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Laurentian SETAC
Laurentian Chapter of the Society of Environmental Toxicology and Chemistry

June 14-18, 2021

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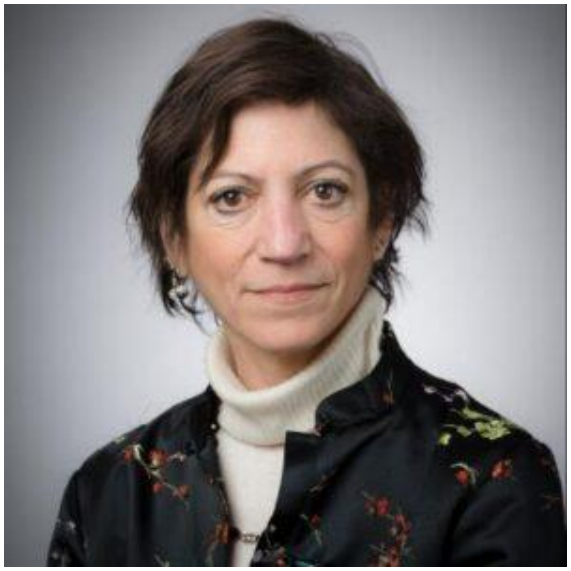
Two board member positions are open! E-mail for more information on how to join.

2021 AGM AT A GLANCE

Date	Eastern Standard Time (EST)	Program
All Week	N/A	**Student Virtual Platform Competition (all week)** **Twitter Poster Competition (all week)**:
Monday, June 14	1:00-3:00 p.m.	**AGM Opening and Welcome** **Plenary Speaker**: Gail Krantzberg, PhD (McMaster University) "*Great Lakes Great Responsibility*" **LSETAC & PNC Chapter Activities and Business Meeting**
Tuesday, June 15	7:00-9:00 p.m.	**Plenary Speaker:** Chris McLaughlin, PhD (BARC) *Challenges in communicating progress: environmental quality and community engagement in Hamilton Harbour* *SETAC North America Update*
Wednesday, June 16		*No Virtual Activities Schedule
Thursday, June 17	1:00-5:00 p.m.	**Short Course:** Dr. Brittney G. Borowiec Science Communication for Scientist and SciComm Clinic
Thursday, June 17	7:00-10:00 p.m.	**AGM Social (*Gathertown*)**
Friday, June 18	2:00pm-4:00 p.m.	**Research Discussion Sessions (1hr)** **AGM Student Award Presentations**: **Closing Remarks**

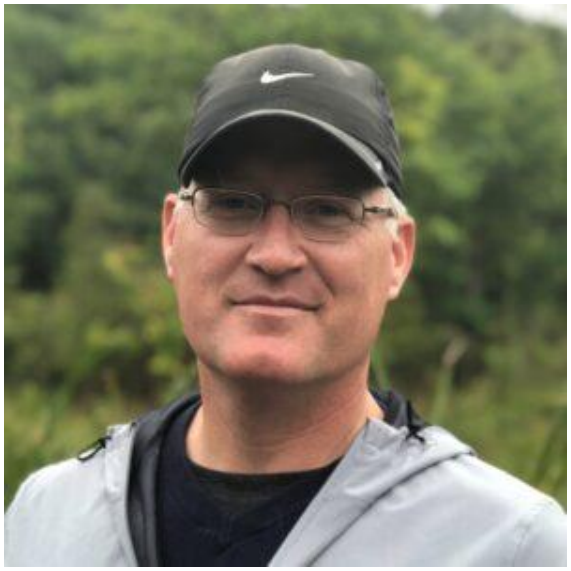
PLENARY SPEAKERS

Dr. Gail Krantzberg, McMaster University



Dr. Krantzberg is Professor of Engineering and Public Policy in the Booth School of Engineering Practice and Technology at McMaster University offering Canada's first Master's Degree in Engineering and Public Policy. Gail completed her M.Sc. and Ph.D. at the University of Toronto in environmental science and freshwaters. She worked for the Ontario Ministry of Environment from 1988 to 2001, as Coordinator of Great Lakes Programs, and Senior Policy Advisor on Great Lakes. In her tenure there she was intensely engaged in binational Great Lakes science and policy venues, including direct interactions with the Great Lakes Commission, the Great Lakes Observing system, president of the International Association of Great Lakes Research, Board Member of the Canadian Water Foundation and Georgian Bay Forever, member of the International Joint Commission's Water Quality Board, Sediment Priority Action Committee, Indicators Implementation Task Force, and Council of Great Lakes Research Managers. Dr. Krantzberg was the Director of the Great Lakes Regional Office of the International Joint Commission from 2001 to 2005. In 2007 she was appointed as an adjunct faculty member of the United Nations University Institute for Water and Environmental Health and participated in the twinning of the Laurentian and African Great Lakes (principally Lake Victoria). She has edited and co-authored 7 books and more than 160 scientific and policy articles on issues pertaining to ecosystem quality and sustainability and is a frequent speaker to media and the public. When not on the job, she enjoys family, photography, gardening and peace in the woods.

Chris McLaughlin, Bay Area Restoration Council



Chris McLaughlin has worked in the environmental sector since 1990 as an educator, author, researcher, consultant and chief executive. Chris is currently the executive director of the Bay Area Restoration Council, a non-profit corporation representing the public interest in the recovery of Hamilton Harbour. Chris holds a PhD from McMaster University for a study of Great Lakes policy and governance and an adjunct faculty appointment in its School of Geography & Earth Sciences, and also serves on the International Joint Commission's Great Lakes Water Quality Board and the Canadian Environmental Law Association's Healthy Great Lakes Advisory Committee.

SCIENCE COMMUNICATION FOR SETAC

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Laurentian & Prairie Northern SETAC

JOINT VIRTUAL

AGM SHORT COURSE

June 17, 2021

SETAC AGM Social Event

Games: Treasure hunt, trivia, and more

Prizes: Everyone has a chance to win!

When: Thursday June 17th 7:00-10:00 pm

Where: Gathertown Virtual Interactive Space + Zoom

... stay tuned for more details

Let's get social ...
... at a distance

Gather

ABSTRACTS

1. Toxicology – Laboratory

Student presentation – M.Sc.

Toxicity of water additives used in forest and municipal firefighting to terrestrial and aquatic biota

Jenna Anderson & Ryan Prosser

University of Guelph, School of Environmental Sciences

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Keywords: firefighting water additives, aquatic toxicity, terrestrial toxicity

The use of firefighting water additives has greatly increased over past decades in both wildland and residential fires in order to increase extinguishing efficacy. Fluorinated fire-fighting additives were used extensively in the past, however, due to their bioaccumulative potential and persistence in the environment they are no longer permitted in Canada for forest and residential applications. With greater concern of the environmental fate of firefighting water additives, new formulations have been developed that are meant to be “eco- friendly” alternatives for fire suppression. There currently exists very little data on the toxicity of additives in current use with respect to terrestrial and aquatic biota. This study will assess the toxic effects of nine different types of firefighting water additives on terrestrial and aquatic species. This will include acute lethality testing of the aquatic species *Daphnia magna*. The terrestrial portion will include chronic testing for the springtail species *Folsomia candida* and germination and emergence tests for three plant species (*Picea glauca, Agropyron cristatum*, and *Raphanus sativus*). The *D. magna* portion of the study revealed considerable risk for all tested products with the exception of Eco-gel and TetraKO. The *F. candida* tests revealed relative sensitivity to all products with the exception of TetraKO.and Bio FOR N. *Picea glauca* and *A. cristatum* germination tests showed relatively high sensitivity at the lowest administered concentrations for all tested products, whereas *R. sativus* showed relatively low sensitivity to all tested products with the exception of LC95A. Finally, emergence tests with *R. sativus* also showed relatively high sensitivity to LC95A. The results of this study highlight the potential hazard that firefighting water additives pose to aquatic and terrestrial organisms.

Student presentation – Ph.D.

Does MeHg exposure affect spring reproductive onset in songbirds?

Bottini Claire[1], Calista Henry[1,2] & Scott MacDougall-Shackleton[1,2]

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Keywords: methylmercury, avian, seasonal transition, HPG axis

Organisms regularly adjust their physiology to respond to predictable seasonal environmental variation. In spring, increased duration of daylight stimulates the hypothalamus-pituitary-gonadal axis in seasonally breeding birds, inducing a transition from winter non-breeding physiology toward reproductive physiology. While numerous studies documented hormonal, physiological, behavioural and reproductive deficits in methylmercury (MeHg) exposed birds during the breeding season, it is currently unknown if MeHg disrupts the transition from winter to spring physiology. To evaluate this we fed song sparrows (*Melospiza melodia*) an environmentally relevant level of methylmercury (0.22 ppm MeHgCl w.w. mixed in food) or uncontaminated diet during 3 months, and then photostimulated birds and for a post-exposure period of 21 days. Our preliminary results show no treatment effects on the number of hypothalamic GnRH producing cells, blood testosterone levels, or testis mass. This indicates that spring reproductive onset might not be affected by carry-over effects of winter MeHg exposure in birds. This contrasts with our prior results demonstrating that a similar level of MeHg exposure affected summer to fall seasonal transition (e.g., moult duration, migratory behaviour) in this species. This suggests that reproductive physiological dysregulation in MeHg exposed birds results from direct effects of MeHg during the breeding season instead of carry-over effects of exposure from wintering sites.

***Student presentation* – M.Sc.**

Multigenerational effects of maternally deposited 1,2,5,6-Tetrabromocyclooctane (TBCO) on reproduction of Japanese Medaka

Chloe Devoy[1], Jon Doering[1] & Steve Wiseman[1]

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Keywords: brominated flame retardant, TBCO, Japanese Medaka, multigenerational

Brominated flame retardants (BFRs) are added to a variety of flammable products to increase their fire resistance. BFRs can leach from materials into aquatic ecosystems where they can bioaccumulate, biomagnify and induce toxicity in organisms. 1,2,5,6-tetrabromocyclooctane (TBCO) is an emerging BFR that is a potential replacement for the widely-used BFR, hexabromocyclododecane (HBCD). Little is known about effects of TBCO on aquatic organisms. In a previous study, exposure of zebrafish (*Danio rerio*) embryos to waterborne TBCO caused developmental toxicity. In another study, dietary exposure to TBCO impaired reproduction of Japanese medaka (*Oryzias latipes*). During fish development, embryos can be exposed to the same effective internal concentration as the maternal organisms from which the eggs originated. Effects of maternally deposited TBCO on fish development and reproduction have yet to be studied. This study explores the effects of maternally deposited TBCO on fish development and reproduction in Japanese Medaka. Sexually mature fish were fed either a control, low (100 µg/g) or high (1000 µg/g) dose of TBCO spiked fish food for 21 days (N=40). During the exposure, embryos were collected to assess developmental toxicity caused by maternally deposited TBCO and grown to reproductive maturity to assess reproductive performance. Exposure to dietary TBCO had no significant effect on reproduction of the F0 generation. In the F1 generation, embryos showed concentration dependent trends of increased functional mortality, increased incidence of swim bladder malformation, increased incidence of spinal curvature, and decreased heart rate. These results suggest that maternally deposited TBCO has similar effects on early life stage fish development as does waterborne exposure. Additionally, TBCO was shown to impair reproductive performance of the F1 generation. Effects of TBCO on reproduction of the F2 generation are currently being investigated.

Clothianidin impairs olfaction and interferes with formation of dominance hierarchies in rusty crayfish (Orconectus rusticus)

Lee E. Scholl[1], Tamanna Sultana[2], Chris Metclafe[3] & William A. Dew[1,4]

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Keywords: clothianidin, crayfish, dominance, olfaction

Clothianidin is a neonicotinoid pesticide used in agriculture to control insect pests, and can make its way into surface waters via drainage from fields. To test the effects of clothianidin on a non-target group (crayfish), rusty crayfish (Orconectus rusticus) were exposed to increasing concentrations of clothianidin and its effect on a variety of behavioural endpoints was measured. These endpoints included response to a food cue, locomotion, and various endpoints related to agonistic encounters between crayfish. It was expected that because clothianidin is an acetylcholine blocker, exposure would result in a reduction in movement and potentially affect aggression in crayfish. The results demonstrated that there was a loss of response to the food cue (i.e., olfactory impairment) at all concentrations; however, there was no difference in locomotion of the crayfish due to exposure. In terms of agonistic encounters, while there was no change in aggression upon exposure to clothianidin, there were changes in a number of ecologically-important endpoints. Crayfish in a clothianidin-contaminated environment were not able to recognize that they had encountered an animal previously, indicating that the crayfish were unable to set up a dominance hierarchy. Our results indicate that crayfish in surface waters contaminated with clothianidin not only lose their ability to detect chemical cues in the water, they may not be able to establish dominance hierarchies, which may have a profound effect on the ecology of crayfish.

Student presentation – M.Sc.

Effects of 2-(2H-Benzotriazol-2-yl)-4-methylphenol (UV-P) on the reproductive success of Japanese medaka (*Oryzias latipes*)

Fujita Kaden[1], Jon Doering[1], Zhe Lu[2] & Steve Wiseman[1,3]

[1] Department of Biological Sciences, University of Lethbridge, Lethbridge, AB
1. [2] Institut des Sciences de La Mer de Rimouski, Université du Quebec à Rimouski, Rimouski, QC
[3] Water institute for Sustainable Environments (WISE), University of Lethbridge, Lethbridge, AB.

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Keywords: Benzotriazole UV Stabilizers, reproductive toxicity, steroidogenesis

Benzotriazole ultraviolet stabilizers (BUVSs) are a class of chemicals that are added to various products to prevent damage due to sun exposure and have emerged as pollutants of concern. Although BUVSs are detected in aquatic biota, both in Canada and abroad, very few studies have assessed the potential toxic effects of these chemicals. The objective of this study was to assess the potential adverse effects of 2-(2H-Benzotriazol-2-yl)-4-methylphenol (UV-P) on the reproductive success of fish. To test this, a 21-day reproduction assay using Japanese medaka (*Oryzias latipes*) was utilized. Japanese medaka were exposed to UV-P through a foodborne exposure to 0, 25, 125, and 625 ng/g (UV-P/food) for a total of 28 days with 7 days of exposure prior to the start of the reproduction assay. No significant effect on egg production was observed in Japanese medaka. Analysis of gene expression levels in individuals exposed to UV-P indicated no changes to the levels of mRNA transcripts of *erα*, *cyp1a*, or *cyp3a4* in the livers of male or female fish. However, a decrease in levels of mRNA transcripts of *cyp19a* and *cyp11a* in the female gonad was observed. Concentrations of plasma E2 and T showed an increasing trend in female fish exposed to UV-P while concentrations of 11-KT were unchanged in males. The responses suggest weak perturbation of the steroidogenesis pathway which might be linked to UV-P's suggested antiandrogenic action. Overall, results of this study indicate that UV-P does not significantly impact reproductive success of Japanese medaka; however, impacts on the steroidogenesis pathway could indicate a potential mechanism of toxicity which might lead to reproductive impairment in more sensitive species.

Student presentation – M.Sc.

Adverse Outcome Pathways using Japanese Medaka Embryos (*Oryzias Latipes*) Exposed to 2,3,7,8-Tetrachlorodibenzodioxin

Shreya Jain, [1], Linda Lara-Jacobo [1], & Denina B.D. Simmons [1]

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Keywords: adverse outcome pathways, toxicology, key events, genetic markers

Adverse outcome pathways (AOPs) are an open, collaborative framework that categorize the impact of chemicals from the molecular to the ecosystem level. This research aims to refine two existing AOPs (21 and 150) that are initiated by dioxins and dioxin-like chemicals binding to the Aryl hydrocarbon receptor (AhR), ultimately resulting in an adverse outcome of altered cardiovascular development in a multitude of organisms. AOP 21 proposes that crosstalk between HIF-1a and AhR causes the adverse effect, while AOP 150 proposes that increased COX-2 is the key event downstream of AhR. Our preliminary studies show that medaka (*Oryzias Latipes*) embryos exposed for 1 hour to 0.001 ppb of dioxin during development display altered cardiovascular development seen as reduced blood flow, pericardial edema, and impaired angiogenesis. When embryonic development is adversely impacted by dioxins, we hypothesize that there are differences in gene and protein expression, which will distinguish the molecular level key events in these AOPs. Medaka embryos were exposed to 0.001, 0.01, 0.1, 1, and 10 ppb of 2,3,7,8-Tetrachlorodibenzodioxin (TCDD) for 1 hour at the 4-hour-post-fertilization mark. Embryos were collected at 2 days post fertilization (dpf) and 7dpf. We conducted non-targeted proteomics and qPCR on embryo homogenates, with primers targeting the AhR2a, HIF-1a, and COX-2 genes. These were linked to higher level adverse effects observed as cardiac impairment via heartrate analysis using open-source *HeartBeat* software on 7dpf videos. We also recorded malformations, scoring by the severity of the pericardial edema. Our qPCR results strongly suggest AOP 21 is likely more influential than AOP 150 in causing altered cardiovascular development. Refining these AOPs will benefit society by improving our ability to respond to chemical contaminants of concern more effectively.

Student presentation – Ph.D.

Toxicity of naphthenic acid extracts from oil sands process-affected water and commercial mixtures in mammalian hepatocytes

Jamshed Laiba[1], Richard A.Frank[2], Mark Hewitt[2], Philippe J.Thomas[3] & Alison C.Holloway[1]

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[2] Water Science. And Technology Directorate, Environment and Climate Change Canada, Burlington, ON, Canada
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Keywords: Naphthenic Acids, Oil Sands Process-affected Water, NA-fraction, mammals

Bitumen extraction generates residual water known as oil sands process-affected water (OSPW). The toxicity of OSPW has been primarily attributed to bitumen-derived soluble organic mixtures, which include naphthenic acids (NA). The complexity of structure and composition of NA- fractionated component mixtures within OSPW (NAFC) is much greater than commercial NA mixtures (CNA) which are sourced from petroleum. The variability in size and structure of NAs between these mixtures have been associated with differing toxicity in invertebrate models. Some studies have postulated that CNAs are more acutely toxic than NAFCs, however there is limited evidence to support this hypothesis in mammalian models.

To determine the effects of NAFC and CNA exposure on key pathways involved in hepatocyte function, McA-RH7777 cells were exposed to a CNA mixture (Sigma-Aldrich) and an NAFC from OSPW (Frank et al.,2006) for 24 and 48 hours, at environmentally relevant concentrations (0.25,1.25,25,125 mg/L). We assessed the mRNA expression of genes involved in cellular stress response(Gdf15,Egr1), tryptophan catabolism(Tdo2,Ido2,Tph1), inflammation(Il1b,Ptgs2), aryl- hydrocarbon receptor activation(Cyp1a1,Cyp1b1) and peroxisome proliferator-activated receptor activation(Angptl4,PPARa,PPARy).

At the 125mg/L NA concentration, there were no major differences in gene transcription between CNAs and NAFCs. However, with exposure to 1.25mg/L NA, some notable differences were present in targets associated with tryptophan catabolism and inflammation at 48h, with CAN inducing a greater response than NAFCs. Interestingly, induction of these targets by NAFC at 24h showed a very similar pattern to induction of target genes by CNAs at 48h.

These data indicate that gene-variability in CNA and NAFC-exposure profiles may be dose and time-dependent. Future studies are necessary in verifying these findings with a larger number of NA mixtures and extracts from multiple sources.

Student presentation - PhD

Effectiveness of reducing firefighters' exposure to PAHs and genotoxins by implementing dermal cleaning interventions

Jennifer L. Keir[1] Tracy L. Kirkham[2], Rocio Aranda-Rodriguez[3], Paul A. White[3] & Jules M. Blais[1]

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Keywords: occupational exposures, PAHs

Firefighters experience above average risks of cancer and other serious illness. Their exposures to combustion emissions, including polycyclic aromatic hydrocarbons (PAHs), are a concern. To reduce dermal exposure, cleaning of firefighters' skin immediately after firefighting is often implemented. However, such efforts lack scientific evidence. To assess the ability of dermal cleaning methods to reduce firefighters' exposures, PAHs and subsequent genetic damage was measured and compared between participants following current decontamination protocols (i.e., no dermal decontamination) and those who added a dermal decontamination step using skin cleaning wipes or soap and water (i.e., the intervention groups). During training fires, we collected (1) personal air samplers; (2) wipe samples of skin before and after the fire, and after a dermal decontamination; and (3) urine samples before and after the fire. We measured PAHs in the air and wipes of skin, and PAH metabolites and mutagenicity in urine. Firefighters experienced significantly elevated concentrations of urinary PAH metabolites in their urine and PAHs on their skin ($p<0.05$). Soap and water was the only intervention to remove a significant amount of PAHs from the skin ($p<0.05$). However, fold changes of urinary PAH metabolites were not affected by implementing a dermal cleaning step. These data suggest that despite on-site attempts to remove PAHs from firefighters' skin, it does not reduce the overall dose received. Mutagenicity analyses will be conducted in the future to reveal if exposures to other mutagens are influenced by dermal decontamination efforts.

Student presentation – M.Sc.

Optimizing sex ratios of *Hyalella azteca* to reduce variability in brood size

Hufsa Khan[1], Yaryna Kudla[1], Ryan Prosser[1] & Adrienne Bartlett[2]

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Keywords: intraspecific competition, chronic endpoints, crustacean reproduction

Hyalella azteca is a freshwater benthic crustacean used in ecotoxicology because it is ubiquitous in North American freshwater systems and is sensitive to changes in water quality. Standard toxicological test methods for this species incorporate both lethal and sub-lethal (growth, reproduction) endpoints, though lethal endpoints are often favoured when testing in the context of environmental monitoring. However, sub-lethal endpoints are important to consider as they are ecologically relevant and are often more sensitive than lethality. It is difficult to achieve robust data for reproduction in *H. azteca* because there is naturally a high biological variability associated with reproductive yield and because effects on reproduction often co-occur with effects on growth. Furthermore, males of the species partake in complex interactions when competing for mates which adds to the variability in brood sizes that females produce.

The purpose of this study was to characterize the reproductive capacity of *H. azteca* by determining the role of sex ratios in reproductive yield. It was hypothesized that a lower male: female ratio will reduce intraspecific male aggression, improve reproductive success, and lower biological variability in the total number of young produced. Experiments were initiated in the absence of toxicants with 6-7-week-old individuals that were placed in different male to female ratios (1:1, 2:3, 3:2 and 3:7). Reproduction was monitored weekly for 7 weeks to determine which sex ratio had the least variable reproductive output over time. Preliminary results suggested that reduced reproductive variability occurred in treatments with low male to female ratios. The results will provide insight into optimizing the reproductive capacity of *H. azteca,* which will increase the ability of reproductive toxicity tests to capture effects of chemicals or contaminated sediment on amphipod reproduction.

Student presentation – M.Sc.

Impacts of pristine microplastic spheres to the larval (glochidium) stage of freshwater mussel *Lampsilis fasciola*

Yaryna Kudla,[1], Patricia L. Gillis[2], C. James Bennet[2], Joseph Salerno[2] & Ryan S. Prosser[1]

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Keywords: Unionidae, ecotoxicology, glochidia, microplastics, toxicity thresholds

Plastic debris polluting our waterways has been a concern for decades. Recently increased attention has been placed on microplastics (MPs) contamination of aquatic ecosystems. These small particles of plastics (<5 mm) have been observed in marine and freshwater ecosystems all over the Earth. Although effects of MPs ingestion on important marine invertebrate species have been demonstrated, little is known on the effect of microplastics on freshwater species. To date, freshwater studies have focused on the presence and/or concentration of microplastics in surface waters, but in order to assess their risk, there is a need to compare the environmental concentrations of microplastics to concentrations that cause adverse effects. Freshwater mussels are a group of filter-feeding organisms that have experienced a global decline due to habitat destruction and declines in water quality and they are under-represented in microplastics research. In this study, standard methods were used to conduct acute (48 h) toxicity tests with glochidia (larvae) of *Lampsilis fasciola,* a species of special concern. Tests were performed with pristine microplastic spheres of varying polymer types and sizes. Polystyrene (6 and 90 µm), polyethylene (75-90 µm), and cellulose acetate (1000 µm) spheres were used in treatment concentrations spanning 50-300,000 MP/L. Glochidia viability (i.e., the ability to close valves) was used as a surrogate for survival. L. siliquoidea glochidia were insensitive to each type of microsphere tested with effect concentrations being >300,000 MP/L for polystyrene and polyethylene and >1000 MP/L for cellulose acetate. This data will help inform the risk assessment of microplastics to freshwater biota.

Copper effects the acute ventilatory response and O_2 sensing ability of neuroepithelial cells in the killifish, *Fundulus heteroclitus*

E.M. Leonard, [1,2], S.J.C. Baker,[1,2], M.G.Jonz, [3] & G.B. McClelland[2]

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Keywords: neuroepitelial cells, copper, ventilation, killifish

Control of breathing, whether gill ventilation or air-breathing, is influenced by receptors located in the peripheral and/or central nervous system. These receptors respond to changes in PO_2 and PCO_2/H^+, a trait which is essential for the survival of aerobic organisms. O_2-sensing neuroepithelial cells (NECs), which initiate the cardiorespiratory reflexes in aquatic vertebrates, are the peripheral receptors involved in the control of breathing. Exposure to environmental contaminants, such as copper (Cu), may affect the ability of these cells to respond appropriately to changes in PO_2 and PCO_2/H^+ in the environment. We examined the effects of Cu on the acute ventilatory drive of killifish at several levels of biological organization. Cu blunts the acute ventilatory drive of killifish, reducing the fish's ability to respond to hypoxia. Morphometric analysis of the gills demonstrated that Cu causes a reduction in NEC projection area. Using ratiometric calcium imaging, we investigated whether Cu modulates hypoxia-induced changes in intracellular calcium concentration ($[Ca^{2+}]_i$), a response known to be important for O_2 sensing. We demonstrated that Cu (100 µg/L) reduces the $[Ca^{2+}]_i$ response to hypoxia in NECs from killifish gills by blocking T-type low threshold Ca channels but not L-type (HVA) Ca channels. Overall, Cu prevents killifish from mounting an appropriate physiological responses to low oxygen by reducing the $[Ca^{2+}]_i$ response through blocking T-type low threshold Ca channels.

Student Presentation – M.S.c

Toxic potency and effects of the emerging per-fluoroalkyl substance and PFOS-alternative, perfluoro-4-ethylcyclohexanesulphonate (PFECHS)

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Keywords: PFAS, characterization, toxicity, mechanisms

Per and poly-fluoroalkyl substances (PFAS) have unique physicochemical characteristics that make them versatile industrial and consumer chemicals. The widespread application of PFAS has resulted in some isomers being ubiquitous in environmental matrices, and their resistance to degradation have allowed them to accumulate in wildlife and humans with associated toxic effects. While certain isomers of concern have been phased-out or banned, new isomers continue to emerge in the environment and alternative substances continue to be produced. One such substance of concern is perfluoro-4-ethylcyclohexanesulphonate (PFECHS), an analogue of perfluoroctanesulphonic acid (PFOS) which has recently been detected in multiple environmental media around the globe. However, there is little information on the toxic potency of PFECHS and cyclic-PFAS in general. Therefore, this research elucidated effects of PFECHS exposure in a two-tiered approach. Tier 1 focused on *in vitro* experiments to quantify cytotoxicity, reactive oxygen species generation, effects on membrane potential and fluidity, and transcriptomic expression using fathead minnow and rainbow trout cell lines. Tier 2 involved an early-life stage *in vivo* experiment to quantify apical effects related to development of fathead minnow embryos. Determining toxicities associated with exposure to PFECHS will not only characterize a new and emerging chemical of concern, but also further elucidate the interrelated molecular mechanisms associated with PFAS overall.

Student presentation – Ph.D

Comparing the effects of five insecticides on the survival and reproduction of the soil invertebrate *Folsomia candida*

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Keywords: collembola, insecticides, neonicotinoids, soil ecotoxicology

Ecotoxicological research into the effects of neonicotinoid insecticides on non-target terrestrial and aquatic invertebrate species has had a significant impact on the regulation and use of this class of pesticides in many regions in the world, including Canada. As a result, a number of different classes of insecticides have emerged to fill the gap left by neonicotinoids. There is therefore potential for a significant increase in both the environmental concentrations and distribution of contamination of these substances beyond historic levels. This could then result in both a greater number of exposed invertebrate populations and an increased magnitude of these exposures. Soil invertebrates have a high potential for exposure to agricultural pesticides due to their presence in agricultural ecosystems and in those impacted by spray drift, erosion, and leaching.

Springtails are entognath hexapods with a worldwide distribution that play a key ecological role in soil systems, especially in Canada. *Folsomia candida* is a widespread parthenogenic species of springtail that is used extensively in soil ecotoxicology in large part due to their ability to thrive under laboratory culture conditions. This study aims to compare the effects of several insecticides on the survival and reproduction of the soil invertebrate *Folsomia candida* in 28-day exposures in an agricultural soil medium. Similar soil concentrations of neonicotinoid insecticides and several new insecticides that have seen an increase in application alongside the decline of neonicotinoid use were used among separate bioassays.

Student Presentation- M.Sc.

Inhibition of oocyte maturation by organophosphate insecticides in zebrafish (*Danio rerio*) after *in vitro* and waterborne exposure.

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Keywords: Oogenesis, zebrafish, maturation inducing hormone, membrane progestin receptor.

Oogenesis is the process by which a primary oocyte develops into a fertilizable egg, making it critical to successful reproduction in fishes. During successful oocyte maturation, 17α,20β-dihydroxy-4-pregnen-3-one (MIH) is synthesized in follicular cells, released to activate the membrane progestin receptor (mPR), which thereby induces maturation by germinal vesicle breakdown. *In vitro*, anthropogenic chemicals like pesticides and phthalates can dysregulate the mPR to inhibit MIH-induced oocyte maturation. Using zebrafish as a model organism, the objective of this research was to establish whether assays of *in vitro* of oocyte maturation are predictive of reproductive performance. Malathion, an organophosphate insecticide known to inhibit MIH-induced oocyte maturation *in vitro* was used as a model chemical. It was established that the magnitude of MIH-stimulated oocyte maturation inhibition after *in vitro* exposure was highly similar to the magnitude of inhibition of *ex vivo* MIH-stimulated maturation of oocytes extracted from fish exposed to waterborne malathion. This identical trend was observed in response to the structurally related organophosphate, dimethoate. To determine whether the *in vitro* assay is predictive of reproductive performance, female zebrafish were exposed for 21 days to 0, 0.5, 5, or 50 µg/L of malathion to evaluate daily fecundity and fertility. After exposure, oocytes were excised and induced to mature *ex vivo*. A significant decrease in *ex vivo* MIH-stimulated oocyte maturation was observed after 21-day exposure in all fish exposed to malathion in comparison to control groups. However, exposure did not impact fecundity or fertilization success. This study increases understanding of oogenesis as a target of chemical stressors, but the link between impairment of oocyte maturation and reproductive performance requires additional research.

Student presentation – M.Sc.

Identifying impacts of nickel exposure in the biofluids of rainbow trout using a proteomics approach

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Keywords: metals, proteomics, blood plasma, mucus

The discovery of a nickel rich ore in the Ontario Ring of Fire (OROF) located in Northern Ontario raises the possibility of nickel contamination in one of Ontario's most precious freshwater regions, the James Bay Lowlands. Nickel is an established carcinogen and can cause skin allergies in humans at high doses. In fish, nickel predominantly accumulates within their kidneys and chiefly impacts their respiratory system. The aim of this research is to identify sex-specific biomarkers in the blood plasma and skin mucus proteome of rainbow trout as indicators of waterborne nickel stress. The skin mucus interfaces with the external environment, can sequester excess metals, and synthesize antimicrobial enzymes and proteins to provide immunity against pathogens. The protein composition of fish mucus is thus dynamic and modulated depending on the environment. Likewise, the proteins transported in the blood plasma of fish reflect the whole organism's physiological status, including responses to stressors. Employing liquid chromatography tandem mass spectrometry (LC-MS/MS) will help establish proteomic biomarkers of baseline effects at ambient nickel levels in the OROF, and at other environmentally relevant concentrations. Biofluids such as plasma and mucus have proven to be useful as minimally invasive tools to deliver holistic information about the status of fish health, rendering them applicable and desirable for future biomonitoring and risk assessment programs.

Integrated assessment of sediment quality in reservoirs and lakes of the Saskatchewan River Basin

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Keywords: aquatic toxicology, sediment, remediation, delta

The Saskatchewan River Delta (SRD) is the largest inland delta in North America. Over the past fifty years, anthropogenic changes upstream, including the construction of E.B. Campbell and Gardiner Dam, have altered the water and sediment transport dynamics such that a sediment deficit has been created. This has lowered the productivity of the SRD far below historical norms, resulting in cultural and economic devastation for the community of Cumberland House that is located in the SRD. Among multiple restoration options currently discussed, transporting sediment from elsewhere in the Saskatchewan River Basin to the SRD may be one potential solution. To screen candidate sediments for their quality, chemical and physico-chemical properties such as metal concentrations and sediment texture, as well as the potential to cause adverse biological effects, will be assessed. Cell-based bioassays with either fish or mammalian cell lines will be used to screen for cytotoxicity and detect the potential for effects from environmentally-relevant chemicals such as dioxin-like chemicals, estrogenic and anti-estrogenic chemicals, androgenic and anti-androgenic chemicals, as well as genotoxicants. This integrated sediment quality assessments will provide valuable information for future decision- making to the Delta Stewardship Committee in Cumberland House.

Student presentation – M.Sc.

Untargeted Plasma Proteomics Offers Many Insights on Toxicity of PFAA Mixtures, Legacy and Short Chain Compounds with PPARβ/δ and Developmental Neurotoxicity as Avenues of Interest

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Keywords: PFAS, mixture, proteomics, plasma

Perfluoroalkyl acids (PFAAs) are persistent environmental pollutants often being the final degradation products of many forms of per- & polyfluoroalkyl substances (PFAS). PFAAs typically make up the majority of PFAS in surface waters, and are present as extensive mixtures of structurally similar congeners. Unfortunately, there is a scarcity of toxicological information available for the majority of PFAAs and the potential for additive/subtractive and synergistic effects of PFAA mixtures is not established. In order to address these knowledge gaps, we performed a 3-week, aqueous exposure of rainbow trout to 3 different concentrations of a PFAA mixture (50 ng/L, 100 ng/L & 500 ng/L) and conducted untargeted proteomics on the plasma. Another set of exposures to individual PFAAs (25 nM PFOS, 25 nM PFOA, 25 nM PFBS, 25 nM PFBA) was conducted at higher concentrations. Overall, the results revealed 90 proteins to be in common across all treatments with differences in proteomic responses being difficult to discern. The mixture exposures caused a disproportionately high change in the number of significantly altered proteins (FDR<0.05), but were 20-200-fold lower in molarity when compared to the single compound exposures. Biological pathway analysis revealed PPARβ/δ to be elevated in many of the treatments along with several proteins involved in lipid metabolism. Another process which was found to be affected across all treatments was nervous system development and cellular junction organization. Overall, the current study emphasizes the need for toxicological testing of PFAA mixtures, potential developmental neurotoxicity of PFAAs and PPARβ/δ activation as another target of PFAAs in lesser studied vertebrates.

Coupled hydrologic, chemical fate, and uptake models for predicting current and future contaminant trends in the South Saskatchewan River.

'Student Presentation' – M.Sc

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Keywords: South Saskatchewan River Basin, Contaminants, Climate Change, Aquatic Ecosystem, Chemical Fate Models

Global changes in climate have been observed over the past decades, which lead to varied conditions in many environments, including freshwater ecosystems. These variations, in turn, also impact the processes by which chemical contaminants move through aquatic environments. These chemicals are eventually taken up by aquatic organisms, where they can cause harmful effects. However, knowledge gaps related to the5 impacts of climate change on the underlying hydrological, chemical, and biological processes currently limit our ability to forecast potential future changes in contaminant concentrations accurately. This research aims to combine computer models for the prediction of hydrologic processes, chemical fate, and uptake of chemicals into aquatic organisms. The study site for this research will be the hydrologically well-characterized South Saskatchewan River in Saskatchewan, which is one of the most important water resources in Western Canada. Along this area, high-quality data on the concentration of specific contaminants in water, suspended particles, and sediments are currently lacking and will be generated through chemical analysis to develop and test these models. Fish species native to the area will also be collected and analyzed for chemical concentrations to understand the contaminant uptake. Results obtained from the sample analyses will provide useful baseline contaminant profiles for the South Saskatchewan River. The coupled model will be a highly valuable tool for the prediction of the impacts of climate change on contaminant movement through the South Saskatchewan River. It would benefit Canadians, especially Indigenous communities who rely on the river for food and water, in helping them to adapt to or mitigate future climate change-related water threats. This study could also serve as a blueprint for other river systems around the world.

Student presentation – M.Sc.

Exposure to dibenzothiophene and its alkylated congeners adversely affect reproductive success through mitochondrial dysfunction in the placenta

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Keywords: Petroleum, Reproductive Toxicology, Mitochondrial Dysfunction, Trophoblast

Introduction: While there is evidence that polycyclic aromatic hydrocarbons can adversely affect mammalian reproduction, less is known about the effects of other polycyclic aromatic compounds including sulphur-containing heterocyclic aromatic compounds (S-HACs) commonly detected in crude oil. We have previously shown that the S-HAC, dibenzothiophene (DBT), and its alkylated congener, 2,4,7-trimethylDBT, impact key processes important for placental development. Moreover, DBT has been reported to increase markers of oxidative stress and contribute to mitochondrial dysfunction. Mitochondrial activity is imperative for normal placental function, which impacts reproductive success. However, the effects of DBT on placental mitochondrial function are unknown. Therefore, the goal of this study was to evaluate the impact of DBT and its alkylated congeners on markers of placental mitochondrial function.

Methods: BeWo cells, third trimester placental trophoblasts, were exposed to DBT, 2-methylDBT, 2,8-dimethylDBT, and 2,4,7-trimethylDBT for 96 hours at concentrations representative of tissue levels measured in wildlife collected near active petroleum extraction sites in Northern Alberta. We assessed mRNA expression of key mitochondrial markers including PGC-1α, ERRγ, PPARγ, and COXIV, and evaluated mitochondrial electron transport chain (ETC) activity via COXIV activity.

Results: 2,8-dimethylDBT exposure increased PGC-1α gene expression. The mRNA expression of ERRγ, PPARγ, and COXIV were not altered by any compound. Although COXIV mRNA levels were not affected, COXIV activity was decreased by 2,8-dimethylDBT and 2,4,7-trimethylDBT.

Conclusion: Impaired ETC activity caused by exposure to alkylated DBT congeners may affect placental function and ultimately fetal health, potentially leading to lower reproductive success in animals exposed to these compounds.

Student Presentation – B.Sc.

The effects of UV-Stabilizers, UV-9 and UV-090, on oocyte maturation in zebrafish (*Danio rerio*).

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Keywords: UV-stabilizers, zebrafish, oocyte maturation, oogenesis

Benzotriazole UV-Stabilizers (BUVs) are chemicals that protect against UV degradation. BUVs are found in industrial and consumer products and can enter aquatic environments via wastewater. Although studies have demonstrated widespread contamination of BUVs, little is known about the toxicological effects. This study explored whether BUVs, UV-9 and UV-090, impair reproduction of zebrafish (*Danio rerio*) by inhibition of oocyte maturation. Results were compared between maturation assays, where oocytes were exposed to BUVs *in vitro* or *in vivo*. To assess effects of *in vitro* exposure, stage IV oocytes were excised from sexually mature female zebrafish and exposed to various concentrations of each BUV, followed by a maturation-inducing hormone. Exposure to UV-9 *in vitro*, resulted in a significant decrease in maturation at the 200µg/L concentration. In the UV-090 exposure, there was significantly less maturation of oocytes exposed 200, 2000, or 20000µg/L concentrations, compared to the control. To assess effects of *in vivo* exposure, sexually mature zebrafish were fed a diet of 25 (low), 125 (medium) or 625 (high) ng BUV/g food. Following 10-days of exposure, stage IV oocytes were excised to assess maturation in response to maturation-inducing hormone. There was significantly less maturation of oocytes from fish exposed to UV-9 at 125 and 625ng/g food, compared to the control. However, there was no inhibition of oocytes from fish exposed to UV-090. Results suggest that UV-9 impairs oocyte maturation *in vitro* and *in vivo*; whereas UV-090 only inhibits maturation *in vitro*. Further studies are required to assess effects of UV stabilizers on reproductive capacity and to determine whether assays of oocyte maturation are predictive of reproductive performance. This study increases understanding of possible toxicological effects of BUV exposure in aquatic wildlife.

Student presentation – B.Sc.

Developmental effects of lead exposure during early-life stages of the amphibian, Xenopus laevis

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Keywords: African clawed frog, metals, sub-lethal, developmental abnormalities

The environmental distribution of lead is widespread, mainly due to anthropogenic activities. Exposure to lead can induce a wide variety of effects in fish and amphibians, including mortality, developmental abnormalities, endocrine disruption and altered behaviour. Although most research has focused on impacts on fish, evidence exists that developing amphibians are also susceptible to the adverse effects of lead exposure. Developmental abnormalities in particular can have devastating effects on swimming ability in tadpoles, which is vital for prey hunting, predator avoidance, and travelling. The objective of this research was to determine the effects of early-life stage exposure to lead on Xenopus laevis tadpoles by evaluating mortality, growth, development, and the incidence/severity of developmental abnormalities. Embryos were exposed at 48 h post-fertilization to 70, 210, or 630 µg/L lead nitrate (Pb(NO3)2) and exposures were continued through to 22 days post-fertilization (dpf) with 50% daily water renewal. Body weight and length were measured at the end of the exposure while incidence/severity of developmental abnormalities were assessed both mid-way (14 dpf) and at the end of exposure (21 dpf). While there was no significant mortality in the lead-exposed groups, tadpoles exposed to the high lead concentration (630 µg/L) had reduced body length and increased incidence (46.3%) of developmental abnormalities with the most common being axial abnormalities (33.33%), abdominal and cardiac edema (28.4%), and wavy tail malformation (13.7%). The results showed that exposure to Pb during critical early developmental stages can have adverse effects on both growth and development; however, the highest concentration of lead used in this study is above environmentally relevant levels. Research is underway to identify specific molecular mechanisms that drive the adverse effects of lead in amphibians.

Student presentation – Ph.D.

Legacies of glyphosate use for invasive plant control: effects of leaching from treated plant material on the recolonization of native macrophytes

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Keywords: Bioavailability, Herbicide, Management, Wetland

Management of invasive plants can support the restoration of contemporary, native plant communities. Glyphosate-based herbicides are commonly used in invasive plant management because glyphosate does not persist at toxic concentrations in water and soil, thus posing minimal risks to non-target species. However, glyphosate can accumulate in the tissues of treated plants. If accumulated glyphosate is released into surrounding substrate when plants decay, it might impair recolonization of managed areas by native plants. Moreover, leachate from some plants contains allelopathic substances that can affect seed germination and seedling growth, but the potential interactive effects of leachate and glyphosate residues are unknown. We sprayed realistic concentrations of glyphosate (Roundup WeatherMAX®) on two macrophytes that are invasive in North America: *Phragmites australis* and *Typha* × *glauca*. Nine weeks after spraying, we submerged sprayed and unsprayed plant tissues in water to create leachate. We quantified glyphosate concentrations in the leachate over 21 days, and assessed the effect of sprayed and unsprayed invasive plant leachate on the seed germination and seedling growth of two co-occurring native macrophytes, *Typha latifolia* and *Ammannia robusta*. Leachate of both treated invasive plants contained glyphosate, with *P. australis* leaching more glyphosate on average than *T.* × *glauca*. Native *T. latifolia* germination and growth were not impaired by leachate either with or without glyphosate. *Ammannia robusta* germination and growth exhibited mixed responses, with some indication that plant leachate and glyphosate residues exert inhibitory effects. We recommend that invasive plant management plans consider the potential for glyphosate-sprayed plant material to release glyphosate. Removal of invasive plant material from areas near vulnerable species can limit potential impacts from glyphosate residues and allelochemicals in leachate.

Student Presentation – M.Sc.

Acute Toxicity of Palladium to the Chemosensory Response in Rainbow Trout (*Oncorhynchus mykiss*)

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Keywords: chemosensory detection, bioaccumulation, palladium, rainbow trout

Platinum group elements (PGEs) are desirable for industrial applications due to their exceptional physical and chemical properties. Despite their widespread use, few toxicological studies have been explored using these metals. Of the six PGEs, demand for palladium (Pd) has steadily increased over the years resulting in increased extraction, processing, and occurrence in the environment. Use of Pd in vehicle exhaust catalysts has led to its unprecedented accumulation in the environment, especially in aquatic ecosystems. Despite its growing and widespread use, there are few available data on Pd ecological risk assessment. As well, the uptake and toxicity of Pd to aquatic species remains largely unknown. This study aims to investigate the Pd-induced chemosensory response in juvenile rainbow trout using electro-olfactography (EOG). Fish were exposed to concentrations ranging from 0 µg/L - 120 µg/L of Pd for 96-hours. Two odorants, taurocholic acid (TCA) and L-alanine, were investigated to assess the fish's ability to perceive both social (TCA) and food (L-alanine) cues. Accumulation of Pd within a variety of tissues was also quantified. Neurophysiological data from EOG analysis demonstrate that Pd causes sublethal chemosensory impairment in juvenile rainbow trout after a 96-h exposure. Findings also reveal that Pd equally inhibits a fish's ability to detect both social and food cues. Lastly, Pd was found to accumulate within gill and olfactory tissue only. Taken together, these results suggest that Pd could pose a realistic risk to aquatic organisms, and that more data is needed for a comprehensive risk assessment of this data poor metal.

Student presentation – M.Sc.

Assessing Hormones and Growth Promoters in Watershed Soils and Surface Runoff Water from Fields Under Different Manure Application Methods

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Applying cattle manure to agricultural fields is a common manure management strategy with the potential to facilitate the transport and release of manure-borne steroid hormones and growth promoters into ecosystems. To minimize environmental impacts, identifying manure management practices that contribute less hormones to ecosystems is essential. Therefore, this research aims to determine if watershed soils, and surface runoff water from conventional (constant) and precision (variable) rate manure-amended fields differ in hormone and growth promoter occurrence and levels. Beef cattle manure – from windrow piles, and watershed soils and runoff waters – from nine watershed basins, was collected from within three field application zones: commercial fertilizer (control), constant manure rate, and variable manure rate. Chemical analysis was used to assess compound concentrations in manure and soil samples collected May and August of 2019, and water samples collected March and June of 2019, and April of 2020. Analytes targeted in manure, soil, and water samples included natural and synthetic hormones, their metabolites, and a β-adrenergic agonist: estrone, trenbolone acetate, melengestrol acetate, 17α-trenbolone, 17β-trenbolone, trendione, melengestrol, and ractopamine. Chemical analysis revealed no measurable analyte levels in any samples. Since hormones are often active at levels below chemical detection limits, reporter gene bioassays were used to assess androgenic activity of 2019 samples. Mirroring chemical analysis results, no androgenic activity was detected in any samples by the bioassays. Future work will assign and identify anti-androgenic, and (anti-)estrogenic activities and concentration equivalents in manure, soil, and water using reporter gene bioassays.

Student presentation – M.Sc.

Determining the Differences in Effect of Chromate, Chromite, and Chromium Picolinate in Rainbow Trout (*Oncorhynchus mykiss*)

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Keywords: Chromium, Metals, Proteomics, Toxicology

The Ring of Fire is a region in the James Bay Lowlands of northern Ontario, slated for mining development. The 2127 km^2 region houses the world's richest deposit of chromite. It is also a part of the world's largest peatland, as well as a part of the traditional territory of several Indigenous communities. Due to the geography of the Ring of Fire region, Cr^{6+} and Cr^{3+} contamination in the water is a possibility. Chromium in its hexavalent form can result in carcinogenic, genotoxic, cytotoxic and neurotoxic effects. Cr^{3+} has been shown to be genotoxic due to its role in DNA adduct formation. The goals of this study are to better understand the relative effects of Cr^{6+} to Cr^{3+} in fish, and to identify potential non-lethal biomarkers to distinguish between Cr^{6+} and Cr^{3+} exposure. Furthermore, we also wish to determine whether chromium picolinate has a beneficial or harmful effect in rainbow trout, as it is a commonly prescribed nutritional supplement. To do this, we nominally exposed sexually immature rainbow trout to potassium chromate (0.02 ppb, 0.2 ppb & 20 ppb), chromium (III) acetate (0.02 ppb, 0.2 ppb & 20 ppb) and chromium picolinate (20 ppb) under flow through conditions in the lab. We then sampled blood from the chromium exposed rainbow trout and used LC-MS/MS to characterize the plasma proteome of fish from each treatment. We also performed a micronucleus assay on red blood cells to determine potential genotoxicity for phenotypic anchoring. In this presentation, we will present the preliminary results from these analyses, and identify what biological processes are affected by the different chromium treatments. The reported results are from the measured chromium concentrations and speciation in the water. We hope that this study will lead to the advancement of knowledge on chromium toxicity in fish, in order to protect wild fish populations, as well as all of the people and organisms that inhabit the Ring of Fire region of Canada.

Student presentation – Master of Environmental Science (MES)

Investigation of the effect of metals and selective serotonin reuptake inhibitors on the development of freshwater gastropod embryos

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Keywords: metals, SSRIs, gastropod, embryo

Gastropods are not well studied compared to other freshwater species in ecotoxicology. Additionally, embryonic development in freshwater gastropods is not formally characterized, resulting in their developmental milestones rarely being used for ecotoxicological endpoints. It is increasingly important now to improve our understanding of the impact of contaminants to freshwater gastropod embryos and their development, considering the intense change that many populations are experiencing through exposure to pollutants, including metals and selective serotonin reuptake inhibitors (SSRIs). Mining and metallurgic industry activities lead to heightened levels of metals in many aquatic systems. Current wastewater systems lack the necessary infrastructure to remove SSRIs fully before they enter surface waters. The focus of this study was to examine the impact of metals and SSRIs on the development of freshwater gastropod embryos. The embryos of the freshwater pulmonate snail *Planorbella pilsbryi* were exposed to the metals copper, cadmium, and nickel, as well as SSRIs citalopram, paroxetine, fluoxetine, and sertraline. Our preliminary results demonstrate that both the metal and SSRI interactions with the egg mass membrane result in adverse outcomes at increasing concentrations, each with varying levels of toxicity. Certain metals such as copper and SSRIs are able to fully disrupt embryo development, some after only a day of exposure. However, exposure to other metals such as cadmium are less disruptive to embryo development but result in adverse outcomes for juveniles after hatching. This data may help predict the adverse outcomes of similar contaminants to gastropod populations in the wild.

A device for one-pot microplastic extraction from lotic and lentic water samples

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Keywords: microplastics, extraction, isolation, detection

The increasing importance of microplastic detection for environmental pollution emphasizes the need for affordable, readily available and accurate extraction equipment. We developed a device that enables one-pot digestion and density extraction using readily available stainless-steel equipment. The device provides flexibility and modularity to incorporate a variety of methodologies to isolate and extract microplastics from a multitude of matrices. To determine efficiency, water samples were collected from local stormwater ponds and the North Saskatchewan River and spiked with fluorescent polyethylene microspheres of various sizes (63µm-710µm) and densities (0.996-1.22g/cc). To isolate solids, samples were strained through to a 37µm stainless steel mesh. Removal of organic matter was accomplished by digestion with Fenton's reagent. After digestion, the solution was drained in place and the apparatus was refilled with a saturated solution of NaCl (1.17g/mL) to separate materials by density. A valve enables isolation of floating plastics, which were transferred to a gridded filter for microscopic photography and enumeration. This entire process was accomplished in a closed system, ensuring minimal loss and reducing contamination from vessel transfers. Preliminary results shows that recovery rates for our one-pot methodology vary from 65-100% for particles >250µm and 35-95% recovery for PE microspheres between 63-150µm. The modularity of this system allows an individual to modify the system based on what they wish to accomplish for MP detection and extraction by adapting and interchanging various parts to accommodate other matrices (e.g. sediment), or by altering filter sizes, density extraction solutions, and digestion methods.

The presence of sediment alters the toxicity of cadmium and microplastic to the benthic freshwater invertebrate, *Hyalella azteca*

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Keywords: metals, mixtures toxicity, sediment toxicity

Metals are ubiquitous in freshwater environments and pose potential risks to the health of aquatic organisms as many metals, such as cadmium, are non-essential and toxic to freshwater species. Microplastics are emerging contaminants due to the increased use of plastic in consumer products. The inevitable introduction of microplastics to freshwater systems by domestic and commercial effluent results in increasing occurrence of microplastics in aquatic systems globally. While it is unclear whether microplastics are toxic to aquatic life, microplastics can interact with metals, allowing them to serve as an uptake vector for other known toxicants. Microplastics are frequently detected in aquatic organisms as they are easily ingested due to their small size. Most research investigating microplastic mixtures toxicity has been focused on water-borne exposures. To understand the impact of sediment on the toxicity of cadmium and microplastic mixtures to an epibenthic species, we exposed Hyalella azteca to sub-lethal concentrations of cadmium, microplastics, and their mixture and monitored apical and behavioural endpoints after 96-hours. The presence of sediment hindered survival and movement and increased mortality in microplastic-containing treatments. This work suggests the potential for microplastic-sediment interactions that may impact toxicity and highlights the importance of including sediment when assessing ecologically relevant microplastic mixture toxicity scenarios.

2. Field Ecotoxicology

Student presentation – M.Sc.

Influence of Different Catchment Features on Stream Water Quality in The Grand River Watershed

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Keywords: water quality, benthic macroinvertebrates, agriculture, spatial variability

Streams are nested, hierarchical structures wherein the larger scale characteristics constrain the smaller components, determining instream ecology. A catchment-scale study is necessary to effectively analyze and compare the complex interactions that influence stream water quality. The objective of this study was to assess the influence of different catchment landscape and instream characteristics on water quality across a gradient of agricultural intensity in the Grand River watershed in Southern Ontario. Twenty-one sites across the central watershed were sampled in October 2020 and June 2021. A micro-basin polygon was generated for each site wherein land drainage at each site was mapped and analyzed for spatial heterogeneity (i.e., land use, surficial geology, riparian buffer extent) using ArcGIS®. At each site, benthic macroinvertebrate assemblages were sampled, water chemistry samples collected and measured directly, and habitat quality assessed. It is hypothesized that micro-basins with a greater proportion of agricultural best management practices (i.e., greater buffer extent, cover crop presence) would contain better water quality as indicated by the water chemistry measurements and macroinvertebrate community composition. Shannon diversity index values for the October 2020 invertebrate data ranged from 1.5 to 2.7, species richness ranged from 18 to 33, and the EPT index ranged from 10 to 50. Greater diversity, richness, and percent EPT values were associated with micro-basins that had a lower gradient of agricultural land use and greater riparian buffer presence, suggesting that land use and buffer extent play a large role in determining stream health. An enhanced understanding of the landscape characteristics that most significantly influence water quality will help watershed managers provide accurate recommendations for upstream catchments to preserve stream health.

Histopathological examination of Lake Chub (*Couesius plumbeus*) in a tributary adjacent to Canadian Oil Sands Activity

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Keywords: Oil Sands, Histolopathology, Field Biology, Wild Fish Health Monitoring

The Fort McMurray region in Northern Alberta is rich in polycyclic aromatic hydrocarbons (PAHs). Naturally occurring exposed bitumen beds combined with Oil Sands industry expansion and surface mining activity in the region contribute to PAH richness in the aquatic environment. As a result, resident fish may be exposed to either naturally occurring sources of bitumen or anthropogenically refined sources extracted through surface mining. The Ells river located approximately 60 km north-east of Fort McMurray serves as the predominant drinking water source for the First Nations and Métis communities of Fort McKay, as well as representing an important food gathering location. As such, the health and productivity of this tributary is of high importance. Previous studies have reported a myriad of health effects in fish exposed to PAHs including altered visual acuity and reproductive effects. This study employs a histopathological examination of the effects of PAH exposure on various tissues of adult lake chub (*Couesius plumbeus*) at two sites in the Ells River. These sites were selected to represent (a) an upstream reference site falling outside of the McMurray deposit and (b) a downstream site within the deposit, potentially impacted by anthropogenic development. At each site, 20M and 20F wild fish were collected, and gill, gonad, intestine and eye were all dissected and preserved for subsequent histological analysis. Eyes of fish from the downstream site exhibited smaller lenses and altered retinal layers relative to eyes in upstream fish. Fish from both sites demonstrated significant gill hyperplasia and other deformities. No effects were observed in the intestine. This work contributes to a larger wild fish health monitoring program on the lower Athabasca River and its tributaries.

Student presentation – M.Sc.

Improving Monitoring of Fish Health in the Athabasca Oil Sands Region Using Regularization Techniques and Water Quality Variables

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Keywords: Alberta oil sands, Environmental monitoring, Variable selection, Machine learning

The ongoing industrial development of the oil sands region in Alberta Canada has raised concerns about potential impacts it may have on the local environment. Trout-perch are monitored as proxy variables for the overall health of aquatic ecosystem. Fish health has previously been modeled using categorical variables such as year and site. This research seeks to improve upon existing models by replacing the general explanatory variables with year-site specific water quality measures. We employ the lasso and elastic net procedures to select a subset of variables for modeling. We find that the use of water quality measures paired with regularization techniques greatly improves the predictive accuracy over the traditional regression models. Additionally, we find that some of the variables selected by the regularization techniques are not being actively monitored in the Athabasca River suggesting that current monitoring programs and protective regulations may not be sufficient in scope.

Student presentation – M.Sc.

Identifying Metabolic Indicators of Cyanobacteria and Comparing the Temporal Changes in Algal Community Composition in Two Lake Ontario Areas of Concern.

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Keywords: harmful algal blooms, Lake Ontario, cyanobacteria, metabolomics

When the surface waters of freshwater lakes are warm, still, and abundant with nutrients in the summer, algal blooms can transition into harmful algal blooms (HABs) where toxins are produced and ecosystem health is reduced. In addition to toxins, areas of hypoxia formed during HAB decomposition can impair or kill aquatic life. Furthermore, predicting HABs is resource-intensive and is not often practical in smaller aquatic systems. However, changes in algal community composition over the progression of the summer could give insight into how algae behave leading up to and following a HAB. Additionally, the point at which an algal bloom transitions into a HAB is not fully understood but algal metabolites could be used as indicators. Similarly, temporal changes in algal protein abundance might help to identify the transition point. We think that molecular and community-level information will better predict the transition to a toxic HAB than models based on nutrients alone. This study consisted of ten weeks of sampling in 2020 from August to October in Hamilton Harbour and the Bay of Quinte, two Lake Ontario areas of concern. Species composition was obtained via microscopy and water quality parameters were assessed. Metabolomics and proteomics were performed using liquid chromatography mass spectroscopy to identify changes in metabolites and proteins over time. Our preliminary data from these analyses will be presented within the context of community-level interactions among freshwater algae. Ultimately, we expect the results of this study will expand our ability to predict when algal blooms will transition to produce toxins and strengthen the knowledge between key water quality variables and the progression of HABs.

Student presentation – Ph.D.

Are fish attracted to wastewater? The impacts of wastewater effluent on fish communities in summer and winter

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Keywords: wastewater treatment plant effluent, Hamilton Harbour, biodiversity, seasonality

Municipal wastewater treatment plant (WWTP) effluents are a ubiquitous source of contamination whose impacts on fish and other aquatic organisms span across multiple levels of biological organization. Despite this, few studies have addressed the impacts of WWTP effluents on fish communities, especially during the winter—a season seldom studied. Here, we assessed the impacts of wastewater on fish community compositions and various water quality parameters during the summer and winter along two effluent gradients in Hamilton Harbour, an International Joint Commission Area of Concern in Hamilton, Canada. We found that fish abundance, species richness, and species diversity were generally highest in sites closest to the WWTP outfalls, but only significantly so in the winter. Fish community compositions differed greatly along the effluent gradients, with sites closest and farthest from the outfalls being the most dissimilar. Furthermore, the concentrations of numerous contaminants of emerging concern (CECs) in the final treated effluent were highest during the winter. Water quality of sites closer to the outfalls was poorer than at sites farther away, especially during the winter. We also demonstrated that WWTPs can significantly alter the thermal profile of effluent-receiving environments, increasing temperature by as much as 9 °C during the winter. Our results suggest that wastewater plumes may act as ecological traps in winter, whereby fish are attracted to the favourable temperatures near WWTPs and are thus exposed to higher concentrations of CECs. This study highlights the importance of winter research as a key predictor in further understanding the impacts of wastewater contamination in aquatic ecosystems.

Student presentation – M.Sc.

Assessing Characterizing Arsenic and Mercury Levels in Fish Tissue in the Mushkegowuk Territory, Northern Ontario

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Keywords: fish; metal(loid)s; exposure assessment, risk communication

Natural and anthropogenic processes can impact mercury and arsenic levels in the environment and biota. Mercury bioaccumulates in fish and may present health risks for wild fish consumers. Additionally, while organic arsenic compounds are known to be less harmful to health, inorganic arsenic is a carcinogen and is highly toxic. Through this proposed work, we are characterizing the links between environmental change, water quality, fish health, food safety, and food security in Fort Albany First Nations community.

FIShNET includes two components: 1) human health research, and 2) environmental monitoring. Due to the COVID-19 pandemic, the first component has been postponed.

For the second component our lab is focusing on analyzing fish samples samples collected in 2017 by Dr. Alex Litsinov in partnership with Fort Albany First Nation and Mushkegowuk Council. We are characterizing mercury and arsenic contamination in these fish tissue samples of Cisco, Lake Whitefish, and Northern Pike. Initial analyses show elevated levels of total arsenic in some species, and there are existing consumption advisories based on total mercury and total arsenic levels date generated by the province of Ontario. Due to a lack of information on arsenic speciation, the health risks posed by the reported arsenic levels are highly uncertain currently. Arsenic speciation analyses will therefore occur in 2021.

The main outcomes of this work include i) quantification of inorganic arsenic levels in fish tissue; and ii) communication of exposure assessment knowledge on mercury and arsenic contamination to Fort Albany First Nation.

Findings will support public health strategies that promote traditional food reliance in ways that limit contaminant exposure and will inform measures to improve food security in the context of global climate change.

Student Presentation – M.Sc.

Contaminants and nutrients in the subsistence fisheries of the Saint John River: Do benefits outweigh risks?

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Keywords: mercury, fatty acids, subsistence fishing

Fish from the Saint John River (SJR), NB support the subsistence fisheries of six First Nations communities. Fish provide a rich source of essential fatty acids (EFAs), including eicosapentaenoic acid and docosahexaenoic acid, which aid in neurocognitive development and cardiovascular health. Nevertheless, the health risks from methylmercury contamination can undermine the nutritional value of fish. Furthermore, the SJR contains a large hydroelectric dam, and dams are known to change mercury (Hg) speciation and mobilize previously sequestered Hg, increasing its bioaccumulation in fish. The objectives of this study were to: 1) characterize Hg and EFA profiles in subsistence fish from the SJR, 2) examine how Hg and EFAs vary geographically in relation to the dam, and 3) determine how Hg and EFAs vary with trophic position and basal food source, as measured by $\delta^{15}N$ and $\delta^{13}C$ ratios, respectively. Smallmouth Bass (*Micropterus dolomieu*; SMB), Yellow Perch (*Perca flavescens*; YP), and snails were collected in 2020 from sites upstream and downstream of the dam and are being analyzed for total Hg concentrations, fatty acid profiles and stable isotope ratios ($\delta^{15}N$, $\delta^{13}C$). 50% of the SMB exceeded Canadian guidelines for retail fish. SMB caught just downstream of the dam had the highest Hg concentrations compared to other sites, whereas YP had their highest Hg concentrations upstream from the dam. Furthermore, significant positive associations were observed between Hg and $\delta^{15}N$ in SMB. Next, we will analyze how EFAs vary among the species and sites in relation to the dam. These results will inform the local First Nation communities of risks and benefits of consuming traditional foods.

Student presentation – M.Sc.

Quantification of microplastics in biotic and environmental samples taken near municipal wastewater treatment plants

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Keywords: Microplastics, Wastewater

While microplastics (small plastic particles <5 mm in size) are present in municipal wastewater effluents, the fate of these contaminants in downstream abiotic and biotic compartments warrants further investigation. The Grand River and its tributaries in southern Ontario, receive inputs from 30 municipal wastewater treatment plants (WWTPs). Of the plants in this region, the Kitchener and Waterloo WWTPs use secondary treatment and service a population of ~140,000 and ~240,000 people, respectively. The present study evaluated whether microplastics levels in the digestive tracts of wild caught rainbow darter (*Etheostoma caeruleum*), and in water and sediment samples, were elevated near WWTP outfalls. Ten rainbow darter were collected from 10 sites up- and downstream of the Kitchener and Waterloo WWTPs in the fall of 2019 using a backpack electrofisher; surface water and sediment samples were also collected from each site. Tissue was digested in 20% KOH and environmental samples were processed using filtration and density separation prior to visual identification. Compared to less impacted sites, particles were significantly elevated in sediment samples at the Waterloo outfall, and in water samples at the Kitchener outfall. Particles in rainbow darter did not reflect elevated environmental levels at either WWTP outfall site. Fibers were abundant across all sample types, aligning with previous research that has primarily identified fibers in samples collected near WWTPs. To confirm whether these particles are microplastics, samples will undergo Raman spectroscopy. Overall, these results will contribute to our understanding of the stressors impacting this system and will inform future studies looking at the impacts of microplastics on riverine biota.

3. Risk Assessment

Correlation between pesticides in vitro toxicity and in vivo risk guidelines in support of risk assessment: A meta-analysis

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Keywords: human cell lines; pesticides; toxicity; IC50

While in vitro cell systems as a suitable alternative model for animal testings are used to support hazard characterization and identify mechanisms involved in the toxicity, effectively using in vitro data for risk assessment is challenging. As part of a large interdisciplinary effort to assess the human health risk of a complex pesticide mixture, we aimed to evaluate in vitro assays that could be used in a human health risk assessment format.

PubMed, Web of Science (ISI), and Medline were systematically searched for studies that assessed the toxicity of pesticides on human cell lines. The IC50s derived from the evaluated endpoints were compared to NOEL/NOAELs and ADIs using Spearman correlation and linear regression models.

Out of 2362, 66 studies met the inclusion criteria. In total, our database included 108 pesticides evaluated at four endpoints on ten human-derived cell types. While human neuroblastoma cells (SH-SY5Y) were the most sensitive, HepG2 was the most used cell line in evaluating the toxicity of pesticides. The IC50s derived from SH-SY5Y cells, using MTT-24 & 48 h (the most used assay) showed significant correlations ($\rho = 0.56 - 0.79$; $p < 0.05$) with ADIs and NOEL/NOAELs.

From all the used cell lines only SH-SY5Y cells showed a significant correlation with in vivo guidelines. The high sensitivity of SH-SY5Y cells suggests that they could be appropriate cells to assess pesticide toxicity. Further research is needed to investigate the toxicity of more pesticides on SH-SY5Y cells to ensure their usefulness for predicting in vivo risk guidelines.

Student Presentation - Ph.D.

Using Time Course of Histopathological and Behavioural Changes to Identify Target Organ Toxicity in a Rat Model Following Oral Exposure to Contaminated Groundwater from an Industrial Site

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Keywords: Complex groundwater mixture, Sprague Dawley rats, Toxicity

Groundwater containing a complex mixture of known and unknown contaminants was collected from an industrial site for characterization of toxic effects. An oral exposure to a single concentration (0.05% v/v) of groundwater compared to control (7, 14, 28, and 56 days exposure) in male Sprague Dawley rats (n=10/group). A transient, significant increase in white blood cell count was seen in the day-7 experimental group compared to the control. Blood smears showed occasional lymphocytosis and neutrophilia, but these did not differ significantly with treatment at any time-point. Moreover, 40% of the experimental rats at all time points had bite cells. Bone marrow smears showed hypercellularity after 56 days contaminated drinking water consumption compared to control. While gross behaviour appeared normal, a novel object exploratory test showed an increased duration and number of interactions in the 56 day-exposed rats. In summary, this study provides a framework for future studies of unknown, complex mixtures to characterize a broad range of toxic effects and target organs. The evidence of immunotoxicity, hematotoxicity, and neurological toxic effects, that will be explored in more mechanistic detail with a targeted dose-response experiment in the second tier of experiments.

Student Presentation – PhD

Predicting the toxicity of historic gold mining using lake sediment cores as historical archives

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Keywords: risk assessment, sediment, Giant Mine, legacy contamination

Ore processing techniques used in Yellowknife's largest mining operation, Giant Mine, is responsible for the atmospheric release of approximately 20,000 tonnes of particulate arsenic trioxide and other heavy metal(loids). This rapid deposition of heavy metal(loids) is thought to have caused ecological disturbances to aquatic food webs. Here we examine lake sediment cores from 20 lakes within a 50km radius of Yellowknife. These cores were dated by ^{210}Pb and ^{137}Cs, and metal(loid) concentrations were determined in each. Toxicity of sediment intervals to aquatic biota were assessed using palaeotoxicity modelling. We found that metal(loid) profiles in sediment peaked during the height of mining operations. These peak metal(loid) concentrations were highest in lakes near the mine's roaster stack, and decreased with distance from the stack. Temporal analysis of lakes closest to the mine, and in the predominant wind direction, show probable adverse effects to biota even prior to the onset of mining operations. However, these risks increased substantially during the period of gold mine operations in the region. In recent years, the toxicological risk has decreased in some lakes. Although our results show a pattern of recovery in the region, the results indicate that aquatic ecosystems in Yellowknife continue to have lingering effects to aquatic biota despite the closure of the mine two decades ago.

Student presentation – B.Sc.

Exposure Assessment of Pesticides in Surface Waters of Ontario, Canada, from 2002 to 2016

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Keywords: Environmental exposure distributions, Environmental monitoring, Detection frequency

The objectives of this study were 1) to characterize the exposure of aquatic ecosystems in Southern Ontario to pesticides by constructing environmental exposure distributions (EEDs) including censored data; 2) use the EEDs to predict the probability of exceeding regulatory guidelines; and 3) assess whether crop types in catchments of sampling sites correlate with the pesticide(s) detected. Surface water samples were collected from the Great Lakes and its associated tributaries over a 15-year period by Environment and Climate Change Canada (ECCC). The dataset contained 167 compounds, sampled across 114 individual sites, and had a total of 2,213 distinct samples. There were 67,920 total data observations: 55,058 non-detects (81%), and 12,862 detects (19%). We ultimately focused on two compounds, atrazine and glyphosate. Atrazine had an overall detection frequency of 91.4%. The maximum observed concentration of atrazine-river or stream (18,600 ngL^{-1}) and 4.3% of the samples in the generated EED exceed the regulatory acute guideline (1,000 ngL^{-1}). However, the calculated 99^{th} centile of the EED (4,067 ngL^{-1}) indicates that these are rare occurrences in streams. Regression analysis between the annual average atrazine concentrations and percent land coverage of corn was performed and showed a significant relationship (r^2 = 0.26, p = 0.05). Glyphosate (n = 427) was the 11^{th} most detected compound (33.3% detection). The modelled 50^{th} centile concentrations indicated glyphosate-Pond (2,004 ngL^{-1}), and glyphosate-River or stream (383 ngL^{-1}) had the two highest "average" concentrations of the dataset, with measured maximum concentrations smaller than their 99^{th} centiles, potentially pointing to the existence of higher peak concentrations missed in sampling. Overall, both the data and generated models for glyphosate had <0.01% chance of exceeding of acute benchmarks. This study provides important insight into the risk that pesticide compounds can pose to aquatic ecosystems in southern Ontario, and the approach taken here could be modelled in other jurisdictions.

Student presentation – Ph.D.

Evidence for the effectiveness of the use of fish molecular mechanistic responses in regulatory risk assessment: A systematic review and assessment using the Bradford Hill criteria for causality

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Keywords: risk assessment, molecular mechanistic responses, adverse outcomes, fish

Mechanistic toxicology approaches are increasingly considered as tools to address limitations of traditional risk assessment methods that are time and resource intensive and heavily rely on live animal testing. However, the adoption of such approaches is still limited. The objective of this systematic review was to evaluate the current evidence supporting the inclusion of molecular mechanistic responses in regulatory risk assessment based on their potential to establish causal relationships between toxicant exposure and adverse apical outcomes in fish. We searched four databases to conduct three systematic literature searches according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidance. The studies selected were included in two lines of evidence either focusing on molecular effects analyses alone (LOE1) or on both molecular and apical outcomes analyses in fish (LOE2). These were then evaluated against the nine principles of the Bradford Hill criteria to quantitatively determine the weight-of-evidence for the use of molecular data for regulatory purposes. During this review, a lack of information about the “specificity”, “temporality” and “consistency” of the association between exposure and effect in fish were noticed in a majority of studies considered under each LOE. Thus, “specificity” and “temporality” criteria were not met by both LOEs and “consistency” criterion was not met by LOE1. However, as the other principles were met by both LOES, this review was considered as strongly supportive for the inclusion of molecular responses in regulatory risk assessments. Nevertheless, future efforts to standardize molecular effects testing such as transcriptomics, proteomics and metabolomics analyses would be necessary to increase their applicability for regulatory risk assessments.

Student presentation – B.Sc

Assessing AhR-mediated toxicity of benzotriazole ultraviolet stabilizers (UV-P, UV-9, UV-090) using in vivo microinjection exposure and in vitro AhR activation assay.

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Keywords: UV stabilizers, Microinjection, LRG assay, Zebrafish

Plastics are a ubiquitous environmental contaminant and contain various chemical compounds that enhance the longevity and quality of the product. Specifically, the addition of benzotriazole ultraviolet stabilizers (BUVS's) helps prevent the degradation and discoloration of plastics. Due to improper disposal of plastics, chemicals such as BUVS's can leach and into aquatic ecosystems. As a result, BUVS's are ubiquitously detected in aquatic environments and biota, causing concern for the health of fishes and other aquatic wildlife. There is currently only limited toxicity data present for BUVS's, but these studies suggest that certain BUVS's might dysregulate the aryl hydrocarbon receptor (AhR) causing early life stage toxicity in fishes. Therefore, there is need for a more comprehensive analysis of the effects caused by exposure to BUVS's and risks posed by these chemicals. The present study exposed embryos of zebrafish (*Danio rerio*) to precise serial doses of three priority BUVS's, namely2-(benzotriazol-2-yl)-4-methylphenol (UV-P), 2-(Benzotriazol-2-yl)-4-methyl-6-prop-2-enyl-phenol (UV-9), or 2-[3-(2H-benzotriazol-2-yl)-4-hydroxyphenyl]ethyl methacrylate (UV-090) through microinjection. Toxicity of each priority BUVS was assessed by recording early life stage malformations and mortality. Embryos exposed to BUVS experienced mortality in a dose-dependant manner, with UV-P, the most potent chemical tested, having the highest median lethal dose (LD50) and UV-090 being the least potent chemical with the lowest median LD50. Additionally, the extent to which each of the BUVS activates the AhR was determined with a luciferase reporter gene (LRG) assay using COS-7 cells transfected with the AhR of zebrafish and two native fish species of regulatory concern in Canada. Results from this study will guide more objective assessment of risks posed by BUVS's for the protection of Canada's diverse fish populations.

New Draft Federal Environmental Quality Guidelines; Aluminium, Siloxanes (D4), Selenium

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Keywords: guidelines, aquatic life, water quality

Federal Environmental Quality Guidelines (FEQGs) provide thresholds of acceptable quality in the ambient environment in support of various federal activities including risk assessment, risk management, and environmental quality monitoring. Where the FEQG is met there is low likelihood of adverse effects from the chemical on aquatic life directly exposed via the water or sediment or through the diet for chemicals that may bioaccumulate in wildlife that consume aquatic life (e.g. birds and mammals). Draft FEQGs will soon be published for a 60-day public comment period for three substances; aluminium (water quality guideline), siloxane D4 (water, sediment, tissue, and wildlife diet guidelines), and selenium (fish tissue and bird egg guidelines). This presentation will provide a brief introduction to environmental quality guidelines and a summary of the new draft guidelines.

Aluminium- The draft FEQG for water follows the current CCME (2007) derivation protocol and uses a multiple linear regression (MLR) approach allowing for the incorporation of toxicity modifying factors pH, DOC, and water hardness for site-specific application.

Selenium- CEPA Risk Assessment (2017) predicted no effect concentrations (PNECs) have been adopted as draft fish tissue FEQGs and the draft bird egg FEQG is adopted from the USEPA (2019).

Siloxane D4- The PNEC from the CEPA Risk Assessment for D4 (2008) has been adopted as the draft FEQG for water. Additional guideline values for sediment and wildlife diet were developed according to CCME protocols (1995, 1998) while the aquatic biota tissue guideline was developed using the target lipid model.

Student presentation – M.Sc.

Identification of molecular toxicity pathways of benzo[a]pyrene in early-life stage rainbow trout (Oncorhynchus mykiss)

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Keywords: benzo[a]pyrene, toxicogenomics, risk assessment, alternative toxicity testing

Traditional approaches in ecological risk assessment primarily focus on toxicology studies that identify apical outcomes such as growth, reproduction, and survival, which require time to manifest and often indicate significant damage has already occurred. With new chemicals entering the market yearly, new approach methods (NAMs) are needed for regulatory agencies to reach decisions about the environmental risk of chemicals in a timely, effective, and ethical manner. Identification of molecular events that underly apical responses could be the key to predicting the ecological risks of chemical contamination before irreversible damage occurs. The establishment of such emerging approaches requires careful calibration with outcomes across biological levels. Environmental contaminants with a well-described toxicology such as polyaromatic hydrocarbons (PAHs) are prime candidates. The objective of this research is to establish an embryo toxicity model for PAHs in fish by describing and linking toxic responses across biological levels from early molecular alterations to apical outcomes of regulatory relevance. Embryo-alevin assays using early life-stage rainbow trout (RBT) were exposed in replicates of five to graded concentrations (water, vehicle control, 1, 3, 9, 27, and 81 ug/L) of benzo[a]pyrene (B[a]P) under static renewal conditions. Embryos were sampled 4 days post hatch (dph), with remaining fish continuing through to 28 dph. Endpoints (body weight, length and morphological abnormalities) were measured for individuals at both time points, with histological analysis in RBT 28 dph. Toxicogenomic and biochemical response patterns in RBT 4 dph will be assessed via transcriptomic analysis, EROD and oxidative stress assays. Morphometric analysis in 28 dph early fry indicate differences in body length at higher B[a]P exposure concentrations, with a noticeable decreasing trend in body weight. Responses at the molecular level will be linked with changes in apical outcomes to further cement relationships between molecular and individual level effects of exposure.

Student presentation – M.Sc.

The application of in-vitro in-vivo extrapolation using isolated perfused trout livers towards high throughput screening of environmental contaminants

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Keywords: in-vivo, in-vitro, biotransformation, modeling

Bioconcentration factor (BCF) is one of the most common endpoints in chemical risk assessment, informing bioaccumulation status. While BCF as determined from in-vivo whole fish exposures is still considered the gold standard to inform this criterion, there is growing concern in academia, governments, and industries about the suitability and reproducibility of this test, especially for chemicals that are biotransformed. Alternative approaches using in-vitro biotransformation assays based on hepatocytes or liver sub-cellular fractions in combination with in-vitro in-vivo extrapolation (IVIVE) models have been developed as potential replacements. However, extrapolation to BCF is complicated by confounding factors, e.g., extrahepatic biotransformation and quality issues with experimental BCFs. Therefore, there is a need for an ex-situ model at an intermediate level of biological organization. A recently developed method is that of the rainbow trout isolated perfused liver, seeking to reduce uncertainty in IVIVE of clearance rates of chemicals. The present study seeks to obtain hepatic clearance data of four environmental contaminants of interest within the isolated perfused trout liver and cross-validate with prior standardized in-vitro methods. Livers of sexually immature rainbow trout were cannulated via the hepatic portal vein and perfused for six hours with a physiological buffer spiked at varying concentrations of pyrene, 4-nonylphenol, deltamethrin, and methoxychlor. Afferent and efferent samples were taken in 15-minute intervals across the perfusion period. Samples were analyzed using high-performance-liquid-chromatography with fluorescence detection (HPLC-FLD) and gas-chromatography (GC) to calculate hepatic extraction fraction and clearance. Results demonstrate that this experimental method can be used to validate IVIVE models, as illustrated by the excellent fit of predicted versus measured hepatic clearance values. This study has the potential to settle an important debate in this field and enables scientists to focus on other factors to allow for confident predictions of bioconcentration in fish.

Student presentation – B.Sc.

PFAS "Forever Chemicals" in your takeout food containers

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Keywords: PFAS, fast-food packaging, food-contact materials, PIGE

PFAS are a class of chemicals that are highly persistent in the environment and pose an array of threats to the health of humans and biota. PFAS are widely used in industrial processes and in consumer products due to their oil and water-repelling properties. Despite increasing scientific evidence linking adverse health effects to PFAS exposure, this class of chemicals is poorly regulated in many parts of the world, including Canada which has implemented controls on only a few of the many PFAS.
The goal of our study is to determine the prevalence of PFAS in Canadian and US fast-food packaging, including paper bags, compostable bowls and other food-contact materials from popular restaurants. Results showed the prevalence of PFAS in specific items, notably in paper donut bags, bagasse paper ("compostable") takeout bowls and popcorn bags. For example, total fluorine analysis of fast-food packaging revealed 2235 ppm fluorine in a "compostable" bagasse takeout container and 783 ppm F in a paper bakery bag. Inclusion of these containers in the recycling stream can contaminate paper products with PFAS and disposal to landfills leads to accumulation of PFAS in landfill leachate, ultimately entering the environment. The joint Canadian-US project now seeks to understand the breadth of products sold in Canada that contain PFAS and to estimate the fate of this PFAS.

Risk Based Approach to Hardness Modified Joint Action Sulfate and Chloride Toxicity in an Industrial Process Water Discharge

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Treatment of groundwater for removal of salts by several processes leaves residual wastewater that is elevated in sulphate and chloride. At our client's industrial site, it mixes with site runoff in a reservoir prior to discharge to the Conestogo River. Expansion of plant capacity required an amended Environmental Compliance Approval with discharge limits for the two major ions. Detailed understanding of in-plant waste streams allowed collection of a series of composite and ion-specific samples for acute toxicity testing and chemical characterisation. This provided hardness-modified lethal thresholds for the joint action of chloride and sulphate exposures which were used to recommend effluent limits. Assimilation analysis of the receiver showed no impacts from past discharges or predicted impacts from discharges at the limits of 640 mg/L for Cl and 5140 mg/L sulphate. Monitoring protocols were developed for episodic discharges, for discharges after drought periods with no runoff to dilute the process water and to separate the role of uncontrolled road salt runoff from that of controllable inputs of process water in determining discharge characteristics.

4. Chemistry

Student presentation – M.Sc.

Predicting the metabolism and biotransformation of 'novel' organophosphate esters (OPEs): in silico modelling to prioritize OPEs of potential environmental concern

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Keywords: OPEs, biotransformation, fate and transport, in silico modelling

Following the phasing out and regulation of many brominated flame retardant (BFR) chemicals, production and usage of organophosphate esters (OPEs) has increased as both replacements for BFRs and as plasticizers. With the current state of transition in the flame retardant industry from BFRs to OPEs, research has been conducted concerning the fate of OPEs in the environment, including water, wastewater, sewage, soil, sediment and biota as well as occurrence, transport and biotransformation. Many legacy, commonly studied OPEs have been reported at environmental concentrations higher than the BFRs they replaced, are frequently sampled in water and wastewater worldwide, and even detected in remote polar regions, suggesting long range transport. As a large class of compounds, with industrial production often including isomers and complex mixtures, there are several 'novel' OPEs which remain less well-studied. Lacking data as to their biotransformation and stability, the environmental fate of 'novel' OPEs remains largely unknown and the growing industrial trend towards polymerization adds further uncertainty regarding the implications of longer chained, oligomeric OPEs of higher molecular weight.
Several 'novel' OPEs, much like their legacy counterparts, have been detected in remote environments and in biota across several species, indicating ubiquitous environmental distribution. To assess the stability of these novel compounds in the environment, biotransformation and metabolism were predicted via in silico modelling tools (OECD Toolbox v4.4.1, EPI SuiteTM). In vitro and in vivo metabollites are predicted for rat liver S9 and microsomal fractions, with physicochemical properties, biotransformation rate constants and biodegradability estimated for each metabolite. Based on these data, specific 'novel' OPEs are proposed as warranting prioritization for future research due to the potential for greater environmental concern. The metabolism and stability of long-chain, high moleuclar weight OPEs is specifically compared to other shorter-chain 'novel' compounds.

5. Policy and Regulation

***Student presentation* – Ph.D.**

Developing environmental assessment programs using fish-oriented environmental services

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Keywords: ecosystem services, environmental impact assessment, environmental monitoring, fish

Environmental Impact Assessment (EIA) is a process that considers positive and negative aspects of a development project to determine if it should be approved and with what mitigation. To assist in the decision-making process, the Ecosystem Services (ES) concept was developed to describe the ecosystem attributes that create benefits for human well-being. In Canada, a dominant aspect of the environmental protection process requires meeting the needs of the *Fisheries Act*, which requires that fish, fish habitat, and the use of fish are protected. The challenge, as in many countries, is that the regulatory processes and evaluation procedures for environmental risk assessment, environmental assessment, cumulative effects assessment, and post-operational impact assessments are disjointed and poorly aligned, which creates ineffective monitoring programs filled with a discord of different approaches and metrics. It is possible that re-orienting the Canadian environmental assessment process along the lines of critical needs and benefits from the perspectives of the *Fisheries Act* could serve to better align risk, development, and monitoring assessment processes. We will present the critical ecosystem functions from a fish perspective and suggest how a fish-oriented ES approach could be incorporated into the design of monitoring programs to better align pre-development, development, and post-operational monitoring programs.