Laurentian SETAC 21st

AGM & CONFERENCE

June 24, 2016 | University of Waterloo | Waterloo, ON

WATERSHED SCIENCE UNDER MULTIPLE STRESSORS

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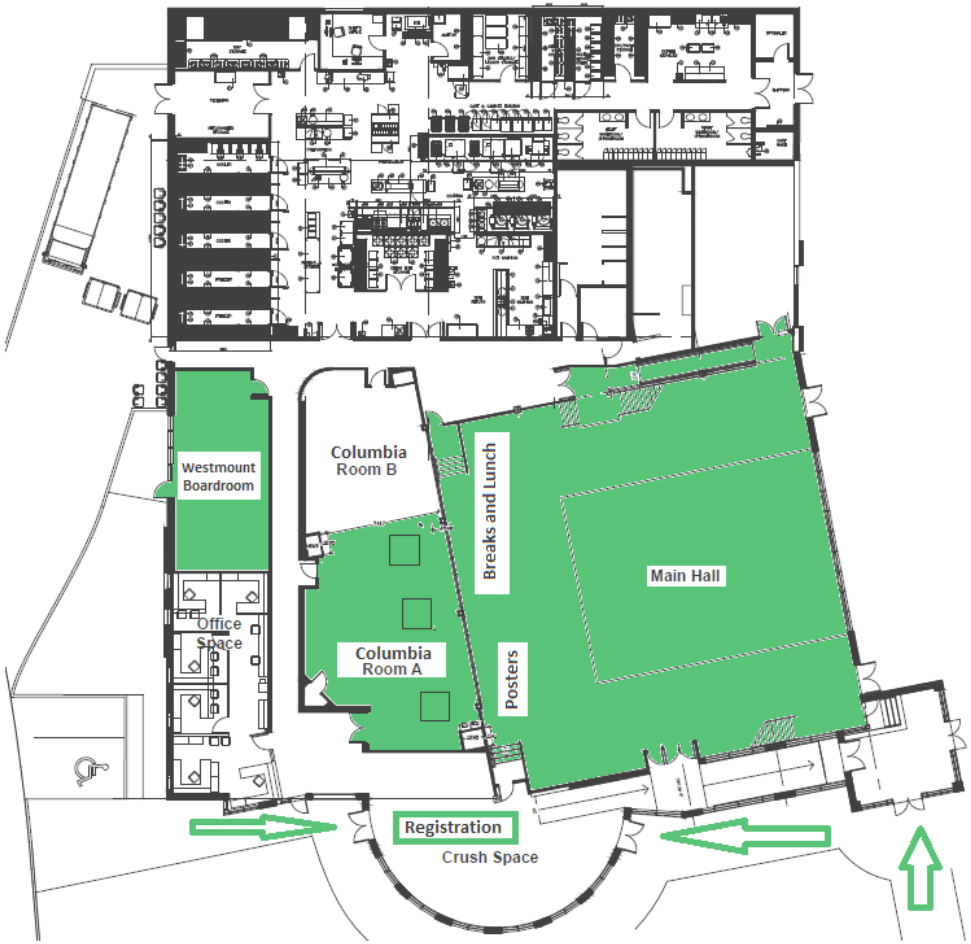

UNIVERSITY OF WATERLOO

CONFERENCE PROGRAM

Friday, June 24th, 2016

Time	Location	Schedule Item
8:00-8:30	Crush Space	***Registration***
	Back of Main Hall	*Poster set-up*
8:30-8:40	Main Hall	***Opening Remarks***
8:40 – 9:25	Main Hall	***Responses to Estrogenic Endocrine Disruptors Are Variable in Common Model Teleosts (A Fish is not a Fish is not a Fish)*** MacLatchy, Deborah L., Andrea L. Lister & Thiviya Kanagasabesan Wilfrid Laurier University, Waterloo, ON
9:25 - 10:10	Main Hall	***Control and Mitigation of HABs in Canadian Waters: Multiple Stressors and their Challenges for Lake Managers - "It's More than Just Phosphorus"*** Hutchinson, Neil, Tammy Karst-Riddoch, Kris Hadley & Dörte Köster Hutchinson Environmental Sciences Ltd, Bracebridge, ON
10:10 – 10:40	Back of Main Hall	***Posters*** *and Morning Break (Student poster judging)*
10:40 – 11:25	Main Hall	***Research and Science Policy: Experiences Gained from Canada's Ecosystem and Issue Initiatives*** Chambers, Patricia Environment and Climate Change Canada, Burlington, ON
11:25 - 12:00	Main Hall	***Annual General Meeting*** & SETAC North America updates

CONFERENCE PROGRAM (cont'd)

Friday, June 24th, 2016

Time	Location	Schedule Item
12:00 - 2:00	Back of Main Hall	***Buffet Lunch***
12:00 - 2:00	Wilfrid Laurier University	***Lab Tour: Centre for Cold Regions & Water Science***
2:00 - 2:20	Main Hall, Columbia Room A and Westmount Boardroom	***Concurrent Platform Presentations*** **Sessions A, B & C**
2:20 - 2:40		
2:40 - 3:00		
3:00 - 3:30	Back of Main Hall	***Posters*** *and Afternoon Break* (Student poster judging)
3:30 – 3:40	Back of Main Hall	**Book Draw**
3:40 - 4:00	Main Hall, Columbia Room A and Westmount Boardroom	***Concurrent Platform Presentations*** **Sessions D, E & F**
4:00 - 4:20		
4:20 - 4:40		
4:40 – 5:00		
5:00 - 5:30	Columbia Room A	***Student Judges meet***
	Back of Main Hall	*Take down posters*
5:30 - 9:00	**Bombshelter Pub** (Student Life Centre)	***Student Awards Social and Dinner***

Platform Presentations

Time	Session A: Contaminated Sediments Main Hall
2:00 - 2:20	**Anthropogenic mercury deposition in Flin Flon, Manitoba and the Experimental Lakes Area, Ontario (Canada): A multi-lake sediment core reconstruction** Wiklund, Johan A[1], Jane L. Kirk[1], Derek C.G. Muir[1], Marlene Evans[2], Fan Yang[1], Jonathan Keating[2] & Matthew T. Parsons[3] [1]Aquatic Contaminants Research Division, Environment Canada, Burlington, ON [2]Aquatic Contaminants Research Division, Environment Canada, Saskatoon, SK [3]Air Quality Science Unit, Environment Canada, Edmonton, AB
2:20 - 2:40	**Finding love in the mud: Assessing sediment contamination using reproductive endpoints** *Stevack, Kathleen[1], Paul Sibley[1] & David Poirier[2] [1]School of Environmental Sciences, University of Guelph, Guelph, ON [2]Aquatic Toxicology Unit, Ontario Ministry of Environment and Climate Change, Toronto, ON
2:40 - 3:00	**Sequestration of mercury and PCBs in sediments via amendments** Béchard, Karen[1], Matt Vanderkooy[1], David Himmelheber[2], Jeff Roberts[3] & Thomas Krug[1] [1]Geosyntec, Guelph, ON [2]Geosyntec, Princeton, NJ [3]SiREM, Guelph, ON

*** Student presentation**

Platform Presentations (cont'd)

Time	Session B: Municipal Wastewater Toxicity Columbia Room A
2:00 - 2:20	**Distinct changes to respiratory and metabolic physiology in two Great Lakes fish exposed to wastewater effluent** *Du, Sherry N.N.[1], Erin S. McCallum[2], Maryam Vaseghi-Shanjani[1,2], Jasmine A. Choi[1], Theresa R.Warriner[2], Sigal Balshine[2] & Graham R. Scott[1] [1]Department of Biology, McMaster University, Hamilton, ON [2]Department of Psychology, Neuroscience & Behaviour, McMaster University, Hamilton, ON
2:20 - 2:40	**An assessment of the spatial and temporal variability of biological endpoint responses of rainbow darter (*Etheostoma caeruleum*) collected along an urban gradient** *Fuzzen, Meghan L. M.[1], Gerald Tetreault[2], Leslie Bragg[1], Paulina Bahamonde[3], Rajiv Tanna[1], Mark McMaster[2] & Mark Servos[1] [1]Department of Biology, University of Waterloo, Waterloo, ON [2]Water Science and Technology Directorate, Environment Canada, Burlington, ON [3]Canadian Rivers Institute and Department of Biology, University of New Brunswick, Saint John, NB
2:40 - 3:00	**Endocrine disruption in wild fish is reduced after municipal wastewater treatment plant upgrades** *Hicks, Keegan[1], Meghan Fuzzen[1], Katie McCann[1], Leslie Bragg[1] Gerald Tetreault[2], Mark McMaster[2] & Mark Servos[1] [1]Department of Biology, University of Waterloo, Waterloo, ON [2]Water Science and Technology Directorate, Environment Canada, Burlington, ON

*** Student presentation**

Platform Presentations (cont'd)

Time	Session C: Cumulative Stressors Westmount Boardroom
2:00 - 2:20	**Internal versus external dose for describing ternary metal mixture (Ni, Cu, Cd) chronic toxicity to *Lemna minor*** Gopalapillai, Yamini & Beverley Hale School of Environmental Sciences, University of Guelph, Guelph, ON
2:20 - 2:40	**Invertebrate community response to cumulative anthropogenic stress in the Laurentian Great Lakes** Bowman, Michelle F.[1], Lee C. Grapentine[2], Jan J.H. Ciborowski[3], Mei Cai[4], Lucinda B. Johnson[4], J. David Allan[5] & Sigrid D.P. Smith[5] [1]Forensecology, Guelph, ON [2]Environment & Climate Change Canada, Burlington, ON [3]Department of Biological Sciences, University of Windsor, Windsor, ON [4]Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN [5]School of Natural Resources & Environment, University of Michigan, Ann Arbor, MI
2:40 - 3:00	**Variability in multiple stressors and their impacts on water quality and periphyton communities along agriculture-urban land-use gradients** Gage Comeau[1], Sabrina Bedjera[1,2] & Kirkwood, Andrea[1] [1]Faculty of Science, University of Ontario Institute of Technology, Oshawa, Ontario [2]Present Address: NSERC Chair in Water Treatment, Dept. of Civil and Environmental Engineering – University of Waterloo, Waterloo, ON

Platform Presentations (cont'd)

Time	Session D: Aspects of Risk Assessment Main Hall
3:40 - 4:00	**Estimating background metal concentration ranges for Canadian surface waters** Proulx, Catherine.L.[1], Bruce Kilgour[1], Anthony Francis[1], Rachel Bouwhuis[2] & Jonathan Hill[2] [1]Kilgour & Associates Ltd., Ottawa, ON [2]Ecological Assessment Division, Environment and Climate Change Canada, Gatineau, QC
4:00 - 4:20	**Unique approaches to evaluating risks associated with scattered contamination at large sites** Leon, Leah M. & Harriet A. Phillips Canada North Environmental Services, Markham, ON
4:20 - 4:40	**Two-eyed seeing in contaminated site assessment and management** Fraser, Alison J. & Rachel Speiran Shared Value Solutions, Guelph, ON
4:40 – 5:00	**Risks and benefits of consuming fish from Lake Ontario** Strandberg, Ursula[1], Satyendra Bhavsar[2] & Michael T. Arts[1] [1]Department of Chemistry and Biology, Ryerson University, Toronto, ON [2]Ontario Ministry of the Environment and Climate Change, Sport Fish Contaminant Monitoring Program, Environmental Monitoring and Reporting Branch, Toronto, ON

Time	Session E: Indicators of Exposure Columbia Room A
3:40 - 4:00	**Identification of serum biomarkers for bitumen exposure in sockeye salmon (*Oncorhynchus nerka*)** Dindia, Laura A.[1], Sarah L. Alderman[1], Anthony P. Farrell[2], Christopher J. Kennedy[3] & Todd E. Gillis [1] [1]University of Guelph, Guelph, ON; [2]University of British Columbia, Vancouver, BC; [3]Simon Fraser University, Burnaby, BC
4:00 - 4:20	**From transcriptome to metabolome: Multigenerational biomarkers of BPA exposure during embryogenesis** Birceanu, Oana[1], Laura Dindia[1], Alam Mohammad[1,2], Owen Woody[1], Brendan McConkey[1], Neel Aluru[1] & Matt Vijayan[1,2] [1]Department of Biology, University of Waterloo, Waterloo, ON;[2]Department of Biological Science, University of Calgary, AB
4:20 - 4:40	**The consumption of aquatic insects by bats may alter the dating and stable isotope profiles in a 4,000-year-old bat guano core from Jamaica** *Gallant, Lauren R.[1], Chris Grooms[2], Linda E. Kimpe[1], John P. Smol[2], Wieslaw Bogdanowicz[3], Stefan Stewart[4] & Jules M. Blais[1] [1]Department of Biology, University of Ottawa, Ottawa, ON; [2]Department of Biology, Queen's University, Kingston, ON; [3]Museum and Institute of Zoology, PAS Wilcza, Warsaw, Poland; [4]Jamaican Caves Organization, Ewarton, Jamaica
4:40 – 5:00	**Assessment of DNA damage in freshwater mussels from the Hamilton Harbour watershed** Gilroy, Ève A.M.[1], Sara Witzke[1], Sheena Campbell[1], Kelly A. McNichols-O'Rourke[2], Todd J. Morris[2], Joseph Salerno[3], Patricia L. Gillis[3], Thys Theismeyer[4] & Shane R. de Solla[5] [1]Green House Science, Burlington, ON; [2]Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON; [3]Aquatic Contaminants Research Division, Environment and Climate Change Canada, Burlington, ON; [4]Royal Botanical Gardens, Burlington, ON; [5]Ecotoxicology and Wildlife Health Division, Environment and Climate Change Canada, Burlington, ON

* **Student presentation**

Platform Presentations (cont'd)

Time	Session F: Aspects of Bioavailability Westmount Boardroom
3:40 - 4:00	**Use of an *in vivo* rat model to evaluate relationships between bioaccessibility and bioavailability of nickel in laterite soils** *Sowa, Jessica M.[1], Luba Vasiluk[1], Beverley Hale[1], Mike Dutton[2] & Paul Sandborn[3] [1]School of Environmental Sciences, University of Guelph, Guelph, ON [2]Vale Base Metals, Mississauga, ON [3]Department of Environmental Science, University of Northern British Columbia, Prince George, BC
4:00 - 4:20	**Passive sampling for measuring the availability of hydrophobic organic chemicals: The end-user perspective** Roberts, Jeff[1], Michael Healy[1], Matt Vanderkooy[2], Karen Bechard[2] & Jason Conder[3] [1]SiREM, Guelph, ON [2]Geosyntec, Guelph, ON [3]Geosyntec, Huntington Beach, CA
4:20 - 4:40	**Evaluating the ability of *Alyssum murale* to extract aged nickel from nickel-contaminated organic soils** *Zupfer, Kimberly R.[1], Beverley Hale[1] & Mike Dutton[2] [1]School of Environmental Sciences, University of Guelph, Guelph, ON [2]Vale Base Metals, Mississauga, ON

*** Student presentation**

List of Poster Presentations

Metal mixtures in soil: Testing the concentration-addition approach as a risk assessment tool

*Arora, Pooja[1], Steve Siciliano[2] & Beverley Hale[1]
[1] School of Environmental Sciences, University of Guelph, Guelph, ON
[2] University of Saskatchewan, Saskatoon, SK

Identifying the toxic organic components within bitumen-influenced groundwaters

*Bauer, Anthony E.[1], J.L. Parrott[2], R. Vanderveen[2], M. Rudy[2], J.W. Roy[2], G. Bickerton[2], D.G. Dixon[1], L.M. Hewitt[2] & R.A. Frank[2]
[1]Department of Biology, University of Waterloo, Waterloo, ON
[2]Aquatic Contaminants Research Division, Environment Canada, Burlington, ON

Bioaccessible nickel in various particle sizes of house dust from Sudbury, ON

*Dai, Nancy[1], Luba Vasiluk[1], Beverley Hale[1] & Mike Dutton[2]
[1]School of Environmental Sciences, University of Guelph, ON
[2]Vale Base Metals, Mississauga, ON

The influence of life history on tissue mercury concentration in fish from coastal rivers of the Hudson Bay Lowlands

*DeJong, Rachel[1], Tom Johnston[2, 3], Bill Keller[2], John Gunn[2] & Heidi Swanson[1]
[1]University of Waterloo, Waterloo, ON
[2]Living with Lakes Centre, Laurentian University, Sudbury, ON
[3]Ontario Ministry of Natural Resources and Forestry

Variation in the timing of sexual differentiation in Zebrafish (*Danio rerio*)

*Hammill, Kristine M., Shamaila Fraz & Joanna Y. Wilson
Department of Biology, McMaster University, Hamilton, ON

A whole lake ecosystem study into the fate and effects of diluted bitumen following cleanup: A new research program at the Experimental Lakes Area

Hanson, Mark[1], Bruce P. Hollebone[2], Jules M. Blais[3], Michael Paterson[4] & Vince Palace[4]
[1]University of Manitoba, Winnipeg, MB
[2]Environment and Climate Change Canada, Ottawa, ON
[3]University of Ottawa, Ottawa, ON
[4]International Institute for Sustainable Development - Experimental Lakes Area (IISD-ELA), Winnipeg, MB

*** Student presentation**

List of Poster Presentations (cont'd)

Occurrence of wastewater contaminants in Norway House Cree Nation, Manitoba

Jonathan Challis[1], Kim Luong[2], Chelsea Lobson[3], Charles Wong[2] & Hanson, Mark[3]
[1]Department of Chemistry, University of Manitoba, Winnipeg, MB
[2]Department of Chemistry, University of Winnipeg, Winnipeg, MB
[3]Department of Environment and Geography, University of Manitoba, MB

Effects of venlafaxine and climate change stressors on microRNA abundance in reproductive tissue of Zebrafish (*Danio rerio*)

*Ikert, Heather & Paul M. Craig
Department of Biology, University of Waterloo, Waterloo, ON

Characterizing dietary methylmercury (MeHg) exposure in subarctic First Nations communities in the Dehcho region of the Northwest Territories, Canada

*Laird, Matthew J.[1], Juan Aristizabal Henao[2], Ken Stark[2], George Low[3], Heidi Swanson[4] & Brian Laird[1]
[1]School of Public Health and Health Systems, University of Waterloo, ON
[2]Department of Kinesiology, University of Waterloo, Waterloo, ON
[3]Aboriginal Aquatic Resources & Oceans Management, Hay River, NT
[4]Department of Biology, University of Waterloo, Waterloo, ON

Multi-stressor impacts on fish energetics: From pharmaceutical contaminants to climate change

*Mehdi, Hossein, Heather Ikert, Shahithiya Santoskhumar & Paul Craig
Department of Biology, University of Waterloo, Waterloo, ON

Potential application of polydimethylsiloxane (PDMS) passive air sampler for measuring inhalation exposure of officers to flame retardants

Maria Lorenzo[1,2], *Nguyen, Linh V. [2], Suman Dhal[2], Joseph O. Okeme[3] & Miriam L. Diamond [2, 3]
[1]Food and Environmental Safety Research Group (SAMA-UV), Faculty of Pharmacy, University of Valencia, Spain
[2]Department of Earth Sciences, University of Toronto, Toronto, ON
[3]Department of Physical and Environmental Science, University of Toronto Scarborough, Toronto, ON

*** Student presentation**

List of Poster Presentations (cont'd)

Risk communication for environmental pollutants: The case of mercury in fish

*Packull-McCormick, Sara, Mylene Ratelle & Brian Laird
School of Public Health and Health Systems, Department of Applied Health Science, University of Waterloo, Waterloo, ON

Remediation of nickel toxicity by liming: Field validation

*Pellegrino, Amanda, Luba Vasiluk, Elizabeth Jones, Ryan Thorn, Sharareh Dehghani, Santiago Martinez, Amanda Laird & Beverly Hale
School of Environmental Science, University of Guelph, Guelph, ON

Water-only toxicity testing with *Chironomus dilutus*: Tips and tricks from the Ontario Ministry of the Environment and Climate Change (MOECC) Aquatic Toxicology Unit (ATU)

*Raby, Melanie[1], Kim Mahon[2], Lisa Kennedy[2], Maegan Rodrigues[3], Duncan McTaggart[1], Trudy Watson-Leung[2] & Dave Poirier[2]
[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
[3]Department of Chemistry, University of Waterloo, Waterloo, ON

Microcystin production under atrazine-induced oxidative stress in *Microcystis aeruginosa*

*Racine, Marianne, Ammar Saleem & Frances R. Pick
Center for Advanced Research in Environmental Genomics, University of Ottawa, Ottawa, ON

Assessing mercury risks for the optimization of nutrient benefits from wild-harvested fish consumption in the Northwest Territories, Canada

*Reyes, Ellen S.[1], Juan J. Aristizabal Henao[2], Katherine M. Kornobis[3], Rhona M. Hanning[1], Shannon E. Majowicz[1], Karsten Liber[4], Ken D. Stark[2], George Low[5], Heidi K. Swanson[3] & Brian D. Laird[1]
[1]School of Public Health and Health Systems, University of Waterloo, Waterloo, ON
[2]Department of Kinesiology, University of Waterloo, Waterloo, ON
[3]Department of Biology, University of Waterloo, Waterloo, ON
[4]Toxicology Centre, University of Saskatchewan, Saskatoon, SK
[5]Aboriginal Aquatic Resources and Ocean Management, Hay River, NWT

*** Student presentation**

List of Poster Presentations (cont'd)

Lanthanum toxicological effects on *Helianthus annuus L.* growth and chlorophyll content

*Rezaee, Arefeh[1], Yi Wai Chiang[1], Beverley Hale[2] & Rafael Santos[3]
[1]School of Engineering, University of Guelph, Guelph, ON
[2]School of Environmental Sciences, University of Guelph, Guelph, ON
[3]School of Applied Chemical and Environmental Sciences, Sheridan College, Brampton, ON

Investigation on the accumulation and the effects of lead on invertebrate nervous system function and behavior

Lauren Lubecki[1], Stacy Ruvio[2] & Stewart, David T.R.[1]
[1]Chemistry Department, D'Youville College, Buffalo, NY
[2]Deparment of Biology and Math, D'Youville College, Buffalo, NY

The third phase of Canada's Chemicals Management Plan

Sullivan, Katrina & Mark Bonnell
Ecological Assessment Division, Environment and Climate Change Canada, Gatineau, QC

Is plastic debris a source of flame retardants in Ring-billed Gulls?

*Thaysen, Clara[1], Miriam Diamond[1], Jonathan Verreault[2], Manon Sorais[2] & Chelsea Rochman[3]
[1]Department of Earth Sciences, University of Toronto, Toronto, ON
[2]Département des Sciences Biologiques, Université du Québec à Montréal, Montréal, QC
[3]Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, ON

Using XANES to identify the effect of ageing, speciation and mineral association of nickel on its bioaccessibility in soil

Thorn, Ryan J.[1], Beverley Hale[1] & Mike Dutton[2]
[1]School of Environmental Sciences, University of Guelph, Guelph, ON
[2]Vale Base Metals, Mississauga, ON

*** Student presentation**

Plenary Speakers

Main Hall

Research and science policy: Experiences gained from Canada's ecosystem and issue initiatives

Chambers, Patricia

Watershed Hydrology and Ecology Research Division, Water and Science Technology Directorate, Environment and Climate Change Canada, Canada Centre for Inland Waters, Burlington, ON

Canada's Environment Department conducts ecosystem and issue-driven initiatives to advance science-based policy to ensure environmental sustainability. Here I discuss science results from several science initiatives and how conclusions informed policy decisions. The Northern River Basins Study was an ecosystem initiative focused on effects of pulp mill expansion. Findings on: (a) dissolved oxygen depletions under ice and sensitivities of vulnerable life stages of fish resulted in new objectives for oxygen; (b) nutrient enrichment led to a cap on wastewater discharge; and (c) drying-out of a riverine delta led to changes in hydroelectric dam regulation. The National Agri-Environmental Standards Initiative was an issue-driven initiative to identify ecosystem thresholds protective of aquatic life in agriculturally-dominated watersheds. Thresholds identified for nitrogen, phosphorus and suspended sediments served to define environmental outcomes for watershed management programs, prioritize options for beneficial management practices, and set risk levels for a national report card. Experience has shown that delivering science to policy makers demands science programs be designed at the onset to address policy questions and requires a personal commitment to give fearless science advice.

Control and mitigation of HABs in Canadian waters: Multiple stressors and their challenges for lake managers - "It's more than just phosphorus"

Hutchinson, Neil, Tammy Karst-Riddoch, Kris Hadley & Dörte Köster

Hutchinson Environmental Sciences Ltd.
Bracebridge, ON

The occurrence of Harmful Algal Blooms (HABs) has been increasing in temperate regions around the world and threatens beneficial uses of water bodies including recreation, drinking water, and aquatic habitat. Lake managers are faced with the challenge of finding ways to effectively reduce and prevent their occurrence while considering social, economic, and environmental concerns.

Management of HABs requires an understanding of the multiple natural and anthropogenic stressors controlling them. In many cases nutrient enrichment from external or internal loading can favour algal production; however, more recent research has identified other micronutrients and climate-mediated physical changes in water bodies as drivers of HABs, which can vary for different algal species. The traditional approach to managing HABs by controlling external sources of phosphorus through point source and watershed management alone can therefore be ineffective in many cases, requiring innovative solutions that include active in-lake control techniques such as sediment inactivation, destratification, dredging, aeration or induction of turbulence.

While such "active management" techniques have proven safe and effective over decades of application in the USA and abroad, there is little experience in active management in Canada. Management actions are complicated by a lack of full scientific understanding of HAB causation, a lack of institutional experience in lake management, inaccurate risk perception and management, and social factors such as cost and absence of a framework for cooperative lake management.

This presentation will begin with a personal reflection on changes in pollutant sources, toxicity and management over the past 50 years into the modern era of cumulative effects at the planetary scale. It will highlight HABs as a response to cumulative stressors and the need to link scientific investigation with lake management through case studies in Ontario, New Brunswick, Quebec and Alberta, and recent research on causal factors and investigative tools.

Responses to estrogenic endocrine disruptors are variable in common model teleosts (A fish is not a fish is not a fish)

MacLatchy, Deborah L., Andrea L. Lister & Thiviya Kanagasabesan

Department of Biology and Institute of Water Science, Wilfrid Laurier University, Waterloo, ON

Different reproductive responses have been observed across common model teleosts to an environmental estrogen, 17α-ethinylestradiol (EE2), which suggest that species-specific responses exist. These observations point to the need to proceed with caution when extrapolating across fish species or in the use of a single species as a surrogate in screening reproductive effects. In the freshwater Zebrafish (*Danio rerio*) and Fathead Minnow (*Pimephales promelas*) exposure of adults to low levels of EE2 (less than 25ng/L) causes significant reductions in the numbers of eggs that are spawned. EE2 exposure for three weeks at 10-fold higher concentrations, however, does not inhibit spawning in an estuarine killifish, the Mummichog (*Fundulus heteroclitus*). Environmental salinity has been eliminated as a factor in uptake and effects of EE2 in Mummichog. EE2 accumulates differentially in Mummichog compared to other common model teleosts. Despite differences in spawning levels, EE2 has been shown to consistently induce vitellogenin in males and cause abnormalities in gonadal differentiation and sex reversal in embryos of all three species. Molecular endpoints including steroidogenic enzymes and luteinizing hormone receptor are negatively affected by EE2 exposure in Zebrafish and Fathead Minnow; in Mummichog, analyses are pending to establish whether responsiveness at the molecular level differs, including at different stages of ovarian development. Understanding gonadal physiology and control of steroidogenesis in Mummichog may be keys to determining why responses at the level of egg production vary. Overall, there is a growing body of research showing that the reproductive effects of EDSs in mature fish is species-dependent and may be linked to differences in basic biology of the species.

Platform Presentations

(in alphabetical order by family name of presenter)

Sequestration of mercury and PCBs in sediments via amendments

Béchard, Karen[1], Matt Vanderkooy[1], David Himmelheber[2], Jeff Roberts[3] & Thomas Krug[1]

[1]Geosyntec, Guelph, ON
[2]Geosyntec, Princeton, NJ, USA
[3]SiREM, Guelph, ON

E-mail: kbechard@geosyntec.com

Key Words: mercury, amendment, sediment, bioaccumulation

Chemicals such as polychlorinated biphenyls (PCBs), and mercury (Hg) are present as contaminants in sediment at numerous sites globally. Amendments are sometimes used in conjunction with Monitored Natural Recovery (MNR) to accelerate chemical sorption, sequestration, or biodegradation processes, and to reduce bioavailability and toxicity. To gain regulatory acceptance for this Enhanced MNR (EMNR) method, the site-specific physical, biological and chemical processes that reduce bioavailability or degrade contaminants must be well understood, demonstrated, and quantified in laboratory treatability tests and in field pilot tests.

Laboratory treatability testing was conducted to demonstrate the potential for a variety of in situ amendments to reduce concentrations of Hg, methylmercury (MeHg) and PCBs in water mixed with sediment from a contaminated sediment site in a tidal estuary with brackish water under simulated anaerobic conditions over eight weeks. The concentrations of PCBs, Hg and MeHg in the aqueous phase were measured and the concentrations in the treated microcosms were compared with the concentrations in the controls. Results of the testing demonstrated that significant reductions in the concentration of PCBs, Hg and MeHg in water in contact with the sediment could be obtained with the specific amendments evaluated in the test. A combination of powdered activated carbon and iron amendments was successful in reducing the concentrations of PCBs in the simulated porewater by over 99% relative to controls and reducing Hg and MeHg by 89% and 82% relative to controls, respectively. Further testing is underway to further assess the bioavailability of Hg in post remediated sediments versus control sediments.

From transcriptome to metabolome: Multigenerational biomarkers of BPA exposure during embryogenesis

Birceanu, Oana[1], Laura Dindia[1], Alam Mohammad[1,2], Owen Woody[1], Brendan McConkey[1], Neel Aluru[1] & Matt Vijayan[1,2]

[1]Department of Biology, University of Waterloo, Waterloo, ON,
[2]Department of Biological Science, University of Calgary, Calgary, AB

E-mail: obirceanu@gmail.com

Key Words: bisphenol A, maternal transfer, transcriptomics, metabolomics

Bisphenol A (BPA), an endocrine disruptor ubiquitously present in the environment, is maternally transferred to the eggs and affects offspring development in fish. Here, we investigated the impact of BPA accumulation in eggs on the embryo transcriptome and metabolome at hatch (42 days post-fertilization, dpf) in two generations of Rainbow Trout (*Oncorhynchus mykiss*). RNA sequencing (RNAseq) by next generation sequencing with the Illumina platform was used to construct and characterize the Rainbow Trout transcriptome. Bioinformatics analysis, including gene ontology enrichment, revealed 148 genes that were differentially expressed in the BPA groups. Of these, 16 genes were consistently downregulated in both generations and most were related to embryo and lens development, cellular response to stress and xenobiotic detoxification. Induced network module analysis mapped 14 of the 16 downregulated genes to 21 distinct proteins that were involved in development, metabolism, stress and cell-to-cell signaling, growth and xenobiotic detoxification. Analysis of the metabolome identified metabolites involved in energy production pathways and growth regulation as markers of BPA exposure. Overall, BPA accumulation in eggs impacts the embryo transcriptome and metabolome in multiple generations, leading to the proposal that maternal transfer of BPA affects developmental programming, and some of these effects may be heritable in trout.

Invertebrate community response to cumulative anthropogenic stress in the Laurentian Great Lakes

Bowman, Michelle F.[1], Lee C. Grapentine[2], Jan J.H. Ciborowski[3], Mei Cai[4], Lucinda B. Johnson[4], J. David Allan[5] & Sigrid D.P. Smith[5]

[1]Forensecology, Guelph, ON
[2]Environment & Climate Change Canada, Burlington, ON
[3]Department of Biological Sciences, University of Windsor, Windsor, ON
[4]Natural Resources Research Institute, University of Minnesota Duluth, MN
[5]School of Natural Resources & Environment, University of Michigan, Ann Arbor, MI

E-mail: michelle.f.bowman@gmail.com

Key Words: multiple stressors, Great Lakes, invertebrates

Relationships between benthic macroinvertebrate (BMI) community composition and cumulative anthropogenic stress were documented using monitoring data collected as part of the Great Lakes Action Plan and stressor gradients defined in the Great Lakes Environmental Assessment and Mapping Project (GLEAM). The objective of the Action Plan was to restore water quality and beneficial uses of the ecosystem by cleaning up Areas of Concern (AOCs) identified as being most degraded. GLEAM estimated the spatial distribution of cumulative stress from aquatic habitat alterations, climate change, coastal development, fisheries management, invasive species and non-point and toxic chemical pollution. As expected, we found that littoral, nearshore and pelagic BMI communities were distinct from one another and changed across gradients in anthropogenic stress. For example, nearshore communities in the Manitoulin-Lake Simcoe Ecoregion changed most distinctly along gradients of warming and phosphorus loading from tributaries. Identifying these biological responses to both individual and cumulative stresses will help guide effective resource management in the Laurentian Great Lakes.

Identification of serum biomarkers for bitumen exposure in Sockeye Salmon (*Oncorhynchus nerka*)

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Key Words: salmon, bitumen, proteomics, biomarker

Diluted bitumen (dilbit) extracted from Alberta oil sands is transported across North America in pipelines that cross important watersheds that are home to large populations of Pacific salmon. Spilling of dilbit into these watersheds is a critical threat as components of dilbit are known to hinder reproduction, impair development and reduce swimming performance of salmon. The purpose of this study was to assist in the development of biomonitoring tools by identifying serum biomarkers of dilbit exposure that also indicate compromised performance. Juvenile Sockeye were exposed to an environmentally relevant level of the water-soluble fraction of dilbit (WSFd) for one or four weeks, and half of the exposed fish also underwent an exhaustive swimming test. Serum proteome analysis was conducted using isobaric tags for relative and absolute quantitation (iTRAQ) paired with mass spectrometry. Three proteins were robust predictors of WSFd exposure, independent of exposure duration or exercise, namely complement component C7, hemopexin, and alpha-2-marcoglobulin. In non-exercised salmon, WSFd altered plasma levels of 17 proteins related to coagulation, immune, and stress responses. In WSFd-exposed and exercised salmon, 20 proteins were significantly altered including increased abundance of myosin, suggesting that WSFd exposure exacerbates exercise-induced muscle injury. This study has identified several potential serum biomarkers for WSFd exposure and suggests that dilbit exposure could impair the capacity of salmon to sustain or recover from intensive exercise.

Distinct changes to respiratory and metabolic physiology in two Great Lakes fish exposed to wastewater effluent

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Key Words: field exposure, bluegill sunfish, round goby, metabolism, mitochondria, haemoglobin

Pharmaceuticals and personal care products are contaminants of emerging concern in aquatic ecosystems, and relatively little is known about how these chemicals affect the bioenergetics and metabolic physiology of fish in the wild. We caged Bluegill Sunfish (*Lepomis macrochirus*) – a fish native to the Great Lakes – and invasive Round Goby (*Neogobius melanostomus*) for 3 weeks at varying distances downstream of a residential wastewater treatment plant (WWTP). Bluegill, but not Round Goby, incurred a metabolic cost of living near the WWTP, as reflected by increased resting rates of O_2 consumption. They accommodated this increased metabolic cost with increases in mitochondrial respiration capacity and decreases in haemoglobin-oxygen affinity (which should enhance tissue O_2 delivery). Mitochondrial ROS emission was also reduced by exposure to WWTP effluent, possibly to compensate for contaminant-induced oxidative stress. The lack of comparable changes in Round Goby suggests that tolerance of contaminants could contribute to the invasive success of this species in the Great Lakes.

Two-eyed seeing in contaminated site assessment and management

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Key Words: risk assessment, Indigenous Communities

The assessment and management of contaminated sites and identified areas of concern (AOC) across Canada is a fairly prescriptive process. For many impacted sites, where unacceptable concentrations of contaminants have been identified, a human health and ecological risk assessment (HHERA) is carried out to determine what, if any, adverse risks could potentially occur to both humans and the environment. Although the HHERA is designed to be site-specific, for contaminated sites located within traditional lands or in the vicinity of Indigenous communities, the incorporation of Indigenous knowledge and land use is often lacking in the risk assessment process. This represents a significant data gap in the site assessment and risk assessment process, which could result in the use of unrealistic exposure assumptions in the calculation of health risks. Inaccurate study conclusions, and potentially flawed risk management decisions, are the likely outcome of this data gap. Using case studies, the importance of Indigenous community involvement in the assessment, remediation and management of contaminated sites will be illustrated. Practical means by which Indigenous knowledge relevant to the environmental and health risk assessment process can be gathered through Indigenous community engagement will be discussed.

An assessment of the spatial and temporal variability of biological endpoint responses of Rainbow Darter (*Etheostoma caeruleum*) collected along an urban gradient

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Key Words: municipal wastewater effluent, endocrine disruption, field study, meta-data

It is well established that exposure of aquatic organisms to endocrine-disrupting chemicals (EDCs) contained in municipal wastewater effluent (MWWE) can have deleterious effects on the health of fish populations. While this has been well demonstrated in the laboratory, it remains difficult to associate EDCs in MWWE with impacts on the health of wild fish populations. Our ability to detect change in exposed ecosystems is currently limited by our poor understanding of how responses to EDCs vary across levels of biological organization. The purpose of this study was to evaluate biological indicators of EDC exposure by observing their annual variability in a wild population of fish exposed to MWWE. The system used to conduct this study was the central reach of the Grand River in Kitchener, Ontario, where two municipal wastewater treatment plants are located. Rainbow Darters (*Etheostoma caeruleum*) were collected from sites across an urban gradient in the spring and fall between 2007 and 2012. Analysis of selected pharmaceuticals, liver gene expression, gonadal sex steroid production, gonad histology, and somatic indices were compared across years and seasons. We found that in this system the consistency of biological responses varies according to the level of biological organization. Exposure and biological measures at the lower levels of organization (e.g. gene expression) are highly variable while measures that were at the middle of the biological scale (e.g. gonad histology) were the most consistent between seasons and years. Although endpoints representing higher levels of biological organization (e.g. somatic indices) are desirable because of their relevance, they are influenced by natural variability and more difficult to link to specific stressors. The findings of this study have important implications for future research efforts on environmental impacts of contaminants, as well as for the design and interpretation of biological monitoring programs globally.

The consumption of aquatic insects by bats may alter the dating and stable isotope profiles in a 4,000-year-old bat guano core from Jamaica

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Bats are excellent ecological indicators owing to their long life spans, global distribution, and predictable responses to environmental stressors as seen in the bioaccumulation of pollutants from dietary intake. Bat guano deposits can be used as environmental archives as stable isotopes and metals are well preserved within the cave environment allowing for the reconstruction of dietary changes and contaminant exposure, respectively. Three radioisotopes commonly used to date lake sediments (^{14}C, ^{210}Pb, and ^{137}Cs) were applied to the bat guano deposit. A gap in the dating profile may, in part, be the result of a reservoir effect owing to the consumption of aquatic insects by bats. Furthermore, this study is the first to examine long-term dietary trends in bat guano using three stable isotopes. The $\delta^{13}C$ profile tracks changes in the photosynthetic pathway-type of the consumed vegetation, while the $\delta^{15}N$ and $\delta^{34}S$ profiles track changes in fertilizer and fungicide use, respectively. I will also present trends in long-term contaminant exposure within this bat guano deposit in relation to the timing of different anthropogenic activities. Periods of increased atmospheric emissions of metals result in an increase in metal concentrations within this bat guano deposit. For example, the Industrial Revolution and the introduction of leaded gasoline increased atmospheric concentrations of lead, which peak at the corresponding times within this guano deposit.

Assessment of DNA damage in freshwater mussels from the Hamilton Harbour watershed

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In the last century, several regions of the Great Lakes have suffered from considerable habitat degradation due to the influence of intensive industrial, agricultural and urban development. Cootes Paradise is a shallow wetland located west and upstream of Hamilton Harbour, and is part of the Hamilton Harbour Area of Concern. Cootes Paradise receives the effluent of a secondary wastewater treatment plant (WWTP), and is also downstream of agricultural landscapes. Hence the water quality of this wetland is affected by elevated concentrations of pesticides, pharmaceuticals, and high nutrient loadings, among other stressors.

A variety of chemicals can induce damage to the DNA of animals, which, if not repaired, can lead to a cascade of biological effects at any level of biological organization, from cellular to community and population level. First developed in the 1980s, the single cell gel electrophoresis assay – or Comet assay - is used to visualize and quantify cellular DNA damage. In recent years, a number of studies have used this approach to evaluate DNA damage from exposure to specific chemicals (e.g., PAHs), as well as from complex mixtures of contaminants, such as industrial or municipal effluents.

The objective of the present study was to validate the Comet assay in wild freshwater mussels and to quantify the DNA damage in mussels from the Hamilton Harbour watershed in comparison with that in mussels from reference sites in southern Ontario. Giant Floater Mussels (*Pyganodon grandis*) (91 ± 18 mm, $n = 68$) were collected from three sites: Cootes Paradise; a small stream directly under highway 401 near Campbellville; and in a small agricultural stream in Embro, Ontario. Although freshwater mussels were successfully collected in Cootes Paradise, the catch per unit effort at that site was considerably lower than that in Campbellville and Embro. The mussels were brought to the laboratory and held overnight, a small quantity of hemolymph (blood) was collected the next morning, and the mussels were returned to their habitat of origin within 24 hours. The density and viability of haemocytes (blood cells) were quantified by flow cytometry, and the presence and relative quantity of DNA strand breaks were quantified using the Comet assay.

Cell density was significantly elevated in Giant Floater Mussels collected in Campbellville and Cootes Paradise, compared to those collected in Embro. The haemocytes of mussels from Cootes Paradise had significantly greater DNA damage than those from Campbellville and Embro, suggesting exposure to genotoxic compounds. As it has been linked to reduced growth, abnormal development and reduced survival, DNA damage, if not repaired, could have repercussions at the individual and community level. Validation of the Comet assay in other aquatic species, and follow-up studies in Hamilton Harbour AOC are under consideration.

Internal versus external dose for describing ternary metal mixture (Ni, Cu, Cd) chronic toxicity to *Lemna minor*

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Key Words: bioaccumulation, metal speciation, biotic ligand, concentration addition

Resolving the inability to predict risk from metal mixtures in waters surrounding Canada's many current and legacy extractive mining sites is a high priority for Environment Canada, Health Canada, as well as base metal mining companies. Mixtures of forms of the same metal and mixtures of different metals may have toxicity that would not be predicted additively. Bioavailability is now accepted as a crucial consideration in toxicity studies, and models that account for the modifying effect of water chemistry factors on the interaction of the metal with the biological receptor (called the biotic ligand or BL) to predict toxicity to biota are gaining popularity. Our study aimed to validate the 'concentration addition' (CA) approach to predicting the toxicity of a ternary metal mixture (Ni, Cu, Cd) to *Lemna minor* (one of Environment Canada's recommended test plant species for bio-monitoring of mining effluents). Simultaneous determination of total metal concentration and free metal ion activity in solution (external dose) and metal accumulation in plants (internal dose) was done to assess the best representative of 'bioavailable dose' for use with the CA approach. In addition, a mechanistic investigation using accumulation kinetics and response surface regression of internal dose versus root growth inhibition was conducted. The results of this study indicate that Cu and Cd share binding sites in plant, while Ni does not. A synergistic interaction between Cu and Cd was suggested by the increase in binding affinity (Kd) from single metal to mixture exposure for the two metals, while Ni affinity decreased. This study also demonstrates that concentration addition is an appropriate model for estimating mixture toxicity when the dose metric approximates the amount of metal delivered to the plant (internal dose), suggesting that risk assessments for metals in water should utilize internal tissue metal concentration as an indicator of dose.

Endocrine disruption in wild fish is reduced after municipal wastewater treatment plant upgrades

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Key Words: municipal wastewater, intersex, Rainbow Darter

Impacts on fish exposed to effluent from municipal wastewater treatment plants (WWTP) are a concern globally, with endocrine disruption being one of the most prominent effects observed. The objective of this study was to assess whether major treatment upgrades at a WWTP would reduce endocrine disruption previously observed in wild fish. The WWTP located in Kitchener, Ontario, is a conventional activated sludge plant that discharges effluent into a heavily urbanized reach of the Grand River. Multiple years of data have been collected since 2007 for a sentinel fish species, the Rainbow Darter (*Etheostoma caeruleum*) associated with the Kitchener WWTP outfall. Intersex in male fish has been the most consistent effect observed, and this has been linked to reduced reproductive success. In 2012, major upgrades took place to convert the WWTP from non-nitrifying to a fully nitrifying activated-sludge plant. Effluent quality improved with declines in contaminants such as nutrients and select pharmaceuticals, also reflected in the river water down-stream of the WWTP. The effluent estrogenicity was measured as high as 17 ng/L total 17β-estradiol equivalents prior to treatment changes, but has decreased with implementation of the upgrades. Intersex was assessed in male Rainbow Darter downstream of the Kitchener WWTP in three consecutive years post-upgrade. There was a reduction in intersex incidence by as much as 85%, suggesting that the Rainbow Darter is responding to process upgrades. This is one of the first studies to document the recovery of a wild fish population after improved effluent quality from a municipal WWTP.

Variability in multiple stressors and their impacts on water quality and periphyton communities along agriculture-urban land-use gradients

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Key Words: water quality, periphyton, land-use, agriculture, urbanization

Lotic systems that traverse landscapes impacted by agriculture and urbanization are unique in that their longitudinal flow enables cumulative impacts along their continuum. Thus water quality experienced at a downstream urban site may include the footprint of water quality impacts from upstream agricultural activities. What remains less-known is how upstream water quality footprints are modified as they move downstream, and if their cumulative effects combined with urban impacts are additive or synergistic along the unidirectional continuum. To assess the cumulative impacts of multiple environmental stressors from agricultural (e.g. pesticides, turbidity) and urban (e.g. chloride, metals, turbidity) land-use on periphyton communities, we studied four Lake Ontario tributaries that experience agriculture-urban land-use gradients. Rather than finding cumulative increases in stressors, there was notable variability in stressor concentration along each creek's continuum, from agricultural to urban land-use. One factor that typically gets over-looked is groundwater recharge in lotic systems. We suspect groundwater recharge at various points along our study creeks' flow-path may explain, in part, the high variability measured. Not surprisingly, periphyton community response was also variable along each creek's continuum. However, linear regression and multivariate analyses revealed notable relationships between periphyton biomass and specific stressors such as chloride and turbidity. Additionally, community diversity and composition did shift to reflect the most impacted sites (e.g. high chloride and turbidity). Overall, our study shows the importance of spatial and temporal influence on the magnitude and variability of environmental stressors, regardless of location and land-use type along a creek's continuum.

Unique approaches to evaluating risks associated with scattered contamination at large sites

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Key Words: risk assessment, reclamation, Yukon, spatial weighting

Risk assessments often tend to over-predict potential exposures and risks to humans and wildlife since sampling efforts are generally geared to areas of known contamination ("hot-spots"). These areas tend to be localized as they are associated with a spill or a given activity and there are large parts of the site with little to no contamination. This sampling approach causes a dilemma to the risk assessor as carrying out a risk assessment involves the selection of ecological receptors with home ranges that tend to be larger than the contaminated areas and humans who tend to move around the site and are not expected to spend large amounts of time in the contaminated area.

A unique approach to the development of exposure point concentrations for these situations will be discussed using a large mining site in the Yukon as an example. This site has numerous adits, tailings, and waste rock piles across a 15,000 hectare area and involves several different watersheds. A watershed approach was used, taking into account the unique contamination profiles, expected reclamation activities, and anticipated future land uses at different exposure locations within each watershed or catchment area. In addition, a spatial averaging approach was used to develop the soil and terrestrial vegetation exposure point concentrations. The assessment was carried out for residual contamination associated with post-reclamation conditions which involved the removal or covering of tailings and waste rock piles.

Estimating background metal concentration ranges for Canadian surface waters

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Key Words: metal concentrations, reference condition, water quality, background data

Background concentration ranges of naturally occurring substances, such as metals in the aquatic environment, can be used to support the identification of elevated concentrations associated with anthropogenic activity, and to aid in predictive modelling. The Ecological Assessment Division of Environment and Climate Change Canada is interested in an approach to quantify background concentration ranges of metals to inform ecological risk assessments in the next phase of the Chemicals Management Plan initiative. Data from over 40,500 water samples from about 1,230 stations were combined from various federal and joint federal-provincial/territorial monitoring programs (e.g. Freshwater Quality Monitoring and Surveillance Program, Ontario's Provincial Water Quality Monitoring Network). Data included concentrations of metals, major ion concentrations and ancillary data (e.g. hardness, pH, temperature). The underlying natural relationship between conductivity and alkalinity was used to identify sites that are in a "reference" or least-disturbed condition. Water samples whose measured conductivity value deviated from the predicted conductivity value by more than 50 µs/cm were deemed to not be in reference condition. This approach to identifying reference condition was then compared to the percent disturbance of adjacent land uses in each station's catchment. Water samples from sites identified to be in reference condition will be used to calculate normal ranges for 15 metals of interest: aluminum (Al), barium (Ba), beryllium (Be), bismuth (Bi), copper (Cu), lithium (Li), manganese (Mn), molybdenum (Mo), selenium (Se), silver (Ag), tellurium (Te), titanium (Ti), thallium (Tl), zinc (Zn) and cyanide (HCN).

Passive sampling for measuring the availability of hydrophobic organic chemicals – The end-user perspective

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Key Words: passive sampling, bioavailability

Passive sampling approaches are now recognized as one of the best tools to quantify the availability of organic compounds in sediment, surface water and soil. They provide data to estimate contaminant bioavailability and toxicity to environmental receptors that is more representative than conventional grab samples, as it quantifies contaminants only in the dissolved form. Despite dozens of publications detailing the development and application of passive sampling approaches over the last 15 years, recent enthusiastic regulatory support (e.g., USEPA's 2012 passive sampling guidance), and a 6-paper series detailing a successful 2012 SETAC Pellston workshop on passive sampling, the majority of the end-user community (i.e., industrial and government organizations with environmental responsibilities and consultants) continues to move slowly in applying this powerful technology.

This presentation will highlight the current real and perceived barriers to widespread application of passive sampling from an end-user's point of view, as well as practical lessons learned from applying passive sampling techniques in the field. The use of passive samplers in laboratory treatability studies will be discussed and a case study presented where passive samplers were used to characterize PCB concentrations in sediment pore water amended with different amounts of activated carbon to determine the optimal dose of carbon for field application. We will discuss where the field of passive sampling needs to head in the next few years to maximize the adoption of passive sampling approaches. Despite the current challenges and research action items, it is clear that currently-available passive sampling approaches are ready for widespread application and can provide high-quality data to aid environmental decision makers.

Use of an *in vivo* rat model to evaluate relationships between bioaccessibility and bioavailability of nickel in laterite soils

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Key Words: bioavailability, bioaccessibility, nickel, laterite soils

Nickel (Ni) is one of the leading soil contaminants found at former mining and smelting sites across Canada. Unfortunately, current deterministic generic soil quality guidelines often overestimate actual risk of toxicity via contaminated soil ingestion. Agencies are now turning toward probabilistic risk assessments by analyzing two key factors of soil Ni toxicity: bioaccessibility and bioavailability.

This study tested three hypotheses to relate findings of Ni bioaccessibility using the Solubility/Bioavailability Research Consortium (SBRC) method and Ni bioavailability using an *in vivo* rat model in a grouping of different naturally Ni-elevated soils ("laterite soils"). Findings of this study indicated that with increasing Ni-compound solubility, there was increased absorbance in the small intestine of animals and thus an increase in the bioavailability of the Ni from soil. Second, Ni bioavailability could be adequately determined from urine content; however, bioavailability was not linearly correlated with bioaccessibility measurements. Lastly, while bioaccessibility was found to generally overestimate bioavailability, this relationship was not consistent amongst the soils tested.

Overall, findings demonstrate that the relationship between bioaccessibility and bioavailability of Ni in these soils is not straightforward. It is concluded that there are additional factors that may complicate this relationship, including Ni speciation and soil mineralogy. However, research into bioaccessibility and bioavailability relationships continues to move toward probabilistic risk assessment.

Finding love in the mud: Assessing sediment contamination using reproductive endpoints

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Key Words: sediment toxicology, Areas of Concern, chronic testing

Contaminated sediment has been identified as one of the major impediments to the remediation of many Areas of Concern (AOCs) in the Great Lakes. The AOCs within the Lake Ontario watershed investigated as part of this project are the metro Toronto Harbour region and Hamilton Harbour. These sites each present a unique set of beneficial use impairments in relation to sources and type of sediment contamination, and each has a unique Remedial Action Plan geared toward beneficial use improvement. In this study, the *Hyalella azteca* 42-day and the *Chironomus dilutus* life-cycle tests (USEPA, 2000) were utilized to determine sublethal (growth, reproduction) effects of sediment exposure. These tests were performed as part of a greater weight-of-evidence assessment of current sediment contamination for these AOCs. Previously conducted short-term exposures with these sediments failed to identify high levels of contamination, but did not provide necessary resolution for identifying moderately contaminated sediments. A comprehensive assessment of the current state of impairment for these sites and comparisons with historical data sets will determine if current remedial actions have had a positive impact toward the goal of delisting each AOC.

Risks and benefits of consuming fish from Lake Ontario

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Key Words: omega-3 fatty acids, persistent organic pollutants, docosahexaenoic acid, eicosapentaenoic acid

Risks associated with consuming fish are widely recognized and have prompted international, national as well as regional consumption advisories for different fish species. However, fish consumption has significant health benefits for humans, mainly related to high content of omega-3 fatty acids, which have been linked with a lower risk of cardiovascular disease (CVD). Decreasing fish consumption may compromise the adequate intake of omega-3 fatty acids and increase the prevalence of CVD in humans. Here we present preliminary results of a risk-benefit analysis of fish consumption for Lake Ontario fish. For the risk-benefit analysis we used data on contaminants (mainly persistent organic pollutants) and omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), from 13 fish species.

The risk of fish consumption is expressed as the maximum number of fish meals that can be safely consumed per month based on contaminant concentrations. Two simulated consumption advisories were assigned for each species, reflecting recommended consumption for the general population and the sensitive population (i.e. women of child-bearing age and children under the age of 15). Various health organizations have issued guidelines and recommendations for adequate intake of EPA and DHA. These guidelines were used to evaluate benefits of fish consumption. The amount of EPA+DHA per fish meal was multiplied by the calculated maximum consumption advisory (i.e. the number of fish meals that can be “safely” consumed per month) based on the contaminant threshold, resulting in the EPA+DHA (mg) intake per month. The calculated maximum intake of EPA+DHA from different fish species varies due to species-specific differences in the EPA+DHA content, as well as due to the consumption advisories issued because of contaminant levels in fish.

Anthropogenic mercury deposition in Flin Flon, Manitoba and the Experimental Lakes Area, Ontario (Canada): A multi-lake sediment core reconstruction

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Key Words: mercury inventory, Flin Flon, Experimental Lakes Area, multi-core paleolimnology

High-resolution records of anthropogenic mercury (Hg) deposition were constructed from nine lakes located 5-75 km from the Flin Flon, Manitoba smelter (formerly one of North America's largest atmospheric Hg point sources) and from five lakes in the Experimental Lakes Area (ELA), Ontario (a region remote from major Hg point sources). Anthropogenic Hg deposition, as both a flux and inventory, was determined after accounting for lake-specific natural Hg background concentrations, changes in sedimentation and sediment focusing. Results show that records of anthropogenic flux and inventory of Hg were remarkably consistent among the ELA lakes, but varied by 2 orders of magnitude among Flin Flon lakes. The relationship between Hg inventories (normalized for prevailing wind direction) and distance from the smelter was used to estimate the total Hg fallout within a 50 km radius in five year time-steps, thus providing a spatial-temporal Hg depositional history for the Flin Flon region. The propensity for Hg to undergo long-range, even global transport explains why Hg deposition within 50 km of the Flin Flon smelter was less than estimated releases. However, when smelter releases were reduced more than 10-fold (after 2000), observed deposition exceeded smelter releases, suggesting that landscape re-emission/remobilization of legacy Hg is a major ongoing regional source of Hg. Total landscape deposition of smelter-sourced Hg is estimated to be 64±16 tonnes (~11% of facility emissions) within a 50 km radius.

Evaluating the ability of *Alyssum murale* to extract aged nickel from nickel-contaminated organic soils

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Key Words: hyperaccumulator, sequential cropping, STELLA Professional software, systems modeling

Port Colborne, Ontario, has an area of nearly 30 km^2 that has been contaminated by emissions from a nickel (Ni) refinery that was in operation between 1918 and 1984. Elevated Ni concentrations in the surrounding soil are causing phytotoxicity and are suspected of reducing crop yield in some agronomic species. Common remediation techniques (such as 'dig and dump') are not feasible or economically efficient because of the large area that has been contaminated. Phytoremediation would be a sustainable alternative if its efficacy could be demonstrated on spatial and temporal scales.

Nickel-hyperaccumulating species are able to accumulate at least 1000 mg kg^{-1} of Ni in their dry biomass without succumbing to toxicity. *Alyssum murale*, a hyperaccumulator of Ni that is native to Ni-rich serpentine soils from Mediterranean Europe, is a species of interest for phytoremediation techniques. Tissue concentrations of Ni in shoots of *A. murale* have been determined using field-contaminated soils in pot and field studies; however the spatial and temporal capacity of this species as a perennial crop to measurably reduce the concentration of Ni in soils has not been demonstrated. The uptake of aged Ni by wild-type *A. murale* from Ni-contaminated organic soils will be compared to extractable soil Ni as it is influenced by varying chemical and physical properties of soil, and sequential cropping. From this study, we will establish a hypothetical timeline for reduction in soil Ni concentration, for consideration in a site remediation plan.

Poster Presentations

(in alphabetical order by family name of presenter)

Metal mixtures in soil: Testing the concentration addition approach as a risk assessment tool

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Key Words: concentration addition, metal mixtures, toxic units

The risk assessment of metal mixtures in soils is critical to Canada's mining industry and regulatory system. The assessment of mixtures relative to impacts of mining and associated activities is of high priority for Environment Canada and Canadian base metal mining sites. 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 toxicity of a ternary metal mixture (As, Co, Zn). Toxic units (TUs) are widely used in the comparison of single compounds when assessing mixture toxicity. This study will use current regulatory Soil Quality Guidelines (SQGs) as TUs to predict toxicity of metal mixtures to test the CA model. Metal mixture impacts 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 using field contaminated, reference, and artificial soils. Soils from Deloro, ON, contaminated from anthropogenic sources of metals in mixtures, will be used in the toxicity testing. The outcome of this research will serve as a predictive risk assessment tool for mixtures and their interaction in soils at base metal mining sites in Canada.

Identifying the toxic organic components within bitumen-influenced groundwaters

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Key Words: oil sands, fractionation, fathead minnow, Japanese medaka

Surface mining operations in the region surrounding Ft. McMurray, AB are employed where bitumen deposits are relatively shallow. The by-products of surface mining are stored in large tailings ponds, and have been accumulating for decades with increases in oil sands extraction. Investigations have identified the presence of oil sands process-affected water (OSPW) in nearby groundwater due to tailings seepage. However, these same groundwater systems often flow through bitumen deposits, potentially mobilizing water-soluble bitumen components leading to natural bitumen inputs to the Athabasca River watershed. Current research is focussed on chemically profiling natural and anthropogenic bitumen-derived compound influences to groundwaters, and also on toxicity investigations designed to prioritize compound classes of interest for monitoring initiatives. The present study assessed the toxicity of isolated groundwater soluble organic fractions through exposure to two freshwater fish; Fathead Minnow (*Pimephales promelas*) and Japanese Medaka (*Oryzias latipes*). Four samples representing natural bitumen only (two samples) and anthropogenic plus natural bitumen (two samples) sources (>100 L each) were fractionated using a preparative solid phase extraction methodology. This protocol produced three fractions of the soluble organics separated using a range in polarity. Both fish bioassays displayed distinct toxicological differences between fractions within sites and between sites. Generally, the fish bioassay results were very similar but distinct from invertebrate bioassays conducted in parallel. Coupled with high resolution chemical characterization data, this study will aid in guiding future comprehensive fractionation studies intent on better elucidating the bioactive components within bitumen-influenced waters. The present study is important for the development of water quality criteria in future water monitoring programs in the Athabasca region.

Bioaccessible nickel in various particle sizes of house dust from Sudbury, ON

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Key Words: human health risk assessment, metals, indoor pollutants

Indoor dust particles that settle on surfaces adhere upon contact to the hands and are ingested through hand-to-mouth behaviours. Ingestion of elevated levels of nickel from dust may be a significant source of exposure. Nickel accumulation in mammalian organs can lead to chronic inflammation, increasing the risk for cancer, especially from soluble nickel compounds. Bioaccessible nickel, the amount of nickel that becomes available for intestinal absorption as a result of digestion in the stomach, is likely a more accurate exposure measure than total nickel concentration present in house dust.

For bioaccessible nickel, the role of particle size depends on the site of origin and the distribution of organic and inorganic nickel phases with their varying rates of dissolution and adsorption to dust. We are examining the relationship between particle size and nickel bioaccessibility in Sudbury house dusts. Samples were separated using plastic sieves into ranges of <10 µm, 10-41 µm, 41-70 µm, 70-105 µm, 105-250 µm. Bioaccessibility was determined using SBRC glycine digestion, which simulates stomach pH and churning via shaking the dust with extraction fluid in a water bath at body temperature. Nickel concentration was determined using GFAAS, and multiple linear regression was performed on the data. Dust particle size and total nickel concentration together explain 88% of the variance in bioaccessible nickel concentration, adjusted R^2 = .88, $F(2,37) = 144.90$, $p < 0.001$. Dust particle size was strongly correlated with bioaccessible nickel concentration, r = -.66, and moderately correlated with total nickel concentration, r = -.43. Study results will inform risk assessors on the contribution of indoor dust to total nickel exposure through ingestion, for populations close to nickel mining and smelting activities.

The influence of life history on tissue mercury concentration in fish from coastal rivers of the Hudson Bay Lowlands

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Key Words: mercury, fisheries, life history

Mercury (Hg) is a bioaccumulative neurotoxin that humans are largely exposed to through fish consumption. Many factors influence fish Hg concentration, including water temperature and chemistry, fish trophic position, food source, and growth rate. Previous research in the North has shown that faster-growing anadromous (i.e., sea-run) life history types of fish have lower mercury concentrations than their slower-growing freshwater resident counterparts. The Hudson Bay Lowlands is home to many Aboriginal communities that rely on subsistence fisheries. Proposed developments in the region and a changing climate could impact Hg dynamics and fish movement; it is therefore important to determine which life history types of subsistence fish species are present, and how life history affects fish Hg concentrations. Fish were collected from tidewater-influenced and fully freshwater regions of the Severn, Winisk, and Attawapiskat Rivers. Using otolith microchemistry, Hg, and stable isotope analyses, we aim to: 1) determine the extent of anadromy in three subsistence food fishes (Lake Whitefish (*Coregonus clupeaformis*), Cisco (*Coregonus arterdi*) and Northern Pike (*Esox lucius*)); 2) determine the relative importance of freshwater and marine-derived prey in anadromous fish; 3) compare fish Hg concentrations among species and life history types. Study results will be used to inform guidance provided to communities regarding safety and security of subsistence fisheries in northern coastal communities.

Variation in the timing of sexual differentiation in Zebrafish (*Danio rerio*)

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Key Words: sexual differentiation, Zebrafish, pharmaceuticals, endocrine disruption

The timing of sexual differentiation has been shown to vary across Zebrafish (*Danio rerio*) experiments, demonstrating a need for individual facilities to determine their own sexual differentiation timing to better investigate this as a parameter of endocrine disruption. Twenty fish were sampled at each of six different time points (15-75 days post fertilization, dpf) and prepared for histological analysis. Serial sections were cut, stained with hematoxylin and eosin and reviewed under light microscopy. At 15 dpf, all fish had indifferent gonads with germ cells. By 25 dpf, juvenile ovaries were first observed as well as the first signs of a juvenile ovary to testis transition. By 35 dpf, all gonads could be defined as a juvenile ovary, maturing ovary, transitioning ovary or immature testis. The first mature testes, defined by the presence of spermatozoa, were observed by 45 dpf and by 75 dpf all testes had matured. Cortical alveolar growth was first observed at 35 dpf and by 75 dpf 86% of ovaries had entered cortical alveolar growth. No vitellogenic oocytes were observed at any time point. Although the initial stages of the juvenile/transitioning ovary are similar to the timeline presented in the seminal paper by Maack and Segner (2003), maturation occurred faster with an earlier frequency of spermatozoa and onset of cortical alveolar growth (not detected). In a secondary part to this study, the impact of parental exposure to carbamazepine or gemfibrozil on the sexual differentiation of the F_1 generation will be explored. Samples were collected at 45 and 60 dpf, time points which should allow for identification of differences in testicular and ovarian development and determination of sex ratio, respectively.

A whole lake ecosystem study into the fate and effects of diluted bitumen following cleanup: A new research program at the Experimental Lakes Area

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Key Words: dilbit, adverse outcome pathway, remediation

The National Academies of Science (US), the Royal Society of Canada, and others have highlighted significant knowledge gaps regarding the fate and behaviour of oil in freshwater environments following spill events. They specifically identified the need for ecosystem-level studies to examine the efficacy of first response strategies, cleanup procedures, and the effects of residual oil on the ecosystem following completion of spill recovery efforts. A multi-year research program addressing these knowledge gaps is currently being developed at the Experimental Lakes Area (IISD-ELA) field station in northwestern Ontario, Canada, including model scenarios for examining responses related to a dilbit (diluted bitumen) release. The authors are soliciting input from the research community regarding, but not limited to, the most significant knowledge gaps to address, experimental design options, and effects endpoint identification as they relate to oil entering boreal ecosystems, aquatic and terrestrial. Please feel free to stop by and share your thoughts and ideas.

Occurrence of wastewater contaminants in Norway House Cree Nation, Manitoba

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Key Words: passive sampling, micropollutants

Water was sampled at four sites throughout the lagoon and treatment facility, downstream of the discharge into Little Playgreen Lake, and at an upstream control site at the community's drinking water source. Samples were taken in the summers of 2014 and 2015 and in the winter of 2016. Nutrients (nitrogen and phosphorus) and basic water quality parameters (e.g., pH, temperature, conductivity and dissolved oxygen) were measured at all sites. While nutrients were effectively removed by the wastewater treatment plant, no improvement in water quality or reduction in nutrients was observed within the primary, secondary, and tertiary lagoons. Pharmaceuticals and pesticides were measured by passive sampling using established Polar Organic Chemical Integrative Samplers (POCIS) and newly developed organic-Diffusive Gradients in Thin films (o-DGT) samplers. This work summarizes the field evaluation of o-DGT and reports on a novel application of these samplers under ice at near-zero temperatures. Eight of 42 target compounds were detected at the four treatment sites, with carbamazepine, sulfamethoxazole, sulfapyridine and trimethoprim the most abundant across years and seasons. Pharmaceutical concentrations at upstream and downstream sites were below detection limits, indicating no exposure via drinking and recreational waters. Reduction of most compounds from lagoon to final effluent was limited.

Effects of venlafaxine and climate change stressors on microRNA abundance in reproductive tissue of Zebrafish (*Danio rerio*)

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Key Words: multiple stressors, microRNA, Zebrafish

As the human population increases, increased anthropogenic stress is placed on the environment. Venlafaxine is an antidepressant found downstream of wastewater treatment plants, at 1 µg/L. Also, increased water temperature has been observed as a product of climate change. These effects are being studied in a multi-stressor approach to elucidate the combinatory effects of chronic stressors. Specifically, the effects of venlafaxine and increased temperature on microRNA levels in reproductive tissue of Zebrafish were studied to examine heritable effects. Also, the ability of the altered microRNA levels to return to normal when Zebrafish were no longer exposed to stressors was studied. Zebrafish were exposed to control (27°C), temperature (32°C), venlafaxine (1 µg/L, 27°C), and temperature & venlafaxine (1 µg/L, 32°C) treatments for 21 days. Half of the fish were returned to control conditions for a 21 day recovery period. Gonadal tissue was removed, microRNA was extracted and RT-qPCR was performed on 5 specific miRNA to determine their relative abundances. Total miRNA levels were also measured. A statistically significant decrease in the relative abundance of miR-22b and miR-301a was observed in response to the stressors, a response observed in many cancers. These differences were no longer observed after the recovery period, which indicates that the miRNA levels are able to return to normal. A larger amount of total miRNA was observed in females, indicating the possibility of a stronger heritable effect from females to offspring. This specific and reversible altered miRNA profile can be used as a tool for diagnosis and prognosis for the future of an exposed population.

Characterizing dietary methylmercury (MeHg) exposure in subarctic First Nations communities in the Dehcho region of the Northwest Territories, Canada

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Key words: risk-benefit analysis, methylmercury, First Nations, long-chain fatty acids

Fish are an important dietary source of fatty acids and other essential nutrients for many populations, and serve as fundamental components of traditional food systems in subarctic Indigenous communities. However, methylmercury (MeHg) is a common contaminant often found in traditional foods including fish, and can pose health risks. Currently in the third year of a long-term project, this study measured total mercury (HgT) and fatty acid (FA) content, and calculated nutrient to Hg ratios for fish tissue collected across two lakes in the Northwest Territories.

Samples from seven fish species were harvested from Kakisa Lake and Mustard Lake in August 2015. HgT in fish tissue was measured using a Direct Mercury Analyzer, and FAs were measured by lipid extraction on pulverized fish tissue and subsequent analysis through a gas chromatograph. FA:Hg ratios were calculated by dividing mean EPA+DHA concentration by mean Hg concentration for each species. Higher FA:Hg ratios, corresponding to relatively greater nutrients and lower Hg concentrations, were found in fish tissue of species at lower trophic levels. Average Hg concentration in Northern Pike was greater ([Hg] = 0.29 mg/kg) in samples harvested from Kakisa Lake than from those sampled in Mustard Lake ([Hg] = 0.156 mg/kg)

HgT and FA concentrations appeared to vary significantly between species. HgT appeared higher in fish found at higher trophic levels, including Lake Trout, Northern Pike, and Walleye. Species at lower trophic levels (including Lake Whitefish, Cisco, and Longnose Sucker) appeared to have higher FA:Hg ratios than their predatory counterparts. These findings will facilitate the design of dose reconstruction models to inform local public health organizations in the development of food consumption advisories for northern First Nations communities, with the goal of minimizing risks of Hg exposure and maximizing dietary consumption of fish in traditional food systems.

Multi-stressor impacts on fish energetics: From pharmaceutical contaminants to climate change

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Key Words: multi-stressor, venlafaxine, temperature, metabolism

Aquatic organisms face numerous stressors simultaneously in their environments. While each of these stressors pose great threats to aquatic life, studying each stressor individually is not sufficient, as these stressors are not independent, but work cumulatively and synergistically to alter aquatic ecosystems. The objective of this study was to examine the impact of chronic exposure to mixed environmental stressors that aquatic organisms continuously face. Our study set out to understand the effects of environmentally relevant concentrations of venlafaxine, an antidepressant pharmaceutical contaminant found abundantly in wastewater treatment plant effluents, in combination to elevated water temperatures on the metabolism and swimming performance of Zebrafish (*Danio rerio*). Adult Zebrafish were exposed to a series of treatments consisting of different combinations of these stressors for 21-days. Muscle tissue was sampled immediately post-exposure to measure enzyme activity of major metabolic enzymes, carnitine palmitoyltransferase (CPT), β-hydroxyacyl CoA dehydrogenase (HOAD), pyruvate kinase (PK), and citrate synthase (CS). Following exposure, oxygen consumption was measured using closed-chamber respirometers to assess the effects of stressors on whole-body basal metabolic rate, which can be used as an ecological performance indicator. The results of this study will contribute to the recognized importance of including multi-stressor approach assessments to make predictions regarding the impact of stressors on fish health and abundance.

Potential application of polydimethylsiloxane (PDMS) passive air sampler for measuring inhalation exposure of officers to flame retardants

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Key Words: Passive air sampling, PDMS, inhalation exposure, flame retardants.

Brominated and phosphate flame retardants (BFRs and OPFRs) are semi-volatile organic compounds (SVOCs) used in a variety of household products and building materials including furniture, electrical and electronic equipment and building insulation. Exposure to SVOCs that are released from these sources has been linked to a range of potential health effects. Limiting human and ecosystem exposure to SVOCs can be initiated from knowing their abundance. Active air samplers are conventionally used for this purpose but their use is hindered by cost, need for electrical power, skilled operation and their noise. Passive air samplers (PAS), which work by diffusion, are efficient alternatives to active samplers, as they do not have such limitations. In previous studies, PDMS passive sampler has shown promise for collecting a wide range of SVOCs due to its hydrophobicity, flexibility, and high permeability to gas-phase SVOCs. This project aims to assess the use of PDMS as an alternative personal passive sampler in characterizing the inhalation exposure of officer workers to flame retardants. A five-day calibration study was conducted with five participants wearing PDMS broaches alongside low-volume active air samplers in their breathing zone while working in their offices for 8 hours daily. Post-deployment samples were extracted and analysed for BFRs and OPFRs using gas chromatography mass spectrometry (GC-MS). The preliminary results demonstrate slopes of the uptake curves were linear for all target compounds. Sampling rates of PDMS for BFRs and OPFRs ranged from ~3 to 6 m^3/day. The results indicate that PDMS broaches worn for 8 hours for 3 to 5 days can capture personal exposure to these chemicals. In conclusion, PDMS passive air samplers could potentially be used to estimate inhalation exposure to BFRs and OPFRs at a workplace.

Risk communication for environmental pollutants: The case of mercury in fish

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Key Words: risk communication, methylmercury, fish

There are many obstacles to effectively communicating environmental risks. In the case of fish consumption, risks and benefits must be balanced and risk communication must be approached carefully. Fish are an important source of nutrients such as protein, omega-3 fatty acids, and vitamins, with increased consumption resulting in health benefits such as reduced risk of cardiovascular disease and stroke. For these reasons, the general population is encouraged to eat fish. However, fish can contain elevated levels of toxic methylmercury, which can cause detrimental neurological, cardiovascular, and reproductive effects. In the Northwest Territories, multiple fish consumption advisories have been released due to elevated levels of mercury in some fish species. However, after the release of contaminant advisories, it was reported that some individuals decreased their overall consumption of fish. Risk communication must take into account the benefits as well as the risks in the case of mercury in fish.

In this case, these six key elements of risk communication, identified from the literature, are valuable: 1) collaborate to build trust and credibility, 2) incorporate local knowledge, 3) choose appropriate languages and supports, 4) facilitate the public in making their own informed decisions, 5) create an adaptable communication plan, and 6) involve the community at each step. Failing to take some or all of these aspects into consideration puts even a well-designed project at risk of missing its target. However, with careful planning, environmental risk communication can be effective. These elements must be integrated in the messaging about mercury in fish for consumption.

Remediation of nickel 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. Changes in pH not only affect bioavailability of metals but also soil nutrients and may cause adverse effects to plants. Treatments of 88t/ha of calcitic or dolomitic lime as well as positive control with no lime (mechanical equipment only) and a negative control with no treatment were applied to a field in Port Colborne early in 2015. The soil was sampled before and after lime application, and soybeans planted in July 2015. Soybean was harvested in October and yield was calculated. Soil pH, pseudo-total Ni, plant-available Ni (using $CaCl_2$) were measured on samples collected before and after liming. It was found that both types of lime increased soil pH, though calcitic lime resulted in a greater increase than dolomitic. A decrease in pseudo-total Ni was seen following liming, though this 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 calicitic had a greater effect than dolomitic. It was found that there is a very predictable relationship between soil pH and plant available Ni, which does not depend on the way the pH was increased. 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 than only the calcitic treatment and not the dolomitic. Higher yield was seen in the dolomitic treatment than calcitic, which may be due to calcitic pH being too high for optimal soybean production.

Water-only toxicity testing with *Chironomus dilutus*: Tips and tricks from the Ontario Ministry of the Environment and Climate Change (MOECC) Aquatic Toxicology Unit (ATU)

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Key Words: aquatic toxicity, method development

Chironomus dilutus (formerly *C. tentans*) is a model organism typically used in sediment toxicity testing. *Chironomus dilutus* can also be used in water-only exposures with a thin layer of silica sand as substrate, to assess toxicity of chemicals in solution. At the Ministry of the Environment and Climate Change Aquatic Toxicology Unit, *C. dilutus* are used in water-only reference toxicant testing to track organism culture health over time, and for the assessment of species sensitivity to water soluble contaminates. Here we present *C. dilutus* culturing, test organism selection, and aqueous acute and chronic toxicity testing techniques, improvements, and experiences. Results indicate that organism body size is not always a predictive indicator of instar. Additionally, organism behaviour needs to be considered when maintaining or increasing survival in water-only exposures. We also present the methodologies of a semi-static flow-through system for *C. dilutus* reproduction testing that allows for solution renewals that minimizes handling and maximizes organism survival and reproduction. The work presented here strengthens the use of *C. dilutus* as not only a model aquatic toxicity organism for sediment testing but also as an ideal candidate for aqueous toxicity testing.

Microcystin production under atrazine-induced oxidative stress in *Microcystis aeruginosa*

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Key Words: Cyanobacteria, microcystin, oxidative stress, UPLC-QTOF

Microcystins (MCs) are hepatotoxic secondary metabolites produced by certain cyanobacteria species found in lakes, ponds and flowing waters. The increasing toxicity and occurrence of cyanobacteria blooms is now a public health concern, as they are difficult to predict and even harder to prevent. More research on the biological role of MC is required in order to determine the process of their up-regulation. Even though many hypotheses have been suggested to explain the physiological role of MCs, most have been rejected over the past few years because of conflicting results. One remaining hypothesis suggests MCs act as a protection against oxidative stress such as that caused by high UV radiation, high salt concentrations or pesticides which are associated with the formation of reactive oxygen species (ROS). ROS are normally formed during photosynthesis, but are harmful when produced in excess. I am testing this hypothesis by measuring intracellular MCs production and metabolite variation in *Microcystis aeruginosa* exposed to various concentrations of atrazine, an herbicide commonly used in North America and often found in waters impacted by agriculture runoff. Atrazine can trigger oxidative stress by blocking the electron-binding site in the quinone of the PSII. In this study, UPLC-QTOF, a new instrument technique, was used to separate and quantify metabolite extracts of the toxic *Microcystis aeruginosa* strain CPCC300 in order to determine whether atrazine exposure led to changes in MCs (upregulation or changes in MCs composition).

Assessing mercury risks for the optimization of nutrient benefits from wild-harvested fish consumption in the Northwest Territories, Canada

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Key Words: risk assessment; mercury; nutrients; probabilistic modelling

The consumption of fish, often rich in essential nutrients, promotes health in humans; however, methylmercury, a contaminant in fish, may pose health risks. To better understand these risks and benefits, total mercury (HgT), selenium (Se) content, and omega-3 fatty acid (*n*-3 FA) composition within the muscle tissues of fish from three lakes in the Northwest Territories were characterized. Thereafter, a probabilistic optimization software (Crystal Ball's OptQuest) was utilized to inform dietary recommendations that mitigate risks of Hg exposure.

Average HgT levels ranged from 0.057 mg kg^{-1} (Cisco) to 0.551 mg kg^{-1} (Northern Pike), while average *n*-3 FAs levels ranged from 101 mg/100 g (Burbot) to 1,689 mg/100 g (Lake Trout).
In contrast, average Se concentrations were relatively similar among species. Interestingly, fish HgT covaried with the nutrient content for Lake Trout, Northern Pike, Walleye, Lake Whitefish, and Cisco. These analyses indicated that Lake Whitefish, Cisco, and Longnose Sucker had the highest nutrient levels relative to HgT content. For the OptQuest model, the term best solutions refers to the optimum food choices that maximize nutrient intake, while also limiting Hg's toxicological reference values (TRVs). To achieve nutritional adequacy for *n*-3 and Se intake, respectively, the total amount of fish within the best solutions for women of child-bearing age were 546 and 1,359 g/week and the general population were 851 and 1,848 g/week. The models indicated that the consumption of Burbot, Cisco, Lake Whitefish, and Longnose Suckers would most help people achieve nutritional adequacy without exceeding the Hg TRV.

The nutrient:Hg ratios and OptQuest model approaches that were utilized to determine the optimal food choices that achieve nutritional sufficiency without exceeding the Hg TRV yielded different answers. Future research will be necessary to determine which of these approaches yields the most useful information regarding the balance between nutrient benefits and contaminant risks.

Lanthanum toxicological effects on *Helianthus annuus L.* growth and chlorophyll content

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Key Words: rare earth elements, phytotoxicity, *Helianthus annuus L.*, Inhibition Concentration (IC_{50})

Rare Earth Elements (REEs) are known as high-tech metals. These metals are used in high-technology appliance production and new industry development. Also, REEs are utilized as fertilizers in the field of agriculture and forestry. The vast REEs application and utilization cause these metals to be released into the environment in high amounts; therefore, increase in the amount of REEs in the environment leads these metals to be considered as emerging environmental pollutants. However, information about REEs' toxicity and bioavailability is scarce. Due to this scarcity, there is no regulation on the REEs thresholds for soil, which can be used to regulate release into the environment.

Considering the facts that REEs are emerging pollutants, and information about the effect of these elements on the environment is limited, further studies are required to be done in this field. As a result, in this study *Helianthus annuus L.* dose-response to lanthanum (La) *in-vitro* was assayed. Murashige and Skoog medium (MS) was used as the growth medium, and La with four different dosages was added to the media. After sterilization, the seeds of *H. annuus* were inoculated in the media. La phytotoxicity effects on the growth of the plant were determined by measuring the root length, shoot length and leaf biomass of the plant. Moreover, the chlorophyll content in the plant's leaves was measured. Based on these measurements, the Inhibition Concentrations (that which causes a 50% decrease in the plant's growth and chlorophyll content - IC_{50}) were then calculated, The results showed that La at a low concentration, had hormetic impact on the shoot mass of the plant. However, this element at high dosages caused phytotoxicity. The IC_{50}s for shoot and root lengths were 190 mg/kg and 174 mg/kg, respectively.

Investigation of the accumulation and the effects of lead on invertebrate nervous system function and behavior

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Key Words: lead, bioaccumulation, nervous system

Lead is a metal that interferes with a variety of body processes and is toxic to many organs in humans and other animals. Recently, in Flint, Michigan the water has been an issue and high concentrations of lead have been found in several homes. This can have a harmful effect on humans, especially children. To learn more about the effects lead can have on organisms, zebra mussels and *C. elegans* worms were dosed with lead at concentrations that have been measured in Flint.

Zebra mussels are an invasive species in the Great Lakes. They were subjected to very low levels of lead over the course of six weeks, and later tested using atomic absorption spectroscopy (AAS) to determine the amount that accumulated in their tissue. *C. elegans* were dosed with two different concentrations of lead based on the "allowed" amount in municipal water systems and the highest concentration found in the Flint, Michigan household water. Their behavior was studied to have a better understanding of potential neurological effects in humans.

This research was conducted with Lewiston-Porter High School students whose interest in and concern about heavy metal toxicity in the environment led to the start of the project. These students have already presented the zebra mussel work and will soon present the *C. elegans* work at the International Students Science Fair (ISSF).

The third phase of Canada's Chemicals Management Plan

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Key Words: Chemicals Management Plan, risk assessment

Under the Chemicals Management Plan (CMP), the Government of Canada is assessing and managing, where appropriate, the ecological and human health risks of substances. Building on previous work under the CMP (over 2500 substances addressed from 2006 to 2015), 1550 substances have been identified for assessment over the coming five years. Examples of the 1550 substances that will be addressed include quaternary ammonium compounds, alkyl aryl sulfonates / linear alkyl benzene sulfonates (LABS) and derivatives, parabens, aluminum, cyanides, and polymers.

To date, several approaches have been developed under the CMP to tailor the assessment to the appropriate level of complexity. Over the coming years (2016-2020), these approaches will be built upon with emphasis on using assessment approaches that are "fit-for-purpose". The approaches that may be applied are outlined in a Risk Assessment Toolbox. A Type 1 Approach addresses the substance or group with a science-based policy response. A Type 2 Approach addresses substances using a broad-based approach to efficiently deal with those that have a lower potential for risk (e.g., Rapid Screening, Ecological Risk Classification). A Type 3 Approach addresses substances using a more traditional risk assessment approach that considers both hazard and exposure in more detail. This type of approach is subdivided into three levels representing a continuum of increasingly complex assessment approaches. For example, a Type 3-3 Approach could consider cumulative risk in an assessment of a group of chemicals.

Is plastic debris a source of flame retardants in Ring-billed Gulls?

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Key Words: plastic debris, flame retardants, gulls, St. Lawrence River

Plastic debris has been recognized as a contaminant of concern for wildlife both physically and as a vector for hazardous chemicals. This is particularly true for seabirds as more than 50% of all species are known to ingest plastic. As part of a long-term study, the diet, foraging behaviour, and chemical exposure and body burden of flame retardants (FRs) have been investigated in a population of Ring-billed Gulls (*Larus delawarensis)*. The population nests on Île Deslauriers on the St. Lawrence River, 3km north-east of Montréal, QC. The birds forage in a variety of environments, including urban areas, rivers, landfills, and agricultural fields and were found to have accumulations of FRs in their liver and plasma. Individuals that foraged in landfills were found to have the greatest tissue concentrations of selected FRs. A number of sources have been proposed including diet and airborne dust. Here, we hypothesise that ingested plastic is one source of FRs to these gulls. FRs are added to some plastics during manufacturing and can also adsorb FRs from ambient air and water post-manufacturing. Preliminary analyses based on 15 gulls collected from this colony showed that 8 out of 9 dissected birds contained plastic in their gut including expanded polystyrene and microbeads. These plastics will be analysed by GC/MS for a suite of FRs and the profiles compared to the profiles of accumulated FRs in the liver and plasma. These gulls present a unique opportunity to study a high trophic level organism of both terrestrial and aquatic food webs. Results of the study will help clarify the sources of FRs to these gulls as well as increase our understanding of plastic debris as a vector for contaminants in wildlife.

Using XANES to identify the effect of ageing, speciation and mineral association of nickel on its bioaccessibility in soil

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Key Words: Bioaccessibility, speciation, mineralogy, sequential extraction

Changes in the speciation and bioaccessibility of Ni in soil columns spiked with nickel-sulphate-hexahydrate were measured over a 168 day period as a function of soil organic content and synthetic precipitation (leach) rate. X-ray Absorption Near Edge Structure (XANES) spectroscopy identified a rapid conversion of added $NiSO_4 \bullet 6H_2O$ to less labile phases post spiking because of surface sorption kinetics and precipitate formation. Soils with an average pH >7 contained 47-70% $Ni(OH)_2$/NiO within fourteen days, while only 37% of Ni was present as $Ni(OH)_2$/NiO at day 1 in soil with a pH <7. Conversion to $Ni(OH)_2$/NiO slowed substantially after day 1 in all soils, due to slower ageing processes such as diffusion, incorporation into crystal lattices, and Ostwald ripening of precipitates. Bioaccessibility was significantly increased with the presence of increased SOM due to the higher proportion of exchangeable complexes with carbonate and organics. Bioaccessibility decreased at nearly identical rates (0.11-0.13% day^{-1}) in all columns. Leach rate did not significantly influence speciation, but Ni bioaccessibility was increased in wetter soils. Increased stability of Ni complexations and the formation of Ni precipitates are assumed to account for much of the reduction of bioaccessible Ni through ageing-related mechanisms.