

***Canada and
Environmental Science:
An Impressive Past and
a Progressive Future***

A vertical green bar on the left side of the page contains a white topographic map graphic with contour lines and a central point with four arrows pointing outwards.

**22nd Annual General
Meeting & Conference
June 2nd 2017**

**University of Ontario
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CONFERENCE PROGRAM

Friday, June 2nd, 2017

Time	Location	Schedule Item
8:00 - 9:00	Science Building (UA) West Atrium	Registration
		<i>Poster set-up</i>
9:00 - 9:20	UA 1350	Opening Remarks Dr. Robert Bailey, VP and Provost of UOIT & SETAC North America update – Ève Gilroy
9:20 - 10:00	UA 1350	<i>A story of environmental science and regulation in Canada viewed through your cell phone</i> Dr. Miriam Diamond Professor, Department of Earth Sciences, University of Toronto
10:00 - 10:40	UA 1350	<i>Effective risk communication: Making the science make sense</i> Dr. Ron Brecher Risk Assessment & Risk Communication Specialist
10:40 - 11:20	UA West Atrium	<i>Posters and Morning Break (Student poster judging)</i>
11:20 - 12:00	UA 1350	<i>Equity is the only acceptable goal</i> Dr. Imogen Coe Dean, Faculty of Science, Ryerson University
12:00 - 1:00	UA West Atrium	Buffet Lunch
	UA 1120	<i>Annual General Meeting</i>

CONFERENCE PROGRAM (cont'd)

Friday, June 2nd, 2017

Time	Location	Schedule Item
1:00 - 2:00	Science Building	<i>Tour of Doug Holdway's lab</i>
	Automotive Centre of Excellence(ACE)	<i>Climatic Wind Tunnel Visit</i>
2:00 - 2:20	UA 1120 UA 1220 & UA 1350	Concurrent Platform Presentations Sessions A, B & C
2:20 - 2:40		
2:40 - 3:00		
3:00 – 3:20		
3:20 - 3:50	UA West Atrium	<i>Posters and Afternoon Break (Student poster judging) & Book Draw</i>
3:50 - 4:10	UA 1120 UA 1220 & UA 1350	Concurrent Platform Presentations Sessions D, E & F
4:10 - 4:30		
4:30 – 4:50		
4:50 – 5:10		
5:10 - 5:30	UA 1120	<i>Student Judges meet</i>
	UA West Atrium	<i>Take down posters</i>
5:30 - 9:00	Shagwells on the Ridge Campus Ice Center	Student Awards Social

Platform Presentations

Time	Session A: Pesticides in the Environment Room UA 1120
2:00 - 2:20	<p>Investigating the exposure of songbirds to neonicotinoids and the effects on breeding success in agricultural and natural sites</p> <p>* <u>Chaudhry, Tehmeena</u> Department of Biology, York University, Toronto, ON</p>
2:20 - 2:40	<p>Acute toxicity of neonicotinoid pesticides to mayfly nymphs</p> <p>* <u>Raby, Melanie</u>¹, Dave Poirier² & Paul Sibley¹ ¹ School of Environmental Science, University of Guelph, Guelph, ON ² Aquatic Toxicity Unit, Laboratory Services Branch, Ontario Ministry of Environment and Climate Change, Etobicoke, ON</p>
2:40 - 3:00	<p>Distribution and quantification of lampricides in non-target fish tissues</p> <p>* <u>Foubister, Darren D.</u>¹, Christopher White¹, Terrance Hubert², Jeffry Bernardy² & Michael Wilkie¹ ¹Department of Biology, Wilfrid Laurier University, Waterloo, ON ²Upper Midwest Environmental Sciences Center, United States Geological Survey, La Crosse, WI, USA</p>
3:00 - 3:20	<p>A study on lampricide detoxification capacity in lake sturgeon (<i>Acipenser fulvescens</i>) and larval sea lamprey (<i>Petromyzon marinus</i>) – alternative treatments and their implications</p> <p><u>Birceanu, Oana</u>¹, Lisa O'Connor², Jonathan M. Wilson¹ & Michael P. Wilkie¹ ¹Department of Biology, Wilfrid Laurier University, Waterloo, ON ²Great Lakes Laboratory for Fisheries and Aquatic Sciences, Central and Arctic Region, Fisheries and Oceans Canada, Sault Ste. Marie, ON</p>

* Student presentation

Platform Presentations (cont'd)

Time	Session B: Elements of Aquatic Toxicology Room UA 1220
2:00 - 2:20	Early-life stage effects of metformin in Japanese medaka (<i>Oryzias latipes</i>) * <u>Ussery, Erin</u> , Matthew. D. Overturf, Zacharias Pandelides, John Guchardi & Douglas Holdway Faculty of Science, University of Ontario Institute of Technology, Oshawa, ON
2:20 - 2:40	Acute and chronic effects of multiple stressors on microRNA in zebrafish * <u>Ikert, Heather</u> & Paul M. Craig Department of Biology, University of Waterloo, Waterloo, ON
2:40 - 3:00	Multi-stressor impacts on fish energetics: A comparison between lab and field studies * <u>Mehdi, Hossein</u> , Leslie M. Bragg, Mark R. Servos & Paul M. Craig Department of Biology, University of Waterloo, Waterloo, ON
3:00 - 3:20	Optimization of clearance rate as an effect endpoint in toxicity testing with freshwater mussels * <u>Salerno, Joseph</u> ¹ , Patricia Gillis ² , Paul Sibley ¹ & Ryan Prosser ² ¹ School of Environmental Sciences, University of Guelph, Guelph, ON ² Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON

* Student presentation

Platform Presentations (cont'd)

Time	Session C: Lampricide Fate and Effects Room UA 1350
2:00 - 2:20	<p>Influences of water chemistry on the gill microenvironment of non-target fishes exposed to lampricide</p> <p>* <u>Tessier, Laura</u>, Oana Birceanu, Jonathan Wilson & Michael Wilkie Wilfrid Laurier University, Waterloo, ON</p>
2:20 - 2:40	<p>The influence of water chemistry on the uptake and sensitivity to TFM, for juvenile lake sturgeon</p> <p>* <u>Hepditch Scott L.</u>, M.P. Wilkie, J.M. Wilson & O. Birceanu Biology Department, Wilfrid Laurier University, Waterloo, ON</p>
2:40 - 3:00	<p>The pathophysiological effects of 3-trifluoromethyl-4-nitrophenol (TFM) on lake sturgeon (<i>Acipenser fulvescens</i>)</p> <p>* <u>Ionescu, R. Adrian</u>, Scott Hepditch, Oana Birceanu & Michael Wilkie Department of Biology, Wilfrid Laurier University, Waterloo, ON</p>
3:00 - 3:20	<p>The effects of decomposition on forensic markers of lampricides in <i>Oncorhynchus mykiss</i></p> <p>* <u>White, Chris¹</u>, Darren Foubister¹, Oana Birceanu¹, Jeffry Bernardy², Terrance Hubert² & Michael Wilkie¹ ¹Department of Biology, Wilfrid Laurier University, Waterloo, ON ²Upper Midwest Environmental Sciences Center, La Crosse, WI</p>

* Student presentation

Platform Presentations (cont'd)

Time	Session D: Terrestrial Toxicology and Risk Assessment Room UA 1120
3:50 - 4:10	<p>Toxic effects of rare earth elements on radish and durum wheat</p> <p>* <u>Pellegrino, Amanda</u>, Bianca Pereira & Beverley Hale School of Environmental Science, University of Guelph, Guelph, ON</p>
4:10 - 4:30	<p>Accumulation of methylmercury in masked shrews (<i>Sorex cinereus</i>) and invertebrates at an upland forest-peatland interface in northern Minnesota, USA</p> <p>* <u>Tavshunsky, Ilana</u>¹, Susan Eggert² & Carl P.J. Mitchell¹</p> <p>¹ Department of Physical & Environmental Sciences, University of Toronto Scarborough, Toronto, ON ² United States Forest Service, Northern Research Station, Grand Rapids, MN, USA</p>
4:30 - 4:50	<p>Evaluating the ability of <i>Alyssum murale</i> L. to extract nickel from nickel-elevated soils from Port Colborne, Ontario</p> <p><u>Zupfer, Kimberly</u>¹, Beverley Hale¹ & Michael Dutton²</p> <p>¹ School of Environmental Sciences, University of Guelph, Guelph, ON ² Vale Ltd. Toronto, ON</p>
4:50 - 5:10	<p>The development of regional background concentrations with the consideration of naturally elevated areas</p> <p><u>Lucas, Caroline</u>, Nicole Thackeray, Katherine Woolhouse, Stacey Fernandes & Harriet Phillips Canada North Environmental Services, Markham, ON</p>

* Student presentation

Platform Presentations (cont'd)

Time	Session E: Large-scale Assessments Room UA 1220
3:50 - 4:10	<p>Mercury methylation and demethylation across different riparian landscapes</p> <p>* <u>Ng, Kevin K.F.</u>^{1,2}, Nathan W. Johnson³, Jeff D. Jeremiason⁴ & Carl P.J. Mitchell^{1,2}</p> <p>¹ Department of Geography, University of Toronto – St. George, Toronto, ON ² Department of Physical and Environmental Sciences, University of Toronto – Scarborough, Toronto, ON ³ Department of Civil Engineering, University of Minnesota-Duluth, Duluth, MN, USA ⁴ Department of Chemistry, Gustavus Adolphus College, Saint Peter, MN, USA</p>
4:10 - 4:30	<p>Organophosphate ester <i>in vitro</i> metabolism, structure-activity relationships, and fate in polar bears (<i>Ursus maritimus</i>) and their ringed seal (<i>Pusa hispida</i>) prey</p> <p>* <u>Strobel, Adelle</u>¹, Robert J Letcher^{1,2}, William Willmore¹, Christian Sonne³ & Rune Dietz³</p> <p>¹ Department of Biology, Carleton University, Ottawa, ON ² Ecotoxicology and Wildlife Health Division, Environment and Climate Change Canada, National Wildlife Research Centre, Carleton University, Ottawa, ON ³ Department of Bioscience, Arctic Research Centre, Aarhus University, DK-4000 Roskilde, Denmark</p>
4:30 - 4:50	<p>Coal mining and selenium in Canada: The challenges faced and advancements made</p> <p><u>Béchar, Karen</u> & Thomas Krug Geosyntec, Guelph, ON</p>
4:50 - 5:10	<p>Role of urbanization in nutrient and fecal contamination of surface waters</p> <p><u>Kirkwood, Andrea E.</u> Faculty of Science, University of Ontario Institute of Technology, Oshawa, ON</p>

* Student presentation

Platform Presentations (cont'd)

Time	Session F: Aspects of Risk Assessment and Management Room UA 1350
3:50 - 4:10	An approach to deriving provisional criteria for elements with insufficient available toxicity data <u>Thackeray, Nicole</u> , Katherine Woolhouse, Harriet Phillips & Stacey Fernandes Canada North Environmental Services, Markham, ON
4:10 - 4:30	Ecological risk classification of inorganic substances under the third phase of the Chemicals Management Plan <u>Beking, Michael A.</u> , Vincent Dorais, Marie-Claude Sauvé, Rachel Bouwhuis, Joël Gauthier, Olivier Marois, Mei Lin & Jonathan Hill Ecological Assessment Division, Environment and Climate Change Canada, Gatineau, QC
4:30 - 4:50	Proposed framework to optimize environmental monitoring program design <u>Ethier, Adrienne</u> Arcadis Canada Inc., Ottawa, ON
4:50 - 5:10	Health Impact Assessment (HIA) in transportation: Implications for climate change <u>Waheed, Faiza</u> ^{1,2} , Glenn Ferguson ¹ & Donald Cole ² ¹ Intrinsik Corp., 6605 Hurontario St., Suite 500, Mississauga, ON ² Dalla Lana School of Public Health, University of Toronto, ON

* Student presentation



List of Poster Presentations

The combinatorial effects of hydroxypropyl- β -cyclodextrin (HP β CD) and synthetic steroids on American flagfish growth and reproduction

*Anderson, Jordan C.¹, M.D. Overturf², L. Beyger¹, J. Guchardi¹ & D.A. Holdway¹

¹University of Ontario Institute of Technology, Oshawa, ON

²University of Louisiana at Monroe, Monroe, LA, USA

Metal mixtures in soil: Testing the Concentration Addition approach as a risk assessment tool

*Arora, Pooja¹, Steve Siciliano² & Beverley Hale¹

¹School of Environmental Sciences, University of Guelph, Guelph, ON

²Department of Soil Science, University of Saskatchewan, Saskatoon, SK

Novel brominated polyphenyl ether flame retardants: In vitro competitive binding with thyroxine for human transthyretin and albumin

Hill, Katie L.^{1,2,3}, William G Willmore², Daniel Teclechiel⁴ & Robert J Letcher^{1,2}

¹Ecotoxicology and Wildlife Health Division, ECCO, Carleton University, Ottawa, ON

²Department of Biology, Carleton University, Ottawa, ON

³Intrinsic Corp., Ottawa, ON

⁴AccuStandard, New Haven, Connecticut, USA

¹H NMR-based metabolomics of *D. magna* exposure to 17 α -ethynylestradiol, carbamazepine, imidacloprid and perfluorooctane sulfonate in the presence of dissolved organic matter

Kovacevic, Vera^{1,2}, André J. Simpson^{1,2} & Myrna J. Simpson^{1,2}

¹Department of Chemistry, University of Toronto, Toronto, ON

²Environmental NMR Centre and Department of Physical & Environmental Sciences, University of Toronto Scarborough, Toronto, ON

Effects of water chemistry on the toxicity and bioaccumulation of selenite to *Hyalella azteca*

*Milne Wilkinson, Lesley¹, Warren P. Norwood² & D. George Dixon¹

¹Department of Biology, University of Waterloo, Waterloo, ON

²Aquatic Contaminants Research Division, Environment Canada, Burlington, ON

*** Student presentation**

List of Poster Presentations (cont'd)

Comparison of pharmaceutical and signaling pathway inhibitor effects on expression of genes related to swim bladder inflation in Japanese medaka

*Pandelides, Zacharias, Matthew. D. Overturf, Erin Ussery, John Guchardi & Douglas Holdway

Faculty of Science, University of Ontario Institute of Technology, Oshawa, ON

Using Diffused Gradient Thin Films (DGT) and Ion Exchange Technique (IET) to relate bioaccessibility and phytotoxicity of rare earth elements

*Pereira, Bianca, Amanda Pellegrino & Beverley A. Hale

School of Environmental Sciences, University of Guelph, Guelph, ON

Insights into the mechanism of brain swelling under no oxygen and high ammonia conditions

*Pham-Ho, Phillip, Erik Darcozi, *Alexandra Negotei, Oana Birceanu & Michael Wilkie

Department of Biology, Wilfrid Laurier University

Lead contamination of water and soil in Daniel Boone National Forest

Kernan, Selina¹, Jonathan Malzone² & David T.R. Stewart¹

¹Chemistry Department, D'Youville College, Buffalo, NY, USA

²Geology Department, Eastern Kentucky University, Richmond, KY, USA

Remediation of Ni toxicity by liming - Field validation

*Vandeven, Judith, Luba Vasiluk, Amanda Pellegrino, Kimberley Zupfer, Elizabeth Jones, Ryan Thorn, Sharereh Dehghani, Santiago Martinez, Amanda Laird & Beverley Hale

School of Environmental Science, University of Guelph, Guelph, ON

Indoor sources of and human exposure to brominated flame retardants (BFRs), organophosphate esters (OPEs) and phthalate esters (PAEs)

Yang, Congqiao¹, S.A. Harris^{2,3,4}, L.M. Jantunen^{5,1}, D. Tsirlin², L. Latifovic², B. Fraser⁶, R. De La Campa⁷, H. You⁶, R. Kulka⁶ & M.L. Diamond^{1,3}

¹Department of Earth Sciences, University of Toronto, Toronto, ON

²Population Health and Prevention, Prevention and Cancer Control, Cancer Care Ontario

³Dalla Lana School of Public Health, University of Toronto, Toronto, ON

⁴Occupational Cancer Research Center, Cancer Care Ontario

⁵Centre for Atmospheric Research Experiments, Environment and Climate Change Canada

⁶Exposure Assessment, Water and Air Quality Bureau, Health Canada

⁷Canada Mortgage and Housing Corporation

* **Student presentation**



Plenary Speakers

Room UA 1350



A story of environmental science and regulation in Canada viewed through your cell phone

Dr. Miriam Diamond

Professor, Department of Earth Sciences, University of Toronto

Canada has a long and enviable history of accomplishments in environmental science and translation of that science into environmental protection. Our notable “firsts” of science followed by evidence-based policies and legislation include acid rain, phosphorus and eutrophication, and persistent organic pollutants (POPs). However, a globalized economy, the increasing complexity of technologies, and fragmented political discourses present new and difficult challenges for Canadian environmental protection. These challenges are illustrated through the issue of minimizing adverse effects to humans and the ecosystem from flame retardants (FRs) released from computing system hardware. This issue, which turns out to be a “wicked” problem, is characterized by multiple disciplinary silos, knowledge gaps, competing priorities and vested interests, the position of the problem between organizational boundaries, the requirement of changing human behavior and economic imperatives, and that solutions can lead to unintended consequences.

FRs are used in virtually all computing system hardware including CPUs and casings (e.g., cell phones, computer cases, printed circuit boards, wiring), but they migrate from their source polymer with disposition in global human and ecosystem populations. Studies continue to emerge that link exposure to specific FRs with adverse human and ecosystem effects. The presentation follows now-controlled PBDEs and their organophosphate ester replacements that are used to comply with product-based flammability standards. These standards are disconnected from efforts to control “problematic” chemicals under the Chemical Management Plan and initiatives such as Extended Producer Responsibility enacted to address the problem of “end-of-life” hardware. We see that the strengths of the Canadian regulatory regime of being evidence-based and flexible are threatened by societal complexity and vested interests. At this point, one needs to circle back to the wicked components of the problem in order to clarify potential solutions.



Effective risk communication: Making the science make sense

Dr. Ron W. Brecher

Risk Assessment & Risk Communication Specialist

When responding to complex health and environmental risk issues in the public eye, scientists and engineers must communicate effectively with non-technical stakeholders, including decision makers and the people that influence them. Stakeholder concerns can range from health and safety to environmental and economic. Some people may also have questions about accountability, process and fairness. Left unanswered, these concerns can lead to misunderstandings and stakeholder outrage. This in turn can erode credibility not only for the spokesperson, but also for the information, the organization, and the stakeholder engagement process.

This presentation explores some key determinants of communication success, and outlines a framework for planning to communicate. A “Top 10 Tips” approach will be used to give provide practical advice for improving stakeholder understanding, building credibility and preparing to communicate effectively “in the spotlight.”



Equity is the only acceptable goal

Dr. Imogen R. Coe

Dean of Science, Ryerson University



Platform Presentations

(in alphabetical order by family name of presenter)

Rooms UA 1120, UA 1220 & UA 1350



Coal mining and selenium in Canada: The challenges faced and advancements made

Béchar, Karen & Thomas Krug

Geosyntec, Guelph, ON

E-mail: kbechar@geosyntec.com

Key Words: selenium, coal mining, selenium treatments

Coal has been mined in Canada for over three centuries but it wasn't until the early 1980s that selenium associated with coal mining activities was identified as a concern for aquatic ecosystems. Selenium is a naturally occurring element, and can be released from rock exposed to air in the coal mining process. Exposure to air allows the more inert forms of selenium in rock associated with coal to be oxidized and converted into species with a higher solubility. These more soluble forms of selenium can leach from rock piles and eventually reach rivers and lakes. Reducing risks associated with selenium can involve actions to reduce leaching of selenium from exposed rock and/or treatment of water containing selenium. This presentation will:

- 1) describe the history of coal mining in Canada and the identification of selenium issues;
- 2) summarize the current regulation of selenium;
- 3) provide a review of the selenium control and treatment strategies employed in the coal mining industry;
- 4) deliver a case study of a relatively novel selenium treatment and how it is being implemented; and
- 5) speculate on next steps for the coal mining industry.



Ecological risk classification of inorganic substances under the third phase of the Chemicals Management Plan

Beking, Michael A., Vincent Dorais, Marie-Claude Sauvé, Rachel Bouwhuis, Joël Gauthier, Olivier Marois, Mei Lin & Jonathan Hill

Ecological Assessment Division, Environment and Climate Change Canada,
Gatineau, QC

E-mail: michael.beking@canada.ca

Key Words: metals, ecological assessment, rapid screening

Under the *Canadian Environmental Protection Act, 1999*, Environment and Climate Change Canada and Health Canada assess and manage, where appropriate, risks of chemical substances to the environment and to human health. The Chemicals Management Plan (CMP) is a Government of Canada initiative that addresses approximately 4300 substances identified as priorities for assessment. In the third phase of the CMP (2016-2020), about 1550 substances remain to be addressed, including approximately 380 inorganic substances. Early activities to address remaining inorganic substances include identifying data needs, developing tailored strategies and novel approaches, and preliminary stages of assessment drafting.

In particular, a relative risk approach is under development for identifying and classifying the potential ecological risks of inorganic substances. Predictive modelling results and measured environmental concentrations are two key lines of evidence for this approach. Data from the Domestic Substances List inventory update (DSL-IU) and National Pollutant Release Inventory (NPRI) combined with conservative exposure scenarios form the basis for modelling environmental concentrations. Measured environmental concentrations are determined from surface water quality data from Canadian monitoring and surveillance programs. The relative ecological risk of individual inorganic substances and groups was determined by comparing predicted and measured concentrations to selected predicted no-effect concentrations to determine an overall preliminary risk classification. Recent updates to preliminary ecological risk classifications for inorganic substances will be presented. The ecological risk classification of inorganic substances is a novel and efficient method allowing Environment and Climate Change Canada to focus ecological assessment efforts on remaining substances of higher ecological concern.

A study on lampricide detoxification capacity in lake sturgeon (*Acipenser fulvescens*) and larval sea lamprey (*Petromyzon marinus*) – alternative treatments and their implications

Birceanu, Oana¹, Lisa O'Connor², Jonathan M. Wilson¹ & Michael P. Wilkie¹

¹Department of Biology, Wilfrid Laurier University, Waterloo, ON

²Great Lakes Laboratory for Fisheries and Aquatic Sciences, Central and Arctic Region, Fisheries and Oceans Canada, Sault Ste. Marie, ON

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Key Words: lampricide, glucuronidation, sturgeon, detoxification

The lampricide 3-trifluoromethyl-4-nitrophenol (TFM) is used to control sea lamprey populations in the Great Lakes. Typical treatments involve the application of TFM in lamprey nursery streams at the minimum lethal concentration (MLC) of the sea lamprey ammocoetes (99.9% mortality over 9h). Lake sturgeon, a culturally important fish and an endangered species in the Great Lakes, are particularly sensitive to TFM during early development (juveniles <15-20 cm). Since sturgeon can detoxify TFM via glucuronidation, we proposed that their detoxification capacity is overwhelmed during TFM treatments, leading to mortality. Therefore, we investigated the effectiveness of an alternative TFM regimen, where fish were exposed to a lower concentration of TFM for a longer time, to decrease the burden on their detoxification capacity. Consequently, ammocoetes and lake sturgeon were simultaneously treated with the 9h and 24h MLC of the lamprey. Lamprey mortality was 100% over the two treatments, while sturgeon mortality decreased from 65% during exposure to the 9h MLC, to <5% during exposure to the 24h MLC. In addition, the lake sturgeon were able to detoxify TFM three times more efficiently during the long and low TFM regimen compared to the 9h MLC exposure, typical of a TFM field application. This study revealed that when lamprey were exposed to the long and low TFM regimen, they exhibited a limited detoxification capacity of the lampricide. Our current study has shown that the “long-and-low” TFM regimen is an effective treatment alternative, that eliminates lake sturgeon mortality without compromising the effectiveness of the lampricide, and it has offered insights into the ability of lake sturgeon and sea lamprey to detoxify TFM.



Investigating the exposure of songbirds to neonicotinoids and the effects on breeding success in agricultural and natural sites

Chaudhry, Tehmeena

Department of Biology, York University, Toronto ON

E-mail: ctehmeena@gmail.com

Neonicotinoids are systemic pesticides that claim to have a very low affinity to vertebrate receptors, however sublethal effects after exposure have been seen in studies done on mammals and birds. Studies done on mammals have revealed that the metabolite of the pesticide can be found in urine after ingestion; the primary aim of this research is to apply this to birds. After spiking blank Tree Swallow (TRES) urine samples with a metabolite, there was a significantly consistent retrieval, verifying the extraction protocol. TRES nest boxes at Long Point Bird Observatory will be used to set up 3 dosing treatments for nestlings: a control, low and high dose with 10 nests per treatment. After collecting the samples at regular intervals, we can analyze the samples to see how much of a metabolite we can find compared to the dose and time. The second part is to apply this to the field by collecting Savannah Sparrow nestling urine samples from agricultural and natural sites in Guelph, ON, where farms have been known to use neonicotinoids. We want to see if there is a difference between the two site types. Using part one, we will be able to extrapolate how much the birds are being exposed to, based on what we find in their urine samples. We hope this research helps determine what may be driving grassland bird declines and develop a method to use birds as indicator species to determine what potential contaminants are present in an environment.

Proposed framework to optimize environmental monitoring program design

Ethier, Adrienne

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The recognition of the need to protect non-human biota in the environment from the effects of radiological, metal, and organic contamination released from historical facilities or waste management areas continues to grow in Canada and abroad. This is evidenced by an increasing number of activities and initiatives to mitigate or remediate the source terms and/or receiving environments. Risk management decisions, such as these, are strongly influenced by data collected from available environmental monitoring programs.

These environmental monitoring programs need to be cost-effective and consider a multitude of factors for each area of concern, including potential risk to biota and humans, chemical properties of the contaminant(s) of concern, risk management intentions for the area of interest (i.e., reuse), effectiveness of mitigation systems, and background concentrations.

The presentation will provide an overview of a step-wise framework that can be followed to design or optimize current environmental monitoring programs in a cost-effective manner and better inform risk management decisions, along with the justification needed for any program enhancements or reductions in the extent of environmental and/or biological monitoring.



Distribution and quantification of lampricides in non-target fish tissues

Foubister, Darren D.¹, Christopher White¹, Terrance Hubert², Jeffry Bernardy² & Michael Wilkie¹

¹Department of Biology, Wilfrid Laurier University. Waterloo, ON

²Upper Midwest Environmental Sciences Center, United States Geological Survey, La Crosse, WI, USA

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Key Words: fish, lampricides, toxicity, forensics

The lampricides 3-trifluoromethyl-4-nitrophenol (TFM) and niclosamide are applied to tributaries of the Great Lakes to control parasitic sea lamprey (*Petromyzon marinus*) populations. Although TFM is selectively toxic to larval sea lampreys, on occasion lampricides can cause non-target mortality. It is therefore important to determine if lampricides play a role in instances where unexpected fish kills take place. Using forensic approaches, the goal of this work is to determine which tissues are best suited for measuring post-mortem lampricide and metabolite concentrations in the non-target fishes and how different tissue handling and storage techniques impact the stability of lampricides and their metabolites. To this end, rainbow trout (*Oncorhynchus mykiss*), and white sucker (*Catostomus commersonii*) were exposed to sub-lethal concentrations of these pesticides and their tissues (liver, muscle, plasma, red blood cell pellet and whole blood) were processed and analyzed. Rainbow trout had a 12-h LC₅₀ of 17.7 mg/L, compared to a value of 15.03 mg/L TFM in white sucker. Our data showed that the liver contains the highest concentration of TFM at 19.14 µg TFM/g-wet tissue compared to muscle (2.14 µg TFM/g wet tissue). Follow-up measurements include determining the effect that storage of tissue samples at different temperatures has on the stability of the lampricides and their metabolites. This research will determine how stable these compounds are under various handling and storage techniques. Our work will facilitate the development of specific standard operating procedures to be used by sea lamprey control agents.

The influence of water chemistry on the uptake and sensitivity to TFM, for juvenile lake sturgeon

Hepditch, Scott L., M.P. Wilkie, J.M. Wilson & O. Birceanu

Department of Biology, Wilfrid Laurier University, Waterloo, ON

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Key Words: lake sturgeon, threatened species, fisheries, Great Lakes research

Application of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) to control invasive sea lamprey (*Petromyzon marinus*) within the Laurentian Great Lakes seldom causes non-target mortality. However, under certain conditions, TFM can harm species such as the lake sturgeon (*Acipenser fulvescens*). Juvenile lake sturgeon are vulnerable to TFM-induced mortality, particularly when smaller than 10cm in length, and are thought to be more susceptible to TFM toxicity in waters of higher alkalinity, which contrasts with the reductions in toxicity observed for sea lamprey and teleost fishes. The rationale behind the sensitivity to TFM for the juvenile sturgeon has not been elucidated. The threat of TFM to lake sturgeon is of concern because populations are reduced in the Great Lakes, due to overharvesting and habitat destruction, decimating populations to 1-2% of their historic levels. There is therefore a need to better understand why juvenile lake sturgeon are more sensitive to TFM, and how their susceptibility is influenced by water chemistry. The objective of this research will be to quantify the rates of TFM uptake at varying pHs and alkalinities for juvenile lake sturgeon below the size of 10 cm, and to compare these rates to those seen in fishes greater than 15 cm. An understanding of the physiological mechanism behind the observed sensitivity of juvenile lake sturgeon to TFM could provide alternatives to current lampricide application methods within the Great Lakes basin. This would better protect sensitive non-target species from TFM toxicity, without compromising the efficiency of sea lamprey treatments.

Acute and chronic effects of multiple stressors on microRNA in zebrafish

Ikert, Heather & Paul M. Craig

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Key Words: microRNA, multiple stressors, pharmaceuticals, climate change

As the human population continues to grow, increased anthropogenic stress is placed on the aquatic environment. Pharmaceuticals, such as venlafaxine (VFX), a heavily prescribed and readily detectable antidepressant, are found downstream of wastewater treatment plants. As a result of climate change, increased surface water temperatures and decreased dissolved oxygen levels have been observed. In this study, a multi-stressor approach was used to determine the cumulative, sublethal effects of the aforementioned stressors on microRNA (miRNA) in adult zebrafish (*Danio rerio*). MiRNA are small, conserved, non-coding RNA which act by decreasing mRNA translation. This impacts the functional responses of downstream targets and is a method of environmental and epigenetic regulation of phenotypic response. Adult zebrafish were exposed to control (27°C, 100% O₂, 0 µg/L VFX) or stressed (32°C, 50% O₂, 1.0 µg/L VFX) conditions for 24 hours or 21 days. RNA was extracted from liver, gonad, and muscle tissue and RT-qPCR was performed on specific miRNA related to proteins that respond to hypoxia, heat stress, or contaminants. This comparison between lengths of exposure showed differences between initial and acclimated responses. Due to the conserved nature of miRNA, this will improve our understanding of the effects that environmental stressors have on epigenetic regulation.



The pathophysiological effects of 3-trifluoromethyl-4-nitrophenol (TFM) on lake sturgeon (*Acipenser fulvescens*)

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Parasitic sea lampreys (*Petromyzon marinus*) have plagued fish populations since the 19th century in the Great Lakes. The application of TFM to larval lamprey nursery streams every 3-4 years results in the elimination of multiple generations of larvae in tributaries and rivers of the Great Lakes, with minimal effects on non-target fishes. The detoxification of TFM is due to glucuronidation of the lampricide, catalyzed by UDP-glucuronyltransferase (UDPGT), an enzyme abundant in most non-target fishes but highly reduced in sea lamprey: However, lake sturgeon (*Acipenser fulvescens*), are more sensitive to TFM than other fish species. Our acute toxicity tests confirmed that lake sturgeon have a TFM 12h LC₅₀ of 4.16 mg/L (LCL/UCL 4.52/4.92) at pH 8.55 ± 0.05, similar to that of sea lamprey under similar conditions. Using methods such as real-time polymerase chain reaction (RT-PCR; UDPGT mRNA), enzyme-linked immunosorbent assay (ELISA; cortisol), high pressure liquid chromatography (HPLC; TFM and TFM-glucuronide) and various enzyme/metabolite activity assays (e.g. glycogen, lactate), the goal of this study was to determine the pathophysiological cause(s) behind the lake sturgeon's increased sensitivity to lampricides compared to other non-target fishes. This work will help improve lamprey control efforts while maximizing the protection of economically and culturally important fishes such as the lake sturgeon.



Role of urbanization in nutrient and fecal contamination of surface-waters

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Key Words: urbanization, water quality, fecal bacteria, nutrients

Currently, over 80% of Canadians live in urban areas, and this percentage is expected to increase over the next decade. With increased urbanization come increased impacts to local urban environments, including local surface waters. Developed urban areas are typically dominated by impervious surfaces (roads, parking lots, buildings, etc.) that impede rain water penetration into underlying soil. As a result, contaminants readily flush off of the landscape and into receiving waters. Contaminants typically associated with urban environments include chloride, heavy metals, and suspended sediments. However, it is becoming increasingly apparent that other contaminants such as nutrients and coliform bacteria are strongly associated with urbanization.

The Kirkwood Lab at UOIT has been studying water quality trends along agro-urbanization gradients in Durham Region, and our studies reveal cumulative increases of nutrients and fecal bacteria with increasing urbanization. This indicates that the environmental impacts from urbanization are not necessarily distinct from agricultural impacts, although the sources may differ. As such, disentangling impacts from one land-use type to the other is challenging, and detecting biological response in the form of periphyton communities is typically only detectable at the extreme ends of water quality gradients. With respect to fecal contamination, we conducted a comprehensive fecal source-tracking study in 2016 to pinpoint source-locations of fecal contamination in three Durham Region sub-watersheds. Storm-sewer samples clearly showed a higher degree of fecal contamination in older urban areas. Quantitative-PCR was employed to delineate human vs. animal-sourced fecal bacteria, and detected spatial hotspots for human-sourced fecal bacteria (*Bacteroides* Hf183) in older urban areas dominated by residential sewersheds.



The development of regional background concentrations with the consideration of naturally elevated areas

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Key Words: background soil concentrations, geologic formations, arsenic

Establishing background soil concentrations is an important part of risk assessment, and provides context as to what natural levels are for the area. A robust estimate of background concentrations will help strengthen the risk assessment and can be used to inform risk management decisions. The FCSAP guidance (2015) indicates that background is representative of the true range of concentrations associated with the geographic area of the site. In some areas there are natural geologic formations such as volcanic rock areas which contain ore deposits of gold, silver, copper, zinc and lead making it a prime location for mining activities. These may not be representative of the surrounding areas with lower concentrations. This presentation discusses an approach for development of background concentrations and how the various considerations of background can be used in risk assessment. The discussion will use arsenic as an example and will touch on different statistics to describe background as well as the handling of method detection limits.

Multi-stressor impacts on fish energetics: A comparison between lab and field studies

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Key Words: wastewater, energetics, stress, metabolism

Aquatic organisms are continuously exposed to multiple environmental stressors that work cumulatively and synergistically to alter ecosystems. The objective of this study was to compare the impacts of multiple stressors under lab and field conditions using two fish species, zebrafish (*Danio rerio*) and rainbow darters (*Etheostoma caeruleum*). Under lab conditions, the study examined the impacts of chronic exposure to environmentally relevant concentrations of venlafaxine and elevated water temperatures, on the energetics and stress response of zebrafish. Venlafaxine is a frequently prescribed antidepressant that is readily detectable in many Canadian waterways that receive discharged wastewater treatment plant effluent. Under field conditions, rainbow darters were collected upstream and downstream of the Waterloo wastewater treatment plant in the Grand River. Enzyme activities of major metabolic enzymes and metabolites were measured in muscle tissue of both species. Oxygen consumption was measured to assess the effects of stressors on routine metabolic rate, active metabolic rate, aerobic scope, and critical swimming speed, all of which are significant ecological performance indices. Aligning field and lab results will highlight the importance of including multi-stressor approach assessments in making predictions regarding the impact of environmental stressors on non-target organisms.



Mercury methylation and demethylation across different riparian landscapes

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Key Words: methylmercury, methylation, demethylation, riparian

Through water quality and fish monitoring across Minnesota watersheds, five rivers have been identified to have particularly elevated mercury concentrations in fish despite relatively low total mercury concentrations in water and sediment. One hypothesis for these “high-five” rivers is that methylmercury production in riparian areas and the hydrological connectivity of riparian areas to streams in these five watersheds are important contributors to river methylmercury loads and bioaccumulation. To test this hypothesis, we conducted methylation (k-meth) and demethylation (k-demeth) assays, using enriched mercury isotopes, across two geomorphically distinct riparian zones in each of the five watersheds and across seasons from 2015 through 2016. Early analysis suggests that mercury methylation is enhanced in riparian areas within both wetland and agricultural landscapes versus riparian areas within forested landscapes. Methylmercury demethylation is similarly greatest in the wetland and agricultural riparian environments compared to forested riparian zones, although significant variability is observed. Our results suggest that both higher methylation and demethylation are positively related to areas that are more frequently inundated, such as in the agricultural and wetland landscapes. Riparian areas within forested regions may not contribute as much to riverine methylmercury because of lower inundation frequency and extent across these watersheds.



Optimization of clearance rate as an effect endpoint in toxicity testing with freshwater mussels

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Freshwater mussels play an integral role in aquatic ecosystems by assisting in nutrient cycling, energy transfer, habitat structure, and water quality. Populations of freshwater mussels can significantly impact water quality by filtering out particulates such as algae, zooplankton, bacteria, and detritus from the water column which can lower ammonia, nitrate, phosphorus, and dissolved organic carbon concentrations in aquatic systems. When investigating the potential risks that waterborne contaminants pose to freshwater mussels it is important to assess ecologically relevant sub-lethal endpoints since these organisms will most likely be exposed to low environmental concentrations of contaminants in aquatic systems. Therefore, this study examined how to optimize our current method of quantifying the ability of mussels to filter algae from solution after being employed in toxicity tests. For the purposes of a toxicity test endpoint, clearance rate was defined as the amount of algal cells that an individual mussel can remove from the overlying water by filtration. Two methods were implemented for determining clearance rate; absorbance and direct microscopic examination. Investigation into optimized methods included the following considerations: concentration of algae mixture required at test initiation, duration of clearance rate assay, and statistical power. Experimental vessels were set up with juvenile *Lampsilis siliquoidea*. The optimized clearance rate assay was required to run for 48 hours, 1.77e7 cells/mL of algae mixture added at test initiation, and a minimum of four replicates per treatment to detect a 25% effect, if present. After an exposure to sodium chloride, LC₅₀ results from the optimized clearance rate assay were compared to established mussel toxicity endpoints: survival and burial. Although clearance rate by direct microscopic examination was slightly more sensitive than burial and survival, no significant difference was detected between the reported LC₅₀ values of the three endpoints when comparing the 95% confidence intervals.



Organophosphate ester *in vitro* metabolism, structure-activity relationships, and fate in polar bears (*Ursus maritimus*) and their ringed seal (*Pusa hispida*) prey

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Key Words: wildlife toxicology, OPEs

The Arctic is a sink for anthropogenic substances via long-range transport. Replacement flame retardants, organophosphate esters (OPEs) have been quantified in airborne particles in the Arctic. Thus, Arctic wildlife are exposed to legacy and novel persistent organic pollutant (POP) contaminants. Low or non-detectable levels of several OPEs in Arctic biota compared to high environmental exposure suggests rapid metabolism. The present study provides toxicology and fate data of a subset of OPEs in polar bears (n=6) and ringed seals (n=7) collected from Scoresby Sound, East Greenland. The *in vitro* metabolic biotransformation assay was initiated by the addition of hepatic microsomes to a 2 µM OPE dosing solution and terminated at set time points. Quantification of OP triester and diester metabolites was conducted by UPLC-MS/MS. *In vitro* metabolism data strongly suggests that the OP triester metabolic rates are more rapid in polar bears than ringed seals. Thus, it appears possible that polar bear exposure to OPEs could occur from dietary and environmental sources. Additionally, the difference in rate of OP triester depletion can be used to better describe the role of structure on the fate of OPEs. This research will provide toxicokinetic data on priority OPEs in Arctic marine predators. This information can then be applied to current regulatory decision-making through risk assessments and food web modeling.

Accumulation of methylmercury in masked shrews (*Sorex cinereus*) and invertebrates at an upland forest-peatland interface in northern Minnesota, USA

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Key Words: mercury, shrew, exposure, methylation

Mercury (Hg), a metal found ubiquitously throughout the environment, is a substantial health concern due to its toxicity and bioaccumulation potential, particularly in methylated form. In comparison to aquatic ecosystems, methylmercury (MeHg) production and biotic uptake are poorly understood in terrestrial ecosystems, particularly in ecosystems at the wetland-terrestrial interface, known as MeHg “hot spots”. In this paper, we compared levels of THg and MeHg within muscle, kidney, liver and brain tissues of shrews inhabiting the upland-wetland interface of a northern temperate peatland to concentrations in peat and invertebrates from the same area. As a first such investigation outside of point-contaminated areas, we hypothesized that despite atmospheric deposition being the only source of Hg to this area, there would be significant biotic uptake at this ecotone. We found that the insectivorous shrew samples had low THg concentrations, ranging from 40 ng/g to 71 ng/g (almost entirely MeHg), which were surprisingly less than those in wolf spiders (mean 98.0 ng/g) and well below values considered a toxicological risk (> 1.1 µg/g). However, all shrews collected were juveniles, and since shrews consume higher trophic invertebrates with age, they may accumulate much higher concentrations of MeHg as adults. The shrews showed increasing concentrations with age and concentrations were highest in kidneys, followed by muscle, liver, and finally brain tissue. Overall, relatively high MeHg accumulation in peat and invertebrates at the upland-peatland interface does not lead to worrisome MeHg accumulation in shrews. Further research could be focused on both reasons for the middling MeHg accumulation in shrews despite their voracious predation of invertebrates, as well as their role in transferring wetland MeHg to both avian and terrestrial food chains.



Influences of water chemistry on the gill microenvironment of non-target fishes exposed to lampricide

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Key Words: Toxicology, physiology, lampricide

Lake sturgeon (*Acipenser fulvescens*), an ecologically and culturally significant fish, are a species of conservation concern in the Great Lakes. As juveniles, they live along the banks of streams and tributaries of the Great Lakes, often sharing the same habitat as larval sea lamprey (*Petromyzon marinus*). Sea lamprey invaded the Great Lakes in the 1950's, with detrimental effects on native fishes.

Currently the majority of sea lamprey populations are controlled via applications of the lampricide TFM (3-trifluoromethyl-4-nitrophenol) to streams where larvae are present in high density. Non-target species may be exposed during these treatments, and this study will focus on the effects of water chemistry on two of those fish species. TFM toxicity is dependent on its speciation; at lower pHs, higher proportions of unionized TFM are present and taken up through a mediated acid-base exchange process at the gills. Therefore, the gill microenvironment may affect TFM uptake and clearance. In this study, fish will be placed in a divided chamber and fitted with a latex mask, separating inspired and expired water, with surgically implanted pH opercular catheters. Fish will be exposed to radiolabeled TFM (¹⁴C-TFM) to track rates of TFM uptake and clearance. Ventilation rate and volume will be recorded through observation and collection of expired water. Lake trout have uni-directional respiration, where water is drawn through the mouth and irrigated over the gills. Lake sturgeon have ventrally-positioned mouths, uniquely adapted as bottom-dwellers. The mouth may be occluded during feeding, resulting in bi-directional ventilation. It is predicted that differences between these ventilation strategies may influence the pH of the gill microenvironment, resulting in differences in TFM toxicity.



An approach to deriving provisional criteria for elements with insufficient available toxicity data

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Key Words: metals, provisional criteria, surface water, soil

There are a number of elements for which regulatory authorities do not provide generic criteria; however, these elements are released into the environment from facilities and may need to be evaluated. Commonly, elements without criteria are either not assessed at all or compared to background concentrations. An approach for developing criteria for these elements is discussed using gold as an example. Gold is a commonly used metal in jewelry and the potential for toxic effects to humans are considered negligible and subsequently little to no toxicity data exists. Although widely considered non-toxic, a few studies have identified concentrations with which gold has had harmful effects on the environment. Criteria for gold in surface water, groundwater, sediment, and soil were derived based on the available toxicity data compiled from a literature search. The CCME provides a rationale for the development of soil, sediment, surface water and groundwater guidelines; however this approach was modified due to the fact that only a small database on toxicity exists for elements such as gold. This modified approach for developing criteria protective of humans and the environment is discussed, which includes the use of surrogates, as well as the overall uncertainties associated with the modified approach.



Early-life stage effects of metformin in Japanese medaka (*Oryzias latipes*)

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Key Words: metformin, pharmaceuticals, early-life stage, growth and development

In recent years, there is a growing concern that human pharmaceutical wastes threaten many natural processes of living organisms through the introduction of stressors and unnatural contaminants into the environment. One of the most abundant environmental contaminants is the type 2 diabetic drug metformin. Metformin has been measured in surface waters and wastewater effluents in the $\mu\text{g/L}$ concentration range. Recent studies have observed adverse effects of metformin on adult fathead minnows, resulting in an increase in vitellogenin expression, an increased occurrence of intersexuality, a decrease in weight and condition factor in males, and a decrease in the size and amount of egg clutches produced by breeding minnows. To date, there have been no studies investigating the effect of metformin on the sensitive early life stages of aquatic organisms. The present study utilized the Organization for Economic Cooperation and Development (OECD) 210 Early-life Stage (ELS) study to investigate the impacts metformin has on Japanese medaka growth and development. Medaka were treated with a nominal concentration range of 1.0, 3.2, 10, 32 and 100 $\mu\text{g/L}$ metformin from embryo through 28 days post hatch. Medaka exposed to the pharmaceutical were found to have a significantly shorter length (mm) and a significantly smaller weight (mg) than control fish. It is apparent that metformin does cause growth effects in exposed fish, however because of the molecule's size, it is argued that metformin cannot get into the fish to elicit such a response. This study proves that water-borne metformin is indeed able to enter both the embryo and larvae of Japanese medaka.



Health Impact Assessment (HIA) in transportation: Implications for climate change

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Key Words: HIA, transportation, climate change, GHG emissions

With increasing urbanization, the potential impact of transportation infrastructure on health is an emerging area of public concern worldwide. Globally, transportation contributes to 14% of total Greenhouse Gas emissions, 95% of which are due to the burning of fossil fuels (IPCC, 2014). Within Ontario, the transportation sector is the highest contributor to GHG emissions. A recent Canadian study found that approximately 10 million individuals, or 32% of the population, live within 100 metres of a major road or 500 metres of a highway, and that approximately one-third of all Canadian urban elementary schools are located in zones of high traffic proximity (Brauer et al., 2012).

Health Impact Assessments (HIAs) are evidence-based processes that evaluate broad potential positive or negative impacts of a project or policy on community health and the distribution of those impacts within the community. The research presented here is a continuation of an international systematic scoping review of HIAs of transportation projects, plans and policies, in which 164 HIAs published since 2000 were identified. We observed that these transportation HIAs conducted limited assessment of potential impacts on health due to climate change, and most did not consider GHG emissions during the lifecycle of the project. Our research identifies a need for and suggests ways through which future transportation HIAs can incorporate a structured approach for evaluation of GHG emissions and climate change impacts on health.

The effects of decomposition on forensic markers of lampricides in *Oncorhynchus mykiss*

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Key Words: forensics, lampricides

The lampricides 3-trifluoromethyl-4-nitrophenol (TFM) and niclosamide have been used for decades to control invasive sea lamprey (*Petromyzon marinus*) populations in the Great Lakes, normally with little harm to other fish populations. However, due to the nature of lampricide treatments and the chemical properties of TFM and niclosamide, adverse effects to non-target fishes and non-target mortality occasionally occur. Investigations of non-target mortality can be complex, particularly if fish deaths are not noticed immediately, due to decomposition of the carcasses. It is important to determine the cause of death in fishes in the hours, days or weeks that follow a treatment, to determine whether or not lampricides contributed to the incident. Indeed, fish kills can occur for many reasons besides pesticide use such as aquatic contaminants, oxygen depletion, and/or disease. Currently, it is unknown how stable TFM, niclosamide and their metabolites are in decomposing fish tissues, but such information is needed to aid investigators in discovering the cause of a fish kill following lampricide treatments. This research aims to use forensic toxicology to help determine the stability of TFM, niclosamide and their metabolites in different tissues collected from rainbow trout (*Oncorhynchus mykiss*) left to decompose in water and in air. Using this approach it will be possible to identify forensic markers of lampricide toxicity that can ultimately be used in the development of standard operating procedures and criteria that can be used in the rare circumstances where death may have resulted from lampricide exposure.



Evaluating the ability of *Alyssum murale* L. to extract nickel from nickel-elevated soils from Port Colborne, Ontario

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Key Words: phytoremediation, hyperaccumulator, partitioning coefficient, total soil Ni

Alyssum murale, a hyperaccumulator of Ni that is native to Ni-rich serpentine soils, is a species of interest for phytoremediation of Ni-elevated soils by industry emissions in Port Colborne, Ontario. To determine the extraction efficiency and feasibility of using *A. murale* for Ni mass transfer, two phytoextraction studies were conducted. A 30-day scoping study was completed to determine short term extraction capability. Results showed a statistically significant decrease in total soil Ni concentration over time. To determine extraction efficiency over a full growing season, a 100-day study was conducted. Results showed a decrease in total and extractable soil Ni concentrations and a constant partitioning coefficient over time, suggesting bioaccessibility of Ni does not decrease and extraction efficiency remains constant. Despite successful reduction in soil Ni concentration, there was not a mass balance between soil Ni mass reduction and *A. murale* Ni mass accumulation. Using modeling software and data from the two phytoextraction studies, a hypothetical timeline for reduction in soil Ni mass was established.



Poster Presentations

(in alphabetical order by family name of presenter)

UA West Atrium



The combinatorial effects of Hydroxypropyl- β -cyclodextrin (HP β CD) and synthetic steroids on American flagfish growth and reproduction

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The prevalence of pharmaceuticals and personal care products (PPCPs) in the environment has been an increasing concern over the past two decades. Many studies have demonstrated the reproductive impacts of many PPCPs have on non-target aquatic organisms. The goals of this study were to firstly, understand the reproductive toxicity of 17 α -ethinylestradiol (EE2), levonorgestrel (LNG), and etonogestrel (ENG) alone on the American flagfish (*Jordanella floridae*); secondly, to identify if hydroxypropyl- β -cyclodextrin (HP β CD) can alter the identified toxicity of EE2, LNG, and ENG. HP β CD is used as an odour suppressant in Febreze[®], as well as an excipient in some pharmaceutical applications. It is amphiphilic and toroidal in shape with the ability to include non-polar compounds within its central cavity, including many synthetic steroids. Results from this study indicate that in the presence of HP β CD, the 96 hr acute toxicity of EE2 to larval American flagfish was significantly reduced in a 1:1 molar ratio (EE2:HP β CD) ($P \leq 0.05$). Thus an interaction between HP β CD and EE2 can be detected though a biological assay. In order to characterize the environmentally relevant concentrations of these compounds in a chronic setting, a 30 day early life-stage toxicity test was undertaken using juvenile American flagfish. Fish were exposed to 1 ng/L, 3.2 ng/L, 10 ng/L, 32 ng/L, 100 ng/L, and 320 ng/L LNG in triplicate. No significant differences in wet ($n=96-104$) or dry weight ($n=30$) were observed. A minor increase in length was observed at 32 ng/L LNG, when compared to the control ($P \leq 0.05$). A series of reproductive exposures involving EE2, LNG, and ENG, alone and in combination with HP β CD are currently being conducted with results to be discussed.



Metal mixtures in soil: Testing the Concentration Addition approach as a risk assessment tool

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Key Words: Concentration Addition, metal mixtures, risk assessment, toxic units

Metals co-occur in the environment at toxic concentrations as a result of mining and industrial activities. The risk assessment of metal mixtures in soils relative to these associated impacts has become of high priority for Canada's mining industry and federal agencies as they develop regulatory frameworks for metal-elevated sites. Current risk assessment tools that are in place to regulate mixture toxicity are based on dose-response studies of single metals. There are limited data available on the toxicity of mixtures to soil organisms, particularly in field application. The proposed research will evaluate the validity of the Concentration Addition (CA) model in predicting the phytotoxicity of a ternary metal mixture (As, Cu, and Zn) on higher plant species. Barley (*Hordeum vulgare*) and tomato (*Lycopersicon esculentum*) will be assessed for growth parameters (root and shoot length; root and shoot dry weight) and metal uptake. These growth studies will use field-contaminated and reference soils from a decommissioned gold mine site. In order to consider remediation of this land for other uses such as agriculture, it is critical to have proper risk assessment tools in place for more effective decision-making. Toxic units (TUs) are widely used in the comparison of single compounds when assessing mixture toxicity to extrapolate laboratory data to more field applicable results. This study will use current regulatory NOECs as TUs to predict toxicity of metal mixtures, to test the CA model. The outcomes of this research will serve as a predictive risk assessment tool for mixtures and their interaction in soils at precious metal mining sites across Canada, as well as other similar contaminated sites worldwide. This study aims to reduce the need for determination of site-specific remediation objectives by providing a robust process for estimating metal mixture toxicity.



Novel brominated polyphenyl ether flame retardants: *In vitro* competitive binding with thyroxine for human transthyretin and albumin

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Key Words: flame retardants, endocrine disruption, thyroid transport, *in vitro* assay

Tetradecabromo-1,4-diphenoxybenzene (TeDB-DiPhOBz) is a highly brominated flame retardant (BFR) and an alternative for 2,2',3,3',4,4',5,5',6,6'-decabromodiphenyl ether (BDE-209). There are several known commercial formulations and products containing TeDB-DiPhOBz, however little information is available on the magnitude and global range of its use. With 14 bromine atoms, TeDB-DiPhOBz has low bioavailability; however it can undergo rapid photolytic debromination to e.g. Br₄- to Br₇-DiPhOBz. These photodegradation products have increased bioavailability, and toxicological concern is therefore warranted. Interestingly, methoxylated Br₄- to Br₆-DiPhOBz have recently been identified for the first time in eggs of herring gull (*Larus argentatus*), a bioindicator species of the Laurentian Great Lakes. These novel contaminants are thus suspected degradation products of TeDB-DiPhOBz, and metabolism studies using gull microsomes confirm that several methoxy- and hydroxy- polybrominated DiPhOBz compounds are formed *in vitro*. Virtually no toxicological data exist for this BFR or its potential degradation products. However *in vitro* chicken hepatocyte and avian PCR assays using photodegradation products of TeDB-DiPhOBz report some alterations in mRNA expression (e.g. CYP1A4 involved in the metabolic pathway). The present study investigates the potential thyroidogenicity of tetrabromo-DiPhOBz along with methoxy- and hydroxy- conjugates, using an *in vitro* competitive binding assay with human thyroid hormone transport proteins transthyretin and albumin. Perturbation of thyroid hormone transport is considered to be one mechanism of action that may affect thyroid function, which is a major toxicological concern with PBDEs and especially hydroxy-BDE metabolite compounds.



^1H NMR-based metabolomics of *D. magna* exposure to 17 α -ethynylestradiol, carbamazepine, imidacloprid and perfluorooctane sulfonate in the presence of dissolved organic matter

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Key Words: contaminant toxicity, dissolved organic matter, metabolomics

Molecular-level techniques are needed to evaluate the impact of dissolved organic matter (DOM) on the toxicity of emerging contaminants. In general, the sorption of hydrophobic organic contaminants to DOM reduces the freely dissolved concentration and the bioavailability of these compounds, and hence the toxicity of these contaminants is often reduced. In contrast, many polar and ionizable organic contaminants do not strongly sorb to DOM and therefore DOM is not expected to mitigate the toxicity of polar contaminants. To test this hypothesis, ^1H nuclear magnetic resonance (NMR)-based metabolomics was used to investigate how the metabolome of *Daphnia magna* changes when Suwannee River DOM (5 mg organic carbon/L) is included in the acute exposure of four individual chemicals with varying hydrophobicity. Sub-lethal concentrations of the hydrophobic chemical 17 α -ethynylestradiol (EE2), the relatively more polar compounds carbamazepine and imidacloprid, or the anionic chemical perfluorooctane sulfonate (PFOS) were used. The metabolic response to EE2 exposure was reduced the most with DOM, suggesting that DOM may alleviate the toxicity of EE2. The metabolome was relatively unaltered with exposure to carbamazepine and imidacloprid in the presence of DOM. PFOS exposure resulted in a more significant metabolic response with DOM suggesting that DOM enhanced the bioavailability of PFOS. Here we show that DOM can significantly alter the sub-lethal toxicity of contaminants to *D. magna*. The differences in the metabolic responses are likely related to the sorption affinities of these contaminants to DOM. As such, potential sorption to DOM should be considered when assessing the toxicity of chemicals and the potential deleterious impacts of organic contaminants in aquatic ecosystems.



Effects of water chemistry on the toxicity and bioaccumulation of selenite to *Hyaletta azteca*

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Key Words: selenium, water chemistry, modelling

Selenium is a trace element essential for humans that is sometimes considered a metalloid. Like other metalloids or metals, it can be toxic above essential concentrations. Anthropogenic sources of Se are often by-products from metal ore refining, but Se is also of interest due to its use in manufacturing. Se is more toxic in an organic form and from a dietary route of exposure; however, the inorganic waterborne forms can also have toxic effects. As part of the Canadian government's Chemicals Management Plan, it is of interest to determine how different water chemistry impacts mortality, growth, and bioaccumulation of Se in *Hyaletta azteca* after acute (7-day) and chronic (28-day) exposures to selenite.

These endpoints were examined after exposure to a concentration series of sodium selenite (Na_2SeO_3) at three different levels of pH, DOC, or alkalinity in soft water. In acute (7-day) exposures, it was found that a higher pH had a protective effect. However, in chronic exposures (28-day) mortality at pH 8.5 greatly increased. Increasing dissolved organic carbon from a natural source increased toxicity. The lethal body concentration of Se in these high DOC treatments was significantly lower than other exposures and growth was significantly lower compared to control. Low alkalinity exposures also increased selenite toxicity.



Comparison of pharmaceutical and signaling pathway inhibitor effects on expression of genes related to swim bladder inflation in Japanese medaka

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Key Words: swim bladder, pharmaceuticals, development, embryonic exposure

Inadequate swim bladder inflation can have serious long term effects on fish populations. Many environmental contaminants can inhibit swim bladder inflation of larval fish. Previous studies in our laboratory have determined that embryonic exposure to pharmaceuticals including 17 α -ethinylestradiol, levonorgestrel, and diclofenac, both alone and in mixtures, can impair swim bladder inflation of Japanese medaka (*Oryzias latipes*). Understanding how this occurs and developing biomarkers for this effect is important. In the first part of this study, it was established that embryonic exposure to 1 μ M IWR-1, a wnt signalling inhibitor, as well as 5 μ M cyclopamine a Hedgehog (Hh) signaling inhibitor, resulted in >95% inhibition of swim bladder inflation of Japanese medaka larvae. The effects of these inhibitors on the expression of medaka genes related to the Hedgehog (Hh) and wnt pathways, as well as genes involved in the formation of the three cell layers that make up the swim bladder (epithelial, mesenchyme, and outer mesothelium) were determined at 80, 96, 101, 144, 180 and 216 hours post fertilization. Following this experiment, the expression of these key genes was measured following exposure to 17 α -ethinylestradiol, levonorgestrel, and diclofenac. We established that these pharmaceutical compounds significantly inhibited the expression of genes related to the formation of the three layers of the swim bladder, with levonorgestrel causing the most significant effects. While sharing some similar effects to the inhibitors there were also some important differences, such as 17 α -ethinylestradiol and diclofenac targeting *pbx1b*, a gene involved in surfactant production.



Using Diffused Gradient Thin Films (DGT) and Ion Exchange Technique (IET) to relate bioaccessibility and phytotoxicity of rare earth elements

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Key Words: rare earth elements, toxicity, IET, DGT

The extractive mining and use of rare earth elements (REEs) has increased in recent decades, thus increasing deposition of emissions and waste associated with the mining and manufacturing processes to surrounding environments. There are insufficient data describing the ecotoxicity of this group of metallic elements to establish regulatory soil quality guidelines. Unlike data-rich metals such as Cu and Ni, toxicity associated with REEs has not yet been well demonstrated to relate to the soil REEs that are readily available for uptake from the soil (also known as bioaccessibility). Bioaccessibility of REEs will be measured using Diffusive Gradient Thin Films (DGT) and Ion Exchange Technique (IET) to determine which is more predictive of the true exposure of plants, thus better correlated with toxicity. It will also be compared to the theoretical values predicted by the modeling program WHAM 7 with the expectation is that the values determined by IET and WHAM will be more similar than DGT and WHAM. Doing so will fill in data gaps that will contribute to the development of federal soil quality guidelines as well as site specific risk assessment protocols. Preliminary results will be discussed.

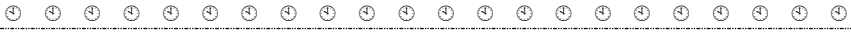
Insights into the mechanism of brain swelling under no oxygen and high ammonia conditions

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Elevated internal ammonia (NH_4) concentrations (hyperammonemia) and insufficient levels of oxygen (anoxia) both result in brain swelling and ion disturbances in the goldfish (*Carassius auratus*). However, the mechanism of ammonia and anoxia-induced brain swelling in fishes remains unsolved. This study investigates the underlying mechanisms of ammonia and anoxia-induced swelling in the fish brain. Exposure of goldfish to high external ammonia (HEA; 5 mmolL^{-1}) for 48h led to a 12% increase in brain water content, and a 10-fold increase in plasma ammonia. Dry brain sodium (Na^+) displayed similar trends to brain water content, increasing by approximately 45%, while potassium (K^+) was reduced by approximately 10%. Goldfish exposed to anoxia ($<1 \text{ mg/L}$ dissolved O_2) exhibited an 8% increase in brain water content, 20-fold increase in blood lactate, and 2-fold increase in blood ethanol. Although we are able to demonstrate that HEA and anoxia exposure resulted in brain water accumulation, there appear to be differences in the underlying mechanism between exposures.



Lead contamination of water and soil in Daniel Boone National Forest

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Key Words: lead, wetlands, soil

Lead is a metal that interferes with a variety of body processes and is toxic to many organs in humans and other animals. In collaboration with Eastern Kentucky University, water and soil samples from wetlands in the Daniel Boone National Forest were tested for levels of lead. The sites were either natural or constructed, ephemeral wetlands at higher elevations where no obvious source of water is present besides rain. Amphibian populations at these sites have been studied for approximately 10 years. Dr. Malzone is measuring the water budget and soil conditions to understand factors that influence the amount of surface water available for spawning and development.

An Atomic Absorption Spectrophotometer with a graphite furnace module was used to measure lead in liquid samples to part per billion levels. The water samples were filtered and analyzed using a standard addition method. The soil samples went through an acid digestion process to obtain a liquid sample prior to filtration and standard addition analysis.

The water and soil samples were run in duplicate and the final reported concentrations in ppb were averages of the two values. All but four water samples fell below our LOQ, or limit of quantitation, of 1 ppb. Soil cores were sampled in duplicate at varying depths. All of the soil samples showed some level of lead contamination, but it is not clear if the concentrations systematically change with depth.



Remediation of Ni toxicity by liming - Field validation

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Key Words: Nickel, metal, liming, remediation

Toxicity of metals is dependent on soil chemistry, especially pH. Liming of field soils contaminated with Ni in Port Colborne ON was studied as a remediation technique. Raising pH affects bioavailability of metals and soil nutrients and may cause adverse effects on plants. Treatments of 88t/ha of calcitic or dolomitic lime and positive control (mechanical equipment only) and a negative control were applied to a field in Port Colborne in 2015. The soil was sampled before and after application, and soybean planted in July 2015 and harvested in October. Soil pH, pseudo-total Ni and plant-available Ni were measured on samples collected before and after liming. Both types of lime increased soil pH, though calcitic resulted in a greater increase. The decrease in pseudo-total Ni seen following liming could be explained by the dilution effect of adding 88t/ha of lime to the top 5 cm of soil. Plant-available Ni was reduced by both types of lime; however calcitic had a greater effect. It was found that there is a very predictable relationship between soil pH and plant-available Ni, which did not depend on the form of lime. Soybean yield was significantly lower than that observed for Ontario due to late seed planting. The greatest yield was seen on the negative control; due to large error for that treatment the negative control yield was statistically greater. Higher yield was seen in the dolomitic treatment, which may be due to calcitic pH being too high for optimal soybean production.



Indoor sources of and human exposure to brominated flame retardants (BFRs), organophosphate esters (OPEs) and phthalate esters (PAEs)

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Indoor concentrations of, and exposures to brominated flame retardants (BFRs), organophosphate esters (OPEs) and phthalate plasticizers (PAEs) are influenced by poorly understood sources and, in some cases, poorly understood exposure pathways. Furthermore, the physical-chemical properties of compounds within each class vary greatly, influencing their indoor partitioning and residence time, and hence indoor levels and exposure. Here we report on a study of 51 participants residing in the Greater Toronto Area and Ottawa, Ontario. Our goal was to characterize indoor concentrations and to estimate exposure of premenopausal women participants to BFRs, OPEs, and PAEs. Floor dust and indoor air samples were collected. Wipes of principal household electronics and participants' hands were also analysed. The median concentrations were used to estimate external exposure of participants to FRs and PAEs via inhalation, dust ingestion and hand-to-mouth contact. Chemical profiles on a participant's hands resembled profiles found in that person's electronic products. Exposure to these compounds via hand-to-mouth contact equaled or exceeded exposure by dust ingestion. Inhalation intake contributed the least to human exposure of all chemical groups.

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