Risk Assessment in Northern Ecosystems: Opportunities and Challenges
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Emergency information: If emergency services are needed phone 911.

The PNC SETAC registration desk is located in front of the Education Lounge, Room 1005. Registration hours are from 07:15–12:00, Friday, June 15, 2012

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:

- morning coffee break
- lunch
- afternoon coffee break
- poster session reception (cash bar)

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 the Education Building.

Platform presenters: PowerPoint presentations should be submitted to a student member (Sarah Crawford, Leanne Flahr, Jonathan Doering) in the Quance Theatre from 08:00 onwards. In addition, please identify yourself to the Session Chair before the session begins.
**Poster presenters:** Please put your posters up on Friday, June 15, from 07:15 to 10:00 in the Education Lounge.

Please take down your poster between Friday, June 15 at 18:30 and Monday, June 18 at 08:00.

If you require assistance putting up your poster please see the registration table (located in front of the Education Lounge). It is important that students are present next to their poster during coffee breaks (10:00 and 15:00) and during the Poster Session & Social held between 16:30 and 18:00.

**Silent Auction:** All books will be available to view next to the registration table throughout the entire day. The silent auction will close after the Poster Session, and winners will be announced at the Banquet.

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

**We would like to express our gratitude to SETAC for donating a variety of books for our meeting.**
PNC SETAC Meeting will take place at the Education Building,
28 Campus Drive
Saskatoon, SK S7N 0X1
(General Office: 966-5973)

Parking on Campus: If travelling by vehicle, public parking is located in Lot 4, highlighted with a triangle. Lot 4, located off North Road, pay on exit $4.00 (per exit) per day.
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<td>Annual General Board Meeting</td>
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<td>08:15</td>
<td>Opening Remarks: Dr. David Janz, Dr. Markus Hecker, University of Saskatchewan</td>
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<td>08:30</td>
<td>C. Wong: Pharmaceutical and Nutrient Fate in Manipulative Constructed Wetland Mesocosms</td>
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<td>08:45</td>
<td>P. Cardinal: Fate and Effects of Pharmaceuticals in Outdoor Mesocosms After Pre-Treatment Harvesting of Typha spp.</td>
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<td>09:00</td>
<td>L. Flahr: Physiological and Functional Effects of Aroclor 1254 on Avian Cognition and Migratory Behaviour</td>
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<td>09:15</td>
<td>J. Doering: The Aryl Hydrocarbon Receptor Signaling Pathway of White Sturgeon: Implications for Sturgeon Sensitivity to Dioxin-like Compounds</td>
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<td>09:30</td>
<td>C. Gerger: Acute Effects of β-naphthoflavone on Swim Performance, Cardiorespiratory Function, and Energy Stores in Adult Zebrafish (Danio rerio)</td>
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<td>Plenary Speaker: Dr. Susan Cormier, Ph.D., Office of Research and Development Cincinnati, OH, “Causation, Confounding and Field-derived Exposure Response Relationships”</td>
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<td>10:45</td>
<td>Z. Hoover: The Effects of Sub-Lethal Salinity Concentrations on the Anti-predator Responses of Fathead Minnows</td>
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<td>11:00</td>
<td>J. Ouellet: Food Quantity as a Contributing Factor in Reducing Fathead Minnow (Pimephales promelas) Egg Production During Metal Mine Effluent Exposures</td>
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<td>11:15</td>
<td>A. Manek: The Interactive Effects of UV Radiation and Cadmium on Physiological Stress Response, Club Cell Investment and Alarm Cue Production in Fathead Minnows (Pimephales promelas)</td>
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<td>13:15</td>
<td>Plenary Speaker: Mark Wittrup, MSc., P.Eng., P.Geo., Assistant Deputy Minister, Environmental Protection and Audit, Saskatchewan Ministry of Environment “The Future of Environmental Regulation”</td>
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<td>13:45</td>
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<td>J. Thomas: Consequences of Sublethal Dietary Selenomethionine Exposure on Repeat Swim Performance, Metabolic Capacities and Energy Metabolism in Adult Zebrafish</td>
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<td>14:30</td>
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<td>14:45</td>
<td>S. Crawford: Quantifying Bioavailability and Toxicity of Sediment-Associated Uranium to a Model Freshwater Benthic Organism (Chironomus dilutes)</td>
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<td>15:30</td>
<td>Plenary Speaker: Dr. Jon Martin, Associate Professor, in the Division of Analytical and Environmental Toxicology, University of Alberta, “The Known and (Mostly) Unknown Risks of Oil Sands Process Affected Water”</td>
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Field-derived exposure-response relationships have a major advantage: barring errors in measurement, they characterize the real world. We adapted the standard method for deriving U.S. EPA water quality criteria for use with field data to estimate the toxicity associated with ionic strength for a mixture with dominant ions of calcium, magnesium, bicarbonate, and sulfate. Data analysis was adapted from the standard EPA methodology in using the 5th percentile of a species sensitivity distribution (SSDs) as the benchmark. Species were aggregated to genera and interpolation was used to estimate the percentile. However, the points in the SSDs are extirpation concentrations (XCs) rather than median lethal concentrations (LC50s) or chronic values. A genus was considered to be extirpated at the conductivity value below which 95% of the observations of the genus occur. We then used an explicit weight-of-evidence process to answer two questions: 1) Does the evidence indicate that the relationship is causal? 2) Does the evidence support any alternative that may account entirely or in part for the apparent causal relationship (i.e., are there confounders)? This method and conductivity benchmark is being used by USEPA as the best available science to support decision-making regarding this ionic mixture.
Mark Wittrup’s experience in environmental affairs encompasses executive roles in both the private and public spheres. Currently the Assistant Deputy Minister, Environmental Protection and Audit, he leads the activities of the Ministry through the Municipal, Industrial, Compliance Audit, Wildfire Management, Technical Resources, and Environmental Assessment branches. As executive sponsor he has been deeply involved in the results-based regulatory initiative and the development of the Saskatchewan Environmental Code.

He came to this position with more than 30 years of experience in the mining industry where he was involved in virtually every aspect of the industry. Most of that time was spent providing leadership on the environmental aspects of mining, most particularly environmental assessment and regulatory affairs. This work has also included significant experience in corporate governance, enterprise risk management, management systems, and audit. His work has spanned the globe with projects across Canada, in the United States, where he lived for two years, as well as Australia, Kazakhstan, Kyrgyzstan and Mongolia.

Mark is a professional engineer and geoscientist with degrees in geology from Lakehead University and the University of Saskatchewan. He is the author of a number of Environmental Impact Studies, including the McArthur River Project, which continues to be highly regarded.
Jon Martin, Ph.D.
Associate Professor, in the Division of Analytical and Environmental Toxicology
University of Alberta

Jon completed his doctoral work at the University of Guelph in 2002 and conducted an NSERC postdoctoral fellowship at the University of Toronto before joining the University of Alberta in 2004. He is an Associate Professor and a multidisciplinary scientist with expertise in toxicology, analytical chemistry, and environmental chemistry. His research activities are focused on the effects and fate of toxic and persistent environmental contaminants, and he has published more than 80 peer-reviewed papers on topics that include sources of human exposure to contaminants, global chemical transport pathways, the effects of in utero chemical exposures, and remediation of contaminated water.

Oil sands process affected water (OSPW) from surface mining is a highly complex mixture of contaminants that is acutely toxic. Even after decades of in situ bioremediation, OSPW continues to be chronically toxic to aquatic organisms. The long term remediation of OSPW in end-pit lakes, for future discharge to natural systems, is therefore highly uncertain, and the future risks of OSPW are therefore difficult to predict. This problem will be discussed with respect to what we know, and what we don't know, about the analytical chemistry, environmental chemistry, toxicology, and remediation of OSPW.
1. Bioavailability of polycyclic aromatic hydrocarbons after repeated exposure in the juvenile swine model. Peters, R E, Siciliano S D, Wickstrom M
6. The fate and toxicity of the wastewater tracer sucralose in model wetlands. Joudan S, Hanson M L, Wong C S
11. Distribution and impact of neonicotinoid Insecticides on agricultural wetlands of prairie Canada. Main A, Morrissey C
15. Assessing the risk of petroleum contaminants in migratory shorebirds. Labarrére C R, Morrissey C A
17. Effects of triphenyltin exposure during the larval period in wood frogs (Rana sylvatica). Higley E, Tompsett A, Wiseman S, Giesy J P, Hecker M
18. Oil spill on the Pacific North Coast of British Columbia: a modelled case study to estimate movement, bioaccumulation and human exposure to PAHs in crude oil at sea using GNOME and FHX. Mahboubi P
19. Ammonia oxidiser metal tolerance development in smelter contaminated soils. Garvey P
20. Responding to toxicity issues using international human rights. McCrimmon D
Platform Session

Pharmaceutical and Nutrient Fate in Manipulative Constructed Wetland Mesocosms

Cardinal, Pascal1, Low, Jennifer E2, Carlson, Jules C2,3, Challis Jonathan K2, Beattie, Sarah A2, Bartel Caitlin N2, Elliott, Ashley D2, Favreau, Alex3, Wong, Charles S1,2, Hanson, Mark L3

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2 Richardson College for the Environment, The University of Winnipeg, Winnipeg, MB
3 Department of Environment and Geography, University of Manitoba, Winnipeg MB

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Many rural Canadian communities rely on wastewater lagoon to treat sewage prior to release. However, wastewater contains nutrients and organic micropollutants such as pharmaceuticals and personal care products, as well as pesticides. Constructed wetlands are one economical approach that may sequester excessive nutrients and promote organic contaminant degradation. However, little is known about how these types of wetlands perform in the harsh Canadian Prairie climate. Accordingly, we assessed the fate and effects on wetland plants of selected pharmaceuticals and simulated wastewater in model constructed wetlands comprised of eighteen 3500L mesocosms. The experiment tested the role of aquatic plants [systems with and without population of *Typha* spp (Cattails), *Myriophyllum sibiricum* (Water milfoil) and *Utricularia vulgaris* (Bladderwort) in the removal of wastewater contaminants introduced through a single release. Treatments were fortified through pulse addition of artificial wastewater and pharmaceuticals (carbamazepine, clofibric acid, fluoxetine, naproxen, sulfamethoxazole and sulfapyridine). While nutrient and drug removal was observed and quantified there was no evidence indicating enhanced removal in the presence of aquatic plants. Pharmaceuticals were removed through sorption and photodegradation while nutrients were eliminated by assimilation and absorption into plant tissues and sediments.

Keywords: Macrophytes, mesocosms, pharmaceuticals, wastewater
Fate and Effects of Pharmaceuticals in Outdoor Mesocosms After Pre-Treatment Harvesting of *Typha* spp.

**Cardinal, Pascal**¹, Low, Jennifer E², Carlson, Jules C², Challis Jonathan K², Beattie, Sarah A², Bartel Caitlin N², Elliott, Ashley D², Favreau, Alex³, Wong, Charles S¹,², Hanson, Mark L³

¹ Department of Chemistry, University of Manitoba, Winnipeg,
² Richardson College for the Environment, The University of Winnipeg
³ Department of Environment and Geography, University of Manitoba

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Rural communities across the Canadian Prairies discharge effluent from their secondary treatment lagoons as a pulse once or twice a year. These wastewaters can contain nutrients above discharge guidelines, and contaminants such as pharmaceuticals. Constructed wetlands may provide cost effective enhanced treatment of wastewater in rural areas for these types of chemical stressors. Accordingly in the fall of 2011, we studied the fate and effects of selected pharmaceuticals after a pre-treatment harvest of a *Typha* spp. community in simulated constructed wetlands (nine 3000L mesocosms). The mesocosms were spiked with carbamazepine, clofibric acid, fluoxetine and naproxen at 10 µg/L, and sulfamethoxazole and sulfapyridine at 200 µg/L each, plus untreated controls (n=3). The aquatic plants *Typha* spp and *Myriophyllum sibiricum* were assessed for growth, total phosphorus (TP) and pharmaceutical content, after treatment. *Typha* spp. shoot trimmings obtained post-harvest contained twice the amount of TP as compared to prior trimmings, most likely due to nutrient mobilization from the onset of senescence. No other significant differences were observed in either macrophytes for growth or TP content. Pharmaceutical concentrations, measured by LC-MS/MS, decreased at a slower rate than expected due to lower temperatures and sunlight intensity, as compared to those observed in an earlier summer study. These results provide insight into the nutrient and contaminant removal efficiency and potential design and management of constructed wetlands in rural municipalities.

**Keywords:** pharmaceuticals, mesocosms, fate, macrophytes
Physiological and Functional Effects of Aroclor 1254 on Avian Cognition and Migratory Behaviour

Flahr, Leanne¹, Jones, Paul¹, ³, Morrissey, Christy¹, ², ³

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²Department of Biology, University of Saskatchewan, Saskatoon, SK
³School of Environment and Sustainability, University of Saskatchewan, Saskatoon, SK

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There is an increasing level of concern regarding endocrine disruption by a number of chemical pollutants that are widespread in the environment. They are commonly found in the tissues of wildlife. In avian models, exposure to polychlorinated biphenyls (PCBs) has resulted in reduced hatching success, altered parental behaviour, lower growth rates, teratogenicity and immunotoxicity. Birds exposed to endocrine disrupting chemicals during early development may develop neurological changes affecting learning, cognition and migratory behaviour. This study focuses on effects on the hypothalamic-pituitary-thyroid axis (HPT) following low dose exposure during early development. Alterations in the HPT axis could result in impaired thyroid function and physiological responses which could lead to behavioural changes in adults. We are investigating the potential of Aroclor 1254, a PCB mixture, as a thyroid hormone disruptor in European starlings (Sturnus vulgaris) during the period of nestling development. Birds were orally administered 0, 0.35 or 0.70µg Aroclor 1254/g-bw for 18 days. Body mass, tarsus, wing-chord and bill-lengths were measured and blood was taken to assess thyroid function. A subset of birds were taken into captivity and exposed to two photoperiod shifts to simulate autumn and spring migrations. Emlen funnel trials were used to assess migratory orientation. There were no significant effects of treatment on growth parameters. Dose group effects were indistinct; however, migration was induced in captive starlings. Contaminant, biomarker and thyroid hormone analyses are ongoing. This study is attempting to link alterations in avian behaviour to contaminant-specific mechanisms. Alterations in thyroid hormones could give rise to larger-scale effects, including changes in cognition and migratory behaviour, which could explain observed global declines in migratory species.

Keywords: PCB, thyroid hormones, endocrine disruption
The Aryl Hydrocarbon Receptor Signalling Pathway of White Sturgeon: Implications for Sturgeon Sensitivity to Dioxin-like Compounds

Doering, Jon¹, Wiseman, Steve¹, Beitel, Shawn¹, Giesy, John P.¹,²,³, Hecker, Markus¹,⁴

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²Dept. Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon, SK, Canada.
³Department of Biology & Chemistry, City University of Hong Kong, Kowloon, Hong Kong, China
⁴School of the Environment and Sustainability, University of Saskatchewan, Saskatoon, SK, Canada

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Activation of the aryl hydrocarbon receptor (AhR) regulates all known effects of exposure to dioxin-like compounds (DLCs). Exposure to DLCs causes a range of adverse effects in fishes, including teratogenicity, hepatotoxicity, and reproductive impairment. Sturgeons are ancient species of fish and due to their endangered status are of interest for ecological risk assessment. However, little is currently known about the AhR signalling pathway of these or other ancient fishes. To begin characterizing the sensitivity of sturgeons to DLCs we investigated the biochemical and molecular responses of white sturgeon (WS; Acipenser transmontanus) to a model AhR agonist, β-naphthoflavone (βNF). WS were found to be among the more responsive of fishes with regard to inducibility of CYP1A. Partial nucleotide sequences from three distinct AhRs (AhR1, AhR2, AhR3) were identified for the first time in WS using Illumina sequencing. All three identified AhRs had greatest expression in liver, gill, and heart tissues of WS. Following exposure to βNF, AhR2 and AhR3 expression was up-regulated in liver, gill, and intestine; however AhR1 was only up-regulated in gill. The functional significance of sturgeons expressing three AhR genes and implications for sturgeon sensitivity to DLCs is currently unclear. However, the great sensitivity of salmonids to DLCs is hypothesized to be partially driven by these species expressing multiple, functional AhR genes. Additionally, in birds, subtle differences in AhR structure have been shown to result in significant differences in function. Further research is necessary to investigate the toxicological significance of the unique AhR signalling pathway in WS and determine how this knowledge could be used to predict the sensitivity of other species of endangered sturgeons.

Keywords: endangered species, CYP1A, PCB
Acute Effects of β-naphthoflavone on Swim Performance, Cardiorespiratory Function, and Energy Stores in Adult zebrafish (Danio rerio)

Gerger, Courtney J.1, Weber, Lynn P.1,2

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2Veterinary Biomedical Science, University of Saskatchewan, Saskatoon, SK S7N 5B4

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The class of chemicals known as polycyclic aromatic hydrocarbons (PAHs) are known agonists of the aryl hydrocarbon receptor (AHR). They are also contaminants of rivers, lakes, and marine shorelines, making fish a primary target species, but acute adult fish toxicity is thought to be minimal or absent. In the present study adult zebrafish (Danio rerio) were aqueously exposed to solvent control (DMSO) or three increasing concentrations of the commonly used model PAH β-naphthoflavone (BNF; 0.1, 10, and 1000 µg/L) for a 48 hour period. Following exposure fish were subjected to swimming tests with concurrent oxygen consumption measurement (n=10 fish/treatment) or echocardiography to determine cardiac function (n=10 fish/treatment). Oxygen consumption (MO2) was increased at all exposure concentrations compared to control, reaching statistical significance at the second highest BNF exposure at a swim speed of 23.1 cm/s (p<0.01 in Fisher’s LSD test after two-way ANOVA). MO2 at zero water velocity was positively correlated with ventricular volume at diastole (r=0.957) and ejection fraction (r=0.859), but negatively correlated with acceleration of blood through the ventricle (r=−0.988) in resting fish. In contrast, BNF had no significant effect on Ucrit, tissue triglyceride, or glycogen concentrations. The effect of BNF on MO2 is likely to be physiologically important given that fish have a critical need for adequate oxygen to fuel aerobic activities such as swimming. Future studies should be directed at examining the effects of more toxic and environmentally relevant PAHs on fish cardiorespiratory function and determining possible mechanisms of toxic effect.

Keywords: Beta-naphthoflavone, swim performance, cardiac toxicity, zebrafish
The Effects of Sub-Lethal Salinity Concentrations on the Anti-Predator Responses of Fathead Minnows

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²Department of Biomedical Sciences, WCVM, 52 Campus Drive, Saskatoon, SK, S7N 5B4, Canada

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Salinization, both natural and anthropogenic, of inland waters is a major facet of environmental change, and can have detrimental effects on aquatic systems. Fish facing increasing levels of salinity must do more than simply survive salinization, they must also undertake important behaviours such as predator avoidance. Here, we exposed fathead minnows (Pimephales promelas) to three levels of salinity crossed by three levels of predation risk cues. We found a reduction in pre-stimulus movement and a lowered intensity of anti-predator response for the highest salinity exposure (8,000 ppm). We also found that the typical threat-sensitive anti-predator response (an important behaviour conferring fitness advantages) was absent in the two highest salinity exposure treatments. Our data demonstrate that salinization can have negative effects on critical behaviours well below physiological tolerance levels.

Keywords: salinity, sub-lethal, fathead minnow, anti-predator
Food Quantity as a Contributing Factor in Reducing Fathead Minnow (*Pimephales promelas*) Egg Production During Metal Mine Effluent Exposures

Ouellet, Jacob D.*, Dubé, M.G.\(^1\), and Niyogi, S\(^1\).

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\(^2\)Sustainability Division, Total E&P Canada Ltd., Calgary, AB  
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Treated metal mine effluents (MMEs) are discharged into waterways. Some of these mine effluents have been shown to reduce invertebrate densities and fathead minnow (*Pimephales promelas*) egg production during chronic exposures, however it is often unknown which factors cause effects. Traditionally, metal contamination was believed to be the main factor in reducing both chironomid densities and fathead minnow egg production. This study examined whether the quantity of *Chironomus dilutus* available as food could influence fathead minnow egg production during exposure to a MME. Breeding pairs of fathead minnows were exposed to either reference water or MME and fed 0.4 g (low food) or 1.2 g (high food) daily for 21 days during which egg production was monitored daily. Reference fish were fed *C. dilutus* cultured in reference water while MME exposed fish were fed *C. dilutus* cultured in MME. We observed significantly greater egg production, gonad sizes, liver sizes, and body sizes in the high food reference and MME fathead minnows relative to the low food reference and MME fathead minnows (Two-way ANOVA; \(P \leq 0.05\)). Our results suggest that food quantity influenced egg production and fish morphometrics, while the presence of MME was not a major factor in decreasing fathead minnow egg production. These results are significant as they suggest that any environmental contaminant that reduces *C. dilutus* densities might also therefore indirectly contribute to decreases in fathead minnow egg production. This could further contribute to possible reductions in population sizes.

Keywords: Fathead minnows, metal mine effluent, food quantity, egg production
The Interactive Effects of UV Radiation and Cadmium on Physiological Stress Response, Club Cell Investment and Alarm Cue Production in Fathead Minnows
(Pimephales promelas)

Manek Aditya1, Ferrari Maud2, Sereda Jeff1, Niyogi Som1 & Chivers Douglas1

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Recent anthropogenic activities have depleted the stratospheric ozone layer, resulting in a global increase in ultraviolet radiation (UVR). Cadmium (Cd) is an ubiquitous aquatic pollutant and is known to be toxic to aquatic organisms at extremely low concentrations. The skin of many fishes contains large epidermal club cells (ECCs) that are known to release chemicals (alarm cues) that warn other fishes of danger. This study investigated the effects of in vivo UVR exposure to fathead minnows (Pimephales promelas), both in the absence and presence of waterborne Cd. Specifically, we examined ECC investment, physiological stress responses and alarm cue production in fish. We found that fish exposed to UVR, either in the presence or absence of Cd, showed consistent decrease in ECC investment compared to non-exposed controls. However, the combined exposure of UVR and Cd reduced cortisol levels relative to that in UVR only exposure. Surprisingly there was no difference in the potency of the cues prepared from the skin of UVR-exposed or non-exposed fish indicating that UVR exposure may have little influence on chemically-mediated predator-prey interactions.

Keywords: UV radiation- Cadmium-Cortisol-Epidermal Club Cells
The Zebrafish Larvae As a Model System For Mercury Accumulation in Sensory Cells

MacDonald, Tracy1,3,4, Korbas, Malgorzata2, Sylvain, Nicole3, Pickering, Ingrid4, George, Graham3,4 and Krone, Patrick3

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Mercury (Hg) is found in both organic and inorganic forms in the atmosphere, in sediment and in water bodies due to natural and anthropogenic releases of mercury. Limited information is available on the uptake and accumulation of Hg in developing organisms, particularly as it relates to chemical form of the metal. To address this problem we utilized synchrotron X-ray fluorescence imaging in zebrafish (Danio rerio), a well-known model system for embryonic development as well as model vertebrate for investigating chemical toxicity.

Zebrafish larvae were randomly assigned to one of four different chemical forms of mercury or a control group. Adjacent serial sections were utilized for synchrotron imaging and histological staining, respectively. Sections imaged using the X-ray fluorescence imaging technique. Significant variations in mercury accumulation were found in fish exposed to organic mercury compared to fish exposed to inorganic mercury. However, some similarities were also found in sensory organs.

Lateral lines are mechano-sensory cells that are critical in fish for schooling, prey detection and predator avoidance. All four forms of mercury were found to accumulate in the lateral lines of exposed zebrafish larvae. To further explore the localization and the effects of mercury accumulation in the lateral lines, two different techniques were used. High resolution synchrotron and vital stain imaging were used to visualize mercury localization and to determine the effects on cellular activity. Preliminary results demonstrate that mercury accumulates in neuromasts and negatively affects cellular activity.

Keywords: mercury, zebrafish, synchrotron imaging
Mercury Cycling and Sea Ice Evolution From Multiyear Sea Ice Cores

Beattie, S. A.,1 Armstrong, D.,1 Wang, F.1

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In recent years the Arctic Ocean has undergone drastic changes; the most notable being the significant decrease in summer sea ice extent and the replacement of multiyear ice with first-year ice. The effects of this on the transport, transformation and ultimate environmental fate of chemical contaminants in the Arctic Ocean have yet to be fully understood. One such contaminant is mercury (Hg) and its various species, most of which demonstrate severe ecotoxicological implications. The objective of this study is to investigate the cycling and distribution of mercuric species in multiyear sea ice. Replicate sea ice cores spanning the entire thickness were taken from a single sampling site on a multiyear sea ice floe in the southern Beaufort Sea in August 2011 as part of the ArcticNet cruise of the CCGS Amundsen. Quantification of total mercury (THg), monomethylmercury (MMHg), Chlorophyll a, and δ18O was performed on separate cores, and temperature and salinity profiles were recorded. A distinct slush layer was observed in the cores at around 270 m, indicating a sudden change in sea ice evolution processes at that layer. THg concentrations were found to be elevated at the ice surface (> 7 ng L−1), suggesting particulate and brine layer enrichment, decreased gradually to levels ranging from 0.25-1 ng L−1 in the interior of the core, and peaked again near the core bottom. Preliminary MMHg results suggest there is little MMHg present in sea ice, and thus the increase in THg at the bottom of the core may be due to adsorption of particulate Hg onto the surface of ice algae. This data implies that multiyear sea ice is not a significant source of MMHg into the Arctic marine ecosystem.

Keywords: Mercury, Sea Ice, Arctic
Selenium Toxicity Impacts 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 when present at concentrations above the nutritional requirement. Selenium is released into aquatic systems at surface coal mines due to high weathering rates of disturbed bedrock and soil. Selenium toxicity thresholds in these systems are often expressed as effect concentrations for individual fish but are difficult to apply to impacts at the fish community and/or population level.

We investigated the extent of selenium inputs from surface coal mine sites and the impacts of long-term selenium exposure on fish communities in coal mining areas of Alberta and British Columbia, Canada. Water analyses indicate elevated selenium concentrations downstream of mines and suggest that food chain selenium levels at impacted sites are greater than those at un-impacted sites and comparable to published toxicity thresholds for aquatic organisms. Fish tissue concentrations, relative fish biomass, and relative fish abundance were not related to water selenium concentrations. Spatial analyses were performed on water and fish tissue selenium concentration gradients and comparisons were made between observed tissue concentrations and expected values based on recent trophic transfer models. Results suggest that fish tissue concentrations, while not directly related to water selenium concentrations at the point of capture, are affected by nearby gradients in water selenium concentration. These preliminary results indicate that fish movements and the role of un-contaminated refugia may be significant in determining the extent of selenium exposure and toxicity and the response of fish communities in impacted streams.

Keywords: selenium, mining, fish communities
Adult Zebrafish Exposed To Waterborne Selenite Have Reduced Swim Performance and Aerobic Capacity

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Selenium (Se) is a contaminant of potential concern in aquatic environments primarily because it bioaccumulates in fish, resulting in larval teratogenic deformities. The subtle physiological effects produced through low level waterborne selenite exposure in fish such as swim performance and aerobic capacity have not been sufficiently investigated. To evaluate the potential effect of selenite on these responses, adult zebrafish (Danio rerio) were exposed to 0, 10 or 100 µg/L of sodium selenite for 14 days. Upon completion of the exposure period, the fish underwent two successive swim trials in a swim tunnel respirometer to determine critical swim speed (Ucrit), oxygen consumption (MO2), resting and active metabolic rates, aerobic scope, and cost of transport (COT) followed by analysis of whole body triglyceride and glycogen levels. Selenite had a significant negative effect on Ucrit and aerobic capacity. Active metabolic rates and aerobic scope were significantly decreased in both selenite-exposed groups after the second swim trial. No significant effects were observed in MO2, resting metabolic rate, COT, triglyceride and glycogen levels, or condition factor among groups. These results suggest that aqueous selenite at environmentally relevant concentrations produce adverse effects on aerobic capacity that can diminish endurance and maximum swim speeds, which may lower fish survivability.

Keywords: selenite, zebrafish, swim, performance, aerobic scope
Consequences of Sublethal Dietary Selenomethionine Exposure on Repeat Swim Performance, Metabolic Capacities and Energy Metabolism in Adult Zebrafish

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The aim of the present study was to investigate consequences of sublethal dietary SeMet exposure on repeat swimming performance, metabolic capacities and energy metabolism in adult zebrafish. Fish were fed varying concentrations of Se (1, 3, 10 and 30 µg Se/g, dry weight) in the form of SeMet for 90 days. At the end of the exposure, fish from each treatment group were divided into three subgroups: a) no swim, b) swim, and c) repeat swim. Fish from the no swim group were euthanized at 90 days and whole body triglycerides, glycogen and lactate, and gene expression of energy metabolism and methionine catabolism enzymes were determined. Individual fish from the swim group were placed in a swim tunnel respirometer and swim performance was determined using the critical swimming speed (U_{crit}) method. After both U_{crit} and MO₂ analyses, fish were euthanized and whole body energy stores and lactate were determined. Similarly, individual fish from the repeat swim group were subjected to two U_{crit} tests performed with a 60 min recovery period between tests, followed by determination of energy stores and lactate. Impaired U_{crit} was observed in fish fed greater than 3 µg Se/g in the form of SeMet. Standard metabolic rate and COT were significantly greater in fish fed elevated dietary SeMet diets. Whole body triglycerides increased with increasing dietary SeMet exposure. Elevated dietary SeMet exposures significantly down-regulated gene expression of energy metabolism and methionine catabolism enzymes. The results of this study suggest chronic sublethal dietary SeMet exposure could impact fitness of adult fish inhabiting Se-impacted aquatic ecosystems.

Keywords: selenomethionine, zebrafish, swim performance, energetics
Evaluating Sublethal Effects of Dietary Selenium Exposure on Juvenile Fathead Minnow

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Selenium (Se) is known to cause chronic toxicity in aquatic species. In particular, dietary exposure of fish to selenomethionine (SeMet), the primary form of Se in the diet, is of concern. Recent studies suggest that chronic dietary exposure to SeMet alters energy and endocrine homeostasis in adult fish. However, little is known about the direct effects of dietary SeMet exposure in juvenile fish. The objective of the present study was to investigate sublethal physiological effects of dietary SeMet exposure in juvenile fathead minnow (Pimephales promelas). Twenty days-post-hatch fathead minnow were exposed for 60 days to different measured concentrations (2.8, 5.4, 9.9, 26.5 ug Se/g dry weight) of Se in food in the form of SeMet. After exposure, samples were collected for trace metal analysis and fish were subjected to a swimming performance challenge (critical swimming speed, Ucrit). A decrease in critical swimming speed (Ucrit) occurred at the 9.9 and 26.5 ug Se/g exposure groups compared to the control group. An increase in oxygen consumption (MO2) and cost of transport (COT) was observed in the 9.9 and 26.5 ug Se/g exposure groups compared to the control group. Energy storage capacity was measured via whole-body glycogen and triglyceride concentrations. Triglyceride concentrations in non-fatigued fish were elevated in the 5.4 ug Se/g group relative to controls. Swim motion, as well as energy storage capacity will be measured in fatigued fish and the stress biomarker cortisol will also be determined. The results will then be compared between exposure groups as well as between swam and un-swam fish to gain new insights into the sublethal effects of dietary Se exposure on a juvenile fish species.

Keywords: Selenium, Selenomethionine, Dietary
Quantifying Bioavailability and Toxicity of Sediment-Associated Uranium to a Model Freshwater Benthic Organism, *Chironomus dilutus*

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With northern Saskatchewan’s rich deposits of uranium (U), high concentrations of U in both water and sediment have been documented in areas downstream of U mining and milling operations. The anticipated increase in demand for nuclear power production will thus put a strain on our ability to manage and minimize the risk of U contamination in the aquatic environment adjacent to U mining areas. Current approaches for the derivation of sediment quality guidelines (SQGs) for U are inadequate to assess the bioavailability and toxicity of U to benthic communities. Thus, the objective of this research was to investigate parameters, such as surface mineral coatings, particle size, and organic carbon content, that are likely to influence the bioavailability and hence toxicity of U to a model freshwater benthic organism, *Chironomus dilutus*. A series of 10-d sediment toxicity studies were designed to investigate important sediment factors individually in order to gain insight into their roles as modifiers of U bioavailability. Test endpoints and measurements included survival and growth, and U concentrations in organisms, whole-sediment and water (overlying water and porewater). Results from these studies have shown that with similar concentrations of U in sediment, the actual amount of U available for biological uptake is influenced by the composition of the sediment. Formulated sediments consisting of higher amount of clay or organic carbon content were seen to significantly reduce bioaccumulation of U to exposed *C. dilutus* larvae. This demonstrates that the current SQG approach of using total sediment concentrations as a basis for predicting U effects downstream of U mining areas, is not reliable and should thus be incorporating sediment factors that can alter U bioavailability.

Keywords: Spiked sediment, Uranium, metal bioavailability, *Chironomus dilutus*
Sustainability of Human Societies: Toward the Berlin Declaration

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An ad hoc task group of SETAC’s Advisory Group on Sustainability is drafting the Berlin Declaration. SETAC has a unique opportunity to contribute meaningfully to the global dialogue on sustainability. SETAC’s tripartite structure of governmental, academic, and industry professionals offers a model for the trans-disciplinary development of a science of sustainability. Since its inception in 1979, SETAC’s orientation has evolved from primarily environmental to include many aspects of social, economic and behavioural sciences, including decision analysis and policy analysis.

SETAC enters the worldwide sustainability discussion in an interesting time. Humans are able to reach into any corner of the planet and for materials that enable development of megacities and allow us to live in a state far from equilibrium with our local landscapes. This reach also allows us to occupy marginal lands that could not support even the smallest of human communities long-term. Living on marginal lands and importing food, fibre, and energy places great demand from the goods side of the ecological landscape (the rate at which the system supplies desired food, water, and other materials), but also from the services side (the assimilation rate of societal wastes).

As these challenges are discussed, a new paradigm is emerging, one that is different from the widely endorse three pillars of sustainability. The new paradigm considers a nested relationship in which economies reside within societies, which in turn are wholly dependent upon surrounding ecological systems. This new perspective relates to the Millennium Ecosystem Assessment that highlights societies dependency on ecosystem services. SETAC’s challenge is to embrace and reinforce this science-informed conceptual model of sustainable social – ecological landscapes, within this professional society and out into the greater sustainability community.

Keywords: Sustainability, Ecosystem Services
Bioavailability of Polycyclic Aromatic Hydrocarbons after Repeated Exposure in the Juvenile Swine Model

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Polycyclic aromatic hydrocarbons (PAHs) are widely distributed in the environment, and as such, are contaminants of concern when completing human risk assessments. In risk assessment, internal dose of a compound is calculated by multiplying external exposure by an absorption factor. Absorption factors are typically garnered from research done with a single dose. In the case of compounds like PAHs, which cause the induction of enzymes, bioavailability may change after repeated exposure to the compounds. In this study, juvenile swine were orally dosed with a mixture of PAHs in one of four media for 14 days and blood time courses were completed on day 1 and day 7 of dosing. These time courses were used to calculate area under the curve and from this bioavailability was determined. Different media were incorporated in order to determine if there was different variability observed between media. The media included food, corn oil, artificial soil and historically contaminated soil. Blood samples were also collected on day 14 to determine the formation of micronuclei. Preliminary results indicate that bioavailability of PAHs appears to be unaffected by repeat exposure. Also, micronuclei levels do not appear to be changed after repeat exposure.

Keywords: bioavailability, PAHs, juvenile swine
Multi-Species Comparison of the Mechanism of Biotransformation of MeO-BDEs to OH-BDEs in Fish

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Polybrominated diphenyl ethers (PBDEs) and their methoxylated- (MeO-) and hydroxylated- (OH-) analogs are ubiquitously distributed in the environment worldwide. The OH-BDEs are more potent than PBDEs for many endpoints and can be produced from the transformation of MeO-BDEs. The objectives of the current study were to 1) identify the enzyme(s) that catalyze the biotransformation of 6-MeO-BDE-47 to 6-OH-BDE-47 in livers from rainbow trout, and 2) compare transformation of 6-MeO-BDE-47 to 6-OH-BDE-47 among rainbow trout, white sturgeon and goldfish. Cytochrome P450 1A (CYP1A) enzymes did not catalyze the transformation reaction. However, transformation was inhibited by the CYP inhibitors clotrimazole and 1-benzylimidazole but not gestodene. Therefore, the reaction is likely catalyzed by CYP2 enzymes. When transformation was compared among species, concentrations of 6-OH-BDE-47 were 3.4 and 9.1 times greater in microsomes from trout compared to goldfish and sturgeon, respectively. Concentrations of 6-OH-BDE-47 in microsomes from goldfish were 2.7 times greater than in sturgeon. The initial rate of transformation in microsomes from trout was 2.9 and 6.2 times greater than that of goldfish and sturgeon, respectively, while the initial rate in goldfish was 3.1 times greater than in sturgeon. Overall, differences in CYP mediated transformation of MeO-BDEs to OH-BDEs could influence concentrations of OH-BDEs in different species of fish.

Keywords: flame retardants, natural brominated compounds, species sensitivity, metabolism
Assessment of the Sensitivity of Four North American Fish Species to Disruptors of Steroidogenesis In vitro

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There is increasing concern regarding the release of natural and synthetic chemicals into the environment that can interfere with the endocrine system of aquatic organisms. Disruption of steroidogenesis is a critical mechanism of action in fishes, which can lead to altered hormone levels, abnormal gonad morphology, and delays in sexual development, or ultimately result in reproductive failure. In this context, little is known regarding the sensitivity of fishes native to northern ecosystems to endocrine disrupting chemicals (EDCs), in particular disruptors of steroidogenesis. Therefore, the aim of this study was to develop an in vitro gonadal explant assay that enables the assessment of effects of EDCs on sex-steroid production in wild fish species. Mature female northern pike (Esox lucius), walleye (Sander vitreus), whitefish (Coregonus clupeaformis), and white sucker (Catostomus commersoni) were sampled from Lake Diefenbaker, Saskatchewan. Gonadal tissue was excised and exposed for 24 hours in 24 well plates containing media dosed with a model inducer (forskolin) and inhibitor (prochloraz) of steroidogenesis. Concentrations tested were 0.1, 1.0, 10.0 µM of forskolin and 0.01, 0.1, 1.0, 10.0 µM for prochloraz. Sex steroid concentrations present in media were quantified using HPLC-MS/MS. Exposure to prochloraz resulted in a dose dependant increase in testosterone and decrease in estradiol. Of the four species studied, white sucker and walleye showed the greatest sensitivity to prochloraz and forskolin respectively. This study suggests this in vitro method represents a useful tool in assessing species-specific responses to disruptors of sex steroidogenesis.

Keywords: Endocrine Disruption, Forskolin, Prochloraz
Assessment of Endocrine Disruption through Development of Fluorescence Visualization of SWS1 Expression in Live Rainbow Trout

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The prevalence of endocrine disrupting chemicals in the environment is a concern and there is potential for adverse human and environmental effects. The possibility of disruption of thyroid hormone (TH) signaling in vertebrates is an issue, as many contaminants possess similar chemical structures to TH. TH is a key component of the vertebrate endocrine system and essential for normal growth, development and metabolic functions. However, the robust regulation of vertebrate TH levels, combined with few measurable biological endpoints, makes evaluation of perturbations to the thyroid system difficult to assess. A recently characterized TH-dependent process that may be an effective endpoint, is the natural degeneration of ultraviolet-sensitive (UVS) cone cells in the retina of rainbow trout.

The objective of the current study was to create a trout with visible UVS cones in vivo that could be used to assess the endocrine disrupting potential of environmental chemicals. To this end, a DNA construct encoding a green fluorescent protein (GFP) was injected into newly fertilized rainbow trout eggs. The DNA construct contained the promoter sequence for SWS1, an opsin gene specific to UVS cones. Initiation of SWS1 transcription in the embryo was expected to generate GFP from the incorporated construct, and the resulting fluorescing UVS cones would be visible with a fluorescent microscope. Injected embryos were screened for fluorescence at hatch and fin clips analyzed by PCR for presence of the construct. Successful incorporation of the transgene is expected to provide a means of detecting real time disruption of thyroid signaling pathways.

Keywords: fish, endocrine disruption, eye, development
All Mixed Up: Phenotypic Plasticity in a Genotypic World

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The processes of sexual differentiation and development are dependent upon a cascade of molecular signals and deviations from normal can have catastrophic effects on individual fertility and fitness. Previously, studies have shown that exposure of *Xenopus laevis* to sufficiently potent estrogens at critical times during development results in feminization and/or demasculinization, including male to female phenotypic sex reversal. However, given that genotyping of *X. laevis* has only recently become possible, studies performed in the past were rarely able to make concrete linkages between genetic and phenotypic sex. Therefore, to further characterize this relationship, *X. laevis* tadpoles were exposed to 0.09, 0.84, or 8.81 µg/L 17α-ethynylestradiol (EE2), the synthetic estrogen commonly used in oral contraceptives, from 12 h post-oviposition through 13 wks post-hatch. All EE2 treatments resulted in significant delays in time to metamorphosis. Genotyping showed that genetic sex ratios were similar among treatments. However, morphological evaluation revealed that phenotypic sex ratios were altered in all EE2 treatments. Interestingly, complete male to female phenotypic sex reversal was rare at the concentrations tested, and many individuals displayed intersex gonads, abnormal gonads, and induced vitellogenin expression, that were only diagnosed upon histological examination. The impacts of these conditions on fertility and fitness are not known but are likely to be adverse. In all likelihood, the relatively great number of intersex and abnormal animals is a result of estrogens functioning downstream of the initial molecular signals of sexual differentiation. Thus, genetically male animals receive mixed endogenous male and exogenous female signals that cause disordered sexual development. The induced vitellogenin expression was probably temporally independent from primary effects on sexual differentiation and likely drove the significant delays to metamorphosis that were observed in all EE2 treatments.

Keywords: amphibian, estrogen, sexual development
The Fate and Toxicity of the Wastewater Tracer Sucralose in Model Wetlands

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Sucralose, a trichlorinated sugar used as an artificial sweetener, is not metabolized by humans. Once excreted, it is believed to pass through most wastewater treatment processes unchanged due to its high stability and water solubility. Thus, sucralose has been suggested as a tracer of wastewater contamination in waters, that is superior to existing tracers (e.g., fecal coliforms, other chemicals, genetic analyses). In order for sucralose to be used as a tracer for wastewater contamination, its degradation in the environment must be understood. Sucralose is not photosensitive and is unlikely to sorb to natural particulate matter, therefore microbial biotransformation may be a significant removal process. Accordingly, model wetlands in 3000 L mesocosms at the Prairie Wetland Research Facility will be used to investigate the fate of sucralose. Varying amounts of phosphorous (control, low and high levels) will be added as a fertilizer to induce different amounts of biomass within the tanks. We hypothesize that more productive systems will see enhanced removal due to greater microbial biomass (as monitored via BIOLOG plates). Plant, sediment, and water samples will be taken over the 28 day study and analyzed for sucralose concentrations. Quantification will be performed using ultra high performance liquid chromatography-tandem mass spectrometry, using multiple reaction monitoring based on two major fragment masses. If the recalcitrance of sucralose in wetlands can be confirmed, it could be used as a potential chemical identifier in future environmental monitoring.

Keywords: Wetlands, wastewater, sucralose, bioremediation
Reconstructing the Past Nutrient Status of a Canadian Great Plains Reservoir Using Depositional Sediments and Paleolimnological Techniques

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Lake Diefenbaker, a reservoir created in 1967 in Saskatchewan, Canada, supplies drinking water to 45% of the province’s population. Recent anecdotal evidence suggests that the frequency of cyanobacterial blooms is increasing within this reservoir. Toxins released from these blooms are a potential threat to the health of humans, livestock, and aquatic animals. Cyanobacterial blooms are known to emerge due to increased nutrient availability (typically phosphorus) and thus there is a need to investigate nutrient loading trends within the reservoir. Because limited empirical data are available to determine environmental trends, a paleolimnological study is being conducted to reconstruct the historical nutrient status of Lake Diefenbaker using physicochemical variables and subfossil remains archived in the sediment. The general objective is to determine if the nutrient status of Lake Diefenbaker has changed over time and whether this change is of concern. Cores of sediments were collected from deep-water locations near potential point sources of nutrients, and at corresponding reference sites. Cores were vertically sectioned into 1-cm increments and each layer analyzed for total phosphorus and three sedimentary forms of phosphorus (apatite inorganic, non-apatite inorganic, and organic phosphorus) to determine trends in phosphorous loading over time. Total sediment metals were determined due to their influence on nutrient dynamics. Stable isotope ratios of carbon, nitrogen, and sulphur were quantified to identify historical sources of organic matter. In addition, subfossil remains of diatoms were isolated from each section and taxonomically identified (minimum of 300 valves per sample). Preliminary results suggest that the diatom community in Lake Diefenbaker has typically consisted of planktonic species. Phosphorus loading and diatom community compositions have remained relatively constant in proximity to the Swift Current Creek outflow, suggesting a stable nutrient status over time. However, increased phosphorus loading and shifts in diatom community composition were observed in proximity to a large commercial fish farm, suggesting a trend towards increasing nutrient status. Future work with the three forms of sedimentary phosphorus, total sediment metals and stable isotope ratios will help to better understand nutrient dynamics and to trace organic matter sources within Lake Diefenbaker.

Keywords: Nutrients, Reservoir, Sediment, Phosphorus, Diatoms, Paleolimnology
Comparison of Multimetric and Multivariate Bioassessment Tools in Assessing Saskatchewan Prairie Stream Health

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In evaluating the feasibility of applying aquatic health measures to Northern Great Plains rivers we must ensure we are choosing a model that 1) is as accurate as possible, 2) provides the most amount of information about the aquatic health possible, and 3) is not too complicated to be easily delivered. To study this we conducted a comparison of the most common aquatic health measurement tools employed in Western North America for their frequency of committing error, level of detail, and utility. Specifically, our bioassessment performance comparison compares the false-positive and false-negative rates for assessments made using the multimetric (MMI) and metric-based Test Site Analysis (TSA) approaches. We find that the false-positive and false-negative rates uncovered using TSA were consistently lower than those achieved using the MMI bioassessment approach. In addition, TSA was able to account for correlations among metrics, and quantify the certainty in assessments where MMI was able to do neither. The use of redundant or correlated metrics in traditional MMI can give inappropriate weight to the aggregate score and can result in a test site appearing more or less impaired than it actually is. For ease of delivery, both MMI and TSA require a certain degree of specialized knowledge; essentially, the amount of effort for analysis is comparable. Therefore, because of the relatively high degree of accuracy and biological information provided by TSA over MMI we recommend that TSA be adopted in the design and delivery of benthic macroinvertebrate-based aquatic health assessment in the Northern Great Plains.

Key Words: biomonitoring, multivariate, multimetric, benthic macroinvertebrates
The Effects of Chronic Cadmium Exposure on Reproduction in Fathead Minnows
(Pimephales promelas)

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Cadmium is a major source of pollution around the world. It is known to be toxic to aquatic animals including fish at fairly low concentrations. Numerous studies have been done to investigate the influence of cadmium exposure (acute or chronic) on fish, but few of them concern reproductive effects, especially its effects on reproductive behaviours. In the current study, spawning fathead minnows were exposed to cadmium for 21 days via water at four different concentrations (0, 1, 2.5 and 5 µg/L, respectively) based on short-term reproductive assay and multiple ecological, physiological as well as behavioural endpoints were evaluated during this experiment. We found that mean egg production significantly reduced when breeding fathead minnows were exposed to cadmium, and spawning frequency increased along with concomitant decrease in brood size was also detected in cadmium-exposed groups. On the other hand, delayed hatching was detected in cadmium-exposed eggs relative to control ones and hatching success significantly reduced in high cadmium concentration group. These findings also suggest that cadmium may stimulate hatching synchronously. Once there was one egg hatched in one clutch, the eggs in cadmium-exposed groups needed shorter time to complete whole-clutch hatching than control ones. The analysis of reproductive behaviours showed that even not significantly, cadmium affected breeding behaviours of fathead minnows.

Key words: cadmium, fathead minnow, reproduction.
Brook Stickleback Display Population-Specific Responses to Oil Sands Sediments

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The Athabasca River flows through the McMurray formation in Alberta and as a result, is exposed to a natural source of bitumen. Oil sands mining occurs in this area, and there is concern that these operations could adversely affect local fish populations. Brook stickleback (Culaea inconstans) are a common inhabitant of Athabasca River tributaries occurring throughout the McMurray formation. If active mining operations do contribute wastes from bitumen extraction downstream, the fish in this area may have adapted to changes in water quality that could confer an advantage to further toxic challenge. In an effort to understand potential population-level effects of bitumen constituents on local fish populations, stickleback were collected both upstream and downstream of active oil sands mining along the Athabasca River. Fish from both populations were maintained in clean de-chlorinated water for 6 weeks prior to initiation of the experiment. Oil sands area sediment was used to test the relative sensitivity of these two brook stickleback populations to increasing sediment concentrations for four weeks. Histological changes in gill morphology were used as means of comparing responses of the fish. Similar effects on gills were observed in both upstream and downstream populations with increasing sediment concentrations. Observed changes included alterations in chloride cell numbers, “clubbing” of secondary lamellae, and variation in secondary lamellar lengths and widths, indicating effects on gas exchange. The severity of the responses were more pronounced in the downstream population, suggesting that possible previous exposure to similar toxicants did not confer an advantage, and may make fish more susceptible to subsequent exposure.
Distribution and Impact of Neonicotinoid Insecticides on Agricultural Wetlands of Prairie Canada

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Wetlands in Canada’s Prairie Pothole Region (PPR) are under serious threat from agriculturally-influenced degradation. A newer class of insecticides – neonicotinoids – though designed for improved agricultural production, may degrade wetland water quality. Because of their persistence, toxicity and solubility in water, neonicotinoids have become a growing global concern for their toxicity toward non-target insects such as bees and aquatic invertebrates. Currently, little is known about the landscape level relationship between pesticide fate and transport and few studies, if any, predict risk of contamination at the landscape scale while being validated by field data collection. This multi-year study is currently being conducted at approximately 140 Saskatchewan wetlands to determine which landscape-level features directly and indirectly influence the fate and transport of neonicotinoid insecticides. Preliminary predictive maps were created in ArcGIS that outlined the study area based on reported neonicotinoid loading (PMRA sales and survey data) by crop type. Collection of water samples for analysis of neonicotinoid insecticides (clothianidin, thiamethoxam, imidacloprid and acetamiprid) along with quality parameters (pH, temperature, DO, depth, and conductivity) during April, July and September will be analyzed against rapid wetland assessments which examine the effects of ecological variables such as buffer width, vegetation community structure, influence of crop type, and landscape condition. Pesticide applications directly overlap with seasonal invertebrate production and the avian breeding season for a range of species which has important implications for future preservation of PPR wetlands. There is an immediate need to examine the distribution of neonicotinoid contamination across the Canadian Prairies and the potential impacts of these chemicals in agricultural wetland ecosystems. The results of this study will be used to effectively model the fate and distribution of these and other insecticides at the regional scale.

Keywords: neonicotinoid insecticides, agricultural wetlands, risk assessment, landscape ecology
Toxicity of Untreated and Ozone-treated Oil Sands Process-Affected Water to Early Life Stages of the Fathead Minnow (*Pimephales promelas*)

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The Alberta oil sands are the world’s second largest reserve of petroleum. There is growing concern regarding the environmental impacts of the increasing volumes of oil sands process-affected water (OSPW) being produced. OSPW is acutely and chronically toxic to fish and other aquatic organisms, but the mechanisms of toxicity are poorly understood. Early life stages of fathead minnows exposed to OSPW have a greater incidence of hemorrhaging, premature hatching, pericardial edema, and spinal malformations. The toxicity of OSPW is thought to be mostly attributable to water soluble organic compounds, in particular naphthenic acids (NAs). Ozonation of OSPW might be an effective method for remediation by reducing concentrations of dissolved organic compounds, including NAs. This study examined the effects of untreated and ozone-treated OSPW (O₃-OSPW) on embryos of fathead minnows. To elucidate the potential mechanism(s) of toxicity, the transcript abundance of genes involved in biotransformation of xenobiotics, response to oxidative stress, and regulation of apoptosis were quantified. Embryos exposed to OSPW had significantly greater transcript abundance of CYP3A, GST, SOD, Casp9 and ApoEn by 2.35±0.34, 2.15±0.26, 3.08±0.74, 3.26±0.57 and 2.38±0.25-fold, respectively, than those exposed to control waters. This indicates that exposure to OSPW might cause oxidative stress and apoptosis, leading to the development of malformations. None of the effects observed in the embryos exposed to OSPW were observed in those exposed to O₃-OSPW. The results suggest that the dissolved organic fraction of OSPW impairs development of embryos of fathead minnows through oxidative stress and apoptosis.

Keywords: naphthenic acids, apoptosis, oxidative stress
Do Oil Sands Sediments Affect Northern Pike Development?

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The Athabasca River in Alberta is home to more than twenty fish species, including Northern pike, a commercially important apex aquatic predator. The Athabasca River and its tributaries flow through the McMurray formation, and thus local fish populations are exposed to naturally eroding bitumen. Pike are not easily cultured in the laboratory and little information exists to assess exposure of early developmental stages to bitumen in river sediments. The current study describes a daily-renewal bioassay, designed to assess potential effects of sediments obtained from the Athabasca oil sands area on pike early developmental stages. Gametes were harvested from spawning wild pike collected from Lake Diefenbaker, SK, and fertilized in vitro. The objectives of the study were to develop a viable exposure method for pike, test the toxicity of two different sediments, and determine the sensitivity of developing pike to these sediments. Fertilized eggs were exposed to treatments containing increasing concentrations of one of two sediments collected from the oil sands area, for twenty-one days. Embryos were examined for changes in growth, survival, and developmental abnormalities. The assay design was determined to be an effective exposure system for pike embryos. Embryonic deformities and pathologies increased in frequency with increasing sediment concentration. Embryo growth rate decreased with increasing sediment concentration. The two sediment treatments exhibited differences in embryo survival and frequency/type of deformities. This study provides essential information on the effects of Athabasca oil sands area sediments on fish growth and survival, and provides a method for assessing toxicity to early developmental stages of other relevant species.

Keywords: Fish, bioassay, oil sands, sediment
Does Exposure to Oil Sands Sediments Alter Walleye Visual Pigment Gene Expression?

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Athabasca River fish populations are exposed to naturally eroding bitumen from the McMurray Formation. Bitumen may have adverse effects on early fish development, and in particular, may affect visual development of fish. Walleye are a commercially important species found in the Athabasca River, and a high level aquatic predator in the ecosystem. Walleye retina contains a visual pigment for vision in low light, RH1, found in rod cells, and 3 visual pigments found in cone cells for vision in bright light. These colour vision pigments are LWS (red; long wavelength-sensitive), RH2 (green; middle wavelength-sensitive), and SWS2 (blue; short wavelength-sensitive). The current study was undertaken to determine if walleye visual pigment gene expression is altered in response to oil sands sediment exposure. Walleye are extremely difficult to rear in the lab, and a daily-renewal bioassay was designed to expose developing walleye to Athabasca oil sands sediments, under optimal rearing conditions. Gametes were harvested from spawning wild walleye collected from Lake Diefenbaker, SK, and fertilized in vitro. Fertilized eggs were exposed for twenty-one days to treatments containing increasing concentrations of sediments collected from the oil sands area. Embryos were examined for mortality, abnormal development, and differences in eye histology and retinal gene expression of RH1, RH2, LWS and SWS2. Mortalities, embryonic deformities and pathologies increased in frequency with increasing sediment concentration. Preliminary results suggest that visual pigment gene expression is altered in response to increasing sediment concentration. These results can provide vital information on the effects of Athabasca oil sands area sediments on fish visual development.

Keywords: Fish, sediment, oil sands, vision
Assessing the Risk of Petroleum Contaminants in Migratory Shorebirds

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Evidence suggests that an increased number of oil spills are leading to widespread exposure of shorebird populations to petroleum derivatives across their migratory range. We hypothesize that sublethal exposure to oil contaminants, specifically Polycyclic Aromatic Hydrocarbons (PAH) may be contributing to the decline of shorebird populations. This study is focused on understanding the extent to which shorebirds are exposed to PAHs from petroleum sources across their range in North and South America and their sensitivity to a range of PAH concentrations. The preliminary risk assessment involves evaluation of levels of PAH compounds with 2–5 rings (including USEPA’s priority 16) in the environment (prey and sediment) from key stopover and wintering sites in Canada, United States, and Brazil to monitor the exposure and regional sources of contamination. The second phase of the study involves evaluating in vitro induction of ethoxyresorufin O-deethylase (EROD) activity in primary hepatocyte cell cultures of a target shorebird species, Sanderlings (Calidris canutus), to identify the toxic potency of PAH mixtures and sensitivity of this species to a wide range of doses. The risk characterization will be done by comparing levels in sediment and prey with reference LOAEL standard values and results from the in vitro study to determine if PAHs are a potential concern to shorebird populations. The results from this research will guide future actions with regard to the conservation and sustainability of migratory shorebird populations in North and South America.

Keywords: PAH, Calidris canutus, EROD, conservation
Exploring Water Resource Management In Partnership With The Community Of Water Users Of Lake Diefenbaker

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A community-based participatory research (CBPR) approach is being applied to explore the health, social, economic, cultural, and environmental dimensions of water resource management of Lake Diefenbaker. Lake Diefenbaker is a large, multi-operational and multi-use reservoir located in the central region of Saskatchewan. The study region incorporates three basins; the South Saskatchewan River, Swift Current creek and Upper Qu’Appelle River and was selected to reflect the spatial, temporal, historical and contemporary water resource management issues of the lake. Stages in the CBPR process: forming partnerships with communities; identifying local concerns through consultation; taking action to address identified concerns; and evaluating the effectiveness of actions to address the concerns; guide the research. The methodological research design incorporates multi-phases and mixed-methods procedures. In the first research phase, focus groups and interviews are utilized to gather qualitative data on issues meaningful and relevant to the community of water users. In second phase, stakeholder analysis is applied to identify the social, economic and cultural impacts associated with the management of the lake from the perspectives of the water user groups in the region. In subsequent phases, quantitative water quality data is reviewed to explore health and environmental risks associated with lake management options. Preliminary consultations with water users have revealed numerous concerns such as changing reservoir water levels; human waste lagoons; bank erosion and sedimentation; water quality and economic growth patterns in the region. Through identifying water user issues and understanding expectations of Lake Diefenbaker management from the perspective of all water users in the region, this research may significantly contribute towards future management practices. Additionally, through the application of CBPR, it is anticipated that a participatory model for water resource management will be developed.

Keywords: Community-based participatory research, Lake Diefenbaker, water resource management, water users
Effects of Triphenyltin Exposure During the Larval Period in Wood Frogs (*Rana sylvatica*)

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Triphenyltin (TPT) is a fungicide that is widely used in agriculture on crops such as pecans, potatoes and sugar beets. In areas of the United States, levels as high as 6 µg/L TPT have been measured in the water of rivers and lakes and significant biomagnification of TPT through the food web has been shown. Furthermore, several studies have documented acute toxicity in some amphibian species at concentrations as low as 1.25 µg/L TPT after 48 hours. However, to date no studies have been performed on the sensitivity of the wood frog (*Rana sylvatica*) to TPT despite the continued use of TPT within its range. Thus, the current study was designed to assess the sensitivity of wood frog tadpoles to Triphenyltin chloride (TPTCl) from 1 week post hatch through metamorphic climax. Wood frog tadpoles were exposed to 0.1, 1 and 5 µg/L TPTCl. Endpoints that were examined included mortality, time to metamorphosis and basic morphometrics of tadpoles and metamorphing froglets. Complete mortality of wood frog tadpoles was observed after 9 days when exposed to 5 µg/L TPTCl. During this same time period, mortality in control treatments was negligible. Furthermore, after seven days the weight and length of wood frog tadpoles treated with 5µg/L TPTCl was significantly less than that of the control. No significant differences were observed in the 0.1 and 1 µg/L TPTCl treatments for weight and length after the same time period.

**Keywords**: Triphenyltin, *Rana sylvatica*, fungicide, amphibian
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