science to Influence Policy: Lessons from the Experimental Lakes Area**
9:25	Gallant, M (U of S) | Developmental sensitivity to benzo[a]pyrene-induced changes in immune and biotransformation-related gene expression in the amphibian *Xenopus laevis*
9:40	Anderson, S (U of C) | Empirical relationships between cyanobacterial growth, nitrogen, phosphorus and microcystins in shallow prairie lakes
9:55	Gill, N (U of S) | Towards improved methods for determination of aldehyde oxidase activity in fish
10:10	Dudley, L (EcoMetrix) | Development of a quantitative risk assessment approach for wildlife: Case study of woodland caribou in Saskatchewan's Athabasca region
10:15 - 10:45	**Coffee Break and Poster Viewing | Education Lounge**
10:40	Watts, T (U of S) | Occurrence and *in vitro* toxicity of disinfection by-products in Saskatchewan water treatment plants
10:55	Evans, M (Environment and Climate Change Canada) | Atmospheric emissions from the Athabasca oil sands and their impact of boreal lakes: spatial and temporal trends.
11:10	Bianchini, K (U of S) | Effects of dietary polycyclic aromatic hydrocarbon exposure on pre-migratory fuelling in captively-dosed Sanderling
11:25	Akre, R (U of S) | Juvenile soil invertebrate avoidance to soil contaminants
11:40	Warrack, S (U of M) | Microplastic contamination in Lake Winnipeg, Canada
12:00 - 13:00	**Lunch Break | Education Lounge**
12:15	SETAC Board of Directors Meeting | 1255 Education Lounge
12:45	NASAC Meeting | 1255 Education Lounge
13:10	Plenary: Dr. Ken Coates, School of Public Policy, University of Saskatchewan **Rethinking Resource Development: Indigenous peoples, technology, environments, and the coming transformation of the extractive industries.**
13:50	Currie, Z (U of S) | The photo-induced toxicity of polyaromatic hydrocarbons and a hydraulic oil in the amphibian species *Xenopus laevis* and *Lithobates sylvaticus*
14:05	Chaves-Barquero, LG (U of M) | Subsurface filtration technology to attenuate pharmaceuticals and nutrients for rural wastewaters in northern prairie climate
14:20	Yeung, C (U of S) | The cardiorespiratory effects of acute naphthalene and pyrene exposure in adult zebrafish (*Danio rerio*)
14:35	Parkinson, R (U of S) | Locust visual motion detection and avoidance behaviours are disrupted by a sublethal dose of imidacloprid
14:40 - 15:00	**Coffee Break and Poster Viewing | Education Lounge**
15:05	Qi, A (U of A) | Exploring the toxicity of nanoencapsulated bifenthrin on rainbow trout (*Oncorhynchus mykiss*)
15:20	Shehk, K (U of S) | Expression stability and selection of optimal reference genes for gene expression normalization in early life stage rainbow trout exposed to cadmium and copper
15:35	Gamhewage, M (U of M) | Detections of pesticides in four Manitoba rivers
15:50	Plenary: Dr. Patrick Guiney, SETAC World Council **Science Integrity, Publication Bias, and Normative Science in Ecotoxicology**
16:30	Closing remarks: Dr. Mark Hanson (U of M).
16:30 - 17:45	**Poster Social | Education Lounge**
18:30	**Banquet & Awards Ceremony | Prairie Sun Brewery**

University of Saskatchewan | Campus Map



Conference Information:
Social Events at SETAC PNC

Tox on Tap | Dr. Greg Poelzer (U of S)

Thursday June 15 | 6 - 9 PM | The Wood's Alehouse | 148 2nd Ave N

Trump, the Paris Agreement, and Climate Change: What is the Future of the Global Energy Transition?

Come to Tox on Tap to discuss climate change, geopolitics, and the future of global energy. The discussion will be lead by Dr. Greg Poelzer, a Professor at the U of S (School of Environment and Sustainability), Ph.D. Political Science (U of A). So come out to Tox on Tap for some good discussion, great beer, and excellent science! It'll trump all other social events.

Poster Social | Wine and Cheese

Friday June 16 | 4 - 6 PM | Education Lounge | U of S

Come for the wine and cheese, stay for the science! This year's Poster Social will feature a prize raffle with tons of great prizes! Tickets will be available from our volunteers, and prizes will be on display!

Banquet | Prairie Sun Brewery

Friday June 16 | 6:45 PM - Late | 2020 Quebec Ave

Come celebrate another successful PNC meeting at one of Saskatoon's best local microbreweries: Prairie Sun Brewery! Locally-sourced food, great music, giant board games, and all the craft beer you can handle. This is one banquet experience you don't want to miss!

Conference Information:
Plenary Speakers

8:45 AM

Planning and Conducting Environmental Science to Influence Policy: Lessons from the Experimental Lakes Area

Dr. Vince Palace *is the Head Research Science at the International Institute for Sustainable Development - Experimental Lakes Area (IISD-ELA), and is based out of Winnipeg, Manitoba.*

1:10 PM

Rethinking Resource Development: Indigenous Peoples, Technology, Environments, and the Coming Transformation of the Extractive Industries

Dr. Ken Coates *is a Canada Research Chair in Regional Innovation at the Johnson-Shoyama Graduate School of Public Policy, and is based out of Saskatoon, Saskatchewan*

3:50 PM

Science Integrity, Publication Bias, and Normative Science in Ecotoxicology

Dr. Patrick Guiney *is the former President of the Society of Environmental Toxicology and Chemistry World Congress, and is based out of Madison, Wisconsin.*

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Platform Presentations

Platform presentations are 12 minutes, followed by a 3-minute question/discussion and transition period.

PowerPoint or PDF presentations may be emailed to PNCabstracts2017@gmail.com prior to the meeting or submitted at the Registration Desk via USB flask drive. All presentations must be received by 8:20 am on June 16.

SPECIAL THANKS TO OUR VOLUNTEER STUDENT PLATFORM JUDGES!

9:25 | Developmental sensitivity to benzo[a]pyrene-induced changes in immune and biotransformation-related gene expression in the amphibian *Xenopus laevis*

M. Gallant[1], and N. Hogan[1]
[1]*Toxicology Centre, University of Saskatchewan, 44 Campus Drive, Saskatoon, SK, S7N 5B3; *mjg098@mail.usask.ca*

The immune system of amphibians undergoes dramatic changes throughout development. Consequently, contaminant-induced immunotoxic responses in developing amphibians may vary depending on timing of exposure. As a key component of the innate immune system, cytokines are among the first to respond to pathogens by mounting an inflammatory response and analysis of cytokine mRNA levels has been used to predict the immunomodulatory potential of chemicals. The present study compared the effects of benzo[a]pyrene (B[a]P) exposure on immune and biotransformation responses at different developmental stages of the amphibian, *Xenopus laevis*. Individuals were exposed for 96 h at embryo-larval, pre- and pro-metamorphosis and gene expression was measured: pro-inflammatory cytokines (tumor necrosis factor α (TNFα), interleukin-1β (IL-1β), colony stimulating factor-1 (CSF-1)), cytochrome P450 1A1 (CYP1A1) and aryl hydrocarbon receptor (AhR). B[a]P is a model polycyclic aromatic hydrocarbon and a known immunotoxicant in mammals and fish; however, little immunotoxicity data is available for amphibians. Pre-metamorphic tadpoles exposed to B[a]P had lower TNFα expression and no change in IL-1β while the opposite was true for pro-metamorphic tadpoles. Induction of CYP1A1 was observed at all life-stages, suggesting biotransformation capacity and production of reactive metabolites. Future studies will determine whether developing immune cells and organs responsible for cytokine production are affected by reactive metabolites, leading to B[a]P-induced suppression of tadpole humoral immunity.

Keywords: cytokines, *Xenopus laevis,* developmental immunotoxicity, benzo[a]pyrene

9:40 | Empirical relationships between cyanobacterial growth, nitrogen, phosphorus and microcystins in shallow prairie lakes

S. Anderson[1], and L. Jackson[1]
[1]*Department of Biological Science, University of Calgary; *anderssm@ucalgary.ca*

The frequency of cyanobacterial blooms has been thought to be increasing over recent decades. Cyanobacteria can produce toxins that can affect surface drinking water sources and limit recreational activities. These toxins can also kill dogs and cattle. Cyanobacterial blooms can also lead to fish kills and alter aquatic food web structure, potentially altering energy cycling. While it is currently unknown why cyanobacteria produce toxins, evidence supports the idea that production is turned on and off. This research looks at whether microcystins levels are correlated with nitrogen limitation in lakes to help answer whether there are environmental thresholds to microcystin production. We choose 25 shallow prairie lakes east of Calgary based on a range of salinity to sample four times throughout summer 2016 to determine if there were specific concentrations of nutrients that led to cyanobacterial blooms, and whether there was a correlation of microcystins with N:P. Our results show that many lakes had favourable conditions for cyanobacterial growth. Chlorophyll concentrations ranging from 0 (below detectable limits) to 4725 µg/L suggest that the lakes we sampled may fall into distinct high and low chlorophyll categories. Five out of 25 lakes had microcystin levels above the 20 mg/L WHO recreational limit. One lake had 5688 mg/L microcystin levels. Weak correlations with the N:P ratio were observed but no clear thresholds were observed.

Keywords: cyanobacteria, shallow lakes, microcystins

9:55 | Towards improved methods for determination of aldehyde oxidase activity in fish

N. Gill[1], and M. Brinkmann[1]
[1]*Toxicology Centre, University of Saskatchewan, 44 Campus Drive, Saskatoon, SK, S7N 5B3;*

Research has characterized the important role of aldehyde oxidases (AOX) in detoxifying xenobiotics in mammals. However, research pertaining to AOX activity in non-mammalian vertebrates is lacking. This research developed and validated a method enabling assessment of AOX activity in fish, which can potentially be applied to a wider range of vertebrate species. Furthermore, this work aimed to overcome the low sensitivity and arduous procedures of established photometric AOX detection. To this end, a novel fluorometric assay was developed to quantify the conversion of exogenous 4-(dimethylamino)cinnamaldehyde (DMAC) substrate into its corresponding acid by AOX in partially purified liver cytosol of mammals and fish. Absence of CYP-mediated biotransformation in cytosolic fractions was quantified by 7-ethoxyresorufin-O-deethylase (EROD) activity, as a prototypic microsomal activity in both cytosol and microsomes. Michaelis-Menten parameters (K_m, V_{max}) of the reaction were comparable to reported photometric monitoring of decreasing substrate concentrations. Hydralazine, a selective inhibitor of mammalian AOX was utilized to reveal similar half maximal inhibitory concentrations (IC_{50}s) in fish. Application of the established assay to purified mammalian cytosol exhibits the potential for future use in research. Quantification of product formation opposed to substrate measurement creates potential for *in vitro* experimentation with permanent cell lines, eliminating cytosol purification steps. In summary, a sensitive and rapid assay for determination of AOX activity was successfully established. The novel procedure has broad applicability in environmental, toxicological, and pharmacological assessments pertaining to assessment of compounds metabolized by AOX.

Keywords: *toxicokinetics, biotransformation, molybdenum oxidases*

10:10 | Development of a quantitative risk assessment approach for wildlife: Case study of a woodland caribou in Saskatchewan's Athabasca Region

L. Dudley[1], J. Tang[1], and G. Ivanis[1]
[1]*EcoMetrix Incorporated; *ldudley@ecometrix.ca*

Risk assessment guidance requires that critical life stages be considered when assessing risk for wildlife species. For quantitative assessments this entails understanding species life histories and behaviours during critical life stages. This is particularly important when assessing species-at-risk and species with large home ranges. Using Woodland Caribou as a case study, this presentation outlines the rationale we have used to integrate wildlife species with large home ranges into environmental assessments for mining operations in Saskatchewan's Athabasca Region. The presentation discusses the roles of toxicity reference values, animal behavior, and exposure pathways in aquatic and terrestrial environments.

Keywords: *quantitative risk assessment, woodland caribou, species at risk*

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10:40 | Occurrence and *in vitro* toxicity of disinfection by-products in Saskatchewan water treatment plants

T. Watts[1], H. Peng[1,2], J.P. Giesy[1,3], and P.D. Jones[1,4]
*[1]Toxicology Centre, University of Saskatchewan, Saskatoon, SK; [2]Department of Chemistry, University of Toronto, Toronto ON; [3]Department of Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon SK; [4]School of Environment and Sustainability, University of Saskatchewan, Saskatoon SK; *tena.watts@usask.ca*

Halogenated disinfection by-products (DBPs) are a diverse class of compounds formed during treatment of drinking water through the reaction of NOM and halogen salts with disinfectants. While Health Canada regulates a handful of DBPs, there are many 'novel' and unregulated DBPs that have been reported and even more that remain unknown. Using untargeted chemical analysis, novel brominated and iodinated DBPs were identified in water collected from two drinking water treatment plants in Saskatchewan. To understand what factors influence the profile of DBPs produced, over the course of a year, samples of water were collected from various stages of treatment and data from both chemical analysis and *in vitro* toxicity assays were studied. Increased toxicity was observed in chlorinated waters compared to source waters, indicating the production of toxic DBPs during disinfection. Some source waters were found to cause cytotoxicity and oxidative stress that was independent of the presence of DBPs, and a significant correlation was found between these endpoints. In contrast, there was no correlation between oxidative stress and cytotoxicity in clearwell or finished water.

Keywords: *disinfection by-products, untargeted screening, water treatment, organobromines*.

10:55 | Atmospheric emissions from the Athabasca oil sands and their impact on boreal lakes: Spatial and temporal trends

M. Evans[1], M.U.M Anas[2], B. Wissel[2], D. Jeffries[3], D. Andrews[4], and C. Cooke[5]
*[1]Environment and Climate Change Canada, Saskatoon; [2]Department of Biology, University of Regina, Regina; [3]Environment and Climate Change Canada, Burlington; [4]Western Resources Solutions, Calgary; [5]Alberta Environment and Parks, Edmonton; *Marlene.evans@canada.ca*

The Athabasca oil sands developments along the Athabasca River have raised concerns including the potential impacts of acidifying and metal emissions on lake systems. Since 1999, 28-50 lakes have been monitored annually over a broad area of the Alberta as part of comprehensive monitoring associated with the industry. Water chemistry analyses focus on parameters related to acidity and metals although chlorophyll and plant nutrients are measured and zooplankton have been collected. Five physiographic regions are identifiable based on differences in their water chemistry, especially base cations, sulphate, nitrate, trace metals and dissolved organic carbon. Over 1999-2015, there was no evidence of changes in water chemistry that could be related to acidifying emissions from the oil sands industry but some evidence of increasing alkalinity, possibly associated with increased dust from the developments. While some temporal changes occurred in zooplankton species compositions over 2008-2015 at some lakes, no clear trends emerged in terms of changes being associated to similar (and sensitive) taxa, time periods or to regions. Northwestern Saskatchewan is more vulnerable to acidification given its landscape features. Environment Canada and Climate Change Canada has been monitoring this region, in addition the Northwest Territories and Alberta, since 2012; highlights of these studies are presented.

Keywords: *water quality, environmental monitoring, oil sands*

11:10 | Effects of dietary polycyclic aromatic hydrocarbon exposure on pre-migratory fuelling in captively-dosed Sanderling

K. Bianchini[1], and C.A Morrissey[2,3]
*[1] Toxicology Centre, University of Saskatchewan, Saskatoon, SK; [2] Department of Biology, University of Saskatchewan, Saskatoon, SK; [3] School of Environment and Sustainability, University of Saskatchewan, Saskatoon, SK; *k.bianchini@usask.ca*

Many migratory birds depend on key stopover sites to refuel and, ultimately, to replenish the fat stores that sustain subsequent migration flights. Proper fuelling is important because it increases a bird's probability of surviving migration and fuelling rates can affect reproductive performance. Therefore, migratory success and the demographics of migratory bird populations are closely related to the ecological health of stopover sites along their migration routes. Stopover site contamination by oil pollution thus poses a serious threat to migrant birds. Indeed, the polycyclic aromatic hydrocarbons (PAHs) found in oil have the potential to interfere with avian refuelling physiology. However, a direct link between PAH exposure and impaired pre-migratory fuelling has yet to be established. In this study, a captive population of 49 Sanderling (*Calidris alba*) was orally dosed for 21 days with ecologically relevant concentrations (0, 12.6, 126, and 1260 µg PAH/kg body weight/day) of a commercial PAH mixture. We found that EROD activity was significantly elevated in the high dose group relative to controls. Higher PAH exposures were associated with reduced serum bile acid concentrations, elevated serum creatine kinase concentrations, and with high serum lipase concentrations in female birds only. These results suggest that PAH exposure can interfere with lipid transport and metabolism and can cause muscle damage. Ultimately, these results suggest that PAH exposure can affect the mechanisms involved in avian pre-migratory fuelling.

Keywords: *polyaromatic hydrocarbons, captive study , migration, birds*

11:25 | Juvenile soil invertebrate avoidance to soil contaminants

R. Akre[1], A. Gainer[1,2] and S. D. Siciliano[1,2]
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Avoidance tests have been developed in recent years to assess the avoidance behaviour of soil organisms when exposed to contaminated soils as they are quick and inexpensive. These tests are useful for ecotoxicology risk assessments as avoidance of contaminated soils can reduce the ecosystem services provided by soil organisms and can impact the energy budget of the organisms. Existing literature on avoidance of soil invertebrates utilize adult individuals and lack juvenile responses. The sensitivity of juveniles to contaminated soils influences the habitat range of populations and influences the soil capacity to provide ecosystem services. Avoidance of juvenile organisms to contaminated soil may be a more or less sensitive endpoint compared to adult avoidance. The objectives of this study were to determine if juveniles avoid soil contaminants and to compare juvenile avoidance to adult avoidance. Three contaminants, phenanthrene, sodium chloride, and copper sulfate, were chosen. Juveniles of three species of soil invertebrates, *Folsomia candida*, *Eisenia fetida*, and *Enchytraeus crypticus* were tested with each of the contaminants. Artificial soil prepared to the guidelines of the OECD was used for each experiment and dosed. Soils were divided and the net movement of juveniles between clean and contaminated soil assessed over a 48-hour period. Preliminary results suggest that in general, juveniles of invertebrates only avoid contaminants at much higher concentrations than adults. The implications of this reduced avoidance on long term community survival is currently not clear.

Keywords: *avoidance response, soil invertebrates, behavioural toxicology*

11:40 | Microplastic contamination in Lake Winnipeg, Canada

P. Anderson[1], S. Warrack[2], V. Langen[3], J. Challis[4], M. Hanson[2], and M. Rennie[3,6]
*[1] Department of Biology, University of Saskatchewan, Saskatoon, SK; [2] Department of Environment and Geography, University of Manitoba, Winnipeg, MB; [3] Department of Biology, Lakehead University, Thunder Bay, ON; [4] Department of Chemistry, University of Manitoba, Winnipeg, MB; [6] IISD-Experimental Lakes Area, Winnipeg MB; *umwarras@myumanitoba.ca*

To better understand microplastic contamination in North American freshwaters, we report for the first-time densities of microplastics in Lake Winnipeg, Manitoba, the 11th largest freshwater body in the world. Samples collected in 2014, 2015 and 2016 revealed similar or significantly greater microplastic densities in Lake Winnipeg compared to those reported for the Laurentian Great Lakes. The vast majority of identified particles appeared to be fibers of secondary origin. Using scanning electron microscopy, we determined that 23% of the manually identified particles were not plastic. We detected significantly greater corrected densities of microplastics in the North Basin compared to the South Basin of the lake in 2014, but not in 2015 or 2016. Mean lake-wide densities across all years were comparable and not statistically different. Our research contributes to a growing field that suggests that microplastic contamination is far-reaching into freshwater ecosystems, across both sparsely-populated and urbanized watersheds.

Keywords: *microplastics, Lake Winnipeg, freshwater contamination*

13:50 | The photo-induced toxicity of polycyclic aromatic hydrocarbons and a hydraulic oil in the amphibian species *Xenopus laevis* and *Lithobates sylvaticus*

Z. Currie[1], N.S. Hogan[1,2]
*[1]Toxicology Centre, University of Saskatchewan, Saskatoon SK; [2]Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon SK; *zac660@mail.usask.ca*

Polycyclic aromatic hydrocarbons (PAHs) can exhibit photo-induced toxicity with ecologically relevant intensities of ultraviolet (UV) light, resulting in increased toxicity to aquatic organisms. Early life-stages of amphibians may be particularly susceptible to PAH photo-induced toxicity as they are translucent, have permeable skin and undergo embryo and larval development in shallow ponds. The objective of the present study was to evaluate and compare the sensitivity of a model organism (*Xenopus laevis*) and an ecologically native species (wood frog, *Lithobates sylvaticus*) to the photo-enhanced toxicity of PAHs and a petroleum-based hydraulic oil, UNIVIS J13, known to contain a mixture of PAHs. Tadpoles were exposed to individual PAHs (anthracene, naphthalene, benzo(a)pyrene) or UNIVIS J13 for 8 hours, transferred to clean water, and then exposed to UV light for 12 hours. In the presence of UV light, anthracene and benzo(a)pyrene significantly increased mortality of both larval wood frog and *Xenopus*. The co-exposure of anthracene and UV light also significantly decreased wood frog tadpole length while the co-exposure of naphthalene and UV light significantly decreased *Xenopus* tadpole length. UNIVIS J13 and UV light had no significant effects on tadpole mortality or length. This study demonstrates that a UV component is an important consideration when assessing the toxicity of PAHs to larval amphibians, or hazard may be greatly underestimated.

Keywords: *polycyclic aromatic hydrocarbons, amphhibians, phototoxicity, multiple stressors*

14:05 | Subsurface filtration technology to attenuate pharmaceuticals and nutrients for rural wastewaters in northern prairie climate.

L.G. Chaves-Barquero[1,3], K.H. Luong[2], M.L. Hanson[1], C.S. Wong[1,2,3]
*[1]University of Manitoba, Department of Environment and Geography, Winnipeg, MB; [2]University of Winnipeg, Department of Chemistry and Environmental Studies, Winnipeg, MB; [3]Costa Rica Institute of Technology, Department of Chemistry, Cartago, Costa Rica; *chaveslg@myumanitoba.ca*

To better understand the effect of hydraulic retention time and acclimation on the efficacy of wastewater treatment in rural Canada, we characterized the occurrence of pharmaceuticals from the input through treatment and release at a facility in Dunnottar, Manitoba. Wastewater treatment in this community is performed by a two-lagoon system with subsequent subsurface filtration and ultraviolet treatment. Grab samples for pharmaceuticals were collected during the summer of 2015 and 2016 along the wastewater path. Polar Organic Integrative Chemical Samplers (POCIS) were deployed at the input, output and post-UV treatment on the filter. Nutrients (i.e. phosphorus, ammonia) concentrations were measured at the input and output of the filter in 2015, with significant reduction being observed. Six pharmaceuticals were consistently detected throughout the filter, and most were mainly removed between the lagoons (~56%-86% reduction), with little to no attenuation being determined for these compounds within the subsurface filter, which is consistent with previous studies at this facility. Neither an increase in hydraulic retention time nor acclimation (i.e. 2015 vs 2016) of the filter had a significant effect on pharmaceuticals removal.

Keywords: *waste water lagoons, pharmaceuticals, subsurface filtration*

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14:20 | The cardiorespiratory effects of acute naphthalene and pyrene exposure in adult zebrafish (*Danio rerio*).

C. Yeung[1,2], and L. Weber[1,2]
*[1]Toxicology Centre, University of Saskatchewan, Saskatoon SK; [2]Department of Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon SK; *Chy214@mail.usask.ca*

Naphthalene (NAP) and pyrene (PYR), important petrogenic polycyclic aromatic hydrocarbons (PAHs), are not as well studied as benzo-a-pyrene (BaP). We hypothesized acute exposure (48h) to NAP and PYR will cause sublethal cardiorespiratory impairment similar to acute BaP exposure in adult zebrafish (*Danio rerio*). To investigate this hypothesis, adult zebrafish were aqueously exposed to PAHs (NAP, 37, 370, and 3700µg/L; PYR, 0.25, 2.5 and 25µg/L) using static renewal (24h) and compared to dimethysulfoxide controls. At 48h, fish were subjected to high frequency cardiac ultrasound (n=16 fish/group) or swim tunnel analysis (n=12fish/group). Zebrafish from the 370µg NAP/L group increased stroke volume (SV) without alterations in end-systolic volume (ESV), heart rate or cardiac output (CO). The paradoxical lack of response at 3700µg NAP/L may be related to the whole-body edema observed upon dissection. PYR changes in cardiac function were only observed at 25µg PYR/L; decreased ESV, increased ejection fraction, and decreased heart rate without alterations in SV or CO. In general, both NAP and PYR showed a U-shape response to increased standard metabolic rate (SMR), but not active metabolic rate (AMR) leading to reduced factorial aerobic scope (FAS) in low/moderate, but not high doses. This was associated with minimal changes in swimming endurance with either NAP or PYR. In conclusion, acute aqueous NAP and PYR exposure cardiac effects do not resemble BaP, while effects on respiration, metabolism and swimming do resemble BaP. High concentrations of NAP have additional cardiorespiratory toxic effects, making it a greater concern for acute sublethal toxicity in adult fish.

Keywords: *naphthalene, pyrene, zebrafish*

14:35 | Locust visual motion detection and avoidance behaviours are disrupted by a sublethal dose of imidacloprid

R. Parkinson[1], J. Little[1], and J. Gray[1]
[1]*Department of Biology, University of Saskatchewan, Saskatoon, SK; *rachel.parkinson@usask.ca*

Neonicotinoids are known to affect foraging behaviour and navigation in insects, although the mechanisms of these effects are not fully understood. A visual motion sensitive neuron in the locust, the Descending Contralateral Movement Detector (DCMD), integrates visual information and is involved in eliciting escape behaviours. The DCMD receives coded input from the compound eyes and synapses with motorneurons involved in flight and jumping. We show that imidacloprid (IMD), a neonicotinoid insecticide, impairs neural and behavioural responses to visual stimuli at sublethal concentrations, and these effects are sustained two and twenty-four hours after treatment. Exposure to 10 ng/g IMD (0.4% of LD50) attenuates escape manoeuvers while 100 ng/g IMD (4% of LD50) prevents the ability to fly and walk. Behavioural and neural effects are correlated: IMD disrupted DCMD bursting, a coding property important for motion detection. Specifically, IMD reduced the DCMD peak firing rate within bursts at ecologically relevant doses of 10 ng/g (ng IMD per g locust body weight). Thus, IMD causes significant and lasting impairment of an important pathway involved with visual sensory coding and escape behaviours at ecologically-relevant doses. These results show, for the first time, that a neonicotinoid pesticide directly impairs an important, taxonomically conserved, motion-sensitive visual network.

Keywords: *visual processing, behavioural toxicology, neurotoxicology, neonicotinoids*

15:05 | Exploring the toxicity of nanoencapsulated bifenthrin on rainbow trout (*Oncorhynchus mykiss*)

A. Qi[1], T. Blewett[1], A. Weinrauch[1], G. Goss[1].
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A new nano-enabled pesticide formulation produced by Vive Crop Protection involves the encapsulation of the pesticide bifenthrin within Allosperse, a polymer shell intended to increase water solubility and reduce overall application rate and runoff into the environment. However, the toxicity of this formulation has remained largely untested. Juvenile rainbow trout (*Oncorhynchus mykiss*) were subject to acute 96 h LC_{50} and LC_{20} exposures of control, bifenthrin, polymer-coated bifenthrin, polymer, or methanol treatments. The LC_{50} of bifenthrin was determined to be 6 µg/L. Gill histology did not reveal changes in inter-lamellar cell mass (ILCM), lamellar length, or lamellar width in all treatments. EROD activity indicated significant CYP1A1 induction in all treatments relative to control, indicative of Phase I metabolism. Na^+/K^+-ATPase and H^+-type ATPase activity levels were significantly upregulated in only the bifenthrin treatment, suggesting a mechanism of bifenthrin toxicity in rainbow trout and shedding light on the benign nature of Allosperse. Overall, these data suggest that Allosperse mitigates the toxicity of bifenthrin to rainbow trout, which will help reduce environmental risk to other aquatic organisms.

Keywords: *Allosperse, bifenthrin, rainbow trout, toxicity*

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15:20 | Expression stability and selection of optimal reference genes for gene expression normalization in early life stage rainbow trout exposed to cadmium and copper

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Gene expression analysis represents a powerful approach to characterize the mechanisms by which contaminants interact with organisms. To reach meaningful conclusions with relative quantification, expression levels of reference genes must be stable and cannot vary as a function of experimental conditions. However, information on the stability of commonly used reference genes across developmental stages, tissues and after exposure to contaminants such as metals is lacking for many species including teleost fish. In this study, we assessed the stability of expression of 8 reference gene candidates in the gills and skin of three different early life-stages of rainbow trout after exposure (24 hours) to two metals, cadmium (Cd) and copper (Cu) using qPCR. Four algorithms, geNorm, NormFinder, BestKeeper, and comparative ΔCt method were employed to evaluate the expression stability of these candidate genes under control and exposed conditions as well as across three different life-stages. Finally, stability of genes was ranked by taking geometric means of the ranks established by the different methods. The results demonstrated that the stability of reference genes depended on the metal, life-stage and organ in question. Thus, attention should be paid to these factors before selection of reference gene for relative quantification of the gene expressions in mechanistic toxicity studies

Keywords: *reference gene stability, relative quantification, rainbow trout, metals*

.

15:35 | Detection of pesticides in four Manitoba rivers

M. Gamhewage[1,2], A. Farenhorst[1], C. Sheedy[2], and D. Nilsson[2]

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Pesticide transport from agricultural land to surface waters leads to environmental contamination. This study examined the types and concentrations of pesticides in the water and the bottom sediments of four major rivers of Manitoba that flow into the Lake Winnipeg. From May to August 2016, 83 water-column and 69 bottom sediment samples were collected and analyzed by a GC-MS/MS for a suite of 161 pesticides. Results showed that 78% water-column and 99% of the sediment samples contained at least one pesticide. In the Fisher River, MCPA was the mostly detected pesticide in both water column (53%) and bottom sediments (60%) with maximum concentrations of 70 µg/L and 28 µg/L, respectively. MCPA also had the highest detection frequencies in water-column (89%) and sediments (95%) of the Red River and in sediments (73%) of the Winnipeg River. The croplands in the Fisher Branch area seem to be contributing to pesticide loadings into the Fisher River. The pesticide uses in the city of Winnipeg appear to be substantially contributing to the contamination of the Red River, in some months more than the agricultural use.

Keywords: *pesticides, Manitoba rivers, sediments*

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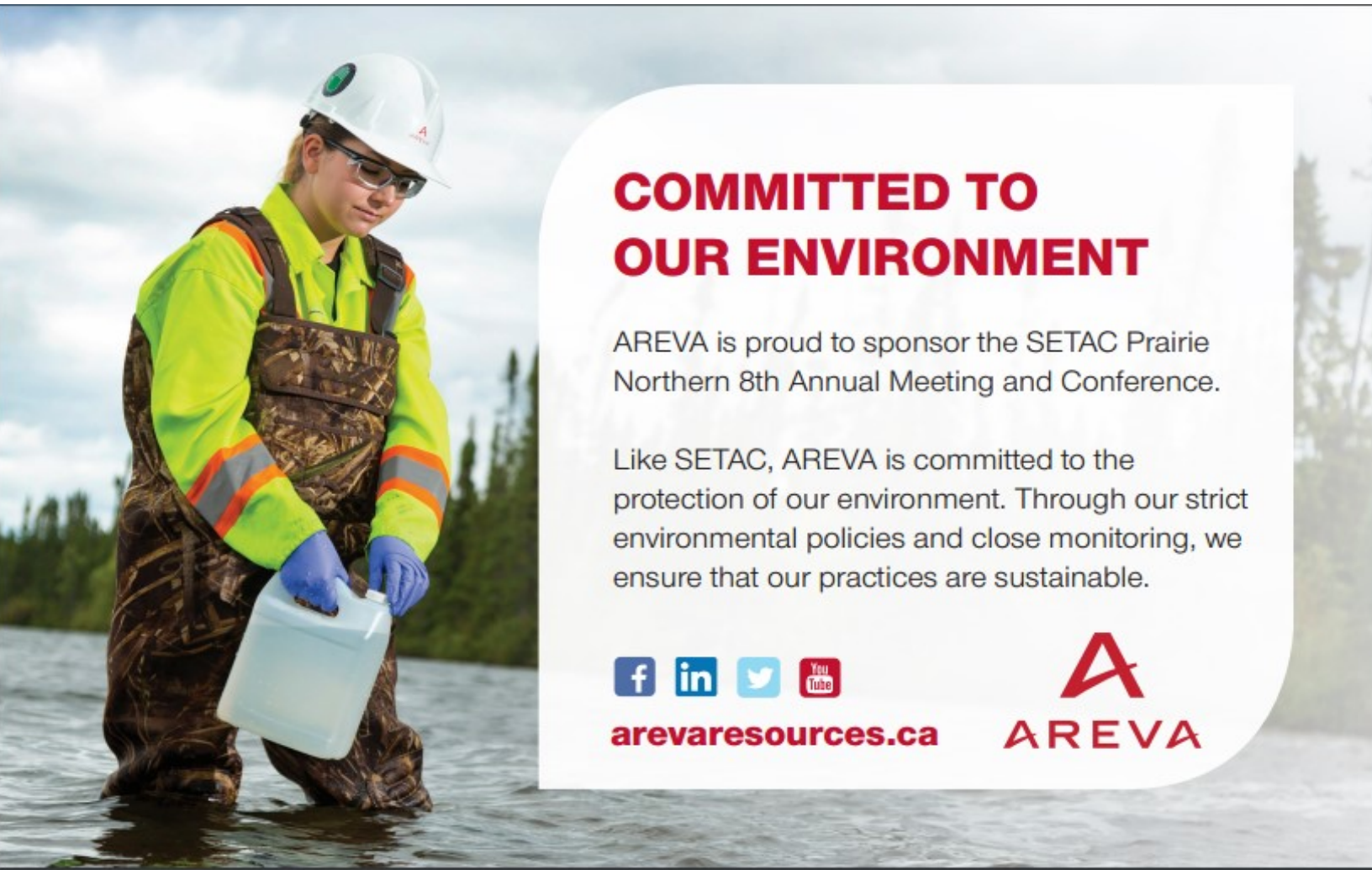

Poster Presentations

Poster set up will take place in the Education Lounge outside of Quance Theatre (Education Building) from 7:30 to 8:20 am on Ju.ne 16th. Presenters should set up their posters on the board corresponding to the number assigned to their poster in the program.

Materials will be provided on site. Presenters are encouraged to attend their posters during conference breaks.

Posters should be max 4’ tall and 3’ wide.

SPECIAL THANKS TO OUR VOLUNTEER STUDENT PLATFORM JUDGES!

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Aquatic and Terrestrial Toxicology

1 Does the fate, persistence, and toxicity of a semi-volatile hydraulic lubricating oil vary across Canadian soil types?
A. Gainer, R. Akre, and S.D. Siciliano
Keywords: soil invertebrates, soil remediation

2 Toxicity of the water accommodated fraction of a petroleum-based hydraulic oil to aquatic organisms.
Z. Currie, L. McPhee, L. Halyk, D. Tkatchuk, S.D. Siciliano, and N.S. Hogan
Keywords: complex mixtures, aquatic organisms, hazard assessment

3 Tissue uptake and genotoxic potential of diamondoids in rainbow trout.
E. Lin, I. Chen, B. Tendler, C. Watts, P. Jones, and J. Raine
Keywords: fish, oil sands, diamondoids, genotoxicity

4 Elucidating mechanisms of toxic action of dissolved organic chemicals in oil sands process affected water (OSPW)
G. Morandi, S. Wiseman, M. Guan, X. Zhang, J. Martin, and J. Giesy
Keywords: oil sands, genotoxicity, toxicity

5 Neonicotinoid Insecticide Mixtures: Cumulative Toxicity under Chronic Exposure Scenarios
E. Maloney, C.A. Morrissey, J. Headley, K. Peru, and K. Liber
Keywords: aquatic insects, neonicotinoids, mixture toxicity

6 Exposure of early life stages of zebrafish to diamondoids
I. Chen, E. Lin, P. Jones, and J. Raine
Keywords: fish, oil sands, diamondoids, early life stage

Thinking Outside the Box: Innovations in Modeling and Toxicity Testing

7 Novel approaches in toxicokinetic modeling to meet the challenges of chemical risk assessment in the 21st century
M. Brinkmann, and M. Hecker
Keywords: toxicokinetic modeling, PBTK modeling, quantitative AOP

8 Establishing an *in vitro* model system for mechanistic amphibian immunotoxicity research
M. Gallant,, and N.S. Hogan
Keywords: *xenopus* A6 cells, lipopolysaccharide, cytokines, PAH

9 Modeling trace metal concentrations in freshwater systems
K. Newman, M. Evans, M. Davies and D. de Boer
Keywords: fish, oil sands, diamondoids, genotoxicity

10 An investigation into the ability of fish otoliths to reconstruct background trace element concentrations in Manitoba lakes.
A. Vanderpoint, N. Halden, and M. Hanson
Keywords: otolith, freshwater, water quality, microchemistry

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Ecotoxicity of Selenium

11 Selenium and the escape response of fathead minnows: a multivariate approach to kinematic analysis

P. Anderson, M.C.O. Ferrari, and D.P. Chivers

Keywords: selenium, escape response, kinematics, fathead minnow

12 The role of oxidative stress in early life-stage toxicity of l-selenomethionine in fathead minnows

Gerhart, A., and Janz, D

Keywords: selenium, oxidative stress, embryo, teratogenicity

13 Effect of selenomethionine on the toxicity and organ tissue distribution of mercuric chloride in zebrafish

N. Dolgova, T. MacDonald, S. Nehzati, P. Krone, G. George, and I. Pickering

Keywords: selenium, mercury, zebrafish, toxicity

14 An approach to improve the understanding of trophic transfer of selenium in freshwater environments and its potential hazard in fish

K. Bluhm, B. Markwart, K. Raes, T. Lane, D. Green, S. Graves, L. Doig, K. Liber, D. Janz, and M. Hecker.

Keywords: selenium, biotransformation, trophic transfer, toxicity

15 Does community structure matter? Assessing the tropic transfer of selenomethionine to an amphipod (*Hyalella azteca*) through a diet of field-collected microorganism communities.

K. Raes, L. Doig, K. Liber, B. Markwart, and M. Hecker.

Keywords: ecotoxicology, selenium, amphipods, periphyton

16 Characterizing the uptake and trophic transfer of selenium in Canadian boreal lake food webs

S. Graves, K. Liber, V. Palace, M. Hecker, and D. Janz

Keywords: selenium, boreal lakes, food web, trophic transfer

17 Development effects of maternally transferred selenium to early life stage fathead minnow (*Pimephales promelas*).

T.Lane, D. Janz, K. Liber, and M. Hecker

Keywords: trace element, bioaccumulation, maternal transfer, teratogenicity

18 The influence of community composition on selenium bioconcentration in freshwater periphyton.

B. Markwart, K. Liber, M. Hecker, D. Janz, K. Raes, and L.E. Doig.

Keywords: enrichment function, periphyton, selenium, community composition

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Emerging Contaminants and Aquatic Environments

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A.J. Alcarez, D. Green, K. Bluhm, T. Lane, M. Brinkmann, N.. Baldwin, J. Taghavimehr, A. Masse, D. Crump, N. Basu, N. Hogan, and M. Hecker.
Keywords: 17α-ethinylestradiol, fluoxetine, RNASeq, shotgun proteomics

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C. Lobson, L. Chaves-Barquero, D. Moore, C. Wong, C. Knapp, and M. Hanson
Keywords: wastewater, antibiotic resistance, aquatic insects

21 Factors affecting the microbial composition in the gastrointestinal tract of captive fishes
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Keywords: 16s rRNA gene, gut bacteria, next generation sequencing

22 *In vitro* comparison of sensitivities among four Canadian fish species to emerging contaminants of concern.
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Keywords: native species, *in vitro,* emerging contaminants

23 Determination of acute and sub-chronic toxicity of emerging contaminants in early life stages of three Canadian fish species
D. Schultz, T. Song, C. Miller, D. Janz, and M. Hecker.
Keywords: emerging contaminants, wastewater, fish

Environmental Monitoring and Toxicological Effects

24 The role of hydropeaking and shoreline morphology in mercury retention in spottail shiner (*Notropis hudsonius*) populations downstream of a hydroelectric dam
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A. Parajas, K. Luong, and C. Wong.
Keywords: QuEChERS, HPLC, oxilofrine

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M. Evans, S. Backus, H. Keith, D. Muir, P. Collopy, A. Hergott, and J. Keating
Keywords: mercury, fish, environmental monitoring

Toxicogenomic characterization of EE2 and fluoxetine effects in fathead minnows: Identifying signature toxicity pathways to predict adverse outcomes

A.J. Alcaraz[1], D. Green[1], K. Bluhm[2], T. Lane[1], M. Brinkmann[2], N. Baldwin[1], J. Taghavimehr[1], A. Masse[1], D. Crump[3], N. Basu[4], N. Hogan[1,5], and M. Hecker[1,2]

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Pharmaceuticals and personal care products (PPCP) cause environmental concern due to non-target organism toxicity. These include the endocrine disrupting compound 17α-ethinylestradiol (EE2) and the selective serotonin reuptake inhibitor fluoxetine (FLX). Little is known about low dose (sub-)chronic effects of EE2 and FLX. Information on molecular pathways driving cascade of events resulting in phenotypic adverse outcomes is limited. Advances in next generation 'omics' technologies provide a platform for unbiased characterization of toxicity pathways. Omics allows probing of entire biological systems without a priori knowledge of toxicity mechanisms. Therefore, our goal is to identify key molecular toxicity pathways predictive of EE2- and FLX-induced apical responses. Sequence-by-synthesis-based whole transcriptome (RNASeq) and high-resolution mass-spectroscopy-based shotgun proteomics will be utilized to characterize pathways associated with downstream biological responses of ecological and regulatory relevance. Ideally, this strategy will identify signature toxicity pathways predictive of EE2- and FLX-induced toxicity. This approach would facilitate identification of pathways and genes involved in toxic responses and lead to development of an early life-stage gene expression assay capturing critical toxicity pathways for prediction of apical outcomes of multiple chemicals. The assay would take place prior to swim up, addressing the need for alternative screening approaches.

Keywords: *17α-ethinylestradiol, fluoxetine, RNASeq, shotgun proteomics*

Selenium and the escape response of fathead minnows: a multivariate approach to kinematic analysis

P.J. Anderson[1], M.C.O. Ferrari[2] and D.P. Chivers[1]

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This study investigated the effects of dietary selenomethionine on the escape behaviours of the Fathead Minnow (*Pimephales promelas*). Minnows rely on a fast-start escape response to evade the strike of a potential predator. When selenium-rich effluent is released into a body of water, serious impacts on fish health and community structure can be observed. Selenium exposure in minnows has been shown to depress their critical swimming speed. Minnows were administered either a control or a selenomethionine spiked diet (6ppm or 12ppm nominal) for 36 days. Individual fish were placed in an arena where responses to a looming stimulus was recorded by a high-speed camera. Velocity, acceleration, latency to respond, escape angle and body angle were calculated for each fish. A multivariate approach was used to analyze the data, and get a more complete understanding of the trends present. There was no significant difference between the mean values of the principle components, but there appeared to be an increase in the response variables for the high dose treatment group. Altered escape performance in prey can influence established predator-prey equilibrium, and ultimately lead to a shift in the community dynamics of the system. These results will help to develop a study using longer exposures and assess the potential for recovery.

Keywords: *Selenium, Escape Response, Kinematics, Fathead Minnow*

An approach to improve the understanding of trophic transfer of selenium in freshwater environments and its potential hazard in fish

K. Bluhm[1], B. Markwart[1], K. Raes[1], T. Lane[1], D. Green[1], S. Graves[1], L. Doig[1], K. Liber[1,2], D. Janz[1], and M. Hecker[1,2].
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Selenium (Se) is a naturally occurring essential element but also a pollutant of great concern in North America and elsewhere. Anthropogenic activities represent significant sources for Se into aquatic environments where it is usually found in inorganic forms in the water phase. These forms of Se are rapidly biotransformed to organic species of Se (e.g. selenomethionine) by algae and microorganisms, thereby increasing the bioavailability of Se for higher trophic taxa, which can accumulate potentially toxic levels of Se. Today, the risk assessment of Se is hampered by our incomplete understanding of its trophic transfer, especially at the base of the food web. Knowledge regarding the processes that govern transformation, assimilation and accumulation of Se as well as the transfer along aquatic food chains would facilitate its regulation. To address this issue, a representative aquatic food chain (natural biofilm – amphipod: *Hyalella azteca* – fish: *Pimephales promelas*) will be investigated to gain insight into biotransformation, bioaccumulation, transfer along the food chain and toxicity to fish and its offspring at the upper trophic level. In addition, a mesocosm study will help refine the knowledge on Se accumulation and trophic transfer under more realistic conditions. The obtained data set can be used to assist in the development of an advanced environmental risk assessment for Se.

Keywords: *selenium, biotransformation, trophic transfer, risk assessment*

Novel approaches in toxicokinetic modeling to meet the challenges of chemical risk assessment in the 21st century

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An ever-increasing number of chemicals are released into the environment that are potentially toxic to humans and wildlife. Current regulations for the assessment of the toxicological risks of these chemicals rely on extensive live-animal testing using a few standard model species. In addition to the huge costs and ethical objections regarding animal testing, these approaches are often not adequately protective of organisms of concern, such as native species or humans. Recent advances in omics technologies and systems biology, as well as in the field of *in vitro* high-throughput testing provide promising tools to address these challenges. Application of these methodologies in context with chemical risk assessment, however, requires the translation of their results into outcomes of regulatory relevance. To bridge these gaps, this study explores the use of novel approaches in toxicokinetic modeling to extrapolate effects obtained with *in vitro* assays to whole organisms, as well as among species, life stages and levels of biological organization. Successful implementation of these approaches in chemical risk assessment will represent a great step towards more sustainable, efficient, and unbiased assessments of the safety of the large number of chemicals in use today and in the future, and may potentially save billions of dollars and millions of animals.

Keywords: *toxicokinetic modeling, PBTK modeling, quantitative AOP*

Toxicity of the water accommodated fraction of a petroleum-based hydraulic oil to aquatic organisms

Z. Currie[1], L. McPhee[1], L. Halyk[1], D. Tkatchuk[1], S.D. Siciliano[1,2], and N.S. Hogan[1,3]
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The growing global demand for oil and gas requires vast pipeline networks to transport the material across diverse ecological regions. Automated actuator valves pressurize and control the flow of oil and gas using hydraulic fluid as a lubricant. UNIVIS J13 hydraulic oil has been found to be leaking from actuator valves onto adjacent soil and water bodies. The toxicity of UNIVIS J13 is uncertain; therefore, the purpose of this study was to assess the hazard of UNIVIS J13 to aquatic organisms. Acute toxicity of fresh UNIVIS J13 was assessed in protists (Microtox), invertebrates (*Daphnia magna)*, plants (*Lemna minor)*, fish (*Pimephales promelas)*, and amphibians (*Xenopus laevis* and *Lithobates sylvaticus)*. Acute toxicity of used UNIVIS J13 was also assessed in *D. magna* and *X. laevis.* Water accommodated fractions (WAF) of UNIVIS J13 were prepared and serial dilutions were performed to achieve test concentrations. Estimated EC_{50} values for fresh UNIVIS J13 were determined to be 129, 279, and 881 g/L WAF for *D. magna,* Microtox*,* and *L. minor* respectively, while EC_{50} values for used UNIVIS J13 were determined to be 411 and 423 g/L WAF in *D. magna* and *X. laevis* respectively. Results indicate that *X. laevis* is more sensitive to used UNIVIS J13 compared to fresh UNIVIS J13; however, the toxicity data gained from the present study indicate that UNIVIS J13 WAF pose minimal hazard to aquatic organisms.

Keywords: *complex mixtures, aquatic organisms, hazard assessment, water accommodated fractions*

Modelling trace metal concentrations in freshwater systems

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The input of trace metals as a result of human activity has led to a growing concern about water quality in Canada and elsewhere. These metals are derived from a variety of sources and follow various pathways, both through the atmosphere and on the surface. Ground water, surface runoff, and bank erosion are additional sources of metals to rivers and lakes. Metal concentrations may, on occasion, exceed CCME water quality guidelines for the protection of aquatic life. Detection of trends in metal concentrations (and causal factors) can be challenging due the complexity of rivers resulting in spatial and temporal variability in metal concentrations, and interactions between different tributary sources such as groundwater, overland flow, and precipitation. Using data collected by the Regional Aquatics Monitoring Program (RAMP) over 1999-2014, we develop a method to predict trace metal concentrations in water using proxies including DOC (dissolved organic carbon), alkalinity, and TSS (total suspended solids). The efficacy of this model is demonstrated for the Athabasca River, the Clearwater River, and the east and west bank tributaries. In doing so, we characterize their unique chemical features, improving our understanding of the variability of metal concentrations in the oil sands area as a whole. This allows for improved investigations of temporal and spatial variations in metal concentrations and other aspects of the water chemistry within the watershed including how they vary with proximity to industry. Moreover, these predictive models provide an alternative method (to simple considerations of concentration) for investigating trends in trace metal concentrations by the inclusion of easily measured influencing variables. Additionally, our methods could be generalized to other watersheds.

Keywords: *Trace metals, water quality, monitoring, modeling*

Effect of selenomethionine on the toxicity and organ and tissue distribution of mercuric chloride in zebrafish

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Mercury is a highly potent environmental toxin. Its concentrations in the atmosphere and aquatic environment are constantly rising from both natural (volcanic eruptions) and anthropogenic sources. Mercury accumulates in biological organisms, and is biomagnified to high concentrations in higher trophic level organisms, which can lead to problems in top predators. Additionally, consumption of fish containing mercury is a concern for human health. It has been shown that selenium can counteract the toxic effects of mercury, but it is also known that in some cases selenium can increase mercury toxicity. This research is focused on the effects of selenomethionine on mercury absorption in zebrafish larvae as a model vertebrate, using X-ray fluorescence imaging to visualize the tissue distribution of mercury and selenium. We found that the levels of mercury in zebrafish tissues are substantially affected by selenomethionine treatment, and that decreased toxicity does not necessarily translate to lower tissue concentration. Details of the complex interactions between mercury and selenium at the tissue and organ level in zebrafish will be presented. The results of this work are important for understanding mercury toxicity in vertebrates and provide insights into the possible use of selenium to alleviate the effects of this toxin.

Keywords: *selenium, mercury, zebrafish, toxicity*

In vitro comparison of sensitivities among four Canadian fish species to emerging contaminants of concern.

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Large numbers of chemicals are discharged into aquatic ecosystems and have been identified in municipal wastewater effluents (MWWEs). While adverse effects of some of these chemicals on fishes have been identified, there is an increasing number of emerging contaminants (ECs) for which little or no toxicity data regarding aquatic organisms is available. Many ECs, such as 17α-ethynylestradiol (EE2), an estrogen agonist used in oral contraceptives, fluoxetine, a common antidepressant, and hexabromocyclododecane (HBCD) a widely-used flame retardant, may pose significant risks to aquatic ecosystems due to their prevalence in the environment. Specifically, while data for some of these compounds are available on model laboratory species, such as rainbow trout (RT; *Oncorhynchus mykiss*), little is known of their effects to native species of cultural, recreational and commercial importance to Canadians, including lake trout (LT; *Salvelinus namaycush*), northern pike (NP; *Esox lucius*) and white sturgeon (WS; *Acipenser transmontanus*). Additionally, there is increasing concern with regard to live animal testing, especially for long-lived and/or endangered species such as LT and WS; therefore, alternative testing methods, such as *in vitro* tissue explant assays, are needed. The aim of the current study is to validate the predictivity of our *in vitro* results by comparing to a parallel *in vivo* study with the same species. Following an *in vitro* tissue explant assay in which LT, NP, RT, and WS livers were exposed to EE2, fluoxetine or HBCD, transcript abundance of select genes was measured in these species and a species-specific response was characterized. RT had the greatest response among species when exposed to EE2 and HBCD. With exposure to fluoxetine, RT and WS had equal responses while LT and NP had lesser responses.

Keywords*: native species, in vitro, emerging contaminants*

Investigations of temporal trends in mercury concentrations in predatory fish in northern Alberta and Saskatchewan

M. Evans[1], S. Backus[2], H. Keith[3], D. Muir[2], P. Collopy[1], A. Hergott[1], and J. Keating[1]
*[1]Environment and Climate Change Canada, Saskatoon, SK; [2]Environment and Climate Change Canada, Burlington, ON; [3]Hatfield Consultants, Vancouver, BC, Canada; *Marlene.evans@canada.ca*

Recent studies have reported mercury increases in predatory fish in northern Canada with trends related to warming temperatures and increasing mercury emissions. Here we investigate mercury trends in fish collected as part of: oil sands monitoring programs over 1998-2016; recent collections made by Environment and Climate Change Canada in western and eastern Lake Athabasca and lakes east and south of the oil sands; and periodic collections made by others during the 1970s to early 1990s. No trends were detected for walleye and pike from the immediate oil sands area while concentrations decreased in western Lake Athabasca and Lac La Loche (pike only) fish; concentrations increased in Pinehouse (pike but not walleye) and Peter Pond (walleye) Lakes. Mercury concentrations increased in lake trout in eastern Lake Athabasca (but not western) and Namur Lake but decreased in Reindeer Lake. Studies conducted in lakes in other areas, e.g., Ontario, also have shown that mercury trends can differ markedly in their direction suggesting that local watershed features and processes occurring within lakes influence mercury trends in addition to broad scale factors such as changing emissions and climate. Average mercury concentrations were below the 0.5 µg/g guideline for the commercial sale of fish. Length and age were primary determinants of fish mercury concentration.

Keywords: *mercury, environmental monitoring, fish*

Does the fate, persistence and toxicity of a semi volatile hydraulic lubricating oil vary across Canadian soil types?

A. Gainer[1,2], R. Akre[1], and S. D. Siciliano[1,2]
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Specialized pipeline equipment in Canada utilize hydraulic lubricating oils that are released to the environment with no containment or liners to protect the underlying soil. This results in contamination of soils with C10 to C34 petroleum hydrocarbons fractions. Petroleum hydrocarbons in surface soils have the capacity to breakdown via microbial degradation. An effective management strategy oh hydrocarbon contaminated soil includes nitrogen and phosphorus amendments to accelerate the biodegradation process. Canadian soils display a range of characteristics like clay and organic matter content, affecting rates of soil petroleum hydrocarbon biodegradation as well as toxicity to soil organisms. Collembola (*Folsomia candida*) are a widespread soil invertebrate inhabiting a range of soils in Canada. They are an Environment Canada standardized test species with ecological relevance as they contribute to the breakdown of soil organic matter. The first objective of this study was to assess the fate and persistence of a hydraulic lubricating oil in soils under unfertilized and fertilized conditions. Secondly, we also investigated the toxicity of the contaminated soils to the soil ecotoxicology invertebrate, *F. candida*. Fertilized and unfertilized soil samples from numerous Canadian soils were collected weekly and C10 to C34 hydrocarbon concentrations determined to assess the fate and persistence of the lubricating oil. Multiple and single toxicity tests with *F. candida* were conducted on numerous uncontaminated and contaminated Canadian soils to determine the effects of the lubricating oil on survival and reproduction.

Keywords*: soil invertebrates, soil remediation*

Establishing an *in vitro* model system for mechanistic amphibian immunotoxicity research

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Recent large-scale disease driven population declines have highlighted the need to understand mechanisms of immunotoxicity in amphibians. *In vitro* assays represent an ideal method for studying the molecular basis of contaminant-induced immunotoxicity. Using the *Xenopus* A6 cell line, derived from kidney epithelial cells, we are developing an *in vitro* approach to screen chemicals for their potential to impair the innate immune response in amphibians. Lipopolysaccharide (LPS), a major component of bacterial outer membranes, was used as an immune challenge. *Xenopus* A6 cells exposed to 1 and 10 µg/ml LPS for 3 and 6 h induced expression of immune-related genes (tumor necrosis factor α (TNFα), interleukin -1 β (IL-1β), colony stimulating factor-1 (CSF-1)), indicating the capacity to mount an inflammatory response. Exposure to benzo[a]pyrene (50 – 3200 ng/ml), a model immunotoxicant, resulted in a dose-dependent increase in the expression of cytochrome P450 1A1 (CYP1A1) but no change in aryl hydrocarbon receptor (AhR) after a 3 h exposure. Results from these assays will be used to design contaminant/pathogen co-exposures to determine if exposure to B[a]P impacts the ability of the cells to respond to an LPS challenge. This *in vitro* model system will allow us to examine the mechanism of immunotoxicity in amphibians for a variety of environmental contaminants of concern.

Keywords: *Xenopus A6 cells, lipopolysaccharide, cytokines, polycyclic aromatic hydrocarbons*

The role of oxidative stress in early life-stage toxicity of l-selenomethionine in fathead minnows.

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Numerous studies have shown that oviparous vertebrates, fishes in particular, are highly susceptible to elevated dietary selenium concentrations during early life stages. During yolk reabsorption, it is hypothesized that larvae metabolize selenium-containing proteins to produce reactive compounds that interact with biomolecules such as lipids and proteins to induce oxidative stress. This study characterizes the effects of selenium, in the form of seleno-L-methionine, on development of fathead minnow embryos when exposed during early life stages. Fathead minnow embryos were exposed in aqueous solutions spiked with Seleno-L-Methionine at concentrations of 0, 5, 25, and 125 µg/L between stages 6 and 10 of embryonic development. In addition to mortality, characteristics such as spinal deformities (lordosis, kyphosis, and scoliosis), edema, as well as fin and craniofacial malformations in developing fish larvae were recorded and scored based on severity. Experiments are ongoing and results regarding mortality and deformities will be discussed. The information obtained from this research will increase our mechanistic understanding of early life stage selenium toxicity in fishes.

Keywords: *Selenium, oxidative stress, embryo, teratogenicity*

Characterizing the uptake and trophic transfer of selenium in Canadian boreal lake food webs

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Selenium (Se) is increasingly being recognized as a contaminant of concern in aquatic systems, particularly due to its teratogenic effects on egg-laying vertebrates, but limited information is available on how selenium moves through food webs in boreal lake systems. The objectives of the current research are to use limnocorrals (in situ enclosures) spiked with Se to characterize the uptake and trophic transfer of Se through a representative boreal lake food web. Nine limnocorrals (1 m deep and 2 m in diameter) have been installed in the littoral zone of Lake 114 at the Experimental Lakes Area in Northwestern Ontario and will be spiked with 1 µg/L or 10 µg/L Se (3 replicates each). These treatments will be compared to three controls with baseline levels of Se (approximately 0.15 µg/L). Biota will be collected biweekly to assess time to steady state and after 2.5 months of exposure, the uptake into periphyton, phytoplankton, invertebrates and female fathead minnows will be assessed. In addition, ecological (i.e. food web structure) and physiological (i.e. productivity and growth) factors affecting Se uptake in organisms will be assessed. Experimental design and methods for the above analyses will be discussed. This research will be important for risk assessment of selenium in Canadian boreal lakes, and for determining if current federal guidelines for Se are protective of these systems.

***Keywords**: selenium, boreal lakes, food web, trophic transfer*

The role of hydropeaking and shoreline morphology in mercury retention in spottail shiner (*Notropis hudsonius*) populations downstream of a hydroelectric dam

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Hydroelectric reservoir construction imparts chemical and physical changes in impounded waters that encourage biomethylation of mercury (Hg) and subsequent bioaccumulation of methylmercury (MeHg) in impounded and downstream foodwebs. Mercury concentrations in four commercial fish species (pike, sauger, walleye, goldeye) sampled from the Tobin Lake reservoir and downstream fishery at Cumberland Lake, Saskatchewan, showed multi-decadal declines (1970-2014) indicative MeHg accumulation after the commissioning of the E. B. Hydroelectric dam in 1963, though concentrations declined slower in downstream fish despite little evidence of ongoing Hg inundation. These incongruent findings may be due to a decrease in growth dilution of Hg in downstream fish due to environmental stress, as stressful events reduce energy available for biological endpoints like reproduction and growth. While there may be several stressors downstream of dams, hydropeaking (the manipulation of water flow through a dam to tailor energy production to demand) was a probable downstream stressor in this system as as fish were observed stranded on low-pitched shores after flow restriction. Analyses conducted on a shoreline dwelling species (spottail shiner; “shiner”; *Notropis hudsonius*) in 2014 revealed decreased condition and energy stores, and increased Hg concentrations at downstream sites ($P < 0.01$), though shoreline pitch did not solely predict these effects. Acute-stress challenges the following year suggested inhibition of the cortisol response in shiner from the downstream low-pitched shore site ($P < 0.01$) which may indicate a chronically stressful environment. However, analyses of condition and triglyceride concentrations did not corroborate deficits in the downstream population observed the previous year ($P > 0.01$). These results suggest peaking stress may exacerbate Hg concentrations in downstream fish, but that mitigating factors may override this effect.

***Keywords:** Reservoirs, hydropeaking, mercury, stress, fisheries.*

Developmental effects of maternally transferred selenium to early life stage fathead minnow (*Pimephales promelas*)

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Selenium (Se) displays a narrow range between essentiality and toxicity, rendering it of increasing environmental concern. Anthropogenic activities release inorganic Se into surface waters where it is biotransformed by algae and microorganisms to organic Se (e.g. selenomethionine [SeM]). SeM can bioaccumulate to significant amounts at higher trophic levels, with oviparous vertebrates being at particular risk because of maternal transfer of excess Se to embryos during vitellogenesis. Maternal transfer of SeM is a key route of Se exposure in early life stage fish and can lead to teratogenic effects in many species. Unfortunately, this process is challenging to study in long-lived species of concern that inhabit Canadian ecosystems. The objective of this study is to develop and validate an embryo injection approach to model maternal transfer of SeM, which could be applied to any fish species of interest. The maternal transfer of dietary SeM and its effect on the F1 generation will be initially characterized in a short-lived species native to Canadian freshwater systems, the fathead minnow *(Pimephales promelas*). Specifically, 120 breeding pairs will be fed a SeM-spiked diet (0, 5, 15, 45 mg/g d.w) and bred for 45 days. Average Se embryo concentrations from this study will be used as the basis for subsequent embryo injection studies. Developmental endpoints from both studies will be compared to determine if the injection approach is appropriate for simulating maternal transfer.

Keywords: *trace element, bioaccumulation, maternal transfer, teratogenicity*

Tissue uptake and genotoxic potential of diamondoids in rainbow trout

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Oil sands mining along the Athabasca River (AB, Canada) has the potential to adversely affect the surrounding ecosystem through air emissions, water use, wastewater production, groundwater contamination, and land and habitat disturbances. A new group of naphthenic acids, diamondoids, have been identified in oil sands process-affected water and weathered crude oil. Diamondoids are polycyclic saturated hydrocarbons with a cage-like carbon skeleton similar to that of diamond. Very little is known about the toxicity of these compounds, although there is recent evidence to suggest that environmentally relevant concentrations are genotoxic to rainbow trout hepatocytes in vitro and to marine mussels. The aim of this study was to determine tissue uptake and genotoxicity of three different diamondoids (1-adamantane carboxylic acid, 3,5-dimethyladamantane carboxylic acid and 3,5,7-trimethyladamantane carboxylic acid) in juvenile rainbow trout. Fish were exposed to 0, 0.06 µM, 0.6µM or 6µM of one of these chemical for 96 hours. Water, blood and tissue concentrations of each diamondoid were measured to determine uptake from the water and possible metabolism of the chemicals. DNA damage identified in blood samples using the Comet assay suggested that genotoxicity varied with diamondoid and treatment concentration. These results provide evidence of genotoxicity and provide the foundation for further studies.

Keywords: *fish, oil sands, diamondoids, genotoxicity*

Aquatic insects as a mechanism of dispersal for antibiotic resistance genes in the environment

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Human-use antibiotics are commonly released into aquatic ecosystems from wastewater effluents emanating from lagoons on the Canadian Prairies. This can lead to selection for antibiotic resistant gene-bearing bacteria (ARGs) in these environments (both lagoons and receiving waters). We hypothesize that as aquatic insects emerge from these lagoons, they could be a vector for ARGs into surrounding environments. To test this, we deployed emergence traps in three wastewater lagoons and the effluent-receiving creek at Dunnottar, MB to determine the type and abundance of aquatic insects emerging from wastewater lagoons. The ARGs were measured on emerged insects, in the water and were quantified using qPCR. The antibiotic resistance genes targeted were sul1, sul2, and sul3 and were compared to 16S-rRNA to calculate the proportion of resistant genes relative to total bacterial genes. The concentrations of sulfonamide antibiotics were characterized as well. The greatest proportion of sulfonamide resistant genes relative to 16S-rRNA was measured in the primary lagoon, followed by the secondary lagoon with lesser amounts observed in the rest of the wastewater system. Lagoons had greater abundances of emerging insects than the reference site. We were not able to detect sul-type resistant genes within emerging insects, suggesting that this mechanism of spread is unlikely to be significant compared to other means (e.g., direct release of improperly treated wastewaters).

Keywords: *wastewater, antibiotic resistance, aquatic insects*

Neonicotinoid Insecticide Mixtures: Cumulative Toxicity under Chronic Exposure Scenarios

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Neonicotinoid insecticides are a popular class of systemic treatment, widely used to protect crops against sucking-biting pests. Due to their widespread detection in global surface waters and their potential to cause adverse impacts on non-target invertebrate species, neonicotinoids have recently come under international scrutiny. Current research and regulation has primarily focussed on the toxicological effects of individual compounds. However, neonicotinoids are frequently detected in aqueous systems as binary and ternary mixtures. This research aims to characterize and compare the cumulative toxicity of binary and ternary mixtures of select neonicotinoids (imidacloprid, clothianidin, thiamethoxam) to the sensitive aquatic insect *Chironomus dilutus* under chronic (28 d) exposure scenarios. Preliminary assessments of single compound toxicity (EC_{50}) were completed. These values were used to develop parametric models, which were statistically compared to the toxicity of binary and ternary mixtures from similar laboratory studies, using a regression-based approach (MIXTOX). Results indicate that the toxicity of neonicotinoid mixtures cannot be predicted using the common assumption of additive joint activity, as most mixtures display statistically significantly deviations from concentration-additive toxicity. However, these trends differ between acute and chronic exposure scenarios, emphasizing the need for further research into the ecotoxicological effects of neonicotinoid insecticide mixtures in field settings, the development of better toxicity models for neonicotinoid mixture exposures, and the consideration of mixture effects when setting water quality guidelines for this class of pesticides.

Keywords: *aquatic insects, neonicotinoids, mixture toxicity*

The influence of community composition on selenium bioconcentration in freshwater periphyton

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In freshwater ecosystems, bioconcentration and biotransformation of inorganic selenium occurs primarily in phytoplankton and periphyton, and associated biofilms. This process is the most important step towards the introduction of organic selenium compounds into local food chains. There is a large body of evidence to suggest that selenium enrichment functions can vary by up to 5 orders of magnitude for different species of planktonic algae and that biotransformation processes can differ among taxa. Similarly, previous work has shown that many bacterial genera are also capable of biotransforming and accumulating selenium using different strategies. Currently, the influence of freshwater periphyton community composition on the accumulation and subsequent food-chain transfer of selenium compounds is poorly understood. The aim of this research is to assess variability across individual taxa and periphytic community assemblages to address the primary question asked of this project: Does community composition matter when estimating selenium accumulation in biofilms? Lab-cultured single-species periphyton biofilms and field-sampled periphyton from five different lakes were exposed to aqueous selenite or selenate at concentrations of 5 or 25 µg Se/L for periods of 14 and 8 days, respectively. Selenium enrichment functions varied by up to 20-fold in field-collected periphyton and 3-fold in single-species lab-cultured periphyton that were exposed to the same concentration and species of selenium under controlled conditions. The results of this work will aid in more reliable modelling of selenium transport through Northern freshwater food-webs. This will enable regulators and industry to more accurately predict the effects of selenium transfer to higher order consumers, such as fish and waterfowl.

Keywords: *enrichment function, periphyton, selenium, community composition*

Factors affecting the microbial composition in the gastrointestinal tract of captive fishes

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Pollutants affect the health of aquatic organisms but little research has explored their effects on microorganisms within the gastrointestinal tracts of such organisms. These microorganisms play important roles in gut function, metabolism, and immune defense. An alteration in the microbial composition of the gut therefore has the potential to negatively impact host well-being. Previous research has shown the gut microbiome of organisms can be altered by phylogeny, diet, and antibiotics. This study evaluated the microbiomes of two evolutionarily distant fish species; lake sturgeon (*Acipenser fulvescens*) and rainbow trout (*Oncorhynchus mykiss*). Gastrointestinal microbiome composition was determined using next generation sequencing of the 16S rRNA gene. This study found that the microbiomes of these two species were significantly different from each other at a phylum level and species level of classification. The most abundant phylum in lake sturgeon and rainbow trout were fusobacteria and firmicutes, respectively. These differences occurred despite being reared in the same lab, being fed the same diet, as well as living in similar conditions in the wild, suggesting the variance between the two species is due to evolutionary differences. Ongoing experiments are exposing rainbow trout to benzo[a]pyrene and triclosan as representatives of two classes of ubiquitous environmental contaminants; polycyclic aromatic hydrocarbons (PAHs) and antimicrobials. This research aims to provide insight into the role pollutants can play in the alteration of microbial composition and the resultant effects on organism health.

Keywords: *16S rRNA qene, gut bacteria, next generation sequencing*

Elucidating mechanisms of toxic action of dissolved organic chemicals in oil sands process affected water (OSPW)

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Oil sands process-affected water (OSPW), produced during extraction of bitumen during surface-mining of oil sands in Alberta, Canada is acutely and chronically toxic to aquatic organisms. Organic compounds in OSPW are responsible for most toxic effects, but knowledge of the specific chemicals, or the associated mechanism(s) of toxicity, is very limited. By use of the *Escherichia coli* K-12 strain MG1655 gene reporter system, the purpose of the present study was to investigate relationships between toxic potencies, expression of genes and characterization of chemicals in each of five acutely toxic and one non-toxic extracts of OSPW. Effects on expressions of genes related to response to oxidative stress, protein stress and DNA damage were indicative of exposure to acutely toxic extracts of OSPW. Additionally, evidence presented supports a role for sulfur- and nitrogen-containing chemical classes in toxicity of extracts of OSPW.

Keywords: *Oil sands process affected water, toxicity, genotoxicity*

Does community structure matter? Assessing the trophic transfer of selenomethionine to an amphipod (*Hyalella azteca*) through a diet of field-collected microorganism communities

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The mobilization and contamination of selenium (Se) into environmental systems is of significant global concern. A variety of natural and anthropogenic sources and site-specific differences in biogeochemistry are the source for different forms and concentrations of Se in aquatic environments (eg. selenate [$SeO4^{-2}$] and selenite [$SeO3^{-2}$]). These inorganic forms of Se are efficiently assimilated, biotransformed, and bioaccumulated by aquatic microorganisms into organoselenium compounds, which are transferred to higher trophic levels via dietary pathways. The present study aims to quantify the trophic transfer factors of selenomethionine to a primary consumer through the biotransformation of inorganic oxyanion Se forms (selenate and selenite) by field-collected communities of microorganisms. Biofilm samplers were placed in the epilimnetic zone of uncontaminated lakes in northern Saskatchewan and allowed to accumulate natural communities of periphytic microorganisms representative of these lake habitats. DNA samples were collected from each biofilm sample for microscopic and metagenomic characterization of the biofilm communities. Samples were exposed in the laboratory to aqueous concentrations of selenite and selenate respectively, at concentrations of 0, 5 and 25 µg Se/L, and uptake and biotransformation by the biofilm to selenomethionine was quantified. The amphipod *Hyalella azteca*, a primary consumer characteristic of Canadian freshwater ecosystems, grazed on the spiked biofilm communities with the intent to determine trophic transfer efficiencies as a function of microorganism community structure. This research will serve to assist in improving environmental risk assessment strategies for the release of Se into aquatic environments.

Key words: *Ecotoxicology, Selenium, Amphipods, Periphyton*

Analysis of oxilofrine in citrus fruits using ultrahigh performance liquid chromatography (UHPLC-MS/MS) and modified QuEChERS clean-up method

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The objective of this study was to develop and validate an extraction and quantification method to extract the amphetamine oxilofrine from a citrus matrix. Oxilofrine is not known to occur naturally in citrus fruits but its structural similarity to synephrine, which also elicits similar stimulatory effects and has been extracted from various types of oranges, strongly suggests that it may be present. Due to the potential adverse health effects of oxilofrine, there is a need for more sophisticated methods to analyse this illegal pharmaceutical in food products. The QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe) method has proven effective in analyte extraction from fruit, so it was used to extract oxilofrine along with dispersive solid phase extraction (dSPE) to remove matrix components. Ultrahigh performance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS) was used for analysis and quantification. Recoveries of oxilofrine ranged from 83.3 and 90.6% using magnesium sulfate, primary secondary amine exchange material and endcapped c18 sorbents. In a survey of twelve oranges of different types and sources, oxilofrine was found at concentrations from 5.5 to 85.7 ng g^{-1}. The highest concentrations were observed in samples labeled as mandarins, which correlates with synephrine, which occurs at high levels in mandarins and tangerines.

Keywords: *QuEChERS, HPLC, oxilofrine*

Ecofriendly natural pesticide based on acetylcholinesterase inhibitory activity for pest Callosobruchus maculatus

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Currently available organophosphate pesticides based on acetylcholinesterase inhibitory activity have been found to be present in the natural resources owing to their high persistence above permissible limits. In literature, Lantana camara has been shown to exhibit acetylcholinesterase inhibitory activity. Plant extract was prepared from the aerial part of Lantana camara. Callosobruchus maculatus causes huge annual loss to leguminous crops in every part of the world. We evaluated the insecticidal activities of Lantana camara extracts at different concentrations (0.5%, 1%, 1.5%, 2.0%, 5%, 7.5% and 10%) on oviposition, egg deterrence and adult emergence.The adult emergence was 55.65% at 10% conc., 56.33% at 7.5% conc. and 59.28% was at 5.0% extract conc. thus having very insignificant difference. Germination in experimental seeds was found to be 95.25% under normal conditions and 37.5% after being exposed to the pests. While, the seeds treated with 5.0% extract dose had 84.25% germination which was considerably higher even after exposure to pests. The extract dose of 5.0% exhibited highest 71.15% egg deterrence and very significantly prevented the seeds from weight loss by 72.07% and seed loss by 71.73%. The study infers that 5.0% methanolic extract is the most efficient to protect seeds from pulse beetle infestation. This dose helps in protecting crop by oviposition deterrence thereby reducing adult emergence, besides it also prevents weight loss and complete seed loss. Dose of 5% extract of L. camara also protects germplasm of the seeds so that they can be used for further cultivation.

Keywords: pest, plant extract, oviposition

Determination of Acute and Sub-Chronic Toxicity of Emerging Contaminants in Early Life Stages of Three Canadian Fish Species

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Emerging contaminants (ECs) are gaining notoriety due to their ubiquity in the aquatic environment as well as the lack of data available regarding their toxicity. ECs of concern such as flame retardants, pharmaceuticals, and nanoparticles primarily enter the aquatic environment as mixtures through municipal wastewater effluent (MWWE), a mixture of industrial and domestic wastes that may be released into receiving waters with very little treatment, which is not uncommon in rural Canada. Most data to date has utilized standard laboratory species, which may not be relevant to Northern species considering species-specific toxicities of chemicals. Consequently, inaccurate extrapolation from between these species represents a significant uncertainty factor in ecological risk assessment. In this study, Oncorhynchus mykiss, Salvelinus namaycush, and Esox lucius gametes were exposed to six waterborne concentrations of Prozac™ (FLX), silver nanoparticles (AgNPs), 17α-ethynylestradiol (EE2), and two concentrations of Saskatoon MWWE under continuous flow-through conditions. Lowest doses reflect environmental relevance and increased incrementally. Subsamples were collected at critical developmental stages to assess acute and sub-chronic toxicity. Initial findings suggest that the three species vary significantly in their sensitivities towards the aforementioned ECs. Ongoing work aims to fully elucidate and link biochemical and histological effects associated with exposures to ECs. Overall, this work will aid in the development of more appropriate environmental risk assessment strategies for native fishes to ECs of concern.

Keywords: *Emerging Contaminants, Wastewater, Fish*

An investigation into the ability of fish otoliths to reconstruct background trace element concentrations in Manitoba lakes.

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The Coordinated Aquatic Monitoring Program (CAMP) is a long-term, system-wide water management program for much of Manitoba Hydro's impounded and some of Manitoba's non-impounded sub-basins. CAMP monitoring includes water quality (e.g., trace elements) and fish communities with archiving of fish age-structures (e.g., otoliths). Fish otoliths (ear bones) are metabolically-inert, calcified structures which are thought to be of value in determining trace element exposure history over time. This can be accomplished by analyzing their chemical signatures through methods such as laser ablation ICP-MS. CAMP presents a unique opportunity to test several hypotheses around trace elements in water and corresponding otolith concentrations. In this study, CAMP water quality data from 2008-2014 (for the elements Ba, Mn, Sr, Mg and Na) was compared to otolith chemistry of two commercially relevant fish species, lake whitefish (*Coregonus clupeaformis*) and walleye (*Sander vitreus*) caught in 2013-2014 from several CAMP water bodies. The effect of fish species, underlying water body geology, and water body impoundment status were analyzed for their influence on otolith signature. We observed that walleye take up Ba and lake whitefish take up Mn and Sr more so than each other in the same waterbody. Water concentrations of Na and Mg correspond poorly to otolith concentrations. Our preliminary findings indicate that fish species strongly influences the level of trace element detection in fish otolith, and therefore re-constructing past trace element exposures must be done with caution.

Keywords: *otolith, freshwater, water quality, microchemistry*

Exposure of early life stages of zebrafish to diamondoids

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Diamondoids are a group of naphthenic acids that have recently been identified as components of oil sands process-affected water (OSPW) and weathered crude oil from the Athabasca oil sands area. These chemicals get their name from their cage-like carbon skeleton. There is little is known about the toxicity of these compounds. The current study uses a well-established model organism, the zebrafish, to investigate the mechanism of toxicity of diamondoids and tests the hypothesis that oxidative stress contributes to their toxic effects. Three diamondoids (1-adamantane carboxylic acid, 3,5-dimethyladamantane carboxylic acid and 3,5,7-trimethyladamantane carboxylic acid) were used in this study. Viable one day post-fertilization zebrafish embryos were exposed to 0, 0.06 µM, 0.6µM or 6µM of one of these three diamondoids in 12-well culture plates held at 28°C. Renewal of 50% of the 3 ml volume for each of 3 treatment concentration replicates was performed daily until the swim up stage of development. Developmental endpoints included mortality, developmental abnormalities, time to hatch and hatching success, time to swim-up and changes in growth. Analysis of expression of genes encoding anti-oxidant enzymes were also assessed. The results of this study will provide information on the developmental toxicity of environmental concentrations of diamondoids and the possible contribution of oxidative stress in their mechanism of action.

Keywords: fish, oil sands, diamondoids, early life stage

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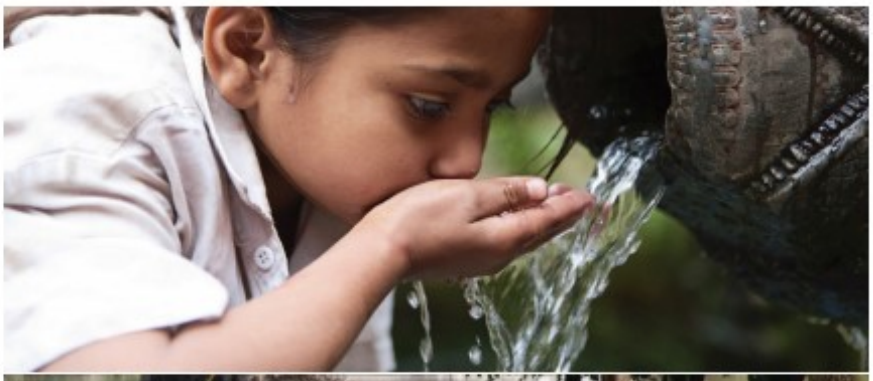

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Our water security is at risk

Water was rated by the *2016 World Economic Forum Global Risks Report* as one of the top 10 risks to our future. The health and wellness of all living creatures depend on water and the economic livelihoods of the world's population cannot thrive without it, but many factors, including climate change and human actions, are altering the historical patterns of water availability, its quality and the nature and severity of floods and droughts.

The Global Institute for Water Security is a leader in water research for the world's cold regions—the source of water for over 50 per cent of the world's population, including many Indigenous communities.

Faculty, students and partners of the institute ensure that citizens worldwide have the understanding and the tools they need to prepare for and sustainably manage water-related risks.

Together with our partners, we explore the interconnections of water, land and climate to improve policies and empower people to make sustainable choices in an era of rapid societal and environmental change.

QUICK FACTS:

Founded in 2011 with the appointment of Canada Excellence Research Chair in Water Security Dr. Howard Wheater, the Global Institute for Water Security **integrates expertise of 211 members from 15 academic units** at the University of Saskatchewan.

Established a new professional **Master of Water Security** graduate programme where students work with one of the strongest water security research communities in North America.

The Global Institute for Water Security is leading the $143 million "Global Water Futures: Solutions to Water Threats in an Era of Global Change" initiative having an unprecidented 156 partners**—the largest university-led water research programme ever funded worldwide.**

Leading three global programmes: 1) Changing Cold Regions Network, Regional Hydroclimate Programme, World Climate Research Programme (WCRP); 2) INARCH – International Netwokr of Alpine Research Catchment Hydrology, WCRP and UNESCO; 3) Future Earth: Sustainable Water Future Programme – Canadian Node.