SETAC – PNC
4th Annual Meeting
Lethbridge
June 7- 8, 2013

University of Lethbridge

Sharing Water Resources in a Growing Economy: Science to Policy

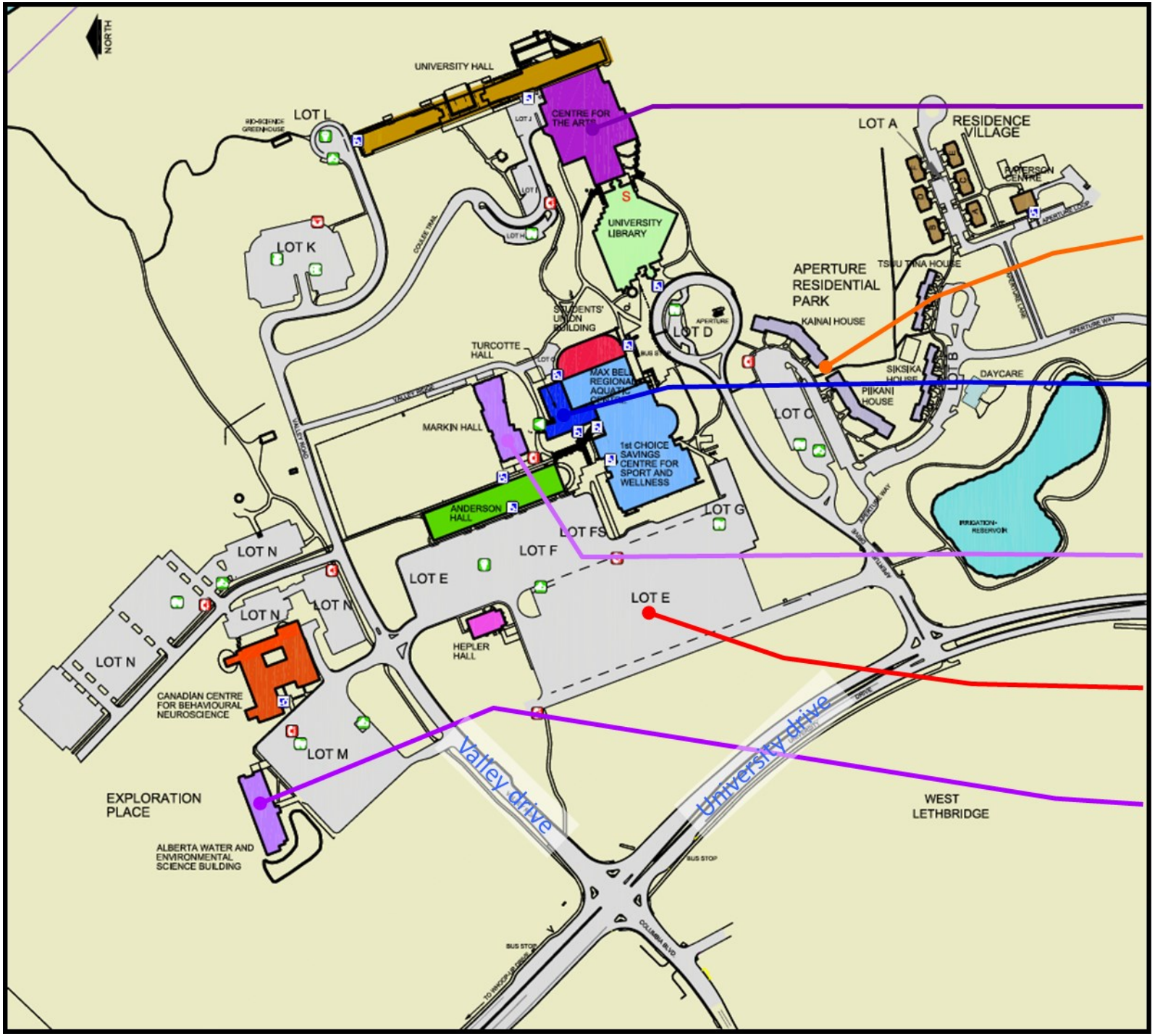
1 – **Residence**
University of Lethbridge
See university map for location
reservation through:
http://goo.gl/ZZB5F
(cheapest and closest location)

2 – **Lethbridge Lodge Hotel**
320 Scenic Dr S, T1J 4B4
(403) 328-1123

3 – **Days Inn Hotel**
100 3 Ave S, T1J 4L2
(403) 327-6000

4 – **Holiday Inn Express**
120 Stafford Dr. S, T1J 4W4
(403) 394- 9292

5 – **Coast Lethbridge Hotel**
526 Mayor Magrath Drive,
T1J 3M2
(403) 327-5701



Banquet & Silent auction
University Hall Atrium

Residence

Platform sessions & Onsite registration
Turcotte Hall TH 201

Saturday course
TH 204

Poster session & Lunch
Markin Hall Atrium

Parking
Lot E

Thursday evening registration
AWESB

SETAC - PNC

Society of Environmental Toxicology and Chemistry
Prairie Northern Chapter Annual meeting

SETAC-PNC is very grateful for the support of our sponsors!

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Conference Information

Local Organizing Committee:

Co-chairs: Drs. Alice Hontela and Greg Pyle

Members: Drs. Andreas Luek and Bill Dew

Student Liaison: Jeff Decker

Emergency information: If emergency services are needed phone 911.

University of Lethbridge security contact: ext. 2345

Registration and booklet pick up:

- Thursday June 6th, the registration desk will be in the lobby of the Alberta Water and Environmental Science Building (AWESB) from 4:30-10:00 pm, light snacks will be provided
- Friday June 7th, the registration desk will be in Turcotte Hall outside of TH201 (presentation room)

Registration fees: Your registration fee covers the costs associated with your entry to all scientific sessions, as well as the following meals, refreshment breaks and receptions:

- Thursday evening light snacks
- Friday morning coffee break
- Friday lunch
- Friday afternoon coffee break

Name badges: Please wear your name badge during all meeting activities.

Cell phone etiquette: Please turn off or mute your cell phones during the scientific sessions and plenaries.

Smoking: Smoking is prohibited within Turcotte and Markin Hall.

Platform presenters: PowerPoint presentations or PDF files should be submitted to the student volunteer in TH201 from 7:30 am onwards. In addition, please identify yourself to the Session Chair before the session begins.

Poster presenters: Please put your posters up on Friday, June 7th, from 8:00 to 10:00 am in the Markin Hall Atrium. Posters will be taken down by the afternoon coffee break on Friday, June 7th by student volunteers, and brought to TH201.

If you require assistance putting up your poster please see the registration table It is important that students are present next to their poster during the poster session.

Student Competition: Winners will be announced at the end of the Banquet.

Silent Auction: Bring your items to the registration desk or banquet. All silent auction items will be available to view in the University Hall Atrium before and during the banquet.

Any silent auction item purchased for under $20 will be a cash only sale, and items that sell for more than $20 can be paid for by cash or cheque. Please make your cheque payable to: ***The Prairie Northern Chapter of SETAC.***

We would like to express our gratitude to SETAC for donating a variety of books for our meeting.

Session Chairs: Drs. Alice Hontela and Andreas Luek

Time	*Presenter*	*Platform presentations (TH 201)*
8:00	Introductory remarks	Alice Hontela (Local organizing committee Co-chair, University of Lethbridge) Chris Nicol (Dean, Faculty of Arts and Science, University of Lethbridge) Karsten Liber (Director, Toxicology Centre, University of Saskatchewan)
8:15	**Plenary Talk** **Wendell Koning** **(Alberta Environment and Sustainable Resource Development)**	**Water quality issues in the South Saskatchewan River Basin (Alberta)**
8:45	Lars Brinkmann (U of Lethbridge)	Bioenergetic effects of food web simplification on mercury biomagnification in northern pike (*Esox lucius*)
9:05	Ava Zare (U of Calgary)	Effects of environmental contaminants on goldfish liver and gonad transcripts
9:25	Brett Lucas (U of Saskatchewan)	Reconstructing temporal trends in nutrient availability and primary productivity within Lake Diefenbaker, a great plains reservoir, using depositional sediments
9:45	Jonathan Challis (U of Winnipeg)	Nutrients, pharmaceuticals, and antibiotic resistance genes in municipal wastewater after wetland treatment: A case study at Grand Marais, MB, Canada
10:05		*Coffee Break*
10:20	Jith Thomas (U of Saskatchewan)	Sensitivity of early life stages of zebrafish (*Danio rerio*) to selenium
10:40	Bill Dew (U of Lethbridge)	Comparison between the effects of copper at the olfactory epithelium and gills of fish
11:00	Carol Best (U of Calgary)	The antidepressant venlafaxine at environmentally relevant levels disrupts the stress response in rainbow trout.
11:20	David Saunders (U of Saskatchewan)	Investigation into endocrine modulation and TCDD-like effects of three novel brominated flame retardants: TBPH, TBB & TBCO
11:40	Alistair Brown (U of Winnipeg)	Poly- and perfluorinated compounds (PFCs) in indoor air, and their impact on young children in Winnipeg, Manitoba

Session Chairs: Drs. Bill Dew and Greg Pyle

Time	*Presenter*	*Platform presentations (TH 201)*
12:00		*Lunch – Markin Hall Atrium*
1:00		*Poster session – Markin Hall Atrium*
2:00	**Plenary Talk** **Kelly Munkittrick (COSIA)**	**A new paradigm for monitoring the cumulative effects of stressors**
2:30	Erin Faught (U of Calgary)	Plasma Hsp70 levels as a biomarker of environmental stress in rainbow trout
2:50	Jon Doering (U of Saskatchewan)	Investigation into sturgeon responses to dioxin-like compound exposure through whole transcriptome analysis
3:10	Leanne Flahr (U of Saskatchewan)	Effects of Aroclor 1254 on migratory behaviour in juvenile European starlings
3:30		*Coffee break*
3:45	**Plenary Talk** **Greg Goss (U of Alberta)**	**Much Ado about (almost) nothing**
4:15	Shawn Beitel (U of Saskatchewan)	*In vitro* assessment of the disruption of steroidogenesis in three North American fish species
4:35	Zhe Lu (U of Manitoba)	Stereoselective formation of hydroxylated polychlorinated biphenyls by rat cytochrome P-450 2B1 isozyme
4:55	Tanja Wildemann (U of Saskatchewan)	Cardiovascular effects of lead in rats: Is there a safe level?
5:15	Steven Knaus (U of Saskatchewan)	Activation of the renin-angiotensin system explains high pulse pressure in rats during vitamin D deficiency but not toxicity
5:35	Closing Remarks	Greg Pyle (Local organizing committee Co-chair, University of Lethbridge)
6:30		*Cocktails in the University Hall Atrium*
7:00		*Banquet and Silent Auction (University Hall Atrium)*
Saturday 9am-2pm	**Kelly Munkittrick (COSIA)**	**Design of field monitoring and research programs – 10 stupid things not to do (TH 204)**

Plenary Speaker

Wendell Koning

Wendell Koning is a limnologist (one of 12) working for the provincial department of the Environment (Alberta Environment and Sustainable Resource Development). His key functions are: water quality monitoring program design, data interpretation and reporting. All his work is in the southern part of the province. Additional duties include working with various stakeholders in watershed management programs. His educational background includes a BSc and MSc from the U of Alberta. His past employment includes environmental consulting throughout western Canada and overseas in China.

Wendell Koning, M.Sc.,P.Biol., Limnologist
Regional Operations, Southern Region
Alberta Environment and Sustainable Resource Development

Plenary Speaker

Kelly Munkittrick

Kelly came to COSIA from the University of New Brunswick, where he held the Canada Research Chair in Ecosystem Health Assessment and was the Scientific Director of the Canadian Water Network, part of the Networks of Centres of Excellence of Canada. He is a co-founder of the Canadian Rivers Institute, was Co-leader of the Lakes Working Group for the United Nations University's review of GEF international waters projects, and sat on the Great Lakes Fisheries Commission Board of Technical Experts where he led the theme on Ecosystem Dysfunction. Previously, he worked for Environment Canada as the Project Chief with the Ecosystem Health Assessment Project at the National Water Research Institute and as a research scientist with Fisheries and Oceans' Great Lakes Laboratory for Fisheries and Aquatic Sciences. He has developed regional and national monitoring programs in South America, Asia and North America, and has worked with governments to improve environmental assessment models. Dr. Munkittrick received a B.Sc. in fish and wildlife biology in 1980 and an M.Sc. in environmental physiology in 1983, both from the University of Guelph. He completed his PhD in 1988 in Aquatic Toxicology at the University of Waterloo.

Kelly R. Munkittrick, Ph.D.
Director, Environmental Monitoring and Risk Assessment, COSIA.

Plenary Speaker

Greg Goss

Dr. Goss is the Executive Director of the newly formed University of Alberta Water Initiative. He is also Director of the Office of Environmental Nanosafety at the University of Alberta and works jointly with industry and the National Institute of Nanotechnology on research projects to develop new materials for environmental clean technologies. He is the scientific co-leader on a large multi-institutional research grant focusing on the safer application of nanotechnologies. He is a Professor in Biological Sciences and is cross-appointed to the School of Public Health and the National Institute of Nanotechnology. He is also past-President of the Canadian Society of Zoologists, serves on the Council for numerous national and international societies and advisory boards, is an Associate Editor of the Canadian Journal of Zoology and on the Editorial Board for 2 other international journals. He also is the President of a consulting company, Aquosity Environmental Consulting that consults for government agencies on environmental justice cases. Dr. Goss was appointed Assistant Professor in July 1997, and earned ranks of Associate and Full Professor in July of 2002 and 2005, respectively. Prior to his faculty position, Dr. Goss held two post-doctoral appointments at Hospital for Sick Children, Toronto, Ontario and Beth Israel Hospital, Harvard Medical School, Boston, MA. He completed his B.Sc. (1986) and M.Sc. (1988) at McMaster University and obtained a Ph.D. in 1993 at the University of Ottawa. In 2008, Dr. Goss was awarded the Killam Annual Professorship at the University of Alberta and in 2010-11, was a McCalla Professor at the U of A. He is the past winner of the Petro-Canada Young Innovator Award, the Canadian Society of Zoologists Early Investigator Award and the American Physiological Society Young Investigator Award.

Dr. Goss' currently leads a large research group (~19 HQP) focused in the areas of environmental toxicology and physiology with grants from both government and industry sources. His work focuses on effects of micro pollutants in industrial and municipal wastewater on fishes. He also has programs testing the efficacy of novel engineering approaches in mitigating effects of these micro pollutants and in the safety of nanomaterials at they are introduced into commerce.

Greg Goss, PhD
Professor, Department of Biological Sciences / School of Public Health
University of Alberta Water Initiative
Fellow, National Institute of Nanotechnology
Director, Office of Environmental Nanosafety

PLENARY TALK
8:15 AM

Water quality issues in the South Saskatchewan River Basin (Alberta)

Wendell Koning
Limnologist, Alberta Environment and Sustainable Resource Development, Calgary, AB

Much of southern Alberta lies within what is formally called the semi-arid region of North America. We have few natural lakes, and our rivers are small in flow. There are multiple demands for our surface waters in the south, from urban to agricultural supply, and in particular for irrigation use. Water quality issues in our southern water bodies include the potential impact of climate change (reduced flows); providing for sufficient environmental (instream) flows; managing nutrient loading, especially below major urban centres; responding to concerns about pharmaceuticals and other endocrine disrupting substances; cyanobacteria blooms in reservoirs and dugouts; determining the origins of waterborne pathogens, in particular in water bodies subject to urban and agricultural/livestock presence; and the desire to more intensively manage our surface waters, recognizing seasonal (summer – winter) differences in conditions. Much of our current work is now conducted in partnership with stakeholders, and therefore there is a stronger educational/communication component and a desire for transparency in data and decision-making.

8:45 AM

Bioenergetic effects of food web simplification on mercury biomagnification in northern pike (*Esox lucius*)

Brinkmann, Lars and Rasmussen, Joseph B.

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Fish communities in reservoirs can vary based on access routes and other factors. Certain species constitute important trophic links in food chains, performing critical roles in the energy transfer between the food web base and higher consumers. As such they also affect the transmission of contaminants, such as mercury, whose primary route of exposure is through dietary uptake. This study investigated the importance of lake whitefish, a zooplanktivore inhabiting some reservoirs in southern Alberta, as a resource for the apex predator northern pike, and its effect on growth and mercury biomagnification in this common sport fish. In the absence of lake whitefish, diets of northern pike were dominated by macrobenthos, whereas lake whitefish formed the primary dietary component in lakes where it occurs. Food chains were longer in the presence of lake whitefish. Concomitant with an invertebrate diet, growth rates of pike in the absence of lake whitefish are lower than in piscivorous pike, consistent with reduced growth efficiency in pike feeding on invertebrates. Mercury levels in apex consumers are linked to both food chain length and growth efficiency, which determine the exposure level and biomagnification factor from prey to consumer, respectively. Biomagnification rates relative to their diet were higher in pike feeding on invertebrates, consistent with a pattern of poor growth efficiency. However, overall mercury levels in pike were lower in the absence of lake whitefish, due to shorter food chains and low mercury levels in the diet of these fish.

9:05 AM

Effects of environmental contaminants on goldfish liver and gonad transcripts

Zare Ava, Jackson Leland, and Habibi Hamid R.

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The presence of contaminants with hormone like activity in water supplies and aquatic ecosystems and their potential harmful effects have been a major concern for over 30 years. Previous work in our lab has demonstrated the presence of environmental contaminants and significant female-biased sex ratios (up to 90% female) in Longnose Dace (*Rhinichthys cataractae*), populations in the Oldman River, Alberta. High expression of the egg yolk protein vitellogenin (Vtg) mRNA in male dace provided evidence for exposure to contaminants with estrogen-like activity. Organic contaminant analyses by Alberta Environment and our labs have found Bisphenol A (BPA), Nonylphenol (NP) and Bis(2-ethylhexyl)phthalate (DEHP) present in relatively high concentrations in the Oldman River. We exposed goldfish (*Carassius auratus*) to environmentally measured concentrations (individually and in mixture) of these chemicals for 10 days and measured, via quantitative real-time PCR, the expression of genes involved in reproduction, gonadal differentiation and development (Vtg, DMRT, subtypes of estrogen receptors, AR, STAR, aromatase, LHR, FSHR) in gonad and hepatic tissue. Results indicate that these contaminants have endocrine disrupting ability and suggest mechanisms by which contaminants may have induced feminization of male fish and disrupted the expression of the genes involved in testicular development. These contaminants dysregulate fish responsiveness to endogenous estrogen and differentially regulate male and female gene expression. We also demonstrate that gene expression differs when fish are exposed to individual contaminants and the mixture.

9:25 AM

Reconstructing temporal trends in nutrient availability and primary productivity within Lake Diefenbaker, a Great Plains reservoir, using depositional sediments

B.T. Lucas[1], K. Liber[1, 2], P.D. Jones[1, 2], J.P. Giesy[1, 3, 5], H.S. Wheater[4], and L.E. Doig[1]

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[2]School of the Environment and Sustainability, University of Saskatchewan, Saskatoon, SK
[3]Dept. Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon, SK
[4]Global Institute for Water Security, Saskatoon, SK
[5]Dept. of Biology & Chemistry, City University of Hong Kong, Kowloon, Hong Kong, China

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Lake Diefenbaker, a reservoir created in 1967, supplies drinking water to 65% of Saskatchewan's population. Anecdotal evidence suggests an increasing frequency and severity of algal blooms within the reservoir. Blooms typically emerge due to increased nutrient availability (e.g., phosphorus) and thus there is a need to investigate nutrient loading trends. A paleolimnological study was conducted to reconstruct the historical nutrient status of Lake Diefenbaker using physicochemical variables and subfossil remains archived in depositional sediments. Cores of sediments were collected along the reservoir to evaluate spatial patterns. Cores were vertically sectioned into 1-cm increments and a subset analyzed for total phosphorus, three sedimentary forms of phosphorous (apatite inorganic, non-apatite inorganic, and organic phosphorus), total organic carbon and nitrogen content, and nitrogen stable isotope ratios to determine temporal trends in nutrient loading and primary productivity within the reservoir. Subfossil remains of diatoms were isolated from each section and taxonomically identified to species level (minimum of 300 valves per sample). Results indicated that phosphorus loading, primary productivity and diatom community composition have remained relatively constant throughout the temporal profiles of sediment cores collected at three up-reservoir locations. However, increased phosphorus loading and increased levels for indicators of primary productivity were observed in more recently deposited sediments from down-reservoir sediment core samples. These cores also showed three major shifts in diatom community composition suggesting changes in nutrient loading and primary productivity over time. Strong correlations were observed between total organic carbon content and both total sediment phosphorus concentrations and the more biologically available phosphorus fractions (the non-apatite inorganic and organic phosphorus fractions). The results seem to suggest that phytoplankton populations are light limited in up-reservoir locations due to high turbidity. Light-limitation seems to be lifted at down-reservoir locations resulting in phytoplankton growth and greater utilization of nutrients.

9:45AM

Nutrients, pharmaceuticals, and antibiotic resistance genes in municipal wastewater after wetland treatment: A case study at Grand Marais, MB, Canada

Anderson, Julie C.[1], Carlson, Jules C.[1,2], Low, Jennifer E.[1], Challis, Jonathan K.[1,3], Wong, Charles S.[1,3], Knapp, Charles W.[4], and Hanson, Mark L.[2]

[1]Richardson College for the Environment, Department of Environmental Studies and Sciences and Department of Chemistry, The University of Winnipeg, Winnipeg, MB
[2]Department of Environment and Geography, University of Manitoba, Winnipeg, MB,
[3]Department of Chemistry, University of Manitoba, Winnipeg, MB
[4]David Livingstone Centre for Sustainability, University of Strathclyde, Glasgow, UK

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The discharge of complex mixtures of nutrients, organic micropollutants, and antibiotic resistance genes (ARGs) from treated municipal wastewater into freshwater systems are global concerns for human health and aquatic organisms. In the rural community of Grand Marais, Manitoba, Canada, wastewater is treated passively in a sewage lagoon prior to passage through a treatment wetland and subsequent release into surface waters. Using this facility as a model system for the Canadian Prairies, the two aims of this study were to assess: (a) the presence of nutrients, micropollutants (i.e., pesticides, pharmaceuticals), and ARGs in lagoon outputs, and (b) their potential removal by the treatment wetland prior to release to surface waters in 2012.

Concentrations of nitrogen and phosphorus species were greatest in the lagoon and declined with movement through the wetland treatment system. Pharmaceutical and agricultural chemicals were detected at concentrations in the ng/L range. Concentrations of these compounds spiked downstream of the lagoon following discharge and attenuation was observed as the effluent migrated through the wetland system. Results suggest that the wetland attenuated atrazine and carbamazepine significantly. Hazard quotients calculated for micropollutants of interest indicated minimal toxicological risk to aquatic biota. There was no significant targeted removal of ARGs in the wetland and our data suggest that the bacterial population in this system may have genes imparting antibiotic resistance.

10:20 AM

Sensitivity of early life stages of zebrafish (*Danio rerio*) to selenium

Thomas, J.K.[1] and Janz, D.M.[1, 2]

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[2]Department of Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon, SK

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Chronic exposure to environmentally relevant concentrations of dietary selenium (Se) is reported to cause reproductive toxicities in both warm and cold water fishes. The goals of the present study were to investigate toxicities of an organic-Se compound, selenomethionine (SeMet), to early life stages of zebrafish via maternal transfer and microinjection exposure routes, and to compare the sensitivity of zebrafish to early life stages of other fishes to Se toxicity. In the maternal transfer exposure study, adult zebrafish were fed different concentrations (1, 3, 10 or 30 µg/g dry mass) of Se in the form of SeMet for 90 days. After the exposure period, larvae were collected to study the occurrence of developmental toxicities and mortality. In the microinjection exposure study, embryos were injected with different doses (1, 3, 10 or 30 ng/egg) of SeMet to mimic natural maternal transfer of SeMet and to test whether such exposure shows similar results as maternal transfer of SeMet. Statistically significant increases in developmental toxicities and mortalities were observed after exposure to SeMet by both routes. A species sensitivity distribution based on Se toxicity thresholds of fishes suggests that early life stages of zebrafish are the most sensitive fish species studied to date, and that zebrafish is a good laboratory model to investigate mechanisms of Se-induced toxicities in early life stages of fish.

10:40 AM

Comparison between the effects of copper at the olfactory epithelium and gills of fish

Dew, William A.[1], Azizishirazi, Ali[2], and Pyle, Greg G.[1]

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Present regulations concerning the safe concentration of copper in waterways is based on lethality testing with a variety of aquatic species. The lethal effect of copper to fish is driven by the interaction of copper with the gills of fish. Much is known about the complex interplay between copper, cations, and water chemistry at the gill, which drives the toxicity of copper to fish at the gills. In order to protect against non-lethal effects of copper to fish, it has been proposed that the olfactory epithelium (OE) be used to develop guidelines for safe copper concentrations in waterways. To that end, we tested whether or not a number of the observations of interactions between copper at the gill hold for the OE. Specifically, we tested if increasing copper exposure duration results in increased effect, whether calcium protects against copper-induced dysfunction, and whether copper induces an effect on the OE at the tissue level, or if specific elements of the OE are more or less susceptible to copper. Unlike at the gill where increasing copper exposure durations increase the effect of copper, increasing the exposure length of copper on the OE results in less effect over time. Calcium was shown to offer no protection to copper-induced dysfunction, and we demonstrated that only a subset of cells in the OE are impaired by copper. Taken together, the data demonstrates that assuming that copper interacts with the OE in the same manner as it does at the gill is ill-advised.

11:00 AM

The antidepressant venlafaxine at environmentally relevant levels disrupts the stress response in rainbow trout.

Best, Carol[1,2], Melnyk-Lamont, Nataliya[2], Gesto, Manuel[2], and Vijayan, Matt. M.[1,2]

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The antidepressant venlafaxine has been detected at low concentrations in municipal wastewater effluent, but its biological effects on non-target organisms are unknown. We tested the hypothesis that venlafaxine at levels detected in the aquatic environment disrupts the stress response in fish. Juvenile rainbow trout (*Oncorynchus mykiss*) were exposed to low levels of venlafaxine (0.2 and 1 µg/L) for seven days, after which they were subjected to an acute physical stressor or a social stressor. Venlafaxine exposure affected the levels of serotonin, dopamine and norepinephrine levels in a region-specific manner in the brain. The physical stressor-induced glucose response was attenuated by venlafaxine exposure, while there was no significant effect on plasma cortisol levels. To further assess the impact of venlafaxine exposure on social stressor response, a behavioural study using feeding as a proxy for dominance was carried out. While plasma glucose levels remained unchanged, cortisol levels in subordinate fish treated with venlafaxine were higher than in control subordinate individuals. Overall, environmentally relevant levels of venlafaxine disrupt the highly conserved adaptive stress responses in rainbow trout.

11:20 AM

Investigation into endocrine modulation and TCDD-like effects of three novel brominated flame retardants: TBPH, TBB & TBCO

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The novel brominated flame retardants (NBFRs), Bis(2-ethylhexyl)-2,3,4,5-tetrabromophtalate (TBPH), 2-ethylhexyl-2,3,4,5 tetrabromobenzoate (TBB), and 1,2,5,6 tetrabromocyclooctane (TBCO) are components of flame retardant mixtures including Firemaster 550 and Saytex BC-48. Despite the detection of these NBFRs in environmental and biotic matrices, studies regarding their toxicological effects are poorly represented in the literature. The present study determined potential endocrine disruption by these three NBFRs by use of the yeast YES/YAS reporter assay and the mammalian H295R steroidogenesis assay. Activation of the aryl hydrocarbon receptor (AhR) was also assessed by use of the H4IIE reporter assay. The maximum inhibitory effects of TBCO in the YAS-(74%) and YES-(46%) assays were observed at 300 mg L^{-1} and 30 mg L^{-1} respectively. Concentrations of 17β-estradiol (E2) were 3.3-fold greater in cells exposed to TBCO compared to controls. At 0.05 mg L^{-1} TBB also resulted in a 2.8-fold increase in concentrations of E2 compared to solvent controls. TBPH caused antagonistic effects in the YAS assay with a maximum inhibitory effect (59%) observed at 1500 ppm, and resulted in 5.3-fold greater concentrations of E2 compared to solvent controls. This is one of the first studies to demonstrate *in vitro* androgen and estrogen modulating potentials of TBPH, TBB, and TBCO.

11:40 AM

Poly- and perfluorinated compounds (PFCs) in indoor air, and their impact on young children in Winnipeg, Manitoba

Brown, Alistair[1], Nikoobakht, Neda[2]

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Poly- and perfluorinated compounds (PFCs) have been detected in humans and animals and have been found to be persistent, bioaccumulative, and toxic. Fluorotelomer alcohols (FTOHs), perfluorooctane sulfonamides (FOSAs), and perfluorooctane sulfonamidoethanols (FOSEs) have been shown to biodegrade into perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA). These compounds predominate in biological tissues, are widely detected in human blood and serum and are of concern due to their potential toxicity. This study is a component of the CHILD (Canadian Healthy Infant Longitudinal Development) study which follows young children's development in correlation to various environmental factors. We investigated the concentrations of the volatile neutral PFCs in indoor air in residential homes in Winnipeg, Manitoba, Canada. 77 air samples were collected over a 21 day period through passive air samplers containing (XAD - 4) sorbent- impregnated polyurethane foam discs, then analysed by gas chromatography- mass spectrometry. Indoor air was dominated by 8:2 FTOH and 10:2 FTOH with geometric mean concentrations of 629 and 459 pg/m^3, respectively. Among the FOSAs and FOSEs, MeFOSE exhibited the highest concentration with a geometric mean of 435 pg/m^3. There was a significant median increase, from summer to winter, in 8:2 FTOH (554%), and MeFOSE (111%). There was a consistent significant trend in 10:2 FTOH with respect to predicting concentrations in homes across 22 geographical coordinates in Winnipeg that had at least one child with wheezing episodes. Moreover, there appeared to be no significant correlation between home ambient temperature and changes in concentrations. To the best of our knowledge, this is the first time temperature was logged continuously (every 4 minutes) during the sampling periods to elucidate any trend.

PLENARY TALK
2:00 PM

A new paradigm for monitoring the cumulative effects of stressors

Kelly R. Munkittrick
Director, Environmental Monitoring and Risk Assessment, COSIA.

There are a wide variety of aquatic monitoring programs that currently exist in any watershed, including pre-construction environmental impact assessments, compliance permit monitoring, environmental effects monitoring (EEM), cumulative effects assessment, crisis and spills management, and regional and national monitoring programs. Linking the programs in a unifying framework is complicated by the absence of a common philosophy, or standardized study designs, and the absence of an integrated approach. The existing paradigm for ecosystem health assessment is based on the human medical paradigm of defining health. Historically, definitions of "normal" levels of responses are used to detect deviations from normal and the absence of "health". In effect, health is determined based on the absence of signs that there is poor health. This has resulted in the focus in ecological health assessment of defining reference levels, assessing deviation from normal and trying to evaluate the magnitude of change that would suggest poor health. The focus of determining health only signs of ill health challenges extrapolating retrospective assessments to assisting with evaluation of future potential impacts, or predicting the consequences of development. There is perhaps a more useful paradigm, where the ability of organisms to integrate responses can be used holistically to evaluate performance. Under this effects-based paradigm, study designs seek out natural variability, and a system self-defines its level of health, thresholds of responses, and triggers to inform management decisions. Relationships also translate ecological information into currencies relevant for land use planning, natural resource management and impact mitigation. It represent a simpler site-specific approach that requires a commitment to baseline monitoring, consistency, and commitment to long term planning that is usually absent in current situations.

2:30 PM

Plasma Hsp70 levels as a biomarker of environmental stress in rainbow trout

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Heat shock protein 70 (Hsp70) expression in response to various stressors is a highly conserved cellular stress response; however, the potential of plasma Hsp70 levels as a biomarker of environmental stress has yet to be explored. We developed a competitive antibody-capture enzyme linked immunosorbent assay (ELISA) for detecting low levels of Hsp70 in rainbow trout plasma. Validation of this ELISA was carried out by exposing trout to an acute heat shock (+10-12^{o}C above ambient temperature (13°C) for 1 h). To assess the short-term effect of heat on plasma Hsp70 levels fish were sampled at 1, 4 and 24 h, while long-term effects were evaluated by repeatedly sampling fish over 7 days. While plasma Hsp70 levels remained unchanged over a 24 h period, there was a significant decrease in the level of plasma Hsp70 at both 1 and 7 days after heat shock exposure compared to the control animals. Furthermore, a 14 d exposure to municipal waste water effluent (MWWE; either 20% or 90% MWWE) significantly reduced plasma Hsp70 levels in trout at 2 and 14 days post-exposure. Taken together, our results for the first time highlight the potential of using plasma Hsp70 levels as a biomarker of exposure to environmental stressors in fish.

2:50 PM

Investigation into sturgeon responses to dioxin-like compound exposure through whole transcriptome analysis

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Exposure to dioxin-like compounds (DLCs) causes adverse effects in fishes through activation of the aryl hydrocarbon receptor (AhR) pathway. Sturgeons are ancient species of fishes and little is known about effects of DLCs to these or other ancient fishes. In order to begin hypothesizing novel adverse outcome pathways for fishes, white sturgeon (*Acipenser transmontanus*) were exposed to the model AhR agonist, β-naphthoflavone (βNF), and transcriptional responses were evaluated by use of *Illumina* RNAseq by use of a *de novo* assembled reference transcriptome. Abundances of greater than 2,000 transcripts were altered in livers of sturgeon exposed to βNF compared to controls. Abundances of transcripts of genes known to be regulated by the AhR, including those encoding proteins that catalyse Phase I, II, and III metabolism of xenobiotics, were greater in livers from sturgeon exposed to βNF. In addition, abundances of transcripts of genes from pathways not known to be involved in activation of the AhR were different. For example, abundances of transcripts of genes involved in responses to low concentrations of oxygen, such as aryl-hydrocarbon receptor nuclear transporter (ARNT) and hypoxia-inducible factor 1 (HIF1α), were lesser in livers from sturgeon exposed to βNF. This could affect performance of sturgeon co-exposed to DLCs and hypoxia. Overall, next-generation sequencing technologies, such as *Illumina*, could prove useful in the discovery of novel biological responses to contaminants in non-model species.

3:10 PM

Effects of Aroclor 1254 on migratory behaviour in juvenile European starlings

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Onset of migratory restlessness, orientation, and navigation during avian migration are directly under neurological and hormonal control. Birds exposed to endocrine disrupting chemicals during development could develop neurological changes affecting learning and migratory behaviour. We are investigating the potential of Aroclor-1254, a PCB mixture, as a thyroid hormone disruptor in juvenile European starlings (*Sturnus vulgaris*). 84 birds were orally administered 0, 0.35, 0.70, or 1.05 µg Aroclor-1254/g-bw from 1 to 18 days post-hatch. Birds were taken into captivity and exposed to a 6-week photoperiod shift to simulate autumn migration. Morphological measurements were taken biweekly. Emlen funnel trials were used to assess migratory orientation and activity. There was a significant increase in mass, fat, and moult score over time. This, combined with a significant increase in activity as starlings were shifted from 13L:11D to 12L:12D (light:dark) photoperiod, demonstrates that migratory condition was induced in captive starlings. At 12L:12D, control birds showed a directional preference for 155.95° (South-southeast), while birds treated with 1.05 µg Aroclor-1254 exhibited a random distribution, indicating a lack of orientation ability. Instead, these birds showed a delayed directional preference for 197.48° (South-southwest) under 10L:14D, concomitant with delays in moult and fattening. These findings link alterations in avian behaviour to contaminant-specific mechanisms. We speculate that subtle alterations in development could give rise to larger-scale effects, including changes in cognition and migratory behaviour, which could partly explain observed global declines in migratory species.

PLENARY TALK
3:45 PM

Much Ado about (almost) nothing

Greg Goss
Professor, University of Alberta, Edmonton AB

Manufactured nanomaterials are already in the marketplace and, in all likelihood, are finding their way into our lakes, rivers and streams. However, due to the great diversity of nanomaterials, their incorporation into composites and the inability to detect them in environmental matrices, the challenge of assessment becomes quite daunting. Moreover, the lack of data with regard to distribution, measurement and effects will challenge our ability to proactive ensure the safe and successful implementation of these technologies. To understand the nature and mechanisms of nanoparticle toxicity, we have begun an ordered systematic approach to examine the potential effects various nanoparticles. In collaboration with materials scientists, we have investigated the transport, fate and toxicity of specific silicon (Si) and carbon based nanomaterials by varying side-group functionalizations of the core particle, varying the size of the particle and varying the charge of the particle. The goal of this research is to derive fundamental principles governing nanoparticle toxicity to serve as predictive indicators of potential toxicity. This talk will give a summary of our recent progress and outline the challenges facing our future research.

4:15 PM

***In vitro* assessment of the disruption of steroidogenesis in three North American fish species**

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There is concern regarding exposure of aquatic organisms to chemicals that interfere with the endocrine system. One critical mechanism of endocrine disruption is impairment of steroidogenesis that can lead to altered hormone levels, altered or delayed sexual development, and ultimately reproductive failure. There is also a need to address the large number of animals required by current toxicity testing approaches, particularly when working with species native to environments of concern. The aim of this study was to develop an *in vitro* gonadal explant assay enabling the assessment of endocrine disrupting chemicals on sex-steroid production in wild fish species. Northern pike (*Esox lucius*), walleye (*Sander vitreus*), and white sucker (*Catostomus commeroni*) were sampled from Lake Diefenbaker, Saskatchewan at pre-spawn and multiple post-spawn time-points. Gonads were excised and exposed for 24 hours to a model inducer (forskolin) and inhibitor (prochloraz) of steroidogenesis. Hormone concentrations in media were quantified using ELISA. Tissues exposed to forskolin showed a concentration dependent increase in 11-ketotestosterone and estradiol. Exposure to prochloraz resulted in a decrease of 11-ketotestosterone and estradiol. White sucker were found to be the most sensitive species, with the seasonal time-point of greatest sensitivity differing between sexes. Seasonality of reproductive function needs to be considered when using this here-established *in vitro* explant assay to assess responses of native species to disruptors of steroidogenesis, as the time-of-exposure is of great importance.

4:35 PM

Stereoselective formation of hydroxylated polychlorinated biphenyls by rat cytochrome P-450 2B1 isozyme

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The atropisomer enrichment of chiral PCBs by purified rat cytochrome P-450 2B1 (CYP2B1) and their hydroxylated metabolites were investigated *in vitro*. Rat CYP2B1 could stereoselectively biotransform chiral PCBs to generate 5-OH-PCBs as the major metabolites. Non-racemic enantiomer fractions (EFs) of 5-OH-PCBs were detected as 0.17, 0.20, 0.85, 0.77 and 0.41 for incubations with PCBs 91, 95, 132, 136 and 149, respectively. CYP -mediated stereoselective formation of diOH-PCBs was observed for the first time. Both 4-OH-PCB 95 and 5-OH-PCB 95 were stereoselectively biotransformed. These transformations generated non-racemic 4,5-diOH-PCB 95, with EFs of 0.58 and 0.53, respectively. The biotransformation interference between two atropisomers of PCB 136 was first time elucidated in this study. Our *in vitro* results were consistent with that observed for stereoselective PCB biotransformation by rat microsomes and *in vivo*. Thus, stereoselective metabolism of chiral PCBs and OH-PCBs by CYPs is a major mechanism for atropisomer enrichment of PCBs and metabolites in the environment, with the degree of enrichment dependent, at least in part, on stereoselective interference of atropisomers with each other at the enzyme level.

4:55 PM

Cardiovascular effects of lead in rats: Is there a safe level?

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BACKGROUND**:** Health Canada estimates average dietary intake of 0.1 µg/kg/day in Canadians. Epidemiological studies indicate an association between lead and hypertension, which is a leading factor in death from cardiac disease. The objective of this study was to confirm cardiovascular effects of sub-chronic, low level exposure to lead in rats and determine thresholds for effect.

METHODS**:** Male rats (n = 3-6) were exposed for 4 weeks to lead acetate in the drinking water ranging from 3 to 42000 µg/kg/day). Ultrasonography of the carotid artery and heart were performed at 0, 2 and 4 weeks of exposure. After 4 weeks, ECG and blood pressure were measured.

RESULTS**:** Dose-response relationships were generally U-shaped. Systolic and diastolic blood pressure decreased significantly at doses ≤7 µg/kg/day. However, systolic pressure increased significantly at doses ≥1500 µg/kg/day compared to control. Other cardiovascular endpoints evaluated were not significantly altered by lead.

CONCLUSIONS**:** In human health risk assessment, such dose-response curves can be used to derive No-Observed-Adverse-Effect-Levels (NOAELS). Based on the results in this study, the suggested sub-chronic NOAEL for cardiovascular effects is 53 µg/kg/day. Since the estimated daily intake for the average Canadian is less than this NOAEL, only select sub-populations (e.g. occupational exposures) are at risk of hypertension. However, longer term exposures may potentially put average Canadians at risk.

5:15 PM

Activation of the renin-angiotensin system explains high pulse pressure in rats during vitamin D deficiency but not toxicity

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This study investigated mechanisms linking cardiovascular disease and vitamin D status. The goal is to provide a stronger basis for establishing vitamin D requirements and supplementation limits that consider cardiovascular health. Male Wistar rats were fed diets with deficient, normal, or toxic vitamin D levels for 28 days. Intra-arterial blood pressure and heart rate were monitored using telemetry. Plasma renin and angiotensin II were measured to assess activation of renin-angiotensin system (RAS). Plasma α-2-macroglobulin was measured to assess inflammation. Pulse pressure was significantly increased during vitamin D deficiency and toxicity ($p<0.05$ in Fisher's LSD after 1-way ANOVA; n=3). In vitamin D deficient rats, renin levels were significantly increased ($p<0.05$; n=7). Angiotensin II levels followed a similar trend but there was no significant difference ($p=0.067$; n=6-7). In vitamin D toxicity rats, there was a trend for α-2-macroglobulin to increase ($p=0.067$; n=6). In rats, both vitamin D deficiency and toxicity lead to increased pulse pressure, a known risk factor for adverse cardiovascular outcomes. Increased renin levels during vitamin D deficiency support the hypothesis that vitamin D is needed to suppress renin release and prevent hypertension. In contrast, inflammation may be the mechanism for increased pulse pressure during vitamin D toxicity. These differing mechanisms need to be considered for determining optimal vitamin D supplementation.

POSTER 1: Sub-chronic exposure of fathead minnow (*Pimephales promelas*) to environmentally relevant concentrations of glyphosate and the glyphosate-based herbicide Roundup

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Glyphosate (*N* – (phosphonomethyl) glycine) is currently the most widely used agricultural herbicide globally. Initially identified in 1970 to have herbicidal properties, glyphosate is now a crucial tool in modern agricultural weed control. Sold under a variety of trade names, glyphosate-based herbicides were initially praised for the active ingredient's low toxicity to non-target organisms. However, recent evidence has suggested that adjuvants and surfactants included in commercial formulas can have negative effects, particularly on non-target species in the aquatic environment. In this study, fathead minnows were exposed to environmentally relevant concentrations of commercially available glyphosate-based herbicide as well as the active ingredient separately to determine differential effects of exposure to a sentinel fish species. Following a 21 day exposure fish were assayed for a range of biochemical, physiological and molecular endpoints including; brain acetylcholinesterase (AchE) activity, liver vitellogenin expression as well as gonad aromatase and steroidogenic acute regulatory (StAR) protein expression. Following treatment and subsequent recovery, differences in mortality, brain AChE and gene transcription were observed. Fish swimming endurance was assayed, prior to and following herbicide exposure, to determine effects of exposure on energy storage and metabolism. Individuals exposed to herbicide were less able to recover from endurance trials than controls, suggesting glyphosate based herbicides may negatively affect energy storage and metabolism. (Funding provided by Alberta Institute for Water Research).

POSTER 2: Assessment of physicochemical and microbiological water quality of the Rawal Lake, Islamabad

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Physicochemical and Microbiological analysis of surface water of Rawal Lake was investigated for a period of eight months. Rawal Lake in Islamabad, Pakistan is an artificial reservoir that provides the water needs for the cities of Rawalpindi and Islamabad. Grab water samples were collected according to standard protocols from ten different locations of lake and tributaries. Temperature, pH, Electrical Conductivity, Dissolved Oxygen, Hardness, Alkalinity and Turbidity of water samples were determined onsite to study the water quality characteristics. The physicochemical parameters showed higher values at the tributaries as compared to the sampling locations within the lake such as values of hardness and alkalinity were 298 mg/L and 244 mg/L respectively at the tributary of Nurpur stream. Bacterial strains were isolated by streaking on differential and selective growth media by observing colony morphology and template DNA was prepared from pure cultivated bacteria using Norgen DNA isolation kit and the 16S rRNA analysis was performed using 27F/1492R primers for bacteria. Sequencing was performed by using Big Dye terminator cycle sequencing kit. Sequences of nearest relatives were identified by BLAST and used as reference sequences for phylogenetic analysis. Phylogenetic characterization of microbes showed various phylotypes, including *Firmicutes, Teobacteria* and *Proteobacteria*.

POSTER 3: Toxicological effects of tailings pond water on waterfowl using captive mallards (*Anas platyrhynchos domestica*) as an experimental model

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In the Alberta Oil sands large quantities of waste water are produced during bitumen extraction. By-products are stored in tailings ponds and include fine particulate matter, hydrocarbon solids, sand, water and residual bitumen. These large, open bodies of water are attractive to waterfowl. Experts contend ponds pose little threat to birds provided they do not encounter bitumen, and do not remain on the water for long periods. Very little data exists to test this assumption and toxicological studies often use very high concentrations of toxic material and expose birds by invasive methods such as intubation, methods not necessarily representative of natural processes. In order to emulate the repeated short-term exposures to tailings water that birds are thought to experience in the oil sands, Pekin ducks (*Anas platyrhynchos domestica*) were exposed to repeat multi-hour baths in either control or recycled tailings pond water over two years. Each trial consisted of three exposures over three weeks; weights, body measurements, and blood samples were collected. Toxicity will be evaluated through clinical biochemistry, endocrinology, hematology, and heavy metal analyses. If recycled tailings pond water is found to be non-toxic then deterrent practices in the oil sands can reflect this, for example by creating bitumen free safe zones in the centre of ponds, and intensifying perimeter deterrent efforts, where bitumen tends to accumulate most.

POSTER 4: The role of organic matter in altering the bioavailability of sediment-associated uranium to the freshwater midge (*Chironomus dilutus*)

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The importance of bioavailability in influencing toxicity of metals in aquatic systems has been well-established; however, our understanding of the mechanisms controlling the bioavailability of many metals is incomplete. In particular, there is limited information regarding the bioavailability and toxicity of sediment-associated uranium (U) to freshwater benthic invertebrates. The goal of our research is to investigate the effects of sediment physicochemical characteristics on the bioavailability of U to a model benthic organism, *Chironomus dilutus*. The objective of the specific studies described here were to determine how differences in U binding capacity of different types and concentrations of organic matter (OM) affected U bioavailability. This was examined through three 10-d bioaccumulation tests with *C. dilutus* larvae in U-spiked formulated sediments. The influence of OM type was evaluated in two experiments, one using peat moss and the other α-cellulose as the OM source. The third study utilized several concentrations of OM ranging from 0 to 40 % peat moss d.w. in a silica sand based sediment to quantify the influence of OM concentration on U bioavailability. Test endpoints included *C. dilutus* survival and growth, as well as U accumulation in whole organisms, whole-sediment, overlying and pore water. Results revealed a strong relationship with increasing OM concentrations resulting in decreasing U bioaccumulation in *C. dilutus* larvae. Interestingly, similar trends in U bioaccumulation were observed for peat moss and α-cellulose amended sediments under similar U-spiked conditions.

POSTER 5: The reliability of sucralose as a wastewater contamination tracer

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Sucralose (SplendaÒ) is an artificial sweetener that is difficult to metabolize, and is thus excreted unchanged. Sucralose may be suitable as a wastewater tracer if it is truly nonreactive given its high water solubility, chemical stability, and sole environmental input via human ingestion only. We show rapid disappearance of sucralose from shallow freshwater wetland systems from unknown biotransformation or removal processes, through exposure experiments on 1,500L wetland mesocosms containing macrophytes (e.g., *Typha* sp.) to varying levels of sucralose (1, 100, 1000 µg/L) in triplicate. Sucralose was removed with pseudo-first order rate constants of 0.053 ± 0.013 (s), 0.047 ± 0.021, and 0.043 ± 0.019 respectively. We hypothesize that sucralose was removed by *Typha* due to this plant's known ability to uptake polar organic chemicals such as pharmaceuticals. Sorption to sediment may be only a minor dissipation process due to sucralose's high polarity. Data to test these hypotheses will be presented, through chemical analysis on plant and sediment samples from the mesocosm experiment. Knowledge of the factors affecting the dissipation of sucralose would provide a better estimation of wastewater contamination scope and scale. However, the drastic removal observed suggests that sucralose may not be as reliable a tracer as once assumed.

POSTER 6: Physiological effects of selenium and mercury mixtures in two salmonid species: rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Savelinus fontinalis*)

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Selenium (Se) is an essential element that becomes toxic at concentrations slightly above homeostatic requirements. Mercury (Hg), a non-essential element, accumulates in fish tissue and biomagnifies in the food chain in its methylated form, methylmercury. The concern over Hg contamination of fish, together with recent evidence suggesting that its interaction with Se may protect against the toxicity of this contaminant, led to proposals that adding Se to Hg-contaminated aquatic systems could decrease Hg concentrations.

The goal of this study is to do a laboratory investigation of the physiological of Se and Hg combinations in rainbow trout, considered highly sensitive to Se, and brook trout, considered less sensitive to Se. Fish were exposed to Se (Se-methionine) at three concentrations through diet from 14 days and to Hg ($HgCl_2$) administered once (intra-peritoneal) at a dose selected in a pilot study to achieve a muscle Hg concentration of 2 mg/kg. Preliminary results indicate that tank water Hg concentrations were higher in the Hg-Se treatment than Hg alone treatment for brook trout, but lower in rainbow trout. Although condition factor did not differ between fish species or treatments, treatment-dependant effects on weight gain were detected in rainbow trout, with lowest weight gain in Se-Hg treatments. Both fish species exposed to Hg or Se-Hg had higher hepatosomatic index (HSI) than control fish and fish exposed only to Se. These preliminary results suggest species differences in effects of Se-Hg mixtures exist and can be investigated in the laboratory. Analyses of Se and Hg tissue concentrations, biolelectrical impedance analysis, oxidative stress and hormonal status are in progress. (Funded by NSERC and CRC)

POSTER 7: Development of an immuno-PCR assay for the quantification of manure-borne estrogens

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Estrogens disrupt the endocrine system by interfering with hormonal synthesis and degradation, thereby altering normal physiological and behavioural activity in a wide range of species. Concentrated animal feedlot operations (CAFO's) are a major source of estrogens via livestock effluents and manure-enriched land. Current methods for the detection and quantification of estrogens rely on expensive, complicated and time-consuming techniques such as gas chromatography (GC) and high pressure liquid chromatography coupled to mass spectrometry (HPLC-MS). ELISAs or enzyme linked immunosorbent assays rely on specific antibodies to detect antigens of interest; however current assays are insufficiently sensitive for environmental monitoring. By linking PCR to ELISA, the limit of detection (LOD) can be enhanced 100- to 10,000 fold. By combining specific (E2) and generic (E1+E2+E3) antibodies previously developed for ELISA with PCR amplification, we hope to develop a cheap, simple and effective assay suitable for the quantification of estrogens E1, E2, and E3 in environmental matrices.

POSTER 8: Assessment of risks to the US population posed by exposure to gold and ceramic dental restorations

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There is significant mercury exposure from dental amalgam used in restorative practice. However, little is known about the chemical exposures and risks of alternative dental restorative materials. Thus, it is difficult for clinicians to weigh the performance, risks, and benefits of dental amalgam to alternate restorative materials. Here we provide the first population-level risk assessment for gold alloy and ceramic restorative materials. Employing the US National Health and Nutrition Examination Survey (NHANES) data from 2001 to 2004, we assessed the exposure of adults to the components of gold alloy and ceramic dental restorations in the US general population. Three specific exposure scenarios were considered: 1) all restorations were either gold alloy or ceramic; 2) all crowns were gold alloy or ceramic; and 3) 11% of fillings were either gold alloy or ceramic, in 30% of the population. Silver appears to be the most problematic component of gold alloy restorations, due to a combination of relatively high toxicity and high proportional composition. Lithium appears to be the most problematic component of dental ceramics. All other ceramic components considered resulted in estimated daily doses well below their respective RELs. Relative to dental amalgam and gold alloys, ceramics present the fewest and lowest chemical exposures and risks.

POSTER 9: In-channel beaver impoundments increase food-web available mercury downstream

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The construction of impoundments by beavers (*Castor* sp.) in stream channels alters the way material flows through streams and thus has the potential to increase the availability of methyl mercury (MeHg) to downstream food webs. Because MeHg is toxic to piscivorous wildlife and humans, its biomagnification through the aquatic food web should be closely monitored. This study examines food web available MeHg above and below in-channel beaver impoundments in Kananaskis Country, Alberta. Water, periphyton and invertebrates were collected from 15 streams at locations up- and downstream from beaver ponds. While nutrient concentrations were not significantly elevated below ponds, there was a significant increase in MeHg concentrations in invertebrate primary consumers and predators. This suggests that beaver impoundments increase the availability and subsequent uptake of MeHg by basal food web organisms with consequences for fish and wildlife. Continued investigation of processes at the base of the food web will provide more information about the influence of beavers on food web ecology and metal bioaccumulation in stream ecosystems.

POSTER 10: Effects of chemical insecticides, Canadian entomopathogenic biocontrol candidate *Metarhizium anisopliae*, and surfactants on three aquatic arthropods: northern crayfish, *Orconectes virilis*, phantom midge, *Chaoborus americanus,* and the cladoceran water flea *Ceriodaphnia dubia*

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Field-equivalent and multiple rates of Decis (deltamethrin), Matador (cyhalothrin-lambda), and Lorsban (chlorpyrifos) were tested on phantom midge, *Chaoborus americanus,* and compared to treatment with the fungal entomopathogen *Metarhizium anisopliae,* which has been recently developed for agricultural pest control (against grasshoppers and other insect pests). To determine whether the entomopathogen could infect or otherwise detrimentally affect northern crayfish, *Orconectes virilis*, two 21-days replicated tank studies were conducted with constant exposure to field -equivalent and higher rates of spores, with additional tests designed to determine the effect of wetting agents. A third study was conducted to assess potential pathogenesis of this fungus to a representative to the cladoceran *Ceriodaphnia dubia*, and compare to insecticide contamination of water. Acute mortality and population responses of chronic exposure to the agricultural adjuvant nonylphenol polyethoxylate R-11, the chemical pesticide neonicotinoid imidacloprid, and suspended conidia of *M. anisopliae* S54 on the crustacean, *C. dubia* were examined. In all three sets of experiments, chemical insecticides showed severe effects on mortality and population parameters, but the entomopathic fungus did not cause significant mortality to any of these test species.

POSTER 11: Exposure to environmentally relevant concentrations of Bisphenol A affects hypothalamic neurogenesis in embryonic zebrafish

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A strong causative relationship has been established linking environmental contaminant exposure during early development to various cognitive and behavioral disorders, such as autism and anxiety disorder. However, the molecular mechanisms responsible for transducing toxin exposure into disrupted neurodevelopment remains relatively unexplored. Here, we study the effect of Bisphenol A (BPA) at concentrations found in the Oldman River, AB, on the neurogenic period of the hypothalamus, a small but powerful region of the brain responsible for controlling various neuroendocrine physiologies. Given that hypothalamic progenitor cells express aromatase, the key enzyme for estrogen biosynthesis, we reasoned that estrogenic BPA might influence the maintenance of hypothalamic progenitors and affect the timing of neuronal birth, ultimately perturbing circuitry establishment of key neuroendocrine pathways. To test this hypothesis, we exposed embryonic zebrafish to BPA at key developmental time points and examined the profile of hypothalamic neurogenesis using molecular markers to measure neuronal differentiation. Results to date indicate that BPA exposure advances neurogenesis, but only affects specific hypothalamic regions. Current studies seek to determine whether these region-specific increases in neuronal differentiation are due to transient Aromatase B expression, and are estrogen receptor mediated. Understanding the molecular consequences of environmental toxins on hypothalamic brain development may shed insight into the underlying etiology of a variety of endocrine-mediated neurological disorders. NSERC (HRH), NSERC (DMK)

POSTER 12: Effect of selenium on arsenic-induced endothelial dysfunction and inflammation

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Millions of people suffer from chronic arsenic poisoning, mostly due to drinking arsenic contaminated water. Alongside other severe diseases, chronic arsenic exposure has been associated with cardiovascular disease, such as atherosclerosis and hypertension, but the molecular mechanisms are not fully understood. The micronutrient selenium is a known arsenic antagonist, and protects tissue from damage caused by oxidative stress.

This *in vitro* study aims to determine the molecular mechanisms of arsenic effects leading to cardiovascular disease, and if selenium can inhibit these effects by looking at the expression of inflammatory markers in human aortic endothelial cells (HAEC), endothelial integrity and wound-healing capacity after treatment with sodium-arsenite (As), sodium-selenite (Se) and seleno-L-methionine (SeMet).

Exposure of HAEC to As for 24 hrs leads to an increase in IL-8 expression, which was significantly reduced when cells are co-incubated with Se. ICAM -1 expression is also increased by As, as determined by flow cytometry. Endothelial integrity and wound healing capacity of HAEC is decreased by As, and Se and SeMet reverse this As-induced effect. This work in progress suggests that Se and SeMet antagonize As-induced vascular disease by decreasing the expression of inflammatory mediators and by protection from endothelial damage.

POSTER 13: Selenium exposure and effects on fish community composition in streams draining surface coal mines

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Selenium is a micronutrient that can produce toxic effects in fish and other aquatic organisms when present at elevated concentrations. We investigated the influence of selenium released from surface coal mines on fish communities in watersheds of the Canadian Rockies. We measured selenium concentrations in water, biofilm, invertebrates, and juvenile salmonid fishes (rainbow, westslope cutthroat, bull and brook trout) in streams with upstream mining influence and in reference streams. Quantitative electrofishing was performed to determine the relationship between selenium exposure and fish community biomass. We found that selenium concentrations in water and biota were significantly higher in mine -affected than reference streams and that there was positive trophic transfer of Se at each level of the lotic food chain. Juvenile fish muscle tissue Se concentrations were positively related to invertebrate tissue concentrations and reached or exceeded proposed toxicity thresholds for larval deformities and mortalities in some species. Fish biomass was only negatively related to fish muscle tissue Se concentration in rainbow trout while community-level effects were not detectable in other species at the stream reach scale.

POSTER 14: Linking migratory pathways of a sanderling (*Calidris alba*) population from Chaplin Lake, Saskatchewan to contaminant exposure on the wintering grounds

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The lack of information about Sanderling (*Calidris alba*) migration ecology and connectivity make it difficult to associate the migratory movements to potential risks that birds face during the annual cycle, specifically from persistent organic pollutants. This study aims to identify possible wintering grounds of a poorly studied Sanderling population that migrates northward through Chaplin Lake (Saskatchewan, Canada) and to determine the link between the migratory patterns and potential risks of exposure to Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs) and Dioxins. During winter, fifteen Sanderlings will be captured in Texas (U.S.A.), South and Northeast of Brazil; and during spring migration ~100 Sanderlings will be captured at Chaplin Lake, representing birds from known and unknown origins respectively. From each bird, one primary covert wing feather will be sampled for stable isotope (δ^{15}N, δ^{13}C and δ^{2}D) analysis. We will be test whether the combination of isotopes can distinguish the three groups of Sanderlings from known origin. The similarities between isotopic signatures of known and unknown-origin birds will be compared to identify variation and potential wintering locations of this population. Additionally, concentration of the most toxic PAHs, PCBs and Dioxins will be quantified in the sediment and prey from the same study sites. Finally, it will be identified if the environmental concentrations of those compounds present a risk to Sanderlings. This research will guide future actions regarding conservation and sustainability of migratory shorebird populations in North and South America

POSTER 15: Biotic and abiotic changes in an end-pit mine after lake fertilization to remediate selenium contamination

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Selenium is a trace nutrient that at elevated concentrations leads to severe impacts on aquatic ecosystems. Selenium toxicity is of particular concern in end-pit mine lakes of the eastern slope Rockies, where it leaches out of waste rock from open-pit coalmines. We tested a potential whole lake method of reducing selenium concentration in end-pit lake water by stimulating the anaerobic, sulphur and selenium reducing, bacterial community present in the lakes' sediment. We fertilized a medium-sized end-pit lake with a retention time of >1yr in the spring of 2012 and monitored it over the ice-free season, while using an adjacent end-pit lake as a reference. Fertilization lead to elevated surface temperatures and a rise in the thermocline. A phytoplankton bloom established shortly after fertilization, increasing the dissolved oxygen concentration on the surface to super-saturation, while decreasing oxygen levels below surface to the metalimnion. However, anoxia did not establish below the metalimnion. The zooplankton community increased in abundance by 50-fold approximately two weeks after bloom establishment but was not able to control the phytoplankton. This made the bloom stable for approximately two months. Selenium concentrations did not change over the course of the experiment, likely due to strong wind mixing and subsequent higher than usual dissolved oxygen concentrations in the hypolimnion. We suggest that maintaining highly eutrophic regimes while adding more organic matter into the lake might increase anoxic habitat with higher bacterial growth and subsequent reduction of selenium from within the system over the long-term.

POSTER 16: Phytoremediation of pharmaceuticals with sandbar willow

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Urban wastewater and agricultural runoff may contain pharmaceuticals, natural and synthetic hormones, herbicides and other compounds in sufficient quantities to harm aquatic organisms. Phytoremediation is one option for purification of contaminated water before its discharge into rivers, and a possibly suitable species is sandbar willow (*Salix exigua* Nutt.). It is a common native in low-elevation riparian zones on rivers throughout North America, fast-growing and inundation-tolerant. Here we have investigated its ability to take up from hydroponic solution a common synthetic estrogen,17α-ethynylestradiol (EE2); other pharmaceuticals, diltiazem and diazepam (Valium); and the herbicide atrazine, which is known to be absorbed. Within 24 h of exposure, rooted cuttings of the willow removed up to 80% of radiolabeled compounds. The radiolabel was subsequently recovered mostly from roots (EE2 and diltiazem) or from shoots (atrazine) or equally from both (diazepam), generally in solvent-extractable form, except for EE2. The relative uptake of these compounds, and their distribution, was predictable based on their chemical properties.

These outcomes suggest the potential value of (1) artificial riparian zones including well-adapted native species, such as *Salix exigua,* for purification of urban wastewater before release into rivers; and (2) natural riparian buffer zones for removal of contaminants in agricultural runoff, or after wastewater inputs.

POSTER 17: Changes in fish health and community composition in rivers of the Athabasca oil sands - a review of historical and current data

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There has been much debate about the environmental impact of the Athabasca oil sands operations. Fish are good indicators for changes in aquatic ecosystems. Their health and their community composition can be used to assess changes over a long time period, and responses of higher trophic levels of the food web. A considerable amount of data has been accumulated in the past decades. However, a comparison of the current status with historical data is hindered by the information being scattered among numerous reports by different agencies and companies, and by differences in sampling techniques, timing of sampling, and sampling locations. We gathered and analyzed comparable data from historical and more recent reports. The focus was on the Muskeg River watershed, the watershed with the highest rate of land change. Preliminary results show massive declines and changes in the community composition of larger migrating species as well as smaller fish. Tumor rates and other external abnormalities peaked in the late 1990ies, and the highest rates in the Athabasca River were detected near the mouth of the Muskeg River. These rates were considerably higher compared to historical reports and background levels based on other studies in northern rivers in Alberta and elsewhere in North America. Our findings, though preliminary, are alarming.

POSTER 18: Growth, survival and toxicant accumulation in rainbow trout stocked in urban stormwater ponds in southern Alberta

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To lessen the over exploitation of natural watercourses in southern Alberta and to create additional fishing opportunities, it has been suggested that urban stormwater ponds be stocked with rainbow trout. Thirty-one ponds were assessed for their suitability to support put-and-take recreational fisheries. Of these, six ponds met the physical, biological and water quality parameters necessary for trout survival and were each stocked with four hundred rainbow trout. From May to October, stocking success was determined by i) fish survival, ii) fish growth, and iii) toxicant levels in fish tissues. Fish survived in four of the six ponds with predation, water temperature and limited food sources causing two ponds to fail as viable rainbow trout fisheries. Specific growth rates ranged from 1.01 to 1.75% body weight gain per day. Mercury concentrations in fish muscle tissues were below CCME guidelines for all ponds. Cortisol concentrations, as an indicator of stress, were similar in all ponds and were comparable to hatchery fish. Two distinct groups of vitellogenin values, as an indicator of estrogenic pollutants, were present that correspond to values found in unpolluted male and female fish from other studies. Acetylcholinesterase values declined through the course of the study and may be indicative of pesticide exposure, but have also been correlated with an increase in fish length in other studies. Despite the low proportion of suitable stormwater stocking locations, stormwater ponds are very abundant on the urban landscape and numerous viable recreational fishing opportunities could be created.

POSTER 19: Characterization for microcystins toxicity in Lake Winnipeg

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Cyanobacteria can produce potent algal toxins. Cyanobacterial blooms are now common during the open water season in Lake Winnipeg and contribute to declining water quality. To assess the hazards and risks associated with these toxins this lake, an understanding is needed of the concentrations and distributions of algal toxins in the lake. A compound-specific analysis was performed on passive water samplers deployed in 2011 and 2012 at three locations on Lake Winnipeg. Samplers were extracted for microcystin-LR, -RR, -YR, -WR, -LA, -LY, -LW, –LF and anatoxin-a, and quantified using ultra high performance liquid chromatography-tandem mass spectrometry, and time-weighted-average water concentrations determined from sampling rates reported in the literature. Additionally, microcystin exposure data from near-shore and pelagic monitoring stations was compiled from 1999 to 2012. Preliminary data suggests that acute toxicity from cyanotoxins was unlikely to occur in humans, with a probability of ~1% of exceeding Health Canada's guidelines for drinking water (1.5 µg/L for total microcystin) in pelagic areas and ~8.5% for beaches. Our exposure can be related to existing regulatory risk assessment for possible adverse health outcomes for the ecosystem or human consumers.

POSTER 20: Phase I stereoselective biotransformation of hexabromocyclododecanes (HBCDs) by cytochrome P-450 (CYP) isozymes

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Hexabromocyclododecanes (HBCD) are anthropogenic brominated flame retardants that have been produced since the 1960s, and have been mainly used in thermoplastic polymers. However HBCDs can be transported among different compartments of the environment, such as air, water, sediment and biota, can be bioaccumulated and biomagnified in the food web, and can lead to toxic effects on thyroid function, brain development and neuron function, and reproduction and development. While HBCDs are known to biotransform humans and other biota, the mechanisms are not well understood. The objective of this study is to investigate *in vitro* biotransformation of HBCDs by cytochrome P-450 (CYP) isozymes, to determine if this biotransformation is stereoselective, and to characterize metabolites of HBCDs resulting from this biotransformation. This will be achieved by *in vitro* incubation of recombinant CYP 2B/3A isozymes with the three major HBCD diastereoisomers. We hypothesize that HBCDs can be biotransformed by CYP 2B/3A isozymes, and this biotransformation is a stereoselective process, as we have shown recently for chiral polychlorinated biphenyls with rat CYP 2B1. These results will be useful in assessing toxicokinetics and elimination of HBCDs that enter the body.

POSTER 21: The fate of copper and sulfamethoxazole in wastewater and their effects on sedimentary microbial antibiotic resistance development

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The fate of copper and the antibiotic sulfamethoxazole, and their effects on sedimentary microbial antibiotic resistance development were investigated. Antibiotics are in wastewaters because of agricultural and medicinal use. Copper is also found in waters from both natural sources and from human activities. Both antibiotics and copper may modulate microbial populations and, as we hypothesize, antibiotic resistance. Accordingly, microcosms with sediment, 13 L water and artificial wastewater were spiked with either 5 mg Cu/L and/or 100 mg/L sulfamethoxazole once a week for 85 days to simulate periodic wastewater inputs, or left untreated for negative controls. Antibiotic resistant bacteria over time were assayed by quantitative real-time polymerase chain reaction for antibiotic resistance genes and by plate inoculation that reflected the tank's contents. Cu levels spiked with repeated inputs, while sulfamethoxzole dissipated at rates consistent with photolysis. Preliminary results suggest that copper, sulfamethoxazole and copper+sulfamethoxazole cultures displayed no statistically significant growth or decline while the control culture did show population decline (P=0.0002). This suggests that the bacterial cultures were able to develop and transfer antibiotic resistance genes to permit their survival in a harmful environment, although no significant bacteria growth was observed.

POSTER 22: Investigating the molecular and pathological effects of chronic dietary selenomethionine in juvenile white sturgeon (*Acipenser transmontanus*)

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Sturgeon are an ancient family of fish, which have changed little in 200 million years. Of the 26 species worldwide many are endangered. White sturgeon (*Acipenser transmontanus*) are endemic to western North America where they are prized by Aboriginal peoples and sport fisheries. Unfortunately, their populations have been steadily declining since the late 1800's due to overharvesting, habitat alteration and pollution. Selenomethionine (SeM) has become a particular environmental concern as it bioaccumulates and biomagnifies through the food chain. This study will research the effects of chronic dietary SeM on juvenile white sturgeon. Juvenile sturgeon will be given food spiked with 0, 5, 25, or 125 ug SeM /g food for 90 days. After 10 days a sub-sample will be collected to investigate molecular changes across the transcriptome using the *Illumina* sequence-by-synthesis method to investigate potential novel adverse outcome pathways. Genes of interest, such as those involved in stress response and steroidogenesis, will be verified using real-time polymerase chain reaction (RT-PCR). Molecular changes will be linked to observable whole organism effects by investigation of liver and head kidney histopathology, alterations in stress response and changes in behaviour. This study aims to increase the understanding of juvenile white sturgeon sensitivity to SeM and to aid in the risk assessment of this unique and endangered species.

POSTER 23: Genotoxicity of OSPW and Merichem naphthenic acids by the SOS ChromeTest™

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Oil Sands Process Water (OSPW) is a by-product of the hot alkaline water extraction process used in the surface mining oil sands industry in northern Alberta. Its constituents include residual bitumen, silts, clays, inorganic ions, and a complex mixture of organic compounds that includes naphthenic acids (NA). Toxicological effects of OSPW and NAs include liver inflammation in fish and birds, metamorphosis delay in amphibians and endocrine disruption but the genotoxicity of OSPW and NA is not well studied. The objective of this study was to evaluate the genotoxicity of OSPW and commercial NAs via the SOS ChromeTest. The acid extract from 1 L of OSPW of 6655 ppm, and a solution of 100 ppm of Merichem NA were created and several dilutions made. *E. coli* T100 was exposed for 4 hours to the solutions, with and without S9 fraction. The results demonstrated an increasing dose dependent genotoxicity. Metabolic activation via S9 enzymes increased the genotoxicity of OSPW and NAs, implying bio-activation of NAs may have contributed to genotoxicity in OSPW. In conclusion, the acid extract of OSPW and Merichem NAs can cause genotoxicity to *E. coli* T100 in the commercial SOS ChromeTest, and further examination of the mutagenicity is warranted.

Saturday Program

Join us Saturday June 8th from 9 am - 2 pm for a free short course given by Dr. Kelly Munkittrick, director of Environmental Monitoring and Risk Assessment, COSIA.

Location: TH204 (beside platform presentation room)

Topic:

Design of field monitoring and research programs – 10 stupid things not to do

This course will provide an overview of the essential questions to ask for designing a monitoring program. The design of the course is primarily philosophical, and based on my experience in designing regional monitoring frameworks in 8 different countries and in 5 regions of Canada. It focuses on 10 specific aspects to focus on during program development, including the philosophical differences and limitations of different monitoring approaches and different receptors (i.e., community versus population versus individual). It will also address issues of appropriate sampling designs, power analysis, replication and statistical approaches which apply to any environmental monitoring program. Interpretation of monitoring data can be challenging and participants will learn how to consider confounding factors, natural variability, ecological relevance and pseudoreplication. The course will cover issues related to interpreting study results, and warning signs and issues related to interpreting other peoples' data, and the future direction that monitoring is heading. While much of the data will examine fish, benthic invertebrates and water quality, the principles are easily applied to any environmental program.

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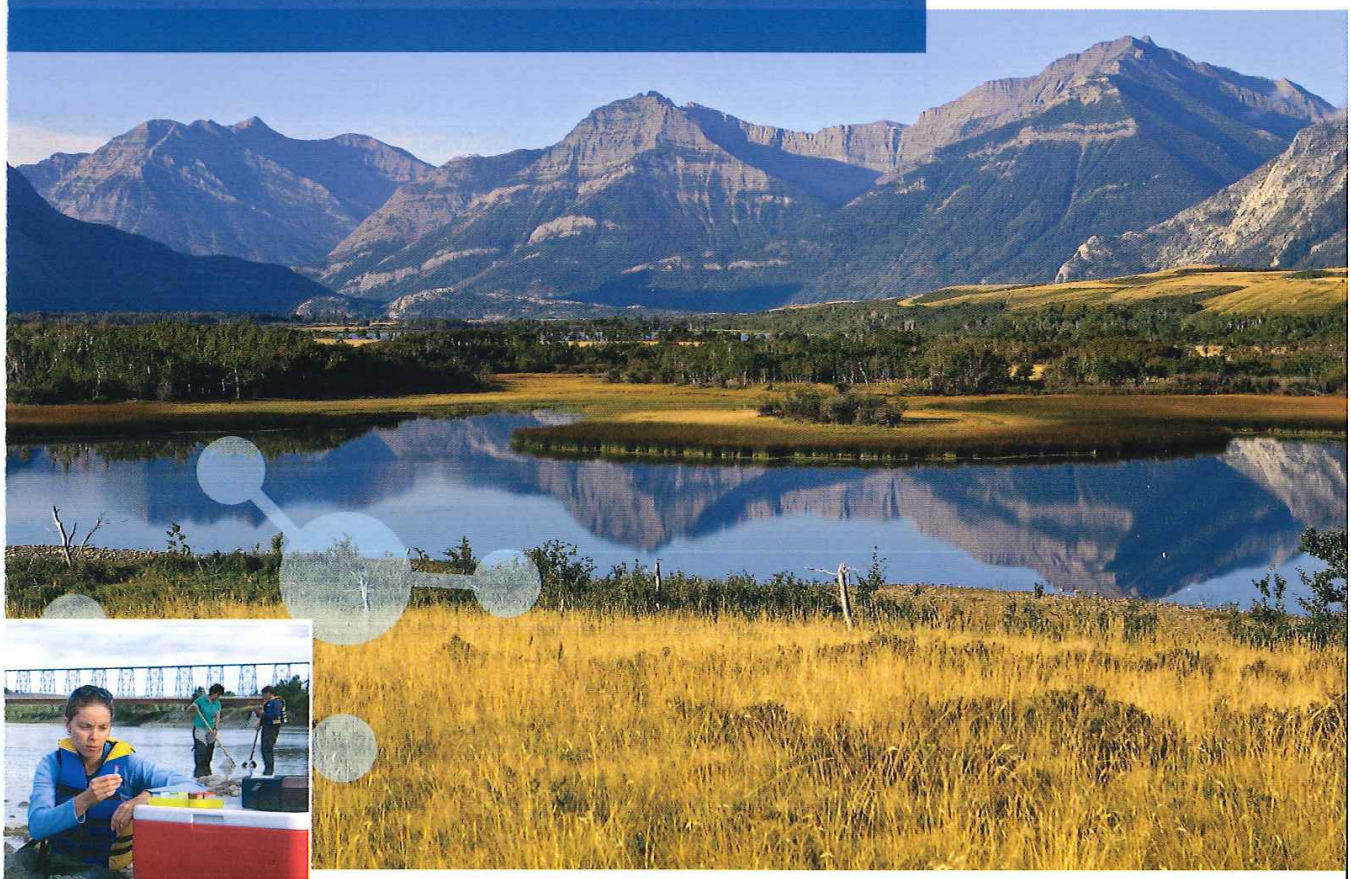
Water Research

University of Lethbridge



Recognizing the interconnectedness of the issues affecting water, scholars at the University of Lethbridge adopt a multidisciplinary approach to research that explores ways to conserve water, diversify water sources, protect water quality and mitigate the impacts of climate change.

Working in the living laboratory that is southern Alberta, the U of L is a fountainhead of solution-oriented studies that will assure the long-term security, quality and sustainability of our water resources.

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